



**LOWER SNAKE RIVER COMPENSATION PLAN
STEELHEAD FISH HATCHERY
EVALUATIONS—IDAHO**

**Brood Year 2008
Hatchery Steelhead Report**



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ABSTRACT

This report summarizes production, survival, and adult return information for brood year 2008 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, Hagerman National, Magic Valley, and Niagara Springs fish hatcheries received eyed eggs from broodstock collection facilities and reared them for one year prior to release. Eyed egg-to-smolt survival across all hatcheries and stocks was high with an average of 85% (range 74-92%). Average smolt size at release ranged from 4.9 fish per pound (fpp) to 3.7 fpp, with most release groups slightly smaller than the targeted goal of 4.5 fpp. Combined, these facilities released 5,682,987 smolts at multiple sites in the Clearwater 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 80.6% (range 58.4%-94.1%).

Recovery of coded-wire tags (CWT) from fisheries and hatchery traps was used to reconstruct the brood year 2008 return of adult steelhead. The total estimated return to the mouth of the Columbia River from Brood Year 2008 releases was 82,952 adult steelhead during the 2010-11, 2011-12, and 2012-13 steelhead runs. Production from LSRCP funded facilities (Clearwater, Hagerman National, and Magic Valley fish hatcheries) accounted for 48,357 steelhead, which represents 41% of the total LSRCP mitigation goal for these three facilities. Production from Niagara Springs Fish Hatchery accounted for 34,595 adult steelhead, which accounts for 42% of the total estimated adult return for all four facilities. The majority (71,297) of the returning brood year 2008 adults escaped upstream of LGD where production from Clearwater and Magic Valley fish hatcheries met their respective adult mitigation goals to LGD. Exploitation by recreational anglers upstream of LGD accounted for 37,282 of the return to LGD, which includes fish straying and caught outside their expected migration corridor. A total of 14,923 were caught at hatchery traps, which includes 283 EFNAT fish that were released upstream of the weir. The remaining fish (19,564) were classified as unharvested escapement. These included fish that were returning to offsite releases with no trapping facility to remove them.

In addition to estimating adult returns through run reconstruction methodologies, brood year 2008 steelhead releases from all three LSRCP rearing facilities and Niagara Springs Fish Hatchery were PIT tagged at a sufficiently high rate to estimate returns to Bonneville and Lower Granite dams. The return estimates based on the sum of PIT expansion values exceeded the run reconstruction estimates by 33% at Bonneville Dam and by 10% at LGD.

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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 returning adults 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 (110,200 downstream of project area; Lower Granite Dam) to escapement (55,100 to 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, and 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, Hagerman National, and Magic Valley fish hatcheries 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, 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 expects these releases to return at rates comparable to the LSRCP facilities.

Hatchery Evaluation Component

The LSRCP includes a hatchery evaluation component to document the accomplishments of the Idaho-LSRCP program towards meeting the adult steelhead mitigation goal. Hatchery evaluations also identify limiting factors to meeting those goals and may 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 2008 hatchery steelhead released in Idaho from the LSRCP and the IPC mitigation programs. The report timeline is lagged seven years to allow sufficient time for adults from brood year 2008 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 or RMIS (<http://www.rmipc.org>).

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	USACE
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 (USACE) that is not included in this report.

** Satellite facilities operated by the Sawtooth Fish Hatchery.

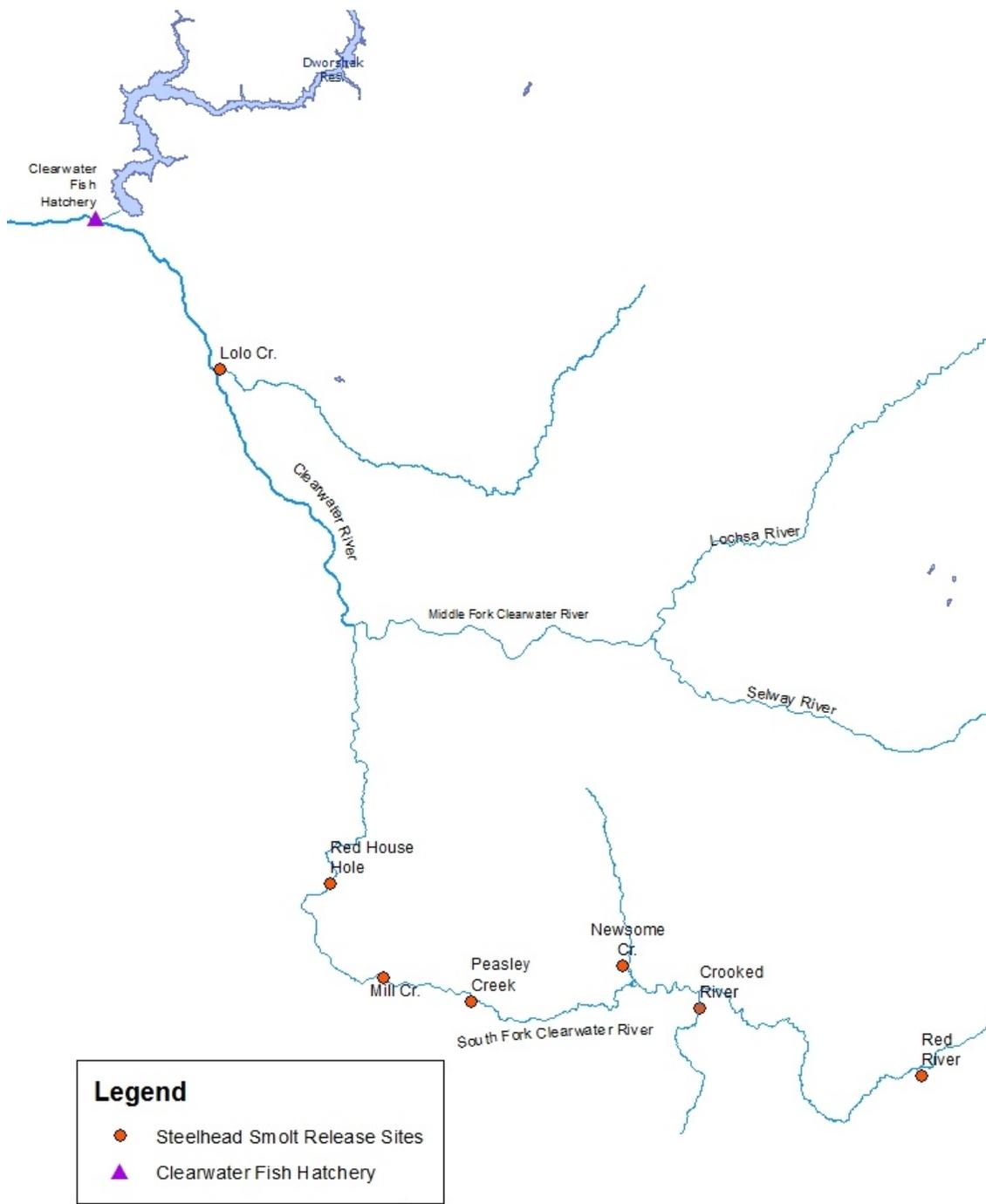


Figure 1. The location of hatchery steelhead release sites and the Clearwater Fish Hatchery facility in the Clearwater River basin.

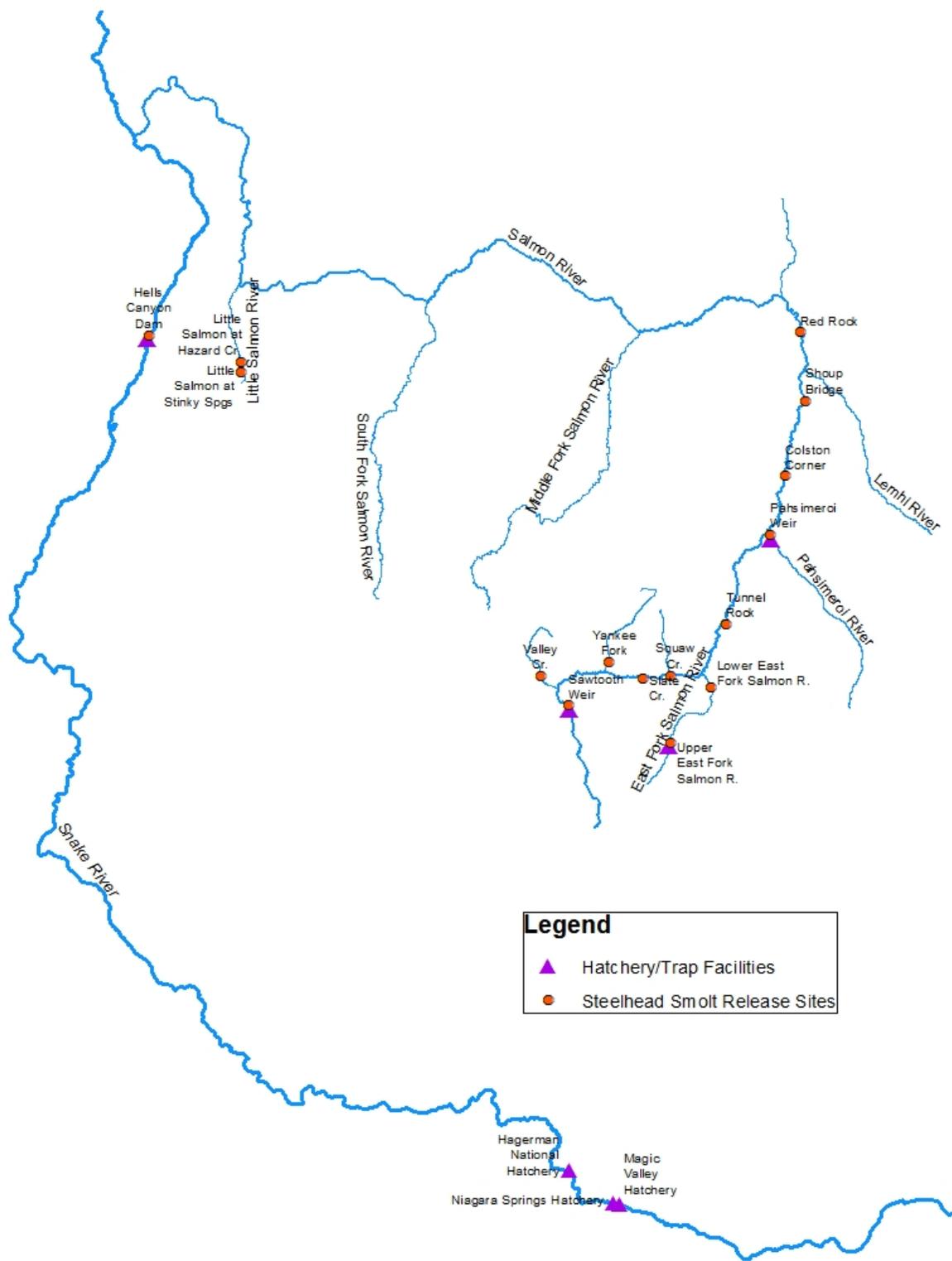


Figure 2. The location of hatchery steelhead release sites and hatchery facilities in the Salmon River and Snake River basins associated with the IPC and LSRCP mitigation programs.

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 fish hatcheries (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 River 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 is permitted for fish with a clipped adipose fin (ad-clipped) distinguishing them from fish of natural origin (ad-intact). 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. These fish are generally referred to as “A-run” fish and the majority 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 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 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 hatchery broodstock in the Salmon River that produced larger (primarily 2-ocean) returning adults. This stock was sourced from progeny of DWOR stock adults spawned at Dworshak Fish Hatchery that were reared at Magic Valley Fish Hatchery (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. Although the goal is to develop a fully self-sustaining USAL stock, DWOR stock smolts will continue to be released into the Salmon River to backfill production when there are inadequate USAL adult returns.

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 Lower Granite Dam, which was used to identify a project area escapement upstream of Lower Granite Dam.

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 Return Goal	SAS (%) ²	Escapement Target to LGD	Smolt Production Target
LSRCP	Clearwater	42,000	4.98	14,000	843,000
LSRCP	Hagerman	40,800	3.58	13,600	1,450,000
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.

² This is the SAS required to meet the adult return goal based on current smolt production targets

Clearwater Fish Hatchery (Clearwater) is located at the confluence of the North Fork Clearwater and mainstem Clearwater rivers near Ahsahka, Idaho. Clearwater’s mitigation goal is to annually return 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 for final rearing and release into the Salmon River.

Hagerman National Fish Hatchery (Hagerman) is located along the Snake River in southern Idaho near the town of Hagerman, Idaho. Hagerman’s mitigation goal is to annually return 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 1,450,000 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 2008 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 (Magic Valley) is located along the Snake River near Filer, Idaho. The mitigation goal for this facility is to return 34,980 adult steelhead annually. To achieve this goal Magic Valley was originally intended to release 2,000,000 smolts annually; however, the actual annual production targets was reduced in the early 2000s due to declines in water availability. By brood year 2005, production was reduced to 1,600,000 smolts, which was also the target in brood year 2008. 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 (Niagara Springs) 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 facilities.

METHODS

Juvenile Production

Broodstock Collection and Smolt Production

Adult steelhead trapping, spawning, and egg production information is compiled from 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, number of green eggs collected, and number of eggs shipped. Parameters reported by rearing facilities include the number of eggs kept for production needs, number of smolts released, and average size at release (number of fish per lb). The number of eyed eggs kept for program needs is based on the number of smolts released plus any mortality that occurred from when the rearing facility received the eggs. Adjusted number of females spawned is derived from the number of eyed eggs kept for production needs, eye-up rates, and fecundity. Eyed egg-to-smolt survival rates do not include any excess production that was discarded or released into non-anadromous waters.

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. The use of CWTs for monitoring and evaluating steelhead harvest and stray estimates is being replaced with parentage-based tagging. Parentage-based tagging (PBT) is a new monitoring and evaluation tool developed to assign the progeny of hatchery broodstock to a known pairing of adults, with the ability to track their entire hatchery life history through the PBT database. The database of parentage genotypes is created from the annual sampling of hatchery broodstock, storing information on 95 single nucleotide polymorphism (SNP) markers from essentially all of the brood fish that contributed progeny to the population of released steelhead smolts. Progeny from any of these parents (collected either as juveniles or adults), can be nonlethally sampled and, if genotyped, be assigned back to their parents, thus identifying their hatchery of origin and brood year (Steele et al. 2013). Advantages of PBT over CWT technology include increased sample size of the tag group and the option of acquiring nonlethal tissue samples at any stage of their life history with minimal handling. By genotyping all parental broodstock, every juvenile is genetically “tagged.” Genotyping information from the 2008 brood year of adults is the first year that 100% of the steelhead spawned within Snake River basin hatcheries were stored in the database. Production from the 2008 brood year was not tracked to release site; as a result, only the stock and brood year can be determined from recoveries from this brood year.

Passive integrated transponder (PIT) tags serve multiple purposes and like CWTs and PBT are an important tool for monitoring and evaluating hatchery steelhead programs. PIT tags are used to generate estimates of juvenile survival to Lower Granite Dam 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. The brood year 2008 release group is the second consecutive year in which release groups were represented by PIT tags at almost all release sites. We also increased the total number of PIT tags in fish released from Niagara Springs from 1,194 tags in brood year 2007 smolts to 24,464 tags in brood year 2008 smolts. This increase provided a commensurate improvement in the power to estimate juvenile survival rates to Lower Granite Dam 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 had CWTs). 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. Coded wire tagging rate information for Dworshak, State of Oregon, and State of Washington releases in the Snake basin was obtained from these cooperators. Taking tissue samples (fin clips) from harvested fish for PBT analysis was not fully implemented in the IDFG creel survey until the fall of 2012 and the spring of 2013. This timeframe corresponded to age 5 steelhead (3-ocean) from the 2008 brood year.

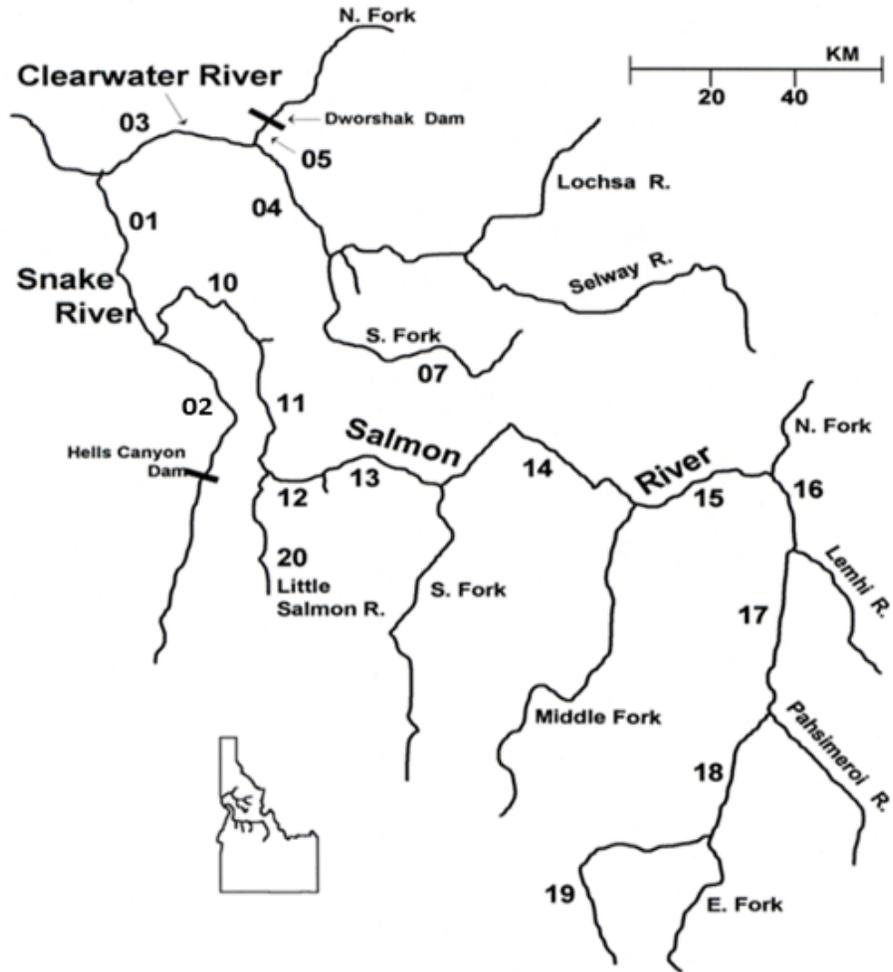


Figure 3. Idaho Department of Fish and Game river section designations where hatchery steelhead are available for harvest. Major tributaries or dams indicated on the map are used as section boundaries.

Harvest Outside of Idaho

In 2015, I queried CWT recovery information submitted to the RMIS to estimate harvest in the Columbia River and the Lower Snake River outside of Idaho. 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 all the harvest and combining with the escapement. I rely on surrogate releases to estimate escapement of release groups of steelhead released at offsite locations. If the surrogate's smolt-to-adult return (SAR) is less than the estimated harvest of the group of interest, the SAR and the total estimated adult return will be based on the harvest estimate. Harvest rates are not determined for ad-intact 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, Smolt-To-Adult, and Smolt-To-Adult Survival" 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. Surrogates used for offsite release groups were typically released at a nearby broodstock collection facility with a permanent weir. For brood year 2008 the surrogate groups were stocks released at Sawtooth, Pahsimeroi, East Fork Salmon River, Hells Canyon, and Dworshak facilities. Estimated SAR data for the Dworshak release group 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, Smolt-To-Adult Return, and Smolt-To-Adult Survival

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 an 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 a total smolt-to-adult survival rate (SAS) that represents the total number of adults produced.

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. The number of male and female spawners used in the calculation is adjusted to exclude parents whose progeny were culled to eliminate excess production or parents that were culled because they tested positive for disease. 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, assuming a 1:1 male to female spawner ratio. At the current production level of 843,000 smolts produced from 145 male/female pairings at Clearwater, a PPR of 145 is required to meet the return objective of 42,000 adults. Smolt releases from Hagerman produced from 353 male/female pairings require a PPR of 58 for an escapement objective of 40,800 adults, and smolt releases from Magic Valley produced from 394 male/female pairings require a PPR of 44 to meet an escapement objective of 34,980 adults.

In addition to estimating adult returns through a traditional run reconstruction methodology as described above, brood year 2008 steelhead releases from all three LSRCP rearing facilities and Niagara Springs Fish Hatchery were PIT tagged at a sufficiently high rate to directly estimate the returns to Bonneville and Lower Granite dams. 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 2010, 2011, and 2012. This methodology assumes equal tagged to untagged ratios in the juveniles and returning adults (i.e. no tag loss or differential mortality of tagged and untagged fish).

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 extended 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 2008, prespawn mortality was approximately 10% for OX stock.

Spawning and egg production information provided in Table 3 reflects the total number of females spawned, including females from which excess eggs were acquired and females that tested positive for infectious hematopoietic necrosis (IHN) whose eggs were subsequently disposed. Mean fecundity for most A-run stocks in brood year 2008 dropped slightly from brood year 2007 but increased for the USAL stock (Appendix A). There were consistent differences in fecundity between stocks, which are due to differences in age structure. The majority of PAH, SAW, and OX 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.

Survival from the green egg to eyed egg stage (eye-up rate) ranged from 66.5% for the USAL stock raised at MVFH to 92.5% for the DWOR stock raised at Clearwater in brood year 2008 (Table 3, Appendix B). Eye-up rates for the USAL stock increased compared to brood year 2007 but remained lower compared to other stocks in brood year 2008. Reasons for the lower eye-up of the USAL stock may be the result of the extra handling of broodstock, which were either trapped at the Squaw Creek weir or caught and handled by anglers who placed the fish in PVC holding tubes before they were placed in the live box at Squaw Creek. These fish were then transported to the East Fork satellite facility where they were held until spawning. 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 2008.

Broodstock	Rearing Hatchery	Females Spawned	Fecundity	Green Eggs ¹	Eye-up rate (%)	Production Shipped
Dworshak (DWOR)	Clearwater	205	7,103	1,453,342	92.5	951,290
	Hagerman	38	7,103	271,321	90.9	215,000
	Magic Valley	150	7,103	1,070,650	90.9	869,017
East Fork (EFNAT)	Magic Valley	26	4,770	124,031	80.8	100,263
Oxbow (OX)	Niagara Springs	296	5,010	1,482,988	87.0	1,004,696
	Hagerman	78	4,685	364,838	87.3	217,119
	Magic Valley	160	4,685	738,161	87.3	435,000
Pahsimeroi (PAH)	Niagara Springs	458	4,685	2,124,234	89.7	1,109,953
	Sho-Ban Egg Box	177	4,685	829,764	89.6	506,250
Sawtooth (SAW)	Hagerman	285	4,943	1,419,602	89.3	1,151,100
	Magic Valley	127	4,943	633,339	89.3	513,550
	Sho-Ban Egg Box	155	4,943	770,359	89.3	624,654
Squaw Cr. (USAL)	Magic Valley	14	7,410	103,764	66.5	68,988

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

Onsite survival at rearing facilities was based on the number of eggs kept for program needs and the number of smolts released (Table 4). Eyed egg-to-smolt release survival averaged 87% across all stocks at all four rearing facilities. None of the rearing hatcheries reported disease outbreaks or any other unanticipated events resulting in significant mortalities of eggs or fish prior to release as smolts. Niagara Springs Fish Hatchery received all of their BY 2008 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. Good early rearing survival of all their steelhead stocks at Niagara Springs resulted in the release of 437,850 lbs of smolts averaging 4.05 fish/lb into anadromous waters, meeting their mitigation goal to release 400,000 lbs of smolts. An additional 254,065 (3,050 lbs) excess PAH and OX stock fish were released into Salmon Falls Creek Reservoir in the fall of 2008. Better than predicted survival of eggs and fry at Magic Valley also resulted in the release of 19,995 (481 lbs) DWOR stock and 32,508 (450 lbs) SAW stock excess fish into Salmon Falls Creek Reservoir in the fall of 2008. Size at release of all stocks ranged from 3.7 fish/lb to 4.9 fish/lb, which is consistent with releases from recent brood years (Table 4, Appendix D).

Table 4. Brood year 2008 number of females spawned to acquire eyed eggs kept for program needs, eyed egg-to-smolt (onsite) survival estimates, and smolt size at release (fish per pound [fpp]) from LSRCP and IPC steelhead facilities.

Rearing Hatchery	Stock	Females Spawned ¹	Eyed Eggs Kept for Program Needs	Smolts Released	Size at Release (fpp)	Onsite Survival (%)
Clearwater	DWOR	145	951,290	835,636	4.7	88%
	Total	145	951,290	835,636		
Hagerman	DWOR	34	212,867	171,094	4.6	80%
	PAH	53	217,119	200,290	4.7	92%
	SAW	266	1,150,056	1,048,926	4.3	91%
	Total	353	1,580,042	1,420,310		
Magic Valley	DWOR	133	834,242	714,349	4.8	86%
	EFNAT	26	92,086	67,821	4.6	74%
	PAH	103	423,881	375,682	4.9	89%
	SAW	118	511,923	436,881	4.6	85%
	USAL	14	65,171	57,464	4.8	88%
	Total	394	1,927,303	1,652,197		
Niagara Springs	OX	205	1,004,696	770,470	4.8	77%
	PAH	289	1,213,185	1,004,374	3.7	83%
	Total	494	2,217,881	1,774,844		

¹ Number of females spawned is adjusted to include only females for which eyed eggs were kept for program needs.

Smolt Releases

A combined total of 5,682,987 brood year 2008 steelhead smolts were released from all rearing facilities from March through May 2009 (Table 5). Clearwater Fish Hatchery and Hagerman National Fish Hatchery were both slightly below their smolt release goals of 843,000 and 1,450,000 respectively. Niagara Springs Fish Hatchery released a total of 1,774,844 smolts (437,850 lbs) at 4.48 fish/lb, slightly more 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/tag information for brood year 2008 hatchery steelhead released in Idaho for the IPC and LSRCP mitigation programs.

Hatchery	Release Site	Stock	AD	AD/CWT	CWT	None	Total Release
Clearwater	Crooked R.	DWOR			20,651	52,636	73,287
	Lolo Cr.	DWOR				50,250	50,250
	Newsome Cr.	DWOR				25,354	25,354
	Peasley Cr.	DWOR	147,106	118,483			265,589
	Red R.	DWOR				131,803	131,803
	Mill Cr.	DWOR				25,354	25,354
	Red House Hole	DWOR	143,235	120,764			263,999
	Total		290,341	239,247	20,651	285,397	835,636
Hagerman	E. Fk. Salmon R. (lower)	DWOR	17,231	67,667			84,898
	Little Salmon R. (lower)	PAH				51,797	51,797
	Little Salmon R. (upper)	PAH				148,493	148,493
	Little Salmon R. (upper)	DWOR	22,155	64,041			86,196
	Salmon R. (Sawtooth)	SAW	674,487	80,389			754,876
	Yankee Fk.	SAW	148,863			145,187	294,050
	Total		862,736	212,097	0	345,477	1,420,310
Magic Valley	E. Fk. Salmon R. (lower)	DWOR	155,989	61,469			217,458
	E. Fk. Salmon R. (trap)	EFNAT			66,690	1,131	67,821
	Little Salmon R. (upper)	DWOR	156,362	61,739			218,101
	Pahsimeroi R. (weir)	PAH	520	30,701			31,221
	Salmon R. (Colston)	PAH	94,100	30,785			124,885
	Salmon R. (McNabb)	SAW	94,917	30,250			125,167
	Salmon R. (Red Rock)	PAH	95,935	30,156			126,091
	Salmon R. (Shoup Br.)	PAH	93,485				93,485
	Salmon R. (Tunnel)	SAW	62,192				62,192
	Slate Cr.	SAW	523	30,859		62,588	93,970
	Squaw Cr.	DWOR	220,069	58,721			278,790
	Squaw Cr.	USAL	958	56,506			57,464
	Valley Cr.	SAW				62,336	62,336
Yankee Fk.	SAW	31,561	30,433		31,222	93,216	
	Total		1,006,611	421,619	66,690	157,277	1,652,197
Niagara Springs	Little Salmon R. (upper)	OX	223,082	20,645			243,727
	Little Salmon R. (upper)	PAH	158,987	19,862			178,849
	Pahsimeroi R. (weir)	PAH	793,948	31,577			825,525
	Hells Canyon	OX	506,514	20,229			526,743
	Total		1,682,531	92,313	0	0	1,774,844
Grand Total			3,842,219	965,276	87,341	788,151	5,682,987

Juvenile Migration Timing and Survival

Survival rates of PIT-tagged steelhead from release to LGD had an unweighted average of 80.6%, which is similar to recent years (Appendix E). The ad-intact Crooked River DWOR stock release (Clearwater Hatchery) had the lowest survival rate (58.4% +/- 4.8) and the ad-clipped Little Salmon River PAH stock release (Niagara Springs) had the highest survival rate (94.1% +/- 2.6) (Table 6). The majority of migrants arrived at LGD from late April through May of 2009.

Table 6. Travel times and estimated survival of brood year 2008 smolts from release site to LGD after release from LSRCP and IPC facilities in migration year 2009.

Hatchery	Stock	Release Site	Number PIT Tagged	Release Date	80% Arrival Window (# Days)	% Survival Estimate to LGD (+/- 95% CI)
Clearwater	DWOR	Crooked R.	1,987	4/11	5/7-5/20 (15)	58.4 (±4.8)
	DWOR	Lolo Cr.	1,398	4/21	5/4-5/18 (16)	71.2 (±4.8)
	DWOR	Peasley Cr.	7,151	4/14	4/23-5/14 (23)	88.3 (±1.6)
	DWOR	Red House Hole	7,088	4/10	4/22-5/6 (16)	92.9 (±1.4)
	DWOR	Red R.	3,570	4/10	4/24-5/20 (28)	71.6 (±2.4)
Hagerman	DWOR	E. Fk. Salmon R. (lower)	4,288	5/9	4/25-5/20 (27)	79.2 (±2.5)
	DWOR	Little Salmon R. (upper)	4,056	4/10	4/20-5/18 (30)	86.8 (±1.9)
	PAH	Little Salmon R. (lower)	1,190	4/3	4/14-5/8 (26)	93.0 (±2.9)
	PAH	Little Salmon R. (upper)	4,700	4/3	4/5-5/11(28)	88.6 (±1.7)
	SAW	Salmon R. (Sawtooth)	7,653	4/23	4/26-5/19 (23)	83.7 (±2.3)
	SAW	Yankee Fork (ad-intact)	1,463	5/7	5/31-6/13 (15)	71.9 (±4.8)
	SAW	Yankee Fork (ad-clip)	1,571	5/9	5/29-6/11 (15)	74.6 (±4.6)
Magic Valley	DWOR	East Fork Salmon R.	4,148	4/18	4/27-5/18 (23)	81.5 (±2.4)
	DWOR	Little Salmon R. (upper)	4,174	4/7	4/22-5/19 (29)	80.9 (±1.9)
	DWOR	Squaw Cr.	5,361	4/23	5/1-5/21 (22)	75.2 (±2.7)
	EFNAT	E. Fk. Salmon R. (trap)	1,296	4/25	5/9-5/27 (20)	71.8 (±6.0)
	PAH	Pahsimeroi R. (weir)	595	4/14	4/23-5/7 (16)	71.7 (±5.0)
	PAH	Salmon R. (Red Rock)	2,376	4/10	4/26-5/19 (25)	81.2 (±3.8)
	PAH	Salmon R. (Shoup Br.)	1,788	4/14	4/22-5/6 (16)	85.8 (±2.9)
	PAH	Salmon R. (Colston)	2,382	4/15	4/24-5/14 (22)	81.8 (±2.7)
	SAW	Salmon R. (McNabb)	2,388	4/17	4/24-5/10 (18)	84.9 (±2.7)
	SAW	Salmon R. (Tunnel)	1,192	4/21	4/25-5/14 (21)	85.2 (±3.8)
	SAW	Slate Cr. (ad-intact)	433	4/21	5/9-5/19 (12)	78.7 (±10.8)
	SAW	Slate Cr. (ad-clip)	1,194	4/27	5/7-5/19 (14)	81.0 (±6.1)
	SAW	Valley Cr.	1,196	4/29	5/8-5/20 (14)	77.2 (±5.8)
	SAW	Yankee Fk. (ad-intact)	1,027	4/21	4/28-5/19 (23)	72.4 (±5.5)
	SAW	Yankee Fk. (ad-clip)	1,342	4/30	5/20-6/10 (23)	74.0 (±5.6)
USAL	Squaw Cr.	6,932	4/24	5/7-5/20 (15)	73.5 (±2.5)	
Niagara Springs	OX	Hells Canyon	7,400	3/28	4/22-6/7 (48)	88.1 (±1.9)
	OX	Little Salmon R. (upper)	4,175	4/3	4/24-5/21 (28)	90.4 (±2.2)
	PAH	Little Salmon R. (upper)	2,581	4/9	4/20-5/15 (27)	94.1 (±2.6)
	PAH	Pahsimeroi R. (weir)	10,308	4/14	4/27-5/19 (24)	88.8 (±2.1)
Total PIT Tagged:			108,403			

Adult Returns

Recreational Harvest Upstream of Lower Granite Dam

Adult steelhead from brood year 2008 releases contributed to fisheries over the course of multiple runs from the fall of 2010 through the spring of 2013. During that time recreational fisheries for steelhead occurred in the Snake, Clearwater, Little Salmon, and Salmon rivers in Idaho. Partitioning out the statewide harvest estimate into hatchery-stock-age groups was based on CWT recoveries from each fishing season. Recreational anglers harvested approximately 34,265 adult ad-clipped steelhead from brood year 2008 (Table 7), which is substantially lower than the harvest of 106,551 fish from brood year 2007. The harvest of brood year 2007 fish exceeded the harvest of any previous brood year cohort for which records have been maintained for the Idaho fishery (Warren 2016). Tribal harvest estimates were not available.

Table 7. Estimated recreational harvest upstream of LGD for brood year 2008 hatchery origin steelhead released from LSRCP and IPC facilities in Idaho. Stock composition of the statewide harvest estimates were derived from coded-wire-tag recoveries in the fisheries from the fall 2010 through the spring of 2013.

Hatchery	Stock	1-ocean	2-ocean	3-ocean	Total
Clearwater	DWOR	297	8,538	98	8,933
Clearwater Total		297	8,538	98	8,933
Hagerman	DWOR	131	793	21	945
	SAW	2,344	1,676	0	4,020
Hagerman Total		2,475	2,469	21	4,965
Magic Valley	DWOR	111	789	30	930
	PAH	3,029	280	31	3,339
	SAW	1,115	436	0	1,551
	USAL	29	439	0	468
Magic Valley Total		4,283	1,944	61	6,288
Niagara Springs	OX	2,275	1,114	217	3,605
	PAH	9,325	1,135	13	10,473
Niagara Springs Total		11,600	2,249	230	14,078
Grand Total		18,655	15,200	410	34,265

Harvest Downstream of Lower Granite Dam

Brood year 2008 releases from LSRCP and IPC facilities contributed 11,442 adult steelhead to fisheries in the ocean, Columbia River, and Lower Snake River downstream of Lower Granite Dam (Table 8). This estimate includes harvest from all release groups, including ad-intact fish, which was estimated from RMIS data available from the non-selective tribal fishery in Zone 6. 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 Lower Granite Dam (LGD) for brood year 2008 hatchery steelhead released from LSRCP and IPC facilities. Only release groups for which harvest was detected are included in this table.

Hatchery	Stock/Clip Status	Ocean Sport	Zone 1-5 Sport	Zone 6 Sport	Zone 6 Tribal	Columbia R. Upstream of McNary Sport	SNAKE R. Downstream of LGD Sport	Total Harvest Downstream of LGD
Clearwater	DWOR ad-clipped	9	201	7	768	53	109	1,146
	DWOR ad-intact	-	-	-	56	-	-	56
	Clearwater Total	9	201	7	823	53	109	1,202
Hagerman	DWOR ad-clipped	-	67	8	116	1	83	275
	PAH ad-intact	-	13	-	73	-	19	104
	SAW ad-clipped	-	906	-	556	-	203	1,666
	SAW ad-intact	-	9	-	53	-	13	75
	Hagerman Total	-	995	8	798	1	318	2,120
Magic Valley	DWOR ad-clipped	-	86	18	79	-	110	293
	EFNAT ad-intact	-	4	-	25	-	6	35
	PAH ad-clipped	-	507	24	263	20	30	844
	SAW ad-clipped	-	301	7	158	47	9	523
	SAW ad-intact	-	10	-	57	-	14	81
	USAL ad-clipped	-	32	4	25	-	23	84
	Magic Valley Total	-	941	53	606	67	192	1,860
Niagara Springs	OX ad-clipped	-	2,059	24	1,019	707	475	4,284
	PAH ad-clipped	-	978	-	715	-	283	1,976
	Niagara Springs Total	-	3,037	24	1,735	707	757	6,260
Grand Total		9	5,175	92	3,962	828	1,377	11,442

Harvest Rates

Harvest rates of hatchery steelhead downstream of LGD ranged from 4.2% to 31.0% of the estimated total adult return of ad-clipped fish (Table 9). Harvest rates upstream of LGD ranged from 13.8% to 84.5% for most groups (Table 9). Estimated harvest of the Clearwater DWOR group upstream of LGD exceeded the adult estimated return of ad-clipped fish to LGD that was based on using Dworshak National Fish Hatchery's ad-clipped SAR of 1.25% as a surrogate. The estimated return of ad-clipped Clearwater DWOR fish based on PIT tag detections at LGD (3,785 fish) was also less than the harvest estimate. As a result, the harvest rate upstream of LGD for this group is reported as being 100% of the return.

Table 9. Estimated harvest and harvest rates upstream and downstream of Lower Granite Dam (LGD) for brood year 2008 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 Lower Granite Dam			Upstream of Lower Granite Dam			Combined	
Rearing Facility	Stock	Return	Harvest	Harvest Rate (%)	Return	Harvest	Harvest Rate (%)	Harvest	Harvest Rate (%)
Clearwater ¹	DWOR	10,082	1,146	11.4	8,933	8,933	100.0	10,080	100.0
Clearwater Total		10,082	1,146	11.4	8,933	8,933	100.0	10,080	100.0
Hagerman	DWOR	2,026	275	13.6	1,751	945	54.0	1,220	60.2
	SAW	9,242	1,666	18.0	7,541	4,020	53.3	5,686	61.5
Hagerman Total		11,268	1,941	17.2	9,292	4,965	53.4	6,906	61.3
Magic Valley	DWOR	7,059	293	4.2	6,763	930	13.8	1,223	17.4
	PAH	7,602	844	11.1	6,746	3,339	49.5	4,183	55.0
	SAW	2,832	523	18.4	2,310	1,551	67.1	2,073	73.2
	USAL	638	84	13.1	554	468	84.5	552	86.5
Magic Valley Total		18,131	1,744	9.6	16,372	6,288	38.4	8,032	44.3
Niagara Springs	OX	13,839	4,284	31.0	9,525	3,605	37.9	7,889	57.0
	PAH	20,757	1,976	9.5	18,657	10,473	56.1	12,449	60.0
Niagara Springs Total		34,595	6,260	18.1	28,182	14,078	50.0	20,338	58.8
Grand Total		74,076	11,091	15.0	62,780	34,265	54.6	45,356	61.2

¹ Estimated harvest of Clearwater Hatchery's ad-clipped returns upstream of LGD exceeded the estimated return that was based on a surrogate SAR from Dworshak Fish Hatchery.

Hatchery Trap Returns

The numbers of adult steelhead from brood year 2008 trapped at broodstock facilities are summarized by age and sex in Table 10. 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 intermittently 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 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 2008 hatchery origin steelhead returning to LSRCP and IPC broodstock collection facilities in Idaho.

	Males				Females				Total
	One-Ocean		Two-Ocean		One-Ocean		Two-Ocean		
Hatchery	Number	Length (cm)							
East Fork	158	57	21	72	62	58	82	69	323
Hells Canyon	1,525	60	458	72	1,090	59	1,071	68	4,144
Pahsimeroi	3,500	56	195	69	3,134	56	857	66	7,686
Sawtooth	1,289	59	292	69	711	57	691	67	2,983
Squaw Creek ¹	3	59	37	75	7	56	23	75	70

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 2008. The majority (93%) of strays were observed in fisheries upstream of LGD (Table 11). 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 17.19% stray rate of the adults that returned to LGD (Table 12). 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 upstream of the mouth of the Little Salmon River in river sections 12 and 13 during the fall fishing seasons of 2010 and 2011 (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 fish released 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 the lower reaches of river section 2 (Figure 3). In most instances, strays were caught during the fall fishing seasons. If they had not been harvested, it is likely many would have returned to their normal migration corridor in route to their smolt release site. The low numbers of strays that show up at

the Hells Canyon Dam and Dworshak National Fishery Hatchery trap facilities supports this assumption.

Table 11. Stray estimates of adult hatchery steelhead from Idaho LSRCP and IPC brood year 2008 releases observed at hatchery racks and fisheries in tributaries of the Columbia and Snake rivers.

Rearing Facility	Stock	Columbia R. Below McNary Dam		Columbian River Above McNary Dam		Snake River Below Lower Granite Dam		Snake River Above Lower Granite Dam		Total
		Harvest	Rack	Harvest	Rack	Harvest	Rack	Harvest	Rack	
Clearwater	DWOR ¹	-	2	-	-	-	-	-	-	2
Clearwater Total		0	2	-	-	-	-	-	-	2
Hagerman	DWOR	-	-	-	-	-	-	126	-	126
	PAH ¹	-	-	-	-	-	3	-	-	3
	SAW ¹	11	13	11	-	-	2	138	-	175
Hagerman Total		11	13	11	-	-	5	264	-	304
Magic Valley	DWOR	-	-	-	-	-	4	60	-	64
	EFNAT ¹	-	-	-	-	-	1	-	-	1
	PAH	4	-	-	-	-	7	-	-	11
	SAW ¹	-	-	-	-	-	2	66	-	68
	USAL	-	-	-	-	-	-	16	-	16
Magic Valley Total		4	-	-	-	-	14	142	-	160
Niagara Springs	OX	-	30	-	-	-	-	1,637	-	1,667
	PAH	9	79	-	26	-	9	970	-	1,093
Niagara Springs Total		9	109	-	26	-	9	2,607	-	2,760
Grand Total		24	124	11	26	-	28	3,013	-	3,226

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

Table 12. Stray rates of adult hatchery steelhead from Idaho LSRCP and IPC brood year 2008 releases. Summary only includes information for ad-clipped release groups.

		Downstream of Lower Granite Dam			Upstream of Lower Granite Dam			Combined	
Rearing Facility	Stock	Adult Returns	Strays	Stray Rates (%)	Adult Returns	Strays	Stray Rates (%)	Total Strays	Total Stray Rates (%)
Clearwater	DWOR	10,082	2	0.02	8,933	0	0.00	2	0.02
Clearwater Total		10,082	2	0.02	8,933	0	0.00	2	0.02
Hagerman	DWOR	2,026	0	-	1,751	126	7.19	126	6.22
	SAW	9,241	35	0.38	7,541	138	-	-	-
Hagerman Total		11,268	35	0.31	9,292	264	2.84	299	2.65
Magic Valley	DWOR	7,059	4	0.05	6,763	60	0.89	64	0.90
	PAH	7,602	11	0.15	6,746	0	0.00	11	0.15
	SAW	2,832	0	-	2,310	66	2.86	66	2.33
	USAL	638	0	-	554	16	2.89	16	2.51
Magic Valley Total		18,131	15	0.08	16,372	142	0.87	157	0.86
Niagara Springs	OX	13,839	30	0.21	9,525	1,637	17.19	1,667	12.04
	PAH	20,757	123	0.59	18,657	970	5.20	1,094	5.27
Niagara Springs Total		34,595	153	0.44	28,182	2,607	9.25	2,760	7.98
Grand Total		74,076	205	0.28	62,780	3,013	4.80	3,218	4.34

Brood Year Reconstruction, Smolt-To-Adult Return, Smolt-To-Adult Survival, and Parent-To-Progeny Ratio

Lower Snake River Compensation Plan production goals for fish reared at Clearwater, Hagerman, and Magic Valley fish hatcheries is to return a combined total of 117,780 adult steelhead to the mouth of the Columbia River and 39,260 adult steelhead to the project area upstream of LGD. Brood year 2008 production from these three facilities returned a total of 48,357 adult steelhead to the mouth of the Columbia River during the 2010-11, 2011-12, and 2012-13 run years (Table 13), which is a 59% shortfall of the total adult return mitigation goal. However, a total of 43,114 of these fish survived and returned to LGD, surpassing project area mitigation goals by 3,854 adult steelhead (Appendix G). Harvest downstream of LGD accounted for 9.7% of the total adult return from LSRCP facilities, the majority of which were in the Zones 1-5 sport and Zone 6 tribal fisheries (see Table 8, above). Production from Clearwater had a SAS rate of 1.9%, which is the highest survival rate observed for the three LSRCP facilities, but was approximately 26,000 short of its mitigation goal of adults to the mouth of the Columbia River. Hagerman had an SAS of 0.9%, which is approximately 27,700 short of its mitigation goal, and Magic Valley had an SAS of 1.2%, which is approximately 15,650 short of its mitigation goal. Although Idaho Power Company does not have an adult return mitigation goal, production from Niagara Springs accounted for approximately 34,600 adult steelhead for an SAS of 1.9%.

The progeny-to-parent ratio (PPR) of adult steelhead returning to the mouth of the Columbia River was 54.8 for DWOR stock releases from Clearwater brood year 2008 spawners. Hagerman had a PPR of 18.6, Magic Valley had a PPR of 24.5, and Niagara Springs had a PPR of 34.5 for their combined stock releases. None of the three LSRCP rearing facilities attained a PPR required to meet total adult escapement objectives for the number of broodstock spawned.

The brood year 2008 smolt release was the second consecutive year-class in which most release groups were represented with PIT tags. This provided an opportunity to use PIT tag detections at Bonneville Dam and at LGD to derive estimates of adult escapement to both of those locations. It also provided an opportunity to make a comparison between escapement estimates using PIT tags and run reconstruction methodologies (Table 14). The total adult return estimate from all four hatchery facilities to Bonneville Dam based on PIT tag detections was 110,062 fish compared to 82,952 fish estimated using the traditional run reconstruction methodology. At LGD, the total estimate based on PIT tag detections was 78,783 fish compared to 71,297 fish estimated based on run reconstruction methodologies. There are no consistent differences between the two methodologies in comparisons of escapement at the hatchery or stock release group level. For example, the estimated adult return of Clearwater smolt releases to Bonneville Dam is 6,883 fish higher using the run reconstruction method compared to the PIT tag detection method. On the other hand, the adult return estimate of releases from Hagerman is 9,991 fish higher using the PIT tag detection method than the estimate using the run reconstruction method. Of the four production facilities, total estimated returns from Magic Valley smolt releases are the most similar between the two methodologies. Another methodology to estimate adult escapement to LGD that will be used beginning with brood year 2010 return data is to use a combination of window count and systematic biological sampling at the Lower Granite Dam trap to proportionally decompose the hatchery return into release groups through PBT assignments. While this tool for assigning individual samples to specific release groups is starting to be implemented for harvest data, the first year that it will be used for decomposing the escapement estimate at LGD is for the 2012-13 run year.

Table 13. Brood Year 2008 summary of total adult returns, smolt-to-adult survival rates (SAS), progeny-to-parent ratios (PPR), harvest, and stray estimates downstream of Lower Granite Dam (LGD) for Idaho LSRCP and IPC steelhead releases. Estimates of survival to Lower Granite Dam include smolt-to-adult return ratios (SAR), harvest in the terminal fishery, number trapped at brood collection facilities, stray estimates, and unharvested escapement estimates. Numbers released include ad-clipped and ad-intact fish combined.

Hatchery/ Stock	Adults Spawned	Number released	Total Adults	SAS (%)	PPR	Downstream of LGD		Adults to LGD	SAR (%)	Above LGD			Unharvested Escapement
						Harvest	Strays			Harvest	Trap	Strays	
Clearwater													
DWOR ¹	290	835,636	15,909	1.9	54.8	1,202	2	14,704	1.8	8,933		0	5,771
Total	290	835,636	15,909	1.9	54.8	1,202	2	14,704	1.8	8,933		0	5,771
Hagerman													
DWOR	67	171,094	2,026	1.2	30.2	275	0	1,751	1.0	945		126	680
PAH ¹	106	200,290	1,073	0.5	10.1	104	3	966	0.5	0		0	966
SAW ¹	532	1,048,926	10,019	1.0	18.8	1,741	37	8,241	0.8	4,020	2,983	138	1,100
Total	705	1,420,310	13,118	0.9	18.6	2,120	40	10,958	0.8	4,965	2,983	264	2,746
Magic Valley													
DWOR	266	714,349	7,059	1.0	26.5	293	4	6,763	0.9	930		60	5,773
EFNAT ¹	52	67,821	363	0.5	7.0	35	1	327	0.5	4	323	0	283
PAH	206	375,682	7,602	2.0	36.9	844	11	6,746	1.8	3,339		0	3,407
SAW ¹	236	436,881	3,668	0.8	15.5	604	2	3,063	0.7	1,551		66	1,446
USAL	28	57,464	638	1.1	22.8	84	0	554	1.0	468	70	16	0
Total	788	1,652,197	19,330	1.2	24.5	1,860	18	17,452	1.1	6,292	393	142	10,909
Niagara Springs													
OX	410	770,470	13,839	1.8	33.8	4,284	30	9,525	1.2	3,605	4,144	1,637	139
PAH	592	1,004,374	20,757	2.1	35.1	1,976	123	18,657	1.9	10,473	7,686	970	0
Total	1,002	1,774,844	34,595	1.9	34.5	6,260	153	28,182	1.6	14,078	11,830	2,607	139
Grand Total	2,785	5,682,987	82,952	1.5		11,442	213	71,297	1.3	34,269	14,923	3,013	19,565

¹ All or part of these fish were released with intact adipose fins (see Table 5) and therefore not subject to harvest in mark-selective fisheries.

Table 14. Adult steelhead return estimates to Bonneville Dam and to Lower Granite Dam based on the expansion of PIT tag detections in the adult ladders comparing estimates made with run reconstruction methods.

Hatchery	Stock	Run Reconstruction Estimate		Total PIT Tags Released	PIT Tag Detection Expansion Estimate	
		Bonneville	Lower Granite		Bonneville	Lower Granite
Clearwater	DWOR	15,908	14,704	21,193	9,025	5,940
Clearwater Total		15,908	14,704	21,193	9,025	5,940
Hagerman	DWOR	2,026	1,751	8,344	1,709	1,269
	PAH	1,073	966	5,890	3,933	3,111
	SAW	10,019	8,241	10,687	17,467	13,670
Hagerman Total		13,118	10,958	24,921	23,109	18,050
Magic Valley	DWOR	7,059	6,763	13,683	3,949	2,613
	EFNAT	363	327	1,296	697	619
	PAH	7,602	6,746	7,143	7,621	6,042
	SAW	3,668	3,063	8,343	6,199	4,929
	USAL	638	554	6,932	752	453
Magic Valley Total		19,330	17,452	37,397	19,218	14,656
Niagara Springs	OX	13,839	9,524	11,575	27,422	17,851
	PAH	20,757	18,657	12,889	31,288	22,286
Niagara Springs Total		34,595	28,182	24,464	58,709	40,137
Grand Total		82,952	71,297	107,975	110,062	78,783

ACKNOWLEDGMENTS

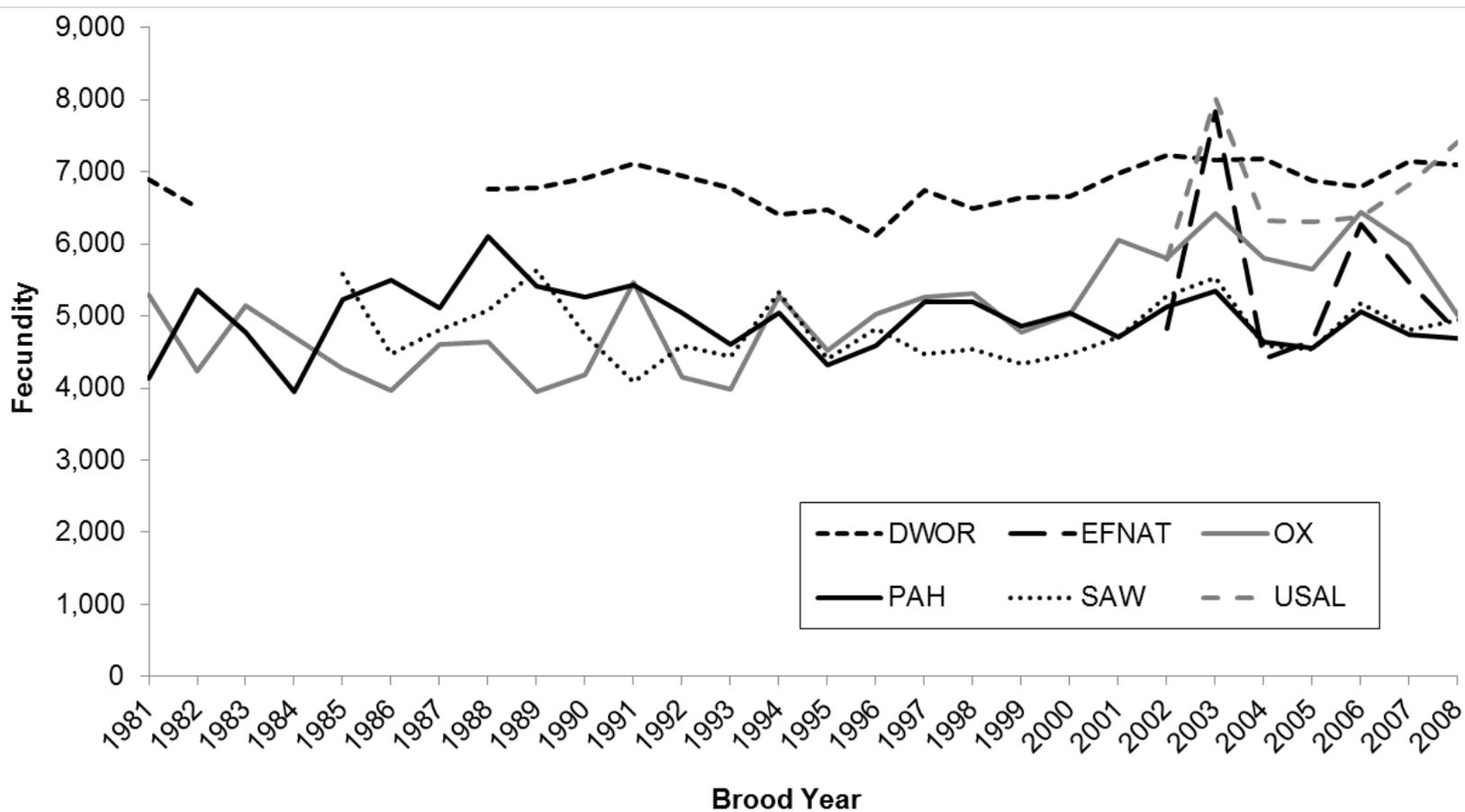
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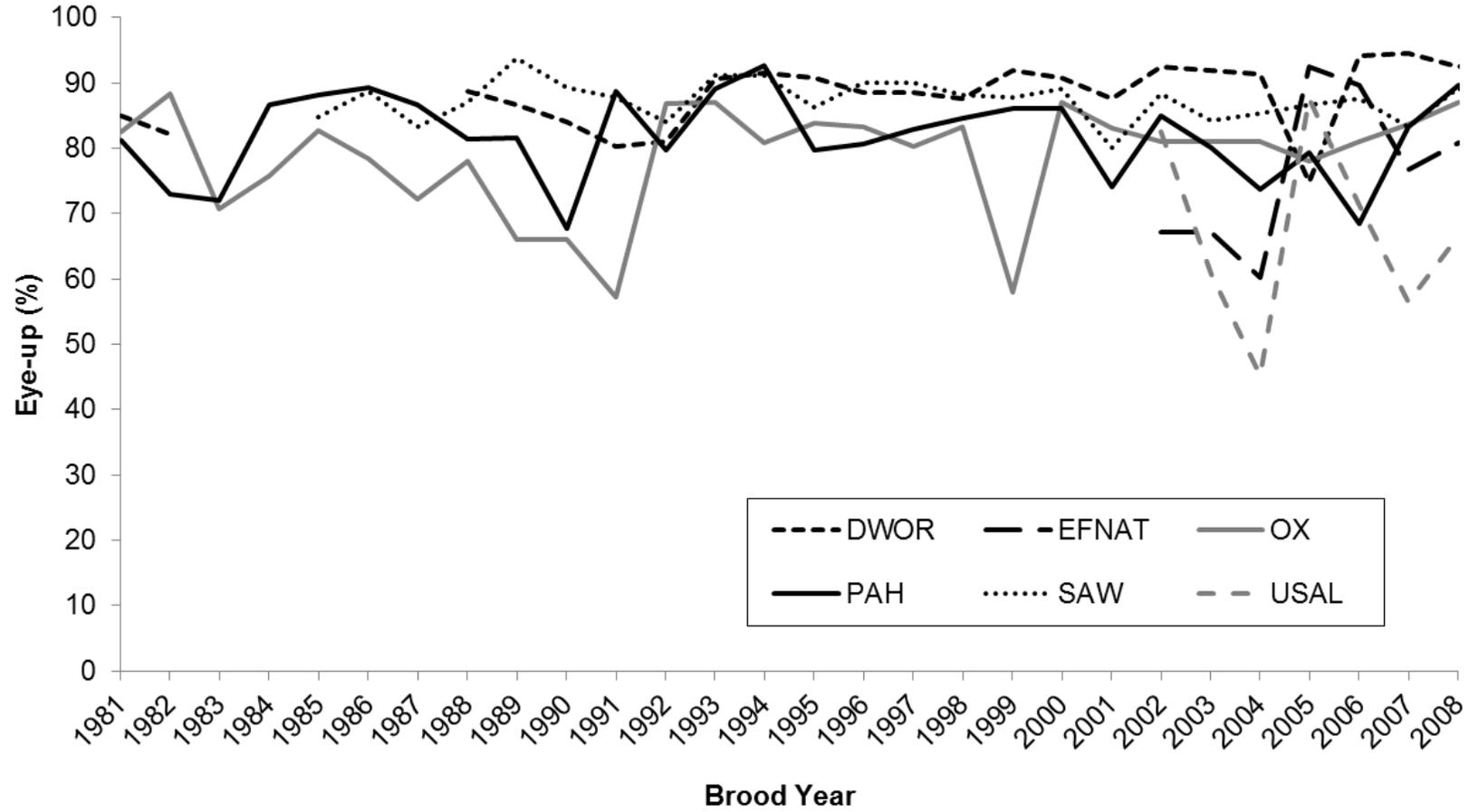
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APPENDICES

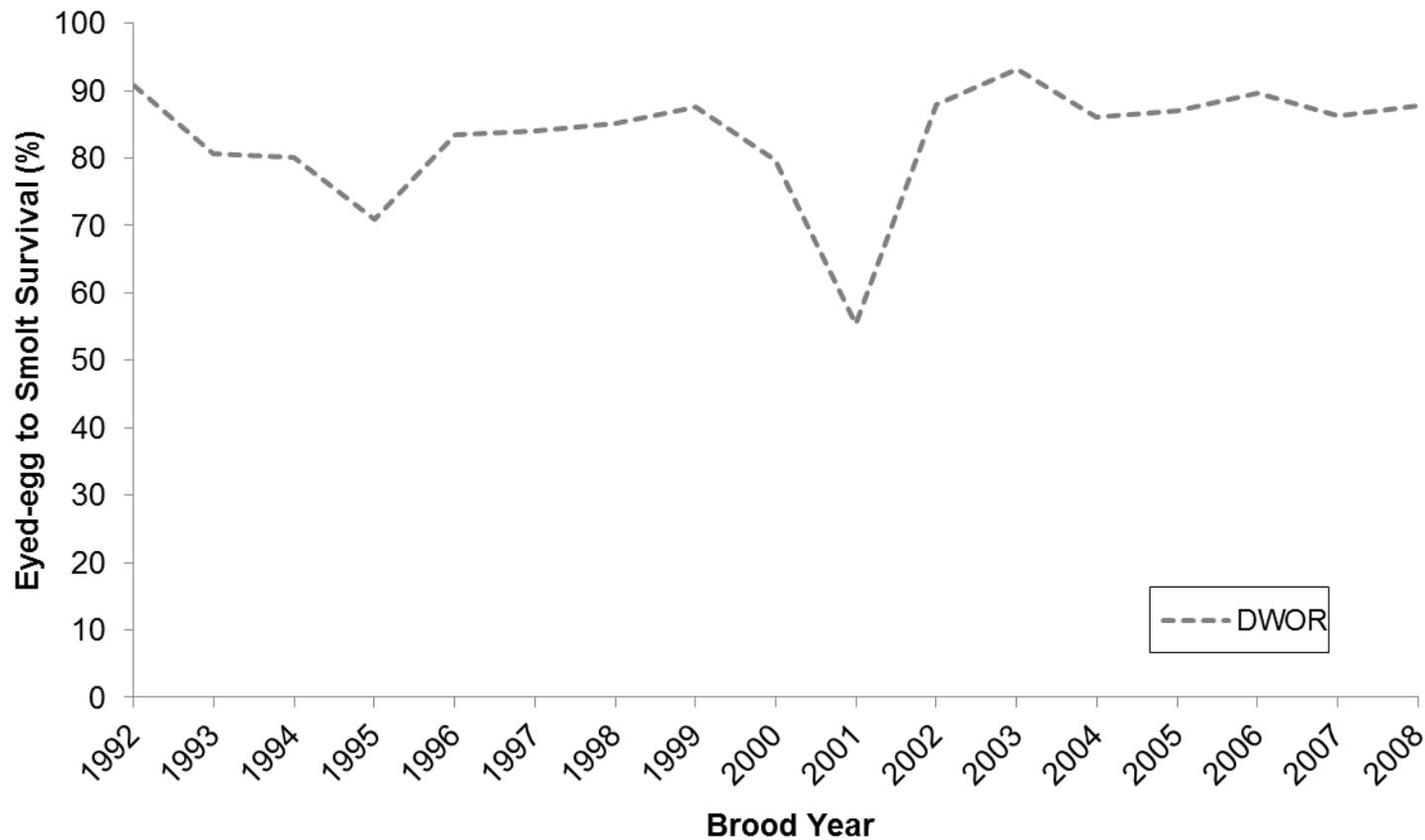
Appendix A. Mean fecundity by stock for steelhead reared at LSRCP and IPC hatchery facilities in Idaho for brood years 1981 through 2008.



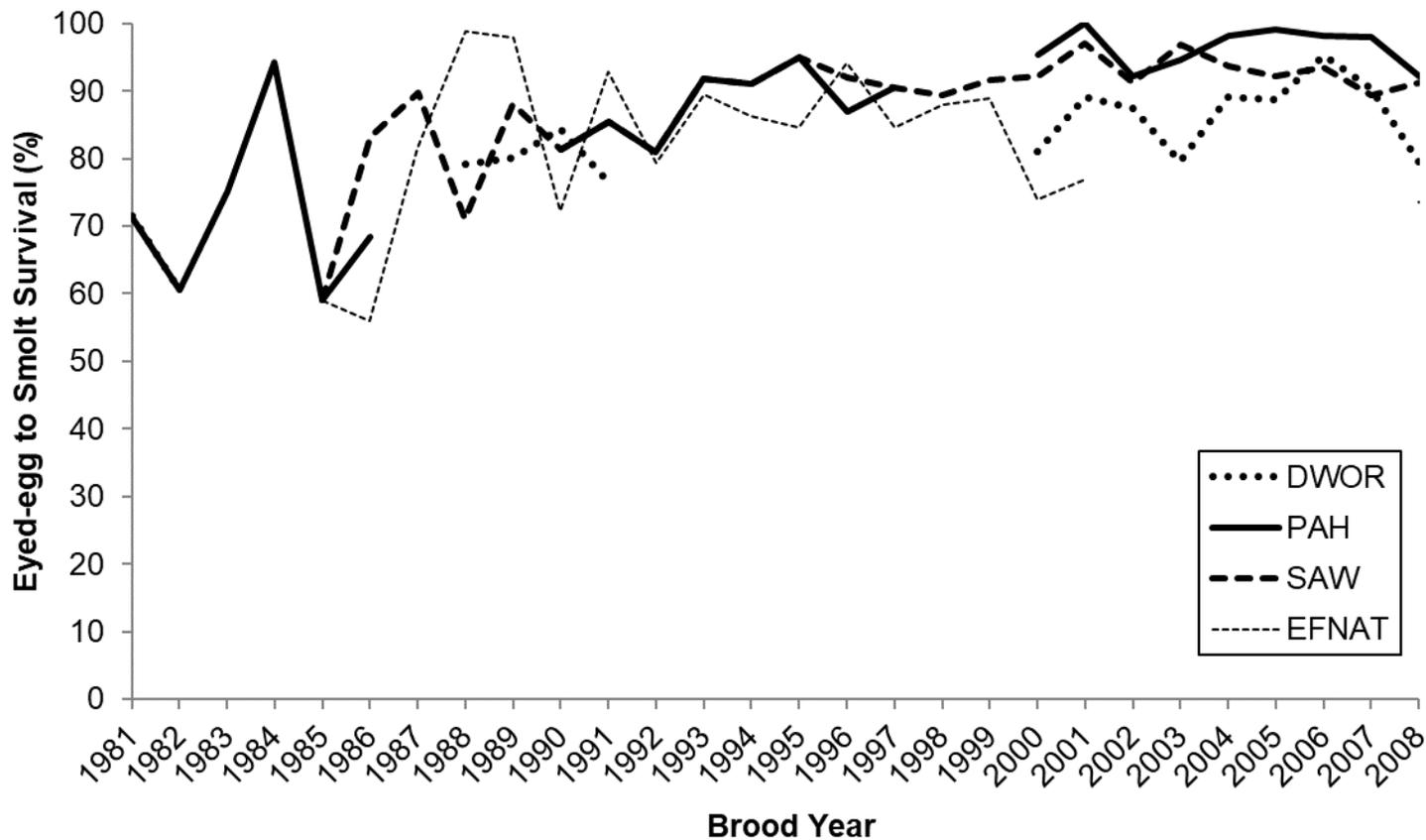
Appendix B. Eye-up rates by stock for steelhead production reared at LSRCP and IPC facilities in Idaho for brood years 1981 through 2008.



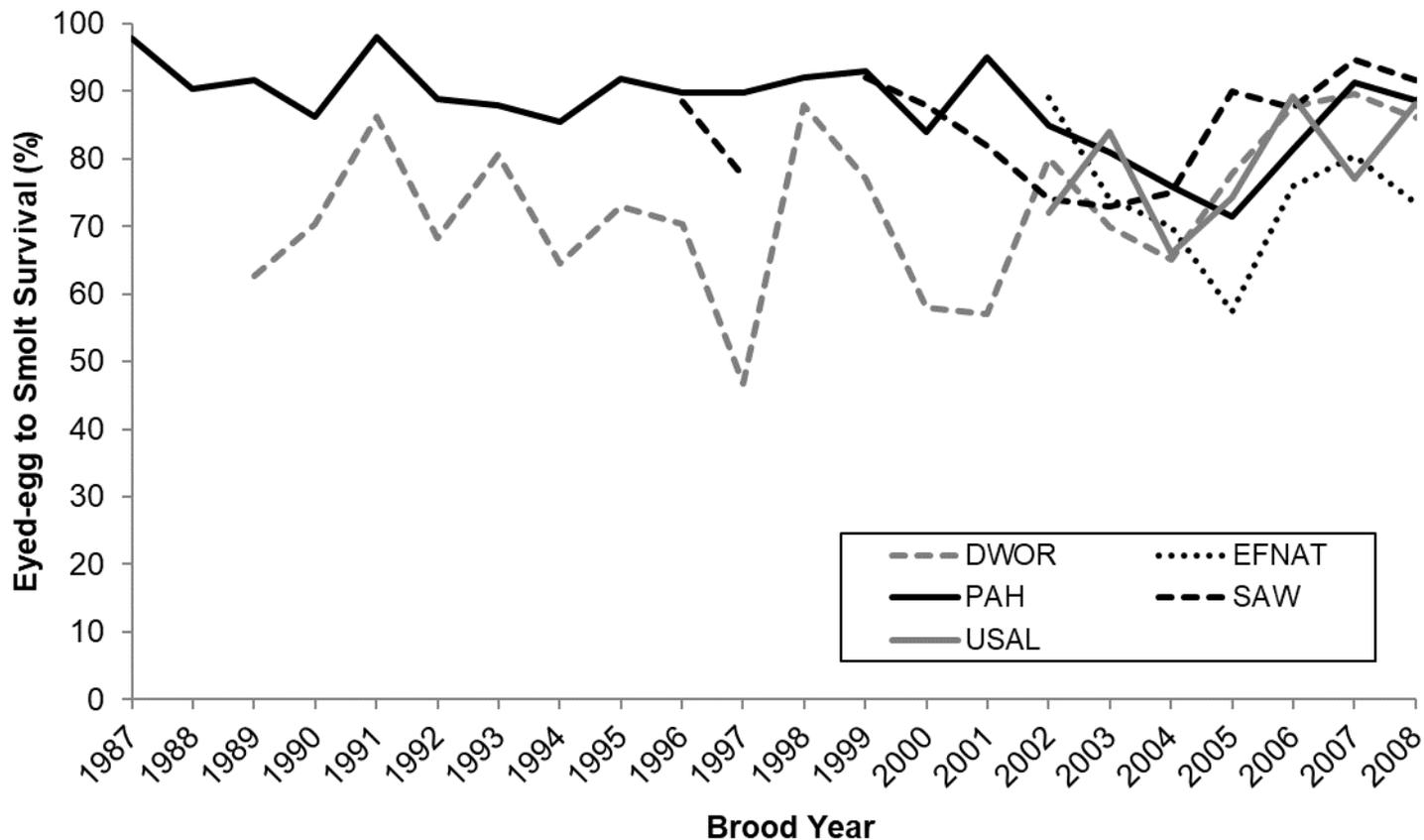
Appendix C1. Summary of onsite survival (eyed-egg to release) for production reared at Clearwater Fish Hatchery from brood year 1992 through 2008.



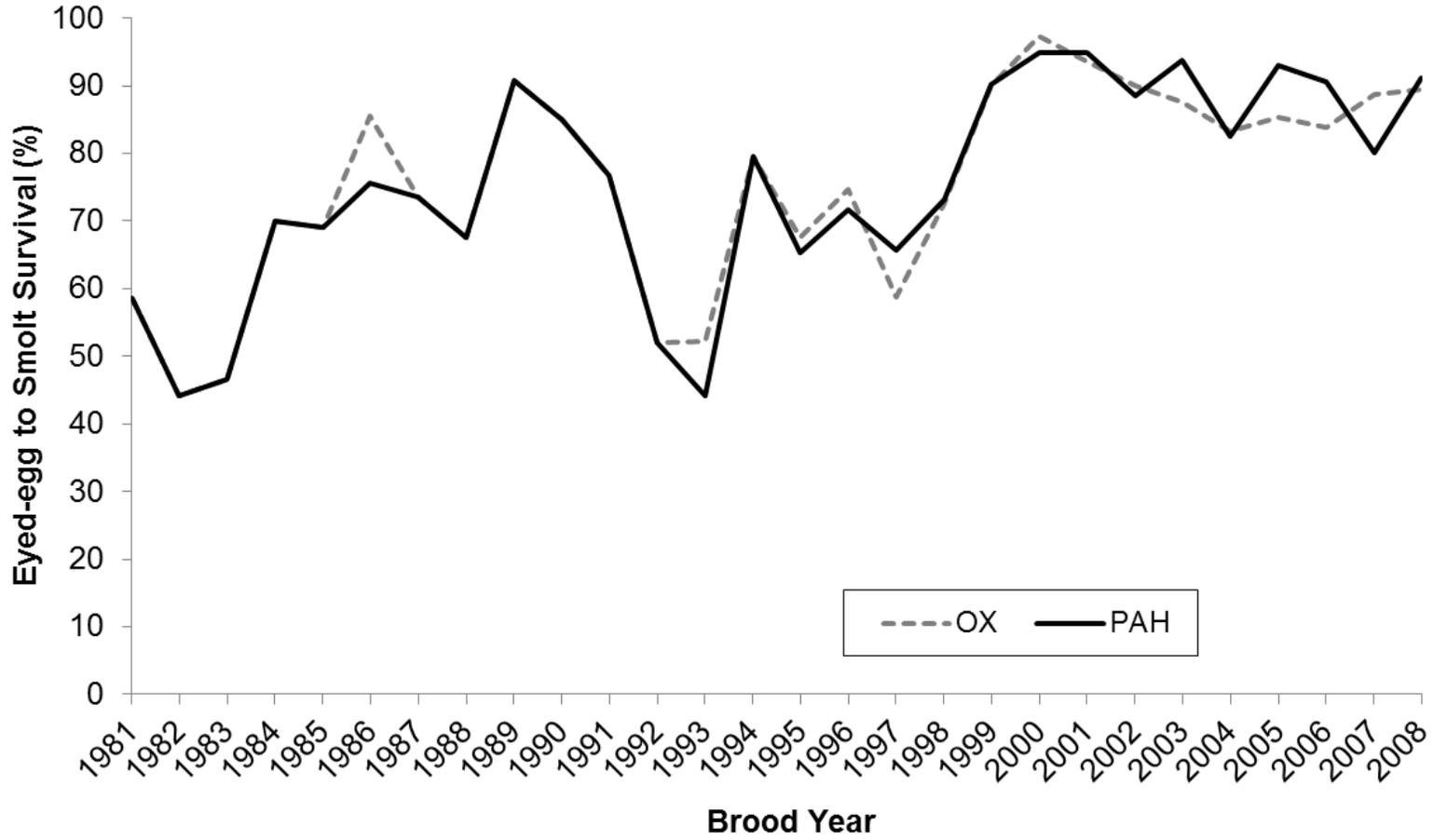
Appendix C2. Summary of onsite survival (eyed egg to release) by stock for production reared at Hagerman National Fish Hatchery from brood year 1987 through 2008.



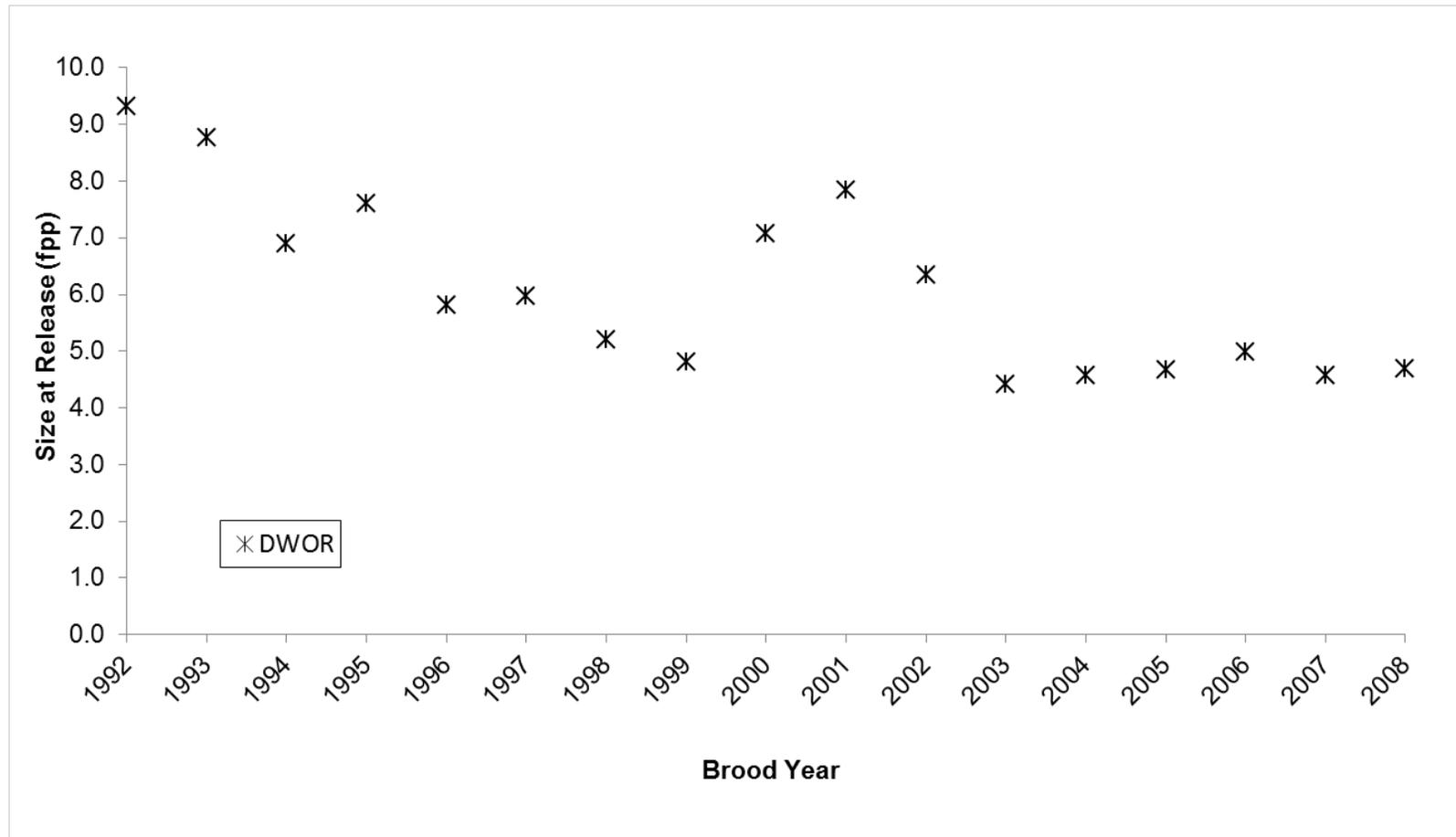
Appendix C3. Summary of onsite survival (eyed egg to release) by stock for production reared at Magic Valley Fish Hatchery from brood year 1987 through 2008.



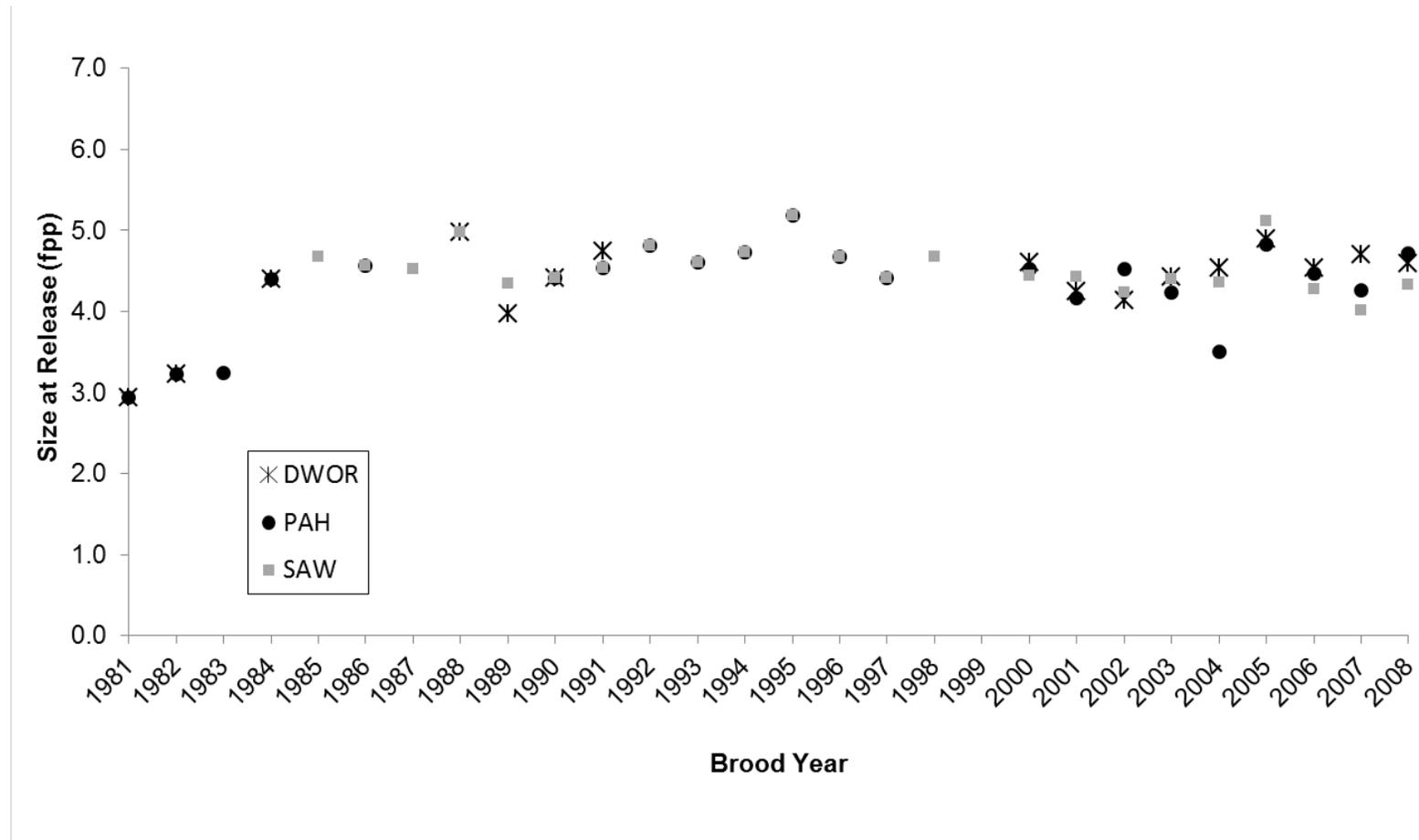
Appendix C4. Summary of onsite survival (eyed egg to release) by stock for production reared at Niagara Springs Fish Hatchery from brood year 1981 through 2008.



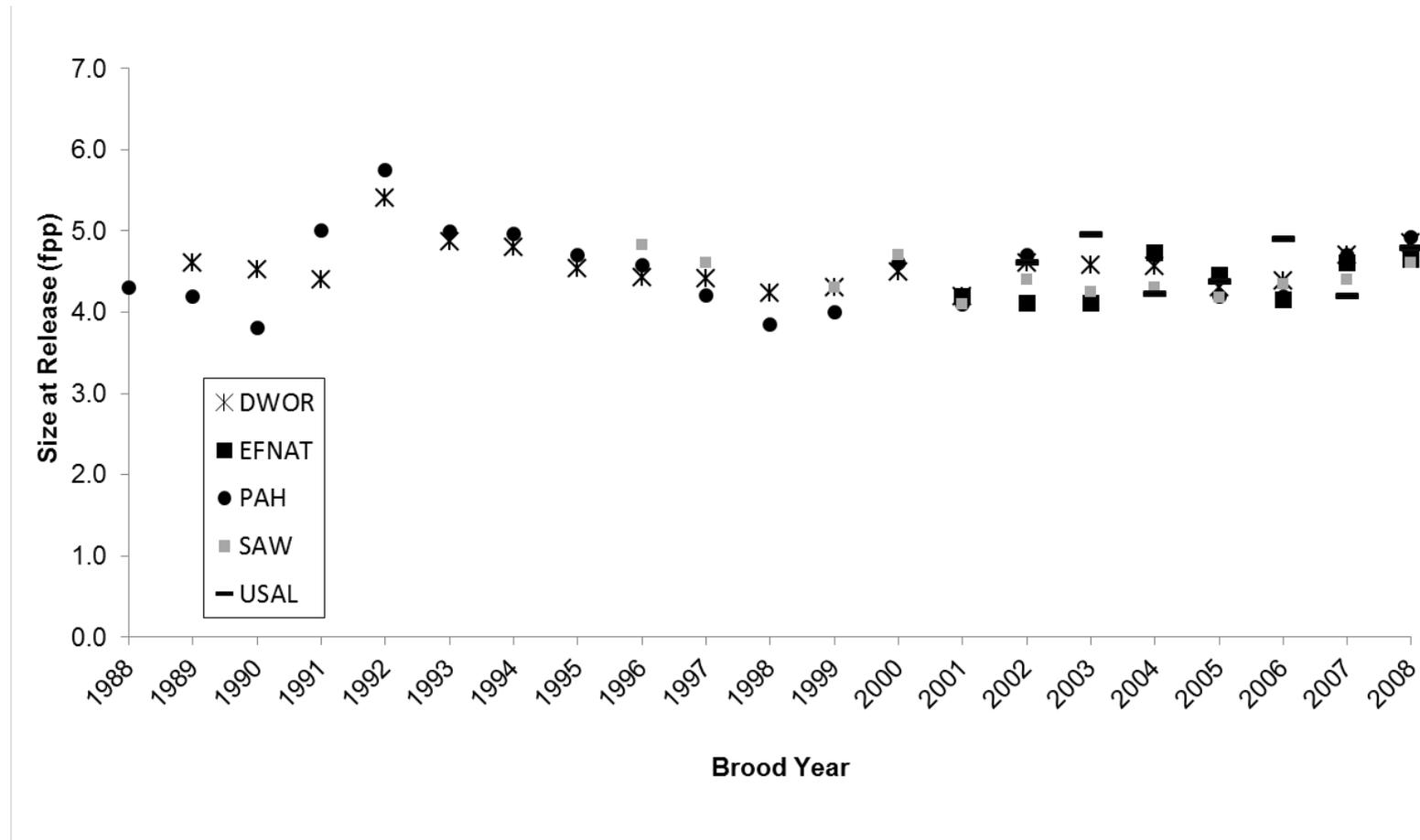
Appendix D1. Size at release (fish per pound [fpp]) for steelhead smolts reared at Clearwater Fish Hatchery from brood year 1992 through 2008.



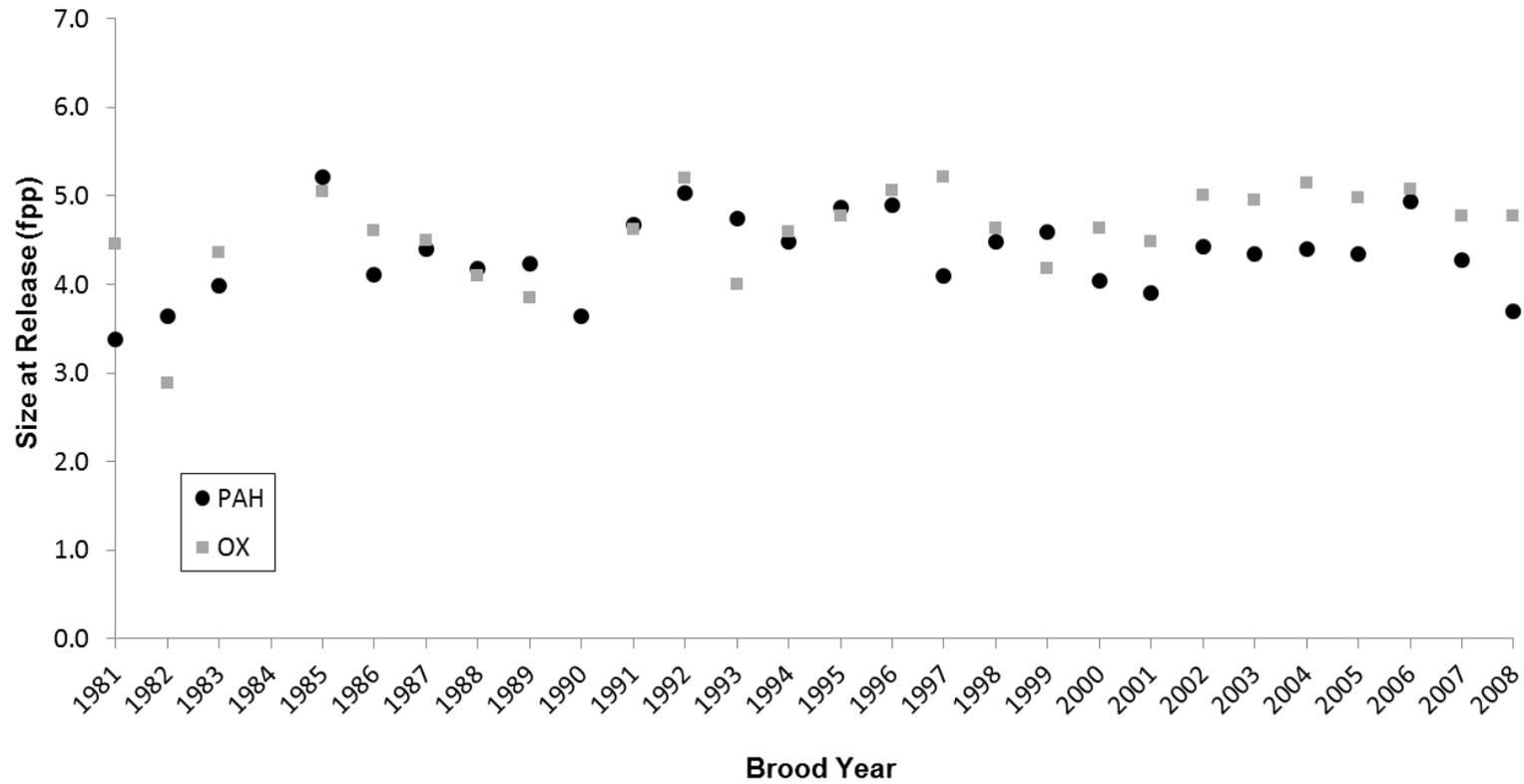
Appendix D2. Size at release (fish per pound [fpp]) for steelhead smolts reared at Hagerman from brood year 1981 through 2008.



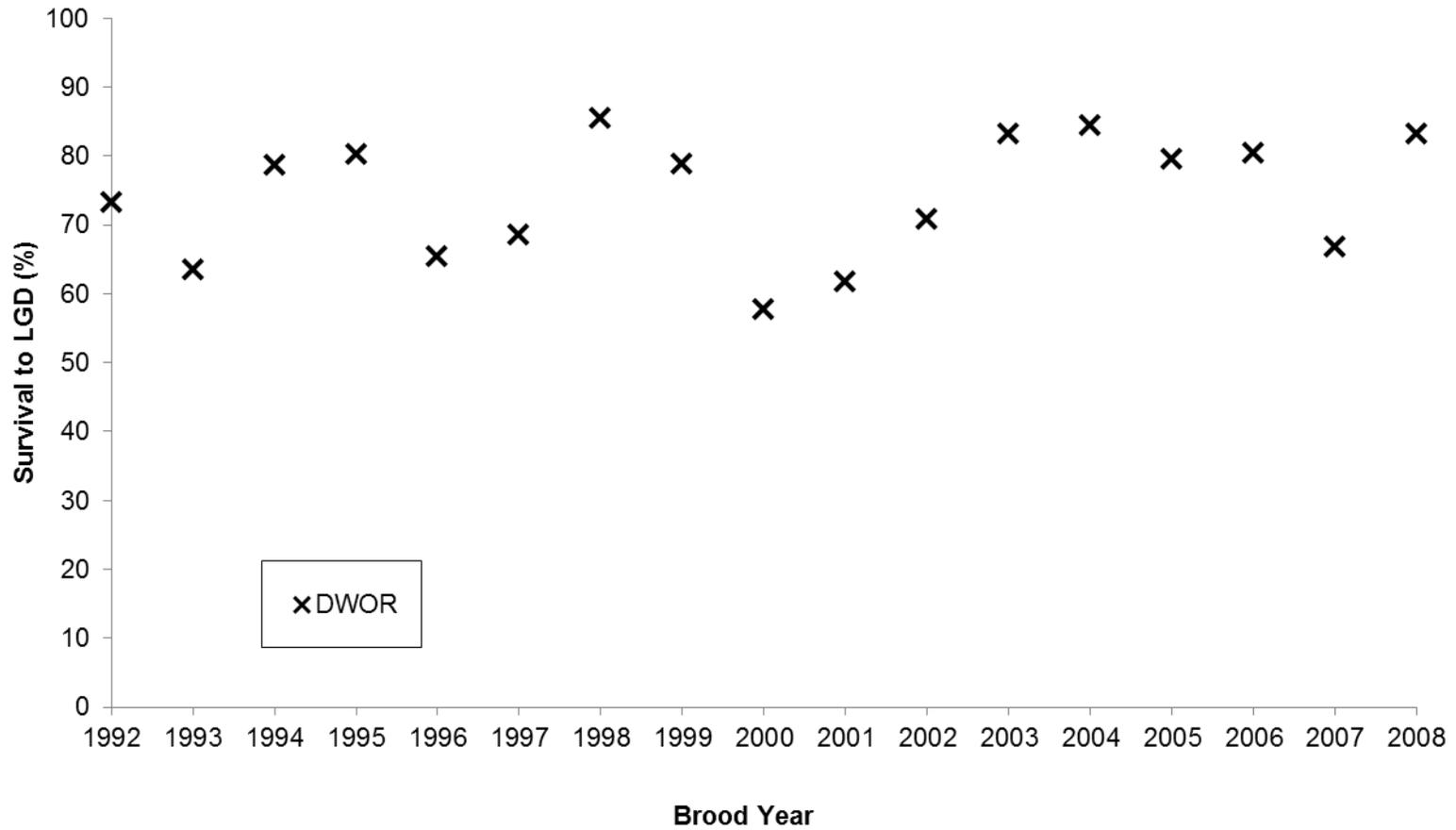
Appendix D3. Size at release (fish per pound [fpp]) for steelhead smolts reared at Magic Valley Fish Hatchery from brood year 1987 through 2008.



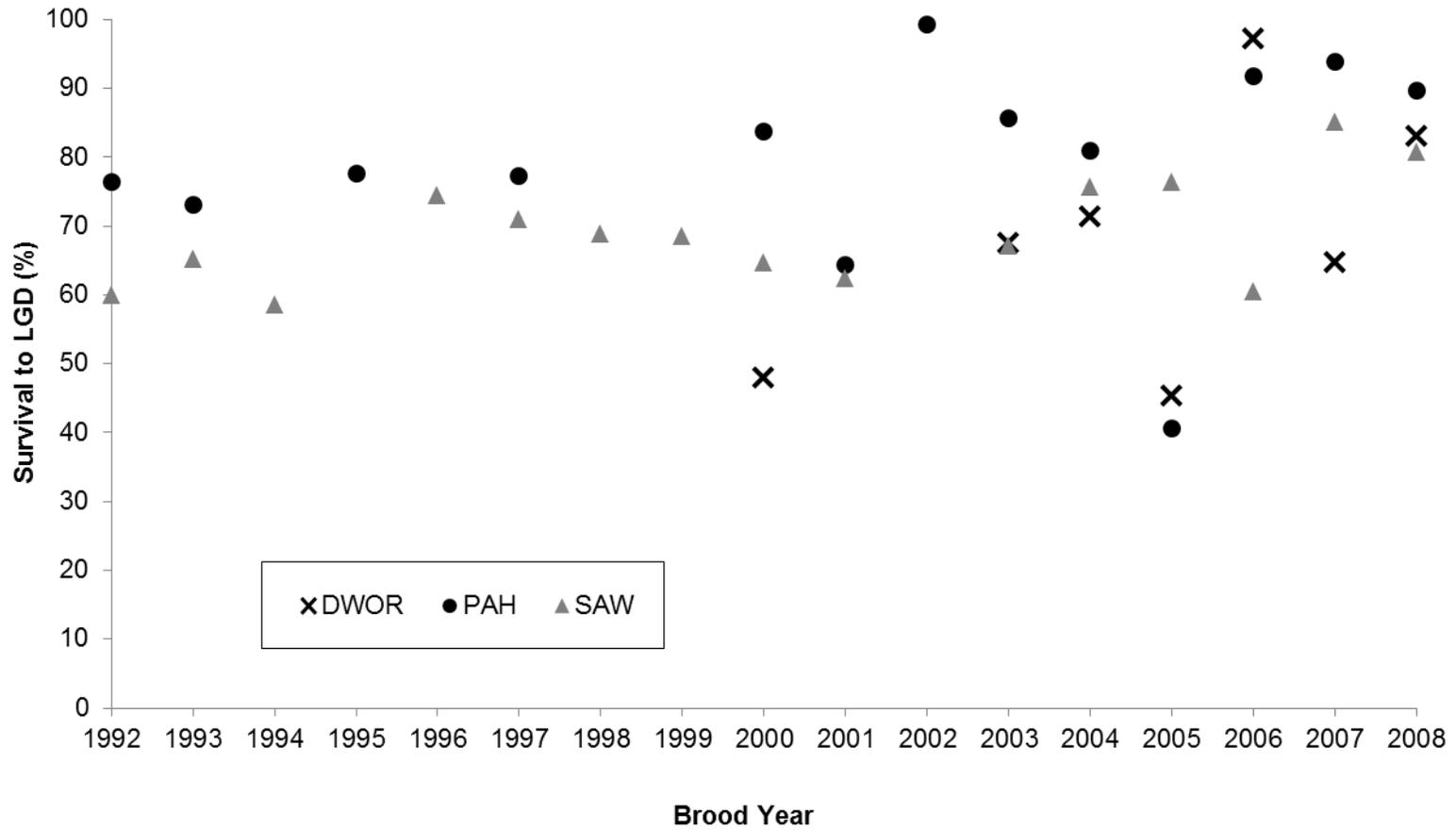
Appendix D4. Size at release (fish per pound [fpp]) for steelhead smolts reared at Niagara Springs Fish Hatchery from brood year 1981 through 2008.



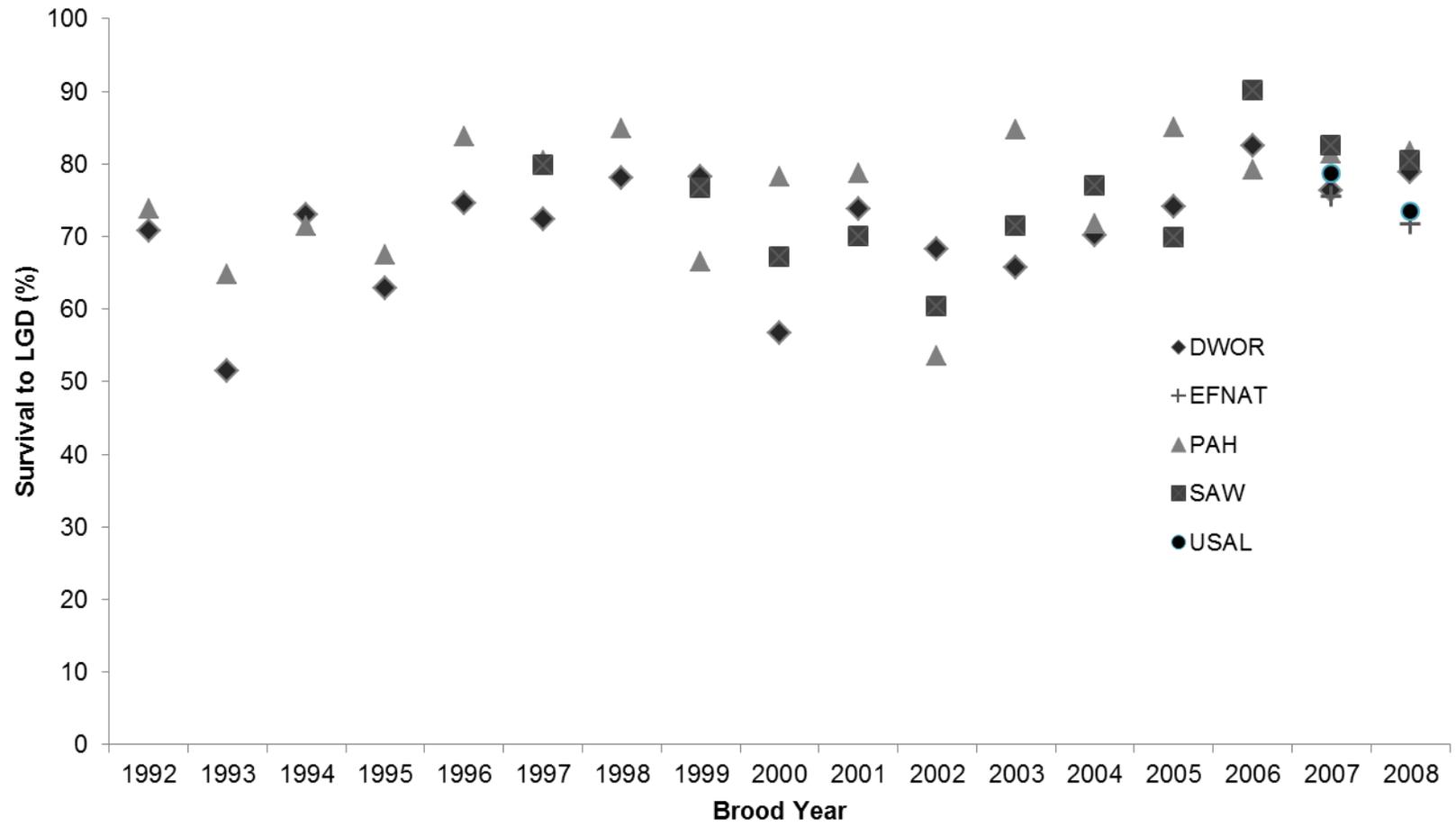
Appendix E1. Survival of smolts from release to Lower Granite Dam for steelhead released from Clearwater Fish Hatchery from brood year 1992 through 2008.



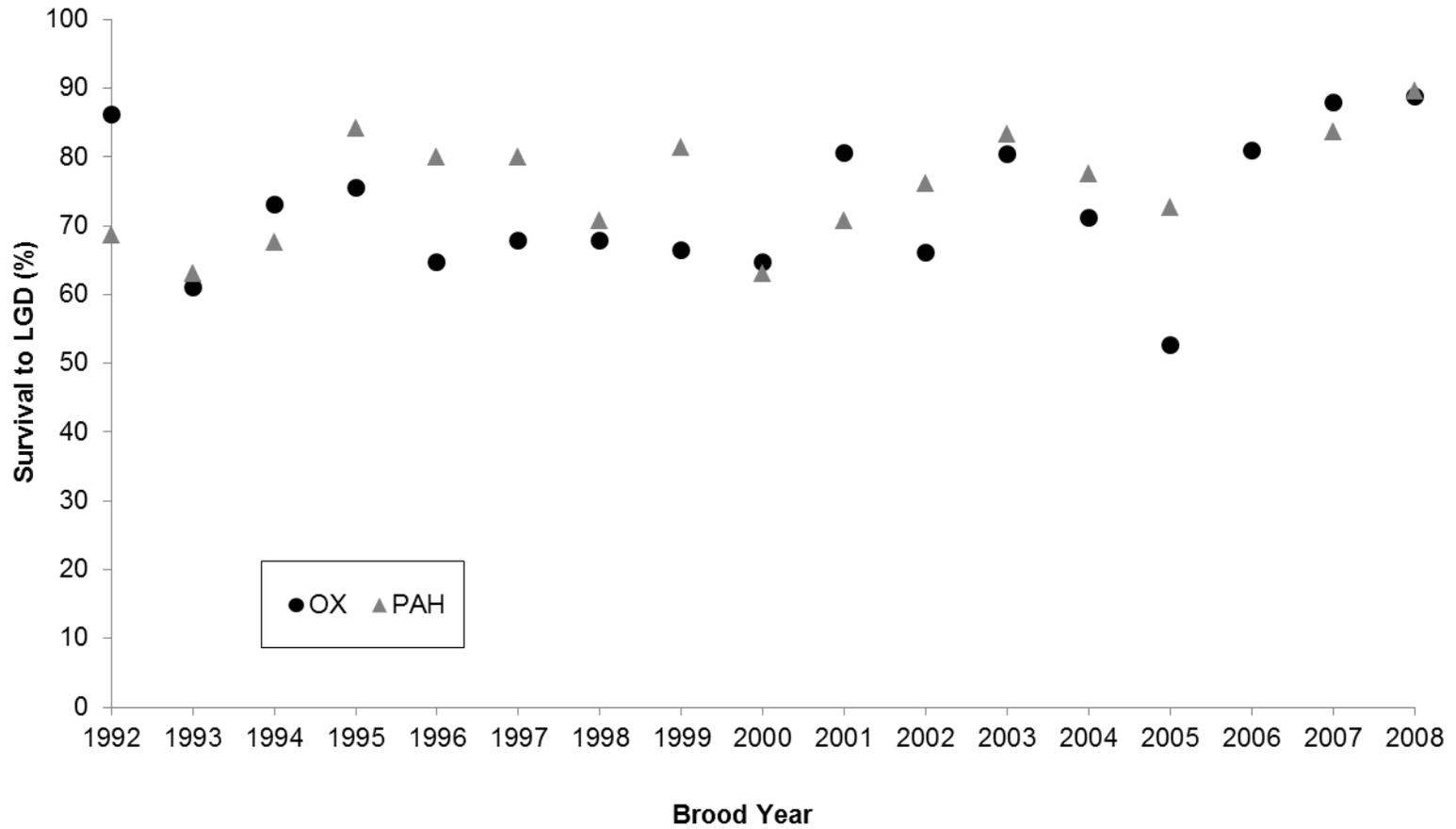
Appendix E2. Survival of smolts from release to Lower Granite Dam for steelhead released from Hagerman from brood year 1992 through 2008.



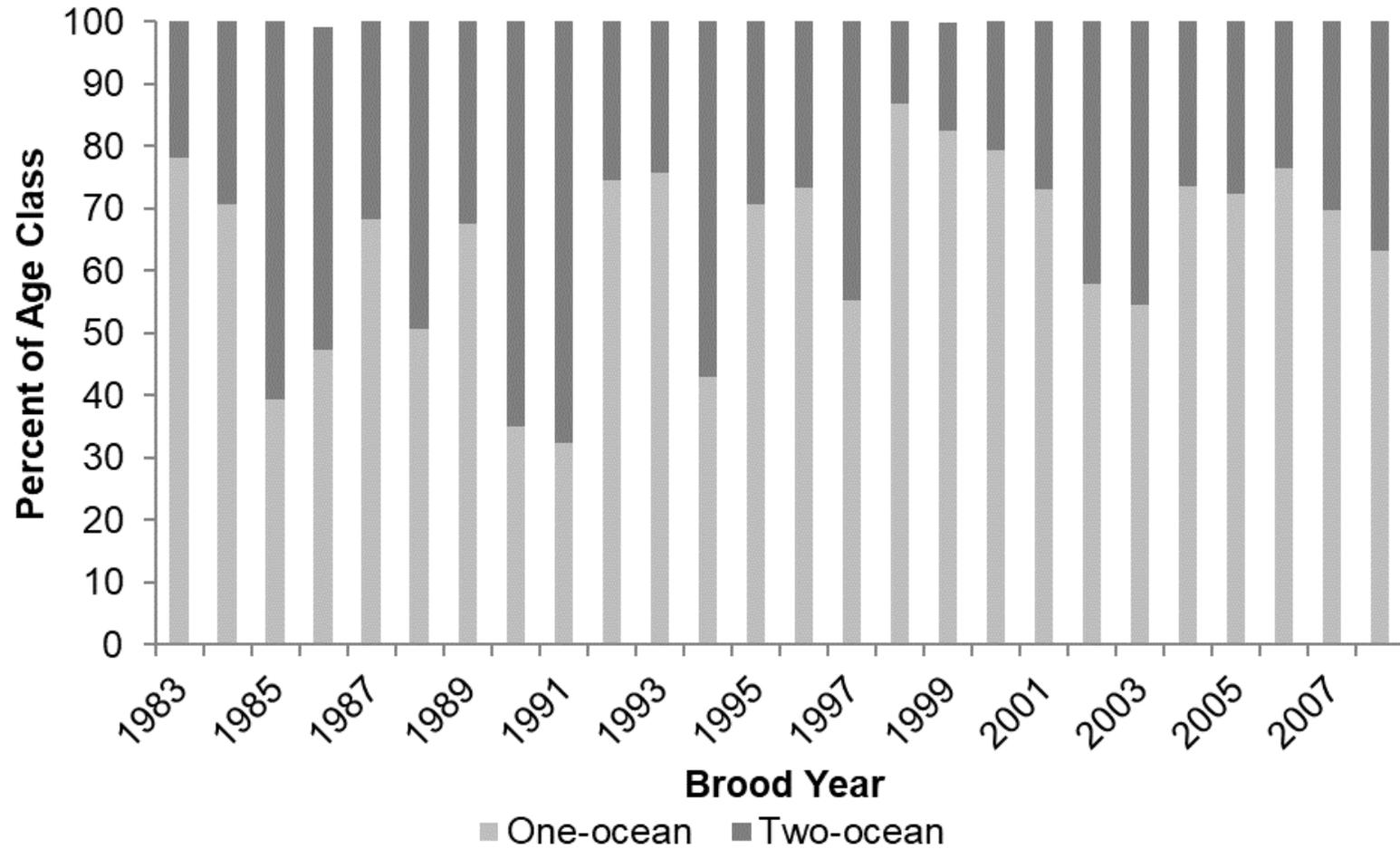
Appendix E3. Survival of smolts from release to Lower Granite Dam for steelhead released from Magic Valley Fish Hatchery from brood year 1992 through 2008.



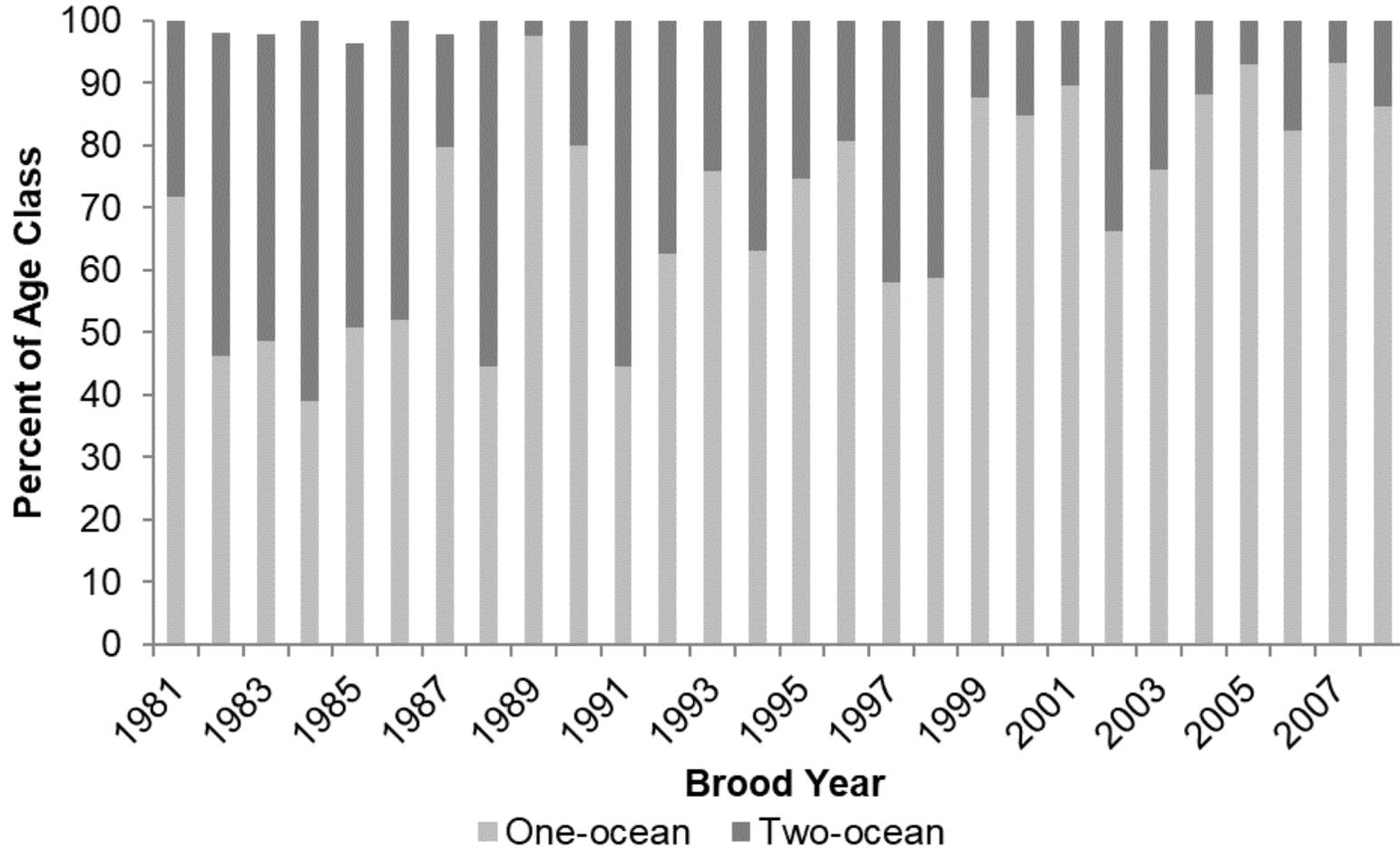
Appendix E4. Survival of smolts from release to Lower Granite Dam for steelhead released from Niagara Springs Fish Hatchery from brood year 1992 through 2008.



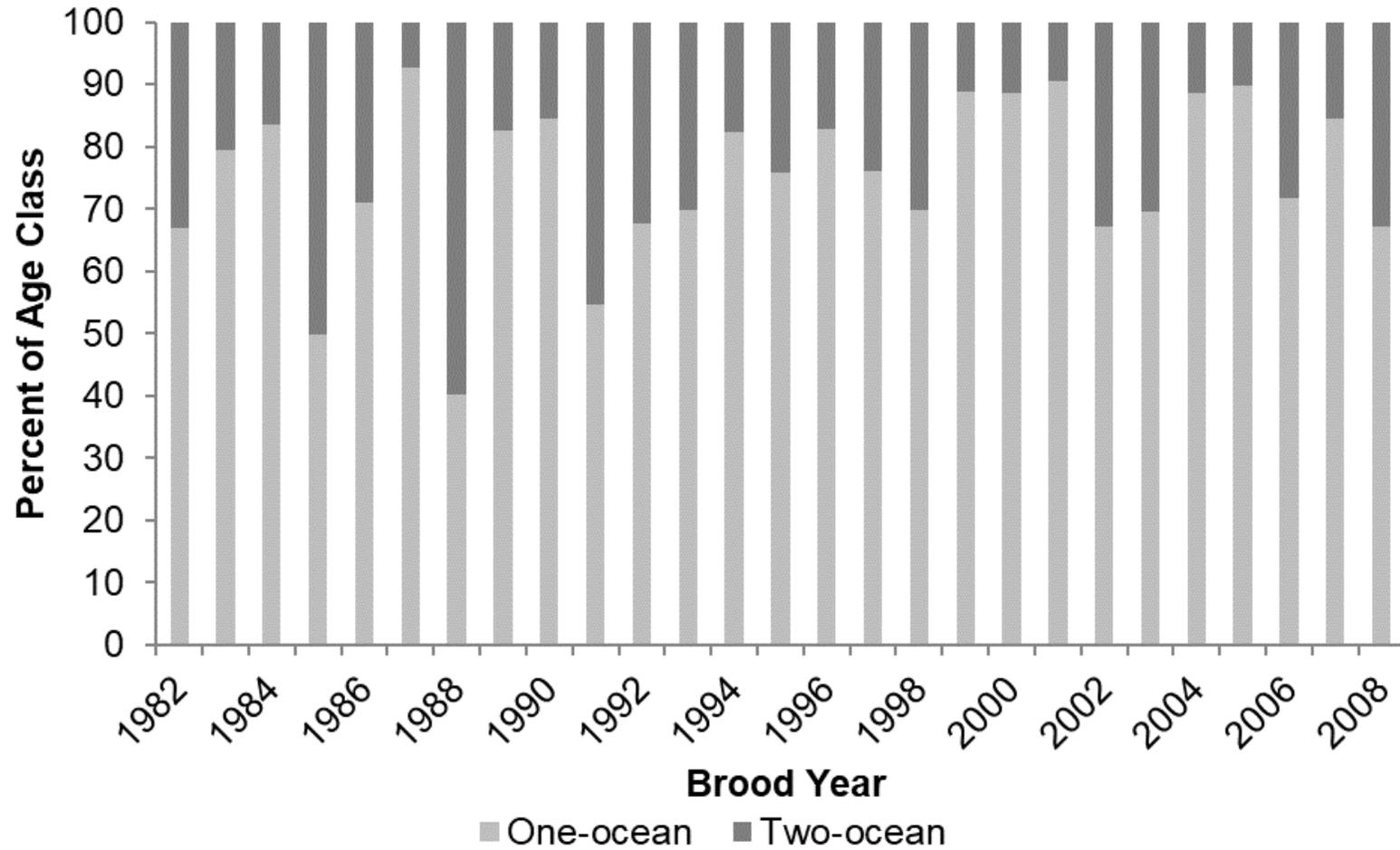
Appendix F1. Age composition for adult hatchery steelhead returning to the Hells Canyon Trap (OX stock) for brood years 1983 through 2008.



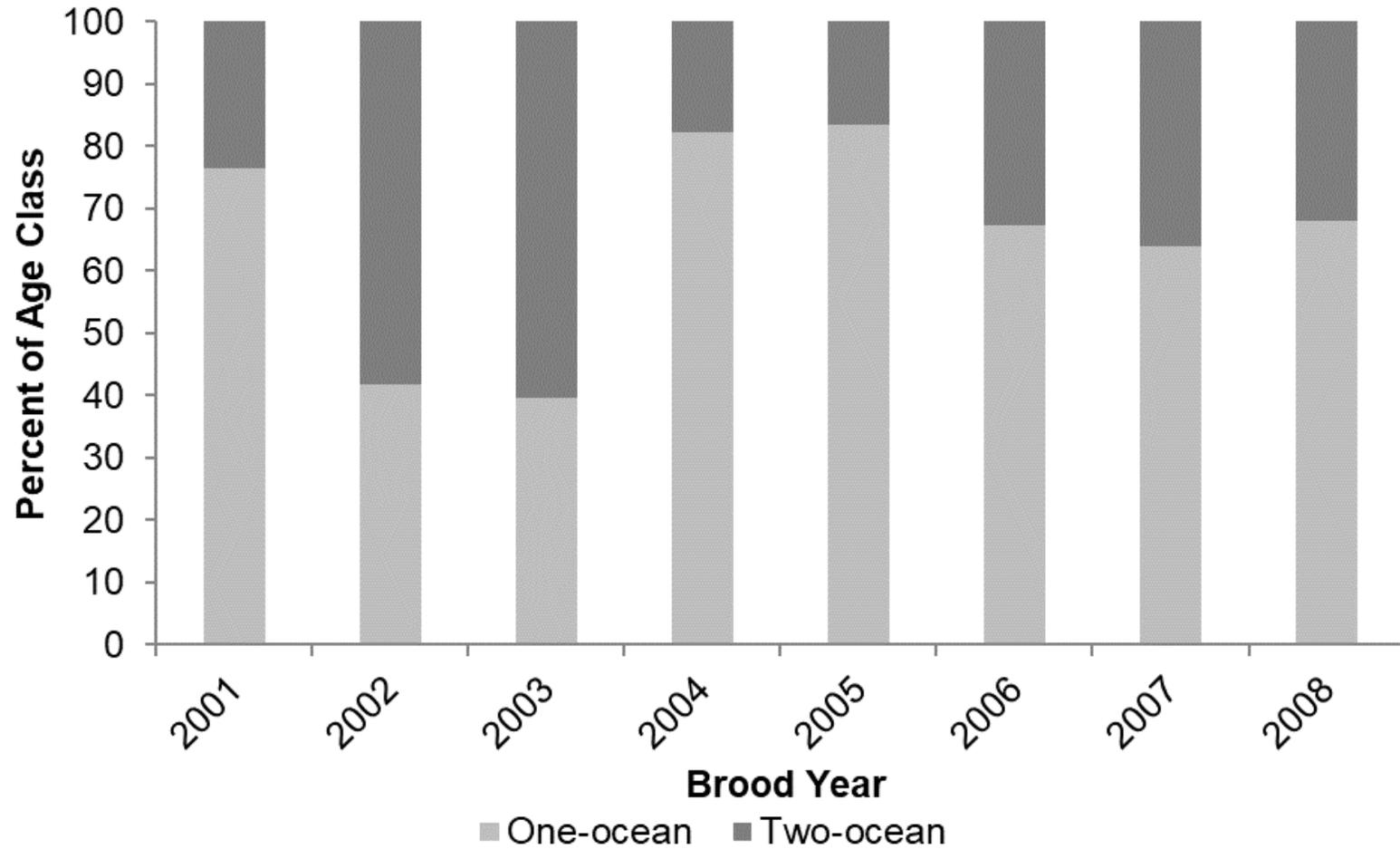
Appendix F2. Age composition for adult hatchery steelhead returning to Pahsimeroi Fish Hatchery (PAH stock) for brood years 1981 through 2008.



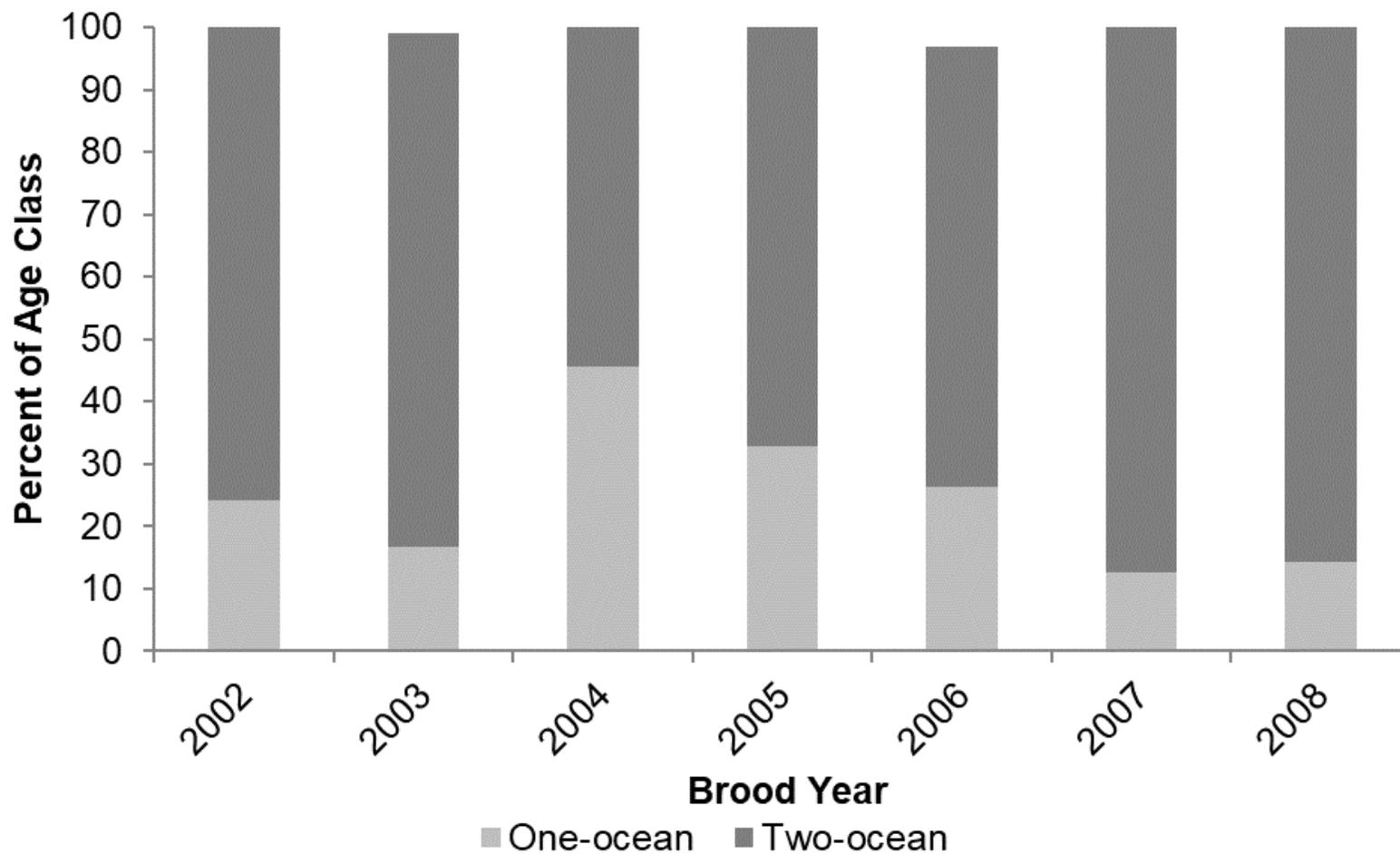
Appendix F3. Age composition for adult hatchery steelhead returning to Sawtooth Fish Hatchery (SAW stock) for brood years 1982 through 2008.



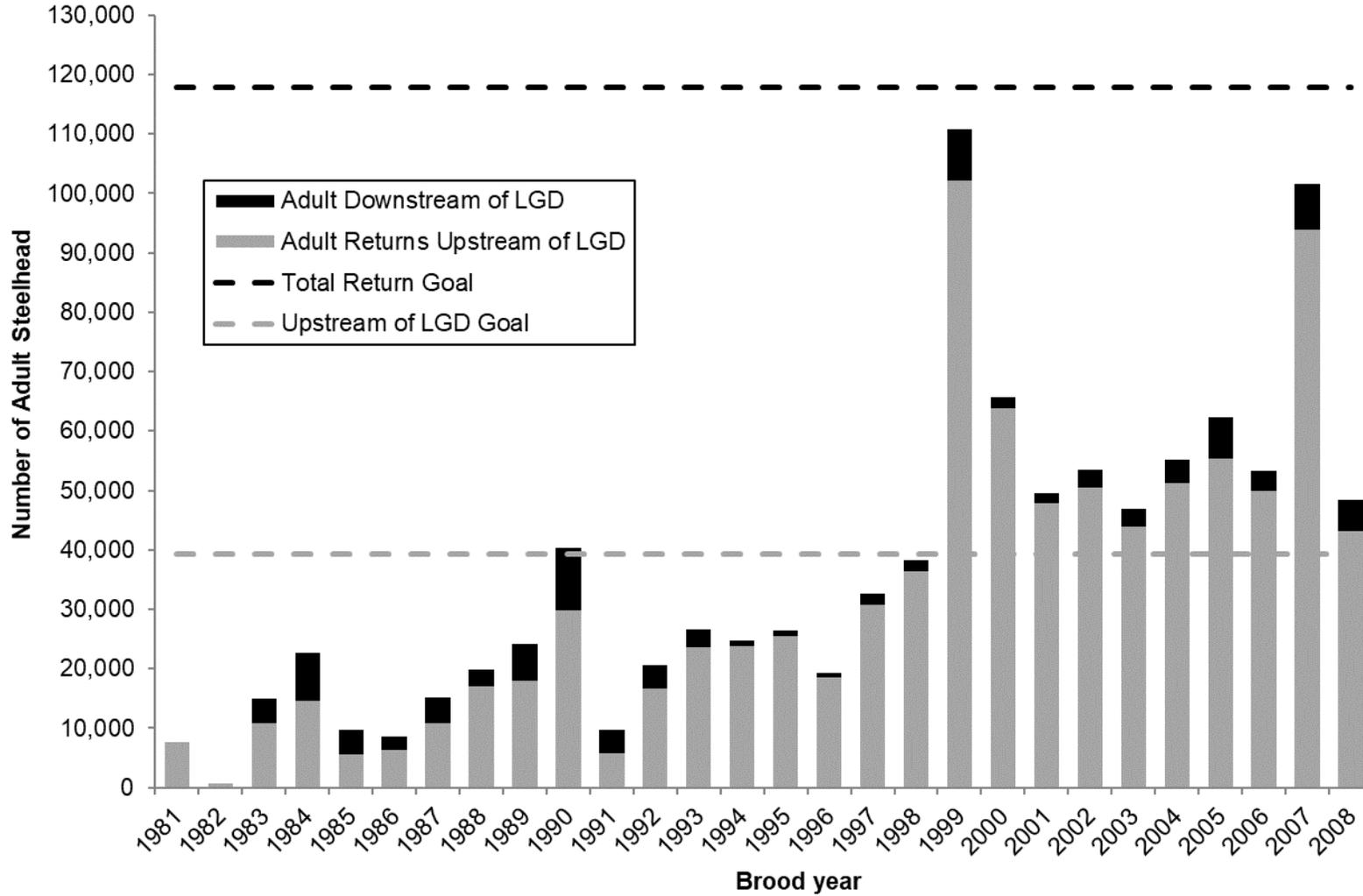
Appendix F4. Age composition for adult hatchery steelhead returning to East Fork Satellite Facility (EFNAT stock) for brood years 2001 through 2008.



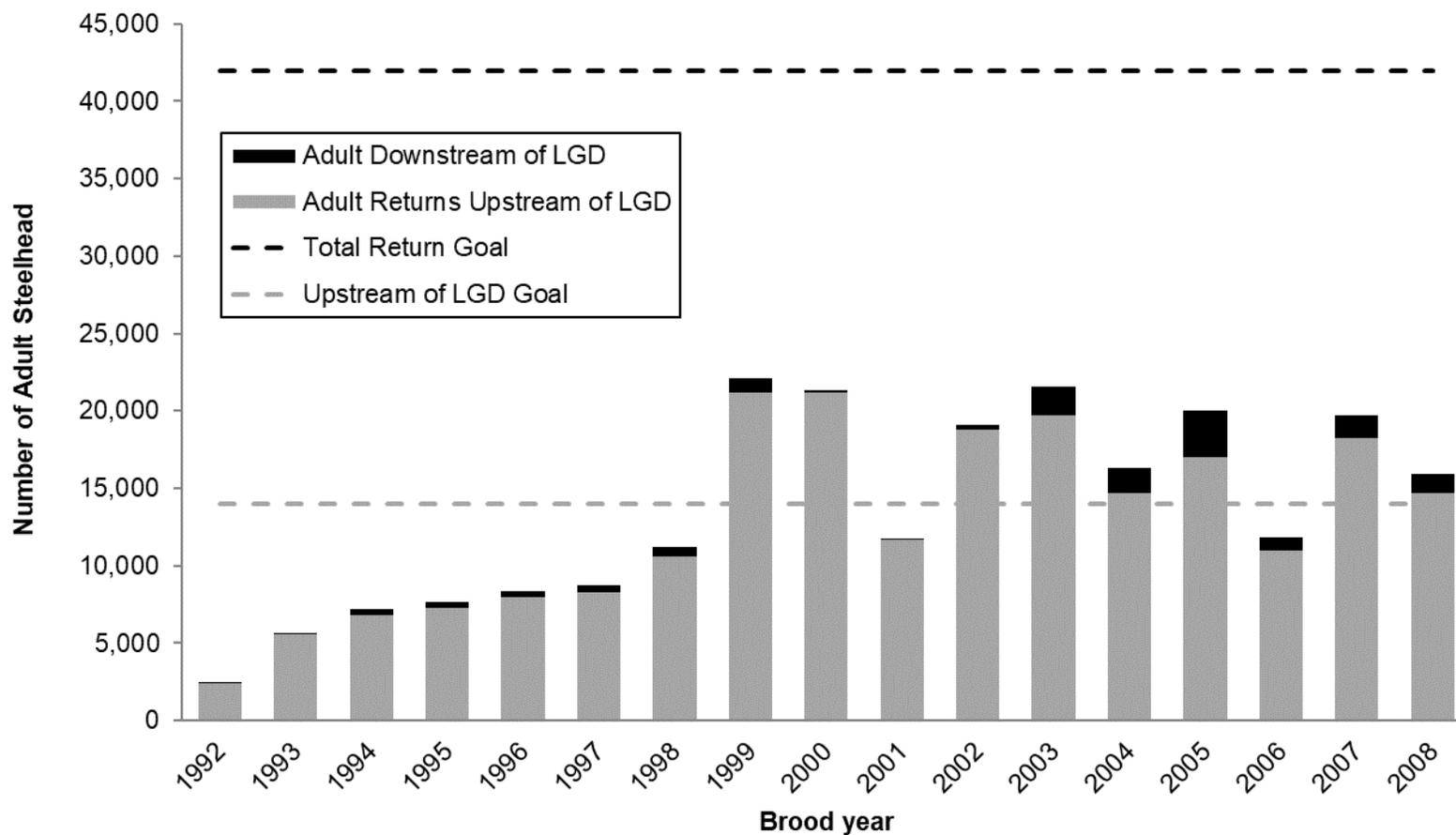
Appendix F5. Age composition for adult USAL hatchery steelhead for brood years 2002 through 2008. Age at return was estimated using CWT recovered in fisheries due to the limited sample size of CWT recovered at Squaw Creek temporary weir.



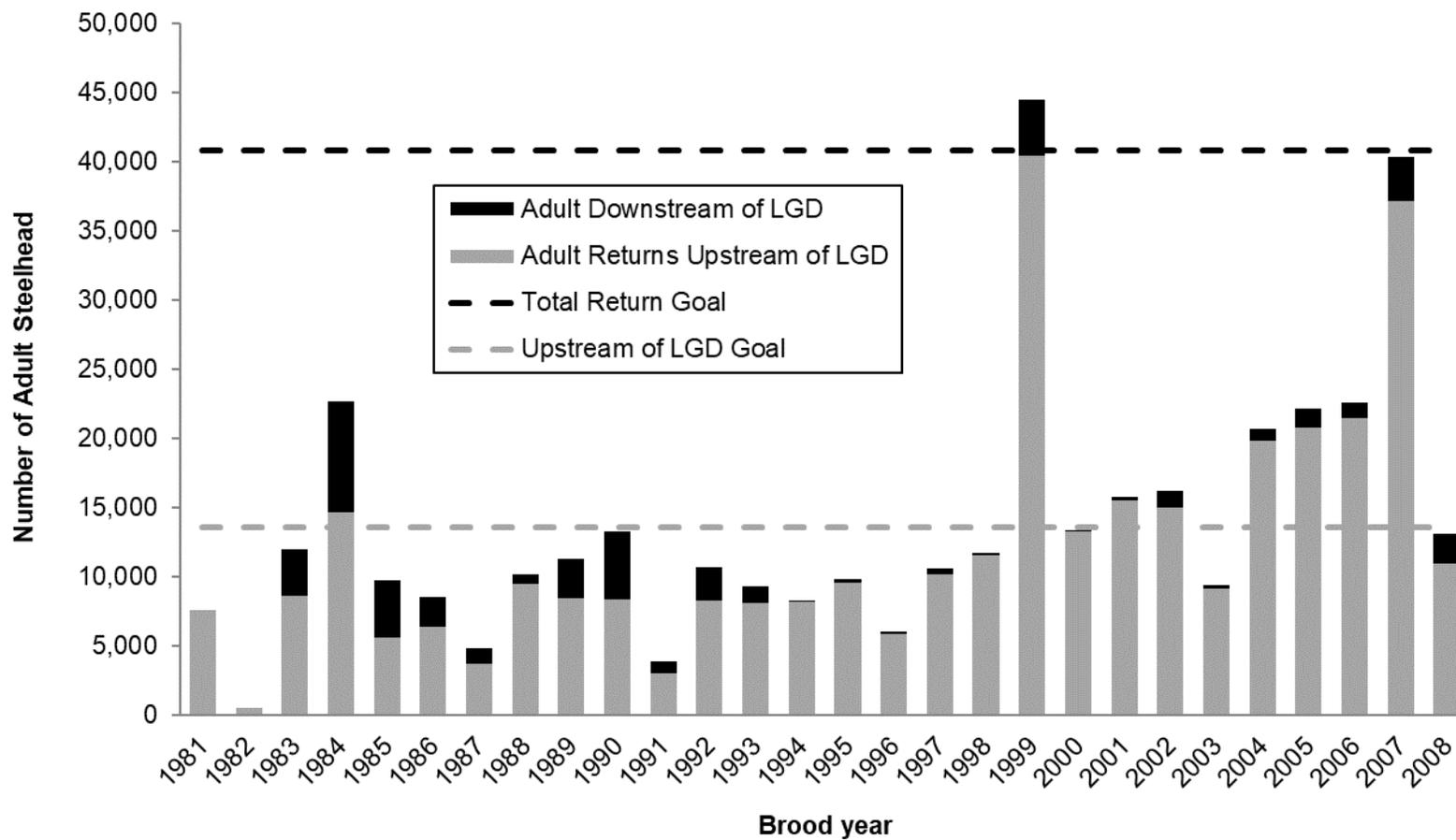
Appendix G1. Combined adult returns summary for steelhead released from LSRCP funded facilities (Clearwater [1992-2008], Hagerman [1981-2008], and Magic Valley [1982-2008]).



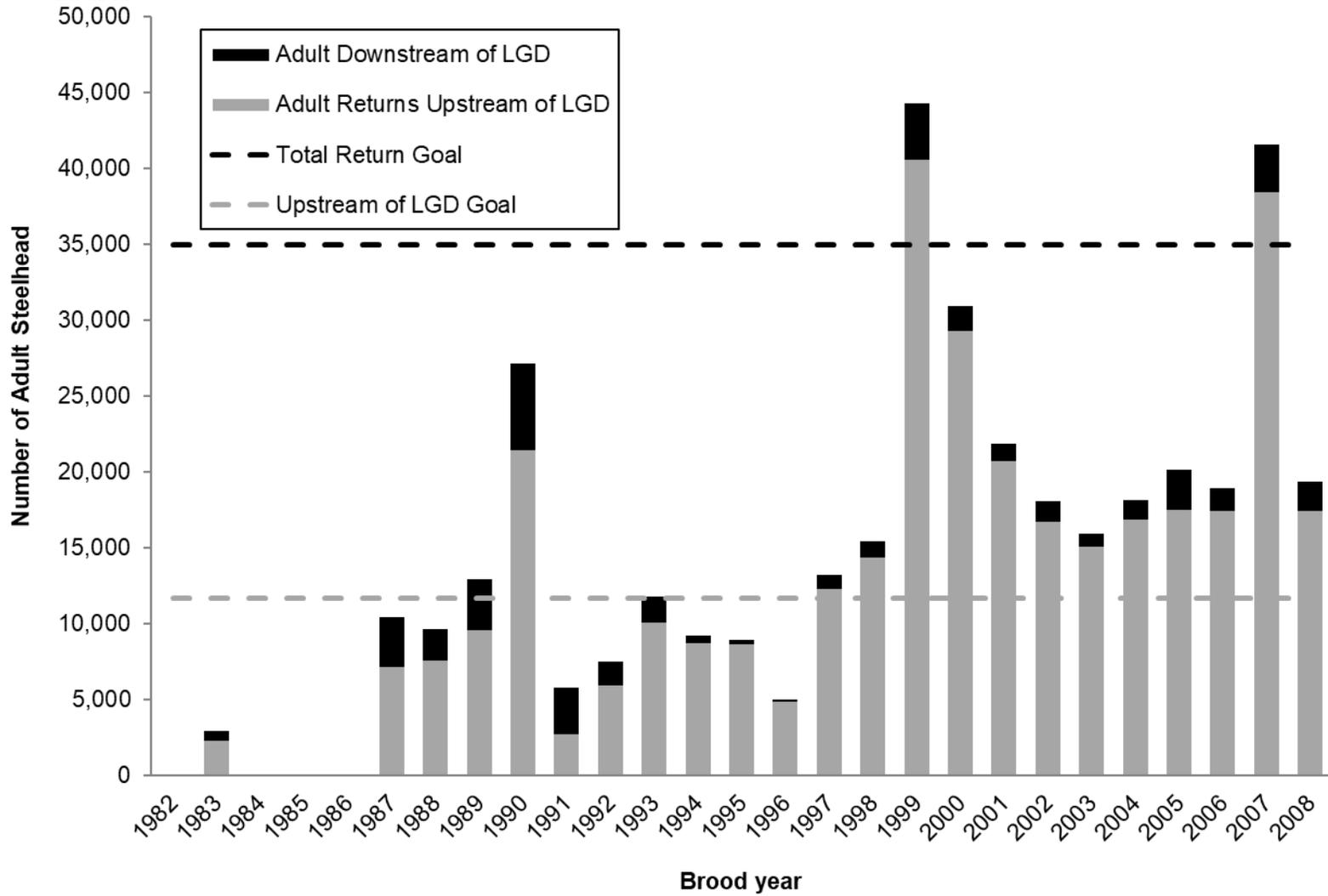
Appendix G2. Total adult return summaries upstream and downstream of the lower Snake River project area for steelhead released from Clearwater Fish Hatchery for brood years 1992 through 2008.



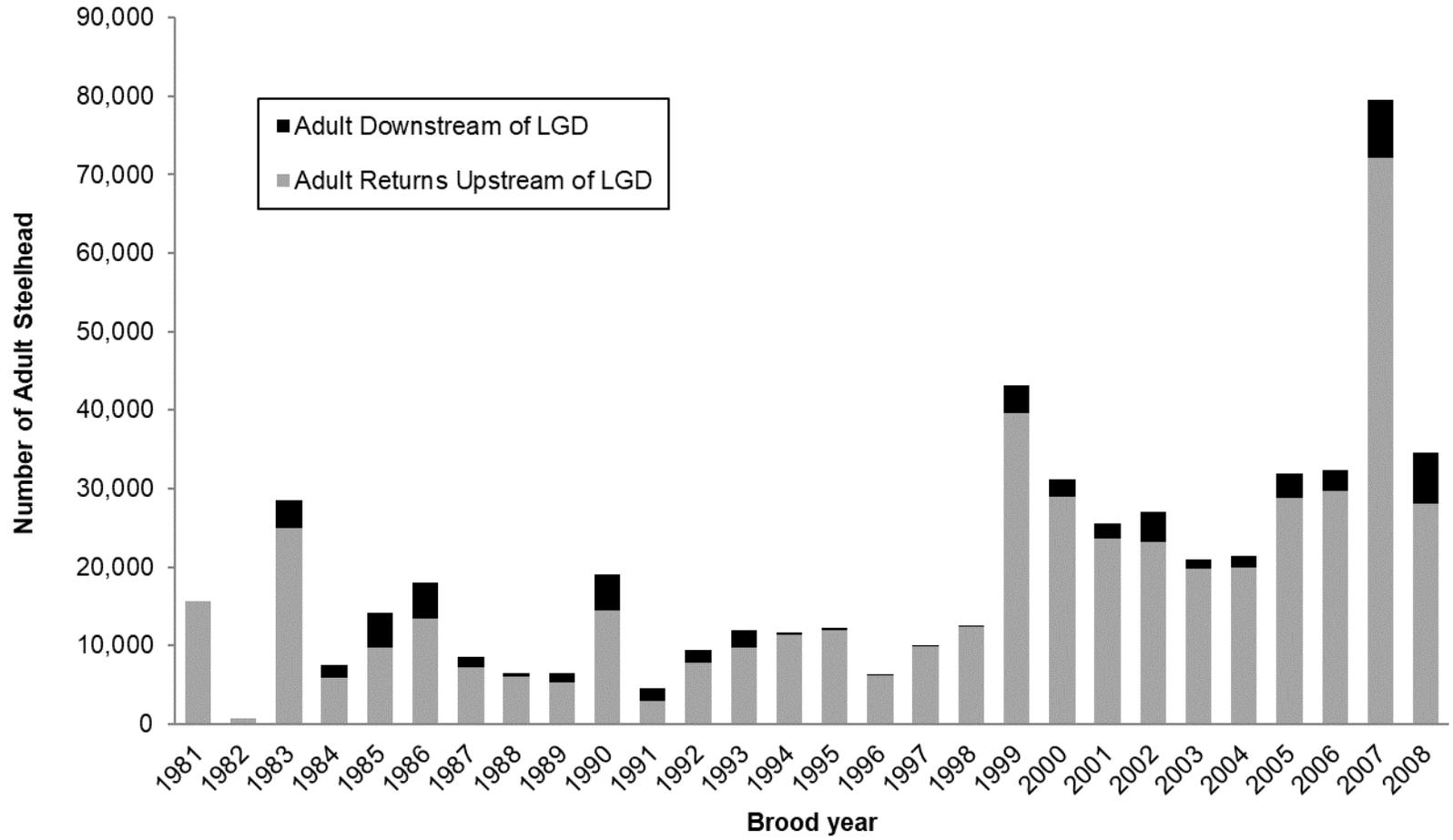
Appendix G3. Total adult return summaries upstream and downstream of the lower Snake River project area for steelhead released from Hagerman National Fish Hatchery for brood years 1981 through 2008.



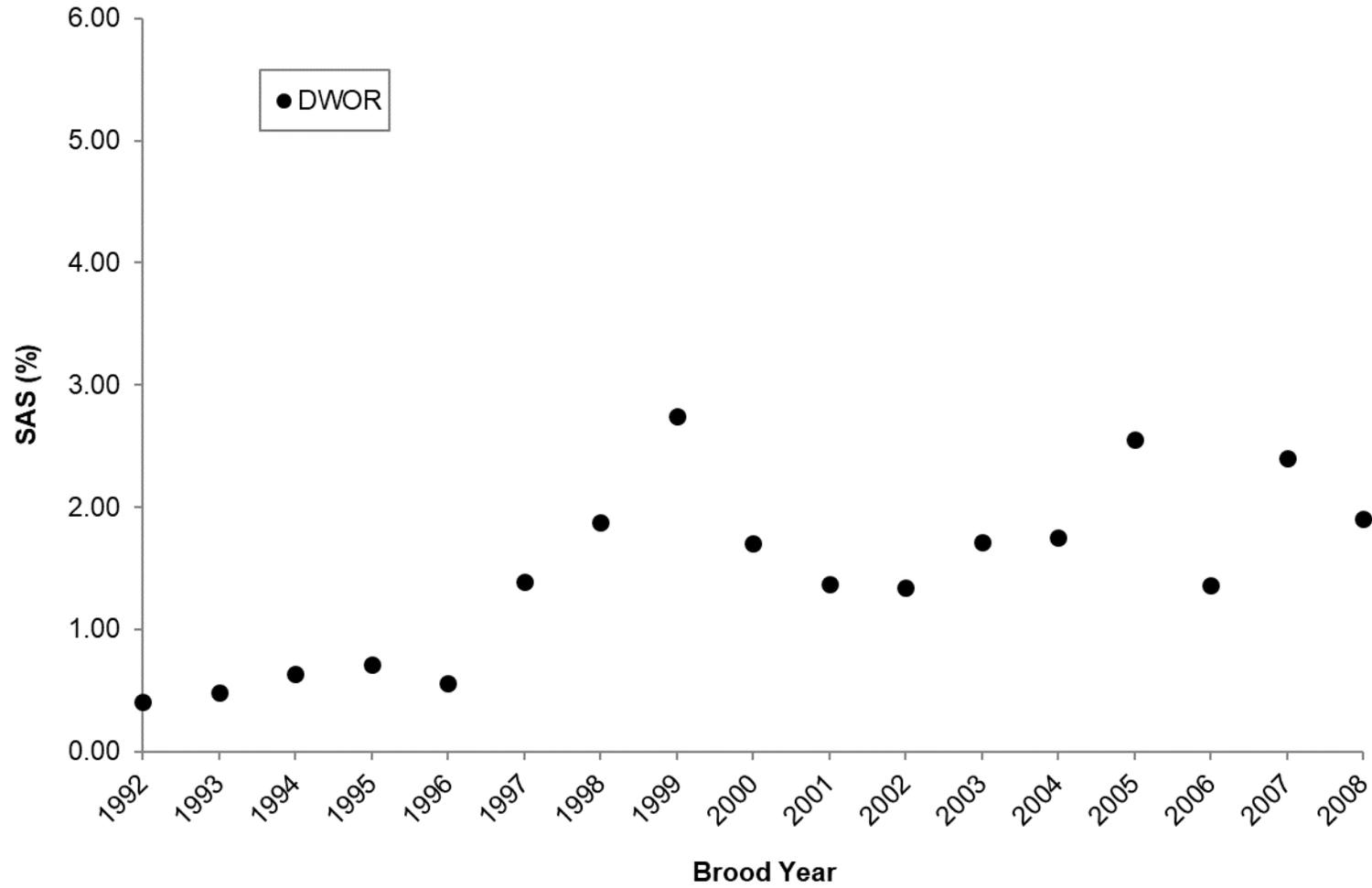
Appendix G4. Total adult return summaries upstream and downstream of the lower Snake River project area for steelhead released from Magic Valley Fish Hatchery for brood years 1982 through 2008.



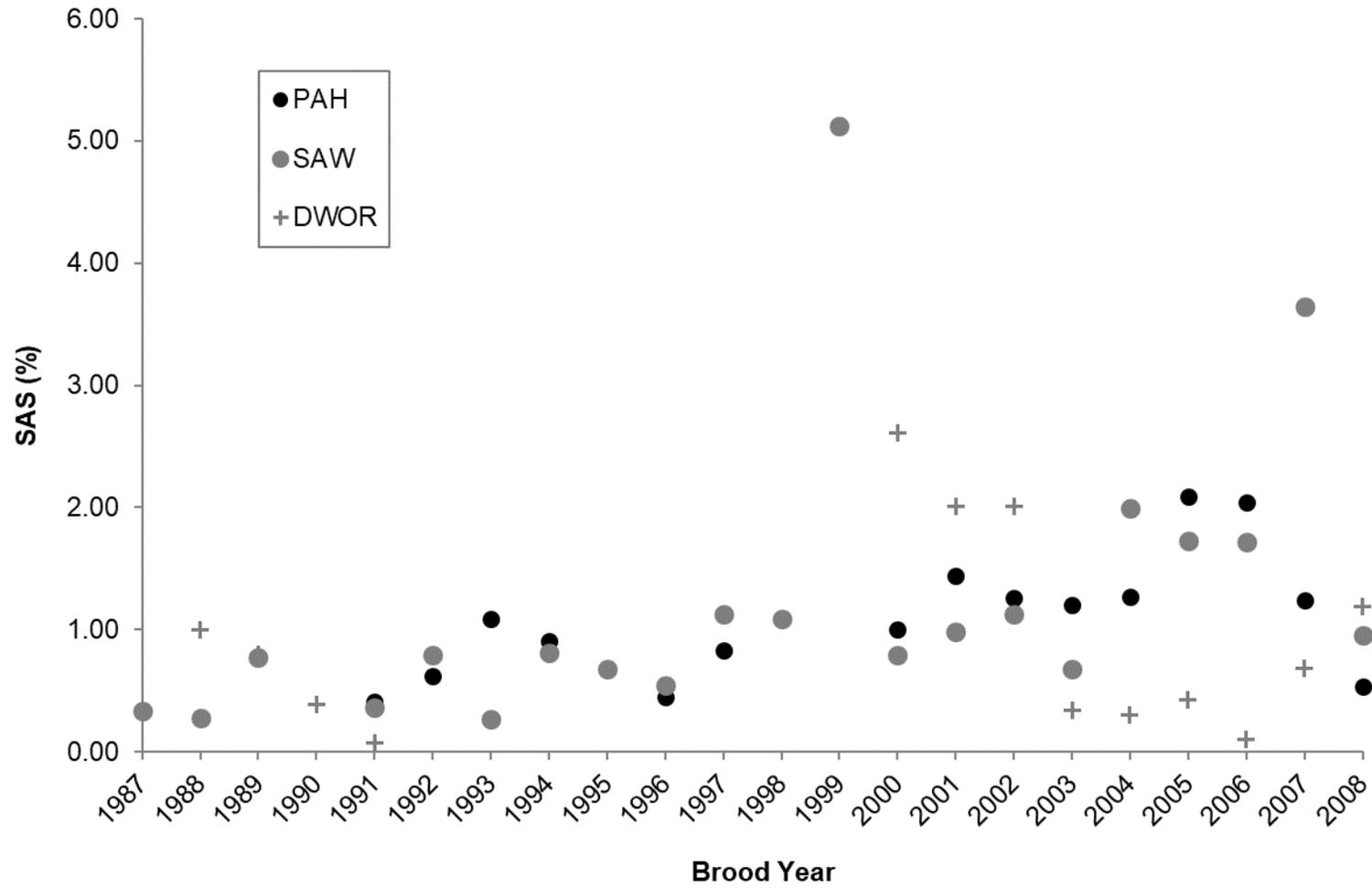
Appendix G5. Total adult return summaries upstream and downstream of the lower Snake River project area for steelhead released from Niagara Springs Fish Hatchery for brood years 1981 through 2008.



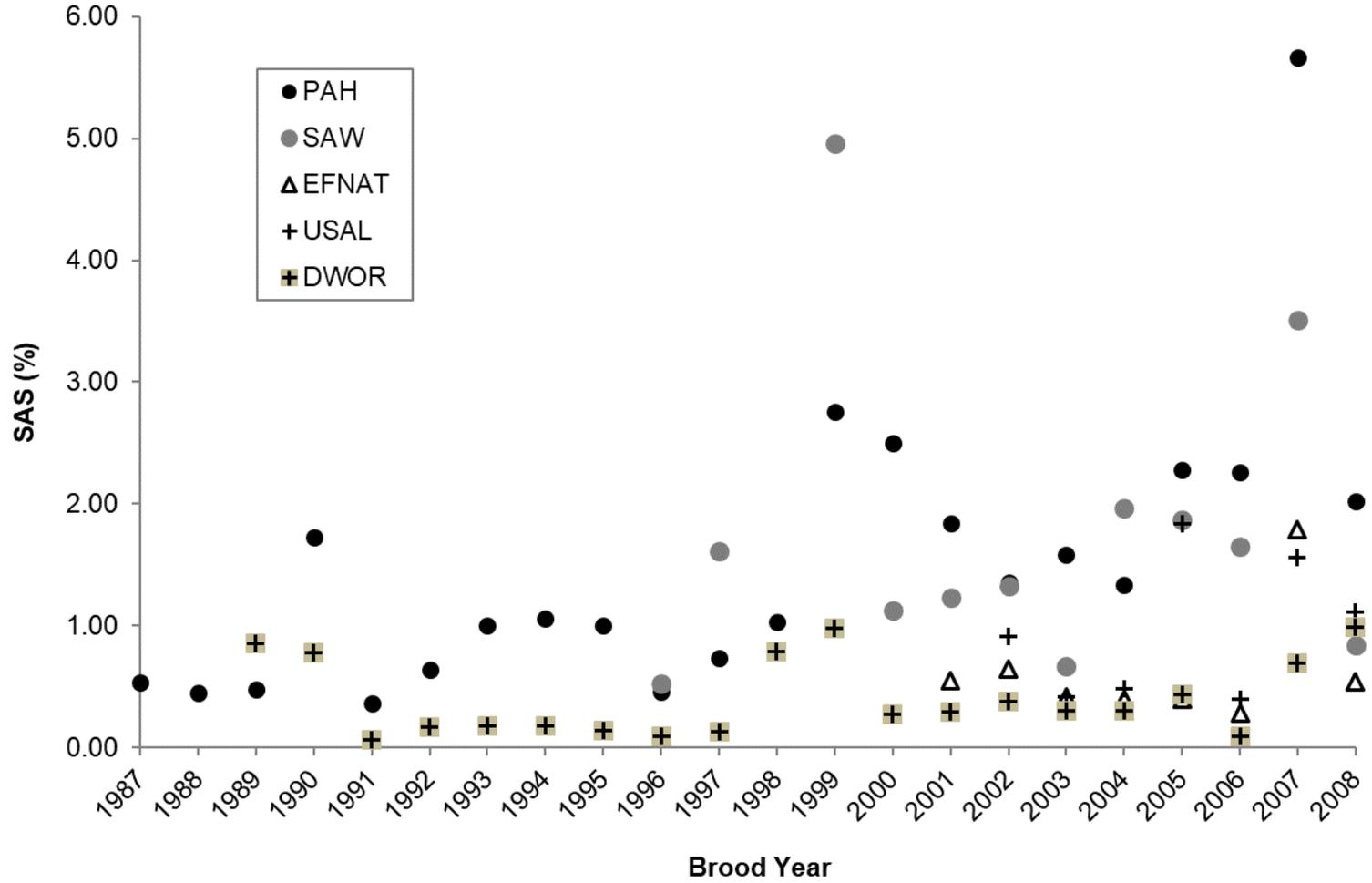
Appendix H1. Smolt-to-adult survival rates (SAS) of steelhead released from Clearwater Fish Hatchery for brood years 1992 through 2008.



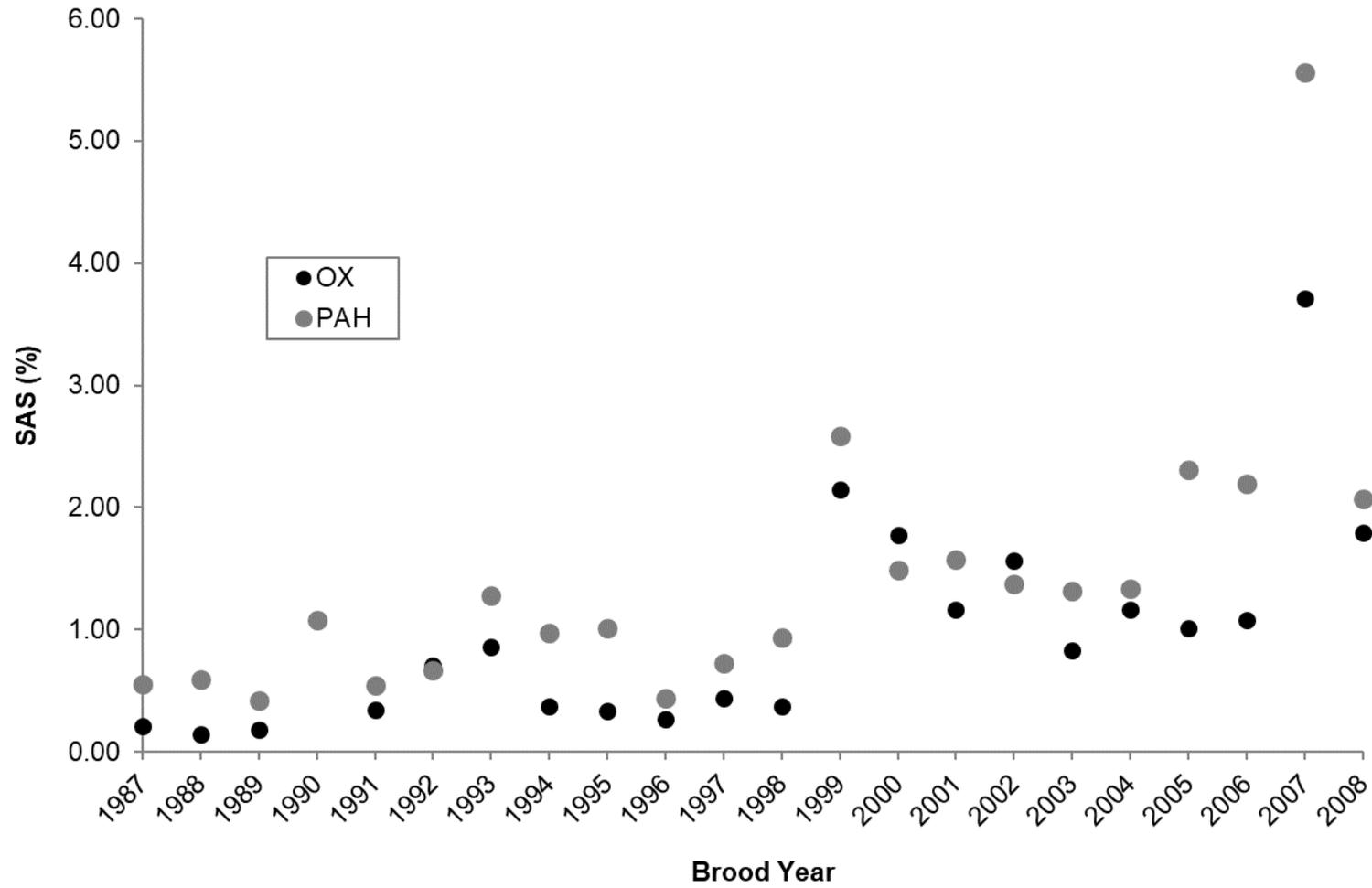
Appendix H2. Smolt-to-adult survival rates (SAS) for steelhead released from Hagerman National Fish Hatchery for brood years 1987 through 2008 for production released into the Salmon River.



Appendix H3. Smolt-to-adult survival rates (SAS) for steelhead released from Magic Valley Fish Hatchery for brood years 1987 through 2008 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 2008.



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