Dworshak National Fish Hatchery Spring Chinook Salmon Program

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Introduction and Background

Dworshak National Fish Hatchery is in North Central Idaho approximately one mile downstream from Dworshak Dam, at the confluence of the North Fork Clearwater River (NFCR) and the mainstem of the Clearwater River. The hatchery, originally constructed in 1969, is owned by the United States Army Corps of Engineers and was built to mitigation for the loss of summer steelhead resulting from the construction of Dworshak Dam on the NFCR. In 1982 the hatchery was expanded with the funding and construction of thirty raceways to rear 1.4 million spring Chinook salmon (SCS) as part of the Lower Snake River Compensation Project.

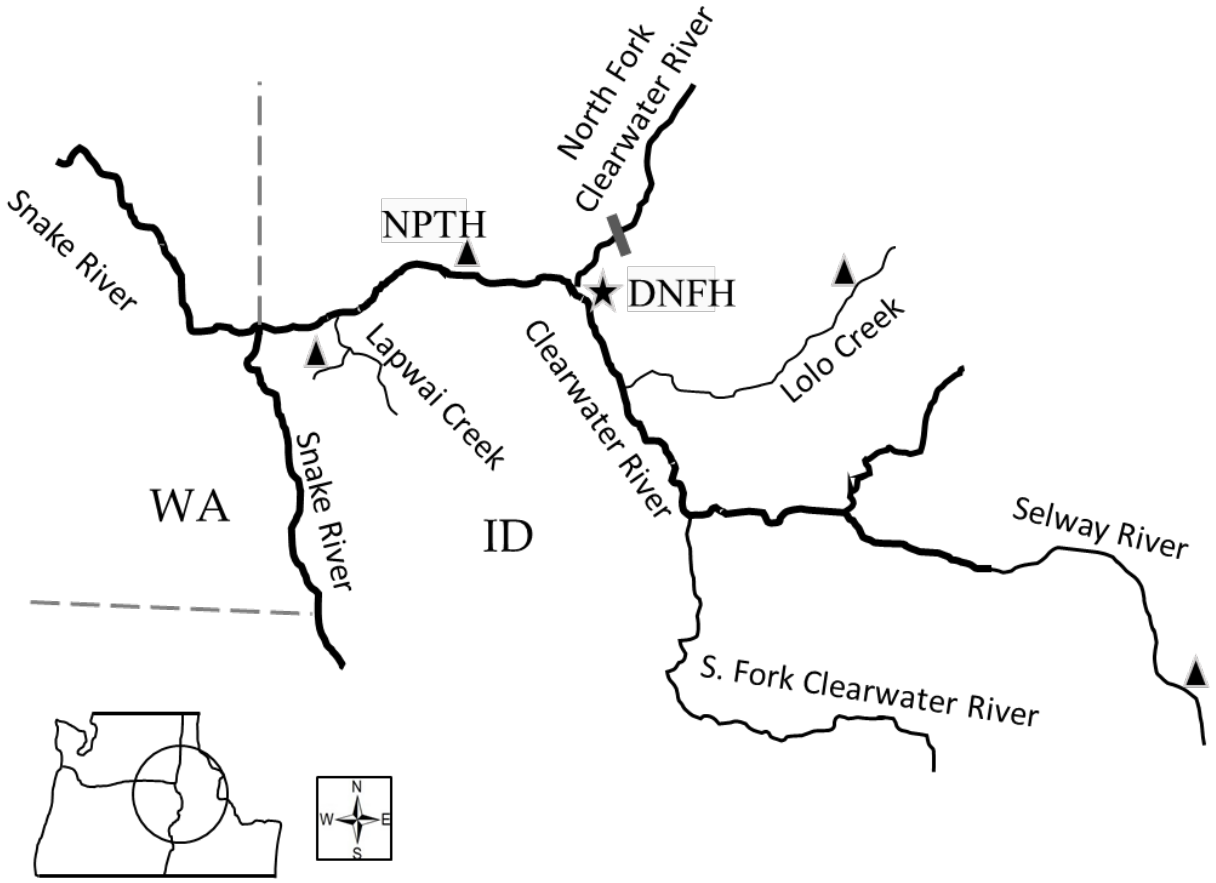
The United States Fish and Wildlife Service (USFWS) operated the hatchery until the Congressionally authorized Snake River Basin Adjudication (SRBA) Settlement Agreement (SRBA Agreement) gave joint management of the hatchery to the Nez Perce Tribe. In 2022 the NPT assumed full operational authority of the hatchery.

The adult return goal for the Dworshak SCS program is 9,135 spring Chinook to the project area above Lower Granite Dam. This was after an expected harvest of 36,500 in the ocean, Columbia River and Lower Snake River sport, tribal and commercial fisheries. The original production goal of 1.4 million smolts was changed in 1996 to 1.05 million smolts resulting from the lowering of rearing densities in the raceways. Additional changes were made since 2010 that will be discussed in this report. Currently the SCS release goal as described in the US vs OR agreement, is 1.35 million smolts at 20 fish per pound (fpp; Table 1). If adequate brood stock was available a maximum of 1.65 million smolts are reared and released as part of a co-manager agreement to increase production in the basin. In addition to the onstation smolt release, the DNFH LSRCP SCS program includes the rearing and release of 300,000 parr released into the upper Selway River and 180,000 pre-smolts transferred to Nez Perce Tribal Hatchery (NPTH) for final rearing and release at other locations in the basin (Table 1; Figure 1). The NPT smolts were originally released in Lolo Creek. However, difficulties reaching the release site in the spring resulted in this group being released at NPTH in numerous years. Starting in 2022 (BY2020), this group will be released in Sweetwater Creek (a tributary of Lapwai Creek) in hopes of increasing survival and adult returns, providing a local Tribal fishery and potentially a future brood stock collection location.

Table 1. Lower Snake River Compensation Project spring Chinook salmon release groups reared and/or released at Dworshak National Fish Hatchery. Fish per pound – fpp; Adipose fin clipped – AD; coded wire tagged – CWT; passive integrated transponder tag – PIT; parentage-based tagging – PBT.

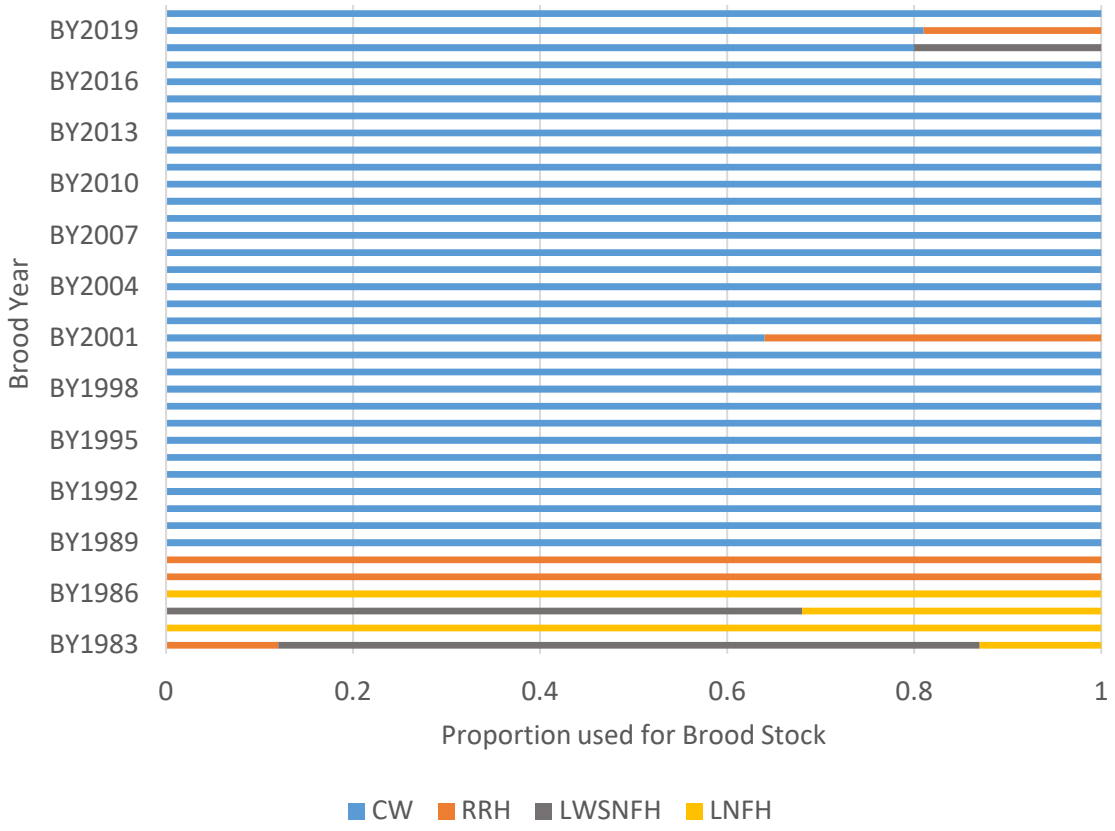
Release Group	Release Goal	Size at Release (fpp)	Release timing	Marking	tagging
NF Clearwater River	1,350,000	20	Spring smolt	100% AD	120k CWT; 52k PIT; PBT
Selway River	300,000	100	Summer parr	unmarked	PBT
Lolo/NPTH/Sweetwater	180,000	20	Spring smolt	100% AD	60K CWT; 600 PIT; PBT

Figure 1. Map of the Clearwater River basin with the location of Dworshak National Fish Hatchery (DFNH; star) and satellite release locations (triangles) of the Lower Snake River Compensation Project spring Chinook salmon program.



For the first five years of the program the SCS brood stock source were a mixture of Carson and Rapid River stocks (Figure 2). Since then, the brood source goal is locally-trapped Clearwater stock, which has been largely successful since 1989 (Figure 2). SCS in the Clearwater basin are managed as a single stock to ensure brood needs are met for all hatcheries and release groups. SCS in the basin were reared and released at multiple locations in the basin. DNFH largely relies on fish returning to the hatchery but will utilize fish trapped at other locations to meet brood shortages (mainly from Kooskia Fish Hatchery). In addition, a relatively large proportion of SCS from other release sites, especially from fish reared at Clearwater Fish Hatchery (CFH) and released in the NFCR (across the NFCR from DNFH) enter the DNFH trap where it is not possible to distinguish among them. This results in a single brood stock consisting of the consistent annual mixing of SCS from multiple release locations.

Figure 2. Hatchery brood stock spawned at Dworshak National Fish Hatchery from 1982 to 2020. Dworshak/Clearwater – CW; Rapid River Hatchery – RRH; Little White Salmon Hatchery – LWSNFH; Leavenworth National Fish Hatchery – LNFH.



Management Objectives

- Provide for lost sport and tribal fishing opportunities in the Lower Clearwater River.
- Return adequate brood stock to meet Clearwater River basin production needs.
- Minimize impacts to natural populations in the Clearwater and downstream migration corridor.

Monitoring and Evaluation Objectives

- Evaluating the effectiveness of the program so it can be managed adaptively.
- Determining the annual total adult returns to assess if the program is meeting its mitigation goals.
- To document and communicate the program's success at meeting its program and management goals.
- Coordination of hatchery production and research, monitoring, and evaluation activities.
- Provide science-based recommendations for adaptive management of the DNFH SCS program.

Monitoring and Evaluation Results

The monitoring and evaluation (M&E) of DNFH spring Chinook program collects, manages and analyzes data from a range of performance measures generally following the definitions of the Ad Hoc Supplementation Workgroup performance measures (Beasley et al. 2008). For this document the metrics were grouped in four categories 1) In-hatchery performance; 2) juvenile performance; 3) adult performance and; 4) harvest performance. The key performance metric data for each category are presented in Table 2, with references to supporting figures at the end of the document. Unless otherwise specified, the estimates pertain to the NFCR onstation release group only. Data from the satellite releases are included in the figures, but in general haven't significantly influenced management decisions or included a limited number of release years. Ongoing production and M&E activities are described in annual reports (Young et al. 2019; Annual Report for Dworshak National Fish Hatchery, Fiscal Year 2020).

Impacts to natural populations were not extensively evaluated for this program, other than tracking adult straying to out-of-basin hatcheries and natural spawning areas using coded-wire tag recoveries. Results revealed that straying of spring Chinook was generally low, with rare recoveries at hatcheries or natural spawning areas outside the two mainstem Clearwater River basin hatchery trapping facilities (Nez Perce Tribal Hatchery and Kooskia Fish Hatchery). Recoveries of strays in natural spawning areas are not common or consistently recovered at any location.

Table 2. Monitoring and evaluation metrics for the Dworshak National Fish Hatchery spring Chinook program.

	Metric	Estimate (95% C.I.) or number of years goal was met	Comments
In-Hatchery Performance	Brood stock Abundance 1998 - 2020	21/23 years goal was met	Brood stock goals have generally been met for the program (Fig. 3). Trapping begins in mid-June and ends when brood needs are met. Shortages in BY18 and BY19 were backfilled with adults from Little White Salmon Hatchery and Rapid River Hatchery, respectively. Progeny from out-of-basin brood were released at sites without trapping facilities (Selway River parr) to limit incorporation in future brood.
	Pre-spawn Mortality 1998 - 2021	0.058 (0.042 - 0.075)	Recent adult prespawn mortality from 2007 - present averaged 1.7% and ranged from 0.1 to 3.0% (Fig. 4). Post-spawn female cull rate from BKD monitoring is also low, averaging 2.6% (Fig. 5).
	Egg-to-Smolt Survival 1998-2019	0.805 (0.825 - 0.785)	Egg-to-smolt survival was generally high with little variation. Estimates ranged from 68% to 91% (Fig. 6).
	Juvenile Release Number 1998 - 2021	22/24 years goal was met	Juvenile release goals were within 10% of goals for all but two years since 1998 (Fig. 7).
Juvenile Performance	Survival in the Hydrosystem 1998 - 2021	0.781 (0.767 - 0.794)	Juvenile survival to Lower Granite Dam was high and ranged from a low of 0.655 in 2017 to a high of 0.893 in 2010 (Fig. 8).
	Travel Time (days) 1998 - 2020	30.9 (32.4 - 29.3)	Juvenile travel time from release to Lower Granite Dam ranged from 13.9 (2019) to 43.3 days (2009; Fig 6). The relatively rapid travel times observed over the last few years resulted in a negative trend in the number of days from release to LGR (Fig. 9).

	Median Arrival Date/ Transport probablity 1998 - 2020	27-Apr	Given the juvenile by-pass capture probabilities and increased spill the proportion of fish transported has declined and averaged 20.6%. Transport rates over the last 5 years were less than 10% (Fig. 10).
Adult Performance	Adult Abundance 1998 - 2021	6,236 (4,468 - 7,938)	Overall adult return mitigation goal of 9,135 was achieved four times from 2010 to 2020, ranging from 951 to 11,087 (Fig. 11).
	Straying	<5%	Straying of DNFH released SCS was low, with few fish recovered at hatcheries or spawning grounds outside of the Clearwater River basin. Within the Clearwater River basin DNFH adult were observed at hatcheries, but few in natural spawning areas.
	Age-at-Return 1985 - 2019	Age 3= 9.5% (8.2 - 10.7) Age 4= 69.5% (66.7 - 72.2) Age 5= 21.1% (17.9 - 24.3)	The majority (79.3%) of adults return at age 4 and this was unchanged over time. The proportion of age 5 fish has declined over time from 20% to an average of 7% of the population currently (Fig 12). Historically jacks (age 3) made up approximately 6% of the population. Jack numbers started increasing in 2007 and now comprise approximately 15% of the population on average (Fig. 13).
	SAR/SAS 1998 - 2016	SAR = 0.48% (0.32 - 0.64) SAS = 0.53% (0.38 - 0.78)	Return goals for Smolt-to-adult return (Fig. 14) were met 4/12 years. Smolt-to-adult survival goals were never met. The low SAR/SAS observed in BY2015 and BY2016 may have been negatively affected by being reared in a period of high total dissolved gas in the raceways. BY2015 juveniles showed extensive signs of gas bubble disease prior to release in the spring of 2017 (see 2a. below).
	Recruits/ Spawner 1998 - 2016	8.7 (7.2 - 10.2)	The average recruits per spawner was above replacement (>2) and was highly variable ranging from 0.9 (BY2015) to 22.3 (BY1998; Fig. 15).
Harvest Performance	Tribal Harvest 1997 - 2020	24/24 years	Tribal harvest from the NFCR, a surrogate for DNFH harvest, has occurred every year since 1998 (Fig. 16). Average adult harvest was 694 and ranged from 36 (1999) to 2,098 (2016). Although this was positive, the level of harvest did not meet NPT expectations of meaningful and significant harvest. In low return years a limited ceremonial harvest occurred.

	Sport Harvest 1997 - 2020	22/24 years	Sport harvest of DNFH returning adults in the Clearwater River has occurred for most years from 1998 – 2020. Average adult harvest was 1,665 and ranged from 0 (1999, 2019) to 8,355 (2001).
	Below LSRCP area Harvest 1998 - 2020	22/23 years	Harvest of DNFH adults below the compensation area (Ocean and Columbia River) varied greatly (Figure 17). Since 1998, harvest was reported for every year except 2019, peaking in 2001 with an estimated 4,546 adults harvested in ocean and in Columbia River sport and commercial and tribal fisheries.

Adaptive Management

Monitoring and Evaluation metrics were used to inform management decisions for three major objectives 1) increase adult returns; 2) maximize juvenile performance and; 3) optimize hatchery management. Below are brief descriptions of adaptive management changes that have occurred for each of these objectives since the last spring Chinook program review in 2010.

1. Increase Adult Returns

a. **SCS smolt production increases**: SCS smolt production was increased from 1.05 million to 1.35 million in BY2010 to increase adult returns and enhance harvest in the basin. Facility improvements providing increase flows and less water reuse to the raceways informed the decision to restore the raceway densities to that from the early years of the program.
b. **Conversion of Selway parr to smolt**: Beginning with BY20 the 300k parr were reared to smolt and released into the NFCR, increasing the onstation smolt release from 1.35 million to 1.65 million. Although evaluations were limited for the Selway parr group, evidence from PBT sampling at LGR indicated that very few adults returned from this release (Figure 10). Consequently, rearing to smolt will significantly increase survival and adult returns compared to the parr release.
c. **Move the Lolo Creek release group to Lapwai Creek**: The Lolo Creek smolt release began in BY16 but only occurred twice due to spring snowpack making it impossible for the trucks to reach the release site. In those years the smolts were released from NPTH. The restoration of river flows through the reduction in water withdrawals in Sweetwater Creek (major tributary of Lapwai Creek) restored higher natural spring/summer flows and reduced temperatures. Improved water quality and flows allowed for the opportunity to release SCS smolts into the Lapwai Creek drainage. The releases will provide an exclusive Tribal fishery and possible brood stock collection location. Releasing smolts

into the Lapwai Creek drainage has multiple benefits compared to Lolo Creek. Juvenile survival to LGR was lower for the Lolo Creek release compared to DNFH or NPTH (Figure 7), likely because the release site was higher in the basin. The release should provide benefits to juvenile survival and show increased SARs, similar to the release at NPTH. We will monitor this release and confirm survival increases and higher adult returns. Although a small number of adults from the Lolo Creek release were harvested in a pass-through fishery in the Lower Columbia River and in the Clearwater River, very few adults were harvested in an exclusive Tribal fishery in Lolo Creek. It is anticipated that adults returning to Lapwai Creek will provide significantly higher harvest, especially in the Tribal Fishery. Finally, Lapwai Creek is relatively small making it feasible to install and operate a picket weir to trap and collect adults for brood stock. During low return years it was difficult to trap brood stock to meet the needs of the entire basin with the limited adult trapping locations. Having an additional trapping location will provide an additional opportunity to collect adults and reach basin-wide brood stock goals.

d. **Increase juvenile rearing densities**: Following a three-year density study demonstrating increased adult returns from raceways with higher juvenile rearing densities, densities were increased from approximately 0.25 to 0.35 in all raceways. These results allowed for the increase smolt production as described in #2. Higher adult returns using the same space and water were an efficient way to increase production with minimal cost. A comprehensive description of the study design and results will be presented separately.

2. **Maximize juvenile performance**

a. **Installation of low-head oxygenators to the raceways**: Low-head oxygenators were installed during a long period (2017 – 2019) of high total dissolved gas in the NFCR (main water source). These units inject oxygen at the head of the raceway to supersaturate the water with oxygen. This not only maintains high oxygen levels but drives off nitrogen gas, reducing the impacts of nitrogen supersaturation and gas bubble disease. Starting in the winter/spring of 2017 and continuing through the spring of 2019, high snowpack and an extended turbine outage resulted in high spill levels from Dworshak Dam. BY15 Chinook salmon showed clinical signs of gas bubble trauma and were released early. After it was determined that high TDGs would likely continue for multiple years, LHOs were installed on A-bank raceways in spring of 2017 and on B-bank raceways in September of 2018. Monitoring revealed that oxygen levels were maintained at a higher level throughout the raceways. In addition to mitigating for the effects of high TDGs in the water, high oxygen levels should enhance the conditions throughout the rearing cycle, reduce disease outbreaks and produce higher quality smolts.

b. **Release timing study**: a study was initiated at DNFH and two other Clearwater basin hatcheries (CFH and NPTH) to investigate the affect of release timing on juvenile survival and adult returns. The study was initiated with releases in 2020 and will

continue for at least three years. Half of the release groups from each hatchery were released two weeks apart, with the first release around April1 and the second release around April 14. Juvenile survival to LGR will be evaluated using PIT tag detections. Adult returns will be evaluated using PBT at the LGR adult trap, fishery creel surveys and returns to hatchery traps. Although juvenile survival to LGR relatively high (Figure 7), the study will determine if small gains in survival are possible with different release times. Evaluating adult returns will provide complete live-cycle response to release time changes.

3. **Optimize hatchery management**

   a. **Hatchery coordination**: All Clearwater River basin hatcheries were managed through yearly Annual Operation Plan (AOP) meetings, weekly coordination calls and ad hoc meetings as needed to effectively manage brood stock collections, hatchery rearing, releases and harvest. The AOP process included two written documents, a Standard Operating Procedures (SOP), that describes normal or planned operations, and an AOP document that highlights deviations from the planned operations. These documents are edited and agreed to by co-managers annually. The AOP meetings also provide preseason run forecasts that are used to plan for adult collections, develop brood stock collection plans and set harvest shares. In-season planning occurs through weekly coordination calls. Adult returns are tracked in real-time through PIT tag detections in the hydrosystem and trapping and harvest levels at each hatchery or area are adjusted based on in-season abundance estimates. Weekly coordination calls continue from early spring until late fall when spawning is completed for all species and runs. Finally, at the end of the season comanagers meeting to review returns, production and harvest based on data and outcomes from the previous year.
   b. **Development and refinement of a brood stock collection methods**: The use of a brood stock calculator tool was started prior to the last program review and has been refined to become increasingly valuable for managing brood stock collections and spawning. Production and M&E staff collected data and calculated metrics important for projecting final smolt totals such as fecundity, female prespawn mortality, female disease culling and egg to smolt survival. The five-year average estimate for each metric was entered into a worksheet (brood stock calculator) along with the projected smolt release number to produce the number of male and female adult collection goal. This ensured that the brood stock target is based on the most recent biological, environmental and in-hatchery variables affecting smolt production. The main goal is to collect an optimal number of fish for brood and leave the remaining fish in the river for sport and Tribal fisheries and provide supplementation benefits where applicable.
   c. **Parentage-based tagging**: This was started in 2008, prior to the last program review, and has become an invaluable tool for all M&E and hatchery production. Utilizing parental

genotyping and genetic parentage analysis, PBT tags nearly 100% of juveniles and allows for non-lethal sampling hatchery juveniles and adults nearly anywhere from release to return. Current and future small-scale studies conducted at DNFH rely on PBT to evaluate adult returns, providing increased flexibility in study design at a lower cost compared to other tagging methods (CWT). For example, the density study and release timing study estimated adult returns from fish trapped and sampled at LGR, in the sport fishery creel surveys and at returns to hatchery racks. DNFH M&E staff are developing a database with progeny and parental data to investigate genetic components (heritability) of important traits such as size-at-return, age-at-return and spawn timing. It also could be possible to evaluate adult returns from different rearing systems, methods and containers and track adult returns following disease outbreaks or other rearing issues. The use of PBT increased precision around the annual estimates of adult returns to the LSRCP area through the systematic sampling of adults trapped at LGR.

Conclusions

Management of the DNFH spring Chinook program is guided by adaptive management principles and extensive basin-wide collaboration among comanagers. Though not yet consistently reaching mitigation goals, these efforts create a dynamic program that continuously explores ways to maximize both in-hatchery and post-release productivity and survival. This science-based process relies on regionally accepted M&E metrics and small-scale studies that provide managers with the best information in which to guide the program. The ultimate objective is to achieve DNFH mitigation goals and provide abundant adult returns and harvest of spring Chinook salmon in the Clearwater River basin.

Figures

Figure 3. The number of spring Chinook salmon brood stock trapped (blue bars) and brood stock goals (black lines) at Dworshak National Fish Hatchery for spawn years 1989 to 2020.

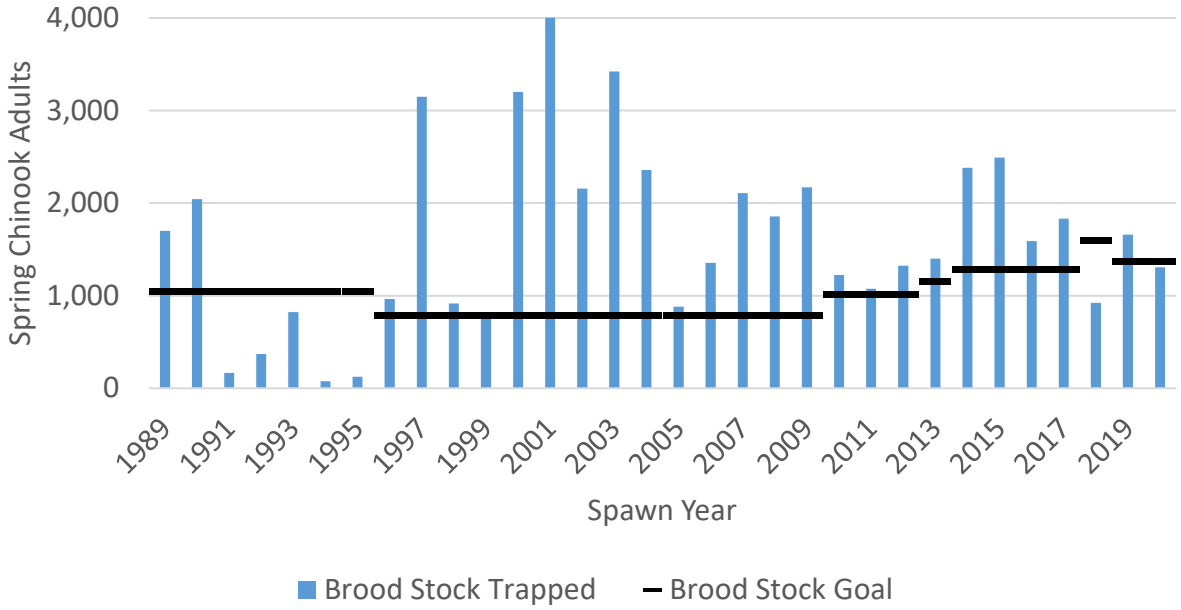


Figure 4. Pre-spawn mortality of spring Chinook salmon brood stock trapped and spawned at Dworshak National Fish Hatchery for spawn years 1996 to 2021.

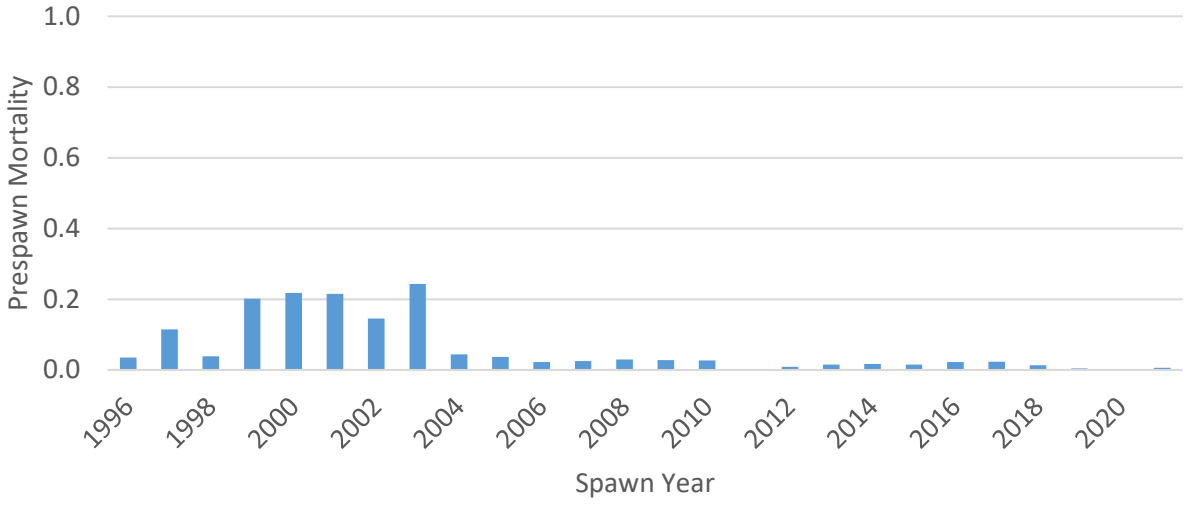


Figure 5. Female spring Chinook salmon bacterial kidney disease (BKD) annual cull rate at Dworshak National Fish Hatchery for spawn years 2006 to 2021.

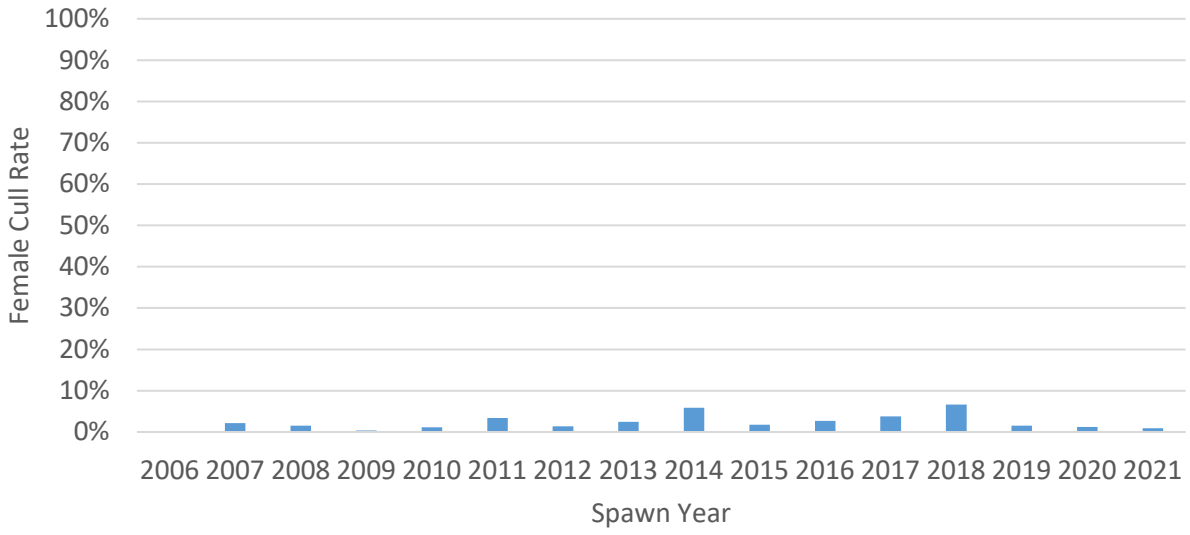


Figure 6. Green egg to smolt survival of spring Chinook salmon spawned and reared at Dworshak National Fish Hatchery for spawn years 2000 to 2021.

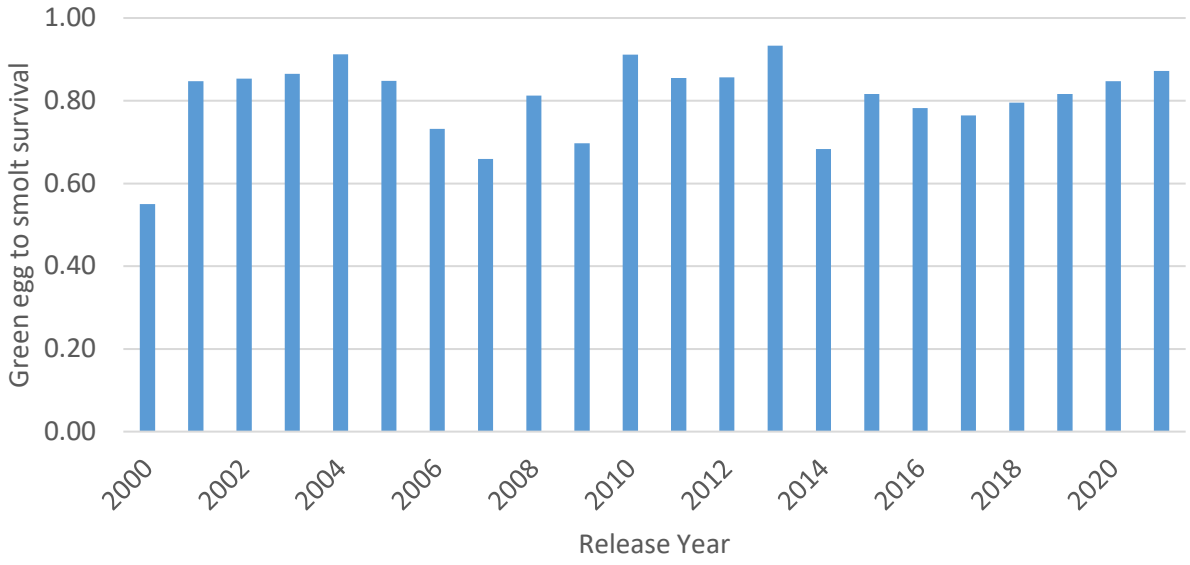


Figure 7. Annual spring Chinook salmon juvenile release numbers (bars) and release goals (black lines) from Dworshak National Fish Hatchery for release years 1983 to 2020.

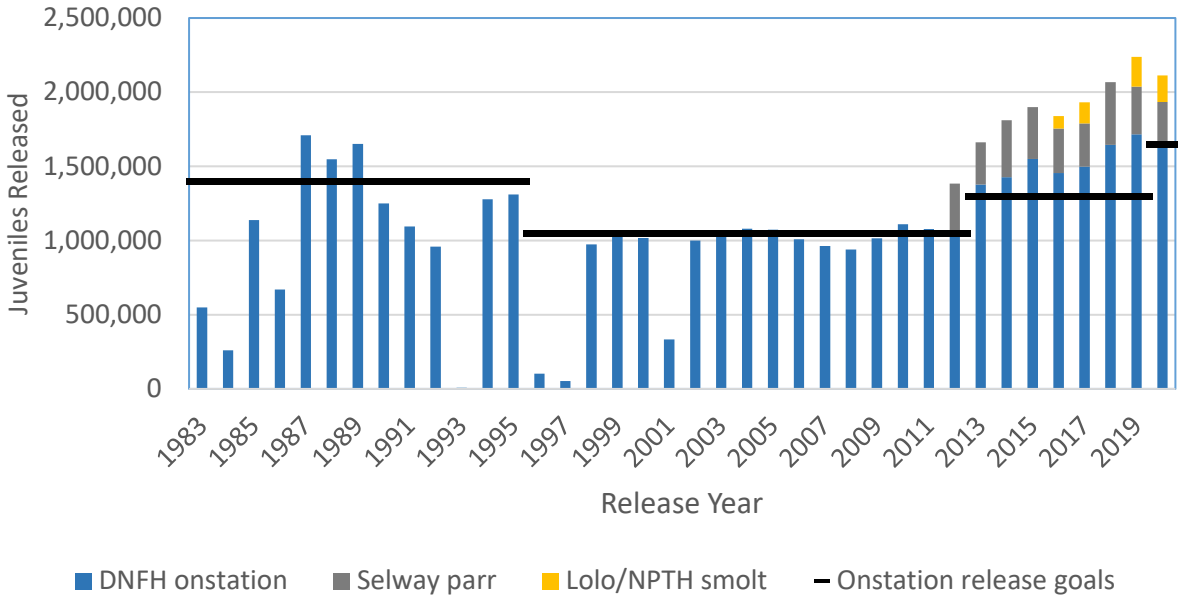


Figure 8. Annual spring Chinook salmon juvenile survival from release to Lower Granite Dam for Dworshak National Fish Hatchery for release years 1998 to 2020.

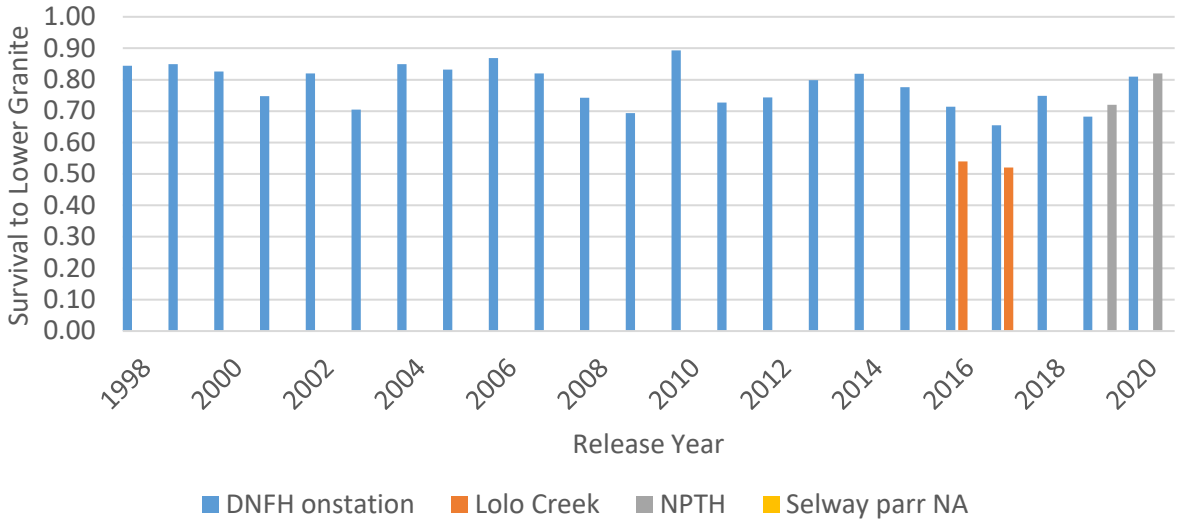


Figure 9. Travel time in days from release to detection at Lower Granite Dam for juvenile spring Chinook salmon juveniles released from Dworshak National Fish Hatchery and the trend line (black hashed) from release years 1998 to 2020.

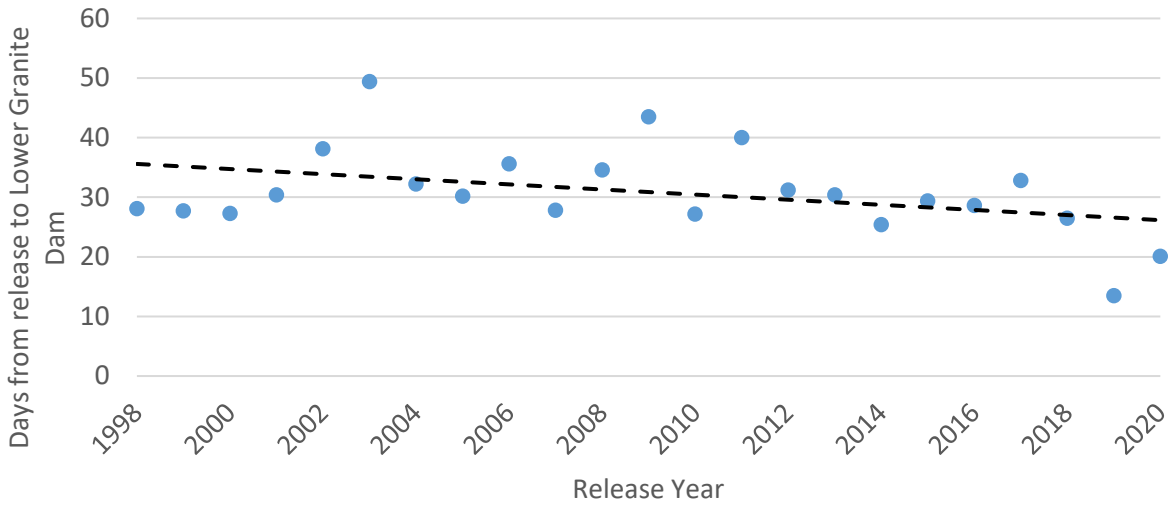


Figure 10. Proportion of juvenile spring Chinook salmon released from Dworshak National Fish Hatchery that were captured at Lower Granite Dam and transported through the hydrosystem from migration years 1998 to 2020.

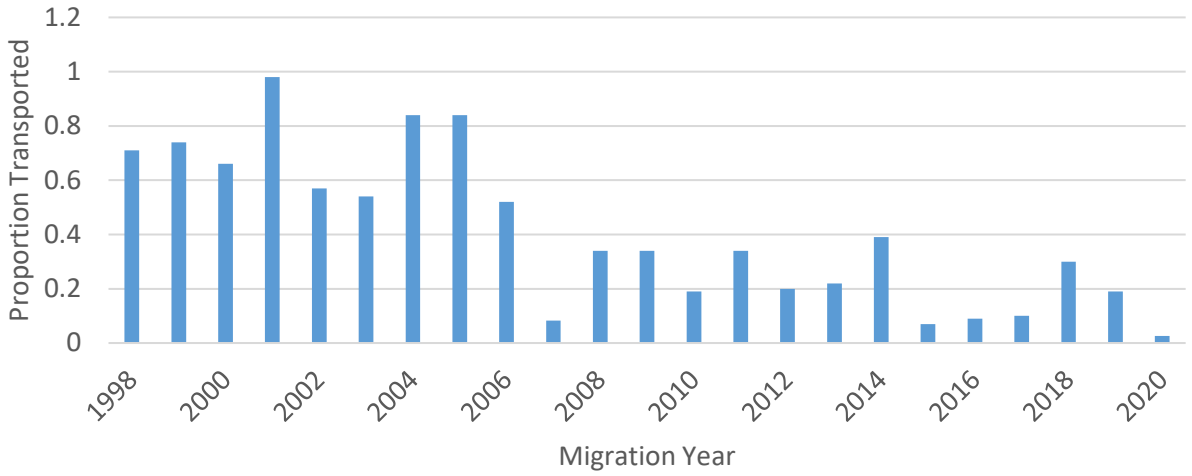


Figure 11. Annual adult returns to Lower Granite Dam from Dworshak National Fish Hatchery (DNFH) spring Chinook salmon releases, including the North Fork Clearwater River, Selway River parr and Lolo Creek/Nez Perce Tribal Hatchery groups for return years 1985 to 2020. The orange bar is the Lower Snake River Compensation Project mitigation goal for DNFH.

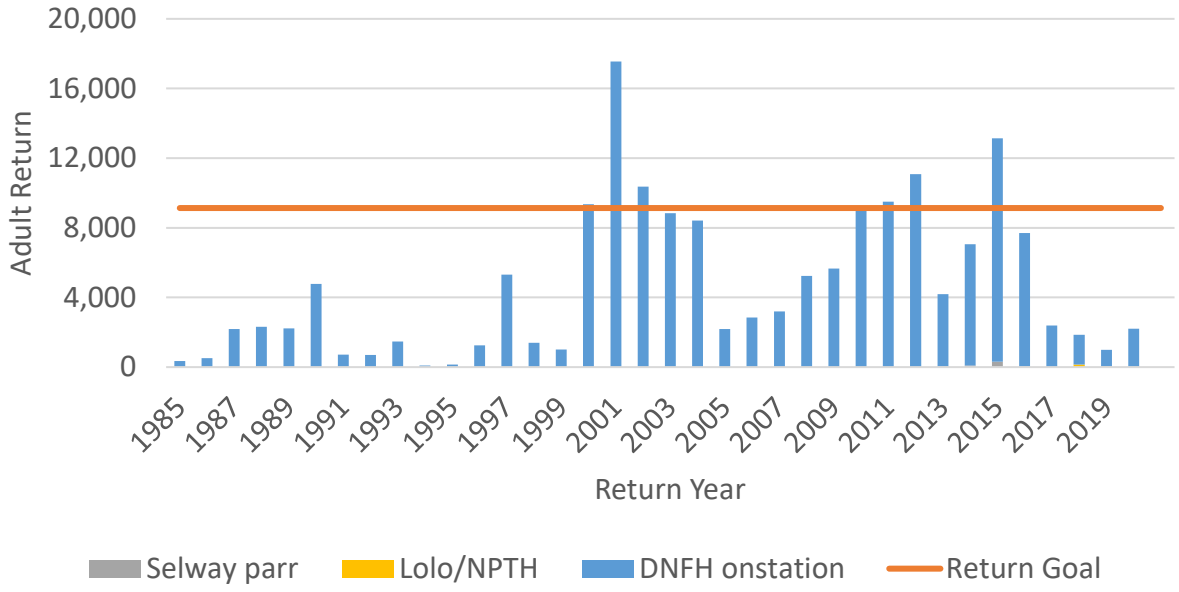


Figure 12. Age-at-return of adult spring Chinook salmon returing to Dworshak National Fish Hatchery (DNFH) spring Chinook salmon releases from brood years 1983 to 2016.

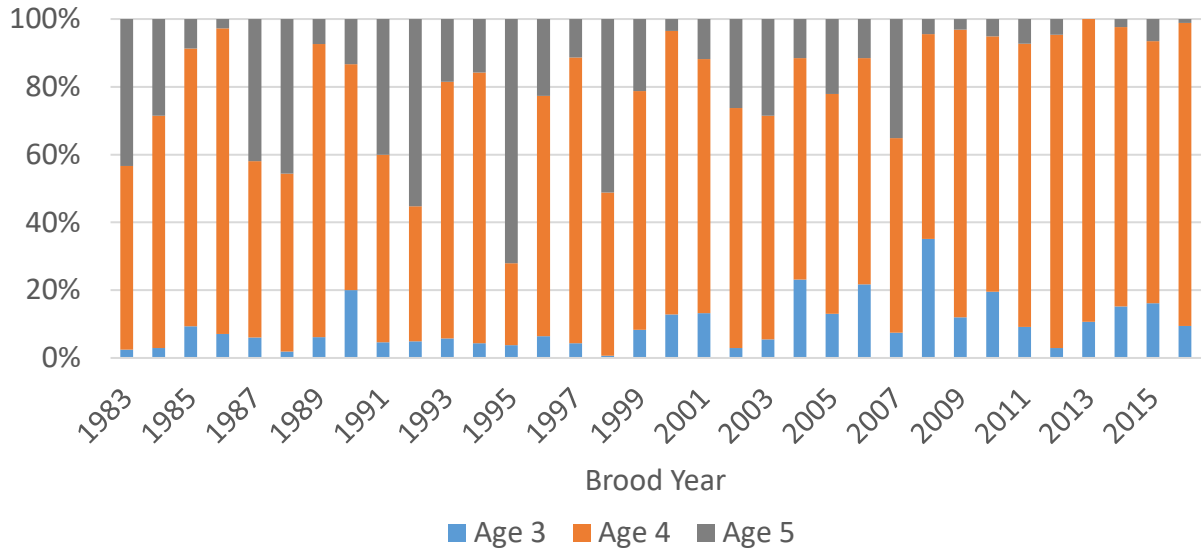


Figure 13. Five-year average trends in age-at-return of spring Chinook salmon adults returning to Dworshak National Fish Hatchery (DNFH) from brood years 1983 to 2016.

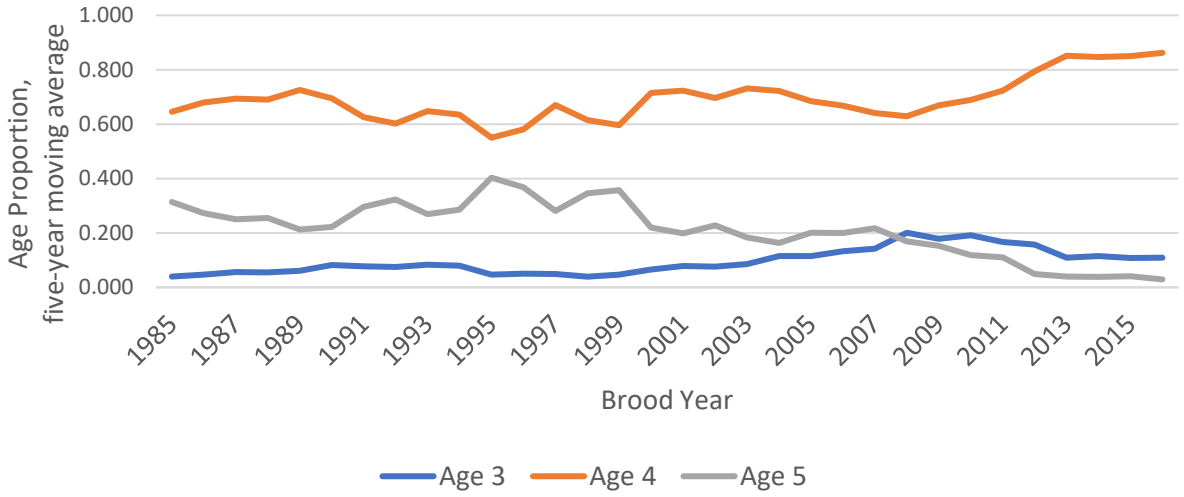


Figure 14. Smolt-to-adult (SAR) and smolt-to-adult survival (SAS) of spring Chinook salmon from juveniles released at Dworshak National Fish Hatchery (DNFH) to adult returns at Lower Granite Dam from brood year 1983 to 2016.

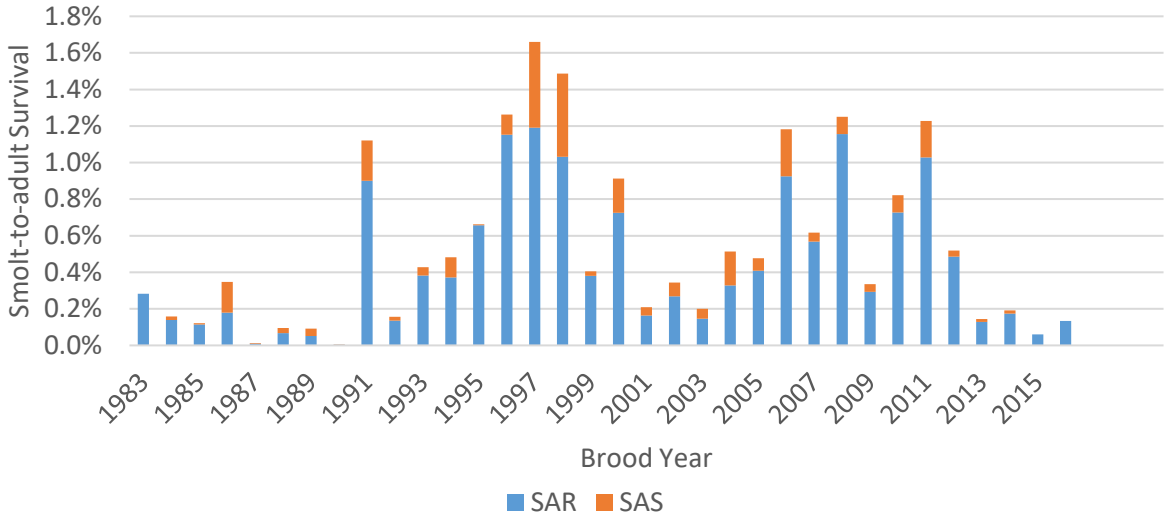


Figure 15. Annual Recruits per spawner of spring Chinook salmon adults returning to Dworshak National Fish Hatchery (DNFH) from brood years 1983 to 2016.

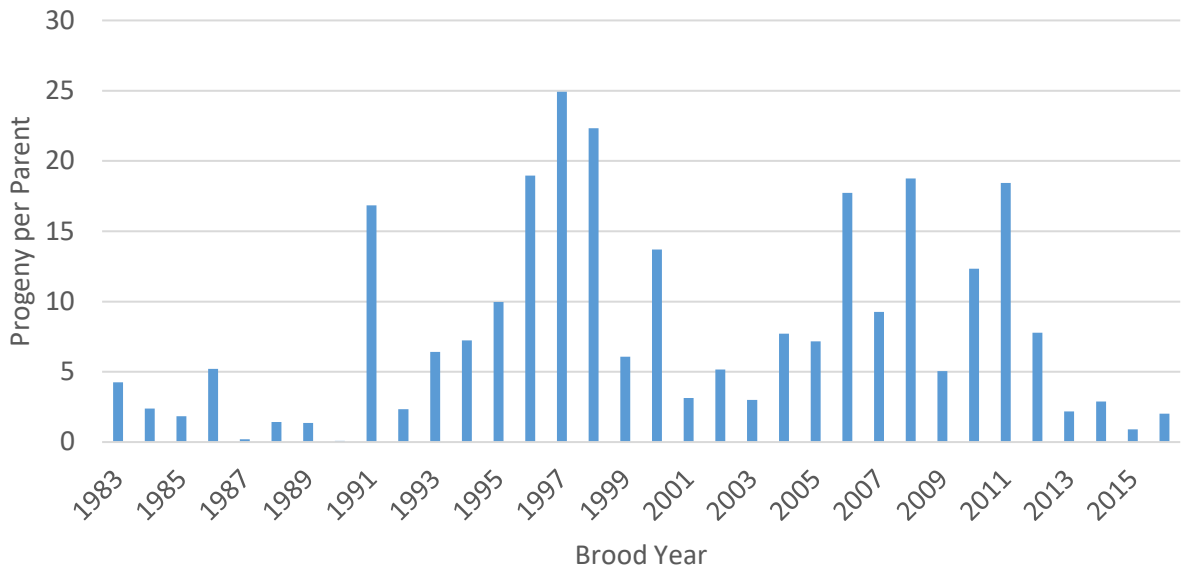


Figure 16. Estimated Tribal harvest of spring Chinook salmon adults from the North Fork Clearwater River from return years 1997 to 2020.

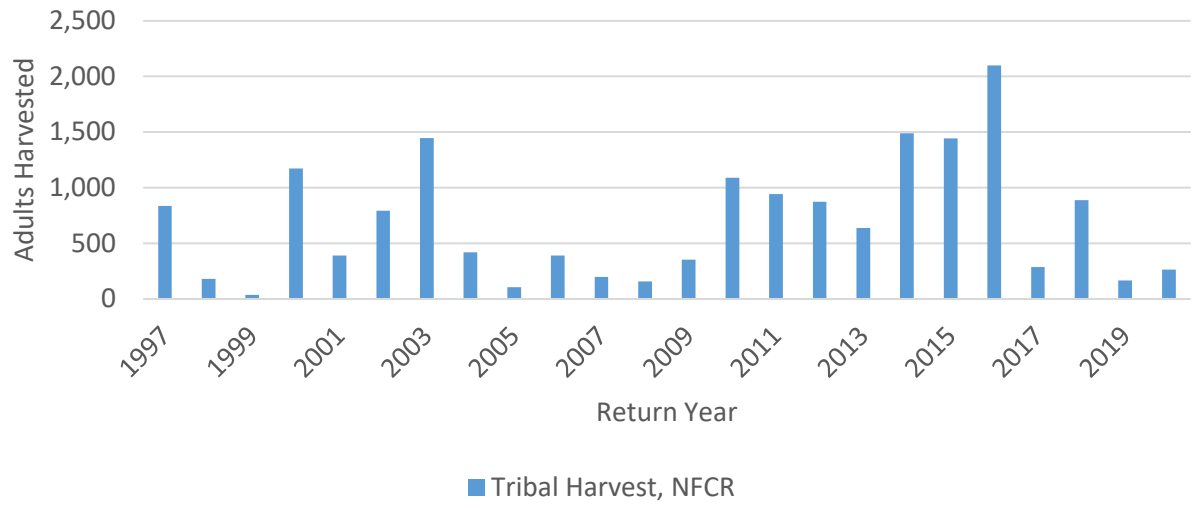
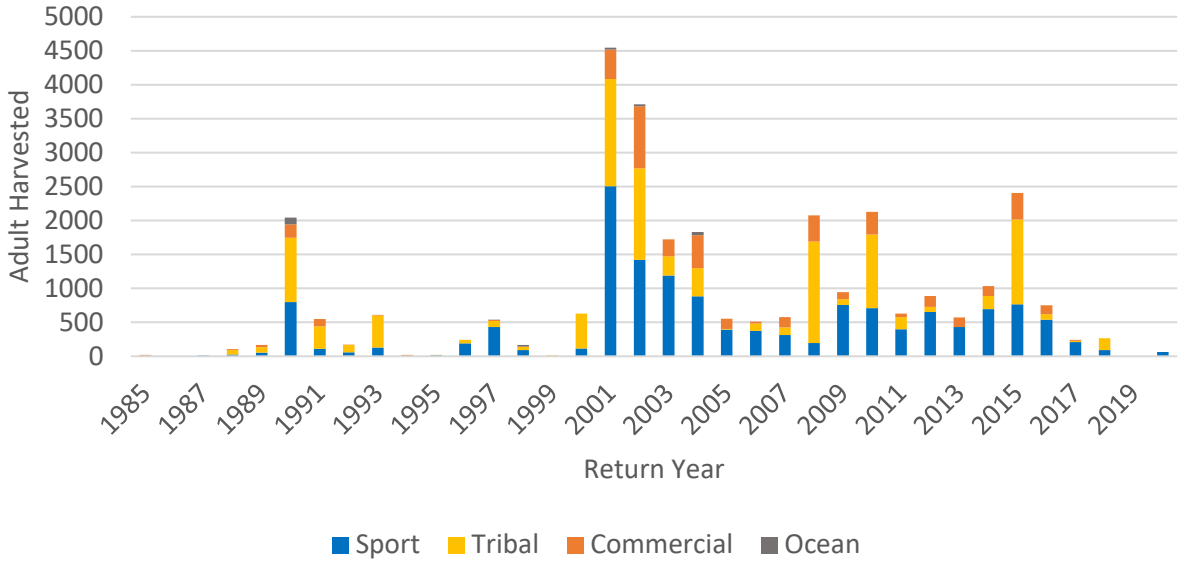


Figure 17. Dworshak National Fish Hatchery spring Chinook salmon harvested below the Lower Snake River Compensation Project compensation area in ocean and Columbia River commercial, sport and tribal fisheries from 1985 – 2020.



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