EVALUATION OF STEELHEAD KELT ABUNDANCE, CONDITION, PASSAGE, AND CONVERSION RATES THROUGH LOWER COLUMBIA RIVER DAMS, 2002

Monitoring Report

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EXECUTIVE SUMMARY

Limited information exists on the population of steelhead (*Oncorhynchus mykiss*) kelts (i.e., post-spawn) migrating past Columbia River dams. We evaluated the abundance and condition of steelhead kelts at McNary (McN) and John Day (JDD) dams, their passage, and eventual fates. To acquire such information, radio telemetry was used to determine kelt downstream travel rates, route specific passage, and conversion (i.e., survival) through lower Columbia River dams, while Passive Integrated Transponder (PIT) tags were used to monitor the returns from these fish. To assess the effects of lower Columbia River dams and pools on the return rates of kelts passing JDD, kelts were transported from JDD downstream to Dalton Point, bypassing The Dalles (TDA) and Bonneville (BON) dams and their respective pools. Return rates (i.e., proportions) from transported kelts were compared to the return rates of in-river kelts from JDD.

The objectives of this study were to determine:

1) kelt abundance and condition for McN and JDD dams (including associated pool abundance),
2) downstream travel times/rates,
3) project passage efficiencies,
4) the effectiveness of spill treatments at JDD on kelt passage,
5) system conversion rates (to the study area exit gates below BON),
6) the effects of pools and dams on return rates of kelts passing JDD, and
7) return rates to the Columbia River.

General

Ultrasound was used to differentiate steelhead pre-spawn fallbacks from kelts at McN and JDD from April through June of 2002. Kelts that were in good or fair condition[1] were radio tagged (McN n=300; JDD n=17), PIT tagged and allowed to re-enter bypass systems on their own volition. At JDD, 533 kelts were PIT tagged and assigned to either the Transport (n=286) or In-river (control; n=247) treatments.

Abundance and Condition

McNary Dam: During the study period at the McN bypass (1 April to 9 June, 2002), total kelt abundance was estimated to be over 2,022 fish or 70.9% of the total bypass population (N). Upper and lower confidence intervals indicate the percentage lies between 67.7% and 74.1%. Of these kelts, 1,208 were estimated to be wild, ESA-listed. Over half of all sampled kelts (59%) were categorized as being in good or fair condition. In the McN pool, according to Chapman's modification of the Peterson estimator, an estimated 14,057 kelts (12,418 $_{\text{lower 95\% C.I.}}$ to 16,051 $_{\text{upper 95\% C.I}}$) were present.

John Day Dam: During the study period (17 March to 23 June, 2002), total kelt abundance at the JDD bypass was estimated to be 2,233 fish or 66.8% of the total bypass population. Upper and lower confidence intervals suggest the percentage lies between 65.4% and 68.2%. Of these kelts, 1,307 were estimated to be wild, ESA-listed. Roughly, half of this year's sampled kelts (49%; 584/1184) were categorized as being in good or fair condition. Based on route specific telemetry data, an estimated 13,081 kelts passed JDD during a nine-week period in our 14-week study.

[1] Criteria used to rate fish condition characteristics can be found in Appendix A.

Telemetry Data

John Day Dam: Route specific passage was documented for 72% (195/272) of tagged kelts. Of these, 85% passed via the spillway, 5% juvenile bypass, 6% turbine units, and 5% passed by undetermined routes. Project passage efficiency (non-turbine / [non-turbine + turbine]) was 94%. Guidance efficiency (guided / [guided + turbine])) from screen systems was 48%. Spillway efficiency (spill / [non-turbine + turbine]) was 89%.

The Dalles Dam: Route specific passage was documented for 70% (200/284) of tagged kelts that passed The Dalles. Of these, 89% passed via the spillway, 6.5% passed via the ice and trash sluiceway, and 4.5% passed turbine units. All kelts passed The Dalles Dam during spill conditions. Project passage efficiency was 95%. Spillway efficiency (SPE) was 89%, and spillway effectiveness (SPE / [spill discharge / project discharge])) was 2.5:1. Kelt sluice passage efficiency (SLE; (sluice / [sluice + turbine])) was 59% and sluice effectiveness (SLE / [sluice discharge / powerhouse discharge])) was 47.8:1.

Bonneville Dam: Route specific passage was documented for 62% (195/315) of tagged kelts. Of these, 65% passed via the spillway, 17% via juvenile bypass, 9% via the ice and trash sluiceway, and 9% passed turbine units. Project passage efficiency was 90%. Kelt spillway efficiency was 65%, and spillway effectiveness was 1.4:1. Sluiceway efficiency was 100%, and sluice effectiveness was 258.7:1. Guidance efficiency from screen systems was 62%.

Conversion Rates

From the kelts released at McN (n=300), contact histories were; JDD 75% (225/300); TDA 70% (209/300), and at BON 66% (197/300). The study area exit gates (~ 35 km downstream from BON) detected 60% (179/300) of released kelts. Kelts in good condition reached the exit gates in higher proportion than kelts from the other condition categories. Proportions of good, fair, and poor condition kelts contacted by the exit gates were 72% (150/208), 33% (22/66), and 27% (7/26), respectively.

Transport Evaluation

Current information indicates that 10.1% of the in-river treatment and 11.9% of the transport treatment kelts have been detected passing upstream through BON. No statistically significant difference was detectable between the return rates of the two treatments ($P = 0.31$).

Return Rates

From 2001, return rates of kelts PIT tagged at McN are currently at 10.3% (7/68), while rates from kelts released at JDD are at 7.4% (36/484). From 2002, return rates of good and fair kelts from McN are currently at 6.0% (21/352), whereas return rates from their JDD counterparts (including transported kelts) are at 10.7% (61/568).

Summary

In 2002, kelt passage through lower Columbia hydro-projects was primarily via spill. Sluiceways were shown to be highly effective in passing kelts around project powerhouses. No benefits have been observed from transporting kelts from JDD. Our data indicates that in 2002, the hydro-system below JDD did not significantly impair kelts from returning on upstream migrations. Ongoing improvements in the lower Columbia River hydro-system (i.e., BON Powerhouse II Corner Collector, TDA spill-wall) should prove beneficial for the survival and return rates from kelts. In contrast to the lower Columbia river, kelt telemetry information from the Snake River (Evans 2002) indicate that other protocols (e.g., reconditioning, short term reconditioning & transport) may be warranted in mitigating for the effects of impoundment on the genetic composition and reproductive productivity of Snake and upper Columbia rivers stocks.

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INTRODUCTION

In anadromous Pacific salmon, repeat spawning is limited to trout species. Post-spawn salmonids attempting seaward migrations are referred to as kelts. Reduced genetic contributions from stocks formerly supplemented by repeat spawners may have contributed to declines of Columbia Basin steelhead (*Oncorhynchus mykiss*) populations. These declines have led to listings of threatened and endangered for Snake, lower' and mid' Columbia rivers, and upper' Columbia River stocks, respectively, under the U.S. Endangered Species Act (ESA; NMFS 1998). Because steelhead trout have the potential to spawn multiple times, information regarding kelt abundance, travel, passage routes, conversion (i.e., survival), and return rates are needed to better adapt hydro facilities and operations to complement the life histories of these fish.

Initial steelhead kelt identification work in the Snake River (SnR) indicated that many more post-spawn steelhead were attempting seaward migrations than was previously believed (Evans and Beaty 2001). In 2001, telemetry data from kelts released at Lower Granite Dam (LGR), the uppermost Federal Columbia River Power System (FCRPS) project on the SnR, suggests high migrational attrition rates from these fish (Evans 2002). Telemetry data from kelts tagged at McNary (McN) and John Day Dams (JDD) in 2001, in the mainstem Columbia River below McN, suggests enhanced outmigration success compared to the SnR releases. Kelt passage in the lower Columbia River at The Dalles (TDA) and Bonneville (BON) dams was predominately via spill and sluice when such routes were available (Wertheimer et al. 2002). Such data on kelt passage distributions were not obtainable at JDD in 2001. Moreover, the population size of kelts in the main-stem Columbia River has never been estimated, nor have the current return rates from these fish. That is, despite the scope of hydroelectric development in the Columbia Basin, and the widespread distribution of steelhead stocks listed under ESA, no studies have attempted to quantify the effects of impoundment on the return rates from these fish.

To address the need for such data; kelt abundance, condition, travel, passage, and returns were monitored through the FCRPS of the Columbia basin. Radio telemetry was used to determine travel times, passage routes, and passage rates of steelhead kelts migrating through the lower Columbia River. Passive Integrated Transponder (PIT) tags were used to compile information on the return rates from these fish. In an attempt to quantify the effects of lower Columbia River dams and pools on the return rates of kelts passing JDD, kelts were transported from JDD downstream to Dalton Point (rkm 213.8), bypassing The TDA and BON dams and their respective pools. The return rates (i.e., proportion) from transported kelts were compared to the return rates of kelts left in-river at JDD. Because data from kelt reconditioning and radio telemetry have demonstrated low survival rates by kelts classified in poor condition (Evans et al. 2001; Evans 2002) these fish were excluded from the in-river and transport treatment groups. In this report, data are presented mainly from good and fair condition kelts radio & PIT-tagged at LGR, McN, and JDD dams.

The objectives of this study were to determine:
1) kelt abundance and condition for McN and JDD dams (including associated pool abundance),
2) downstream travel times/rates,
3) project passage efficiencies,
4) the effectiveness of spill treatments at JDD on kelt passage,
5) system conversion rates (to the study area exit gates ~ 35 km below BON),
6) the effects of pools and dams on return rates of kelts passing JDD, and
7) return rates to the Columbia River.

METHODS

Study Sites
This report focuses on kelt project abundance, passage, conversion, and return rates through the lower Columbia River dams, which are described and depicted below (Figure 1).

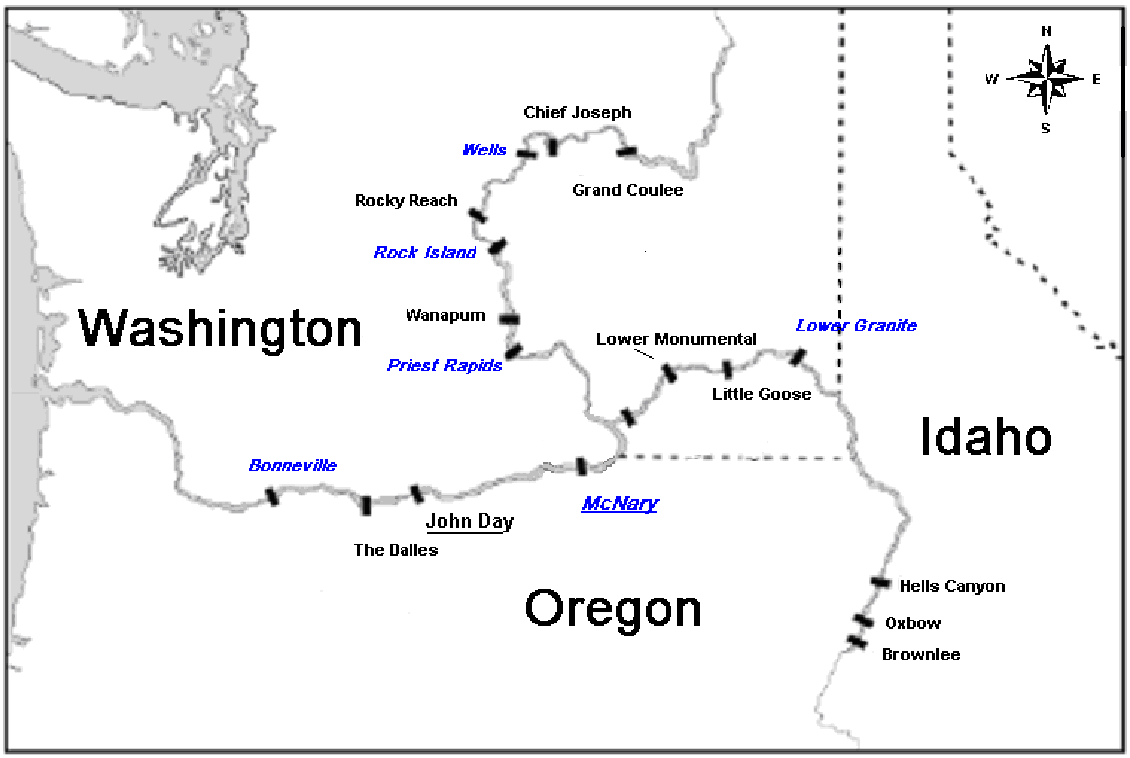

Figure 1. Hydroelectric projects of the FCRPS and the Snake and Columbia rivers. Sample collection sites on the Columbia River are underlined. Projects capable of Adult PIT-detection are italicized in blue.

McNary Dam is located at river kilometer (rkm) 469.8, is the furthest downstream juvenile fish transport facility on the Columbia River. The navigation lock is located on the Washington shore with the spillway and powerhouse side by side perpendicular to river flow. McNary's spillway consists of 22 vertical lift gates. The powerhouse contains 14 screened turbine units with a hydraulic capacity of 6,567 m^3/s. There are two fish ladders at the dam for upstream passage, one located on each shore.

John Day Dam is located at rkm 346.9. The navigation lock is sited on the Washington shore with the spillway and powerhouse spanning the river to the Oregon shore. The spillway has 20 tainter gates. The powerhouse, with 16 turbine units and four skeleton bays, has a hydraulic capacity of 9,113 m^3/s. The turbine units are screened (one 14" diameter orifice per gatewell) to divert downstream migrants into a collection channel and down to a smolt monitoring facility located on the Oregon shore. This facility has the capacity to divert juvenile and adult fish to tanks within the lab. There are two fish ladders at the dam, one on each shore. The John Day Pool (Lake Umatilla) is approximately 123 km.

The Dalles Dam is located at rkm 310. The powerhouse, which contains 22 turbine units and two fish units, and it's concrete overflow wall is positioned parallel to the river flow along the Oregon shoreline. The hydraulic capacity of The Dalles is approximately 10,613 m^3/s. The spillway connected to the overflow wall has 23 tainter gates and is perpendicular to the river flow. There are two fish ladders at the dam, one on each side of the river. There is no screening or bypass facility for downstream migrants at The Dalles. Sluice gates and gatewell orifices (one 6" diameter orifice per gatewell) allow fish to pass into the sluiceway and around the powerhouse to the tailrace. The Dalles pool (Lake Celilo) is approximately 36 km.

Bonneville Dam is located at rkm 235.1, and is unique among Columbia River Basin hydroelectric projects as it consists of two separate powerhouses and an unattached central spillway. Each powerhouse has it's own adult fish ladder system. At both powerhouses, turbine units are screened to divert downstream migrants into gatewell orifices[2] to a juvenile bypass system (JBS). Powerhouse I (PH I) connects Oregon on the south shore and Bradford Island on the north and contains ten turbine units with a total hydraulic capacity of ~ 3,850 m^3/s. The Bonneville Dam spillway, which lies between Bradford and Cascades Islands, has 18 spill gates. Powerhouse II (PH II) is separated from the spillway on the south end by Cascades Island and connected to the Washington shore on the north end. It contains eight turbine units and two fish units with a total hydraulic capacity of about 4,332 m^3/s. The Bonneville pool (Lake Bonneville) is approximately 74 km.

Kelt Sampling
Adult steelhead were obtained from the U.S. Army Corps of Engineers (Corps) juvenile bypass system (JBS) separators at McN and JDD dams. Steelhead were removed via sanctuary dip-net from the bypass wet separator at McN, or diverted from the bypass dry separator to the adult holding tank at JDD, and transferred to a nearby sampling tank containing river water with a buffered solution of clove oil at 30 mg/L (Prince and Powell 2000). To differentiate between emigrating kelts and prespawn fallbacks, specimens were scanned with an Aloka®[3] ultrasound machine to assess gonadal maturation and sex. Male specimens with testis area < 1.50 cm^2 were considered kelts, whereas, those specimens with testis areas > 1.50 cm^2 were classified as pre-spawners (Evans And Beaty 2001).

Fish condition factors of all steelhead were evaluated and recorded concurrent with the ultrasound spawning status identification. Data on fish length (fork length), condition (good, fair, poor, dead), coloration (bright, intermediate, dark), fin wear, fungus, hatchery or wild lineage (adipose fin clips), physical anomalies (e.g., head burn), and abdominal appearance (fat, intermediate, imploded/thin) were recorded. Condition classification guidelines can be observed in Appendix A.

After ultrasound examination, specimens were scanned with an International Standards Organization (ISO) PIT-detector (134.2 KHz). Condition data from previously tagged kelts (recaptures) was recorded. PIT-tags were inserted into the musculature anterior to the pelvic girdle of kelts from all condition categories, and all radio-tagged kelts were PIT tagged. Examination and kelt tagging averaged roughly five minutes per specimen. After sampling, fish were placed in the recovery tank and allowed to exit to the river of their volition. The PIT tag code and fundamental information from each kelt (including recaptures) was recorded into PIT Tag Information Systems (PTAGIS) software (version 3) and submitted after sampling via computer to the Pacific States Marine Fisheries Commission (PSMFC).

Calculations of Steelhead Abundance at the Bypass Facilities
At McN, Corps personnel monitored the bypass separator 24 hours per day, seven days a week. These personnel counted both the total number of steelhead present and the fish's origin (hatchery or wild), providing a complete census of the bypass population. Adult steelhead were sampled from 1 April to 10 June 2002 for a total of 10 weeks. Samples were treated as a simple random sample, however, it should be noted that despite the large sample size at McN, randomization was not used to determine which days of the week or hours of the day to sample.

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[2] PH I, has 12" orifices; PH II, 12.5" orifices (Units 11-14 two orifices per gatewell, one in other units).
[3] Use of trade name does not imply endorsement by the USACE.

At JDD, adult steelhead abundance had to be estimated because a complete 24-hour census was not available. Adult steelhead were captured for sampling via diverting steelhead from the JBS into an adult holding tank five days a week, approximately 24 hours a day. Shifts ran from 0400 on Monday morning to about noon on Saturday. An estimate of the steelhead population passing the JBS was generated using a weighed approach based on sampling effort, whereby the number of adults diverted during each hour for each week was assumed to be proportional to the number entering the JBS during each non-observation hour for that same week. Adult steelhead were diverted from the JBS from 18 March to 21 June, 2002 for a total of 14 weeks. Similar to McN, randomization was not used to determine which days of the week or hours of the day to sample.

Calculations of Kelt Abundance at the Bypass Facilities
Once the total number of adult steelhead encountered at the bypass facilities was calculated, kelt abundance estimates were generated. The overall abundance of kelts passing both the McNary and John Day JBS was estimated by multiplying the proportion of kelts identified by ultrasound during each week of sampling (week = Sunday to Saturday) by the total number of steelhead removed from the separator during that week and adding the weekly estimates. Because the migration timing of adult steelhead may differ between hatchery and wild origin fish, abundance estimates were generated separately for wild and hatchery fish (Evans et al. 2001). Methodologies used to estimate kelt facility and pool abundance can be viewed in Appendix B. Variance and 95% confidence bounds were calculated using a stratified estimate (Schaeffer 1986; equation follows). Estimated variance of the weekly or stratified kelt proportion:

$$(v_i) = \frac{1}{N^2}\sum_i^L N_i^2 \left(\frac{N_i - n_i}{N_i}\right)\left(\frac{p_i q_i}{n_i - 1}\right)$$

Confidence error bound:

$$p_{st} \pm 2\sqrt{v(p_{st})}$$

Telemetry Monitoring
Radio-tagged kelts were monitored by aerial and underwater antenna/receiver 'fixed station' telemetry arrays located in and around JDD, TDA, BON, and mainstem tributary entrances, through the study area exit gates. Exit gates spanned the river channel in river reaches with low water depth, thus, providing high radio-tag detection efficiencies. The first set of 'gates' originated near Reed Island (rkm 200.0), with the next set of telemetry arrays situated near the mouth of the Washougal River (rkm 193.4), and final array at the western end of Government Island (i.e., I-205 bridge; rkm 181.0). Fixed stations were maintained by University of Idaho (UI) and by U.S. Geological Survey (USGS) researchers (USGS telemetry stations described by Beeman (et al. 2001) Appendix C).

Radio Tags
Steelhead kelts, most in good or fair condition, were tagged with thirty-six day radio-tags operating on a frequency of 150.600 MHZ. Attached radio tags were 9.2 mm (diameter) x 20 mm, weighed 1.3 g in air, and transmitted once every five seconds (code #'s 1–106 in triplicate). Attachment of the radio tags, fixed receiving system telemetry-equipment, monitoring arrays, and data transfer are more thoroughly described by Wertheimer (et al. 2002). The primary release site for radio-tagged kelts was McN. Kelt releases were conducted every other week to minimize the potential for radio-tag overlap. Radio-tag releases began 15 April, however, as USGS telemetry arrays were only available to listen for our tags from 29 April to 14 June, passage route histories for the early portion of the kelt-run were not completely represented. Kelt conversion was monitored at the study area exit gates for the entire study.

John Day Dam Transport Evaluation
To evaluate the effects of pools and dams on the return rates of kelts passing JDD, kelts were transported from JDD downstream to Dalton Point (rkm 213.8), bypassing TDA and BON dams and their respective pools. The return rates of transported kelts were compared to the return rates of kelts left in-river at JDD. Kelts used for each treatment (i.e., transport; in-river) were of either good or fair condition. Treatments were conducted using daily blocks. On days of the transport treatment, after tagging, kelts were held in an insulated 300-gallon aerated transport tank until the day's tagging was complete. Fish densities were kept to less than 2 lb's/gallon. Once collection was complete, usually before 1400 hours, kelts were transported to the Dalton Point boat ramp. The transport tank was checked for mortalities and kelts released. The adult PIT detectors at BON recorded data on kelt return rates. Data were checked for evidence of differences between dates within the treatment releases (homogeneity) before pooling into a single table. A test for comparing two proportions (Zar 1999) was then used to determine whether there was a statistically significant difference between the return rates of the two treatments; the significance level of the test was 0.05.

Adult PIT Detection
By the spring of 2002, three facilities in the FCRPS of the Columbia basin were capable of PIT interrogation of adult upstream migrants (i.e., BON, McN, and LGR). All three of the ladder systems at BON were fitted with Adult PIT detectors (in submerged orifices) capable of reading ISO tags. At McN, ISO PIT detectors were installed in orifices of both the Oregon and Washington ladders. At LGR, the adult trap allows for PIT interrogation of all fish ascending through the project. Data from these monitoring systems were acquired through queries to the PSMFC (PTAGIS).

Data Management and Analyses
Forebay residence, travel times, and travel rates were calculated to describe the kelt migration through the FCRPS projects and pools to the study area exit gates. Forebay residence times are the amount of time between the first and last contacts in the forebay from which a kelt passed. Pool travel times were calculated as the amount of time from first tailrace contact at the upstream project to first forebay contact at the downstream project. Travel rates were calculated by dividing the length of the pool by the amount of time within the pool (tailrace-forebay). Kelts must have been contacted by tailrace arrays, and contacted in the subsequent forebay for pool travel data to be calculated. Thus, travel times through the river- reaches are often derived from sample sizes smaller than actual number of kelts passing each dam. Statistical analyses were run with SAS[4] software (SAS, version 8.0, SAS Institute Inc., N.C., USA).

Metrics that illustrate the efficacies of spill and mechanical structures in passing juveniles away from turbines were calculated to describe kelt passage efficiencies. Radio tags were placed on dead steelhead to test for the presence of false positive detections. That is, to ensure that tagged kelt mortalities were not being detected at downriver locations. The employed metrics are defined below:

- Kelt passage efficiency (PE) = (non-turbine / [non-turbine + turbine])
- Kelt guidance efficiency (GE) = (guided / [guided + turbine])
- Kelt sluice passage efficiency (SLE) = (sluice / [sluice + turbine])
- Kelt sluice effectiveness (SLF) = (SLE / [sluice discharge / powerhouse discharge])
- Spillway efficiency (SPE) = (spill / [non-turbine + turbine])
- Spillway effectiveness (SPF) = (SPE / [spill discharge / project discharge])

[4] Use of trade name does not imply endorsement by the USACE.

RESULTS

Project Operations
The volume of water through the Columbia River in April, May, and June of 2002 averaged flows of 259.7, 253.7, and 263.9 thousand cubic feet per second (kcfs) at John Day, The Dalles, and Bonneville dams, respectively. Spill occurred at all three projects starting on 10 April and continued through 30 June.

At John Day Dam, spill alternated between 24-hour (30:30) and nighttime spill (0:54), at a season average of 85.6 kcfs. At The Dalles Dam, a 'juvenile' spill pattern occurred every day (24 hour/day), at an average of 99.8 kcfs. The juvenile spill pattern emphasizes moving water through the northerly portion of the spillway to pass juveniles away from shallow areas, rocks, and islands present in the south half of the tailrace. At Bonneville Dam, spill occurred during the study (24 hour/day), at an average of 122.1 kcfs. Mean discharges through the dams during spill for 2001 and 2002 can be observed below (Table 1; COE).

Table 1. Average flows through the Columbia River during spill at John Day, The Dalles, and Bonneville hydroelectric projects in 2001 and 2002.

Project	2001 During Spill	2002 During Spill	Increase
John Day	140.0 kcfs	273.6 kcfs	95.4%
The Dalles	138.6 kcfs	267.0 kcfs	92.6%
Bonneville	150.1 kcfs	277.7 kcfs	85.0%

McNary Dam & Pool: Abundance and Condition
McNary Bypass steelhead abundance: In total, 2,857 adult steelhead were documented during the study. Of these, 1,710 were wild, ESA-listed and the remaining 1,147 fish of hatchery origin.

McNary Bypass kelt abundance: Based on 10 statistical sampling weeks (Figure 2), total kelt abundance at the McNary bypass was estimated to be 2,022 fish or 70.9% of the total bypass population (N). Upper and lower confidence intervals suggest the percentage lies between 67.7% and 74.1%. Of these kelts, 1,208 were estimated to be wild, ESA-listed. The total number of wild summer-run steelhead counted passing upstream through the McNary fishways from 1 June 2001 to 31 May 2002 – the period used to determine yearly run counts – was 95,579 pre-spawners (FPC 2003). Hence, between 1.2% and 1.3% of the wild run were observed as kelts during a ten-week sampling period at the McNary bypass. As in the previous year's study, the ratio of kelts to pre-spawners changed throughout the study period with kelts encompassing almost 100% of the sample as the season progressed into June.

McNary Bypass kelt condition: Over half of sampled kelts (59%) were categorized as good or fair condition (Table 2). This compares to 76% (1983/2617) of kelts sampled at LGR in 2002 being in good or fair condition (Hatch et al. 2003). The proportion of sampled kelts at McN categorized as poor was higher this year at 41% compared to 33% in 2001 (Figure 3). Nearly all of the sampled kelts (98%; 614/629) were rated as having bright or intermediate coloration. Based on adipose fin clips, Corps personnel reported 58% (981/1,679) of the steelhead visually identified as kelts were naturally produced (i.e., wild). With ultrasound, sexual status was discernible for 57% (356/629) of kelts. Of these, 89% (317/356) were determined to be female (Appendix D-1). Overall, 402 kelts were PIT-tagged at McN (Appendix E-1). The prevalence of head burn on these fish can be observed below (Table 3). Head burn affliction, is defined by Elston (1996) as an "exfoliation of the skin and underlying connective tissue of the jaw and cranial region of salmonids".

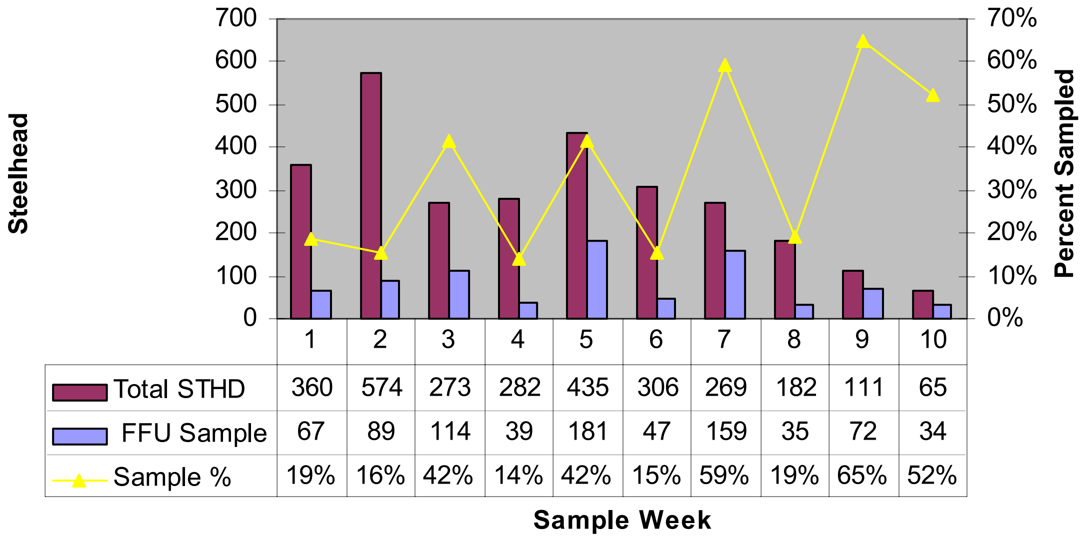

Figure 2. Weekly proportion of the total steelhead population sampled at the juvenile fish facility separator of McNary Dam, Columbia River 2002. Week #1 begins April 1 and week #10 ends June 9.

McNary Pool kelt abundance: Overall, 1,625 PIT-tagged kelts were released above McNary reservoir (i.e., from LGR) between 31 March and 8 June 2002. According to Chapman's modification of the Peterson estimator, an estimated 14,057 kelts (12,418 $_{\text{lower 95\% C.I.}}$ to 16,051 $_{\text{upper 95\% C.I}}$) were present in the McNary Pool during the study period (M = 1,625 C = 2,022, and R_e= 233). Due to limited recaptures, this estimate should be interpreted with caution and viewed as the best available approximation. Recapture numbers (R not R_e) were not adequate to estimate the wild and hatchery components separately.

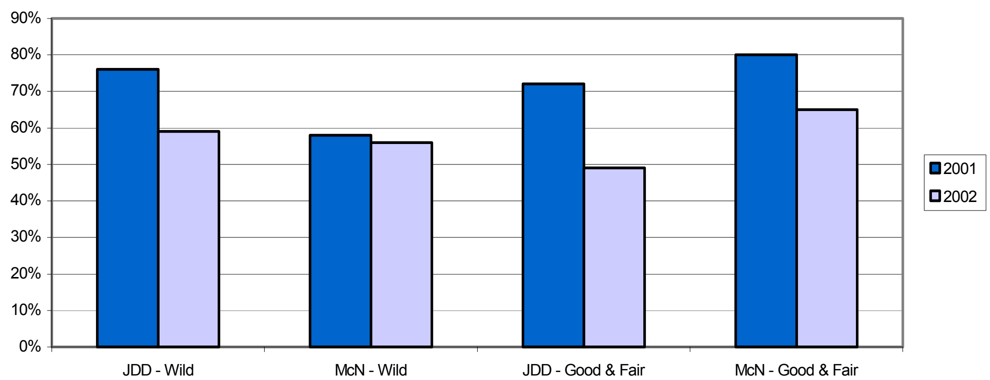

Figure 3. Condition and origin compared for 2001 (n=1105) and 2002 (n=1184) sampling at McNary and John Day Dams.

Table 2. Condition and coloration of pre and post spawn steelhead sampled at McN in 2002.

	Pre -Spawn Coloration				Kelt Coloration			
Condition	**Bright**	**Intermediate**	**Dark**	**Ttal**	**Bright**	**Intermediate**	**Dark**	**Total**
Good	73	24	0	**97**	229	40	1	**270**
Fair	8	18	1	**27**	47	51	1	**99**
Poor	26	47	7	**80**	79	161	8	**248**
Dead	0	4	0	**4**	0	7	5	**12**
Total	**107**	**93**	**8**	**208**	**355**	**259**	**15**	**629**

Table 3. Percentage of the steelhead sample at McN (n = 837) with head conditions in 2002.

Condition	Pre-spawn	Kelt	Total
Head burn	68 (8.1%)	180 (21.5%)	248 (29.6%)
Head fungus	3 (0.4%)	31 (3.7%)	34 (4.1%)
Head burn & fungus	1 (0.1%)	4 (0.5%)	5 (0.6%)
Head scrape	0 (0.0%)	25 (3.0%)	25 (3.0%)
Eye problem	7 (0.8%)	27 (3.2%)	34 (4.1%)
Total	79	267	346

John Day Dam & Pool: Abundance and Condition

John Day Bypass steelhead abundance: Based on the hourly average of adult steelhead counts at the JDD bypass facility – weighed for each week of observation (Appendix D-2) – an estimated 3,344 steelhead were present during the 14 week period. Of these, an estimated 1,710 were wild and 1,634 were hatchery. Observation effort was relatively constant and averaged 55.7% of the available hours throughout the study period (Figure 4).

John Day Bypass kelt abundance: Based on 14 weeks (17 March to 23 June, 2003) of ultrasound sampling, total JDD kelt bypass abundance was estimated to be 2,233 fish or 66.8% of the total bypass population. Upper and lower confidence intervals suggest the percentage lies between 65.4% and 68.2%. Of these kelts, 1,307 were estimated to be wild, ESA-listed. The total number of wild steelhead counted passing upstream through JDD fishways from 1 June 2001 to 31 May 2002 was 114,571 (FPC 2003). Thus, between 1.1% and 1.3% of the wild run was observed as kelts during 14 weeks of sampling at the John Day bypass.

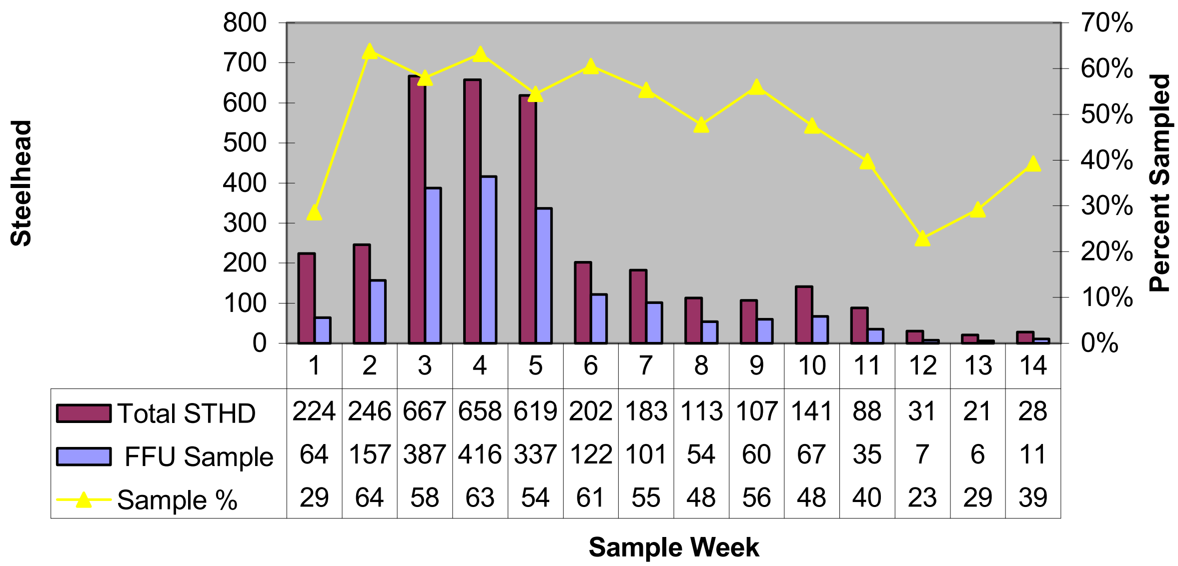

Figure 4. Weekly proportion of the total steelhead population sampled at the smolt monitoring facility at John Day Dam, Columbia River 2002. Week #1 begins March 17 and week #14 ends June 22.

John Day Bypass kelt condition: Nearly half of sampled kelts, 49% (584/1184), were categorized as being in good or fair condition. Most of the sampled kelts (90%; 1064/1184) were rated as having bright or intermediate coloration (Table 4). The percentage of kelts categorized as poor was higher this year at 51% compared to 28% during last year's study at John Day (Figure 3). Sexual status was discernible for 52% (617/1184) of sampled kelts, of these, 86% (528/617) were determined to be female (Appendix E-2). The prevalence of head conditions from sampled steelhead are shown below (Table 5).

Table 4. Condition and coloration steelhead sampled at John Day Dam, 2002.

	Pre-Spawn Coloration				Kelt Coloration			
Condition	Bright	Intermediate	Dark	Total	Bright	Intermediate	Dark	Total
Good	120	109	29	**258**	190	107	15	**312**
Fair	16	51	20	**87**	66	194	12	**272**
Poor	35	159	74	**268**	93	379	86	**558**
Dead	5	10	4	**19**	8	27	7	**42**
Total	**176**	**329**	**127**	**632**	**357**	**707**	**120**	**1184**

Table 5. Percentage of sampled steelhead (n = 1824) at John Day Dam with head conditions, 2002.

Condition	Pre-spawn	Kelt	Total
Head burn	147 (8.1%)	233 (12.8%)	380 (20.8%)
Head fungus	62 (3.4%)	116 (6.4%)	178 (9.8%)
Head burn & fungus	40 (2.2%)	68 (3.7%)	108 (5.9%)
Head scrape	0 (0.0%)	4 (0.2%)	4 (0.2%)
Eye problem	39 (2.1%)	39 (2.1%)	78 (4.3%)
Total	**288**	**460**	**748**

John Day Pool kelt abundance (mark recapture estimate): According to Chapman's modification of the Peterson estimator, an estimated 12,767 kelts (8,603 $_{\text{lower 95\% C.I.}}$ to 21,006 $_{\text{upper 95\% C.I}}$) were present in the John Day reservoir during the radio telemetry monitoring period (M = 307, C = 828, and R_e=19). Four kelts tagged at McN in 2002 were physically recaptured at JDD. Of these, two kelts were still in good condition. A kelt in fair condition at McNary was in poor condition at JDD, and one poor condition from McNary, was moribund at JDD. A kelt tagged in good condition at JDD in 2001, was again sampled at JDD (poor condition), indicating this fish was attempting at least its third outmigration.

John Day Dam kelt abundance (passage estimate): Based on route specific passage data, an estimated 13,081 kelts passed John Day Dam during a nine-week period. Passage histories were available from 221 kelts (i.e., including LGR released kelts) contacted passing John Day Dam from 21 April to 22 June 2002. During this time-period, an estimate 828 kelts were observed in the JDD bypass facility. This number is much smaller than the total John Day bypass kelt estimate (n=2,233) because radio-tagged fish were not in the river for the entire period of ultrasound sampling. The abundance estimate from passage data (i.e., 13,081) is supported as it lies within the 95% C.I. generated by Chapman's modification.

Telemetry Sample

Radio tags were attached to 317 kelts (McN n = 300; JDD n = 17). Of the 317 radio-tagged kelts, two were dead, 31 were in poor condition, 70 were in fair condition, and 214 were in good condition. A summary of the morpho-metric information from radio-tagged kelts can be observed in Appendix E-3.

Detection efficiency

Detection efficiencies are based upon the number of tagged kelts not contacted by telemetry arrays within a given reach location, subsequently contacted at downriver sites. For instance, a kelt that was not contacted passing John Day Dam (e.g., forebay, passage routes, or tailrace areas) that was confirmed at a lower river location (i.e., TDA, BON, or survival gates) was considered a missed detection (Table 6).

Table 6. Estimated detection efficiency of radio-tagged kelts released from the McNary Dam bypass, 2002.

Reach Location	Estimated Detection Efficiency	Detections (n)	Missed Detections (n)
John Day Dam	88%	210	29
The Dalles Dam	94%	206	14
Bonneville Dam	96%	192	8
Gate One (Reed Island)	90%	156	17
Gate Two (Washougal River)	66%	106	37

Travel rates

Travel rate data are from the 300 radio-tagged kelts released at McN. Over two-thirds (68%) of kelt-travel times, from McNary Dam through the study exit gates were spent in the John Day Pool. Travel rates through the pools below John Day Dam were typically at twice the pace of those rates observed in the John Day Pool (Table 7). Median time (days) from release at McN to the first set of survival gates (i.e., Reed Is.), and from first contact in tailrace areas to Reed Island are depicted below (Table 8).

Table 7. Travel times (TT:hours (h)) and travel rates (TR:km/h) of the kelts through the pools (tailrace - forebay) between the lower Columbia River dams, and from the Bonneville Dam tailrace to the first set of exit gates (free flowing). Note: 25th percentile (Q1), median, and 75th percentiles (Q3).

Reach	N	TT (Q1)	TT (median)	TT (Q3)	TR (median)
JDD Pool (~123 km)	201	63.6 h	80.8 h	112.5 h	1.5 km/h
TDA Pool (~36 km)	142	9.6 h	11.3 h	14.1 h	3.2 km/h
BON Pool (~74 km)	130	22.2 h	25.6 h	31.9 h	2.9 km/h
Free Flowing (~35 km)	156	6.2 h	7.5 h	9.6 h	4.7 km/h

Table 8. Travel times (TT) of kelts from first contact in Tailrace (TR) areas to the first set of survival gates (i.e., Reed Island). Note: 25th percentile (Q1), median, and 75th percentiles (Q3) in days (d).

Travel times (days)	N	TT (Q1)	TT Median	TT (Q3)
McNary Dam TR (~267 km)	158	5.3 d	6.8 d	9.5 d
John Day Dam TR (~ 147 km)	122	1.8 d	2.2 d	3.3 d
The Dalles Dam TR (~ 110 km)	113	1.3 d	1.6 d	2.3 d
Bonneville Dam TR (~ 35 km)	156	0.3 d	0.3 d	0.4 d

John Day Dam – Passage

Route specific passage histories were documented for 72% (195/272) of kelts that passed JDD after 29 April (Figure 5). Project kelt passage efficiency (PE) was 94%. Guidance efficiency (GE) from screen systems was 48%. Spillway efficiency (SPE) was 89%. Median forebay residence times areas were as follows: JBS (4.1 h), spillway (9.3 h), and turbine units (32.6 h). A comparison of kelt passage during continuous (30:30) and night spill (0:54) can be seen below (Table 9).

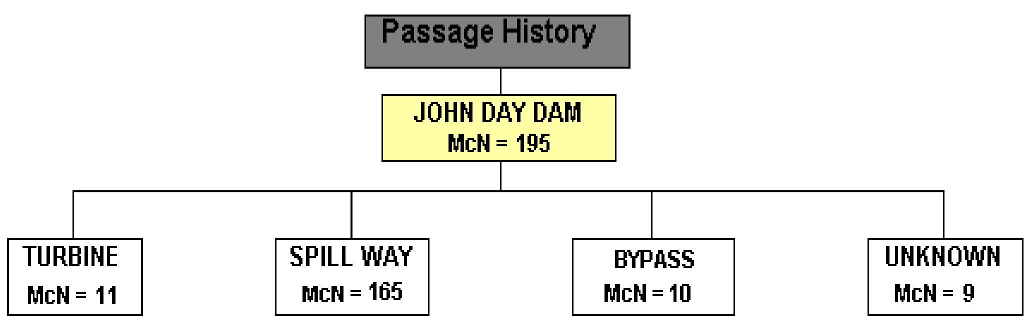

Figure 5. Passage histories at John Day Dam representing radio-tagged kelts released from the McNary Dam juvenile fish separator in 2002.

Table 9. Comparison of kelt passage (PE), guidance (GE), spillway efficiency (SPE), and spillway effectiveness (SPF) under continuous (30:30) and night spill (0:54) at John Day Dam.

Test Conditions	n	PE (%)	GE (%)	SPE (%)	SPF
30% Continuous Spill	89	94	47	91	3.0:1
0% Day: 54% Night Spill	59	90	43	88	1.6:1

Note: The Period of 0% daytime spill was between 07:00-17:59, and was not consistent with our definition of daylight hours (i.e., 05:00 – 20:59). Kelt passage efficiencies and effectiveness depicted in this table were exclusively during each of the spill treatments and at the prescribed levels.

Time of passage (diel)
Kelt passage timing was variable. Daytime hours (05:00 – 20:59) accounted for 66.7% of total available hours. During 24-hour spill, passage routes were mainly via the spillway, and much 72% (64/89) of kelt passage occurred during daytime hours (Figure 6). During the 54% night spill (16:59-07:00 hours) kelt passage was predominately via the spillway (Figure 7).

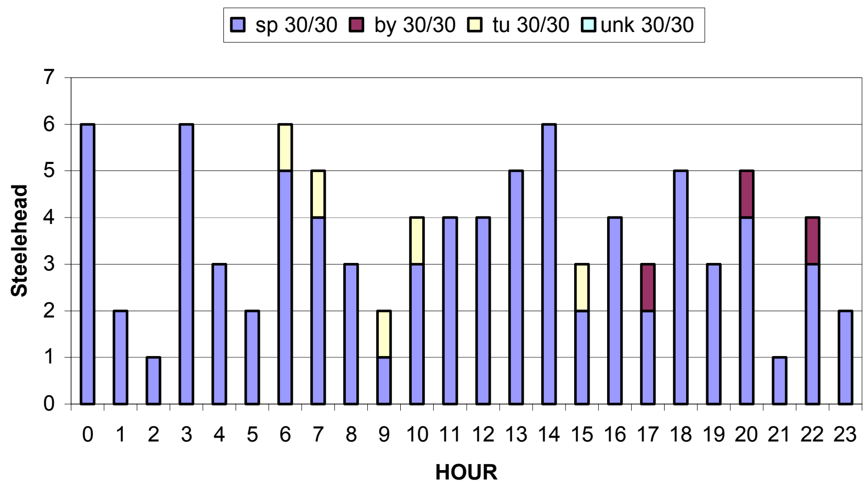

Figure 6. Hourly steelhead kelt passage during 24-hour spill (30/30) at John Day Dam, 2002.

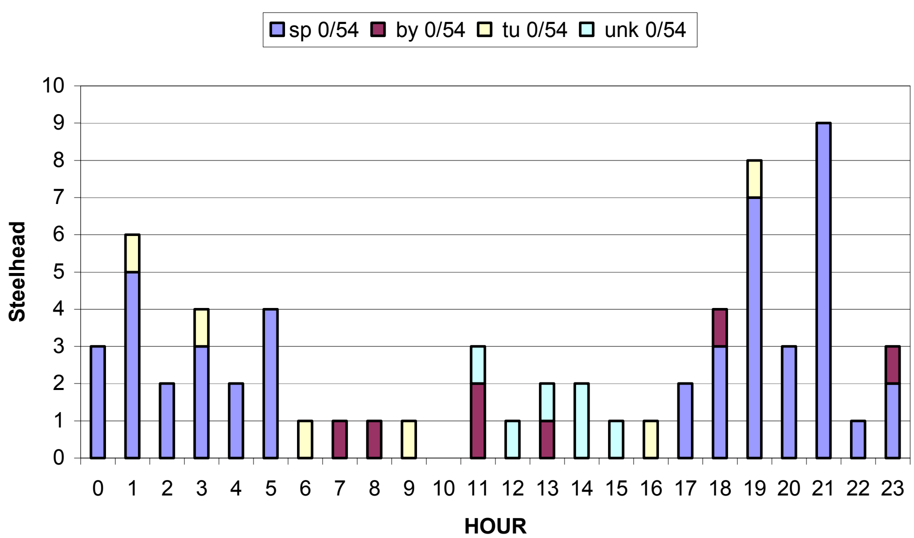

Figure 7. Hourly steelhead kelt passage during night spill (0/54) at John Day Dam, 2002.

The Dalles Dam – Passage
Telemetry data provided route specific passage histories for 70% (200/284) of radio-tagged kelts that passed TDA after 29 April (Figure 8). All kelts passed TDA during spill conditions. Kelt PE was 95%. Kelt SPE was 89%, and SPF was 2.5:1 (0.89/0.35). Less than 7% of kelts passed via the sluiceway, and fewer than 5% of kelts passed turbine units. Kelt SLE was 59%, and SLF was 47.8:1.

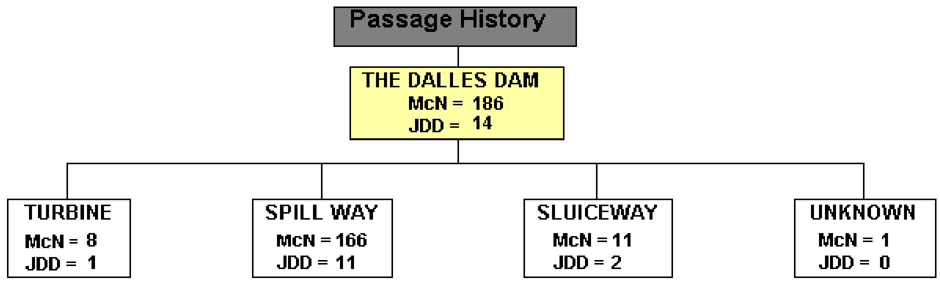

Figure 8. Passage histories at The Dalles Dam representing radio-tagged kelt groups released from McNary and John Day dams, 2002.

Time of passage (diel)

Kelt passage was skewed toward daytime hours (Figure 9). Spillway passage was daylight biased (81%), whereas turbine (67%) and sluiceway passage (62%) were roughly proportional with daylight hours.

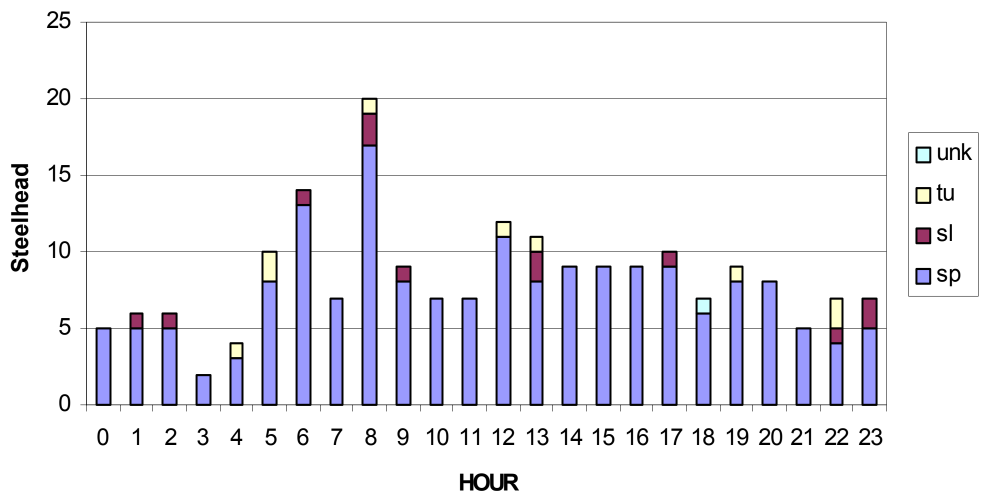

Figure 9. Hourly passage history at The Dalles Dam for radio-tagged kelts in 2002.

Bonneville Dam – Passage

Route specific passage histories were documented for 62% (195/315) of released kelts (Figure 10). Project PE was 90%. Kelt SPE was 65%, and SPF was 1.4:1. At PH I, SLE was 100%, and SLF 258.7:1.

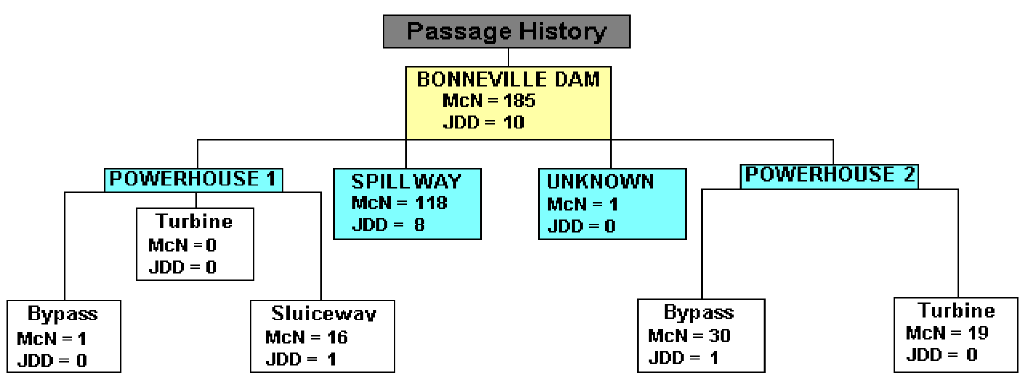

Figure 10. Passage histories at Bonneville Dam representing radio-tagged kelt groups released from McNary and John Day dams, 2002.

Behavior
Median forebay residence times at PH I, the spillway, and PH II were 5.3 h, 0.4 h, and 6.5 h, respectively. Most kelts (85%) passed from the initial forebay they entered. Initial forebay entrance proportions at PH I, the spillway, and PH II were 7%, 57%, and 36%, respectively.

Time of passage (diel)
At PH I, 88% of sluiceway passage occurred during daytime hours. Of the kelts passing via the spillway, over half (63%; 79/126) passed during daytime hours. At PH II, daytime passage rates through the JBS and turbine units were 74% (23/31) and 74% (14/19), respectively (Figure 11).

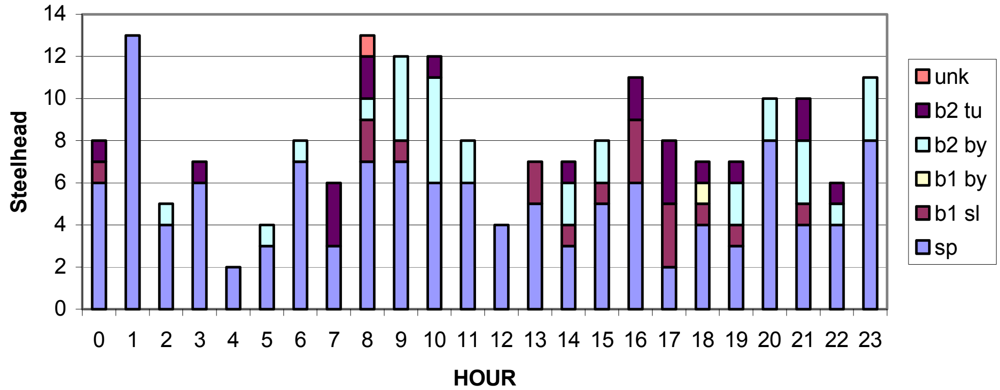

Figure 11. Hourly passage history at Bonneville dam for radio-tagged kelts in 2002.

Project FGE Comparison
Route specific passage behaviors were relatively uniform as kelts passed lower Columbia River dams. A direct comparison of the overall project passage, guidance, spillway efficiencies, and spillway effectiveness for JDD, TDA, and BON can be seen in Table 10.

Table 10. Project kelt passage (PE), guidance (GE), sluiceway (SLE), and spillway (SPE) efficiencies, including sluiceway (SLF) and spillway effectiveness (SPF).

Project	PE (%)	GE (%)	SLE (%)	SLF	SPE (%)	SPF
JDD	94	48	N/A	N/A	89	*
TDA	95	N/A	59	47.8:1	89	2.5:1
BON	90	62 (PH II)	100 (PH I)	258.7:1	65	1.4:1

* See Table 9.

Conversion Rates
Kelt loss after release and before detection at JDD accounted for the greatest portion of contact attrition. Specifically, 25% (75/300) of kelts radio tagged and released at McN were not contacted at or below JDD, whereas only an additional 15% (46/300) of tagged kelts were not contacted passing the study area exit below BON. As radio tagged kelts from McNary Dam passed through the lower Columbia hydrosystem they had the following detection rates (UI, USGS-antenna arrays): JDD 75% (225/300), TDA 70% (209/300), and 66% (197/300) at BON. Study area exit gates detected 60% (179/300) of these fish. Kelts in good condition reached the exit gates in higher proportion than kelts from the other condition categories. Proportions of good, fair and poor condition kelts contacted by the study area exit gates were 72% (150/208), 33% (22/66), and 27% (7/26), respectively (Figure 12). Naturally produced (i.e., wild) and hatchery kelts were contacted in equivalent proportions (~ 60%) at the study area exit gates.

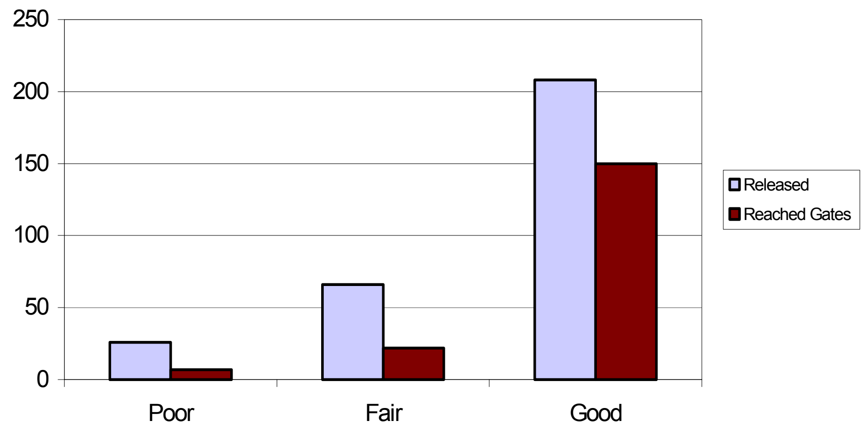

Figure 12. Conversion rate to the survival gates for kelts in the three condition categories, 2002.

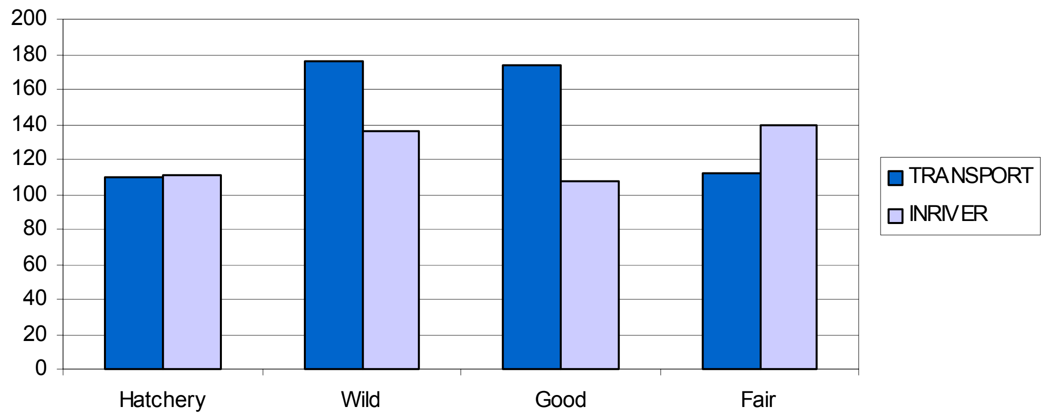

Figure 13. Condition and origin of In-river and Transport treatment kelts from John Day Dam in 2002.

Transport Return Rates

To date, 10.1% (25/247) of the in-river treatment and 11.9 % (34/286) of the transport treatment fish have been detected passing upstream at BON. No evidence of differences between days, in terms of probability of returns was found (Monte Carlo Estimate for the Fisher Exact Test; P= 0.30), and data were grouped into a single table. No statistically significant difference has been found in the proportions of steelhead that have returned from either treatment (P = 0.31).

Return Rates

Overall from 2001, adult PIT-detectors at BON and LGR have documented returns by 7.6% (43/563) of the PIT-tagged kelts. Return rates of these kelts from McN are currently at 10.3% (7/68), whereas rates from kelts released at JDD are at 7.2% (36/495). From 2002, return rates of good and fair kelts from McN are currently at 6% (21/352), whereas return rates from their JDD counterparts (including transported kelts) are at 10.7% (61/568). In 2002, 809 PIT-tagged kelts were released at JDD and 402 were released at McN. Included are fish from the in-river and transport treatments from JDD, and the 317 radio-tagged kelts. Eighty-four of these kelts (10.3%) have been documented passing BON on upstream migrations (Table 11). Detection numbers reflect the possibility of non-detection from one project to the next. That is, some fish detected at upriver sites may not have been detected at each facility along their migration route. A release summary for returning fish can be found in Appendix E-5.

Table 11. Individual detections of upstream migrating steelhead through FCRPS (and PUD) projects from kelts PIT-tagged in 2001 and 2002.

		UPSTREAM ADULT LADDER INTERROGATIONS					
Release	**n**	**BON**	**McN**	**Ice Harbor**	**LGR**	**Priest R.**	**Wells**
*** 2001**							
McNary	68	6	2	0	1	0	0
John Day	495	34	3	0	2	0	0
2002 – John Day							
In-River	247	25	10	2	4	0	0
Transport	286	34	13	1	1	0	0
Radio-tag	17	0	0	0	0	0	0
Other	259	4	2	0	0	1	0
2002 - McNary							
Radio-tag	300	18	14	3	5	4	3
Other	102	*3*	*2*	*1*	*1*	*0*	*0*
Totals	**1774**	**124**	**46**	**7**	**14**	**5**	**3**

* In 2001, adult PIT detection capabilities were only available in the BON Washington shore ladder and at LGR.

The condition of kelts migrating through the FCRPS is a factor in their ability to successfully return on repeat spawning migrations. Combining 2002 release data from McN and JDD shows that kelts of good, fair, and poor conditions have returned at rates of 11.1%, 5.4%, and 0.7%, respectively (Table 12). Similar to the data from kelts in poor condition, no kelts of dark coloration (0/78) have returned. Of the 78-tagged kelts that were of dark coloration, 30 were of good or fair condition. Apparently, once a kelt undergoes the transformation to dark coloration it's potential to return is diminished.

Table 12. Upstream detections for kelts tagged in 2002 in the three condition categories.

		UPSTREAM ADULT LADDER INTERROGATIONS					
Condition	**n**	**BON**	**McN**	**Ice Harbor**	**LGR**	**Priest R.**	**Wells**
Good	568	63	32	6	10	4	2
Fair	352	19	9	1	1	1	1
Poor	290	2	0	0	0	0	0
Totals	1210	84	41	7	11	5	3

The origin of kelts migrating through the FCRPS may also be a factor in their ability to successfully return on repeat spawning migrations. Kelts of wild origin have returned at higher rates than kelts of hatchery origins (Table 13). Currently, returns from wild female kelts of good and fair conditions are at 9.3% (46/493), whereas returns from their hatchery counterparts are at 3.9% (15/384). Similarly, though based upon smaller sample size, a higher percentage of wild good and fair condition male kelts (6.8%; 4/59) have returned than their hatchery counterparts (0%; 0/15).

Table 13. Returns from Hatchery and Wild kelts (good, fair, & poor) tagged at McN and JDD (2002).

Release Location	**Hatchery (N)**	**Hatchery Returns**	**Wild (N)**	**Wild Returns**
McNary	131	3 (2.3%)	280	18 (6.4%)
John Day	337	20 (5.9%)	484	43 (8.9%)
Totals	468	23 (4.9%)	764	61 (8.0%)

Two behavior patterns are observed in the number of days from release to upstream return timing at BON (Figure 14). Upstream migrations past BON began approximately eighty-days post release. Successful members of this cohort will spawn in consecutive years. The second group of returns begins around 400 days post-release. These fish have been foraging over the winter, presumably in the ocean, estuary, or in combinations of these environments. Hatchery kelts are poorly represented in the cohort of kelts that over-wintered at sea before returning. Many of the kelts that spent an additional sea-winter before returning were tagged in the mid and later components of the out-migration (i.e., May-June; Figure 15).

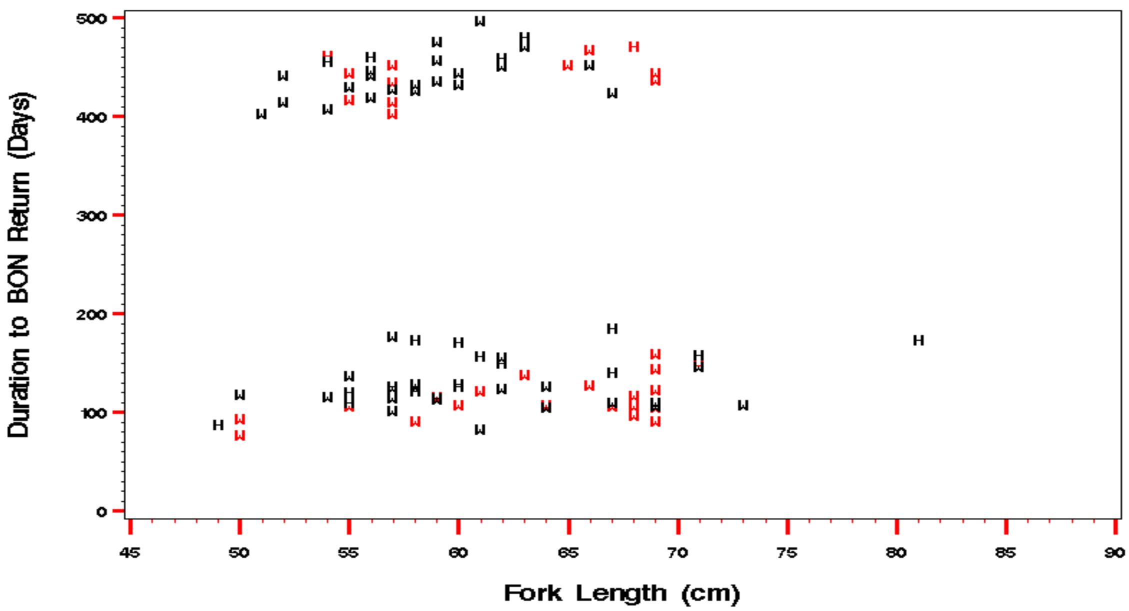

Figure 14. The number of days from release at John Day Dam (2001-2002) to Bonneville return and the corresponding fork length recorded for each individual at the time of sample. Note: 2001 PIT- tagged hatchery (H) and wild (W) kelts represented by red, with 2002 hatchery (H) and wild (W) kelts in black.

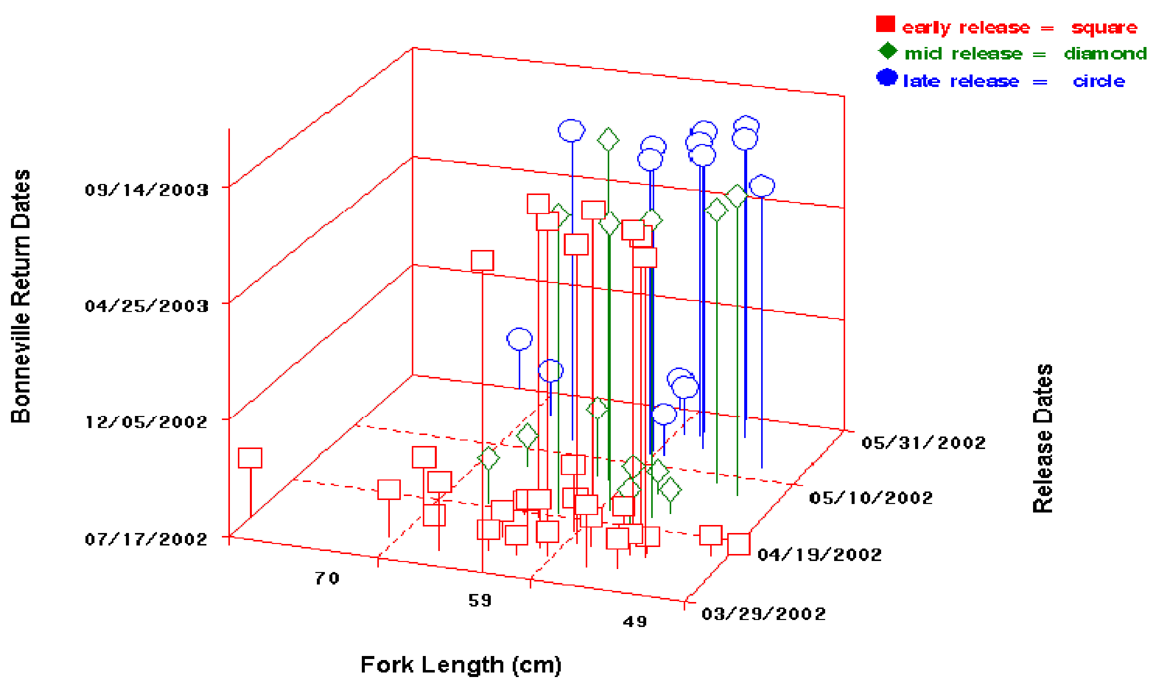

Figure 15. Release dates (by outmigration period), fork length (when PIT-tagged), and return timing from kelts PIT-tagged in 2002.

PROJECT SUMMARY AND DISCUSSION

Abundance: Kelt population estimates appear reasonable. These estimates are conservative due to the limited time-period evaluated during the kelt passage season. Abundance estimates of kelts within the pools (McN & JDD) and from kelts passing JDD were similar and large compared to the number of kelts available in the JDD bypass (from screen systems). Developing surface bypass and collection technologies applied at appropriate locations could provide for more effective passage routes, or allow access to more kelts than pass via screened bypass systems.

Columbia basin kelt populations degrade in overall condition (and many kelts perish) during seaward migrations. Clearly, management actions (e.g., reconditioning, short term reconditioning and transport) where found appropriate should focus on obtaining kelts as close to their natal spawning grounds as possible. Quality ESA listed kelt populations such as those passing LGR should continue to be evaluated, and management protocols tested to better aid these fish. The endangered status of upper Columbia River steelhead warrants that upper Columbia River hydro facilities should be assessed for: 1) kelt abundance and condition, and 2) the potential to mitigate (for impoundment affects) in recovering this 'endangered' Evolutionarily Significant Unit (ESU). Adult interrogation sites at McNary, Ice Harbor, and Priest Rapids provide for future differentiation of the returns & rates from the differing ESU's within the mid Columbia, upper Columbia, and Snake river's.

Telemetry: Radio telemetry has proved to be an effective method for evaluating the travel and passage of kelts through lower Columbia River dams. However, monitoring kelt conversion (i.e., survival) proved problematic due to high initial loss of kelts (i.e., ~20%). Due to the unknown influence of such factors as tag loss, tag failure, and potential attrition due to sampling stress, estimates of conversion (~60%) may underestimate the survival rates of good and fair condition kelts migrating through the study area.

Kelt travel rates in impounded reaches were less rapid than rates observed in the free flowing reach below BON. However, pool length, project operations (i.e., spill), fish size, fish condition, and other factors probably also influence kelt migration rates. Data from upriver steelhead stocks indicates serious impoundment effect on kelt travel times. The effects of the longer-term exposure (compared to pre-impoundment) to increasing seasonal temperatures on disease resistance, and the bioenergetic costs of these exposure profiles remain unexplored.

Passage was primarily via the spillways at lower Columbia River projects. At JDD, 30% continuous spill proved more effective for kelts passage than 54% night spill. Prior results at TDA and BON, indicating that even moderate spill levels result in enhanced project passage efficiencies, appear relevant at JDD. Emerging surface flow bypass technologies such as removable spillway weirs hold promise to enhance passage efficiencies and the effectiveness of project spillways.

Sluiceways effectively passed kelts around project powerhouses. In the Pacific Northwest, hydro-projects effecting steelhead populations should maintain springtime project operations that allow these fishes access to these downstream passage routes (where available).

Return Rates & Transport: No benefits were observed from transporting kelts from John Day Dam (around TDA and BON). In fact, despite a slight but perceptible bias in the transport sample of wild female kelts of good condition, no statistically significant difference has been found in the proportions of steelhead that have returned from each treatment (to date). These data are supported by the travel rates (times) and passage data for kelts below JDD. Our data indicates that in 2002, the hydro-system below John Day Dam did not significantly impair kelts from returning on upstream migrations.

A variety of factors effect kelt return rates. Such factors include phylogenetic constraints, geographic location, environmental conditions, sex, size at maturity, and differential reproductive energy budgets among stocks and species (Fleming 1998). As would be expected, kelts of good condition returned at higher rates than those of fair and poor condition. Despite roughly equivalent outmigration success, kelts of wild origin produced higher return rates than hatchery kelts, especially, when viewing the proportion of kelts that over-wintered before returning on upstream migrations (Fig. 14). Domestication selection for early run timing from hatchery fish (Leider et al. 1986; Mackey et al. 2001) may be influencing the periodicity of return behaviors from naturally spawning hatchery kelts. However, it should be cautioned that this study was not designed to differentiate the effects of kelt origin (i.e., hatchery, wild) on return rates. A more detailed analyses regarding the effects of kelt condition, origin, coloration, and passage routes on the returns from these fish will be available in the forthcoming report (Madson et al. In-preparation).

Current information warns that many hatchery steelhead are spawning in the wild. A portion of our sample of hatchery kelts contained one or more opercula punches, indicating they were recycled at hatcheries for sport and other fisheries. Hatchery release and management practices should continue to be evaluated for their affect on the straying rates from these fish.

Early in the kelt passage season a portion of the male steelhead identified as kelts had visual and ultrasound diagnostic characteristics (i.e., slim medium abdomen, testis < 1.5 cm^2) reflective of kelts, yet, as indicated by rapid upstream migration, these males were still undergoing gonadal maturation. Due to potential for overlap in testis area between prespawn and kelts further study is needed to establish testis size criteria thresholds at main-stem Columbia River facilities.

Telemetry data suggests that the downstream surface orientations of juvenile steelhead are maintained through their adult life histories. Continued research, monitoring, engineering, and deployment of surface bypass systems in the lower Columbia River should prove beneficial for the survival and return rates from kelts.

Acknowledgements

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Appendix A

Supplemental Sheet/Key for Morphological Data

Criteria		Description	Notation
Abdomen	Fat[a]	Fish will have a rounded abdomen with substantial girth. A bulge just posterior to the pectoral fin is very noticeable. Abdomen will often feel soft to the touch. Head is often smaller relative to abdomen. Fish are almost always female pre-spawners.	F
	Fat-intermediate	Similar to fat specimens, these fish clearly have a rounded abdomen and girth. However, the difference is subtle and the abdomen will appear uniform in size between the pectoral and pelvic fins. Dorsal flanks will be slightly smaller than the ventral flanks in girth.	F-I
	Thin-intermediate	Abdomen will appear slightly concave when viewed from the side. Abdomen no longer looks perfectly rounded.	T-I
	Thin	Fish will appear atretic and emaciated with a snake-like appearance. Abdomen is often hard and imploded. Head is typically as wide as abdomen.	T
Condition	Good	Overall appearance of the specimen is excellent. These fish will lack major scars, often have no or very little fin-wear, and do not have noticeable fungus. No other damage is evident.	Good
	Fair	Overall appearance is still good, however, fish will have some fin-wear, small scars or lesions, and/or minor fungus.	Fair
	Poor	Overall appearance is poor. These fish will have substantial fin-wear, fungus infections, and/or major scars and lesions. Fish with missing eyes, substantial head-burn, etc.. should be considered in poor overall condition.	Poor
Coloration	Bright	Fish has an overall silvery appearance. The abdomen is dominated by a white color.	B
	Intermediate	Fish is a mixture of silver and dark-grey blotches. Grey blotches often below the lateral line.	I
	Dark	Fish has dark complexion on both the dorsal and ventral flanks. Dark blotches are also on the ventral surface.	D

[a] These fish are often pre-spawners and if ultrasound exam concurs, they should immediately be released. In general, assessment of abdominal appearance is more difficult with males.

Appendix B

Calculations of In-River Kelt Abundance

In-river kelt abundance (i.e., the total number of kelts within a given river segment) was calculated based on mark-recapture techniques from tagged kelts released that were subsequently recaptured at the bypasses. Estimates were calculated using Chapman's modification of the Petersen estimator (Ricker 1975):

$$N_{reservoir} = \frac{(M+1)(C+1)}{R_e+1}$$

where:

M $_{(mark)}$ = Number of kelts marked and released at the bypasses

C $_{(subpopulation)}$ = Total number of kelts encountered in the bypasses (McNary and John Day).
Re $_{(estimated\ recaptured\ population)}$ = Number of released kelts recaptured (i.e., PIT and telemetry) at the bypasses

Confidence intervals (± 95%) were calculated using Pearson's formula (Ricker 1975), which approximates the confidence intervals for a Poisson distribution for a large number (i.e., >50) of recaptures:

$$R_e + 1.92 \pm 1.960\sqrt{R_e + 1.0}$$

Assumptions and Limitations of Chapman's Modification: Many factors can both influence and bias the in-river abundance estimate at McN. For example, an adequate calculation of confidence intervals requires that at least 50 recaptured specimens are available. Both radio telemetry and PIT-tagging endeavors yielded recapture data < 50 individuals and greatly reduce the precision of the estimate. Furthermore, unknown mortality rates also impact recapture rates and severely alter the accuracy of the estimate. One approach is to estimate mortality within the hydrosystem using attrition rate data generated from radio-tagged kelts reaching McNary, which was done to generate R_e in the equation above.

The following is a list of additional assumptions associated with our in-river kelt abundance estimate at McNary in 2002. Unfortunately, there is currently very little data available to test the validity of these assumptions.

- Kelts outmigrating from tributaries between the mark and recapture location (e.g., the Upper Columbia, Walla Walla, Tucanon rivers, etc.) may have contributed unaccounted for individuals into the calculation, thereby exaggerating the estimate to an unknown degree.

- The calculation assumes that reservoir mortality rates are similar for all migrants, regardless of their previous passage route and that all tagged individuals have an equal probability of recapture.

- Estimate assumes that the tagging methods used to mark kelts did not reduce the survival potential and/or passage behavior relative to untagged individuals.

- Radio-tags and PIT-tags were operating correctly at both the release and recapture location.

- Kelt abundance estimates for the bypass facilities are accurate.

- The ratio of wild to hatchery fish observed in the bypass separator is similar to that of in-river migrants (i.e., separator hatchery-to-wild ratio is representative of those fish passing via spill, turbine, lock, and fishway).

- Abundance estimate applies only to the number of kelts present within a particular reservoir and does not predict the eventual fate of outmigrants (although telemetry data provides some convincing evidence).

John Day Dam**:** In-river kelt abundance was estimated at John Day Dam based on route-specific passage data obtained from telemetred kelts passing the facility. Using radio-telemetry contacts at the dam, we extrapolated in-river abundance based on the 1) total number of kelts in the bypass facility and 2) the relative proportions of tagged fish passing various dam passage routes. This estimate applies to the over-all number of kelts that passed John Day Dam during the sampling period, as apposed to the number of kelts within the John Day reservoir. Although kelt abundance estimate for the JDD bypass facility were generated over the course of 14 weeks, telemetry monitoring was only conducted for nine weeks. Thus, in-river abundance estimates apply to a nine-week period, as apposed to the 14-week kelt bypass abundance estimate.

Assumptions and Limitations of the In-river Passage Efficiency Estimator

- The nine-week kelt abundance estimate for the JDD bypass facility is accurate.

- Passage behavior of radio tagged kelts is indicative of non-radio tagged kelts.

- Differences in spill patterns and river discharge were effectively averaged throughout the nine-week period.

Appendix C

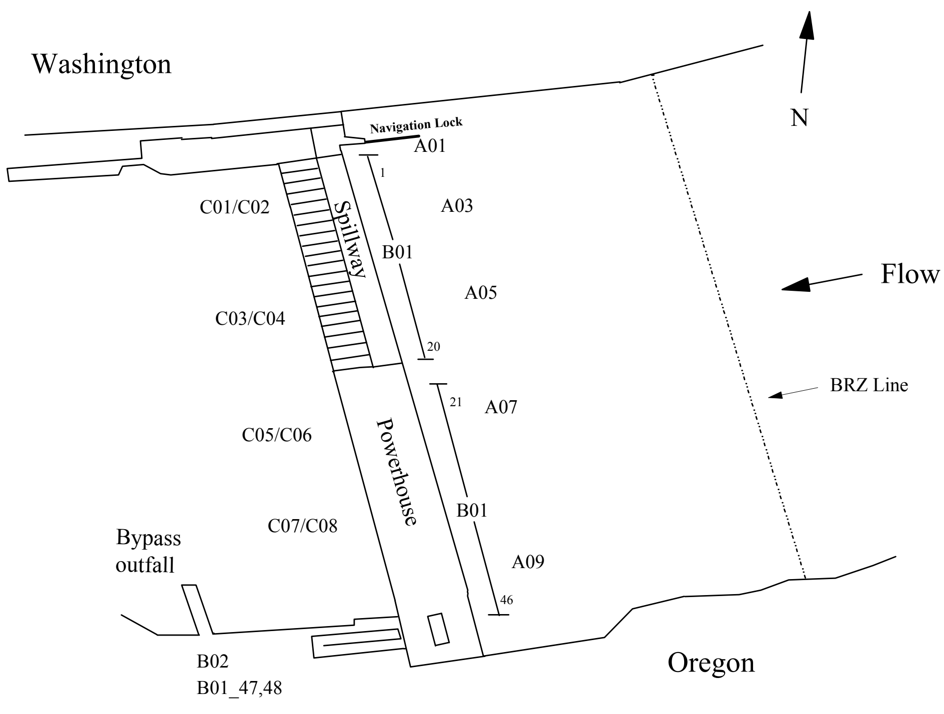
Summary of **University of Idaho** fixed site aerial and underwater receiver/antenna telemetry arrays in available to FFU in 2002. Arrays were operated and maintained by University of Idaho. Data from these locations were forwarded to the Fisheries Field Unit.

SITE CODE	RIVER, CREEK, LANDMARK	TRIB CODE	RIVER KM	RIVER MILE
COL	1BO RECEIVER SITE-SOUTH SHORE, MOUTH OF TANNER CREEK	1BO	232.3	144.5
COL	2BO RECEIVER SITE-NORTH SHORE, HAMILTON ISLAND	2BO	232.3	144.4
COL	BRADFORD ISLAND		233.5	145.1
COL	3BO IN NEW NAV LOCK	3BO	235.1	146.0
COL	BONNEVILLE DAM	BO	235.1	146.1
COL	FORT RAINS FIXED SITE - WA SHORE	FTR	235.3	146.2
COL	BOG RECEIVER SITE (AT TOP END OF BO FOREBAY FB STUDY AREA)	BOG-COL	238.6	148.3
COL	ROCK CREEK, WA	ROC	241.4	150.0
COL	HERMAN CREEK, OR	HER-COL	242.5	150.7
COL	HERMAN CREEK FIXED RECEIVER SITE	HCK	242.5	150.7
COL	STEVENSON BOAT LAUNCH RECEIVER SITE	SBL	242.7	150.9
COL	CARSON DEPOT ROAD RECEIVER SITE	DPR	246.6	153.3
COL	UNION PACIFIC RAILROAD RECEIVER SITE (ACROSS DEPOT RD)	UPA	246.6	153.3
COL	WIND RIVER, WA	WIN	248.6	154.5
WIN	WIN RECEIVER SITE	WIN	249.2	154.9
COL	LWD (DOWNSTREAM OF LWS) RECEIVER SITE	LWD-COL	260.1	161.7
COL	LITTLE WHITE SALMON RIVER, WA-DRANO LAKE	LWS	260.7	162.0
LWS	LWS RECEIVER SITE	LWS	261.0	162.2
COL	LWU (UPSTREAM OF LWS) RECEIVER SITE	LWU-COL	261.3	162.4
COL	WHD (DOWNSTREAM OF WHITE SALMON) RECEIVER SITE	WHD-COL	270.3	168.0
COL	WHITE SALMON RIVER, WA	WHR	270.8	168.3
WHR	WHR RECEIVER SITE	WHR	270.9	168.2
WHR	WHITE SALMON RIVER UPSTREAM RECEIVER SITE	WSU	272.5	169.4
COL	HOOD RIVER, OR	HDR	272.6	169.4
HDR	MOUTH	HDR	272.6	169.4
COL	HOOD RIVER BRIDGE RECEIVER SITE	HBL	273.2	169.8
COL	BINGEN MARINA RECEIVER SITE	BMA	276.4	171.8
KTR	MOUTH (HWY 14)	KTR	290.3	180.4
KTR	KTR RECEIVER SITE (STATE ROUTE 142)	KTR	290.7	180.7
COL	MAYER STATE PARK RECEIVER SITE	MSP	293.0	182.1
COL	1TD RECEIVER SITE-SOUTH SHORE, DOWNSTREAM OF TAILRACE	1TD	304.9	189.5
COL	2TD RECEIVER SITE-NORTH SHORE, DOWNSTREAM OF TAILRACE	2TD	304.9	189.5
COL	DALLES DAM	TD	308.1	191.5
COL	AVERY BOAT LAUNCH RECEIVER SITE	ABL	320.0	198.9
COL	WISHRAM RECEIVER SITE, WA	WSM	325.3	202.2
COL	DSM (DOWN STREAM OF DES MOUTH) RECEIVER SITE	DSM-COL	327.1	203.3
DES	MOUTH	DES	328.4	204.1
DES	DES RECEIVER SITE	DES	328.9	204.4
COL	BIGGS BRIDGE RECEIVER SITE	BBL	334.6	208.0
COL	1JD RECEIVER SITE-SOUTH SHORE, DOWNSTREAM OF TAILRACE	1JD	345.0	214.4
COL	2JD RECEIVER SITE-NORTH SHORE, DOWNSTREAM OF TAILRACE	2JD	345.1	214.5
COL	JOHN DAY DAM	JD	346.9	215.6
COL	PASTURE POINT LAUNCH RECEIVER SITE	PTL	364.4	226.5
COL	ROCK CREEK, WA	RCK	367.7	228.5
COL	ROCK CREEK RECEIVER SITE	RCK	370.0	229.9

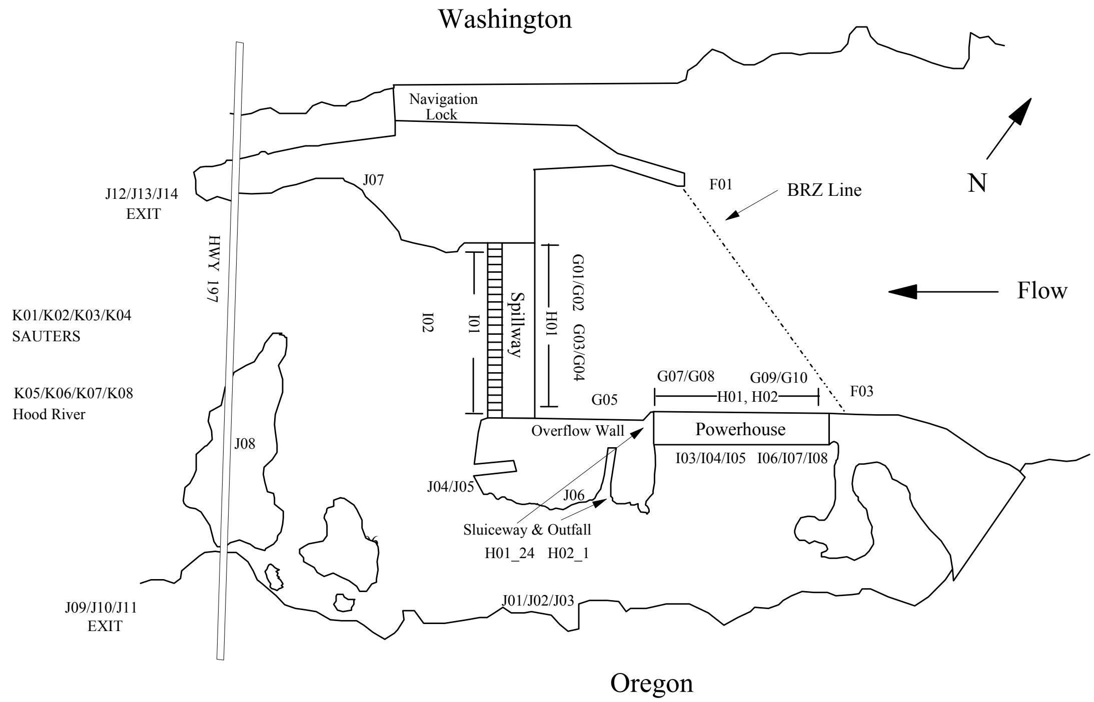
COL	SUNDALE PARK RECEIVER SITE	SDL	382.1	237.5
COL	ROOSEVELT RECEIVER SITE	RVT	390.0	242.4
COL	PINE CREEK RECEIVER SITE	PCK	401.0	249.2
COL	ALDER CREEK RECEIVER SITE	ALD	415.1	258.8
COL	PATTERSON RECEIVER SITE	PSN	443.3	275.5
COL	1MN RECEIVER SITE-SOUTH SHORE, DOWNSTREAM OF TAILRACE	1MN	467.3	290.4
COL	2MN RECEIVER SITE-NORTH SHORE, DOWNSTREAM OF TAILRACE	2MN	467.3	290.4

USGS Telemetry Site Maps

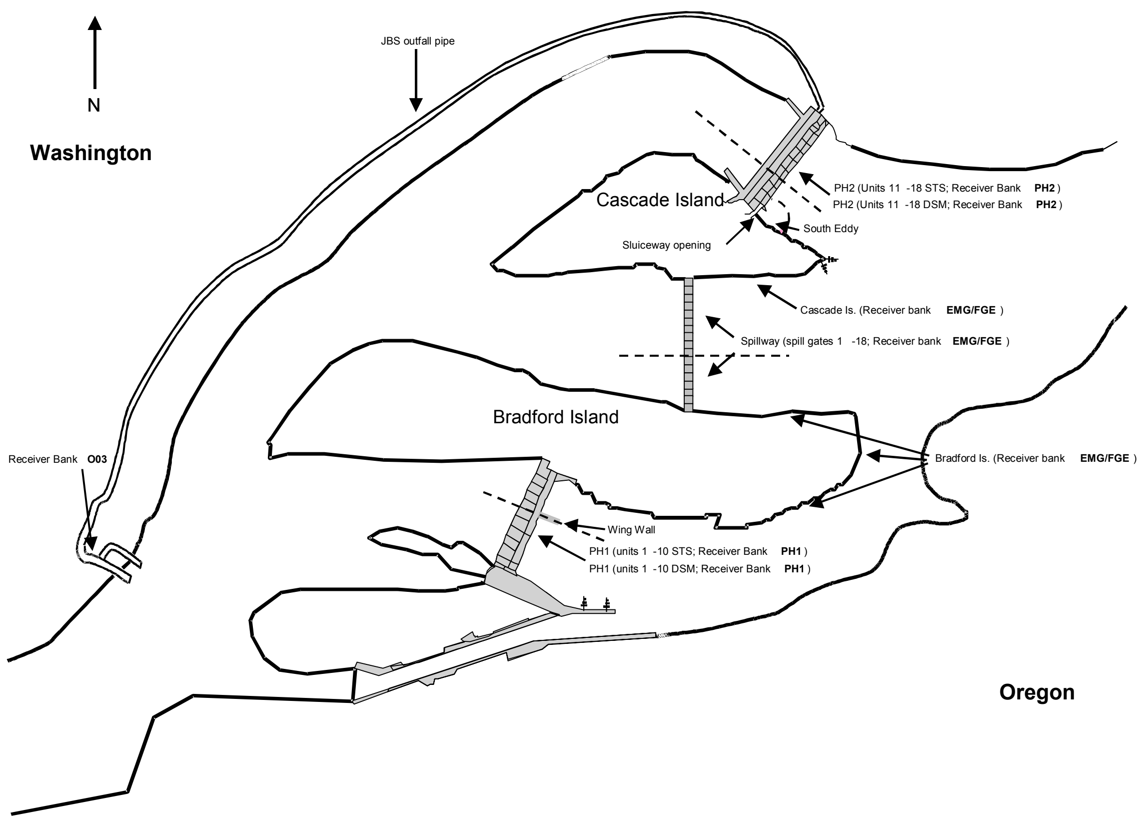
John Day Dam



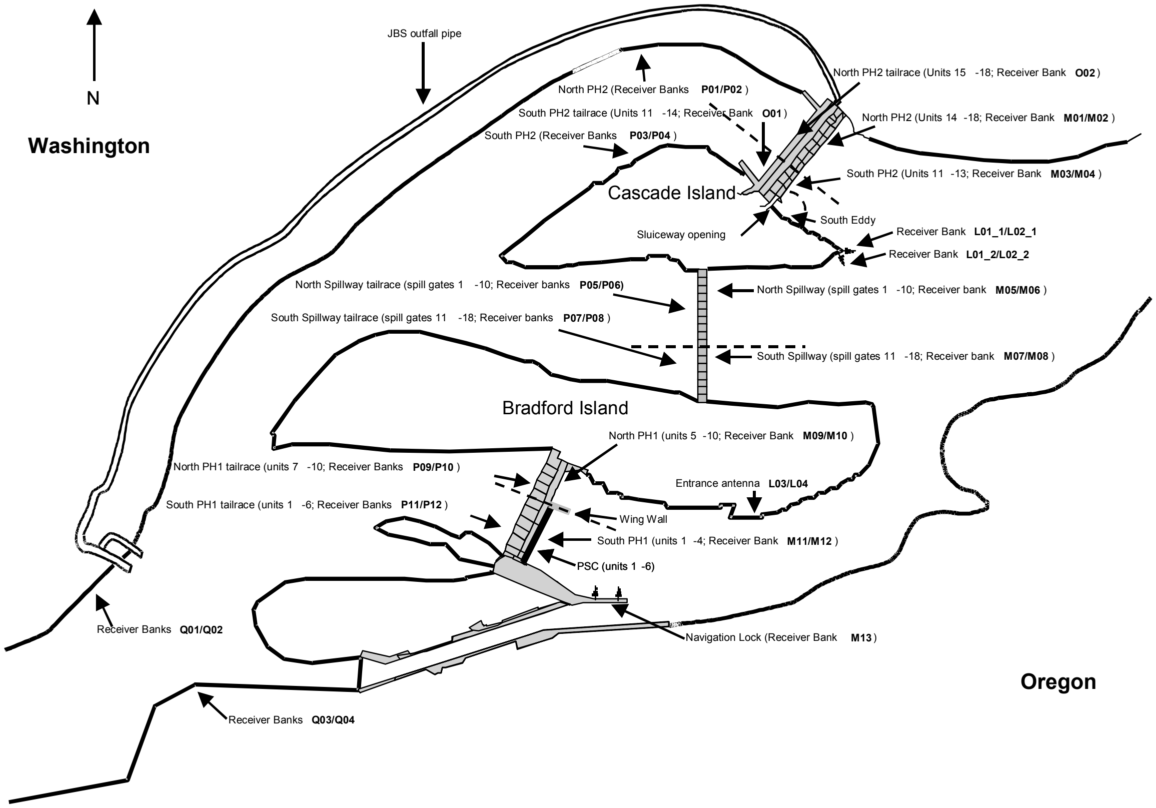
The Dalles Dam



Bonneville - Underwater Telemetry



Bonneville - Aerial Telemetry sites



Appendix D

Table D-1. Summary of the sample date, sample size (n), sample mean, standard deviation (SD), range of the fork lengths (cm), sex, origin, ultrasound diagnostic and recaptures of steelhead at McNary Dam in spring of 2002.

McNary Sample		Fork Length (cm)			Sex			Origin		Ultrasound		Recaps
Date	n	Mean	SD	Range	M	F	UN	Wild	Hatch	Pre	Kelt	LGR
April 2	9	55.63	2.77	52 – 59	2	6	1	4	5	7	2	0
April 3	30	64.07	8.16	55 – 82	7	22	1	23	7	24	6	0
April 4	16	60.50	4.84	51 – 68	7	8	1	11	5	12	4	0
April 5	12	59.17	7.42	52 – 73	4	8	0	7	5	7	5	0
April 8	18	59.61	8.29	45 – 82	7	11	0	8	10	14	4	0
April 9	22	61.91	10.66	47 – 92	10	12	0	15	7	13	9	0
April 10	23	62.04	7.79	51 – 79	10	13	0	19	4	10	13	0
April 11	10	64.30	7.29	56 – 80	4	6	0	9	1	3	7	0
April 12	16	64.69	10.65	47 – 93	8	8	0	13	3	4	12	0
April 15	27	58.31	5.68	47 – 70	7	18	2	20	7	8	19	0
April 16	29	58.48	5.30	48 – 98	5	19	5	21	8	6	23	0
April 17	20	57.35	3.80	50 – 65	4	15	1	12	8	7	13	0
April 18	26	60.62	5.76	52 – 72	1	20	5	16	10	3	23	1
April 19	12	59.75	5.75	53 – 72	2	10	0	7	5	3	9	0
April 22	12	61.42	6023	50 – 73	3	7	2	7	5	1	11	0
April 23	6	68.33	5.01	63 – 74	4	1	1	4	2	2	4	0
April 24	8	66.75	15.25	47 – 95	1	6	1	6	2	3	5	0
April 25	5	58.80	11.01	47 – 77	2	3	0	5	0	2	3	0
April 26	8	65.13	5.08	57 – 72	1	5	2	7	1	3	5	0
April 29	38	60.68	6.55	49 – 77	5	30	3	22	16	7	31	0
April 30	35	58.14	5.83	49 – 74	2	22	11	21	14	0	35	0
May 1	32	58.90	4.56	53 – 71	5	17	10	22	10	4	28	1
May 2	35	62.14	6.90	50 – 81	4	23	8	20	15	3	32	1
May 3	41	61.17	9.18	53 – 76	3	34	4	24	17	6	35	1
May 6	22	61.41	7.26	47 – 77	4	16	2	18	4	8	14	0
May 7	3	71.00	8.72	65 – 81	0	3	0	3	0	0	3	0
May 8	5	61.6	6.58	54 – 71	1	4	0	5	0	1	4	0
May 9	9	59.22	6.32	50 – 71	4	5	0	6	3	3	6	0
May 10	8	60.13	6.24	56 – 75	1	6	1	5	3	2	6	0
May 13	23	60.00	5.72	53 – 72	3	18	2	18	5	1	22	0
May 14	38	56.47	3.21	49 – 65	0	35	3	15	23	2	36	1
May 15	37	60.19	6.31	52 – 77	2	23	12	19	18	1	36	2
May 16	38	59.63	6.85	50 – 80	0	34	4	20	18	0	38	1
May 17	23	61.39	7.25	53 – 80	1	17	5	14	9	2	21	0
May 20	10	62.50	8.49	53 – 77	0	10	0	6	4	1	9	0
May 21	8	60.25	6.54	50 – 70	2	6	0	6	1	1	7	1
May 22	6	68.00	6.70	57 –76	1	5	0	6	0	0	6	0
May 23	8	63.38	8.37	53 – 77	0	8	0	5	3	0	8	0
May 24	3	64.67	8.62	57 – 74	0	3	0	2	1	0	3	0
May 27	6	58.33	3.33	54 – 64	1	5	0	4	2	2	4	0
May 28	23	59.87	6.23	47 – 73	5	18	0	16	7	1	22	0
May 29	9	60.56	9.95	50 – 77	2	5	2	7	2	0	9	1
May 30	14	59.00	4.96	50 – 67	1	10	3	13	1	0	14	0
May 31	17	59.47	4.86	51 – 74	5	11	1	14	3	1	16	0
June 1	3	56.00	5.00	51 – 61	0	2	1	0	3	0	3	0
June 3	2	60.00	4.24	57 – 63	0	1	1	2	0	0	2	0
June 4	1	57.00	0.00	57 – 57	0	1	0	1	0	0	1	0
June 5	9	60.56	9.38	53 – 83	2	7	0	7	2	0	9	1
June 6	15	59.53	7.1	53 – 83	3	11	1	11	4	0	15	0
June 7	6	56.33	6.15	49 – 66	1	4	1	5	1	0	6	0
June 8	1	57.00	0.00	57 – 57	0	0	1	1	0	0	1	0
Total	**837**				**147**	**592**	**98**	**552**	**284**	**178**	**659**	**11**

Table D-2 Summary of the sample date, sample size (n), mean, standard deviation (SD) and range of the fork length (cm), sex, origin, ultrasound diagnostic and recaptures of steelhead at John Day Dam in the spring of 2002.

John Day sample		Fork Length (cm)			Sex			Origin		Ultrasound		Recaps
Date	n	Mean	SD	Range	M	F	UN	Wild	Hatch	Kelt	Pre	McN
Mar 18	9	61.8	4.2	57 – 68	3	6	0	2	7	6	3	0
Mar 19	10	64.6	6.9	55 – 76	2	7	1	3	7	5	5	0
Mar 20	17	62.8	7.5	54 – 87	14	3	0	7	10	15	2	0
Mar 21	10	60.7	4.2	55 – 70	3	5	2	2	8	5	5	1
Mar 22	9	63.7	9.9	54 – 86	3	6	0	1	8	1	8	0
Mar 23	9	61.3	1.9	58 – 64	4	4	1	3	6	6	3	1
Mar 25	4	61.8	12.6	48 – 77	2	1	1	2	2	3	1	0
Mar 26	42	62.7	5.8	53 – 81	17	21	4	17	25	22	20	0
Mar 27	35	63.4	8.6	48 – 86	13	16	6	14	21	15	20	0
Mar 28	20	61.4	8.0	47 – 85	8	11	1	4	16	5	14	0
Mar 29	36	63.5	6.3	56 – 84	11	15	10	8	28	15	21	0
Mar 30	20	61.0	6.0	53 – 75	6	9	5	6	14	10	8	0
April 1	22	60.5	5.9	54 – 82	5	13	4	7	15	12	10	0
April 2	46	61.6	5.3	53 – 78	12	32	2	14	32	21	25	0
April 3	58	61.6	5.9	53 – 80	16	33	9	21	37	25	33	0
April 4	99	60.9	6.6	53 – 98	29	56	14	45	54	50	48	0
April 5	87	61.2	5.9	52 – 81	21	54	12	38	49	41	46	0
April 6	75	60.7	6.6	51 – 84	15	57	3	29	46	24	51	0
April 8	37	59.1	4.6	50 – 73	11	22	4	15	22	24	13	0
April 9	149	61.5	7.8	49 – 90	40	105	4	68	81	81	68	0
April 10	88	60.4	5.4	51 – 76	16	57	15	36	52	59	28	0
April 11	69	59.5	6.2	47 – 81	19	43	7	32	37	29	39	0
April 12	36	60.0	5.1	50 – 74	11	19	6	14	22	20	16	0
April 13	37	58.6	5.1	50 – 72	8	26	3	24	13	23	14	0
April 15	28	60.3	6.3	51 – 74	4	20	4	12	16	20	8	0
April 16	75	59.0	5.1	48 – 78	16	41	18	40	35	58	17	0
April 17	56	63.3	6.9	53 – 83	8	24	24	31	25	44	11	0
April 18	66	59.4	5.6	44 – 72	15	40	11	42	24	44	21	0
April 19	72	60.2	5.8	47 – 76	14	48	10	39	33	54	18	0
April 20	40	59.7	5.6	53 – 75	6	30	4	26	14	34	6	1
April 22	4	62.5	9.3	55 – 75	2	2	0	2	2	2	2	0
April 23	28	59.1	5.2	51 – 74	4	24	0	17	11	21	7	0
April 24	25	59.8	5.8	54 – 75	4	21	0	11	14	17	8	0
April 25	32	60.4	5.7	48 – 72	4	23	5	16	16	27	5	0
April 26	20	61.0	5.2	52 – 76	1	12	7	11	9	18	2	0
April 27	13	58.8	4.1	55 –68	2	10	1	8	5	11	2	1
April 30	20	61.9	5.4	53 – 73	1	14	5	12	8	19	1	0
May 1	18	61.9	6.4	54 – 76	0	14	4	16	2	15	3	0
May 2	12	59.4	2.8	54 – 63	2	8	2	10	2	11	1	1
May 3	29	60.2	5.3	49 – 73	5	15	9	21	8	23	6	1
May 4	22	60.2	5.6	52 – 73	2	18	2	19	3	21	1	0
May 7	14	59.9	5.3	54 – 70	1	11	2	13	1	13	1	0
May 8	12	60.2	6.8	52 – 70	0	8	4	10	2	12	0	1
May 9	16	58.6	6.8	52 – 73	2	12	2	11	5	15	1	1
May 10	6	63.7	8.8	52 – 76	0	4	2	5	1	6	0	1
May 11	6	59.6	6.6	53 – 70	2	4	0	5	1	6	0	0
May 14	12	60.2	6.8	52 – 72	0	10	2	9	3	12	0	0
May 15	20	61.7	6.4	53 – 75	3	8	9	15	5	20	0	1
May 16	11	59.1	3.2	55 – 66	3	6	2	7	4	8	3	0
May 17	4	62.5	3.4	59 – 67	0	2	2	4	0	4	0	0
May 18	13	57.6	3.8	52 – 66	1	7	5	8	5	12	1	0
May 21	6	59.3	5.0	54 – 67	1	2	3	5	1	5	1	0
May 22	13	60.3	3.0	57 – 68	0	4	9	8	5	13	0	0
May 23	12	58.6	6.5	52 – 70	0	4	8	9	3	12	0	0
May 24	21	60.5	7.3	52 – 79	2	18	1	15	6	19	2	0

May 25	15	60.4	5.7	53 – 73	0	13	2	12	3	15	0	0
May 28	2	58.5	9.2	52 – 65	0	1	1	2	0	2	0	0
May 29	11	59.3	7.0	52 – 76	0	7	4	7	4	10	1	0
May 30	11	58.5	6.9	51 – 76	2	5	4	6	5	11	0	1
May 31	4	63.5	6.4	59 – 73	0	3	1	4	0	4	0	0
June 1	7	57.3	5.9	48 – 65	3	3	1	5	2	7	0	0
June 4	1	52.0	0.0	52 – 52	0	1	0	1	0	1	0	0
June 5	2	64.0	11.3	56 – 72	0	2	0	2	0	2	0	0
June 8	4	57.3	5.5	52 – 65	1	2	1	4	0	4	0	0
June 11	2	52.0	2.8	50 – 54	1	0	1	2	0	2	0	0
June 12	1	62.0	0.0	62 – 62	0	0	1	1	0	1	0	0
June 13	1	54.0	0.0	54 – 54	0	1	0	0	1	1	0	0
June 14	1	58.0	0.0	58 – 58	0	0	1	1	0	1	0	0
June 15	1	63.0	0.0	63 – 63	0	1	0	1	0	1	0	0
June 19	5	67.0	8.7	60 – 77	2	3	0	5	0	5	0	0
June 20	4	65.0	10.9	52 – 78	0	3	1	3	1	3	1	0
June 21	2	49.5	5.0	46 – 53	0	2	0	1	1	1	1	0
TOTALS	**1824**				**403**	**1132**	**289**	**926**	**898**	**1184**	**632**	**11**

Appendix E

Table E-1. Summary of the collection date, sample size (n), sample mean, standard deviation (SD), range of the fork lengths (cm), sex, origin, maturation and condition of PIT-tagged steelhead from McN in 2002.

McNary	PIT	Fork Length (Cm)			Sex			Origin		Ultrasound		Kelts
Date	n	Mean	SD	Range	M	F	Un	Wild	Hatch	Kelt	Pre	G & F
04/02/2002	2	54.0	0.0	54 - 54	0	1	1	1	1	2	0	2
04/03/2002	5	61.0	5.0	56 - 69	1	3	1	4	1	4	1	2
04/04/2002	3	63.3	5.7	57 - 68	0	2	1	3	0	3	0	1
04/05/2002	2	62.5	6.4	58 - 67	0	2	0	2	0	2	0	1
04/08/2002	2	56.0	1.4	55 - 57	1	1	0	0	2	2	0	1
04/09/2002	5	62.6	11.9	47 - 78	1	4	0	4	1	5	0	4
04/10/2002	11	64.1	9.0	51 - 79	4	7	0	8	3	11	0	9
04/11/2002	5	65.2	10.0	56 - 80	2	3	0	5	0	5	0	4
04/12/2002	11	60.6	8.0	47 - 73	6	5	0	11	0	11	0	9
04/15/2002	8	59.3	7.9	47- 70	1	7	0	6	2	8	0	5
04/16/2002	10	60.0	5.2	53 - 68	0	8	2	9	1	10	0	8
04/17/2002	9	57.2	3.8	53 - 65	0	9	0	6	3	9	0	8
04/18/2002	13	60.4	5.9	52 - 71	0	12	1	8	5	13	0	12
04/19/2002	5	60.8	7.1	55 - 72	0	5	0	5	0	5	0	3
04/22/2002	6	58.2	5.9	50 - 68	2	4	0	3	3	6	0	4
04/23/2002	2	67.0	4.2	64 - 70	1	1	0	2	0	2	0	2
04/24/2002	1	65.0	0.0	65 - 65	0	1	0	1	0	1	0	1
04/25/2002	2	51.5	6.4	47 - 56	0	2	0	2	0	2	0	2
04/26/2002	2	67.0	5.7	63 - 71	0	1	1	2	0	2	0	1
04/29/2002	20	60.5	6.9	49 - 77	1	19	0	15	5	20	0	20
04/30/2002	22	58.1	5.8	49 - 74	1	15	6	14	8	22	0	16
05/01/2002	19	59.1	4.9	53 - 71	1	12	6	14	5	19	0	15
05/02/2002	26	60.2	5.5	50 - 70	2	20	4	13	13	26	0	22
05/03/2002	27	61.1	6.2	53 - 76	2	22	3	13	14	27	0	22
05/06/2002	5	61.8	1.9	59 - 64	0	3	2	5	0	5	0	5
05/07/2002	1	67.0	0.0	67 - 67	0	1	0	1	0	1	0	1
05/08/2002	2	59.5	3.5	57 - 62	0	2	0	2	0	2	0	2
05/09/2002	5	55.0	3.3	50 - 59	1	4	0	3	2	5	0	4
05/10/2002	4	58.5	2.1	56 - 61	0	3	1	3	1	4	0	3
05/13/2002	13	61.0	6.4	53 - 72	1	10	2	9	4	13	0	12
05/14/2002	28	55.9	2.9	49 - 65	0	25	3	11	17	28	0	26
05/15/2002	22	60.0	6.4	52 - 77	1	17	4	13	9	22	0	19
05/16/2002	21	60.9	7.8	52 - 80	0	20	1	13	8	21	0	20
05/17/2002	12	61.3	7.6	53 - 73	1	7	4	7	5	12	0	12
05/20/2002	7	62.7	10.2	53 - 77	0	7	0	5	2	7	0	7
05/21/2002	1	54.0	0.0	54 - 54	0	1	0	0	0	0	1	0
05/22/2002	0	0.0	0.0	0 - 0	0	0	0	0	0	0	0	0
05/23/2002	4	62.0	10.4	53 - 77	0	4	0	3	1	4	0	4
05/24/2002	0	0.0	0.0	0 - 0	0	0	0	0	0	0	0	0
05/27/2002	0	0.0	0.0	0 - 0	0	0	0	0	0	0	0	0
05/28/2002	10	60.0	6.1	52 - 72	1	9	0	7	3	10	0	10
05/29/2002	8	61.9	9.8	51 - 77	2	4	2	7	1	8	0	7
05/30/2002	9	58.8	4.8	50 - 66	1	5	3	8	1	9	0	9
05/31/2002	10	59.8	2.6	55 - 62	2	7	1	7	3	10	0	10
06/01/2002	3	56.0	5.0	51 - 61	0	2	1	0	3	3	0	3
06/03/2002	2	60.0	4.2	57 - 63	0	1	1	2	0	2	0	1
06/04/2002	1	57.0	0.0	57 - 57	0	1	0	1	0	1	0	1
06/05/2002	9	60.6	9.4	53 - 83	2	7	0	7	2	9	0	9
06/06/2002	11	60.8	7.9	56 - 83	2	8	1	9	2	11	0	11
06/07/2002	5	57.4	6.2	49 - 66	1	4	0	5	0	5	0	5
06/08/2002	1	57.0	0.0	57 - 57	0	0	1	1	0	1	0	1
TOTALS	*** 412**				**41**	**318**	**53**	**280**	**131**	**410**	**2**	**356**

* Includes recaptured fish already implanted with a PIT tag

Table E-2. Summary of the collection date, sample size (n), sample mean, standard deviation (SD), range of the fork lengths (cm), sex, origin, maturation and condition of PIT-tagged steelhead from JDD in 2002.

John Day	Pit	Fork Length (Cm)			Sex			Origin		Ultrasound		Kelts
Date	n	Mean	SD	Range	M	F	Un	Wild	Hatch	Kelt	Pre	G & F
03/18/2002	6	62.2	3.5	58 - 66	3	3	0	1	5	6	0	1
03/19/2002	5	61.8	4.4	55 - 67	2	2	1	2	3	5	0	2
03/20/2002	15	62.5	7.9	54- 87	12	3	0	6	9	15	0	10
03/21/2002	5	58.6	2.9	55 - 62	1	2	2	1	4	5	0	4
03/22/2002	1	60.0	0.0	60 - 60	0	1	0	0	1	1	0	1
03/23/2002	5	62.4	1.7	60 - 64	3	2	0	2	3	5	0	1
03/25/2002	4	61.8	12.6	48 - 77	2	1	1	2	2	3	1	2
03/26/2002	22	63.6	7.1	55 - 81	10	8	4	8	14	21	1	8
03/27/2002	12	61.2	6.4	54 - 78	6	1	5	5	7	12	0	5
03/28/2002	8	61.4	5.4	58 - 73	4	3	1	2	6	5	2	3
03/29/2002	13	64.3	6.8	57 - 81	0	4	9	5	8	13	0	7
03/30/2002	11	59.9	6.6	53 - 75	2	5	4	5	6	10	0	3
04/01/2002	12	61.6	7.1	56 - 82	1	7	4	4	8	12	0	6
04/02/2002	19	61.5	6.6	53 - 78	3	14	2	5	14	19	0	13
04/03/2002	22	60.1	4.4	53 - 73	0	13	9	12	10	22	0	12
04/04/2002	42	61.0	5.9	53 - 84	5	26	11	22	20	42	0	21
04/05/2002	36	61.9	6.7	52 - 81	2	26	8	20	16	36	0	25
04/06/2002	22	62.0	7.6	51 - 84	3	16	3	11	11	22	0	10
04/08/2002	23	59.5	4.2	54 - 67	7	13	3	11	12	23	0	11
04/09/2002	54	60.4	6.4	49 - 77	5	46	3	27	27	54	0	31
04/10/2002	40	60.3	5.9	51 - 76	2	30	8	20	20	40	0	25
04/11/2002	21	58.6	5.6	49 - 73	1	16	4	12	9	21	0	20
04/12/2002	11	59.5	2.9	56 - 65	0	6	5	6	5	11	0	10
04/13/2002	15	58.3	5.7	50 - 71	1	12	2	9	6	15	0	12
04/15/2002	12	60.5	7.4	51 - 74	0	12	0	4	8	12	0	8
04/16/2002	31	59.4	6.0	51 - 78	3	18	10	17	14	31	0	28
04/17/2002	28	64.2	7.4	55 - 83	0	16	12	19	9	28	0	23
04/18/2002	31	59.4	4.8	49 - 70	2	21	8	22	9	30	0	25
04/19/2002	29	61.4	5.8	52 - 74	0	23	6	19	10	29	0	26
04/20/2002	17	58.5	4.1	53 - 67	1	14	2	13	4	17	0	16
04/22/2002	0	0.0	0.0	0 - 0	0	0	0	0	0	0	0	0
04/23/2002	12	57.4	3.4	51 - 63	0	12	0	9	3	12	0	11
04/24/2002	5	59.6	5.5	54 - 67	0	5	0	2	3	5	0	5
04/25/2002	20	60.0	4.8	54 - 69	2	13	5	11	9	20	0	20
04/26/2002	12	59.1	3.6	52 - 66	0	6	6	6	6	12	0	10
04/27/2002	9	58.2	3.8	56 - 68	1	7	1	6	3	8	1	8
04/30/2002	5	57.8	3.1	53 - 61	0	4	1	4	1	5	0	5
05/01/2002	9	60.0	5.4	54 - 73	0	6	3	7	2	9	0	6
05/02/2002	4	58.3	3.9	54 - 62	0	3	1	4	0	4	0	1
05/03/2002	10	60.1	4.2	53 - 69	1	7	2	9	1	10	0	8
05/04/2002	17	60.5	6.1	52 - 73	2	14	1	15	2	17	0	12
05/07/2002	7	58.3	4.8	54 - 68	1	6	0	6	1	7	0	6
05/08/2002	9	59.1	6.2	52 - 69	0	5	4	8	1	9	0	6
05/09/2002	7	57.9	6.9	52 - 68	1	6	0	5	2	7	0	4
05/10/2002	2	58.5	9.2	52 - 65	0	1	1	2	0	2	0	2
05/11/2002	3	59.3	9.3	53 - 70	1	2	0	3	0	3	0	1
05/14/2002	7	60.7	6.7	52 - 72	0	7	0	7	0	7	0	5
05/15/2002	13	63.5	6.3	57 - 75	0	7	6	10	3	13	0	9
05/16/2002	2	56.5	2.1	55 - 58	0	2	0	1	1	2	0	2
05/17/2002	1	67.0	0.0	67 - 67	0	0	1	1	0	1	0	1
05/18/2002	8	57.0	3.6	52 - 64	0	3	5	5	3	8	0	8
05/21/2002	4	58.8	3.6	56 - 64	0	1	3	3	1	4	0	4
05/22/2002	6	60.3	2.5	58 - 64	0	3	3	4	2	6	0	6
05/23/2002	8	60.9	6.8	53 - 70	0	3	5	7	1	8	0	6
05/24/2002	16	61.9	7.7	52 - 79	0	15	1	13	3	16	0	13
05/25/2002	10	61.6	6.6	53 - 73	0	9	1	9	1	10	0	7

05/28/2002	2	58.5	9.2	52 - 65	0	1	1	2	0	2	0	2
05/29/2002	7	60.3	8.5	53 - 76	0	3	4	5	2	7	0	7
05/30/2002	9	58.1	7.7	51 - 76	1	4	4	5	4	9	0	4
05/31/2002	3	65.0	6.9	61 - 73	0	2	1	3	0	3	0	3
06/01/2002	4	58.5	5.7	51 - 65	2	2	0	3	1	4	0	4
06/04/2002	1	52.0	0.0	52 - 52	0	1	0	1	0	1	0	1
06/05/2002	0	0.0	0.0	0 - 0	0	0	0	0	0	0	0	0
06/08/2002	2	54.0	2.8	52 - 56	0	1	1	2	0	2	0	2
06/11/2002	2	52.0	2.8	50 - 54	1	0	1	2	0	2	0	1
06/12/2002	1	62.0	0.0	62 - 62	0	0	1	1	0	1	0	0
06/13/2002	1	54.0	0.0	54 - 54	0	1	0	0	1	1	0	0
06/14/2002	1	58.0	0.0	58 - 58	0	0	1	1	0	1	0	0
06/15/2002	1	63.0	0.0	63 - 63	0	1	0	1	0	1	0	1
06/19/2002	5	67.0	8.7	60 - 77	2	3	0	5	0	5	0	3
06/20/2002	3	64.0	13.1	52 - 78	0	2	1	3	0	3	0	2
06/21/2002	1	53.0	0.0	53 - 53	0	1	0	1	0	1	0	1
TOTALS	*** 821**				**96**	**533**	**192**	**484**	**337**	**813**	**5**	**566**

*Includes recaptured fish already implanted with a PIT tag.

Table E-3. Summary of the collection location, date, sample size (n), sample mean, standard deviation (SD), range of the fork lengths (cm), sex, and origin and condition of radio-tagged steelhead kelts in 2002.

Collection		Fork Length (cm)			Sex			Origin		Cond.
Site/Tag Date	**n**	**Mean**	**SD**	**Range**	**M**	**F**	**UN**	**Wild**	**Hatch**	**G & F**
MCN 15-April	7	59.6	8.4	47 - 70	0	7	0	5	2	4
MCN 16-April	10	60.0	5.2	53 – 68	0	8	2	9	1	8
MCN 17-April	9	57.2	3.8	53 – 65	0	9	0	6	3	8
MCN 18-April	12	59.5	5.2	52 – 70	0	11	1	7	5	11
MCN 19-April	5	60.8	7.1	55 – 72	0	5	0	5	0	3
MCN 29-April	19	60.5	7.1	49 – 77	0	19	0	14	5	19
MCN 30-April	19	58.3	6.2	49 – 74	0	15	4	13	6	14
MCN 1-May	17	59.3	5.2	53 – 71	0	12	5	12	5	14
MCN 2-May	25	60.1	5.6	50 – 70	2	19	4	13	12	22
MCN 3-May	26	61.3	6.3	53 – 76	2	21	3	13	13	21
MCN 13-May	12	61.7	6.1	55 – 72	0	10	2	8	4	12
MCN 14-May	25	56.2	2.7	52 – 65	0	22	3	10	15	25
MCN 15-May	18	59.7	5.4	52 – 70	0	15	3	10	8	17
MCN 16-May	20	60.8	8.0	52 – 80	0	19	1	13	7	20
MCN 17-May	12	61.3	7.6	53 – 73	1	7	4	7	5	12
MCN 28-May	10	60.0	6.1	52 – 72	1	9	0	7	3	10
MCN 29-May	7	62.9	10.1	51 – 77	2	3	2	7	0	7
MCN 30-May	9	58.8	4.8	50 – 66	1	5	3	8	1	9
MCN 31-May	10	59.8	2.6	55 – 62	2	7	1	7	3	10
MCN 1-June	3	56.0	5.0	51 – 61	0	2	1	0	3	3
MCN 5-June	8	61.0	9.9	53 – 83	2	6	0	7	1	8
MCN 6-June	11	60.8	7.9	56 – 83	2	8	1	9	2	11
MCN 7-June	5	57.4	6.2	49 – 66	1	4	0	5	0	5
MCN 8-June	1	57.0	0.0	57 – 57	0	0	1	1	0	1
JDD 8-June	2	54.0	2.8	52 – 56	0	1	1	2	0	2
JDD 11-June	2	52.0	2.8	50 – 54	1	0	1	2	0	1
JDD 12-June	1	62.0	0.0	62 – 62	0	0	1	1	0	0
JDD 13-June	1	54.0	0.0	54 – 54	0	1	0	0	1	0
JDD 14-June	1	58.0	0.0	58 – 58	0	0	1	1	0	0
JDD 15-June	1	63.0	0.0	63 – 63	0	1	0	1	0	1
JDD 19-June	5	67.0	8.7	60 – 77	2	3	0	5	0	3
JDD 20-June	3	64.0	13.1	52 – 78	0	2	1	3	0	2
JDD 21-June	1	53.0	0.0	53 – 53	0	1	0	1	0	1
Overall:	**317**				**19**	**252**	**47**	**212**	**105**	**284**

Table E-4. Summary of the collection date, sample size (n), sample mean, standard deviation (SD), range of the fork lengths (cm), sex, origin, coloration and condition of In-River vs. Transport steelhead from JDD in 2002.

Collect	Treatment		Fork Length (cm)			Sex			Origin		Coloration			Condition	
Date		n	Mean	SD	Range	M	F	Unk	Wild	Hatch	Bright	Inter	Dark	Good	Fair
18-Mar	TRAN	1	60.0	0.0	60 - 60	1	0	0	0	1	0	1	0	0	1
19-Mar	IR	2	63.0	1.4	62 - 64	1	0	1	0	2	0	1	1	0	2
20-Mar	TRAN	10	64.8	8.7	57 - 87	8	2	0	3	7	2	7	1	7	3
21-Mar	TRAN	3	56.7	1.5	55 - 58	1	0	2	0	3	0	3	0	3	0
22-Mar	IR	1	60.0	0.0	60 - 60	0	1	0	0	1	0	1	0	1	0
23-Mar	IR	1	64.0	0.0	64 - 64	1	0	0	0	1	0	1	0	1	0
25-Mar	IR	2	62.5	20.5	48 - 77	1	0	1	0	2	1	0	1	2	0
26-Mar	TRAN	8	63.6	7.8	56 - 81	5	3	0	1	7	0	5	3	8	0
27-Mar	IR	5	58.0	3.8	54 - 62	3	0	2	2	3	0	3	2	4	1
28-Mar	IR	1	58.0	0.0	58 - 58	1	0	0	1	0	0	0	1	0	1
28-Mar	TRAN	2	65.5	10.6	58 - 73	0	2	0	1	1	0	2	0	0	2
29-Mar	IR	7	62.9	6.2	57 - 76	0	3	4	1	6	0	5	2	3	4
30-Mar	IR	3	61.3	11.9	53 - 75	0	2	1	1	2	1	2	0	1	2
01-Apr	IR	6	63.3	9.5	56 - 82	1	4	1	1	5	2	4	0	1	5
02-Apr	IR	13	60.6	5.9	53 - 78	1	10	2	3	10	6	4	3	6	7
03-Apr	TRAN	11	60.4	5.9	53 - 73	0	5	6	5	6	4	7	0	7	4
04-Apr	TRAN	21	59.2	4.1	53 - 71	3	12	6	11	10	13	6	2	10	11
05-Apr	IR	25	62.3	6.9	52 - 81	2	16	7	16	9	22	2	1	16	9
06-Apr	TRAN	10	59.1	4.9	53 - 70	0	8	2	6	4	1	9	0	0	10
08-Apr	IR	11	57.9	2.8	54 - 62	3	8	0	5	6	5	4	2	2	9
09-Apr	TRAN	31	60.3	6.0	52 - 76	1	28	2	14	17	8	22	1	13	18
10-Apr	IR	23	61.3	6.2	51 - 75	0	17	6	10	13	11	10	2	9	14
11-Apr	TRAN	18	59.3	5.6	53 - 73	0	15	3	10	8	8	10	0	12	6
12-Apr	IR	10	59.3	3.0	56 - 65	0	5	5	6	4	1	9	0	3	7
13-Apr	TRAN	11	59.5	6.0	50 - 71	0	9	2	6	5	4	7	0	7	4
15-Apr	IR	8	60.5	7.7	51 - 74	0	8	0	3	5	1	7	0	3	5
16-Apr	IR	28	59.3	6.3	51 - 78	3	16	9	16	12	12	15	1	17	11
17-Apr	IR	23	64.0	6.4	55 - 74	0	12	11	16	7	12	11	0	6	17
18-Apr	TRAN	24	59.6	4.7	49 - 70	0	17	7	18	6	10	13	1	15	9
19-Apr	IR	24	61.3	5.3	54 - 74	0	21	3	15	9	6	18	0	7	17
20-Apr	TRAN	14	58.9	4.1	54 - 67	0	12	2	11	3	5	9	0	6	8
23-Apr	TRAN	11	57.5	3.6	51 - 63	0	11	0	8	3	4	7	0	4	7
24-Apr	IR	5	59.6	5.5	54 - 67	0	5	0	2	3	2	3	0	3	2
25-Apr	TRAN	18	60.2	5.1	54 - 69	0	13	5	9	9	8	10	0	15	3
26-Apr	IR	10	59.1	2.3	55 - 62	0	5	5	5	5	4	6	0	5	5
27-Apr	TRAN	8	58.4	4.0	56 - 68	0	7	1	5	3	3	5	0	4	4
30-Apr	IR	5	57.8	3.1	53 - 61	0	4	1	4	1	2	3	0	4	1
01-May	TRAN	6	58.8	2.0	56 - 61	0	3	3	4	2	1	5	0	3	3
02-May	IR	1	56.0	0.0	56 - 56	0	1	0	1	0	0	1	0	0	1
03-May	TRAN	8	59.8	4.6	53 - 69	0	6	2	7	1	3	5	0	4	4
04-May	TRAN	10	60.5	6.4	52 - 73	0	10	0	9	1	8	2	0	9	1
07-May	TRAN	4	59.0	6.2	54 - 68	0	4	0	3	1	2	2	0	3	1
08-May	IR	6	57.7	5.2	52 - 67	0	3	3	5	1	5	1	0	3	3
09-May	TRAN	3	61.0	6.6	55 - 68	0	3	0	3	0	3	0	0	3	0
10-May	IR	1	65.0	0.0	65 - 65	0	1	0	1	0	1	0	0	1	0
11-May	IR	1	70.0	0.0	70 - 70	0	1	0	1	0	0	1	0	0	1
14-May	IR	5	60.4	7.2	52 - 72	0	5	0	5	0	4	1	0	4	1

15-May	TRAN	9	63.2	6.2	57 - 75	0	4	5	7	2	6	3	0	3	6
16-May	TRAN	2	56.5	2.1	55 - 58	0	2	0	1	1	2	0	0	2	0
17-May	IR	1	67.0	0.0	67 - 67	0	0	1	1	0	1	0	0	0	1
18-May	TRAN	8	57.0	3.6	52 - 64	0	3	5	5	3	6	2	0	8	0
21-May	TRAN	4	58.8	3.6	56 - 64	0	1	3	3	1	3	1	0	4	0
22-May	IR	6	60.3	2.5	58 - 64	0	3	3	4	2	2	4	0	0	6
23-May	TRAN	6	61.0	6.9	53 - 70	0	2	4	5	1	4	2	0	4	2
24-May	TRAN	13	60.7	7.9	52 - 79	0	13	0	11	2	11	2	0	10	3
25-May	TRAN	7	63.1	7.3	53 - 73	0	7	0	6	1	5	2	0	7	0
28-May	IR	2	58.5	9.2	52 - 65	0	1	1	2	0	0	2	0	0	2
29-May	IR	7	60.3	8.5	53 - 76	0	3	4	5	2	7	0	0	5	2
30-May	TRAN	3	53.3	2.5	51 - 56	0	1	2	3	0	0	3	0	1	2
31-May	IR	3	65.0	6.9	61 - 73	0	2	1	3	0	1	2	0	0	3
01-Jun	TRAN	2	62.0	4.2	59 - 65	0	2	0	1	1	2	0	0	2	0
04-Jun	IR	1	52.0	0.0	52 - 52	0	1	0	1	0	1	0	0	1	0
TOTALS	***IR***	***247***				***17***	***158***	***72***	***136***	***111***	***110***	***121***	***16***	***108***	***139***
	TRAN	***286***				***19***	***205***	***62***	***176***	***110***	***126***	***152***	***8***	***174***	***112***
	Total	**533**				**36**	**363**	**134**	**312**	**221**	**236**	**273**	**24**	**282**	**251**

Table E-5. Summary of returns by release date, sample mean, standard deviation (SD), and range of the fork lengths (cm), sex, origin and condition of steelhead kelts from 2002 releases.

Returns		Fork Length (cm)			Sex			Origin		Condition		
Release Date	**n**	**Average**	**SD**	**Range**	**Male**	**Female**	**Unk**	**Wild**	**Hatch**	**Good**	**Fair**	**Poor**
03/29/2002	1	63.00	0.00	63-63	0	1	0	0	1	0	1	0
04/03/2002	1	67.00	0.00	67-67	0	0	1	0	1	1	0	0
04/04/2002	1	57.00	0.00	57-57	0	0	1	1	0	1	0	0
04/05/2002	5	66.60	8.05	55-81	1	3	1	3	2	4	1	0
04/06/2002	1	60.00	0.00	60-60	0	0	1	0	1	0	1	0
04/08/2002	1	61.00	0.00	61-61	0	1	0	0	1	1	0	0
04/09/2002	1	62.00	0.00	62-62	0	1	0	0	1	0	1	0
04/10/2002	4	57.75	3.49	54-64	0	3	1	1	3	3	1	0
04/11/2002	4	60.00	4.94	54-69	0	1	3	4	0	2	2	0
04/12/2002	1	57.00	0.00	57-57	1	0	0	1	0	1	0	0
04/13/2002	1	50.00	0.00	50-50	0	1	0	1	0	1	0	0
04/15/2002	1	60.00	0.00	60-60	0	1	0	0	1	1	0	0
04/16/2002	3	59.33	2.16	56-62	0	0	3	0	3	3	0	0
04/17/2002	3	65.00	4.24	59-71	0	3	0	3	0	1	2	0
04/18/2002	7	58.14	4.26	49-64	0	6	1	6	1	6	0	1
04/19/2002	2	56.00	0.00	56-56	0	2	0	2	0	1	1	0
04/20/2002	3	62.00	3.54	57-67	0	3	0	1	2	3	0	0
04/23/2002	2	57.50	1.22	56-59	0	2	0	2	0	2	0	0
04/24/2002	1	65.00	0.00	65-65	0	1	0	1	0	1	0	0
04/25/2002	1	55.00	0.00	55-55	0	1	0	0	1	1	0	0
04/27/2002	1	58.00	0.00	58-58	0	1	0	0	1	1	0	0
04/29/2002	1	64.00	0.00	64-64	0	1	0	1	0	1	0	0
04/30/2002	2	57.50	2.04	55-60	0	2	0	2	0	2	0	0
05/01/2002	5	59.40	5.43	54-71	1	3	1	5	0	4	0	1
05/02/2002	2	57.50	0.41	57-58	0	2	0	1	1	2	0	0
05/03/2002	2	57.00	3.27	53-61	0	1	1	2	0	1	1	0
05/04/2002	4	62.00	5.48	52-67	1	3	0	4	0	4	0	0
05/07/2002	1	54.00	0.00	54-54	0	1	0	1	0	1	0	0
05/13/2002	2	70.50	0.41	70-71	0	2	0	2	0	2	0	0
05/14/2002	5	56.20	2.91	52-60	0	5	0	4	1	5	0	0
05/15/2002	3	63.67	2.27	60-66	0	3	0	2	1	2	1	0
05/17/2002	1	71.00	0.00	71-71	0	1	0	1	0	0	1	0
05/18/2002	1	57.00	0.00	57-57	0	0	1	1	0	1	0	0
05/22/2002	2	58.50	0.41	58-59	0	1	1	1	1	0	2	0
05/23/2002	1	69.00	0.00	69-69	0	0	1	1	0	0	1	0
05/24/2002	2	56.50	1.22	55-58	0	2	0	2	0	1	1	0
05/30/2002	1	56.00	0.00	56-56	0	1	0	1	0	1	0	0
05/31/2002	2	67.00	4.90	61-73	0	1	1	2	0	0	2	0
06/01/2002	1	51.00	0.00	51-51	1	0	0	1	0	1	0	0
06/05/2002	1	54.00	0.00	54-54	0	1	0	1	0	1	0	0
TOTALS	**84**				**5**	**61**	**18**	**61**	**23**	**63**	**19**	**2**