



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

**Brood Year 2009  
Hatchery Steelhead Report**



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## ABSTRACT

This report summarizes production, survival, and adult return information for brood year 2009 (BY09) 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 88% (range = 72%-96%). Average smolt size at release ranged from 5.2 fish per pound (fpp) to 3.7 fpp. Combined, these facilities released 5,656,363 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 82.6% (range 67.6%-99.1%).

Recovery of coded wire tags (CWT) and analysis of parentage based tagging (PBT) from the fisheries and hatchery traps was used to reconstruct the BY09 return of adult steelhead. The total estimated return to the mouth of the Columbia River from BY09 releases was 109,057 adult steelhead during the 2011-12, 2012-13, and 2013-14 runs including 62,133 from LSRCP funded facilities (Clearwater, Hagerman National, and Magic Valley fish hatcheries) and 46,924 from IPC funded Niagara Springs Fish Hatchery. The estimated return of adults back to the project area upstream of LGD was 91,175 including 53,879 from the three LSRCP facilities and 37,296 from Niagara Springs Fish Hatchery. Exploitation by recreational anglers upstream of LGD accounted for 55,315 of the returns and steelhead recovered at hatchery traps accounted for 18,852 of the returns to LGD. The remaining fish (17,008) were classified as unharvested escapement and composed of fish that were returning to offsite release locations with no trapping facility to remove them.

The smolt to adult survival rate (SAS), defined as the percent of smolts released that returned as adults to the Columbia River mouth was 1.9% for all hatcheries and release groups combined. Smolt to adult return rate (SAR), defined as the percent of smolts released that returned as adults to the project area upstream of LGD, was 1.6% for all rearing hatcheries and release groups combined. Progeny to parent ratios (PPR), which is the ratio of the total number of adults produced to the number of males and females spawned to create the progeny in question, ranged from 52.6 for DWOR stock releases from Clearwater Fish Hatchery to 8.9 for the EFNAT stock released into the East Fork Salmon River from brood year 2009 spawners.

In addition to estimating adult returns through run reconstruction methodologies, brood year 2009 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 estimate based on the sum of PIT expansion values exceeded the run reconstruction estimates by 10% at Bonneville Dam. The PIT tag return estimate at LGD was 9% less than the run reconstruction estimate.

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## INTRODUCTION

The Lower Snake River Compensation Plan (LSRCP) summer steelhead *Oncorhynchus mykiss* hatchery mitigation program was established to provide in-place and in-kind mitigation for lost harvest and 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. The anticipated 2:1 distribution of harvest benefits downstream:upstream of the project area 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 including 39,260 back to the project area upstream of Lower Granite Dam (Table 2).

In addition to the LSRCP, Idaho Power Company (IPC) funds 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 (HCSA) 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 HCSA does not specify an adult return goal, Idaho Department of Fish and Game (IDFG) anticipates these releases to return at rates comparable to what was modeled for the LSRCP program facilities and equates to approximately 43,200 adults (Table 2).

This report includes survival information from all life stages of BY09 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 BY09 to return (five-year generation length) plus two additional years to allow for all out-of-state coded wire tag recoveries to be submitted to the RMIS database (Regional Mark Information System, <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 and 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.

<b>Broodstock Collection Facilities</b>	<b>Stock Abbreviation</b>	<b>Mitigation Program</b>
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.

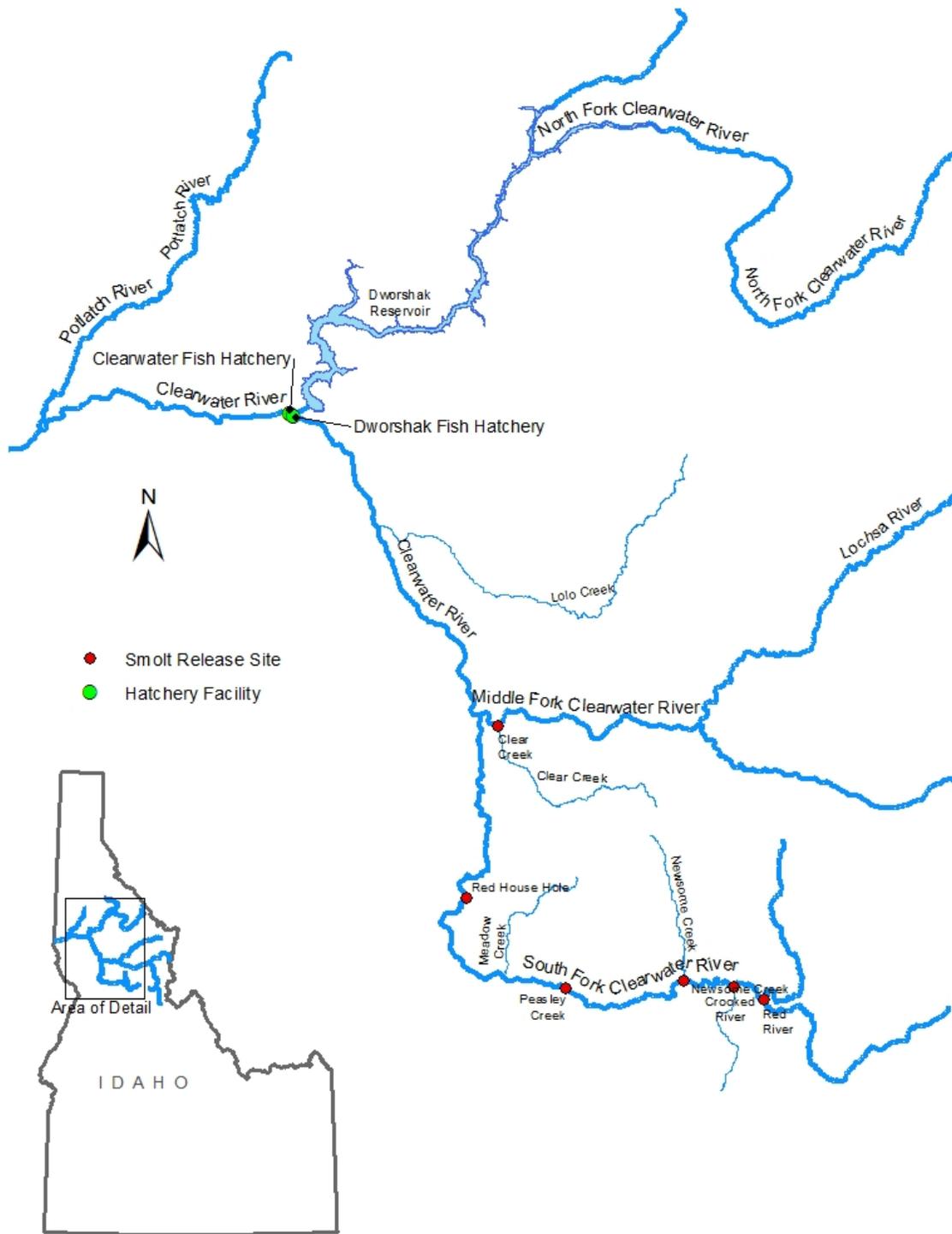


Figure 1. The location of hatchery steelhead release sites and the Clearwater Fish Hatchery facility in the Clearwater River basin.

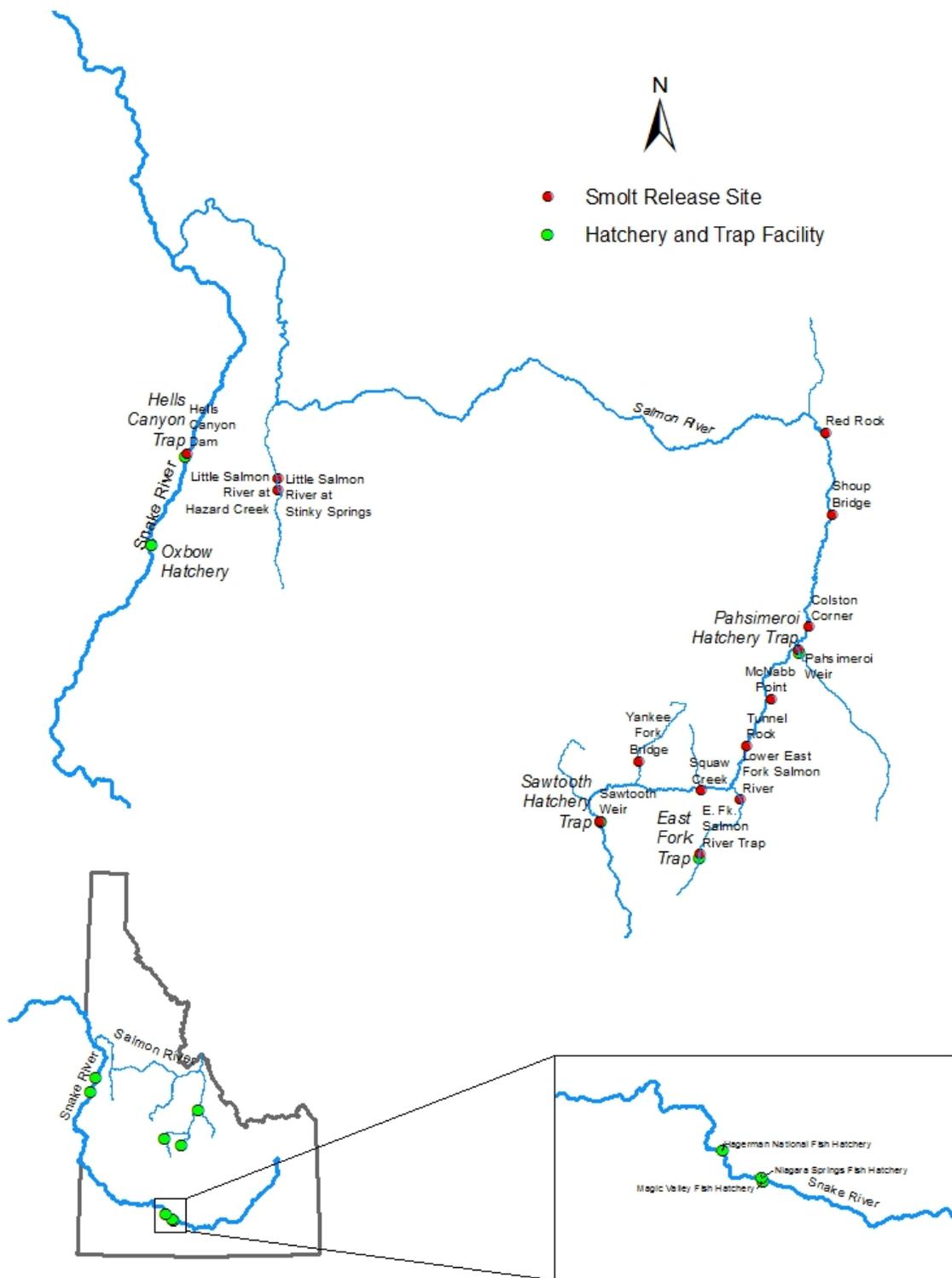


Figure 2. The location of hatchery steelhead release sites and hatchery facilities in the Salmon River and Snake River basins associated with the IPC and LSRCP mitigation programs.

## **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 as part of the Snake River Basin Steelhead 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). The majority (approximately 90%) of these fish mature after two or more years in the ocean. Smolts from this stock are also released in the Salmon River basin as part of the LSRCP mitigation program.

**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. The majority of these fish 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.

**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. Like the stock from which they were derived, the majority of SAW fish mature after one year in the ocean.

**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 majority of EFNAT hatchery-origin steelhead mature after one year in the ocean.

**Upper Salmon (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 annual adult production goals for each of the three LSRCP rearing facilities in Idaho as well as escapement objectives to the project area upstream of LGD (Table 2, USACE 1975). Annual smolt production targets were identified for each facility based on adult return goals and anticipated smolt-to-adult survival rates; however, the actual production targets changed over time. These changes are discussed in the facility descriptions below. The Smolt-to-adult survival (SAS) and Smolt-to-adult Return (SAR) rates listed in Table 2 represent the survival rates needed to meet the adult mitigation goals under current smolt release targets.

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

Mitigation Program	Rearing Hatchery	Adult Production		Escapement Objective to		Smolt Production Target
		Goal	SAS (%) <sup>1</sup>	LGD	SAR(%) <sup>2</sup>	
LSRCP	Clearwater	42,000	4.98	14,000	1.66	843,000
LSRCP	Hagerman	40,800	2.81	13,600	0.94	1,450,000
LSRCP	Magic Valley	34,980	2.19	11,660	0.73	1,600,000
IPC	Niagara Springs <sup>3</sup>	43,200	2.40	14,400	0.80	1,800,000

<sup>1</sup> This is the SAS required to meet the adult return goal based on current smolt production targets.

<sup>2</sup> This is the SAR required to meet the escapement objective at LGD based on current smolt production targets

<sup>3</sup> The mitigation goal established in the Hells Canyon Settlement agreement specifies the annual release of 400,000 pounds of steelhead smolts. The adult return goal and escapement objective listed here for IPC are for comparative purposes and reflect the expectations of IDFG based on similar survival metrics used for the LSRCP program.

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 eyed 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 due to litigation over water rights that could have substantially reduced water availability. The litigation was resolved in the late 1990s and Hagerman's brood year 2009 production target was 1,450,000 smolts. Hagerman receives eyed eggs from two stocks (EFNAT 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 2009. Magic Valley receives eyed eggs from four stocks (DWOR, 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 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 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. 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 monitoring and evaluation tool developed to assign the progeny of hatchery broodstock to a known pairing of adults. The database of parentage genotypes is created from the annual sampling of tissue from all hatchery broodstock that contribute to production. 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. Development of the PBT database began with the 2008 brood year and continued with the sampling of all BY09 stock in Idaho and several stocks in the Oregon and Washington portion of the Snake River basin. Essentially all of the progeny from the BY09 year can be tracked back to their rearing hatchery, stock, and cohort, while only some can be tracked to the release site. Progress towards being able to track all progeny back to individual release sites is being made.

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 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. Since PIT tags represent a proportion of the released population, an expansion value (inverse of the tag rate) is associated with each tagged release group. For brood year 2009, smolt release groups from all three LSRCP hatcheries and from Niagara Springs were represented with PIT tags to the release site level.

### **Juvenile Migration Timing and Survival**

The Columbia Basin PIT Tag Information System (PTAGIS, <https://www.ptagis.org/>) is the centralized database for PIT-tagged fish in the Columbia River system, storing PIT tag release and detection information from throughout the basin. I used PIT tag detection information submitted to PTAGIS to estimate juvenile survival from release to LGD by querying the database for PIT tags that represented the release groups from Idaho steelhead hatcheries. 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 concludes, 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). Hatchery of origin, age, and stock

composition (release group) of the catch from each stratum were based on the results of angler surveys conducted by roving creel survey personnel gathering information from anglers and their catch throughout the fishing season. Data gathered during these surveys include the collection of CWT from tagged fish. 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 tag tagging rate information for Dworshak, State of Oregon, and State of Washington releases in the Snake basin was obtained from these cooperators. The use of PBT technology for allocating harvest to release groups was not fully implemented until the fall fishing season of 2012. This methodology uses the proportion of successfully genotyped broodstock to assign tagging rates to release groups in the same way that tag rates are assigned to release groups with CWT. Since this timeframe corresponded to the return of age 4 (2-ocean) steelhead from the brood year 2009 cohort, CWT methodologies were used to allocate harvest of the age 3 (1-ocean) return and PBT methodologies were used to allocate harvest of the age 4 (2-ocean) and age 5 (3-ocean) return.

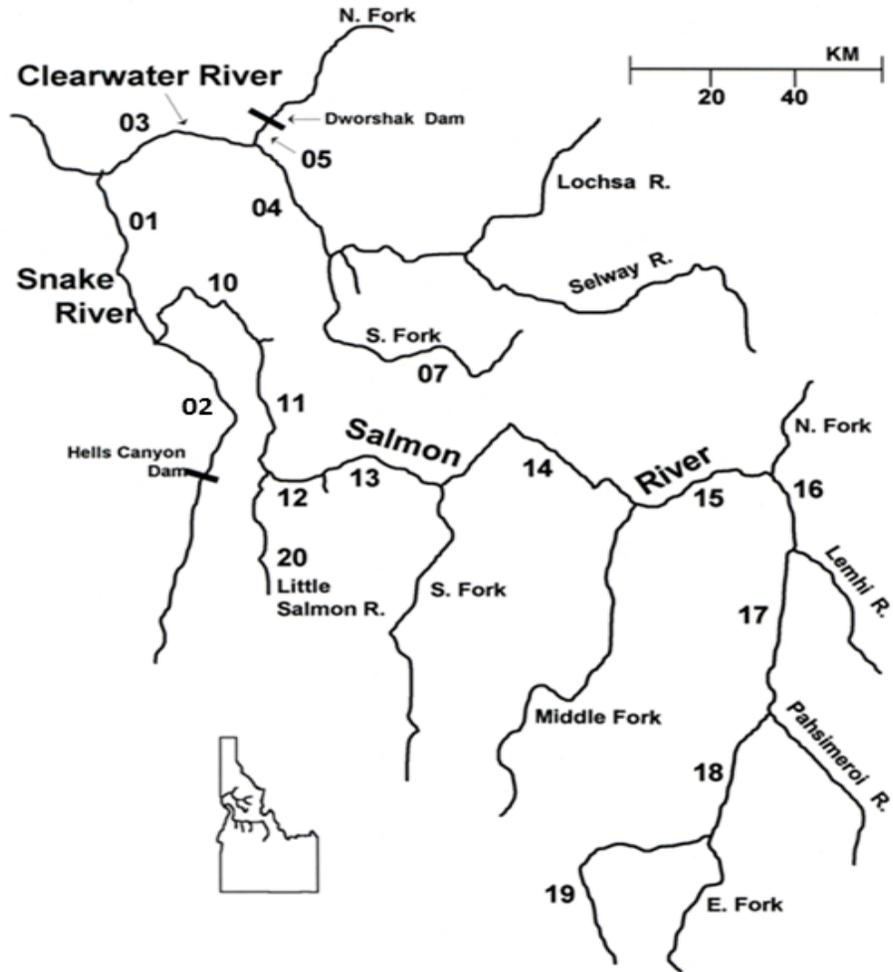


Figure 3. Idaho Department of Fish and Game river section designations where hatchery steelhead are available for harvest. Major tributaries or dams indicated on the map are used as section boundaries.

### Harvest Outside of Idaho

Although all releases of Snake River stocks of steelhead have been entered into the PBT database, sampling protocols had not been implemented in the sport fishery between Bonneville Dam and the Idaho border by the summer of 2011 to use the technology to assess the harvest. Estimates of harvest outside of Idaho therefore continued to be assessed from the query of CWT recovery information submitted to the RMIS database. 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 in the Columbia River, which was used to estimate harvest of ad-intact and ad-clipped adult steelhead from that fishery.

## Hatchery Trap Returns

Hatchery staff enumerated and recorded biological information from steelhead that escaped fisheries and were collected at hatchery traps. In spawn year 2012, hatchery personnel scanned all adult returning fish for CWT, collecting and sending snouts with tags and associated fork length information to the CWT laboratory for recovery. In spawn years 2013 and 2014 hatchery personnel continued to scan for and collect CWT and also took fin tissue samples and associated fork length information from fish used as broodstock for PBT analysis. Age and length data recovered from fish with CWTs and from PBT analysis was used with the *mixdist* library package (Macdonald 2010) in the R statistical and graphics software program to estimate the proportion of each age group from the total annual 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. Surrogates used for offsite release groups were typically released at a nearby broodstock collection facility with a permanent weir. For brood year 2009 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

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. 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. The exception to this is fish recovered in the John Day arm and Drano Lake as these areas were inundated with slack water from the Columbia River. Upstream of LGD I also exclude Salmon River and Snake River release groups recovered in the lower Clearwater in the fall, and Salmon River release groups recovered in the Snake River upstream of the mouth of the Salmon River in the fall, and Hells Canyon release groups recovered in the lower Salmon River in the fall. While some of these recoveries are outside of the direct migratory path to their release sites, these are areas where fish stage in the fall, and it is likely that many recoveries from fisheries in these areas are fish that would have continued back to their release site had they not been harvested. This is supported by the lack of strays recovered in the spring angler harvest period.

### **Brood Year Reconstruction, Smolt-to-Adult Survival Rates, Smolt-to Adult Return Rates, and Progeny-to-Parent Ratios**

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 compare returns to 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 a 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 life cycle (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 due to disease concerns. 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, assuming a 1:1 male to female spawner ratio. At the current production level of 843,000 smolts produced from 170 male/female pairings at Clearwater, a PPR of 123 is required to meet the adult mitigation goal of 42,000 adults. Smolt releases from Hagerman produced from 396 male/female pairings require a PPR of 52 to meet the mitigation goal of 40,800 adults, and smolt releases from Magic Valley produced from 400 male/female pairings require a PPR of 44 to meet the adult mitigation goal of 34,980 adults.

In addition to estimating adult returns through a run reconstruction methodology as described above, brood year 2009 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 2011, 2012, and 2013. This methodology assumes equal tag to untagged ratios from juvenile release to adult detection (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 in October and November 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% or less 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 2009, prespawn mortality was approximately 1.5%.

Fecundity for OX, PAH, and SAW stocks in brood year 2009 averaged 4,981 eggs per female, while fecundity of DWOR and USAL stocks averaged 7,292 eggs per female (Table 3, Appendix A). Fecundity of the brood year 2009 EFNAT stock was 5,061 eggs per female, which consisted of 38 females of hatchery origin and four females of natural origin. Differences in fecundity between stocks are due primarily to differences in the size and age structure of the returning adults. 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. Approximately 40% of the females trapped at the East Fork facility for the EFNAT program in 2009 were age four, (2-ocean) returning fish.

Survival from the green egg to eyed egg stage (eye-up rate) ranged from 66.3% for the USAL stock raised at MVFH to 96.4% for the DWOR stock raised at CFH in brood year 2009 (Table 3, Appendix B). Eye-up rates for the USAL stock remained the same compared to brood year 2008 but continued to be lower compared to other stocks in brood year 2009. Reasons for the lower eye-up of the USAL stock may be the result of the extra handling of broodstock, which are either trapped at the Squaw Creek weir or caught and handled by anglers who place the fish in PVC holding tubes before they were placed in the live box at Squaw Creek. These fish are then transported to the East Fork satellite facility where they are 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 and released into water bodies not conducive to anadromy.

Table 3. Spawning and egg production information for steelhead eggs shipped to LSRCP and IPC rearing facilities for brood year 2009.

<b>Broodstock</b>	<b>Rearing Hatchery</b>	<b>Females Spawned</b>	<b>Fecundity</b>	<b>Green Eggs <sup>1</sup></b>	<b>Eye-up rate (%)</b>	<b>Production Shipped</b>
Dworshak (DWOR)	Clearwater	168	7,279	1,222,872	96.4	994,863
	Magic Valley	209	7,279	1,525,057	92.7	948,419
East Fork (EFNAT)	Hagerman	42	5,061	212,572	78.9	167,775
Oxbow (OX)	Niagara Springs	296	5,359	1,586,227	87.4	884,874
	Magic Valley	152	4,310	653,845	90.0	573,983
Pahsimeroi (PAH)	Niagara Springs	332	4,310	1,390,163	90.9	1,203,068
	Sho-Ban Egg Box	168	4,310	724,647	90.9	658,704
Sawtooth (SAW)	Hagerman	358	5,274	1,880,591	82.3	1,487,230
	Magic Valley	32	5,274	166,063	82.3	131,328
Squaw Cr. (USAL)	Magic Valley	25	7,304	182,602	66.3	121,035

<sup>1</sup> Extra green eggs are produced to ensure egg production requests were met. This excess production is included 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). Neither Clearwater, Magic Valley nor Niagara Springs reported disease outbreaks or any other unanticipated events resulting in significant mortalities of eggs or fish prior to release as smolts. Good onsite survival of fry at Magic Valley resulted in the release of 50,035 DWOR stock, 47,489 PAH stock, and 9,382 SAW stock excess fry into nonanadromous waters in the fall of 2009. Good onsite survival of fry at Niagara Springs also resulted in the release of 45,491 OX stock, and 133,979 PAH stock excess fry into nonanadromous waters. Hagerman reported several disease outbreaks and sporadic elevated mortality levels throughout the rearing cycle. Despite these incidents, several treatments with antibiotics and chemical therapeutics resulted in an onsite survival of 88% of their SAW stock production, which comprised 91% of their total release. Smolt size at release ranged from 5.2 fish/lb. for the OX stock to 3.7 fish/lb for the PAH stock from Niagara Springs.

Table 4. Eyed eggs kept for program needs and eyed egg-to-smolt (onsite) survival estimates for LSRCP and IPC steelhead rearing facilities for brood year 2009.

Rearing Facility	Stock	Eyed Eggs Kept for Program Needs	Number Released	Percent of Release Goal	Size at Release (fish/lb.)	Onsite Survival
Clearwater	DWOR	973,593	854,960	<b>101%</b>	4.5	88%
	<b>Total</b>	<b>973,593</b>	<b>854,960</b>			
Hagerman	EFNAT	168,160	120,918	<b>97%</b>	4.3	72%
	SAW	1,458,875	1,290,915		4.4	88%
	<b>Total</b>	<b>1,627,035</b>	<b>1,411,833</b>			
Magic Valley	DWOR	898,385	864,239	<b>100%</b>	5.0	96%
	PAH	575,453	522,630		4.8	91%
	SAW	130,427	117,883		4.6	90%
	USAL	117,677	95,023		4.6	81%
	<b>Total</b>	<b>1,721,942</b>	<b>1,599,775</b>			
Niagara Springs	OX	863,815	811,266	<b>99%</b>	5.2	92%
	PAH	1,107,696	978,529		3.7	88%
	<b>Total</b>	<b>1,971,511</b>	<b>1,789,795</b>			

### Smolt Releases

A combined total of 5,656,363 brood year 2009 steelhead smolts were released from all rearing facilities from March through May 2010 (Table 5). All three LSRCP facilities and Idaho Power's Niagara Springs facility were within 97% of their respective smolt release targets (Table 4).

Table 5. Smolt release and mark/tag information for brood year 2009 hatchery steelhead released in Idaho for the IPC and LSRCP mitigation program.

Hatchery	Release Site	Stock	Ad-clip	Ad-clip and CWT	CWT	No Clip or CWT	Total Released
Clearwater	Clear Creek	DWOR	144,934	0	0	0	144,934
	Crooked River	DWOR	0	0	0	86,743	86,743
	Newsome Creek	DWOR	0	0	0	107,312	107,312
	Peasley Creek	DWOR	129,192	47,002	0	0	176,194
	Red River	DWOR	0	0	0	153,644	153,644
	Red House Hole	DWOR	114,554	71,579	0	0	186,133
<b>Total</b>			<b>388,680</b>	<b>118,581</b>	<b>0</b>	<b>347,699</b>	<b>854,960</b>
Hagerman	E. Fk. Salmon River	EFNAT	0	0	116,967	3,951	120,918
	Tunnel Rock	SAW	47,300	19,118	0	0	66,418
	Sawtooth Weir	SAW	718,976	78,081	0	0	797,057
	Yankee Fork	SAW	126,208	83,154	0	0	209,362
	Yankee Fork	SAW	0	0	0	218,078	218,078
<b>Total</b>			<b>892,484</b>	<b>180,353</b>	<b>116,967</b>	<b>222,029</b>	<b>1,411,833</b>
Magic Valley	E. Fk. Salmon River	DWOR	246,829	60,120	0	0	306,949
	Little Salmon	DWOR	166,912	112,759	0	0	279,671
	Little Salmon	PAH	164,402	18,500	0	0	182,902
	Pahsimeroi Weir	USAL	0	0	92,172	2,851	95,023
	Colston Corner	PAH	96,854	56,939	0	0	153,793
	McNabb Point	SAW	60,731	57,152	0	0	117,883
	Red Rock	PAH	48,250	76,123	0	0	124,373
	Shoup Bridge	PAH	42,570	18,992	0	0	61,562
Squaw Creek	DWOR	217,561	60,058	0	0	277,619	
<b>Total</b>			<b>1,044,109</b>	<b>460,643</b>	<b>92,172</b>	<b>2,851</b>	<b>1,599,775</b>
Niagara Springs	Little Salmon	OX	251,354	30,245	0	0	281,599
	Little Salmon	PAH	116,930	28,692	0	0	145,622
	Pahsimeroi Weir	PAH	746,353	86,554	0	0	832,907
	Hells Canyon Dam	OX	442,293	87,374	0	0	529,667
<b>Total</b>			<b>1,556,930</b>	<b>232,865</b>	<b>0</b>	<b>0</b>	<b>1,789,795</b>
<b>Grand Total</b>			<b>3,882,203</b>	<b>992,442</b>	<b>209,139</b>	<b>572,579</b>	<b>5,656,363</b>

## Juvenile Migration Timing and Survival

Survival rates of PIT-tagged steelhead from release to LGD had an unweighted average of 82.6%, which is similar to recent years (Appendix E). The ad-clipped SAW stock release at Tunnel Rock from Hagerman had the lowest survival rate (67.6% ± 14.5) and the ad-clipped Little Salmon River PAH stock release from Magic Valley had the highest survival rate (99.1% ± 10.8) (Table 6). The majority of migrants arrived at LGD from late April through May of 2010. The 80% arrival window to LGD is the time period between the date that the first 10% of the total number of PIT tag detections occurs to when 90% of the total detections occurs. Eighty percent arrival windows for brood year 2009 smolts ranged from 15 to 38 days.

Table 6. Travel times and estimated survival of brood year 2009 smolts from release site to Lower Granite Dam (LGD) after release from LSRCP and IPC facilities in migration year 2010.

Hatchery	Stock	Release Site	Number PIT Tagged	Release Date	80% Arrival Window (# Days)	% Survival Estimate to LGD (± 95% C.I.)
Clearwater	DWOR	Clear Cr.	4,079	4/20	4/24 - 5/11 (17)	90.9 (±10.2)
	DWOR	Crooked R.	2,392	4/14	4/30 - 5/30 (30)	72.2 (±10.7)
	DWOR	Newsome Cr.	2,755	4/15	4/24 - 5/24 (30)	78.8 (±10.0)
	DWOR	Peasley Cr.	4,968	4/19	4/26 - 5/19 (23)	89.0 (±8.3)
	DWOR	Red House Hole	5,237	4/19	4/24 - 5/10 (16)	86.9 (±7.9)
	DWOR	Red R.	4,171	4/12	4/24 - 5/24 (30)	74.6 (±8.5)
Hagerman	EFNAT	E. Fk. Salmon R.	6,804	5/3	5/19 - 6/7 (19)	70.9 (±7.0)
	SAW	Salmon R. (Tunnel Rock)	934	4/12	4/29 - 5/24 (25)	67.6 (±14.5)
	SAW	Salmon R. (Sawtooth)	12,936	4/13	4/27 - 5/27 (30)	76.6 (±6.0)
	SAW	Yankee Fork	7,258	5/5	5/21 - 6/17 (27)	72.0 (±4.4)
Magic Valley	DWOR	E. Fk. Salmon R.	5,576	4/16	5/2 - 6/2 (31)	72.9 (±7.8)
	DWOR	Little Salmon R.	5,563	4/13	4/26 - 6/3 (38)	88.2 (±7.1)
	DWOR	Squaw Cr.	3,285	4/21	5/10 - 6/4 (25)	68.8 (±9.6)
	PAH	Little Salmon R.	3,385	4/9	4/23 - 5/23 (30)	99.1 (±10.8)
	PAH	Salmon R. (Colston)	2,590	4/7	4/24 - 5/24 (30)	84.3 (±10.5)
	PAH	Salmon R. (Red Rock)	2,082	4/5	4/24 - 5/23 (29)	77.9 (±11.7)
	PAH	Salmon R. (Shoup Bridge)	989	4/6	4/24 - 5/21 (27)	78.9 (±19.9)
	SAW	Salmon R. (McNabb)	2,097	4/27	5/5 - 5/26 (21)	90.6 (±17.3)
	USAL	Pahsimeroi R.	7,172	4/28	5/12 - 5/27 (15)	84.3 (±10.5)
Niagara Springs	OX	Hells Canyon Dam	8,256	5/14	5/6-6/5 (15)	93.4 (±7.2)
	OX	Little Salmon R.	4,287	4/6	4/24-6/3 (27)	88.7 (±9.0)
	PAH	Little Salmon R.	2,687	4/9	4/23-5/23 (26)	98.9 (±13.9)
	PAH	Pahsimeroi Weir	12,897	5/19	4/29-5/24 (19)	94.6 (±7.8)
<b>Total PIT Tagged:</b>			<b>112,400</b>			

## Adult Returns

### Recreational Harvest upstream of Lower Granite Dam

Adult steelhead from brood year 2009 releases contributed to fisheries over the course of multiple runs from the fall of 2011 through the spring of 2014. During that time recreational fisheries for steelhead occurred in the Snake, Clearwater, Little Salmon, and Salmon rivers in Idaho. Recreational anglers harvested approximately 55,314 adult steelhead from brood year 2009 (Table 7), which is higher than the harvest of 33,604 fish from brood year 2008. Tribal harvest estimates were not available.

Table 7. Estimated recreational harvest upstream of Lower Granite Dam for brood year 2009 hatchery origin steelhead released from Lower Snake River Compensation Plan and Idaho Power Company facilities in Idaho. Estimates were derived from coded-wire-tag recoveries in the fisheries from the fall 2011 through the spring of 2014.

Hatchery	Stock	1-Ocean	2-Ocean	3-Ocean	Total
Clearwater	DWOR	1,043	9,931	27	11,001
<b>Clearwater Total</b>		<b>1043</b>	<b>9,931</b>	<b>27</b>	<b>11,001</b>
Hagerman	EFNAT	19	0	0	19
	SAW	9,328	2,138	0	11,466
<b>Hagerman Total</b>		<b>9,347</b>	<b>2,138</b>	<b>0</b>	<b>11,485</b>
Magic Valley	DWOR	198	1,371	8	1,577
	PAH	5,674	901	54	6,629
	SAW	1,157	186	0	1,343
	USAL	6	0	0	6
<b>Magic Valley Total</b>		<b>7,035</b>	<b>2,459</b>	<b>62</b>	<b>9,556</b>
Niagara Springs	OX	6,926	3,809	126	10,861
	PAH	8,907	3,497	8	12,412
<b>Niagara Springs Total</b>		<b>15,833</b>	<b>7,306</b>	<b>134</b>	<b>23,273</b>
<b>Grand Total</b>		<b>33,258</b>	<b>21,834</b>	<b>223</b>	<b>55,314</b>

## **Harvest Downstream of Lower Granite Dam**

Brood year 2009 releases from LSRCP and IPC facilities contributed 17,760 adult steelhead to fisheries in the Columbia River and Lower Snake River downstream of Lower Granite Dam (Table 8). Harvest estimates include ad-intact fish caught in the non-selective tribal fishery in Zone 6. Approximately 50% of the brood year 2009 harvest downstream of LGD was from the Zone 1-5 sport harvest section and about 19% was from the sport harvest within the Snake River downstream of LGD. The Zone 6 Tribal Harvest accounted for about 29% of the harvest. Production from Niagara Springs Fish Hatchery accounted for 54% of the total harvest downstream of LGD, which is the same proportion of harvest as the brood year 2008 return (Warren 2018).

Table 8. Harvest summary in the Columbia River (Col R) and Snake River downstream of Lower Granite Dam (LGD) for brood year 2009 hatchery steelhead released from LSRCP and IPC facilities. Only release groups for which harvest was detected are included in this table.

<u>Release Group</u>				<u>Harvest Type</u>						
<u>Facility</u>	<u>Stock</u>	<u>Marks</u>	<u>Ocean Age</u>	<u>Ocean Sport</u>	<u>Zone 1-5 Sport</u>	<u>Zone 6 Sport</u>	<u>Zone 6 Tribal</u>	<u>Col R above MCN</u>	<u>Snake Below LGD</u>	<u>Total Harvest Below LGD</u>
Clearwater	DWOR	Ad-clipped	1	0	0	0	0	0	3	3
			2	0	196	25	574	3	216	1,014
			3	0	22	0	0	0	0	22
	Ad-intact	1	0	0	0	0	0	0	0	0
		2	0	0	17	393	0	0	0	410
		3	0	0	0	0	0	0	0	0
	<b>DWOR Total</b>				<b>0</b>	<b>218</b>	<b>42</b>	<b>967</b>	<b>3</b>	<b>219</b>
<b>Clearwater Total</b>				<b>0</b>	<b>218</b>	<b>42</b>	<b>967</b>	<b>3</b>	<b>219</b>	<b>1,449</b>
Hagerman	EFNAT	Ad-intact	1	0	0	0	71	0	0	71
			2	0	10	0	17	0	0	27
			3	0	0	0	0	0	0	0
	<b>EFNAT Total</b>				<b>0</b>	<b>10</b>	<b>0</b>	<b>88</b>	<b>0</b>	<b>0</b>
Hagerman	SAW	Ad-clipped	1	0	1,659	18	675	41	491	2,884
			2	0	598	13	132	5	153	901
			3	0	0	0	0	0	0	0
	Ad-intact	1	0	0	0	129	0	0	129	
		2	0	18	0	31	0	0	49	
3	0	0	0	0	0	0	0	0		
<b>SAW Total</b>				<b>0</b>	<b>2,275</b>	<b>31</b>	<b>967</b>	<b>46</b>	<b>644</b>	<b>3,963</b>
<b>Hagerman Total</b>				<b>0</b>	<b>2,285</b>	<b>31</b>	<b>1,055</b>	<b>46</b>	<b>644</b>	<b>4,061</b>
Magic Valley	DWOR	Ad-clipped	1	0	0	5	0	0	0	5
			2	6	69	11	65	6	136	293
			3	0	0	0	0	0	0	0
	<b>DWOR Total</b>				<b>6</b>	<b>69</b>	<b>16</b>	<b>65</b>	<b>6</b>	<b>136</b>

<u>Release Group</u>				<u>Harvest Type</u>						
Facility	Stock	Marks	Ocean Age	Ocean Sport	Zone 1-5 Sport	Zone 6 Sport	Zone 6 Tribal	Col R above MCN	Snake Below LGD	Total Harvest Below LGD
			1	0	774	11	437	11	527	1,760
	PAH	Ad-clipped	2	0	282	7	20	2	14	325
			3	0	0	0	0	0	0	0
	<b>PAH Total</b>			<b>0</b>	<b>1,056</b>	<b>18</b>	<b>457</b>	<b>13</b>	<b>541</b>	<b>2,085</b>
			1	0	146	0	74	0	10	230
	SAW	Ad-clipped	2	0	39	0	27	0	0	66
			3	0	9	0	0	0	0	9
	<b>SAW Total</b>			<b>0</b>	<b>193</b>	<b>0</b>	<b>101</b>	<b>0</b>	<b>10</b>	<b>304</b>
	USAL		1	0	0	0	4	0	0	4
		Ad-intact	2	0	0	0	4	0	0	4
			3	0	0	0	0	0	0	0
	<b>USAL Total</b>			<b>0</b>	<b>0</b>	<b>0</b>	<b>8</b>	<b>0</b>	<b>0</b>	<b>8</b>
<b>Magic Valley Total</b>				<b>6</b>	<b>1,319</b>	<b>35</b>	<b>631</b>	<b>19</b>	<b>687</b>	<b>2,696</b>
			1	18	1,327	54	681	115	636	2,832
	OX	Ad-clipped	2	9	1,715	36	556	24	206	2,546
			3	0	0	0	0	0	0	0
	<b>OX Total</b>			<b>27</b>	<b>3,042</b>	<b>90</b>	<b>1,237</b>	<b>139</b>	<b>842</b>	<b>5,378</b>
			1	0	1,372	29	893	0	934	3,227
	PAH	Ad-clipped	2	0	612	0	336	0	0	948
			3	0	0	0	0	0	0	0
	<b>PAH Total</b>			<b>0</b>	<b>1,984</b>	<b>29</b>	<b>1,229</b>	<b>0</b>	<b>934</b>	<b>4,175</b>
<b>Niagara Springs Total</b>				<b>27</b>	<b>5,027</b>	<b>119</b>	<b>2,466</b>	<b>139</b>	<b>1,776</b>	<b>9,553</b>
<b>Grand Total</b>				<b>33</b>	<b>8,849</b>	<b>226</b>	<b>5,119</b>	<b>207</b>	<b>3,326</b>	<b>17,760</b>

## **Hatchery Trap Returns**

The numbers of adult steelhead from brood year 2009 trapped at broodstock facilities are summarized by age and sex in Table 9. Trapping numbers at the Hells Canyon trapping facility 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. Collection of broodstock for the USAL program is being shifted from Squaw Creek to the Pahsimeroi weir, where 95,000 USAL unclipped smolts tagged with CWT were released in the spring of 2010. This change was implemented because the collection of broodstock at Squaw Creek has relied on a temporary weir and contributions of adult USAL fish caught by anglers, which has not been an effective or reliable means to collect broodstock. Trapping numbers of USAL stock returns are therefore based on returns of 1-ocean fish to the Squaw Creek weir in the spring of 2012 and 2-ocean fish to the Pahsimeroi weir in the spring of 2013. Appendix F provides an age summary for each broodstock collection facility across all brood years.

Table 9. Summary of age at maturity and average length at age of brood year 2009 hatchery origin steelhead returning to LSRCP and IPC broodstock collection facilities in Idaho.

Broodstock Collection Facility	Stock	Males				Females				Total Trapped
		1-Ocean		2-Ocean		1-Ocean		2-Ocean		
		Number Trapped	Average Length (cm)							
Clearwater	DWOR	26	66	117	849	1	71	100	80	244
East Fork	EFNAT <sup>2</sup>	480	57	27	74	146	57	145	69	798
Hells Canyon	OX	1,283	59	800	71	955	58	1,727	69	4,765
Pahsimeroi	PAH	3,525	57	3,339	70	466	56	1,273	67	8,603
Pahsimeroi	USAL	90	61	99	78	23	63	248	73	460
Squaw Creek <sup>1</sup>	USAL	7	56	-	-	7	59	-	-	14
Sawtooth	SAW	1,898	58	444	71	1,296	57	1,091	68	4,729

<sup>1</sup> USAL stock program shifted from Squaw Creek to Pahsimeroi beginning with brood year 2009 release.

<sup>2</sup> Numbers trapped at the East Fork collection facility include hatchery origin fish that were released upstream of the weir to spawn naturally.

## **Stray Estimates**

Straying of hatchery steelhead was observed at low levels/rates across most facilities in brood year 2009. The majority (89%) of strays were observed in fisheries upstream of LGD (Tables 10 and 11). Estimates of strays in the recreational harvest fishery upstream of LGD are a subset of the harvest estimates included in Table 7. In some recovery areas these represent minimum estimates as it is unfeasible to survey all tributaries that these fish may enter.

The highest stray rate observed were OX and PAH stock releases from Magic Valley and Niagara Springs fish hatcheries. Angler harvest data indicates that most of the strays were fish from Salmon River release groups caught in the Snake River upstream of the mouth of the Salmon River (River Section 2), and fish from Little Salmon River release groups caught in the Salmon River upstream of the mouth of the Little Salmon River (River Sections 12 and 13).

Table 10. Stray estimates of adult hatchery steelhead from Idaho LSRCP and IPC brood year 2009 releases observed at hatchery racks and fisheries in tributaries of the Columbia and Snake rivers. Summary includes ad-clipped and ad-intact release groups.

Facility	Stock	Ocean Age	Columbia River Below McNary Dam		Columbia 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 <sup>1</sup>	1	0	0	0	0	0	0	0	0	0
		2	0	0	0	0	0	0	0	0	0
		3	0	0	0	0	0	0	0	0	0
	<b>DWOR Total</b>		<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>Clearwater Total</b>			<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
Hagerman	EFNAT <sup>1</sup>	1	0	0	0	0	0	0	0	0	0
		2	0	0	0	0	0	0	0	0	0
		3	0	0	0	0	0	0	0	0	0
	<b>EFNAT Total</b>		<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
Hagerman	SAW <sup>1</sup>	1	0	13	0	0	0	0	0	0	13
		2	0	3	3	0	0	0	0	0	6
		3	0	0	0	0	0	0	0	0	0
	<b>SAW Total</b>		<b>0</b>	<b>16</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>19</b>
<b>Hagerman Total</b>			<b>0</b>	<b>16</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>19</b>	
Magic Valley	DWOR <sup>1</sup>	1	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	0
		2	0	0	0	0	0	0	73	0	73
		3	0	0	0	0	0	0	0	0	0
	<b>DWOR Total</b>		<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>73</b>	<b>0</b>	<b>73</b>
	PAH	1	0	2	15	3	0	3	229	0	252
		2	0	0	0	0	0	4	0	0	4
3		0	0	0	0	0	0	0	0	0	
<b>PAH Total</b>		<b>0</b>	<b>2</b>	<b>15</b>	<b>3</b>	<b>0</b>	<b>7</b>	<b>229</b>	<b>0</b>	<b>256</b>	
SAW	1	0	0	0	0	0	0	0	0	0	

Facility	Stock	Ocean Age	Columbia River Below McNary Dam		Columbia 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	
		2	0	0	0	0	0	0	0	0	0
		3	0	0	0	0	0	0	0	0	0
	<b>SAW Total</b>		<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
		1	0	0	0	1	0	0	0	0	1
	USAL <sup>1</sup>	2	0	0	0	1	0	0	0	0	1
		3	0	0	0	0	0	0	0	0	0
	<b>USAL Total</b>		<b>0</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2</b>
<b>Magic Valley Total</b>			<b>0</b>	<b>2</b>	<b>15</b>	<b>5</b>	<b>0</b>	<b>7</b>	<b>302</b>	<b>0</b>	<b>331</b>
		1	0	0	0	0	0	0	106	0	106
	OX	2	0	0	12	0	0	0	136	0	148
		3	0	0	0	0	0	0	42	0	42
	<b>OX Total</b>		<b>0</b>	<b>0</b>	<b>12</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>284</b>	<b>0</b>	<b>296</b>
<b>Niagara Springs</b>											
		1	22	10	0	0	0	10	256	0	298
	PAH	2	0	10	0	10	0	0	183	0	203
		3	0	0	0	0	0	0	0	0	0
	<b>PAH Total</b>		<b>22</b>	<b>20</b>	<b>0</b>	<b>10</b>	<b>0</b>	<b>10</b>	<b>439</b>	<b>0</b>	<b>501</b>
<b>Niagara Springs Total</b>			<b>22</b>	<b>20</b>	<b>12</b>	<b>10</b>	<b>0</b>	<b>10</b>	<b>723</b>	<b>0</b>	<b>797</b>
<b>Grand Total</b>			<b>22</b>	<b>38</b>	<b>30</b>	<b>15</b>	<b>0</b>	<b>17</b>	<b>1,025</b>	<b>0</b>	<b>1,147</b>

<sup>1</sup> All or part of these fish were released with intact adipose fins (see Table 5), are therefore not subject to harvest in mark selective fisheries.

Table 11. Stray rates of adult hatchery steelhead from Idaho LSRCP and IPC brood year 2009 releases. Summary includes ad-clipped and ad-intact release groups.

		Downstream of Lower Granite Dam			Upstream of Lower Granite Dam			Combined	
Facility	Stock	Return	Strays	Stray Rates (%)	Return	Strays	Stray Rates (%)	Total Strays	Total Stray Rates (%)
Clearwater	DWOR	14,626	0	0.0%	13,177	0	0.0%	0	0.0%
<b>Clearwater Total</b>		<b>14,626</b>	<b>0</b>	<b>0.0%</b>	<b>13,177</b>	<b>0</b>	<b>0.0%</b>	<b>0</b>	<b>0.0%</b>
Hagerman	EFNAT	915	0	0.0%	817	0	0.0%	0	0.0%
	SAW	23,219	19	0.1%	19,237	0	0.0%	19	0.1%
<b>Hagerman Total</b>		<b>24,134</b>	<b>19</b>	<b>0.1%</b>	<b>20,054</b>	<b>0</b>	<b>0.0%</b>	<b>19</b>	<b>0.1%</b>
Magic Valley	DWOR	5,580	0	0.0%	5,281	73	1.4%	73	1.3%
	PAH	15,059	27	0.2%	12,947	229	1.8%	256	1.7%
	SAW	2,256	0	0.0%	1,952	0	0.0%	0	0.0%
	USAL	478	2	0.4%	468	0	0.0%	2	0.4%
<b>Magic Valley Total</b>		<b>23,373</b>	<b>29</b>	<b>0.1%</b>	<b>20,648</b>	<b>302</b>	<b>1.5%</b>	<b>331</b>	<b>1.4%</b>
Niagara Springs	OX	21,017	12	0.1%	15,627	284	1.8%	296	1.4%
	PAH	25,907	62	0.2%	21,669	439	2.0%	501	1.9%
<b>Niagara Springs Total</b>		<b>46,924</b>	<b>74</b>	<b>0.2%</b>	<b>37,296</b>	<b>723</b>	<b>1.9%</b>	<b>797</b>	<b>1.7%</b>
<b>Grand Total</b>		<b>109,057</b>	<b>122</b>	<b>0.1%</b>	<b>91,175</b>	<b>1,025</b>	<b>1.1%</b>	<b>1,147</b>	<b>1.1%</b>

### **Brood Year Reconstruction, Smolt-to-Adult Survival Rates, Smolt-to Adult Return Rates, and Progeny-to-Parent Ratios**

Steelhead from BY09 returned to fresh water as adults across three return years (2011-12, 2012-13, and 2013-14). Adult returns to the Columbia River mouth included 62,133 fish from the three Lower Snake River Compensation Plan funded facilities (Clearwater, Hagerman, and Magic Valley fish hatcheries) and 46,924 from the Idaho Power funded program at Niagara Springs Fish Hatchery (Table 12). Adult returns to the project area upstream of Lower Granite Dam included 53,879 fish from the three LSRCP facilities, and 37,296 fish from the Idaho Power program.

Smolt to adult survival rates (SAS) is defined as the percent of smolts released that returned as adults to the Columbia River mouth. The SAS of the combined smolt release and return of adults from all four facilities was 1.9% (Table 12). The SAS of the combined smolt release and return of adults from all three LSRCP funded facilities was 1.6%, and the SAS for Niagara Springs Fish Hatchery was 2.6%.

Smolt to adult return rate (SAR) is defined as the percent of smolts released that returned as adults to the project area upstream of LGD. The SAR of the combined smolt release and return of adults from all four facilities was 1.6% (Table 12). The SAR values for all three LSRCP funded facilities ranged from 1.3% to 1.5%, which exceeds the SAR value required to meet minimum escapement objectives to the project area. The SAR for Niagara Springs Fish Hatchery was 2.1%.

Progeny to parent ratio (PPR) of adult steelhead returning to the mouth of the Columbia River ranged from 52.6 for DWOR stock releases from Clearwater to 8.9 for the EFNAT stock released into the East Fork Salmon River from brood year 2009 spawners (Table 12). Minimum PPR values needed to meet total adult return LSRCP mitigation goals are approximately 123 for Clearwater Fish Hatchery, 52 for Hagerman National Fish Hatchery, and 44 for Magic Valley Fish Hatchery. The PPR from Niagara Springs releases was 41.5, which exceeds the minimum PPR value of 34 needed for that facility to meet performance expectations similar to LSRCP facilities.

All brood year 2009 smolt release groups were represented with PIT tags at the stock level. 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 13). The total adult return estimate from all four hatchery facilities to Bonneville Dam based on PIT tag detections was 119,942 fish compared to 109,057 fish estimated using the traditional run reconstruction methodology. At LGD, the total estimate based on PIT tag detections was 83,940 fish compared to 91,175 fish estimate based on run reconstruction methodologies. Although the differences in the total estimates between the methodologies were not substantial, the differences at the rearing hatchery and stock level were inconsistent and substantiate the need for using a methodology that provides a higher level of confidence in the accuracy and precision of the estimate. 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 12. Brood Year 2009 summary of total adult returns, smolt-to-adult survival rates (SAS), parent-to-progeny 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 rate (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	Downstream of Lower Granite Dam					Upstream of Lower Granite Dam					Unharvested Escapement
			Total Adult Return	SAS (%)	PPR	Harvest	Strays	Adults to LGD	SAR (%)	Harvest	Trap	Strays <sup>1</sup>	
<b>Clearwater</b>													
DWOR <sup>2</sup>	278	854,960	14,626	1.7	52.6	1,449	0	13,177	1.5	11,001	244	0	1,932
<b>Total</b>	<b>278</b>	<b>854,960</b>	<b>14,626</b>	<b>1.7</b>	<b>52.6</b>	<b>1,449</b>	<b>0</b>	<b>13,177</b>	<b>1.5</b>	<b>11,001</b>	<b>244</b>	<b>0</b>	<b>1,932</b>
<b>Hagerman</b>													
EFNAT <sup>2,3</sup>	103	120,918	915	0.8	8.9	98	0	817	0.7	19	36	0	762
SAW <sup>1</sup>	695	1,290,915	23,219	1.8	33.4	3,963	19	19,237	1.5	11,466	4,729	0	3,042
<b>Total</b>	<b>798</b>	<b>1,411,833</b>	<b>24,134</b>	<b>1.7</b>	<b>30.2</b>	<b>4,061</b>	<b>19</b>	<b>20,054</b>	<b>1.4</b>	<b>11,485</b>	<b>4,765</b>	<b>0</b>	<b>3,804</b>
<b>Magic Valley</b>													
DWOR	273	864,239	5,580	0.6	20.4	298	0	5,281	0.6	1,577	14	73	3,690
PAH	297	522,630	15,059	2.9	50.7	2,085	27	12,947	2.5	6,629	0	229	6,317
SAW	64	117,883	2,256	1.9	35.3	304	0	1,952	1.7	1,343	0	0	609
USAL <sup>2</sup>	47	95,023	478	0.5	10.2	8	2	468	0.5	6	460	0	2
<b>Total</b>	<b>681</b>	<b>1,599,775</b>	<b>23,373</b>	<b>1.5</b>	<b>34.3</b>	<b>2,696</b>	<b>29</b>	<b>20,648</b>	<b>1.3</b>	<b>9,556</b>	<b>474</b>	<b>302</b>	<b>10,620</b>
<b>Niagara Springs</b>													
OX	516	811,266	21,017	2.6	40.7	5,378	12	15,627	1.9	10,861	4,766	284	0
PAH	614	978,529	25,907	2.6	42.2	4,175	62	21,669	2.2	12,412	8,603	439	654
<b>Total</b>	<b>1,130</b>	<b>1,789,795</b>	<b>46,924</b>	<b>2.6</b>	<b>41.5</b>	<b>9,553</b>	<b>74</b>	<b>37,296</b>	<b>2.1</b>	<b>23,273</b>	<b>13,369</b>	<b>723</b>	<b>654</b>
<b>Grand Total</b>	<b>2,887</b>	<b>5,656,363</b>	<b>109,057</b>	<b>1.9</b>	<b>37.8</b>	<b>17,760</b>	<b>122</b>	<b>91,175</b>	<b>1.6</b>	<b>55,315</b>	<b>18,852</b>	<b>1,025</b>	<b>17,008</b>

<sup>1</sup> Strays upstream of Lower Granite Dam are a subset of harvest and trap estimates in this table.

<sup>2</sup> 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.

<sup>3</sup> Number trapped does not include fish of hatchery origin released upstream of the weir.

Table 13. Adult steelhead escapement estimates to Bonneville Dam and to Lower Granite Dam based on traditional run reconstruction methods compared to the expansion of PIT tag detections in the adult ladders.

Hatchery	Stock	Run Reconstruction Estimate		Total PIT Tags Released	PIT Tag Detection Expansion Estimate	
		Bonneville	Lower Granite		Bonneville	Lower Granite
Clearwater	DWOR	14,626	13,177	23,602	14,546	10,374
<b>Clearwater Total</b>		<b>14,626</b>	<b>13,177</b>	<b>23,602</b>	<b>14,546</b>	<b>10,374</b>
Hagerman	EFNAT	915	817	6,804	1,652	1,315
	SAW	23,219	19,234	21,128	23,391	15,955
<b>Hagerman Total</b>		<b>24,134</b>	<b>20,054</b>	<b>27,932</b>	<b>25,044</b>	<b>17,270</b>
Magic Valley	DWOR	5,580	5,281	14,424	2,097	1,604
	PAH	15,059	12,947	9,046	10,893	7,884
	SAW	2,256	1,952	2,097	2,577	1,613
	USAL	478	468	7,172	868	607
<b>Magic Valley Total</b>		<b>23,373</b>	<b>20,648</b>	<b>32,739</b>	<b>16,435</b>	<b>11,708</b>
Niagara Springs	OX	21,017	15,627	12,543	30,282	20,867
	PAH	25,907	21,669	15,584	33,634	23,721
<b>Niagara Springs Total</b>		<b>46,924</b>	<b>37,296</b>	<b>28,127</b>	<b>63,916</b>	<b>44,588</b>
<b>Grand Total</b>		<b>109,057</b>	<b>91,175</b>	<b>112,400</b>	<b>119,942</b>	<b>83,940</b>

## **ACKNOWLEDGMENTS**

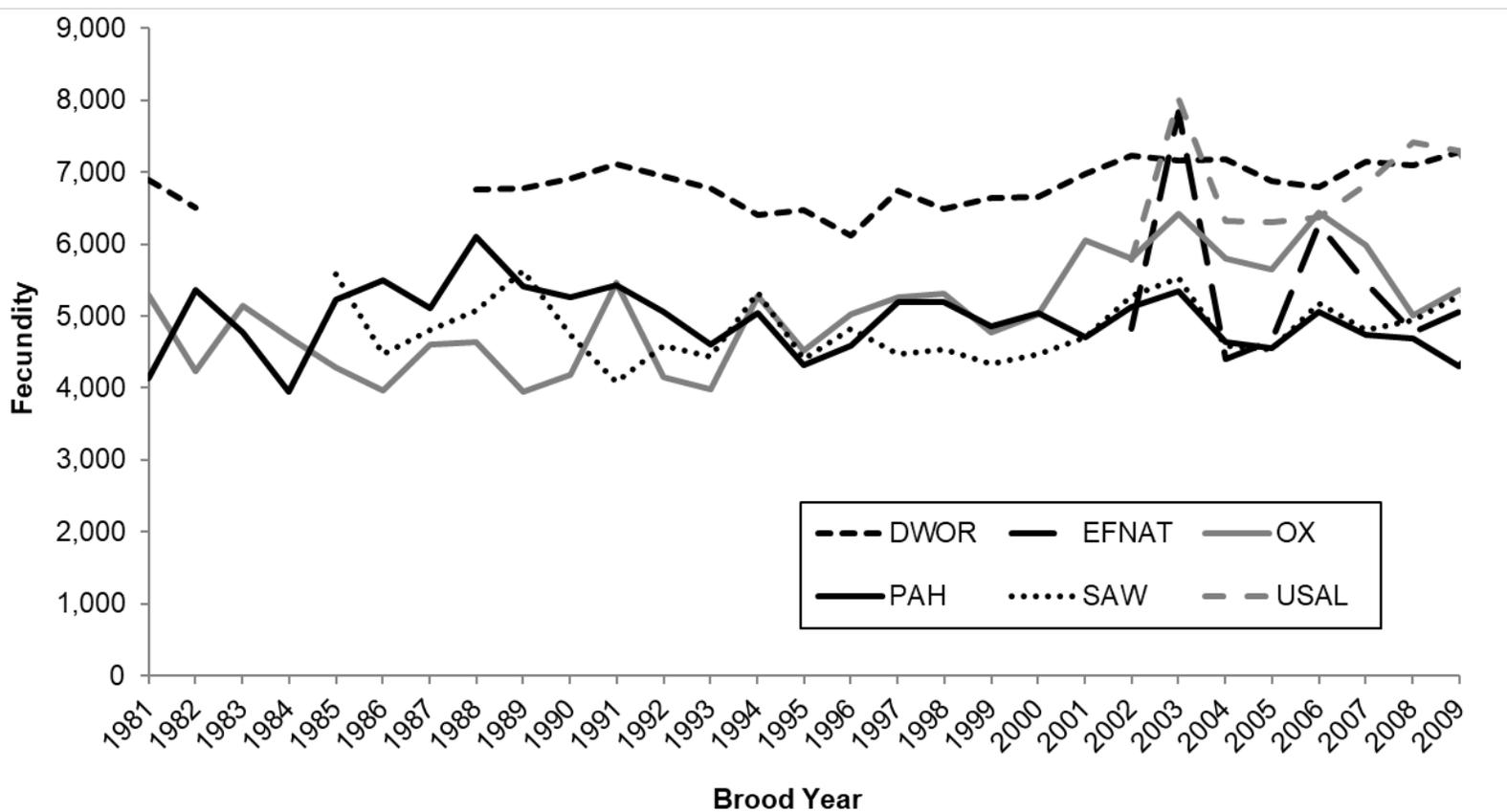
Staff from the Pacific States Marine Fisheries Commission provided assistance with data collection, proofing, summarization, and report compilation. A special thanks is extended to Cheryl Leben for completing the report formatting and editing, as well as to Brian Leth and Stuart Rosenberger for reviewing this report and providing feedback. 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.

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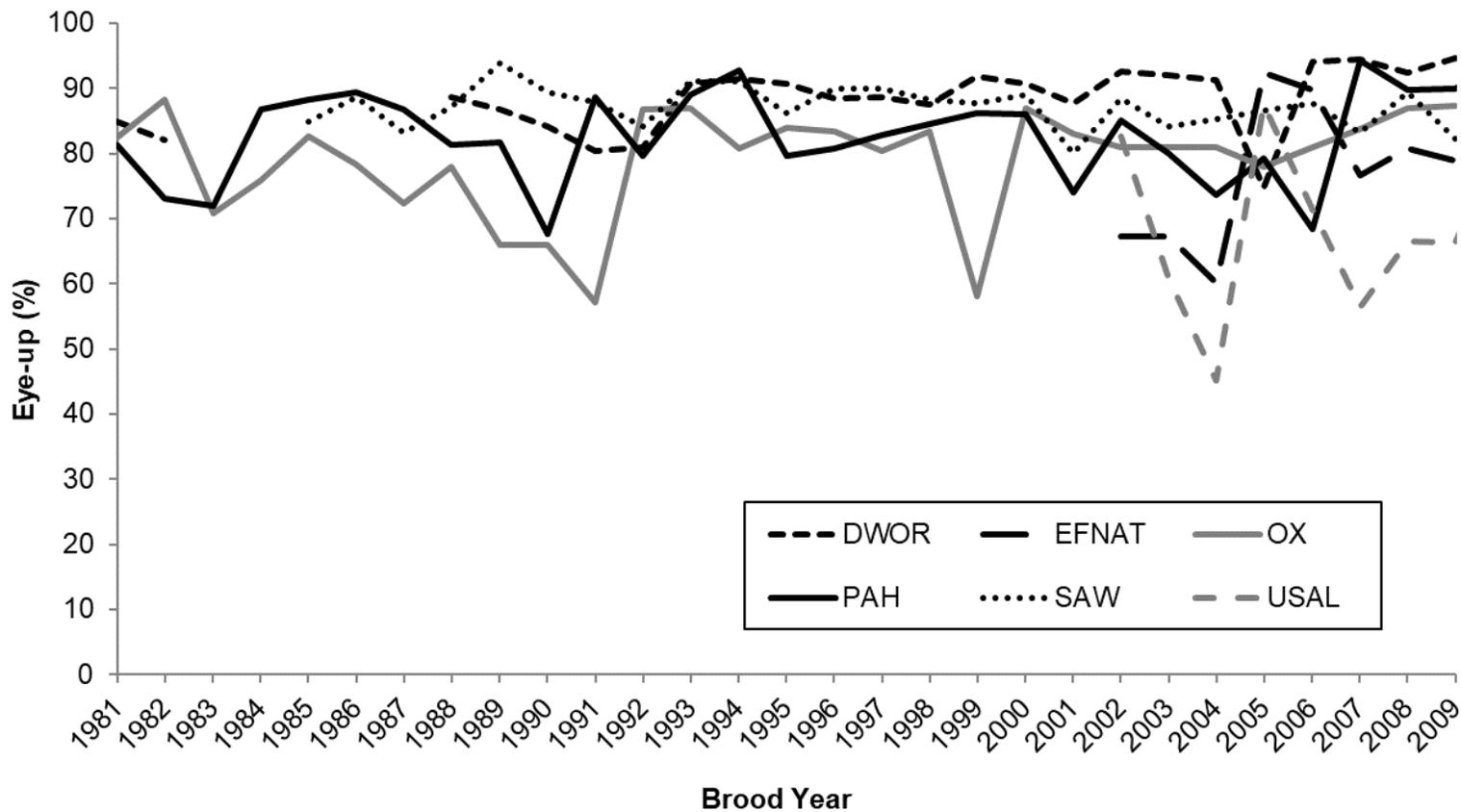
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## **APPENDICES**

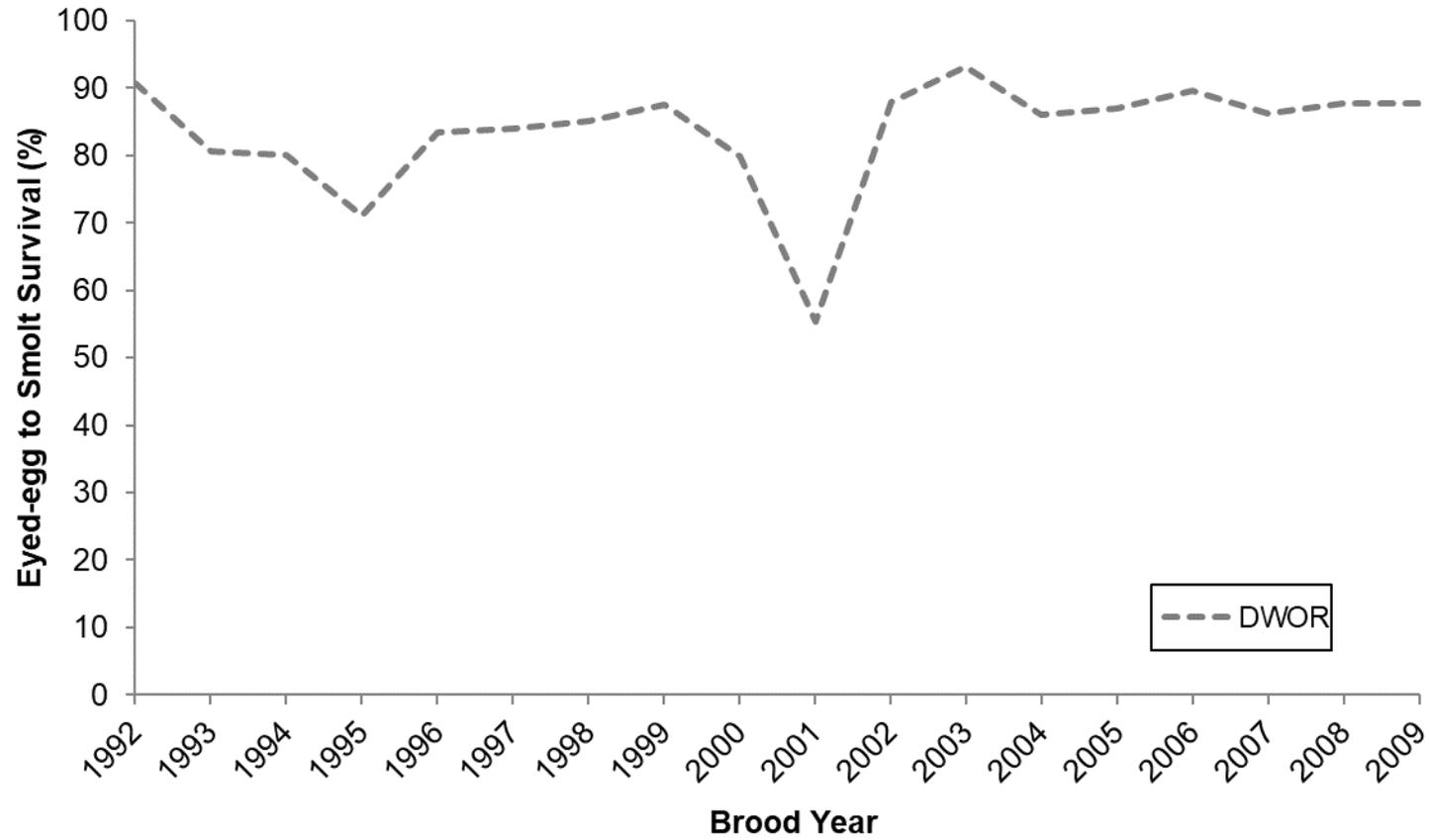
Appendix A. Fecundity rates by stock for steelhead reared at LSRCP and IPC hatchery facilities in Idaho for brood years 1981 through 2009.



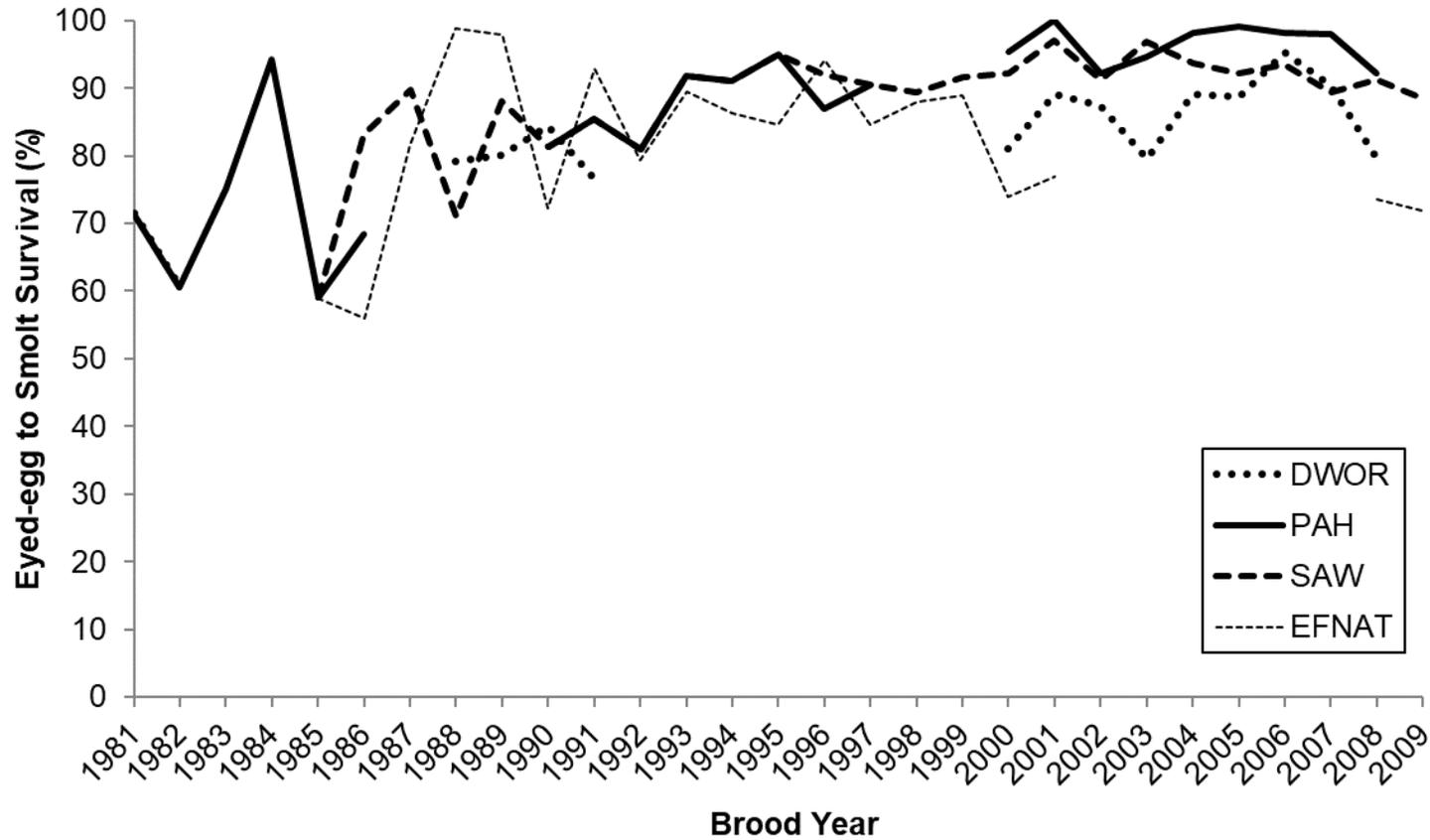
Appendix B. Eye-up rates by stock for steelhead production reared at LSRCP and IPC facilities in Idaho for brood years 1981 through 2009.



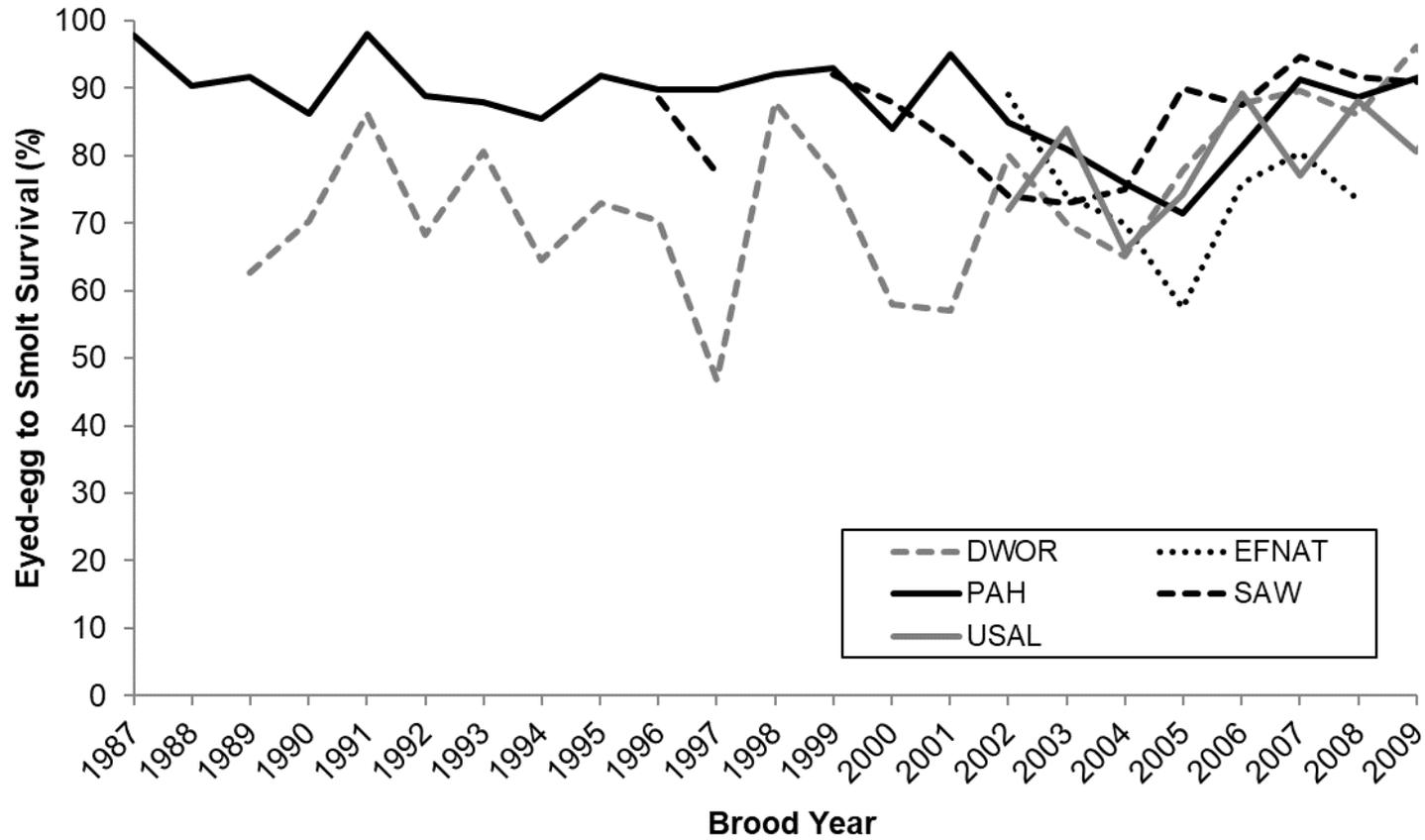
Appendix C1. Summary of onsite survival (eyed-egg to release) for production reared at Clearwater Fish Hatchery from brood year 1992 through 2009.



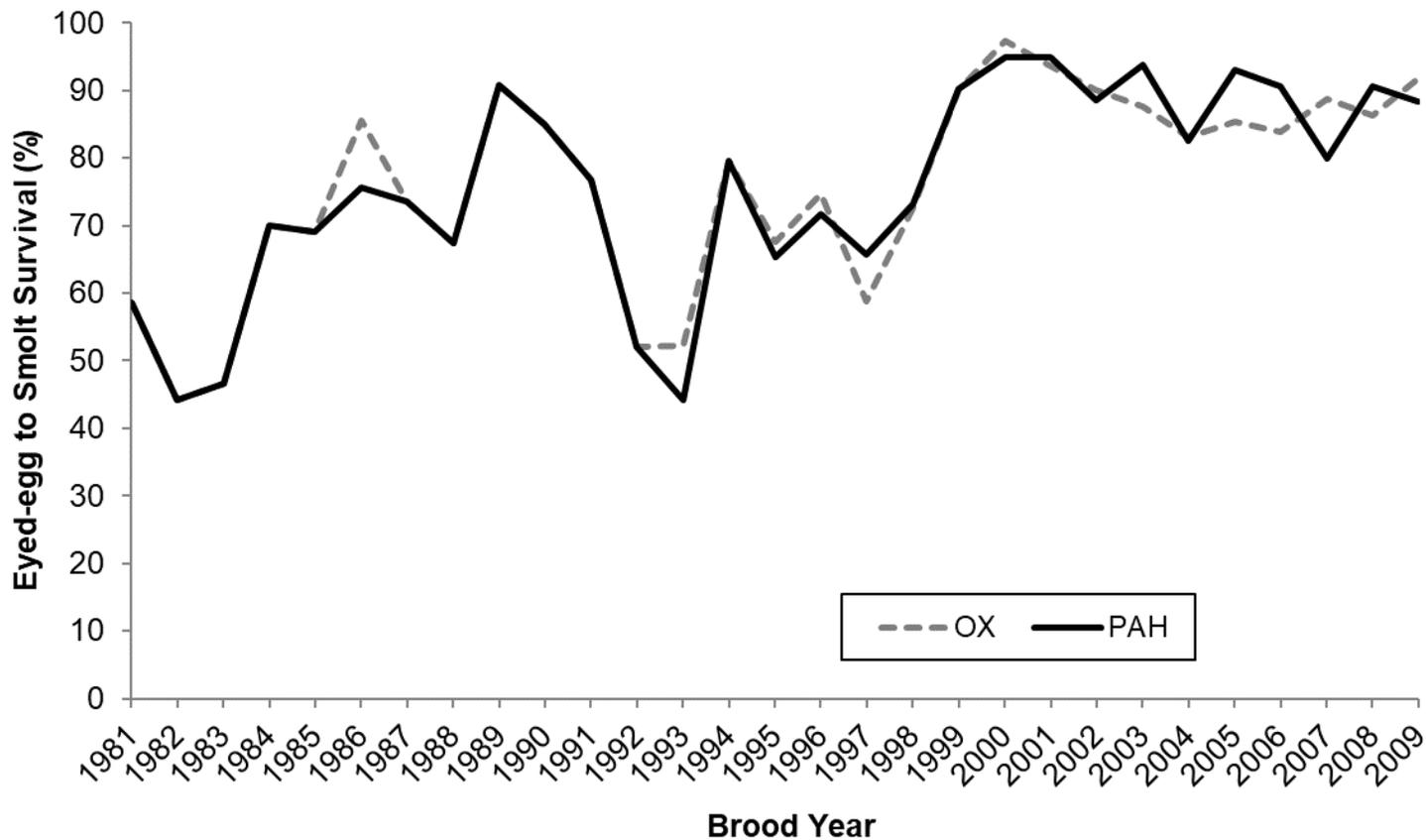
Appendix C2. Summary of onsite survival (eyed egg to release) by stock for production reared at Hagerman National Fish Hatchery from brood year 1987 through 2009.



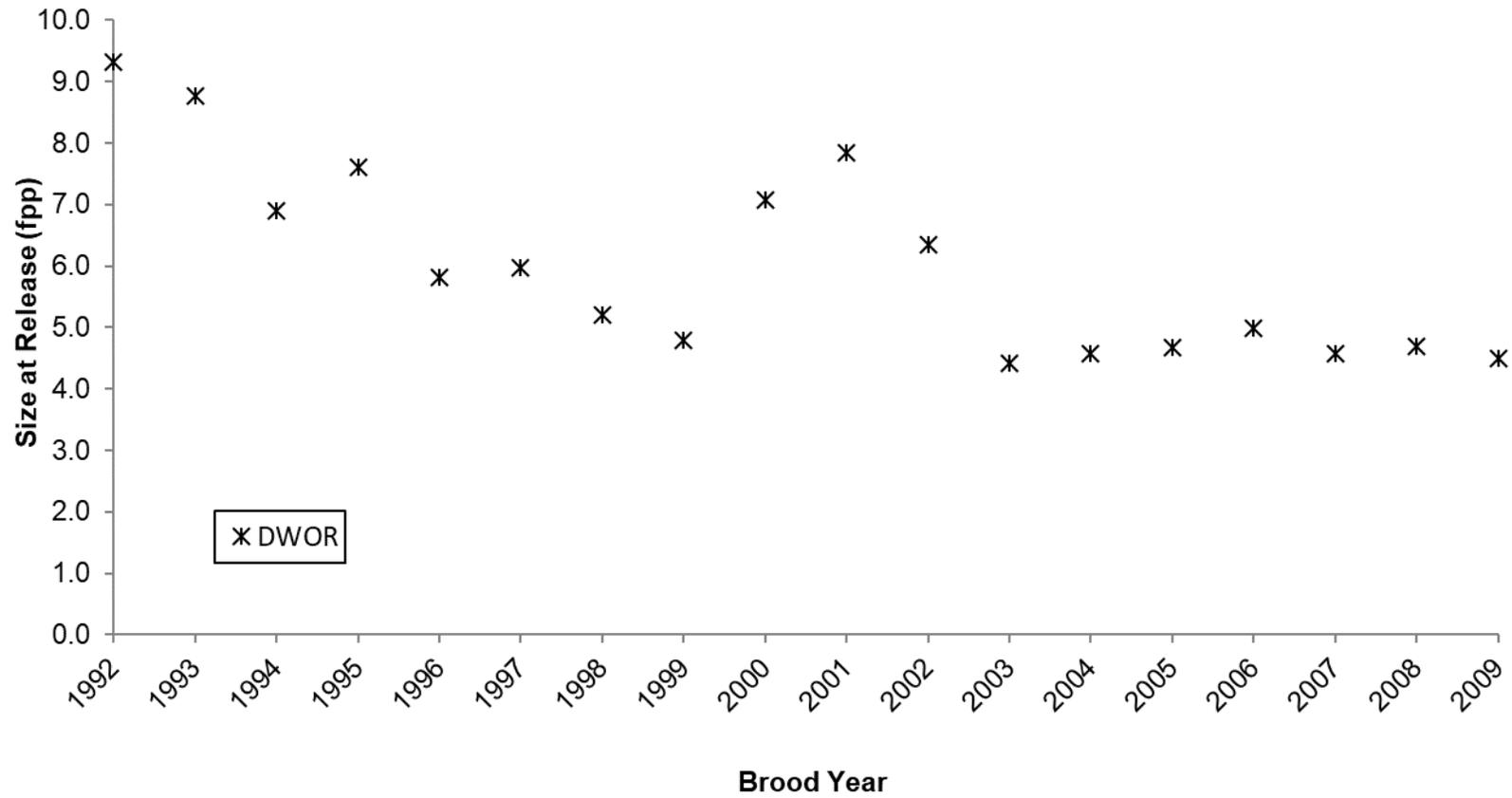
Appendix C3. Summary of onsite survival (eyed egg to release) by stock for production reared at Magic Valley Fish Hatchery from brood year 1987 through 2009.



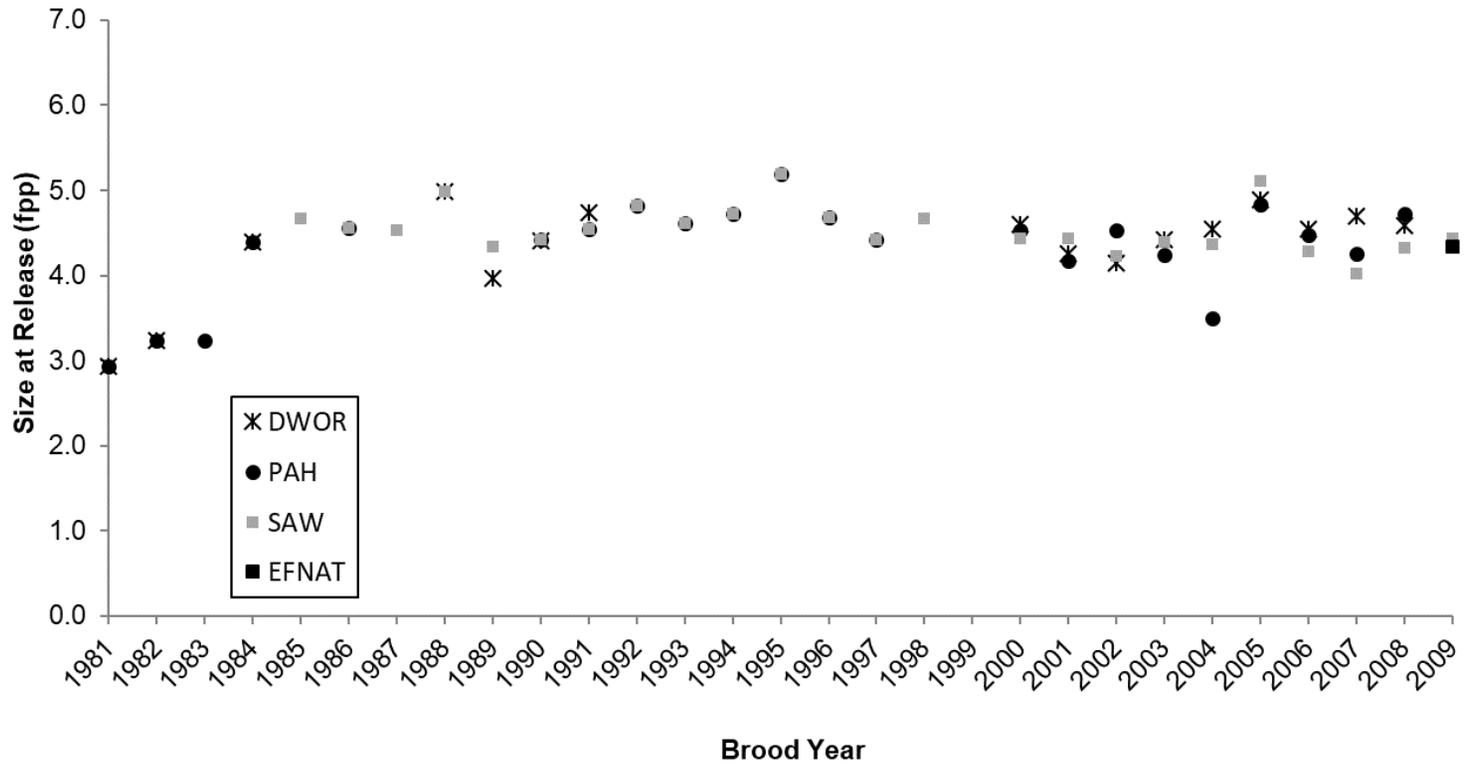
Appendix C4. Summary of onsite survival (eyed egg to release) by stock for production reared at Niagara Springs Fish Hatchery from brood year 1981 through 2009.



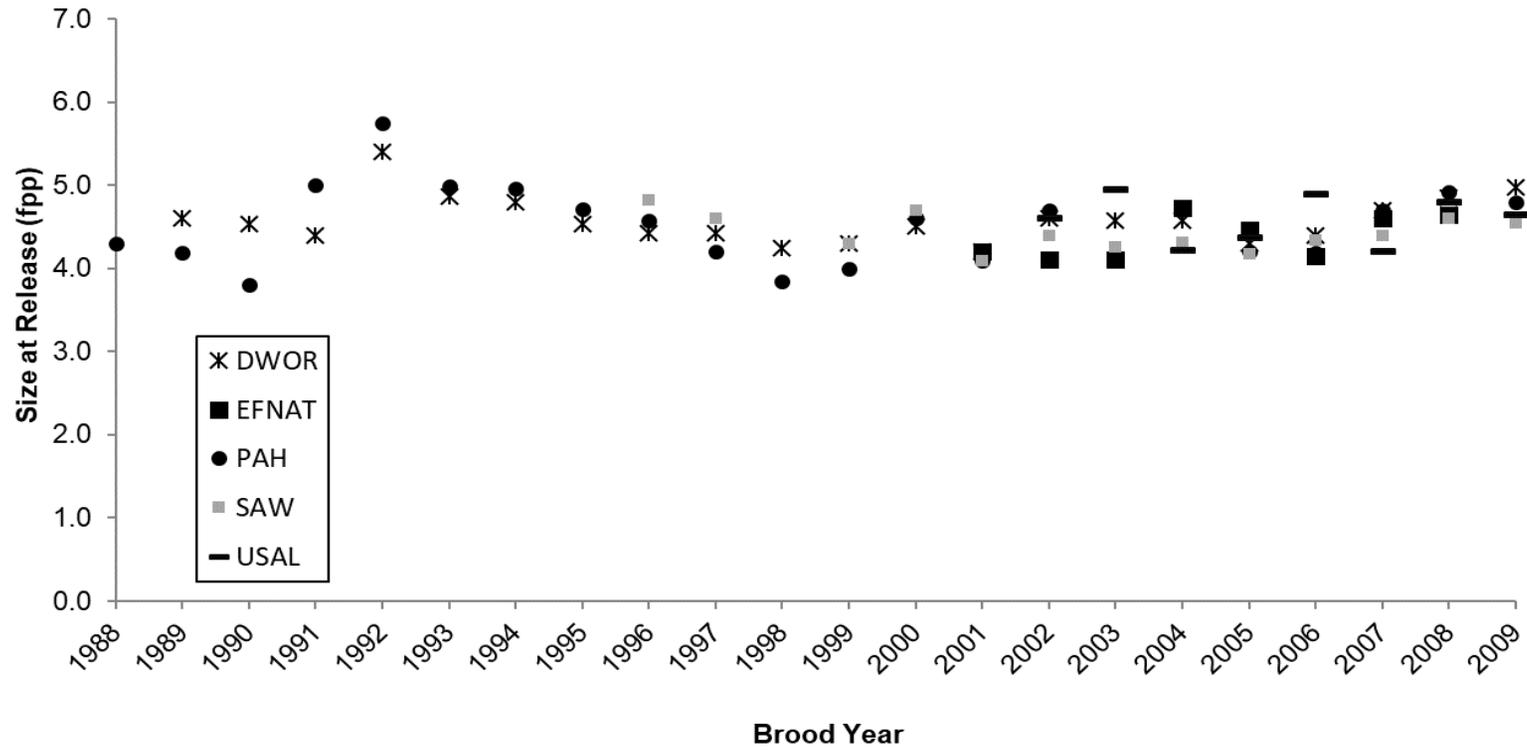
Appendix D1. Size at release (fish per pound [fpp]) for steelhead smolts reared at Clearwater Fish Hatchery from brood year 1992 through 2009.



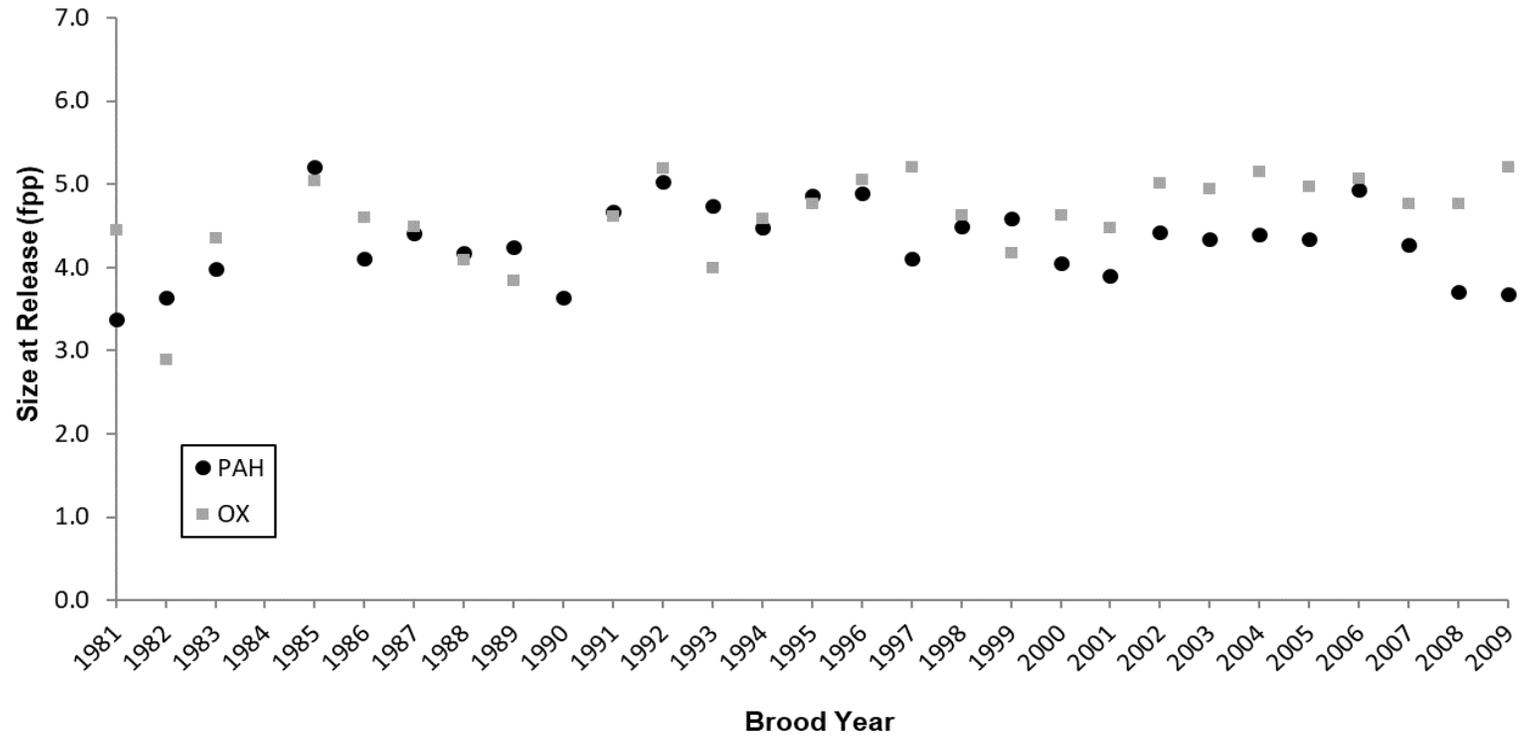
Appendix D2. Size at release (fish per pound [fpp]) for steelhead smolts reared at Hagerman National Fish Hatchery from brood year 1981 through 2009.



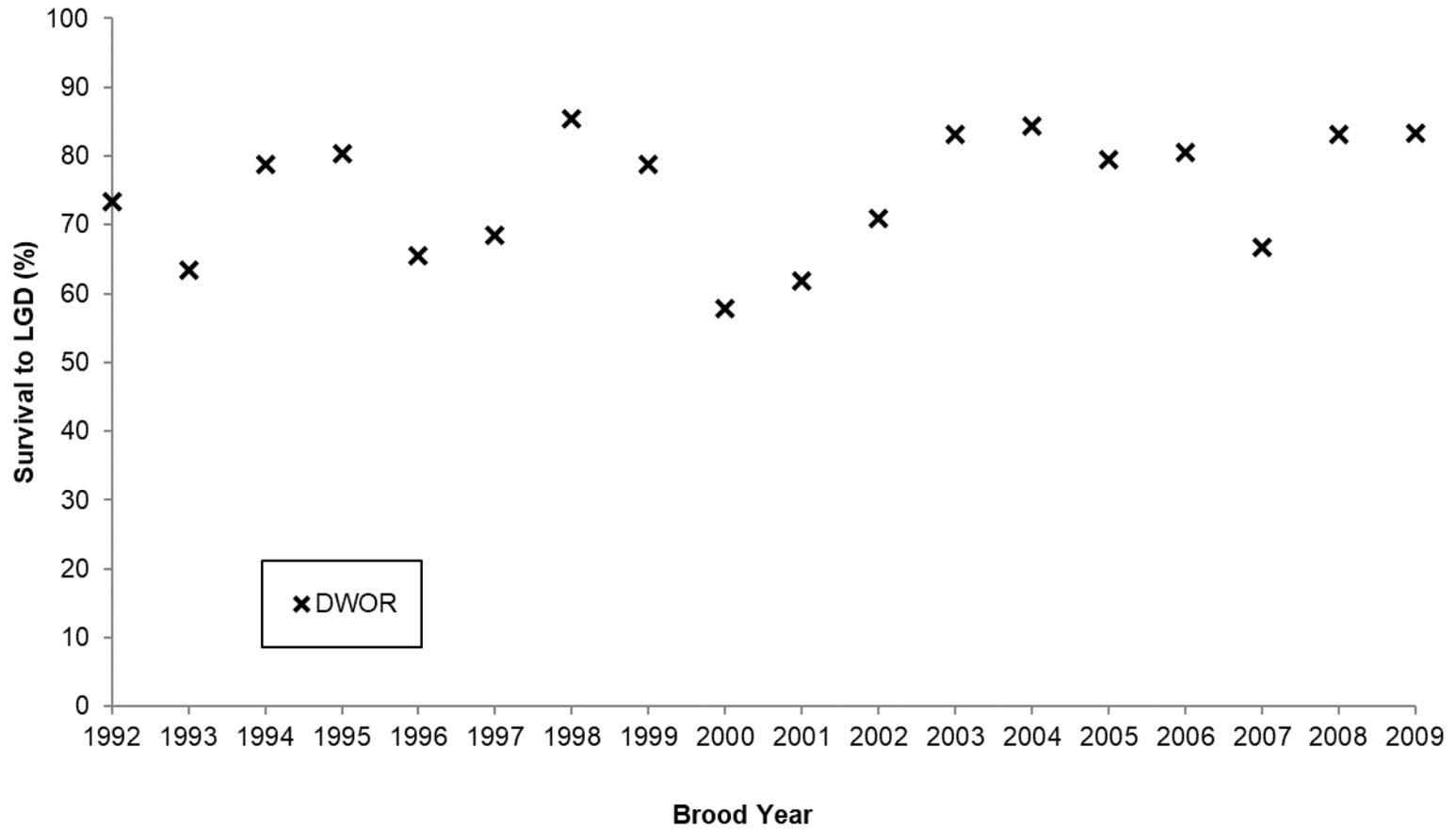
Appendix D3. Size at release (fish per pound [fpp]) for steelhead smolts reared at Magic Valley Fish Hatchery from brood year 1987 through 2009.



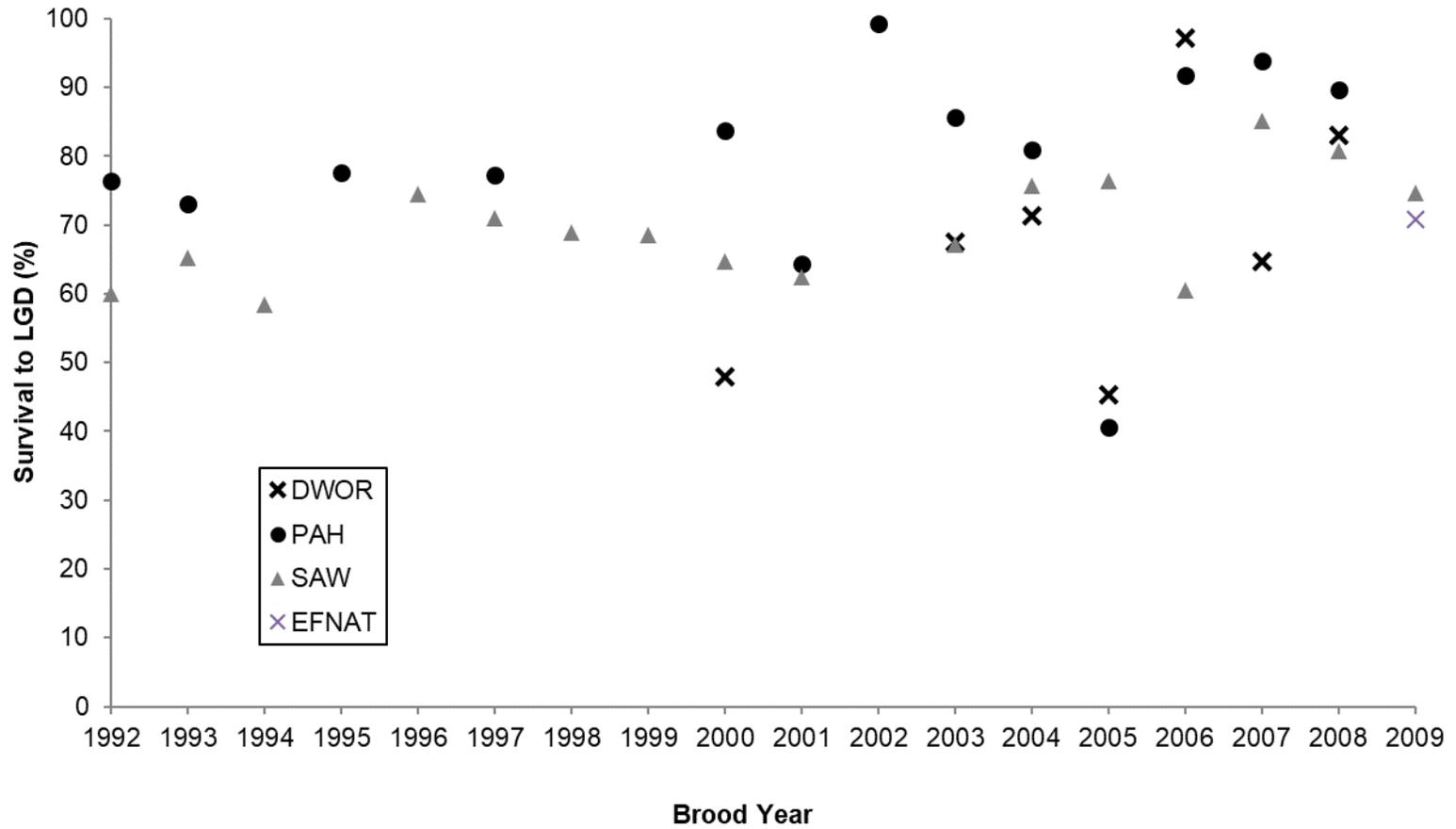
Appendix D4. Size at release (fish per pound [fpp]) for steelhead smolts reared at Niagara Springs Fish Hatchery from brood year 1981 through 2009.



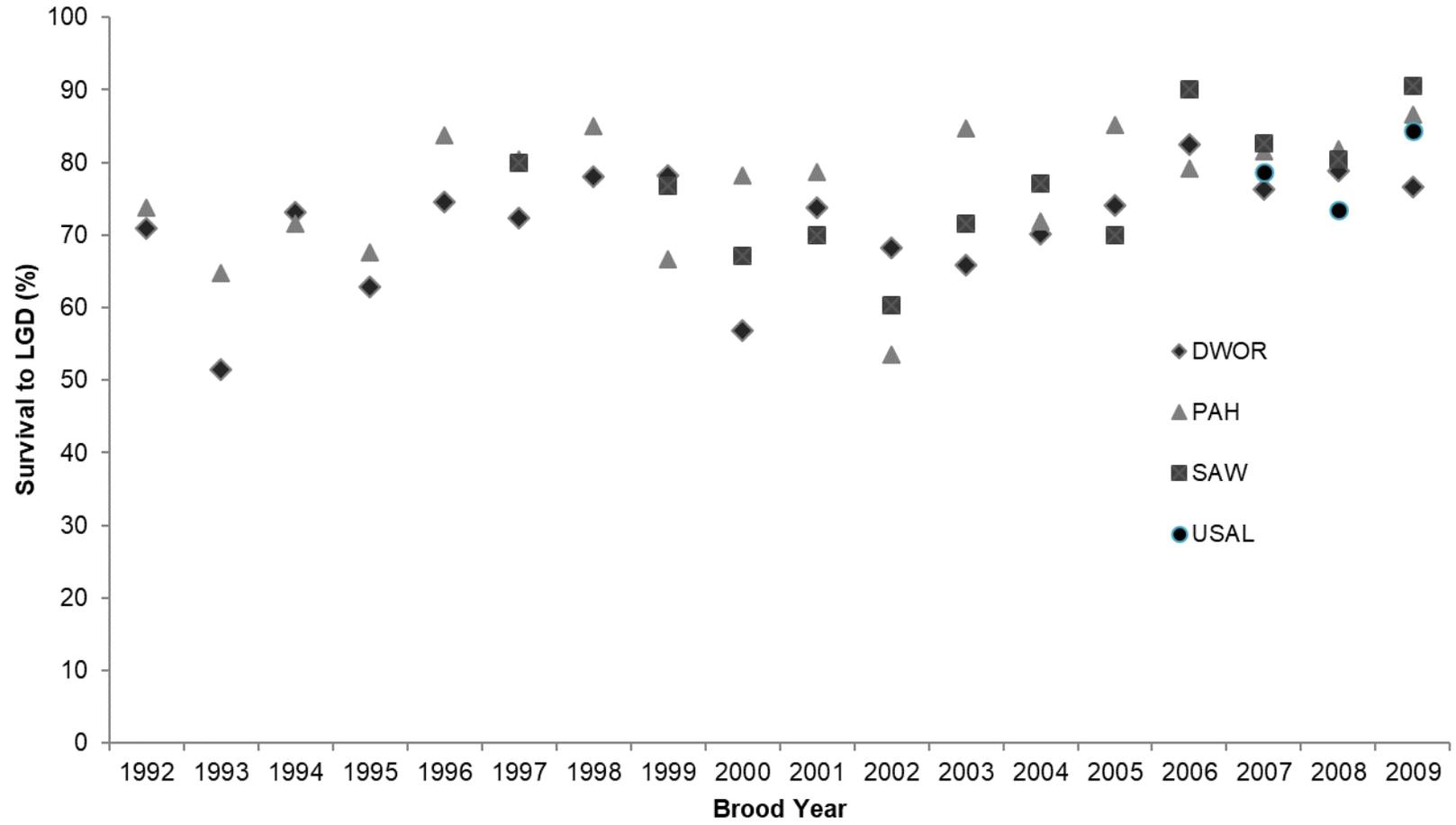
Appendix E1. Survival of smolts from release to Lower Granite Dam for steelhead released from Clearwater Fish Hatchery from brood year 1992 through 2009.



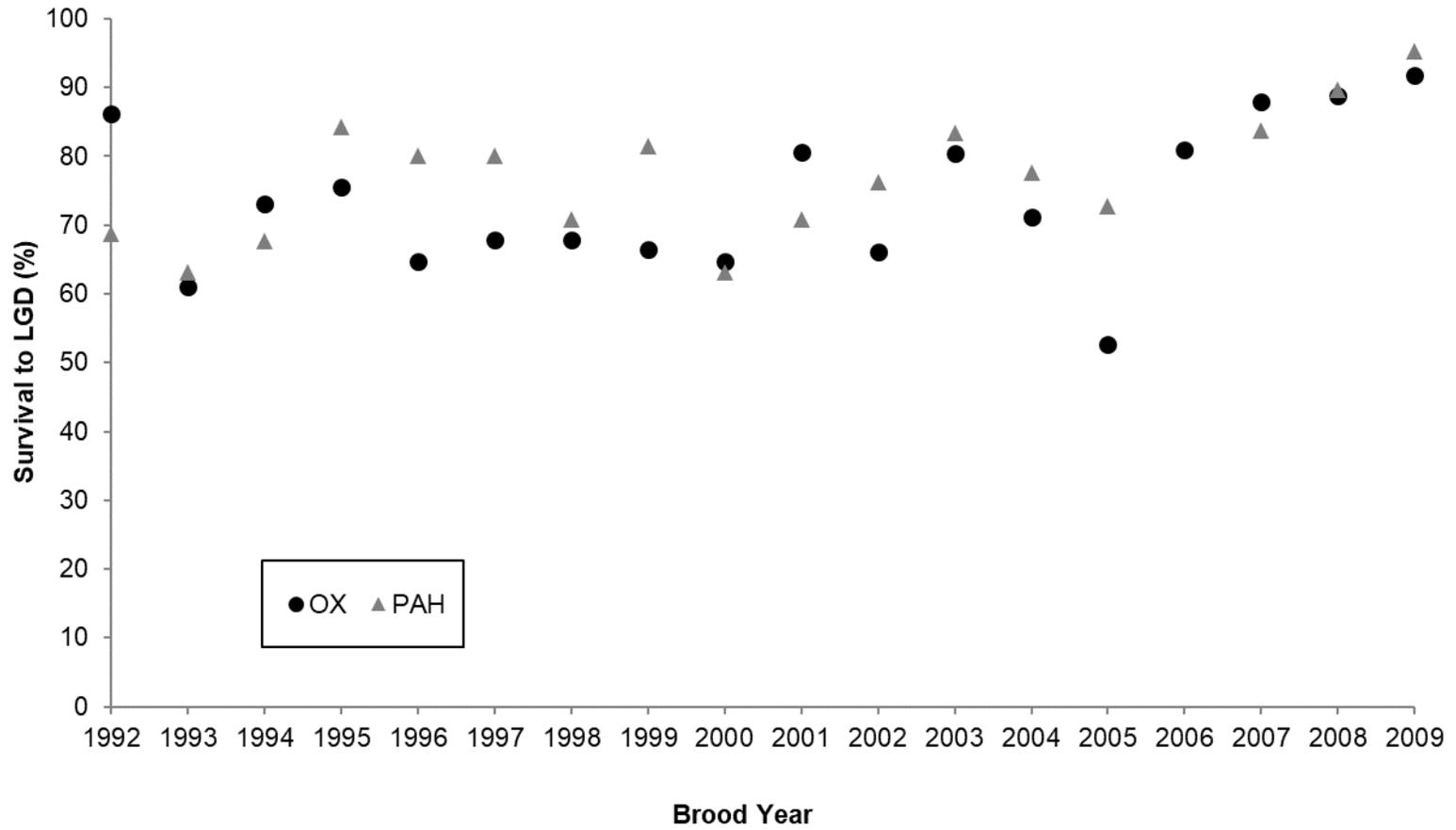
Appendix E2. Survival of smolts from release to Lower Granite Dam for steelhead released from Hagerman from brood year 1992 through 2009.



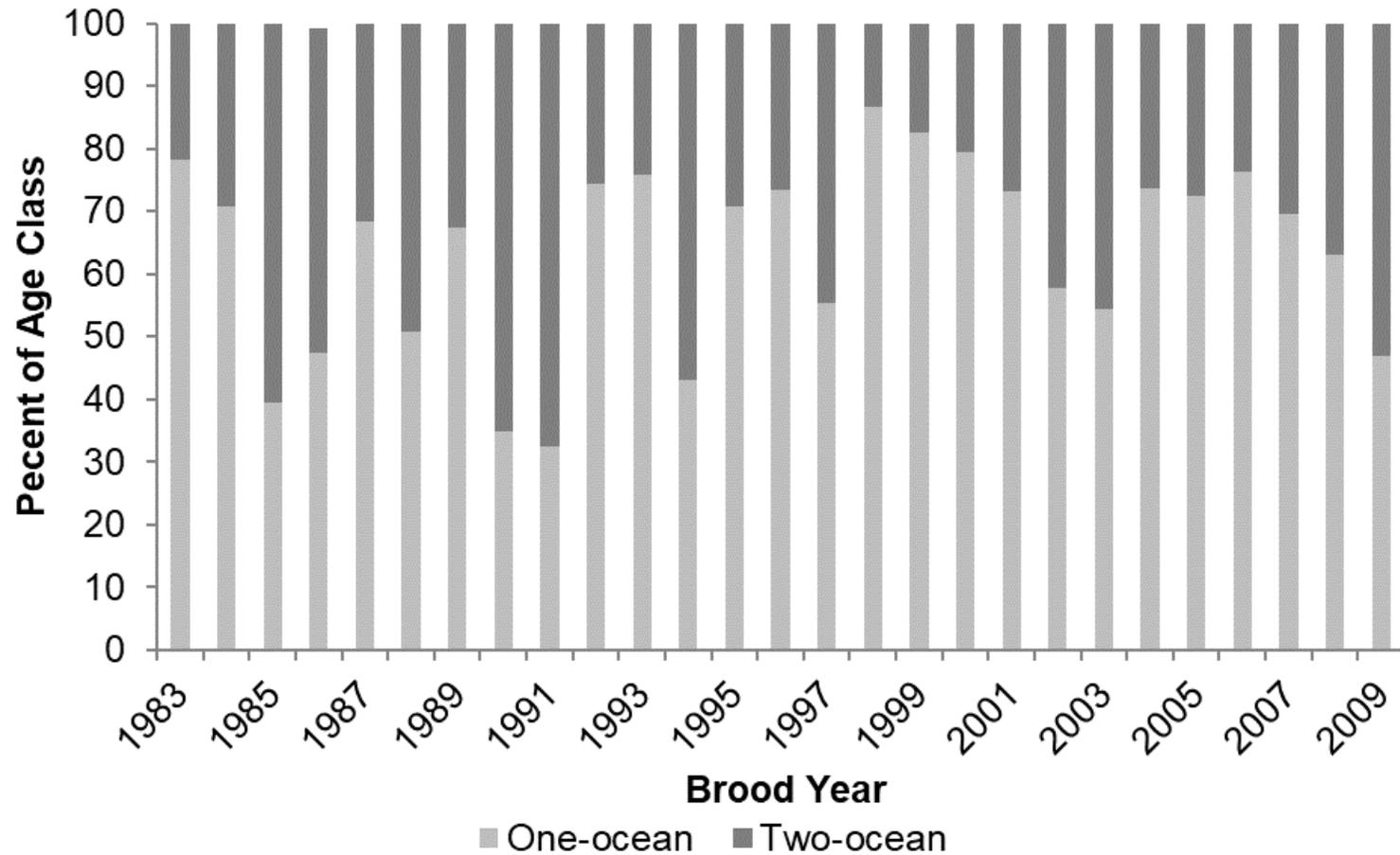
Appendix E3. Survival of smolts from release to Lower Granite Dam for steelhead released from Magic Valley Fish Hatchery from brood year 1992 through 2009.



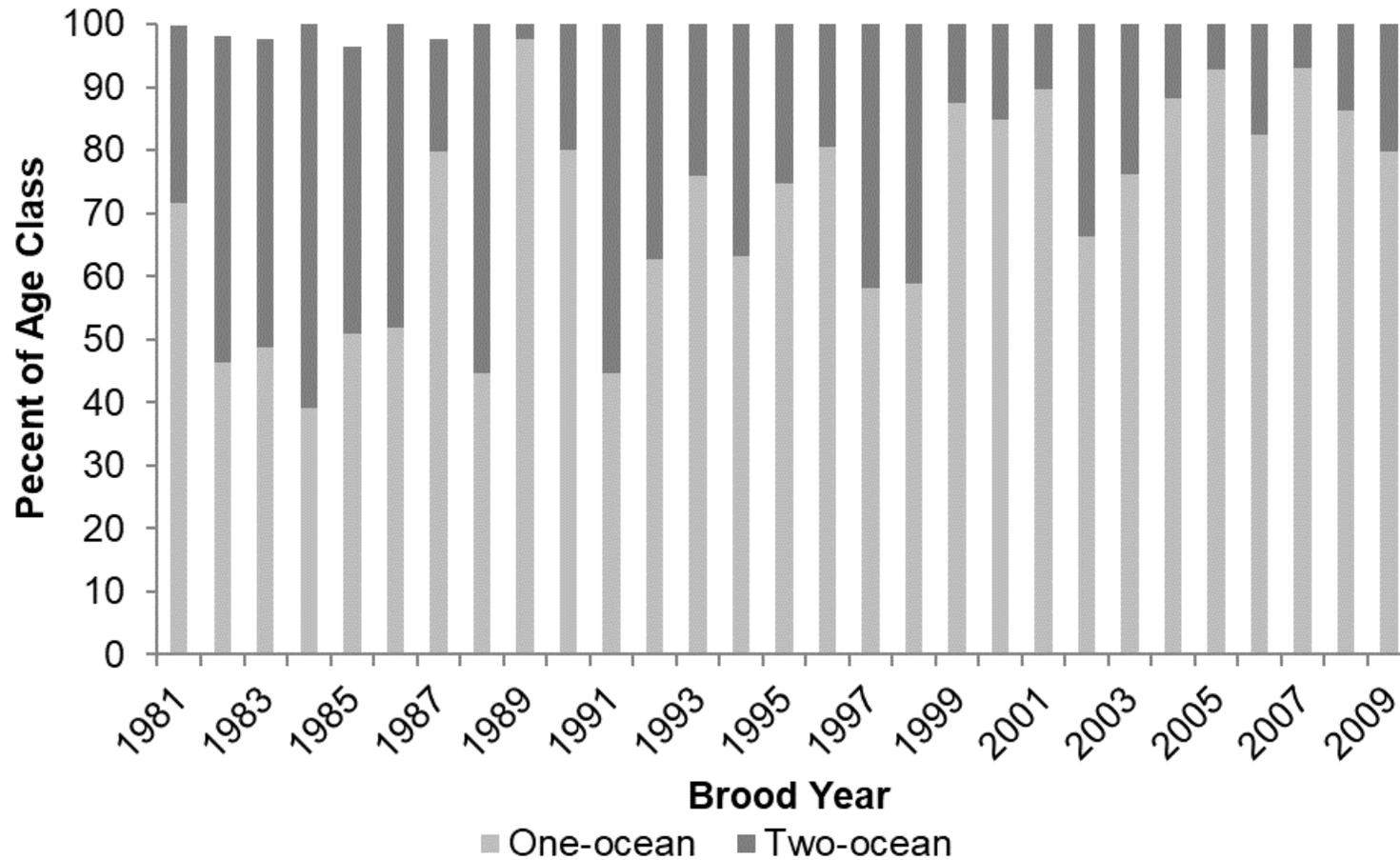
Appendix E4. Survival of smolts from release to Lower Granite Dam for steelhead released from Niagara Springs Fish Hatchery from brood year 1992 through 2009.



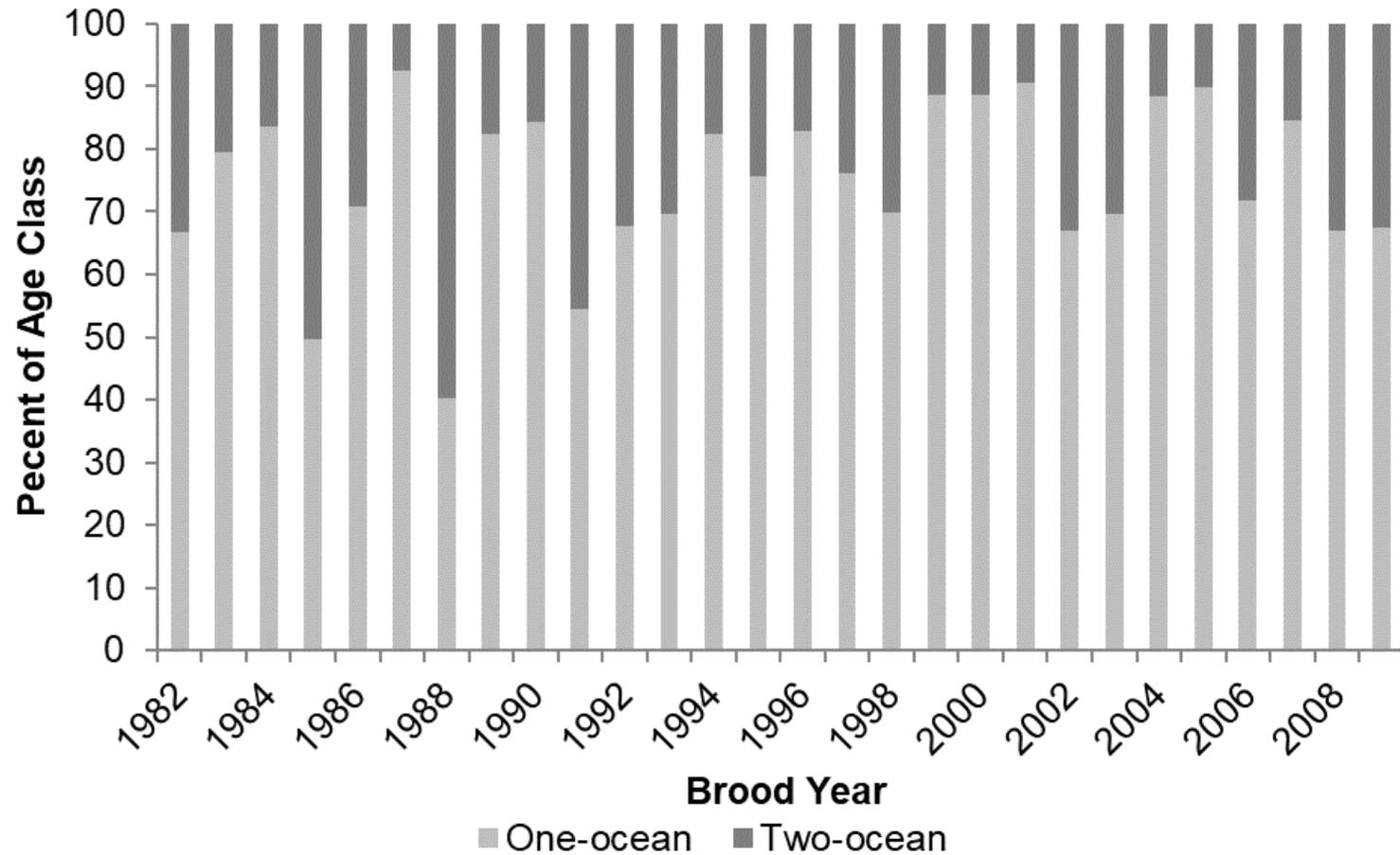
Appendix F1. Age composition for adult hatchery steelhead returning to the Hells Canyon Trap (OX stock) for brood years 1983 through 2009.



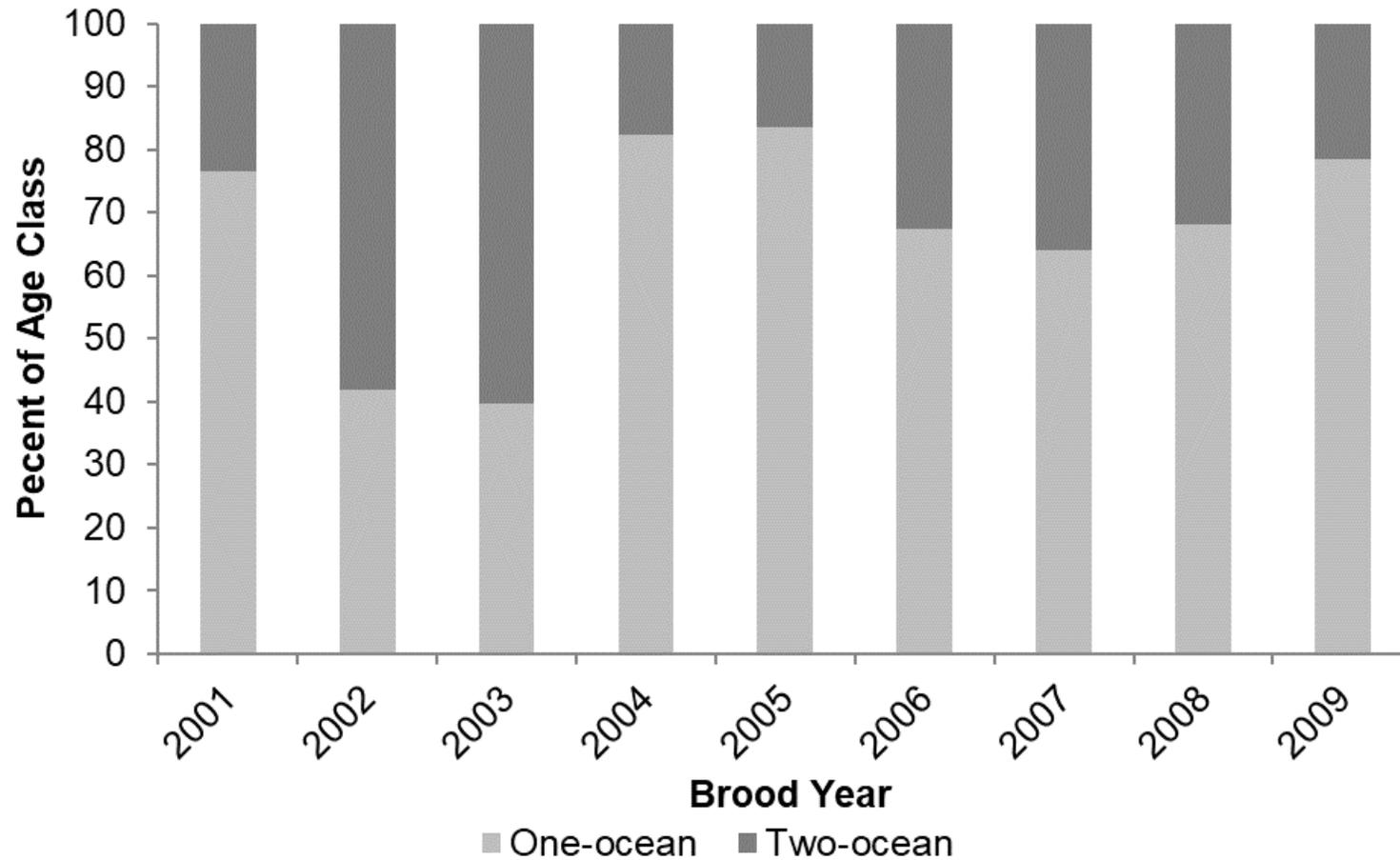
Appendix F2. Age composition for adult hatchery steelhead returning to Pahsimeroi Fish Hatchery (PAH stock) for brood years 1981 through 2009.



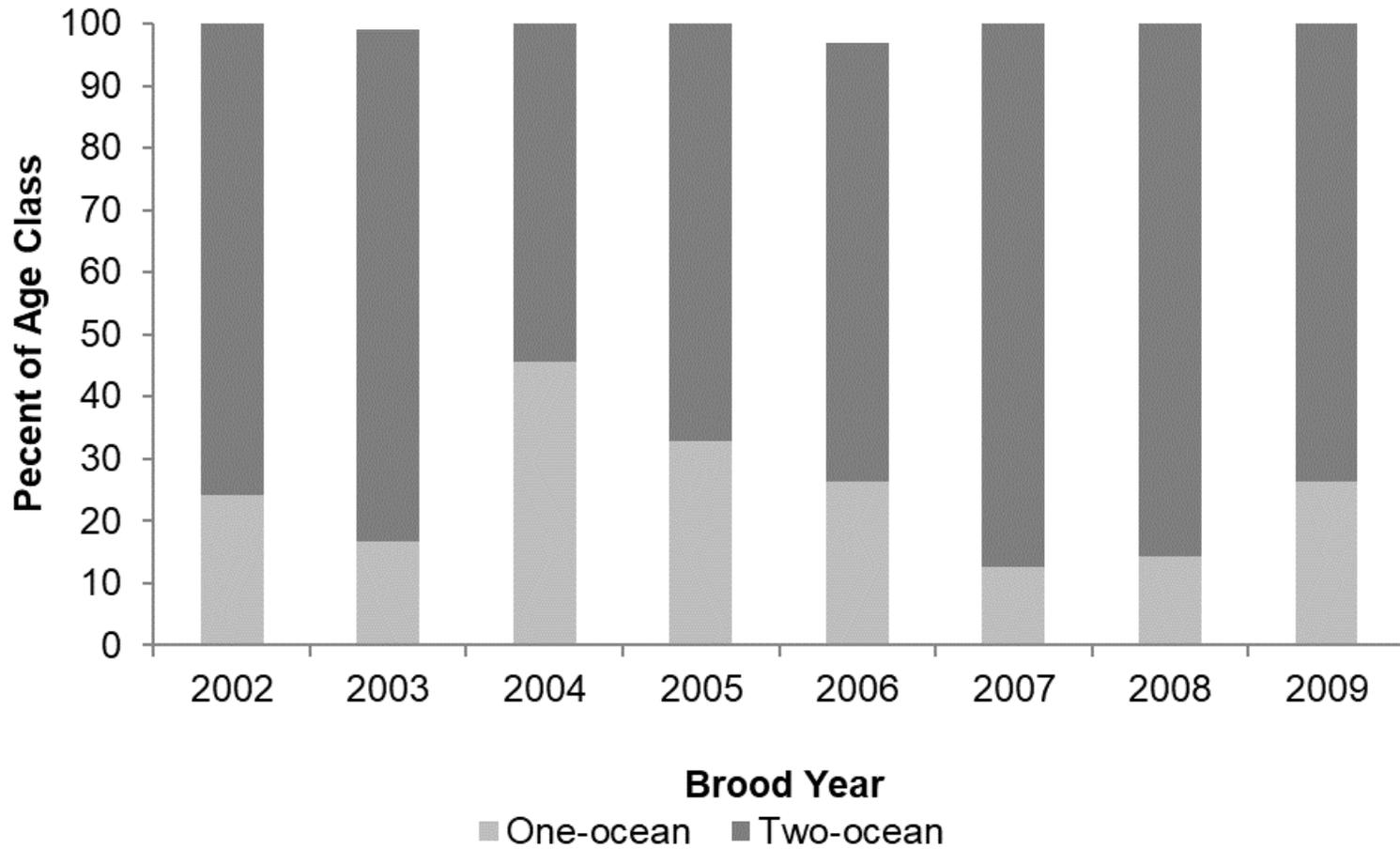
Appendix F3. Age composition for adult hatchery steelhead returning to Sawtooth Fish Hatchery (SAW stock) for brood years 1982 through 2009.



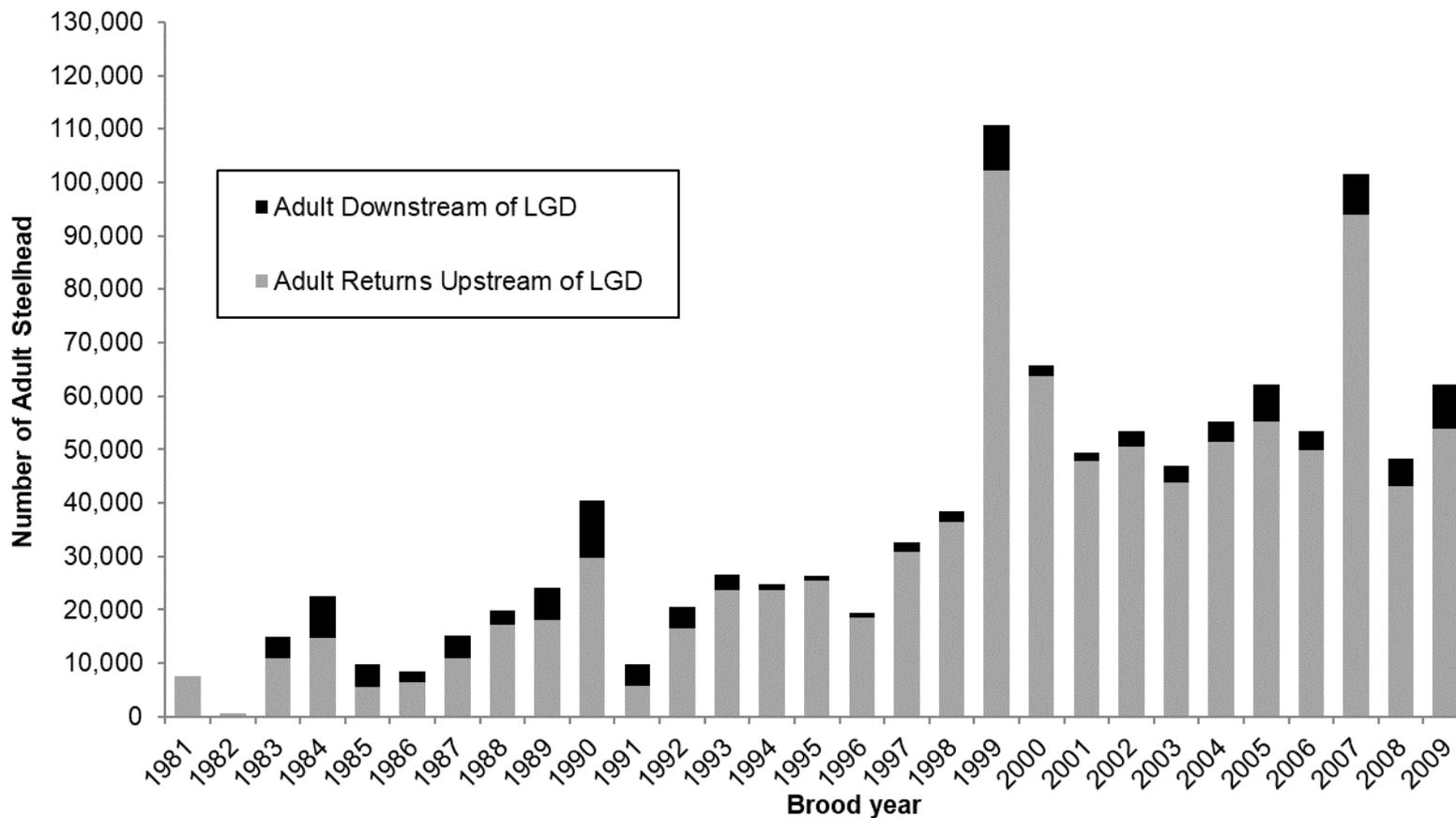
Appendix F4. Age composition for adult hatchery steelhead returning to East Fork Satellite Facility (EFNAT stock) for brood years 2001 through 2009.



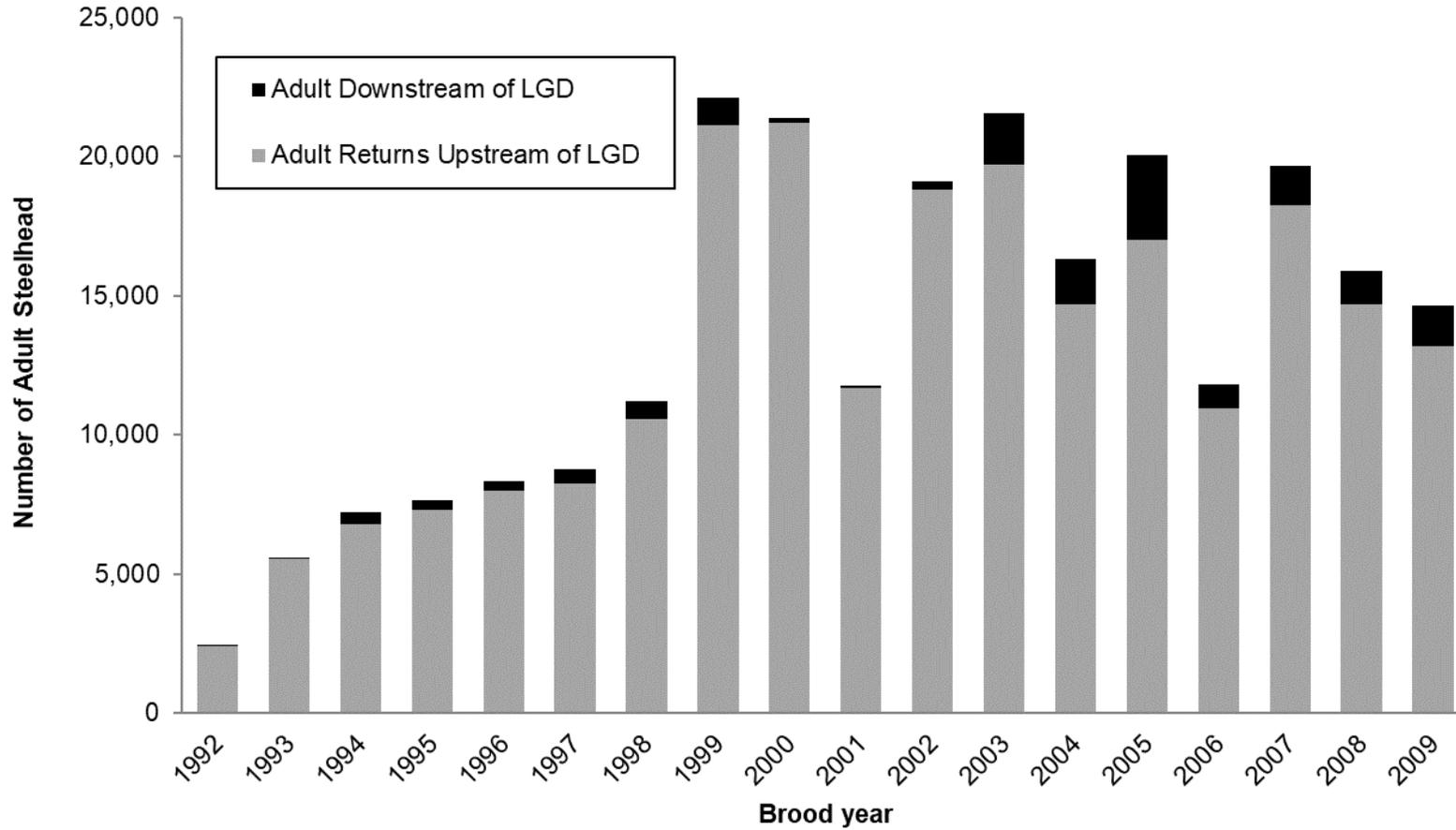
Appendix F5. Age composition of adult USAL hatchery steelhead at Squaw Creek weir for brood years 2002 through 2009, then at Pahsimeroi weir in 2009.



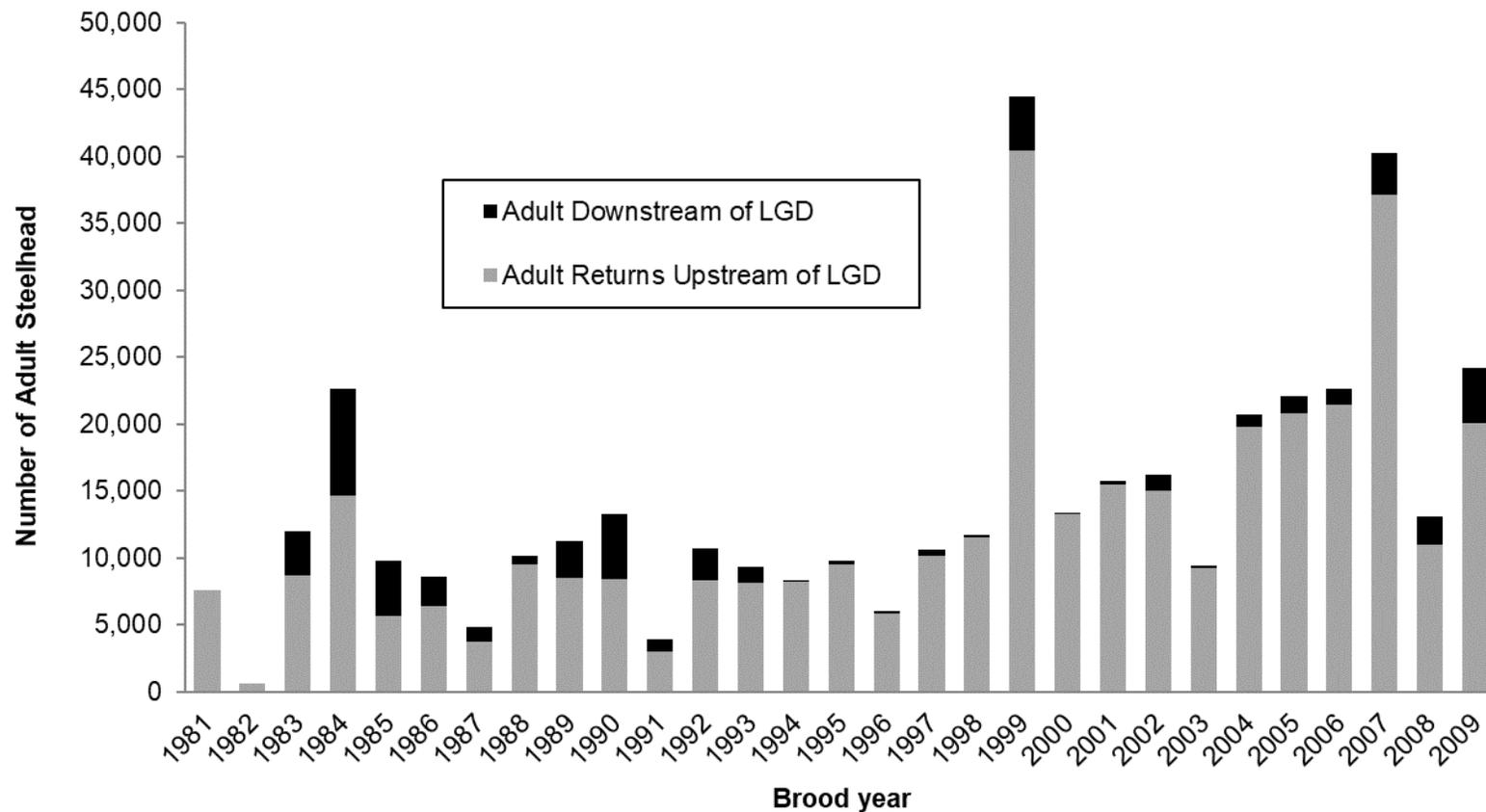
Appendix G1. Combined adult returns summary for steelhead released from LSRCP funded facilities (Clearwater [1992-2009], Hagerman [1981-2009], and Magic Valley [1982-2009]).



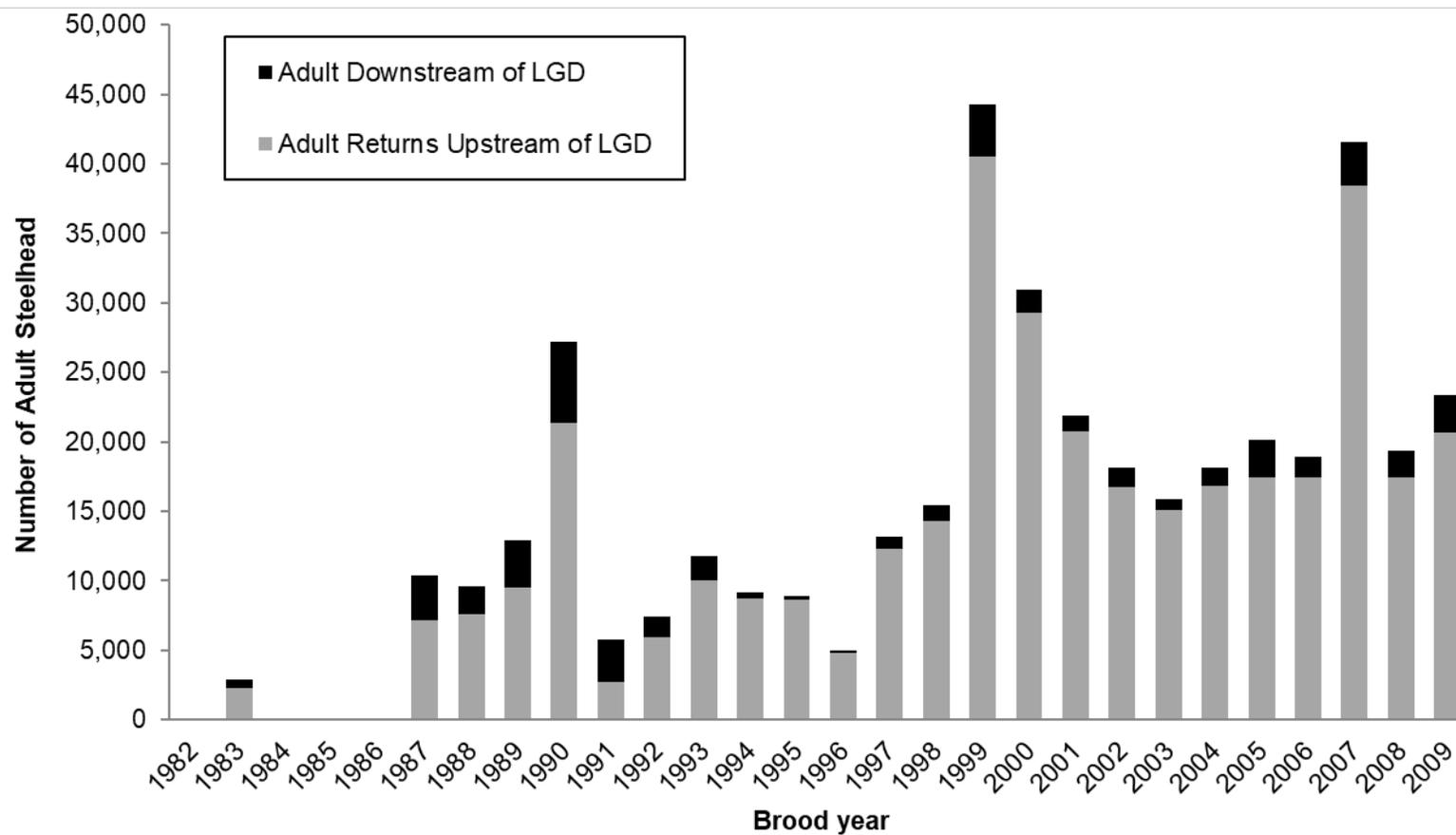
Appendix G2. Adult return summaries for steelhead released from Clearwater Fish Hatchery for brood years 1992 through 2009.



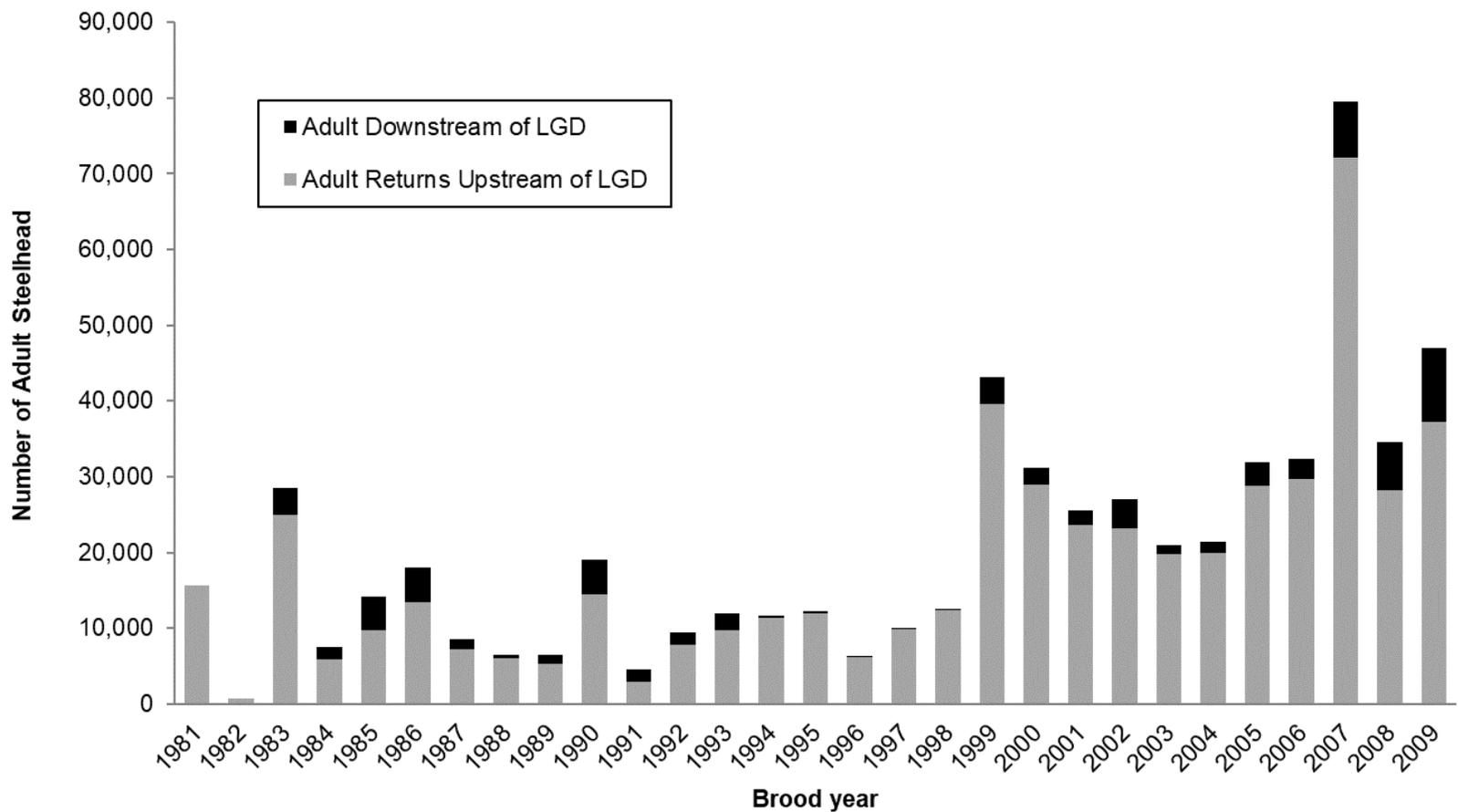
Appendix G3. Adult return summaries for steelhead released from Hagerman National Fish Hatchery for brood years 1981 through 2009.



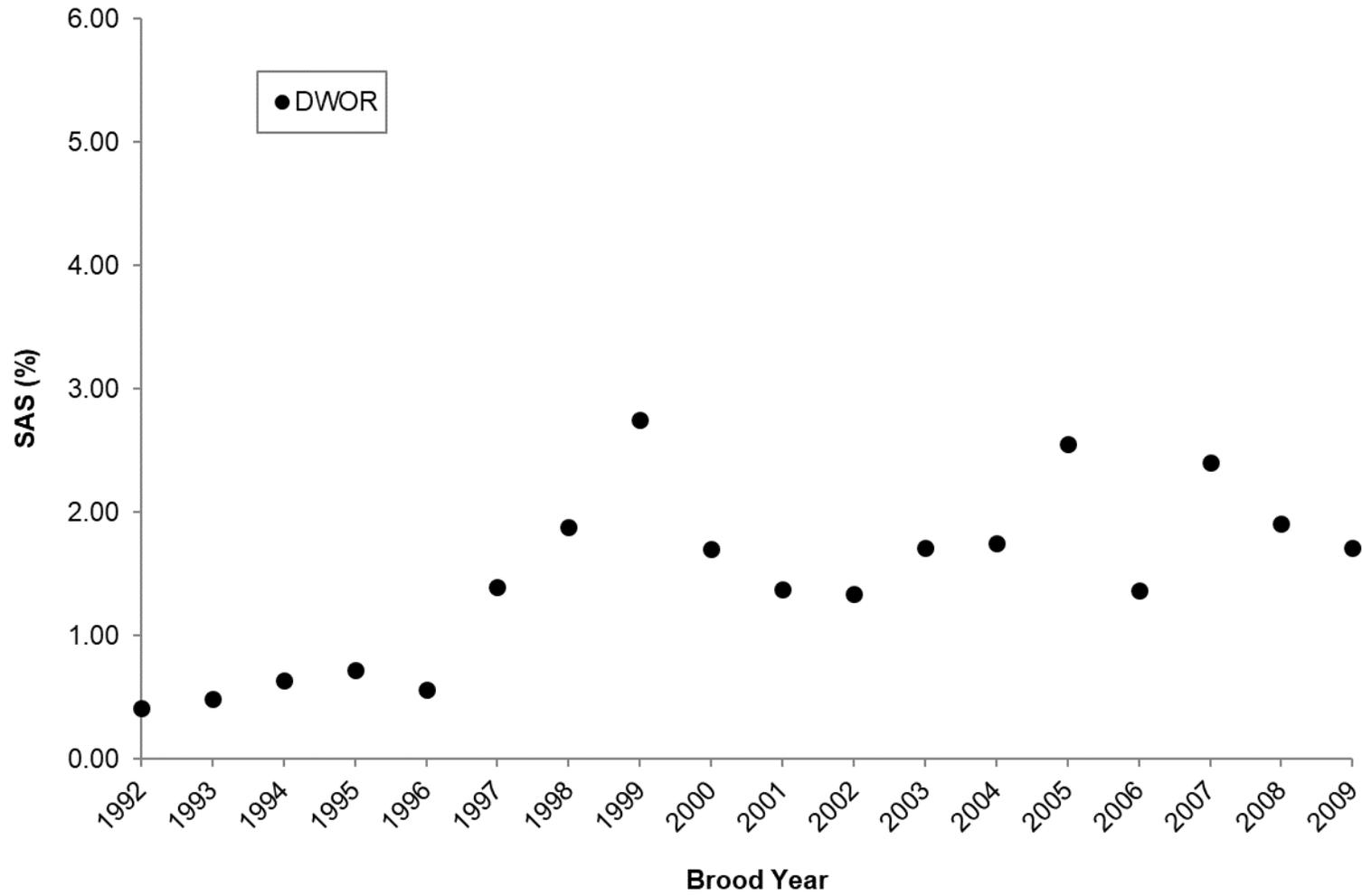
Appendix G4. Adult return summaries for steelhead released from Magic Valley Fish Hatchery for brood years 1982 through 2009.



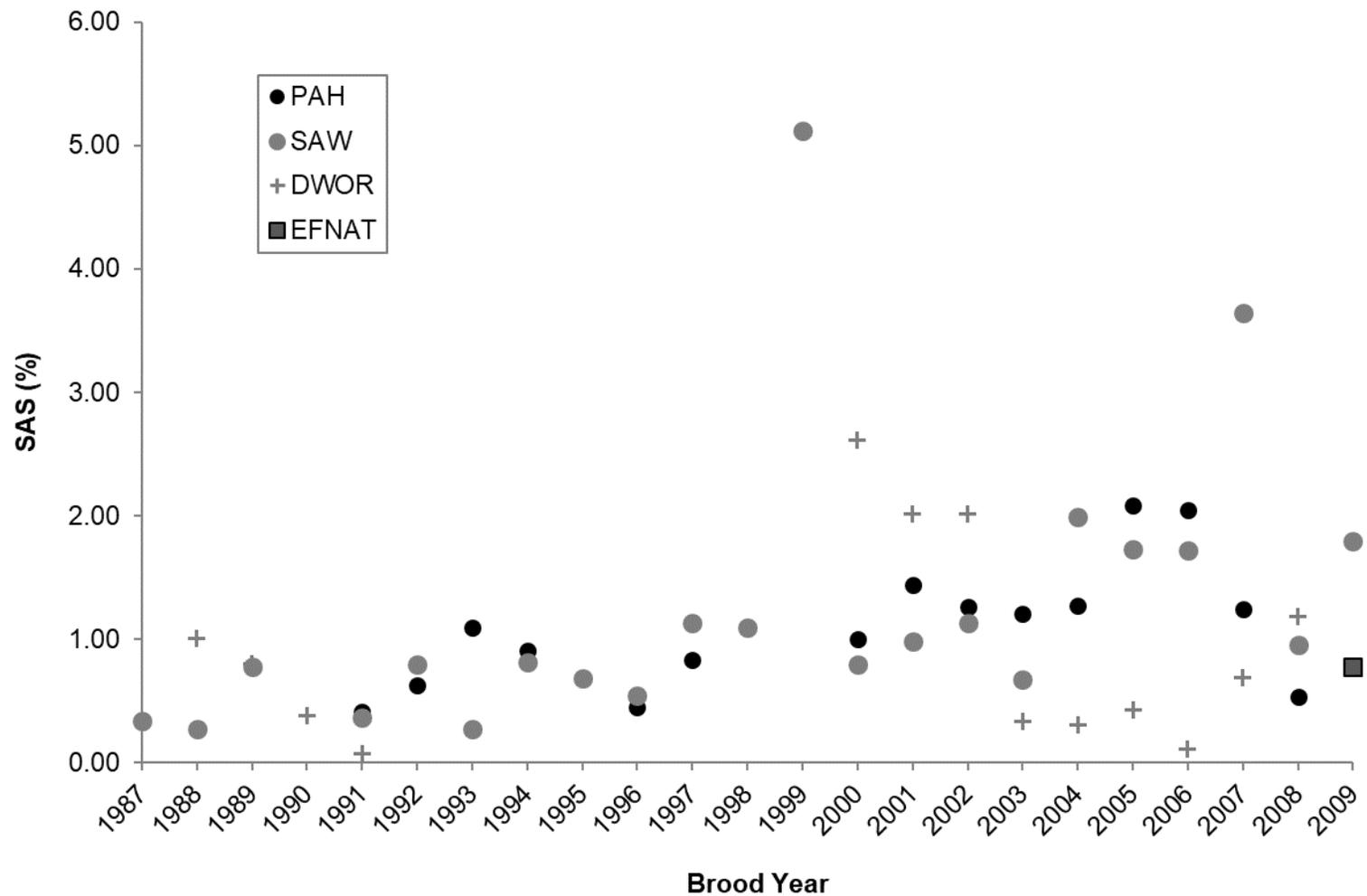
Appendix G5. Adult return summaries for steelhead released from Niagara Springs Fish Hatchery for brood years 1981 through 2009.



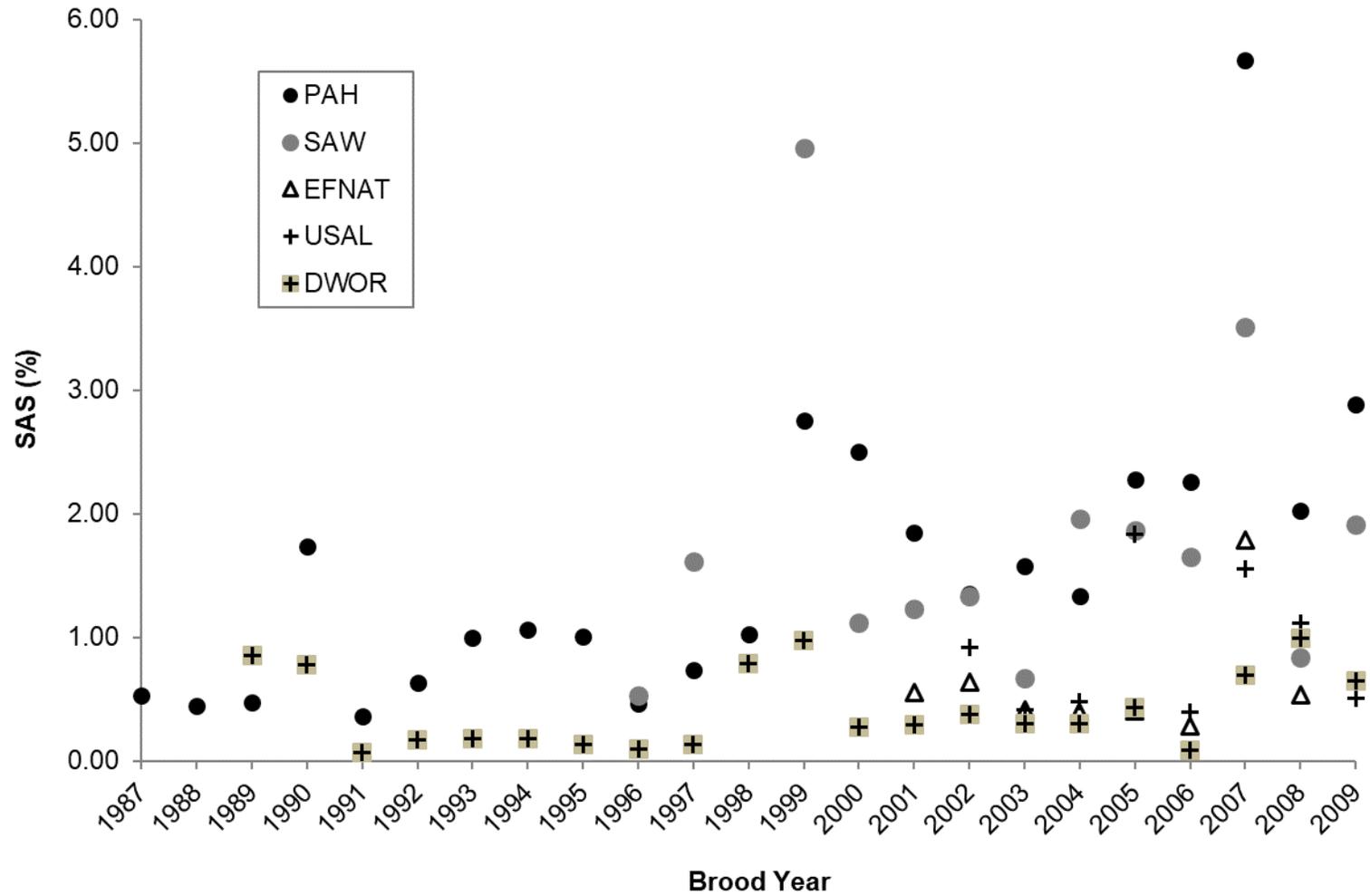
Appendix H1. Smolt-to-adult survival rates (SAS) of steelhead released from Clearwater Fish Hatchery for brood years 1992 through 2009.



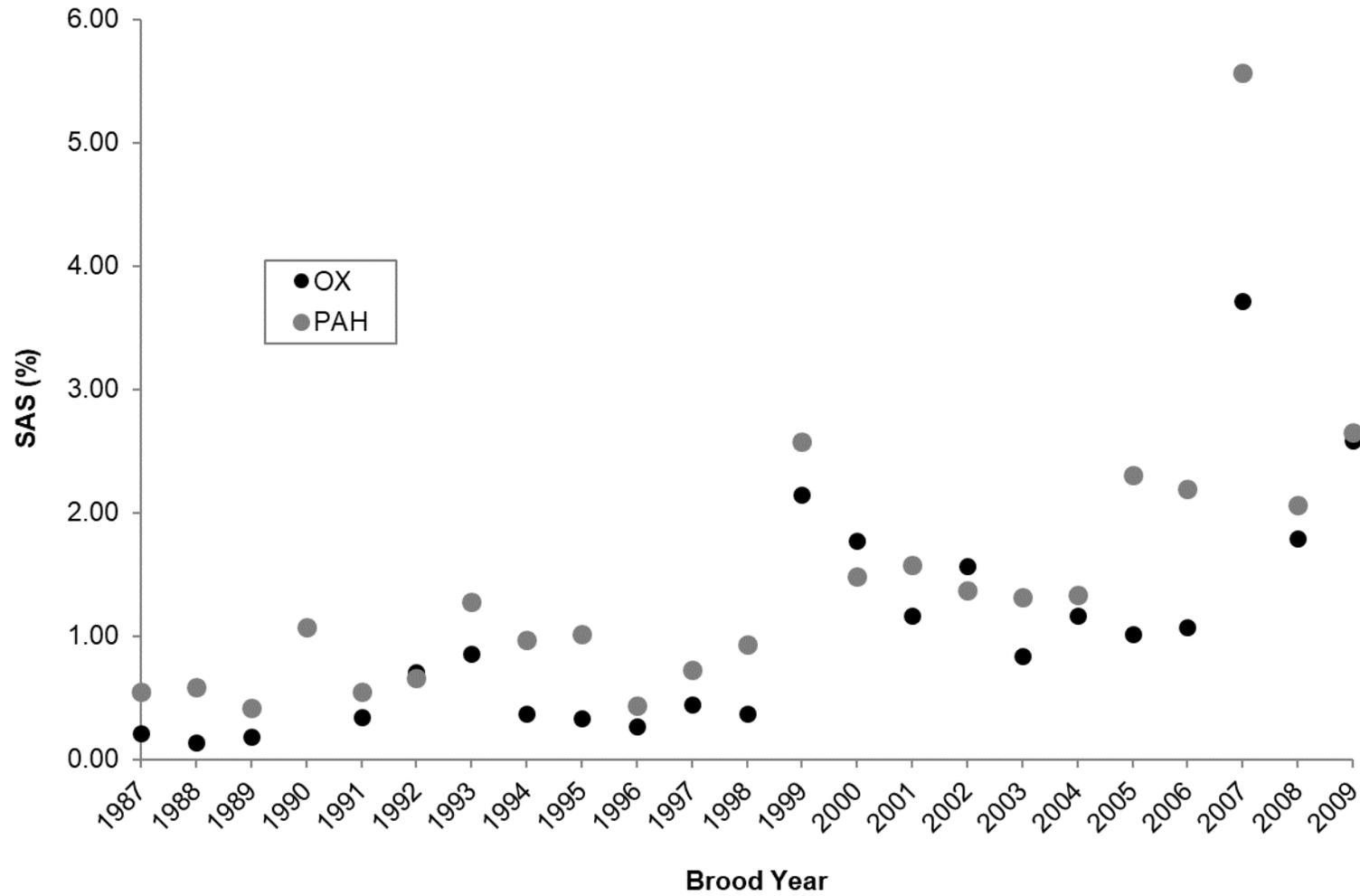
Appendix H2. Smolt-to-adult survival rates (SAS) for steelhead released from Hagerman for brood years 1987 through 2009 for production released into the Salmon River.



Appendix H3. Smolt-to-adult survival rates (SAS) for steelhead released from Magic Valley Fish Hatchery for brood years 1987 through 2009 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 2009.



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