YAKIMA RIVER BASIN
CHINOOK AND COHO SALMON
MONITORING AND EVALUATION PLAN

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January, 2024

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Suggested citation:
Bosch B., M. Johnston, C. Frederiksen, A. Matala, S. Pandit, T. Newsome, M. Goudy, A. Haukenes, A. Fritts, G. Temple, and C. Johnson. 2024. Yakima River Basin Chinook and Coho Salmon Monitoring and Evaluation Plan. January, 2024. Confederated Tribes and Bands of the Yakama Nation, Toppenish, WA.

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INTRODUCTION

The Yakima-Klickitat Fisheries Project (YKFP) is a joint project of the Yakama Nation (lead entity) and the Washington State Department of Fish and Wildlife (WDFW) and is sponsored in large part by the Bonneville Power Administration (BPA) with oversight and guidance from the Northwest Power and Conservation Council (NPCC). It is among the largest and most complex fisheries management projects in the Columbia Basin in terms of data collection and management, physical facilities, habitat enhancement and management, and experimental design and research on fisheries resources. The YKFP is attempting to evaluate all stocks historically present in the Yakima Subbasin and apply a combination of habitat restoration and hatchery supplementation or reintroduction, to restore the Yakima Subbasin ecosystem with sustainable and harvestable populations of salmon, steelhead and other at-risk species.

Due to human population growth and development activities throughout the Columbia River Basin over the past 200 years, returns of all anadromous salmon and steelhead species to the Yakima River Basin experienced substantial declines from historical levels. In an attempt to reverse this trend, the NPCC (formerly the Northwest Power Planning Council, NPPC) in 1982 first encouraged BPA to "fund the design, construction, operation, and maintenance of a hatchery to enhance the fishery for the Yakima Indian Nation as well as all other harvesters" (NPPC 1982). After years of planning and design, an Environmental Impact Statement (EIS) for the Yakima Fisheries Project (now the YKFP) was completed in 1996. While initially envisioned as an "all stocks initiative" (BPA 1990), the final EIS and record of decision for the project approved only construction of a spring Chinook supplementation and research facility in the upper Yakima and a feasibility study for the re-introduction of Coho to the Basin. The EIS stated that the project "would include an extensive monitoring and evaluation program to measure Yakima River Basin salmonid responses to supplementation activities [and] to test the hypothesis that new supplementation techniques can be used in the Yakima River Basin to increase natural production and to improve harvest opportunities, while maintaining the long-term genetic fitness of the wild and native salmonid populations and keeping adverse ecological interactions within acceptable limits" (RASP 1992; BPA 1996).

Project scientists developed a Spring Chinook Supplementation Monitoring Plan in 1997 (Busack et al. 1997). Production activities in the Yakima Basin have expanded since 1996-97 and are described below under "Production objectives". While the original Monitoring and Evaluation (M&E) Plan has been augmented (e.g., Busack et al. 2006; YN 2019), and extensive monitoring and evaluation of these activities has occurred (Blodgett et al. 2023), the original M&E Plan has never been formally updated until now.

Principles, rationale, objectives, strategies, and methods for evaluating supplementation and artificial production programs have been well described (Mobrand et al. 2005; Galbreath et al. 2008; Paquet et al. 2011; Hillman et al. 2019), and are used broadly throughout the Columbia Basin, including in the Yakima River Basin for monitoring and evaluation. This monitoring and evaluation plan documents methods and strategies specific to the Yakima Basin that are being employed as part of a long-term, comprehensive monitoring project (199506325); specific M&E objectives, tasks and strategies are listed in Appendix A. Habitat action effectiveness monitoring is being conducted on an opportunistic basis such as during species interactions work and through cooperative work with other scientists as part of BPA's Columbia Basin-wide Action Effectiveness Monitoring Program (e.g., see Clark and Roni 2018).

The results of M&E activities are presented in annual reports (e.g., Blodgett et al. 2023). A science conference is held annually to present study findings to other agencies and interested members of the public. Study results and conference materials are stored on the web. Data and research findings are also presented in peer-reviewed scientific publications as information matures and time and resources allow. A number of Yakima Basin studies have already been published relating to elements of the Regional Assessment of Supplementation Project (RASP) definition of supplementation. These include: discussion and establishment of ecological risk guidelines (Pearsons and Hopley 1999; Ham and Pearsons 2001; Temple and Pearsons 2012); competition, predation, and other species interactions (McMichael and Pearsons 1998; McMichael et al. 1999b; Fritts and Pearsons 2004, 2006, 2008; Major et al. 2005; Murdoch et al. 2005; Fritts et al. 2007; Pearsons and Temple 2007; Pearsons et al. 2007; Pearsons and Temple 2010; Temple et al. 2017); precocial maturation in males (Beckman et al. 2000; Larsen et al. 2004, 2006, 2010, 2013; Pearsons et al. 2009; Galbreath et al. 2021); homing (Dittman et al. 2010); straying (Fast et al. 2015); fitness and relative reproductive success (Busack et al. 2007; Beckman et al. 2008; Knudsen et al. 2006, 2008; Schroder et al. 2008, 2010, 2012; Koch et al. 2022; Bosch et al. 2023); and genetic divergence (Waters et al. 2015, 2018, 2020).

RELATIONSHIP TO COLUMBIA BASIN RESEARCH PLAN

The Columbia River Basin Research Plan (NPCC 2017), which was developed with input from the Independent Scientific Advisory Board (ISAB), the Independent

Scientific Review Panel (ISRP), and the Pacific Northwest Aquatic Monitoring Partnership (PNAMP), identified a number of critical uncertainties that are relevant to, and can be informed by, research, monitoring, and evaluation activities being conducted in the Yakima Basin:

> Fish Propagation Question 1. Are current propagation efforts successfully meeting harvest and conservation objectives while managing risks to natural populations?
>
> 1.2. Can hatchery production programs meet adult production and harvest goals (integrated and segregated) while protecting naturally spawning populations?
>
> 1.3. What are the interactions, by life stage, between hatchery-origin and natural-origin populations with respect to competition, predation (direct and indirect), and disease including harvest in fisheries targeting hatchery-origin adults; and from hatchery effluent?
>
> 1.4. What is the magnitude of any demographic benefit or detriment to the production of natural-origin juveniles and adults from natural spawning of hatchery-origin supplementation adults?
>
> 1.5. What are the range, magnitude and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules including the proportion of hatchery fish permitted on the spawning grounds, and the proportion of natural origin adults in the hatchery broodstock?
>
> Predation Question 1. Are the current efforts to address predation and reduce numbers of predators effective?
>
> Predation Question 2. Are there actions other than removing predators that could reduce predation on listed species?
>
> Harvest Question 1. Do current harvest and escapement strategies provide the expected results in supporting recovery efforts and providing harvest opportunities?
>
> Monitoring and evaluation methods Question 1. Are current methods to … count fish and to measure productivity adequate to cost effectively inform decisions?

> Monitoring and evaluation methods Question 2. Are there innovative methods for counting fish and measuring their productivity that would better inform decisions?

The M&E activities described here focus on determining the success of Yakima Basin Chinook and Coho Salmon hatchery programs, the effects on native stocks, and address the critical uncertainties listed above.

PRODUCTION OBJECTIVES

As supported by the Yakama Nation Fisheries Strategic Plan (YN 2021), the Yakama Nation seeks a future where salmon and their ecosystems are restored to a point that:

- Columbia River (Zone 6) fisheries are no longer restricted for conservation concerns,
- Salmon for ceremonial and subsistence use are harvested from the river, not transported from hatchery "surplus",
- Returns to "usual and accustomed" fishing areas near tribal homes are again sufficient to allow parents and elders to teach the importance and methods of salmon fishing to tribal youth, and
- The quality of the water and the fish is such that the tribes can maintain their culture and traditions without risking the health of their people.

Wy-Kan-Ush-Mi Wa-Kish-Wit, the Columbia River Anadromous Fish Restoration Plan of the Nez Perce, Umatilla, Warm Springs and Yakama Tribes, summarized adult return goals to the Yakima Subbasin, including both spawning escapement and terminal harvest; for Chinook and Coho these goals were: 5,000 Coho, 26,300 spring Chinook, 12,000 summer Chinook, and 4,700 fall Chinook (CRITFC 1995). From 2017-2020, the Columbia Basin Partnership Task Force of the Marine Fisheries Advisory Committee, consisting of sovereigns and stakeholders throughout the Columbia Basin, developed a shared vision and shared goals for salmon and steelhead. These goals were published in the Partnership's Phase 2 report (CBPTF 2020). Natural production goals specific to the Yakima Basin are summarized in Table 1; the high-range goals represent abundances consistent with healthy and harvestable stocks.

Table 1. Columbia Basin Partnership natural production goals for Chinook and Coho Salmon in the Yakima River Basin.

		Abundance		Potential Goal Range		
Species	**Population**	**Recent**	**Historical**	**Low**	**Med**	**High**
Spring Chinook	U. mainstem	4,000	124,500	4,000	12,870	55,700
	Naches/American	2,000	74,500	2,000	6,630	28,700
Coho	Yakima Basin	800	75,000	2,000	5,000	10,000
Summer Chinook	Yakima Basin	100	89,500	1,000	3,500	10,000
Fall Chinook	Yakima Basin	1,000	150,000	2,000	3,500	10,000

Artificial production activities in the Yakima Basin generally fall into three categories. The first type, integrated recovery and restoration programs, are intended to support or restore natural populations (Mobrand et al. 2005). These programs focus on increasing the natural production of targeted fish populations, but are also intended to provide additional fish for harvest. A fundamental assumption of this strategy is that hatchery fish returning to the spawning grounds are biologically similar to naturally produced fish and do not degrade natural reproductive capacity over time. The second type, re-introduction programs, intend to restore extirpated species that were historically present and native to the Basin. Re-introductions have the potential to increase viable salmon population (VSP; McElhany et al. 2000) parameters such as abundance, spatial and temporal distribution, and diversity, thereby enhancing overall ecosystem health. Lastly harvest augmentation programs are intended to increase harvest opportunities while limiting interactions with wild-origin counterparts. These are typically managed as segregated programs (Mobrand et al. 2005); however, in the Yakima Basin these types of programs attempt to use brood stock comprised of fish that are most compatible with natural spawning to the maximum extent practical (e.g., local, natural-origin fish) as it is recognized that some fish are likely to escape to natural spawning areas.

Production facilities in the Yakima Basin rear salmon pursuant to *U.S. v Oregon* management agreements, including Mitchell Act and John Day Mitigation obligations (Parties to *U.S. v OR* 2018). Present facilities are:

- Levi George Supplementation and Research Facility in Cle Elum, WA (CESRF). This is a spring Chinook supplementation program that includes both integrated and segregated production lines (Fast et al. 2015).

- Melvin R. Sampson Coho Facility near Thorp, WA (MRS). This is an integrated Coho supplementation program.

- Prosser Hatchery Complex, Prosser, WA. These fish are primarily for harvest purposes in marine, Columbia River, and Yakima River fisheries. It includes a summer-run Chinook program attempting to re-introduce this species and restore these fish to spawning areas in the middle reaches of the Yakima Basin. The complex also includes a summer steelhead reconditioning program whereby post-spawned, natural-origin kelt steelhead are held and fed for approximately 6 months, then released to the river during the peak of upstream migration to return to their natural life-cycle.

Actions are also ongoing in the Yakima Basin to restore Sockeye, Bull Trout, Sturgeon, Lamprey, and freshwater Mussels. However, these actions, as well as the Prosser steelhead reconditioning program, are beyond the scope of this monitoring and evaluation plan although information collected pursuant to this plan (e.g., counts of fish at Prosser and Roza dams) are shared with those responsible for monitoring these programs.

Artificial production objectives (release targets) for the programs and facilities relevant to this M&E Plan are listed in Table 2.

Table 2. Artificial production goals for Chinook and Coho in the Yakima River Basin.

Species	Facility	Release Target	Life Stage	Release Locations
Spring Chinook[a]	CESRF	810,000	yearling	Easton, Jack Creek, and Clark Flat acclimation sites
Coho[b]	MRS	500,000	parr	Targeted tributaries
		200,000	yearling	MRS; targeted tributaries
Coho[b]	Prosser complex	1.5 million	yearling	Prosser
Summer Chinook[b]	Prosser complex	900,000	subyearling	Upriver acclimation sites
		100,000	yearling	Prosser
Fall Chinook[b]	Prosser complex	2.2 million	subyearling	Prosser; ~500,000 at upriver acclimation sites
Fall Chinook[b]	Prosser complex	210,000	yearling	Prosser

[a] BPA 1996.

[b] YN 2019. Note that for Coho and Summer Chinook, some of this production may eventually be moved into the Naches subbasin.

The YKFP recognizes that rebuilding natural populations will ultimately depend on improving habitat, water quality and quantity, fish passage survival, and habitat connectivity (CRITFC 1995; ISRP 2011; Milbrink et al. 2011; Venditti et al. 2017; NOAA 2022). Hatchery programs, even "state of the art" integrated supplementation programs designed to follow all of the best management practice recommendations (Cuenco et al. 1993; Mobrand et al. 2005), do not directly affect any of these habitat parameters which are vital to improving natural productivity. To this end, the YKFP is working with partners in multiple forums to implement habitat restoration and water resource management projects designed to address factors limiting productivity (see Yakima Subbasin, Recovery, and Integrated plans).

FISH POPULATION STATUS MONITORING

Adult Fish Populations (Abundance)

Methods: Adult salmon populations in the Yakima River Basin are enumerated at Prosser Dam using video equipment installed in all three adult fish ladders (monitoringresources.org methods 143, 144, 307, 515). At both Prosser and Roza Dams, adult fish traps are also used on a seasonal basis for biological sampling and enumeration (monitoringresources.org methods 135). When the Roza adult trap is not in operation, video equipment is also employed at the adult fish ladders there. However, camera placement and actual viewing area are limited; these combined with water clarity issues during certain river conditions all affect video enumeration at Roza Dam. Automatic Passive Integrated Transponder (PIT) tag detectors are also employed at all fish ladders at both dams (see sites RZF and PRO in ptagis.org). For the safety and protection of personnel and equipment, video and PIT-detection equipment are removed during periods of high river flow. In these instances, biologists attempt to extrapolate fish counts using data from before and after the high flow event. Although adult passage over spillways is believed to occur when flows are favorable, Prosser Dam counts are generally considered by Yakama Nation biologists to be within +/- 5% of actual fish passage. Roza Dam counts during trap operation (generally the entire spring Chinook counting period, March-September) are considered virtually 100% accurate; however, during the late fall and winter counting period when video equipment is used at least part of the time, accuracy may fall to only 50-75% of actual fish passage based on preliminary evaluation of PIT tag detection data. Fish are denoted as hatchery- or natural-origin based on presence or absence respectively, of observed external or internal marks or tags (monitoringresources.org method 342). Chinook are denoted as spring-, summer-, or fall-run based on review of PIT-detection data and visual observations of coloration and body morphometry.

At Prosser Dam, time-lapse video recorders (VHS) and a video camera were used in prior years at viewing windows at each of the three fishways. Digital video recorders (DVR) and progressive scan cameras (to replace the VHS systems) were tested at each of the three Prosser fishways in 2007 and became fully operational in February of 2008. The new system functions very similarly to the VHS system but provides digital video data readily downloadable to the viewing stations in Toppenish. This new system also allows technicians in Toppenish to scan rapidly to images of fish giving more timely and accurate fish counts. The technicians review the images and record various types of data for each fish that migrates upstream via the ladders. For each fish, technicians record passage date, passage time, facility/ladder, and species in a database. Similarly, adult trap sample data for operations at both Prosser and Roza Dams are entered into databases. These databases are automatically uploaded daily so that integrated (trap and video) count and Yakima Basin adult trap sampling (login required) data for the Prosser and Roza data sets can be viewed at: https://yakamafish-nsn.gov/fish-data. Count data for these facilities are also mirrored on the Columbia River DART (Data Access in Real Time) web site. Counts are regularly reviewed and adjusted for data gaps and knowledge about adult and jack lengths from sampling activities with corrections made to our master data sets during the course of the season and post-season.

Spring Chinook began returning from the Cle Elum Supplementation and Research Facility (CESRF) in 2000 (jacks) and 2001 (adults). All CESRF-origin spring Chinook are marked. Due to physical and logistical constraints at the Prosser Hatchery it is not possible to mark all hatchery releases of summer/fall run Chinook without jeopardizing fish health and survival but these issues are being addressed through the Master Planning process (Yakama Nation 2019). Thus, enumeration of hatchery- and natural-origin summer/fall run Chinook adult returns is not presently available but will be available in the future. New marking protocols made it possible to distinguish hatchery- and natural-origin coho beginning with return year 2001.

Adult Productivity

Methods:

We use recruit-per-spawner relationships (Ricker 1975) to describe adult-to-adult productivity indices. Species-specific methods are as follows.

Spring Chinook

Estimated natural-origin spawners for the Upper Yakima River are calculated as the estimated escapement above Roza Dam plus the estimated number of spawners between the confluence with the Naches River and Roza Dam. Total natural-origin returns to the Upper Yakima River are developed using run reconstruction techniques (Bosch 2023). Age composition for Upper Yakima returns is estimated from spawning ground carcass scale samples (monitoring resources.org method 112) for the years 1982-1996 and from Roza Dam brood-stock collection samples (Knudsen et al. 2006;

Bosch 2023) for the years 1997 to present. Since age-3 fish (jacks) are not collected for brood-stock in proportion to the jack run size, the proportion of age-3 fish in the upper Yakima for 1997 to present is estimated using the proportion of jacks (based on visual observation) counted at Roza Dam relative to the total run size.

Estimated spawners and total returns for Naches River Subbasin natural-origin spring Chinook are calculated using run reconstruction techniques (Bosch 2023). Age composition for Naches Basin age-4 and age-5 returns are estimated from spawning ground carcass scale samples (monitoring resources.org method 112). The proportion of age-3 fish is estimated after reviewing jack count (based on visual observations) data at Prosser and Roza dams.

Estimated spawners at the CESRF are the total number of wild/natural fish collected at Roza Dam and taken to the CESRF for production brood-stock (Knudsen et al. 2006; Bosch 2023). Total returns of CESRF-origin fish are based on run reconstruction and Roza dam sampling operations. Age composition for CESRF fish is estimated using scales and PIT tag detections from CESRF fish sampled passing upstream through the Roza Dam adult monitoring facility (Knudsen et al. 2006; Bosch 2023).

Coho
From central British Columbia south, the vast majority of coho salmon adults are 3-year-olds, having spent approximately 18 months in fresh water and 18 months in salt water (Loeffel and Wendler 1968; Wright 1970). Therefore, we estimate a natural-origin productivity (recruits per spawner) index by dividing natural-origin returns to Prosser Dam by the estimated returns to Prosser Dam three years prior. We compute this index for both adult and combined adult and jack returns per adult and combined adult and jack spawner. Note that this method will bias productivity estimates high, as it assumes no natural production from hatchery-origin spawners.

Summer/Fall Run Chinook
Adult fall Chinook returning to the Yakima Basin consist of hatchery-origin returns from releases at and above Prosser Dam and natural-origin returns from fish spawning naturally in the Yakima River. Due to fiscal, physical, logistical, and policy considerations, only a small proportion of hatchery-origin releases have been externally marked. Therefore, it is impossible at present to know the origin of unmarked adult fall Chinook counted at Prosser. Additional marking is proposed for hatchery-origin releases as part of the Master Plan (Yakama Nation 2019), which will allow development of a comprehensive brood/cohort age at return table for natural- and hatchery-origin returns. Methods and results for evaluating adult productivity of summer/fall run Chinook will be included in future reports and publications as the data become available.

Juvenile Abundance

Methods: The Yakama Nation releases a number of hatchery-origin smolts annually pursuant to *U.S. v Oregon* Management Agreements (Parties to *U.S. v OR* 2018). Adult returns from these releases serve to mitigate for lost harvest opportunity (due to alteration of the Columbia River ecosystem and associated losses in natural production and productivity), to augment the number of fish spawning naturally (supplementation), or a combination of the two. Juveniles are released from many locations, as yearlings or subyearlings, depending on the goals of the specific programs. As these juveniles migrate downstream, they are mixed with naturally produced juveniles.

Above Prosser Dam, a portion of the river flow is diverted into the Chandler canal to generate electrical power and serve irrigation districts downstream. Juvenile fish are diverted into the Canal (and subsequently the Chandler juvenile monitoring facility-CJMF) at different rates depending on river and canal flow. Smolt sampling efforts at the CJMF near Prosser Dam are conducted annually from early winter through early summer corresponding with salmon smolt out-migrations. A portion of entrained salmon outmigrants (regulated by a timed gate) was manually counted and sampled for biological data on a daily basis and all PIT tagged fish are interrogated. Sampling methods are described in Busack et al. (1997) and Pandit et al. (2023); see also monitoringresources.org methods 32 and 3875.

Paired releases of PIT-tagged smolts are made in order to estimate the fish entrainment and canal survival rates in relation to river conditions and canal operations. For outmigration years 1999 through 2014, these data were used to generate a multi-variate river flow/canal entrainment relationship (D. Neeley 2010, 2012; Pandit et al. 2023). Over a range of flow diversion rates, juvenile fish entrainment rates generally fit a logistic curve: at low diversion rates, the entrainment rate is lower than the diversion rate, and at high diversion rates the entrainment rate is higher than the diversion rate. In recent years it became difficult to adapt the model to higher winter and spring flows and to river channel changes, partly because at low diversion rates it was difficult to capture enough fish to get many point estimates of entrainment rate. The releases that were made, however, still tended to support a low entrainment rate relative to diversion rate at high river flows. For some years, Prosser smolt passage estimates produced by this model were outside of what were considered reasonable bounds (e.g., entrainment-based Prosser passage estimates approached or even exceeded known releases for hatchery-origin spring Chinook far upstream). This required us to reevaluate and change our methodology. The proportions of all PIT- tagged smolts released above Prosser and detected at mid-Columbia dams that were previously detected in the Chandler Canal bypass now serve as estimates of bypass-detection efficiency. Expanded

Prosser passage estimates are then derived using the juvenile sample counts and detection efficiencies as described in Pandit et al. (2023). These methods are generally consistent with monitoringresources.org methods 134, 271, 1636 and 6786.

Juvenile Migration Survival to McNary Dam

Methods: For all species, releases of PIT tagged smolts provide a means to estimate smolt survival to McNary Dam. For most releases, PIT-tag detectors are located in or near the exit(s) from the release sites and allow estimation of the number of PIT-tagged fish leaving the release sites (monitoringresources.org 6572). To estimate the survival of smolts detected leaving the release sites that eventually pass McNary Dam, the proportion of PIT-tagged smolts detected leaving the release sites that were later detected at McNary Dam is divided by McNary Dam's detection efficiency. The estimated detection efficiency is the number of smolts detected passing dams downstream of McNary that are previously detected passing McNary divided by the total number of smolts passing the downstream dams, whether or not the smolts are previously detected at McNary. Our methods are described in detail in Pandit et al. (2023) and are generally consistent with Sandford and Smith (2002) and the Columbia Basin Comparative Survival Studies (McCann et al. 2022). We use weighted logistic or weighted least squares analysis of variance to analyze differences in survival metrics and indices between various release sites, years and treatments.

Juvenile Productivity (smolt-to-adult returns)

Methods:

Methods used to derive smolt abundance passage estimates at Prosser were described above. For spring Chinook, adult return estimates to the Yakima River mouth are derived using Prosser and Roza adult abundance and harvest data (methods described here) and run reconstruction techniques (Bosch 2023). For coho, we use Prosser adult abundance.

Adult fall Chinook returning to the Yakima Basin consist of hatchery-origin returns from releases at and above Prosser Dam and natural-origin returns from fish spawning naturally in the Yakima River. Due to fiscal, physical, logistical, and policy considerations, only a small proportion of hatchery-origin releases have been externally marked. Therefore, it is impossible at present to know the origin of unmarked adult fall Chinook counted at Prosser. Additional marking is proposed for hatchery-origin releases as part of the Master Plan (Yakama Nation 2019). To derive rough smolt-to-adult return indices for fall Chinook, aggregate (marked and unmarked combined) smolt passage estimates for the age-3, -4, and -5 components for a given return year are averaged and the aggregate adult passage estimate for that return year is divided by this average smolt passage estimate. For example, the "Prosser Average Smolts" for adult return year 1988 is the average of marked and unmarked Prosser smolt estimates for juvenile migration years 1983-1985.

We also query the PTAGIS database for PIT-tagged summer- and fall-run Chinook and Coho that were released in the Yakima Subbasin in recent years and produce McNary Dam juvenile (smolt) to Bonneville Dam adult SAR indices using juvenile detections at or downstream of McNary and adult detections at or upstream of Bonneville Dams.

Spatial Distribution (Redd Counts)

Methods: Regular foot and/or boat surveys (monitoringresources.org methods 29, 131, 211, and 285) are conducted within the established geographic range for each species (this is increasing for coho as acclimation sites are located upriver and as the run increases in size). Redds are individually marked during each survey and carcasses are sampled to collect egg retention, scale sample, sex, and body length information and to check for possible experimental marks. River conditions vary from year to year and preclude complete accounting, especially for fall Chinook and Coho. Other agencies (Pacific Northwest National Laboratory, and private contractors) also conduct foot, boat, or aerial surveys for fall Chinook redds in the Yakima River Basin and we have attempted to incorporate available information from those surveys into our long-term data sets.

Diversity Metrics

Methods:

Diversity metrics collected for the Cle Elum Supplementation and Research Facility spring Chinook program in the Upper Yakima River include parameters relating to: eggs (e.g., egg size, KD at emergence, emergence timing, etc.), juveniles (growth and survival, migration timing, fish health, etc.), and adults (size at age, sex composition, migration timing, etc.). Methods for monitoring the spring Chinook program were documented in: the YKFP Monitoring Plan (Busack et al. 1997), the project's "Supplementation Monitoring Plan" (Busack et al. 2007), and numerous manuscripts in the published literature (see References and Project-related Publications).

Diversity metrics for returning adult summer/fall Chinook and coho collected at the Prosser Dam denil fish trap include sex ratios, lengths, and weights (monitoringresources.org methods 454, 1548, 1549, 1551, 1577, 1747, 4041, 6723). We also query the PTAGIS database for PIT-tagged summer- and fall-run Chinook that were released in the Yakima Subbasin in recent years and use PIT-detection data at Bonneville Dam for upstream migrants to estimate age composition and run timing of returning fish.

HABITAT MONITORING

While the majority of YKFP habitat activities in the Yakima Basin are addressed in other projects (e.g., 1992-06-200, 1996-03-501, and 1997-051-00), activities covered under this M&E Plan include monitoring stream sediment loads associated with the operation of dams and other anthropogenic factors (e.g. logging, agriculture and road building) as sediment loads can affect survival of salmonids (Jensen et al. 2009; also see description and references here).

Status and Trend of Fine Sediment

Methods: Representative gravel samples (McNiel core samples, monitoring resources 199) are collected from various reaches in the Little Naches and Upper Yakima Rivers. Each sample is analyzed to estimate the percentage of fine or small particles present (<0.85 mm). The Washington State Timber, Fish, and Wildlife program established guidelines that specify the impacts that estimated sedimentation levels can have on salmonid egg-to-smolt survival. These impact guidelines will inform future analyses of "extrinsic" factors on natural production in the Yakima Basin.

HARVEST MONITORING

Marine and Mainstem Columbia Fisheries

Methods: We evaluate recoveries of coded-wire tags (CWTs) and PIT tags in out-of-basin fisheries using queries of regional mark information system (RMIS) and PIT Tag Information System (PTAGIS) databases. We coordinate with agencies responsible for harvest management (WDFW, ODFW, USFWS, CRITFC, etc.) to estimate the harvest of target stocks. We review reports produced annually by the Pacific Fishery Management Council (marine) and the *U.S. v Oregon* Technical Advisory Committee (mainstem Columbia) to evaluate estimated harvest or exploitation rates on comparable stocks in these fisheries.

For spring Chinook, additional information is employed that is not readily available for fall Chinook and coho. Standard run reconstruction techniques (Bosch 2023) are employed to derive estimates of harvest from the Columbia River mouth to the Yakima River mouth for spring Chinook. Data from databases maintained by the *U.S. v Oregon* Technical Advisory Committee are used to obtain harvest rate estimates downstream of the Yakima River for the aggregate Yakima River spring Chinook population and to estimate passage losses from Bonneville through McNary reservoirs. These data, combined with the Prosser Dam counts and estimated harvest below Prosser, are used to derive a Columbia River mouth run size estimate and Columbia River mainstem harvest estimate for Yakima spring Chinook.

Yakima Subbasin Fisheries

Methods: The two co-managers, Yakama Nation and WDFW, are responsible for monitoring their respective fisheries in the Yakima River. Each agency employs fish monitors dedicated to creel surveys and/or fisher interviews at the most utilized fishing locations and/or boat ramps. From these surveys, standard techniques are employed to expand fishery sample data for total effort and open areas and times to derive total harvest estimates. Fish are interrogated for various marks. Methods are consistent with monitoringresources.org methods 1127, 1410, 1480, and 3816.

HATCHERY RESEARCH

Effect of Artificial Production on the Viability of Natural Fish Populations

WDFW is addressing some critical uncertainties (see Columbia River Basin Research Plan and Critical Uncertainties for the Columbia River Basin Fish and Wildlife Program) related to genetic and ecological interactions under project 1995-064-25. The YN and WDFW work jointly to address the following additional fish propagation uncertainties:

> 1.2. Can hatchery production programs meet adult production and harvest goals (integrated and segregated) while protecting naturally spawning populations?
>
> 1.4. What is the magnitude of any demographic benefit or detriment to the production of natural-origin juveniles and adults from natural spawning of hatchery-origin supplementation adults?
>
> 1.5. What are the range, magnitude and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules including the proportion of hatchery fish permitted on the spawning grounds, and the proportion of natural origin adults in the hatchery broodstock?

Methods:

The YKFP began a spring Chinook salmon hatchery program at the CESRF near Cle Elum on the upper Yakima River (river kilometer 297, measuring from the confluence with the Columbia River; Figure 1) in 1997. This program is a supplementation effort targeting the upper Yakima River population and is designed to test whether artificial propagation can be used to increase natural production and harvest opportunities while limiting ecological and genetic impacts (RASP 1992). It is an integrated hatchery program (Mobrand et al. 2005) because only natural-origin brood-stock are used and returning hatchery-origin adults are allowed to spawn in the wild. The program employs "best practice" hatchery management principles (see Cuenco et al. 1993, Mobrand et al. 2005) including reduced pond densities, strict disease management protocols, random brood-stock selection, and factorial mating (Busack and Knudsen 2007) to maximize effective population size. Fish are reared at the central facility, but released from three acclimation sites located near the central facility at: Easton approximately 25km upstream of the central facility, Clark Flat about 25km downstream of the central facility, and Jack Creek about 12km upstream from the Teanaway River's confluence with the Yakima River (Figure 1). The CESRF collected its first spring Chinook brood-stock in 1997, released its first fish in 1999, and age-4 adults have been returning since 2001. The first generation of offspring of CESRF and wild fish spawning in the wild returned as adults in 2005. The program uses the adjacent, un-supplemented Naches River population as an environmental and wild control system.

To evaluate demographic benefits for spring Chinook, we compare redd count and natural-origin adult return data for the supplemented Upper Yakima and un-supplemented (control) Naches populations using a Before/After Control/Impact (BACI) analysis (Stewart-Oaten et al. 1986; Smith et al. 1993). For redd counts, the before period is defined as 1981 to 2000 and the after period as 2001 to present (hatchery-origin age-4 adults first returned to integrate with natural-origin fish on the natural spawning grounds in 2001). The first natural-origin returns of age-4 fish from these integrated population redds did not occur until 2005, so the pre- and post-supplementation (before/after) periods for natural-origin return evaluation are defined as 1982 to 2004 and 2005 to present, respectively. A synthesis of findings after three generations of returns was published in Fast et al. (2015). We are working to incorporate additional out-of-basin control populations in this evaluation and these results will be considered for publication at a later date.

To evaluate fitness parameters for an integrated spring Chinook population, we use methods described in Knudsen et al. (2006, 2008), Schroder et al. (2008, 2010, and 2012) and Waters et al. (2015). To evaluate relative reproductive success, we use methods described in Koch et al. (2022). For coho, we are evaluating both demographic benefits and some fitness parameters using methods described in Bosch et al. (2007).

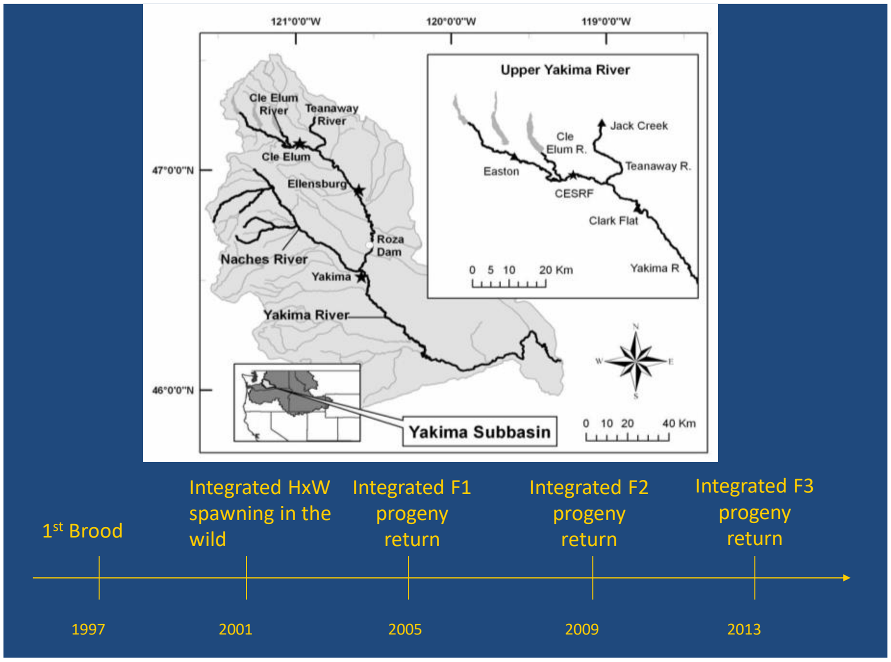

Figure 1. Map of the Yakima River Basin, Cle Elum Supplementation and Research Facility (CESRF) locations, and timeline of the spring Chinook supplementation program.

Effectiveness of Hatchery Reform

Hatcheries have long been a part of the fisheries landscape in the Pacific Northwest with programs originally designed to provide abundant returns for harvest in river ecosystems that were becoming increasingly exploited to serve human needs (Lichatowich 1999). Historically, hatchery programs were designed to release a specified number of juveniles from a central facility, and adult survivors, after providing many fish for harvest during their marine and freshwater migrations, would return to swim-in ladders and adult holding ponds at that same facility to spawn successive generations. Over the past two decades or more, such programs have been the subject of much scientific study regarding risks, such as domestication, they pose to natural populations if these fish spawn in the wild (e.g., see Naish et al. 2007; Araki et al. 2008; Kostow 2009; Christie et al. 2014).

The concepts of supplementation and hatchery reform, where hatchery programs could be (re)designed to serve conservation as well as harvest purposes, first began to appear in regional discussions and the literature in the late 1980s and early 1990s (e.g, RASP 1992; Cuenco et al. 1993). In Mobrand et al. (2005) and Paquet et al. (2011), the Hatchery Scientific Review Group (HSRG) described in more scientific detail several principles that should guide integrated (conservation-oriented) hatchery programs which purposefully allow fish to spawn in the wild (note that virtually all of the HSRG recommendations were designed into the integrated CESRF program described above). The HSRG reports also recommended that traditional, harvest-oriented hatchery programs should be segregated as much as possible from natural populations to minimize risks by limiting the number of returning fish that escape to natural spawning grounds.

YKFP efforts to monitor and evaluate hatchery reform focus on the CESRF spring Chinook program which was designed explicitly for this purpose from its inception (BPA 1996). To the extent that is practical, we will evaluate similar metrics for the summer/fall run Chinook and coho programs and publish those results in future reports as the Revised Master Plan (Yakama Nation 2019) is implemented and the programs mature over time.

In addition to the integrated (supplementation-S) hatchery program described above for the CESRF, this facility also introduced a segregated "hatchery control" (HC) program in 2002 as recommended by independent scientific review. To protect the integrity of the integrated program evaluation described above, returning HC line fish are either harvested or trapped and removed at the Roza Adult Monitoring Facility (RAMF); no HC line fish are allowed to escape to the spawning grounds (determination of fish origin is based on a differential marking strategy for S and HC fish; unmarked fish are presumed wild). CESRF-project scientists hypothesized that HC-line fish, which use only returning hatchery-origin fish as brood source, would increasingly diverge in phenotypic and genetic characteristics from wild (WC or wild control) fish with increasing generations of hatchery influence, whereas S-line fish, which use only wild or natural-origin fish for brood source, would remain relatively close in characteristics to wild fish (Figure 2). These hypothetical outcomes were based on hatchery reform theory which suggests that, by using only wild or natural-origin parents to spawn successive generations of fish in the hatchery environment, mean fitness of an integrated population in the natural environment can be maintained relatively close to that of a wild population (Mobrand et al. 2005).

Methods:

Methods for enumerating natural- and CESRF-origin fish at Roza Dam were described above (adult abundance) and in Knudsen et al. (2006). Methods for evaluating genetic differentiation between the wild founding, integrated, and segregated populations at the CESRF were described in Waters et al. (2015).

A recently developed parameter to monitor the mean fitness of an integrated population in the natural environment is called Proportionate Natural Influence (PNI). PNI is an approximation of the rate of gene flow between the natural environment and the hatchery environment (Busack et al. 2008). The equation describing PNI is

$$PNI = \frac{pNOB}{pNOB + pHOS}$$

where pNOB is the proportion of natural-origin brood-stock and pHOS is the proportion of hatchery-origin spawners. We evaluate PNI for the CESRF program using a pNOB value of 1.0 as only natural-origin fish are used for the integrated program's broodstock.

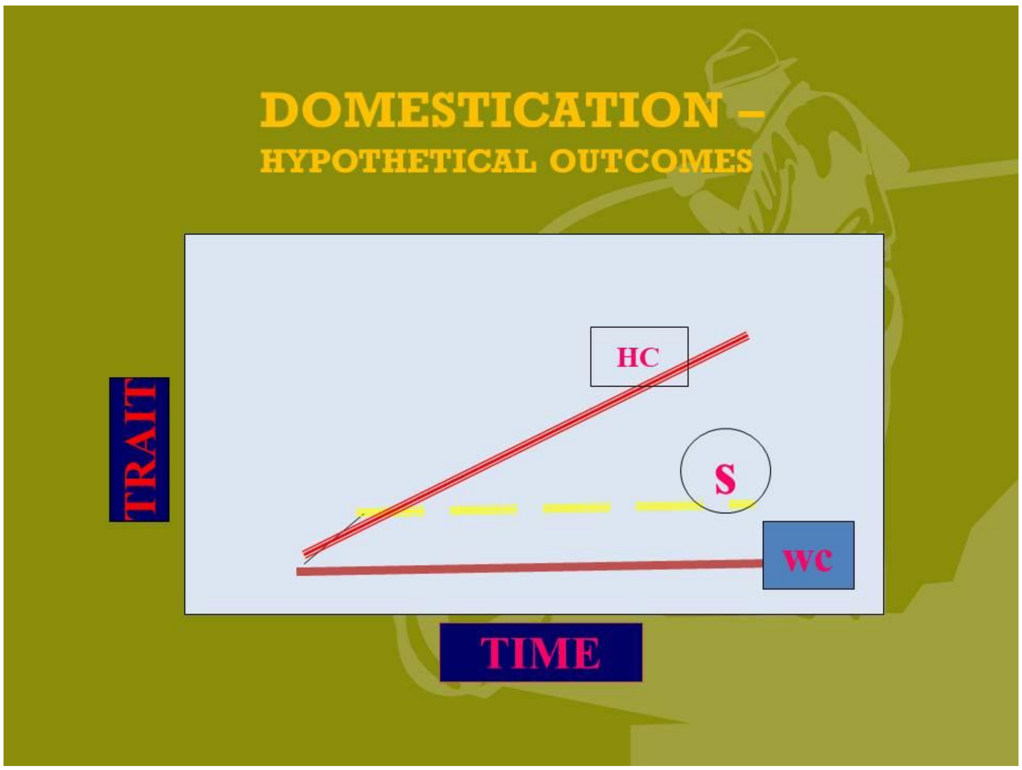

Figure 2. Hypothetical outcomes of trait divergence (domestication effects) over time for a segregated (hatchery-control or HC) line of fish, compared to an integrated (supplementation or S) line of fish and a wild (wild-control or WC) line of fish (D. Fast, Yakama Nation).

PREDATION MANAGEMENT AND PREDATOR CONTROL

Avian Predation Index

Avian predators are capable of significantly depressing smolt production. The loss of wild spring Chinook salmon juveniles to various types of avian predators has long been suspected as a significant constraint on production and could limit the success of supplementation. Therefore, a long-standing objective of the YKFP has been to monitor, evaluate, and index the impact of avian predation on annual salmon and steelhead smolt production in the Yakima Subbasin. Accurate methods of indexing avian predation across years have been developed.

Methods:

River Reach Surveys

The spring river surveys include six river reaches (Table 3) and are generally consistent with avian point count methods described in monitoringresources.org methods 6813 and 6815. The survey accounts for coverage of approximately 70 miles of the lower portion of the Yakima River.

Table 3. Avian predation river reach survey start and end locations and total reach length.

Survey Name	*River Mile Start*	*River Mile End*	*Survey Distance*
Parker	107.0	93.8	13.2
Granger-Emerald	85.3	66.5	18.8
Mabton- Prosser	60.6	48.5	12.1
Below Prosser	46.4	36.6	9.7
Chandler Power Plant -Benton	36.6	30.2	6.5
Below Horn Rapids-Van Giesen	16.8	9.4	7.4

All river reach surveys are conducted by a two-person team from a 16-foot drift boat or 12-foot raft. Surveys begin between 8:00 am and 9:00 am and last between 2 to 6 hours depending upon the length of the reach and the water level. All surveys are conducted while actively rowing the drift boat or raft downstream to decrease the interval of time required to traverse the reach. One person rows the boat while the other person records piscivorous birds encountered (Table 4).

Table 4. Yakima River Avian Predators.

Common Name	*Scientific Name*	Acronym
Common Merganser	*Mergus merganser*	COME
American White Pelican	*Pelecanus erythrorhynchos*	AWPE
California Gull	*Larus californicus*	GULL
Ring-billed Gull	*Larus delawarensis*	GULL
Belted Kingfisher	*Ceryle alcyon*	BEKI
Great Blue Heron	*Ardea herodias*	GBHE
Double-crested Cormorant	*Phalacrocorax auritus*	DCCO
Black-crowned Night-Heron	*Nycticorax nycticorax*	BCHE
Forster's Tern	*Sterna forsteri*	FOTE
Great Egret	*Ardea alba*	GREG
Hooded Merganser	*Lophodytes cucullatus*	HOME
Bald Eagle	*Haliaeetus leucocephalus*	BAEA
Osprey	*Pandion haliaetus*	OSPR
Caspian Tern	*Sterna caspia*	CATE

All birds detected visually or aurally are recorded, including time of observation, species, and sex and age if distinguishable. Leica 10x42 binoculars are used to help observe birds. All piscivorous birds encountered on the river are recorded at the point of initial observation. Most birds observed are only mildly disturbed by the presence of the survey boat and are quickly passed. Navigation of the survey boat to the opposite side of the river away from encountered birds minimizes escape behaviors. If the bird attempts to escape from the survey boat by moving down river a note is made that the bird was being pushed. Birds being pushed are usually kept in sight until passed by the survey boat. If the bird being pushed down river moves out of sight of the survey personnel, a note is made, and the next bird of the same species/age/sex to be encountered within the next 1000 meters of river is assumed to be the pushed bird. If a bird of the same species/age/sex is not encountered in the subsequent 1000 meters, the bird is assumed to have departed the river or passed the survey boat without detection, and the next identification of a bird of the same species/age/sex is recorded as a new observation.

Avian Predator Hotspot Surveys

Two "hotspots" of avian predators have been identified within the Lower Yakima River (Figure 3). These "hotspots" consist of an area below the Chandler fish bypass outfall pipe and below Wanawish Dam. To include data about these hotspots weekly bird counts are conducted at each of these "hotspots" by YN personnel and BOR personnel. Data are single day counts of piscivorous birds during the early morning.

Acclimation Site Surveys

Three Spring Chinook acclimation sites in upper Yakima River (Clark Flat, Jack Creek, and Easton) are surveyed for piscivorous birds. Surveys are generally conducted between January and June, though dates can vary by site and year. Three surveys are conducted at the Spring Chinook sites each day, at 8:00 am, 12:00 noon, and 4:00 pm. Surveys are conducted on foot. All piscivorous birds within the acclimation facility, along the length of the artificial acclimation stream, and 50 meters above and 150 meters below the acclimation stream outlet, into the main stem of the Yakima River or its tributaries, are recorded.

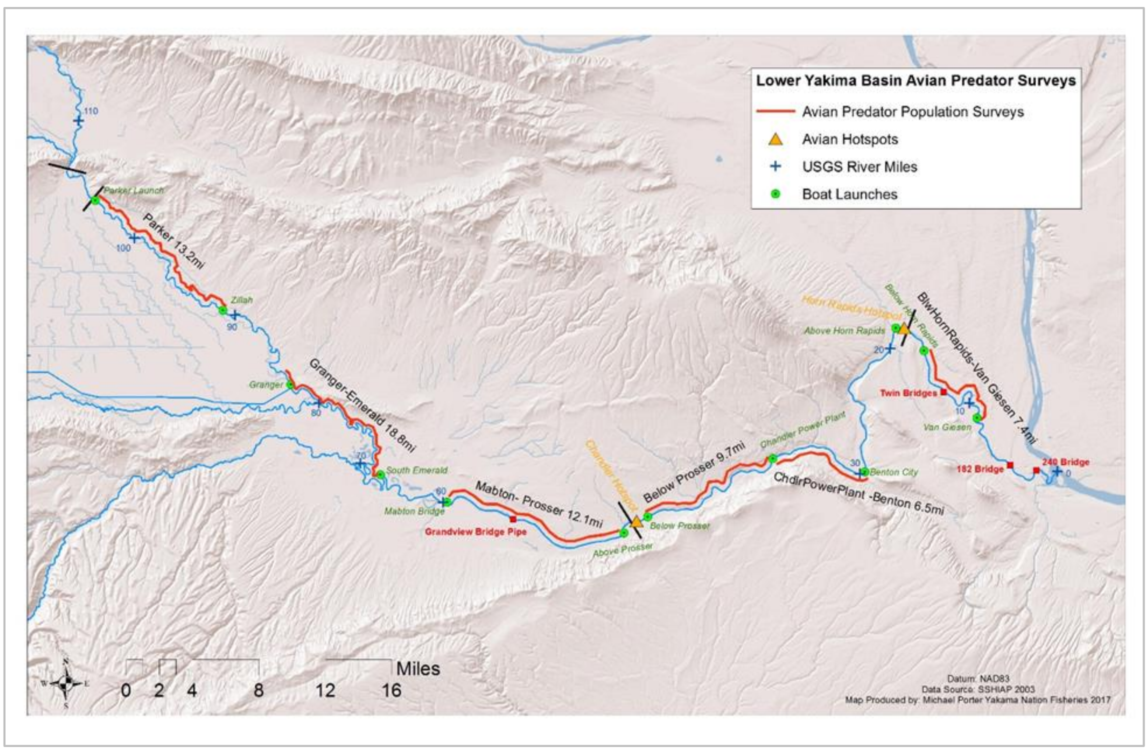

Figure 3. Avian Predator Survey Locations.

Fish Predation Index and Predator Control

Fish predators are also capable of significantly depressing smolt production. Thus the YKFP has a long-established objective to monitor, evaluate, and manage the impact of piscivorous fish on annual smolt production of Yakima Subbasin salmon and steelhead. By indexing the mortality rate of upper Yakima spring Chinook attributable to piscivorous fish in the lower Yakima River, the contribution of in-basin predation to variations in hatchery- and natural-origin spring Chinook smolt-to-adult survival rate can be deduced.

Based on YKFP and WDFW studies of piscivorous fish in the Yakima River Basin (Fritts and Pearsons 2004, 2006, 2008), it was determined that management of the piscivorous fish populations in the area is necessary to improve survival of juvenile salmonids. Initial steps were taken in 2009 to identify locations that would be suitable for a multi-pass removal population study. In early 2010, the YKFP began initial study checks to determine management and study goals for piscivorous fish. Presence and absence of piscivorous fish was determined through electro-fishing various sections of the Yakima River to determine temporal and spatial trends of each species of piscivorous fish. On March 1, 2013, the Washington Fish and Wildlife Commission adopted numerous changes to sport fishing rules, including the elimination of catch restrictions for non-native predators.

Methods:

Data is collected on piscivorous fish from six electrofishing sites within the Yakima River (Figure 4). Sites are sampled via boat electrofishing through time to assess spatial and temporal patterns of fish abundance and distribution. Each sampling segment is defined by river features of dams and boat launches. The partitioned sample locations consist of four ten mile surveys, one four-mile survey, and one six-mile survey (Table 5). Total river mile distance of the combined Yakima River surveys is 50 miles. Survey locations are marked by GPS unit (Garmin GPSmap 78; Garmin International, Olathe, Kansas). After marking sampling reaches, we sample weekly beginning in April and ending in June (dates may vary depending on river stage). Methods are generally consistent with monitoringresources.org methods 116, 117, 120, 121, 165, 190, 1013, and 1058.

Sampling is conducted using three different types of vessels and electrofisher. For five of the Yakima River surveys sampling is conducted using a Smith Root SR-16H Electrofishing boat equipped with the 7.5 GPP electrofishing unit powered by a 6,000-W Kohler boat generator. For the Yakima River survey below Prosser sampling is conducted with a 13-foot raft equipped with a smith root 1.5-KVA electrofisher powered by Honda EU2000i generator. For the survey in the McNary pool sampling is conducted with a 16-foot aluminum jet boat equipped with a Smith Root VVP-15B electrofisher powered by a Honda EM3500S generator. Electro-fishing settings are adjusted to continuous DC for an output of approximately 700 V and 9–12 A. Invasive species monitoring for the Yakima River is used as an aid for tracking changes in fish populations and abundance as the area experiences global climate change.

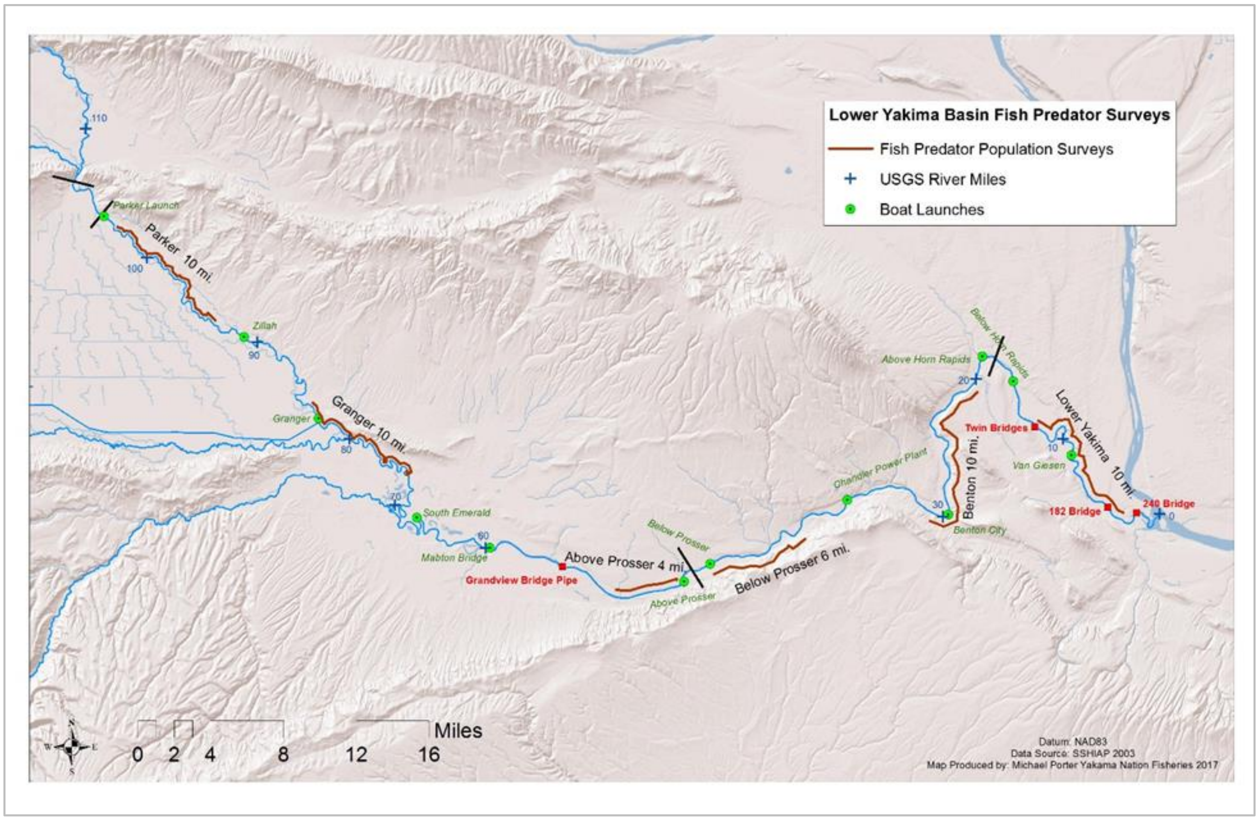

Figure 4. Fish Predator Survey Locations.

Table 5. Fish Predator Survey River Miles and Distances.

Survey Name	*River Mile Start*	*River Mile End*	*Survey Distance Miles*
Parker	106.1	96.1	10
Granger	85.3	75.3	10
Above Prosser	52.4	48.4	4
Below Prosser	46.4	40.4	6
Benton	31.1	21.1	10
Lower Yakima	13.8	3.8	10

Sampling is conducted continuously along river margins when possible. As river stage changes, limiting access to areas within survey segments, continuous electro-fishing is not always possible. The start and endpoints of shocker operation within the segment at low river stages is marked, resulting in discontinuous, marked sub-segments of electrofisher operation within each survey area.

Data collected during each sampling event consists of:

- Water Temperature, Dissolved Oxygen, Specific Conductivity gathered by a HACH 30qd water multi-meter
- Water Turbidity gathered by a HACH TSS Handheld Instrument
- River CFS gathered from Bureau of Reclamation gaging stations
- Electrode start and end times
- Numbers and species (Table 6) of all fish observed and their size class greater than or less than 100mm

At the start of each sampling event a small group of fish are caught and examined to insure that electro-fishing settings are not causing visible injuries. To further insure injuries to fish are minimized, sampling procedures by the National Marine Fisheries Service, "Guidelines for Electrofishing Waters Containing Salmonids Listed under the Endangered Species Act", are followed.

Table 6. Yakima River Fish Species.

Family	Common Name	*Scientific Name*	Acronym
Salmonidae:			
	Steelhead/Rainbow trout	*Oncorhynchus mykiss*	STH
	Coho Salmon	*Oncorhynchus kisutch*	COHO*
	Chinook Salmon	*Oncorhynchus tshawytscha*	SPCK/FACK*
	Mountain Whitefish	*Prosopium williamsoni*	WT
Cyprinidae:			
	Chiselmouth	*Acrocheilus alutaceus*	CH
	Carp	*Cyprinus carpio*	CP
	Peamouth	*Mylocheilus caurinus*	PEA
	Speckled Dace	*Rhinichthys osculus*	SPDA
	Northern Pikeminnow	*Ptychocheilus oregonensis*	NPM
	Redside Shiner	*Richardsonius balteatus*	SH
Catostomidae:			
	Sucker	*Catostomus columbianus*	SK
		Catostomus catostomus	
Ictaluridae:			
	Brown Bullhead	*Ameiurus nebulosus*	BRCT
	Channel Catfish	*Ictalurus punctatus*	CHCT
Centrarchidae:			
	Pumpkin Seed	*Lepomis gibbosus*	PKSC
	Blue Gill	*Lepomis macrochirus*	BG
	Smallmouth Bass	*Micropterus dolomieui*	SMB
	Large Mouth Bass	*Micropterus salmoides*	LMB
	Black Crappie	*Pomoxis nigromaculatus*	CRAP
Percidae:			
	Walleye	*Stizostedion vitreum vitreum*	WALLEYE
	Yellow Perch	*Perca flavescens*	YP
Cottidae:			
	Sculpin	*Cottus bairdi*	SC
Clupeidae:			
	Shad	*Alosa sapidissima*	SHAD

ADAPTIVE MANAGEMENT

The YKFP is a collaborative effort involving many agencies, boards, and individuals. As such, project coordination and review of project standards and protocols occurs continually amongst tribal, state, federal, and local entities during normal day-to-day operations of the project. Adaptive management is a process that can improve management practices iteratively by implementing plans in ways that maximize opportunities to learn from experience (e.g., Salafsky et al. 2001). Adaptive management protocols and procedures for the YKFP were described in BPA (1996) and in Chapter 5 of the Revised Master Plan for Chinook and Coho Salmon (YN 2019). Pursuant to the project's adaptive management policies, the YKFP holds policy group meetings monthly, and internal and external project review meetings annually (Blodgett and Bosch 2023).

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APPENDIX A. OBJECTIVES, TASKS, AND STRATEGIES FOR CHINOOK AND COHO SALMON MONITORING AND EVALUATION IN THE YAKIMA RIVER BASIN

A.1 Hatchery Indicators

Objective A.1.1. Operate adult trap(s) at Prosser Denil ladder and Roza adult fish monitoring facility to collect brood stock and/or to sample returning fish for stock composition. Hold and spawn fish maintaining established fish health standards.

Approach: YN biologists and technical staff will operate adult fish traps at the Prosser Hatchery swim-in denil ladder, and the right bank river denil ladder above Prosser Dam and Roza ladder for broodstock development. Other possibilities for capturing and/ or monitoring adult returns to the Naches River will be explored as resources allow. YN staff have operated the Prosser right bank denil facility to collect data from returning fish in the fall as well as collect brood stock. Factors such as weir/trap impedance/avoidance, run timing, spawn timing, population demographics, phenotypic and genetic characteristics, and return rates are part of the necessary evaluation that will be conducted to facilitate future adaptive management of this program. Additionally, the Prosser Hatchery swim-in denil has been operating since 2006 and has been instrumental in further developing our in-basin broodstock. The structure was built to guarantee the capture of in-basin broodstock that were reared and released from the hatchery. Evaluation staff is responsible for daily record keeping of all species captured, passed, or hauled for broodstock, along with any biological samples collected. These adult traps are also used for estimating adult returns (see A.3). Feasibility studies for broodstock collection in the Naches subbasin will be conducted in the future as resources allow.

Task A.1.1.1. Operate adult trap(s) at the Prosser denil ladder and Roza Adult Monitoring Facility (RAMF).

Task A.1.1.2. Collect scale samples on all fish processed both sites. Scales from each fish will be used to document age-structure.

Task A.1.1.3. Collect and transport broodstock for the CESRF spring Chinook, Melvin R. Sampson (MRS) Coho, and Prosser complex Chinook and Coho salmon hatcheries.

Task A.1.1.4. Hold broodstock and document mortalities during holding.

Task A.1.1.5. Compile all data from trapping and spawning, and calculate return rates (using CWT, PIT tag, and mark-recapture analysis) for program evaluation.

Task A.1.1.6. Utilize USFWS fish health professionals during spawning to collect and analyze appropriate fish health samples. Cull fish as necessary per established USFWS and YKFP fish health protocols (See A.7 Disease monitoring).

Objective A.1.2. Determine the origin and stock of salmon used as broodstock. Monitor and evaluate changes in the phenotypic and genotypic characteristics of salmon used at the YN Hatchery facilities.

Approach: YN, WDFW co-managers and NMFS desire to maintain the integrity of salmon stocks in the Yakima Basin and to minimize the potential negative effects of hatchery operations on ESA listed populations. In addition, the project has goals of protecting the health of natural populations while also providing fish for harvest mitigation production.

Broodstock Management

To monitor the phenotypic and genotypic integrity of populations cultured for the program, YN staff strives to collect and mate adults for broodstock to monitor stock demographics (e.g. run/spawn timing, age structure, sex ratios and size of fish) for gametes retained for production. Ideally this would be accomplished by selecting broodstock from throughout the run/spawning season.

YN will use PIT tags, CWTs, fin clips, scale readings, and DNA sampling to identify natural-origin fish for broodstock. The Prosser segregated program(s) may use returning hatchery-origin fish from either the integrated or segregated program for broodstock.

Since all natural-origin fish will be unmarked/untagged, any external or internal marks will be used to identify hatchery-origin fish so that fish can be properly managed according to the appropriate integrated or segregated program protocols.

Task A.1.2.1. Examine all salmon for marks and tags, and determine sex. Recover and decode all tags from all spawned hatchery-origin carcasses.

Task A.1.2.2. Select natural-origin salmon (per protocols described in project documents, e.g. YN 2019, generally no more than one of every two or three returning NOR fish) for use as integrated program brood stock.

Task A.1.2.3. Calculate the rate at which natural origin salmon are included in broodstock.

Task A.1.2.4. Estimate stock composition (e.g., integrated or segregated hatchery- and natural-origin) of fish retained for broodstock.

Task A.1.2.5. Examine salmon for marks, wire (CWT), sex, and collect scales to determine age composition after spawning.

Task A.1.2.6. Collect length and weight samples from hatchery and natural origin spawned females. Estimate fecundity for each and create relationships with body size information to track for long-term changes.

Task A.1.2.7. Enumerate jacks retained in broodstock each week to assist with reporting and to assure jacks are incorporated in broodstock within the spawning protocol guideline.

Task A.1.2.8. Document brood year specific phenotypic characteristics for salmon used at the Yakima Basin hatchery facilities (natural-origin, segregated, or integrated), and compare and report changes that have occurred over time. Methods will be similar to those described in Knudsen et al. (2006) and Knudsen et al. (2008).

Objective A.1.3. Monitor and evaluate the survival of hatchery salmon produced and reared at Yakima Basin hatchery facilities.

Approach: YN staff will collect data on growth and survival of salmon produced and reared at the Yakima Basin hatchery facilities by life stage, from egg to release as pre-smolts.

Task A.1.3.1. Using gravimetric methods, estimate the number of eggs spawned.

Task A.1.3.2. Enumerate live eggs at "shock" time using an egg counter.

Task A.1.3.3. Document fry mortalities during incubation.

Task A.1.3.4. Estimate the number of fish ponded as the live egg count less documented fry mortalities.

Task A.1.3.5. Document mortalities during rearing by pond and month.

Task A.1.3.6. Document size of fish (length and weight) using sub-sample by rearing pond and month.

Task A.1.3.7. Document feed type and food conversion (weight gained divided by pounds of food fed) by rearing pond and month.

Task A.1.3.8. Estimate the number of fish released (e.g., if 100% of the fish are marked, this is the number of fish marked (see A.1.4) less documented mortalities from ponding to release).

Objective A.1.4. Comply with HSRG guidelines and program goals for natural stock restoration and local, natural-origin brood stock development.

Approach: Establish and maintain program marking protocols that allow returning fish to be distinguished by origin and stock. Marking strategies (Table A-1) are preliminary and may change pending further review of available budgets and logistical feasibility. Fish in programs targeted for harvest will be 100% adipose fin-clipped to facilitate harvest in all fisheries. Sufficient staff is available to mark-sample all fish that are handled at the Prosser denil and Roza adult trap facilities. Fisheries will strive to achieve a 20% mark-sample rate for at least adipose presence or absence. These mark and adult return sample rates are equivalent to or exceed those used in most other Columbia Basin programs with similar purposes. Therefore, we believe they will be sufficient to provide reasonable confidence in the parameters (e.g., fishery contribution, survival to Yakima river mouth, pHOS, pNOB, etc.) we are attempting to evaluate. We expect to detect and correct any insufficiencies through our annual review process.

Task A.1.4.1. Mark hatchery-origin salmon produced at the Yakima Basin hatchery facilities as documented in Table A-1.

Task A.1.4.2. Estimate the total number of fish on hand at marking.

Task A.1.4.3. Observe marks on returning fish and use these data to manage proportion of natural fish in brood stock (PNoB – Objective A.1.2) and proportion of hatchery fish on the spawning grounds (PHoS – Objective A.3.1) per guidelines established by the YKFP Policy Group (as recommended by technical implementation teams).

Table A-1: Hatchery release numbers, number marked, and mark type by species and hatchery component

Species	Facility	Component	# Released	# Marked	Tag or Mark
Spring Chinook	CESRF	Integrated	720,000	720,000	100% ad-clip + elastomer + CWT (snout), 5% PIT
Spring Chinook	CESRF	Segregated	90,000	90,000	100% ad-clip + elastomer + CWT (post-dorsal), 10% PIT
Coho	Prosser	Segregated smolts	1,500,000	100%	100% AD-Clip of which 100% CWT[1] 5-10% PIT
Coho	MRS	Integrated smolts	200,000	100%	0% AD-Clip 100% CWT post-dorsal 5-10% PIT
Coho	MRS	Integrated parr	500,000	100%	0% AD-Clip 100% CWT snout 5-10% PIT
Summer- and Fall-Run Chinook	Prosser/ Upriver	Integrated subyearling smolts	1,500,000	100%	0% AD-Clip 100% CWT snout[1] 5-10% PIT
Fall-Run Chinook	Prosser	Segregated smolts	1,700,000 Subyearlings 210,000 yearlings	100%	100% AD-Clip[1] 10% CWT snout[1]

[1] Requires purchase of Northwest Marine Technologies' autofish system (https://www.nmt.us/autofish-system/)

Objective A.1.5. Monitor and evaluate the quality and release of salmon produced at the Yakima Basin hatchery facilities.

Approach: Evaluation staff will analyze marking data and releases of juvenile salmon to determine survival rates between life stages and examine potential variables that may influence observed survivals. To document PIT tag loss that occurs between tagging and release of salmon, we will install and maintain PIT tag arrays in the outlet channels at all release sites.

Task A.1.5.1. Evaluate mark quality and tag retention before release.

Task A.1.5.2. Evaluate fish health of a sub-sample of fish at release. Document and report release size and general condition of juvenile salmonids prior to release.

Task A.1.5.3. Summarize hatchery records for each brood year to document and report green egg-to-fry, fry-to-smolt, and green egg-to-smolt survival rates for each release strategy where appropriate (e.g. – parr or presmolt).

Task A.1.5.4. Based on above monitoring, recommend changes in rearing, marking, and/or tagging protocols to hatchery and YKFP management.

Task A.1.5.5. Install and maintain PIT tag antenna array in the outlets of all final rearing and release locations.

Task A.1.5.6. Document the number of PIT tagged fish in the release and calculate the number of PIT tags shed between tagging and release.

Task A.1.5.7. Document the number of CWT tagged fish in the release and calculate the number of CWT tags shed between tagging and release.

Task A.1.5.8. Report tagged release data to regional PTAGIS and RMIS data bases.

Objective A.1.6: Evaluate release strategies, release sites, and smolt out-migration timing and survival from the Yakima Basin hatchery facility releases to downstream detection sites.

Approach: Acclimation facilities are located throughout the Yakima River basin to promote homing to historical spawning grounds. In addition, PIT arrays have been installed and are operated throughout the Yakima Basin on a year-round or seasonal basis as access and flows allow. Out-migration timing can be derived from PIT tag detections at smolt monitoring facilities at Prosser and in the Columbia basin. Our primary evaluations will be performed on fish released from CESRF acclimation sites and tributary streams in the upper Yakima and Naches basins as well as those released onstation from the Prosser Hatchery. Smolt releases will primarily occur in mobile acclimation sites located throughout the Yakima Basin. PIT tags will be used to document arrival, duration, and travel times between dams. These data along with size at release data, projected flow data, and projected spill data will be used to determine the optimal release date. PIT tags will be used for adult return calculations and for spawning procedures. Calculated SARs for the releases will be used to compare and contrast performance, and will be the primary metric for determining relative success of subyearling and yearling releases. Marking strategies were given above in Table A-1.

A subsample of outmigrating smolts is also evaluated at both Roza and Prosser/Chandler during annual juvenile sampling operations. Environmental and trap data are recorded along with biological data on a subsample of each salmonid species represented. The excess and non-salmonid fish are tallied by species. Biodata consists of fork lengths, weights and smoltification stage. Environmental and trap data recorded includes weather conditions, and water temperature and clarity.

Task A.1.6.1. Maintain services of a qualified biometrician with experience in estimating smolt trap efficiency rates as well as smolt-to-smolt and smolt-to-adult survival rates for Yakima Basin fish.

Task A.1.6.2. PIT tag juvenile fish in canal or trap operations for use in entrainment, survival and smolt-to-adult survival rate estimation.

Task A.1.6.3. Collect fork lengths, weights, smoltification state, genetic samples, and scale samples from hatchery- and natural-origin juvenile salmon obtained in juvenile sampling operations.

Task A.1.6.4. PIT tag groups of salmon released from acclimation sites, mobile acclimation or on station Yakima Basin hatchery facilities. Total PIT tag groups may vary from year to year depending on size and timing of releases.

Task A.1.6.5. Document migration timing and survival for yearling and subyearling salmon on a daily, seasonal and annual basis using PIT tag detections at Columbia River dams.

Task A.1.6.6. Track enzyme levels of hatchery juveniles released from hatchery facilities and acclimation sites to determine their migratory status. Compare with enzyme levels of natural-origin fish. Use this information to refine hatchery rearing practices and the hatchery release schedule.

Task A.1.6.7. Maintain a database of all biological data for yearling and subyearling releases from Yakima Basin hatchery facilities and for natural-origin fish.

Objective A.1.7. Assist in the planning, spawning, record keeping, and summarizing data for spawned salmon at Yakima Basin hatchery facilities.

Approach: YN biologists will annually assist in the spawning operations of salmon at the Yakima Basin hatchery facilities. The role of the evaluation staff has been and will be to collect the biological data (date of spawning, sex, length, scales, marks/tags, extraction of CWTs, DNA and scale sampling, fecundity estimation, etc.) from all fish retained/spawned for broodstock. This collaborative role will be critical for optimizing production strategies. In addition, evaluation staff will work closely with the hatchery staff to provide weekly /monthly /yearly summaries of the data for hatchery reports and permit compliance as necessary.

Task A.1.7.1. Develop or update spawning protocols as needed for review and approval by YKFP technical teams and Fish Management staffs prior to the onset of spawning for all species.

Task A.1.7.2. Assist in the spawning of salmon at the Yakima Basin hatchery facilities.

Task A.1.7.3. Collect biological data from all (or representative sample) spawned fish (sex, length, scales, DNA, marks/tags, CWT extraction and verification, PIT tag detection, fecundity estimation).

Task A.1.7.4. Where applicable, assist or provide hatchery staff with the necessary data summaries for completion of hatchery records from spawning activities.

A.2 Harvest

Harvest monitoring of Yakima River-origin salmonids will be performed by WDFW and the Yakama Nation. The WDFW is responsible for monitoring non-tribal sport and commercial fisheries in the Columbia River, Yakima River, and ocean. The fisheries monitoring methodologies used by WDFW and other state and federal agencies are outside the scope of this document.

The Tribal harvest monitoring program is designed to achieve project goals through:

- sampling subsistence fisheries below Bonneville Dam and at Cascade Locks, The Dalles Dam, John Day Dam, and McNary Dam on the mainstem Columbia River
- sampling all Tribal fisheries in the Yakima River

Objective A.2.1. Monitor Tribal Subsistence Fisheries in the Columbia River

Approach: YN biologists and technicians annually monitor tribal ceremonial and subsistence fisheries in the Columbia River from the newly established tribal fishing area below Bonneville Dam upstream to McNary Dam. Fishing areas are observed to record total effort in a monitored time frame, with a subsample of effort monitored for observed catch. Biologists expand recorded data for each fishing area and time frame to estimate total catch.

Task A.2.1.1. Monitor Tribal fisheries below Bonneville Dam and at Cascade Locks, The Dalles, John Day, and McNary dams daily whenever fisheries are conducted.

Task A.2.1.2. Each fishing day will be divided into three 8-hour periods. A different observer will be used to monitor each 8-hour period.

Task A.2.1.3. Every 2 hours, the observer will record the number of active gear, the number of fish captured per gear type, and the length of the observation period.

Task A.2.1.4. Catch estimates will be calculated by expanding the counts for both time and gear.

Task A.2.1.5. Caught fish will be randomly sub-sampled for marks. Fish species and (if possible) sex will be identified for each fish and each fish will be examined for marks. Length measurements will be taken for each fish caught. Scale samples will be collected on each fish for aging. DNA samples will also be collected on a sub-sample of fish if required as part of genetic studies being undertaken by YN or other research groups.

Task A.2.1.6. Recovered CWTs will be sent to WDFW for processing. WDFW will report tag recoveries and information to the appropriate regional databases.

Task A.2.1.7. YN will be responsible for reporting PIT-tag recoveries to PITAGIS (the PIT-Tag Information System) and other regional databases.

Task A.2.1.8. YN reports estimated harvest in these fisheries through the *U.S. v Oregon* Technical Advisory Committee (TAC). Annual harvest in these fisheries is maintained as part of the TAC record.

Task A.2.1.9. YN biologists will analyze available data and estimate the number of Yakima released salmon and steelhead by origin caught in these fisheries.

Objective A.2.2. Monitor Fisheries in the Yakima River Basin

Approach: The majority of Tribal fishing activities in the Yakima River occur mainly at the Wapato, Sunnyside, Prosser, and Horn Rapids irrigation diversion dams. These fisheries will be monitored in a manner similar to that described in Objective A.2.1. Non-tribal recreational fisheries also occur in the Yakima River and are monitored by WDFW using standard creel methods.

Task A.2.2.1. YN staff will monitor tribal subsistence fisheries in the Yakima Basin using methods described in Objective A.2.1.

Task A.2.2.2. YN staff will conduct interviews with Tribal fishers. Their catch may be subsampled as described in Objective A.2.1 above.

Task A.2.2.3. WDFW will monitor recreational fisheries in the Yakima River using standard creel methods.

Objective A.2.3. Estimate harvest of Yakima Basin salmon in Marine Fisheries.

Approach: The Regional Mark Information System (RMIS) will be queried regularly for any CWT recoveries of Master Plan hatchery facility salmon releases in ocean or Columbia River mainstem fisheries. The results of these queries will be analyzed to estimate the number of fish harvested in marine and lower Columbia River non-tribal fisheries.

Task A.2.3.1. YN staff will maintain a database of CWT codes released from the Master Plan hatchery facility programs.

Task A.2.3.2. YN staff will run annual queries of the regional RMIS database, searching for recoveries of Yakima Basin hatchery facility salmon CWT codes.

Task A.2.3.3. YN staff will estimate harvest of Yakima Basin hatchery facility salmon in marine and lower Columbia River fisheries and report these estimates in annual reports.

A.3 Escapement

Objective A.3.1. Estimate escapement of salmon to the mouth of the Yakima River by origin.

Approach: YN staff utilize video cameras at all ladders at Prosser Dam and maintain a database of counts of fish by date, ladder, and species. In addition, YN biologists and technical staff will operate adult fish traps at the Prosser denil ladder and Roza for broodstock development and biological sampling (Objective A.1.1). As discussed earlier, sites in the Naches subbasin may be brought online in the future as resources allow. YN staff has been operating the Prosser and Roza facilities for years to sample returning fish and to collect broodstock. Adult trap data and

Prosser/Roza PIT and CWT detection data will also be used for estimating adult return composition (stock and origin).

Task A.3.1.1. Enumerate returning fish using ladder count data, other databases, and present methods.

Task A.3.1.2. Operate Prosser denil and Roza trapping operations and conduct fish sampling per established protocols.

Task A.3.1.3. Evaluate trapping operation and tag detection databases to estimate composition of returning fish by stock and origin.

Task A.3.1.4. Evaluate harvest estimates for Yakima Basin fisheries and spawning survey data to estimate escapement.

Task A.3.1.5. Summarize and report above data.

Objective A.3.2: Estimate adult returns, collect life history characteristics, and document distribution of adults to spawning areas.

<u>*Approach:*</u> Measuring adult returns to the point of release and to other intermediate areas is necessary to determine program success. YN monitors the returns of salmon and steelhead throughout the Yakima Basin via video counts and adult trap operations at Prosser and Roza dams and hatchery swim-in ladders, spawning ground surveys, mark-recapture estimation (as warranted using PITs or CWTs for substock determination), and harvest monitoring. Trapped and/or spawned broodstock fish and carcasses provide data concerning origin, stray rates, sex ratios, and composition of each year's run. Spawning surveys provide numbers of redds, spawn timing, and distribution of fish in each of the surveyed reaches and tributaries. These are primary actions to track program performance and progress toward meeting goals.

Task A.3.2.1. Conduct spawning ground surveys to count redds, determine distribution of spawners, and sample carcasses (sex, length, scales for age composition, and tissue for genetic typing) to document life history characteristics of salmon in the Yakima Basin.

Task A.3.2.2. Process scales and CWTs for age composition.

Task A.3.2.3. Estimate stray rates from the PTAGIS and RMIS regional databases and DNA sampling.

A.4 Productivity

Objective A.4.1. Estimate juvenile smolt production of salmon by species, stock and origin.

<u>*Approach:*</u> YN staff will maintain and operate the Roza and Prosser/Chandler juvenile sampling facilities, and instream PIT arrays, and potentially, rotary screw traps in the Yakima Subbasin. A number of salmon juvenile migrants will be sub-sampled annually. Staff will maintain a database containing length, weight, marks, DNA, etc. information collected from these samples. These and available PIT data will be analyzed to estimate smolt outmigration past Prosser Dam and smolt-to-adult productivity (return) rates.

Task A.4.1.1. Operate Chandler juvenile monitoring facility and collect phenotypic and genotypic data from a subsample of migrating juveniles.

Task A.4.1.2. Maintain a database of these sample data.

Task A.4.1.3. Use PIT or acoustic tags and technologies to evaluate flow and entrainment relationships to estimate annual smolt outmigration at Prosser by species and origin.

Task A.4.1.4. Evaluate available PIT data to estimate smolt-to-smolt and smolt-to-adult survival indices (see objective A.1.6), using analysis techniques such as those in Buchanan and Skalski (2007) or similar.

Objective A.4.2. Estimate adult-to-adult productivity of salmon in the Yakima Basin.

Approach: YN staff will compile and maintain annual run reconstruction tables using the data collected from the objectives and tasks described above. Available age-at-return data will be used to develop brood/cohort return tables and adult return per spawner productivity.

Task A.4.2.1. Compile available escapement, harvest, and age-at-return data. Update and maintain these data annually in appropriate databases and spreadsheets.

Task A.4.2.2. Report these data in annual reports and other appropriate technical fora.

A.5 Ecological Interactions

Objective A.5.1. Monitor inter- and intra-specific interactions and evaluate potential negative influence on the abundance and productivity of natural populations.

Approach: WDFW staff will continue non-target taxa of concern monitoring conducted under the YKFP M&E umbrella project, 199506325 (see https://www.cbfish.org/Document.mvc/Viewer/P155169 for an example annual report). YN staff will use information from the literature as well as in-basin demographic and migratory data collected from other tasks identified in this appendix as indicators of potential survival or productivity bottlenecks for natural populations.

Task A.5.1.1. Establish criteria for demographic or migratory parameters that would indicate potential bottlenecks. Criteria development may include risk assessment of competition and other ecological interactions as described in Pearsons and Hopley (1999), Ham and Pearsons (2001), and Kostow (2009).

Task A.5.1.2. Using PIT or acoustic tagging of hatchery juveniles prior to release, generate travel time and smolt-to-smolt survival estimates to the mouth of the Yakima River (from objective A.1.5 and A.4.1, using PIT tag detections at the Yakima juvenile sampling operations, and Bonneville Dam, or alternatively using acoustic tagging and monitoring). Evaluate data on hatchery juvenile distribution and duration of presence in the subbasin from this effort as well as from Tasks A.1.5.8 and A.4.1.4, and from expanded fish presence/absence sampling in the mainstem and tributaries.

Task A.5.1.3. Investigate feasible alternative methods for monitoring certain ecological interactions (such as competition) relative to conditions in the Yakima subbasin (i.e. direct observations of competition via snorkeling is impractical due to glacially-induced visibility limitations, extensive electrofishing in certain river reaches introduces risk to adult salmonids).

Task A.5.1.4. Annually review results from Yakima Subbasin Monitoring and Evaluation activities. Evaluate results relative to established criteria. Work with YKFP policy and technical teams to design and implement changes to Yakima production programs when criteria are exceeded.

Task A.5.1.5. Periodically review results from other ongoing Columbia Basin interactions studies for recommendations. Implement recommendations deemed practical and relevant to Yakima production programs.

A.6 Predation

Objective A.6.1. Estimate juvenile smolt mortalities of salmon and identify mortality "hot spots" in the Yakima system during outmigration. Utilize collected data to develop and make recommendations to policy makers that will improve juvenile survival through the Yakima system migration corridor.

Approach: YN staff will continue avian and northern pikeminnow predation studies conducted under the YKFP M&E umbrella project, 199506325.

Task A.6.1.1. Monitor, evaluate, and index the impact of avian predation on annual salmon and steelhead smolt production in the Yakima Subbasin. The index consists of two main components: 1) an index of bird abundance along sample reaches of the Yakima River and 2) an index of consumption along both sample reaches and at key dam and bypass locations (called hotspots).

Task A.6.1.2. Examine roosting and nesting sites for the presence of salmon PIT tags. Link tag detections to sources of release and correlate with river flows. Analyze and utilize these data to recommend changes in present water and irrigation facility management practices to policy makers that will improve juvenile survival through the Yakima River system migration corridor.

Task A.6.1.3. Monitor, evaluate, and index impact of piscivorous fish on annual smolt production of Yakima Subbasin salmon and steelhead.

Task A.6.1.4. Develop methods to remove some salmonid predators from the Yakima system.

A.7 Disease

Objective A.7.1. Maintain Yakima Basin hatchery operation protocols that minimize potential disease transmission within and outside of the hatchery, assuring that fish reared at the Yakima

Basin facilities have high survival rates with little chance of pathogen transmission to naturally-rearing fishes and aquatic organisms.

Approach: YN staff will work with USFWS fish health specialists to implement disease management protocols and monitor hatchery operations for specific fish pathogens in accordance with the Washington Co-Managers Salmonid Disease Control Policy and the USFWS Fish Health Policy and Implementation Guidelines.

Task A.7.1.1. On at least a monthly basis, both healthy and clinically diseased fish from each fish lot will be given a health exam. The samples will include a minimum of 10 fish per lot.

Task A.7.1.2. At spawning, a minimum of 150 ovarian fluids and 60 kidney/spleens will be examined for viral pathogens from on-station broodstock. The enzyme linked immunosorbent assay (ELISA) sampling will be performed on all spawned salmon females to reduce potential vertical transmission of *Renibacterium salmoninarum* (causative agent of bacterial kidney disease) to the progeny. Additional fish health samples will be collected to assess the incidence of other bacterial and parasitic pathogens.

Task A.7.1.3. Prior to transfer or release, fish will be given a health exam. This exam may be in conjunction with the routine monthly visit. This sample will consist of a minimum of 60 fish per lot.

Task A.7.1.4. Whenever abnormal behavior or mortality is observed, the fish health specialist will examine the affected fish, make a diagnosis and recommend the appropriate remedial or preventative measures, such as optimal fish-rearing densities.

Task A.7.1.5. Movements of fish and eggs will be conducted in accordance with the Co-Managers Salmonid Disease Control Policy and the USFWS Fish Health Policy and Implementation Guidelines. As needed, fish transferred from other facilities to the Yakima Basin will be given a health inspection.

Task A.7.1.6. At spawning, eggs will be water-hardened in iodophor as a disinfectant. All eggs transferred to the facility will be surface-disinfected with iodophor as per the USFWS Fish Health Policy.

Task A.7.1.7. Juvenile fish will be administered antibiotics orally when needed for the control of bacterial infections.

Task A.7.1.8. Formalin (37% formaldehyde) will be dispensed into water for the control of fungus on eggs and the control of parasites on juveniles and adult salmon. Treatment dosage and time of exposure may vary with species, life-stage and condition being treated.

Task A.7.1.9. All equipment (nets, tanks, rain gear) will be disinfected with iodophor between different fish/egg lots.

Task A.7.1.10. Different fish/egg lots will be kept in separate ponds or incubation units.

Task A.7.1.11. Tank trucks or tagging trailers will be disinfected when brought onto the station. Foot baths containing iodophor will be strategically located on the hatchery grounds (i.e., entrance to hatchery building) to prevent spread of pathogens.

Task A.7.1.12. Therapeutants approved by the U.S. Food and Drug Administration or those under Investigative New Animal Drug permits will be used for treatments. Under special circumstances, extra-label usage of other animal drugs may be prescribed by a veterinarian to control resistant disease organisms.

A.8 Genetics

Objective A.8.1. Gain a thorough understanding of the genetic make-up of target stocks in order to maintain long term genetic variability and minimize the impacts of domestication on supplemented stocks.

Approach: YN staff will collect genetic samples from adult and juvenile salmon. Analysis of genetic markers will be used to evaluate the relationship of salmon populations in the Yakima River relative to others in the Columbia River Basin and estimate origin of salmon returning to the Yakima River. Subpopulation structure within the Yakima subbasin will also be evaluated for changes over time.

Task A.8.1.1. Collect genetic samples from adult salmon at the Prosser and Roza adult sampling facilities, and from fish used for broodstock to evaluate genetic structure, and fish origins (e.g., segregated vs. integrated, hatchery vs. wild, in-basin vs. immigrant). All fish used for broodstock will be genetically sampled and will be incorporated into a multi-generational parentage-based tagging (PBT) baseline.

Task A.8.1.2. Collect genetic samples from juvenile salmon at juvenile sampling facilities.

Task A.8.1.3. Send samples for analysis by CRITFC geneticists or other similarly qualified lab with information added to existing databases.

Task A.8.1.4. Evaluate results with particular interest to the following questions:

1. How is the genetic composition of natural-origin salmon in the Yakima Basin changing over time (e.g., see Williamson et al. 2010 and Hess et al. 2011)?
2. Are there differences in genetic composition between segregated and integrated hatchery-origin and natural-origin salmon? How is genetic composition of these various components changing over time?

Task A.8.1.5. Incorporate information into future reports and management actions through review with YKFP policy and technical teams.

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