Commissioners:
MICHAEL DONEEN
T. JAMES DAVIS
LYNN M. HEMINGER

Chief Executive Officer/Manager:
WILLIAM C. DOBBINS

Public Utility District No.1 of Douglas County

1151 Valley Mall Parkway • East Wenatchee, Washington 98802-4497 • 509/884-7191 • FAX 509/884-0553

April 26, 2002

Ms. Magalie Salas
Federal Energy Regulatory Commission
888 1st Street N.E.
Washington, D. C. 20426

Subject: Wells Hydroelectric Project - FERC No. 2149 WA
Annual Report - Fish Settlement Agreement

Dear Ms. Salas:

In accordance with paragraph E of the order approving the Settlement Agreement issued January 24, 1991, Public Utility District No. 1 of Douglas County submits the enclosed annual report of activities related to this Settlement Agreement. A copy of the January 24, 1991 order is enclosed for your reference.

As directed by the order, the annual report addresses activities during the previous year. This annual report covers activities performed in 2001 and those planned for 2002.

Very truly yours,

Robert W. Clubb, Ph.D.
Chief of Environmental & Regulatory Services

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Enclosures

C: (with report, but not appendices)

Mr. Ron Boyce
Mr. Brian Cates
Ms. Margaret Delp
Mr. Mike Erho
Mr. Cary Feldmann
Mr. William Frymire
Mr. Ritchie Graves
Mr. Harry Hall
Mr. Stuart Hammond
Mr. James Hastreiter
Mr. Robert Heinith
Mr. Garfield Jeffers
Mr. Jerry Marco
Mr. Mark Quehrn
Mr. Robert Salter
Mr. Steve Saugee
Mr. Nolan Shishido
Mr. Tim Weaver
Mr. Rod Woodin
Mr. Ron Wright

54 FERC ¶ 61,056

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

Before Commissioners: Martin L. Allday, Chairman; Charles A. Trabandt, Elizabeth Anne Moler, Jerry J. Langdon and Branko Terzic.

Public Utility District No. 1 of Douglas County, Washington) Project No. 2149-002
) Docket No. E-9569-002

ORDER APPROVING SETTLEMENT AGREEMENT

(Issued January 24, 1991)

This is the most recent of a series of settlement agreements that have emerged from our consolidated proceeding on anadromous fish issues on the mid-Columbia River in Washington State. Before us today is a comprehensive, uncontested, long-term settlement of such issues arising out of the operation of Wells Project No. 2149, located in Douglas and Okanogan Counties, Washington. We will approve the settlement, with clarifications and conditions that are consistent with our approval of related recent settlements.

BACKGROUND

In 1979, the Commission consolidated and set for hearing in Docket No. E-9569 a set of related petitions seeking modification of the operation of five licensed projects on the mid-Columbia River to protect and enhance salmon and steelhead trout. 1/ The petitions were filed by various state and federal fishery agencies and Indian tribes, and sought to protect anadromous fish migration downstream through project facilities. Wells Project No. 2149 was one of the five projects. The proceeding has generated a series of interim and long-term settlements. Most recently, the Commission approved long-term settlements resolving the Vernita Bar Phase (Priest Rapids Dam) of the proceeding, 2/ and issues involving Rock Island Project No. 943-002 (Chelan County). 3/ We also have had occasion to approve a settlement of fishery issues in Project No. 2149-017, a related proceeding

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1/ 6 FERC ¶ 61,210 (1979).

2/ 45 FERC ¶ 61,401 (1988).

3/ 46 FERC ¶ 61,033 (1989).

involving the raising of the surface elevation of the reservoir. 4/

On October 30, 1990, the parties in the above-captioned proceeding filed an offer of settlement with the presiding administrative law judge. On November 19, 1990, the Commission's trial staff filed comments in support of the settlement. On December 4, 1990, the presiding administrative law judge certified the settlement and the staff's comments to the Commission for decision.

The parties to the settlement are Public Utility District No. 1 of Douglas County, Washington (the PUD); Puget Sound Power & Light Company, Pacific Power and Light Company, the Washington Water Power Company, and Portland General Electric Company (collectively, the Power Purchasers); and the Washington Department of Fisheries, the Washington Department of Wildlife, the Oregon Department of Fish and Wildlife, the National Marine Fisheries Service, the U.S. Fish and Wildlife Service, the Confederated Tribes and Bands of the Yakima Indian Nation, the Confederated Tribes of the Umatilla Indian Reservation, and the Confederated Tribes of the Colville Reservation (collectively, the Joint Fishery Parties).

As summarized by the trial staff in its comments, the settlement agreement provides for the following.

The agreement has a term from its execution date to the expiration of the license (2012) plus any annual licenses. During that time, the agreement is intended to satisfy the PUD's obligations under Article 41 of the license. The agreement is not subject to modification prior to March 1, 2004. There are procedures (discussed, in part, below) for the resolution of disputes.

The PUD has agreed to provide juvenile and adult fish passage and a hatchery program. The juvenile fish passage system will be a program of controlled spills using five bypass baffles. The agreement specifies criteria for the operation, timing, and performance of the bypass system. The adult passage system will use the existing fish ladder. Criteria are established for water depth over the weirs, entrance gate settings, and jet and trashrack operations.

The PUD's hatchery program is designed to mitigate fish passage losses at the Wells Project. The physical structures include adult collection sites, a central hatchery facility and acclimation facilities. The amount of compensation is to be

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4/ 30 FERC ¶ 61,285 (1985).

determined by a formula using a five-year running average of adult runs by species. In 1991, the PUD will produce spring chinook yearlings, sockeye juveniles, and steelhead smolts. The production will then be evaluated and, based on those results, the PUD will either increase sockeye production or eliminate sockeye production and add production of summer chinook juveniles.

At completion of a project juvenile mortality/survival study, adjustment will be made to production levels, except for steelhead, to reflect the differences between the mortality rate developed in the study and the mortality rate assumed in developing the original production amounts. Adjustments will also be made to compensate for any unavoidable and unmitigated adult losses.

Once the five-year rolling average estimate of the juvenile run size reaches 110 percent of the estimated juvenile production used to establish the original production, the Joint Fisheries Parties can request a compensation increase in juvenile run size, except for steelhead.

The settlement also provides for continued studies and evaluations of the program. Studies will also be conducted on the potential unutilized habitat and on establishing sockeye in new habitat. The studies will be conducted under the direction of the Wells Project Coordinating Committee, which will be composed of one technical representative of each signatory to the agreement.

The Joint Fisheries Parties agree with the PUD that the Wells Project portion of the proceeding in Docket No. E-9569 should be terminated. These parties also agree to support the PUD when it requests relicensing of the project. The Joint Fisheries Parties further are of the view that the PUD's performance of its responsibilities under the agreement satisfies the PUD's fish protection and compensation obligations under the Federal Power Act and all other applicable laws and regulations.

In their offer of settlement, the parties indicate that it represents the culmination of two years of intensive negotiation, and that it "is intended to resolve, at least until March 1, 2004, the anadromous fish issues" pending in the proceeding.

The trial staff, in its comments supporting the settlement, requests that the Commission "make clear that the Commission's authority to require changes in structures and operations, should the need arise, is preserved" during the period when the settlement is not subject to modification. The trial staff also suggests adding certain reporting requirements to enable the

Commission to monitor compliance with the settlement. The trial staff does not propose modification of any of the substantive terms of the settlement, and no party opposes the settlement.

DISCUSSION

As we noted in approving an earlier settlement in this proceeding, 5/ the issues have been thoroughly ventilated and debated, and the settlement agreement is the result of a concerted effort to resolve these important matters in a way that is acceptable to all of the participants. We commend the participants for their efforts. We believe the settlement agreement is in the public interest, and we will adopt it. The agreement balances the continued operation of the project with an effective, long-term program for protection, mitigation, and enhancement of the fishery resources affected by the project.

We will clarify the dispute resolution provisions of the settlement agreement in the same manner as we did in our above-cited 1988 and 1989 orders approving related settlements. 6/ Section I.D. of the settlement agreement provides that, if the Wells Project Coordinating Committee cannot resolve a dispute among the signatories and if the amount in controversy is less than $325,000, then any party may request the Commission to refer the dispute to (1) the presiding judge in the mid-Columbia Proceeding, Docket No. E-9569, (2) the Commission's Chief Administrative Law Judge, or (3) the Division of Project Compliance and Administration, Office of Hydropower Licensing, "in the order listed," for expedited review. For the reasons stated in our prior orders, the Commission will in most cases refer such disputes to the Division of Project Compliance and Administration, and will use its best efforts to resolve such disputes within the time frames set forth in the agreement. In appropriate circumstances, such as when there are material facts in dispute, we may refer a matter to an administrative law judge. In either event, the initial staff decision will be subject to *de novo* review by the Commission. And, as we emphasized in our 1989 order, any resolution by the Coordinating Committee, or a third party, pursuant to Section I.D. that contemplates a change in the license or in the operation of the project thereunder shall result in the filing of an appropriate application therefor by the licensee as soon as practicable after the dispute is resolved.

5/ *See* 45 FERC at p. 62,259.

6/ *See* 45 FERC at pp. 62,259-60 and 46 FERC at p. 61,197.

As we noted in our prior orders with respect to the settlements approved therein, 7/ approval of the settlement agreement does not affect the Commission's authority, as reserved in the license, to require, after notice and opportunity for hearing, alterations to project facilities or operations that may be warranted by changed circumstances. We intend that any such reserved authority would be exercised only after full consideration of the benefit sought to be achieved thereby, balanced against the possibility that as a consequence the settlement could be voided, thereby eliminating the benefits obtained thereunder. If any party voids the agreement, the licensee shall, within 30 days, so inform the Commission in writing.

Finally, we will adopt the reporting provisions proposed by the trial staff in its comments.

<u>The Commission orders</u>:

(A) The settlement agreement filed in this proceeding on December 4, 1990, is approved and made a part of the license for Wells Project No. 2149.

(B) The Wells Project No. 2149 portion of the proceeding in Docket No. E-9569 is terminated.

(C) The Commission's approval of the settlement agreement shall not constitute approval of, or precedent regarding, any principle or issue in these or any other proceedings.

(D)(1) Whenever a violation of the settlement agreement occurs, the licensee shall, within 30 days of the occurrence, file with the Commission, and send a copy to the Regional Office, a report containing an explanation of the circumstances surrounding the violation and the licensee's plan to avoid any repetition thereof.

(2) Whenever a dispute arises under Section I.D. of the settlement agreement that is resolved without referral to the Commission, the licensee shall, within 30 days, file with the Commission, and send a copy to the Regional Office, a report containing an explanation of the dispute and the nature of the resolution.

7/ <u>See</u> 45 FERC at p. 62,260 and 46 FERC at p. 61,198.

(E) The licensee: (a) shall notify the Commission and the Commission's Portland Regional Office of all meetings of the Coordinating Committee; (b) shall file functional design drawings, including all information required by 18 C.F.R. § 380.3, at least 90 days prior to construction of any facilities under the agreement; (c) shall file for approval all changes in monitoring, evaluation, study and production plans, not specified in the agreement; and (d) shall file an annual report. The annual report shall be filed on April 30 of each year and shall include:

(1) A description of plans developed during the previous year for any studies, evaluations, monitoring programs, production programs, system operations, or fish passage efforts;

(2) The results of all studies, evaluations and monitoring of the previous year;

(3) An outline of all actions taken towards fulfillment of the terms of the agreement;

(4) An explanation of the reasons for exercising specific alternatives stipulated in the agreement;

(5) A chronology of compliance for the previous year, outlining schedule changes, the reasons for the changes, and documentation that the Joint Agencies were consulted prior to implementation of the changes;

(6) A schedule of activities for the next year; and,

(7) Summaries or meeting minutes from each of the meetings of the Coordinating Committee for the previous year.

(F) This order is final unless a request for rehearing is filed within 30 days from the date of its issuance, as provided in Section 313(a) of the Federal Power Act. The filing of a request for rehearing does not operate as a stay of the effective date of this order or of any other date specified in this order, except as specifically ordered by the Commission. The licensee's failure to file a request for rehearing shall constitute acceptance of the order.

By the Commission.

(S E A L)

Lois D. Cashell,
Secretary.

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON, D.C. 20426

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Report to
the Federal Energy Regulatory Commission
of activities under the Long-Term Settlement Agreement
between Fisheries Agencies and Tribes
and Public Utility District No. 1
of Douglas County
for the 2001 calendar year

Wells Hydroelectric Project

F.E.R.C. Project No. 2149

Public Utility District No. 1
of Douglas County, Washington
1151 Valley Mall Parkway
East Wenatchee, WA 98802-4497

April 2002

Table of Contents

Foreword

On January 24, 1991, the Federal Energy Regulatory Commission approved a Settlement Agreement to resolve anadromous fish issues for the Wells Hydroelectric Project on the Columbia River in Washington State. The Agreement was a product of negotiations with state and federal fisheries agencies and tribes on the operations of the Wells Project (No. 2149). The F.E.R.C. directed that the licensee of the Wells Project has certain reporting responsibilities. This document is intended to fulfill portion (E)(d) of the Order requiring an annual report to be filed by April 30. This is the twelfth annual report under the Agreement and will cover the period from January 1 to December 31, 2001.

Report to
the Federal Energy Regulatory Commission
of activities under the Long-Term Settlement Agreement
between Fisheries Agencies and Tribes
and Public Utility District No. 1
of Douglas County
for the 2001 calendar year

(1) Development of Studies, Plans and Evaluations

The Public Utility District No. 1 of Douglas County (District) worked closely with fisheries agencies and tribes to carry out various studies and obligations specified in the Settlement Agreement. These included various monitoring studies and operation plans.

1.1 Annual Bypass System Operations Plan for 2001

The Settlement Agreement calls for the District to provide an Annual Bypass System Operational Plan to members of the Wells Coordinating Committee (WCC) by December each year. The District submitted the 2001 plan in November 2000 to the WCC for review. The spring and summer migrations of juvenile salmonids in the Columbia River are monitored by hydroacoustics along with in-turbine fyke netting at Wells Dam. The Bypass Operation Plan was approved for the 2001 season (01-2[1]; Appendix A).

The Bypass Team decides on bypass operations at Wells during both spring and summer migration periods. Representatives from the agencies, tribes and District make up the team (Agreement II.F.3). Brian Cates (US Fish and Wildlife Service; USFWS), Jerry Marco (Colville Confederated Tribes; CCT) and Rick Klinge for the District were the 2001 Bypass Team members.

1.2 Misidentification of adult fish at Mid-Columbia Dams

The Yakama Nation (YN) presented information on the mis-identification of adult coho returning to mid-Columbia dams (01-1). The reestablishment of coho in the mid-Columbia is an important goal of the tribe. Accurate identification of returning adults is necessary for measurement of progress in reaching the goal. The District and other mid-Columbia PUD's worked with their fish counters on coho identification.

1.3 Adult Radio Telemetry Studies

The mid-Columbia PUD's were requested by National Marine Fisheries Service (NMFS) to perform an adult steelhead telemetry study for 2001. The study would tag up to 400 adult steelhead at Priest Rapids Dam to monitor passage through all five PUD dams and various tributaries in 2001. The Wells Interim Biological Opinion by NMFS required the District to conduct additional adult steelhead passage studies. The District was opposed to using telemetry technology to attempt to generate adult survival information as some members of the joint fisheries parties had requested (01-1). Chelan and Grant PUD expressed concern that this may not a good year for the work. The construction of juvenile passage facilities in 2001 would impact the adult passage assessment (01-2). A new study plan emerged in March with eight objectives, including a kelt behavior component (01-3). The study plan was approved in April (01-4) and tags were ordered (01-5). There was concern that warm water in the Columbia may shut down tagging activity as NMFS limits tagging of steelhead to temperatures under 20° C. Changing

[1] 01-2 refers to the minutes of the Wells Coordinating Committee from year 2001, the second meeting.

the tagging schedule to tag more fish earlier in the migration was recommended along with tagging only in the morning (01-7).

1.4 Okanagan Sockeye Habitat Study

The District worked with the fisheries agencies and first nations in British Columbia to identify habitat improvement projects that could benefit sockeye as an alternative to the Cassimer Bar Hatchery Program. The Okanagan Basin Technical Working Group (OBTWG) is technical organization responsible for the fisheries management for the Okanagan River in Canada. The OBTWG recommended six sockeye enhancement / habitat improvement projects to the District that they could support if the WCC also approved any of them as mitigation for unavoidable losses of sockeye at Wells Dam. Plans were made to have a meeting between the OBTWG and the WCC (01-1,2). The OBTWG submitted a proposal to the WCC for a water management optimization plan as their preferred project (01-4: Appendix B). The OBTWG plan was designed to meet the obligation of unavoidable sockeye losses at Wells; however, the WCC requested a spawning channel. The Canadian parties would not give their full support to the permit process for a spawning channel at this time. The Flow Management Proposal was the only option that all the Canadian interests could agree to (01-4). The 1990 Settlement Agreement requires three years of sockeye hatchery production and evaluation after which if the hatchery program was unsuccessful, other non-sockeye programs would be selected in lieu of the sockeye hatchery (01-4). The District was hopeful that the WCC would support one of the Canadian based alternatives. . The WCC requested additional information to better understand how the evaluation of the Flow Management Program would be performed. It was the sense of Dr. Kim Hyatt (Canada Department of Fisheries and Oceans) that on average, the Flow Management Program would produce a 15% increase in sockeye production (01-6). The WCC was unclear what assurances the Canadian government would give to meet the intent of the proposal. The WCC would need to provide their support by July to collect needed information to benefit the production from 2001 brood (01-6). By November, the District distributed a decision tree that outlined a mitigation pathway for sockeye as requested by the JFP. This decision tree had input from WDWF and the Colville Tribes (01-8). The JFP modified the decision tree and a new version was ready for consideration in December (01-9). The first step of the decision tree is the Flow Management Program and evaluation. If Flow Management fails to meet the District's mitigation responsibility for sockeye, then the spawning channel option would be explored. If both the Flow Management and the Spawning Channel fail to meet the District sockeye mitigation obligation, the District would substitute spring chinook production at the Methow Hatchery that would be destine for the Okanogan basin for the sockeye obligation. Part of the District's sockeye obligation as outlined in the Settlement Agreement was substituted for spring chinook production at the Methow Hatchery (15,000 pounds). The new decision tree also provides a transition period to eliminate the spring chinook substitution for sockeye by allowing continued spring chinook production through the brood collection for 2003 with rearing through 2005. A statement was also added should Canadian funding become available, the District would divert those dollars from the program into a WCC approved sockeye enhancement program (01-9). The JFP were concerned that it was hard to set an obligation for sockeye as a sockeye survival study had not been done. There was discussion about what that might look like and when it could be done (01-9). There was a difference of opinion about what information could be collected from a survival study verses a sockeye surrogacy study. After lengthy discussion, the WCC gave their support for the decision tree (01-9; Appendix C). The decision tree will be incorporated into the Habitat Conservation Plan.

1.5 Okanogan Sockeye Pilot Program

Since 1991, there have been several programs implemented at the Cassimer Bar Experimental Hatchery for replacing unavoidable losses of sockeye smolts at Wells Dam. Initially, fingerlings raised at the Cassimer Bar Hatchery were released into the south basin of Osoyoos Lake. Next, fingerlings were exposed to short-term acclimation in net pens and released as pre-smolts. Fish were released below

Osoyoos Lake in the Okanogan River, both as fingerlings and yearlings. Finally, fingerling releases were again made in Osoyoos Lake. Evaluations of adult returns at Columbia River dams and spawning ground surveys in British Columbia indicated very few adults returned from these programs. Because the Cassimer Bar Hatchery program did not increase the number of returning adults to the spawning grounds, the program was determined ineffective and other options were sought to replace the unavoidable sockeye losses at Wells Dam (See 1.4). The Cassimer Bar Hatchery did not collect broodstock in 2001. Fingerlings from the 2000 brood year adults were released to Lake Osoyoos in October 2001.

1.6 Bull Trout Study

Pursuant to a January 10, 2000 request by the U.S. Fish and Wildlife Service to F.E.R.C. for bull trout consultation at Columbia River projects, a study was proposed for 2001 to understand the effect of large hydroelectric dams on the migratory behavior of bull trout in the mid-Columbia River. At Wells, ten bull trout were trapped from the east ladder over a five-week period (01-1,5). Trapping of bull trout at Wells started on May 21 (01-5) and by May 29 all ten bull trout were radio-tagged.

1.7 Spring Chinook Program

The Washington Department of Fish and Wildlife (WDFW) proposed a change in the rearing strategy for the Methow Spring Chinook Supplementation Program. Originally, the Settlement Agreement called for fish to be reared to a size of 15 fish per pound. The Hatchery Evaluation staff had recommended the release size be increased to 11-12 fpp and changing the release target from 550,00 to 407,000 smolts (01-1). The District expressed concern that the original concept for supplementation was being lost (01-4).

Lee Bernheisel from the Okanogan Wilderness League proposed not to collect wild broodstock at tributary traps, but to use hatchery return adults for the hatchery program in 2001 as the forecast was for a strong return of adult spawners (01-3). Rod Woodin responded that WDFW has a mandate to encourage natural spawning and another to compensate for losses at dams. The WDFW circulated a draft broodstock protocol for review (01-4,5; Appendix D).

1.8 Habitat Conservation Plan

The District, National Marine Fisheries Service, U.S. Fish and Wildlife Service, Washington Department of Fish and Wildlife, the Colville, Yakama and Umatilla Tribes and American Rivers continued to negotiate a Habitat Conservation Plan (HCP). At one point, it was suggested to split the Wells HCP (Douglas PUD) from the Rocky Reach and Rock Island HCPs (Chelan PUD) into two separate processes (01-6). It was felt in August that the Final Environmental Impact Statement for Wells might be ready by mid-January 2002 (01-7). Later, the three HCP's were brought back into a single process and negotiations continued through the calendar year. (Note: The process was completed in March 2002 and a Final EIS is scheduled for September 2002. The Wells HCP is intended to supersede the Long Term Settlement Agreement).

1.9 Wells Hatchery Operations

Due to the extremely low water year, the District proposed that Wells Hatchery broodstock be collected from the west fish ladder instead of the hatchery outfall channel (01-5). The operation of the outfall channel requires from 100 to 150 cubic feet per second of water to attract adult broodstock. The District proposed this as a water saving measure that could be used for power production

The proposed broodstock collection protocol for the Wells Hatchery was adequate to reach the production goals for the hatchery, but was shy on providing enough fish for research requests in the mid-

Columbia (01-6; Appendix D). An additional 30 adult summer chinook would be required to meet this request for study fish

WDFW proposed a modification of the Wells Hatchery program to shift the zero age summer chinook production to a yearling cycle (01-2). Kirk Truscott, WDFW, proposed to eliminate the zero age production released in June and add additional yearling production that are released in April (01-6). The justification was to increase the survival rate for juveniles released to returning adults and the reduction of adults required for broodstock. It was recommended that a comprehensive analysis of the proposal be presented to the WCC. A draft protocol was offered by the next meeting by Rod Woodin (01-6).

1.10 Dissolved Gas Monitoring

Christ Maynard from Washington Department of Ecology (DOE) explained to the WCC that a Total Daily Maximum Load (TMDL) approach to water quality would be sought for both dissolved gas and water temperature (01-7). A draft TMDL for the mid-Columbia River would be available by the end of 2001.

1.11 Reporting of Ladder Counts

Reporting of ladder passage data from mid-Columbia PUD dams was taking a long time to be posted to the Corps' web site. The JFP complained they were unable to acquire "real time" passage information during a record fish passage year. It was suggested that the PUDs work with the University of Washington who post river environment and fish passage data on their DART web page (01-6).

1.12 Wells Ladder PIT Tag Detection

The District put forward plans to install a Passive Integrated Transponder (PIT) tag detection system at both Wells Dam ladders during the annual maintenance period this winter. The system would be available for collecting information on returning PIT tagged adults as they pass Wells Dam (01-8)

1.13 2002 Bypass Operational Plan

The District submitted a Bypass Operational Plan for 2002 to the WCC, as per Section II.F.1 of the Settlement Agreement on November 16, 2001 (01-8). The plan outlined scheduled hatchery releases above Wells Dam and anticipated the starting and completion date of bypass operations (Appendix E).

(2) Results of Studies, Evaluations and Monitoring Efforts

2.1 Operation of the Juvenile Bypass

Hydroacoustic sampling was started on March 15 to help collect background index levels of activity prior to the spring migration (01-3). The juvenile bypass was initiated on April 15 and ran through June 21 for the spring migration. A total of 68 days and a flow of 0.7 million-acre feet, or 8.0% of the total discharge was dedicated to spring bypass (01-7). Summer bypass started on June 22 at 0000h and ran until August 31, for a total of 72 days. There was 0.75 MAF or 8.3% of the total discharge dedicated to summer bypass. During summer bypass, there were 3 hours (0.2%) that had forced spill (Appendix F).

2.2 Sockeye Pilot Program

Sockeye production from 2000 broodstock was reared at the Cassimer Bar Hatchery until their release in October. 118,000 Fish at 15.6 grams were released into Osoyoos Lake for a total of 4,070 lbs. These fish received a left ventral fin clip. There was no sockeye brood collected in 2001 as the WCC had decided to support the Canadian Flow Management Proposal instead of the Cassimer Bar Hatchery program.

2.3 Dissolved Gas Monitoring

Flows in the Columbia River, January through July of 2001, were 59% of the historic average at Grand Coulee Dam. Monitoring of total dissolved gas at Wells showed a range of 12-hour daily high values from 100.1% to 111.7% in the forebay and ranged from100.4% to 112.0% in the tailrace (Appendix G). The operation of the bypass had little to no effect on TDG build.

2.4 Spring Chinook Salmon Hatchery

The Methow Spring Chinook Supplementation Hatchery release of 1999 brood smolts was a comprised of 180,775 Methow River composite (Methow and Chewuch rivers) population spring chinook released at 11 fpp and 67,408 Twisp River population spring chinook released at 9.5 fpp. Total pounds of spring chinook released for this brood year was 23,530 pounds. NMFS and WDFW came to an agreement not to release fish from the composite population from the Chewuch ponds in 2001. There was concern with the high percentage of Carson stock parents that made-up the 99 brood (Memo from L. Brown, 25 May 2000).

The 2000 brood year production by December was comprised of 266,695 fish at 32 fpp for the Composite population and 157,177 fish at 28 fpp for the Twisp population. These fish will be released in the spring of 2002 from acclimation ponds in the Methow, Chewuch and Twisp.

The 2001 broodstock were collected at the Methow Hatchery outfall, Chewuch trap and Twisp trap. At spawning, adults are killed and gametes are removed and held separately until the coded wire tag (CWT) could be removed from each parent and read. Gametes were retained at Methow only when corresponding CWT identify the fish as being from the Methow Composite population (combination of both Methow and Chewuch basin parents) or from the Twisp population. Also, adipose present adults that did not show a hatchery scale pattern were retained as part of the composite population. At the "eye-up" point in egg development, the Methow Hatchery transferred 174,221 eggs to the Winthrop Hatchery, planted 129,149 eggs as "eyed-eggs" in the Methow River, and retained 64,418 eggs from Twisp parents, 118,033 eggs from Chewuch parents, and 289,006 Composite population eggs.

2.5 Steelhead Telemetry Study

In 2001, the mid-Columbia PUDs funded research to follow passage of steelhead adults from below Priest Rapids Dam through the mid-Columbia projects and into tributaries. Tagging started in mid-July continued through October. By January 7, 2002, there were 244 steelhead that had passed Wells Dam with tracking into the Methow and Okanogan rivers. Radio tags provide information on reservoir and tributary movement into the spring of 2002.

(3) Outline of Action Taken Toward Fulfillment of the Settlement Agreement

3.1 Methow Spring Chinook Facility

The Settlement Agreement calls for a hatchery based compensation program for spring chinook composed of adult collection sites; a central hatchery facility for incubation, early rearing, and adult holding; and acclimation facilities for final rearing (Agreement IV). During 2001, hatchery personnel reared and released progeny from adults that returned in 1999 and reared progeny from adults that returned in 2000.

The Settlement Agreement calls for evaluation of the hatchery program. Several aspects of the hatchery were evaluated.

3.2 Cassimer Bar Sockeye Hatchery

The Settlement Agreement calls for a pilot effort to culture Okanogan sockeye for three years at 8,000 pounds of production (IV.A.3.(a)(2)) with an evaluation to gauge the success of the program. Brood have been collected since 1993 at Wells Dam. The Colville Confederated Tribes collected information on culture of sockeye at the Cassimer Bar facility. There were no adults collected for broodstock in 2001 as the emphasis of the program was being shifted into British Columbia through the Flow Management Proposal submitted by the Okanagan Basin Technical Working Group (Appendix B).

3.3 Contract for Professional Services in Implementing the Settlement Agreement.

During 2001, the District contracted with Mike Erho to serve as Studies Coordinator for the Wells Coordinating Committee. Mr. Erho also serves as coordinator for the Mid-Columbia Coordinating Committee and Rock Island Coordinating Committee. The District also contracted with Dr. Skalski to provide statistical evaluation of methods and studies.

3.4 Juvenile and Adult Fish Passage Operations at Wells Dam

During 2001, the juvenile bypass system operated as per conditions outlined in the Settlement Agreement (II,C,D,and F). The bypass team recommended operations based upon information from hydroacoustics and fyke net samples at Wells.

The east ladder operated at the criteria established by the fisheries agencies and tribes (Agreement III. B; C; D; E; F). On August 20, a severe build up of aquatic weeds on the diffusion grate in the west ladder became a concern that the grate may fail and fall into the ladder. This grate serves as a barrier to adult fish from swimming into the attraction flow pumping area. The loss of the grate would delay fish from passage and possibly trap them during de-watering and maintenance procedures. The District consulted with National Marine Fisheries Service on a possible solution. It was decided on August 21 to lower the attraction flow differential from 1.5 to 1.0 feet to reduce the strain on the blocked grate. The west ladder was operated with a 1.0 foot differential for the remainder of the passage season.

3.5 Steelhead Production at Wells Hatchery

The Settlement Agreement specified that the District will fund additional steelhead compensation of 30,000 pounds at 6 fish per pound after 1991 (IV.3.a), bringing the total obligation to 80,000 pounds. Records from the Wells Hatchery show that 555,040 steelhead or 92,507 pounds were liberated in 2001.

3.6 Other Actions Toward Fulfillment of the Settlement Agreement

The District funded evaluations and studies that are part of the District's responsibility in the Settlement Agreement. These were described in Sections 2 and 3.

(4) Explanation of Alternatives Chosen

4.1 Wells Ladder Operating Criteria

Information from the NMFS telemetry studies in 1992 and 1993 lead to the recommendation that another study be conducted to evaluate passage through the side entrance on both the east and west fish ladders. In 1997,1998 and 1999, additional telemetry studies tested ladder passage times with the side gates opened and side gates closed to determine if there was a change in total passage times. Studies showed that when the side gates were open, there was a net loss of fish once they entered the attraction chambers of the fish ladders, thus increasing the total average passage time. Tests with summer chinook showed that by closing the side gates at Wells, passage time was cut in half. The WCC recommended that the side gates be closed to improve passage timing. This was done on March 15, 2001.

4.2 Sockeye Pilot Program

The District worked with the WCC and OBTWG to move the sockeye mitigation program currently at Cassimer Bar to a Flow Management Program in British Columbia. The District believes that the highest probability of success to mitigate for unavoidable sockeye losses at Wells Dam lay with measures as close to the spawning area as possible. A Flow Management Proposal from the OBTWG was supported by the WCC as replacement of the Experimental Cassimer Bar Sockeye Hatchery program. This proposal became part of an all incorporating strategy adopted by the WCC for implementation through 2005 (Appendix C).

(5) Chronology of compliance for 2001

Items (3) and (4) above contain chronology of compliance in 2001. Documentation that the Joint Fisheries Parties were consulted prior to implementation of changes is provided in the minutes of the Wells Coordinating Committee. These records are included as Appendix I.

(6) Schedule of Activities for 2002

The following schedule of activities is planned for 2002

Dec. (2001)	Develop Annual Bypass System Operation Plan between District, Agencies and Tribes
January	Meeting with District, Agencies and Tribes on adult passage concerns
March 1	Annual Bypass System Operation Plan finalized
March 1	Determine Bypass Team members for bypass season
March 1	Develop Annual Passage Monitoring Plan between District, Agencies and Tribes
March 15	Begin monitoring juvenile migration via hydroacoustics
April 1	Bypass barriers in place
April 15	Anticipated start of the juvenile migration
May 1	Start collecting spring chinook broodstock at Methow Basin tributary traps
October	Production Plan annual review between District, Agencies and Tribes
on going	Planning sockeye mitigative strategies
on going	Planning for operations and protocols of the Methow River Spring Chinook Facilities

(7) Minutes of Meetings

7.1 Minutes of the Wells Coordinating Committee for 2001

The Wells Project was removed from the mid-Columbia proceedings on January 24, 1991 as the Settlement Agreement between the fisheries agencies and tribes was approved by F.E.R.C. Minutes from the meetings of the WCC for 2001 are attached as Appendix I.

Table of Appendices

ANNUAL BYPASS OPERATION PLAN
YEAR 2001

APPENDIX A

WELLS HYDROELECTRIC PROJECT
JUVENILE BYPASS SYSTEM OPERATIONS PLAN
for the 2001 Bypass Season

The Wells Long Term Settlement Agreement (II.F.1) specifies that Douglas PUD will submit an Annual Operations Plan for the bypass to the Wells Coordinating Committee by December prior to the spring migration. This plan will be reviewed and approved by the Committee by March 1.

The Bypass System
The PUD will install five bypass barriers in spill gates of the Wells Project. The bypass will operate per criteria in the Settlement Agreement (II.C, E).

Operation Criteria
The operation criteria includes operation of the bypass in partnership with adjacent turbine units, the amount of water required for bypass operation and criteria for full bypass system operation.

Bypass Operations Timing Criteria
The bypass will be in place from two weeks before predicted start of the migration until two weeks after the migration is complete.

Projected Hatchery Releases above Wells Dam
Estimated hatchery releases for 2001 above Wells Dam are as follows:

Facility	Species	No. in thousands	Dates
Winthrop (USFWS)	Spr. Chinook	215	4/11
Methow (WDFW)	Spr. Chinook	250	4/15
Carlton (WDFW)	Sum. Chinook	415	4/15
Similkameen (WDFW)	Sum. Chinook	630	4/15
Wells (WDFW)	Sum. Steelhead	547	4/20
Winthrop (USFWS)	Sum. Steelhead	100	5/01
Winthrop (USFWS)	Coho	250	4/25
Cassimer Bar (CCT)	Sockeye	84	10/15

Starting Dates and Ending Dates
Bypass barriers will be in place between March 15 and September 15. Hydroacoustic sampling will start on March 15 and be collected until August 29. Fyke netting will be done between March 15 to either April 10 or the start of the Bypass, which ever occurs first and again from August 15 through 31.

The bypass team will decide the start and end of bypass operation. Hydroacoustics and fyke net information at Wells will be used to show the start and completion of the spring and summer migrations. Preseason dates for bypass operation for spring and summer migration are April 10 through May 30 and July 1 through August 15.

(2/15/01)

:\Data Files\bypass\bypass01

FLOW MANAGEMENT PROPOSAL FROM THE OKANAGAN BASIN TECHNICAL WORKING GROUP

APPENDIX B

Okanagan Basin Technical Working Group

Water management tools to increase production of Okanagan River sockeye salmon

Project identification

Proponent: **Okanagan Basin Technical Working Group**
Lead: Department of Fisheries and Oceans

Project leads: **OBTWG participants (Hyatt, Flynn, Machin, Mathewes, Symonds etc...)**

Project location: **Okanagan Basin Lakes and River System**

Funding request: **$XXX. (CAN)**

Project Overview: This proposal is a response to a request from Douglas County Public Utility District (DCPUD) in Washington State for the Okanagan Basin Technical Working Group (OBTWG) to identify a single sockeye salmon stock restoration option that both groups would be willing to support for funding consideration in 2001/02.

Several elements of the proposal and its execution warrant comment here are as follows. First, the general objective is to incorporate current knowledge about processes controlling upstream and downstream fisheries production values (i.e. sockeye and kokanee salmon) into a set of "user friendly" information processing tools to make water management decisions applied to the Okanagan River system in Canada more "fish friendly". The principal result anticipated is that significant production benefits may be achieved for sockeye salmon as well as for other resident salmonids. Second, successful execution of the proposal will depend on establishing a team of interdisciplinary specialists (e.g. fisheries biologists, habitat managers, water resource managers,hydrologists, modellers-programmers etc.) drawn from both "public" (DFO, MOELP, WMB, ONFC) and private sources (e.g. consulting firms). Third, successful completion of the project will progress through a number of phases spanning three years of time including: (1.) a fish and water management "business analysis" phase, (2.) a models and information processing tools design phase, (3.) a models and tools building phase, (4.) a testing and refinement phase and finally (5.) a resource manager's routine-use phase.

To ensure success, key personnel from the three party (Canada Department of Fisheries and Oceans; BC Ministry of Environment Lands and Parks; and the Okanagan Nation Fisheries commission) Okanagan Basin Technical Working Group are prepared to make a multiyear commitment to serve as steering committee members and/or as participants on the project team from its inception in year one to the point of routine implementation by the end of year three.

Introduction:

Okanagan River sockeye salmon are one of the southerly most distributed stocks of this species throughout their geographic range. They are the only significant, remnant stock of more than a dozen anadromous salmon stocks that historically returned to Canada through U. S. portions of the Columbia River. The cumulative effects of extensive hydroelectric development in both Canada and the U. S.; agricultural, urban, recreational and forest land use practices; continuing restriction to sub-optimal habitat and global climate change all pose serious threats to Okanagan sockeye. Long term maintenance of abundance levels sufficient to avoid stock extirpation, and meet First Nations aspirations for harvest in both Canada and the U.S. continues to be a challenge.

Significant declines in Okanagan sockeye production have occurred in recent years in spite of curtailment of both marine and freshwater harvest. In Canada, this issue has become a focus for activities of the Okanagan Basin Technical Working Group (**OBTWG**) which is composed of representatives from Canada's Department of Fisheries and Oceans (**DFO**), the British Columbia Ministry of Environment , Lands and Parks **MOELP**) and the Okanagan Nation Fisheries Commission (**ONFC**). Early in 1998, the OBTWG was approached by representatives of Washington State's Public Utility District No. 1 of Douglas County (**DCPUD**) who also have an interest in identifying viable options for increasing the production of Okanagan sockeye in order to meet salmon mitigation requirements that are a condition of their Federal Energy and Regulatory Commission (**FERC**) license for operation of the Wells hydropower dam.

Extensive consultation between the OBTWG and DCPUD in 1999 led the parties to collaborate during the year 2000 on a program of work aimed at identifying procedures that might be used to permanently increase the overall production of Okanagan sockeye salmon. This initial year of work dealt with an assessment of the potential benefits, costs and feasibility of several salmon stock enhancement and restoration options that had been identified in earlier work (Bull, 1999) including: (i.) a general program of riparian and in-stream habitat restoration, (ii.) construction of a sockeye spawning channel, (iii.) an adult trap-and-transport program, and (iv.) salmon production optimization through improvements to Okanagan River flow management procedures.

Early in 2001, members of the OBTWG participated in a series of meetings to review results from these studies first with representatives of Douglas County Public Utility Division (March 22, 2001, Westbank, BC) and then with members of both DCPUD and the Wells Committee (March 27, 2001, Vancouver, BC). At both of these sessions, personnel from DCPUD emphasized that further support would only be provided for pursuit of stock enhancement or restoration options that:

(i.) would provide readily quantifiable benefits,

(ii.) have the potential to provide a sockeye production benefit on the order of 100,000 smolts per annum,

(iii.) appear economically attractive relative to alternate approaches,

(iv.) have the potential to achieve regulatory approval by each of several levels of government, and

(v.) could be implemented and provide results within 1-3 years.

The OBTWG acknowledged these requirements and provided additional criteria based on their commitment to the conservation and restoration of Okanagan fisheries resources within an "ecosystem based management framework" (see Appendix 1.). These criteria include:

(vi.) sockeye restoration activities should provide benefits at the single species level to sockeye and at the ecosystem level to other, high value, indigenous fish species (*i.e. provide ecosystem benefits*),

(vii.) manipulations of fish or habitat should be amenable to formal risk assessment as one component of benefit-cost analysis,

(viii.) manipulations of fish or habitat components should follow an adaptive management process (*i.e. adaptive management involves adoption of an incremental approach to project implementation, a commitment to assessment and monitoring prior to, during and after project completion and cyclical review of information to make key decisions, see Appendix 1.)*

The habitat restoration and trap-and-transport options were set aside because they could not meet many of the DCPUD criteria at this time. However, the spawning channel and water management options appeared to satisfy enough of the DCPUD-OBTWG criteria to warrant further consideration. Although feasibility studies and analysis conducted to date suggest that both the spawning channel and water management options have potential to increase annual production of Okanagan sockeye salmon, **DCPUD requested the OBTWG to identify a single stock restoration option for pursuit in 2001**. Following further consideration of the criteria above, a concensus emerged among OBTWG members that the water management option was their top priority given that:

(i.) analyses by Hyatt et al and Summit Environmental (2000) indicate that changes to water management practices have the potential to increase average, sockeye production by roughly 15 % (i.e. between 1997 and 1999 this would have equated to roughly 300,000 smolts per year; see Appendix 3 for additional commentary on the origins of this estimate),

(ii.) costs to achieve this production increase are highly economical given a requirement for a total investment in year one of approximately $XXXXXXX CDN and annual maintenance costs thereafter of approximately $XXXXXXX CDN respectively (see details below),

(iii.) implementation of the water management option can be achieved within the context of the existing Okanagan Basin Water Agreement established between the Government of Canada and the Province of British Columbia (*i.e. no special regulatory approvals are required to implement water management actions contemplated under this option*),

(iv.) development of the decision support tools, testing, refinement and then routine implementation required to achieve results would be completed within the bounds of a three year program,

(v.) provision of decision support tools to key resource managers (i.e. water comptroller/managers, habitat managers, fisheries managers) to improve water management practices for sockeye production will also provide ecosystemic benefits for other high value fish species (e.g. kokanee, rainbow trout, mountain whitefish, etc…),

(vi.) knowledge of fish-water interactions has progressed far enough to support formal risk assessments of potential changes in water management procedures, and

(vii.) alterations to seasonal water storage and/or release practices will readily lend themselves to implementation through an adaptive management procedure.

Fish-Water Management Tools Project

It is proposed that the Okanagan Basin Technical Working Group coordinate a program of work that will result in the development of a family of "user friendly models" of biological and physical interactions that control production variations of sockeye salmon from parent spawners to seaward migrating smolts. The family of models (Okanagan River water management rules, Okanagan River hydrology; sockeye production; kokanee production etc…) will form the basis for the provision of decision support tools to key resource managers (i.e. water comptroller/managers, habitat managers, fisheries managers) to improve water management practices and multiyear production of Okanagan sockeye salmon.

Project background:

The Okanagan River system is a regulated river system, with most of the storage (340 Mm^3) provided by Okanagan Lake as regulated by the control structure at Penticton. Minor additional storage is provided in tributary headwater reservoirs (principally for domestic and agricultural use) and in Skaha and Osoyoos Lakes. Key considerations in the regulation of the Okanagan River and Lake include:

- minimizing flooding damage (around Okanagan Lake and along the Okanagan River downstream of Okanagan Lake);
- protection of fisheries values (esp. Okanagan Lake shore spawning kokanee eggs and alevin,and Okanagan River sockeye eggs and alevin);
- domestic and irrigation water supply (keeping intakes submerged);
- recreation, navigation and tourism (maintaining acceptable water levels for boat docks and ramps and for river float tourist businesses).

The Okanagan sockeye salmon population is one of two remaining viable sockeye populations in the Columbia River system, and the sole remaining salmon population within the Columbia River basin in Canada. This population spawns in October in the Okanagan River between Vaseux and Osoyoos Lakes, and principally in the 5 km. river section immediately downstream of Vaseux Lake. Egg and alevin development to swim-up occur between October and early May. Fry rearing occurs in Osoyoos Lake on a year-round basis.

Okanagan River flows can affect the sockeye population in the following ways:

- migration to the spawning grounds may be impaired (with resulting pre-spawn mortality and/or reduced gamete viability) as a result of high flows;
- high summer flows in the Okanagan River downstream of Osoyoos Lake directly and to the extent that they reduce water temperatures may reduce pre-spawn mortality during the upstream migration from the Wells Dam pool to Osoyoos Lake;
- eggs and alevins can be impacted (physical damage and inability to survive in the water column) if redds are scoured as a result of flood control water releases during the pre-emergence spring period;
- eggs and alevins can be dessicated if incubation period flows are reduced substantially from those experienced during the spawning period
- seasonal distributions, growth and survival of sockeye fry rearing in Osoyoos Lake are influenced by temperature and oxygen conditions which may be modified by changes in the quality and quantity of Okanagan River inflow.

In order to mitigate these impacts, the Canada/British Columbia Report on the Okanagan Basin Agreement (1982) specified preferred fishery flows for the Okanagan River at Oliver:

Life history stage	**Dates**	**Preferred range (m^3/sec.)**	**Additional information**
Adult migration	Aug. 1 – Sept. 15	8.5 – 12.7	
Spawning	Sept. 16 – Oct. 31	9.9 – 15.6	
Incubation	Nov. 1 – Feb. 15	5.0 – 28.3	Incubation flows >= 50% spawning
Fry migration	Feb. 16 – Apr. 30	5.0 – 28.3	After Feb. 1 flood control takes precedence and 28.3 may be exceeded

A 1999 review (Bull, 1999) showed that minimum flows were less than the specified minimums on at least one occasion in 21 out of 48 cases between 1982 and 1998 (a case being one of the life history stages in each of the years, 3 life history stages per year). Maximum flows exceeded the specified preferred maximums in 27 out of 48 cases. Specified targets are not achieved due to conflicting demands, including:

- flood control
- minimizing dewatering of shore-spawning kokanee eggs and alevins in Okanagan Lake
- irrigation and domestic water demands;
- recreational and navigation interests.

The Canada/British Columbia Report on the Okanagan Basin Agreement (1982) and more recently Ward et al (2000) specified lake levels to minimize impacts on shore-spawning kokanee:

- The level of Okanagan Lake should be less than 341.75 (as per Ward et al 2000) and certainly no greater than 341.9 m on October 15th (Okanagan Basin Agreement, 1982);
- Okanagan Lake drawdown between October 15th and Feb. 1st should be 15 cm or less.

Further analysis by Summit Environmental (2000) and Hyatt et al (2000) supported the inference that significant losses of sockeye fry were likely to occur in many years across a continuum of flow values that are well below the maximum flow levels specified by the Okanagan Basin agreement. Sockeye and/ or kokanee egg and fry losses are clearly unavoidable in some years of extreme climate variation (e.g. record high flow years such as 1997; record low flow years such as the 1929-1931drought). However, **potential losses associated with water management decisions in many years would have been avoidable if local resource managers had been provided with better information**.

Water management decisions may be improved from a fisheries management perspective by identifying relationships among:

1. Sockeye adult migration rates, mortality and gamete viability in relation to discharge and water temperature;
2. Sockeye spawning success and gamete viability in relation to discharge during the spawning period;
3. Sockeye egg and alevin mortality in relation to post-spawning flow reductions;
4. Sockeye egg and alevin development in relation to stream and intra-gravel temperatures;
5. Sockeye egg and alevin mortality in relation to discharge increases (above spawning flows) prior to alevin emergence;
6. Kokanee spawning success in relation to riverine and lake water levels and temperature variations during the spawning period,
7. Kokanee egg and alevin mortality in relation to lake level reduction during the incubation period;
8. Social and economic costs in relation to the degree of lake refill failure;
9. Social and economic costs in relation to flood stage in Okanagan and Osoyoos Lakes and in the Okanagan River downstream of Skaha Lake.

Although the relative value of reducing uncertainty with respect to all of the above factors is unknown, great progress has been achieved through recent OBTWG and DCPUD sponsored projects on topics 1, 3, 4, 5 and 6. Specifically, synthesis of results from studies conducted by Summit Environmental (2000) and Hyatt et al (2000) suggest that sockeye production increases in excess of an average of 100,000 smolts per annum should be possible through implementation of more informed water management decisions (*see Appendix 3 for comments on numeric estimation procedures).* Consequently, OBTWG members are in agreement that the time is right to enter into a collaborative, interagency effort to create a set of predictive models and associated decision support "tools" that will allow local resource managers to achieve a better balance of fish production and other water management objectives.

Project Description

The fish and water management tools project has three major components identified as **(A.) Fish-Water Management Tools**, **(B.) Annual Field Assessments for Supporting Data and (C.) Project Coordination**. The series of tasks under each component along with personnel, financial requirements (summarized in Appendix 2.), timelines and products associated with their completion are dealt with below.

A. Fish-Water Management Tools:

The heart of the Fish-Water Management Tools component will consist of the creation of a set of models (spreadsheet, simulation and/or expert system) and/or decision analysis tools that will provide:

(1) A synthesis of the fundamental hydrological and biological relationships known to control production variations of Okanagan sockeye salmon from parent spawners to seaward migrating smolts.

(2) A lake level, water release and biological production sub-model to predict consequences of water management decisions for annual production variations of Okanagan Lake kokanee. This component is required because water storage and release decisions designed to optimize sockeye production in the Okanagan River are likely to have impacts on production variations of headwater populations of kokanee that spawn on beaches in Okanagan Lake (the main water storage reservoir).

(3) A clearly articulated model of the current decision "rules" and system limits faced by water managers. The hydraulics and hydrology of the system of rivers, streams, lakes and dams in the Okanagan Basin are primarily of interest to water managers for their relevance to maintenance of flood control and irrigation benefits. Thus, the current decision operations "rules" and system limits (including social costs of managing water supplies to include greater consideration of fish production values) faced by water managers will have to be articulated and represented as a sub-model that provides a source of constraints on system management to optimize annual production of salmon.

Products, Timelines and Costs by Task:

Task A1: Core database (water and fish) development and annual maintenance. This task consists of creating a multiyear database on Okanagan River hydrology, daily water temperature, fish distribution, abundance and key biological traits (age, size, sex ratio, fecundity etc...) by species (sockeye, kokanee) and life history stage (total adults, adult spawners, eggs, fry, smolts). A portion of this work focused on assembly of historic physical variable data was completed with DCPUD support in an earlier study (Stockwell and Hyatt, 2000). However, assembly of data for key life history stages of both sockeye (partially complete) and kokanee still requires attention.

Product : Common sets of physical and biological observations stored on CD-ROM for ready distribution and repeated use as inputs or reference data to meet modelling and analysis needs of project team members (including local resource managers).

Timeline - Milestones: (1) Assembly, review and distribution of historic data sets to all participants by fall, 2001. (2) Annual updates of incoming field data or supplemental historic data as required.

Costs-Personnel: $XXXXXX. to support a data technician @ $XXX per day for 100 days. $XXXXX in disbursements (travel, computer lease, materials etc...).

Task A2: Synthesis and documentation of year 2000 project results pertaining to fish production, water management issues. The Fish-Water Management Tools project is based on a preliminary synthesis of findings from several projects (Hyatt et al Limiting Factors Analysis; Summit Environmental's Redd Scour Study; ONFC-HRSEP Spawning Habitat Utilization Study) supported by the OBTWG, DCPUD and DFO's Habitat Restoration and Salmon Enhancement Program during the year 2000. Results from this synthesis have been presented at meetings involving OBTWG, DCPUD and Wells Committee members. However, short timeframes for project completion and reporting during the year 2000 precluded thorough reviews, cross project synthesis and final documentation.

Product : A formal project initiation document (PID) that provides detailed results of cross project analyses serving as the foundation for the Fish-Water Management Tools project.

Timeline - Milestones: Draft document to project participants by August 15.

Costs-Personnel: $XXXXXX. to support a analyst-writer @ $XXX per day for 40 days. $XXXXX. in disbursements (travel, computer lease, materials etc...).

Task A3: Create conceptual model and provide empirical relationships to programmers for hydrology model. Provide collaborative expertise on hydrology and water management practices to programmer-modellers. Seasonal and daily variations in Okanagan River discharge are controlled by a combination of natural events (e.g. precipitation, snow melt) and anthropogenic interventions (i.e. water storage and flow control) at several low head dams at lake outlets along the Okanagan River mainstem. Seasonal water level variations in Okanagan Lake and stage and discharge variations in the Okanagan River that are critical to annual fry recruitment outcomes for kokanee and sockeye respectively. These variations need to be linked to uncontrolled water inputs from precipitation and snow pack melt events as well as to flow management limitations of Okanagan Basin dams.

Product : Component report providing a conceptual model of flow inputs and outputs to Okanagan Lake and their associations with seasonal changes in

Okanagan Lake level and Okanagan River discharge at key locations. Summary of key empirical relations between lake and river levels that define the magnitude of flood damage to riparian property and that predict seasonal water withdrawals for irrigation and/or municipal use. Hydrology expertise to be provided to programmers during sub-model building and testing phases.

Timeline - Milestones: Draft to be completed by early November, 2001.

Costs-Personnel: $XXXXXX. to support a hydrologist-analyst for 40 days @ $XXX per day. $XXXX. in expenses.

Task A4: Create conceptual model and provide empirical relationships for sockeye life history, limiting factors and production model. Provide collaborative expertise on sockeye ecology to programmer-modellers. Annual variations in sockeye production are controlled at several life history stages within the freshwater environment of the Okanagan River and Osoyoos Lake system. These have been the subject of several projects completed by a variety of investigations (including the LFAP of Hyatt et al, 2000) the results of which provide an excellent information base for the creation of a sockeye limiting factors and production model. The core of the sockeye production model is anticipated to be based on assembly of the set of empirical relations that define associations among several life history events (spawning, egg incubation, fry emergence, fry migration, fry rearing and smolt migration), changes in physical variables associated with climate or river hydrology and annual sockeye smolt production outcomes.

Product : Component report providing a conceptual model of seasonal to annual variations in physical conditions (stage, discharge, temperature, oxygen) in the Okanagan River (or Osoyoos Lake) and the consequences of these changes for annual variations in sockeye smolt production. Summary of key empirical relations between variations in physical (or where necessary biological) conditions in freshwater and sockeye smolt production variations mediated by changes in: adult abundance, spawning success, egg incubation success, fry recruitment success (to Osoyoos Lake) and fry rearing success (in Osoyoos lake). Sockeye ecology and population dynamics expertise to be provided to programmers during sub-model building and testing phases.

Timeline - Milestones: Draft to be completed by early November, 2001.

Costs-Personnel: $XXXXXX to support a fisheries scientist-analyst for 40 days at $XXX per day. $XXXX. for expenses. (Fisheries scientist input may be provided by Dr. Hyatt in which case costs incurred would be $XXXXX to support a research assistant for 40 days at $XXX per day plus $XXXX for expenses).

Task A5: Create conceptual model and provide empirical relationships for kokanee beach spawning, egg incubation and fry production model. Provide collaborative expertise on kokanee ecology to programmer-modellers. Annual variations in kokanee production are controlled at several life history stages within the freshwater environment of Okanagan Lake. These have been the subject of several projects completed by a variety of investigations (including the OLAP studies of Ashley et al 1999, 2000) the results of which provide an excellent information base for the creation of a kokanee limiting factors and production model. The core of the kokanee production model is anticipated to be based on assembly of the set of empirical relations that define associations among several life history events (spawning, egg incubation, fry emergence), changes in physical variables associated with changes in Okanagan Lake levels and annual kokanee fry production outcomes.

Product : Component report providing a conceptual model of seasonal to annual variations in physical conditions (water level, water temperature) at spawning beaches in Okanagan Lake and the consequences of these changes for annual variations in kokanee fry production. Summary of key empirical relations between variations in physical (or where necessary biological) conditions in freshwater and kokanee fry production variations mediated by changes in: adult abundance, spawning success, egg incubation and emergence success. Kokanee ecology and population dynamics expertise to be provided to programmers during sub-model building and testing phases.

Timeline - Milestones: Draft to be completed by early November, 2001.

Costs-Personnel: $XXXXXX to support a fisheries scientist-analyst for 40 days at $XXX per day. $XXXX. for expenses.

Task A6: Develop visual basic programs or employ Facet Decision Corp's Scenario Builder to create computer based physical, biological and decision analysis sub-models models reflecting the contents of tasks A2, A3, A4 and A5. Project team to develop interactive decision analysis model.

The decision analysis model will be developed in collaboration with the Okanagan Basin Technical Working Group and the fish-water management project team. It is anticipated that the creation of the physical, biological and decision analysis sub-models noted above will provide a sound basis for specifying and refining "real time" water management decisions that will reduce average sockeye production losses without incurring collateral losses for kokanee or unacceptable alterations to system operations to meet flood control or licensed water withdrawal needs.

The decision steps to be informed by model use will be the monthly (February – June) decision on total discharge from Okanagan Lake for the ensuing month as well as the daily maximum recommended discharge within any month during critical life history stages for Okanagan River sockeye and Okanagan Lake kokanee. The decision analysis sub-model will also have to take into account

relationships between (i.) discharge, and economic and social costs of d/s flooding and (ii.) summer lake levels (June - August), and economic and social costs (flood damage, recreational impacts, etc.).
Sub-model programs will be developed either in Visual Basic or as modules within Facet Decision Corporation's Scenario Builder software (Williams et al. 2000).

Product : Integrated biophysical and decision analysis model with "user friendly" graphical interface for analysis of real time data to support informed water management decisions that will "optimize" annual production of sockeye within system constraints. Model currently envisaged for development within Facet Decision Corporation "expert system" software running on a Sun Microsystems Work Station (*Descriptions of the programming and tool environment for this system is provided by Williams et al. 2000. The Fraser Salmon Integrated Management Model. GIS Applications in Natural Resources 2: 360-368 and Williams et al 2000. Spatially explicit cumulative effects model for estimating in season impact of temperature and discharge on migrating Fraser River sockeye. Proceedings of the 4th International Conference on Integrating GIS and Environmental Modelling. Banff, Alberta, Canada*).

Timeline - Milestones: Programming and decision analysis sub-model creation scheduled for initiation by Nov 2001 and completion by March 2002. Complete initial programming by Dec 31, 2001. Run and debug models by testing output against test data sets provided from Tasks A1-A5 to be completed by Feb 28, 2002.

Costs-Personnel: $XXXXXX for senior programmer-analyst for 25 days @ $XXX per day. $XXXXXX for junior programmer analyst for 25 days @ $XXX per day. $XXXXX for travel and miscellaneous expenses.

Task A7: Provide full documentation of computer models, any associated software and user interface tools.

Product : Documentation of models, associated relationships and source code used to implement models. Model and subroutine user manual for routine reference by local resource managers.

Timeline - Milestones: Draft manual to be developed by March 2002.

Costs-Personnel: $XXXXX to support senior analyst-writer for 10 days at $XXX per day. $XXXXX to support junior analyst-writer for 10 days at $XXX per day. $XXXX for travel and manual production expenses.

Task A8: Train fisheries and water managers in model applications and use of associated decision formulation "tools".

Product : Transfer of model and decision support tools expertise to local resource managers for routine application.

Timeline - Milestones: Completion of initial round of training by March 31, 2002.

Costs-Personnel: $XXXXXX for training workshop.

Other Costs: Sun Microsystems Work Station @ $XXXXXX. Facet Decision Corp Software @ $XXXXX.

B. Annual Field Assessments for Supporting Data.

Task B1: Completion of hydrology and redd scour analysis and documentation. Summit Environmental (2000) noted a requirement for analytical refinements to their redd scour study dependent on obtaining discharge and bedload movement data that were not available as of Dec 2000.

Product : Updated redd scour analysis reflecting refinements to: (i.) stage and discharge data to extend fiekd rating curves and increase confidence in modelling results for high discharge, (ii.) validation of model results through field observations of bedload movement sampled across a range of discharge that includes the maximum guideline discharge of 28.3 m^3/s.

Timeline - Milestones: Completion of new stage discharge and bedload observations by May 30, 2002 or as discharge events permit. Note that water shortages during spring 2001 precluded obtaining measurements for higher discharge levels at that time.

Costs-Personnel: $XXXXXX. In salary and disbursements as per estimates in Table 4.1 of Summit Environmental (2000).

Task B2: Establish and maintain automated station(s) for provision of "real time water temperature, discharge and/or lake level observations for sockeye salmon and kokanee spawning grounds in the Okanagan River and in Okanagan Lake respectively. There are no continuous water monitoring stations currently established in the Okanagan River or Lake to serve as a source of immediate observations of water temperature and discharge pertaining to salmon spawning areas. Consequently, predictions of salmon hatching times, emergence times or redd scour events currently involve delays of several weeks to more than a year (e.g. water temperature reconstructions from multiday mean air temperature data, Stockwell and Hyatt 2000; Hyatt et al… 2000). Both fisheries and water managers require real time water temperature and discharge data for analyses to determine: (i.) year-specific hatching dates and emergence dates for sockeye and kokanee fry, and (ii.) the frequency and magnitude of redd scour or redd dessication events that result in losses of sockeye or kokanee eggs and fry.

Product: Continuous stream of sockeye and kokanee spawning ground water temperature, discharge and/or lake level data that are remotely accessible in real time to analysts and resource managers through standard telecommunications links. Real time temperature and discharge observations are key data inputs for biophysical interaction models identified under project component A. above.

Timeline-Milestones: (1) Purchase and installation of stations to be completed by August 2001. (2) Procedures for station maintenance and data management to be developed and documented by May 30, 2002.

Costs-Personnel: Automated water station hardware and associated software $XXXXXX. Field installation and annual maintenance $XXXXXX. Data downloading and management $XXXXXX.

Task B3: Assessment of sockeye spawner distributions by spawning interval, habitat type and location. A DFO funded Habitat Restoration and Enhancement Project coordinated by the ONFC and executed by Summit Environmental Consultants documented the distribution and abundance of sockeye spawners by time interval and sub-habitat types in the Okanagan River in the year 2000. Data from this project were used as inputs to the river discharge and redd scour prediction study funded by DCPUD. The discharge-redd scour relationship is likely to be very sensitive to both seasonal and annual changes in sub-habitat use by spawning sockeye. The year 2000 assessments of spawner distribution were the first to be conducted at a high enough level of resolution to provide reliable predictions of the magnitude of redd scour and potential egg losses. Year 2000 sockeye returns were also the largest on record within the past 20 years, consequently adult spawner distributions in 2000 will represent sub-habitat use at high abundance but may not be especially representative of sub-habitat use at more average or low abundance levels. Accordingly, spawner distribution and abundance assessments by weekly interval should be repeated for several years in order to provide precise inputs for the discharge and redd scour sub-model.

Product: A report documenting the abundance, distribution by sub-habitat type and river section at weekly intervals for adult sockeye spawners in the Okanagan River.

Timeline-Milestones: Field assessments and mapping of redd distributions to be completed between Sept 1, 2001 and November 30, 2001. Report to be completed by Dec 31, 2001.

Costs-Personnel: $XXXXXX for 30 days of senior biologist time @ $XXX per day; $XXXXXX for 70 days of fisheries technicians time @ $XXX per day; $XXXXX for travel and field gear expenses.

Task B4: Assessment of kokanee spawner distributions by spawning interval, habitat type and location. Recent studies sponsored by MOELPS Okanagan

Lake Action Plan program documented the distribution and abundance of kokanee spawners by time interval and sub-habitat types on Okanagan Lake beaches. Data from this project have been used to predict the vulnerability of kokanee eggs and alevins to variations in Okanagan Lake levels subsequent to the fall spawning period for kokanee. The lake level, egg loss relationship is likely to be very sensitive to both seasonal and annual changes in sub-habitat use by spawning kokanee. Most assessments of spawner areal and depth distribution have been conducted at relatively low population densities, consequently adult spawner distributions represent sub-habitat use at low levels of population abundance but may not be especially representative of sub-habitat use at more average or higher abundance levels. Accordingly, spawner distribution and abundance assessments by weekly interval should be repeated for several years in order to provide precise inputs for the discharge and redd scour sub-model.

Product: A report documenting the abundance, distribution by sub-habitat type and lake beach section at weekly intervals for adult kokanee spawners in Okanagan Lake.

Timeline-Milestones: Field assessments and mapping of redd distributions to be completed between Sept 1, 2001 and November 30, 2001. Report to be completed by Dec 31, 2001.

Costs-Personnel: $XXXXXX for 30 days of senior biologist time @ $XXX per day; $XXXXXX for 70 days of fisheries technicians time @ $XXX per day; $XXXXX for travel and field gear expenses.

Task B5: Biological sample acquisition and processing for species (sockeye or kokanee), age, size, sex composition and female fecundity. Annual estimates of sockeye egg or fry losses associated with redd scour or dessication require reliable starting estimates of total sockeye egg deposition. Reliable estimates of egg deposition require precise estimates of female abundance (i.e. sex ratio), female size and fecundity at biweekly intervals from the spawning grounds. There is currently no program of annual biosampling of sockeye adults from the Okanagan River spawning grounds to provide these estimates. An annual biosampling program component is required to provide explicit values for the sockeye production sub-model.

Product: Annual stock composition report providing: (i.) summary tables of sex, size and age composition (from scale and otolith samples) of Okanagan River sockeye spawners and (ii.) summary tables of female size and fecundity variations.

Timeline-Milestones: Biological sampling to be completed at biweekly intervals between Sept 10, 2001 and November 5, 2001. Report to be completed by Dec 31, 2001.

Costs-Personnel: $XXXX for 15 days of fisheries technician time @ $XXX per day. $XXXX for sample processing.

Task B6: Systematic sampling of eggs and fry for verification of egg hatch, fry emergence and migration times for sockeye and kokanee from riverine and lake spawning areas. In their limiting factors analysis project, Hyatt et al calculated annual values for 100 % hatch and emergence times for Okanagan River sockeye on the basis of empirical relationships used in a temperature and sockeye incubation time model. Given annual variations in peak spawning dates and riverine temperature, estimates over a 50 plus year interval indicated a range of hatch and emergence dates across all years of greater than 90 days (mean time to 100 % hatch of 138 days). Verification of the reliability of these estimates rests solely on a single years observations of Okanagan sockeye fry emergence and migration assessed by Shepherd and Inkster in 1994. Although model predictions agree reasonably well with this single observation, additional assessments of fry emergence success and timing are warranted given the extent to which inferences about the potential for increasing sockeye production through improved water management decisions rest on the validity of the egg hatching and timing predictions.

Accordingly, assessments are required during the 2001 season to monitor egg and alevin survival and development in relation to stream and intra-gravel temperatures and discharge. Key elements of this component are:

- Accurate marking or survey location of spawning redds (by river segment, water depth, velocity and distance from stream margin); subsequent monitoring of egg and alevin survival by redd excavation and/or freeze-coring following flow reductions. Monthly monitoring of egg development and downloading of temperature data to Jan. 31st; subsequent bi-weekly monitoring

- Monitor egg and alevin emergence in relation to discharge. The methodology will duplicate the fyke-netting methodology used by Bruce Shephard in 1997.

Product: Stock assessment report on egg incubation progress, hatch and fry emergence dates dates (i.e. time to 25 %, 50 % and 100 % egg hatch and fry emergence). Key observations to verify components of the sockeye production sub-model.

Timeline-Milestones: The timeframe for the egg incubationt component of this project is from October, 2001 to May, 2002 and for the fry emergence component from March 2002-May 2002.

Costs-Personnel: $XXXXXX for 60 days of fisheries technician time @ $XXX per day. $XXXX for sample processing and field expenses.

C. **Project Coordination**: Given the magnitude of the Fish-Water Management Tools Project and the diversity of participants, provision of overall project coordination will be a key to the successful completion of work on time and on budget. Accordingly support is required for a contract coordinator to liaise with Douglas County PUD, the OBTWG and to oversee and facilitate the work of the project team.

Task C1: Coordinate activities of project participants drawn from multiple agencies (DFO, MOELP, WMB, ONFC, DCPUD etc...) and provide liason with Douglas County Public Utility Division personnel. Organize project team meetings and workshops among project participants including resource analysts, contract biologists, contract programmers-modellers and local resource managers.

Product:Timely meetings, summary budget reports to DCPUD and OBTWG contacts, workshop organization and scheduling, regular project overviews.

Timeline-Milestones: Overall project scoping workshop among OBTWG, DCPUD and Contract participants to be organized and executed within a month of project approval. Monthly working group meetings and progress reports on component project progress, content, budget status etc...

Costs-Personnel: $XXXXXX required for 50 days of senior biologist-coordinator time @ $XXX per day.

Study Team Strategy: The authority for fish, habitat and water management decisions in British Columbia is shared between Canada's Department of Fisheries and Oceans and the Province of British Columbia. Further, the Okanagan Nation Alliance has a constitutionally guaranteed access to fisheries resources for food, ceremonial and societal purposes. Consequently, both fish and water management decisions involve the exercise of delegated authority by personnel in each of several Federal, Provincial and First Nations groups. Participation of key personnel from these groups is therefore essential to the development and routine use of any decision analysis tools if they are to be employed successfully to improve fish and water management decisions pertaining to Okanagan River sockeye as well as other resident fish species. In consideration of this, the three party Okanagan Basin Technical Working Group has agreed to act as a steering committee and source of "agency" expertise (see summary in Appendix 2.) for the duration of the fish water management tools project.

Some of the expertise or professional time required for completion of the fish and water management tools project is not currently available within the ranks of the OBTWG. Consequently sub-contracts will be required to provide both specialized analytical, modelling or programming skills and supplemental field support dictated by some of the project components (e.g. Tasks A3, A4, A6, A7, A8, B1-B6 and C1, Appendix 2.). The Okanagan Basin Technical Working Group will provide ongoing technical review to confirm which project components are to be delegated to agency personnel as well as those that are to be supported through sub-contracts to private firms as the project progresses.

Finally, given current workloads plus the interdisciplinary nature of the fish and water management tools proposal, OBTWG members are unanimous in their view that a contracted project facilitator (Appendix 2, Task C) will be required to: (i.) provide a monthly reporting link between the OBTWG acting as the project steering committee and Douglas County PUD as the project sponsor, (ii.) facilitate timely interactions between agency and/or contracted experts tasked with timely completion of separate but interdependent components of the project, (iii.) schedule workshops, (iv.) provide updates to the OBTWG on the progress of the work, and (v.) provide advice or recommendations to the OBTWG regarding problems encountered and options for their solution during the course of the project team's activities.

Appendix 1. Okanagan Basin Technical Working Group - Feb. 21, 2001.

Development of Okanagan Basin Aquatic Ecosystem Principles , Risk Assessment and Adaptive Management Approaches to Dealing with Uncertainty

Ecosystem Principles:

The Okanagan Basin Technical Working Group (OBTWG) is committed to developing an ecosystem and science based fish stock and habitat restoration program to: (i.) conserve and protect "native" fish stocks and habitats that in the absence of active intervention are considered to be at imminent risk of loss (e.g. Okanagan River sockeye salmon; remnant wetlands and riparian habitat), (ii.) rehabilitate or restore highly valued, native fish populations or segments thereof that have been degraded or lost (e.g. sockeye salmon, kokanee, rainbow trout etc...) such that restoration will satisfy both historic and/or new sustainable use patterns *subject to the laws or agreements of the people of Canada or their representatives,* (iii.) rehabilitate or restore natural aquatic and riparian habitats or segments thereof that have been degraded or lost (e.g. river meanders, oxbow lakes, natural communities of riparian flora and fauna etc...) and (iv.) to maintain and/or re-establish, within practicable limits, components of natural ecosystem processes (e.g. sediment recruitment and loss, large woody debris recruitment, riparian zone succession) considered by best available science to be essential to the long term persistence of the desired ecosystem configuration.

Detailed articulation of an ecosystem based management framework constitutes a challenging task that will represent an ongoing activity of the OBTWG over several years of time. However significant progress has been made to date through OBTWG agreement on several principles including:

(i.) Annual returns of the native population of Okanagan sockeye salmon are depressed to an extent relative to historic levels of production that no surplus currently exists to satisfy even minimal use patterns (i.e. Section 35) of First Nations people and accordingly stock or habitat restoration projects that might benefit recovery of this species to historic levels are desirable.

(ii.) Given the value of Okanagan sockeye to First Nations and non-First Nations peoples, a complex life history, a sensitivity shared with other salmonids to environmental degradation, and a multidecadal, quantitative record of abundance, Okanagan sockeye constitute an important "end-point", indicator of whether we are achieving success in maintaining the integrity of specific freshwater and marine ecosystems. Consequently, (iii.) stock or habitat restoration activities focused on rehabilitating Okanagan sockeye salmon within an ecosystem context will generally provide collateral benefits for an entire complex of desirable native (e.g. coldwater) species.

(iv.) The sum of our conservation and restoration activities will not be restricted to single-species, resource management values and, over time, will reflect a balance of multispecies, ecosystem concerns.

(v.) A corollary to the "sockeye collateral benefits principle" noted above is that restoration of riparian and aquatic habitat components which move the entire system to a more natural state will provide benefits to many species including sockeye salmon.

(vi.) Ecosystems are not only more complex than we think, *they are more complex than we can think* (Jack Ward Thomas, 1992). Thus, attempts to manipulate components of either fish stocks or habitats are usually accompanied by variable levels of risk and uncertainty with respect to achieving predicted outcomes. Consequently, manipulations of fish populations or habitat components should be: (a) preceded by some form of benefit-cost analysis where potential risks are assessed as components of cost and then (b) implemented through adoption of an adaptive management process that will improve the prospects for achieving the desired objective(s) while avoiding the creation of undesirable outcomes that were not anticipated.

Dealing with Uncertainty through Risk Assessment and Adaptive Management Approaches

Numerous discussions among OBTWG members within the past three years have repeatedly identified that manipulations of fish populations and their habitats are rarely executed with certainty regarding final outcomes. Introductions of Mysis relicta (oppossum shrimp) into British Columbia lakes and associated collapses of kokanee populations serve as one example of a purposeful but highly unsuccessful manipulation to "improve the ecosystem" for the benefit of native fish populations (see summary comments in Table 1.). This example underscores the reality that we generally make decisions from an incomplete knowledge base such that outcomes are seldom certain no matter how well intentioned. This general observation applies more or less to virtually all of the habitat and stock rehabilitation options that OBTWG members have identified to date for possible implementation (see summary comments in Table 2.).

Table 1. A summary of anticipated benefits, perceived risks, and unanticipated outcomes associated with the introduction of the exotic invertebrate Mysis relicta into lakes throughout western North America.
Option: Introduction of the oppossum shrimp (Mysis relicta) **Predicted Benefits**: Relatively large shrimp to serve as a supplemental food source for fish (e.g. rainbow trout and kokanee) such that salmonid production increases and larger numbers of "trophy size" rainbow trout are available to recreational fishermen. **Uncertainties**: Unclear whether introductions would be successful in establishing self sustaining populations of mysids and if so what magnitude of benefits would materialize for native species of fish. **Observed Outcomes**: Mysid introductions appeared to be unsuccessful up until 15-30 years after introductions were completed. Mysids eventually established large, self sustaining populations but have generally not become a staple food source of salmonids as originally intended because of effective predator "avoidance" behaviour. Mysids have been established as effective competitors with salmonids for limited supplies of high value planktonic prey such as Daphnia spp. Severe population declines of several species of pelagic fish (e.g. kokanee) have been repeatedly observed in association with mysid introductions and population increases (e.g. Kootenay Lake, Okanagan Lake, Lake Tahoe etc.). **Lessons**: Ecosystem manipulations are often accompanied by unexpected outcomes. Completion of risk assessments are important prior to implementing ecosystem manipulations. The degree to which a given manipulation is reversible constitutes an important element of any risk assessment. Reversible manipulations (e.g. introductions of short lived effluents to water bodies) are inherently less risky than irreversible ones (e.g. species introductions) because they permit an adaptive management decision to reverse the manipulation and its consequences if something goes wrong.

Table 2. A summary of anticipated benefits and potential uncertainties associated with various fish-habitat restoration options under consideration by the Okanagan Basin Technical Working Group and DCPUD for 2001/02.
Option A: Spawning Channel **Predicted Benefit(s)**: Improved egg-to-fry survival and a net gain in annual sockeye production relative to a reference interval (e.g. 1970-2000 average). **Uncertainties**: (i.) precise magnitude of net production benefit relative to cost of construction and operation, (ii.) impact of operating requirements on mainstem and natural side-channel hydraulic responses between the channel intake and outlet given seasonally variable water supplies, (iii.) biological impact on various components of the existing sockeye run (i.e. early, peak and late) or on other high value resident species.
Option B: Riffle Restoration Project(s) **Predicted Benefit(s)**: Provision of a more "fish friendly" engineering alternative to existing vertical drop structures for dissipating hydraulic forces i.e. modification of flood channel hydraulics to facilitate passage by wider range of fish species and sizes. Restoration of more natural habitat components in flood channel segments to support greater diversity and biomass of resident fish. Restoration of diversity of in-stream habitat components offering cover, foraging sites, spawning sites for several species of resident fish (e.g. rainbow trout, mountain whitefish etc…). **Uncertainties**: (i.) influence of riffle structure(s) on debris retention, dike stability, adjacent groundwater levels and annual costs of channel maintenance, (ii.) potentially complex influences of introducing engineered riffle structures on the overall riverine fish community and the secondary effects this might have on potentially elevated mortality levels of migrating sockeye fry. For example, creation of channel cover and foraging sites for piscivores such as trout, pike minnow and sculpins or facilitation of upriver passage and routine access to sockeye spawning sites by egg eaters such as sculpins, suckers, carp and bullheads represents an unknown risk to the key objective of achieving a net gain in annual productivity of sockeye salmon.
Option C: Oxbow Restoration **Predicted Benefits**: Reconnection, restoration of natural habitat components on flood plain to support greater diversity and biomass of resident fish. **Uncertainties**: Potentially complex responses of mixtures of native and exotic species currently composing the Okanagan Basin fish community and the net effects these responses may have on production of native species. For example, reconnected oxbow habitats may benefit exotic species such as smallmouth bass, carp, crappie and bullheads to an extent that restoration of historic production

levels by native species is reduced. Oxbow "entrainment" of migrating sockeye fry also represents uncertain risks and net production consequences for one of our target indicator species.
Option D: Riparian Vegetation Restoration **Predicted Benefits**: Restoration of more natural community of riparian flora and associated fauna. Improvements in cover and food sources for both native and non-native fish species that depend on nearshore habitats. **Uncertainties**: Influence of riparian vegetation succession on integrity and maintenance of dikes.
Option C: Okanagan River Flow Management **Predicted Benefits**: Reductions of losses of sockeye eggs and alevins through flood and scour or drought and dessication processes. **Uncertainties**: Degree to which flow management for downstream benefits will compromise upstream benefits for irrigation, flood control or management of Okanagan Lake levels for kokanee production. Impact of climate variations (e.g. global climate change) on annual water supplies. Future water withdrawal requirements to meet needs of expanding human populations.

Aquatic ecosystems in the Okanagan Basin have been subjected to "disturbance regimes" that are increasingly influenced by activities associated with both global and local human population growth. Although some of the elements of this new disturbance regime may have been beneficial to aquatic ecosystems and the fish-habitat complex, most have not. Consequently, human impact management through directed interventions to conserve, protect and restore aquatic ecosystem elements has become an unavoidable activity if aquatic ecosystems in the Okanagan Basin are to retain some semblance of their historic character (e.g. healthy populations of both anadromous and resident cold water fishes). Although directed interventions are essential, as noted above, they inevitably involve both risk and uncertainty regarding outcomes (e.g. Tables 1 and 2). Because our intent is to do more good than harm, it will always be necessary to explicitly assess the nature and magnitude of the risks associated with human interventions and to adaptively manage these during implementation to avoid producing unexpected negative consequences whenever possible. Thus, if the OBTWG intends to coordinate a long term effort to "tinker intelligently" to maintain the natural character of aquatic ecosystems in the Okanagan Basin then its members should give consideration to:

(1) routine inclusion of risk assessment analysis for all projects prior to final decisions for their implementation,
(2) adoption of an adaptive management framework for implementation of any project considered to involve moderate to high levels of risk or uncertainty regarding final outcomes.

Note that adaptive management has been generally supported as a useful approach to dealing with the many uncertainties that are the product of highly complex biotic and abiotic interactions that characterize most natural ecosystems. The adaptive management approach includes: (i.) adoption of a stepwise approach to project implementation, (ii.) a commitment to assessment and monitoring prior to, during and after project completion and (iii.) cyclical review of incoming assessment information to support a stepwise decision making process that includes the option of project termination (or, where appropriate reversal) at any point where information clearly indicates the costs are likely to outweigh the benefits.

Appendix 2. Summary of Fish-Water Management Tools Project Costs by Component.

Water Mgt. Component	**Cost (1000's)**	**Coordinator - Executor(s)**
(A.) Water-Fish Mgt Tools		
A1: Core database development and annual maintenance (water and fish)	XX	DFO - Hyatt et al in 2001
A2: Limiting factors 2000 analysis documentation	XX	DFO - Hyatt et al
A3: Provide conceptual and empirical basis for hydraulics and hydrology model	XX	MOELP-WMB-Contracts (Summit) Symonds-McGregor
A4: Provide conceptual and empirical basis for sockeye limiting factors & production model	XX	Contractor assumption or DFO-Hyatt-Assistant assumption
A5: Provide empirical basis for kokanee fry limiting factors & production model	XX	MOELP- Mathews-Sawada (Contractor)
A6: Develop biophysical and decision models in Facet Scenario Builder or as Visual Basic code with GUI tools.	XXXX	Williams-Facet and/or ESSA with input from project team (i.e. DFO MOELP, WMB, ONFC etc...)
A7: Document models and user interface tools	XX	Williams-Facet and/or ESSA
A8: Train fisheries and water managers in model applications and use of associated fish-water decision formulation tools	XX	OBTWG workshops with decision tool development team and facilitators
Other Costs: Sun Microsystems Work Station	XX	DFO - Science - Habitat Mgt
Facet Decision Corp Software	XX	DFO - Science - Habitat Mgt
Total A	**$XXX**	
(B.) Field Assessment Components		
B1: Summit hydrology and redd scour analysis and documentation	XX	Summit
B2: Installation, maintenance and monitoring of two automated water stations.	XX	ONFC-Summit
B3: Assessments of sockeye spawner distribution by time interval, habitat type and location	XXXX	DFO-ONFC-Contracts
B4: Assessments of kokanee distribution by time interval, habitat type and location	XXXX	MOELP-ONFC-Contracts

B5: Biological sample acquisition and processing for species (sockeye or kokanee), age, size & sex composition plus female fecundity.	XXXX	ONFC-DFO-Contracts
B6: Egg hatch, fry emergence success and migratory timing verification	XXXX	DFO-ONFC-Contracts
Total B	**$XXXX**	
Total (A+B)	**$XXXX**	
(C.) Project Coordination and Facilitation	XX	Contract Coordinator (e.g. C. Bull)
Fish-Water Mgt Tools Project Total (A+B+C)	**$XXXX**	

Appendix 3.

Details of the analysis for quantifying the smolt production increases identified in the current proposal involve a synthesis of results provided in several component reports from last year's work. Although this synthesis is to be reported on in detail under Task A2 of the current proposal, the general approach taken is as follows.

First the intervals during which eggs and alevins were expected to be present in the gravel for each year were identified by estimating the time of peak egg deposition and the time to 100 % hatch. The former date(s) were estimated from either direct observations of peak spawn timing or from an assumption that the peak date in years lacking high resolution observations would follow the all year mean for the dozen or more years in which high quality spawner abundance observations were available. The date to 100 % egg hatch was based on the Hyatt et al temperature and incubation-time analysis results presented to the Wells committee in our spring meeting.

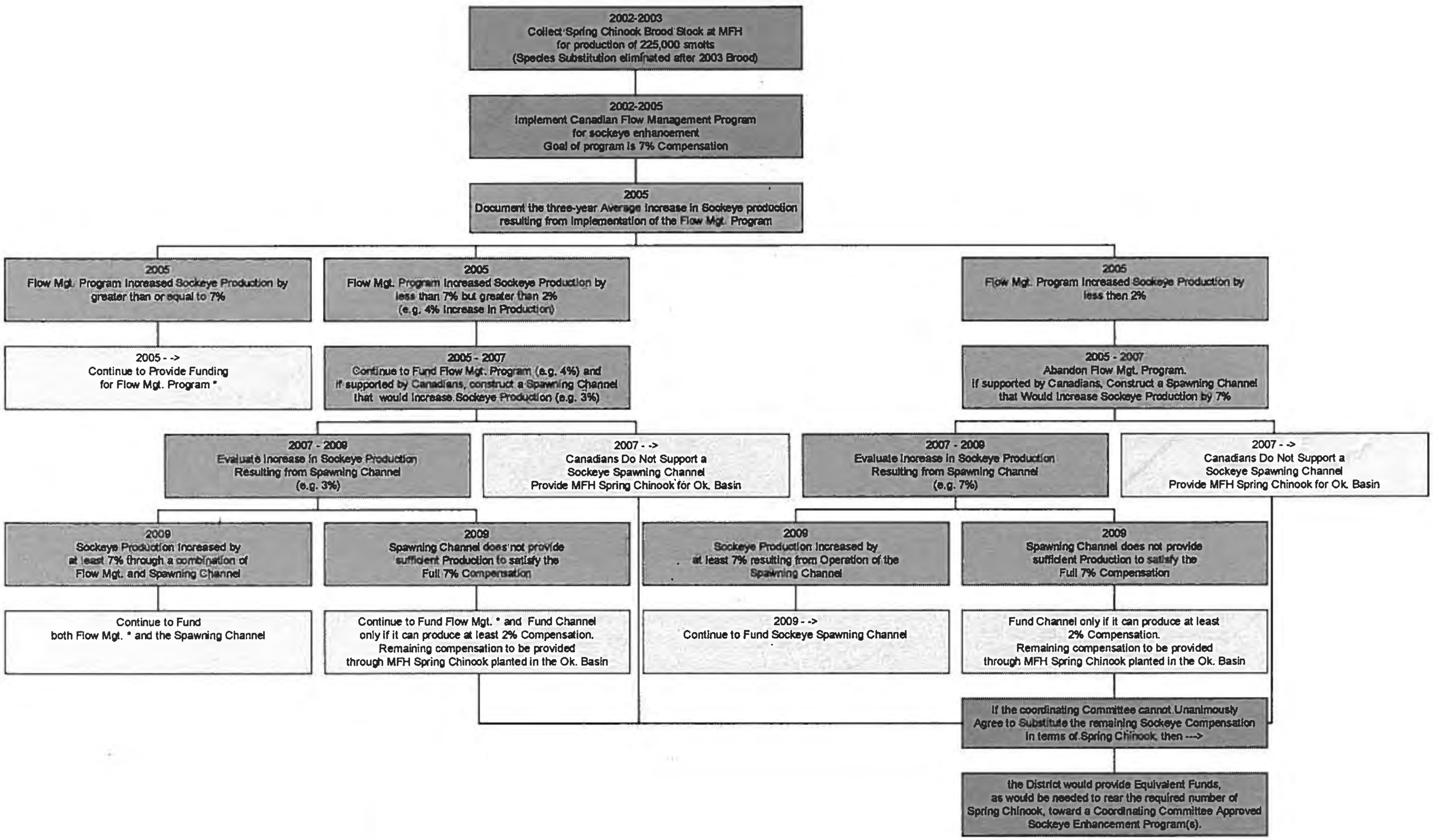
Next, the sockeye redd scour relationship developed across sub-habitat types (*documented in the Summit Environmental year 2000 analysis*) was applied to each of the most recent 15 years of observed seasonal discharge patterns (*from Canada Department of Environment daily discharge records*) to estimate the magnitude of egg and alevin loss that would potentially result from scour during each of the year specific intervals associated with egg deposition and 100 % hatch (*i.e. predicted egg losses depend on Summit's scour versus discharge values as applied only during the interval when eggs were predicted to be vulnerable*).

The final step was then to determine, by inspection, whether water releases could have been altered sufficiently to avoid the loss. This final step was required because in some years (e.g. 1997) managers have no flexibility to alter water releases to avoid scour events. I then averaged the estimated losses of redds (*estimates provided as a percent of all redds present*) over all years and then examined the actual size of the adult spawning stocks (*from terminal spawning ground counts*) and the actual size of juvenile sockeye populations in recent years (*as per Hyatt et al acoustic and trawl surveys of presmolt numbers in Osoyoos Lake*) to estimate what level of juvenile production these **avoidable losses** should translate into. For the initial test data set involving more than 10 years of observations, the predicted egg and/or alevin losses amounted to an average of 15 % of annual production. In recent years this would have translated into losses of between 150,000 and 300,000 smolts.

SOCKEYE ENHANCEMENT DECISION TREE

APPENDIX C

Sockeye Enhancement Decision Tree



*Should the Canadian Parties be capable of funding all or a portion of the Flow Mgt. Program, then the District would be willing to redirect an equivalent level of funds, that would have been required to continue implementation of the Flow Mgt. Program, toward a different Coordinating Committee approved sockeye enhancement program.

BROODSTOCK COLLECTION PROTOCOL, 2001

APPENDIX D

STATE OF WASHINGTON
DEPARTMENT OF FISH AND WILDLIFE
Mid-Columbia Field Office
610 North Mission St. Suite B8 • Wenatchee, WA 98801 • (509) 664-3149 • FAX (509) 662-6606

12 February 2001

To: Joint Fishery Parties / Mid-Columbia Coordinating Committee

From: Kristine Petersen

Subject: **SECOND DRAFT YEAR 2001 UPPER COLUMBIA RIVER SALMON AND STEELHEAD BROODSTOCK OBJECTIVES AND SITE-BASED BROODSTOCK COLLECTION PROTOCOLS**

The draft adult broodstock collection schedule for year 2001 is keyed on target numbers at various collection sites operated by WDFW that provide broodstock for WDFW facilities. Hatchery programs or facilities operated by other agencies or tribes are not addressed in the document. This protocol is necessary to allow adequate time for discussion and operational planning to achieve the desired hatchery program and species recovery objectives (BAMP 1998). This adult broodstock collection schedule is to be considered an interim and dynamic hatchery broodstock collection plan, which may be altered following joint fishery party (JFP) discussions. As such, there may be significant in-season changes in broodstock numbers, locations, or collection times, brought about through continuing co-manager consultation and in-season monitoring of the anadromous fish runs to the Columbia River above Priest Rapids Dam.

The spring chinook collection protocols have some significant changes from last year because of either altered direction of the program, as is the case for the Chiwawa program or because of large run size that allows for us to move forward with the plans to target specific stocks of fish as is the case in the Methow Basin.

The JFP have agreed to develop a composite Chiwawa/Nason spring chinook stock in the Wenatchee Basin. White River spring chinook have been determined to be a genetically unique stock and shall be managed as a separate stock. A proposal to collect spring chinook at Tumwater Dam and use DNA analysis to segregate fish by stock has been developed. If we are able to determine the origin of fish using the DNA technology with a high level of confidence, then we can selectively retain Chiwawa and Nason origin fish. Fish identified from the White River would be released and allowed to spawn naturally. The DNA database necessary to attempt this segregation is under development by WDFW but will not be completed in time for use in 2001. Since 1993, a estimated 25% of all Chiwawa spring chinook recovered on the spawning grounds were found in Nason Creek. Under the current program, we are essentially mining the Chiwawa River of spring chinook and supplementing Nason Creek. Therefore, I am recommending that broodstock be collected from both the Chiwawa River and Nason Creek to begin the composite stock.   I believe this is important measure toward collecting sufficient adults for broodstock for this program that will supplement the Chiwawa River and Nason Creek.

The Methow Basin spring chinook programs continue to be a contentious issue for the JFP's and the general public. How we deal with the large run expected in 2001 will be the focus of many eyes. In light of this, the BAMP (1998), and the recent draft Biological Opinion released by NMFS, I believe that WDFW should collect broodstock in a manner that reduces the possibilities of collecting Winthrop NFH Carson lineage fish. Per discussions with the hatchery managers, Fish Management, and Douglas PUD biologists, the collection protocol outlines tributary trapping on the Methow, Chewuch, and Twisp rivers. Tributary trapping should significantly reduce the number of Winthrop NFH origin fish WDFW collects. Douglas PUD has initiated repair work needed at Fulton Dam on the Chewuch River and is preparing the Twisp weir for installation later this spring to allow for tributary trapping.

The year 2001 outlook for ESA-listed upper Columbia River spring chinook is encouraging. The TAC forecast is 142% of last year's run at the mouth of the Columbia River. Upper Columbia summer chinook and sockeye salmon are expected to be at least as large as 2000 returns. The A-run steelhead component, which includes Upper Columbia stocks, is forecast to be 93% of the 2000 run to Bonneville Dam.

Reference:

Biological Assessment and Management Plan (BAMP). 1998. *Mid-Columbia River Hatchery Program. National Marine Fisheries Service, U. S. Fish and Wildlife Service, Washington Department of Fish and Wildlife, Confederated Tribes of the Yakama Indian Nation, Confederated Tribes of the Colville Indian Reservation, Confederated Tribes of the Umatilla Indian Reservation, Chelan County Public Utility District, and Douglas County Public Utility District. Mid-Columbia Mainstem Conservation Plan. 176 pp.*

Distribution List:

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Cindy LeFleur	Jerry Moore	Rick Stilwater	Bob Jateff	Heather Bartlett
John Easterbrooks	Art Viola	Bob Rogers	Andrew Murdoch	Charlie Snow

The following year 2001 run sizes are forecast for the Columbia River (TAC, various).

Spring Chinook (TAC)   364,600 total run to Bonneville

206,700 destined to Snake Basin
119,800 destined to Middle Columbia Basins
38,100 destined to Upper Columbia Basins (6,300 wild)
23,576 to Priest Rapids Dam

A. Viola, WDFW — 22,222 to Rock Island Dam
(Jack to adult regression)

A. Viola, WDFW
(AAR + SAR methods) — 2,172 – 11,945 to Wenatchee Basin
1,094 – 9,313 to Icicle Creek (280 wild)
640 – 1,052 wild to upper Wenatchee basin
438 – 696 hatchery origin to Chiwawa River
3,426 – 5,436 to Entiat River
134 – 211 wild
3292 – 5,225 to Entiat NFH
1,190 – 6,704 to above Wells Dam
473 – 1,014 wild
146 – 2,746 Winthrop NFH stock (100% station release)
371 – 2,944 Methow FH stocks (55% station release)

Summer Chinook (TAC) 33,700 total run to Bonneville
9,200 destined to Snake Basin (90% increase)
24,500 destined to above Priest Rapids (18% increase)

Sockeye (TAC) 78,105 total run to Bonneville
37,000 destined to Wenatchee Basin
41,000 destined to Okanogan Basin
105 destined to Snake Basin

A. Murdoch, WDFW, SAR alternate for Lake Wenatchee is survival of 1.3% for wild and 2.5% for hatchery smolts = 24,000 adults

Steelhead (TAC-Index) 201,300 A-run to Bonneville

Year 2001 Upper Columbia Broodstock Collection Targets by Species and Program

Spring Chinook

Chiwawa/Nason composite spring chinook hatchery program and assumptions:

R.I. Settlement Program	672,000 yearling smolts
Propagation survival	83% fertilization to release
Fecundity	4,400 eggs per female
Female to male ratio	1 to 1
Pre-spawn survival	97%
Broodstock required	379

Chiwawa River Trap Chiwawa spring chinook following BY94 through BY2000 schedule (weir operates 4 days up and 3 days down), anticipating an effective extraction rate of about 13% of the run. Spring chinook retained will be transferred to Eastbank Fish Hatchery (FH) for holding in well water. All bull trout trapped at the Chiwawa weir will be transported by tank truck and released into a resting/recovery pool at least 1.0 km upstream from the Chiwawa River weir.

Nason Creek Construct and operate a temporary picket weir trap on Nason Creek in a manner similar to the Chiwawa weir (trap in place 4 days and is open 3 days). The trap should have an upstream and downstream collection box to prevent delay, injury or death to fish moving downstream. Spring chinook retained will be externally marked with a visual implant elastomer tag posterior to the eye then transferred to Eastbank FH for holding in well water. These fish will be held with fish trapped from Chiwawa River. To reflect spawner distribution in the basin, no more than 40% (152 fish) of the total collection goal should come from Nason Creek. If less than 20 salmon from both traps have been collected by 17 August, trapping will be discontinued and all fish will be released back to their stream of origin. All bull trout trapped at the weir will be transported by tank truck and released into a resting/recovery pool at least 1.0 km upstream from the trap. Operation of this trap may require 24-hour on site monitoring.

Tumwater Dam Adipose fin clipped spring chinook have been collected at Tumwater Dam for the past several years. The low efficiency of the Chiwawa weir has made this an important site for collecting spring chinook. All spring chinook retained from this site will be elastomer marked with a color different from those from Nason Creek.

Gametes from the Nason Creek captive broodstock program at the Aquaseed facility in Rochester will be incorporated into the Chiwawa/Nason composite stock. No collection of eggs from redds on spawning grounds will occur.

White River Continue collection of BY01 eyed eggs for the captive broodstock. Up to

25 redds will be hydraulically sampled to obtain 40 individuals from each redd (BAMP 1998). Approximately 25,000 eggs are anticipated in 2001 from the ongoing captive broodstock program.

Methow Basin

Methow FH spring chinook program (BAMP 1998) and assumptions:

Wells Settlement Program	738,000 yearling smolts
HCP Modified Program	550,000 yearling smolts
Size at release study	450,000-550,000 yearling smolts
Propagation survival	90% fertilization to release
Fecundity	4,200 eggs per female
Female to male ratio	1 to 1
Pre-spawn survival	95%
Broodstock required	250-306

The forecast spring chinook run to Wells Dam is 6,704, which far exceeds the Mid-Columbia Mainstem Conservation Plan's Tier 3 level of 1,415 fish, above which broodstock collection will be at levels required for the combined Methow FH and Winthrop NFH composite Methow stock production (Interim Production Objectives, BAMP 1998). Following the recent draft Biological Opinion (NMFS) concerning Permit 1196 to WDFW, Permit 115/Modification 3 to Chelan PUD and Permit 1246 to Douglas PUD, we proposed collection of spring chinook broodstock from tributary traps in the Methow Basin for the 2001 programs. A size at release study is proposed for the 2001 brood group, comparing survival of fish released at 15 fish per pound (FPP) to those released at 11 FPP. The details of this study are evolving but we estimate it would reduce the production goal to around 450,000 fish. The HCP release goal is 550,000 yearling smolts. Therefore, this protocol describes the adult collections for both scenarios. The broodstock collection goal for the size at release study is 250 fish and for the HCP program is 306 fish. The gametes from adults returning to the Methow Basin from Winthrop NFH releases (Carson Lineage stock) that are identified at spawning will be returned to Winthrop NFH. If trapping at Fulton Dam on the Chewuch River and at the weir on the Twisp River is successful, then we would expect the fish collected to primarily be of Methow composite or Twisp stock. If these tributary traps are inoperable, then the primary collection site will be the Methow FH outfall. In 2000, 23% of the adults collected at the Methow FH outfall were from Winthrop NFH (Carson stock). In order to ensure sufficient gametes of Methow Composite stock and Twisp stock are collected the broodstock collection goal would increase to 307-376 fish.

Foghorn Dam No trapping

Fulton Dam The Fulton irrigation diversion dam on the Chewuch River has not been used since 1993. In 1993 trap efficiency was 60%. Maintenance work scheduled to be conducted prior to the start of trapping this year should restore the trap to conditions similar to 1996 whereby we can anticipate a trap efficiency approaching 60%. The median escapement estimate of 266 wild (range 169-363) and 674 hatchery (range 151-1,197) origin salmon returning to the Chewuch River would result in trapping approximately 564 adults. We propose retention of up to 200 run-at-large fish from this trap to use as broodstock for the Methow Composite program. Adipose fin clipped fish and wild fish will be retained in proportion to their occurrence in the run.

Twisp Weir A floating weir on the Twisp River provides for collection of Twisp stock spring chinook. Historically trap efficiency is low at this facility at about 22%. The median escapement estimate of 155 wild (range 99-211) and 69 hatchery origin (range 15-122) fish would suggest that up to 50 Twisp spring chinook could be collected at this facility. We propose to retain all spring chinook trapped for the Twisp program. Operation of this weir will likely require 24-hour on site monitoring during much of the trapping season.

Methow FH The temporary trap adjacent to the Methow FH in 2000 resulted in the collection of 137 adult spring chinook. Sixty-one percent of these fish were originated from releases from Methow FH and 7% were from releases in the Twisp River. Collection of the target stocks of Twisp and Methow Composite at this location will be greatest if Winthrop NFH has their ladder open as many of the fish originating from their programs will return to the facility if allowed. We expect to collect 100-200 adults for broodstock for Methow FH programs from the hatchery outfall. If the Twisp Weir and/or Fulton Dam are inoperable, then this is the primary trapping site and the collection goal would increase to 307-376 fish.

Wells Dam No trapping of spring chinook will occur at Wells Dam because of the expectation that tributary trapping and hatchery returns will be sufficient to achieve Methow Composite stock production objectives.

Twisp River Captive Brood: The JFP have agreed to discontinue captive brood efforts involving the Twisp stock. The fish currently being held as captive broodstock will be reared until maturity and the resultant gametes will be included in the Twisp program at Methow FH. We anticipate up to 100,000 eggs may be transferred from Aquaseed to Methow FH for incorporation into the Twisp program. However, the 2000 brood fry from Aquaseed have high levels of BKD already. The survival to release of this group will likely be very low.

Summer Chinook

Wenatchee summer chinook program and assumptions:

Program	864,000 yearling smolts
Propagation survival	78% fertilization to release
Fecundity	5,000 eggs per female
Female to male ratio	1 to 1
Pre-spawn survival	90%
Broodstock required	492

Trap **492**-mixed origin, run-at-large (including jacks) summer chinook at **Dryden Dam**.

Methow/Okanogan summer chinook program and assumptions:

Program	976,000 yearling smolts
Propagation survival	78% fertilization to release
Fecundity	5,000 eggs per female
Female to male ratio	1 to 1
Pre-spawn survival	90%
Broodstock required	556

Trap **556**-mixed origin, run-at-large (including jacks) at **Wells Dam east ladder**.

Wells Hatchery summer chinook programs and assumptions:

Wells program	320,000 yearling smolts
	484,000 sub yearlings
Lake Chelan program	100,000 late release sub yearlings
Rocky Reach program	200,000 yearling smolts
	450,000 accelerated sub yearlings
	628,000 normal sub yearlings
Propagation survival	81% fertilization to 0+ release
	78% fertilization to 1+ release
Fecundity	5,000 eggs per female
Female to male ratio	1 to 1
Pre-spawn survival	90%
Broodstock required	1,208

Collect **1,208** run-at-large (including jacks) **volunteers** to Wells Fish Hatchery outfall, (296 for yearling programs and 912 for sub yearling programs), representing zero impact to upriver runs.

Sockeye

Lake Wenatchee sockeye program and assumptions:

R.I. Settlement Program	200,000 fall release sub yearlings

Propagation survival	79% fertilization to release
Fecundity	2,340 eggs per female
Female to male ratio	1 to 1
Pre-spawn survival	85%
Broodstock required	260

Trap **260** from run-at-large at **Tumwater Dam**, representing an extraction rate of 0.7% of a TAC forecast of 37,000 Wenatchee sockeye.

Steelhead

Wenatchee summer steelhead program and assumptions:

Program	400,000 yearling smolts
Propagation survival	75% fertilization to release
Fecundity	5,400 eggs per female
Female to male ratio	1 to 1
Pre-spawn survival	95%

Trap **208** mixed origin, run-at-large steelhead at **Dryden and Tumwater dams**. In the event our steelhead collections run behind schedule, as has been the case in some years due to trap inefficiency at Dryden, WDFW may capture some adult steelhead from the mainstem Wenatchee River by hook and line. While hook and line capture of broodstock is not specifically mentioned in Section 10 Permit #1094, such activity is consistent with proposed activities in WDFW's Section 10 Direct Take Permit Application (15 August 1997), describing the biological assessments and basis for the permitted steelhead recovery program.

Wells Dam

Wells Hatchery summer steelhead programs and assumptions:

Methow R program	280,000 yearling smolts
Okanogan R program	200,000 yearling smolts
WNFH transfer (Methow R)	116,280 eyed eggs for 100,000 smolts
Ringold transfer (Col. R.)	209,303 eyed HxH eggs for 180,000 smolts
Propagation survival	87% fertilization to eyed egg
	86% eyed egg to yearling release
	75% fertilization to yearling release
Fecundity	5,400 eggs per female
Female to male ratio	1 to 1
Pre-spawn survival	95%

Trap **395** mixed origin, run-at-large steelhead at **Wells Dam west ladder**.

Year 2001 Upper Columbia Broodstock Collections and Operations by Trapping Site

Wenatchee Basin

Dryden Dam **5 July - 17 Nov** **7 days/week**
Passive operation at right and left bank 24-hours a day, checked daily

- **Summer chinook**
  492 mixed origin, run-at-large fish, throughout the run. Up to 25% of brood (123 fish) may be taken at Tumwater Dam after 15 August. Broodstock held and spawned at Eastbank FH.
- **Steelhead**
  To reach total of 208 mixed origin, run-at-large fish, following weekly collection quota, when combined with Tumwater Dam or hook and line collections. Broodstock held and spawned at Eastbank FH

Tumwater Dam **19 July - 17 Nov** **3 days/week** Active operation 8-hours each day

- **Spring chinook**
  Adipose fin clipped spring chinook may be retained as part of the Chiwawa/Nason broodstock. These fish will be marked with an elastomer tag prior to transfer to Eastbank FH for holding and spawning.
- **Summer chinook**
  Up to 123 summer chinook may be taken after 15 August to augment the Dryden summer chinook collection as necessary.
- **Sockeye**
  260 mixed origin, run-at-large, after Rock Island Dam passage peak, but no earlier than 15 July. Hold and spawn sockeye brood at Lake Wenatchee net pens.
- **Steelhead**
  To reach total of 208 mixed origin, run-at-large, following weekly collection quota, when combined with Dryden Dam or hook and line collections. Hold and spawn at Eastbank FH.

Chiwawa Weir **14 May - 14 Sept** **4 days/week**

- **Spring chinook**
  Up to 379 total combined with Nason and Tumwater Dam collections, run-at-large fish. Operate weir and trap 24-hours a day for **4 days up** and then **3 days down**, maintaining a consistent schedule to ensure unimpeded escapement upstream.

Nason Picket Weir **14 May - 14 Sept** **4 days/week**

- **Spring chinook**
  Up to 152 (40% of total) combined with Chiwawa and Tumwater Dam collections, run-at-large fish. Operate weir and trap 24 hours a day for **4 days** and then **3 days down**, maintaining a consistent schedule to ensure unimpeded escapement upstream. These fish will be marked with an elastomer tag for identification at spawning.

Spring chinook target **not to exceed 379 mixed origin, fish from Chiwawa, Nason and Tumwater Dam**. Spring chinook retained will be transferred to Eastbank Hatchery for holding in cool well water. If less than 20 salmon have been collected by 17 August, trapping will be terminated and all spring chinook held in captivity will be returned to the point of collection for natural spawning. All **bull trout** trapped will be transported by tank truck and released into a quiet water area at least 1.0 km upstream of the weir.

Methow Basin

Foghorn Dam **Do not operate in 2001**

Fulton Dam **1 May - 15 July** **7 days/week**
Passive operation 24-hours a day, checked minimum of twice daily

- **Spring chinook**
  Retain up to **200** fish

Twisp Weir **1 May - 15 July** **7 days/week**
Passive operation 24-hours a day, checked minimum of twice daily

- **Spring chinook**
  Retain up to **50** fish

Methow FH **1 June - 25 August** per WDFW operating standards

- **Spring chinook**
  Primary collections will be at Chewuch and Twisp traps. Collection of spring chinook from the Methow FH outfall will be determined in season as needed. If the other trapping sites are successful, then up to 126 fish may be collected here. In the event Fulton Dam and the Twisp weir are inoperable 307-376 fish may be collected. Spawning will be done concurrent with Winthrop NFH. In-situ stock separation of Methow Composite, Carson-based Winthrop stock and stray fish via scales and CWTs during spawning operations. Twisp hatchery stock adults and know Twisp wild fish will be spawned together, and if there are a sufficient number of families, will be reared separately at Methow FH until tagged. Chewuch and Methow hatchery stocks and non-Twisp origin wild stocks will be combined into the composite Methow basin stock. Adults and/or gametes from all known Winthrop hatchery stock will be transferred to Winthrop NFH.

Columbia River

Wells Dam
East Ladder **10 July - 30 Aug** **3 days/week**
Active trapping 16-hours a day with the ladder open to passage at night

- **Methow/Okanogan summer chinook**
  Collect **556** from the run at large for transfer to and holding/spawning at Eastbank FH.

Wells Dam
West Ladder **10 July - 22 Nov** **3 days/week**
Passive trapping 24-hours a day on a Monday-Wednesday schedule

- **Steelhead**
  Collect **395 mixed origin fish from the run-at-large**, spaced throughout the summer cycle. The steelhead broodstock will be held and spawned at Wells FH to satisfy recovery and production requirements for the Methow and Okanogan River basins, and for Ringold FH.

Wells FH **10 July - 31 Aug** **continuous** per WDFW operating standards

- **Summer chinook**
  Collect **1,208 salmon, including jacks,** to satisfy Wells FH and Turtle Rock FH programs. There are no provisions for any "extra" yearling smolts for 2003 survival studies (if any) in this protocol. Broodstock holding and spawning is at Wells FH. In the event excess fish are collected, they will be returned to the Columbia River below Wells Dam.

DRAFT ANNUAL BYPASS OPERATION PLAN, YEAR 2002

APPENDIX E

WELLS HYDROELECTRIC PROJECT
JUVENILE BYPASS SYSTEM OPERATIONS PLAN
for the 2002 Bypass Season

The Wells Long Term Settlement Agreement (II.F.1) specifies that Douglas PUD will submit an Annual Operations Plan for the bypass to the Wells Coordinating Committee by December prior to the spring migration. This plan will be reviewed and approved by the Committee by March 1.

The Bypass System
The PUD will install five bypass barriers in spill gates of the Wells Project. The bypass will operate per criteria in the Settlement Agreement (II.C, E).

Operation Criteria
The operation criteria includes operation of the bypass in partnership with adjacent turbine units, the amount of water required for bypass operation and criteria for full bypass system operation.

Bypass Operations Timing Criteria
The bypass will be in place from two weeks before predicted start of the migration until two weeks after the migration is complete.

Projected Hatchery Releases above Wells Dam
Estimated hatchery releases for 2002 above Wells Dam are as follows:

Facility	Species	No. in thousands	Dates
Winthrop (USFWS)	Spr. Chinook	200	4/15
Methow (WDFW)	Spr. Chinook	380	4/15
OTID Elisford (CCT)	Spr. Chinook	300	4/15
Omak Creek (CCT)	Spr. Chinook	40	4/15
Carlton (WDFW)	Sum. Chinook	365	4/15
Similkameen (WDFW)	Sum. Chinook	560	4/15
Wells (WDFW)	Sum. Steelhead	400	4/20
Winthrop (USFWS)	Sum. Steelhead	150	5/01
Winthrop (USFWS)	Coho	200	4/25

Starting Dates and Ending Dates
Bypass barriers will be in place between March 15 and September 15. Hydroacoustic sampling will start on March 15 and be collected until August 29. Fyke netting will be done between March 15 to either April 10 or the start of the Bypass, which ever occurs first and again from August 15 through 31.

The bypass team will decide the start and end of bypass operation. Hydroacoustics and fyke net information at Wells will be used to show the start and completion of the spring and summer migrations. Preseason dates for bypass operation for spring and summer migration are April 10 through May 30 and July 1 through August 15.

(11/08/01)

MEMORANDUM ON SUMMARY OF WELLS BYPASS OPERATIONS IN 2001

APPENDIX F

Memorandum

TO:	Brian Cates, USFWS
	Jerry Marco, Colville Confederated Tribes
FROM:	Rick Klinge, Douglas PUD
DATE:	September 21, 2001
SUBJECT:	Summary of Bypass Operations at Wells Dam, 2001

====================================

Flows in the Columbia River were some of the lowest on record for 2001. Wells Dam had all ten units available during the most of the bypass operations. This season, highest hourly discharge occurred on June 20 at 1700 hours with 190.0 kcfs.

The 2001 outmigration was from brood year 1999 for the spring migration and 2000 for the summer migration. Spring chinook natural escapement was small since in 1999 natural escapement was only 413 (Wells Count – hatchery volunteers). Sockeye outmigration was moderate as the adult return to Wells in 1999 was 12,388 adults. Natural escapement of summer / fall chinook in 2000 was very strong with 13,574 adults and jacks escaping above Wells Dam.

The bypass team used a combination of fyke net catch ratios of salmonids and historical fyke net data to adjust the hydroacoustic index for non-salmonids. From March 15 through April 10 and after August 15, actual fyke net data were used to adjust the index. Between the initiation of the bypass through May 30, it was assumed the index represented 100% salmonids. A ten-year average correction for salmonids was applied to the index from June 1 until August 15.

Hydroacoustic sampling started at Wells on March 15 to collect background data prior to the start of the spring migration. Initial levels were low. Levels jumped on April 19 as releases from the USFWS Winthrop Hatchery reached Wells Dam. The bypass was initiated on April 15, in anticipation of arrival of yearling summer chinook from the Similkameen Ponds. Spring chinook were released from the two Methow Hatcheries on April 17. The spring bypass operated until June 21 for a total of 68 days and with a total discharge of 0.71 MAF, or 8.0% of total project discharge. During the spring bypass operation, there was no forced spill.

When the hydroacoustics indicate a pause between the spring and summer migrations, the bypass is suspended temporarily. The bypass team could not discern this phenomenon in 2001.

Summer bypass started on June 22 at 0000h and ran until August 31, for a total of 72 days. There was 0.75 MAF or 8.3% of the total discharge dedicated to summer bypass. During the summer operation, there were 3 hours (0.2%) that had forced spill.

There were seven occasions for fyke netting this year to aid in adjustment of the raw index. Fyke netting was done on March 22, 29 and April 5 in the spring and August 15, 23, 28 and 29 for the summer. The ratios of salmonids from the catch and the composition of the catch are shown in Table 1.

DISSOLVED GAS MONITORING AT WELLS DAM FOREBAY AND TAILRACE, 2001

APPENDIX G

Dissolved Gas Monitoring at Wells Dam Forebay and Tailrace, 2001

Rick Klinge

Douglas County Public Utility District No. 1

1151 Valley Mall Parkway

East Wenatchee, WA 98802

April 2002

Dissolved Gas Monitoring at Wells Dam Forebay and Tailrace, 2001

Introduction

Total dissolved gas (TDG) levels at mid-Columbia dams have been monitored during the spring and summer months since the early 1980's. These data provide information on how projects and project operations affect TDG in the Columbia River. Spill at hydroelectric dams can increase TDG during months when adult and juvenile salmonids are migrating in the river. It has been well documented that fish can be injured or die from sustained exposure to elevated dissolved gas (Ebel, et al., 1975; Weitkamp and Katz, 1980). Today, TDG in the Columbia River is monitored at the forebay of all hydroprojects and at least one point in the tailrace.

Initial review in 1996 of TDG generation at Wells Dam compared forebay to forebay data between Wells and Rocky Reach Dam. This initial comparison showed a reduction of gas levels. In 1997, the third highest flow year on record, Wells tailrace TDG transects were made at least once a week. The data showed spill events ranging between 6% and 55%, an increase in TDG was seen over eight weeks (Klinge, 1998). A fixed tailrace monitor has shown an increase in TDG when spill events occurred since 1998 (Klinge, 1999, 2000, 2001).

Wells Dam was built as a hydrocombine; that is the spillway is situated directly above the powerhouse. The eleven spillways at Wells have vertical lift gates with bottom discharge. The water level of the tailrace is within five feet of the spill ogee elevation under most spring and summer flow conditions. Thus, there is little to no vertical plunge of spill. The juvenile bypass system modified five spillway entrances to increase attraction velocity for guidance of salmon and steelhead smolts. The even numbered gates (2,4,6,8,and 10) are dedicated for bypass operation. Two of the five modified spillways have top spill trash sluiceways. Bypass flow through top gates (less than 2,000 cfs) drops approximately 65 feet. All forced spill and nitrogen replacement spill is passed through the remaining odd numbered gates.

In 2001, TDG was recorded at 15 minute intervals from the forebay and tailrace at Wells. This report describes methods and results of TDG data collection along with river discharge and spill volumes.

Methods

Two Hydrolab MiniSonde sensors equipped with a dissolved gas and temperature probe collected data approximately every fifteen minutes from April 1 to September 15. The forebay sensor was located midway across the face of the dam at Unit 5 and the tailrace sensor was located on the left bank approximately 2 miles below the dam (Figure 1 & 2). Both sensors were placed at 15 feet below normal forebay and tailwater levels. Data from both stations were automatically transmitted by radio and stored in a personal computer file. Data on the hour were sent via the Internet to the Army Corps of Engineers for posting at various Web pages. Hourly values are based upon that reading at the top of the hour rather than an average of the four 15 minute interval data points. Columbia River Environmental provided pre-season and monthly calibrations of sensors. Barometric data were recorded from a Capricorn 2000 weather station with an electronic barometer located on the deck of the dam at approximately elevation 810. These data were used in both forebay and tailwater calculations of percent TDG. The Douglas PUD Power Operations provided hourly hydraulic data for discharge and spill.

Results

There were potentially 16,128 fifteen-minute intervals of records collected between April 1 and September 15. The systems for transmitting and logging data had intermittent problems, and records were not logged on 158 occasions. A review of the records at the end of the season showed some anomalies with the forebay temperature sensor. This data has been removed post season from the data set. Also, data were removed at the onset of sensor calibration for a period of two hours. This allowed time for needed service plus at least an hour of acclimation of the new probe membrane to the river environment. After

Figure 1. Location of Wells Dam on the Columbia River.

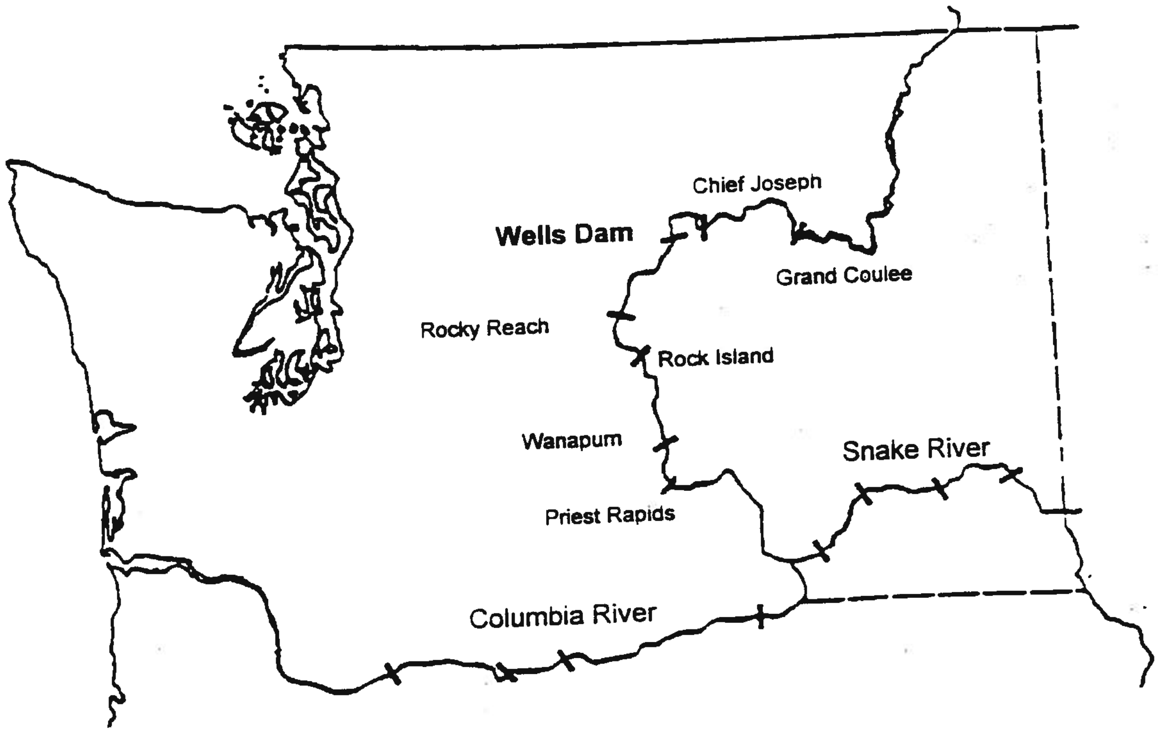
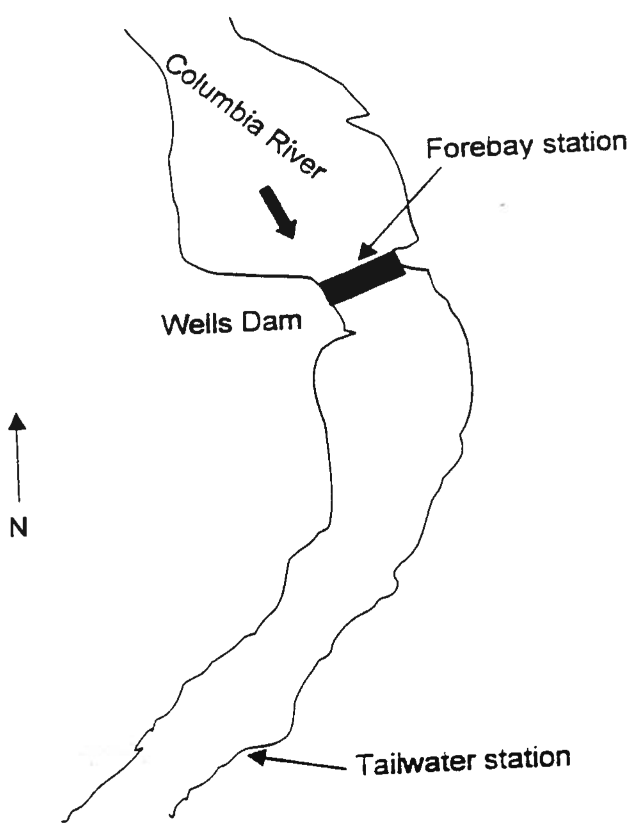


Figure 2. Wells Dam and the TDG sampling locations.



quality control, there were at least 15,720 usable records for forebay and tailwater data sets. Guidelines for state and federal water quality standards for TDG are based upon an average from the twelve highest hourly values during a 24 hour day (12h). Data for this analysis will be presented in hourly and daily 12 hour values.

Forebay TDG

The ranges of percent TDG from the hourly records were 98.5% on September 7 at 0458 hours and 114.1% on July 12 at 1558 hours. The 12h values ranged from 100.1% on September 7 to 111.7% on July 12. The 12h forebay values exceeded 110% on 26 of 168 days of the monitoring season. The longest continuous stretch the 12h daily values exceeded 110% was from July 9 – 15 (Figure 3; Appendix A).

Tailrace TDG

Tailrace TDG values for the hourly interval ranged between 97.1% on September 12, at 0658 hours to 112.7% on July 10 at 1658 hours (Figure 3). The 12h value had a range of 100.4% on September 7 and 112.0% on July 10. The 12h values exceeded 110% for 41 days, the longest continuous period being from July 4 through 14 (Figure 3, Appendix A).

Columbia River flows at Wells Dam were extremely low during the spring and summer of 2001. The volume of water released at Grand Coulee between January and July was 37.4 million acre feet (MAF), or 59% of the thirty year average. The Wells Dam daily average discharge and all spills are shown in Figure 4. Peak hourly discharge occurred on June 20 at 1700 hours at 191.1 thousand cubic feet per second (kcfs). Daily average flow between April 1 and September 15 ranged from 26 to 110 kcfs (Figure 4; Appendix B).

Figure 3. 12 Hour (12h) average forebay and tailwater percent TDG at Wells Dam, 2001.

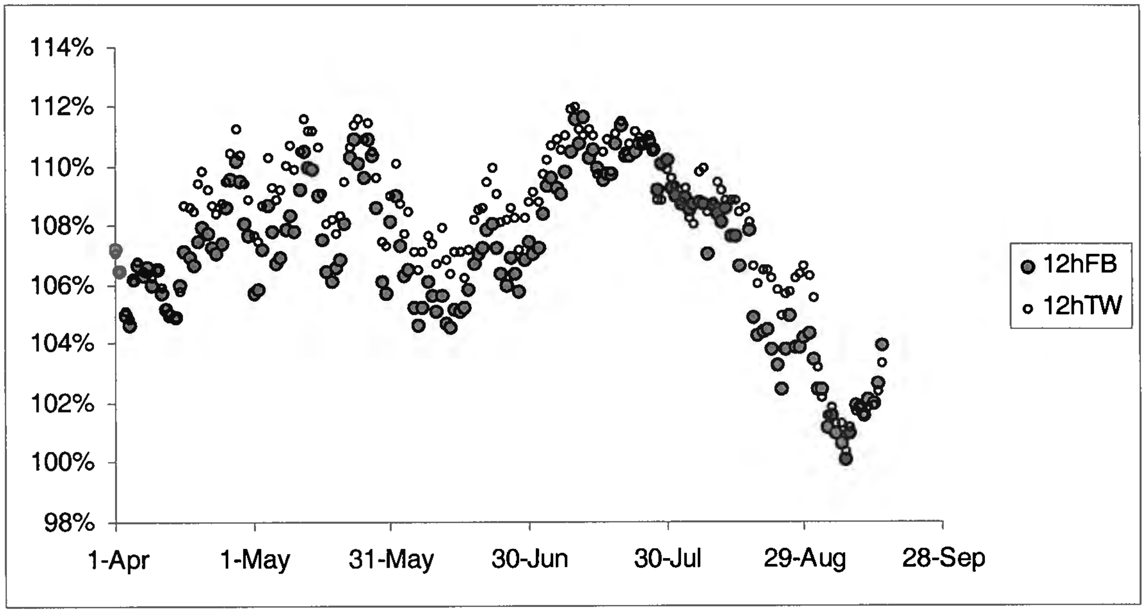
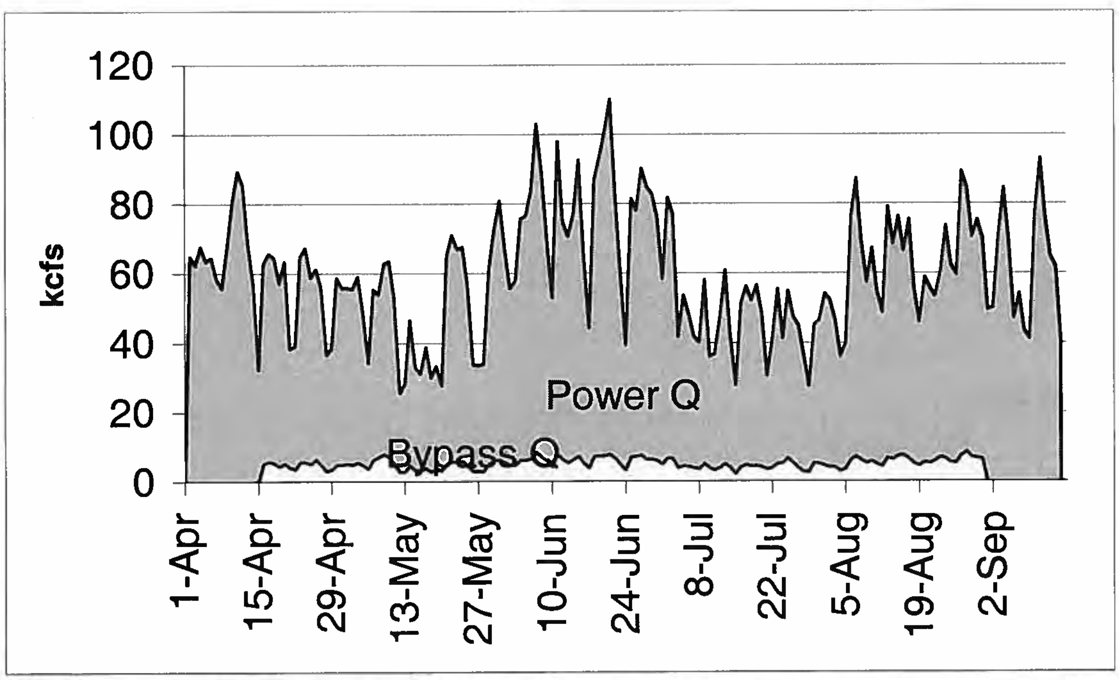


Figure 4. Wells Dam daily average levels of Power, Bypass and Spill flow, 2001.



Spill at Wells was a combination of juvenile bypass flow and forced spill. The juvenile bypass operated for the spring migration from April 15 through June 21 and for the summer migration from June 22 to August 31. Bypass operation in 2001 used between 6.7 - 11.6% of the daily average project flow. Forced spill occurred on only three hours in late August and ranged from 0.7 to 8.6 kcfs. There was no nitrogen replacement spill in 2001. Combined spill was analyzed with regards to how it changed TDG between forebay to tailrace sensors. Previous monitoring suggests that every 4% of river spilled, TDG would increase by 1% at Wells. Percent spill verses the change in forebay to tailrace TDG showed no correlation as in years past (Figure 5). The hour with the highest percent spill (32.0%) had bypass flow of 5.5kcfs and total plant discharge of 17.2 kcfs on August 29. High spill events (>30% spill) in previous years occurred with much larger volumes of water.

Of the 4,032 hourly readings collected in the 2001 season, 18% of the records occurred with no spill. On the average, there was no difference in TDG from forebay to tailrace for non-spill hours.

Columbia River Environmental calibrated the sensors monthly starting in May. There was little movement or drift in between calibrations. Problems with the forebay temperature sensor were seen during the monitoring season. There were 99 hourly records pulled, the longest being between June 22 and June 25 (68 hours) because problems with the forebay temperature sensor. Post season repair by the manufacturer found a faulty circuit board.

Other hydraulic conditions

The spring and summer water temperatures in the Columbia River at Wells Dam were slightly below normal (Figure 6). The solubility of air in water is inversely proportional to the temperature of the water. Thus in a warming river, while the mass of gas will not change, the gas pressure will increase. Figure 7 shows a very close relationship of movement in temperatures and gas pressure seen at the forebay for July 20 – 26. In addition, temperature that will change

Figure 5. Relation of percent spill to percent change in TDG from tailwater to forebay stations, Wells Dam 2001.

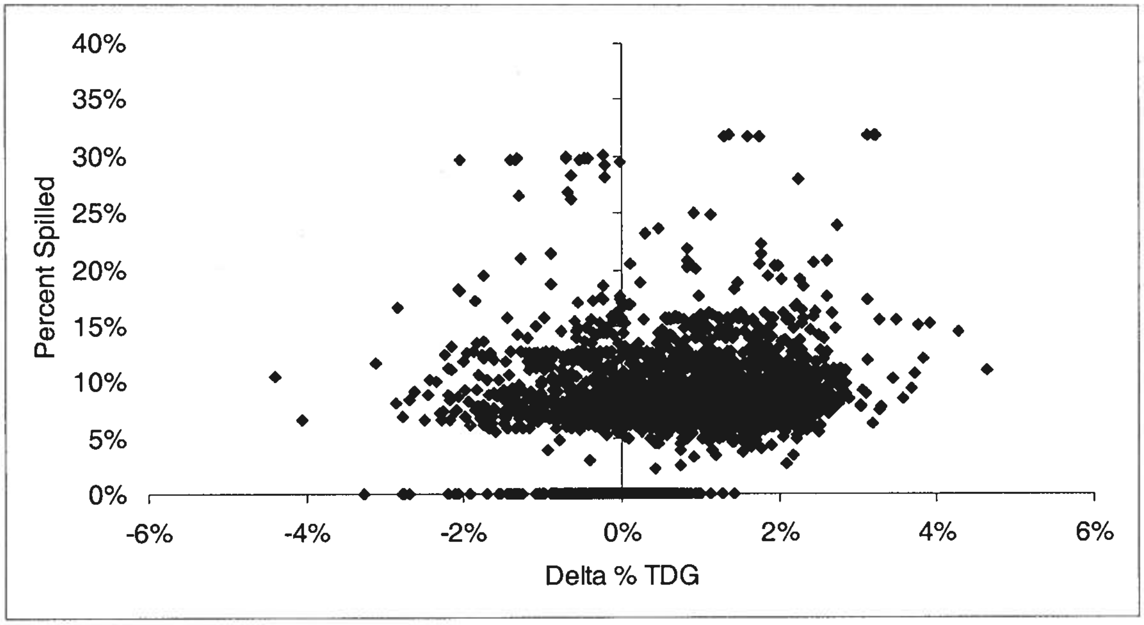
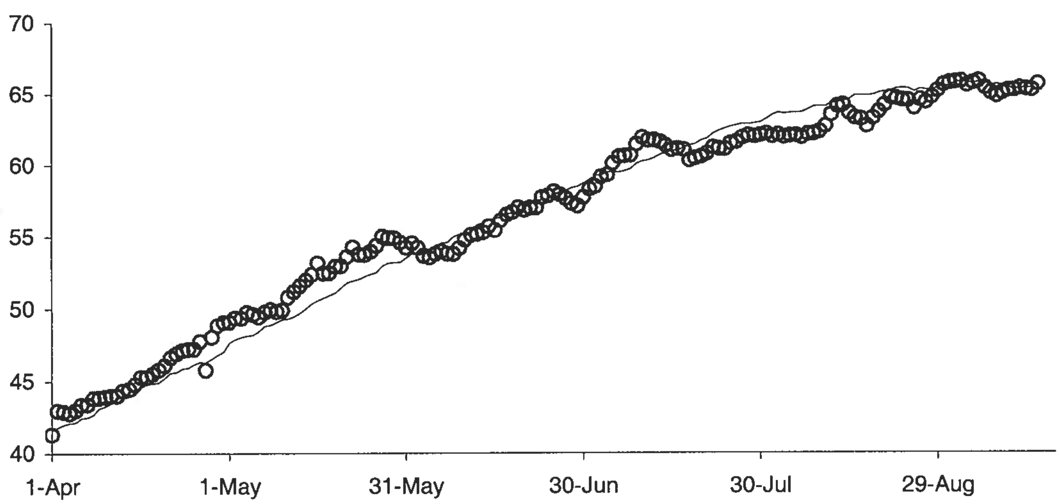


Figure 6. Columbia River temperatures in 2001 and 16 year average, Wells Dam.



TDG, other factors such as wind action on a reservoir or biological activity from aquatic vegetation will also change gas levels.

The forebay temperatures occasionally logged as much as 1.3° C. higher than the tailwater river temperatures. Initially we thought this was on account of water was completely mixed at the sensors. During monthly calibration of instruments, there was nothing that showed a bad sensor. As already mentioned a bad circuit board was why logged data from the forebay probe dropped 8.3°C on June 22 until the next monthly calibration on July 18. The forebay data during this interval was tossed.

Discussion

Forebay TDG levels at Wells Dam is driven by operations upstream, namely from Chief Joseph and Grand Coulee dams or projects upstream of the International Boundary. Figure 8 shows records of receiving TDG for 2001 as posted on the DART Page[1] at the Boundary station (RM 745), Chief Joseph (RM 545), Wells (RM 515) and Rocky Reach (RM 474). Data show both slight rising and dropping in TDG levels from station to station moving downstream (Figure 8). The operators at both Grand Coulee and Chief Joseph dams in the past five years have dramatically improved TDG condition of the Columbia River through the mid-Columbia reach.

The operations of dams to meet the daily power loads will change the volume of water discharged past the dam. These changes will affect travel time of water from the dam to the tailwater sensor. The arrival of water at the tailwater sensor from a 30% spill event is slower with flows at 80 kcfs compared to 240 kcfs. The comparison of percent spill to change in percent TDG between tailwater and forebay monitors was done for data at the same hour. There was no attempt to correct for the lag time an action at the dam would reflect at the tailwater sensor.

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[1] **University of Washington DART page http://www.cbr.washington.edu/dart/river.html**

Figure 7. Temperature and gas pressure in mm Hg for July 20 – 27, 2001 in the Columbia River, Wells forebay TDG station.

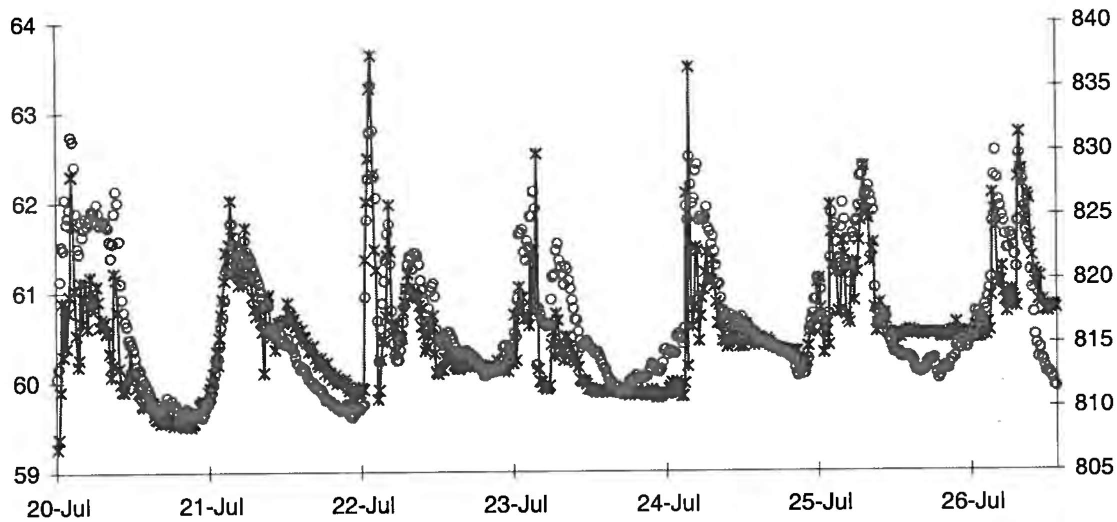
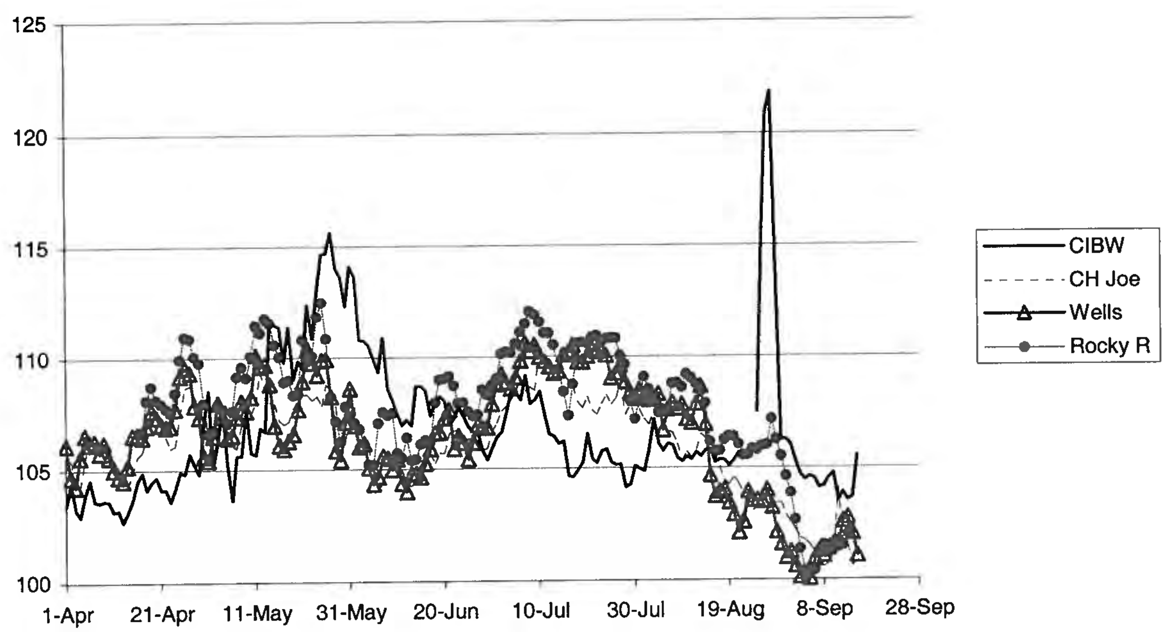


Figure 8. Receiving TDG at Boundary, Chief Joseph, Wells and Rocky Reach forebay stations, 2001.



In 2001, operations at Wells may have added slightly to TDG receiving levels at Rocky Reach Dam. Possibly some of the increase may be attributed to a slight warming of the river as it passes from reservoir to reservoir. The Washington Department of Ecology has modified water quality standards to allow a maximum of 120% saturation in the tailrace below a dam and 115% in the forebay of the next project. Daily average forebay levels at Rocky Reach as shown from the DART page only reached as high as 112%.

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Appendix A. TDG Sampling at Wells Dam, 2001.

Wells Dam 2001 Forebay

Total Disovled Gas Saturation (%) - Average of 12 highest, 24 h average and 24 h High

	24 h	12 h		#
Date	Avg	Avg	High	Hr
1-Apr	106.6%	107.2%	109.2%	24
2-Apr	106.1%	106.5%	106.7%	24
3-Apr	104.8%	105.0%	105.1%	23
4-Apr	104.2%	104.7%	105.0%	24
5-Apr	105.5%	106.2%	106.6%	22
6-Apr	106.6%	106.7%	106.9%	24
7-Apr	106.2%	106.4%	106.6%	24
8-Apr	106.3%	106.6%	107.0%	24
9-Apr	105.7%	106.0%	106.2%	24
10-Apr	106.3%	106.5%	106.6%	24
11-Apr	105.6%	105.7%	106.1%	24
12-Apr	105.0%	105.2%	105.4%	24
13-Apr	104.7%	105.0%	105.5%	24
14-Apr	104.5%	104.9%	105.6%	24
15-Apr	105.2%	106.0%	106.3%	24
16-Apr	106.4%	107.1%	107.6%	24
17-Apr	106.6%	106.9%	107.5%	24
18-Apr	106.5%	106.7%	106.9%	24
19-Apr	107.0%	107.5%	107.8%	24
20-Apr	107.6%	108.0%	108.3%	24
21-Apr	107.4%	107.7%	108.2%	24
22-Apr	107.0%	107.3%	107.5%	21
23-Apr	106.9%	107.1%	107.4%	24
24-Apr	107.0%	107.4%	107.9%	24
25-Apr	107.6%	108.7%	110.3%	24
26-Apr	109.0%	109.6%	110.1%	23
27-Apr	109.6%	110.2%	110.4%	24
28-Apr	109.4%	109.6%	109.7%	24
29-Apr	107.9%	108.1%	108.4%	24
30-Apr	107.3%	107.7%	108.1%	24
Avg	106.5%	106.9%	107.4%	24

	24 h	12 h		#
Date	Avg	Avg	High	Hr
1-May	105.6%	105.7%	106.2%	22
2-May	105.4%	105.8%	106.4%	24
3-May	106.3%	107.2%	108.3%	24
4-May	107.9%	108.7%	109.0%	24
5-May	107.5%	107.8%	108.5%	24
6-May	106.4%	106.7%	107.2%	24
7-May	106.6%	107.0%	108.1%	24
8-May	107.2%	107.9%	108.2%	24
9-May	108.1%	108.4%	108.7%	24
10-May	107.6%	107.9%	108.1%	24
11-May	108.3%	109.3%	110.0%	24
12-May	109.8%	110.5%	111.2%	24
13-May	109.6%	110.0%	110.5%	24
14-May	109.7%	109.9%	110.2%	24
15-May	108.8%	109.1%	109.3%	24
16-May	107.1%	107.6%	108.7%	24
17-May	106.1%	106.5%	106.9%	24
18-May	105.8%	106.1%	106.4%	24
19-May	106.3%	106.6%	107.1%	24
20-May	106.3%	106.9%	108.3%	24
21-May	107.6%	108.1%	108.6%	24
22-May	108.8%	110.3%	110.8%	24
23-May	110.3%	111.0%	113.2%	21
24-May	109.8%	110.2%	110.5%	24
25-May	109.2%	109.7%	111.0%	24
26-May	109.8%	110.9%	112.0%	24
27-May	109.9%	110.4%	111.3%	24
28-May	108.2%	108.7%	109.3%	24
29-May	105.9%	106.2%	106.6%	24
30-May	105.4%	105.7%	106.6%	24
31-May	107.0%	108.2%	108.7%	24
Avg	107.7%	108.2%	108.9%	24

	24 h	12 h		#
Date	Avg	Avg	High	Hr
1-Jun	108.6%	109.1%	109.7%	24
2-Jun	107.0%	107.3%	107.8%	24
3-Jun	106.0%	106.4%	107.0%	24
4-Jun	106.1%	106.5%	107.1%	24
5-Jun	105.1%	105.2%	105.4%	24
6-Jun	104.4%	104.6%	104.9%	24
7-Jun	104.6%	105.2%	105.5%	24
8-Jun	105.6%	106.1%	106.7%	24
9-Jun	105.5%	105.6%	105.8%	24
10-Jun	105.0%	105.1%	105.2%	24
11-Jun	105.5%	105.7%	105.7%	24
12-Jun	104.4%	104.7%	105.1%	24
13-Jun	103.9%	104.6%	105.1%	24
14-Jun	104.8%	105.2%	105.6%	24
15-Jun	104.8%	105.1%	105.4%	24
16-Jun	104.6%	105.2%	105.6%	24
17-Jun	105.2%	105.9%	106.8%	24
18-Jun	105.8%	106.7%	107.1%	24
19-Jun	106.6%	107.1%	108.6%	24
20-Jun	106.6%	107.3%	107.8%	24
21-Jun	107.2%	107.9%	108.2%	22
22-Jun	107.8%	108.1%	108.7%	24
23-Jun	107.0%	107.3%	107.5%	24
24-Jun	106.1%	106.4%	106.8%	24
25-Jun	105.5%	106.0%	106.2%	24
26-Jun	106.5%	106.9%	107.6%	24
27-Jun	106.2%	106.4%	106.5%	24
28-Jun	105.4%	105.8%	106.9%	24
29-Jun	106.1%	106.9%	107.8%	24
30-Jun	106.9%	107.5%	107.8%	24
Avg	105.8%	106.3%	106.7%	24

	24 h	12 h		#
Date	Avg	Avg	High	Hr
1-Jul	108.6%	109.1%	109.7%	24
2-Jul	107.0%	107.3%	107.8%	24
3-Jul	106.0%	106.4%	107.0%	24
4-Jul	106.1%	106.5%	107.1%	24
5-Jul	105.1%	105.2%	105.4%	24
6-Jul	104.4%	104.6%	104.9%	24
7-Jul	104.6%	105.2%	105.5%	24
8-Jul	105.6%	106.1%	106.7%	24
9-Jul	105.5%	105.6%	105.8%	24
10-Jul	105.0%	105.1%	105.2%	24
11-Jul	105.5%	105.7%	105.7%	24
12-Jul	104.4%	104.7%	105.1%	24
13-Jul	103.9%	104.6%	105.1%	24
14-Jul	104.8%	105.2%	105.6%	24
15-Jul	104.8%	105.1%	105.4%	24
16-Jul	104.6%	105.2%	105.6%	24
17-Jul	105.2%	105.9%	106.8%	24
18-Jul	105.8%	106.7%	107.1%	24
19-Jul	106.6%	107.1%	108.6%	24
20-Jul	106.6%	107.3%	107.8%	24
21-Jul	107.2%	107.9%	108.2%	22
22-Jul	107.8%	108.1%	108.7%	24
23-Jul	107.0%	107.3%	107.5%	24
24-Jul	106.1%	106.4%	106.8%	24
25-Jul	105.5%	106.0%	106.2%	24
26-Jul	106.5%	106.9%	107.6%	24
27-Jul	106.2%	106.4%	106.5%	24
28-Jul	105.4%	105.8%	106.9%	24
29-Jul	106.1%	106.9%	107.8%	24
30-Jul	106.9%	107.5%	107.8%	24
31-Jul	106.8%	107.1%	107.5%	24
Average	105.9%	106.3%	106.7%	24

Appendix A. TDG Sampling at Wells Dam, 2001.

Wells Dam 2001 Forebay

Total Disovled Gas Saturation (%) - Average of 12 highest, 24 h average and 24 h High

	24 h	12 h		#		24 h	12 h		#
Date	Avg	Avg	High	Hr	Date	Avg	Avg	High	Hr
1-Aug	108.4%	109.0%	110.7%	24	1-Sep	102.2%	102.5%	102.7%	24
2-Aug	108.2%	108.8%	109.2%	24	2-Sep	101.6%	102.5%	103.6%	24
3-Aug	108.5%	109.0%	109.3%	24	3-Sep	101.0%	101.2%	101.4%	24
4-Aug	108.2%	108.6%	108.9%	24	4-Sep	101.2%	101.6%	101.9%	24
5-Aug	108.1%	108.8%	109.8%	24	5-Sep	100.7%	101.0%	101.2%	24
6-Aug	108.1%	108.9%	109.1%	24	6-Sep	100.2%	100.6%	101.2%	24
7-Aug	108.4%	108.8%	109.2%	24	7-Sep	99.6%	100.1%	100.7%	24
8-Aug	106.7%	107.1%	107.4%	24	8-Sep	100.0%	101.0%	101.6%	24
9-Aug	107.5%	108.7%	110.2%	24	9-Sep	100.9%	101.9%	103.2%	24
10-Aug	107.9%	108.5%	108.9%	24	10-Sep	101.3%	101.9%	102.7%	24
11-Aug	107.7%	108.2%	109.3%	24	11-Sep	101.1%	101.6%	102.3%	24
12-Aug	107.8%	108.7%	110.3%	24	12-Sep	101.4%	102.2%	102.9%	24
13-Aug	107.2%	107.7%	108.2%	24	13-Sep	101.6%	102.0%	102.5%	24
14-Aug	107.0%	107.7%	108.6%	24	14-Sep	101.7%	102.7%	103.4%	24
15-Aug	106.7%	106.7%	108.3%	12	15-Sep	102.7%	104.0%	105.0%	24
16-Aug				0					
17-Aug	107.0%	107.9%	108.7%	22					
18-Aug	104.7%	104.9%	105.2%	24					
19-Aug	103.7%	104.3%	105.4%	24					
20-Aug	103.9%	104.5%	104.9%	24					
21-Aug	104.0%	104.5%	104.8%	24					
22-Aug	103.5%	103.8%	104.0%	23					
23-Aug	103.0%	103.3%	103.6%	21					
24-Aug	102.1%	102.5%	102.8%	24					
25-Aug	102.7%	103.8%	104.9%	24					
26-Aug	103.9%	105.0%	106.4%	24					
27-Aug	103.6%	103.9%	104.1%	24					
28-Aug	103.5%	103.9%	104.5%	24					
29-Aug	103.5%	104.3%	105.0%	24					
30-Aug	103.9%	104.4%	104.9%	24					
31-Aug	103.3%	103.5%	103.9%	23					
Avg	105.8%	106.3%	107.0%	23	Avg	101.1%	101.8%	102.4%	24

Appendix A. TDG Sampling at Wells Dam, 2001.

Wells Dam 2001 Tailwater

Total Disovled Gas Saturation (%) - Average of 12 highest, 24 h average and 24 h High

	24 h	12 h		#
Date	Avg	Avg	High	Hr
1-Apr	106.4%	107.1%	107.5%	24
2-Apr	106.3%	106.5%	106.6%	24
3-Apr	104.9%	105.1%	105.3%	23
4-Apr	104.3%	104.8%	105.4%	24
5-Apr	105.4%	106.1%	106.4%	22
6-Apr	106.6%	106.8%	107.1%	24
7-Apr	106.2%	106.5%	106.8%	24
8-Apr	106.1%	106.4%	106.7%	24
9-Apr	105.9%	106.2%	106.6%	24
10-Apr	106.2%	106.5%	106.9%	24
11-Apr	105.7%	105.9%	106.2%	24
12-Apr	105.1%	105.3%	105.5%	24
13-Apr	104.7%	105.0%	105.4%	24
14-Apr	104.5%	104.9%	105.4%	24
15-Apr	105.0%	105.8%	106.3%	24
16-Apr	107.2%	108.7%	109.3%	24
17-Apr	108.2%	108.7%	109.1%	24
18-Apr	108.2%	108.5%	109.0%	24
19-Apr	108.6%	109.5%	110.4%	24
20-Apr	109.3%	109.9%	110.7%	24
21-Apr	108.8%	109.2%	109.7%	24
22-Apr	108.4%	108.7%	109.0%	21
23-Apr	108.2%	108.5%	109.0%	24
24-Apr	108.1%	108.8%	109.4%	24
25-Apr	108.6%	109.5%	110.1%	24
26-Apr	110.0%	110.5%	111.0%	23
27-Apr	110.5%	111.3%	111.7%	24
28-Apr	110.1%	110.4%	111.1%	24
29-Apr	109.0%	109.5%	109.7%	24
30-Apr	108.5%	108.9%	109.7%	24
Avg	107.2%	107.7%	108.1%	24

	24 h	12 h		#
Date	Avg	Avg	High	Hr
1-May	107.1%	107.7%	110.7%	23
2-May	107.0%	107.5%	108.0%	24
3-May	107.9%	108.7%	109.2%	24
4-May	109.4%	110.3%	110.8%	24
5-May	109.0%	109.3%	109.7%	24
6-May	108.2%	108.9%	109.5%	24
7-May	108.1%	109.2%	110.5%	24
8-May	109.4%	110.0%	110.4%	24
9-May	110.4%	110.8%	111.4%	24
10-May	109.6%	110.0%	110.4%	24
11-May	109.7%	110.6%	110.8%	24
12-May	110.8%	111.6%	112.2%	24
13-May	110.7%	111.2%	111.7%	24
14-May	110.7%	111.2%	111.6%	24
15-May	110.2%	110.7%	111.2%	24
16-May	108.7%	109.1%	109.9%	24
17-May	107.6%	108.1%	108.5%	24
18-May	107.3%	108.2%	108.8%	24
19-May	107.1%	107.8%	108.2%	24
20-May	107.3%	108.4%	108.8%	24
21-May	108.4%	109.5%	109.9%	24
22-May	109.8%	110.7%	111.8%	24
23-May	110.7%	111.4%	112.2%	20
24-May	111.1%	111.6%	112.1%	24
25-May	110.4%	110.9%	111.4%	24
26-May	110.5%	111.5%	112.0%	24
27-May	110.1%	110.5%	110.9%	24
28-May	109.0%	109.7%	110.1%	24
29-May	107.0%	107.5%	107.8%	24
30-May	106.9%	107.3%	107.5%	24
31-May	108.1%	109.1%	109.5%	24
Avg	109.0%	109.6%	110.2%	24

	24 h	12 h		#
Date	Avg	Avg	High	Hr
1-Jun	109.6%	110.2%	110.6%	24
2-Jun	108.1%	108.8%	109.4%	24
3-Jun	107.3%	107.8%	108.4%	24
4-Jun	107.8%	108.5%	109.0%	24
5-Jun	106.9%	107.1%	107.4%	24
6-Jun	106.2%	106.6%	107.0%	24
7-Jun	106.5%	107.2%	107.5%	24
8-Jun	107.2%	107.7%	108.0%	24
9-Jun	107.0%	107.4%	107.7%	24
10-Jun	106.4%	106.8%	107.2%	24
11-Jun	107.1%	107.9%	108.2%	24
12-Jun	106.4%	106.9%	107.3%	24
13-Jun	105.8%	106.4%	106.8%	24
14-Jun	106.4%	107.2%	107.6%	24
15-Jun	106.7%	107.1%	107.4%	24
16-Jun	105.8%	106.3%	106.9%	24
17-Jun	106.4%	107.2%	107.7%	24
18-Jun	107.1%	108.2%	108.6%	24
19-Jun	107.8%	108.6%	108.9%	24
20-Jun	107.8%	108.6%	109.0%	24
21-Jun	108.6%	109.6%	109.8%	22
22-Jun	109.5%	110.0%	110.4%	24
23-Jun	108.6%	109.2%	109.5%	24
24-Jun	107.6%	108.2%	108.7%	24
25-Jun	107.3%	108.2%	109.0%	24
26-Jun	108.0%	108.6%	109.0%	24
27-Jun	108.0%	108.3%	108.5%	24
28-Jun	106.8%	107.2%	107.6%	24
29-Jun	107.4%	108.3%	108.7%	24
30-Jun	108.2%	108.9%	109.1%	24
Avg	107.3%	108.0%	108.4%	24

	24 h	12 h		#
Date	Avg	Avg	High	Hr
1-Jul	108.7%	109.2%	109.4%	24
2-Jul	108.4%	108.8%	109.1%	24
3-Jul	109.0%	109.8%	110.1%	24
4-Jul	109.7%	110.3%	110.8%	24
5-Jul	109.8%	110.7%	111.4%	24
6-Jul	109.9%	111.0%	111.8%	24
7-Jul	109.6%	110.6%	111.2%	24
8-Jul	109.6%	111.1%	112.3%	24
9-Jul	110.7%	111.9%	112.3%	24
10-Jul	110.6%	112.0%	112.6%	24
11-Jul	110.3%	111.3%	111.9%	24
12-Jul	109.5%	111.1%	111.7%	24
13-Jul	110.3%	111.3%	111.9%	24
14-Jul	109.6%	111.1%	111.9%	24
15-Jul	108.3%	109.8%	110.8%	24
16-Jul	109.4%	110.6%	111.3%	24
17-Jul	109.5%	110.9%	111.6%	24
18-Jul	109.1%	109.9%	110.8%	22
19-Jul	110.3%	111.1%	111.5%	24
20-Jul	110.6%	111.5%	112.2%	24
21-Jul	110.0%	110.5%	111.5%	24
22-Jul	110.0%	110.8%	111.4%	24
23-Jul	110.3%	111.2%	112.0%	23
24-Jul	109.7%	111.0%	112.5%	24
25-Jul	109.8%	110.8%	111.1%	24
26-Jul	109.8%	111.1%	111.5%	24
27-Jul	109.4%	110.6%	111.4%	24
28-Jul	108.4%	108.9%	109.6%	24
29-Jul	107.8%	108.9%	109.7%	24
30-Jul	109.1%	110.0%	110.6%	24
31-Jul	108.7%	109.7%	110.2%	24
Avg	109.5%	110.6%	111.2%	24

Appendix A. TDG Sampling at Wells Dam, 2001.

Wells Dam 2001 Tailwater

Total Disovled Gas Saturation (%) - Average of 12 highest, 24 h average and 24 h High

Avg	24 h	12 h		#		24 h	12 h		#
Date	Avg	Avg	High	Hr	Date	Avg	Avg	High	Hr
1-Aug	108.0%	109.4%	110.1%	24	1-Sep	102.7%	103.2%	103.7%	24
2-Aug	108.0%	108.8%	109.1%	24	2-Sep	101.2%	102.2%	102.9%	24
3-Aug	108.5%	109.3%	109.8%	24	3-Sep	101.1%	101.6%	101.8%	24
4-Aug	107.4%	108.3%	108.9%	24	4-Sep	101.3%	101.9%	102.0%	24
5-Aug	107.0%	108.1%	109.0%	24	5-Sep	100.8%	101.3%	101.8%	24
6-Aug	108.2%	109.8%	110.3%	24	6-Sep	100.6%	101.3%	102.1%	24
7-Aug	109.0%	110.0%	110.4%	24	7-Sep	99.8%	100.4%	101.0%	24
8-Aug	107.7%	108.5%	108.9%	24	8-Sep	100.0%	101.2%	101.8%	24
9-Aug	107.9%	108.9%	109.4%	24	9-Sep	100.7%	101.7%	102.4%	24
10-Aug	108.6%	109.6%	110.2%	24	10-Sep	101.1%	101.8%	102.2%	24
11-Aug	108.4%	109.3%	110.1%	24	11-Sep	100.9%	101.6%	102.2%	24
12-Aug	107.6%	108.9%	109.9%	24	12-Sep	100.7%	101.8%	102.3%	24
13-Aug	107.9%	108.9%	109.3%	24	13-Sep	101.1%	101.9%	102.5%	24
14-Aug	107.7%	108.9%	109.4%	24	14-Sep	101.5%	102.4%	102.8%	24
15-Aug	108.0%	108.5%	108.7%	22	15-Sep	101.9%	103.3%	103.9%	24
16-Aug	108.1%	108.6%	109.6%	23					
17-Aug	108.0%	108.2%	108.7%	16					
18-Aug	106.2%	106.7%	107.0%	24					
19-Aug	105.5%	106.1%	106.7%	24					
20-Aug	105.5%	106.5%	107.0%	24					
21-Aug	105.7%	106.6%	107.2%	24					
22-Aug	105.3%	106.3%	107.3%	23					
23-Aug	105.3%	105.8%	106.7%	21					
24-Aug	104.0%	105.0%	105.4%	24					
25-Aug	104.7%	105.7%	106.4%	24					
26-Aug	105.3%	105.8%	106.1%	24					
27-Aug	105.9%	106.3%	106.8%	24					
28-Aug	105.8%	106.4%	107.4%	24					
29-Aug	106.3%	106.7%	107.2%	24					
30-Aug	106.0%	106.4%	106.9%	24					
31-Aug	105.2%	105.6%	105.9%	23					
Avg	106.9%	107.7%	108.2%	23	Avg	101.0%	101.9%	102.4%	24

Appendix B. Daily average flows at Wells Dam, 2001.

all values in kcfs

Date	Total Q	Bypass	Spill Q	N2 Spill
1-Apr	35.4	0.0	0.0	0.0
2-Apr	65.6	0.0	0.0	0.0
3-Apr	63.3	0.0	0.0	0.0
4-Apr	68.4	0.0	0.0	0.0
5-Apr	64.3	0.0	0.0	0.0
6-Apr	65.2	0.0	0.0	0.0
7-Apr	59.2	0.0	0.0	0.0
8-Apr	56.6	0.0	0.0	0.0
9-Apr	67.9	0.0	0.0	0.0
10-Apr	81.2	0.0	0.0	0.0
11-Apr	90.2	0.0	0.0	0.0
12-Apr	86.2	0.0	0.0	0.0
13-Apr	69.3	0.0	0.0	0.0
14-Apr	57.7	0.0	0.0	0.0
15-Apr	33.6	0.1	0.0	0.0
16-Apr	68.8	5.3	0.0	0.0
17-Apr	72.5	5.9	0.0	0.0
18-Apr	70.7	5.5	0.0	0.0
19-Apr	62.6	4.5	0.0	0.0
20-Apr	69.5	5.4	0.0	0.0
21-Apr	43.5	4.2	0.0	0.0
22-Apr	43.7	3.7	0.0	0.0
23-Apr	71.3	5.7	0.0	0.0
24-Apr	73.7	5.7	0.0	0.0
25-Apr	64.9	5.3	0.0	0.0
26-Apr	68.7	6.6	0.0	0.0
27-Apr	61.6	5.0	0.0	0.0
28-Apr	40.7	3.1	0.0	0.0
29-Apr	43.1	3.6	0.0	0.0
30-Apr	64.5	5.0	0.0	0.0
Avg	62.8	2.5	0.0	0.0

Date	Total Q	Bypass	Spill Q	N2 Spill
1-May	61.6	4.9	0.0	0.0
2-May	62.0	5.2	0.0	0.0
3-May	61.4	5.0	0.0	0.0
4-May	65.5	5.6	0.0	0.0
5-May	54.6	4.9	0.0	0.0
6-May	39.2	3.9	0.0	0.0
7-May	62.7	6.5	0.0	0.0
8-May	62.0	7.2	0.0	0.0
9-May	71.6	8.1	0.0	0.0
10-May	71.4	7.2	0.0	0.0
11-May	58.7	5.2	0.0	0.0
12-May	29.5	2.9	0.0	0.0
13-May	32.0	2.9	0.0	0.0
14-May	52.1	4.7	0.0	0.0
15-May	37.1	3.4	0.0	0.0
16-May	35.5	3.4	0.0	0.0
17-May	43.6	4.0	0.0	0.0
18-May	34.0	3.0	0.0	0.0
19-May	38.0	3.7	0.0	0.0
20-May	32.0	3.3	0.0	0.0
21-May	71.0	5.1	0.0	0.0
22-May	77.7	5.9	0.0	0.0
23-May	73.4	5.6	0.0	0.0
24-May	74.3	5.9	0.0	0.0
25-May	61.9	4.7	0.0	0.0
26-May	37.8	3.2	0.0	0.0
27-May	37.6	3.1	0.0	0.0
28-May	37.8	3.0	0.0	0.0
29-May	67.2	5.2	0.0	0.0
30-May	79.6	6.2	0.0	0.0
31-May	88.0	6.4	0.0	0.0
Avg	55.2	4.8	0.0	0.0

Date	Total Q	Bypass	Spill Q	N2 Spill
1-Jun	73	5	0.0	0.0
2-Jun	61	5	0.0	0.0
3-Jun	63	5	0.0	0.0
4-Jun	83	6	0.0	0.0
5-Jun	84	5	0.0	0.0
6-Jun	91	4	0.0	0.0
7-Jun	112	6	0.0	0.0
8-Jun	98	7	0.0	0.0
9-Jun	76	8	0.0	0.0
10-Jun	58	7	0.0	0.0
11-Jun	107	5	0.0	0.0
12-Jun	82	3	0.0	0.0
13-Jun	77	3	0.0	0.0
14-Jun	84	5	0.0	0.0
15-Jun	101	3	0.0	0.0
16-Jun	71	3	0.0	0.0
17-Jun	49	4	0.0	0.0
18-Jun	95	3	0.0	0.0
19-Jun	102	4	0.0	0.0
20-Jun	109	3	0.0	0.0
21-Jun	119	5	0.0	0.0
22-Jun	90	6	0.0	0.0
23-Jun	65	6	0.0	0.0
24-Jun	44	6	0.0	0.0
25-Jun	89	5	0.0	0.0
26-Jun	86	3	0.0	0.0
27-Jun	99	3	0.0	0.0
28-Jun	92	3	0.0	0.0
29-Jun	90	5	0.0	0.0
30-Jun	83	6	0.0	0.0
Avg	84.5	4.8	0.0	0.0

Date	Total Q	Bypass	Spill Q	N2 Spill
1-Jul	64.3	5	0.0	0.0
2-Jul	89.3	7	0.0	0.0
3-Jul	84.6	7	0.0	0.0
4-Jul	46.7	4	0.0	0.0
5-Jul	58.9	4	0.0	0.0
6-Jul	53.8	4	0.0	0.0
7-Jul	46.6	4	0.0	0.0
8-Jul	44.7	4	0.0	0.0
9-Jul	64.1	5	0.0	0.0
10-Jul	40.9	4	0.0	0.0
11-Jul	41.2	3	0.0	0.0
12-Jul	52.8	4	0.0	0.0
13-Jul	66.9	5	0.0	0.0
14-Jul	46.8	4	0.0	0.0
15-Jul	31.0	2	0.0	0.0
16-Jul	56.3	4	0.0	0.0
17-Jul	61.9	5	0.0	0.0
18-Jul	57.5	4	0.0	0.0
19-Jul	61.9	5	0.0	0.0
20-Jul	53.1	4	0.0	0.0
21-Jul	35.1	4	0.0	0.0
22-Jul	45.8	4	0.0	0.0
23-Jul	61.5	5	0.0	0.0
24-Jul	47.6	5	0.0	0.0
25-Jul	62.5	7	0.0	0.0
26-Jul	53.6	5	0.0	0.0
27-Jul	49.8	4	0.0	0.0
28-Jul	40.4	3	0.0	0.0
29-Jul	31.2	3	0.0	0.0
30-Jul	51.2	5	0.0	0.0
31-Jul	52.7	5	0.0	0.0
Avg	53.4	4.5	0.0	0.0

Appendix B. Daily average flows at Wells Dam, 2001.

all values in kcfs

Date	Total Q	Bypass	Spill Q	N2 Spill	Date	Total Q	Bypass	Spill Q	N2 Spill
1-Aug	59.5	4.6	0.0	0.0	1-Sep	50.4	0.0	0.0	0.0
2-Aug	57.4	4.2	0.0	0.0	2-Sep	51.0	0.0	0.0	0.0
3-Aug	51.3	4.2	0.0	0.0	3-Sep	71.7	0.0	0.0	0.0
4-Aug	40.3	3.2	0.0	0.0	4-Sep	85.3	0.0	0.0	0.0
5-Aug	44.2	3.6	0.0	0.0	5-Sep	70.7	0.0	0.0	0.0
6-Aug	83.5	6.4	0.0	0.0	6-Sep	48.0	0.0	0.0	0.0
7-Aug	95.4	7.3	0.0	0.0	7-Sep	55.0	0.0	0.0	0.0
8-Aug	76.3	6.3	0.0	0.0	8-Sep	44.6	0.0	0.0	0.0
9-Aug	63.6	5.3	0.0	0.0	9-Sep	42.1	0.0	0.0	0.0
10-Aug	75.5	5.9	0.0	0.0	10-Sep	78.2	0.0	0.0	0.0
11-Aug	60.6	5.1	0.0	0.0	11-Sep	93.9	0.0	0.0	0.0
12-Aug	54.1	4.4	0.0	0.0	12-Sep	76.7	0.0	0.0	0.0
13-Aug	86.8	6.9	0.0	0.0	13-Sep	65.7	0.0	0.0	0.0
14-Aug	75.8	6.5	0.0	0.0	14-Sep	62.5	0.0	0.0	0.0
15-Aug	84.5	7.4	0.0	0.0	15-Sep	41.5	0.0	0.0	0.0
16-Aug	75.0	7.7	0.0	0.0	16-Sep		0.0	0.0	0.0
17-Aug	82.9	6.6	0.0	0.0	17-Sep		0.0	0.0	0.0
18-Aug	61.4	5.2	0.0	0.0	18-Sep		0.0	0.0	0.0
19-Aug	51.6	4.6	0.0	0.0	19-Sep		0.0	0.0	0.0
20-Aug	65.2	5.6	0.0	0.0	20-Sep		0.0	0.0	0.0
21-Aug	61.9	5.3	0.0	0.0	21-Sep		0.0	0.0	0.0
22-Aug	60.3	6.0	0.0	0.0	22-Sep		0.0	0.0	0.0
23-Aug	68.4	7.1	0.0	0.0	23-Sep		0.0	0.0	0.0
24-Aug	81.2	6.8	0.0	0.0	24-Sep		0.0	0.0	0.0
25-Aug	68.7	5.5	0.0	0.0	25-Sep		0.0	0.0	0.0
26-Aug	66.2	5.4	0.4	0.0	26-Sep		0.0	0.0	0.0
27-Aug	97.9	7.6	0.1	0.0	27-Sep		0.0	0.0	0.0
28-Aug	93.8	8.7	0.0	0.0	28-Sep		0.0	0.0	0.0
29-Aug				0.0	29-Sep		0.0	0.0	0.0
30-Aug				0.0	30-Sep		0.0	0.0	0.0
31-Aug				0.0					
Avg	69.4	5.8	0.0	0.0	Avg	62.5	0.0	0.0	0.0

PROJECT SURVIVAL ESTIMATE FOR YEARING SUMMER STEELHEAD MIGRATING THROUGH THE WELLS HYDROELECTRIC FACILITY, 2000

APPENDIX H

PROJECT SURVIVAL ESTIMATES FOR YEARLING SUMMER STEELHEAD MIGRATING THROUGH THE WELLS HYDROELECTRIC FACILITY, 2000

by

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March 23, 2001

EXECUTIVE SUMMARY

In the spring of 2000, the Public Utility District No. 1 of Douglas County conducted a PIT-tag survival study at the Wells Hydroelectric Project. Yearling hatchery summer steelhead smolts were collected, PIT-tagged and released above and below the project on twelve different occasions. The primary goal of the study was to precisely estimate the survival of PIT-tagged steelhead migrating from the mouth of the Methow River to and through the tailrace of the Wells Hydroelectric Project. Specific objectives toward accomplishing the primary goal included 1) testing the assumptions of the single (SRR) and paired (PRR) release-recapture models, 2) estimating capture and reach specific survival probabilities and 3) developing component estimates of reach survival for steelhead passing from the mouth of the Methow River to the tailrace of the Wells Hydroelectric Project.

Steelhead smolt survival from the mouth of the Methow River to the tailrace of Wells Dam was assessed through the release of 23,857 steelhead at Pateros and 23,925 steelhead into the tailrace of Wells Dam. The Methow River release site was located 13 km upstream of Wells Dam at river km 843. The tailrace or control release site was located 300 meters downstream of Wells Dam at river km 829.6. Twelve replicate releases of steelhead were completed at both the Methow and tailrace release sites. Each replicate release at each release site contained approximately 2,000 yearling steelhead.

To minimize differences between replicate release groups, fish destined for release at the Methow and tailrace release sites were treated identically throughout the collection, tagging, recovery and transportation phases of the study. Toward this goal, the PIT-tagging crews were continually rotated between the Methow and tailrace release groups. Holding containers and tagging equipment were randomly assigned to release groups. Columbia River water was utilized throughout the collection, tagging, recovery and release phases of the study to provide consistent pre-release conditions between replicate release pairings. Water chemistry was monitored and recorded hourly to ensure consistency between the two release sites and within each of the twelve replicate release pairs.

Fish physiology for the Methow and tailrace release groups was monitored throughout the study. Six of the twelve Methow/tailrace release replicates were sampled to provide pre-release comparisons of fish physiology between replicate release pairs. Physiological data amassed included indices of steelhead handling stress (plasma cortisol and plasma glucose), morphology (length, weight and mesenteric fat), fish condition (fin erosion, descale, and injury rates), smoltification (ATPase and silvering) and fish health (organ tissue color, size and texture). In addition to sampling tagged fish, several control groups of untagged fish were also sampled. Information from the control groups was used to develop baseline indices of fish stress, fish condition and smoltification prior to the tagging procedure.

The information on fish physiology was used to detect subtle differences in fish handling (handling stress and fish condition) within and between the Methow and tailrace release groups. Physiological information was also used to detect differences in fish condition within and between replicate release pairs (smoltification, morphology and fish health). It was hypothesized that subtle differences in handling, stress, or fish condition might increase the variability and uncertainty surrounding reach survival estimates. In extreme cases, differences within a replicate might result in biased estimates of reach survival.

Overall, meaningful differences either within or between the six replicate release pairs sampled were lacking. Differences included a marked decline in fish condition, ATPase levels and fat indices over time. Overall, fish appeared to be healthy with little descaling, fin erosion or injuries noted.

The collection of short-term and long-term stress indices were informative and indicated that collection, handling, tagging and transportation techniques were not meaningfully different either within or between replicate release pairs sampled. In general, indices of short-term and long-term stress were moderate for PIT-tag sample groups. Stress indices for tagged fish were similar to literature values for fish exposed to short-term handling stress.

Recapture and passive interrogation of study fish took place at Rocky Reach, McNary, John Day and Bonneville dams. Additional study fish were detected at the Columbia River estuary by a boat towed PIT-tag trawl. The majority of the Methow and tailrace release replicates (Methow/tailrace) migrated downstream together. Similar to results from the 1999 steelhead survival study, the Methow/tailrace release pairings generally exhibited homogeneous arrival distributions at McNary, John Day and Bonneville dams. Chi-square tests indicated that arrival distributions at Rocky Reach were significantly different within all twelve replicate release pairs. However, visual inspection of the twelve arrival distributions at Rocky Reach Dam clearly demonstrated good mixing between the treatment and control release groups.

Detection and survival probabilities for the Methow/tailrace release pairings were not significantly different for the majority of the release pairings. Detection rates for Douglas PUD released steelhead smolts averaged 0.587 ($\widehat{SE} = 0.009$), 0.155 ($\widehat{SE} = 0.005$) and 0.149 ($\widehat{SE} = 0.013$) at Rocky Reach, McNary and John Day dams, respectively.

Survival through Wells Dam was estimated based upon the relative survival of Methow and tailrace release groups. Survival from the Methow release site through to the tailrace of Wells Dam ranged from 0.865 to 1.022. To remain consistent with survival estimates from previous studies at Wells Dam and from studies conducted at other Snake and Columbia river dams, all reported point estimates of survival were based upon the weighted average of the replicate survival estimates. The weighted average survival for yearling steelhead passing from the mouth of the Methow River to 300 m downstream of Wells Dam was 0.946 ($\hat{SE} = 0.015$) (n = 12) during 2000. The survival estimate generated for steelhead in 2000 was the product of survival through the reservoir, forebay, dam and tailrace for ESA listed summer steelhead smolts. The 2000 Wells survival estimate was not significantly different (p = 0.9636) from the 1999 Wells steelhead survival estimate of 0.943 ($\hat{SE} = 0.016$) (n = 15).

Estimates of reach specific survival were derived from release sites to immediately downstream of Rocky Reach, McNary and John Day dams. Survival from the Rocky Reach tailrace to the McNary tailrace and from the McNary tailrace to the John Day tailrace were not significantly different ($p < 0.10$) between the paired Douglas PUD release groups. As a result, the independent estimates of reach survival were pooled. Average steelhead survival from the Rocky Reach tailrace to the McNary tailrace averaged (weighted) 0.656 ($\hat{SE} = 0.011$). Survival from the McNary tailrace to the John Day Dam tailrace averaged 1.017 ($\hat{SE} = 0.053$).

In addition to Douglas PUD tagged steelhead, the Fish Passage Center released three replicate release groups of PIT-tagged yearling spring chinook from the Winthrop National Fish Hatchery. Estimates of detection and survival from this group of fish provided an interesting contrast between spring chinook and summer steelhead survival during the 2000 outmigration.

Detection rates for year 2000 Winthrop spring chinook averaged 0.261 ($\hat{SE} = 0.028$), 0.206 ($\hat{SE} = 0.034$) and 0.063 ($\hat{SE} = 0.010$) at Rocky Reach, McNary and John Day dams. Estimated reach survival for Winthrop fish migrating from Winthrop to the tailrace of Rocky Reach Dam averaged 0.705 ($\hat{SE} = 0.040$). Estimated reach survival from the Rocky Reach tailrace to the McNary tailrace for Winthrop fish averaged 0.692 ($\hat{SE} = 0.088$). The 2000 reach survival estimate for Winthrop spring chinook was not significantly different from the reach survival estimates generated for Winthrop spring chinook released in 1998 and 1999 and from steelhead reach survival estimates generated in 1999 and 2000.

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1.0 INTRODUCTION

In the spring of 1998, the Public Utility District No. 1 of Douglas County conducted a pilot survival study at the Wells Hydroelectric Project. Results from the 1998 study indicated that the critical assumptions of the SRR and PRR models could be satisfied during PIT-tag survival studies at Wells Dam. Chinook survival through the Wells project was estimated based upon the relative survival of chinook released at Pateros and chinook released below Wells Dam. Estimated chinook survival from the mouth of the Methow River to the tailrace of Wells Dam averaged 99.7% ($S\hat{E}$ = 0.015) in 1998 (Bickford et al. 1999).

Estimated survival from the Rocky Reach tailrace to the McNary tailrace during 1998 averaged 0.659 ($S\hat{E}$ = 0.040) for yearling Wells summer chinook, 0.720 ($S\hat{E}$ =0.091) for yearling Winthrop spring chinook and 0.720 ($S\hat{E}$ = 0.084) for yearling Methow run-of-river chinook (Bickford et al., 1999). Estimated reach survival from Rocky Reach to McNary were not significantly different (p=0.5390) between Winthrop spring and Wells summer chinook. Likewise, estimated survival for Wells summer chinook and Methow run-of-river chinook were not significantly different (p=0.2040).

In the spring of 1999, Douglas County PUD conducted a second year of PIT-tag survival studies at Wells Dam. The 1999 survival study was designed to accurately estimate the survival of PIT-tagged steelhead smolts migrating through the Wells Hydroelectric Project. During the 1999 study, fifteen replicate pairs of ESA listed yearling summer steelhead were released. Estimated steelhead survival from the mouth of the Methow River to the tailrace of Wells Dam averaged 0.943 ($S\hat{E}$ = 0.016) (Bickford et al., 2000).

Estimated survival from the Rocky Reach tailrace to the McNary tailrace during 1999 averaged 0.686 ($S\hat{E}$ =0.010) for yearling Wells summer steelhead and 0.727 ($S\hat{E}$ =0.053) for yearling Winthrop spring chinook (Bickford et al., 2000a; Bickford et al., 2000b). Estimated reach survival from Rocky Reach to McNary were not significantly different (p > 0.10) between Winthrop spring chinook and the Okanogan, Pateros and Wells tailrace releases of PIT-tagged Wells summer steelhead.

During the spring of 2000, Douglas PUD conducted a third year of PIT-tag survival studies. The 2000 survival study was designed to be similar to previous survival studies conducted at Wells Dam. Goals of the study included evaluating critical model assumptions, estimating reach specific survival rates, estimating precisely the survival for yearling summer steelhead migrating from the mouth of the Methow River through and to the tailrace of the Wells Hydroelectric Project, and rigorously comparing survival estimates from this study with survival estimates generated from other survival studies.

2.0 STUDY AREA

The Wells Hydrocombine generating facility is located at river km (R km) 830 on the upper Columbia River (Figure 1). The Wells Hydrocombine, unlike typical Columbia River hydroelectric projects, efficiently combines generation, spill and fish passage facilities into one structure. The generation facilities at Wells Dam contain ten Kaplan turbines capable of producing 840,000 kilowatts of electricity. Juvenile fish are bypassed away from turbines via a highly effective surface collection system. The Wells bypass system provides a safe, non-turbine passage route through the dam for over 92% of the spring and 96% of the summer migrants (Johnsen et al., 1992; Skalski et al., 1996). Wells is the uppermost generating project on the Columbia River which anadromous chinook (*Oncorhynchus tshawytscha*), steelhead (*O. mykiss*) and sockeye salmon (*O. nerka*) migrate through. Adult fish passage is provided by two fish ladders located at either end of the powerhouse.

The reservoir formed by Wells Dam is called Lake Pateros. The Methow River enters Lake Pateros at R km 843 (Figure 2). The Methow is the most important production area for Upper Columbia River salmon and steelhead upstream of Wells Dam. Both natural and hatchery produced steelhead smolts originate from this system. The Okanogan River enters Lake Pateros at R km 870. Steelhead smolts migrating out of the Okanogan River are mostly hatchery fish planted into this system each spring by staff from the Wells Fish Hatchery.

Figure 1. Mainstem Columbia and Snake rivers depicting important hydroelectric projects.

3.0 METHODS AND MATERIALS

3.1 Fish Collection

The collection of yearling hatchery summer steelhead (study animals) took place at the Wells Fish Hatchery. Steelhead smolts ready to migrate were allowed to volitionally exit Pond #4 via an overflow weir. Fish passing over the weir were washed downstream through an outfall pipe and deposited into a 23,000 L collection trap.

Two to three days prior to each tagging session, sufficient numbers of steelhead smolts were collected from the trap. Fish were pumped from the trap into a 2,000 L transportation container with a 20 cm Aqualite Harvester hydraulic fish pump (Magic Valley Harvest, Hagerman, Idaho). The transportation container was outfitted with a displacement meter, water re-circulation pump and metered compressed oxygen. The displacement meter ensured that the density of fish inside the transport container never exceeded 0.16 Kg fish/L. Once inside the transport container, the fish were transported less than 0.5 km to one of two concrete pre-tagging holding raceways. Transport time from the collection site to the holding raceways was less than 15 minutes per load.

The Wells pre-tagging raceways contained a minimum of 70,000 L of single pass river water. Rearing pond #4 and pre-tagging raceway #1 and #2 all received a continuous supply of gravity fed river water from the Wells Hatchery water distribution system.

3.2 Tagging and Holding Procedures

On tagging days, small groups of untagged steelhead, being held in either of the two pre-tagging raceways, were crowded toward a pint-sized-pescalator (PRA Manufacturing, Nanaimo, British Columbia, Canada). The pescalator was comprised of a 30 cm diameter fiberglass pipe with an Archimedies screw built into the center. As the pescalator rotated, it captured and transported water and fish up and out of the raceway. At the top of the pescalator, fish and water were deposited into a 10 cm transport pipe. The transport pipe delivered each fish directly into an anesthetic bath containing 40 ppm of Methanosulfonate-222 (MS-222). Once fish began to lose equilibrium, small groups of fish were dip netted into an 8 L container filled with a lighter (20-30 ppm) solution of MS-222.

Once anesthetized, diseased, mortally wounded and residual steelhead were removed from the study group. Remaining healthy steelhead smolts were tagged within the body cavity using 12-gauge hypodermic needles loaded with individual 12 mm Destron-Fearing 134.2-kHz ISO PIT-tags. Fish were tagged according to criteria described in Prentice et al. (1987) and Bickford et al. (1999, 2000a and 2000b). To prevent disease transmission, each hypodermic needle was soaked in ethyl alcohol for 10 minutes and allowed to dry before being reloaded with a PIT-tag. Needles were used only 11 times each to ensure sharpness and promote rapid healing of the tag incision.

Immediately following tagging, each unique tag code for each fish was entered into a database. In addition to the tag code, date of tag implantation, tag personnel identification code, fish length, water temperature and obvious abnormalities were recorded.

A 10 cm diameter pipe half full of water was used to transfer the tagged fish into 1,200 L release containers for recovery. During tagging and initial recovery, the release containers were supplied with a continuous flow of single pass river water in addition to metered compressed oxygen. Water and dissolved oxygen levels were closely monitored throughout the entire 36-hour recovery period. Between 400 and 412 tagged steelhead were placed inside each release container. Loading densities were established to ensure that no release container held more than 0.03 Kg of fish/liter water (Kg fish/L).

Containers with recovering tagged steelhead were supplied with 50-60 L/min of river water through a 5 cm flex-hose. Water temperature and dissolved oxygen levels inside each release container were closely monitored and recorded each hour to ensure that the pre-release recovery history of each container was similar within and between tagging groups. PIT-tag release groups were randomized at the time of tagging, release containers alternated between release groups and tagging personnel rotated between and among tagging groups.

3.3 Transportation and Release Procedures

Releases of PIT-tagged WFH steelhead took place at the Methow River and tailrace release sites on April 24, 26, 28, and 30 and May 2, 4, 6, 8, 10, 12, 14 and 16. On each of the twelve release days, five release containers were transported with a flatbed truck to each of the barge loading sites.

Pateros release groups were removed from the water supply lines at 0800 hours and transported to the barge loading site at the Methow River. In the afternoons, five tailrace release containers were removed from the water supply lines at 1300 hours and transported to the barge loading site in the Wells tailrace. Release times were staggered to allow Pateros fish additional time to arrive at Wells Dam prior to the release of tailrace fish.

After being disconnected from the river water supply lines, metered compressed oxygen was immediately supplied to each release container. To compensate for differences in travel distances between the Methow and tailrace barge loading sites, the transport vehicle destined for the tailrace site made purposeful excursions to ensure that the total travel times, stress and subsequent pre-release histories of the Methow and tailrace release groups were similar.

At the barge loading stations, the release containers were hoisted off the transport trucks and loaded onto barges for final release. Barges were outfitted with water supply lines. Immediately after the release containers were loaded onto the barges, the metered compressed oxygen supply system was disconnected and the on-board river water supply system was turned on. Dissolved oxygen and water temperatures for each container were recorded periodically throughout the transportation process. Desired dissolved oxygen concentrations inside each container were manually adjusted to maintain between 9 and 12 mg O_2/L. Injured and moribund fish were removed and recorded. River water flow through each container on the barge was estimated at 60-80 L/minute.

Barges carrying release containers were towed to their respective release locations (Figure 2). Temperature, dissolved oxygen, and fish activity levels were recorded prior to final release. Following the pre-release inspection for mortalities, the fish were released directly into the Columbia River though 20 x 15 cm eccentric reducers. Water to water transfers were maintained throughout the entire study. Fish were released at the Methow and tailrace release sites approximately 1 hour after water supply lines at the WFH were disconnected. The Methow releases were initiated at 0900 hours and the tailrace releases were initiated at 1400 hours.

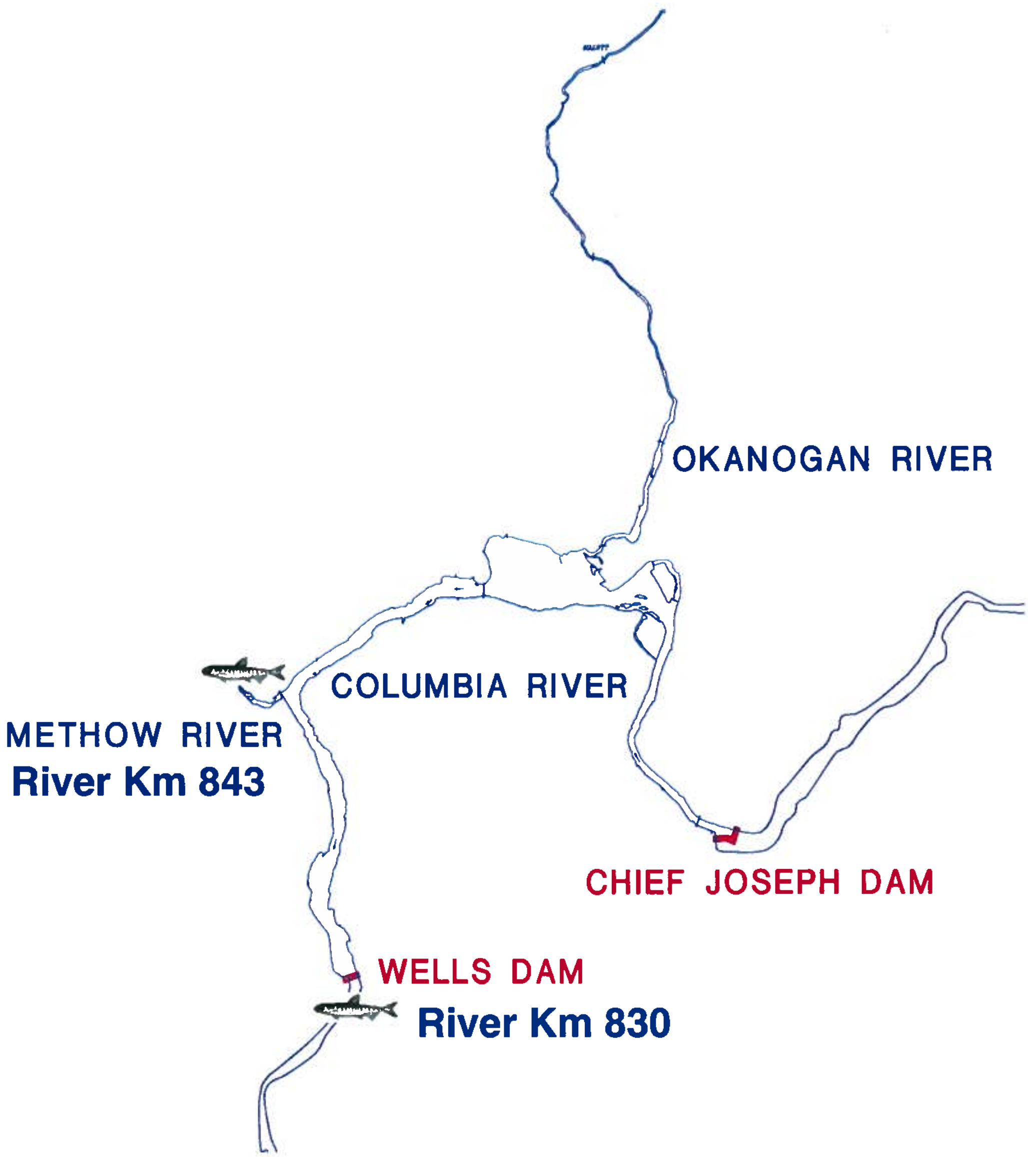
3.4 Physiological Monitoring

A sub-sample of at least 10 fish from the Pateros release group and at least 10 fish from the tailrace release group were collected on six of the twelve release days (April 24 and 28, May 2, 6, 10, and 14). These fish were used for the collection of important physiological information pertinent to the interpretation of survival estimates. Measures of smoltification (gill ATPase and smolt index), measures of stress (plasma cortisol and plasma glucose), morphological measures (length, weight) and indices of fish health (color and texture of internal organs, fin erosion, descale, infection) were collected. The physiological information collected was used to assess differences in stress, fish condition and fish health within and between replicate release pairs. In addition, comparisons were also made between replicate releases destined for the same release locations. Additional information collected from the post-mortem examination of steelhead included estimates of PIT-tag retention, observations of tag placement and tag implantation related injuries.

To provide a baseline level of fish stress, condition and health, a control group of 20 untagged steelhead was also sampled. Control fish were not anesthetized and tagged but were subjected to the same collection (fish pump), holding (raceway) and sampling conditions (lethal dose of anesthetic) as treatment (tagged) fish.

Collection of stress measures was particularly important for assessing the impact of stress experienced by fish during the tagging and recovery components of the study. In addition, stress levels within and between replicate release pairs were compared to indices of fish health, smolt status and fish condition. Statistical comparisons of physiological measures were accomplished with one-way ANOVA's followed by Tukey tests (Zar, 1984).

Figure 2. Release sites utilized during the 2000 Wells steelhead survival study.



PIT-Tag Release Sites

3.5 PIT-Tag Detection

PIT-tagged steelhead released during the 2000 survival study were detected at five downstream locations (Figure 3). The first of these sites was located in the surface collector bypass pipes at Rocky Reach Dam. At Rocky Reach Dam, the detection of 134.2 kHz PIT-tags was made possible by the installation of two 12 inch dual coil ISO PIT-tag detection systems and four single coil 24 inch ISO PIT-detection systems. Biomark, Inc. of Boise, Idaho installed this system through funding provided by the Public Utility District No. 1 of Douglas County and the Public Utility District No. 1 of Chelan County. Operation of the Rocky Reach juvenile bypass system was conducted by the Public Utility District No. 1 of Chelan County.

Recapture and detection of study fish also occurred at McNary, John Day and Bonneville dams. Additional detections took place at the Columbia River estuary-sampling site where NMFS operates a mid-water trawl equipped with a PIT-tag detection tunnel. The PTAGIS database managed by the Pacific States Marine Fisheries Commission was used to store and archive all the release and recapture information available for study fish. Operation of downstream fish passage facilities and PIT-tag detection facilities were funded by the United States Army Corps of Engineers and the Bonneville Power Administration. Faculty and staff at the Columbia Basin Research Unit, University of Washington conducted model testing, verified model assumptions and provided detection and reach survival probabilities.

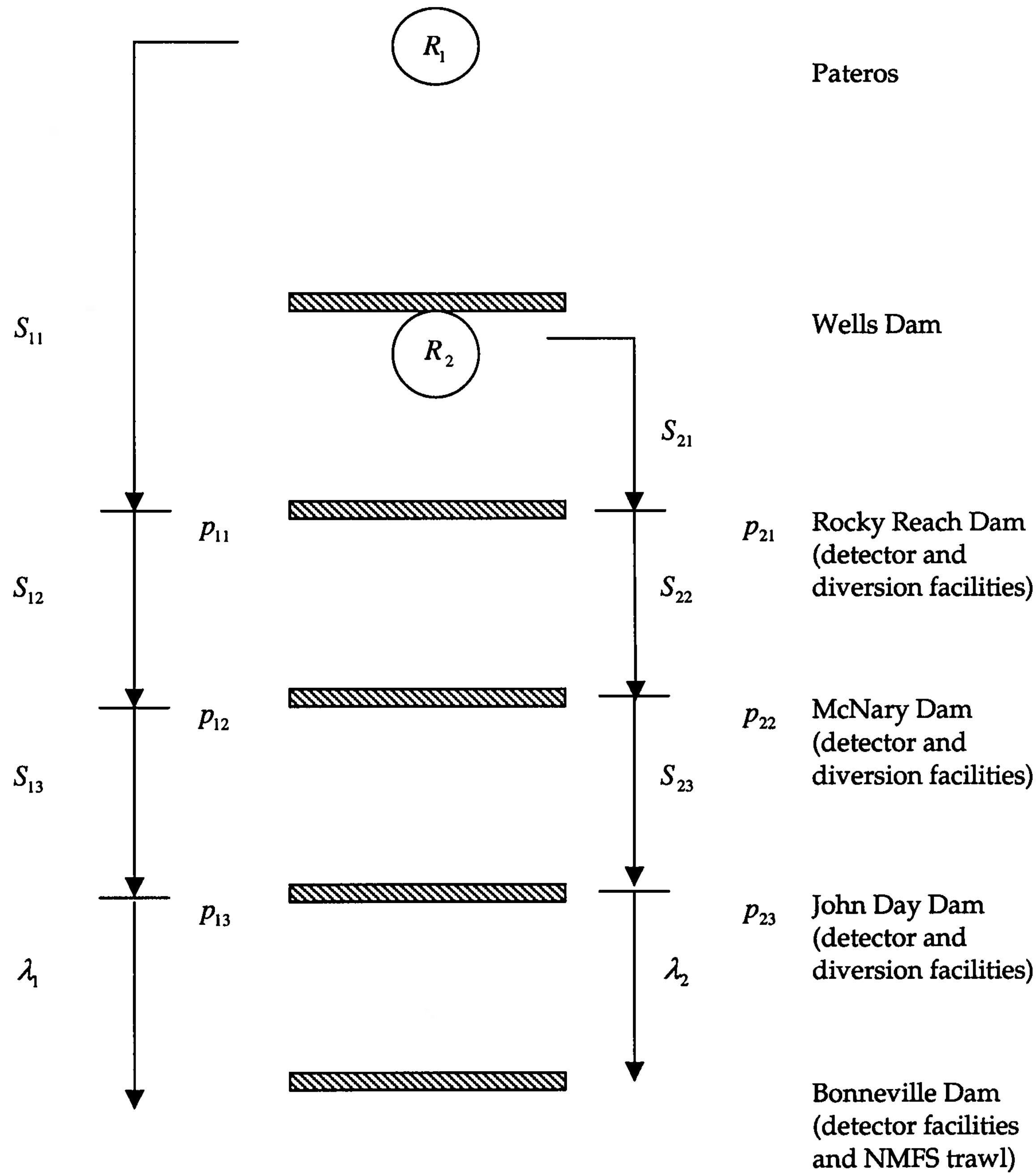
3.6 Release and Recapture Design for the Survival Study

Two release locations were used to estimate Wells project survival in the 2000 PIT-tag survival study (Figure 3). One release location was at the mouth of the Methow River near the town of Pateros, Washington (R_1). The second release location was in the tailrace of the Wells Dam approximately 300 m downstream of the project (R_2). Releases at these two sites were coordinated. The study consisted of 12 pairs of hatchery releases at the upstream(R_1) and downstream (R_2) sites. On a particular release day, approximately 2,000 hatchery fish were released at each of the upstream and downstream sites. The fish at the top of the pool (R_1) were released at 0900 hours with the tailrace group (R_2) released at 1400 hours. Release times were coordinated to facilitate mixing between the upstream and downstream release groups (i.e., 5 hours apart). The paired releases were conducted every other day for a total of approximately 48,000 hatchery yearling summer steelhead from Wells Fish Hatchery. The quantitative goal of these releases was to estimate mean smolt survival through the Wells project with a $\pm$5% confidence interval around a point estimate calculated at the 95% confidence level.

3.7 Analysis of the PIT-Tagging Data

The single release-recapture model provided estimates of reach-specific survival and capture probabilities for all but the last recovery site (Figure 3) for each release group. Of primary interest is the smolt survival probability for the Wells Hydroelectric Project. Releases R_1 and R_2 of Figure 3 were used to estimate survival from Pateros to and through the Wells tailrace $(\hat{S}_W)$. Due to the current nature of salmon survival studies in the Mid Columbia Basin, analyses results that will be used as a basis for the following year's studies are required prior to the point of certainty that no further study fish will be detected. A date is determined that the additional detections will be so few as to not seriously affect survival estimates, and the analyses are based on that data. This year, all analyses contained within this report are based on the data obtained from the PTAGIS database on July 18, 2000.

Figure 3. Schematic of release and PIT-tag detection facilities used in the 2000 Wells Project Survival Study. Parameters that will be estimated from the release-recapture data are indicated.



Survival through the Wells project $\left(\hat{S}_W\right)$ was estimated from the results of the upstream and downstream releases (e.g., R_1 and R_2) by the expression:

Estimated Wells project survival:

$$\hat{S}_W = \frac{\hat{S}_{11}}{\hat{S}_{21}} \tag{1}$$

with associated variance estimate based on the Delta method (Seber 1982: pp. 7-9) of

$$\begin{aligned} \hat{Var}\left(\hat{S}_W\right) &\doteq \left(\frac{\hat{S}_{11}}{\hat{S}_{21}}\right)^2 \left[\frac{Var\left(\hat{S}_{11}\right)}{\hat{S}_{11}^2} + \frac{Var\left(\hat{S}_{21}\right)}{\hat{S}_{21}^2}\right] \\ &\doteq \hat{S}_W^2 \left[\hat{CV}\left(\hat{S}_{11}\right)^2 + \hat{CV}\left(\hat{S}_{21}\right)^2\right] \end{aligned} \tag{2}$$

and where

$$\hat{CV}\left(\hat{\theta}\right) = \frac{\sqrt{Var\left(\hat{\theta}\right)}}{\hat{\theta}}.$$

Separate estimates of $\hat{S}_W$ were calculated for each of the 12 paired-releases.

A weighted average of the survival estimates from the replicate releases was calculated according to the formula

$$\hat{\bar{S}} = \frac{\sum_{i=1}^{k} W_i \hat{S}_i}{\sum W_i} \tag{3}$$

where k = number of replicate releases (e.g., 12);

$\hat{S}_i$ = survival estimates from the ith release pair $(i = 1, \ldots, k)$;

$$W_i = \frac{1}{\left(\frac{\hat{Var}\left(\hat{S}_i\right)}{\hat{S}_i^2}\right)} = \frac{1}{CV\left(\hat{S}_i\right)^2} \tag{4}$$

with variance

$$\hat{Var}\left(\hat{\bar{S}}\right) = \frac{\sum_{i=1}^{k} W_i \left(\hat{S}_i - \hat{\bar{S}}\right)^2}{(k-1)\sum_{i=1}^{k} W_i}. \tag{5}$$

It was found that by weighting simply inversely proportional to $Var(\hat{S}_i)$, the weights were correlated with the point estimates [i.e., Equation (2)], resulting in downward bias in the average survival. By calculating the relative variance [Equation (4)], this correlation between the variance estimate and the point estimate is eliminated or reduced.

An asymptotic $(1-\alpha)$ 100% confidence interval for the weighted average of the survival estimates was computed according to the formula

$$\hat{\bar{S}} \pm Z_{1-\frac{\alpha}{2}} \sqrt{V\hat{a}r\left(\hat{\bar{S}}\right)}.$$

The paired release-recapture methods of Burnham et al. (1987) were used to find the most parsimonious models for estimating reach survival [Equations (1)]. A forward-sequential procedure was used in model selection based on likelihood-ratio tests of nested models. The most efficient estimates of reach survival were based on the statistical models for the paired-releases that properly shared all common parameters. The best models for characterizing the paired-releases were found using Program SURPH.1 (Smith et al. 1994).

Proportionate daily detection distributions (mixing) of the release groups (e.g., R_1 and R_2) of smolts is sufficient but not necessary for valid estimation of reach survival. For example, estimates of $\hat{S}_{11}$ and $\hat{S}_{12}$ can be derived independently without mixing of upstream and downstream smolts based on the assumptions of the single release-recapture model. The assumptions of the single release-recapture model are the following (Skalski et al. 1998):

A1. The test fish are representative of the population of inference.

A2. Test conditions are representative of the conditions of interest.

A3. The number of fish released is exactly known.

A4. PIT-tag codes are accurately recorded at the time of tagging and at all detection sites.

A5. For replicated studies, data from different releases are statistically independent.

A6. The fate of each individual fish is independent of the fates of all other fish.

A7. All fish in a release group have equal survival and detection probabilities.

A8. Prior detection history has no effect on subsequent survival and detection probabilities.

In order to estimate S_W, the survival S_{11} is assumed to be of the form:

$$S_{11} = S_W \cdot S_{21} \tag{6}$$

leading to the relationship

$$\frac{S_{11}}{S_{21}} = \frac{S_W \cdot S_{21}}{S_{21}} = S_W .$$

The equality (6) suggests two additional assumptions for valid estimation of Wells project survival. These are:

A9. Survival in the Wells project (S_W) is conditionally independent of survival in the Rocky Reach (S_{21}) project.

A10. Releases (R_1) and (R_2) experience the same survival probability in the Rocky Reach (S_{21}) project.

Assumption (A9) implies that there is no synergistic relationship between survival processes in the Wells and Rocky Reach projects. In other words, smolts that survived the Wells project are no more or less susceptible to mortality in the Rocky Reach project than smolts released in the tailrace of Wells. Assumption (A10) can be satisfied by mixing of the two release groups R_1 and R_2 but can also be satisfied if the survival process at Rocky Reach (S_{21}) is stable over the course of smolt passage by the two releases. A stable survival process might well be expected for one to a few days under similar flow and dam operations at Rocky Reach. Near constant survival rates at Lower Granite, Little Goose, and Lower Monumental projects over the majority of the outmigration have been reported by Skalski et al. (1997). Furthermore, unlike paired-release methods of the earlier Mid-Columbia survival studies in the 1980s, the assumption of equal capture probabilities is unnecessary for estimator (1) to be valid.

3.7.1 Tests of Model Assumptions

The assumptions of the single release-recapture model were tested for each PIT-tag release group. Model assumptions were also tested for each paired-release used in estimating reach survival.

Tests Within a Release for the Single Release-Recapture Model

For the single release-recapture model to be valid, certain data patterns should be evident from the capture histories. For each release group, a series of tests of assumptions were performed to determine the validity of the model (i.e., goodness-of-fit). The data from a single-release can be summarized by an m-array matrix of the form below where the m_{ij}'s are the number of smolts released at site i that are next detected at site j:

	Recovery Site			
Release Site	Rocky Reach (2)	McNary (3)	John Day (4)	Bonneville (5)
Initial (1)	m_{12}	m_{13}	m_{14}	m_{15}
Rocky Reach (2)		m_{23}	m_{24}	m_{25}
McNary (3)			m_{34}	m_{35}
John Day (4)				m_{45}

Burnham et al. (1987: p. 65, pp. 71-74) presents a series of tests of assumptions called Test 2 that examine whether upstream detections affect downstream survival and/or detection. For each release, two contingency table tests were performed, as follows:

Test 2.2

m_{13}	m_{14}	m_{15}
m_{23}	m_{24}	m_{25}

χ_2^2 (7)

Test 2.3

$m_{14}+m_{24}$	$m_{15}+m_{25}$
m_{34}	m_{35}

χ_1^2 (8)

Overall significance of Test 2 was based on the sum of the chi-square statistics $\chi_2^2+\chi_1^2=\chi_3^2$. Test-wise error rates were adjusted for the experimental-wise error rate of $\alpha_{EX}=0.10$ across the replicate releases.

Burnham et al. (1987: p. 65, pp.74-77) also present a series of tests of assumptions called Test 3 that also examine whether upstream capture histories affect downstream survival and/or capture. For each release, contingency tables were constructed of the form:

		Capture History to McNary Dam	
		101	111
Capture History	11		
at John Day and	10		
Bonneville Dams	01		
	00		

χ_3^2 (9)

Contingency table (9) tests whether capture at Rocky Reach Dam has a subsequent effect on capture histories at John Day and Bonneville dams. To test whether capture at Rocky Reach and/or McNary dams has a subsequent effect on the capture history at Bonneville Dam, a contingency table can be constructed of the form:

		Capture History at John Day Dam			
		1111	1101	1011	1001
Capture History	1				
at Bonneville	0				

χ_3^2 (10)

Contingency tables (9) and (10) are slight modifications from Burnham et al. (1987) to take into account more of the information from the individual capture histories. Overall significance of Test 3 was based on the sum of the chi-square statistics $\chi_3^2 + \chi_3^2 = \chi_6^2$. Test-wise error rates were adjusted for the experimental-wise error rate of $\alpha_{EX} = 0.10$ across the replicate releases.

Tests Between Releases Within a Paired-Release

At each downstream PIT-tag recapture site (i.e., Rocky Reach, McNary, John Day, Bonneville), a test of the assumption of mixing among the releases of smolts (e.g., R_1 and R_2) was conducted. A test of homogeneous recoveries over time was performed using a contingency table listing the daily downstream detections at each dam for each pair of releases:

		Release	
		R_1	R_2
Day of Detection	1		
	2		
	3		
	⋮	⋮	⋮
	D		

(11)

A contingency table of form (11) was calculated for each of the 12 Pateros/Wells paired releases. Each test was performed at $\alpha = 0.10$. Because of the multiple tests across release-pairs, Type I error rates were adjusted for an overall experimental-wise error rate of $\alpha_{EX} = 0.10$. A Type I error occurs when a hypothesis test falsely rejects the null when it is true. In this case, our null hypothesis is that there is no difference in downstream detections for a pair of releases. When $\alpha = 0.10$ for a specific test, we realize that if the null hypothesis is true, it will be erroneously rejected 10 percent of the time. When calculating a number of comparisons, though, the likelihood that a Type I error will occur increases. For 12 comparisons of the daily detection rates at McNary Dam, for example, the probability of at least one Type I error increases to 71.8%. To decrease this likelihood, the test-wise Type I error per comparison is reduced to $\alpha = 0.0087$, so that the experimental-wise error rate is $\alpha_{EX} = 0.10$. When the rejection of a hypothesis test does occur, this does not lead to rejecting the experiment, but indicates that this particular data set is inconsistent with the null hypothesis.

To test whether releases with a paired-release (e.g., R_1 and R_2) had similar downstream survival and capture histories for Rocky Reach Dam and below, likelihood ratio tests were performed to compare models with alternative downstream survival and capture scenarios. These tests were used to help determine the most parsimonious paired-release model for the estimation of S_W. Burnham et al. (1987: pp.128, Test 1.T2) suggests using a 2 x 2 contingency table test to determine where the capture and survival rates for the R_1 and R_2 releases were equal at and below Rocky Reach Dam (i.e., $p_{11} = p_{21}$, $S_{12} = S_{22}$, $p_{12} = p_{22}$, etc.), another indication of complete mixing. The 2 x 2 table of the form below was constructed for each paired-release:

Test 1.T2

	Release		
	R_1	R_2	
m_1	m_{11}	m_{21}	(12)
z_1	z_{12}	z_{22}	

where m_{i2} was the number of smolts detected at Rocky Reach for the ith release group $(i = 1, 2)$ and z_{i2} was the number of smolts that were released that were not detected at Rocky Reach but were subsequently detected at McNary Dam or below.

Two additional Test 1's were also performed. A Test 1.T3 was performed of the form:

Test 1.T3

	Release		
	R_1	R_2	
m_1	m_{13}	m_{23}	(13)
z_1	z_{13}	z_{23}	

where m_{i3} was the number of smolts detected at McNary Dam for the ith release group $(i = 1, 2)$ and z_{i3} was the number of smolts that were not detected at McNary but were subsequently detected at John Day Dam or below.

A Test 1.T4 was also performed of the form:

Test 1.T4

	Release		
	R_1	R_2	
m_4	m_{14}	m_{24}	(14)
z_4	z_{14}	z_{24}	

where m_{i4} was the number of smolts detected at John Day Dam for a release $i\left(i=1,2\right)$ and z_{i4} was the number of smolts that were not detected at John Day Dam but were subsequently detected at Bonneville Dam.

While contingency tables (12-14) test for equality of overall recapture for releases R_1 and R_2, it does not provide the fine-grained test of equal site-specific capture and survival rates for both releases available using the likelihood-ratio tests. For this reason, inferences concerning downstream mixing will be largely based on the sequential use of likelihood-ratio tests.

Tests of Handling Effects at Rocky Reach and Rock Island Dams

Smolts passing through the bypass systems at Rocky Reach and Rock Island dams were collected and anesthetized for potential tagging as part of the Chelan PUD smolt survival studies. During the 2000 study, 3,400 PIT-tagged steelhead smolts released upstream of Rocky Reach, as part of the Douglas PUD smolt survival study, were intercepted and anesthetized a second time at Rocky Reach. At Rock Island, the number of smolts intercepted was 1,471. Chi-square contingency table tests were used to assess whether this second handling affected downstream detection and survival probabilities. For each dam (Rocky Reach and Rock Island), the downstream histories of "handled" fish and "detected, but not handled" fish at that dam were compared in a table the form of (Table 15). Both groups of fish traveled through the bypass systems, with the only difference being the collection and anesthetizing process.

		Handled fish	Detected, but not handled fish
Capture History	111		
at McNary, John Day	110		
and	101		
Bonneville Dams	100		
	011		
	010		
	001		
	000		

(15)

3.7.2 Modeling Paired-Tag Releases

For each pair of Pateros and tailrace release groups used to estimate survival through the Wells project, a model fitting routine was performed to identify the most appropriate and parsimonious likelihood model. Two approaches to model fitting were used for each release pair: (a) forward-step fitting routine and (b) test of overall fit of the selected model.

The forward-step fitting routine began with all detection, survival, and last reach probabilities unique. The forward sequential procedure was used to test whether (in order) $\underset{\sim}{p_1}$, $\underset{\sim}{S_2}$, $\underset{\sim}{p_2}$, $\underset{\sim}{S_3}$, $\underset{\sim}{p_3}$, and $\underset{\sim}{\lambda}$ were homogeneous between release groups from Pateros and the Wells tailrace. The forward-step fitting procedures kept survival probabilities S_{11} and S_{21} unique throughout all steps of the test (Figure 3). The selected model was then compared to the fully parameterized Cormack-Jolly-Seber (CJS) model to assess whether the selected model adequately described the capture data.

3.7.3 Smolt Survival Comparison

Using the estimates from 1999 and this year (2000), a comparison of mean survival was performed. The test of equal survival was based on an asymptotic Z-test of the form:

$$Z = \frac{\left|\hat{\hat{S}}_{1999} - \hat{\hat{S}}_{2000}\right|}{\sqrt{V\hat{a}r\left(\left(\hat{\hat{S}}_{1999}\right) + V\hat{a}r\left(\hat{\hat{S}}_{2000}\right)\right)}}$$

where

$\hat{\hat{S}}_{1999}$ = weighted average of Wells survival from the 1999 PIT-tag study, and

$\hat{\hat{S}}_{2000}$ = weighted average of Wells survival from the 2000 PIT-tag study.

The two-tailed test of equality of survival estimates was performed at α = 0.10.

4.0 RESULTS

4.1 Fish Collection

Steelhead collected from the earthen rearing pond (Pond #4) were not directly counted. Instead volumetric displacement was used to estimate the number of steelhead collected and transported to the pre-tagging raceways. Two days before tagging, roughly 4,500 steelhead were crowded and fish pumped into the transport truck. The transport truck then released these fish directly into pre-tagging raceways located proximal to the PIT-tagging facility. No steelhead losses were recorded during the fish pumping and transportation process. The steelhead collected from Pond #4 were allowed to recover in the pre-tagging raceways at least 48-hours prior to being tagged.

4.2 Tagging and Holding

In total, 49,370 steelhead were collected for tagging purposes. Not all of the 49,370 hatchery steelhead collected for tagging were retained and tagged. In total, 1,103 excess steelhead were released directly into the Columbia River below Wells Dam. The majority of these fish were simply in excess of the number of fish needed for tagging. A smaller component of these fish were removed because they did not represent the population of steelhead expected to migrate through Wells Dam in 2000. Fish were removed from tagging when they expressed signs of disease, serious injury, precocity or grotesque growth abnormalities.

Steelhead smolts were the population of inference for the 2000 survival study at the Wells Hydroelectric Project. As such, precocious steelhead parr were excluded because they were not expected to migrate through the dam in 2000. Fish with serious injuries, growth abnormalities and external signs of disease were excluded because they were not expected to survive the tagging and handling procedures. The remaining 48,267 steelhead were tagged for use in the Wells project survival study.

Of the 48,267 steelhead smolts PIT-tagged for the Wells project survival study, a total of 14 (0.03%) tagged steelhead died after being tagged. Fish loss was evenly divided between the Pateros (7) and tailrace release groups (7) (Table 1). In addition to tagging related losses, an additional 126 (0.3%) tagged steelhead were sacrificed for physiological sampling. An additional 345 shed PIT-tags were recovered inside release containers utilized for the 2000 Wells project survival study. Shed tags were recovered in similar number from the Pateros (182 or 0.76%) and tailrace (175 or 0.73%) release groups. In total, 23,857 PIT-tagged steelhead were released at Pateros and 23,925 PIT-tagged steelhead were released into the Wells tailrace (Table 1).

4.3 Transportation and Release

Releases of PIT-tagged WFH steelhead took place at the Methow River and tailrace release sites on April 24, 26, 28 and 30 and May 2, 4, 6, 8, 10, 12, 14 and 16. On each of the twelve release days, five release containers were transported to each of the two barge loading sites on time and within the parameters established in Section 3.3 (Methods and Materials). Standardization of truck loading, transportation, and barge loading times were achieved both within and between replicate release groups. Loading required 10 minutes, transport time averaged 16 minutes and barge loading times required 10 minutes. As each container was loaded onto a barge, it was immediately connected to the barge water supply line. The maximum amount of time that any individual release container was not being supplied by river water did not exceed 30 minutes.

Dissolved oxygen and water temperatures for each container were recorded at pre-determined intervals throughout the transportation process. Records of dissolved oxygen and temperature indicated similar trends within and between replicate release sites. Concentrations of dissolved oxygen varied slightly between release containers but for the most part dissolved oxygen concentrations were consistently maintained between 9 and 12 mg O_2/L throughout the transportation interval.

Water temperatures within a replicate pair varied less than one degree during the transportation phase of the study. Water temperatures in the Pateros and tailrace release containers were maintained within 0.5° C of Columbia River water temperatures at all times. Over the course of the study, Columbia River water temperatures climbed from an average of 8.2° C on the first release day to 11.3° C by the end of the study.

Table 1: Tag releases for the 2000 Wells steelhead survival study.

Tagging Study	Release Site	Release No.	Tagged	Morts.	Sacrificed	Tags shed	**Total Released**
Wells Dam	Pateros	1	2,017	2	11	6	1998
		2	2,003			12	1991
		3	2,019	1	10	18	1990
		4	2,008	2		14	1992
		5	2,016		10	14	1992
		6	2,001			13	1988
		7	2,011		10	8	1993
		8	2,001	1		17	1983
		9	2,011	1	12	23	1975
		10	2,002			10	1992
		11	2,015		10	26	1979
		12	2,005			21	1984
Wells Project	Pateros	Sub-total	24,109	7 (0.03%)	63 (0.26%)	182 (0.75%)	23,857

Table 1 (Continued).

Tagging Study	Release Site	Release No.	Tagged	Morts.	Sacrificed	Tags shed	**Total Released**
Wells Dam	Tailrace	1	2,015	1	11	10	1993
		2	2,008	1		13	1994
		3	2,019	1	10	10	1998
		4	2,008			8	2000
		5	2,016	1	11	13	1991
		6	2,045			33	2012
		7	2,011		11	12	1988
		8	2,001			8	1993
		9	2,011		10	12	1989
		10	2,000	2		9	1989
		11	2,013		10	14	1989
		12	2,011	1		21	1989
Wells Project	Tailrace	Sub-total	24,158	7 (0.03%)	63 (0.26%)	163 (0.67%)	23,925
Wells Project	**Survival Study**	**Grand Total**	**48,267**	**14** (0.03%)	**126** (0.26%)	**345** (0.71%)	**47,782**

4.4 Physiological Monitoring

Measures of smolt morphology, smolt readiness, indices of stress, fish condition and fish health were collected from six of the twelve PIT-tag release groups. These samples were collected from fish scheduled for release on April 24, 28 and May 2, 6, 10 and 14. Physiological samples of smolt status, fish health and stress levels were conducted to facilitate interpretation of variations in post-release behavior and survival within and between release groups of steelhead.

The mean fork length of PIT-tagged WFH steelhead sampled for physiological indices ranged from 198.7 to 207.7 mm (Table 2-A). A statistical analysis of mean fork length within and between replicate release pairings found no significant differences (one-way ANOVA, $p > 0.05$). This included comparisons between release locations, release days and control (untagged) versus treatment (tagged) fish. The mean weights of tagged steelhead ranged from 61.5 to 81.3 g. A statistical analysis of the differences between sample groups found no significant (one-way ANOVA, $p > 0.05$) differences between mean fish weights (Table 2-B). Mean condition factor ranged from 0.9605 to 0.8215 (Table 2-C). In general, fish condition declined during the course of the study. No significant differences ($p > 0.05$) in mean condition factor were detected within or between replicate release pairings.

Indices of fish health collected during the study included indices of smolt status, scale loss, fin condition, fat coverage of the mesenteries (fat index) and the color of the liver and bile duct. In general indices of fish health were typical of healthy fish. The mean smolt index for the tagged steelhead release groups ranged from 4.9 to 5.0. The smolt index remained consistently high throughout the six replicate release groups sampled. No trends in mean smolt indices were observed between replicates 1-12 (Table 2-D). Scale loss was nominal in all groups including the untagged physiological control group. Fin erosion was not observed to any measurable extent in any of the groups sampled. The mean fat index ranged from 2.6 to a maximum of 4.0. Mean fat indices decrease markedly during the May 14 sample. Fat coverage of the mesenteries (index) averaged 100% for sample groups released on April 28, May 2 and May 10. The lowest fat index recorded was collected from the May 14 Pateros release group. This release group had average fat coverage of the mesenteries of 70% with individual fish samples collected on that day ranging from 0% to 100% (Table 2-D). Color and size of internal organs was noted as normal for all groups sampled. In general, organ color and size was indicative of healthy pathogen free fish. The mean liver index varied only slightly over the course of the study with mean values ranging from 1.9 to 2.0. The mean bile index similarly remained high with values ranging from 2.7 to 3.0 (Table 2-D).

Blood plasma was collected for analysis of plasma glucose. Concentrations of glucose were utilized as an indicator of short and long-term stress. Plasma glucose concentrations ranged from 5.11 to 7.78 mMoles/L plasma (Table 3-A). A one-way ANOVA was used to determine whether there were significant differences within any of the 6 replicate release pairs sampled. The results indicated that the mean values for plasma glucose within replicate release pair 3 were significantly different ($p < 0.05$). In this pair, the Methow release group had higher indices of stress relative to the paired control release in the tailrace. Although the mean glucose values were significantly different, the differences were not sufficiently large enough to warrant concern regarding the resultant survival estimate for replicate 3. The remaining mean glucose values were not significantly ($p > 0.05$) different within individual replicate release pairs. In general, mean glucose concentrations for tagged fish declined slightly from the start to the end of the study.

As a secondary indicator of short-term handling stress, plasma cortisol concentrations were also collected from tagged and untagged steelhead. Concentrations of plasma cortisol during the 2000 study ranged from 112.45 to 329.46 ng cortisol/ml plasma for tagged steelhead (Table 3-B). The highest mean value was collected from Methow release replicate 7 and this value was significantly ($p < 0.05$) higher than all other sample means. The lowest mean cortisol value was collected from tailrace group 3. The sample mean for this one release group was nearly half that of the overall study sample mean. No significant differences ($p > 0.05$) were observed within replicate release pairings. No meaningful trends in mean cortisol values were observed over time.

Gill ATPase levels were measured to provide a quantitative comparison of smolt readiness. Values recorded for steelhead smolts ranged from 28.48 to 40.67 nmoles/mg protein/minute (Table 3-D). A comparison of mean ATPase values resulted in no significant differences ($p > 0.05$) within replicate release pairs used to estimate survival through Wells Dam. However, differences between individual release groups were significant. In general, gill ATPase values declined as the study progressed. The values observed in 2000 were similar to values observed in 1999 and comparable to values reported during past analyses conducted at the Wells Fish Hatchery.

Table 2. Lengths, Weights, Condition Factors and Health Indices for Wells Hatchery steelhead smolts, 2000.

A. Lengths.

Date	Sample Group	Release Group	Source	Release Site	Mean (mm)	S.D.	Min. (mm)	Max. (mm)	n
April 22	1	Control	Pre-tag	NA	199.6	18.7	172	240	12
April 22	2	Control	Pre-tag	NA	203.5	10.9	183	225	10
April 24	3	1	Tagged	Pateros	198.7	11.9	179	216	11
April 24	4	1	Tagged	tailrace	199.8	5.5	188	209	11
April 28	5	3	Tagged	Pateros	207.6	16.2	183	228	0
April 28	6	3	Tagged	tailrace	207.7	15.5	184	222	10
May 2	7	5	Tagged	Pateros	201.6	7.5	194	220	10
May 2	8	5	Tagged	tailrace	199.8	15.1	176	220	10
May 6	9	7	Tagged	Pateros	206.6	13.0	184	221	10
May 6	10	7	Tagged	tailrace	203.7	17.9	173	230	10
May 10	11	9	Tagged	Pateros	198.2	14.5	176	217	10
May 10	12	9	Tagged	tailrace	200.1	15.0	174	220	10
May 14	13	11	Tagged	Pateros	192.0	15.3	174	219	10
May 14	14	11	Tagged	tailrace	201.9	11.7	185	218	10

B. Weights.

Date	Sample Group	Release Group	Source	Release Site	Mean (mm)	S.D.	Min. (mm)	Max. (mm)	n
April 22	1	Control	Pre-tag	NA	75.31	22.8	45.0	131.6	12
April 22	2	Control	Pre-tag	NA	81.43	12.5	60.7	107.8	10
April 24	3	1	Tagged	Pateros	70.83	14.7	54.4	98.9	11
April 24	4	1	Tagged	tailrace	71.22	5.1	61.4	79.7	11
April 28	5	3	Tagged	Pateros	81.32	18.6	55.6	107.2	10
April 28	6	3	Tagged	tailrace	79.79	17.5	52.0	98.2	10
May 2	7	5	Tagged	Pateros	72.05	6.2	64.9	83.4	10
May 2	8	5	Tagged	tailrace	72.84	18.3	50.4	98.2	10
May 6	9	7	Tagged	Pateros	75.62	12.7	54.4	192.0	10
May 6	10	7	Tagged	tailrace	73.49	17.6	47.6	105.5	10
May 10	11	9	Tagged	Pateros	64.56	14.8	45.8	87.2	10
May 10	12	9	Tagged	tailrace	72.14	17.3	44.4	96.7	10
May 14	13	11	Tagged	Pateros	61.49	18.8	42.3	94.6	20
May 14	14	11	Tagged	tailrace	70.04	13.6	50.5	85.6	10

C. Condition Factor.

Date	Sample Group	Release Group	Source	Release Site	Mean (mm)	S.D.	Min. (mm)	Max. (mm)	n
April 22	1	Control	Pre-tag	NA	0.9235	0.0536	0.8359	1.0057	12
April 22	2	Control	Pre-tag	NA	0.9605	0.0347	0.8973	1.0147	10
April 24	3	1	Tagged	Pateros	0.8934	0.0786	0.7869	0.9994	11
April 24	4	1	Tagged	tailrace	0.8918	0.0273	0.8607	0.9353	11
April 28	5	3	Tagged	Pateros	0.8955	0.0505	0.8387	1.0113	10
April 28	6	3	Tagged	tailrace	0.8763	0.0310	0.8282	0.9222	10
May 2	7	5	Tagged	Pateros	0.8789	0.0407	0.7832	0.9237	10
May 2	8	5	Tagged	tailrace	0.8963	0.0476	0.8148	0.9881	10
May 6	9	7	Tagged	Pateros	0.8518	0.0477	0.7220	0.8910	10
May 6	10	7	Tagged	tailrace	0.8569	0.0348	0.8155	0.9193	10
May 10	11	9	Tagged	Pateros	0.8215	0.0915	0.5804	0.9179	10
May 10	12	9	Tagged	tailrace	0.8839	0.0407	0.8306	0.9581	10
May 14	13	11	Tagged	Pateros	0.8477	0.0580	0.7718	0.9789	10
May 14	14	11	Tagged	tailrace	0.8421	0.0728	0.7480	1.10138	10

D. Health indices.

Date	Sample Group	Release Group (Range)	Smolt Index (1-5)	Scale Index	Fin Index	Fat Index (1-4)	Liver Index	Bile Index	n
April 22	1	Control	5.0	0.083	0.083	3.5	2.0	2.7	12
April 22	2	Control	4.8	0.200	0.300	3.6	2.0	2.9	10
April 24	3	1	4.9	0.182	0.182	3.5	2.0	2.6	11
April 24	4	1	5.0	0.182	0.364	3.7	2.0	2.8	11
April 28	5	3	5.0	0.300	0.500	4.0	2.0	3.0	10
April 28	6	3	5.0	0.500	0.500	4.0	2.0	2.8	10
May 2	7	5	5.0	0.000	1.000	4.0	1.9	3.0	10
May 2	8	5	5.0	0.200	0.800	4.0	2.0	2.9	10
May 6	9	7	4.9	0.100	0.500	4.0	2.0	3.0	10
May 6	10	7	5.0	0.300	1.000	3.7	2.0	2.8	10
May 10	11	9	5.0	0.200	0.400	4.0	2.0	3.0	10
May 10	12	9	5.0	0.000	0.500	4.0	2.0	3.0	10
May 14	13	11	5.0	0.200	0.300	2.6	2.1	3.0	10
May 14	14	11	4.9	0.100	0.800	3.0	2.0	2.9	10

Table 3. Mean, standard error and sample size for physiological sampling of Wells Hatchery steelhead smolts, 2000.

A. Blood plasma glucose.

					Glucose (mMoles/L plasma)		
Date	Sample Group	Release Group	Source	Release Site	Mean (mm)	S.D.	n
April 22	1	Control	Pre-tag	NA	5.81	0.378	10
April 22	2	Control	Pre-tag	NA	5.90	0.276	10
April 24	3	1	Tagged	Pateros	6.62	0.411	10
April 24	4	1	Tagged	tailrace	7.27	0.562	10
April 28	5	3	Tagged	Pateros	7.78	0.368	10
April 28	6	3	Tagged	tailrace	5.66	0.234	10
May 2	7	5	Tagged	Pateros	5.90	0.399	10
May 2	8	5	Tagged	tailrace	6.86	0.274	10
May 6	9	7	Tagged	Pateros	7.03	0.452	9
May 6	10	7	Tagged	tailrace	6.19	0.324	10
May 10	11	9	Tagged	Pateros	5.74	0.460	10
May 10	12	9	Tagged	tailrace	5.11	0.644	10
May 14	13	11	Tagged	Pateros	5.86	0.334	10
May 14	14	11	Tagged	tailrace	6.37	0.449	10

B. Blood plasma cortisol.

					Cortisol (ng/ml plasma)		
Date	Sample Group	Release Group	Source	Release Site	Mean (mm)	S.D.	n
April 22	1	Control	Pre-tag	NA	222.57	16.217	10
April 22	2	Control	Pre-tag	NA	222.95	26.380	10
April 24	3	1	Tagged	Pateros	240.26	33.074	10
April 24	4	1	Tagged	tailrace	199.75	35.480	10
April 28	5	3	Tagged	Pateros	272.52	36.678	10
April 28	6	3	Tagged	tailrace	112.45	27.381	10
May 2	7	5	Tagged	Pateros	195.44	31.808	10
May 2	8	5	Tagged	tailrace	214.95	27.909	10
May 6	9	7	Tagged	Pateros	329.46	42.266	10
May 6	10	7	Tagged	tailrace	284.36	45.959	10
May 10	11	9	Tagged	Pateros	266.16	47.466	10
May 10	12	9	Tagged	tailrace	245.35	42.594	10
May 14	13	11	Tagged	Pateros	233.67	30.653	10
May 14	14	11	Tagged	tailrace	256.84	30.599	10

Table 3. (Continued).

C. Gill ATPase.

Date	Sample Group	Release Group	Source	Release Site	ATPase (nmoles/mg protein/min) Mean (mm)	S.D.	n
April 22	1	Control	Pre-tag	NA	32.83	3.083	10
April 22	2	Control	Pre-tag	NA	32.70	3.233	10
April 24	3	1	Tagged	Pateros	38.97	3.883	10
April 24	4	1	Tagged	tailrace	40.67	3.533	10
April 28	5	3	Tagged	Pateros	39.90	3.700	10
April 28	6	3	Tagged	tailrace	36.88	2.650	10
May 2	7	5	Tagged	Pateros	29.98	1.950	10
May 2	8	5	Tagged	tailrace	36.50	2.167	10
May 6	9	7	Tagged	Pateros	35.55	1.850	10
May 6	10	7	Tagged	tailrace	33.32	2.000	10
May 10	11	9	Tagged	Pateros	31.67	3.867	10
May 10	12	9	Tagged	tailrace	32.23	2.633	10
May 14	13	11	Tagged	Pateros	30.25	1.800	10
May 14	14	11	Tagged	tailrace	28.48	1.900	10

4.5 Estimates of Detection and Reach Survival Probabilities

Steelhead smolts released at Pateros and released into the Wells tailrace had the potential to be collected and passively interrogated at downstream PIT-tag detection facilities located at Rocky Reach, McNary, John Day, and Bonneville dams. A small number of additional fish were detected by the experimental PIT-tag trawl operated by the National Marine Fisheries Service and were pooled with the Bonneville Dam collections. Detection histories for barge-transported smolts were censored at the point of transportation. Release group specific detection histories are summarized in Table 4.

For simplicity, each tag group was given a two-part group identification code. The first part of the code denotes release locations (i.e., w = Wells tailrace, p = Pateros), and the second component, the sequential release number of the paired-release (i.e., 1, . . . , 12). For example, w03 denotes the third release from Wells tailrace. Subsequent analyses utilized all 12 replicate release pairs for estimating reach-specific survival and dam-specific detection probabilities.

Using the single-release model (Cormack 1964, Jolly 1965, Seber 1965), reach-specific survival was estimated for the following reaches:

1. Release location to the tailrace of Rocky Reach Dam (S_1).
2. Rocky Reach tailrace through to the tailrace of McNary Dam (S_2).
3. McNary tailrace through to the tailrace of John Day Dam (S_3).

Survival probabilities and associated standard errors for each group are reported in Table 5.

Table 4. Complete detection history for each release group. Counts of smolt by detection history for each release group used in the 2000 Wells steelhead survival study. The digit 1 denotes detected; 0, not detected; and 2, censored at Rocky Reach, McNary, John Day, and Bonneville dams. Detection histories reflect data downloaded from PTAGIS on July 18, 2000.

Release	1111	0111	1011	0011	1101	0101	1001	0001	1110	0110	1010	0010	1100	0100	1000	0000	1200	0200	Release Size
Pateros																			
p01	8	6	25	28	29	20	73	65	17	31	100	113	72	77	571	758	4	1	1998
p02	5	2	20	20	29	15	70	66	26	25	68	79	80	63	606	813	1	3	1991
p03	8	7	17	21	19	19	89	62	22	14	70	80	80	68	593	812	5	4	1990
p04	1	6	22	16	27	12	113	70	17	16	78	75	76	58	706	697	1	1	1992
p05	5	2	19	9	19	8	85	52	18	13	71	57	95	51	775	709	2	2	1992
p06	2	1	17	8	22	11	97	62	13	7	81	62	88	51	848	616	1	1	1988
p07	0	2	10	12	13	14	104	66	7	14	38	45	67	91	747	756	4	3	1993
p08	0	1	13	9	5	6	87	58	3	6	54	51	37	46	819	785	2	1	1983
p09	4	1	6	15	8	11	73	79	6	8	42	49	37	52	687	895	1	1	1975
p10	1	0	1	1	5	8	57	64	2	2	39	45	51	32	852	831	0	1	1992
p11	1	0	3	3	7	5	44	47	5	3	32	38	58	54	810	864	4	1	1979
p12	0	1	13	1	5	3	53	32	7	1	36	30	65	39	973	715	9	1	1984
Wells																			
w01	13	16	40	33	26	15	64	61	39	34	119	134	80	83	547	680	2	7	1993
w02	5	4	25	27	23	27	80	62	25	23	103	84	89	61	720	630	4	2	1994
w03	6	2	23	25	28	12	105	74	24	27	101	84	98	59	731	593	3	3	1998
w04	8	1	28	16	25	5	120	54	17	12	122	59	106	45	908	467	7	0	2000
w05	6	0	31	12	22	4	119	39	21	10	104	42	88	45	946	494	5	3	1991
w06	6	0	15	10	35	7	130	29	24	7	100	32	140	30	1103	338	5	1	2012
w07	0	2	15	12	21	12	107	51	17	5	55	44	108	50	942	546	1	0	1988
w08	1	0	7	5	10	5	142	39	5	3	70	35	51	11	1092	514	2	1	1993
w09	2	0	11	6	6	4	92	59	11	6	51	40	47	26	1009	619	0	0	1989
w10	0	1	6	2	8	4	76	52	6	4	50	31	53	38	931	724	1	2	1989
w11	1	0	3	5	4	6	57	52	6	7	46	37	59	49	909	733	3	4	1981
w12	0	0	1	2	9	10	83	29	7	4	44	28	79	41	1094	550	5	3	1989

Table 5. Cormack-Jolly-Seber (1964) estimates of survival and detection probabilities for each release group used in the 2000 Wells smolt survival study. The joint probability of recovery from John Day to Bonneville and being detected at Bonneville Dam (λ) is reported in the last column. Standard errors are reported in parentheses.

Release	Survival: Release to Rocky Reach	Survival: Rocky Reach to McNary	Survival: McNary to John Day	Probability of Detection at: Rocky Reach	Probability of Detection at: McNary	Probability of Detection at: John Day	Combined detection and survival (λ)
Pateros							
p01	0.918 (0.029)	0.661 (0.048)	1.030 (0.116)	0.490 (0.019)	0.219 (0.018)	0.264 (0.028)	0.204 (0.022)
p02	0.870 (0.029)	0.592 (0.045)	1.159 (0.155)	0.523 (0.021)	0.243 (0.021)	0.207 (0.027)	0.192 (0.025)
p03	0.856 (0.028)	0.674 (0.055)	0.957 (0.125)	0.530 (0.021)	0.214 (0.020)	0.219 (0.027)	0.222 (0.027)
p04	0.919 (0.028)	0.668 (0.059)	1.122 (0.164)	0.569 (0.020)	0.176 (0.018)	0.169 (0.023)	0.195 (0.026)
p05	0.884 (0.027)	0.662 (0.066)	0.949 (0.159)	0.618 (0.022)	0.184 (0.021)	0.176 (0.027)	0.180 (0.028)
p06	0.960 (0.029)	0.700 (0.076)	1.125 (0.218)	0.613 (0.021)	0.147 (0.018)	0.127 (0.022)	0.147 (0.026)
p07	1.002 (0.040)	0.681 (0.082)	0.872 (0.181)	0.496 (0.023)	0.158 (0.020)	0.109 (0.021)	0.188 (0.034)
p08	0.970 (0.042)	0.756 (0.146)	0.735 (0.190)	0.530 (0.026)	0.074 (0.015)	0.128 (0.025)	0.168 (0.032)
p09	0.971 (0.048)	0.527 (0.073)	0.983 (0.204)	0.450 (0.025)	0.128 (0.019)	0.132 (0.024)	0.198 (0.035)
p10	1.002 (0.052)	0.633 (0.134)	3.291 (1.966)	0.505 (0.028)	0.081 (0.018)	0.022 (0.013)	0.033 (0.019)
p11	0.965 (0.050)	0.626 (0.123)	1.122 (0.446)	0.505 (0.029)	0.115 (0.024)	0.064 (0.023)	0.082 (0.030)
p12	0.921 (0.038)	0.714 (0.155)	0.495 (0.152)	0.635 (0.028)	0.100 (0.023)	0.139 (0.033)	0.169 (0.040)
Weighted Average	0.925 (0.014)	0.652 (0.014)	1.027 (0.071)				
Mean				0.539 (0.017)	0.153 (0.016)	0.146 (0.019)	0.165 (0.016)
Wells							
w01	0.933 (0.026)	0.688 (0.042)	0.885 (0.077)	0.500 (0.018)	0.246 (0.018)	0.381 (0.030)	0.238 (0.021)
w02	0.980 (0.029)	0.603 (0.044)	1.046 (0.124)	0.550 (0.020)	0.223 (0.019)	0.241 (0.027)	0.206 (0.024)
w03	0.973 (0.026)	0.683 (0.052)	1.084 (0.139)	0.576 (0.019)	0.197 (0.018)	0.204 (0.024)	0.192 (0.023)
w04	0.968 (0.022)	0.781 (0.075)	0.848 (0.122)	0.693 (0.018)	0.150 (0.017)	0.206 (0.025)	0.202 (0.025)
w05	0.938 (0.022)	0.687 (0.068)	0.842 (0.125)	0.719 (0.019)	0.159 (0.018)	0.210 (0.027)	0.217 (0.027)
w06	0.972 (0.018)	0.640 (0.055)	1.165 (0.203)	0.797 (0.017)	0.204 (0.020)	0.134 (0.022)	0.160 (0.026)
w07	0.983 (0.028)	0.659 (0.072)	0.885 (0.165)	0.648 (0.021)	0.168 (0.020)	0.132 (0.023)	0.193 (0.032)
w08	0.930 (0.025)	0.624 (0.106)	1.756 (0.533)	0.744 (0.022)	0.077 (0.015)	0.062 (0.017)	0.103 (0.027)
w09	1.014 (0.039)	0.502 (0.078)	1.187 (0.296)	0.609 (0.026)	0.101 (0.018)	0.106 (0.023)	0.150 (0.032)
w10	0.950 (0.039)	0.631 (0.115)	1.391 (0.494)	0.599 (0.027)	0.098 (0.019)	0.060 (0.020)	0.090 (0.029)
w11	1.040 (0.049)	0.601 (0.109)	1.211 (0.428)	0.528 (0.027)	0.112 (0.021)	0.070 (0.023)	0.086 (0.027)
w12	1.006 (0.035)	0.546 (0.085)	3.540 (2.055)	0.661 (0.025)	0.145 (0.024)	0.022 (0.013)	0.035 (0.020)
Weighted Average	0.967 (0.008)	0.659 (0.018)	1.009 (0.081)				
Mean				0.635 (0.026)	0.157 (0.015)	0.152 (0.029)	0.165 (0.018)

The SRR model also provided capture probabilities (Table 5) for the following PIT-tag detector dams:

1. Rocky Reach Dam (p_1).
2. McNary Dam (p_2).
3. John Day Dam (p_3)

For the last reach between John Day and Bonneville Dams, only the joint product of survival and detection at Bonneville Dam (λ) could be estimated (Table 5).

In general, the capture probabilities in 2000 were substantially higher than those observed in 1998 and 1999 at Rocky Reach Dam. The mean capture probabilities in 2000 for steelhead were 0.587, 0.155, and 0.149 at Rocky Reach, McNary, and John Day dams, respectively.

4.6 Estimation of Survival Through the Wells Project

The analysis of Wells project survival consisted of three elements; (a) tests of assumptions, (b) model fitting, and (c) estimation of reach survival. These elements of the estimation of Wells project survival are provided below.

4.6.1 Tests of Assumptions

The Pateros and Wells tailrace releases of tagged Wells Fish Hatchery (WFH) steelhead were used to estimate survival through the Wells project. However, before reliable survival estimates can be derived, each PIT-tag release must fulfill various assumptions of the release-recapture models. Unlike Mid-Columbia paired and index survival studies of the 1980s, survival and capture probabilities can be independently estimated for each release group (Table 5). The ability to independently estimate parameters for each release of PIT-tagged steelhead allows for more robust estimation of project survival. Nevertheless, minimal model assumptions must be met and the best approach to estimating reach survival must be determined. The subsequent tests of assumptions assisted in the selection of the most appropriate approach for estimating reach survival.

Homogeneous Downstream Mixing of Release Groups

A convenient but not necessary condition for validly estimating reach survival is the downstream mixing of the Pateros and Wells tailrace releases within a paired release. One measure of mixing is the homogeneous arrival of smolts from the two releases at downstream detector dams (Appendix A). Table 6 summarizes the P-values for tests of homogeneous arrivals at Rocky Reach, McNary, John Day, and Bonneville dams. The release pairs generally had homogeneous arrival patterns at McNary, John Day, and Bonneville dams $(p > 0.10)$. Three of 36 chi-square tests (8.33%) at these dams were significant at $P \leq 0.10$. However, all 12 paired-release groups showed significant non-mixing $(P \leq 0.10)$ when they arrived at Rocky Reach Dam, the first downstream dam with PIT-tag detectors. Inspection of the arrival plots (Appendix A) nevertheless suggests good mixing, with both releases within pairs showing very similar modes of arrival at detector dams.

In order to use the simple Ricker (1958) relative recovery estimates for the Wells survival estimates, detection and survival rates at and below Rocky Reach Dam must be equal. Burnham et al. (1987) Tests 1.T2-1.T4 were used to test this assumption of the simple Ricker model. Table 7 summarizes the P-values associated with the tests of significance, while Appendix B provides details of the analysis. Eight of the 12 pairs showed significant differences in detection and survival probabilities to Rocky Reach Dam. Five of the 24 tests (20.83%) showed significant differences in detection or survival rates at McNary or John Day Dam.

Likelihood ratio tests will ultimately be used to determine the most appropriate description for the mixing of the individual releases within a paired-release.

Burnham et al. (1987) Test 2: Upstream Detections Do Not Affect Downstream Survival and /or Detection

To validate estimation of smolt survival using the SRR model, upstream detection history of alive fish should have no affect on downstream detection and survival probabilities of test fish. Test 2.2 tests whether the detections at Rocky Reach affected downstream capture histories at McNary, John Day, or Bonneville dams. Test 2.3 tests whether detections at Rocky Reach or McNary had no effect on downstream captures at John Day or Bonneville dams. Of the overall Test 2 results, 4 of the 24 release groups (16.7%) were significant at $\alpha = 0.10$ (Table 8). However, after adjustment for an experimental-wise error rare of $\alpha_{EX} = 0.10$ ($\alpha_{TW} = 0.0043$), only one of the Test 2 results was significant (i.e., release p07). In addition, details of the 2.2 and 2.3 tests showed no consistent pattern of violating model assumptions across release groups (Appendix B).

Burnham et al. (1987) Test 3: Upstream Detections Do Not Affect Downstream Survival and/or Detection

Another series of tests developed by Burnham et al. (1987) also tests whether upstream detection histories affect downstream detection or survival. Test 3.1 tests whether detection at Rocky Reach affects detection histories at John Day or Bonneville dams (Table 8). Test 3.2 tests whether detections at Rocky Reach and McNary affect detection histories at Bonneville Dam. Four of 48 Tests 3.1 and 3.2 were significant at $P \leq 0.10$ (8.33%). None of 48 individual tests were significant after adjustment for an experimental-wise error rate of $\alpha_{EX} = 0.10$ ($\alpha_{TW} = 0.0022$). Three of 24 (12.5%) overall Burnham Tests 3's were significant at $P \leq 0.10$. Details of the 3.1 and 3.2 tests can be found in Appendix B.

Tests of Handling Effects at Rocky Reach and Rock Island Dams

In 2000, smolts passing through the bypass systems at Rocky Reach and Rock Island dams were collected and anesthetized for potential tagging as part of the Chelan PUD smolt survival studies. During the 2000 study, 3,400 PIT-tagged steelhead smolts released upstream of Rocky Reach, as part of the Douglas PUD smolt survival study, were intercepted and anesthetized a second time at Rocky Reach. At Rock Island, the number of smolts intercepted was 1,471. Chi-square contingency table tests were used to assess whether this second handling affected downstream detection and survival probabilities (Table 8). During the 2000 survival study, four of 24 (16.77%) of the release groups showed significant differences $(P < 0.10)$ between handled and non-handled smolts at Rocky Reach Dam. Two of 24 (8.3%) of the release groups showed significant differences ($(P < 0.10)$ between handled and non-handled smolts at Rock Island Dam. After an adjustment to an experimental-wise error rate of $\alpha_{EX} = 0.10$ ($\alpha_{TW} = 0.0044$), none of the tests at either site were significant. For this reason, all smolts regardless of detection histories at Rocky Reach and Rock Island dams were included in the reach survival estimates.

Table 6. Results (i.e., P-values) of chi-square tests of mixing for Pateros and Wells release groups based on arrival timing at Rocky Reach, McNary, John Day, and Bonneville dams.

Release Pair	P-value			
	Rocky Reach	McNary	John Day	Bonneville
p01 & w01	0.0017	0.2767	0.8423	0.6322
p02 & w02	< 0.0001	0.8183	0.5495	0.9230
p03 & w03	< 0.0001	0.6345	0.6766	0.5480
p04 & w04	< 0.0001	0.7322	0.0853	0.9916
p05 & w05	< 0.0001	0.1969	0.8549	0.8295
p06 & w06	< 0.0001	0.5779	0.5733	0.5362
p07 & w07	< 0.0001	0.2748	0.4184	0.1516
p08 & w08	< 0.0001	0.4310	0.3385	0.1562
p09 & w09	< 0.0001	0.8281	0.0362	0.9785
p10 & w10	< 0.0001	0.4934	0.6167	0.1611
p11 & w11	< 0.0001	0.5560	0.6648	0.0788
p12 & w12	< 0.0001	0.1203	0.9758	0.4009

Table 7. Results (i.e., P-values) of Burnham et al. (1987) Test 1.T2, 1.T3 and 1.T4 for equal detection and survival probabilities at downriver detection sites for the Pateros and Wells tailrace releases.

Release Group	P-value		
	Rocky Reach (1.T2)	McNary (1.T3)	John Day (1.T4)
p01 & w01	0.373	0.597	0.004
p02 & w02	0.267	0.373	0.392
p03 & w03	0.074	0.276	0.738
p04 & w04	< 0.001	0.949	0.120
p05 & w05	< 0.001	0.089	0.852
p06 & w06	< 0.001	0.021	0.889
p07 & w07	< 0.001	0.880	0.260
p08 & w08	< 0.001	0.115	0.068
p09 & w09	< 0.001	0.200	0.926
p10 & w10	0.057	0.648	0.862
p11 & w11	0.647	0.314	0.812
p12 & w12	0.774	0.756	0.079

Table 8. Results (i.e., P-values) of Burnham et al. (1987) Tests 2 and 3 for goodness-of-fit to the single release-recapture assumptions for the Pateros and Wells tailrace releases. Also included are the results (P-values) of tests for the effects of smolt handling at Rocky Reach and Rock Island dams.

Release	Burnham Tests						Handling Effects at	
	2.2	2.3	Overall 2	3.1	3.2	Overall 3	Rocky Reach	Rock Island
Pateros								
p01	0.530	0.068	0.203	0.114	0.474	0.207	0.159	0.283
p02	0.138	0.945	0.265	0.417	0.337	0.399	0.642	0.451
p03	0.056	0.848	0.122	0.810	0.507	0.771	0.960	0.879
p04	0.186	0.957	0.338	0.046	0.297	0.070	0.205	0.738
p05	0.395	0.531	0.522	0.771	0.598	0.809	0.930	0.716
p06	0.545	0.200	0.415	0.986	0.753	0.969	0.351	0.725
p07	0.001	0.377	0.002	0.471	0.501	0.558	0.928	0.720
p08	0.041	0.885	0.093	0.752	0.777	0.890	0.835	0.967
p09	0.637	0.480	0.706	0.413	0.162	0.238	0.017	0.544
p10	0.192	0.373	0.251	0.351	0.032	0.060	0.530	0.978
p11	0.452	0.998	0.662	0.712	0.829	0.894	0.187	0.987
p12	0.785	0.924	0.920	0.286	0.016	0.028	0.033	0.739
Wells								
w01	0.840	0.909	0.948	0.343	0.314	0.331	0.862	0.743
w02	0.847	0.097	0.380	0.401	0.601	0.569	0.067	0.806
w03	0.231	0.663	0.373	0.097	0.277	0.117	0.591	0.613
w04	0.452	0.957	0.661	0.120	0.295	0.145	0.778	0.344
w05	0.481	0.625	0.637	0.102	0.405	0.167	0.054	0.865
w06	0.062	0.744	0.129	0.608	0.226	0.403	0.622	0.916
w07	0.043	0.867	0.096	0.144	0.186	0.116	0.370	0.796
w08	0.038	0.962	0.088	0.366	0.816	0.662	0.819	0.040
w09	0.556	0.024	0.100	0.755	0.667	0.838	0.850	0.044
w10	0.776	0.683	0.879	0.626	0.597	0.726	0.575	0.723
w11	0.973	0.330	0.800	0.588	0.590	0.698	0.851	0.558
w12	0.082	0.876	0.170	0.300	0.680	0.561	0.251	0.924

4.6.2. Modeling the Paired-Releases

All model testing was conducted at a significance level of α = 0.10. Results of the model selection procedures for each of the 12 paired Pateros-Wells tailrace releases is summarized in Table 9. In 2 of the 12 paired releases, model parameters were homogeneous beginning with the capture probabilities at Rocky Reach Dam (i.e., Model $M_{\underset{\sim}{S_1}}$, the most parsimonious model). Alternative models were selected for the 8 remaining replicate releases. The best model that described release-pairs 3, 4, 5, 6, 7, 8, 9, and 10 was Model $M_{\underset{\sim}{S_1},\underset{\sim}{p_1}}$ which allowed detection rates at Rocky Reach to vary between the treatment and control release groups. For release pairs 1 and 12, Model $M_{\underset{\sim}{S_1},\underset{\sim}{p_1},\underset{\sim}{S_2},\underset{\sim}{p_2},\underset{\sim}{S_3},\underset{\sim}{p_3}}$ was selected as the simplest model that was not significantly different from the Cormack-Jolly-Seber model.

4.6.3 Wells Project Survival Estimates

From the model selection process came the separate estimates of survival S_{11} and S_{21} for each release (Table 10) location to Rocky Reach Dam within a paired-release. The ratio of these separate estimates (Equation 1) provides the estimates of Wells project survival $\left(\hat{S}_W\right)$ from the mouth of the Methow River to Wells Dam tailrace (Table 11). The weighted average for survival from the 2000 study was $\hat{S}_W = 0.946$ (SE = 0.015) compared to a weighted average of $\hat{S}_W = 0.943$ (SE = 0.016) calculated from the 1999 investigations. A Z-test of the difference in the mean survival estimates for 2000 and 1999 was not significantly different at $P = 0.9636$.

Table 9. Forward-sequential model selection results for Pateros-Wells tailrace release pairs.

a. Release groups p01 & w01

Hypothesis	χ^2	Df	P-value
$p_1 \mid \underset{\sim}{S_1}, \underset{\sim}{S_2}, \underset{\sim}{p_2}, \underset{\sim}{S_3}, \underset{\sim}{p_3}, \underset{\sim}{\lambda}$	0.1349	1	0.7134
$M_{\underset{\sim}{S_1}}$ vs. CJS	16.4499	6	0.0115
$S_2 \mid \underset{\sim}{S_1}, \underset{\sim}{p_1}, \underset{\sim}{p_2}, \underset{\sim}{S_3}, \underset{\sim}{p_3}, \underset{\sim}{\lambda}$	0.1240	1	0.7248
$M_{\underset{\sim}{S_1}, \underset{\sim}{p_1}}$ vs. CJS	15.5743	5	0.0082
$p_2 \mid \underset{\sim}{S_1}, \underset{\sim}{p_1}, \underset{\sim}{S_2}, \underset{\sim}{S_3}, \underset{\sim}{p_3}, \underset{\sim}{\lambda}$	1.4873	1	0.2226
$M_{\underset{\sim}{S_1}, \underset{\sim}{p_1}, \underset{\sim}{S_2}}$ vs. CJS	11.3257	4	0.0231
$S_3 \mid \underset{\sim}{S_1}, \underset{\sim}{p_1}, \underset{\sim}{S_2}, \underset{\sim}{p_2}, \underset{\sim}{p_3}, \underset{\sim}{\lambda}$	1.0852	1	0.2975
$M_{\underset{\sim}{S_1}, \underset{\sim}{p_1}, \underset{\sim}{S_2}, \underset{\sim}{p_2}}$ vs. CJS	10.9868	3	0.0118
$p_3 \mid \underset{\sim}{S_1}, \underset{\sim}{p_1}, \underset{\sim}{S_2}, \underset{\sim}{p_2}, \underset{\sim}{S_3}, \underset{\sim}{\lambda}$	8.1047	1	0.0044
$M_{\underset{\sim}{S_1}, \underset{\sim}{p_1}, \underset{\sim}{S_2}, \underset{\sim}{p_2}, \underset{\sim}{S_3}, \underset{\sim}{p_3}}$ vs. CJS	1.1748	1	0.2784

b. Release groups p02 & w02

Hypothesis	χ^2	Df	P-value
$p_1 \mid \underset{\sim}{S_1}, \underset{\sim}{S_2}, \underset{\sim}{p_2}, \underset{\sim}{S_3}, \underset{\sim}{p_3}, \underset{\sim}{\lambda}$	0.8857	1	0.3466
$M_{\underset{\sim}{S_1}}$ vs. CJS	2.9435	6	0.8159

Table 9. (Continued)

c. Release groups p03 & w03

Hypothesis	χ^2	Df	P-value
$p_1 \mid \underset{\sim}{S_1}, \underset{\sim}{S_2}, \underset{\sim}{p_2}, \underset{\sim}{S_3}, \underset{\sim}{p_3}, \underset{\sim}{\lambda}$ [1]	2.6535	1	0.1033
$M_{\underset{\sim}{S_1}}$ vs. CJS	5.2953	6	0.5065
$S_2 \mid \underset{\sim}{S_1}, \underset{\sim}{p_1}, \underset{\sim}{p_2}, \underset{\sim}{S_3}, \underset{\sim}{p_3}, \underset{\sim}{\lambda}$	0.1368	1	0.7115
$M_{\underset{\sim}{S_1}, \underset{\sim}{p_1}}$ vs. CJS	1.9363	5	0.8579

Note: Model fit to the data were indicated by a "~" when the parameters were treated as a vector (i.e. different between releases within a pair). The notation indicates which parameter was tested for homogeneity given (i.e. " | ") the specification of the other model parameters.

d. Release groups p04 & w04

Hypothesis	χ^2	df	P-value
$p_1 \mid \underset{\sim}{S_1}, \underset{\sim}{S_2}, \underset{\sim}{p_2}, \underset{\sim}{S_3}, \underset{\sim}{p_3}, \underset{\sim}{\lambda}$	22.2913	1	2.34e-6
$S_2 \mid \underset{\sim}{S_1}, \underset{\sim}{p_1}, \underset{\sim}{p_2}, \underset{\sim}{S_3}, \underset{\sim}{p_3}, \underset{\sim}{\lambda}$	0.9292	1	0.3351
$M_{\underset{\sim}{S_1}, \underset{\sim}{p_1}}$ vs. CJS	3.7961	5	0.5791

[1] Though the P-value for this test is just above the 0.10 decision level set for this analysis, it was decided that due to earlier hypothesis testing (Tables 6 and 7) indicating that the detection rates at Rocky Reach were different for the two releases in the pairing and the P-value's proximity to the critical value, to investigate the next parameter.

Table 9. (Continued)

e. Release groups p05 & w05

Hypothesis	χ^2	df	P-value
$p_1 \mid \underset{\sim}{S_1}, \underset{\sim}{S_2}, \underset{\sim}{p_2}, \underset{\sim}{S_3}, \underset{\sim}{p_3}, \underset{\sim}{\lambda}$	12.1124	1	0.0005
$S_2 \mid \underset{\sim}{S_1}, \underset{\sim}{p_1}, \underset{\sim}{p_2}, \underset{\sim}{S_3}, \underset{\sim}{p_3}, \underset{\sim}{\lambda}$	0.0732	1	0.7868
$M_{\underset{\sim}{S_1}, \underset{\sim}{p_1}}$ vs. CJS	4.2561	5	0.5132

f. Release groups p06 & w06

Hypothesis	χ^2	df	P-value
$p_1 \mid \underset{\sim}{S_1}, \underset{\sim}{S_2}, \underset{\sim}{p_2}, \underset{\sim}{S_3}, \underset{\sim}{p_3}, \underset{\sim}{\lambda}$	55.6617	1	8.61e-14
$S_2 \mid \underset{\sim}{S_1}, \underset{\sim}{p_1}, \underset{\sim}{p_2}, \underset{\sim}{S_3}, \underset{\sim}{p_3}, \underset{\sim}{\lambda}$	0.5204	1	0.4707
$M_{\underset{\sim}{S_1}, \underset{\sim}{p_1}}$ vs. CJS	7.3333	5	0.1970

g. Release groups p07 & w07

Hypothesis	χ^2	df	P-value
$p_1 \mid \underset{\sim}{S_1}, \underset{\sim}{S_2}, \underset{\sim}{p_2}, \underset{\sim}{S_3}, \underset{\sim}{p_3}, \underset{\sim}{\lambda}$	32.5448	1	1.16e-8
$S_2 \mid \underset{\sim}{S_1}, \underset{\sim}{p_1}, \underset{\sim}{p_2}, \underset{\sim}{S_3}, \underset{\sim}{p_3}, \underset{\sim}{\lambda}$	0.0477	1	0.8271
$M_{\underset{\sim}{S_1}, \underset{\sim}{p_1}}$ vs. CJS	2.1774	5	0.8241

Table 9. (Continued)

h. Release groups p08 & w08

Hypothesis	χ^2	df	P-value
$p_1 \mid \underset{\sim}{S_1}, \underset{\sim}{S_2}, \underset{\sim}{p_2}, \underset{\sim}{S_3}, \underset{\sim}{p_3}, \underset{\sim}{\lambda}$	42.5987	1	6.72e-11
$S_2 \mid \underset{\sim}{S_1}, \underset{\sim}{p_1}, \underset{\sim}{p_2}, \underset{\sim}{S_3}, \underset{\sim}{p_3}, \underset{\sim}{\lambda}$	0.0202	1	0.8869
$M_{\underset{\sim}{S_1}, \underset{\sim}{p_1}}$ vs. CJS	7.3378	5	0.1967

i. Release groups p09 & w09

Hypothesis	χ^2	df	P-value
$p_1 \mid \underset{\sim}{S_1}, \underset{\sim}{S_2}, \underset{\sim}{p_2}, \underset{\sim}{S_3}, \underset{\sim}{p_3}, \underset{\sim}{\lambda}$	19.1822	1	1.1 e-5
$S_2 \mid \underset{\sim}{S_1}, \underset{\sim}{p_1}, \underset{\sim}{p_2}, \underset{\sim}{S_3}, \underset{\sim}{p_3}, \underset{\sim}{\lambda}$	0.0536	1	0.8169
$M_{\underset{\sim}{S_1}, \underset{\sim}{p_1}}$ vs. CJS	5.2118	5	0.3906

j. Release groups p10 & w10

Hypothesis	χ^2	df	P-value
$p_1 \mid \underset{\sim}{S_1}, \underset{\sim}{S_2}, \underset{\sim}{p_2}, \underset{\sim}{S_3}, \underset{\sim}{p_3}, \underset{\sim}{\lambda}$	5.8849	1	0.0153
$S_2 \mid \underset{\sim}{S_1}, \underset{\sim}{p_1}, \underset{\sim}{p_2}, \underset{\sim}{S_3}, \underset{\sim}{p_3}, \underset{\sim}{\lambda}$	0.4829	1	0.4871
$M_{\underset{\sim}{S_1}, \underset{\sim}{p_1}}$ vs. CJS	3.6299	5	0.6038

Table 9. (Continued)

k. Release groups p11 & w11

Hypothesis	χ^2	df	P-value
$p_1 \mid \underset{\sim}{S_1}, \underset{\sim}{S_2}, \underset{\sim}{p_2}, \underset{\sim}{S_3}, \underset{\sim}{p_3}, \underset{\sim}{\lambda}$	0.3430	1	0.5581
$M_{\underset{\sim}{S_1}}$ vs. CJS	1.9228	6	0.9267

l. Release groups p12 & w12

Hypothesis	χ^2	df	P-value
$p_1 \mid \underset{\sim}{S_1}, \underset{\sim}{S_2}, \underset{\sim}{p_2}, \underset{\sim}{S_3}, \underset{\sim}{p_3}, \underset{\sim}{\lambda}$	0.4628	1	0.4963
$M_{\underset{\sim}{S_1}}$ vs. CJS	15.1034	6	0.0195
$S_2 \mid \underset{\sim}{S_1}, \underset{\sim}{p_1}, \underset{\sim}{p_2}, \underset{\sim}{S_3}, \underset{\sim}{p_3}, \underset{\sim}{\lambda}$	1.0396	1	0.3079
$M_{\underset{\sim}{S_1}, \underset{\sim}{p_1}}$ vs. CJS	14.9756	5	0.0105
$p_2 \mid \underset{\sim}{S_1}, \underset{\sim}{p_1}, \underset{\sim}{S_2}, \underset{\sim}{S_3}, \underset{\sim}{p_3}, \underset{\sim}{\lambda}$	1.7256	1	0.1890
$M_{\underset{\sim}{S_1}, \underset{\sim}{p_1}, \underset{\sim}{S_2}}$ vs. CJS	14.4830	4	0.0059
$S_3 \mid \underset{\sim}{S_1}, \underset{\sim}{p_1}, \underset{\sim}{S_2}, \underset{\sim}{p_2}, \underset{\sim}{p_3}, \underset{\sim}{\lambda}$	12.2074	1	0.0005
$M_{\underset{\sim}{S_1}, \underset{\sim}{p_1}, \underset{\sim}{S_2}, \underset{\sim}{p_2}}$ vs. CJS	12.4118	1	0.0004
$p_3 \mid \underset{\sim}{S_1}, \underset{\sim}{p_1}, \underset{\sim}{S_2}, \underset{\sim}{p_2}, \underset{\sim}{S_3}, \underset{\sim}{\lambda}$	9.1978	1	0.0024
$M_{\underset{\sim}{S_1}, \underset{\sim}{p_1}, \underset{\sim}{S_2}, \underset{\sim}{p_2}, \underset{\sim}{S_3}, \underset{\sim}{p_3}}$ vs. CJS	0.4628	1	0.4963

Table 10. Estimates of survival, detection, and λ parameters for the best-fit paired-release models selected by stepwise-fitting procedures.

Population	Survival			Detection			Product of Capture/ Survival Below John Day
	to Rocky Reach	RR --> McNary	McN --> John Day	Rocky Reach	McNary	John Day	
p01	0.918 (0.029)	0.661 (0.048)	0.965 (0.089)	0.490 (0.019)	0.219 (0.018)	0.282 (0.023)	0.224 (0.015)
w01	0.933 (0.026)	0.688 (0.041)	0.921 (0.068)	0.500 (0.018)	0.246 (0.017)	0.366 (0.025)	
p02	0.858 (0.023)	0.614 (0.029)	1.000 (<0.001)	0.537 (0.014)	0.226 (0.013)	0.240 (0.013)	0.213 (0.012)
w02	0.992 (0.024)						
p03	0.854 (0.023)	0.684 (0.033)	1.000 (<0.001)	0.531 (0.011)	0.204 (0.012)	0.214 (0.012)	0.208 (0.012)
w03	0.975 (0.023)			0.575 (0.018)			
p04	0.918 (0.024)	0.720 (0.047)	0.977 (0.100)	0.569 (0.019)	0.163 (0.012)	0.187 (0.017)	0.198 (0.018)
w04	0.968 (0.020)			0.692 (0.018)			
p05	0.880 (0.024)	0.677 (0.047)	0.885 (0.092)	0.621 (0.020)	0.171 (0.013)	0.194 (0.019)	0.200 (0.019)
w05	0.941 (0.021)			0.717 (0.018)			
p06	0.947 (0.024)	0.694 (0.042)	1.000 (<0.001)	0.621 (0.019)	0.169 (0.012)	0.145 (0.011)	0.170 (0.012)
w06	0.977 (0.017)			0.793 (0.017)			
p07	0.990 (0.031)	0.670 (0.054)	0.879 (0.122)	0.502 (0.019)	0.163 (0.014)	0.120 (0.015)	0.191 (0.024)
w07	0.989 (0.026)			0.644 (0.020)			
p08	0.955 (0.035)	0.719 (0.071)	1.000 (<0.001)	0.539 (0.023)	0.072 (0.009)	0.097 (0.011)	0.144 (0.015)
w08	0.936 (0.025)			0.740 (0.021)			
p09	1.014 (0.044)	0.508 (0.052)	1.072 (0.171)	0.431 (0.022)	0.114 (0.031)	0.119 (0.017)	0.174 (0.024)
w09	0.992 (0.033)			0.623 (0.023)			
p10	0.968 (0.041)	0.749 (0.095)	1.000 (<0.001)	0.523 (0.025)	0.076 (0.011)	0.066 (0.009)	0.099 (0.013)
w10	0.973 (0.038)			0.584 (0.025)			
p11	0.946 (0.036)	0.614 (0.082)	1.165 (0.308)	0.517 (0.020)	0.114 (0.016)	0.067 (0.016)	0.084 (0.020)
w11	1.058 (0.039)						
p12	0.921 (0.038)	0.714 (0.155)	0.495 (0.152)	0.635 (0.028)	0.100 (0.029)	0.139 (0.033)	0.169 (0.040)
w12	1.006 (0.035)	0.546 (0.085)	3.540 (2.029)	0.661 (0.025)	0.145 (0.024)	0.022 (0.013)	0.035 (0.020)

Table 11. Replicate estimates of Wells Project survival ($\hat{S}_W$) from Pateros to Wells Dam tailrace based on the best parsimonious model selected for each paired-release using the stepwise-fitting procedure. Weighted average and standard error based on Equations (4 -6).

Release Groups	$\left(\hat{S}_W\right)$
p01/w01	0.984 (0.041)
p02/w02	0.865 (0.031)
p03/w03	0.876 (0.031)
p04/w04	0.948 (0.032)
p05/w05	0.935 (0.033)
p06/w06	0.969 (0.030)
p07/w07	1.001 (0.041)
p08/w08	1.020 (0.046)
p09/w09	1.022 (0.056)
p10/w10	0.995 (0.057)
p11/w11	0.894 (0.047)
p12/w12	0.916 (0.049)
Weighted Average	0.946 (0.015)

5.0 DISCUSSION

5.1 Fish Collection

In total, 49,560 steelhead were collected for tagging on twelve separate occasions during the 2000 survival study. The volitional collection and handling of hatchery steelhead in 2000 took place without measurable impact upon the study animals. The use of a 20 cm Aqualite harvester, a 2,000 L fish transportation container and short distances to move fish helped to maintain fish health at optimum levels throughout the collection phase of the study.

5.2 Tagging and Holding

Of the 49,560 steelhead collected at the Wells Fish Hatchery, 1,293 steelhead smolts were not tagged. The majority of these fish were in excess of the number of fish needed for the study. Exactly 607 (1.2%) of the total number of fish collected were not tagged because they displayed outward signs of disease, serious injury, residualism, precocity or grotesque growth abnormalities. The remaining 48,267 steelhead were tagged and randomly assigned to either the Pateros or the tailrace release groups.

In order to assess project related survival with the paired release-recapture technique it is important that the collection, tagging and pre-release conditions experienced by the study groups are closely matched. Two metrics used to compare handling effects are the number of mortalities and the number of shed tags collected from the treatment and control groups. During the holding phase of the study, pre-release mortality was closely matched with 7 Pateros and 7 tailrace mortalities observed. Rates of tag shed were also similar between the Pateros (0.76%) and tailrace (0.73%) release pairs.

Twelve replicate pairs of fish were successfully held and paired for use in estimating survival through Wells Dam. After accounting for mortality, tag shed and fish sacrificed for physiological assessment, the study goal of releasing a minimum of 20,000 steelhead at each of the two release locations was achieved with a total of 23,857 fish released at Pateros and 23,925 fish released into the Wells tailrace.

5.3 Transportation and Release

In order to isolate survival of the project from handling effects, it is important to minimize differences resulting from transportation and release techniques. Performance standards were established to ensure consistency within and between replicate release groups. Performance standards included loading and unloading times and techniques, travel times and road conditions and water quality parameters. Real-time monitoring and adjustment was used to ensure that the performance standards were achieved.

Transport times totaled less than one hour from tagging sites to release locations for all twelve release groups. Recovery and transport times remained constant within and between release groups. Transportation, loading and travel conditions (water temperature, travel time, dissolved oxygen concentrations and final fish condition) were closely matched between the Pateros and tailrace release pairs. The use of specially designed release containers, on-board oxygen supply systems and short distances to release sites helped to ensure that fish condition, upon arrival, was comparable for all twenty-four release groups. No changes to the loading, transportation or release are required for future PIT-tag survival studies utilizing the Methow and tailrace release sites.

5.4 Physiological Monitoring

Physiological monitoring provided a comparative index of fish health and stress between treatment and control release groups and provided a robust comparison of physiological indices between tagged and untagged fish. The collection of detailed physiological indices was used to verify that subtle differences in handling (stress) and fish condition did not interfere with the assessment of project survival at Wells Dam.

Variability <u>within</u> replicate release pairs (e.g. fish health, smolt condition and stress levels) had the potential to bias estimates of survival through Wells Dam. By measuring physiological parameters, a more accurate description of actual project effects could be developed. For example, large differences in fish health or fish handling within a replicate pair could result in biased project survival estimates.

Variability in fish health, condition and fish handling <u>between</u> replicate releases would not result in biased estimates of survival through the dam but could complicate the interpretation of the resultant survival estimates. For example, differences in fish health between replicate pairs might correlate with unrelated changes in river operation. Without measuring the physiological differences between replicate release groups, one could improperly conclude that river operations resulted in the observed fish survival response, when in fact fish health and morphology might be the overriding survival variable.

To address concerns related to the variability within and between release pairs, statistical comparisons of fish physiology and morphology were conducted. To provide this information, 126 tagged steelhead and 20 untagged steelhead were sacrificed and sampled prior to release.

In general, no significant differences were observed between tagged and untagged steelhead. This included indices of morphology, health, condition and stress. No relevant differences in health, condition and stress were observed within replicate release pairs sampled (Methow versus tailrace). Based on the 6 replicates (12 release groups) and two control groups studied, PIT-tagged Wells Hatchery steelhead smolts were approximate surrogates for untagged steelhead smolts migrating past Wells Dam in 2000. Significant differences in fish health, fish condition and smolt readiness were lacking within replicate pairs. Trends in estimated fish survival, over time, did not appear to be related to fish condition, fish health or fish handling indices.

The range of plasma glucose values observed during 2000 for PIT-tagged steelhead smolts were similar to literature values for chinook smolts following short-term handling stress and were only slightly higher than literature values for fish at rest (3.17 to 6.67 mMoles/L plasma) (Barton et al., 1986; Maule et al., 1988). The concentrations of glucose found in the blood of WFH steelhead smolts after capture, PIT-tagging and holding for 48-hours were similar to fish sampled prior to PIT-tagging and were similar to fish exposed to short-term handling during other studies (e.g. juvenile coho - Iwama et al., 1995; juvenile chinook - Barton et al., 1986). Typically, plasma glucose concentrations increase rapidly following a short-term stress. In the absence of additional stress plasma glucose concentrations are expected to return to resting values within 24-hours of the stress event (Iwama et al., 1995; Barton et al., 1986; Groot et al., 1995).

Plasma cortisol values in the 100 to 250 ng/ml plasma range are typical of fish, including steelhead smolts, exposed to short-term handling and transport stress. The majority of the samples collected during the 2000 survival study fell within this range of values. The highest reading measured during the survival study was 329 ng/ml plasma well short of the stress levels observed by researchers conducting laboratory experiments. Values as high as 500 ng/ml have been reported for steelhead smolts following severe confinement (Barton and Iwama, 1991). The concentrations of cortisol found in blood plasma samples collected from tagged and untagged steelhead smolts were similar to one another and contained no observable trend over time. In only a few cases were sample means from fish tagged during the 2000 survival study in excess of 250 ng/ml plasma.

Compared to literature values, gill ATPase values from all of the steelhead sampled in 2000 were low compared to values for smolts prepared for salt-water entry. Similar observations were made during the 1999 steelhead survival study (Bickford et al., 2000). Weitkamp and Loeppke (1983) reported values in the 387 to 602 nmoles/mg protein/minute range for Upper Columbia River steelhead smolts collected downstream of Wells Dam at Priest Rapids and McNary dams. It is common for the ATPase values from inland stocks of salmonids to be low at the start of migration. In contrast, ATPase values for coastal stocks that encounter saltwater shortly after migration typically exhibit much higher ATPase values at the onset of migration (Ewing et al., 1980).

5.5 Estimation of Detection and Reach Survival Probabilities

Mean detection probabilities for all 12 Douglas PUD release groups averaged 0.587 at Rocky Reach, 0.155 at McNary and 0.149 at John Day dams. Mean detection probabilities for Wells steelhead released in 1999 were 0.250, 0.198, and 0.358 at Rocky Reach, McNary, and John Days dams, respectively (Bickford et al., 2000a). Mean detection probabilities for yearling chinook in 1998 were 0.098, 0.111, and 0.118 at Rocky Reach, McNary, and John Day dams, respectively (Bickford et al., 1999). The doubling of steelhead detection rates at Rocky Reach between 1999 and 2000 stemmed from technical improvements in PIT-tag interrogation capabilities rather than differences in operation of the bypass facility.

Estimated reach survival from the mouth of the Methow River to the Rocky Reach tailrace averaged 0.907 ($\hat{SE}$ = 0.018) in 1999 and 0.925 ($\hat{SE}$ = 0.14) during 2000. Estimated reach survival from the tailrace of Wells Dam to the tailrace of Rocky Reach averaged 0.959 ($\hat{SE}$ = 0.010) in 1999 and 0.967 ($\hat{SE}$ =0.008) during 2000. Estimated survival for 1998 yearling chinook migrating from the Methow to the Rocky Reach tailrace and from the Wells tailrace to the Rocky Reach tailrace averaged 0.943 ($\hat{SE}$ = 0.073) and 0.952 ($\hat{SE}$ = 0.066), respectively.

Survival downstream of Rocky Reach, as expected, was homogeneous between the two Douglas PUD release groups (p = 0.3070). Consequently, replicate reach survival estimates were pooled to provide more precise estimates of survival through the downstream river reaches. Estimated survival from the Rocky Reach tailrace to the McNary tailrace was precise and averaged 0.656 ($\hat{SE}$ = 0.011) for Douglas PUD tagged steelhead in 2000 [CI ($0.634 \leq S \leq 0.678$) = 0.95].

The reach survival estimates from the Rocky Reach tailrace to the McNary tailrace in 2000 for Wells summer steelhead was not significantly different ($p > 0.10$) from the estimates of survival for 1999 summer steelhead (0.686, $\hat{SE}$ = 0.010), 2000 yearling spring chinook (0.692, $\hat{SE}$ = 0.088), 1999 yearling spring chinook (0.727, $\hat{SE}$ = 0.053), 1998 yearling spring chinook (0.720, $\hat{SE}$ = 0.091), 1998 yearling Methow run-of-river chinook (0.720, $\hat{SE}$ = 0.084), 1998 yearling summer chinook (0.659, $\hat{SE}$ = 0.040), 2000 yearling summer chinook (0.731, $\hat{SE}$ = 0.063) and 2000 yearling coho (0.715, $\hat{SE}$ = 0.123) (Appendix C).

5.6 Estimation of Survival through the Wells Project

Individual estimates of survival for replicate releases of summer steelhead smolts migrating from the mouth of the Methow River to and through the tailrace of Wells Dam ranged from 0.865 (SE = 0.031) to 1.022 (SE = 0.056). Project survival (pool and dam) for yearling steelhead in 2000 averaged 0.946 with a standard error (SE) of 0.015 and a 95% CI of ± 2.9%. Wells project survival (pool and dam) for yearling steelhead in 1999 averaged 0.943 with a standard error (SE) of 0.016 and a 95% CI of ± 3.1%. Project survival (pool and dam) for yearling chinook in 1998 averaged 0.997 with a standard error (SE) of 0.015 and a 95% CI of ± 2.9%.

6.0 SUMMARY OF FINDINGS

For the third year in a row, Douglas PUD has produced precise estimates of survival for juvenile fish migrating through the Wells Hydroelectric Project. During the 2000 survival study, summer steelhead smolts migrating from the mouth of the Methow River mixed adequately with smolts released in the tailrace of Wells Dam. The weighted average estimate of summer steelhead survival in 1999 was 0.943 and in 2000 was 0.946. Precision for the 2000 Wells survival study was also high with a 95% CI of +/- 2.9%.

7.0 ACKNOWLEDGMENTS

The authors would like to thank the employees of Douglas PUD, Biomark, the University of Washington, School of Aquatic Sciences and Fisheries and LGL Limited for their time, effort and dedication to the 2000 survival study. Their efforts were entirely responsible for the successful completion of the study.

In particular we thank Jim McGee, Dick Weinstein and Wayne Marsh for their efforts during the study. We also appreciated the insight and encouragement provided by Rick Klinge and Bob Clubb. We thank the professional and technical staff at the Wells Hydroelectric Project, whose efforts and work ethic made the study logistically feasible. We thank the District line crews for their help at the barge loading sites. We also would like to thank the professional fish culture staff at the Wells Fish Hatchery for allowing the study team access to the crew facilities and hatchery equipment during the study. We also thank the Fish Passage Center, specifically Larry Basham, for once again providing PIT-tag information for yearling spring chinook released from the Winthrop National Fish Hatchery.

Finally we thank the fish and wildlife staff at Chelan County PUD for providing PIT-tag interrogation data and for their careful operation of the fish bypass system at Rocky Reach Dam.

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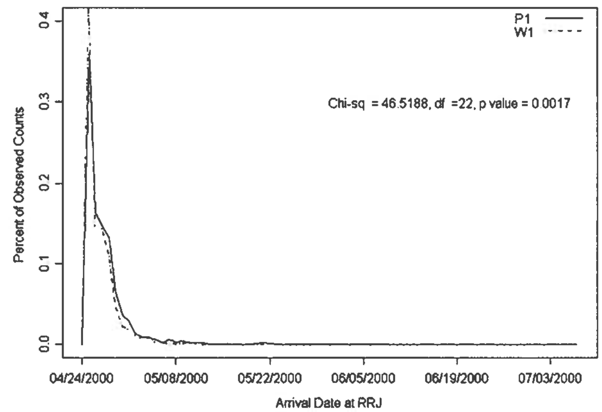
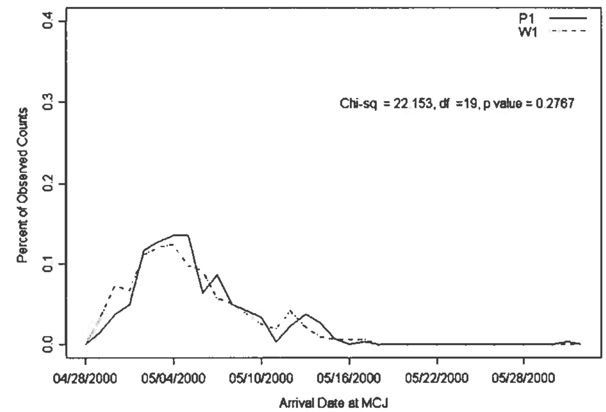
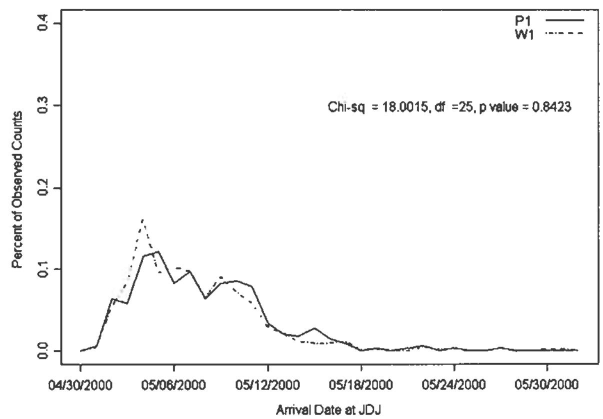
APPENDIX A

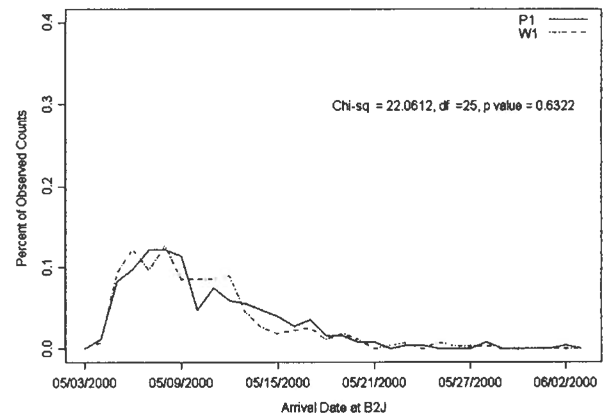
Graphics and chi-square tests of downstream detection trends for paired PIT-tag release groups.

Pair P01 and W01









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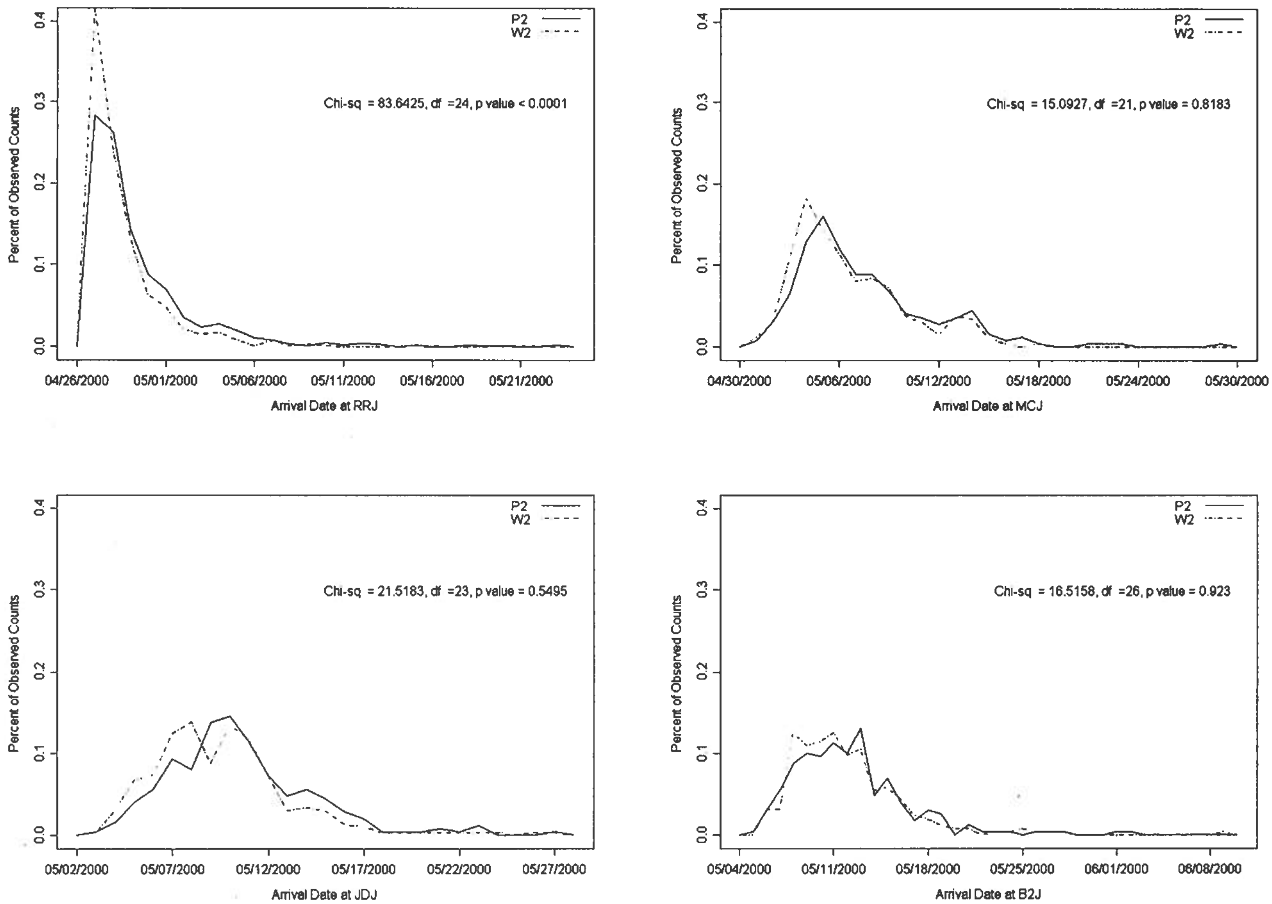

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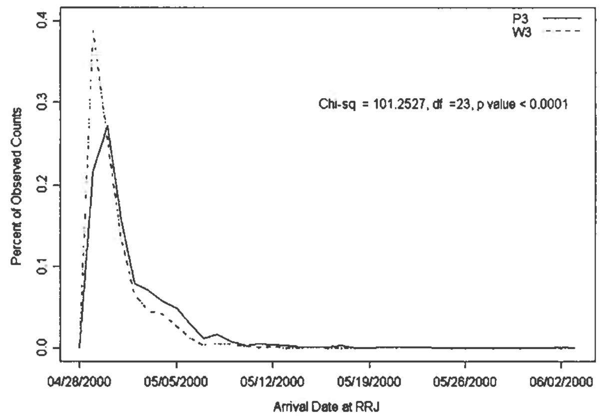

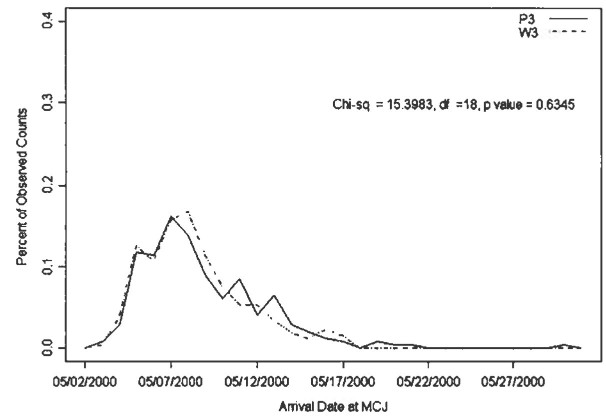

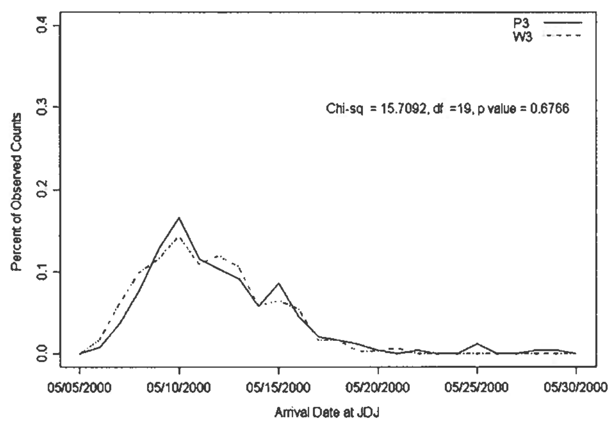

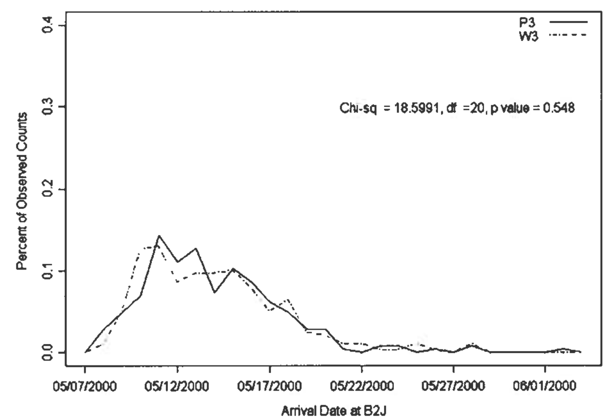

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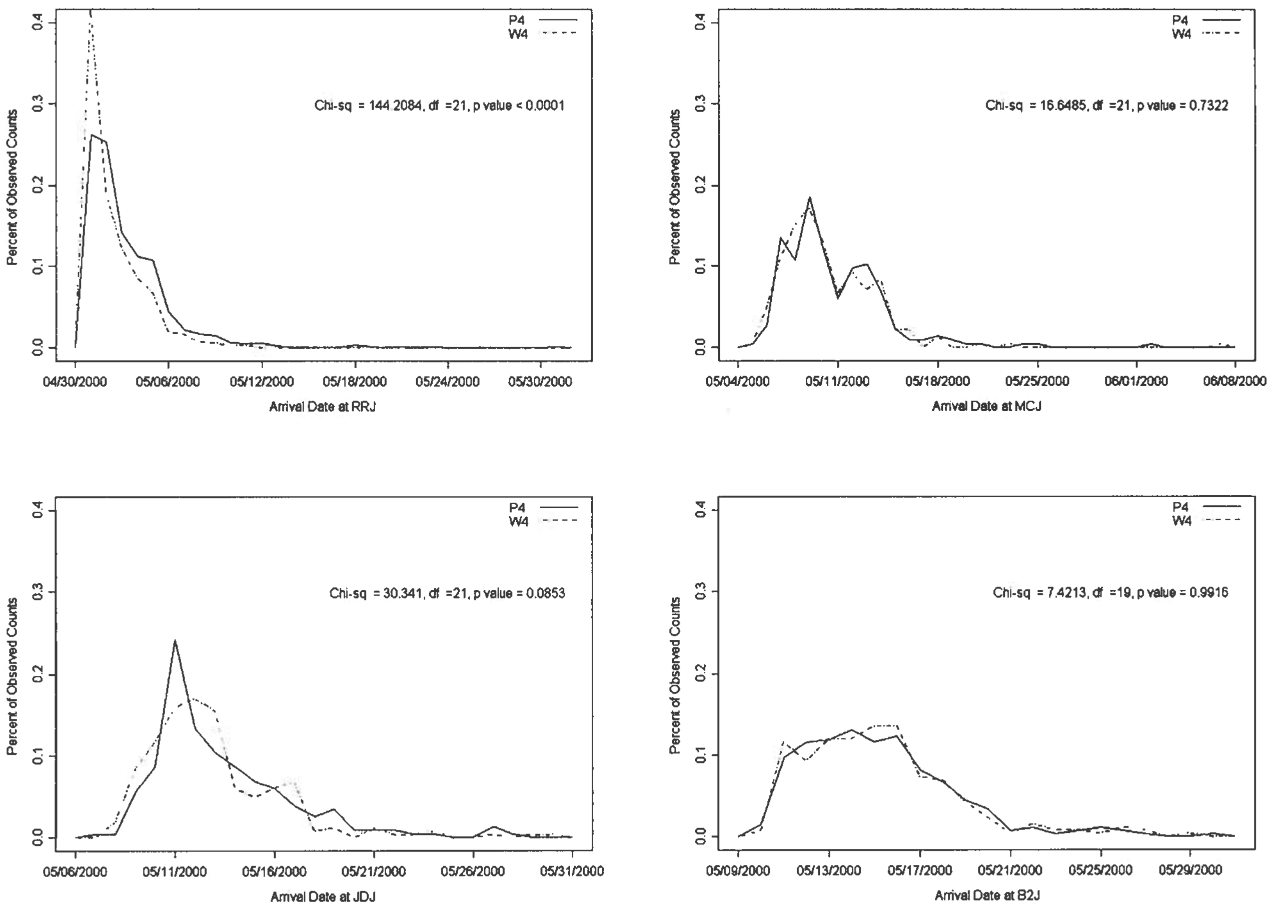

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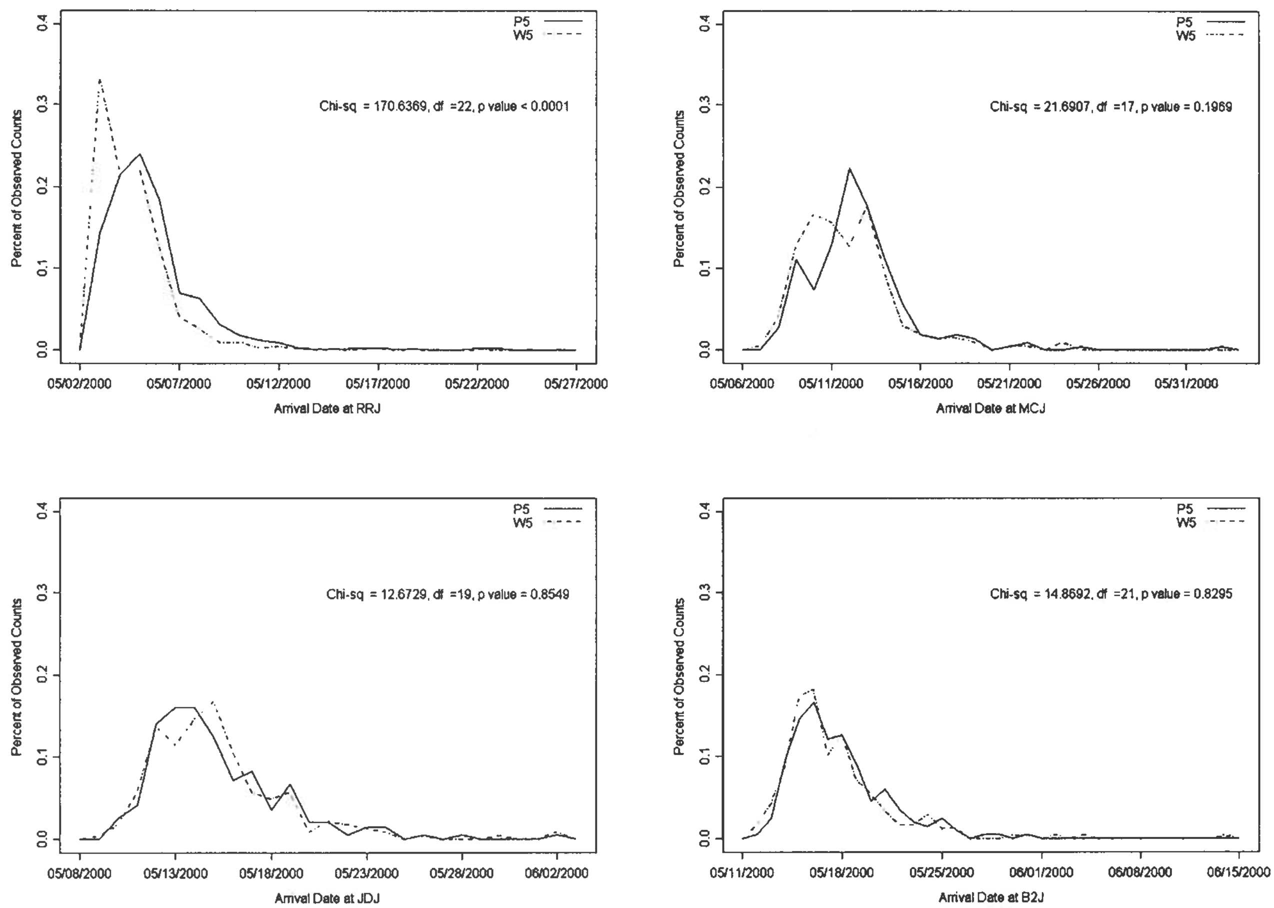

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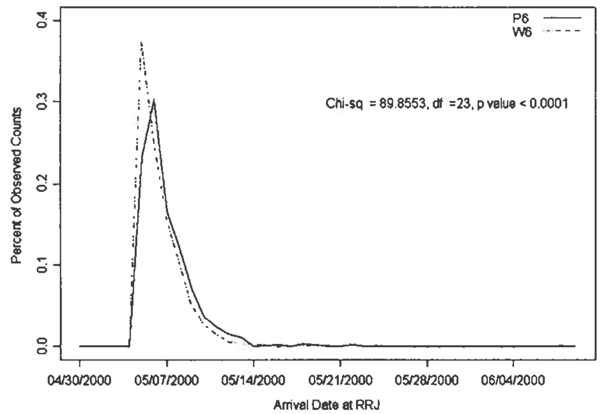

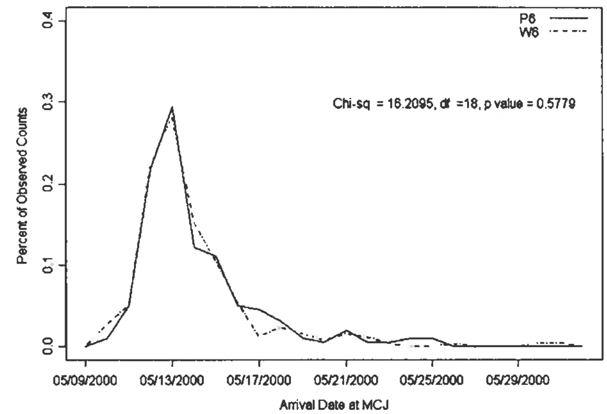

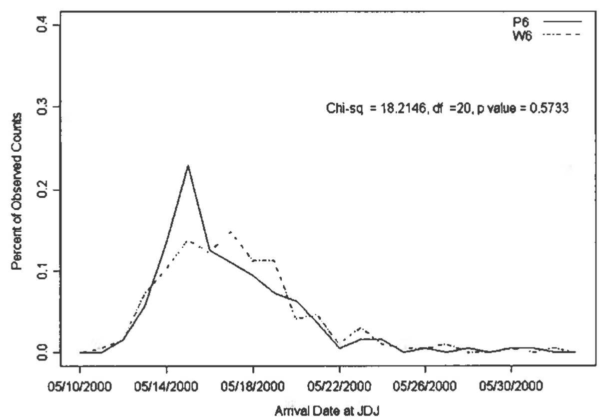

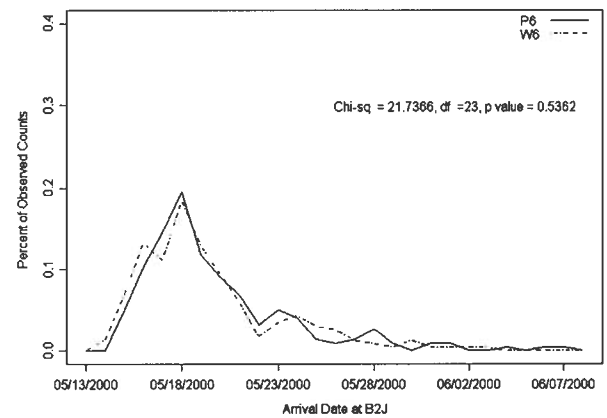

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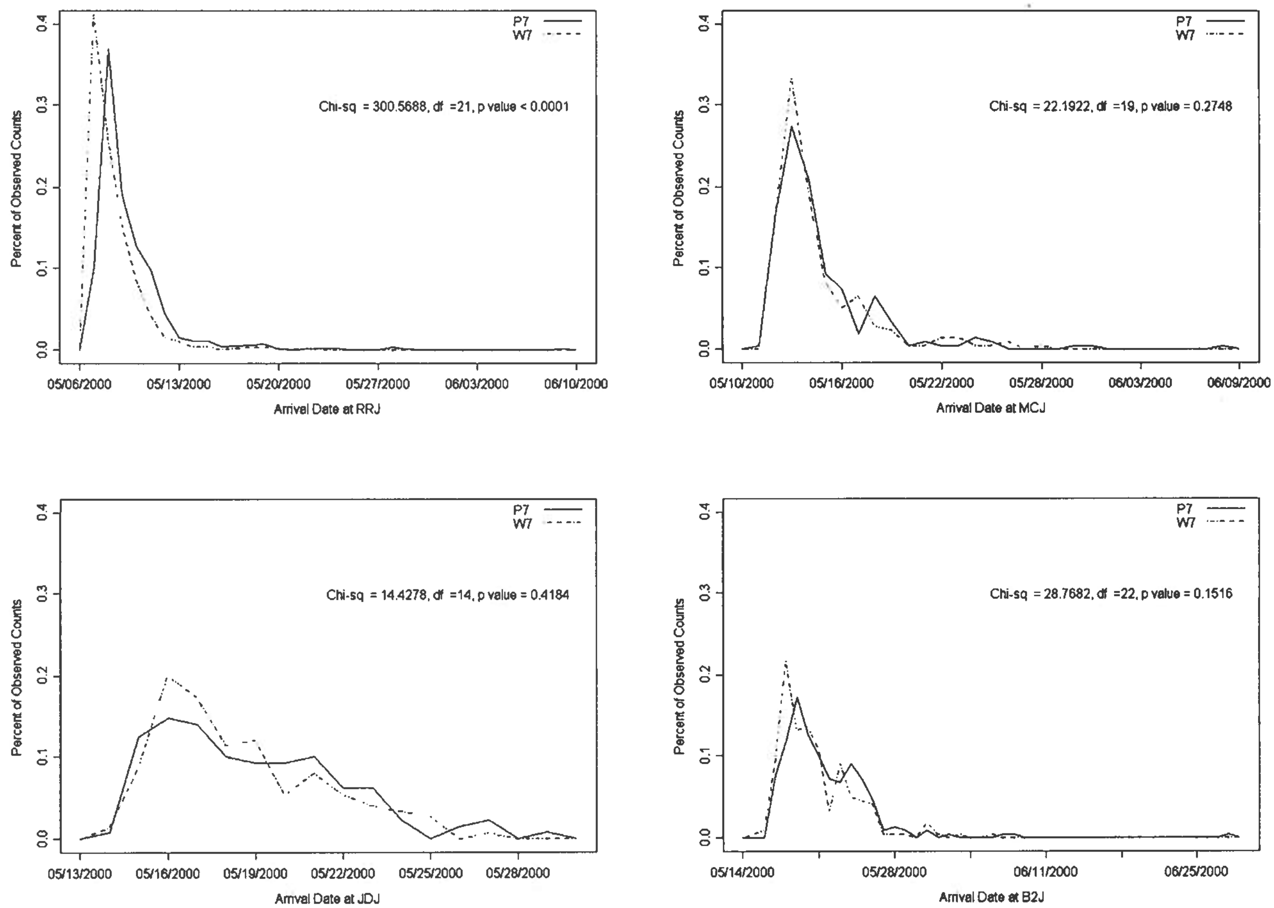

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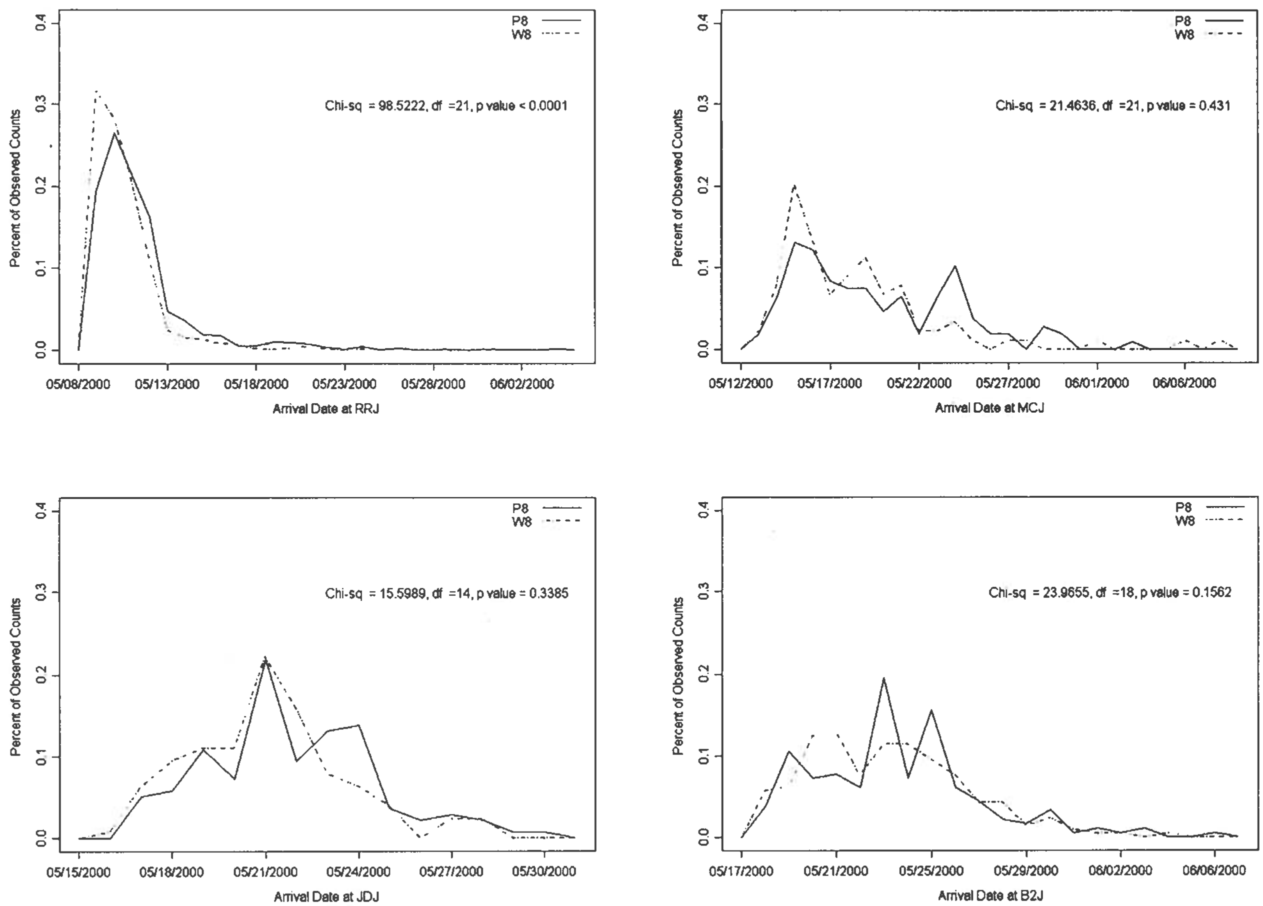

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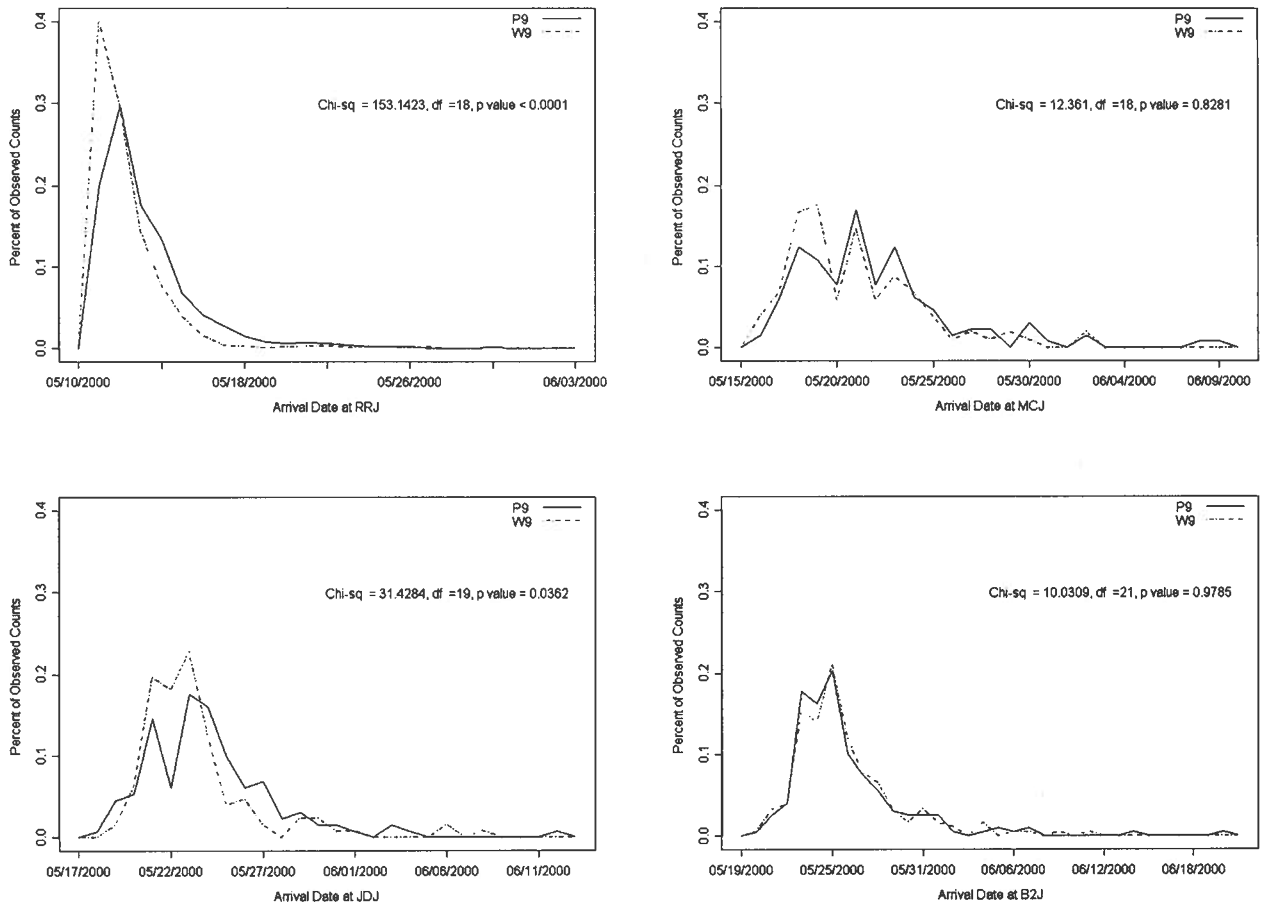
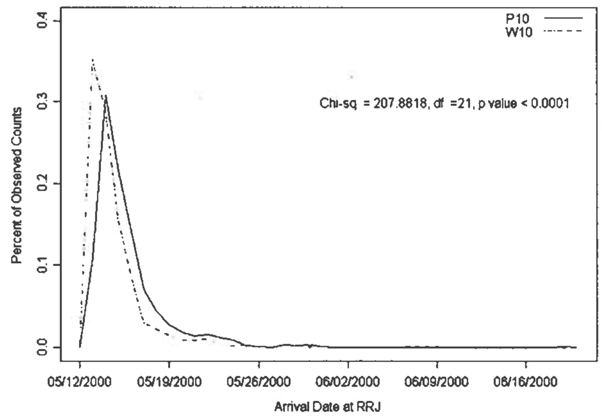
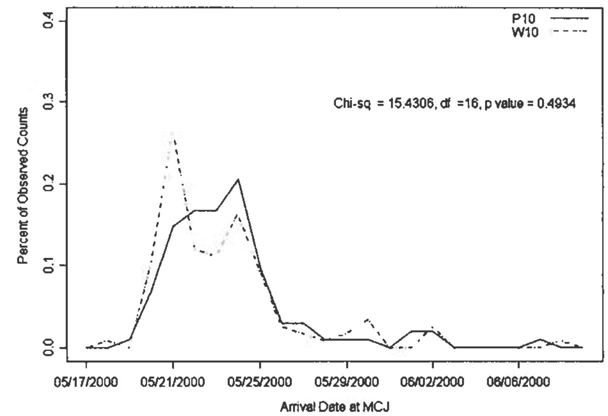
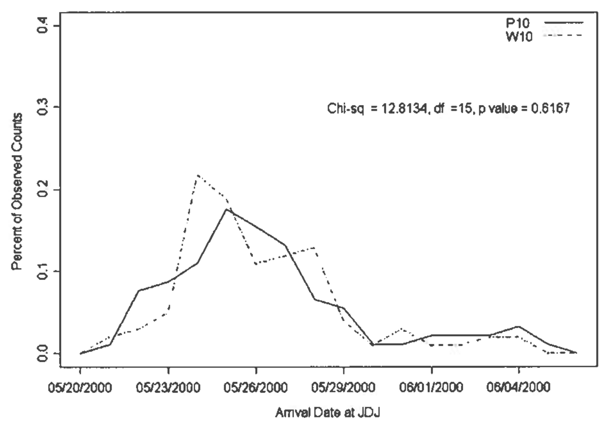
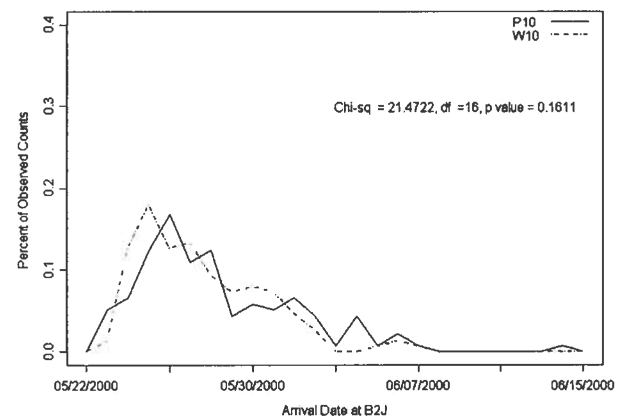


Pair P10 and W10

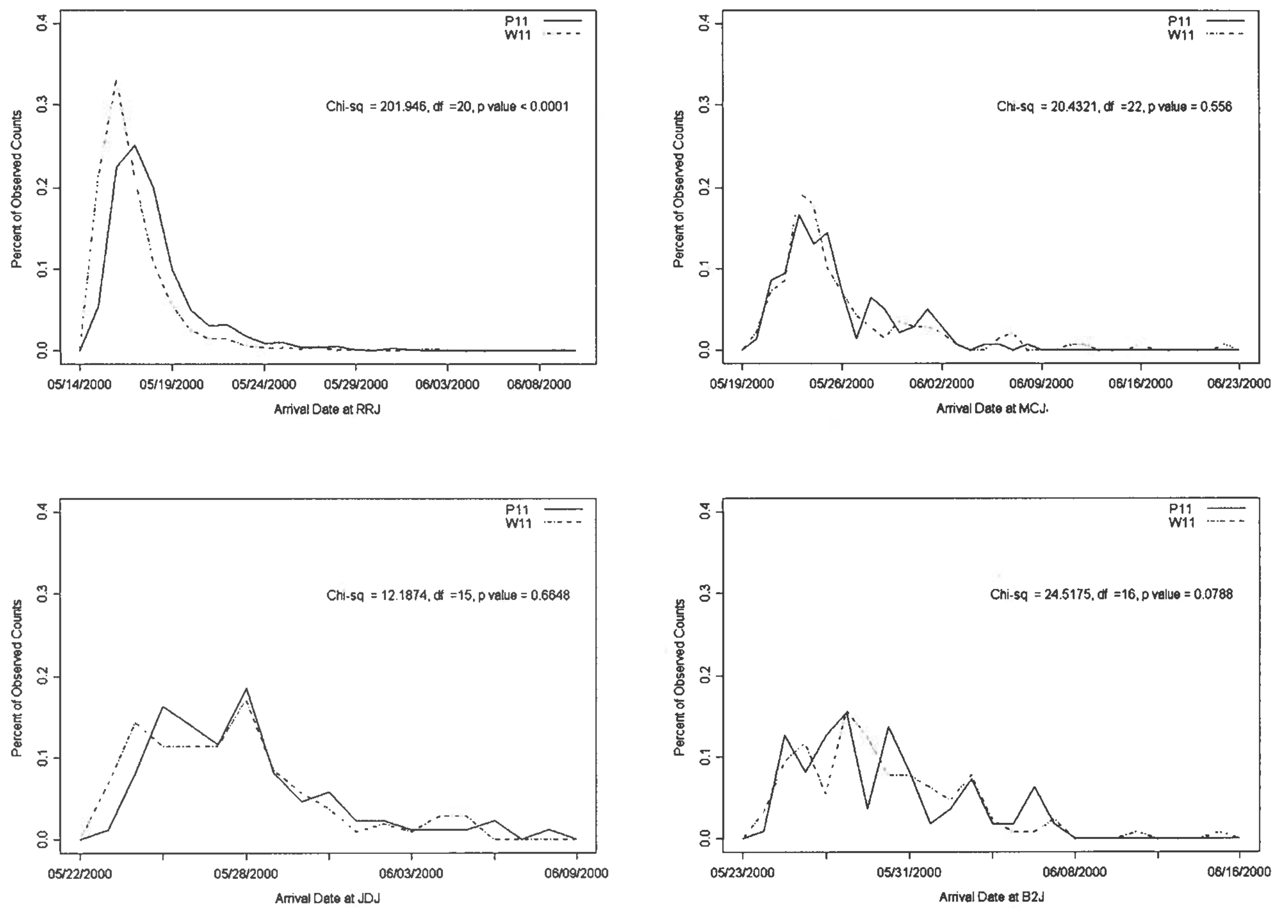




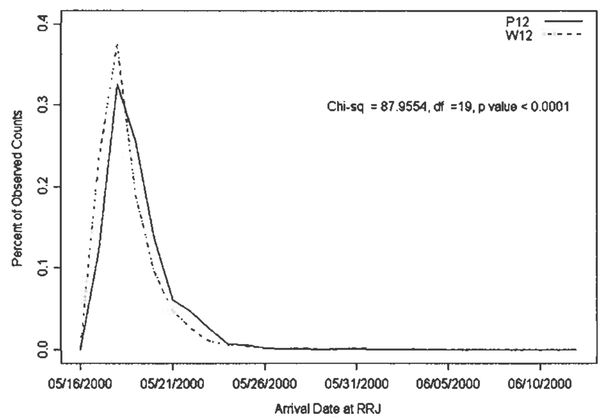


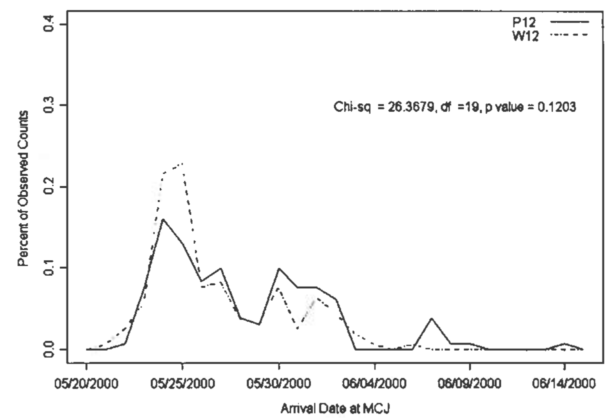


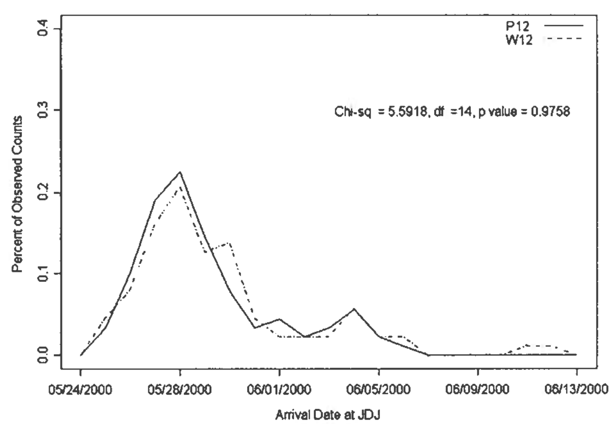
Pair P11 and W11

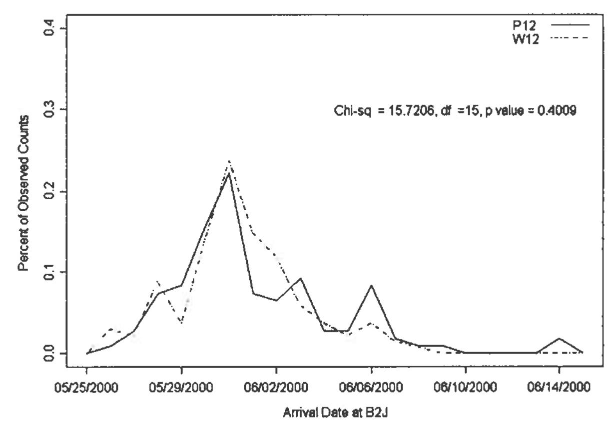


Pair P12 and W12









APPENDIX B

Chi-square tables for Burnham et al. (1987) Tests 1, 2, and 3. Chi-square tests for the effects of smolt handling at Rocky Reach and Rock Island dams.

Table B1. Burnham Test 1.T2 and 1.T3 for Pateros and Wells tailrace paired-releases. The m_i are the number of fish detected at that dam, z_i are the number of fish *not detected* at that dam, but detected downstream.

Release Group	History	Rocky Reach Release: Pateros	Wells	χ_1^2	P-value	History	McNary Dam Release: Pateros	Wells	χ_1^2	P-value
p01 & w01	$m_{.2}$	899	930			$m_{.3}$	265	315		
	$z_{.2}$	341	383	0.795	0.373	$z_{.3}$	404	451	0.279	0.597
p02 & w02	$m_{.2}$	905	1074			$m_{.3}$	249	263		
	$z_{.2}$	273	290	1.234	0.267	$z_{.3}$	323	381	0.794	0.373
p03 & w03	$m_{.2}$	903	1119			$m_{.3}$	246	262		
	$z_{.2}$	275	286	3.193	0.074	$z_{.3}$	339	412	1.185	0.276
p04 & w04	$m_{.2}$	1041	1341			$m_{.3}$	215	226		
	$z_{.2}$	254	192	26.030	< 0.001	$z_{.3}$	374	399	0.004	0.949
p05 & w05	$m_{.2}$	1089	1342			$m_{.3}$	215	204		
	$z_{.2}$	194	155	13.868	< 0.001	$z_{.3}$	293	347	2.886	0.089
p06 & w06	$m_{.2}$	1169	1558			$m_{.3}$	197	255		
	$z_{.2}$	203	116	48.929	< 0.001	$z_{.3}$	327	316	5.336	0.021
p07 & w07	$m_{.2}$	990	1266			$m_{.3}$	215	216		
	$z_{.2}$	247	176	29.591	< 0.001	$z_{.3}$	275	284	0.023	0.880
p08 & w08	$m_{.2}$	1020	1380			$m_{.3}$	107	89		
	$z_{.2}$	178	99	46.682	< 0.001	$z_{.3}$	272	298	2.488	0.115
p09 & w09	$m_{.2}$	864	1229			$m_{.3}$	129	102		
	$z_{.2}$	216	141	44.945	< 0.001	$z_{.3}$	264	259	1.639	0.200
p10 & w10	$m_{.2}$	1008	1131			$m_{.3}$	102	117		
	$z_{.2}$	153	134	3.636	0.057	$z_{.3}$	207	217	0.209	0.648
p11 & w11	$m_{.2}$	964	1088			$m_{.3}$	138	139		
	$z_{.2}$	151	160	0.209	0.647	$z_{.3}$	167	200	1.012	0.314
p12 & w12	$m_{.2}$	1161	1322			$m_{.3}$	131	158		
	$z_{.2}$	108	117	0.083	0.774	$z_{.3}$	165	187	0.097	0.756

Table B2. Burnham Test 1.T4 for Pateros and Wells tailrace paired-releases. The m_1 are the number of fish detected at John Day dam, z_1 are the number of fish *not detected* at that dam, but detected downstream.

Release Group		John Day			
		Release		χ_1^2	P-value
	History	Pateros	Wells		
p01 & w01	$m_{.4}$	328	428		
	$z_{.4}$	187	166	8.512	0.004
p02 & w02	$m_{.4}$	245	263		
	$z_{.4}$	323	381	0.732	0.392
p03 & w03	$m_{.4}$	239	292		
	$z_{.4}$	189	219	0.112	0.738
p04 & w04	$m_{.4}$	231	263		
	$z_{.4}$	222	204	2.411	0.120
p05 & w05	$m_{.4}$	194	226		
	$z_{.4}$	164	184	0.035	0.852
p06 & w06	$m_{.4}$	191	194		
	$z_{.4}$	192	201	0.019	0.889
p07 & w07	$m_{.4}$	128	150		
	$z_{.4}$	197	191	1.266	0.260
p08 & w08	$m_{.4}$	137	126		
	$z_{.4}$	156	196	3.341	0.068
p09 & w09	$m_{.4}$	131	127		
	$z_{.4}$	171	161	0.009	0.926
p10 & w10	$m_{.4}$	91	100		
	$z_{.4}$	134	140	0.030	0.862
p11 & w11	$m_{.4}$	85	105		
	$z_{.4}$	103	119	0.057	0.812
p12 & w12	$m_{.4}$	89	86		
	$z_{.4}$	93	131	3.088	0.079

Table B3. Burnham Test 2.2 for individual release groups. This procedure tests the assumption of whether detections at Rocky Reach affect downstream survival and/or detection.

Release		Test 2.2			χ_2^2	P-value
Pateros		Recovery Site				
	Release Site	McNary	John D.	Bonn.		
p01	Pateros	135	141	65		
	Rocky Reach	130	125	73	1.268	0.530
p02	Pateros	108	99	66		
	Rocky Reach	141	88	70	3.964	0.138
p03	Pateros	112	101	62		
	Rocky Reach	134	87	89	5.764	0.056
p04	Pateros	93	91	70		
	Rocky Reach	122	100	113	3.363	0.186
p05	Pateros	76	66	52		
	Rocky Reach	139	90	85	1.859	0.395
p06	Pateros	71	70	62		
	Rocky Reach	126	98	97	1.215	0.545
p07	Pateros	124	57	66		
	Rocky Reach	91	48	104	14.298	0.001
p08	Pateros	60	60	58		
	Rocky Reach	47	67	87	6.392	0.041
p09	Pateros	73	64	79		
	Rocky Reach	56	48	73	0.902	0.637
p10	Pateros	43	46	64		
	Rocky Reach	59	40	57	3.305	0.192
p11	Pateros	63	41	47		
	Rocky Reach	75	35	44	1.587	0.452
P12	Pateros	45	31	32		
	Rocky Reach	86	49	53	0.484	0.785

Table B3. (Continued)

Release		Test 2.2			χ_2^2	P-value
Wells		Recovery Site				
		McNary	John D.	Bonn.		
w01	Wells	155	167	61		
	Rocky Reach	160	159	64	0.348	0.840
w02	Wells	117	111	62		
	Rocky Reach	146	128	80	0.332	0.847
w03	Wells	103	109	74		
	Rocky Reach	159	124	105	2.935	0.231
w04	Wells	63	75	54		
	Rocky Reach	163	150	120	1.589	0.452
w05	Wells	62	54	39		
	Rocky Reach	142	135	119	1.463	0.481
w06	Wells	45	42	29		
	Rocky Reach	210	115	130	5.562	0.062
w07	Wells	69	56	51		
	Rocky Reach	147	70	107	6.315	0.043
w08	Wells	20	40	39		
	Rocky Reach	69	77	142	6.551	0.038
w09	Wells	36	46	59		
	Rocky Reach	66	62	92	1.173	0.556
w10	Wells	49	33	52		
	Rocky Reach	68	56	76	0.507	0.776
w11	Wells	66	42	52		
	Rocky Reach	73	49	57	0.056	0.973
w12	Wells	58	30	29		
	Rocky Reach	100	45	83	5.004	0.082

Table B4. Burnham Test 2.3 for individual release groups. This procedure tests the assumption of whether detections at McNary affect downstream survival and/or detection.

Release		Test 2.3		χ_1^2	P-value
Pateros		Recovery Site			
	Release Site	John Day	Bonn.		
p01	Pateros + Rocky Reach	266	138		
	McNary	62	49	3.334	0.068
p02	Pateros + Rocky Reach	187	136		
	McNary	58	44	0.005	0.945
p03	Pateros + Rocky Reach	188	151		
	McNary	51	38	0.037	0.848
p04	Pateros + Rocky Reach	191	183		
	McNary	40	39	0.003	0.957
p05	Pateros + Rocky Reach	156	137		
	McNary	38	27	0.392	0.531
p06	Pateros + Rocky Reach	168	159		
	McNary	23	33	1.639	0.200
p07	Pateros + Rocky Reach	105	170		
	McNary	23	27	0.780	0.377
p08	Pateros + Rocky Reach	127	145		
	McNary	10	11	0.021	0.885
p09	Pateros + Rocky Reach	112	152		
	McNary	19	19	0.498	0.480
p10	Pateros + Rocky Reach	86	121		
	McNary	5	13	0.794	0.373
p11	Pateros + Rocky Reach	76	91		
	McNary	9	12	< 0.001	0.998
p12	Pateros + Rocky Reach	80	85		
	McNary	9	8	0.009	0.924

Table B4. (Continued)

Release		Test 2.3		χ_1^2	P-value
Wells		John Day	Bonn.		
w01	Wells + Rocky Reach	326	125		
	McNary	102	41	0.013	0.909
w02	Wells + Rocky Reach	239	142		
	McNary	57	50	2.748	0.097
w03	Wells + Rocky Reach	233	179		
	McNary	59	40	0.190	0.663
w04	Wells + Rocky Reach	225	174		
	McNary	38	30	0.003	0.957
w05	Wells + Rocky Reach	189	158		
	McNary	37	26	0.238	0.625
w06	Wells + Rocky Reach	157	159		
	McNary	37	42	0.107	0.744
w07	Wells + Rocky Reach	126	158		
	McNary	24	33	0.028	0.867
w08	Wells + Rocky Reach	117	181		
	McNary	9	15	0.002	0.962
w09	Wells + Rocky Reach	108	151		
	McNary	19	10	5.075	0.024
w10	Wells + Rocky Reach	89	128		
	McNary	11	12	0.166	0.683
w11	Wells + Rocky Reach	91	109		
	McNary	14	10	0.949	0.330
w12	Wells + Rocky Reach	75	112		
	McNary	11	19	0.025	0.876

Table B5. Burnham et al. (1987) Test 3.1 for individual release groups. This procedure tests whether capture histories at Rocky Reach affect downstream detection histories at John Day and Bonneville.

Release	Capture History at John Day and Bonneville Dams	Capture History to McNary Dam		χ^2_3	P-value
		101	111		
p01	11	6	8		
	10	31	17		
	01	20	29		
	00	77	72	5.9494	0.1141
p02	11	2	5		
	10	25	26		
	01	15	29		
	00	63	80	2.8388	0.4172
p03	11	7	8		
	10	14	22		
	01	19	19		
	00	68	80	0.9642	0.8099
p04	11	6	1		
	10	16	17		
	01	12	27		
	00	58	76	7.9886	0.0462
p05	11	2	5		
	10	13	18		
	01	8	19		
	00	51	95	1.1237	0.7714
p06	11	1	2		
	10	7	13		
	01	11	22		
	00	51	88	0.1479	0.9855
p07	11	2	0		
	10	14	7		
	01	14	13		
	00	91	67	2.5257	0.4707
p08	11	1	0		
	10	6	3		
	01	6	5		
	00	46	37	1.2040	0.7520
p09	11	1	4		
	10	8	6		
	01	11	8		
	00	52	37	2.8632	0.4132

Table B5. (Continued)

Release	Capture History at John Day and Bonneville Dams	Capture History to McNary Dam		χ_3^2	P-value
		101	111		
p10	11	0	1		
	10	2	2		
	01	8	5		
	00	32	51	3.2730	0.3514
p11	11	0	1		
	10	3	5		
	01	5	7		
	00	54	58	1.3735	0.7118
p12	11	1	0		
	10	1	7		
	01	3	5		
	00	39	65	3.7812	0.2861
Wells					
w01	11	16	13		
	10	34	39		
	01	15	26		
	00	83	80	3.3360	0.3427
w02	11	4	5		
	10	23	25		
	01	27	23		
	00	61	89	2.9370	0.4014
w03	11	2	6		
	10	27	24		
	01	12	28		
	00	59	98	6.3166	0.0972
w04	11	1	8		
	10	12	17		
	01	5	25		
	00	45	106	5.8427	0.1195
w05	11	0	6		
	10	10	21		
	01	4	22		
	00	45	88	6.2096	0.1018

Table B5. (Continued)

Release	Capture History at John Day and Bonneville Dams	Capture History to McNary Dam		χ_3^2	P-value
		101	111		
w06	11	0	6		
	10	7	24		
	01	7	35		
	00	30	140	1.8307	0.6083
w07	11	2	0		
	10	5	17		
	01	12	21		
	00	50	108	5.4081	0.1442
w08	11	0	1		
	10	3	5		
	01	5	10		
	00	11	51	3.1699	0.3662
w09	11	0	2		
	10	6	11		
	01	4	6		
	00	26	47	1.1912	0.7551
w10	11	1	0		
	10	4	6		
	01	4	8		
	00	38	53	1.7510	0.6257
w11	11	0	1		
	10	7	6		
	01	6	4		
	00	49	59	1.9251	0.5881
w12[2]	11	---	---		
	10	4	7		
	01	10	9		
	00	41	79	2.4088	0.2999

[2] There were no detections at both John Day and Bonneville Dams for release w12, so the chi-square test has 2 degrees of freedom.

Table B6. Burnham et al. (1987) Test 3.2 for individual release groups. This procedure tests whether capture histories at Rocky Reach and McNary affect downstream detection history at Bonneville.

Release	Capture History at John Day and Bonneville Dams	Capture History to John Day Dam				χ^2_3	P-value
		1111	1101	1011	1001		
p01	0	17	100	31	113		
	1	8	25	6	28	2.5057	0.4743
p02	0	26	68	25	79		
	1	5	20	2	20	3.3807	0.3366
p03	0	22	70	14	80		
	1	8	17	7	21	2.3276	0.5072
p04	0	17	78	16	75		
	1	1	22	6	16	3.6905	0.2969
p05	0	18	71	13	57		
	1	5	19	2	9	1.8772	0.5983
p06	0	13	81	7	62		
	1	2	17	1	8	1.2007	0.75287
p07	0	7	38	14	45		
	1	0	10	2	12	2.3608	0.5010
p08	0	3	54	6	51		
	1	0	13	1	9	1.1019	0.7766
p09	0	6	42	8	49		
	1	4	6	1	15	5.1321	0.1624
p10	0	2	39	2	45		
	1	1	1	0	1	8.8196	0.0318
p11	0	5	32	3	38		
	1	1	3	0	3	0.8846	0.8291
p12	0	7	36	1	30		
	1	0	13	1	1	10.3697	0.0157

Table B6. (Continued)

Release	Capture History at John Day and Bonneville Dams	Capture History to John Day Dam				χ^2_3	P-value
		1111	1101	1011	1001		
Wells							
w01	0	39	119	34	134		
	1	13	40	16	33	3.5557	0.3136
w02	0	25	103	23	84		
	1	5	25	4	27	1.8664	0.6006
w03	0	24	101	27	84		
	1	6	23	2	25	3.8598	0.2770
w04	0	17	122	12	59		
	1	8	28	1	16	3.7059	0.2950
w05	0	21	104	10	42		
	1	6	31	0	12	2.9129	0.4053
w06	0	24	100	7	32		
	1	6	15	0	10	4.3488	0.2262
w07	0	17	55	5	44		
	1	0	15	2	12	4.8121	0.1861
w08	0	5	70	3	35		
	1	1	7	0	5	0.9377	0.8163
w09	0	11	51	6	40		
	1	2	11	0	6	1.5673	0.6668
w10	0	6	50	4	31		
	1	0	6	1	2	1.8812	0.5974
w11	0	6	46	7	37		
	1	1	3	0	5	1.9184	0.5895
w12	0	7	44	4	28		
	1	0	1	0	2	1.5120	0.6795

Table B7. Counts of smolt by detection history for fish recaptured in the Rocky Reach sampling facility. Chi-square tests compare these counts with smolt counts for fish detected at Rocky Reach Dam, but not detected at the Rocky Reach sampling facility. Histories are for Release, Rocky Reach, McNary, John Day, and Bonneville Dams.

Release	11111	11110	11101	11100	11011	11010	11001	11000	11200	χ^2	df	p-value
Pateros												
p01	4	4	8	20	13	28	22	147	2	11.8346	8	0.1587
p02	1	5	6	10	1	15	9	92	0	6.0516	8	0.6415
p03	1	4	2	10	3	9	10	87	0	2.5442	8	0.9596
p04	0	1	2	8	3	9	18	114	1	10.9443	8	0.2049
p05	1	2	2	15	1	10	13	96	0	3.0700	8	0.9299
p06	0	1	3	1	1	8	5	48	0	8.9027	8	0.3506
p07	0	0	1	5	1	1	8	45	0	2.4908	7	0.9278
p08	0	0	1	3	0	6	11	102	0	3.5047	7	0.8347
p09	0	2	2	5	0	3	7	36	0	18.6757	8	0.0167
p10	1	0	1	8	0	6	8	136	0	6.0874	7	0.5296
p11	0	1	0	1	0	4	7	57	0	11.2710	8	0.1868
p12	0	1	1	0	0	0	1	22	0	15.2271	7	0.0332
Wells												
w01	4	13	7	21	14	35	14	145	1	3.9427	8	0.8623
w02	0	6	2	23	7	21	14	137	3	14.6192	8	0.0670
w03	1	5	3	9	1	9	9	78	1	6.5040	8	0.5910
w04	1	2	3	22	6	21	18	173	0	4.8116	8	0.7775
w05	0	7	8	14	1	22	26	211	2	15.2999	8	0.0536
w06	0	0	1	6	0	7	8	58	1	6.2231	7	0.6223
w07	0	0	1	6	2	1	9	87	0	7.5946	8	0.3697
w08	0	0	2	9	2	7	22	157	0	4.4088	8	0.8185
w09	0	1	0	3	1	4	6	45	0	3.3608	7	0.8497
w10	0	1	1	5	0	7	11	79	0	5.6983	7	0.5754
w11	0	0	1	10	0	6	11	129	0	4.0649	8	0.8512
w12	0	0	0	4	0	3	0	24	0	9.0245	7	0.2509

Table B8. Counts of smolt by detection history for fish recaptured at Rock Island Dam. Chi-square tests compare these counts with smolt counts for fish not recaptured at Rocky Island Dam but detected somewhere downriver[3]. Histories are for McNary, John Day, and Bonneville Dams.

Release	111	110	101	100	011	010	001	200	χ^2	df	p-value
Pateros											
p01	0	1	0	3	0	0	4	0	8.5918	7	0.2833
p02	0	0	0	3	1	0	4	0	6.7943	7	0.4506
p03	0	0	0	4	1	4	5	0	3.0657	7	0.8789
p04	0	0	0	0	1	3	3	0	4.3538	7	0.7382
p05	1	1	1	6	1	2	4	0	4.5418	7	0.7157
p06	0	0	0	3	0	0	2	0	4.4647	7	0.7250
p07	0	0	0	4	0	1	7	0	4.5070	7	0.7199
p08	0	0	0	3	0	2	4	0	1.8614	7	0.9671
p09	1	1	0	4	0	4	5	0	5.9650	7	0.5438
p10	0	0	0	4	0	2	5	0	1.6141	7	0.9781
p11	0	0	0	2	0	2	1	0	1.3569	7	0.9869
p12	0	0	0	6	1	1	2	0	4.3488	7	0.7388
Wells											
w01	0	0	0	3	0	2	2	0	4.3133	7	0.7431
w02	0	2	1	2	1	2	1	0	3.7654	7	0.8064
w03	0	0	1	4	2	1	3	0	5.3820	7	0.6134
w04	0	0	1	5	0	1	7	0	7.8742	7	0.3380
w05	0	0	1	5	1	2	5	0	3.2143	7	0.8645
w06	0	1	0	7	1	4	7	0	2.6437	7	0.9159
w07	0	0	2	3	0	2	3	0	3.8541	7	0.7964
w08	0	0	0	4	0	2	4	1	14.6738	7	0.0404
w09	0	2	2	1	1	2	5	0	12.9397	6	0.0440
w10	0	1	0	2	1	3	4	0	4.4833	7	0.7227
w11	0	1	1	2	0	1	2	0	5.8431	7	0.5582
w12	0	0	1	3	0	1	4	0	1.9521	6	0.9241

[3]It cannot be determined whether fish not detected at Rock Island Dam or below survived to Rock Island Dam; those fish and the fish not detected at Rock Island Dam or below are removed from the chi-square test of homogeneity

APPENDIX C

Between-year (1998 – 2000) and between-species comparisons of capture and survival processes through common reaches of the Mid-Columbia River.

Table C1. Summary of reach survival estimates from Rocky Reach tailrace to McNary Dam. Weighted averages reported for chinook salmon and steelhead for the years 1998-2000.

Species	Source	Year	$\hat{\hat{S}}$	$\hat{SE}\left(\hat{\hat{S}}\right)$	95% C.I.
Steelhead	Douglas Hatchery	1999	0.686	0.010	0.666 – 0.706
Steelhead	Douglas Hatchery	2000	0.656	0.011	0.634 – 0.678
Summer-Spring Mixed Chinook	Douglas run-of-river	1998	0.720	0.084	0.555 – 0.885
Summer Chinook	Douglas Hatchery	1998	0.659	0.040	0.581 – 0.737
Summer Chinook	Douglas Hatchery	2000	0.731	0.063	0.608 – 0.854
Spring Chinook	Winthrop Hatchery	1998	0.720	0.091	0.542 – 0.898
Spring Chinook	Winthrop Hatchery	1999	0.727	0.053	0.623 – 0.831
Spring Chinook	Winthrop Hatchery	2000	0.692	0.088	0.520 – 0.864
Coho	Winthrop Hatchery	2000	0.715	0.123	0.474 – 0.956

Table C2. Summary of detection probabilities for the 1998, 1999 and 2000 outmigrations.

Species	Year	Fish Origin	Detection Rates (SE)		
			Rocky Reach	McNary	John Day
Spring Chinook	1998	Winthrop Hatchery	0.128 (0.010)	0.126 (0.014)	0.089 (0.016)
Spring Chinook	1999	Winthrop Hatchery	0.172 (0.010)	0.306 (0.017)	0.210 (0.088)
Spring Chinook	2000	Winthrop Hatchery	0.261 (0.028)	0.206 (0.034)	0.063 (0.010)
Summer-Spring Mixed Chinook	1998	Run-of-River PT	0.126 (0.016)	0.135 (0.038)	0.128 (0.012)
Summer Chinook	1998	Douglas Hatchery PT, WT	0.085 (0.004)	0.110 (0.009)	0.095 (0.013)
Summer Chinook	2000	Douglas Hatchery OK	0.086 (0.016)	0.170 (0.049)	0.104 (0.055)
Summer Steelhead	1999	Douglas Hatchery OK, PT, WT	0.250 (0.009)	0.198 (0.005)	0.358 (0.013)
Summer Steelhead	2000	Douglas Hatchery PT, WT	0.587 (0.009)	0.155 (0.005)	0.149 (0.013)
Coho	2000	Winthrop Hatchery	0.543 (0.018)	0.118 (0.021)	0.104 (0.026)

APPENDIX D

Supplemental Figures D1, D3, D3, D4, D5, D6 and D7. Trends in mean fish length, weight, condition factor, fat index, ATPase, plasma cortisol and glucose.

Figure D1. Trends in mean fish length during the 2000 steelhead survival study.

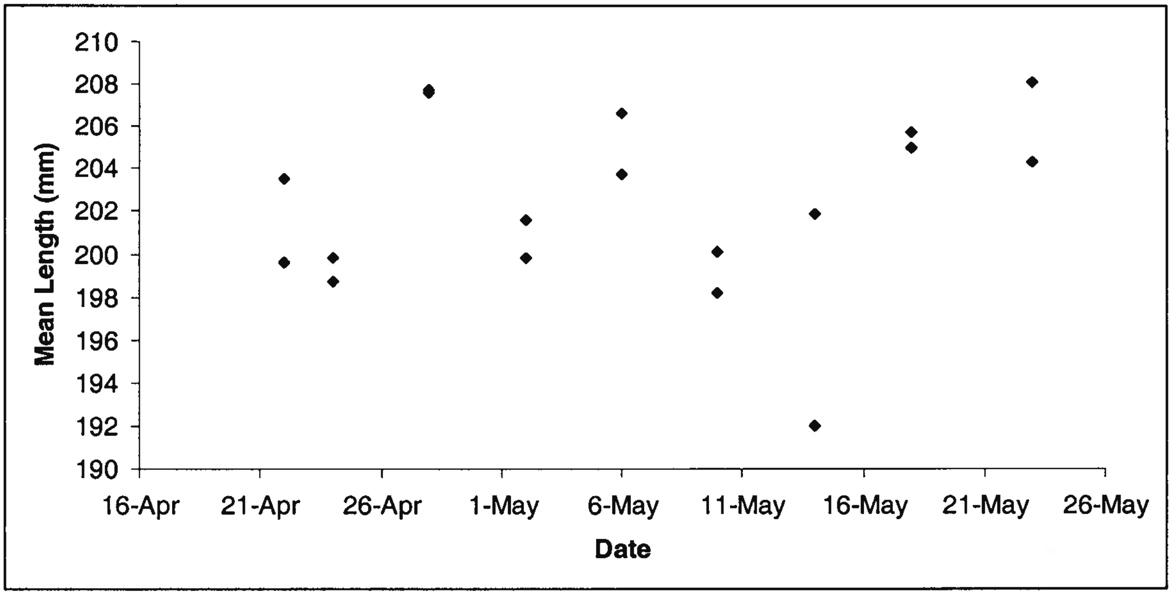


Figure D2. Trends in mean fish weight during the 2000 steelhead survival study.

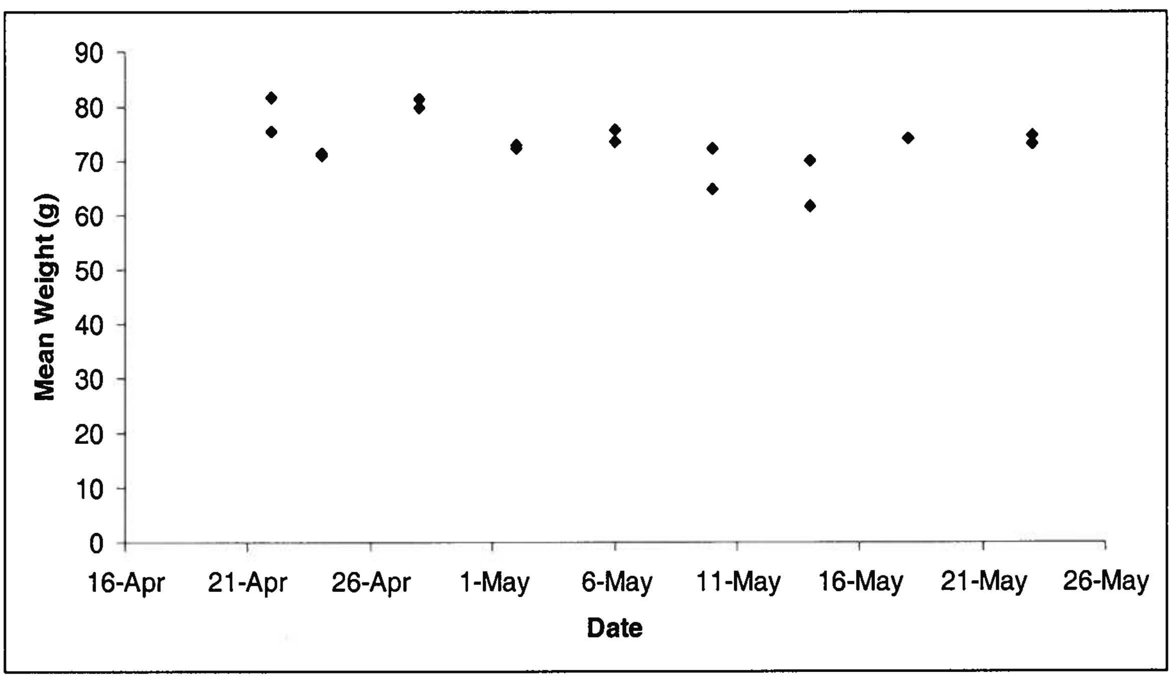


Figure D3. Trends in mean fish condition factor during the 2000 steelhead survival study.

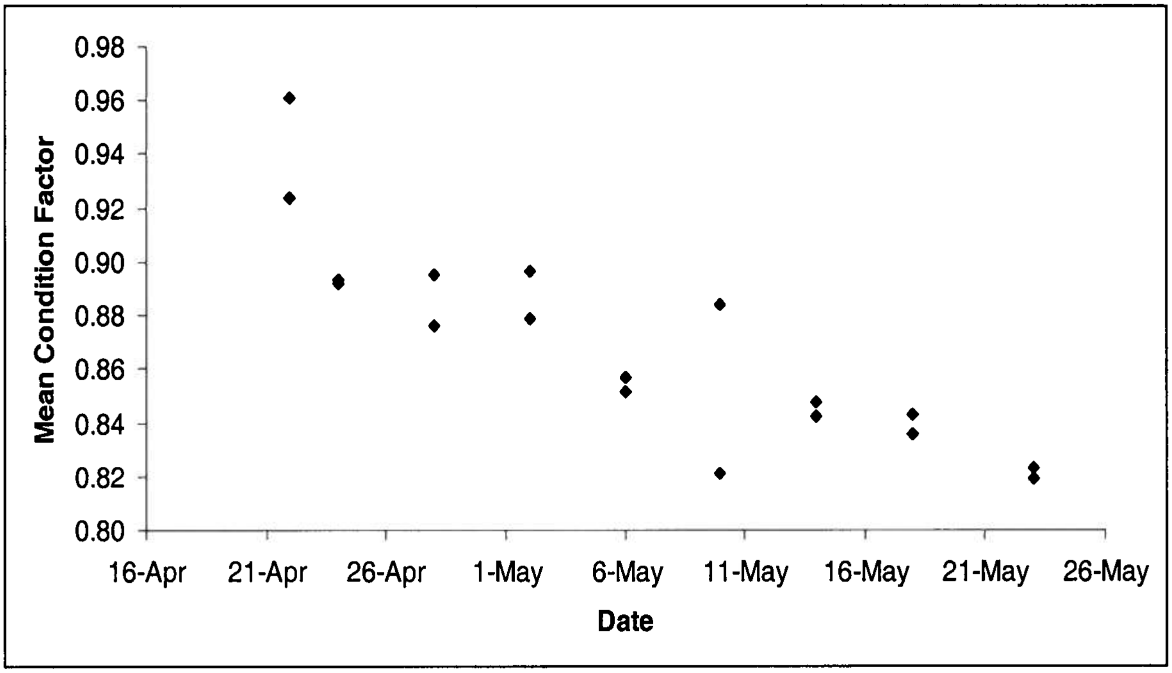


Figure D4. Trends in mean fish fat indices during the 2000 steelhead survival study.

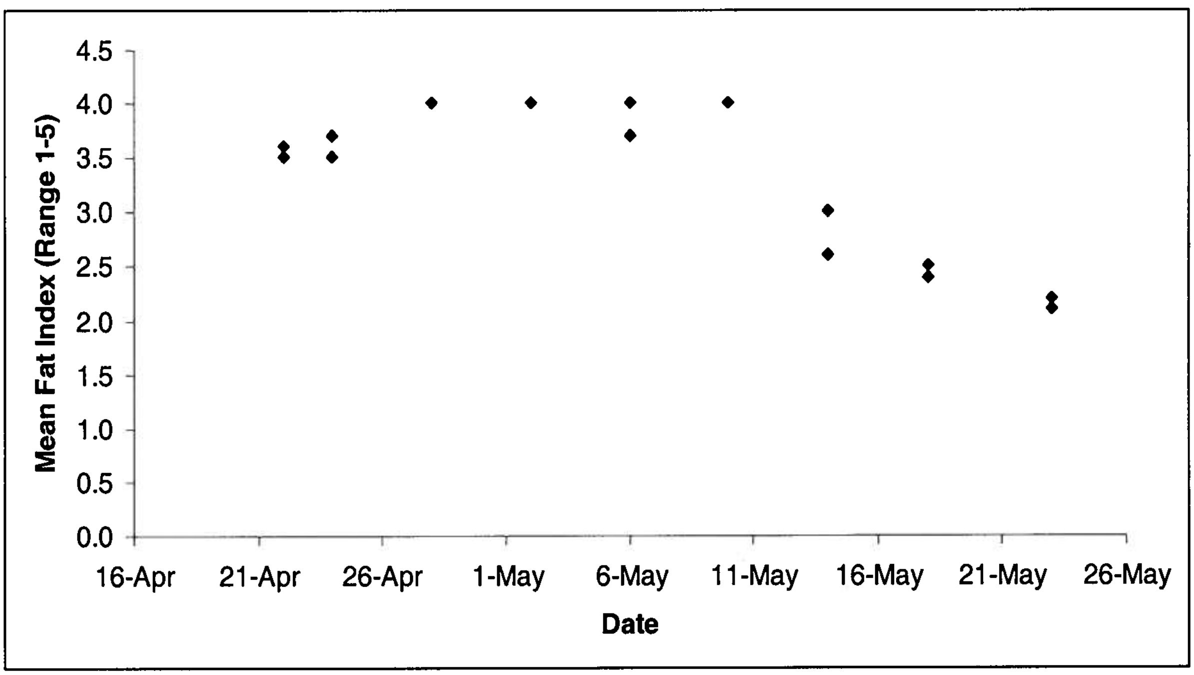


Figure D5. Trends in mean fish ATPase values during the 2000 steelhead survival study.

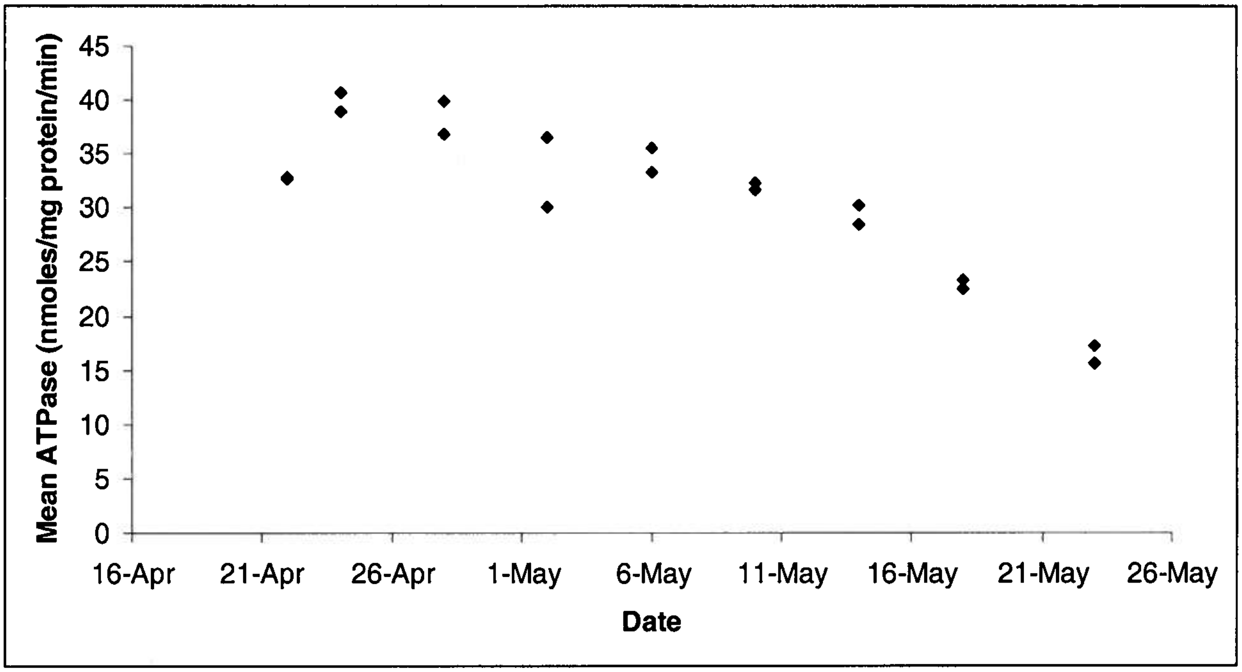


Figure D6. Trends in mean fish cortisol concentration during the 2000 steelhead survival study.

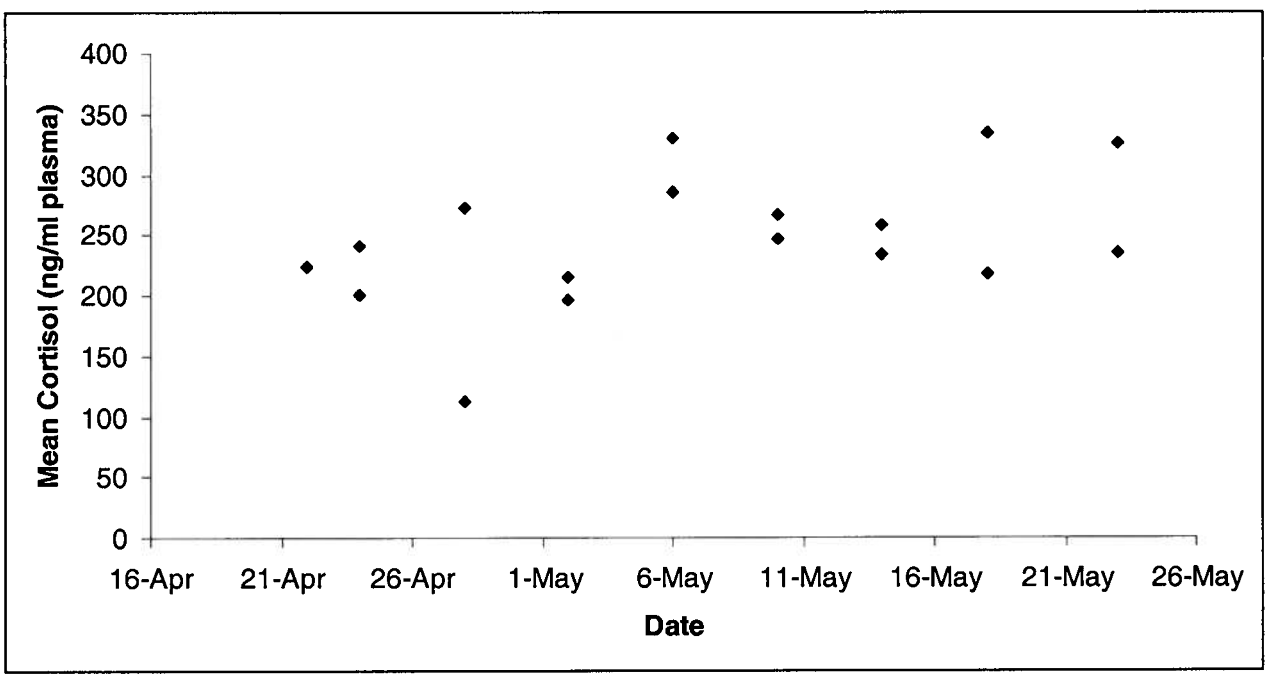
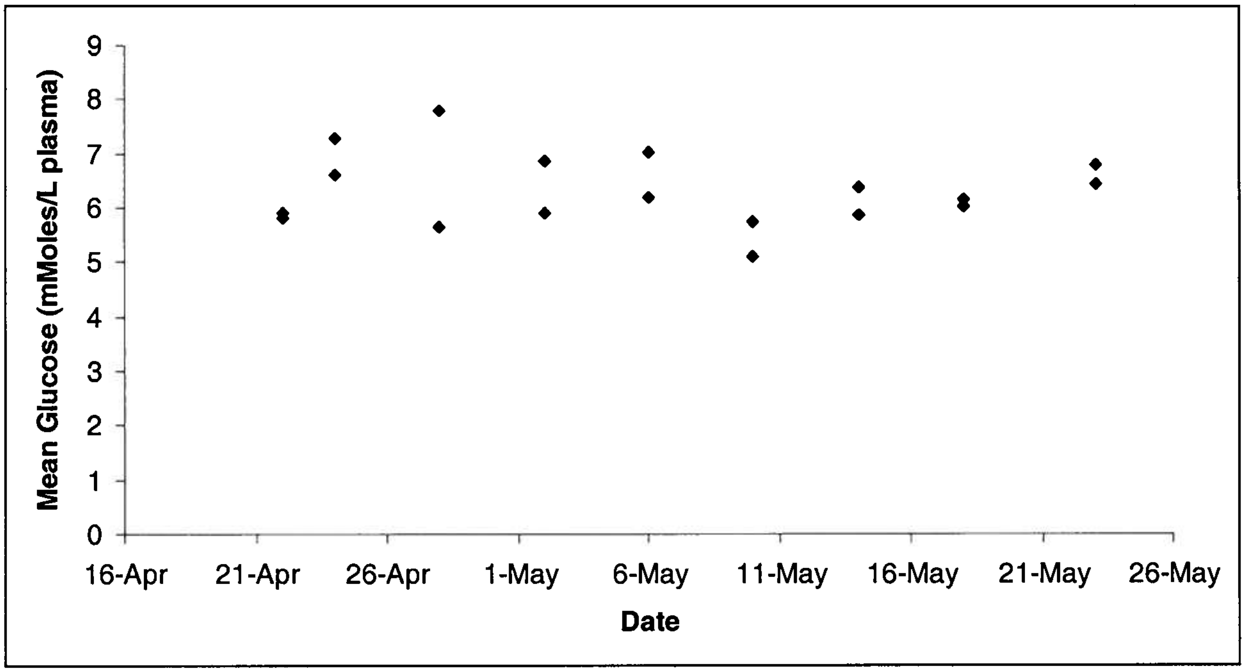


Figure D7. Trends in mean fish glucose values during the 2000 steelhead survival study.



APPENDIX E

Responses to comments received on the Draft report entitled: "Project survival estimates for yearling summer steelhead migrating through the Wells Hydroelectric Project, 2000."

RESPONSE TO COMMENTS FROM

BRYAN NORDLUND, BOB DACH AND STEVE SMITH, NMFS

The following pages contain NMFS's comments related to the 2000 Wells PIT-tag survival study. Each comment is followed by a response (bold text).

NMFS's Comments Follow:

Dear Mr. Bickford:

Thank you for the opportunity to review this report. In general, the document reflects the level of quality that we have come to expect from the Douglas County Public Utility District (PUD). We greatly appreciate your design and implementation efforts and the uncommon care that the researchers showed in handling endangered juvenile steelhead.

The majority of our comments are largely editorial in nature, although we do feel some additional effort should be taken to compare and contrast your results with similar information conducted from other studies, particularly the Chelan and Grant county evaluations, and other mainstem efforts on the lower Columbia River. The comparative information provided for the Winthrop fish, tagged by the Fish Passage Center, certainly helps to support your results but it would be interesting to note if fish released near the Wells Dam had the same downstream migration rate and survival (through common reaches) as fish released above the Lower Granite Dam, for example, or as fish released at the Priest Rapids Project (a comparison with information collected at The Dalles Dam would also help to ensure that cumulative effects were minimal). Through survival comparisons of test fish released at alternative locations we would hope to see similar survival trends through common downstream reaches. Inconsistent data may identify concerns with a particular reach or may indicate some level of cumulative effect currently not being addressed. In either case, the quality of the data and analysis provided in your report would lend itself to this type of comparison. A separate section in the report specifically addressing this issue would be very helpful.

Please also note the following specific comments:

1. Executive Summary (3rd paragraph from end): This is the first time reach survival estimates are noted. As discussed above, your weighted averages for survival from Rocky Reach to McNary (0.656) and from McNary to John Day (1.017) are almost opposite of those reported in the Chelan County PUD study - 1.032 and 0.696 for the same reaches respectively (Table 4-2, Skalski et al. November 9, 2000 Draft). Please discuss in the document possible explanations for this discrepancy. Only reporting comparative information that supports your data may have unintended effects on how your study results are viewed. Also, as you know, this type of evaluation does not specifically measure survival to a finite point (e.g., to the McNary tailrace) - some clarification of this terminology should be provided.

   The area of interest for this report was the Methow River to the Well's Dam tailrace. As such, it is more informative to compare Douglas PUD's fish with those of the Fish Passage Center released from the Winthrop National Fish Hatchery. A comparison of Chelan County PUD's study to this one for lower reaches has numerous confounding factors, different stock and species of fish, handling techniques, time of the year in the river, etc. While some of these also are true of the Winthrop fish, they were selected due to the common stretch of river they experienced with the Well's study.

2. Page 1, para. 4, line 5: Should "$p<0.10$" be "$p>0.10$" (talking about p value for non-significant result).

   This typographical error has been changed.

3. Page 1, para. 2, line 7: We suggest using "Estimated survival...averaged" in place of "Survival...averaged"

   The suggested change has been made.

4. Page 2, para. 3, last sentence: Sentence confusing. What does "this system" refer to? Is it not correct that smolts migrating out of the Okanogan River are already in the system? Why do they need to be planted?

   The majority of the steelhead migrating out of the Okanogan River Basin are hatchery fish. To clarify, the draft statement has been changed to, "Steelhead smolts migrating out of the Okanogan River are mostly hatchery fish planted into this system each spring by staff from the Wells Fish Hatchery."

5. Page 6, Section 3.3, para. 5, line 2: We suggest a more exact definition of what "fish status" was recorded immediately before release. Probably just a check for mortalities?

   The statement has been modified to clarify that fish status refers to fish activity and general appearance prior to release. The mortality check is also an important part of the pre-release inspection.

6. Page 7, Section 3.4: Where and when (at what point in the tagging/holding operation) were fish collected for physiological monitoring? The same information for untagged fish would be helpful (e.g., were untagged fish anesthetized?).

   Control fish were sampled as they exited the pescalator. In this way the control group of fish experienced identical collection, holding and sampling conditions relative to treatment groups of fish. The difference between treatment and control fish was isolated to the tagging and post-tagging recovery period. Section 3.4 has been modified to more accurately describe the sampling protocol.

7. Page 10, Section 3.6, last sentence: '...with a precision of ±5% and a 95% confidence interval' is somewhat confusing. Wouldn't '...with a ±5% confidence interval around the point estimate calculated at the 95% confidence level' be more accurate?

   The suggested change has been made.

8. Page 13, beginning of assumption section: We suggest defining "mixing." We suspect that what is meant is "proportionate daily detection distributions at downstream dams." This type of mixing is certainly desirable, and makes commonality of parameters more likely, but this

type of mixing is not sufficient to ensure that parameters will be common. Differences in the composition of the two groups, or differences in the way they were handled, for example, could lead to differences in parameters despite proportionality of detection distributions.

We agree. Proportionality in detection distributions between treatment and control releases does not directly translate into a lack of difference between parameters. Conversely, differences in parameters should not be inferred simply because proportionality in daily detection distributions was not attained between release groups. In the final report, "Mixing" has been defined as, "proportionate daily detection distributions." Because of these issues, downstream homogeneity of parameters are performed using likelihood ratio tests with R x C contingency tables used as supplemental information only.

9. Page 15, m-array: The authors need to explain exactly what m_{ij}'s are. See our comments on contingency tables for Tests 1.T below.

The following phrase has been added to the first paragraph found on page 15. "...of the form below where m_{ij}'s are the number of smolts released at site *i* that are next detected at site *j*:"

10. Page 17, para. 1: "the assumption...was conducted" should be "a test of the assumption...was conducted."

The suggested change has been made.

11. Page 17, table (11)--Not all readers will know what numbers go into the cells of the table.

Change "An R x C contingency table test of homogeneous recoveries over time was performed using a table of the form:" to "A test of homogeneous recoveries over time was performed using a contingency table listing the daily downstream detections at each dam for each pair of releases:"

12. Page 17: Some discussion of proper use of experiment-wise error rates would be helpful (see comment regarding results below). Test-wise error rates implied by experiment-wise level of 0.10 should be stated. Does rejection of a test at the *experiment*-wise level properly lead to rejection of the *experiment*, not just that one test?

Add after "overall experimental-wise error rate of α_{EX} = 0.10." : "A Type I error occurs when a hypothesis test falsely rejects the null when it is true. In this case, our null hypothesis is that there is no difference in downstream detections for a pair of releases. When α = 0.10 for a specific test, we realize that if the null hypothesis is true, it will be erroneously rejected 10 percent of the time. When calculating a number of comparisons, though, the likelihood that a Type I error will occur increases. For 12 comparisons of the daily detection rates at McNary Dam, for example, the probability of at least one Type I error increases to 71.8%. To decrease this likelihood, the test-wise Type I error per comparison is reduced to α = 0.0087, so that the experimental-wise error rate is α_{EX} = 0.10. When the rejection of a hypothesis test does occur, this does not lead to rejecting the experiment, but indicates that this particular data set is inconsistent with the null hypothesis."

13. Pages 18 and 19: In the tables for Tests 1.T, the notation m_{ij}, is different from that for the m-array on page 15 (e.g., m_{13} in the m-array is the number of fish detected for the first time at McNary Dam, while in Table 14 [Test 1.T4], m_{13} is the total number of fish detected at John Day Dam, regardless of previous history. This is very confusing. To be consistent with the notation in Burnham et al. (admittedly, not always a desirable goal!), the m-array notation would have an additional subscript to denote release group ("t" and "c" in Burnham et al.; see page 113) and the total number of fish from group i detected at John Day Dam would be m_{i4} (the "4" in the subscript is the reason the test is called "Test 1.T4").

Notation for m_{ij} changed in the report to be more consistent with Burnham.

14. Page 19: If the 1.T tests are worth mentioning, why omit 1.R tests?

See the reply to comment 15 below.

15. Page 19: It is suggested that Burnham et al. provided useful tests for "equality of overall recapture for releases R_1 and R_2," but that their suggested testing sequence is not as fine-grained as likelihood ratio tests used in this analysis. In reality, TEST 1 of Burnham et al. (adding the 1.R tests to 1.T presented here) is a series of contingency table tests with 1-to-1 correspondence to the likelihood ratio tests used for model selection in this analysis. For example, the five one-degree-of-freedom tests for the first pair of releases, reported in Table 9a, correspond to TESTs 1.R1, 1.T2, 1.R2, 1.T3, and 1.R3.

Though the hypotheses of the Burnham Test 1's correspond to the likelihood ratio tests (LRT), there is a subtle difference in execution. Burnham Test 1.T2 and the initial likelihood ratio test for each paired release both tested for similar detection rates at the first dam, Rocky Reach. The difference is that Burnham adds the assumption that all parameters downstream are assumed to be equal for the treatment and control releases (Burnham, et al. 1987:p. 66). The likelihood ratio tests do not make this initial assumption, as the collapsing of dimensions in the likelihood may mask potential effects that would only be discernable in the full model. Because of the flexibility and interpretation of LRT's, we recommend discontinuing the use of both Test 1.T's and 1.R's in the future, and rely solely on the likelihood ratio tests.

16. Page 21, Section 4.1, para. 1 line : The Methods section did not refer to an "earthen pond." Is this Pond #4?

Pond #4 is the same as the earthen rearing pond. The report has been modified to reflect the suggested change.

17. Page 21, Section 4.2: What proportion of the 1,103 were released because they were "excess" and what proportion for the other reasons? The first paragraph gives four criteria for exclusion of fish (signs of disease, serious injury, precocity, or grotesque growth abnormalities), and gives the reason for removal that "they did not represent the population of steelhead expected to migrate through Wells Dam in 2000." What is the source of the fish which the PIT-tagged sample is supposed to represent? If it is the other ponds at the hatchery, then surely those ponds have their share of diseased, injured, and precocious fish; some justification is needed for this claim of non-representativeness. The second paragraph gives reasonable justification for removing precocious parr and those with

serious injuries and growth abnormalities, but the fourth criterion–signs of disease is not mentioned.

Approximately 700 steelhead were released because they were in excess of tagging needs. Rational for excluding fish with external signs of disease, injury, precocity and growth abnormalities was added to the final report.

18. Page 23, Table 1: We suggest adding percentages to the sub- and grand total lines for morts, sacrificed, and tags shed.

The suggested change has been made.

19. Page 25, 2nd paragraph: You note that fish size ranged from 198.7 to 207.7 mm. These fish seem comparatively large when compared to other yearling steelhead (and yearling chinook as we tend to expect similar survival rates for these two species). Please provide a comparison to the size range of 'natural' outmigrants at the Wells Dam and discuss how differences may result in higher survival levels.

<u>Mean fork</u> lengths for fish <u>sampled</u> for physiological parameters ranged from 198.7 to 207.7 mm. The range in sizes for fish sampled however was much broader (172 to 240 mm). Fork lengths for the entire population of PIT-tagged steelhead ranged from 127 mm to over 250 mm during the 2000 survival study.

We are unaware of any project survival studies in the Mid-Columbia that have compared the survival of wild and hatchery steelhead.

20. Page 25, Section 4.4, para. 2, last 2 sentences: This seems to say that there was no difference in condition factor between tagged and untagged fish early in the study, but significant differences toward the end. This does not seem indicative of "general decline," but rather a decline that was specific to (or most pronounced for) tagged fish. If condition did decline during the course of the study, is this an expected event and how then would survival later in the season compare to survival earlier in the season? Clarification is needed.

Mean fish condition gradually declined over time for tagged fish (See Appendix D, Figure D3). The observed decline in condition factor was not significant within or between replicate release pairs sampled for physiology. The only significant difference in condition factor was

observed between the control group and fish sampled during the last two treatment sample groups.

The declining trend in fish condition followed the removal of roughly 120,000 fish from Pond #4. These fish were removed for release, by hatchery staff, into tributary streams upstream of Wells Dam. No other significant differences in condition factor were observed either within or between replicate pairs or between tagged and untagged steelhead.

21. Page 25, 3rd paragraph: Please describe the mean smolt and fat indices, particularly the possible range, when presenting the associated estimates (i.e., 4.9 to 5.0 on a scale of what?). Possible ranges of plasma cortisol concentrations and of gill ATPase should also be provided (pages 26 and 27 respectively).

    The range of possible values for mean smolt and mean fat indices has been added to Table 2. A discussion of relative plasma cortisol concentrations and gill ATPase levels can be found in the Discussion.

22. Page 26, para. 1: The lowered fat index for the May 14 group is dramatic. Is there an explanation?

    Typically, the more robust (fat) fish outmigrate from the hatchery ponds first followed in time by increasingly smaller and less robust fish. Roughly 10% of the hatchery population each year residualize within the hatchery rearing ponds. The later two release groups were drawn from the remaining 10-15% of the hatchery production.

23. Page 27, first full para: In our copy of the draft report, there is a passage that appears highlighted, perhaps flagged for later editing when data become available, as HSP70 data are missing from Table 3. If read as-is, the p value ("<0.05") in the highlighted passage appears to be incorrect, as it is referring to a non-significant result ("analysis...found no significant differences").

    Unfortunately, the laboratories at the University of British Columbia and University of Victoria have been, to date, unable to acquire critical enzymes for the processing of the HSP70 samples. As such, we have moved to finalize the report without these results.

24. Pages 28-31, Tables 2 and 3: Graphical presentation of at least some of this information would be useful; perhaps for those variables that showed a trend; condition factor, ATPase, glucose?

A graphical presentation of the trend in fish length, weight, condition factor, fat index, ATPase, plasma cortisol and glucose concentrations was added to the report. These graphs can be found in Appendix D, Page 92.

25. Table 2 gives length data for the sampled fish, but length was measured for all tagged fish. How do the samples compare to the groups as a whole?

Mean fish length was not significantly different between tagged and sampled and tagged and released groups of steelhead. However, the range in size for fish sampled versus fish tagged was different. See response to comment #19 (above).

26. Page 32, para. 1, line 6—"censured" should be "censored". Also, please discussed why the trawl recoveries were pooled with Bonneville. We are assuming that insufficient trawl recoveries were available to estimate the probability of detection at the Bonneville Dam.

Spelling correction has been made.

At the time the analysis was performed, only 473 fish had been detected by the trawl, across the 12 paired releases. Of those, 78 had been previously detected at Bonneville Dam, leaving 395 unique additional detections.

27. Page 32, bullets 1 - 3: If the PIT-tag detectors are located at the dams, are the reach survival estimates calculated for those fish specifically detected at a dam different from the reach survival estimates that include fish not specifically detected at that particular location but at some downstream location? It seems these two different groups could have different survival histories.

If this question is directed to the detections by the trawl and pooled with the Bonneville detections, those fish had to first survive through Bonneville to be detected by the trawl. Including those fish improves the information on survivals to Bonneville, but there is not enough information to extend survival and detection probabilities further downstream. In addition, pooling or not pooling trawl detections with the Bonneville detections has no effect on the estimate of Well's project survival.

28. Page 34, Table 5 and elsewhere— Are estimates and analyses based on PIT-tag interrogation data up to a certain date, after which a few more detections would be expected to "trickle in?" If so, it should be mentioned in table captions and in the text.

    Data for this analysis was downloaded on July 18, 2000, and is noted in the caption for Table 4 (Complete detection history for each release group), and the Methods Section 3.7 (page 10).

29. Page 36, para. 1, line 1: What is meant by "convenient?"

    In this case, convenient refers to the most straightforward test.

30. Page 36, para. 1: Is there any way to improve the mixing at Rocky Reach Dam? Should the 5-hour difference between release times be adjusted? Is there an important fish behavior or project operation at Rocky Reach Dam that would cause non-mixed groups of fish arriving at the dam to become mixed below the dam?

    The 5-hour release delay allows fish from both treatment and control groups to be collected, tagged and held for recovery at the same time and place. This cadence allows fish to be randomly assigned to treatment and control groups and reduces the potential of systematic sampling bias.

31. Page 38: The methods used to test handling effects should be given in the Methods section, including the nature of the statistical test employed. Tables B7 and B8 cannot be understood without an explanation of the methods and rationale for the test.

    The suggested change has been incorporated into the final report.

32. Page 43: Section 4.6.2— Table 9 seems to indicate that only 2 pairs (#2 and #11) had homogeneous parameters beginning with detection probability at Rocky Reach Dam. Release pair 12 appears to have the same model selected as release pair 1. The model for pairs 2 and 11 is identified as the "Ricker Model," but this is not quite accurate (see next comment).

Descriptions of final models have been corrected. "Ricker Model" has been changed to "most parsimonious model".

33. Page 49, Table 11: (This is not so much an editorial comment, but perhaps the seed for further discussion on methodology for paired-release studies such as this one. We are involved in similar studies and are consequently interested in such discussion): In attempting to replicate the analysis, we derived survival estimates that differed slightly from those in Table 11. Several explanations are possible: (1) the nature of PIT-tag analysis, where independent analyses rarely give precisely the same result;(2) slight differences in selected models; (3) PIT-tag data retrieved from PTAGIS in January 2001 vs. fall 2000. In any case, differences in survival estimates were small and not important.

However, there were two pairs for which the standard errors were substantially different, and these had an effect on the weighted average. The two pairs were 2 and 11, for which the "Ricker Model" was selected. Strictly speaking, the Ricker, or relative-recovery model, is a 2-parameter model: the Wells project survival estimate is derived from the ratio of the two recovery proportions. The model reported in Table 11 has 8 parameters (separate survival estimates for the two groups to Rocky Reach Dam, common detection probabilities at Rocky Reach, McNary, and John Day Dams, common survival probabilities to McNary and John Day Dams, and common survival/detection at Bonneville Dam). Consequently, the Wells Project survival probability is estimated with less precision than in the true relative-recovery model.

In the case of the 2000 Wells Project survival study, using the 2-parameter model for pairs 2 and 11 instead of the 8-parameter one reduces the weighted average estimate by about 1% (our result was 0.933). However, there are other models used for individual pairs in Table 11 that could have their parameter number reduced: for pairs 3 through 10 we really need only 5 parameters instead of 9, for instance. The general question is this: if our focus is on survival of the two groups in the first reach, should we use the model with the fewest parameters possible to increase the precision of each estimate?

We choose to use the full model, versus a collapsed model with less estimated parameters, for several reasons:

1. **The fuller model is consistent with the analytic approach given in Burnham et al.**
2. **The analysis strategy is consistent with the pre-project analysis plan (Skalski 2000). We consider it essential that the analysis follow the *a priori* analysis plan to remain objective and not be accused of finding an analysis to conform to the desired results. Different modeling approaches are guaranteed to produce slightly different results.**
3. **The analysis of the 2000 data is consistent with the prior analyses in 1998 and 1999.**
4. **The Ricker Model is the least robust to the violations of equal downstream parameters. The resulting variance estimate may be a poor characterization of the MSE (i.e. variance + bias^2). As such, the most biased estimates may also have the greatest weights under your proposed strategy.**

34. Page 54, 1st paragraph last sentence: How do you know that higher detection rates at Rocky Reach stemmed from technical improvements in PIT-tag interrogation capabilities rather than differences in operation of the bypass facility?

In 1999 we estimated a mean detection probability for Surface Collector No. 2 (SC2) of 0.250 ($\hat{SE}$ = 0.009). SC1 was not equipped with compatible PIT-tag detectors in 1999. In 2000 we estimated a mean detection probability of 0.587 ($\hat{SE}$ = 0.009) with both SC1 and SC2 covered by ISO PIT-tag detectors. Radio-tag and PIT-tag releases conducted by Chelan PUD in 1999 and 2000 indicated nearly equal detection probabilities between the two surface collectors.

35. Page 54 2nd paragraph: If survival from the Methow River to the Rocky Reach tailrace is 92.5% as reported, and survival from the Wells tailrace to the Rocky Reach tailrace is 96.7%, it seems survival from the Methow River to the Wells tailrace should be 95.7% as opposed to the 94.6% calculated in the report. Is this just a rounding error?

The ration of the weighted averages is 95.7% which is not the same as a weighted average of ratios. The weighted average of the ratios provides the same estimate as the reported survival estimate (94.65%) for fish traveling from the Methow River to the Wells tailrace.

Again, thank you for the opportunity to review this report. If you have any questions regarding these comments, please contact Bob Dach of my staff at (503) 736-4734.

Sincerely,

Bryan D. Nordlund, Chief
FERC and Water Diversions Branch

cc: MCCC

MINUTES OF THE WELLS COORINATING COMMITTEE
FOR 1999

APPENDIX I

WELLS COORDINATING COMMITTEE
MEETING SUMMARY
January 23, 2001

Agreements Reached:

1.

I. JOINT ITEMS

A. Introductions

The chair introduced Jim Dunnigan, Yakama Nation, filling in for Tom Scribner who was unable to attend. Chuck Peven introduced Rob Salter, Chelan PUD, who will be heading up the Chelan PUD Fish and Wildlife Group. Salter said he would not be attending all meetings but was looking forward to involvement with the committee from time to time.

B. Approval of December 17 Meeting Summaries.

The chair stated that comments received had been incorporated in the final summaries. He asked for committee approval to distribute the final summaries. Dach asked if the committee was being asked to approve the final summaries without seeing the changes that were made. The committee discussed the matter and it was decided that, in the future, the draft summaries would be sent out, with changes indicated, with the preliminary agenda of the next meeting. That way the summaries, as modified, can be approved at that meeting.

C. Dam Count Discrepancies

Jim Dunnigan distributed information regarding the mid-Columbia coho program being conducted by the Yakama Nation. Releases of hatchery fish began in 1996 in the Methow and 1999 in the Wenatchee River. He said Wenatchee River releases are now being partially PIT tagged for evaluation purposes. He summarized the coho returns to the Methow and Wenatchee River basins and said the counts appear to show few adults returning. He showed the adult coho counts at McNary Dam, Prosser Dam on the Yakama River, and Ice Harbor Dam along with the counts from the mid-Columbia Dams. He pointed out that it appears coho were being missed or mis-identified at the PUD dams. He said this might reflect that counters are unaware of the coho program and not looking for that species. He explained that accurate counts are important for evaluation of the Yakama Nation's coho program. Peven and Hammond both acknowledged the need to improve accuracy of the coho counts. Hammond said Chris Carlson was there specifically to address adult fish counts at the Grant PUD projects. Heinith asked if the mid-Columbia counts included video counting. It was stated that all of the Chelan PUD and Douglas PUD adult counts were video counts. Heinith asked Hammond if Grant PUD was going to go back and review the 2000 Wanapum video counts. Hammond said they were not planning to review the 2000 video counts. He said in 2001 they would be reporting Wanapum adult counts within 24 hours of the day counted.

D. Meeting Dates

The committee established the following dates for meetings in February and March:

- February 8 Rocky Reach Tech. Work Group Vancouver, B.C.

▪	February 13	Mid-Columbia, Rock Island, and Wells Coord. Comm.	Sea/Tac
▪	March 1 or 9	Wells Coordinating Committee	Vancouver, B.C.
▪	March 22	Mid-Columbia, Rock Island, and Wells Coord. Comm.	Sea/Tac
▪	March 23	Rocky Reach/Rock Island Technical Work Group	To be announced

E. 2001 Adult Telemetry Studies

Peven said Chelan PUD sent a letter to Brian Brown of NMFS saying if a detailed study plan was received from the JFP, Chelan would consider conducting an adult telemetry study in 2001. He said they need to see what new information would be expected to be gained from another adult study before committing to such a study. Hammond said Grant PUD had sent a letter on January 22 which reiterated the Grant PUD position previously stated which questions the value of repeating an adult study just to add another year of information. He said Grant PUD is interested in looking at additional objectives that could be addressed by another adult study. Dach said he had drafted a letter for JFP review, which he will look at following JFP comment, to see if it meets their needs for a response to Chelan and Grant PUD's letter. Bickford said that the Wells Interim BiOp contains a Conservation Recommendation advising Douglas PUD toconduct a second adult steelhead passage study.
With this said, Douglas PUD is not supportive of using radio tags to conduct adult survival studies.

II. WELLS DAM

A. Okanagan Sockeye

Klinge said the reports received from the Canadian OTWG were distributed on January 16. He said they continue to work toward measures that support an ecosystem concept. The Canadian parties were unhappy that the reports were needed by January. They would like the reports to be considered working documents and could change somewhat in final form. Klinge reported that the Canadian parties will be meeting on February 1-2 to discuss the reports with the understanding that they would sit down with the Wells Coordinating Committee on 3/1 or 3/8 to discuss a joint approach to Okanagan sockeye projects.

Klinge reported that Douglas PUD has discussed purchase possibilities with the landowner of the property holding the highest priority for development of a spawning channel. He said Douglas PUD was interested in working with the Wells Committee to develop a plan that is supported on both sides of the border. Woodin asked if there are portions of the projects being studied that Douglas PUD would not want to support and would the Canadians likely support some of the activities. Klinge said the Canadians are interested in doing some of the activities studied but probably not the more costly ones.

Heinith asked if these things had been discussed in the U.S. Canada Treaty forum, especially the habitat activities. Klinge said he wasn't aware that the Okanagan initiative had been discussed in that forum.

Klinge said Douglas PUD was looking to the JFP to provide some input concerning the PUD's potential participation in Okanagan sockeye enhancement and how Douglas PUD's sockeye mitigation responsibilities relate to the activities being considered in Canada. Klinge said they have administrative support and funding available to move forward. He said he needs JFP input and support for going ahead.

Klinge said the Canadians consider a channel as an extension of the natural habitat and feel it would provide a buffer for the effect of natural conditions on the sockeye resources. A question was raised regarding whether or not their were successful sockeye spawning channels in British Columbia. Bickford said there were about 150 channels in British Columbia with about 90% of them operating successfully.

Klinge said he would send the other reports to the committee as soon as they are received. The meeting with the Canadians will be held March 1 or 9 if they are available on either of those dates. The meeting will probably be held in Vancouver, B.C. He said following that meeting the Wells Committee should meet to discuss where to go from here.

B. Bull Trout Trapping

Mark Miller, USFWS, joined the meeting by telecom at this time. Bickford said the plan is to trap 10 bull trout at Wells Dam in the spring of 2001. He said starting May 21 the east ladder trap will be operated three days per week, eight hours per day from noon to 8 PM, for five weeks or until ten bull trout are captured. The total bull trout counted at Wells Dam in 2000 was 89. Bickford said his inclination is to tag fish relatively quickly and not operate the trap anymore than necessary to avoid unnecessarily impacting listed spring chinook . Bickford said if the ten fish aren't collected during the five weeks they would continue to look for bull trout during summer chinook brood collections.

C. Spring Chinook Broodstock Protocol

Woodin said Chris Petersen would be developing the protocols, hopefully by the end of January. The collection of broodstock for the Methow Hatchery will focus on tributary collection with any collection at Wells coordinated with bull trout trapping.

D. Size at Release for Spring Chinook at the Methow Hatchery

Woodin said WDF&W hatchery and evaluation group is recommending that the existing program be modified by rearing spring chinook to 11-12 fish per pound by release rather than the 16 fish per pound currently being reared. They feel this will result in increased smolt to adult returns. This change would include reducing the target number of fish to be reared to 407,000 from the current target of 540,000.

Klinge said that Douglas PUD has some reservations regarding an apparent movement away from the supplementation approach the program was designed to follow. He said he feels this type of change needs to be discussed in the Wells Committee as was the decision to collect broodstock at Wells Dam in previous years. Feldmann asked if this decision had already been made or is there time for the Wells Committee to consider whether or not the change should be made. Woodin said WDF&W feels the proposed change would result in a more effective program. No decision was made regarding the proposed change.

E. Habitat Conservation Plan (Taken from Mid-Columbia meeting summary under Rocky Reach

Nordlund said he wanted this subject on the agenda to give committee members a "heads up". Dach explained that there is a procedural policy to hold a public meeting between December 29 and March 29 to discuss the DEIS. He said this isn't a requirement but if there are any controversial issues they would like to meet with the parties to address those issues. All discussion pertaining to the HCP need to be part of the record which accompanies the final HCP EIS submittal. Nordlund said this is important in consideration of alternatives. The first meeting is to identify issues which then will be considered in follow-up discussions. Dach outlined the necessary steps NMFS will take to arrive at a final Section 10 Permit and record of decision. The completed Section 10 Permit would come with an EIS.

Woodin asked if it wouldn't be advisable to use the meeting on the DEIS to ferret out other entities that may have an interest in the outcome rather than just a meeting of parties making up the Mid-Columbia Coordinating Committee. Dach asked if he thought that should be done at the same time as the meeting of the parties making up the MCCC. Salter suggested a morning/afternoon agency type meeting followed by a public meeting in the evening. It was suggested that early March might be a good time frame for those meetings. Issues identified prior to March 29 that can't be resolved by "word smithing" will be addressed reconvening the HCP technical committee. That committee would have until July to resolve issues if a final record of decision is to be filled before April 2002. March 6,7, or 8 were selected as possible dates for a dual meeting in Wenatchee.

The next meeting of the Wells Coordinating Committee will be February 13 at Sea/Tac.

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WELLS 2001-2

WELLS COORDINATING COMMITTEE MEETING SUMMARY

February 13, 2001

Agreements Reached:

1.

I. JOINT ITEMS

A. 2001 Adult Studies

Peven said they had received a letter from Dach that raised a lot of good points but it didn't address what Chelan PUD had asked for. He said their intent is to not conduct an adult study in 2001. Woodin asked for clarification from Peven. Peven explained that they feel the information from the 2000 study was adequate to address existing conditions. They feel it would be more appropriate to conduct an adult study after construction of the juvenile bypass at Rocky Reach.

Hammond said he would give a short response on a 2001 adult study. He said they feel the issue, of whether or not to do an adult study, should be discussed in the context of a long-term agreement. He said he would like to see a technical group begin working on an adult study. He said there are still technical issues that need to be addressed before an adult study, addressing the NMFS desires is actually conducted. Dach said he feels that many of the technical issues raised by Grant PUD have been worked out over eight years of such study on the Snake and Lower Columbia Rivers. He said they have addressed this question in the re-licensing forum as well as the Mid-Columbia Coordinating Committee and tried to be as clear as possible. He said they can try to make their position more clear if this is necessary.

Hammond said Grant PUD's position regarding adult studies is basically that it should be dealt with as part of a long-term agreement. In addition, Hammond said there are still technical issues that need to be addressed before Grant PUD would be comfortable conducting another adult study. Dach said NMFS has tried to make it clear that it is difficult for NMFS to move forward on re-licensing without having priority studies conducted of which an adult minimum survival study is one. He said with the technology currently available they are able to develop minimal survival estimates but are not able to differentiate between natural mortality and tagging effects. He said 2001 is likely to be the lowest flow year on record and it would be a shame to miss this opportunity to address adult survival. He said adult studies are going forward on the lower Columbia in 2001 and this would make it more practical to extend those studies into the mid-Columbia. Dach went on to say that it is consistent across all re-licensing efforts that when there is cooperation on the part of the licensee to conduct studies considered necessary by NMFS, the process goes smoother.

B. Juvenile Survival Studies – 2001

Hammond reported on the status of the planned 2001 at Priest Rapids and Wanapum Dams. Preparations have been made at Wells Hatchery to accommodate tagging. A contract has been let to construct the tanks necessary to conduct the study. The release mechanism is being constructed so that it can be adapted to the Douglas PUD tanks, if necessary. A helicopter demonstration will be conducted next week (February 21).

Tagging will begin about March 19 and after a four day holding period will be transported to Priest Rapids. As fish are loaded at Wells they will go through a pescolator where the tags will be read.

Dach asked if the radio tags will be released with the PIT tags. Hammond said no, they will be sticking with the procedures established for earlier radio-tag studies. Dach asked, how is that likely to effect comparison of PIT and radio-tag results. Hammond acknowledged there were differences in release methodologies but he said the advantage of radio-tags is that the release point can be anywhere the tags are detected. Therefore, the established release point will be the same for both tag groups.

Dach asked for clarification on objective 9 in the draft study plan. Hammond explained that unit operation would be in blocks and the tags detected during those blocks would be used to estimate survival during those operating conditions. The replicate is the time block of operation and the tags that pass and are detected during that block.

Woodin said he wanted to address another question related to low flows. He said there are discussions taking place about possible changes in McNary operations and the fish may be barged rather than using spill at that project. Collection rate may increase at McNary but if the fish are barged those fish won't be available for collection at John Day or Bonneville. Hammond said he will be talking to Skalski about implications of changes in detection rates at McNary, John Day, and Bonneville. There was discussion about the potential for separation by tag code at McNary where individual tag codes can be diverted from collection/transportation facilities and placed back in the river. Dach stressed that the request to do so needs to be made ahead of time.

Dach asked why no mention was made of physiological assessment as part of the study plan. Hammond responded by saying that physiological assessment wasn't included at this time. He asked Dach if he would like to see that work included. Dach said the info could be used to assess the study fish condition in relation to in-river fish. Bickford reviewed the physiological work done in association with the Douglas PUD survival studies and the value of the assessment of various physiological parameters. Hammond said he would talk to LGL about the possibility of collecting that kind of data during the Grant PUD study in 2001.

Dach asked if the 2000 study report had been sent out yet. Hammond said no. Dach said he wanted to review the 2000 report before commenting further on the 2001 study plan. He said the selection of which detections to use was one area that he wanted to look at more closely.

Peven reported that Chelan PUD is canceling the telemetry portion of the 2001 study. He said they are concerned that with the low flows fish might not move fast enough to be detected within the tag life times. He said the PIT tag study will go forward pending information from Skalski re: changes in detection rates at McNary, John Day, and Bonneville. He said they will also conduct a pilot acoustic tag study but no survival estimate will be developed for the acoustic tag. In summary Peven said that Chelan PUD will do a PIT tag survival study (pending information from Skalski), a pilot acoustic tag study at Rock Island, and the telemetry study is cancelled for 2001.

There was considerable discussion concerning the lack of reliability of radio-tags used in past studies. Hammond said Peven's comments concerning low flows and possible longer travel times and fish likely not clearing the study area before the tag fails, will cause him to re-assess their study plans for 2001.

Hammond referred to the sub-yearling survival study plan previously distributed. Hammond said this study used 30,000 Priest Rapids Hatchery fish with 2000 run-of-river fish seined from the Wanapum pool (Crescent Bar). Woodin explained that the study was to determine how many fish can be used without impacting production releases and to develop the methodology for sub-yearling studies. A question was raised regarding the adequacy of the number of fish being considered for this study. Dach said it might be good to consider additional fish for the study but, this might not be the year for that. The committee agreed to support the sub-yearling study proposed.

II. WELLS DAM

A. Okanagan Sockeye

Klinge reported that the reports from Canadian studies are now in and have been distributed to the committee. He went on to say that the Canadians have informed Douglas PUD that they are going to send a letter to Douglas which will contain four boxes that will have the following elements:

Fish Habitat
Okanagan River Flow Management
Evaluation Tools
Project Manager

They will not, at this time bring forward a single recommendation for implementation. They have ruled out a siphon and adult transport. While they haven't ruled out a spawning channel, they are moving toward water management as a preferred option. They feel additional information needs to be developed. Woodin said he sees some logic to wanting to have better water management if 90% of the production is in the gravel and only 10% is in a spawning channel. Klinge said the letter is coming and he will forward it to the committee when it comes. He said the meeting with the Canadians and the committee will be March 27 in Vancouver at the Fairmont Hotel in the airport terminal.

B. Proposed Changes to Wells and Methow Hatchery Programs

Klinge reported that WDF&W is developing an analysis of the changes being proposed in the operation of the Methow and Wells Hatchery Programs. When this is distributed, it will be placed on the agenda for committee consideration. Bickford explained the reasoning behind the change being proposed for summer chinook at the Wells Hatchery. He said production of study fish the last several years has demonstrated that additional yearlings can be safely reared at Wells Hatchery so the WDF &W is proposing to shift the sub-yearling production to yearling production. Bickford said eliminating all sub-yearling production may not be Douglas PUD's preferred alternative. There was discussion of where these summer Chinook spawn and it was pointed out that Chelan Powerhouse tailrace and Wells tailrace are known spawning areas. Bickford also mentioned that the Colville Tribal fishery in the Chief Joseph tailrace is effective on summer Chinook, taking over 10% of the Wells summer chinook count.

C. Wells Hydroelectric Project Juvenile Bypass Operations

Klinge distributed a handout on the proposed operation of the Wells juvenile bypass required by the Wells Settlement Agreement. He said the proposed 2001 plan is identical to the 2000 plan. Dach asked if it was necessary to do any fyke netting and said he would prefer to see this phased out. He said as long as there is hydro acoustic monitoring he questions whether fyke netting is necessary or desirable. Bickford pointed out that in the discussion leading to the development of the proposed HCP the parties had agreed to continue hydro acoustic and fyke net monitoring through 2003. The committee agreed to the proposed 2001 Wells Juvenile Bypass monitoring plan.

D. Methow Spring Chinook Broodstock Collection

Klinge gave a "heads up" on the permit acquisition process for refurbishing Fulton Dam on the Chewuch River to allow collection of spring chinook broodstock for the Methow Hatchery. Dach said the application should be sent to NMFS at the same time it is submitted to the Corps of Engineers to speed up the process.

The next meeting of the Wells Coordinating Committee will be March 22 at Sea/Tac.

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WELLS COORDINATING COMMITTEE
MEETING SUMMARY
March 22, 2001

Agreements Reached:
1.

I. JOINT ITEMS
A. Spring Chinook Broodstock Protocol

Lee Bernheisel asked to speak to the committee regarding his position on the 2001 Methow River spring chinook broodstock protocol. He told the committee that he had reviewed the draft broodstock protocol and he noted that it called for collection of broodstock from the Methow River tributaries. He referred to his memo to the committee dated 10/16/99 in which he pointed out the importance of wild fish spawning. He questioned whether it was necessary to collect broodstock for hatchery production in 2001 given the strong return expected this year. He said it could be viable to use fish returning to the hatcheries for broodstock and allow wild fish to spawn naturally. He said he doesn't expect the committee to make a decision on this issue today but he wanted to reinforce the possibility of allowing all wild fish to spawn naturally.

Bernheisel also spoke to the question of Methow Composite broodstock concept being implemented by WDF&W. He said he questions the decision to pursue the composite brood concept. Woodin said the state is operating under two objectives, one to encourage natural spawning and the second, to compensate for losses through hydro projects. He said, in addition, there are on-going evaluation programs which are attempting to establish hydro loss levels that will help to refine the hatchery production levels necessary to meet compensation requirements for losses in the hydro system.

Cates asked about the status of repairs to the Fulton irrigation dam. Bickford reported that the permits were in place except for the Corps permit. The Corps needs to have a Section 7 consultation and the process is taking time. The contractor is standing by to start the re-hab as soon as the OK is given.

There was considerable discussion of Methow River flows and the impact on hatchery water supplies. Bernheisel discussed the designation of consumptive and non-consumptive water rights. The surface water supply to the Methow and Winthrop Hatcheries is in jeopardy. There was discussion of possible curtailment of production in 2001 due to the precarious water supplies. Woodin said that WDF&W is engaged in drought year planning for the state hatchery system.

Woodin asked if there were any comments on the spring chinook broodstock protocol which was distributed at the February coordinating committee meeting. He said he would like to finalize the protocol as soon as possible. Woodin said they would like to have final comments on the protocol for the Methow and Wenatchee spring chinook broodstock collection by the next coordinating committee meeting which will be April 16 at Sea/Tac.

Bickford pointed out the potential for curtailment of broodstock collection at Wells Dam if the water temperature reaches 69 degrees F. This is a provision in the Wells Project Biological Opinion. He said this has only happened once in the years Wells Dam has been in operation. There is a possibility that steelhead broodstock collection could take place on the east ladder during summer chinook broodstock collection which would leave the west ladder open for passage during the high temperature occurrences.

B. Adult Steelhead Telemetry Study

Bickford said the PUD's had met earlier in the week. He said there are eight objectives to the proposed study including a new objective which would assess kelt behavior. He said the study design calls for 400 tags to be applied to steelhead collected at Priest Rapids. Fish would be released at the same location above Vernita Bridge as in the 1999 study. Hammond said he had been in touch with Art Viola, WDF&W, who said the permit for tagging fish trapped at Priest Rapids is "in the mill".

Bickford distributed a draft study plan for the Adult Steelhead Telemetry Study. Marco asked what changes were being proposed to assess kelt behavior. Bickford said the most important change effecting kelt assessment will be coordination of tag codes to avoid duplication of juvenile and adult tags. In addition, the tributary monitoring stations will be left in place through the kelt migration and aerial flights will be added in late June/early July. Bickford said another change that will allow better assessment of kelt behavior will be monitoring for kelts at the dams. Bickford said he would like to have final comments by the next coordinating committee meeting (April 16). Woodin pointed out that Chelan PUD had prepared a project specific study plan and asked if Grant PUD and Douglas PUD were going to also prepare project specific plans. Hammond said Grant PUD would prepare one and Bickford said Douglas PUD would prepare one if people thought it was necessary. The committee recognized that Bob Dach might not be back in his office in time to review the general plan before the April 16 call for final comments. The committee agreed to allow Dach to comment after April 16 if needed.

Woodin asked for information from the 1999 study concerning spawning areas determined from radio tags detected. Bickford said these had been shown by LGL in the 1999 report and that was the latest information available. Hammond demonstrated a process developed by LGL which will graphically display tag detection by tributary. Marco asked about the duration of the 2001 study. Bickford said they are planning to extend the study through July of 2002 if fish are still moving.

C. McNary Transport Study

Nordlund said he wanted to make the committee aware of interest, on the part of NMFS, to use mid-Columbia radio-tagged chinook for a transport study they will be conducting at McNary Dam in 2001. He said NMFS would want to make sure the mid-Columbia studies retain high precision. Peven mentioned the potential to tag additional fish for this study. Hammond said the matter, insofar as the Grant PUD study is concerned, has been turned over to Skalski to address NMFS questions regarding PUD study precision and how precision would be effected by transporting a portion of detected tags at McNary. Hammond said when you do the math, if 50% of the Grant PUD tags are detected at McNary, some diversion of tags for transportation would be possible without a serious reduction in precision. There are some practical concerns, however, that must be taken into consideration. If tags are taken for transportation, it could effect individual tag groups or portions of tag group selectively. There was considerable discussion concerning what provisions would have to be made to allow fish from the PUD study to be transported without compromising the integrity of the PUD study. Two requirements that were mentioned were: 1) Fish would have to be taken at equal rates across all release groups and 2) Empirical assurance of detection rate at McNary.

Woodin said he would not want the PUD's to give NMFS the OK to go ahead without bring the matter back to the coordinating committee. He said he supports having fish for the NMFS transport study tagged prior to arrival at McNary rather than collecting and tagging fish at McNary. The committee supports the NMFS Transport Study concept but doesn't want to see the PUD studies compromised.

Hammond said Skalski had looked at a range of possible detection rates at McNary from 11½ to 75%. He said if the actual detection rate at McNary is less than 50% he wouldn't want any Grant PUD study fish transported. The committee felt that if further discussion with NMFS looks like the PUD fish can't be used, this will be reported at the April coordinating committee meeting. If it looks like the fish might be used, a coordinating committee conference call will be set up.

D. Vernita Bar Flows

Nordlund said Jim Ruff brought this issue to his attention. The target flow at Priest Rapids is 65 kcfs. At 55 kcfs it would provide 95% protection of redds. Hammond pointed out that this is maybe accurate for redds on Vernita Bar but doesn't necessarily mean 95% protection of redds on the entire Hanford Reach spawning area. Nordlund said the predicted benefit to Grand Coulee by dropping the Vernita Bar protection level 5 kcfs (to 60 kcfs) would be one foot of reservoir elevation with another one foot of elevation if protection flow was dropped another 5 kcfs (55 kcfs). Hammond pointed out that the Vernita Bar Agreement provides for reduced protection level at Vernita Bar when water forecast is at or below "critical (42 MAF). Woodin said his agency had made an assessment of going to 60 kcfs and estimated a 10% loss of redds (3 million fry). Woodin went on to say that the provision for the reduced protection level does not include refill of Grand Coulee. Woodin said he would like for Nordlund to carry the message back to the BPA and others that if they can't demonstrate a proportional impact to power generation there shouldn't be an impact to Vernita Bar protection and they should live with the provisions of the Vernita Bar Agreement. In addition, refill is not an acceptable objective for reduced protection levels at Vernita Bar.

Marco said he would like to see some projections on what these actions would mean in terms of spring flow benefits and possible Coulee refill which might enhance summer migration benefits. Cates said Howard Shaller would be the USF&WS person to provide their perspective. Hammond explained that BPA historically has not met the spirit of the Vernita Bar Agreement in the fall to keep the redd protection level at the lowest elevation possible.

II. WELLS DAM

A. Wells Bypass

Bickford said hydroacoustic monitoring began March 15. The bulkheads are in place and the first fyke net sample was collected on March 21. Four lamprey comprised the sample. Operations will start when the fish arrive. The bypass operations plan for 2001 was distributed to the committee at the February meeting. Woodin asked if they were ready to start the bypass operations and Bickford said they were. Bickford reported that repairs on the surface spill gate two should be complete by April 1. Repairs to spill gate six have already been made.

The next meeting of the Wells Coordinating Committee will be April 16 at Sea/Tac.

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WELLS COORDINATING COMMITTEE
MEETING SUMMARY
APRIL 16, 2001

Agreements Reached:

1. The Committee agreed to support the adult steelhead telemetry study plan previously distributed to the Committee.

I. JOINT ITEMS

A. Approval of March 22, 2001 Mid-Columbia Coordinating Committee meeting

The draft summary of the March 22, 2001 Mid-Columbia Coordinating Committee was sent to the committee members on April 12. Committee members requested more time to review the draft meeting summaries before they are finalized. The chair will send out the final summaries as soon as comments and suggestions are received.

B. Next Meeting Date and Place

The next meeting of the Mid-Columbia Coordinating Committee will be May 15-16 and will include tours of mid-Columbia hydro projects. An itinerary and preliminary agenda will be distributed around the end of April. Dach said he would like to tour mid-Columbia fish production facilities on the Wenatchee and Methow Rivers. Committee members will be available to show production facilities to Dach on May 17. Dach said he would probably attend a committee meeting on May 16 but would not take hydro project tours on that day.

Looking ahead at June, the committee decided to meet on June 21 if a meeting in June is necessary.

C. Adult Steelhead Telemetry Study - 2001

Bickford stated that he had not received any comments on the study plan distributed prior to the last meeting. He said this is basically the same as the 1999 study with the same seven objectives plus the addition of the objective of kelt behavior. Dach said we had talked about additional work in the tributaries in attempting to develop more information on spawning locations. Peven said there would be additional work in the tributaries but he wasn't sure if this work would be definitive, e.g. spawning associated with release location. Dach inquired about information on kelt behavior late in the season. He also asked about possible information on Snake River and Yakima River movement. Bickford said they would be adding flights into July if kelts are still moving. He said they had also talked to Bjornn about sharing data for fish moving to below Priest Rapids. Dach asked if there was a possibility that monitoring in the lower river could take place that would add information on over wintering, etc. Bickford said that would be difficult with the equipment available. Peven said people working in the lower river could be notified, re: mid-Columbia tag frequencies. Dach stated that it would be good to be able to use information developed from the telemetry study for future development of acclimation sites. Another question that might be addressed is what happens to kelts. Do they move all the way to the estuary or do they stay in the river system before moving upstream again to spawn? Peven mentioned that there has been a noticeable increase in kelts in the Rocky Reach bypass since the fishery in the Methow River closed. Marco asked Woodin if there were plans to re-initiate the Methow sport fishery. Woodin said his agency would like to see the sport fishery reopened. As far as he knows, there would not be any changes in the near term.

There was discussion concerning the status of the NMFS permit to do the adult telemetry study. The status of any necessary permit was unclear. Dach said it is possible that the study could be tied to the Wells Bi-Op. Dach said he was interested in the possible use of information from the telemetry study to develop a data base similar to what was used in the Federal System Bi-Op.

Concerning the study plan, Dach said he was comfortable that it was similar to the previous study. The study should provide information he could use in assessing adult steelhead survival. The PUD committee members and Dach did not agree on the efficacy of using telemetry studies to assess adult survival.

The Committee agreed to support the adult steelhead telemetry study plan previously distributed to the Committee.

D. Broodstock Protocol

The draft broodstock protocol was distributed to the committee in mid-March. Spring chinook collection will begin shortly and we need to finalize the protocol. Klinge said that with the run size developing it should be possible to move back toward more emphasis on collection of naturally produced fish. The previous protocols have been developed in response to low adult escapement in recent years. There was discussion concerning the Carson stock influence on the Methow Composite stock. The high contribution of Carson genes in the yearling fish which had been scheduled for release in the Chewuch River resulted in a decision by the Washington Department of Fish and Wildlife to not release the fish in that river. Klinge said he feels this year there should be an emphasis on unmarked fish in the broodstock.

Klinge went on to say that he also believes there needs to be a movement back to the original concept of supplementation at the Methow Hatchery. Clubb pointed out that the size goal for the hatchery yearlings as one area which appears to be shifting away from the supplementation concept. The original goal was to release fish similar in size to the natural migrants and now the target appears to be much larger. Truscott pointed out that what they are attempting to do is produce fish that have an increased probability of survival to produce more adults to spawn naturally. Clubb said what they see are decisions being made that appear to Douglas PUD to signal a change in philosophy without discussion on the rationale for those changes. Woodin said these changes are the result of considerable analysis by WDF&W and not just unfounded decisions. Klinge will draft a response to the WDF&W broodstock collection protocol within the next two weeks and attempt to resolve the matter through discussion with WDF&W. If WDF&W and Douglas PUD can come to agreement between now and the May meeting, a conference call will be set up to ask for Wells Coordinating Committee approval so that spring chinook broodstock collection can proceed.

As far as the Wenatchee River is concerned, there is a question concerning funding for a temporary weir in Nason Creek. Broodstock collection will take place on the Chiwawa River and at Tumwater Dam. Dach asked when collection on Nason Creek would start if funding was available. Woodin said it would be July. Woodin pointed out that redd mining would only take place on White River.

E. Adult Fish Counting

Woodin had requested that this item be placed on the agenda to get an idea of when counting would start. Hammond said they began counting on April 15 at Priest Rapids Dam and Peven said that they began counting on April 15 at Rock Island and Rocky Reach Dams. Woodin asked if Douglas PUD would start counting at Wells Dam prior to May 1 if the run was early. Klinge said they would probably bring the fish counters in on May 1 but they could video tape earlier counts if fish were present. Klinge went on to say that in view of the numbers of fish passing McNary Dam, Douglas PUD would initiate video taping of passage at Wells Dam on April 17.

F. Upper Columbia Salmon Recovery Board

Rose brought to the attention of the Committee activities taking place in the Salmon Recovery Board (SRB) forum. He said that he, Bickford, and Cates participate on the Regional Technical Team of the SRB. The intent of the SRB is to coordinate funding and salmon recovery activities of Chelan, Douglas, and Grant Counties. Rose said they feel there may be a broader involvement of the SRB and could include habitat, HCP, re-licensing, etc. He referred to the Northwest Power Planning Council initiative on Priority Watersheds. Rose said he would like to have Mid-Columbia Coordinating Committee representation at a meeting they are trying to set up this week.

Rose said his intent in bringing this matter up today is a "heads up" and by the next meeting of the Committee he would like to have 20 minutes to present the vision that is developing, to the Committee. He went on to say they would like to conclude an acceptable framework that would fit into the NMPPC process regarding Priority Watersheds. Dach said how NMFS might participate depends on what happens with the mid-Columbia HCP's.

II. WELLS DAM

A. Juvenile Bypass Operations

Klinge said that hydroacoustic monitoring had indicated the bypass should be started soon. That resulted in initiation of the bypass on April 15 at 2000 hours. He said some of the hatchery fish upstream of Wells Dam have been released and others are scheduled to be released this week. Clubb said that Douglas PUD is committed to meeting license conditions and operation of the bypass is one of those conditions. He said he was hopeful, given the dire power picture, that the JFP would join Douglas PUD in operating the bypass with the most liberal interpretation in such things as the period between the end of the spring migration and the start of the summer migration.

B. Okanagan Sockeye

Clubb reviewed the status of discussions regarding Okanagan sockeye enhancement. He said a letter had been drafted to the Committee chair for distribution to the Committee. A conference call was held on April 11 for the JFP to discuss this matter. Marco reviewed the results of the JFP conference call. He said concerning the issue of the proposed water management optimization plan, the JFP agreed there was potential for production gains but not at the level projected. The JFP feels the benefits should more properly be considered as an element of habitat improvement rather than as hatchery production offset. The JFP feels the spawning channel option should be moved forward and it has the potential to replace hatchery production.

They feel that the channel process needs to continue until there is assurance that the channel can, in fact, be built. In the meantime, the JFP feel that Cassimer Bar Hatchery should continue to operate. There is interest in better evaluation of Cassimer Bar Hatchery production with the use of PIT tags. Marco said it was his understanding that there would be PIT tag detection at Wells Dam within the next several years. Clubb acknowledged the possibility that PIT tag detection at the Wells Dam adult ladders might be available in the future.

Cates said there was discussion about the scaling of production at Cassimer Bar to allow rearing of quality fish for evaluation. Marco said associated questions raised are: 1) how large a fish does it take to allow PIT tagging and 2) how many fish would be required to allow a valid evaluation.

Clubb reviewed the provisions of the Wells Settlement Agreement insofar as sockeye mitigation is concerned. He said that every since 1991 there has been an attempt to find a way to successfully rear sockeye. He pointed out that the Canadian interests had been opposed to a program which moved hatchery fish into the Osoyoos Lake system. He said he felt Douglas PUD had gone the extra mile in attempting to support development of a successful sockeye program. He said their evaluation of mitigation obligations leads them to believe that support of whatever option the Canadian interests and the Wells Committee can agree on is the only option that Douglas PUD can pursue. Funding of the Cassimer Bar Hatchery beyond the release of the fish currently being reared is not something that Douglas PUD can support. Klinge said the Canadians continue to say they are committed to an ecosystem approach for sockeye enhancement. He said he believes the District can do something positive for the resource by implementing a Canadian supported program.

Marco said it wasn't his understanding that there was a lack of Canadian support for a spawning channel. Clubb said that discussions between the Canadian parties and Douglas PUD cast doubt on the commitment of B.C. Environment to a spawning channel. When asked if they would support what ever permits or licensees were necessary for channel construction, B.C. Environment was less than convincing of their support. The water management optimization option was the only one presented to the PUD that had unanimous Canadian support.

Woodin said he felt that water management optimization was something that should go forward regardless of Douglas PUD involvement. He said the purchase of necessary hardware could be something that Douglas PUD could receive production credit for. Woodin went on to say that their preference would be to pursue both the channel and water management options but they would like to see other parties involved and not rely on Douglas PUD to fund the entire cost of both options. Woodin asked if Douglas PUD would be willing to support PIT tagging of the current years production at Cassimer Bar. Marco said he would expect their would be approximately 80,000 fish for release into Osoyoos Lake this fall. A question was raised concerning the viability of PIT tagging sockeye and sub-yearling chinook.

There was discussion concerning whether or not the Committee would be able to count on the Canadian parties to follow through on an agreed water management optimization program. It was recognized that this was something that could be addressed in dialog with the Canadian parties leading up to an agreement but ultimately it would be up to them to implement such a program.

It was pointed out that the Canadians had indicated a desire to pursue all of the options presented. The Committee understood the Douglas PUD position was to implement a single option if that option was adequate to meet the production level necessary to meet Douglas PUD mitigation level. Woodin said the JFP isn't saying some support of water management optimization by the PUD isn't appropriate, but they question whether that support should be perpetual.

In response to a question from Truscott, Clubb reviewed the Water Management Optimization option in terms of what data would be collected and how it would be used to benefit sockeye production. Truscott said that from the standpoint of his coming into this issue late, it would seem to him to be appropriate to evaluate production increases from flow management before terminating hatchery production and this wouldn't necessarily require a lengthy evaluation.

Marco asked about the sockeye species substitution which was discussed last week. Clubb read from the HCP document which addressed the question of species substitution. The species substitution was carried forward from the Wells Settlement Agreement.

Dach said it seemed appropriate to him to go back to the Canadian parties to see if they could support the spawning channel as part of a four option program. Clubb said the Canadian parties might go along with something like that but Douglas PUD isn't willing to provide funding for more than one option. Dach pointed out there were other players that should be brought into the process (i.e. Chelan and Grant PUDs). Dach asked how the Canadian parties came to the position of supporting just the water management option. They had originally asked for two additional years of study. Klinge explained how the Canadian parties had, during development of the spawning channel option, raised concerns that cast doubt on that option.

Dach asked if the evaluation of water management would be adequate to determine additions to production from water management. Clubb said they haven't presented an evaluation plan but it was expected that such a plan would be adequate to evaluate production increases. He also said that they (JFP) also need an understanding that should the expected benefits not materialize, other options to increase production would be developed.

Woodin said they also need a better understanding of what the water management optimization program actually consists of . Marco said the JFP need to have further discussions on this matter. Douglas PUD will request that the Canadian parties provide a more detailed plan for water management optimization and a formal monitoring and evaluation plan that is adequate to determine production gains. Douglas PUD will also request that Kim Hyatt (DFO) provide additional information and documentation concerning the survival benefits of flow management. After receiving this information, the JFP will discuss whether or not this is an option they can support. Bickford likened the Monitoring and Evaluation need as being one level above the ongoing Vernita Bar Evaluation.

The next meeting of the Wells Coordinating Committee will be May 16 - 17 at Wanapum Village.

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WELLS COORDINATING COMMITTEE
MEETING SUMMARY
MAY 16, 2001

Agreements Reached:

1. The Committee agreed to support the adult steelhead telemetry study plan previously distributed to the Committee.

I. JOINT ITEMS

A. Next Meeting Date and Location

The next meeting of the Mid-Columbia Coordinating Committee will be June 21 in Portland, Oregon.

B. Spring Chinook Broodstock Protocol

Truscott distributed a draft broodstock protocol document. He said there had been some policy level decisions made that drive the draft protocol. He said there will be no broodstock collection at the Winthrop Hatchery in 2001. The 1000 adult spring chinook needed for the Winthrop and Methow Hatcheries combined will be collected at traps on the Chewuch and Twisp Rivers and the Methow Hatchery. There will be no sorting by adipose present or absent at the tributary traps although there is the assumption that a certain proportion of the fish collected will be adipose present fish from natural spawning. Klinge reported that, to date, approximately 24% of the 6000 fish that passed Wells Dam through May 15, are adipose present fish.

Klinge reiterated that 2001 is a good year to move back toward the original objective of the Methow Hatchery, i.e. supplementation. Klinge pointed out the surface water supply issue at the Methow and Winthrop Hatcheries which could impact production if the hatcheries are at maximum loading. Klinge also called attention to the decision made by WDF&W and others to maximize production. Cates said there is a need to develop a long-term strategy for the use of the Methow and Winthrop Hatcheries.

Klinge said that Douglas PUD is interested in seeing the west ladder trap at Wells Dam used for collection of summer chinook broodstock rather than relying on the channel flow for attracting volunteers. Truscott said that Wells Hatchery personnel have provided some reasons for not using the ladder trap and would prefer to use the volunteer trap instead. Klinge said this hasn't been a problem in the past but this year, with the energy crunch, Douglas PUD is looking for ways to conserve water use, where alternatives exist, to provide more power generation. Bickford said the PUD is also proposing that summer chinook and steelhead collection be combined to make a more efficient operation.

The Committee discussed implications of elevated water temperatures on broodstock collection and Truscott said if they see water temperatures rising to near 18 degrees C., they may try to front load the collection process.

C. McNary Transportation Study

Steve Smith, NMFS, joined the meeting by telephone at this point. Hammond reviewed previous Committee discussion concerning McNary transport of Mid-Columbia study fish. He said NMFS has recently reviewed the recovery of Grant PUD survival study PIT tagged fish. Their analysis indicates the detection rate is about 50%. Smith said their updated information from PITagis shows a detection rate over 50%. He went on to say that the John Day detection rate also appeared to be about 51% based on the fish detected at McNary. For clarification, Smith said they had proposed to transport 25% of the mid-Columbia study fish detected at McNary. He said the one-half of the fish detected every other day will be transported while 100% are released into the river on the other days. Smith said, of the 68 tag groups being released in the mid-Columbia, there is a target percentage per group that will not be exceeded. Smith reminded everyone that the objective of their transport study was to determine adult return rates. They anticipate needing to transport 100 smolts for every adult expected or needed.

Woodin said he doesn't have a big problem with transporting the number or percentage of fish Smith wants but is very doubtful that the adult return rate will be as high as Smith anticipates. Woodin also said he hoped the Grant PUD study would not be compromised as a result of transporting a portion of those fish. Hammond asked Smith what he needed from him. Hammond said he would contact Dave Marvin indicating the OK to proceed with transport of fish from McNary under the conditions stated previously. Since today was a collection day, Smith was hopeful they could still transport a percentage of the Grant PUD fish collected today.

D. Bull Trout Trapping and Tagging

Hays said he had heard that one bull trout was tagged yesterday (5/15) but he wasn't sure which dam the fish was tagged at. Trapping began on May 15 at Rock Island and Rocky Reach. Bickford said trapping at Wells Dam will begin on Monday, May 21 with the objective of tagging 10 bull trout. Trapping at Wells will be three days per week until 10 fish are tagged. Hays said anyone who wants the bull trout information, and is not on their relicensing group, should request this information and it will be sent to them.

E. Adult Fish Count Reporting

Woodin asked why it seems to be taking so much time for the counts from Rock Island, Rocky Reach, and Wells to be included in the Corps of Engineers reporting system. Klinge said there has been a communications snafu that has impacted the reporting of all data from Wells Dam to the Corps. This is being worked on and they anticipate the matter being cleared-up shortly. Woodin also asked if Douglas PUD had followed through on their earlier agreement to use video taping of passage prior to the start of the active fish counting period. Klinge said they had the taped passage but had not had a chance to read the tapes as yet.

Woodin asked Hays and Carlson if Chelan and Grant PUD's planned to have any additional counter training for identification of coho. This has not been done, as yet, but both Hays and Carlson said they may be able to do something before the start of the coho passage season. Woodin said WDF&W may have a video which could be used for training and he offered to make that tape available to both PUD's.

F. Adult Steelhead Telemetry Study

Bickford said the tags had been ordered and things were moving forward on the study. Truscott said he would be talking to Koch this week about a permit for the study. Hammond said the logistics for the 2001 study would be the same as used in 1999. There was some discussion of the water temperature criteria for shutting down trapping if the water temperature exceeds 69 degrees F. This criteria is the same as used in 1999 which resulted in shutting down trapping several times in that year. The possibility of trapping later in the evening or in the morning to try to avoid high water temperatures was discussed.

II. WELLS DAM

A. Okanagan Sockeye Update

Klinge reviewed the previous discussion regarding Canadian activities related to Okanagan sockeye enhancement options. Douglas PUD has received a draft plan from the Canadian parties which is, in Douglas PUD's opinion, inadequate for Committee purposes. They are continuing to work with the Canadians on this plan and as it is received it will b forwarded on to the Wells Coordinating Committee. It is expected that this will then become Douglas PUD's obligation for Okanagan sockeye mitigation.

Cates asked when the Okanagan/Similkameen Work Shop will be held. It is apparently sometime in June but no one was sure of the date. Hays said Chelan PUD had been approached by Bob Rose, of the Yakama Nation, to have sockeye enhancement discussions under the Rocky Reach relicensing Natural Resources Group. He said it appears that this is an appropriate forum to hold these discussions and if anyone has any ideas they should come forward. Woodin questioned why this was being proposed for the relicensing forum when it previously was handled under HCP deliberations. He said he is becoming frustrated at swapping issues back and forth between forums.

Marco reported that an operator at the Rock Island bypass trap indicated that a number of large sockeye smolts, with a ventral fin missing, had been observed last year. Marco said he asked for this data to be made available.

B. Foghorn Dam Rehabilitation

Cates said the Biological Assessment for the Foghorn Dam Rehabilitation just went out to the NMFS and USFWS for review. The construction window indicated was July 1 to August 30 and November to February.

C. Juvenile Bypass Operations

Klinge distributed a review of the 2001 operation of the Wells Juvenile Bypass. He pointed out that the hydroacoustic index has been elevated the last week or so. He said he feels the steelhead numbers may be decreasing and the sockeye numbers increasing. He reported that he and Bickford were at Zosel Dam on May 11 and observed large numbers of sockeye smolts passing at the dam. He described modifications which had been made in a spill gate at Zosel and how manipulation of a gate or gates resulted in immediate passage of schools of sockeye smolts accumulating above the dam.

The next meeting of the Wells Coordinating Committee will be June 21 in Portland.

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WELLS COORDINATING COMMITTEE
MEETING SUMMARY
JUNE 21, 2001

Agreements Reached:
1.

I. JOINT ITEMS

A. A. Next Meeting Date and Location

The next meeting of the Mid-Columbia Coordinating Committee will be August 7 at Sea/Tac.

B. HCP Progress Report

Dach reviewed the request from Douglas PUD to separate their HCP proceedings from the Chelan PUD HCP proceedings. He said he thinks this request will receive a favorable response from NMFS.

Dach said they had been looking at how the DEIS needs to be modified. He indicated that the process was still on track to have the process complete by April 2002. The permit application would have to be placed in the Federal Register by November to make the April 2002 schedule for completion. Dach said there are a number of issues in the HCP that would have to be resolved to go ahead with the final EIS. He said he envisions a substantial re-write of the DEIS based on comments received from Chelan PUD whereas the comments received from Douglas PUD probably wouldn't require a re-write. He said their intent is to work on both the Douglas PUD and Chelan PUD process concurrently but he would not expect the processes to move along at the same speed. He said there are two modifications that have been requested that require analysis and may take considerable effort. One is analysis of other species and the other is looking at a connection between the tributary funding and the tributary projects envisioned. Bickford asked if a list of projects, that could be funded by a certain level of funding, would be helpful. Dach said that would be helpful. He said he expected a list of projects could be developed and prioritized.

Dach said Parametrix had recommended that if the two processes, i.e. the Douglas PUD and Chelan PUD HCP processes, were separated a notice would have to be placed in the Federal Register explaining the reason why this was being done and a statement that the EIS information is still applicable. He said it would be advantageous to also note that the QAR was also available at that time.

C. Broodstock Protocol Discussion

Truscott said the original broodstock protocol, distributed to the committee earlier in the year, did not provide for fish for studies. Chelan PUD has requested 100,000 fish for studies in 2003 which would require that an additional 30 summer chinook would have to be taken for broodstock this year. There was no opposition expressed to taking the additional 30 fish at Wells Dam.

Truscott updated the committee on trapping of spring chinook broodstock in the Methow Basin. He said they are presently holding 427 fish 36 of which were trapped at the Twisp River trap and 55 trapped at the Chewuch trap. The target for collection in 2001 is 1000 fish. Three hundred thirty six of the fish were trapped at the Methow Hatchery. There have been 75 fish trapped since June 15. Truscott explained that the Methow Hatchery crew is monitoring the number of fish allowed to enter the Methow Hatchery outfall channel. Woodin said that a decision had been made, on a June conference call, to shoot for 800 fish by the first week in July and then to evaluate where we are on collecting necessary broodstock. He asked Truscott if, at the current rate of collection, would we meet the 800 fish goal by the first of July. Truscott said it looks as if that goal will be made.

It was reported that there are currently approximately 300 fish in the Winthrop Hatchery outfall channel above the weir that is across the channel mouth. Scribner suggested that those fish be placed back in the river to spawn naturally since there is a strong probability that the necessary broodstock can be collected at the Methow Hatchery.

Truscott reviewed the trapping on the Twisp River and said in the interest of providing for passage past the weir, a chute was placed on the weir near the trap entrance. This appears to be effective in allowing passage past the weir and there is some indication that it may also make the trap more effective. Scribner asked if there were any plans to remove the weir if there is evidence that fish were stacking up below the weir. It was pointed out that the weir would be removed on July 15 or sooner if the target number of broodstock was reached.

Wenatchee River basin spring chinook broodstock collection was summarized by Truscott. He said they had trapped and retained 184 out of the target objective of 379 fish. Truscott said the objective of the supplementation project is to take wild fish for broodstock. Approximately 80% of the fish collected thus far are of hatchery origin. Woodin said that the program that they initiated yesterday was to emphasize natural origin broodstock by fishing the trap during the day and selecting for wild fish. They plan to take all the natural origin fish collected or 20 fish per day. If they don't collect 20 naturally produced fish, they will supplement the number taken with hatchery fish to reach the 20 fish daily goal.

There was discussion concerning the expected number of naturally produced fish that would likely be available from the Chiwawa. Truscott said the Tumwater Dam count through June 11 was about 1956 fish with about 773 of those with adipose fins present. The current thinking is to avoid taking more than 33 % of the natural origin fish for broodstock. Scribner said he could support what is being done now but would like to revisit the matter later. He said the tribe places the most emphasis on meeting the program goal of 750,000 smolts annually produced with less emphasis on taking naturally produced broodstock. Truscott said he originally considered review of the protocol on July 1 but now would like to have a review when additional Tumwater Dam counts are available. Scribner suggested a conference call on Thursday, June 28 to see where things stand. The chair will set this up and e-mail a notice to the membership.

Truscott reviewed the protocol for summer steelhead broodstock collection. He said they would like to exclude Hatchery X Hatchery crosses from broodstock collection in the interest of avoiding the earlier spawning of hatchery fish. Truscott said the H X H component is expected to be less than 15% of the total. Truscott went on to say that the target is 208 fish for Wenatchee River summer steelhead broodstock. He said he expected the trap at Dryden Dam to be more effective with the low river flows expected this year. The intent is to move the spawning period of hatchery produced fish back toward the natural spawning timing.

D. Water Temperature Related to Broodstock Collection and Trap Operation

Truscott reviewed concerns regarding water temperatures and broodstock collection. He said there are inconsistencies between the water temperature conditions established for radio tagging steelhead at Priest Rapids and the water temperature conditions established for collecting broodstock at Wells Dam. In addition, summer chinook collections at the Wells Dam left bank ladder also has water temperature implications. Hammond asked if there was any standard for how and where water temperature should be taken. There was discussion concerning whether post trapping water temperature effects could reasonably be lower than ambient river water temperature. There seemed to be more concern with pre-trapping effects of higher water temperatures. Dach said handling fish when water temperature reaches 69 degrees F. is asking for trouble. He strongly recommended that trap operations cease when the water temperature reaches 69 degrees. Woodin said it was probable, if there are no objections, that WDF&W would begin collecting summer chinook at Wells Dam next week. Front loading the broodstock collection could be one way of dealing with water temperature concerns. Dach said he would recommend that we plan around the 69 degree water temperature upper limit for trap operation. If we find, in the future, that we are "pushed-to-the-wall" then we can reconsider other actions. Bickford said looking at past year's temperatures, the 69 degree F. restriction would knock about six weeks of the steelhead telemetry study. Dach said let's proceed with the guidelines established and see what happens with the thought of modifying the guidelines if necessary. The committee also discussed the possibility of front-loading the steelhead telemetry study to try to avoid high water temperatures later in the year. The committee recognized that elevated water temperatures in excess of 69 degrees were likely and could threaten the steelhead telemetry study.

E. Adult Sockeye Sampling at Bonneville Dam

Jeff Fryer, CRITFC, explained the stock identification work they have been doing over the past 15 years to differentiate Okanagan sockeye from Wenatchee Basin sockeye. He distributed a study plan, 2000 report, and information on criteria used to separate these stocks. He is proposing to sample 3-400 fish at Wells Dam and Tumwater Dam, in 2001, with about 600-700 sampled at Bonneville Dam.

Klinge said this matter is being discussed today so that the Committee is aware of what Fryer has proposed. Woodin said Fryer needs to be aware that WDF&W is going to begin summer chinook broodstock trapping at Wells Dam next week. Klinge said their main concern is that the trapping operation be coordinated with other trapping operations and not an additional trapping effort. The committee did not oppose to the study plan presented by Fryer.

II. WELLS DAM

A. Methow Hatchery Surface Water Pump-back

Klinge explained the conditions attached to the surface water permit for the Methow Hatchery. He explained that this requires surface water discharge to be returned to the point of diversion during certain low stream flow conditions. Douglas PUD's engineering consultant is now working on how and where this water is to be returned. Woodin asked what stream flow requires this pump-back. Klinge said this is detailed in the permit and varies according to season. Dach asked if there would be a temperature difference between river water and hatchery effluent. Klinge said the temperature could be lower than river water temperature due to the influence of ground water mixed in the discharge. Woodin said serious consideration should be given to plumbing the return flow into the trap at Foghorn Dam. Klinge said this could be done.

Scribner asked if in planning for this pump-back they could look at ways to make the hatchery run more water flow efficient. He used the example of designing the system to allow pump-back of more than the current seven cfs of surface water to allow for increased production in the future. Hays discussed the changes in hatchery loading criteria that had taken place following construction of the hatchery.

B. Adult Fish Count Reporting

Klinge said this year has been extremely frustrating from a fish counting perspective. Between computers not talking to each other and computer people not talking to each other the adult fish counts from Wells Dam are still not being reported by the Corps. Woodin said none of the mid-Columbia PUD counts were in the data base last week. Klinge said they are in the process of developing a web site which will include the adult fish count information. They are hoping that people interested in the count information will be able to access this information on the web site. Hammond said the Corps has been unwilling to take counts from the Grant PUD web site for the reporting data base. Klinge said the chinook count thus far at Wells Dam exceeds 9600 fish.

Dach said he would prefer to see all the mid-Columbia counts in one place and tell the Corps that if they want this information to "come and get it". Woodin said that in the interim, until a better system is developed, Chelan and Grant PUDs could transmit information to the Fish Passage Center on a weekly basis as Douglas PUD currently does. That way the mid-Columbia counts would be available to anyone interested. Hammond offered to check with the Fish Passage Center to see if their data base could be modified to accommodate mid-Columbia counts from the web sites. Dach said that as an alternative to either not having the information available in a timely manner, or having to visit three different sites to get the information, combining the Mid-Columbia data in one location would be helpful. Then the COE could access that site (along with everyone else) to get all of the Mid-Columbia information.

Bickford suggested that the DART system could be used to report mid-Columbia counts. Bickford will explore how the DART system might be used to make mid-Columbia fish counts available to the region.

Woodin stressed the importance of the mid-Columbia fish counts to WDF&W fish managers who will want to evaluate potential for opening chinook fisheries.

C. Juvenile Bypass Operations

Klinge said they are continuing to operate the Wells Juvenile Bypass under spring operating conditions. He said he was hopeful that by now they would be able to either suspend operations or shift to summer operations. He said the index counts have been fairly high but the pattern of detections has been atypical for salmonids. Klinge reported that approximately 7.8% of total flow has been bypass flow.

D. WDF&W Proposed Shift in Summer Chinook Rearing Strategy at Wells Hatchery

Truscott said there has been a proposal to shift production of summer chinook at Wells Hatchery to entirely yearling production rather than a combination of yearling and sub-yearling production. He said their reasoning is to take advantage of the higher smolt to adult survival of yearlings. This would also have the advantage of requiring fewer adults for broodstock.

Scribner said he was most interested in the comparative survival information. He said, in general, the region is interested in trying to mimic nature and this proposal is contrary to that philosophy. He said we should make sure what is being proposed won't have long-term detrimental effects on the overall health of mid-Columbia summer chinook stocks. Scribner strongly suggested that the analysis be broadened beyond just a comparison of smolt to adult survival.

Hays said there is less information on sub-yearling fish than on yearling fish. He recalled evidence that yearling and sub-yearling summer chinook coded-wire tags were recovered in different areas of the ocean which may suggest behavioral differences which could be an important consideration.

Woodin said they will have a complete proposal available at or prior to the next meeting.

E. Okanagan Sockeye

Kim Hyatt, Canadian Department of Fisheries and Oceans, joined the meeting by telephone at this time. Hyatt explained the involvement of the Okanagan Basin Technical Working Group in sockeye enhancement planning. He said that Douglas PUD had asked for a single option to pursue sockeye enhancement in the Okanagan Basin. He went over the analysis that the Canadian parties had gone through to evaluate the water management option. He pointed out that there is reason to believe that up to 15% of annual production could be saved through more effective water management. He said they envision establishment of a multiple discipline team that would be set up over a three year process to provide the guidance and expertise necessary to make the project work. Hyatt likened the proposed work on the Okanagan to what is being done on the Fraser River. He pointed out that the Okanagan project is more complex due to its trans-boundary nature.

Dach asked how this program is being effected by the participation of Douglas PUD. Hyatt said the short answer to Dach's question is that the program would be unlikely to have come this far without the participation of the PUD.

Woodin asked, for clarification, if the proposal was basically a three year program to develop and document the water management tool and are the Canadian parties planning to ask for additional funds on an annual basis for O&M. Hyatt said there would be a need for ongoing funding for O&M and he said he expected that Douglas PUD would be a contributor.

There was a suggestion that Douglas PUD and the Wells Coordinating Committee was interested in more than just a projection of expected benefits but would expect to be able to document actual benefits from the activities proposed. The committee discussed the competition between those interested in kokanee enhancement and those interested in sockeye enhancement. Woodin expressed concern that in the future a decision could be made to favor kokanee enhancement in water management decisions. Hyatt said he understood Woodin's concerns but felt that the administrative structure that would be in place would be able to guard against a change of focus on the objective of enhancing sockeye production.

Hyatt said the final word he would like to leave with the Committee is that there was a great deal of work that went into where we are today. The Canadian parties view the exercise as one that may have application in other trans-boundary issues. They are very appreciative of the working agreement that has been developed with Douglas County PUD and look forward to working with the Wells Committee in the future.

Dach said he has doubts that the U.S. would actually receive very much out of pursuing this proposal. They could develop the tools and information needed to better manage flow but there is no assurance that the Canadian water managers would follow through to allow expected benefits to actually be realized. Hyatt responded by saying that there were initiatives ongoing that would be watching for violations of the intent of the information and processes developed. He called attention to the provision in the U.S. / Canada Treaty for monitoring compliance with agreements associated with southern trans-boundary issues.

Woodin asked Hyatt when they would have to know in order to benefit the next brood year. Hyatt said they would need to know by the end of July.

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Kim Hyatt	**(by telecom)**	
Mike Erho	**The Committee**	**merho@televar.com**

WELLS COORDINATING COMMITTEE MEETING SUMMARY AUGUST 7, 2001

Agreements Reached:
1.

I. JOINT ITEMS

A. Approval of June 21 Meeting Summary

The comments received on the draft June 21 meeting summary have been incorporated into a final draft which is ready for distribution. Nordlund asked if the revised summary could be distributed for review. The revised summary will be e-mailed to the Committee for review of the changes and if no further comments are received by August 10, the final summary will be distributed.

B. Next Meeting Date and Place

The Committee considered setting meeting dates for September and October. Because of ongoing HCP activities it was felt that Committee members would be too involved to attend a Mid-Columbia Coordinating Committee meeting during those months. It was suggested that Committee members could provide monthly updates to the chair who would compile the information and distribute it to the other Committee members. In addition, if issues arise that need discussion or resolution, conference calls will be used.

Looking ahead, the Committee selected November 8 for the next Mid-Columbia Coordinating Committee meeting which will be held in Portland.

C. Habitat Conservation Program Activities

Nordlund reported on progress on the HCP process. He said they are getting close to bring things together and are looking at forming technical committees to work on resolution of certain outstanding issues. National Marine Fisheries Service is asking for volunteers from the Fisheries Agencies and Tribes to work on these committees. The technical committees will deal with the following five issues:

1. Rocky Reach Surface Collection
2. Measurement and Performance Standards
3. QAR Process
4. Clean-up of the HCP Document
5. Dispute Resolution

By the end of the month there will be responses to comments on the HCP DEIS. Parametrix will prepare the response to comments.

The first draft of the final EIS will be ready by the end of September and will be reviewed internally by NMFS at that time. It will then go to other parties, by the end of November, for review. The draft Bi-Op will be out around the end of December. The final EIS is expected to be ready by mid-January and is scheduled to be entered into the Federal Register by February 1. The application for FERC permit will be finalized April 1.

Dach pointed out that the time frame for resolving all outstanding technical issues is from now until October 26.

D. Adult Steelhead Telemetry Study

Bickford reported that as of last week, 37 adult steelhead had been tagged. He said tagged fish have been detected at all projects. Two thirds of the fish have been using the right bank fishway at Priest Rapids. The steelhead count at Priest Rapids exceeds 6000 fish. Bickford said the study is on schedule, however, this schedule could be severely impacted by warm water temperatures. Bickford estimated, based on historic data, that the water temperatures would exceed the 69 degree Fahrenheit, the cut-off temperature for trapping steelhead, by the end of August. Hammond said the water temperature in the trap has been running 18.5 to 19.0 degrees Celsius. Peak temperatures in the trap are usually in the early evening hours (about 8 PM). The daily variation in temperature is generally 1.5 to 2.0 degrees C.

Dach asked why the tagging effort wasn't front loaded to make up for tags that might not be placed during September/October when high water temperatures restrict access to fish. Hammond said restrictions on tagging will be due to water temperatures rather than lack of numbers. In September, according to the tagging schedule, approximately 50 fish per week will be tagged. This is during the likely peak of water temperature. Dach said he doesn't understand why tagging more fish early is necessarily a bad thing. Truscott said if the intent is to try to duplicate the 1999 study, tagging fish earlier is not the way to do it.

Hammond asked what flexibility there might be for modifying the water temperature regulations. The specific cut-off temperature, it was pointed out, relates to the Wells Project Bi-Op. for broodstock collection. Hammond asked if it wasn't fish condition that was important rather than a specific water temperature. The committee agreed. Bickford estimated that the tagging would be shut-down within two weeks due to rising water temperatures. The schedule that is being followed is one that tags a proportion of the fish arriving at the Priest Rapids trap. The study plan called for tagging a certain number of fish each week based on the fish available at the trap during the past ten year period.

The Committee felt it would be desirable to have half of the tags applied by the first week in September. If 25 fish were tagged each tagging day through August, eight days, it would total 200 fish. Realistically, there will probably be only six tagging days available due to water temperature restrictions. Dach suggested shorter tagging days and more days, i.e. four, four hour days. It was suggested that the trap be put into operation earlier in the day rather than starting at 8 AM as they do now to try to make more fish available for tagging earlier in the day. Dach suggested tagging as many fish as possible until the operation is shut-down by high water temperatures, with the goal of having half of the tags applied by September 1. Truscott asked about the possibility of a cooler to cool the holding tank water temperature. Several suggestions were made for ways to cool the anesthetic water and holding tank water temperature. Heinith pointed out that the cut-off water temperature at Bonneville Dam is 70 degrees F. The plan the Committee agreed should be followed was outlined by Dach, as follows:

1. The tagging effort will be increased in an effort to release 200 tags by September 1 or whenever elevated water temperatures shut down tagging.
2. When water temperature reaches 69 degrees F. the tagging should go to An early morning schedule to continue the tagging effort.

3. Explore ways to reduce holding water temperature.

E. Dissolved Gas

Maynard reported on efforts by Oregon, Washington, and Idaho to develop TDML for water quality standards. A modeler has been retained to work on this effort. He said the initial draft is available on the EPA Region 10 web page. Maynard said he looked at the agenda for this meeting and realized that a number of the agenda items could be effected by this TDML effort. He feels the Mid-Columbia parties need to keep a finger on the pulse of what is going on. He said the intent is to have final standards for the mid-Columbia by the end of this year. If, in the future, it was found that the standards could not be met the Committee could work together in an attempt to have special conditions recognized. These would have to be achievable and WDOE would examine the special conditions requested. There was discussion concerning whether or not the new standards would allocate a TDML based on changes from the delta temperature or TDG level. Maynard said they would.

F. Broodstock Protocol Update

Truscott reported on Methow Basin spring chinook broodstock collection. A total of 897 fish were collected by July 27 with 776 of those from the Methow Hatchery outfall. Seventy-three fish were collected from the Chewuch River trap, 32 of which had adipose fins present. Forty-eight fish were collected from the Twisp River trap, 35 of which had adipose fins. Very few of the fish collected from the Methow Hatchery outfall had adipose fins. Truscott said the first egg take at the Methow Hatchery will be on August 8 while the first egg take at the Winthrop Hatchery will be August 15.

Truscott reported that the Wenatchee Basin spring chinook broodstock goal of 379 fish had been reached before July 15. Thirty percent of the fish collected had adipose fins present.

The discussion turned to the spring chinook captive brood program. It was reported that the gametes from the Twisp captive brood fish would be taken to the Methow Hatchery as unfertilized gametes. Nason Creek fish which are maturing will be taken to Nason Creek and released to spawn naturally. Eggs from White River adults will be eyed-out at Rochester. Peven said if captive brood eggs are going to be taken to a Chelan PUD hatchery, the PUD will require a written long-term plan for those fish before they are taken on the project since Chelan PUD doesn't want responsibility for those fish.

Dach said NMFS wants to have a meeting on captive brood right away to make sure everyone is on the same track. This meeting will be set up for next week.

Truscott said summer chinook and steelhead collection is ongoing. Sixty-six percent of the Wenatchee Basin summer chinook broodstock target have been collected (326 fish). Eighteen steelhead have been collected to date of the 208 fish goal. Truscott said 78% of steelhead observed at Dryden trap are adipose present fish.

Collection of volunteer summer chinook at Wells Hatchery was complete two weeks early (1208 fish). This doesn't include survival study fish requested by Chelan PUD. Collection of summer chinook in the east ladder trap at Wells Dam was very poor since 90% of the summer chinook were passing at the west ladder. Collection was shifted to the west ladder trap last Tuesday. On August 1, 366 fish had been collected of the 556 fish target. Truscott said collection at the east ladder trap was predominantly three year fish and the hatchery crew is adjusting at the west ladder trap for four and five year fish to bring year classes into line. Twenty-seven steelhead have been collected through July 26 out of the 395 fish target.

II. WELLS DAM

A. 2001 Wells Dam Juvenile Bypass Operations

Klinge reported on operations of the Wells Juvenile Bypass for the spring and summer migrations. He said the bypass had operated from April 15 through June 21, a total of 68 days. Bypass flow totaled 7 million acre feet or approximately 8;% of project flow. There has been no forced spill in 2001. Summer bypass began on June 22 and through August 6 has been in operation, a total of 46 days. There has been some fish activity in the forebay at Wells, as indicated by hydroacoustic monitoring, but until fyke net samples are taken there is no species composition data. The first fykenetting will be August 15. Klinge said there have been reports of large numbers of stickleback this year at Wells and also reports of the same at the Rock Island bypass trap.

B. Okanagan Sockeye

During the lunch break the Joint Fisheries Parties caucused to discuss a JFP position on the Okanagan sockeye proposal presented to Douglas PUD by the Canadian parties involved with Okanagan sockeye.

Klinge reviewed the activities associated with Wells Coordinating Committee consideration of the Okanagan sockeye proposal. He reviewed the letter from Douglas PUD to the Committee outlining the PUD's position regarding this proposal. He stressed the interest of the PUD to get on with a sockeye mitigation program which would meet Douglas PUD's obligation for sockeye mitigation. Heinith asked where things stood with the spawning channel option. Klinge said there was some interest in a spawning channel but they now feel the site originally selected was not as suitable as they thought. The biggest resistance to the spawning channel option was from the Ministry of Environment who had a number of questions regarding channel production and the effect the environment. The single option that had unanimous support from the Canadian parties was enhanced water management.

Heinith asked if there was a commitment from the water management agencies in Canada to operate according to the information developed under this proposal. Klinge said that they have told him that the information would be used to operate the system to reduce impacts of water management operations. He said they have stressed that the system will not be operated strictly to benefit fish since there are so many competing interests. They would expect to use the model information to manage water more efficiently to protect fish.

Rose asked how the "positive benefits" would be measured under the proposal. Klinge said they would identify the critical times when operations could result in benefits to the resource. Given the sensitivity to the First Nations interests, it would be more difficult to ignore operations which have been shown to benefit sockeye. In the past we could only speculate the operations that would benefit sockeye. The proposed plan would develop the tools that would remove the speculation.

Rose stated the Yakama Nation interests in having accountability concerning the water management option implementation. They feel the information could be very useful and should be collected by someone, whether that someone is Douglas PUD or someone else. They are concerned about what would happen if the projected benefits to sockeye don't actually happen. They are adamantly opposed to substitution of chinook production for sockeye. Klinge pointed out that of the six options considered, water management optimization was the only option which received unanimous support. Woodin said he recognized that, but, he wants to see how benefits would be assessed.

Marco said the Colville Tribe supported the water management optimization proposal but they are concerned that there wouldn't be any sockeye production benefits for three years while data is being collected. Klinge said he is hopeful, if the proposal goes forward, that there would be benefits this year with the large escapement and near record low flows.

Klinge said some Committee members have expressed interest in having Douglas PUD "jump-start" the water management optimization process and then turn it over to the Canadian entities. He said that there are a lot of laws on the books in Canada that there is no funding available to implement. That is the case with water management and the Canadians have stated that without Douglas PUD's support, it is unlikely that any needed information would be collected. Heinith stated that there are studies in the U.S. that would be helpful in benefiting sockeye. Would Douglas PUD be in a position to support those? Klinge said, from a PUD perspective, the support for the initial year of this study implementation the financial cost would be greater than what was needed for support of the Cassimer Bar Program. The annual support would be of the same magnitude as Cassimer Bar support. Douglas PUD is not interested in supporting other studies, at this time.

Rose said he appreciated the initiative of Douglas PUD in identifying options for sockeye mitigation. He said, however, there are two other entities in the mid-Columbia that will have sockeye mitigation responsibilities and both Grant and Chelan PUD's need to "step-up" to the plate and be involved in sockeye mitigation planning. Peven said they have opened up discussions regarding sockeye mitigation under the re-licensing arena.

Dach said what he senses from the Committee is that Douglas needs to show more detail on what will happen in the next three years. If the program works, the Committee would like to see support of the water management shifted to the Canadian parties and the level of funding by Douglas shifted to other sockeye mitigation purposes. If the program fails, the level of funding from Douglas would be shifted to other sockeye mitigation purposes and the alternative program evaluated to determine if mitigation is being achieved.

There was substantial discussion regarding what happens if the water management proposal doesn't work. The JFP are of the opinion that the species substitution provision of the Wells Settlement Agreement is moot since the Wells Settlement Agreement provides for a re-opener in three years. There was considerable discussion concerning how uncertainty with the water management option might be dealt with in terms of the financial obligation of the PUD under successful or unsuccessful water management implementation. There appears to be support for setting the financial obligation of the PUD to the level of support of a water management optimization program with the funds to be used for other sockeye mitigation projects if the program is successful and the Canadians take over support. If the program is unsuccessful, there is some question as to how the cost of species substitution summer chinook production might be factored into determining the PUD's financial obligation for another mitigation option. Douglas PUD will draft a statement of how, following this discussion, the PUD views moving ahead to implement the water management optimization option.

The JFP appears to be in support of the water management optimization proposal under the caveats discussed above.

Klinge posed the following question to Heinith: if we proceed with the proposal as discussed today, would Intertribe's concerns be addressed? Heinith said he feels they would.

The next meeting of the Wells Coordinating Committee will be November 8 in Portland.

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WELLS COORDINATING COMMITTEE MEETING SUMMARY NOVEMBER 16, 2001

Agreements Reached:

1. The committee agreed to proceed with Option 2 in the Truscott analysis of the 2001 summer chinook egg take shortage which includes shifting a portion of the sub-yearling summer chinook production at Wells Hatchery to yearling production.

2. The committee agreed to the closure of the orifice gates at Wanapum and Priest Rapids adult passage facilities with the understanding that Grant PUD would investigate other fish passage problems when they are identified through either MCCC or the relicensing process.

I. GENERAL MID-COLUMBIA ISSUES

A. Approval of August 7 Meeting Summary

The Committee approved distribution of the final summary of the August 8 Mid-Columbia, Rock Island, and Wells Coordinating Committee meetings.

B. Next Meeting Date and Place

The Committee decided to hold the next Mid-Columbia, Rock Island, and Wells Coordinating Committee meetings on December 13 at Sea/Tac.

C. NMFS Science Center Survival Study

Paul Wagner, NMFS, joined the meeting for the discussion of the proposed Science Center transportation study. Gene Mathews, from the Science Center joined the meeting by telecom to discuss the proposed study. NMFS is proposing to PIT tag hatchery fish at several hatcheries in the mid-Columbia in 2002. Tagged smolts will be collected at McNary Dam to assign to test (transport) or control (inriver) lots to evaluate smolt to adult returns of smolts transported from McNary Dam vs. smolts estimated to have migrated from the tailrace of McNary Dam through the remaining three dams and reservoirs. In some previous transportation studies the fish were collected and tagged at the dams. Mathews reviewed the numbers of fish required for the studies and explained the rationale for those numbers. Mathews said that NMFS considers this a high priority study. With the number of fish proposed to be tagged for the study, NMFS feels that there should be a high degree of resolution.

Peven asked if they are proposing a two year study or something else. Wagner said this is intended to be at least a three year study. Peven pointed out the potential problem with PUD study fish being transported from McNary Dam which would adversely impact PUD studies. Wagner said provisions would be improved at McNary which would allow PUD study fish to be returned to the river. Woodin expressed some concern about PUD study fish being inadvertently diverted for transport just due to the large number of tags encountered and the frequency of diverter gate operation.

Woodin inquired about the smolt to adult return(SAR) ratio used to develop the release numbers required. Mathews said they used 1% for all three populations which is the number that kept popping up during the review of previous studies. Woodin questioned whether 1% SAR was realistic in terms of yearling and sub-yearling chinook. It was pointed out that the SAR was based on return to Bonneville Dam. Woodin suggested that Mathews review the data he used to develop sub-yearling release numbers with more recent information from Priest Rapids Hatchery and the Hanford Reach.

Woodin asked if it wouldn't be worthwhile to consider tagging fish in the fall rather than closer to the migration. Mathews said this is a possibility although there is a limited amount of time to prepare for the 2002 study. Petersen pointed out the difficulties hatchery crews would have to accommodate the proposed level of tagging on steelhead. She said there were on-going studies that would be impacted by commitment of fish numbers of this magnitude in 2002.

Graves asked if the PUD study fish in 2002 could be used in any way in the proposed transport study. Mathews said he would be reluctant to mix yearling ocean-type chinook with yearling stream-type chinook in the proposed study due to the behavioral differences.

Wagner summarized the discussion with the following observations:

- It is unlikely that steelhead could be used in the proposed 2002 study.
- There are complications with consideration of yearling chinook use but it may be possible to use fish from a single source i.e. Leavenworth Hatchery.
- Sub-yearling chinook are the population that most likely could be used as proposed.

Mathews pointed out that it wold be difficult to use sub-yearlings since they would have to be tagged at the time they are busy tagging other fish.

There was discussion of the need to have PIT tag detection capability at the hatchery to have an accurate accounting of the tagged fish actually released. This would prevent inappropriate assessment of survival through the mid-Columbia which could result from the assumption that all fish tagged are actually released alive.

Woodin raised the question of coordination of this proposed study with the CSS planned studies. Mathews said he would contact Larry Basham, Fish Passage Center, to determine how the studies could be coordinated and reduce, to the extent possible, the number of fish being tagged.

Peven that the PUD's prepare a joint response to the NMFS transport study proposal. Klinge said he thought this would be a good idea. Woodin said that WDF&W would also be preparing a response on the NMFS proposal.

D. Yakama Hydro Project

Woodin reported on a scoping meeting with the Yakama Hydro Project where they were discussing possible field studies. He said he told that group that they should coordinate those efforts with the Mid-Columbia Coordinating Committee. Peven expressed the importance of coordination of any field studies to prevent, to the extent possible, adverse impacts to each others studies. The committee agreed on the importance of having coordination among all entities who anticipate conducting studies in the mid-Columbia to avoid conflicts between studies.

II. WELLS DAM

A. Summary of Juvenile Bypass Operation

Klinge provided a summary of the 2001 Wells Dam Juvenile Bypass operation. He said this was for the committee members information.

B. Draft Implementation Plan

Klinge distributed a proposed operation plan for the Wells Juvenile Bypass for 2002. This included a summary of the hatchery fish that would be released above Wells Dam in 2002. He pointed out the spring chinook releases by the Colville Confederated Tribes on the Okanagan system. Marco said they would be releasing those spring chinook about April 15.

C. Canadian Flow Management on the Okanagan System

Klinge distributed a decision tree for how Douglas PUD is proposing to proceed with Okanagan River sockeye enhancement in Canada. He reported on a recent meeting he attended in British Columbia where fish managers, water managers, and modelers discussed how information could be shared and how they could use the modeling effort to better manage water and realize fish benefits. Klinge said Douglas PUD has contracted for sockeye and kokanee spawning ground surveys in 2001. The First Nations in Canada reported seeing approximately 40,000 sockeye on the spawning grounds. They also saw one adipose clipped sockeye and one chinook salmon on the spawning grounds. Klinge reported that the Canadians are very interested in the modeling effort and the benefits they anticipate for sockeye and kokanee by improved water management.

D. Wells HCP Discussions

Bickford reviewed the sockeye enhancement decision tree that was refined by Douglas PUD based on a rough draft from Woodin and Marco. Bickford asked Marco if he had a chance to review the tree. Marco said that it appears this was something that the Colville Confederated Tribes could support. Woodin also indicated support for the elements covered in the decision tree. Marco said he planned to review this with the Umatilla's and Yakama's and Columbia River Intertribal Fisheries Commission.

There was discussion of the effects going of the Flow Management Program on the future production of spring chinook at the Methow Hatchery. It was pointed out that if the Flow Management Plan was implemented, then the species substitution of spring chinook for sockeye, which is an existing portion of the Methow spring chinook production, would be reduced in future years. Truscott inquired as to what Douglas PUD had in mind for spring chinook should the Flow Management Program fail to produce a sufficient increase in sockeye survival. Bickford said that if the Flow Management Program was not successful, Douglas PUD would then try to increase sockeye survival through the construction of a spawning channel. If the combination of the Flow Management Plan and/or a spawning channel were not sufficient to boost sockeye survival by 7%, then the Douglas PUD would propose supplying spring chinook for use in the Okanagan. They were not suggesting that they would provide acclimation facilities for those fish. He went on to say that these would probably be Carson stock but they would use whatever stock the JFP determined appropriate.

Petersen asked how the annual increase in sockeye production, resulting from improved water management, would be evaluated. Klinge explained that Kim Hyatt was in the process of developing the evaluation plan and it is expected that the Committee would want to have an opportunity to review and provide input on that plan. Woodin expressed the need to have periodic review of the production increases under the Flow Management Optimization Program.

No one expressed opposition to the decision tree or the concept of Okanagan Basin water management optimization. This matter will be discussed at the upcoming (11/20/01) HCP meeting. Bickford said they would like to use the decision tree to guide discussion at that meeting.

E. Wells Adult PIT Tag Detector

Bickford reviewed Douglas PUD's plans to install PIT tag detection at Wells Dam. He explained that this was different than some of the Corps projects due to the unique configuration of Wells Dam. Bickford showed drawings that demonstrated the way the detectors would be installed. He said they would install one detector prior to shutdown for winter maintenance. They would then install the other three detectors. Bickford explained that unlike the Corps projects, if a problem develops in any detector they could replace that detector readily without an extended ladder outage. He said Douglas PUD plans to install detectors at the hatchery outfall and ladder traps, if there is sufficient interest, in 2003/2004. Bickford said the system will provide real-time data to the Pacific Salmon Treaty folks who were elated in the prospects of receiving this real-time information.

The next meeting of the Wells Coordinating Committee will be December 8 at Sea/Tac.

ATTENDANCE LIST

Name	Representing	e-mail address
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Cary Feldmann	Puget Sound Energy	cfeldm@puget.com
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WELLS COORDINATING COMMITTEE
MEETING SUMMARY
December 3, 2001

Agreements Reached:

1. The WCC unanimously agreed to support Douglas PUD's sockeye enhancement proposal which includes working with the Canadian fisheries parties to jointly develop a Flow Management Model and to implement other actions that will enhance sockeye production as outlined in the November 30th Sockeye Enhancement Decision Tree. Subsequent to the conference call, Ritchie Graves notified the chairman that NMFS supported Douglas PUD's sockeye enhancement proposal as summarized in the November 30 th Decision Tree.

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Chairman's Note: Since I was unable to participate on the call, this summary was prepared from notes taken by others during the conference call and a tape recording of the discussion.

Bob Clubb explained the new sockeye decision tree that was sent to the JFP for consideration on Friday November 30th. The new tree had three changes from the decision tree sent out on November 6 by Shane Bickford. The first change was a commitment to continue spring chinook production at the Methow Hatchery for the 2002 and 2003 brood years at 225,000 smolts. The second change added additional flexibility should flow management and a potential spawning channel fail to meet the 7% mitigation goal, then the District would commit the equivalent O&M dollars necessary to rear the required number of Spring Chinook toward a Coordinating Committee approved sockeye enhancement program. The last change was a commitment to redirect an equivalent level of funding that would have been required to continue to implement the Flow Management Program should the Canadian Parties be capable of funding all or a portion of the Flow Management Program.

It was mentioned that, during previous discussions, several people expressed concerns regarding the reduction of spring chinook production at the Methow Hatchery being proposed in the District's November 6th sockeye decision tree. The District was asked to consider continuing the commitment to raise spring chinook through 2005 in lieu of verified increases in the production of sockeye resulting from the Flow Management Program. In response the District prepared a new decision tree (November 30th version) which included spring chinook brood collections for the years 2002 and 2003 allowing the species substituted spring chinook (225,000 fish) to be reared at the MFH through 2005 when the Flow Management decision will be made.

Clubb explained the second change in the decision tree was a result of a request by Bob Rose and Bob Heinith for greater flexibility should the Flow Management option and the spawning channel not meet the required level of mitigation., Both Rose and Heinith wanted the ability to consider something other than spring chinook substitution, if the Coordinating Committee agreed.

An additional change to the decision tree was in response to a request from several Committee members that the District would provided funds equal to the Canadian Flow Management Program for a Coordinating Committee approved sockeye enhancement program if the Canadians are able to fund a part or all of the Flow Management Program in the future,

Bob Rose asked about a sockeye surrogate study that had been discussed in the fall of 2000. Clubb said the District has several concerns about a sockeye surrogacy study that would compare sockeye survival with chinook survival through a common river reach (Rocky Reach to McNary). Logistically, a sockeye surrogate study could not be done in 2002 since study fish have been committed to other studies. For 2003, the prototype surface collector and PIT tag detection system at Rocky Reach may be gone, which would prevent a sockeye surrogate study. Clubb said the District is uncomfortable committing to a study that it may not be able to perform because of the many unknowns. Bob Rose asked if the concept was off the table. Clubb said it is not off the table. Rose asked at what time would it be appropriate to start conversations related to the implementation of a sockeye surrogacy study. Clubb said that it might be possible to do a sockeye surrogate study in 2003 if the Committee agreed to a study identical to the one the District proposed in September 2000. However, Clubb said there is still a concern about the availability of test fish (hatchery chinook) in 2003. All of the excess production from the 2001 brood summer chinook at the Wells Hatchery have been assigned to Grant PUD for their 2003 survival study. Possibly spring chinook could be considered as the surrogacy species. Bickford said that the surrogacy study would have a side-by-side comparison of chinook to sockeye, preferably summer chinook, or some other group of yearling chinook. Rose said this was not the time to have discussions on the levels of detail for this work. He said he was satisfied long as it was not off the table in future years if the WCC decides the decision tree is the direction to go. Woodin said project and species specific studies for gathering FPE measurements would be something he would also like to see. Woodin said what we are searching for is better information for the interim calculation of sockeye survival at Wells. Clubb said right now, he is comfortable in keeping with what has been proposed (the 2000 sockeye surrogacy study plan. He said there are many technical problems with "at-dam" measurements of sockeye survival and FPE and the District is not willing to commit to an "at-dam" sockeye survival study. Clubb clarified that the District is willing to conduct the sockeye surrogate study that was proposed in 2000, but does not agree to all the issues raised by Woodin because current technology is not adequate for collecting meaningful information on sockeye. He said they are willing to gather information on relative survival to better understand what sockeye are doing in the mid-Columbia. Woodin said he understands that with today's technology, some of these things are not possible. Clubb indicated that discussions in the HCP negotiations have focused on a commitment by the District to use new technologies after they are developed. The District is not interested in assuming the responsibility for development of new technology for this effort. Clubb said the District believes the November 30th decision tree will allow for a meaningful program for the enhancement of the Okanogan sockeye and makes sense to the Canadian Agencies and Tribes and, he hopes, the members of the WCC. Clubb said the purpose of today's call is to secure acceptance of the November 30th sockeye enhancement decision tree which would allow the District to move forward with the proposed program.

Woodin asked for clarification of the decision tree diagram. He asked, if flow management or the spawning channel could not provide a 2% benefit, would other options be implemented? Bickford said yes. An efficiency of costs would not occur if we saw only 0.5% benefit in sockeye production from Flow Management, then we would want to put all our efforts into the channel. If Flow Management gave 4% benefit and the channel gave 3%, we would be there. The original decision tree had species substitution to make up the difference whereas the new decision tree provides flexibility in terms of making up the difference should other options fail to produce the required 7% increase in production.

Woodin asked about the provision in the decision tree that provides flexibility to the WCC to use the equivalent costs of the spring chinook rearing program in a new program to make up the shortfall if the flow management or spawning channel do achieve the desired level of benefits. Clubb said the dollars would not include Capital expense, but only the Operation and Maintenance costs to rear the number of spring chinook necessary to make up the shortfall. Bickford said, currently the sockeye portion of the MFH program is around 28 – 30% of the total spring chinook production (15,000 pounds). Woodin said he felt the sockeye production was closer to 50% since the facility was downsized from 740,000 to 550,000 smolts. Bickford said that the Districts obligation was based on pounds of fish reared (presently 49,200 pounds). When fish are not reared to 15 fpp as provided by the Settlement Agreement but are in fact being reared at 10 or 9 fpp, then 550,000 fish equates to over 55,000 pounds of production. Last year, releases average 10 to 9 fpp. Rose asked how the Flow Management Dollars fit into the equation. Clubb said annual Flow Management O&M costs are a little more than $100,000. Assuming up to $150,000 for the Methow substitution production, the total would be approximately $250,000 annual funds under the worse case scenario from provisions included in the decision tree.

Woodin asked about the asterisk at the bottom of the decision tree. Bickford said the asterisk was used instead of additional boxes on an already complex decision path and is not part of any one box. If Canadian funding became available, then equivalent dollars would be made available to the WCC for a yet to be identified committee approved sockeye program. Woodin wanted to see the asterisk placed inside those boxes it would apply to. Bickford said the decision tree would be changed to show the asterisk in the three pertinent boxes.

The Wells Coordinating Committee members, participating on the call, gave their unanimous support of the sockeye decision tree. Bob Rose said the Yakama Tribes would send a letter that showed their support along with concerns they have. He indicated he would send a draft of the letter to Clubb for review. Clubb asked Rose if he thought Heinith would support the decision tree as modified. Rose indicated that the letter from the Yakama might be able to include Heinith's support. Clubb said he would bring the decision of the WCC to the District's Commissioners and he expected the Commissioners would agree to move forward on the Flow Management Proposal.

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ATTENDANCE LIST

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2000 MEMBERSHIP LIST
OF THE
WELLS COORDINATING COMMITTEE

APPENDIX J

Appendix J

2001 Membership List of the Wells Coordinating Committee

Ron Boyce
Oregon Department of Fish and Wildlife

Brian Cates
U.S. Fish and Wildlife Service

Brian Nordlund
National Marine Fisheries Service

Mike Erho
Wells Coordinating Committee Chairman

Cary Feldmann
Power Purchasers

Bob Heinith
Umatilla Tribes

Rick Klinge
Douglas County P.U.D.

Jerry Marco
Colville Confederated Tribes

Bob Rose
Yakama Indian Nation

Rod Woodin
Washington Department of Fish and Wildlife

THE LONG TERM SETTLEMENT AGREEMENT
FOR THE
WELLS HYDROELECTRIC PROJECT

APPENDIX K

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

Public Utility District No. 1 of Douglas County, Washington)	Project No. 2149 Docket No. E-9569

SETTLEMENT AGREEMENT

This Settlement Agreement is entered into this 1st day of October, 1990, by the Public Utility District No. 1 of Douglas County, Washington (the PUD), Puget Sound Power & Light Company, Pacific Power and Light Company, the Washington Water Power Company, Portland General Electric Company (collectively the Power Purchasers), the Washington Department of Fisheries, the Washington Department of Wildlife, the Oregon Department of Fish and Wildlife, the National Marine Fisheries Service, the U.S. Fish and Wildlife Service, the Confederated Tribes and Bands of the Yakima Indian Nation, the Confederated Tribes of the Umatilla Reservation, and the Confederated Tribes of the Colville Reservation (collectively the Joint Fishery Parties).

I. GENERAL

A. PURPOSE AND SCOPE

1. This Agreement establishes the PUD's obligations with respect to the installation and operation of juvenile downstream migrant bypass facilities and measures; hatchery compensation for fish losses; and adult fishway operation at least until March 1, 2004, as described in subsection I.C. For purposes of the Wells Project, these measures, in conjunction with existing hatchery

compensation programs, and when carried out pursuant to this Agreement, shall be conclusively considered to fulfill the PUD's obligation to protect, mitigate, and compensate for the anadromous fish resource at least until March 1, 2004. These measures are expected to contribute to the Northwest Power Planning Council's goals of rebuilding the natural spawning populations of salmon and steelhead in the Columbia Basin and providing harvest opportunities.

2. This Agreement establishes the Joint Fishery Parties' obligations in support of this settlement. This Agreement also requires evaluation programs for fishery measures and establishes procedures for coordination between the PUD and Power Purchasers and the Joint Fishery Parties.

3. It is the intent of the Parties that this Agreement shall be the basis for the dismissal of the Mid-Columbia proceeding, Docket No. E-9569, insofar as it pertains to the Wells Project, and for compliance by the PUD with the Northwest Power Planning Council's 1987 Columbia River Basin Fish and Wildlife Program, as amended.

4. The fish passage, mitigation, and compensation measures set out in this Agreement are intended to implement Article 41 of the License for Project No. 2149 issued by FERC to the PUD. The PUD's obligations under this Agreement shall be enforceable as if they were conditions of its FERC license. Notwithstanding any other provision of its FERC license, once this Agreement is approved by FERC the PUD shall be bound by the terms of this

Agreement.

5. For purposes of this Agreement, except under subsections VI.B, VII.B and E, VIII.B and D, the Power Purchasers collectively will be a single Party. For all purposes under this Agreement, except under subsections VI.B, VII.B and E, VIII.B and D, the Power Purchasers shall participate through a single representative, whom they will designate from time to time.

B. <u>DURATION</u>

The term of this Agreement shall commence on the date of execution by all Parties and shall continue for the term of the current license for the Wells Project, plus the term of any annual licenses which may be issued after the current license has expired.

C. <u>MODIFICATIONS TO THE AGREEMENT</u>

1. Notwithstanding subsection I.B, at any time after March 1, 2004, any Party may request all other Parties to commence negotiations to modify the terms and conditions of this Agreement in whole or in part. Any such modification shall be subject to FERC approval, except that the Parties may agree to implement on an interim basis, pending FERC approval, any measure not requiring prior FERC approval. No Party shall file a petition with FERC pursuant to subsection I.C.2 to modify this Agreement without first presenting the proposed modification to all Parties and allowing a reasonable opportunity to negotiate, not to exceed 90 days without consent of all Parties.

2. Subject to the limitation stated in the above subsection, at any time after March 1, 2004, any Party to this Agreement may:

(a) Request the imposition by the FERC of different, additional, reduced or modified fish protection measures;

(b) Bring any cause of action, raise any defense or claim, or rely on any theory related to this Agreement in any appropriate forum;

(c) Petition any appropriate administrative agency or political body for relief, including the deletion or addition of one or more measures otherwise in effect under this Agreement; or

(d) Take other appropriate action relating to any issue or matter addressed by this Agreement or which could have been addressed by this Agreement or that otherwise relates to the fisheries issues of the Wells Project.

3. In any action under this subsection I.C, the petitioning Party shall have the burden of proof. The Parties will continue to implement this Agreement pending final resolution of any modification sought in the FERC, or until the relief sought becomes effective by operation of law, or unless otherwise agreed.

4. With respect to any petition or suit filed pursuant to this subsection I.C and any subsequent judicial review thereof, nothing in this Agreement shall bar, limit or restrict any Party from raising any relevant issue of fact or law, regardless of whether such issue is or could have been addressed by this Agreement. Notwithstanding any other provision of this Agreement, no claim shall be made for damages arising from the failure to provide or the provision of inadequate downstream fish passage facilities or programs, or upstream adult passage facilities, or

both, that might have arisen during the period March 7, 1979, through March 1, 2004.

5. Notwithstanding any other provision of this subsection I.C, any Party may participate in any legislative or administrative proceeding dealing with fish protection or compensation issues provided, that, consistent with this subsection, no Party shall advocate or support the imposition of fish protection, mitigation, or compensation measures at the Wells Project that are different from or in addition to those required by this Agreement until after March 1, 2004.

6. The Parties intend that this subsection I.C shall apply to each and every provision of this Agreement, and therefore the terms of this subsection are hereby incorporated by reference into and shall apply to every other provision of this Agreement as if set out fully in each such provision.

D. RESOLUTION OF DISPUTES

1. Any dispute between the Parties concerning compliance with this Agreement shall be referred for consideration to the Wells Project Coordinating Committee (the Coordinating Committee) established under Section V. The Coordinating Committee shall convene as soon as practicable following issuance of a written request by any Party. All decisions of the Coordinating Committee must be unanimous. In the event the Coordinating Committee cannot resolve the dispute within fifteen (15) days after its first meeting on a dispute, it will give notice of its failure to resolve the dispute to all Parties. Thereafter, if the dispute qualifies

under subsection I.D.2, any Party may request the FERC to refer the dispute to (1) the presiding judge in the Mid-Columbia proceeding; or (2) in the event the Mid-Columbia proceeding is terminated, to the Chief Administrative Law Judge of the Commission; or (3) to the Division of Project Compliance and Administration within the Office of Hydropower Licensing, or its successor (any one of which is hereinafter referred to as the Decisionmaker), in the order listed herein (unless otherwise agreed by the Parties or directed by FERC), for expedited review in accordance with the procedures set forth in this subsection. Any issue in dispute that is not subject to the expedited review process may be referred to the FERC for resolution pursuant to the FERC's Rules of Practice and Procedure.

2. The expedited review process specified in this subsection shall be utilized, unless otherwise agreed pursuant to subsection I.D.5, to resolve any issue(s) in dispute between the Parties that arises under this Agreement where the amount in controversy is less than $325,000 (1988 dollars). For the purpose of this subsection I.D, the amount in controversy shall be determined by calculating the difference between the calculated annual cost of the Joint Fishery Parties' proposal for resolution of the dispute and the calculated annual cost of the PUD's proposal for resolution of the dispute.

3. Under the expedited review process, each Party that desires to present an initial position statement to the Decisionmaker shall file the statement with the Decisionmaker and all other Parties within twenty (20) days of mailing of notice by a

Party that expedited review is requested. Responsive statements shall be filed and served within forty (40) days of the mailing of the notice. The Decisionmaker shall set a date for submission of any briefing, affidavits or other written evidence and a further date for hearing of oral evidence and argument. Except by agreement of all Parties involved in the dispute, the hearing shall be held not later than seventy (70) days after the date of mailing of the requesting Party's notice or as soon thereafter as the Decisionmaker shall be available. The hearing shall be held in Seattle, Portland or any other location agreed upon by the Parties, or mandated, upon a finding of special circumstances, by the Decisionmaker. The Decisionmaker shall decide all matters presented within fifteen (15) days of the hearing or as soon thereafter as possible.

4. All decisions under the expedited review process shall be effective upon issuance and pending appeal, if any. Nothing in this subsection I.D shall limit or restrict the right of any Party to petition the FERC for de novo review of any decision under the expedited review process. All such appeals shall be in accordance with the FERC's Rules of Practice and Procedure.

5. The Parties may agree to refer any issue subject to expedited review to a third party Decisionmaker other than someone within FERC for processing pursuant to this subsection or as otherwise agreed by the Parties.

E. EFFECTIVE DATES

1. Except as otherwise specified in this subsection I.E, this Agreement shall become effective upon the issuance of a final order by the FERC approving this Agreement.

2. Notwithstanding subsection I.E.1 above, the Parties will immediately upon execution of this Agreement, implement the provisions of the Agreement that do not require formal FERC approval.

3. The Parties agree to immediately seek interim approval by the FERC of Section IV of this Agreement in order to implement construction of hatchery facilities.

II. JUVENILE FISH PASSAGE

A. GENERAL SCOPE OF JUVENILE PASSAGE MEASURES

1. Subject to the schedules, criteria, and conditions in this Agreement, the PUD will fund the installation, operation, maintenance, and evaluation of juvenile fish bypass systems and measures at the Wells Project. Bypass systems and measures are those intended to attract and route juvenile salmonids past operating powerhouse generating units.

2. All facilities under this Agreement shall be designed and constructed using quality materials and then current engineering standards for the purpose of obtaining a high quality product designed to require low maintenance and have a long useful life.

B. BYPASS SYSTEM

The PUD will continue to implement a program of controlled spill using five (5) bypass baffles at the Wells Project to meet the criteria set out in subsections II.C, D, and E.

C. NORMAL BYPASS OPERATIONS CRITERIA

1. No turbine will be operated during the juvenile migration period unless the adjacent bypass system is operating according to the following criteria.

2. The five (5) bypass system bays will be Nos. 2, 4, 6, 8, and 10. Operation of the turbines will be in pairs with the associated bypass system bays, as follows:

Turbines Operated	Bypass Bays Operated
1 and/or 2	2
3 and/or 4	4
5 and/or 6	6
7 and/or 8	8
9 and/or 10	10

(For example, if turbines 1, 5, and 6 are operating, bypass systems 2 and 6 will be operating.)

3. At least one bypass will be operating continuously throughout the juvenile migration period, even if no turbines are operating.

4. The bypass systems and spillgates will be operated in configuration K of the 1987 bypass system report (bottom spill, 1 foot spill gate opening, 2,200 cfs, vertical baffle opening) for all bypass system bays.

5. If top spill is shown to be as effective as bottom spill in bypass bays 2 and 10, then top spill will be allowed in these bays.

6. If the Chief Joseph Dam Uncoordinated Discharge Estimate is 140,000 cubic feet per second (140 Kcfs) or greater for the following day, all five bypass systems will be operated continuously for 24 hours regardless of turbine unit operation.

7. If the Chief Joseph Dam Uncoordinated Discharge Estimate is less than 140 Kcfs, bypass system operation will be as follows:

Number Turbines Operating	Minimum Number Bypass Systems Operating
10	5
9	5
8	4
7	4
6	3
5	3
4	2
3	2
2	1
1	1
0	1

D. BYPASS OPERATIONS TIMING CRITERIA

1. Bypass systems will be in place at least two (2) weeks prior to preseason forecasted beginning of juvenile migration.

2. Bypass systems will remain in place for at least two (2) weeks after the juvenile migration period ends.

3. Monitoring of fish runs will begin when bypass baffles are in place and will end when the baffles are removed.

4. Bypass systems will be available to operate continuously, 24 hours per day, during the juvenile migration period.

E. BYPASS PERFORMANCE CRITERIA

1. At a minimum, bypass system operations will be provided as described in subsections II.B, C, and D for the entire juvenile migration period as defined in the annual operations plan under subsection II.F, and subject to the provisions of subsection II.F.3.

2. Bypass operations as described in subsections II.B, C, and D are intended to provide fish passage efficiency (FPE) of at least eighty percent (80%) for the juvenile spring migration, and FPE of at least seventy percent (70%) for the juvenile summer migration. For purposes of this Agreement, FPE is expressed by the following formula:

Where A = Sum of daily migrants successfully passed by the device during the spring or summer migration

and B = Sum of daily migrants passing through the turbine unit intakes during the same migration

$$FPE = \frac{A}{A + B} \times 100$$

3. If bypass operations under subsections II.B, C, and D do not meet the minimum FPE levels specified in subsection II.E.2, the PUD will modify those operations by implementing one or more of the following measures:

(a) Change in configuration or addition of lights or other physical changes.

(b) Change in "normal operation" under subsection II.C to operation of five bypass system bays at forecast flow of 120 Kcfs.

4. Unless and until these modifications are in place to meet the minimum FPE levels specified in subsection II.E.2, or if these modifications are not sufficient to meet the FPE levels specified therein, then the PUD will increase spillbay bypass flow up to two times normal operation (up to a total of 4.4 Kcfs) per bypass at night (1 hour before sunset to sunrise) for the period:

(a) During which 80% of the spring migration pass the Wells Project;

(b) During which 80% of the summer migration pass the Wells Project, or for 40 days, whichever is less.

5. If portions of the runs do not receive protection at the minimum FPE levels specified under subsection II.E.2, then compensation will be provided based on the difference between the minimum FPE levels specified in subsections II.E.2 and 3 and the actual FPE achieved during the evaluation provided under subsections II.H.1 and 2. The appropriate level of compensation will be calculated based on actual loss. The form of this additional compensation (i.e., fish production) will be determined by the Joint Fishery Parties in consultation with the PUD.

F. <u>ANNUAL OPERATIONS PLANS</u>

1. The PUD will develop an annual bypass systems operations plan consistent with the criteria in subsections II.B, C, D, and E in consultation with the Joint Fishery Parties by the December prior to each migration period. The plan will be reviewed and approved by the Coordinating Committee by March 1 of each year. The plan will be developed from inseason projected hatchery release

dates from facilities above Wells and previous passage monitoring data. The plan will contain predicted dates for the beginning and end of the juvenile migration period; criteria for identifying the beginning and end of the spring and summer runs; and procedures for bypass operations within the constraints of subsections II.B, C, D, and E, including dates for installation and removal of spill baffles, dates for run time monitoring, and criteria for initiation and cessation of bypass operations. If unanimous agreement cannot be reached within the Coordinating Committee regarding all items in the plan, disagreements will be resolved by expedited dispute resolution under subsection I.D.

2. A Bypass Team will be established composed of one representative each for the Party fishery agencies, the Party tribes, and the PUD.

3. Notwithstanding the provisions of subsections II.F.1 and 2 above, the Bypass Team may agree to relax the operations and performance criteria of subsections II.C and E for a period between the end of the juvenile spring migration and the beginning of the juvenile summer migration. Such a modification can only be made with the agreement of all of the members of the Bypass Team, and will be limited to one or more of the following measures:

(a) Less than continuous 24-hour operation of bypass systems.

(b) Fewer than one bypass system operated for two adjacent turbines operated.

(c) Less than 1 foot spill gate slot opening.

4. Once the annual bypass plan is adopted, decisions regarding adjustments to the plan will be made by unanimous agreement of the Bypass Team. If unanimous agreement cannot be reached, the decision on such adjustments will be by majority vote of the Bypass Team.

G. ANNUAL PASSAGE MONITORING PLAN

1. The PUD shall develop an Annual Passage Monitoring Plan, in consultation with the Joint Fishery Parties for review and approval by the Coordinating Committee by March 1 of each year. The Plan will include development of inseason indices of relative fish abundance on a daily basis and annual estimates of juvenile migrant production. Estimates of relative abundance will be used to guide bypass operations decisions under subsections II.E.4, II.F.1, II.F.3, and II.F.4. Estimates of juvenile migrant production will be used as the basis for compensation adjustments (Hatchery-Based Compensation - Phase IV) as provided in subsection IV.A.3.

H. FPE EVALUATION PLAN

1. The PUD shall develop an FPE evaluation plan, in consultation with the Joint Fishery Parties, for review and approval by the Coordinating Committee by March 1, 1990. The purpose of the plan shall be to evaluate whether minimum FPE levels set out in subsection II.E are being met. The plan will provide for evaluation beginning in 1990 and continuing for at least three consecutive years after baffles are installed and operating in accordance with this Agreement in all five (5) bypass bays. If physical or

operational changes are made to the bypass systems, additional FPE evaluation under a new or amended plan will be required to provide at least three consecutive years of evaluation after completion of the changes.

2. It is the goal of evaluations under the plan to be able to determine FPE within plus or minus five percent (5%) at the ninety-five percent (95%) confidence level. If the FPE point estimates are equal to or greater than eighty-five percent (85%) for the spring run and seventy five percent (75%) for the summer run, then the accuracy of plus or minus ten percent (10%) at the ninety percent (90%) confidence level is acceptable. If the FPE point estimate for the spring run is between eighty (80) and eighty-five (85) percent, or the FPE point estimate for the summer run is between seventy (70) and seventy-five (75) percent, the PUD will implement one of the following actions:

(a) Take the necessary steps to achieve a FPE accuracy of plus or minus five percent (5%) at the ninety-five percent (95%) confidence level, or

(b) Take steps outlined in subsection II.E.3 to increase the FPE point estimates to eighty-five percent (85%) and seventy-five percent (75%) for the spring and summer runs, respectively.

3. The PUD will fund a biometrician or statistician selected by unanimous agreement of the Coordinating Committee to review the draft plan to ensure that the plan meets the objectives of subsections II.H.1 and 2, and to review results developed under the plan.

III. ADULT FISH PASSAGE

A. GENERAL SCOPE OF ADULT PASSAGE MEASURES

The current operating and maintenance criteria for facilities for the passage of adult anadromous fish over the Wells Project Dam are specified in this Section III. Changes in these criteria must be by unanimous agreement of the Coordinating Committee.

B. WATER DEPTH CRITERIA

The water depth over the weirs of the adult fish ladder will be 1.0 to 1.2 feet.

C. ENTRANCE CRITERIA

1. Head: 1.5 feet

2. Gate Settings:

a) March 1 - November 30

	Side Wing Gate	End Wing Gate
(i) Spill less than 80 Kcfs	4 ft	6 ft
(ii) Spill greater than 80 Kcfs	Closed	8 ft

(iii) Low level fixed orifice entrance to be open whenever side gate is closed.

b) December 1 - February 28

(i) Side and end gates open 2 feet six days per week for 24-hour periods.

(ii) Side and end gates open 4 feet and 6 feet, respectively, one day per week for a 24-hour period.

D. ATTRACTION JET CRITERIA

1. Jets are located in a vertical line immediately upstream of the side wing gates.

2. Lower jet (30-inch diameter) will operate only when the low level fixed orifice entrance is open.

3. Three 24-inch diameter jets (at elevations 700, 708, and 717 msl) will each be discharging when tailwater reaches that level.

E. STAFF GAUGE AND WATER LEVEL INDICATOR CRITERIA

Staff gauge and water level indicators will:

1. Be located upstream and downstream of all entrances, and at convenient locations for viewing along ladder.

2. Be located upstream and downstream of adult fishway exit trashrack.

3. Be readable at all water levels and be kept clean.

4. Be checked against panel board water surface readings to insure proper adjustment of water level sensing equipment.

F. TRASHRACK CRITERIA

1. Visible buildups of debris will be cleaned immediately from picketed leads near counting stations, and from trashracks at adult fishway exits.

2. The staff gauges upstream and downstream of the adult fishway exit trashrack will be monitored for water surface differential, which will reflect buildup on submerged trashrack. The trashrack will be cleaned immediately if the differential reading is greater than 0.3 feet.

G. MONITORING AND EVALUATION OF ADULT PASSAGE

1. In 1990, the PUD, in consultation with the Joint Fishery Parties, will develop a study plan to determine the extent of adult

delay and mortality at the Wells Project. The study plan will be reviewed and approved in advance by the Coordinating Committee. Studies will begin in 1991 and continue for a period of time determined by the Coordinating Committee based on preliminary results.

2. If the study identifies delays and/or mortality, the operating criteria specified in this Section III will be changed to alleviate these problems. If changes in the operating criteria do not alleviate the problems, adult passage facility modifications will be made. Provided, however, that any disagreements over the appropriateness of facility modifications of $325,000 or less (1988 dollars) may be taken through the expedited dispute resolution procedure in subsection I.D. And, provided further, that any disagreements over the appropriateness of facility modifications of more than $325,000 (1988 dollars) may be resolved under the FERC Rules of Practice and Procedure at any time.

IV. HATCHERY-BASED COMPENSATION

The PUD will fund a hatchery-based compensation program (the "Program") as provided in this Section IV. The Program will include the design, construction, operation, maintenance and evaluation of facilities required to implement the elements of a production plan (the "Production Plan") as set forth in this Section. The purpose of the Program is to mitigate for fish passage losses at Wells Dam. The Program is composed of adult collection sites; a central hatchery facility for incubation, early rearing, and adult holding; and acclimation facilities in the tributaries above Wells Dam for final rearing and release.

A. <u>PRODUCTION PLAN</u>

1. The Joint Fishery Parties have developed the Production Plan to define the requirements of hatchery-based compensation under this Agreement. The Production Plan describes juvenile rearing and release requirements, including species mix and target release sizes; and related broodstock requirements under subsection IV.D.

2. The Production Plan will be reviewed annually by the Joint Fishery Parties, and may be modified by the Joint Fishery Parties in consultation with the PUD. Modifications to the Production Plan may include changes to the species mix and rearing and release strategies as required to accommodate the Joint Fishery Parties' management needs. Modifications to the Production Plan will not require an increase in the rearing capability of the Program beyond that required to satisfy Phases One and Two of the Production Plan as shown in subsections IV.A.3(a) and (b) or Phases Three and Four of the Production Plan to be determined as shown in sections IV.A.3(c) and (d). The Production Plan and any modifications thereto will be consistent with guidelines and procedures developed under the Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program.

3. The Production Plan is comprised of four phases of hatchery-based compensation as described below. It also includes related broodstock requirements under subsection IV.D.

(a) Phase One

Phase One will begin in 1991 and will consist of the following compensation elements:

(1) 49,200 pounds of spring chinook yearlings at about 15/pound;

(2) 8,000 pounds of sockeye juveniles at about 25/pound; and

(3) 30,000 pounds of steelhead smolts at about 6/pound

(4) After 1991, space to rear additional steelhead will be provided by the PUD at Wells Hatchery, if such space is available and not needed to meet other PUD fish production responsibilities. The PUD will not be obligated to fund or supply well water to rear the fish.

(b) Phase Two

Phase Two will begin after evaluation of the Phase One Production Plan and will be restricted to the Program required by either the Phase Two A or Two B Production Plan as shown below. At the time of implementation, the Phase Two A or Phase Two B Production Plan may be modified based on other Phase One evaluations described in subsection IV.C, Studies and Evaluations, subject to the provisions of subsection IV.A.2.

(1) Phase Two A

Increase sockeye production from 8,000 pounds to 15,000 pounds of juveniles at about 25/pound.

(2) Phase Two B

(i) Eliminate sockeye production;

(ii) Add 15,000 pounds of summer chinook yearlings at about 10/pound; and 6,500 pounds of zero-age summer chinook juveniles at about 40/pound.

(c) Phase Three

Phase Three will begin as soon as practicable following Coordinating Committee approval of the results of the Wells Project juvenile mortality/survival study or no later than the third brood year after Coordinating Committee determination of the adjustments required and will consist of the following compensation elements:

(1) Except for steelhead, which shall remain at 30,000 pounds, adjust compensation requirement to reflect the difference between the juvenile mortality rate determined by the mortality/survival study under subsection IV.C.5 and the assumed mortality rate shown in Appendix A; and

(2) Adjust compensation requirement to reflect unavoidable and unmitigated adult losses, as determined by Coordinating Committee approved estimates from studies conducted under subsection III.G, and converted to juvenile production based on adult to smolt ratio estimates as described in Appendix B.

(d) Phase Four

Phase Four will begin at such time as the Coordinating Committee approved five-year rolling average estimate of juvenile run size, estimated as described in subsection IV.C.6 and Appendix A, increases to at least 110% of the 9,034,700 estimated juvenile migrant salmon production used to establish the Phase One and Phase Two compensation levels shown in subsections IV.A.3(a) and

IV.A.3(b). Phase Four will consist of compensation adjustment, if requested by the Joint Fishery Parties, to reflect the percentage increase in juvenile run size, except for steelhead, which shall remain at 30,000 pounds. The Joint Fishery Parties, in consultation with the PUD, will determine the appropriate form of compensation (i.e., fish production) for any adjustments required in Phase Four.

B. COMPENSATION PROGRAM

1. The facilities provided in the Program will be designed, constructed, operated, maintained, and evaluated to produce the hatchery-based compensation set forth in the Production Plan.

2. If the evaluations described in subsection IV.C indicate that the Program is not meeting the production levels called for in the Production Plan, then reasonable modifications to the Program will be made.

3. The PUD will only be obligated to assure the capability of facilities provided under this Agreement to produce high quality juvenile fish at the compensation levels shown in subsection IV.A.3.

4. The Program facilities described in this Agreement are in addition to the existing mitigation program at Wells. The existing mitigation program at Wells consists of annual production of 50,000 pounds of steelhead and 56,500 pounds of summer chinook salmon. Under the 1984 Mid-Columbia Stipulation, which expired in 1989, 400,000 summer chinook at 90/pound have been reared at Wells for release into the Methow River. This production will continue until

Phase One production is initiated. Nothing in this Agreement will affect the annual production of 25,000 pounds of steelhead under the Oroville-Tonasket agreement between the PUD and the U.S. Bureau of Reclamation.

5. Facilities provided in the Program will consist of:

(a) Phase One

Phase One compensation facilities, including satellite facilities, shall be capable of rearing and releasing 57,200 pounds of salmon and 30,000 pounds of steelhead annually.

(b) Phase Two

Phase Two compensation facilities shall be capable of increased production to accommodate the Production Plan as described in subsection IV.A.3(b).

(c) Phase Three

Phase Three compensation facilities shall be capable of production levels to reflect the compensation adjustments which may be required as described in subsection IV.A.3(c).

(d) Phase Four

Phase Four compensation facilities shall be capable of production levels to reflect the compensation adjustments which may be required as described in subsection IV.A.3(d). Facilities for the required adjustments will be constructed by the PUD as soon as practicable and be operational no later than the third brood year following the Joint Fishery Parties request under subsection IV.A.3(d).

6. Production and acclimation facilities used in the Program shall be consistent with planning efforts underway by the Northwest Power Planning Council to the fullest extent practicable. The biological criteria and guidelines described in subsection IV.D shall apply to production and acclimation facilities used in the Program.

C. STUDIES AND EVALUATIONS

1. The PUD will develop and fund studies in 1990, approved by unanimous agreement of the Coordinating Committee, to determine:

(a) Potential for spawning and rearing sockeye in unutilized habitat in the Okanogan and Similkameen systems;

(b) Potential for establishing sockeye populations in the new habitat.

2. The PUD will fund the Joint Fishery Parties' effort to determine the success of Phase One sockeye compensation based on review of smolt production. The Joint Fishery Parties may make this determination after the evaluation of the third brood year's production.

3. The PUD will fund the Joint Fishery Parties to develop and conduct studies to evaluate the adequacy of the Program and the effectiveness and success of the Production Plan subject to the provisions of Section V, Coordinating Committee. The studies will meet standards developed for similar efforts under the Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program. The studies will pass the test of reasonableness with respect to cost and duration.

(a) The studies will involve marking a portion of the juvenile fish produced under subsection IV.B and will involve recoveries of juvenile and adult fish to estimate various parameters such as fish health, fishery contribution, survival, spawning time and spawning locations.

(b) The PUD will fund recovery efforts at Wells Dam and hatchery and tributary spawning areas above Wells Dam. Existing recovery operations, currently funded through different sources, will be utilized to the extent possible. Approved studies may require the PUD's participation in funding a portion of other recovery efforts.

(c) The evaluations provide data necessary to determine the success of the Program to produce the intended compensation levels and the effectiveness of the Production Plan to meet management objectives.

(d) Evaluation of the Production Plan and Program effectiveness will be initiated in Phase One for all species in the Production Plan.

(e) To the extent that the Joint Fishery Parties elect to modify the Production Plan, the PUD will fund studies to evaluate the modifications. The studies will be mutually agreeable and are intended to evaluate only the changes called for in the modification. The studies will be consistent with the provisions of Section V, <u>Coordinating Committee</u>.

(f) The PUD will fund an analysis of annual fish production and adult contribution to harvest and escapement to be conducted by the Joint Fishery Parties. The analysis will be consistent with the provisions of Section V, Coordinating Committee. Draft and final reports will be provided to the Parties.

5. No later than 1990, a Wells Project juvenile mortality/survival study will be developed by the PUD in consultation with the Joint Fishery Parties and approved by unanimous agreement of the Coordinating Committee. The studies will begin in 1991, after the installation of new turbine runners at the Wells Project, for the purpose of determining juvenile losses.

6. The PUD will provide data from its ongoing, annual adult passage monitoring program that will allow the Joint Fishery Parties to compute the five-year rolling average estimate of juvenile run size which will be the basis for Phase Four compensation, as indicated in subsection IV.A.3(d). Calculation of increases in juvenile run size will be based on fish from existing mitigation programs, natural production and future compensation programs. The method of calculation will be as described in Appendices A and B.

D. PRODUCTION/ACCLIMATION FACILITIES

Production and acclimation facilities under this Section shall be consistent with planning efforts underway by the Northwest Power Planning Council to the fullest extent practicable. The following biological criteria and guidelines shall apply to production and acclimation facilities under this subsection IV.D. Criteria are not to be exceeded. Guidelines are not to be exceeded if practicable.

1. Salmon Criteria

(a) Adult Holding

(i) Density not to exceed one (1) fish per ten (10) cubic feet of space.

(ii) Flow must be at least one (1) gallon per minute per 20 pounds of fish.

(b) Juvenile Rearing

(i) Density not to exceed 0.75 pounds of fish per cubic foot of rearing space for yearling chinook to a size of 10 fish per pound. Maximum density is achieved at release date. The density through out the rearing period is proportionately lower and directly related to fish size.

(ii) Pond or raceway loading rate not to exceed 6.0 pounds of fish per gallon of water per minute inflow for yearling chinook at a size of 10 fish per pound. Maximum loading rate is achieved at release date. The loading rate throughout the rearing period is proportionately lower and directly related to fish size.

(iii) Density for sockeye juveniles in net pens not to exceed 0.33 pounds of fish per cubic foot of rearing space.

(c) Water Supply

(i) Water will be of highest quality practicably available at appropriate sites. Ground water may be required at sites. All water supplies will be pathogen free if practicable. The water source must not preclude transfer of the stocks being reared to their point of origin due to presence of fish disease organisms in the rearing water supply.

(ii) Reuse of water is not acceptable for either egg incubation or juvenile rearing.

(iii) Reuse water is acceptable for adult holding.

(iv) Effluent water from egg incubation may require treatment for fish diseases (e.g., chlorination/dechlorination).

(v) Construction of facilities must accommodate the potential to treat the juvenile rearing and adult holding water for disease pathogens.

(d) General

(i) Facilities must have the capability to maintain stock segregation from adult holding through incubation and rearing.

(ii) Facilities must have reasonable capability to provide for isolation and treatment of diseased fish.

(iii) Protection from mammalian and avian predators must be provided.

2. Salmon Guidelines

(a) Water Temperatures

(i) Egg incubation - no greater than 55°F nor less than 38°F.

(ii) Fry starting - 48-52°F.

(iii) Juvenile rearing - not to exceed 52°F.

(iv) Adult holding - not to exceed 55°F.

(b) Release Size, Time, and Location

(i) Yearling spring chinook - 15 fish/pound in late April.

(ii) Yearling summer chinook - 10 fish/pound in late April.

(iii) Subyearling summer chinook - 40 fish/pound in June.

(iv) Subyearling sockeye - 25 fish/pound in June.

(v) Juvenile fish will be acclimated and released in tributaries above Wells Dam.

(c) Adult Brood Stock

(i) Sufficient adults of the appropriate species and stocks will be trapped and held to meet the egg requirements for each phase of salmon production.

(ii) Fifty percent (50%) of the adults trapped will be females and it is assumed there will be approximately eighty percent (80%) survival of eggs from trapping of females to ponding of fry.

(iii) Adult brood stock will be collected at the following sites:

a) Spring chinook - Chewack River, Methow River above Winthrop, and Twisp River above river mile 2.0.

b) Summer chinook and sockeye - at Wells Dam

(iv) Tributary brood stock collection facilities will require an annually installed rack and a semi-permanent box trap.

(v) Wells Dam brood stock collection may require a separator/sorter in the left bank fishway. The final design of the left bank trap and any modification of the right bank trap will be approved by unanimous agreement of the Coordinating Committee.

(vi) The adults will be transferred in a water-to-water system from traps to tank trucks to holding ponds.

(vii) The PUD shall provide funds for personnel to separate and sort adult fish in the right bank fishway at Wells Dam and at other required adult collection sites. All brood stock collection shall be conducted in a manner to minimize delay of non-target species and individual fish.

3. Steelhead Criteria

The goal for this program is to use the existing facilities including well and river water, raceways, rearing ponds, house, shop, freezer, office, etc., in the manner they are being used now. Most of the following criteria and guidelines fit the existing program.

(a) Adult Holding

(i) Density not to exceed 2.5 pounds of fish per cubic foot of water.

(ii) Flow must be at least one gallon per minute for 3.3 pounds of fish.

(b) Juvenile Rearing

(i) Density: Calculated density limit not to exceed Pipers density formula: W= D x V x L where

W = Permissible weight in pounds.

D = Density index (.25 for raceways and .03 for rearing ponds).

V = Useable volume in container in cubic feet.

L = Fish length in inches.

ii) Water flow: Calculated flow should not allow weight to exceed Pipers flow formula: W= F x L x I where

W = Permissible weight in pounds.

F = The loading factor from Table 1.

L = Fish length in inches.

I = Water flow in gallons per minute.

Table 1. Load factor as related to water temperature and elevation.

Water Temperature(°F)	Load Factor(lbs/in/gpm) Raceways(1)	Load Factor(lbs/in/gpm) Rearing Ponds(2)
40	2.70	3.62
41	2.61	3.53
42	2.52	3.44
43	2.43	3.35
44	2.34	3.26
45	2.25	3.17
46	2.16	3.08
47	2.07	2.99
48	1.98	2.90
49	1.89	2.81
50	1.80	2.72
51	1.73	2.65
52	1.67	2.59
53	1.61	2.53
54	1.55	2.47
55	1.50	2.42
56	1.45	2.37
57	1.41	2.33
58	1.36	2.28
59	1.32	2.24
60	1.29	2.21
61	1.25	2.17
62	1.22	2.14
63	1.18	2.10
64	1.15	2.07

1) From Piper et al. 1978
2) From Wells hatchery

(c) Water Supply

(i) Water supply to be of highest quality practicably available using ground and river water. Any disease contracted because of water source must not stop release of fish in local water-sheds.

(ii) Reuse water not acceptable for egg incubation.

(iii) Reuse water normally acceptable (unless disease problem) for adult holding.

(iv) Effluent water from egg incubation will require treatment for fish diseases.

(v) Adult holding and juvenile rearing water may have to be treated for disease pathogens.

(d) General

(i) Facilities must have reasonable capability to provide for isolation and treatment of diseased fish.

(ii) Protection from mammalian and avian predators must be provided.

4. Steelhead Guidelines

(a) Water Temperatures

(i) Egg incubation: 38°F to 55°F

(ii) Fry starting: 48°F to 54°F

(iii) Juvenile Rearing not to exceed 57°F

(iv) Pre-smolt not to exceed 54°F

(v) Adult holding not to exceed 54°F

(b) Release age, time, size and location

(i) Released as yearlings

(ii) April 10 to May 10 at six to the pound.

(iii) Juvenile steelhead will be released in tributaries or into the mainstem above Wells Dam.

(c) Adult Broodstock

(i) Fifty percent (50%) will be females and assume eighty percent survival of eggs to ponding of fry.

(ii) Adults will normally be trapped at the existing facilities on the right bank, however new trap at left bank may be used sometimes.

(iii) Adults will be transferred in water from traps to holding ponds.

V. WELLS PROJECT COORDINATING COMMITTEE

A. COORDINATING COMMITTEE

There shall be a Wells Project Coordinating Committee composed of one (1) technical representative of each Party to this Agreement. The Coordinating Committee shall meet whenever requested by any two (2) Parties following a minimum of ten (10) days written notice (unless waived), or pursuant to subsection I.D, and shall act only by unanimous agreement of all Parties. Any Joint Fishery Party may, at any time, elect by written notice not to participate in the Coordinating Committee. The PUD shall fund a neutral third party to record and distribute minutes of Coordinating Committee meetings.

B. USE OF COMMITTEE

The Coordinating Committee will be used as the primary means of consultation and coordination between the PUD and the Joint Fishery Parties in connection with the conduct of studies and implementation of the measures set forth in this Agreement and for dispute resolution pursuant to subsection I.D. All study designs and modifications to study designs will be subject to agreement by all Parties.

C. STUDIES AND REPORTS

1. All studies and reports prepared under this Agreement will be available to all Parties as soon as reasonably possible. Draft reports will be circulated through Coordinating Committee representatives for comment, and comments will either be addressed in order or made an appendix to the final report.

2. All studies will be conducted following accepted techniques and methodologies in use for similar studies in the Columbia Basin. All studies will be based on sound statistical design and analysis.

3. Fish passage efficiency tests will be conducted using hydroacoustic means and direct capture methods for species identification.

VI. JOINT FISHERY PARTIES' RESPONSIBILITIES

A. LIMITATION OF MID-COLUMBIA PROCEEDING

The Joint Fishery Parties agree to join with the PUD to request that the FERC terminate the Mid-Columbia proceeding insofar as it pertains to the Wells Project. The Parties specifically agree to reserve the right to enforce the terms and conditions of this Agreement before the FERC.

B. <u>SUPPORT FOR RELICENSE</u>

The PUD's FERC license for the Wells Hydroelectric Project expires in 2012. The Joint Fishery Parties agree to be supportive of the PUD's new or renewal license application to the FERC, provided that the PUD has adhered to the terms and conditions of this Settlement Agreement, as well as any future terms, conditions, and obligations agreed upon by the Parties hereto or imposed upon the PUD by the FERC. To the extent that the PUD has met such terms and conditions, the Joint Fishery Parties agree that the PUD is a competent license holder with respect to its obligations to anadromous fish resources. Nothing in this paragraph shall limit or preclude any Party hereto from requesting at the time of any license renewal the provision of or supporting different, modified or additional fish protection measures and compensation; or from requiring that the fishery protection measures contained in a competing license application be included as a condition of the PUD's new license, or in the absence of such additional or modified measures in a new license, or in the absence of measures contained in a competing license application requested by the Joint Fishery Parties, from requesting that the PUD's new or renewal license application be denied.

C. STIPULATION OF ADEQUACY

The Joint Fishery Parties stipulate that the performance of the PUD's responsibilities under this Agreement constitutes adequate fish protection and full compensation for all fishery losses caused by the Wells Project at least until March 1, 2004. It is further stipulated that this Agreement satisfies any obligations of any Party relating to the adequacy of fish protection and compensation for fish losses caused by the Wells Project, and arising under applicable laws and regulations, including but not limited to the Federal Power Act, the Pacific Northwest Electric Power Planning and Conservation Act, and the Electric Consumers Protection Act of 1986, at least until March 1, 2004. This Agreement shall not otherwise affect the rights of any Party except as expressly covered by this Agreement.

D. FISH AND WILDLIFE PROGRAM

The Joint Fishery Parties stipulate that the performance of the PUD's responsibilities under this Agreement shall constitute full compliance with the applicable provisions of the Northwest Power Planning Council's 1987 Fish and Wildlife Program, at least until March 1, 2004. The Joint Fishery Parties stipulate that the PUD shall receive full credit for its hatchery production in meeting any requirements that may be established as a result of implementation of Section 203 of the Council's Program.

E. LIMITATION ON REOPENING

The Joint Fishery Parties shall not invoke or rely upon any reopener clause set forth in any license applicable to the Wells

Project for the purpose of obtaining additional fish measures or changes in project structures or operations pertaining to fishery issues until after March 1, 2004.

F. ADDITIONAL MEASURES

The Joint Fishery Parties shall refrain from contending on their own behalf or supporting any contention by other persons in any proceeding or forum that additional fish measures or changes in project structures or operations pertaining to fishery issues should be imposed at the Wells Project until after March 1, 2004.

VII. MISCELLANEOUS

A. COOPERATION

The Parties shall cooperate in conducting studies and shall provide assistance in obtaining any approvals or permits which may be required for implementation of this Agreement.

B. NOTICES

All written notices to be given pursuant to this Agreement shall be mailed by first-class mail, postage prepaid, to each Party at the address listed below or such subsequent address as a Party shall identify by written notice to all other Parties. Notices shall be deemed to be given three (3) days after the date of mailing.

C. WAIVER OF DEFAULT

Any waiver at any time by any Party hereto of any right with respect to any other Party with respect to any matter arising in connection with this Agreement shall not be considered a waiver with respect to any subsequent default or matter.

D. ENTIRE AGREEMENT -- MODIFICATIONS

All previous communications between the Parties hereto, either verbal or written, with reference to the subject matter of this Agreement are hereby abrogated, and this Agreement duly accepted and approved, constitutes the entire agreement between the Parties hereto, and no modifications of this Agreement shall be binding upon any Party unless executed or approved in accordance with the procedures set forth in subsection I.C.

E. BENEFIT AND ASSIGNMENT

This Agreement shall be binding upon and inure to the benefit of the Parties hereto and their successors and assigns provided, no interest, right or obligation under this Agreement shall be transferred or assigned by any Party hereto to any other Party or to any third party without the written consent of all other Parties, except by a Party:

(a) To any person or entity into which or with which the Party making the assignment or transfer is merged or consolidated or to which such Party transfers substantially all of its assets; or

(b) To any person or entity that wholly owns, is wholly owned by or is wholly owned in common with the Party making the assignment or transfer.

F. FORCE MAJEURE

The PUD shall not be liable for failure to perform or for delay in performance due to any cause beyond its reasonable control. This may include, but is not limited to, fire, flood, strike or other labor disruption, act of God, act of any governmental authority or of the Joint Fishery Parties, embargo, fuel or energy unavailability, wrecks or unavoidable delays in transportation, and inability to obtain necessary labor, materials or manufacturing facilities from generally recognized sources in the applicable industry. The PUD will make all reasonable efforts to resume performance promptly once the force majeure is eliminated.

G. INFLATION CALCULATIONS

All dollars specified in this Agreement are 1988 dollars. Dollar figures shall be adjusted annually for each year after 1988 based on the "Consumer Price Index for All Urban Consumers" published by the Bureau of Labor Statistics of the U.S. Department of Labor. If this index is discontinued or becomes unavailable, a comparable index agreeable to all Parties will be substituted.

H. METHOW RIVER HATCHERY WATER SUPPLY

1. The PUD agrees to cooperate with the Washington Department of Fisheries (WDF) to secure the necessary water rights and permits for facilities to be provided under this Agreement.

2. With respect to the proposed Methow River hatchery, the Parties agree that WDF and the PUD may utilize for the proposed Methow River hatchery facility up to 7 cfs of the water right now

held by the U.S. Fish and Wildlife Service (FWS), and subject to full or partial recall by FWS for any reason. The PUD shall not obtain legal title or ownership of the FWS water right.

3. To the extent that the utilization of water does not occur or is recalled or returned to FWS, the PUD and WDF shall use their best efforts to acquire an alternative source of water that meets applicable State requirements for water rights in order to satisfy obligations under this Agreement.

4. The PUD agrees to cooperate with WDF to secure the necessary permits in order to construct and provide for the operation of the proposed Methow River hatchery. The hatchery will be designed and constructed with the capability of installing pump-back facilities for returning the flow to the point of diversion.

5. If hatchery and/or river water supply requirements dictate the need for installation of a pump-back scheme, the PUD shall install and WDF shall operate the pump-back facilities.

VIII. REGULATORY APPROVAL

A. FERC ORDERS

All Parties agree to join in the filing of an offer of settlement with the FERC based on this Agreement and to request that the FERC issue appropriate orders approving the settlement. All Parties shall refrain from seeking judicial review of the FERC orders approving this Agreement.

B. PERFORMANCE CONTINGENT ON APPROVAL

Performance of all Parties' obligations under this Agreement is expressly made contingent on obtaining all necessary regulatory approvals, specifically including all FERC orders referred to in subsection VIII.A above, and all applicable federal, state and local permits. It is expressly agreed by all Parties that this Agreement shall be submitted to the FERC as a unit and any material modification of its terms, approval of less than the entire Agreement, or addition of material terms by the FERC shall make this Agreement voidable at the option of any Party.

C. NO PREJUDICE

All Parties stipulate that neither FERC approval nor any Party's execution of this Agreement shall constitute approval or admission of, or precedent regarding, any principle, fact or issue in the Mid-Columbia proceedings, or any other FERC proceeding, including subsequent modification proceedings under Section I.

D. EXECUTION

This Agreement may be executed in counterparts. A copy with all original executed signature pages affixed shall constitute the original Agreement. The date of execution shall be the date of the final Party's signature. Approval of this Agreement must be acknowledged by the Commissioner of Indian Affairs and the Secretary of the Interior, or their delegates, to the extent required by 25 U.S.C. § 81.

E. AUTHORITY

Each Party to this Agreement hereby represents and acknowledges that it has full legal authority to execute this Agreement and shall be fully bound by the terms hereof.

F. ACTION FOR NONCOMPLIANCE

Notwithstanding any other provision of this Agreement, any Party may seek relief arising solely from noncompliance with this Agreement by any Party; provided, all requests for specific performance of any provision of this Agreement shall be filed with the FERC pursuant to subsection I.D.

IN WITNESS WHEREOF, the Parties have executed this Agreement the day and year first written above.

APPENDIX A

JUVENILE MIGRANT LOSS ESTIMATES USED FOR COMPENSATION PLANS IN THE WELLS DAM SETTLEMENT AGREEMENT

1. Steelhead

The number of juvenile steelhead migrants killed by passage through the Wells Project reservoir and dam were not estimated for the purposes of this Settlement Agreement. As an alternative the parties have agreed to continue steelhead production programs and plans initiated under previous Mid-Columbia settlements.

2. Salmon Loss Estimates

The number of juvenile salmon migrants killed by passage through the Wells Project reservoir and dam were estimated as follows:

a. The number of juvenile migrant salmon, by species and race, entering the Wells Reservoir was estimated for natural production by applying sex ratios, egg per female data and theoretical egg to migrant survival rates to the numbers of adults passing above Wells Dam to spawn. These juvenile migrant numbers were computed annually and averaged over the passage years 1975-1984 for spring and summer chinook and averaged over the passage years 1975-1986 for sockeye. The recent average level of hatchery releases at Winthrop National Fish Hatchery were added to the spring chinook migrant estimates. The resulting estimates of average annual numbers of juvenile migrant salmon entering Wells reservoir are:

Spring Chinook	=	1,504,400
Summer Chinook	=	2,913,300
Sockeye	=	4,617,000
Total	=	9,034,700

b. The total project mortality at Wells, including reservoir mortality, was estimated to be 14%. Applying this mortality rate to the population estimates in Item 1 above results in the following estimates of juvenile migrants killed by species:

Spring Chinook	=	210,600
Summer Chinook	=	407,900
Sockeye	=	646,400
Total loss	=	1,264,900

3. Derivation of Production Plan

a. The Phase I compensation Production Plan and Program is an initial step in production which is not intended to provide full compensation for juvenile migrant losses. The lack of full compensation is due to the experimental nature and developmental aspects of the sockeye Production Plan and Program.

b. To accommodate logistic and per-unit cost factors in Phase I development, about 225,000 (15,000 pounds) spring chinook were substituted for 231,000 sockeye.

c. Items (1) through (3) below describe the derivation of the hatchery-based compensation levels included in the body of the Agreement.

(1) Steelhead production is set at 30,000 lbs./year to continue the successful program initiated under prior Mid-Columbia Settlement Agreements.

(2) Phase I compensation includes a pilot program for hatchery production of sockeye. The sockeye production level is set to allow assessment of Program success rather than provide full compensation for the estimated juvenile losses at Wells.

(3) The Phase II Chinook/Sockeye Production Plan is sized to mitigate for estimated juvenile losses:

	Estimated Annual Losses at Wells	Annual Production Phase IIA or	Phase IIB
Spring Chinook	210,600	450,000	450,000
Summer Chinook	407,900	400,000	810,000
Sockeye	646,400	375,000	-
TOTALS	1,264,900	1,225,000	1,260,000

4. Chelan PUD/Douglas PUD Compensation Exchange

In recognition of the specific requirements for spring and summer chinook rearing facilities and the characteristics of the water supply at the PUD's proposed spring chinook rearing facility on the Methow River, the Joint Fisheries Parties, Douglas PUD and Chelan County PUD have reviewed the respective compensation

15,000 lbs. of Summer Chinook @ 10/lb.

6,500 lbs. of Summer Chinook at 40/lb.

obligations of Douglas PUD as set forth in this Agreement, and Chelan County PUD under terms of the Rock Island Settlement. In consideration of biological efficiency and logistical effectiveness, the parties have agreed to adjusted compensation obligations under this agreement and the Rock Island

Settlement in the following manner:

a. Douglas PUD will assume responsibility for 19,200 pounds of Methow River sub-basin spring chinook production.

b. Chelan PUD will assume responsibility for 40,000 pounds of Methow River summer chinook production.

The resulting changes in production with the Douglas-Chelan compensation exchange agreement are (number of juveniles/year):

	Douglas Production	Chelan Production
Spring Chinook	Increases 288,000	Decreases 288,000
Summer Chinook	Decreases 400,000	Increases 400,000
Sockeye	No Effect	No Effect

c. The resultant Douglas PUD annual compensation program under this agreement (Phase II Production) is:

<u>Phase IIA</u>

30,000 lbs. of Steelhead @ 6/lb.

49,200 lbs. of Spring Chinook @ 15/lb.

15,000 lbs. of Sockeye @ 25/lb.

OR

<u>Phase IIB</u>

30,000 lbs. of Steelhead @ 6/lb.

49,200 lbs. of Spring Chinook @ 15/lb.

APPENDIX B

DETERMINATION OF RESPONSIBILITY FOR HATCHERY COMPENSATION

For each year of determination, calculate an average smolt output as follows:

1. Calculate a 5-year running average adult run (by species) for naturally spawned fish (Ays) as follows:

$$\bar{A}ys = \frac{Ay + Ay\text{-}1 + Ay\text{-}2 + Ay\text{-}3 + Ay\text{-}4}{5}$$

   Where Ay is the total adult count for each species at Wells minus the hatchery escapement for the species in year y; Ay-1 = the same in the previous year (y-1) and so on.

2. Multiply Ays by the average expected adult to smolt production factor Kys for each species, where Kys is calculated as follows:

   a. Spring Chinook:

   Ksp = 0.94 (Wells Dam to spawner survival)
   x 0.50 (sex ratio) x 5000 (eggs/female)
   x 0.10 (av. survival to smolt) = 235

   b. Summer Chinook:

   Ksu = 0.94 x 0.50 x 5000 x 0.30 = 705

c. Sockeye:

$$Kso = 0.94 \times 0.50 \times 2700 \times 0.12 = 152$$

3. Add the number of hatchery smolts HSys by species, which is a running average of the same 5 years as in Ays.

$$\overline{HSys} = \frac{HSy + HSy\text{-}1 + HSy\text{-}2 + HSy\text{-}3 + HSy\text{-}4}{5}$$

4. Total smolts (by species):

$$\overline{S}ys = Kys \times \overline{A}ys + \overline{HS}ys$$

5. Grand Total = Sum of all species:

$$Sgt = \overline{S}sp + \overline{S}su + \overline{S}so + \overline{\ldots}$$

6. If other salmon species or races, for which the above smolt production factors (Kys) do not apply, become established in the production areas above Wells Dam, appropriate K factors for these fish will be established by consensus of the Coordinating Committee. Juvenile migrant production will be computed for these species or races. These numbers will be included in the grand total for juvenile migrant production and the 5-year running averages.

WELLS PHASE IV THEORETICAL CALCULATION EXAMPLE

NATURAL PRODUCTION

DATA USED IN EXAMPLE CALCULATION OF NATURAL PRODUCTION

Adult Count	Ay	Ay-1	Ay-2	Ay-3	Ay-4	5 Year Average
Spring Chinook	3,000	2,200	3,100	5,000	2,900	3,240
Summer Chinook	2,400	2,800	3,700	4,000	4,700	3,520
Sockeye	40,000	20,000	35,000	15,000	30,000	28,000

Ay = Wells Count Minus Hatchery Escapement for Year Y

Ksp = Calculated Spring Chinook Smolts

Ksu = Calculated Summer Chinook Smolts

Ksoe = Calculated Sockeye Smolts

Spring Chinook $\overline{A}y$ $= \frac{Ay + Ay-1 + Ay-2 + Ay-3 + Ay-4}{5}$

$= \frac{3000 + 2200 + 3100 + 5000 + 2900}{5}$

$= 3240$

Summer Chinook $\overline{A}y$ $= \frac{Ay + Ay-1 + Ay-2 + Ay-3 + Ay-4}{5}$

$= \frac{2400 + 2800 + 3700 + 4000 + 4700}{5}$

$= 3520$

Sockeye $\overline{A}y$ $= \frac{Ay \div Ay-1 \div Ay-2 \div Ay-3 \div Ay-5}{5}$

$= \frac{40,000 \div 20,000 + 35,000 + 15,000 + 30,000}{5}$

$= 28,000$

Ksp, su, soc = Adult/redd factor x sex ratio x eggs/female x eggs to smolt survival x dam count minus hatchery return

Calculated Average Total Smolts (Natural)

Spring Chinook Ksp = .94 x .50 x 5000 x .10 x 3240
= 235 x 3240
= 761,400

Summer Chinook Ksu = .94 x .50 x 5000 x .30 x Ay
= 705 x 3520
= 2,481,600

Sockeye Ksoc = .94 x .50 x 2700 x .12 x Ay
= 152 x 28,000
= 4,263,800

Average Total Natural Smolts

= Ksp + Ksu + Ksoc
= 761,400 + 2,481,600 + 4,263,800
= 7,506,800

HATCHERY PRODUCTION

DATA USED IN EXAMPLE DETERMINATION OF HATCHERY PRODUCTION

SMOLT PRODUCTION IN MILLIONS BY YEAR

Hatchery	Y	Y-1	Y-2	Y-3	Y-4	5 Year Average
Winthrop	1.5	1.1	1.0	.95	.95	1.1
Methow	.8	.8	.675	.40	.25	.585
Twisp Acclimation	.40	.40	.40	.25	.2	.33
Sockeye Net Pens	.2	.2	.2	.15	.1	.17

Hatchery Smolt Production

Winthrop Hatchery = $\frac{1,500,000 + 1,100,000 + 1,000,000 + 950,000 + 950,000}{5}$

= 1,100,000

Methow Hatchery = $\frac{800,000 + 800,000 + 675,000 + 400,000 + 250,000}{5}$

= 585,000

Twisp Accl. Pond = $\frac{400,000 + 400,000 + 400,000 + 250,000 + 200,000}{5}$

= 330,000

Sockeye Net Pens* = $\frac{200,000 + 200,000 + 200,000 + 150,000 + 100,000}{5}$

= 170,000

*Need Adjustment Factor For Survival To Migration

Average Total Hatchery Smolts

Winthrop	=	1,100,000
Methow	=	585,000
Twisp	=	330,000
Net Pens	=	170,000
		2,185,000

Average Total Hatchery/Natural Smolts
(5 Year Average for Years Y-4, Y-3, Y-2, Y-1 and Y)

Natural	=	7,779,000
Hatchery	=	2,185,000
Total	=	9,964,000

PHASE IV DETERMINATION

Base Number Smolts Used for Initial Compensation	=	9,034,700
Calculated Average Natural + Hatchery Smolts in Years Y-4, Y-3, Y-2, Y-1 and Y	=	9,964,000
Calculated Average Natural + Hatchery Smolts Minus Base Number Smolts	=	929,300
Difference Between Base Number Smolts and Calculated Natural + Hatchery Smolts X Wells Project Mortality Rate	=	929,300 X .14
= Additional Smolts Possible Under Phase IV		130,102

FOR PUBLIC UTILITY DISTRICT NO. 1
OF DOUGLAS COUNTY, WASHINGTON:

Howard Prey
Commissioner

Michael Doneen
Commissioner

T. James Davis
Commissioner

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FOR PACIFIC POWER & LIGHT COMPANY:

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FOR THE WASHINGTON WATER POWER COMPANY:

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FOR PORTLAND GENERAL ELECTRIC COMPANY:

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FOR THE WASHINGTON DEPARTMENT
OF FISHERIES:

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FOR THE WASHINGTON DEPARTMENT
OF WILDLIFE:

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Commissioner

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FOR THE WASHINGTON WATER POWER COMPANY:

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OF FISHERIES:

[signature] 6/11/90

FOR THE WASHINGTON DEPARTMENT
OF WILDLIFE:

Ray Ryan 6/11/90

FOR THE OREGON DEPARTMENT OF
FISH AND WILDLIFE:

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FOR THE NATIONAL MARINE
FISHERIES SERVICE:

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FOR THE U.S. FISH & WILDLIFE SERVICE:

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FOR THE CONFEDERATED TRIBES AND BANDS
OF THE YAKIMA INDIAN NATION:

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FOR THE CONFEDERATED TRIBES
OF THE UMATILLA INDIAN RESERVATION:

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FOR THE CONFEDERATED TRIBES
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Marvin L. Plenert, Regional Director
FOR THE U.S. FISH & WILDLIFE SERVICE

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