2004 Annual Report

Kelt Reconditioning: A Research Project to Enhance Iteroparity in Columbia Basin Steelhead *(Oncorhynchus mykiss)*

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ABSTRACT

Iteroparity, the ability to repeat spawn, is a life history strategy that is expressed by some species from the family Salmonidae. Rates of repeat spawning for post-development Columbia River steelhead *Oncorhynchus mykiss* populations range from 1.6 to 17%. It is expected that currently observed iteroparity rates for wild steelhead in the Basin are severely depressed due to development and operation of the hydropower system and various additional anthropogenic factors. Increasing the expression of historical repeat spawning rates using fish culturing methods could be a viable technique to assist the recovery of depressed steelhead populations, and could help reestablish this naturally occurring life history trait. Reconditioning is the process of culturing post-spawned fish (kelts) in a captive environment until they are able to reinitiate feeding, growth, and redevelop mature gonads. Kelt reconditioning techniques were initially developed for Atlantic salmon *Salmo salar* and sea-trout *S. trutta*. The recent Endangered Species Act listing of many Columbia River Basin steelhead populations has prompted interest in developing reconditioning methods for wild steelhead populations within the Basin. To test kelt steelhead reconditioning as a potential recovery tool, wild emigrating steelhead kelts were placed into one of three study groups (direct capture and transport, short-term reconditioning, or long-term reconditioning.

Steelhead kelts from the Yakima River were collected at the Chandler Juvenile Monitoring Facility (CJMF, located on the Yakima River at river kilometer 75.6) from 15 March to 21 June 2004. In total, 842 kelts were collected for reconditioning at Prosser Hatchery. Captive specimens represented 30.5% (842 of 2,755) of the entire 2003-2004 Yakima River wild steelhead population, based on fish ladder counts at Prosser Dam. All steelhead kelts were reconditioned in 20-foot circular tanks, and fed freeze-dried krill initially or for the duration of the experiment. All steelhead kelts received hw-wiegandt multi vit dietary supplement as a means to improve initial nutrition. Long-term steelhead kelts received Moore-Clark pellets to provide essential minerals and nutrients necessary for gonadal redevelopment. Oxytetracycline was administered to all reconditioned fish to boost immune system response following the stress of initial capture. To control parasitic infestations two methods were used, first, after initial capture an intubation of Ivermectin^{TM} was administered to control internal parasites (e.g., *Salmincola spp.*) next, a Formalin drip was used for the duration of reconditioning to prevent fungal outbreaks. Captured kelts were separated into three experimental groups: short-term reconditioning, long-term reconditioning, and direct transport and release.

Success indicators for the short-term experiment include the proportion of fish that survived the reconditioning process and the proportion of fish that initiated a feeding response. Short-term kelts were reconditioned for 3 to 5 weeks. Surviving specimens were released for natural spawning on May 11, 2004. Survival-to-release was good for the short-term experiment, with a rate of 79.0%. Long-term steelhead kelts are

currently being held for a 6-9 month period with a scheduled release in December 2004. Long-term success indicators include the proportion of fish that survived the reconditioning process and the proportion of surviving fish that successfully remature. Survival and rematuration for long-term kelts has not been determined and will be presented in the 2005 annual report. Direct transport and release kelts and short-term reconditioned kelts were radio or acoustic tagged to assess their travel time and migratory behaviors below Bonneville Dam. A total of 29 direct-transport and release kelts and 29 short-term reconditioned kelts received surgically implanted radio tags, and a total of 28 direct-transport/release and 26 short-term reconditioned fish received surgically implanted hydro acoustic tags. These tags will allow us to determine out-migration timing for adults as well as determine if reconditioning has any deleterious effects on migration behavior. Long-term reconditioned fish will have radio tags inserted gastrically to monitor migration to spawning grounds.

As in previous years, the kelts reconditioned during this project should substantially bolster the number of repeat spawners in the Yakima River. Valuable knowledge regarding kelt husbandry, condition, and rearing environments were obtained during this research endeavor. The authors were very pleased with the high survival rates. Information collected during this feasibility study will be incorporated into the experimental design for next year's research, and is expected to continue to increase survival of long-term reconditioned fish and the successful expression of iteroparity.

ACKNOWLEDGEMENTS

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We also thank Michael (Sonny) Fiander, Carrie Skahan, Chuck Carl, Mark Johnston, Bill Fiander and other Yakama Nation Fisheries Program staff for providing fish husbandry and telemetry expertise. Thank you to Deborah Christensen for your exemplary surgical skills. This work would not have been possible without their assistance. We thank André Talbot, Phil Roger, Bobby Begay, Jeff Fryer, Saang-Yoon Hyun, Rishi Sharma, Jennifer Brianard, Denise Kelsey, and Donette Miranda from the Columbia River Inter-Tribal Fish Commission for their assistance in the field, comments on the project, maps, and reviews of the annual report. We would also like to thank Oregon State University and the Corps of Engineers for the use of their acoustic telemetry arrays. Importantly, we thank the University of Idaho and the National Marine Fisheries Service for coordination and for donating radio tags to this project. Also, we would like to thank the U.S. Coast Guard for permission to place research buoys in the lower river. Finally we would like to thank Micheal Parsely (USGS), Mary Mosser (NOAA) and Dr. David Welch (POST) for listening for our kelts.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

1.1 History

Populations of wild steelhead *Oncorhynchus mykiss* have declined dramatically from historical levels in the Columbia and Snake rivers (Nehlsen et al. 1991; NRC 1996; *US v. Oregon* 1997; ISRP 1999). Since 1997[1] steelhead in the upper Columbia River have been listed as endangered under the Endangered Species Act (ESA). Those in the Snake River have been listed as threatened, since 1997[1]. Stocks originating in the mid-Columbia were listed as threatened in 1999[2]. Causes of the declines are numerous and well known (TRP 1995; NPPC 1986; NRC 1996; ISRP 1999). Regional conservation plans recognize the need to protect and enhance weak upriver steelhead populations while maintaining the genetic integrity of those stocks (NPPC 1995).

Iteroparity, the ability to repeat spawn, is a natural life history strategy that is expressed by *0. mykiss,* with rates estimated to be as high as 79% for populations in the Utkholok River of Kamchatka, Russia 1994-96 (Savvaitova et al. 1996). Historical rates for the Columbia River have not been accurately documented but outmigrating steelhead averaged 58% of the total upstream runs in the Clackamas River from 1956 to 1964 (Gunsolus and Eicher 1970). Current iteroparity rates for Columbia River basin steelhead are considerably lower, due largely to high mortality of downstream migrating kelts (post-spawn steelhead) at hydropower dams (Evans and Beaty 2001), and potentially inherent differences in iteroparity rate based on latitudinal and inland distance effects (Withler 1966; Bell 1980; Fleming 1998). The highest recent estimates of repeat spawners from the Columbia River Basin were in the Kalama River (tributary of the unimpounded lower Columbia River) have exceeded 17% (NMFS 1996). Farther upstream, 4.6% of the summer run in the Hood River (above only one mainstem dam) are repeat spawners (J. Newton, ODFW, pers. comm.). Iteroparity rates for Klickitat River steelhead were reported at 3.3% from 1979 to 1981 (Howell et al. 1984). Summer steelhead in the South Fork Walla Walla River have expressed 2% to 9% iteroparity rates (J. Gourmand, ODFW, pers. comm.), whereas repeat spawners

[1] Final Rule 8/18/97: 62 FR 43937-43954.

composed only 1.6% of the Yakima River wild run (from data in Hockersmith et al. 1995) and 1.5% of the Columbia River run upstream from Priest Rapids Dam (L. Brown, WDFW, unpubl. data).

1.2 Rationale

Post spawn steelhead represent the portion of the population that successfully survived through an entire life cycle and spawned. These fish have experienced and survived stochastic events, selective forces and have demonstrated their ability to reproduce successfully. Investing efforts to revitalize the kelt steelhead life history strategy could be a very low cost and biologically effective tool for restoration. Kelt reconditioning promotes re-initiation of feeding, thereby enabling kelts to survive and rebuild energy reserves required for gonadal development and iteroparous spawning. Techniques used in kelt reconditioning were initially developed for Atlantic salmon *Salmo salar* and sea-trout *S. trutta.* A review of these studies and those applicable to steelhead kelts are summarized in Evans *et al*. (2001). Additional reviews of this subject (Hatch et al. 2002 and 2003) provide strong support of the benefits of kelt reconditioning to address population demographic and genetic issues in steelhead recovery. This year's project identifies and systematically tests short- and long-term kelt reconditioning approaches as well as direct transport and release.

1.2.1 Direct Transport and Release Study

This year we directly transported steelhead kelts around the hydro system to evaluate the effects on iteroparity rates. Given the high mortality rates of emigrating kelts observed via radio telemetry in the Snake River (Evans et al. 2001; Evans 2002; Hatch et al, in review), iteroparity may simply be augmented by transporting kelts around the hydro system, thereby increasing the number of kelts that successfully have access to the marine environment.

[2] Final Rule 3/25/99: 64 FR 14517-14528.

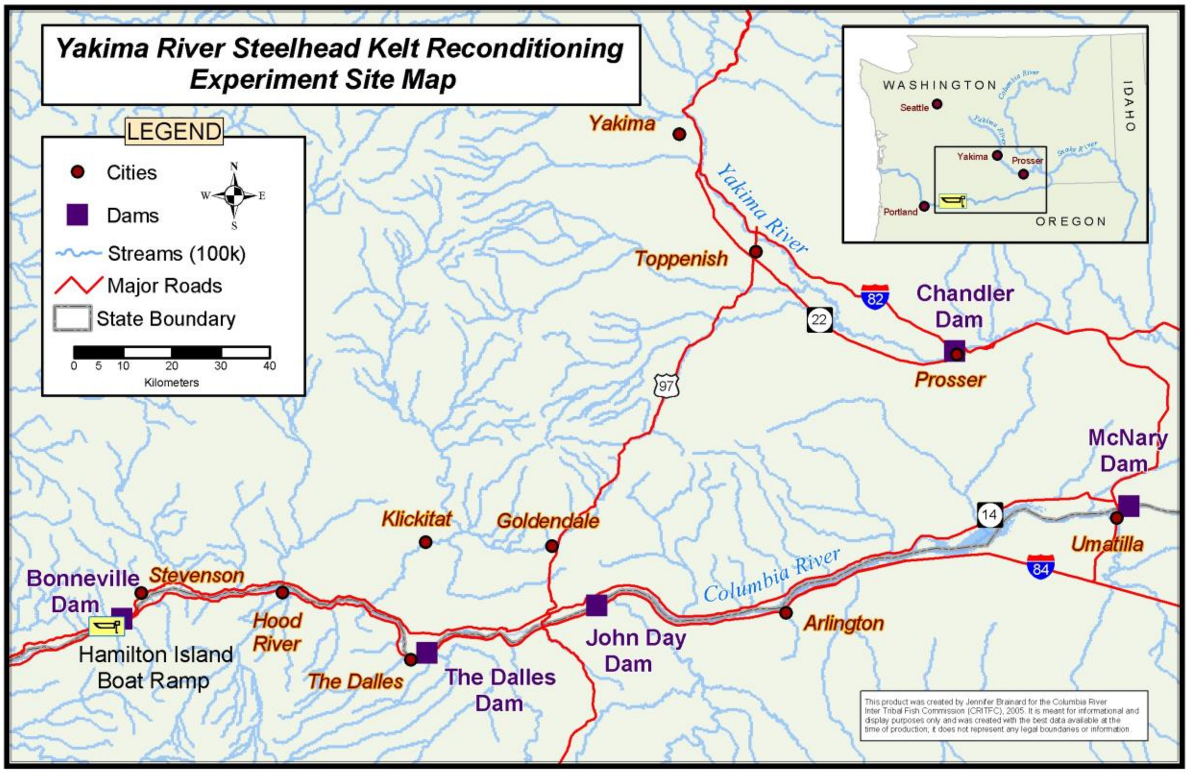

Figure 1: Reconditioning Site (Prosser, WA) and Release Site (Hamilton Is. Boat Ramp).

The purpose for this objective is to evaluate the lowest cost alternative aimed at increasing steelhead iteroparity. Prior to an implementation of a large-scale kelt steelhead transportation program, it is important to evaluate whether these fish migrate through the estuary and recondition in the ocean or if they maintain residence in the estuary, which could impact salmonid smolts. To address this unknown, all steelhead kelts were PIT-tagged and the majority were surgically implanted with either a radio or hydro-acoustic tag. This will provide us with the necessary information regarding fish movement, distribution, travel time, velocity, as well as residence time in the estuary.

1.2.2 Short-Term Reconditioning Study

Successful expression of iteroparity in steelhead may be limited by post-spawning starvation and downstream passage through the mainstem corridor. Thus, short-term reconditioning may augment iteroparity rates by initiating the feeding process and then allowing kelts to naturally undergo gonadal recrudescence in the estuary and marine environments. Short-term reconditioning is defined as the period of time needed

(approx. 3-5 weeks) for kelts to initiate post-spawning feeding, followed by the transportation of kelts around mainstem hydroelectric facilities for release, natural rearing, and rematuration in the Pacific Ocean. Since short-term reconditioned fish were also transported and released below Bonneville dam it is also important to assess fish movement, distribution, travel time, velocity, as well as residence time in the estuary.

1.2.3 Long-term Reconditioning Study

We have defined long-term reconditioning as holding and feeding post-spawn steelhead until approximately the end of the calendar year and then releasing them at Prosser Hatchery, thus allowing them to mingle with the upstream run. By this time most surviving fish remature. Based on the past three years' results, long-term feasibility of steelhead reconditioning looks promising. During 2004, we continued with the most efficient and successful of the long-term steelhead reconditioning regimes by repeating the most successful diet and treatment identified during the 2001 and 2002 studies (krill and Moore-Clark pellets) (Hatch et al. 2001 and Hatch et al. 2002). Long-term reconditioned steelhead kelt release is scheduled for December 2004 with results of the reconditioning being published in 2005.

1.2.4 Biotelemetry

The success of kelt reconditioning should be assessed based on the number of individuals that successfully spawn in the wild following reconditioning and release. Although it is difficult to witness individual fish spawning in the wild, and even more difficult to assess the viability and quality of gametes, we have designed future experiments to determine if reconditioned kelts contribute to subsequent generations.

Data collected by Foster and Schom (1989) provided evidence that the ability to home in Atlantic salmon kelts is imprinted during the fish's juvenile life stage and that reconditioning does not alter homing instincts. Based on the data collected by Foster and Schom (1989) we believe that it reconditioning should have no deleterious effects on outward migration as well. Because the kelts collected at Prosser Dam are wild fish that could have originated in any of several upstream areas, we cannot know locations

of specific spawning grounds for specific individuals. However, use of radio telemetry technology, acoustic telemetry technology and Passive Integrated Transponder (PIT) tags can help address such critical uncertainties.

1.2.5 Reproductive Success

Long-term reconditioning and subsequent captive spawning will provide valuable new quantitative and temporal data on endocrine function and gonadal processes of steelhead rematuration. Data resulting from this research will greatly contribute to the evaluation of reconditioning. This experiment involves a replicated, controlled experimental design to assess and compare egg and progeny viability of reconditioned vs. virgin (non-reconditioned) spawners. Ideally we intend to study wild summer steelhead collected from appropriate sites, however, if ESA-permitting or low run sizes during given years limit the use of wild fish for this research, hatchery fish may be used as surrogates.

1.2.6 Management Recommendations

Major goals of this research project are to: 1) definitively, objectively, and conclusively evaluate the ability of various tested scenarios to enhance wild steelhead iteroparity (e.g. short- and long-term reconditioning, kelt transportation around the FCRPS), 2) to perform benefit/risk and cost/benefit analyses on resulting project data, and 3) provide management recommendations concerning implementation of tested treatments. To the extent possible, pre-existing empirical run-size data from each of the populations undergoing reconditioning will be compiled to serve as the system-specific baselines against which to measure the success of project objectives. Project research also generates valuable empirical data on potential effects of kelt reconditioning on egg and progeny viability, relative to non-reconditioned iteroparous spawners. Therefore, appropriate, rigorous statistical analyses of generated project data are essential to making such determinations.

2.0 Tasks and Objectives

2.1 Area and Facilities

Kelt reconditioning research was conducted at the Prosser Fish Hatchery in Prosser, Washington. Prosser Hatchery is located on the Yakima River at river kilometer (Rkm) 75.6, downstream from Prosser Dam, and adjacent to the Chandler Juvenile Monitoring Facility (CJMF). The Yakima River is approximately 344 km in length and enters the Columbia River at Rkm 539. Summer steelhead populations primarily spawn upstream from Prosser Dam in Satus Creek, Toppenish Creek, Naches River, and other tributaries of the Yakima River (TRP 1995). The Yakama Nation (YN) operates Prosser Hatchery, with a primary function of rearing, acclimation, and release of fall chinook salmon *O. tshawytscha*. The facility is also used for coho salmon *O. kisutch* rearing prior to acclimation and release in the upper Yakima River Basin.

2.1.1 Kelt Collection and In-Processing

After spawning naturally in tributaries of the Yakima River, a proportion of the steelhead kelts that encounter the Prosser Dam facility during emigration are diverted into an irrigation channel that directly connects to the Chandler Juvenile Monitoring Facility (CJMF). The CJMF diverts migratory fishes away from the irrigation canal to reduce mortality associated with agriculture. Once diverted into the CJMF, emigrating kelts can be manually collected from a fish separation device (a device which allows smaller juvenile salmonids to "fall through" for processing in the juvenile facility while larger fish can be dipnetted off the separator for processing or release back to the river). Yakama Nation (YN) staff monitored the Chandler bypass separator 24 hours a day from 15 March to

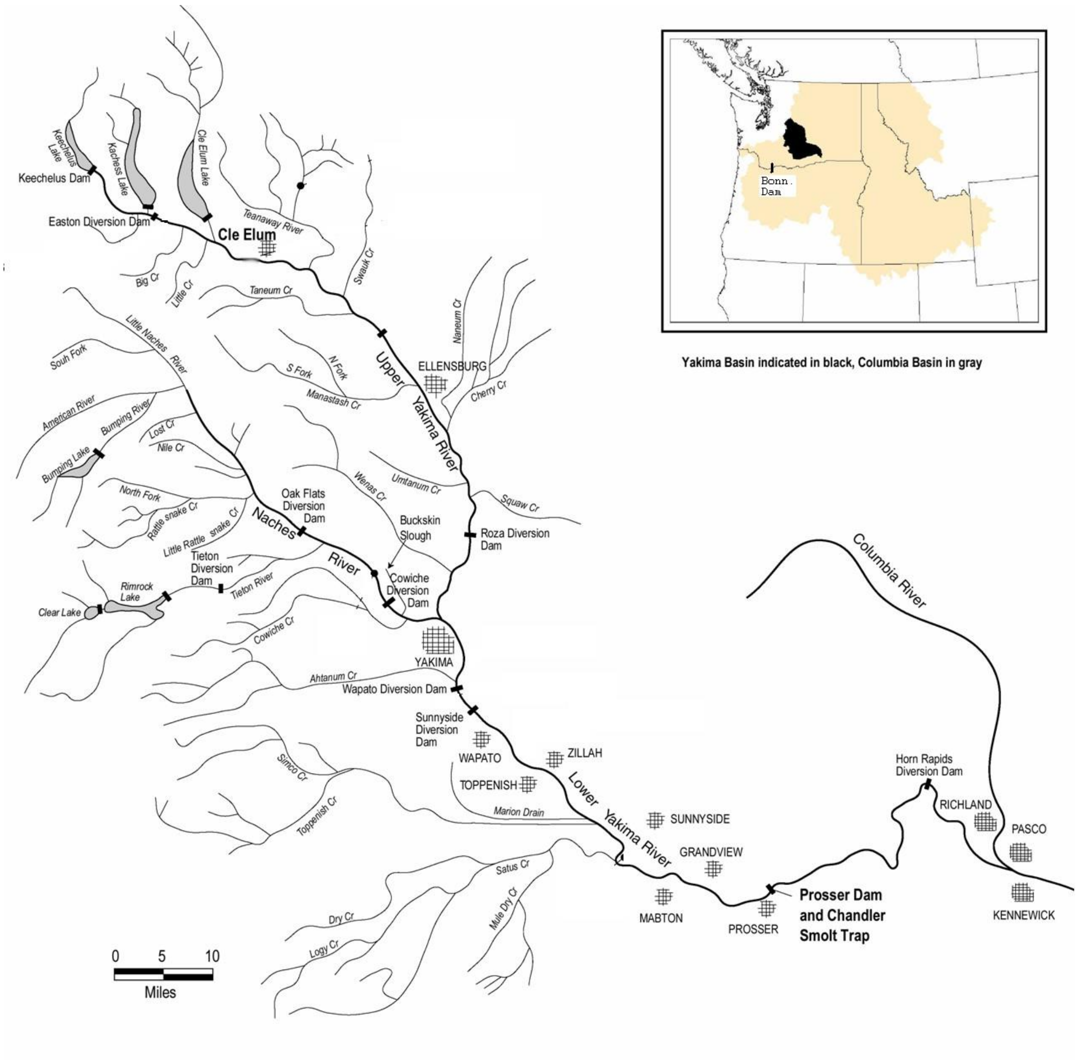

Figure 2: Yakima River Basin.

21 June 2004. All adult steelhead arriving at the CJMF separator, regardless of maturation status (kelt or pre-spawn[3]), were dipnetted off the separator and placed into a water-lubricated PVC pipe slide that was directly connected to a temporary holding tank 20' (l) x 6' (w) x 4'(h) containing oxygenated well water (57^{0}F or 13.8^{0}C).

Out-migrating steelhead kelt specimens were identified (Evans and Beaty 2001) then transferred with a dipnet from the temporary holding tank to a nearby 190-L sampling tank containing fresh river water, and anesthetized in a buffered solution of tricaine methanesulfonate (MS-222) at 60 ppm.

[3] The term pre-spawner refers to a sexually mature fish that has yet to spawn.

All specimens visually determined to be prespawn individuals were immediately returned to the Yakima River. Following kelt identification, we collected data on weight (collected in pounds but converted to kg for this report), condition (good- lack of any wounds or descaling, fair- lack of any major wounds and/or descaling, poor- major wounds and/or descaling), coloration (bright, medium, dark), and presence or absence of physical anomalies (e.g., head burn, eye damage). All steelhead kelts deemed to be in "good" condition were retained for reconditioning while steelhead kelts found to be in poor condition and dark in color were released back to the river. Passive Integrated Transponder (PIT) tags (if not already present) were then implanted in the fish's abdominal cavity for individual fish identification during reconditioning.

2.1.2 Reconditioning Tanks

Upon admission of kelts to the reconditioning program at Prosser Hatchery, all kelts were retained in one of four 20'(l) x 20'(w) x 4'(h) circular tanks. Individual tank carrying capacity was set at a maximum of 200 fish based on the aquaculture experience of YN hatchery staff, and the project goal of maximizing kelt survival in captivity. Formalin was administered five times weekly at 1:6,000 for 1 hour in all reconditioning tanks to prevent fungal outbreaks.

In kelt reconditioning tanks, severe infestation of parasites can be lethal to cultured fishes, steelhead may be especially susceptible to *Salmincola* in such environments. *Salmincola* is a genus of parasitic copepod that can inhibit oxygen uptake and gas exchange at the gill lamellae/water surface interface by attachment to the lamellae. Recent research by Johnson and Heindel (2000), suggested that Ivermectin^{TM} – a treatment often used to control parasites in swine and cattle – increases the survivorship of cultured fish by killing the adult morph of the parasite. Due to its successful use in treating *Salminicola* in this project's kelt reconditioning experiments during 2000 (Evans and Beaty 2000), Ivermectin^{TM} was diluted with saline (1:30) and injected into the posterior end of the fish's esophagus using a small (1cc) plastic syringe. Fish also received an initial treatment of Oxytetracycline and hw-wiegandt

multi vit as a dietary supplement. Success was assessed based on increased survival and increases in weight gain.

2.1.3 Kelt Mortality

The following data was collected on all kelts that died during the reconditioning process at Prosser Hatchery. On discovery of a mortality, fish were first subjected to an external examination by hatchery personnel to record the suspected time of death, general condition (good, fair, poor), fish color (bright, intermediate, dark), color of the gill arches (red, pink, white), size of the abdomen (fat, thin), presence of any scars or obvious lesions, and any other anomalies. Once the external exam was completed, an internal examination was conducted to record color of muscle tissue (red, pink, white), type of gonads (ovaries, testes), size of gametes (small, large), and presence of any internal anomalies. PIT tags, acoustic tags and radio tags were also removed from mortalities and identification numbers were entered into a computer database along with the growth measurement data. We attempted to reuse viable tags whenever possible.

2.1.4 Maturation Assessment and Release for Spawning

Upon release all surviving steelhead in the long-term experiment were examined with ultrasound equipment (Evans *et al*. 2001) to assess maturation status. Steelhead kelts from the short-term and direct transport and release experiments were weighed prior to release respectively on April 22 and 29, 2004, to ascertain if they were feeding. Based on weight change during captivity, we classified surviving specimens as feeders or non-feeders. Fish in the long-term experiment will be released December of 2004 to coincide with natural spawn timing. Growth measurement data and rematuration status were also recorded on all released individuals. Overall success of the reconditioning process was based on the proportion of fish that survived the reconditioning process and specifically for the long-term experiment the number of fish that successfully rematured (based on ultrasound examinations).

2.2 Objectives

In order to evaluate the feasibility of kelt reconditioning as a potential recovery and restoration strategy for wild steelhead in the Columbia River basin, this project was designed to satisfy the following research objectives:

Objective 1: Evaluate effects of directly transporting steelhead kelts around the hydro system on enhancement of iteroparity.

Objective 2: Evaluate effects of short-term kelt reconditioning and subsequent transportation of kelts around the hydro system on enhancement of iteroparity.

Objective 3: Evaluate effects of long-term kelt reconditioning and subsequent release for natural spawning on enhancement of iteroparity.

Objective 4: Evaluate effects of long-term kelt reconditioning and captive spawning on: a) gamete and progeny viability; and b) enhancement of iteroparity.

Objective 5. Comprehensive project evaluation and management recommendations.

2.3 Direct Transport and Release

Objective 1: Evaluate effects of directly transporting steelhead kelts around the hydro system on enhancement of iteroparity.

2.3.1 Feeding and Treatment

Direct transport and release steelhead kelts were held for 1 week or less. All direct transport and release kelts received oxytetracycline to boost immune system response after the initial stress of capture and captivity. The following design, employing one tank was used:

C4 = Steelhead kelts were collected from 26th to the 29th of April 2004 and held till May 3, 2004. They received a strict diet of freeze-dried krill for the duration of their captivity.

2.3.2 Truck Transport

All direct transport and release kelts were transported then released via truck at the Hamilton Island Boat Ramp, below Bonneville Dam. We expect fish to return from this study in 2005 and possibly 2006.

2.3.3 Biotelemetry

Direct transport and release kelts were surgically implanted with either an acoustic tag or a radio tag. A licensed veterinarian performed surgeries so that adverse effects associated with handling and surgery would be minimized and that steelhead kelts would have a high tag retention rate. Each radio and acoustic tag has a unique acoustic bandwidth pulse that provides individual identification codes. After initial release, in cooperation with Oregon State University, we were able to detect when kelts reached the lower river and when they left for the ocean using a system of acoustic telemetry lines that spanned sections of the lower river estuary (See Appendix B for array locations). The entirety of this array was up and running from late April until mid June of 2004. In mid June CRITFC operated a line of the array that was located at the Jim Crow site through October of 2004 to detect any returning steelhead kelts. At times we needed to make changes to this array to accommodate gill net fisheries in the lower river. Lotek mobile radio receivers were used in conjunction with fixed winged aircraft and watercraft to track steelhead kelts after initial release. This tracking provided a good idea of dispersment after release along with timing to the estuary and estimates of velocity.

2.3.4 PIT Tags

Kelt movement, timing, and survival can be assessed with PIT tags as the fish move through the hydropower system in the Yakima and Columbia rivers. When caught in the CJMF, the PIT tags are implanted into the abdominal cavity via syringe. All direct transport and release kelts released have a PIT tag implanted (if one is not already present). Each tag is unique and identifies an individual fish. Automatic adult PIT detectors are present in all ladders at Bonneville and McNary Dams. At Prosser Dam,

adult migrants passing upstream via the right bank denil fish ladder and trapping facility are bio-sampled and interrogated for PIT tags. These data can be helpful in telling us how many fish survive as they move from one life stage to the next or from one location to the next.

2.4 Short-Term Reconditioning

Objective 2: Evaluate effects of short-term kelt reconditioning and subsequent transportation of kelts around the hydro system on enhancement of iteroparity.

2.4.1 Feeding and Treatment

Short-term reconditioned kelts were fed a diet of krill for the duration (3-5 weeks) of their captivity. All short-term kelts received oxytetracycline, formalin and hb multi vit to improve fish health and to elicit a feeding response during captivity. The following design, employing one tank was used:

C2 = Steelhead kelts were collected from the 8th to 20th of April 2004 and reconditioned through May 11, 2004 then subsequently released. During captivity steelhead kelts received a strict diet of freeze-dried krill for the duration of their captivity.

2.4.2 Truck Transport

All short-term conditioned kelts were transported then released via truck at the Hamilton Island Boat Ramp, below Bonneville Dam. We expect fish to return from this study in 2005 and possibly 2006.

2.4.3 Biotelemetry

This year short-term kelts fish were surgically implanted with either an acoustic tag or a radio tag. A licensed veterinarian performed surgeries so that adverse effects associated with handling and surgery would be minimized and that steelhead kelts would have a high tag retention rate. Each radio and acoustic tag has a unique acoustic bandwidth pulse that provides individual identification codes. We were able to detect when kelts reached the lower river and when they left for the ocean using the

same system of acoustic telemetry lines that were used to detect direct-transport and release kelts (See Section 2.3.3 for details about array deployment and Appendix B for array locations). Lotek mobile radio receivers were used in conjunction with fixed winged aircraft and watercraft to track steelhead kelts after initial release. This tracking provided a good idea of dispersment after release along with timing to the estuary and estimates of velocity.

2.4.4 PIT Tags

Kelt movement, timing, and survival can be assessed with PIT-tags as the fish move through the hydropower system in the Yakima and Columbia rivers. When caught in the CJMF, the PIT tags are implanted into the abdominal cavity via syringe. All short-term reconditioned kelts released have a PIT tag implanted (if one is not already present). Each tag is unique and identifies an individual fish. Automatic adult PIT detectors are present in all ladders at Bonneville and McNary Dams. At Prosser Dam, adult migrants passing upstream via the right bank denil fish ladder and trapping facility are bio-sampled and interrogated for PIT tags. These data can be helpful in telling us how many fish survive as they move from one life stage to the next or from one location to the next.

2.5 Long-Term Reconditioning

Objective 3: Evaluate effects of long-term kelt reconditioning and subsequent release for natural spawning on enhancement of iteroparity.

2.5.1 Feeding and Treatment

The long-term reconditioned fish were initially fed freeze-dried krill for 2.5 months and are currently being fed unaltered Moore-Clarke pellets.

C1 = Fish were collected from March 3 to April 8 of 2004 and will be reconditioned from March 16 to December 2004.

C2 = Fish were collected from May 11th to June 21st of 2004 and will be reconditioned from May 11 to December 2004.

C3 = Fish collected from the 13th to the 20th of April 2004 and will be reconditioned from April 13 to December 2004.

C4= Fish collected from May 3rd to May 7th of 2004 and will be reconditioned from May 03 to December 2004.

2.5.2 Truck Transport

Most long-term reconditioned kelts were transported then released via truck at the Mabton Boat Ramp (Yakima Rkm 96.3) near the Prosser Hatchery and a small portion released at Wallula Gap above McNary Dam (Rkm 509). We expect fish to return from this study in 2005 and possibly 2006.

2.5.3 Minimize Eye Damage Experienced by Long-Term Reconditioned Steelhead Kelts

Through 2000-2002 the project had a relatively high number of reconditioned steelhead kelt that were observed with damaged eye(s) at the Prosser Hatchery. The fish's behavior to avoid negative effects of direct sunlight (i.e. seeking shade) has contributed to eye infections. The problem is significant enough that it requires attention to reduce the prevalence and severity of eye damage. The general solution was to provide shade to all kelts in the reconditioning tanks at Prosser Hatchery. Large tank covers were installed 2 years ago to increase overall shading. The bottom of the tanks were also painted a blue color with the tank walls left the original white, and delivering food in different locations around the tank to minimize crowding (e.g., we have observed kelts crowding in the same tank location in anticipation of feeding). Unfortunately, the paint barely made it past the season, so a similar color schemed polyurethane coating was sprayed on the tank walls and bottom to soften the walls as well as keep kelts towards the middle of the tank. An added benefit to the polyurethane coating was a shorter and less intensive tank cleansing.

2.5.4 Biotelemetry

We plan to radio tag 20 steelhead kelts from the long-term reconditioning along with 20 virgin spawners to investigate in-season homing and migration patterns for comparison. Radio tags will be used for the in-season homing investigation of long-term reconditioned kelts and virgin spawners. Tags for in-season homing will be

programmed to last a minimum of 30 days while tags used to observe migration routes will be programmed to last for at least 155 days. These radio tags will be placed using the gastric insertion technique. The fish used for the in-season homing investigation will be trucked to the Wallula Gap near the McNary Dam (Rkm 509) pool and released in December 2004. Assessment of in-season homing will be based on observations of this tagged fish back to the Yakima River Basin and will be included in the 2005 annual report. A small portion of the long-term reconditioned steelhead will have radio transmitters placed to observe migration routes and spawning ground selection. This group will then be released at the Mabton boat launch near Prosser Hatchery in December 2004. These fish will be tracked using fixed and mobile tracking systems in conjunction with telemetry work currently being conducted on coho salmon.

Fixed receiver sites are located at Prosser Dam (Rkm 75.6), Slagg Ranch (Rkm 106.2), Sunnyside Dam (Rkm 167.0), Roza Dam (Rkm 205.8), Naches River (Cowiche Dam Rkm 5.8), Toppenish Creek (Rkm 71.1), and Simcoe Creek (Rkm 13.0). Mobile tracking will be done by road and by raft. Mobile tracking allows for actual pinpoint locations and observations of steelhead kelt redd construction and spawning. The mobile and fixed radio-tracking receivers made by Lotek Inc. and National Marine Fisheries Service (NMFS) will be used in 2005-06. We will primarily rely upon upstream movement and visual observations as indicators of live fish. Tags will be recovered from dead fish whenever possible. Results from this aspect of the study will be published in 2005.

2.5.5 PIT Tags

Kelt movement, timing, and survival can be assessed with PIT-tags as the fish move through the hydropower system in the Yakima and Columbia rivers. When caught in the CJMF, the PIT tags are implanted into the abdominal cavity via syringe. All long-term reconditioned kelts released have a PIT tag implanted (if one is not already present). Each tag is unique and identifies an individual fish. Automatic adult PIT detectors are present in all ladders at Bonneville and McNary Dams. At Prosser Dam, adult migrants passing upstream via the right bank denil fish ladder and trapping facility are bio-

sampled and interrogated for PIT tags. These data can be helpful in telling us how many fish survive as they move from one life stage to the next or from one location to the next.

2.6 Reproductive Success

Objective 4: Evaluate effects of long-term kelt reconditioning and captive spawning on: a) gamete and progeny viability; and b) enhancement of iteroparity.

2.6.1 Gamete Viability

We intend to capture a minimum of 20 virgin spawners along with 20 long-term reconditioned steelhead kelts retained from the 2004 long-term reconditioning experiment. Female broodstock will be held for 1-2 years in large circular tanks and reconditioned. Prior to actually reconditioning of these virgin spawners, base-line data of fecundity, egg diameter, fertilization rates, and progeny growth and survival will be collected. Eggs from these fish will be non-lethally extracted, and fertilized using cryopreserved sperm. This objective will be accomplished at the U of I Moscow campus. This research will be performed as part of an MS degree research program under the supervision of salmon reproductive biologist Dr. Joseph Cloud and Dr. Rolf Ingermann at the University of Idaho.

To avoid stress and handling mortality, blood samples will only be taken from each of the female broodstock every three months during this 1-2 year period to estimate the concentrations of estradiol 17 ß (the major estrogen in salmonids; a secretory product of the granulosa cells of the ovary) and vitellogenin (the yolk precursor lipoprotein secreted from the liver in response to estrogen) in circulation. These indicators provide important markers to track re-maturation (gonadal recrudescence) of post-spawned reconditioning steelhead.

A second spawning of the reconditioned female broodstock will be performed in an identical manner to the initial captive spawning; mating with the same paired females

and cryopreserved males to rigorously evaluate potential effects of long-term reconditioning on egg viability.

Specifically, the following parameters and variables will be measured to assess and compare egg viability from the same experimental fish following virgin and repeat spawning (reconditioned):

1) Proportion of eggs within lots that reach 2-cell/4-cell stages (percent fertilization)
2) Proportion of eggs within lots that successfully complete early development
3) Proportion of eggs within lots that hatch
4) Egg diameter may also be measured and compared between virgin (first) and reconditioned (second) spawnings, to evaluate variability in egg size associated with reconditioning

Where appropriate, parametric and/or non-parametric tests will compare outcomes of the experiments performed.

2.6.2 Progeny Viability

The following parameters and variables will be measured to assess and compare juvenile fish viability from the same experimental fish following virgin and repeat spawning (reconditioned):

1) Percent survival of various early life stages
2) Growth, length, weight, and condition factor measurements
3) Growth hormone and IL-1 (insulin-like growth factor 1) concentrations
4) Oxygen consumption per unit time as a measure of their metabolic rate
5) Where appropriate, parametric and/or non-parametric tests will compare outcomes of experiments performed.

2.7 Management Recommendations

Objective 5. Comprehensive project evaluation and management recommendations.

2.7.1 Statistical Data Analysis

This aspect of the study is designed to evaluate project data with appropriate parametric and/or non-parametric tests, depending on the nature of resulting empirical data distributions. This project essentially imposes treatment structure on an otherwise observational study, to provide rigorous comparisons between and among short and

long-term kelt reconditioning and transportation around the FCRPS (i.e. treatments). Several analytical approaches are available, based on resulting distributions of empirical data generated by this study:

1) Perform a non-parametric ANOVA, median test, K-W and/or Mann-Whitney U tests to compare treatment effects on kelt return proportions or percentages.

2) Perform categorical modeling (e.g. SAS CATMOD) allowing all different grouped treatment comparisons. For example, once such comparison could test a null hypothesis stating that "effects of short- and long-term kelt reconditioning (Objectives 2 and 3) and bypassing kelts around the FCRPS are not significantly different". In addition, return percentages of short-term vs. long-term reconditioned fish will be tested with these procedures.

3) Perform iterated (Monte Carlo) Chi-square analysis between return proportion of short-term reconditioned vs. bypassed (non-reconditioned) kelts.

Initial analyses will be presented in the 2005 report.

2.7.2 Benefit/Risk Analysis

In addition to provision and analyses of data generated in this study, an objective benefit/risk analysis will be completed to evaluate potential effects. Currently, potential effects of kelt reconditioning and transport are relatively unknown. For example, do any of these experimental treatments elicit changes population genetic characters such as diversity maintenance or relatedness among individuals within populations?

Because maintenance and/or potential loss of population genetic variation may or may not be directly quantifiable, we propose the use of various simulation modeling approaches to estimate potential changes in genetic variation. Theoretically predicted and empirically observed changes in population genetic signals can be tested against specific experimental treatments in this study to assess potential correlative relationships. Several scenarios should be modeled, including but no limited to: increasing and decreasing population growth rates, a range of reconditioning success and failures, capture efficiencies, and natural kelting or iteroparity rates. Demographic approaches, also involving genetic data where available, should also be pursued

(population viability and/or minimum pop size approaches). Consultation with tribal, agency, and academic scientists is expected to enhance and expedite this analysis.

2.7.3 Cost/Benefit Analysis

A comprehensive literature review of appropriate cost/benefit evaluations and/or models is being performed to fully determine the best method of analysis. This analysis will incorporate pertinent issues and approaches currently being addressed in the IEAB's "Artificial Production Review – Economic Analysis" work, and other relevant IEAB documentation for the Power Council (e.g. Draft Council Staff Paper: "Methods of Economic Analysis of Salmon" and "River Economics: Evaluating Trade-offs in Columbia River Basin Fish and Wildlife Programs and Policies.

3.0 RESULTS/DISCUSSION

3.1 General Population Characteristics

A total of 842 kelts were kept for reconditioning while 124 were culled due to poor condition or found to be dead on arrival, at Prosser Hatchery from 15 March to 21 June 2004. Collection generally followed migrational waves with the peak collection day occurring around April 14 (Figure 1). The total number of kelts used for reconditioning represented 30.5% (842 of 2,755) of the entire Yakima River ESA-listed population, based on fish ladder counts obtained from Prosser Dam for the period July 1, 2003 to June 30, 2004. It is highly possible that many of the out-migrating kelts from the Yakima River were never diverted into the irrigation channel and passing via spillway, due to especially high flows during collection time. A total of two kelts were determined to be of hatchery origin, based on the presence of an adipose clip.

Many of the emigrating kelts appeared emaciated upon capture at Chandler bypass. Abdominal surfaces, recorded as "thin" during processing, were often so gaunt that the specimens had a "snake-like" appearance. The average weight of captured kelts was smaller than last year with the average weight at 1.68 kg (range: 0.58– 3.78 kg). Research on energy expenditure during migration and spawning, a period when many

salmonids are believed to stop feeding, suggested that anadromous fish depleted over 60% of their lipid, protein, and ash reserves during the spawning process (Love 1970). Much of the muscle tissue during this time was converted into water with some individuals' digestive tracts and stomach linings becoming severely arthritic (Love 1970).

The overwhelming majority of kelts captured were female (Table 1) which is a consistent finding in previous steelhead kelt reconditioning work, (approximately 88% during 2000 and 2001 at Prosser Dam were female). This may be indicative of the evolutionary advantage of female iteroparity. Based on visual observations, 753 (90.4%) of the kelts were classified as female, whereas only 79 (9.5%) as male in 2004. Naturally occurring female iteroparity essentially is analogous as cryopreservation of males is in other ESA listed salmon populations within the Columbia River Basin. In addition, since females are naturally able to reproduce in different years, this should increase the probability of gene flow between and among cohorts or year classes. This has a direct theoretical benefit in the form of increasing the number of breeders (N_b), and the effective population size (N_e) during each spawning season, thus contributing to increased population viability and persistence, crucial to threatened and endangered fish restoration. Rather than a genetic hazard, experimental reconditioning should be viewed as a potential demographic and population genetic enhancement measure, aimed at restoring a recently jeopardized, but naturally occurring evolutionarily stable life history strategy.

Table 1: Sex and survival to release of adult steelhead captured for reconditioning at Prosser Hatchery, 2003.

Sex	No. Captured	No. Released
Male	79 (9.4 %)	Results 2005
Female	753 (89.4 %)	Results 2005
Unknown	10 (1.2 %)	Results 2005
Total	842	Results 2005

The majority of kelts collected for reconditioning during 2004 were considered in good or fair overall condition. In terms of gross morphological and physiological condition at the time of release for most short-term release kelts and direct transport/release, 58 (41.4%) kelts were classified as good, 82 (58.5%) as fair. Regarding fish coloration, we classified 48 (34.2%) as bright, 90 (64.2%) as intermediate, and 2 (1.4%) as dark. This data will be updated in the 2005 report to reflect the state of long-term reconditioned fish after release in December of 2004.

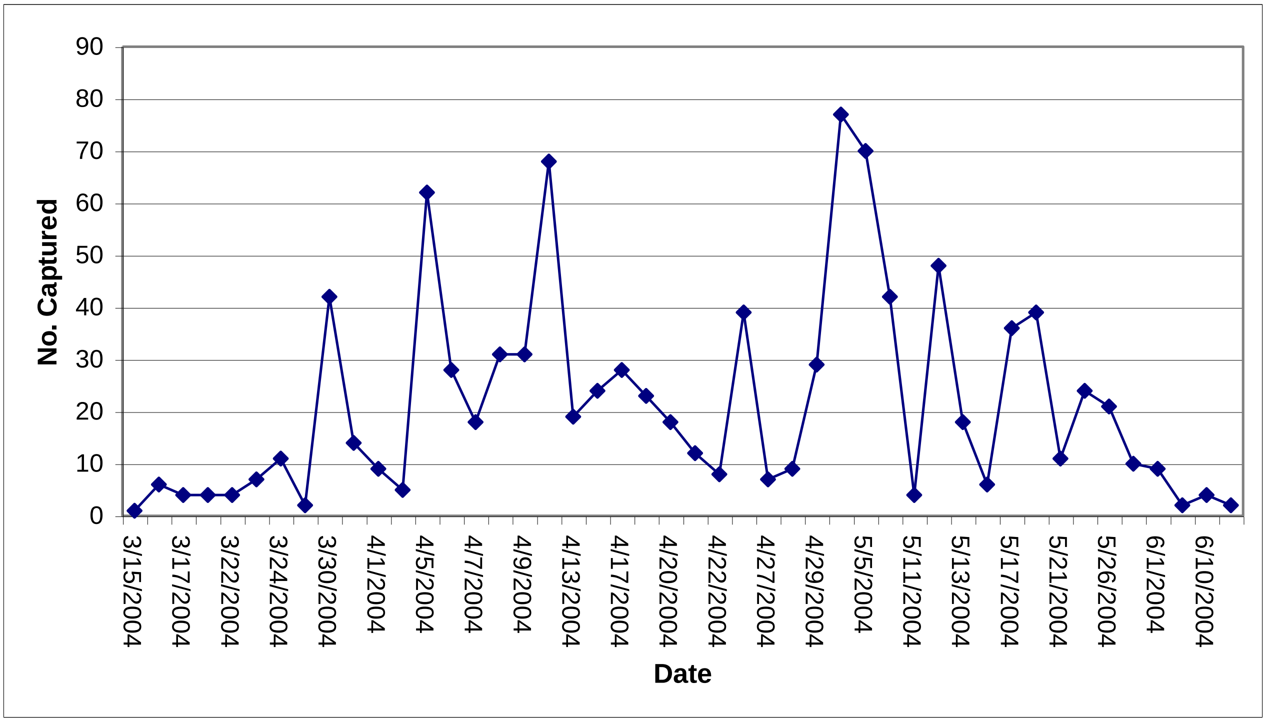

Figure 3. Kelt collection dates and numbers of fish removed from Chandler bypass facility involved in reconditioning procedures at Prosser Hatchery during 2004.

3.2 Direct Transport and Release

Objective 2: Implement and evaluate direct transport and release downstream from Bonneville Dam.

3.2.1 Kelt Survival and Rematuration

For the direct transport and release experiment, kelts were captured through 26 April – 29 April 2004 and released on 03 May 2004. In 2004 survivorship was very good with

84.0% (Table 4) surviving until release. As was expected, this experimental group of kelts did not remature.

Table 2: Population statistics for kelts in the direct transport and release experiment.	
Tank	C4 (1 Week Maximum)
No. Collected	75
No. (%) Released	63 (84.0%)
Mean In-Weight (kg.)	1.6
Mean Out-Weight (kg.)	1.6

3.2.2 Mortality Statistics

All known mortalities for the direct transport and release experiment occurred shortly after capture, fish processing, and subsequent surgery (See Table 3). Some of the mortalities may be associated with the handling stress caused by capture, biological assessments, transport, PIT tagging, or radio/acoustic tag surgery. Specific sources would be difficult to discern since all sampling and tagging procedures occurred on the same day. Another possibility was that outside temperatures were much warmer than the previous effort, which likely compounded the amount of stress that the fish were under. Unfortunately, we had 7 mortalities associated with radio tag procedure (7 mortalites /36 total fish surgically implanted = 19.4% mortality). For the acoustic surgery group, there were a total of 5 steelhead kelt mortalities (5 mortalites/ 33 total fish surgically implanted = 15.1% mortality) Next year, we will try to reduce mortalities in this group by utilizing an ice bath as well as splitting surgery times and data collection. Overall, mortalities for this group are still relatively low, but it should still be noted that the high survival rates of direct transport/release steelhead kelts may be misleading due to the possibility of additional mortalities in the wild after release.

Table 3: The number of direct transport and release kelts and associated mortality

Total No. Of Steelhead Kelt Mortality	12
Mortalities Associated With Surgical Procedures and Handling	12

3.2.3 Treatment Summary

The main objective for the direct/transport release group was to determine if direct/transport is an effective method for increasing iteroparity in steelhead kelts. The other goal of this experiment was to keep it cost effective. Since fish were held for such a short time period it was determined that feed was not necessary. After initial capture steelhead kelts were given an initial shot of oxytetracycline to boost immune system response associated with capture and handling stress.

3.2.4 Biotelemetry

2004 Experimental Data for Direct Transport/Release Steelhead Kelts

We successfully surgically implanted 29 direct-transport and release kelts with radio tags to assess their out-migration behavior and timing after release from below Bonneville Dam to the estuary. Another 28 steelhead kelts were successfully implanted surgically with acoustic tags.

Radio Telemetry

Radio tagged steelhead kelts were released on 5/03/04 below Bonneville Dam (RM 145) and intensively tracked for the first two weeks (5/03-5/27) with a final tracking day on June 17, 2004. Typically fish after release milled around the boat ramp and appeared to be feeding on flying insects (species unknown), although a few individuals immediately began to emigrate. After 2 days, the vast majority of kelts appeared to have left the Hamilton Boat Ramp area and began their journey downriver. We detected a total of 7 fish in the Columbia River Estuary (near RM 28) during our initial two weeks of radio tracking. It should be noted that a number of other kelts were

detected in the estuary but that radio telemetry signals were difficult to code during high tides probably due to the inhibiting effects of salt water on radio signal clarity. Steelhead kelts were detected in the estuary as early as 4 days after release (See Appendix A, Figure 3). Most of the steelhead kelts detected were below Portland, OR (RM 105), within the first 6 days of release (See Appendix A, Figure 1). This data suggests that short-term reconditioned kelts rapidly migrate to the estuary after initial release. Lack of detections in the lower river on our last aerial survey (6/17/04) likely means that steelhead kelts entered the ocean shortly after arrival to the estuary. There were a couple of detections with little to no movement between early May and mid June (Channel- Code, 6-90 and 7-79 with 7-87) and it's possible that these fish are either holding in the same location (most likely 6-90) or are mortalities (7-79 and 7-87).

Acoustic Telemetry

Acoustic tagged steelhead kelts from the direct transport and release were released on 5/03/04 below Bonneville Dam (RM 145). Telemetry arrays were deployed at various locations in the estuary from well beyond the Columbia River Jetty to Jim Crow Point (RM 29). A total of 28 steelhead kelts were tagged, of these, 20 (71%) were detected entering the estuary at the Jim Crow telemetry array. Average time to the estuary was nearly 4 days (See Table 4). Estuary residence for kelts averaged just under a day based on first and last detections (Table 4). We detected 15 kelts (53% of total tagged) at the Columbia River Jetty arrays. On average it took kelts less than a week to outmigrate completely to the ocean (Table 4). Based on the last signal it was assumed that they then headed further into the ocean beyond the array's detection range. It is possible that some of our fish may not have been detected outmigrating to the ocean either due to tag loss (encapsulation then expulsion), too much ambient sonar noise, or may have passed during times when there were holes in the detection system due to lost receivers. One of our tags (code 2108) exhibited some errant behavior. It was detected passing the Jim Crow array and then at the Astoria Bridge arrays a few days later. After 16 days from it's last detection it was then detected again at Jim Crow then 5 days later at the Seal Island array and subsequently 4 days later again at Jim Crow with it's last detection 2 days later. We then queried PITTAGIS to see if this kelt may

potentially be migrating upriver again, we have yet to receive any detections so far. It's quite possible that this kelt is either residing in the estuary or more likely preyed or scavenged upon by a seal or bird. It also looks like we may have a returning kelt, on 8/23 we detected code 2092 at Jim Crow, its last detection was at the ocean array at the mouth of the Columbia on May 6, 2004.

Table 4: Detection Statistics of Direct Transport/Release Steelhead Kelts

Total Estuary Detections		Time to Estuary	Time of Estuary Residence	Time to Ocean from release	avg. mi/hr from Bonneville to Estuary	mi/hr from Bonneville to Ocean
20	All Fish Avg (hr:min:sec)	98:55:57	21:45:32	NA	34.18	NA
Total Ocean Detections	Ocean Detected (hr:min:sec)	121:35:54	20:27:06	123:54:02	36.08	29.51
15	Estuary Only Detected (hr:min:sec)	128:50:20	26:39:40*	NA	28.47	NA
	Time in Days	4.08	0.88	5.13		
*Steelhead code 2108 excluded from estuary due to errant tag history in estuary.						

3.2.5 PIT-Tag

2004 Release

All direct transport and release steelhead kelts were PIT-tagged (n = 63). Currently we have not detected any kelts migrating through the PIT tag detection systems. We expect to see returns in 2005 and 2006. We will report our initial findings in the 2005 annual report.

3.3 Short-Term Reconditioning

Objective 1: Implement and evaluate short-term kelt reconditioning, transportation and release downstream from Bonneville Dam.

3.3.1 Kelt Survival and Rematuration

For the short-term reconditioning experiment, kelts were captured from 8 April – 20 April 2004 and released on 11 May 2004. In 2004 survivorship again was very good with 79.0% (Table 2) surviving until release. The designers of this experiment expected that

these kelts would not remature in such a short time span but the fish would reinitiate feeding behavior and thus increase survival and maturation in the wild.

Table 5: Population statistics for kelts in the short-term reconditioning experiment.	
Tank	C2 (3-5 Weeks)
No. Collected	105
No. (%) Released	83 (79.0%)
No. (%) Feeders	6/83 (7.2%)
Mean In-Weight (kg.)	1.56
Mean Out-Weight (kg.)	1.52

3.3.2 Mortality Statistics

The majority of mortalities for the short-term reconditioning experiment occurred after the first ten days of capture (Table 6). This is opposite of what has been observed in past experiments where the mortality was attributed to handling stress, failure to accept starter feed, an inability to convert feed into an appreciable weight gain, or moribund status when collected. After the 10-day capture period mortalities actually increased in this years experiment, with 20% of all the mortalities attributed to surgery and its inherent stress (4 mortalities, which require handling and very invasive procedures). Unfortunately, we had 2 mortalities associated with radio tag procedure (2 mortalites /31 total fish surgically implanted = 6.4% mortality). For the acoustic surgery group, there were a total of 2 steelhead kelt mortalities (2 mortalites/ 28 total fish surgically implanted = 7.14% mortality). Overall, mortalities for this group are still relatively low, however it should be noted that the high survival rates of short-term reconditioned kelts might be misleading due to the possibility of more mortalities in the wild after release.

Table 6: The number of short-term reconditioned kelts from capture-to-death that perished within the time interval at Prosser Hatchery, 2004.

Time to Mortality	No. of Steelhead Kelts
10	4
30	16
Total Mortality	20

3.3.3 Feeding and Treatment Summary

Short-term reconditioned steelhead kelts received a solitary diet of krill. The main objective for the short-term experiment was to elicit a feeding response from steelhead kelts. It is hypothesized that regaining the feeding response for steelhead kelts will benefit the fish once they are released and have natural prey items available. Unfortunately, few kelt steelhead in the short-term experiment fed on krill this year, while very few maintained or gained weight. This may be a function of the low nutritional value in the krill-only diet or due to the relatively short reconditioning time for the addition of any measurable weight gain. Many of the short-term kelts actually lost weight for the duration of this experiment (Table 2). This suggests that adding a greater nutritional component to the diet may be beneficial in the future. The short-term reconditioning population showed 19.0% gaining weight, 72.5% losing weight, and 8.0% with no weight change. As has been noted in past annual reports, it appears that krill is an important component of the steelhead diet, but that there is something vital missing from a strictly krill diet for rematuration (Hatch et al. 2002). Studies of ocean going steelhead have revealed that their ocean diet is diverse with such prey as squid, euphausiids, amphipods and various fishes (LeBrasseur 1966) and (Manzer 1968).

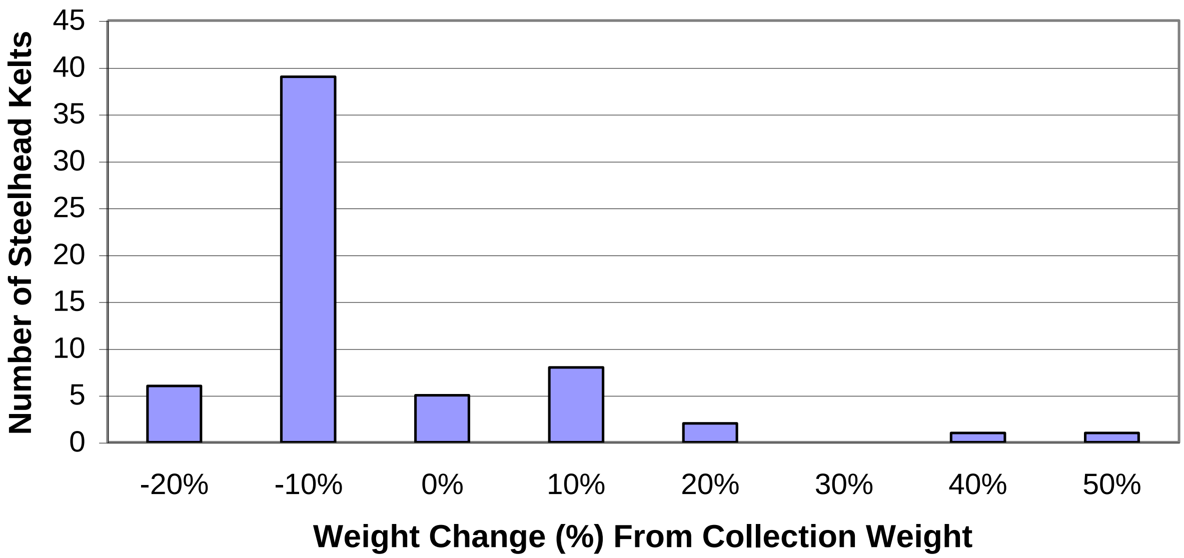

Figure 4: Weight gain distribution (weight gain as a percentage of collection weight) for short-term reconditioned kelts at Prosser Hatchery during 2004.

3.3.4 Biotelemetry

2004 Experimental Data for Short-term Reconditioned Steelhead Kelts.

We successfully surgically implanted a total of 29 short-term reconditioned kelts with radio tags to assess their out-migration behavior and timing after release from below Bonneville Dam to the estuary. Another 26 steelhead kelts were surgically implanted with acoustic tags.

Radio Telemetry

Short term reconditioned radio tagged steelhead kelts were released on 5/11/04 below Bonneville Dam (Rkm 233) and intensively tracked for the first two weeks (5/11-5/27) with a final tracking day on June 17, 2004. Typically fish after release milled around the boat ramp and appeared to be feeding on flying insects (species unknown), although a few individuals immediately began to emigrate. After 2 days, the vast majority of kelts appeared to have left the Hamilton Boat Ramp area and began their journey downriver. We detected a total of 6 fish that in the Columbia River Estuary (near Rkm 45) during our initial two weeks of radio tracking. It should be noted that a number of other kelts were detected in the estuary but that radio telemetry signals were difficult to code during high tides due to the inhibiting effects of salt water on radio signal clarity. Steelhead kelts were detected in the estuary as early as 3 days after release in the estuary (See Appendix A, Figure 4). Over half of the steelhead kelts were detected below Portland, OR (Rkm 169), within the first 6 days of release (See Appendix A, Figure 2). This data suggests that short-term reconditioned kelts rapidly head to the estuary after initial release. Lack of detections in the lower river on our last aerial survey (6/17/04) would likely mean that steelhead kelts entered the ocean shortly after arrival to the estuary.

Acoustic Telemetry

Acoustic tagged steelhead kelts from the short-term reconditioning were released on 5/11/04 below Bonneville Dam (Rkm 233). Telemetry arrays were deployed at various locations in the estuary from well beyond the Columbia River Jetty to Jim Crow Point (Rkm 47). A total of 26 steelhead kelts were acoustic tagged, of these, 19 (73%) were detected entering the estuary at the Jim Crow telemetry array. Average time to the estuary was nearly 5 days (See Table 7). Estuary residence for kelts averaged just over half a day based on first and last detections (Table 7). We detected 11 kelts (42% of total tagged) at the Columbia River Jetty arrays. On average it took kelts less than a week to outmigrate completely to the ocean (Table 7). Based on the last signal it was assumed that they then headed further into the ocean beyond the array's detection range. It is possible that some of our fish may not have been detected in the emigration due to tag loss (encapsulation then expulsion), too much ambient sonar noise, or may have passed by during times when there were holes in the detection system due to lost receivers.

Table 7: Detection Statistics of Short-term Reconditioned Steelhead Kelts

		Time to Estuary	Time of Estuary Residence	Time to Ocean from release	avg. mi/hr from Bonneville to Estuary	Mi/hr from Bonneville to Ocean
Total Estuary Detections	All Fish Avg (hr:min:sec)	118:28:21	15:26:20	NA	29.32	NA
19	Ocean Detected (hr:min:sec)	121:35:54	15:58:29	148:06:14	29.57	26.50
Total Ocean Detections	Estuary Only Detected (hr:min:sec)	114:10:29	14:42:09	NA	28.97	NA
11	Time in Days	4.92*	0.63*	6.17		

* All steelhead kelts that made it to estuary represented

3.3.5 PIT-tag Data

2002 Release

In 2002 we released 332 short-term reconditioned kelts. In 2003 we detected 40 (12.0%) of these individuals passing Bonneville Dam. This year we detected three kelts from the 2002 releases returning to the Columbia River. The detections by the three individuals were all at different locations: Bonneville Dam, John Day Dam, and Mcnary

Dam. In total we have had 12.9% of the short-term reconditioning fish attempting to return to the basin. None of these individuals were detected at Chandler Dam. Another PIT-tag detector should be functional by late 2004, and we could possibly detect at least some more individuals in 2005. These returning individuals in 2003 and 2004 alone represent .95% (43/4,525) of the 2002 counted run in the Yakima River.

2003 Release

As of March 2, 2004, we had detected a total of 4 (2.1%) of the 187 short-term reconditioned fish in the release had subsequent upstream detections. As of September 11, 2004 we had 4 additional returns 3 of these were detected at Bonneville Dam while one individual was detected at McNary Dam. Combining 2003 and 2004's returns it looks like 4.3% (8/187 returns/releases) have returned so far, with more expected in 2005. To this date, short-term reconditioning returns represent .36% (8/2,235) of the 2003 counted run in the Yakima River.

2004 Release

All direct transport and release steelhead kelts were PIT-tagged. A total of 63 steelhead kelts were PIT-tagged. Currently we have not detected any kelts at the PIT-tag detectors at the dam. We expect to see returns in 2005 and 2006. We will report our initial findings in the 2005 annual report.

3.4 Long-Term Reconditioning

Objective 2: Continue to refine and improve efficiency and success of long-term steelhead reconditioning at the Prosser Hatchery.

3.4.1 Kelt Survival and Rematuration

Long-term kelts will be held for 6-to-9 months in three different tanks. Results of the 2004 long-term reconditioning will be presented in the 2005 annual report.

Table 8: Population statistics for kelts in the long-term reconditioning experiment.				
Tank	C1	C2	C3	C4
No. Collected	202	194	105	161
No. (%) Released	2005 Annual Report	2005 Annual Report	2005 Annual Report	2005 Annual Report
No. (%) Mature	2005 Annual Report	2005 Annual Report	2005 Annual Report	2005 Annual Report
Mean In-Weight (kg.)	1.70	1.64	1.66	1.67
Mean Out-Weight (kg.)	2005 Annual Report	2005 Annual Report	2005 Annual Report	2005 Annual Report
Mature Feeders (%) (Mature feeders/total mature fish)	2005 Annual Report	2005 Annual Report	2005 Annual Report	2005 Annual Report
Immature Feeders (%) (feeders/immature fish)	2005 Annual Report	2005 Annual Report	2005 Annual Report	2005 Annual Report

3.4.2 Mortality Statistics

Mortality statistics for 2004 long-term reconditioned kelts will be reported in the 2005 annual report

3.4.3 Feeding and Treatment Summary

For all long-term experiments, steelhead kelts were fed krill as a starter diet for 2.5 months and then were given Moore-Clarke pellets based on the exceptional weight gain of the diet used in 2001 and 2002 diet experiments. In 2004 fish were administered approximately 30ml of hw- wiegandt GmbH's multi vit mixed into daily Moore-Clarke pellet feed for the first three weeks of the experiment. Results this aspect of the 2004 experiment will be published in the 2005 annual report.

3.4.4 Radio Telemetry

2003 Experimental Data for Long-term Reconditioned Steelhead Kelts

During the 2003 season a total of 301 (62.4 %) long-term reconditioned kelts survived reconditioning to be released, with 276 kelts rematuring. A total of 48 kelts of the 301 were radio-tagged with 24 tags from UI and 24 from the Yakama Nation then released. Each tag was inserted using the gastric insertion technique. A total of 29 radio tags

were used to determine migration routes, and these fish were released at Wallula Gap in the McNary Pool. We detected 12 (41%) of the tagged individuals entering the Yakima River. As for in-season homing, 19 individuals were released at the Mabton boat ramp on the Yakima River. Nine of the 19 (47%) individuals were tracked to 4 tributaries of the Yakima with a total of 5 of these individuals migrating up Satus Creek (See Figure 5). Yakama biologists observed that at least 4 to 5 of the reconditioned kelts in this group were lost to predation by river otters (*Lutra canadensis)*. It's important to note that there could be initial mortalities after release due to handling stress as well as tag loss (steelhead are notorious for tag regurgitation), or from predation (i.e. river otters, black bears, osprey, etc). Based on the number of kelts detected in spawning grounds, it's feasible that at least 138 potential steelhead kelts could have made it back to the spawning grounds. These results could translate into a 3.92% increase in iteroparous spawners in the basin.

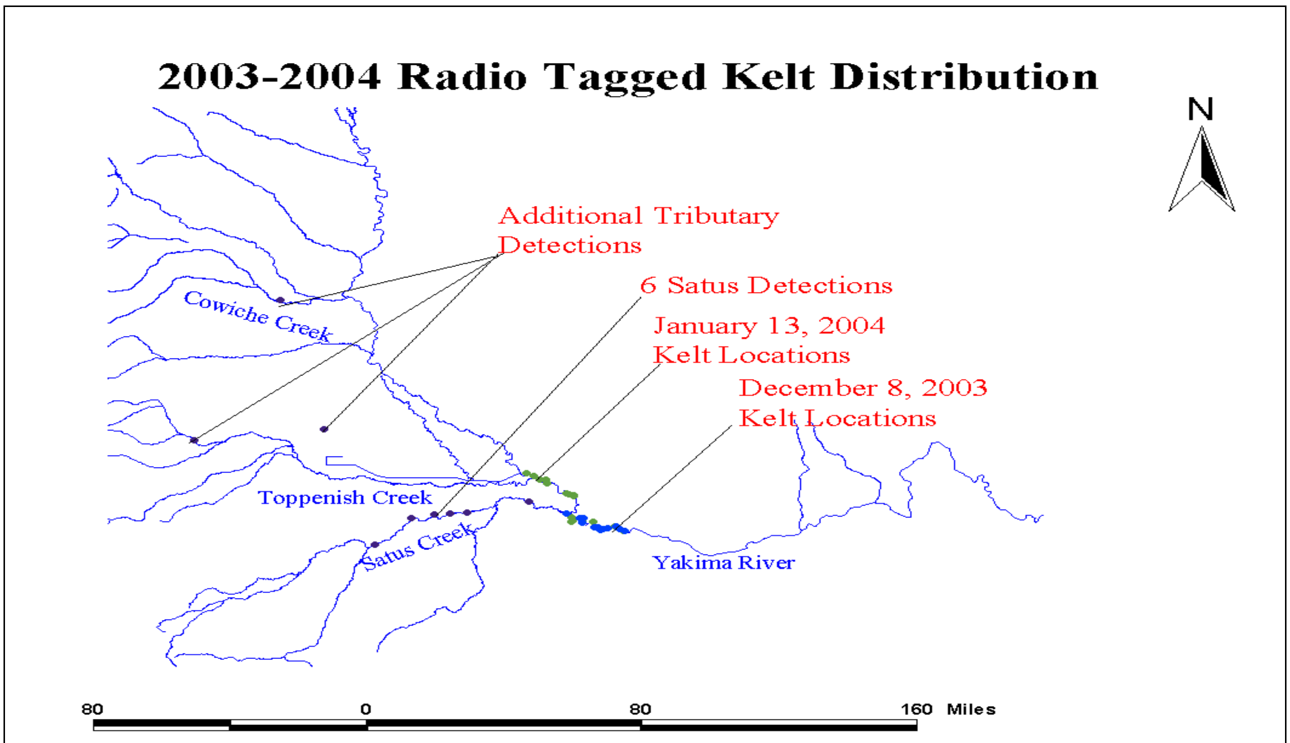

Figure 5. Distrubution of kelts released from the Mabton Boat Ramp, Yakima River (2003) with subsequent detections during 2003-2004.

2004 Experimental Data for Long-term Reconditioned Steelhead Kelts

We intend to radio tag up to 20 long-term reconditioned kelts and 20 virgin spawners using the gastric insertion technique to study in-season homing December 2004. We also plan on tagging an additional 20 steelhead kelts to study migration routes from the Wallula Gap section of the McNary Pool in December of 2004. Results from this aspect of the study will be made available in 2005.

3.4.5 PIT-Tag Data

2002 Long-term Reconditioning Release

In 2002 142 steelhead kelts were released at the Mabton Boat Ramp on the Yakima River on December 10, 2002. In total, 39 post-spawn steelhead kelts were recaptured at CJMF or were detected further downriver at one of the other dams. About half of the long-term steelhead kelts were recaptured at CJMF were used in 2003 long-term or short-term reconditioning experiments. It appeared that there were two separate steelhead kelts from the 2002 releases that were detected in 2003 and 2004 migrating upstream to spawn above Roza Dam. Together these fish represented 28% of the long-term reconditioning release and .91 % of the counted 2002 run (41/4,525).

2003 Long-term Reconditioning Release

During the 2003 season a total of 301 (62.4 %) long-term reconditioned kelts survived reconditioning to be released on December 8, 2003. In 2004, 16 post spawn long-term reconditioned kelts were recaptured at the Chandler Juvenile Evaluation Facility. Many of these fish were used in either the short-term reconditioning or direct transport experiments in 2004. Detections at McNary Dam picked up 4 kelts that appeared to be trying to outmigrate towards the ocean. We also detected one fish at Roza Dam, which appeared to be emigrating, but was not detected anywhere else in the system. These fish represented 7% of the long-term reconditioning release and .93 % of the counted 2003 run (21/2,235). It's possible that some kelts are getting by the PIT tag detection systems or the rate of mortality on spawning grounds is high. We expect that there will be possible returns in 2005.

2004 Long-term Reconditioning Release

Results of data from the 2004 long-term reconditioning experiment will be published in the 2005 annual report.

3.4.6 Minimize Eye Damage Experienced by Long-term Reconditioned Steelhead Kelts

In 2001-2002 the Yakama Nation technicians installed large tank covers to increase shading, painted the bottom of the tanks a blue color leaving the tank walls white, and dispensed food in different locations in the tank to minimize crowding. The new alterations to the tanks led to very favorable results with an overall decrease in eye damage. Comparing short-term release versus long-term release, it appears that the longer kelts are held, the probability increases that they will incur some type of eye damage. In 2003 paint on the tanks began to peel off possibly increasing the amount of eye damage observed. In 2004 we used a polyurethane coating that utilized the same color scheme. Results this aspect of the 2004 experiment will be published in the 2005 annual report.

3.5 Reproductive Success

3.5.1 Gamete Viability

Initial results from the 2004 experiment will be reported in the 2005 annual report.

3.5.2 Progeny Viability

Initial results from the 2004 experiment will be reported in the 2005 annual report.

3.6 Management Recommendations

3.6.1 Statistical Data Analysis

Short-term and long-term reconditioning scenarios are schemes that can be used to assist post spawn steelhead survival. The short-term approach is less invasive than long-term reconditioning, is cost beneficial, and also permits the fish to utilize the therapeutic benefits of saltwater. Long-term reconditioning allows the release of rematured fish ready to spawn but it is more expensive and presents more challenges to the fish culturists. In future reports we will compare short and long-term reconditioning scenarios with other approaches such as barging collected fish and allowing kelts to remain in the river.

Results regarding other aspects from this section of the 2004 experiment will be published in the 2005 annual report.

3.6.2 Benefit/Risk Analysis

Results of this aspect of the 2004 experiment will be published in the 2005 annual report.

3.6.3 Cost/Benefit Analysis

Results of this aspect of the 2004 experiment will be published in the 2005 annual report.

4.0 CONCLUSIONS

4.1 Kelt Research

- Steelhead kelt reconditioning shows great promise to assist the restoration of imperiled wild steelhead populations in the Columbia basin, based on empirical results of this project.

  During 2000, the Yakama Nation collected 512 wild kelts (38% of the subbasin's run that year) at the Chandler Juvenile Monitoring Facility (CJMF) for reconditioning at Prosser Hatchery, producing a first year recondition rate of 10% (51/512). Subsequently, kelt rematuration rates in captivity more than doubled from 10% (2000), 21% (2001), 50% (2002), and 85% (2003). As previously reported by Evans *et al*. (2001) and Hatch *et al*. (2002) in this project's previous annual reports, kelts reconditioned by this project will substantially bolster the number of repeat spawners in the Yakima River.

  The number of kelts successfully outmigrating to the ocean has been increased. We're seeing preliminary numbers that indicate that there is an increase in the number of multiple spawning kelts returning to the Yakima River.

  - This project is successfully refining techniques, which appear very applicable to increasing project success and has the potential to help population enhancement efforts at larger geographic scales for wild Columbia Basin steelhead.

  - In general, we feel the results of the study still warrant additional research, but feel that we are much closer to devising a management program for ESA-listed steelhead populations in the Columbia River Basin.

- Kelt reconditioning at this time should be viewed as experimental, but has been quite successful, is rapidly improving, and very promising. The general approach should also be viewed as one of several available research techniques to guide enhancement of steelhead iteroparity expression. Implementation of best methods should be targeted following several years of rigorous, replicated studies of each approach, including ecological and economic cost/benefit analysis.

4.2 Management Implications of Successful Kelt Reconditioning

Unlike other species of Pacific salmon *(Oncorhynchus spp.)* anadromous steelhead naturally exhibit varying degrees of iteroparity (repeat spawning). Wild steelhead populations have declined dramatically from historical levels in the Columbia and Snake Rivers, for many reasons. Successful steelhead iteroparity involves downstream migration of kelts (post-spawned steelhead) to estuary or ocean environments. Thousands of ESA listed kelts in the Snake R. and mid-Columbia River are incidentally collected each spring (March - June) in the juvenile collection systems throughout the Snake and Columbia rivers. Despite their efforts to out migration, results from a telemetry study Evans et al. (2001) suggested that only a very small percentage (<5%) successfully navigated the Snake and Columbia River hydropower system, although this survey occurred during low and no-spill years. In-river survival rates of emigrating kelts may increase considerably during average and above water years since emigration paths through open spillways may be available. For this life history expression (iteroparity) to persist in future steelhead runs, successful methods must be developed to augment the current rate of iteroparity among Snake and Columbia River steelhead populations.

CRITFC and Yakama Nation's collaborative effort is a promising approach to increase natural production of wild steelhead to enhance their iteroparous life history strategy with reconditioning techniques. Reconditioning promotes re-initiation of feeding for kelts, enabling them to survive and rebuild energy reserves required for gonadal development

and successful iteroparous spawning. Evans *et al*. (2001) provided a comprehensive literature review of kelt reconditioning which, combined with past years data, suggests that reconditioning is a potentially valuable recovery tool for threatened and endangered steelhead in the Columbia River Basin and elsewhere.

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6.0 Appendix

6.1 Appendix A.

Figure 1. Detected radio tagged direct transport and release experimental steelhead kelts through May 3, 2004 through June 17, 2004 organized by color and listed by channel and code.

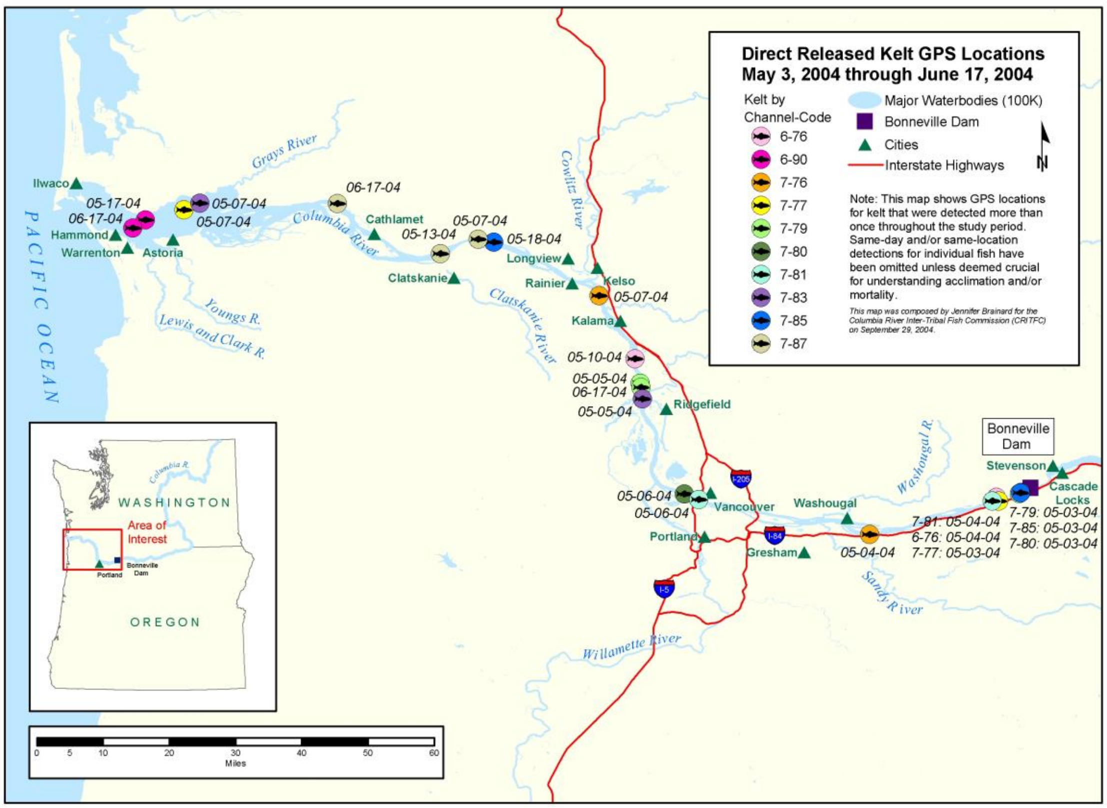


Figure 2. Detected radio tagged short-term reconditioned experimental steelhead kelts through May 3, 2004 through June 17, 2004 organized by color and listed by channel and code.

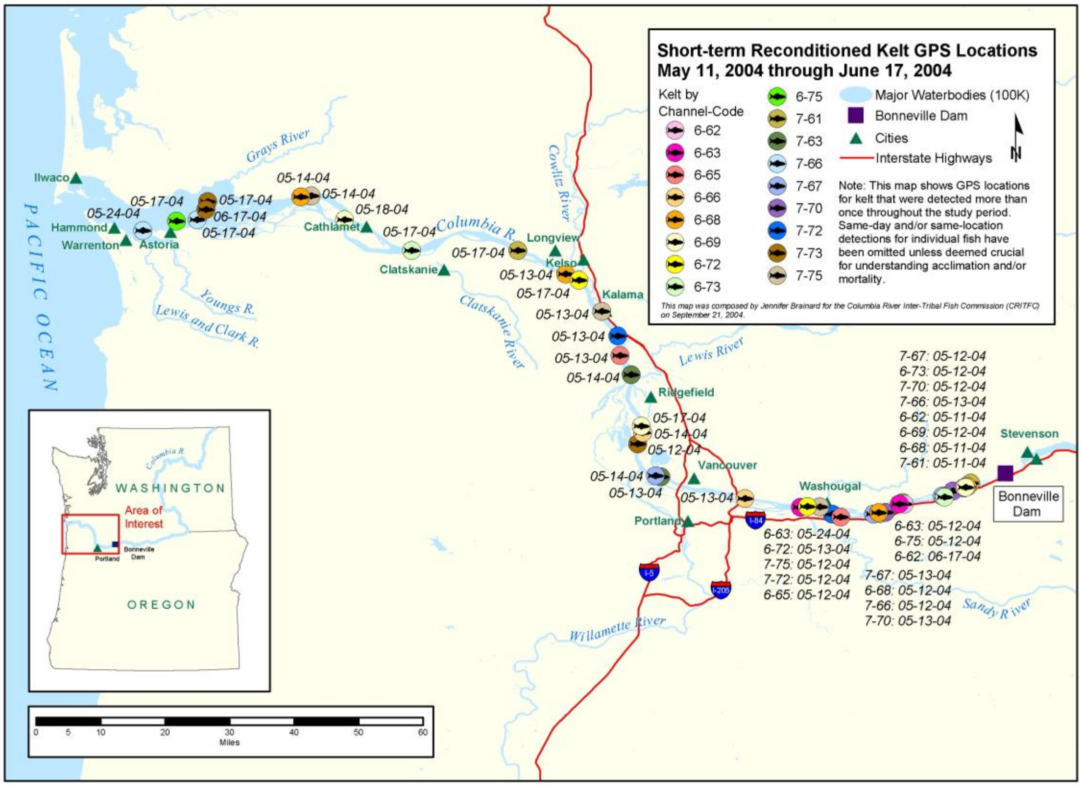


Figure 3. Radio tagged direct transport and release experimental steelhead kelts detected at the Columbia River Estuary through May 3, 2004 through June 17, 2004 organized by color and listed by channel and code.

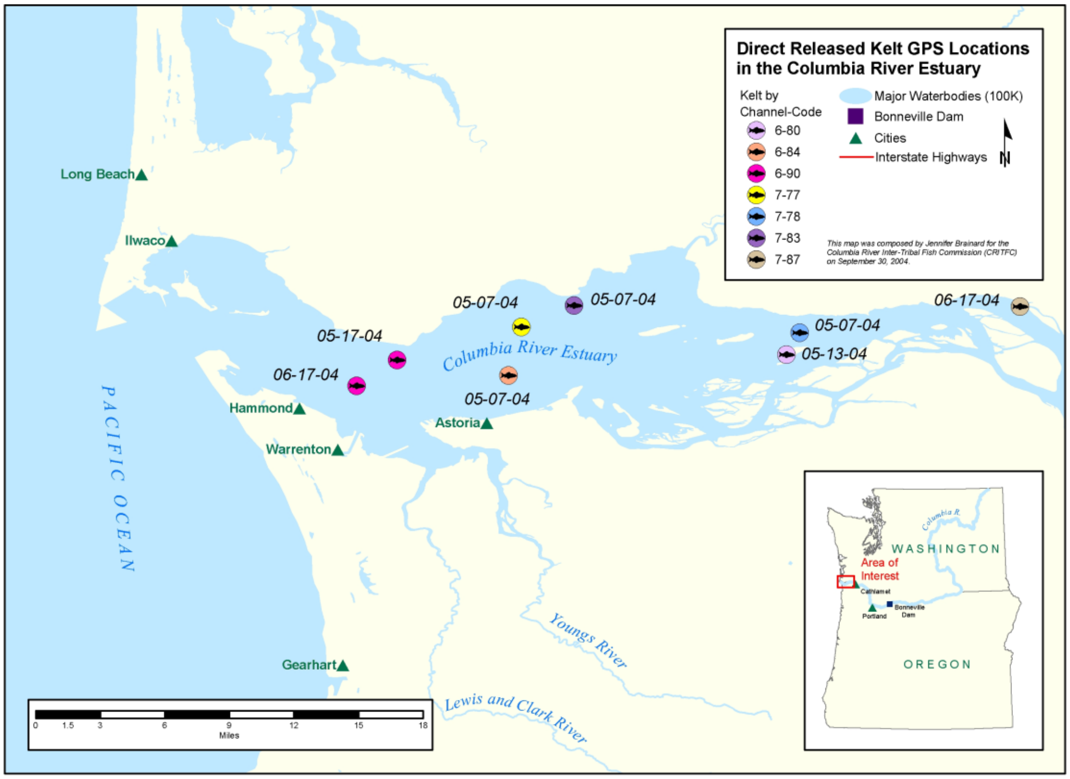
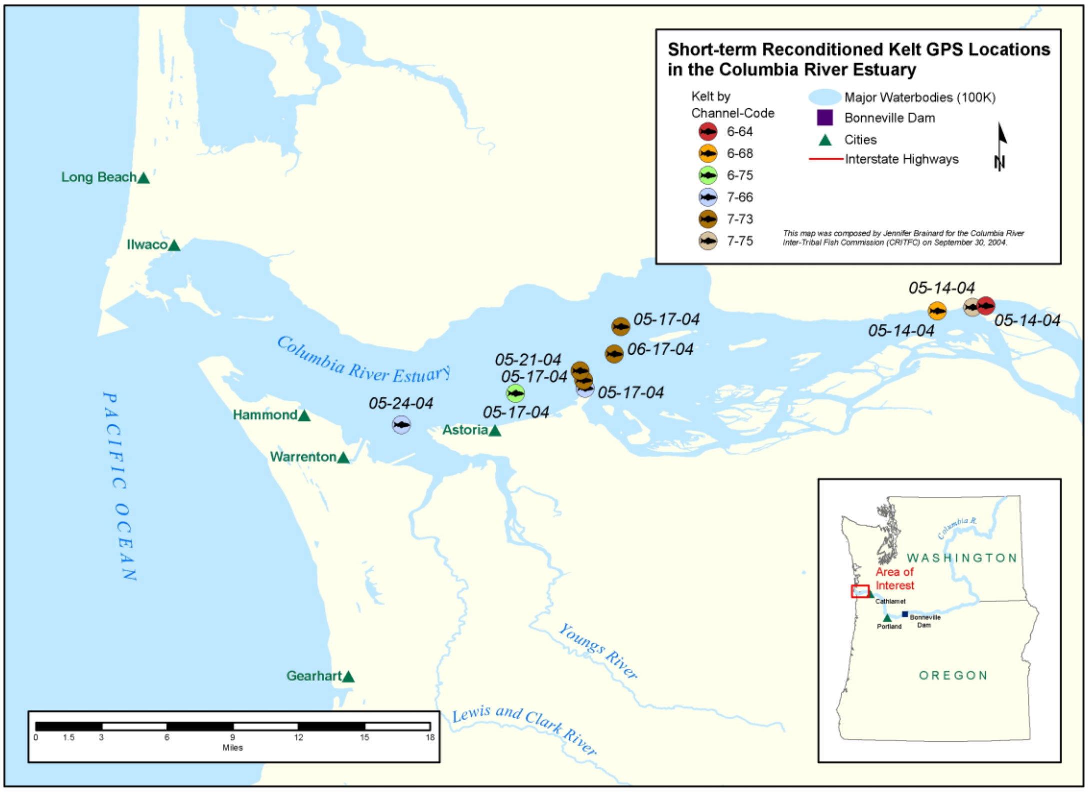


Figure 4. Radio tagged short-term reconditioned experimental steelhead kelts detected at the Columbia River Estuary through May 3, 2004 through June 17, 2004 organized by color and listed by channel and code.



6.2 Appendix B.

Figure 1. The location of the three main arrays and individual buoy-receiver systems used during the 2004 field season.

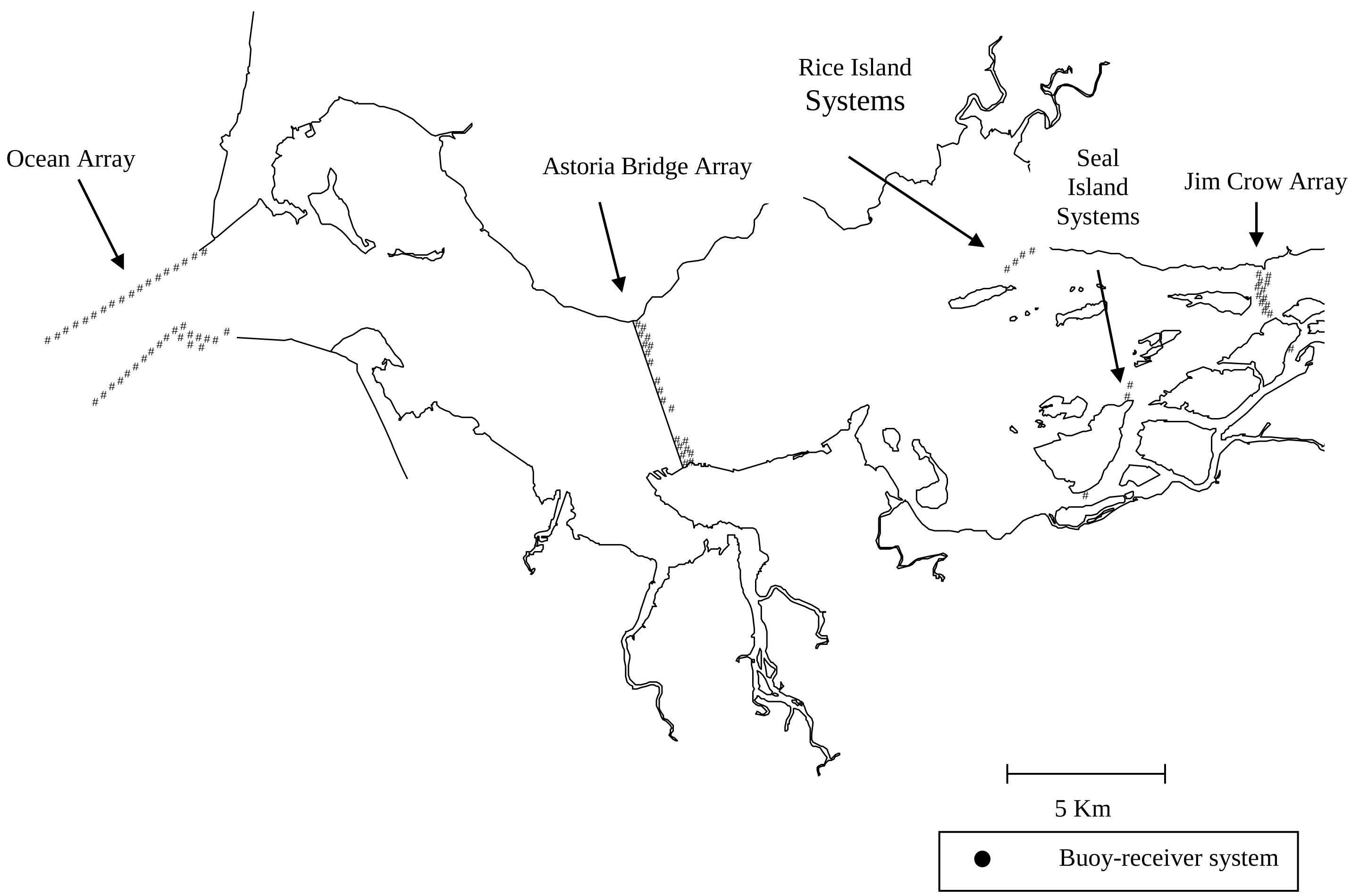
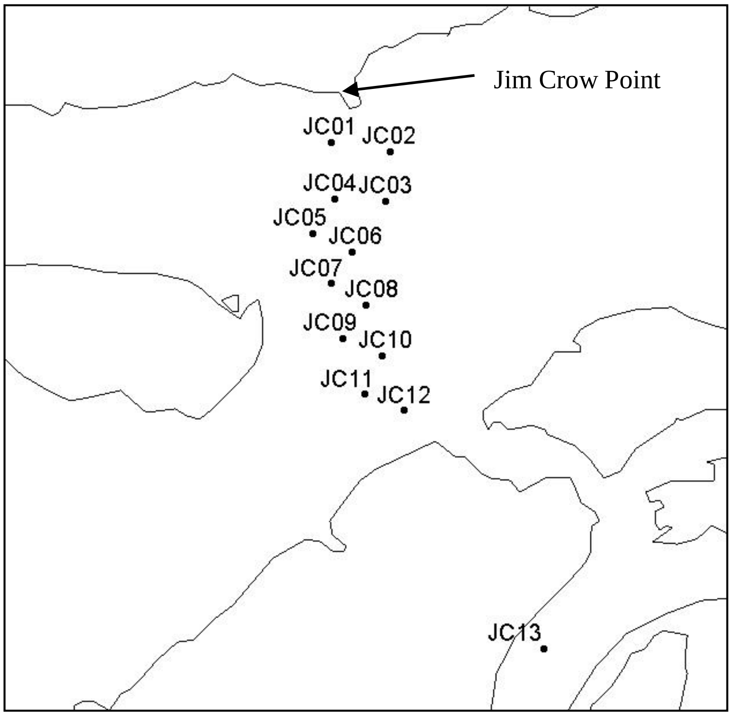
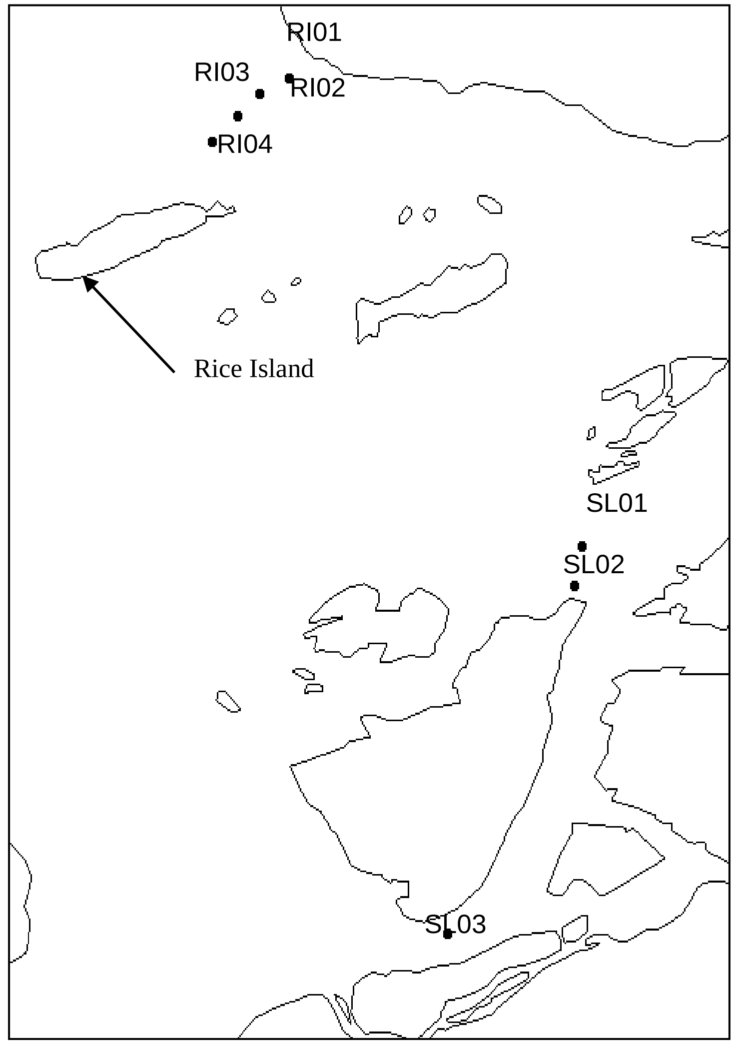


Figure 2. Buoy-receiver numbering at the (A) Jim Crow array and at the (B) Rice and Seal Island sites.





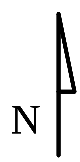


Figure 3. Buoy-receiver numbering at the (A) Astoria Bridge and (B) ocean arrays.