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Survival Estimates for the Passage of Spring-Migrating Juvenile Salmonids through Snake and Columbia River Dams and Reservoirs

Annual Report 2004 - 2005 October 2005 DOE/BP-00004922-6

This Document should be cited as follows:

Smith, Steven, William Muir, Douglas Marsh, John Williams, John Skalski, "Survival Estimates for the Passage of Spring-Migrating Juvenile Salmonids through Snake and Columbia River Dams and Reservoirs", 2004-2005 Annual Report, Project No. 199302900, 107 electronic pages, (BPA Report DOE/BP-00004922-6)

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P.O. Box 3621
Portland, OR 97208

This report was funded by the Bonneville Power Administration (BPA), U.S. Department of Energy, as part of BPA's program to protect, mitigate, and enhance fish and wildlife affected by the development and operation of hydroelectric facilities on the Columbia River and its tributaries. The views in this report are the author's and do not necessarily represent the views of BPA.

Survival Estimates for the Passage of Spring-Migrating Juvenile Salmonids through Snake and Columbia River Dams and Reservoirs, 2004

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Report of research prepared for

U.S. Department of Energy
Bonneville Power Administration
Division of Fish and Wildlife
Contract 00004922
Project 199302900

October 2005

EXECUTIVE SUMMARY

In 2004, the National Marine Fisheries Service and the University of Washington completed the twelfth year of a study to estimate survival and travel time of juvenile salmonids (*Oncorhynchus* spp.) passing through dams and reservoirs on the Snake and Columbia Rivers. All estimates were derived from detections of fish tagged with passive integrated transponder tags (PIT tags). We PIT tagged and released a total of 19,621 hatchery steelhead, 8,128 wild steelhead, and 9,227 wild yearling Chinook salmon at Lower Granite Dam. In addition, we utilized fish PIT tagged by other agencies at traps and hatcheries upstream from the hydropower system and sites within the hydropower system. PIT-tagged smolts were detected at interrogation facilities at Lower Granite, Little Goose, Lower Monumental, McNary, John Day, and Bonneville Dams and in the PIT-tag detector trawl operated in the Columbia River estuary. Survival estimates were calculated using a statistical model for tag-recapture data from single release groups (the single-release model).

Primary research objectives in 2004 were to 1) estimate reach survival and travel time in the Snake and Columbia Rivers throughout the migration period of yearling Chinook salmon *O. tshawytscha* and steelhead *O. mykiss*; 2) evaluate relationships between survival estimates and migration conditions; and 3) evaluate the survival-estimation models under prevailing conditions.

This report provides reach survival and travel time estimates for 2004 for PIT-tagged yearling Chinook salmon (hatchery and wild), hatchery sockeye salmon *O. nerka*, hatchery coho salmon *O. kisutch*, and steelhead (hatchery and wild) in the Snake and Columbia Rivers. Results are reported primarily in the form of tables and figures; details on methodology and statistical models used are provided in previous reports cited here.

Survival and detection probabilities were estimated precisely for most of the 2004 yearling Chinook salmon and steelhead migrations. Hatchery and wild fish were combined in some of the analyses. Overall, the percentages for combined release groups used in survival analyses were 68% hatchery-reared yearling Chinook salmon and 32% wild. For steelhead, the overall percentages were 73% hatchery-reared and 27% wild.

Estimated survival from the tailrace of Lower Granite Dam to the tailrace of Little Goose Dam averaged 0.923 for yearling Chinook salmon and 0.860 for steelhead. Respective average survival estimates for yearling Chinook salmon and steelhead were 0.875 and 0.820 from Little Goose Dam tailrace to Lower Monumental Dam tailrace; 0.818 and 0.519 from Lower Monumental Dam tailrace to McNary Dam tailrace (including passage through Ice Harbor Dam); and 0.809 and 0.465 from McNary Dam

tailrace to John Day Dam tailrace. Survival for yearling Chinook salmon from John Day Dam tailrace to Bonneville Dam tailrace (including passage through The Dalles Dam) was 0.735. We were unable to estimate survival through this reach for steelhead during 2004 because too few fish were detected at Bonneville Dam due to operation of the new corner collector at the second powerhouse.

Combining average estimates from the Snake River smolt trap to Lower Granite Dam, from Lower Granite Dam to McNary Dam, and from McNary Dam to Bonneville Dam, estimated annual average survival through the entire hydropower system from the head of Lower Granite reservoir to the tailrace of Bonneville Dam (eight projects) was 0.353 (s.e. 0.045) for Snake River yearling Chinook salmon. We could not empirically estimate survival through the entire system for steelhead in 2004 because of low detection rates for this species at Bonneville Dam.

For yearling spring Chinook salmon released in the Upper Columbia River, estimated survival from point of release to McNary Dam tailrace was 0.484 (s.e. 0.005) for fish released from Leavenworth Hatchery, 0.748 (s.e. 0.015) for fish released from Entiat Hatchery, 0.738 (s.e. 0.036) for fish released from Winthrop Hatchery, and 0.702 (s.e. 0.048) and 0.747 (s.e.0.047) for those from Methow Hatchery, Chewuch Pond and Twisp Pond, respectively. Using pooled data, estimated survival for these groups was 0.741 (s.e. 0.038) from McNary Dam tailrace to John Day tailrace and 0.840 (s.e. 0.111) from John Day Dam tailrace to Bonneville Dam tailrace.

For 13 groups of steelhead released in the Upper Columbia River, estimated survival from point of release to McNary Dam tailrace ranged from 0.510 (s.e. 0.025) for fish released from Wells Hatchery in the Similkameen River (507 km from McNary Dam) to 0.293 (s.e. 0.022) for fish released from East Bank Hatchery into Nason Creek (373 km from McNary Dam). Using pooled data, estimated survival for these groups was 0.786 (s.e. 0.059) from McNary Dam tailrace to John Day tailrace and 0.620 (s.e. 0.264) from John Day Dam tailrace to Bonneville Dam tailrace.

Because of the relatively dry winter and cool spring, flow volume during the majority of the 2004 spring migration period was similar to that in 2002, and only slightly higher than in 2001, which was the lowest recorded during the twelve years of this study. Because of low flows, spill was curtailed in the Snake River and transportation was maximized for most of the spring migration season, similar to 2001. Yearling Chinook salmon and steelhead (where it could be estimated) survival in 2004 was lower than in 2002 and 2003, but higher than in 2001 through all reaches. Steelhead survival remained depressed compared to earlier years through some reaches and the entire hydropower system. PIT-tag detections on avian bird colonies in those reaches continued to account for much of the additional loss compared with earlier years.

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INTRODUCTION

Accurate and precise survival estimates for juvenile Chinook salmon *Oncorhynchus tshawytscha*, sockeye salmon *O. nerka* and steelhead *O. mykiss* that migrate through reservoirs, hydroelectric projects, and free-flowing sections of the Snake and Columbia Rivers are essential to develop effective strategies for their recovery. Many present management strategies were based on estimates of system survival (Raymond 1979; Sims and Ossiander 1981) derived in a river system considerably different from today's (Williams and Matthews 1995; Williams et al. 2001). Knowledge of the magnitude, locations, and causes of smolt mortality under present passage conditions, and under conditions projected for the future, are necessary to develop strategies that will optimize smolt survival during migration.

From 1993 through 2003, the National Marine Fisheries Service (NMFS) and the University of Washington (UW) demonstrated the feasibility of using three statistical models to estimate survival of PIT-tagged (Prentice et al. 1990a) juvenile salmonids passing through Snake River dams and reservoirs (Iwamoto et al. 1994; Muir et al. 1995, 1996, 2001a, 2003; Smith et al. 1998, 2000a,b, 2003; Hockersmith et al. 1999; Zabel et al. 2001, 2002). Evaluation of assumptions for these models indicated that all were generally satisfied, and accurate and precise survival estimates were obtained.

In 2004, NMFS and UW completed the twelfth year of the study. Spring-time flow levels during 2004 were only slightly higher than in 2001. As a result, spill was curtailed at Snake River dams for most of the spring migration season and transportation was maximized, similar to 2001. Research objectives were to: 1) estimate reach survival and travel time in the Snake and Columbia Rivers throughout the yearling Chinook salmon and steelhead migrations; 2) evaluate relationships between survival estimates and migration conditions; and 3) evaluate the performance of the survival-estimation models under prevailing operational and environmental conditions. Additionally, as adult return information becomes available, as part of this study we will evaluate relationships between juvenile survival and subsequent adult returns for fish with different juvenile migration histories. This task was recently completed for adult returns through 2003 and reported via Technical Memorandum (Williams et al. 2004).

METHODS

Experimental Design

The Single-Release (SR) Model was used to estimate survival for groups of PIT-tagged yearling Chinook salmon, sockeye salmon, and steelhead released from Snake River Basin hatcheries and traps, Lower Granite Dam, and Upper Columbia River hatcheries and dams in 2004 (Cormack 1964; Jolly 1965; Seber 1965; Skalski 1998; Skalski et al. 1998; Muir et al. 2001a,b). Iwamoto et al. (1994) presented background information and underlying statistical theory.

During the 2004 migration season, automatic PIT-tag detectors (Prentice et al. 1990a,b,c) were operational in the juvenile bypass systems at Lower Granite (RKm 695), Little Goose (RKm 635), Lower Monumental (RKm 589), McNary (RKm 470), John Day (RKm 347), and Bonneville (RKm 234) Dams (Fig. 1). The most downstream site for PIT-tag detections was in the Columbia River estuary between RKm 65 and 84, where a pair trawl towed a PIT-tag detector (Ledgerwood et al. 2004). During 2004, the new corner collector at Bonneville Dam's second powerhouse was operated during the spring. This diverted many smolts away from the PIT tag detectors in the second powerhouse bypass system.

A large proportion of PIT-tagged yearling Chinook salmon released above Lower Granite Dam were released for a multi-agency comparative survival study (CSS) in 2004. Of CSS fish detected at Lower Granite Dam in 2004, 61% were collected and transported, and 36% of those detected at Little Goose Dam were transported. A large proportion of PIT-tagged fish in the Upper Columbia River were released for a study of transportation from McNary Dam; about 47% of those detected at McNary Dam were collected and transported. All other PIT-tagged fish detected at dams were diverted back to the river by slide gates, which allowed for the possibility of detection of a particular fish at more than one downstream site (Marsh et al. 1999).

For fish released in the Snake River Basin, we used the records of downstream PIT-tag detections in the SR Model to estimate survival from the point of release to Lower Granite Dam tailrace, from Lower Granite Dam tailrace to Little Goose Dam tailrace, from Little Goose Dam tailrace to Lower Monumental Dam tailrace, from Lower Monumental Dam tailrace to McNary Dam tailrace, from McNary Dam tailrace to John Day Dam tailrace, and from John Day Dam tailrace to Bonneville Dam tailrace. For fish released in the Upper Columbia River, we estimated survival from the point of release to the tailrace of McNary Dam, from McNary Dam tailrace to John Day Dam tailrace, and from John Day Dam tailrace to Bonneville Dam tailrace.

Lower Granite Dam Tailrace Release Groups

During 2004, hatchery steelhead, wild steelhead, and wild yearling Chinook salmon were collected at the Lower Granite Dam juvenile facility, PIT tagged, and released in approximate proportion to their arrival at Lower Granite Dam throughout the migration season. No hatchery yearling Chinook salmon were PIT tagged specifically for this study because the numbers of fish PIT tagged and released from Snake River Basin hatcheries and traps for other studies were sufficient for analysis.

For both yearling Chinook salmon and steelhead tagged above Lower Granite Dam and subsequently detected at Lower Granite Dam and released to the tailrace, we created daily "release groups" by combining detections at Lower Granite Dam that occurred on the same day. These groups were then combined with fish tagged and released each day at Lower Granite Dam. These daily release groups were then pooled into weekly groups, and we estimated survival probabilities in the reaches between Lower Granite Dam tailrace and McNary Dam tailrace for both the daily and weekly groups.

McNary Dam Tailrace Release Groups

For both yearling Chinook salmon and steelhead tagged at all locations in the Snake River Basin, and for fish tagged in the Upper Columbia River, we created daily "release groups" of fish according to the day of detection at McNary Dam. Daily groups consisted of fish that were detected and returned to the tailrace, and daily groups were pooled into weekly groups. For weekly groups leaving McNary Dam, we estimated survival from McNary Dam tailrace to John Day Dam tailrace and from John Day Dam tailrace to Bonneville Dam tailrace (yearling Chinook salmon only in 2004).

Hatchery and Trap Release Groups

In 2004, most hatcheries in the Snake River Basin released PIT-tagged fish as part of research separate from the NMFS/UW survival study. We analyzed data from hatchery releases of PIT-tagged yearling Chinook salmon, sockeye salmon, coho salmon, and steelhead to provide estimates of survival and detection probabilities from release to the tailrace of Lower Granite Dam and to points downstream. We also estimated survival from release to the tailrace of McNary Dam for yearling spring Chinook salmon released from Winthrop, Entiat, Leavenworth, and Methow hatcheries and steelhead from Wells, Chelan, East Bank, Ringold, and Winthrop hatcheries in the Upper Columbia River Basin. In the course of characterizing the various hatchery releases, preliminary analyses

were performed to determine whether data from multiple release groups could be pooled to increase sample sizes. We neither intended nor attempted to analyze the experiments for which the hatchery groups were released.

We also estimated survival for releases of wild and hatchery PIT-tagged yearling Chinook salmon and steelhead from the Salmon (White Bird), Snake, and Clearwater River traps, and many more smolt traps throughout the Snake River Basin to Lower Granite Dam tailrace and points downstream.

Survival was also estimated for releases of yearling summer/fall Chinook salmon from four Upper and Mid Columbia River dams to the tailrace of McNary Dam and to points downstream.

Data Analysis

Tagging and detection data were uploaded to and later retrieved from the PIT Tag Information System (PTAGIS), a regional database maintained by the Pacific States Marine Fisheries Commission (PSMFC 1996). Data were examined for erroneous records, inconsistencies, and data anomalies. Records were eliminated where appropriate, and all eliminated PIT-tag codes were recorded with the reasons for their elimination. For each remaining PIT-tag code, we constructed a record ("detection history") indicating at which sites the tagged fish was detected and at which it was not detected. Methods for data retrieval, database quality assurance/control, and construction of detection histories were the same as those used in past years (see Iwamoto et al. 1994 for detail).

These analyses were conducted with currently available data. It is possible, for a variety of reasons, that the data in the PTAGIS database may be updated. Thus, estimates provided by NMFS or employed in analyses in the future may differ slightly from those presented here.

Tests of Assumptions

As in past years, we evaluated assumptions of the SR Model as applied to the data generated from PIT-tagged juvenile salmonids in the Snake and Columbia Rivers (Burnham et al. 1987).

Survival Estimation

Estimates of survival probabilities under the SR Model are random variables, subject to sampling variability. When true survival probabilities are close to 1.0 and/or when sampling variability is high, it is possible for estimates of survival probabilities to exceed 1.0. For practical purposes, estimates should be considered equal to 1.0 in these cases.

When estimates for a particular river section or passage route were available from more than one release group, the estimates were often combined using a weighted average (Muir et al. 2001a). Weights were inversely proportional to the respective estimated relative variance (coefficient of variation squared). The variance of an estimated survival probability from the SR Model is a function of the estimate itself. Consequently, lower survival estimates tend to have smaller estimated variance. Therefore, we do not use the inverse estimated absolute variance in weighting because lower survival estimates have disproportionate influence, and the resulting weighted mean is biased toward the lower survival estimates.

All survival estimates presented are from point of release (or the tailrace of a dam) to the tailrace of a dam downstream. All survival and detection probability estimates were computed using the statistical computer program SURPH ("Survival with Proportional Hazards") for analyzing release-recapture data, developed at the University of Washington (Skalski et al. 1993; Smith et al. 1994).

Survival Estimates from Point of Release to Bonneville Dam

We estimated survival from point of release to the tailrace of Bonneville Dam (the last dam encountered by seaward-migrating juvenile salmonids) for various stocks from both the Snake and Upper Columbia Rivers. These estimates were obtained by first estimating weighted average estimated survival over shorter reaches for daily or weekly release groups using the same weighting scheme described above. These average survival estimates were then multiplied to compute the estimated survival probability through the entire reach.

We pooled similar fish from different release sites when we re-formed release groups at downstream sites. For example, for Snake River yearling Chinook salmon, we multiplied the weighted mean survival estimate for daily groups from Lower Granite Dam tailrace to McNary Dam tailrace by the weighted mean estimate for weekly groups from McNary Dam tailrace to Bonneville Dam tailrace to obtain an overall estimated mean survival probability from Lower Granite Dam tailrace to Bonneville Dam tailrace.

Finally, we multiplied this result by the survival estimate from fish released from the Snake River trap to Lower Granite Dam to compute estimated survival from the head of Lower Granite Reservoir to the tailrace of Bonneville Dam; essentially the entire eight-project hydropower system negotiated by juvenile salmonids from the Snake River Basin.

Travel Time and Migration Rate

Travel times were calculated for yearling Chinook salmon and steelhead from 1) Lower Granite Dam to Little Goose Dam (60 km), 2) Little Goose Dam to Lower Monumental Dam (46 km), 3) Lower Monumental Dam to McNary Dam (199 km), 4) Lower Granite Dam to McNary Dam (225 km), 5) Lower Granite Dam to Bonneville Dam (461 km), 6) McNary Dam to John Day Dam (123 km), 7) John Day Dam to Bonneville Dam (113 km), and 8) McNary Dam to Bonneville Dam (236 km). Travel time between any two dams was calculated for each fish detected at both dams as the number of days between last detection at the upstream dam (generally at a PIT-tag detector close enough to the outfall site that fish arrived in the tailrace within minutes after detection) and first detection at the downstream dam. Travel time included the time required to move through the reservoir to the forebay of the downstream dam and any delay associated with residence in the forebay, gatewells, or collection channel prior to detection in the juvenile bypass system.

Migration rate through a river section was calculated as the length of the section (km) divided by the travel time (days) (which included any delay at dams as noted above). For each group, the 20th percentile, median, and 80th percentile travel times and migration rates were determined.

The true complete set of travel times for a release group includes travel times of both detected and nondetected fish. However, using PIT tags, travel times cannot be determined for a fish that traverses a river section but is not detected at both ends of the section. Travel time statistics are computed only from travel times for detected fish, which represent a sample of the complete set. Nondetected fish pass dams via turbines and spill; thus, their time to pass a dam is typically minutes to hours shorter than detected fish passing to the tailrace via the juvenile bypass system.

Comparison of Annual Survival Estimates

We made two comparisons of 2004 results to those obtained in previous years of the NMFS/UW survival study. First, we related survival estimates from specific hatcheries to Lower Granite Dam to migration distance. Second, we compared season-wide survival estimates for specific reaches across years.

Flow and Spill In Relation to Juvenile Salmonid Survival and Travel Time

Annual travel time and reach survival estimates were compared across years to investigate relationships with general flow and spill conditions during the spring migration. Trends within the 2004 season are also discussed.

RESULTS

Lower Granite Dam Tagging and Release Information

During 2004, a total of 69,068 yearling Chinook salmon (46,686 hatchery origin, 22,318 wild) were detected and released or PIT tagged and released to the river in the tailrace of Lower Granite Dam. Steelhead we tagged at Lower Granite Dam and released to the tailrace were combined with those that were released upstream, detected at the dam, and returned to the river, for a total of 55,028 (40,150 hatchery origin, 14,878 wild).

For both species, not all fish were included in the analyses because some fish passed Lower Granite Dam early or late in the season when sample sizes were too small to produce reliable survival or travel time estimates. Survival estimates for wild and hatchery fish combined were predominately based on fish of hatchery origin for yearling Chinook salmon (68% hatchery) and steelhead (73% hatchery) during 2004.

Survival Estimation

Tests of Assumptions

Assumption tests for 2004 indicated a few more significant results than would be expected by chance alone. We present a detailed discussion of the assumption tests, the extent of their violations, possible reasons for the occurrence of the violations, and the implications in the Appendix.

Snake River Yearling Chinook Salmon

Survival probabilities were estimated for weekly groups of yearling Chinook salmon released to the tailrace of Lower Granite Dam for 13 consecutive weeks from 30 March through 28 June. Survival estimates from Lower Granite Dam tailrace to Little Goose Dam tailrace averaged 0.923 (s.e. 0.004; Table 1). From Little Goose Dam tailrace to Lower Monumental Dam tailrace, estimated survival averaged 0.875 (s.e. 0.012). From Lower Monumental Dam tailrace to McNary Dam tailrace, estimated survival averaged 0.818 (s.e. 0.018). For the combined reach from Lower Granite Dam tailrace to McNary Dam tailrace, survival averaged 0.666 (s.e. 0.011).

We estimated survival probabilities for weekly groups of yearling Chinook salmon released in the tailrace at McNary Dam for nine consecutive weeks from 20 April through 21 June. From McNary Dam tailrace to John Day Dam tailrace, estimated survival averaged 0.809 (s.e. 0.028; Table 2). From John Day Dam tailrace to Bonneville Dam tailrace estimated survival averaged 0.735 (s.e. 0.092). For the combined reach from McNary Dam to Bonneville Dam, estimated survival averaged 0.594 (s.e. 0.074).

The product of the average estimates from Lower Granite Dam to McNary Dam and from McNary Dam to Bonneville Dam provided an overall survival estimate from Lower Granite Dam tailrace to Bonneville Dam tailrace of 0.395 (s.e. 0.050). Estimated survival probability through Lower Granite Reservoir and Dam for Snake River wild and hatchery Chinook salmon released from the Snake River trap was 0.893 (s.e. 0.009). Thus, estimated survival probability through all eight hydrosystem projects encountered by Snake River yearling Chinook salmon was 0.353 (0.045).

We also calculated separate survival probability estimates for weekly groups of hatchery and wild yearling Chinook salmon from Lower Granite Dam tailrace to McNary Dam tailrace (Tables 3 and 4). Weighted mean survival estimates for wild and hatchery yearling Chinook salmon were nearly the same for the combined reach from the tailrace of Lower Granite Dam to the tailrace of McNary Dam in 2004.

Estimated survival probabilities for daily Lower Granite Dam release groups of yearling Chinook salmon (hatchery and wild combined) detected and released to the tailrace of Lower Granite Dam did not show any consistent increase or decrease through the migration season during 2004 through Snake River reaches (Table 5, Fig. 2).

Estimates of detection probability at Snake River dams for the weekly groups varied throughout the season, primarily because of varying levels of spill, including no spill from 14 April through the end of May at Lower Granite and Little Goose Dams, and from 14 May through the end of May at Lower Monumental Dam (Tables 6-9).

Snake River Steelhead

We estimated survival probabilities for weekly groups of steelhead released in the tailrace of Lower Granite Dam for 11 consecutive weeks from 30 March through 14 June. Survival estimates from Lower Granite Dam tailrace to Little Goose Dam tailrace averaged 0.860 (s.e. 0.006; Table 10). From Little Goose Dam tailrace to Lower Monumental Dam tailrace, estimated survival averaged 0.820 (s.e. 0.014). From Lower

Monumental Dam tailrace to McNary Dam tailrace, estimated survival averaged 0.519 (s.e. 0.035). For the combined reach from Lower Granite Dam tailrace to McNary Dam tailrace, survival averaged 0.379 (s.e. 0.023).

We estimated survival probabilities for weekly groups of steelhead released in the tailrace of McNary Dam for six consecutive weeks from 27 April through 7 June. From McNary Dam tailrace to John Day Dam tailrace, estimated survival averaged 0.465 (s.e. .078; Table 11). Because of poor detection rates at Bonneville Dam for steelhead, we were unable to estimate survival from John Day Dam tailrace to Bonneville Dam tailrace, or for the combined reach from McNary Dam to Bonneville Dam in 2004.

Lacking an estimate of survival from the tailrace of John Day Dam to the tailrace of Bonneville Dam, we were unable to empirically estimate survival through the entire hydropower system for steelhead in 2004. The product of the average estimates from Lower Granite Dam to McNary Dam and from McNary Dam to John Day Dam provided an overall average survival estimate from Lower Granite Dam tailrace to John Day Dam tailrace of 0.176 (s.e. 0.031). The estimated survival through Lower Granite Reservoir and Dam for Snake River wild and hatchery steelhead released from the Snake River trap was 0.948 (s.e. 0.004). Thus, the estimated survival probability through six of the eight hydrosystem projects encountered by Snake River steelhead was 0.167 (s.e. 0.018).

Survival probabilities were estimated separately for weekly groups of hatchery and wild steelhead from Lower Granite Dam tailrace to McNary Dam tailrace (Tables 12 and 13). Survival estimates for wild and hatchery steelhead through most reaches and the reaches combined were similar.

Estimated survival probabilities from Lower Monumental to McNary Dam (and hence for the overall reach from Lower Granite Dam to McNary Dam) for daily release groups of steelhead (hatchery and wild combined) detected and released, or PIT tagged and released to the tailrace of Lower Granite Dam tended to decrease as the season progressed (Table 14, Fig. 3). Detection probability estimates for the daily and weekly groups varied throughout the season, primarily because of varying levels of spill, including no spill from 14 April through the end of May at Lower Granite and Little Goose Dams, and from 14 May through the end of May at Lower Monumental Dam (Tables 15-18).

Snake River Hatchery Release Groups

Estimated survival probabilities of PIT-tagged hatchery yearling Chinook salmon, sockeye salmon, coho salmon, and steelhead from release at Snake River Basin hatcheries to the tailrace of Lower Granite Dam and downstream dams varied among hatcheries and release locations (Tables 19-21), as did estimated detection probabilities at the detection sites (Tables 22-24).

Snake River Smolt Trap Release Groups

Survival probability estimates for juvenile salmonids PIT tagged and released from Snake River Basin smolt traps were generally inversely related to distance of the traps to Lower Granite Dam (Table 25). Estimated survival for yearling Chinook salmon released from traps "late" (in June) were generally much lower than for earlier releases. Estimated detection probabilities were similar among release groups of the same species from different traps (Table 26).

Upper Columbia River Hatchery Release Groups

Survival probabilities of PIT-tagged hatchery yearling Chinook salmon and steelhead from release at Upper Columbia River hatcheries to the tailrace of McNary Dam varied among hatcheries and release locations (Table 27). Detection probabilities at downstream dams were similar for most yearling Chinook salmon and steelhead from all hatcheries (Table 28). Some yearling Chinook salmon arrived at McNary Dam before the period with greatest spill percentage, and the portion of early arrivals was not equal among hatcheries. This resulted in higher average detection probabilities for fish from Leavenworth Hatchery, and especially for fish from Entiat Hatchery.

Travel Time and Migration Rate

Travel time estimates for yearling Chinook salmon and juvenile steelhead released in the tailraces of Lower Granite and McNary Dams varied throughout the season (Tables 29-36). For both species, migration rates were generally highest in the lower river sections. Migration rates generally increased over time as flow and water temperature increased, and, presumably, as fish became more smolted (Fig. 4). Travel time for yearling Chinook salmon from Lower Granite to McNary Dam decreased during April independent of flow while travel time for steelhead varied throughout the spring with no apparent trend (Fig. 5).

Tagging Details for Fish PIT Tagged at Lower Granite Dam

We tagged 19,621 hatchery steelhead, 8,128 wild steelhead, and 9,227 wild yearling Chinook salmon from 13 April through 11 June at Lower Granite Dam for survival estimates (Table 37-39). There were 30, 12, and 81 mortalities, for hatchery steelhead, wild steelhead, and yearling Chinook salmon, respectively, representing less than 1% of the total handled.

Comparison of Annual Survival Estimates

Estimates of yearling Chinook salmon survival from Snake River Basin hatcheries to Lower Granite Dam tailrace for 2004 were similar to those made in past recent years (Table 40). Over the years of the study, we have consistently observed an inverse relationship between the migration distance from the release site to Lower Granite Dam and the estimated survival through that reach (Fig. 6). For 1993-2004 estimates, the negative linear correlation between migration distance and estimated survival was significant ($R^2 = 0.948$, $P < 0.001$).

For yearling Chinook salmon, estimated survival in 2004 was lower than that estimated in 2003 through all reaches, but improved over survival in 2001 (Table 41; Figs. 7-8). For steelhead, survival estimates in 2004 were lower through all reaches where it could be measured except the first (Lower Granite Dam tailrace to Little Goose Dam tailrace) compared to 2003, but improved over 2001 estimates. Steelhead survival remained particularly depressed through the Lower Monumental Dam to McNary Dam and McNary to John Day Dam reaches (Table 42; Figs. 7-8).

For yearling Chinook salmon, mean survival for all years combined was similar through each of the Snake River reaches (0.90-0.92) and similar but lower through Columbia River reaches (0.85-0.87; Table 41). For steelhead, mean survival across years showed a slight decline through successive reaches, and was lowest through the McNary to John Day reach (0.73), the reach with the longest reservoir (Table 42). Omitting estimates from 2001, average survival estimates for steelhead are more similar to those for yearling Chinook salmon through most reaches.

For several years, we have combined empirical survival estimates from various reaches for Snake River yearling Chinook salmon (data were sufficient starting in 1999) and steelhead (starting in 1997, but not in 2004) to calculate estimates throughout the entire hydropower system, from the head of Lower Granite Reservoir (Snake River smolt

trap) to the tailrace of Bonneville Dam (Table 43). For yearling Chinook salmon, hydropower system survival was the second lowest measured, but higher than in 2001.

Flow and Spill In Relation to Juvenile Salmonid Survival and Travel Time

Snake River flow volume during the yearling Chinook salmon migration period was expressed as flow exposure at Lower Monumental Dam for each release group. Average flow exposure during 2004 (76.9 kcfs) was nearly the same as that in 2002 (77.6 kcfs), much lower than in 2003 (93.5 kcfs) but higher than during 2001 (69.5 kcfs) (Fig. 9). Flows increased in mid- to late May after most of the yearling Chinook salmon migration had left the Snake River.

Because steelhead migrate later in the spring, a larger portion of them migrated during the greater flow volume that occurred later in the migration season. Average flow exposure for steelhead during 2004 was 90.8 kcfs; lower than 2003 (117.4 kcfs), very similar to 2002 (91.6 kcfs), and higher than in 2001 (78.9 kcfs) (Fig.10).

Because of low flows, transportation of smolts was maximized and no spill provided from 14 April through the end of May at Lower Granite and Little Goose Dams, and from 14 May through the end of May at Lower Monumental Dam. Spill continued at all other Snake and Columbia River Dams. During 2001, spill was eliminated at some projects (Lower Granite, Little Goose, and Lower Monumental Dams) and limited in volume and duration at others (Ice Harbor, McNary, John Day, and Bonneville Dams).

Comparing travel times of yearling Chinook salmon and steelhead among years, 2004 travel times between Lower Granite and Bonneville Dams were similar to past years during most of the migration, and much shorter than the travel times observed during 2001 (Fig. 4).

Through all reaches, estimated survival of yearling Chinook salmon in 2004 was lower than estimated survival in other recent years, but substantially greater than in 2001 (Figs. 7-8; Table 41). For steelhead, survival estimates in 2004 were also lower than in other recent years in most reaches, but higher than in 2001. However, survival remained depressed relative to earlier years in the reach from Lower Monumental to McNary Dam and McNary Dam to John Day Dam. (Figs. 7-8; Table 42).

Survival Estimates from Point of Release to Bonneville Dam

Yearling spring/summer Chinook salmon from Lower Granite Dam on the Snake River and yearling summer/fall Chinook salmon from Rocky Reach Dam on the upper Columbia River each migrated past seven projects to the tailrace of Bonneville Dam. Their estimated survival was similar at 0.395 (0.050) for the Snake River stock and 0.411 (0.083) for the Upper Columbia River stock (Table 44). Estimated survival was greater for summer/fall Chinook salmon released from upper Columbia River dams downstream from Rocky Reach Dam. Estimated survival of yearling spring Chinook salmon released at hatcheries in the Upper Columbia River was similar to their Snake River counterparts in 2004, but lower than observed for them in 2003 (Tables 19 and 27). In 2004 average survival estimates were 0.286 (0.021) for fish released at Leavenworth Hatchery (seven projects and 800 km upstream) and 0.377 (0.066) for fish released at Entiat Hatchery (eight projects and 795 km upstream) in the upper Columbia River compared to 0.324 (0.041) for fish released from Dworshak Hatchery (eight projects and 811 km upstream) in the Snake River.

Estimated steelhead survival from Dworshak Hatchery in the Snake River Basin to the tailrace of John Day Dam was lower than for fish from Upper Columbia hatcheries passing a similar number of dams. (Estimates to Bonneville Dam tailrace were not possible for steelhead from the Snake River Basin).

DISCUSSION

Flow volume during the 2004 spring migration of yearling Chinook salmon was nearly the same as during the 2002 migration, only slightly greater than the drought conditions of 2001. The same was true for steelhead, although flow volumes were higher for the later migrating steelhead. Spill was eliminated and transportation maximized at Snake River collector dams during most of the migration, as it was in 2001, but spill continued at the non-collector dams in 2004. Survival for yearling Chinook salmon and steelhead through the entire hydropower system in 2004 was the second lowest yet measured since PIT tag survival studies began in 1993, lower than all years except 2001. In part, this was due to the lack of spill in the Snake River. This is consistent with other findings supporting positive effects of spill on survival on a season-wide basis. Analyses based on early data (1973-1979) suggested that increases in spill had a direct impact on increasing survival (Sims and Ossiander 1981). From our own research, estimated survival through the hydropower system was lower in 1993 and 1994, when spill occurred only in excess of powerhouse capacity, than it was after spill at all dams was prescribed in the 1995 Biological Opinion (NMFS 1995), and was lowest during the 2001 migration when spill was eliminated or reduced at all dams. Demonstrating in-season effects of spill has been more problematic (Smith et al. 2002; Zabel et al. 2002).

For steelhead, estimated survival in 2004 was lower than that estimated in 2003 through all reaches where it could be measured (except the first reach), but improved over survival in 2001. Steelhead survival remained particularly depressed through the Lower Monumental Dam to McNary Dam and McNary to John Day Dam reaches. Avian predation appears to have decreased survival of steelhead. Steelhead are particularly susceptible to predation by birds: Collis et al. (2001) found that greater than 15% of the tags from PIT-tagged steelhead entering the Columbia River estuary in 1998 were later found on estuarine bird colonies. Only 2% of tags from PIT-tagged yearling Chinook salmon were found on the bird colonies. In 1998 the major site of tag recovery was Rice Island, which was then home to the largest Caspian tern *(Sterna caspia)* colony in North America. Ryan et al. (2002, 2003) and Glabek et al. (2003) reported similar results in subsequent years, as the tern colony was relocated from Rice Island to East Sand Island.

Crescent Island in the McNary Dam reservoir harbors the second largest Caspian tern colony in North America (>600 individuals) and large populations gulls (>39,000) (*Larus* spp.*)*. Other avian piscivores that reside at other locations within McNary pool include American white pelicans *Pelecanus erythrorhynchos,* cormorants *Phalacrocorax auritus,* and herons *Ardea alba, A. herodias,* and *Nycticorax nycticorax* (Collis et al. 2002). During 2004, although only Crescent and Foundation Islands were sampled,

18.3% of the PIT tags from steelhead detected at Lower Monumental Dam were found there (Table 45). This percentage would likely increase to a small degree had the other bird colonies been sampled in 2004, although in past years, Crescent Island accounted for the majority (about 70%) of PIT tags found in McNary Pool (B. Ryan, NMFS, personal communication). The percentage of PIT-tagged steelhead detected on Crescent and Foundation Islands in 2004 was higher than during the past two years and nearly as high as it was in 2001. In other years, additional PIT tags (mostly steelhead) have been detected on gull colonies in the John Day and The Dalles Reservoir as well (Glabek et al. 2003, Ryan et al. 2002).

Tag-detection percentage on avian colonies is a minimum estimate of loss due to bird predation, because not all tags taken by birds are detected (Collis et al. 2001, Glabek et al. 2003, Ryan et al. 2001). From 1998 to 2004, survival estimates for steelhead in the Lower Monumental to McNary Dam reach (Table 42) correlate strongly ($R^2 = 0.894$, $P < 0.01$) with the percentage of smolts detected on McNary Reservoir bird colonies (Table 45). There is also significant correlation for yearling Chinook salmon ($R^2 = 0.856$; $P < 0.01$), although the percentage detected on bird colonies is much lower.

In 2004, per-project survival for steelhead was substantially lower in the Lower Monumental to McNary Dam reach (two projects, $0.519^{1/2} = 0.720$) than in the Lower Granite to Little Goose Dam reach (0.860) and the Little Goose to Lower Monumental Dam reach (0.820). Also, estimated per-project survival for steelhead from McNary to John Day Dam (0.465) was lower than estimated per-project survival above Lower Monumental Dam. In contrast, 1.8% of the yearling Chinook salmon detected at Lower Monumental Dam were subsequently detected on Crescent Island and the per-project survival estimates for the reaches directly above and below McNary Dam were similar or lower.

Lacking a PIT-tag detection system at Ice Harbor Dam, we are currently unable to partition the survival estimate between Lower Monumental and McNary Dams into reach-specific estimates. However, there have been studies to estimate spillway and project survival using both PIT tags and radio telemetry. Using radio tags, survival of yearling Chinook salmon passing through the spillway at Ice Harbor Dam was estimated at 0.948 and 0.928 at BiOp and 50% spill levels, respectively in 2003, 0.892 in 2002 and 0.978 in 2000 (B. Eppard, NMFS, personal communication). Ice Harbor Dam project survival in 2003 was estimated at 0.937 and 0.919 at BiOp and 50% spill levels, respectively. In 2001, survival of PIT-tagged yearling Chinook salmon from 5 km upstream from Ice Harbor Dam to McNary Dam tailrace was estimated at 0.724 (Axel et al. 2003). Telemetry studies in 2004 found high project survival for yearling Chinook salmon and steelhead through Lower Monumental and Ice Harbor Dams, but

substantial losses in the forebays of each project, with many of the radio tags later found on Cresent Island (E. Hockersmith, NMFS, personal communication). Operational changes at Lower Monumental or Ice Harbor Dam, including spill levels and spill patterns, could influence vulnerability of steelhead to avian predators. In addition, tailwater elevation at Ice Harbor Dam could influence spillway survival via the effects of spillbay deflectors installed prior to the 1998 migration.

Proportions of PIT-tagged fish (especially steelhead) taken by avian predators have increased in the last several years, with a corresponding decrease in survival. It is unlikely the change is due to increased predator abundance since the Caspian tern colony has not increased in size during this time period (Glabek et al. 2003). Therefore, a change in susceptibility of smolts to avian predators or system operations are the likely cause. Research is ongoing to elucidate the complicated dynamics of this predator-prey system. In particular, we need more fine partitioning of survival estimates in the reach between Lower Monumental and McNary Dams, and we need a better understanding of tern behavior.

One factor that might affect our survival estimates is the maximization of transportation. During years where this occurs (this year and 2001), an extremely high proportion of non PIT tagged smolts are transported while PIT tagged fish are slide-gated back to the river. Thus, by the time fish reach Ice Harbor Dam, relatively few non tagged fish are available for predators. This likely increases the mortality rate on tagged smolts resulting in reduced estimates of survival.

Results from the 2004 studies provide estimates of survival only during the downstream portion of the migration. We will analyze these data in conjunction with adult returns that will occur over the next three years to determine whether variations in spill, flow, temperature, and passage route produce patterns in smolt-to-adult survival consistent with those observed during the downstream migration phase.

RECOMMENDATIONS

1) Coordination of future survival studies with other projects should continue to maximize the data-collection effort and minimize study effects on salmonid resources.

2) To date, little mortality has been found in Lower Granite reservoir and most other reservoirs investigated. However, considerable steelhead mortality was again observed in 2004 in the river reach between Lower Monumental and McNary Dams. Avian predators are the likely cause of this mortality, and this issue merits further investigation. Estimates of survival from hatcheries to Lower Granite Dam suggest that substantial mortality occurs upstream from the Snake and Clearwater River confluence. Efforts should continue to identify where this mortality occurs.

3) Increasing the number of detection facilities in the Columbia River Basin will improve survival investigations. We recommend installation of detectors and diversion systems at Ice Harbor, The Dalles, and Upper Columbia River dams. The development of flat-plate and full-flow detector technology in bypass systems and other suitable locations at dams and portable streambed flat-plate detectors for use in tributaries would greatly enhance survival estimation capabilities.

ACKNOWLEDGMENTS

We express our appreciation to all who assisted with this research. C. Stein and staff of the Pacific States Marine Fisheries Commission provided valuable assistance in data acquisition. Fish Ecology Division staff from several research stations participated in the study. J. Harmon, K. McIntyre, and N. Paasch helped coordinate and supervise the tagging at Lower Granite Dam. B. Ryan and B. Sandford provided PIT tag data from avian bird colonies. Support for this research came from the region's electrical ratepayers through the Bonneville Power Administration and the National Marine Fisheries Service.

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TABLES

Table 1. Estimated survival probabilities for Snake River yearling Chinook salmon (hatchery and wild combined) detected and released to or PIT tagged and released to the tailrace at Lower Granite Dam in 2004. Daily groups pooled weekly. Estimates based on the single-release model. Standard errors in parentheses. Abbreviations: LGR-Lower Granite Dam; LGO-Little Goose Dam; LMO-Lower Monumental Dam; MCN-McNary Dam.

Date at LGR	Number released	LGR to LGO	LGO to LMO	LMO to MCN	LGR to MCN
30 Mar-05 Apr	260	1.014 (0.094)	0.779 (0.086)	0.890 (0.147)	0.704 (0.114)
06 Apr-12 Apr	895	1.181 (0.063)	0.629 (0.047)	0.899 (0.090)	0.668 (0.061)
13 Apr-19 Apr	4,034	1.012 (0.018)	0.689 (0.024)	0.891 (0.042)	0.622 (0.025)
20 Apr-26 Apr	7,631	0.892 (0.007)	0.944 (0.069)	0.734 (0.060)	0.618 (0.023)
27 Apr-03 May	18,60	0.897 (0.005)	1.058 (0.054)	0.696 (0.039)	0.660 (0.016)
04 May-10 May	25,72	0.919 (0.004)	0.951 (0.020)	0.817 (0.025)	0.714 (0.017)
11 May-17 May	3,824	0.922 (0.006)	0.845 (0.016)	0.867 (0.057)	0.676 (0.043)
18 May-24 May	3,225	0.942 (0.006)	0.901 (0.016)	0.926 (0.060)	0.786 (0.049)
25 May-31 May	1,696	0.964 (0.007)	0.885 (0.023)	0.916 (0.076)	0.781 (0.063)
01 Jun-07 Jun	1,177	0.964 (0.008)	0.863 (0.022)	0.816 (0.068)	0.678 (0.056)
08 Jun-14 Jun	894	0.935 (0.012)	0.768 (0.030)	0.742 (0.085)	0.532 (0.059)
15 Jun-21 Jun	532	0.827 (0.021)	0.535 (0.034)	0.701 (0.111)	0.310 (0.050)
22 Jun-28 Jun	575	0.770 (0.027)	0.498 (0.051)	0.455 (0.086)	0.174 (0.031)
Weighted mean*		**0.923 (0.004)**	**0.875 (0.012)**	**0.818 (0.018)**	**0.666 (0.011)**

* Weighted means of the independent estimates for daily groups (25 March -31 May), with weights inversely proportional to respective estimated relative variances.

Table 2. Estimated survival probabilities for Snake River yearling Chinook salmon (hatchery and wild combined) detected and released to the tailrace at McNary Dam in 2004. Daily groups pooled weekly. Estimates based on the single-release model. Standard errors in parentheses. Abbreviations: MCN-McNary Dam; JDA-John Day Dam; BON-Bonneville Dam.

Date at MCN	Number released	MCN to JDA	JDA to BON	MCN to BON
20 Apr-26 Apr	1,002	0.678 (0.144)	0.567 (0.248)	0.384 (0.147)
27 Apr-03 May	6,377	0.772 (0.089)	1.498 (0.668)	1.155 (0.498)
04 May-10 May	8,172	0.875 (0.075)	1.060 (0.330)	0.928 (0.277)
11 May-17 May	7,093	0.854 (0.067)	0.531 (0.111)	0.454 (0.087)
18 May-24 May	1,666	0.670 (0.121)	0.952 (0.639)	0.638 (0.412)
25 May-31 May	2,094	0.797 (0.139)	0.728 (0.276)	0.580 (0.195)
01 Jun-07 Jun	769	0.631 (0.170)	1.137 (0.797)	0.719 (0.465)
08 Jun-14 Jun	852	0.788 (0.167)	0.817 (0.546)	0.643 (0.408)
15 Jun-21 Jun	1,150	0.673 (0.138)	0.685 (0.449)	0.461 (0.287)
Weighted mean*		**0.809 (0.028)**	**0.735 (0.092)**	**0.594 (0.074)**

* Weighted means of the independent estimates for weekly pooled groups (20 April-21 June), with weights inversely proportional to respective estimated relative variances.

Table 3. Estimated survival probabilities for Snake River hatchery yearling Chinook salmon detected and released to the tailrace at Lower Granite Dam in 2004. Daily groups pooled weekly. Estimates based on the single-release model. Standard errors in parentheses. Abbreviations: LGR-Lower Granite Dam; LGO-Little Goose Dam; LMO-Lower Monumental Dam; MCN-McNary Dam.

Date at LGR	Number released	LGR to LGO	LGO to LMO	LMO to MCN	LGR to MCN
30 Mar-05 Apr	79	0.805 (0.113)	0.986 (0.156)	0.882 (0.241)	0.700 (0.184)
06 Apr-12 Apr	517	1.165 (0.074)	0.799 (0.094)	0.748 (0.123)	0.697 (0.094)
13 Apr-19 Apr	1,886	1.018 (0.024)	0.704 (0.049)	0.886 (0.078)	0.635 (0.039)
20 Apr-26 Apr	4,403	0.902 (0.010)	0.978 (0.117)	0.716 (0.093)	0.632 (0.032)
27 Apr-03 May	14,675	0.912 (0.005)	1.137 (0.074)	0.647 (0.046)	0.672 (0.018)
04 May-10 May	21,663	0.920 (0.005)	0.978 (0.024)	0.798 (0.028)	0.718 (0.019)
11 May-17 May	1,728	0.930 (0.011)	0.831 (0.028)	0.812 (0.092)	0.628 (0.069)
18 May-24 May	1,068	0.953 (0.010)	0.915 (0.034)	0.914 (0.119)	0.797 (0.100)
25 May-31 May	240	0.988 (0.024)	0.899 (0.089)	0.654 (0.185)	0.581 (0.155)
01 Jun-07 Jun	199	0.952 (0.026)	0.916 (0.077)	0.788 (0.187)	0.688 (0.155)
08 Jun-14 Jun	146	0.912 (0.037)	0.936 (0.110)	0.557 (0.121)	0.475 (0.090)
15 Jun-21 Jun	57	0.843 (0.059)	0.723 (0.119)	0.455 (0.106)	0.277 (0.061)
22 Jun-28 Jun	25	0.640 (0.146)	NA	NA	NA
Weighted mean*		**0.924 (0.008)**	**0.924 (0.029)**	**0.782 (0.024)**	**0.682 (0.013)**

a Weighted means of the independent estimates for weekly pooled groups (30 March-14 June), with weights inversely proportional to respective estimated relative variances.

Table 4. Estimated survival probabilities for Snake River wild yearling Chinook salmon detected and released to or PIT tagged and released to the tailrace at Lower Granite Dam in 2004. Daily groups pooled weekly. Estimates based on the single-release model. Standard errors in parentheses. Abbreviations: LGR-Lower Granite Dam; LGO-Little Goose Dam; LMO-Lower Monumental Dam; MCN-McNary Dam.

Date at LGR	Number released	LGR to LGO	LGO to LMO	LMO to MCN	LGR to MCN
30 Mar-05 Apr	181	1.096 (0.125)	0.719 (0.099)	0.897 (0.186)	0.708 (0.144)
06 Apr-12 Apr	378	1.177 (0.113)	0.566 (0.064)	0.947 (0.115)	0.631 (0.076)
13 Apr-19 Apr	2,144	0.959 (0.025)	0.733 (0.030)	0.874 (0.051)	0.614 (0.033)
20 Apr-26 Apr	3,221	0.881 (0.010)	0.937 (0.086)	0.730 (0.077)	0.602 (0.032)
27 Apr-03 May	3,894	0.841 (0.009)	0.925 (0.074)	0.790 (0.075)	0.615 (0.032)
04 May-10 May	4,040	0.920 (0.008)	0.876 (0.034)	0.878 (0.056)	0.707 (0.037)
11 May-17 May	2,096	0.920 (0.008)	0.865 (0.019)	0.911 (0.072)	0.725 (0.056)
18 May-24 May	2,157	0.937 (0.007)	0.900 (0.018)	0.933 (0.069)	0.788 (0.057)
25 May-31 May	1,456	0.961 (0.008)	0.889 (0.023)	0.955 (0.083)	0.816 (0.068)
01 Jun-07 Jun	978	0.968 (0.008)	0.855 (0.023)	0.819 (0.073)	0.677 (0.060)
08 Jun-14 Jun	748	0.938 (0.012)	0.736 (0.030)	0.774 (0.100)	0.534 (0.068)
15 Jun-21 Jun	475	0.825 (0.023)	0.511 (0.035)	0.760 (0.141)	0.320 (0.061)
22 Jun-28 Jun	550	0.776 (0.027)	0.489 (0.050)	0.482 (0.101)	0.183 (0.036)
Weighted mean*		**0.928 (0.012)**	**0.860 (0.019)**	**0.873 (0.020)**	**0.667 (0.023)**

* Weighted means of the independent estimates for weekly pooled groups (30 March-14 June), with weights inversely proportional to respective estimated relative variances.

Table 5. Estimated survival probabilities for Snake River yearling Chinook salmon (hatchery and wild combined) detected and released to or PIT tagged and released to the tailrace at Lower Granite Dam in 2004. Daily groups pooled as necessary to calculate estimates. Estimates based on the single-release model. Standard errors in parentheses. Abbreviations: LGR-Lower Granite Dam; LGO-Little Goose Dam; LMO-Lower Monumental Dam; MCN-McNary Dam.

Date at LGR	Number released	LGR to LGO	LGO to LMO	LMO to MCN	LGR to MCN
25–31 Mar	37	0.856 (0.156)	0.841 (0.182)	0.819 (0.330)	0.590 (0.237)
01–02 Apr	90	1.092 (0.175)	0.685 (0.129)	0.757 (0.151)	0.567 (0.112)
03 Apr	72	0.943 (0.159)	0.802 (0.156)	1.123 (0.426)	0.849 (0.320)
04 Apr	45	0.970 (0.262)	1.002 (0.317)	1.135 (0.613)	1.106 (0.571)
05–06 Apr	105	1.187 (0.213)	0.654 (0.137)	0.740 (0.157)	0.574 (0.118)
07 Apr	118	1.052 (0.164)	0.682 (0.129)	0.943 (0.230)	0.677 (0.160)
08 Apr	119	1.437 (0.316)	0.531 (0.141)	0.987 (0.356)	0.752 (0.259)
09 Apr	107	1.020 (0.139)	0.775 (0.158)	0.620 (0.182)	0.490 (0.129)
10 Apr	103	1.125 (0.196)	0.729 (0.166)	0.581 (0.110)	0.477 (0.069)
11 Apr	182	1.195 (0.127)	0.602 (0.101)	0.831 (0.159)	0.599 (0.096)
12 Apr	193	1.116 (0.103)	0.644 (0.107)	1.451 (0.459)	1.042 (0.307)
13 Apr	258	0.913 (0.060)	0.763 (0.076)	0.972 (0.138)	0.677 (0.089)
14 Apr	636	1.014 (0.049)	0.736 (0.055)	1.116 (0.143)	0.834 (0.100)
15 Apr	954	0.941 (0.037)	0.730 (0.046)	0.874 (0.075)	0.601 (0.046)
16 Apr	729	1.058 (0.053)	0.703 (0.062)	0.815 (0.097)	0.606 (0.061)
17 Apr	654	1.030 (0.051)	0.716 (0.079)	0.735 (0.100)	0.542 (0.054)
18 Apr	479	0.923 (0.029)	0.822 (0.152)	0.764 (0.160)	0.579 (0.062)
19 Apr	324	0.986 (0.040)	0.548 (0.091)	1.000 (0.208)	0.541 (0.080)
20 Apr	615	0.930 (0.022)	0.815 (0.128)	0.900 (0.179)	0.682 (0.087)
21 Apr	518	0.869 (0.024)	1.155 (0.285)	0.728 (0.213)	0.732 (0.114)
22 Apr	713	0.905 (0.021)	0.700 (0.097)	0.974 (0.163)	0.617 (0.064)
23 Apr	954	0.887 (0.020)	0.705 (0.136)	0.883 (0.188)	0.552 (0.053)
24 Apr	1,366	0.900 (0.016)	0.922 (0.178)	0.722 (0.153)	0.599 (0.053)
25 Apr	1,528	0.927 (0.015)	1.665 (0.486)	0.430 (0.130)	0.663 (0.055)
26 Apr	1,937	0.851 (0.014)	1.114 (0.203)	0.589 (0.115)	0.559 (0.041)
27 Apr	2,072	0.871 (0.014)	1.070 (0.196)	0.648 (0.129)	0.604 (0.048)
28 Apr	3,518	0.905 (0.010)	1.131 (0.146)	0.622 (0.088)	0.638 (0.037)
29 Apr	2,062	0.916 (0.013)	0.967 (0.152)	0.757 (0.132)	0.671 (0.051)
30 Apr	2,654	0.881 (0.012)	1.044 (0.129)	0.630 (0.086)	0.580 (0.034)

Table 5. Continued.

Date at LGR	Number released	LGR to LGO	LGO to LMO	LMO to MCN	LGR to MCN
01 May	2,154	0.867 (0.013)	1.008 (0.135)	0.753 (0.112)	0.660 (0.044)
02 May	2,487	0.909 (0.012)	1.064 (0.136)	0.749 (0.106)	0.724 (0.045)
03 May	3,653	0.910 (0.011)	1.096 (0.129)	0.668 (0.086)	0.667 (0.035)
04 May	7,381	0.923 (0.008)	1.161 (0.082)	0.700 (0.058)	0.750 (0.033)
05 May	8,932	0.927 (0.008)	1.020 (0.048)	0.754 (0.046)	0.714 (0.028)
06 May	3,536	0.924 (0.012)	0.926 (0.050)	0.760 (0.062)	0.650 (0.041)
07 May	1,876	0.878 (0.015)	0.891 (0.052)	0.821 (0.085)	0.642 (0.056)
08 May	1,910	0.930 (0.013)	0.860 (0.041)	0.811 (0.076)	0.649 (0.054)
09 May	937	0.889 (0.016)	0.858 (0.042)	0.875 (0.114)	0.667 (0.083)
10 May	1,153	0.931 (0.013)	0.780 (0.029)	0.916 (0.115)	0.665 (0.082)
11 May	1,058	0.930 (0.012)	0.838 (0.035)	0.928 (0.137)	0.723 (0.104)
12 May	637	0.915 (0.016)	0.855 (0.041)	0.875 (0.149)	0.685 (0.114)
13 May	329	0.965 (0.023)	0.824 (0.056)	0.719 (0.143)	0.572 (0.110)
14 May	680	0.911 (0.014)	0.843 (0.034)	0.901 (0.137)	0.692 (0.104)
15 May	484	0.933 (0.015)	0.805 (0.034)	0.849 (0.130)	0.637 (0.096)
16 May	362	0.907 (0.020)	0.896 (0.053)	0.914 (0.201)	0.743 (0.159)
17 May	274	0.902 (0.023)	0.921 (0.061)	0.831 (0.169)	0.691 (0.135)
18 May	436	0.917 (0.017)	0.876 (0.044)	0.796 (0.144)	0.639 (0.113)
19 May	434	0.928 (0.017)	0.812 (0.038)	0.864 (0.131)	0.651 (0.097)
20 May	462	0.938 (0.015)	0.887 (0.041)	0.838 (0.121)	0.698 (0.097)
21 May	557	0.949 (0.013)	0.914 (0.037)	1.240 (0.233)	1.076 (0.199)
22 May	550	0.955 (0.011)	0.924 (0.034)	0.831 (0.101)	0.734 (0.087)
23 May	429	0.961 (0.014)	0.942 (0.051)	0.911 (0.183)	0.824 (0.160)
24 May	357	0.942 (0.018)	0.972 (0.060)	1.451 (0.483)	1.328 (0.435)
25 May	283	0.950 (0.018)	0.954 (0.048)	1.155 (0.233)	1.048 (0.206)
26 May	357	0.939 (0.019)	0.885 (0.052)	1.110 (0.272)	0.923 (0.222)
27 May	302	0.984 (0.017)	0.873 (0.056)	0.999 (0.228)	0.858 (0.190)
28 May	315	0.970 (0.016)	0.908 (0.064)	0.861 (0.181)	0.759 (0.152)
29 May	226	0.977 (0.018)	0.870 (0.058)	0.703 (0.099)	0.598 (0.077)
30 May	105	0.984 (0.028)	0.860 (0.090)	0.953 (0.379)	0.807 (0.313)
31 May	108	0.951 (0.028)	0.770 (0.065)	0.759 (0.210)	0.555 (0.153)
Weighted mean*		**0.923 (0.004)**	**0.875 (0.012)**	**0.818 (0.018)**	**0.666 (0.011)**

* Weighted means of the independent estimates for daily groups (25 March -31 May), with weights inversely proportional to respective estimated relative variances.

Table 6. Estimated detection probabilities for Snake River yearling Chinook salmon (hatchery and wild combined) detected and released to or PIT tagged and released to the tailrace at Lower Granite Dam in 2004. Daily groups pooled weekly. Estimates based on the single-release model. Standard errors in parentheses. Abbreviations: LGR-Lower Granite Dam; LGO-Little Goose Dam; LMO-Lower Monumental Dam; MCN-McNary Dam.

Date at LGR	Number released	LGO	LMO	MCN
30 Mar-05 Apr	260	0.193 (0.030)	0.608 (0.045)	0.609 (0.102)
06 Apr-12 Apr	895	0.271 (0.020)	0.396 (0.026)	0.559 (0.054)
13 Apr-19 Apr	4,034	0.459 (0.011)	0.285 (0.012)	0.532 (0.023)
20 Apr-26 Apr	7,631	0.842 (0.007)	0.046 (0.004)	0.406 (0.016)
27 Apr-03 May	18,600	0.827 (0.005)	0.043 (0.003)	0.336 (0.009)
04 May-10 May	25,725	0.765 (0.004)	0.170 (0.004)	0.271 (0.007)
11 May-17 May	3,824	0.855 (0.007)	0.684 (0.014)	0.282 (0.020)
18 May-24 May	3,225	0.880 (0.007)	0.689 (0.014)	0.290 (0.020)
25 May-31 May	1,696	0.874 (0.010)	0.646 (0.020)	0.333 (0.030)
01 Jun-07 Jun	1,177	0.911 (0.010)	0.733 (0.021)	0.420 (0.038)
08 Jun-14 Jun	894	0.889 (0.014)	0.672 (0.029)	0.509 (0.059)
15 Jun-21 Jun	532	0.907 (0.020)	0.720 (0.042)	0.735 (0.114)
22 Jun-28 Jun	575	0.860 (0.028)	0.529 (0.057)	0.859 (0.131)

Table 7. Estimated detection probabilities for Snake River yearling Chinook salmon (hatchery and wild combined) detected and released to the tailrace at McNary Dam in 2004. Daily groups pooled weekly.Estimates based on the single-release model. Standard errors in parentheses.Abbreviations:MCN-McNary Dam; JDA-John Day Dam; BON-Bonneville Dam.

Date at MCN	Number released	JDA	BON
20 Apr-26 Apr	1,002	0.171 (0.039)	0.146 (0.058)
27 Apr-03 May	6,377	0.123 (0.015)	0.054 (0.023)
04 May-10 May	8,172	0.151 (0.014)	0.070 (0.021)
11 May-17 May	7,093	0.189 (0.016)	0.173 (0.034)
18 May-24 May	1,666	0.165 (0.032)	0.117 (0.076)
25 May-31 May	2,094	0.114 (0.021)	0.159 (0.055)
01 Jun-07 Jun	769	0.124 (0.036)	0.131 (0.086)
08 Jun-14 Jun	852	0.161 (0.037)	0.165 (0.106)
15 Jun-21 Jun	1,150	0.176 (0.038)	0.174 (0.109)

Table 8. Estimated detection probabilities for Snake River hatchery yearling Chinook salmon detected and released to the tailrace at Lower Granite Dam in 2004. Daily groups pooled weekly. Estimates based on the single-release model. Standard errors in parentheses. Abbreviations: LGR-Lower Granite Dam; LGO-Little Goose Dam; LMO-Lower Monumental Dam; MCN-McNary Dam.

Date at LGR	Number released	LGO	LMO	MCN
30 Mar-05 Mar	79	0.173 (0.052)	0.574 (0.081)	0.625 (0.171)
06 Apr-12 Apr	517	0.325 (0.029)	0.241 (0.030)	0.494 (0.070)
13 Apr-19 Apr	1,886	0.561 (0.017)	0.148 (0.013)	0.500 (0.033)
20 Apr-26 Apr	4,403	0.821 (0.010)	0.031 (0.005)	0.388 (0.021)
27 Apr-03 May	14,675	0.817 (0.005)	0.035 (0.003)	0.332 (0.010)
04 May-10 May	21,663	0.752 (0.005)	0.155 (0.005)	0.263 (0.008)
11 May-17 May	1,728	0.812 (0.012)	0.636 (0.023)	0.257 (0.031)
18 May-24 May	1,068	0.855 (0.013)	0.618 (0.027)	0.264 (0.036)
25 May-31 May	240	0.831 (0.031)	0.566 (0.063)	0.333 (0.096)
01 Jun-07 Jun	199	0.818 (0.034)	0.594 (0.059)	0.400 (0.098)
08 Jun-14 Jun	146	0.796 (0.043)	0.470 (0.069)	0.778 (0.139)
15 Jun-21 Jun	57	0.895 (0.057)	0.676 (0.119)	NA
22 Jun-28 Jun	25	0.813 (0.170)	NA	NA

Table 9. Estimated detection probabilities for Snake River wild yearling Chinook Salmon detected and released to or PIT tagged and released to the tailrace at Lower Granite Dam in 2004. Daily groups pooled weekly. Estimates based on the single-release model. Standard errors in parentheses. Abbreviations: LGR-Lower Granite Dam; LGO-Little Goose Dam; LMO-Lower Monumental Dam; MCN-McNary Dam.

Date at LGR	Number released	LGO	LMO	MCN
30 Mar-05 Mar	181	0.201 (0.037)	0.623 (0.054)	0.600 (0.126)
06 Apr-12 Apr	378	0.204 (0.028)	0.586 (0.038)	0.655 (0.081)
13 Apr-19 Apr	2,144	0.386 (0.015)	0.402 (0.017)	0.559 (0.031)
20 Apr-26 Apr	3,221	0.870 (0.010)	0.066 (0.008)	0.432 (0.025)
27 Apr-03 May	3,894	0.867 (0.009)	0.080 (0.008)	0.355 (0.021)
04 May-10 May	4,040	0.825 (0.009)	0.249 (0.012)	0.310 (0.018)
11 May-17 May	2,096	0.887 (0.009)	0.715 (0.018)	0.297 (0.026)
18 May-24 May	2,157	0.892 (0.008)	0.722 (0.017)	0.302 (0.025)
25 May-31 May	1,456	0.880 (0.010)	0.655 (0.021)	0.333 (0.031)
01 Jun-07 Jun	978	0.929 (0.010)	0.760 (0.023)	0.423 (0.041)
08 Jun-14 Jun	748	0.908 (0.014)	0.722 (0.031)	0.471 (0.063)
15 Jun-21 Jun	475	0.909 (0.022)	0.727 (0.044)	0.692 (0.128)
22 Jun-28 Jun	550	0.862 (0.028)	0.544 (0.058)	0.835 (0.151)

Table 10. Estimated survival probabilities for juvenile Snake River steelhead (hatchery and wild combined) detected and released to or PIT tagged and released to the tailrace at Lower Granite Dam in 2004. Daily groups pooled weekly. Estimates based on the single-release model. Standard errors in parentheses. Abbreviations: LGR-Lower Granite Dam; LGO-Little Goose Dam; LMO-Lower Monumental Dam; MCN-McNary Dam.

Date at LGR	Number released	LGR to LGO	LGO to LMO	LMO to MCN	LGR to MCN
30 Mar-05 Apr	62	0.912 (0.068)	0.821 (0.094)	0.323 (0.096)	0.242 (0.071)
06 Apr-12 Apr	74	1.036 (0.160)	0.716 (0.136)	0.512 (0.148)	0.380 (0.108)
13 Apr-19 Apr	2,273	1.076 (0.050)	0.559 (0.043)	0.981 (0.192)	0.591 (0.111)
20 Apr-26 Apr	3,211	0.958 (0.015)	0.755 (0.079)	0.766 (0.164)	0.554 (0.104)
27 Apr-03 May	6,652	0.909 (0.010)	0.890 (0.060)	0.586 (0.081)	0.474 (0.058)
04 May-10 May	14,737	0.898 (0.005)	1.038 (0.048)	0.419 (0.044)	0.391 (0.037)
11 May-17 May	9,726	0.833 (0.005)	0.782 (0.016)	0.482 (0.062)	0.314 (0.040)
18 May-24 May	9,290	0.847 (0.004)	0.841 (0.015)	0.439 (0.043)	0.313 (0.030)
25 May-31 May	5,053	0.836 (0.006)	0.897 (0.025)	0.504 (0.073)	0.378 (0.053)
01 Jun-07 Jun	2,358	0.801 (0.010)	0.697 (0.030)	0.658 (0.184)	0.368 (0.102)
08 Jun-14 Jun	1,592	0.707 (0.020)	0.569 (0.064)	0.255 (0.090)	0.103 (0.034)
Weighted mean*		**0.860 (0.006)**	**0.820 (0.014)**	**0.519 (0.035)**	**0.379 (0.023)**

a Weighted means of the independent estimates for daily groups (26 March-07 June), with weights inversely proportional to respective estimated relative variances.

Table 11. Estimated survival probabilities for juvenile Snake River steelhead (hatcheryand wild combined) detected and released to the tailrace at McNary Dam in daily groups pooled weekly. Estimates based on the single-release model. Standard errors in parentheses. Abbreviations: MCN-McNary Dam; JDA-John Day Dam; BON-Bonneville Dam.

Date at MCN	Number released	MCN to JDA	JDA to BON	MCN to BON
27 Apr-03 May	206	0.316 (0.273)	NA	NA
04 May-10 May	676	0.382 (0.132)	NA	NA
11 May-17 May	1,107	0.967 (0.521)	NA	NA
18 May-24 May	395	0.486 (0.222)	NA	NA
25 May-31 May	1,001	0.369 (0.094)	NA	NA
01 Jun-07 Jun	730	0.575 (0.260)	NA	NA
Weighted mean*		**0.465 (0.078)**	**NA**	**NA**

[a] Weighted means of the independent estimates for weekly pooled groups (27 April- 07 June), with weights inversely proportional to respective estimated relative variances.

Table 12. Estimated survival probabilities for juvenile Snake River hatchery steelhead detected and released to or PIT tagged and released to the tailrace at Lower Granite Dam in 2004. Daily groups pooled weekly. Estimates based on the single-release model. Standard errors in parentheses. Abbreviations: LGR-Lower Granite Dam; LGO-Little Goose Dam; LMO-Lower Monumental Dam; MCN-McNary Dam.

Date at LGR	Number released	LGR to LGO	LGO to LMO	LMO to MCN	LGR to MCN
30 Mar-05 Apr	11	1.044 (0.323)	NA	NA	NA
06 Apr-12 Apr	24	0.889 (0.240)	1.171 (0.549)	NA	NA
13 Apr-19 Apr	1,560	1.118 (0.063)	0.587 (0.064)	1.106 (0.314)	0.726 (0.195)
20 Apr-26 Apr	2,615	0.961 (0.016)	0.738 (0.077)	0.835 (0.186)	0.592 (0.117)
27 Apr-03 May	5,604	0.911 (0.010)	0.883 (0.062)	0.583 (0.086)	0.469 (0.061)
04 May-10 May	10,534	0.883 (0.006)	1.042 (0.054)	0.383 (0.047)	0.352 (0.039)
11 May-17 May	7,342	0.814 (0.006)	0.790 (0.019)	0.454 (0.067)	0.292 (0.042)
18 May-24 May	6,867	0.825 (0.005)	0.834 (0.018)	0.485 (0.060)	0.334 (0.041)
25 May-31 May	2,997	0.795 (0.009)	0.906 (0.038)	0.472 (0.089)	0.340 (0.063)
01 Jun-07 Jun	1,376	0.780 (0.015)	0.740 (0.054)	0.523 (0.187)	0.302 (0.106)
08 Jun-14 Jun	1,220	0.716 (0.025)	0.582 (0.074)	0.378 (0.184)	0.158 (0.074)
Weighted mean*		**0.846 (0.015)**	**0.832 (0.027)**	**0.521 (0.059)**	**0.389 (0.039)**

[a] Weighted means of the independent estimates for weekly pooled groups (30 March – 14 June), with weights inversely proportional to respective estimated relative variances.

Table 13. Estimated survival probabilities for juvenile Snake River wild steelhead detected and released to or PIT tagged and released to the tailrace at Lower Granite Dam in 2004. Daily groups pooled weekly. Estimates based on the single-release model. Standard errors in parentheses. Abbreviations: LGR-Lower Granite Dam; LGO-Little Goose Dam; LMO-Lower Monumental Dam; MCN-McNary Dam.

Date at LGR	Number released	LGR to LGO	LGO to LMO	LMO to MCN	LGR to MCN
30 Mar-05 Apr	51	0.898 (0.070)	0.846 (0.105)	0.311 (0.104)	0.236 (0.078)
06 Apr-12 Apr	50	1.092 (0.200)	0.640 (0.143)	0.503 (0.131)	0.352 (0.096)
13 Apr-19 Apr	713	0.899 (0.069)	0.638 (0.067)	0.719 (0.180)	0.412 (0.100)
20 Apr-26 Apr	596	0.949 (0.045)	1.901 (1.282)	0.214 (0.198)	0.386 (0.245)
27 Apr-03 May	1,048	0.886 (0.026)	1.010 (0.270)	0.563 (0.240)	0.504 (0.167)
04 May-10 May	4,203	0.930 (0.011)	0.967 (0.097)	0.540 (0.112)	0.486 (0.088)
11 May-17 May	2,384	0.894 (0.008)	0.762 (0.028)	0.568 (0.146)	0.386 (0.099)
18 May-24 May	2,423	0.911 (0.007)	0.859 (0.025)	0.353 (0.054)	0.276 (0.042)
25 May-31 May	2,056	0.898 (0.008)	0.887 (0.033)	0.547 (0.122)	0.436 (0.096)
01 Jun-07 Jun	982	0.838 (0.013)	0.661 (0.032)	0.856 (0.383)	0.474 (0.212)
08 Jun-14 Jun	372	0.684 (0.031)	0.471 (0.102)	NA	NA
Weighted mean*		**0.899 (0.009)**	**0.813 (0.030)**	**0.502 (0.046)**	**0.383 (0.029)**

* Weighted means of the independent estimates for weekly pooled groups (30 March -14 June), with weights inversely proportional to respective estimated relative variances.

Table 14. Estimated survival probabilities for juvenile Snake River steelhead (hatchery and wild combined) detected and released to or PIT tagged and released to the tailrace at Lower Granite Dam in 2004. Daily groups pooled as necessary to calculate estimates. Estimates based on the single-release model. Standard errors in parentheses. Abbreviations: LGR-Lower Granite Dam; LGO-Little Goose Dam; LMO-Lower Monumental Dam; MCN-McNary Dam.

Date at LGR	Number released	LGR to LGO	LGO to LMO	LMO to MCN	LGR to MCN
26 Mar-03 Apr	56	0.892 (0.058)	0.822 (0.093)	0.356 (0.116)	0.261 (0.085)
04-09 Apr	43	0.767 (0.064)	1.266 (0.226)	0.212 (0.091)	0.206 (0.077)
10-12 Apr	46	1.036 (0.174)	0.623 (0.134)	0.702 (0.242)	0.453 (0.162)
13-16 Apr	1,686	1.036 (0.058)	0.574 (0.049)	1.137 (0.283)	0.676 (0.164)
17 Apr	493	1.122 (0.108)	0.568 (0.117)	0.699 (0.265)	0.445 (0.150)
18-19 Apr	94	0.904 (0.094)	0.732 (0.407)	1.092 (1.121)	0.723 (0.623)
20 Apr	441	0.947 (0.041)	0.475 (0.102)	1.881 (1.286)	0.847 (0.554)
21 Apr	465	0.953 (0.039)	0.737 (0.173)	0.996 (0.560)	0.700 (0.359)
22 Apr	472	0.989 (0.046)	1.062 (0.385)	0.363 (0.201)	0.382 (0.160)
23 Apr	457	0.967 (0.041)	0.819 (0.248)	1.151 (0.827)	0.912 (0.596)
24 Apr	621	0.900 (0.024)	0.929 (0.266)	0.646 (0.341)	0.540 (0.239)
25 Apr	254	1.048 (0.067)	1.123 (0.582)	0.198 (0.135)	0.233 (0.104)
26 Apr	501	0.954 (0.042)	0.668 (0.150)	0.705 (0.341)	0.449 (0.194)
27 Apr	1,040	0.918 (0.026)	0.582 (0.087)	1.242 (0.487)	0.664 (0.243)
28 Apr	952	0.886 (0.022)	1.286 (0.270)	0.262 (0.078)	0.299 (0.062)
29 Apr	1,119	0.925 (0.024)	0.789 (0.114)	0.566 (0.158)	0.413 (0.099)
30 Apr	1,363	0.893 (0.022)	0.892 (0.130)	0.599 (0.218)	0.477 (0.160)
01 May	1,195	0.891 (0.025)	0.773 (0.117)	0.645 (0.234)	0.444 (0.147)
02 May	419	0.958 (0.039)	1.490 (0.545)	1.290 (1.328)	1.842 (1.772)
03 May	564	0.936 (0.028)	1.411 (0.481)	0.426 (0.236)	0.563 (0.245)
04 May	1,798	0.917 (0.016)	1.096 (0.198)	0.600 (0.188)	0.604 (0.155)
05 May	2,160	0.939 (0.016)	0.963 (0.141)	0.525 (0.131)	0.475 (0.096)
06 May	2,186	0.917 (0.016)	1.125 (0.166)	0.512 (0.193)	0.529 (0.183)
07 May	2,984	0.880 (0.013)	0.922 (0.085)	0.350 (0.071)	0.284 (0.051)

Table 14. Continued.

Date at LGR	Number released	LGR to LGO	LGO to LMO	LMO to MCN	LGR to MCN
08 May	3,402	0.882 (0.010)	0.890 (0.076)	0.467 (0.107)	0.367 (0.078)
09 May	1,170	0.900 (0.017)	1.030 (0.146)	0.213 (0.074)	0.198 (0.062)
10 May	1,037	0.832 (0.015)	0.872 (0.081)	0.458 (0.242)	0.332 (0.173)
11 May	2,072	0.833 (0.011)	0.704 (0.028)	0.497 (0.131)	0.292 (0.076)
12 May	1,803	0.819 (0.011)	0.825 (0.043)	0.358 (0.089)	0.242 (0.059)
13 May	1,161	0.822 (0.014)	0.760 (0.046)	0.891 (0.481)	0.556 (0.299)
14 May	1,498	0.822 (0.012)	0.756 (0.037)	0.409 (0.125)	0.254 (0.077)
15 May	1,543	0.834 (0.011)	0.787 (0.040)	0.385 (0.118)	0.253 (0.076)
16 May	678	0.865 (0.015)	0.882 (0.074)	1.443 (1.393)	1.102 (1.060)
17 May	971	0.869 (0.014)	0.862 (0.053)	0.521 (0.208)	0.390 (0.154)
18 May	1,090	0.835 (0.013)	0.802 (0.043)	0.264 (0.057)	0.177 (0.037)
19 May	1,177	0.844 (0.012)	0.895 (0.050)	0.417 (0.126)	0.315 (0.094)
20 May	1,201	0.846 (0.012)	0.878 (0.041)	0.577 (0.158)	0.429 (0.116)
21 May	1,806	0.866 (0.010)	0.793 (0.030)	0.440 (0.099)	0.302 (0.067)
22 May	2,165	0.857 (0.008)	0.881 (0.034)	0.434 (0.089)	0.327 (0.066)
23 May	1,375	0.843 (0.011)	0.806 (0.037)	0.472 (0.127)	0.321 (0.086)
24 May	476	0.789 (0.021)	0.821 (0.062)	0.608 (0.262)	0.394 (0.168)
25 May	833	0.802 (0.016)	0.807 (0.051)	0.510 (0.173)	0.330 (0.110)
26 May	1,053	0.838 (0.014)	0.987 (0.066)	0.840 (0.450)	0.695 (0.369)
27 May	1,053	0.846 (0.013)	0.837 (0.039)	0.645 (0.232)	0.457 (0.164)
28 May	882	0.821 (0.017)	1.070 (0.108)	0.451 (0.152)	0.397 (0.127)
29 May	749	0.819 (0.016)	0.852 (0.062)	0.414 (0.113)	0.289 (0.077)
30 May	301	0.931 (0.018)	0.885 (0.097)	0.180 (0.062)	0.149 (0.048)
31 May-02 Jun	835	0.829 (0.014)	0.775 (0.048)	0.830 (0.437)	0.534 (0.279)
Weighted mean*		**0.899 (0.009)**	**0.813 (0.030)**	**0.502 (0.046)**	**0.383 (0.029)**

* Weighted means of the independent estimates for daily groups (26 March-07 June), with weights inversely proportional to respective estimated relative variances.

Table 15. Estimated detection probabilities for juvenile Snake River steelhead (hatchery and wild combined) detected and released to or PIT tagged and released to the tailrace at Lower Granite Dam in 2004. Daily groups pooled weekly. Estimates based on the single-release model. Standard errors in parentheses. Abbreviations: LGR-Lower Granite Dam; LGO-Little Goose Dam; LMO-Lower Monumental Dam; MCN-McNary Dam.

Date at LGR	Number released	LGO	LMO	MCN
30 Mar-05 Apr	62	0.566 (0.075)	0.921 (0.076)	0.625 (0.171)
06 Apr-12 Apr	74	0.235 (0.061)	0.849 (0.081)	0.556 (0.166)
13 Apr-19 Apr	2,273	0.302 (0.017)	0.390 (0.026)	0.191 (0.037)
20 Apr-26 Apr	3,211	0.812 (0.014)	0.177 (0.020)	0.133 (0.026)
27 Apr-03 May	6,652	0.809 (0.009)	0.204 (0.015)	0.144 (0.018)
04 May-10 May	14,737	0.849 (0.005)	0.246 (0.012)	0.140 (0.014)
11 May-17 May	9,726	0.875 (0.005)	0.771 (0.016)	0.145 (0.019)
18 May-24 May	9,290	0.900 (0.004)	0.766 (0.014)	0.231 (0.023)
25 May-31 May	5,053	0.884 (0.006)	0.677 (0.020)	0.221 (0.032)
01 Jun-07 Jun	2,358	0.907 (0.009)	0.723 (0.032)	0.186 (0.053)
08 Jun-14 Jun	1,592	0.760 (0.022)	0.529 (0.060)	0.421 (0.143)

Table 16. Estimated detection probabilities for juvenile Snake River steelhead (hatchery and wild combined) detected and released to the tailrace at McNary Dam in Daily groups pooled weekly. Estimates based on the single-release model. Standard errors in parentheses. Abbreviations: MCN-McNary Dam; JDA-John Day Dam; BON-Bonneville Dam.

Date at MCN	Number released	JDA	BON
27 Apr-03 May	206	0.200 (0.179)	NA
04 May-10 May	676	0.194 (0.071)	NA
11 May-17 May	1,107	0.090 (0.049)	NA
18 May-24 May	395	0.344 (0.159)	NA
25 May-31 May	1,001	0.284 (0.075)	NA
01 Jun-07 Jun	730	0.100 (0.047)	NA

Table 17. Estimated detection probabilities for juvenile Snake River hatchery steelhead detected and released to or PIT tagged and released to the tailrace at Lower Granite Dam in 2004. Daily groups pooled weekly. Estimates based on the single-release model. Standard errors in parentheses. Abbreviations: LGR-Lower Granite Dam; LGO-Little Goose Dam; LMO-Lower Monumental Dam; MCN-McNary Dam.

Date at LGR	Number released	LGO	LMO	MCN
30 Mar-05 Apr	11	0.348 (0.178)	NA	NA
06 Apr-12 Apr	24	0.188 (0.098)	0.560 (0.244)	0.250 (0.217)
13 Apr-19 Apr	1,560	0.329 (0.022)	0.297 (0.031)	0.135 (0.038)
20 Apr-26 Apr	2,615	0.813 (0.015)	0.193 (0.022)	0.133 (0.028)
27 Apr-03 May	5,604	0.805 (0.010)	0.222 (0.016)	0.145 (0.020)
04 May-10 May	10,534	0.846 (0.006)	0.279 (0.015)	0.140 (0.016)
11 May-17 May	7,342	0.868 (0.006)	0.763 (0.019)	0.150 (0.023)
18 May-24 May	6,867	0.890 (0.005)	0.749 (0.017)	0.203 (0.026)
25 May-31 May	2,997	0.864 (0.009)	0.627 (0.028)	0.228 (0.044)
01 Jun-07 Jun	1,376	0.864 (0.015)	0.624 (0.047)	0.216 (0.078)
08 Jun-14 Jun	1,220	0.716 (0.027)	0.502 (0.064)	0.304 (0.146)

Table 18. Estimated detection probabilities for juvenile Snake River wild steelhead detected and released to or PIT tagged and released to the tailrace at Lower Granite Dam in 2004. Daily groups pooled weekly. Estimates based on the single-release model. Standard errors in parentheses. Abbreviations: LGR-Lower Granite Dam; LGO-Little Goose Dam; LMO-Lower Monumental Dam; MCN-McNary Dam.

Date at LGR	Number released	LGO	LMO	MCN
30 Mar-05 Apr	51	0.611 (0.081)	0.903 (0.093)	0.667 (0.192)
06 Apr-12 Apr	50	0.256 (0.076)	0.933 (0.065)	0.800 (0.179)
13 Apr-19 Apr	713	0.259 (0.026)	0.564 (0.045)	0.357 (0.089)
20 Apr-26 Apr	596	0.801 (0.041)	0.049 (0.034)	0.133 (0.087)
27 Apr-03 May	1,048	0.842 (0.026)	0.101 (0.029)	0.134 (0.047)
04 May-10 May	4,203	0.860 (0.011)	0.177 (0.019)	0.141 (0.027)
11 May-17 May	2,384	0.896 (0.008)	0.793 (0.029)	0.132 (0.035)
18 May-24 May	2,423	0.922 (0.007)	0.809 (0.024)	0.310 (0.050)
25 May-31 May	2,056	0.907 (0.008)	0.739 (0.028)	0.211 (0.048)
01 Jun-07 Jun	982	0.956 (0.009)	0.841 (0.038)	0.154 (0.071)
08 Jun-14 Jun	372	0.908 (0.031)	0.698 (0.149)	NA

Table 19. Estimated survival probabilities for PIT-tagged yearling Chinook salmon released from Snake River Basin hatcheries in 2004. Estimates based on the single-release model. Standard errors in parentheses. Abbreviations: Rel-Release site; LGR-Lower Granite Dam; LGO-Little Goose Dam; LMO-Lower Monumental Dam; MCN-McNary Dam.

Release site	Number released	Rel to LGR	LGR to LGO	LGO to LMO	LMO to MCN	Rel to MCN
			Clearwater Hatchery			
Crooked River	299	0.480 (0.030)	1.028 (0.047)	1.056 (0.160)	0.677 (0.186)	0.353 (0.084)
Powell Pond	292	0.775 (0.031)	0.937 (0.058)	0.883 (0.184)	0.895 (0.317)	0.574 (0.170)
Red River Pond	296	0.722 (0.029)	0.973 (0.039)	1.171 (0.235)	0.718 (0.247)	0.590 (0.166)
Papoose Creek	801	0.392 (0.019)	0.894 (0.040)	0.879 (0.132)	1.031 (0.331)	0.317 (0.092)
			Dworshak Hatchery			
Dworshak H.	51,612	0.821 (0.003)	0.982 (0.007)	0.965 (0.030)	0.785 (0.031)	0.611 (0.015)
			Kooskia Hatchery			
Clear Creek	1,505	0.769 (0.017)	0.961 (0.030)	0.750 (0.070)	1.078 (0.149)	0.598 (0.065)
			McCall Hatchery			
Johnson Creek	12,186	0.278 (0.004)	0.920 (0.027)	0.874 (0.110)	0.620 (0.113)	0.139 (0.018)
Knox Bridge	71,363	0.561 (0.002)	0.943 (0.006)	1.000 (0.029)	0.758 (0.030)	0.401 (0.011)

Table 19. Continued.

Release site	Number released	Rel to LGR	LGR to LGO	LGO to LMO	LMO to MCN	Rel to MCN
			Lookingglass Hatchery			
Catherine Creek Pond	20,994	0.254 (0.003)	0.978 (0.018)	0.909 (0.053)	0.901 (0.084)	0.204 (0.015)
Grande Ronde R. Pond (3/22)	982	0.233 (0.015)	0.989 (0.059)	0.805 (0.131)	1.008 (0.298)	0.187 (0.049)
Grande Ronde R. Pond (3/31)	500	0.514 (0.025)	0.935 (0.051)	1.060 (0.321)	0.881 (0.366)	0.449 (0.130)
Imnaha Weir	20,910	0.613 (0.004)	0.973 (0.012)	0.906 (0.044)	0.831 (0.056)	0.449 (0.021)
Lostine River Pond (3/15)	6,633	0.442 (0.007)	1.025 (0.021)	0.753 (0.042)	0.870 (0.070)	0.297 (0.019)
Lostine River Pond (3/29)	9,276	0.533 (0.006)	0.955 (0.011)	0.917 (0.043)	0.875 (0.066)	0.409 (0.025)
Lookingglass H.	5,193	0.564 (0.010)	1.139 (0.038)	0.782 (0.058)	0.791 (0.081)	0.397 (0.031)
			Pahsimeroi Hatchery			
Pahsimeroi River	985	0.528 (0.017)	0.886 (0.034)	1.368 (0.371)	0.820 (0.324)	0.525 (0.152)
			Rapid River Hatchery			
Rapid River H.	51,969	0.694 (0.003)	1.004 (0.007)	0.754 (0.024)	0.878 (0.036)	0.462 (0.012)
			Sawtooth Hatchery			
Salmon River	982	0.547 (0.018)	0.888 (0.032)	1.205 (0.248)	0.578 (0.164)	0.338 (0.067)

Table 20. Estimated survival probabilities for PIT-tagged juvenile steelhead released from Snake River Basin hatcheries in 2004. Estimates based on the single-release model. Standard errors in parentheses. Abbreviations: Rel-Release site; LGR-Lower Granite Dam; LGO-Little Goose Dam; LMO-Lower Monumental Dam; MCN-McNary Dam.

Release site	Number released	Rel to LGR	LGR to LGO	LGO to LMO	LMO to MCN	Rel to MCN
Clearwater Hatchery						
S.F. Clearwater R.	297	0.833 (0.027)	0.958 (0.070)	1.317 (0.684)	NA	NA
Red River Pond	598	0.794 (0.019)	0.881 (0.031)	1.035 (0.244)	0.240 (0.127)	0.174 (0.082)
Crooked River	297	0.779 (0.029)	0.909 (0.050)	0.940 (0.365)	0.222 (0.210)	0.148 (0.127)
Lolo Creek	1,061	0.792 (0.014)	0.874 (0.021)	0.759 (0.096)	0.692 (0.458)	0.363 (0.236)
Meadow Creek	1,504	0.649 (0.013)	0.814 (0.018)	0.894 (0.133)	0.242 (0.109)	0.114 (0.049)
Mill Creek	7,281	0.805 (0.005)	0.885 (0.008)	0.984 (0.053)	0.384 (0.060)	0.269 (0.040)
Dworshak Hatchery						
Clearwater R.	1,496	0.843 (0.011)	0.934 (0.020)	0.899 (0.122)	0.504 (0.152)	0.357 (0.096)
Hagerman Hatchery						
Little Salmon R.	583	0.828 (0.029)	0.885 (0.059)	1.239 (0.378)	NA	0.908 (0.273)*
East Fork Salmon R.	275	0.551 (0.031)	0.854 (0.041)	0.625 (0.065)	NA	0.294 (0.035)*
Sawtooth Hatchery	296	0.704 (0.033)	0.818 (0.057)	NA	NA	NA
Yankee Fork	296	0.445 (0.030)	0.837 (0.038)	0.822 (0.093)	NA	0.306 (0.041)*

Table 20. Continued.

Release site	Number released	Rel to LGR	LGR to LGO	LGO to LMO	LMO to MCN	Rel to MCN
Magic Valley Hatchery						
Hammer Creek	300	0.857 (0.033)	1.036 (0.083)	0.801 (0.205)	NA	0.712 (0.175)*
Lemhi R.	896	0.863 (0.014)	0.898 (0.025)	0.857 (0.112)	NA	0.664 (0.086)*
Little Salmon R.	300	0.808 (0.028)	0.849 (0.042)	0.981 (0.241)	NA	0.673 (0.166)*
East Fork Salmon R.	591	0.802 (0.020)	0.858 (0.028)	0.845 (0.133)	NA	0.582 (0.092)*
Squaw Creek Pond	500	0.675 (0.023)	0.759 (0.029)	1.125 (0.291)	NA	0.576 (0.151)*
Valley Creek	299	0.847 (0.022)	0.917 (0.027)	0.812 (0.085)	NA	0.631 (0.068)*
W. Fork Yankee Fork	299	0.648 (0.029)	0.861 (0.037)	0.581 (0.055)	NA	0.324 (0.034)*
Niagara Springs Hatchery						
Hells Canyon Dam	596	0.796 (0.019)	0.916 (0.028)	0.848 (0.107)	NA	0.618 (0.078)*
Little Salmon R.	300	0.853 (0.026)	0.981 (0.048)	0.756 (0.146)	NA	0.633 (0.120)*
Pahsimeroi Weir	294	0.829 (0.027)	0.816 (0.039)	0.718 (0.092)	NA	0.486 (0.063)*

* Release to Lower Monumental Dam.

Table 21. Estimated survival probabilities for PIT-tagged juvenile sockeye salmon from Sawtooth and Bonneville hatcheries and coho salmon from Kooskia and Clearwater hatcheries released in 2004. Estimates based on the single-release model. Standard errors in parentheses. Abbreviations: Rel-Release site; LGR-Lower Granite Dam; LGO-Little Goose Dam; LMO-Lower Monumental Dam; MCN-McNary Dam.

Release site	Release date	Number released	Rel to LGR	LGR to LGO	LGO to LMO	LMO to MCN	LGR to MCN	Rel to MCN
Sawtooth Hatchery sockeye salmon								
Pettit Lake	06 Oct 03	2,014	0.072 (0.006)	NA	NA	NA	NA	NA
Redfish Lake	07 Oct 03	1,519	0.090 (0.007)	NA	NA	NA	NA	NA
Kooskia Hatchery coho salmon								
Kooskia Hatchery	27 Apr 04	1,498	0.734 (0.014)	0.871 (0.022)	0.724 (0.063)	0.643 (0.192)	0.325 (0.060)[a]	0.298 (0.086)
Clearwater Hatchery coho salmon								
S.F. Clearwater R.	23 Jul 03	2,795	0.025 (0.003)	0.651 (0.093)	0.634 (0.187)	0.653 (0.531)	0.325 (0.060)[a]	0.007 (0.005)
Eldorado Creek	24 Jul 03	3,006	0.020 (0.003)	0.773 (0.090)	0.626 (0.201)	NA	0.325 (0.060)[a]	NA
O'Hara Creek	22 Jul 03	3,124	0.014 (0.002)	0.802 (0.086)	0.875 (0.411)	NA	0.325 (0.060)[a]	NA
Eagle Creek Hatchery coho salmon								
Eagle Creek	Spring 04	2,997	0.406 (0.010)	0.766 (0.025)	0.755 (0.073)	0.552 (0.130)	0.325 (0.060)[a]	0.130 (0.028)

Table 22. Estimated detection probabilities for PIT-tagged yearling Chinook salmon released from Snake River Basin hatcheries in 2004. Estimates based on the single-release model. Standard errors in parentheses. Abbreviations:LGR-Lower Granite Dam; LGO-Little Goose Dam; LMO-Lower Monumental Dam; MCN-McNary.

Release site	Number released	LGR	LGO	LMO	MCN
			Clearwater Hatchery		
Crooked River	299	0.662 (0.042)	0.684 (0.049)	0.360 (0.065)	0.353 (0.093)
Powell Pond	292	0.680 (0.035)	0.696 (0.049)	0.203 (0.050)	0.264 (0.084)
Red River	296	0.711 (0.033)	0.793 (0.039)	0.219 (0.051)	0.195 (0.062)
Papoose Creek	801	0.672 (0.030)	0.776 (0.037)	0.280 (0.050)	0.192 (0.060)
			Dworshak Hatchery		
Dworshak H.	51,612	0.501 (0.003)	0.673 (0.005)	0.112 (0.004)	0.354 (0.009)
			Kooskia Hatchery		
Clear Creek	1,505	0.454 (0.017)	0.663 (0.022)	0.142 (0.017)	0.363 (0.042)
			McCall Hatchery		
Johnson Creek	12,186	0.794 (0.008)	0.787 (0.021)	0.316 (0.044)	0.461 (0.064)
Knox Bridge	71,363	0.747 (0.003)	0.734 (0.005)	0.140 (0.005)	0.297 (0.009)

Table 22. Continued.

Release site	Number released	LGR	LGO	LMO	MCN
		Lookingglass Hatchery			
Catherine Creek Pond	20,994	0.638 (0.008)	0.658 (0.013)	0.217 (0.015)	0.304 (0.024)
Grande Ronde R. Pond (3/22)	982	0.593 (0.036)	0.657 (0.047)	0.261 (0.051)	0.244 (0.070)
Grande Ronde R. Pond (3/31)	500	0.638 (0.034)	0.755 (0.044)	0.096 (0.034)	0.182 (0.058)
Imnaha Weir	20,910	0.612 (0.005)	0.688 (0.008)	0.151 (0.009)	0.305 (0.016)
Lostine River Pond (3/15)	6,633	0.510 (0.010)	0.597 (0.014)	0.190 (0.013)	0.367 (0.025)
Lostine River Pond (3/29)	9,276	0.693 (0.007)	0.749 (0.010)	0.181 (0.010)	0.249 (0.016)
Lookingglass H.	5,193	0.507 (0.011)	0.467 (0.017)	0.243 (0.019)	0.415 (0.035)
		Pahsimeroi Hatchery			
Pahsimeroi River	985	0.757 (0.021)	0.787 (0.032)	0.078 (0.024)	0.160 (0.049)
		Rapid River Hatchery			
Rapid River H.	51,969	0.626 (0.003)	0.681 (0.005)	0.132 (0.005)	0.385 (0.011)
		Sawtooth Hatchery			
Salmon River	982	0.737 (0.022)	0.785 (0.030)	0.127 (0.030)	0.241 (0.052)

Table 23. Estimated detection probabilities for PIT-tagged juvenile steelhead released from Snake River Basin hatcheries in 2004. Estimates based on the single-release model. Standard errors in parentheses. Abbreviations: LGR-Lower Granite Dam; LGO-Little Goose Dam; LMO-Lower Monumental Dam; MCN-McNary Dam.

Release site	Number released	LGR	LGO	LMO	MCN
		Clearwater Hatchery			
S.F. Clearwater R.	297	0.780 (0.030)	0.712 (0.057)	0.143 (0.076)	NA
Red River Pond	598	0.796 (0.021)	0.814 (0.030)	0.335 (0.082)	0.230 (0.115)
Crooked River	297	0.748 (0.032)	0.791 (0.046)	0.351 (0.139)	0.143 (0.132)
Lolo Creek	1,061	0.870 (0.013)	0.848 (0.020)	0.515 (0.067)	0.079 (0.053)
Meadow Creek	1,504	0.916 (0.010)	0.864 (0.018)	0.477 (0.073)	0.174 (0.079)
Mill Creek	7,281	0.795 (0.006)	0.848 (0.007)	0.398 (0.022)	0.158 (0.025)
		Dworshak Hatchery			
Clearwater R.	1,496	0.754 (0.013)	0.830 (0.019)	0.261 (0.038)	0.163 (0.047)
		Hagerman Hatchery			
Little Salmon R.	583	0.574 (0.028)	0.588 (0.042)	0.203 (0.063)	NA
East Fork Salmon R.	275	0.877 (0.030)	0.865 (0.040)	0.892 (0.072)	NA
Sawtooth Hatchery	296	0.734 (0.036)	0.784 (0.053)	0.108 (0.072)	NA
Yankee Fork	296	0.843 (0.035)	0.934 (0.028)	0.794 (0.092)	NA

Table 23. Continued.

Release site	Number released	LGR	LGO	LMO	MCN
Magic Valley Hatchery					
Hammer Creek	300	0.579 (0.036)	0.590 (0.053)	0.270 (0.072)	NA
Lemhi R.	896	0.805 (0.016)	0.811 (0.024)	0.346 (0.048)	NA
Little Salmon R.	300	0.764 (0.031)	0.825 (0.040)	0.384 (0.100)	NA
East Fork Salmon R.	591	0.747 (0.022)	0.871 (0.026)	0.359 (0.061)	NA
Squaw Creek Pond	500	0.877 (0.021)	0.908 (0.025)	0.411 (0.110)	NA
Valley Creek	299	0.900 (0.020)	0.857 (0.030)	0.688 (0.075)	NA
W. Fork Yankee Fork	299	0.847 (0.029)	0.864 (0.036)	0.907 (0.063)	NA
Niagara Springs Hatchery					
Hells Canyon Dam	596	0.759 (0.022)	0.797 (0.028)	0.498 (0.066)	NA
Little Salmon R.	300	0.692 (0.032)	0.757 (0.043)	0.407 (0.083)	NA
Pahsimeroi Weir	294	0.812 (0.029)	0.809 (0.038)	0.653 (0.085)	NA

Table 24. Estimated detection probabilities for PIT-tagged juvenile sockeye salmon from Sawtooth and Bonneville hatcheries and coho salmon from Kooskia and Clearwater hatcheries released in 2004. Estimates based on the single-release model. Standard errors in parentheses. Abbreviations: LGR-Lower Granite Dam; LGO-Little Goose Dam; LMO-Lower Monumental Dam; MCN-McNary Dam.

Release site	Release date	Number released	LGR	LGO	LMO	MCN
Sawtooth Hatchery sockeye salmon						
Pettit Lake	06 Oct 03	2,014	0.731 (0.037)	NA	NA	NA
Redfish Lake	07 Oct 03	1,519	0.701 (0.039)	NA	NA	NA
Kooskia Hatchery coho salmon						
Kooskia Hatchery	27 Apr 04	1,498	0.677 (0.016)	0.797 (0.020)	0.518 (0.046)	0.132 (0.041)
Clearwater Hatchery coho salmon						
S.F. Clearwater R.	23 Jul 03	2,795	0.698 (0.073)	0.794 (0.092)	0.604 (0.181)	0.250 (0.217)
Eldorado Creek	24 Jul 03	3,006	0.649 (0.073)	0.853 (0.078)	0.643 (0.208)	NA
O'Hara Creek	22 Jul 03	3,124	0.672 (0.081)	0.939 (0.059)	0.500 (0.250)	NA
Eagle Creek Hatchery coho salmon						
Eagle Creek	Spring 04	2,997	0.721 (0.016)	0.732 (0.023)	0.415 (0.042)	0.234 (0.054)

Table 25. Estimated survival probabilities for juvenile salmonids released from fish traps in Snake River Basin in 2004. Estimates based on the single-release model. Standard errors in parentheses. Abbreviations: Rel-Release; LGR-Lower Granite Dam; LGO-Little Goose Dam; LMO-Lower Monumental Dam; MCN-McNary Dam.

Trap	Release dates	Number released	Rel to LGR	LGR to LGO	LGO to LMO	LMO to MCN	Rel to MCN
			Wild Chinook salmon				
Snake	25 Mar-02 Jun	1,389	0.862 (0.013)	0.866 (0.021)	0.865 (0.040)	1.090 (0.164)	0.704 (0.103)
Clearwater	12 Mar-19 May	1,249	0.814 (0.019)	0.951 (0.039)	0.898 (0.078)	0.750 (0.102)	0.521 (0.058)
Grande Ronde (spring)	09 Mar-28 May	3,103	0.848 (0.009)	1.024 (0.019)	0.852 (0.040)	0.838 (0.065)	0.620 (0.041)
Imnaha (spring)	26 Feb-31 May	9,183	0.759 (0.006)	1.060 (0.019)	0.692 (0.023)	0.989 (0.055)	0.551 (0.027)
Imnaha (late)	01 Jun-27 Jun	655	0.358 (0.020)	0.818 (0.052)	0.565 (0.068)	NA	NA
Salmon	14 Mar-26 May	7,291	0.758 (0.007)	1.008 (0.017)	0.724 (0.027)	0.842 (0.047)	0.465 (0.022)
Minam	03 Mar-20 May	411	0.531 (0.025)	1.028 (0.042)	0.984 (0.139)	1.167 (0.442)	0.627 (0.222)
Elgin (Grande Ronde R.)	26 Mar-24 May	488	0.722 (0.022)	0.928 (0.030)	1.016 (0.137)	1.050 (0.319)	0.716 (0.196)
Crooked River (spring)	20 Mar-31 May	745	0.438 (0.020)	0.886 (0.030)	0.730 (0.056)	1.482 (0.559)	0.420 (0.158)
Crooked River (late)	01 Jun-28 Jun	183	0.314 (0.038)	0.752 (0.093)	0.553 (0.179)	NA	NA
American River (spring)	26 Mar-23 May	504	0.499 (0.024)	0.910 (0.030)	0.800 (0.063)	0.876 (0.282)	0.318 (0.102)
American River (late)	01 Jun-25 Jun	543	0.538 (0.023)	0.797 (0.034)	0.519 (0.051)	0.816 (0.283)	0.181 (0.064)
Lostine River	09 Mar-17 May	503	0.632 (0.024)	0.938 (0.037)	0.896 (0.089)	NA	NA
Red River	24 Mar-29 May	1,139	0.471 (0.016)	0.887 (0.021)	0.826 (0.043)	0.963 (0.151)	0.332 (0.052)
Crooked Fork Creek	19 Mar-27 May	253	0.326 (0.030)	0.930 (0.053)	0.883 (0.120)	1.151 (0.634)	0.308 (0.169)
Catherine Creek	20 Feb-12 May	525	0.424 (0.022)	0.959 (0.030)	0.761 (0.082)	NA	NA

Table 25. Continued.

Trap	Release dates	Number released	Rel to LGR	LGR to LGO	LGO to LMO	LMO to MCN	Rel to MCN
			Wild Chinook salmon (continued)				
Spoolcart (Grande Ronde)	09 Mar-28 May	525	0.426 (0.022)	0.952 (0.031)	0.952 (0.103)	0.613 (0.176)	0.236 (0.065)
Johnson Creek	25 Feb-29 May	2,388	0.401 (0.010)	0.914 (0.018)	0.881 (0.052)	0.820 (0.121)	0.265 (0.037)
South Fork Salmon R.	04 Mar-18 May	1,293	0.399 (0.014)	0.887 (0.024)	0.951 (0.064)	0.946 (0.192)	0.319 (0.063)
Lemhi River Weir (spring)	09 Mar-30 May	591	0.523 (0.024)	0.888 (0.053)	0.947 (0.172)	1.112 (0.414)	0.490 (0.163)
Pahsimeroi (spring)	26 Feb-31 May	2,037	0.428 (0.013)	0.892 (0.029)	0.711 (0.049)	0.711 (0.089)	0.193 (0.023)
Pahsimeroi (late)	01 Jun-30 Jun	1,862	0.211 (0.010)	0.701 (0.035)	0.390 (0.045)	0.827 (0.266)	0.048 (0.016)
Marsh Creek	17 Mar-31 May	2,130	0.330 (0.011)	0.859 (0.024)	0.780 (0.047)	0.762 (0.127)	0.168 (0.028)
East Fork Salmon	19 Mar-15 Apr	235	0.544 (0.033)	0.966 (0.034)	0.941 (0.128)	1.092 (0.411)	0.540 (0.193)
Sawtooth (spring)	17 Mar-31 May	2,606	0.453 (0.010)	0.930 (0.017)	0.918 (0.053)	0.776 (0.100)	0.300 (0.036)
Sawtooth (late)	01 Jun-30 Jun	468	0.093 (0.015)	0.584 (0.116)	NA	NA	NA
			Wild steelhead				
Snake	25 Mar-02 Jun	1,923	0.936 (0.007)	0.890 (0.013)	0.776 (0.057)	0.339 (0.073)	0.219 (0.044)
Clearwater	12 Mar-19 May	990	0.872 (0.018)	1.195 (0.070)	0.570 (0.079)	1.048 (0.479)	0.623 (0.274)
Grande Ronde (spring)	14 Mar-31 May	771	0.900 (0.013)	0.902 (0.019)	0.725 (0.066)	1.225 (0.813)	0.721 (0.475)
Imnaha (spring)	29 Feb-31 May	427	0.793 (0.006)	0.917 (0.011)	0.896 (0.063)	0.730 (0.206)	0.476 (0.130)
Imnaha (late)	01 Jun-25 Jun	296	0.759 (0.043)	0.703 (0.061)	NA	NA	NA

Table 25. Continued.

Trap	Release dates	Number released	Rel to LGR	LGR to LGO	LGO to LMO	LMO to MCN	Rel to MCN
			Wild steelhead (continued)				
Salmon	17 Mar-25 May	239	0.845 (0.030)	0.920 (0.057)	0.596 (0.158)	1.100 (1.026)	0.510 (0.459)
Lookingglass Creek	23 Feb-31 May	480	0.400 (0.024)	0.957 (0.068)	0.587 (0.125)	0.750 (0.643)	0.169 (0.142)
Minam	10 Mar-26 May	181	0.384 (0.038)	1.002 (0.144)	0.652 (0.525)	NA	NA
Lostine River	09 Mar-26 May	403	0.307 (0.024)	0.863 (0.055)	1.052 (0.305)	NA	NA
Crooked Fork Creek	20 Mar-27 May	208	0.627 (0.036)	1.370 (0.183)	NA	NA	NA
Catherine Creek	20 Feb-20 May	598	0.337 (0.020)	0.878 (0.043)	0.925 (0.241)	0.167 (0.094)	0.046 (0.023)
Spoolcart (Grande Ronde)	08 Mar-18 May	823	0.293 (0.017)	0.801 (0.047)	0.686 (0.159)	0.216 (0.160)	0.035 (0.024)
Johnson Creek	25 Feb-22 May	105	0.631 (0.050)	0.993 (0.114)	0.345 (0.129)	NA	NA
South Fork Salmon R.	17 Mar-18 May	135	0.119 (0.030)	NA	NA	NA	NA
Lemhi River Weir	10 Mar-31 May	921	0.029 (0.011)	NA	NA	NA	NA
Marsh Creek	20 Mar-31 May	227	0.106 (0.020)	1.078 (0.087)	NA	NA	NA
Red River	24 Mar-25 May	56	0.539 (0.067)	1.018 (0.057)	NA	NA	NA
Pahsimeroi	26 Feb-31 May	602	0.085 (0.012)	0.969 (0.196)	NA	NA	NA
Sawtooth	19 Mar-30 May	355	0.321 (0.026)	0.988 (0.069)	0.463 (0.077)	0.564 (0.180)	0.083 (0.028)

Table 25. Continued.

Trap	Release dates	Number released	Rel to LGR	LGR to LGO	LGO to LMO	LMO to MCN	Rel to MCN
			Hatchery Chinook salmon				
Snake	25 Mar-02 Jun	2,127	0.913 (0.011)	0.915 (0.017)	0.852 (0.037)	0.827 (0.066)	0.588 (0.042)
Grande Ronde	18 Mar-17 Apr	1,401	0.721 (0.019)	1.151 (0.051)	0.640 (0.048)	0.961 (0.110)	0.510 (0.052)
Salmon	17 Mar-18 May	4,187	0.731 (0.008)	0.963 (0.015)	0.902 (0.057)	0.741 (0.063)	0.471 (0.028)
			Hatchery steelhead				
Snake	26 Mar-03 Jun	4,843	0.953 (0.005)	0.885 (0.008)	0.928 (0.041)	0.662 (0.125)	0.518 (0.095)
Grande Ronde	20 Mar-31 May	1,539	0.941 (0.011)	0.849 (0.017)	0.858 (0.074)	0.430 (0.111)	0.295 (0.072)
Imnaha (spring)	13 Apr-31 May	3,591	0.863 (0.007)	0.881 (0.009)	0.912 (0.049)	0.480 (0.102)	0.333 (0.068)
Imnaha (late)	01 Jun-27 Jun	895	0.880 (0.023)	0.687 (0.029)	0.500 (0.058)	0.279 (0.159)	0.084 (0.047)
Salmon	01 Apr-25 May	2,241	0.841 (0.009)	0.855 (0.014)	0.860 (0.064)	0.709 (0.205)	0.439 (0.123)

Table 26. Estimated detection probabilities for juvenile salmonids released from fish traps in Snake River Basin in 2004. Estimates based on the single-release model. Standard errors in parentheses. Abbreviations: LGR-Lower Granite Dam; LGO-Little Goose Dam; LMO-Lower Monumental Dam; MCN-McNary Dam.

Trap	Release dates	Number released	LGR	LGO	LMO	MCN
			Wild Chinook salmon			
Snake	25 Mar-02 Jun	1,389	0.653 (0.016)	0.840 (0.017)	0.585 (0.033)	0.346 (0.055)
Clearwater	12 Mar-19 May	1,249	0.535 (0.019)	0.590 (0.026)	0.330 (0.033)	0.435 (0.053)
Grande Ronde (spring)	09 Mar-28 May	3,103	0.618 (0.010)	0.636 (0.015)	0.343 (0.019)	0.440 (0.032)
Imnaha (spring)	26 Feb-31 May	9,183	0.608 (0.007)	0.522 (0.011)	0.387 (0.013)	0.438 (0.023)
Imnaha (late)	01 Jun-27 Jun	655	0.771 (0.032)	0.867 (0.044)	0.763 (0.079)	0.250 (0.153)
Salmon	14 Mar-26 May	7,291	0.603 (0.008)	0.609 (0.012)	0.312 (0.014)	0.492 (0.024)
Minam	03 Mar-20 May	411	0.742 (0.031)	0.717 (0.046)	0.396 (0.068)	0.254 (0.097)
Elgin (Grande Ronde R.)	26 Mar-24 May	488	0.812 (0.023)	0.835 (0.030)	0.291 (0.048)	0.179 (0.054)
Crooked River (spring)	20 Mar-31 May	745	0.681 (0.028)	0.888 (0.026)	0.654 (0.054)	0.230 (0.090)
Crooked River (late)	01 Jun-28 Jun	183	0.749 (0.069)	0.871 (0.085)	0.500 (0.177)	NA
American River (spring)	26 Mar-23 May	504	0.704 (0.031)	0.848 (0.030)	0.697 (0.059)	0.321 (0.107)
American River (late)	01 Jun-25 Jun	543	0.831 (0.025)	0.896 (0.031)	0.713 (0.065)	0.500 (0.177)
Lostine River	09 Mar-17 May	503	0.711 (0.028)	0.798 (0.036)	0.539 (0.064)	0.177 (0.080)
Red River	24 Mar-29 May	1,139	0.712 (0.021)	0.894 (0.018)	0.621 (0.039)	0.400 (0.066)
Crooked Fork Creek	19 Mar-27 May	253	0.787 (0.048)	0.914 (0.048)	0.697 (0.114)	0.286 (0.171)

Table 26. Continued.

Trap	Release dates	Number released	LGR	LGO	LMO	MCN
			Wild Chinook salmon (continued)			
Catherine Creek	20 Feb-12 May	525	0.772 (0.029)	0.911 (0.030)	0.590 (0.074)	0.167 (0.108)
Spoolcart (Grande Ronde)	09 Mar-28 May	525	0.770 (0.030)	0.866 (0.033)	0.610 (0.077)	0.389 (0.115)
Johnson Creek	25 Feb-29 May	2,388	0.803 (0.014)	0.910 (0.015)	0.550 (0.039)	0.334 (0.052)
South Fork Salmon R.	04 Mar-18 May	1,293	0.761 (0.020)	0.926 (0.018)	0.560 (0.048)	0.313 (0.067)
Lemhi River Weir (spring)	09 Mar-30 May	591	0.692 (0.031)	0.740 (0.045)	0.255 (0.056)	0.219 (0.079)
Pahsimeroi (spring)	26 Feb-31 May	2,037	0.582 (0.019)	0.770 (0.024)	0.505 (0.039)	0.582 (0.068)
Pahsimeroi (late)	01 Jun-30 Jun	1,862	0.873 (0.021)	0.881 (0.035)	0.624 (0.069)	0.577 (0.186)
Marsh Creek	17 Mar-31 May	2,130	0.788 (0.017)	0.927 (0.017)	0.705 (0.046)	0.458 (0.081)
East Fork Salmon	19 Mar-15 Apr	235	0.829 (0.035)	0.855 (0.040)	0.428 (0.073)	0.263 (0.101)
Sawtooth (spring)	17 Mar-31 May	2,606	0.806 (0.012)	0.838 (0.018)	0.481 (0.034)	0.379 (0.049)
Sawtooth (late)	01 Jun-30 Jun	468	0.778 (0.088)	0.800 (0.126)	NA	NA
			Wild steelhead			
Snake	25 Mar-02 Jun	1,923	0.809 (0.010)	0.879 (0.012)	0.531 (0.041)	0.262 (0.056)
Clearwater	12 Mar-19 May	990	0.602 (0.019)	0.521 (0.035)	0.440 (0.058)	0.159 (0.073)
Grande Ronde (spring)	14 Mar-31 May	771	0.814 (0.016)	0.888 (0.018)	0.629 (0.059)	0.087 (0.059)
Imnaha (spring)	29 Feb-31 May	427	0.822 (0.006)	0.842 (0.011)	0.428 (0.032)	0.123 (0.035)
Imnaha (late)	01 Jun-25 Jun	296	0.583 (0.042)	0.979 (0.021)	NA	NA

Table 26. Continued.

Trap	Release dates	Number released	LGR	LGO	LMO	MCN
Wild steelhead (continued)						
Salmon	17 Mar-25 May	239	0.728 (0.035)	0.815 (0.053)	0.364 (0.103)	0.119 (0.111)
Lookingglass Creek	23 Feb-31 May	480	0.806 (0.032)	0.738 (0.061)	0.581 (0.122)	0.250 (0.217)
Minam	10 Mar-26 May	181	0.734 (0.058)	0.811 (0.124)	0.250 (0.217)	NA
Lostine River	09 Mar-26 May	403	0.736 (0.044)	0.977 (0.023)	0.588 (0.185)	NA
Crooked Fork Creek	20 Mar-27 May	208	0.706 (0.042)	0.519 (0.087)	NA	NA
Catherine Creek	20 Feb-20 May	598	0.745 (0.034)	0.851 (0.040)	0.531 (0.143)	0.500 (0.250)
Spoolcart (Grande Ronde)	08 Mar-18 May	823	0.789 (0.031)	0.877 (0.041)	0.635 (0.149)	0.500 (0.354)
Johnson Creek	25 Feb-22 May	105	0.785 (0.055)	0.803 (0.102)	0.545 (0.200)	NA
South Fork Salmon R.	17 Mar-18 May	135	0.625 (0.135)	NA	NA	NA
Lemhi River Weir	10 Mar-31 May	921	0.444 (0.176)	NA	NA	NA
Marsh Creek	20 Mar-31 May	227	0.833 (0.076)	0.866 (0.125)	NA	NA
Red River	24 Mar-25 May	56	0.862 (0.064)	0.842 (0.084)	0.250 (0.217)	NA
Pahsimeroi	26 Feb-31 May	602	0.843 (0.060)	0.677 (0.154)	NA	NA
Sawtooth	19 Mar-30 May	355	0.762 (0.043)	0.819 (0.067)	0.855 (0.095)	0.500 (0.177)

Table 26. Continued.

Trap	Release dates	Number released	LGR	LGO	LMO	MCN
			Hatchery Chinook salmon			
Snake	25 Mar-02 Jun	2,127	0.556 (0.013)	0.712 (0.015)	0.358 (0.019)	0.420 (0.032)
Grande Ronde	18 Mar-17 Apr	1,401	0.402 (0.018)	0.435 (0.023)	0.275 (0.023)	0.434 (0.046)
Salmon	17 Mar-18 May	4,187	0.664 (0.010)	0.714 (0.013)	0.150 (0.012)	0.355 (0.023)
Imnaha (spring)	29 Feb-31 May	427	0.822 (0.006)	0.842 (0.011)	0.428 (0.032)	0.123 (0.035)
			Hatchery steelhead			
Snake	26 Mar-03 Jun	4,843	0.758 (0.007)	0.835 (0.008)	0.493 (0.023)	0.120 (0.023)
Grande Ronde	20 Mar-31 May	1,539	0.708 (0.014)	0.822 (0.016)	0.479 (0.043)	0.187 (0.048)
Imnaha (spring)	13 Apr-31 May	3,591	0.811 (0.008)	0.872 (0.009)	0.548 (0.031)	0.138 (0.030)
Imnaha (late)	01 Jun-27 Jun	895	0.608 (0.022)	0.832 (0.026)	0.749 (0.083)	0.333 (0.192)
Salmon	01 Apr-25 May	2,241	0.792 (0.011)	0.834 (0.014)	0.453 (0.035)	0.135 (0.039)

Table 27. Estimated survival probabilities for PIT-tagged yearling Chinook salmon and steelhead from upper-Columbia River hatcheries released in 2004. Estimates based on the single-release model. Standard errors in parentheses. Abbreviations: Rel-Release site; MCN-McNary Dam; JDA-John Day Dam; BON-Bonneville Dam.

Hatchery	Release sites	Number Released	Rel to MCN	MCN to JDA	JDA to BON	MCN to BON	Rel to BON
			Yearling Chinook salmon				
Entiat	Entiat Hatchery	58,625	0.569 (0.010)	0.833 (0.055)	0.795 (0.148)	0.663 (0.117)	0.377 (0.066)
Leavenworth	Leavenworth Hatchery	216,675	0.484 (0.005)	0.839 (0.023)	0.705 (0.053)	0.591 (0.043)	0.286 (0.021)
Winthrop	Winthrop Hatchery	19,887	0.494 (0.023)	0.721 (0.067)	1.205 (0.355)	0.870 (0.251)	0.430 (0.122)
Methow	Chewuch Pond	14,910	0.464 (0.029)	0.875 (0.124)	0.541 (0.138)	0.473 (0.111)	0.220 (0.049)
Methow	Twisp Pond	19,934	0.515 (0.032)	0.872 (0.108)	1.143 (0.363)	0.998 (0.307)	0.514 (0.154)
			Steelhead				
Chelan	Nason Creek	9,584	0.351 (0.054)	0.511 (0.115)	NA	NA	NA
East Bank	Chiwawa River	32,588	0.326 (0.022)	0.548 (0.068)	0.951 (0.421)	0.521 (0.227)	0.170 (0.073)
East Bank	Nason Creek	20,328	0.289 (0.022)	0.845 (0.116)	NA	NA	NA
East Bank	Wenatchee River	30,813	0.396 (0.022)	0.759 (0.079)	0.735 (0.272)	0.558 (0.203)	0.221 (0.079)
Ringold	Ringold Hatchery	96,492	0.450 (0.010)	0.834 (0.043)	0.696 (0.131)	0.581 (0.107)	0.262 (0.048)

Table 27. Continued.

Hatchery	Release Site	Number released	Rel to MCN	MCN to JDA	JDA to BON	MCN to BON	Rel to BON
			Steelhead (continued)				
Wells	Chewuch River	35,929	0.436 (0.024)	0.802 (0.075)	NA	NA	NA
Wells	Methow River	36,854	0.417 (0.021)	0.966 (0.090)	NA	NA	NA
Wells	Okanogan River	6,220	0.306 (0.041)	0.666 (0.166)	NA	NA	NA
Wells	Omak Creek	5,627	0.462 (0.076)	0.813 (0.237)	NA	NA	NA
Wells	Similkameen River	29,729	0.511 (0.025)	0.844 (0.080)	NA	NA	NA
Wells	Twisp Pond	11,685	0.422 (0.032)	0.676 (0.087)	NA	NA	NA
Wells	Twisp River	41,833	0.333 (0.017)	0.810 (0.075)	NA	NA	NA
Winthrop	Winthrop Hatchery	49,475	0.365 (0.018)	0.811 (0.077)	0.750 (0.248)	0.609 (0.198)	0.222 (0.071)

Table 28. Estimated detection probabilities for PIT-tagged yearling Chinook salmon and steelhead from upper-Columbia River hatcheries released in 2004. Estimates based on the single-release model. Standard errors in parentheses. Abbreviations: Rel-Release site; MCN-McNary Dam; JDA-John Day Dam; BON-Bonneville Dam.

Hatchery	Release site	Number released	MCN	JDA	BON
			Yearling Chinook salmon		
Entiat	Entiat Hatchery	58,625	0.430 (0.008)	0.123 (0.008)	0.076 (0.013)
Leavenworth	Leavenworth	216,675	0.309 (0.004)	0.181 (0.004)	0.122 (0.009)
Winthrop	Winthrop Hatchery	19,887	0.260 (0.013)	0.180 (0.015)	0.078 (0.022)
Methow	Chewuch Pond	14,910	0.233 (0.015)	0.106 (0.014)	0.146 (0.033)
Methow	Twisp Pond	19,934	0.182 (0.012)	0.099 (0.011)	0.069 (0.021)
			Steelhead		
Chelan	Nason Creek	9,584	0.118 (0.019)	0.211 (0.034)	0.027 (0.027)
East Bank	Chiwawa River	32,588	0.163 (0.011)	0.212 (0.022)	0.043 (0.019)
East Bank	Nason Creek	20,328	0.169 (0.014)	0.181 (0.021)	0.032 (0.018)
East Bank	Wenatchee River	30,813	0.166 (0.010)	0.199 (0.018)	0.067 (0.024)
Ringold	Ringold Hatchery	96,492	0.223 (0.005)	0.195 (0.009)	0.070 (0.013)
Wells	Chewuch River	35,929	0.129 (0.008)	0.199 (0.015)	0.035 (0.014)
Wells	Methow River	36,854	0.149 (0.008)	0.182 (0.014)	0.039 (0.015)
Wells	Okanogan River	6,220	0.139 (0.020)	0.279 (0.058)	NA
Wells	Omak Creek	5,627	0.111 (0.019)	0.178 (0.043)	NA
Wells	Similkameen River	29,729	0.141 (0.008)	0.221 (0.018)	0.019 (0.011)
Wells	Twisp Pond	11,685	0.152 (0.012)	0.333 (0.034)	0.021 (0.020)
Wells	Twisp River	41,833	0.156 (0.008)	0.219 (0.017)	0.030 (0.013)
Winthrop	Winthrop Hatchery	49,475	0.149 (0.008)	0.194 (0.016)	0.043 (0.014)

Table 29. Travel time statistics for Snake River yearling Chinook salmon (hatchery and wild combined) detected and released to the tailrace at Lower Granite Dam in 2004. Abbreviations: LGR-Lower Granite Dam; LGO-Little Goose Dam; LMO-Lower Monumental Dam; MCN-McNary Dam; BON-Bonneville Dam; N-Number of fish on which statistics are based; Med.-Median.

	LGR to LGO (days)				LGO to LMO (days)				LMO to MCN (days)			
Date at LGR	N	20%	Med.	80%	N	20%	Med.	80%	N	20%	Med.	80%
30 Mar-05 Apr	51	7.0	11.3	17.8	20	3.4	4.8	8.0	65	4.9	6.0	7.9
06 Apr-12 Apr	287	8.2	13.5	20.2	40	3.0	4.2	6.1	132	4.7	5.6	6.8
13 Apr-19 Apr	1,873	5.0	7.9	12.6	277	2.6	3.4	4.8	387	4.3	5.2	6.7
20 Apr-26 Apr	5,736	4.3	5.9	8.9	244	2.0	2.9	4.8	81	3.4	4.2	5.4
27 Apr-03 May	13,799	3.3	4.3	6.4	627	1.5	2.1	4.1	177	3.0	3.6	4.6
04 May-10 May	18,072	2.4	3.5	7.0	2,976	2.1	3.6	7.8	875	2.7	3.4	4.3
11 May-17 May	3,016	3.5	4.7	6.4	1,717	2.3	3.4	6.1	484	3.0	3.7	4.8
18 May-24 May	2,674	2.5	3.3	4.2	1,653	1.8	2.5	3.8	478	2.5	3.0	4.0
25 May-31 May	1,428	2.1	2.7	3.4	814	1.2	1.7	2.2	285	2.7	3.2	4.0
01 Jun-07 Jun	1,034	2.0	2.5	3.4	648	1.3	1.7	2.4	228	2.8	3.4	4.1
08 Jun-14 Jun	743	2.1	2.6	3.6	369	1.8	2.8	6.1	137	3.1	3.8	5.2
15 Jun – 21 Jun	399	3.1	4.1	7.2	148	2.5	6.2	17.2	78	3.3	3.8	5.0
22 Jun-28 Jun	381	2.9	4.0	7.1	89	3.7	9.3	13.8	37	4.1	5.2	5.9

Table 29. Continued.

	LGR to MCN (days)				LGR to BON (days)			
Date at LGR	N	20%	Med.	80%	N	20%	Med.	80%
30 Mar-05 Apr	109	17.9	22.5	26.1	7	24.5	33.5	36.9
06 Apr-12 Apr	328	16.3	19.5	23.1	29	22.4	27.3	29.9
13 Apr-19 Apr	1,319	13.2	15.5	19.0	178	20.4	23.0	27.2
20 Apr-26 Apr	1,890	11.0	12.8	15.2	349	16.6	19.2	23.2
27 Apr-03 May	4,079	8.1	9.4	11.6	858	13.0	15.2	18.2
04 May-10 May	4,898	7.0	8.7	13.3	1,443	12.4	14.6	19.2
11 May-17 May	707	10.4	12.8	15.9	224	14.7	17.0	20.0
18 May-24 May	706	7.9	9.1	10.9	264	11.9	13.2	15.1
25 May-31 May	425	6.7	7.7	9.1	139	10.8	11.9	13.2
01 Jun-07 Jun	318	7.0	7.8	9.2	88	11.0	12.1	13.5
08 Jun-14 Jun	216	7.8	10.5	17.9	44	12.6	14.1	16.0
15 Jun – 21 Jun	108	10.5	14.4	20.3	7	18.7	20.6	23.0
22 Jun-28 Jun	74	12.0	16.1	21.4	2	16.5	17.7	18.9

Table 30. Migration rate statistics for Snake River yearling Chinook salmon (hatchery and wild combined) detected and released to the tailrace at Lower Granite Dam in 2004. Abbreviations: LGR-Lower Granite Dam; LGO-Little Goose Dam; LMO-Lower Monumental Dam; MCN-McNary Dam; BON-Bonneville Dam; N-Number of fish observed; Med-Median.

	LGR to LGO (km/day)				LGO to LMO (km/day)				LMO to MCN (km/day)			
Date at LGR	N	20%	Med.	80%	N	20%	Med.	80%	N	20%	Med.	80%
30 Mar-05 Apr	51	3.4	5.3	8.6	20	5.8	9.7	13.4	65	15.1	19.7	24.4
06 Apr-12 Apr	287	3.0	4.4	7.3	40	7.5	10.9	15.2	132	17.4	21.4	25.4
13 Apr-19 Apr	1,873	4.8	7.6	12.0	277	9.7	13.3	17.4	387	17.7	22.7	27.7
20 Apr-26 Apr	5,736	6.7	10.2	14.0	244	9.5	15.6	22.8	81	22.2	28.5	35.4
27 Apr-03 May	13,799	9.4	13.9	18.1	627	11.1	21.6	31.3	177	26.1	32.6	39.7
04 May-10 May	18,072	8.6	17.0	25.1	2,976	5.9	13.0	22.3	875	27.5	34.5	44.6
11 May-17 May	3,016	9.4	12.7	17.2	1,717	7.5	13.7	19.7	484	24.8	32.4	39.9
18 May-24 May	2,674	14.3	18.3	24.1	1,653	12.0	18.1	25.1	478	30.1	39.0	48.0
25 May-31 May	1,428	17.4	22.6	28.4	814	20.6	27.7	36.8	285	29.8	36.8	43.8
01 Jun-07 Jun	1,034	17.9	24.1	30.3	648	19.5	27.1	35.7	228	28.7	35.5	41.8
08 Jun-14 Jun	743	16.5	23.1	29.1	369	7.5	16.6	25.4	137	23.0	31.5	38.5
15 Jun – 21 Jun	399	8.4	14.6	19.4	148	2.7	7.5	18.5	78	23.6	31.1	35.7
22 Jun-28 Jun	381	2.9	4.0	7.1	89	3.7	9.3	13.8	37	4.1	5.2	5.9

Table 30. Continued.

	LGR to MCN (km/day)				LGR to BON (km/day)			
Date at LGR	N	20%	Med.	80%	N	20%	Med.	80%
30 Mar-05 Apr	109	8.6	10.0	12.6	7	12.5	13.8	18.8
06 Apr-12 Apr	328	9.8	11.5	13.8	29	15.4	16.9	20.5
13 Apr-19 Apr	1,319	11.8	14.6	17.0	178	17.0	20.0	22.5
20 Apr-26 Apr	1,890	14.8	17.6	20.4	349	19.9	24.0	27.8
27 Apr-03 May	4,079	19.4	24.0	27.8	858	25.3	30.3	35.4
04 May-10 May	4,898	16.9	26.0	32.2	1,443	24.0	31.6	37.2
11 May-17 May	707	14.1	17.6	21.7	224	23.1	27.0	31.3
18 May-24 May	706	20.6	24.7	28.4	264	30.5	35.0	38.7
25 May-31 May	425	24.6	29.1	33.7	139	34.8	38.8	42.9
01 Jun-07 Jun	318	24.4	28.7	32.4	88	34.2	38.0	42.1
08 Jun-14 Jun	216	12.6	21.4	28.7	44	28.8	32.7	36.6
15 Jun – 21 Jun	108	11.1	15.6	21.3	7	20.0	22.3	24.7
22 Jun-28 Jun	74	10.5	14.0	18.8	2	24.4	26.0	28.0

Table 31. Travel time statistics for Snake River yearling Chinook salmon (hatchery and wild combined) detected and released to the tailrace at McNary Dam in 2004. Abbreviations: MCN-McNary Dam; JDA-John Day Dam; BON-Bonneville Dam; N-Number of fish on which statistics are based; Med.-Median.

	MCN to JDA (days)				JDA to BON (days)				MCN to BON (days)			
Date at LGR	N	20%	Med.	80%	N	20%	Med.	80%	N	20%	Med.	80%
20 Apr-26 Apr	116	5.1	6.5	9.0	12	2.1	2.3	3.0	56	6.6	7.4	9.5
27 Apr-03 May	606	4.0	4.9	6.2	53	1.8	2.0	2.3	397	5.4	6.4	7.8
04 May-10 May	1,081	3.1	3.8	4.7	82	1.8	2.0	2.4	532	5.0	5.4	6.6
11 May-17 May	1,143	3.1	4.0	5.0	111	1.8	2.0	2.3	560	5.1	5.7	7.0
18 May-24 May	184	3.0	3.4	4.1	21	1.7	1.9	2.3	125	4.4	5.2	5.8
25 May-31 May	190	2.5	2.9	3.7	25	1.6	1.9	2.2	193	3.9	4.2	5.0
01 Jun-07 Jun	60	2.5	2.9	3.7	10	1.5	1.8	2.1	74	4.1	4.4	5.4
08 Jun-14 Jun	108	2.5	2.8	3.6	15	1.7	2.0	2.5	91	4.1	4.5	5.3
15 Jun – 21 Jun	136	2.6	3.1	3.7	17	1.8	2.0	2.2	94	4.4	4.7	5.6

Table 32. Migration rate statistics for Snake River yearling Chinook salmon (hatchery and wild combined) detected and released to the tailrace at McNary Dam in 2004. Abbreviations: MCN-McNary Dam; JDA-John Day Dam; BON-Bonneville Dam; N-Number of fish on which statistics are based; Med.-Median.

	MCN to JDA (km/day)				JDA to BON (km/day)				MCN to BON (km/day)			
Date at LGR	N	20%	Med.	80%	N	20%	Med.	80%	N	20%	Med.	80%
20 Apr-26 Apr	116	13.6	18.9	24.1	12	38.2	49.3	53.1	56	24.8	31.7	36.0
27 Apr-03 May	606	19.8	25.1	31.1	53	49.6	55.7	62.4	397	30.1	37.1	43.9
04 May-10 May	1,081	26.1	32.5	39.8	82	46.7	55.1	62.1	532	35.8	43.6	47.2
11 May-17 May	1,143	24.6	30.8	39.4	111	49.8	56.5	62.1	560	33.5	41.3	46.6
18 May-24 May	184	30.3	36.3	41.4	21	49.1	59.8	67.7	125	41.0	45.6	53.5
25 May-31 May	190	33.4	42.0	49.2	25	50.7	60.1	70.2	193	47.1	56.1	60.5
01 Jun-07 Jun	60	32.9	42.9	50.0	10	54.3	61.1	74.8	74	43.7	53.8	58.0
08 Jun-14 Jun	108	33.8	43.2	49.8	15	45.9	55.7	66.9	91	44.9	52.8	57.4
15 Jun–21 Jun	136	33.4	39.9	46.6	17	52.6	57.9	63.1	94	42.4	50.3	53.8

Table 33. Travel time statistics for juvenile Snake River steelhead (hatchery and wild combined) detected and released to or PIT tagged and released to the tailrace at Lower Granite Dam in 2004. Abbreviations: LGR-Lower Granite Dam; LGO-Little Goose Dam; LMO-Lower Monumental Dam; MCN-McNary Dam; BON-Bonneville Dam; N-Number of fish on which statistics are based; Med.-Median.

	Travel time (days)											
	LGR to LGO				LGO to LMO				LMO to MCN			
Date at LGR	N	20%	Med.	80%	N	20%	Med.	80%	N	20%	Med.	80%
30 Mar-05 Apr	32	4.8	7.2	10.0	23	2.6	3.2	4.2	8	3.3	4.1	4.8
06 Apr-12 Apr	18	3.1	3.8	5.2	9	2.5	3.0	3.9	12	3.8	4.4	5.5
13 Apr-19 Apr	739	3.3	8.6	13.5	146	2.9	4.1	7.2	101	3.9	4.6	5.8
20 Apr-26 Apr	2,496	3.7	5.5	8.7	321	2.3	4.2	7.4	36	3.4	4.2	5.6
27 Apr-03 May	4,891	2.7	4.0	7.6	848	1.7	2.9	5.7	89	3.0	3.6	4.4
04 May-10 May	11,230	2.4	3.5	6.3	2,804	1.9	3.3	8.9	196	2.5	3.0	3.8
11 May-17 May	7,091	2.7	4.4	7.6	4,207	2.2	4.0	7.2	304	2.3	2.7	3.3
18 May-24 May	7,084	2.4	2.9	4.7	4,500	1.9	3.0	4.8	477	2.0	2.5	3.0
25 May-31 May	3,732	1.5	2.4	3.4	2,235	1.1	1.8	3.2	265	2.1	2.6	3.0
01 Jun-07 Jun	1,714	1.9	2.6	3.9	853	1.3	2.0	3.9	103	2.2	2.7	3.4
08 Jun-14 Jun	856	2.0	3.4	8.5	253	1.6	2.8	4.9	30	2.8	3.7	4.9

Table 33. Continued.

	Travel time (days)							
	LGR to MCN				LGR to BON			
Date at LGR	N	20%	Med.	80%	N	20%	Med.	80%
30 Mar-05 Apr	8	15.5	16.9	26.1	3	20.2	24.0	31.5
06 Apr-12 Apr	14	10.1	11.4	13.6	5	18.0	18.7	27.6
13 Apr-19 Apr	250	11.4	15.6	21.5	37	20.6	28.2	31.3
20 Apr-26 Apr	231	11.8	14.0	17.6	53	19.8	22.7	30.5
27 Apr-03 May	443	8.8	10.5	13.0	113	14.4	16.7	19.4
04 May-10 May	788	6.5	8.2	11.8	133	11.9	13.6	17.6
11 May-17 May	416	9.7	13.5	18.5	61	14.8	18.0	24.2
18 May-24 May	633	7.4	9.1	11.8	55	12.4	15.2	19.4
25 May-31 May	401	5.4	6.7	8.6	34	10.2	13.3	15.2
01 Jun-07 Jun	147	6.4	8.1	16.4	12	11.6	12.1	20.0
08 Jun-14 Jun	62	11.5	16.1	19.7	4	14.4	15.3	17.6

Table 34. Migration rate statistics for juvenile Snake River steelhead (hatchery and wild combined) detected and released to or PIT tagged and released to the tailrace at Lower Granite Dam in 2004. Abbreviations: LGR-Lower Granite Dam; LGO-Little Goose Dam; LMO-Lower Monumental Dam; MCN-McNary Dam; BON-Bonneville Dam; N-Number of fish on which statistics are based; Med.-Median.

	LGR to LGO (km/day)				LGO to LMO (km/day)				LMO to MCN (km/day)			
Date at LGR	N	20%	Med.	80%	N	20%	Med.	80%	N	20%	Med.	80%
30 Mar-05 Apr	32	6.0	8.4	12.6	23	11.1	14.6	17.7	8	24.9	28.8	35.6
06 Apr-12 Apr	18	11.6	15.9	19.6	9	11.8	15.3	18.3	12	21.5	27.2	31.6
13 Apr-19 Apr	739	4.5	7.0	18.3	146	6.4	11.2	16.0	101	20.6	25.9	30.5
20 Apr-26 Apr	2,496	6.9	10.9	16.2	321	6.2	10.9	20.1	36	21.4	28.3	35.4
27 Apr-03 May	4,891	7.9	15.1	22.4	848	8.1	15.8	26.7	89	27.4	32.7	40.3
04 May-10 May	11,230	9.5	17.2	25.3	2,804	5.2	14.1	24.7	196	31.4	39.1	47.8
11 May-17 May	7,091	7.9	13.8	21.9	4,207	6.4	11.6	21.4	304	36.0	43.4	52.4
18 May-24 May	7,084	12.7	21.0	25.3	4,500	9.6	15.2	24.6	477	39.3	47.6	58.3
25 May-31 May	3,732	17.5	25.4	40.5	2,235	14.6	26.0	40.4	265	39.7	46.7	57.5
01 Jun-07 Jun	1,714	15.4	22.6	32.3	853	11.7	23.4	36.2	103	35.2	44.7	55.3
08 Jun-14 Jun	856	7.1	17.7	30.8	253	9.3	16.2	27.9	30	24.2	32.4	42.7

Table 34. Continued.

	LGR to MCN (km/day)				LGR to BON (km/day)			
	N	20%	Med.	80%	N	20%	Med.	80%
30 Mar-05 Apr	8	8.6	13.3	14.5	3	14.6	19.2	22.9
06 Apr-12 Apr	14	16.6	19.8	22.3	5	16.7	24.7	25.6
13 Apr-19 Apr	250	10.5	14.5	19.7	37	14.7	16.4	22.4
20 Apr-26 Apr	231	12.8	16.0	19.1	53	15.1	20.3	23.3
27 Apr-03 May	443	17.4	21.4	25.5	113	23.8	27.6	31.9
04 May-10 May	788	19.0	27.4	34.4	133	26.3	33.9	38.7
11 May-17 May	416	12.2	16.7	23.2	61	19.0	25.6	31.1
18 May-24 May	633	19.1	24.7	30.4	55	23.7	30.4	37.3
25 May-31 May	401	26.1	33.7	41.6	34	30.3	34.8	45.0
01 Jun-07 Jun	147	13.7	27.7	35.2	12	23.1	38.2	39.7
08 Jun-14 Jun	62	11.4	14.0	19.6	4	26.2	30.1	32.0

Table 35. Travel time statistics for juvenile Snake River steelhead (hatchery and wild combined) detected and released to or PIT tagged and released to the tailrace at McNary Dam in 2004. Abbreviations: MCN-McNary Dam; JDA-John Day Dam; BON-Bonneville Dam; N-Number of fish on which statistics are based; Med.-Median.

	Travel Time (days)											
	MCN to JDA				JDA to BON				MCN to BON			
Date at LGR	N	20%	Med.	80%	N	20%	Med.	80%	N	20%	Med.	80%
27 Apr-03 May	13	4.7	5.9	8.1	1	1.6	1.6	1.6	5	6.6	11.5	16.4
04 May-10 May	50	3.4	4.3	5.7	6	1.8	2.0	2.0	29	5.4	6.1	9.8
11 May-17 May	96	3.5	4.6	8.0	3	2.1	2.2	2.4	26	5.4	6.5	8.4
18 May-24 May	66	3.6	4.4	6.1	2	1.7	1.8	1.8	7	5.6	6.3	8.7
25 May-31 May	105	2.7	3.6	4.7	9	1.5	1.6	1.7	22	4.3	5.2	7.0
01 Jun-07 Jun	42	3.0	4.1	5.5	4	1.6	1.6	1.7	15	5.0	5.8	9.4

Table 36. Migration rate statistics for juvenile Snake River steelhead (hatchery and wild combined) detected and released to or PIT tagged and released to the tailrace at McNary Dam in 2004. Abbreviations:MCN-McNary Dam; JDA-John Day Dam; BON-Bonneville Dam; N-Number of fish on which statistics are based; Med.-Median.

	Migration rate (km/day)											
	MCN to JDA				JDA to BON				MCN to BON			
Date at LGR	N	20%	Med.	80%	N	20%	Med.	80%	N	20%	Med.	80%
27 Apr-03 May	13	15.2	20.7	26.4	1	69.8	69.8	69.8	5	14.4	20.5	35.9
04 May-10 May	50	21.6	28.9	36.5	6	56.2	57.1	61.4	29	24.1	38.7	43.8
11 May-17 May	96	15.3	27.0	35.1	3	46.3	51.1	52.8	26	28.1	36.1	43.9
18 May-24 May	66	20.2	27.9	34.6	2	61.1	64.2	67.7	7	27.2	37.5	42.4
25 May-31 May	105	26.4	34.3	45.2	9	65.7	71.1	77.4	22	33.7	45.4	55.0
01 Jun-07 Jun	42	22.5	29.8	41.0	4	67.7	70.2	72.4	15	25.1	40.4	46.9

Table 37. Number of PIT-tagged hatchery steelhead released at Lower Granite by day for survival estimates in 2004. Also included are tagging mortalities and lost tags by date.

Release date	Number released	Mortalities	Lost Tags	Release date	Number released	Mortalities	Lost Tags
13 Apr	166	0	3	13 May	664	1	1
14 Apr	256	10	1	14 May	664	1	0
15 Apr	299	0	1	15 May	647	1	1
16 Apr	311	0	3	18 May	483	2	4
17 Apr	365	0	0	19 May	490	0	0
20 Apr	349	1	1	20 May	488	1	1
21 Apr	355	0	0	21 May	485	1	4
22 Apr	343	0	2	22 May	483	1	6
23 Apr	349	0	1	25 May	348	1	1
24 Apr	349	1	0	26 May	349	0	1
27 Apr	700	0	1	27 May	347	0	3
28 Apr	695	1	4	28 May	347	0	3
29 Apr	696	1	2	29 May	349	0	1
30 Apr	699	1	1	02 Jun	258	1	5
01 May	735	0	0	03 Jun	291	0	4
04 May	732	0	1	04 Jun	277	0	2
05 May	628	0	2	05 Jun	252	0	11
06 May	426	0	1	08 Jun	258	1	4
07 May	770	1	2	09 Jun	258	0	5
08 May	798	1	2	10 Jun	263	0	1
11 May	665	0	0	11 Jun	256	1	6
12 May	678	1	1	**Total**	19,621	30	93

Table 38. Number of PIT-tagged wild steelhead released at Lower Granite by day for survival estimates in 2004. Also included are tagging mortalities and lost tags by date.

Release date	Number released	Mortalities	Lost Tags	Release date	Number released	Mortalities	Lost Tags
13 Apr	65	0	0	13 May	168	0	1
14 Apr	76	6	0	14 May	297	0	0
15 Apr	198	1	1	15 May	396	1	0
16 Apr	111	0	0	18 May	225	0	1
17 Apr	99	0	0	19 May	296	0	0
20 Apr	50	0	0	20 May	215	0	0
21 Apr	63	0	0	21 May	295	0	1
22 Apr	96	0	0	22 May	308	1	1
23 Apr	66	1	0	25 May	124	0	0
24 Apr	96	0	1	26 May	347	0	0
27 Apr	72	0	0	27 May	451	0	0
28 Apr	36	0	0	28 May	388	0	0
29 Apr	26	0	0	29 May	254	0	1
30 Apr	41	0	0	02 Jun	268	0	7
01 May	31	0	0	03 Jun	273	0	2
04 May	227	1	0	04 Jun	273	0	2
05 May	177	0	0	05 Jun	100	0	1
06 May	171	1	0	08 Jun	74	0	0
07 May	172	0	0	09 Jun	75	0	1
08 May	589	0	0	10 Jun	116	0	0
11 May	360	0	0	11 Jun	64	0	0
12 May	309	0	0	Total	8,128	12	20

Table 39. Number of PIT-tagged wild yearling Chinook salmon released at Lower Granite by day for survival estimates in 2004. Also included are tagging mortalities and lost tags by date.

Release date	Number released	Mortalities	Lost Tags	Release date	Number released	Mortalities	Lost Tags
13 Apr	106	0	0	13 May	72	0	0
14 Apr	258	1	0	14 May	327	1	0
15 Apr	298	1	0	15 May	199	1	0
16 Apr	318	1	0	18 May	138	1	0
17 Apr	320	0	0	19 May	140	0	0
20 Apr	395	5	0	20 May	140	0	0
21 Apr	182	2	0	21 May	140	0	0
22 Apr	513	3	0	22 May	137	3	0
23 Apr	446	4	0	25 May	57	1	0
24 Apr	440	10	0	26 May	175	0	0
27 Apr	347	13	0	27 May	142	0	0
28 Apr	342	18	0	28 May	124	0	0
29 Apr	201	0	0	29 May	124	1	0
30 Apr	420	0	0	02 Jun	157	0	0
01 May	419	0	0	03 Jun	157	0	0
04 May	260	0	0	04 Jun	151	8	0
05 May	230	0	0	05 Jun	95	2	0
06 May	290	0	0	08 Jun	47	0	0
07 May	139	2	0	09 Jun	6	0	0
08 May	376	3	1	10 Jun	0	0	0
11 May	199	0	0	11 Jun	0	0	0
12 May	200	0	0	Total	9,227	81	1

Table 40. Estimated survival for yearling Chinook salmon from selected Snake River Basin hatcheries to the tailrace of Lower Granite Dam, 1993-2004. Distance from each hatchery to Lower Granite Dam in parentheses in header. Standard errors in parentheses following each survival estimate.

Year	Dworshak (116 km)	Kooskia (176 km)	Lookingglass* (209)	Rapid River (283)	McCall (457)	Pahsimeroi (630)	Sawtooth (747)	Mean
1993	0.647 (0.028)	0.689 (0.047)	0.660 (0.025)	0.670 (0.017)	0.498 (0.017)	0.456 (0.032)	0.255 (0.023)	0.554 (0.060)
1994	0.778 (0.020)	0.752 (0.053)	0.685 (0.021)	0.526 (0.024)	0.554 (0.022)	0.324 (0.028)	0.209 (0.014)	0.547 (0.081)
1995	0.838 (0.034)	0.786 (0.024)	0.617 (0.015)	0.726 (0.017)	0.522 (0.011)	0.316 (0.033)	0.230 (0.015)	0.576 (0.088)
1996	0.776 (0.017)	0.744 (0.010)	0.567 (0.014)	0.588 (0.007)	0.531 (0.007)	–	0.121 (0.017)	0.555 (0.096)
1997	0.576 (0.017)	0.449 (0.034)	0.616 (0.017)	0.382 (0.008)	0.424 (0.008)	0.500 (0.008)	0.508 (0.037)	0.494 (0.031)
1998	0.836 (0.006)	0.652 (0.024)	0.682 (0.006)	0.660 (0.004)	0.585 (0.004)	0.428 (0.021)	0.601 (0.033)	0.635 (0.046)
1999	0.834 (0.011)	0.653 (0.031)	0.668 (0.009)	0.746 (0.006)	0.649 (0.008)	0.584 (0.035)	0.452 (0.019)	0.655 (0.045)
2000	0.841 (0.009)	0.734 (0.027)	0.688 (0.011)	0.748 (0.007)	0.689 (0.010)	0.631 (0.062)	0.546 (0.030)	0.697 (0.035)
2001	0.747 (0.002)	0.577 (0.019)	0.747 (0.003)	0.689 (0.002)	0.666 (0.002)	0.621 (0.016)	0.524 (0.023)	0.653 (0.032)
2002	0.819 (0.011)	0.787 (0.036)	0.667 (0.012)	0.755 (0.003)	0.592 (0.006)	0.678 (0.053)	0.387 (0.025)	0.669 (0.055)
2003	0.720 (0.008)	0.560 (0.043)	0.715 (0.012)	0.691 (0.007)	0.573 (0.006)	0.721 (0.230)	0.595 (0.149)	0.654 (0.028)
2004	0.821 (0.003)	0.769 (0.017)	0.613 (0.004)	0.694 (0.003)	0.561 (0.002)	0.528 (0.017)	0.547 (0.018)	0.648 (0.044)
Mean	0.769 (0.024)	0.679 (0.030)	0.660 (0.014)	0.656 (0.032)	0.570 (0.021)	0.526 (0.041)	0.415 (0.049)	

* Released at Imnaha River Weir.

Table 41. Annual weighted means of survival probability estimates for yearling Chinook salmon (hatchery and wild combined), 1993-2004. Standard errors in parentheses. Reaches with asterisks comprise two dams and reservoirs (i.e., two projects); the following column gives the square root (i.e., geometric mean) of the two-project estimate to facilitate comparison with other single-project estimates. Simple arithmetic means across all years, and across all years excluding 2001 are given. Abbreviations: SNKTRP-Snake River Trap; LGR-Lower Granite Dam; LGO-Little Goose Dam; LMO-Lower Monumental Dam; IHR-Ice Harbor Dam; MCN-McNary Dam; JDA-John Day Dam; TDA-The Dalles Dam; BON-Bonneville Dam.

Year	SNKTRP-LGR	LGR-LGO	LGO-LMO	LMO-MCN*	LMO-IHR IHR-MCN	MCN-JDA	JDA-BON*	JDA-TDA TDA-BON
1993	0.828 (0.013)	0.854 (0.012)						
1994	0.935 (0.023)	0.830 (0.009)	0.847 (0.010)					
1995	0.905 (0.010)	0.882 (0.004)	0.925 (0.008)	0.876 (0.038)	0.936			
1996	0.977 (0.025)	0.926 (0.006)	0.929 (0.011)	0.756 (0.033)	0.870			
1997	NA	0.942 (0.018)	0.894 (0.042)	0.798 (0.091)	0.893			
1998	0.925 (0.009)	0.991 (0.006)	0.853 (0.009)	0.915 (0.011)	0.957	0.822 (0.033)		
1999	0.940 (0.009)	0.949 (0.002)	0.925 (0.004)	0.904 (0.007)	0.951	0.853 (0.027)	0.814 (0.065)	0.902
2000	0.929 (0.014)	0.938 (0.006)	0.887 (0.009)	0.928 (0.016)	0.963	0.898 (0.054)	0.684 (0.128)	0.827
2001	0.954 (0.015)	0.945 (0.004)	0.830 (0.006)	0.708 (0.007)	0.841	0.758 (0.024)	0.645 (0.034)	0.803
2002	0.953 (0.022)	0.949 (0.006)	0.980 (0.008)	0.837 (0.013)	0.915	0.907 (0.014)	0.840 (0.079)	0.917
2003	0.993 (0.023)	0.946 (0.005)	0.916 (0.011)	0.904 (0.017)	0.951	0.893 (0.017)	0.818 (0.036)	0.904
2004	0.893 (0.009)	0.923 (0.004)	0.875 (0.012)	0.818 (0.018)	0.904	0.809 (0.028)	0.735 (0.092)	0.857
Mean	**0.930 (0.013)**	**0.923 (0.013)**	**0.896 (0.013)**	**0.845 (0.023)**	**0.918 (0.013)**	**0.848 (0.021)**	**0.756 (0.033)**	**0.868 (0.019)**
Mean excluding 2001	0.928 (0.015)	0.921 (0.014)	0.903 (0.013)	0.860 (0.020)	0.927 (0.011)	0.864 (0.017)	0.778 (0.030)	0.881 (0.017)

Table 42. Annual weighted means of survival probability estimates for steelhead (hatchery and wild combined), 1993-2004. Standard errors in parentheses. Reaches with asterisks comprise two dams and reservoirs (i.e., two projects); the following column gives the square root (i.e., geometric mean) of the two-project estimate to facilitate comparison with other single-project estimates. Simple arithmetic means across all years, and across all years excluding 2001 are given. Abbreviations: SNKTRP-Snake River Trap; LGR-Lower Granite Dam; LGO-Little Goose Dam; LMO-Lower Monumental Dam; IHR-Ice Harbor Dam; MCN-McNary Dam; JDA-John Day Dam; TDA-The Dalles Dam; BON-Bonneville Dam.

Year	SNKTRP-LGR	LGR-LGO	LGO-LMO	LMO-MCN*	LMO-IHR IHR-MCN	MCN-JDA	JDA-BON*	JDA-TDA TDA-BON
1993	0.905 (0.006)							
1994	NA	0.844 (0.011)	0.892 (0.011)					
1995	0.945 (0.008)	0.899 (0.005)	0.962 (0.011)	0.858 (0.076)	0.926			
1996	0.951 (0.015)	0.938 (0.008)	0.951 (0.014)	0.791 (0.052)	0.889			
1997	0.964 (0.015)	0.966 (0.006)	0.902 (0.020)	0.834 (0.065)	0.913			
1998	0.924 (0.009)	0.930 (0.004)	0.889 (0.006)	0.797 (0.018)	0.893	0.831 (0.031)	0.935 (0.103)	0.967
1999	0.908 (0.011)	0.926 (0.004)	0.915 (0.006)	0.833 (0.011)	0.913	0.920 (0.033)	0.682 (0.039)	0.826
2000	0.964 (0.013)	0.901 (0.006)	0.904 (0.009)	0.842 (0.016)	0.918	0.851 (0.045)	0.754 (0.045)	0.868
2001	0.911 (0.007)	0.801 (0.010)	0.709 (0.008)	0.296 (0.010)	0.544	0.337 (0.025)	0.753 (0.063)	0.868
2002	0.895 (0.015)	0.882 (0.011)	0.882 (0.018)	0.652 (0.031)	0.807	0.844 (0.063)	0.612 (0.098)	0.782
2003	0.932 (0.015)	0.947 (0.005)	0.898 (0.012)	0.708 (0.018)	0.841	0.879 (0.032)	0.630 (0.066)	0.794
2004	0.948 (0.004)	0.860 (0.006)	0.820 (0.014)	0.519 (0.035)	0.720	0.465 (0.078)	NA	NA
Mean	**0.934 (0.008)**	**0.899 (0.015)**	**0.884 (0.021)**	**0.713 (0.057)**	**0.836 (0.038)**	**0.733 (0.087)**	**0.728 (0.048)**	**0.851 (0.028)**
Mean excluding 2001	0.937 (0.008)	0.909 (0.012)	0.901 (0.012)	0.759 (0.038)	0.869 (0.023)	0.798 (0.068)	0.723 (0.059)	0.847 (0.033)

Table 43. Hydropower system survival estimates derived by combining empirical survival estimates from various reaches for Snake River yearling Chinook salmon and steelhead (hatchery and wild combined), 1997-2004. Standard errors in parentheses. Abbreviations: Trap-Snake River Trap; LGR-Lower Granite Dam; BON-Bonneville Dam.

	Yearling Chinook Salmon			Steelhead		
Year	Trap-LGR	LGR-BON	Trap-BON	Trap-LGR	LGR-BON	Trap-BON
1997	NA	NA	NA	0.964 (0.015)	0.474 (0.069)	0.457 (0.067)
1998	0.925 (0.009)	NA	NA	0.924 (0.009)	0.500 (0.054)	0.462 (0.050)
1999	0.940 (0.009)	0.557 (0.046)	0.524 (0.043)	0.908 (0.011)	0.440 (0.018)	0.400 (0.016)
2000	0.929 (0.014)	0.486 (0.093)	0.452 (0.087)	0.964 (0.013)	0.393 (0.034)	0.379 (0.032)
2001	0.954 (0.015)	0.279 (0.016)	0.266 (0.015)	0.911 (0.007)	0.042 (0.003)	0.038 (0.003)
2002	0.953 (0.022)	0.578 (0.060)	0.551 (0.057)	0.895 (0.015)	0.262 (0.050)	0.234 (0.045)
2003	0.993 (0.023)	0.532 (0.023)	0.528 (0.023)	0.932 (0.015)	0.309 (0.011)	0.288 (0.011)
2004	0.893 (0.009)	0.395 (0.050)	0.353 (0.045)	0.948 (0.004)	NA	NA

Table 44. Average survival estimates (with standard errors in parentheses) from point of release to Bonneville Dam tailrace for various spring-migrating salmonid stocks in 2004. For each reach, the survival estimate represents a weighted average of daily or weekly estimates (some of which are presented in other tables in this document). In some cases, fish from separate release sites were pooled at downstream sites so survival estimates were identical. Dam release sites are in tailraces. Abbreviations: RLS-release site; MCN-McNary Dam; JDA-John Day Dam; BON-Bonneville Dam; SP-spring Chinook salmon; SP-SU-spring-summer; S-F-summer-fall Chinook salmon.

		Survival Estimates (standard errors)				
Stock	Release Location	RLS-MCN	MCN-JDA	RLS-JDA	JDA-BON	RLS-BON
Snake R. Chinook (Sp-Su)	Lower Granite Dam	0.666 (0.011)	0.809 (0.028)	0.538 (0.021)	0.735 (0.092)	0.395 (0.050)
U. Columbia Chinook (S-F)	Wells Dam	0.609 (0.014)	0.758 (0.017)	0.462 (0.015)	0.882 (0.142)	0.384 (0.077)
U. Columbia Chinook (S-F)	Rocky Reach Dam	0.653 (0.017)	0.758 (0.017)	0.495 (0.017)	0.882 (0.142)	0.411 (0.083)
U. Columbia Chinook (S-F)	Rock Island Dam	0.746 (0.018)	0.758 (0.017)	0.565 (0.019)	0.882 (0.142)	0.470 (0.095)
U. Columbia Chinook (S-F)	Wanapum Dam	0.862 (0.038)	0.758 (0.017)	0.653 (0.032)	0.882 (0.142)	0.543 (0.111)
U. Columbia Chinook (S-F)	Priest Rapids Dam	0.877 (0.025)	0.758 (0.017)	0.665 (0.024)	0.882 (0.142)	0.553 (0.112)
Yakima R. Chinook	Several Locations	NA*	0.821 (0.036)	NA*	0.671 (0.123)	NA*
Snake R. Steelhead	Lower Granite Dam	0.379 (0.023)	0.465 (0.078)	0.176 (0.031)	NA	NA

* Fish were released at numerous locations in the Yakima River basin. Single point of release to McNary survival estimate not possible.

Table 45. Percentage of PIT-tagged smolts (wild and hatchery combined) detected at Lower Monumental Dam later detected on McNary pool bird colonies, 1998-2004.

Year	Yearling Chinook salmon	Steelhead
1998	0.49	4.20
1999	0.84	4.51
2000	0.98	3.66
2001	5.59	21.06
2002	1.19	10.09
2003[a]	1.06	3.71
2004[b]	1.80	18.32

a. Only Crescent Island Caspian tern colony sampled.

b. Only Crescent Island and Foundation Island colonies sampled.

FIGURES

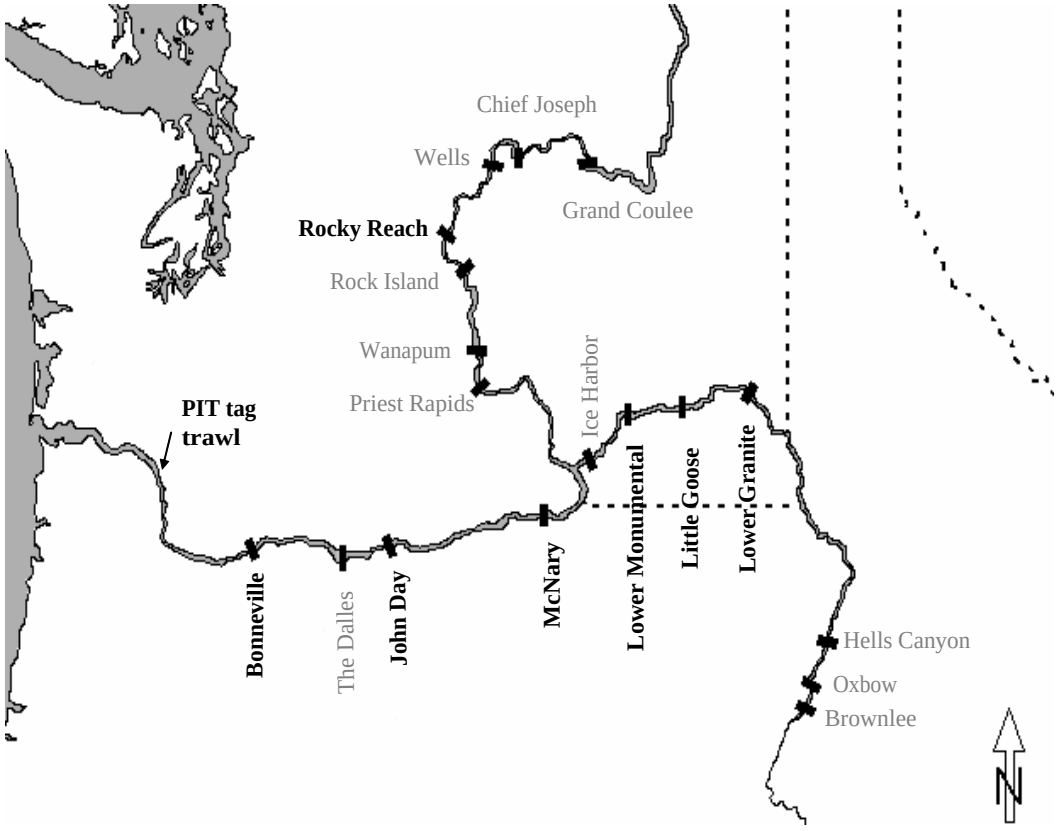

Figure 1. Study area showing sites with PIT-tag detection facilities (names in black), including dams and the PIT-tag trawl in the Columbia River estuary. Dams with names in gray do not have detection facilities.

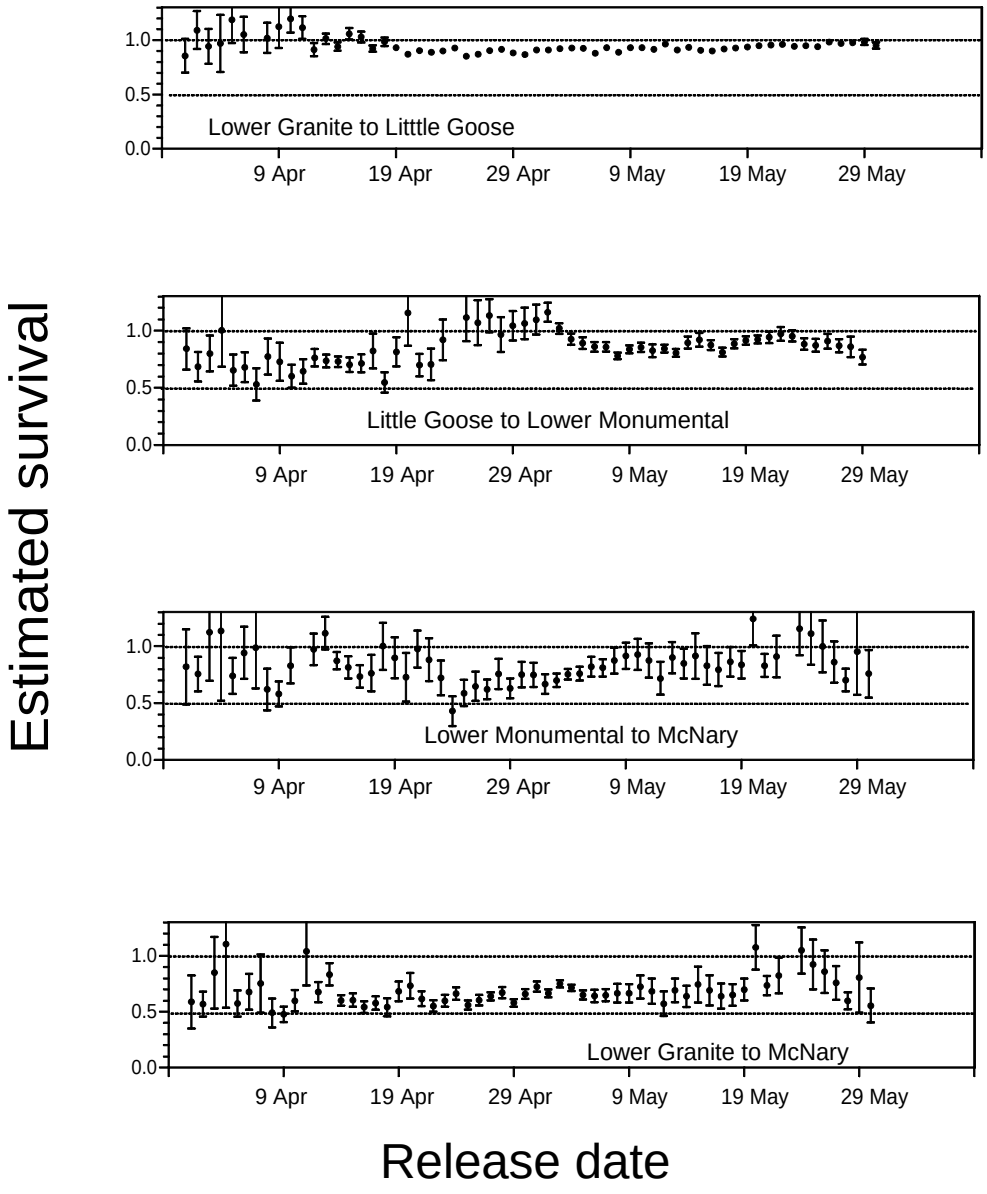

Figure 2. Estimated survival through various reaches vs. release date at Lower Granite Dam for daily release groups of Snake River yearling Chinook salmon, 2004. Bars extend one standard error above and below point estimates.

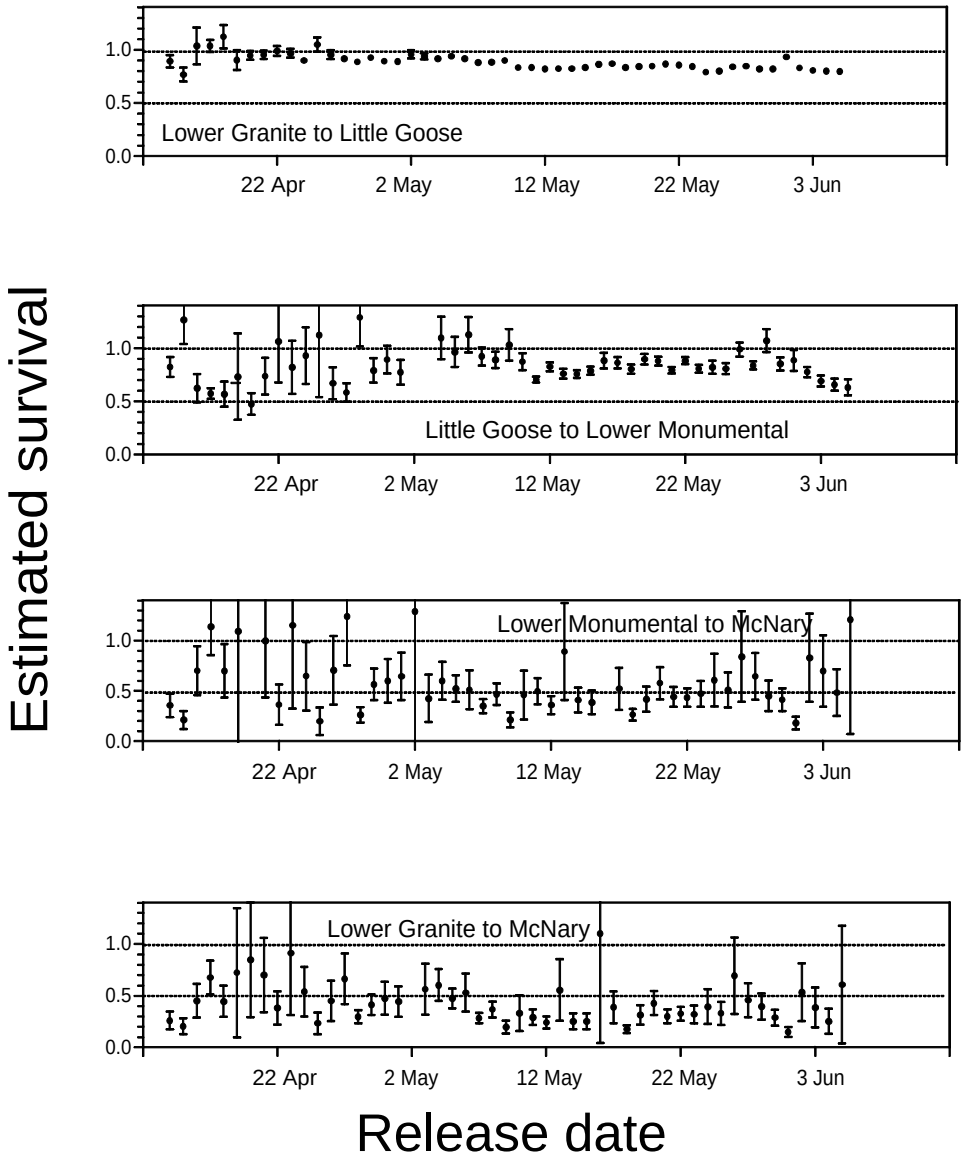

Figure 3. Estimated survival through various reaches versus release date at Lower Granite Dam for daily release groups of Snake River steelhead, 2004. Bars extend one standard error above and below point estimates.

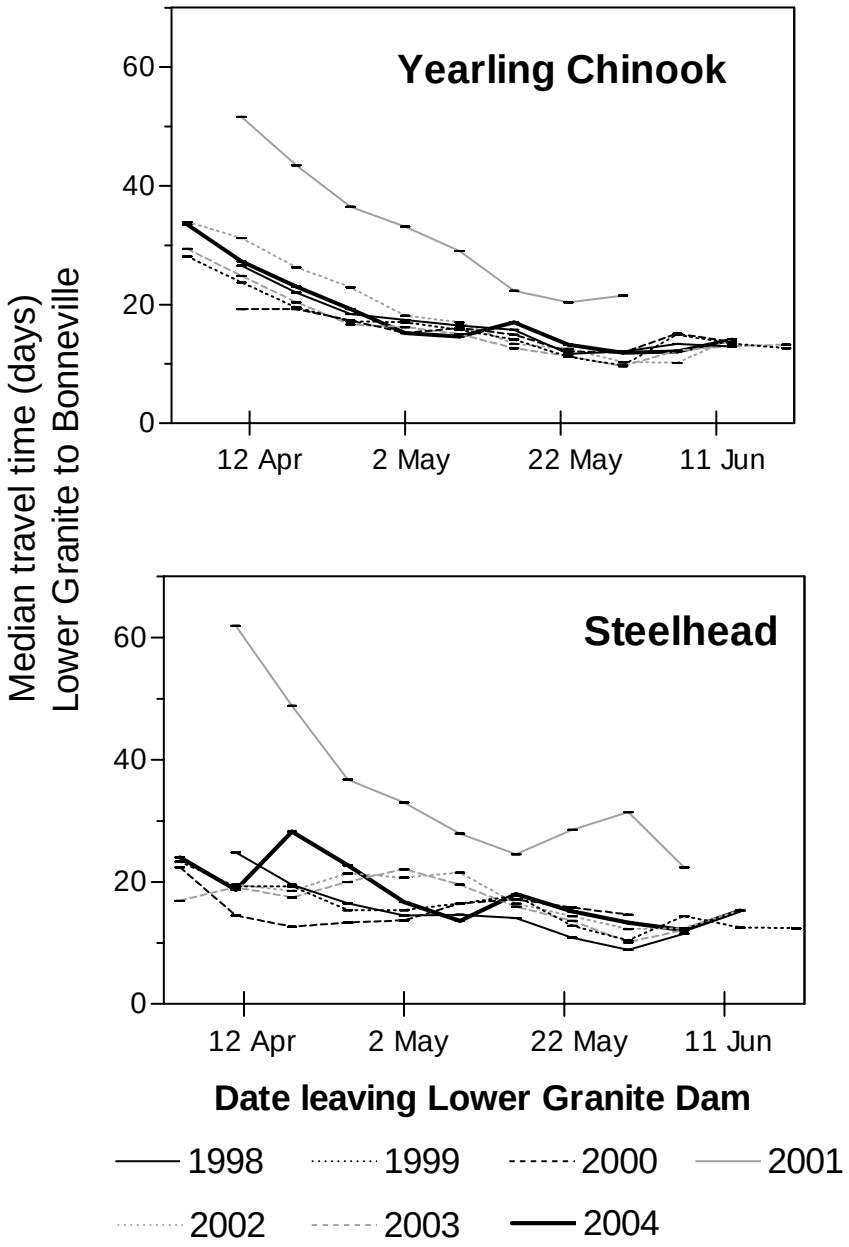

Figure 4. Median travel time (days) from Lower Granite Dam to Bonneville Dam for weekly release groups of Snake River yearling Chinook salmon and steelhead from Lower Granite Dam, 1998-2004.

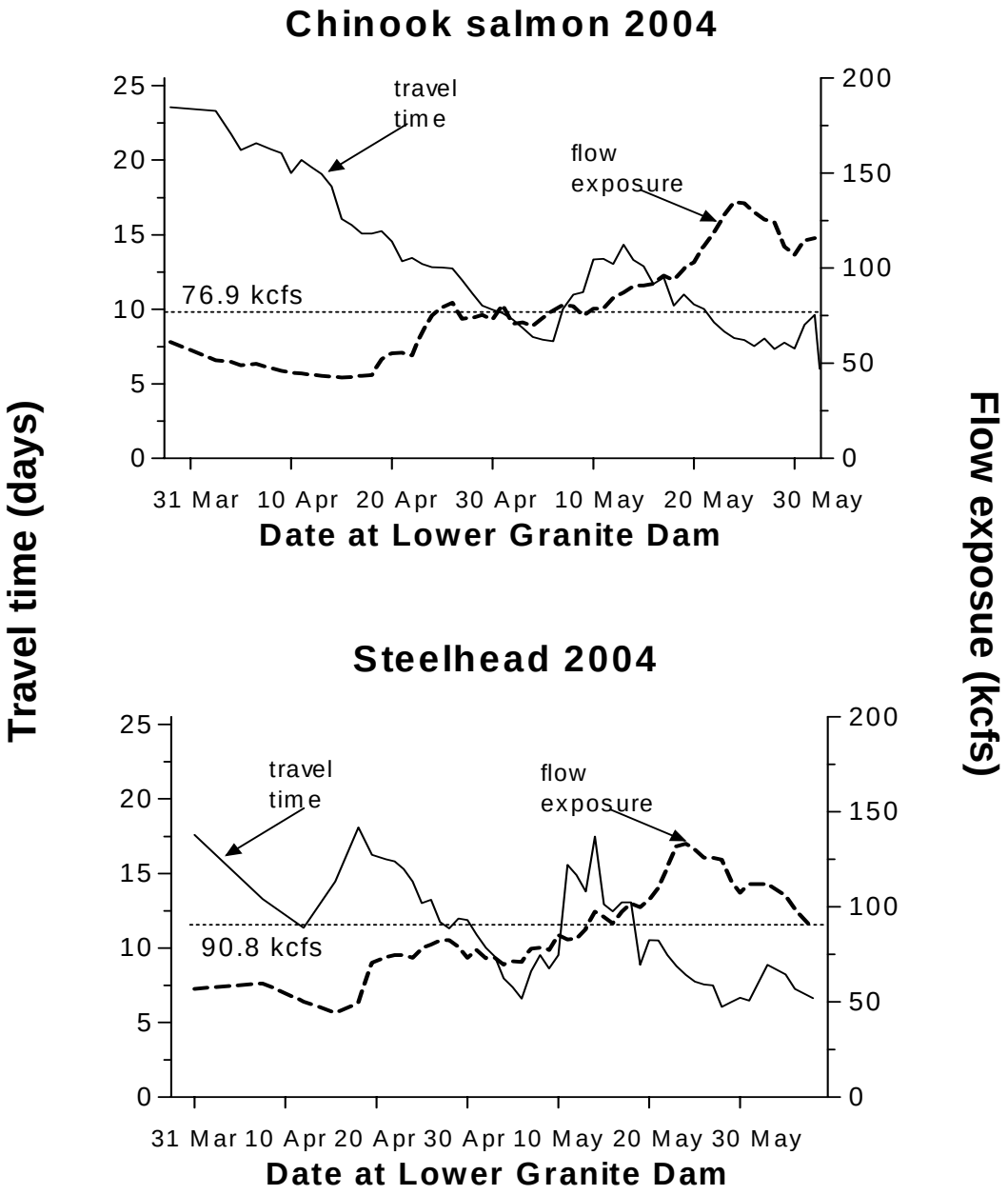

Figure 5. Travel time (days) for yearling Chinook salmon and steelhead from Lower Granite Dam to McNary Dam and index of flow exposure at Lower Granite Dam (kcfs) for daily groups of PIT-tagged fish during 2004. Dashed horizontal lines represent the annual average flow exposure index, weighted by the number of PIT-tagged fish in each group.

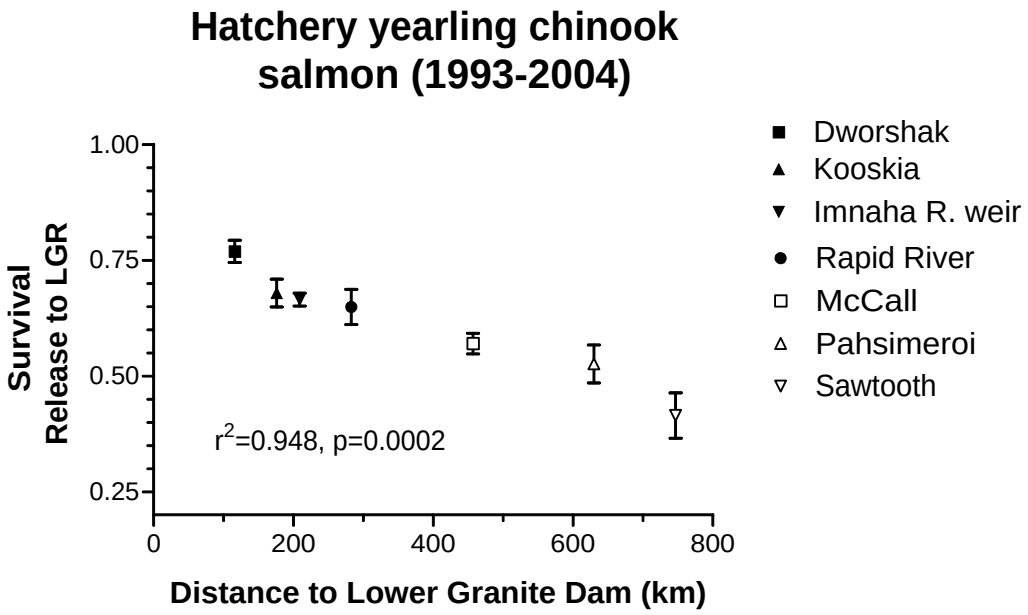

Figure 6. Estimated survival with standard errors from release at Snake River Basin hatcheries to Lower Granite Dam tailrace, 1993-2004 vs distance (km) to Lower Granite Dam. The correlation between survival and migration distance is also shown.

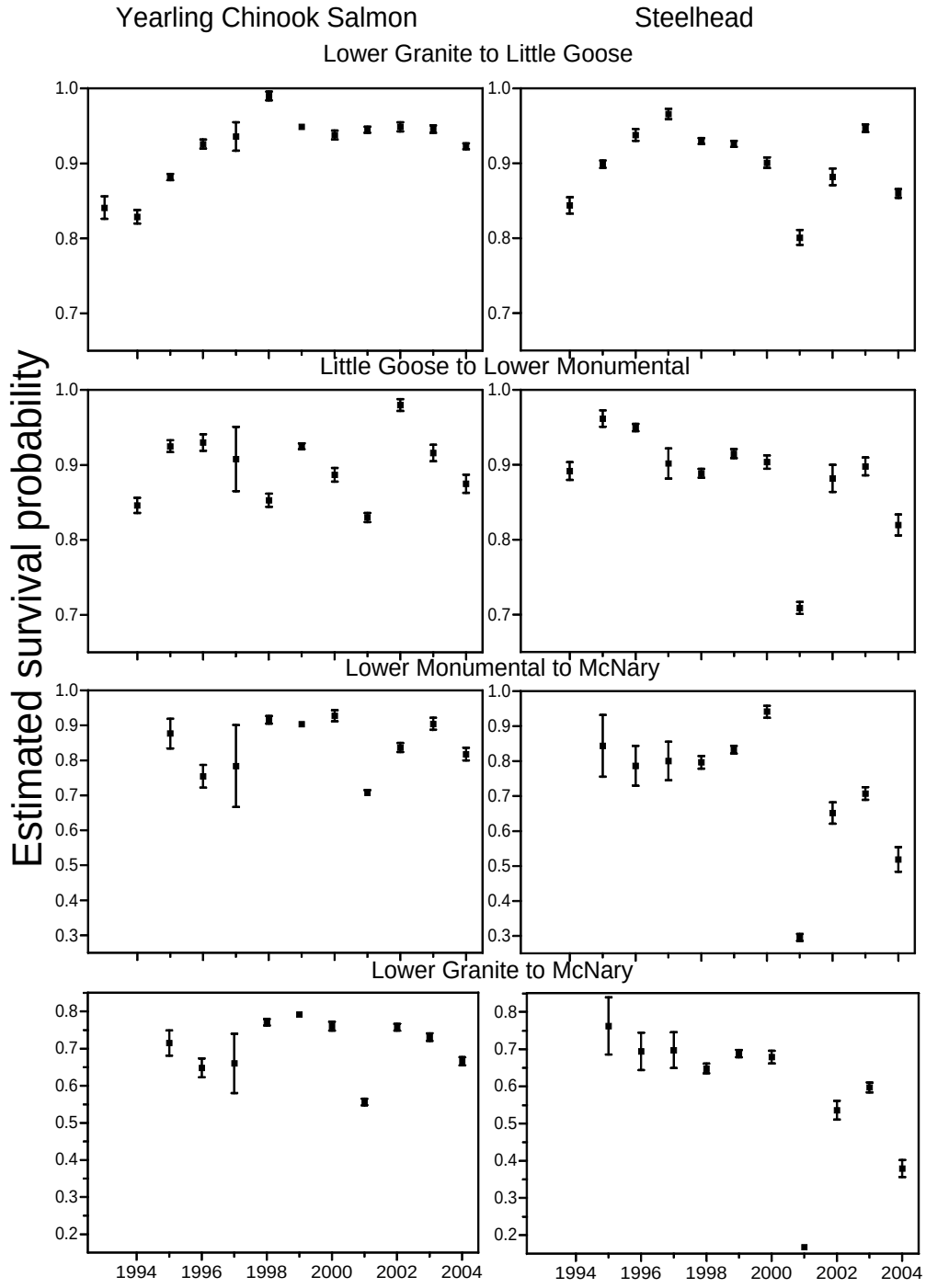

Figure 7. Annual average survival estimates for PIT-tagged yearling Chinook salmon and steelhead through Snake River reaches, 2004. Estimates are from tailrace to tailrace with standard errors.

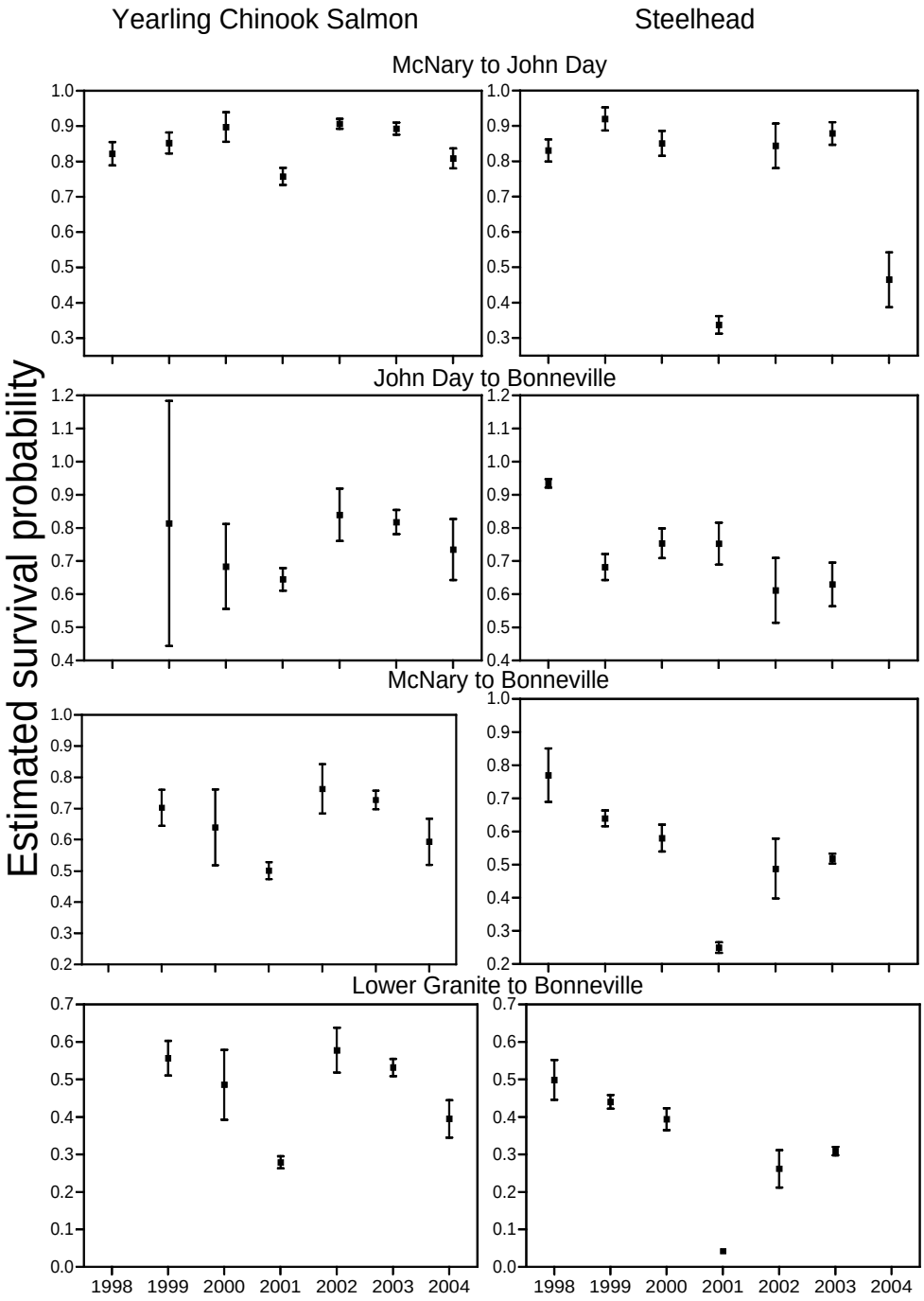

Figure 8. Annual average survival estimates for PIT-tagged Snake River yearling Chinook salmon and steelhead through Columbia River reaches and from Lower Granite Dam to Bonneville Dam, 2004. Estimates are from tailrace to tailrace with standard errors.

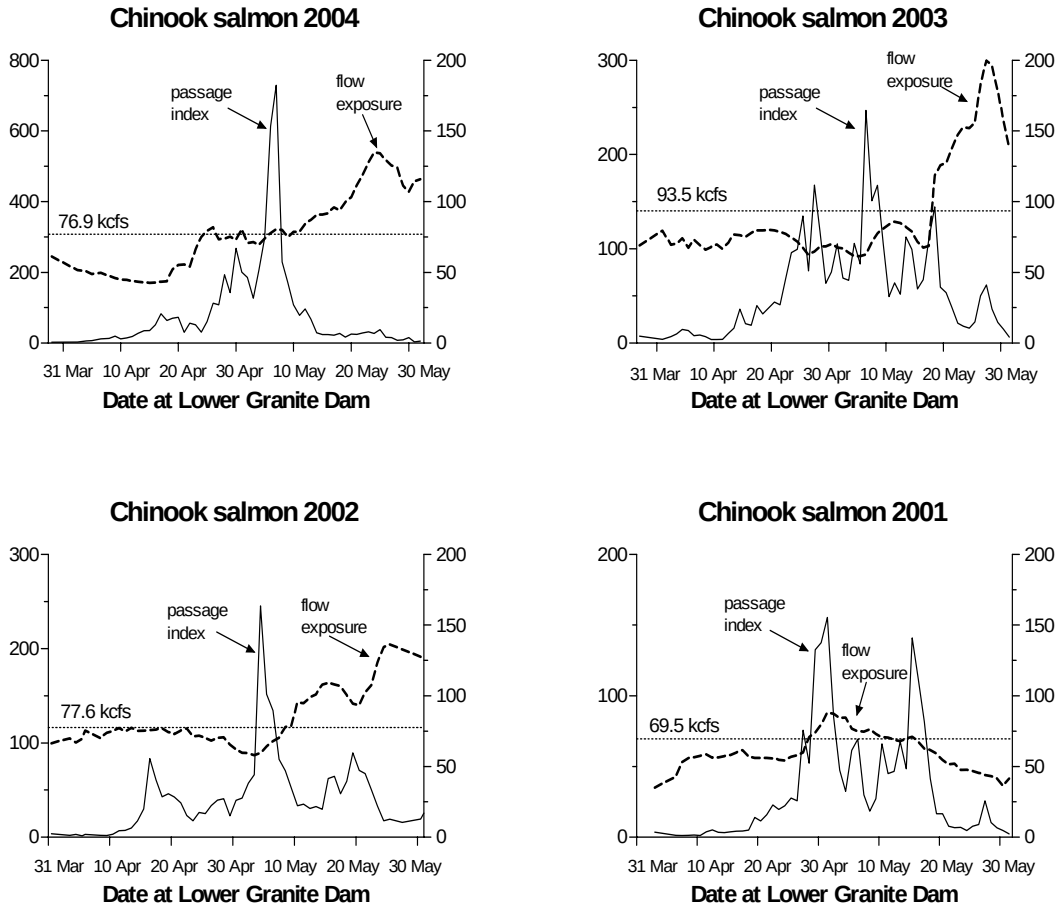

Figure 9. Passage index for yearling Chinook salmon at Lower Granite Dam and index of flow exposure at Lower Granite Dam (kcfs) for daily groups of PIT-tagged yearling Chinook salmon from Lower Granite Dam during 2001, 2002, 2003, and 2004. Dashed horizontal lines represent the annual average flow exposure index, weighted by the number of PIT-tagged fish in each group.

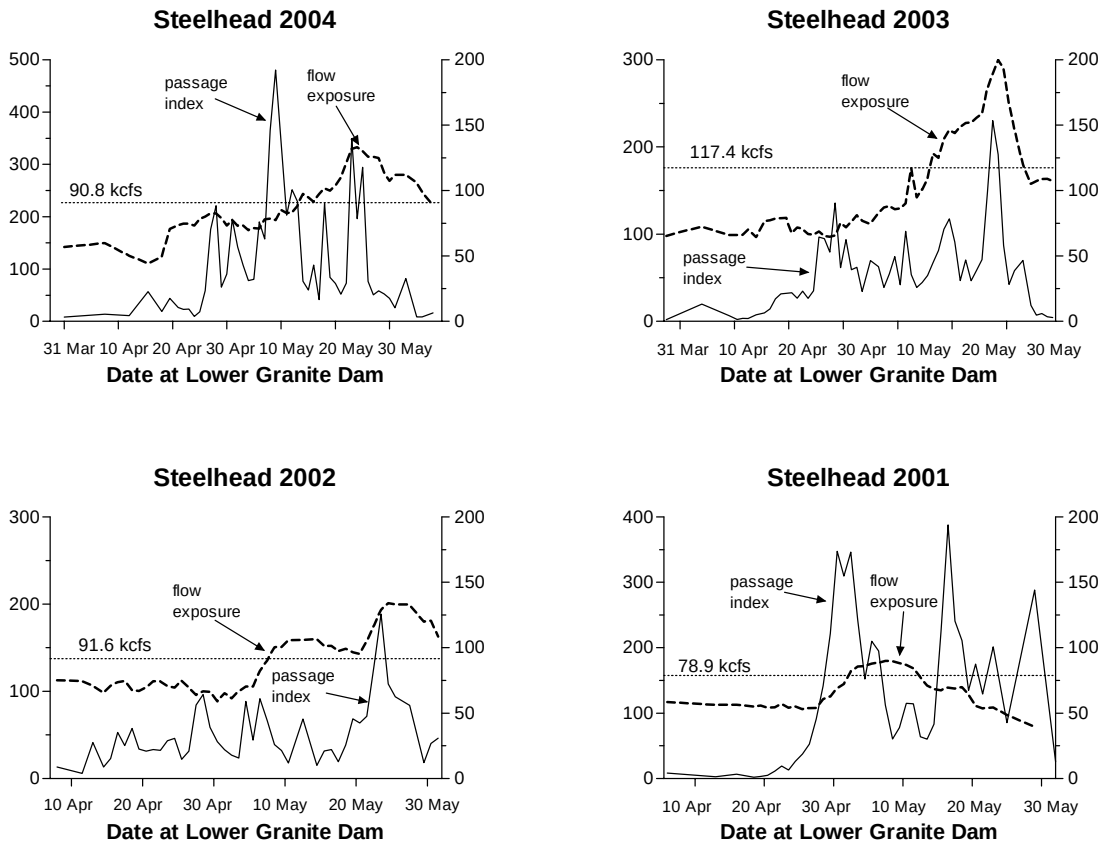

Figure 10. Passage index for steelhead at Lower Granite Dam and index of flow exposure at Lower Granite Dam (kcfs) for daily groups of PIT-tagged steelhead from Lower Granite Dam during 2001, 2002, 2003, and 2004. Dashed horizontal lines represent the annual average flow exposure index, weighted by the number of PIT-tagged fish in each group.