Evaluation of Idaho Power Hatchery Mitigation Program

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ABSTRACT

The use of hatchery-produced fish was not the preferred method of mitigating effects to the area anadromous fisheries from construction and operation of the three-dam Hells Canyon Complex. This form of mitigation came about only after efforts to provide fish passage at the projects were deemed unsuccessful for replacing natural production lost to the area. IPC's hatchery program was developed in the 1960s and was revised by the 1980 *Hells Canyon Settlement Agreement*. IPC has complied with the terms and conditions of this agreement by expanding original hatchery facilities where necessary to accommodate additional egg and smolt production. By its terms, the *Hells Canyon Settlement Agreement* remains in effect through the existing license for the Hells Canyon Complex.

In implementing the *Hells Canyon Settlement Agreement*, IPC has set smolt production objectives for its hatcheries at 3 million spring chinook at Rapid River Fish Hatchery, 400,000 pounds of steelhead at Niagara Springs Fish Hatchery, and 1 million spring/summer chinook at Pahsimeroi Fish Hatchery.

Based on expansion of coded wire tag data, adult fish produced from IPC hatcheries have ranged from 2,499 to 41,049 adult steelhead and 182 to 15,746 adult spring chinook annually, with mean annual adult contributions of 12,522 and 5,445, respectively. Data are not available with which to perform similar analyses for summer chinook and fall chinook. The contribution of adult steelhead to sport fisheries in Idaho has been significant: in select years, IPC-produced fish make up as much as 66.1% of all sport-harvested steelhead. Contributions of spring chinook are similar and have even reached 100% in recent years when sport fisheries have been severely restricted. In addition, resource managers have extensively used surplus adults, eggs, fry, and smolts from IPC facilities to establish or expand other fisheries programs in the region.

The role of hatcheries under the Endangered Species Act is only beginning to develop. Recent scrutiny of hatchery programs suggests that numerous reforms are necessary to ensure that hatchery operations either assist or do not hamper recovery of listed species. Some IPC hatcheries may be readily converted to operate in a conservation mode while others may best serve the public interest by continuing to support harvest augmentation. Goals and objectives developed by fisheries managers will dictate how best to use IPC hatchery facilities.

1. INTRODUCTION

For nearly 40 years, Idaho Power Company (IPC) has operated a fish hatchery program to mitigate for anadromous fish losses associated with constructing and operating the Hells Canyon Complex (HCC) of dams on the Snake River. Initial efforts by IPC and state and federal resource managers to preserve anadromous fish in the Snake River centered on providing fish passage around the three-dam complex. The transition to an artificial propagation program occurred only after it became evident that fish passage measures were unsuccessful. Beginning in 1961 and continuing through 1967, IPC constructed a series of four fish hatcheries and associated trapping facilities for artificially propagating spring chinook (*Oncorhynchus tshawytscha*), fall chinook (*O. tshawytscha*), and summer steelhead (*O. mykiss*) that were known to inhabit the Snake River and its tributaries. These facilities continue to operate today, producing millions of chinook and steelhead smolts annually.

In 1996, IPC began conducting environmental studies to support the process of relicensing the HCC with the Federal Energy Regulatory Commission (FERC). Developed cooperatively with the Aquatic Resources Work Group (ARWG) of the Collaborative Team, these studies grew out of issues that the ARWG identified as significant concerns relating to the HCC's ongoing operation. The ARWG identified only one issue relating to the anadromous hatchery mitigation program: because the existing IPC hatchery mitigation program may conflict with management plans for recovering or protecting wild stocks of anadromous fish, the hatchery program may be unable to fully mitigate for the effects of the HCC. From this single issue of concern, the following list of study objectives was developed:

1. Describe key events leading to the development of a hatchery program.
2. Describe rationale used to develop the initial hatchery mitigation program.
3. Describe program changes associated with the 1980 *Hells Canyon Settlement Agreement*.
4. Summarize hatchery production to date.
5. Assess program success relative to the *Hells Canyon Settlement Agreement*.
6. Evaluate compatibility of the current hatchery program with state fish management programs and the Endangered Species Act.
7. Evaluate suitability of the IPC hatcheries for recovery or reintroduction efforts.

2. HATCHERY DEVELOPMENT

2.1. Early History

During the late 1940s, both private and federal interests were contemplating several proposals for hydroelectric dam construction in Hells Canyon. By 1950, IPC was also exploring options for constructing a dam or series of dams in this area. Despite an emphasis on economic growth and the expansion of the West, state and federal agencies responsible for managing and conserving anadromous fish in the middle Snake River opposed constructing dams in Hells Canyon. As early as 1953, the Oregon Fish Commission (OFC) protested to the Federal Power Commission (FPC and precursor to FERC), stating:

> The Idaho Power Company has not satisfied the requirements of this Commission regarding the protection of the fish life which can be completely destroyed by the construction of these projects…The proposal of the Idaho Power Company jeopardizes the existing fisheries and planned increases in runs expected as the result of recent management policies of the state fisheries agencies.

The Oregon Game Commission (OGC) (1953) noted:

> Hells Canyon, the farthest downstream of the three dams, would be 320 feet in over-all height…as yet, there is no way known of successfully passing migratory fish both up and down past a barrier of this height. The other two dams are also of a height such as to make the passage of fish doubtful, or impossible…The State of Oregon will suffer an irreparable loss of and damage to its wildlife resources from the construction and operation of said project…

Nonetheless, after hearing testimony that amounted to 19,215 transcript pages and 400 exhibits, the FPC issued a license on August 4, 1955. This license allowed IPC to construct the HCC.

Discussions of appropriate means of conserving the anadromous fish of the middle Snake River date back to August 12, 1954. On that date, IPC initiated dialog via a letter to the U.S. Fish and Wildlife Service (USFWS) requesting information on the type of fish-handling program the hydroelectric projects would require (Gale 1954). Once it became evident that the projects were destined to become reality, the agencies were faced with developing a conservation plan in short order. In his historical review of HCC construction, Chapman (2001) notes that only 33 months separated the issuance of the license from the closure of Brownlee Dam in May 1958. Under the terms of Article 34 of the license, state and federal agencies investigated or considered all known methods for mitigating losses to the anadromous fish runs. These possible methods included passage, translocation, artificial and semi-artificial propagation, and natural redistribution of fish in streams below the projects (Haas 1965).

Since the late nineteenth century, hatcheries appeared to some as a solution to the problem of declining salmon populations (Mighetto and Ebel 1995). So appealing were hatcheries that, by 1929, 72 hatcheries for salmon and steelhead were annually stocking 500 million fry and fingerling in the Pacific Northwest (Lichatowich and McIntyre 1987). Additionally, the Mitchell Act of 1938 had already set the precedent of using hatcheries to mitigate for the loss of anadromous fish associated with Bonneville and Grand Coulee dams. But hatcheries were not the option of choice for mitigating impacts from the HCC.

Of the methods considered for protecting the fisheries resource, passage was most appealing to the agencies because it focused on natural production and continuing use of historic spawning and rearing habitats. The use of hatcheries to replace natural production lost to the HCC might have received greater consideration were it not for the unfavorable results of hatchery-siting studies conducted by the USFWS. These studies indicated a general scarcity of available sites with adequate water supplies and suitable water temperatures for hatchery development. While these concerns did not entirely rule out the use of hatcheries at some future date (Haas 1965), it did make them a secondary option to be held in reserve and investigated further before being fully considered.

When agency biologists adopted the fish passage policy, they understood completely that it was an experimental program. Knowledge and experience with fish passage at high-head hydroelectric projects were minimal, and biologists had no way of predicting whether their plan would succeed. Further, they were aware that additional hydroelectric projects further downstream would probably be constructed. The biologists knew that the facilities and measures that they ultimately recommended would be tentative.

From 1957 to 1960, all efforts focused on designing, constructing, and operating a forebay net barrier and adult collection facilities so that fish could be transported around the project.

2.2. Transition to Hatcheries

It appears that the first significant discussion of converting from a passage program to hatchery mitigation occurred at a meeting of IPC and agency officials in August 1960. By this time, some biologists had concluded that experiments with artificial propagation of fall chinook were now essential. They based their conclusions on the fish passage program's experimental nature and on growing suspicions that the program was ineffective at maintaining anadromous fish populations. At the meeting, they discussed a pilot program in which 200 adult fall chinook would be spawned and temporary hatching facilities organized for the resulting eggs. They envisioned constructing this supplemental production facility at the Oxbow Dam site. Looking ahead, they would move the facility downstream as successive dams were built on the Snake River (Moore 1960). Within months, the FPC (1960) ordered IPC to construct artificial propagation facilities below Oxbow Dam that were capable of holding 2,000 adult fall chinook and their resulting eggs. In July 1961, construction of Oxbow Fish Hatchery began. The facility became operational in September of that year.

What started as suspicions of failure became fact as state and federal agencies assembled biological data on the efficiency of the forebay net barrier. Preliminary study results prompted IPC to explore alternatives to fish passage at the HCC. In August 1962, IPC fishery biologist Wendell Smith outlined a plan for transferring spring chinook and steelhead into the undammed Salmon River drainage (Smith 1962). Unsuccessful fish passage efforts and the probable development of additional downstream hydroelectric projects (which would further complicate fish conservation) left agency personnel with little choice. They now had to seriously consider artificial propagation as a tool for replacing fish lost through construction of the HCC. This shift in thinking is reflected in an order issued by the FPC that would be the most significant event in the development of the hatchery mitigation program. On December 11, 1963, after reviewing the results of passage efficiency studies conducted by state and federal resource agencies, the FPC ordered IPC to abandon the barrier net and fish passage program and shift its efforts to other means of conserving anadromous fish. The order required Oxbow Fish Hatchery to expand its operation to include trapping and spawning *all* returning fall chinook. The order also mandated acquiring property on Rapid River near Riggins, Idaho, on which an experimental hatchery could be constructed. The hatchery would be able to rear 600,000 chinook salmon or steelhead and provide for expansion of both. Construction of Rapid River Fish Hatchery began in March 1964. While still under construction, the hatchery became operational in May 1964.

Agency thoughts on using artificial propagation were formalized on August 25, 1965. On that date, L. Edward Perry, Columbia River Basin Fishery Technical Committee coordinator, submitted a plan to the FPC on behalf of the seven state and federal resource agencies involved with the HCC. The plan was titled *Policy for the Perpetuation and Management of Anadromous Fish in the Snake River Drainage Upstream from Salmon River* (Perry 1965). This policy statement included discussion of a permanent system of artificial propagation facilities for maintaining fish runs of the middle Snake River system. On January 28, 1966, the FPC issued an order implementing most of the recommendations made in this document by interested resource agencies. The recommendations included constructing 1) a steelhead rearing facility near Buhl, Idaho, capable of rearing 200,000 pounds of fish and 2) steelhead smolt acclimation and trapping/spawning facilities in Lemhi County, Idaho, with a capacity of 3.3 million steelhead eggs. Subsequent to this order, IPC's Niagara Springs and Pahsimeroi fish hatcheries became operational in July 1966 and March 1967, respectively.

While a complete shift to artificial propagation had clearly been made, some details remained vague. Perry (1965), speaking on behalf of the state and federal resource agencies, stated that anadromous fish populations must be restored to levels not less than the maximum counts of record[1] at Oxbow and Brownlee dams. However, there appear to be no records or information suggesting how the initial hatchery capacities and production levels were correlated with these trap counts. Additionally, the general tone of the various FPC orders prescribing fish facilities suggests that the hatcheries were viewed as experimental facilities, subject to modification as necessary to satisfy their intent. Examples of this perception include 1) expanding the Rapid River facility from its original capacity of 300 adults and 600,000 eggs to 2,700 adults and 1 million eggs, 2) terminating the transfer of steelhead eggs to Rapid River Fish Hatchery (based on poor success and the presence of a dedicated steelhead facility at Niagara Springs), and 3) relocating the Lemhi River steelhead trout acclimation and spawning/incubation facilities to the Pahsimeroi River because of low water conditions on the Lemhi River (all by FPC order dated February 9, 1967). In a similar manner, Rapid River Fish Hatchery was again expanded, this time from 1 million eggs to 3 million eggs to take advantage of the abundant return of adults experienced immediately after its startup (Chapman 2001).

The rapid pace of development that was established during construction of Brownlee Dam carried over into the hatchery program. Oxbow, Rapid River, and Niagara Springs hatcheries were all operational within a few months of the FPC orders requiring their construction. Given the speed at which the hatchery program was launched, it is not surprising that some issues were either overlooked or lacked sufficient time for thorough evaluation and incorporation into the overall plan. One such issue was mitigation for the anadromous fish formerly produced in the

[1] The maximum trap counts for adult fall chinook, spring chinook, and steelhead were 17,848, 2,631, and 5,185, respectively.

Snake River between Oxbow and Hells Canyon dams. Citing IPC trap records at Oxbow Dam (1958 through 1965) and Hells Canyon Dam (1965 through 1967), Schneider and Schoning (1968) conservatively estimated 5,000 adult steelhead were produced between Oxbow and Hells Canyon dams, primarily in Pine and Indian creeks. In a draft stipulation prepared for IPC review in March 1968, the agencies recommended that IPC double its steelhead production at Niagara Springs Fish Hatchery to mitigate for these fish. A release site for the steelhead would be determined based on the extent of downstream hydroelectric development on the Snake River. Despite agencies' assertions that they had previously reserved the right to recommend additional mitigation measures for steelhead using the river between Oxbow and Hells Canyon (Schneider and Schoning 1968), IPC was reluctant to expand the Niagara Springs facility until the current steelhead program was fully evaluated (Moore 1968). This debate continued for some years, with IPC preferring to wait and see how well Niagara Springs Fish Hatchery performed while the agencies pressed for more immediate facility expansion.

By 1970, unresolvable water quality and disease problems at Oxbow Fish Hatchery were limiting IPC's ability to adequately sustain fall chinook production. Each year fewer and fewer adults were trapped until the final spawn take, in 1969, yielded only 55,000 eggs. Resolving these two issues alone may not have been extremely difficult. But other concurrent events in the Northwest exacerbated the disagreement, and tensions mounted between IPC and the state and federal agencies. IPC was extremely concerned about impacts from additional hydroelectric projects constructed (or planned for construction) downstream of the HCC. Citing concern for reduced steelhead survival associated with elevated reservoir temperatures, delayed migration speed, and turbine mortality, IPC Vice President H. R. Moore (1968) wrote that it would not seem reasonable for IPC to invest in new facilities at the present time. IPC also argued that replacing 17,000 fall chinook counted at the Brownlee–Oxbow construction site was not solely IPC's responsibility. Since completion of the HCC, four additional hydroelectric dams had been constructed on the Columbia and Snake rivers. IPC believed that at least a portion of the responsibility for the demise of fall chinook should be assigned to these projects (Smith 1974a).

In an effort to resolve the steelhead issue as well as seek additional compensation for fall chinook, the agencies prepared a draft stipulation dated April 11, 1974. The stipulation outlined measures requiring IPC to replace these remaining fish (Kruse 1974). Measures listed in this stipulation were 1) expanding Rapid River Fish Hatchery to 3.5 million smolts to provide a return of 19,700 spring chinook (thereby replacing fall chinook with spring chinook); 2) expanding Niagara Springs Fish Hatchery to double its production and achieve a return of 10,000 adult steelhead; and 3) constructing an adult trap and combination smolt acclimation and adult holding pond below Hells Canyon Dam. For reasons previously noted, the agencies and IPC were unable to resolve these issues and sought relief from the FPC.

2.3. The *Hells Canyon Settlement Agreement*

On January 28, 1976, several state and federal fishery agencies (collectively known as petitioners) filed a petition with the FPC for a Declaratory Order Amending and Supplementing Orders Prescribing Fish Facilities. The agencies included the National Marine Fisheries Service (NMFS), Idaho Department of Fish and Game (IDFG), Oregon Department of Fish and Wildlife (ODFW), Washington Department of Fisheries (WDF), and Washington Department of Game

(WDG). The petitioners alleged that previous measures implemented by IPC had not provided appropriate mitigation for losses of anadromous fish associated with the construction and operation of the HCC and that certain fall chinook and steelhead runs had been eliminated by the construction of the HCC. They further alleged that the U.S. Army Corps of Engineers (COE) had prepared a comprehensive plan for the compensation of fish and wildlife losses that resulted from the construction and operation of the four federal dams on the lower Snake River and were implementing configuration and operational changes to improve the survival of anadromous fish at these projects. The petitioners requested that the FPC require similar measures of IPC. The FPC published public notice that the petition was filed and took comments, protests, and motions to intervene in the petition until June 18, 1976. After considering the petition and the comments received, the FPC issued an order dated April 20, 1977. This order established a proceeding and provided for a hearing in Docket No. E-9579 stating:

> The subject petition for declaratory order, as a review of previous Commission orders on this subject illustrates, is but the latest of what has been an extensive and continuing attempt to resolve the anadromous fish problems related to the construction and operation of Licensee's dams. Anticipation of further hydroelectric development of the Snake River below Hells Canyon Dam, only recently settled by Congress, has produced a ten-year hiatus since the last Commission order dealing with this subject was issued. Accordingly, there would appear to be a need to develop a new record to reflect the condition of the anadromous fisheries resource in the project area as it exists today. It shall therefore be the objective of the Presiding Administrative Law Judge to compile a fresh and self-contained record upon which our future decisions respecting this matter may be based (FPC 1977).

For nearly three years, the parties engaged in a formal proceeding before the FPC to explore the issues raised by the petition. After extensive litigation—including discovery, briefing, and the presentation of written testimony—the parties entered into negotiations that ultimately resolved all anadromous fish issues relating to the HCC under the current license. IPC and the petitioners resolved the issues raised by the petition that had been filed with FPC by jointly filing an uncontested offer of settlement with the Federal Energy Regulatory Commission (FERC, formerly the FPC). The settlement, which became known as the *Hells Canyon Settlement Agreement,* was embodied in a written agreement (Appendix C) dated February 14, 1980, and signed by IPC; the State of Idaho, through IDFG; the State of Oregon, through ODFW; the State of Washington, through the WDG and Washington Department of Fisheries (WDF); and the U.S. Department of Commerce, through NMFS. FERC accepted the offer of settlement by order dated February 27, 1980. In its order, FERC concluded:

> The offer of settlement provides that its requirements would constitute full and complete mitigation for all numerical losses of salmon and steelhead caused by the construction and operation of Project No. 1971 under the existing license. According to the offer of settlement, IPC will provide, operate, and maintain fish traps, fish hatchery facilities, and fish handling and transportation facilities that will provide annual production levels of fall chinook, spring chinook, and steelhead smolts. Facilities development includes providing a permanent adult trapping facility on the Oregon side of the Snake River below Hells Canyon Dam, refurbishing the Oxbow hatchery facilities, enlarging the Pahsimeroi Hatchery, and modifying the Niagara Springs Hatchery… The offer of

> settlement resolves all of the issues set for hearing in our order of April 20, 1977. We conclude that the offer of settlement is reasonable and in the public interest in carrying out the provisions of the Federal Power Act and should be approved (FERC 1980).

This 1980 order approving the settlement is the most recent and the last order issued by FERC on the subject of fish mitigation at the HCC. This order and the *Hells Canyon Settlement Agreement* form the basis of the IPC hatchery mitigation program today.

2.4. Post-Settlement Agreement Developments

Section IV.A.2. of the *Hells Canyon Settlement Agreement* required IPC to "contract with appropriate state and federal agencies or otherwise provide for the trapping of sufficient adult fall chinook salmon and the fertilizing and eyeing up of sufficient eggs to permit raising up to 1,000,000 fall chinook smolts" (*Hells Canyon Settlement Agreement* 1980). In an effort to implement this provision, IPC entered into an agreement with COE dated May 31, 1984. According to the agreement, IPC would provide a portion of the construction cost of COE's Lyons Ferry Hatchery in exchange for sufficient capacity within the new Lyons Ferry facility to ensure availability of approximately 1.3 million eyed fall chinook eggs annually. Due to the critically depleted size of fall chinook populations in the Snake River at that time, the agreement further stated that IPC would not be entitled to any eggs in any year until such time that Lyons Ferry had obtained 80% of its annual quota of 12 million eggs. Recently, this qualifier has been modified by annual fall agreements pursuant to U.S. v. Oregon litigation. Distribution of Lyons Ferry fall chinook eggs between the Washington Department of Fish and Wildlife, Nez Perce Tribe and IPC programs is now negotiated among state, federal and tribal salmon managers. Consequently, IPC would not receive any fall chinook eggs with which to implement the provisions of Section IV.A.2. until December 7, 2000.

3. Facilities Description and Operation

3.1. Oxbow Fish Hatchery

Oxbow Fish Hatchery (hereafter OFH) was constructed in 1961 pursuant to an FPC order dated November 11, 1960. Originally, OFH was an experimental facility for evaluating the feasibility of supplementing Snake River fall chinook populations through artificial propagation. The facility is located downstream of the Oxbow Power Plant on the Oregon shore of the Snake River immediately upstream of the mouth of Pine Creek (Figure 1). It originally consisted of a hatchery building for primary egg incubation, a clay-lined earthen adult holding pond, and a horseshoe-shaped incubation and rearing channel for final egg incubation and early rearing. Water was supplied to the hatchery from two 8,000-gallon per minute (gpm) pumps located in the Snake River. Temporary trapping facilities for collecting broodstock were initially located at the Oxbow Dam construction site. Trapping facilities were relocated to the Hells Canyon Dam site when construction began there. During the first two years of operation (1961–1962 and 1962−1963), fertilized eggs were placed in vertical stack incubators in the hatchery building and incubated on raw Snake River water until eye-up. At eye-up, eggs were transferred to the incubation channel where they were planted at a density of 6,000 eggs per linear yard and buried under 4 to 6 inches of gravel. After hatching and emergence, fry were fed a combination of frozen and dry fish feed. Fry were allowed to migrate volitionally from the incubation channel to the Snake River. Fry traps were used to estimate emigration timing and rate. Beach seines were used to remove any remaining fish from the channel.

During the winter of 1964, Craig (1964) reported that six 100 ft long by 6 ft wide by 4 ft deep (shown in this report as 100 × 6 × 4 ft) concrete raceways were constructed to replace the incubation and rearing channel. Fry were transferred to the raceways at swim-up and remained there until release to the Snake River. Still further changes were made to the hatchery in 1965 when a new 160 × 70 × 5 ft concrete adult holding pond was built to accommodate both fall chinook and steelhead. In 1966, this pond was equipped with dividers and mechanical crowding devices to segregate fish by species and sex for spawning. Also in 1966, truck-loading equipment formerly used at the Oxbow Dam trap was installed at the hatchery to facilitate loading spring chinook onto trucks for transport to Rapid River Fish Hatchery and sorting fall chinook and steelhead during spawning operations. In 1967, the mechanical crowding equipment was modified to allow hatchery personnel easier means of sorting fish for sexual maturity during spawning. With only minor modifications, the adult holding ponds, spawning building, and hatchery building remain in use today.

Two groundwater wells were constructed in 1992. These wells provide 120 gpm each of constant temperature, pathogen-free water for egg incubation. A 70-horsepower water chiller added in 1993 allows hatchery personnel to manipulate incubation temperatures between 54 °F and 40 °F, as necessary, to regulate embryonic development. To comply with the Sections IV.A.1.(a)(2) and IV.A.2. of the *Hells Canyon Settlement Agreement* (1980), some additional modifications have been made. These modifications include constructing 1) a permanent adult trap on the Oregon shore of the Snake River downstream of Hells Canyon Dam in 1983 and 2) two concrete raceways capable of rearing approximately 200,000 fall chinook in October 2000. Current capacities of the various facilities at OFH appear in Table 1. A plan view of the present-day OFH appears in Figure 2.

Today OFH is operated by IDFG and staffed with one full-time hatchery manager and 2,740 hours of seasonal manpower. Current operation of OFH centers around three IDFG fishery management objectives: trapping and spawning steelhead broodstock, trapping and transferring spring chinook broodstock to Rapid River Fish Hatchery, and evaluating fall chinook rearing success.

Regarding steelhead production, Hills (2001) says that the IDFG management objective of OFH was to trap and spawn enough steelhead to produce 1.3 million eyed eggs and/or fry for transfer to Niagara Springs Fish Hatchery. Hills also notes that the broodstock collection strategy is to trap 75% of the necessary broodstock in the fall and 25% in the spring. Collection of adult steelhead commences in the fall when Snake River water temperatures drop to 60 °F (mid-October). IDFG, ODFW, and IPC have agreed informally to operate the Hells Canyon Trap five days per week until 600 fish are collected. Once this goal is reached, trap operation is reduced to three days per week (Monday−Wednesday) until 1,200 fish have been trapped and transported to OFH. This reduction in trapping effort is directed at maintaining a quality sport fishery in the Snake River immediately below Hells Canyon Dam. Depending on the strength of the run in a given year, IDFG and ODFW may then choose to discontinue trapping until spring or continue trapping with the intent of outplanting “surplus” adults to selected Oregon and Idaho waters. In the later case, trapping is halted when freezing air temperatures create icing problems at the trap (usually mid-December). Trapping resumes five days per week on April 1 as river conditions allow[2] and continues until sufficient broodstock are collected to meet IDFG needs. During both fall and spring trapping, all fish are removed from the trap daily and transported by truck to OFH for interrogation (a process during which total length is measured and the fish are assessed for fin clips, tags and external injuries). Any wild chinook or steelhead (identified by the presence of an adipose fin) are returned immediately to the Snake River, pursuant to the terms of the Endangered Species Act (ESA) Section 10(a)(1)(B) permit #903 issued to IDFG. In 1997, NMFS listed Snake River summer steelhead as threatened under the ESA. Although Oxbow stock steelhead are not currently included in this listing, NMFS considers them to be part of the evolutionarily significant unit (ESU) for Snake River summer steelhead. These fish may represent a genetically important component of the evolutionary legacy of Snake River summer steelhead.

Steelhead spawning commences in mid-March and continues through early May on a twice-per-week basis. Viral and bacterial pathogen samples are collected from all adults to facilitate culling eggs from positive parents, as necessary. Eggs are incubated on site in mechanically chilled, pathogen-free well water, according to standard salmonid fish culture techniques described by Piper et al. (1982). Using chilled water extends incubation time by up to two weeks, thereby reducing the size of smolts produced at Niagara Springs Fish Hatchery. Most eggs are shipped to Niagara Springs Fish Hatchery at eye-up. Since 1994, approximately one-third to one-half of the eggs destined for Niagara Springs Fish Hatchery have been incubated to hatch at OFH and shipped as swim-up fry. This practice serves to further retard development of the earliest eggs and minimizes overcrowding at Niagara Springs Fish Hatchery.

Hills (2001) stated that the IDFG goal for the spring chinook program at OFH is to trap sufficient adults to provide for the collection of eggs to produce 1 million smolts. Trapping operations for spring chinook are similar to those used for steelhead. Trapping begins May 1 and continues until July 15 or as otherwise determined by IDFG. The trap is operated five days per week, and all fish are removed from the trap daily and transported to OFH for interrogation. Wild fish are returned to the Snake River while hatchery fish are placed in holding for periodic transfer to Rapid River Fish Hatchery, where they will be spawned and their progeny reared to smolt. These fish are not listed as threatened under the ESA, nor are they considered part of the Snake River spring/summer ESU by NMFS.

Due to the unavailability of eggs from Lyons Ferry Hatchery, the fall chinook program at OFH is still in the early stages of development. To date, IDFG’s goals have simply been to evaluate the feasibility of rearing fall chinook at this facility. A rearing trial was conducted in 2000–2001, and a second trial is anticipated in 2001–2002. Briefly, eyed eggs are transported to OFH from Lyons Ferry Hatchery in Washington state in early December. Egg incubation is completed on constant-temperature, pathogen-free well water. Eggs hatch in late December, and swim-up fry

[2] The Hells Canyon Trap becomes inoperable at flows of 48,000 cubic feet per second or greater.

are moved to the outdoor raceways in late January. A combination of raw Snake River water and well water is supplied to the raceways for rearing purposes. IPC transports subyearling smolts to the release site below Hells Canyon Dam in late May.

3.2. Rapid River Fish Hatchery

Rapid River Fish Hatchery (RRFH) was constructed in 1964 on Rapid River, a tributary to the Little Salmon River approximately 7 mi from the community of Riggins, Idaho (Figure 1). Reingold (1966) gives a good account of the various structures making up the original facility, including the office and incubation building with ten 16-tray vertical incubators, twelve 100 × 6 × 4 ft concrete raceways, and an 80 × 25 × 6 ft adult holding pond. Estimated capacities of the original facility were 1.3 million eggs, 800,000 juvenile salmon, and 800 adult salmon or steelhead (Reingold 1966). Water for the hatchery was diverted directly from Rapid River through a 30-inch diameter pipeline. An upstream migrant trap was constructed approximately 1.5 mi downstream of the main hatchery. Adult salmon collected here were trucked to the holding pond at the main hatchery.

RRFH was constructed as an experimental facility for artificially propagating spring chinook, summer steelhead, and to a lesser extent, fall chinook. During the first year of operation, cold water temperatures were believed to have caused excessive prespawning mortality and abnormal maturation of female fall chinook. Steelhead spawning efforts were more successful. Nonetheless, low water temperatures reduced juvenile growth rates so that it took 24 months to produce 150 to 200 mm smolts, compared with only 12 months in the warm spring water of the Hagerman Valley. Based on these findings, efforts to rear fall chinook and steelhead at RRFH were abandoned, and the facility was dedicated to spring chinook production (Reingold 1966).

During the winter of 1966−1967, RRFH was expanded to include a 150 × 40 × 6 ft earthen adult holding pond with a capacity for 1,900 adult salmon[3]; a 200 × 80 × 3 ft earthen rearing pond with a capacity for 1 million smolts; and an incubation building that can house twenty-two 16-tray vertical incubators, bringing the total incubation capacity to 3.3 million eggs. A third earthen adult holding pond (250 × 80 × 6 ft) and a second earthen rearing pond (370 × 70 × 3 ft) were added in 1969, along with a 24-inch diameter pipeline to supply river water to these structures (increasing the total water supply to 28 cubic feet per second [cfs]). Finally, a new incubation building was constructed in 1981 to consolidate all fifty 16-tray vertical incubators into one location. With the exception of the third adult holding pond, which has been removed from service, all other structures remain in use today with only slight modifications[4]. No facility modifications were necessary for compliance with the *Hells Canyon Settlement Agreement*. Current capacities of the various facilities at RRFH appear in Table 2. A plan view of the present-day RRFH appears in Figure 3.

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[3] This was an estimated carrying capacity. Experience has shown that this pond is capable of holding 3,000 adult salmon.

[4] Improvements to pond walls and water distribution structures have slightly altered the rearing and adult pond volumes. Data presented in Table 2 reflect current conditions.

IDFG currently operates RRFH with one full-time hatchery manager, one full-time assistant manager, one full-time fish culturist, and 5,780 hours of seasonal manpower. IDFG operates RRFH to satisfy two fishery management objectives: 1) trap and spawn sufficient adults to provide for the annual production of 3 million spring chinook smolts and 2) produce eggs or fry for other IDFG supplementation programs statewide (Steiner et al. 2000). In brief overview, returning adults are trapped from late April through July. After interrogation at the trap, hatchery fish are transported by truck, approximately 1.5 mi to the holding ponds. All wild fish (identified by the presence of an adipose fin) are returned to Rapid River pursuant to the terms of ESA Section 10(a)(1)(B) permit #903 issued to IDFG for the operation of RRFH. Additionally, hatchery spring chinook trapped at Hells Canyon Dam are delivered to RRFH by IPC tanker and placed in holding. Spawning begins in mid-August and continues through mid-September on a twice-per-week basis. Eggs are incubated on site on raw river water according to standard salmonid fish culture techniques described by Piper et al. (1982). Viral and bacterial pathogen samples are collected from all adults to facilitate culling eggs from positive parents. At swim-up, fry are moved to outdoor raceways where they remain until June. At that time, IDFG personnel remove the adipose fin from all fish and transfer the fingerlings to the final rearing ponds. Fish remain in these ponds until smoltification the following March. SectionsIV.A.1.(b)(1) and (2) of the *Hells Canyon Settlement Agreement* also state that 1 million smolts are to be released in the Snake River while 2 million smolts are to be released in Rapid River. IDFG and ODFW typically exercise their authority under Section IV.A.1.(d) of the *Hells Canyon Settlement Agreement* to deviate from this schedule by volitionally liberating most, or sometimes all, of the smolts directly to Rapid River. When off-site releases are desired, IDFG directs IPC to release smolts by tanker trucks at locations such as the Snake River below Hells Canyon Dam or Little Salmon River. The Rapid River spring chinook stock is not listed as threatened under the ESA, nor is it considered part of the Snake River spring/summer ESU by NMFS.

3.3. Niagara Springs Fish Hatchery

On January 28, 1966, the FPC ordered IPC to construct and maintain a fish hatchery capable of rearing 200,000 pounds of steelhead smolts annually. After experiencing low steelhead growth rates on relatively cold water at RRFH, IPC sought a warmer water source for its steelhead facility. The appropriate site was found at Niagara Springs, a constant 59 °F spring water source flowing from the basalt cliffs of the Snake River Canyon, approximately 10 mi south of Wendell, Idaho (Figure 1). Unlike the previously constructed IPC hatcheries that were experimental in nature and dealt with multiple species, Niagara Springs Fish Hatchery (NSFH) was designed and constructed as a dedicated steelhead hatchery. The facility was constructed in 1966 and released its first fish into the Pahsimeroi River in the spring of 1967.

The original hatchery facility consisted of a main hatchery building housing an office, shop, and incubation room equipped with standard 8-tray vertical incubators; fourteen 300 × 10 × 2.5 ft concrete raceways; and three operator residences. One hundred thirty-two cfs of spring water was supplied to the hatchery via gravity flow. Eyed steelhead eggs received from Oxbow and Pahsimeroi fish hatcheries were hatched in the vertical incubators and moved directly to the outside raceways at swim-up. They remained in these raceways for approximately 11 months before being transported by IPC trucks to release sites.

As with other IPC hatcheries, a number of changes have occurred since original construction. To alleviate low dissolved oxygen problems during incubation, the vertical incubators were replaced in 1974 with 20 upwelling incubators and associated 6-ft in diameter circular nursery vats. In 1977, an off-line waste-settling pond was constructed to prevent cleaning wastes from discharging into Niagara Springs Creek and the Snake River. A fourth residence was added in 1981 to accommodate increased staffing of the facility.

Following the signing of the *Hells Canyon Settlement Agreement*, steelhead production goals at NSFH increased from 200,000 to 400,000 pounds of fish annually. No facility modifications were necessary to accommodate this increased production demand. However, as part of a waste treatment expansion project in 1993−1994, IPC elected to construct five additional concrete raceways at the request of IDFG to reduce smolt-rearing densities. Further efforts to reduce rearing densities were made in 1998 when the 20 circular nursery vats were replaced with 21 60-ft^3 linear nursery vats. Ten additional upwelling incubators were added at the same time. In 1997, overhead netting was installed to exclude avian predators from the raceways and to reduce the risk of pathogen transmission. Current capacities of the various facilities at NSFH appear in Table 3. A plan view of the present-day NSFH appears in Figure 4.

IDFG currently operates NSFH with one full-time hatchery manager, one full-time assistant manager, two full-time fish culturists, and 5,700 hours of seasonal manpower. Like wording in the *Hells Canyon Settlement Agreement*, the IDFG fishery management objectives for NSFH, identified by Chapman et al. (2000), are to rear 200,000 pounds of steelhead smolts for release in the Salmon River and its tributaries and 200,000 pounds of steelhead smolts for release in the Snake River below Hells Canyon Dam. In both cases, Chapman et al. (2000) cites an IDFG goal of providing a quality sport fishery while still returning 1,000 adults each to the Hells Canyon Trap and Pahsimeroi Fish Hatchery for broodstock purposes. Present-day hatchery operations have not changed significantly from historical practices. The two most significant operational changes have been the incubation of all eggs on mechanically chilled water at OFH to retard embryonic development and the delivery of swim-up fry to NSFH. These measures evolved in response to exceedance of desired smolt size. The larger sizes were caused by an apparent shift in spawn timing of adult steelhead at Pahsimeroi and Oxbow fish hatcheries and the accelerated growth rates of juvenile steelhead at NSFH achieved from more efficient commercially available diets.

The Oxbow and Pahsimeroi fish hatcheries supply eggs to NSFH. Eyed eggs and swim-up fry are received during June and July. After rearing briefly in nursery vats, fry are transferred to outdoor raceways for final rearing. Transport to release sites begins in late March and continues through early May using two IPC-owned 5,000-gallon tanker trucks. To reduce handling stress, smolts are hauled in chilled water. While the *Hells Canyon Settlement Agreement* (1980) states that smolts are to be released in the Pahsimeroi and Snake rivers, IDFG routinely exercises its authority under Section IV.1.A.3.(f) of the agreement to include additional release sites to enhance sport harvest opportunities within Idaho.

3.4. Pahsimeroi Fish Hatchery

The last hatchery facility IPC constructed as part of its hatchery mitigation program was Pahsimeroi Fish Hatchery (PFH). This facility was originally slated for construction on the Lemhi River where IDFG was already operating a juvenile migrant trapping facility. However, increased use of Lemhi River water for irrigation and recurring drought conditions prompted agency officials to select a new site on the Pahsimeroi River (Reingold 1967). In November 1966, IPC began construction of the Upper PFH approximately 14 mi upstream of the mouth of the Pahsimeroi River (Figure 1). The site consisted of two 45 × 500 ft steelhead smolt acclimation ponds, feed storage and delivery equipment, and a two-bedroom home. The acclimation ponds received up to 10 cfs of water directly from the Pahsimeroi River. Each spring from 1967 through 1971, IPC transported steelhead smolts from NSFH to the Upper PFH for acclimation and eventual release into the Pahsimeroi River. Concurrently, IDFG conducted extensive evaluation studies of this release strategy. Steelhead smolt acclimation was discontinued in 1972 after Reingold (1972) concluded that directly released steelhead smolts survived as well or better than acclimated smolts. Since then, all steelhead smolts have been directly released into the Pahsimeroi River immediately below the barrier weir at the lower hatchery site.

In October 1968, IPC began constructing adult trapping and egg incubation facilities on the lower Pahsimeroi River, approximately 1 mi above its confluence with the main Salmon River (Figure 1). The Lower PFH consisted of a barrier weir across the Pahsimeroi River channel and fish ladder leading to three 70 × 16 × 6 ft adult holding ponds, an egg incubation and office building equipped with twenty 16-tray stacks of vertical incubators, a pump house supplying 120 gpm of spring water for incubation, and two mobile homes for seasonal employees. Forty cfs of water for operating the fish ladder and adult holding ponds was supplied directly from the Pahsimeroi River via open canal. Steelhead trapping and spawning began in 1969, with the first returns of NSFH smolts released in 1967, and continues to the present.

Following implementation of the *Hells Canyon Settlement Agreement*, the role of PFH was expanded to include the production of 1 million chinook smolts annually. While no changes to the PFH facility were necessary to accommodate the additional steelhead eggs needed to double production at NSFH, a number of modifications were necessary to accommodate expanded chinook production. In 1981, four concrete raceways (100 × 4 × 3 ft) were constructed at the Lower PFH, along with a pump house to supply 120 gpm of river water for chinook egg incubation. At the Upper PFH, the steelhead acclimation ponds were shortened to 300 × 40 × 5 ft and equipped with outlet-control structures and drum screens to facilitate their use as chinook rearing ponds. Finally, a walk-in freezer was added in 1982 for fish feed storage. Since that time, additional improvements not related to compliance with the *Hells Canyon Settlement Agreement* have included a two-room dormitory and shop building, a spawning building, two permanent residences, a water alarm system, storage buildings, and drum screens to prevent wild fish from being entrained at hatchery water intake diversions. Current capacities of the various facilities at both the Upper and Lower PFH appear in Table 4. Plan views of the present-day PFH facilities appear in Figure 5 and Figure 6.

The chinook production program at PFH has gone through a considerable evolution in its 20-year history. Broodstock originally consisted of indigenous Pahsimeroi River summer chinook combined with Rapid River and Lemhi River spring chinook that IDFG transferred to PFH in 1981. Spring chinook culture was short-lived since IDFG began phasing out the use of this stock in 1985. From 1985 to 1991, IDFG continued to spawn returning spring chinook but excluded them from the hatchery inventory by transferring the eggs to other locations. By 1992, no adult spring chinook returned to PFH. In 1986, IDFG began releasing roughly one-third of returning adult summer chinook upstream of the barrier weir to spawn naturally in the Pahsimeroi River in an effort to maintain a wild population of summer chinook in the Pahsimeroi River. Further program changes occurred in 1992, when Pahsimeroi River summer chinook were listed as threatened by NMFS under the ESA. This listing prompted IDFG to shift the program into a conservation mode aimed at species recovery.

At present, IDFG operates PFH with one full-time hatchery manager, one full-time assistant manager, and 1,835 hours of seasonal manpower. IDFG's objectives for operating PFH, as described by Garlie and Engemann (2000), are to trap and spawn enough summer chinook to collect 1.5 million green eggs, rear 1 million summer chinook smolts for release in the Pahsimeroi River, and trap and spawn sufficient adult steelhead to produce 1.5 million eyed eggs for transfer to NSFH.

To meet its current steelhead program objectives, IDFG operates the adult trap annually from February to early May. The hatchery stocks of Pahsimeroi steelhead are not listed, nor are they part of the ESU. Therefore, hatchery-origin adults are placed in holding while naturally produced adults are released above the barrier weir to spawn in the Pahsimeroi River. Spawning operations begin in mid-March and continue through early May on a twice-per-week basis. Spawned out carcasses are distributed to the public and charitable organizations for human consumption. In recent years, all eggs have been shipped green to OFH via airplane for incubation on mechanically chilled, pathogen-free well water. This procedure is part of IDFG's effort to regulate smolt size at release by slowing embryonic development. From OFH, eyed eggs and swim-up fry are transferred to NSFH for rearing. Egg handling and egg and fry transfer procedures are the same as those described for OFH.

Despite the straightforward goal of trapping and spawning sufficient summer chinook to produce 1 million smolts annually, IDFG's present-day operation of PFH for summer chinook is far from simple. Owing to the listing status of summer chinook, culture of this species is heavily regulated by the ESA and equally complicated. To comply with ESA guidelines, PFH maintains three distinct fish classifications: ESA listed-naturally produced fish, ESA listed-hatchery produced fish, and unlisted-hatchery produced fish. ESA listed-naturally produced fish spawn and rear naturally in the Pahsimeroi River and bear no identifying marks. They are the product of prior natural crossings of ESA listed-naturally produced fish or ESA listed-hatchery produced adults released above the barrier weir to spawn naturally. ESA listed-hatchery produced fish are the product of returning ESA listed-hatchery produced adults artificially spawned with returning ESA listed-naturally produced adults. They are reared at PFH and marked with a pelvic fin clip prior to release to identify their mating history. Finally, unlisted-hatchery produced fish are the product of returning unlisted-hatchery fish artificially spawned with other returning unlisted-hatchery fish. They are reared separately from ESA listed-hatchery produced fish at PFH and receive an adipose fin clip prior to release. Unlisted-hatchery produced fish are not considered threatened by NMFS. In any given year, IDFG (through consultation with NMFS) determines the ratio of ESA listed-naturally produced, ESA listed-hatchery produced, and unlisted-hatchery produced adults retained for artificial propagation at PFH or released above the barrier weir to spawn naturally.

Summer chinook return to PFH in June through early October. The trap is checked daily, and all fish are handled according to the IDFG protocols described above. Adults retained for artificial propagation are placed in holding ponds to await spawning. Chinook spawning commences in late August and continues through early October on a twice-per-week basis. Adults are sampled for viral and bacterial pathogens to facilitate culling eggs from positive parents as necessary. Eggs are incubated to eye-up on pathogen-free spring water at PFH according to standard salmonid fish culture techniques described by Piper et al. (1982). At eye-up, eggs are transferred to IDFG's Sawtooth Hatchery near Stanley, Idaho, for hatching and early rearing on well water. This transfer limits the exposure of chinook fry to *Myxobolus cerebralis*, the causative agent of whirling disease that is present in the PFH water source. Rearing PFH summer chinook on well water until they reach a minimum size of 70 mm before transferring them back to PFH for final rearing reduces the prevalence of *M. cerebralis* (Munson and Johnson forthcoming). In late September, hatchery personnel mark chinook parr before transferring them back from Sawtooth Hatchery. The parr are reared to smolt at the Upper PFH site. Volitional release from the rearing ponds occurs the following April.

4. PROGRAM EVALUATION

4.1. License Compliance

Following issuance of the license to construct the HCC, there have been numerous orders issued under authority of Article 35 of the license by the FPC establishing and modifying fish protection facilities and operations at the project. The original FPC order, issued February 12, 1958, was modified by orders of September 23, 1960; November 17, 1960; December 11, 1963; January 28, 1966; February 9, 1967; and February 27, 1980. These orders and the *Hells Canyon Settlement Agreement* have provided the basis for the IPC hatchery mitigation program since its inception in 1961. Details of these various provisions were discussed in Sections 2.2., 2.3., and 2.4. IPC has complied with all of its obligations to mitigate for losses of anadromous fish associated with the construction and operation of the HCC, although provisions of Section IV.A.2. of the *Hells Canyon Settlement Agreement* relating to fall chinook have yet to be fully implemented because of the unavailability of sufficient fall chinook eggs from Lyons Ferry Hatchery. IPC undertook efforts to comply with that portion of the *Hells Canyon Settlement Agreement*, stating that "facilities will be ready for use within 6 months of written notification by the fishery agencies of the availability of eggs". The parties in attendance at the August 3, 2000, annual *Hells Canyon Settlement Agreement* meeting agreed to make approximately 225,000 fall chinook eggs[5] available to IPC in December 2000 for rearing at OFH. In response to this

[5] Because egg collection was less than anticipated at Lyons Ferry Hatchery, this number was reduced to 122,500.

decision, IPC undertook immediate measures to construct raceways capable of rearing these eggs to smolt. Construction was complete in December 2000, and IDFG placed the facilities in operation in January 2001. Long-term availability of eggs from Lyons Ferry Hatchery is unpredictable because of variable adult returns to the hatchery and requests for eggs from competing hatchery programs. IPC's ability to implement the provisions of Section IV.A.2. of the *Hells Canyon Settlement Agreement* will depend on the company's preparedness to receive larger numbers of eggs from Lyons Ferry Hatchery.

4.2. Egg and Smolt Production

To facilitate an assessment of hatchery production, IPC compiled a complete summary of egg and smolt production for each IPC hatchery. IPC obtained data from IDFG annual hatchery reports, annual evaluation reports, monthly narrative reports, monthly trap reports, and various IDFG correspondence. Some information was also obtained from IPC records.

4.2.1. Oxbow Fish Hatchery

Fall Chinook

As previously discussed, OFH began operating in the fall of 1961. Its purpose was to produce subyearling fall chinook smolts to supplement wild fish production in the Snake River. From 1961 to 1973, adult fall chinook were trapped at Oxbow and Hells Canyon dams and transported to OFH for spawning. During the first two years of operation, less than half of the fish trapped at the Oxbow Dam site were delivered to OFH. The majority were transported above Brownlee Dam and released to spawn naturally. However, as trap catches declined in subsequent years, an increasing proportion of fish were transferred to OFH for artificial propagation (Table 5).

Smith (1974b, cited in Chapman 2001) attributed high prespawning mortality in adults held at OFH to excessive temperatures of holding pond water and columnaris disease (*Flexibacter columnaris*). IDFG reported that *Ceratomyxa shasta* and *Aeromonas pseudomonas* also had a detrimental effect on adult survival. This circumstance severely hampered spawning efforts and resulted in collection of fewer than 1 million eggs in six of the nine years of operation. In 1969, spawning success was so poor that 500,000 eyed fall chinook eggs were acquired from Spring Creek National Fish Hatchery on the Columbia River to supplement the OFH program. Aside from the adult holding problems, agency personnel were relatively successful at incubating, rearing, and releasing subyearling smolts from OFH. From 1962 to 1970, 5.49 million subyearling smolts were released from OFH. Eye-up rates for this same time averaged over 90% and fry-to-smolt survival averaged 75%. Efforts to culture fall chinook continued through 1973; however, extremely low adult collections and complete broodstock mortality resulted in no smolt production beyond 1970. After only 13 years of operation, fall chinook culture at OFH was abandoned since the facility had never spawned and reared the progeny of 2,000 adults annually.

No further fall chinook production occurred at OFH until December 2000, when 122,514 eyed eggs were received from Lyons Ferry Hatchery pursuant to the *Hells Canyon Settlement Agreement*. Subyearling smolts produced from these eggs were released below Hells Canyon

Dam in May 2001. A complete summary of adult fall chinook collection and spawning operations and smolt production from OFH appears in Table 5.

Summer Steelhead

OFH began collecting summer steelhead broodstock for artificial propagation in September 1965, with the first eggs collected in March 1966. The hatchery continues to operate in this capacity today. Egg collections have ranged from 54,169 to over 8 million, and an average of approximately 2.03 million green steelhead eggs are produced annually (Table 6). In addition to its primary responsibility of supplying eggs and swim-up fry to NSFH, IDFG has distributed surplus production from OFH in the form of eggs, fry, and adults to other hatchery programs in Idaho, Oregon, and Washington (Table 7). IDFG has relocated most surplus adults to the Boise and Payette rivers and Hells Canyon Reservoir to provide sport-fishing opportunities.

Neither FPC orders nor the *Hells Canyon Settlement Agreement* specifically states the number of steelhead eggs to be supplied to NSFH from OFH. Rather, the *Hells Canyon Settlement Agreement* speaks in terms of trapping and spawning enough adults to reasonably provide for the production of 200,000 pounds of steelhead smolts annually. Reports by Snider (1993), Hislop (1998), and Hills (2001) suggest that IDFG strives to produce 1.3 million eyed eggs at OFH to meet the 200,000-pound steelhead smolt goal at NSFH. IDFG hatchery personnel have met or exceeded this level of production in 10 of 34 years, or 29.4% of the time. This rate does not necessarily imply, however, that NSFH was under capacity 70% of the time. IDFG has routinely relied more heavily on eggs from PFH to fill NSFH and has not made use of all OFH steelhead eggs for IPC mitigation purposes. By including years when potential egg production would have reached 1.3 million (but IDFG chose to either destroy surplus eggs and fry or ship adults, eggs, and fry to other locations), the record increases to 47.4%. Furthermore, it is important to note that original plans were to completely transfer Snake River steelhead to the Salmon River and phase out broodstock operations at OFH. From brood years 1966 to 1979, less than 5% by weight of the NSFH production was released in the Snake River below Hells Canyon Dam (Table 8). Corresponding adult returns declined throughout this time and are reflected in low egg collection at OFH. If analysis of OFH’s record of egg production is limited to only those years when full-sized smolts were released below Hells Canyon Dam (1982 to 2001) and includes those years when IDFG chose to either destroy surplus eggs and fry or ship adults, eggs, and fry to other locations, the percentage of years in which IDFG would have reached their 1.3 million eyed egg goal increases to 84.2%. In only one case was fish health an issue in supplying eggs to NSFH. In 1990, over 94% of the steelhead eggs died prior to eye-up. The reasons for this unprecedented mortality remain unclear; IDFG attributed the loss to poor incubation water quality; however, some evidence suggests egg-handling procedures by hatchery personnel may have been a contributing factor.

Spring Chinook

In the mid-1960s, OFH satisfied its initial spring chinook obligations by providing broodstock to establish the Rapid River spring chinook program. RRFH quickly became self-sufficient, and OFH ceased trapping spring chinook. Collection of spring chinook broodstock at Hells Canyon Dam resumed in 1983 after the *Hells Canyon Settlement Agreement* was implemented. While the *Hells Canyon Settlement Agreement* calls for trapping enough adults to reasonably produce

1 million smolts at RRFH, it does not specifically state how many adults are needed to reach that level of production. By applying the mean spring chinook fecundity observed at RRFH of 4,004 and assuming a 50:50 sex ratio and an 80% egg-to-smolt survival rate, the estimated number of adults needed to produce one million smolts annually is 624 fish. From 1983 to 2000, trap catches of adult spring chinook at Hells Canyon Dam have met or exceeded this number only four times (22.2%) (Table 9). Low capture rates of adult chinook at Hells Canyon Dam are attributed to the inconsistent pattern, adopted by IDFG and ODFW, of stocking spring chinook smolts at this location. Since 1981, stocking rates have averaged only 303,000 smolts annually and have only met the *Hells Canyon Settlement Agreement* level of 1 million smolts once. As with steelhead, the relatively small contribution of broodstock returning to Hells Canyon Dam should not be interpreted as evidence of failure to mitigate for spring chinook. Adult escapement to RRFH has generally been sufficient to meet smolt production goals despite OFH's limited contribution of broodstock.

4.2.2. Rapid River Fish Hatchery

Spring Chinook

Rapid River Fish Hatchery began operating in 1964 with a production goal of 600,000 chinook smolts annually. The first group of smolts was released to Rapid River in 1966, and the first jacks returned in 1967. Based on favorable adult returns, the production goal was expanded to 1.6 million smolts in 1967 and 3.0 million smolts in 1969. From brood years 1964 through 1998, RRFH has collected over 213 million green eggs and released over 85 million smolts for mitigation purposes (Table 10). Mean annual releases are 2,257,664 smolts to Rapid River (from 1966 through 2000), and 313,303 smolts to the Snake River (from 1981 through 2000). From these same brood years, smolt production at RRFH has met or exceeded the production goals in 12 of 35 years, or 34.3% of the time. Of the 23 years during which RRFH failed to meet targeted mitigation production, failure resulted from adult underescapement and insufficient egg collection in 10 of these years. In the remaining 13 years (56.5%), failure to meet established smolt production targets resulted from IDFG transferring eggs, fry, or smolts to supplement other fisheries programs. If data are adjusted to include years when adult escapement and egg collection were sufficient but smolt production at RRFH did not meet mitigation goals due to egg or fish transfers, the record of performance increases to 71.4%.

The relative success of the RRFH spring chinook program has afforded IDFG and ODFW the opportunity to make use of this stock extensively to supplement other fish management programs within Idaho and Oregon. Since 1964, approximately 75,454,000 surplus eggs and 16,831,000 surplus parr and smolts have been produced at RRFH for use in programs in the Clearwater, Lochsa, upper Salmon, Lemhi, and Grande Ronde river basins. These programs are unrelated to IPC mitigation. IDFG has even transferred Rapid River stock spring chinook eggs to Minnesota in exchange for walleye (*Stizostedion vitreum*) eggs. Transfers of this nature have occurred in 27 of 35 years (77.1%) of operation. The number and disposition of these surplus fish are summarized in Table 11.

4.2.3. Niagara Springs Fish Hatchery

Summer Steelhead

NSFH began operating in 1966, with the first group of smolts released in 1967. The production goal at that time was 200,000 pounds of steelhead smolts annually. From 1967 through 1980, 29,577,694 steelhead weighing 3,018,153 pounds were produced at this facility. Mean annual production during this time was 215,575 pounds or 2,112,692 fish. The majority of these fish (99.6% by weight) were released directly into anadromous waters for mitigation purposes. With an emphasis on transplanting Snake River stock steelhead to the Salmon River, most of these fish were released into the Pahsimeroi River, and less than 5% by weight were allotted to the Snake River (Table 8). Attempting to supplement naturally spawning steelhead and distribute fish to underutilized streams, IDFG used a small percentage of the NSFH production to stock the main Salmon River and various small tributary streams upstream of the Middle Fork Salmon River (Reingold 1982). During this same period, IDFG transferred approximately 0.4% by weight (11,035 pounds) of the NSFH production to other locations for research purposes or to nonanadromous waters within Idaho.

With the signing of the *Hells Canyon Settlement Agreement* in February 1980, IPC agreed to continue operating the NSFH and modify it as necessary to permit the production of 400,000 pounds of steelhead smolts annually. From 1980 through 1999, 36,392,419 steelhead weighing 7,392,833 pounds were produced. Mean annual production during this time was 369,642 pounds or 1,819,621 fish. When compared with mean annual production during the 1967 to 1980 period, this represents a 71% annual increase by weight and a 14% decrease in the number of fish produced each year. This resulting divergence between weight and numbers of fish is probably because of IDFG's emphasis on producing larger smolts to increase survival rates. Following Reingold's (1974) recommendation that steelhead smolts be at least 170 mm to optimize downstream migration, mean size of steelhead smolts produced at NSFH increased from 176 mm in 1973 to 237 mm in 1983 and has remained above 200 mm each year.

As during the previous period, virtually all of the fish produced at NSFH from 1980 to 1999 (98.6% by weight) were released into anadromous waters for mitigation purposes. During this more recent period, however, fish were more equally split between the Snake and Pahsimeroi rivers. This split reflects *Hells Canyon Settlement Agreement* requirements and resource agencies' associated desire to promote the recreational potential of the Snake River below Hells Canyon Dam (Table 12). To disperse angling effort and enhance the quality of the steelhead angling experience, IDFG also increased the steelhead stocked to other sites within the Salmon River drainage from 1.5% to over 15.0%.

Under the terms of the original FPC order, NSFH met or exceeded the 200,000-pound annual production target in 8 of 14 years, or 57.1% of the time. Following implementation of the *Hells Canyon Settlement Agreement*, this average dropped to 35% (7 of 20 years). Since the installation of bird netting to eliminate avian predation in 1997, annual production appears to be trending upward, with production exceeding 400,000 pounds in each of the next two brood years. A complete summary of steelhead production from NSFH appears in Table 13.

4.2.4. Pahsimeroi Fish Hatchery

Summer Steelhead

IDFG began releasing smolts reared at NSFH in 1967, and the first one-ocean adults returned to the Pahsimeroi River in 1969. Efforts to collect summer steelhead broodstock at PFH for artificial propagation began in March 1969. Since operation began, nearly 152 million steelhead eggs have been collected at PFH, ranging from a low of 1,620,000 to over 11 million annually (Table 14). Average egg collection over the 32-year history of the facility is 4,742,649 eggs annually. Approximately 53% of the eggs and fry produced at PFH have been shipped to NSFH. The remaining 47%, or 57,423,006 eggs identified as surplus to IPC mitigation needs by IDFG, have been used in the form of eggs or fry in various locations to enhance sport-fishing opportunities, supplement natural steelhead production, and fill other hatchery mitigation programs. Most notable in the list of recipients are Magic Valley and Hagerman National fish hatcheries. Since 1980, PFH has routinely supplied eggs to these two facilities to offset egg shortages at their broodstock facility. In the past 20 years, these two facilities have received approximately 20,354,500 eggs and fry from PFH.

Adult escapement to the hatchery has also exceeded broodstock requirements in some years, creating opportunities for adult redistribution by IDFG. The disposition of eggs, fry, and adults from PFH appears in Table 15. Moore's (1984) statement that "one of IDFG's objectives for PFH is to collect up to 9 million steelhead eggs annually" provides an interesting insight into the relative success of the PFH steelhead program and IDFG's dependence on this facility to supply eggs for other programs.

The provisions of the *Hells Canyon Settlement Agreement* relative to supplying steelhead eggs to NSFH are expressed in terms of trapping and spawning enough adults to permit the production of 200,000 pounds of steelhead smolts annually. Moore (1984, 1985) indicates that 2.0 million eggs are needed to achieve this level of production while, in more recent years, a slightly lower value of 1.5 million eggs has been used (Bertellotti and Engemann 1998). Therefore, for purposes of analysis, we assumed that the egg production goal from 1969 to 1995 was 2.0 million, while the goal from 1990 to present has been 1.5 million eggs. Relative to these targets, IDFG hatchery personnel have met or exceeded desired egg production in 13 of 32 years, or 40.6% of the time. By including years when egg production met the target but IDFG chose to ship adults, eggs, and fry to other locations, the success rate increases to 87.5%.

Summer Chinook

IDFG's involvement with the culture of summer chinook at PFH dates back to 1969, with eggs collected at PFH, shipped to Mackay Hatchery for rearing, and then returned to PFH for acclimation and release as subyearlings or yearling smolts. While data for the period from 1969 to 1977 are included here (Table 16), to complete the record of hatchery operation, it is noteworthy that efforts to rear summer chinook prior to 1981 were considered experimental and not part of the FPC-mandated mitigation for the HCC. The IPC chinook mitigation program at PFH began in 1981, with the collection of eggs from four female summer chinook and the receipt of 616,823 spring chinook eggs from RRFH. The first release of hatchery smolts associated with IPC mitigation occurred in 1983. From brood year 1981 through 1999, PFH has produced approximately 7,203,601 spring and summer chinook smolts (Table 17), averaging slightly over 379,000 smolts annually. Unlike the Rapid River and Niagara Springs fish hatchery programs, which quickly attained sufficient adult escapement to satisfy egg requirements, the PFH summer chinook program has failed to provide a sufficient number of eggs to meet program needs. Attainment of the mitigation objective of producing 1 million smolts annually has occurred in only 3 of 19 years of operation (15.8% of the time). These years of compliance coincide with receipt of surplus eggs from Rapid River and McCall fish hatcheries. By including potential production of spring chinook that could have occurred in 1985 and 1986 during the transition from spring to summer chinook the success rate increases to 26.3%.

Despite poor performance at smolt production, PFH did produce surplus spring chinook adults, eggs, and fry as that stock was being phased out. Adult salmon were outplanted for ceremonial fisheries by the Shoshone-Bannock Tribe, while eggs and fry were distributed to Lookingglass, Irrigon, and Sawtooth hatcheries (Table 18).

4.3. Adult Contribution

IPC's mitigation responsibilities for the loss of anadromous fish associated with the construction and operation of the HCC are formally stated in the *Hells Canyon Settlement Agreement* and have been discussed previously in this report. While these responsibilities are defined in terms of hatchery facilities and smolt production objectives, reviewing adult contribution helps us understand the overall performance of IPC's hatchery mitigation program. Using data from several sources, we estimated the total number of adult salmon and steelhead produced for selected years through the IPC hatchery mitigation program. Those sources included coded wire tag (CWT) data from the Pacific States Marine Fisheries Commission's Regional Mark Information System database, as well as IDFG sport and Nez Perce tribal harvest estimates and hatchery rack returns. Total adult production estimates were obtained by multiplying the number of marked fish recovered in fisheries, at hatchery racks and on spawning grounds by the mark rate (percentage of smolts released that contained CWT) and the sample rate at the point of recovery. Analysis was limited by the fact that CWTs were not used prior to brood years 1974 (for spring chinook) and 1976 (for steelhead). Additionally, not all smolt release groups contained representative CWT marks. As a result, we were unable to make data expansions by individual release group. Instead, all release groups from a given brood year were pooled for analysis, and we assumed that all fish survived and contributed equally to fisheries and rack returns.

4.3.1. Summer Steelhead

The estimated number of adult steelhead produced annually by NSFH from 1979 to 1998 ranges from 2,499 in 1979 to 41,049 in 1984 (Figure 7). The average number of adult steelhead produced annually during this period is 12,552. Although numbers varied considerably among years, the top four categories of adult contribution were Salmon River sport harvest (35.0%), Pahsimeroi Hatchery Rack (24.0%), Columbia River Gillnet (21.3%), and Hells Canyon Trap (11.9%). The combined total of these four categories represent over 91% of the adult steelhead produced from NSFH during the 1979 to 1998 period. Freshwater sport harvest, Columbia River sport harvest, and Treaty subsistence fisheries made up the next most significant categories of adult contribution, representing 7.0% of the adults produced from NSFH. Adult contributions by location, type, and return year appear in Table 19. It is important to note that sport harvest data for steelhead taken in the Snake River above the mouth of the Salmon River are unavailable and have not been included in this analysis. Omission of Snake River harvest data effectively underestimates the number of adult steelhead produced by NSFH.

Looking specifically at harvest contribution within Idaho, harvest estimates made by Ball (K. Ball, IDFG, unpubl. data) for NSFH steelhead within the Salmon River were compared with statewide harvest estimates that IDFG made. The estimated contribution of NSFH steelhead, as a percentage of Salmon River and total Idaho harvest, appears in Table 20, Figure 8, and Figure 9. Between the return years 1969 and 1998, NSFH steelhead averaged 34% of the Salmon River steelhead harvest and 22% of the statewide steelhead harvest. Once again, it is important to note that sport harvest data for steelhead taken in the Snake River above the mouth of the Salmon River are unavailable and have not been included in this analysis. Omission of Snake River harvest data effectively underestimates the contribution of NSFH steelhead to in-state harvest.

4.3.2. Spring Chinook

The estimated number of adult spring chinook RRFH produced annually between 1978 and 1998 ranged from 182 fish in 1995 to 15,746 in 1997. The average number of adult spring chinook produced annually from RRFH during the same period is 5,445 (Figure 10). Adult contributions of RRFH spring chinook by location, type, and return year appear in Table 21.

A total accounting for adult chinook produced as part of the IPC hatchery mitigation program should also include an estimate of adult spring and summer chinook produced at PFH. During most years, however, PFH chinook smolts were not differentially marked to identify them from wild fish, nor were they marked with CWT for evaluation purposes. Consequently, little is known about their distribution and fisheries contribution. From what little data do exist, we know that 10 individuals were recovered at the PFH rack, two individuals were recovered at Dworshak National Fish Hatchery, and two individuals were recovered in the Lower Granite Dam fish ladder. Figure 11 shows total rack returns of wild and hatchery-produced Pahsimeroi River spring and summer chinook for run years 1982 through 2000. However, without more substantive data, we cannot determine the PFH component of total adult chinook contribution from IPC facilities.

The estimated contribution of RRFH spring chinook to the total Idaho sport harvest appears in Table 22 and Figure 12. Rapid River spring chinook comprised 100% of the total Idaho harvest for 1985 through 1988 and for 1993 when sport fishing was restricted to the Little Salmon River. There was no spring chinook sport-fishing season for 14 of the 26 years between 1975 and 2000. RRFH spring chinook also contributed to Nez Perce tribal harvest in most years (Table 21).

4.3.3. Fall Chinook

As discussed in Section 4.2.1, the initial fall chinook hatchery program was fraught with problems and abandoned in 1973. Because fish released from OFH had no distinguishing marks, it is impossible to determine the number of adults produced from this effort or their fisheries contribution. The steady decline of fall chinook through the late 1960s suggests that few, if any, smolts produced at OFH contributed to adult returns.

In recent years, no adult fall chinook production has occurred from OFH. Pursuant to a contractual arrangement, Lyons Ferry Hatchery has provided eggs to IPC in only 1 of the last 17 years (see Section 4.1.). Subyearling smolts were released in 2001, and adult contributions will not be realized until the fall of 2002. It is also noteworthy that the 2001 release group has only its adipose fin clipped. The lack of other differential marks will preclude estimating year-class survival or fisheries contribution.

4.4. Hatchery Performance Standards

Currently, more than 90 hatchery facilities produce salmon and steelhead in the Columbia River Basin. Most of these facilities were originally constructed to mitigate for fish habitat loss associated with construction and operation of dams and other water projects (IHOT 1995). Many different entities fund, manage, and operate these facilities for many different management objectives, including supplementation, restoration, harvest, egg banking, and research. Because of their varied nature, these facilities often have different operating guidelines. These differences do not contribute to a consistent basinwide approach to hatchery management.

Recognizing the need to improve coordination of anadromous hatcheries throughout the Columbia River Basin, the Northwest Power Planning Council (NPPC) responded by forming the Integrated Hatchery Operations Team (IHOT) in 1992 (NPPC 1992). IHOT was a multi-agency and tribal group responsible for developing new basinwide standards for managing and operating fish hatcheries. The team's ultimate goal was to ensure that Columbia River Basin anadromous fish hatcheries operated in concert to provide the best possible tool for meeting regional hatchery production needs while also supporting efforts to rebuild wild and natural populations. IHOT established five basic policies: 1) hatchery coordination, 2) hatchery performance standards, 3) fish health, 4) ecological interactions, and 5) genetics. Next, members developed a series of standardized criteria in association with each of the five policies to provide a point of reference against which to measure performance and monitor change. IHOT then audited each hatchery against these performance measures and formulated recommendations for corrective actions. The audit was based on information gathered from hatchery personnel's responses to a 109-page IHOT questionnaire and a site inspection conducted by an independent contractor. Based on the compliance status for each performance measure, the team developed suggestions for remedial actions. Remedial actions were divided into five categories and summarized in a hatchery evaluation report prepared for the NPPC:

Type 1: Noncompliance results from items beyond human control

Type 2: Remedial action requires changes in agency policies or procedures

Type 3: Remedial action requires change in monitoring coverage or interval

Type 4: Remedial action requires significant capital expenditure from funding source

Type 5: Remedial action may require significant capital but not clearly definable at this time

IHOT developed the performance standards by drawing on the combined knowledge and experience of fish hatchery management experts throughout the Columbia River Basin. The standards represent conditions that these experts believe are necessary for optimal hatchery production. The IHOT audit process provides an excellent means of evaluating the four IPC hatcheries' performance without trying to make direct comparisons among hatcheries. Using an independent contractor, IHOT audited all IPC hatchery facilities in 1996 through 1997. Audit results were summarized in hatchery evaluation reports. Specific areas of nonconformity with IHOT standards have been gleaned from these reports and are presented here by facility and by species without alteration. It is important to note that some IHOT performance standards may not be appropriate for all situations. Further investigation and evaluation are warranted before proceeding with any suggested remedial actions.

4.4.1. Oxbow Fish Hatchery

Two separate audits of OFH were performed. One was performed from the standpoint of summer steelhead production, and the other one from the standpoint of spring chinook production. Fall chinook were not being reared at OFH when this work was completed, so production of this species was not audited.

Spring Chinook

OFH was in general compliance with most IHOT performance measures associated with spring chinook production (Montgomery Watson 1996a). A list of specific areas where OFH failed to meet performance standards appears in Table 23. Most of the nonconformities are categorized as either type 2 or type 3, and may be addressed by simply verifying or changing current IDFG and IPC policies and operating procedures or by changing current monitoring intervals. With the exception of performance measures (PM) #3 and 24, changes would be easy to implement and the hatchery's current operating budget would absorb any associated costs. Implementing hatchery evaluation and contribution studies would probably require additional IPC funding and coordination among all of the signatories to the *Hells Canyon Settlement Agreement*. With regard to facility improvements, the only major recommendations for the OFH spring chinook program involved installing a more sophisticated alarm system and intake screening and constructing smolt acclimation ponds. Developing a pathogen-free water source (PM# 5h) would also involve major facility modifications, but IHOT did not recommend this action because of the short holding period for adult spring chinook before they are transferred to RRFH. Finally, altering the current practice of rearing chinook smolts at RRFH (Salmon River basin) for release in the Snake River basin (PM# 22b) would require discussion by all parties to the *Hells Canyon Settlement Agreement* and additional funding from IPC.

Summer Steelhead

Here again, the OFH summer steelhead program was found to be in general compliance with most of the IHOT performance measures audited (Montgomery Watson 1996b). Specific areas where noncompliance was noted (Table 24) overlap to a large degree with those previously discussed as part of the spring chinook audit. Improving spawning practices and developing a genetic monitoring plan were the only additional issues not previously noted.

4.4.2. Rapid River Hatchery

RRFH was also in general compliance with most of the IHOT performance measures (Montgomery Watson 1996c). As with OFH, nearly half of the nonconformities were either type 2 or type 3 items that could be addressed by verifying or changing current IDFG and IPC policies and operating procedures or by changing current monitoring intervals. Although classified as type 2 issues, implementing hatchery evaluation and contribution studies would require more effort because additional IPC funding and coordination among all the signatories to the *Hells Canyon Settlement Agreement* would be necessary. RRFH had more type 4 issues than OFH did. Remedies include modifying 1) intake screening, 2) adult holding and handling, 3) early rearing containers, 4) food storage, and 5) water quality. Montgomery Watson estimated that remedial actions for type 4 issues would cost from $1,000,200 to $2,333,800. A complete list of recommended actions to meet IHOT standards appears in Table 25.

4.4.3 Niagara Springs Hatchery

The audit at NSFH identified many of the same policy and procedural issues noted at other IPC facilities. Remedies include 1) developing a genetic monitoring plan, 2) conducting fisheries evaluation studies, 3) modifying food-handling procedures, and 4) monitoring water quality parameters at regular intervals. Of all IPC's hatcheries, NSFH had the greatest number of type 4 deficiencies. Nearly half were associated with insufficient incubation and nursery rearing volume and density-dependent fry mortality. The need for additional smolt transportation equipment and acclimation ponds was the next most significant item noted in the audit. Predator control, an alarm system, and pathogen-free water round out the list (Table 26).

4.4.4. Pahsimeroi Fish Hatchery

Summer Chinook

Nonconformities with IHOT performance standards for summer chinook production at PFH appear in Table 27. Roughly half of the nonconformities that the audit identified were either type 2 or type 3 items that could be addressed through IPC and IDFG policy or procedural changes. Hatchery evaluation studies are exceptions that may require additional IPC funding and regional coordination. Regarding facility improvements, installing a more sophisticated alarm system, adding rearing capacity, altering smolt liberation facilities, and installing predator-control devices were recommended. Groundwater development for temperature control and pathogen elimination was classified as type 5 because of its expense and unknown feasibility.

Summer Steelhead

In auditing the PFH steelhead program, Montgomery Watson (1996c) found it to be in general compliance with most of the IHOT performance measures. This audit showed the highest percentage of type 2 and type 3 nonconformities (78%) of all IPC programs audited (Table 28). As previously discussed, these items can be addressed through IPC and IDFG policy or procedural changes without significant capital expenditure. Type 4 items were limited to installing an alarm system and constructing smolt acclimation ponds.

5. IMPACTS OF HATCHERY OPERATION

According to NMFS (1999), artificial propagation programs have the potential to adversely affect listed salmon and steelhead through operation of hatchery facilities, interaction between hatchery and natural populations in the natural environment, and collection of broodstock. More specifically, hatchery actions may adversely affect listed fish through direct mortality (through predation, broodstock collection, and disease transmission) and indirectly through genetic and ecological interactions in the natural environment (NMFS 1999). Numerous authors have examined the beneficial and adverse effects of hatchery production on natural populations of salmon and steelhead. Despite these reviews, NMFS (1999) acknowledges that the absence of long-term monitoring programs makes it difficult to quantify the effect of hatchery operation on threatened and endangered species. NMFS (1995, 1999) and IDFG (1993a,b; 2000) summarize the effects of hatchery operations, including the IPC hatcheries, from a qualitative standpoint.

5.1. Competition and Predation

NMFS (1999) notes that direct competition for food and space between hatchery and listed fish may occur in spawning or rearing areas, the migration corridor, and ocean habitat. Impacts are assumed to be greatest in the spawning and nursery areas and at points of hatchery smolt release where fish densities are greatest. Implicitly, competition intensity decreases as smolts disperse and begin their downstream migration. NMFS (1999) suggests that releasing hatchery smolts that are physiologically ready to migrate may reduce the period of interaction between hatchery fish and wild stocks, thereby also reducing the potential for competition.

5.1.1. Niagara Springs Steelhead

IDFG (1993a,b; 2000) evaluated the potential for competition among listed Snake River spring/summer chinook, fall chinook, sockeye, and hatchery smolts released from IPC’s NSFH. IDFG acknowledges that the timing of hatchery steelhead smolt releases overlaps with listed spring/summer chinook and (to a lesser degree) listed sockeye in the upper Salmon River basin. However, because steelhead smolts (and residuals) probably do not use the exact same habitats as the smaller migrating spring/summer chinook and sockeye smolts, competition for food and space and behavioral interactions are minimized. Serial releases of steelhead smolts over a period of several days likely helps reduce any behavioral interactions that might otherwise occur from a large-group release. Finally, IDFG assumes that migration is rapid in the free-flowing migration corridor and that ample food is available to support smolts of all three species.

IDFG's analysis of impacts to fall chinook in the Snake River is similar. Spatial separation of steelhead smolts and smaller emerging fall chinook fry likely precludes competition for food and space. Additionally, hatchery steelhead and fall chinook exhibit different migration timing, which reduces competitive interactions in the migration corridor.

In 1993, IDFG attempted to quantify predation of chinook fry by hatchery steelhead smolts (and residuals). Data collected from the upper Salmon River suggest that the proportion of hatchery steelhead smolts likely to consume chinook fry is less than 0.05 %, even when hatchery steelhead are released in chinook production areas (IDFG 1993c). They estimated that the predation rate of chinook fry by hatchery steelhead was less than 0.15%. NSFH steelhead releases in the Pahsimeroi River occur downstream of spawning areas, so these fish probably have limited contact with emergent chinook fry. In addition to occupying different habitats, any life stages that might be encountered in the mainstem Salmon River would be larger and less vulnerable to predation.

Predation of sockeye smolts is also thought to be minimal. In addition to the temporal and spatial separation of sockeye smolts and hatchery steelhead smolts discussed above, sockeye smolts are thought to be too large for most steelhead smolts to prey on effectively. Citing an average size of 98.5 mm fork length for 1993 sockeye outmigrants, IDFG estimates that steelhead smolts would have to be at least 295.0 mm long to consume sockeye smolts (IDFG 1993b). Mean size of NSFH smolts during the last 10 years has not exceeded 214.3 mm.

While the potential exists for predation of fall chinook by hatchery steelhead in the Snake River below Hells Canyon Dam, several factors suggest that the potential is low: 1) steelhead smolts are emigrating rapidly out of fall chinook spawning and rearing areas, 2) migrating steelhead smolts do not use the same habitat that fall chinook fry do, and 3) any residualization of steelhead smolts likely occurs well upstream of most fall chinook spawning sites (IDFG 1993b). During cursory examinations of stomach contents of steelhead smolts and residuals in the Hells Canyon reach of the Snake River in 1992, IDFG found no evidence of piscivory.

5.1.2. Rapid River Spring Chinook

IDFG also evaluated the release of spring chinook smolts from IPC's RRFH (IDFG 1993a,b; 2000). IDFG cited two primary reasons for the minimal competition and behavioral interaction between wild spring/summer chinook and hatchery chinook: size differences and the associated differences in habitat use. Within Rapid River itself, hatchery chinook smolts are released downstream of significant spawning and rearing habitat (where competitive interactions would be greatest). Once in the migration corridor, some spatial and temporal overlap may occur, but food and space are not believed to be limiting factors that would elicit competitive behaviors.

With regard to fall chinook and sockeye, potential interactions are limited to the migration corridor. Once again, spatial and temporal differences in migratory behaviors probably preclude significant competition. Sockeye smolts begin emigrating from Redfish Lake (295 mi upstream of RRFH) between mid-April and mid-May (IDFG 1993b), while spring chinook smolt releases from RRFH occur in mid-March. As a result, IDFG believes that hatchery chinook precede sockeye as they move through the lower Salmon and Snake rivers. Similarly, IDFG (1993b) anticipates that the majority of hatchery chinook smolts released in the Snake River in April will have moved out of fall chinook spawning areas by the time fall chinook fry emerge. While some temporal overlap between hatchery smolt migration and fall chinook fry emergence may occur, IDFG (1993a) suggests that interaction is limited to the brief time immediately after emergence when fry and smolts may occupy similar habitat. Interactions decrease as fry move into shallow, shoreline areas not typically used by larger, actively migrating smolts.

Predation by hatchery chinook smolts on naturally produced chinook has not been documented in the literature (USFWS 1993). Nonetheless, if predation could occur, IDFG believes that it would be limited to emergent chinook fry. Chinook fingerling and parr are thought to be too large to be prey items. This potential is further minimized by the location of hatchery chinook releases in Rapid River: they are released where they will not migrate over wild chinook spawning areas. Hatchery smolts in the Snake River migrate over fall chinook redds, but IDFG believes that outmigration precedes emergence of fall chinook fry. Interactions between hatchery spring chinook smolts and sockeye are limited to the migration corridor where sockeye smolts are believed to be too large for predation by hatchery smolts.

5.1.3. Pahsimeroi Summer Chinook

IDFG evaluated potential impacts of releasing summer chinook smolts from PFH (IDFG 1993a, 1994, 1998a). In the absence of data specific to the Pahsimeroi River, much of their analysis was based on the same information they used to evaluate the spring chinook and steelhead programs. Competition and behavioral interactions between hatchery and wild or natural chinook are minimal, which IDFG attributes to habitat segregation, rapid outmigration of hatchery smolts, and differences in migration timing. Hatchery chinook smolts are released in the Pahsimeroi River in areas of natural production. Some information indicates that hatchery smolts may “pull” smaller age-0 fingerling from their rearing stations as the hatchery fish drift downstream (IDFG 1993a). IDFG has some evidence to suggest that this behavior does not occur in the upper Salmon River. Once in the migration corridor, spatial and temporal overlap between hatchery summer chinook and listed spring/summer chinook occurs; however, IDFG provided no information to suggest that adverse impacts occur.

Regarding fall chinook and sockeye smolts, potential interactions are limited to the migration corridor where both spatial and temporal differences in migratory behaviors again preclude significant competition. Sockeye smolts begin emigrating from Redfish Lake (83 mi upstream of the mouth of the Pahsimeroi River) between mid-April and mid-May (IDFG 1993b), while PFH releases summer chinook smolts in mid-March. As a result, hatchery chinook are believed to precede sockeye as they move through the Salmon and Snake rivers. IDFG (1993b) anticipates that the majority of hatchery chinook smolts released in March will have moved out of fall chinook spawning areas by the time fall chinook fry emerge.

Although predation by hatchery chinook smolts on naturally produced chinook has not been documented in the literature (USFWS 1993), newly emerged chinook fry may be vulnerable to predation by summer chinook smolts released from PFH. The risk of predation decreases as fry move to shallow, shoreline areas not typically used by larger, actively migrating hatchery smolts.

Reingold (1967) observed that natural chinook fry in the Pahsimeroi River had reached 45 to 55 mm fork length by April. IDFG believes that fry of this size would be too large to be a prey item for hatchery smolts.

5.1.4. Results of Impact Analysis

In their impact analysis of the IPC hatchery mitigation program, IDFG acknowledged that, in many cases, no information was available to quantify the effects of competition and predation on listed species. IDFG (1993a,b) concluded that the IPC spring chinook, summer chinook, and steelhead programs would not reduce the likelihood of survival and recovery of listed Snake River spring/summer chinook, fall chinook, steelhead, and sockeye in the wild. IDFG later expanded the scope of their analysis to include potential impacts to Snake River steelhead, upper and lower Columbia River steelhead (IDFG 1998b), upper Columbia River spring chinook, middle Columbia River steelhead, lower Columbia River chinook, Columbia River chum (*O. keta*), upper Willamette River chinook, and upper Willamette River steelhead (IDFG 1999). In all cases, the conclusions were the same: while the level of incidental take was unquantifiable, continuing to operate the IPC hatchery program would not jeopardize the continued existence of the various listed species. Since 1992, NMFS has concurred with this analysis by annually issuing or renewing Section 10 Incidental Take and Direct Take permits to IDFG for continued operation of the IPC hatchery mitigation program. The NMFS *Biological Opinion on Artificial Propagation in the Columbia River Basin* (NMFS 1999) contains a similar analysis and conclusion: continuing the IPC hatchery mitigation program is not likely to produce competition or predation interactions that would jeopardize the continued existence or recovery of listed species.

5.2. Straying or Genetic Introgression

The genetic implications of hatchery-reared salmon mating with wild salmon are complex. Hatchery adults and wild adults are adapted to different environments and likely have different genotypes. Incorporating hatchery genotypes into the wild population may produce progeny that are poorly adapted to their environment, thereby leading to a loss of fitness in the wild population. According to the Independent Scientific Advisory Board, the predominant view of scientists is that interbreeding between hatchery-reared and wild salmon could produce offspring with just such incompatible genotypes.

Under IDFG's direction, the current IPC hatchery mitigation program respects the scientific community's opinion and does not promote the interbreeding of hatchery adults with wild adults in nature. Rather, IDFG releases hatchery smolts in locations that limit their interaction with wild fish and encourage their return to terminal fisheries, hatchery weirs, or stream reaches where the potential for interbreeding is minimized. Consequently, we don't discuss the biological implications of deliberate hatchery and wild crosses in this report. The greatest risk of genetic introgression from the current IPC hatchery mitigation program comes from mature adults straying into nonnatal waters. Our discussion is limited to this specific issue.

Straying is the migration of mature fish to spawn in streams other than those in which they originated (Quinn 1993). The associated cumulative effects of unidirectional gene flow from nonnative hatchery strays may interfere with the gene pool of locally adapted wild stocks (Quinn 1997, NMFS 1999). Some of the risks of genetic introgression to wild stocks include loss of genetic variability within populations, genetic drift, and domestication (NMFS 1999). The extent of the effect of genetic introgression on listed salmon and steelhead depends on the level and duration of genetic interactions, the distribution of the affected population, and the genetic differences between the stray and natural population (NMFS 1999). The implications of straying are particularly important, considering that 12 stocks of anadromous fish in the Snake and Columbia river basins have threatened or endangered status.

Hatchery rearing and release techniques can increase straying and thereby increase the potential for genetic interactions between hatchery and wild populations (Pascual et al. 1995). Water temperature, flow, water quality, and quality of habitat can influence straying. Low flows and high temperatures may increase straying in the Columbia and Snake rivers (IDFG 2000). In addition, the degree of straying in outplanted hatchery fish often differs from that of locally reared and released hatchery fish and appears to be determined by complex interactions between 1) rearing location, 2) release site, 3) release date, 4) physiology, and 5) migration (Quinn 1997). It is possible that fish exposed to site-specific odors at the correct time of year and during the correct physiological period may not completely imprint on a site unless they also migrate at the time during which they are exposed to the odors (Pascual et al. 1995). Pascual et al. (1995) also found that early and late releases of hatchery fall chinook produced much higher straying levels than intermediate release dates. Fish reared at one hatchery and transplanted to a release site strayed at a higher rate than local fish of the same release site and brood year. It may be possible to reduce straying of hatchery fish by using local broodstocks and by rearing and releasing hatchery fish in their natal basins (Schroeder et al. 2001).

It is unknown whether hatchery-reared salmonids stray at higher rates than wild salmonids do. In most cases, estimates of straying come from hatchery-produced fish. Because wild fish are generally tagged less frequently than hatchery fish, little is known about the straying of wild populations (Quinn 1997).

ODFW is particularly concerned that the straying of hatchery salmon and steelhead may pose a threat to wild Deschutes River populations. In 1994, 76% of the summer steelhead spawners in the Deschutes were stray hatchery fish (Foster 1997). ODFW believes that the predominant cause for declining numbers of local wild steelhead in the Deschutes River is genetic mixing with out-of-basin hatchery strays (Foster 1997). Out of this concern, NMFS and ODFW agreed to jointly review available data on straying to mutually define the issue (Robinson 1997). As a result, a multi-agency work group has been assembled to determine the magnitude and cause of straying. Progress toward the goal is unknown.

In contrast, IDFG has not identified straying hatchery chinook as a threat to listed chinook populations in Idaho. IDFG acknowledges that straying hatchery steelhead may pose a threat to wild populations elsewhere (because of their greater tendency to stray). But IDFG believes that the impacts of hatchery strays on wild steelhead populations are minimized because of their poor reproductive success (IDFG 2000). IDFG estimated a 0.6% stray rate for adult steelhead between hatchery racks within Idaho and believes that it is reasonable to assume that out-of-basin stray rates are similar (IDFG 2000). Additionally, IDFG draws a clear line between straying and wandering. IDFG suspects that many steelhead strays trapped at weirs would eventually return to their natal streams if given the opportunity, thereby further reducing the risk of genetic impact.

The highest risk of genetic introgression exists where hatchery adults stray or are released into wild or natural production areas (IDFG 2000). The IDFG anadromous fish hatchery program manages this risk by striking a balance between protecting wild salmon and steelhead populations and providing a mitigation fishery (IDFG 2000). In managing the steelhead program, IDFG distinguishes between native, naturally reproducing populations and hatchery-influenced populations. Because of this distinction, spawning surveys of Idaho areas having wild (native, naturally reproducing) populations indicate minimal to nonexistent straying of hatchery fish into those areas.

To minimize genetic introgression on natural populations, NMFS recommends that the number of strays (of nonnative hatchery fish) should not exceed 5% of any naturally produced population (NMFS 1999).

To quantify the stray rates of hatchery fish produced by the IPC mitigation program, we analyzed CWT data from the Pacific States Marine Fisheries Commission's Regional Mark Information System database. Analysis was limited because CWTs were not used before brood year 1974 for spring chinook and 1976 for steelhead and because not all release groups were represented with CWTs.

5.2.1. Niagara Springs Steelhead

NSFH steelhead strayed at an average rate of 2.6% between the brood years 1978 through 1995. A maximum stray rate of 6.9% occurred in brood year 1993. There was no straying of NSFH steelhead during brood year 1982. Stray rates exceeded 5% in 3 of the 18 brood years analyzed (1979, 1981, and 1993). Stray rates of NSFH steelhead are shown as a percentage of brood year returns in Figure 13 and as a percentage of return years in Figure 14.

The majority (96%) of all NSFH strays were recovered in the Deschutes River system while only 4% strayed to areas outside of the Deschutes River System. Figure 15 shows the total distribution of NSFH steelhead strays as the percentage of strays by recovery location. Table 29 shows the distribution of NSFH steelhead as a percentage of strays by return year. Of the Deschutes River strays, 80% of recoveries came from sport fishery catch at the mouth of the Deschutes River, Mack's Canyon, and below Sherars Falls; 20% of strays were captured as rack returns at Pelton Dam and Round Butte Trap (Figure 16).

5.2.2. Rapid River Spring Chinook

RRFH spring chinook strayed at an average rate of 3.1% between the run years 1978 and 1999. A maximum stray rate of 29.0% occurred in 1995, which was an exceptionally low return year (182 adults) for Rapid River spring chinook. However, the number of adult strays was similar to that for other years analyzed (53 adults). If the average stray rate is calculated without the 1995 return year, the average value drops to 1.8%. There were no reported strays for 1982, 1983, 1984, 1986, and 1994. Stray rates exceeded 5% in only 2 of the 21 years analyzed (1979 and 1995). Stray rates for RRFH spring chinook are shown as a percentage of run year returns in Table 30 and Figure 17.

Thirty-seven percent of all RRFH strays were recovered in the Deschutes River system, 19% were recovered in the Lewis River sport fishery, 10% were recovered in the Cowlitz River sport fishery, and 14% were recovered at other hatchery racks (Figure 18). Of the Deschutes River strays, 36% were recovered in the Sherars Falls sport fishery, 50% were recovered at the Pelton and Round Butte traps, and 14% were rack recoveries at the Warm Springs National Fish Hatchery (Figure 19).

5.2.3. Pahsimeroi Spring/Summer Chinook

During most years, PFH chinook smolts were not differentially marked with CWTs for evaluation purposes. Consequently, little is known about their distribution and fisheries contribution. From what little data do exist, we know that 10 individuals were recovered at the Pahsimeroi Hatchery Rack, two individuals were recovered at Dworshak National Fish Hatchery, and two individuals were recovered in the Lower Granite Dam ladder. No further straying analysis was possible.

5.2.4. Results of Impact Analysis

Average stray rates of 2.6% for NSFH steelhead and 3.1% for RRFH spring chinook are similar to levels reported in the literature. Shapovalov and Taft (1954, cited in Quinn 1993) reported natural stray rates of 2 to 3% for steelhead between two creeks in California; McIsaac (1990, cited in Quinn 1993) reported a wild fall chinook stray rate of 3.2% and a hatchery fall chinook stray rate of 4.6% in the Lewis River, Washington. Schroeder et al. (2001) reported an average stray rate of 11% for hatchery winter steelhead in 16 coastal Oregon streams. Hard and Heard (1999) observed a relatively low stray rate of 1.2% in transplanted chinook salmon hatchery runs in Alaska. The low stray rate was attributed to strong imprinting of smolts to the release site. Quinn (1997) gives 10% plus or minus 10% as a rough estimate of salmon straying, based largely on data from hatcheries.

In a study presented by Bjornn and Jepson (1998), 735 steelhead were radio-tagged at Bonneville Dam in 1996 and tracked throughout their migration. Thirty-nine percent of the fish that reached the mouth of the Deschutes River entered the river. Of the fish that entered, 64% left the Deschutes River. Mean residence time in the Deschutes River was 35 days. Seventy-four percent of the fish that entered did not migrate as far as Sherars Falls. There was no difference in straying behavior between hatchery and wild fish.

The stray rates presented for NSFH steelhead and RRFH spring chinook may be a bit misleading because they are based on all CWT recoveries, rather than only on those fish that actually spawned in nonnatal waters. Any fish captured while “wandering” or “probing” into nonnatal waters would have been included as a stray in calculations of stray rates. Quinn (1993) notes that it is uncertain whether any fish harvested in a fishery or trapped at a hatchery rack would have eventually left the system. In light of these observations, it is probable that many of the

NSFH fish reported as strays in the sport fishery would have left the Deschutes system of their own volition, thereby lowering the reported stray rate. When expressed as a percentage of the total number of adults accounted for, the apparent stray rate of NSFH steelhead and RRFH spring chinook is relatively low, but the actual proportion of the Deschutes River population is unknown.

In their impact analysis of the IPC hatchery mitigation program, IDFG acknowledged that, in many cases, no information was available to quantify the effects of straying or genetic introgression on listed species. IDFG (1993a,b) concluded that the IPC spring chinook, summer chinook, and steelhead programs would not reduce the likelihood of survival and recovery for listed Snake River spring/summer chinook, steelhead, and sockeye in the wild. IDFG later expanded the scope of their analysis to include potential impacts to Snake River steelhead, upper and lower Columbia River steelhead (IDFG 1998b), upper Columbia River spring chinook, middle Columbia River steelhead, lower Columbia River chinook, Columbia River chum, upper Willamette River chinook, and upper Willamette River steelhead (IDFG 1999). In all cases, the conclusions were the same: while the level of incidental take was unquantifiable, continued operation of the IPC hatchery mitigation program would not jeopardize the continued existence of the various listed species. Regarding the RRFH spring chinook program and PFH summer chinook program, NMFS has concurred with this analysis by annually (since 1992) issuing or renewing Section 10 Incidental Take and Direct Take permits to IDFG for continued operation of the IPC hatchery mitigation program. The NMFS *Biological Opinion on Artificial Propagation in the Columbia River Basin* (NMFS 1999) contains a similar analysis and conclusion. The opinion states that the risk of genetic introgression inherently involved with continuing to operate the IPC hatchery mitigation program is low enough that it is not likely to jeopardize the continued existence or recovery of listed species. NMFS did, however, find that the use of a nonendemic stock of steelhead in certain portions of the IPC steelhead program posed a significant risk to listed Snake River summer steelhead. Specifically, NMFS was referring to the release of Oxbow stock steelhead smolts in the lower Salmon River. To avoid jeopardy to listed Snake River steelhead, IDFG was required to take the following measures:

1) Develop a hatchery genetics management plan (HGMP) for summer steelhead in the lower Salmon River that addresses the transition to locally adapted steelhead stocks in the lower Salmon River and phasing out the nonendemic Oxbow stock steelhead program

2) Terminate Oxbow stock steelhead releases in all areas except the Little Salmon River by 2000

3) Develop a timeline for transitioning to a locally adapted broodstock in the HGMP and phasing out the Oxbow stock entirely

By carrying out these special-permit requirements, IDFG can obtain necessary NMFS authorization to continue operating the IPC steelhead program.

A new *Biological Opinion on Artificial Propagation in the Columbia River Basin* is due to be released in 2002 (Herb Pollard, NMFS, pers. comm.). Conclusions about using Oxbow stock steelhead are expected to remain unchanged. In addition, the NMFS document will contain the same jeopardy conclusions regarding the use of nonendemic Pahsimeroi stock steelhead in the upper Salmon River. Reasonable and prudent alternatives that NMFS will require to remove jeopardy on listed steelhead ESUs will probably include the following:

1) Analyze existing data to determine the number and origin of Snake River hatchery steelhead that stray into primary spawning areas within the Deschutes River

2) Assess strategies to identify numbers and sources of Snake River hatchery-origin steelhead that stray into the Deschutes River steelhead spawning areas

3) Initiate strategies that reduce the number of stray adult Snake River hatchery-origin steelhead to less than 5% in the Deschutes River spawning areas

4) Monitor and evaluate potential straying of Snake River hatchery steelhead into listed steelhead spawning areas that have no existing trapping facilities or monitoring and evaluation programs in place

5) Participate in subbasin planning efforts and NMFS recovery planning to determine strategies for conservation and recovery of listed populations, maintaining mitigation programs, and meeting tribal trust and public fisheries responsibilities

5.3. Pathogen Transfer

While it is difficult to prove conclusively that pathogens are transmitted between hatchery and wild stocks, it is equally difficult to disprove (Constantine 1997). Wright (1997) suggests that many of the pathogens that fishery managers deal with are normal inhabitants of the aquatic environment and can be transmitted from either wild to cultured fish or from cultured to wild fish. The direction is dependent on the pathogen status of the fish and the circumstances in which they live. NMFS (1999) considers hatchery fish to be reservoirs for disease pathogens because of the high rearing density and associated stress of the hatchery environment. Furthermore, NMFS believes that interactions between hatchery fish and listed fish in the natural environment may transfer pathogens from headwater spawning and rearing areas downstream through the entire migration corridor. Of particular concern is the release of large numbers of hatchery fish in close proximity to listed species. The increased population density and associated environmental changes may be sufficient to trigger an epizootic. In contrast, Steward and Bjornn (1990) found little evidence to suggest that diseases are routinely transmitted from hatchery to wild fish. Chapman et al. (1994) concluded that disease transmission from hatchery to wild populations is probably not a major factor negatively affecting wild steelhead in the Columbia River Basin.

5.3.1. Niagara Springs Steelhead

IDFG (1993a,b; 2000) evaluated the potential for pathogen transmission from NSFH steelhead to listed stocks in the Snake and Columbia rivers. A number of pathogens have been observed at NSFH (Table 31). IDFG (1993a) cites infectious hematopoietic necrosis virus (IHNV), infectious pancreatic necrosis virus (IPNV), and *Aeromonas salmonicida* as the most significant pathogens at this facility. They believe that *Myxobolus cerebralis*, IHNV, IPNV, and *Renibacterium salmoninarum* are the most significant pathogens that can be transmitted directly or indirectly from hatchery steelhead to listed species in the upper Salmon River. Of these four pathogens, *Myxobolus cerebralis* has never been isolated at NSFH, and *Renibacterium salmoninarum* has been observed only occasionally. In addition, *Myxobolus cerebralis* and *Renibacterium salmoninarum* are already present in the upper Salmon River in naturally produced populations of salmon and steelhead. IHNV and IPNV are rarely observed in naturally occurring Idaho chinook populations.

In their analysis, IDFG concludes that adult-to-adult horizontal transmission of pathogens between hatchery steelhead and wild salmon is greatly reduced because of their temporal and spatial separation in the upper Salmon River. Horizontal transmission because of the overlap in their migrations. Both IHNV and IPNV have been observed in adults returning to PFH (Table 32). Regarding pathogen transmission from hatchery smolts to listed species, IDFG acknowledges that pathogen transmission is possible; however, they provide no information to suggest that disease-related mortality of listed stocks would occur from the IPC steelhead program. IDFG (1993a) believes that dilution, low water temperature, and low population density make the risk of disease-related mortality very low. IDFG also employs a fish health management program to control pathogens in the hatchery and reduce or eliminate the presence of pathogens in liberated smolts. The cornerstone of this program is pathological sampling of female broodstock and the culling of high positive IHNV and IPNV eggs.

IDFG's analysis of potential impacts of NSFH steelhead to fall chinook in the Snake River is similar. IPNV and IHNV are the significant pathogens of concern in the Snake River. Both adult steelhead returning to the Hells Canyon Trap and juvenile steelhead reared at OFH have been observed with these pathogens (Table 33). Adult steelhead and adult fall chinook are present in the Snake River at the same time. While the presence of both fish may elevate risks for horizontal pathogen transmission, IDFG (1993a) has no information indicating that horizontal pathogen transmission is causing any mortality to adult fall chinook. Whirling disease has never been observed at NSFH and should therefore not be a concern when releasing hatchery smolts into the Snake River. It is possible that returning adults could carry this pathogen, but to date *Myxobolus cerebralis* has not been isolated from adult steelhead captured at the Hells Canyon trap.

5.3.2. Rapid River Spring Chinook

IDFG also evaluated pathogen transfer associated with the RRFH spring chinook program (IDFG 1993a,b; 2000). IDFG states that pathogen transmission between hatchery fish and natural fish is possible and identifies *Renibacterium salmoninarum* and erythrocytic inclusion body syndrome virus (EIBSV) as the two most significant pathogens at RRFH. The risk of impact to natural populations is low because *Renibacterium salmoninarum*, the causative agent of bacterial kidney disease or BKD, is already established in naturally produced populations in both the Snake and Rapid rivers and EIBSV is not believed to be horizontally transmissible (IDFG 1993a). In addition, data collected by Elliot and Pascho (1997) in 1992 through 1994 indicate that the prevalence and levels of *Renibacterium salmoninarum* are not higher in hatchery fish than in wild fish in the Snake River basin. As in their analysis of the steelhead program, IDFG cites dilution, low water temperature, low population density of naturally produced fish, and use of an aggressive fish health program as factors that further reduce the risk of pathogen transmission from hatchery smolts to naturally occurring populations. IDFG's fish health program includes prophylactic use of antibiotics in adults and juveniles and culling of eggs from BKD positive females. IHNV and *Ceratomyxa shasta* have been observed at RRFH (Table 34), but they are not believed to present significant fish health issues. With regard to adult fish, IDFG (1993a) believes that temporal separation between hatchery-produced adults and listed sockeye, steelhead, and fall chinook greatly reduces the risk of horizontal pathogen transmission.

5.3.3. Pahsimeroi Summer Chinook

In their analysis of pathogen transmission associated with the PFH summer chinook program, IDFG (1993a, 1994, 1998a) identified *Renibacterium salmoninarum* and *Myxobolus cerebralis* as the two most significant pathogens present at this site (Table 35). IDFG concluded that, while pathogens could be transmitted from hatchery chinook to listed species, the potential is low. IDFG's basis for this conclusion is threefold: 1) PFH has the lowest prevalence of *Renibacterium salmoninarum* in both brood and juvenile fish of any chinook hatchery in Idaho, 2) laboratory attempts to affect horizontal infection of whirling disease have been unsuccessful, and 3) both pathogens are already established in naturally produced salmon and steelhead populations in the upper Salmon and Pahsimeroi rivers. The remainder of their analysis, including the fish health program and efforts to cull high-risk eggs, is identical to that for RRFH.

5.3.4. Results of Impact Analysis

While pathogen transmission between cultured and wild fish is biologically plausible, pathogen transmission alone is not a sufficient cause to assume that an adverse effect (or disease) will occur. Diseases tend to be multifactorial in nature, involving many physical, chemical, biological, and ecological parameters that either cause stress to the host or benefit the proliferation of the pathogen (Constantine 1997). For the most part, wild fish coexist alongside many pathogens in their environment, with no apparent negative effects (Wright 1997). Exotic pathogens, such as viral hemorrhagic septicemia and infectious salmon anemia, may be the exception. However, these pathogens have never been associated with the IPC hatchery mitigation program.

In their analysis of impacts of the IPC hatchery mitigation program, IDFG was unable to quantify the effects of pathogen transfer on listed species. IDFG concluded that there was insufficient evidence to demonstrate that the IPC spring chinook, summer chinook, and steelhead programs would reduce the likelihood of survival and recovery of listed Snake River spring/summer chinook, fall chinook, steelhead, and sockeye in the wild. IDFG later expanded the scope of their analysis to include potential impacts to Snake River steelhead, upper and lower Columbia River steelhead (IDFG 1998b), upper Columbia River spring chinook, middle Columbia River steelhead, lower Columbia River chinook, Columbia River chum, upper Willamette River chinook, and upper Willamette River steelhead (IDFG 1999). In all cases the conclusions were the same: while the level of incidental take was unquantifiable, continuing to operate the IPC hatchery mitigation program would not jeopardize the continued existence of the various listed species. Since 1992, NMFS has concurred with this analysis by annually issuing or renewing Section 10 Incidental Take and Direct Take permits to IDFG for continued operation of the IPC hatchery mitigation program. The NMFS *Biological Opinion on Artificial Propagation in the Columbia River Basin* (NMFS 1999) contains a similar analysis and conclusion that the risk of pathogen-related mortality associated with the continued operation of the IPC hatchery mitigation program is unlikely to jeopardize the continued existence or recovery of listed species.

6. Role of IPC Hatcheries In Recovery or Reintroduction Efforts

For nearly 100 years, production hatcheries have been a prominent feature of fisheries enhancement efforts for Pacific salmon and steelhead. During this time, technological advances in fish culture have made production hatcheries very efficient at producing large numbers of fish for harvest augmentation. In turn, fisheries managers have become so reliant on hatchery production to sustain commercial and sport fisheries that fisheries management and hatchery management are essentially inseparable. Despite its widespread use, artificial propagation remains largely unproven for increasing natural production. In his review of over 300 supplementation projects, Miller (1990) reported that, while many programs were successful at returning adult fish, few were successful at rebuilding natural runs. Dentler and Buchanan (1986) and Brannon (1993) made similar conclusions.

These and other authors' findings have radically changed the traditional view of hatcheries and their perceived benefits. Today the role of artificial production in the recovery of listed species is unclear. Although artificial propagation may conserve populations now listed under the ESA, its long-term effect on the distinctiveness of natural populations is unknown. Hard et al. (1992) reflect this uncertainty by stating that the use of artificial propagation for recovering listed species under the ESA must be viewed as experimental. Furthermore, hatcheries pose genetic and ecological risks that may result in maladaptive changes and a reduction in natural productivity. Genetic risks include extinction, loss of genetic variability within and among populations, and domestication. Ecological risks include disease transfer, increased competition for food and habitat, increased predation, and altered migration.

Nonetheless, these risks must be weighed against the risk to listed species that not using artificial production for recovery purposes would have. In some cases, the risks posed by artificial propagation may be outweighed by the potential to rapidly increase abundance and avoid extinction. Hard et al. (1992) offer four circumstances in which conservation hatcheries should be considered for species recovery:

1) When extinction of the natural population is likely before limiting factors can be addressed and natural recovery can occur

2) When populations are at less immediate risk of extinction but factors impeding recovery cannot be remedied in a reasonable time

3) When outplanting artificially propagated fish may be necessary to aid recolonization of unutilized but suitable habitat

4) When habitat crucial to the viability of a natural population is lost

In all cases, the donor stock must be part of the ESU and the artificial propagation program must be considered a temporary measure to be discontinued and reevaluated as population changes occur.

A decision tree (Figure 20) developed by Flagg and Nash (1999) provides an excellent depiction of the considerations involved in decisions to employ conservation hatcheries to help recover listed species. This diagram is not only helpful in defining the use of conservation hatcheries, but it also provides a role for continued operation of production hatcheries. As discussed by Chandler and Chapman (2001), societal pressures to maintain sport, tribal, and commercial fisheries are substantial, even in the midst of ESA protection efforts. According to Hard et al. (1992), propagating unlisted species is acceptable and also consistent with the ESA, as long as it neither impedes recovery of listed species nor compromises the viability or distinctiveness of unlisted species. In such cases, isolation of hatchery and wild fish should be as complete as possible, and straying, competition, predation, and disease transfer should be minimized (Hard et al. 1992). Based on specific circumstances and the assumption that these criteria can be met, it is quite possible that some hatcheries may take on a conservation role while others remain dedicated to fisheries enhancement.

6.1. Suitability of Hatchery Stocks

Based on criteria discussed above, some portions of the IPC hatchery program may be suited for use in species recovery or reintroduction while others may not.

NMFS has identified Oxbow stock steelhead as part of the ESU for Snake River steelhead. This hatchery stock originated from wild fish trapped at Oxbow and Hells Canyon dams from the fall of 1965 through the spring of 1968 and probably represents a mixture of fish that spawned primarily in the Wildhorse River, Pine Creek, and Indian Creek and possibly in the Weiser River and Eagle Creek. While Oxbow and Pahsimeroi stock steelhead (see below) are discussed separately in this report, they share the same origins and, until recently, were managed as one population by IDFG. Depending on the relative availability of eggs from OFH and PFH, Oxbow stock smolts were sometimes stocked in the upper Salmon River, and Pahsimeroi stock smolts were sometimes stocked in the Snake River below Hells Canyon Dam. Therefore, the influence of Dworshak B-run fish and wild Pahsimeroi River fish on the Pahsimeroi stock may be felt in the Oxbow stock as well. Despite knowing about this hatchery influence, NMFS has determined that this stock possesses genetically based characteristics similar to those of natural-spawning Snake River steelhead. To date, IDFG and NMFS have not seen the need to shift the production of Oxbow stock steelhead at NSFH from a production mode to a conservation mode. Current use of Oxbow stock steelhead provides harvest opportunities in the Snake and Salmon river basins that are consistent with the goals of the IDFG *2001–2006 Fisheries Management Plan* (IDFG 2001), ODFW *Steelhead Plan* (ODFW n.d.), and ARWG (Chandler and Chapman 2001).

However, given their ESU status, these fish could contribute to recovery or reintroduction efforts if necessary.

Pahsimeroi stock summer chinook are part of the ESU for Snake River spring/summer chinook. IDFG is using these fish in stock recovery efforts in the Pahsimeroi River. The PFH operates under an ESA Section 10(a)(1)(A) directed take permit (#922) from the NMFS for the enhancement and propagation of endangered or threatened species under the ESA of 1973 to supplement the depressed population of Pahsimeroi River summer chinook with hatchery fish. IDFG (1994) expects this program to enhance listed summer chinook by providing an egg-to-adult survival advantage through hatchery rearing that would not be achieved through natural incubation and rearing. Because of the spatial separation from spring/summer chinook that historically inhabited the Snake River above Hells Canyon Dam, Pahsimeroi stock summer chinook is not a likely candidate for reintroduction efforts above Hells Canyon Dam.

Rapid River stock spring chinook originated from wild adults trapped at Oxbow and Hells Canyon dams from 1964 through 1969 and transferred to the Salmon River basin. There are no records to suggest that spring chinook from other locations contributed to the development of this broodstock (Chapman 2001). The one exception is the probable contribution of wild Rapid River summer chinook. Before beginning to mark all hatchery-reared spring chinook smolts in 1992, returning spring chinook adults were indistinguishable from wild summer chinook adults. IDFG's subjective efforts to segregate the two groups were probably incomplete. Results of genetic analysis of marked hatchery adults (spring chinook) and unmarked natural adults (summer chinook) returning to Rapid River in 1997 suggest that the two stocks are no longer genetically distinct (Moran 1998).

Owing to its out-of-basin transfer and long history of hatchery influence, Rapid River stock spring chinook are not considered part of the Snake River spring/summer chinook ESU. For that reason, Rapid River stock are not appropriate for recovery efforts. Propagation of this stock does, however, remain acceptable for harvest augmentation and reintroduction purposes. As previously stated, propagating unlisted species is consistent with the ESA when it neither impedes recovering listed species nor compromises the viability or distinctiveness of unlisted species. Sections 5.1.2, 5.2.2, and 5.3.2 of this report provide information to demonstrate that production of spring chinook at RRFH currently meets these criteria. Providing harvest opportunity through the use of unlisted, hatchery-produced fish is consistent with the goals of the IDFG *2001−2006 Fisheries Management Plan* (IDFG 2001) and ARWG (Chandler and Chapman 2001). Rapid River spring chinook contribute significantly to both sport and tribal harvest in Idaho (Table 21). Stocks selected for reintroduction into areas where indigenous anadromous stocks have been completely extirpated do not have to meet the same requirements as those used for recovery. Both Armour (1990) and Chapman (2001) suggest that Rapid River stock spring chinook are probably the best available for any efforts to reintroduce spring chinook above Hells Canyon Dam.

Pahsimeroi stock steelhead share the same origin as Oxbow stock steelhead, consisting solely of adult steelhead that spawned in Snake River tributaries upstream of Hells Canyon Dam. Adult fish were trapped at Oxbow and Hells Canyon dams from 1965 through 68. Beginning in 1967, the progeny from these fish were released in the Pahsimeroi River. In 1969, efforts to trap and spawn hatchery fish returning to the Pahsimeroi River began. After this time, some wild

Pahsimeroi River steelhead may have contributed to the hatchery population because IDFG records do not indicate that hatchery personnel attempted to segregate hatchery returns from wild returns to the Pahsimeroi weir. Additionally, B-run steelhead smolts originating from Dworshak National Fish Hatchery were released into the Pahsimeroi River in 1974 and 1978. Reingold (1977) reports that, upon return as adults, these fish were not segregated from Pahsimeroi stock and that eggs and sperm were mixed during spawn-taking operations.

With such a complex history, it is not surprising that this group of fish was excluded from the Snake River steelhead ESU and potential recovery efforts. Citing no jeopardy to other listed stocks, however, IDFG has continued using Pahsimeroi stock extensively in the upper Salmon River. For over 30 years, Pahsimeroi stock have contributed significantly to sport harvest in that portion of the river. The NMFS new *Draft Biological Opinion on Artificial Propagation in the Columbia River Basin*, to be released in 2002, will conclude that continuing to use this stock is probably impacting the stock structure and genetic integrity of Snake River steelhead in negative ways (Herb Pollard, NMFS, pers. comm.). Based on these findings, Pahsimeroi steelhead may soon be phased out in favor of a locally adapted stock.

6.2. Suitability of Hatchery Facilities

Hatchery facility design and operating procedures may significantly influence how well artificially produced fish perform. In nature, salmonids prefer habitats that contain rock or gravel substrate; structure in the form of fallen trees, root wads, or undercut banks; and overhead cover. In contrast, production hatcheries, which are geared toward mass production, afford few (if any) of these habitat features. Reisenbichler and Rubin (1999, cited in Flagg and Nash 1999) concluded that the only similarities between the hatchery and natural environment for salmon and steelhead are water and photoperiod. All other factors—including food, substrate, density, competitors, and predators in the hatchery environment—are unnatural.

In theory, both environmental conditioning and artificial selection pressure that the hatchery environment produces can be alleviated with culture practices that simulate a more natural rearing environment (Maynard et al. 1996). This approach to increasing the post-release survival of hatchery-reared salmonids has received the acronym NATURES for Natural Rearing Enhancement System. The result is a rearing facility capable of breeding and propagating a stock of fish with the equivalent genetic resources of the native stock and with the full ability to return to reproducing naturally in its native habitat (Flagg and Nash 1999). Unfortunately, no true conservation hatcheries exist at the present time. Various production hatcheries are applying some conservation strategies in attempts to improve fitness and increase stock survival. But currently, no single hatchery is capable of applying a full package of strategies to produce fish with the equivalent genetic resources of local native stock (Flagg and Nash 1999). PFH, IPC's only facility currently operated for species recovery, has not undergone any specific structural or operational modifications to transition from production to conservation mode.

To date, the work of Maynard et al. (1996) best summarizes desirable features for a conservation hatchery. Unfortunately, the information is mainly conceptual or experimental. Their strategies have not been tested or applied on a production scale, and they provide no insight for applying their concepts to existing hatcheries. For example, in tests conducted at the WDF Simpson

Hatchery, the time required to clean a raceway fitted with a gravel substrate was twice that of a conventional concrete raceway (Maynard et al. 1996). At NSFH, where raceway cleaning takes 32 to 40 man hours per week (J. Chapman, IDFG, pers. comm.), doubling raceway cleaning time would significantly impact other fish culture activities. This is not to say that the work of Maynard et al. (1996) is not encouraging or that the concepts presented in their report cannot be adapted or further modified to function on a large scale. It simply means that no specific template currently exists for successfully converting a production hatchery to a conservation hatchery. Without some knowledge of which strategies apply to production facilities, it is impossible to fully evaluate the suitability of IPC hatchery facilities for conservation use.

Cursory evaluation of the IPC hatchery facilities suggests that RRFH and PFH might be best suited for applying NATURES philosophy. Both facilities use rearing ponds with earthen bottoms for over 50% of the chinook rearing cycle. Piper et al. (1982) reports that fish reared in earthen ponds have better cryptic coloration, fin quality, and overall health than those reared in concrete containers. Adding boulders, stumps, and logs could further improve earthen ponds by creating in-stream structure. We don’t know whether earthen ponds provide similar advantages for installation of overhead cover, subsurface/natural feed delivery systems, or predator conditioning devices.

Because of the fish rearing density and intense cleaning requirements of conventional concrete raceways, NSFH may not be well suited to installation of in-stream cover. On the other hand, modifying the existing avian predator netting at NSFH may provide suitable shade and overhead cover.

Any technologies IPC applies to its facilities will be experimental in nature and their relative success should be thoroughly evaluated.

6.3. Source for Marine-Derived Nutrients

Spawning salmon and their carcasses were once integral components of aquatic and terrestrial habitats. Loss of anadromous escapements has reduced nutrient supply and productivity in some tributary basins (Cederholm et al. 1999). The ARWG has expressed interest in using anadromous fish carcasses to restore the natural trophic structure to areas blocked by the HCC.

Current practices at OFH and RRFH call for spawned-out salmon and steelhead carcasses to be transported to sanitary landfills for burial. Treating prespawning broodstock with formalin (for controlling fungi) and erythromycin (for controlling BKD) precludes using these carcasses for human consumption. In contrast, no drugs or chemicals are used at PFH, so it distributes its steelhead carcasses to the public or charitable organizations for human consumption. In recent years, PFH has returned up to 90% of the chinook carcasses to the stream channel for nutrient replacement. IDFG discontinued this practice in 2001 to avoid public criticism for using salmon testing positive for whirling disease.

Existing anadromous hatchery programs offer logical sources of marine-derived nutrients for restoring natural trophic structure in select basins. However, process details can be quite complex. At present, state agencies have no specific policies governing the use of fish carcasses for nutrient replacement. In lieu of specific policies, current fish health standards treat carcass distribution no differently than live fish stocking. For example, IDFG does not support distributing carcasses upstream of hatchery water sources or transporting them out of the basin. If hatcheries want to transfer carcasses out of the basin, they must first perform thorough pathogen sampling. IDFG fish health policy does not allow carcasses from PFH (where whirling disease is common) into Snake River tributaries upstream of HCC (where this pathogen is not found). Under the current policy, only steelhead carcasses from OFH would be suitable for use upstream of the HCC.

Additionally, many hatcheries, including IPC facilities, administer antibiotics, antifungals, and anaesthetics. The U.S. Department of Agriculture Food and Drug Administration or the U.S. Environmental Protection Agency regulate the use of these drugs. Some compounds require a 21-day withdrawal period prior to liberating live fish. Large-scale distribution of carcasses treated with controlled drugs or chemicals would require consultation and approval from the governing agency.

7. Summary and Conclusions

As construction of Brownlee Dam began in the mid-1950s, mitigation using hatchery-produced fish was not the preferred means for conserving anadromous fish that inhabited the Snake River and its tributaries. At that time, maintaining naturally spawning salmon and steelhead populations in the healthy and accessible spawning and rearing habitat that remained was clearly the desired outcome. But construction of the HCC was not an isolated event. Human development throughout southern Idaho was already altering the habitat for anadromous fish (Chandler and Chapman 2001, Groves 2001). It is questionable whether anadromous fish could have sustained themselves in Snake River tributaries, even if passage at the HCC had been successful. Placing these fish in the hatchery environment has changed their genetic makeup to some degree. However, hatcheries have provided a stronghold for genetic information that otherwise may have been completely lost.

Despite its controversial beginnings, IPC's hatchery program has a 40-year history of mitigating for anadromous fish losses associated with the HCC's construction. Although initial efforts to rear fall chinook met with failure, such failure has been the exception rather than the rule. More often than not, the program has met its intended purpose of producing a specified number of smolts. More importantly, favorable adult escapements have consistently allowed fish managers to offer sport and tribal fishing opportunities and to supplement other agency-sponsored enhancement programs. All the while, wild fish populations throughout the Snake and Salmon river basins have declined precipitously.

Since the listing of several stocks of anadromous fish in the Pacific Northwest, the role of artificial propagation in fisheries management has come under intense scrutiny. Programs that were once perceived as beneficial to anadromous populations are now being linked to their demise. But even as the Northwest shifts its emphasis to protecting habitat and restoring naturally spawning populations, hatchery programs will probably continue to play important roles in fisheries management (IHOT 1995). Along with supporting species recovery, hatchery programs respond to the strong societal demand for harvestable numbers of salmon and steelhead, which natural production alone cannot meet. We believe that, if artificial propagation is managed properly, it can ultimately meet both species recovery and harvest augmentation needs. The success of hatchery supplementation for species recovery hinges on using locally adapted broodstocks and developing new rearing techniques that minimize domestic selection and promote natural survival-related behaviors. For traditional production programs to succeed, unlisted species must be kept as separate as possible from listed species. This separation minimizes deleterious effects from competition, predation, and pathogen transmission.

IPC's summer chinook and fall chinook programs appear to have some application for stock recovery, while the spring chinook and steelhead programs may exert greater influence as production facilities. The details of these two applications for artificial propagation are only beginning to be developed.

Before enacting hatchery reforms, fisheries managers must develop specific goals and objectives for hatchery facilities. Once those overall goals and objectives are developed, operational changes can be implemented at the hatchery level to achieve those outcomes.

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Table 1. Carrying capacities for rearing containers at Oxbow Fish Hatchery.

Container	Volume	Carrying Capacity
Vertical incubators	384 trays	3,400,000 eggs
Raceways (2)	1,980 ft^3 each	200,000 subyearling smolts
Adult holding pond	56,000 ft^3	19,200 adults

Table 2. Carrying capacities for rearing containers at Rapid River Fish Hatchery.

Container	Volume	Carrying Capacity
Vertical incubators	800 trays	3,200,000 eggs
Raceways (12)	1,890 ft^3 each	3,800,000 fry
Rearing pond 1	54,625 ft^3	1,000,000 smolts
Rearing pond 2	92,827 ft^3	2,000,000 smolts
Adult holding pond 1	12,000 ft^3	1,000 adult chinook
Adult holding pond 2	36,000 ft^3	3,000 adult chinook

Table 3. Carrying capacities for rearing containers at Niagara Springs Fish Hatchery.

Container	Volume	Carrying Capacity
Upwelling incubators	30 units	1,800,000 eggs
Nursery vats (21)	60 ft^3 each	1,260,000 fry
Outdoor raceways (19)	7,500 ft^3 each	1,800,000 smolts

Table 4. Carrying capacities for rearing containers at Pahsimeroi Fish Hatchery.

Container	Volume	Carrying Capacity
Vertical incubators	320 trays	2,000,000 chinook eggs
		6,000,000 steelhead eggs
Raceways (4)	1,200 ft^3 each	1,000,000 fry
Rearing pond 1	60,000 ft^3	500,000 smolts
Rearing pond 2	60,000 ft^3	500,000 smolts
Adult holding ponds (3)	20,160 ft^3	2,000 adult chinook
		5,000 adult steelhead

Table 5. Fall chinook trapped and spawned, eggs collected, and smolts produced at Oxbow Fish Hatchery in brood years 1961 through 2000.

Brood Year	Adults Trapped	Adults Ponded	Prespawn Mortality	Females Spawned	Eggs Collected	Number Eyed	Percent Eye-up	Eggs Distributed	Eggs Received	Smolts Released	Fry-to-Smolt Survival
1961	6,658	2,022	63.0%	398	1,668,900	1,466,752	87.89%	329,552	0	601,636	52.91%
1962	2,402	819	31.4%	424	2,015,000	1,911,500	94.86%	477,000	0	1,100,119	76.69%
1963	945	614	54.6%	202	774,000	558,100	72.11%	0	0	495,540	88.79%
1964	1,503	504	27.3%	163	779,000	716,900	92.03%	0	24,408	650,460	87.74%
1965	1,584	1,576	63.8%	119	545,200	497,000	91.16%	0	0	214,720	43.20%
1966	3,612	3,557	38.9%	409	1,691,126	1,582,670	93.59%	0	0	1,473,590	93.11%
1967	1,249	1,235	64.7%	217	821,890	798,900	97.20%	0	0	202,350	25.33%
1968	412	403	22.5%	75	274,030	266,871	97.39%	0	0	255,536	95.75%
1969	50	50	no data	11	54,990	50,591	92.00%	0	500,000	497,298	90.32%
1970	48	12	100.0%	0	0	0	n/a	0	0	0	n/a
1971	4	4	100.0%	0	0	0	n/a	0	0	0	n/a
1972	7	2	100.0%	0	0	0	n/a	0	0	0	n/a
1973	1	1	100.0%	0	0	0	n/a	0	0	0	n/a
1974	15	0	n/a	0	0	0	n/a	0	0	0	n/a
1975	13	0	n/a	0	0	0	n/a	0	0	0	n/a
1976	0	0	n/a	0	0	0	n/a	0	0	0	n/a
1977	4	0	n/a	0	0	0	n/a	0	0	0	n/a
1978	1	0	n/a	0	0	0	n/a	0	0	0	n/a
1979	8	0	n/a	0	0	0	n/a	0	0	0	n/a
1980–1999[1]	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2000	0	0	n/a	0	0	0	n/a	0	122,514	115,220	94.05%

[1] No production during this period.

Table 6. Summer steelhead trapped and spawned and eggs collected at Oxbow Fish Hatchery in brood years 1966 through 2000.

Brood Year	Total Trapped	Marked Fish Trapped	Unmarked Fish Trapped	Fish Ponded	Prespawn Mortality	Females Spawned	Eggs Collected	Fecundity	Number Eyed	Percent Eye-up
1966	4,519	0	4,519	1,819	no data	1,145	3,642,640	3,181	3,085,194	84.7%
1967	4,954	0	4,954	4,954	16.5%	2,547	8,181,420	3,212	8,102,840	99.0%
1968	1,609	0	1,609	1,609	9.4%	801	2,553,990	3,188	2,469,536	96.0%
1969	1,466	no data	no data	1,466	17.2%	701	2,946,130	4,202	2,495,335	85.0%
1970	441	113	328	441	7.7%	272	1,526,054	5,610	1,320,494	86.4%
1971	284	170	114	284	7.4%	175	810,204	4,418	663,201	90.0%
1972	696	no data	no data	no data	no data	no data	no data	no data	no data	no data
1973	435	230	205	435	4.8%	321	1,399,168	4,359	1,261,300	90.0%
1974	126	no data	no data	126	5.5%	77	327,350	4,245	262,698	90.0%
1975	34	no data	no data	34	8.8%	9	54,169	6,019	51,559	95.0%
1976	258	no data	no data	258	no data	182	772,468	no data	731,442	95.0%
1977	201	no data	no data	201	no data	143	591,420	4,136	564,466	95.0%
1978	186	no data	no data	186	no data	102	452,257	4,434	441,069	97.5%
1979	36	no data	no data	36	no data	22	134,122	6,096	124,814	93.0%
1980	339	no data	no data	339	53.7%	136	608,308	4,473	596,696	97.8%
1981	158	no data	no data	158	5.0%	69	365,838	5,302	310,978	82.5%
1982	205	no data	no data	205	3.4%	68	294,226	4,237	259,801	88.3%
1983	872	no data	no data	872	2.4%	444	2,281,292	5,138	1,616,295	70.9%
1984	1,116	no data	no data	1,116	12.9%	279	1,313,668	4,708	996,460	75.8%
1985	1,343	no data	no data	1,343	3.0%	700	2,974,362	4,249	2,458,870	82.7%
1986	2,438	2,187	251	2,438	3.0%	332	1,316,000	3,964	1,032,233	78.4%
1987	3,209	3,147	62	3,043	no data	618	2,851,100	4,613	2,074,900	72.3%
1988	2,524	2,416	108	2,524	7.5%	1,065	4,939,441	4,638	3,853,757	78.0%
1989	2,729	2,708	21	2,729	35.2%	334	1,321,000	3,955	872,500	66.0%
1990	2,728	2,725	3	2,728	14.0%	565	2,359,950	4,177	114,520	4.9%
1991	1,151	1,123	28	1,151	4.0%	570	3,116,947	5,468	1,781,427	57.2%
1992	1,714	1,700	14	1,714	14.3%	660	2,743,500	4,157	2,381,600	86.8%
1993	1,267	1259	8	1,267	14.0%	407	1,600,800	3,982	1,375,700	87.0%
1994	1,403	1,387	16	1,403	12.8%	635	3,348,066	5,273	2,704,522	80.8%
1995	1,597	1,555	42	1,516	4.6%	697	3,156,929	4,529	2,649,527	83.9%
1996	1,383	1,381	2	1,379	15.6%	411	2,062,797	5,019	1,717,366	83.3%
1997	1,270	1,270	0	1,268	24.4%	301	1,583,235	5,260	1,271,524	80.3%
1998	2,407	2,406	1	2,396	24.2%	527	2,798,775	5,311	2,331,850	83.3%
1999	2,042	1,943	99	1,943	2.0%	641	3,063,596	4,779	1,778,024	58.0%
2000	2,231	2,107	124	2,126	4.5%	303	1,523,428	5,028	1,319,069	86.6%

Table 7. Distribution of summer steelhead adults, eggs, and fry from Oxbow Fish Hatchery by brood year.

Brood Year	Eggs Collected	Eggs, Fry to NSFH	Surplus Adult Outplants	Surplus Eggs, Fry Destroyed	Surplus Eggs, Fry to IDFG Hatcheries	Surplus Fry Outplants	Surplus Eggs to ODFW	Surplus Eggs to WDFW
1966	3,642,640	0	2,700	0	2,477,104	143,990	464,100	0
1967	8,181,420	3,215,652	60	0	524,648	0	4,362,540	0
1968	2,553,990	2,469,536	0	0	0	0	0	0
1969	2,946,130	1,957,354	0	0	0	0	537,981	0
1970	1,526,054	1,320,494	0	0	0	0	0	0
1971	810,204	700,161	0	0	0	0	0	0
1972	no data	1,819,721	0	0	0	0	0	0
1973	1,399,168	1,261,300	0	0	0	0	0	0
1974	327,350	280,098	0	0	0	0	0	0
1975	54,169	51,559	0	0	0	0	0	0
1976	772,468	731,442	0	0	0	0	0	0
1977	591,420	564,466	0	0	0	0	0	0
1978	452,257	441,069	0	0	0	0	0	0
1979	134,122	124,814	0	0	0	0	0	0
1980	608,308	596,696	0	0	0	0	0	0
1981	365,838	310,978	0	0	0	0	0	0
1982	294,226	259,771	0	0	0	0	0	0
1983	2,281,292	748,256	143	0	0	626,183	0	0
1984	1,313,668	610,652	657	0	0	365,632	0	0
1985	2,974,362	1,786,398	0	0	404,950	140,736	0	0
1986	1,316,000	935,190	1,461	0	0	94,700	0	0
1987	2,851,100	1,277,000	1,752	797,900	0	0	0	0
1988	4,939,441	1,213,400	0	1,938,357	0	702,000	0	0
1989	1,321,000	872,500	1,206	0	0	0	0	0
1990	2,359,950	114,500	1,051	0	0	0	0	0
1991	3,116,947	929,242	0	0	1,074,739	0	0	0
1992	2,743,500	971,000	220	0	0	0	0	693,500
1993	1,600,800	1,375,700	312	0	20,000	0	0	0
1994	3,348,066	1,100,115	259	880,045	682,963	0	0	0
1995	3,156,929	1,397,102	28	29,499	1,210,688	0	0	0
1996	2,062,797	1,304,396	464	377,079	0	0	0	0
1997	1,583,235	1,250,426	446	64,999	0	0	0	0
1998	2,798,775	1,433,735	1,112	0	695,592	184,538	0	0
1999	3,063,596	1,139,126	685	0	638,898	0	0	0
2000	1,523,428	1,046,437	1,169	248,908	0	0	0	0
Total	69,014,650	35,610,286	13,725	4,336,787	7,729,582	2,257,779	5,364,621	693,500

Table 8. Number and pounds of steelhead produced and percentage of total by use, stocking location, and season at Niagara Springs Fish Hatchery in brood years 1966 through 1979.

Destination and Season	Number	Percentage by Number	Pounds	Percentage by Weight
Pahsimeroi River—spring	20,762,433	70.2%	2,834,604	93.9%
Pahsimeroi River–fall	0	0.0%	0	0.0%
Snake River—spring	1,898,977	6.4%	98,434	3.3%
Snake River—fall	3,491,101	11.8%	29,524	1.0%
Other anadromous—spring[1]	434,520	1.5%	41,900	1.4%
Other anadromous—fall[a]	2,407,164	8.1%	2,656	0.1%
Total Anadromous	28,994,195	98.0%	3,007,118	99.6%
Research	367,202	1.2%	6,975	0.2%
Resident stocking	216,297	0.7%	4,060	0.1%
Total Nonanadromous	583,499	2.0%	11,035	0.4%
Total NSFH Production	29,577,694	100.0%	3,018,153	100.0%

[1] Mainstem Salmon River and various Salmon River tributaries.

Table 9. Numbers of spring chinook trapped at Oxbow and Hells Canyon dams and transferred to Rapid River Fish Hatchery (RRFH) for spawning.

	Chinook Trapped		Shipped to RRFH	
Brood Year	Jacks	Adults	Jacks	Adults
1964	no data	no data	33	316
1965	no data	no data	57	351
1966	no data	no data	224	1,287
1967	no data	no data	0	974
1968	no data	no data	15	351
1969	no data	no data	1	671
1970	0	6	0	0
1971	no trap	no trap	0	0
1972	no trap	no trap	0	0
1973	no trap	no trap	0	0
1974	no trap	no trap	0	0
1975	no trap	no trap	0	0
1976	no trap	no trap	0	0
1977	no trap	no trap	0	0
1978	no trap	no trap	0	0
1979	no trap	no trap	0	0
1980	no trap	no trap	0	0
1981	no trap	no trap	0	0
1982	no trap	no trap	0	0
1983	0	16	0	12
1984	no trap	no trap	0	0
1985	61	663	60	676
1986	13	380	11	351
1987	4	543	4	532
1988	13	458	12	381
1989	3	84	2	86
1990	0	30	0	0
1991	44	25	0	0
1992	22	912	20	892
1993	2	429	1	410
1994	1	28	1	28
1995	1	35	1	34
1996	54	24	49	14
1997	1	943	1	788
1998	0	74	0	60
1999	72	7	19	3
2000	207	967	17	950

Table 10. Numbers of spring chinook spawned, eggs collected, and smolts released for mitigation purposes from Rapid River Fish Hatchery for brood years 1964 through 1998.

Brood Year	Females Spawned	Eggs Collected	Release Year	Smolts Released	
				Rapid River	Snake River
1964	197	887,616	1966	588,000	0
1965	133	603,800	1967	479,267	0
1966	621	2,296,000	1968	1,460,150	0
1967	518	2,055,000	1969	900,192	0
1968	1,809	6,640,000	1970	3,178,000	0
1969	1,415	5,171,697	1971	2,718,720	0
1970	3,520	14,560,280	1972	2,809,200	0
1971	1,722	6,038,785	1973	2,908,425	0
1972	3,825	15,072,604	1974	2,707,917	0
1973	3,454	13,510,465	1975	3,373,700	0
1974	1,756	6,890,186	1976	3,358,940	0
1975	2,184	8,503,606	1977	2,921,172	0
1976	3,055	11,492,878	1978	2,413,678	0
1977	3,781	14,160,330	1979	2,866,933	0
1978	2,350	10,026,888	1980	2,604,823	0
1979	1,141	5,648,722	1981	2,372,607	1,001,700
1980	543	1,756,827	1982	1,473,733	0
1981	1,666	6,122,273	1983	2,998,103	250,020
1982	1,883	7,482,330	1984	3,246,197	500,850
1983	859	3,449,471	1985	2,491,238	437,360
1984	821	3,125,911	1986	1,594,688	140,000
1985	2,962	11,082,369	1987	2,836,400	103,000
1986	2,451	10,673,138	1988	2,630,200	400,600
1987	1,310	5,656,145	1989	2,319,500	500,000
1988	1,645	7,905,702	1990	2,520,400	551,200
1989	1,082	4,478,045	1991	2,564,900	500,500
1990	1,063	4,217,103	1992	2,615,500	500,500
1991	657	2,553,218	1993	2,060,283	200,300
1992	1,177	4,534,400	1994	2,547,644	380,500
1993	1,737	7,103,037	1995	2,786,919	499,530
1994	116	490,249	1996	379,167	0
1995	35	132,001	1997	85,840	0
1996	329	1,171,610	1998	896,170	0
1997	1,138	4,472,573	1999	2,847,283	300,000
1998	723	3,409,130	2000	2,462,354	0
Total	53,678	213,374,389		79,018,243	6,266,060

Table 11. Surplus spring chinook eggs, fry and smolts distributed from Rapid River Fish Hatchery for brood years 1964 through 1998.

Brood Year	Total Count	Life Stage	Site
1964	No transfer		
1965	No transfer		
1966	No transfer		
1967	No transfer		
1968	757,376	Eggs	Clearwater Hatchery
1969	497,610	Eggs	Dworshak National Fish Hatchery
1970	4,417,454	Eggs	Sweetwater Eyeing Station
	2,224,119	Eggs	Kooskia National Fish Hatchery
	526,516	Eggs	Hayden Creek Hatchery
	2,473,983	Eggs	Clearwater Hatchery
	200,520	Fry	Lemhi River
	353,970	Fry	Decker Pond
	100,094	Fry	Sandpoint Hatchery
	91,800	Smolts	Lochsa River
1971	600,496	Eggs	Hayden Creek Hatchery
	53,562	Fry	Lemhi River
	104,300	Fry	Red River
	89,800	Fry	Ten Mile Creek
	44,700	Fry	American River
	14,900	Fry	Papoose Creek
	59,600	Fry	Brushy Fork Creek
	44,700	Fry	Fish Creek
	14,900	Fry	Post Office Creek
	44,700	Fry	Squaw Creek (Lochsa)
	61,500	Fry	Lochsa River
	200,880	Fry	Sandpoint Hatchery
	401,305	Fry	Decker Pond
	197,303	Smolts	South Fork Clearwater River
1972	5,256,662	Eggs	Sweetwater Eyeing Station
	3,012,358	Eggs	Hayden Creek Hatchery
	1,293,592	Eggs	Red River
1973	3,915,900	Eggs	Sweetwater Eyeing Station
	2,101,824	Eggs	Hayden Creek Hatchery

Table 11. (Cont.)

Brood Year	Total Count	Life Stage	Site
	104,760	Eggs	Hagerman National Fish Hatchery
	502,200	Eggs	Crooked River
	702,000	Eggs	Kooskia National Fish Hatchery
	504,000	Eggs	Minnesota (walleye trade)
	210,734	Fry	Sandpoint Hatchery
	206,360	Fry	Kooskia National Fish Hatchery
	88,480	Fry	Ten Mile Creek
	18,200	Fry	Newsome Creek
	633,000	Fry	Lemhi River
	10,428	Fry	Capehorn Creek
	117,000	Smolts	South Fork Clearwater River
1974	809,400	Eggs	Hayden Creek Hatchery
	407,012	Eggs	Indian Creek
	203,500	Fry	Sandpoint Hatchery
	21,840	Fry	Capehorn Creek
	59,962	Fry	Red River
	30,750	Fry	Newsome Creek
	10,250	Fry	Ten Mile Creek
	1,140,300	Fry	Lemhi River
	205,700	Smolts	South Fork Clearwater River
1975	2,363,200	Eggs	Sweetwater Eyeing Station
	252,200	Eggs	Mullan Hatchery
	255,000	Eggs	Hayden Creek Hatchery
	280,659	Eggs	Indian Creek
	34,000	Fry	Ten Mile Creek
	156,000	Fry	Lemhi River
	315,710	Fry	South Fork Clearwater River
	412,800	Fry	Decker Pond
	209,950	Fry	Sandpoint Hatchery
	36,143	Fry	Bear Valley Creek
1976	1,615,608	Eggs	Mullan Hatchery
	2,937,994	Eggs	Sweetwater Eyeing Station
	261,900	Eggs	Hayden Creek Hatchery
	261,900	Eggs	Sandpoint Hatchery
	1,267,208	Eggs	Mackay Hatchery

Table 11. (Cont.)

Brood Year	Total Count	Life Stage	Site
	47,008	Fry	University of Idaho
	311,850	Fry	Mackay Hatchery
	104,500	Fry	Lolo Creek
	501,600	Fry	Red River
	80,600	Fry	South Fork Clearwater River
1977	2,633,400	Eggs	Sweetwater Eyeing Station
	2,287,800	Eggs	Kooskia National Fish Hatchery
	2,689,200	Eggs	Mullan Hatchery
	288,000	Eggs	Hayden Creek Hatchery
	20,700	Eggs	University of Idaho
	1,007,340	Eggs	Crooked River
	723,000	Fry	Mackay Hatchery
	50,800	Fry	Decker Pond
	200,025	Fry	Red River
	265,600	Fry	Lemhi River
	156,362	Smolts	White Sand Creek
	44,373	Smolts	Newsome Creek
1978	729,246	Eggs	Hayden Creek Hatchery
	970,728	Eggs	Mackay Hatchery
	1,540,282	Eggs	Sweetwater Eyeing Station
	706,936	Eggs	Dworshak National Fish Hatchery
	38,160	Eggs	University of Idaho
	48,940	Eggs	University of Idaho Hayden Creek
	1,250,010	Eggs	Crooked River
	249,696	Eggs	Indian Creek
	232,500	Fry	Red River
	10,000	Fry	Ten Mile Creek
	157,440	Smolts	White Sand Creek
1979	806,400	Eggs	Hayden Creek Hatchery
	330,880	Eggs	Dworshak National Fish Hatchery
	293,249	Fry	Red River
1980	No transfer		
1981	608,384	Eggs	Pahsimeroi Hatchery
	256,608	Eggs	Oxbow Hatchery
	449,280	Eggs	Dworshak National Fish Hatchery

Table 11. (Cont.)

Brood Year	Total Count	Life Stage	Site
1982	493,346	Eggs	Looking Glass Hatchery
	1,332,000	Eggs	Pahsimeroi Hatchery
	375,028	Eggs	Dworshak National Fish Hatchery
	125,055	Eggs	Hagerman National Fish Hatchery
	306,000	Fry	Red River
1983	No Transfer		
1984	No Transfer		
1985	497,520	Eggs	Oregon Fish and Wildlife
	3,668,000	Eggs	Dworshak National Fish Hatchery
	2,450,907	Eggs	Sawtooth Hatchery
	100,590	Fry	Boulder Creek
	349,650	Fry	Crooked River
	200,158	Fry	Eldorado Creek
	55,123	Fry	Hopeful Creek
	144,443	Fry	Crooked Fork Creek
	70,282	Fry	White Sand Creek
	49,437	Fry	Ten Mile Creek
	102,282	Fry	Newsome Creek
	115,352	Fry	Brushy Fork Creek
1986	2,368,400	Eggs	Dworshak National Fish Hatchery
	712,905	Eggs	Sawtooth Hatchery
	348,600	Fry	Crooked Fork Creek
	202,400	Fry	White Sand Creek
	98,000	Fry	Big Flat Creek
	238,900	Fry	Red River
1987	30,000	Fry	Little Salmon River
	103,800	Fry	Lolo Creek
	53,200	Fry	Eldorado Creek
	137,800	Fry	Crooked Fork Creek
	62,200	Fry	Hopeful Creek
	228,000	Fry	White Sand Creek
	72,200	Fry	Big Flat Creek
	113,800	Fry	American River
	112,100	Fry	Newsome Creek
	100,100	Fry	Meadow Creek

Table 11. (Cont.)

Brood Year	Total Count	Life Stage	Site
	200,100	Fry	Crooked River
	50,100	Fry	Red River
	50,100	Fry	Yankee Fork
	202,000	Fry	Brushy Fork Creek
	150,100	Fry	Ten Mile Creek
1988	1,475,677	Eggs	Oregon Fish and Wildlife
	149,570	Fry	Little Salmon River
	399,570	Fry	Little Salmon River
	200,556	Fry	Ten Mile Creek
	201,924	Fry	Crooked River
	200,725	Fry	Newsome Creek
	100,641	Fry	Boulder Creek
	195,398	Fry	Brushy Fork Creek
	200,067	Fry	White Sand Creek
	150,770	Fry	American River
	39,163	Fry	Meadow Creek
1989	211,509	Fry	Crooked River
	548,876	Fry	Sawtooth Hatchery
	100,100	Smolts	Little Salmon River
1990	200,000	Eggs	Looking Glass Hatchery
	403,400	Fry	Sawtooth Hatchery
1991	3,050	Fry	Hayden Creek Hatchery
	10,126	Fry	Squaw Creek (Lochsa)
	90,125	Fry	White Sand Creek
1992	942,897	Eggs	Dworshak National Fish Hatchery
1993	2,526,841	Eggs	Clearwater Hatchery
1994	58,791	Eggs	Clearwater Hatchery
1995	16,402	Eggs	Clearwater Hatchery
1996	168,754	Eggs	Clearwater Hatchery
1997	1,015,496	Eggs	Clearwater Hatchery
	200,000	Smolts	Little Salmon River
1998	510,848	Eggs	Clearwater Hatchery

Table 12. Numbers and pounds of steelhead produced and percentage of total by use, stocking location, and season at Niagara Springs Fish Hatchery in brood years 1980 through 1999.

Destination/Season	Number	Percentage by Number	Pounds	Percentage by Weight
Pahsimeroi River—spring	14,202,157	39.0%	3,256,070	44.0%
Pahsimeroi River—fall	228,800	0.6%	12,000	0.2%
Snake River—spring	12,723,194	35.0%	2,840,756	38.4%
Snake River—fall	1,532,985	4.2%	64,015	0.9%
Other anadromous—spring[1]	5,082,512	14.0%	1,105,301	15.0%
Other anadromous—fall[a]	1,103,120	3.0%	10,975	0.1%
Total Anadromous	34,872,768	95.8%	7,289,117	98.6%
Research	0	0.0%	0	0.0%
Resident stocking	1,519,651	4.2%	103,716	1.4%
Total Nonanadromous	1,519,651	4.2%	103,716	1.4%
Total NSFH Production	36,392,419	100.0%	7,392,833	100.0%

[1] Mainstem Salmon River and various Salmon River tributaries.

Table 13. Distribution of steelhead produced at Niagara Springs Fish Hatchery by category for brood years 1966 through 1999.

	Distribution Category[1]							
Brood Year	Snake River[2]	Pahsimeroi River	Salmon River and Tributaries above the Middle Fork	Salmon River and Tributaries below the Middle Fork	Resident Stocking	Research	Total Number Produced	Total Pounds Produced
1966	616,913	1,292,402	72,440	0	0	0	1,981,755	153,552
1967	342,144	1,544,325	120,000	0	0	349,839	2,356,308	208,570
1968	109,200	1,665,117	0	0	0	0	1,774,317	184,186
1969	1,143,400	1,608,000	0	0	4,508	0	2,755,908	299,235
1970	670,960	1,630,002	0	0	208,069	0	2,509,031	204,803
1971	215,625	1,555,050	0	0	0	0	1,770,675	235,375
1972	848,700	1,543,349	2,159,964	0	0	4,171	4,556,184	163,839
1973	0	1,605,898	354,480	0	3,720	10,429	1,974,527	187,494
1974	0	1,331,280	0	0	0	536	1,331,816	166,640
1975	40,977	1,610,350	80,040	0	0	505	1,731,872	248,708
1976	126,000	1,448,681	0	0	0	1,622	1,576,303	251,835
1977	281,208	1,266,025	0	0	0	0	1,547,233	154,829
1978	344,944	1,372,454	0	0	0	100	1,717,498	244,887
1979	897,207	1,097,060	0	0	0	0	1,994,267	314,100
1980	612,760	862,494	0	0	0	0	1,475,254	316,330
1981	354,150	995,205	0	0	0	0	1,349,355	374,350
1982	92,750	496,140	546,250	0	0	0	1,135,140	181,150
1983	628,700	980,995	0	0	0	0	1,609,695	310,000
1984	952,912	878,530	394,651	0	61,100	0	2,287,193	313,450
1985	1,150,015	614,038	246,440	0	0	0	2,010,493	339,885
1986	839,995	712,200	299,700	0	0	0	1,851,895	419,000
1987	1,281,400	665,800	206,300	0	0	0	2,153,500	405,515
1988	735,500	508,300	415,200	7,200	0	0	1,666,200	406,800
1989	947,200	501,600	401,800	655,700	0	0	2,506,300	476,170
1990	912,000	475,000	381,000	0	0	0	1,768,000	484,025
1991	660,964	504,300	0	282,300	0	0	1,447,564	305,286
1992	660,507	761,800	0	222,560	47,098	0	1,691,965	366,165
1993	609,115	379,948	334,941	214,092	0	0	1,538,096	350,101
1994	614,560	829,277	0	257,772	160,000	0	1,861,609	380,060
1995	630,152	799,220	0	304,123	157,600	0	1,891,095	352,750
1996	660,651	830,654	0	262,348	149,040	0	1,902,693	347,970
1997	653,276	801,541	0	199,007	0	0	1,653,824	361,745
1998	657,665	829,199	0	356,336	183,924	0	2,027,124	444,455
1999	601,907	830,316	0	372,312	760,889	0	2,565,424	457,626

[1] See Appendix A for key to specific distribution categories.
[2] Includes fish stocked in Grande Ronde River (BY 1966) and Clearwater River (BY 1972).

Table 14. Summer steelhead trapped and spawned and eggs collected at Pahsimeroi Fish Hatchery in brood years 1969 through 2000.

Brood Year	Total Trapped	Marked Fish Trapped	Unmarked Fish Trapped	Fish Ponded	Prespawn Mortality	Females Spawned	Eggs Collected	Fecundity	Number Eyed	Percent Eye-up
1969	850	798	52	850	no data	467	1,620,000	3,469	1,477,695	91.2%
1970	508	504	4	504	22.2%	348	1,661,973	4,773	1,480,150	89.1%
1971	720	713	7	713	19.9%	409	1,758,000	4,300	1,440,000	81.9%
1972	4,953	4,904	49	4,578	no data	2,829	11,081,000	3,917	10,006,143	90.3%
1973	1,458	1,458	no data	1,458	no data	975	4,500,000	4,600	3,640,500	80.9%
1974	1,795	1,795	no data	1,675	1.8%	1,132	5,128,402	4,531	4,277,210	83.4%
1975	691	691	no data	691	0.9%	503	2,765,232	5,497	2,234,978	80.8%
1976	585	585	no data	no data	no data	399	1,800,000	4,475	1,499,400	83.3%
1977	1,504	1,504	no data	no data	no data	752	3,019,608	4,015	2,523,000	84.1%
1978	2,803	2,803	no data	no data	no data	554	2,919,170	5,415	2,295,000	76.5%
1979	2,501	2,501	no data	2,501	no data	662	3,594,150	5,428	3,199,275	89.0%
1980	1,620	1,620	no data	1,620	1.4%	897	3,251,702	3,625	2,589,142	79.6%
1981	6,899	6,899	no data	6,899	2.6%	1,635	6,904,277	10,930	5,633,022	81.6%
1982	3,444	3,444	no data	3,444	6.8%	1,502	8,409,640	12,592	6,192,966	73.6%
1983	5,008	5,008	no data	5,008	5.2%	1,815	9,102,552	11,076	6,694,934	73.6%
1984	13,883	13,883	no data	13,883	1.0%	1,749	7,090,636	10,528	6,098,572	86.0%
1985	4,944	4,944	no data	4,944	no data	1,388	8,217,136	5,231	6,404,012	77.9%
1986	4,505	4,435	70	4,228	no data	1,011	5,597,471	5,500	5,003,943	89.4%
1987	5,033	4,774	259	5,033	0.2%	1,216	6,219,644	5,114	5,388,432	86.6%
1988	1,981	1,521	460	1,981	0.7%	983	5,817,830	6,097	5,602,570	96.3%
1989	1,926	1,760	166	1,760	0.5%	1,005	5,433,876	5,407	5,272,889	90.2%
1990	2,092	1,974	118	1,804	2.0%	1,094	5,773,543	5,098	3,905,802	67.7%
1991	719	693	26	693	0.5%	342	1,855,681	5,426	1,645,950	88.7%
1992	1,727	1,688	39	1,688	0.4%	796	4,020,454	5,051	3,202,559	79.7%
1993	2,275	2,251	24	2,251	0.3%	1,027	4,729,711	4,605	4,211,087	89.0%
1994	849	814	35	814	0.1%	473	2,365,000	5,000	0	no data
1995	1,418	1,401	17	1,401	0.0%	800	3,459,200	4,324	2,756,850	79.7%
1996	2,940	2,923	17	2,923	no data	1,178	5,398,600	4,583	4,357,500	80.7%
1997	2,264	2,239	25	2,239	no data	753	3,910,369	5,193	3,242,641	82.9%
1998	2,142	2,094	48	2,094	no data	1,035	5,366,086	5,195	4,534,672	84.5%
1999	1,729	1,691	38	1,691	no data	820	3,962,649	4,851	3,412,150	86.1%
2000	2,004	1,946	58	1,946	0.0%	998	5,031,178	5,041	3,792,065	86.0%
Total	87,770	86,258	1,512	81,314		31,547	151,764,770		124,015,109	

Table 15. Distribution of summer steelhead adults, eggs, and fry from Pahsimeroi Fish Hatchery by brood year.

Brood Year	Eggs Collected	Eggs, Fry to NSFH	Surplus Adult Outplants	Surplus Eggs, Fry Destroyed	Surplus Eggs, Fry to IDFG Hatcheries	Surplus Eggs, Fry to Sho-Ban Tribe	Surplus Fry Outplants
1969	1,620,000	1,477,695	0	0	0	0	0
1970	1,661,973	1,480,150	0	0	0	0	0
1971	1,758,000	1,440,000	7	0	0	0	0
1972	11,081,000	10,006,143	40	0	0	0	0
1973	4,500,000	3,640,500	172	0	0	0	0
1974	5,128,402	4,277,210	120	0	0	0	0
1975	2,765,232	2,234,978	0	0	0	0	0
1976	1,800,000	1,499,400	0	0	0	0	0
1977	3,019,608	2,523,000	46	0	0	0	0
1978	2,919,170	2,000,000	2,090	0	0	0	0
1979	3,594,150	2,622,825	1,600	0	576,450	0	0
1980	3,251,702	1,697,010	36	0	892,132	0	0
1981	6,904,277	2,203,211	266	0	1,503,577	0	2,051,399
1982	8,409,640	2,113,758	702	0	2,178,412	0	1,713,336
1983	9,102,552	2,671,897	2,486	0	1,706,820	0	1,587,673
1984	7,090,636	2,333,760	10,928	0	1,973,553	0	2,180,200
1985	8,217,136	1,332,152	3,028	0	0	0	3,000,000
1986	5,597,471	1,293,571	2,963	0	265,753	0	2,434,100
1987	6,219,644	1,850,682	3,541	0	2,288,519	0	1,828,355
1988	5,817,830	1,256,289	484	0	4,010,850	0	481,102
1989	5,433,876	778,649	206	0	4,365,187	0	120,000
1990	5,773,543	2,020,886	288	0	3,189,225	0	0
1991	1,855,681	650,427	26	0	995,574	0	0
1992	4,020,454	1,107,424	75	0	2,094,235	0	0
1993	4,729,711	1,292,320	264	0	2,918,767	0	0
1994	2,365,000	1,042,728	24	0	690,000	0	0
1995	3,459,200	1,401,000	54	0	1,146,000	208,000	0
1996	5,398,600	1,297,500	667	0	1,559,000	614,000	0
1997	3,910,369	1,450,400	724	0	700,000	543,800	0
1998	5,366,086	1,416,800	364	698,000	873,000	848,400	470,000
1999	3,962,649	1,717,897	287	0	520,074	825,160	349,019
2000	5,031,178	1,389,074	375	620,043	1,164,091	633,791	605,469
Total	151,764,770	65,519,336	31,863	1,318,043	35,611,219	3,673,151	16,820,653

Table 16. Summary of IDFG's experimental summer chinook culture at Pahsimeroi Fish Hatchery prior to the *Hells Canyon Settlement Agreement*.

Brood Year	Total Trapped	Prespawn Mortality	Females Spawned	Eggs Collected	Fecundity	Number Eyed	Percent Eye-up	Smolts Released[1]
1969	no data	no data	no data	464,150	no data	444,192	95.7%	393,840
1970	272	5.1%	74	443,772	5,997	339,396	76.5%	252,000
1971	106	28.3%	62	357,864	5,772	290,943	81.3%	232,000
1972	253	no data	75	382,950	5,106	281,468	73.5%	217,000
1973	379	no data	91	491,400	5,400	399,508	81.3%	330,000
1974	107	no data	45	220,000	4,889	172,700	78.5%	no data
1975	44	no data	45	249,546	5,545	229,832	92.1%	121,000
1976	274	no data	66	302,000	4,576	269,082	89.1%	234,000
1977	558	7.7%	175	900,000	5,143	762,300	84.7%	508,000
Total	1993		633	3,811,682		3,189,421		2,287,840

[1] Released as subyearlings during late May of each year.

Table 17. Numbers of summer chinook (1981–2000) and spring chinook (1981–1984) trapped and spawned, eggs collected and received, and smolts released for mitigation purposes from Pahsimeroi Fish Hatchery.

Brood Year	Adults Trapped	Females Spawned	Eggs Collected	Eggs Received	Smolts Released
Summer chinook					
1981	35	4	22,772	0	13,690
1982	39	13	75,402	0	55,803
1983	109	45	261,188	0	209,155
1984	37	4	23,999	0	12,095
1985	110	24	127,332	200,448	258,600
1986	345	106	476,281	374,041	598,500
1987	473	122	696,004	605,091	1,016,300
1988	838	164	1,053,536	317,272	1,058,000
1989	347	66	294,893	0	227,500
1990	470	151	662,641	0	605,900
1991	238	87	437,157	0	375,000
1992	131	35	172,139	0	130,510
1993	169	29	167,200	0	147,429
1994	36	0	0	0	0
1995	80	35	157,938	0	116,811
1996	89	18	85,660	0	65,648
1997	147	32	171,836	0	135,669
1998	127	13	74,105	0	53,837
1999	377	79	371,354	0	283,063
2000	459	123	633,906	0	0
Subtotal	4,656	1,150	5,965,343	1,496,852	5,363,510
Spring chinook					
1981	no data	0	0	616,823	437,332
1982	107	27	107,234	1,332,200	1,143,029
1983	232	75	279,398	0	178,782
1984	112	32	145,341	0	80,948
Subtotal	451	134	531,973	1,949,023	1,840,091
Grand Total	5,107	1,284	6,497,316	3,445,875	7,203,601

Table 18. Distribution of surplus spring chinook adults, eggs, and fry from Pahsimeroi Fish Hatchery.

Brood Year	Surplus Adults	Adult Destination	Surplus Smolts	Surplus Eggs to IDFG	Surplus Eggs to ODFW	Surplus Fry to IDFG
1985	659	Yankee Fork	444,700	1,478,439	0	391,665
1986	3,388	Panther Creek	0	313,262	952,210	0
1987	1,505	Yankee Fork	0	1,128,750	1,000,000	0
1988	600	Yankee Fork	0	0	0	0
1989	392	Yankee Fork	0	0	0	0
1990	73	Lemhi River and Yankee Fork	0	0	0	0
1991	0	Lemhi River and Yankee Fork	0	22,235	0	0
Total	6,617		444,700	2,942,686	1,952,210	391,665

Table 19. Distribution of adult steelhead produced at Niagara Springs Fish Hatchery.

Run Year	Coastal Gill Net	Columbia River Gill Net	Columbia River Sport	Commercial Seine	Estuary Sport	Foreign Research Vessel	Freshwater Sport	Hatchery Rack	Mixed Net & Seine	Ocean Sport	Ocean Trawl By-Catch	Ocean Troll	River Trap	Test Fishery Net	Treaty Ceremonial	Treaty Subsistence	Pahsimeroi Rack	Salmon River Harvest	Hells Canyon Rack	Snake River Harvest	Run Year Total
1979	0	82	152	0	0	0	0	0	0	0	0	0	0	0	0	0	195	2,047	23		2,499
1980	0	76	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,620	1,634	339		3,669
1981	0	1,448	71	0	0	0	152	15	19	0	0	0	46	0	0	0	3,491	3,347	158		8,746
1982	0	1,045	383	0	0	0	122	0	57	0	0	0	30	0	0	0	3,092	4,401	205		9,335
1983	0	935	290	0	0	0	1,387	28	33	21	0	0	21	0	28	113	4,651	10,171	872		18,550
1984	0	6,148	692	76	0	0	2,211	669	17	0	0	0	34	57	54	1,078	13,776	15,120	1,116		41,049
1985	0	4,126	17	0	0	0	69	138	0	0	0	0	0	0	0	612	4,237	4,569	1,343		15,111
1986	0	8,447	798	39	0	10	615	42	83	0	10	14	0	0	0	397	3,905	6,779	2,438		23,578
1987	0	9,099	1,000	0	0	0	62	62	0	0	0	0	0	0	0	0	5,274	11,691	3,209		30,397
1988	0	3,553	16	0	0	16	112	0	67	0	0	0	0	0	0	41	1,521	3,187	2,524		11,036
1989	0	4,175	587	0	0	0	0	0	0	0	0	0	0	0	0	0	1,760	4,774	2,729		14,025
1990	0	3,439	324	33	0	0	322	33	136	0	0	0	0	0	0	0	1,974	4,091	2,728		13,081
1991	0	882	0	37	0	0	147	0	33	0	0	0	0	0	0	152	693	318	1,151		3,413
1992	0	606	66	0	0	28	84	74	0	0	0	0	0	0	0	79	1,688	970	1,714		5,310
1993	0	3,882	875	0	0	0	197	72	0	0	0	0	0	9	0	0	2,756	2,246	1,259		11,295
1994	0	2,706	725	0	16	0	239	36	0	0	0	0	0	54	0	0	814	693	1,403		6,686
1995	16	1,156	280	0	0	0	320	226	33	0	0	0	0	0	19	0	1,401	1,259	1,597		6,306
1996	6	1,138	384	0	0	0	1,310	168	0	0	0	0	0	0	0	0	2,923	3,130	1,383		10,443
1997	0	415	212	0	0	0	747	83	0	0	0	0	0	0	0	0	2,182	3,730	1,270		8,640
1998	0	10	0	0	0	0	0	15	0	7	0	0	0	0	0	0	2,094	3,340	2,407		7,873
Total	22	53,368	6,872	185	16	54	8,096	1661	478	28	10	14	131	120	101	2,472	60,047	87,497	29,868		251,042

Table 20. Contribution of Niagara Springs Fish Hatchery (NSFH) steelhead to in-state fisheries.

Run Year	NSFH Steelhead Harvested in Salmon River	Estimated Total Salmon River Harvest	Percentage of Total Salmon River Fishery NSFH Contributed	Estimated Total Statewide Harvest	Percentage of Statewide Harvest NSFH Contributed
1969	522	9,040	5.8%	21,616	2.4%
1970	406	10,200	4.0%	19,163	2.1%
1971	637	7,946	8.0%	16,580	3.8%
1972	4,124	9,177	44.9%	16,007	25.8%
1973	1,484	5,963	24.9%	15,814	9.4%
1974	1,278	3,704	34.5%	8,128	15.7%
1975	305	shortened season	no data	726	42.0%
1976	n/a	catch and release	n/a	catch and release	n/a
1977	1,998	2,883	69.3%	3,096	64.5%
1978	2,520	7,717	32.6%	21,924	11.5%
1979	2,047	no data	no data	3,096	66.1%
1980	1,634	2,811	58.1%	2,839	57.6%
1981	3,347	7,466	44.8%	12,076	27.7%
1982	4,401	9,765	45.0%	10,916	40.3%
1983	10,171	13,248	76.7%	27,076	37.6%
1984	15,120	18,765	80.5%	28,101	53.8%
1985	4,569	6,336	72.1%	31,990	14.3%
1986	6,779	18,097	37.5%	32,585	20.8%
1987	11,691	27,057	43.2%	47,900	24.4%
1988	3,187	6,983	45.6%	17,987	17.7%
1989	4,774	8,947	53.4%	23,521	20.3%
1990	4,091	15,110	27.1%	48,885	8.4%
1991	318	4,388	7.2%	19,191	1.7%
1992	970	12,515	7.8%	18,572	5.2%
1993	2,246	18,831	11.9%	44,663	5.0%
1994	693	11,212	6.2%	27,336	2.5%
1995	1,259	11,435	11.0%	19,618	6.4%
1996	3,130	14,921	21.0%	22,106	14.2%
1997	3,730	18,581	20.0%	27,211	13.7%
1998	3,340	21,628	15.4%	35,935	9.3%

Table 21. Distribution of adult spring chinook produced at Rapid River Fish Hatchery.

Run Year	Ocean Troll	Columbia River Gill Net	Columbia River Sport	Test Fishery Net	Freshwater Sport	Hatchery Rack	Spawning Ground	River Trap	Treaty Ceremonial	Treaty Troll	Nez Perce Harvest	Little Salmon Sport	Rapid River Rack	Run Year Total
1978	0	0	0	0	121	26	0	0	0	0	0	1,309	5,769	7,225
1979	0	516	465	0	373	26	0	0	132	0	0	0	3,404	4,916
1980	0	0	0	0	0	13	0	0	20	0	0	0	1,960	1,993
1981	49	246	0	94	0	47	0	0	119	0	0	0	3,263	3,818
1982	0	107	221	117	0	0	0	0	58	0	0	0	3,676	4,179
1983	0	47	0	0	0	0	0	0	0	0	0	0	1,958	2,005
1984	0	87	0	41	0	0	0	0	53	0	100	0	2,356	2,637
1985	0	193	443	80	0	40	0	0	465	0	2,023	2,313	6,727	12,284
1986	0	296	390	130	0	0	0	0	723	0	1,855	1,430	6,723	11,547
1987	160	0	0	0	218	11	0	0	527	0	2,430	422	3,808	7,575
1988	24	2,226	1,350	111	0	88	6	0	892	0	3,520	692	3,780	12,689
1989	0	156	0	0	101	17	0	0	310	0	544	0	2,800	3,928
1990	0	29	435	33	54	0	0	0	383	0	970	565	2,606	5,076
1991	0	88	166	47	44	18	0	0	802	0	0	0	1,913	3,079
1992	0	54	153	0	72	38	0	0	265	0	643	499	2,466	4,190
1993	0	75	86	52	0	21	0	0	947	11	696	423	4,468	6,778
1994	0	48	0	0	0	0	0	0	33	0	0	0	265	346
1995	0	0	0	0	0	53	0	0	0	0	0	0	129	182
1996	0	0	0	0	13	59	0	0	76	0	0	0	1,412	1,560
1997	37	0	0	0	0	279	3	27	396	0	2,196	2,289	10,520	15,746
1998	0	28	0	0	0	92	13	0	77	0	618	172	1,591	2,591
Total	270	4,196	3,709	705	996	828	22	27	6,278	11	15,595	10,114	71,594	114,344

Table 22. Contribution of Rapid River Fish Hatchery (RRFH) chinook as a percentage of total Idaho sport harvest.

Run Year	RRFH Chinook Sport Harvest	Estimated Total Statewide Sport Harvest	Percentage of Statewide Harvest RRFH Contributed
1970	824	5,500	15.0%
1971	1,357	3,500	38.8%
1972	3,285	6,500	50.5%
1973	2,896	9,721	29.8%
1974	322	1,557	20.7%
1975	0	no season	no season
1976	0	no season	no season
1977	1,430	3,682	38.8%
1978	1,309	6,921	18.9%
1979	0	no season	no season
1980	0	no season	no season
1981	0	no season	no season
1982	0	no season	no season
1983	0	no season	no season
1984	0	no season	no season
1985	2,313	2,313	100.0%
1986	1,430	1,430	100.0%
1987	422	422	100.0%
1988	692	692	100.0%
1989	0	no season	no season
1990	565	932	60.6%
1991	0	no season	no season
1992	499	553	90.2%
1993	423	423	100.0%
1994	0	no season	no season
1995	0	no season	no season
1996	0	no season	no season
1997	2,289	3,460	66.2%
1998	172	271	63.5%
1999	0	no season	no season
2000	2,883	6,995	41.2%

Table 23. Performance measures (PM) at Oxbow Fish Hatchery not meeting Integrated Hatchery Operations Team (IHOT) compliance standards for spring chinook production.

Type	PM#	Performance Measure Description	Basis for Noncompliance	Remedial Action Proposed
1	41	Broodstock collection procedures	Insufficient adult numbers	Improve adult returns
1	5h	Pathogen-free water source	Surface water used for adult holding	None suggested due to short holding time
2	3	Hatchery monitoring and evaluation (M&E) plan	No M&E plan in place	Develop M&E plan
2	15	Fish transport facilities	Unsure if IPC equipment meets standards	Verify adequate transport systems are available
2	23	Disinfection and maintenance of transport equipment	Unable to confirm procedures IPC uses	Verify and implement IHOT procedures
2	24	Evaluation practices	No evaluation studies being conducted	Conduct studies to evaluate fisheries contribution
2	25	Training practices	No training schedule	Develop training schedule
2	4a	Adult contribution	Unsure if information has been collected	Document adult contribution to fisheries, spawning ground, and hatchery
3	5b	Dissolved gas criteria	No baseline data	Monitor DO and total dissolved gasses regularly
3	5c	Water chemistry criteria	Some baseline data missing; high pH and iron readings	Run complete water chemistry analysis
3	5d	Turbidity criteria	No baseline data	Monitor turbidity regularly
3	5f	Nitrite criteria	No baseline data	Monitor nitrite regularly
3	5g	Contaminants criteria	No baseline data	Monitor parameters regularly
4	6	Hatchery alarm systems	No adult pond or security alarm, no phone pagers, crew keeps no log of alarms	Expand existing alarm system and create alarm log book
4	10	Intake screening	No intake screens; approach velocity exceeds criteria	Install intake screen system
4	22b	Production within subbasin	Smolts not acclimated	Construct acclimation ponds
5	22b	Production within subbasin	Smolts reared out of subbasin	Provide rearing in subbasin

Table 24. Performance measures (PM) at Oxbow Fish Hatchery not meeting Integrated Hatchery Operations Team (IHOT) compliance standards for summer steelhead production.

Type	PM#	Performance Measure	Basis for Noncompliance	Remedial Action Proposed
1	41	Broodstock collection procedures	Insufficient adult numbers	Improve adult returns
1	42	Spawning practices	Number of spawners and sex ratios fail to meet standards	Improve adult returns
1	5h	Pathogen-free water source	Surface water used for adult holding	None suggested due to short holding time
2	3	Hatchery monitoring and evaluation (M&E) plan	No M&E plan in place	Develop M&E plan
2	23	Disinfection and maintenance of transport equipment	Unable to confirm procedures IPC uses	Verify and implement IHOT procedures
2	24	Evaluation practices	No evaluation studies being conducted	Conduct studies to evaluate fisheries contribution
2	25	Training practices	No training schedule	Develop training schedule
2	43	Genetic monitoring plan	No plan in place	Develop genetic monitoring plan
2	4a	Adult contribution	Unsure if information has been collected	Document adult contribution to fisheries, spawning ground and hatchery
3	5b	Dissolved gas criteria	No baseline data	Monitor DO and TDG regularly
3	5c	Water chemistry criteria	Some baseline data missing; high pH and iron readings	Run complete water chemistry analysis
3	5d	Turbidity criteria	No baseline data	Monitor turbidity regularly
3	5f	Nitrite criteria	No baseline data	Monitor nitrite regularly
3	5g	Contaminants criteria	No baseline data	Monitor parameters regularly
4	6	Hatchery alarm systems	No adult pond or security alarm, no phone pagers, crew keeps no log of alarms	Expand existing alarm system and create alarm log book
4	10	Intake Screening	No intake screens; approach velocity exceeds criteria	Install intake screen system
4	22b	Production within Subbasin	Smolts not acclimated	Construct acclimation ponds
5	22b	Production within Subbasin	Smolts reared out of subbasin	Provide rearing in subbasin

Table 25. Performance measures (PM) at Rapid River Fish Hatchery not meeting Integrated Hatchery Operations Team (IHOT) compliance standards for spring chinook production.

Type	PM #	Performance Measure	Basis for Noncompliance	Remedial Action Proposed
1	6	Facility alarms system	No security alarm, no telephone pagers	Ensure adequate staffing to offset need for security alarm; use telephone dialer in place of pagers
1	22a4	Smolt release goal	Meets goal 1 of last 2 yrs	Improve adult returns
1	22a6	Smolt release date	Delay in National Marine Fisheries Service approval for liberation	None recommended
1	4c	Egg take goal	Meets goal 2 of last 5 years	Improve adult returns
1	4g	Smolt production goal	Meets goal 4 of last 5 years	Improve adult returns
1	4h	SAR goal	Meets goal 0 of last 5 years	Improve adult returns
2	3	Hatchery monitoring and evaluation (M&E) plan	No M&E plan in place	Develop M&E plan
2	12	Food storage and quality control	No quality checks done on feed	Evaluate feed quality
2	23	Disinfection and maintenance of transport equipment	Unsure of IPC disinfection and in-transit monitoring procedures	Verify IHOT procedures are followed
2	24	Evaluation practices	Unsure if fishery contribution studies have been conducted	Improve communication between IDFG hatchery and research staff; conduct studies as necessary
2	26	Monthly fish health monitoring	Pathologist visits every 6 months	Increase frequency of visits
2	28	Sanitation practices	Not following all sanitation practices	Install footbaths in incubation building
2	43	Genetic monitoring plan	No plan in place	Develop genetic monitoring plan
2	22a1	Percent smoltification	No smoltification goal	Develop smoltification goal
2	5a	Incubation and rearing temperature criteria	Exceeds criteria 3 of last 5 years	Criteria may not be appropriate for this facility
3	5c	Water chemistry criteria	Incomplete baseline data	Run complete chemistry analysis
3	5c	Water chemistry criteria	Exceeds iron and zinc criteria	None
4	7	Adult holding criteria	Excessive prespawn mortality	Improve adult holding and crowding systems

Table 25. (Cont.)

Type	PM #	Performance Measure	Basis for Noncompliance	Remedial Action Proposed
4	9	Rearing facilities	Insufficient early rearing troughs; need ability to drain, dry and disinfect raceways	Need additional troughs and incubation building expansion; modify raceways as necessary; obtain additional water rights and increase water delivery to rearing ponds
4	10	Intake screening	Approach velocity exceeds criteria	Modify intake to meet criteria and also reduce sediment transport into hatchery
4	12	Food storage and quality control	Storage temperature exceeded during power outages	Install backup generator
4	28	Sanitation practices	No pathogen-free water	Develop groundwater for incubation and early rearing
4	4b	Prespawning survival criteria	Exceeds criteria 3 of 5 years	Improve adult holding and crowding systems
4	5d	Turbidity criteria	Exceeds during high flows	Water treatment for incubation and early rearing
4	5h	Pathogen-free water source	Surface water used for incubation and rearing	Disinfection of incubation water could be considered; sediment removal is also needed; use of groundwater not advised due to impacts on embryonic development
5	19	Rearing practices	Raceways and ponds exceed density and flow indices	None recommended; not perceived as limitation by facility manager

Table 26. Performance measures (PM) at Niagara Springs Fish Hatchery not meeting Integrated Hatchery Operations Team (IHOT) compliance standards for summer steelhead production.

Type	PM#	Performance Measure	Basis for Noncompliance	Remedial Action Proposed
1	5e	Alkalinity and hardness criteria	Exceeds criteria	None recommended
2	12	Food storage and quality control	No quality checks done on feed	Evaluate feed quality
2	12	Food storage and quality control	Feed buckets exposed to heat and light	Relocate feed buckets to better location
2	23	Disinfection and maintenance of transport equipment	Unsure of IPC disinfection and in-transit monitoring procedures	Verify IHOT procedures are followed
2	24	Evaluation practices	No evaluation studies being conducted on Snake River releases	Conduct studies to evaluate fisheries contribution in Snake River
2	43	Genetic monitoring plan	No plan in place	Develop genetic monitoring plan
2	22a1	Percent smoltification	Smoltification not measured; no smoltification goal	Develop smoltification goal and monitor compliance
2	4h	SAR goal	No goal in place	Develop goal
3	5b	Dissolved gas criteria	No baseline data	Monitor TDG regularly
3	5c	Water chemistry criteria	Most baseline data missing	Run complete water chemistry analysis
3	5g	Contaminants criteria	No baseline data	Monitor parameters regularly
4	6	Hatchery alarm systems	No water or security alarms	Install alarm system
4	8	Incubation facilities	Insufficient incubation capacity	Install more incubators
4	9	Rearing facilities	Insufficient nursery capacity	Install more vats
4	11	Predator control facilities	No bird netting	Install netting
4	12	Food storage and quality control	Storage bins not insulated	Insulate bins
4	15	Fish transport facilities	Exceed hauling density criteria	Obtain additional transport vehicles
4	18	Incubation practices	Exceed DI criteria	Install more incubators
4	19	Rearing practices	Exceed DI criteria	Install more nursery vats
4	22a6	Meets release date goal	Does not meet goal	Obtain additional transport vehicles
4	22b	Production within subbasin	Smolts not acclimated	Construct acclimation ponds
4	4e	Eyed egg-to-fry survival	Meets goal 0 of last 4 years	Install more incubators and nursery vats
4	4f	Fry-to-smolt survival	Meets goal 0 of last 3 years	Install more incubators and nursery vats
4	5a	Incubation water temperature criteria	Exceeds criteria	Install 400 gpm water chiller
4	5h	Pathogen-free water source	No pathogen-free water	Install bird net; remove fish from hatchery water source

Table 27. Performance measures (PM) at Pahsimeroi Fish Hatchery not meeting Integrated Hatchery Operations Team (IHOT) compliance standards for summer chinook production.

Type	PM#	Performance Measure	Basis for Noncompliance	Remedial Action Proposed
1	41	Broodstock collection procedures	Insufficient adult numbers	Improve adult returns
1	42	Spawning practices	Number of spawners, sex ratios, and fertilization protocols fail to meet standards due to low number of fish available	Improve adult returns
1	22a4	Smolt release goal	Meets goal 0 of last 5 years	Improve adult returns
1	4c	Egg take goal	Meets goal 0 of last 5 years	Improve adult returns
1	4g	Smolt production goal	Meets goal 0 of last 5 years	Improve adult returns
1	4h	SAR goal	Meets goal 0 of last 5 years	Improve adult returns
2	12	Food storage and quality control	No quality checks done on feed; feed sacks left open for days	Evaluate feed quality; review handling procedures
2	23	Transportation facilities	Exterior and cab of transport vehicle not disinfected; DO not monitored during transport; water temperature exceeds criteria	Follow IHOT protocols for transport vehicle disinfection; monitor DO and temperature
2	24	Evaluation practices	No evaluation studies being conducted	Conduct studies to evaluate fisheries contribution
2	25	Training practices	No training schedule	Develop training schedule
2	28	Sanitation practices	Not following all sanitation practices	Install footbaths in incubation building; sanitize broodstock handling equipment prior to use elsewhere; disinfect egg transport containers between uses
2	43	Genetic monitoring plan	No plan in place	Develop genetic monitoring plan
2	22a1	Percent smoltification	Smoltification not measured; smoltification goal not defined	Develop smoltification goal and monitor for compliance
2	4a	Adult contribution	No documentation of adult contribution	Document adult contribution to fisheries, spawning ground and hatchery
3	5b	Dissolved gas criteria	No baseline data	Monitor DO and TDG regularly

Table 27. (Cont.)

Type	PM#	Performance Measure	Basis for Noncompliance	Remedial Action Proposed
3	5c	Water chemistry criteria	Some baseline data missing; high pH and iron readings	Run complete water chemistry analysis
3	5d	Turbidity criteria	No baseline data	Monitor turbidity regularly
3	5e	Alkalinity and hardness criteria	No baseline data	Monitor parameters regularly
3	5f	Nitrite criteria	No baseline data	Monitor nitrite regularly
3	5g	Contaminants criteria	No baseline data	Monitor parameters regularly
4	6	Hatchery alarm systems	Very limited alarm system, no phone pagers, crew keeps no log of alarms	Expand existing alarm system and create alarm log book
4	9	Rearing facilities	Exceed DI in raceways	Construct 4 more raceways
4	11	Predator control facilities	No predator control at rearing ponds	Install bird netting and fencing at ponds
4	13	Release facilities	Release pipe runs through settling pond	Construct new release pipe directly to river
4	14	Pollution abatement facilities	Smolt liberation disturbs solids; ponds are not cleaned regularly	Construct new release pipe
4	19	Rearing practices	Exceed DI in raceways	Construct 4 more raceways
4	4e	Eyed egg-to-fry survival	Meets goal 4 of last 5 years	None recommended
4	4f	Fry-to-smolt survival	Meets goal 3 of last 5 years	None recommended
5	5a	Rearing water temperature criteria	Exceeds criteria	Develop 4 cfs of groundwater
5	5h	Pathogen-free water source	Surface water used for adult holding and rearing	Develop 4 cfs of groundwater

Table 28. Performance measures (PM) at Pahsimeroi Fish Hatchery not meeting Integrated Hatchery Operations Team (IHOT) compliance standards for summer steelhead production.

Type	PM#	Performance Measure	Basis for Noncompliance	Remedial Action Proposed
1	5h	Pathogen-free water source	Surface water used for adult holding	None suggested due to short holding time
2	23	Transportation facilities	Personnel do not wear protective gear when handling fish eggs	Follow IHOT protocols for egg handling
2	24	Evaluation practices	No evaluation studies being conducted	Conduct studies to evaluate fisheries contribution
2	25	Training practices	No training schedule	Develop training schedule
2	28	Sanitation practices	Not following all sanitation practices	Install footbaths in incubation building; sanitize broodstock handling equipment prior to use elsewhere; disinfect egg transport containers between uses
2	41	Broodstock collection procedures	Biased broodstock collection in past	None suggested
2	42	Spawning practices	Number of spawners, sex ratios and fertilization protocols fail to meet standards	Follow IHOT protocols
2	43	Genetic monitoring plan	No plan in place	Develop genetic monitoring plan
2	22c	Smolt release strategy	Unsure if strategy is appropriate	Review release strategy relative to overall program goals
3	5b	Dissolved gas criteria	No baseline data	Monitor DO and TDG regularly
3	5c	Water chemistry criteria	Some baseline data missing; high pH and iron readings	Run complete water chemistry analysis
3	5d	Turbidity criteria	No baseline data	Monitor turbidity regularly
3	5e	Alkalinity and hardness criteria	No baseline data	Monitor parameters regularly
3	5f	Nitrite criteria	No baseline data	Monitor nitrite regularly
3	5g	Contaminants criteria	No baseline data	Monitor parameters regularly
4	6	Hatchery alarm systems	No adult pond or security alarm; no phone pagers; crew keeps no log of alarms	Expand existing alarm system and create alarm log book
4	22b	Production within subbasin	Smolts not acclimated	Construct acclimation ponds
5	22b	Production within subbasin	Smolts reared out of subbasin	Provide rearing in subbasin

Table 29. Distribution of Niagara Springs Fish Hatchery steelhead strays as percentage of its total strays by return year.

Return Year	Drano Lake	Dworshak Hatchery	E Fork Salmon River	Kooskia Hatchery	Little White Salmon River	Macks Canyon Sport Fishery	McCall Weir– S. Fork Salmon	Mouth of Deschutes Sport Fishery	Nestucca River Sport Fishery	Pelton Dam	Round Butte Trap	Sherars Falls Sport Fishery	Three Mile Dam– Umatilla	Warm Springs Hatchery	Wells Dam Spawning Channel	Wells Hatchery	White Salmon River
1981		16.7%				16.7%		66.7%									
1982						39.0%		44.4%				16.6%					
1983				1.0%		21.3%		64.2%		1.0%		12.6%					
1984						15.6%		37.3%		20.8%	2.4%	23.9%					
1985			18.1%			0.5%	9.0%			45.2%		27.1%					
1986										6.4%		93.6%					
1987										54.6%		45.4%					
1988								100.0%									
1989																	
1990						16.0%		74.6%		9.4%							
1991								100.0%									
1992										21.6%		43.2%	35.3%				
1993			4.5%			9.0%		45.9%	4.5%	36.0%							
1994						11.6%		81.3%		5.8%						1.3%	
1995					0.7%			25.8%		72.0%					1.1%		0.4%
1996	28.9%					12.1%		33.3%		23.2%	2.5%						
1997								60.7%		39.3%							
1998														100.0%			

Table 30. Distribution of Rapid River Fish Hatchery spring chinook strays as percentage of its total strays by return year.

Return Year	Chiwawa & Tumwater Falls, Wenatchee River	Cowlitz River	Cowlitz Hatchery	Dworshak Hatchery	Imnaha River Spawn	Imnaha River Trap	Kalama Falls Hatchery	Kalama R iver	Klickitat Hatchery	Kooskia Hatchery	Lewis River	Little White Salmon Hatchery	Lyons Ferry Hatchery	McCall Weir: S. Fork Salmon River	Mult. Channel Sport-Willamette	Pahsimeroi Hatchery	Pelton Dam-Deschutes	Round Butte Trap-Deschutes	S. Fork Salmon River Trap	S. Fork Salmon: IDFG #21	Sawtooth Hatchery	Sherars Falls-Deschutes	Warm Springs Hatchery	Willamette River Lower
1978										17.9%	82.1%													
1979		56.5%		8.9%							34.6%													
1980																	100.0%							
1981														24.6%			75.4%							
1985																					100.0%			
1987																	12.8%				12.8%	74.4%		
1988						10.8%								10.8%			43.1%			10.8%			24.6%	
1989								34.9%						4.9%			9.8%							50.4%
1990															100.0%									
1991						100.0%																		
1992									25.4%							25.4%	49.3%							
1993																			100.0%					
1995			26.8%									73.2%												
1996																			62.8%			21.5%	15.7%	
1997	5.2%					7.6%	5.5%						10.7%				16.8%	39.0%	5.2%	0.9%			9.0%	
1998			5.3%		9.9%	9.9%						10.6%					50.5%	13.7%						

Table 31. Pathogen incidence in juvenile steelhead reared at Niagara Springs Fish Hatchery[1].

	BKD	CSH	CWD	EIBS	ERM	FUR	ICH	IHN	IPN	MAS	PKD	WHD
1975			f		ca	f						
1976			f		ca	f		f	cl			
1977			f		ca	f						
1978			f		ca	ca		ca	f			
1979												
1980												
1981												
1982							ca, cl	ca	f			
1983												
1984												
1985					f	ca, cl						
1986								f	ca			
1987			ca		f	cl		ca	ca, cl		f	f
1988	f		ca	f	f	f		ca, cl	f			f
1989	f	f	f	f	f	f		f	f	ca		f
1990	ca		cl	f	ep	cl	f	f	ca	cl		f
1991	f		ca, cl, ep		f	f		f	f	ca, cl	f	
1992	f		cl, ep		f	f		ca, ep	f	ca		
1993	f		ca		f	cl, ep		ca, cl, ep	f	f		f
1994	f		ca, cl		f	f		ca, cl, ep	ca	ca, cl		f
1995	ca		ca		f	ca, cl, ep		cl, ep	f			f
1996	f		ca, cl		f	ca		ca	f	cl, ep		f
1997	ca, cl		cl		ca, cl	f		cl	f	cl		f
1998	f		ca, cl		f	cl		ca	f	ca, cl		f
1999	f		ca, cl, ep		f	ca, cl		Cl	f	ca, cl, ep		f

[1] See Appendix B for key to abbreviations used in this table.

Table 32. Pathogen incidence in adult steelhead trapped at Pahsimeroi Fish Hatchery[1].

	BKD	CSH	EIBS	ERM	FUR	IHN	IPN	WHD
1987	cl			ca	f	f	f	
1988	ca	f	f			f	f	ca
1989			f			f	f	ca
1990	f		cl	f	f	f	f	ca, cl
1991	f	f	f			ca	ca	f
1992	ca	f	ca			f	f	f
1993	ca					f	f	f
1994	ca					f	f	ca
1995	ca					f	f	ca
1996	ca					f	f	ca
1997	ca, cl					f	f	f
1998	f					f	f	ca
1999	f					f	f	f

[1] See Appendix B for key to abbreviations used in this table.

Table 33. Pathogen incidence in adult (Ad) and juvenile (Juv) steelhead at Oxbow Fish Hatchery[1].

	BKD		CSH		CWD		EIBS		ERM		FUR		IHN		IPN		MAS		PKD		WHD	
	Ad	**Juv**	**Ad**	**Juv**	**Ad**	**Juv**	**Ad**	**Juv**	**Ad**	**Juv**	**Ad**	**Juv**	**Ad**	**Juv**	**Ad**	**Juv**	**Ad**	**Juv**	**Ad**	**Juv**	**Ad**	**Juv**
1987	f		f						f		f		ca		f							
1988	ca		f						f		f		ca		f		ca				f	
1989	f		f		f		ep		f		f		f		f		f				f	
1990	f		f	f	cl	f		f	f	f	f	f	f	f	f	f	cl			f		f
1991	f		f				f						ca		ca						f	
1992	cl		ca, cl	ca			f						ca		f						f	
1993	ca		cl		cl				f		f		f		f		cl		f		f	
1994	f				ca				f		f		f		f		ca					
1995	ca		ca										f		f						f	
1996	ca		ca						f		f		ca		f						f	
1997	ca, cl												f		f						f	
1998	f												f		f						f	
1999	f												f		f						f	

[1] See Appendix B for key to abbreviations used in this table.

Table 34. Pathogen incidence in adult (Ad) and juvenile (Juv) spring chinook at Rapid River Fish Hatchery[1].

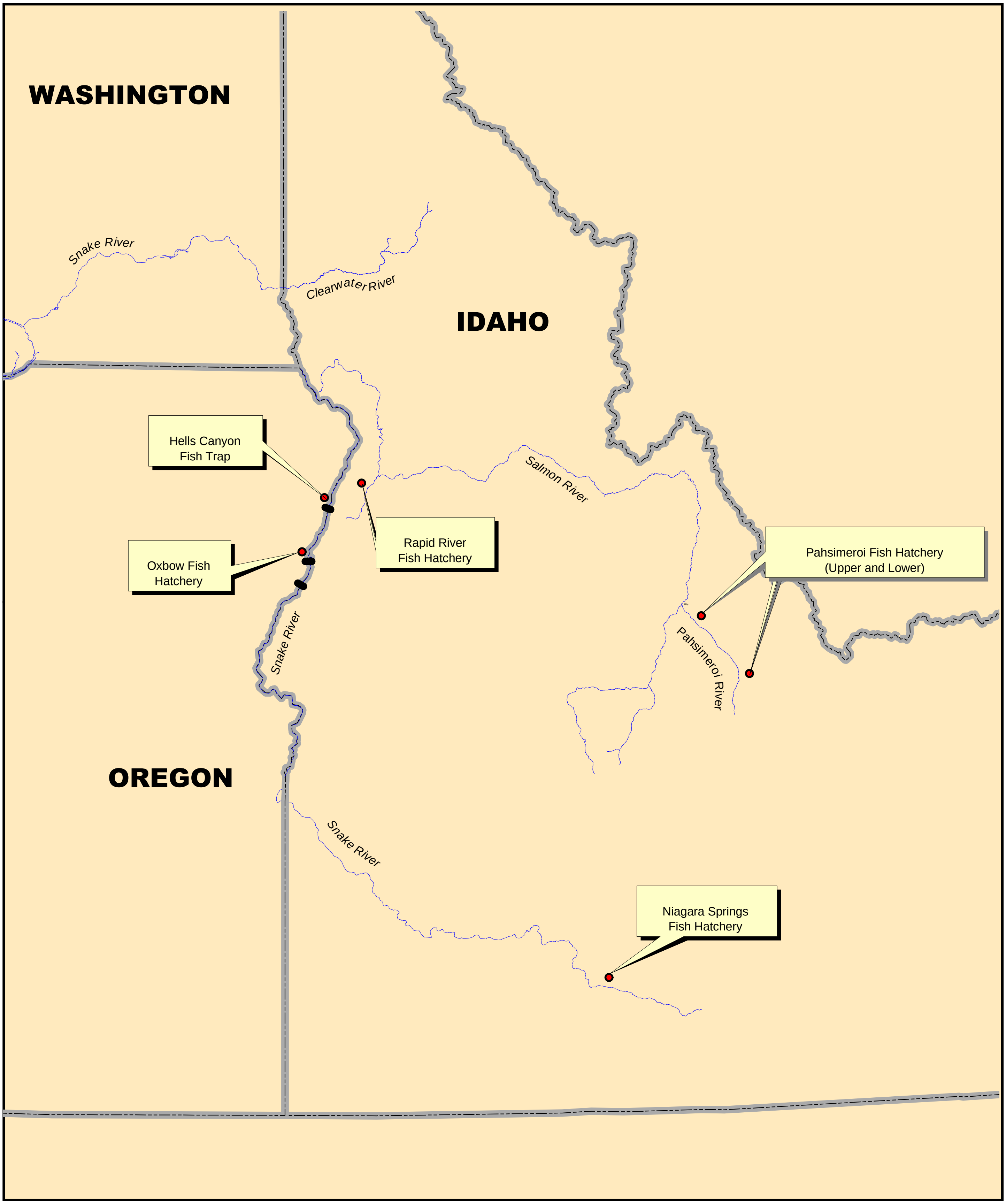
	BKD		CSH		EIBS		ERM		FUR		IHN		IPN		MAS		MYXO		PKD		WHD	
	Ad	Juv	Ad	Juv	Ad	Juv	Ad	Juv	Ad	Juv	Ad	Juv	Ad	Juv	Ad	Juv	Ad	Juv	Ad	Juv	Ad	Juv
1987		ca, cl		f				f		f	f	f	f	f								f
1988	ca	ca			f	ca, ep		f		f	ca	ca	f	f							f	f
1989	ca, cl	ca, cl	ca	f	f	ca, cl		f		f	f	f	f	f								f
1990	f	f	f	cl	f	ca, cl		f		f	f	f	f	f							f	f
1991	ca, cl	cl	ca	f	f	ca, cl		f		f	f	f	f	f						f		f
1992	ca, cl	cl				ca		f		f	f	f	f	f		f		ca				f
1993	ca, cl	ca, cl				f		f		f	ca	f	f	f		ca, cl						f
1994	ca	ca, cl	ca			ca, cl		f		f	ca	f	f	f		ca					f	f
1995	ca	ca						f		f	ca	f	f	f				ca			f	f
1996	ca, cl	ca				f		f		f	ca	f	f	f				ca			f	f
1997	ca, cl	ca						f		f	f	f	f	f		cl					f	f
1998	ca, cl	ca, cl				f		f		f	ca	f	f	f		ca, cl					f	f
1999	ca	ca				f	f	f	f	f	f	f	f	f	f	f		ca			f	f

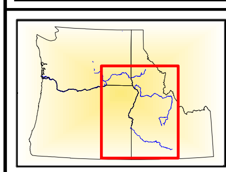
[1] See Appendix B for key to abbreviations used in this table.

Table 35. Pathogen incidence in adult (Ad) and juvenile (Juv) spring and summer chinook at Pahsimeroi Fish Hatchery[1].

	BKD		CSH		CWD		EIBS		ERM		FUR		ICH		IHN		IPN		MAS		MYXO		PKD		WHD	
	Ad	**Juv**	**Ad**	**Juv**	**Ad**	**Juv**	**Ad**	**Juv**	**Ad**	**Juv**	**Ad**	**Juv**	**Ad**	**Juv**	**Ad**	**Juv**	**Ad**	**Juv**	**Ad**	**Juv**	**Ad**	**Juv**	**Ad**	**Juv**	**Ad**	**Juv**
1987	ca, cl																									ca
1988	ca	ca	f				f	f	f		f				f	f	f	f							ca	ca
1989	ca	ca, cl	f	f			f	f		f		f			f	f	f	f							f	ca
1990	ca	f	f	f		cl	f	f		f		f		f	f	f	f	f		ca					ca	ca, cl
1991	ca	ca	ca			f	f	f		f		f			ca	f	f	f		cl	ca			f	ca	ca
1992	ca, cl	ca				ca, cl				f		f			f	f	f	f		f						ca, cl
1993	ca, cl	ca				f				f		f			f	f	f	f		ca					f	ca, cl
1994		ca				f				f		f				f		f								ca
1995	ca	ca													f	f	f	f							f	ca
1996	ca	f				ca				f		f			f	f	f	f		ca					ca	f
1997	ca	ca				f				f		f			f	f	f	f							f	ca, cl
1998	ca, cl	ca, cl				f				f		f			f	f	f	f		f					ca	ca
1999	ca	ca	f												f	f	f	f							f	

[1] See Appendix B for key to abbreviations used in this table.





Vicinity Map

IDAHO POWER
An IDACORP Company

Legend

- Hatchery
- River
- Hells Canyon Complex Dams

GN
MN
0 08'
2 MILS
17 30'
311 MILS

UTM GRID AND 1987
MAGNETIC NORTH
DECLINATION AT CENTER
OF OXBOW QUADRANGLE

Hells Canyon Project - FERC No. 1971

Tech. Report E.3.1-4 Figure 1

Location of Idaho Power Company Hatchery Facilities

Scale 1:3,130,248

0 10 20 40 60 80 Miles

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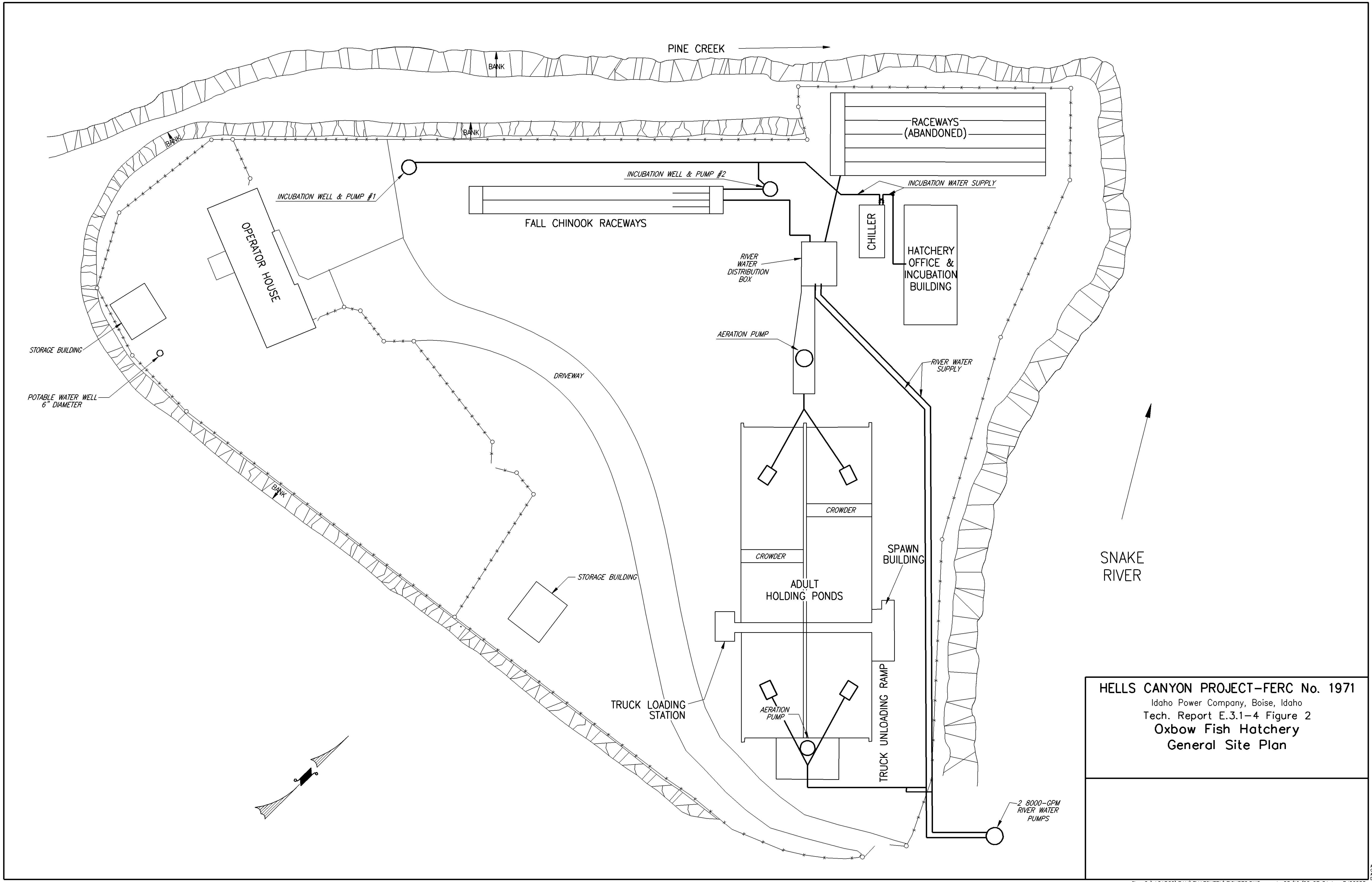

HELLS CANYON PROJECT-FERC No. 1971
Idaho Power Company, Boise, Idaho
Tech. Report E.3.1-4 Figure 2
Oxbow Fish Hatchery
General Site Plan

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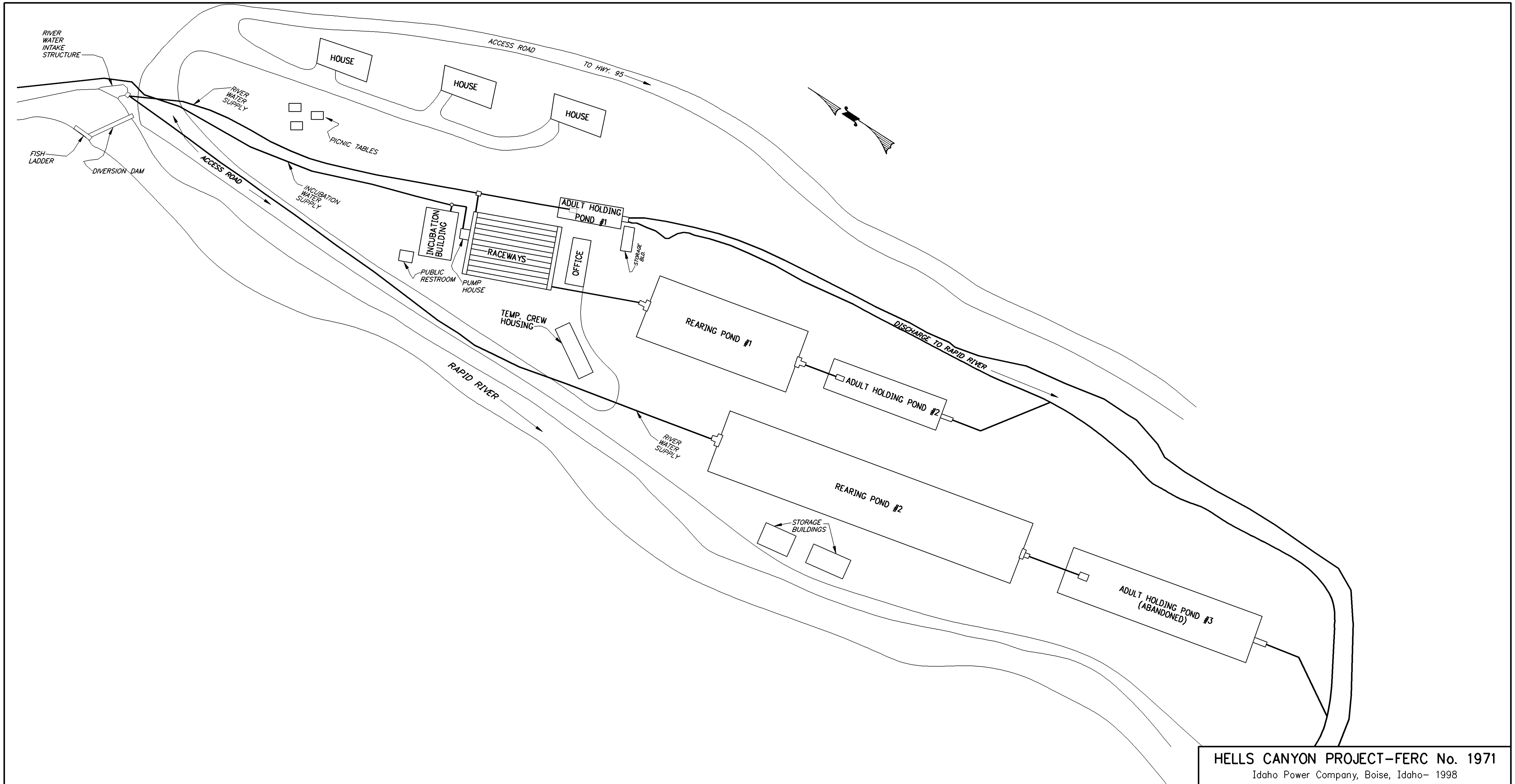

HELLS CANYON PROJECT–FERC No. 1971
Idaho Power Company, Boise, Idaho– 1998
Tech Report E.3.1–4 Figure 3
Rapid River Fish Hatchery
General Site Plan

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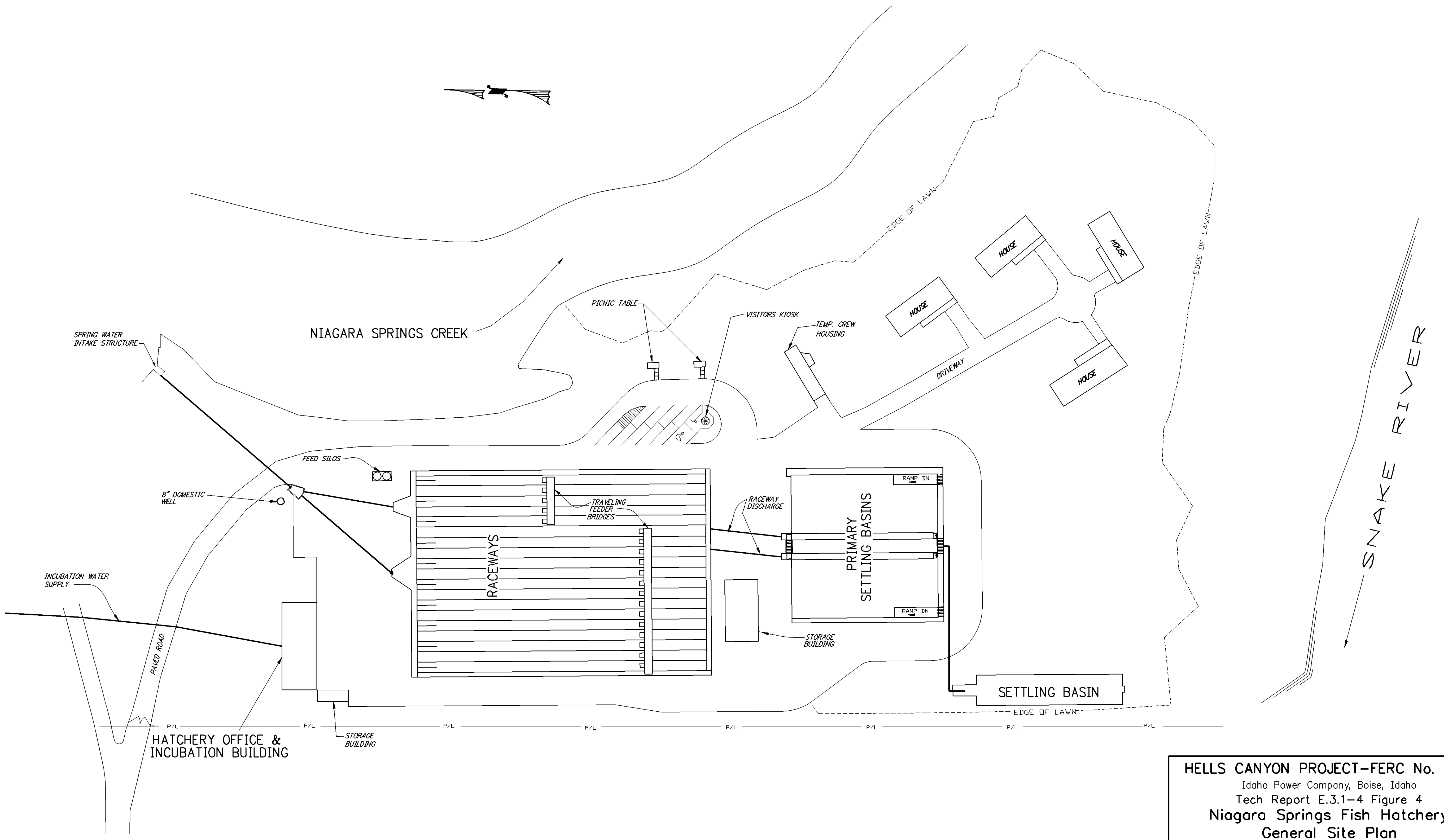

HELLS CANYON PROJECT-FERC No. 1971

Idaho Power Company, Boise, Idaho

Tech Report E.3.1-4 Figure 4

Niagara Springs Fish Hatchery

General Site Plan

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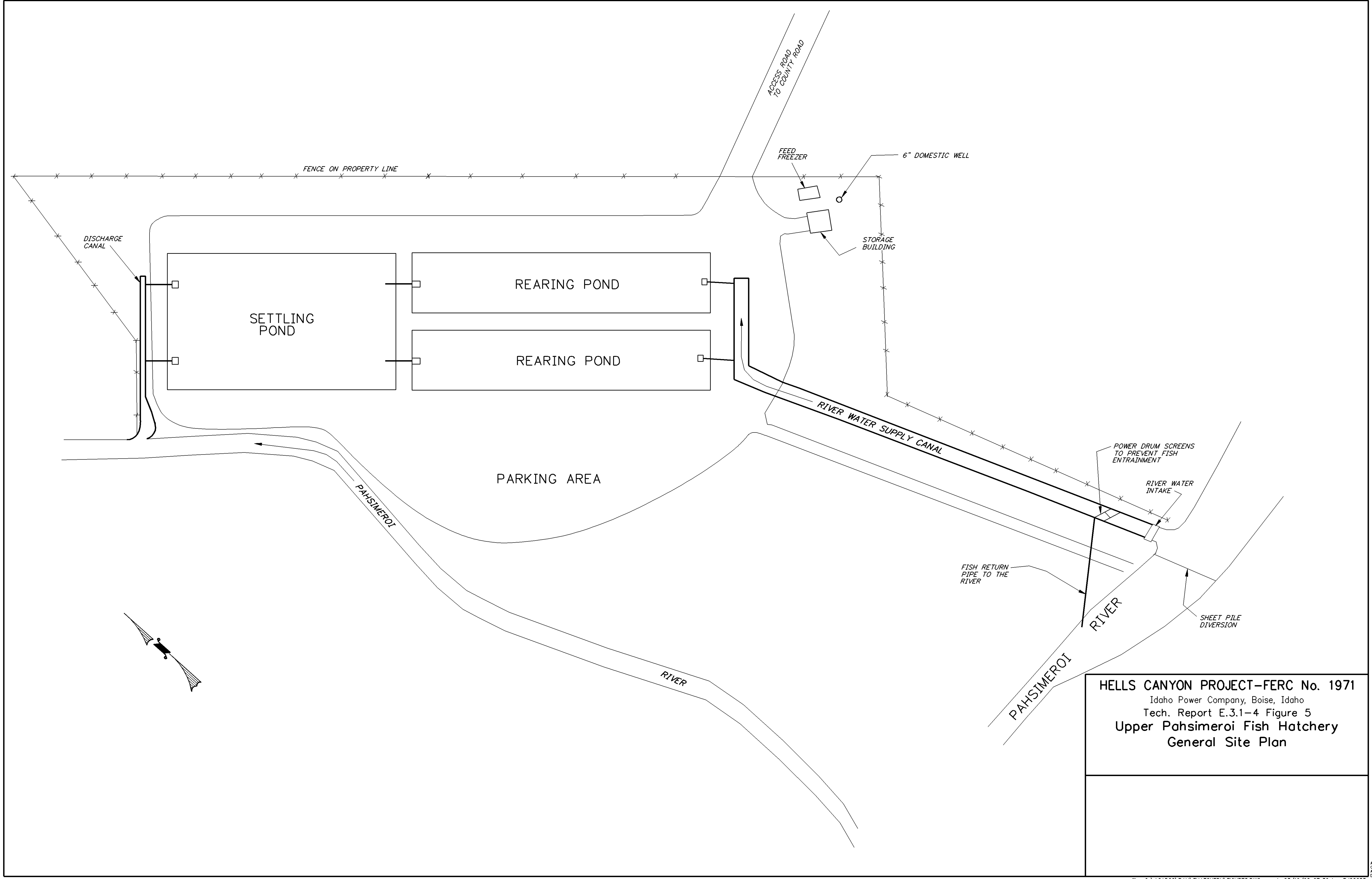

HELLS CANYON PROJECT-FERC No. 1971

Idaho Power Company, Boise, Idaho

Tech. Report E.3.1-4 Figure 5

Upper Pahsimeroi Fish Hatchery General Site Plan

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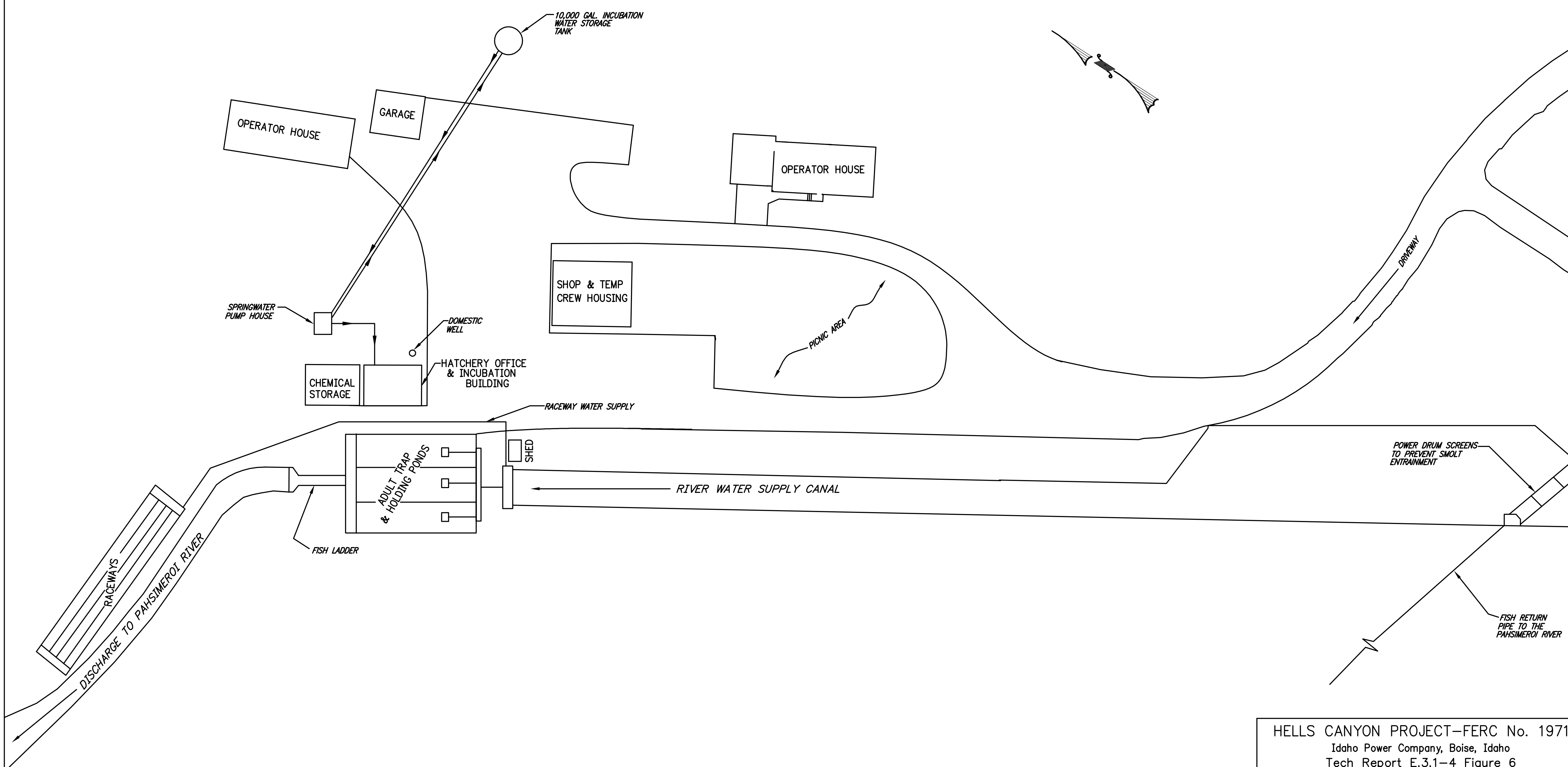

HELLS CANYON PROJECT–FERC No. 1971
Idaho Power Company, Boise, Idaho
Tech Report E.3.1-4 Figure 6
Lower Pahsimeroi Fish Hatchery
General Site Plan

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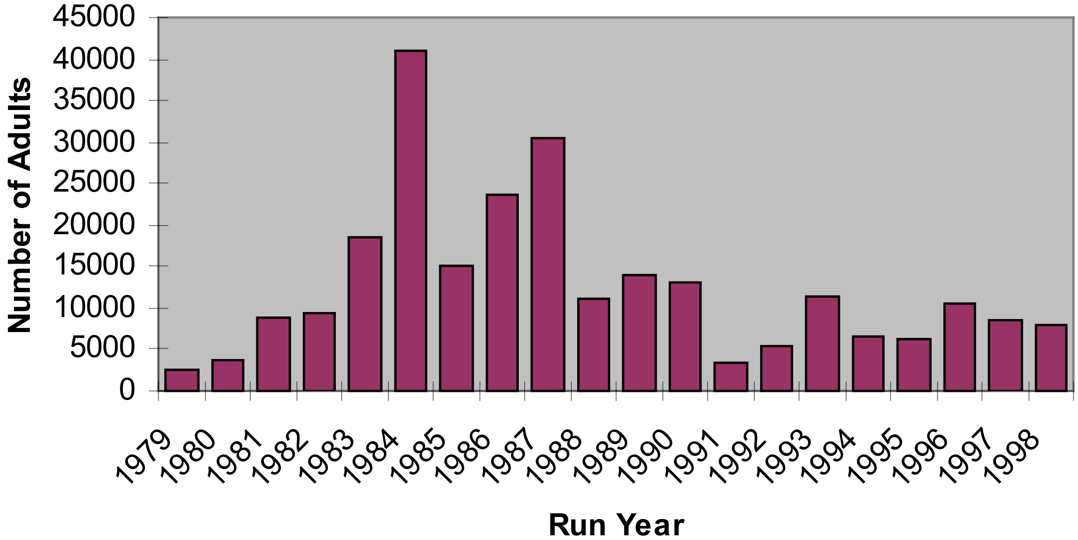


Figure 7. Number of adult steelhead that Niagara Springs Fish Hatchery produced by run year.

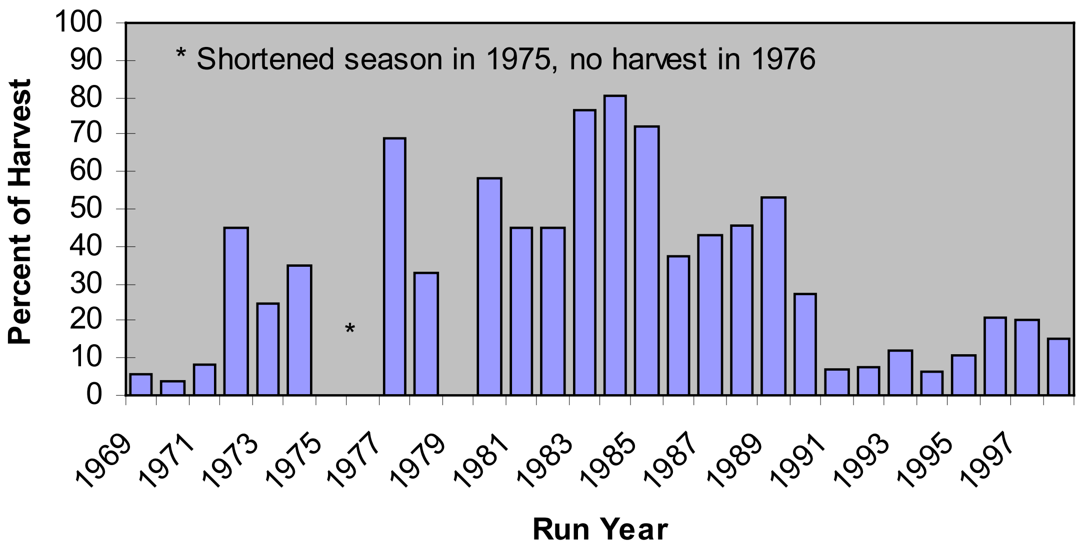


Figure 8. Percentage of the total Salmon River steelhead harvest that Niagara Springs Fish Hatchery produced by run year.

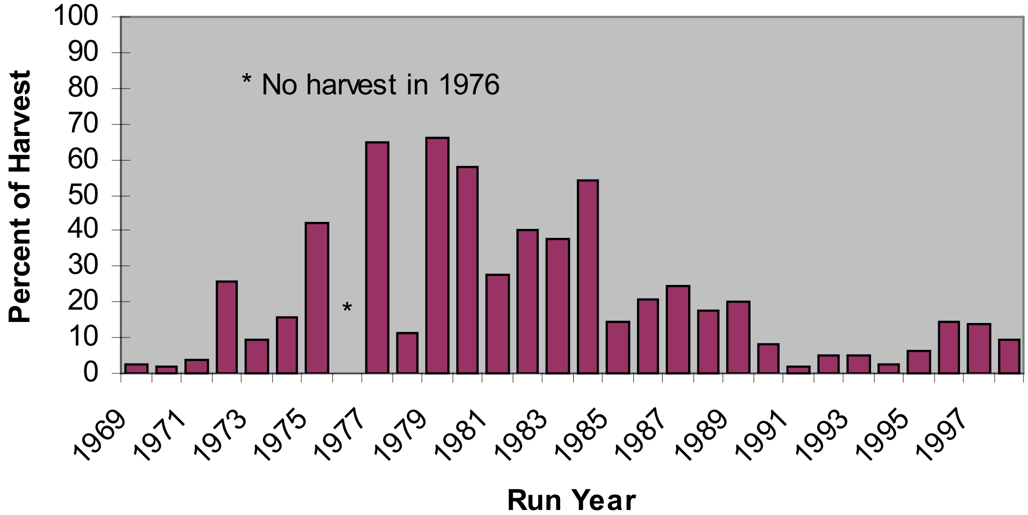


Figure 9. Percentage of the total statewide steelhead harvest that Niagara Springs Fish Hatchery produced by run year.

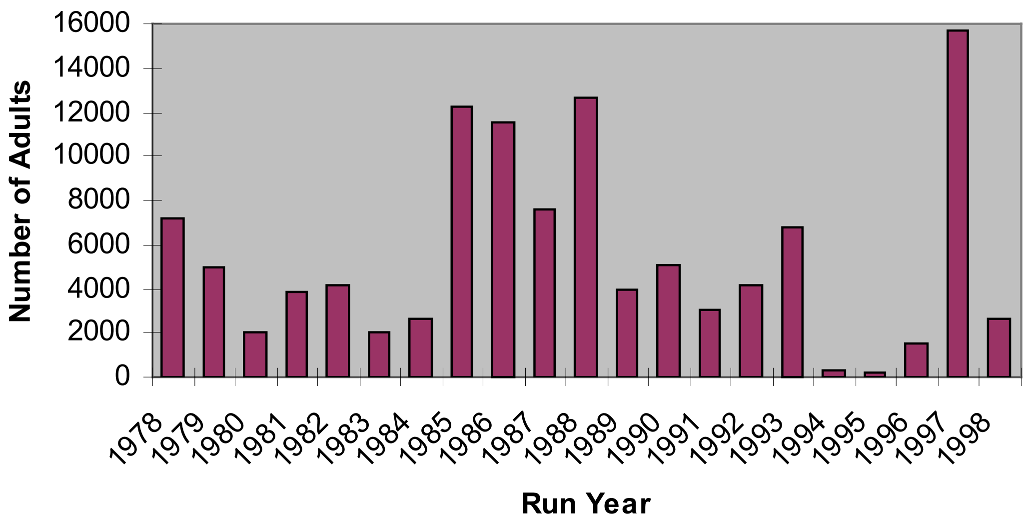


Figure 10. Number of spring chinook adults that Rapid River Fish Hatchery produced by run year.

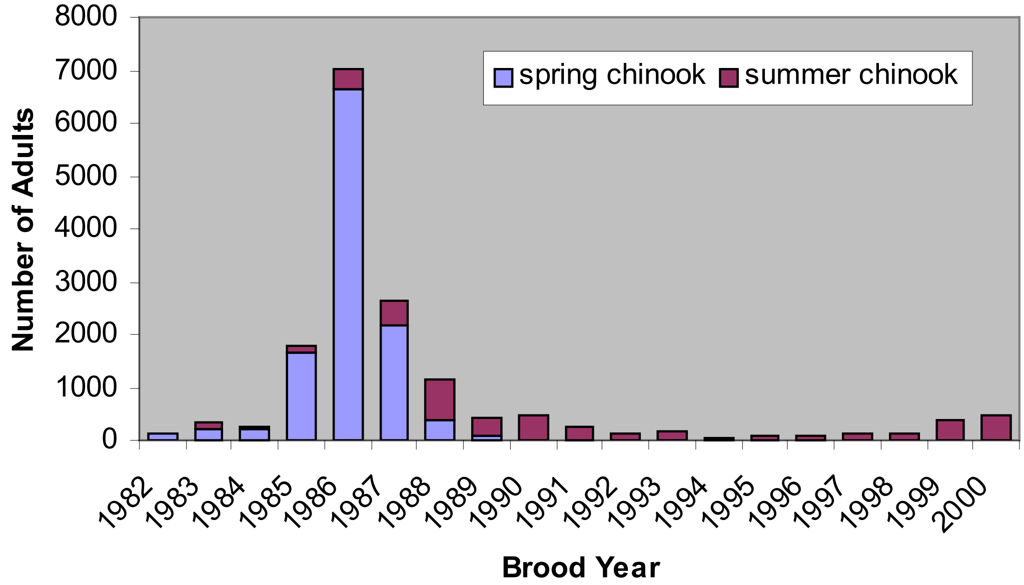


Figure 11. Numbers of wild and hatchery-produced adult spring and summer chinook returning to the Pahsimeroi Fish Hatchery's adult trap by brood year.

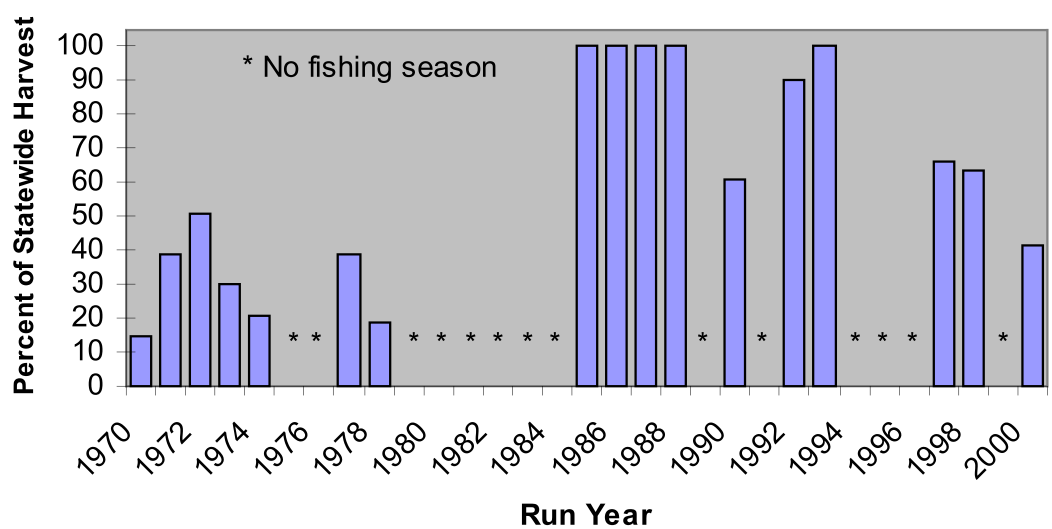


Figure 12. Percentage of the total statewide spring chinook sport harvest that Rapid River Fish Hatchery produced by run year.

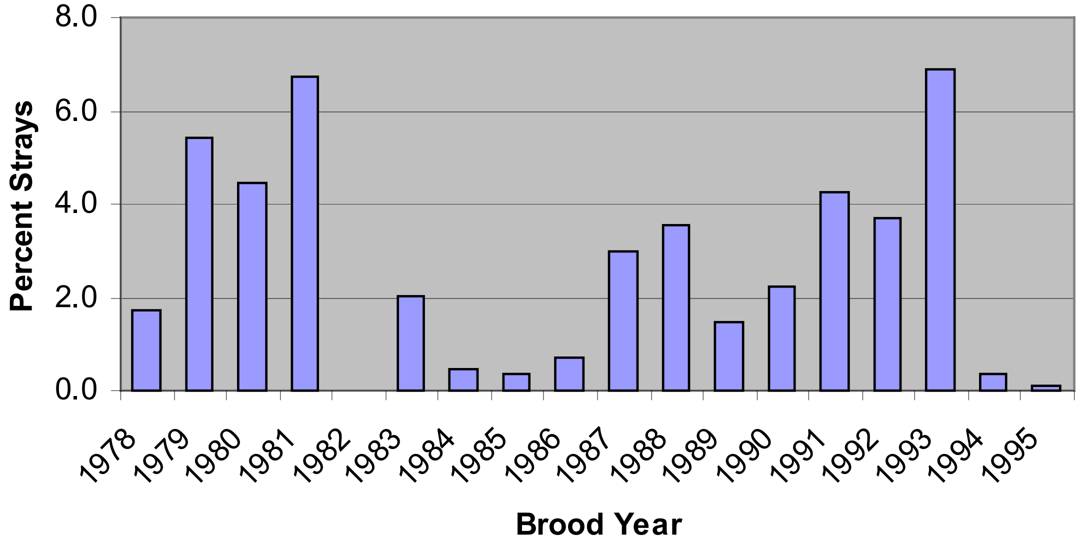


Figure 13. Percentage of steelhead produced at Niagara Springs Fish Hatchery that strayed by brood year.

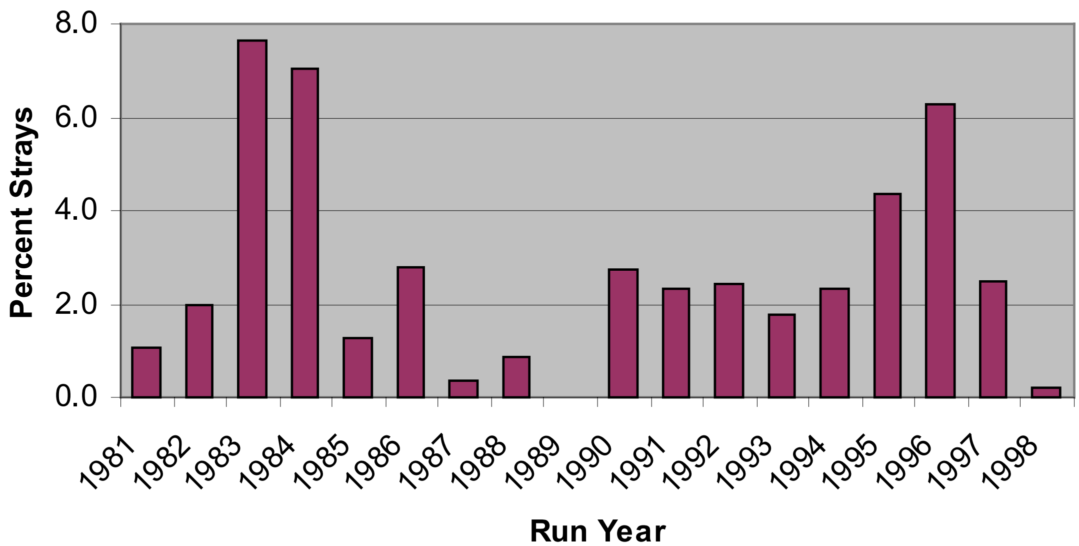


Figure 14. Percentage of steelhead produced at Niagara Springs Fish Hatchery that strayed by return year.

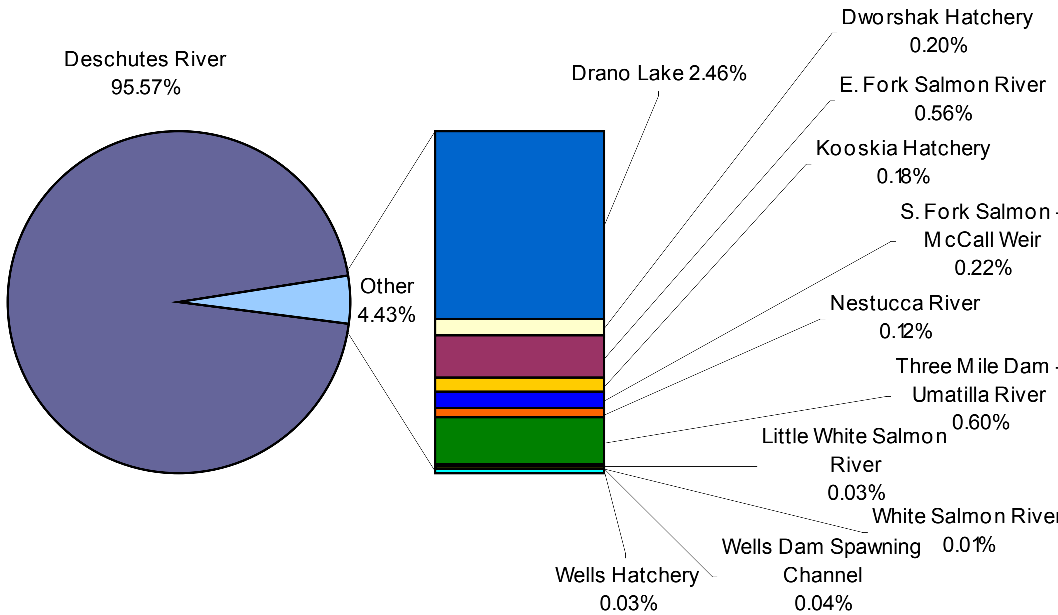


Figure 15. Distribution of stray Niagara Springs Fish Hatchery steelhead by recovery location, 1981−98.

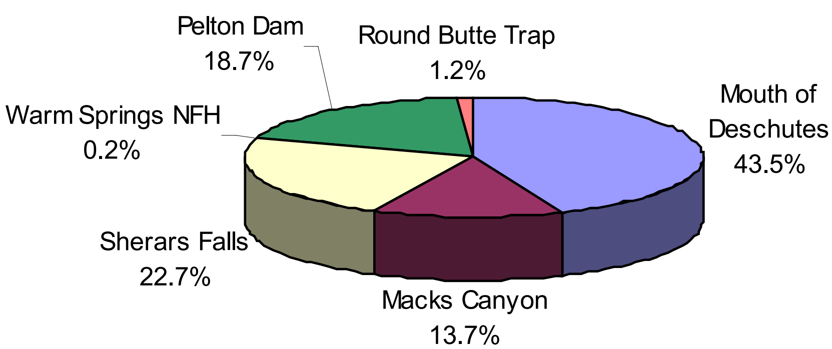


Figure 16. Distribution of stray steelhead produced at Niagara Springs Fish Hatchery that were recovered within the Deschutes River.

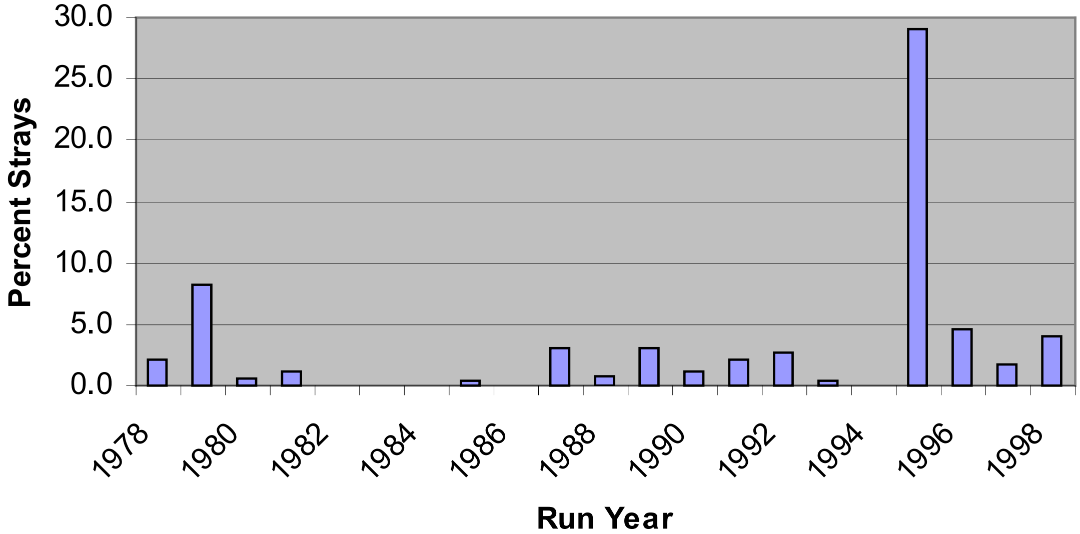


Figure 17. Percentage of spring chinook produced at Rapid River Fish Hatchery that strayed by run year.

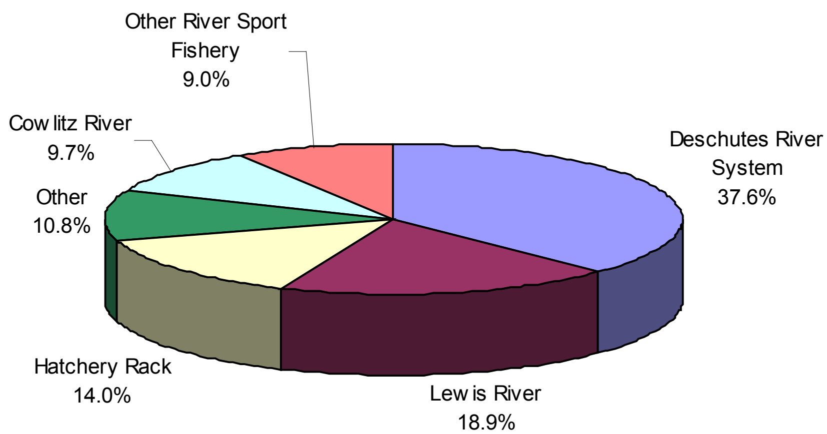


Figure 18. Distribution of stray Rapid River Fish Hatchery spring chinook by recovery location, 1978−98.

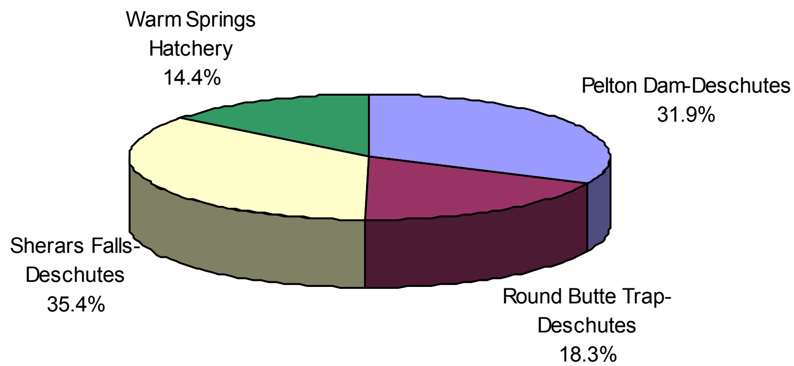
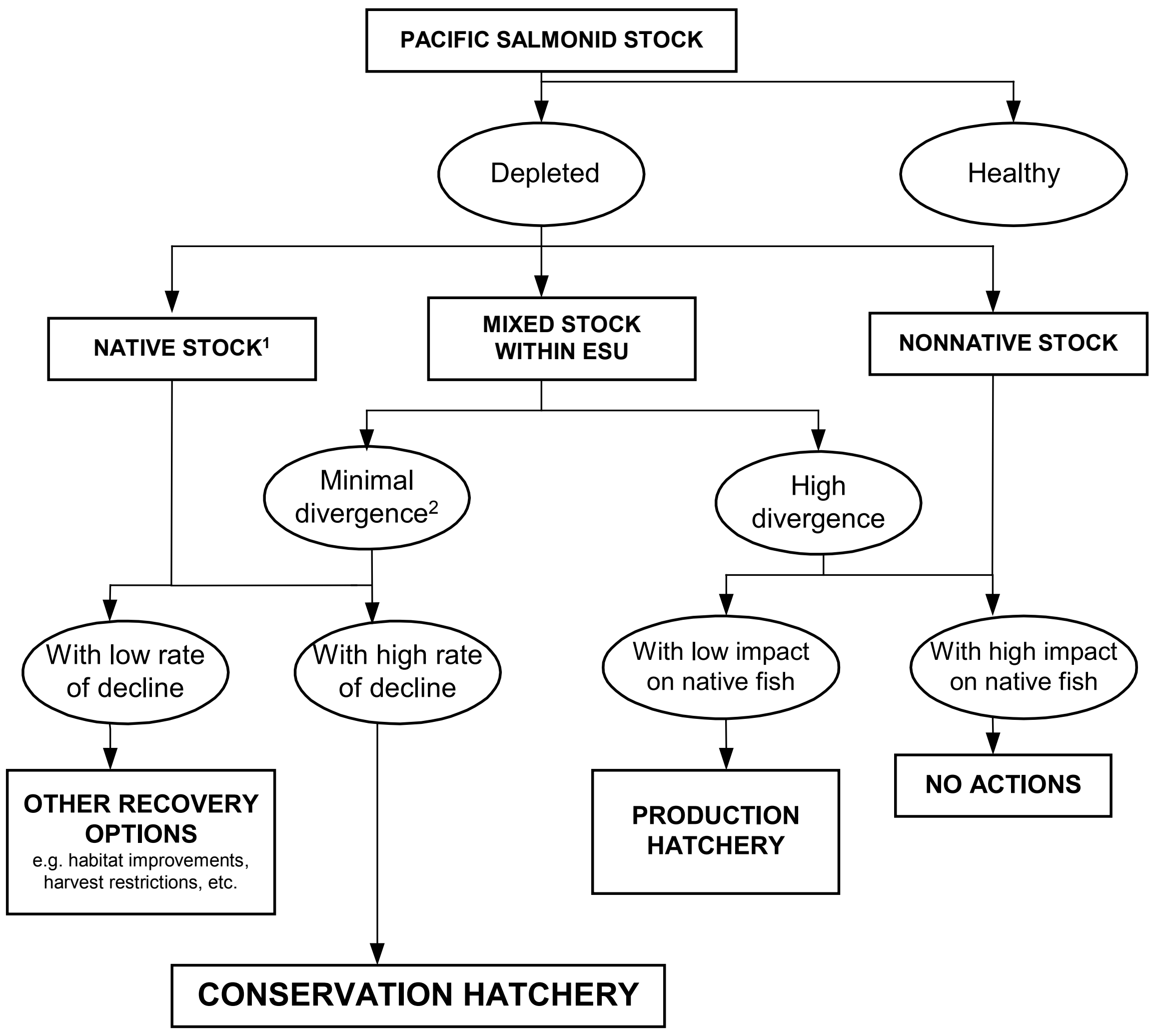


Figure 19. Distribution of stray spring chinook produced at Rapid River Fish Hatchery that were recovered within the Deschutes River.



[1] In all cases this would be the preferred source. For an extirpated stock, another from within the same Evolutionarily Significant Unit (ESU) can be substituted.

[2] Stock with traits identified as useful for recovery.

Figure 20. Conservation hatchery decision tree for determining when to apply artificial propagation to recover listed species. Adapted from Figure 1 in Flagg and Nash (1999).

Appendix A. Specific release sites associated with fish distribution categories that appear in Table 13.

Distribution Category	Specific Release Sites
Snake River	Below Oxbow Dam
	Below Hells Canyon Dam
	Grand Ronde
	Clearwater River
Pahsimeroi River	Pahsimeroi Trap
	Pahsimeroi Holding Ponds
	Pahsimeroi River at Dowton Lane
Salmon River and Tributaries above the Middle Fork	Salmon River at Blaine County Bridge
	Salmon River at Valley Creek
	Yankee Fork
	East Fork of the Salmon River
	Salmon River at Bruno Bridge
	Salmon River at Mouth of Pahsimeroi
	Salmon River at Ellis Bridge
	Salmon River at Shoup Bridge
	Lemhi River
	Twin Creek
	North Fork Salmon River
	Hughes Creek
	Indian Creek
	Spring Creek
	Moyer Creek
	Salmon River at Panther Creek
Salmon River and Tributaries below the Middle Fork	French Creek
	Little Salmon River at Hazard Creek
	Little Salmon River
	Salmon River at Hammer Creek
	Salmon River at Pine Bar

Appendix A. (Cont.)

Distribution Category	Specific Release Sites
Resident Stocking	Hagerman Hatchery
	Niagara Springs Creek
	Payette River
	Brownlee Reservoir
	Mormon Reservoir
	CJ Strike Reservoir
	Paddock Reservoir
	Lucky Peak Reservoir
	Roseworth Reservoir
	Oakley Reservoir
	Mountain Home Reservoir
	Salmon Falls Creek Reservoir
	American Falls Reservoir
	Lake Walcott
	Cascade Reservoir
	Arrowrock Reservoir
	Magic Reservoir
Research	Hayden Creek Hatchery
	Idaho State University
	University of Idaho
	USFWS, Seattle

Appendix B. Key to abbreviations of pathogens and levels of occurrence presented in Tables 31 through 35.

Abbreviation	Pathogen	Disease
BKD	*Renibacterium salmoninarum*	Bacterial kidney disease
CSH	*Ceratomyxa shasta*	Ceratomyxosis
CWD	*Cytophaga psychrophila*	Cold water disease
EIBS	Erythrocytic inclusion body syndrome virus	Erythrocytic inclusion body syndrome
ERM	*Yersinia ruckeri*	Enteric redmouth disease
FUR	*Aeromonas salmonicida*	Furunculosis
IHN	Infectious hematopoietic necrosis virus	Infectious hematopoietic necrosis
IPN	Infectious pancreatic necrosis virus	Infectious pancreatic necrosis
MAS	*Motile areomonad septicemias*	
MYXO	*Myxobolus* sp.	
PKD	*Nucleospora salmonis*	Proliferative kidney disease
WHD	*Myxobolus cerebralis*	Whirling disease

Abbreviation	Level of Pathogen Incidence
ca	Carrier
cl	Clinical disease symptoms
ep	Epizootic
f	Pathogen sampled but not detected
blank cell	No data available

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Appendix C. *1980 Hells Canyon Settlement Agreement.*

UNITED STATES OF AMERICA

BEFORE THE

FEDERAL ENERGY REGULATORY COMMISSION

Idaho Power Company Docket No. E-9579

SETTLEMENT AGREEMENT

AGREEMENT made and entered into this 14th day of February, 1980, between and among the UNITED STATES DEPARTMENT OF COMMERCE acting by and through the NATIONAL MARINE FISHERIES SERVICE, THE STATE OF IDAHO acting by and through THE IDAHO FISH AND GAME DEPARTMENT, THE STATE OF OREGON acting by and through THE OREGON DEPARTMENT OF FISH AND WILDLIFE, THE STATE OF WASHINGTON acting by and through THE WASHINGTON DEPARTMENT OF FISHERIES, and THE WASHINGTON DEPARTMENT OF GAME, hereinafter collectively referred to as "Petitioners" or "Fishery Agencies", and the IDAHO POWER COMPANY, hereinafter referred to as "Licensee":

I.

By entering into this agreement, Petitioners and Licensee intend to settle all issues except as might be advanced under paragraph III below, raised by this proceeding related to the numbers of salmon and steelhead lost or destroyed as a result of the construction of, and operation within the existing license for, Project No. 1971, and to terminate the proceeding now pending before the Federal Energy Regulatory Commission identified as Docket No. E-9579, except as Commission approval of drawings may be necessary.

II.

Idaho, Oregon and Washington agree that the numbers of fish herein agreed upon constitute full and complete mitigation for all numerical losses of salmon and steelhead caused by or in any way associated with the construction of, and operation within the existing license for, Project No. 1971. Idaho, Oregon, and Washington further agree not to contend or support contentions by others before any agency or in any proceeding that additional fish or fish facilities are required by or in any way associated with the construction of, or operation within the existing license for, Project No. 1971.

III.

Petitioners agree that they will not for the duration of the current Project No. 1971 license seek relief from the Federal Energy Regulatory Commission on any matter concerning Licensee's responsibility to compensate for salmon and steelhead losses under the Fish and Wildlife Coordination Act or the Federal Power Act nor seek changes in the operation of Project No. 1971 except that, on the basis of technological advances, or substantial changes in condition, Petitioners may seek from the Federal Energy Regulatory Commission additional relief, if necessary, related exclusively to the enhancement of out-migration conditions for fall chinook smolts in the free flowing stretch of the Snake River below Project No. 1971, after they are released by Licensee pursuant to this agreement. The parties agree that changes in operations within the restrictions of the existing license for Project No. 1971 shall not alone be considered a substantial change of condition.

Further, in the event that storage space upstream of Project No. 1971 is hereafter acquired by the fishery agencies for the purpose of preserving or enhancing fish habitat or survival downstream of Project No. 1971, if the parties are unable to agree on the conditions under which water released from such space will be passed through Project No. 1971, Petitioners or Licensee may petition the Federal Energy Regulatory Commission for an order setting forth the conditions under which water released from such storage space will be passed through Project No. 1971 by Licensee.

IV.

The numbers of smolts and facilities to be provided and operations to be conducted by Licensee as mitigation for salmon and steelhead losses caused by construction and operation of Project No. 1971 within the existing license for Project No. 1971 are as follows:

A. Licensee shall provide, operate and maintain fish traps, fish handling and fish transporting facilities, and fish hatchery facilities, as necessary, to provide an annual production of 1,000,000 fall chinook smolts, 4,000,000 spring chinook smolts, and 400,000 pounds of steelhead smolts. The facilities to be provided and their operation shall be as follows:

1 Spring Chinook. Annual production by Licensee of 4 million spring chinook smolts shall be accomplished by utilizing the following described facilities in the following described manner, all costs for which shall be borne by Licensee, unless otherwise specified:

(a) At a site on the Snake River, at or near the location of Project 1971, Licensee shall, to the extent possible, trap a sufficient number of adult spring chinook to permit the taking of a quantity of eggs reasonably necessary to produce one million smolts for release by Licensee in the

Snake River near Hells Canyon Dam. To accomplish this, Licensee shall:

(1) Continue to operate and maintain the existing barge trap at its present location at the face of Hells Canyon Dam on a daily basis commencing on May 1, or such later date as the fishery agencies request, and continuing not later than July 15, water conditions permitting, or until a sufficient number of adults has been trapped in said barge trap and the trap described in subparagraph (a)(2) immediately following, to reasonably provide for the production of one million smolt; provided, however, that, at any time upon the request of the fishery agencies, adult fish trapped during the above specified period of trap operation shall be made available to the fishery agencies pursuant to subparagraph (a)(4); and provided further that all trapped adults made available to the agencies pursuant to subparagraph (a)(4) shall, to the extent necessary, be applied toward Licensee's obligation to trap sufficient adults for production of one million smolts.

(2) Construct, operate and maintain a second adult trapping device, designed and built pursuant to drawings approved by the Commission and Idaho Department of Fish and Game as hereinafter provided, at a location on the Snake River approximately ___ miles downstream from Hells Canyon Dam, on the Oregon shore. Said trap shall be operated on a daily basis commencing on May 1, or such later date as the fishery agencies request, and continuing not later than July 15, water conditions permitting, or until a sufficient number of adults has been trapped in this trap and the barge trap described in subparagraph (a)(1) immediately hereinabove, to reasonably provide for the production of one million smolts; provided, however, that, at any time upon the request of the fishery agencies, adult fish trapped during the above specified period of trap, operation shall be made available to the fishery agencies pursuant to subparagraph (a)(4); and provided further that all trapped adults made available to the agencies pursuant to subparagraph (a)(4) shall, to the extent necessary, be applied toward Licensee's obligation to trap sufficient adults for production of one million smolts.

(3) All adult spring chinook trapped shall be transported to Licensee's Rapid River Hatchery or released to the fishery agencies under subparagraph (a)(4). To facilitate an efficient transportation program, Licensee may, when water conditions permit, temporarily accumulate and hold trapped adults in the holding pond

existing at Licensee's Oxbow Hatchery or in the traps before transporting them to the Rapid River Hatchery or hold them at other facilities, and take, fertilize, and eye eggs at such other facilities, with the agreement of the fishery agencies. The holding pond at Oxbow shall be cleaned and refurbished by Licensee before it is used for temporary holding purposes.

(4) Within the trap operation period above stated, and at the request of the fishery agencies, Licensee shall continue to operate the two traps described herein when not trapping adults to transport to Rapid River to meet Licensee's production obligations set out in subparagraph (a) above. Licensee shall place all adults so trapped in appropriate holding facilities and make them and the adult loading facilities available to the fishery agencies for immediate transporting and use, as they desire, at the agencies' cost.

(b) At Licensee's Rapid River Hatchery the following alterations in operations shall be made:

(1) Licensee shall continue to operate and maintain Rapid River Hatchery, but shall reduce its present smolt production from Rapid River spring chinook spawners to an annual production of 2 million smolts, and shall segregate said fish from all other fish during all stages of development at the Hatchery.

(2) In addition to continued rearing of two million smolts produced from spawners trapped at Rapid River, Licensee shall segregate, hatch and rear to smolts, one million fish, produced from adult spawners trapped in the Snake River near Hells Canyon Dam, or from a combination of such spawners and adults trapped at Rapid River stock as provided in paragraph (3) immediately below. These smolts shall then be transported and released at or near Hells Canyon Dam.

(3) In years when it appears that the two adult traps near Hells Canyon Dam will be unable to provide sufficient spawners for the production of one million smolts, Licensee shall, at the request of the fishery agencies, undertake at Rapid River to trap and spawn a sufficient additional number of adults, which, when combined with those trapped at Hells Canyon Dam, will reasonably provide adequate eggs for one million smolts to be released at Hells Canyon.

(c) At Licensee's Pahsimeroi Hatchery, the following additions and alterations shall be accomplished in the method of operations and in the facilities of the Hatchery to accommodate the production of one million chinook smolts annually:

(1) Without interfering with the existing steelhead program at the Hatchery, Licensee shall trap and spawn from available adult chinook salmon returning to the existing Pahsimeroi trap, up to a sufficient number to reasonably provide for the production of one million smolts, as directed by the fishery agencies.

(2) The chinook eggs so taken from the trapped adults shall be hatched in the existing Pahsimeroi hatching facilities, and, upon hatching, the fry shall for a period of initial rearing be placed in four concrete initial rearing ponds. Said initial rearing ponds, each with dimensions of four feet by one hundred feet, shall be constructed near the existing adult holding ponds, and shall be supplied with an adequate supply of water.

(3) After an initial rearing period, the fry shall be removed to the two existing Pahsimeroi acclimation ponds, where they will be reared to smolt size and released into the Pahsimeroi River. The water supply for each of the existing acclimation ponds shall be increased to approximately 10 cfs.

(4) At the request of the fishery agencies, if adult chinook salmon in excess of the number required meet Licensee's production obligations are taken at the Pahsimeroi River trapping facilities, they shall be placed in the holding facilities and made available to the fishery agencies for immediate transporting and use at their cost, as they desire.

(5) Petitioners may, at their cost, construct adult loading facilities at Licensee's Pahsimeroi Hatchery.

(d) At the request of the fishery agencies, Licensee shall deviate from the above schedule of release points and relative smolt production from adults trapped in the Snake River, Rapid River or Pahsimeroi River, within the total of 4,000,000 smolts. All added costs resulting from any such deviation shall be borne by the fishery agencies. In the event that the proposed use of the additional 1,000,000 spring chinook smolts at Rapid River for rebuilding runs in the Snake River does not result in satisfactory adult returns, the parties agree that the fishery agencies will, within a reasonable time and after consultation with the parties, release such additional smolts in other areas with the goal of achieving a satisfactory rate of adult returns.

2. Fall Chinook. Licensee will modify its existing Oxbow Hatchery facilities to permit raising a total of 1,000,000 fall chinook smolts annually.

Licensee will contract with appropriate state and federal agencies or otherwise provide for the trapping of sufficient adult fall chinook salmon and the fertilizing and eyeing up of sufficient eggs to permit raising up to 1,000,000 fall chinook smolts. The eggs will be transported by Licensee to its Oxbow Hatchery for rearing. The facilities will be ready for use within 6 months of written notification by the fishery agencies of the availability of eggs.

The smolts will be transported by truck by Licensee to and released at appropriate points in the Snake or Columbia Rivers, as determined by the fishery agencies.

Pursuant to paragraph III on page 2 of this agreement, the Petitioners may monitor the survival of the fall chinook smolts provided under this paragraph and take action essential for the protection of those smolts in the free flowing stretch of the Snake River below Project No. 1971.

3. Steelhead Trout.

(a) Licensee will continue to operate and maintain its existing Pahsimeroi River Hatchery facilities, to permit trapping sufficient upstream migrant adult steelhead trout and the taking, fertilizing and eying up of sufficient eggs to permit raising 200,000 pounds of steelhead trout smolts annually at its Niagara Springs hatchery facilities. The eyed eggs will be transported to Licensee's Niagara Springs hatchery facilities for rearing. At the request of the agencies, Licensee will provide additional eyed eggs, if available from its Pahsimeroi River facilities, up to their capacity, to permit building up the production of the Niagara Springs facilities to 400,000 pounds of steelhead trout smolts.

(b) Licensee will continue to operate its existing Niagara Springs Hatchery facilities and modify them as necessary to permit the annual total production of 400,000 pounds of steelhead trout smolts, not to exceed a total of 3,200,000 smolts. Licensee will transport the smolts from the Pahsimeroi River stock to its Pahsimeroi River facilities for release and the smolts from the Snake River stock to Hells Canyon Dam for release, except during the time prior to receiving enough eggs from the Snake River stock to permit raising 200,000 pounds of steelhead trout smolts, excess smolts from Pahsimeroi River stock will be taken to Hells Canyon Dam for release.

(c) Licensee will operate and maintain the trapping facilities described in paragraphs l (a)(1) and 1(a)(2) hereof for the purpose of trapping upstream migrant adult steelhead trout. Said traps shall be operated on a daily basis, water conditions permitting, commencing each autumn on September 1, or on such later date as the fishery agencies request, and continuing not later than December 20, and again each spring commencing on March 1, or on such later date as the fishery agencies request, and continuing not later than April 30, or until a sufficient total number of adults has been trapped to reasonably provide for the annual production of 200,000 pounds of steelhead smolts. Trapped adults will be held in Licensee's existing Oxbow facilities until mature, at which time their eggs will be taken, fertilized and eyed up at the Oxbow facilities, and then transported for rearing to Licensee's Niagara Springs facilities, where they will be kept separate from the Pahsimeroi River stock. The resulting smolts shall be hauled to Hells Canyon Dam and released below the dam by the Licensee.

(d) If excess adults are taken at the Pahsimeroi River or Hells Canyon Dam trapping facilities, they shall be placed in the holding facilities and made available to the fishery agencies for immediate transportation and use at their cost, as they desire.

(e) Petitioners may, at their cost, construct adult loading facilities at Licensee's Pahsimeroi Hatchery.

(f) At the request of the fishery agencies, Licensee shall deviate from the above schedule of release points or relative production of Pahsimeroi River and Snake River stocks within the total 400,000 pounds of steelhead trout smolts. All added costs resulting from any such deviation shall be borne by the fishery agencies.

B. By agreement with the fishery agencies, Licensee may deviate from the numbers or pounds of smolts to be provided, or the construction, maintenance and operation of any of the facilities herein described.

C. In the event that sufficient water is not available to permit annual production of 400,000 pounds of steelhead trout at Licensee's Niagara Springs facilities, any additional production required beyond that possible at the Niagara Springs facilities shall be accomplished as mutually agreed by Licensee and Petitioners. In the event agreement cannot be reached, any party hereto may petition the Commission for an order resolving the matter.

V.

November 1, 1979, through May 31, 1982, Licensee will operate Project No. 1971 according to the following schedule, unless relieved there from by any of the Exceptions set out below:

1. <u>November 1 Through November 30</u>. Outflow from Hells Canyon Dam shall be reduced to a low-flow discharge and continuously maintained for at least 4 hours each day. The low-flow selected shall be between 12,500 cfs and 10,000 cfs unless the preceding 7-day average inflow to Brownlee Reservoir is less than 10,000 cfs. If the 7-day average inflow to Brownlee is between 10,000 cfs and 8,500 cfs, the 4-hour low flow shall be no less than the 7-day average inflow. If the 7-day average inflow is less than 8,500 cfs, the 4-hour low-flow shall be at least 5,400 cfs. The maximum permissible ramp rate shall be 1.7 feet per hour at Johnson's Bar, which for the purposes of this agreement the parties agree will be 2.0 feet per hour measured at Hells Canyon gauge.

<u>Exception:</u> Should an emergency occur that requires the operation of Project No. 1971 during the November 1 to November 30 period contrary to the aforesaid scheme, project discharges shall be brought back into conformance with the low flow scheme as soon as practicable after the emergency has passed.

2. <u>December 1 Through April 30</u>. An instantaneous minimum flow requirement shall be determined from the 4-hour low-flow discharges that occurred during the preceding November 1 through November 30 period in the following manner: The minimum flow shall be equivalent to that flow necessary to maintain the Hells Canyon Gage at an elevation not more than 1 foot below the 6th highest 4-hour low-flow discharge that occurred during the preceding November 1 through November 30 period, but not less than 8,500 cfs, unless the 6th highest 4-hour low-flow during the November 1 through November 30 period is 5,400 cfs; in such case, the minimum flow shall be 5,400 cfs.

If, during the November 1 through November 30 period, an emergency or emergencies forces deviation from the 4-hour low-flow operating scheme, those days of emergency operation shall he disregarded in determining the minimum flow for the December 1 through April 30 period.

3. <u>May 1 Through May 30</u>. The maximum permissible ramp rate shall be one-half foot per hour at the Hells Canyon Gage.

4. <u>June 1 Through October 31</u>. Present license restrictions will apply.

<u>Exception</u>: Licensee may deviate from any of the requirements set out in Paragraphs 1, 2 and 3 hereof in the event of an emergency. For the purpose of this Agreement, an emergency is defined as a loss or partial loss of a generating unit or resource, or access thereto, whether on or off the Company's system, or short term adverse weather, or streamflow conditions, which result or may likely result in the Company's being unable to meet its firm load requirements.

<u>Exception</u>: During the month of March, drafting of Brownlee Reservoir will not be required solely to meet the target minimum flow established as set out in Paragraphs 1 and 2 hereof.

Exception: If the March 1 Weiser run-off forecast by the SCS is 4.4 million acre-feet or less for the April through September period, then on the date the Corps of Engineers releases Idaho Power Company from any requirement of maintaining storage space in Brownlee Reservoir, or April 1, whichever comes first, the Project minimum flow requirement becomes 5,000 cfs.

5. In years subsequent to 1982, Licensee will attempt to operate Project No. 1971 in such a manner as to reduce adverse effects on anadromous fish spawning, rearing and out-migration below the Project, consistent with the provisions of its license for Project No. 1971 and its obligations as a public utility.

6. Licensee and Petitioners shall meet at least annually to exchange information and discuss possible Project operations to reduce adverse effects on anadromous fish below the Project. All parties to the proceedings in FERC Docket No. E-9579 shall be invited to attend and participate.

7. Licensee will notify Petitioners as soon as possible concerning a condition which has or is likely to result in a deviation from the schedule pursuant to one of the stated exceptions. Notice shall be given to a person to be designated by the Idaho Department of Fish and Game.

8. The implementation of the above plan of operation is contingent upon Licensee's receiving authority from the Commission to permit operation of the project pursuant to paragraph 1 above, relating to the maximum ramp rate of 1.7 feet per hour at Johnson's Bar, which is different from the existing license. Licensee will apply to the Commission for a temporary operating variation to cover the months of November 1979, 1980 and 1981. Petitioners will support that application by Licensee before the Commission.

VI.

The parties will request the Commission to enter an order to the effect that:

A. Licensee shall provide, operate and maintain fish traps, fish handling and fish transporting facilities, and fish hatchery facilities, as necessary, to provide an annual production of 1,000,000 fall chinook smolts, 4,000,000 spring chinook smolts, and 400,000 pounds of steelhead trout smolts, consistent with the provisions of the Settlement Agreement dated February 14, 1980, executed by the fishery agencies and Licensee, which agreement is hereby approved.

B. Final agreement has been reached among the fishery agencies and Licensee concerning numbers of salmon and steelhead to be produced by Licensee in mitigation of salmon and steelhead losses caused by or associated with the construction and operation of Project No. 1971.

C. The Licensee shall not commence construction of any facilities described herein until:

(1) The Commission shall have reviewed functional drawings which shall be prepared by the Licensee in accordance with the Settlement Agreement respecting fishery resource mitigation entered into by Licensee and the fishery agencies of the States of Oregon, Washington, and Idaho, and the United States of America's National Marine Fisheries Service, dated February 14, 1980; and

(2) Plans, specifications or construction drawings have been approved by the Idaho Department of Fish and Game, on behalf of Petitioners.

D. Any previous orders of the Commission, or its predecessor, the Federal Power Commission, in any way in conflict herewith be rescinded.

E. The Commission's approval of this settlement shall not constitute approval of a precedent regarding any principle or issue in this proceeding.

VII.

The parties agree to submit a stipulation embodying Paragraph VI hereof and this Agreement to the presiding Administrative Law Judge in Docket No. E-9579, and to provide testimony and exhibits in support thereof if required by order of the presiding Administrative Law Judge, and to support this Agreement before any court or agency in any proceeding, state or federal.

Further, the parties agree to cooperate with and assist each other in efforts to secure licenses, permits and approvals from any government agency or entity which are or may become necessary for implementation or continued performance of the provisions of this agreement.

IDAHO POWER COMPANY
Licensee

By: ___________________________
President

ATTEST:

____
Secretary

STATE OF IDAHO
By and through the Fish and Game
Commission and the Department of Fish and Game

By: ___________________________
Chairman, Idaho Fish and Game
Commission

By: ___________________________
Director, Idaho Department of
Fish and Game

STATE OF OREGON
By and through the Fish and Wildlife
Commission and the Department
of Fish and Wildlife

By: ________________________
Chairman, Oregon Fish and
Wildlife Commission

By: ________________________
Director, Oregon Department
of Fish and Wildlife

STATE OF WASHINGTON
By and through the Department
of Game and the Department
of Fisheries

By: ________________________
Director, Washington Department
of Game

By: ________________________
Director, Washington Department
of Fisheries

UNITED STATES DEPARTMENT
OF COMMERCE
By and through the National
Marine Fisheries Service

By: ________________________