Narrative

Table 1. Proposal Metadata

Project Number	200845800
Proposer	Yakama Nation Fisheries Resource Management
Short Description	Upper Columbia Kelt Reconditioning Program
Province(s)	Columbia Cascade
Subbasin(s)	Wenatchee, Entiat, Methow, Okanogan, Mainstem
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Information transfer:

A. Abstract

Upper Columbia River (UCR) steelhead are listed as "Endangered" under the ESA, and naturally-spawning populations currently exist at threshold levels. Unlike other species of Pacific salmon, anadromous steelhead are iteroparous. However, rates of iteroparity for UCR populations are extremely low, likely due to high mortality imposed by such factors as extreme energetic demand, degraded habitat quality, and post-spawning migration through the Columbia River hydropower system.

This project proposes to take advantage of iteroparity in natural-origin (NOR) steelhead populations to increase the abundance of NOR spawners by enhancing the survival of post-spawning females (kelts) intercepted at various locations in the UCR at seaward migration. Several related projects within the Columbia Basin have shown that kelt survival and contribution to naturally-spawning populations can be increased by "reconditioning" in captivity. This project will initiate a kelt reconditioning program in the UCR to collect kelts, recondition them in captivity under two treatment protocols, monitor a set of variables related to condition and reproductive state, and track their post-release contribution to natural spawner abundance. Natural-origin steelhead kelts will be collected from hatchery broodstock that are live-spawned and at locations known to encounter kelts, such as UCR hydroproject fish bypass systems, tributary smolt traps, and weirs. This project could add up to 250 NOR adults, or roughly 10%, to current average NOR abundance.

This kelt reconditioning program aims primarily to evaluate the survival of kelts under alternative reconditioning treatments. Project performance measures therefore examine the relationship between reconditioning protocols and post-release survival of reconditioned kelts. Larger questions concerning the reproductive success of reconditioned kelts and effect on the productivity of natural populations will be addressed through collaboration with on-going and planned studies that are outside the scope of this project.

B. Problem statement: technical and/or scientific background

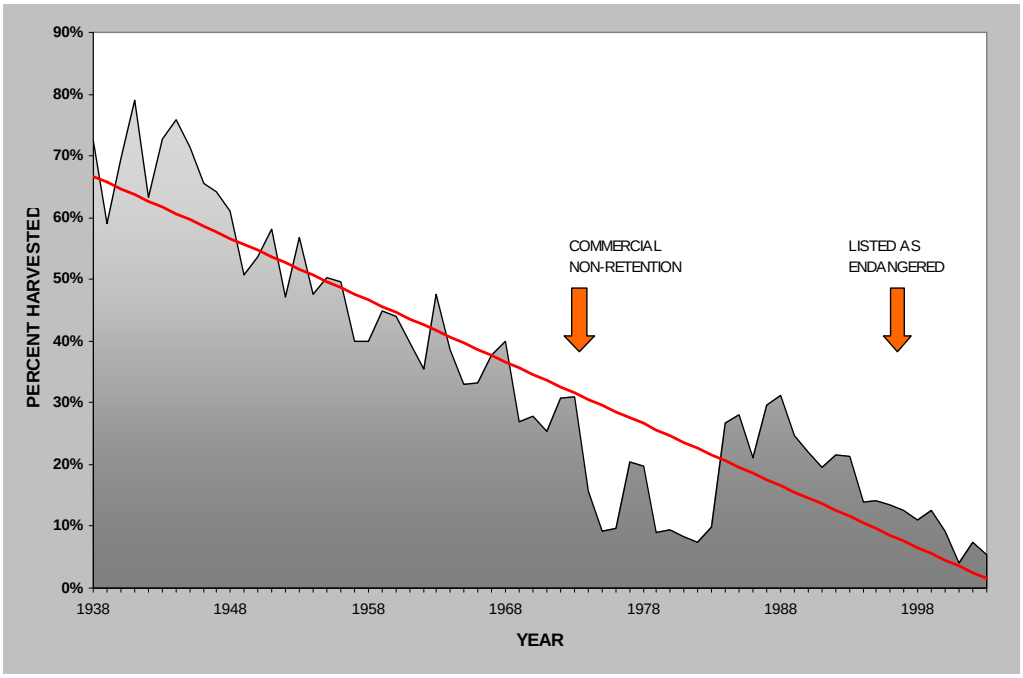
B.1 UCR Steelhead Background and History

Upper Columbia River tributaries were once productive wild summer steelhead systems, but the populations have declined significantly since the early 1900s. Intensive commercial fisheries dating from the late 1800's and the concurrent industrial and agricultural development of the Columbia Basin were largely responsible for the decline of the wild steelhead run (Mullan et al. 1992; Chapman et al. 1994b). Unlike chinook and sockeye salmon catches, steelhead harvest remained fairly constant from the early 1900's through 1940 at about 300,000 fish. Between 1938 and 1942, lower river commercial fisheries, including tribal fisheries at Celilo Falls and elsewhere, harvested about 70% of the run. Curtailing the commercial fisheries resulted in a resurgence of wild steelhead productivity in the upper Columbia River region, where the run size tripled (5,000 fish to 15,000 fish) between 1941-1954 (Mullan et al. 1992). Subsequent to this dramatic increase, wild stock escapements to the Columbia Basin have fluctuated widely.

Wild stock productivity and abundance declined again coincident with the construction of the Columbia River hydropower system, continuing loss and degradation of habitats, and mitigation for these impacts using hatchery fish replacements. Hatchery steelhead typically were produced to mitigate for quantifiable losses associated with direct dam-related mortality and habitat loss. Although total steelhead counts at Bonneville Dam have remained relatively constant since counting began in 1938, the replacement of wild fish by hatchery fish in the time series of counts documents the gravity of the reduction in wild fish production. Exacerbating the loss of productivity associated with human development, wild adults were subjected to unsustainable harvest rates in mixed-stock fisheries targeting abundant hatchery stocks. The management response, arguably belated, included the prohibition of steelhead sales by non-Indians in 1975, adoption of mark-selective fisheries by Washington in 1982, and a suite of time/area/gear restrictions designed to steadily reduce wild steelhead harvest rates in all fisheries. While these actions have largely succeeded in reducing harvest impacts on wild steelhead (Figure 1), UCR NOR steelhead abundance remains depressed. The average estimated NOR run size at Priest Rapids Dam since the 1985-6 run year is 2,722 (range 785-5,715) for the Okanogan, Methow, Entiat, and Wenatchee watersheds as well as small streams not regularly monitored for steelhead escapement (source: TAC Biological Assessment of the 2008-2017 *US v Oregon* Management Agreement).

Mullan et al. (1992) calculated the maximum sustainable yield (MSY) run size and escapement for UCR steelhead to be 16,000-19,000 and 4,000–7,000, respectively, based on extant habitat capacity and spawner-recruit analysis.

Figure 1. Trend in steelhead harvest rates in the Columbia River mainstem fisheries since 1938. The trend line is fitted by eye.



B.2 ESA Listing Status

Upper Columbia River summer steelhead were listed as Endangered in August 1997, based on the determination by NMFS that naturally-reproducing populations of steelhead in the UCR are not self-sustaining and warrant ESA protection (NMFS 2006). Hatchery fish derived from local populations were included in the listing because NMFS determined that they are necessary to achieve recovery. The Interior Columbia Technical Recovery Team (ICTRT) developed population viability curves that showed naturally-spawning UCR steelhead populations are far from viable (ICTRT 2007a) and showed further that UCR steelhead exhibit the largest "gap"- about 16% - between current levels of productivity and those needed to reach delisting (ICTRT 2007b). NMFS (2008) concludes that rates of productivity for UCR naturally-reproducing steelhead populations must increase by 2 to 6 times to escape imminent risk of extinction.

B.3 Current Situation and Proposed Action

There is little doubt that UCR steelhead populations are in a precarious demographic state having a variety of anthropogenic causes. It is likely that the cumulative effect of human intrusion into the UCR steelhead ecosystem has elevated the mortality schedule for NOR populations to levels that cannot be compensated by fecundity and intrinsic productivity rates. The Northwest Power and Conservation Council sub-basin plans document the primary factors limiting steelhead productivity, but stop short of proposing remedies. NMFS' recovery plan for the UCR steelhead DPS describes a broad set of action categories that address identified limiting factors. Most will require considerable investments of time, capital, and political will but others may be more

tractable and immediate. Among these are actions to manage the effects of hatchery mitigation programs on NOR population productivity and genetic integrity.

The persistence of a truly wild steelhead population in the UCR is doubtful given the relatively high hatchery return rates, low (below replacement) natural stock productivity, and genetic homogeneity of hatchery and wild steelhead (Chapman et al. 1994b). Arguments regarding the benefits and costs of hatchery production notwithstanding, most fishery biologists agree that maximizing the influence of NOR spawners in natural populations and integrated hatchery programs is a prudent and desirable management objective (HSRG 2008). Indeed, both the Northwest Power and Conservation Council's Sub-basin Plans and the ESA Recovery Plan for UCR steelhead identify the influence of hatchery steelhead in natural populations as a primary factor limiting natural stock productivity.

Hatchery-based supplementation programs associated with hydrosystem mitigation currently sustain the natural production of steelhead in the UCR, and hatchery-origin fish have become a dominant component of the stocks that currently exist there. Federal and PUD-supported hatcheries release approximately 950,000 steelhead smolts annually in the Wenatchee and Methow and Okanogan basins (400K Wenatchee, 450K Methow, and 100K Okanogan). Releases into the Entiat were terminated after 1998 to provide a "control" for assessing the effectiveness of supplementation programs in the other watersheds. Investigations are currently underway to determine the proportion of steelhead spawning in the Entiat River which may be strays from other hatchery programs. In view of the demographic realities facing NOR steelhead, mitigation responsibilities associated with operation of the hydroelectric power system, and the need to provide some level of resource benefit to stakeholders, fishery managers will be challenged to balance management priorities for hatchery and natural populations in the UCR.

The concept of "kelt reconditioning" is a recent approach to increasing the abundance of NOR spawners quickly and inexpensively compared to current alternatives. Iteroparity, or repeat spawning, is a reproductive strategy in *O. mykiss* not shared by its congeners. Post-spawning adults, or "kelts," return to saltwater where they mature a new batch of gametes, engage in the spawning migration to natal streams, and produce additional generations of offspring. Reconditioning is the process of culturing post-spawned fish in a captive environment by reinitiating feeding, rehabilitating muscle tissue, and redeveloping mature gonads. Reconditioning techniques were initially developed for Atlantic salmon (*Salmo salar)* and sea-trout *(S. trutta)* and are common in the commercial culture of rainbow trout and steelhead. In the Columbia Basin, workers observing the hundreds to thousands of kelts passing mainstem hydroelectric facilities each spring have come to the sensible conclusion that these fish represent a significant opportunity to aid the recovery of steelhead populations.

The incidence of iteroparity in Columbia Basin steelhead populations appears to be negatively correlated with distance from the ocean. Estimated percentages of repeat spawners in adult returns range from 17% in populations downstream of Bonneville Dam to1.6% in the UCR (Table 1). The highest recent estimates of repeat spawners from the Columbia Basin were in the Kalama River where they exceeded 17% of the total return (NMFS 1996). Farther upstream, repeat spawning averaged 4.6% of the summer run in the Hood River (J. Newton, ODFW, pers. comm.). This comports well with reported iteroparity averaging 3.3% for Klickitat River steelhead (Howell et al. 1985). The percentage of iteroparous adults in summer steelhead runs

to the South Fork Walla Walla River ranged from 2% to 9% (J. Gourmand, ODFW, pers. comm.), whereas repeat spawners comprised only 1.6% of the Yakima River wild run (Hockersmith et al. 1995). On average, 1.6% of the UCR natural steelhead passing Priest Rapids Dam and about 1.8% of the previous year's NOR escapement were repeat spawners (Table 2 & 3).

Table 2. Average incidence of iteroparity in steelhead populations compared with distance and number of dams above the Columbia River mouth. Data sources in text.

Tributary	Col. River Confluence (RM)	Number of Dams	Avg. Rate of Iteroparity (%)
Kalama	73	0	17.0
Hood	169.5	1	4.6
Klickitat	180.5	1	3.3
Yakima	3349	4	1.6
Walla Walla	315	4	2 - 9
Wenatchee	469	7	1.6[a]
Entiat	484	8	
Methow	524	9	
Okanogan	533	9	

[a] Measured through scale analysis from steelhead trapped at PRD. Not a true measure of the repeat spawner rate for kelts in the Upper Columbia. The value of 1.6% represents the mean proportion of repeat spawners with the run of steelhead above Priest Rapids Dam (WDFW unpublished data).

Table 3. Percentage of repeat spawners in upper Columbia NOR steelhead passing Priest Rapids Dam, 1986-2006 (based on data from WDFW and the *US v Oregon* TAC).

Run Year	Escapement of NOR Steelhead at PRD	% of Repeat Spawners in PRD Samples	Number of Repeat Spawners at PRD	% of Previous Year's NOR Escapement
1986-7	2,342	1.59%	37	
1987-8	4,058	1.42%	58	2.5%
1988-9	2,670	1.01%	27	0.7%
1989-0	2,685	0.00%	0	0.0%
1990-1	1,585	0.00%	0	0.0%
1991-2	2,799	1.86%	52	3.3%
1992-3	1,618	0.00%	0	0.0%
1993-4	890	0.00%	0	0.0%
1994-5	885	9.26%	82	9.2%
1995-6	993	1.03%	10	1.2%
1996-7	843	1.37%	12	1.2%
1997-8	785	1.27%	10	1.2%
1998-9	928	0.00%	0	0.0%
1999-0	1,374	2.17%	30	3.2%
2000-1	2,341	2.34%	55	4.0%
2001-2	5,715	0.61%	35	1.5%
2002-3	2,983	2.06%	61	1.1%
2003-4	2,836	4.97%	141	4.7%
2004-5	2,985	0.00%	0	0.0%

2005-6	3,127	3.38%	106	3.5%
2006-7	1,677	0.00%	0	0.0%
Average	2,724	1.6%	34	1.8%

Kelts migrating from above Lower Granite Dam have 8 hydropower dams to migrate through, this figure is similar to the 7-9 hydropower Dams kelts migrating from the Upper Columbia must navigate. High downstream kelt mortality is directly correlated to the relative low iteroparity estimates for upriver steelhead populations (Wertheimer and Evans 2005; Evans et al. 2008).

Kelt reconditioning holds special promise for UCR populations subject to high mortality rates that depress productivity and iteroparity. Each spring (March-June), hundreds of kelts from UCR steelhead populations are observed passing hydroelectric facilities en route to the ocean. Data from the Yakima River suggest that perhaps 50 percent of females survive spawning and initiate downstream migration (Hatch, pers. comm.). Few of these kelts successfully navigate the hydrosystem to spawn again (Table 2). Mortality rates for radio-tagged downstream migrating kelts ranged from 20% to 40% for fish tagged at lower Columbia River dams and from 84% to 96% for kelts tagged at Lower Granite Dam on the Snake River (Wertheimer and Evans, 2005). Successfully reconditioning otherwise doomed NOR kelts represents a considerable opportunity to augment the proportion of NOR spawners contributing to the natural population. It is conceivable that a successful reconditioning program could augment the NOR run sizes shown in Table 2 by 10 percent.

B.3.1 Reconditioning Studies

Successful expression of iteroparity in steelhead may be limited by post-spawning starvation and downstream passage through the mainstem Columbia River hydrosystem (Branstetter et al. 2007). Previous workers have described the rationale for testing the effectiveness of both short-term and long-term reconditioning in contributing to natural spawning populations (Hatch et al. 2003; Branstetter et al. 2007). We describe the basic concepts below.

Short-Term Reconditioning Treatment

The objective of a short term reconditioning program is to augment iteroparity rates by initiating the feeding response while still allowing kelts to naturally undergo gonadal development in the estuary and marine environments. Short-term reconditioning is defined as the period of time needed for kelts to initiate post-spawn feeding (approximately 3-12 weeks), followed by transportation of kelts around mainstem hydroelectric projects for release and maturation in the Pacific Ocean (Branstetter et al. 2007). Because gonadal development occurs in the marine environment, the reproductive success of short-term reconditioned kelts is assumed to be similar to that of kelts not artificially reconditioned.

Results of the short-term reconditioning program in the Yakima River show high survival to release compared to kelts entering the long-term reconditioning program, but repeat spawning rates for this group have been low (Table 3). The average survival to release below Bonneville Dam for short-term reconditioned kelts from 2001-2008 was 79.4%, but the percentage subsequently detected crossing Bonneville Dam was quite variable around an average of 6.5%.

Data from short term reconditioned kelts collected between 2005-2008 can be compared to a 'no-term' treatment group and a control 'in-river' group. The 'no-term' treatment group was not

reconditioned, but were transported below Bonneville Dam, the 'in-river' control group was PIT tagged and was returned to the river to complete their downstream emigration. The mean number of kelts returning to repeat spawn was 2.4%, 2.0%, and 3.9% for short term, no-term, and in-river groups respectively.

To date, a clear benefit to short-term reconditioning or transportation has not been detected from these data (4 years of comparisons). At this point in time we are not including a short-term reconditioning program within this proposal. However, we may include a short-term option in the future if new data suggests it is warranted.

Long-Term Reconditioning Treatment

Long term reconditioning is defined as culturing post-spawned fish (kelts) for 6-10 months in a captive environment where they reinitiate feeding, grow and again develop mature gonads. Long term reconditioned kelts would be released in the fall, typically in mid-to late October, coincident with run-timing into upper Columbia tributaries. Reconditioned fish typically are released near or downstream of their capture location to over-winter and return to the spawning site on their own volition. The proportion of reconditioned fish released in this treatment option is uniformly higher than the proportion of short-term fish returning to repeat-spawn (Table 4). A study by the Yakama Nation indicates that the survival of long-term reconditioned kelts ranged from 19.6% to 61.8%, with an average survival to release of 35.7% (Branstetter et al. 2006). These survival rates are more than five times greater than the return rates for short-term kelts and over 20 times the rate of repeat spawning for UCR kelts not taken into captivity.

Table 4. Survival statistics by year for long- and short-term kelts reconditioned at Prosser Hatchery, 2001-2007(Branstetter et al. 2007).

	2001	2002	2003	2004	2005	2006	2007	Total
Long-Term								
Held for Reconditioning	551	420	482	662	386	279	422	3202
Survived to Release	197	140	298	253	86 [a]	85	221	1280
Survival-to-Release	35.7%	33.3%	61.8%	38.3%	22.3%	30.5%	52.4%	39.9%
Mature at Release	108	76	254	216	75	79	202	1010
% mature at release	19.6%	18.1%	52.7%	32.6%	19.3%	28.3%	47.9%	31.5%
Repeat Spawner Success	n/a	n/a	n/a	n/a	n/a	n/a		n/a
Short-Term								
Held for Reconditioning		479	208	105	106	56	40	994
Released		334	187	83	96	50	38	788
Survival-to-Release		69.7%	89.9%	79.0%	90.6%	89.3%	95.0%	83.5%
Returned to Bonneville		43	8	5	0	0	0	42
% Detected Returning to Bonneville		9.3%	2.7%	3.4%	1.0%	0%	0%	5.9%

[a] Twenty of these fish were retained for gamete quality and reproductive success studies
[b] Iteropary rates are unknown.

Despite these encouraging statistics, studies of the reproductive success of kelts released from long-term reconditioning programs are inconclusive. A kelt reconditioning project conducted by the Yakama Nation has documented successful redd construction by kelts through telemetry and direct observation, but the production of viable offspring has not been rigorously examined and this ultimate determinant of program success remains uncertain.

An attempt by Yakama Nation staff to examine reproductive success in natural conditions was beset by operational difficulties and returned inconclusive results (Branstetter et al. 2006). In 2005, researchers released 16 steelhead into Section Corner Creek (Yakama Reservation) to compare the relative reproductive success of kelts and first-time spawners. The release was composed of five reconditioned female kelts, six female first-time spawners, and five male first-time spawners (Branstetter et al. 2006). Parentage analysis of 159 juveniles indicated that all were from first-time spawning females only. However, the reconditioned kelts were held on well water and released in March, and it is believed the reconditioned kelts were over-ripe and did not spawn (Branstetter et al. 2006).

An ongoing study of reproductive success in the Yakima basin should produce results in 2009. Steelhead smolts trapped at the Chandler Juvenile Fish Facility near Prosser will be genotyped to determine whether any are the offspring of 60 reconditioned kelts released to spawn in 2007. The experimental design predicts that 10-15% of sampled smolts can be assigned to one reconditioned parent if the reproductive success of reconditioned kelts equals that of first-time spawners.

Gamete viability tests at the Parkdale Fish Facility near the Powerdale Dam on the Hood River indicated that gamete viability of reconditioned kelts may be lower (13%) than that of first time spawners (47%). However, only one female in the test group lived to be spawned a second time, making it difficult to draw any conclusions about the potential effect of artificial reconditioning on progeny viability (Branstetter et al. 2007). In another hatchery study, Hatch et al. (2006) showed that the progeny of long-term kelts incubated in hatchery conditions showed good survival until shortly after hatch, when 50-60% died from undetermined causes. A study now in progress will determine whether kelts held in captivity after first-time spawning at the Parkdale facility will produce viable eggs and offspring (Hatch, pers. comm.).

Somewhat confounding results have been recorded in studies based on parental genotyping. The first documented evidence that an artificially reconditioned steelhead kelt could successfully reproduce in the wild was obtained when three juveniles collected in Omak Creek were determined to be the offspring of a male kelt (Branstetter 2007). Yet Stephenson et al. (2007), using DNA technology to identify the parents of outmigrating steelhead smolts, failed to identify any offspring from reconditioned kelts released into the streams where the study was conducted. It is not clear whether viable offspring were not produced or simply not detected, but the successful production of viable offspring by reconditioned female kelts remains undocumented.

These mostly negative results have produced more questions than answers regarding gamete viability and reproductive success of kelts in a long-term reconditioning treatment. Nevertheless, the ISRP (2006) concluded that this work needs to be replicated several times, perhaps in several locations, in order to get reliable estimates of reconditioned kelt contributions to natural spawning populations. We agree. The uncertainties of kelt reconditioning will be addressed in a coordinated and systematic way by ongoing kelt reconditioning projects funded by Bonneville Power (Project Number 2007-401-00) as well as the new project proposed below (Project Number 2008-458-00). The significant gains to NOR population status through successful kelt reconditioning should obligate sustained regional efforts to a thorough evaluation of this potential recovery tool.

Proposed Action: **Increase repeat spawning by anadromous steelhead *(O. mykiss)* through kelt reconditioning to increase the abundance of NOR spawners in UCR steelhead populations.**

We propose to increase the potential for increased NOR spawning and advance the understanding of kelt reconditioning. We will initially implement only a long-term reconditioning program unless data from other programs suggests that inclusion of a short-term program is warranted.

Because kelt mortality rates increase and iteroparity decreases in populations with a greater number of hydropower dams to navigate during their downstream migrations (Wertheimer and Evans 2005), additional measures such as kelt reconditioning, transportation, or both may be warranted to boost repeated spawner rates in upstream populations.

The proposed project takes advantage of existing hatchery and M&E facilities to the greatest extent possible. Kelt collection will be conducted at Wells Hatchery, where NOR broodstock will no longer be sacrificed after spawning, tributary smolt traps in the Wenatchee and Methow

basins, and in juvenile bypass facilities at Rocky Reach, Rock Island, and Priest Rapids dams. Collected kelts will be reconditioned at Entiat NFH by agreement with the USFWS. Other collaborators include the mid-Columbia PUDs (Douglas, Chelan, and Grant counties), WDFW, NMFS, and the Columbia River Inter-Tribal Fish Commission (CRITFC). Due to the data rich environment for salmonid monitoring within the Upper Columbia (ISEMP, Chelan and Douglas PUD M&E Plans, Grant PUD M&E plans, Okanogan Basin Monitoring and Evaluation Plan (OBMEP), and BOR research in the Methow River) we believe the proposed long term program will begin to answer critical uncertainties associated with kelt recondition.

Though not within the scope of this proposal, we will collaborate extensively with ongoing and planned RM&E projects to get to the threshold question of reproductive success by reconditioned kelts. Proponents acknowledge that merely increasing spawner abundance does little to promote recovery if reconditioned spawners do not produce viable offspring. However, it is considered duplicative of effort and an inefficient use of resources for this project to undertake the intensive, expensive, and elaborate level of investigation needed to properly address reproductive success in view of the extensive RM&E network currently deployed in the UCR. The M&E plan shown in Section 4.0 integrates extensively with the RM&E infrastructure already in place as a result of the ISEMP (Integrated Status and Effectiveness Monitoring Program; BPA project number 200701700) and Mid-Columbia PUD mitigation programs. Indeed, we believe this proposed reconditioning project is uniquely positioned to advance the body of knowledge regarding the contribution that kelt reconditioning can make to the production of offspring from natural spawning grounds.

C. Rationale and significance to regional programs

This project is one element of a comprehensive regional goal to enhance and restore the productivity of ESA-listed steelhead populations in the UCR to delisting levels. Delisting requires the presence of "*self-sustaining populations reproducing in their natural habitats*." [1] Essential to delisting is the accumulation of NOR abundance even as the factors limiting NOR productivity are being addressed separately.

To the extent that successful kelt reconditioning provides an alternative to hatchery-based supplementation as a means of increasing natural spawner abundance, this project is consistent with guidance from a variety of scientific and technical advisors concerned about the risks posed to natural populations by hatchery operations. The UCR Sub-basin Plans (NPCC 2004) go so far as to rank hatchery influence above habitat degradation and the Columbia River hydropower system as the Primary Limiting Factor affecting the productivity of UCR steelhead populations. A small, but growing, base of empirical studies describes the genetic risks of hatchery programs to NOR populations (e.g., Araki, et al 2006), and the ICTRT (2007a) addresses the implications of hatchery programs for the viability and recovery of ESA-listed populations. The HSRG recommendations on hatchery reform call for limiting hatchery influence in natural production areas by physically removing as much as 90% of returning adult hatchery steelhead before they can spawn (HSRG 2009). Debates about the benefits and risks of hatchery supplementation aside, few would argue that kelt reconditioning represents a valuable opportunity to avoid the uncertainties of hatchery intervention in the enhancement of NOR populations.

[1] Endangered Species Act of 1974.

D. Relationships to other planning processes

This project is consistent with, and derives from, assessments of limiting factors and remedies described in Northwest Power and Conservation Council sub-basin plans, ESA recovery plans, and PUD mitigation plans. It is specifically identified in the Columbia River Fish Accords and the FCRPS BiOp as having considerable potential to "close the gap" between current UCR steelhead population status and that needed to achieve delisting.

D.1 Sub-basin Plans

D.1.1 Wenatchee and Entiat Sub-basin Plans

This project is consistent with, and will help achieve, the goals of the Wenatchee and Entiat subbasin plans. Specifically, Goal 3 of the Wenatchee subbasin plan addresses the restoration of sustainable levels of naturally-produced populations.

From the Wenatchee and Entiat Subbasin Plans:

> *Goal 3. Restore maintain, or enhance fish and wildlife populations to sustainable and harvestable levels, while protecting biological integrity and the genetic diversity of the species.*
>
> - *Maintain and/or restore performance (productivity, abundance, and life history diversity) of wild, indigenous populations in a manner that maintains or enhances genetic similarity to naturally producing populations. Artificial propagation is considered a relatively short term measure and is not intended to replace naturally reproducing population over the longer term*

The proposed kelt reconditioning program will develop and implement fish culture techniques to rehabilitate NOR steelhead kelts that are intended to spawn in the natural environment. It is anticipated that successful reconditioning will enhance the abundance and average productivity of natural spawners while promoting life history diversity. Because reconditioned kelts will spawn in natural conditions, we do not expect any genetic divergence of their progeny.

D.1.2 Methow Sub-basin Plan

The Methow Subbasin Plan states that the goal for steelhead is, "*run size and spawning escapement levels that provide for the recovery of ESA-listed upper Columbia River steelhead in the Methow subbasin; management effectively mitigates for hydro-system losses and supports a harvestable surplus*". The proposed kelt reconditioning program is one tool that may help achieve the goal for steelhead within the Methow subbasin plan by enhancing both abundance and life-history diversity. Further, the proposed reconditioning plan will help achieve the overall vision for the subbasin.

From the Methow Sub-basin Plan:

> *Our vision for the Methow subbasin includes viable, self-sustaining, harvestable, and diverse populations of fish and wildlife and their habitats, along with recognition of the need to support the economies, customs, cultures, subsistence, and recreational opportunities within the subbasin.*

D.1.3. Okanogan Subbasin Plan

The Okanogan Subbasin Plan recommends using steelhead kelt reconditioning as one strategy to achieve steelhead recovery objectives (Strategy 20-3; page 404).

D.2 Goals and objectives of the 2000 Fish and Wildlife Program

The Northwest Power and Conservation Council's 2000 Fish and Wildlife Program recommends that artificial production programs be operated in a manner that maintains diversity in life history types. The proposed Upper Columbia Kelt Reconditioning Program comports with the objectives and principles of the 2000 Fish and Wildlife Program by aiding in the recovery of ESA-listed, NOR steelhead populations affected by the development and operation of the hydro system. The project will contribute to the preservation of life history diversity within UCR steelhead populations by promoting the survival and reproduction of NOR kelts. This is entirely consistent with overarching FWP objectives to sustain an abundant, productive, and diverse community of fish and wildlife.

The Northwest Power and Conservation Council recommendations also state that artificial production programs should include an experimental, adaptive management component that includes an aggressive program to evaluate risks and benefits and address scientific uncertainties. In collaboration with ongoing and planned RM&E projects in the UCR, the proposed kelt reconditioning program will track the performance of reconditioned kelts after release to determine whether the program is meeting its goals. Project objectives and operations will be responsive to the results of effectiveness monitoring for variables such as post-release survival, maintenance of phenotypic traits (e.g., migration timing, fecundity), and reproductive success.

D.3 Upper Columbia River Salmon Recovery Plan

The Upper Columbia River Salmon Recovery Plan lists several objectives for hatchery programs and specifically calls for examining the feasibility and effectiveness of kelt reconditioning in the Wenatchee, Entiat, Methow, and Okanogan Rivers. The Upper Columbia Regional Technical Team (UCRTT) has prioritized monitoring and research needs identified in the Recovery Plan and has ranked the need to assess the feasibility and effectiveness of kelt reconditioning as a Tier 1 (highest priority) research need. This proposal includes a robust M&E plan to evaluate the effectiveness of reconditioning techniques and strategies.

D.4 Columbia River Fish Accords

The Columbia River Basin Accords recognize that hatchery actions can provide important benefits to ESA-listed species and to the Columbia River Treaty Tribes in support of their treaty fishing rights. The Accords identify UCR Steelhead Kelt Reconditioning as a new artificial production action. The proposed Upper Columbia Steelhead Kelt Reconditioning program will be carefully coordinated with other kelt reconditioning programs funded through the Accords (e.g. Snake River, Yakima River, Omak Creek) to identify uncertainties associated with kelt reconditioning, allocate research questions among projects, and develop coordinated study plans that make most efficient use of project resources and cost shares to deliver results and promote adaptive management.

D.5. FCRPS BiOp

This project was identified during the FCRPS BiOp remand process as a measure to "close the gap" between current population status and that needed to reach ESA delisting for UCR steelhead. As such, it is included as a Reasonable and Prudent Alternative (RPA) in the BiOp issued to the FCRPS to cover continued operation of the federal hydropower system.

Interestingly, the BiOp does not specify an expected benefit of this project, perhaps because 1) NMFS recognizes that kelt reconditioning is in a developmental phase that makes the calculation of expected benefits highly uncertain, and 2) it is recognized that any benefit greater than approximately zero is a net gain to UCR steelhead populations. It is likely the project appears as a RPA in part to spur the research and development of successful reconditioning techniques. Specifically, the BIOP says "implementation of kelt reconditioning actions (RPA #33 and #42) would likely result in a substantial proportion of the adults passing through juvenile bypass systems or other, similar structures being captured and transported to reconditioning facilities. Implementing these actions should substantially reduce the mortality of the captured steelhead kelts compared to what otherwise would occur if these fish were left to migrate in-river." One of the required actions for BPA under RPA #42 states "For **Upper Columbia Steelhead**: Fund a program to recondition natural origin kelts for the Entiat, Methow and Okanogan basin including capital construction, operation and monitoring and evaluation costs."

D.6. Mid-Columbia HCPs and Settlement Agreements

The hydroelectric projects owned and operated by Douglas County PUD (Wells), Chelan County PUD (Rocky Reach and Rock Island) have developed Habitat Conservation Plans under Section 10 of the ESA. Grant County PUD has chosen to develop the Priest Rapids Settlement Agreement to provide mitigation and ESA coverage for its operation of Wanapum and Priest Rapids dams ESA "Take" permits are issued by NMFS on the basis of approved HCPs and agreements, and approved actions are included as terms and conditions of the FERC licenses issued to the PUDs. The HCPs include robust M&E components that require project operators to document that protection and mitigation measures do not adversely affect the status of listed populations. Pursuant to M&E plans, the PUDs fund intensive studies on, among other things, the effect of hatchery mitigation programs on listed populations. These monitoring programs include on-going and planned parental genotyping studies of UCR spring chinook and steelhead populations to elucidate the fitness effects of hatchery-origin spawners on naturally-spawning populations.

The proposed UCR kelt reconditioning project will take advantage of ongoing and planned research by NMFS and WDFW to obtain specific information on the reproductive success of reconditioned kelts. Pedigree analysis will reveal, among other things, the extent to which reconditioned kelts produce offspring. Through close collaboration with field researchers from other agencies, we will use this information to systematically identify and address uncertainties surrounding reconditioning techniques that affect the reproductive success of reconditioned kelts.

E. Relationships to other Projects

Table 5. Relationship to existing projects

Funding Source	Project #	Project Title	Relationship (brief)
BPA	200501700	Integrated Status and Effectiveness Monitoring Program	We expect that the monitoring and evaluation plan described for this proposal will coordinate closely with data being collected for ISEMP. ISEMP funded activities which would provided data for the M&E plan associated with this narrative include remote PIT tag detection sites throughout the Wenatchee and Entiat basins, steelhead spawning ground surveys in the Wenatchee River, and the potential for capture kelts in ISEMP funded rotary smolt traps.
BPA	199604000	Mid-Columbia Coho Restoration	We expect that the proposed kelt reconditioning program may share some facilities or equipment (e.g. smolt traps for collection of kelts, and fish transport tanks) with the mid-Columbia coho restoration project.
BPA	2007-401-00	Evaluate the Relative Reproductive Success of Reconditioned Kelt Steelhead	We expect to coordinate and collaborate with ongoing kelt reconditioning programs in the Columbia River Basin. Through annual meetings we will share results to learn from each program and collectively determine how research in multiple locations may be used to increase statistical power, or determine if which project is best suited to answer key critical uncertainties.

Funding Source	Project #	Project Title	Relationship (brief)
Chelan and Douglas PUDs	N/A	Hatchery Compensation Program for Methow and Wenatchee Steelhead.	A portion of natural origin steelhead collected as broodstock for the Chelan and Douglas County hatchery compensation programs would be live spawned and then incorporated in to the proposed kelt reconditioning program. Reconditioning natural origin steelhead spawned in a hatchery facility would provide the opportunity to then spawn in the natural environment. Additionally trapping facilities at Rock Island and Rocky Reach dams are proposed for use to capture natural origin kelts. In addition to the ISEMP project mentioned above, the steelhead/sockeye monitoring activities under the HCP funded by Chelan and Douglas PUD, and the BOR-funded habitat and steelhead studies in the Methow, 24 separate PIT tag arrays have been installed in strategic locations in the Wenatchee and Methow basins (12 in each basin) plus 3 in the Entiat Basin. The Okanogan also has arrays, the exact number could not be determined. These arrays will be critical for our M & E data collection, by helping locate spawning distribution of reconditioned kelts.
BPA BOR CCPUD DCPUD		Effects of Hatchery Influence on the Reproductive Success of Steelhead in UCR Watersheds	Will incorporate our PIT-tagged kelts into the spawning population for parental genotyping within the proposed reproductive success studies. These studies will likely occur in the Wenatchee and Methow Basins, but could include the entire Upper Columbia. A collaborative reproductive success evaluation would provide the opportunity to measure the relative reproductive success of first time NOR spawners, first time HOR spawners, reconditioned kelts and non-reconditioned second time spawners (HORs and NORs).

A steelhead reproductive success study will be implemented by WDFW and NMFS within the next two years in the Wenatchee and Methow river basins. This study is required under the conditions of Douglas's and Chelan's HCPs. The study will provide critical information on the ultimate success of reconditioned kelts from this project and their contribution to productivity of the steelhead populations in the Columbia Cascade Province. The goal of the study is to directly measure the relative reproductive success of hatchery and natural-origin steelhead in the natural

environment. The study aims to determine the degree to which any differences in reproductive success between hatchery and natural origin steelhead can be explained by heritable differences in fitness and/or measurable biological characteristics such as run timing, morphology, spawn timing, or spawning location. Reconditioned kelts from this project will be included in this study, and results will be incorporated into a feedback system to evaluate reconditioning procedures.

G. Proposal biological/physical objectives, work elements, methods, and metrics

G.1 Project Objectives

The general objective of this project is to increase the abundance of naturally-produced UCR steelhead on natural spawning grounds by as much as 10 percent through the use of kelt reconditioning.

> Objective 1: Implement a kelt reconditioning program in the UCR to increase NOR spawner abundance relative to current conditions.
> Objective 2: Evaluate kelt survival and program effectiveness.
> Objective 3: Collaborate with ongoing M&E studies to document the reproductive success of kelts released from the reconditioning program

G.2 Objective 1: Implement a kelt reconditioning program in the UCR

Work Element 1: Kelt collection.

Work Element Title	Work Element Description	Metric
Trap/Collect/Transport Fish	Trap, collect and transport kelts from collection facilities in the Wenatchee, Entiat, Methow, and Okanogan and Columbia rivers to the reconditioning facility.	**40 - 190 kelts from Wells FH broodstock** **Up to 300 kelts from all sources**

Upper Columbia steelhead kelts will be obtained from two sources: 1) NOR adults incorporated into Wells Hatchery broodstocks would be live-spawned (rather than the current practice of killing 100% of all NOR spawners) and subsequently reconditioned, and 2) NOR kelts that have naturally spawned in the Wenatchee, Entiat, Methow and Okanogan basins would be collected at a variety of locations such as mainstem juvenile bypass systems located on Rocky Reach and Rock Island dams, tributary smolt traps, weirs, or other site where kelts are routinely observed. So not to affect steelhead supplementation efforts by the Mid-Columbia HCP parties, gametes from live-spawned NOR broodstock would continue to be incorporated into their respective hatchery programs.

Broodstock collection protocols for Methow and Wenatchee steelhead supplementation programs incorporate NORs as part of the overall broodstock propagation program. Broodstock for both the Methow and Wenatchee summer steelhead programs are held and spawned at Wells Fish Hatchery (FH). Presently, all NOR broodstock are sacrificed at spawning for virology sampling. Modification of the current disease control policy to allow only a sub-sampling of NORs at spawning is required for this source of kelts.

NOR broodstock, which are collected as first-time spawners in the summer/fall and held in the hatchery through spawning in the early spring, may have a higher reconditioning success rate than their naturally-spawning counterparts. The reduced energy expenditure and avoidance of physical damage during spawning may increase condition factors and the probability of successful reconditioning for NOR adults held in the hatchery.

Potential numbers of NORs collected and incorporated into both the Methow and Wenatchee programs at Wells Hatchery are listed in Table 6. All collected steelhead kelts would be transported to the reconditioning facility. For this proposal, NORs not required for virology sampling will be live-spawned and incorporated into the program. The proportion of steelhead needed for fish health sampling is currently undetermined. We expect that live-spawned NORs from Wells FH would provide a large proportion of the steelhead for this reconditioning program.

Table 6. Total number of NOR males and females in the Wenatchee (WEN) and Methow (MEOK) summer steelhead supplementation programs, 1999-2007 (data provided by WDFW).

Broodyear	WEN F	WEN M	MEOK F	MEOK M	TOTAL
1999	31	21	18	9	79
2000	20	16	22	16	74
2001	21	30	10	15	76
2002	65	31	14	4	114
2003	34	15	18	8	75
2004	39	36	64	51	190
2005	52	35	39	24	150
2006	59	34	51	35	179
2007	42	34	26	18	120

Natural-origin kelts also would be collected where opportunities exist, such as mainstem juvenile bypass systems, tributary smolt traps, and tributary weirs. In large escapement years several hundred kelts may be encountered at the Rocky Reach and Rock Island dam bypass traps (T. Mosey CCPUD, pers. comm.; Table 7.). Collection duration and holding capacities would need to be coordinated between YN and Chelan County PUD (CCPUD) prior to implementation of this work element. Kelts may be collected from the Rocky Reach juvenile bypass during the time periods that the sampling facility is operational (approximately 2 hours per day). Data from the Rocky Reach bypass in Table 7 does not reflect the number of kelts that could be captured under the current operational protocols. Rotary smolt traps within the subbasins may also provide a source of NOR kelts for reconditioning, although expected contributions would be low. Trap operations conducive to our collection goals would include Monitor, Nason, Chiwawa, Entiat, Twisp, and the Methow. All kelts collected from these locations would fall within the upper Columbia ESU and could be incorporated into the reconditioning program.

Table 7. Number of total steelhead kelts encountered at Rocky Reach and Rock Island bypass facilities, 2000-2007 (data provided by CCPUD).

Year	Rocky Reach	Rock Island
2000	177	21
2001	na	14
2002	124	77

2003	na	18
2004	na	35
2005	na	43
2006	na	67
2007	na	50

Steelhead kelts collected for the reconditioning program would be held at the various collection locations until transportation arrives to deliver these individuals to the reconditioning facility. Holding duration could range from a couple of hours to one day depending on logistics, equipment, densities and multi-agency cooperation that would need to be identified by all entities prior to collection. Collection and holding facilities are identified in 'Section H: Facilities and Equipment'.

Work Element 2: Fish Health and Containment.

Work Element Title	**Work Element Description**	**Metric**
Maintain Fish Health	USFWS will be subcontracted to provide fish health monitoring, pathology sampling, laboratory processing of samples and produce recommendations.	

A high priority is placed on bio-security through fish health practices and isolation of reconditioning tanks. The design of the reconditioning facility must be able to accommodate isolation and treatment of potential pathogens. Virology sampling will not be possible for kelts entering the reconditioning facility, but pathogen sampling during spawning at Wells FH will provide a proportionate, annual disease profile for the stocks taken into the program. Historical disease profiles for Wells stock indicate that neither IPNV nor IHNV have been discovered within the last 20 years and virology results have been negative for the past 10+ years (R. Rodgers, WDFW fish health, unpubl. data). Wenatchee disease profiles are not available at this time but are presumed to have low incidences for viral infections. A disease management plan will be developed to establish protocols to assess and manage risks associated with transfers of kelts to the facility, during reconditioning, and at release of fish. Initial bio-security measures could include tank isolation from each capture location, effluent water treatment, and regular fish health examinations. All mortalities will be sampled by USFWS fish health staff to determine cause of death.

Work Element 3: Kelt Processing.

Work Element Title	**Work Element Description**	**Metric**
Collect/generate/validate field and lab data	Record detailed fitness and condition data for each kelt upon collection.	
Mark/Tag Animals	All kelts entering the reconditioning program or released to the river will be marked with a PIT tag for unique identification.	
PIT Tags	PIT tags are purchased through	

	BPA	
Create/Manage/Maintain Database	Create and maintain a database of all kelts entering the program to track reconditioning results.	

This work element is designed to provide baseline information on kelt condition at the outset of reconditioning that can be used to assess survival in the program and post-release performance of reconditioned kelts. Kelt processing begins at each collection site where fish are individually transferred to a temporary holding tank for anesthetisation and biological assessment. At the trapping location and prior to transportation, all kelts will go through an initial evaluation process to determine overall fitness and will be assigned a condition score (Table 8). The condition scores in Table 8 are additive. Kelts with the highest scores would be considered the poorest condition. Based on empirical data of kelt survival within the program, the fish condition score may eventually be used to determine which fish are suitable for inclusion into the reconditioning program and control group, or to evaluate potential reasons why one group may have had a higher or lower survival rate. In addition to the condition score, we will measure somatic lipid levels as a secondary index of condition. All live kelts will be randomly assigned to either the reconditioning program or an in-river control group (see Section G.3). If necessary, ultrasound will be used at non-broodstock locations to ensure that fish collected are post-spawning individuals. Kelts in the control group will receive a PIT tag and be released back to the river with no further intentional handling.

Table 8. Kelt condition scoring criteria.

Condition	**Score**	**Comment**
Descaling (0-5%) right side	0	
Descaling (0-5%) left side	0	
Descaling (6-19%) right side	1	
Descaling (6-19%) left side	1	
Descaling (≥ 20%) left side	2	
Descaling (≥ 20%) right side	2	
Body Injury (open wounds)	1	One point per injury, multiple injuries will result in multiple points (no point limit)
Fin Injury (absent, or exposed fin rays)	1	One point per fin, multiple fin injuries will result in multiple points (up to 5 points)
Eye Injury	1	One point per injured eye (up to 2 points)
Head Injury	1	One point per injury
Opercle Injury	1	One point per injury
External Parasites (copepods <25% gill area)	1	
External Parasites (copepods ≥ 25% of the gill area)	2	
Fungus (0-5% of body)	0	

Fungus (6-19% of body)	1	
Fungus (≥ 20% of body)	2	

Upon entering the reconditioning program, each kelt will be isolated by collection location. PIT tags will be applied for unique identification of each kelt throughout the reconditioning process and after release. The tag codes map to capture location and will be critical when determining a specific release location for reconditioned steelhead (e.g., kelts from Wells FH broodstock would be released above Wells Dam). Non-lethal somatic lipid measurements taken at collection will serve as a baseline index of condition from which to measure relative fat gain during the two reconditioning treatments. This index also can be compared with lipid concentrations measured prior to spawning to provide a target lipid content for kelts ready for release from the long-term program. Determining energy expenditure between pre- and post-spawning fish may provide a quantifiable measure for determining when a fish is ready for reintroduction into the natural environment, or at least determine the build-up of energy reserves from the depleted state post-spawning.

Biological work-up will include weight, fork length, POH length, scales, sex determination, and origin of transport. If not already tagged, a PIT tag will be inserted in the pelvic girdle for identification purposes.

Work element 4: Kelt rearing

Work Element Title	**Work Element Description**	**Metric**
Build Artificial Production Facility	The proposed program makes use of existing facilities but additions, including circular tanks and effluent isolation will be necessary.	
Rear Fish	Fish culture techniques will be used to recondition steelhead prior to re-release.	Up to 200 kelts taken into reconditioning program
Collect/Generate/Validate Field and Lab Data	Periodic evaluation of reconditioning success including maturation, weight gain, blood indicators (ATPase and Thyroxine), and/or other determining factors will be assessed prior to an individual fish being deemed ready for release.	
Create/Manage/Maintain Database	Create and maintain a database of all kelts entering the program and reconditioning results.	

Although limited data indicates that reproductive success for reconditioned kelts could be low, through collaboration with ongoing monitoring programs (HCP Hatchery M&E plans and ISEMP), we believe the Upper Columbia Region is uniquely suited to test differences between

the two types of reconditioning programs (see section '4.0. Monitoring and Evaluation'). It is therefore premature to select only one of these conditioning strategies at this early planning stage. However, we anticipate having determinate results within six years of releasing reconditioned kelts.

Once kelts have been initially processed and admitted into their respective rearing units by strategy, the following fish culture activities and monitoring will occur:

1. All circular tanks will be treated using preventative measures for fungal outbreaks that may occur. Treatment will include 5 days a week formalin drip at 1:6,000 for 1 hour. Flow rates for each tank will range between 150-200 gallons-per-minute (gpm) of ground water; dependant on water availability. In addition to formalin treatments, steelhead will be administered with an initial treatment of Ivermectin, diluted with saline, due to the success in treating *Salmincola* (parasitic copepod*)* observed within the Yakima program. Typically, steelhead adults are susceptible to these parasitic copepods that reside on the gill lamellae. If left untreated, they will inhibit a fish's oxygen uptake resulting in mortality. Daily formalin treatments as well as any other additional treatments would be provided by YN staff.
2. An external/internal assessment will be conducted for all mortalities removed from the program to document any abnormal processes or reasons for the moribund fish. Mortality assessment would be conducted by YN or USFWS fish health staff. Carcass disposal would likely occur at the local landfill or alternate location at the recommendation of fish health specialists.
3. Feeding will occur daily. Based on results from the Yakima reconditioning program, krill works extremely well to re-initiate feeding. Once feeding has been successfully re-initiated, manufactured pellets (top-coated with squid and krill) will be incorporated into the diet. Other feed options are being used by the Colville Confederated Tribes (CCT) at the Cassimer Bar reconditioning facility. Feed sources include cod liver oil, anchovies, squid, and herring to mimic natural food sources that may be found in marine environments. When pelletized food is introduced, natural food sources are still kept in rotation to provide trace minerals and polyunsaturated fatty acids that have been determined to be important in fish health and survival (Johnson et al. 1987). Feeding would be conducted by YN staff.
4. Periodic evaluation of reconditioning success will be conducted by YN staff by collecting biological assessment data; similar to the introduction sampling.
5. Measures of fish condition and readiness for release will be assessed routinely during captivity. Gamete maturation, weight gain, somatic lipid concentration, and blood indicators (ATPase and Thyroxine) will be assessed prior to an individual fish being deemed ready for release. Maturation will be verified through ultrasound. Blood indicators would be performed on long-term reared individuals as an alternate means to determine which fish are maturing. A pre-spawn length-weight relationship will be derived for Wenatchee River Basin NORs to establish a target condition factor for reconditioned steelhead.
6. A tissue sample collected from each kelt prior to release will be processed for genotyping and added to the database for reproductive success studies being funded by Chelan PUD in the UCR. Within the limits of the study design, estimates of relative reproductive success for each released kelt can be related to measurements of fish condition and rearing protocols described above.

Kelts will likely remain in the reconditioning facility for 6-10 months to facilitate gamete regeneration. Reconditioned individuals will be released as nearly as possible to match the migratory timing of the natural, actively-migrating run at large so that reconditioned kelts have a high likelihood of successfully mating with other NORs or naturally-spawning HORs.

Work element 5: Kelt release

Work Element Title	Work Element Description	Metric
Trap/Collect/Hold/Transport Fish	Kelts being released will be transported from the reconditioning facility to the designated release point (Table F-8)	Number of fish surviving captivity that are transported and released
Collect/Generate/Validate Field and Lab Data	Fish condition at release will be assessed by measurements of various condition factors	

Release locations for reconditioned kelts will be determined by capture location through PIT tag identification. Multiple vehicles will be available for transportation to release sites. Radio-tags may be inserted into a portion of individuals to compare migration behaviour with measures of fish condition, blood indicators, and time of release. Telemetry also will allow tracking reconditioned kelts to specific locations where spawning behaviour - or lack of it - can be observed. Release sites for long-term reconditioned kelts are identified in Table 9.

Table 9. Proposed kelt collection and release sites.

Stock	Kelt Collection Site	Release Site
Methow NOR broodstock	Wells FH (broodstock collected at Wells Dam)	Columbia River between Wells Dam and the confluence with the Methow River
Methow NOR spawners	Methow basin rotary smolt traps and weirs	Methow River or tributary of collection
Wenatchee River NOR broodstock	Wells FH (broodstock collected at Tumwater and Dryden dams)	Wenatchee River between Dryden Dam and Peshastin Creek
Wenatchee River NOR spawners	Wenatchee River rotary smolt traps	Wenatchee River or tributary of collection, upstream of collection facility
NOR spawners	Rocky Reach juvenile bypass	Columbia River between Rocky Reach Dam and the Entiat River
NOR spawners	Rock Island juvenile bypass	Columbia River between Rock Island Dam and the Wenatchee River

G.3. Objective 2: Evaluate kelt survival and program effectiveness

Work element 1. Monitoring and Evaluation

Work Element Title	Work Element Description
Collect/Generate/Validate Field and Lab Data	Data will be collected in order to determine recondition success in the hatchery, repeat spawn rate, spawn timing, and spawn distribution. The full description of metrics to be collected can be found following this table.
Create/Manage/Maintain Database	A comprehensive reconditioning database for storage of all reconditioning data collected.
Analyze/Interpret Data	
Produce Annual Progress Report	

This objective is intended to be used to adaptively manage the program and make program improvements. In collaboration with others, we will also advance the understanding of relationships between kelt reconditioning and the reproductive success of reconditioned kelts. Over time, this collaboration is expected to produce quantitative estimates of the production of viable offspring (e.g., smolts/spawner) by individual reconditioned kelts.

The main evaluations to be performed under this objective are the following:

1. Quantify the relative rate of repeat spawning by UCR steelhead in the reconditioning program to rates for non-reconditioned kelts
2. Quantify the contribution reconditioned kelts to the total abundance of NOR spawners in the UCR
3. Evaluate relationships between hatchery environment, reconditioning protocols, kelt condition, gamete maturity, kelt survival in captivity, and contribution to the abundance of NOR spawners.

Evaluation 1: Quantify the relative rate of repeat spawning by UCR steelhead in each reconditioning treatment relative to rates for non-reconditioned kelts

The main objective of the kelt reconditioning program is to contribute to the recovery of UCR summer steelhead by supporting the iteroparous life history of steelhead. The purpose of this evaluation is to quantify the potential for the UCR kelt reconditioning program to augment NOR spawner abundance relative to the current "no action" alternative. A comparison of the relative proportions of reconditioned kelts and non-reconditioned kelts that return to the point of collection will be used to evaluate this objective.

Evaluations will be based on PIT tag data retrieved from the PTAGIS database and adjusted as needed to account for variable tag detection rates. In addition to the complex of detection arrays erected throughout the mainstem Columbia River, a large number of arrays have been deployed within the Wenatchee, Entiat, Methow and Okanogan sub-basins that will allow for relatively fine-scale tracking of tagged study fish. Currently in the Wenatchee Basin PIT arrays are installed in Peshastin and Nason Creeks, Tumwater Dam, Tumwater Canyon, Chiwawa River and are planned for the lower Wenatchee, White and Little Wenatchee Rivers. Three PIT tag arrays are installed in the Entiat Basin, at the mouth of the Entiat River, RM 16.1, and at the mouth of the Mad River. In the Methow River arrays are currently installed or planned in Beaver Creek, Gold Creek, Libby Creek, Chewuch River, Methow River above the Chewuch, Twisp

River, Methow River about the Twisp River and the Mouth of the Methow. Within the Okanogan, PIT tag arrays can be found in Omak Creek, and may be installed in Antoine, 9 mile, and Salmon creeks. PIT tag detections at these arrays are recorded and will be retrievable from PTAGIS in real time.

Hypothesis:

Ho_1: Repeat spawner rate $_{\text{reconditioned ketls}}$ > Repeat spawner rate $_{\text{control group}}$

Measured Variables:

- The number of kelts entering the reconditioning program
- The number of non-reconditioned PIT tagged kelts sampled and released.
- The number of long-term reconditioned kelts released and subsequently detected ascending upstream to spawning grounds
- The number of non-reconditioned PIT tagged kelts returning and subsequently detected ascending upstream to spawning grounds.

Derived Variables:

- The estimated proportion of steelhead entering the long term reconditioning program that return survived to repeat spawn.
- The estimated proportion of non-reconditioned steelhead kelts that return a second year to repeat spawn.

As we develop and refine reconditioning techniques we expect the results of this analysis to show a considerable potential benefit from reconditioning treatments. However, it is recognized that this parameter does not equate to spawning success or the production of offspring.

Data collected in evaluation 1 will also allow us to quantify the contribution of reconditioned kelts to the total NOR spawner population in the UCR.

Evaluation 2. Determine if the run timing, spawn timing, and spawning distribution of reconditioned kelts is similar to the target population.

Inherent in the purpose of the program is that reconditioned kelts and naturally spawning steelhead are intended to spawn together in similar locations. Run timing, spawn timing, and spawning distribution may be affected through the reconditioning program. It is unknown if biological conditions at ENFH or Wells FH (for kelts entering the program as NORs taken into broodstock of other hatchery programs) will affect maturation rates or homing of reconditioned steelhead.

The Integrated Status and Effectiveness Monitoring Program (ISEMP) and HCP Hatchery M&E programs are currently installing remote PIT tag detection arrays at multiple locations throughout the Wenatchee, Entiat, Methow and Okanogan Rivers. Currently in the Wenatchee Basin PIT arrays are installed in Peshastin and Nason Creeks, Tumwater Dam, Tumwater Canyon, Chiwawa River and are planned for the lower Wenatchee, White and Little Wenatchee Rivers. Three PIT tag arrays are installed in the Entiat Basin, at the mouth of the Entiat River, RM 16.1,

and at the mouth of the Mad River. In the Methow River arrays are currently installed or planned in Beaver Creek, Gold Creek, Libby Creek, Chewuch River, Methow River above the Chewuch, Twisp River, Methow River about the Twisp River and the Mouth of the Methow. Within the Okanogan, PIT tag antennae arrays can be found in Omak Creek, and may be installed in Antoine, 9 mile, and Salmon creeks. Collaboration with ISEMP, OBMEP (Okanogan Basin Monitoring and Evaluation Plan) and the HCP M&E programs will allow for detailed PIT tag data collection and spawning ground surveys to effectively measure run timing, spawn timing, spawning distribution and post-release homing fidelity.

PIT tag data, in some cases, may result in approximate redd locations. Specific redd location data may be collected either through radio-telemetry or through an external mark such as a floy or disc tag which would be visible on the spawning grounds. Any tags or marks with the exception of PIT tags may only be appropriate for kelts released from the long-term reconditioning program.

Potential Monitoring Questions:

Q1: Is the migration timing of reconditioned kelts and first time spawning steelhead similar?

Hypotheses:
Ho_1: Migration Timing $_{\text{reconditioned kelts}}$ = Migration timing $_{\text{control group}}$ = Migration timing $_{\text{first-time spawners}}$

Measured Variables:

- PIT tag detection timing within tributaries (e.g. Tumwater, Dryden, tributary weirs in the Wenatchee, Entiat, Methow, and Okanogan Rivers)

Derived Variables

- Mean time of arrival for each reconditioned kelts, control group, and first-time spawners.

Potential Monitoring Questions:
Q2: Is the timing of spawning similar for reconditioned kelts and first time spawners similar?

For detailed analysis, Q2 would require the use of an external mark or tag visible during spawning ground surveys (or radio-tag).

Hypotheses:
Ho_1: Spawn timing $_{\text{reconditioned kelts}}$ = Spawn timing $_{\text{control group}}$ = Spawn timing $_{\text{first-time spawners}}$

Measured Variables:

- Time of redd completion for reconditioned kelts and first time naturally produced spawners within defined reaches.

Derived Variables

- Mean time of redd completion for each treatment group

Potential Monitoring Questions:
Q3: is the spawning distribution of reconditioned kelts and first time spawners similar?

For detailed analysis, Q3 would require the use of an external mark or tag visible during spawning ground surveys (or radio-tag).

Hypotheses:
Ho_1: Spawning distribution $_{\text{reconditioning kelts}}$ = Spawning distribution $_{\text{control group}}$ = Spawning distribution $_{\text{first-time spawners}}$

Measured Variables:
- Spawning Location for reconditioned kelts and first-time spawners (GPS coordinate)

Derived Variables
- Spawning location for reconditioned kelts and first-time spawners (RKm)
- Calculate percent overlap in distribution across available spawning habitat.

Statistical Analysis
- ANOVA by treatment and location
- Type I Error of 0.05
- Effect sizes will be reported annually

Evaluation 3: Determine relationships between reconditioning protocols, kelt condition, gamete maturity, kelt survival in captivity, and contribution to NOR spawner populations

This evaluation is necessary to refine reconditioning techniques and improve the quality of kelts released from the program. It is evident from ongoing kelt reconditioning programs that fish culture practices and assessments of kelt condition may affect not only kelt survival in captivity but the likelihood of successful spawning after release (Branstetter, et al. 2006). An assortment of measurements associated with kelt collection, handling, and reconditioning protocols has been detailed in previous sections describing those activities. It is the intent of this evaluation to quantify relationships between those variables and a set of response variables, such as the probability of survival to release or the probability of successful spawning, that represent program success.

Regression analysis and ANOVA will describe relationships among factors affecting program success. Since individual kelts will be identified by unique PIT tags, each kelt can be considered as a single event for statistical analysis. Sample sizes will accumulate quickly and preliminary analyses will occur within the first year of operation. For example, a first pass of accumulating data might describe means and variances to determine whether the distributions are appropriate for parametric methods.

To the extent that robust relationships among the variables listed in Table 10 can be described, they will be used to quantify goals, identify thresholds, and otherwise inform the refinement of practices employed in kelt reconditioning.

Table 10. Examples of independent and dependant variables which may be investigated to improve and adaptively manage the reconditioning program.

Metric	Test Data
Survival to release	Treatment and control groups Condition at capture Date of capture Capture location / kelt source (hatchery vs ad lib) Time to first feeding Feed type Hatchery environment (water temp, water flow, density, etc) Gender Age
Survival to spawning	Treatment and control groups Condition at release Timing of release Release location Gamete regeneration Condition at capture Date of capture Capture location / kelt source (hatchery vs. ad lib) Time to first feeding Feed type Hatchery environment (water temp, water flow, density, etc) Gender Age
Condition at release	Treatment and control groups Condition at capture Date of capture Capture location (hatchery vs. ad lib) Time to first feeding Feed type Hatchery environment (water temp, water flow, density, etc) Age
Gamete regeneration (Long-term treatment group only)	Condition at capture Date of capture Capture location / kelt source(hatchery vs. ad lib) Time to first feeding Feed type Hatchery environment (water temp, water

	flow, density, etc) Gender Age
Spawn Distribution and Timing	Treatment and control groups Condition at release Timing of release Release location Gamete regeneration Condition at capture Date of capture Capture location / kelt source (hatchery vs. ad lib) Time to first feeding Feed type Hatchery environment (water temp, water flow, density, etc) Gender Age
Relative Reproductive Success [a]	Treatment and control groups Timing of release Capture location Hatchery environment (water temp, water flow, density, etc) Feed type Gender Age Condition at release Gamete regeneration Spawn Distribution and Timing

[a] Reproductive success would be determined through a collaborative effort with ongoing or planned studies (Chelan County PUD, DCPUD, BOR, CRITFC/CCT). We are not proposing to implement an independent relative reproductive success evaluation under this proposal.

G.4. Objective 3: Collaborate with ongoing M&E studies to document reproductive success of reconditioned kelts.

The reproductive success of reconditioned kelts will help us assess the program's contribution to recovery. However, opportunities to measure the reproductive success will likely be very limited due to the large geographical scope of the program and by the large number of successfully reconditioned kelts. The reproductive success of long-term reconditioned kelts is currently being evaluated in Omak Creek through a pedigree study, although sample sizes have been low. On-going and planned studies on the relative reproductive success of hatchery and wild steelhead in the UCR will provide a research platform for evaluating the reproductive success of kelts released from this proposed project under varying reconditioning protocols and conditions.

Steelhead reproductive success evaluations are required under the Chelan County PUD and Douglas County PUD HCP hatchery sections. To meet these requirements, the HCP Hatchery Committee is identifying objectives from which a pedigree study will be implemented by NMFS and WDFW. We propose to coordinate with NMFS and WDFW on planned evaluations in the

Methow and Wenatchee Rivers which will be funded by the Mid C PUDs and the Bureau of Reclamation to measure the reproductive success of reconditioned steelhead kelts. Any reconditioned steelhead from this project that spawn within the designated study areas (which will likely include the Wenatchee River upstream of Tumwater Dam, Twisp River and Omak Creek, but could be expanded to a larger geographical area within the Upper Columbia), would be incorporated into the reproductive success study.

Reconditioned kelts which spawn upstream of Tumwater Dam would be included in the study. The proposed study includes the following objectives:

- Determine the relative fitness of hatchery and natural origin steelhead at the population scale, which may include assessment at various life stages. (would include both first and second time spawners and reconditioned kelts)
- Assess the genetic effects on reproductive success of natural and hatchery origin steelhead (including HxH, HxW, and WxW parental crosses).
- Assess effects on the reproductive success associated with ecological/phenotypic characteristics (spawn timing, location, redd microhabitat, redd meso habitat, emergence timing, fecundity, egg size and sex ratio) of natural and hatchery origin steelhead adults

The relative reproductive success evaluation will use genetic parentage analysis (microsatellite genotyping) to estimate the number of sampled progeny (juvenile and adult) produced each potential spawner sampled at Tumwater Dam. Parentage assignments will be made using the likelihood methods of Meagher and Thompson (1986) and Gerber et al. (2000). Absolute fitness (progeny counts) within sexes will be converted to relative fitness by dividing by the mean fitness. Differences in reproductive success may arise through genetic causes (domestication), or environmental (hatchery practices), or their interaction.

A similar study is expected for the Methow River. As reconditioned kelts are encountered in the study areas, they will be incorporated into the pedigree analyses. These studies present a rare opportunity to compare the relative reproductive success of reconditioned kelts alongside hatchery and natural first-time spawners (and potentially natural second time spawners).

H. Facilities and equipment

H.1 Temporary Kelt Holding and Transportation

Steelhead kelts collected for the reconditioning program would be held at the various collection locations until transportation arrives to deliver these individuals to the reconditioning facility. Holding duration could range from a couple of hours to one day depending on logistics, equipment, densities and multi-agency cooperation. Logistical issues will be identified and resolved by all entities prior to kelt collection. Several vehicles will need to be retrofitted with transportation tanks to accommodate the dispersed collection and release locations inherent to this project. Currently, the mid-Columbia Field Station has two, 300-gallon tanks and a 960-gallon transportation truck to assist as needed with the two new 500-gallon transportation vehicles.

Listed below are logistical scenarios for kelt collection at the named facilities.

Wells FH

In coordination with WDFW and Douglas County Public Utility District (DCPUD), live-spawned steelhead would be placed into some type of temporary holding, after removal of gametes. Spawning of NOR steelhead typically begins in late December and runs through late-March/early-April. Ideally, especially on larger spawn days, YN staff would be present to load a portion of the live-spawned kelts into the necessary vehicles and transport them to a central reconditioning facility. Two 500-gallon transportation vehicles would be available that could support a maximum of 40 fish per tank (1 lb/gal of H2O). These vehicles could be supplemented by the use of a 960-gallon transportation truck, if necessary. If transportation cannot occur immediately, temporary holding options would have to be identified, such as existing structure, holding tank, and/or net pens.

The first option for holding would be to utilize potential existing structure, such as the collection facility adjacent to the broodstock holding pond. This containment area is typically used for shunting adults from the west ladder trap of Wells Dam to the on-station area. These fish then await processing which typically occurs 1x per week. This area has been used to collect steelhead and coho broodstock for their respective upper Columbia production programs. If during the time frame of kelt collection, this holding area is not used, it would provide a convenient location for temporary holding of NOR spawned steelhead until drivers are available for transport. Temporary holding would be minimized as much as possible to reduce adverse conditions that may be present for these individuals, i.e. minimal temporary holding infrastructure plus bacterial and invertebrate infestations. YN staff would need to coordinate logistics of removing these kelts with DCPUD and WDFW hatchery staff.

The second option for temporary holding would occur with net pens installed at the lowest raceway prior to the effluent leaving the hatchery. There has been no mortality or disease from this method of holding which has been used for the past three years with adult coho collected from the Wells west ladder operations. Holding would be minimal and provide the least amount of stress possible.

The third option would require setting up a temporary holding tank in the general vicinity of the spawning area that would be equipped with re-circulating water. The water source is unidentified at this time but would likely come from the same location as the net pens, which is the lowest point in the hatchery effluent system, to minimize any cross-contamination.

Rocky Reach bypass facility

Steelhead kelts are typically encountered between mid-April to the end of May. A determination of the ability to perform kelt collection needs to be performed in consultation with Chelan PUD. If feasible, collection at Rocky Reach would be limited to CCPUD staff on-hand, if staff time is available, that operates the trap for ongoing survival studies and juvenile run enumeration unless co-permitting in obtainable and trap operations are allowed by YN staff. Currently, the Rocky Reach bypass trap is typically operated 2-3 hours per day, seven days a week. CCPUD and/or YN staff would be able to easily capture any actively migrating kelts from the sorter with a dip net. IF kelts can be collected, they would be placed into a temporary holding tank. The tank would consist of a circulating water system and could potentially hold 10+ adults at one time. This tank would need to be fabricated by YN. Pick up from this facility would need to be coordinated between YN and CCPUD and occur daily. Staffing needs would be identified through consultation with CCPUD staff.

Rock Island bypass facility

Kelts are encountered during the same timeframe as the Rocky Reach collection facility. The Rock Island juvenile bypass facility passively traps emigrating kelts. Typically when encountered, steelhead kelts are enumerated, sexed, and included in WDFW's daily collection sample that is reported to the Fish Passage Center (FPC). These kelts would be transported to a temporary holding tank until YN transportation arrives. Holding tank specifications would be similar to that used at Rocky Reach. Pick up times, transportation, and delivery to the central facility need to occur daily and coordination between YN, WDFW, and CCPUD is required.

Tributary rotary smolt traps/weir traps

Kelt encounters are relatively rare at these locations but entrapped kelts would be incorporated into the program. Currently, many of the weir sites do not have the logistical capabilities to collect down-migrating kelts. Collection alternative may be possible but would require multi-agency coordination and involvement. If collection is plausible, portable in-stream holding boxes would be used for temporary kelt holding. Transportation to the reconditioning facility would need to occur as soon as possible and coordination between trapping agencies and YN will be required.

Additional collection facilities

Priest Rapids Dam may be a valuable contingency option if the aforementioned locations collectively do not provide adequate numbers of NOR's for the program. Logistics and collections numbers will be identified at a later date and designed as a secondary option. This facilities' distance from the proposed central reconditioning facility makes it a less desirable alternative.

H.2 Kelt Reconditioning Facility

We are currently evaluating the possibility of combining the kelt reconditioning facility with facilities currently planned for the Mid-Columbia Coho Reintroduction Program (BPA Project Number 199604000). The proposed location is located adjacent to Dryden Dam on property currently owned by the Washington Department of Transportation. We are currently in the property acquisition phase.

The reconditioning facility would include construction of similar infra-structure used in the Yakima River steelhead kelt program at Prosser, which includes circular rearing units and a work-up station. Circular tank dimensions would be 20' diameter by 4' in height. Numbers of circulars would be determined by study objectives with no fewer than four tanks initially. Initial source groups would be Wenatchee broodstock, Wells broodstock, Rock Island/Rocky Reach, and miscellaneous traps. Circular tanks will be used because of the results from the Yakima's program of trial-and-error of various rearing vessels. The YN found that circular tanks provide maximum duration of feed presence for kelts during the reconditioning process which is critical in the early stages when trying to re-initiate feeding. The capacity of these tanks is 200 adults per rearing container. One significant tank modification would include the installation of baffles in each circular tank. This modification would theoretically prevent problematic eye rubbing which may result in blindness as documented within the Yakima River program. These baffles are designed to break-up the continuous wall surface of the tanks that tend to cause the optic lens abrasions and to artificially simulate back-water eddies and feeding lanes that are typically observed in the natural environment.

Kelts would be reconditioned on a combination of surface and well water. While surface water may potentially introduce an unknown level of pathogens, we believe that a natural water temperature profile is needed to establish successful gonad development and may be one cause for overdevelopment of some long-term kelts within the Yakima program (Branstetter et al. 2007). During the summer months, a higher proportion of well water would be utilized to temper the summer surface water temperatures, or could be used exclusively depending on conditions. River water would likely be used the remainder of the year.

Entiat National Fish Hatchery (ENFH) has been identified as a potential back-up location for the reconditioning program due to its centralized location among all the trapping facilities and with space availability with the absence of the spring Chinook program. Current reconditioning facilities at ENFH are not available at this time and would be constructed as described above. Currently, an on-going study is being performed at ENFH with coho juveniles and rainbow trout to determine the pathogens that are present within the Entiat watershed as well as infectious time periods.

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Hatch, D.R., R.D. Branstetter, J. Blodgett, B. Bosch, D. Fast, and T. Newsome. 2003. Kelt reconditioning: A research project to enhance iteroparity in Columbia Basin steelhead (*Oncorhynchus mykiss*). 2002 Annual Report to U.S. Dept. of Energy, Bonneville Power Administration, Project No. 2000-017. Prepared by the Columbia River Inter-Tribal Fish Commission, Portland, OR.

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J. Key personnel

Mr. Tom Scribner will have the prime responsibility for ensuring that the project remains on schedule and within budget and will be directly accountable to the BPA. Ms. Keely Murdoch and/or Mr. Cory Kamphaus will be responsible and provide oversight for all program deliverables. Staff biologists will be responsible for successful execution of all field components of the proposal. These two individuals will ensure that data acquisition remains on schedule and of the highest possible quality. We will also contract with USFWS for fish health monitoring but incidental work performed by USFWS hatchery personnel at the ENFH.

J.1 Curriculum Vitae for Key Personnel

J.1.1 Tom Scribner – Yakama Nation Policy /Project Manager

Project Responsibility: Provides overall Tribal oversight and management of the BPA funded Coho Restoration contract. Directs, plans and manages activities and tasks in accordance with established policies, regulations, ordinances, and resolutions to achieve the YN Tribal goals of coho salmon restoration in the Mid-Columbia region.

Education

1975-77 University of Washington
Master of Science Degree, 1977
Major: Fisheries

1967-71 Middlebury College
Bachelor of Arts Degree
Major: Biology (Dean's List)

Experience

7/82 - present **Yakama Nation - Title: Mid-Columbia Policy Advisor**

Present: Oversee all salmon production in the Mid-Columbia for the Tribe including all fish propagation/outplantings done by the Yakama Nation or any other fisheries agency.

Tribal representative on the Rock Island, Rocky Reach and Wells Dam HCP Hatchery Committee. This interagency committee is responsible for implementing hatchery compensation measures and associated monitoring/evaluation plans to fulfill Chelan/Douglas PUDs No Net Impact obligations.

Tribal representative on the Priest Rapids Hatchery Committee. Similar to the HCP Hatchery Committee, this interagency committee is responsible for implementing hatchery compensation measures and associated monitoring/evaluation plans to fulfill Grant PUD's No Net Impact obligations.

Tribal representative on the Production Advisory Committee established to exchange information and to review and analyze present and future artificial and natural production programs pursuant to the *U.S. v. Oregon* Columbia River Fish Management Plan. Committee Chairman, 1993; re-elected for 1994.

92-94 Tribal representative on the Integrated Hatchery Operations Team. The team's purpose was to both develop and coordinate regional hatchery policies concerning fish health, genetics and ecological conditions and to provide hatchery performance standards. The team also developed a hatchery audit procedure and policy implementation plans.

85–90 Tribal representative on Northwest Power Planning Conservation Council's Artificial Production Review Team. This group comprised of resource managers and environmental organizations submits recommendations to the Council's review of hatchery operations and production.

Publications

M.S. Thesis, 1977. Relationship Between Growth and Population Density in Sockeye Salmon Fry, 111 pgs.
"Recommendation for Proposal and Evaluation of Salmonid Facilities", 84 pgs. (Publication for Congressional Act; Salmon and Steelhead Enhancement Act, 1980).
"Evaluation of Potential Species Interaction Effects in the Planning and Selection of Salmonid Projects", 72 pgs. (same publication conditions as above).
Scribner, T.B. 1993. "Spring Chinook Spawning Ground Surveys of the Methow River Basin." Report to Public Utility District No. 1 of Douglas County. Yakima Indian Nation, Fisheries Resource Management Program. Toppenish, WA.

J.1.2 Keely G. Murdoch, Fisheries Biologist

Project Responsibility: Provide oversight for M&E project deliverables

Education: **M.S. Biology, August 1996**
Central Washington University, Ellensburg, Washington
Coursework included Fisheries Management, advanced statistical analysis, research and study design.

B.S. Biology, June 1994
Western Washington University, Bellingham, Washington

Professional Experience:

Feb 2000-Present **Fisheries Biologist**
Yakama Nation, Fisheries Resource Management
Peshastin, Washington
Responsible for implementing the mid-Columbia coho reintroduction feasibility study monitoring and evaluation plan. Design and implement biological studies to assess ecological interactions between coho salmon, spring chinook, summer steelhead, and sockeye salmon. Studies include use of radio-telemetry to identify stray and drop-out rates of reintroduced coho salmon, redd surveys, hydro-acoustic surveys, direct predation evaluations, and micro-habitat use and competition evaluations. Techniques used include smolt-trap operation, underwater observation, electro-fishing, and tow-netting. Coordinate research activities with the USFWS, USFS, WDFW, CCPUD, DCPUD, GCPUD, private landowners and consultants. Contribute to the design, construction and implementation of coho acclimation sites in the Wenatchee River Basin. Designed and implemented adult coho trapping program. Responsible for spawning up to 1400 coho salmon and early egg incubation. Participate in technical work group meetings. Prepare annual reports and presentations. Supervise five biologists and up to nine fisheries technicians.

Mar 1997- Dec 1999 **Fisheries Biologist,** *Chelan County Public Utility District, Wenatchee WA*
Jan 1999 - Dec 1999 **Instructor - Statistical Analysis,** *Wenatchee Valley College, Wenatchee WA*
June 1996- Mar 1997 **Fisheries Biologist,** *U.S. Fish and Wildlife Service, Leavenworth WA.*
April 1995- Aug 1995 **Hydroacoustic Research Technician,** *Hydroacoustic Technology, Inc., Seattle, Washington*

Publications

Murdoch, K.G., C.M. Kamphaus, and S. A. Prevatte. 2005. Feasibility and Risks of coho reintroduction in mid-Columbia tributaries: 2003 Annual Monitoring and Evaluation Report. *Prepared for* Bonneville Power Administration, Portland OR.
Murdoch, K.G. and C.M. Kamphaus. 2004. Mid-Columbia coho reintroduction feasibility project: 2001 annual broodstock development report. *Prepared for:* Bonneville Power Administration, Portland OR. Project Number 1996-040-000.
Mosey, T. R., and K.G. Murdoch. 2000. Spring and summer chinook spawning ground surveys on the Wenatchee River Basin, 1999. Chelan County Public Utility District, Wenatchee Washington.
Titus, K. 1997. Stream Survey Report, Chumstick Creek, Washington. U.S. Fish and Wildlife Service, Mid-Columbia River Fisheries Resource Office, Leavenworth WA.

J.1.3 Corydon M. Kamphaus

Project Responsibility: **Provide project oversight for operations and deliverables**

Education: B.S. Zoology, December 1997
Washington State University, Pullman, Washington

Professional Experience:

Feb 2002- Fisheries Biologist
Present *Yakama Nation, Fisheries Resource Management*

Responsible for O&M activities for the mid-Columbia coho reintroduction feasibility program including**:**

1. Oversee acclimation for Wenatchee Basin coho releases
2. Determine in-pond survival at various acclimation sites by modeling predator consumption compared to PIT tag survival
3. Analyze multiple rearing strategies such as long versus short term juvenile rearing and semi-natural versus conventional acclimation
4. Design and implement adult collection protocols to maximize upstream collection facilities
5. Maintain broodstock integrity through run-at-large collection
6. Coordinate and facilitate broodstock collection with Chelan County PUD, USFWS, and WDFW.
7. Implement new propagation and incubation techniques to increase survival
8. Participate in technical work group meetings and prepare annual reports and presentations

Apr 1998- Fisheries Technician
Feb 2002 *WDFW-Hatchery Evaluation*

Responsible for monitoring and evaluating Chelan County PUD supplementation programs in the Wenatchee and Methow Rivers. Conduct hatchery evaluations on juvenile steelhead, spring chinook, summer chinook, and sockeye. Lead supervisor of the Methow/Okanogan summer chinook broodstock collection facilitated at Wells Dam. Conduct spawning ground surveys for Wenatchee River Basin sockeye, spring and summer chinook, and steelhead as well as the Okanogan summer chinook. Assist in the preparation of annual reports.

Publications

Murdoch, K.G., C.M. Kamphaus, and S. A. Prevatte. 2005. Feasibility and Risks of coho reintroduction in mid-Columbia tributaries: 2003 Annual Monitoring and Evaluation Report*. Prepared for* Bonneville Power Administration, Portland OR.

Kamphaus, C.K. and K.G. Murdoch. 2005. Mid-Columbia coho reintroduction feasibility project: 2003 annual broodstock development report. *Prepared for:* Bonneville Power Administration, Portland OR. Project Number 1996-040-000.

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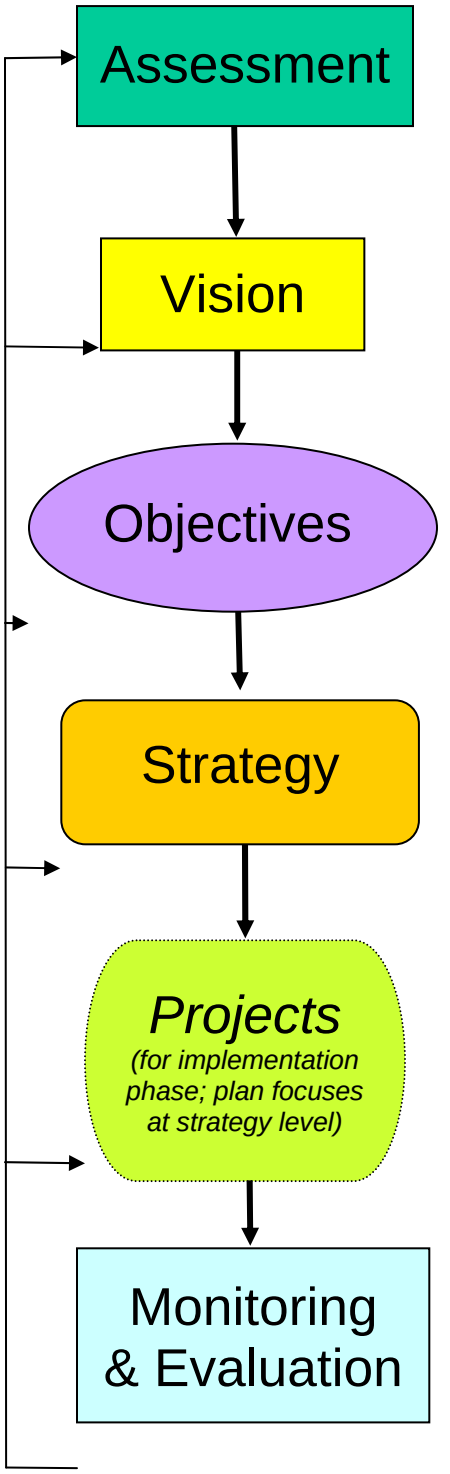
Kamphaus, C.K. and K.G. Murdoch. 2004. Mid-Columbia coho reintroduction feasibility project: 2002 annual broodstock development report. *Prepared for:* Bonneville Power Administration, Portland OR. Project Number 1996-040-000.

Attachment: ISRP Flowchart: Subbasin Plan Logic Path



Identifies Limiting Factors

Spawning habitat loss due to development in headwaters, passage problems at culverts, high water temperature in lower reaches, extinct coho run

Guides and Prioritizes Actions

Establish protected and rebuilt self-sustaining fish runs; maintain genetic integrity; reconnect habitats

Type 1, Population: Return 5,000 spring Chinook & 1,000 coho

Type 2, Habitat: Water temperature <70 in lower reaches

Build from Strength - *protect all actively spawning redds*
Restore Ecosystem - *recover riparian functions in lower reach*
Artificial Production - *restoration of coho run*

Habitat Acquisition in Headwaters 1985-045-01	Culvert Replacement and Fencing Exclosure 2001-000-01
Coho Reintroduction (RFP)	

Indicators: water temperature, sediment load, redd and juvenile counts
Performance Standards: lower reach water temperatures not to exceed 70

Note: the numbers given above are hypothetical and, for habitat projects, the ISRP and ISAB have recommended that performance standards may be more usefully articulated by coupling the potential range of parameter conditions (i.e., median, range, and variance) with a predicted rate of change from the current to the desired state. See the ISAB's report: A Review of Strategies to Recover Tributary Habitat (ISAB 2003-2) www.nwcouncil.org/library/isab/isab2003-2.htm.