Imnaha River Summer Steelhead Hatchery Program Review

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INTRODUCTION AND BACKGROUND

This paper provides background information, management goals and objectives, program development history, assessment of program performance and future challenges for the Imnaha River summer steelhead *Oncorhynchus mykiss* hatchery program. We cover the time period from the program initiation in 1982 to the present (2010).

The Imnaha River basin is located in Northeast Oregon. The basin originates in high elevation areas of the eastern Wallowa Mountains and the plateau between the Wallowa River drainage and Hells Canyon. The Imnaha River enters the Snake River at river kilometer (rkm) 308. Eight main stem hydroelectric dams and associated reservoirs exist between the Imnaha River and the ocean.

The Imnaha River historically supported an abundant run of summer steelhead. Recreational fisheries occurred throughout the basin from autumn through late spring. Steelhead escapement to the Snake River declined substantially following the completion of the four lower Snake River dams. Annual index redd counts in the Imnaha River tributaries showed a drastic decline following completion of Lower Granite Dam in 1974.

In 1976, the U.S. Congress authorized the Lower Snake River Compensation Plan (LSRCP). The LSRCP mandated a compensation program to mitigate for the losses of anadromous fishes that resulted from construction and operation of the four lower Snake River dams–Ice Harbor, Lower Monumental, Little Goose, and Lower Granite.

The Imnaha River steelhead hatchery program was initiated in 1982 in response to severe declines of steelhead that occurred throughout the 1970s. Annual adult mitigation, brood year specific smolt-to-adult return rate, total smolt-to-adult survival rate, and annual smolt production goals were established to compensate for the estimated annual loss of 48% of adult production (Table 1). Interim smolt production goals that are less than the original have been adopted through the adaptive management process.

The adult return and smolt-to-adult return rate goals for the compensation area represent the required performance to the area above Lower Granite Dam (LGD). The total adult and smolt-to-adult survival rate goals were determined based on the LSRCP plan analyses which assumed that a downriver harvest to compensation area escapement ratio of two-to-one existed prior to construction of the dams. We recognized that this level of exploitation in downriver areas under current conditions is an unreasonable expectation. Current status of upriver natural steelhead populations that are listed under the Endangered Species Act (ESA) along with the associated limits on harvest take for recovery purposes will preclude, possibly indefinitely, reestablishing downriver fisheries of the magnitude that existed prior to construction of the dams.

Table 1. Lower Snake River Compensation Plan mitigation goals for Oregon's summer steelhead in the Imnaha River basin. Adult and survival goals are expressed for returns to the compensation area and total catch and escapement.

Category	Goal
Compensation Area	
Annual smolt goal	330,000 smolts (215,000 interim)
Annual pounds of production	66,000 lbs.
Annual adult goal	2,000 adults
Brood year smolt-to-adult return rate (SAR)	0.61% (0.93% interim)
Total Catch & Escapement	
Annual adult goal	6,000 adults
Brood year smolt-to-adult survival rate (SAS)	1.83%

Implementation of the LSRCP Imnaha steelhead hatchery program has been guided by five priority management objectives: 1) establish an annual supply of broodstock capable of meeting production goals; 2) maintain and enhance natural production while maintaining long-term fitness of the natural population; 3) re-establish historic tribal and recreational fisheries; 4) establish a total return number of summer steelhead that meets the LSRCP goals; and 5) operate the hatchery program to maintain the genetic and life history characteristics of the natural population and have hatchery fish characteristics mimic those of natural fish, while achieving management objectives.

A comprehensive research, monitoring and evaluation (RM&E) program has been underway since 1984. The primary objectives of the RM&E program are: 1) document and assess fish culture and hatchery operational practices and performance; 2) determine optimum rearing and release strategies that will produce maximum survival to adulthood; 3) determine total catch and escapement, smolt survival to LGD, total smolt-to-adult survival (SAS), smolt-to-adult return rate to the compensation area (SAR), and assess if adult production meets mitigation goals; 4) assess and compare recruits-per-spawner of hatchery reared and natural spawning fish; 5) determine the magnitude and patterns of straying; 6) assess response in natural population abundance and productivity (adult recruits-per-spawner, smolts-per-spawner) to supplementation; 7) assess and compare life history characteristics (age structure, run timing, sex ratios, smolt migration timing, fecundity) of hatchery and natural fish; and, 8) assess success in restoring fisheries to historical levels.

The steelhead production program involves three hatchery facilities. Adult broodstock are collected, held, and spawned at the Little Sheep Creek Facility, which is located at rkm 8.0 on Little Sheep Creek (Figure 1). Embryos are immediately transported to Wallowa Fish Hatchery where they are incubated on temperature mediated spring water. Once embryos reach the eyed stage they are transferred to Irrigon Hatchery for final incubation, hatching, and final rearing on well water. Ten to 12 months after fertilization (March-April) smolts are transferred back to the Little Sheep Creek acclimation pond for final rearing and acclimation. Smolts are released in April or early May as yearlings.

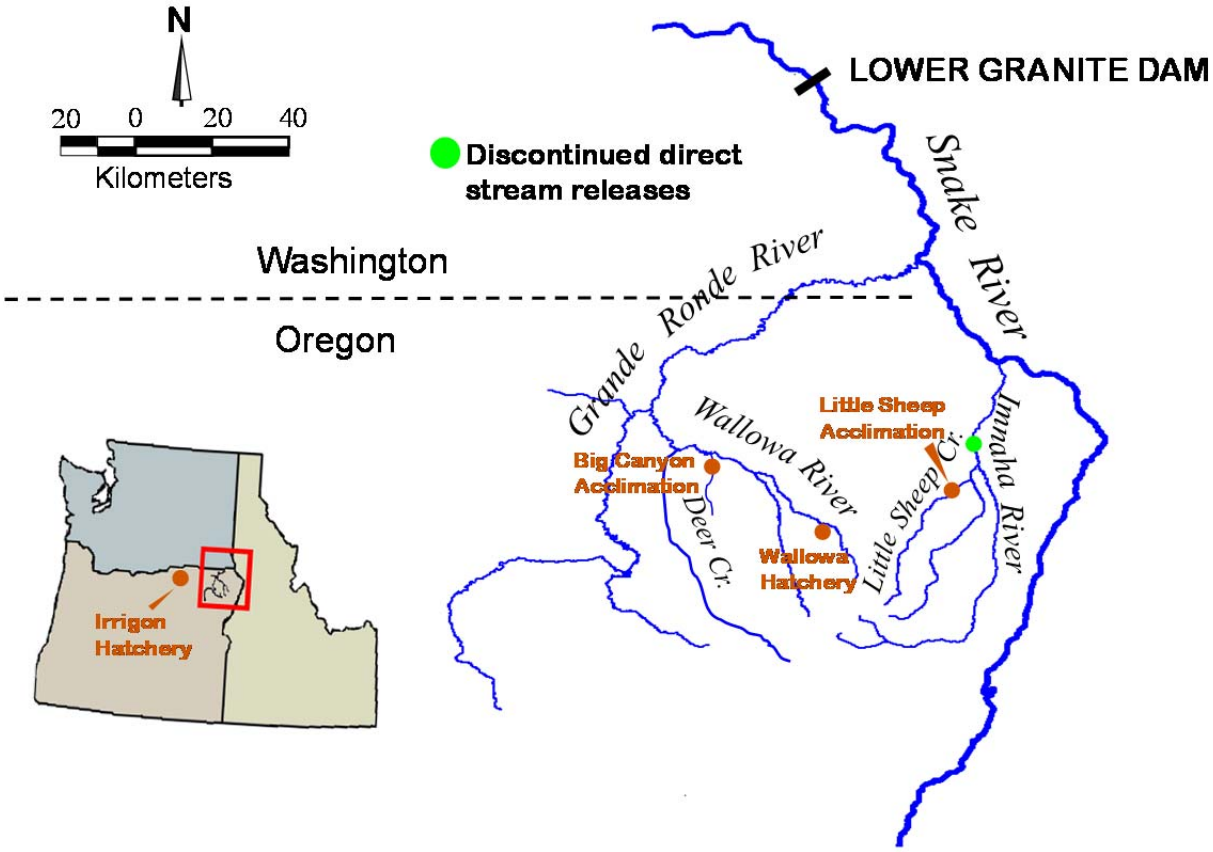

Figure 1. Map showing locations of acclimation sites on Deer and Spring creeks in the Grande Ronde River basin and Little Sheep Creek in the Imnaha River basin and a discontinued direct-stream release site. Inset shows location of study area within a three-state region and the location of Irrigon Fish Hatchery.

PROGRAM ASSESSMENT

Fortuitously, the local biologists recognized the importance of initiating broodstock from a local source. Natural-origin adults were collected from Little Sheep Creek beginning in 1982. Natural-origin adults comprised a majority of the broodstock from 1982-1986. When significant numbers of hatchery fish began to return in 1987 the broodstock was dominated by hatchery-origin fish (Table 2). The proportion of broodstock that were natural origin has only reached 25% in the most recent years.

Table 2. History of natural- and hatchery-origin broodstock collection at Little Sheep Creek, spawn years 1982 to 2011.

Spawn Years	Number of Females in Broodstock		Percent Natural Run Retained for Broodstock
	Natural	Hatchery	
1982-1986	25-75	0-19	63.2-81.6
1987-1994	6-33	94-165	20.8-59.3
1995-2007	2-6	95-346	3.5-54.5
2008-2011	5-16	51-106	4.8-10.0

Spawning escapement above the weir is well regulated with an adult trapping facility that provides nearly 100% collection capability. Few hatchery fish were passed above the weir to spawn naturally in the early years of program development (Table 3). Large numbers of hatchery fish and few natural fish were released above the weir to spawn naturally from 1987-2007. This management strategy resulted in very low proportion natural influence (PNI) for this entire time period (range 0.02-0.18). Beginning in 2008 an alternative sliding scale management framework (Table 4) was implemented to increase the proportion of broodstock that are natural-origin, increase the proportion of fish spawning in nature that are natural origin, and reduce the total number of spawners above the weir. This sliding scale has substantially improved the PNI in recent years (Table 3).

Prespawning mortality of broodstock has been low with the exception of the first few years when temporary holding facilities were used. Green egg-to-smolt survival has been highly variable and low in some recent years (Figure 2), primarily due to cold-water disease.

We estimate total number of green eggs based on the estimated number of eyed eggs plus the number of eggs that died prior to the eyed egg stage. The number of eyed eggs are estimated at the time of shocking. We count 1,000-2,000 towel dried eyed eggs and weigh the total to get an average number of eggs per gram. The remaining eyed eggs are then towel dried and weighed and total number of eyed eggs is determined. Green-to-eyed egg survival is calculated by dividing the total number of eyed eggs by the total number of green eggs. The number of embryos that are culled, transferred, or are in excess of program needs is recorded and is subtracted out of the total eyed egg inventory when determining embryo to smolt survival.

After hatching and ponding in indoor circulars, fry are transported to outside raceways for final rearing. Each month, fish in each raceway are crowded and three separate samples of approximately 20 pounds each are weighed and then counted. Average fish per pound is calculated from these samples. Beginning in late February, fish are loaded onto liberation trucks and hauled to acclimation ponds (or hauled later and direct-stream released) to be acclimated for a 1-6 week period and are then released. The number of fish hauled to acclimation ponds or direct-stream released is calculated during loading. At loading, an average fish/lb for each raceway is again calculated as it was during each previous month during rearing. As fish are

loaded into liberation tanks, the number of lbs of fish is estimated using a calibrated displacement gauge on each tank of each truck which estimates the number of pounds of fish loaded. To estimate the number of fish in each acclimation pond, we multiply the average fish/lb estimate by total lbs to get the total number of fish on each liberation truck, and then the totals are summed. In 2012, the number of fish estimated using the displacement method during grading when fish from each raceway are loaded into a liberation truck deviated from a complete count of fish during adipose-fin clipping by only 0.17%, thus indicating that the displacement method accurately estimates the number of steelhead. The total number of smolts released is calculated using the number hauled to the acclimation ponds (or direct-stream released) minus mortality from the acclimation ponds (or observed immediately after the direct stream release). Embryo-to-smolt survival for production releases is calculated by dividing the number of smolts released by the eyed embryos minus any culled, transferred, or excess embryos.

To determine size at release for each release group, we conduct pre-release sampling at each acclimation pond immediately prior to release (the day before or the day of release). Fish are crowded and a sample of approximately 1,000 fish is held in a live box. We measure fork length (FL) of 100 fish and weigh (g) 50 fish for each production and experimental group (Ad-only, AdLV, and AdRV clipped fish). For direct-stream released fish, we measure FL of 200-250 fish prior to hauling to release sites and use the monthly fish/pound to determine weight.

Table 3. History of the spawning disposition of hatchery- and natural-origin Imnaha stock steelhead that returned to the weir on Little Sheep Creek. PNI is the proportion of natural influence and is calculated as [PNOB ÷ (PNOB+PHOS)].

Spawn Years	Total Number Spawning in Nature	% Hatchery-origin Spawning in Nature (PHOS)	% Natural-origin in Brookstock (PNOB)	PNI
1982-1986	0-36	0-8.3	71.0-100	0.90-1.0
1987-1994	55-610	46.8-97.0	4.2-15.3	0.02-0.18
1995-2007	46-1,387	66.0-93.8	1.1-9.7	0.02-0.06
2008-2011	281-346	25.1-52.2	12.4-25.2	0.10-0.50

Table 4. Sliding scale guidelines and associated percent natural influence (PNI) for hatchery- and natural-origin broodstock collections and passage above the weir at Little Sheep Creek.

No. Natural-origin Fish Returning to Weir	No. Natural-origin Retained for Broodstock*	% Hatchery-origin Fish Above Weir	PNI
≤ 100	10 (≤10%)	Any % hatchery to make 250 fish escapement goal	0.14**
150	30 (20%)	52%	0.30
200	50 (25%)	40%	0.48
250	70 (28%)	32%	0.65
300	90 (30%)	16%	0.81

* When number of natural-origin fish exceeds 100, keep 10 adults plus 40% of the natural run greater than 100.
** Assumes return of 100 natural-origin adults.

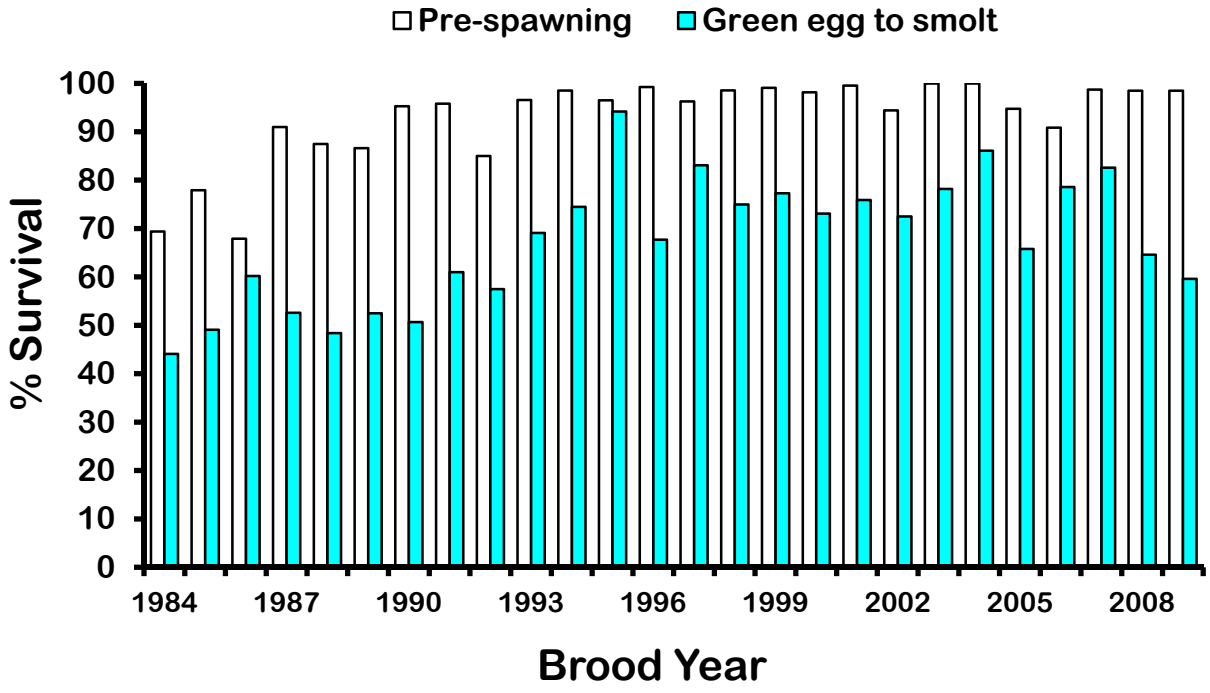

Figure 2. Imnaha stock hatchery steelhead adult pre-spawning survival and green egg-to-smolt survival from brood years 1984 to 2009.

The smolt production goal of 330,000 was met in most years once the program reached full implementation. The reduced interim production goals were met in three of the last four years (Figure 3). Smolt survival rates from the Little Sheep Creek Facility to Lower Granite Dam have been highly variable with the highest rates observed (80-90%) in the two most recent years (Figure 4). The smolt migration pattern for hatchery fish is similar to that of natural smolts with initial arrival timing in mid-April and migration completion by mid-June (Figure 5).

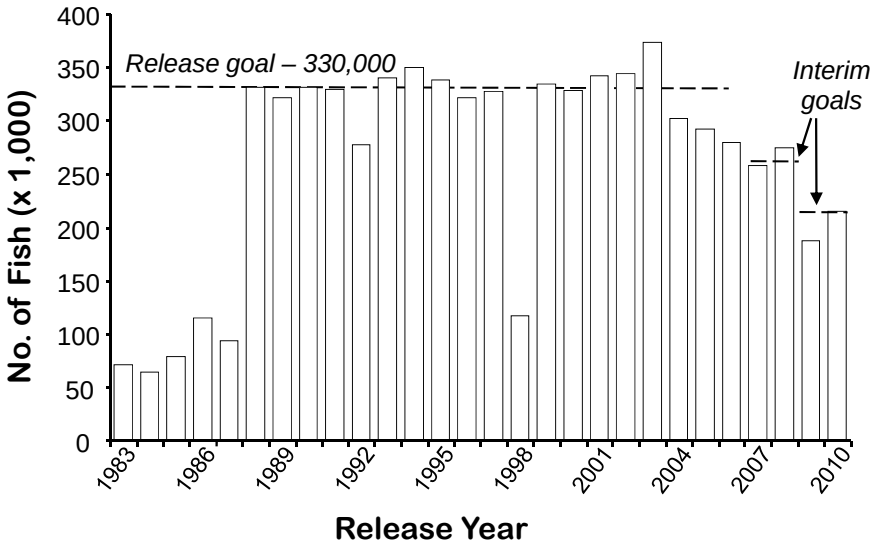

Figure 3. Annual number of Imnaha stock hatchery steelhead smolt releases into the Imnaha River basin, release years 1983 to 2010.

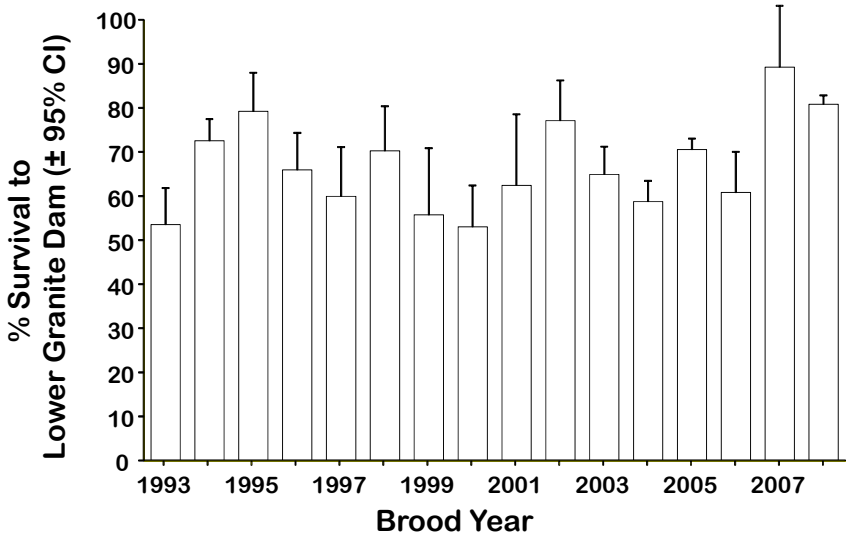

Figure 4. Average annual outmigration survival to Lower Granite Dam of PIT tagged Imnaha stock hatchery steelhead smolts released from the Little Sheep Creek Facility, brood years 1993 to 2008.

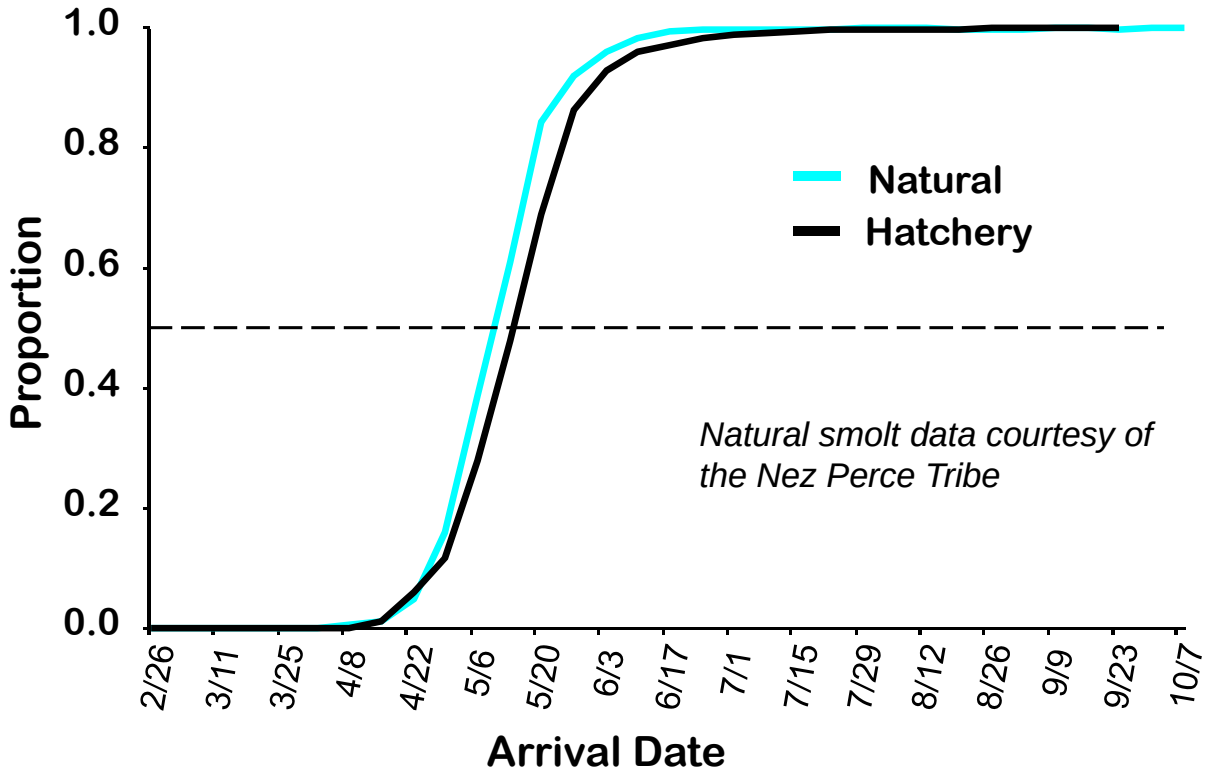

Figure 5. Average proportion of PIT tagged Imnaha stock hatchery steelhead smolts and natural-origin Imnaha River steelhead smolts that arrived at Lower Granite Dam from late February through early October, migration years 1994 to 2011.

Prior to 2001-02 run year, adult returns to the compensation area were well below the mitigation goal of 2,000 in all run years except one (Figure 6). Since the 2001-02 run year the returns have exceeded the goal in every year and have been two times greater than the goal in three of the last eight years. One of the key measures of performance is the SAR relative to the program goal of 0.61%. Over the past 10 brood years, the SAR has ranged from 0.28% to 1.60% (Figure 7). Prior to the recent 10 brood years, the goal was rarely achieved. We have exceeded the SAR goal in eight of the last 10 brood years (Figure 7). The SAS goal has never been achieved; however, SAS was much greater in the most recent 10 brood years than the first 10 brood years.

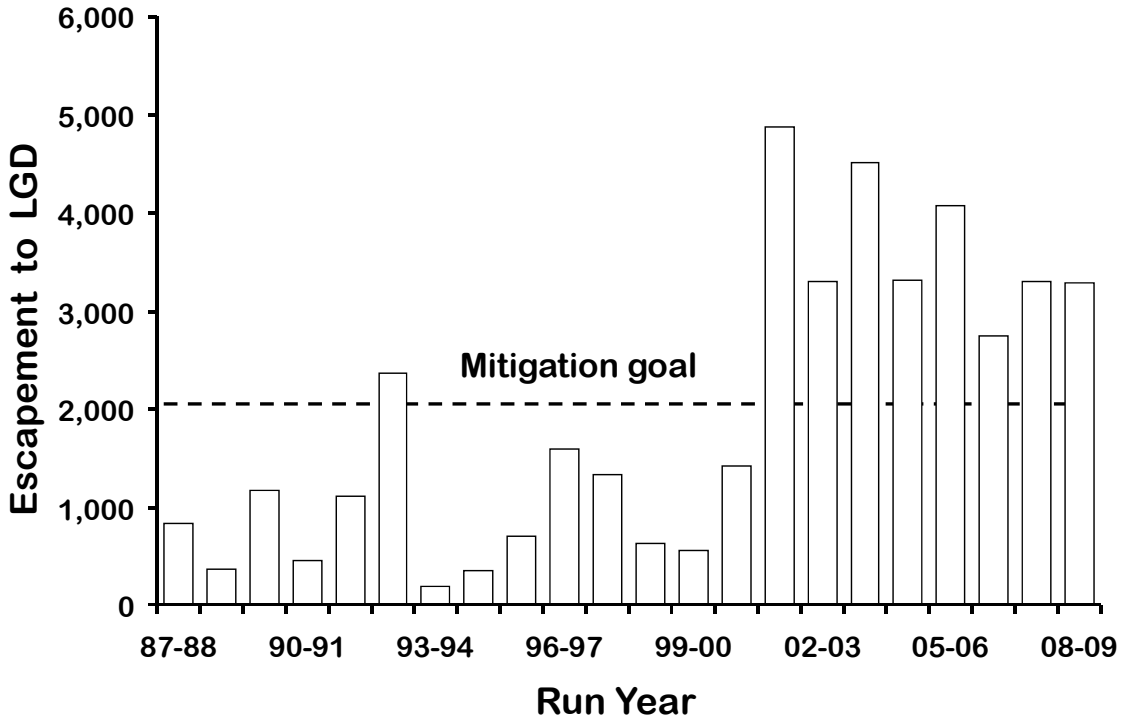

Figure 6. Imnaha stock hatchery steelhead adult escapement to the LSRCP Area above Lower Granite Dam, run years 1987-88 to 2008-09.

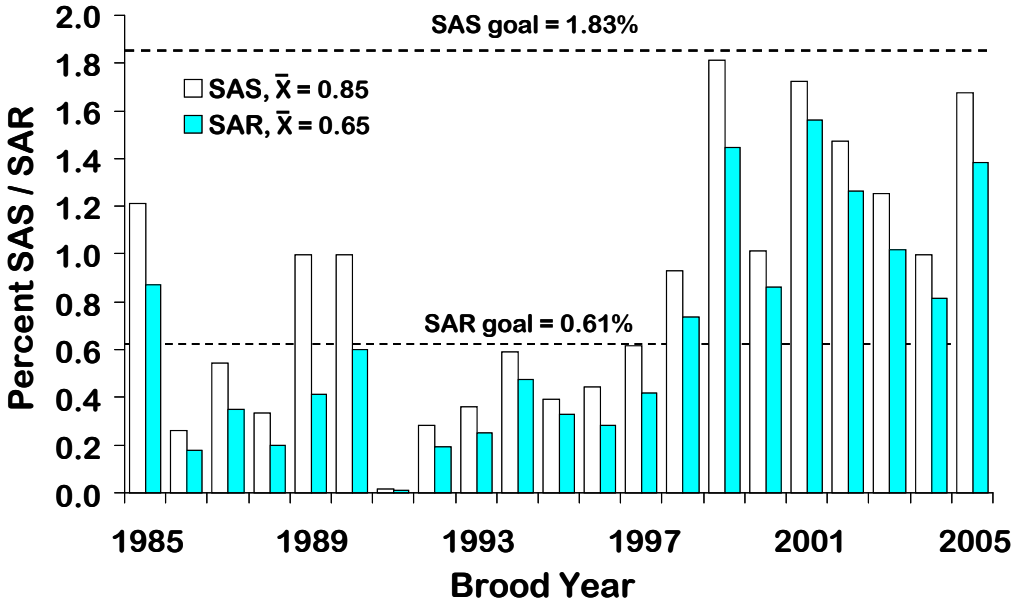

Figure 7. Percent smolt-to-adult survival (SAS) and smolt-to-adult return (SAR) to Lower Granite Dam of Imnaha stock hatchery steelhead, brood years 1985-2005.

One of the key indicators of the full life cycle advantage provided by a hatchery supplementation program is the hatchery-to-natural ratio in adult recruits-per-spawner (R/S). The hatchery R/S has averaged 8.6 times the R/S of naturally spawning fish (Figure 8). In recent years, the ratio has been higher. Natural spawner recruits-per-spawner has been below 1.0 for most years only exceeding 1.0 in five of 18 recent years.

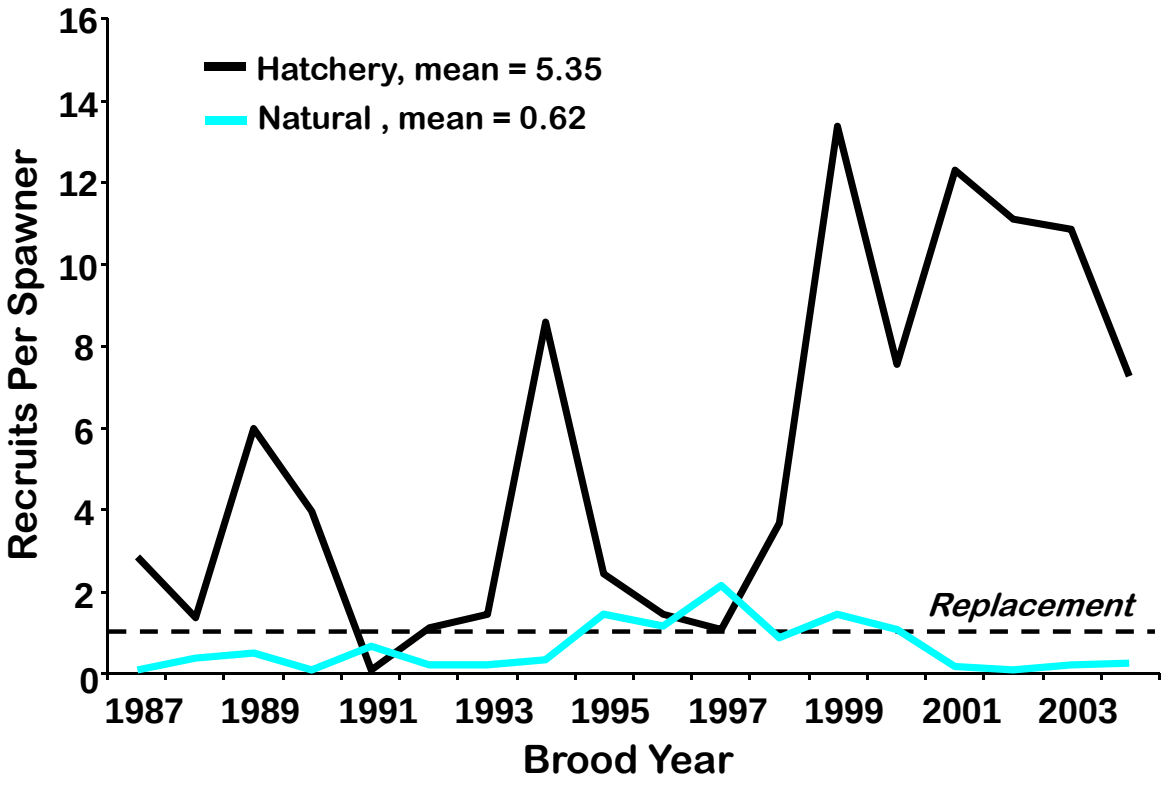

Figure 8. Adult recruits per spawner for natural- and hatchery-origin Imnaha stock steelhead that returned to and were counted at the Little Sheep Creek weir, brood years 1987-2004.

Imnaha River hatchery steelhead have a diverse catch and escapement profile with contributions to fisheries throughout their entire adult freshwater migration path. Few fish are harvested in the ocean and the freshwater harvest is distributed into small proportions across many fisheries (Table 5). Relative to other Snake River hatchery steelhead stocks, the Imnaha hatchery stock has a low overall exploitation rate. This low rate is a primarily due to the low exploitation rate in the Imnaha River recreational fishery. In recent years, a majority (66%) of the escapement to the Imnaha River is collected at the Little Sheep Creek Facility and outplanted into Big Sheep Creek (Figure 9). In addition, harvest and passage above the Little Sheep weir comprise significant proportions of the hatchery fish disposition. A majority of the natural-origin adults that returned to Little Sheep Creek have been passed above the weir to spawn naturally (Figure 10).

Table 5. Catch and escapement distribution (%) of Imnaha stock hatchery steelhead.

Recovery Location	Percent of Total				
	Brood Year				
	2001	2002	2003	2004	Mean
Ocean	0.0	0.0	0.1	0.0	0.0
Columbia River					
Sport	3.5	6.4	11.9	6.1	7.0
Tribal	2.3	2.0	1.3	1.4	1.8
Stray Harvest	1.4	1.4	1.7	3.8	2.1
Stray Rack	.2	0.7	1.7	1.8	1.1
Snake River Basin					
Stray below LGD	0.0	0.0	0.1	0.0	0.0
Stray above LGD Harvest	1.6	0.0	0.0	2.6	1.1
Stray above LGD Rack	0.1	0.0	0.0	0.7	0.2
Sport below LGD	2.0	3.5	2.2	5.1	3.2
Sport above LGD	13.1	13.2	9.8	14.1	12.6
Imnaha Sport	5.2	8.5	7.1	7.9	7.2
Escapement to Weir	70.6	64.3	64.2	56.3	63.9

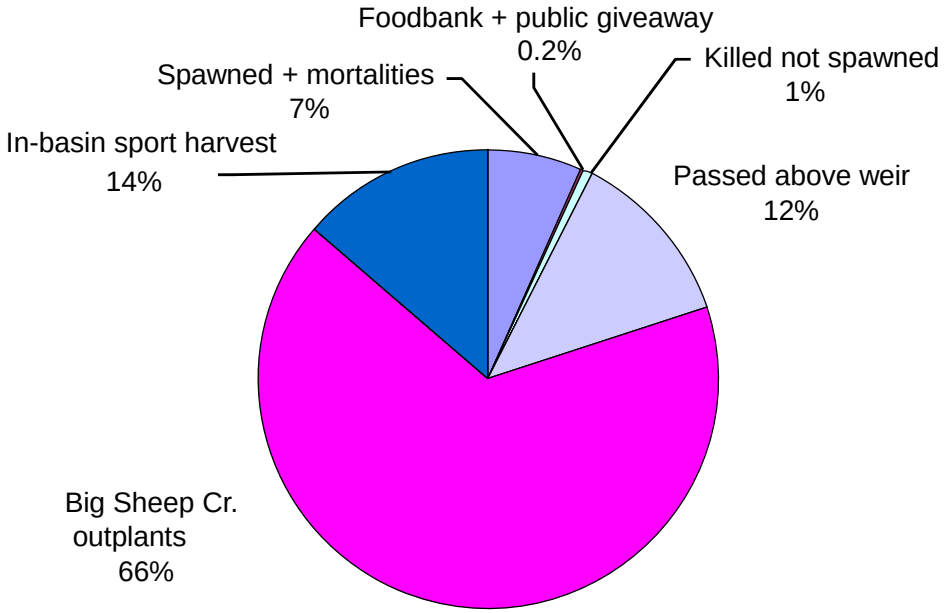

Figure 9. Escapement distribution of Imnaha stock hatchery steelhead within the Imnaha River basin, run years 2003-04 to 2007-08.

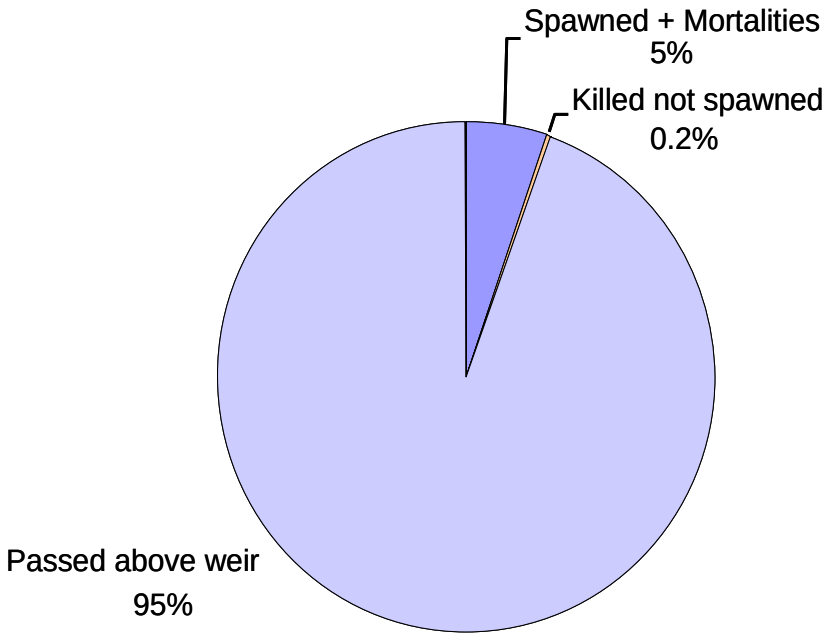

Figure 10. Escapement distribution of natural-origin Imnaha stock steelhead that returned to the Little Sheep Creek weir, return years 2004 to 2008.

Stray rates have been highly variable ranging from 3% to 19% (Figure 11). Most of the Imnaha River hatchery strays have been recovered in the Deschutes River recreational fishery or at Warm Springs River and Pelton Dam traps (Figure 12). The number of hatchery and natural adults released above the weir to spawn naturally has been highly variable due to the run size variation and divergent strategies for managing escapement through time. In recent years escapement has been reduced and the fraction of natural-origin spawners has been far greater than earlier years, consistently exceeding 50% (Figure 13).

Adult outplanting from Little Sheep Creek into Big Sheep Creek has been ongoing since the 1999 run year. Number of adults outplanted has been highly variable but has been above 1,000 in most years (Figure 14). A substantial percentage of the adults outplanted to Big Sheep Creek fall back out of Big Sheep Creek and rerun back to Little Sheep Creek.

We have not observed meaningful differences in adult run timing between hatchery- and natural-origin adults, with both exhibiting a broad normal distribution over an 11-week time period in the spring (Figure 15). There is no significant difference ($\alpha = 0.05$) in ocean age at return between hatchery- and natural-origin adults for combined sexes (Figure 16). However, we did observe a significant difference in ocean age at return for males, with hatchery-origin males returning at a younger age (Figure 17). Mean length at age is similar for natural and hatchery adults (Figure 18). Fecundity of 2-ocean females is significantly greater than 1-ocean females for both hatchery- and natural- origin fish. We found no significant difference in ocean age-specific fecundity between hatchery and natural females (Figure 19).

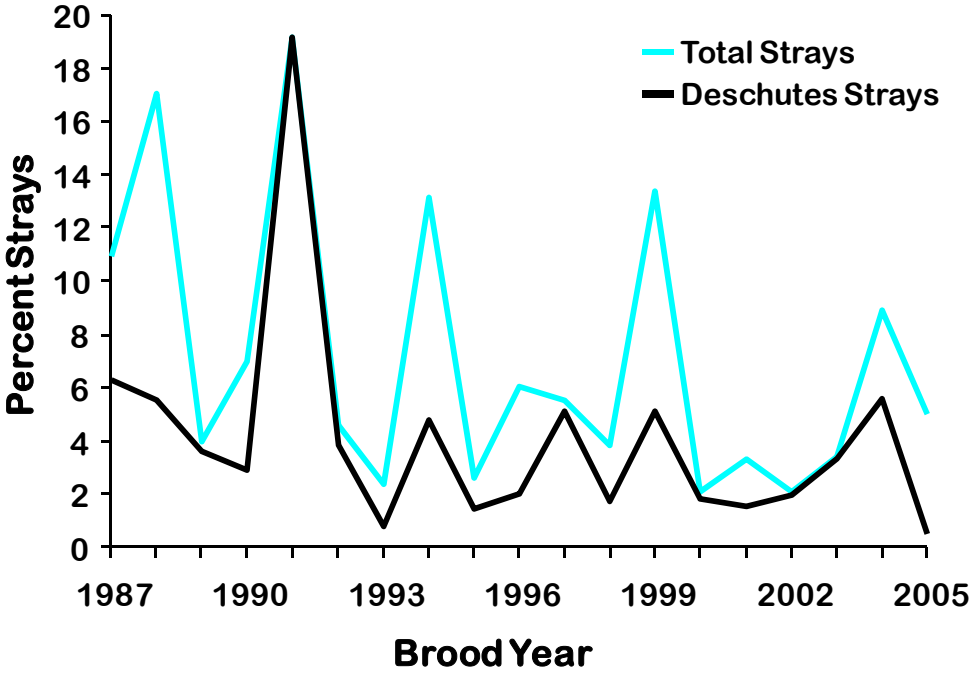

Figure 11. Percentage of Imnaha stock hatchery steelhead adults that stray, and the percentage that stray into the Deschutes River, a tributary to the Columbia River, brood years 1987-2005.

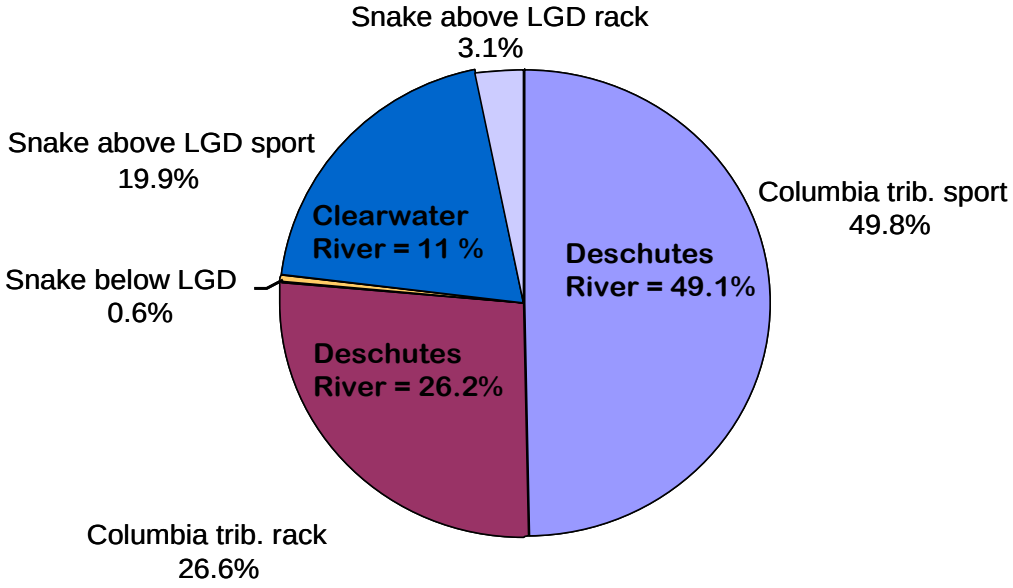

Figure 12. Distribution of adult Imnaha stock steelhead strays in the Columbia River basin, brood years 2001 to 2004.

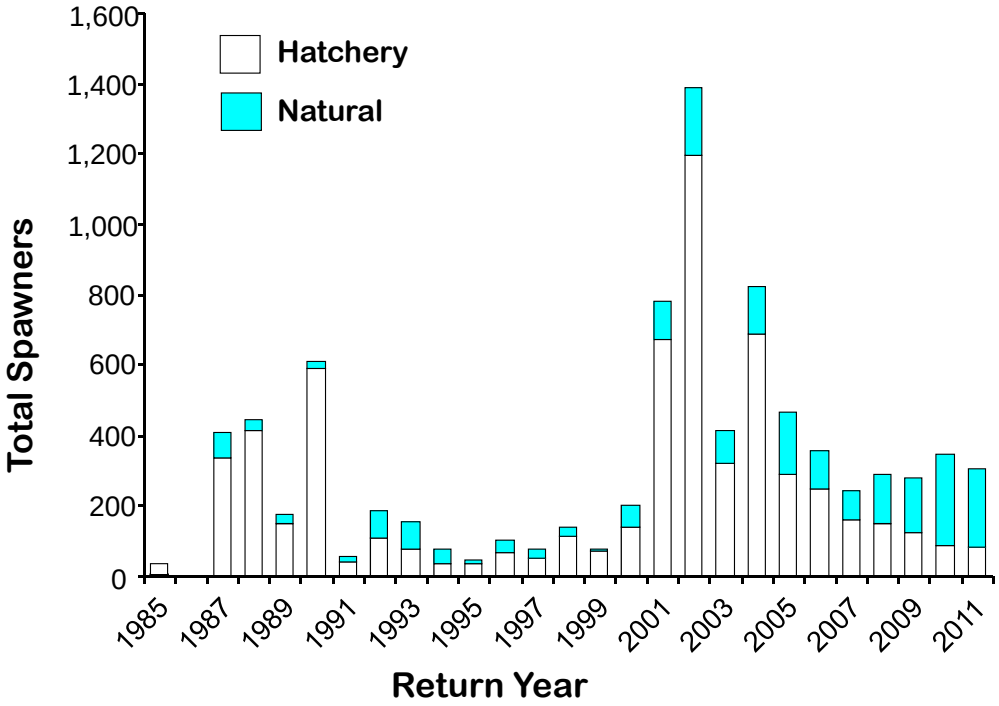

Figure 13. Annual number of hatchery- and natural-origin Imnaha stock steelhead passed above the Little Sheep Creek weir, return years 1985 to 2011.

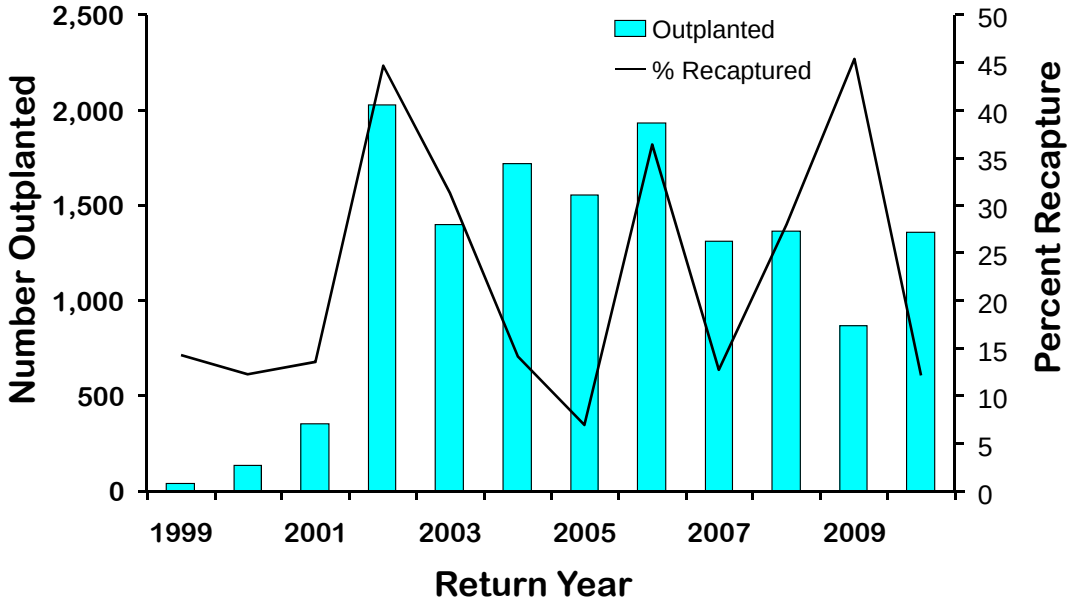

Figure 14. Number of adult Imnaha stock hatchery steelhead that were captured at the Little Sheep Creek weir and then outplanted into Big Sheep Creek, and the percentage that subsequently returned to the trap at Little Sheep Creek, return years 1999 to 2010.

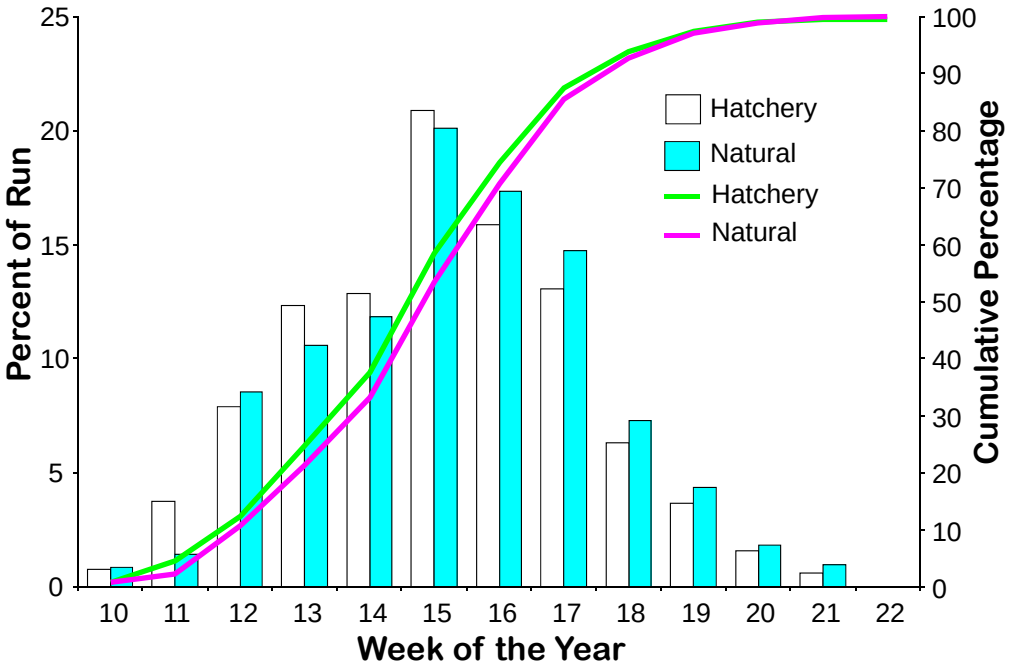

Figure 15. Average hatchery- and natural-origin return timing of Imnaha stock steelhead adults to the Little Sheep Creek weir and cumulative percentage that returned by week of the year. Data are from return years 2006 to 2010.

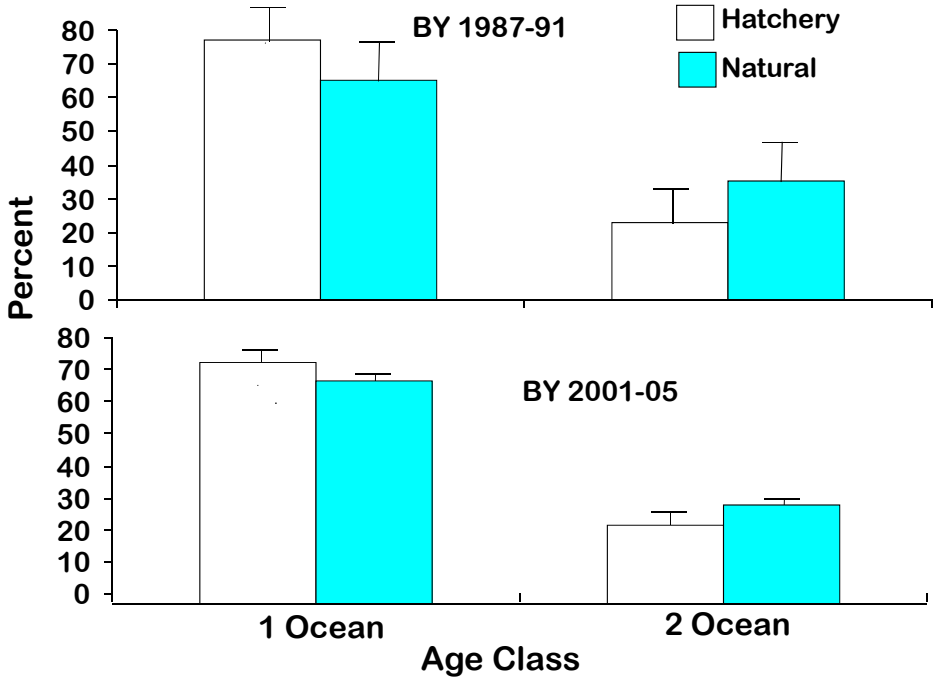

Figure 16. Percentage of 1-ocean and 2-ocean adult Imnaha stock hatchery- and natural-origin steelhead that returned to the Little Sheep Creek weir. Data are averages for early years (brood years 1987-91) and current (brood years 2001-05) time periods.

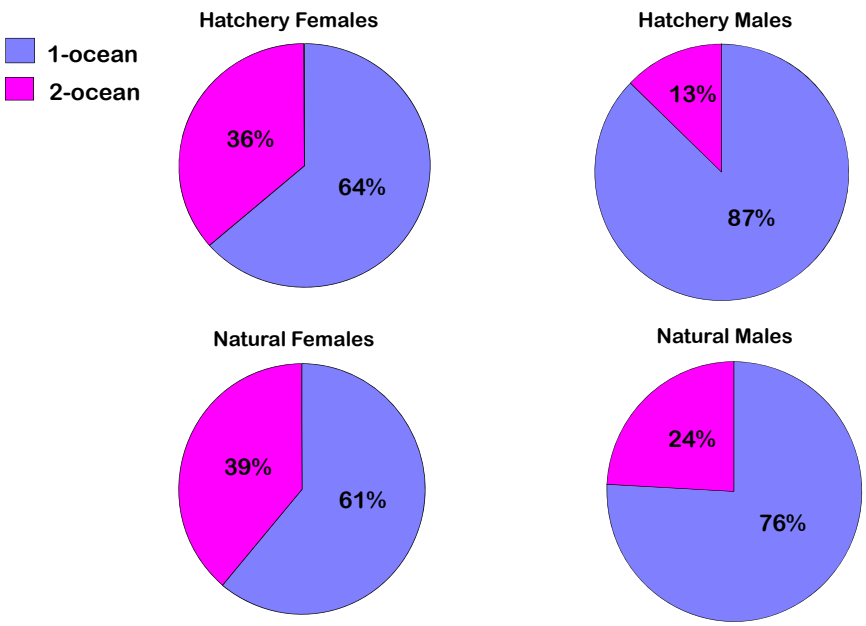

Figure 17. Average ocean age of hatchery- and natural-origin Imnaha stock steelhead females and males, brood years 1986 to 2004.

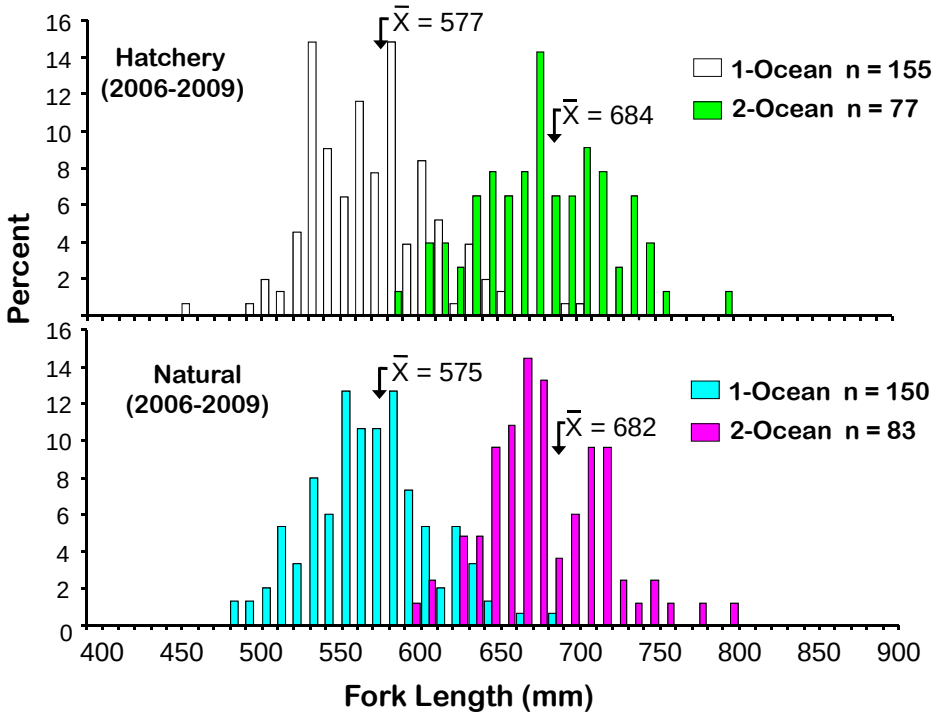

Figure 18. Length-frequency histograms showing average fork lengths of 1- and 2-ocean adult Imnaha stock hatchery- and natural-origin steelhead that returned to Little Sheep Creek in return years 2006 to 2009.

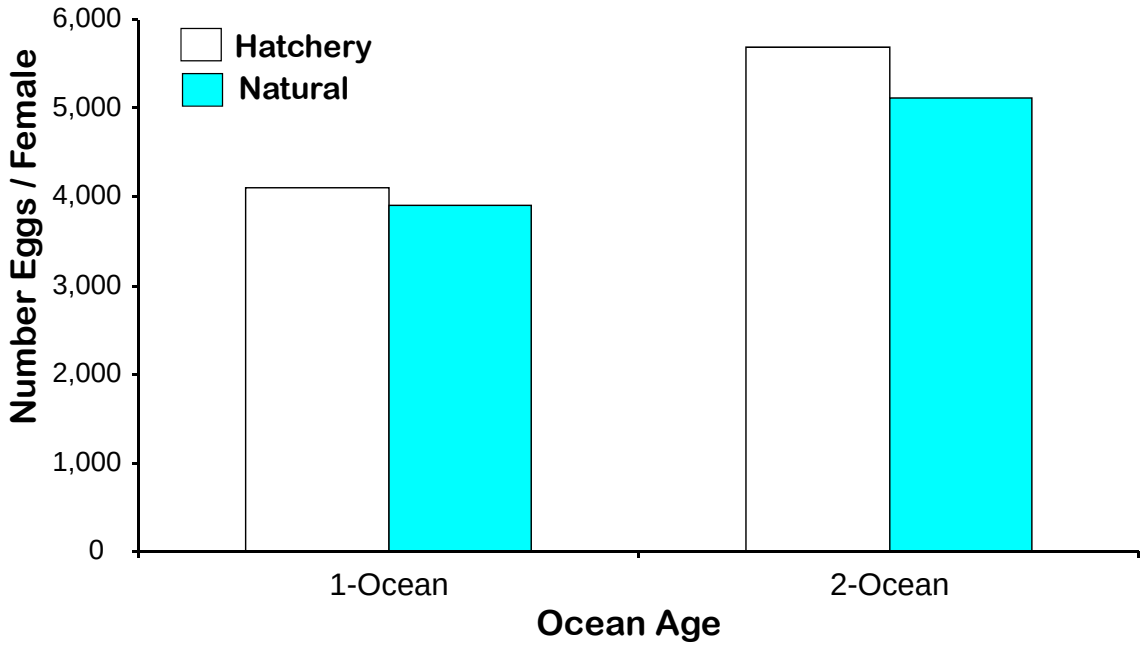

Figure 19. Mean age-specific fecundity of hatchery- and natural-origin Imnaha steelhead females.

The Imnaha River steelhead hatchery supplementation program was initiated in Little Sheep Creek prior to development of any experimental design to evaluate response. There were no pre-treatment data collected nor were there any reference/control streams established and monitored. Without pre-treatment data or reference streams we are forced to use alternative post-hoc approaches to assess natural abundance and productivity supplementation response in Little Sheep Creek. We compared natural-origin abundance of the Snake River population aggregate assessed at Lower Granite Dam with natural-origin abundance in Little Sheep Creek. If productivity of the natural-hatchery spawning aggregate in Little Sheep Creek is declining over time we would expect an asymptotic relationship or a distribution of residuals around the regression line to be skewed negatively for recent years. We found a highly significant linear relationship between run year specific natural-origin abundance at Lower Granite Dam and natural-origin abundance in Little Sheep Creek (Figure 20). There was no trend in residuals through time. Although this analysis does not adequately address the critical questions of whether supplementation has enhanced natural production or altered productivity, it does demonstrate that recent year natural-origin adult abundance in Little Sheep Creek during supplementation has maintained a consistent relationship to the Snake River aggregate returns.

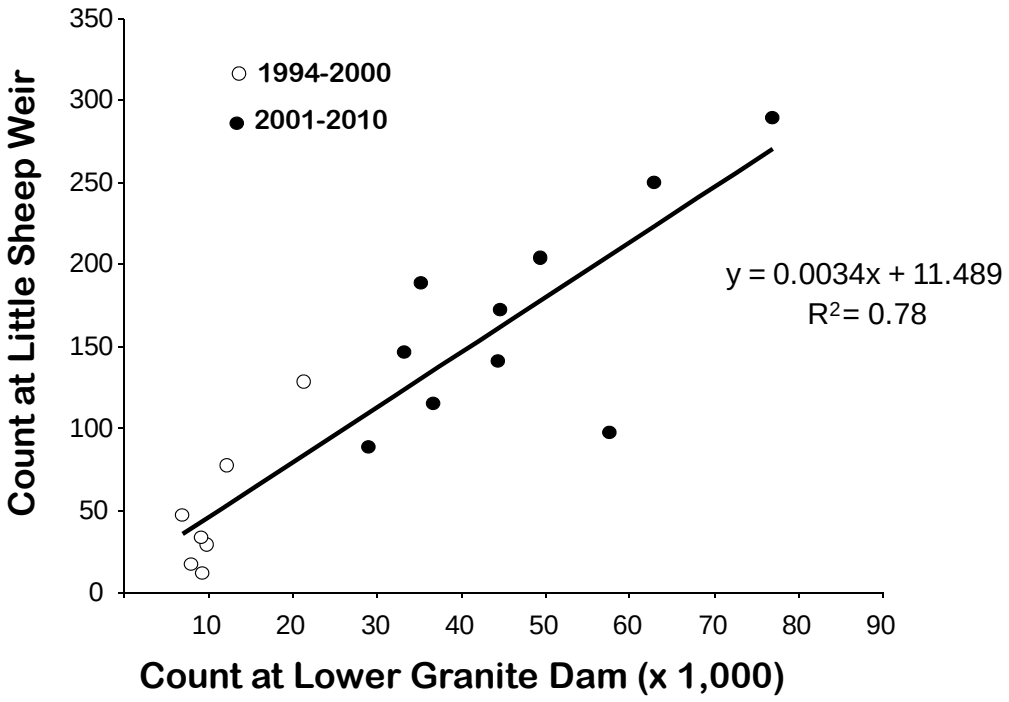

Figure 20. Number of natural-origin Imnaha stock steelhead adults returning to the Little Sheep Creek weir plotted against the number of natural-origin steelhead counted at Lower Granite Dam. Open circles are data from run years 1994 to 2000 and closed circles are from 2001 to 2010.

We conducted adult-to-adult stock recruitment analyses for Little Sheep Creek to investigate the extent of density dependence and to assess our escapement goal relative to the maximum recruitment estimate. We found a significant relationship between adult spawners and recruits and a strong signal of density dependence (Figure 21). The maximum recruitment estimate of 410 adult spawners is greater than our escapement target of 250 adults (Figure 21). However, there are a number of years prior to implementation of the new sliding scale when escapement was at or above the maximum recruitment level.

One of the important management objectives for this program is to restore recreational fisheries to historical levels. As stated previously, the recreational fishery was closed from 1975 through 1985. Sport fisheries have occurred every year since the fishery was reopened in 1986 and the number of miles of river open to fishing has increased slightly compared to historic fishing areas. Total combined catch of hatchery and natural fish increased annually from the late 1990s through 2006 (Figure 22). The highest total catch occurred in the 2007-2008 run year when we estimated a catch of nearly 2,500 steelhead. Natural fish consistently comprise greater than 50% of the fish caught. Total harvest has been variable; however, we have observed an increasing trend in harvest since the late 1990s (Figure 23).

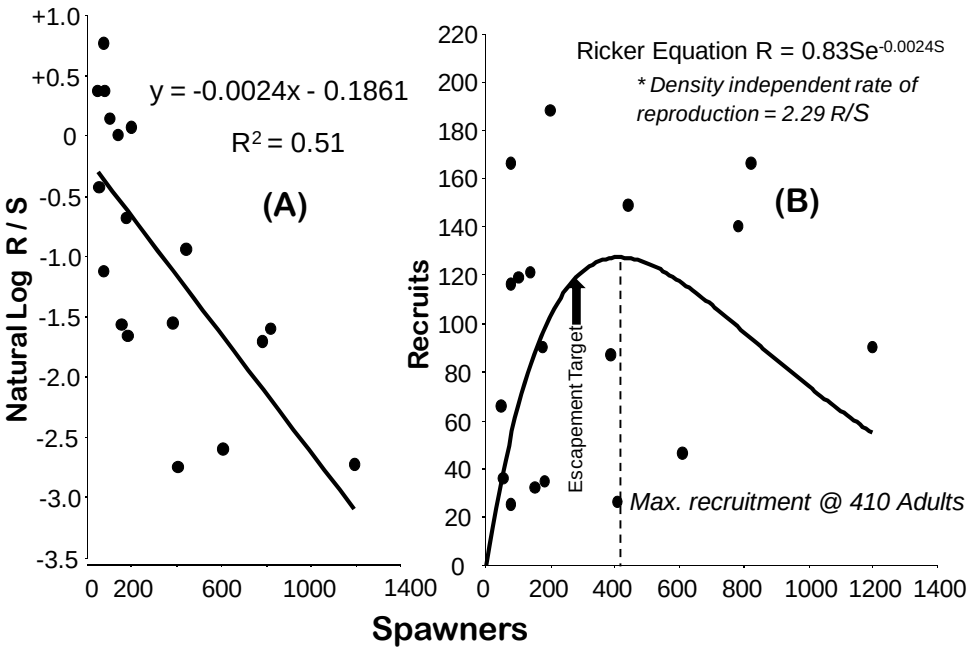

Figure 21. Adult-to adult stock recruitment for Imnaha stock steelhead spawning above the weir in Little Sheep Creek. (A) is a least square regression fit of the natural log of recruits/spawner plotted against the number of spawners; (B) is a Ricker recruitment curve fit to the number of recruits plotted against the number of spawners. The management target is for 250 adults to be passed above the weir.

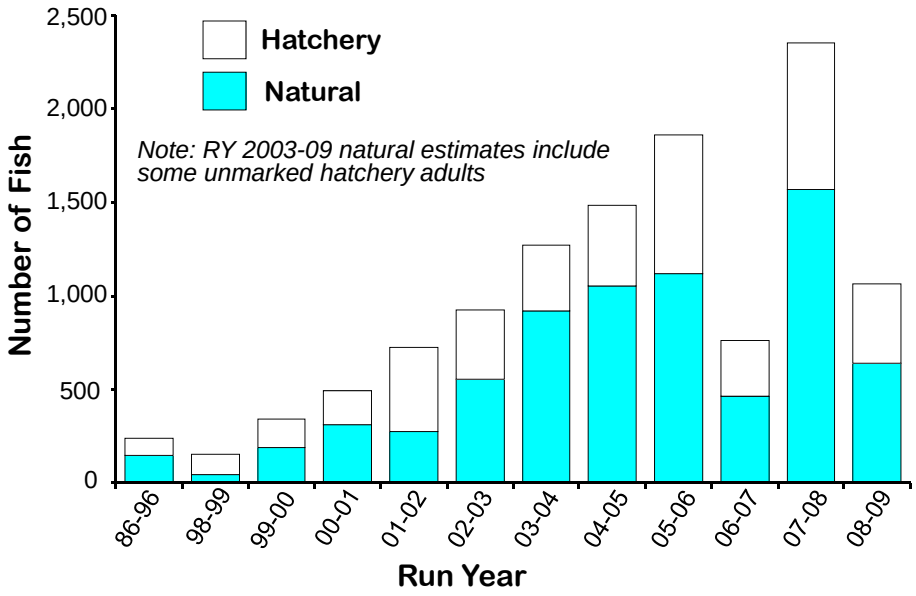

Figure 22. Estimated number of hatchery- and natural-origin steelhead caught in the Imnaha River fishery based on a statistical creel survey. Data from 1986-96 are an average annual catch estimate.

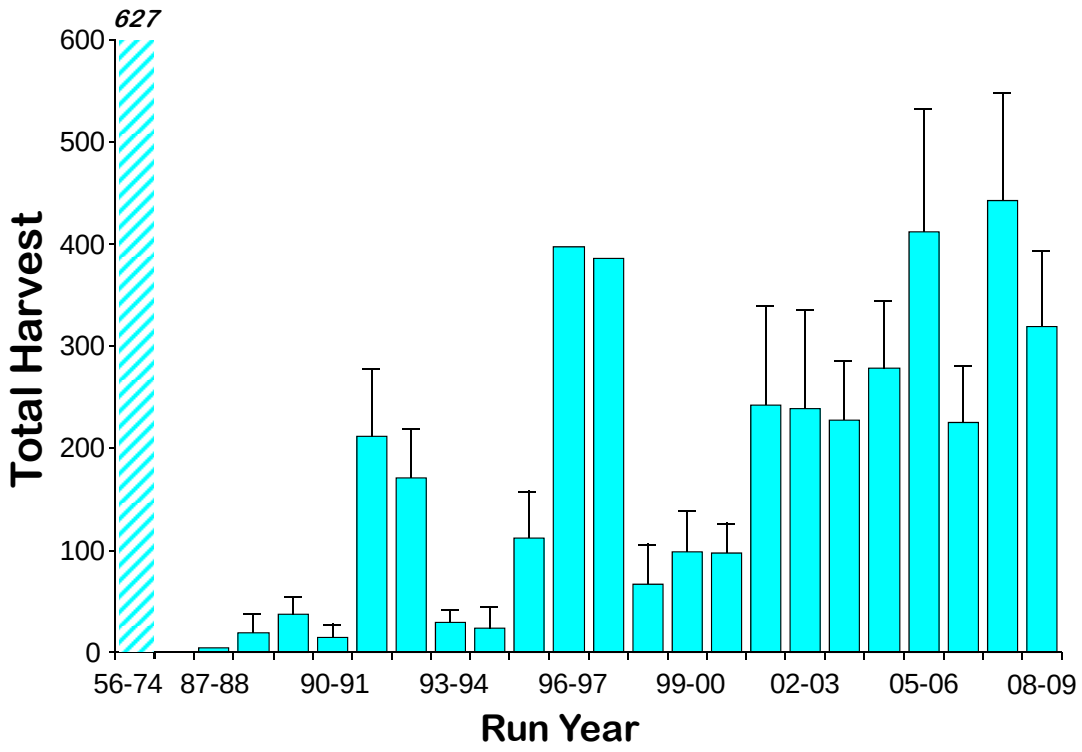

Figure 23. Estimated total annual harvest of hatchery-origin steelhead in the Imnaha River based on a statistical creel survey, run years 1987-88 to 2008-09. Data from 1956-74 are an average annual harvest estimate.

The steelhead recreational fishery was closed from 1975 to 1985 due to the depressed status of the natural population. The season was reopened in 1986 in the main stem Imnaha River in the same areas that had historically been open to fishing. The season has been open from early fall through mid-April and the fishery has been managed as a marked fish select harvest fishery with mandatory release of all natural-origin fish.

Annual harvest has been well below the historical average of 627 adults. Catch rates have been good since 2000 and have been far better than our goal of 10 hours/fish (Figure 24). Angler effort in the Imnaha fishery as indicated by angler days has been consistently below the historical average and has remained relatively stable at about 1,000 angler days. The majority of anglers participating in the Imnaha steelhead fishery are local anglers from Wallowa and Union counties (Figure 25).

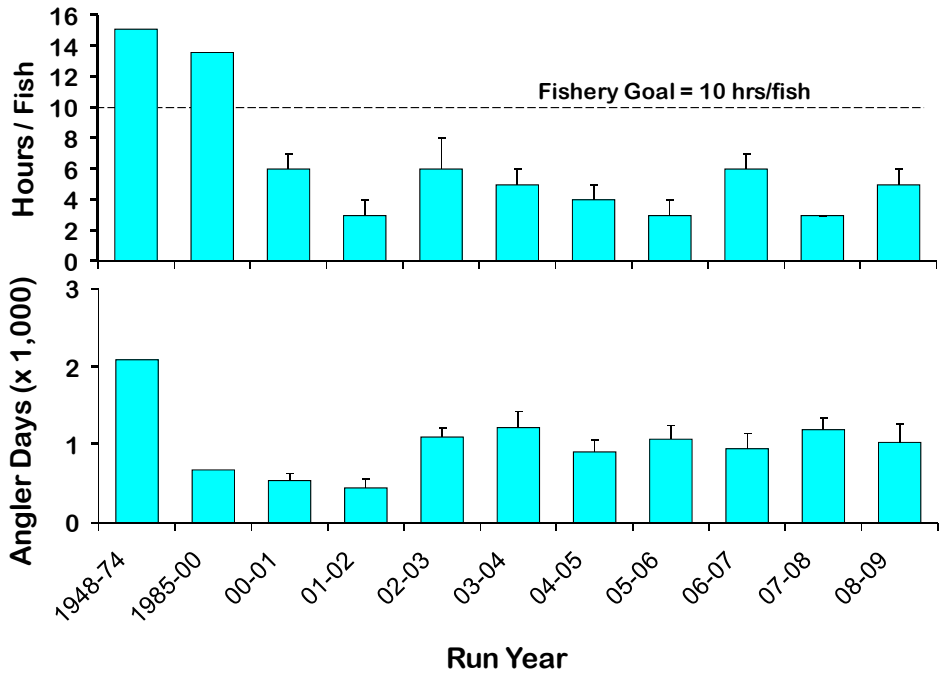

Figure 24. Recreational fishing effort (angler days) and catch rate (hours/fish) in the Imnaha River steelhead fishery based on a statistical creel survey, run years 2000-01 to 2008-09. Data from 1948-74 and 1985-2000 are average annual estimates.

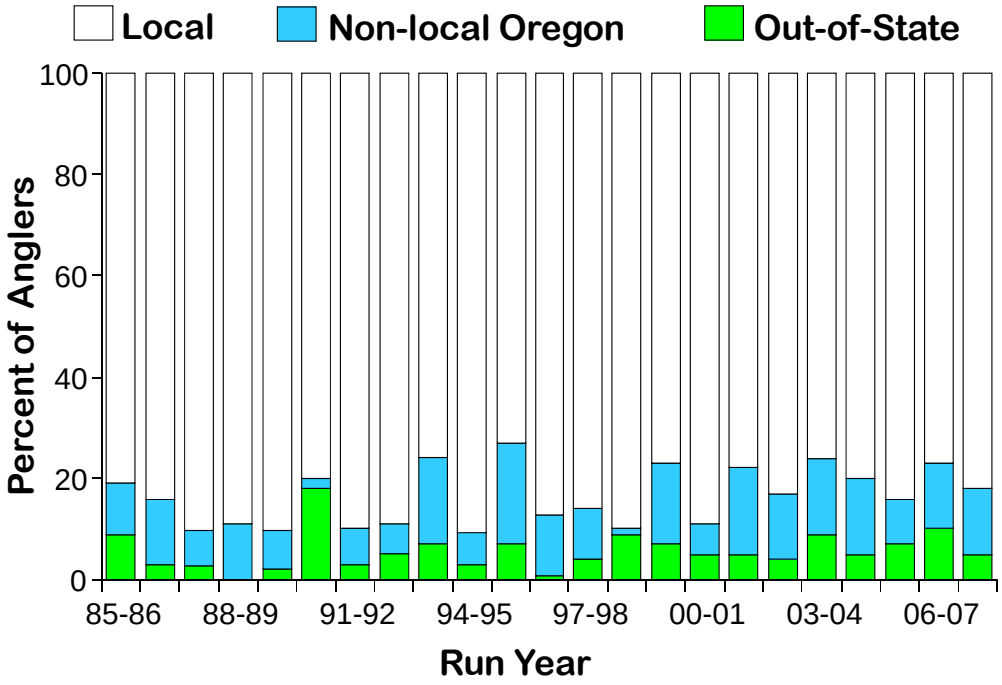

Figure 25. Origin of anglers fishing the Imnaha River, run years 1985-1986 to 2006-2007.

We estimated annual economic value for summer steelhead recreational fisheries in the Grande Ronde, Wallowa, and Imnaha river basins based on total estimated angler days (total hours fished/hours per completed angler), origin of anglers (local = Union and Wallowa counties; non-local = all other Oregon counties; Washington, and other states), and average expenditures of local and non-local angler days. Estimated angler days and origin of anglers were summarized from angler surveys conducted on the lower Grande Ronde, Wallowa, and Imnaha rivers each year from 1999 through 2009.

Average angler day expenditures for local and non-local anglers was obtained from data reported in *Fishing, Hunting, Wildlife Viewing, and Shellfishing in Oregon, 2008 State and County Expenditure Estimates*. These estimates included expenditures per day for the eastern Oregon travel region that included both "travel expenditures" and "fishing-related equipment expenditures" for freshwater local anglers ($74.31 per angler day) and for non-local anglers ($90.09 per angler day). Travel-related expenditures include accommodations, food services, food stores, ground transportation, outfitter/guide service, and equipment (tackle, clothing, boats, etc.).

Estimated annual expenditures by anglers participating in the Imnaha steelhead fishery is relatively low at less than $100,000 (Figure 26). Low angler effort is the primary reason that overall expenditures are low.

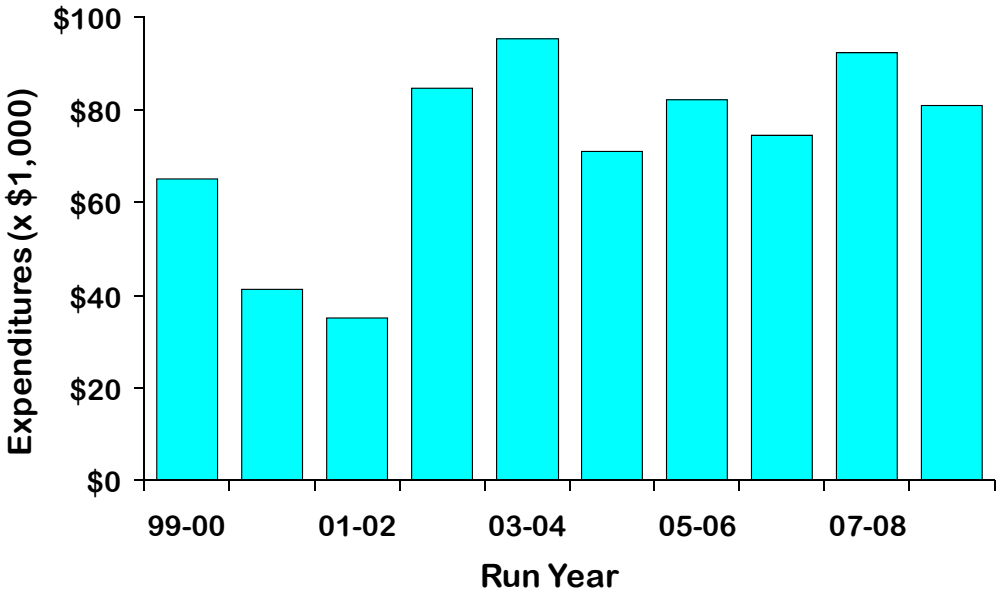

Figure 26. Estimated annual expenditures by anglers fishing the Imnaha River in run years 1999-00 to 2008-09.

The principle fish health issue influencing the Imnaha steelhead program is cold-water disease (Table 6). Cold-water disease was responsible for substantial mortality in only a few years during the program's operational history.

Table 6. Fish health issues in the Imnaha stock steelhead hatchery program.

Disease Issues	Consequences	Fish Health Response
Bacterial cold-water disease (CWD) caused by *Flavobacterium psychrophilum*	• CWD loss in most brood years primarily after ponding fry into indoor circular tanks at Irrigon Hatchery in late June/early July • After hauling to acclimation some smolts develop open sores with CWD bacteria being a contributing factor	• Antibiotic treatment with florfenicol for 10 d • 2005-2009 used florfenicol at 15 mg/kg • Recent years have had to treat at 10 mg/kg. Some repeat treatments necessary. • New approaches to be taken in 2012 for prevention of early lifestage CWD loss: 1)Vexar substrate for heath trays for both stocks 2)BioPro starter feed trial for both stocks

SUMMARY AND CONCLUSIONS

Broodstock Development and Management

Broodstock development to levels providing adequate returns to meet smolt production goals occurred rapidly (by year six). Natural-origin fish dominated the broodstock composition from 1982-1986; however, natural-origin fish comprised a very small fraction of broodstock from 1987-2007. The PNI was very low until recent years when the new escapement and broodstock collection sliding scale management plan was implemented.

In-Hatchery Performance

Adult prespawn mortality poses no significant problem in the program. Egg-to-smolt survival has been highly variable and poor in some years, primarily due to cold-water disease related mortality.

Production, Survival, and Adult Return Performance

We have reached our production goals in most years since 1988 and for those years in which we did not meet our goals we were only slightly below target. Smolt survival rates to Lower Granite Dam are moderate compared to other Snake River hatchery steelhead and are lower than rates for

Wallowa stock. We have consistently reached our adult return goals with achievement in eight of the last ten years. SAR goals have been achieved in eight of the last ten years. The SAS goal has not been achieved for any broodyear to date. The R/S values for hatchery fish have been consistently high and have averaged nine times the R/S of natural spawners in Little Sheep Creek.

Imnaha hatchery steelhead are exploited at very low rates (36%) relative to other Snake River hatchery steelhead stocks. Thus, the resulting escapement rates to the release locations are high. Large numbers of surplus hatchery fish return to Little Sheep Creek annually and most of this surplus is outplanted to Big Sheep Creek. A significant proportion of the Big Sheep outplants rerun back to Little Sheep Creek. There is inadequate monitoring underway to assess the benefits or impacts of outplanting into Big Sheep Creek.

Stray rates have generally been low for Imnaha hatchery fish and the majority of strays are recovered in the Deschutes River basin. Few strays have been recovered in the Snake River basin tributaries. Although recreational fisheries have been reopened and sustained on an annual basis, harvest and effort have not been restored to historical levels.

Natural Production Monitoring

The natural population viability status is unknown due to a lack of abundance data at the population scale. Abundance and productivity monitoring has been expanded considerably with PIT tag arrays and weir counts operated by the Nez Perce Tribe. These efforts will significantly improve estimates of abundance/productivity, spatial structure, and hatchery fraction.

Supplementation: Life History and Spawning Characteristics

Hatchery fish return at a similar ocean age as do natural-origin fish for combined sexes. However, a higher proportion of hatchery males return as 1-ocean adults. Run timing and spawn timing are similar between hatchery and natural fish. We have not observed any difference in size-at-age.

Supplementation: Abundance and Productivity

We have achieved a significant life cycle survival advantage for hatchery steelhead with a R/S advantage of 9:1. We have substantially increased total spawners in Little Sheep Creek with passage of large numbers of hatchery fish above the weir. We have observed a trend of increasing number of natural-origin fish in many years; however, the trend parallels the Snake River aggregate natural-origin abundance and therefore cannot be attributed to supplementation.

Recruits per spawner for naturally spawning natural- and hatchery-origin fish has averaged much less than 1.0 and has been above replacement for only five of the last 18 brood years. The relative reproductive success of hatchery fish is less than one-half that of natural-origin fish. This poor natural production performance is a strong contributor to the low R/S for the spawning aggregate.

Stock recruitment analyses indicate that adult escapement levels were well into the range of strong density dependence for many recent years. It appears that the escapement target of 250 adults annually is a sound management target near the inflection of the stock-recruitment curve.

Imnaha Steelhead Hatchery Program Adaptive Management Changes

We have made many adaptive changes to this program throughout the years of operation. Adaptive management changes included the following: 1) reduced smolt production numbers to reduce the magnitude of surplus returns to Little Sheep Creek; 2) modified sliding scale to increase proportion of natural-origin broodstock, reduce hatchery proportion above the weir, improve PNI, and provide a more reasonable escapement level given capacity considerations; 3) implemented volitional release strategies with removal of non-migrants to reduce juvenile ecological interaction risks; 4) implemented 4.5/lb release size goal over 5/lb to maximize SAS; and 5) developed food bank outlets for surplus hatchery returns.

Imnaha Steelhead Program Hatchery Scientific Review Group (HSRG) and Hatchery Review Team (HRT) Recommendations and Responses

HSRG – Develop conservation objectives for the Big Sheep Creek component, develop abundance and productivity estimates, develop a properly integrated program with appropriate PNI, pNOB and pHOS to achieve conservation standards. Requires ability to collect natural origin adults and manage spawning composition.

> Response: Outplanting of large numbers of adults continues and discussions are underway on conservation objectives and monitoring plan. Adult PIT tag arrays will provide estimates of natural escapement.

HSRG – Convert the existing integrated program into a "stepping stone" program for Little Sheep Creek. Include a small integrated program to achieve conservation benefit and a segregated program to achieve harvest.

> Response: Managers have not yet adopted this strategy; rather, they reduced smolt production and revised the sliding scale management plan to address the concerns with low PNI.

HRT – Discontinue the release of smolts and adults into Big Sheep Creek unless this activity can be justified based on specific goals. Goals must be developed and weighed against the risks that outplants pose to the natural population, which are currently high. Develop a monitoring and evaluation program that will determine if the desired benefits are being obtained.

> Response: The Big Sheep outplanting program is under co-manager discussion. No actions have been taken to address the HRT recommendations.

HRT - Revisit and adjust the sliding scale so that it is consistent with research and conservation goals of the program.

> Response: The sliding scale has been revised to reduce hatchery proportions spawning naturally to 50% and to increase the natural-origin proportions in the broodstock.

HRT – Continue to monitor residualism.

> Response: Monitoring of residual abundance and characteristics continues annually in Little Sheep Creek.

FUTURE PROGRAM CHALLENGES AND NEEDS

There are a number of program challenges that face this hatchery program in the future. It is desirable to improve the PNI for this program to a level that is appropriate for a supplementation program. This will be difficult given the numbers of natural-origin fish that return annually and the substantial number of broodstock needed to meet annual smolt production goals.

The disposition of large numbers of surplus hatchery adults remains a challenge. Continued outplanting of large numbers of hatchery adults into Big Sheep Creek places the Big Sheep Creek spawning aggregate at risk. Recent data indicate that there are substantial numbers of natural-origin spawners that return to Big Sheep Creek and supplementation may not be warranted.

We have documented significant residualism of hatchery releases in Little Sheep Creek. Continued focus on developing rearing and releasing strategies that maximize SAS and minimize residualism would be prudent.

Improving the relative reproductive success of hatchery fish is essential to achieving supplementation success; however, alternatives other than improving PNI have not been identified.

Increasing angler participation to increase in-basin exploitation and reduce surplus hatchery fish is desired; however, beyond increasing public outreach few other alternatives are available.