Summary and Assessment of Accomplishments

Through Year Five

CEDAR RIVER WATERSHED
HABITAT CONSERVATION PLAN

Prepared by the City of Seattle for
The HCP Oversight Committee in support of its
FIVE-YEAR HCP COMPREHENSIVE REVIEW

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Contents

Appendices

List of Figures

List of Tables

Chapter 1. Introduction

1.1. Background on the Habitat Conservation Plan

The federal Endangered Species Act (ESA) prohibits the direct take of animal species listed as Endangered, and, in some cases, species that are listed as Threatened. The ESA does, however, provide a number of mechanisms for take that is incidental to otherwise lawful activities (i.e., incidental take). Section 9 of the ESA provides for the issuance of an Incidental Take Permit (ITP), contingent upon the approval of a Conservation Plan (commonly called a Habitat Conservation Plan [HCP]) by the U.S. Fish and Wildlife Service (USFWS) and/or the National Marine Fisheries Service of the National Oceanic and Atmospheric Administration (NOAA Fisheries), together known as the Federal Services. In 1994, when the City of Seattle (Seattle Public Utilities (SPU) and Seattle City Light (SCL), referred to here as "the City") was faced with the potential listing of several species of fish affected by its operations on the Cedar River, it began developing an HCP for its water supply, hydroelectric, and land management operations on the river and within the Cedar River Municipal Watershed. The Cedar River Watershed HCP was approved and ITPs were issued in April of 2000 by the Federal Services for 7 listed and 76 unlisted, but at-risk, species of fish and wildlife. Both aquatic and terrestrial species are included in the HCP and covered by the ITP; among the listed species are Chinook salmon, bull trout, northern spotted owl, and marbled murrelet. The HCP provides a comprehensive set of conservation measures for this group of 83 species that are designed to mitigate any take and produce a net benefit to each species.

In addition to addressing the ESA, the HCP also addresses issues from other agencies, both state and federal, and the Muckleshoot Indian Tribe. It includes conservation measures to mitigate, under state law, for blockage to fish at the Landsburg Diversion Dam; to improve fish survival at the Ballard Locks, operated by the U.S. Army Corps of Engineers (Corps); and to provide an instream flow regime for the

Cedar River. Of the agencies and tribes involved in developing the HCP, not all were signatories to the HCP agreements described below; however, all entities did participate in preparing the plan.

The HCP includes three legal agreements: (1) an Implementation Agreement (IA) between the City and the Federal Services; (2) an Instream Flow Agreement (IFA) between the City, the Federal Services, the Washington Department of Ecology, and the Washington Department of Fish and Wildlife (WDFW); and (3) a Landsburg Mitigation Agreement (LMA) between the City, the Federal Services, and the WDFW.

To support these three agreements, three standing committees were established: (1) an HCP Oversight Committee, which includes broad stakeholder involvement, to provide advice to the City regarding implementing the HCP as a whole; (2) the Instream Flow Commission (IFC), which includes signatories to the IFA, the Muckleshoot Tribe, the Corps, and King County, to provide a real-time, decision-making body to implement the instream flow regime and associated research and monitoring program described in the HCP and the IFA; and (3) the Anadromous Fish Committee (AFC), which includes signatories to the LMA and other key stakeholders, to make recommendations regarding implementation of the LMA. These committees have been functioning and meeting since shortly after the HCP was implemented in 2000. For clarification, it should be pointed out that HCP year 1 included the part of year 2000 after the ITP was issued (April to December) and all of year 2001.

1.2. Purpose of this Document

The IA, one of the three legal agreements included in the HCP, requires comprehensive reviews of the HCP by the HCP Oversight Committee after years 2, 5, 8, 11, and 15, and then at subsequent 5-year intervals for the remainder of the HCP. The requirement for a comprehensive review after HCP year 2 was met by the first two of five annual accomplishments reports, which documented HCP activities. As noted in section 13.2 of the IA, the purposes of a comprehensive review are "to evaluate overall progress on implementation, and to identify and address significant issues."

In 2005, the Cedar River Watershed HCP reached its 5-year mark, which has again created an opportunity for review and evaluation of what was accomplished during that time period. The purpose of this review document (referred to here as the "review") is to provide the HCP Oversight Committee with comprehensive information on implementation of the HCP through HCP year 5 (2005). The HCP Oversight Committee may use the information provided in this review to prepare its 5-year Comprehensive Review.

At the end of year 5, the City and its partners have accomplished significant on-the-ground work, including major capital construction projects and smaller habitat restoration projects. The HCP Oversight Committee agreed to complete the 5-year Comprehensive Review by the end of 2006.

This document provides a review of the conservation measures under the HCP aimed at habitat restoration and protection and protection of species of concern, as well as a review of associated research and monitoring programs. It includes a summary of accomplishments for HCP commitments over the first 5 years, an assessment of the effectiveness of the HCP after this period of implementation, and a discussion of the ecological and sociological aspects of implementing the HCP.

As described above, the HCP was developed as a comprehensive set of conservation measures designed to mitigate for the incidental take of, as well as to benefit, the 83 species of concern listed in the HCP. These species of concern include anadromous, resident and adfluvial salmonids, amphibians, and terrestrial birds, mammals, and invertebrates. At the time of issuance of the ITP, 7 of these species were listed as Threatened or Endangered under the ESA, and the remaining species of concern were identified by regional experts and agencies as being at risk. As development within the region has progressed since the year 2000, conditions have worsened for some of these species, and numerous agencies, municipalities, and groups are working to protect and restore habitat for many of them.

The City staff believes that the HCP has contributed and will continue to contribute significantly to regional habitat protection and restoration efforts. The HCP provides key ecological protections and connections in a landscape that is increasingly challenged by development and its associated effects. The comprehensive, ecosystem-based environmental protection and restoration measures included in the HCP provide a foundation for regional salmon conservation efforts that can contribute substantially to the restoration efforts.

1.3. Organization and Focus of the Review

A summary of the conservation measures that the City has accomplished is presented in this review. Details of these accomplishments are available in the HCP Annual Accomplishment Reports for HCP years 1 to 5, and are not repeated here. In addition to summarizing conservation measures, this document focuses largely on an overview and assessment of what has been accomplished, what that may mean in a regional context, and what challenges and issues the City faces in the years ahead. Because it is still early in implementation of the 50-year HCP, most of the information on accomplishments through year 5 relates to specific commitments within the HCP. Information with respect to the ecological effectiveness of these measures is limited this early in implementation of the 50-year HCP. Many of the ecological effects, including effects on HCP species of concern, are expected to take many more years to manifest to a measurable degree. What data do exist on effectiveness, however, are summarized in this report.

The HCP includes three primary components: instream flow management (flows), mitigation for the blockage to fish at the Landsburg Diversion Dam (fish), and management of the Cedar River Municipal Watershed (forests). To some extent, these three components and associated commitments to research and monitoring were developed individually to address issues specific to that domain of City operations. These three components, however, also were developed to perform as an integrated set of conservation measures that would benefit many species over a large geographic area by influencing the ecosystems on which they depend.

Because scientists' understanding of the ecosystems and species of concern is limited in many cases, practicing effective conservation of species and their habitats over time also involves a commitment to improve understanding (learning) and incorporate new knowledge into management decisions (managing adaptively). Because the world does not stand still, the City and its partners also need to be watchful and prepared for changes in the physical and social environments that may need to be addressed in order to successfully achieve the objectives of the HCP. Examples of such changes include the emerging recognition of systematic climate change and its implications; recognition of the ecological threat posed by non-native, invasive organisms; and challenges associated with protecting species that move through different jurisdictions in the face of substantial, ongoing land development. Faced with these challenges, the HCP establishes a framework for learning over time that will improve the effectiveness of the HCP program and allow the program to adapt to new knowledge and changing conditions.

The success of the HCP also depends on partnering with other institutions and groups, as well as continuing involvement of the stakeholders. Recognizing this need for partnerships, the HCP and its three implementing agreements established an implementation structure that includes standing committees and stakeholder involvement, as described above. The function of these partnerships and the value of collaboration with other agencies and groups have been of significant importance to the successful implementation of the HCP to date, and the City believes, to some of its partners as well.

The assessment component of this review includes both a summary of accomplishments and the effectiveness of conservation measures, as well as a discussion of the following three broad aspects of implementing the HCP:

- Ecological function and landscape connectivity (how the HCP is contributing to ecological function and landscape connectivity from a regional perspective)
- Intentional learning (the use of knowledge and information to improve performance over time)
- The value of collaboration.

Chapter 2 contains a summary of accomplishments, which are also listed in tabular form in Appendix 1. This summary provides an overview for the assessment presented in Chapter 3, which is based on what has been determined to this point regarding the effectiveness of HCP actions and the value of these actions in a regional context. Chapter 4 includes discussion of the issues and challenges that have emerged in the first 5 years of implementation that could influence the long-term success of the HCP in achieving its goals.

Chapter 2. Summary of Accomplishments through HCP Year 5

The following summary of accomplishments through year 5 of the HCP includes descriptions of conservation measures that were provided as specific commitments in the HCP as well as descriptions of other relevant activities that are contributing to achieving the goals and objectives of the HCP, but that are not specifically required by the HCP. This summary describes management of the HCP program as a whole and progress of activities within the three main components of the HCP: *Instream Flows* (management of flows in the Cedar River to protect and restore instream resources, *Landsburg Mitigation* (mitigation for the blockage to anadromous fish at the Landsburg Diversion Dam), and *Watershed Management* (protection and restoration of the Cedar River Municipal Watershed).

2.1. Summary of HCP Program Management through Year 5

The HCP consists of nearly 100 separate projects and activities that are being conducted by a team of City staff that is comprised of more than 40 professionals. These staff members have expertise in many disciplines, including ecosystems, fisheries, forest ecology, botany, hydrology, geomorphology, information technology, geographic information systems, business management, cultural resource management, communications, water supply engineering, road and bridge engineering, civil engineering, natural resources planning, and environmental and utility law. To most effectively implement the HCP, the City also has relied on consultants and partnerships with other organizations for many of the HCP activities.

While particular team members are responsible for meeting specific HCP commitments or sets of commitments, overall management of the HCP program is essential to keep the team and the program moving forward in a coordinated, and effective manner. HCP program management requires team coordination, communications, addressing legal issues, financial monitoring and management, reporting, business management, and ensuring that the City evaluates its activities to implement the HCP, learns from that evaluation, and improves its decisions over time.

2.1.1. Financial Management and Reporting

The HCP includes specific reporting requirements. Therefore, when the HCP legal agreements were signed in 2000, the management team began developing the internal systems needed to support HCP financial management and reporting requirements. The HCP set caps, or "commitments" for each project and activity that limit the City's financial obligation for each HCP project and activity to a set dollar amount. Tracking and reporting these HCP commitment costs separately from all costs incurred by the City has been a particular challenge. Because actual implementation costs typically exceed the commitment amount, it is necessary to track and report these expenditures separately. For example, through the end of 2005, $40.3 million total dollars had been spent on HCP implementation, of which only $33.7 million counted toward the cost commitments. Recent work on development of an HCP Information Management System (HIMS) is expected to facilitate performance tracking and streamline reporting in future years.

One important nuance of tracking HCP costs is the notion of "date ranges." For each activity and project, the HCP establishes a cost commitment amount that corresponds to a body of work that is to be accomplished during a specific time period, with variations on the schedule of activities within that time period. Some conservation measures are scheduled to be accomplished in specific HCP years and others within certain ranges of HCP years. Annual Bull Trout spawning surveys, for example, are to be conducted between HCP years 1 through 8 (2001 through 2008), and the associated cost commitment for surveys during that 8-year period is approximately $340,000 (in 2005 dollars). In contrast, 500 acres of ecological thinning are projected to occur within the period HCP years 1 to 8, with no annual commitment amount and a total cost commitment of about approximately $300,000 (in 2005 dollars).

Financial summaries through year 4 have reported only on annual HCP expenditures because capturing date-range expenditures proved too difficult. With the development of HIMS, however, the HCP year 5 Accomplishments Report does provide financial data in terms of the particular date range for each activity and project.

Pursuant to the manner in which commitments are described in the HCP, financial performance is assessed in terms of date ranges. For projects and activities with date ranges that end on or before HCP year 5, most cost commitments have been met. Exceptions are noted in Appendix 2. In many cases, the date range that includes HCP year 5 (the year through which this Comprehensive Review reports) extends past HCP year 5. Because the date range has not yet ended in these cases, a comparison of the percentage of commitment expended relative to the date range and the total HCP cost commitment relative to the date range is useful to assess how close the expenditures for a project or activities are to uniform progress in meeting the cost commitment set forth in the HCP. Here again, the table in Appendix 2 provides an explanation of where actual expenditures deviate significantly from HCP cost commitments.

2.1.2. Legal Aspects of Program Management

The three agreements that constitute the legal framework for the HCP set forth roles and responsibilities for the involved parties. A key role of the HCP program managers, for example, is to ensure that the City fulfills the provisions of these three legal agreements, including how and when work is performed, how to reach agreement on specific work-related issues, and how to make changes to the HCP.

Legal challenges have distinguished these startup years of HCP implementation. In 2003, the Muckleshoot Indian Tribe filed a lawsuit against NOAA Fisheries for its issuance of the Incidental Take Permit for the HCP. The lawsuit largely contended that NOAA Fisheries lacked sufficient information about the impacts of the City's existing or future increased water diversions on Chinook salmon to issue the permit. The City enjoined this lawsuit and its efforts from 2004 through 2005, which resulted in a negotiated agreement between the Muckleshoot Indian Tribe and the City. (Note: this agreement was approved in June 2006 by the City Attorney and City Council, and the Muckleshoot Tribal Council, and is subject to approval by the federal judge for the case.) Also during 2003, a citizen appeal of the Final Environmental Impact Statement (EIS) for the Cedar River Sockeye Hatchery occupied HCP staff through and beyond year 5. Section 4 of this report provides more detail and the current status of these legal challenges.

2.1.3. Standing Committees and Ad Hoc Stakeholder Involvement

As detailed in the summary below and in Appendix 1, the City and its partners have already accomplished a significant amount of work, including major capital construction projects and smaller-scale habitat restoration projects, as well as research and monitoring to provide both an assessment of baseline conditions and useful guidance for ongoing program management decisions. The importance of collaboration and partnerships to this effort is discussed in Section 3 of this document, but we can note here that collaboration has been essential and has added substantial value and quality to HCP implementation.

Stakeholder involvement in HCP implementation includes three standing committees and several *ad hoc* efforts. Establishing these three standing committees during the startup years of the HCP required a significant effort on the part of HCP team members that included recruiting and approving committee members and developing and adopting committee bylaws, as well as other important team-building efforts. Although some member turnover has occurred over the past 5 years, the majority of the original committee members continue to serve. The duties and work performed by the three standing committees is described below.

HCP Oversight Committee (OC)

The HCP OC was formed in year 2001 and has met a total of nine times from 2001 through 2005. A chartering session was held in October of 2001, during which bylaws were drafted and the format for future meetings was established. City staff presented updates of HCP implementation at most of these OC meetings, and OC members were given opportunities to see projects on the ground during field trips to the watershed. During meetings, briefings of work progress afforded OC members opportunities to provide valuable input as well as discuss issues of concern. HCP OC meetings have been characterized by strong attendance, a high level of interest and engagement, and poignant and constructive discussions. See Appendix 3 for a current OC roster.

Anadromous Fish Committee (AFC)

The AFC was formed in July of 2000, and a charter was established at that time to guide the committee in its advisory role to the Parties to the LMA. The committee is comprised of 10 members: one each from the four Parties (City, NOAA Fisheries, USFWS, and WDFW); one representing the Muckleshoot Indian Tribe; one representing the group of organizations the were signatory to the June 11, 1999, Notice of Appeal of the FEIS for the HCP; three other stakeholders selected by unanimous agreement of the Parties; and one representative from King County (non-voting member). The AFC has generally held 10 meetings per year and has provided recommendations on fish passage design, research priorities, funding allocation, hatchery design and operations. It has also, reviewed reports and study plans of significance to the Cedar River and Lake Washington basin. Perhaps as important as the recommendations made by the AFC, these meetings have provided a forum for discussion of the issues and challenges associated with salmon populations. Although there have been some changes in membership on the committee, members have in general, tended to stay on this committee for years. See Appendix 3 for a current AFC roster.

Instream Flow Commission (IFC)

The IFC first convened in July of 2000, shortly after formal approval of the HCP. Representatives from signatory parties to the Cedar River IFA and the Muckleshoot Indian Tribe participate as voting members of the IFC. King County and the Corps participate as non-voting members. See Appendix 3 for a current IFC roster.

Initial meetings of the IFC in 2000 were devoted to chartering the group by formalizing its mission and establishing bylaws. Since that time, the IFC has convened in regularly scheduled meetings on the first Wednesday of each month. The group has also convened, in full or in part, for additional meetings as required. Draft agendas and associated materials are distributed to participants approximately 1 week in advance of meetings. The meetings have been well attended with active participation by all members, and all meetings have been documented with formal meeting minutes.

The regular monthly meetings have been scheduled to last approximately ½ day and are typically characterized by full agendas and extensive discussions. Topics usually include the following:

- Assess current hydrologic conditions and review hydrologic forecasts
- Review the current status and relevant activities of biological resources in relation to instream flow management
- Monitor compliance with the HCP-guaranteed instream flow management regime

- Guide the allocation of guaranteed supplemental flows and, when available, the allocation of water over and above the guaranteed regime
- Plan, develop, and oversee implementation of the technical study program as provided in Section E of the IFA
- Assess the effectiveness of the instream flow management regime as relevant data becomes available.

Although the IFC bylaws provide for formal voting procedures for decision-making, they encourage decision-making by consensus. To date, consensus has been achieved on nearly all key decisions. The IFC has faced a broad array of decisions on topics ranging from including the annual allocation of supplemental stream flows, guiding instream flow management during formally declared drought conditions, peak flow management during the winter and spring, and a variety of decisions regarding the planning and implementation of complex biological investigations. The City is grateful to all the members of the IFC for their very constructive engagement and consistent commitment to effective management of Cedar River instream flows.

Ad Hoc Stakeholder Involvement

Additional stakeholder involvement has been solicited when appropriate. Two examples are described below. They include the involvement of outside scientists to develop an adaptive management program for the sockeye hatchery, and a workshop and related stakeholder involvement conducted for the ecological thinning program in the watershed.

2.1.4. Development of Adaptive Management

The HCP requires the application of adaptive management throughout the life of the 50-year plan. During 2005, a framework was developed for applying the principles of adaptive management to HCP conservation measures. Using a model developed by Steve Yaffee, School of Natural Resources and Environment at the University of Michigan, and, with support from the HCP Oversight Committee, a set of questions that will evaluate the effectiveness of the HCP has been developed, together with a process for answering these questions. This model, along with a "measures of success" model developed by The Nature Conservancy, is also being developed for watershed restoration at a more detailed level. Setting up this framework during the early years of the HCP will help assure that the City is ready to respond to new information when it becomes available, and that it will be able to apply this new knowledge to ongoing work throughout the term of the HCP and beyond.

2.1.5. Management of Information

The success of the HCP depends on effective management of information. Data deemed to be important must be collected, analyzed, and reported in a transparent manner that best supports decision-making. Several members of the HCP OC have pointed out that information management is the most often underestimated aspect of environmental management. In addition, the City is committed to openly sharing information about HCP implementation and making that information available to interested parties.

Although not required by the HCP, Annual Accomplishments Reports were produced for each of the first 5 years. These reports were not intended to evaluate overall program effectiveness, but rather each report was intended to provide a moderately detailed record of a single year's accomplishments. The HIMS was developed in year 5 to capture HCP data and make it accessible in a variety of reports for both internal staff use and external reporting. Because this new tool is satisfying information management and reporting requirements, City staff can now explore approaches to communication that focus on evaluation, effectiveness, and adaptive management.

In addition, the City is combining funds received from the Bonneville Power Administration (BPA) for construction of a new electric transmission line through the watershed (described below) with other available funds to develop information systems for managing scientific information (the Scientific Information Management System [SIMS]) and information related to the transportation system in the municipal watershed (TIMS). The first phase of SIMS, a catalog for science documents (the Science Information Catalog [SIC]), was completed in 2005. Work on TIMS and watershed aquatic, riparian, and upland forest database management commenced in 2005 and is scheduled to proceed into 2006 and 2007.

2.2. Summary of Accomplishments on Specific HCP Commitments through Year 5

Commitments in the HCP are described in two ways: the accomplishment of specific conservation measures and a commitment to spend a certain amount of money for each measure (cost commitments, as described above). A table listing accomplishments keyed to specific HCP commitments is included in Appendix 2. A summary of expenditures toward HCP cost commitments is provided in Appendix 2 and Section 2.1 above.

Following is a narrative summary of major accomplishments with respect to specific HCP commitments, including examples to illustrate the different kinds of activities. It is organized according to the three major components of the HCP (Watershed Management, Landsburg Mitigation, and Instream Flows). The summary addresses both conservation measures and associated monitoring and research.

The HCP commits to a variety of conservation measures intended to improve habitat for species of concern. While the City must choose where and/or how to conduct activities and implement projects associated with the HCP, it faces uncertainties and gaps in knowledge about the ecosystems it hopes to restore, the conditions of habitats across the watershed, the species of concern, and techniques of restoration that might be employed. To address these uncertainties and determine whether the City's actions are accomplishing stated objectives, the HCP includes a monitoring and research program. Project monitoring addresses compliance monitoring—did the City do what it intended to do; effectiveness monitoring—did the project produce the intended ecological results; and validation monitoring—were the City's assumptions and hypotheses correct. In addition, the HCP also commits to trend monitoring, which addresses changes in habitats or species over time.

Ongoing research is targeted at key questions about the impact of City operations on species of concern and uncertainties about key species and their ecosystems. Furthermore, other studies related to the HCP also have been initiated by the City to address emerging issues or to respond to stakeholder concerns. The purpose of these programs is to achieve informed decision-making and to facilitate adaptive management over time.

2.2.1. Watershed Management

HCP activities in the watershed during the first 5 years of the HCP were conducted along two parallel tracks: (1) planning and implementing projects on the ground in the near term to meet commitments regarding conservation measures, and (2) developing long-term, landscape-level plans to guide the performance of work as the program progresses. Commitments in the HCP related to watershed management include restoration projects, monitoring, and research. Interdisciplinary teams (in collaboration with other agencies and scientists, and using consultants) worked to develop long-term strategic plans for characterizing the watershed to support restoration planning; prioritizing areas for restoration; and monitoring projects, habitats, and species.

Restoration Projects

Restoration projects in the watershed were completed in the following categories: road and road crossing projects, stream and riparian projects, and upland forest projects (Figure 1).

Road and Road Crossing Projects

An extensive network of roads in the watershed was a major legacy of past timber management, and a total of approximately 620 miles of mapped roads existed when HCP implementation began. Many of the roads were constructed decades ago and do not meet modern construction standards for the protection of aquatic habitats. Because the HCP commits to managing watershed forests as an ecological reserve by prohibiting timber harvest for commercial purposes, much of the road system is no longer needed. Decommissioning unneeded roads and improving core roads needed for watershed management is a high priority in the HCP. A total of 236 miles (38%) of the road system was identified in the HCP for decommissioning over the first 20 years of the HCP. A major objective of the road decommissioning and improvement program is to reduce the likelihood of road failures during storms and to reduce road erosion and delivery of sediment to streams.

Decommissioning involves removing road fill that is unstable, providing for adequate natural drainage of water to prevent failure of the former road prism, and implementing measures to revegetate old road beds and control erosion. Road improvements include activities such as applying rock for stability, increasing

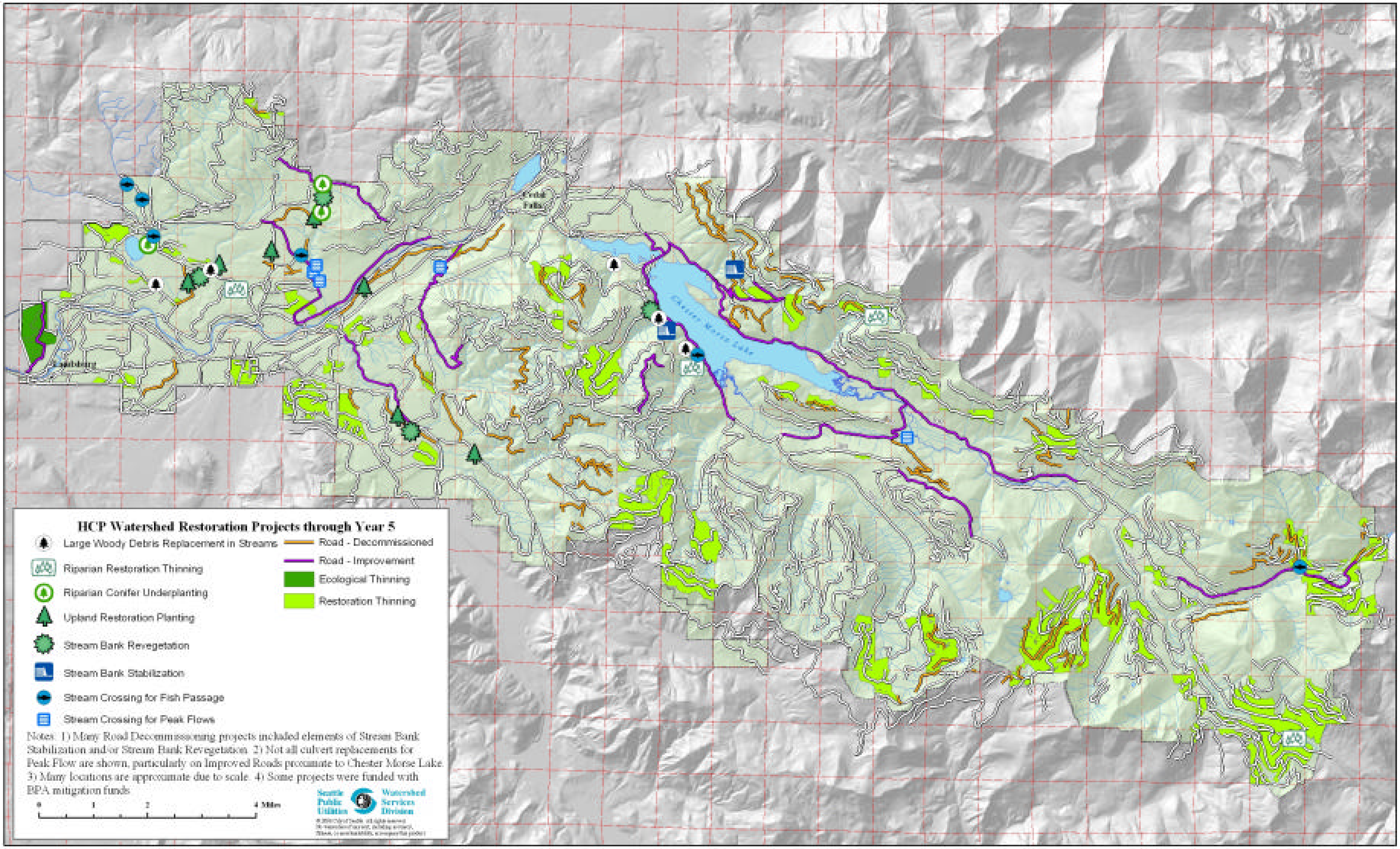


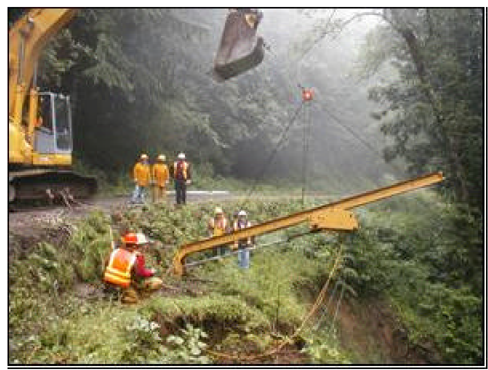
Figure 1. HCP Watershed Restoration Projects through Year 5

frequency of cross-drains, stabilizing fills, removing unstable sidecast material, dismantling perched landings, and, in some cases, realigning the road bed. Road projects to date have included the decommissioning of approximately 55 miles of roads and improvements on approximately 22.5 miles of roads (see Figure 1). In addition, extra efforts have been made to maintain an annual average of about 42 miles of roads that directly impact aquatic habitats and water quality.

Where roads cross streams, culverts installed years ago can either block the upstream passage of fish (if present) or be inadequate to pass peak stream flows, resulting in failure during severe storms and the delivery of sediment to streams. To date, a total of six stream crossings that blocked fish have been upgraded to effect fish passage, in some cases by installing steel bridges to replace culverts. In addition, 39 culverts that were sized too small or inadequately designed to pass peak flows have been upgraded to adequately pass peak flows.

Innovations in Road Projects:
Soil Nailing and Steel Bridges

Several innovative and cost-effective techniques have been developed for road improvements that reduce environmental impacts. *Soil nailing* (top photo) was found to be a less expensive method for stabilizing road fill than realignment of the road prism, with very little environmental disturbance during the project.



Staff also determined that replacing stream-crossing culverts with *prefabricated steel bridges* (bottom photo) was cost-effective and created far less disturbance during construction than would the installation of another, larger culvert. A bridge is also a more reliable way to provide fish passage than is a culvert.

Stream and Riparian Restoration Projects

Road decommissioning and improvement projects are linked with other HCP aquatic restoration projects (including streambank stabilization and streambank revegetation) whenever possible to increase the ecological benefit of removing or improving the road. A total of 4,907 feet of streambank has been revegetated to control erosion, and a total of 950 feet of streambank near road crossings has been stabilized, primarily using large rocks.

Besides being affected by poorly designed roads, streams, wetland, and other water bodies have been affected by past timber harvest practices. For most of the 20th century, clear-cutting often occurred to the edge of water bodies, and wood was often removed from streams after logging. Such practices had adverse impacts on streams and other aquatic habitats. Large pieces of wood (large woody debris, or LWD) are now known to be essential to naturally functioning aquatic habitats, as are healthy riparian forests. Aquatic restoration in the short term often involves placing LWD into streams and wetlands. In the long term, restoration involves the use of silvicultural techniques to accelerate development of naturally functioning riparian forests, which supply streams with natural levels of wood, shade, and food in the form of vegetative material and insects.

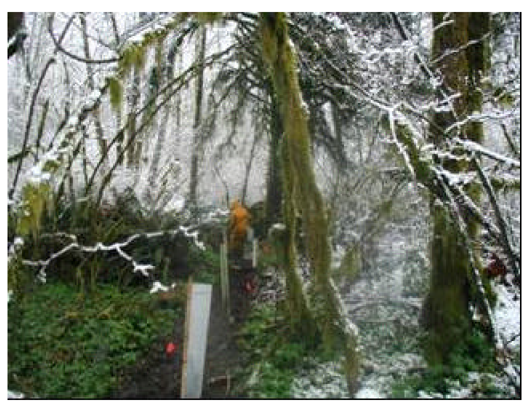
Four projects have been completed since HCP implementation began in which LWD has been added to streams, and one in which LWD was added to a wetland. Techniques for adding LWD have ranged from cutting trees on site and dropping them into streams to transporting logs and root wads to a stream from off site. A total of 120 acres of riparian forest was thinned to accelerate tree growth and the development forest structure, and conifers were under-planted in a total of about 21 acres of primarily hardwood forest that was originally dominated by large conifers (see Figure 1).

Experiments in Conifer Under-planting: What's needed?

The HCP commits to planting conifers in areas once dominated by conifers that have been converted to hardwoods through past land uses. Experience indicates that seedlings face strong competition from existing shrub communities and herbivory from elk and deer.

A total of 360 Sitka spruce (top photo) and western red cedar seedlings were planted in 2001 along Webster Creek in a replicated and controlled experiment to investigate seedling survival in a variety of conditions. Two site-preparation techniques (brushing, and brushing with rototilling) were compared to no treatment, and two types of protectors for seedlings (corrugated plastic tubes and plastic netting; bottom photo) were compared to no protection.

Subsequent monitoring indicates that site preparation is needed for conifer survival, but brushing alone was found to be as effective as brushing with rototilling. Possibly because ungulate populations have been relatively low in the watershed during the time since the experiment was installed, little browsing of the seedlings has occurred.



Upland Forest Restoration Projects

Old-growth forests in this region are known to support the greatest level of biodiversity of any stage of forest succession, in part because of the natural processes of tree death and decay over long periods of time that result in substantial heterogeneity of conditions in such forests—thus more habitat niches for organisms. Natural disturbances in this region, such as moderate forest fires, typically leave legacies, including large live trees, snags, and logs, as well as species of plants, fungi, and animals associated with those legacy features. Research has shown that the carryover of legacies into the regenerating forest produces relatively high structural and species diversity in young naturally generated stands. In contrast, traditional timber harvest by clear-cutting has been shown to result in comparatively uniform forest structure and relatively poor diversity. Uniformity can be increased when areas are planted to one species of conifer, such as Douglas-fir, which was the practice in the early 20th century.

Approximately 85% of the watershed's forested land was logged, and many areas now have low structural and biological diversity. Diversity is expected to be lowest in areas of currently dense conifer forest with little understory. The forest restoration component of the HCP focuses on using silviculture to accelerate development of structural and species diversity where most appropriate. In the youngest forest stands (less that 30 or 40 years old), *restoration thinning* is being used to reduce tree density and accelerate tree growth. About 16,000 acres of young forest was identified in the HCP, nearly all of which was characterized by very high tree density and intense competition. Most of this young forest was identified for potential thinning.

The watershed includes much larger areas of forest that are more than 30 to 40 years old, but the HCP takes a conservative approach to restoration in these older forests by committing to *ecological thinning* in only a small fraction of this area of older second growth. The objectives of ecological thinning include accelerating tree growth by reducing tree density (competition) as well as developing more variable tree spacing and density, as is characteristic of older forests. Restoration planting is often incorporated into ecological thinning projects. Selling logs from ecological thinning units is allowed under the HCP, if biological objectives can be met. As the City expected, the ecological thinning projects have generated some controversy and questions, in large part because of the sale of logs.

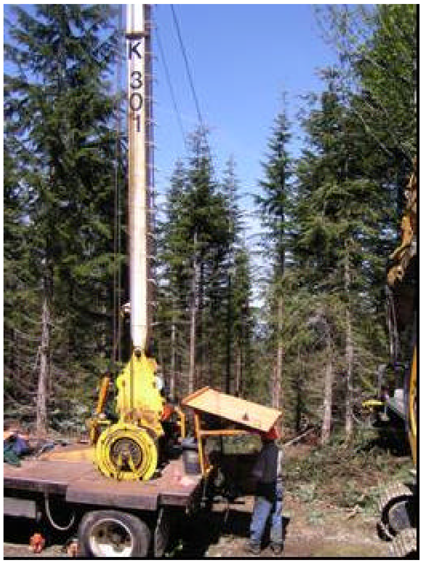
To date, a total of about 5,965 acres of young forest has been thinned by *restoration thinning*. Most of this forest is at higher elevations in the upper watershed, where timber harvest most recently occurred. The first ecological thinning project, and the only thinning project completed to date in an older forest), is the 45 Road Forest Restoration Project, implemented in 2003. The project included a combination of variable density thinning (to create uneven tree spacing) on about 157 acres and planting for increased diversity on 64 acres of thinned forest. The second ecological thinning project, the 700 Road Forest Restoration Project, was approved in early 2005 by the Seattle City Council after extensive public involvement and revision during 2004. About 350 acres are slated for variable density thinning in this project, with limits for maximum tree diameter, species, and area of stems to be cut. The project was put out to bid fall 2005, but no acceptable bids were received. After an investigation of issues, the City revised the plan and modified the contract. This project was sold summer of 2006, and implementation has started.

To investigate the possibilities of using forest gaps to increase tree diversity and to learn more about light levels needed for different tree species, an experiment was conducted in 2005 in which small forest gaps were created by cutting trees, then seedlings of various species were planted in and near the gaps.

Innovations to address new challenges: risk of fire and protection of habitat

The traditional practice of forest landowners when thinning young stands is to cut trees and leave them in place. This practice results in slash that can increase fire risk temporarily and can damage berry bushes and other plants. In response to comments from elders of the Muckleshoot Tribe, feedback from the forest certification assessment team, and concerns of City staff, the City expanded the objectives of restoration thinning in 2005 to include slash control to reduce fire risk and protect berry bushes and habitat for elk and deer.

City staff has been investigating a variety of ways to identify the best, most cost-effective approaches for particular conditions. For example, staff experimented with a Spyder (a low-impact, all-terrain vehicle; top photo) to treat slash, used volunteers (middle photo), and tried a small version of a skyline yarding system (bottom photo) to remove trees from the site. In addition, the City used contractors to cut up (lop) and pile slash to reduce fire risk without having to remove the trees form the site, a more costly approach



Monitoring and Research

Project Monitoring

Many of the watershed restoration actions described in Appendix 2 are expected to produce ecological effects that may take decades to verify. While the City has collected pre-project data for most restoration projects implemented to date, as well as some post-project data, insufficient time has passed for the collection of data adequate for judging the ecological effectiveness of these projects. As described in Section 3, however, post-project monitoring has been accomplished to the extent that an evaluation of project implementation could be compared to project objectives.

While the City is still considering how best to monitor the effectiveness of road decommissioning and improvement projects with regard to aquatic habitats and water quality, two newly developed tools can help estimate the environmental benefit of road decommissioning and improvement: a road inventory completed in 2004 and a linked sediment delivery model (WARSEM). The model has been used with the inventory data to identify roads for which decommissioning or improvement could provide the greatest benefits to aquatic systems. The City plans to use BPA mitigation funds to perform validation of the model.

Long-term habitat monitoring

The designs for the long-term monitoring programs for upland, riparian, and aquatic habitats are not yet final, but some core elements have been completed. Following a review of how other public landowners are monitoring changes in forests over time, and with assistance from consultants, the City installed a series of about 100 Permanent Sample Plots (PSPs) on a random, systematic grid across the watershed to monitor upland forest development over the long term, in conjunction with the use of remote-sensing data. A similar series of about 60 Permanent Sample Reaches (PSRs) has been installed in riparian habitats along rivers and streams to monitor riparian forest development over the long term, also in conjunction with the use of remote-sensing data. The upland PSPs will be useful in planning forest restoration, and the riparian PSRs will be useful for monitoring and planning both riparian and aquatic restoration. The PSPs and PSRs also will provide reference condition information for restoration efforts.

Working with the United States Geological Survey (USGS), the City has completed one study and initiated a second to determine the best use of benthic macroinvertebrates as an aquatic monitoring tool. An initial investigation into the utility of employing benthic macroinvertebrates with one or more Benthic Indices of Biotic Integrity (BIBIs) as a monitoring tool was conducted prior to implementation of the HCP. Results from this study were mixed, and the sensitivity of BIBIs to detect expected changes in water quality was questioned. As a result, a second USGS investigation was initiated in 2005 to reevaluate changes in macroinvertebrates using traditional methods (BIBIs) and to assess two other approaches that may allow detection of small, gradual trends in water quality. To evaluate stream function over time, the City of Seattle also installed three PSRs in streams. With assistance from consultants, the City developed a framework for long-term aquatic sampling with the intention of finalizing panel design (an approach for future sampling) and beginning implementation of the monitoring program in 2006.

The City also located and re-measured a set of 21 historic forest PSPs that were installed between the 1950s and 1970s. Data from these plots will be used with forest growth models to improve the City's ability to understand and predict forest changes, with and without intervention, and will complement monitoring of the new set of PSPs and PSRs. The City reviewed candidate models for projecting forest growth and development, and plans to select a model in 2006. With the help of a consultant, the City also reviewed candidate models for relating terrestrial species to habitats in a manner that can be used for planning restoration projects and monitoring their effectiveness. The City plans to select a model or models in 2006 that can be linked to the forest growth and development model.

Species Monitoring

A number of efforts have been made to determine the distribution of species or groups of species, and to monitor the status of certain species in the watershed. Some of these efforts comply with specific HCP commitments, but others were initiated by the City to provide more general information needed for prioritizing habitat restoration in accordance with objectives stated in the HCP.

Surveys for two of the threatened species of concern, the northern spotted owl and marbled murrelet, were conducted by consultants in 2005 for the first time since the HCP was approved. Owl surveys focused on six remaining tracts of old-growth forest, mostly at elevations greater than 2,500 feet in the eastern section of the watershed, including all areas of the historic sightings. Murrelet surveys involved the use of van-mounted radar to determine general patterns of movement into and out of the watershed and locate areas of activity.

Annual spawning surveys for the threatened bull trout have been conducted since before implementation of the HCP. Better information on movements and habitat in the reservoir and tributaries should be available soon as a result of studies initiated in 2005 with USGS. Tagging studies using acoustic sensors in the reservoir and Passive Integrated Transponder (PIT) tag sensors in selected tributaries were initiated in 2005 with USGS. These studies will also provide information on pygmy whitefish and rainbow trout in the reservoir system.

The City has monitored common loons nesting on the reservoir annually, and has continued a program of deploying floating nesting platforms initiated in 1990 that was designed to mitigate the effects of reservoir fluctuations. During reservoir refill in the spring, when loons are nesting, close coordination between wildlife biologists in the watershed and water managers allows decisions to be made that mitigate the effects of refill to some extent.

Other surveys have been conducted to provide a better understanding of the distribution and habitat associations of other HCP species of concern to support prioritization and planning of restoration projects. A survey of amphibians revealed that depressional wetlands are important for a variety of species, and that knowledge has been incorporated into a landscape approach to restoration. Surveys of bats, using sonic detecting equipment, have revealed habitat associations that also can be used in planning forest thinning projects. Surveys of spawning kokanee salmon have provided baseline information about the level of reproductive activity of this species in the Walsh Lake system. Using interns, volunteers, and staff, the City has conducted some surveys of arthropods and lichens, mosses, and other nonvascular plants. Using volunteers, SPU also conducted surveys of vascular plants, working with the University of Washington Herbarium to store voucher specimens. This collection can be used over the long term to evaluate species changes in the watershed. BPA mitigation funds will be used in 2006 to continue biodiversity surveys.

Research

SPU supported completion of a Master's thesis research project investigating forest development patterns in the Pacific silver fir zone. The results of this research, expected in 2006, will inform decisions about forest tree density and spatial patterns in the restoration thinning program.

Experiments were initiated in 2005 by a consultant to determine the impact of reservoir refill (inundation) on bull trout eggs and alevins. Artificial redds were installed, without eggs, in the gravel of inundation areas and control areas of tributaries to the Chester Morse Lake reservoir. Eggs will be added to these artificial redds in 2006, and other experiments will be initiated as well.

The City continues to evaluate the utility of LiDAR (Light Detection and Ranging) data that were acquired from King County for the purpose of characterizing forest structural development across the landscape to support prioritization of restoration projects. Evaluation of LiDAR will continue in 2006.

Strategic Planning

The fact that the City owns the Cedar River Watershed allows the opportunity for comprehensive, strategic planning related to the Watershed Management component of the HCP. Strategic planning was done for a number of elements of the HCP.

The road inventory, completed mostly in 2004, was used with a sediment model (WARSEM) in 2005 to calculate potential sediment delivery to water bodies from individual road segments and systems. The roads have been classified by road segment and segment clusters with respect to potential for sediment delivery, and the classification is being used to prioritize roads for decommissioning or improvement to produce the greatest environmental benefits.

With help from consultants, SPU completed a Strategic Asset Management Plan (SAMP) in 2005 for the Cedar River Watershed transportation system, which includes all roads, bridges, and related structures, such as culverts. The plan encompasses HCP commitments and non-HCP work, such as bridge upgrades for safety. The SAMP was accompanied by a decision model for determining potential core roads (roads needed for utility purposes) on the bases of the utility of the road, and both the environmental consequences and costs of keeping or removing the road. The list of potential core roads will be refined in 2006 and later to determine a core road system that will be used for planning road decommissioning and improvements in the future.

Interdisciplinary teams made considerable progress on strategic restoration plans for aquatic, riparian, and upland habitats. A team made progress developing a strategic approach to characterizing habitats for restoration and for monitoring and research. Another interdisciplinary team worked on synthesizing the strategic plans for different types of restoration into an overall landscape approach (synthesis) that takes advantage of potential synergies among different types of restoration (upland, riparian, and aquatic habitats, and watershed roads). The synthesis team held a workshop in the fall of 2005 with Dr. David Peterson with the University of Washington and the U.S. Forest Service, an expert in fire ecology, climate change, and forest management, to develop a conceptual approach, or template, for landscape-level, long-term planning. The synthesis provides a landscape level first-cut at choosing areas for potential restoration or intervention to ameliorate risks and to foster synergy among the different types of restoration. Using assessments of habitat conditions developed through the Watershed Characterization Plan, the three restoration plans provide the rationale for choosing specific sites within the landscape template.

The strategic plans will include a description of desired future conditions (DFCs) and indicators that will be used to track progress towards those DFCs. The City plans to complete the following strategic plans during 2006:

- Landscape Synthesis Plan
- Upland Forest Strategic Restoration Plan
- Riparian Strategic Restoration Plan
- Aquatic Strategic Restoration Plan
- Watershed Characterization Plan
- Strategic Monitoring and Research Plan.

Strategic planning will also be needed in 2006 and beyond to address a number of emerging issues that are discussed below, including controlling the ecological effects of non-native invasive plants and responding to the effects of observed and potential climate change.

Evaluation and Learning

In 2005, City initiated a process to obtain certification of its watershed restoration and management program under the Forest Stewardship Council (FSC) guidelines. The primary reasons for seeking certification included the value of having regular external audits of the City's restoration program and being able to sell surplus logs from thinning or blow down events as certified. The City worked with an assessment team from FSC affiliate SmartWood during 2005 to pursue certification of watershed management under the FSC program. Certification was formalized in summer of 2006.

The City's Watershed Ecosystems staff also conducted their first annual review in early 2006 to evaluate progress on HCP commitments, identify issues and problems, and develop strategies to address problems. The group intends to improve this process to have an effective annual review cycle that feeds into annual work planning.

Partnerships

Partnerships have been essential to much of the work for Watershed Management. Some of these partnerships include:

- University of Washington - Master's research project on development of Pacific silver fir forests and collaborative design of experiments to test thinning approaches in older forest (using BPA funds, with a principal investigator from the University of Washington)
- USGS - assistance with design and implementation of stream surveys for benthic invertebrates and use of indices for habitat characterization and monitoring, and studies of fish movement and habitat use in the reservoir and tributaries.

2.2.2. Landsburg Mitigation

The HCP includes a suite of activities that collectively address mitigation concerns associated with Landsburg Dam. These commitments, documented in the LMA, include two large capital projects, fish passage facilities, and fish hatchery facilities. Fish ladders were designed to allow upstream passage of all native species into 17 miles of previously blocked mainstem and tributary habitat. The fish passage facilities also allow capture and exclusion of sockeye salmon, as passage of this mass-spawning species would jeopardize drinking water quality and safety. To mitigate for the continued effects of the blockage on sockeye, a hatchery was included in the HCP by agreement with the state and tribal fisheries co-managers and federal HCP partners. Mitigation also includes research funding, operational funding, and funding for habitat acquisition in the lower river basin downstream of the City's current ownership boundaries. Much has been accomplished in the first 5 years of implementation of the LMA.

Fish Passage

Construction of fish passage improvements at the Landsburg Dam is key to the recovery concept of reconnecting habitat, providing access to additional habitat to Chinook, coho, and steelhead. The completion of fish passage facilities at Landsburg in 2003 resulted in reopening access to 17 miles of habitat for all species, except sockeye salmon, for the first time in a century. Beginning in 2002, all salmon and trout were able to access an additional half mile of river as the result of completion of rock drop structures that provided passage over the aqueduct. Seven steps were created in the river bottom that allow salmon and trout to pass upstream without noticeable delay over a wide range of flow conditions. Downstream passage improvements to safely pass fish downstream were completed in 2003. Project design was a collaborative effort, involving federal and state resource agency staff, SPU and their consultants, the AFC, and others. The design was reviewed by and benefited from input from the general contractor as well, utilizing an alternative contracting approach.

The operation of the fish passage facilities has focused on safe and timely passage of fish above the dam. During active sorting, which begins in early September, sockeye are separated from other species and used for hatchery broodstock or released downriver. Research interests have extended the active sorting period to allow collection of biological samples from coho for DNA evaluation. The passage facilities switch back to passive mode in January, allowing unrestricted passage of all upstream migrating fish after nearly all coho have passed upriver.

Incremental improvements to the fish passage facilities have been made each year to further enhance fish and worker safety. A significant result is that incidental losses of fish passing the facilities have been lowered to near zero. The cutting edge photography system for automatically recording species passing through the ladder required extensive work with the supplier to enable the system to function properly. The system is now reliable, and the staff is working to improve the quality of night photographs so species identification is enhanced.

The downstream fish passage improvements included the modification of the #2 spill gate in Landsburg Dam and installation of a large intake screen facility. Both are intended to provide safe passage to downstream migrants and appear to be working well.

Rock drop structure at pipeline crossing below Landsburg Diversion Dam

Fish ladder and sorting complex at Landsburg Diversion Dam

New intake screen at Landsburg designed to avoid harm to fish passing downstream.

Sockeye Mitigation

The sockeye run in the Cedar River has fluctuated in abundance, with peak numbers being seen in the 1970s and 1980s (Figure 2). Declining abundance during the 1980s resulted in support for an interim hatchery to supplement natural sockeye fry production. Hatchery releases began in 1992, and hatchery origin fish first contributed to adult returns in 1995. Since then, the spawning population has been composed of a mix of natural origin and hatchery origin sockeye, as are the broodstock that are used for ongoing hatchery production.

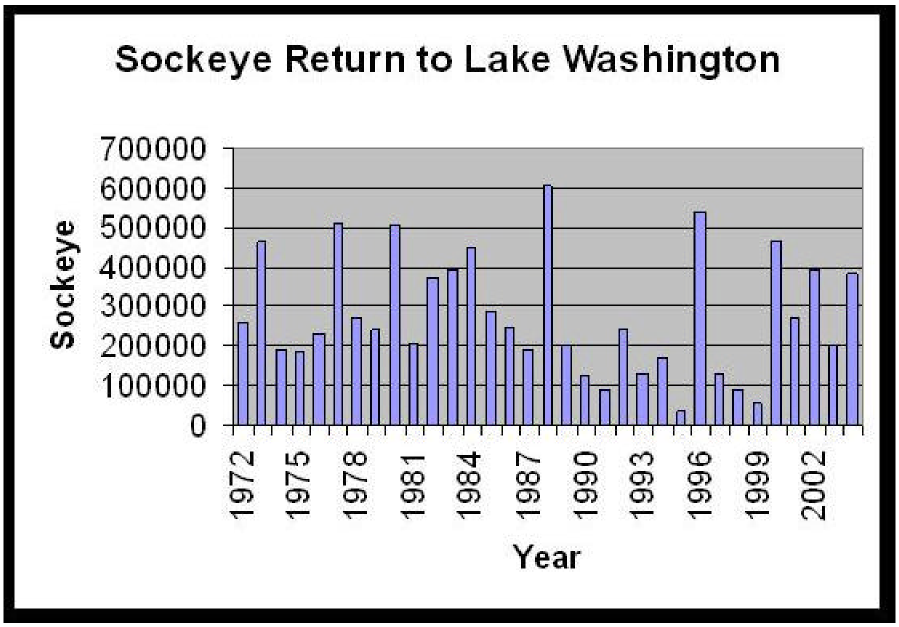


Figure 2. Sockeye Return to Lake Washington: 1972-2002 (WDFW and MIT data)

In 2000, the interim hatchery began operating under funding provided through the LMA. The WDFW operates the hatchery under contract with SPU, with oversight provided by the AFC and the Parties to the LMA. The LMA assumed that the replacement sockeye hatchery would begin operations in 2005, but lengthy appeals to the project-specific FEIS and Supplemental EIS (SEIS) have delayed construction. Under the LMA, the interim hatchery continues to operate while the challenges to the replacement hatchery are resolved.

Broodstock collection is a major challenge, both in terms of meeting the hatchery production and biological goals and to avoid unintended impacts to upstream migrating salmon (Chinook, coho, and sockeye). The HCP committed funding to broodstock collection solutions, and some of those funds were used to evaluate other options. Alternative locations were evaluated, as well, to better access representative broodstock. A report provided help in identifying several sites, including the site at I-405 that is currently being considered as the most likely location for a new broodstock collection facility. Further research identified a promising design for a new fish collection weir that provides improved ability to collect sockeye at higher flows and to withstand flows that result in damage to the existing weir. This weir design is known as a resistance-board or an Alaskan-style weir.

The agreements required the development of a series of documents to help reduce risk and enhance the prospects for success of the replacement hatchery. The HCP required development of hatchery guidelines to guide design, operations, monitoring, and research associated with the hatchery. These guidelines were developed by a panel of experts representing genetics, fish health, sockeye biology, Lake Washington ecology, and hatchery reform. The LMA also required the development of several programmatic documents for the replacement hatchery, including the operating protocols, the adaptive management plan, the design, and hatchery capacity analysis. These have been completed and approved. Collectively, these documents describe how the replacement hatchery will operate, as well as how monitoring and adaptive management activities will be conducted.

Sockeye Monitoring

Continued hatchery production of sockeye salmon under the LMA and HCP is accompanied by monitoring commitments as well as requirements to carefully consider how to reduce risks of unintended adverse effects on naturally reproducing populations. A suite of required monitoring activities has been implemented that provide information on juvenile and adult sockeye. This information, along with other monitoring data, provides a basis for evaluating trends, making comparisons between hatchery and natural origin sockeye, and evaluating interactions with other species (Figure 3).

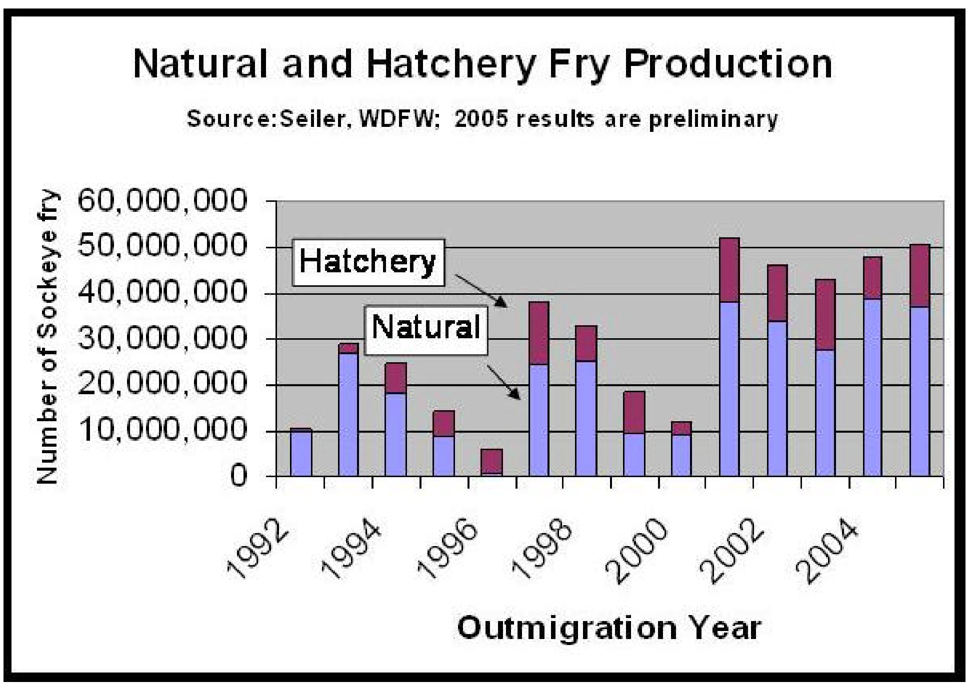


Figure 3. Cedar River Natural and Hatchery Origin Fry Production 1992–2005 (WDFW data)

While most of the monitoring activity is prescribed as HCP commitments, there have been some opportunities and needs that have resulted in changes to the original monitoring program. An example is the use of funds originally programmed to support year-round zooplankton surveys in years 1 to 4 to instead support juvenile sockeye surveys in Lake Washington. This change was made because ongoing grant funding was already supporting zooplankton data collection and additional funding was not needed to obtain the information. Instead, the AFC and Parties to the LMA supported using these funds to conduct juvenile surveys in Lake Washington.

Another change involved the genetic funding provided through the HCP for adult research in Lake Washington. Here, there was consensus that existing genetic work on sockeye was sufficient and that a higher priority was to learn about timing and distribution of sockeye adults in Lake Washington—information that would be useful to the co-managers in planning fisheries.

Part of the monitoring program involves marking all hatchery origin fry. This allows evaluation of the natural and hatchery origin groups at various life history stages. When samples have been taken from adult sockeye caught in a fishery, the hatchery contribution has ranged from about 20% to 25% of the total. Marking has been used to enable analysis of the performance of different groups by time and location of release as well as to identify those fry that were held and fed for a short time before release.

Enumeration at various life history stages is important for understanding the factors that affect survival and the variability associated with returns. The sockeye monitoring program includes funding for the Cedar River fry trap that is used to estimate the production of natural origin juvenile sockeye and Chinook from the Cedar River. Juvenile fish abundance in Lake Washington has been assessed in the fall and spring using trawling and hydroacoustic equipment, providing estimates of sockeye and smelt, the major planktivore of the lake. Adult returns are estimated by the Muckleshoot Tribal staff at the locks and through river surveys that include the WDFW, the Muckleshoot Tribe, SPU, and King County staff.

Because sockeye are dependent on Lake Washington during the 1+ year that they are rearing in the lake, it is important to understand the capacity of the lake to support sufficient growth. The sockeye monitoring program provides funding for zooplankton surveys to assess food supply, and data collected from juvenile surveys are used to evaluate sockeye growth.

The monitoring program allows assessment of potential genetic risks to naturally spawning sockeye populations, including straying and reproductive fitness. Sampling of adult sockeye occurred in Bear Creek from 1999 to 2001. Estimates of fry production and spawning adults can be used to track the number of young produced per adult each year. While this metric is affected by a number of factors, it provides a basis for evaluating whether change is occurring and insight into why.

2.2.3. Instream Flows

The Cedar River instream flow management program is characterized by four prominent features: 1) a guaranteed stream flow regime and facility improvements designed to ensure the protection of instream resources at all times of the year; 2) the City's commitment to limit annual diversions from the Cedar River; 3) adaptive allocation of stream flows above the guaranteed levels when additional water is available; and 4) research and monitoring to ensure compliance and to encourage continued learning and improvement of instream flow management practices. All of the features are implemented in collaboration with the Cedar River IFC.

Guaranteed Flow Regime

The ***guaranteed*** flow regime provides for both ***minimum*** and ***supplemental*** daily stream flows. Minimum stream flows must be met or exceeded at all times of the year. Supplemental flows are provided in addition to the minimums at certain times of the year when hydrologic conditions are favorable. Supplemental flows are provided in accordance with biological need and with an expected set of occurrence frequencies.

The minimum daily flow regime follows the pattern of the generalized natural hydrograph and has been established to meet the year-round needs of instream resources. The minimum flows are not static, but rather vary over the course of the year in a manner designed to meet the needs of key species and life stages during each week of the year. Supplemental flows can provide additional benefits to instream resources, but cannot be guaranteed with the same certainty provided for minimum flows. Because hydrologic conditions can vary rather dramatically within and across years, it is often appropriate and beneficial to provide enhanced flows above and beyond the normal minimum levels. The Cedar River instream flow management regime also includes the provision for dropping below the guaranteed normal minimums to ***critical flow levels*** during periods of extreme drought. The critical levels help maintain basic stream functions during extreme conditions, but do not entirely prevent hardship for aquatic resources.

Throughout HCP years 1 through 5, stream flows in the Cedar River have remained at or above guaranteed normal minimums at all times. Stream flows have not dropped to critical flow levels at any time during the period, even though the region experienced two very unusual winter droughts in 2001 and 2005.

The instream flow regime provides for supplemental flows during four separate periods of the year:

1. Spring supplemental flows, designed primarily to enhance conditions for emigrating juvenile salmonids
2. Summer supplements, targeted primarily for increased protection of incubating steelhead
3. Early fall supplement, to enhance conditions for early arriving Chinook and sockeye spawners
4. Late fall flow supplement, to benefit Chinook and sockeye that spawn later in the season.

The target frequencies with which these supplemental flows were expected to be provided were met for three of the four annual supplements. Targets frequencies for the spring supplemental flows were not fully achieved. Figure 4 shows instream flow compliance for calendar year 2005, and Table 1 summarizes performance with respect to the four specific supplemental flow periods. Table 2 summarizes the late fall 2005 supplemental flow period.

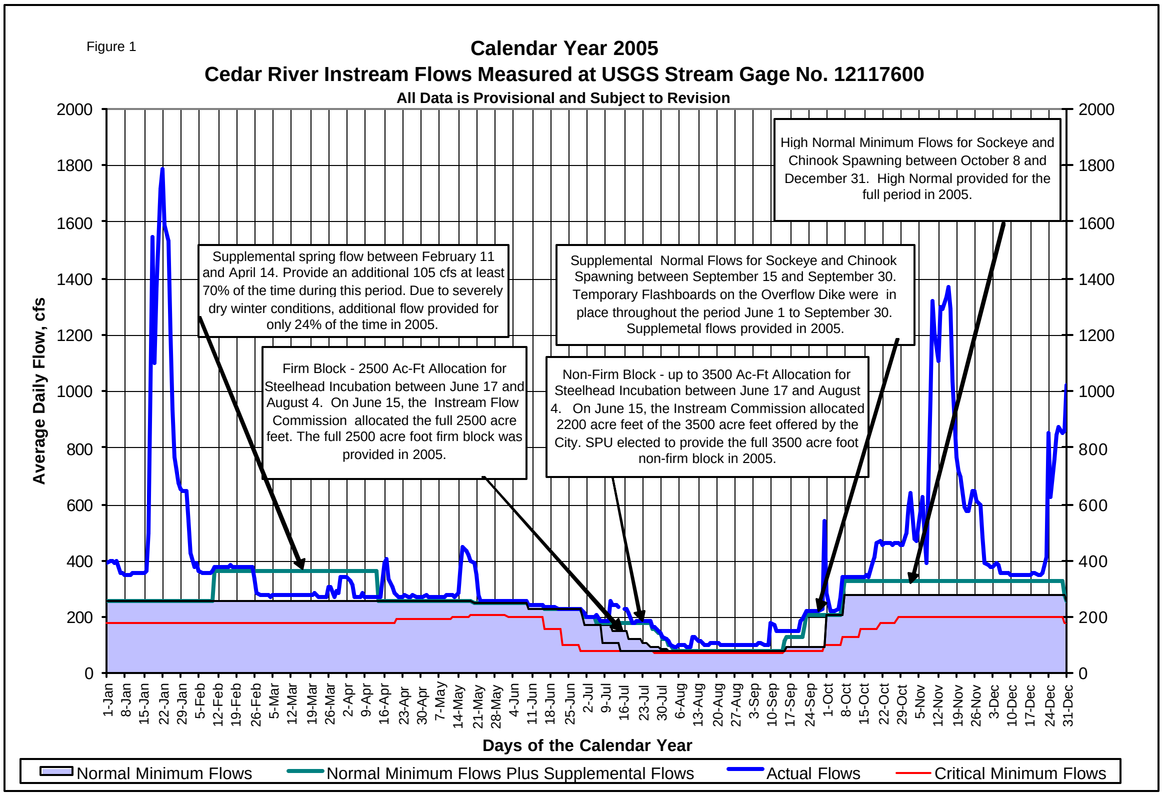


Figure 4. Year 2005 Instream Flow Compliance

Supplemental Category	Target Frequency	Actual Frequency
Spring supplement	70% of days in all normal years	100% of days in two years, 91% of days in one year, 13% of days in 2001, and 24% of days in 2005
Summer supplement	Provide in 63% of all years	Provided in 80% of years
Early fall supplement	Provide in all years in which flashboards are in place in the Morse Lake overflow dam	Flashboards in place in all years, and supplement provided in all years
Late fall supplement	Provided in 60% to 80% of years, depending on the week	Fall supplement target frequency met or exceeded; see detail in Table 2

Table 1. Supplemental Flow Summary for HCP Years 1-5

Week Period	Expected Supplement Frequency (%)	Actual Supplement Frequency (%)
Oct. 8 – Oct. 14	60	83
Oct. 15 – Oct.21	60	100
Oct. 22 – Oct. 28	60	83
Oct. 29 – Nov.4	50	83
Nov. 5 – Nov. 11	55	83
Nov. 12 – Nov. 18	65	83
Nov. 19 – Nov. 25	65	83
Nov. 26 – Dec. 2	70	83
Dec. 3 – Dec. 9	75	83
Dec. 10 – Dec. 16	75	83
Dec. 17 – Dec. 23	80	83
Dec. 24 – Dec. 30	80	83

Table 2. Late Fall High Normal Flow Frequency Summary: 2000 - 2005

In the spring of both 2001 and 2005, the Governor of Washington declared a statewide drought emergency. In both years, the central Puget Sound region faced unusual winter conditions with periods of extended dryness and/or record low snowpack. SPU worked closely with the Cedar River IFC in developing and implementing strategies to successfully manage the effects of both of these relatively extreme events on the Cedar River.

Because of the timing of the events, one of the first response actions taken was to curtail spring supplemental stream flows. This action was taken in consultation with, and with the concurrence of, the IFC. SPU provided the IFC with clear and detailed rationale for the action during regular briefings and in subsequent written reports as prescribed by Section B.3.b. of the IFA. The suspension of supplemental flows was coordinated with formal implementation of Seattle's Water Shortage Contingency Plan, which included increased public messaging and other measures to encourage municipal water users to conserve water. Messaging was designed to specifically link the need for water conservation with the need to minimize impacts of the drought on instream resources. In both years, the drought response efforts were successful in limiting municipal demand and positioning the water system favorably to provide supplemental stream flows and meet municipal water demands later in the same year.

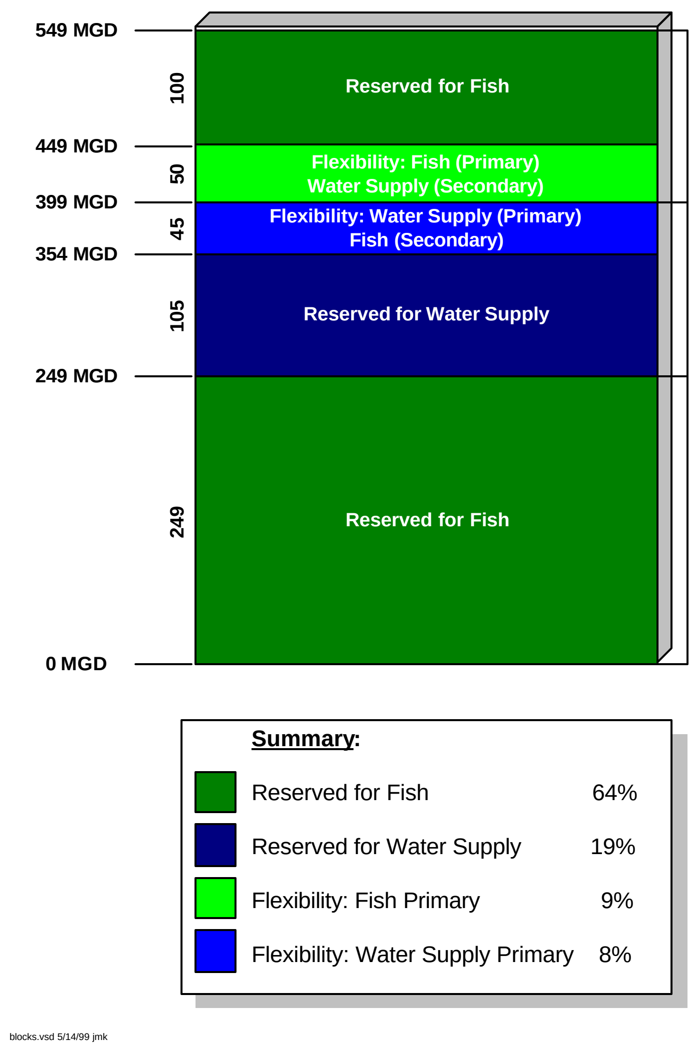
Limiting Diversions

Figure 5 describes the allocation of river flows for diversions and instream purposes. Seattle typically diverts approximately 20% of the annual average flow of the Cedar River for its municipal water supply. During the last half of the 20th Century, average annual diversions ranged from 84 to 144 million gallons per day (MGD), with an overall average of approximately 118 MGD. Due largely to increased water conservation efforts by the City's customers, diversions from the Cedar River have recently declined. By the late 1990s, diversions ranged from approximately 98 to 105 MGD. In addition to providing the guaranteed instream flow regime, the City agreed to relinquish 100 MGD of its original 300 MGD water claim to the river. The City has further committed to make every effort to manage the Cedar River system in a manner that maintains annual average diversion rates at or below 105 MGD through the year 2010.

Distribution and Hierarchy of Cedar River Flows

Figure 5. Distribution and Hierarchy of Cedar River Flows

Average annual flows in MGD



Record of Average Annual Diversions through 2005

Average annual diversions have been maintained below the maximum diversion target in all years from HCP years 1 through 5 (Table 3). Average annual diversions for the period 2000-2005 are summarized below. (Note that HCP year 1 includes both 2000 and 2001.)

Year	Average annual diversions from the Cedar River (MGD)
2000	93
2001	90
2002	79
2003	82
2004	86
2005	79

Table 3. Mean Annual Diversion Summary: 2000-2005

Managing Water in Excess of the Guaranteed Instream Flows

With the HCP limitations on the City's water claim and constraints on average annual diversions, water in excess of the guaranteed instream flow regime is available for significant portions of most years. The configuration of facilities on the Cedar River allows water managers to exert significant, but not complete, control on instream flows downstream of the City's water management facilities. The water storage reservoir (Chester Morse Reservoir) on the Cedar River is relatively small and captures inflow from only the upper 43% of the basin. Therefore, the effect of water management activities on the natural hydrologic patterns is somewhat constrained.

As demonstrated by the actual hydrographs from HCP years 1 through 5, stream flows in the Cedar River can remain well above the guaranteed levels for significant periods of time during the year. These excursions above the guaranteed levels may be classified into two broad categories of events: 1) those in which basin inflows exceed the capacity of water management facilities and operations to exert greater effect on downstream stream flows (e.g., peak flow events during major storms); and 2) those in which significant water management capacity remains available to shape the allocation of water to areas downstream of City facilities.

Events of the first type are often associated with large storms during the late fall and winter that can result in substantial peak flows or flooding throughout the basin. While storage capacity can and is typically used to reduce the magnitude of these events, resulting stream flows can be many times greater than the guaranteed flow regime. Working with the IFC, City water managers have attempted to reduce the magnitude of peak flow events during the fall and winter in an attempt to limit the sometimes severe effects of bed scour on the survival of incubating salmon. During the first 5 HCP years, these efforts have significantly reduced the magnitude of all potential major scour events. However, flood management capacity has not been sufficient to hold peak stream flows below the salmon redd scour target threshold of approximately 2,000 cubic feet per second (cfs) at all times.

Events of the second type tend to be much more varied and can occur at any time of the year. For portions of each year from 2000 through 2005, the IFC worked with City water managers to shape the allocation of water in excess of the guaranteed levels to benefit instream resources during periods of relative hydrologic abundance. Some examples are listed below:

- Year 2000: Summer base flows augmented to provide general enhancement to instream resources during the typical low flow period of the year.
- Year 2001: Early increase in fall flow regime to further enhance holding and spawning conditions for first arriving salmon.
- Year 2002: Release of excess reservoir storage during the spring in a series of naturally shaped freshets to emulate natural conditions during a wet spring and encourage steelhead to spawn in areas safe from subsequent dewatering.
- Year 2004: Increased winter and spring base flows to enhance redd dewatering protection for incubating Chinook and sockeye spawned during a period of unusually high sustained flows in the fall.
- Year 2005: Early initiation of the fall flow regime for general enhancement of instream conditions during the typical low flow period of the year.

Stream Flow Downramping

Stream flow downramping refers to the rate at which stream flows are reduced by water management activities. Such prescriptions are most commonly associated with hydroelectric facilities that operate in a "peaking" mode. Peaking operations frequently alter the rate of flow through electrical generating equipment to meet varying diel electrical consumption demands. This mode of operation can frequently result in substantial changes in stream flows during the course of a day. Downramping prescriptions are designed to moderate the rate at which peaking operations or other activities reduce stream flows to reduce the risk of stranding various species of stream dwelling fish.

Although the Cedar River facilities are not operated in a peaking mode, and reductions in flow are much less frequent than under typical peaking operations, facility operations do result in stream flow changes. Therefore, the HCP includes relatively restrictive downramping prescriptions to help protect instream resources. While facility operations have generally complied with downramping prescriptions, several inadvertent, relatively minor downramping exceedance events have occurred in each HCP year. The magnitude and duration of these events have generally been small, and they are not believed to have resulted in major impacts to instream resources. Nevertheless, the City and the IFC carefully monitor these events, their causes, and the implementation of corrective measures to help prevent recurrence. The great majority of the events have been associated with the operation of new fish passage facilities at the Landsburg

Dam and the operation of new fish and flow protection facilities at the Seattle City Light (SCL) Cedar Falls Hydroelectric facilities. By continually improving the new facilities and their associated operating protocols, operators are striving to reduce the incidence of downramping exceedance events.

Provisions for Facilities Upstream of Landsburg

In these first 5 years of the HCP, the Cedar Falls Powerhouse and Masonry Dam underwent substantial physical and operational changes to provide benefits to downstream aquatic resources while limiting detrimental effects. The physical changes included the installation of an emergency bypass system and a tailrace barrier at the Cedar Falls Powerhouse, and a new low flow valve at the Masonry Dam.

Physical Changes

Emergency Bypass System

In its original configuration, the Cedar Falls Hydroelectric Project was not equipped with facilities to prevent an interruption in water delivery to the river during emergency shutdown of electrical generating equipment. To remedy this situation, in early 1999 the City installed equipment to provide bypass flows around its hydroelectric turbines during most emergency plant shutdowns. This original bypass system's flow capacity was limited to approximately 70% of the original flow passing through the generator prior to the load rejection. The city expanded the emergency bypass system's scope beyond what was committed in the HCP to improve the flow capacity through the bypass system to further reduce the risk of stranding juvenile salmonids and dewatering salmonid redds. This work was completed in 2002 and has resulted in a more reliable system that has provided matching flow continuation to the river during most emergency shutdowns. There have been a few circumstances where the bypass system has not performed as anticipated. Each time, the problem was identified, and additional modifications and refinements were made. As a result of the expanded scope to provide better fish protection during emergency plant shutdowns, the cost also expanded from the original cost commitment of $350,000 documented in the HCP to a total cost of $2,716,565.

Tailrace Barrier

With the original configuration of the tailrace at the Cedar Falls Hydroelectric Project, upstream migrating adult fish were at risk of entering the turbine effluent pipes where they were subject to injury or mortality. The City committed to installing a tailrace barrier prior to the construction of fish passage facilities and subsequent upstream passage of anadromous fish past the Landsburg diversion dam. These barrier facilities prevent potential injury to fish that may move into this area after migrating past the Landsburg Dam. The tailrace barrier was installed at the Cedar Falls Powerhouse in 2002, meeting the fish passage facilities accelerated schedule of providing anadromous fish passage above the Landsburg Dam in 2003. Currently, no anadromous fish have been documented in the reach of the river where the Cedar Falls Powerhouse is located. As a result, the barrier has not yet been truly tested.

Low-level Valve Installation in Masonry Dam

Approximately 0.5 mile of potential anadromous fish habitat is present in the "Canyon Reach" of the Cedar River between the tailrace of the Cedar Falls Hydroelectric Project at RM 33.7 and natural migration barrier formed by Lower Cedar Falls at RM 34.2. The City has committed to providing a minimum of 30 cfs in the "Canyon Reach," to commence with fish passage above the Landsburg Dam. Modification to the dam was required, which included the installation of a new valve and new automated control system to provide the continuous minimum river flow of 30 cfs and to improve the control system for downramping. The new guaranteed flow of 30 cfs began in September, 2003, and has been successfully implemented ever since.

Operational Changes

As part of the HCP, the City proposed new interim downramping guidelines to the HCP IFC in December 2002. The proposal defined downramping rates, criteria, and procedures for operating the equipment at both the Masonry Dam and the Cedar Falls Powerhouse pursuant to the HCP IFA. The reason the City proposed the downramping prescriptions as interim guidelines was to allow for a 2-year grace period to provide time to test, monitor, and refine operations. In January of 2003, the IFC adopted the interim downramping guidelines. In 2005, the guidelines for both the Masonry Dam and Cedar Falls Powerhouse were finalized. Overall, the implementation of these new guidelines has been successful, particularly at Masonry Dam where the remote controls and automated downramping system have made consistent operations much more achievable. Since the downramping guidelines have been in place, there have been a few short-lived downramping exceedances. Operators continue to refine facilities and operating protocols to further minimize the risk of downramping rate exceedances.

Research and Monitoring

Developers of the Cedar River Instream Flow Management Program clearly recognized the need to monitor program compliance and effectiveness. As with many other areas of the HCP, they also recognized the need to address biological uncertainty with continued learning and to establish a framework for applying new information to management practices. Toward that end, the HCP enlists the resources of the City and the IFC in the development and implementation of an instream flow monitoring and research program.

Supplemental Biological Studies

Several key areas of biological uncertainty with respect to instream flow management are described in the HCP and associated IFA. To address these uncertainties, the IFC developed an instream flow study program that includes a variety of study topics, including the effects of stream flow and the Cedar River sockeye broodstock collection facility on the spawning distribution of adult Chinook salmon; the effects of stream flow on the behavior and performance of juvenile Chinook and sockeye; the effects of peak flow magnitude and duration on the survival of incubating salmon; and an assessment of the potential significance of differences between regulated flows and expected unregulated flows on ecological structure and function in the Cedar River.

While existing information on most of these topics was used in the development of the HCP instream flow management regime, the IFA identifies nine general study topics area for additional exploration. The IFC partitioned these study areas into 18 study questions. By the end of 2001, the IFC had prioritized the study questions and developed preliminary scopes for each one. The IFC identified four questions as high priority, eight as medium-high priority, three as medium-low priority, and three as lowest priority. By the end of 2005, work had been initiated and is currently ongoing on three high priority questions, three medium-high priority questions, and one medium-low priority question (Table 4). The majority of the funds expended to date have been used to support an extensive investigation of juvenile Chinook rearing habitat preferences and the relationship between stream flow and juvenile Chinook rearing habitat availability.

Supplemental Study Questions
TOP PRIORITY
Study Question 2: Is Chinook survival to smolt and adult correlated with early life history strategy?
Study Question 3a: What is the preferred rearing habitat of juvenile Chinook in the Cedar River, and how is it affected by stream flow?
Study question 4a: What is the effect of stream flow on the temporal and spatial distribution of Chinook spawning activity in the Cedar River?
MEDIUM/HIGH PRIORITY
Study Question 1a: Are the numbers of recently emerged Chinook fry that arrive at the fry trap in the Cedar River at Renton correlated with stream flow?
Study Question 9a: In what ecologically significant ways do present regulated stream flows differ from historic unregulated flows in the Cedar River?
Study Question 9c: How do the integrated effects of stream flow regulation and alteration of the stream channel and riparian corridor affect habitat conditions in the Cedar River?
MEDIUM/LOW PRIORITY
Study question 4c: What, if any, are the confounding effects of the sockeye broodstock collection activities on the temporal and spatial distribution of Chinook spawning activity in the Cedar River?

Table 4. Priority Questions

The protection of incubating steelhead is one of many key objectives of the instream flow management program. Framers of the program recognized the need for both real-time and long-term trend information on this topic. Therefore, the IFA provides specific funding for annual steelhead spawning and incubation studies. Information from these studies has been used in all years by the IFC to inform the specific daily allocation of summer blocks of supplemental water and thus help ensure steelhead redds are protected from dewatering as stream flows decline to summer base flow levels. In addition, the studies are providing insights into incubation duration and the effects of stream flow on spawner behavior and spawning site selection.

To date, the Supplemental Biological Study Program has generated a number of products including the following:

- Annual Cedar River Chinook Redd Survey Reports for brood years 2000 through 2004
- Annual Cedar River Steelhead Spawning and Incubation reports for brood years 2000 through 2005
- Initial scoping study for evaluation of the effects of stream flow on juvenile Chinook life history pattern
- Scope and work plan for Cedar River Indicators of Hydrologic Alteration study
- Low elevation aerial video surveys of the entire Cedar River below Masonry Dam
- Annual Cedar River Juvenile Salmonid Emigration Enumeration Report (funded primarily with funds external to the instream flow management program; resulting information is integrated with and provides key information for activities of the IFC).

Because of the nature of the study topics, the supplemental study program will require fairly long-term data sets to properly address the study objectives. For many of the questions, definitive results are still years away. However, some early results are beginning to suggest potentially important findings that can be applied to instream flow management practices. These early results are discussed in Section 3.2.3.

Accretion Flow Study

The contribution of local inflows in the 20 miles of the mainstem Cedar River below the City's instream flow management compliance point is important information for instream flow managers. Although substantial modeling work has been conducted to simulate inflows in the lower basin during the development of the instream flow management regime, water managers need to monitor this important component of instream flow to detect potential changes over time. Toward that end, the IFA provides for a long-term accretion flow monitoring program.

The City began an initial level of accretion flow monitoring and reporting in 2003, and this activity was performed continuously through 2005. In the lower Cedar River, the City provides partial funding for three existing stream gages through the cooperative stream gauging program with the USGS. These stream gages continuously record mean daily streamflow data in the Cedar River just upstream of the Landsburg Dam (USGS Stream Gage No. 12117500 at river mile 23.4), immediately downstream of Landsburg Dam (USGS Stream Gage No. 12117600 at river mile 20.4), and at a location in Renton near the mouth of the Cedar River (USGS Stream Gage No. 12119000 at river mile 1.6). The City also continuously monitors and records average daily water diversions made at the Landsburg facilities (river mile 21.8). In addition, the City operates and maintains an existing weather station at the Landsburg Dam. The data collected at these existing monitoring stations are providing useful information to help characterize the accretion flow patterns in the lower Cedar River. The data will be continuously collected over the specified study period for subsequent analysis.

Switching Criteria Study

As mentioned previously, the guaranteed instream flows allow for the provision of reduced or critical stream flows during periods of extreme drought. A variety of criteria, such as reservoir inflow and reservoir elevation, are typically used as indicators to assess the severity of drought conditions and the need to drop stream flows to critical levels. Rather than provide firmly established mandatory switching criteria, the IFA currently provides ***alert phase*** criteria that trigger the onset of conditions severe enough for resource managers to develop and implement response activities. Response activities are developed on a case by case basis and can include dropping to critical flow levels. City water managers and resource agencies have agreed to explore development of more precise and accurate indicators of drought conditions to help guide potential response actions. The IFA provides funding for a switching criteria study to meet this need.

Daily status of actual hydrologic conditions in relation to existing HCP switching criteria have been monitored continuously since 2001. Compilation of this data is important for anticipated future analysis. A specific study to evaluate information collected to date has not yet been initiated.

Chester Morse Reservoir Delta Modeling Study

The HCP points to the need to better understand the potential effects of extensive reservoir drawdown on the ability of bull trout to continue to pass over reservoir inlet delta areas during their annual spawning migration. The delta modeling project was launched in 2004 to address this need. The objectives of the study are to characterize the bathymetry of the lake especially in the delta regions, assess the composition of the delta substrates, and model the behavior of the delta stream channels during periods when the reservoir is drawn below the elevation of the deltas.

Detailed topographic surveys of the Cedar and Rex river deltas have been completed, and data from these surveys have been successfully integrated with topographic maps for the rivers upstream of the delta areas. Delta sediment and geomorphic assessments and subsequent stream channel behavior modeling are scheduled to begin in 2006.

Ballard Locks Downstream Fish Passage and Water Efficiency Improvements

The HCP recognizes the importance of fostering ecological connectivity throughout the aquatic environment. To help address this important need, the IFA provides funding for juvenile fish passage facilities and water efficiency improvements at the Corps' Ballard Locks.

In 2001, HCP funds were used to construct and install downstream fish passage flumes, called "smolt flumes," at the Ballard Locks to provide safe passage for migrating juvenile salmonids as they pass out of Lake Washington to the marine environment. The smolt flumes have been in operation every season since and are believed to provide very substantial benefit to all anadromous salmonids in the Lake Washington Basin.

A number of fish migration and behavior studies have also been completed since 2001 to help assess the effectiveness of the smolt flumes and provide baseline information for the development improvements to foster the more efficient use of water at the Ballard Locks. These studies have been jointly funded by Seattle, the U. S. Army Corps of Engineers and King County.

2.3. Summary of Other Accomplishments through Year 5

This section summarizes accomplishments that were not specific HCP commitments but that are contributing to achieving the goals and objectives of the HCP. Often accomplished with partners, these activities were funded in several ways.

2.3.1. BPA-funded Work Enhancing or Accelerating the HCP

Under the BPA Mitigation Program, SPU is using more than $6 million in compensatory mitigation funds to enhance implementation of the HCP and address other issues, consistent with an agreement between BPA and the City concerning the construction of a new transmission line by BPA through the Cedar River Watershed. The following work related to the HCP had been completed under the BPA mitigation program by the end of 2005:

Aquatic and Riparian Restoration

- Used a Chinook helicopter to place 105 pieces of LWD into Rock Creek for habitat restoration.
- Used a consultant to complete a survey of LWD in the Cedar River above the Landsburg to support development of a LWD management plan for that reach.
- Used a consultant to begin developing options for managing LWD above the Landsburg Dam.
- Continued work on the fatal flaw analysis being conducted to evaluate the feasibility of re-diverting the drainage of Walsh Lake back into Rock Creek, completing an effort to remove European milfoil from Walsh Lake and additional sampling.
- Continued support for the collaborative studies with NOAA Fisheries and the University of Washington designed to evaluate recolonization of salmon above the Landsburg Dam to support future decisions.
- Installed 18 PSRs in the lower watershed for monitoring riparian forests over time.
- Completed work, using USGS and a consultant, contributing to development of an aquatic monitoring plan for the HCP.

Upland Forest Restoration

- Hosted a 2-day workshop with regional land managers and experts on the subject of restoring biodiversity in forested watersheds.
- Used a consultant to complete a data model for a forest information management system (FIMS) to support planning of forest restoration projects.
- Completed projects on the BPA right of way to remove invasive, nonnative plants, and create wildlife habitat by moving and piling woody debris. Monitored bark beetles in dead wood.

- Removed a variety of invasive, nonnative plants, including yellow and orange hawkweed, Japanese knotweed, tansy ragwort, spotted knapweed, Scots broom, and evergreen and Himalayan blackberry, and planted native plants at some sites.
- Continued collaboration with the University of Washington on a project to design and conduct experiments to evaluate approaches to ecological thinning in the watershed.
- Used LiDAR to evaluate data for forest characterization.

Road Decommissioning and Improvement

- Decommissioned approximately 3.4 miles of roads to complement decommissioning under the HCP, decommissioning roads through a wetland on Williams Creek (33 Road) and along Taylor Creek (80 Road).
- Made progress on developing an information management system for the watershed transportation system (TIMS; including roads, bridges, and related infrastructure).

2.3.2. Additional Activities and Projects Partially or Completely Funded by SPU that Enhance Implementation of the HCP

In addition to the work funded under the agreement with BPA described above, SPU implemented a number of other projects and engaged in activities that contributed to the effectiveness of the HCP but were not required by the HCP. Some examples are described below.

Noxious Weeds

Invasive, alien organisms are recognized by scientists as a major ecological problem around the world. Although the HCP did not mention the need for control of these organisms, in the late 1990s, City staff recognized problems with the spread and effects of invasive, non-native plants in the municipal watershed and initiated extensive inventories and control efforts. The distributions of several key species have been mapped, and tens of thousands of plants have been removed or suppressed by physical means. In 2005, a team began working on a strategic plan for invasive plants, which should be completed in 2006 or 2007. Some funding from BPA was used, but most was from SPU.

Biodiversity Initiative

The HCP has a general goal of protecting and restoring natural biodiversity, but includes no specific conservation measures expressly for this purpose. SPU developed a biodiversity initiative that includes collaborating with other organizations regarding biodiversity and conducting basic biodiversity inventories. In collaboration with the University of Washington and using volunteers, vascular plants were inventoried, voucher specimens were stored in the University of Washington Herbarium, and a database of plant species was created. Some inventory work was also done for insects, mosses, and lichens. In 2005, using BPA funds as described above, SPU hosted a 2-day workshop on biodiversity. A second workshop and additional biodiversity surveys are planned for the future.

Volunteer Projects

Volunteers have been used extensively for control of invasive plants, planting for restoration, control of slash within thinning units, biodiversity surveys, and monitoring. Nearly 1,000 volunteer days have been logged, and SPU has partnered with more than 20 different organizations. Many of the volunteers were recruited by the Friends of the Cedar River Watershed. EarthCorps also was a partner for some of these projects through grants and contracts.

DNA Analyses

SPU staff took small tissue samples from carcasses of spawned kokanee in the Walsh Lake system and from bull trout in the reservoir system. DNA analyses of these samples were performed by outside labs. Results to date indicate that (1) the kokanee population in the Walsh Lake system is distinct from others in the Lake Washington Basin, but whether it is introduced or native is not clear; and (2) bull trout in different tributaries to Chester Morse Lake are genetically differentiated.

Climate Change Studies

The City entered into a Memorandum of Agreement with the University of Washington's Climate Impacts Group to address the issue of long-term climate change impacts on water supply and demand and to develop strategies for management. More details on this work are provided in Chapter 4 of this review.

Adaptive Management Workshops

As part of a settlement for an appeal of the State Environmental Policy Act (SEPA) EIS for the HCP, the City committed to fund and conduct a series of three workshops on adaptive management in collaboration with Washington Trout. The three workshops were held between 2001 and 2005. The first was a dialog between scientists and decision-makers. The second included a series of case studies from other parts of the country and small-group discussions of how adaptive management might be developed for a hypothetical example. The third workshop, conducted in 2005, was designed in collaboration with Shared Strategy for Puget Sound to support salmon recovery efforts in the Puget Sound region. Dr. Steven Yaffee, Director of the Ecosystem Management Initiative at the University of Michigan, worked with watershed groups in a 4-step evaluation process for performing adaptive management using a model that has been successfully used by collaborative natural resource groups across the country. This model is being used for the HCP and in the salmon recovery effort.

Instream Flow Workshop

The City helped plan and sponsor a full-day workshop on technical advances and emerging issues in the applied science of instream flow management. More than 300 people participated in the workshop at the University of Washington, which attracted presenters and participants from around the country. The workshop brought together a broad range of perspectives from academic researchers, federal, state, tribal and local government practitioners, environmental groups, and private sector organizations involved in the study and management of instream resources.

Grants

In an effort to supplement Cedar HCP Downstream Habitat Protection and Restoration program funds, in 2003 and 2004, SPU collaborated with staff from King County's Cedar River Legacy Program to apply for grant funding under the Cooperative Endangered Species Conservation Fund (CESCF) program. The CESCF program is administered by the US Fish and Wildlife Service under Section 6 of the ESA. These grants provide funds to states and territories to acquire land associated with approved HCPs. Grants do not fund the mitigation required of an HCP permittee; instead, they support acquisitions by the state or local governments that complement actions associated with the HCP. SPU and King County were awarded $1.5 million in 2003 and $1.0 million in 2004. These awards are being used by King County to acquire lands in the lower Cedar River Watershed, which is the area of focus of the HCP Downstream Habitat program. In 2005, SPU applied for funding under this program and was awarded another $1.7 million, bringing the total award from the CESCF program for lower Cedar River land acquisitions to $4.2 million.

Chapter 3. Assessment of Accomplishments through HCP Year 5

This section of the review provides an assessment of accomplishments through HCP year 5, focusing on accomplishments with respect to both the planned schedule and the effectiveness of activities for which there are data and implementation of the HCP in a broader perspective. The HCP represents a microcosm of issues in the Pacific Northwest, encompassing many of the most significant natural resource challenges in the region: protection and recovery of salmon; management of river flows; dealing with the effects of fish blockages; forest management; addressing the needs of threatened and endangered species; enlightened operation of fish hatcheries; ecosystem restoration; and natural resource management in a changed and changing environment. Those professionals implementing the HCP, like others tackling many of the issues listed above, have to confront the facts that there are large gaps in available knowledge about ecosystems, species, and techniques of restoration, and the reality that success of the HCP will depend on effective collaboration among many stakeholders, agencies, and groups. This section of the review includes an assessment of contributions of the HCP in a broader context, discussing the regional implications of work to date under the HCP, the value of collaboration and partnerships to the success of the HCP, and the importance of structuring management of the HCP for intentional learning over time.

3.1. Overview of Accomplishments, Schedule, and Finances

Overall, the City and its partners have accomplished a great deal in the first 5 years of the HCP. Nearly all HCP conservation measures are on track (see Appendix 2), and a considerable number of projects and activities have been completed or initiated beyond what was required in the HCP (see Section 2.3).

3.1.1. Delays and Other Challenges

For a variety of reasons, a small number of HCP projects or activities have deviated from the planned HCP schedule and cost. The reasons for these deviations are described below, and some examples are provided.

Delays Agreed Upon Because Circumstances Changed After the HCP Was Approved

In two cases, projects or activities were delayed and/or modified as a result of consultation with and agreement by parties to one of the HCP agreements. In 2002, the IFC voted to amend the IFA to delay the feasibility analysis of permanent access to Cedar Dead Storage for 5 years in view of supply and demand forecasts indicating adequate water supply beyond 2060. In addition, a delayed schedule was agreed upon for the associated environmental studies.

In 2003, through a minor modification, the USFWS agreed to redirect funding related to an experimental fish weir and live-box trap counts for bull trout for two reasons. First, significant data had been collected on the status of bull trout spawning populations revealing that the population is robust and not declining. Second, the City and the Federal Services recognized that construction of one or more weirs in major tributaries to the reservoir would have some adverse impacts on fish. Considering that a major purpose of the fish weir and live-box traps was to evaluate the status of the bull trout population, the City and Federal Services agreed that the incremental value of this project as a means to determine population status was negated by its potential adverse impacts. The two parties agreed to develop an alternative use of funding that would better contribute to bull trout conservation.

Other Delays

Downstream habitat land acquisition, which was scheduled to occur in HCP years 2 through 4, has been delayed as a result of protracted and ultimately unsuccessful negotiations with King County over a collaborate land acquisition and stewardship program. Land acquisition efforts have begun, but are constrained by the willingness of landowners to sell their properties.

Because of the complexity of the HCP and the continually changing circumstances that affect the ability of the City to meet cost and schedule commitments, staff recognizes the need to routinely track, record, and report deviations from the original HCP commitments. The HIMS includes the capacity to record such deviations in an historical log. In addition, staff intends to develop a communication approach to keep the HCP parties and the Oversight Committee informed of such deviations.

Legal Challenges

The legal challenges to Cedar River HCP during the first 5 years of implementation are discussed in Chapter 4.

Budget Challenges

Adhering to HCP cost and schedule for activities that are funded in the City's Operations and Maintenance budget (i.e., activities that cannot be capitalized) was particularly challenging in HCP years 3 and 4, when the City experienced sharp revenue decreases and mandatory budget reductions affecting all City departments. Some HCP activities were delayed, but to date these activities are back on track.

3.2. Summary of Effectiveness of HCP Conservation Measures through HCP Year 5

Demonstrating the effectiveness of conservation measures implemented to date is challenging this early in the implementation of the 50-year HCP. The species and ecosystems affected by the implementation of the HCP are also affected by other environmental changes and human activities, and many of the responses of target ecosystems and species to the conservation measures are expected to manifest over a period of decades or more. Some results to date, however, are available to indicate the effectiveness of at least some conservation measures and the City's operations overall. Below is a brief discussion of results of monitoring that provides some insight into the effectiveness of the HCP through year 5. The results are organized by the three major components of the HCP (Watershed Management, Landsburg Mitigation, and Instream Flows).

A variety of kinds of information can be used to judge the effectiveness of conservation measures under the HCP. The HCP includes commitments to monitor projects, to monitor long-term trends in habitat and species, and to monitor elements of the environment to provide information needed for real-time decisions. In addition, the HCP includes commitments to research that can inform decisions.

Project monitoring can determine if the project produced the desired ecological effects. Long-term monitoring of habitats can determine if habitats are changing or improving as expected. Monitoring of individual species can provide information about the status of those species in the watershed, the distribution of individuals or nests for use in real-time decisions, and, to some extent, responses to the conservation measures as a whole. Because many regional and/or global factors affect species, however, there are limits to what can be concluded from the results of species monitoring with respect to the effectiveness of the HCP.

3.2.1. Watershed Management

The Watershed Management component of the HCP includes commitments to design and implement a variety of kinds of restoration projects, from forest restoration, to aquatic restoration, to decommissioning and improvement of forest roads. As described in Section 2.2, some project monitoring has been conducted, but few post-project effectiveness data are as yet available for most projects. No data are available on long-term trends in habitat, but some species monitoring data are available.

Project Monitoring

Ecological Thinning

Post-project monitoring for the first ecological thinning project (in older forest), the 45 Road Forest Restoration Project, indicated that both residual tree density and variability in tree spacing were less than planned after the variable density thinning prescriptions had been applied. An assessment of the project indicated that this was a result of contract specifications that were found to be inadequate for meeting all project objectives, and, to a lesser extent, a windstorm following the project that toppled some trees. These conclusions are being used in planning future ecological thinning projects. More attention is being given to designing contract specifications that will produce the desired ecological results, and the City is developing a model for forest disturbances to incorporate into future planning.

Conifer Under-planting

Logging in some riparian areas originally dominated by conifers resulted in invasion by, and dominance of, hardwoods. In some of these areas, a dense understory of salmonberry appears to be inhibiting regeneration of conifers. Experiments were initiated in 2001 along Webster Creek to test methods for conifer under-planting in an area of riparian second growth that was originally dominated by conifers prior to logging. Results to date indicate that few conifer seedlings survived when no site preparation was done, but that cutting shrubs back to the ground was as effective as rototilling in increasing seedling survival. Possibly because elk populations have dropped dramatically since the late 1980s, no benefits to seedling survival were observed with either of two types of protective sleeves placed around some cedar seedlings to protect against elk and deer browsing. These experiments indicate that a relatively low-cost option, cutting back shrubs, may be all that is needed to facilitate survival of seedling conifers in areas dominated by hardwoods and salmonberry. Survival of these seedlings will continue to be tracked to determine if the trees continue to grow and survive.

Restoration Thinning

Restoration thinning projects, in younger forests, were implemented as planned, but City staff concluded that early approaches to thinning these young stands needed to be changed. This conclusion was shared by the assessment team for forest certification (see Section 3.4), which found that thinning prescriptions were too uniform and recommended that the City make greater efforts to create heterogeneity. The original focus of this program was to thin to increase spacing among trees, reducing competition and encouraging more rapid growth. This approach was based on an assumption that variability in spacing would be achieved later in forest development, when disturbance mortality would begin to dominate competition mortality. After consulting with experts, staff decided that development of structural diversity would proceed more rapidly if more variability in spacing were to be introduced at this early stage of forest development, both within stands and across the landscape (among stands). In addition, to increase tree species diversity, the City is beginning to incorporate tree-planting with thinning in younger stands where tree species diversity is low.

Long-term Habitat Monitoring

Plots for long-term monitoring in upland forest (PSPs) and riparian forest (PSRs) have been installed, but have only been measured once. Ongoing analysis of data from 20 historic PSPs is revealing how second growth is developing in the watershed, promising to provide information to improve forest growth projections.

Species Monitoring

Northern Spotted Owl and Marbled Murrelet

During surveys of the threatened northern spotted owl conducted in 2005, no spotted owls were detected, but consultants did detect the competing barred owl. As barred owls are a major concern with respect to conservation for spotted owls, the City plans to better evaluate barred owl distribution during 2006.

Surveys for the threatened marbled murrelet initiated in 2005 using van-based radar revealed that murrelets entered the watershed along several routes and moved into several areas of the upper watershed, almost assuredly for nesting. More studies, including ground observations, are planned for 2006 to locate nesting areas.

Bull Trout and Pygmy Whitefish

Annual spawning surveys conducted for the threatened bull trout yielded redd counts between 236 and 587 during HCP years 1 to 5 (Figure 6). With the increased and more consistent level of effort under the HCP, the City now has good data indicating that: (1) spawning is at a level expected for a population of the size previously estimated to exist in the reservoir, (2) the bull trout population in the watershed is relatively robust, and (3) the bull trout population in the watershed is not likely declining. Surveys being conducted in tributaries up to passage barriers are nearly complete, and the City has a good idea of overall distribution. Annual surveys of pygmy whitefish during the spawning season (November-December) documented consistently large numbers of adults in major tributaries to the reservoir. As described in Chapter 2, better information on movements and habitat use in the reservoir and selected tributaries should be

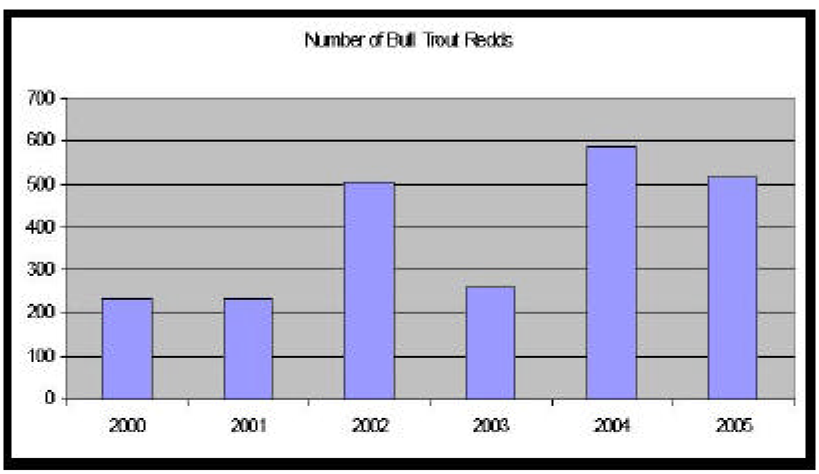


Figure 6. Annual Spawning Surveys for Bull Trout Redds: 2000-2005

available as a result of acoustic studies begun in 2005 by SPU in the reservoir and PIT tag studies in selected tributaries conducted in collaboration with USGS (Figure 7).

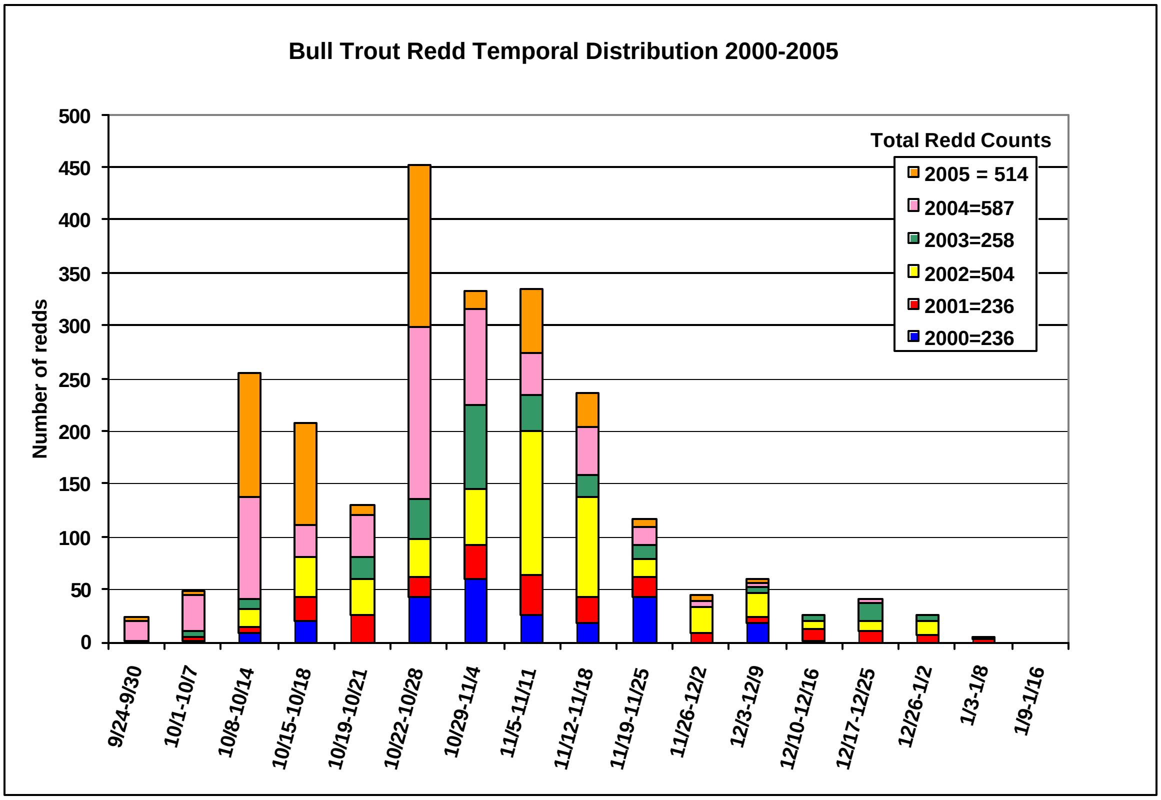


Figure 7. Bull Trout Redd Temporal Distribution: 2000-2005

Common Loons

The annual program for installing floating nest platforms and monitoring common loons nesting on the reservoir system began in 1990. The Chester Morse Lake and Masonry Pool complex has traditionally had three loon nesting territories. Monitoring has revealed that pairs have nested a total of 35 times in the period 1990 to 2005. Pairs of loons have used the platforms about 77% of the time. During this period, 35 chicks were produced, about 80% of which were produced from platform nests It can be concluded that loons preferentially choose the floating nest platforms, and that nesting on the platforms results in at least as much success as nesting on natural substrates.

From a regional perspective, it should be noted that the three pairs of common loons that typically nest on the reservoir complex have constituted more than 1/4 of the loons nesting in Washington State in recent years. The production of fledglings from the watershed has, in many years, constituted an even larger fraction of the fledged loons produced in the state, likely as a result of the degree of security within the watershed compared to the high levels of human disturbance to nesting loons on lakes open to the public.

There has typically been considerable variation in site occupancy, nest establishment, and reproductive success among the 12 to 15 loon nesting territories (or sites) currently known in Washington State, including the 3 sites observed in the Cedar River Municipal Watershed since 1989. Occupancy of the 3 watershed sites has been consistent throughout the 16-year study period, but, although 1 of the 3 pairs has at least attempted to nest every year, the other 2 pairs have been variable in establishing nests from year to year, especially in more recent seasons. Even if nest(s) are established, there are many factors that ultimately determine reproductive success, including viability of eggs, incubating conditions, fluctuating water levels, egg scavenging and predation, and post-hatch mortality from various causes.

Since approximately the year 2000, each of the 3 pairs has been particularly inconsistent in reproductive success, resulting either from lack of nest establishment, uncharacteristically fluctuating water levels, or nest predation and post-hatch mortality. In particular, various observations strongly suggest that harassment of adults incubating eggs on nests, direct scavenging of eggs, or post-hatch predation on young chicks by bald eagles has become a substantial threat to loons nesting in this region. Observations made this year by a staff biologist in the South Fork Tolt River Watershed, the City's other municipal watershed, documented the mortality of a loon chick, hatched on an artificial nest platform, that occurred on open water within 1 hour of departing the platform with both adults. River otters have occasionally been a threat to loon eggs in nests, but do not seem to have been as consistent a threat as eagles have apparently become. It also has been suggested recently that the state's loon population has declined significantly as a result of ingesting lead sinkers on line attached to escaped fish. This particular theory, however, does not apply directly to the Chester Morse Lake and Masonry Pool reservoir complex because no fishing of any type is allowed on this body of water and the number of loon pairs occupying the system has not changed over the last 17 years.

Because loons typically nest immediately at the water's edge or on emergent substrates (e.g., logs), loons that nest on the reservoir complex, as compared with natural lakes, are more vulnerable to the potentially adverse effects of constantly changing water levels (i.e., nest inundation, nest stranding). While artificial nesting platforms can compensate for a variety of water level conditions, they are much less effective when water elevations are extremely high (e.g., lack vegetation cover and protection from wind) or when water levels are particularly low and platforms, like natural nest sites, can be stranded.

Other Species

As described in Chapter 2, other surveys were conducted to provide a better understanding of the distribution and habitat associations of various species and species groups to support prioritization and planning of restoration projects and to help with overall management to sustain biodiversity. The survey of vascular plants in the watershed revealed the value of basic inventories, as the invasive water milfoil was discovered in Walsh Lake in time to initiate control methods before the small infestation spread. Follow-up monitoring is planned to determine if eradication efforts were successful.

3.2.2. Landsburg Mitigation

Landsburg Fish Passage

Reconnecting habitat is one of the primary strategies of salmon recovery, and the HCP is significant on a watershed and regional scale in terms of the increase in the amount of habitat that is now accessible to resident and anadromous species. No one really knew how many fish to expect when the fish ladder was first opened in 2003. Through 2005, 3 years of adult returns have used the passage facilities, and observers are beginning to document the level of variability among years.

Through 2005, 199 Chinook and 316 coho passed the Landsburg Dam. Although it is not known how many of these fish actually spawned, there is ample evidence that successful reproduction is occurring above the Landsburg Dam based on redd surveys, carcass inspections, and juvenile surveys. For Chinook, the proportion of redds above the Landsburg Dam has ranged from 3% to 5% of the total number of redds in the river. Because estimates of the number of coho spawning in the lower Cedar River are not being made, it is not clear what proportion of the coho spawning in the Cedar River is occurring above the Landsburg Dam.

Tables 5 and 6 show the numbers of fish passed to date at the Landsburg Dam by species, sex, and origin. Data have also been collected on the size of coho and Chinook. The collection of detailed information of salmon passing the Landsburg Dam was a decision by the HCP parties through an amendment to the Incidental Take Permit. The collection of data at the Landsburg Dam coincided with the first Issaquah Hatchery returns that were mass-marked (fin clipped), allowing the presence of hatchery origin Chinook to be determined. This raised a question about the passage of hatchery origin Chinook above the dam. The question was resolved, however, through consultation with the parties to the LMA and resulted in the conclusion that the LMA language required that all native species, including hatchery origin Chinook, be passed above the dam.

As can be seen from Table 5, the number of Chinook would be substantially lower if hatchery origin Chinook were excluded from passage. The passage of hatchery origin Chinook provides an opportunity to look at relative productivity, but low numbers and potential breeding combinations make it less likely that results will be useful in comparing productivity between hatchery and natural origin spawners. Since significant numbers of hatchery returns spawn with natural origin returns in the lower Cedar River, assessing recolonization success while passing hatchery origin Chinook represents the scenario that currently exists within the Cedar River as a whole.

	Adult Chinook						
Brood Year	**Female Clipped**	**Female Unclipped**	**Total Female**	**Male Clipped**	**Male Unclipped**	**Total Male**	Total
2003	10	6	16	45	18	63	79
2004	15	7	22	19	10	29	51
2005	5	12	17	24	28	52	69
Total	30	25	55	88	56	144	199

Table 5. Number of Chinook Passing Landsburg Dam: 2003-2005

	Adult Coho						
Brood Year	**Female Clipped**	**Female Unclipped**	**Total Female**	**Male Clipped**	**Male Unclipped**	**Total Male**	**Total**
2003	3	18	21	1	25	26	47
2004	2	32	34	0	65	65	99
2005	2	64	66	4	100	104	170
Total	7	114	121	5	190	195	316

Table 6. Number of Coho Passing Landsburg Dam: 2003-2005

The numbers of sockeye entering the fish ladder at the Landsburg Dam has been roughly 1,000 per year. These fish are either returned to the river or used for broodstock for the sockeye hatchery. When sockeye are returned to the river, few fish have returned to the fish ladder a second time.

Sockeye Hatchery

The interim sockeye hatchery facility is capable of producing up to 17 million fry per year. However, actual production is usually below this capacity because of the difficulty collecting sufficient numbers of sockeye for broodstock. Between the years 2000 and 2005, the interim hatchery produced 64.6 million fry. The proportion of adults used as broodstock for the hatchery has ranged from 4% to 13%. Broodstock collection is affected by operating protocols to limit effects on Chinook, by the location of the weir, and by the vulnerability of the weir to high flows.

IHN virus is one of the most significant challenges facing sockeye hatchery programs. This virus is common in natural populations of sockeye, and it can have devastating impacts when outbreaks occur in a hatchery. Protocols developed by the Alaska Department of Fish and Game have resulted in fewer outbreaks and lower losses, where they have been adopted. The Cedar River sockeye program has relied on similar protocols and has generally avoided losses to IHN. One exception was the loss of nearly 1 million fry to the IHN virus during the 2002 brood year . This outbreak occurred during the first year that sockeye could reach the dam as a result of fish passage improvements. The proximity of spawning sockeye close to the hatchery raised the risk of transfer of virus to the hatchery. In response to the outbreak, a water system that has less vulnerability to contamination is being designed, and these improvements are expected to be completed in the year 2007.

Sockeye returns to the Cedar River during the first 5 years of the HCP (2000 to 2005) have been generally higher than those in the 1990s. The interim hatchery began to contribute adult returns to the natural spawning population in 1995. When random sampling has occurred in recent years, during fishing and more recently at the locks, the hatchery contribution has generally been 20% to 25%. This level of hatchery return has allowed additional fishing opportunity by increasing returns above thresholds and allowing for harvest as established by the co-managers. Improved sockeye abundance has likely been helped by the interim hatchery, along with a number of important factors, including moderate winter Cedar River flows in most years and improved ocean conditions.

Experience gathered through the operation of the interim hatchery has been very useful in designing the replacement facilities. There are known limitations in water temperature control, broodstock collection location, and facility design that have been addressed in designing the replacement hatchery.

3.2.3. Instream Flows

Since implementation of the HCP, the City has worked closely with the Cedar River IFC to manage stream flows, implement specified technical studies, incorporate newly acquired information into management decisions, and monitor program compliance and effectiveness. The City, the IFC, and others have initiated the collection of potentially useful long-term hydrologic and biological information in a number of areas. As this information accumulates, it can be used to evaluate the effectiveness of the instream flow management program. Because the HCP is still in the early stages of implementation, it is not yet possible to detect definite trends in many of the parameters being monitored. Nevertheless, in this section some of this early information is presented in an effort to detect potential trends and to help demonstrate the importance of continued data collection.

As summarized in Section 2.2.3, the instream flow management program has progressed in general concordance with HCP commitments. Through Seattle's continued participation in the USGS cooperative stream gauging program, stream flows have been monitored continuously in 15-minute intervals at each designated compliance point. The cooperative stream flow gauging project provides the foundation for monitoring both compliance and effectiveness of instream flow management practices. The program also provides vital information from gages throughout the basin that is used in short-term water management decision-making and in mid- and long-range water management planning.

Integrating this hydrologic information with key biological data is allowing the City to assess the effectiveness of the instream flow management program and potentially improve the overall understanding of some of the mechanisms affecting instream resources. For example, continued enumeration of the number of spawning salmon and subsequent enumeration of their resulting offspring provides a basis for assessing salmon spawning and incubation success. This information can in turn provide a measure of relative habitat quality for these species in any given year.

Hydrologic Summary

The Cedar River basin has experienced a broad range of hydrologic conditions since the formal approval of the HCP, from the winter and spring droughts in 2001 and 2005 to the large peak flow events in January 2006. Figure 8 provides mean daily flow traces for each calendar year from 2000 through 2005.

Several key points emerge from this somewhat chaotic picture of the last 6 years:

- Stream flows remained at or above normal guaranteed minimums at all times.
- For substantial periods in each year, stream flows remained near the normal guaranteed levels.
- Because reservoir storage capacity is relatively limited when compared to the contributing watershed, and that substantial inflows enter the river downstream of the storage reservoir, stream flows have also remained well above the normal guaranteed levels for significant periods of time in all years.
- The Cedar River IFC has often been engaged in the management of these flows above the guaranteed levels in an effort to provide additional benefits for instream resources.
- Fall and winter instantaneous peak flow events have been relatively subdued during the HCP period and have exceeded the believed initial sockeye redd scour threshold of 2000 cfs, less frequently than during the previous 6 years.

The HCP provides limitations on the maximum amount of water that can be diverted from the Cedar River by the City. These limitations have been further strengthened by a pending settlement agreement with the Muckleshoot Indian Tribe (see Chapter 4 for additional details). Therefore, it is expected that similar occurrences of flows in excess of guaranteed flows will occur in the future, thus ensuring substantial management flexibility to refine instream flow management practices as new information is collected and conditions change.

Improvements at Masonry Dam and Cedar Falls Powerhouse

In these first 5 years of the HCP, the Cedar Falls Powerhouse and Masonry Dam underwent substantial physical and operational changes to limit potential detrimental effects and provide additional benefits to downstream aquatic resources. The physical changes included the installation of an emergency bypass system and a tailrace barrier at the Cedar Falls Powerhouse and a new low-flow valve at the Masonry Dam. Facility improvements were completed ahead of

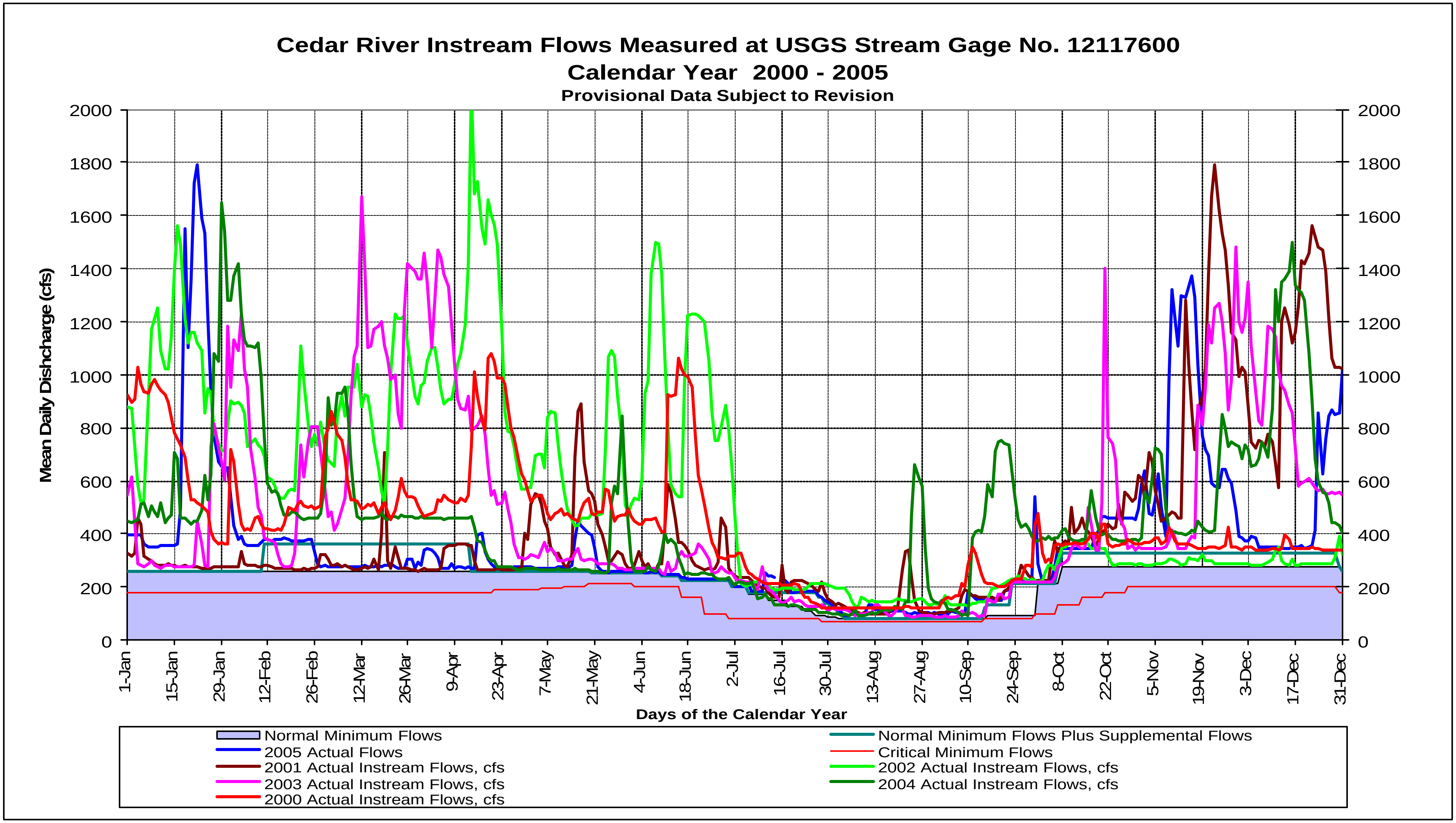


Figure 8. Cedar River Instream Flows: 2000-2005

schedule and were operational prior to the passage of the first salmon through the new fish passage facilities at the Landsburg Diversion Dam.

Structural and operational modifications at the two facilities have helped reduce the frequency and magnitude of downramping events throughout the lower Cedar River. With the construction of water flow bypass facilities at Cedar Falls, the risk of major downramping events associated with storms causing electrical generation disruptions has been greatly reduced. Because relatively few salmon and steelhead have migrated upstream of Landsburg and nearly all have spawned well downstream of the Cedar Falls Powerhouse, the protective tailrace barrier has not yet been tested

General Status of Salmon and Steelhead Spawning Populations

The number of salmon and steelhead spawning in the Cedar River has been monitored annually with the combined efforts of WDFW, the Muckleshoot Tribe, the City, and King County. This monitoring information, summarized in Figures 9 through 11, indicates that the number of salmon spawning in the Cedar River has remained stable or increased somewhat since the late 1990s.

Many other factors in addition to instream flows can control the performance of these populations, but the potential recent reversal in the declining trends is encouraging. In contrast to the situation with Chinook and coho (see Figures 9 and 10), steelhead numbers have declined sharply since the early 1990s (see Figure 11). Fishery managers are currently perplexed by the recent decline in the anadromous life history pattern of Cedar River rainbow trout (steelhead),

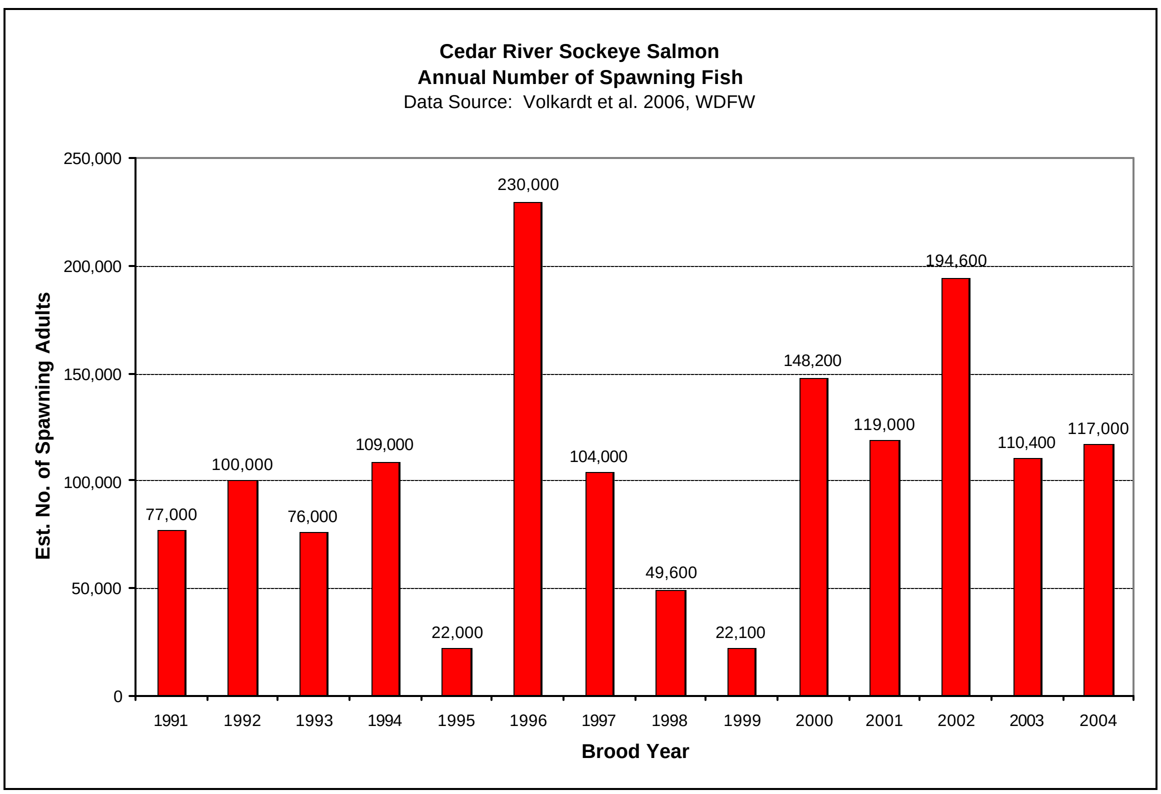


Figure 9. Cedar River Sockeye Salmon Annual Spawning Numbers: 1991-2004

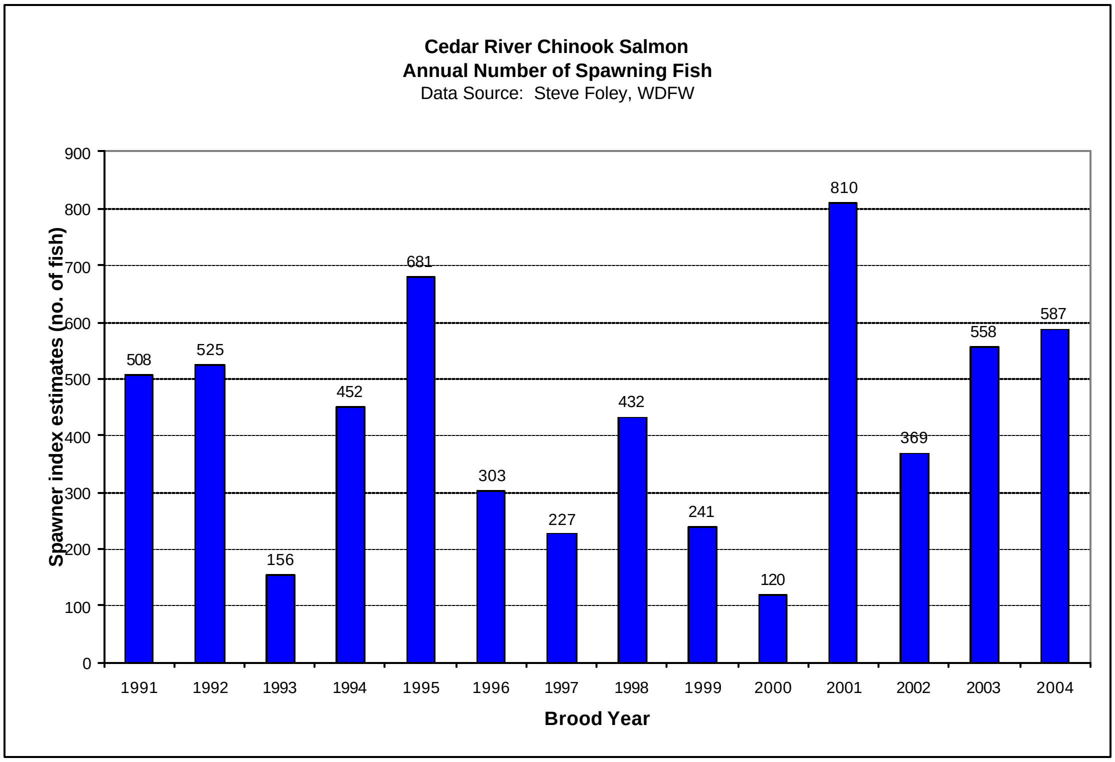


Figure 10. Cedar River Chinook Salmon Annual Spawning Numbers: 1991-2004

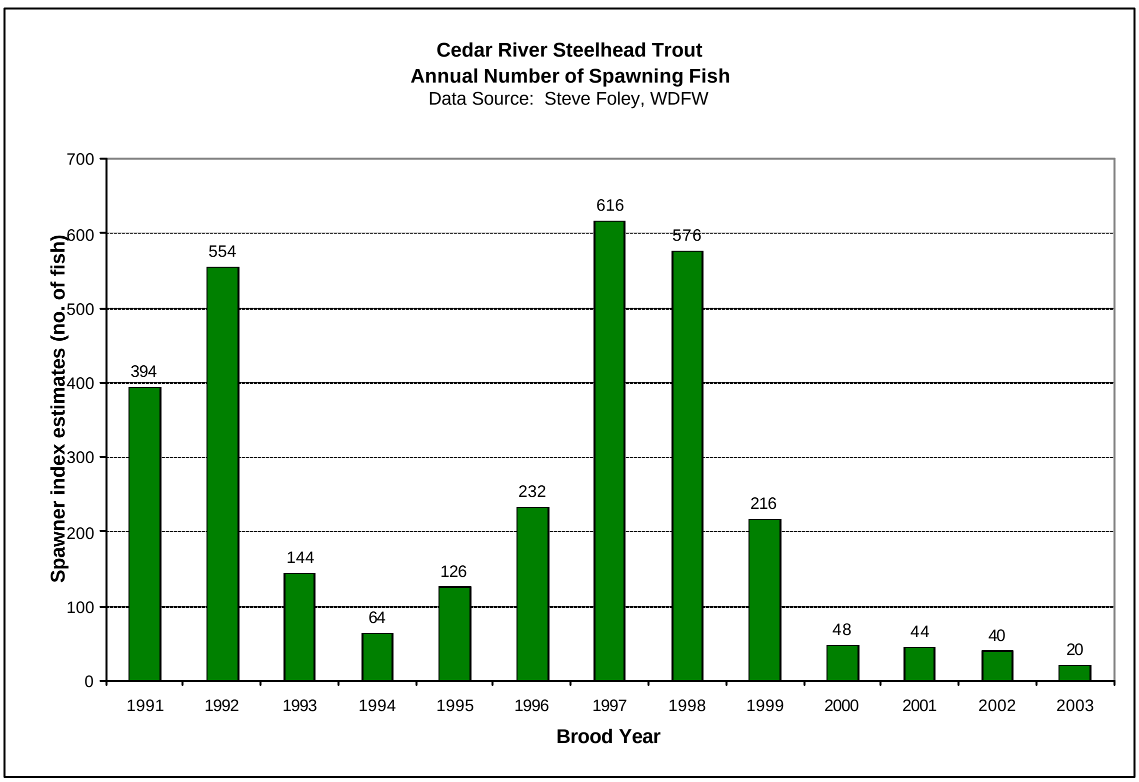


Figure 11. Cedar River Steelhead Trout Annual Spawning Numbers: 1991-2003

while populations of adfluvial and resident rainbow trout appear to have exhibited a general increase in numbers.

Formal monitoring of Chinook redds and anecdotal observation of sockeye redds indicate that more than 99% of all sockeye and Chinook redds were protected from dewatering during HCP years 1 through 5. Formal monitoring of steelhead redds was initiated in 1995. In 1995, 1996, and 1999 all steelhead redds were fully protected from dewatering. In 1997, with a total of 380 redds, 376 were fully protected, 3 redds were partially dewatered and 1 redd was fully dewatered. In 1998, with a total of 355 redds, 354 were fully protected and 1 redd was fully dewatered. During HCP years 1 through 5, all steelhead redds were fully protected from dewatering.

Production and Early Survival of Juvenile Salmon

As mentioned previously, ongoing efforts to monitor annual returns of spawning Chinook and sockeye, coupled with estimates of the number of subsequent juvenile emigrants, provide the basis for an initial assessment of annual salmon production. Salmon survival from egg deposition through juvenile emigration can be affected by a variety of factors, including redd scour during peak stream flow events, other forms of physical disruption, redd dewatering, stream flow and general habitat conditions during early rearing and emigration, predator abundance, water quality, habitat structure, and associated habitat quality. Measures of egg-to-emigrant survival cannot necessarily identify the degree to which specific factors influence juvenile production. However, they can provide a measure of the integrative effects of the variety of in-river factors influencing production and help identify potential areas of concern.

WDFW initiated juvenile sockeye emigrant enumeration in brood year 1991 and juvenile Chinook emigrant enumeration in brood year 1998. The project has been jointly funded by King County, the City, and WDFW. Annual production of juvenile Chinook and sockeye has generally increased since the late 1990s (Figures 12 and 13). This increase can be attributed to a number of factors, including the number of spawning adults, incubation conditions, and in-river rearing and emigration conditions.

Measures of egg to emigrant survival can provide a more precise assessment of in-river conditions for juvenile salmonid production because they eliminate the effect of spawner abundance. Figures 14 and 15 suggest significant inter-annual variability for both sockeye and Chinook egg to emigrant survival rates. In-river survival of juvenile sockeye appears to have rebounded from low levels in the mid 1990s. Recent in-river survival of Chinook does not appear to exhibit a significant increasing or decreasing trend.

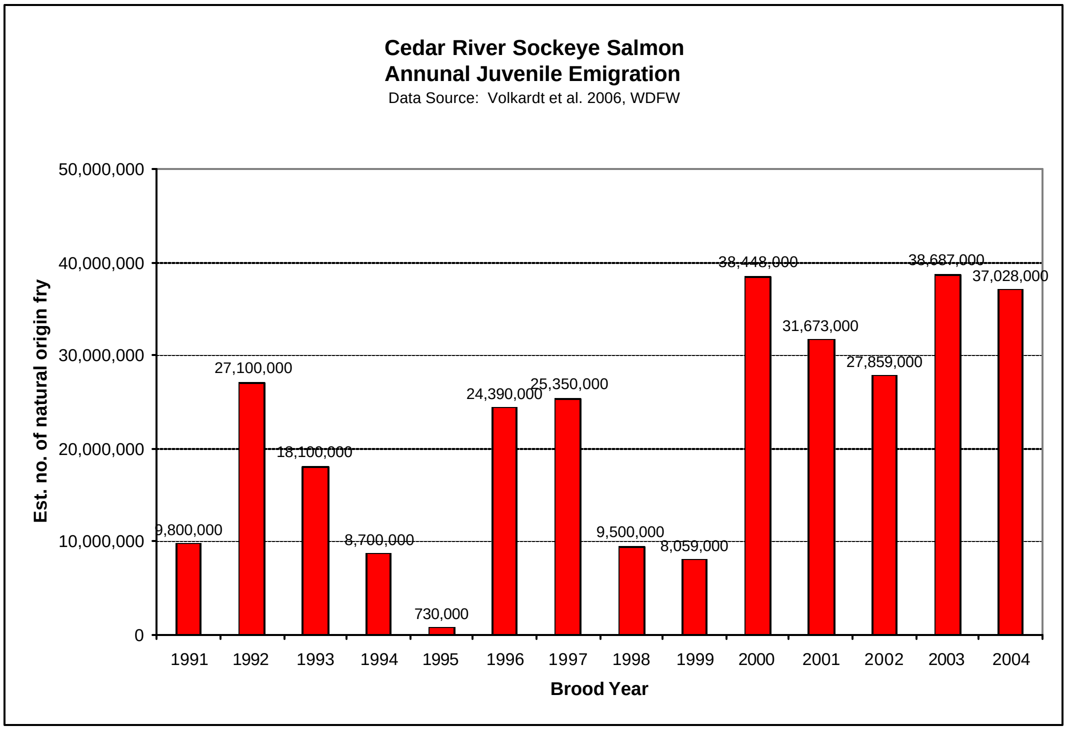


Figure 12. Cedar River Sockeye Salmon Annual Juvenile Emigration: 1991-2004

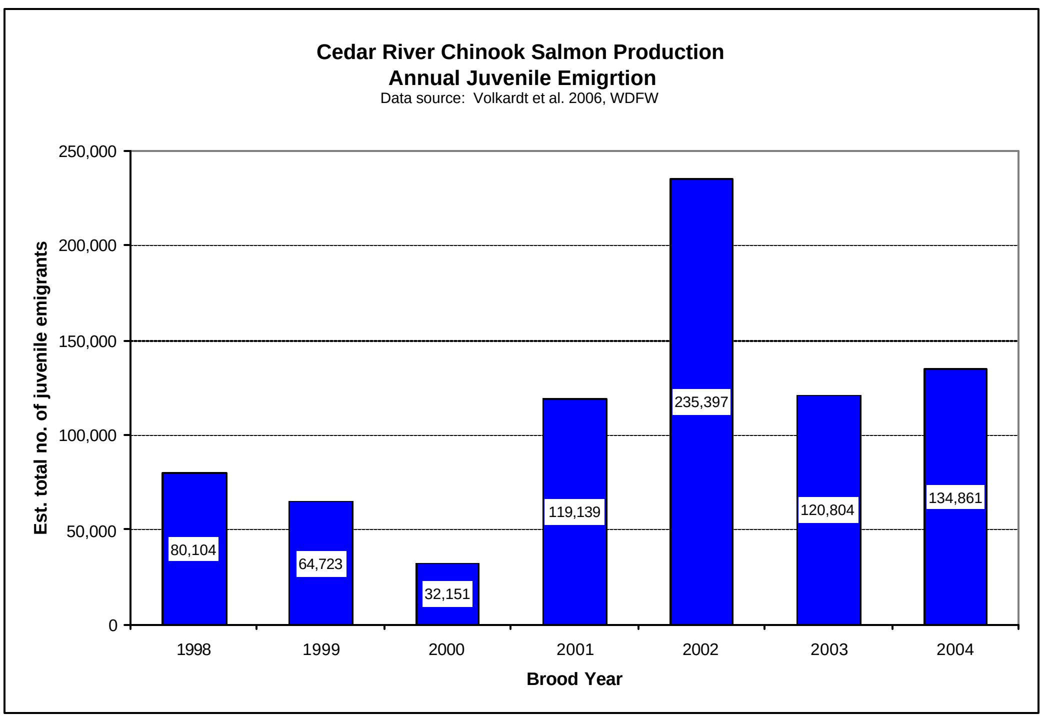


Figure 13. Cedar River Chinook Salmon Annual Juvenile Emigration: 1998- 2004

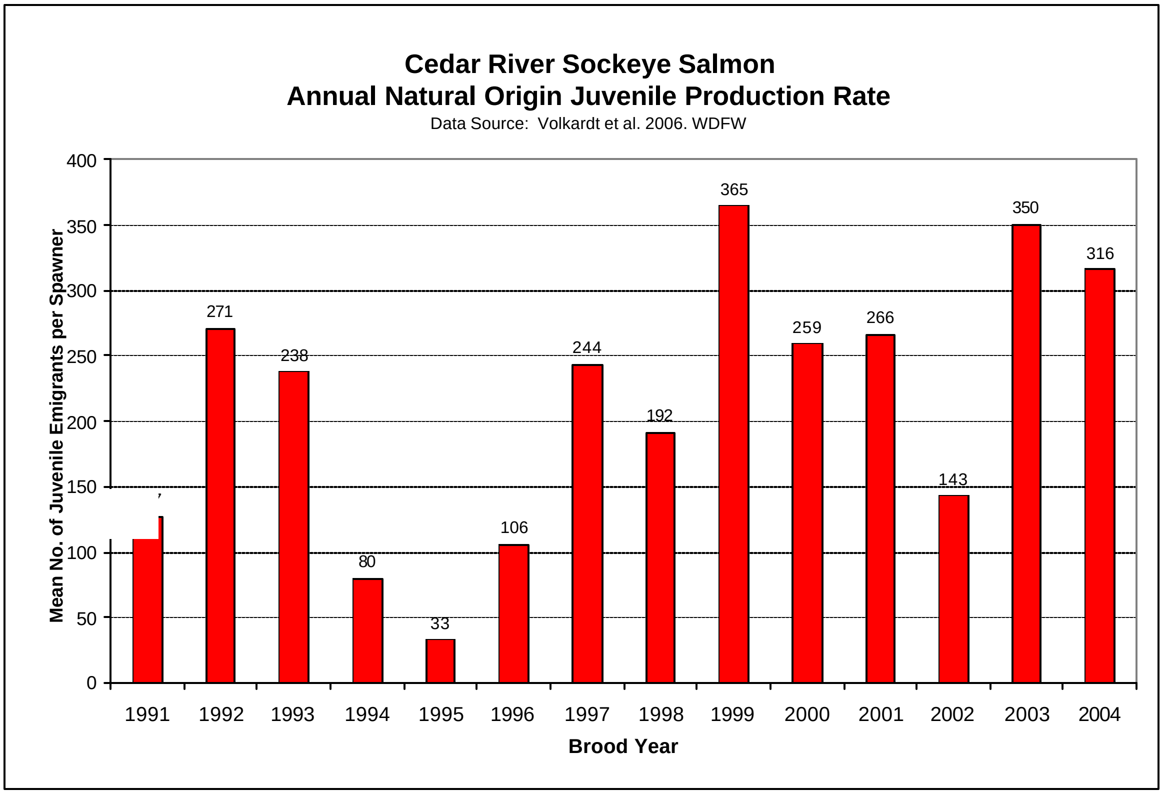


Figure 14. Cedar River Sockeye Salmon Annual Natural Origin Juvenile Production Rate: 1991-2004

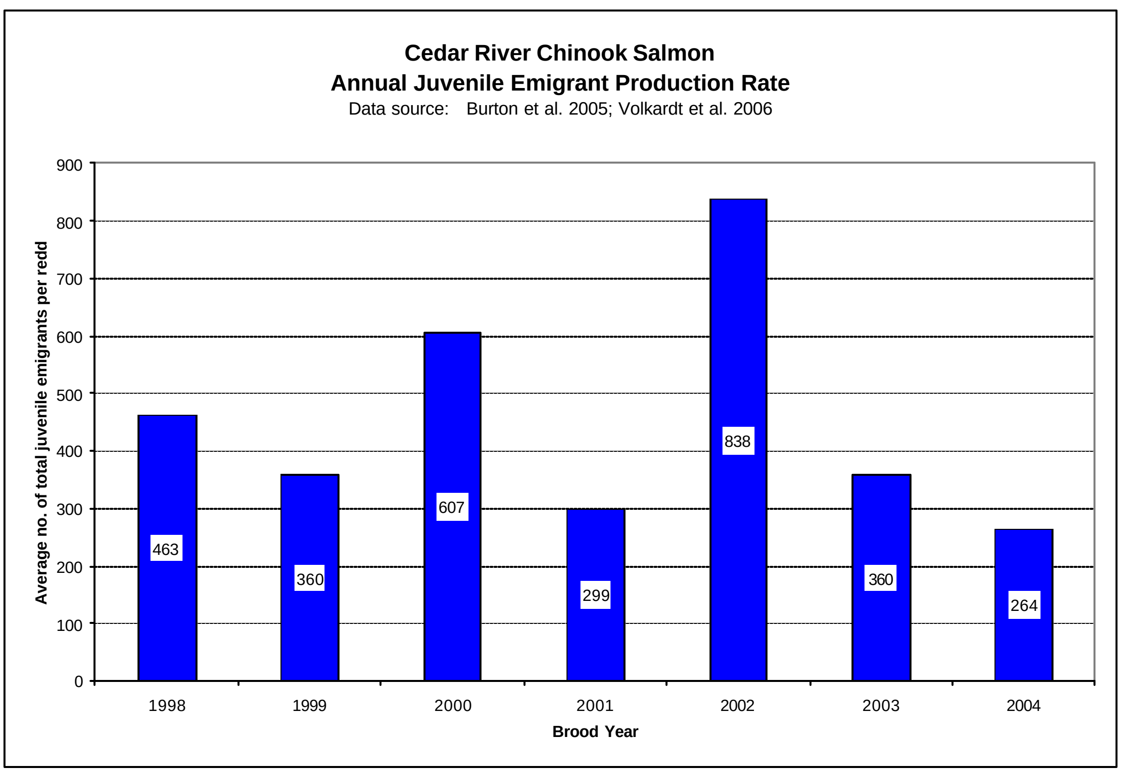


Figure 15. Cedar River Chinook Salmon Annual Emigrant Production Rate: 1998-2004

The Cedar River IFC has a keen interest in the effect of stream flow on Chinook juvenile life history pattern and subsequent contributions of the different patterns to adult returns. Like many ocean-type Chinook populations in the region, Cedar River Chinook display two primary early life history patterns: 1) young fish that migrate downstream out of the river very shortly after emergence from their redds (fry); and 2) those that rear in the river for up to 3 months prior to migrating out of the river (smolts). Although in-river survival rate of juvenile Chinook does not show strong trends, in recent years, there has been an increasing trend in the number of fish that migrate from the river as smolts (Figure 16). It is not clear what factors might be causing this trend.

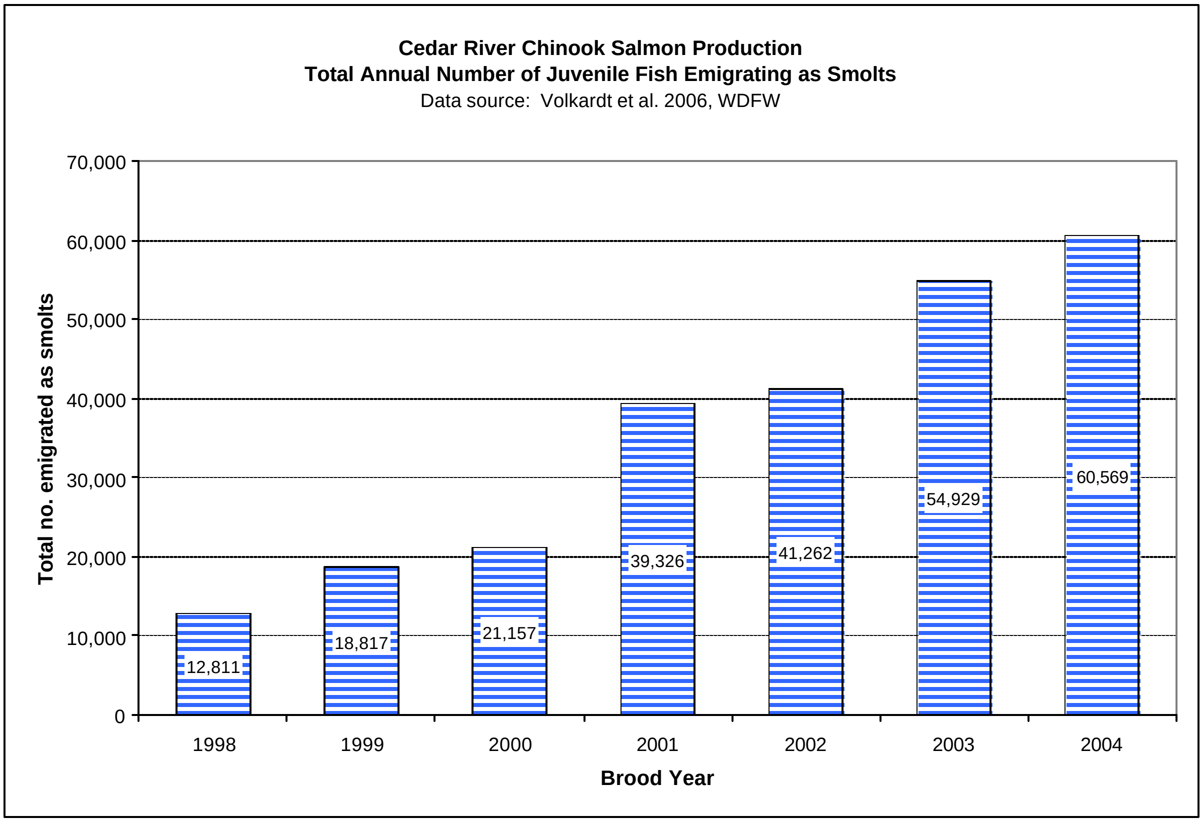


Figure 16. Cedar River Chinook Salmon Annual Number of Juveniles Emigrating as Smolts: 1998-2004

The potential effect of late winter and early spring stream flow on the relative proportion of the two Chinook early life history types is one of the top priority questions posed by the IFC for its Cedar River Supplemental Biological Study Project. While it is still too early in the investigation to establish definite trends, the proportion of juvenile Chinook migrating as fry appears to trend upward with increasing stream flow during the late winter and spring (Figure 17).

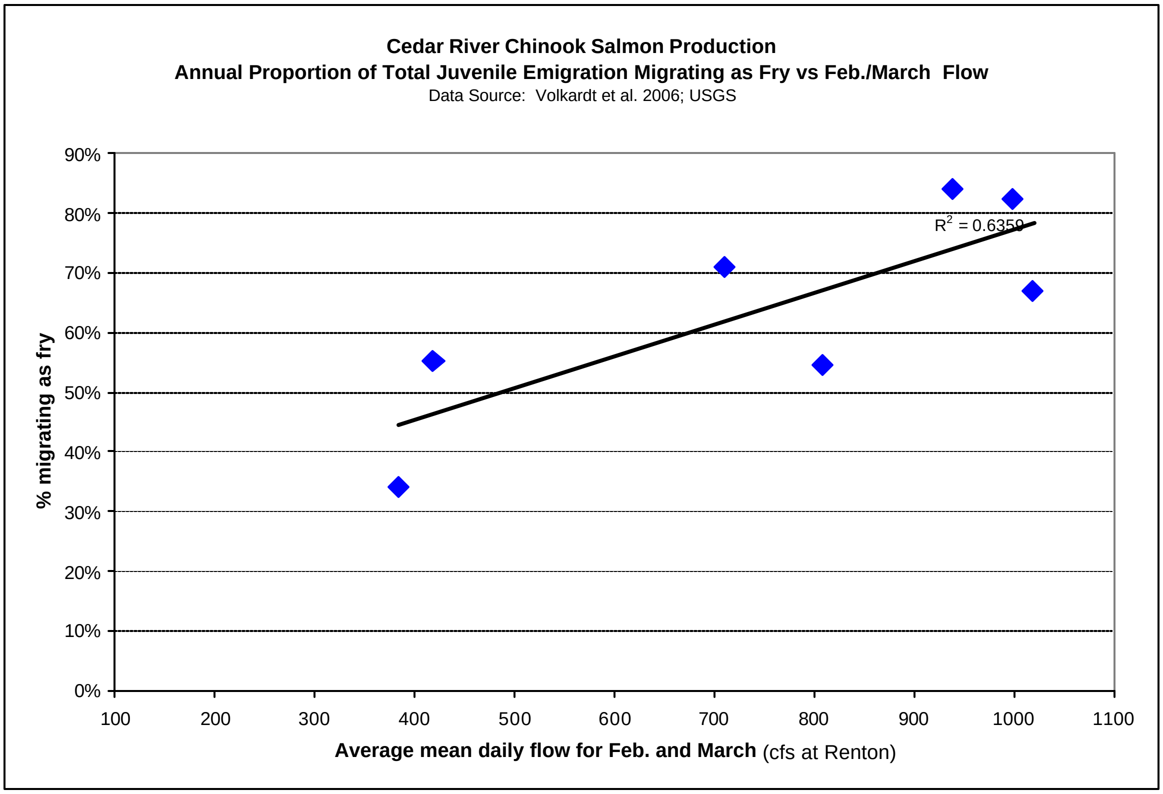


Figure 17. Cedar River Chinook Salmon Annual Proportion of Total Juvenile Emigration as Fry vs. Feb/March Flow

The total annual number of juvenile Chinook migrating from the river does not appear to vary with spring stream flow (Figure 18). Nor have the results thus far exhibited a strong relationship between peak incubation flow and Chinook egg to emigrant survival rate (Figure 19). This is in contrast to an observed significant downward trend in sockeye egg to emigrant survival rates with increasing peak flow magnitude during incubation reported by Volkhardt et al. 2006.

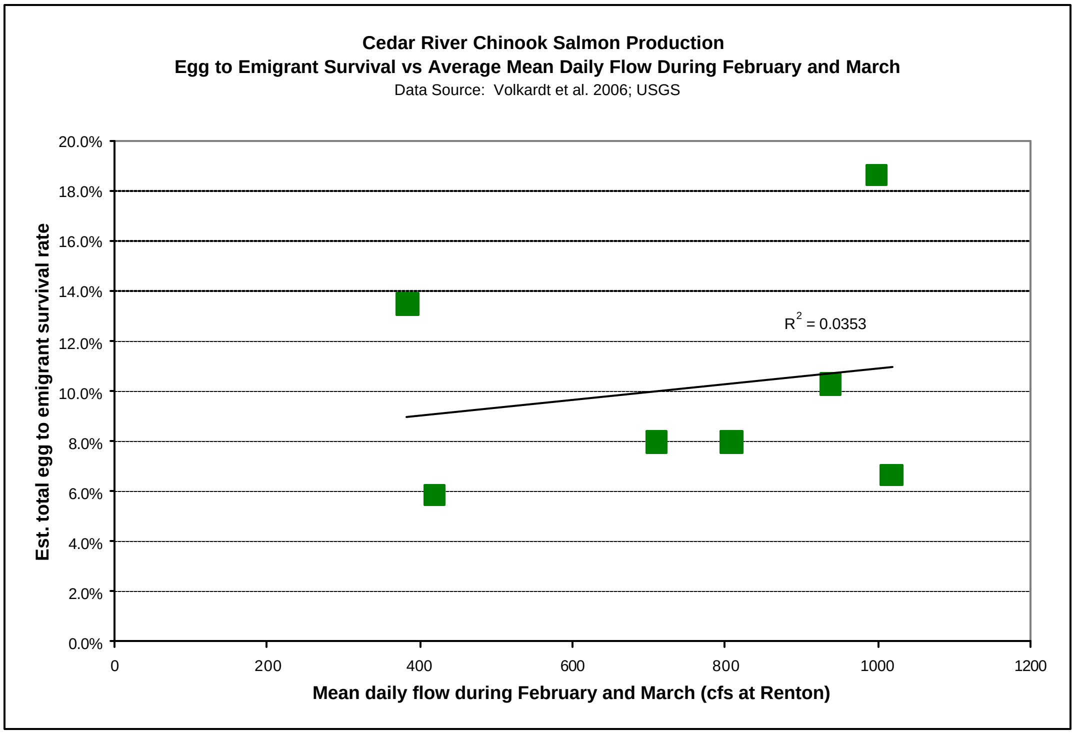


Figure 18. Cedar River Chinook Egg to Emigrant Survival vs. Average Mean Daily Flow Feb/March: 1999-2005

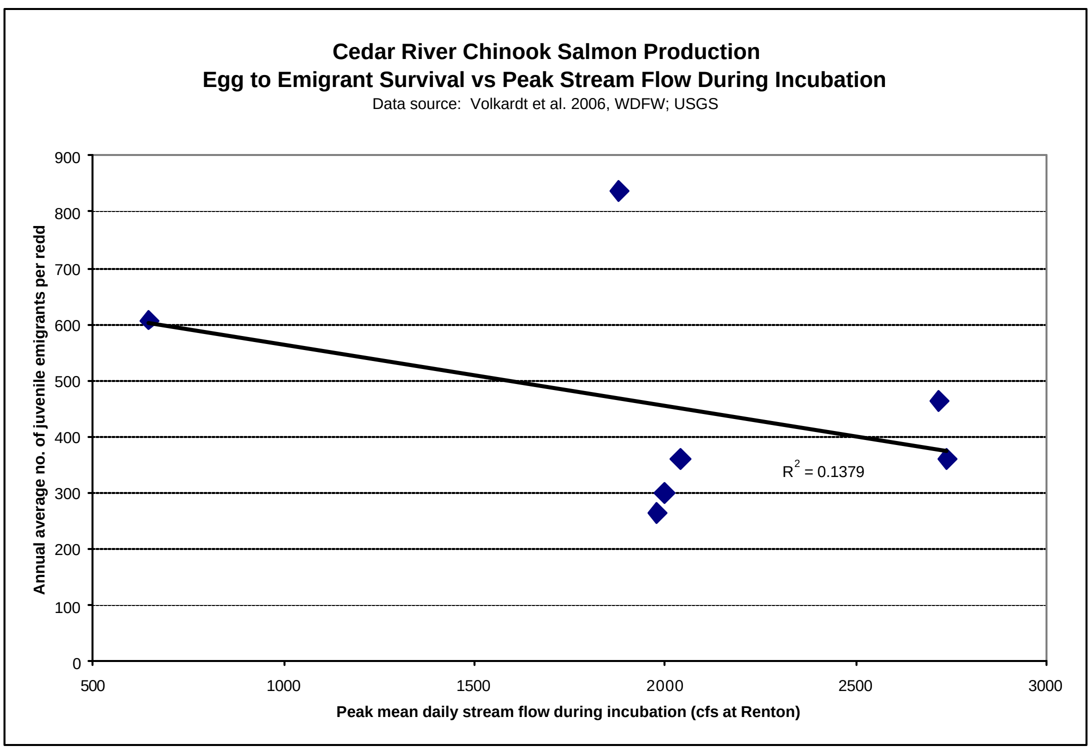


Figure 19. Cedar River Chinook Salmon Egg to Emigrant Survival vs. Peak Stream Flow Incubation: 1999-2005

3.2.4. Assessment of Landscape Function and Connectivity

This section of the comprehensive review focuses on evaluating the effects of the HCP through HCP year 5 on the basis of ecological function and connectivity at the landscape level and within a regional context. The section includes identification of some key considerations pertinent to a regional assessment, descriptions of several simple spatial **frameworks** for assessing effectiveness at the regional scale (Figure 20), and the assessment of HCP accomplishments in terms of landscape function and connectivity (Figure 21).

In discussing the value of the HCP with respect to ecological function and landscape connectivity, several considerations are relevant:

- SPU's responsibility and authority within the Lake Washington basin as it applies to the HCP
- The effects of past hydromodification of the Lake Washington basin on the ecology of the system and the salmonid species present
- The influence of land development on landscape connectivity
- The recognition that connectivity for fish differs from connectivity for animals that use the land as habitat or to disperse.

Responsibility

While the City controls the Cedar River Municipal Watershed and diverts water from the Cedar River, it has limited influence on or responsibility for land use in the Cedar River below the Landsburg Dam or on the north, east, and south sides of Lake Washington (see Figure 20). Primary responsibility for land management activities that affect the river downstream of City ownership boundary falls with King County and those municipalities that are on or influence the river.

The City has some influence on the near-shore saltwater environment, but no responsibility or authority related to harvest of fish. (Note that SPU is engaged in conservation strategies for urban creeks that drain into Puget Sound and Lake Washington, but these programs are not part of the HCP, which focuses only on operations related to drinking water.) While the Cedar River supplies approximately half of the water supply to Lake Washington, the primary responsibility for ecological effects on the lake falls with municipalities on the lake or its tributaries, including the City, and the Corps, which manages the level of the Lake through its management of the Ballard Locks. And while the water discharged from the Cedar and Sammamish rivers into lake Washington influences how the Corps can manage the Ballard Locks, the primary responsibility for managing the water that flows through the Locks belongs to the Corps, and the primary effects on the Lake Washington Ship Canal are through Corps operations and urban influences.

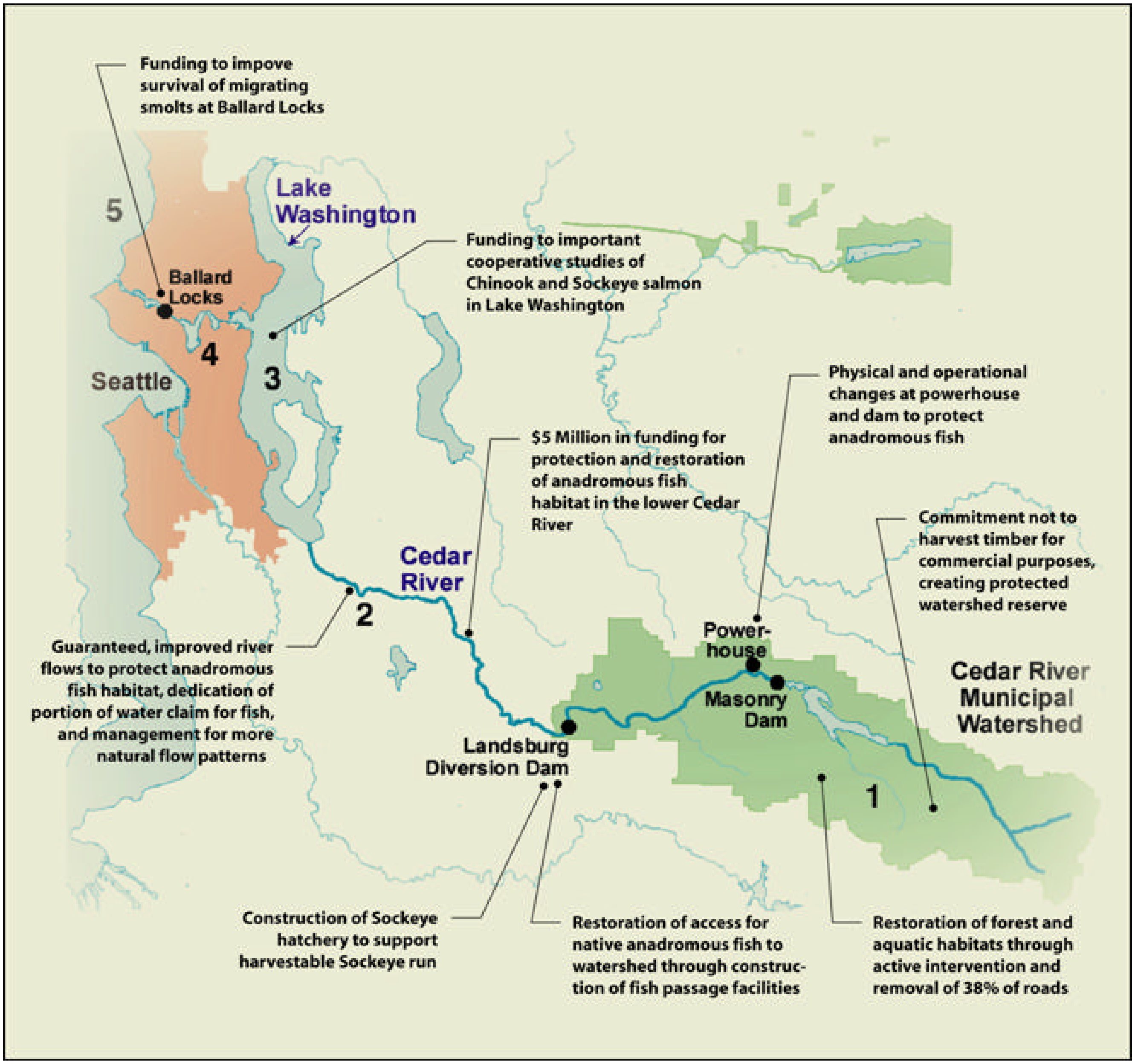


Figure 20: Framework One: Five Links in the Cedar River Salmon Lifecycle

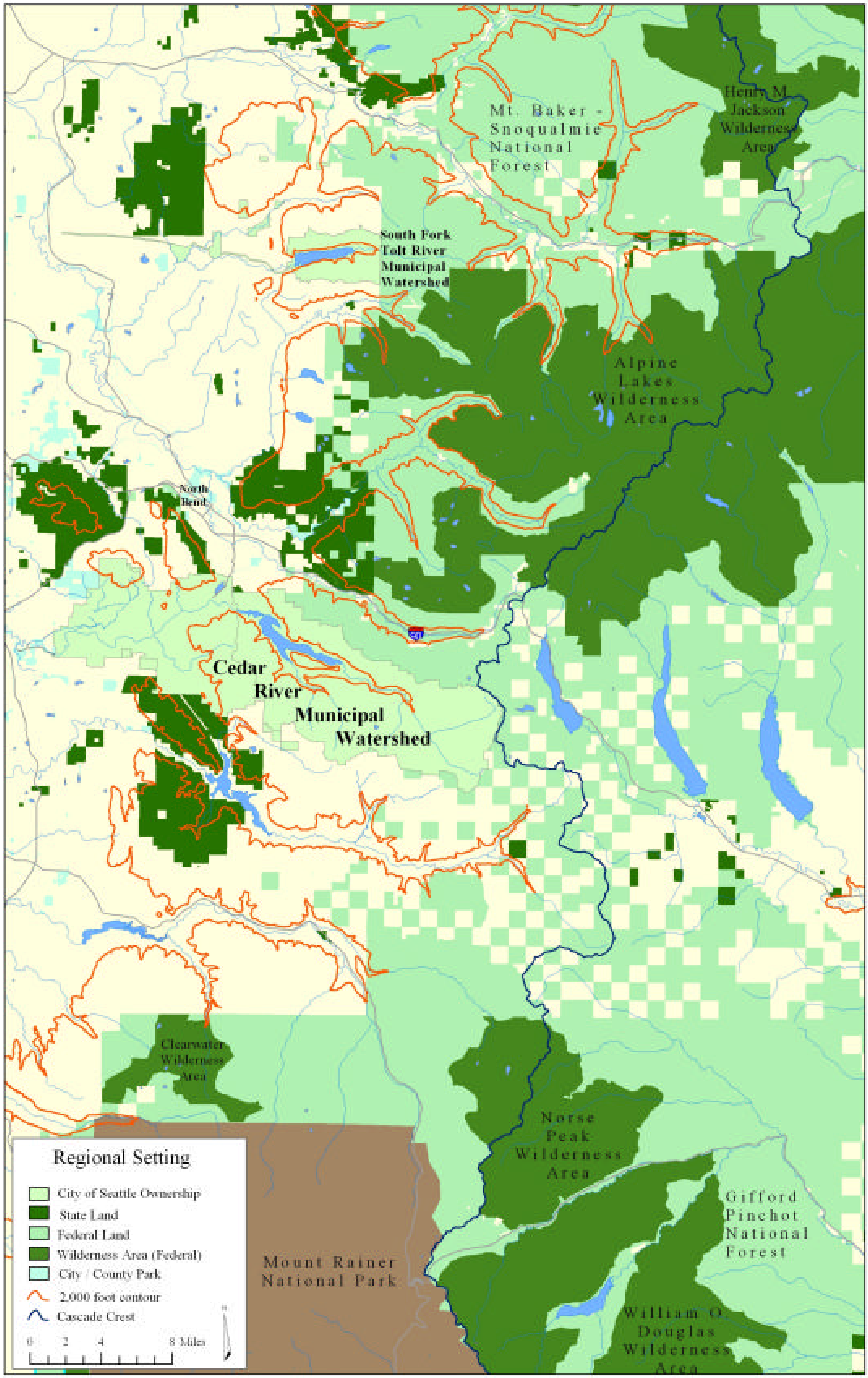


Figure 21. Framework Two: Regional Forest Connectivity

Hydromodification and Its Consequences

While considering how the HCP functions, it is important to note that the hydrological configuration of the Lake Washington basin is fundamentally different from the original, natural configuration. During World War I, when the Lake Washington Ship Canal was constructed, the level of Lake Washington was lowered about 9 feet, and the Cedar River was rerouted from its original discharge into the Black River (feeding into the Duwamish River then Puget Sound) to Lake Washington. This fundamental hydromodification likely had very substantial and lasting effects on the ecology of Lake Washington and the salmonids that used the system.

This change in hydrology may be one of the primary reasons why native chum and pink salmon disappeared from the system, as fry of these species typically move directly after hatching to saltwater estuaries. The reconfigured system was likely hostile to these species, with a large lake between the river and Puget Sound and the entrance into Puget Sound no longer a river estuary. It is also reasonable to assume that this hydromodification may have adversely affected the local "ocean-type" Chinook salmon, believed to move as fry or juveniles within a period of days or months to saltwater estuaries.

On the other hand, the changes created the kind of system to which sockeye salmon are adapted: a river above a large freshwater lake. Relatively small numbers of young sockeye were introduced by the state into the Cedar River from the North Cascades in the 1940s. These early plants were discontinued after several years, and the population gradually increased in numbers, becoming the predominant salmonid species in the system and supporting a highly popular recreational and tribal fishery.

Salmon are known to import marine nutrients into freshwater environments, increasing biological productivity of affected streams and riparian areas. Spawning activity by mass spawning species like pink, chum, and sockeye displaces fine sediments, creating more porous substrate that facilitates water movement that is beneficial for incubating eggs. Spawning activity creates a pulse of suspended particulates resulting in temporary but significant decreases in periphyton biomass. It can result in benthic invertebrate mortality and access to food for resident species or juvenile anadromous species. Nest digging may reduce the scouring effects of high flows by increasing critical sheer stress through the sorting of substrate sizes. It is reasonable to conclude that salmon spawning at relatively higher densities have a relatively greater effect on their spawning streams. It could also reasonably be argued that the mass-spawning sockeye filled, to some extent, the ecological niches vacated by the locally extinct, mass-spawning chum and pink salmon.

As indicated in the preceding discussion, the hydromodification of the Lake Washington system has several important implications related to an assessment of the HCP that can be summarized as follows:

- Since World War I, native anadromous fish have had to take a different, and for some, a more hostile route into and out of the Cedar River as a consequence of major hydromodification. Likely as a consequence of hydromodification, several indigenous species of mass-spawning salmon (chum and pink salmon) have become extinct in the Cedar River system

- For one species native to the region (sockeye salmon), a non-indigenous stock (form Baker Lake) was introduced into an environment now suited to its life history

- Achieving effective landscape connectivity in this modified system is challenging, as potentially hostile conditions exist at many points in the migratory path of salmon.

Continued monitoring of Lake Washington has demonstrated that the lake is dynamic and evolving in ways that we only partially understand. Long-term monitoring begun by Dr. Tommy Edmondson of the University of Washington and continued by Dr. Dan Schindler and his colleagues indicates a warming trend and biological changes that are of potential significance to fish in the lake (Schindler and Scheuerell 2005, Schindler et al. 2005). The best information that we have on sockeye survival indicates that fry to smolt survival is relatively low compared to other sockeye lakes. Size of sockeye juveniles is generally quite large, but shows variability corresponding to the 2-year cycle of smolt abundance. The HCP contribution of continued monitoring of zooplankton and fish populations addresses interests that go beyond questions related to sockeye and the hatchery and are relevant to questions about the effects of climate change. This demonstrates the value of providing resources for consistent, long-term monitoring.

Land Use and Development

Land development is proceeding apace in the Lake Washington basin, and the ecological effects of past development are marked in the basin. Urban development around Lake Washington and along the Lake Washington Ship Canal contributes warm, polluted water to the system. Development along the lower Cedar River, channelization, and the hardening of the banks along about 65% of this part of the river have collectively reduced the length of the stream, increased its gradient, decreased its width, decreased river sinuosity, and disconnected the river from it floodplain. These changes have reduced available spawning and rearing habitat for salmonids, increased the velocity and scouring effects of flood flows, and generally simplified the system.

Most of the forest in urban and suburban areas has been removed, fragmented, or degraded. Urban development has moved eastward in King County, and land in the lowlands or foothills in the Puget Sound region is largely developed, in agricultural use, forest land that is threatened with development, or forest land that in under intensive timber management, in which forests rarely reach sufficient age or development to fully support species dependent on late-successional and old-growth forest environments.

Substantial federal land exists under management by the USDA Forest Service (USFS) or National Parks Service that has older forest, but nearly all of this land is at relatively high elevations near the Cascades crest. Furthermore, as a result of construction of the transcontinental railroad in the nineteenth century, a pattern of checkerboard ownership prevails along the I-90 corridor. The checkerboard pattern is characterized by alternating 1-square-mile sections in private and federal ownership, with most of the private land under intensive timber management. This has produced a fragmented landscape, with less capacity to support species dependent on late-successional and old-growth forest habitats. To make matters even more challenging for species dependent on older forests, the east-west width of federal ownership is constricted in the central Cascades (see Figure 21).

Elements of Connectivity

For fish, several characteristics of the aquatic environment can serve as barriers to passage, effectively fragmenting the landscape and reducing the amount of available habitat. Human-made, physical barriers are, of course, a primary cause of fragmentation. These include dams and some road crossings. In addition, some aquatic habitats may have hostile conditions, such as extremely high temperatures in summer, which render them either blockages or mortality traps. Restoring connectivity in aquatic systems may involve attempts to restore original conditions, but more likely entail substitution for those conditions. Examples of substitution would be the installation of fish ladders at dams (such as the City's Landsburg Diversion Dam) instead of removal of those dams, or redesigned crossings, where better designed culverts or bridges are installed that allow fish to pass upstream, such as is being done under the HCP within the municipal watershed.

For upland forests, landscape fragmentation and the inclusion of hostile environments in the landscape can drastically reduce ecological connectivity and impede the dispersal and migration of many kinds of forest animals. The pattern of land use in King County described above has dramatically reduced landscape connectivity for species dependent on late-successional and old-growth forests, both along a north-south axis within the Cascades and along an east-west axis between high and low elevations. The Cedar River Watershed is in a prime location to improve landscape connectivity and overall ecological function for species dependent on older forests along both these axes (see Figure 21).

3.2.5. Assessing Landscape Function and Connectivity in a Regional Context: Two Spatial Frameworks

Because the species of concern under the HCP encompass anadromous salmonids to upland vertebrates and invertebrates, no single spatial model of the landscape fits well for all species. SPU proposes to use two simple, spatially oriented conceptual frameworks for evaluating the effectiveness of the HCP to date, the first of which is described in the HCP.

Framework One: 5 Links in the Cedar River Salmon Life Cycle

For anadromous salmonids that use the Cedar River, SPU proposes a spatial framework (or geographic model) that attempts to encompass the full life history pattern of these species. The framework proceeds in a roughly linear arrangement from the crest of the Cascade Mountains downstream to the marine environment. This model portrays the relationship between salmon and their ecosystem as a chain of 5 links, or what has been dubbed "5 Links in the Chain for Salmon" (see Figure 20). This construct is based on the recognition that the well being of anadromous salmonids (and other anadromous species) that spawn in the Cedar River and move between the ocean and the Cedar River depends on the ecological processes, functions, and interconnection in each of the following five links:

Link 1. Headwaters of the Cedar River

1. Cedar River Municipal Watershed, 2/3 of the Cedar River basin, managed by SPU, subject to land and water management activities
2. Provides water, sediment, and wood to streams within the municipal watershed and to the mainstem downstream of the City's ownership boundaries
3. Includes 17 miles of potential stream habitat within the municipal watershed for Chinook and coho salmon as well as fluvial, adfluvial, and anadromous rainbow trout.

Link 2. Lower Cedar River

4. Approximately 22 miles of mainstem Cedar River from the Landsburg Diversion Dam to Lake Washington, mostly in unincorporated King County, and subject to land development and regulation of river flows
5. Routes and sorts water, sediment, and wood, which interact to form stream habitat for anadromous salmonids and other species.
6. Type of lowland habitat that historically formed exceptionally productive freshwater areas for anadromous salmonids.

Link 3. Lake Washington

7. Recent addition to the chain (1917) that is subject to impacts of urbanization and water management activities associated with operation of the Ballard Locks
8. Receives and routes water, provides rearing and staging habitat, and serves as migratory corridor for anadromous fish
9. Provides opportunities for some anadromous species (e.g., sockeye salmon, which were introduced and have flourished in the Cedar River) and challenges for others (e.g., pink salmon, which are now extinct in the Cedar River).

Link 4. Lake Washington Ship Canal and Ballard Locks

10. Included with the recent addition of Lake Washington to the basin's anadromous fish life cycle, and subject to effects of the urban environment and water management navigation and fish passage activities at the Ballard Locks
11. Feature that forms the interface between the freshwater and marine environments
12. Provides passage to and from the marine environment and functions as a transition and staging zone for juvenile fish as they migrate from fresh water and adults as they return to fresh water.

Link 5. Puget Sound and the Pacific Ocean

13. Where many anadromous species spend the largest portion of their life and subject to the effects of commercial and recreational harvest, near shore land and marine management activities, pollution, climate variation, and many other factors

14. Relatively fertile marine ecosystem provides productive environment for migration, growth and maturation of sub-adults to adults.

While the HCP is focused on the City's land ownership and management of the drinking water supply and hydroelectric generation facilities in the Cedar River basin, it is expected to make substantial contributions to all four freshwater links, and even provides some elements that can help support anadromous fish in the marine environment. These contributions include both the effects of directed conservation actions and relevant studies to improve understanding of the system in support of continued improvement of ongoing land and water management practices.

Expected *contributions* specific to each of the links include the following:

Link 1. Headwaters of the Cedar River

Land Management Practices and Habitat Restoration Activities:

15. Protect and improve water quality, providing benefit to a variety of habitats throughout the watershed, including direct benefit to aquatic resources in the Cedar River and Lake Washington

16. Encourage and protect natural sediment delivery and transport, providing benefit to aquatic resources within the watershed and throughout the lower Cedar River

17. Protect and restore riparian habitat and associated stream processes, providing direct benefit to anadromous fish in municipal watershed and indirect benefits to anadromous fish in the lower river

18. Associated studies of fish in the reservoir system provide information to help guide the operation of the reservoir and to plan habitat restoration.

Landsburg Fish Passage Project:

19. Provides upstream passage for Chinook and coho salmon, anadromous, fluvial and adfluvial rainbow trout up to the historic fish passage barrier at lower Cedar falls, reconnecting 17 stream miles of productive habitat in the protected municipal watershed with the lower river

20. By allowing the removal of sockeye salmon, reduces the risks to drinking water quality associated with large numbers of a mass-spawning salmon species

21. Associated recolonization studies provide information to help guide the operation of fish passage facilities, plan habitat restoration, and measure the effectiveness of fish passage facilities and associated habitat protection measures in the municipal watershed.

Link 2. Lower Cedar River

22. Habitat acquisition, protection and restoration linking with similar efforts by King County, the City of Renton, and others to improve habitat conditions in the 22 miles of mainstem Cedar River downstream of the City's ownership boundary

23. Cedar River sockeye salmon hatchery program as mitigation for the lost sockeye production capacity upstream of the Landsburg Dam. Supports naturally reproducing sockeye population in lower Cedar River and contributes to aquatic communities in lower Cedar River and Lake Washington

24. Comprehensive adaptive management program to help ensure that the sockeye program meets its objectives to produce sockeye while minimizing potential risks to naturally reproducing salmonids in the Cedar River and elsewhere in the Lake Washington basin.

25. Comprehensive instream flow management program to provide beneficial conditions for all life stages of anadromous fish; includes guaranteed minimum and supplemental stream flows, limits on municipal water supply diversions, flow management flexibility with supporting monitoring and research programs.

Link 3. Lake Washington

26. Cedar River provides about 1/2 of the total annual flow through Lake Washington. HCP land and water management prescriptions mentioned above help ensure the continued delivery of high quality water to the lake, which in turn helps support beneficial habitat conditions in the lake for anadromous salmonids and other species

27. Number of studies associated with the sockeye hatchery adaptive management program and instream flow management program provide key information on the lake and its role in the life history of the basin's salmonids and other species.

Link 4. Lake Washington Ship Canal and Ballard Locks

28. Provides funding for smolt passage and water use efficiency improvements at the Ballard Locks

29. Instream flow management regime provides water to support navigation and fish passage at the Ballard Locks

30. Studies conducted as part of the Cedar River instream flow management and sockeye hatchery programs contribute to understanding of fish migration in the ship canal and the Ballard Locks that can be used in ongoing operations and maintenance activities in this key component of the anadromous fish migratory pathway.

Link 5. Puget Sound and the Pacific Ocean

31. While activities affecting this major link in the anadromous fish life cycle are well beyond the scope of the HCP, the plan does provide potential support for harvest management activities through the comprehensive sockeye hatchery fry marking project, ongoing pit tagging studies, and annual Chinook spawning surveys.

Framework Two: Regional Forest Connectivity

The second framework is more appropriate for those species that move across the landscape of the Cascade Mountains and foothills in a manner that is not limited to the use of moving surface waters. This framework focuses on regional habitat capacity for species of concern in the Cedar River Municipal Watershed and linkages among habitats for those species in the mountains and foothills of the region, where some habitat for these species remains. A regional map for this framework is shown in Figure 21.

Many animal species in the Pacific Northwest depend on mature, late-successional, and old-growth conifer forests, including many species that use aquatic and riparian habitats. As a result of substantial and widespread loss, fragmentation, and general degradation of old-growth forest habitats, as well as urbanization and removal of forests in the lowlands, these fish and wildlife species collectively represent one of the greatest at-risk groups in the region.

Considering that habitat changes sharply east of the Cascades crest, many species that inhabit the Cedar River Watershed depend on landscape elements to the north, south, and west (Figure q). Several observations are important in considering the capacity of the landscape to support HCP species of concern: (1) most of the original old-growth forest in the Puget Sound region has been logged, with remnants almost exclusively at higher elevations along the Cascades crest, and (2) most forested habitat at low to middle elevations in the Puget Sound region has either been developed or is managed for intensive timber harvest (with short harvest rotations: usually less than 50 years), with some of the commercial forest land at risk of future development.

The landscape is thus fragmented overall and has dramatically reduced habitat capacity at low to middle elevations for species dependent on late-successional and old-growth forests and associated habitats. In addition, two features of the I-90 corridor are significant from a landscape perspective (see Figure 21): (1) historic checkerboard (intermingled) ownership of federal and private land has resulted in a large degree of forest fragmentation and a substantial reduction of old-growth habitat on private lands, and (2) federal ownership in the national forests has a relatively narrow east-west width in this area, restricting species dependent on old-growth forest to a very narrow north-south corridor for migration and dispersal. These latter features render the I-90 corridor a classic bottleneck for north-south movement of animals many species.

Given its location, size, and characteristics, the Cedar River Watershed has several key features that highlight its potential for making significant contributions for regional terrestrial and aquatic species that depend on older forests in two basic contexts, as described below.

North-South: Connecting northern and southern Cascades

Key features

- Within an area identified by federal biologists as an area of critical importance for species dependent on late-successional or old-growth forests, in part as linkage of habitats in northern and southern Cascades
- Large block of land, with considerable older forest.

Potential contribution

- Provides connectivity for species in north and south Cascades
- Managing as reserve reduces fragmentation within I-90 corridor as forest matures
- Recruitment of late-successional and old-growth forest through protection and active restoration
- Provides substantial potential habitat, over time, for species dependent on older forests and aquatic habitats.

East-West: Connecting mountains and lowlands

Key features

- Large tract of land with more than 85,000 acres of forest in an area of key importance to many at risk species
- Approximately 60% of forest more than 60 years of age, with nearly 14,000 acres of native forest more than 200 years old
- Approximately 55% of forest is below 3,000 feet elevation
- Some of the healthiest stream and riparian habitat in King County, with relatively mature riparian forests.

Potential contribution

- One of the few significant opportunities to reestablish a block of mature, late-successional, and old-growth forest below 3,000 feet in a manner that could effectively link this forest block to existing old growth in other areas of the Cascades
- Recruitment of late-successional and old-growth forest through protection and active restoration
- Reduction of forest fragmentation through road decommissioning and growth and development of reserve forest
- Improvement of aquatic habitats through road improvements and decommissioning, and other restoration projects.

Summary of Assessment of Connectivity and Ecological Function

The HCP has contributed to landscape connectivity and ecological function through stewardship, restoration, and a contribution to understanding that will support better decision-making and planning over time.

Stewardship

A primary contribution of the HCP to date is through stewardship of resources managed or affected by the City's activities. Important among these stewardship activities are:

- Protection of forest in the municipal watershed for 5 years, with no fires, and natural growth and several natural disturbances that improved habitat quality.
- Protection of water quality within the municipal watershed.
- Maintenance of fish in reservoirs and tributaries: listed bull trout population which has been found to be healthy and not declining, and pygmy whitefish population.
- Maintenance of river flows below the Landsburg Dan: protection of redds, maintenance of habitat, support for emigration.
- Grant funding for acquisition of key habitats along lower Cedar River though grants, leveraging City's investments.

Restoration of Connectivity and Ecological Function

A second major contribution of the HCP to date has been through projects and activities that contribute to restoring habitat or species populations. Important among these restoration activities are:

- Fish passage at the Landsburg Dam after a century of blockage: allowing recolonization and importation of marine nutrients, which should increase habitat productivity
- Fish passage at road crossings in municipal watershed: access to upstream habitat for fish
- Improvements for smolt passage at the Ballard Locks: increased survival of smolts
- Reductions in sediment loading to streams from roads: improved water quality and habitat quality for fish and other aquatic organisms
- Addition of LWD to streams: improvement of habitat through development of complexity
- Production of sockeye fry to supplement population, increasing adult returns and associated ecological benefits provided by mass-spawning species of salmon, allowing more fishing opportunities.

Information

- Recolonization studies: collaborative study to gather key information for future decisions on anadromous salmonids using the Cedar River
- Fish studies in the reservoir and tributaries: better understanding of population movements and habitat use, facilitating better decisions in managing reservoir
- Studies in lower the Cedar River and Lake Washington on Chinook and sockeye salmon and the ecosystem upon which they depend.

3.3. Intentional Learning

Ideally, scientists have a solid understanding of the receiving ecosystem and the effects of intervention before designing and implementing environmental projects. It is recognized in the arena of natural resource management, however, that ecosystems are very complex and understanding of most ecosystems and most species is limited, and knowledge of the effectiveness of specific restoration and conservation measures in the long term is uneven. Research focused on these ecosystems and species and on restoration techniques is clearly needed, but such research takes considerable time and money, and conservation actions are needed now. In the face of these challenges, a strategy of intentional learning is appropriate. Such a strategy involves the inclusion of learning the in goals of projects, and an organizational commitment to evaluation and the use of new information in management.

3.3.1. Components of an Intentional Learning Paradigm

Research and Adaptive Management

Ideally, research could be conducted quickly, improving understanding, so projects could be designed with the greatest likelihood of success. Research, however, is a challenging endeavor, and the results of research, because of its very nature, are often uncertain. The HCP includes research, where feasible and appropriate. Where management actions are needed, for example, implementing conservation measures required by the HCP, where there is neither the time nor resources for research in advance, monitoring linked to adaptive management is the best strategy available. Adaptive management is a systematic approach to natural resource management in the face of uncertainty in which management interventions are designed with specific hypotheses in mind regarding the ecological outcome intended by the intervention. Adaptive management entails appropriate monitoring to test those hypotheses and an organizational commitment to use the results of monitoring to inform related decisions.

It is important to note, in this context, that research, monitoring, and adaptive management are part of a spectrum of information-based strategies to manage in the face of uncertainty and risk. Pure monitoring can be considered to be tracking changes, and pure research can be considered to be investigation to answer specific questions or test specific hypotheses, but this difference can blur in the context of adaptive management.

Adaptive Management

Some research involves controlled, replicated experimentation to evaluate a set of competing hypotheses in a comparative context. When this approach is applied to natural resource management to compare competing types of intervention with specific management objectives to in pursuit of a desired outcome, it is called *active adaptive management*. *Passive adaptive management*, on the other hand, is typically based on a single type of intervention based on a "best estimate" for the expected ecological response. It entails monitoring that is not expressly designed to compare treatments in a formal experimental design, but rather monitoring to determine the outcome of the chosen treatment. Passive adaptive management often lacks the controls and replication of active adaptive management, thus limiting the ability of managers to draw clear inferences about results, but it is substantially less expensive and time consuming to design and implement, and it is likely the most prevalent form of adaptive management in use today. The approach to adaptive management under the HCP is described in Section 3.4.3.

Intentional Learning Paradigm

The HCP entails all of the approaches discussed above: research, monitoring, and adaptive management. With respect to the HCP, it should also be noted that research, construed broadly, can involve carefully designed studies, modeling, or simply contacting experts for advice, all with the intent of making better decisions in HCP conservation programs. These approaches fit collectively into an *intentional learning paradigm*, which is intended to improve understanding and performance over time in a systematic fashion, allowing for better decisions making in trying to achieve HCP goals and objectives. Implementing this paradigm involves working with many partners (see Section 3.5on collaboration), and developing an approach to adaptive management, a requirement of the HCP.

One important element of this paradigm is the follow-through of the organization. Learning alone does not constitute adaptive management or managing adaptively. Decisions must also change in response to the results of research and monitoring, and an organizational structure to support closing this loop is essential.

3.3.2. Key Research Findings through HCP Year 5

This section summarizes some of the findings of research to date. Much of this research has been conducted in collaboration with a variety of partner agencies, academic institutions, and organizations. Many studies related to Watershed Management and Instream Flow are in progress, but no results have been analyzed or reported yet for these studies.

Research in Progress Related to the HCP

No results have been analyzed and reported for the following studies in progress:

- Design and conduct of studies in the Chester Morse Lake Reservoir system and its tributaries (with USGS) using acoustic sensors and transmitters implanted in fish, PIT tag sensors, and tags implanted in fish to determine the movement patterns and habitat use of bull tout, pygmy whitefish, and rainbow trout (initiated in 2005)
- Evaluation of wildfire risks in the watershed and strategies to ameliorate those risks, involving modeling studies (with USFS and University of Washington; report due in 2006)
- Collaboration with the State of Washington to design controlled, replicated experiments to test approaches to ecological thinning in conifer forests (treatments scheduled for 2006)

- Collaboration with USGS, the University of Idaho, and Washington Trout in an attempt to use otolith banding patterns and microchemistry to identify juvenile Chinook early life history patterns and the relative contributions of these life history patterns to subsequent adult returns
- Project conducted as part of the IFC instream flow supplemental study program to compare current regulated stream flows to historic unregulated flows and assess the potential ecological implications of differences in the context of the current altered stream channel and associated receiving system.

DNA Analyses of Kokanee and Bull Trout in the Municipal Watershed

Preliminary findings of genetic analysis on kokanee tissue samples indicate that the Walsh Lake population is different from other populations in the Lake Washington basin, but no conclusion can be drawn yet as to whether the population is introduced or native to the watershed. Preliminary findings of genetic analysis on bull trout in the reservoir and tributary system indicate that bull trout in different tributaries to Chester Morse Lake are genetically differentiated.

Sockeye Research

Sockeye research has focused on enumeration of sockeye at key life history stages, the rearing capacity in Lake Washington, and a number of other parameters. Fry production monitoring at the mouth of the Cedar River has been in place since 1992 and provides the sole estimate of natural origin sockeye fry production. Coupled with release numbers from the sockeye hatchery, good information exists on the number of fry by origin that are produced each year in the Cedar River (Figure 22). This information is published in reports produced by WDFW. Fry data resulting from naturally spawning Chinook is collected concurrently with that for sockeye and when added to information collected on smolts, provides a complete picture of Chinook production from the Cedar River (Figure 23).

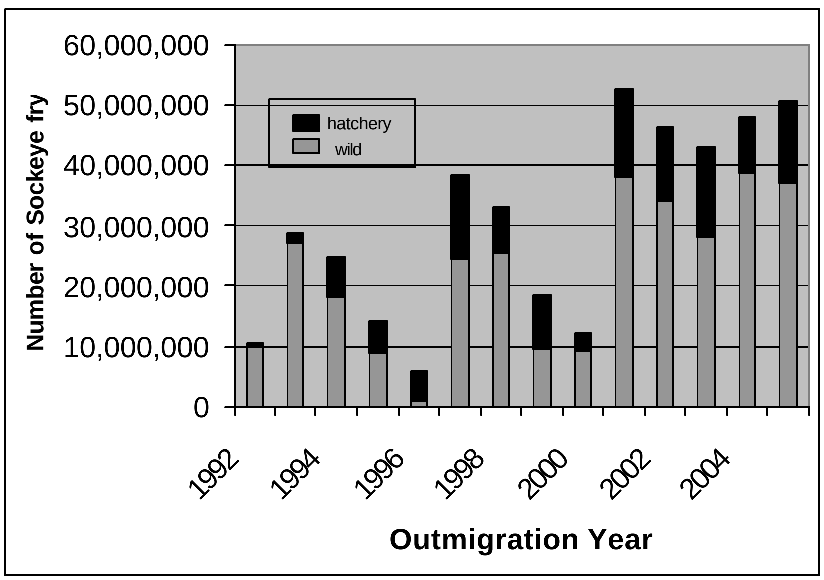


Figure 22. Natural and Hatchery Origin Sockeye Salmon Fry Production from Cedar River: 1992-2005. (WDFW 2006)

Since nearly all sockeye leave the Cedar River soon after they emerge from the gravel as fry, the capacity of Lake Washington to support sockeye fry is of vital interest to the project to ensure that sufficient resources exist to support normal growth. The HCP contained commitments to conduct intensive zooplankton surveys for 4 years, and then committed to spring surveys beginning in year 5. It turned out that the University of Washington was funded by a private foundation to do zooplankton surveys that extended a long-term database in Lake Washington that would have made HCP funded surveys redundant. Instead, the funding was used to survey juvenile sockeye and other species in the lake to assess growth and survival (Table 7).

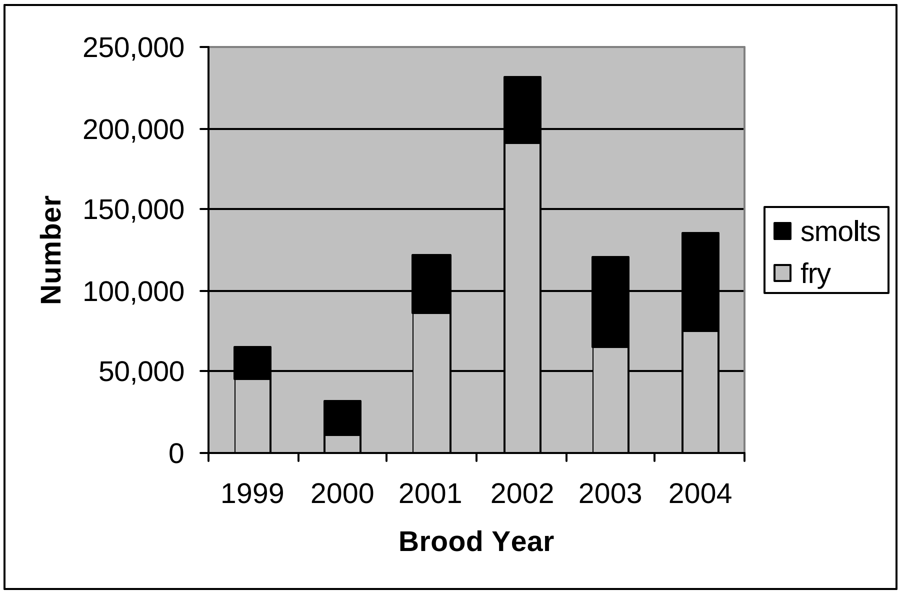


Figure 23. Chinook Fry and Smolt Outmigrants from Cedar River: 1999- 2004 Brood Years (2000-2005 Outmigrant Years) (WDFW 2006)

Assessment of adult returns involves in-river surveys done by WDFW to estimate numbers of live sockeye that are used to generate an estimate of the number of spawning sockeye. Additional sampling must be done to determine the hatchery contribution to the return and to compare characteristics of hatchery and natural origin adults. The adult evaluation has proven to be difficult and complicated by a number of factors, resulting in more limited results. Changes have had to be made to the overall sampling program because of limitations in original sampling protocols. While the initial data were useful for insights into the relationship between release location and adult spawning location and with respect to straying to Bear Creek, they could not be used to reliably estimate contribution by the hatchery. This was the result of challenges in randomly sampling and calculating expansion rates to reflect abundance differences of different groups in different sections of river during the extended spawning period. Since 2005, adult samples have been collected at the Ballard Locks and results expanded using abundance estimates generated by the Muckleshoot Indian Tribe.

Table 7. Sockeye Salmon Abundance and Size for Brood Years 1991-2004

										Lake Washington Juvenile Surveys			
										Kvichak Trawl		Rope Trawl	
Brood Year	Cedar R. Adult Spawners	Cedar R Natural Fry	Cedar R Hatchery Fry	Cedar R Fry Total	Bear Cr Fry Total	Total Fry	Sockeye Juv Fal Estimate	Sockeye pre-smolt Spring Estimate	% Survival CR+BC Fry to Spring Pre-smolt	Fall Size FL (mm)	Spring Size FL (mm)	Fall Size FL (mm)	Spring Size FL (mm)
1991	77,000	9,800,000	600,000	10,400,000									
1992	100,000	27,100,000	1,700,000	28,800,000									
1993	76,000	18,128,574	6,586,361	24,714,935									
1994	109,000	8,705,107	5,600,000	14,305,107									
1995	22,000	730,000	5,200,000	5,800,000									
1996	230,000	24,400,000	13,900,000	38,300,000									
1997	104,000	25,400,000	7,600,000	33,000,000									
1998	49,588	9,500,000	9,000,000	18,500,000	1,523,208	20,023,208							
1999	22,138	9,000,000	3,000,000	12,000,000	189,571	12,189,571							
2000	148,225	37,892,000	14,497,000	52,389,000	2,235,514	54,624,514	2,616,967	2,130,371	3.9%			107.5	108.9
2001	119,000	34,003,795	12,315,006	39,200,000	2,659,782	41,859,782	2,257,532	3,051,433	7.3%	92.1	99.8		104.7
2002	194,640	27,852,350	14,963,447	42,815,797	1,995,294	44,811,091	1,166,328	985,323	2.2%	107.8	109.9		
2003	110,404	38,700,000	9,200,000	47,900,000	177,801	48,077,801	215,578	2,237,916	4.7%	91.9	95.0		
2004	116,978	37,027,961	13,647,787	50,675,748	202,815	50,878,563	507,836			99.2			

(Source: WDFW fry trapping reports, juvenile sockeye survey reports [Overman et al. 2006] and adult estimates [WDFW and MIT]).

A key uncertainty in the adaptive management plan is what influence hatchery production will have on the fitness of natural sockeye spawning in the Cedar River. When the number of fry produced by natural spawners over time was examined, including before and after the hatchery-produced adults began contributing to returns, levels of fry production per spawner were found to be generally higher (Figure 24). This relationship is influenced by environmental factors, the most significant of which is peak flow, but the data are not pointing to depressed fry production at this time. In 2005, collection of reproductive trait data was initiated to detect differences between hatchery and natural origin sockeye or in sockeye over time. This research includes looking at size at age, fecundity, and egg size.

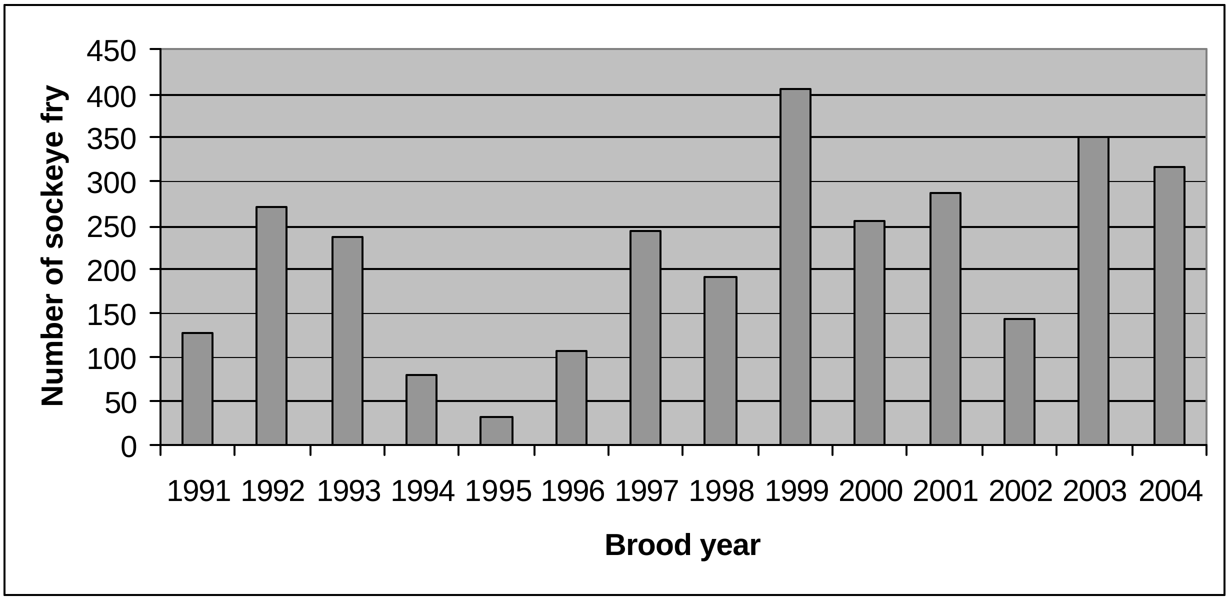


Figure 24. Productivity of Naturally Spawning Sockeye Salmon in Cedar River (Fry per Spawner): Brood Years 1991-2004 (WDFW, MIT Data)

A key concern regarding increased sockeye abundance is the effect of increased harvest on the smaller populations of sockeye in the Lake Washington basin. Funding originally intended for further genetic evaluation of sockeye was allocated to the University of Washington to evaluate the timing and distribution of adult sockeye entering the Lake Washington system. This work indicated that the timing of when sockeye enter the lake has no relationship with spawning timing. This means that harvest is unlikely to unduly affect one segment of the run. The evaluation of distribution in the lake with respect to spawning location led to mixed results between years and suggests that fishery managers will need to be careful in formulating harvest plans to avoid overharvesting smaller populations. An unexpected consequence of the research was the apparent loss of sockeye corresponding to high water temperature at the Ballard Locks during the late portion of the adult migration season. Tagging demonstrated lower recovery of the later tagged fish.

Effects on Other Naturally Spawning Salmon Populations

One uncertainty associated with the sockeye hatchery was the impact of straying to the Bear Creek sockeye population. Samples collected over a 3-year period did not include any marked hatchery origin sockeye, indicating that straying, if it is occurring, is at a very low level. These data have reduced the concern about straying, but further sampling is needed to ensure that remains to be the case.

A key uncertainty that is identified in the hatchery Adaptive Management Plan (AMP) is what impacts the additional sockeye produced through additional hatchery production will have on Chinook in the Cedar River. Data are already being collected that are useful in evaluating this question. One potential impact to Chinook is the delay or redistribution of spawning activity resulting from weir operations. To date, WDFW has concluded that there isn't evidence of significant impacts to the upstream passage of Chinook. Redd surveys are done each year that document the location of each Chinook redd in the river (insofar as possible) and show that on average, about 90% of Chinook spawning activity occurs above the weir. These surveys also document the degree to which sockeye spawning activity overlaps existing Chinook redds. To date, there has been no indication that the proportion of Chinook redds that are spawned over by sockeye is an indicator of lowered juvenile Chinook production. Since superimposition effects are inherently difficult to determine, more monitoring is needed.

O. Mykiss Genetics Study (Steelhead and Resident Rainbow Trout)

Several research projects have been initiated to better understand the life history of steelhead and Chinook in the Cedar River - Lake Washington system. A genetics evaluation of O. mykiss populations suggests close similarity between anadromous and resident forms, as well as between steelhead entering Lake Washington and the Green River. This evaluation, together with other life history information and research on this species, is expected to contribute to future management decisions regarding steelhead.

Predation on Chinook and Other Salmon Species

Additional work is being done to evaluate fish predators of Chinook, and other species in Lake Washington, thought to be the principal factor affecting survival during their tenure in the lake. The expected results will be a projection of predation rate by species, providing a basis for estimating the role of various species on salmon survival. However, the development of population estimates has yet to be done, in part, because of the logistics and cost involved.

Research Infrastructure

HCP funding supports the establishment of special equipment at the Ballard Locks to detect PIT tagged fish that can be individually identified. This information demonstrates that outmigrant smolts are using multiple pathways as they pass through the locks and has provided information that is useful in assessing differences between groups. Additional funding to test the feasibility of similar equipment at the mouth of the Cedar River is also being provided.

Fish Passage and Recolonization Studies

The completion of the fish passage improvements at the Landsburg Dam provide the opportunity to learn about the recolonization process, something of intense interest to many scientists involved in salmon recovery. This has led to a collaborative effort to evaluate how salmon and trout respond to the opportunity to resume access to more than 17 miles of habitat for the first time in a century. A collaborative effort between the University of Washington, NOAA Fisheries, and SPU was forged from a keen interest in taking advantage of this unique learning opportunity.

A primary focus of the recolonization studies has been to identify the distribution of spawning salmon above the Landsburg Dam. These first-generation colonizers are selecting nesting sites without the assumed influence of where their parents spawned. From a scientific standpoint, this raises the rare opportunity to understand habitat features that apparently influence nesting sites without the overlay of parental influence. Chinook redd locations have been mapped for 3 years. Coho redds are more difficult to find due to the higher water conditions and turbidity associated with fall and winter rains, so individual fish were monitored with hydroacoustic methods to determine distribution.

During 3 years of observation, Chinook and coho spawning was concentrated in the lower part of the river closest to the Landsburg Dam. Some coho adults move up and down river extensively prior to spawning. Surprisingly, coho apparently did not spawn in Rock Creek during the 2 years of study, and spawned in the mainstem instead. Small, mature coho males were first observed at the Landsburg fish passage facility in 2005. These are possibly the first returns from parents that spawned above Landsburg in 2003, although this needs to be confirmed through future DNA analysis.

Recolonization research will attempt to answer how the population above the Landsburg Dam will change, relying on voluntary recruitment (straying) and on returns from previous generations that spawn above the dam. To answer this question requires careful counts as the fish pass the dam, where tissue samples have been collected to allow evaluation of DNA matching between parents and subsequent returns. This work was not part of the HCP, so the handling involved with Chinook required an amendment to the HCP Incidental Take Permit. Key to the success of this work is the collaboration between SPU and the University of Washington. SPU has been able to collect samples as part of daily operations of the passage facility, a task that would have been impractical for the University of Washington to do alone. In turn, the University of Washington provides the expertise and facilities for analysis, something outside the capability of SPU. The result is information that is of interest to both parties and to the larger scientific and salmon recovery community as well.

Another focus of the recolonization work is to understand the distribution of juvenile coho and trout over time. Since most coho rear in freshwater for a year prior to entering saltwater, the recruitment of smolts is reliant on rearing habitat and conditions found in the river and its tributaries. How rearing species partition habitat and resources, especially in an area devoid of anadromous species for nearly a century, is of great interest to those trying to develop a better understanding of the processes associated with recolonization. Initial observations of coho juvenile distribution suggests that most are rearing in the lower reach of the river above the dam, similar to the area where spawning occurred. However, the juvenile coho have been found to move upstream into the tributaries to rear.

Sockeye Monitoring and Research

There is little evidence in the monitoring results to date of significant adverse population effects on the naturally spawning sockeye population in the Cedar River from the sockeye hatchery. There are data showing that some groups of hatchery returns are smaller in size than natural origin sockeye of the same age and sex. What is not clear is whether the cause is environmental or genetic. Because size is associated with traits associated with reproductive fitness, further evaluation is needed, particularly when important differences in outmigration timing between hatchery and natural fry are addressed with the improved facilities of the replacement hatchery.

Based on hatchery research elsewhere, there is cause for questioning whether hatchery returns will adversely affect the reproductive fitness of naturally spawning sockeye. Productivity is influenced by environmental as well as biological factors, but reproductive fitness is an area where other researchers have detected changes associated with hatchery production. This research has been focused on species that are reared in a hatchery for an extended period, and there is a void in hatchery research over such effects in a program where fish are released soon after they leave the incubators. It is clear from the data collected over the time that the interim hatchery has been operating that the naturally spawning population is producing the majority of fry coming from the Cedar River and that, in absolute terms, production levels have been generally higher compared to the 1990s. This still leaves the question of the level of individual contribution to fry production, since large numbers of fry could still be produced if larger numbers spawn. To look at this question more closely, a comparison of spawner productivity (number of fry per spawner) over time was done. Compared to the period prior to hatchery returns, natural productivity appears to be higher in recent years. However, since environmental factors influence the number of fry produced per spawner, this is not a definitive assessment of reproductive fitness.

Surveys of Bear Creek conducted from 1999 to 2001 failed to recover any hatchery origin sockeye during the 3 years samples were collected. These results have helped to reduce potential concerns about the risk of straying of hatchery returns to Bear Creek.

The superimposition of sockeye redds on Chinook redds has been cited as an indicator of a potential adverse impact. While direct measurements of Chinook mortality resulting from superimposition by sockeye are not feasible, indicators of Chinook productivity can be analyzed to look for significant relationships. To date, the data suggest that there is no significant relationship between high superimposition rate and survival rate for Chinook. Since many factors affect Chinook incubation survival, this is not conclusive, but nevertheless the available data do not suggest a relationship.

Substantial analysis has been done in the past 5 years to examine questions surrounding the adequacy of food supply for sockeye in Lake Washington. A paper relying, in part, on information generated from the sockeye monitoring program was published by Beauchamp et al. (2004); the authors concluded that sufficient food would be available at the higher sockeye fry levels planned for the replacement hatchery. However, the authors cautioned that the effects of gradual warming in Lake Washington need to be monitored, and other papers have recently been published pointing to changes in species of *Daphnia*, a key food organism for sockeye, and synchrony of *Daphnia* and its food supply.

See Section 2.2.2 for additional monitoring and research results.

Instream Flow Research

Continuous annual monitoring of adult steelhead spawning activity and subsequent incubation duration provides a relatively clear picture of the temporal distribution of these life stages. The Cedar River population exhibits a typical winter run steelhead pattern, with spawning activity extending from early March through early June, and peak activity typically continues from late April through mid-May. Incubation is complete by early August, with peak fry emergence during July. Monitoring of all steelhead redds since the inception of the HCP documents that no active steelhead redds have been dewatered.

Annual Chinook spawning surveys have documented temporal and spatial spawning distribution in the Cedar River. Significant Chinook spawning occurs from mid-September through mid-November, with peak activity in early to mid-October. Although fish have been reported spawning throughout the river, the majority of spawning activity has occurred upstream of river mile 6.5. So far, the relative temporal and spatial distribution of redds has been relatively consistent from year to year, despite relatively broad inter-annual variation in stream flows during the fall. Redd survey data documents that instream flow management practices have protected more than 99% of all Chinook redds from dewatering.

Annual monitoring of natural origin juvenile Chinook and sockeye emigrants illustrates quite different temporal patterns for the two species. Nearly all sockeye migrate out of the river into Lake Washington within 1 to 2 days of emergence. Significant juvenile sockeye emigration begins in mid- to late January, peaks in late March or early April, and continues through mid- to late-May. In contrast, juvenile Chinook appear to exhibit two distinct early life history patterns that are common in other populations of ocean type Chinook salmon. One group of fish are reported to move downstream, out of the river, almost immediately after emergence from mid- to late-January through mid-April, with very little or no rearing in the river. A second group remains in the river to rear for up to 3 months and migrates out of the river primarily as parr or smolts from early May through June. The contribution of these two different life history patterns to eventual adult returns is the subject of a joint research project launched in 2006 with the USGS, University of Idaho and Washington Trout. Annual production rates of juvenile Chinook and sockeye in the Cedar River generally have been greater than production rates in Bear Creek, the other major producer of natural origin Chinook and sockeye in the Lake Washington basin.

The IFC is also overseeing a major investigation of juvenile Chinook rearing habitat selectivity and the relationships between stream flow and juvenile habitat availability. This very complex study is being conducted by Dr. Roger Peters and his staff from the USFWS. The study is examining juvenile Chinook habitat preferences at the micro-, meso- and macro-habitat scales. An initial study report on habitat selectivity is due to the IFC for review in late 2006. Habitat availability investigations may start as early as 2007. Investigations to date indicate some degree of variability in preferences during the day and night, at different times of year and different stages of development, at different stream flow levels, and in side channels versus mainstem areas. However, newly emerged fry appear to show consistent preference trends for shallow, low-velocity areas over fine substrate. Very young fish also appear to be often associated with overhead cover.

3.3.3. Adaptive Management under the HCP

SPU developed a general framework for adaptive management based on work by Dr. Steve Yaffee at the University of Michigan and three workshops on adaptive management cosponsored by SPU and Washington Trout, described in Section 2.3.2. This framework and other applications of adaptive management under the HCP are described below

Yaffee Mode

The Evaluation Cycle, developed by Dr. Steve Yaffee and his colleagues entails a series of four simple steps. The first step is to clarify what an organization is trying to achieve, stating goals and objectives, and identify threats and assets related to achieving those goals and objectives (called situation mapping). The second step is to develop an assessment framework (i.e., clarifying what is needed to determine if progress toward goals is occurring). In this step, evaluation questions are articulated. The third step is to identify what kind of information is needed to answer the evaluation questions. This step entails development of the work plan, including determining what data need to be collected, and how the data will be collected and analyzed. The fourth step is to determine how the information collected will be used to make decisions and changes in program implementation. This is the adaptive management step, where trigger points and responses are described.

Working with the Evaluation Cycle model, and with assistance from Steve Yaffee and his colleague, Sheila Schuller, HCP staff and a subcommittee of the HCP Oversight Committee worked together through the four steps of the cycle to develop an evaluation framework (Appendix 4). The team developed a set of evaluation questions and related information such as key indicators, data sources, trigger points, and responses. Given that the application of this model, and therefore, the selection of evaluation questions, needed to be limited given limited time and resources, this set of evaluation questions focuses a selected set of HCP efforts and activities in an effort to focus on the key questions that would, collectively, best characterize HCP progress. Next steps will entail further development of the scientific framework for answering evaluation questions and implementing business systems within SPU to support ongoing data gathering, analysis, storing and reporting and application of new information to facilitate decision-making during HCP implementation.

TNC Model for Watershed Plans

The Yaffee model is being applied to a variety of activities for the Watershed Management component of the HCP. Being integrated with the Yaffee model is a “measures of success” model that was developed by The Nature Conservancy (TNC) and partner organizations. The measures of success model entails developing specific desired future conditions (within an acceptable range of variation) for targeted ecosystems or species of interest, choosing key ecological attributes that represent the conditions of the targeted ecosystems or species, choosing appropriate indicators of the key ecological attributes, and monitoring those indicators to determine whether success has been achieved. With its focus on biodiversity and specific ecological goals, and its application of ecological models, the TNC model fits well with watershed restoration and provides a complement for the Yaffee model, which is more general and can encompass social as well as ecological goals.

Hatchery Adaptive Management Plan

The HCP requirement to incorporate adaptive management for hatchery operations, coupled with the adaptive management workshops that were coordinated through SPU and Washington Trout, led to the development of a comprehensive adaptive management plan (AMP) for the Cedar River Sockeye Hatchery. At the outset, it was difficult to identify examples of actual plans that could be used as templates, so a team of scientists led by Dr. Tom Quinn developed the AMP using project information and principles of adaptive management adapted from experts like Dr. David Marmorek, Dr. Barry Gold, and Dr. Steve Yaffee. The purpose of the AMP is to guide monitoring efforts to address the most important uncertainties associated with the potential adverse effects of the project as effectively as possible and to provide a framework for a decision-making process that incorporates reliable scientific information in a transparent way. Decisions will focus on how the hatchery should operate and at what capacity.

Adaptive Management for Fish Passage at the Landsburg Dam

The HCP requires monitoring of the effects of fish that pass above the Landsburg Diversion Dam on drinking water quality following the construction of the Landsburg Fish Passage facilities. The HCP allows for adjustment of fish passage for water quality reasons based on monitoring results. The HCP and LMA require the development of a monitoring plan and identification of threshold criteria for the monitoring of and mitigation for effects of fish passage on drinking water quality. Development for this monitoring plan began in 2005, and the plan is expected to be completed in 2006. In the meantime, regular water quality measurements are collected at the Landsburg Diversion Dam. This plan will only be required if a problem with fish carcass above the intake develops, which is unlikely in the near future given the small numbers of salmon passing above the Landsburg Dam annually to date.

Adaptive Management for Accretion Flows

As described in Section 2.2.3, the instream flow regime included in the HCP is based on assumed inflows from tributaries and groundwater in the Cedar River between the Landsburg Dam and Renton (accretion flows). The IFA requires that SPU monitor accretion flows over a period of at least 10 years, with the potential for adjustment of minimum flows for the contingency that accretion flows are "clearly more or less than the previously assumed patterns for causes that cannot be reasonably attributed to factors such as land development and water withdrawals downstream of Landsburg." As described in Section 2.2.3, SPU began an initial level of accretion flow monitoring and reporting in 2003, and this activity was performed continuously through 2005. The HCP and IFA specify the procedure by which minimum flows could be adjusted when the accretion flow study is completed.

3.3.4. Translating Learning to Changes in Management

There are a variety of examples of how the City is using findings from monitoring and research activities, as well as experience with specific projects, to alter strategies and improve performance in implementing the HCP. This section of the review highlights a few of these examples in the context of the intentional learning paradigm.

Forest Certification

As mentioned above in Section 2.3.1, SPU initiated a process in 2005 to obtain certification of its watershed restoration and management program under the FSC guidelines. One of the reasons for undergoing the certification process was to receive an independent audit of watershed management by an independent certification team of technical specialists. After the audit, certification was given by SmartWood during May of 2006, contingent upon SPU responding to seven corrective action requirements (CARs) for "minor noncompliance."

The CARs included requirements for SPU to develop a landscape-level template and conceptual model of forest structural development for planning restoration work; complete forest inventories and categorization of older forest; use benchmark stands, models, or other approaches to develop desired future conditions for accelerating development of old-growth conditions; develop a plan for controlling slash in restoration thinning units to reduce fire risk; and evaluate soil compaction after the use of logging equipment. Six of the seven CARs are to be completed in year. SPU staff was already making progress on the issues raised in the CARs, and expects to complete most responses within the first year of certification. For example, the landscape synthesis team described above has already developed a landscape level template for restoration.

Watershed Annual Review Cycle

SPU Watershed Ecosystems staff also planned their first annual review (conducted in early 2006), to evaluate progress on HCP commitments, identify issues and problems, and develop strategies to address problems. The group intends to improve this process to have an effective annual review cycle that feeds into annual work planning.

Sockeye Hatchery

There are a number of examples of how knowledge gained through monitoring and experience is being applied to future HCP activity.

Monitoring Fry Outmigration Timing

Each year, comparisons between median outmigration dates for hatchery and natural origin sockeye fry from the Cedar River are made and reported in annual reports issued by WDFW. These timing differences appear to affect survival and growth in Lake Washington and may influence adult return size as well. In any case, the average difference of about 3 weeks is inconsistent with the hatchery goal of producing fry as alike as possible to natural fry. During the design of the replacement hatchery, water temperature differences between the spring water used by the hatchery and the river were evaluated. The spring water is generally warmer than the river and results in accelerated development. This knowledge was used to justify the need for equipment that will align the spring water temperature regime with the river, and it is expected to result in timing of hatchery fry being more similar to the natural fry.

Lake Entry and Distribution Study

A 2-year study by the University of Washington, and funded through HCP sockeye monitoring funding, has resulted in a better understanding of the relationship between sockeye entry timing into Lake

Washington and spawning timing in the Cedar River. Researchers found no correlation in timing between the two, which means that harvest of sockeye in Lake Washington is likely to include fish from all portions of the run. This distributes impact across the population and makes it less likely that one portion of the run will be disproportionately affected by harvest.

Evaluation of Sockeye Broodstock Weir Operating Protocols

Weir operating protocols were first developed in 1999 in response to concerns that the broodstock weir was causing delay or shifts in the location of spawning activity for Chinook. These protocols are reviewed annually and modified as necessary to reduce potential impacts of the weir. Information used in this analysis includes the proportion of Chinook redds created above the weir, the number of redds within 25 meters of the weir, and the amount of time that the weir is open to free passage.

Monitoring Zooplankton and Juvenile Fish in Lake Washington

High numbers of sockeye fry in recent years coincide with more intensive monitoring of zooplankton, allowing modeling of the impacts of sockeye on the standing crop of zooplankton. This information led to the conclusion that food supply should be adequate to support the additional increment of sockeye fry from the replacement hatchery.

Estimating Adult Sockeye Returns

A fundamental requirement of the evaluation of differences between hatchery and natural origin groups and between distinct hatchery groups is to be able to estimate the number of adults included in each group, a process called run reconstruction. Initial adult sampling involved carcass collection in the river, and the protocols were designed to address spatial relationships of adult returns and compare them to fry release strategies. Extending the use of these data for run reconstruction proved problematic. The result has been a shift to sampling of adults at the locks, where sampling fractions throughout the return period can be determined, allowing abundance of each group to be estimated. This change was initiated in 2005.

Fish Passage

Evaluating the effectiveness of fish passage facilities is complex, involving short- and long-term time frames, multiple species and life history stages, and various indicators.

The rate of recolonization depends on many factors, and the analysis is expected to inform future management decisions. Decisions could be made regarding the passage of clipped Chinook and coho (presumed hatchery origin from other locations), the use of supplementation as a tool to imprint salmon to the area above the Landsburg Dam to encourage higher returns, and others. One key uncertainty is how the productivity of the upper area compares to that of the lower river, and this might be difficult to answer, particularly if returns to spawners above the Landsburg Dam ultimately spawn in the lower river. Nevertheless, there are questions about how the population as a whole will benefit from having a portion of the Cedar River population spawn above the Landsburg Dam. The answers to these questions will likely differ by species, and, while it is too early to assess many of the questions, the operation of the fish passage facilities over the first 3 years has provided much useful information.

Location of Spawning Adults and Rearing Juveniles

Monitoring has shown that most of the initial use of the area above the Landsburg Dam by coho and Chinook has favored the lower reaches closer to the dam. This provides valuable information that could be useful in locating habitat improvement projects designed to support rearing juveniles.

Improvements to the Fish passage Facilities

Improvements to the fish passage facilities have worked well, avoiding delay and accumulations of fish at the base of the Landsburg Dam. Some refinement has occurred over time as experience has shown where jump protection was needed to prevent the occurrence of incidental losses.

Rock Drop Design

At the time that the aqueduct crossing design options were being evaluated, the use of rock drops to create a series of steps in the river bottom had not been applied to a river as large as the Cedar River. The structures have successfully withstood flows of approximately 4,000 cfs to date and appear to be working as designed. This experience adds to the general knowledge base for application of this technology to other systems.

Archimedes Screw

Another element of the design of the fish passage facilities that was considered experimental by some was inclusion of an Archimedes screw to lift fish out of the water so they could be sorted by species. This device has worked well and represents a significant cost savings over alternatives. Again, this experience adds to the general body of knowledge that can be used in the design of other projects.

Instream Flows

Steelhead Redd Dewatering Vulnerability

Continued steelhead spawning surveys have confirmed earlier work establishing a correlation between stream flow during spawning and the subsequent flow at which redds may become dewatered. This information has helped guide reservoir refill operation during the spring, with managers attempting to avoid prolonged periods of elevated stream flows during which significant numbers of steelhead might spawn in areas highly vulnerable to subsequent dewatering.

Despite efforts, in a number of years, rainfall coupled with snowmelt consumed most of the available water storage capacity, thus requiring the release of additional water downstream. Researchers in the Cedar River Watershed found evidence that steelhead tend to defer the initiation of spawning activity for short periods of time during freshets, then reinitiate spawning after stream flows recede to base levels. Armed with this information, water managers have created naturally shaped freshets to release additional water during wet periods in the spring. These efforts appear to have been successful in reducing subsequent risk of steelhead redd dewatering.

Salmon Redd Scour

Continued monitoring of sockeye spawner escapement and subsequent juvenile emigration has strengthened previous analyses indicating a relatively strong negative correlation between the magnitude of peak flow events during incubation and overall sockeye egg to emigrant survival. This information indicates that damaging redd scour may begin to occur at a flow of approximately 1,800 to 2,000 cfs at Renton. Incubation survival appears to be incrementally reduced as stream flows increase above this level. Working with the IFC, water managers strive each fall and winter to maintain peak stream flows below 1,800 cfs. Although the water management facilities are not configured to assure that this target can always be met, flows have been held below this threshold in some years and the magnitude of peak flow events have been substantially reduced by reservoir operations (multiple times) in HCP years 1 through 5.

3.4. Collaboration

Purposeful actions to create positive environmental change are often heavily regulated and subject to public scrutiny. Because of the number of entities involved and their perspectives, successful collaboration in the development of an action or program can mean the difference between moving forward with an action or no action.

Collaboration has proven to have great value for the City in implementing the HCP, and it is believed that all collaborators have received value as well. Collaboration allows the City to gain needed expertise, get needed work done, leverage resources, and build relationships needed to effectively implement the HCP in a regional context.

3.4.1. Types of Collaboration

The primary forms of collaboration relate to the HCP have included:

- Interactions with standing HCP committees
- Use of panels or forums of scientists to address particular issues
- Agreements and collaborative arrangements with academic institutions or other agencies to design and conduct studies or perform other work
- Collaboration with non-profit groups, including the use of volunteers
- Multi-party collaborative efforts.

3.4.2. Value of Collaboration through HCP Year 5

Collaboration through Standing Committees

HCP Oversight Committee (OC)

The function of the HCP OCs set forth in the HCP IA: "The OC's function is to advise the City concerning HCP implementation, and its authority is limited to that which is expressly granted by the terms of this agreement. It shall serve as a forum for the following:

1. Communication regarding implementation of the HCP

2. Identification of issues that need discussion and resolution

3. Periodic review of HCP progress.

The OC cannot override the decisions or actions taken under the IFA or LMA."

Although the IA requires that the OC meet only annually, the committee has been conducting its meetings twice per year since it was established in 2001. Additionally, the IA requires that the OC conduct comprehensive reviews of the HCP every 3 years during the first 15 years of the HCP. Since its formation, the OC has taken up, as part of its routine responsibilities, the review of an Annual Accomplishments Report. Produced annually by HCP staff, the Annual Accomplishments Report is a fairly detailed accounting of HCP work accomplished within a given year. Since the OC meets only twice per year, this report is helpful in providing OC members with enough detailed information to stay well informed about HCP implementation.

Anadromous Fish Committee (AFC)

The AFC is charged with providing advice to the parties to the LMA on matters pertaining to the required programs and activities included in the agreement. The group has met nearly every month during the first 5 years of the HCP. The benefits of involving this committee in the development of a project were perhaps best demonstrated during the fish passage project, when the AFC served as a forum for discussion of design options and later expedited the permitting process. Their experience on the committee enabled them to understand, support, and help convince others that the designs were the best for this application.

The AFC also has provided a forum for discussion of the challenges facing those involved in salmon recovery. Through the discussion of research priorities for the Interim Mitigation Program for Coho, Chinook and Steelhead, and in other areas, information and perspectives are presented and exchanged, leading to collective learning that can be applied in other situations. These discussions have influenced processes outside the realm of the HCP. An example was the AFC discussion that led to improvements in a Chinook genetics study being undertaken by Watershed Resources Inventory Area (WRIA) 8 and WDFW. The AFC meetings offer opportunities for interagency and stakeholder interaction on resource issues associated with the Cedar River and Lake Washington that occur rarely or not at all. They also serve as an opportunity to invite speakers to share their research with the committee, which contributes to a broader understanding in the scientific community and connects researchers with those that are active in promoting species protection and recovery.

The membership of the AFC has been relatively consistent over the 5 years of the HCP, and most meetings are attended by most members. AFC members are a dedicated group, sitting for most of 4 hours each month, earnestly engaged in the topics at hand.

The AFC has provided a needed forum for discussion of the issues associated with salmon recovery in the Cedar River. The work of the AFC benefits from an understanding of the overall challenges facing salmon and steelhead as members make recommendations associated with LMA requirements. Discussion between representatives of agencies, the Muckleshoot Tribe, and interested stakeholders has been helpful in promoting a better overall understanding of issues, promoting relevant research, and identifying challenges. This discussion is helpful to members in their own work, outside of the HCP.

Instream Flow Commission (IFC)

The Cedar River IFC oversees the implementation of Cedar River instream flow management program and associated research and monitoring projects. The IFC monitors and guides implementation of instream flow management prescriptions, serving as a forum for communication among the parties to the HCP and other specified stakeholders on technical information on management of unallocated water and for exercising specific decision-making authority on a variety of aspects of the instream flow management program, as specified in the IFA. In accordance with section E of the IFA, the IFC developed and is now implementing a suite of monitoring and research projects to assess the effectiveness of the instream flow management program and help guide future instream flow management practices.

The IFC typically meets on a monthly basis, but has met more frequently when required. At each meeting, the group conducts an in-depth assessment of current hydrologic conditions, relevant biological information, and recent compliance with the instream flow management prescriptions. This information is used by the IFC to offer guidance and, as specified by the IFA, decision-making on specific aspects of the instream flow management prescriptions as well as the management of unallocated water. A portion of each meeting is also devoted to review and guidance of the ongoing instream flow research and monitoring projects.

The activities of the IFC have been a central component in the daily management of Cedar River stream flows since the HCP was approved. Membership on the IFC has been relatively stable, and all members have consistently provided constructive and informed input to many key discussions and decisions. The group was very instrumental in helping shape the management of the system during statewide drought declarations in years 2001 and 2005. The IFC is also helping shape innovative investigative approaches to addressing challenging instream flow research questions that could potentially provide important information for instream flow management and salmon recovery efforts in the Cedar River and elsewhere in the region.

Collaboration with the University of Washington and Other Universities

The City has collaborated with scientists and students at the University of Washington on a variety of studies and projects, many of which are described above. Some examples include:

- The City’s support for a master’s thesis project (through an internship) in the Pacific Silver Fir Zone to better understand how forests in this zone develop
- A collaborative study with several scientists at the University of Washington through the Memorandum of Agreement (MOA) for the design and conduct of experimental studies of forest thinning
- Modeling studies of the potential impacts of climate change on water supply through and MOA with the Climate Impacts Group

- Scoping study to guide the development of 30-year, synthetic daily stream flow data sets for the Cedar River under pre- and post-development conditions in support of Indicators of Hydrologic Alteration Study
- Collaborative work on an inventory of vascular and non-vascular plants in the watershed, with voucher specimens stored at the University of Washington Herbarium
- Collaboration on long-term studies in Lake Washington to support decisions regarding sockeye and Chinook
- Modeling studies to assess the risk of wildfire in the municipal watershed and develop (through and MOA)
- A variety of multi-party collaborative studies that involved the University of Washington (see below).

The City has also collaborated with scientists at other academic institutions. For example, the City staff worked with Dr. Steve Yaffee at the University of Michigan to develop an approach to adaptive management.

These collaborative efforts have provided the City with the expertise of all scientists involved and added greatly to the quality of efforts to implant the HCP. In return, the scientists and the students were able to pursue research interests. Finally, City staff has frequently sought the advice of university scientists for a variety of activities under the HCP.

Collaboration with Other Agencies

The City has collaborated with scientists in other agencies on a variety of studies and projects, many of which are described above. Some examples include:

- Contracted studies with USGS concerning design and conduct of long-term stream monitoring and research into habitat use and movements of fish in the reservoir and its tributaries
- Collaborated with WDFW, NOAA Fisheries, and USFWS engineering and biological staff in the design of fish passage facilities at the Landsburg Dam
- Conducted a collaborative survey of Chinook redds and gathered information useful for the evaluation of potential sockeye-Chinook interactions with WDFW, King County, and SPU
- Contracted with the USGS for continuous stream flow monitoring at instream flow compliance points and a variety of other locations
- Contracted with the USFWS to investigate the effects of stream flow on juvenile Chinook at different sub-stages in their early life history.

Multi-Party Collaboration

As can readily be concluded from the descriptions of HCP activities above, much of the City's collaboration has been with multiple parties. Some notable examples include:

- Hosted a 2-day workshop with other land management agencies, conservation organizations, researchers, and regional experts in the fall of 2005 on the restoration of biodiversity in forests of the Pacific Northwest, using the Cedar River Watershed as a case example
- Conducted studies of recolonization of the municipal watershed by salmon associated with construction of fish passage facilities at the Landsburg Dam, with NOAA Fisheries and the University of Washington
- Use of a panel of independent scientists to develop an adaptive management program for the sockeye hatchery
- Collaborated with interest groups, through field trips and workshops, to develop approaches to ecological thinning
- Worked with the WDFW and the Muckleshoot Tribe to evaluate sockeye production and returns to the interim hatchery
- Worked with the WDFW and Muckleshoot Tribe to design the replacement sockeye hatchery facilities
- Hosted a national workshop, in collaboration with WDFW, Washington Department of Ecology, USGS, King County, the North American Instream Flow Council, and various private consulting firms, on emerging technical issues in the science of instream flow management
- Provided information to WDFW and the North American Instream Flow Council for an upcoming publication in which the development and implementation of the Cedar River instream flow management program will be examined as one of 8 riverine management case histories.

Two examples merit more detail than the above list:

- **Fish Passage** – Collaboration among engineers and biologists, various regulatory agencies, and stakeholders provided a robust process that ultimately resulted in a well-designed, successful project design. While fish passage was broadly supported, the selected design included some unconventional elements and construction requirements involved extensive work in sensitive areas, including substantial in-river work. Both aspects could have been causes for significant delay, if not outright denial, during the permit process. While the process for permit approval was time-consuming and expensive at times, the collaborative design process provided substantial credibility and ultimately allowed it to be selected, despite the substantial construction work in sensitive areas.

- **Sockeye hatchery** – The development of the replacement sockeye hatchery program has involved the participation of many scientists from a number of different agencies or perspectives. The inclusion of scientists who have been critical of some of the hatchery practices has been intentional, allowing a robust discussion of issues to occur that has led to innovation. One example is the requirement that, over time, the proportion of hatchery origin adults not exceed the proportion from natural spawning. Designed to encourage substantial influence of natural selection pressures on the integrated sockeye population, it also creates a strong interest in maintaining or improving habitat quality to support natural production.

Collaboration with Non-Profits

As described above, the City has extensively used volunteers on many kinds of projects, many recruited by the Friends of the Cedar River Watershed. The City has had agreements with EarthCorps for restoration work, including large woody debris installation projects, and also has worked with Washington Trout to develop techniques for conducting fish surveys in the watershed.

Chapter 4. Issues, Risks, and Challenges

In implementing the HCP, the City and its partners have experienced and will experience a number of risks and challenges, and a number of substantive issues have emerged during the first 5 years of HCP implementation. These issues, risks, and challenges are described below, including consideration of strategies and next steps planned to address the issues.

4.1. Lawsuit from Muckleshoot Tribe

In response to the lawsuit filed in federal court by the Muckleshoot Indian Tribe in 2003 regarding instream flows, the City entered negotiations with the Tribe. A tentative settlement of the issue of instream flows, water diversions, and related historical damages was reached in 2005, and the negotiations were expanded to include access to the watershed for hunting and other traditional practices. The proposed settlement agreement was approved by the City Attorney and the Seattle City Council in the summer of 2006, and awaits approval by the court. The proposed settlement, which would run in perpetuity, includes as terms the requirement that the HCP be implemented as required, a sockeye hatchery be maintained and operated, and fish passage be maintained at the Landsburg Diversion Dam.

4.2. Appeals of Sockeye Hatchery

The operation of the replacement sockeye hatchery has been significantly delayed from its originally intended startup date of September 2005. A series of administrative and legal appeals has resulted in an extended environmental review period that has delayed the construction of the replacement hatchery facilities. The first appeal challenged the adequacy of the project specific FEIS filed under the State Environmental Policy Act. The resulting decision by the Seattle Hearing Examiner required the City to produce an SEIS that contains worst-case analyses of specified potential effects and provides more detail about the AMP. The adequacy of the SEIS was also challenged by the same party, but the Hearing Examiner found that the appellant had failed to show that the SEIS was inadequate. Shortly after the

Hearing Examiner issued this decision, the same appellant asked for and was granted a judicial review in Superior Court of the hearing examiner's decisions. The delay in construction and the additional work associated with the appeals has increased the project cost substantially. (Note: Another lawsuit was filed in 2006 by the same parity in federal court.)

4.3. Stakeholder Concerns about Ecological Thinning

As the City was preparing its second ecological thinning project for approval by the Seattle City Council in 2003, a number of concerns from stakeholders were expressed, including the need for thinning, the financial motivation of the City, and details of the project plan related to tree diameter, thinning intensity, specific areas to be thinned, and treatment of large dead wood. In response to these concerns, the project was delayed and the City conducted an all-day workshop and other stakeholder outreach activities in 2004. Many good questions were raised, and a healthy dialog ensued. In response, City staff, working with stakeholders, modified the project design.

The City Council unanimously approved the project in 2005. When the project was advertised, however, no bidder proposed a bid that was financially acceptable. Watershed staff worked with actual and potential bidders and City contracting staff to identify the problems, and the City revised the project in early 2006, staying consistent with the constraints of the initial project with respect to tree diameter and total timber volume. Feedback from stakeholders was positive on the changes. The City advertised and sold the project in the summer of 2006, and implementation has begun.

4.4. Climate Change: an Emerging Threat

Because of a lack of agreement among scientists at the time the HCP was being developed, climate change was identified in the HCP as an "unforeseen circumstance." Subsequently, scientists have documented climate change and many of its effects and have begun to construct predictive models of future changes and future effects, including effects on water supplies and ecosystems. While a challenge remains in trying to scale down from predicted global changes to the level of a local watershed, the general patterns of effects are clear and significant.

4.4.1. Climate Change and Water Supply Operation

In response to this emerging potential threat to its water supply, the City is addressing long-term climate change impacts on water supply and demand by developing strategies based on the most current knowledge available and consideration of a wide range of climatic conditions. The City is focusing on making its systems and operations sufficiently robust, resilient, and flexible to meet future needs, given a broad range of possible changes in water supply and demand. The City is also actively working with the University of Washington's Climate Impacts Group and has sponsored climate change research work with this group to explore and develop analysis techniques that could assist water planners in translating global climate change information down to the local watershed level for water supplies located on the western slopes of the Cascades.

In addition, since the late 1800s, the City has invested in, and continues today to strategically improve, its systematic network of meteorological and hydrological monitoring and data collection systems not only for providing real-time information to water managers on river and reservoir operations and conditions but for also providing a long historical record of the data needed for performing longer term hydrologic and climatic trend analyses for the Cedar River Watershed.

4.4.2. Climate Change and Salmon in the Lake Washington System

The potential effects of climate change on salmon recovery efforts in the Lake Washington basin have been receiving increasing attention. Several areas of concern have recently emerged, including:

- The potential effects of increasing lake water temperatures on the temporal occurrence of zooplankton communities and possible dislocation between zooplankton production and the consumption needs of planktivorous fishes
- The potential effects of increasing water temperatures on returning adult Chinook salmon during the late summer in the Lake Washington Ship Canal and Lake Washington
- Increased water temperatures in the Lake Washington Ship canal during the late spring and possible impedance of juvenile Chinook emigration.

4.4.3. Climate Change and Watershed Ecosystems

City staff also began addressing potential impacts of climate change on watershed ecosystems, attending conferences in 2005 on the topic. At this point, City staff is still engaged in problem definition, but the City intends to develop strategies for monitoring indicators of adverse effects of climate change on plant and/or animal communities and developing strategies for mitigating effects of climate change, as feasible and appropriate.

4.5. Invasive Plants: an Emerging Threat

Noxious weeds were not covered by the HCP, but currently are widely recognized as constituting a major threat to ecosystems worldwide. SPU has mapped locations of a number of species of noxious weeds throughout the watershed, conducted a control program, and initiated development of a plan for managing noxious weeds. The value of the botanical surveys mentioned above was reinforced when the collection was found to include one noxious weed, European milfoil, collected in Walsh Lake. This knowledge allowed immediate action by SPU, using consultants, to eradicate the milfoil before it could proliferate and potentially cause water quality problems in downstream reservoirs.

4.6. Disagreement over Chinook Populations in Lake Washington

Considerable debate occurred during the development of the WRIA 8 salmon recovery plan over the number of separate Chinook populations in the Lake Washington basin. The draft recovery plan identifies two naturally reproducing populations, the Cedar River and north Lake Washington (primarily Bear Creek). A genetic study was undertaken by the WRIA 8 Technical Committee, which received input from the AFC regarding study design. The conclusion of the study was that there wasn't enough evidence to conclude that there was more than one population of Chinook in the Lake Washington basin. The study, however, did not conclude that the evidence demonstrated that there was only a single population. The presence of large numbers of hatchery origin Chinook in the Cedar River and Bear Creek suggest that these populations are genetically influenced by straying. It is not clear, however, how this may or may not change in the future, which will likely be determined through management decisions of the regulatory agencies and tribal co-managers.

4.7. Passing Hatchery Origin Fish over the Landsburg Dam

The initiation of marking all Chinook from local hatcheries has generated a better understanding of the proportion of hatchery origin Chinook that spawn in Lake Washington tributaries, including the Cedar River. The past 3 years have demonstrated that hatchery straying occurs each year and suggests that this has been the case for many years. From data collected from carcasses, it is possible to estimate that between 23% and 30% of hatchery origin Chinook spawned in the Cedar River between the years 2003 and 2005. During these years, the proportion of hatchery origin Chinook passing through the Landsburg Dam has been 42% to 70%. Some interested groups have raised objections to the passage of hatchery origin Chinook above the dam, and this received considerable discussion by the parties to the LMA. Ultimately the matter was decided by the language of the LMA, requiring passage of all native species.

The colonization of upstream habitat by anadromous fish has relied on volunteers to enter and spawn in the recently opened habitat. Removal of all hatchery origin Chinook would have reduced the total Chinook passed in 3 years from 199 to 81. With replacement rates in the Cedar River (the ratio of returns to parents) hovering around 1 in some recent years, the colonization process is expected to be slow to produce salmon that are homing to upstream areas because they were born there. A reduction in spawners, as would occur if hatchery origin fish were removed, potentially would slow the recolonization process even more. The collection of tissue samples from all Chinook passing the Landsburg Dam offers an opportunity to evaluate the contribution of each adult to subsequent generations of returns. However, sample size and possible mating combinations may make it difficult to assess how much hatchery origin influences reproductive success. As new information becomes available, there will be opportunities to revisit the practice of allowing all Chinook to pass above the Landsburg Dam.

Chapter 5.   Recommendations

NOTE: The OC may wish to develop recommendations after it has completed its comprehensive review of HCP implementation through year 5. The City may provide suggestions to the OC during the fall of 2006 regarding program changes that may be appropriate after 5 years.

Chapter 6. References

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Appendix 1

Performance Monitoring: Summary of Accomplishments for HCP Conservation Measures or Groups of Measures through HCP Year 5

Appendix 2

Summary of Financial Performance for HCP Conservation Measures or Groups of Measures through HCP Year 5

APPENDIX 3: HCP COMMITTEE AND COMMISSION ROSTERS

Table 3-1. CEDAR RIVER HCP OVERSIGHT COMMITTEE Roster May 9, 2006

Name	Agency/Organization	Area of Interest Represented
Cyndy Holtz	Seattle Public Utilities	Chair, Party Rep. to IA
Matt Longenbaugh	NOAA Fisheries	Party Rep. to IA
Tim Romanski	U.S. Fish and Wildlife Service	Party Rep. to IA
Bob Everitt	Washington Dept. of Fish and Wildlife	Party Rep. to IA
Jeannie Summerhays	Washington Dept. of Ecology	Party Rep. to IFA
Vacant		Elected Official
Isabel Tinoco	Muckleshoot Tribe	Tribal agency
Vacant		Adaptive Management
Walt Canter	Cedar River Water and Sewer District	Purveyors
Kurt Beardslee	Washington Trout	Environmental Organization
Norm Winn	Mountaineers	Env. Org/ Recreation
Jasmine Minbashian	Cascadia Wildlands Project	Environmental Organization/Forest Science
Frank Urabeck	Trout Unlimited	Business/ Sportfishing
Bill Robinson	Unaffiliated	Fishing
Jerry Franklin	UW Dept. of Forest Resources	Forest Science/ Research
Dave Beauchamp	UW School of Fisheries	Fisheries Science/Research
Geoffrey Clayton	RH2 Engineering	WRIA 8
Steve Ralph	Stillwater Sciences	Natural Resource Science
Joel Sisolak	Friends of the Cedar River	Friends of the Cedar River
Tom Quinn	University of Washington School of Fisheries	Fisheries Science/Research
Richard Bigley	Washington Department of Natural Resources	Forest Science/Research
Marian Valentine	US Army Corps of Engineers	Water management
Chris Konrad	US Geological Survey	Research Hydrologist
David Irons		Business
Key Staff		
Jim Erckmann	Seattle Public Utilities	
Rand Little	Seattle Public Utilities	
Bruce Bachen	Seattle Public Utilities	
Liz Ablow	Seattle City Light	

Table 3-2. CEDAR RIVER INSTREAM FLOW COMMISSION Roster April 30, 2006

Name	Agency/Organization	Member Capacity
Dan Basketfield	Seattle Public Utilities	Acting Chair
Rand Little	Seattle Public Utilities	Alternate Chair
Tom Sibley	NOAA Fisheries	Voting Member
Mike Grady	National Marine Fisheries Service	Alternate Member
Steve Hirschey	Washington Department of Ecology	Voting Member
Brad Caldwell	Washington Department of Ecology	Alternate Member
Gary Sprague	Washington Department of Fish and Wildlife	VotingMember
Steve Foley	Washington Department of Fish and Wildlife	Alternate Member
Hal Beecher	Washington Department of Fish and Wildlife	AlternateMember
Tim Romanski	U.S. Fish and Wildlife Service	Voting Member
Isabel Tinoco	Muckleshoot Tribe	Voting Member
Holly Coccoli	Muckleshoot Tribe	Alternate Member
Eric Warner	Muckleshoot Tribe	Alternate Member
Lynne K. Melder	U.S. Army Corps of Engineers	Non-voting Member
Larry Schick	U.S. Army Corps of Engineers	Non-voting Alternate
Marian Valentine	U.S. Army Corps of Engineers	Non-voting Alternater
Jeff Burkey	King County, Water & Land Resources Division	Non-voting Member
Abby Hook	Tulalip Tribes	Information contact
KEY STAFF		
Tom Johanson	Seattle Public Utilities	
Alan Chinn	Seattle Public Utilities	
Karl Burton	Seattle Public Utilities	
Liz Ablow	Seattle City Light	

Table 3-3. CEDAR RIVER ANADROMOUS FISH COMMITTEE Roster April 30, 2006

Name	Agency/Organization	Member Capacity
Bruce Bachen	Seattle Public Utilities	Chair
Phyllis Meyers	National Marine Fisheries Service	Voting Member
Tom Sibley	National Marine Fisheries Service	Alternate Member
Matt Longenbaugh	National Marine Fisheries Service	Alternate Member
Steve Foley	Washington Department of Fish and Wildlife	Voting Member
Paul Seidel	Washington Department of Fish and Wildlife	Alternate Member
Tim Romanski	U.S. Fish and Wildlife Service	Voting Member
Roger Tabor	U.S. Fish and Wildlife Service	Alternate Member
Dennis Moore	Muckleshoot Tribe	Voting Member
Eric Warner	Muckleshoot Tribe	Alternate Member
Isabel Tinoco	Muckleshoot Tribe	Alternate Member
Nick Gayeski	Washington Trout	Voting Member
Kurt Beardsley	Washington Trout	Alternate Member
Frank Urabeck	Fish Advocate	Voting Member
Chuck Wischman	Puget Sound Anglers Lake Washington Chapter	Voting Member
Bill McKay	Puget Sound Anglers Lake Washington Chapter	Alternate Member
Bill Robinson	Public	Voting Member
Hans Berge	King County, Water & Land Resources Division	Non-Voting Member

Appendix 4

HCP Adaptive Management/Evaluation Framework