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2005 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 natural life history strategy that is expressed by some species from the family Salmonidae. Estimated 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 current expression of 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. 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 four study groups (in river release, 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 11 March to 23 June 2005. In total, 519 kelts were collected for reconditioning at Prosser Hatchery. Captive specimens represented 15.0% (519 of 3,451) of the entire 2004-2005 Yakima River wild steelhead population, based on fish ladder counts at Prosser Dam. Steelhead kelts were reconditioned in 20-foot circular tanks, and fed freeze-dried krill initially (first 2 months of long-term reconditioning) or for the duration of the experiment. Long-term steelhead kelts also 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: an intubation of Ivermectin™ was administered to control internal parasites (e.g., *Salmincola spp.* and, a Formalin drip system was administered via drip system for the duration of reconditioning to prevent fungal outbreaks.

From the steelhead kelts collected at the CJMF, four experimental groups were established; in-river release, direct transport and release, short-term reconditioning and long-term reconditioning. Short-term kelts were reconditioned for 3 to 5 weeks. Surviving specimens were released on May 13, 2005 and June 30, 2005. Long-term steelhead kelts are currently being held for a 6-9 month period with a scheduled release in late November 2005.

Direct transport and release kelts and short-term reconditioned kelts received PIT-tags with a portion of each group receiving hydro-acoustic tags to assess return survival, travel time, and migratory behavior below Bonneville Dam. In total, 96 direct-transport and release kelts and 99 short-term reconditioned kelts were PIT-tagged, with 57 direct transport/release and 56 short-term reconditioned kelts successfully receiving a surgically implanted hydro-acoustic tag as well. A portion of the long-term reconditioned fish will have radio tags inserted gastrically to monitor migration to spawning grounds.

ACKNOWLEDGEMENTS

The Bonneville Power Administration, under the direction of the Northwest Power and Conservation Council funded this project. We sincerely appreciate the support, scientific review, and ongoing communication between our project staff and these groups. We appreciate the assistance of Tracy Hauser, our Contracting Officer Technical Representative for her support of this project. The U.S. Bureau of Reclamation owns the land and the fish facilities, and provided services to Prosser Dam and Prosser Hatchery, and we appreciate their support.

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INTRODUCTION

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 emigrating 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).

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. The hydrosystem exerts a strong selection force against iteroparity, therefore, efforts to mitigate for this effect may help preserve the evolutionary legacy of the species. 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 continues to identify and systematically tests short- and long-term kelt reconditioning approaches as well as direct transport and release.

Yakima In-River Release

Beginning this year, we systematically collected a portion of the kelts that would have been suitable for reconditioning, PIT-tagged them, and then released them immediately back to the Yakima River to monitor the rate of natural respawning. These baseline data will provide an opportunity to compare Hockersmith et. al. (1995) reported respawner rates inferred from scale pattern analysis from the Yakima River.

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

Direct Transport and Release Study

This year we directly transported steelhead kelts around the hydro system to evaluate this effect on iteroparity rates. Given the high mortality rates of emigrating kelts observed during radio telemetry experiments 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.

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. It is also important to assess whether transportation impacts the homing ability of these fish. To address this unknown, all steelhead kelts were PIT-tagged with a portion of them receiving hydro-acoustic tags. This will provide us with the necessary information regarding fish movement, distribution, travel time, velocity, residence time in the estuary, and return rates.

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 response 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 or up to 3 months) for kelts to initiate post-spawn feeding, followed by the transportation of kelts around mainstem hydroelectric facilities for release, natural reconditioning, and rematuration in the Pacific Ocean. Since short-term reconditioned fish were also transported and released below Bonneville Dam, PIT-tag and hydro-

acoustic tags were used to assess fish movement, distribution, travel time, velocity, as well as residence time in the estuary.

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 release them at Prosser Hatchery, thus allowing them to mingle with the upstream run. By this time most surviving fish have rematured. Based on the past four years' results, steelhead long-term reconditioning appears very promising. During 2005, 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 2005 with results of the reconditioning being published in 2006. Results from the 2004 long-term release are included in this years report.

Comparison of Direct Transport/Release and Short-term Reconditioning Using 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 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 acoustic telemetry

technology and Passive Integrated Transponder (PIT) tags can help address such critical uncertainties.

Comparisons of the direct transport/release and short-term reconditioning experiments will be made using acoustic telemetry data as a means to quantify any differences that may be present from the two experimental groups.

Gamete and Progeny Success

Long-term reconditioning and subsequent captive spawning will provide valuable new quantitative 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. first time spawners. In 2005 we studied wild summer steelhead collected from Satus Creek, but experienced difficulties holding these fish to maturation. Next year, we plan to use hatchery fish as a surrogate to avoid impacts to wild stocks.

Management Recommendations

Major goals of this research project are to: 1) evaluate the ability of various tested scenarios to enhance wild steelhead iteroparity (e.g. short- and long-term reconditioning, kelt transportation around the hydrosystem); 2) to perform benefit/risk and cost/benefit analyses on resulting project data; and 3) provide management recommendations concerning implementation of tested treatments.

Tasks and Objectives

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) (Figure 1). 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.

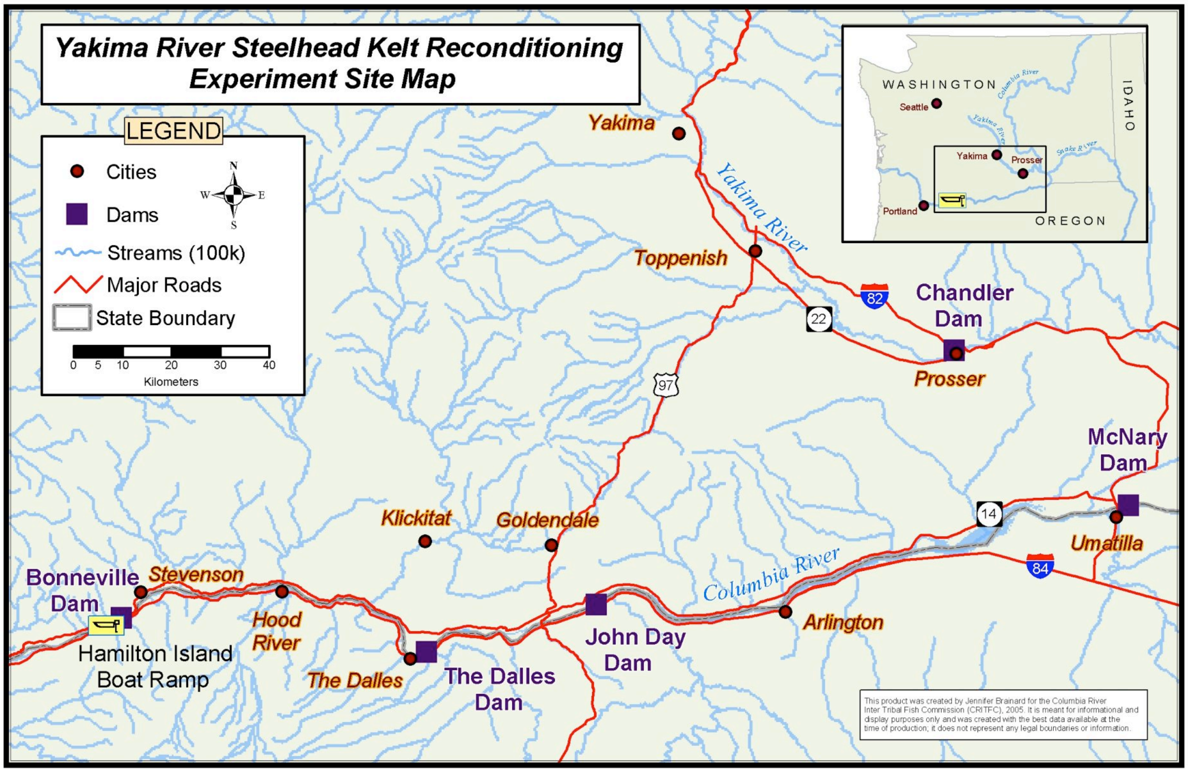

Figure 1: Reconditioning Site (Prosser, WA) and Release Site (Hamilton Is. Boat Ramp).

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 released back to the river).

Yakama Nation (YN) staff monitored the Chandler bypass separator 24 hours a day from March 11 to

June 23, 2005. 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 (57^0F or 13.8^0C).

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.

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). Passive Integrated Transponder (PIT) tags (if not already present) were then implanted in the fish's abdominal cavity for later identification. Every fifth steelhead kelt was released back in river to establish a natural repeat spawner rate. The remaining 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.

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

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

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. Steelhead kelts deemed to be quality candidates for reconditioning received a one-time subcutaneous injection of Oxytetracycline. Success was assessed based on increased survival and increases in weight gain.

Kelt Mortality

The following data were 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.

Maturation Assessment and Release for Spawning

Steelhead kelts from the direct transport/release and short-term experiments were weighed at initial capture and prior to release respectively on April 21 and May 13 for direct transport/release with May 13 and June 30, 2005 for short-term reconditioning, 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 late November 2005 to coincide with natural spawn timing. Upon release all surviving steelhead in the long-term experiment were examined with ultrasound equipment (Evans *et al*. 2001) to assess maturation status. 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).

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 hydrosystem effects or status quo on iteroparity using in-river release.

Objective 2: Evaluate effects of directly transporting steelhead kelts around the hydro system on enhancement of iteroparity.

Objective 3: Evaluate effects of short-term kelt reconditioning and subsequent transportation of kelts around the hydro system on enhancement of iteroparity.

Objective 4: Evaluate effects of long-term kelt reconditioning and subsequent release for natural spawning on enhancement of iteroparity.

Objective 5: Evaluate effects of long-term kelt reconditioning and captive spawning on: a) gamete and progeny viability; and b) enhancement of iteroparity.

Objective 6. Comprehensive project evaluation and management recommendations.

Yakima In-River Release

Objective 1: Evaluate hydrosystem effects or status quo on iteroparity using in-river release.

Capture, Mark, and Release

Yakima in-river release were kelts captured at the CJMF, PIT-tagged, and then immediately released back into the Yakima River. In-river release specimens were selected to correspond with the run timing by systematically sampling every fifth fish that was collected at the CJMF.

Direct Transport and Release

Objective 2: Evaluate effects of directly transporting steelhead kelts around the hydro system on enhancement of iteroparity.

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 employed two separate releases:

Release 1 = Steelhead kelts were collected on the April 18, 2005 and released on April 22, 2005.

Release 2= Steelhead kelts were collected on the May 12-13, 2005 and released on May 13, 2005.

Truck Transport

All direct transport and release kelts were transported then released at the Hamilton Island Boat Ramp, below Bonneville Dam. We expect fish to return from this study in 2006 and possibly 2007.

Biotelemetry

Acoustic Telemetry

Some direct transport and release kelts had acoustic tags surgically implanted in their abdomen. 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 acoustic tag has a unique acoustic bandwidth pulse that provides individual identification codes. After release, the migration to the Pacific Ocean was tracked using acoustic telemetry arrays that spanned sections of the Columbia River and estuary below Bonneville Dam (Appendix A). The complete array was up and running from mid- April until mid October of 2005. At times we needed to make changes to this array to accommodate gill net fisheries and theft of equipment.

PIT Tags

Kelt movement, timing, and survival can be assessed with Passive Integrated Transponder tags (PIT-tags), as the fish move through the hydropower system in the Yakima and Columbia rivers. When caught in the CJMF, all fish used in the direct transport study receive a PIT tag in the abdominal cavity. Each tag is unique and identifies an individual fish. Automatic adult PIT detectors are present in all ladders at Bonneville, McNary Dams, and have been recently installed on all fish ladders at the Prosser Dam on the Yakima River. 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.

Short-Term Reconditioning

Objective 3: Evaluate effects of short-term kelt reconditioning and subsequent transportation of kelts around the hydro system on enhancement of iteroparity.

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 and formalin to improve fish health during captivity. The following design, employing two separate releases was used:

Release 1 = Steelhead kelts were collected from the April 6-11, 2005 and processed on May 13, 2005.

Release 2= Steelhead kelts were collected from the April 25- May 19, 2005 and processed June 30, 2005.

Truck Transport

All short-term reconditioned kelts were transported then released at the Hamilton Island Boat Ramp, below Bonneville Dam. We expect fish to return from this study in 2006 and possibly 2007.

Biotelemetry

Acoustic Telemetry

A portion of the short-term reconditioned kelts had acoustic tags surgically implanted in their abdomen. 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 acoustic tag has a unique acoustic bandwidth pulse that provides individual identification codes. After release, the migration to the Pacific Ocean was tracked using acoustic telemetry arrays that spanned sections of the Columbia River and estuary below Bonneville Dam (Appendix A).

PIT Tags

Kelt movement, timing, and survival can be assessed with Passive Integrated Transponder tags (PIT-tags), as the fish move through the hydropower system in the

Yakima and Columbia rivers. When caught in the CJMF, all fish used in the various treatments receive a PIT tag in the abdominal cavity. Each tag is unique and identifies individual fish. Automatic adult PIT detectors are present in all ladders at Bonneville, McNary Dams, and have been recently installed on all fish ladders at the Prosser Dam on the Yakima River. 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.

Long-Term Reconditioning

Objective 4: Evaluate effects of long-term kelt reconditioning and subsequent release for natural spawning on enhancement of iteroparity.

Feeding and Treatment

2004

The long-term reconditioned fish were initially fed freeze-dried krill for 2.5 months then were fed Moore-Clarke pellets until they were released.

Release 1 = Fish were collected from March 3 to June 21 of 2004 and were reconditioned from March 16 to November 30, 2004.

2005

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

Release 1 = Fish were collected from March 15 to May 25th of 2005 and were reconditioned through release in late November 2005

Truck Transport

All long-term reconditioned kelts will be transported then released at the Mabton Boat Ramp (Yakima Rkm 96.3). We expect fish to migrate to the spawning grounds during the 2005-2006 spawning migration.

Biotelemetry

Radio Telemetry

We plan to radio tag at least 10 steelhead kelts from the long-term reconditioning to investigate in-season homing, migration patterns and spawning ground selection for comparison to previous years' monitoring efforts. Tags for in-season homing will be programmed to last a minimum of 30 days and will be placed using the gastric insertion technique. This group will then be released at the Mabton boat launch near Prosser Hatchery in November 2005. 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 2006.

PIT Tags

Kelt movement, timing, and survival can be assessed with Passive Integrated Transponder tags (PIT-tags), as the fish move through the hydropower system in the Yakima and Columbia rivers. When caught in the CJMF, all fish used in the various treatments receive a PIT tag in the abdominal cavity. Each tag is unique and identifies individual fish. Automatic adult PIT detectors are present in all ladders at Bonneville, McNary Dams, and have been recently installed on all fish ladders at the Prosser Dam on the Yakima River. 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.

Comparison of Direct Transport/Release and Short-term Reconditioning Using Biotelemetry

Using acoustic telemetry data we compared direct transport/release and short-term reconditioning experiments to determine if there are any effects on migrational patterns due to reconditioning. We correlated run timing to tidal oscillations to determine if there were any differences between the release groups and to also determine the type of behavior that these fish were exhibiting as they traveled downstream. Secondly, we directly compared run times between the two experimental groups to determine any migrational differences. We intend to compare any return data that we may collect over the next few years to see if there appears to be any major differences in return timing or behavior.

Gamete and Progeny Success

Objective 5: Evaluate effects of long-term kelt reconditioning and captive spawning on: a) gamete and progeny viability; and b) enhancement of iteroparity.

Gamete Viability

It was determined that the best place to try and catch wild steelhead for this aspect of the study would be to use the Shaddick dam/ladder (Rkm 13.5) on Satus Creek. Yakama Nation fisheries decided that placing a removable picket type structure on the upper end of the ladder and then dip netting the fish out of the ladder was the best alternative. The trap was fished 24 hours a day from February 22, 2004 to March 11, 2004, intermittently. Fish were then truck transported to the Prosser Reconditioning Facility to be held until they ripened for air spawning. Female gametes were collected using the air-spawning technique (Leitritz and Lewis 1980) while male gametes were collected manually. Gametes were sealed in well-oxygenated plastic bags and then placed on ice for delivery to the University of Idaho for gamete and progeny analyses.

Specifically, the following parameters and variables were measured to assess and compare egg viability.

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)

Progeny Viability

The following parameters and variables will be measured to assess and compare juvenile fish viability from the same experimental spawnings from the above gamete viability study:

1) Percent survival of various early life stages
2) Growth, length, weight, and condition factor measurements

Management Recommendations

This report marks the completion of the second year of this study. Following completion of the third year, we will provide an analysis of the potential kelt management strategies. These analyses will include biological metrics as well as cost benefits.

Objective 6. Comprehensive project evaluation and management recommendations.

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 direct transport/release, short, and long-term kelt reconditioning.

RESULTS/DISCUSSION

General Population Characteristics

A total of 808 kelts were captured with 541 kelts kept for reconditioning, 67 were used in the Yakima in-river release, 96 for the direct transport/release, 69 culled due to poor condition, 37 found to be dead on arrival, at Prosser Hatchery from March 11 to June 23, 2005. Collection generally followed migrational waves with the peak collection day occurring around April 18 (Figure 2). The total number of kelts used for reconditioning represented 15.0% (519 of 3,451) of the entire Yakima River ESA-listed population, based on fish ladder counts obtained from Prosser Dam for the period July 1, 2004 to

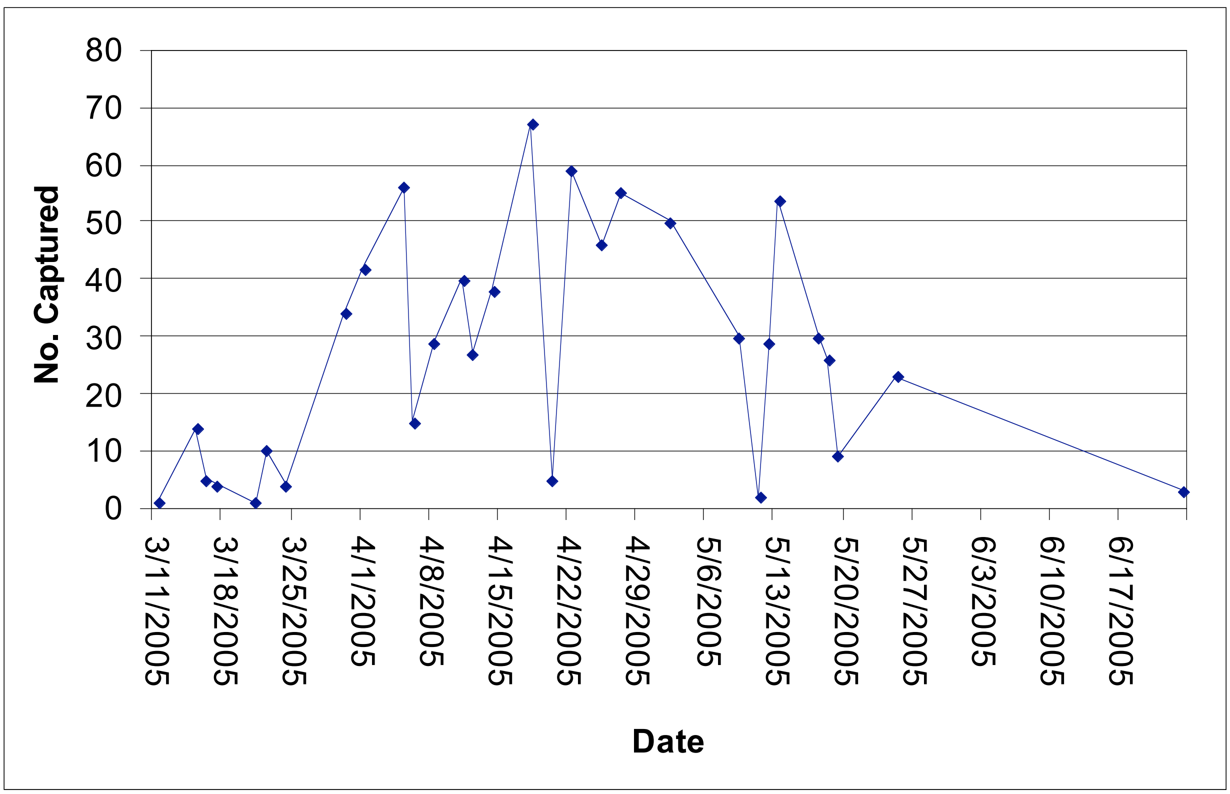

Figure 2. Kelt collection dates and numbers of fish removed from Chandler bypass facility involved in reconditioning procedures at Prosser Hatchery during 2005.

June 30, 2005. It is highly possible that many of the out-migrating kelts from the Yakima River were never diverted into the irrigation channel and passing over the spillway, due to especially high flows during collection time.

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 larger than last year with the average weight at 1.88 kg (range: 0.81– 3.92 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, 738 (91.3%) of the kelts were classified as female, whereas only 63 (7.8 %) as male in 2005. 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 of adult steelhead kelts captured and processed at chandler 2005.	
Sex	No. Captured
Male	63 (7.8 %)
Female	738 (91.3 %)
Unknown	7 (.8 %)
Total	808

The majority of kelts collected for reconditioning during 2005 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, 150 (76.9 %) kelts were classified as good, 29 (14.8%) as fair. Regarding fish coloration, we classified 145 (74.3%) as bright, 31 (15.8%) as intermediate, and 1 (.5 %) as dark. This data will be updated in the 2006 report to reflect the state of long-term reconditioned fish after release in December of 2005.

Yakima In-River Release

Objective 1: Evaluate hydrosystem effects or status quo on iteroparity using in-river release.

Kelt Capture and Survival to Release

Yakima in-river release kelts were captured from April 14, 2005 to May 25, 2005 (Table 2). We assumed that we had high survivorship in this group due to little handling and immediate release to the hydrosystem. We observed no direct mortalities from this particular aspect of the study.

Table 2: Population statistics for kelts from the Yakima in-river release	
No. Collected	67
Mean Capture and Release-Weight (kg.)	1.7

Treatment Summary

The main objective for the Yakima in-river release group was to monitor and determine natural iteroparity rates for the Yakima River and compare those with iteroparity rates from our other experiments. A total of 67 steelhead kelts were captured, assessed, PIT-tagged and then released back to the Yakima River to attempt their seaward migration.

Biotelemetry

PIT-Tag

Currently we have not detected any kelts migrating through the PIT-tag detection systems. We expect to see returns in 2006 and 2007. We will report initial findings in the 2006 annual report.

Direct Transport and Release

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

This objective was to determine if direct/transport is an effective method for increasing iteroparity in steelhead kelts. The other goal of this treatment 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.

Kelt Capture and Survival to Release

The direct transport and release experiment continued two treatment groups in to assess temporal effects 2005. One group was collected on April 18 and released on April 22, while the second group was collected on May 12-13 and released on May 13 (Table 3).

Table 3: Population statistics for kelts in the direct transport and release experiment.		
Tank	C3 Released 4/22/05 (Held 1 Week Maximum)	A1 Released 5/13/05 (Held 1 Week Maximum)
No. (%) Released	48	48
No. Implanted with acoustic tags	30	27
Mean Release Weight (kg.)	NA	2.1

Mortality Statistics

All known mortalities for the direct transport and release experiment occurred shortly after capture, fish processing, and subsequent surgery. Specific sources would be difficult to discern since all sampling and tagging procedures occurred on the same day. We had no mortalities from the first release (0/30 mortalities). The second release had 3 mortalities (3 mortalities/ 30 total fish tagged = 10 % mortality). These individuals likely expired due to elevated stress levels. Overall, mortalities for this group were much lower than last year, 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 after release.

Biotelemetry

Acoustic Telemetry

Acoustic tagged steelhead kelts from the direct transport and release were released on April 22, 2005 and May 13, 2005 below Bonneville Dam (Rkm 233). Telemetry arrays were deployed at various locations in the lower Columbia River, from the North and South Jetties (Rkm 0) to St. Helens (Rkm 138) (See Appendix A). The first release had a total of 30 and the second release had 27 steelhead kelts tagged, of these releases, 11 (36%) of release 1 and 21 (77%) of release 2 were detected entering the estuary at either the Welch Island or Pillar Rock telemetry array (Table 4). The first release travel

time averaged nearly 7 days (Table 4) whereas the second group averaged less than 4 days to the estuary (Table 5). Estuary residence for both release groups averaged just over a day based on first and last detections. We detected 3 kelts (10% of total tagged) of the first release and 10 kelts (37 %) from the second release detected at the Columbia River Jetty arrays. On average it took kelts less than a week to migrate completely to the ocean (Table 5). 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 migrating to the ocean either due to tag loss (encapsulation then expulsion), excessive ambient sonar noise, or may have passed during times when there were holes in the detection system due to lost receivers.

Table 4: Detection statistics of direct transport/release group 1

St Helens Detection		Time to St. Helens	Time to Estuary From Release	Time to Ocean From Release	Avg. km/hr from Hamilton Is. To St. Helens	Avg. km/hr from Hamilton Is. to Estuary	Avg. km/hr from Hamilton Is. to Ocean
22	River Only Detected Fish Avg (hr: min: sec)	85:08:45	NA	NA	1.11	NA	NA
Estuary Detection 11	Estuary Only Detected (hr: min: sec)	128:38:33	210:55:00	NA	0.74	0.85	NA
Ocean Detection 3	Ocean Detected (hr: min: sec)	105:31:40	145:20:00	144:06:00	0.90	1.24	1.60

Table 5: Detection statistics of direct transport/release group 2

St Helens Detection		Time to St. Helens	Time to Estuary From Release	Time to Ocean From Release	Avg. km/hr from Hamilton Is. To St. Helens	Avg. km/hr from Bonneville to Estuary	Avg. km/hr from Hamilton Is. to Ocean
22	River Only Detected Fish Avg (hr: min: sec)	48:52:30	NA	NA	1.97	NA	NA
Estuary Detection 21	Estuary Only Detected (hr: min: sec)	51:55:12	88:43:12	NA	1.86	2.04	NA
Ocean Detection 11	Ocean Detected (hr: min: sec)	88:51:11	124:03:38	175:00:27	1.07	1.45	1.33

PIT-Tag

<u>2004 Release</u>

In 2004 63 direct transport and release fish were PIT-tagged and released on May 3, 2004. We detected 3 of these steelhead kelts at the Bonneville Dam ladder during the later part of 2004. These detections currently represent 4.7 % of the total released for this experiment. We have yet to detect any for 2005.

2005 Release

All direct transport and release steelhead kelts were PIT-tagged (n = 96). Currently we have not detected any kelts migrating through the PIT tag detection systems. We expect to see returns in 2006 and 2007. We will report our initial findings in the 2006 annual report.

Short-Term Reconditioning

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

Kelt Capture and Survival to Release

The short-term reconditioning experiment contained two separate treatment groups to assess temporal effects of steelhead kelts that were captured from April 6 – May 19, 2005 and processed on May 13 and June 30, 2005 (Table 6).

Table 6: Population statistics for kelts in the short-term reconditioning experiment.

Tank	C2 Released 5/13/05 (3-5 Weeks)	C3 Released 7/1/05 (2-3 Months)
No. (%) Released	69	26
No. with acoustic tags	30	26
Mean In-Weight (kg.)	1.72	1.75
Mean Out-Weight (kg.)	1.59	1.37

Mortality Statistics

We had no surgery related mortalities from the first release (0/30) of acoustic-tagged steelhead. The second acoustic surgery group had 4 steelhead kelt mortalities associated with surgical implantation (4 mortalities/ 30 total fish tagged = 13 % mortality). Overall, mortalities for both release groups was 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 after the kelts are released.

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. Many of the short-term kelts lost weight for the duration of this experiment (Table 6). The first release group had 6 individuals gaining weight, 3 with no weight change and the rest losing some weight (Figure 3). Release group 2 had 1 individual gain weight with the rest losing weight (Figure 3). As has been noted in past annual reports, it appears that krill is an important component of the steelhead diet, but that there may be something vital missing from a strictly krill diet for rematuration (Hatch et al. 2002) or that weight loss may be continuing but we are decreasing the rate of weight lost. 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).

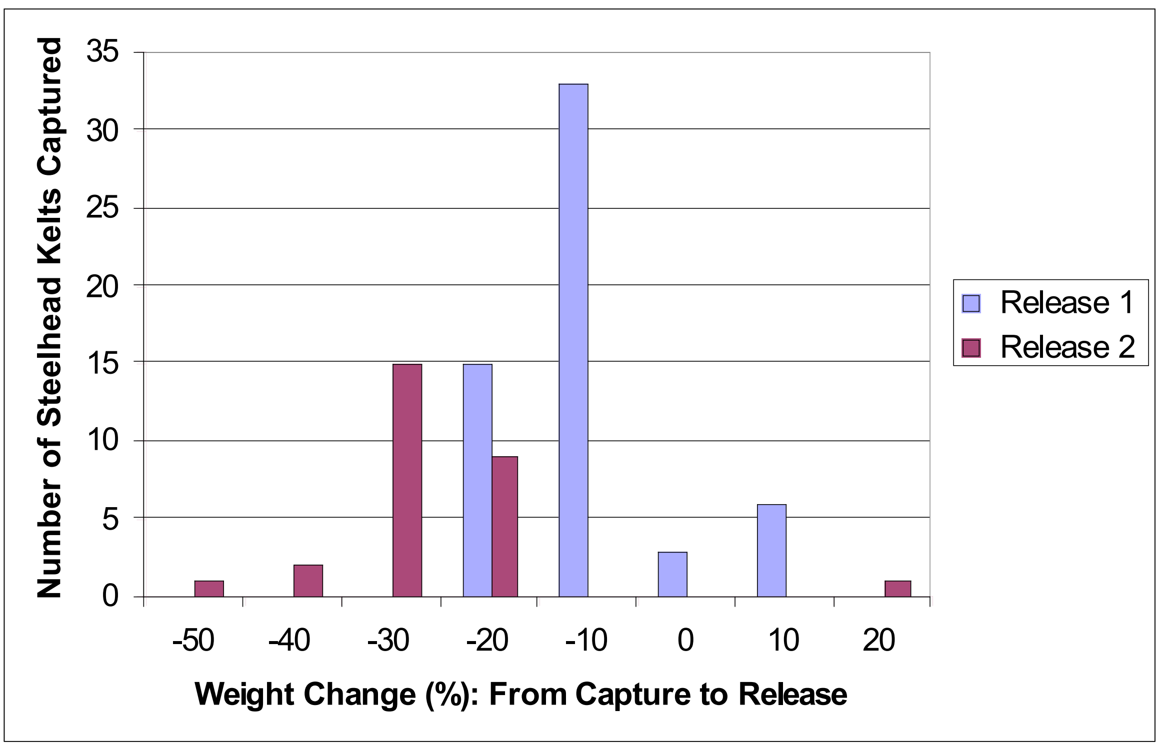

Figure 3: Weight gain distribution (weight gain as a percentage of collection weight) for short-term reconditioned kelts for release group1 and 2 at Prosser Hatchery during 2005.

Biotelemetry

Acoustic Telemetry

A total of 30 short-term reconditioned kelts from the first release and 26 from the second release group received acoustic tags to assess their emigration behavior and timing after release from below Bonneville Dam to the estuary.

Acoustic tagged steelhead kelts from the short-term reconditioning were released on May 13 and June 30, 2005 below Bonneville Dam (Rkm 233) at Hamilton Island. Telemetry arrays were deployed at various locations in the lower Columbia River, from the North and South Jetties (Rkm 0) to St. Helens (Rkm 138) (Appendix A). The first release had a total of 30 and the second release had 26 steelhead kelts tagged, of these releases, 16 (53%) from release 1 and 0 (0%) from release 2 were detected entering the estuary at either the Welch Island or Pillar Rock telemetry arrays (Table 7). Release group 2 had good detection rates at St. Helens (17 individuals detected) and they traveled quickly (averaged 38 hours) to that array when compared to the other release groups (70-100 hours) (Table 8). The reason for no detections of this release group is uncertain, but this group was the latest release of the year and experienced the higher river temperatures. The first release averaged just less than 5 days (Table 7) to the estuary. Estuary residence for release group 1 averaged just under a day based on first and last detections (21 hours). We detected 6 kelts (20% of total tagged) from the first release at the Columbia River Jetty arrays. On average it took kelts less than a week to migrate 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 migrating to the ocean either due to tag loss (encapsulation then expulsion), excessive ambient sonar noise, or may have passed during times when there were holes in the detection system due to lost receivers.

Table 7: Detection statistics of short-term reconditioned kelts release group 1							
St Helens Detection		Time to St. Helens	Time to Estuary	Time to Ocean From Release	Avg. km/hr from Hamilton Is. To St. Helens	Avg. mi/hr from Bonneville to Estuary	Avg. mi/hr from Bonneville to Ocean
22	River Only Detected Fish Avg (hr: min: sec)	57:16:14	NA	NA	1.66	NA	NA
Estuary Detection 16	Estuary Only Detected (hr: min: sec)	67:57:18	115:36:52	NA	1.41	1.56	NA
Ocean Detection 6	Ocean Detected (hr: min: sec)	99:21:13	126:57:04	138:25:39	0.95	1.42	1.68

Table 8: Detection statistics of short-term reconditioned kelts release group 2							
St Helens Detection		Time to St. Helens	Time to Estuary	Time to Ocean From Release	Avg. km/hr from Hamilton Is. To St. Helens	Avg. mi/hr from Bonneville to Estuary	Avg. mi/hr from Bonneville to Ocean
17	River Only Detected Fish Avg (hr: min: sec)	38:49:11	NA	NA	2.50	NA	NA
Estuary Detection 0	Estuary Only Detected (hr: min: sec)	NA	NA	NA	NA	NA	NA
Ocean Detection 0	Ocean Detected (hr: min: sec)	NA	NA	NA	NA	NA	NA

PIT-tag

<u>2004 Release</u>

All direct transport and release steelhead kelts were PIT-tagged for a total of 63 short-term reconditioned individuals receiving tags. Currently we have detected 3 kelts in 2004 and an additional 3 in 2005 at the PIT-tag detectors at Bonneville Dam. These individuals represent 9.5 % of the total released. We may still see additional returns in 2006, and will report any additional returns in the 2006 annual report.

<u>2005 Release</u>

A total of 96 steelhead kelts were PIT-tagged. As of November 10, 2005 we have not detected any returns from this group. We should begin to see returns from these releases in 2006 and 2007. Initial results will be published in the 2006 annual report.

Long-Term Reconditioning

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

Kelt Survival and Rematuration

2004 Long-term Reconditioning

Long-term kelts were held for 6-to-9 months in four different tanks. They were released on November 30, 2004 at the Mabton Boat Ramp (Rkm 96.3).

2005 Long-term Reconditioning

Long-term kelts will be held for 6-to-9 months in three different tanks. Experiment results for the 2005 release will be presented in the 2006 annual report.

Mortality Statistics

2004

Mortalities in all of the tanks were a little above average except for tanks C1 and C2 (Table 9). These values although higher are not markedly so except in the case of tank C2 which saw high numbers of kelts lost during the long-term reconditioning study (Table 9). On the other hand, tank C1 had exceptionally low mortality rates (Table 9). The only possible correlations between mortality and tank were that fish in tank C2 were almost exclusively captured during the month of May while tank C1 was captured during March and April. Another possibility is that the group C2 may have been more competitive for food than fish from the other release groups.

Table 9: Population statistics for kelts in the long-term reconditioning experiment 2004.					
Tank	C1	C2	C3	C4	Composite
No. Released	122	53	47	31	253
No. Mature	106	48	35	27	216
Mean In-Weight (kg.)	1.60	1.53	1.52	1.49	1.53
Mean Out-Weight (kg.)	1.85	2.09	2.36	2.15	2.11
Mature Feeders (%) (Mature feeders/total mature fish)	73 %	91 %	25 %	92 %	70 %
Immature Feeders (%) (feeders/immature fish)	50 %	20 %	81 %	100%	62 %
Mortalities	77	137	62	99	375
Survival (%)	61 %	27 %	43 %	23 %	40 %

2005

Mortality statistics for 2005 long-term reconditioned kelts will be reported in the 2006 annual report

Feeding and Treatment Summary

For all long-term experiments, steelhead kelts were fed krill as a starter diet for approximately 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

Biotelemetry

Radio Telemetry

2004

A total of 41 radio tags were inserted into adult reconditioned steelhead. Each tag was inserted using the gastric insertion technique. All fish were released in the Yakima River the last part of November 2004, at Mabton (Rkm 96.3).

Of the 41 radio tagged kelts, 6 kelts (15%) were detected in the Naches River including 3 that swam to nearly the furthest river mile of the Little Naches River. An additional 10

radio tags were detected past Rkm 112 (mouth of Satus Creek) but never detected again. The tags in these fish likely expired and the fish distributed into select tributaries. Satus Creek had the second highest count of kelts, 4 (10%), followed by the Toppenish Creek, 1 (.02%) and Sulfur Drain with 2 fish detected at the mouth (Figure 4). The furthest tracked kelt, was located at Rkm 19 near the confluence of the North Fork and Middle Fork of the Little Naches River, a tributary of the Naches River. In addition to this male, two other females were located at river kilometer 12.2 and 7.2 respectively were both detected in the Little Naches River. Yakama Nation Fisheries technicians observed bald eagle predation of a male at Dry Creek (tributary of Satus Creek).

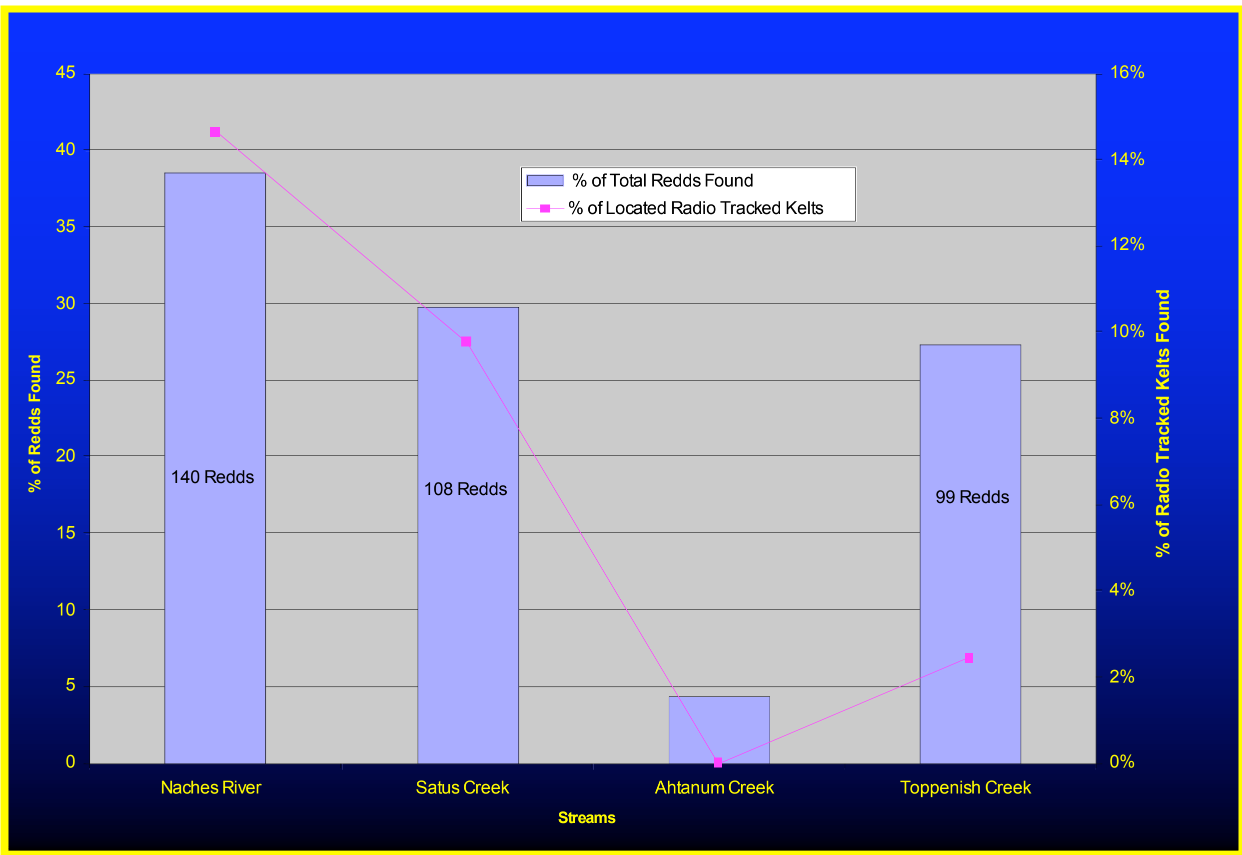

***Figure 4*. Distribution of kelts released from the Mabton Boat Ramp, Yakima River (2004) with subsequent detections during 2004-2005.**

2005

We intend to radio tag up to 10 long-term reconditioned kelts in the same manner that was performed in 2004. Results from this aspect of the study will be published in 2006.

PIT-Tag Data

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 migrate 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 did not have any additional detection of 2003 released long-term kelts in 2005.

2004 Long-term Reconditioning Release

November 30, 2004, 253 long-term reconditioned kelts survived to be released at Mabton (Rkm 96.3) on the Yakima River. In Spring of 2005, 25 of these individuals were recaptured at the Chandler juvenile evaluation facility attempting to emigrate again. A majority of these recaptured individuals (12) were placed back into the long-term reconditioning study, 2 were placed into the direct transport and release study, 3 into the short-term study, 2 into the Yakima in-river release, 1 cull, and 7 were mortalities. The mortalities broke down into 2 dead on arrivals, 3 long-term mortalities, and 2 that were recaptures from the Reproductive Success Project.

Comparison of Direct Transport/Release and Short-term Reconditioning Using Biotelemetry

Based on our analysis the two experimental groups differed little in percentage of fish detected although there was a small difference in run timing (Table 10). The percentage of steelhead kelts detected in the second group was much smaller due to the lack of further detections below the St. Helens array (Rkm 138). This lack of detection further downstream leads us to assume that they were all mortalities but that they may have sought refuge in the Lewis River, WA. We will continue to monitor for all of these individuals at our telemetry arrays and with PITTAGIS.

Table 10. Comparison of Steelhead kelts detected (%) and run timing from direct transport/release and short-term reconditioning

Direct Transport/Release	Run Times	Short-term Reconditioned	Run Times
St Helens Detection 77%	Time to St. Helens (hr: min: sec) 67:00:38	St Helens Detection 70%	Time to St. Helens (hr: min: sec) 48:02:43
Estuary Detection 56%	Time to Estuary (hr: min: sec) 149:49:06	Estuary Detection* 53%	Time to Estuary* (hr: min: sec) 115:36:52
Ocean Detection 25%	Time to Ocean From Release (hr: min: sec) 159:33:14	Ocean Detection* 20%	Time to Ocean From Release* (hr: min: sec) 138:25:39

* Values were derived solely from short-term reconditioning release 1 due to lack of detections for release group 2

We also compared tidal oscillations with records of when our kelts arrived and left a particular array system. Looking at the Pillar Rock (Rkm 40) and Welch Island (Rkm 49) arrays we observed that most kelts seemed to arrive on the outgoing tide and would leave immediately or leave on a later outgoing tide (Figure 5). Short-term reconditoned kelts followed a similar pattern but tended to have about half of them leaving on the incomming tide (Figure 6). We believe that this movement seems to follow typical smolt patterns of adjusting to a more saline environment as their osmo-regulatory functions begin to fit a marine type of environment, but at a truncated pace.

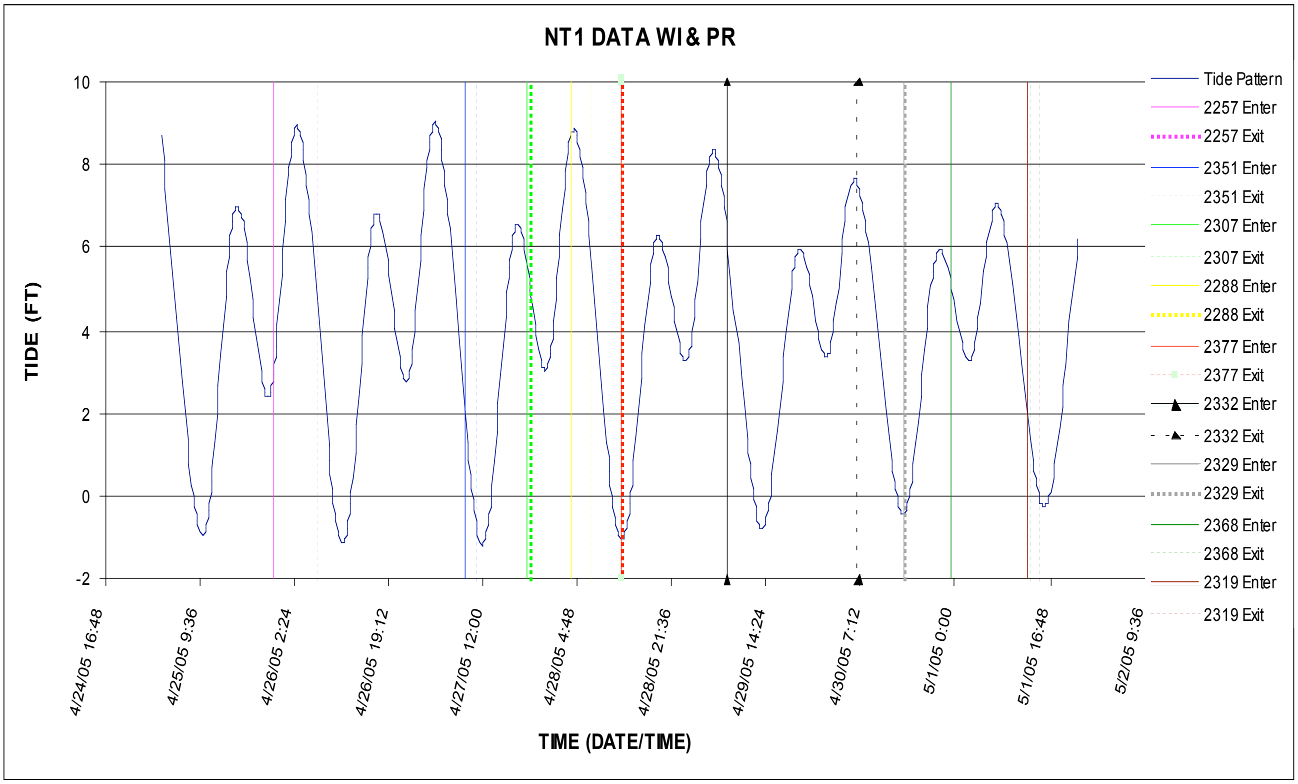

Figure 5. Arrival and departure of direct transport/release steelhead kelts group 1 correlated to tidal oscillations at Welch Island and Pillar Rock Arrays.

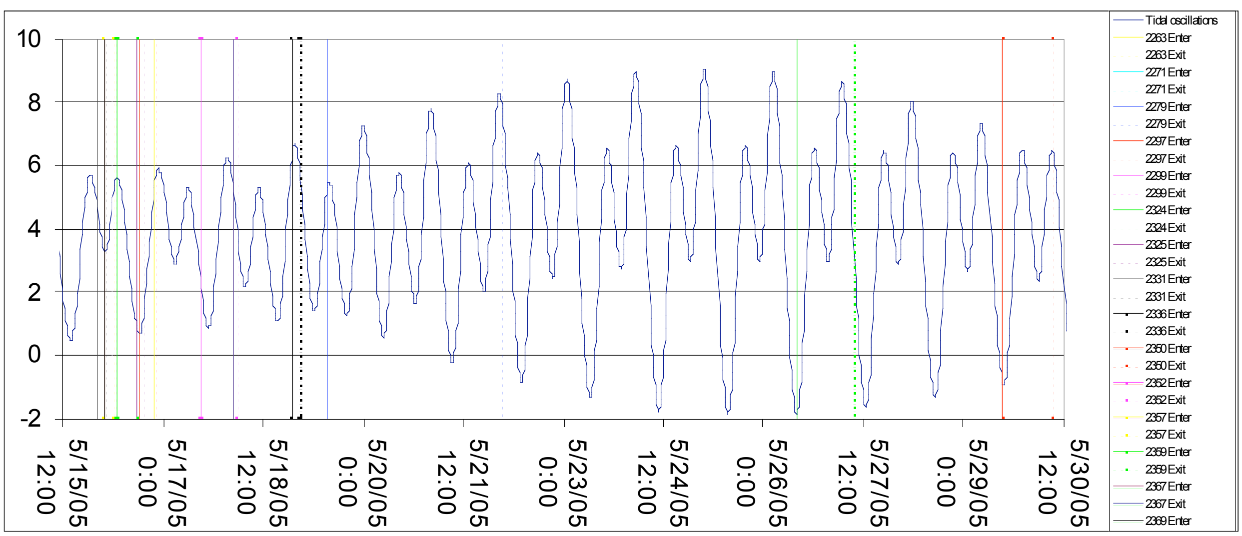

Figure 6. Arrival and departure of short-term reconditioned steelhead kelts group 1 correlated to tidal oscillations at Welch Island and Pillar Rock Arrays.

Looking at data near the mouth of the Columbia (rkm 0) it appears that both experimental steelhead kelt groups are continuing to move out relatively quickly to the ocean (Figures 7 & 8). These particular individuals may be finished acclimating to the saltwater and are now readily migrating to the ocean.

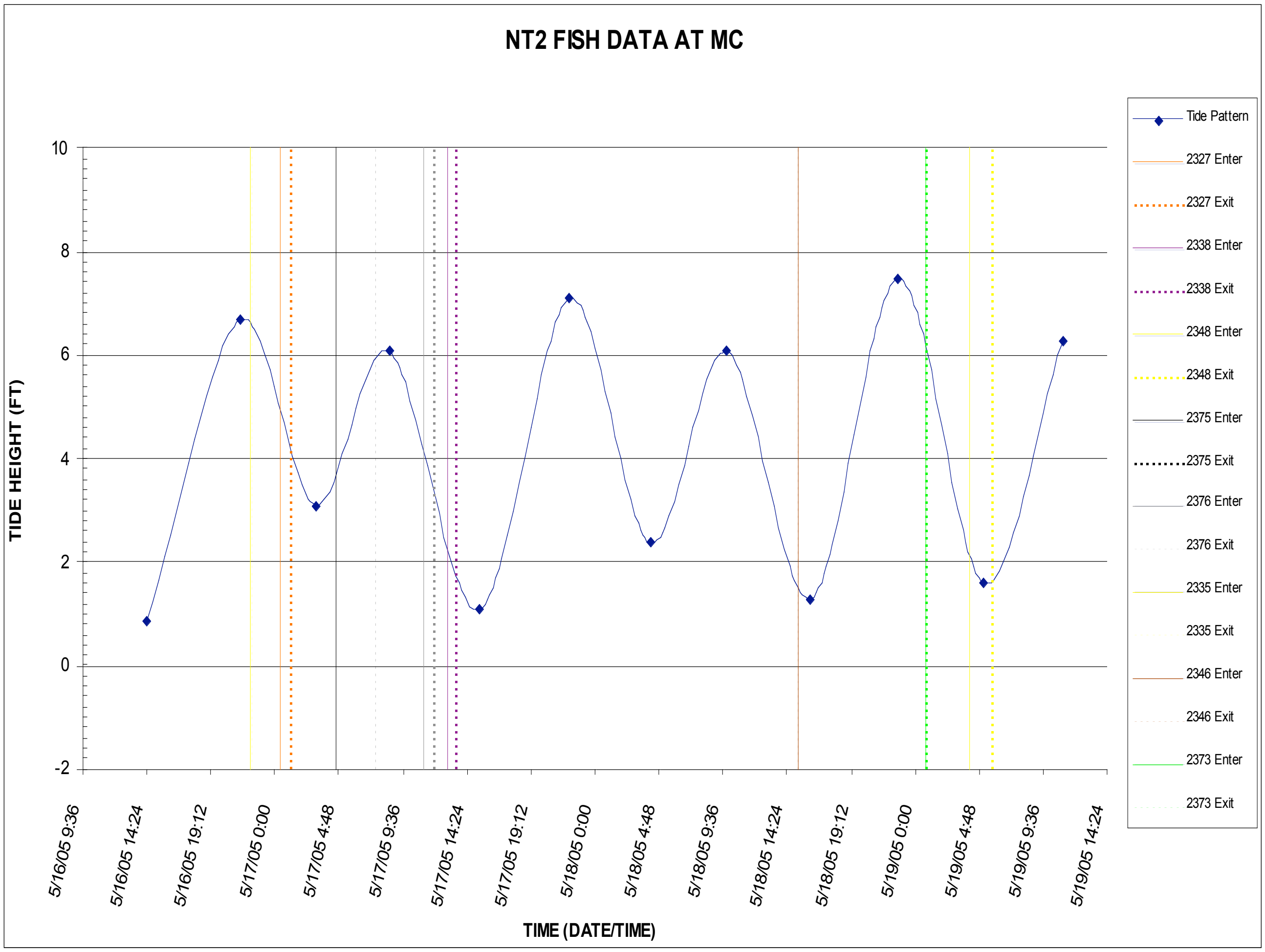

Figure 7. Arrival and departure of direct transport/release steelhead kelts group 2 correlated to tidal oscillations at mouth of the Columbia River.

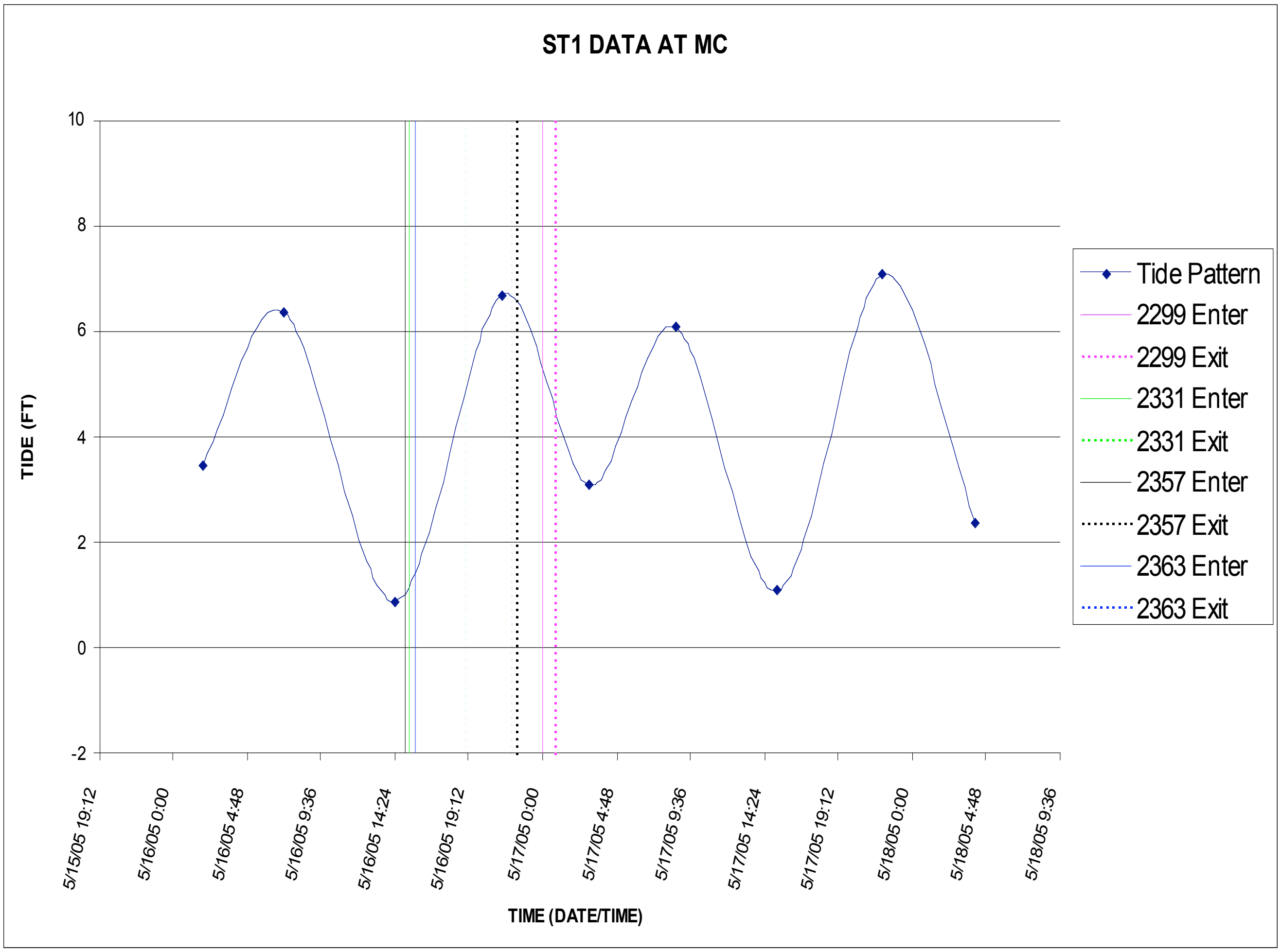

Figure 8. Arrival and departure of short-term reconditioned steelhead kelts group 1 correlated to tidal oscillations at mouth of the Columbia River arrays.

We observed a number of individuals in our data that instead of following the fast outmigrating pattern were instead detected moving back and forth between arrays during tidal oscillations. This movement would suggest that steelhead kelts are utilizing this tactic as a means to change their osmo-regulatory systems in a gradual manner to meet the demands of a saline environment. These behaviors warrant further research. We intend to devise a quantative measure using Na+,K+-ATPase measures or thoroxin (T4) concentrations, this should give us a measure of kelt readiness to migrate. The results from this aspect of the study could prove extremely beneficial in determining if kelts should be placed into a direct/short-term or long-term experimental groups.

Gamete and Progeny Success

Unfortunately, due to complications of collection, transport, holding, and subsequent high mortality of wild first-time spawners till an acceptable period of gamete collection and the availability of suitable females at the end of the season we were only able to procure 1 first time spawner male and female. These gametes were immediately (less than 5hrs) transferred to the University of Idaho for analysis.

Gamete Viability

The gametes, based on the data from University of Idaho, had a high percentage of eye up (90 %) (Appendix B). Survival from eye up to hatch was also very good at 86 % (Appendix B).

Progeny Viability

The progeny study at the aquaculture research institute was split into two separate groups and raised until swim up stage. Both of these groups appeared to be doing well at the time of hatch (day 109/110) with around 80 % survival (See Appendix B for data). Shortly after hatch there was a precipitous increase in mortality (50-60%) in both groups (See Appendix B for data). University of Idaho staff observed that there was a large portion of deformities associated in both of these groups. There could be a number of causes for the high morality observed: such as mechanical or thermal shock, water quality issues, or possibly just a poor pairing of individuals, but due to low sample size it is difficult to isolate the cause of mortality.

Management Recommendations

Statistical Data Analysis

Short-term and long-term reconditioning scenarios are schemes that can be used to assist post spawn steelhead survival. The direct transport and release as with the short-term approach are less invasive than long-term reconditioning, cost efficient, and allows the fish to utilize the naturally therapeutic benefits of marine 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 the 2006 report, 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.

CONCLUSIONS

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), Hatch *et al*. (2002), and other 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 emigrating 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.

- Kelt reconditioning at this time should be viewed as experimental, though it is worth mentioning that it has been very successful, continues to rapidly improve, and appears very promising. Implementation of best methods should be targeted following several years of rigorous, replicated studies of each approach, including ecological and economic cost/benefit analysis.

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 migrate to the ocean, 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 using reconditioning techniques to enhance the iteroparous life history strategy. 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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Appendix A: Acoustic Receiver Locations on the Columbia River

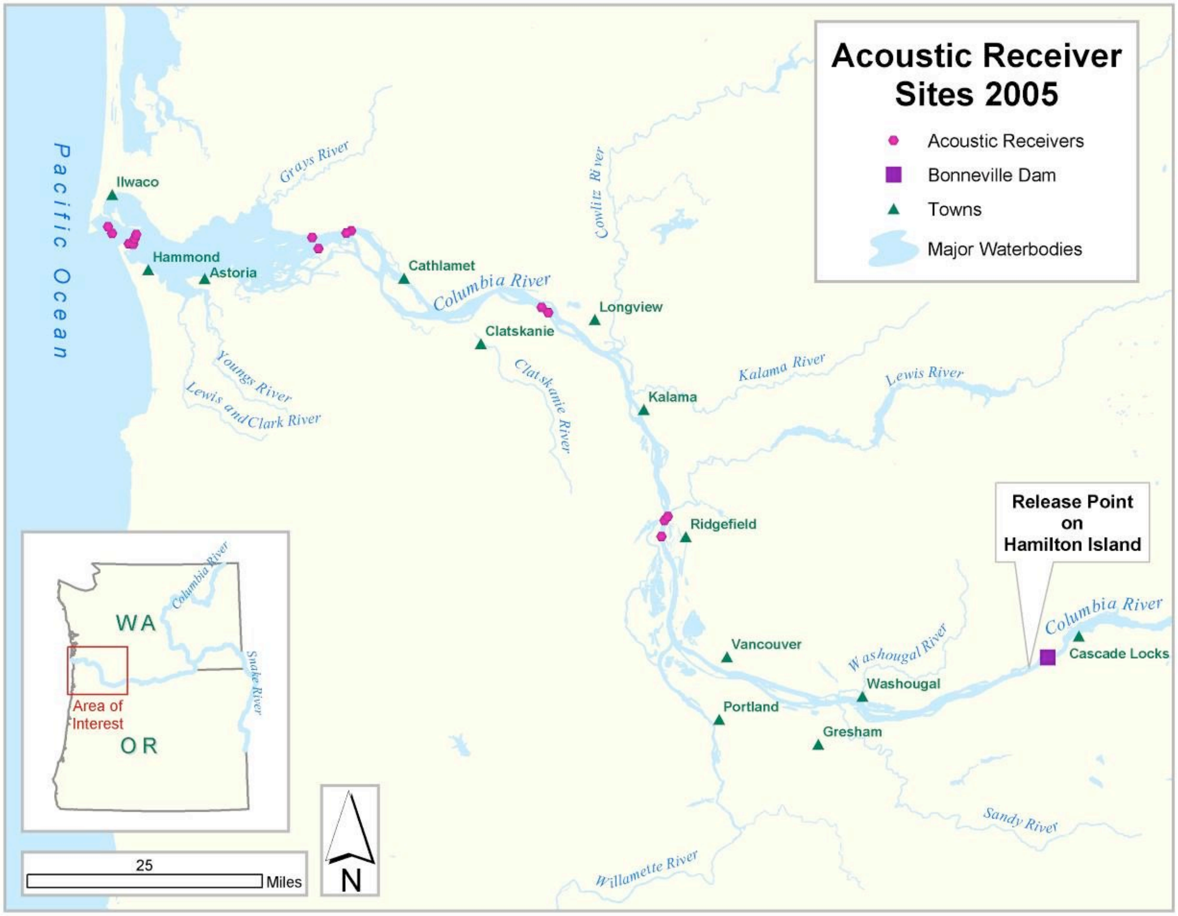


Figure 1. All acoustic receiver deployments 2005 and release site.

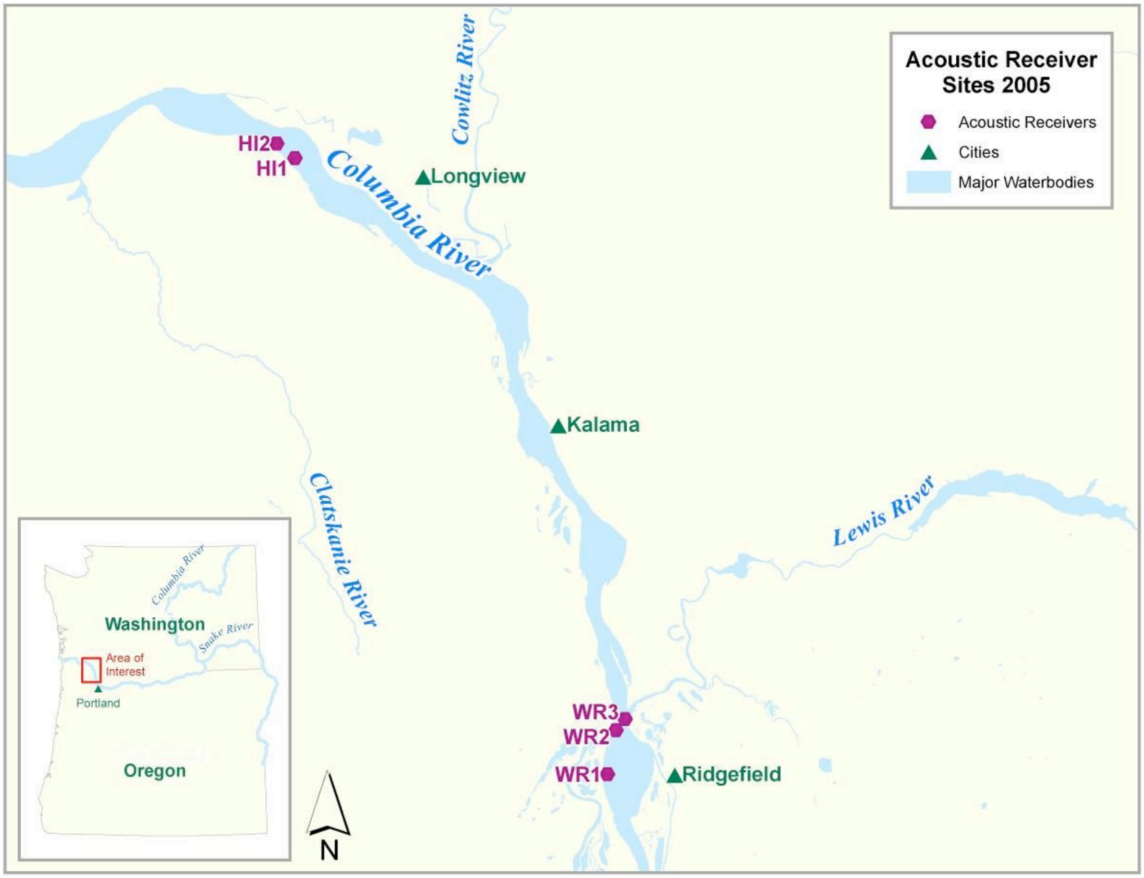


Figure 2. Lower River (upper) deployment 2005.

Figure 3. Lower Columbia River acoustic receiver deployment 2005.

Appendix B: Gamete and Progeny Viability Study 2005

1) Aquatic Habitats growth system installed. Unit has 120 individual chambers. (See photo below)

2) Eggs from single wild female obtained 21 March 2005; fertilized with fresh semen from a single wild male on that date.

a) Approximately 100 (109 actual) eggs were maintained in incubator in Gibb 236 at 10^{o}C. These were sampled at 12 h (fertility), d 12 (keel), d 23 (eye) and at hatch. In addition, mortality data were collected on a daily basis.

b) Approximately 300 (339 actual) eggs were separated into two groups and maintained in incubator at the Aquaculture Research Institute. These were not sampled for development but were monitored for mortality on a daily basis until swim up. At that point, they were transferred from the incubator into growth chambers and growth monitored over time.

Data

Gibb Hall

Eggs (unfertilized): wet wt: 0.0662 ± 0.0027 g (mean±SD); dry wt: 0.0268 ± 0.0008, N=3 (representing total of 14 eggs)

Development:

Fertility: 4 of 23 eggs sampled showed no sign of cleavage: 83% fertilized

Keel: 4 of 20 eggs sampled on d 92 showed no sign of keel: 80% keel

Eye: 2 of 20 eggs sampled on d 103 were without pigmented eyes: 90% eyed

Hatch: 32 eggs hatched (total length at hatch: 1.54 ± 0.05 cm, N=10)

Data analyzed including mortalities: estimate of mortality between developmental stages:

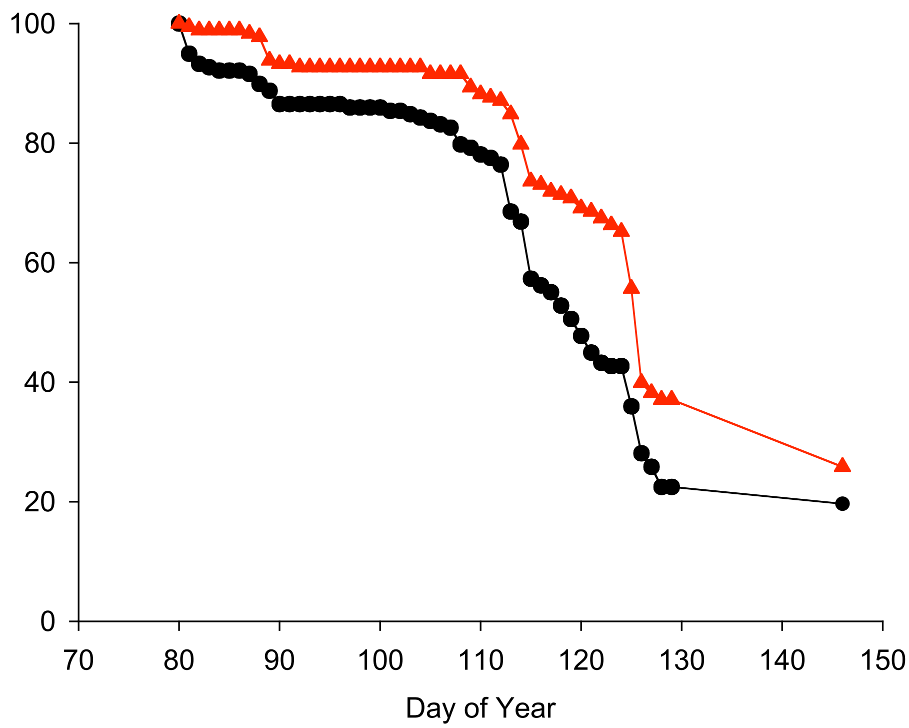
Fert to Keel: [(86 eggs after fertility sampling) – 5 morts (between d 80 & d 92) – (20% of 81 eggs are not developing)] / [86 eggs] “ 25% mortality

Keel to Eye: [(86 eggs postfert – 5 morts – 20 sampled for keel: 61 start) – 4 morts (between d 92 & 103) – (10% of 57 are not developing)] / [61 eggs] “ 16% mortality

Eye to Hatch: [(86 eggs post fert – 9 morts – 20 sampled for keel – 20 sampled for eye: 37 start) – 5 morts – (0% 32 are not developing)] / [37 eggs] “ 14% mortality

Mortality versus time.

Time is expressed as Julian day: eggs were fertilized on 21 March 2005 = day 80
Two groups maintained at ARI: these had 161 (red) and 178 (black) eggs.
Hatch at ARI occurred at about day 109/110
Fry were transferred from incubators to growth system on day 130 (10May05)
These data end with swim up (although surviving fry maintained for growth analysis)



Growth after swim up

Data to date:

fish sampled on d 143 (23May05):

	Group L	Group R
Total length (cm, N=3)	2.4 ± 0.1	2.4 ± 0.1
Wet wt (g, N=3)	0.084 ± 0.008	0.081 ± 0.012
Dry wt (g, N=3)	0.013 ± 0.001	0.012 ± 0.002

fish sampled on d 168 (17June05):

	Group L	Group R
Total length (cm, N=3/4)	3.60 ± 0.53	3.15 ± 0.51
Wet wt (g, N=3/4)	0.389 ± 0.190	0.245 ± 0.130
Dry wt (g, N=3/4)	0.073 ± 0.040	0.042 ± 0.025

fish sampled on d 193 (12July05):

	Group L	Group R
Total length (cm, N=3/3)	4.98 ± 0.30	4.50 ± 0.70
Wet wt (g, N=3/3)	0.969 ± 0.224	0.760 ± 0.355
Dry wt (g, N=3/3)	0.527 ± 0.203	0.393 ± 0.108

Figure 1: Growth Chamber at ARI