FISHERY RESEARCH

LOWER SNAKE RIVER COMPENSATION PLAN STEELHEAD FISH HATCHERY EVALUATIONS—IDAHO

Brood Year 2007
Hatchery Steelhead Report

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Brood Year 2007 Hatchery Steelhead Report: LSRCP Monitoring and Evaluation Programs in the State of Idaho

By

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ABSTRACT

This report summarizes production, survival, and adult return information for brood year 2007 summer steelhead *Oncorhynchus mykiss* for the Lower Snake River Compensation Plan (LSRCP) and Idaho Power Company (IPC) hatchery mitigation programs operated within the state of Idaho.

Clearwater Fish Hatchery, Hagerman National Fish Hatchery, Magic Valley Fish Hatchery, and Niagara Springs Fish hatchery received eyed eggs from broodstock collection facilities and reared them for one year prior to release. Eyed egg-to-smolt survival across most hatcheries and stocks was high with an average of 89% (range = 56-95%). Smolts at all facilities were at or near the size target (4.5 fish per pound) when they were released. Combined, these facilities released 5,525,379 smolts at multiple sites in the Clearwater River and Salmon River basins as well as the Snake River downstream of Hells Canyon Dam. Representative groups of hatchery steelhead in each rearing facility were tagged with passive integrated transponder (PIT) tags to evaluate migration timing and survival from release to Lower Granite Dam (LGD). Survival estimates from release to LGD averaged 76.9% and ranged from 50.7% to 93.8%. Travel times from release to arrival at LGD averaged 20 days and ranged from 10 days to 53 days.

The recovery of coded wire tags (CWT) from the fishery and the hatchery rack was used to reconstruct the brood year 2007 return of adult steelhead. The total estimated return to the mouth of the Columbia River was 172,441 adult steelhead during the 2009-10, 2010-11, and 2011-12 steelhead runs. Production from LSRCP funded facilities (Clearwater, Hagerman, and Magic Valley fish hatcheries) accounted for 95,684 steelhead, which is 81% of the total mitigation goal for returning adult steelhead, making it the second highest adult return in the history of the program. Hagerman National Fish Hatchery was within a few hundred fish of their mitigation goal and Magic Valley Fish Hatchery exceeded their mitigation goal of total adults produced. Clearwater Fish Hatchery was approximately 29,000 short of their mitigation goal. Niagara Springs Fish Hatchery accounted for 76,758 adult steelhead, which is substantially more than any previously documented return from that facility. Niagara Springs Fish Hatchery provided an SAS of 4.5% and 45% of the total harvest from all four hatcheries. The majority (157,351) of the returning brood year 2007 adults escaped upstream of LGD. Exploitation in the terminal fishery accounted for 106,550 of the return to LGD. Steelhead recovered at hatchery traps or recovered as strays included 29,798 and 9,019 of the LGD return respectively. The remaining fish (11,987) were classified as unharvested escapement. These included fish that were returning to offsite releases with no trapping facility to remove them.

For the first time at Clearwater, Magic Valley, and Hagerman National fish hatcheries, sufficiently large groups of juvenile steelhead were PIT tagged to directly estimate the adult returns to Bonneville and LGD. These estimates were compared to those derived from the traditional run reconstruction methodology that utilizes coded wire tag (CWT) recoveries from fisheries, hatchery traps, and spawning grounds. Estimates from both methodologies were similar for Clearwater and Magic Valley fish hatcheries but estimates based on traditional run reconstruction were significantly lower for Hagerman National Fish Hatchery at both Bonneville and LGD. Utilizing results from the PIT tag analysis shows that the LSRCP adult mitigation goal of 117,780 for these three facilities was exceeded by 24,900 fish for brood year 2007.

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INTRODUCTION

The Lower Snake River Compensation Plan (LSRCP) summer steelhead *Oncorhynchus mykiss* hatchery mitigation program was established to provide in-kind mitigation for lost harvest opportunity resulting from the construction and operation of the four lower Snake River hydroelectric dams (Ice Harbor, Lower Monumental, Little Goose, and Lower Granite dams). Total mitigation expected for the LSRCP is 165,300 adults to be produced annually across the entire program which includes releases in Idaho, Oregon, and Washington states. This is based on an assumed 2:1 ratio of catch (downstream of project area; Lower Granite Dam) to escapement (upstream of the project area) (USACE 1975). During the program development, it was anticipated that the majority of the harvest mitigation benefits would be distributed downstream of the project area. However, less than expected returns of hatchery fish produced within the program and the depressed status of natural-origin fish influenced Columbia River fisheries management programs. The anticipated 2:1 distribution of harvest benefits downstream:upstream of Lower Granite Dam (LGD) has not been realized. Regardless of the actual distribution of harvest benefits, it was anticipated that the summer steelhead hatchery programs operated in Idaho at Clearwater Fish Hatchery (Clearwater), Hagerman National Fish Hatchery (Hagerman), and Magic Valley Fish Hatchery (Magic Valley) would contribute 117,780 (71% of the total) adults annually towards the total LSRCP mitigation goal.

In addition to the LSRCP, Idaho Power Company (IPC) maintains a hatchery summer steelhead mitigation program as well. This program mitigates for the construction and ongoing operation of the Hells Canyon Dam Complex (Brownlee, Oxbow, and Hells Canyon dams). Mitigation goals established through the Hells Canyon Settlement Agreement specifies an annual smolt production target 400,000 pounds for Niagara Springs Fish Hatchery (Niagara Springs), which equates to approximately 1,800,000 yearling smolts at 4.5 fish per pound. While the settlement agreement does not specify an adult return goal, IDFG anticipates these releases to return at rates comparable to the LSRCP facilities.

Hatchery Evaluation Component

The LSRCP includes a Hatchery Evaluation Studies component to monitor and determine the best practices for the operation of LSRCP hatcheries in each state. Evaluations consist of two major objectives outlined in the Cooperative Work Agreement established annually between the USFWS and IDFG. The first of these objectives is to document the accomplishments of the Idaho-LSRCP program towards meeting the adult steelhead mitigation goal. The second objective is to identify factors limiting hatcheries from meeting return goals and to recommend improvements as these factors become apparent. Much of this latter task consists of performing specific experiments related to hatchery success and are generally documented in independent reports. Although the IPC mitigation program does not have a specific adult return goal, these and other parameters were compiled for this program to provide hatchery and fishery managers consistent datasets across facilities.

This report includes information from all life stages of brood year 2007 hatchery steelhead released in Idaho from the LSRCP and the IPC mitigation programs. The report was delayed seven years to allow sufficient time for adults from brood year 2007 to return (five-year generation length) plus two additional years to allow for all out-of-state coded wire tag recoveries to be reported to the Regional Mark Information Center.

Steelhead Hatchery Facilities

Broodstock Collection Facilities

The LSRCP and IPC mitigation programs utilize steelhead eggs collected from one of the four hatchery weirs or two satellite facilities operated in Idaho (Table 1, Figure 1, and Figure 2). In most cases, broodstock collection and egg production are managed as segregated programs, only utilizing hatchery-origin adults in the broodstock. One exception is the integrated supplementation program in the East Fork Salmon River (EFNAT) that utilizes naturally produced steelhead in the hatchery broodstock.

Table 1. Hatchery broodstock collection facilities that provide steelhead eggs to the LSRCP and IPC mitigation hatcheries in Idaho.

Broodstock Collection Facilities	Stock Abbreviation	Mitigation Program
Dworshak National Fish Hatchery*	DWOR	USACOE
Oxbow Fish Hatchery	OX	IPC
Pahsimeroi Fish Hatchery	PAH	IPC
Sawtooth Fish Hatchery	SAW	LSRCP
East Fork Satellite Facility**	EFNAT	LSRCP
Squaw Creek Temporary Weir**	USAL	LSRCP

* Dworshak National Fish Hatchery operates a steelhead mitigation program funded by the U.S. Army Corps of Engineers (USACOE) that is not included in this report.

** Satellite facilities operated by the Sawtooth Fish Hatchery.

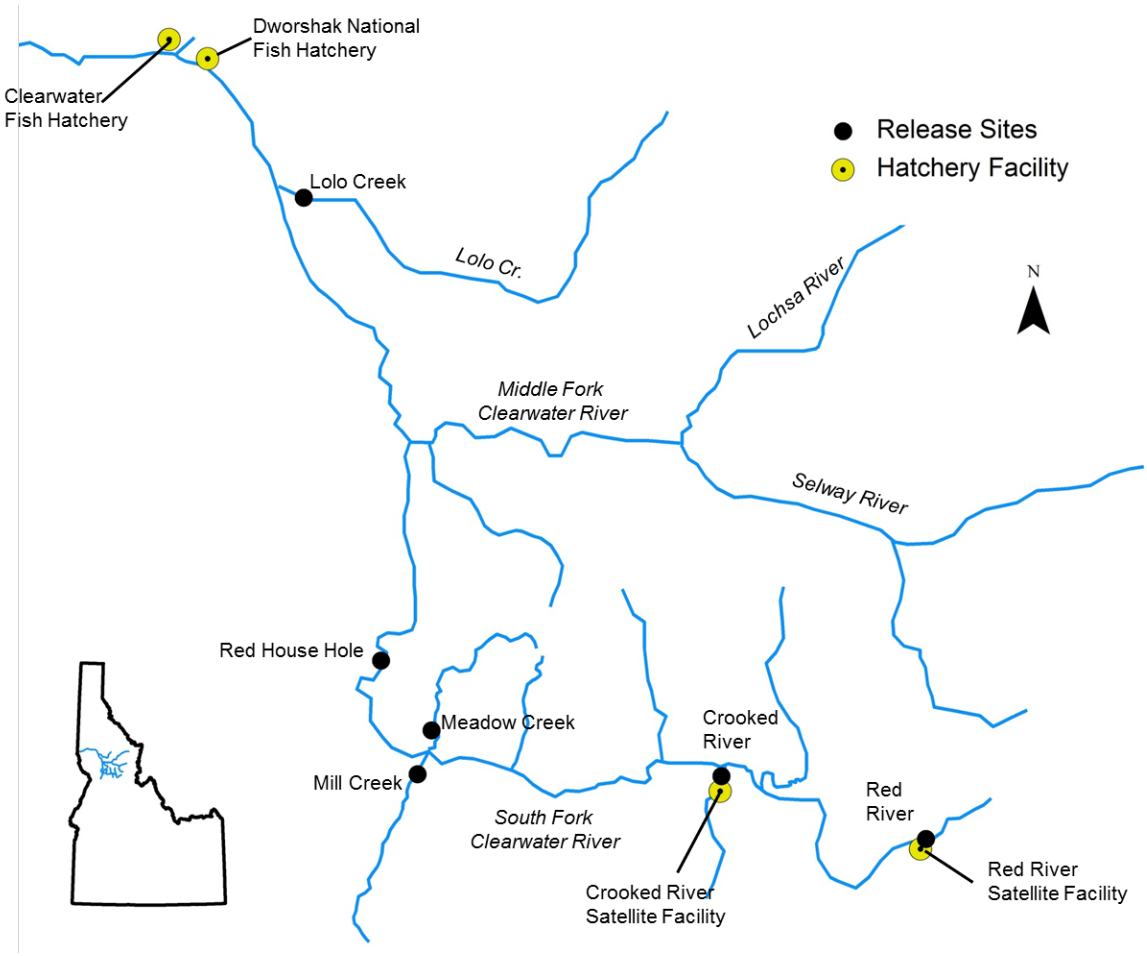

Figure 1. The location of hatchery steelhead release sites and hatchery facilities in the Clearwater River basin associated with the LSRCP mitigation program.

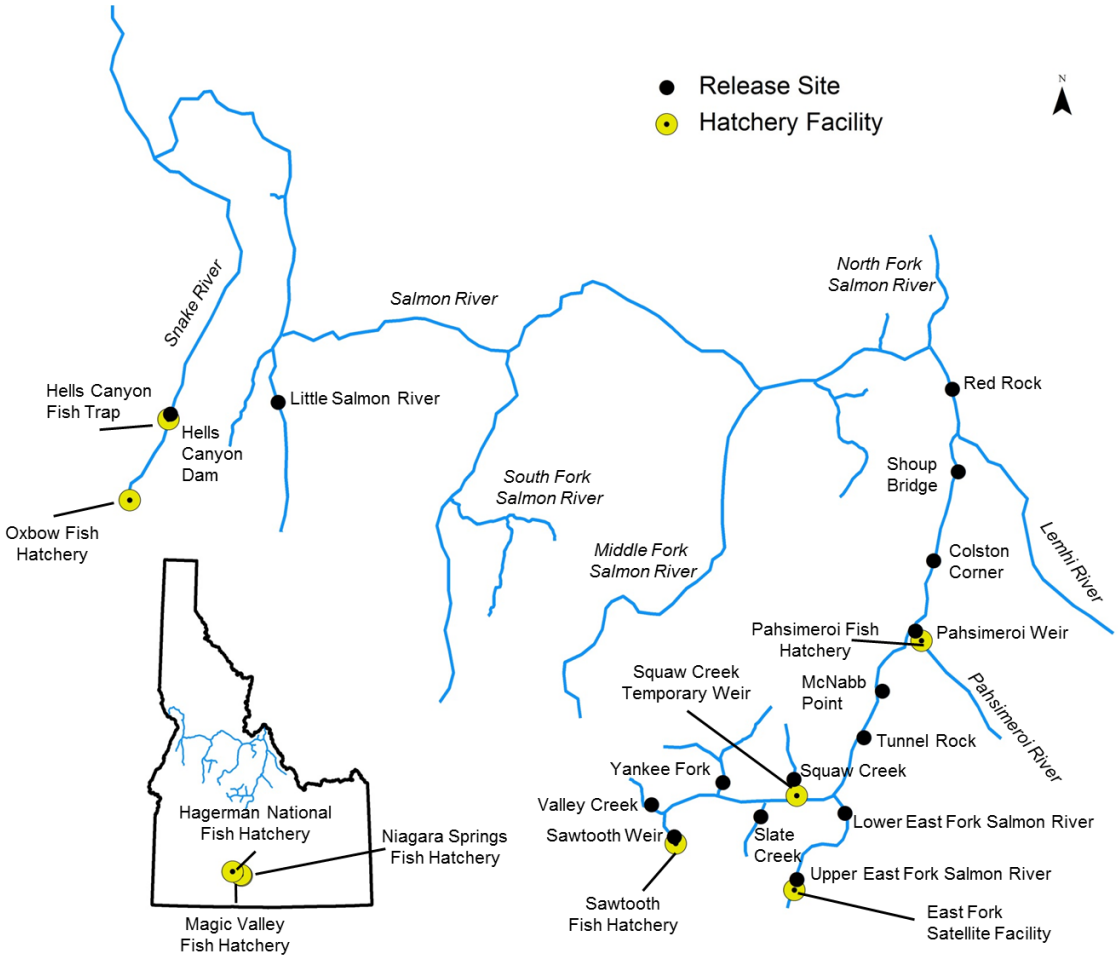

Figure 2. The location of hatchery steelhead release sites and hatchery facilities in the Salmon River and Snake River basins associated with the IPC and LSRCP mitigation programs.

Stock Descriptions and History

Dworshak (DWOR)—The DWOR stock was derived from wild fish returning to the North Fork Clearwater River and collected/spawned at Dworshak National Fish Hatchery (Dworshak) in the late 1960s and early 1970s. This stock has been the primary source of egg production at Dworshak and Clearwater, which release smolts into the Clearwater River basin. Dworshak Dam blocks access to all spawning habitat in the North Fork Clearwater River; therefore, the North Fork Clearwater steelhead population is entirely maintained at Dworshak. This hatchery population is included in the Distinct Population Segment and therefore listed as threatened under the endangered species act (ESA; NOAA 2006). Harvest in mark selective fisheries (adipose fin clipped fish, hereafter known as ad-clipped) for this stock is permitted despite the listing status. These fish are generally referred to as “B-run” fish, as the majority (approximately 90%) mature after two or more years in the ocean. Smolts from this stock have also been released in the Salmon River basin as part of the LSRCP mitigation program. These out-of-basin releases are not listed under the ESA.

Oxbow (OX)—The OX stock was developed by collecting adult steelhead returning to Hells Canyon Dam. Since its development (brood year 1966) this stock has been managed as a locally adapted stock, with few and infrequent releases of other stocks. Although these hatchery fish are the only extant population of the Hells Canyon steelhead Major Population Group they are not listed under the ESA. These fish are generally referred to as “A-run” fish and the majority (approximately 65%) mature after one year in the ocean.

Pahsimeroi (PAH)—The development of PAH stock began in brood year 1966 with the release of OX smolts into the Pahsimeroi River. Their return (brood year 1969) produced the first PAH production. The PAH stock was largely self-sustaining by 1970 and has been managed as a locally adapted stock since then, with few and infrequent releases of other stocks. Like the stock from which they were derived, the majority (approximately 80%) of PAH fish mature after one year in the ocean and are referred to as A-run fish.

Sawtooth (SAW)—The development of the SAW stock was initiated in brood year 1982 by releasing PAH smolts at the Sawtooth weir. Their return (brood year 1985) produced the first SAW production but PAH smolt releases continued at the Sawtooth weir release site until brood year 1999, at which time the SAW stock became fully self-sustaining and PAH releases were discontinued. Since then the SAW stock has been managed as a locally adapted stock and releases of other steelhead stocks at this location have not occurred. Like the stock from which they were derived, the majority (approximately 80%) of SAW fish mature after one year in the ocean and are referred to as A-run fish.

East Fork Natural Stock (EFNAT)—The EFNAT program was initiated in brood year 2001 in a supplementation effort to increase the abundance of naturally produced adult steelhead in the East Fork Salmon River. Adult hatchery and natural steelhead collected at the East Fork Satellite Facility are used as broodstock for this program. The EFNAT hatchery-origin steelhead are listed under the ESA.

Upper Salmon B-run (USAL)—The USAL program was initiated to develop a locally adapted broodstock to the upper Salmon River, in which the majority (90%) of adults mature after two or more years in the ocean. This stock was developed from progeny of DWOR stock adults spawned at Dworshak that were reared at Magic Valley and released in Squaw Creek, a tributary of the upper Salmon River near Clayton, Idaho. Adult returns from the original releases of DWOR smolts have been trapped at a temporary adult weir in Squaw Creek and used as locally adapted component of broodstock for the USAL program since 2002. This locally adapted stock will replace DWOR releases in the Salmon River once the program is up to full production.

LSRCP Rearing Facilities

The LSRCP mitigation plan identified adult return goals for each of the three LSRCP rearing facilities in Idaho (Table 2, USACE 1975). Annual smolt production targets were identified for each facility based on adult return goals and an anticipated smolt-to-adult survival rate; however, the actual production targets changed over time. These changes are discussed in the facility descriptions below. In addition to the adult return goal, the plan also identified an anticipated 2:1 distribution of harvest benefits downstream:upstream of LGD; which was used to identify an escapement to LGD objective.

Table 2. Adult production goals, escapement targets to Lower Granite Dam (LGD), smolt-to-adult survival rates (SAS), and smolt production targets for the LSRCP and IPC steelhead mitigation hatcheries in Idaho.

Mitigation Program	Rearing Hatchery	Adult Production Goal	SAS (%)	Escapement to LGD	Smolt Production Target
LSRCP	Clearwater	42,000	3.91	14,000	1,750,000
LSRCP	Hagerman	40,800	3.16	13,600	1,700,000
LSRCP	Magic Valley	34,980	2.19	11,660	1,600,000
IPC	Niagara Springs	NA	NA	NA	1,800,000[1]

[1] The production goal for Niagara Springs is based on 400,000 pounds of steelhead being released as smolts at 4.5 fish per pound. This facility does not have an adult production or escapement goal.

Clearwater Fish Hatchery—is located at the confluence of the North Fork Clearwater and mainstem Clearwater rivers near Ahsahka, Idaho. Clearwater's mitigation goal is to annually produce 42,000 adult steelhead. Clearwater annually releases approximately 843,000 smolts to achieve this goal. It is important to note that Clearwater's annual smolt production goal was originally 1,750,000 smolts, which has never been met due to limited water availability and to provide more rearing space for the Chinook salmon program at that facility. Despite these smolt reductions, the adult return goal remains the same. Clearwater receives green eggs from one stock (DWOR) and rears them to yearling smolts for release into the Clearwater River basin (Figure 1). In addition to its primary mitigation function as a rearing facility, Clearwater also receives green DWOR eggs that are incubated to the eyed egg stage before being transferred to Magic Valley Fish Hatchery for final rearing and release into the Salmon River.

Hagerman National Fish Hatchery—is located along the Snake River in southern Idaho near the town of Hagerman, Idaho. Hagerman's mitigation goal is to annually produce 40,800 adult steelhead. Hagerman was originally intended to produce 1,700,000 smolts to meet this goal; however, through the 1990s production was incrementally decreased to 1,140,000 smolts due to litigation over water rights that could have substantially reduced water availability. The litigation was resolved in the late 1990s and production was incrementally increased. Hagerman's brood year 2007 production target was 1,450,000 smolts. Hagerman receives eyed eggs from three stocks (DWOR, PAH, and SAW) to meet the production target. This production is released into the Salmon River basin as yearling smolts (Figure 2).

Magic Valley Fish Hatchery—is located along the Snake River near Filer, Idaho. The annual mitigation goal for this facility is to produce 34,980 adult steelhead. To achieve this goal Magic Valley was originally intended to release 2,000,000 smolts annually; however, the actual annual production targets varied through the history of the facility to compensate for production reductions at Hagerman and reduced water availability at Magic Valley. Magic Valley's annual production target was incrementally reduced in the early 2000s due to a decline in water availability. By brood year 2005, production was reduced to 1,600,000 smolts; which was also the target in brood year 2007. Magic Valley receives eyed eggs from five stocks (DWOR, EFNAT, PAH, SAW, and USAL) to satisfy production needs. This production is released into the Salmon River basin as yearling smolts (Figure 2).

IPC Rearing Facilities

Niagara Springs Fish Hatchery—is located on the Snake River near Wendell, Idaho. Unlike other facilities, which receive only eyed eggs, Niagara Springs receives eyed eggs and fry from two stocks (OX and PAH). Steelhead produced at Niagara Springs are released in the Snake and Salmon rivers (Figure 2). The smolt production goal for Niagara Springs is to release 400,000 pounds of smolts annually, which equates to approximately 1,800,000 yearling smolts at 4.5 fish per pound. Although this facility/mitigation program does not have a specific adult return goal, smolts released from Niagara Springs are expected to survive to the adult life stage at rates comparable to other faculties.

METHODS

Juvenile Production

Broodstock Collection and Smolt Production

Adult steelhead trapping, spawning, and egg production information is compiled from brood year or run reports prepared by the broodstock collection facilities. Key parameters for broodstock collection include the total number of adults trapped, number of adult fish spawned, the number of green eggs collected, and the number of eggs shipped.

Juvenile production information is compiled from brood year reports prepared by staff at the rearing facilities. Key parameters reported included eyed eggs received, as well as the number of smolts released and their marks/tags. Hatchery staffs use these values to estimate eyed egg-to-smolt survival rates.

Marking and Tagging

IDFG staff marked (clipped fins) and tagged hatchery steelhead production to meet specific management and evaluation objectives. The presence (ad-intact) or absence of an adipose fin (ad-clip) is used as the sole designator of a harvestable hatchery-origin fish in mark selective fisheries and is also one of the primary indicators of origin at hatchery traps. Some ad-intact hatchery smolts are released pursuant to the 2008-2017 *U.S. v. Oregon* Management Agreement or for other management objectives. Some of these ad-intact fish can be visually identified as hatchery origin by secondary characteristics (fin erosion). Coded wire tags (CWTs) are an important tool for monitoring and evaluating steelhead and are used to generate release group-specific harvest and stray estimates. These tags also provide a known age component at hatchery traps to use in assigning an age composition to the entire hatchery return at each trap. Lastly, CWTs are sometimes used as a differential mark for broodstock and weir management purposes. Passive integrated transponder (PIT) tags serve multiple purposes and like CWTs are an important tool for monitoring and evaluating hatchery steelhead programs. PIT tags are used to generate estimates of juvenile survival to LGD and juvenile run timing through the Snake and Columbia river hydropower system. As fish return as adults, PIT tags provide in-season stock- and age-specific return estimates and arrival timing, as well as conversion rates between dams. There was a substantial increase in the number of PIT tags within release groups as well as an increase in the number of tagged release groups in 2008 compared to previous years. This increase provided a commensurate improvement in the power to estimate juvenile survival rates to LGD as well as estimates of adult returns at detection arrays at Columbia River and Snake River hydroelectric dams for in-season run estimates.

Juvenile Migration Timing and Survival

I used PIT tag detection information submitted to PTAGIS to estimate juvenile survival from release to LGD. Observation sites specified in the query included seven dams on the Snake and Columbia rivers: LGD, Little Goose, Lower Monumental, Ice Harbor, McNary, John Day, and Bonneville. Using this information, the "arrival window" was summarized (the period in which the middle 80% of smolts arrive to LGD). Survival rates of PIT-tagged steelhead, from release to LGD, were estimated using the PitPro program (Westhagen and Skalski 2009). This program generates a point estimate and a standard error for determining 95% confidence intervals. The program uses the Cormack-Jolly-Seber model (Cormack 1964; Jolly 1965; Seber 1965) for single release and multiple recapture events, which accounts for differences in collection efficiency at the main stem Snake and Columbia River dams.

Adult Returns

Harvest in Idaho Fisheries

After each of the fall and spring steelhead fisheries conclude, mail and/or phone harvest surveys are conducted to estimate statewide harvest (SWH). This information is summarized for each river section (Figure 3) and month combination (stratum). I allocated harvest within a stratum to individual release group(s) by expanding CWTs recovered during creel surveys by the sample rate (fraction of the estimated harvest that was observed by creel staff in the stratum) and tagging rate (fraction of release group that was CW-tagged). I then adjusted these expanded estimates to the SWH estimate. Although most release groups were represented with CWTs, return estimates of ad-clipped release groups that were not represented by CWTs were determined by combining them with release groups that did contain CWT fish into a single release group for analysis of recoveries. These larger groups were generally composed of the same stock reared and released from the same hatchery. When groups from different hatcheries or of different stocks were combined, it was assumed that the survival and harvest rate of all fish within the combined group was the same. CWT tagging rate information for Dworshak (USFWS), State of Oregon, and State of Washington releases in the Snake River basin was obtained from these cooperators.

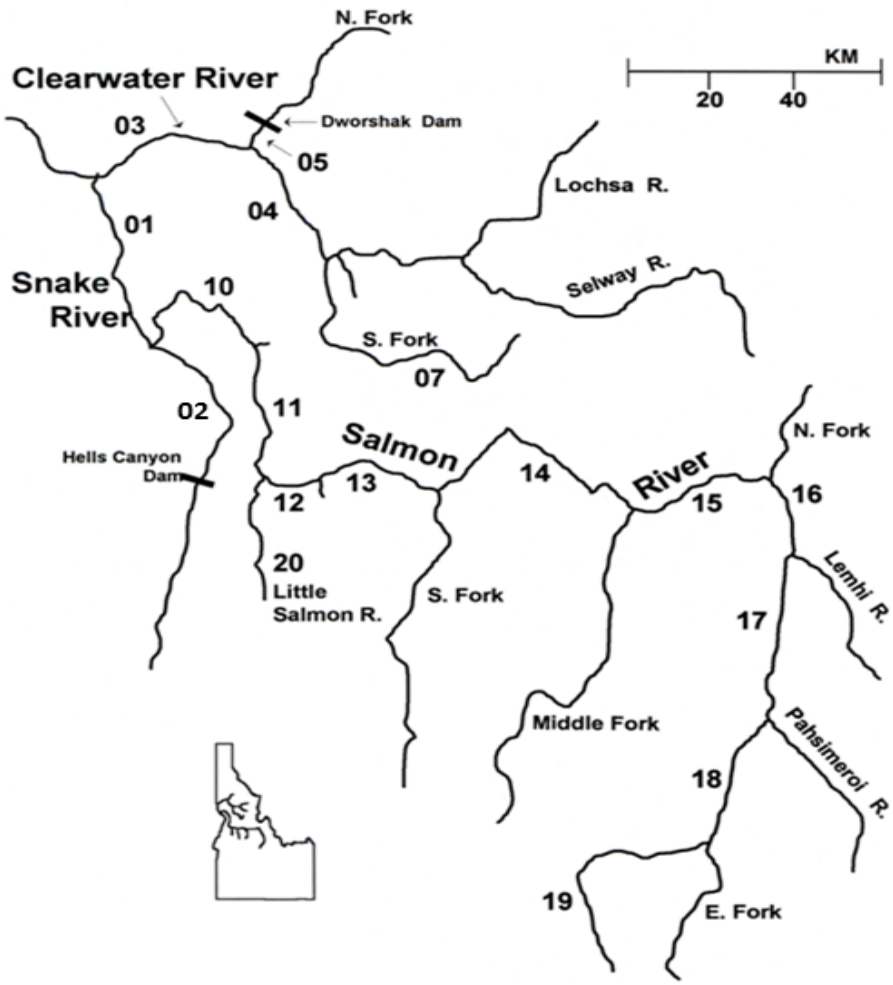

Figure 3. Idaho Department of Fish and Game river section designations where hatchery steelhead are available for harvest. Major tributaries or dams indicated on the map are used as section boundaries.

Harvest Outside of Idaho

In 2014 I queried CWT recovery information submitted to the Regional Mark Information System to estimate harvest in the Columbia River and the Lower Snake River outside of Idaho (RMIS, http://www.rmpc.org). Coded wire tag recoveries were expanded by the tagging rate for each release group and the survey rate reported to RMIS by the respective recovery agency. If a survey rate was not reported for a given CWT recovery, it was assumed to be "1". Data submitted to RMIS also included sampling and CWT recovery information from the non-selective Zone 6 tribal fishery, which was used to estimate harvest of ad-intact and ad-clipped adult steelhead from that fishery.

Harvest Rates

Harvest rate estimates are calculated as the proportion of fish entering a fishery that are harvested. Harvest rates are summarized at the stock level at each hatchery facility. The number of adults entering a fishery is based on reconstructing the run starting in the terminal area and working downstream adding up the all harvest and combining with the escapement. Because most of the ad-intact releases of steelhead occur at offsite locations without adult trapping facilities and I must rely on surrogate releases to estimate the escapement, I do not provide estimates of harvest rates for ad-intact release groups.

Hatchery Trap Returns

Hatchery staff enumerated and recorded biological information from steelhead that escaped fisheries and were collected at hatchery traps. I used this information to estimate the age composition of adults returning to individual hatchery facilities by one of two methods. In cases where enough known age information is available from CWT recoveries, the statistical computer program *R* (R Development Core Team 2010) was used with the *mixdist* library package (Macdonald 2010) to estimate the proportion of each age group from the total return. *Rmix*, as it is called, was designed to estimate the parameters of a mixture distribution with overlapping components, such as the overlapping length distributions associated with adult steelhead returns composed of multiple age classes. If known age information was lacking, then age composition was estimated using the NORMSEP feature in the FAO-ICLARM Stock Assessment Tools (FiSAT) II software (Gayanilo et al. 2005). This method also applies the maximum likelihood concept and provides an estimated proportion of fish in each age class.

Unharvested Escapement for Offsite Releases

Estimating unharvested escapement for offsite releases, where there was no weir to trap fish, presents a problem in that harvest is the only parameter that can be directly estimated for these fish using CWT. To overcome this, I used a smolt-to-adult return rate (see “Brood Year Reconstruction, SAR, and SAS” section below) from a surrogate release group to estimate adult returns upstream of LGD for each offsite release group. I then deducted harvest (a direct estimate) from the estimated return at LGD and the difference between the two values represents the unharvested escapement for the offsite release group in question. Release groups used and surrogates were typically released at a nearby broodstock collection facility with a permanent weir. The Sawtooth release group from Hagerman was used as a surrogate for PAH and SAW stock releases from Magic Valley in the Salmon River downstream to Challis. The Niagara Springs release group at Pahsimeroi was used as a surrogate for all other PAH and SAW releases in the basin, and the Squaw Creek release group was used as a surrogate for all DWOR and USAL releases in the Salmon River basin. Dworshak’s onsite release was used as a surrogate for Clearwater’s releases into the South Fork Clearwater River. SAR data for Dworshak releases was provided by USFWS staff (Chris Peery personal communication).

Straying

Any CWT recovered outside of the direct path to the juvenile release site after they have entered fresh water as an adult is classified as a stray. This includes some areas out of the direct path where fish are known to stage presumably to seek thermal refuge. It is likely that some of the fish recovered from fisheries in these areas would have continued back on the path to their release site had they not been harvested. Because we do not know with certainty which fish would have done this, all fish recovered outside the direct path are classified as strays.

Exceptions to this include fish recovered in the John Day Arm and Drano Lake as these areas were inundated with slack water from the Columbia River. Strays recovered in fisheries downstream and upstream of LGD were expanded using coded wire tags and the methods discussed in the Harvest Outside of Idaho section. Steelhead released with CWT from the production hatcheries in this report do not have a left ventral (LV) fin clip that is used as a flag for CWT fish. If sampling crews rely on visual sampling instead of electronic sampling for CWT, fish originating from these facilities will be missed in the sample.

Brood Year Reconstruction, SAR, and SAS

Adult return estimates to Bonneville Dam and to LGD were based on the combined estimates of harvest, strays, and returns to the rack as described above. Adult returns were summarized by two large geographical areas, upstream and downstream of LGD, to evaluate mitigation goals and provide information for other management purposes. The dispositions of adults within these areas were also summarized to provide perspective on how these returns were utilized.

In addition to evaluating mitigation goals, I used adult return estimates to evaluate survival rates to the adult life stage. The estimated number of adult steelhead escaping to LGD was divided by the number of smolts released for the group in question to generate a smolt-to-adult return rate (SAR). Similarly, the estimated total number of adult steelhead produced (the sum of adults accounted for upstream and downstream of LGD) was divided by the number of smolts released from the group in question to generate total smolt-to-adult survival rate (SAS) that represents the total number of adults produced prior to any human exploitation.

I calculated progeny-to-parent ratios (PPR) to provide the full lifecycle (adult to adult) productivity of program fish. The PPRs were estimated by dividing the total number of adult steelhead returning from a brood year by the number of males and females that were spawned to create the brood in question. Parents whose progeny were culled to eliminate excess production or parents that were culled because they tested positive for disease were not included in the estimate. A PPR value of one is the threshold in which the brood is replacing itself or each male/female pair is returning two progeny as adults to LGD. At the current production levels of 843,000 smolts at Clearwater, 1,450,000 smolts at Hagerman, and 1,600,000 smolts at Magic Valley, a PPR of approximately 70 for Clearwater and 30 for Hagerman and Magic Valley are needed to achieve the total adult mitigation goal.

In addition to estimating adult returns through a traditional run reconstruction methodology as described above, brood year 2007 steelhead releases from Clearwater, Hagerman, and Magic Valley fish hatcheries were tagged at a sufficiently high rate with PIT tags to directly estimate the returns to Bonneville and LGD. The estimates are based on the sum of the expanded PIT tag detections (reciprocal of the tag rate) of steelhead that were detected by PIT tag arrays as they ascended the ladders on both dams in return years 2009, 2010, and 2011. This methodology assumes equal tag to untagged ratios from juvenile release to adult detection.

RESULTS

Juvenile Production

Broodstock Collection and Egg Production

In most cases, hatchery staffs collect broodstock in late March through early May and spawn fish shortly thereafter. The exception to this is the OX stock where broodstock is collected from late September through October at the Hells Canyon Fish Trap and held for spawning until spring at Oxbow Fish Hatchery. Limited broodstock collection does occur at the Hells Canyon Fish Trap in the spring if conditions permit (high flows can prohibit the use of this trap) and generally accounts for 10% of the total adults spawned.

Prespawn mortality occurs at very low rates (<1% of total trapped) for most stocks because steelhead are held in cold water and only held for short periods of time prior to spawning. Due to the fall collection and extending holding period for broodstock captured at Hells Canyon dam, prespawn mortality does occur at a slightly higher rate for the OX stock. For brood year 2007, prespawn mortality was approximately 4%.

Fecundity rates for each stock in brood year 2007 were similar to recent years (Tables 3, Appendix A). There were consistent differences in fecundity between stocks, which are due to differences in age structure. The majority of PAH and SAW fish return as smaller, less fecund adults after one year in the ocean. Conversely, the majority of DWOR and USAL fish return as larger, more fecund adults after two or more years in the ocean. It is also interesting to note that the life history of the OX stock is intermediate to the other groups (a more balanced age at maturity between one- and two-ocean fish).

Survival from the green egg to eyed egg stage (eye-up rate) ranged from 83.2% to 95.1% for DWOR, OX, PAH, and SAW stocks in brood year 2007. Eye-up rates for EFNAT and USAL stocks were 76.7% to 56.4%, respectively (Table 3, Appendix B). The EFNAT and USAL stocks are both small runs spawned at the East Fork Salmon River facility and eye-up rates may have been influenced by the repeated handling of females as they were checked for ripeness. In order to account for lower than expected survival rates, spawning facilities generally collected more eggs than necessary to ensure egg requests were met. Eggs not needed for production were usually culled onsite; however, in some cases these eggs were used in resident trout programs.

Table 3. Spawning and egg production information for steelhead eggs shipped to LSRCP and IPC rearing facilities for brood year 2007.

Broodstock Facility (stock)	Rearing Hatchery	Females Spawned	Fecundity	Green Eggs [1]	Production Shipped	Eye-up rate (%)
Dworshak (DWOR)	Clearwater	177	7,152	1,270,137	950,280	94.5
	Hagerman	45	7,152	320,461	217,137	94.5
	Magic Valley	160	7,152	1,147,096	863,651	94.5
East Fork (EFNAT)	Magic Valley	46	5,460	251,181	192,777	76.7
Oxbow (OX)	Niagara Springs	289	5,980	1,728,208	918,483	83.7
Pahsimeroi (PAH)	Hagerman	87	5,224	456,593	220,000	92.0
	Magic Valley	150	4,906	736,945	496,518	95.1
	Niagara Springs	661	4,598	3,037,379	1,125,003	94.2
Sawtooth (SAW)	Hagerman	287	4,810	1,346,972	1,107,801	83.2
	Magic Valley	98	4,810	462,622	380,478	83.2
Squaw Creek (USAL)	Magic Valley	21	6,834	143,521	80,939	56.4

[1] Extra green eggs are produced to ensure egg production request were met. This excess production is reflected in the green egg number.

Onsite Survival at Rearing Hatcheries

Similar to previous years, eyed egg-to-smolt release survival was high across all hatcheries in brood year 2007, averaging an onsite survival rate of 88.8% for all stocks at all three rearing facilities (Table 4, Appendix C). Hagerman National Fish Hatchery had an epizootic outbreak of *Aeromonas salmonicida* (Furunculosis) diagnosed in all their steelhead stocks in early April, 2008 (U.S. Fish and Wildlife Service 2008). The DWOR stock presmolts were hit hardest, incurring a 1% mortality per day for several days, leading to an overall mortality rate of 16% for the total BY 2007 production from eyed egg stage to release. Magic Valley Fish Hatchery incurred no significant losses due to any unanticipated events or disease outbreaks in their BY 2007 stocks (Lowell et al. 2008). Better than predicted early rearing survival in all their steelhead stocks resulted in the release of 219,172 surplus fry into Salmon Falls Creek Reservoir. Niagara Springs Fish Hatchery received all of their BY 2007 production from Oxbow Fish Hatchery, including PAH stock eggs and fry, which were shipped as green eggs to Oxbow Fish Hatchery from Pahsimeroi Fish Hatchery. Approximately half of the shipment to Niagara Springs Fish Hatchery arrived as eyed eggs while the rest arrived as swim-up fry. A temporary loss of water to the incubation stacks at Oxbow Fish Hatchery during maintenance on a water chiller unit resulted in the loss of 1,180,740 fry before shipping to Niagara Springs Fish Hatchery (Hills et al. 2007). There were also losses of fry after arrival at Niagara Springs Fish Hatchery associated with bacterial coldwater disease *Flavobacterium psychrophilum* (Page et al. 2008). Size at release of all stocks ranged from 4.0 fish/lb. to 4.8 fish/lb., which is consistent with releases from recent brood years (Table 4, Appendix D).

Table 4. Eyed eggs received and eyed egg-to-smolt (onsite) survival estimates for LSRCP and IPC steelhead rearing facility for brood year 2007.

Rearing Hatchery	Stock	Eyed-eggs Received	Smolts Released	Size at Release (fpp)	Onsite Survival (%)
Clearwater	DWOR	1,200,280 [1]	819,549	4.6	86.2
Hagerman	DWOR	198,125	179,036	4.7	90.4
	PAH	209,945	205,546	4.3	97.9
	SAW	1,121,477	1,002,943	4.0	89.4
	Total	**1,529,547**	**1,387,525**		
Magic Valley	DWOR	863,651	690,321	4.7	89.6 [2]
	EFNAT	185,100	155,079	4.6	90.7
	PAH	496,518	372,393	4.7	91.3 [2]
	SAW	409,157	340,802	4.4	94.6 [2]
	USAL	80,148	62,314	4.2	89.3 [2]
	Total	**2,034,574**	**1,620,909**		
Niagara Springs	OX [3]	913,973	810,277	4.8	88.6
	PAH [3]	1,108,682	887,119	4.3	80.0
	Total	**2,022,655**	**1,697,396**		

[1] 250,000 excess eyed eggs were culled from the 1,200,280 eyed eggs delivered from Dworshak.
[2] On site survival estimates include a release of 219,172 excess fry into Salmon Falls Creek Reservoir from DWOR, PAH, SAW and USAL stocks combined in early September, 2007.
[3] Approximately half of the production was received as fry.

Smolt Releases

A combined total of 5,525,000 brood year 2007 steelhead smolts were released from all rearing facilities from March through May 2008 (Table 5). Clearwater and Hagerman were both slightly below their smolt release goals of 843,000 and 1,450,000 respectively. Niagara Springs Fish Hatchery released a total of 1,697,396 smolts (376,800 lbs.) at 4.48 fish/lb., slightly less than their goal of releasing 400,000 lbs. of smolts at about 4.5 fish/lb. Magic Valley Fish Hatchery met their smolt release goal of 1,600,000 fish. Clearwater, Hagerman, and Magic Valley fish hatcheries have all reduced production goals from their original intended levels due to reduced water availability and/or management priorities (see “LSRCP Rearing Facilities” section in the Introduction).

Table 5. Smolt release and mark information for brood year 2007 hatchery steelhead released in Idaho for the IPC and LSRCP mitigation program.

Hatchery	Release Site	Stock	AD	AD/CWT	CWT	None	Total Release
Clearwater	Crooked River	DWOR	78,520	66,095			144,615
	Crooked River	DWOR			26,406	45,763	72,169
	Lolo Cr	DWOR				45,629	45,629
	Red River	DWOR	50,104	32,922			83,026
	Red River	DWOR				163,580	163,580
	Meadow Cr	DWOR				31,431	31,431
	Mill Cr	DWOR				31,430	31,430
	Red House	DWOR	184,752	62,917			247,669
	Clearwater Total		**313,376**	**161,934**	**26,406**	**317,833**	**819,549**
Hagerman	E.Fk.@Dumpster	DWOR	61,345	25,588			86,933
	L.Salmon@Hwy95Br	PAH				44,310	44,310
	L.Salmon@Stinky	DWOR	62,952	29,151			92,103
	L.Salmon@Stinky	PAH				161,236	161,236
	Sawtooth	SAWA	689,622	77,901			767,523
	Yankee Fork	SAWA	100,879			134,541	235,420
	Hagerman Total		**914,798**	**132,640**	**-**	**340,087**	**1,387,525**
Magic Valley	E.Fk.@Dumpster	DWOR	196,869	29,777			226,646
	E.Fk.Trap	EFNAT			61,129	1,891	63,020
	L.Salmon@Pinehurst	DWOR	157,722	59,458			217,180
	Pahsimeroi	PAH	1,946	28,787			30,733
	Colston	PAH	100,238	28,918			129,156
	McNabb	SAWA	87,040	28,483			115,523
	Red Rock	PAH	92,016	29,398			121,414
	Shoup	PAH	91,090				91,090
	Tunnel	SAWA	70,669				70,669
	Slate Ck	EFNAT	959	31,016		60,084	92,059
	Squaw Ck	DWOR	183,585				183,585
	Squaw Ck	USAL	1,870	60,444			62,314
	Squaw Ck ponds	DWOR	2,307	60,603			62,910
	Valley Ck	SAWA				62,484	62,484
	Yankee Fork	SAWA	32,757	28,674		30,695	92,126
	Magic Valley Total		**1,019,068**	**385,558**	**61,129**	**155,154**	**1,620,909**
Niagara Springs	L.Salmon@Pinehurst	OX	244,544	28,362			272,906
	L.Salmon@Pinehurst	PAH	18,260	30,440			48,700
	Pahsimeroi	PAH	776,012	62,407			838,419
	SnakeR@Hells Canyon	OX	508,032	29,339			537,371
	Niagara Springs Total		**1,546,848**	**150,548**	**-**	**-**	**1,697,396**
	Grand Total		**3,794,090**	**830,680**	**87,535**	**813,074**	**5,525,379**

Juvenile Migration Timing and Survival

Survival rates of PIT-tagged steelhead from release to LGD averaged 76.9% (unweighted), which is similar to recent years (Appendix E). The ad-intact Crooked River DWOR stock release (Clearwater) had the lowest survival rate (50.7% ± 6.6) and the ad-clipped Little Salmon River PAH stock release (Hagerman) had the highest survival rate (93.8% ± 4.1) (Table 6). The majority of migrants arrived at LGD from late April through May of 2008. Travel times from release to arrival at LGD averaged 20 days and ranged from 10 days to 53 days.

Table 6. Estimated survival from release to LGD for brood year 2007 (migration year 2008) hatchery origin juvenile steelhead released from LSRCP and IPC facilities in Idaho.

Hatchery	Stock	Release Site	Number PIT Tagged	Release Date	80% Arrival Window (# of Days)	% Survival Est. to LGD (95% C.I.)
Clearwater	DWOR	Lolo Ck	995	4/21	5/4-5/19 (17)	81.3 (+/-12.9)
	DWOR	Meadow Cr.	896	4/18	5/4-5/18 (16)	84.3 (+/-15.3)
	DWOR	Mill Cr.	900	4/18	5/9-5/19 (12)	51.7 (+/-18.4)
	DWOR	Red House Hole	5,676	4/10	4/23-5/12 (21)	82.4 (+/-4.4)
	DWOR	Crooked R. Ad-clip	3,285	4/11	5/4-5/21 (17)	74.5 (+/-5.8)
	DWOR	Crooked R. Ad-intact	2,597	4/11	5/12-6/1 (20)	50.7 (+/-6.6)
	DWOR	Red River Ad-clip	2,786	4/10	5/4-5/22 (18)	64.1 (+/-6.3)
	DWOR	Red River Ad-intact	2,890	4/10	5/8-5/26 (18)	55.0 (+/-5.6)
Hagerman	DWOR	E. Fork Salmon R.	5,192	5/9	5/18-5/26 (10)	71.9 (+/-5.7)
	DWOR	Little Salmon R.	6,140	4/10	4/25-5/19 (26)	57.9 (+/-3.2)
	PAH	Little Salmon R.	5,752	4/16	4/19-5/17 (30)	93.8 (+/-4.1)
	SAW	Sawtooth Weir	9,887	4/27	5/3-5/20 (19)	86.2 (+/-3.5)
	SAW	Yankee Fork Ad-clip	983	5/12	5/19-6/9 (21)	76.8 (+/-9.7)
	SAW	Yankee Fork Ad-intact	1,494	5/12	5/19-6/7 (19)	88.1 (+/-11)
Magic Valley	DWOR	E. Fork Salmon	4,251	4/18	5/5-5/18 (15)	76.6 (+/-4.1)
	DWOR	Little Salmon R.	4,691	4/7	4/20-5/21 (33)	85.3 (+/-4.4)
	DWOR	Squaw Ck	4,712	4/23	5/7-5/20 (15)	70.7 (+/-2.3)
	DWOR	Squaw Pond	1,493	4/15	5/5-5/25 (22)	61.2 (+/-7.1)
	EFNAT	E. Fork Salmon	1,299	4/25	5/9-5/20 (13)	78.2 (+/-8.2)
	EFNAT	Slate Ck Ad-clip	594	4/21	5/3-5/20 (17)	72.1 (+/-8.8)
	EFNAT	Slate Ck Ad-intact	1,247	4/21	5/9-5/26 (17)	75.9 (+/-7.7)
	PAH	Pahsimeroi R.	440	4/14	4/29-5/18 (19)	80.9 (+/-12.1)
	PAH	Salmon R. @ Red Rock	1,396	4/10	4/23-5/44 (23)	81.5 (+/-4)
	PAH	Salmon R. @ Shoup Br.	1,397	4/14	4/29-5/12 (15)	81.6 (+/-7)
	SAW	Valley Ck	996	4/29	5/10-5/20 (12)	92.9 (+/-4.5)
	SAW	Yankee Fork Ad-clip	896	4/30	5/12-6/7 (26)	74.2 (+/-8.7)
	SAW	Yankee Fork Ad-intact	696	4/30	5/12-6/7 (26)	86.9 (+/-15.2)
	USAL	Squaw Ck	6,155	4/24	5/7-5/20 (15)	78.7 (+/-2.7)
Niagara Spgs.	OX	Hells Canyon Dam	300	3/28	4/19-6/9 (53)	85.4 (+/-10.6)
	OX	Little Salmon R.	298	4/7	4/28-5/18 (22)	92.7 (+/-12.4)
	PAH	Little Salmon R.	301	4/9	4/25-5/18 (25)	84.8 (+/-10.7)
	PAH	Pahsimeroi Weir	295	4/14	4/27-5/15 (18)	83.7 (+/-13.6)
	Total PIT Tagged:		**80,930**			

Adult Returns

Recreational Harvest in Idaho Fisheries

Adult steelhead from brood year 2007 releases contributed to fisheries over the course of multiple runs from the fall of 2009 through the spring of 2012. During that time recreational fisheries for steelhead occurred in the Snake, Clearwater, Little Salmon, and Salmon rivers in Idaho. Recreational anglers harvested approximately 106,551adult steelhead from brood year 2007 (Table 7), which exceeds the harvest of any previous brood year cohort for which records have been maintained for the Idaho fishery. Tribal harvest estimates were not available.

Table 7. Estimated recreational harvest upstream of LGD for brood year 2007 hatchery origin steelhead released from LSRCP and IPC facilities in Idaho. Estimates were derived from coded wire tag recoveries in the fisheries from the fall 2009 through the spring of 2012.

Hatchery	Stock	1-ocean	2-ocean	3-ocean	Total
Clearwater	DWOR*	1,081	7,057	24	8,162
Clearwater Total		**1,081**	**7,057**	**24**	**8,162**
Hagerman	DWOR	230	864	-	1,095
	PAH*	-	-	-	-
	SAW*	22,301	1,719	52	24,072
HagermanTotal		**22,531**	**2,584**	**52**	**25,167**
Magic Valley	DWOR	1,052	2,919	146	4,117
	EFNAT*	66	8	-	74
	PAH	13,469	568	47	14,084
	SAW*	4,989	1,908	19	6,916
	USAL	110	720	11	841
Magic Valley Total		**19,686**	**6,123**	**223**	**26,032**
Niagara Springs	OX	11,223	4,769	-	15,991
	PAH	27,223	3,976	-	31,199
Niagara Springs Total		**38,446**	**8,744**	**-**	**47,190**
Grand Total		**81,744**	**24,508**	**299**	**106,551**

* The release included some unclipped fish and therefore not subject to harvest in mark selective fisheries (see Table 5).

Harvest in non-Idaho Fisheries

Brood year 2007 releases from LSRCP and IPC facilities contributed 14,920 adult steelhead to fisheries in the Columbia River and Lower Snake River downstream of the Idaho-Washington state border. Table 8 includes harvest from all release groups, including those with ad-intact fish, which was estimated from RMIS data available from the non-selective tribal fishery in Zone 6. All stocks contributed to these fisheries with OX and PAH stocks released from Niagara Springs contributing to approximately half the harvest. The fisheries in Zones 1-5 (sport) and Zone 6 (tribal) accounted for the vast majority of harvest downstream of LGD.

Table 8. Harvest summary in the Columbia River and Snake River downstream of LGD for brood year 2007 hatchery steelhead released from LSRCP and IPC facilities.

Hatchery	Stock	Ocean	Zones 1-5 Sport	Zone 6 Sport	Zone 6 Tribal	McNary to Snake R.	Snake R. Downstream of LGD	Total
Clearwater	DWOR ad-clipped	-	127	9	910	60	60	1,165
	DWOR ad-intact				271			271
Clearwater Total		-	127	9	1,180	60	60	1,436
Hagerman	DWOR ad-clipped	-	-	3	38	-	19	60
	PAH ad-intact	-	-	-	232	-	-	232
	SAW ad-clipped	-	574	38	1,553	309	165	2,639
	SAW ad-intact				152			152
HagermanTotal		-	574	42	1,974	309	184	3,083
Magic Valley	DWOR ad-clipped	-	91	7	161	56	291	606
	EFNAT ad-clipped	-	43	-	23	-	1	68
	EFNAT ad-intact				139			139
	PAH ad-clipped	15	727	39	735	9	103	1,624
	SAW ad-clipped	-	240	19	192	-	-	451
	SAW ad-intact				105			105
	USAL ad-clipped	-	14	1	36	-	24	75
Magic Valley Total		15	1,115	66	1,392	65	419	3,072
Niagara	OX ad-clipped	37	2,751	38	1,411	-	78	4,315
	PAH ad-clipped	-	1,395	28	1,434	-	159	3,016
Niagara Total		37	4,147	66	2,845	-	237	7,332
Grand Total		52	5,963	183	7,391	434	900	14,923

Harvest Rates

Harvest rates of ad-clipped hatchery steelhead downstream of LGD ranged from 4.1% to 15.8% (8.1% average) of the estimated total adult return (Table 9). Harvest rates upstream of LGD were substantially higher, averaging 72.9% and ranging from 6.2% for the Magic Valley release at Slate Cr. to 96.3% for Magic Valley's DWOR release group. The highest estimated

harvest rates are from the USAL and DWOR groups released from Hagerman and Magic Valley fish hatcheries. All these groups were released at offsite locations which prevents developing an accurate estimate of escapement. It is likely the harvest rates on these groups are overestimated.

Table 9. Estimated harvest and harvest rates upstream and downstream of LGD for brood year 2007 steelhead released from LSRCP and IPC facilities. Unlike Tables 7 and 8, this table includes harvest of fish from only ad-clipped release groups.

		Downstream of LGD			Upstream of LGD			Combined	
Facility	Stock	Return	Harvest	Harvest Rate (%)	Return	Harvest	Harvest Rate (%)	Harvest	Harvest Rate (%)
Clearwater	DWOR	12,371	1,165	9.4	11,207	8,162	72.8	9,327	75.4
Clearwater Total		12,371	1,165	9.4	11,207	8,162	72.8	9,327	75.4
Hagerman	DWOR	1,251	60	4.8	1,184	1,095	92.5	1,155	92.3
	SAW	34,978	2,639	7.5	32,317	24,072	74.5	26,711	76.4
Hagerman Total		36,229	2,699	7.4	33,501	25,167	75.1	27,866	76.9
Magic Valley	DWOR	4,893	606	12.4	4,276	4,116	96.3	4,722	96.5
	EFNAT	1,263	68	5.4	1,195	74	6.2	142	11.2
	PAH	21,687	1,624	7.5	20,024	14,084	70.3	15,708	72.4
	SAW	11,049	451	4.1	10,595	6,916	65.3	7,367	66.7
	USAL	969	76	7.8	884	841	95.1	917	94.6
Magic Valley Total		39,861	2,825	7.1	36,974	26,031	70.4	28,856	72.4
Niagara Springs	OX	27,391	4,315	15.8	23,027	15,991	69.4	20,306	74.1
	PAH	49,366	3,016	6.1	46,319	31,199	67.4	34,215	69.6
Niagara Springs Total		76,757	7,331	9.6	69,346	47,190	68.1	54,521	71.2
Grand Total		165,218	14,020	8.5	151,028	106,550	70.6	120,570	73.1

Hatchery Trap Returns

The numbers of adult steelhead from brood year 2007 trapped at brood stock facilities are summarized by age and sex in Table 10. Although three-ocean fish were occasionally encountered in fisheries, none were observed at hatchery traps this brood year. Trapping numbers at Hells Canyon Trap are minimum estimates of what returned to the trapping site because unlike other permanent weirs, the trap is operated primarily in the fall and not throughout the run. The trapping numbers at Squaw Creek, the broodstock collection site for the USAL stock, do not reflect the actual number of fish that returned to this location. This is because smaller one-ocean fish were excluded from the summary because their origin (A-run or B-run releases) was uncertain. Furthermore, the Squaw Creek temporary weir fails during high-water events allowing fish to pass undetected. Therefore, the trap value for this location is a minimum estimate of what actually returned. Appendix F provides an age summary for each broodstock collection facility across all brood years.

Table 10. Summary of age at maturity and average length at age of brood year 2007 hatchery origin steelhead returning to LSRCP and IPC broodstock collection facilities in Idaho.

	Males				Females				
	One-Ocean		Two-Ocean		One-Ocean		Two-Ocean		
Hatchery	Number	Length (cm)	Number	Length (cm)	Number	Length (cm)	Number	Length (cm)	Total
East Fork	342	61	103	74	113	60	153	71	711
Hells Canyon	2,653	62	655	73	2,247	61	1482	70	7,037
Pahsimeroi	6,485	60	225	70	7,735	59	1,062	68	15,507
Sawtooth	3,448	61	431	72	2,032	56	572	68	6,483
Squaw Creek[1]	2	62	23	82	5	59	30	74	60

[1] Includes fish collected by a temporary weir and contributed by anglers. Only those fish meeting the length criteria (females >75 cm and males >79 cm) or confirmed to be of B-run ancestry, via CWT, were included.

Stray Estimates

Straying of hatchery steelhead was observed at low levels/rates across most facilities in brood year 2007. The majority (98%) of strays were observed in fisheries upstream of LGD (Tables 11 and 12). These estimates represent a minimum estimate as it is unfeasible to survey all tributaries that these fish may enter. The highest stray rate of all release groups was the OX stock released from Niagara Springs, which had a 26.5% stray rate of the adults that returned to LGD. Although the release group data is not broken down by release site in Table 12, most of the OX stock strays were from the Little Salmon River release group that were caught by anglers within the mainstem Salmon River adjacent to or upstream of the mouth of the Little Salmon River in river sections 12 and 13 during the fall fishing seasons of 2009 and 2010 (Figure 3). Hatchery steelhead from the Little Salmon River release generally do not enter the Little Salmon River until the spring. Most of the straying of releases from Hagerman and from Magic Valley occurred in the lower Clearwater River in river section 3, which is typical during the fall period when cool water from Dworshak Reservoir is released to cool the lower Clearwater and Snake rivers. Strays were also recovered in the Snake River upstream of the mouth of the Salmon River in river section 2 (Figure 3). In most instances, strays were caught during the fall fishing seasons and would most likely have returned to their normal migration corridor in route to their smolt release site had they not been intercepted in the fishery.

Table 11. Stray estimates of adult hatchery steelhead from Idaho LSRCP and IPC brood year 2007 releases observed at hatchery racks and fisheries in tributaries of the Columbia and Snake rivers.

		Col. R. Below McNary		Col. R. Above McNary		Snake R. Below LGD		Snake R. and Tributaries Above LGD		
Hatchery	**Stock**	**Harvest**	**Rack**	**Harvest**	**Rack**	**Harvest**	**Rack**	**Harvest**	**Rack**	**Total**
Clearwater	DWOR*	-	-	-	-	-	-	-	-	-
Clearwater Total		**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Hagerman	DWOR	-	4	-	-	-	3	83	-	90
	PAH*	-	-	-	-	-	-	-	-	-
	SAW*	-	11	-	13	-	-	512	43	579
Hagerman Total		**-**	**15**	**-**	**13**	**-**	**3**	**594**	**43**	**669**
Magic Valley	DWOR	-	11	-	-	-	-	119	-	130
	EFNAT*	-	-	-	1	-	-	-	-	1
	PAH	-	25	-	9	1	-	516	-	550
	SAW*	-	3	-	-	-	-	112	-	115
	USAL	-	7	-	-	-	2	11	-	20
Magic Valley Total		**-**	**46**	**-**	**10**	**1**	**2**	**758**	**-**	**817**
Niagara Springs	OX	-	39	-	10	-	-	6,108	-	6,157
	PAH	-	31	-	-	-	-	1,515	-	1,546
Niagara Springs Total		**-**	**69**	**-**	**10**	**-**	**-**	**7,623**	**-**	**7,702**
Grand Total		**-**	**131**	**-**	**32**	**1**	**5**	**8,976**	**43**	**9,189**

* All or part of these fish were released with intact adipose fins (see Table 6) and therefore not subject to harvest in selective fisheries.

Table 12. Stray rates of adult hatchery steelhead from Idaho LSRCP and IPC brood year 2007 releases. Summary includes only information for ad-clipped release groups.

		Downstream of LGD			Upstream of LGD			Combined	
Facility	Stock	Adult Returns	Strays	Stray Rates (%)	Adult Returns	Strays	Stray Rates (%)	Total Strays	Total Stray Rates (%)
Clearwater	DWOR	12,371	-	0.00	11,207	-	0.00	-	0.00
Clearwater Total		**12,371**	**-**	**0.00**	**11,207**	**-**	**0.00**	**-**	**0.00**
Hagerman	DWOR	1,251	7	0.56	1,184	83	7.01	90	7.19
	SAW	34,978	25	0.07	32,317	555	1.72	580	1.65
Hagerman Total		**36,229**	**32**	**0.08**	**33,501**	**638**	**1.90**	**670**	**1.84**
Magic Valley	DWOR	4,893	11	0.23	4,276	119	2.87	130	2.73
	EFNAT	1,263	1	0.08	1,195	-	0.00	1	0.08
	PAH	21,707	35	0.16	20,044	516	2.57	551	2.53
	SAW	11,049	3	0.03	10,595	112	1.06	115	1.04
	USAL	969	9	0.93	884	11	1.24	20	2.06
Magic Valley Total		**39,881**	**59**	**0.15**	**36,994**	**758**	**2.06**	**817**	**2.06**
Niagara Springs	OX	27,391	48	0.18	23,027	6,108	26.53	6,157	22.48
	PAH	49,146	31	0.06	46,099	1,515	3.29	1,546	3.15
Niagara Springs Total		**76,537**	**79**	**0.10**	**69,127**	**7,623**	**11.03**	**7,703**	**10.06**
Grand Total		**165,019**	**170**	**0.10**	**150,828**	**9,019**	**5.98**	**9,190**	**5.57**

* All or part of these fish were released with intact adipose fins (see Table 6) and therefore not subject to harvest in mark selective fisheries.

Brood Year Reconstruction, SAR, SAS, and PPR

From brood year 2007 a total of 172,441 adult steelhead reared at Clearwater, Hagerman, Magic Valley, and Niagara Springs fish hatcheries returned to the mouth of the Columbia River during the 2009-10, 2010-11, and 2011-12 steelhead runs (Table 13). Production from LSRCP funded facilities (Clearwater, Hagerman, and Magic Valley fish hatcheries) accounted for 95,684 steelhead, which is 81% of the total mitigation goal for returning adult steelhead, making it the second highest adult return in the history of the program (Appendix G). Hagerman was within a few hundred fish of meeting their mitigation goal of 40,800 fish and Magic Valley exceeded their mitigation goal of 34,980 by more than 7,000 fish. Clearwater was approximately 29,000 short of their mitigation goal. Clearwater fish predominately follow a two-ocean life cycle, which generally have a lower SAR than fish that follow a one-ocean life cycle. Releases from Clearwater are also approximately half of the original smolt release goal due to reduced water availability and limited rearing space. The highest SAS from the 2007 brood year was the PAH stock (5.82%) reared at Magic Valley (Appendix H). Idaho Power Company does not have an adult return mitigation goal but production from Niagara Springs hatchery accounted for 76,758 adult steelhead, which is substantially more than any previously documented return from that facility. The return from Niagara Springs provided an SAS of 4.5% and 45% of the total harvest from all four hatcheries. Harvest downstream of LGD accounted for 8.6% of the adult returns, the majority of which was in the Zones 1-5 sport and Zone 6 tribal fisheries (see Table 8, above).

An alternate adult return estimate utilizing PIT tag detection information on brood year 2007 fish at Bonneville Dam and at LGD is provided in Table 14. Only return estimates from the three LSRCP facilities are provided because there were not enough PIT tags in the Niagara Springs release groups to assess the adult returns from that facility. The total adult return estimate from all three hatchery facilities to Bonneville Dam based on PIT tag detections was 136,659 fish compared to 95,684 using the traditional run reconstruction methodology. The total adult return estimate based on PIT tags and harvest downstream of Bonneville Dam exceeds the combined total adult production goal of 117,780 fish for Idaho LSRCP facilities by 24,900 fish. Although the total return estimate made with PIT tag detections was higher than the estimate made with the run reconstruction at Bonneville and LGD, differences between the two methodologies were not consistent, particularly at the stock level. The largest discrepancies are from the Hagerman PAH stock release group (10,291 fish difference), and the Hagerman SAW stock release group (24,486 fish difference).

PPR estimates exceeded the replacement threshold for every hatchery/stock combination with an unweighted average of 52.9 progeny/parent, ranging from 21.4 for the Magic Valley DWOR stock to 102.4 for the Magic Valley PAH stock.

The ratio of smolts released to the number of parents spawned was highly variable across stocks and facilities and is a function of several factors: whether the spawning facility uses a 1:1 ratio of males to females in their spawning, the number of eggs or fry that are culled, egg and fry mortality rates, and the fecundity of the stock. All DWOR stocks reared at Clearwater, Hagerman, and Magic Valley had a high ratio of smolts released to adults spawned in brood year 2007 for these reasons. PAH and OX stocks reared at Niagara Springs had the lowest ratio, which was due to high mortality of eggs and fry of both stocks at Oxbow.

Table 13. Brood Year 2007 reconstruction summary for Idaho LSRCP and IPC steelhead releases that includes total adult returns, adult escapement to LGD, smolt-to-adult survival rates (SAS), parent-to-progeny ratios (PPR), smolt-to-adult return to LGD rate (SAR), harvest, and escapement estimates. Summaries include ad-clipped and ad-intact releases.

							Downstream of LGD				Upstream of LGD			
Hatchery	**Stock**	**Adults Spawned**	**Number Released**	**Total Adults**	**SAS (%)**	**PPR**	**Harvest**	**Strays**	**Adults to LGD**	**SAR (%)**	**Harvest**	**Trap**	**Stray**	**Unharvested Escapement**
Clearwater	DWOR[1]	280	819,549	12,688	1.5	45.3	1,436	0	11,253	1.4	8,162		-	3,091
Clearwater Total		**280**	**819,549**	**12,688**	**1.5**	**45.3**	**1,436**	**0**	**11,253**	**1.4**	**8,162**		**-**	**3,091**
Hagerman	DWOR	58	179,036	1,251	0.7	21.6	60	7	1,184	0.7	1,094		83	7
	PAH*	91	205,546	2,551	1.2	28.0	232	0	2,319	1.1	-		-	2,319
	SAW*	554	1,002,943	36,650	3.7	66.2	2,791	24	33,835	3.4	24,072	6,482	555	2,726
Hagerman Total		**703**	**1,387,525**	**40,451**	**2.9**	**57.5**	**3,083**	**31**	**37,338**	**2.7**	**25,167**	**6,482**	**637**	**5,052**
Magic Valley	DWOR	229	690,321	4,893	0.7	21.4	606	11	4,276	0.6	4,117		119	40
	EFNAT*	103	155,079	2,791	1.8	27.1	206	1	2,584	1.7	74	711	-	1,799
	PAH	212	372,393	21,687	5.8	102.4	1,628	35	20,024	5.4	14,084	595	516	4,829
	SAW*	190	340,802	12,205	3.6	64.2	556	3	11,646	3.4	6,916		112	4,619
	USAL	38	62,314	969	1.6	25.5	75	9	885	1.4	841	60	11	-
Magic Valley Total		**772**	**1,620,909**	**42,545**	**2.6**	**55.1**	**3,071**	**59**	**39,415**	**2.4**	**26,032**	**1,366**	**758**	**11,258**
Niagara Springs	OX	326	810,277	27,391	3.4	84.0	4,315	49	23,027	2.8	15,992	7,037	6,108	-
	PAH	512	887,119	49,366	5.6	96.4	3,016	31	46,319	5.2	31,199	14,910	1,515	-
Niagara Springs Total		**838**	**1,697,396**	**76,758**	**4.5**	**91.6**	**7,331**	**79**	**69,348**	**4.1**	**47,190**	**21,947**	**7,623**	**-**
Grand Total		**3,609**	**5,525,379**	**172,441**	**3.1**	**47.7**	**14,921**	**169**	**157,351**	**2.8**	**106,551**	**29,795**	**9,019**	**11,987**

[1] All or part of these fish were released with intact adipose fins (see Table 6) and therefore not subject to harvest in mark-selective fisheries.

Table 14. Adult steelhead return estimates to Bonneville Dam and to LGD based on the expansion of PIT tag detections in the adult ladders. Data excludes Niagara Springs hatchery return estimates due to the low number of tags released.

		Run Reconstruction Estimate		PIT Tag Detection Expansion Estimate		
Hatchery	**Stock**	**Bonneville**	**LGD**	**Total PIT Tags Released**	**Bonneville**	**LGD**
Clearwater	DWOR	12,688	11,253	20,060	13,606	8,142
Clearwater Total		**12,688**	**11,253**	20,060	13,606	8,142
Hagerman	DWOR	1,251	1,184	12,763	1,577	1,003
	PAH	2,551	2,319	5,774	12,842	9,886
	SAW	36,650	33,835	12,468	61,136	43,189
Hagerman Total		**40,451**	**37,338**	31,005	75,556	54,078
Magic Valley	DWOR	4,893	4,276	15,242	3,781	2,756
	EFNAT	2,791	2,584	1,299	2,139	1,655
	PAH	21,687	20,024	4,792	22,529	17,311
	SAW	12,205	11,646	7,170	17,988	13,631
	USAL	969	885	6,161	1,059	639
Magic Valley Total		**42,545**	**39,415**	**34,664**	47,496	35,992
Grand Total		**95,684**	**88,006**	**85,729**	136,659	98,212

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Staff from the Pacific States Marine Fisheries Commission provided assistance with data collection, proofing, summarization, and report compilation. A special thanks is extended to Cheryl Leben for completing the report formatting and editing, as well as to Brian Leth, Stuart Rosenberger, and Sam Sharr for reviewing this report and providing feedback. Additional funding for PIT tagging and PBT projects was provided by the Bonneville Power Association and data resulting from those projects contributed to some of the analyses included in this report. Last but not least, the information included in this report would not be available without the invaluable efforts of the hatchery managers and their staff as well as staff from the harvest monitoring crews at the IDFG regional offices.

LITERATURE CITED

Cormack, R. M. 1964. Estimates of survival from the sighting of marked animals. Biometrika 51: 429-438.

Gayanilo, F. C. Jr., P. Sparre, and D. Pauly. 2005. FAO-ICLARM stock assessment tools II (FiSAT II). WorldFish Center, Food and Agriculture Organization of the United Nations. Rome, Italy. Available at http://www.fao.org/fishery/topic/16072/en.

Hills, K., and J. Nalder. 2007. Oxbow Fish Hatchery Steelhead 2007 Run Report. Idaho Department of Fish and Game.

Jolly, G. M. 1965. Explicit estimates from capture-recapture data with both death and immigrations—stochastic model. Biometrika 52: 225-47.

Lowell, R., P. Moore, T. Tighe, W. Symons, and B. Filloon. 2008. Magic Valley 2007 Brood Year Report. Idaho Department of Fish and Game. Boise. IDFG Report Number 08-127.

Macdonald, P. 2010. Mixdist: finite mixture distribution models (version 0.5-3). McMaster University. Ontario, Canada. Available at: http://cran.us.r-project.org/.

NOAA (National Oceanic and Atmospheric Administration). 2006. Endangered and Threatened Species: Final Listing Determinations for 10 Distinct Population Segments of West Coast Steelhead; Final Rule. Federal Register 71 (3): 833-862.

Page, J., J. Chapman, D. Young, and M. Fife. 2008. Niagara Springs Fish Hatchery 2007 Steelhead Brood Year Report. Idaho Department of Fish and Game. Boise. IDFG Report Number 01-25.

R Development Core Team. 2010. R: A language and environment for statistical computing. R. Foundation for Statistical Computing. Vienna, Austria. Available at http://www.R-project.org.

RMIS (Regional Mark Information System Database [online database]). Continuously since 1977. Portland (OR): Regional Mark Processing Center, Pacific States Marine Fisheries Commission. URL http://www.rmpc.org.

Seber, G. A. F. 1965. A note on the multiple recapture census. Biometrika 52: 249-52.

USACE (United States Army Corp. of Engineers). 1975. Special Report-Lower Snake River Fish and Wildlife Compensation Plan. Walla Walla, Washington.

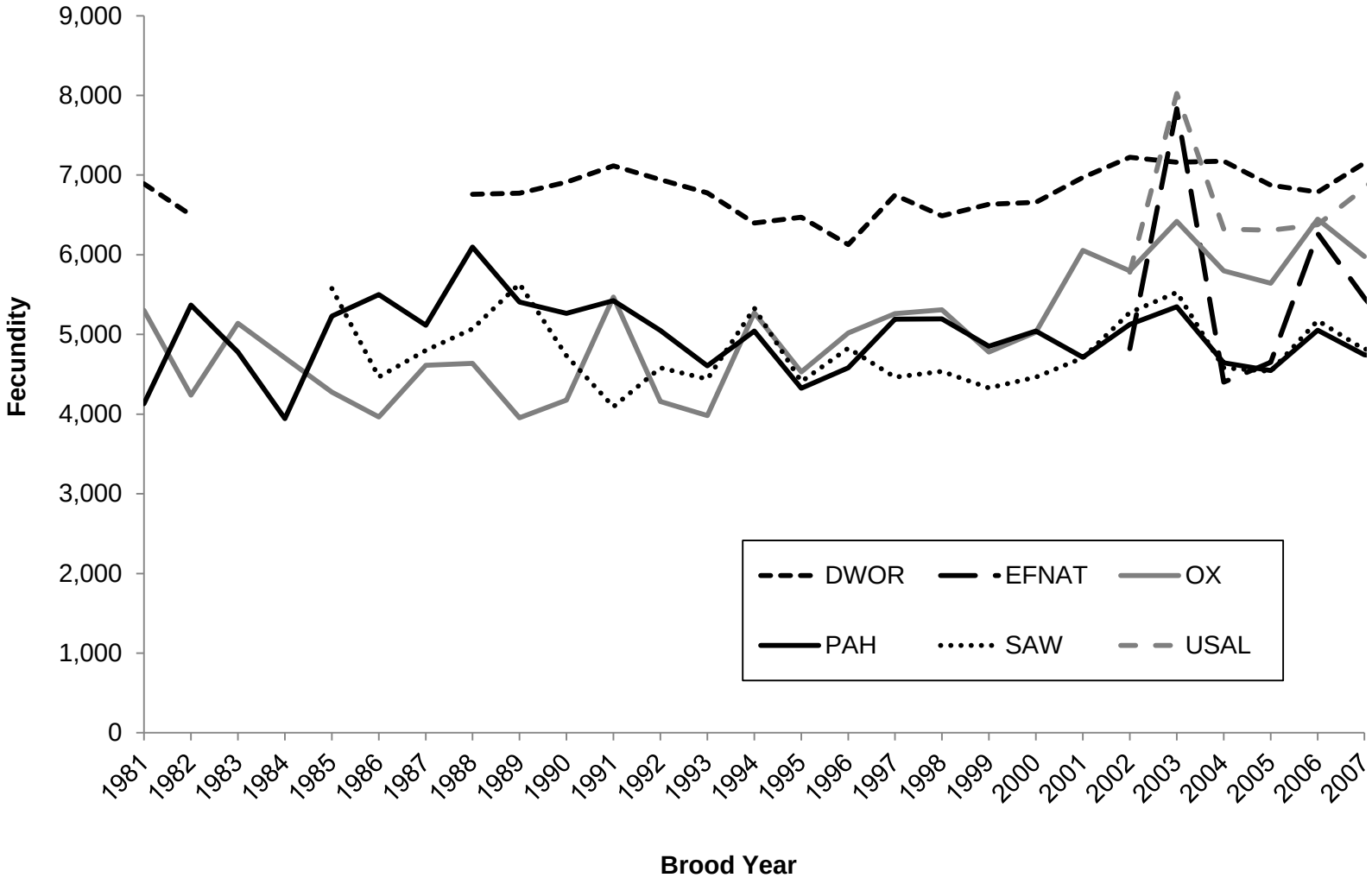
USFWS (United States Fish and Wildlife Service). 2008. Hagerman National Fish Hatchery Fiscal Year 2008 Summary of operations and expenditure. Hagerman, Idaho.

U.S. v. Oregon. 2008. 2008-2017 United States v. Oregon Management Agreement. http://www.westcoast.fisheries.noaa.gov/publications/fishery_management/salmon_steelhead/sr--079.2008-2017.usvor.management.agreement_042908.pdf.

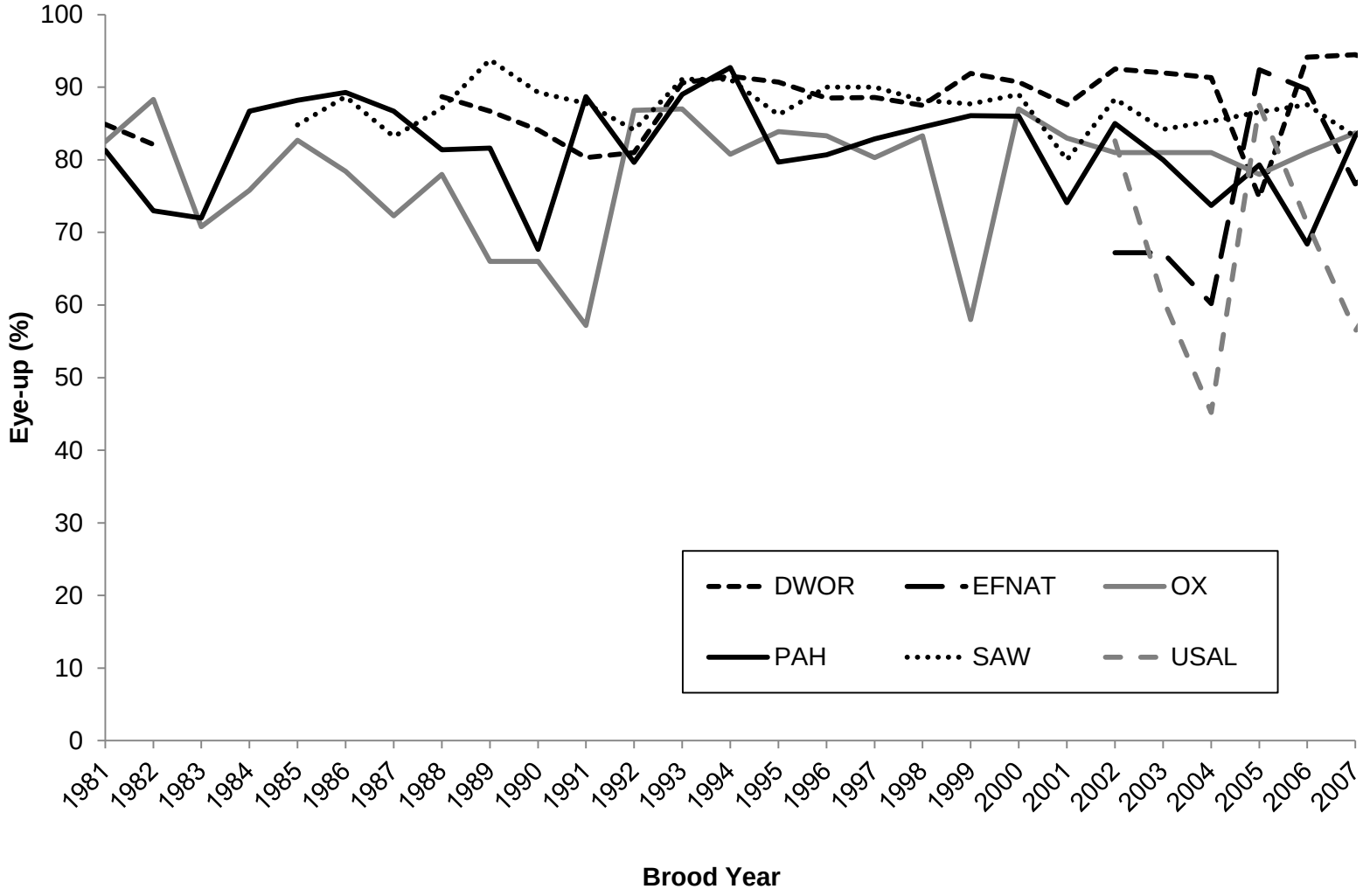
Westhagen, P., and J. R. Skalski. 2009. PitPro (version 4.0). School of Aquatic and Fishery Sciences. University of Washington. Seattle. Available at: http://www.cbr washington.edu/paramest/pitpro/.

APPENDICES

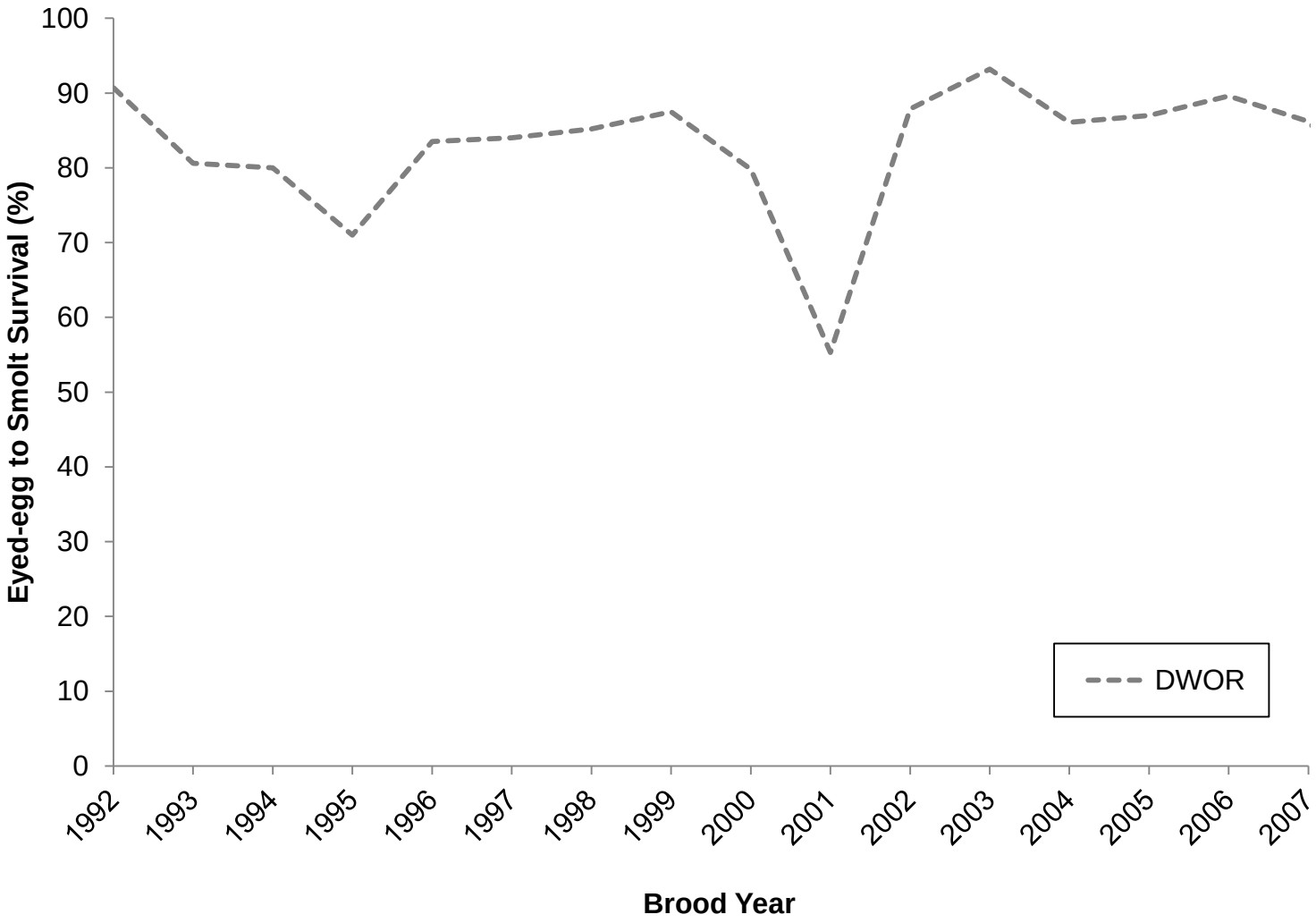
Appendix A. Fecundity rates by stock for steelhead reared at LSRCP and IPC hatchery facilities in Idaho for brood years 1981 through 2007.



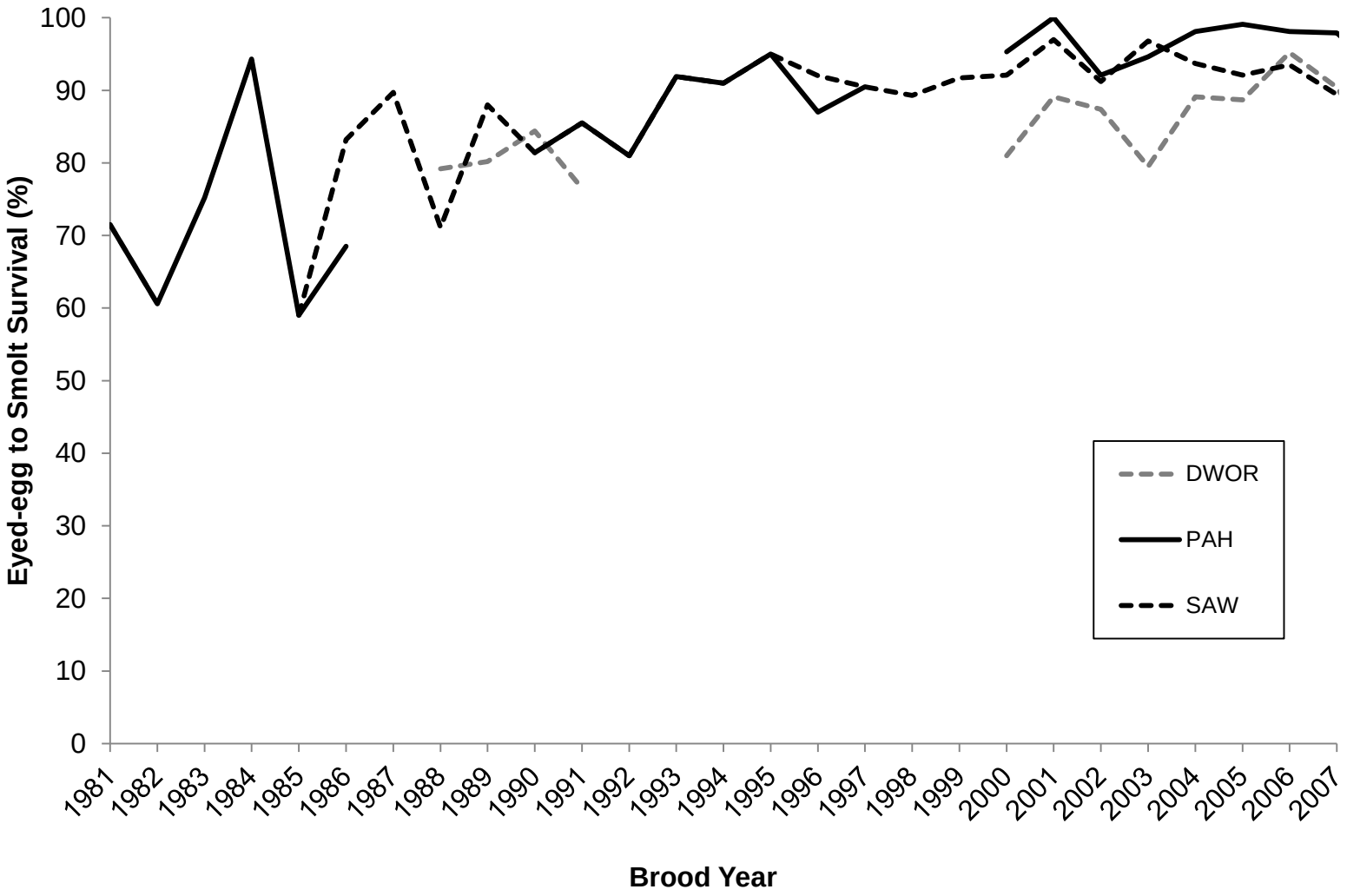
Appendix B. Eye-up rates by stock for steelhead production reared at LSRCP and IPC facilities in Idaho for brood years 1981 through 2007.



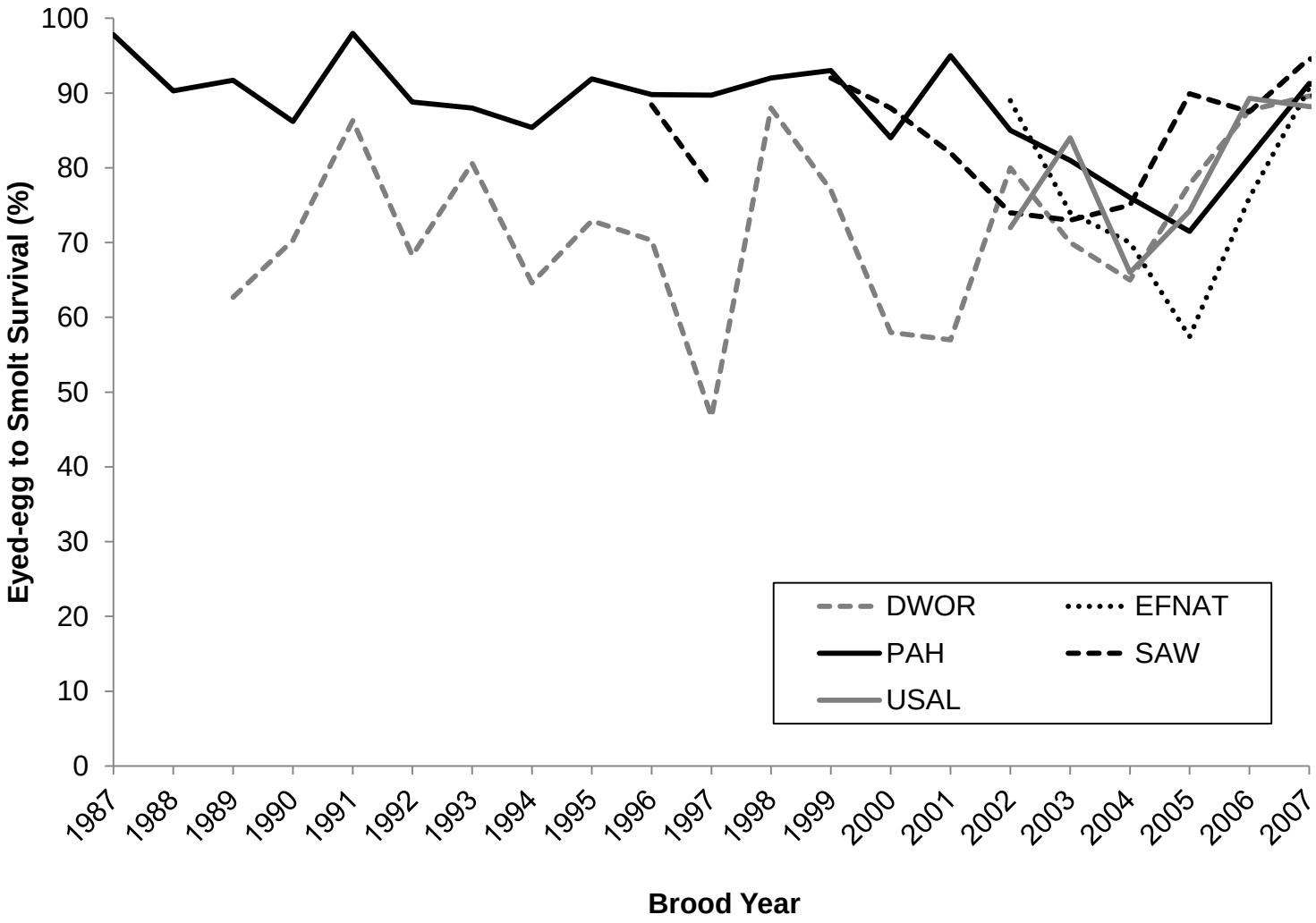
Appendix C1. Summary of onsite survival (eyed egg to release) for production reared at Clearwater Fish Hatchery from brood year 1992 through 2007.



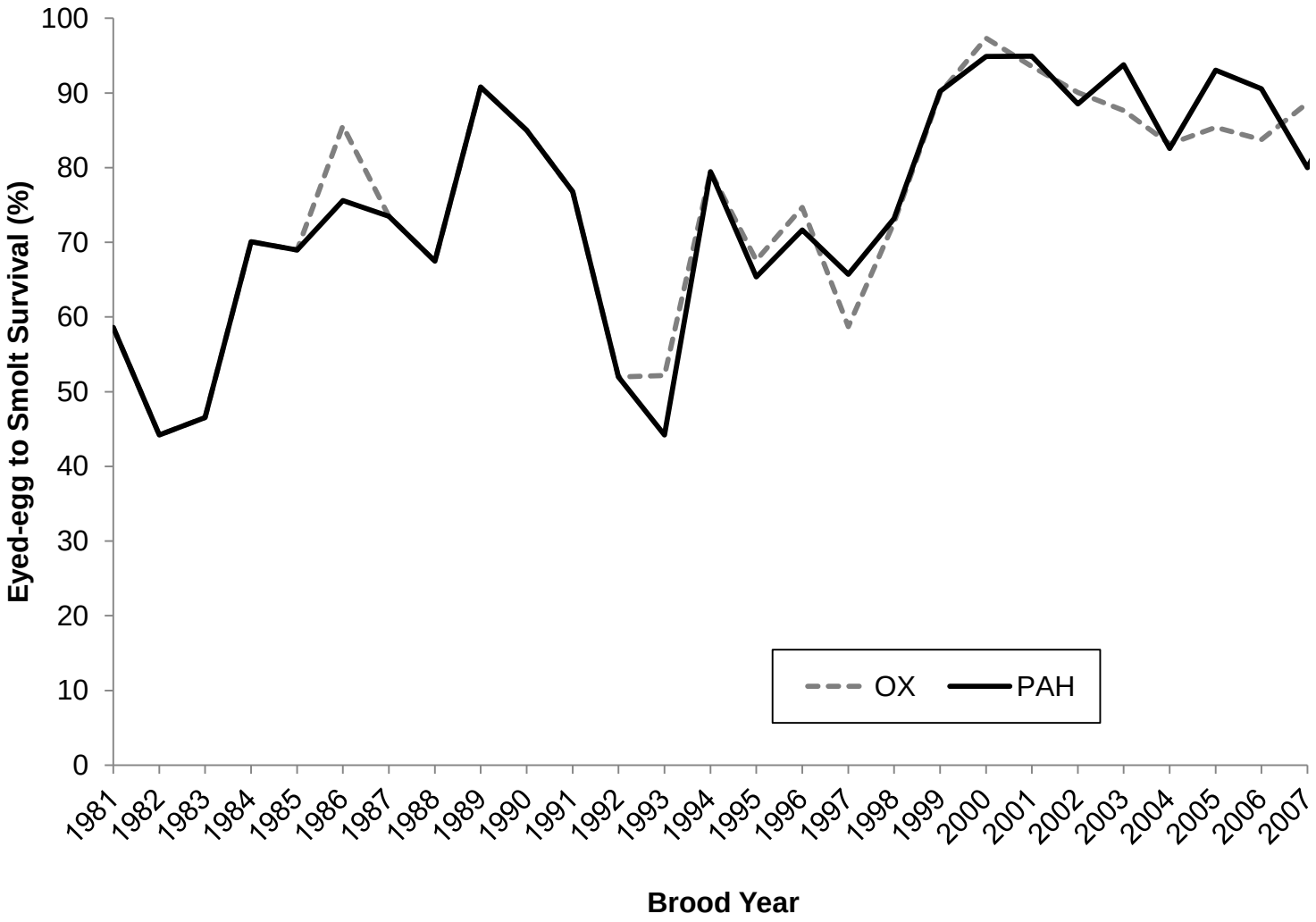
Appendix C2. Summary of onsite survival (eyed egg to release) by stock for production reared at Hagerman from brood year 1987 through 2007.



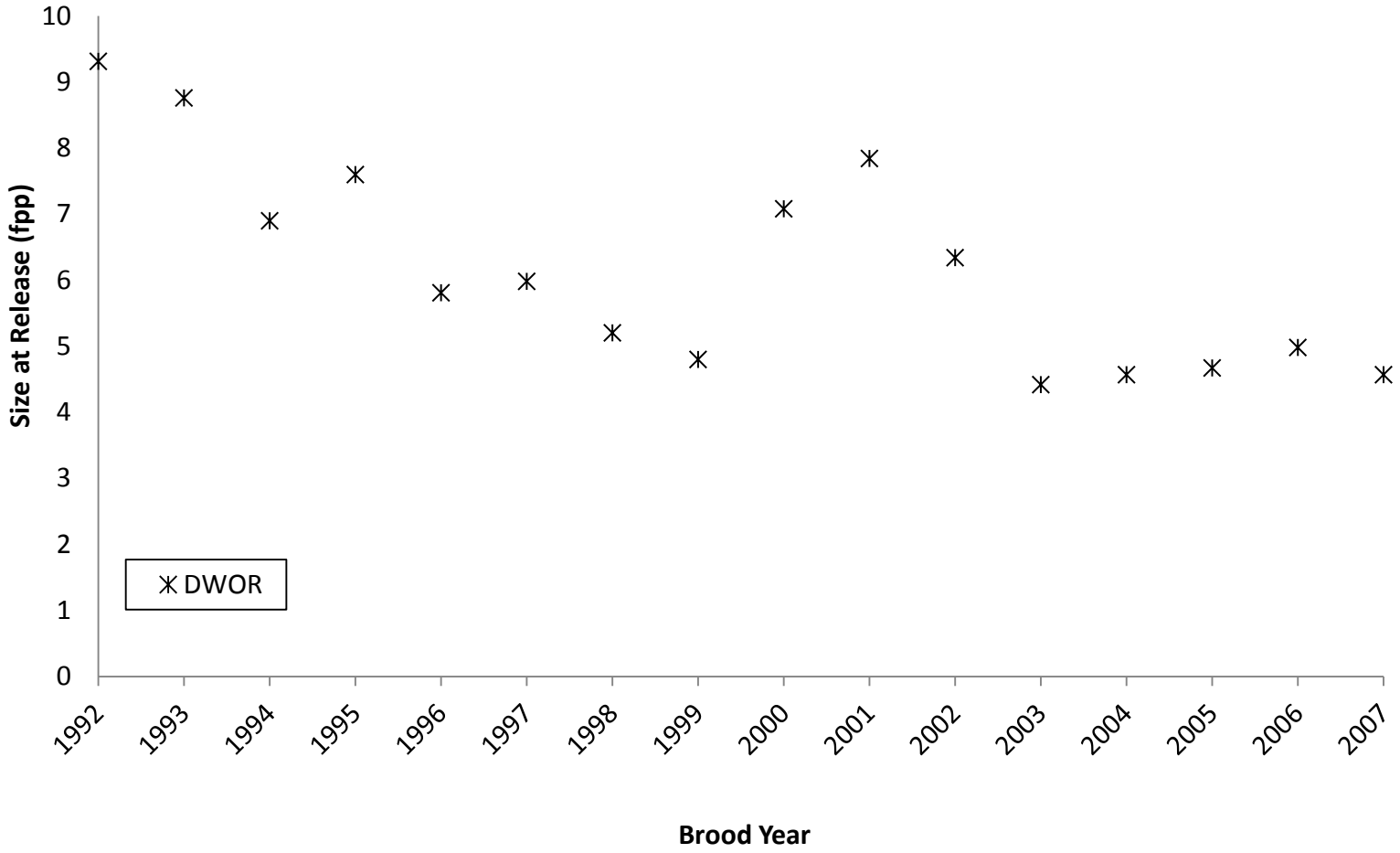
Appendix C3. Summary of onsite survival (eyed egg to release) by stock for production reared at Magic Valley Fish Hatchery from brood year 1987 through 2007.



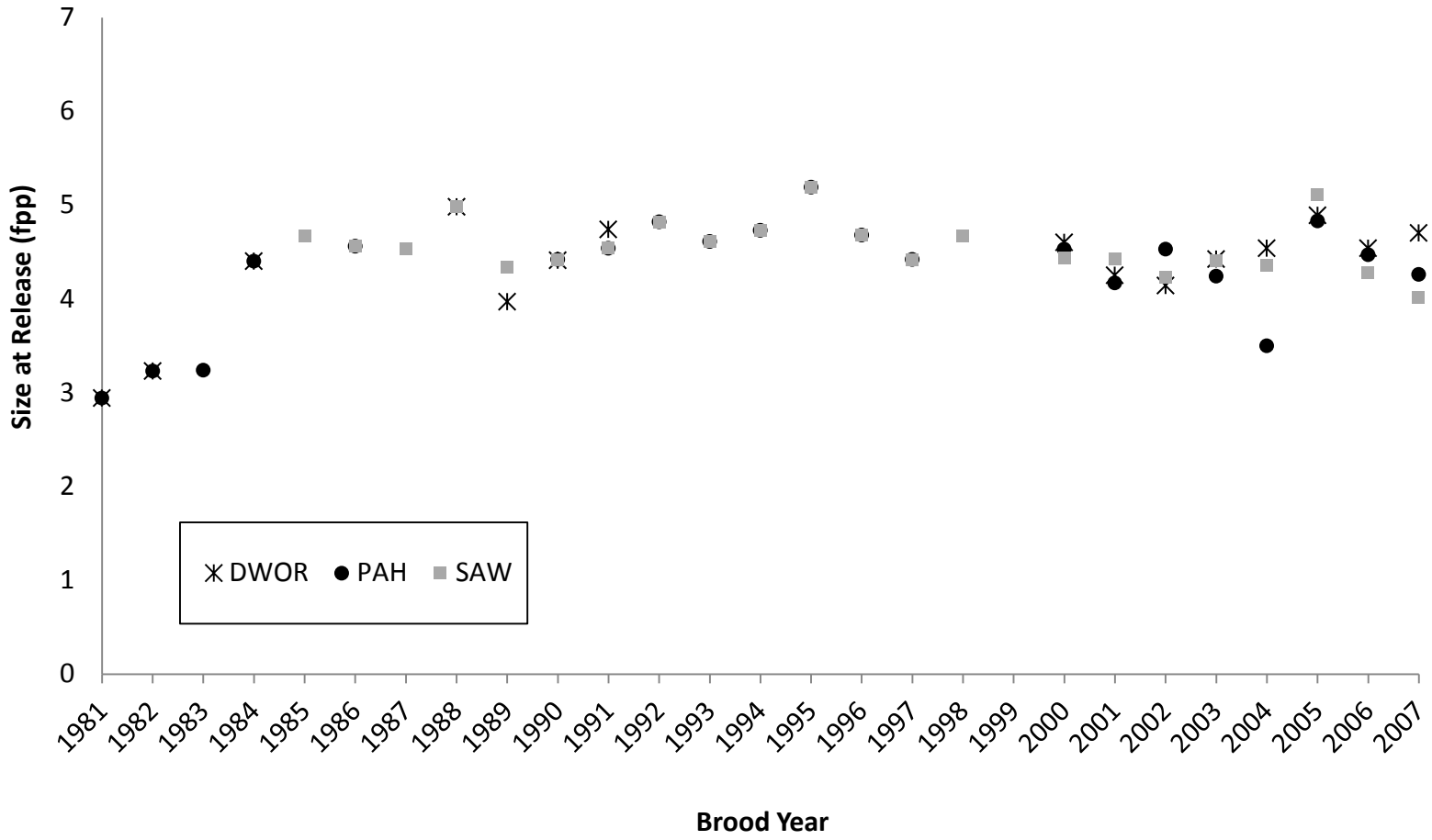
Appendix C4. Summary of onsite survival (eyed egg to release) by stock for production reared at Niagara Springs Fish Hatchery from brood year 1981 through 2007.



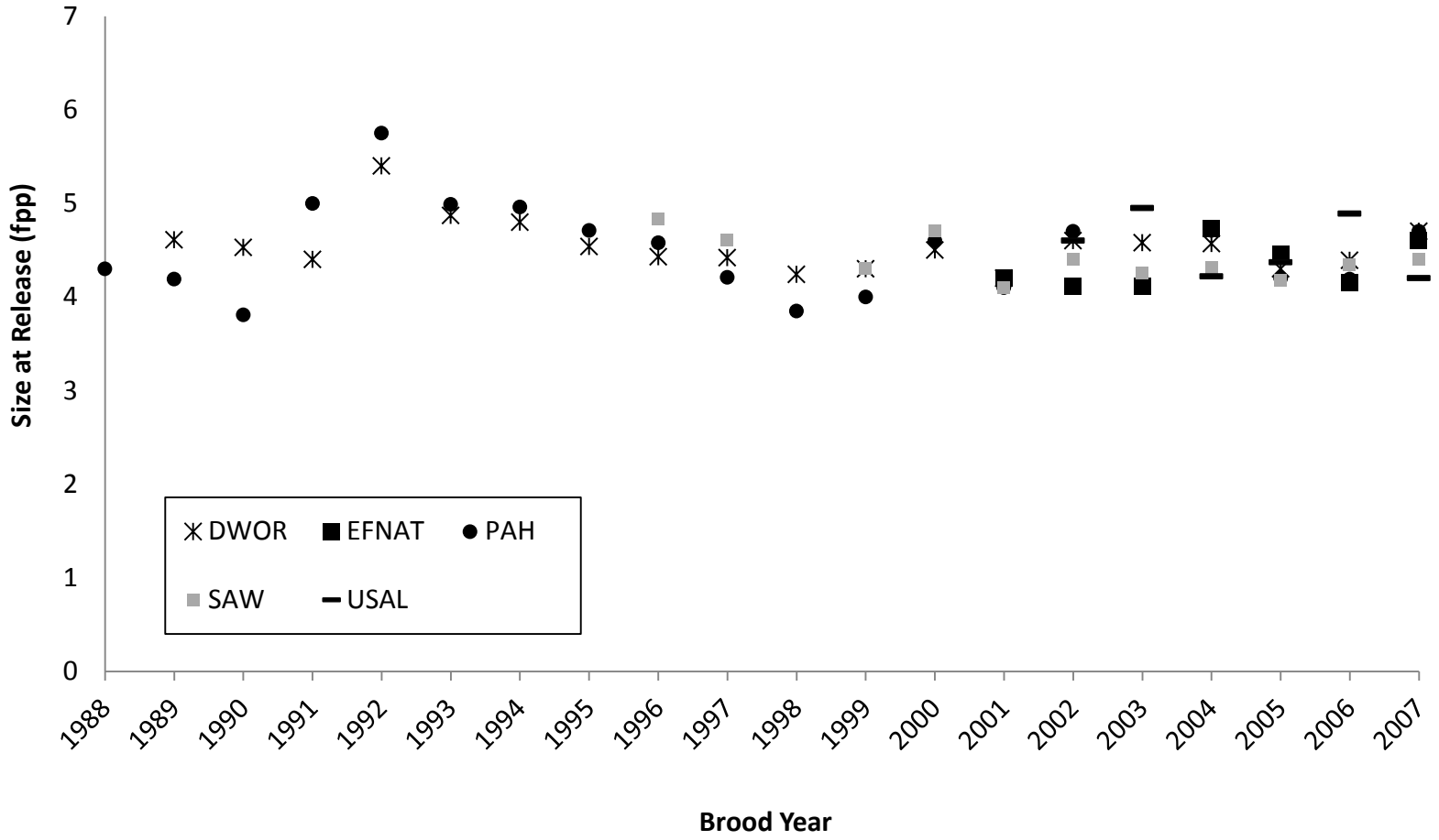
Appendix D1. Size at release (fish per pound [fpp]) for steelhead smolts reared at Clearwater Fish Hatchery from brood year 1992 through 2007.



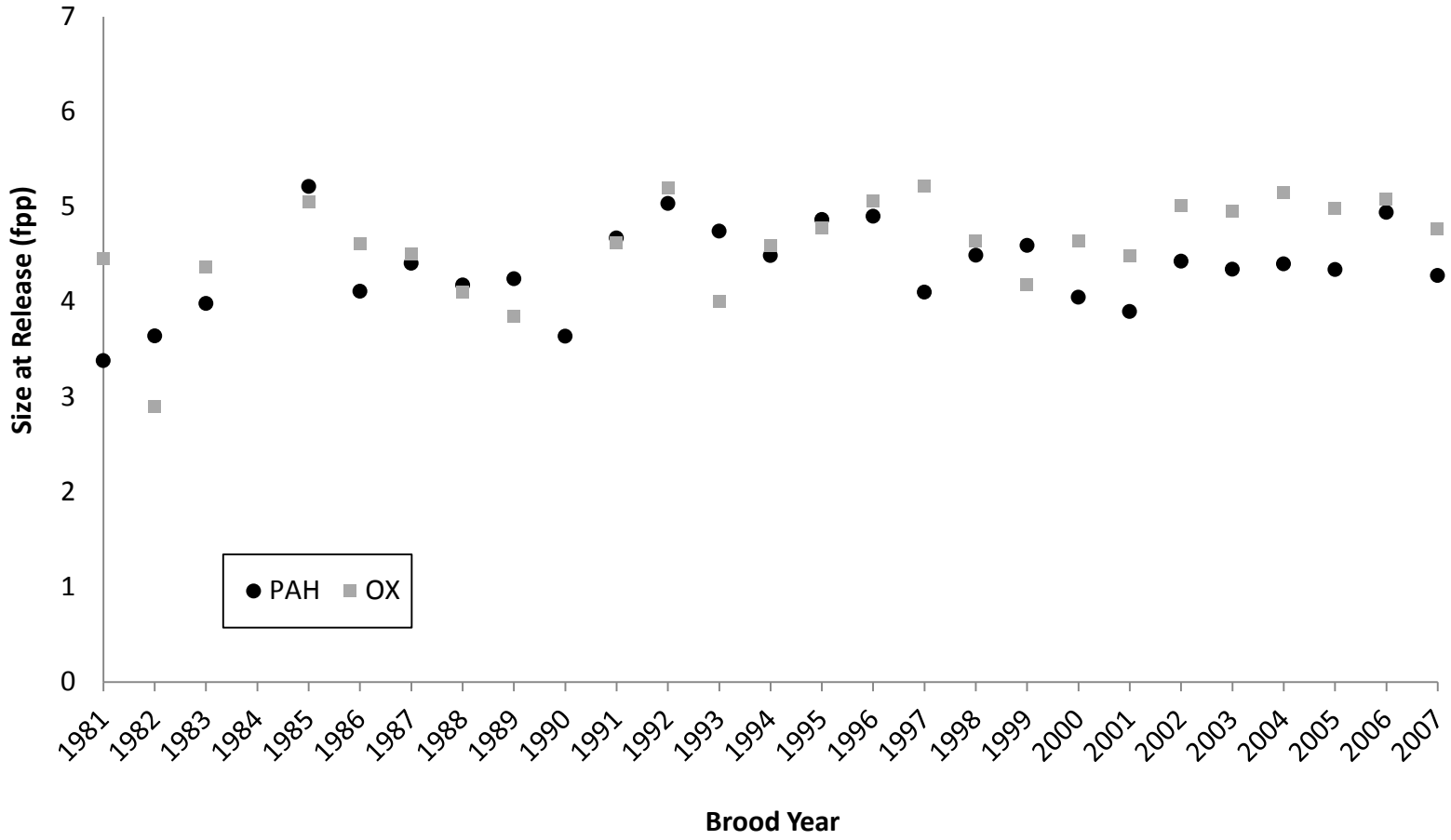
Appendix D2. Size at release (fish per pound [fpp]) for steelhead smolts reared at Hagerman from brood year 1981 through 2007.



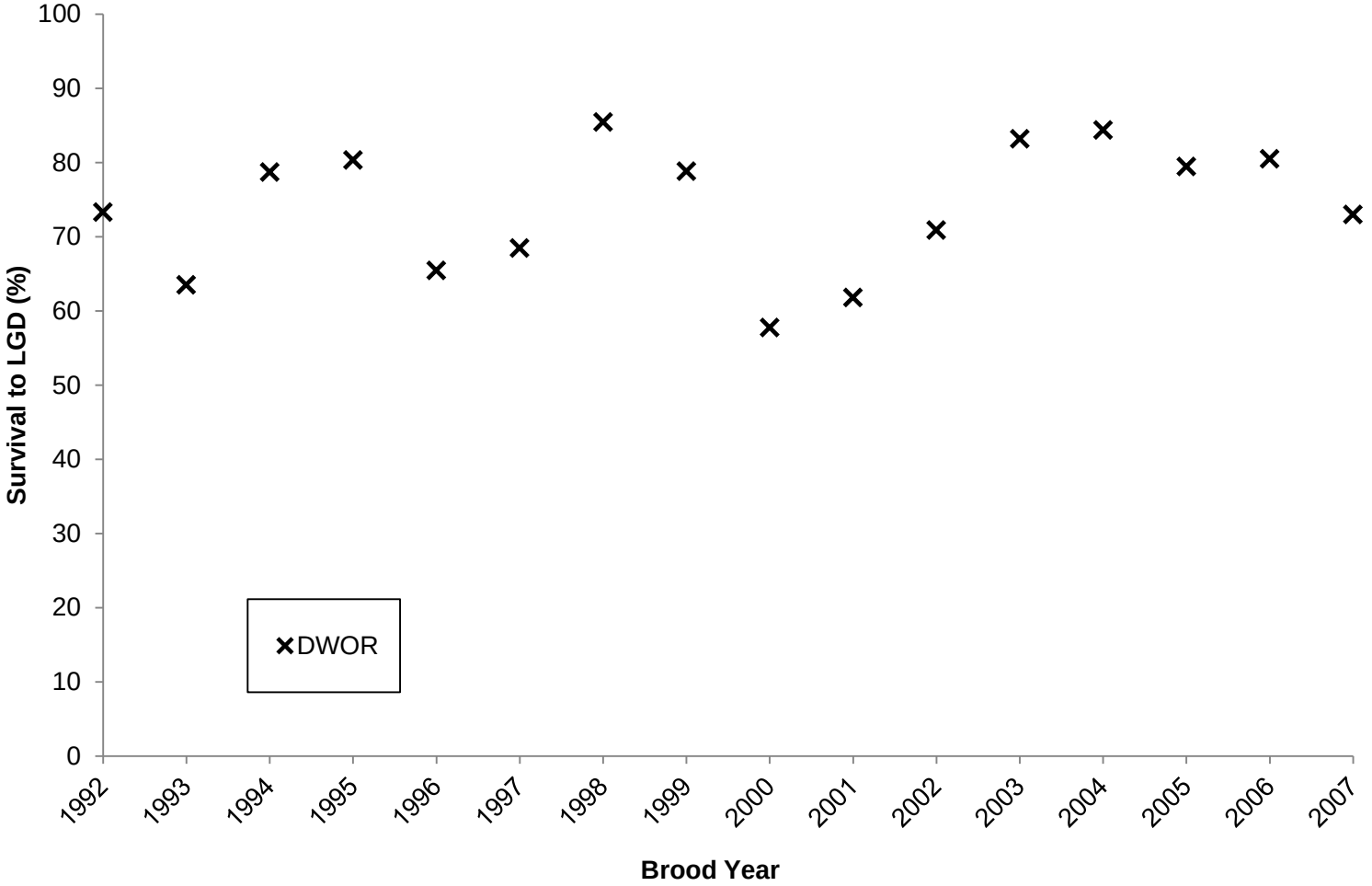
Appendix D3. Size at release (fish per pound [fpp]) for steelhead smolts reared at Magic Valley Fish Hatchery from brood year 1987 through 2007.



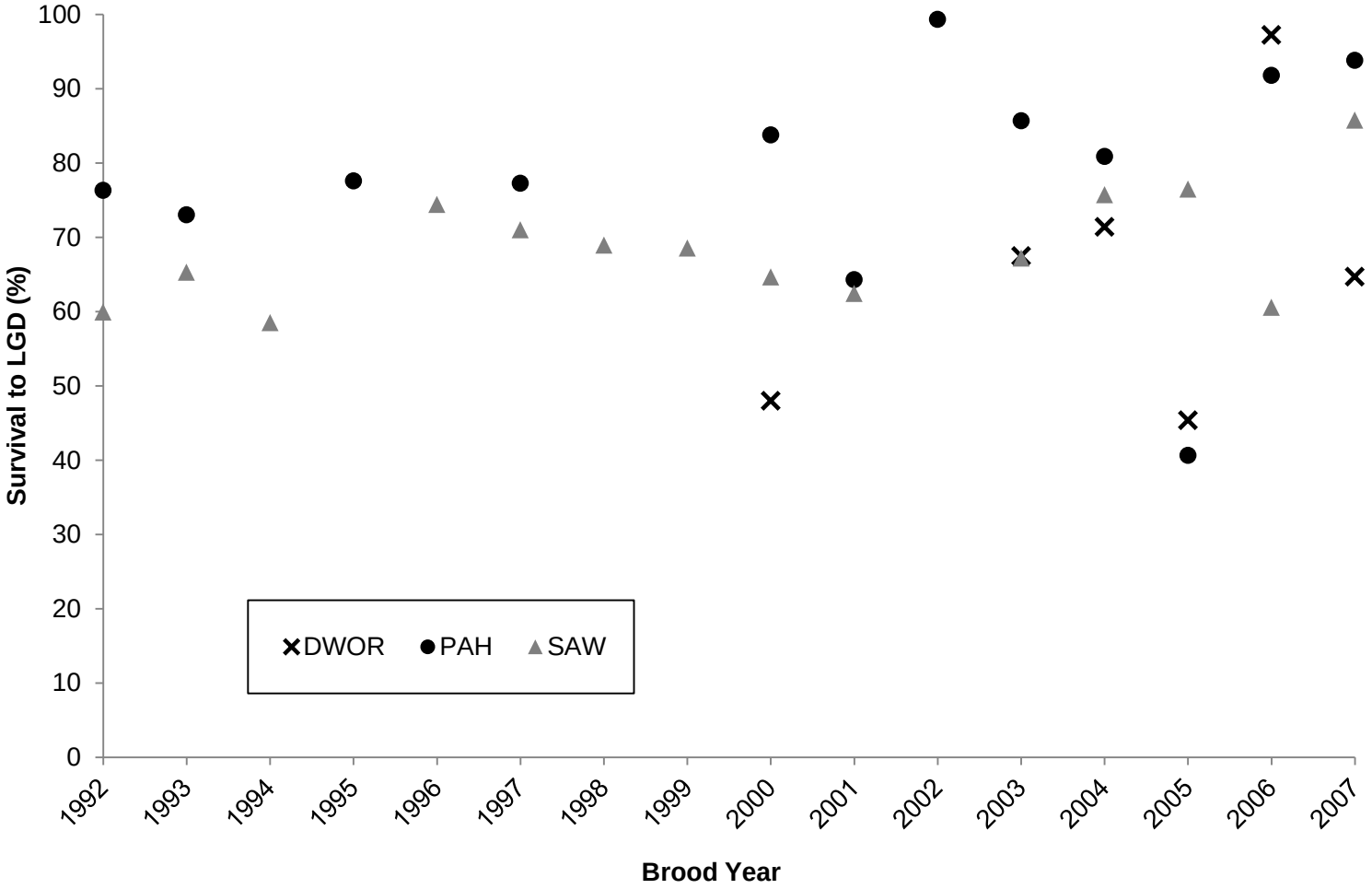
Appendix D4. Size at release (fish per pound [fpp]) for steelhead smolts reared at Niagara Springs Fish Hatchery from brood year 1981 through 2007.



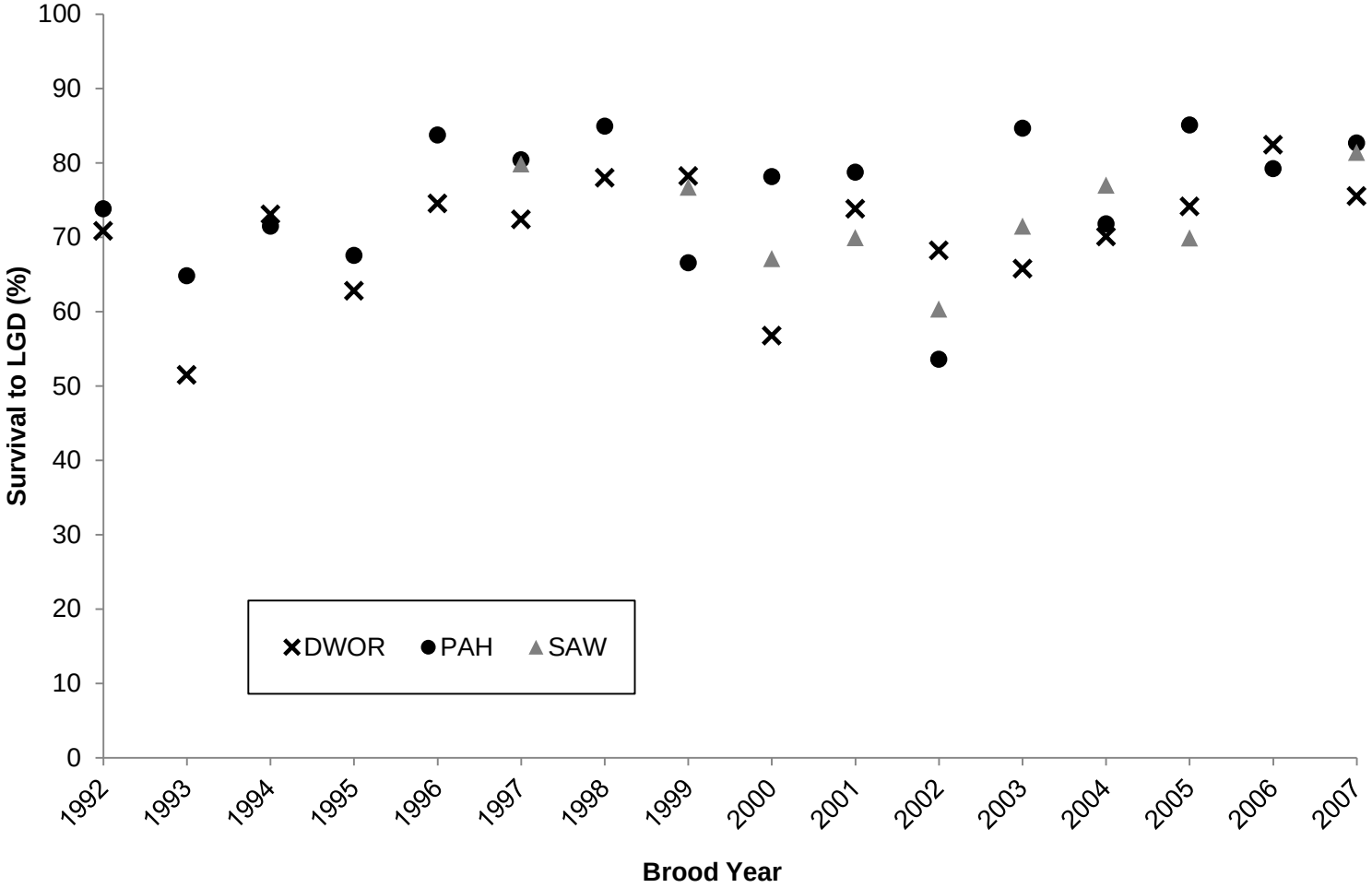
Appendix E1. Survival of smolts from release to LGD for steelhead released from Clearwater Fish Hatchery from brood year 1992 through 2007.



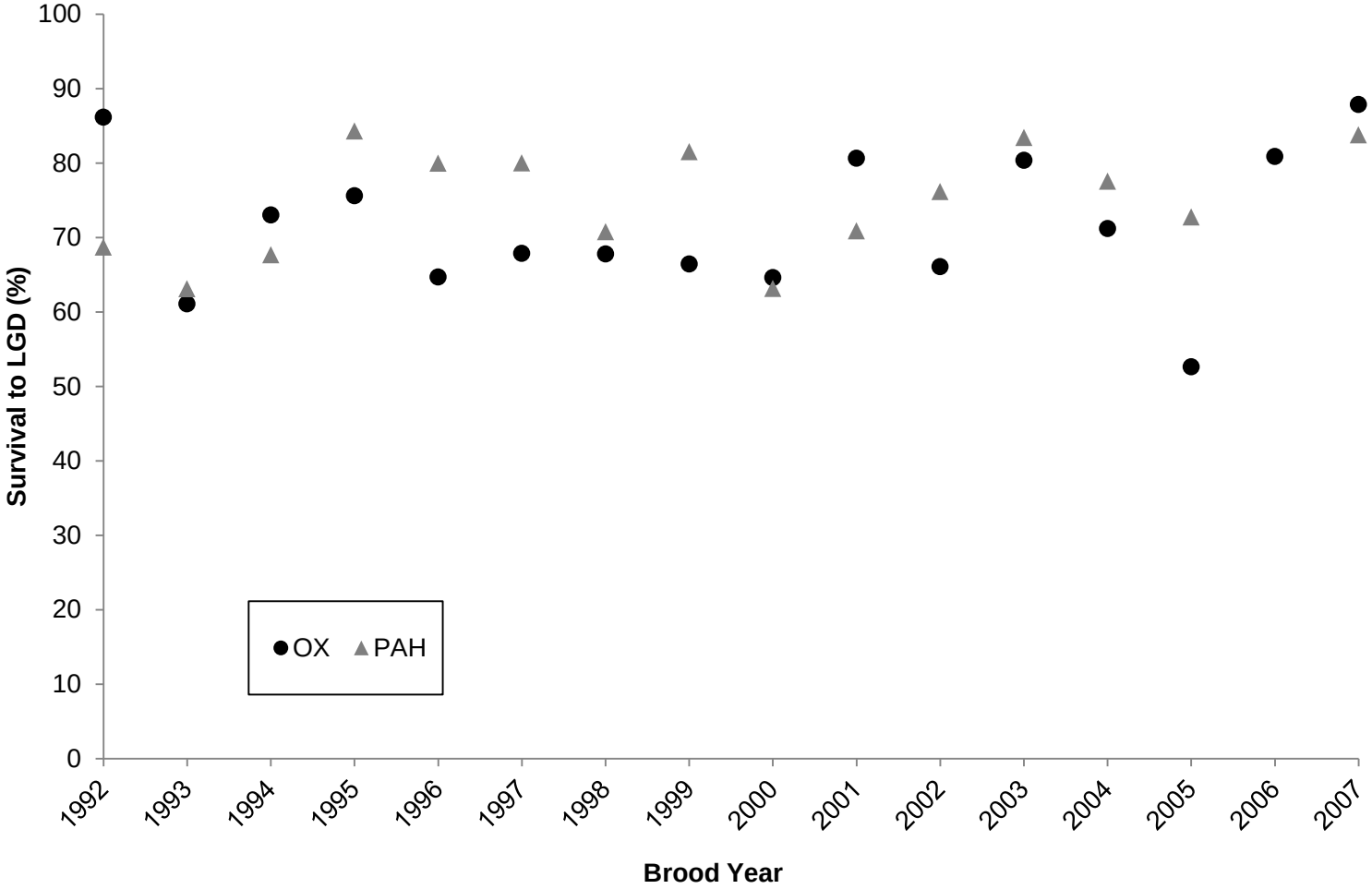
Appendix E2. Survival of smolts from release to LGD for steelhead released from Hagerman from brood year 1992 through 2007.



Appendix E3. Survival of smolts from release to LGD for steelhead released from Magic Valley Fish Hatchery from brood year 1992 through 2007.

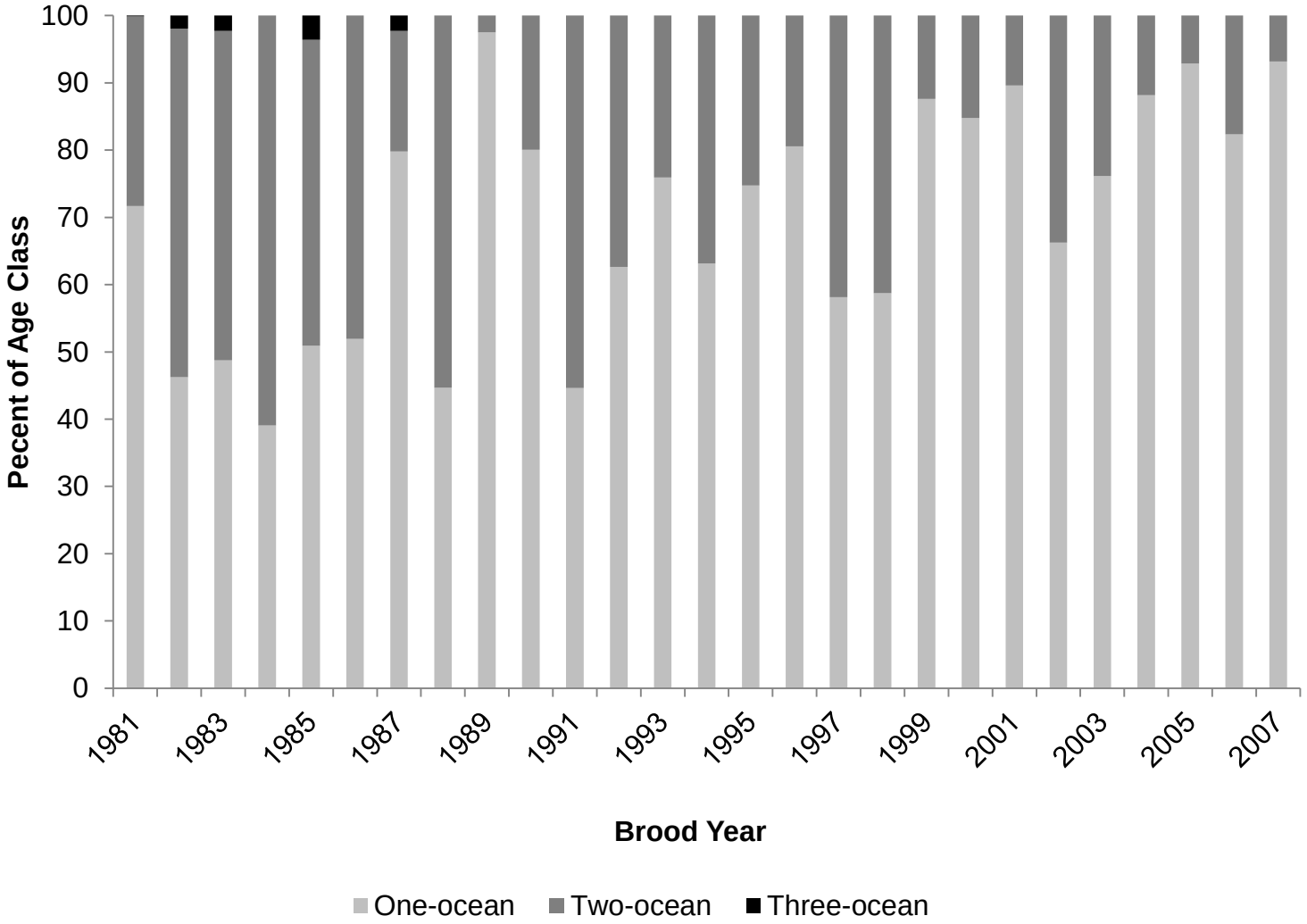


Appendix E4. Survival of smolts from release to LGD for steelhead released from Niagara Springs Fish Hatchery from brood year 1992 through 2007.

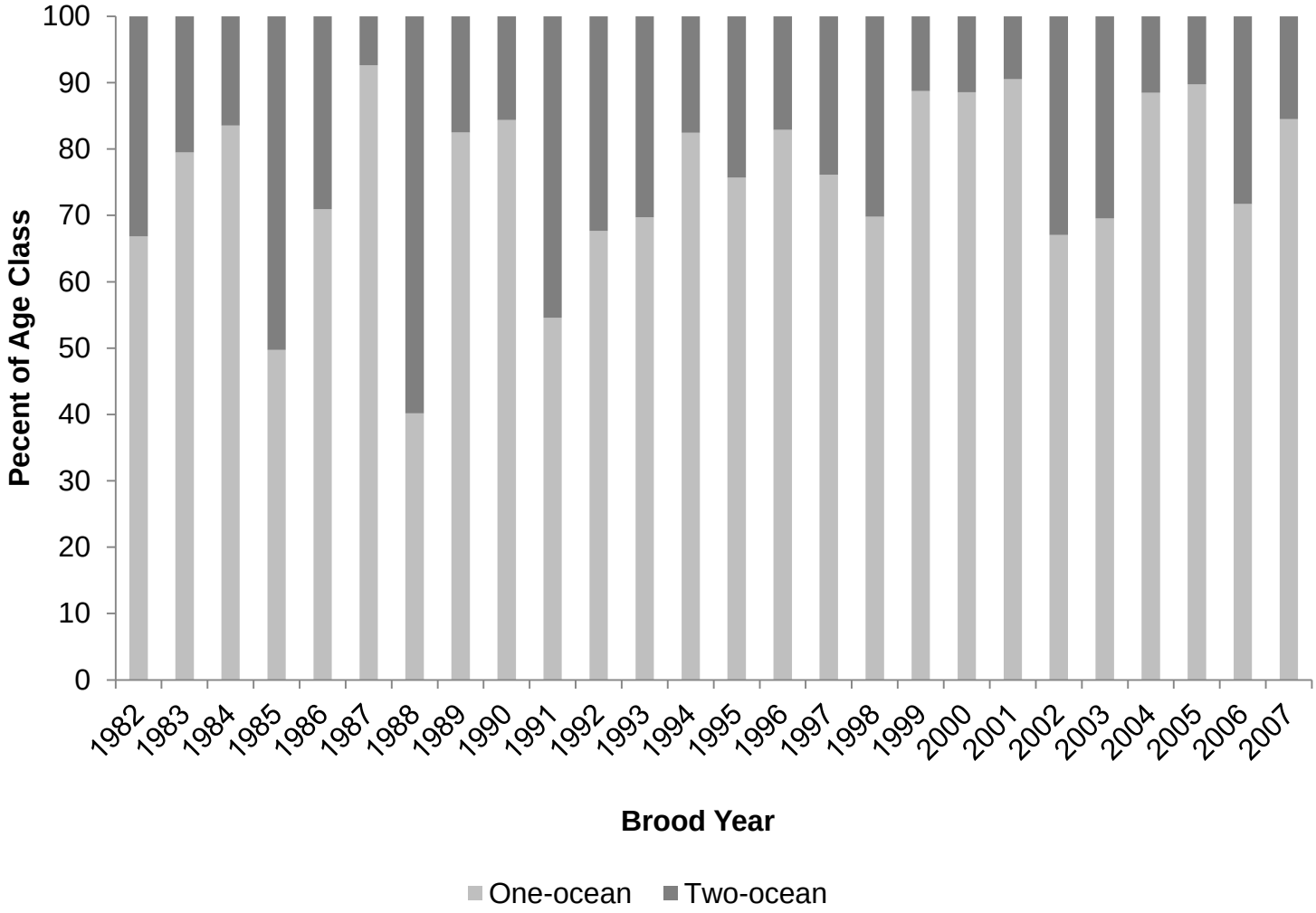


Appendix F1. Age composition for adult hatchery steelhead returning to the Hells Canyon Trap (OX stock) for brood years 1983 through 2007.

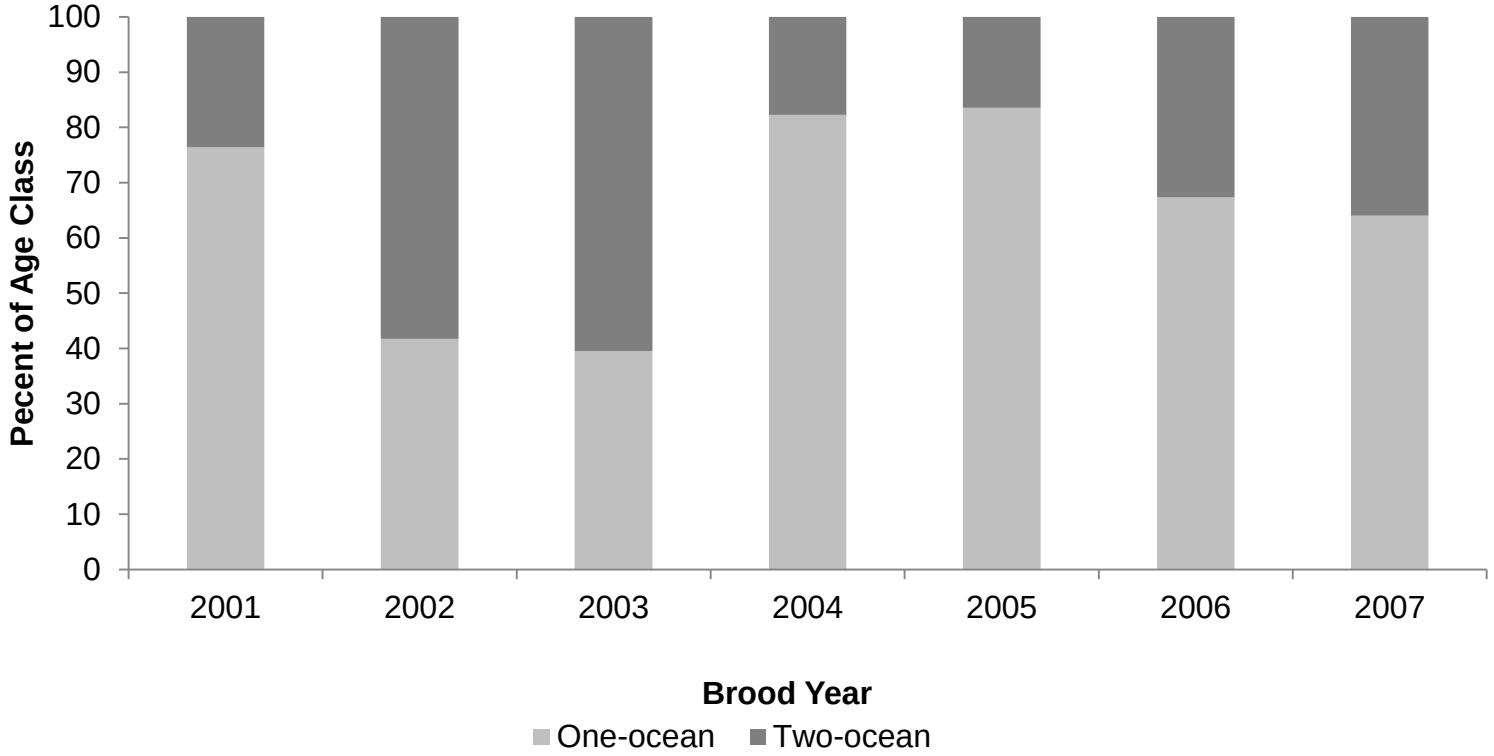
Appendix F2. Age composition for adult hatchery steelhead returning to Pahsimeroi Fish Hatchery (PAH stock) for brood years 1981 through 2007.



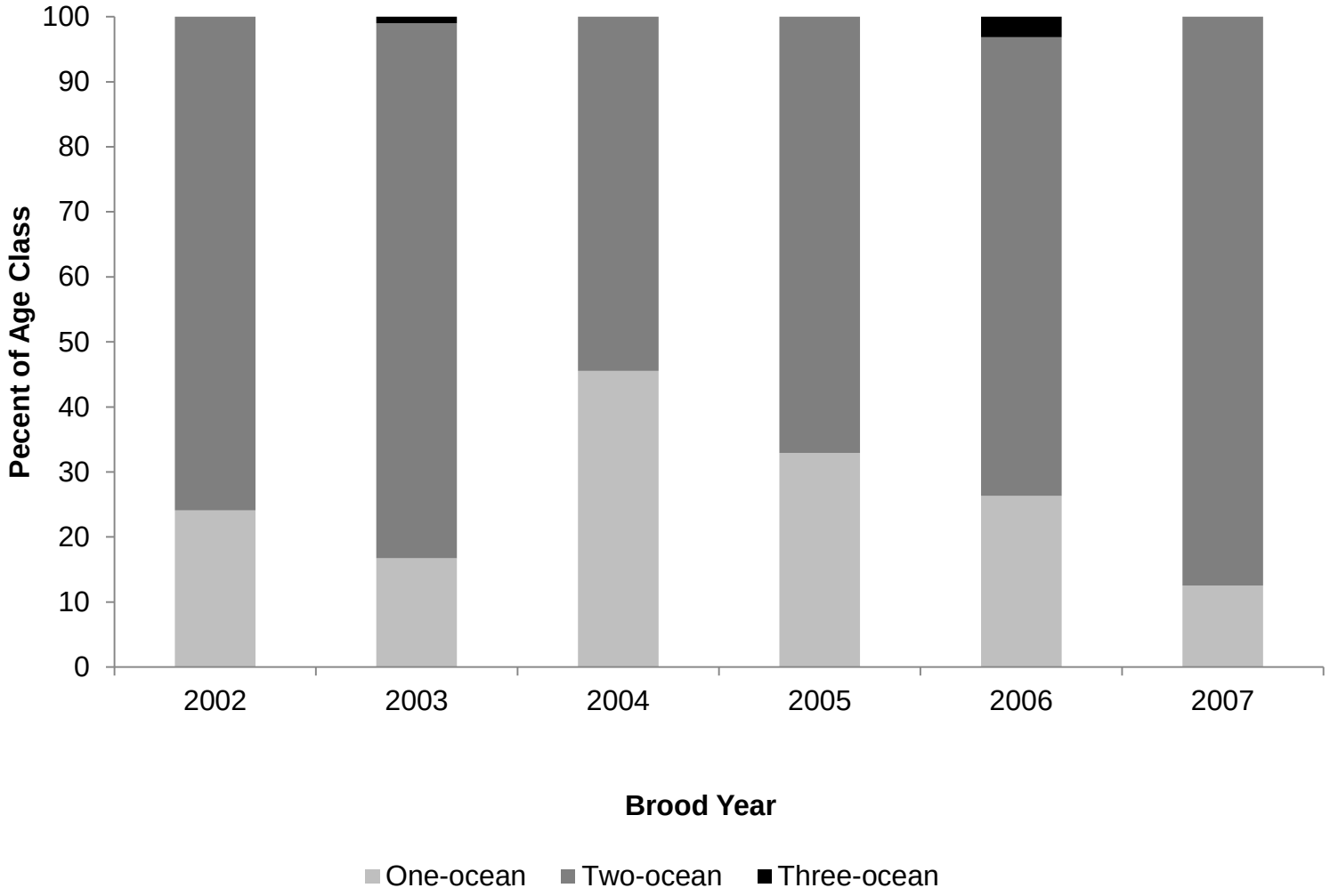
Appendix F3. Age composition for adult hatchery steelhead returning to Sawtooth Fish Hatchery (SAW stock) for brood years 1982 through 2007.



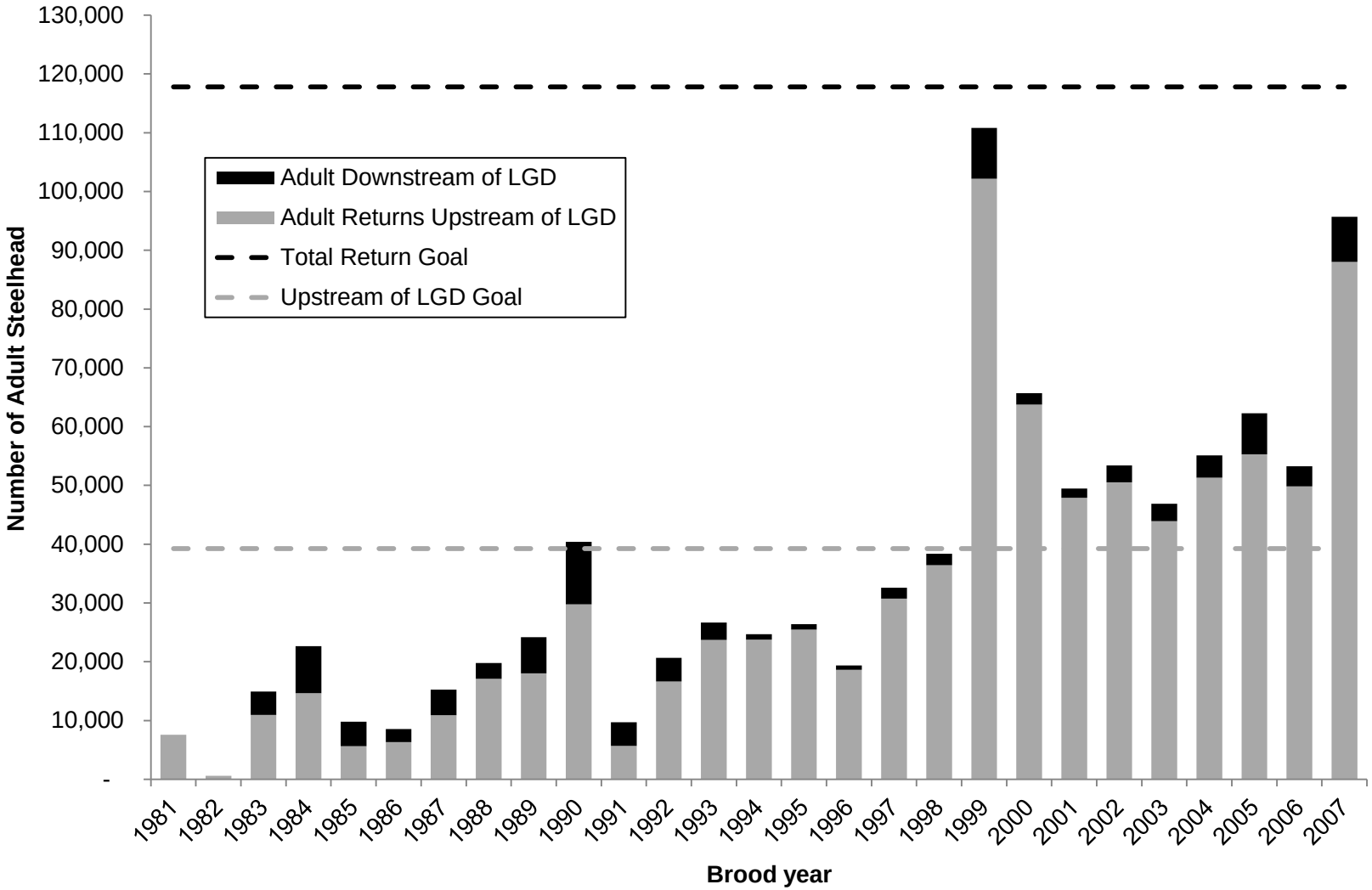
Appendix F4. Age composition for adult hatchery steelhead returning to East Fork Satellite Facility (EFNAT stock) for brood years 2001 through 2007.



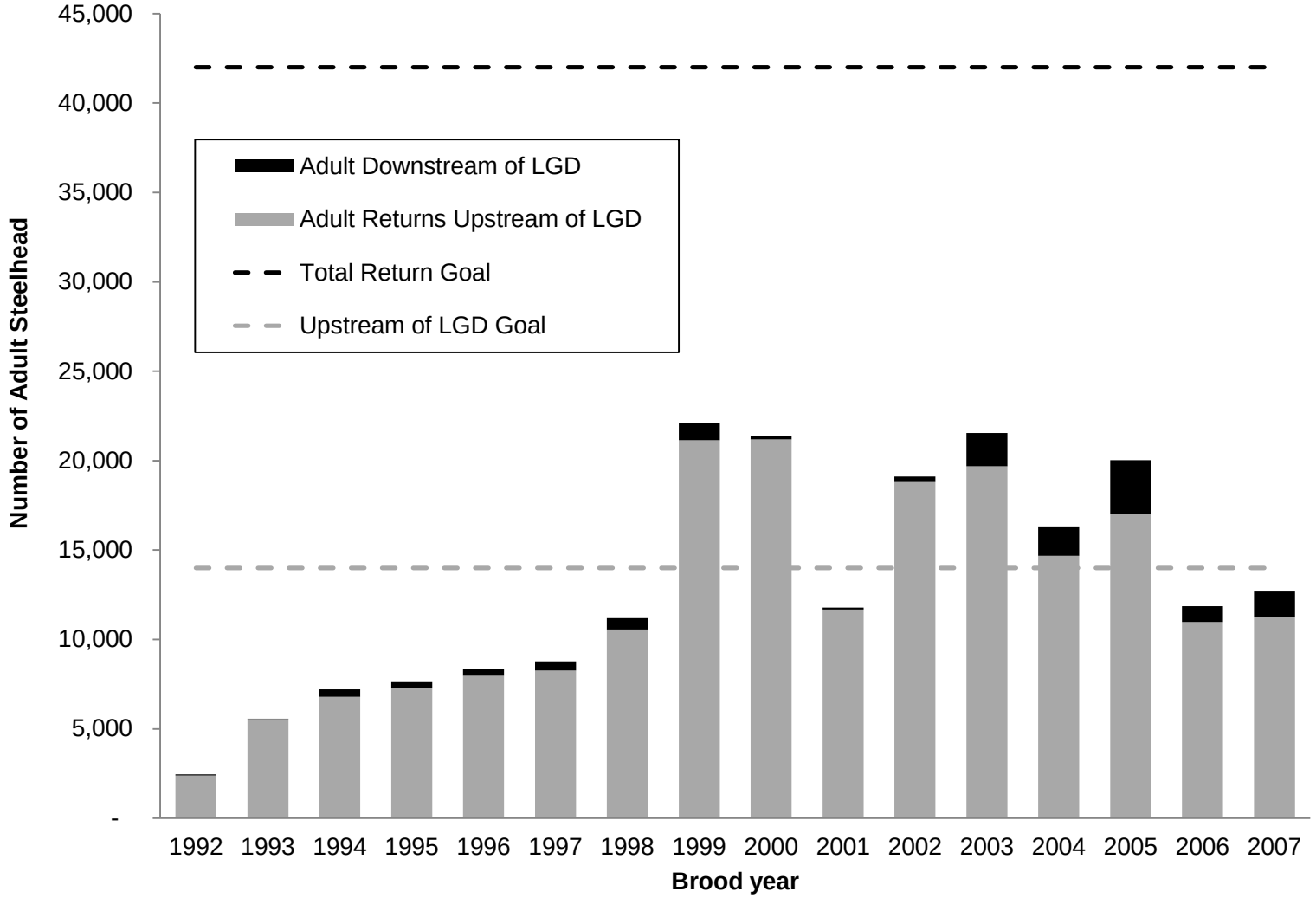
Appendix F5. Age composition for adult USAL hatchery steelhead for brood years 2002 through 2007. Age at return was estimated using CWT recovered in fisheries due to the limited sample size of CWT recovered at Squaw Creek temporary weir.



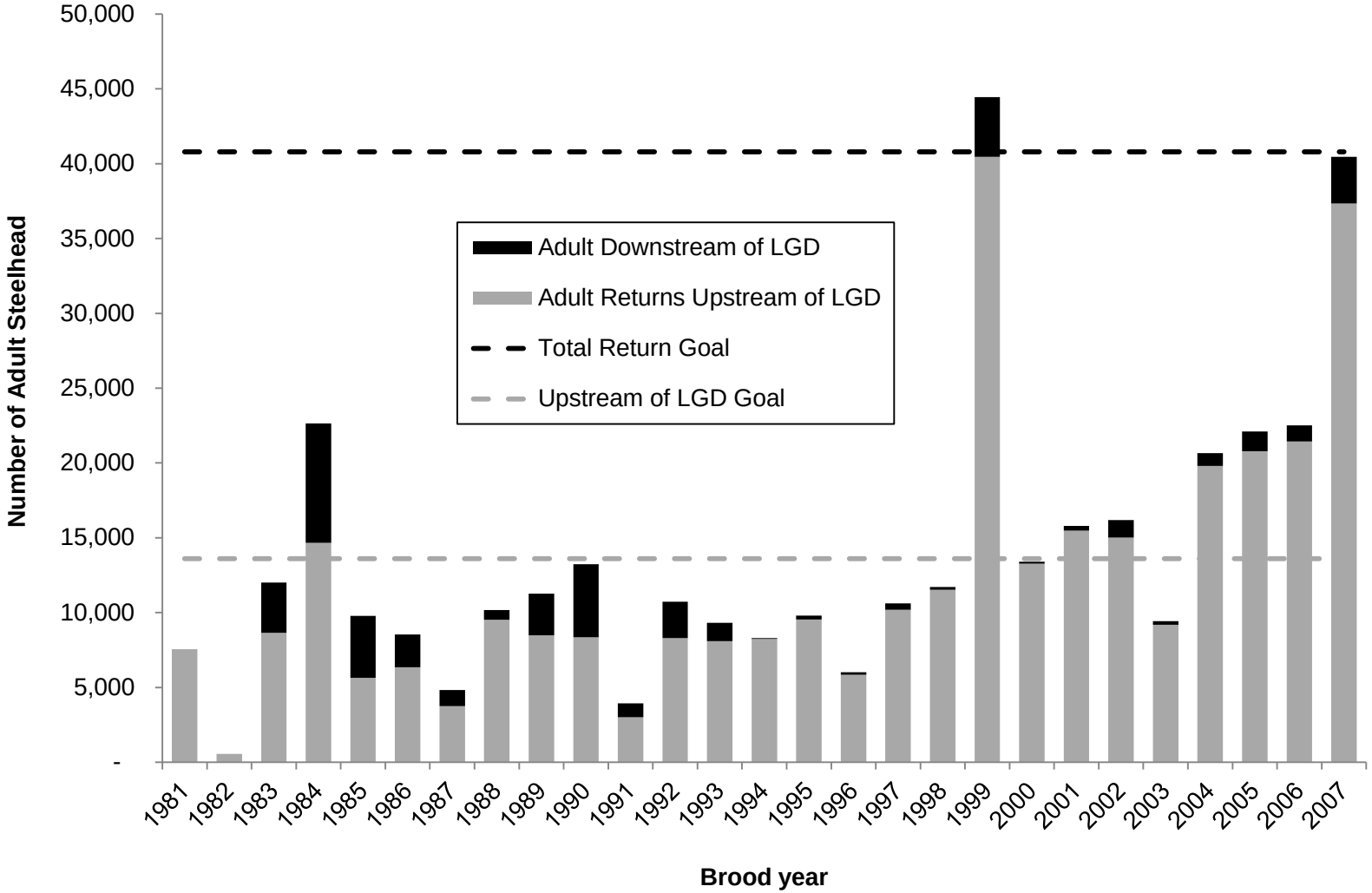
Appendix G1. Combined adult returns summary for steelhead released from LSRCP funded facilities (Clearwater [1992-2007], Hagerman [1981-2007], and Magic Valley [1982-2007]).



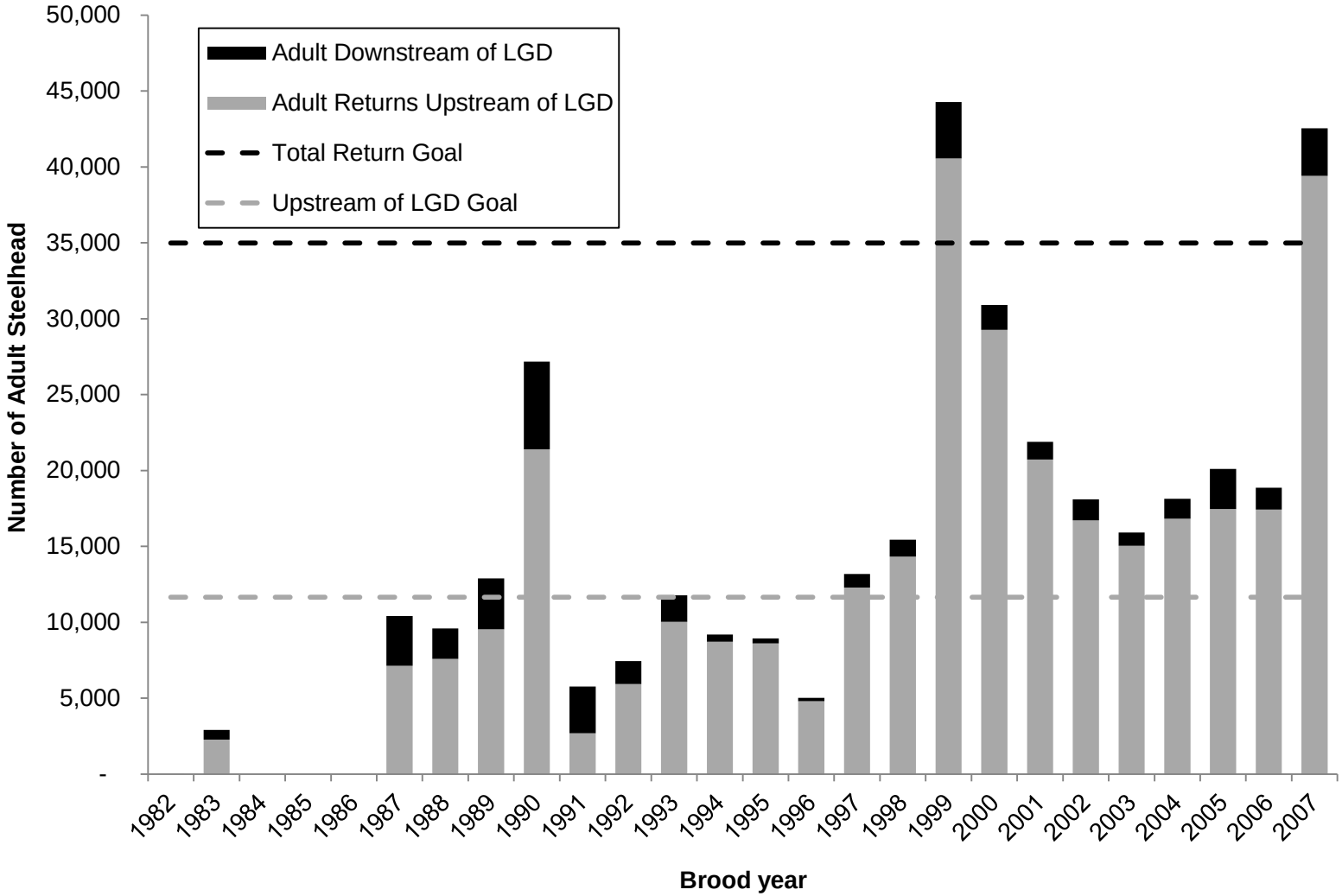
Appendix G2. Adult return summaries for steelhead released from Clearwater Fish Hatchery for brood years 1992 through 2007.



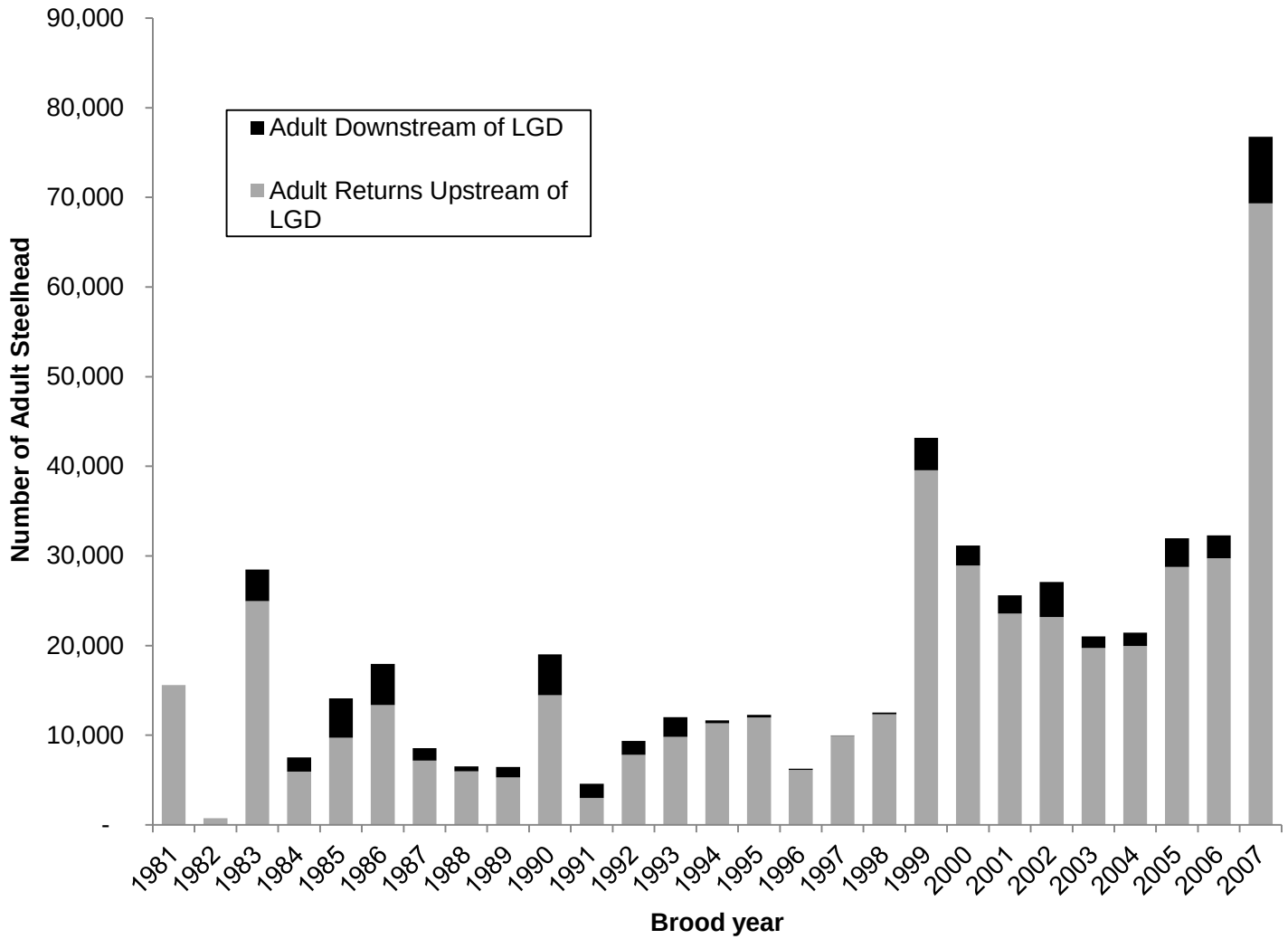
Appendix G3. Adult return summaries for steelhead released from Hagerman for brood years 1981 through 2007.



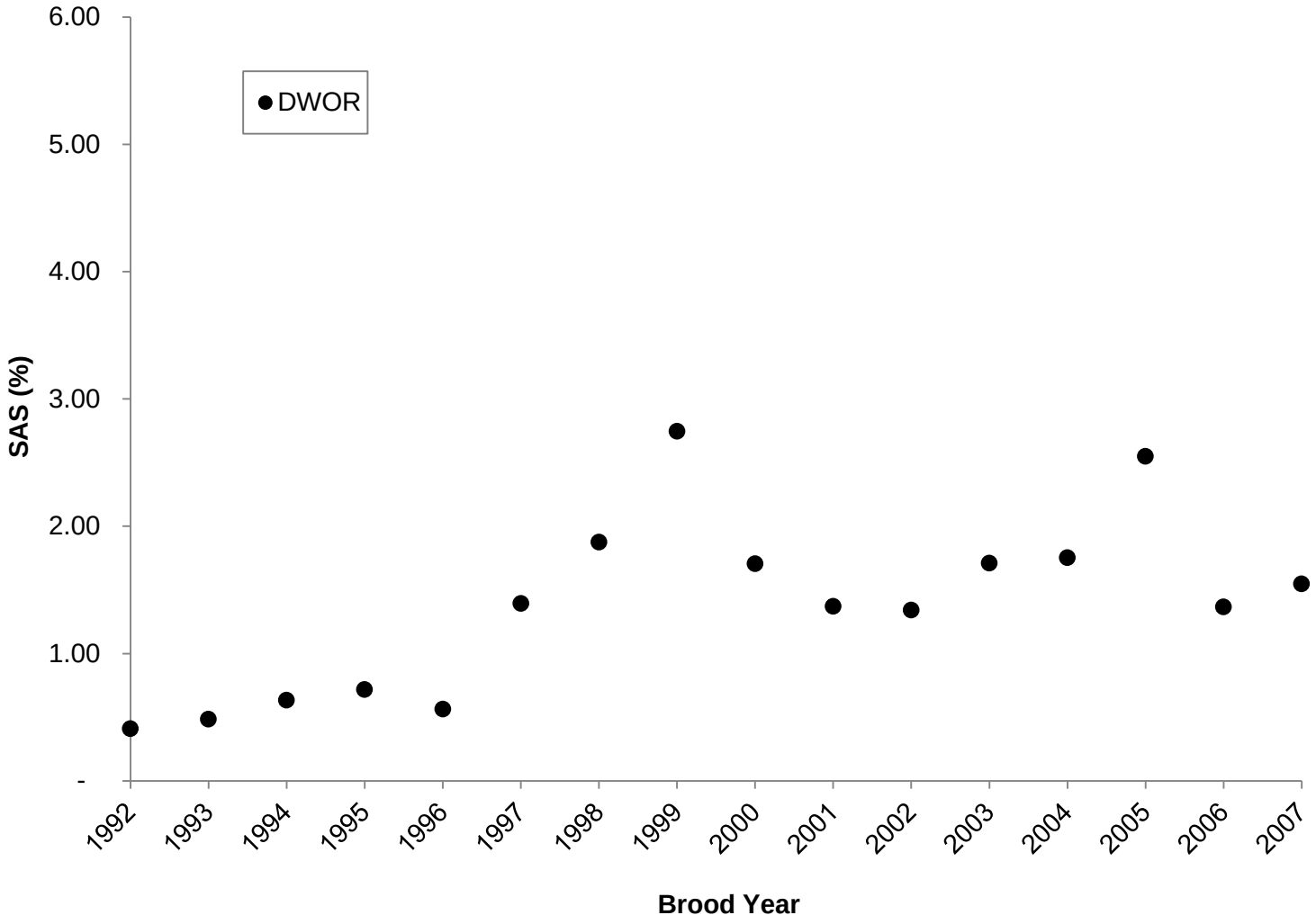
Appendix G4. Adult return summaries for steelhead released from Magic Valley Fish Hatchery for brood years 1982 through 2007.



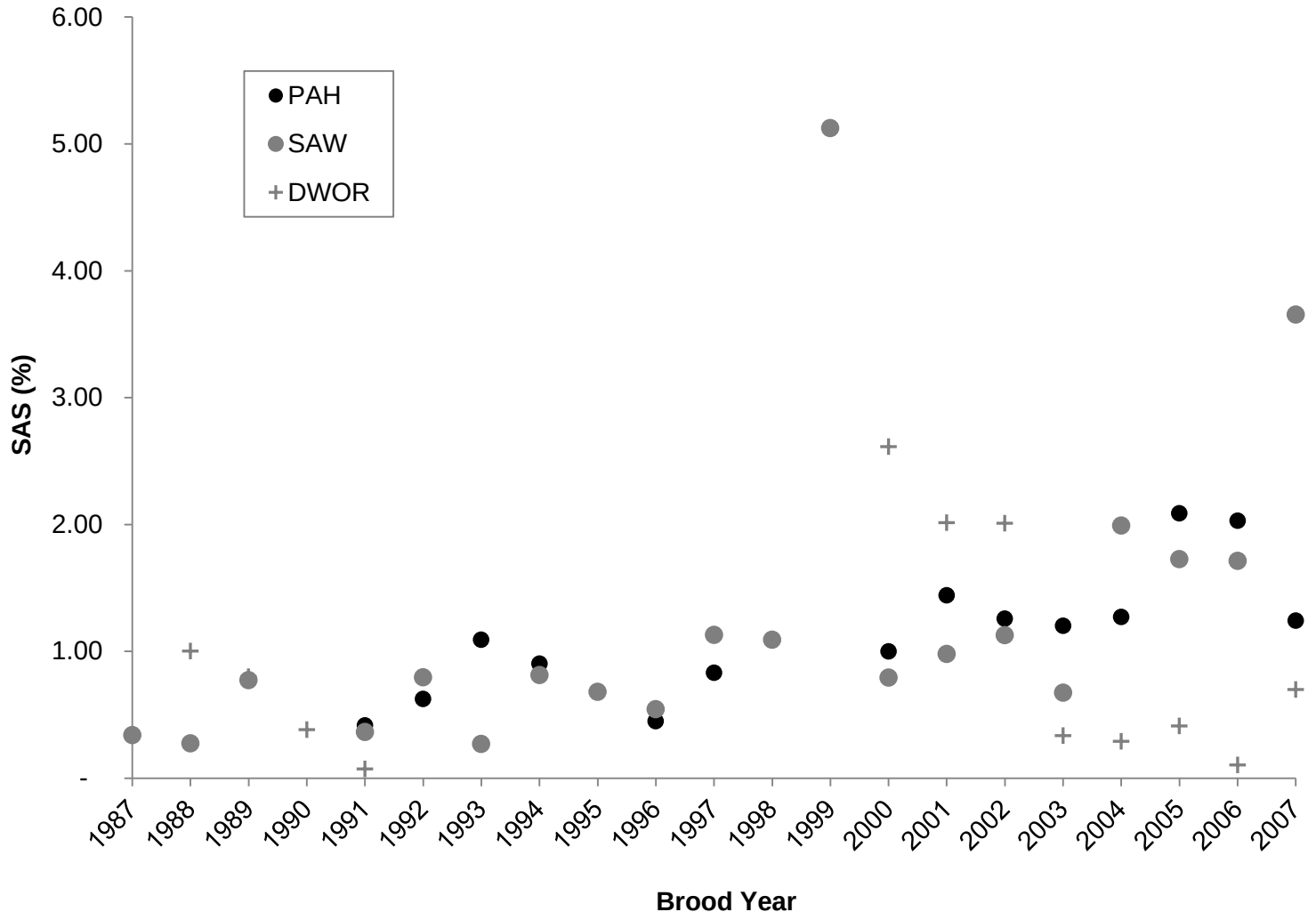
Appendix G5. Adult return summaries for steelhead released from Niagara Springs Fish Hatchery for brood years 1981 through 2007.



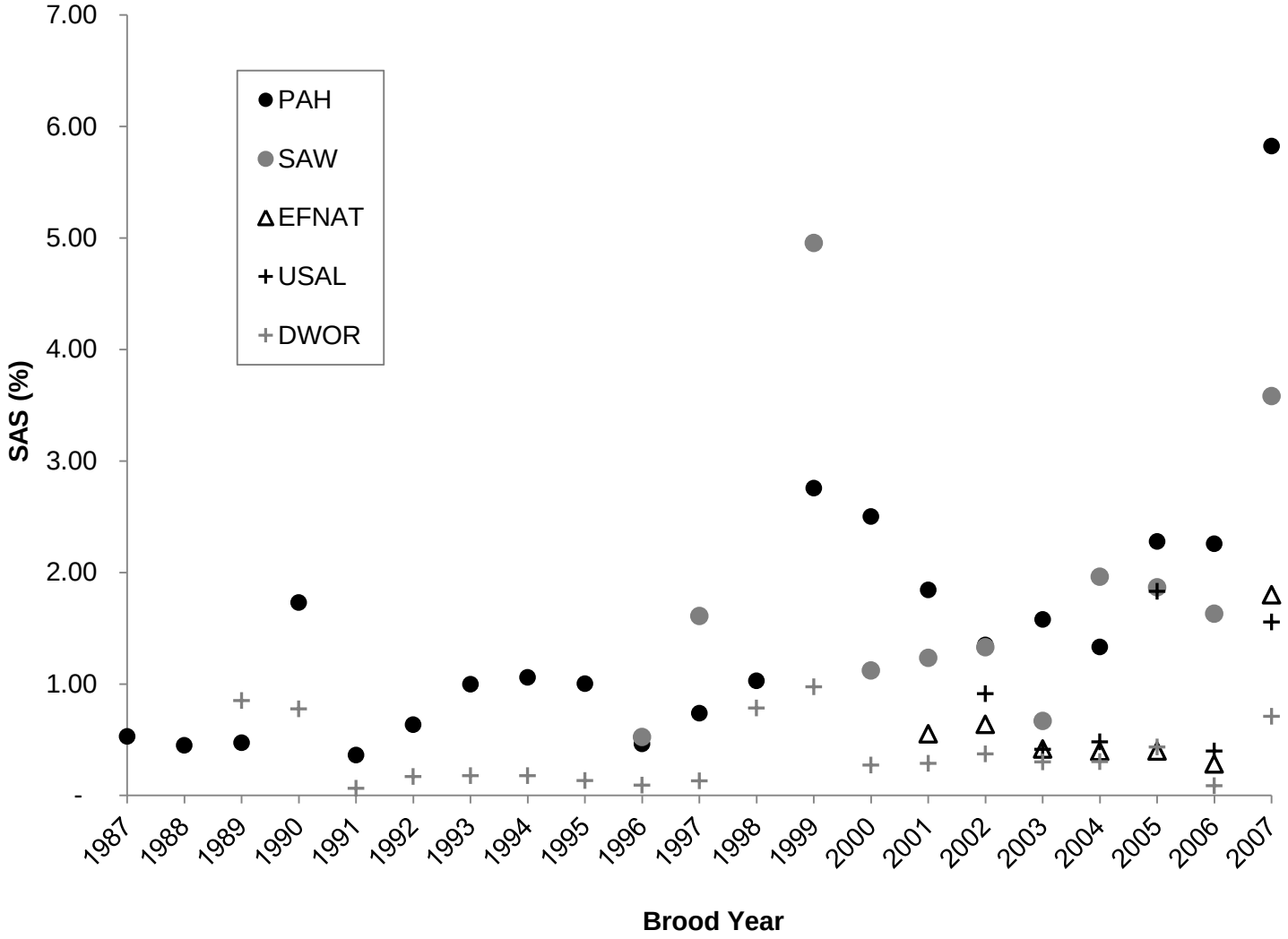
Appendix H1. Smolt-to-adult survival rates (SAS) of steelhead released from Clearwater Fish Hatchery for brood years 1992 through 2007.



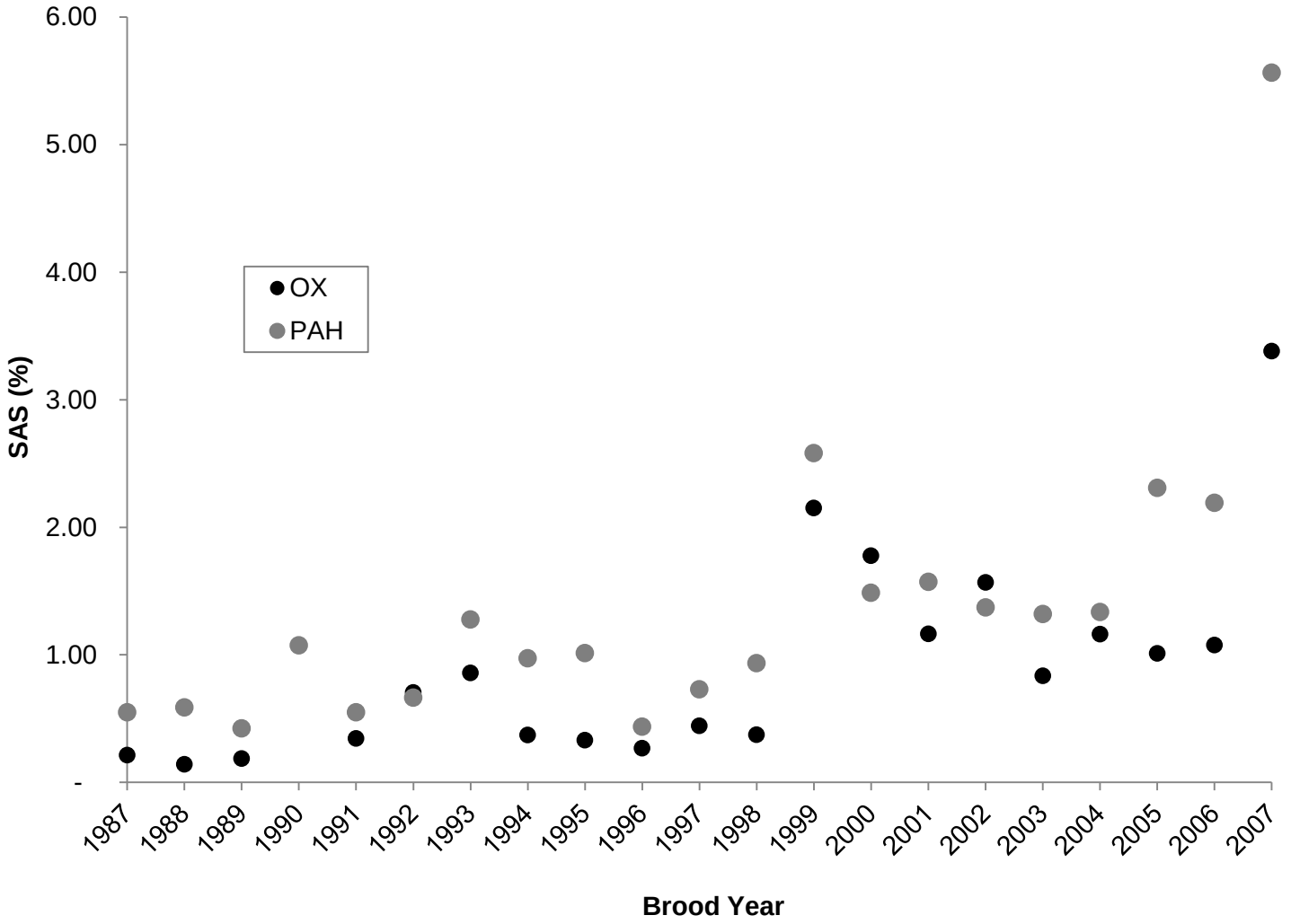
Appendix H2. Smolt-to-adult survival rates (SAS) for steelhead released from Hagerman for brood years 1987 through 2007 for production released into the Salmon River.



Appendix H3. Smolt-to-adult survival rates (SAS) for steelhead released from Magic Valley Fish Hatchery for brood years 1987 through 2007 for production released into the Salmon River.



Appendix H4. Smolt-to-adult survival rates (SAS) for steelhead released from Niagara Springs Fish Hatchery for brood years 1987 through 2007.



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