RELATIVE SURVIVAL OF JUVENILE SALMON PASSING THROUGH THE SPILLWAY OF THE DALLES DAM, 1999

by

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Report of Research

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EXECUTIVE SUMMARY

High rates of spill are presumed to increase passage survival for juvenile salmonid migrants because passage survival through spillways at Columbia and Snake River dams is generally higher than through turbines. However, two conditions at The Dalles Dam may decrease spill passage survival under high spill conditions: 1) a short stilling basin and shallow tailrace result in severe turbulence and lateral currents that may cause physical injury to migrant salmon; and 2) a large proportion of spillway-passed water moves through shallows and islands downstream, where predation on salmonids by gulls (*Larus* spp.) and northern pikeminnow *(Ptychocheilus oregonensis)* may be substantially higher.

In 1997, the National Marine Fisheries Service initiated a study at The Dalles Dam to evaluate survival of juvenile Pacific salmon (*Oncorhynchus* spp.) passed through the spillway when 64% of the river flow was spilled. Results of the 1997 tests suggested losses of about 13% for coho salmon (*O. kisutch*) and 8% for subyearling chinook salmon (*O. tshawytscha*) passing at 64% spill.

In 1998, we expanded the research objectives to include assessment of passage survival through the spillway at high flow (64% of river flow) and moderate flow (30% of river flow) and through the ice and trash sluiceway during daytime periods at moderate flow. Results of the 1998 tests suggested losses of about 11% for coho salmon during the spring migration at 64% spill and 25% for subyearling chinook salmon during the summer migration at 64% spill. At the 30% spill level, losses were much lower at about 3% for coho salmon during the spring migration and 11% for chinook salmon during the summer migration. At 30% spill, losses through the sluiceway were similar to those through the spillway at 4% for coho salmon and 11% for chinook salmon.

In 1999, we continued passage survival tests comparing 30 to 64% spill conditions, but excluded the sluiceway component of the study in order to increase test fish numbers, and thus precision, for the spillway passage evaluations. Test fish were collected from the fish collection facility at John Day Dam and tagged with passive integrated transponder (PIT) tags. Approximately 139,000 yearling chinook and coho salmon were tagged in April and May (spring migrants) and 167,000 subyearling chinook salmon were tagged in June and July (summer migrants).

About 50% of the test fish were released through the spillway at either 30 or 64% spill (~25% each), and about 50% were released in the tailrace as survival reference groups. Half of the test fish were released at night and the other half in daylight. The tailrace groups were released at a site away from turbulence and areas of suspected predation, and at a time to coincide with passage of treatment groups. The spillway releases were apportioned, as equally as possible, to three lateral locations in the spillway forebay, and spill conditions were alternated every 3 days between 30 and 64% of the river flow.

After migrating through 73 km of reservoir, a similar distance to previous years, a portion of the test fish passed through the Bonneville Dam PIT-tag interrogation equipment located in the juvenile salmon (summer migrants) released at The Dalles Dam were interrogated in the bypass systems at Bonneville Dam in 1999. Additionally, 4.3% of the spring migrants and 1.5% of the summer migrants were interrogated in the estuary off Jones Beach at RKm 75 or on abandoned piscivorous bird colonies at RKm 35 and RKm 8.

Point estimates of relative passage survival at 64% spill were 93% for spring migrants (CI 90-97%) and 96% for summer migrants (CI 92-100%). Point estimates at 30% spill were slightly higher than at 64% spill, with relative survival estimates of 96% for spring migrants (CI 92-101%) and 100% for summer migrants (CI 95-104%). Nighttime passage data produced significantly higher relative survival rates than daytime passage data for both the spring and summer migration. By design, these point estimates of survival represent passage survival of mixed fish stocks throughout the migration period; during daytime and nighttime; through spillbays across the width of the spillway; and at ambient spill gate openings, river flows, tailwater elevations, and water temperatures.

Mean travel time to Bonneville Dam averaged 1.8 days for both spring and summer migrants. Travel times were consistently less for tailrace-released (reference) groups than for spillway-released (treatment) groups, with a difference of 0.2 days for spring migrants and 0.1 days for summer migrants.

Tests of passage distribution homogeneity at Bonneville Dam for corresponding spillway- and tailrace-released groups of yearling spring and subyearling summer migrants suggested that daily release groups were not mixed on 28 of 60 test dates. To assess these distribution differences, we compared the number of fish detected from spillway and tailrace release groups in relation to powerhouse operation and river flow. We found negligible differences in powerhouse operations between mixed and non-mixed groups. Analyses of survival estimates between groups that were mixed upon arrival at Bonneville Dam and those that were not mixed produced no significant differences.

Relative survival estimates calculated from PIT-tag detections at Bonneville Dam were consistently lower than those calculated from detections at abandoned bird colonies in the estuary. There are diel behavioral changes for fish and avian predators which may bias PIT-tag detections at both Bonneville Dam and in the estuary. We utilized the combined data from all recovery sites for passage survival analyses.

During the study, spring flows ranged from 5,549 to 15,763 m^3/second (196,000 to 557,000 ft^3/second) and summer flows ranged from 4,726 to 14,235 m^3/second (167,000 to 503,000 ft^3/second).

Based on data collected through the third year of this study, we arrived at the following

1) Detection rates of fish released through the spillway at 64% spill were significantly less than for fish released downstream from The Dalles Dam.

2) In the two years of direct comparison between spill rates, point estimates of relative survival for fish passing at 64% spill have been lower than for fish passing at 30% spill, but these differences have not been statistically significant. However, when annual data from 1998 and 1999 were combined for analysis, the differences were significant for spring migrants ($P = 0.05$) and for summer migrants ($P = 0.04$): respective point estimates for passage survival at 64 and 30% spill were 92 and 98% for spring migrants and 86 and 95% for summer migrants.

3) Data from three years of research has indicated that spillway passage during daytime hours (adult spill patterns) produces substantially lower passage survival than spillway passage during nighttime hours (juvenile spill patterns). Respective point estimates of survival during daytime vs. nighttime passage were 90 vs. 97% for spring migrants ($P = 0.04$) and 86 vs. 98% for summer migrants ($P < 0.01$).

4) Data from the 1998 evaluation of sluiceway passage indicated that for daytime passage at 30% spill, relative survival for daytime fish passage through the sluiceway was similar to that of daytime fish passage through the spillway (1 year of testing).

5) Evaluations of survival in relation to tailwater elevation, spill volume, river flow, and water temperature have indicated poor correlations in both spring and summer tests.

The following are recommendations for research in 2000:

1) Evaluate a single, constant spill rate of less than 64% with juvenile spill patterns during 24 hours/day and include sluiceway- and turbine-passage survival. Maximum fish numbers should be used to obtain the highest possible statistical sensitivity.

2) Continue evaluations that include detection data from PIT tags deposited in estuarine and lower-river bird colonies to provide increased detection numbers.

3) Continue assessment of differences between detection sites and evaluate combined data from 1997, 1998, 1999, and future years.

4) Minimize operations of the sluice chute at Bonneville Dam Second Powerhouse to maximize the PIT-tags detected at Bonneville Dam.

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INTRODUCTION

Based on the 1995 National Marine Fisheries Service Biological Opinion (NMFS 1995), the U.S. Army Corps of Engineers (COE) selected the spillway as the best passage route for migrating juvenile salmon (*Oncorhynchus* spp.) at The Dalles Dam. NMFS recommended increasing spill volumes to 64% of river flow to attain 80% fish passage efficiency (FPE). High volumes of spill at The Dalles Dam produce levels of total dissolved gas (TDG) that are lower than those produced at other dams: during 1996, high volumes of spill at The Dalles Dam produced levels of TDG which were less than 120% of saturation, the maximum approved by state water quality agencies. Because TDG is not a factor that limits spill operations at The Dalles Dam, implementation of alternatives for increasing FPE, such as surface collectors or turbine intake screens with an upgraded sluiceway or bypass system, were deferred in lieu of increased spill.

However, observations at The Dalles Dam, and from the hydraulic model of the dam at the COE Waterways Experiment Station, have raised concerns about passage survival of juvenile salmonids during high spill. Heavy turbulence, back eddies, and lateral flow in the spillway stilling basin may be severe enough to injure fish, and water flows passing through the Bridge Islands downstream from the dam might cause higher-than-expected mortality due to predation (Fig. 1).

Substantial predation by northern pikeminnow *(Ptychocheilus oregonensis*) and gulls (*Larus* spp.) is suspected in the reef and islands area, based upon northern pikeminnow abundance and stomach-content evaluations (Hansel et al. 1993, Ward et al. 1995) and upon observations of salmonid smolts carried off by gulls (Jones et al. 1997; John Snelling, Oregon Cooperative Fisheries Research Unit, Oregon State University, Corvallis, OR 97331-1961, Pers. commun., November 1997). Survival tests conducted in 1995 (Normandeau Associates et al. 1996) corroborated concerns that heavy turbulence in the spillway stilling basin might cause unacceptable increases in mortality.

In 1996, we began discussions with the COE on means to test the premise that high spill levels at The Dalles Dam increase passage survival of migrating juvenile salmonids. A comprehensive review of potential methodologies indicated that assessments of spill passage survival at The Dalles Dam could be conducted using balloon tags, coded-wire tags, or passive integrated transponder (PIT) tags. Balloon tags are appropriate for evaluations of immediate and direct injury and mortality from shear currents and high-velocity impact with structures during dam passage, but not for evaluation of indirect mortality from predation during passage through the tailrace and downstream reservoir. Coded-wire-tag technology provides the ability to effectively evaluate both direct and indirect mortality; however, results are dependent on adult returns, and thus the number of fish necessary for the study would be unacceptably large. Therefore, we selected PIT tags because they provided the only method to evaluate both direct and indirect mortality using feasible numbers of test fish.

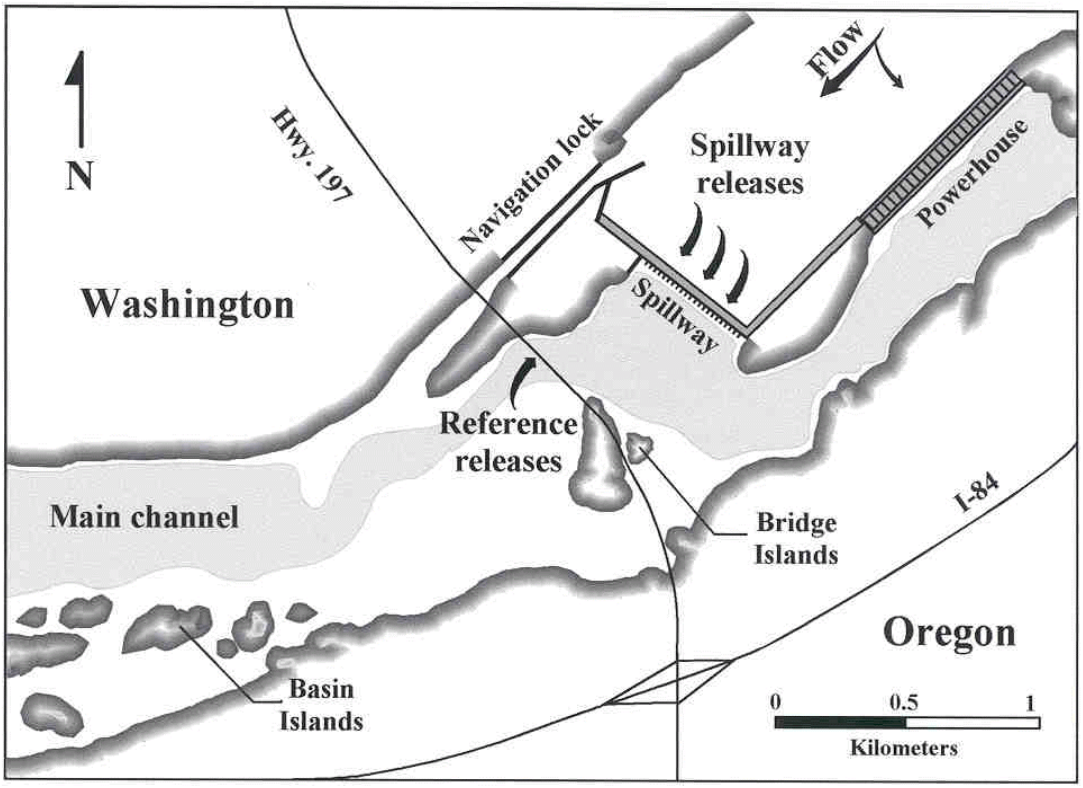

Figure 1. Overview of The Dalles Dam and tailrace area. Spillway and reference group release locations used in the 1999 evaluation of relative survival of juvenile coho salmon, yearling chinook salmon, and subyearling chinook salmon are shown, as well as the position of the main channel in relation to the shallow island areas downstream from the dam.

In 1997, our study objective was to estimate the relative survival of juvenile coho salmon (*O. kisutch)* and subyearling fall chinook salmon (*O. tshawytscha*) passing through The Dalles Dam spillway under 64% spill conditions. Data collected in 1997 from releases of approximately 43,000 coho salmon and 53,000 subyearling chinook salmon suggested survival of about 87 and 92%, respectively (Dawley et al. 1998).

In 1998, we expanded the research to include assessment of passage survival through the spillway at high spill (64% of river flow) and moderate spill (30% of river flow) and through the ice and trash sluiceway during the daytime at moderate spill. In 1998, passage survival for coho salmon was estimated at 89% through the spillway during high flow, 97% through the spillway during moderate flow, and 96% through the sluiceway during moderate flow. Passage survival for subyearling chinook salmon was estimated at 75% through the spillway during high flow, 89% through the spillway at moderate flow, and 89% through the sluiceway at moderate flow (Dawley et al. 2000).

In 1999, we repeated the 1998 tests with increased precision, but excluded the sluiceway component of the study. Point estimates of dam passage survival were again calculated for juvenile salmon during the spring and summer migration periods. Relative survival estimates were based on PIT-tag detections at Bonneville Dam and other downstream sites. Detection percentages of treatment groups released upstream from the spillway were compared to those of reference groups released downstream from the dam, thus providing relative survival estimates.

METHODS

During the spring migration, we captured run-of-the-river juvenile yearling chinook and coho salmon 5 to 7 days/week at the fish-collection facility at John Day Dam [Columbia River Kilometer (RKm) 347] in late April and May. During the summer migration in late June and July, we captured run-of-the-river subyearling chinook salmon 5 to 7 days/week at the same fish-collection facility. We PIT tagged approximately 6,000 fish daily and divided them proportionally among spillway (treatment) and tailrace (reference) groups (Fig. 1).

Tagged fish groups were then transported to The Dalles Dam (RKm 308) and held for 1 day before release upstream from the spillway or in the midstream area of the tailrace. Analyses of relative survival rates were based on subsequent PIT-tag detections from the juvenile bypass systems at Bonneville Dam First and Second Powerhouses (RKm 235), from the PIT-tag detector trawl used in the estuary off Jones Beach (RKm 75), and from flat-plate and pole-mounted detectors used on abandoned bird colonies at RKm 35 and RKm 8 (Ryan et al. in press).

Generally, juvenile salmon for each day of marking were captured during a 6- to 10-hour period from the fish bypass system at John Day Dam. As migrants passed out of the corrugated flume, they slid across a dewatering screen onto the wetted separator, which segregates juvenile

salmon from larger fish and debris. Upon separation, juvenile fish were directed through a 25-cm-diameter PIT-tag detector tunnel to a 3-way rotating gate, where previously PIT-tagged fish were returned to the river and non-tagged fish were diverted through a 25-cm pipe to the juvenile-fish sampling room. At the sampling room, fish were collected in a 6.1-m-long by 152-cm-wide by 107-cm-deep tank and held for marking.

Marking began each evening at 2000 h, when the smolt monitoring sample rate was increased to collect the target number of fish for tagging. The sample rate was initially increased to 25 or 33%, depending on the number of fish collected the previous night and the number of fish passing during that day. Adjustments to the sample rate were made hourly, as needed to collect the required number of fish for tagging, and ranged from 5 to 100%.

After fish were anesthetized, target fish were sorted, scanned for PIT tags, and tagged in approximately equal numbers for spillway (treatment) and tailrace (reference) groups. Taggers alternated between treatment and reference groups throughout the study period. Non-target fish and the occasional PIT-tagged target fish (fish not diverted back to the river at the 3-way rotating gate) were allowed to recover from anesthetic and were then released into the exit flume and returned to the river.

Tagged treatment and reference groups were routed to 800-L insulated aluminum holding tanks and held at maximum densities of less than 24 g/L for mixed coho and spring/summer chinook salmon (825 fish/tank, assuming 23 g average fish weight) and less than 13 g/L for subyearling chinook salmon (1,000 fish/tank, assuming 10.5 g average fish weight). Containers were maintained near ambient river temperature and oxygen concentration with about 75 L/minute water flow.

Generally, holding tanks were transported by truck to The Dalles Dam in the morning. During the 40-minute transport, oxygen was metered into tanks through air stones. When water temperatures approached 20ºC, ice was added to each tank to prevent further increases during the transport period. At The Dalles Dam, water was distributed to each tank at a rate of about 45 L/minute. Fish were generally held until the following morning or the following night, then released. Before release, tanks were inspected for mortalities and loose PIT tags. Tanks were then loaded onto trucks supplied with oxygen and taken to the spillway or tailrace, where they were set on boats and ferried to the release site.

Test Conditions

Tests were designed to evaluate passage survival at spill levels of 64 and 30% of river flow alternating in 3-day periods; however, actual spill levels varied as much as 8% with averages of 30% (SD 2.2%) and 62% (SD 2.4%; Appendix Tables A1-A4). Passage conditions through each spillbay were different and changed through time in association with changes in river flow and hour of the day.

Spill gate openings varied for each spillbay based on the established spill patterns developed to maximize juvenile salmon survival without disrupting adult fish passage

(COE 1997). During nighttime, the juvenile spill pattern is utilized (from 2001 to 0500 h, when spill is greatest on the north side of the spillway). During daytime, the adult spill pattern is utilized (from 0500 to 2000 h, when spill is less at 3 or 4 north- and south-end spillbays and crowned in the center bays). The exception was Spillbay 9, which was closed from 21 April through the daytime release on 27 April. This spillbay was set with an opening of 1.5 m (5 ft) on 27 April for the nighttime release, and it remained at that setting through the remainder of the test period.

Releases were made through the duration of the yearling chinook salmon migration (spring migrants) and at the beginning and peak of the subyearling chinook salmon migration (summer migrants). The experimental design called for releases to be evenly divided between daytime and nighttime (adult and juvenile spill patterns).

Release Methods, Locations, and Times

Daily releases were made from 22 April to 29 May for yearling chinook and coho salmon (spring migration), and from 17 June to 19 July for subyearling chinook salmon (summer migration). Spillway groups were released first, followed by tailrace (reference) groups released about 15 minutes later. Daily releases generally alternated between daylight and dark periods throughout both tests. Spillway and tailrace groups on boats were both released from tanks held at an elevation of about 0.5 m above the water surface.

Daily spillway (treatment) releases were evenly distributed among the north, middle, and south portions of the forebay, with all groups released from a boat about 200 m upstream from the spill gates (Fig. 1). The order of releases was randomized. Tailrace (reference) releases were made from a boat downstream from the dam at the proposed site of the new bypass system outfall (Fig. 1). This site is about 70 m from the Washington shore, about 0.7 km downstream from the spillway, and about 30 m downstream from the Highway 197 bridge in an area of high water-velocity. At this location, released fish are thought to generally pass down the north side of the river, away from predator sanctuary areas (Snelling and Mattson 1998).

We attempted to make all test fish releases during peak periods of daily passage for naturally migrating fish (based on hydroacoustic data; BioSonics 1997). Release times varied, but the mean daytime release time was 1128 h for the spring migration and 1114 h for the summer migration, while the mean nighttime release time was 2052 h for the spring migration and 2254 h for the summer migration (Appendix Tables A1-A4). The average time from the first to last daily release was about 1 hour.

To accurately evaluate relative survival differences in exclusive relation to the effects of dam passage, it is important that treatment and reference groups migrate together (mixed) past the sampling and detection sites: homogeneity in passage ensures that physical conditions other than passage route are comparable. Differential timing or migration route through a river reach

could cause differences in predation and PIT-tag detection rates not directly attributable to dam passage.

To achieve mixing of test fish exiting the tailrace, treatment and reference groups were released sequentially in relation to water-particle travel time from release location to the tailrace exit. Unfortunately, the passage route taken by fish through the dam (i.e., powerhouse, proposed new bypass system, or spillway) affects the lateral location of fish in the tailrace, which in turn affects its passage route and movement rate downstream (Snelling and Mattson 1998). Therefore, some differences in timing from The Dalles Dam to Bonneville Dam were likely related to route of passage through The Dalles Dam. Different arrival timing at Bonneville Dam and in the estuary may affect the comparability of detection rates between groups because of temporal differences in river flow, Bonneville Dam operations, and fish and bird behavior in the estuary.

PIT-Tag Detection Methods and Locations

For this study, PIT-tag detection data was collected from three general areas. First, the majority of tags were detected at smolt bypass systems in the first and second powerhouses of Bonneville Dam (Dawley et al. 1998). Second, detections were made in the estuary off Jones Beach using a pair-trawl fitted with a PIT-tag detector in the cod end (Ledgerwood et al. in prep.). Third, land-based detections were made with flat-plate and pole-mounted PIT-tag detectors used at abandoned piscivorous bird colonies. These colonies were on East Sand and Rice Island (RKm 8 and 34, respectively), on channel markers in the estuary upstream from Rice Island, and upstream from The Dalles Dam on Little Memaloose and Little Miller Islands (RKm 314 and 331, respectively; Ryan et al. in press).

Tags detected on islands upstream from The Dalles Dam were not used to compute relative survival because they represented mortalities to the treatment groups. However, tags detected in the estuary were far downstream from the bird-foraging areas between The Dalles and Bonneville Dams, and thus represented test fish that survived passage through Bonneville Dam and migration through an additional 200 km of river.

Test Fish

Juvenile yearling chinook and coho salmon were used to evaluate spill passage survival at The Dalles Dam during the spring migration period. To limit handling impacts to fish listed under the Endangered Species Act, we did not separate hatchery and wild fish but used both as they arrived at the collection facility. Sorting out wild fish and tagging only hatchery fish would have necessitated the handling of, and consequent stress to, many more wild fish. Subyearling fall chinook salmon were used as test fish during the summer migration period.

Based on previous work, we estimated that detection rates at Bonneville Dam from PIT-tagged fish released in The Dalles Dam tailrace would average 15% for the spring migration and 10% for the summer migration (Dawley et al. 1999). To obtain the desired sensitivity of an 8 and 10% detectable difference between treatment and reference groups, the calculated numbers (Cochran and Cox 1957) of test fish needed were 140,000 spring fish and 168,000 summer fish.

Data Analyses

The primary null hypothesis tested was:

$H_{0(1)}$: Detection rates of treatment groups released to the spillway at 64% spill and to the spillway at 30% spill do not differ from those of reference groups released to the tailrace of The Dalles Dam.

Secondary null hypotheses, which were not necessarily expected to be rejected with one year's data (because of limited test fish numbers) were as follows:

$H_{0(2)}$: There are no differences in relative survival between treatment groups associated with release time (day or night) and lateral release location in the spillway (north to south segments).

$H_{0(3)}$: Relative survival for groups released through the spillway is not correlated with river volume, spill volume, tailwater elevation, or water temperature.

$H_{0(4)}$: Relative survival does not differ with size at realease between small and large fish, where the threshold between small and large is defined at 125 mm for yearling fish and 110 mm for subyearling fish.

$H_{0(5)}$: Detection proportions (treatment to reference release groups) did not differ with site of detection between Bonneville Dam First Powerhouse, Bonneville Dam Second Powerhouse, Jones Beach, and the estuarine bird rookeries.

$H_{0(6)}$: Arrival timing and passage distributions at Bonneville Dam do not differ between treatment and reference groups.

Detection percentages of daily release groups passing the spillway at 64 and 30% spill were compared to those of pooled reference groups (pooled by day) released in the tailrace: means and 95% confidence intervals were calculated from the natural log of treatment to reference detection proportions. Relative survival (detected proportion of spillway-released fish/detected proportion of tailrace-released fish) was calculated in relation to passage variables, which were categorized as follows: Julian date; spill percentage, indexed as 1 for 30% or 2 for 64% spill rates; release period, indexed as 1 for daytime (adult spill pattern) and 2 for nighttime (juvenile spill pattern); spillway release location, indexed as 1 for north bays, 2 for middle bays,

or 3 for south bays. Assessments were made using analysis of variance (ANOVA) of log-transformed detection ratios (treatment/reference).

Correlation coefficients were calculated for the relative survival estimates in relation to dependent variables (Julian date, tailwater elevation, river flow, spill flow, and water temperature) and stepwise linear regressions were conducted to evaluate the predictive potential of log-transformed survival ratios. Data from 1997, 1998, and 1999 used for this evaluation were pooled by release period.

Relative survival in relation to body size at release was evaluated to provide information regarding the effects of size selection on survival. Information from this analysis will be useful in future research activities, when a full range of fish sizes may not be available. Fish were divided into two groups: fish smaller than the size necessary for radio-transmitter implantation and fish larger than this size. The size thresholds presently utilized as minimum for radio tagging are 125 mm for yearling fish and 110 mm for subyearling fish (Rip Shively, U.S. Geological Survey, Columbia River Research Laboratory, Cook, WA, 98605, Pers. commun., October 1998). Student's *t*-test distributions were used to evaluate relative survival in relation to fork length. Paired *t*-tests were used for evaluating survival differences separated by site of detection (Bonneville Dam First Powerhouse, Bonneville Dam Second Powerhouse, the estuary off Jones Beach, and the bird colonies).

We tested the assumption of mixing between treatment and reference groups (i.e., homogeneity of passage distributions at Bonneville Dam) with chi-square tests for each release date, using a Monte Carlo approximation of the exact method to calculate P-values (Mehta and Patel 1992). Significance was established at $P <= 0.05$. Relative survival estimates for groups identified as not mixed were compared to those of mixed groups using a two-sample *t*-test.

r each day or night release, the proportion of reference fish and treatment fish passing hourly at the first or second powerhouses was compared to the hourly proportions of total powerhouse flow and total river flow. Average powerhouse flow percentages were then calculated for spillway (treatment) and tailrace (reference) groups and compared by paired *t*-test.

RESULTS

Spring Migration: Yearling Chinook and Coho Salmon

On test days 21 April-29 May, during hours of release, river flow ranged from 6,119 to 10,992 m^3/second (216,000 to 388,000 ft^3/second), and average spill ranged from 2,125 to 4,108 m^3/second (75,000 to 145,000 ft^3/second) during 30% spill and 4,023 to 5,949 m^3/second (142,000 to 210,000 ft^3/second) during 64% spill (Appendix Tables A1 and A2). Of the 139,078 PIT-tagged chinook and coho salmon released, 19.8% (27,474 unique tags) were detected at one or more downstream sites (Table 1; Appendix Table A5). Of 69,419 PIT-tagged salmon released as tailrace (reference) groups at a site downstream from the Highway 197 bridge, 20.3% (14,102 unique tags) were detected. Proportions of total PIT-tag detections from spring migrants were 18% at Bonneville Dam First Powerhouse, 61% at Bonneville Dam Second Powerhouse, 7% in the estuary off Jones Beach, and 14% from abandoned bird colonies in the estuary.

The PIT-tag detection data were separated by detection site to evaluate variability of relative survival estimates between sites. Average survival estimates for spillway passage calculated from detections at Bonneville Dam First Powerhouse (90%) were lower than those calculated from detections at Bonneville Dam Second Powerhouse (93%). They were also lower than estimates calculated from detections of the trawl off Jones Beach (99%) or detections from the bird colonies (106%)*. Survival estimates from detections at Bonneville Dam First and Second Powerhouse combined averaged 17% lower than those from detections on bird colonies. Statistical analyses of the separated data are presented in Appendix Table B1.

Paired *t*-tests of the natural log of relative survival ratios indicated no significant differences between treatment-to-reference survival ratios from Bonneville Dam First Powerhouse and those from Bonneville Dam Second Powerhouse ($P = 0.30$). Comparisons between combined detections from Bonneville Dam and those from the trawl off Jones Beach suggested a significant difference at $P = 0.19$, and comparisons between combined Bonneville Dam detections and those from bird colonies indicated a significant difference at $P < 0.01$. Finally, a paired *t*-test of the natural log of relative survival between detections measured at Jones Beach vs. those measured on abandoned bird colonies indicated a significant difference at $P = 0.08$. We utilized the combined data from all recovery sites for all further analyses.

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* When true survival probabilities are close to 100% or when sampling variability is high, it is possible for survival probabilities to exceed 100%. For practical purposes, estimates should be considered equal to 100% in these cases (Steven G. Smith, NMFS, Pers. commun., November 1998).

Table 1. Numbers and percentages of PIT-tagged fish released and detected at various locations by treatment and condition for The Dalles survival study in 1999.

	Releases		PIT-tag detections by location					
Conditions	Site	No.	Bon. 1	Bon. 2	Jones B.	Bird Col.	Total*	Detect (%)*
				Spring				
30% Spill, Daytime	Spillway	17,422	613	2304	273	499	3,541	20.3
	Tailrace	17,271	632	2,607	299	453	3,830	22.2
30% Spill, Nighttime	Spillway	17,403	677	1,625	313	538	3,032	17.4
	Tailrace	17,366	717	1,627	307	438	2,968	17.1
64% Spill, Daytime	Spillway	17,376	635	2,278	174	514	3,460	19.9
	Tailrace	17,366	713	2,747	196	496	4,015	23.1
64% Spill, Nighttime	Spillway	17,458	580	2,155	188	576	3,339	19.1
	Tailrace	17,416	643	2,085	164	523	3,289	18.9
	Total*	139,078	5,210	17,428	1,914	4,037	27,474	19.8
	Release (%)		3.7	12.5	1.4	2.9		
	Detections (%)		18.2	61.0	6.7	14.1		
				Summer				
	Site	No.	Bon. 1	Bon. 2	Jones B.	Bird col.	Total*	Detect (%)*
30% Spill, Daytime	Spillway	20,854	479	2,113	0	326	2,871	13.8
	Tailrace	20,858	502	2,286	0	316	3,058	14.7
30% Spill, Nighttime	Spillway	20,821	389	2,144	0	337	2,818	13.5
	Tailrace	20,805	372	2,031	0	358	2,704	13.0
64% Spill, Daytime	Spillway	20,870	451	2,151	0	316	2,875	13.8
	Tailrace	20,870	512	2,281	0	302	3,053	14.6
64% Spill, Nighttime	Spillway	20,821	321	2,016	0	323	2,620	12.6
	Tailrace	20,828	374	2,042	0	302	2,676	12.8
	Total	166,727	3,400	17,064	0	2,580	22,675	13.6
	Release (%)		2.0	10.2	0.0	1.5		
	Detections (%)		14.8	74.0	0.0	11.2		

* Total observed (used for combined analysis) is the number of unique tags observed at any of the sites. Multiple observations of a tag are not counted. Numbers observed at individual sites may include tags observed at other sites, and these data were used to make the inter-site comparisons.

Survival Estimates

Survival for spillway-released coho and spring chinook salmon combined (spring migration) at both 64 and 30% spill was significantly different (lower) from survival of reference fish released downstream from the dam. The point estimate (unweighted geometric mean for all release periods) of relative survival at 64% was 93.4% with a 95% confidence interval ; and at 30% spill was 96.2% (CI 90.2-100.5%; Table 2).

Survival at 30% spill was not significantly different from survival at 64% spill (P = 0.26; Appendix Table B1). Relative survival percentages of daily releases ranged from 78.3 to 115.2%. These point estimates represent passage survival of mixed fish stocks throughout the migration period; during daytime (adult) and nighttime (juvenile) spill patterns; through spillbays across the width of the spillway; at ambient spill-gate openings, river flows, tailwater elevations, and water temperatures.

The experimental design provided numbers of spring test fish sufficient to assess probable relative survival differences between treatment and reference groups at 30 and 64% spill, but these numbers were not sufficient to fully evaluate survival effects related to other controlled and uncontrolled variables. However, we examined the data for survival trends related to other variables.

There was a trend of increased survival through the period of testing (P = 0.04; Fig. 2; Appendix Table B1). Differences between spillway release location (north, middle, or south) were not significant (P = 0.91; Appendix Table B1). Nighttime spillway passage produced higher relative survival than daytime spillway passage (P < 0.01): mean spillway passage survival was 87.6 and 102.6% for daytime and nighttime releases, respectively. These daytime/nighttime differences were observed in data from both 30 and 64% spill conditions (Appendix Table B1). Additionally, relative survival was not strongly correlated to change in

In addition to these analyses, we calculated survival and looked for trends and relationships in the data from coho and yearling chinook salmon separately. Relative survival proportions for coho salmon were similar to those for chinook salmon (Appendix Tables A6, A7, and B2). A paired *t*-test comparing survival estimates between these species found no significant difference (P = 0.98).

Test-fish body size at release was also evaluated as a variable affecting survival. We examined fork-length distributions of daily release groups separated into two fork-length categories: 125 mm or less and greater than 125 mm. Of the 20,842 fish measured at John Day Dam, 94% were large enough to be radio tagged (> 125 mm), while only 6% were too small to radio tag (Fig. 4). Detections from Bonneville Dam and those from the estuary (Jones Beach and bird colonies combined) showed no significant differences by fish size at release (P = 0.09 and 0.44, respectively; Appendix Table B3).

Table 2. Percent survival by condition, date, and release site for juvenile chinook and coho salmon passing through The Dalles Dam spillway in relation to tailrace released counterparts; spring 1999, combined.

Releases–116,911 chinook; 22,165 coho

Daytime 30% spill

Date	North	Middle	South	Average[a]
4/27	60.6	77.4	94.4	82.9
5/2	87.0	87.2	78.0	84.4
5/8	94.6	81.7	72.4	82.9
5/9	88.6	99.5	78.9	89.0
5/15	94.1	80.8	83.2	86.1
5/20	94.9	93.8	84.9	91.2
5/26	100.2	104.5	89.4	98.0
5/27	106.9	113.1	125.5	115.2
Geometric mean[a]	89.8	91.5	87.2	**90.7**

Nighttime 30% Spill

Date	North	Middle	South	Average[a]
4/21	99.3	97.2	103.2	99.8
4/27[b]	107.9	119.0	103.0	109.0
5/2	90.7	109.6	137.4	108.0
5/9	89.8	115.4	111.5	105.6
5/13	97.5	112.4	102.3	103.8
5/20	106.6	111.6	104.3	107.5
5/21	98.7	90.8	119.2	102.9
5/27	87.5	87.5	94.3	89.7
Geometric mean[a]	97.0	104.8	108.7	**103.1**

Day & Night 30% Combined

Geometric mean[c]	**96.2**
95% Confidence interval [c]	**92.0 -100.5**

Interrogations–22,473 chinook; 6,116 coho

Daytime 64% Spill

Date	North	Middle	South	Average[a]
4/23	86.0	82.2	86.5	85.0
4/29	90.8	81.3	99.5	90.6
4/30	96.0	78.3	60.6	78.3
5/5	98.4	83.8	67.1	83.1
5/12	79.6	90.9	104.6	91.7
5/18	84.6	91.4	88.0	88.0
5/24	94.6	89.4	83.0	89.0
5/29	92.4	85.5	81.6	86.5
Geometric mean[a]	90.1	85.2	82.7	**86.4**

Nighttime 64% Spill

Date	North	Middle	South	Average[a]
4/23	94.8	98.5	100.0	97.8
4/30	110.7	95.3	94.4	100.7
5/5	104.6	88.4	97.3	96.8
5/6	103.6	110.7	113.6	109.3
5/12	106.5	85.1	101.3	97.6
5/18	112.2	109.2	105.9	109.1
5/22	110.5	100.4	101.7	104.2
5/29	102.5	100.7	95.2	99.4
Geometric mean[a]	105.5	98.2	101.0	**101.7**

Day & Night 64% Combined

Geometric mean[c]	**93.4**
95% Confidence interval [c]	**90.0 - 97.0**

[a] Average is weighted by total fish released on the designated date and Geometric mean is weighted by date.

[b] Flow changed from 30 to 78% at the end of release.

[c] Mean and confidence interval backtransformed from Ln relative survival proportions of individual releases.

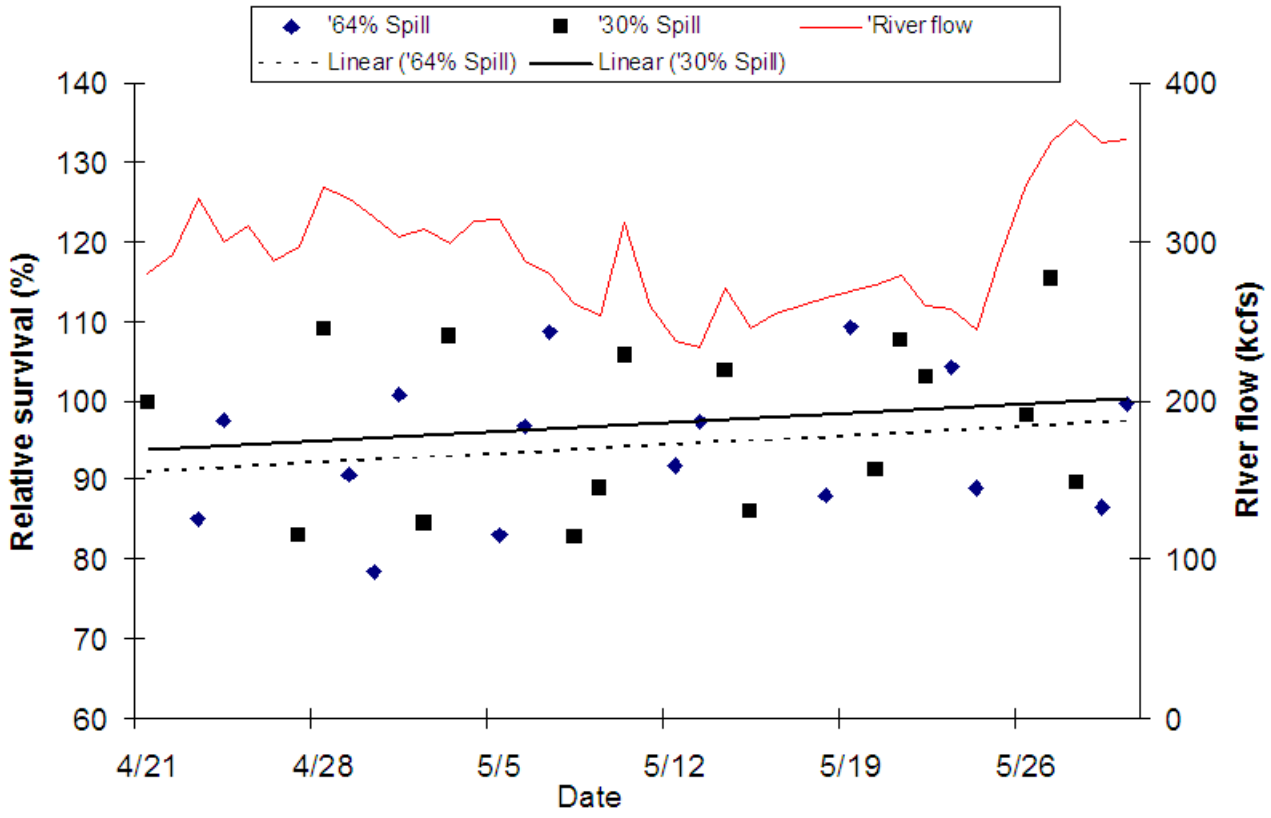

Figure 2. Relative spillway passage survival of yearling chinook and coho salmon and river flow at The Dalles Dam through the period of testing, 1999.

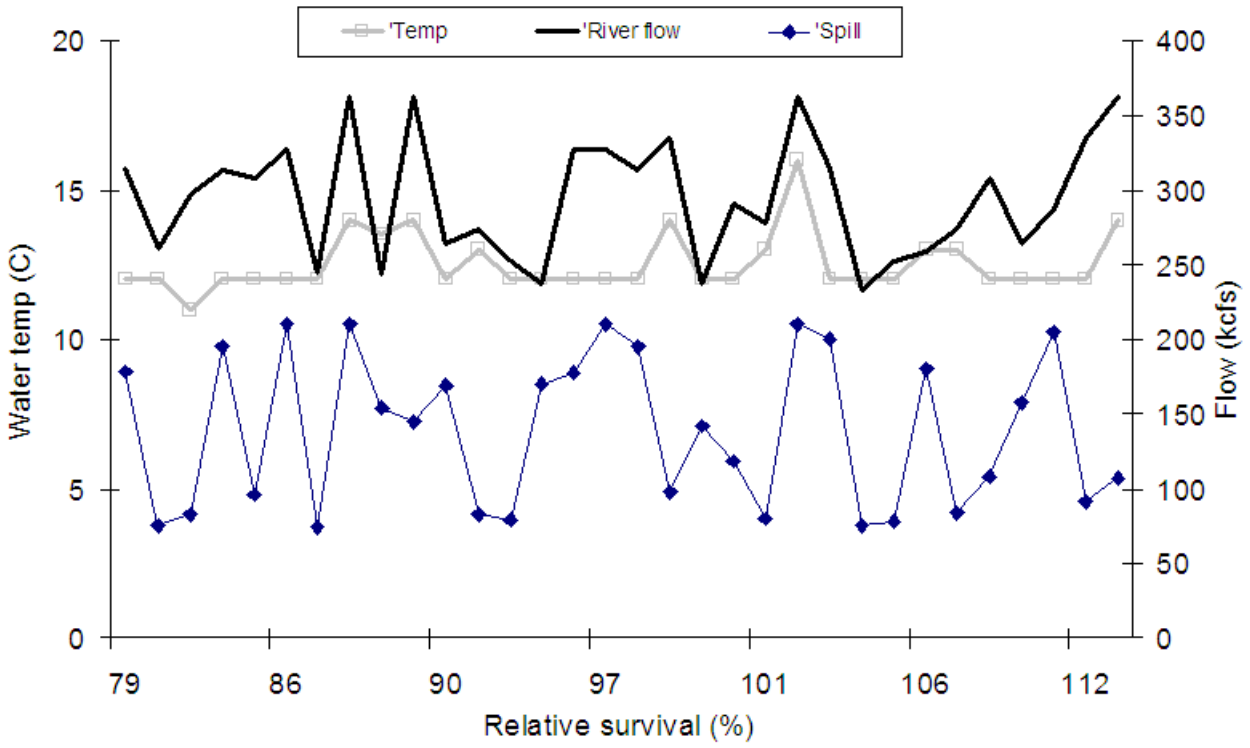

Figure 3a. Relative spillway passage survival of yearling chinook and coho salmon at The Dalles Dam in relation to river flow, spill flow, and water temperature, 1999.

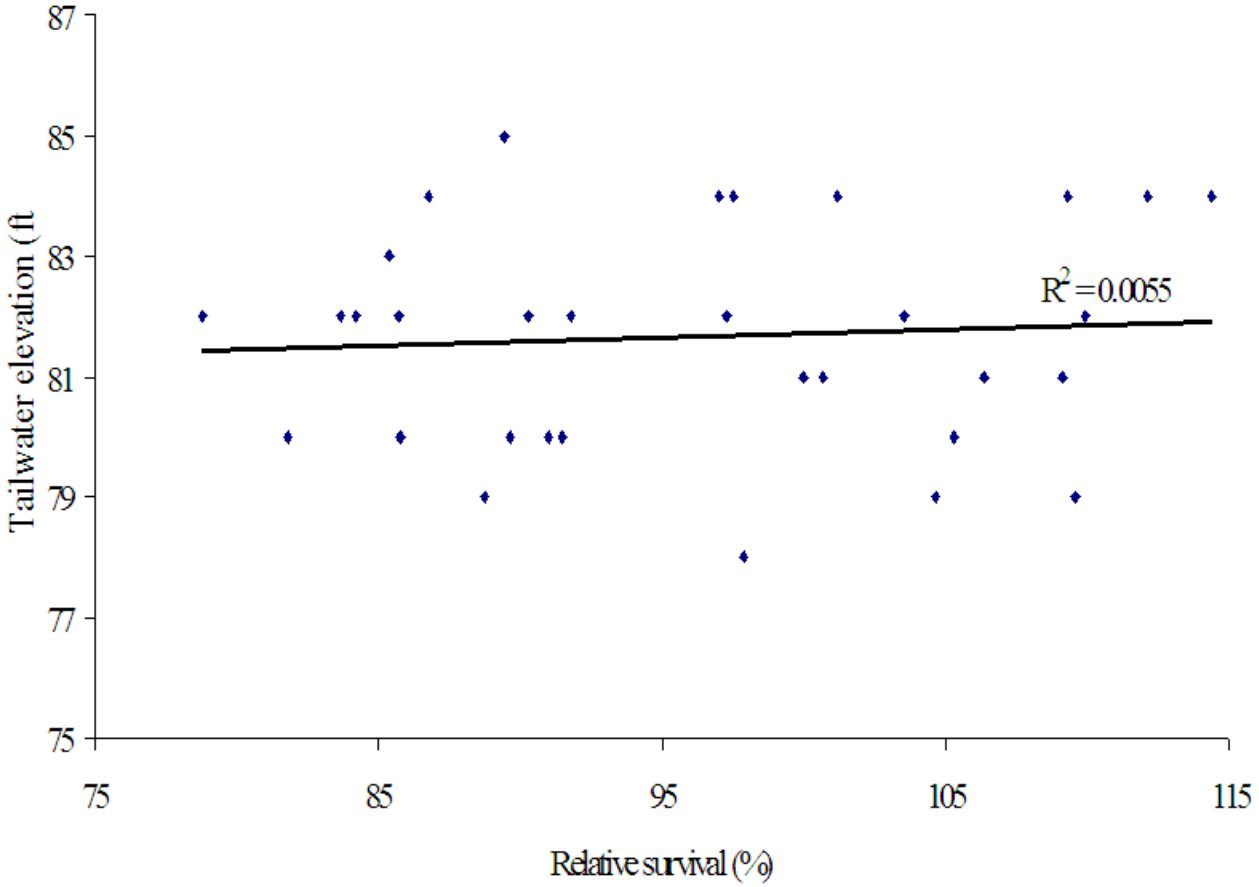

Figure 3b. Relative spillway passage survival of yearling chinook and coho salmon at The Dalles Dam in relation to tailwater elevation, 1999.

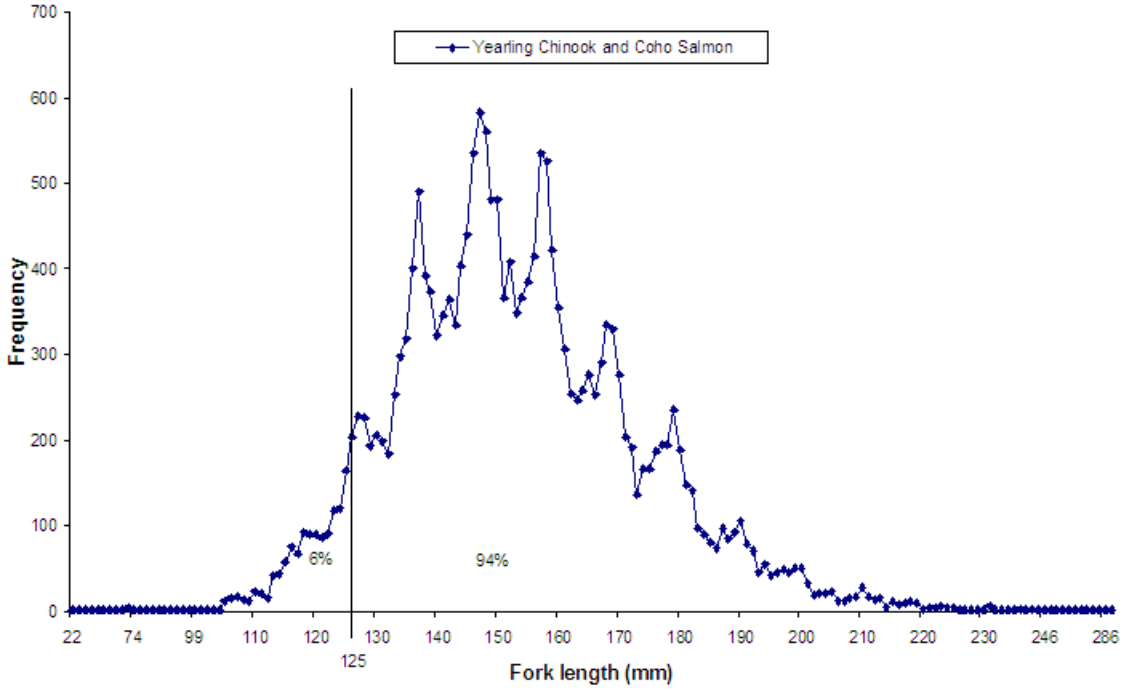

Figure 4. Size distribution of released yearling chinook and coho salmon with vertical line showing the 125-mm size threshold for radio tagging. The Dalles Dam, spring 1999.

Variability Associated with the Experimental Process

To assess differences in temporal distribution among treatment groups (mixing), we compared travel time and daily detection distributions at Bonneville Dam for daily release groups.

Travel time–The simplest method to evaluate whether mixing occurred among treatment groups was to assess travel time differences between treatment groups released during the same time period. Travel times through the 75-km river reach from The Dalles Dam to Bonneville Dam averaged about 1.8 days, with Travel time generally decreased through the test period (r), and river flow did not appear to affect travel time (r = -0.21; Fig. 5). Travel time averaged 1.7 days for daytime releases and 1.9 days for nighttime releases; the difference was not significant (P = 0.16).

Mean travel times for tailrace-released reference groups averaged 0.2 days (5 hours) less than for spillway groups; the difference was significant (P < 0.01; Appendix Table B4). We have no explanation for the differences in travel time to Bonneville Dam, considering that spillway and tailrace fish appeared to exit the tailrace of The Dalles Dam at about the same time, as measured by radiotelemetry data (Theresa Liedtke, U.S. Geological Survey, Columbia River Research Laboratory, 5501A Cook Underwood Rd., Cook, WA 98605, Pers. commun., July 1999).

Temporal detection distributions–The homogeneity of passage distributions at Bonneville Dam (detection through time) for corresponding spillway- and tailrace-released groups of chinook and coho salmon suggested many violations of the mixing assumption. We used a chi-square test to compare passage distribution between tailrace and spillway releases of spring migrants from all 32 release periods. These tests indicated temporal differences in passage distribution at Bonneville Dam for 17 of the 32 periods (Appendix Table B5). Although the statistical analysis indicated that these arrival timing differences were significant, overall passage distributions for both the spillway and tailrace groups were quite compact, with spillway releases arriving only slightly later than tailrace releases.

To assess the importance of distribution differences, we compared the number of fish detected from spillway- and tailrace-release groups in relation to river flow and Bonneville Dam powerhouse operation. For each release period, hourly fish counts at the first or second powerhouse and the percentages of powerhouse flow, in relation to total powerhouse flow or total river flow at the time of passage, were calculated for treatment fish and reference fish separately. For each release period, the average flow percentage/fish for treatment and for reference fish was compared (Appendix Table B6). Differences between treatment and reference groups appeared negligible, averaging 0.0% for total powerhouse flow/fish and 0.1% for total river flow/fish in detections at the first powerhouse and 0.4% for total powerhouse flow/fish and 0.4% total river flow/fish in detections at the second powerhouse.

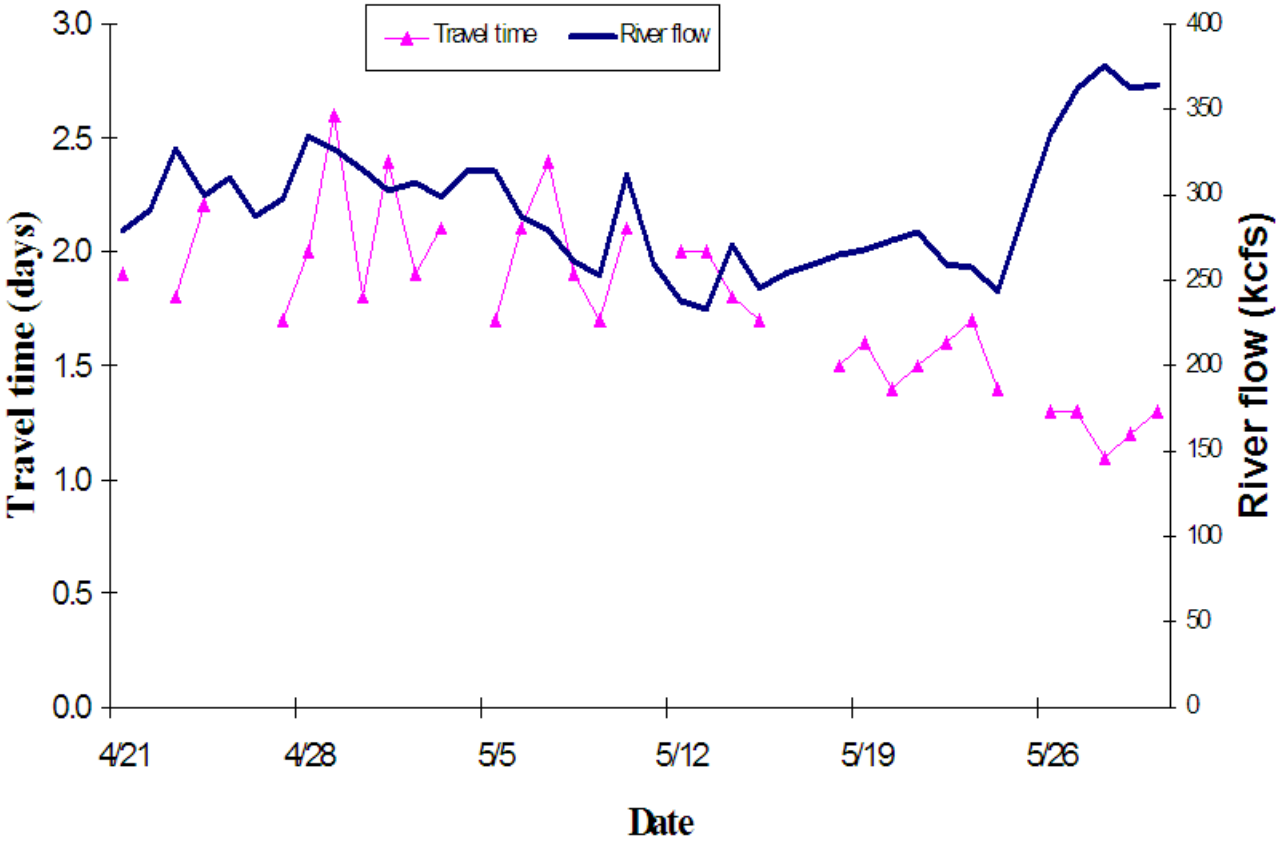

Figure 5. Travel time from The Dalles Dam to Bonneville Dam for daily release groups of spring test fish compared to average river flow, 1999.

Comparison with 1997 and 1998 Results and Trends for Combined Data

Detection site differences–Estimates of relative survival measured at Jones Beach and the bird colonies were compromised by low numbers of detections and resultant high variability among the daily releases (Appendix Table B1, B7, B8, and B9). Survival estimates measured at Bonneville Dam First Powerhouse averaged 2 and 5% higher (non-significant) and 3% lower than estimates measured at Bonneville Dam Second Powerhouse in 1997, 1998 and 1999, respectively. Estimates at Bonneville Dam (combined) were 0 to 19% lower (significant in two of three years) than at the bird colonies. Estimates measured at Jones Beach were 12 to 14% lower than at the bird colonies (significant in one year) and 14% lower than at Bonneville Dam in 1998, but 7% higher in 1999 (non-significant).

In general, estimates at all sites through all years showed greater survival at 30% spill than at 64% spill and greater survival for spillway passage at night with the juvenile spill pattern than during day with the adult spill pattern (Appendix Table B7).

Survival trends–The point estimate for spillway passage survival at 64% spill in 1999 (93%) was higher than in 1998 and 1997 (89 and 87%, respectively). Survival trend lines for 64% spill showed a slight increase through time in 1999, whereas in 1998 and 1997, they showed decreases through time (Fig. 6). The point estimate for spillway passage survival at 30% spill in 1999 (95%) was similar to that in 1998 (97%), but the trend line for spillway passage survival at 30% spill increased through the test period in 1999 but decreased through the test period in 1998 (Fig. 6).

ANOVA of combined 1997, 1998, and 1999 data indicated a significant difference in relative passage survival between 64 and 30% spill ($P = < 0.01$) and between daytime and nighttime releases ($P = 0.04$). Relative survival means were 88.9% at 64% spill and 98.1% at 30% spill. Relative survival means for daytime releases were 86.7 and 93.9% at 64 and 30% spill rates, respectively. These rates were significantly lower than those of nighttime releases, which were 91.2 and 102.5% for 64 and 30% spill levels, respectively ($P = 0.04$; Appendix Table B10).

Because comparisons between high and moderate spill rates were not conducted in 1997, we analyzed the combined data from 1998 and 1999 only. These data indicated a significant difference in relative survival between 64 and 30% spill ($P = 0.05$) and between daytime and nighttime releases ($P = 0.02$). Mean relative survival was 92.0% at 64% spill and 98.0% at 30% spill. Respective mean relative survival at 64 and 30% spill was 89.0 and 93.8% for daytime releases and 95.1 and 102.4% for nighttime releases (Appendix Table B11).

Travel times–Travel times to Bonneville Dam for tailrace (reference) groups were slightly less than those of corresponding spillway (treatment) groups. In 1999, travel times between treatment and reference groups were significantly different ($P < 0.01$); whereas in 1997 and 1998, differences were not significant ($P = 0.22$).

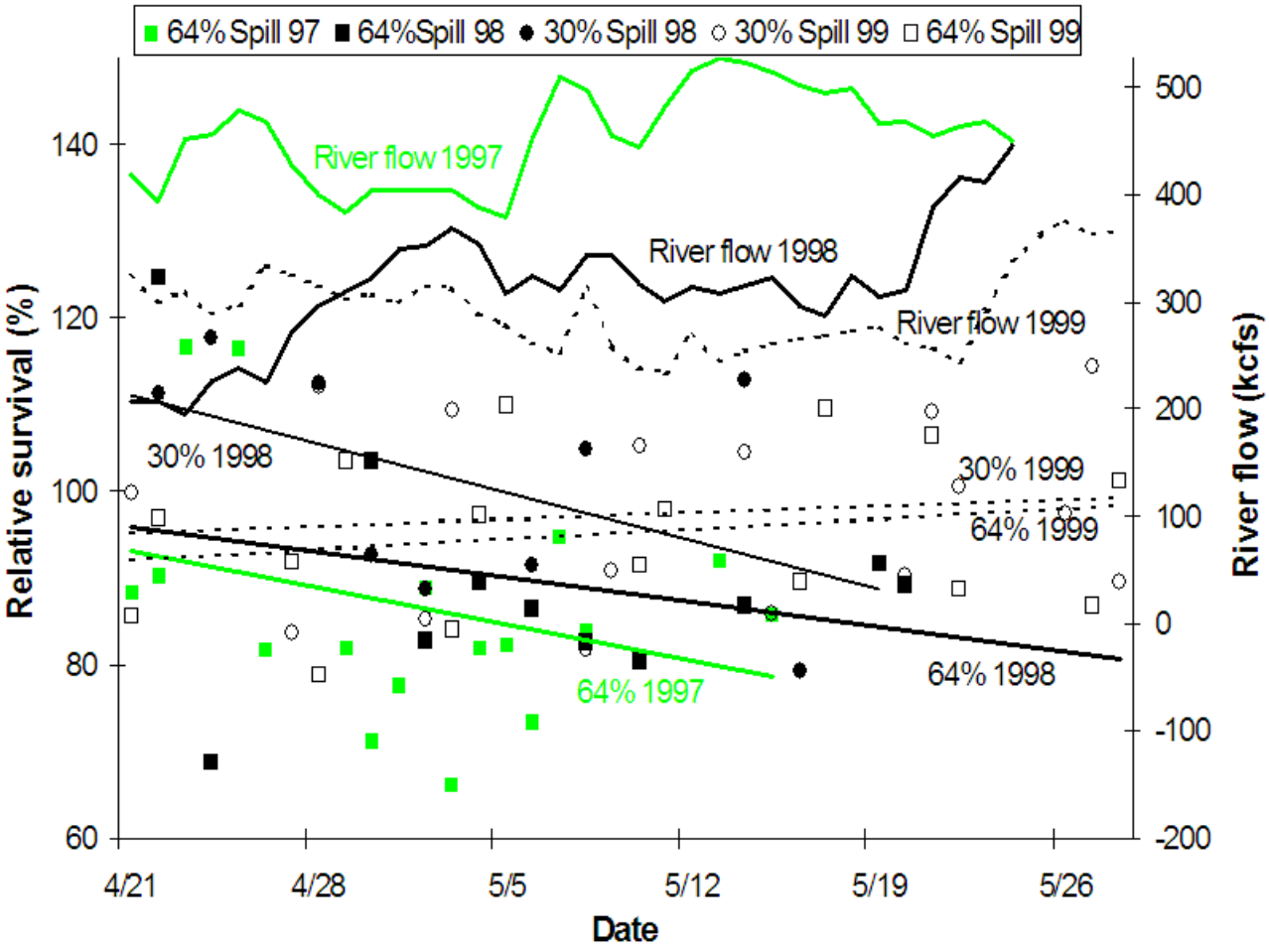

Figure 6. Relative spillway passage survival of yearling chinook and coho salmon and river flow at The Dalles Dam through the period of testing, 1997, 1998, and 1999.

Uncontrolled variables–Evaluations of survival in relation to the following individual dependent variables showed poor correlation in springtime tests using yearling chinook and coho salmon: water temperature, spill flow, river flow, and tailwater elevation (r = 0.04, -0.21, -0.08, and -0.13, respectively; Figs. 7a and 7b). Stepwise regression of dependent variables, excluding spillbay location, provided poor predictive capability utilizing data from either individual years or multiple years; for 1997-1999 combined data (R^2 = 0.15; Appendix Table B12).

Powerhouse operations–Examination of the data on powerhouse operations for each of the 3 years of study showed that differences at Bonneville Dam during passage between tailrace- and spillway-released groups appeared to be minor with no notable trends between years. Average river flows per fish and average powerhouse flows per fish showed no discernable pattern at either powerhouse for any of the treatments (Appendix Tables B6, B13, and B14).

Upstream gull colonies–Land-based PIT-tag surveys of the gull colonies upstream from The Dalles Dam (Little Memaloose and Little Miller Islands) detected approximately 0.2% of all tags from spring migrants released in 1997 and 1998 and 0.08% of all tags from spring migrants released in 1999. It is interesting to note that of the records from these islands, tags from spillway-released (treatment) fish comprised 90% of the detections in 1997 and 1998 and 84% of the detections in 1999 (Brad Ryan, NMFS, P.O. Box 155, Hammond, OR 97121, Pers. commun., February 2000). Nevertheless, the total proportion of tags detected at these colonies was minimal, and the proportion that may have been dropped at other locations is unknown.

Summer Migration: Subyearling Chinook Salmon

On test days 17 June to 19 July during hours of release, river flow ranged from 6,261 to 10,453 m^3/second (221,000 to 369,000 ft^3/second); average spill ranged from 2,040 to 2,975 m^3/second (72,000 to 105,000 ft^3/second) during 30% spill and 3,966 to 5,949 m^3/second (140,000 to 210,000 ft^3/second) during 64% spill (Appendix Tables A3 and A4). Of the 166,727 PIT-tagged subyearling chinook salmon released, 13.6% (22,675 unique tags) were detected at one or more downstream sites (Table 1; Appendix Table A8). Of the 83,361 PIT-tagged subyearling chinook salmon released at the reference location just downstream from the bridge, 13.8% (11,491 unique tags) were detected.

Respective proportions of PIT-tag detections at Bonneville Dam First Powerhouse, Second Powerhouse, and bird colonies were about 15, 74, and of total detections during the summer migration. (Sampling with the detector trawl off Jones Beach was not conducted during the summer migration.) PIT-tag detection data were separated by detection site to evaluate relative survival differences between sites. Average survival estimates from detections at Bonneville Dam First Powerhouse were lower than those from detections at Bonneville Dam Second Powerhouse or the bird colonies (92, 99, and 104%, respectively). Survival estimates for detections at Bonneville Dam (first and second powerhouse combined) averaged 8% lower than those for detections on the bird colonies. Statistical analyses of the separated data are presented in Appendix Table B15.

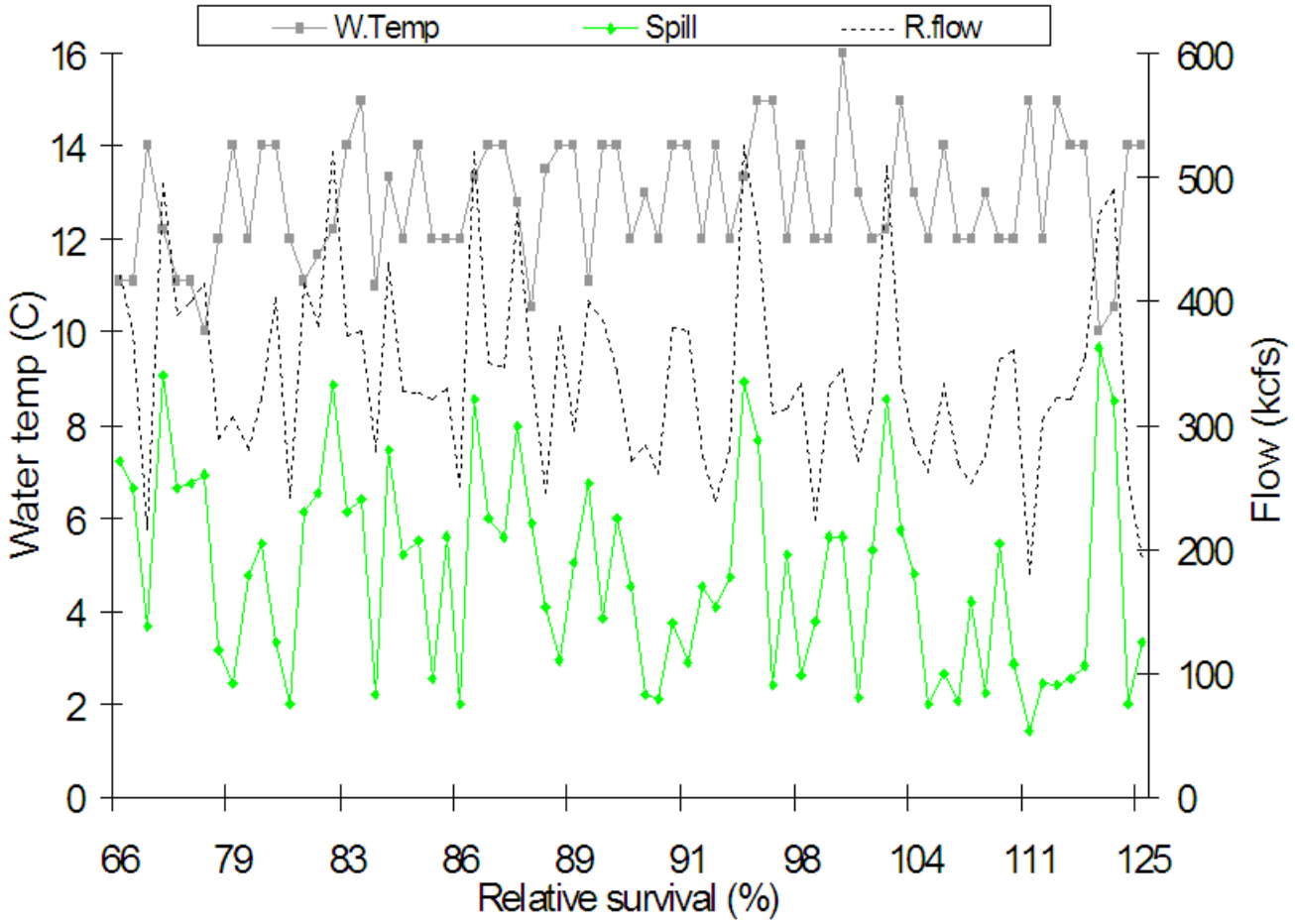

Figure 7a. Relative survival of spring migrating test fish in relation to water temperature, spill volume, and river flow at The Dalles Dam, 1997, 1998, and 1999.

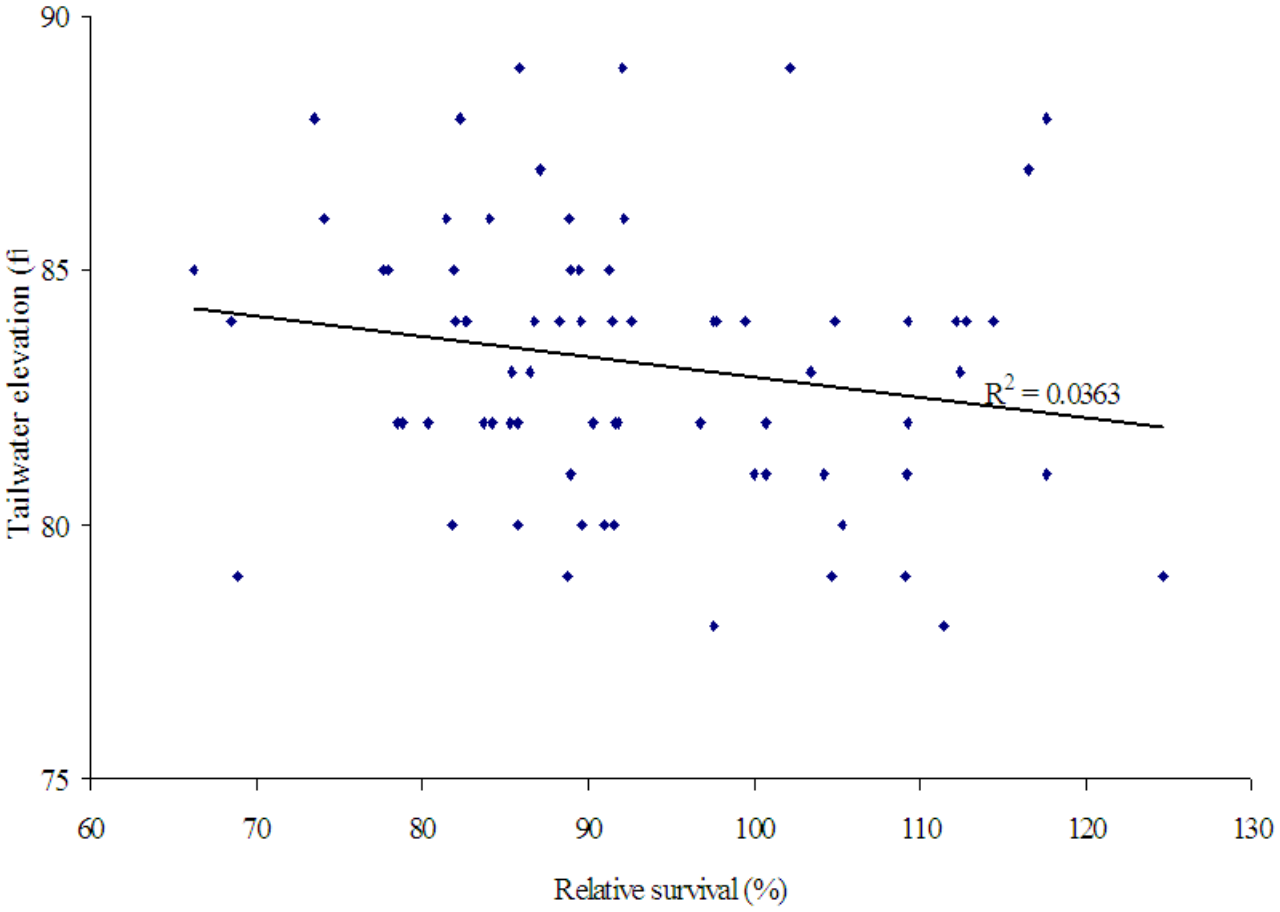

Figure 7b. Relative survival of spring migrating test fish in relation to tailwater elevation at The Dalles Dam, 1997, 1998, and 1999.

Paired *t*-tests were used to compare the natural log of relative survival estimates by PIT-tag detection location and method. These tests indicated a significant difference in relative survival estimates calculated from bypass-system detections at Bonneville Dam First Powerhouse vs. those calculated from bypass-system detections at Bonneville Dam Second Powerhouse (P = 0.02; Appendix Table B5). Comparison of survival estimates calculated from combined detections at Bonneville Dam vs. those calculated from land-based detections at piscivorous bird colonies indicated no significant difference (P = 0.36). We utilized combined data from all recovery sites for all other analyses.

Survival Estimates

Survival at 64% spill for spillway-released (treatment) subyearling chinook salmon was significantly lower than that for tailrace-released (reference) cohorts; whereas survival at 30% spill was not significantly different between treatment and reference fish. The point estimate (unweighted geometric mean for all release periods) of relative survival was 95.9% at 64% spill (CI = 92.3-99.6%), and 99.5% at 30% spill (CI = 94.9-104.3%; Table 3). These point estimates represent passage survival of mixed fish stocks throughout the migration period; during day and night; through spillbays across the width of the spillway; and at ambient spill-gate openings, river flows, tailwater elevations, and water temperatures. Survival at 64% spill was not significantly different (lower) than survival at 30% spill (P = 0.20; Appendix Table B15). Relative survival percentages calculated for daily releases ranged from 80.7 to 121.7%.

The experimental design provided sufficient numbers of test fish to assess probable relative survival differences between spillway (treatment) and tailrace (reference) groups at 30 and 64% spill during summer tests. We examined the data for survival trends or relationships with other controlled and uncontrolled variables; however, the numbers of test fish were not sufficient for these evaluations.

Differences in passage survival between spillway release locations were not significant (P = 0.97; Appendix Table B15). Through the period of testing there appeared to be a trend of decreasing survival at 30% spill but a trend of increasing survival at 64% spill (Fig. 8). Nighttime spillway passage produced higher relative survival than daytime spillway passage (P = 0.02). Mean relative survival was 94.3% for daytime passage and 101.2% for nighttime passage, and these differences were greater at 30% spill than at 64% spill (Appendix Table B15). We saw no strong correlations between relative survival and changes in river flow, spill flow, tailwater elevation, or water temperature (r = 0.27, -0.05, 0.30, and -0.05 respectively; Figs. 9a and 9b).

Test-fish body size at release was evaluated as a variable affecting survival. We examined fork-length distributions of daily release groups separated into two fork-length categories: 110 mm or less and greater than 110 mm. Of the 17,040 fish measured at John Day Dam, 37% were large enough to be radio tagged (>110 mm), while 63% were too small (Fig. 10). Combined detections from Bonneville Dam showed that a significantly higher proportion of larger fish were detected (P = 0.01), as did combined data from the piscivorous bird colonies and the trawl off Jones Beach (P = 0.01; Appendix Table B16).

Table 3. Percent survival by condition, date, and release site for subyearling chinook salmon passing through The Dalles Dam spillway in relation to tailrace released counterparts; summer 1999.

Releases– 166,727 subyearling chinook salmon

Day 30% Spill

Date	North	Middle	South	Average[a]
6/19	106.4	97.5	123.8	109.2
6/25	106.7	103.4	90.3	100.1
6/30	103.0	97.8	89.8	96.9
7/2	111.0	106.6	99.5	105.7
7/8	79.1	81.8	81.2	80.7
7/14	70.4	89.8	88.2	82.8
7/19	81.3	98.3	99.2	92.9
Geometric mean[a]	92.7	239-376	95.2	**94.9**

Night 30% Spill

Date	North	Middle	South	Average[a]
6/19	112.6	118.6	133.9	121.7
6/25	104.4	101.1	103.6	103.0
6/30	128.7	103.1	126.5	119.4
7/2	86.0	98.4	102.3	95.5
7/8	76.1	107.5	83.6	89.0
7/14	123.0	113.2	121.5	119.2
7/19	98.4	97.6	81.0	92.4
Geometric mean[a]	102.6	105.4	105.7	**105.0**

Day & Night 30% Combined

Geometric mean[b]	**99.5**
95% Confidence interval[b]	**94.9-104.3**

Interrogations– 22,953 subyearling chinook salmon

Day 64% Spill

Date	North	Middle	South	Average[a]
6/22	100.5	99.2	103.1	100.9
6/23	100.7	110.1	65.1	92.0
6/27	98.8	105.7	85.8	96.8
7/4	100.8	104.5	85.4	96.9
7/10	93.1	91.9	94.4	93.1
7/11	83.9	85.0	79.4	82.8
7/17	107.3	81.3	111.1	100.0
Geometric mean[a]	97.6	96.3	88.0	**94.5**

Night 64% Spill

Date	North	Middle	South	Average[a]
6/17	111.6	84.3	107.4	101.1
6/23	90.8	101.6	85.0	92.5
6/27	90.9	92.4	115.0	99.4
7/4	93.0	86.2	90.3	89.8
7/11	91.3	89.1	107.0	95.8
7/14	94.0	96.0	109.0	99.6
7/17	107.5	123.4	103.5	111.4
Geometric mean[a]	96.7	95.4	101.9	**98.3**

Day & Night 64% Combined

Geometric mean[b]	**95.9**
95% Confidence interval[b]	**92.3-99.6**

[a] Average is weighted by total fish released on the designated date and Geometric mean is weighted by date.
[b] Mean and confidence interval from ANOVA, Appendix Table B15.
[c] Mean and confidence interval backtransformed from Ln relative survival proportions of individual releases

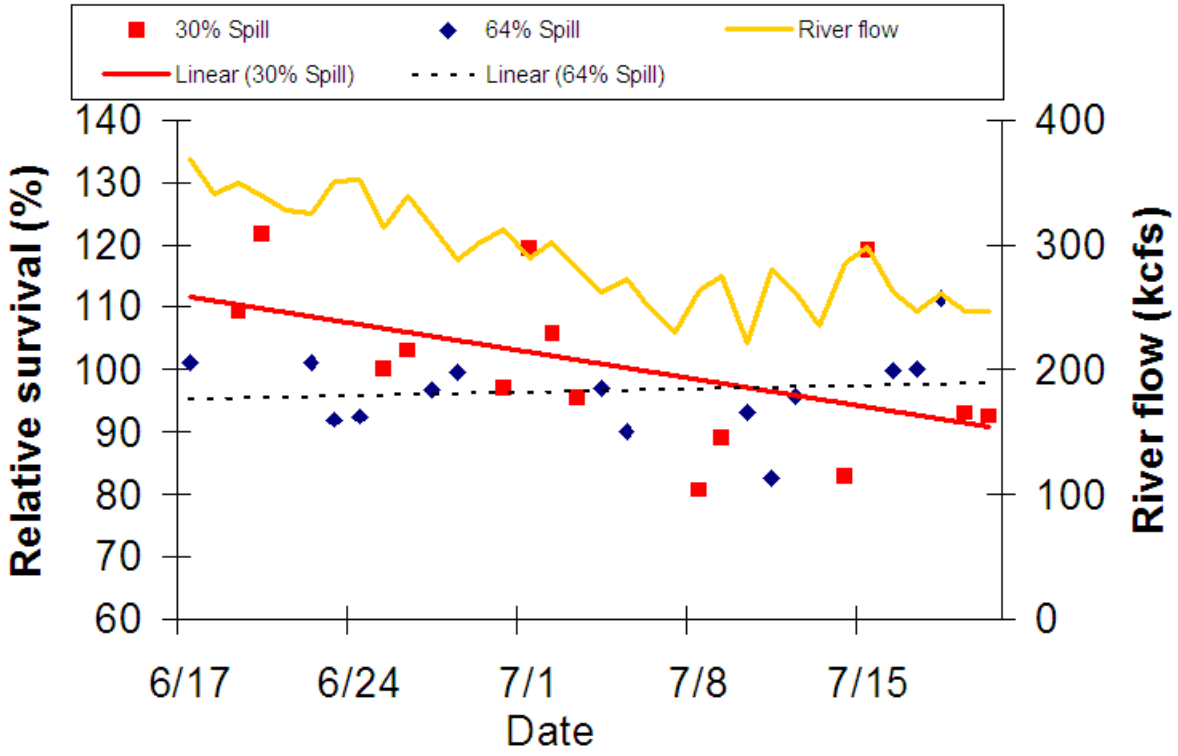

Figure 8. Relative spillway passage survival of subyearling chinook salmon and river flow at The Dalles Dam through the period of testing, 1999.

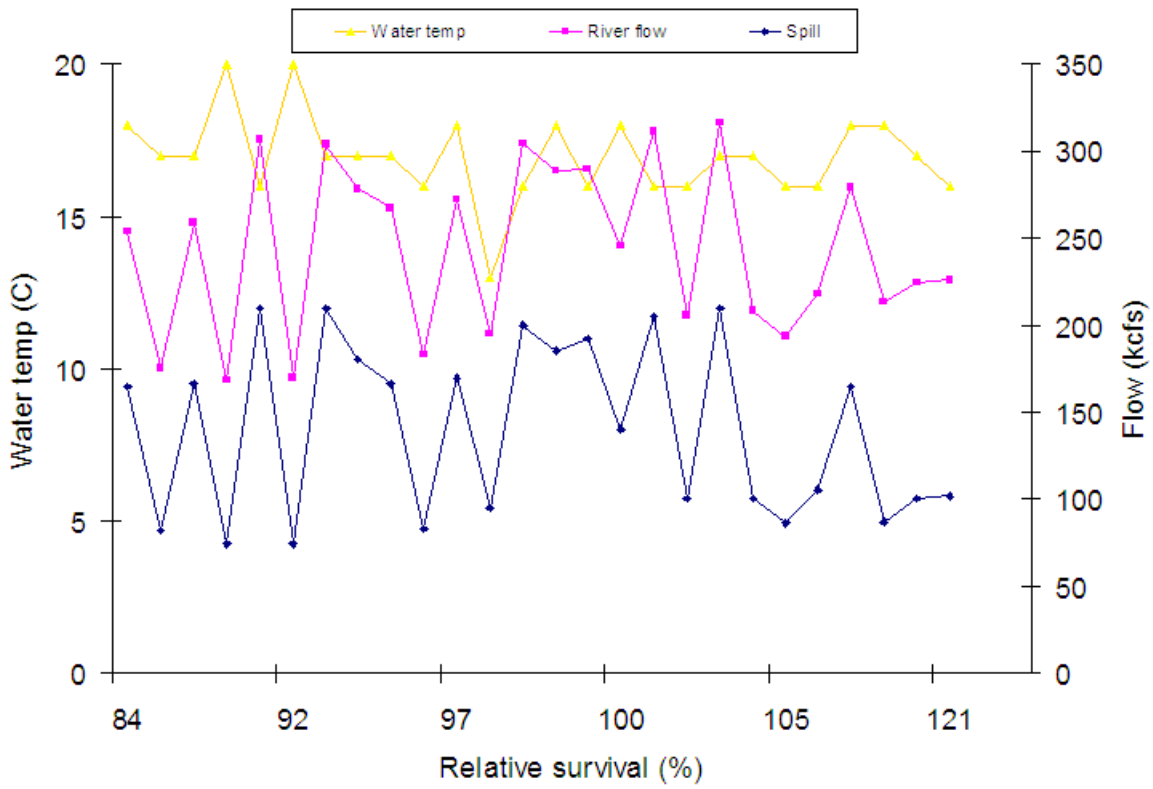

Figure 9a. Relative survival of summer migrating test fish in relation to water temperature, spill volume, and river flow at The Dalles Dam, 1999.

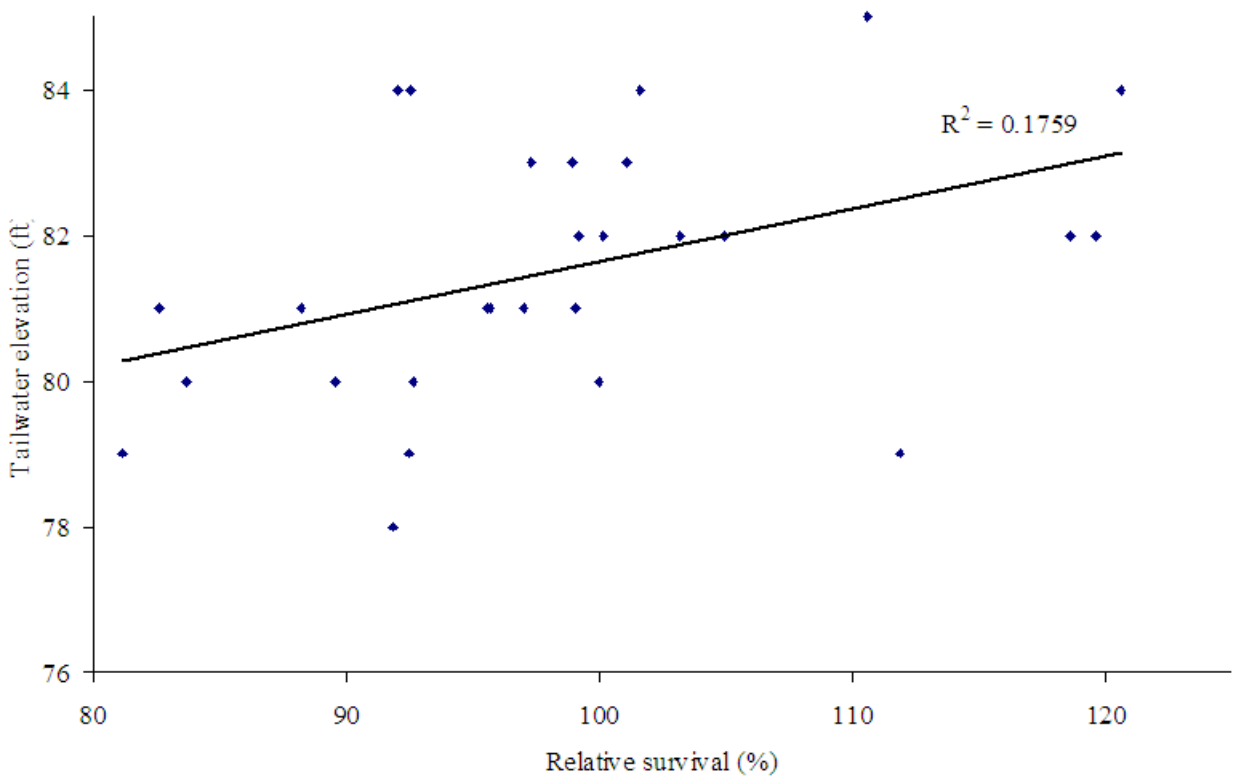

Figure 9b. Relative survival of summer migrating test fish in relation to tailwater elevation at The Dalles Dam, 1999.

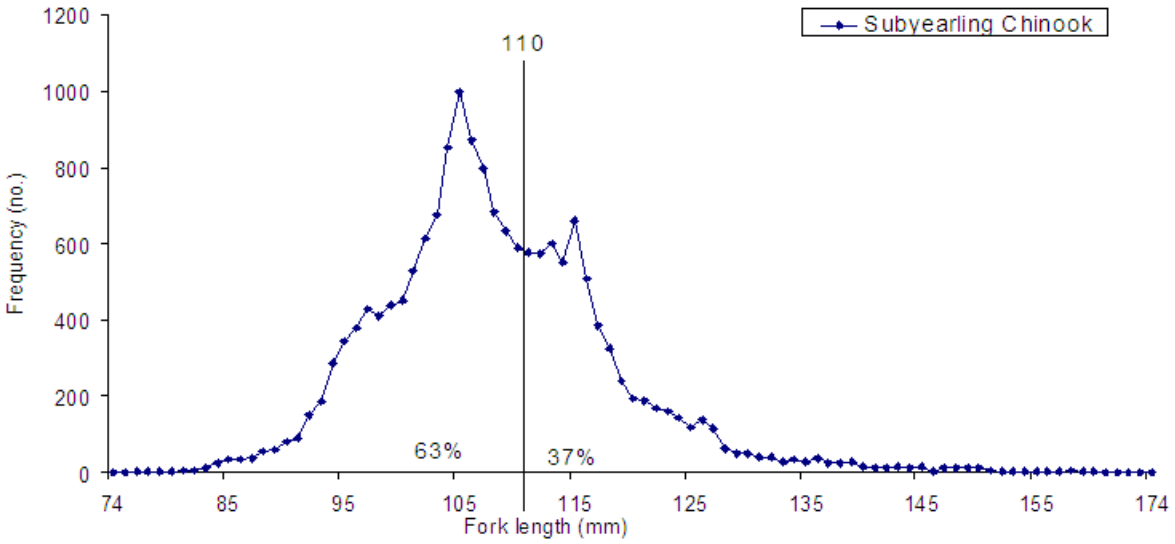

Figure 10. Size distribution of released subyearling chinook salmon with vertical line showing the 110-mm size threshold for radio tagging; The Dalles Dam, summer 1999.

Variability Associated with the Experimental Process

To assess differences in temporal distribution between treatment and reference groups (mixing), we compared travel times over the 75-km reach from the release sites to Bonneville Dam as well as daily detection distributions at Bonneville Dam.

Travel times–The simplest method to evaluate whether mixing occurred among treatment groups was to assess travel time differences between treatment and reference groups released during the same time period.

Bonneville Dam averaged about 1.7 days, with 80% of detections occurring within 1.9 days (Appendix Table B17). Travel times showed a slight increase through the test period (r = 0.55), a period of decreasing river flow (r = -0.64; Fig. 11). Daytime releases averaged 1.7 days to reach Bonneville Dam, and nighttime releases averaged 1.8 days;

(P = 0.00; Appendix Table B17). We have no explanation for the differences in travel time to Bonneville Dam, considering that spillway and tailrace fish exited the tailrace of The Dalles Dam at about the same time, as measured by radiotelemetry data (Theresa Liedtke, U.S. Geological Survey, Columbia River Research Laboratory, 5501A Cook Underwood Rd., Cook, WA 98605, Pers. commun., July 1999).

Temporal detection distributions–We evaluated the homogeneity of passage distributions at Bonneville Dam (PIT-tag detections through time) for corresponding spillway- and tailrace-released groups of subyearling chinook salmon. Using a chi-square test of the homogeneity of passage distributions we found significant differences in temporal distribution between spillway- and tailrace-release groups in 11 of 28 release periods (Appendix Table B5). However, in spite of statistical evidence that the two groups did not mix, passage distributions for both spillway and tailrace groups were quite compact, with spillway groups generally arriving slightly later.

To assess the biological importance of these distribution differences, we compared detections of fish from spillway- vs. tailrace-release groups in relation to powerhouse operation and river flow. For each release period, we calculated hourly fish counts at the first or second powerhouses, and the percentages of powerhouse flow and total river flow/fish at the time of passage for treatment fish vs. reference fish.

We then compared average flow percentages per fish by release period for treatment and reference fish (Appendix Table B18). The data indicated negligible differences in passage conditions between mixed and non-mixed groups. Results showed no difference in total powerhouse flows/fish and an average difference of 0.1% in total river flow/fish between tailrace- and spillway-release groups detected at the first powerhouse. For groups detected at the second powerhouse, we found an average difference of -0.1% in powerhouse flow/fish and -0.1% in total river flow/fish between tailrace- and spillway-release groups.

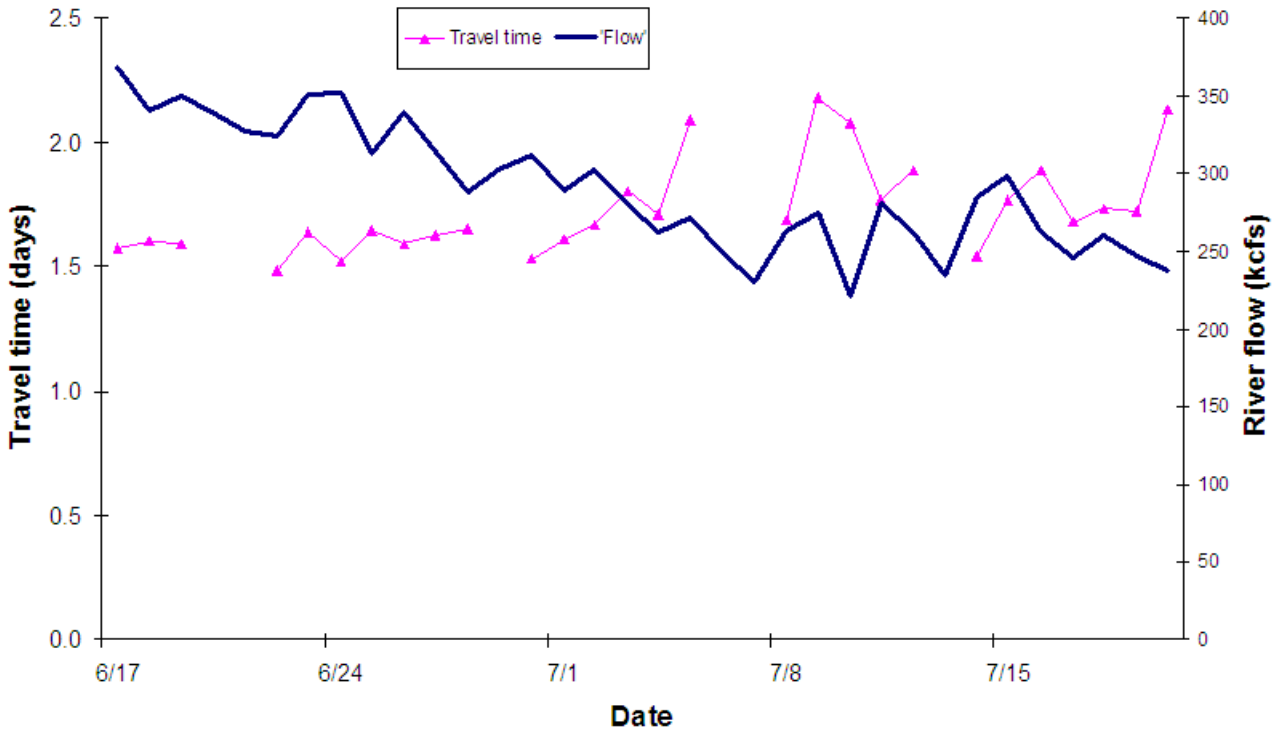

Figure 11. Travel time from The Dalles Dam to Bonneville Dam for daily release groups of summer test fish compared to average river flow, 1999.

Comparison with 1997 and 1998 Results and Trends for Combined Data

Detection site differences–Estimates based on detections at the bird colonies were compromised by low numbers of detections and resultant high variability among daily releases (Appendix Tables B7, B8, B9, and B15). Survival estimates measured at Bonneville Dam First Powerhouse were 3 to 5% lower (significant in two of three years) than estimates measured at Bonneville Dam Second Powerhouse. Estimates at Bonneville Dam (combined) were 5 to 26% lower (significant in two of three years) than at the bird colonies.

In general, estimates at all sites through all years showed greater survival at 30% spill than at 64% spill and greater survival for spillway passage at night with the juvenile spill pattern than during day with the adult spill pattern.

Survival trends–The point estimate for passage survival at 64% spill in 1999 (96%) was higher than those in 1998 and 1997 (75 and 92%, respectively). 1997 and 1998, but a slight increase during 1999 (Fig. 12). The point estimate for passage survival at 30% spill in 1999 was substantially higher than in 1998 (100 and 89%, respectively). In 1999 and 1998, survival at 30% spill decreased through the test period (Fig. 12).

ANOVAs of combined 1997, 1998, and 1999 data indicated significant differences in relative survival between 64 and 30% spill ($P = 0.04$) and between daytime and nighttime releases ($P < 0.01$). Relative survival means were 88.2% at 64% spill and 96.0% at 30% spill. Relative survival means for daytime releases at 64 and 30% spill (84.8 and 87.8%, respectively) were lower ($P = < 0.01$) than for nighttime releases (91.8 and 105.1%, respectively; Appendix Table B10).

Because comparisons between 64 and 30% spill rates were not conducted in 1997, we analyzed the combined data from 1998 and 1999 only. These data indicated significant differences in relative survival between 64 and 30% spill ($P = 0.04$) and between daytime and nighttime releases ($P = 0.02$). Relative survival means were 86.4% at 64% spill and 95.4% at 30% spill. Respective relative survival means at 64 and 30% spill were 83.8 and 87.2% for daytime releases and 89.1 and 104.4% for nighttime releases (Appendix Table B11).

Travel times–Travel times to Bonneville Dam for groups of tailrace-released subyearling chinook salmon were slightly less than those of their spillway-released cohorts in all three years, with differences of 0.3, 0.1, and 0.1 days in 1997, 1998, and 1999, respectively (Appendix Table B17).

Uncontrolled variables–Evaluations of relative survival estimates for subyearling chinook summer migrants showed poor correlation with the following individual dependent variables: water temperature, spill flow, river flow, and tailwater elevation ($r = -0.49$, 0.08, 0.44, and 0.44 respectively; Figs. 13a and 13b). Linear regressions of dependent variables including Julian date provided poor predictive capability, whether analyses were based on individual or multiple years (e.g., for 1997-1999 combined data, $R^2 = 0.32$; Appendix Table B19).

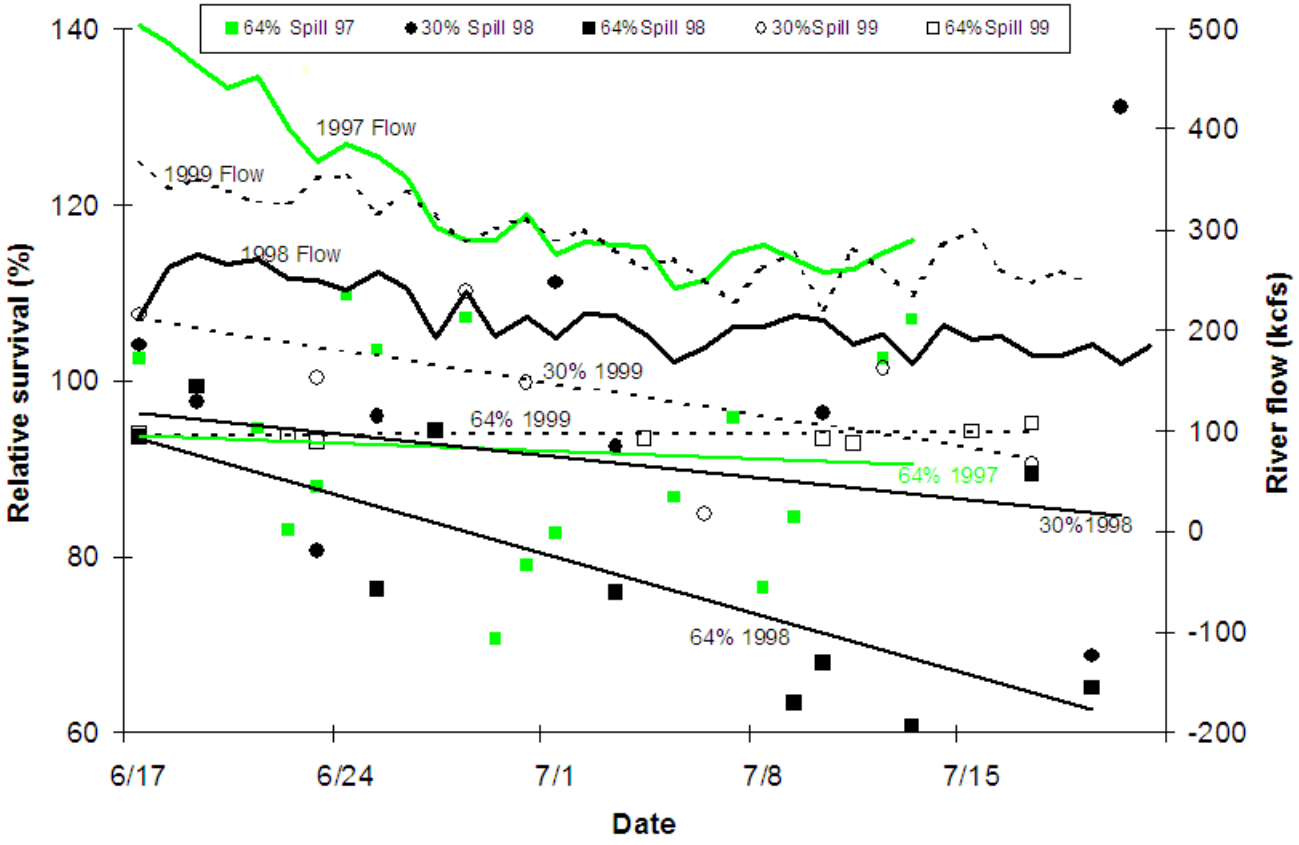

Figure 12. Relative spillway passage survival of subyearling chinook salmon at The Dalles Dam through the period of testing, 1997, 1998, and 1999.

Powerhouse operations–Examination of the data on powerhouse operations for each of the three years of study showed that differences during passage at Bonneville Dam appeared to be minor, with no discernable trends for either tailrace- or spillway-released fish groups. Variation in average flows per fish appeared to be random in both direction and magnitude at both Bonneville Dam powerhouses for all daily release groups (Appendix Tables B13, B14, and B18).

Upstream gull colonies–Land-based PIT-tag surveys of the gull colonies upstream from The Dalles Dam (Little Memaloose and Little Miller Islands) detected approximately 0.05% of all tags from summer migrants released in 1997 and 1998 and 0.06% of all tags from summer migrants released in 1999. It is interesting to note that of the records from these islands, tags from spillway-released (treatment) fish comprised 90% of the detections in all three years (Brad Ryan, NMFS, P.O. Box 155, Hammond, OR 97121, Pers. commun., February 2000). The total proportion of tags detected at these colonies was minimal, and the proportion that may have been dropped at other locations is unknown.

DISCUSSION

We found that average survival estimates differed in relation to whether detections from Bonneville Dam, Jones Beach, or the piscivorous bird colonies were used in the analyses. These differences were not surprising because Bonneville Dam, the Jones Beach pair-trawl, and bird colonies on estuarine islands each utilized different sample mechanisms (guidance screen, towed trawl net, and bird feeding behavior) and each was subject to sampling bias associated with that mechanism.

We speculate that differences in detection probabilities between the two powerhouses at Bonneville Dam could be related to poor spatial mixing of reference and treatment fish groups, with fish staying oriented to the side of the river on which they were released. For example, survival estimates would be higher at the first powerhouse and lower at the second powerhouse if treatment-fish detections were more likely at the first powerhouse and reference-fish detections were more likely at the second powerhouse. This pattern was in fact observed in spring but not in summer tests in 1999 (or in all three years).

Additional differences in detection-rate probabilities between treatment and reference groups may have been related to diel changes in test-fish depth distribution at Bonneville Dam coupled with arrival time differences. Survival estimates based on PIT-tag detections from bird colonies in particular are influenced by whether the treatment and reference groups were completely mixed (pass the islands at the same time and at the same depth) and by hourly variation in the foraging behavior of avian predators.

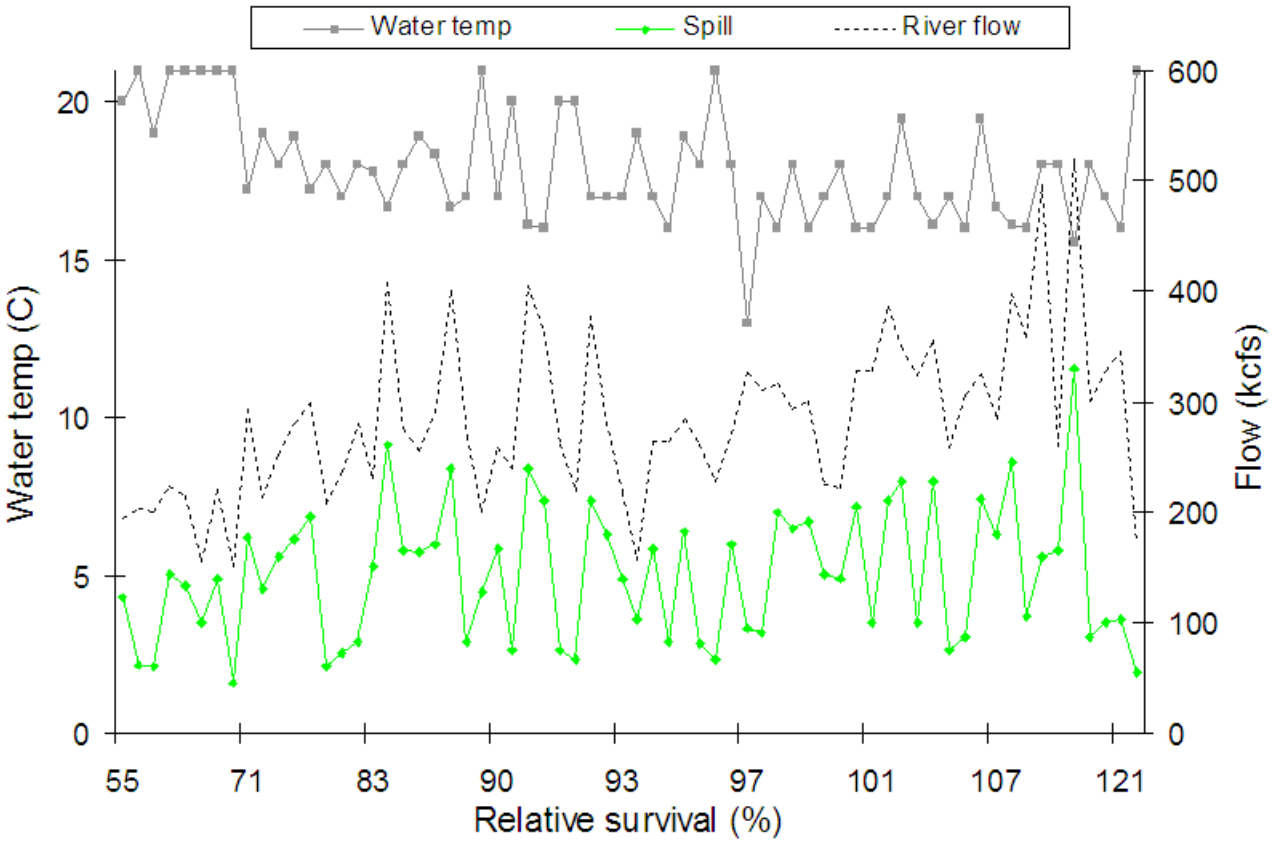

Figure 13a. Relative survival of summer migrating test fish in relation to water temperature, spill volume, and river flow at The Dalles Dam; 1997, 1998, and 1999.

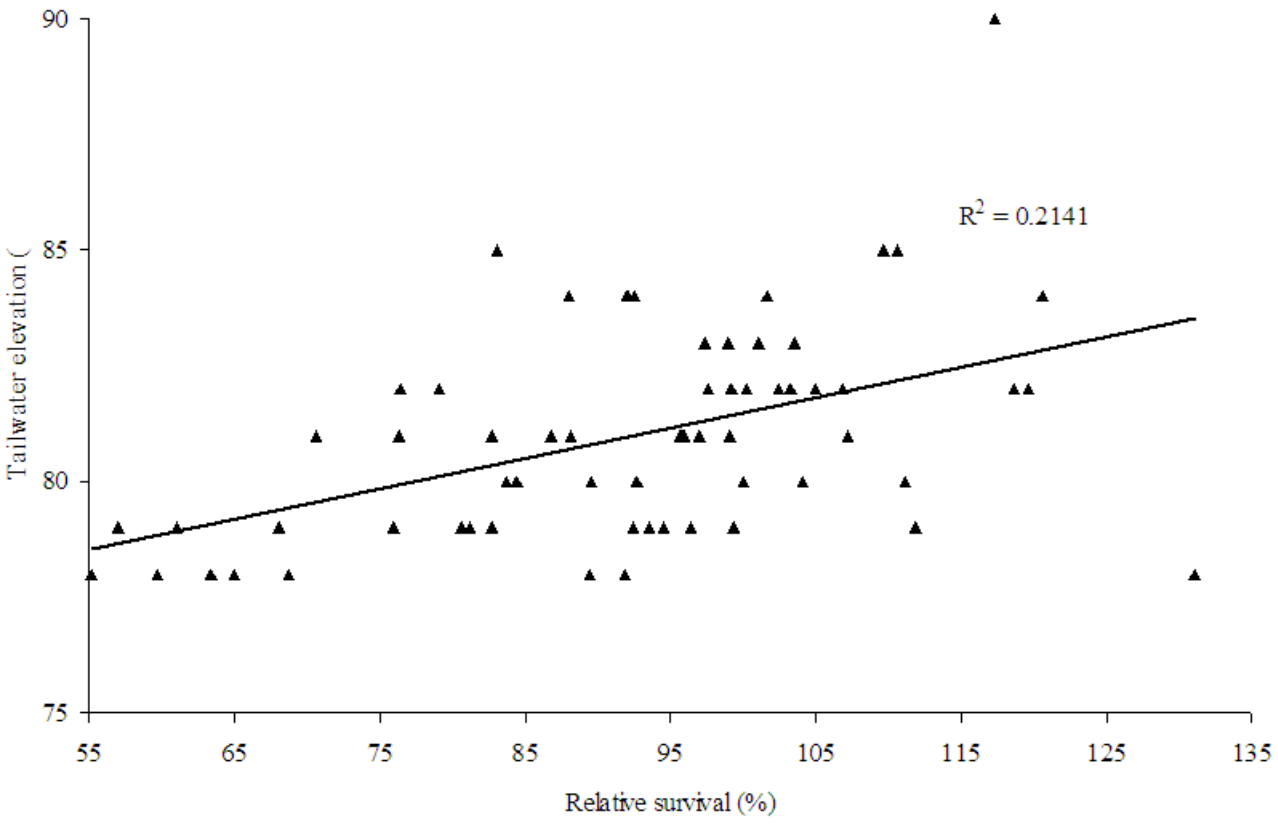

Figure 13b. Relative survival of summer migrating test fish in relation to tailwater elevation at The Dalles Dam, 1997, 1998, and 1999.

In summary, survival estimates based on detections at Bonneville Dam were generally lower than those based on detections at other sites. However, in estimates based on recoveries at all sites, comparisons between 30 and 64% spill and between day and night releases generally trended in the same direction, with detections of fish released at 30% spill and during nighttime hours consistently producing the highest relative survival estimates.

Based on our initial evaluation of the data on powerhouse operations, defined in terms of the ratios between average river flow per fish and average powerhouse flow per fish, we believe that hourly powerhouse operations at Bonneville Dam had no systematic affect on our estimates. Variations in these ratios were minor, with no notable trends within or among the three years; thus we concluded that valid estimates could be derived using combined data from all detection sites. During the study period for all three years, spring flows ranged from 5,549 to 15,763 m^3/second (196,000 to 557,000 ft^3/second) and summer flows ranged from 4,726 to 14,235 m^3/second (167,000 to 503,000 ft^3/second).

The passage survival results related to operations at The Dalles Dam were as follows:

1) Detection rates of fish passing through the spillway at 64% spill were significantly less than those of their cohorts released downstream from the dam (Table 4).

2) In the two years of direct comparison, point estimates for relative survival of fish passing at 64% spill were lower (but not significantly different) than those of fish passing at 30% spill. When annual data from 1998 and 1999 were combined for analysis, differences between spill rates were significant for spring migrants ($P = 0.05$) and for summer migrants ($P = 0.04$). Respective point estimates for passage survival at 64 and 30% spill were 92.0 and 98.0% for spring migrants and 86.4 and 95.4% for summer migrants.

3) Analyses from three years of data show that spillway passage during daytime hours (adult spill patterns) produced lower survival estimates than spillway passage during nighttime hours (juvenile spill patterns), with daytime/nighttime survival estimates of 90.2 vs. 96.7% ($P = 0.04$) for spring migrants and 86.3 vs. 98.2% ($P = < 0.01$) for summer migrants.

4) Comparisons from two years of data indicate that survival estimates for juvenile salmon passing the spillway at The Dalles Dam under 64% spill are lower than estimates for juvenile spillway passage at other dams, and are similar to or lower than survival estimates for turbine passage (NMFS 2000).

5) Data from one year of testing (1998) showed that relative survival estimates for daytime fish passage through the sluiceway were similar to those of daytime fish passage through the spillway at 30% spill.

6) For both spring and summer migrants, evaluations of relative survival in relation to tailwater elevation, spill volume, river flow, and water temperature indicated poor correlations.

Table 4. River flow and point estimates with 95% confidence intervals for relative passage survival of juvenile salmon at The Dalles Dam, 1997, 1998, and 1999.

	River flow (kcfs)		64% Spill	30% Spill	
Year	Median	Range	Spillway survival, % (95% CI)	Spillway survival, % (95% CI)	Sluiceway survival, % (95% CI)
Spring migration (coho or chinook and coho salmon)					
1997	455	379-557	87 (80-94)		
1998	347	196-445	89 (82-95)	97 (88-107)	96 (87 -105)
1999	273	239-376	93 (90 -97)	96 (92-101)	
Summer migration (subyearling chinook salmon)					
1997	301	213-503	92 (86-99)		
1998	212	167-279	75 (68-83)	89 (80-99)	89 (81-98)
1999	300	221-369	96 (92 -100)	100 (95-104)	

RECOMMENDATIONS

The following are recommendations for research in 2000:

1) Evaluate a single, constant spill rate at less than 64% with juvenile spill patterns during 24 hours/day and include sluiceway- and turbine-passage survival. Maximum fish numbers should be used to obtain the highest possible statistical sensitivity.

2) Continue evaluations that include detection data from PIT tags deposited in estuarine and lower-river bird colonies to provide increased detection numbers.

3) Continue assessment of differences between detection sites and evaluate combined data from 1997, 1998, 1999, and future years.

4) Minimize operations of the sluice chute at Bonneville Dam Second Powerhouse to maximize the PIT-tags detected at Bonneville Dam.

ACKNOWLEDGMENTS

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APPENDIX A

Release Numbers, Dates, Times, Locations, and Conditions for Yearling Chinook and Coho Salmon and Subyearling Chinook Salmon at The Dalles Dam in 1999

Appendix Table A1. Times and conditions during daylight releases of yearling chinook and coho salmon at The Dalles Dam, spring 1999.

Date	4/23	4/27	4/29	4/30	5/2	5/5	5/8	5/9	5/12
Start time	11:10	11:20	11:40	10:12	10:30	11:21	11:50	11:00	11:05
End time	12:45	12:55	13:19	11:35	11:50	13:20	12:40	11:50	11:50
Med. time	11:57	12:07	12:29	10:53	11:10	12:20	12:15	11:25	11:27
Turbine low[a]	110	176	88	94	218	125	160	171	97
Turbine high[a]	118	203	105	98	220	126	161	181	98
Turbine mean[a]	114	190	97	96	219	126	160	176	98
Spill low[a]	210	75	166	178	96	195	75	76	170
Spill high[a]	210	90	188	178	96	195	75	81	170
Spill mean[a]	210	83	177	178	96	195	75	79	170
Spill %[b]	64	30	63	64	30	60	31	30	62
Temp. C[c]	12	11	12	12	12	12	12	12	12
Elev. forebay[d]	158	158	158	158	158	158	158	158	158
Elev. tailwater[d]	82	82	82	82	83	82	80	80	80

Date[a]	5/15	5/18	5/20	5/24	5/26	5/27	5/29
Start time	10:20	10:35	10:31	10:45	10:45	10:32	10:55
End time	11:05	11:26	11:18	11:55	11:40	11:20	11:42
Med. time	10:42	11:00	10:54	11:20	11:12	10:56	11:18
Turbine low[a]	154	92	186	86	230	231	129
Turbine high[a]	186	99	203	86	230	237	131
Turbine mean[a]	170	95	195	86	230	234	130
Spill low[a]	69	160	78	154	98	145	210
Spill high[a]	80	178	87	154	98	145	210
Spill mean[a]	75	169	83	154	98	145	210
Spill % [b]	30	62	29	63	29	38	61
Temp. C[c]	12	12	13	13.5	14	14	14
Elev. forebay[d]	158	158	158	158	158	158	157
Elev. tailwater[d]	80	80	82	79	84	85	84

[a] Thousand cubic feet per second (kcfs); English units by COE convention.

[b] Percent of river flow in kcfs.

[c] Temperature during holding.

[d] Units in feet; English units by COE convention.

Appendix Table A2. Times and conditions during nighttime releases of yearling chinook and coho salmon at The Dalles Dam, spring 1999.

Date[a]	4/21	4/23	4/27	4/30	5/2	5/5	5/6	5/9	5/12
Start time	0:03	22:00	22:25	22:00	22:30	22:15	22:00	22:50	22:30
End time	2:25	23:00	0:35	23:35	23:00	23:25	23:10	23:40	23:20
Med. time	1:14	22:30	11:30	22:47	22:45	22:50	22:35	23:15	22:55
Turbine low[b]	123.2	115.4	201.5	112.1	245.4	111.9	126	183.4	68.7
Turbine high[b]	205.1	115.6	211.7	113.8	247.3	113.4	156.9	183.4	83.3
Turbine mean[b]	164	116	207	113	246	113	141	183	76
Spill low[b]	87	210	87	200	108	195	200	78	128
Spill high[b]	150	210	96	200	108	195	210	78	155
Spill mean[b]	119	210	92	200	108	195	205	78	142
Spill %[c]	38	63	30	63	30	62	58	29	63
Temp. C[d]	12	12	12	12	12	12	12	12	12
Elev. forebay[e]	158	159	156	159	158	159	158	158	157
Elev. tailwater[e]	81	84	84	82	84	82	82	80	78

Date[a]	5/13	5/18	5/20	5/21	5/22	5/27	5/29
Start time	22:45	22:25	22:20	22:40	22:40	22:35	22:20
End time	23:45	23:15	23:15	23:30	23:30	23:30	23:10
Med. time	23:15	22:50	22:47	23:05	23:05	23:02	22:45
Turbine low[b]	175	88.8	181.2	183.7	100.5	236.4	128.3
Turbine high[b]	188	91.5	187.9	185.6	100.6	249.8	130.1
Turbine mean[b]	181	90	185	185	101	243	129
Spill low[b]	75	155	84	80	180	104	210
Spill high[b]	75	160	84	80	180	110	210
Spill mean[b]	75	158	84	80	180	107	210
Spill %[c]	29	62	31	30	63	30	61
Temp. C[d]	12	12	13	13	13	14	16
Elev. forebay[e]	159	158	159	159	159	158	158
Elev. tailwater[e]	79	79	81	81	81	84	84

[a] Releases may have occurred partially or entirely during early morning hours of next day.

[b] Thousand cubic feet per second (kcfs); English units by COE convention.

[c] Spill as percent of river flow.

[d] Temperature during holding.

[e] Units in feet; English units by COE convention.

Appendix Table A3. Times and conditions during daylight releases of subyearling chinook salmon at The Dalles Dam, summer 1999.

Date	6/19	6/22	6/23	6/25	6/27	6/30	7/2	7/4	7/8
Start time	10:45	11:43	11:11	10:45	10:51	10:50	10:53	10:55	10:50
End time	11:40	12:31	12:00	11:35	11:40	11:40	11:40	11:45	11:36
Med. time	11:12	12:07	11:35	11:10	11:15	11:15	11:16	11:20	11:13
Turbine low[a]	246	117.5	142.6	219.1	109.8	224	213.2	92.4	159
Turbine high[a]	247	118.5	151.6	223.4	111.5	226.7	213.8	93.7	159
Turbine mean[a]	247	118	147	221	111	225	214	92	159
Spill low[a]	105	205	210	100	200	95	82	166	72
Spill high[a]	105	205	210	100	200	95	90	166	72
Spill mean[a]	105	205	210	100	200	95	86	166	72
Spill % [b]	29	62	58	31	63	29	28	63	30
Temp.(°C)[c]	16	16	16	16	16	13	16	17	17
Elev. forebay[d]	158	159	159	158	158	158	156	156	158
Elev. tailwater[d]	85	82	84	83	83	83	82	81	79

Date[a]	7/10	7/11	7/14	7/17	7/19
Start time	10:17	10:30	10:35	10:45	10:47
End time	11:20	11:15	11:20	11:35	11:30
Med. time	10:48	10:52	10:57	11:10	11:08
Turbine low[b]	96	102	191.3	73.2	160
Turbine high[b]	96.4	107	193.2	79.3	160
Turbine mean[b]	96	105	192	76	160
Spill low[b]	180	162	83	140	74
Spill high[b]	180	168	83	140	74
Spill mean[b]	180	165	83	140	74
Spill (%)[c]	64	60	29	63	31
Temp. (°C)[d]	17	18	18	18	20
Elev. forebay[e]	157	157	156	158	156
Elev. tailwater[e]	80	80	81	80	78

a Thousand cubic feet per second (kcfs); English units by COE convention.

b Spill as percent of river flow.

c Temperature during holding.

d Units in feet; English units by COE convention.

Appendix Table A4. Times and conditions during nighttime releases of subyearling chinook salmon at The Dalles Dam, summer 1999.

Date[a]	6/17	6/19	6/23	6/25	6/27	6/30	7/2	7/4	7/8
Start time	22:55	22:25	22:30	22:23	22:27	22:41	22:30	22:25	22:25
End time	23:45	23:15	23:25	23:20	23:15	23:30	23:10	23:15	23:15
Med. time	23:20	22:50	22:57	22:51	22:51	23:05	22:50	22:50	22:50
Turbine low[b]	160.7	232.1	149.7	218	99.8	204.1	166	84.7	178.2
Turbine high[b]	178.9	242.3	173.6	218	105.6	237.6	185.5	88.2	182.7
Turbine mean[b]	170	237	162	218	103	221	176	86	180
Spill low[b]	210	102	210	100	192	100	75	166	82
Spill high[b]	210	102	210	100	192	100	90	166	82
Spill mean[b]	210	102	210	100	192	100	83	166	82
Spill (%)[c]	54	30	56	31	64	31	31	64	31
Temp. (°C)[d]	17	16	17	17	16	17	16	17	17
Elev. forebay[e]	159	158	158	159	158	158	157	157	157
Elev. tailwater[e]	84	84	84	82	82	82	81	80	81

Date[a]	7/11	7/14	7/15	7/17	7/19
Start time	22:05	22:45	22:30	22:20	22:35
End time	22:50	23:30	23:15	23:05	23:25
Med. time	22:27	23:07	22:52	22:42	23:00
Turbine low[b]	93.5	205.3	97.8	86.7	176.5
Turbine high[b]	97.9	210.2	104.1	89.7	184.6
Turbine mean[b]	96	208	101	88	181
Spill low[b]	160	87	185	165	74
Spill high[b]	180	87	185	165	74
Spill mean[b]	170	87	185	165	74
Spill (%)[c]	63	29	63	64	28
Temp. (°C)[d]	18	18	18	18	20
Elev. forebay[e]	157	157	156	157	156
Elev. tailwater[e]	81	82	81	79	79

[a] Releases may have occurred partially or entirely during early morning hours of next day.

[b] Thousand cubic feet per second (kcfs); English units by COE convention.

[c] Spill as percent of river flow.

[d] Temperature during holding.

[e] Units in feet; English units by COE convention.

Appendix Table A5. Detection numbers, and survival percentages for chinook and coho salmon at each site, separated by passage condition at release; spring 1999.

Daytime 30% Spill Condition																	
Tailrace																	
			Bonneville 1			Bonneville 2			Jones Beach			Bird colonies			Total*		
Tag date	Rel. date	Rel. no.	Det.	Prop.	Ave Prop.	Det.	P rop.	Ave Prop.	Det.	P rop.	Ave Prop.	Det.	P rop.	Ave Prop.	Det.	Prop.	Ave Prop.
4/25	4/27	155	2	0.013		26	0.168		3	0.019		2	0.013		33	0.213	
		525	24	0.046		58	0.110		11	0.021		24	0.046		112	0.213	
		593	23	0.039	0.038	75	0.126	0.125	15	0.025	0.023	13	0.022	0.031	121	0.204	0.209
4/30	5/2	820	33	0.040		137	0.167		13	0.016		21	0.026		198	0.241	
		607	29	0.048		82	0.135		7	0.012		12	0.020		126	0.208	
		597	34	0.057	0.047	102	0.171	0.159	7	0.012	0.013	12	0.020	0.022	148	0.248	0.233
5/6	5/8	811	27	0.033		106	0.131		24	0.030		23	0.028		166	0.205	
		809	32	0.040		111	0.137		18	0.022		16	0.020		171	0.211	
		817	30	0.037	0.037	82	0.100	0.123	20	0.024	0.025	27	0.033	0.027	153	0.187	0.201
5/7	5/9	799	25	0.031		120	0.150		14	0.018		25	0.031		179	0.224	
		814	28	0.034		116	0.143		15	0.018		22	0.027		174	0.214	
		821	20	0.024	0.030	118	0.144	0.145	22	0.027	0.021	23	0.028	0.029	176	0.214	0.217
5/13	5/15	744	27	0.036		111	0.149		14	0.019		22	0.030		163	0.219	
		740	19	0.026		116	0.157		6	0.008		22	0.030		157	0.212	
		689	23	0.033	0.032	90	0.131	0.146	9	0.013	0.013	22	0.032	0.030	138	0.200	0.211
5/18	5/20	774	21	0.027		165	0.213		19	0.025		10	0.013		208	0.269	
		776	23	0.030		163	0.210		19	0.024		15	0.019		209	0.269	
		777	24	0.031	0.029	149	0.192	0.205	19	0.024	0.024	10	0.013	0.015	195	0.251	0.263
5/24	5/26	762	24	0.031		123	0.161		17	0.022		17	0.022		175	0.230	
		766	21	0.027		129	0.168		11	0.014		11	0.014		167	0.218	
		781	36	0.046	0.035	121	0.155	0.162	12	0.015	0.017	19	0.024	0.020	184	0.236	0.228
5/25	5/27	768	40	0.052		98	0.128		2	0.003		23	0.030		159	0.207	
		766	42	0.055		107	0.140		0	---		37	0.048		175	0.228	
		760	25	0.033	0.047	102	0.134	0.134	2	0.003	0.002	25	0.033	0.037	143	0.188	0.208
Total/GeoMean		17,271	632	0.035	0.036	2,607	0.148	0.148	299	0.016	0.014	453	0.024	0.026	3,830	0.220	0.221

Appendix Table A5. Continued.

								Daytime 30% Spill Condition										
								Spillway										
					Bonneville 1			Bonneville 2			Jones Beach			Bird colonies			Total*	
Tag	Rel.	Loc.	Rel.		Relative	Ave		Relative	Ave		Relative	Ave		Relative	Ave		Relative	Ave
date	date	N, M, S	no.	Det.	%Surv	%Surv	Det.	%Surv	%Surv	Det.	%Surv	%Surv	Det.	%Surv	%Surv	Det.	%Surv	%Surv
4/25	4/27	S	598	25	108.6		66	88.4		9	66.1		22	120.1		118	94.4	
		M	600	18	77.9		51	68.1		15	109.7		20	108.8		97	77.4	
		N	158	2	32.9	86.2	13	65.9	76.8	2	55.6	84.2	3	62.0	108.3	20	60.6	82.9
4/30	5/2	N	606	27	93.9		76	79.1		6	74.2		18	133.6		123	87.0	
		M	821	32	82.2		108	82.9		11	100.4		24	131.5		167	87.2	
		S	594	20	71.0	82.4	70	74.3	79.2	5	63.1	81.6	20	151.4	138.0	108	78.0	84.4
5/6	5/8	S	817	28	93.8		58	57.9		15	72.2		23	103.9		119	72.4	
		M	816	24	80.5		76	75.9		17	81.9		23	104.1		134	81.7	
		N	815	35	117.6	97.3	90	90.0	74.6	18	86.8	80.3	17	77.0	95.0	155	94.6	82.9
5/7	5/9	S	811	18	74.0		94	79.7		14	82.4		21	90.0		139	78.9	
		N	815	19	77.7		101	85.2		13	76.1		28	119.5		157	88.6	
		M	809	20	82.4	78.1	115	97.7	87.5	19	112.1	90.2	37	159.0	122.8	175	99.5	89.0
5/13	5/15	M	740	23	97.9		83	76.9		11	111.4		13	57.8		126	80.8	
		S	736	21	89.9		80	74.5		11	112.0		25	111.8		129	83.2	
		N	746	22	92.9	93.5	100	91.9	81.1	9	90.4	104.5	24	105.9	91.9	148	94.1	86.1
5/18	5/20	M	778	23	1,01.2		140	87.8		23	120.7		11	94.0		192	93.8	
		S	779	18	79.1		137	85.8		14	73.4		11	93.9		174	84.9	
		N	777	17	74.9	85.0	155	97.3	90.3	15	78.8	91.0	13	111.2	99.7	194	94.9	91.2
5/24	5/26	S	766	30	1,11.6		99	80.0		14	105.5		16	102.6		156	89.4	
		M	769	39	1,44.6		119	95.8		10	75.1		18	115.0		183	104.5	
		N	767	23	85.5	113.9	122	98.5	91.4	10	75.3	85.3	26	166.5	128.0	175	100.2	98.0
5/25	5/27	N	756	41	1,16.3		110	108.7		3	227.6		21	75.0		168	106.9	
		M	774	38	1,05.3		113	109.1		3	222.3		40	139.5		182	113.1	
		S	774	50	1,38.5	120.0	128	123.6	1,13.8	6	444.6	298.7	25	87.2	100.7	202	125.5	115.2
Total/GeoMean			17,422	613	89.7	93.6	2,304	85.2	86.1	273	98.6	102.3	499	105.6	109.5	3,541	89.5	90.7

Appendix Table A5. Continued.

Nighttime 30% Spill Condition																	
Tailrace																	
			Bonneville 1			Bonneville 2			Jones Beach			Bird colonies			Total*		
Tag date	Rel. date	Rel. no.	Det.	Prop.	Ave Prop.	Det.	P rop.	Ave Prop.	Det.	P rop.	Ave Prop.	Det.	P rop.	Ave P rop.	Det.	Prop.	Ave Prop.
4/20	4/21	691	24	0.035		125	0.181			---		24	0.035		166	0.240	
		616	21	0.034		104	0.169		1	0.002		24	0.039		140	0.227	
		611	15	0.025	0.031	110	0.180	0.177	1	0.002	0.001	24	0.039	0.038	144	0.236	0.235
4/26	4/27	568	16	0.028		31	0.055		4	0.007		17	0.030		68	0.120	
		795	24	0.030		59	0.074		10	0.013		26	0.033		117	0.147	
		797	18	0.023	0.027	66	0.083	0.072	14	0.018	0.013	21	0.026	0.030	116	0.146	0.139
5/1	5/2	597	21	0.035		40	0.067		6	0.010		11	0.018		74	0.124	
		599	22	0.037		42	0.070		10	0.017		4	0.007		78	0.130	
		319	14	0.044	0.038	34	0.107	0.077	3	0.009	0.013	5	0.016	0.013	56	0.176	0.137
5/8	5/9	813	38	0.047		53	0.065		20	0.025		30	0.037		131	0.161	
		819	28	0.034		46	0.056		12	0.015		20	0.024		102	0.125	
		813	34	0.042	0.041	39	0.048	0.056	11	0.014	0.018	20	0.025	0.029	102	0.125	0.137
5/12	5/13	747	32	0.043		55	0.074		12	0.016		16	0.021		111	0.149	
		695	31	0.045		49	0.071		14	0.020		12	0.017		104	0.150	
		744	37	0.050	0.046	53	0.071	0.072	13	0.017	0.018	20	0.027	0.022	120	0.161	0.153
5/19	5/20	795	33	0.042		61	0.077		23	0.029		16	0.020		131	0.165	
		798	30	0.038		52	0.065		22	0.028		12	0.015		111	0.139	
		787	39	0.050	0.043	35	0.044	0.062	26	0.033	0.030	17	0.022	0.019	113	0.144	0.149
5/20	5/21	795	43	0.054		80	0.101		18	0.023		16	0.020		150	0.189	
		798	31	0.039		64	0.080		16	0.020		29	0.036		134	0.168	
		793	42	0.053	0.049	65	0.082	0.088	15	0.019	0.021	21	0.026	0.028	137	0.173	0.176
5/26	5/27	797	33	0.041		117	0.147		19	0.024		27	0.034		176	0.221	
		789	40	0.051		123	0.156		12	0.015		14	0.018		186	0.236	
		790	51	0.065	0.052	124	0.157	0.153	25	0.032	0.024	12	0.015	0.022	201	0.254	0.237
Total/GeoMean		17,366	717	0.040	0.040	1,627	0.087	0.087	307	0.014	0.013	438	0.023	0.024	2,968	0.166	0.166
30%Total/GeoMean		34,637	1,349	0.037	0.038	4,234	0.113	0.113	606	0.015	0.014	891	0.024	0.025	6,798	0.191	0.192

Appendix Table A5. Continued.

								Nighttime 30% Spill Condition										
								Spillway										
					Bonneville 1			Bonneville 2			Jones Beach			Bird colonies			Total*	
Tag	Rel.	Loc.	Rel.		Relative	Ave		Relative	Ave		Relative	Ave		Relative	Ave		Relative	Ave
date	date	N, M, S	no.	Det.	%Surv	%Surv	Det.	%Surv	%Surv	Det.	%Surv	%Surv	Det.	%Surv	%Surv	Det.	%Surv	%Surv
4/20	4/21	N	665	17	81.7		118	100.4		1	144.2		25	100.1		155	99.3	
		M	680	25	117.5		102	84.9		1	141.0		28	100.7		155	97.2	
		S	599	12	64.0	88.8	104	98.2	94.3	2	320.2	197.3	34	151.2	119.2	145	100.3	99.8
4/26	4/27	N	798	30	140.0		58	100.6		8	77.3		30	126.9		120	107.9	
		M	567	11	72.2		49	119.7		11	149.7		28	166.7		94	119.0	
		S	794	22	103.2	108.7	60	104.6	107.1	14	136.0	117.9	22	93.5	125.1	114	103.0	109.0
5/1	5/2	S	318	16	133.7		33	135.5		4	100.3		10	238.2		60	137.4	
		N	594	17	76.1		45	98.9		5	67.1		9	114.8		74	90.7	
		M	598	20	88.9	93.3	53	115.8	113.3	4	53.3	68.6	15	190.0	170.6	90	109.6	108.0
5/8	5/9	S	818	39	116.6		57	123.5		18	125.1		18	76.9		125	111.5	
		M	816	29	86.9		51	110.7		15	104.5		38	162.7		129	115.4	
		N	813	23	69.2	90.9	44	95.9	110.1	14	97.9	109.2	24	103.1	114.2	100	89.8	105.6
5/12	5/13	S	746	33	96.7		53	98.9		12	90.2		22	134.3		117	102.3	
		M	679	37	119.1		47	96.4		17	140.3		22	147.6		117	112.4	
		N	743	27	79.4	97.8	62	116.2	104.0	13	98.1	108.6	12	73.6	117.6	111	97.5	103.8
5/19	5/20	N	799	37	108.1		51	102.6		26	109.1		21	139.0		127	106.6	
		M	799	34	99.3		51	102.6		30	125.9		21	139.0		133	111.6	
		S	797	30	87.8	98.4	62	125.1	110.1	23	96.7	110.6	16	106.2	128.1	124	104.3	107.5
5/20	5/21	S	794	29	75.1		101	145.2		12	73.6		28	127.5		167	119.2	
		M	799	42	108.1		54	77.2		17	103.6		20	90.5		128	90.8	
		N	798	38	97.9	93.8	72	103.0	108.4	13	79.3	85.5	18	81.5	99.8	139	98.7	102.9
5/26	5/27	M	796	37	89.1		94	77.1		21	111.9		22	123.9		165	87.5	
		N	796	31	74.6		98	80.4		20	106.6		29	163.3		165	87.5	
		S	797	41	98.6	87.4	106	86.8	81.4	12	63.9	94.1	26	146.2	144.5	178	94.3	89.7
Total/GeoMean			17,403	677	93.2	94.7	1,625	102.8	103.1	313	105.5	106.7	538	124.2	125.9	3,032	103.4	103.1
30%Tot/GeoMean			34,825	1,290	91.4	94.1	3,929	93.6	94.2	586	102.0	104.5	1,037	114.5	117.4	6,573	96.2	96.7

Appendix Table A5. Continued.

Daytime 64% Spill Condition																	
Tailrace																	
			Bonneville 1			Bonneville 2			Jones Beach			Bird colonies			Total*		
Tag date	Rel. date	Rel. no.	Det.	Prop.	Ave Prop.	Det.	P rop.	Ave Prop.	Det.	P rop.	Ave Prop.	Det.	P rop.	Ave P rop.	Det.	Prop.	Ave Prop.
4/21	4/23	607	35	0.058		126	0.208		10	0.016		24	0.040		183	0.301	
		594	20	0.034		124	0.209		4	0.007		25	0.042		165	0.278	
		516	19	0.037	0.043	107	0.207	0.208	4	0.008	0.010	15	0.029	0.037	142	0.275	0.285
4/27	4/29	752	38	0.051		94	0.125		13	0.017		26	0.035		168	0.223	
		400	16	0.040		58	0.145		8	0.020		13	0.033		90	0.225	
		395	20	0.051	0.048	44	0.111	0.127	2	0.005	0.015	9	0.023	0.031	71	0.180	0.213
4/28	4/30	793	54	0.068		109	0.137		6	0.008		25	0.032		188	0.237	
		795	56	0.070		129	0.162		10	0.013		24	0.030		211	0.265	
		784	57	0.073	0.070	103	0.131	0.144	9	0.011	0.011	17	0.022	0.028	176	0.224	0.242
5/4	5/5	797	33	0.041		124	0.156		6	0.008		24	0.030		181	0.227	
		796	34	0.043		110	0.138		3	0.004		16	0.020		162	0.204	
		793	49	0.062	0.049	99	0.125	0.140	7	0.009	0.007	12	0.015	0.022	163	0.206	0.212
5/10	5/12	769	22	0.029		62	0.081		9	0.012		25	0.033		117	0.152	
		814	22	0.027		87	0.107		9	0.011		13	0.016		129	0.158	
		813	24	0.030	0.028	71	0.087	0.092	11	0.014	0.012	15	0.018	0.022	120	0.148	0.153
5/16	5/18	776	14	0.018		116	0.149		9	0.012		10	0.013		148	0.191	
		781	23	0.029		111	0.142		8	0.010		12	0.015		154	0.197	
		774	21	0.027	0.025	118	0.152	0.148	19	0.025	0.015	12	0.016	0.015	165	0.213	0.200
5/22	5/24	765	26	0.034		154	0.201		12	0.016		25	0.033		212	0.277	
		755	35	0.046		157	0.208		18	0.024		21	0.028		220	0.291	
		763	22	0.029	0.036	183	0.240	0.216	19	0.025	0.021	16	0.021	0.027	232	0.304	0.291
5/27	5/29	779	28	0.036		144	0.185		-			37	0.047		197	0.253	
		777	26	0.033		170	0.219		-			46	0.059		231	0.297	
		778	19	0.024	0.031	147	0.189	0.198	-			34	0.044	0.050	190	0.244	0.265
Total/GeoMean		17,366	713	0.039	0.039	2,747	0.153		196	0.012	0.012	496	0.027	0.027	4,015	0.227	0.228

Appendix Table A5. Continued.

Daytime 64% Spill Condition																		
Spillway																		
				Bonneville 1			Bonneville 2			Jones Beach			Bird colonies			Total*		
Tag date	Rel. date	Loc. N, M, S	Rel. no.	Det.	Relative %Surv	Ave %Surv	Det.	Relative %Surv	Ave %Surv	Det.	Ave %Surv	Ave %Surv	Det.	Ave %Surv	Ave %Surv	Det.	Relative %Surv	Ave %Surv
4/21	4/23	M	503	22	101.5		75	71.7		7	132.7		21	112.0		118	82.2	
		S	616	22	82.9		104	81.2		7	108.4		27	117.6		152	86.5	
		N	591	25	98.2	93.6	99	80.6	78.2	5	80.7	106.0	24	108.9	113.0	145	86.0	85.0
4/27	4/29	M	399	15	78.6		44	87.0		4	67.4		9	72.7		69	81.3	
		S	397	20	105.3		44	87.5		8	135.5		18	146.1		84	99.5	
		N	746	35	98.1	94.9	78	82.5	85.0	15	135.2	117.8	22	95.0	102.4	144	90.8	90.6
4/28	4/30	S	796	32	57.1		71	62.0		5	59.6		17	76.8		117	60.6	
		M	790	38	68.3		84	74.0		7	84.1		28	127.4		150	78.3	
		N	795	51	91.1	72.2	110	96.2	77.4	7	83.5	75.7	24	108.5	104.2	185	96.0	78.3
5/4	5/5	M	799	33	85.0		89	79.8		6	112.0		23	132.1		142	83.8	
		S	794	34	88.1		62	55.9		5	93.9		13	75.1		113	67.1	
		N	791	39	101.4	91.5	109	98.7	78.1	4	75.4	93.8	18	104.4	103.9	165	98.4	83.1
5/10	5/12	N	814	21	90.9		48	64.2		8	81.2		23	127.7		99	79.6	
		M	778	20	90.6		63	88.2		9	95.6		17	98.8		108	90.9	
		S	807	25	109.2	96.9	66	89.1	80.4	12	122.9	99.9	27	151.3	126.3	129	104.6	91.7
5/16	5/18	N	773	18	93.6		90	78.7		12	100.5		13	115.3		131	84.6	
		M	781	22	113.2		95	82.2		10	82.9		22	193.1		143	91.4	
		S	777	23	119.0	108.6	94	81.7	80.9	5	41.7	75.0	20	176.5	161.8	137	88.0	88.0
5/22	5/24	S	775	22	78.1		143	85.3		10	60.1		18	85.5		187	83.0	
		N	774	18	64.0		174	103.9		14	84.3		15	71.4		213	94.6	
		M	758	17	61.7	68.0	159	96.9	95.4	14	86.1	76.7	13	63.2	73.4	197	89.4	89.0
5/27	5/29	S	768	32	133.2		114	75.2		0			30	77.9		166	81.6	
		M	773	30	124.1		116	76.0		0			34	87.7		175	85.5	
		N	781	21	86.0	114.3	147	95.3	82.2	0			38	97.1	87.6	191	92.4	86.5
Total/GeoMean			17,376	635	90.4	91.2	2,278	81.4	82.0	174	88.0	90.8	514	104.8	106.4	3,460	85.9	86.4

Appendix Table A5. Continued.

							Nighttime 64% Spill Condition										
							Tailrace										
			Bonneville 1			Bonneville 2			Jones Beach			Bird colonies			Total*		
Tag date	Rel. date	Rel. no.	Det.	Prop.	Ave Prop.	Det.	P rop.	Ave Prop.	Det.	P rop.	Ave Prop.	Det.	P rop.	Ave Prop.	Det.	Prop.	Ave Prop.
4/22	4/23	697	19	0.027		93	0.133		4	0.006		34	0.049		144	0.207	
		701	23	0.033		106	0.151		6	0.009		30	0.043		158	0.225	
		703	23	0.033	0.031	101	0.144	0.143	7	0.010	0.008	25	0.036	0.042	149	0.212	0.215
4/29	4/30	821	44	0.054		62	0.076		6	0.007		15	0.018		126	0.153	
		609	28	0.046		67	0.110		1	0.002		16	0.026		108	0.177	
		822	33	0.040	0.047	92	0.112	0.098	4	0.005	0.005	17	0.021	0.021	140	0.170	0.166
5/4	5/5	822	32	0.039		90	0.109		9	0.011		20	0.024		147	0.179	
		795	31	0.039		104	0.131		10	0.013		25	0.031		166	0.209	
		815	34	0.042	0.040	83	0.102	0.114	16	0.020	0.014	22	0.027	0.028	151	0.185	0.191
5/5	5/6	816	39	0.048		93	0.114		10	0.012		23	0.028		152	0.186	
		813	35	0.043		88	0.108		12	0.015		24	0.030		153	0.188	
		806	18	0.022	0.038	103	0.128	0.117	12	0.015	0.014	19	0.024	0.027	149	0.185	0.186
5/11	5/12	817	15	0.018		94	0.115		18	0.022		19	0.023		141	0.173	
		736	13	0.018		94	0.128		7	0.010		21	0.029		129	0.175	
		814	23	0.028	0.022	88	0.108	0.117	18	0.022	0.018	19	0.023	0.025	142	0.174	0.174
5/17	5/18	644	30	0.047		61	0.095		1	0.002		10	0.016		101	0.157	
		650	22	0.034		61	0.094		5	0.008		11	0.017		96	0.148	
		642	18	0.028	0.036	57	0.089	0.092	5	0.008	0.006	9	0.014	0.015	86	0.134	0.146
5/20	5/22	647	26	0.040		72	0.111		2	0.003		15	0.023		115	0.178	
		647	29	0.045		68	0.105		7	0.011		20	0.031		121	0.187	
		650	29	0.045	0.043	70	0.108	0.108	4	0.006	0.007	16	0.025	0.026	117	0.180	0.182
5/28	5/29	650	26	0.040		110	0.169		0			31	0.048		154	0.237	
		649	28	0.043		125	0.193		0			40	0.062		180	0.277	
		650	25	0.038	0.041	103	0.158	0.173	0			42	0.065	0.058	159	0.245	0.253
Total/GeoMean		17,416	643	0.036	0.036	2,085	0.118	0.118	164	0.008	0.009	523	0.028	0.028	3,284	0.187	0.187
64%Tot/GeoMean		34,782	1,356	0.037	0.038	4,832	0.134	0.135	360	0.010	0.011	1,019	0.027	0.028	7,299	0.206	0.206

Appendix Table A5. Continued.

Nighttime 64% Spill Condition																		
Spillway																		
					Bonneville 1			Bonneville 2			Jones Beach			Bird colonies			Total*	
Tag	Rel.	Loc.	Rel.		Relative	Ave		Relative	Ave		Ave	Ave		Ave	Ave		Relative	Ave
date	date	N, M, S	no.	Det.	%Surv	%Surv	Det.	%Surv	%Surv	Det.	%Surv	%Surv	Det.	%Surv	%Surv	Det.	%Surv	%Surv
4/22	4/23	S	699	22	101.7		101	101.2		5	88.4		28	94.6		150	100.0	
		N	698	19	88.0		92	92.3		8	141.6		30	101.5		142	94.8	
		M	695	14	65.1	85.0	105	105.8	99.8	7	124.5	118.2	23	78.1	91.4	147	98.5	97.8
4/29	4/30	M	821	34	88.8		71	88.1		4	99.7		30	171.4		130	95.3	
		S	606	24	84.9		59	99.2		8	270.3		9	69.7		95	94.4	
		N	821	30	78.4	84.0	88	109.2	98.8	7	174.6	173.0	34	194.3	152.4	151	110.7	100.7
5/4	5/5	N	822	32	97.6		93	99.3		16	135.3		28	123.6		164	104.6	
		M	818	29	88.9		85	91.2		6	51.0		23	102.1		138	88.4	
		S	808	23	71.4	86.0	99	107.6	99.3	9	77.4	88.0	23	103.3	109.7	150	97.3	96.8
5/5	5/6	S	817	39	126.3		105	110.2		13	114.0		24	108.4		173	113.6	
		M	819	34	109.9		95	99.5		19	166.1		27	121.6		169	110.7	
		N	818	27	87.4	107.9	89	93.3	101.0	24	210.1	163.4	28	126.3	118.8	158	103.6	109.3
5/11	5/12	M	810	10	57.3		81	85.8		14	95.1		18	89.2		120	85.1	
		N	820	20	113.2		97	101.4		14	94.0		28	137.0		152	106.5	
		S	766	12	72.7	81.4	97	108.6	98.4	11	79.0	89.6	22	115.2	113.9	135	101.3	97.6
5/17	5/18	S	646	17	72.8		74	123.9		1	27.2		12	119.9		100	105.9	
		N	640	17	73.5		67	113.2		5	137.5		17	171.4		105	112.2	
		M	645	19	81.5	75.9	67	112.3	116.5	5	136.4	100.3	16	160.1	150.4	103	109.2	109.1
5/20	5/22	M	647	26	93.0		81	115.9		1	23.1		12	70.7		118	100.4	
		S	650	22	78.3		83	118.2		5	115.0		13	76.2		120	101.7	
		N	648	29	103.6	91.6	91	130.0	121.4	6	138.5	92.3	12	70.6	72.5	130	110.5	104.2
5/28	5/29	M	648	40	152.3		102	90.8		0			39	103.8		165	100.7	
		S	648	16	60.9		112	99.7		0			46	122.4		156	95.2	
		N	648	25	95.2	102.8	121	107.7	99.4	0			34	90.5	105.6	168	102.5	99.4
Total/GeoMean			17,458	580	87.0	88.8	2,155	103.8	104.0	188	103.5	113.6	576	108.8	111.4	3,339	101.5	101.7
64%Tot/GeoMean			34,834	1,215	88.7	90.0	4,433	91.9	92.4	362	95.5	101.6	1,090	106.8	108.9	6,799	93.4	93.8

[a] Total (used for combined analysis) is the number of unique tags observed at any of the sites. Multiple observations of a tag are not counted. Numbers observed at individual sites may include tags observed at other sites, and these data are used to make the inter-site comparisons.

Appendix Table A6. Detections numbers, and survival percents for chinook salmon at each site, separated by passage condition at release; spring 1999.

Daytime 30% Spill Condition

			Tailrace															
			Bon1				Bon2			Jones B.			Bird Is.			Total*		
Tag date	Rel. date	Rel. no.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.
4/25	4/27	129	2	0.016		22	0.171		2	0.016		2	0.016		28	0.217	
		475	22	0.046		54	0.114		9	0.019		22	0.046		102	0.215	
		554	21	0.038	0.039	67	0.121	0.123	12	0.022	0.020	11	0.020	0.030	107	0.193	0.205
4/30	5/2	520	26	0.050		67	0.129		10	0.019		10	0.019		111	0.213	
		418	19	0.045		54	0.129		7	0.017		11	0.026		87	0.208	
		543	34	0.063	0.053	89	0.164	0.142	6	0.011	0.016	11	0.020	0.022	134	0.247	0.224
5/6	5/8	576	21	0.036		59	0.102		17	0.030		14	0.024		104	0.181	
		617	21	0.034		68	0.110		14	0.023		13	0.021		113	0.183	
		543	24	0.044	0.038	40	0.074	0.096	17	0.031	0.028	20	0.037	0.027	97	0.179	0.181
5/7	5/9	780	25	0.032		116	0.149		12	0.015		24	0.031		173	0.222	
		686	24	0.035		92	0.134		13	0.019		20	0.029		144	0.210	
		596	11	0.018	0.029	74	0.124	0.137	17	0.029	0.020	16	0.027	0.029	115	0.193	0.210
5/13	5/15	703	25	0.036		104	0.148		12	0.017		22	0.031		152	0.216	
		677	18	0.027		99	0.146		5	0.007		20	0.030		137	0.202	
		661	21	0.032	0.031	87	0.132	0.142	9	0.014	0.013	22	0.033	0.031	133	0.201	0.207
5/18	5/20	680	18	0.026		136	0.200		18	0.026		7	0.010		173	0.254	
		715	21	0.029		142	0.199		16	0.022		14	0.020		183	0.256	
		691	23	0.033	0.030	125	0.181	0.193	18	0.026	0.025	8	0.012	0.014	169	0.245	0.252
5/24	5/26	657	22	0.033		101	0.154		17	0.026		13	0.020		148	0.225	
		716	21	0.029		117	0.163		10	0.014		10	0.014		154	0.215	
		770	36	0.047	0.037	117	0.152	0.156	12	0.016	0.018	19	0.025	0.020	180	0.234	0.225
5/25	5/27	689	38	0.055		89	0.129		2	0.003		16	0.023		142	0.206	
		579	36	0.062		74	0.128		0	---		22	0.038		126	0.218	
		618	21	0.034	0.050	75	0.121	0.126	2	0.003	0.002	16	0.026	0.029	107	0.173	0.199
Total/GeoMean		14,593	550	0.036	0.038	2,068	0.142	0.137	257	0.016	0.015	363	0.023	0.024	3,119	0.212	0.212

Appendix Table A6. Continued.

Daytime 30% Spill Condition																		
Spillway																		
				Bonneville 1			Bonneville 2			Jones Beach			Bird colonies			Total*		
Tag	Rel.	Loc.	Rel.		Relative	Ave		Relative	Ave		Relative	Ave		Relative	Ave		Relative	Ave
date	date	N, M, S	no.	Det.	%Surv	%Surv	Det.	%Surv	%Surv	Det.	%Surv	%Surv	Det.	%Surv	%Surv	Det.	%Surv	%Surv
4/25	4/27	S	563	25	114.3		65	107.8		9	80.5		22	129.3		117	101.5	
		M	572	17	76.5		47	76.7		15	132.0		20	115.7		92	78.6	
		N	147	2	35.0	88.3	12	76.2	90.3	2	68.5	102.1	3	67.5	116.1	19	63.2	86.9
4/30	5/2	N	488	22	84.5		53	93.0		4	52.8		13	123.3		90	82.3	
		M	621	22	66.4		74	102.0		9	93.3		21	156.5		122	87.6	
		S	463	14	56.7	69.2	46	85.1	94.2	3	41.7	65.5	17	169.9	150.1	75	72.3	81.4
5/6	5/8	S	552	13	61.9		37	85.6		12	78.6		15	100.4		76	76.1	
		M	631	13	54.2		46	93.1		12	68.8		16	93.7		84	73.6	
		N	575	27	123.5	79.3	53	117.7	98.7	12	75.5	74.1	13	83.5	92.4	102	98.1	82.4
5/7	5/9	S	687	14	70.0		71	99.1		10	71.5		18	90.0		106	73.6	
		N	609	16	90.3		70	110.2		11	88.7		20	112.9		114	89.3	
		M	611	15	84.4	81.1	74	116.2	108.1	17	136.6	97.8	26	146.2	115.3	121	94.5	85.4
5/13	5/15	M	715	22	98.1		78	99.4		10	109.8		12	53.5		118	79.8	
		S	693	20	92.0		71	93.4		9	101.9		25	115.0		117	81.7	
		N	646	18	88.9	93.2	75	105.8	99.4	5	60.8	91.7	19	93.8	86.9	113	84.6	81.9
5/18	5/20	M	742	23	104.3		132	100.0		21	113.5		10	96.9		181	96.9	
		S	703	17	81.4		113	90.4		14	79.9		9	92.1		148	83.6	
		N	657	17	87.1	91.2	126	107.8	99.2	13	79.4	91.6	10	109.5	99.2	161	97.4	92.6
5/24	5/26	S	707	30	115.1		88	85.8		13	101.0		14	101.0		142	89.3	
		M	719	38	143.4		114	109.3		10	76.4		17	120.6		176	108.8	
		N	703	23	88.7	115.9	109	106.8	100.7	10	78.2	85.2	22	159.7	127.0	159	100.6	99.6
5/25	5/27	N	669	37	109.8		89	88.7		3	211.4		16	83.5		141	106.0	
		M	689	37	106.6		92	89.0		3	205.3		35	177.4		158	115.3	
		S	664	46	137.5	117.8	102	102.4	93.3	5	355.0	256.5	20	105.2	122.6	169	128.0	116.4
Total/GeoMean			14,826	528	86.4	90.7	1,837	96.9	97.9	232	94.2	98.6	413	108.2	112.1	2,901	88.9	90.2

Appendix Table A6. Continued.

Nighttime 30% Spill Condition																	
Tailrace																	
			Bonneville 1			Bonneville 2			Jones Beach			Bird colonies			Total*		
Tag date	Rel. date	Rel. no.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.
4/20	4/21	684	24	0.035		123	0.180		0	---		24	0.035		164	0.240	
		606	21	0.035		104	0.172		1	0.002		22	0.036		138	0.228	
		604	15	0.025	0.032	110	0.182	0.178	1	0.002	0.001	23	0.038	0.036	143	0.237	0.235
4/26	4/27	496	16	0.032		22	0.044		3	0.006		17	0.034		58	0.117	
		743	21	0.028		52	0.070		10	0.013		25	0.034		106	0.143	
		689	16	0.023	0.027	50	0.073	0.070	12	0.017	0.013	20	0.029	0.032	95	0.138	0.134
5/1	5/2	483	15	0.031		29	0.060		5	0.010		7	0.014		54	0.112	
		527	17	0.032		33	0.063		10	0.019		4	0.008		64	0.121	
		228	10	0.044	0.034	15	0.066	0.064	1	0.004	0.013	3	0.013	0.011	29	0.127	0.119
5/8	5/9	663	27	0.041		33	0.050		14	0.021		22	0.033		90	0.136	
		643	20	0.031		30	0.047		7	0.011		17	0.026		72	0.112	
		691	30	0.043	0.039	25	0.036	0.051	8	0.012	0.015	19	0.027	0.029	80	0.116	0.121
5/12	5/13	667	30	0.045		43	0.064		11	0.016		14	0.021		94	0.141	
		641	29	0.045		42	0.066		14	0.022		9	0.014		92	0.144	
		680	34	0.050	0.047	42	0.062	0.070	12	0.018	0.019	15	0.022	0.019	100	0.147	0.144
5/19	5/20	747	31	0.041		56	0.075		19	0.025		15	0.020		120	0.161	
		688	26	0.038		43	0.063		19	0.028		5	0.007		91	0.132	
		707	33	0.047	0.042	33	0.047	0.067	23	0.033	0.028	16	0.023	0.017	101	0.143	0.146
5/20	5/21	715	40	0.056		66	0.092		18	0.025		13	0.018		130	0.182	
		721	29	0.040		53	0.074		14	0.019		22	0.031		114	0.158	
		693	37	0.053	0.050	50	0.072	0.089	13	0.019	0.021	17	0.025	0.024	111	0.160	0.167
5/26	5/27	597	31	0.052		69	0.116		10	0.017		16	0.027		118	0.198	
		662	38	0.057		99	0.150		19	0.029		8	0.012		154	0.233	
		605	44	0.073	0.061	81	0.134	0.095	17	0.028	0.025	8	0.013	0.017	144	0.238	0.223
Total/GeoMean		15,180	634	0.040	0.040	1,303	0.077	0.080	261	0.014	0.013	361	0.021	0.022	2,462	0.156	0.156
30%Total/GeoMean		29,773	1,184	0.038	0.039	3,371	0.103	0.104	518	0.015	0.014	724	0.022	0.023	5,581	0.181	0.182

Appendix Table A6. Continued.

				Nighttime 30% Spill Condition Spillway														
				Bonneville 1			Bonneville 2			Jones Beach			Bird colonies			Total*		
Tag date	Rel. date	Loc. N, M, S	Rel. no.	Det.	Relative %Surv	Ave %Surv	Det.	Relative %Surv	Ave %Surv	Det.	Relative %Surv	Ave %Surv	Det.	Relative %Surv	Ave %Surv	Det.	Relative %Surv	Ave %Surv
4/20	4/21	N	655	17	81.9		116	99.5		1	144.6		25	104.8		153	99.4	
		M	670	25	117.8		100	83.9		1	141.3		26	106.5		151	95.9	
		S	598	12	63.3	88.6	103	96.8	93.2	2	316.7	197.0	34	156.1	121.3	144	102.5	99.2
4/26	4/27	N	740	26	127.8		49	95.3		4	41.7		27	113.5		101	101.6	
		M	473	7	53.8		33	100.4		9	146.7		23	151.2		68	107.0	
		S	741	21	103.1	100.5	52	101.0	98.7	14	145.7	106.6	18	75.5	108.2	101	101.5	102.9
5/1	5/2	S	214	9	124.0		17	124.5		2	72.3		6	247.9		33	129.9	
		N	502	13	76.3		30	93.7		4	61.7		9	158.5		54	90.6	
		M	468	14	88.2	89.6	32	107.2	104.6	3	49.6	58.8	11	207.8	194.2	60	108.0	104.6
5/8	5/9	S	703	32	118.1		39	109.7		17	166.5		17	83.3		100	117.4	
		M	708	23	84.3		38	106.1		13	126.4		31	150.8		101	117.7	
		N	637	18	73.3	92.4	24	74.5	97.5	13	140.5	144.6	15	81.1	105.9	66	85.5	107.6
5/12	5/13	S	689	27	83.8		48	98.9		11	85.8		20	151.9		103	103.9	
		M	634	34	114.6		43	96.3		16	135.6		19	156.8		107	117.3	
		N	667	22	70.5	89.2	49	104.3	99.9	12	96.7	105.3	12	94.1	134.1	92	95.9	105.5
5/19	5/20	N	694	30	102.9		46	98.6		22	111.3		19	162.9		110	108.8	
		M	693	30	103.0		42	90.2		28	141.9		18	154.5		116	114.9	
		S	730	28	91.3	98.9	56	114.1	101.2	21	101.0	117.8	15	122.3	146.2	113	106.3	109.9
5/20	5/21	S	633	25	79.3		74	131.0		10	74.7		20	129.4		128	121.3	
		M	741	40	108.4		48	72.6		15	95.8		19	105.0		118	95.5	
		N	766	38	99.6	96.7	68	99.5	99.5	10	61.8	77.4	18	96.2	109.1	132	103.3	105.9
5/26	5/27	M	557	31	91.8		47	88.9		13	94.6		14	146.4		100	80.4	
		N	588	28	78.6		54	96.7		15	103.4		20	198.1		108	82.3	
		S	655	34	85.6	85.2	76	122.2	103.6	10	61.9	85.5	21	186.8	178.0	138	94.4	86.1
Total/GeoMean			15,156	584	90.5	92.5	1,284	99.3	99.7	266	102.5	104.9	457	132.9	133.8	2,497	102.7	102.5
30%Total/GeoMean			29,982	1,112	88.4	91.6	3,121	98.1	98.8	498	98.3	101.7	870	119.9	122.5	5,398	95.5	96.1

Appendix Table A6. Continued.

Daytime 64% Spill Condition																	
Tailrace																	
			Bonneville 1			Bonneville 2			Jones Beach			Bird colonies			Total*		
Tag date	Rel. date	Rel. no.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.
4/21	4/23	570	33	0.058		113	0.198		9	0.016		24	0.042		167	0.293	
		576	20	0.035		119	0.207		4	0.007		25	0.043		160	0.278	
		511	19	0.037	0.043	106	0.207	0.161	4	0.008	0.010	15	0.029	0.039	141	0.276	0.282
4/27	4/29	649	30	0.046		82	0.126		12	0.018		23	0.035		144	0.222	
		374	15	0.040		52	0.139		8	0.021		12	0.032		82	0.219	
		374	17	0.045	0.044	43	0.115	0.097	2	0.005	0.016	8	0.021	0.031	66	0.176	0.209
4/28	4/30	724	50	0.069		100	0.138		6	0.008		22	0.030		172	0.238	
		618	48	0.078		99	0.160		9	0.015		19	0.031		167	0.270	
		654	45	0.069	0.072	80	0.122	0.107	7	0.011	0.011	13	0.020	0.027	137	0.209	0.238
5/4	5/5	624	26	0.042		75	0.120		4	0.006		15	0.024		117	0.188	
		553	25	0.045		55	0.099		2	0.004		9	0.016		91	0.165	
		629	42	0.067	0.051	58	0.092	0.099	4	0.006	0.006	11	0.017	0.019	113	0.180	0.178
5/10	5/12	669	20	0.030		47	0.070		8	0.012		25	0.037		99	0.148	
		478	10	0.021		41	0.086		5	0.010		4	0.008		60	0.126	
		581	12	0.021	0.024	34	0.059	0.069	8	0.014	0.012	12	0.021	0.024	65	0.112	0.130
5/16	5/18	696	12	0.017		95	0.136		9	0.013		9	0.013		124	0.178	
		613	15	0.024		69	0.113		8	0.013		10	0.016		102	0.166	
		647	15	0.023	0.021	82	0.127	0.112	16	0.025	0.017	9	0.014	0.014	118	0.182	0.176
5/22	5/24	616	21	0.034		115	0.187		12	0.019		17	0.028		162	0.263	
		652	31	0.048		123	0.189		17	0.026		18	0.028		179	0.275	
		639	19	0.030	0.037	151	0.236	0.179	19	0.030	0.025	14	0.022	0.026	196	0.307	0.282
5/27	5/29	620	25	0.040		115	0.185		0			24	0.039		156	0.252	
		663	24	0.036		144	0.217		0			38	0.057		197	0.297	
		512	15	0.029	0.036	88	0.172	0.147	0			15	0.029	0.043	115	0.225	0.261
Total/GeoMean		14,242	589	0.038	0.039	2,086	0.137	0.116	173	0.012	0.013	391	0.025	0.026	3,130	0.211	0.213

Appendix Table A6. Continued.

Daytime 64% Spill Condition																		
Spillway																		
				Bonneville 1			Bonneville 2			Jones Beach			Bird colonies			Total*		
Tag date	Rel. date	Loc. N, M, S	Rel. no.	Det.	Relative %Surv	Ave %Surv	Det.	Relative %Surv	Ave %Surv	Det.	Relative %Surv	Ave %Surv	Det.	Relative %Surv	Ave %Surv	Det.	Relative %Surv	Ave %Surv
4/21	4/23	M	482	20	95.5		73	94.0		6	121.3		20	107.4		112	82.3	
		S	583	18	71.1		96	102.2		7	117.0		27	119.9		140	85.0	
		N	583	24	94.7	86.6	98	104.3	100.5	4	66.9	100.5	24	106.6	111.5	142	86.2	84.6
4/27	4/29	M	352	14	89.6		38	111.7		4	72.2		6	55.4		60	81.5	
		S	367	19	116.7		38	107.1		6	103.8		17	150.5		76	99.1	
		N	604	24	89.5	97.1	59	101.1	105.6	14	147.2	115.2	18	96.8	100.7	110	87.1	89.0
4/28	4/30	S	704	30	59.5		57	75.9		5	64.4		13	68.3		97	57.8	
		M	696	37	74.2		68	91.6		7	91.2		25	132.8		130	78.3	
		N	675	45	93.1	75.3	88	122.2	96.2	6	80.6	78.7	23	125.9	108.7	155	96.3	77.2
5/4	5/5	M	642	25	75.6		62	98.0		5	140.7		17	136.6		104	91.1	
		S	709	28	76.7		47	67.3		4	101.9		13	94.6		91	72.2	
		N	592	27	88.6	80.0	69	118.3	92.9	3	91.5	111.5	15	130.7	119.5	111	105.5	88.6
5/10	5/12	N	668	16	98.5		34	73.9		7	86.2		21	132.5		77	88.9	
		M	570	13	93.8		43	109.5		4	57.7		13	96.1		72	97.4	
		S	604	19	129.4	107.2	42	101.0	93.8	11	149.9	98.3	20	139.6	123.6	91	116.2	100.5
5/16	5/18	N	648	16	115.0		65	89.2		8	73.2		11	118.6		99	86.9	
		M	647	20	144.0		76	104.4		10	91.6		19	205.1		120	105.5	
		S	700	19	126.4	128.4	79	100.3	98.0	5	42.3	68.3	15	149.7	157.6	115	93.4	95.2
5/22	5/24	S	657	18	73.6		116	98.5		9	54.4		14	82.9		154	83.2	
		N	609	12	52.9		123	112.6		13	84.8		7	44.7		148	86.3	
		M	567	13	61.6	63.0	103	101.3	104.0	11	77.1	71.5	9	61.8	63.7	132	82.7	84.1
5/27	5/29	S	640	30	131.5		87	92.8		0			21	76.5		130	77.9	
		M	661	28	118.8		97	100.2		0			31	109.3		152	88.2	
		N	503	20	111.5	121.3	79	107.2	99.5	0			17	78.8	89.2	107	81.6	82.7
Total/GeoMean			14,463	535	91.9	92.4	1,737	98.4	98.7	149	86.6	90.3	416	103.1	106.2	2,725	87.2	87.5

Appendix Table A6. Continued.

			Nighttime 64% Spill Condition Tailrace															
			Bonneville 1			Bonneville 2			Jones Beach			Bird colonies			Total*		
Tag date	Rel. date	Rel. no.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.
4/22	4/23	687	19	0.028		92	0.134		4	0.006		33	0.048		143	0.208	
		671	20	0.030		101	0.151		6	0.009		29	0.043		149	0.222	
		676	19	0.028	0.029	100	0.148	0.134	7	0.010	0.008	25	0.037	0.043	144	0.213	0.214
4/29	4/30	672	30	0.045		48	0.071		3	0.004		13	0.019		93	0.138	
		555	28	0.050		56	0.101		1	0.002		16	0.029		97	0.175	
		664	24	0.036	0.043	64	0.096	0.078	3	0.005	0.004	13	0.020	0.022	100	0.151	0.153
5/4	5/5	650	26	0.040		53	0.082		7	0.011		16	0.025		98	0.151	
		565	18	0.032		48	0.085		9	0.016		15	0.027		88	0.156	
		682	28	0.041	0.038	53	0.078	0.072	14	0.021	0.016	18	0.026	0.026	110	0.161	0.156
5/5	5/6	522	26	0.050		44	0.084		4	0.008		15	0.029		83	0.159	
		504	17	0.034		22	0.044		3	0.006		15	0.030		56	0.111	
		496	13	0.026	0.037	34	0.069	0.067	6	0.012	0.009	14	0.028	0.029	66	0.133	0.135
5/11	5/12	728	15	0.021		72	0.099		16	0.022		17	0.023		118	0.162	
		701	12	0.017		85	0.121		6	0.009		20	0.029		117	0.167	
		755	22	0.029	0.022	71	0.094	0.105	16	0.021	0.017	19	0.025	0.026	123	0.163	0.164
5/17	5/18	590	27	0.046		44	0.075		1	0.002		8	0.014		80	0.136	
		582	21	0.036		43	0.074		4	0.007		10	0.017		76	0.131	
		601	16	0.027	0.036	43	0.072	0.089	4	0.007	0.005	8	0.013	0.015	68	0.113	0.126
5/20	5/22	593	23	0.039		59	0.099		2	0.003		13	0.022		97	0.164	
		572	27	0.047		55	0.096		6	0.010		20	0.035		105	0.184	
		552	24	0.043	0.043	52	0.094	0.118	3	0.005	0.006	10	0.018	0.025	87	0.158	0.168
5/28	5/29	437	23	0.053		56	0.128		0			20	0.046		91	0.208	
		408	19	0.047		68	0.167		0			27	0.066		104	0.255	
		571	25	0.044	0.047	89	0.156	0.138	0			34	0.060	0.057	138	0.242	0.235
Total/GeoMean		14,434	522	0.036	0.036	1,452	0.096	0.097	125	0.007	0.008	428	0.028	0.028	2,431	0.165	0.166
64%Total/GeoMean		28,676	1,111	0.037	0.037	3,182	0.115	0.106	275	0.009	0.010	819	0.026	0.027	5,561	0.187	0.188

Appendix Table A6. Continued.

Nighttime 64% Spill Condition																		
Spillway																		
				Bonneville 1			Bonneville 2			Jones Beach			Bird colonies			Total*		
Tag date	Rel. date	Loc. N, M, S	Rel. no.	Det.	Relative %Surv	Ave %Surv	Det.	Relative %Surv	Ave %Surv	Det.	Relative %Surv	Ave %Surv	Det.	Relative %Surv	Ave %Surv	Det.	Relative %Surv	Ave %Surv
4/22	4/23	S	681	20	103.0		99	108.3		5	87.8		27	92.7		146	100.0	
		N	640	15	82.2		86	100.1		7	130.9		28	102.3		129	94.0	
		M	609	11	63.3	83.6	88	107.7	105.4	5	98.2	105.4	21	80.6	92.1	124	95.0	96.4
4/29	4/30	M	757	31	94.4		62	104.6		4	142.7		29	172.5		118	101.6	
		S	432	20	106.8		36	106.5		6	375.2		7	73.0		66	99.6	
		N	637	22	79.6	92.2	50	100.3	103.6	3	127.2	192.3	25	176.7	150.4	93	95.2	98.9
5/4	5/5	N	581	21	95.2		46	110.4		10	108.8		17	113.3		90	99.3	
		M	639	20	82.5		46	100.4		5	49.5		15	90.9		82	82.2	
		S	538	16	78.4	85.4	44	114.1	107.9	8	94.0	82.7	17	122.3	107.9	82	97.7	92.6
5/5	5/6	S	471	24	138.5		35	110.9		4	99.4		13	95.5		75	118.2	
		M	522	22	114.5		34	97.2		13	291.6		19	125.9		84	119.5	
		N	483	12	67.5	106.8	33	101.9	103.1	11	266.6	222.1	19	136.1	119.5	71	109.1	115.7
5/11	5/12	M	715	7	43.6		66	87.7		11	88.4		17	92.7		100	85.3	
		N	753	19	112.5		83	104.7		11	84.0		27	139.8		134	108.6	
		S	699	12	76.5	78.2	81	110.0	100.8	10	82.2	84.9	18	100.4	111.6	118	103.0	99.1
5/17	5/18	S	576	15	72.1		60	116.9		1	34.2		11	130.2		84	115.4	
		N	603	17	78.1		54	100.5		5	163.3		16	180.9		91	119.4	
		M	563	17	83.7	77.9	44	87.7	101.8	1	35.0	79.2	12	145.3	152.7	71	99.8	111.8
5/20	5/22	M	590	26	102.2		66	94.6		0			7	47.4		97	97.7	
		S	587	19	75.1		68	98.0		2	53.2		12	81.6		100	101.2	
		N	541	21	90.1	89.1	69	107.9	99.9	4	115.4	54.5	10	73.8	67.4	98	107.6	102.0
5/28	5/29	M	463	36	164.3		55	86.3		0			26	98.2		105	96.4	
		S	593	16	57.0		94	115.1		0			46	135.6		140	100.4	
		N	346	12	73.3	96.5	46	96.5	101.0	0			11	55.6	103.5	64	78.7	93.7
Total/GeoMean			14,019	451	85.6	88.3	1445	102.5	102.9	126	104.0	104.5	450	105.1	109.9	2,362	100.5	101.0
64%Total/GeoMean			28,482	986	88.7	90.3	3182	100.4	100.8	275	94.7	97.1	866	104.1	108.0	5,087	93.6	94.0

[a] Total (used for combined analysis) is the number of unique tags observed at any of the sites. Multiple observations of a tag are not counted. Numbers observed at individual sites may include tags observed at other sites, and these data are used to make the inter-site comparisons.

Appendix Table A7. Detection numbers, and survival percentages for coho salmon at each site, separated by passage condition at release; The Dalles Dam, spring 1999.

Daytime 30% Spill Condition																		
Tailrace																		
			Bonneville 1			Bonneville 2			Jones Beach			Bird colonies			Total*		
Tag date	Rel. date	Rel. no.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.
4/25	4/27	26	0			4	0.154		1	0.038		0			5	0.192	
		50	2	0.040		4	0.080		2	0.040		2	0.040		10	0.200	
		39	2	0.051	0.035	8	0.205	0.139	3	0.077	0.052	2	0.051	0.035	14	0.359	0.252
4/30	5/2	300	7	0.023		70	0.233		3	0.010		11	0.037		87	0.290	
		189	10	0.053		28	0.148		0			1	0.005		39	0.206	
		54	0		0.031	13	0.241	0.204	1	0.019	0.007	1	0.019	0.024	14	0.259	0.258
5/6	5/8	235	6	0.026		47	0.200		7	0.030		9	0.038		62	0.264	
		192	11	0.057		43	0.224		4	0.021		3	0.016		58	0.302	
		274	6	0.022	0.033	42	0.153	0.188	3	0.011	0.020	7	0.026	0.027	56	0.204	0.251
5/7	5/9	19	0			4	0.211		2	0.105		1	0.053		6	0.316	
		128	4	0.031		24	0.188		2	0.016		2	0.016		30	0.234	
		225	9	0.040	0.035	44	0.196	0.194	5	0.022	0.024	7	0.031	0.027	61	0.271	0.261
5/13	5/15	41	2	0.049		7	0.171		2	0.049		0			11	0.268	
		63	1	0.016		17	0.270		1	0.016		2	0.032		20	0.317	
		28	2	0.071	0.038	3	0.107	0.205	0		0.023	0		0.015	5	0.179	0.273
5/18	5/20	94	3	0.032		29	0.309		1	0.011		3	0.032		35	0.372	
		61	2	0.033		21	0.344		3	0.049		1	0.016		26	0.426	
		86	1	0.012	0.025	24	0.279	0.307	1	0.012	0.021	2	0.023	0.025	26	0.302	0.361
5/24	5/26	105	2	0.019		22	0.210		0			4	0.038		27	0.257	
		50	0			12	0.240		1	0.020		1	0.020		13	0.260	
		11	0		0.012	4	0.364	0.229	0		0.006	0		0.030	4	0.364	0.265
5/25	5/27	79	2	0.025		9	0.114		0			7	0.089		17	0.215	
		187	6	0.032		33	0.176		0			15	0.080		49	0.262	
		142	4	0.028	0.029	27	0.190	0.169	0		---	9	0.063	0.076	36	0.254	0.250
Total/GeoMean		2,678	82	0.032	0.028	539	0.197	0.200	42	0.025	0.018	90	0.030	0.029	711	0.267	0.269

Appendix Table A7. Continued.

Daytime 30% Spill Condition																		
Spillway																		
				Bonneville 1			Bonneville 2			Jones Beach			Bird colonies			Total*		
Tag	Rel.	Loc.	Rel.		Relative	Ave		Relative	Ave		Relative	Ave		Relative	Ave		Relative	Ave
date	date	N, M, S	no.	Det.	%Surv	%Surv	Det.	%Surv	%Surv	Det.	%Surv	%Surv	Det.	%Surv	%Surv	Det.	%Surv	%Surv
4/25	4/27	S	35	0			1	20.5		0			0			1	11.3	
		M	28	1	102.7		4	102.7		0			0			5	70.8	
		N	11	0		38.9	1	65.3	58.3	0		---	0		---	1	36.1	37.5
4/30	5/2	N	118	5	135.3		23	95.4		2	230.1		5	177.0		33	108.5	
		M	200	10	159.7		34	83.2		2	135.8		3	62.7		45	87.3	
		S	131	6	146.3	149.4	24	89.6	88.3	2	207.3	181.4	3	95.7	102.3	33	97.7	95.9
5/6	5/8	S	265	15	172.5		21	42.1		3	56.7		8	111.4		43	64.6	
		M	185	11	181.2		30	86.1		5	135.3		7	139.6		50	107.6	
		N	240	8	101.6	150.2	37	81.9	67.7	6	125.2	101.6	4	61.5	101.6	53	88.0	84.3
5/7	5/9	S	124	4	92.3		23	95.8		4	133.3		3	90.0		33	102.1	
		N	206	3	41.7		31	77.8		2	40.1		8	144.5		43	80.1	
		M	198	5	72.3	65.0	41	107.0	93.0	2	41.8	62.6	11	206.7	155.0	54	104.6	94.4
5/13	5/15	M	25	1	105.6		5	97.8		1	176.0		1	264.0		8	117.3	
		S	43	1	61.4		9	102.3		2	204.7		0			12	102.3	
		N	100	4	105.6	94.3	25	122.2	113.5	4	176.0	---	5	330.0	235.7	35	128.3	120.0
5/18	5/20	M	36	0			8	72.4		2	267.8		1	111.6		11	84.6	
		S	76	1	52.9		24	102.8		0			2	105.7		26	94.8	
		N	120	0		17.3	29	78.7	85.6	2	80.3	83.1	3	100.4	103.9	33	76.2	83.6
5/24	5/26	S	59	0			11	81.4		1	281.4		2	112.5		14	89.5	
		M	50	1	166.0		5	43.7		0			1	66.4		7	52.8	
		N	64	0		48.0	13	88.7	73.2	0		---	4	207.5	134.3	16	94.3	80.7
5/25	5/27	N	87	4	156.3		21	142.7		0			5	75.6		27	124.1	
		M	85	1	40.0		21	146.1		0			5	77.4		24	112.9	
		S	110	4	123.6	108.5	26	139.8	142.6	1		---	5	59.8	70.0	33	120.0	119.1
Total/GeoMean			2,596	85	101.6	68.4	467	84.0	87.0	41	130.3	99.0	86	114.6	120.6	640	82.5	85.1

Appendix Table A7. Continued.

			Nighttime 30% Spill Condition Tailrace														
			Bonneville 1			Bonneville 2			Jones Beach			Bird colonies			Total*		
Tag date	Rel. date	Rel. no.	Det.	Prop	Ave Prop.	Det.	Prop.	Ave Prop.	Det.	P rop.	Ave Prop.	Det.	P rop.	Ave Prop.	Det.	Prop.	Ave Prop.
4/20	4/21	7	0			2	0.286		0			0			2	0.286	
		10	0			0			0			2	0.200		2	0.200	
		7	0		--- 0			0.083	0		--- 1		0.143	0.125	1	0.143	0.208
4/26	4/27	72	0			9	0.125		1	0.014		0			10	0.139	
		52	3	0.058		7	0.135		0			1	0.019		11	0.212	
		108	2	0.019	0.022	16	0.148	0.138	2	0.019	0.013	1	0.009	0.009	21	0.194	0.181
5/1	5/2	114	6	0.053		11	0.096		1	0.009		4	0.035		20	0.175	
		72	5	0.069		9	0.125		0			0			14	0.194	
		91	4	0.044	0.054	19	0.209	0.141	2	0.022	0.011	2	0.022	0.022	27	0.297	0.220
5/8	5/9	150	11	0.073		20	0.133		6	0.040		8	0.053		41	0.273	
		176	8	0.045		16	0.091		5	0.028		3	0.017		30	0.170	
		122	4	0.033	0.051	14	0.115	0.112	3	0.025	0.031	1	0.008	0.027	22	0.180	0.208
5/12	5/13	80	2	0.025		12	0.150		1	0.013		2	0.025		17	0.213	
		54	2	0.037		7	0.130		0			3	0.056		12	0.222	
		64	3	0.047	0.035	11	0.172	0.152	1	0.016	0.010	5	0.078	0.051	20	0.313	0.247
5/19	5/20	48	2	0.042		5	0.104		4	0.083		1	0.021		11	0.229	
		110	4	0.036		9	0.082		3	0.027		7	0.064		20	0.182	
		80	6	0.075	0.050	2	0.025	0.067	3	0.038	0.042	1	0.013	0.038	12	0.150	0.181
5/20	5/21	80	3	0.038		14	0.175		0			3	0.038		20	0.250	
		77	2	0.026		11	0.143		2	0.026		7	0.091		20	0.260	
		100	5	0.050	0.039	15	0.150	0.156	2	0.020	0.016	4	0.040	0.054	26	0.260	0.257
5/26	5/27	200	2	0.010		48	0.240		2	0.010		11	0.055		58	0.290	
		127	2	0.016		24	0.189		2	0.016		6	0.047		32	0.252	
		185	7	0.038	0.021	43	0.232	0.225	6	0.032	0.020	4	0.022	0.041	57	0.308	0.287
Total/GeoMean		2,186	83	0.037	0.037	324	0.135	0.126	46	0.022	0.018	77	0.036	0.036	506	0.218	0.221
30%Total/GeoMean		4,864	165	0.034	0.032	863	0.164	0.159	88	0.023	0.018	167	0.033	0.032	1,217	0.242	0.244

Appendix Table A7. Continued.

				Nighttime 30% Spill Condition Spillway														
				Bonneville 1			Bonneville 2			Jones Beach			Bird colonies			Total*		
Tag date	Rel. date	Loc. N, M, S	Rel. no.	Det.	Relative %Surv	Ave %Surv	Det.	Relative %Surv	Ave %Surv	Det.	Relative %Surv	Ave %Surv	Det.	Relative %Surv	Ave %Surv	Det.	Relative %Surv	Ave %Surv
4/20	4/21	N	10	0			2	240.0		0			0			2	96.0	
		M	10	0			2	240.0		0			2	160.0		4	192.0	
		S	1	0		--- 1		1200.0	285.7	0		--- 0			76.2	1	480.0	160.0
4/26	4/27	N	58	4	320.0		9	112.5		4	533.3		3	600.0		19	181.0	
		M	94	4	197.4		16	123.4		2	164.5		5	617.0		26	152.8	
		S	53	1	87.5	203.7	8	109.4	116.7	0		226.3	4	875.5	679.0	13	135.5	156.3
5/1	5/2	S	104	7	124.3		16	109.3		2	177.6		4	177.6		27	117.9	
		N	92	4	80.3		15	115.8		1	100.4		0			20	98.7	
		M	130	6	85.2	96.3	21	114.7	113.3	1	71.0	113.3	4	142.1	113.3	30	104.8	107.3
5/8	5/9	S	115	7	118.6		18	140.2		1	27.8		1	32.5		25	104.7	
		M	108	6	108.2		13	107.9		2	59.3		7	242.0		28	124.9	
		N	176	5	55.3	87.9	20	101.8	114.5	1	18.2	32.1	9	190.9	159.1	34	93.1	105.0
5/12	5/13	S	57	6	297.7		5	57.9		1	173.7		2	69.5		14	99.2	
		M	45	3	188.6		4	58.7		1	220.0		3	132.0		10	89.8	
		N	76	5	186.1	222.5	13	112.9	81.6	1	130.3	166.9	0		55.6	19	101.0	97.6
5/19	5/20	N	105	7	132.2		5	70.8		4	90.7		2	50.4		17	89.6	
		M	106	4	74.8		9	126.3		2	44.9		3	74.8		17	88.8	
		S	67	2	59.2	92.7	6	133.2	107.0	2	71.0	68.5	1	39.5	57.1	11	90.9	89.6
5/20	5/21	S	161	4	63.9		27	107.7		2	79.8		8	91.2		39	94.3	
		M	58	2	88.6		6	66.5		2	221.6		1	31.7		10	67.1	
		N	32	0		61.4	4	80.3	94.7	3	602.3	179.2	0		65.8	7	85.2	86.9
5/26	5/27	M	239	6	116.9		47	87.6		8	171.4		8	81.6		65	94.7	
		N	208	3	67.1		44	94.2		5	123.1		9	105.5		57	95.4	
		S	142	7	229.4	126.4	30	94.1	91.5	2	72.1	130.4	5	85.8	91.1	40	98.1	95.8
Total/GeoMean			2,247	93	116.4	115.6	341	117.5	116.0	47	110.8	111.9	81	123.7	107.4	535	112.0	109.4
30%Total/GeoMean			4,843	178	109.1	87.4	808	99.3	100.5	88	118.8	107.0	167	119.0	113.4	1,175	96.1	96.5

Appendix Table A7. Continued.

Daytime 64% Spill Condition																		
Tailrace																		
			Bonneville 1			Bonneville 2			Jones Beach			Bird colonies			Total*		
Tag date	Rel. date	Rel. no.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.
4/21	4/23	37	2	0.054		13	0.351		1	0.027		0			16	0.432	
		18	0			5	0.278		0			0			5	0.278	
		5	0		0.033	1	0.200	0.317	0		0.017	0		---	1	0.200	0.367
4/27	4/29	103	8	0.078		12	0.117		1	0.010		3	0.029		24	0.233	
		26	1	0.038		6	0.231		0			1	0.038		8	0.308	
		21	3	0.143	0.080	1	0.048	0.127	0		0.007	1	0.048	0.033	5	0.238	0.247
4/28	4/30	69	4	0.058		9	0.130		0			3	0.043		16	0.232	
		177	8	0.045		30	0.169		1	0.006		5	0.028		44	0.249	
		130	12	0.092	0.064	23	0.177	0.165	2	0.015	0.008	4	0.031	0.032	39	0.300	0.263
5/4	5/5	173	7	0.040		49	0.283		2	0.012		9	0.052		64	0.370	
		243	9	0.037		55	0.226		1	0.004		7	0.029		71	0.292	
		164	7	0.043	0.040	41	0.250	0.250	3	0.018	0.010	1	0.006	0.029	50	0.305	0.319
5/10	5/12	100	2	0.020		15	0.150		1	0.010		0			18	0.180	
		336	12	0.036		46	0.137		4	0.012		9	0.027		69	0.205	
		232	12	0.052	0.039	37	0.159	0.147	3	0.013	0.012	3	0.013	0.018	55	0.237	0.213
5/16	5/18	80	2	0.025		21	0.263		0			1	0.013		24	0.300	
		168	8	0.048		42	0.250		0			2	0.012		52	0.310	
		127	6	0.047	0.043	36	0.283	0.264	3	0.024	0.008	3	0.024	0.016	47	0.370	0.328
5/22	5/24	149	5	0.034		39	0.262		0			8	0.054		50	0.336	
		103	4	0.039		34	0.330		1	0.010		3	0.029		41	0.398	
		124	3	0.024	0.032	32	0.258	0.279	0		0.003	2	0.016	0.035	36	0.290	0.338
5/27	5/29	159	3	0.019		29	0.182		0			13	0.082		41	0.258	
		114	2	0.018		26	0.228		0			8	0.070		34	0.298	
		266	4	0.015	0.017	59	0.222	0.212	0			19	0.071	0.074	75	0.282	0.278
Total/GeoMean		3,124	124	0.039	0.040	661	0.201	0.210	23	0.012	0.008	105	0.029	0.030	885	0.281	0.290

Appendix Table A7. Continued.

				Daytime 64% Spill Condition Spillway														
				Bonneville 1			Bonneville 2			Jones Beach			Bird colonies			Total*		
Tag date	Rel. date	Loc. N, M, S	Rel. no.	Det.	Relative %Surv	Ave %Surv	Det.	Relative %Surv	Ave %Surv	Det.	Relative %Surv	Ave %Surv	Det.	Relative %Surv	Ave %Surv	Det.	Relative %Surv	Ave %Surv
4/21	4/23	M	21	2	285.7		2	30.1		1	285.7		1	---		6	77.9	
		S	33	4	363.6		8	76.6		0			0			12	99.2	
		N	8	1	375.0	338.7	1	39.5	56.0	1	750.0	193.5	0		---	3	102.3	92.4
4/27	4/29	M	47	1	26.6		6	100.8		0			3	191.5		9	77.6	
		S	30	1	41.7		6	157.9		2	1000.0		1	100.0		8	108.1	
		N	142	11	96.8	74.2	19	105.6	111.8	1	105.6	205.5	4	84.5	109.6	34	97.1	94.4
4/28	4/30	S	92	2	34.1		14	92.3		0			4	136.2		20	82.6	
		M	94	1	16.7		16	103.2		0			3	100.0		20	80.8	
		N	120	6	78.3	46.1	22	111.2	103.1	1	104.4	41.0	1	26.1	81.9	30	94.9	86.9
5/4	5/5	M	157	8	128.5		27	68.8		1	61.6		6	130.4		38	75.9	
		S	85	6	178.0		15	70.6		1	113.7		0			22	81.1	
		N	199	12	152.1	148.7	40	80.4	74.4	1	48.6	65.8	3	51.4	69.6	54	85.1	81.0
5/10	5/12	N	146	5	88.0		14	65.4		1	57.2		2	76.3		22	70.9	
		M	208	7	86.5		20	65.5		5	200.7		4	107.1		36	81.4	
		S	203	6	75.9	83.0	24	80.6	71.0	1	41.1	104.9	7	192.0	129.9	38	88.1	81.1
5/16	5/18	N	125	2	37.5		25	75.8		4	400.0		2	100.0		32	78.0	
		M	134	2	35.0		19	53.7		0			3	139.9		23	52.3	
		S	77	4	121.8	55.8	15	73.8	66.5	0		148.8	5	405.8	186.0	22	87.1	69.9
5/22	5/24	S	118	4	106.2		27	81.9		1	318.6		4	98.0		33	82.8	
		N	165	6	113.9		51	110.7		1	227.9		8	140.2		65	116.6	
		M	191	4	65.6	92.5	56	105.0	101.2	3	590.6	396.6	4	60.6	97.6	65	100.8	101.8
5/27	5/29	S	128	2	93.6		27	99.7		0			9	94.7		36	101.1	
		M	112	2	106.9		19	80.2		0			3	36.1		23	73.8	
		N	278	1	21.5	57.8	68	115.7	104.1	0			21	101.8	85.8	84	108.6	99.2
Total/GeoMean			2,913	100	82.6	89.9	541	80.7	83.6	25	155.2	131.0	98	100.0	103.4	735	86.5	87.7

Appendix Table A7. Continued.

Nighttime 64% Spill Condition																		
Tailrace																		
			Bonneville 1			Bonneville 2			Jones Beach			Bird colonies			Total*		
Tag date	Rel. date	Rel. no.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.
4/22	4/23	10	0			1	0.100		0			1	0.100		2	0.200	
		30	3	0.100		5	0.167		0			1	0.033		9	0.300	
		27	4	0.148	0.104	1	0.037	0.104	0		---	0		0.030	5	0.185	0.239
4/29	4/30	149	14	0.094		14	0.094		3	0.020		2	0.013		33	0.221	
		54	0			11	0.204		0			0			11	0.204	
		158	9	0.057	0.064	28	0.177	0.147	1	0.006	0.011	4	0.025	0.017	40	0.253	0.233
5/4	5/5	172	6	0.035		37	0.215		2	0.012		4	0.023		49	0.285	
		230	13	0.057		56	0.243		1	0.004		10	0.043		78	0.339	
		133	6	0.045	0.047	30	0.226	0.230	2	0.015	0.009	4	0.030	0.034	41	0.308	0.314
5/5	5/6	294	13	0.044		49	0.167		6	0.020		8	0.027		72	0.245	
		309	18	0.058		66	0.214		9	0.029		9	0.029		97	0.314	
		310	5	0.016	0.039	69	0.223	0.202	6	0.019	0.023	5	0.016	0.024	83	0.268	0.276
5/11	5/12	89	0			22	0.247		2	0.022		2	0.022		23	0.258	
		35	1	0.029		9	0.257		1	0.029		1	0.029		12	0.343	
		59	1	0.017	0.011	17	0.288	0.262	2	0.034	0.027	0		0.016	20	0.339	0.301
5/17	5/18	54	3	0.056		17	0.315		0			2	0.037		21	0.389	
		68	1	0.015		18	0.265		1	0.015		1	0.015		20	0.294	
		41	2	0.049	0.037	14	0.341	0.301	1	0.024	0.012	1	0.024	0.025	18	0.439	0.362
5/20	5/22	54	3	0.056		13	0.241		0			2	0.037		18	0.333	
		75	2	0.027		13	0.173		1	0.013		0			16	0.213	
		98	5	0.051	0.044	18	0.184	0.194	1	0.010	0.009	6	0.061	0.035	30	0.306	0.282
5/28	5/29	213	3	0.014		54	0.254		0			11	0.052		63	0.296	
		241	9	0.037		57			0			13	0.054		76	0.315	
		79	0		0.023	14		0.235	0		---	8	0.101	0.060	21	0.266	0.300
Total/GeoMean		2,982	121	0.041	0.042	633	0.193	0.200	39	0.016	0.014	95	0.033	0.028	858	0.282	0.286
64%Total/GeoMean		6,106	245	0.040	0.041	1,294	0.197	0.205	62	0.014	0.010	200	0.031	0.029	1,743	0.281	0.288

Appendix Table A7. Continued.

Nighttime 64% Spill Condition																		
Spillway																		
				Bonneville 1			Bonneville 2			Jones Beach			Bird colonies			Total*		
Tag date	Rel. date	Loc. N, M, S	Rel. no.	Det.	Relative %Surv	Ave %Surv	Det.	Relative %Surv	Ave %Surv	Det.	Relative %Surv	Ave %Surv	Det.	Relative %Surv	Ave %Surv	Det.	Relative %Surv	Ave %Surv
4/22	4/23	S	18	2	106.3		2	106.3		0	---		1	186.1		4	93.1	
		N	58	4	66.0		6	99.0		1	---		2	115.5		13	93.9	
		M	86	3	33.4	53.2	17	189.2	147.7	2	---	---	2	77.9	103.4	23	112.0	103.4
4/29	4/30	M	64	3	73.6		9	95.8		0	---		1	94.0		12	80.6	
		S	174	4	36.1		23	90.0		2	103.7		2	69.2		29	71.6	
		N	184	8	68.2	55.8	38	140.7	113.0	4	196.2	128.3	9	294.3	171.1	58	135.5	100.8
5/4	5/5	N	241	11	97.7		47	84.8		6	266.4		11	135.7		74	97.8	
		M	179	9	107.6		39	94.8		1	59.8		8	132.8		56	99.6	
		S	270	7	55.5	83.7	55	88.6	88.9	1	39.6	124.1	6	66.0	107.7	68	80.2	91.4
5/5	5/6	S	346	15	109.9		70	100.4		9	113.1		11	131.9		98	102.6	
		M	297	12	102.5		61	101.9		6	87.8		8	111.8		85	103.7	
		N	335	15	113.6	108.9	56	82.9	94.9	13	168.7	124.5	9	111.5	118.8	87	94.1	100.0
5/11	5/12	M	95	3	288.9		15	60.2		3	115.6		1	64.2		20	70.0	
		N	67	1	136.6		14	79.7		3	163.9		1	91.0		18	89.4	
		S	67	0		159.8	16	91.0	74.9	1	54.6	111.9	4	364.2	159.8	17	84.4	79.9
5/17	5/18	S	70	2	77.6		14	66.5		0			1	58.2		16	63.1	
		N	37	0			13	116.9		0			1	110.1		14	104.5	
		M	82	2	66.3	57.5	23	93.3	88.0	4	397.6	172.5	4	198.8	129.4	32	107.8	90.6
5/20	5/22	M	57	0			15	135.8		1	199.1		5	248.9		21	130.7	
		S	63	3	108.1		15	122.8		3	540.5		1	45.0		20	112.6	
		N	107	8	169.7	110.0	22	106.1	118.2	2	212.1	300.0	2	53.0	100.0	32	106.1	114.1
5/28	5/29	M	185	4	96.0		47	108.3		0			13	117.0		60	108.0	
		S	55	0			18	139.5		0			0			16	96.9	
		N	302	13	191.2	139.3	75	105.9	110.1	0			23	126.9	110.6	104	114.7	110.6
Total/GeoMean			3,439	129	92.6	88.6	710	101.1	102.4	62	142.5	150.2	126	111.6	125.9	977	96.5	98.3
64%Total/GeoMean			6,352	229	87.0	89.3	1,251	90.3	92.5	87	159.9	139.5	224	105.6	114.1	1,712	91.3	92.9

[a] Total (used for combined analysis) is the number of unique tags observed at any of the sites. Multiple observations of a tag are not counted. Numbers observed at individual sites may include tags observed at other sites, and these data are used to make the inter-site comparisons.

Appendix Table A8. Detection numbers, and survival percents for subyearling chinook salmon at each site, separated by passage condition at release; summer 1999.

Daytime 30% Spill Condition
Tailrace

			Bonneville 1			Bonneville 2			Bird colonies			Total*		
Tag date	Rel. date	Rel. no.	Det.	Prop.	Ave Prop.	De t.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.
6/17	6/19	992	34	0.034		64	0.065		13	0.013		109	0.110	
		998	27	0.027		65	0.065		11	0.011		101	0.101	
		995	34	0.034	0.032	53	0.053	0.061	17	0.017	0.014	103	0.104	0.105
6/23	6/25	998	28	0.028		64	0.064		12	0.012		103	0.103	
		996	38	0.038		52	0.052		8	0.008		97	0.097	
		993	30	0.030	0.032	56	0.056	0.058	17	0.017	0.012	102	0.103	0.101
6/28	6/30	997	19	0.019		153	0.153		15	0.015		185	0.186	
		992	32	0.032		131	0.132		22	0.022		182	0.183	
		993	27	0.027	0.026	93	0.094	0.126	15	0.015	0.017	134	0.135	0.168
6/30	7/2	986	25	0.025		109	0.111		23	0.023		152	0.154	
		994	19	0.019		119	0.120		17	0.017		152	0.153	
		976	12	0.012	0.019	121	0.124	0.118	27	0.028	0.023	158	0.162	0.156
7/6	7/8	992	20	0.020		143	0.144		18	0.018		180	0.181	
		993	17	0.017		155	0.156		18	0.018		185	0.186	
		1000	16	0.016	0.018	143	0.143	0.148	11	0.011	0.016	169	0.169	0.179
7/12	7/14	992	19	0.019		170	0.171		15	0.015		203	0.205	
		998	12	0.012		157	0.157		12	0.012		176	0.176	
		998	15	0.015	0.015	154	0.154	0.161	10	0.010	0.012	179	0.179	0.187
7/17	7/19	991	34	0.034		85	0.086		10	0.010		126	0.127	
		991	22	0.022		102	0.103		14	0.014		135	0.136	
		993	22	0.022	0.026	97	0.098	0.095	11	0.011	0.012	127	0.128	0.130
Total/GeoMean		20,858	502	0.023		2,286	0.102		316	0.014		3,058	0.143	

Appendix Table A8. Continued.

							Daytime 30% Spill Condition								
							Spillway								
					Bonneville 1			Bonneville 2			Bird colonies			Total*	
Tag	Rel.	Loc.	Rel.		Relative	Ave		Relative	Ave		Relative	Ave		Relative	Ave
date	date	N,M,S	no.	Det.	%Surv	%Surv	Det.	%Surv	%Surv	Det.	%Surv	%Surv	Det.	%Surv	%Surv
6/17	6/19	M	998	22	69.3		66	108.5		17	124.0		102	97.5	
		S	994	29	91.7		81	133.7		22	161.1		129	123.8	
		N	995	30	94.7	85.2	69	113.7	118.6	16	117.1	134.1	111	106.4	109.2
6/23	6/25	S	997	20	62.4		57	99.3		18	145.8		91	90.3	
		M	995	35	109.4		55	96.0		16	129.8		104	103.4	
		N	992	19	59.6	77.2	76	133.0	109.4	12	97.7	124.4	107	106.7	100.1
6/28	6/30	M	998	26	99.6		125	99.1		17	97.7		164	97.8	
		S	994	30	115.4		103	82.0		20	115.4		150	89.8	
		N	988	24	92.9	102.6	137	109.7	96.9	11	63.8	92.4	171	103.0	96.9
6/30	7/2	S	990	16	85.3		114	97.5		26	115.9		154	99.5	
		M	984	37	198.5		109	93.8		23	103.1		164	106.6	
		N	986	43	230.2	171.2	105	90.2	93.9	23	102.9	107.3	171	111.0	105.7
7/6	7/8	N	996	15	84.8		117	79.5		13	82.9		141	79.1	
		M	998	17	95.9		118	80.0		12	76.4		146	81.8	
		S	991	18	102.3	94.3	113	77.2	78.9	16	102.5	87.2	144	81.2	80.7
7/12	7/14	S	996	13	84.8		143	89.2		11	89.2		164	88.2	
		N	996	16	104.3		111	69.2		4	32.4		131	70.4	
		M	996	10	65.2	84.8	151	94.2	84.2	7	56.8	59.5	167	89.8	82.8
7/17	7/19	S	989	25	96.4		91	96.4		12	103.1		128	99.2	
		N	990	15	57.8		76	80.4		15	128.8		105	81.3	
		M	991	19	73.1	75.8	96	101.5	92.8	15	128.7	120.2	127	98.3	92.9
Total/GeoMean			20,854	479	92.6		2,113	95.1		326	98.3		2,871	94.7	94.9

Appendix Table A8. Continued.

Nighttime 30% Spill Condition
Tailrace

			Bonneville 1			Bonneville 2			Bird colonies			Total*		
Tag date	Rel. date	Rel. no.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.
6/18	6/19	988	18	0.018		51	0.052		19	0.019		88	0.089	
		998	15	0.015		71	0.071		17	0.017		100	0.100	
		993	25	0.025	0.019	49	0.049	0.057	19	0.019	0.018	91	0.092	0.094
6/24	6/25	988	15	0.015		91	0.092		15	0.015		118	0.119	
		991	15	0.015		94	0.095		17	0.017		125	0.126	
		994	14	0.014	0.015	101	0.102	0.096	22	0.022	0.018	132	0.133	0.126
6/29	6/30	995	13	0.013		97	0.097		22	0.022		130	0.131	
		987	35	0.035		112	0.113		23	0.023		164	0.166	
		996	14	0.014	0.021	122	0.122	0.111	23	0.023	0.023	157	0.158	0.151
7/1	7/2	982	18	0.018		110	0.112		24	0.024		147	0.150	
		993	15	0.015		149	0.150		26	0.026		187	0.188	
		975	19	0.019	0.018	133	0.136	0.133	23	0.024	0.025	170	0.174	0.171
7/7	7/8	995	23	0.023		136	0.137		15	0.015		170	0.171	
		997	9	0.009		151	0.151		21	0.021		176	0.177	
		999	18	0.018	0.017	151	0.151	0.146	17	0.017	0.018	182	0.182	0.177
7/13	7/14	999	15	0.015		68	0.068		9	0.009		91	0.091	
		996	10	0.010		84	0.084		9	0.009		102	0.102	
		975	9	0.009	0.011	79	0.081	0.078	6	0.006	0.008	92	0.094	0.096
7/18	7/19	988	28	0.028		66	0.067		5	0.005		99	0.100	
		981	27	0.028		57	0.058		14	0.014		96	0.098	
		995	17	0.017	0.024	59	0.059	0.061	12	0.012	0.010	87	0.087	0.095
Total/GeoMean		20,805	372	0.017	0.017	2,031	0.092	0.092	358	0.016	0.016	2,704	0.125	0.126
30%Tot/GeoMean		41,663	874	0.020	0.020	4,317	0.097	0.097	674	0.015	0.015	5,762	0.134	0.134

Appendix Table A8. Continued.

							Nighttime 30% Spill Condition								
							Spillway								
					Bonneville 1			Bonneville 2			Bird colonies			Total*	
Tag	Rel.	Loc.	Rel.		Relative	Ave		Relative	Ave		Relative	Ave		Relative	Ave
date	date	N,M,S	no.	Det.	%Surv	%Surv	Det.	%Surv	%Surv	Det.	%Surv	%Surv	Det.	%Surv	%Surv
6/18	6/19	S	997	32	164.9		82	143.3		12	65.2		125	133.9	
		N	996	22	113.5		69	120.7		14	76.1		105	112.6	
		M	990	22	114.1	130.9	81	142.5	135.5	9	49.2	63.6	110	118.6	121.7
6/24	6/25	M	988	18	123.1		91	95.7		19	105.9		126	101.1	
		S	995	20	135.8		92	96.1		20	110.7		130	103.6	
		N	995	17	115.4	124.8	102	106.6	99.5	18	99.6	105.4	131	104.4	103.0
6/29	6/30	N	990	39	189.2		136	123.6		24	106.2		193	128.7	
		M	993	17	82.2		117	106.0		23	101.4		155	103.1	
		S	992	26	125.9	132.4	146	132.4	120.7	23	101.5	103.0	190	126.5	119.4
7/1	7/2	M	981	13	75.2		128	98.2		25	103.0		165	98.4	
		S	984	19	109.5		132	101.0		26	106.8		172	102.3	
		N	994	8	45.7	76.7	123	93.1	97.4	22	89.4	99.7	146	86.0	95.5
7/7	7/8	M	991	9	54.3		168	115.8		14	79.7		188	107.5	
		N	997	9	54.0		116	79.5		11	62.3		134	76.1	
		S	996	8	48.0	52.1	123	84.3	93.1	18	102.0	81.3	147	83.6	89.0
7/13	7/14	M	994	13	114.2		87	112.5		10	124.5		108	113.2	
		S	995	10	87.8		94	121.5		12	149.2		116	121.5	
		N	983	15	133.3	111.7	95	124.3	119.4	7	88.1	120.8	116	123.0	119.2
7/18	7/19	S	986	20	83.5		47	77.6		11	106.7		76	81.0	
		M	991	16	66.5		69	113.4		7	67.5		92	97.6	
		N	993	36	149.2	99.8	46	75.4	88.8	12	115.5	96.6	93	98.4	92.4
Total/GeoMean			20,821	389	96.5	99.5	2,144	106.0	106.6	337	92.9	94.1	2,818	104.6	105.0
30%Tot/GeoMean			41,675	868	94.5	97.2	4,257	100.4	100.9	663	95.5	97.2	5,689	99.5	99.8

Appendix Table A8. Continued.

Daytime 64% Spill Condition
Tailrace

			Bonneville 1			Bonneville 2			Bird colonies			Total*		
Tag date	Rel. date	Rel. no.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.
6/20	6/22	998	27	0.027		94	0.094		15	0.015		134	0.134	
		996	23	0.023		87	0.087		15	0.015		125	0.126	
		997	32	0.032	0.027	101	0.101	0.094	12	0.012	0.014	142	0.142	0.134
6/21	6/23	998	28	0.028		36	0.036		11	0.011		75	0.075	
		987	34	0.034		44	0.045		9	0.009		87	0.088	
		997	33	0.033	0.032	32	0.032	0.038	15	0.015	0.012	78	0.078	0.080
6/25	6/27	994	25	0.025		103	0.104		16	0.016		142	0.143	
		996	20	0.020		113	0.113		18	0.018		148	0.149	
		990	24	0.024	0.023	80	0.081	0.099	20	0.020	0.018	124	0.125	0.139
7/2	7/4	988	24	0.024		105	0.106		30	0.030		152	0.154	
		995	28	0.028		107	0.108		32	0.032		160	0.161	
		995	21	0.021	0.025	95	0.095	0.103	30	0.030	0.031	143	0.144	0.153
7/8	7/10	992	15	0.015		162	0.163		8	0.008		184	0.185	
		991	17	0.017		138	0.139		12	0.012		165	0.166	
		999	12	0.012	0.015	144	0.144	0.149	7	0.007	0.009	161	0.161	0.171
7/9	7/11	994	20	0.020		167	0.168		7	0.007		192	0.193	
		994	25	0.025		153	0.154		7	0.007		185	0.186	
		996	33	0.033	0.026	167	0.168	0.163	6	0.006	0.007	206	0.207	0.195
7/15	7/17	989	26	0.026		105	0.106		9	0.009		139	0.141	
		993	20	0.020		125	0.126		11	0.011		153	0.154	
		991	25	0.025	0.024	123	0.124	0.119	12	0.012	0.011	158	0.159	0.151
Total/GeoMean		20,870	512	0.024		2,281	0.100		302	0.013		3,053	0.142	

Appendix Table A8. Continued.

							Daytime 64% Spill Condition								
							Spillway								
					Bonneville 1			Bonneville 2			Bird colonies			Total*	
Tag	Rel.	Loc.	Rel.		Relative	Ave		Relative	Ave		Relative	Ave		Relative	Ave
date	date	N,M,S	no.	Det.	%Surv	%Surv	Det.	%Surv	%Surv	Det.	%Surv	%Surv	Det.	%Surv	%Surv
6/20	6/22	S	998	20	73.1		106	112.7		14	99.9		138	103.1	
		M	1000	34	124.0		80	84.9		19	135.3		133	99.2	
		N	995	31	113.6	103.6	83	88.5	95.3	20	143.1	126.1	134	100.5	100.9
6/21	6/23	N	987	33	104.9		34	91.7		14	120.9		80	100.7	
		M	993	32	101.2		41	109.9		16	137.3		88	110.1	
		S	992	16	50.6	85.6	31	83.2	95.0	5	42.9	100.3	52	65.1	92.0
6/25	6/27	N	991	28	122.0		95	96.5		18	100.2		136	98.8	
		M	994	19	82.6		115	116.5		14	77.7		146	105.7	
		S	990	16	69.8	91.5	93	94.6	102.5	16	89.2	89.0	118	85.8	96.8
7/2	7/4	S	996	17	69.6		84	81.8		33	107.2		130	85.4	
		N	1000	16	65.3		114	110.6		26	84.2		154	100.8	
		M	996	20	81.9	72.3	117	113.9	102.1	26	84.5	92.0	159	104.5	96.9
7/8	7/10	S	997	17	115.6		137	92.3		8	88.6		161	94.4	
		M	993	16	109.2		132	89.3		8	89.0		156	91.9	
		N	992	11	75.2	100.0	135	91.4	91.0	13	144.7	107.4	158	93.1	93.1
7/9	7/11	M	982	21	81.8		136	84.9		9	136.7		163	85.0	
		S	999	24	91.9		122	74.8		10	149.3		155	79.4	
		N	994	20	77.0	83.6	134	82.6	80.7	12	180.1	155.5	163	83.9	82.8
7/15	7/17	S	999	16	67.1		138	116.3		17	158.1		168	111.1	
		M	991	17	71.8		99	84.1		8	75.0		122	81.3	
		N	991	27	114.1	84.3	125	106.2	102.3	10	93.8	109.1	161	107.3	100.0
Total/GeoMean			20,870	451	86.2		2,151	94.7		316	106.0		2,875	93.9	94.5

Appendix Table A8. Continued.

Nighttime 64% Spill Condition
Tailrace

			Bonneville 1			Bonneville 2			Bird colonies			Total*		
Tag date	Rel. date	Rel. no.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.	Det.	Prop.	Ave Prop.
6/16	6/17	998	17	0.017		69	0.069		14	0.014		96	0.096	
		992	17	0.017		75	0.076		16	0.016		106	0.107	
		998	21	0.021	0.018	70	0.070	0.072	18	0.018	0.016	107	0.107	0.103
6/22	6/23	992	22	0.022		66	0.067		11	0.011		99	0.100	
		994	24	0.024		57	0.057		6	0.006		86	0.087	
		995	15	0.015	0.020	70	0.070	0.065	9	0.009	0.009	93	0.093	0.093
6/26	6/27	998	20	0.020		124	0.124		17	0.017		158	0.158	
		994	22	0.022		94	0.095		20	0.020		134	0.135	
		991	14	0.014	0.019	124	0.125	0.115	20	0.020	0.019	154	0.155	0.150
7/3	7/4	989	20	0.020		122	0.123		30	0.030		171	0.173	
		997	35	0.035		142	0.142		22	0.022		194	0.195	
		997	19	0.019	0.025	144	0.144	0.137	25	0.025	0.026	181	0.182	0.183
7/10	7/11	989	18	0.018		110	0.111		6	0.006		134	0.135	
		993	11	0.011		121	0.122		7	0.007		138	0.139	
		984	16	0.016	0.015	126	0.128	0.120	6	0.006	0.006	148	0.150	0.142
7/14	7/15	993	18	0.018		94	0.095		7	0.007		118	0.119	
		985	15	0.015		86	0.087		17	0.017		117	0.119	
		991	11	0.011	0.015	91	0.092	0.091	11	0.011	0.012	110	0.111	0.116
7/16	7/17	984	18	0.018		73	0.074		13	0.013		102	0.104	
		989	9	0.009		89	0.090		13	0.013		110	0.111	
		985	12	0.012	0.013	95	0.096	0.087	14	0.014	0.014	120	0.122	0.112
Total/GeoMean		20,828	374	0.017	0.018	2,042	0.095	0.095	302	0.013	0.013	2,676	0.125	0.125
64%Tot/GeoMean		41,698	886	0.020	0.021	4,323	0.097	0.098	604	0.013	0.013	5,729	0.133	0.133

Appendix Table A8. Continued.

							Nighttime 64% Spill Condition								
							Spillway								
					Bonneville 1			Bonneville 2			Bird colonies			Total*	
Tag	Rel.	Loc.	Rel.		Relative	Ave		Relative	Ave		Relative	Ave		Relative	Ave
date	date	N,M,S	no.	Det.	%Surv	%Surv	Det.	%Surv	%Surv	Det.	%Surv	%Surv	Det.	%Surv	%Surv
6/16	6/17	S	999	24	130.5		71	99.2		19	118.4		111	107.4	
		M	998	15	81.7		56	78.3		16	99.8		87	84.3	
		N	988	22	121.0	111.0	77	108.8	95.4	17	107.1	108.4	114	111.6	101.1
6/22	6/23	M	992	31	152.7		52	81.0		11	127.1		94	101.6	
		N	957	18	91.9		47	75.9		17	203.7		81	90.8	
		S	997	15	73.5	106.2	56	86.8	81.3	9	103.5	144.0	79	85.0	92.5
6/26	6/27	S	989	15	80.8		132	116.4		27	142.9		170	115.0	
		N	993	9	48.3		112	98.4		15	79.1		135	90.9	
		M	999	16	85.3	71.5	106	92.5	102.4	19	99.5	107.1	138	92.4	99.4
7/3	7/4	S	998	11	44.4		137	100.4		21	81.5		165	90.3	
		M	995	15	60.8		112	82.3		33	128.5		157	86.2	
		N	993	19	77.1	60.7	130	95.7	92.8	23	89.7	99.9	169	93.0	89.8
7/10	7/11	N	998	13	85.9		109	90.7		9	140.8		129	91.3	
		M	983	11	73.8		106	89.6		9	142.9		124	89.1	
		S	997	9	59.5	73.0	136	113.3	97.9	8	125.3	136.3	151	107.0	95.8
7/14	7/15	N	998	17	114.9		87	95.5		6	51.0		109	94.0	
		M	986	16	109.5		83	92.2		11	94.6		110	96.0	
		S	987	15	102.5	109.0	97	107.7	98.5	15	128.9	91.4	125	109.0	99.6
7/16	7/17	M	989	9	69.0		114	132.7		20	149.5		137	123.4	
		S	999	8	60.7		100	115.2		8	59.2		116	103.5	
		N	986	13	100.0	76.5	96	112.1	120.0	10	75.0	94.5	119	107.5	111.4
Total/GeoMean			20,821	321	82.8	84.7	2,016	97.3	97.7	323	106.5	110.1	2,620	98.0	98.3
64%Tot/GeoMean			41,691	772	84.4	86.4	4,167	96.0	96.5	639	106.2	109.8	5,495	95.9	96.4

* Total (used for combined analysis) is the number of unique tags observed at any of the sites. Multiple observations of a tag are not counted. Numbers observed at individual sites may include tags observed at other sites, and these data are used to make the inter-site comparisons.

APPENDIX B

Statistical Analyses of Pit-Tag Interrogation Data, Fork Length Data, and Passage-Condition Data in Relation to Relative Survival for The Dalles Dam Juvenile Passage Survival Study, 1999

Appendix Table B1. Means, Confidence Intervals (CI), *t*-tests, and Analysis of Variance for PIT-tag interrogations of The Dalles Dam passage survival study for spring migrating juvenile salmon at Bonneville Dam, Jones Beach, bird colonies, and combined data, 1999.

Paried *t*-tests

Bonneville PH1 vs. Bonneville PH2

Total detections (n = 5,210) vs. (n = 17,428)

	N	Mean	SD	SE Mean
Ln Bon PH1 Surv.	96	-0.105	0.234	0.024
Ln Bon PH2 Surv.	96	-0.075	0.1845	0.019
		Back Transformed		
Bon. First	0.901		2.078	0.212
Bon. Sec.	0.928		1.677	0.171

t = -1.03 P = 0.30

Bonneville Subtotal vs. Jones Beach

Total detections (n = 22,638) vs. (n = 1,909)

	N	Mean	SD	SE Mean
Ln Bon Surv.	89	-0.0806	0.1589	0.0168
Ln JB Surv.	89	-0.0151	0.4426	0.0469
		Back Transformed		
Bonneville	0.923		1.379	0.1462
Jones Beach	0.985		4.113	0.4360

t = -0.13 P = 0.19

Bonneville Subtotal vs. Bird Colony

Total detections (n = 22,638) vs. (n = 4,037)

	N	Mean	SD	SE Mean
Ln Bon Surv.	96	-0.0805	0.1544	0.0158
Ln Brd. Col. Surv.	96	0.1007	0.2905	0.0296
		Back Transformed		
Bonneville	0.913		1.369	0.143
Bird Colony	1.05.9		3.148	0.321

t = -5.75 P = <0.01

Analysis of Variance

Ln Combined Data

Source	DF	Seq SS	Adj SS	MS	F	P
Julian	1	0.0443	0.0553	0.0553	4.2	0.04
Spill (%)	1	0.0173	0.0167	0.0167	1.3	0.26
Diel	1	0.5976	0.5974	0.5974	45	<0.01
Location	2	0.0022	0.0022	0.0011	0.1	0.92
Spill (%) x Diel	1	0.0013	0.0013	0.0013	0.1	0.75
Spill (%) x Loc	2	0.0641	0.0641	0.032	2.4	0.10
Diel x Loc	2	0.038	0.038	0.019	1.4	0.24
Error	85	1.1237	1.1237	0.0132		
Total	95	1.8882				

Adj. Means & CI			Back Transformed			*t* statist			Back Transformed	
Spill (%)	Ln Mean	Ln SE	Mean	SE	df	at df	CI -	CI +	CI -	CI +
30% 1	-0.0403	0.0166	0.961	0.016	85	1.988	-0.073	-0.007	0.929	0.993
64% 2	-0.0668	0.0166	0.935	0.016	85	1.988	-0.100	-0.034	0.993	0.967
Diel										
Day 1	-0.1325	0.0166	0.876	0.015	85	1.988	-0.166	-0.099	0.847	0.905
Nite 2	0.0254	0.0166	1.026	0.017	85	1.988	-0.008	0.058	0.992	1.060
Location										
North 1	-0.0472	0.0203	0.954	0.019	85	1.988	-0.088	-0.007	0.916	0.993
Middle 2	-0.0550	0.0203	0.947	0.019	85	1.988	-0.095	-0.015	0.909	0.986
South 3	-0.0585	0.0203	0.943	0.019	85	1.988	-0.099	-0.018	0.906	0.982

Ln Bonneville Subtotal

Source	DF	Seq SS	Adj SS	MS	F	P
Julian	1	0.1109	0.1301	0.1301	8.1	0.01
Spill (%)	1	0.0050	0.0047	0.0047	0.3	0.59
Diel	1	0.6613	0.6610	0.6610	41	<0.01
Location	2	0.0125	0.0125	0.0062	0.4	0.68
Spill (%) x Diel	1	0.0038	0.0038	0.0038	0.2	0.63
Spill (%) x Loc	2	0.0279	0.0279	0.0140	0.9	0.42
Diel x Loc	2	0.0845	0.0845	0.0422	2.6	0.08
Error	85	1.3579	1.3579	0.0160		
Total	95	2.2637				

Adj. Means & CI			Back Transformed			*t* statist			Back Transformed	
Spill (%)	Ln Mean	Ln SE	Mean	SE	df	at df	CI -	CI +	CI -	CI +
30% 1	-0.0740	0.0183	0.929	0.017	85	1.988	-0.110	-0.037	0.896	0.963
64% 2	-0.0880	0.0183	0.916	0.017	85	1.988	-0.124	-0.051	0.884	0.950
Diel										
Day 1	-0.1643	0.0183	0.849	0.015	85	1.988	-0.200	-0.127	0.819	0.881
Nite 2	-0.0026	0.0183	1.003	0.018	85	1.988	-0.034	0.039	0.967	1.040
Location										
North 1	-0.071	0.0223	93.2	0.021	85	1.988	-0.115	-0.026	0.891	0.974
Middle 2	-0.097	0.0223	90.8	0.020	85	1.988	-0.141	-0.052	0.869	0.949
South 3	-0.074	0.0223	0.929	0.021	85	1.988	-0.118	-0.030	0.888	0.971

Appendix Table B1. Continued.

Analysis of Variance

Ln Bird Colony Data

Source	DF	Seq SS	Adj SS	MS	F	P
Julian	1	0	0.0780	0	1	0.34
Spill (%)	1	0	0.1291	0	2	0.22
Diel	1	0	0.2287	0	30.1	
Location	2	0	0.0483	0	0	0.75
Spill (%) x Diel	1	0	0.0800	0	1	0.33
Spill (%) x Loc	2	0	0.1913	0	1	0.33
Diel x Loc	2	0	0.0274	0	0	0.85
Error	85	7	7.2181	0		
Total	95	8				

	Adj. Means & CI			Back Transformed		*t* statist				Back Transformed	
Spill (%)	Ln Mean	Ln SE	Mean	SE	df	at df	CI -	CI +	CI -	CI +
30% 1	0.1375	0.0421	1.1474	0.0483	85	1.988	0.054	0.221	1.055	1.248
64% 2	0.0640	0.0421	1.0661	0.0449	85	1.988	-0.020	0.148	0.980	1.159
Diel										
Day 1	0.0519	0.0421	1.0532	0.0443	85	1.988	-0.032	0.136	0.969	1.145
Nite 2	0.1496	0.0421	1.1613	0.0489	85	1.988	0.066	0.233	1.068	1.263
Location										
North 1	0.0794	0.0515	1.0826	0.0558	85	1.988	-0.023	0.182	0.977	1.199
Middle 2	0.1317	0.0515	1.1408	0.0588	85	1.988	0.029	0.234	1.030	1.264
South 3	0.0911	0.0515	1.0954	0.0564	85	1.988	-0.011	0.194	0.989	1.213

Appendix Table B2. Means, Confidence Intervals (CI), *t*-tests, and Analysis of Variance for PIT-tag interrogations of The Dalles Dam passage survival study comparing spring migrating yearling chinook to coho salmon, 1999.

Paired *t*-test, Chinook combined vs. Coho combined

total detections (n = 22,473) vs. (n = 6,116)

	N	Mean	SD	SE
Ln Chin Surv.	96	-0.064	0.161	0.02
Ln Coho Surv	96	-0.065	0.361	0.04
		Back Transformed		
Chinook		0.938	1.175	1.02
Coho		0.937	1.434	1.04
t =0.03		P = 0.98	DF = 95	

Analysis of Variance

Ln Chinook Salmon Total

Source	DF	Seq SS	Adj SS	MS	F	P
Julian	1	0.0983	0.1140	0.114	5.3	0.02
Spill (%)	1	0.0000	0.0000	0.000	0.0	0.98
Diel	1	0.4069	0.4067	0.407	18.9	<0.01
Location	2	0.0086	0.0086	0.004	0.2	0.82
Spill (%) x Diel	1	0.0025	0.0025	0.003	0.12	0.73
Spill (%) x Loc	2	0.0208	0.0208	0.010	0.48	0.62
Diel x Loc	2	0.0935	0.0935	0.047	2.17	0.12
Error	85	1.8307	1.8307	0.022		
Total	95	2.4613				

Adj. Means & CI			Back Transformed			*t* statist				Back Transformed	
Spill (%)	Ln Mean	Ln SE	Mean	SE	df	at df	CI -	CI +		CI -	CI +
30% 1	-0.0636	0.0212	0.938	0.0199	85	1.988	- 0.106	- 0.021		0.900	0.979
64% 2	-0.0643	0.0212	0.938	0.0199	85	1.988	- 0.106	- 0.022		0.899	0.978
Diel											
Day 1	-0.1291	0.0212	0.879	0.0186	85	1.988	- 0.171	- 0.087		0.843	0.917
Nite 2	0.0012	0.0212	1.001	0.0212	85	1.988	- 0.041	0.043		0.960	1.044
Location											
North 1	-0.0691	0.0259	0.933	0.0242	85	1.988	- 0.121	- 0.018		0.886	0.983
Middle 2	-0.0721	0.0259	0.930	0.0241	85	1.988	- 0.124	- 0.021		0.884	0.980
South 3	-0.0506	0.0259	0.951	0.0247	85	1.988	- 0.102	0.001		0.903	1.001

Ln Coho Salmon Total

Source	DF	Seq SS	Adj SS	MS	F	P
Julian	1	0.014	0 .003	0.003	0.02	0.89
Spill (%)	1	0.067	0.065	0.065	0.51	0.48
Diel	1	1.026	1.029	1.029	8.09	0.01
Location	2	0.031	0.031	0.015	0.1	0.89
Spill (%) x Diel	1	0.227	0.227	0.227	1.78	0.19
Spill (%) x Loc	2	0.116	0.116	0.058	0.46	0.64
Diel x Loc	2	0.065	0.065	0.032	0.25	0.78
Error	85	10.819	10.819	0.127		
Total	95	12.364				

Adj. Means & CI			Back Transformed			*t* statist				Back Transformed	
Spill (%)	Ln Mean	Ln SE	Mean	SE	df	at df	CI -	CI +		CI -	CI +
30% 1	-0.0390	0.0515	0.962	0.0496	85	1.988	- 0.141	0.063		0.868	1.066
64% 2	-0.0910	0.0515	0.913	0.0471	85	1.988	- 0.193	0.011		0.824	1.012
Diel											
Day 1	-0.1687	0.0515	0.845	0.0435	85	1.988	- 0.271	- 0.066		0.763	0.936
Nite 2	0.0386	0.0515	1.039	0.0535	85	1.988	- 0.064	0.141		0.938	1.151
Location											
North 1	-0.0401	0.0631	0.961	0.0606	85	1.988	- 0.166	0.085		0.847	1.089
Middle 2	-0.0740	0.0631	0.929	0.0586	85	1.988	- 0.199	0.051		0.819	1.053
South 3	-0.0809	0.0631	0.922	0.0582	85	1.988	- 0.206	0.045		0.814	1.046

Appendix Table B3. PIT-tag detections in relation to size at release comparing proportions above and below the critical size for radio telemetry evaluations; chinook salmon from The Dalles Dam passage survival study, spring 1999.

	Fork length < =125 mm					Fork length >125 mm				
		Detected PIT tags [a]					Detected PIT tags [a]			
	Release	Bonneville		Estuary[b]		Release	Bonneville		Estuary [b]	
date	no. [c]	no.	proport.	no.	proport.	no. [c]	no.	proport.	no.	proport.
4/21	25	3	0.120			1,928	358	0.186	77	0.040
4/23	50	9	0.180			1,120	186	0.166	45	0.040
4/27	85	7	0.082	1	0.006	1,115	125	0.112	29	0.026
4/29	58	6	0.103	2	0.034	537	32	0.060	22	0.041
4/30	66	9	0.136			1,121	148	0.132	31	0.028
5/2	64	3	0.047	2	0.015	1,097	107	0.098	14	0.013
5/5	119	9	0.076	2	0.017	986	133	0.135	15	0.015
5/6	44	6	0.136	1	0.023	413	42	0.102	19	0.046
5/8	39	7	0.179	1	0.026	447	60	0.134	10	0.022
5/9	104	11	0.106	3	0.029	1,019	109	0.107	29	0.028
5/12	68	9	0.132	1	0.015	1,053	123	0.117	34	0.032
5/13	34	4	0.118	1	0.029	491	57	0.116	19	0.039
5/15	41	5	0.122	1	0.024	513	96	0.187	18	0.035
5/18	51	3	0.059	1	0.020	1,073	147	0.137	23	0.021
5/20	44	5	0.114	2	0.045	1,096	189	0.172	20	0.018
5/21	34	6	0.176	2	0.059	536	70	0.131	10	0.019
5/22	39	7	0.179	1	0.026	502	74	0.147	14	0.028
5/24	21	1	0.048			518	113	0.218	16	0.031
5/26	27	4	0.148			545	91	0.167	12	0.022
5/27	89	11	0.124	2	0.015	925	147	0.159	23	0.025
5/29	144	16	0.111			834	106	0.127	40	0.048
Total	1,246	141	0.113	23	0.018	17,869	2,513	0.141	520	0.029

Bonneville ratio: < =125 to >125mm				Estuary ratio: < = 125 to >125mm			
			Ln				Ln
Geomean:	0.83		-0.186	Geomean:	0.879		-0.207
SE:	0.089		0.108	SE:	0.14		0.160
95% CI:	0.668	1.032		95% CI:	0.588	1.125	
t:			-1.727	t:			-1.29
df:			40	df:			34
p:			0.092	p:			0.2

[a] In instances where detections/recoveries were few, proportions were based on cumulative data for several release days. For analysis, the minimum detections was five fish for the size category with the least number.

[b] Detections from Rice Island, Sand Island, or Jones Beach.

[c] All release sites combined by day.

Appendix Table B4. Comparisons of median travel time in days from The Dalles Dam to Bonneville Dam and Jones Beach for daily release groups, diel groups, and treatment groups of spring migrant yearling salmon.

		To Bonneville Dam [a]																		To Jones Beach[*]		
		Spillway												Tailrace			Combined					
		Bonneville First PH				Bonneville Second PH				Bonneville Dam				Bon1	Bon2	Bon	Bon1	Bon2	Bon	Spill	Tail	River
Release		North	Mid	South	avg	North	Mid	South	avg	North	Mid	South	avg	avg.	avg.	avg.	avg.	avg.	avg.	avg.	avg.	flow
Date[b]	Period	days	days	days	days	days	days	days	days	days	days	days	days	days	days	days	days	days	days	days	days	kcfs [c]
4/21	Night	2.9	1.9	3.4	2.2	2.1	1.9	1.9	2.0	2.2	1.9	2.1	2.0	1.9	1.7	1.8	2.2	1.9	1.9	4.8	5.1	279
4/23	Day	1.9	2.9	2.1	2.5	1.8	1.8	1.7	1.8	1.8	2.0	1.8	1.9	2.3	1.6	1.7	2.3	1.6	1.8	3.8	3.1	327
4/23	Night	3.0	2.0	3.3	2.3	2.4	2.2	2.3	2.2	2.5	2.1	2.5	2.2	2.0	2.1	2.1	2.4	2.2	2.2	3.9	3.6	327
4/27	Day	3.1	2.4	2.2	2.6	1.6	1.8	1.8	1.7	1.8	2.0	1.9	1.9	1.7	1.5	1.5	2.0	1.6	1.7	3.3	3.2	297
4/27	Night	2.2	2.5	1.7	2.4	2.2	2.2	1.9	2.2	2.2	2.2	1.9	2.2	1.9	2.0	2.0	2.0	2.0	2.0	3.4	3.3	297
4/29	Day	2.0	2.0	2.5	2.0	2.7	3.6	3.1	3.3	2.4	3.0	2.9	2.8	2.2	2.3	2.3	2.2	2.8	2.6	3.5	3.1	327
4/30	Day	2.4	2.0	1.7	2.1	1.9	1.8	1.8	1.8	2.0	1.9	1.8	1.9	2.1	1.6	1.8	2.1	1.7	1.8	3.2	3.3	314
4/30	Night	2.2	3.5	2.6	3.1	2.6	2.4	2.9	2.5	2.5	2.8	2.8	2.7	2.3	2.1	2.2	2.5	2.4	2.4	4.1	3.8	314
5/2	Day	2.4	2.2	2.0	2.2	1.9	2.2	1.8	2.1	2.0	2.2	1.9	2.1	2.5	1.7	1.9	2.3	1.8	1.9	3.4	3.3	308
5/2	Night	2.1	2.2	2.0	2.2	2.2	2.4	2.5	2.3	2.2	2.3	2.3	2.3	1.9	1.9	1.9	2.0	2.1	2.1	3.4	2.9	308
5/5	Day	1.7	1.7	1.8	1.7	1.8	1.7	2.0	1.8	1.8	1.7	1.9	1.8	1.7	1.6	1.6	1.7	1.7	1.7	3.8	3.5	314
5/5	Night	2.2	2.0	2.1	2.0	2.4	2.1	2.3	2.2	2.3	2.0	2.3	2.1	2.0	2.0	2.0	2.0	2.1	2.1	3.6	3.4	314
5/6	Night	2.6	2.4	2.2	2.5	2.4	2.6	2.5	2.5	2.5	2.5	2.4	2.5	2.7	2.2	2.3	2.5	2.4	2.4	3.6	3.7	288
5/8	Day	2.3	2.0	2.0	2.1	2.4	2.0	2.0	2.1	2.3	2.0	2.0	2.1	1.6	1.7	1.7	1.9	1.9	1.9	3.9	3.5	261
5/9	Day	2.0	2.2	2.2	2.1	2.0	1.9	1.7	1.9	2.0	2.0	1.8	2.0	1.9	1.5	1.6	2.0	1.7	1.7	3.7	3.3	253
5/9	Night	1.9	1.8	2.1	1.8	3.3	2.0	1.9	2.4	2.8	1.9	2.0	2.2	1.8	2.0	2.0	1.9	2.2	2.1	3.4	3.6	253
5/12	Day	1.9	1.9	2.4	1.9	1.8	2.4	2.1	2.2	1.8	2.3	2.2	2.1	2.3	1.8	1.9	2.2	2.0	2.0	3.7	3.6	238
5/12	Night	2.4	1.9	2.4	2.0	2.1	2.0	2.4	2.1	2.0	1.7	2.2	1.8	1.8	1.9	1.9	2.0	2.1	2.0	3.6	3.3	238
5/13	Night	1.7	2.2	1.8	2.1	1.9	2.2	1.8	2.1	1.9	2.2	1.8	2.1	1.6	1.8	1.7	1.8	1.9	1.8	3.5	3.1	233
5/15	Day	2.2	2.3	2.0	2.3	1.7	1.6	1.6	1.6	1.8	1.8	1.7	1.8	1.9	1.5	1.6	2.0	1.6	1.7	3.6	3.3	245
5/18	Day	1.8	1.5	2.0	1.6	1.5	1.5	1.6	1.5	1.5	1.5	1.7	1.5	1.5	1.4	1.4	1.7	1.5	1.5	3.5	2.9	264
5/18	Night	1.8	2.1	1.3	2.0	1.9	1.7	1.8	1.8	1.9	1.8	1.7	1.8	1.2	1.5	1.4	1.4	1.6	1.6	3.5	3.2	264
5/20	Day	1.7	1.9	1.6	1.8	1.4	1.5	1.4	1.5	1.5	1.5	1.4	1.5	1.5	1.3	1.3	1.6	1.4	1.4	3.1	2.9	273
5/20	Night	1.4	1.4	1.4	1.4	1.7	1.5	1.6	1.6	1.6	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.5	1.5	3.1	3.0	273

Appendix Table B4. Continued.

		To Bonneville Dam																		To Jones Beach		
		Spillway												Tailrace			Combined					
		Bonneville First PH				Bonneville Second PH				Bonneville Dam				Bon1	Bon 2	Bon	Bon 1	Bon 2	Bon	Spill	Tail	River
Release Date	Period	North days	Mid days	South days	avg days	North days	Mid days	South days	avg days	North days	Mid days	South days	avg days	avg. days	avg. days	avg. days	avg. days	avg. days	avg. days	avg. days	avg. days	flow kcfs
5/21	Night	1.7	1.5	2.0	1.6	1.8	1.5	1.7	1.6	1.8	1.5	1.8	1.6	1.5	1.6	1.6	1.6	1.7	1.6	3.2	3.2	278
5/22	Night	1.9	2.3	1.7	2.2	1.8	1.7	1.8	1.7	1.8	1.8	1.7	1.8	1.7	1.6	1.6	1.9	1.7	1.7	3.7	3.6	260
5/24	Day	1.5	1.7	1.6	1.6	1.4	1.4	1.5	1.4	1.4	1.5	1.5	1.5	1.4	1.3	1.4	1.5	1.4	1.4	2.8	2.6	244
5/26	Day	1.9	1.7	1.4	1.8	1.3	1.3	1.4	1.3	1.4	1.4	1.4	1.4	1.4	1.1	1.2	1.6	1.2	1.3	2.4	2.4	336
5/27	Day	1.4	1.4	1.5	1.4	1.2	1.2	1.3	1.2	1.3	1.3	1.4	1.3	1.4	1.2	1.2	1.4	1.2	1.3	3.2	3.9	363
5/27	Night	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.0	1.0	1.1	1.0	1.1	2.5	2.4	363
5/29	Day	1.7	1.3	1.4	1.4	1.1	1.2	1.4	1.2	1.3	1.2	1.4	1.2	1.3	1.1	1.1	1.4	1.2	1.2	3.1	3.0	362
5/29	Night	1.3	1.3	1.8	1.3	1.3	1.3	1.4	1.3	1.3	1.3	1.5	1.3	1.2	1.4	1.3	1.3	1.4	1.3	---	---	362
Avg	Day	1.99	1.94	1.91	1.95	1.72	1.81	1.76	1.78	1.75	1.83	1.79	1.80	1.79	1.52	1.58	1.87	1.64	1.68	3.37	3.18	295
Avg	Night	2.04	2.00	2.06	2.01	2.08	1.92	1.99	1.97	2.04	1.91	1.98	1.96	1.75	1.76	1.76	1.88	1.88	1.86	3.54	3.41	291
Avg		2.01	1.97	1.99	1.98	1.90	1.86	1.88	1.88	1.90	1.87	1.89	1.88	1.77	1.64	1.67	1.87	1.76	1.77	3.46	3.29	293
Diff	N - D	0.05	0.06	0.15	0.06	0.37	0.11	0.23	0.19	0.29	0.08	0.18	0.15	-0.04	0.25	0.19	0.01	0.24	0.18	0.17	0.23	-4.7

[a] No significant difference in travel time was detected for north vs. middle vs. south released spillway groups. Mean travel time of spillway groups was significantly different from tailrace released groups (spill group averaged 0.21 day longer at Bonneville and 0.17 day longer at Jones Beach; $P < 0.01$ and < 0.01, respectively). Mean travel time for fish groups detected at Bonneville First Powerhouse was significantly different from those detected at Bonneville Second Powerhouse ($P < 0.01$; PH 1 averaged 0.11 day longer). Mean travel time for nighttime releases was not significantly different from daytime releases ($P = 0.16$; nighttime releases averaged 0.18 day longer).

[b] Average travel time to Bonneville Dam decreased through time, $r = -0.76$.

[c] River flow in thousand ft^3/second by COE convention; 1,000 ft^3/second = 28.3 m^3/second. Average travel time to Bonneville Dam was poorly correlated with river flow, $r = -0.21$.

Appendix Table B5. Tests of homogeneity of Bonneville Dam passage distributions for groups of PIT-tagged yearling chinook and coho salmon and subyearling chinook salmon released into the spillway or tailrace at The Dalles Dam in 1999.

H_o: For spillway and tailrace releases made concurrently at The Dalles Dam, there was no difference in passage distributions at Bonneville Dam.[a]

Yearling Chinook and Coho salmon					Subyearling chinook salmon				
Release date [b]	chi-square	df	P [c]		Release date	chi-square	df	P	
4/21	28.0	24	0.2029		6/17	16.7	13	0.173	
4/23	40.0	30	0.0524	* [d]	6/19	17.0	17	0.4525	
4/23	37.7	30	0.1049		6/19	22.0	15	0.0648	
4/27	28.5	24	0.1666		6/22	24.5	16	0.0313	*
4/27	32.8	27	0.1278		6/23	10.2	15	0.9089	
4/29	47.5	26	0.0006	*	6/23	23.9	17	0.0573	
4/30	46.9	31	0.0086	*	6/25	17.8	14	0.1810	
4/30	35.0	34	0.4036		6/25	25.8	14	0.0117	*
5/2	34.0	28	0.1521		6/27	21.6	17	0.1398	
5/2	34.1	24	0.0388	*	6/27	19.1	14	0.1121	
5/5	26.0	24	0.3272		6/30	46.9	19	<0.0001	*
5/5	32.8	28	0.2016		6/30	24.9	13	0.0102	*
5/6	42.4	35	0.1342		7/2	19.4	16	0.1882	
5/8	73.2	25	<0.0001	*	7/2	26.8	12	0.0039	*
5/9	43.4	23	0.0012	*	7/4	21.2	18	0.2241	
5/9	41.3	31	0.0467	*	7/4	23.1	20	0.2488	
5/12	43.6	22	0.0004	*	7/8	33.4	20	0.0073	*
5/12	37.5	23	0.0066	*	7/8	47.7	21	0.0003	*
5/13	30.4	22	0.0540		7/10	19.5	22	0.6709	
5/15	27.5	20	0.0586		7/11	53.9	21	<0.0001	*
5/18	22.2	14	0.0377	*	7/11	21.0	16	0.1481	
5/18	23.1	20	0.2226		7/14	40.2	18	<0.0001	*
5/20	34.5	17	0.0006	*	7/14	37.9	16	0.0002	*
5/20	31.4	15	0.0019	*	7/15	39.0	14	0.0001	*
5/21	18.8	16	0.2474		7/17	22.0	18	0.1954	
5/22	27.4	20	0.0626		7/17	25.7	18	0.0684	
5/24	45.7	13	0.0001	*	7/19	18.0	14	0.1899	
5/26	68.5	23	<0.0001	*	7/19	23.5	16	0.0833	
5/27	42.7	18	0.0001	*					
5/27	23.2	14	0.0243	*					
5/29	23.3	18	0.1250						
5/29	31.9	16	0.0022	*					

[a] Comparing dates of arrival at Bonneville Dam among treatment groups.

[b] The second occurrence of a date implies two morning /evening releases were made.

[c] Probability values were calculated using a Monte Carlo approximation of the exact method.

[d] * Indicates significant difference in passage distributions of spillway and tailrace released groups; however, passage distributions for both were quite compact (note the small number for degrees of freedom) with the spill group slightly later for yearlings (0.21 day) and slightly earlier for subyearlings (0.06 day).

Appendix Table B6. Comparisons of average of hourly fish counts multiplied by percent flow at Bonneville Dam First or Second Powerhouse, in relation to total turbine discharge or total river flow, for test fish released at The Dalles Dam Spillway or Tailrace, spring 1999.

		Bonneville Dam First Powerhouse							Bonneville Dam Second Powerhouse						
	Spill (%)/diel index[e]	The Dalles spillway groups		The Dalles tailrace groups		D ifference			The Dalles spillway groups		The Dalles tailrace groups		D ifference		
Date		Avg (%)[a] PH flow/fish	Avg (%)[b] Tot flow/fish	Avg (%)[a] PH flow/fish	Avg (%)[b] Tot flow/fish	PH[c] Diff	Total[d] Diff		Avg (%)[a] PH flow/fish	Avg (%)[b] Tot flow/fish	Avg (%)[a] PH flow/fish	Avg (%)[b] Tot flow/fish	PH[c] Diff	Total[d] Diff	
4/21	30/N	36.4	23.2	35.1	22.2	1.3	1.0		64.9	41.9	65.0	41.9	-0.1	0.0	
4/23	64/D	36.1	23.6	35.5	23.1	0.6	0.5	f	64.3	23.8	64.6	23.9	-0.2	0.0	f
4/23	64/N	36.9	23.8	36.6	23.8	0.3	0.0		63.3	40.7	63.5	41.4	-0.2	-0.8	
4/27	30/D	38.5	22.6	37.2	21.5	1.3	1.1		63.8	37.9	64.2	37.9	-0.4	0.0	
4/27	30/N	40.2	23.2	39.7	22.9	0.5	0.2		58.3	34.4	58.3	33.9	0.1	0.5	
4/29	64/D	39.9	25.4	39.8	25.8	0.2	-0.5	f	60.4	40.0	62.2	41.0	-1.8	-1.0	f
4/30	64/D	33.1	21.7	39.3	25.8	-6.2	-4.1	f	61.2	42.0	61.5	42.7	-0.3	-0.7	f
4/30	64/N	36.1	23.0	31.9	20.6	4.2	2.4		64.1	43.1	67.9	45.2	-3.9	-2.2	
5/2	30/D	38.6	25.8	38.2	25.5	0.4	0.3		61.9	42.3	62.1	42.4	-0.2	-0.2	
5/2	30/N	39.2	25.1	38.7	25.2	0.5	0.0	f	61.2	40.9	61.9	41.3	-0.6	-0.4	f
5/5	64/D	41.3	25.4	41.0	25.8	0.3	-0 .3		60.2	40.3	60.4	40.2	-0.2	0.1	
5/5	64/N	42.4	26.4	43.5	26.6	-1.1	-0 .2		57.3	37.8	57.6	38.4	-0.3	-0.5	
5/6	64/N	50.5	28.1	48.3	27.9	2.2	0.2		56.6	36.3	57.5	37.6	-0.8	-1.3	
5/8	30/D	44.3	26.8	45.6	27.3	-1.3	-0.5	f	56.9	35.8	55.9	35.0	1.0	0.8	f
5/9	30/D	41.9	26.6	42.4	26.4	-0.6	0.2	f	58.7	38.2	59.9	39.8	-1.2	-1.6	f
5/9	30/N	45.5	26.7	44.5	26.4	1.0	0.3	f	54.7	34.6	56.1	36.1	-1.4	-1.5	f
5/12	64/D	52.2	28.6	49.3	28.3	2.9	0.3	f	50.4	31.3	49.5	30.4	0.9	0.9	f
5/12	64/N	47.9	29.5	48.4	28.7	-0.5	0.8	f	51.6	32.4	53.3	34.8	-1.7	-2.4	f
5/13	30/N	51.0	29.4	52.8	29.2	-1.9	0.2		50.1	30.7	51.7	32.9	-1.6	-2.2	
5/15	30/D	46.0	28.4	45.2	29.0	0.7	-0 .6		54.5	35.5	54.6	35.7	-0.1	-0.2	
5/18	64/D	45.6	27.6	45.2	28.1	0.4	-0.5	f	54.6	34.7	54.6	35.0	-0.1	-0.3	f
5/18	64/N	47.3	26.9	47.9	27.3	-0.6	-0 .4		57.6	37.0	56.9	36.0	0.7	1.0	
5/20	30/D	43.8	28.3	42.8	27.9	1.0	0.5	f	56.5	37.1	57.2	38.2	-0.7	-1.2	f
5/20	30/N	46.5	27.2	46.5	26.9	0.0	0.2	f	54.3	33.5	53.5	32.2	0.8	1.3	f

Appendix Table B6. Continued.

		Bonneville Dam First Powerhouse							Bonneville Dam Second Powerhouse						
	Spill (%)/diel index[e]	The Dalles spillway groups		The Dalles tailrace groups		D ifference			The Dalles spillway groups		The Dalles tailrace groups		D ifference		
Date		Avg (%)[a] PH flow/fish	Avg (%)[b] Tot flow/fish	Avg (%)[a] PH flow/fish	Avg (%)[b] Tot flow/fish	PH[c] Diff	Total[d] Diff		Avg (%)[a] PH flow/fish	Avg (%)[b] Tot flow/fish	Avg (%)[a] PH flow/fish	Avg (%)[b] Tot flow/fish	PH[c] Diff	Total[d] Diff	
5/21	30/N	44.7	27.4	45.3	27.2	-0.6	0.2		57.2	37.5	57.6	37.8	-0.4	-0.4	
5/22	64/N	45.2	27.7	48.1	28.0	-2.8	-0 .3		55.1	35.6	54.9	35.3	0.2	0.4	
5/24	64/ D	39.1	25.4	38.7	26.2	0.4	-0.8	f	61.5	42.0	61.6	42.7	-0.2	-0.8	f
5/26	30/ D	38.3	22.4	38.3	22.5	0.0	-0.1	f	61.5	35.7	61.8	36.5	-0.3	-0.8	f
5/27	30/ D	38.4	21.8	38.5	21.9	-0.1	-0.1	f	61.6	35.0	61.6	34.9	0.0	0.1	f
5/27	30/ N	38.6	22.2	38.6	22.4	-0.1	-0.2	f	61.4	35.6	61.3	35.5	0.0	0.1	f
5/29	64/D	38.9	23.7	38.8	23.7	0.0	0.0		61.3	37.3	61.2	37.4	0.0	0.0	
5/29	64/ N	38.7	23.6	38.9	23.8	-0.2	-0.2	f	61.2	37.4	61.1	37.2	0.0	0.2	f
Average		42.0	25.5	41.9	25.6	0.1	0.0		58.7	36.8	59.1	37.2	-0.4	-0.4	

[a] Average of hourly data weighted by fish number for counts of fish detected at the designated powerhouse multiplied by percentage of designated powerhouse flow of the total powerhouse flow.

[b] Average of hourly data weighted by fish number for counts of fish detected at the designated powerhouse multiplied by percentage of designated powerhouse flow of total river flow.

[c] Spillway Fish x PH % of PH flow minus Tailrace Fish x PH % of PH flow.

[d] Spillway Fish x PH % of Total flow minus Tailrace Fish x PH % of Total flow.

[e] Index for spill percent (64 or 30) and day or night (D or N) for condition and period of fish releases at The Dalles Dam.

[f] Indicates fish releases that were not mixed according to the Monte Carlo approximation of the exact method. A two-sample *t*-test was conducted on PH Difference and Total Difference for both Bonneville First and Second Powerhouses for fish releases that were not mixed compared to those that were mixed and there was no significant difference between them; P = 0.13-0.92.

Appendix Table B7. Summary of differences between detection sites for estimated spill passage survival at The Dalles Dam; 1997, 1998, and 1999.

Spring Migrants

		Relative percent survival *						Relative percent survival *				
Year	Condition	Bon 1	Bon 2	Bonn	Jones B.	Bird col.	Condition	Bon 1	Bon 2	Bonn	Jones B.	Bird col.
1997	all	85	83	84	--	90						
1998	all	96	91	93	79	93						
1999	all	90	93	92	99	111						
1997	30%	--	--	--	--	--	Day	87	81	84	--	83
	64%	85	83	84	--	90	Night	87	84	86	--	93
1998	30%	102	103	103	132	106	Day	100	89	93	90	94
	64%	96	90	93	73	89	Night	95	91	93	68	91
1999	30%	91	93	93	102	115	Day	90	83	85	93	105
	64%	89	92	92	95	107	Night	90	104	100	104	116
		B1-B2		Bonn-Jones B		Bonn-Bird col		B1-B2		Bonn-Jones B		Bonn-Bird col
1997	30%	--		--		--	Day	6		--		1
	64%	2		--		-6	Night	3		--		-7
1998	30%	-1		-29		-3	Day	11		3		-1
	64%	6		20		4	Night	4		25		2
1999	30%	-2		-9		-22	Day	7		-8		-20
	64%	-3		-3		-15	Night	-14		-4		-16
		Survival @ 30% - Survival @ 64%						Survival @ night - Survival @ day				
		Bon 1	Bon 2	Bonn	Jones B.	Bird I.		Bon 1	Bon 2	Bonn	Jones B.	Bird I.
1997	30-64%	--	--	--	--	--	Night-Day	0	3	2	--	10
1998	30-64%	6	13	10	59	17	Night-Day	-5	2	0	-22	-3
1999	30-64%	2	1	1	7	8	Night-Day	0	21	15	11	11

Summer Migrants

		Relative percent survival *						Relative percent survival *				
Year	Condition	Bon 1	Bon 2	Bonn	Jones B.	Bird I.	Condition	Bon 1	Bon 2	Bonn	Jones B.	Bird I.
1997	all	88	91	90	--	116						
1998	all	78	81	79	--	94						
1999	all	93	98	97	--	102						
1997	30%	--	--	--	--		Day	95	81	83	--	119
	64%	88	91	90	--	116	Night	86	104	98	--	123
1998	30%	99	78	85	--	93	Day	70	77	74	--	86
	64%	69	79	73	--	96	Night	87	86	86	--	105
1999	30%	99	99	99	--	98	Day	92	93	93	--	104
		B1 - B2		Bonn-JonesB		Bonn-Bird I.		B1 - B2		Bonn-JonesB		Bonn-Bird I.
1997	30%	--		--		--	Day	14		--		-36
	64%	-3		--		-26	Night	-18		--		-25
1998	30%	21		--		-8	Day	-7		--		-12
	64%	-10		--		-23	Night	1		--		-19
1999	30%	0		--		1	Day	-1		--		-11
	64%	-9		--		-11	Night	-7		--		1
		Survival @ 30% - Survival @ 64%						Survival @ night - Survival @ day				
		Bon 1	Bon 2	Bonn	Jones B.	Bird I.		Bon 1	Bon 2	Bonn	Jones B.	Bird I.
1997	30-64%	--	--	--	--	--	Night-Day	-9	23	15	--	4
1998	30-64%	30	-1	12	--	-3	Night-Day	17	9	12	--	19
1999	30-64%	12	3	4	--	-8	Night-Day	3	9	8	--	-4

Because of few detections at Jones Beach and the bird islands, detections were pooled by season.

Appendix Table B8. Release and detection data used to compare recovery sites; spring and summer, 1997.

			Spring																			
			Tailrace							Spillway												
Rel. date	Spill (%)	Diel	Rel. no.	Bon1 Det	Bon1 Prop	Bon2 Det	Bon2 Prop	Rice I. Det	Rice I. Prop	Rel. no.	Bon1 Det	Bon1 Surv (%)	Bon2 Det	Bon2 Surv (%)	Bonn Surv (%)	Rice I. Det	Rice I. Surv (%)	Ln of % Relative Survival * Bon1	Bon2	Bonn	Rice I.
4/27	64	Day	295	33	0.112	7	0.024	2	0.007	198	19	85.8	7	149.0	96.8	4	298.0	-0.153	0.3987	-0.0321	1.0919
4/28	64	Day	665	40	0.060	20	0.030	16	0.024	683	37	90.1	18	87.6	89.3	14	85.2	-0.105	-0.1321	-0.1137	-0.16
4/29	64	Day	297	23	0.077	4	0.013	8	0.027	294	14	61.5	4	101.0	67.3	4	50.5	-0.486	0.0102	-0.3953	-0.683
5/3	64	Day	660	42	0.064	36	0.055	29	0.044	642	50	122	12	34.3	81.7	15	53.2	0.202	-1.071	-0.2019	-0.632
5/7	64	Day	686	69	0.101	38	0.055	34	0.050	667	46	68.6	31	83.9	74.0	33	99.8	-0.377	-0.1755	-0.3009	-0.002
5/9	64	Day	1,541	99	0.064	124	0.080	71	0.046	1,538	76	76.9	122	98.6	89.0	55	77.6	-0.262	-0.0143	-0.117	-0.253
5/10	64	Day	1,722	94	0.055	167	0.097	71	0.041	1,535	58	69.2	96	64.5	66.2	40	63.2	-0.368	-0.4387	-0.4126	-0.459
5/11	64	Day	1,881	132	0.070	106	0.056	80	0.043	1,918	108	80.2	91	84.2	82.0	67	82.1	-0.22	-0.1721	-0.1984	-0.197
5/14	64	Day	1,659	87	0.052	96	0.058	64	0.039	1,748	104	113	94	92.9	102.7	75	111.2	0.1262	-0.0733	0.0265	0.1063
Day Tot/Avg			9,406	619	0.073	598	0.052	375	0.036	9,223	512	85.3	475	88.4	83.2	307	102.3				
Weighted by fish number					0.066		0.064		0.040			84.4		81.0	82.7		83.5				
4/29	64	Night	267	15	0.056	5	0.019	2	0.007	258	13	89.7	11	227.7	124.2	15	776.2	-0.109	0.8227	0.2166	2.0492
4/30	64	Night	843	54	0.064	19	0.023	21	0.025	801	62	121	19	105.2	116.8	28	140.3	0.1893	0.0511	0.1551	0.3388
5/2	64	Night	694	49	0.071	19	0.027	11	0.016	674	43	90.4	34	184.3	116.6	21	196.6	-0.101	0.6112	0.1535	0.6759
5/6	64	Night	532	59	0.111	32	0.060	10	0.019	507	45	80	26	85.3	81.9	16	167.9	-0.223	-0.1595	-0.2	0.5181
5/7	64	Night	668	58	0.09	50	0.075	11	0.016	641	35	62.9	36	75.0	68.5	6	56.8	-0.464	-0.2872	-0.3782	-0.565
5/8	64	Night	1,602	101	0.063	135	0.084	56	0.035	1,599	89	88.3	94	69.8	77.7	46	82.3	-0.125	-0.3601	-0.2525	-0.195
5/12	64	Night	1,671	123	0.074	62	0.037	77	0.046	1,724	103	81.2	54	84.4	82.3	77	96.9	-0.209	-0.1694	-0.1953	-0.031
5/13	64	Night	1,254	88	0.070	48	0.038	61	0.049	1,292	62	68.4	41	82.9	73.5	44	70.0	-0.38	-0.1875	-0.3078	-0.357
5/14	64	Night	1,111	58	0.052	83	0.075	62	0.056	1,121	61	104	63	75.2	87.2	52	83.1	0.0415	-0.2847	-0.1374	-0.185
5/15	64	Night	1,025	56	0.055	72	0.070	48	0.047	1,029	51	90.7	57	78.9	84.0	45	93.4	-0.097	-0.2375	-0.1738	-0.068
5/20	64	Night	1,563	93	0.060	43	0.028	99	0.063	1,573	89	95.1	37	85.5	92.1	84	84.3	-0.05	-0.1567	-0.0828	-0.171
5/21	64	Night	582	30	0.052	4	0.007	42	0.072	561	29	100	7	181.6	109.8	33	81.5	0.0028	0.5964	0.0939	-0.204
5/22	64	Night	548	36	0.066	3	0.005	30	0.055	575	20	52.9	7	222.4	66.0	37	117.5	-0.636	0.7992	-0.4158	0.1616
Night Tot/Avg			12,360	820	0.068	575	0.042	530	0.039	12,355	702	86.5	486	119.9	90.8	504	157.5				
Weighted by fish number					0.066		0.047		0.043			85.6		84.6	85.2		95.1				
Grand Tot/Avg			21,766	1,439	0.070	1,173	0.046	905	0.038	21,578	1,214	86.0	961	107.0	87.7	811	134.9				
Weighted by fish number					0.066		0.054		0.042			85.1		82.6	84.0		90.4				

Appendix Table B8. Continued.

			Summer																		
			Tailrace							Spillway											
Rel. date	Spill (%)	Diel	Rel. no.	Bon1 Det	Bon1 Prop	Bon2 Det	Bon2 Prop	Rice I. Det	Rice I. Prop	Rel. no.	Bon1 Det	Bon1 Surv (%)	Bon2 Det	Bon2 Surv (%)	Bonn Surv (%)	Rice I. Det	Rice I. Surv(%)	Ln of % Relative Survival * Bon1	Bon2	Bonn	Rice I.
6/19	64	Day	253	13	0.051	1	0.004	7	0.028	285	14	95.6	5	443.9	120.5	7	88.8	-0.0450	1.4903	0.1863	-0.1191
6/21	64	Day	285	8	0.028	10	0.035	8	0.028	288	13	160.8	8	79.2	115.5	11	136.1	0.4750	-0.2336	0.1437	0.3080
6/25	63	Day	1,780	107	0.060	172	0.097	46	0.026	1782	87	81.2	145	84.2	83.1	35	76.0	-0.2080	-0.1719	-0.1856	-0.2744
6/27	64	Day	1,982	73	0.037	163	0.082	52	0.026	1,990	95	129.6	165	100.8	109.7	59	113.0	0.2594	0.0082	0.0928	0.1223
7/2	64	Day	1,383	64	0.046	228	0.165	22	0.016	1,388	36	56.0	163	71.2	67.9	31	140.4	-0.5790	-0.3392	-0.3871	0.3393
7/4	64	Day	1,973	44	0.022	213	0.108	36	0.018	1,727	26	67.5	160	85.8	82.7	39	123.8	-0.3929	-0.1529	-0.1902	0.2132
7/8	64	Day	1,869	5	0.003	143	0.077	30	0.016	1,950	4	76.7	130	87.1	86.8	31	99.0	-0.2656	-0.1377	-0.1418	-0.0096
7/11	64	Day	1,964	26	0.013	497	0.253	29	0.015	1,950	28	108.5	369	74.8	76.5	38	132.0	0.0813	-0.2906	-0.2685	0.2774
7/12	64	Day	1,979	30	0.015	193	0.098	42	0.021	1,966	30	100.7	157	81.9	84.4	50	119.8	0.0066	-0.1999	-0.1695	0.1809
Day Tot/Avg			13,468	370	0.031	1,620	0.102	272	0.022	13,326	333	97.4	1,302	123.2	91.9	301	114.3				
Weighted by fish number					0.027		0.120		0.020			91.0		81.2	83.0		111.8				
6/20	64	Night	330	15	0.045	10	0.030	9	0.027	348	15	94.8	7	66.4	83.4	11	115.9	-0.0531	-0.4098	-0.1809	0.1476
6/24	63	Night	715	39	0.055	47	0.066	26	0.036	747	33	81.0	52	105.9	94.6	23	84.7	-0.2108	0.0573	-0.0555	-0.1664
6/26	64	Night	1964	109	0.055	146	0.074	49	0.025	1,933	84	78.3	160	111.4	97.2	57	118.2	-0.2445	0.1076	-0.0281	0.1672
6/28	64	Night	1938	107	0.055	183	0.094	53	0.027	1,846	105	103.0	182	104.4	103.9	33	65.4	0.0298	0.0432	0.0382	-0.4251
7/1	64	Night	1563	79	0.051	186	0.119	25	0.016	1,584	70	87.4	218	115.7	107.2	23	90.8	-0.1343	0.1454	0.0699	-0.0967
7/3	64	Night	1761	45	0.026	176	0.100	33	0.019	1,682	38	88.4	129	76.7	79.1	60	190.4	-0.1232	-0.2648	-0.2343	0.6437
7/10	64	Night	1872	52	0.028	208	0.111	35	0.019	1,917	39	73.2	214	100.5	95.0	59	164.6	-0.3114	0.0047	-0.0510	0.4984
7/15	64	Night	1735	78	0.045	111	0.064	37	0.021	1,792	60	74.5	140	122.1	102.5	57	149.2	-0.2947	0.1998	0.0242	0.3998
7/16	64	Night	1335	36	0.027	136	0.102	35	0.026	1,336	37	102.7	146	107.3	106.3	37	105.6	0.0267	0.0702	0.0612	0.0548
Night Tot/Avg			13,213	560	0.043	1,203	0.085	302	0.024	13,185	481	87.0	1,248	101.1	96.6	360	120.5				
Weighted by fish number					0.042		0.091		0.023			86.1		104.0	98.3		119.5				
Grand Tot/Avg			26,681	930	0.037	2,823	0.093	574	0.023	26,511	814	92.2	2,550	112.2	94.2	661	117.4				
Weighted by fish number					0.035		0.106		0.022			88.1		90.9	90.2		115.9				

* Probabilities of difference: Bon 1 vs. Bon 2 = 0.22; and Bon vs. Rice I. = 0.11. Detection numbers include duplicate recoveries of some fish, thus the sum of detections do not correspond with totals used for other evaluations.

Appendix Table B9. Release and detection data used to compare recovery sites; spring and summer 1998.

			Tailrace									Spring																
				Bon1		Bon2		Jones B.		Rice I.				Bon1		Spillway Bon2		Bonn	Jones B.		Rice I.		Ln of % Relative Survival *				
Rel. date	Spill (%)	Diel	Rel. no.	Det	Prop	Det	Prop	Det	Prop	Det	Prop	Rel. no.	Loc.	Det	Surv (%)	Det	Surv (%)	Surv (%)	Det	Surv (%)	Det	Surv (%)	Bon1	Bon2	Bonn	Jones B.	Rice I.
4/29	30	Day	104	7	0.067	8	0.077	0		4	0.038	98	S	8	121. 3	8	106. 1	113.2	0		7	185. 7	0.1930	0.0594	0.1240		0.6190
5/1	30	Day	174	11	0.063	12	0.069	4	0.023	4	0.023	260	N	20	121. 7	22	122. 7	122.2	3	50.2	11	184. 0	0.1962	0.2045	0.2005	-0.6893	0.6100
5/5	30	Day	516	26	0.050	35	0.068	9	0.017	15	0.029	519	MS	22	84.1	45	127. 8	109.2	10	110.5	20	132. 6	-0.1729	0.2455	0.0880	0.0996	0.2819
5/9	30	Day	850	63	0.074	19	0.022	13	0.015	38	0.045	822	MN	51	83.7	21	114. 3	90.8	12	95.5	29	78.9	-0.1778	0.1336	-0.0966	-0.0465	-0.2368
5/15	30	Day	811	46	0.057	43	0.053	4	0.005	25	0.031	470	N	33	123. 8	20	80.3	102.8	3	129.4	17	117. 3	0.2134	-0.2199	0.0272	0.2579	0.1599
5/15	30	Day										465	MN	26	98.6	18	73.0	86.2	2	87.2	25	174. 4	-0.0143	-0.3146	-0.1482	-0.1369	0.5562
5/21	30	Day	1,048	48	0.046	68	0.065	0		59	0.056	437	N	24	119. 9	33	116. 4	117.8	0		31	126. 0	0.1816	0.1517	0.1642		0.2312
5/21	30	Day										631	S	35	121. 1	50	122. 1	121.7	1		36	101. 3	0.1915	0.1998	0.1964		0.0133
5/23	30	Day	1,065	40	0.038	120	0.113	3	0.003	61	0.057	861	N	29	89.7	63	64.9	71.1	3	123.7	61	123. 7	-0.1089	-0.4317	-0.3407	0.2126	0.2126
5/23	30	Day										783	S	24	81.6	55	62.3	67.2	3	136.0	39	87.0	-0.2032	-0.4726	-0.3981	0.3076	-0.1397
5/27	30	Day	1,027	38	0.037	88	0.086	0		48	0.047	1,024	MS	30	79.2	68	77.5	78.0	0		45	94.0	-0.2335	-0.2549	-0.2484		-0.0616
4/28	64	Day	133	12	0.090	9	0.068	0		3	0.023	240	S	15	69.3	30	184. 7	118.8	1		8	147. 8	-0.3671	0.6137	0.1719		0.3905
5/8	64	Day	1,000	69	0.069	87	0.087	12	0.012	35	0.035	980	MN	74	109. 4	61	71.5	88.3	10	85.0	38	110. 8	0.0902	-0.3348	-0.1244	-0.1621	0.1024
5/8	64	Day										993	S	70	102. 2	51	59.0	78.1	9	75.5	23	66.2	0.0214	-0.5271	-0.2470	-0.2807	-0.4128
5/10	64	Day	836	72	0.086	76	0.091	8	0.010	46	0.055	827	N	71	99.7	59	78.5	88.8	7	88.5	39	85.7	-0.0032	-0.2424	-0.1189	-0.1227	-0.1543
5/14	64	Day	274	17	0.062	22	0.080	1	0.004	12	0.044	984	MN	52	104. 4	53	67.7	82.0	5	93.7	43	92.9	0.0428	-0.3902	-0.1990	-0.0654	-0.0732
5/14	64	Day	279	11	0.039	22	0.079	2	0.007	14	0.050																
5/20	64	Day	1,040	44	0.042	79	0.076	10	0.010	52	0.050	558	N	28	118. 6	36	84.9	97.0	1	18.6	32	114. 7	0.1706	-0.1633	-0.0307	-1.6800	0.1371
5/20	64	Day										557	MS	19	80.6	32	75.6	77.4	3	56.0	19	68.2	-0.2153	-0.2793	-0.2559	-0.5796	-0.3824
5/25	64	Day	791	24	0.030	117	0.148	3	0.004	38	0.048	1,290	N	43	97.3	175	97.2	97.2	4	124.9	51	73.0	-0.0274	-0.0281	-0.0280	0.2223	-0.3140
5/25	64	Day	1,223	45	0.037	164	0.134	2	0.002	71	0.058	1,123	MN	32	83.2	154	98.3	95.3	4	143.5	53	87.2	-0.1843	-0.0173	-0.0481	0.3610	-0.1369
5/26	64	Day	953	24	0.025	49	0.051	1	0.001	37	0.039	986	MS	18	70.9	50	100. 4	90.4	1	39.4	37	94.6	-0.3443	0.0044	-0.1004	-0.9321	-0.0556
5/26	64	Day	988	26	0.026	49	0.050	4	0.004	40	0.040	984	S	27	106. 5	48	96.6	100.0	1	39.5	25	64.0	0.0631	-0.0344	-0.0004	-0.9301	-0.4456
Day Tot/Avg			13,112	623	0.052	1,067	0.079	76	0.008	602	0.043	15,892		751	98.5	1,152	94.6	95.2	83	88.1	689	109.6					
Weighted by fish number					0.048		0.081		0.006		0.046				99.5		89.1	92.9		90.1		94.4					
5/7	30	Night	721	68	0.094	43	0.060	11	0.015	24	0.033	578	N	54	99.2	30	86.5	94.3	8	99.2	16	82.7	-0.0076	-0.1445	-0.0587	-0.0076	-0.1900
5/7	30	Night	713	67	0.094	43	0.060	9	0.013	24	0.034	698	MS	69	105. 0	41	97.9	102.3	8	82.2	18	77.0	0.0488	-0.0208	0.0223	-0.1963	-0.2608
5/13	30	Night	1,146	83	0.072	76	0.066	9	0.008	55	0.048	489	MN	33	93.2	31	95.6	94.3	3	78.1	19	81.0	-0.0707	-0.0451	-0.0584	-0.2469	-0.2112
5/13	30	Night										490	MS	48	135. 3	23	70.8	104.4			16	68.0	0.3020	-0.3456	0.0434		-0.3851
5/27	30	Night	997	48	0.048	30	0.030	0		61	0.061	1,193	MN	55	95.8	40	111. 4	101.8	2		58	79.5	-0.0433	0.1082	0.0177		-0.2299
4/30	64	Night	219	13	0.059	22	0.100	3	0.014	6	0.027	217	N	10	77.6	16	73.4	75.0	1	33.6	3	50.5	-0.2532	-0.3093	-0.2881	-1.0894	-0.6840
5/6	64	Night	1,083	83	0.077	37	0.034	25	0.023	21	0.019	993	N	74	99.3	46	137. 6	111.2	13	60.2	27	125. 1	-0.0069	0.3193	0.1060	-0.5071	0.2237
5/6	64	Night	343	24	0.070	11	0.032	6	0.017	10	0.029	509	MS	38	99.5	18	105. 1	101.2	7	63.3	16	144. 6	-0.0051	0.0494	0.0121	-0.4579	0.3688
5/12	64	Night	918	106	0.115	55	0.060	6	0.007	33	0.036	444	MN	37	72.2	24	90.2	78.3	1	34.5	23	144. 1	-0.3261	-0.1029	-0.2442	-1.0654	0.3654
5/12	64	Night										403	S	33	70.9	25	103. 5	82.1	4	151.9	19	131. 2	-0.3437	0.0348	-0.1977	0.4178	0.2712
5/16	64	Night	655	55	0.084	46	0.070	9	0.014	33	0.050	652	N	46	84.0	37	80.8	82.6	5	55.8	24	73.1	-0.1741	-0.2131	-0.1917	-0.5832	-0.3139
5/16	64	Night										662	MN	54	97.1	38	81.7	90.1	5	55.0	25	75.0	-0.0290	-0.2017	-0.1040	-0.5984	-0.2883
5/27	64	Night	1,120	53	0.047	35	0.031	0		68	0.061	1,192	N	51	90.4	39	104. 7	96.1	0		57	78.8	-0.1008	0.0459	-0.0398		-0.2388
6/4	64	Night	590	28	0.047	63	0.107	0		28	0.047	580	S	35	127. 2	43	69.4	87.2	0		31	112. 6	0.2402	-0.3648	-0.1371		0.1189
Night Tot/Avg			8,505	628	0.074	461	0.059	78	0.014	363	0.041	9,100		637	96.2	451	93.5	92.9	57	71.4	352	94.5					
Weighted by fish number					0.074		0.054		0.009		0.043				94.8		91.4	93.4		68.3		90.6					
Grand Tot/Avg			21,617	1,251	0.060	1,528	0.071	154	0.010	965	0.042	24,992		1,388	97.6	1,603	94.2	94.3	140	81.9	1,041	103.7					
Weighted by fish number					0.058		0.071		0.007		0.045				96.0		90.7	93.1		78.6		93.3					

* Probabilities of difference: Bon 1 vs. Bon 2 = 0.36; Bon vs. Jones B. = 0.06; Jones B. vs. Rice I. = 0.02; Bon vs. Rice I. = 0.28.

Appendix Table B9. Continued.

			Summer																					
			Tailrace							Spillway														
Rel.	Spill	Diel	Rel.	Bon1		Bon2		Rice I.		Rel.		Bon1		Bon2		Bonn	Rice I.						
date	%	period	no.	Det.	Prop.	Det.	Prop.	Det.	Prop.	no.	Loc.	Det.	%Surv	Det.	%Surv	%Surv	Det.	%Surv	Bon1	Bon2	Bonn	Rice I.
6/24	30	Day	993	15	0.015	32	0.032	8	0.008	999	N	17	112.7	30	93.2	99.4	13	162	0.1191	-1.2040	-0.0060	0.4795
6/24	30	Day								998	S	10	66.3	31	96.4	86.8	12	149	-0.4105	-1.1712	-0.1416	0.4004
6/30	30	Day	978	13	0.013	86	0.088	9	0.009	689	N	13	117.3	54	87.5	92.0	8	106.4	0.1597	-0.6162	-0.0833	0.0620
6/30	30	Day	763	15	0.020	70	0.092	10	0.013	967	S	13	83.6	58	66.9	69.5	5	47.4	-0.1792	-0.5447	-0.3642	-0.7470
7/8	30	Day	706	3	0.004	11	0.016	10	0.014	665	N	6	152.6	8	75.3	96.2	10	158.9	0.4225	-2.5257	-0.0386	0.4633
7/8	30	Day	985	7	0.007	16	0.016	6	0.006	992	M	9	153.4	18	113.6	124.4	5	53.3	0.4280	-1.7148	0.2183	-0.6298
7/10	30	Day	966	11	0.011	7	0.007	8	0.008	986	N	6	47.4	10	141.1	81.1	8	83.2	-0.7462	-2.3026	-0.2101	-0.1841
7/10	30	Day	982	14	0.014	7	0.007	11	0.011	976	M	11	87.8	9	128.3	102.4	10	105.0	-0.1299	-2.4079	0.0233	0.0492
7/14	30	Day	988	13	0.013	44	0.045	22	0.022	494	S	4	61.5	5	22.7	31.6	9	81.8	-0.4855	-2.9957	-1.1527	-0.2007
7/14	30	Day								492	S	7	108.1	13	59.3	70.5	9	82.2	0.0782	-2.0402	-0.3501	-0.1966
7/22	30	Day	735	8	0.011	12	0.016	9	0.012	757	M	1	16.6	10	71.0	54.6	3	28.4	-1.7984	-2.3026	-0.6045	-1.2594
7/22	30	Day	769	4	0.005	16	0.021	12	0.016	714	M	5	87.8	8	60.2	68.5	7	70.2	-0.1305	-2.5257	-0.3789	-0.3536
7/24	30	Day	722	20	0.028	19	0.026	11	0.015	704	N	15	76.9	16	86.4	81.5	6	55.9	-0.2624	-1.8326	-0.2043	-0.5809
7/24	30	Day								712	S	11	55.8	9	48.0	52.0	9	83.0	-0.5839	-2.4079	-0.6539	-0.1867
6/23	64	Day	1382	46	0.033	30	0.022	11	0.008	699	N	26	111.7	14	92.3	104.1	6	107.8	0.1111	-1.9661	0.0398	0.0755
6/23	64	Day								676	S	13	57.8	13	88.6	69.9	12	223.0	-0.5486	-2.0402	-0.3575	0.8021
7/3	64	Day	990	19	0.019	13	0.013	15	0.015	990	N	17	92.5	15	131.4	107.4	11	92.3	-0.0775	-1.8971	0.0716	-0.0800
7/3	64	Day	1004	18	0.018	10	0.010	9	0.009	995	S	13	70.4	13	113.3	86.8	10	83.5	-0.3508	-2.0402	-0.1411	-0.1803
7/9	64	Day	478	5	0.01	7	0.015	7	0.015	495	N	7	135.2	1	13.8	64.4	6	82.8	0.3015	-4.6052	-0.4404	-0.1891
7/9	64	Day								499	M	7	134.1	4	54.7	87.8	5	68.4	0.2935	-3.2189	-0.1300	-0.3795
7/15	64	Day	771	24	0.031	36	0.047	10	0.013	921	M	15	52.3	30	69.8	62.8	8	67.0	-0.6478	-1.2040	-0.4655	-0.4009
7/17	64	Day	755	28	0.037	14	0.019	16	0.021	356	S	5	37.9	7	106.0	60.6	6	79.5	-0.9710	-2.6593	-0.5010	-0.2290
7/17	64	Day								471	S	5	28.6	5	57.2	38.2	7	70.1	-1.2509	-2.9957	-0.9632	-0.3548
7/23	64	Day	788	47	0.06	18	0.023	13	0.016	709	N	36	95.1	9	82.8	92.3	16	161.1	-0.0507	-2.4079	-0.0798	0.4767
7/23	64	Day	749	43	0.057	8	0.011	6	0.008	738	M	10	25.4	6	53.1	31.5	3	29.0	-1.3717	-2.8134	-1.1539	-1.2374
7/23	64	Day	747	32	0.043	9	0.012	13	0.017	749	S	22	55.0	8	69.7	58.3	7	66.7	-0.5980	-2.5257	-0.5401	-0.4049
Daytime Tot/Avg			17,251	385	0.023	465	0.027	216	0.013	19,443		304	81.7	404	80.1	75.9	211	92.2				
Weighted by fish number					0.022		0.027		0.013				70.1		77.1	73.9		86.7				
6/26	30	Night	991	29	0.029	67	0.068	11	0.011	986	N	28	94.1	63	105.9	101.9	5	45.1	-0.0608	-0.4620	0.0192	-0.7971
6/26	30	Night	964	30	0.031	51	0.053	11	0.011	988	S	35	117.4	59	98.9	105.1	6	54.0	0.1603	-0.5276	0.0496	-0.6168
7/2	30	Night	964	18	0.019	11	0.011	14	0.015	974	N	23	106.3	13	96.1	102.4	17	165.4	0.0607	-2.0402	0.0233	0.5029
7/2	30	Night	836	22	0.026	14	0.017	5	0.006	996	S	14	63.3	12	86.7	72.3	9	85.6	-0.4580	-2.1203	-0.3245	-0.1554
7/16	30	Night	476	20	0.042	10	0.021	3	0.006	492	N	22	98.4	6	64.1	88.3	9	346.1	-0.0164	-2.8134	-0.1249	1.2416
7/16	30	Night	470	23	0.049	8	0.017	2	0.004	574	M	17	65.2	5	45.8	59.4	12	395.5	-0.4284	-2.9957	-0.5202	1.3751
7/24	30	Night	702	23	0.033	0		11	0.016	649	M	31	145.8	4	---	164.6	6	59.0	0.3770	-3.2189	0.4984	-0.5276
6/25	64	Night	997	25	0.025	58	0.058	8	0.008	997	N	36	138.6	56	97.5	110.3	5	71.5	0.3264	-0.5798	0.0979	-0.3355
6/25	64	Night	999	27	0.027	57	0.057	6	0.006	978	S	30	117.7	40	71.0	85.5	13	189.5	0.1633	-0.9163	-0.1561	0.6393
7/1	64	Night	721	13	0.018	8	0.011	9	0.012	732	N	11	84.2	7	80.3	82.6	6	49.2	-0.1725	-2.6593	-0.1909	-0.7097
7/1	64	Night	119	2	0.017	2	0.017	5	0.042	692	S	7	56.6	6	72.8	63.1	13	112.7	-0.5683	-2.8134	-0.4601	0.1197
7/15	64	Night	787	46	0.058	22	0.028	17	0.022	782	M	30	65.6	13	59.5	63.6	13	77.0	-0.4211	-2.0402	-0.4519	-0.2619
7/17	64	Night	725	17	0.023	20	0.028	13	0.018	396	N	2	21.5	7	64.1	44.5	8	112.7	-1.5353	-2.6593	-0.8089	0.1192
7/17	64	Night								368	M	5	57.9	4	39.4	47.9	6	90.9	-0.5457	-3.2189	-0.7356	-0.0951
7/21	64	Night	953	28	0.029	22	0.023	12	0.013	1327	M	26	69.0	36	123.1	92.6	18	131.9	-0.3713	-1.0217	-0.0766	0.2769
7/21	64	Night	1089	30	0.028	23	0.021	9	0.008	938	S	17	63.8	18	87.1	74.0	11	114.0	-0.4493	-1.7148	-0.3014	0.1313
Nighttime Tot/Avg			11,793	353	0.030	373	0.031	136	0.013	12,869		334	85.3	349	79.5	84.9	157	1 31.3				
Weighted by fish number					0.030		0.032		0.012				86.7		85.7	86.2		105.8				
Grand Tot/Avg			29,044	738	0.026	838	0.028	352	0.013	32,312		638	83.1	753	79.9	79.4	368	1 07.1				
Weighted by fish number					0.025		0.029		0.012				77.7		80.8	79.3		94.0				

* Probabilities of difference: Bon 1 vs. Bon 2 = 0.00; Bon vs Rice I. = 0.05. Detection numbers include duplicate recoveries of some fish, thus the sum of detections do not correspond with totals.

Appendix Table B10. Analysis of variance for Ln transformed relative survival proportions derived for spring and summer migrants passing through The Dalles Spillway; 1997-1999.

Analysis of Variance

Spring Migrants -- Ln Combined Data

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Julian	1	0.006	0.01	0.01	0.5	0.47
Spill (%)	1	0.135	0 .16	0 .16	9.4	<0.01
Diel	1	0.074	0.08	0.08	4.7	0.04
Spill (%) x Diel	1	0.006	0.01	0.01	0.3	0.57
Error	68	1.169	1.17	0.02		
Total	72	1.389				

Adjusted Means & CI

	Ln Mean	Ln SE	Back transformed Mean	Back transformed SE	*t* statist df	*t* statist at df	CI -	CI +	Back transformed CI -	Back transformed CI +
Spill (%)										
30% 1	-0.019	0.0 26	0.9 81	0.025	68	2.00	-0.07	0.03	0.932	1.033
64% 2	-0.118	0.0 19	0.8 89	0.017	68	2.00	-0.16	- 0.08	0.855	0.924
Diel										
Day 1	-0.1030.	022	0.9 02	0.019	68	2.00	-0.15	- 0.06	0.864	0.942
Nite 2	-0.034	0.0 24	0.9 67	0.023	68	2.00	-0.08	0.01	0.922	1.014
Spill (%) x Diel										
30% x Day	-0.0630.	033	0.9 39	0.031	68	2.00	-0.13	0.00	0.879	1.002
30% x Nite	0.0248	0.04	1.0 25	0.041	68	2.00	-0.05	0.10	0.947	1.109
64% x Day	-0.1430.	028	0.8 67	0.024	68	2.00	-0.20	- 0.09	0.820	0.916
64% x Nite	-0.0920.	027	0.9 12	0.024	68	2.00	-0.15	- 0.04	0.864	0.962

Summer Migrants -- Ln Combined Data

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Julian	1	0.354	0.379	0.379	15	<0.01
Spill (%)	1	0.087	0.110	0.110	4.3	0 .04
Diel	1	0.226	0.260	0.260	10	<0.01
Spill (%) x Diel	1	0.039	0.039	0.039	1.5	0.23
Error	61	1.578	1.578	0.026		
Total	65	2.284				

Adjusted Means & CI

	Ln Mean	Ln SE	Back transformed Mean	Back transformed SE	*t* statist df	*t* statist at df	CI -	CI +	Back transformed CI -	Back transformed CI +
Spill (%)										
30% 1	-0.041	0.0 32	0.9 60	0.031	61	2.00	-0.11	0.02	0.900	1.025
64% 2	-0.126	0.0 25	0.8 82	0.022	61	2.00	-0.18	- 0.08	0.839	0.928
Diel										
Day 1	-0.148	0.0 28	0.8 63	0.024	61	2.00	-0.20	- 0.09	0.816	0.912
Nite 2	-0.018	0.0 30	0.9 82	0.030	61	2.00	-0.08	0.04	0.925	1.043
Spill (%) x Diel										
30% x Day	-0.1310.	043	0.8 78	0.038	61	2.00	-0.22	- 0.04	0.805	0.957
30% x Nite	0.050	0.0 49	1.0 51	0.051	61	2.00	-0.05	0.15	0.954	1.158
64% x Day	-0.1650.	035	0.8 48	0.030	61	2.00	-0.24	- 0.10	0.790	0.909
64% x Nite	-0.0860.	036	0.9 18	0.033	61	2.00	-0.16	- 0.01	0.854	0.986

Spring & Summer -- Ln Combined Data

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Julian	1	0.056	0.063	0.063	2.7	0.10
Spill (%)	1	0.194	0.248	0.248	11	<0.01
Diel	1	0.268	0.307	0.307	13	<0.01
Spill (%) x Diel	1	0.044	0.044	0.044	1.9	0.17
Error	134	3.118	3.118	0.023		
Total	138	3.68				

Adjusted Means & CI

	Ln Mean	Ln SE	Back transformed Mean	Back transformed SE	*t* statist df	*t* statist at df	CI -	CI +	Back transformed CI -	Back transformed CI +
Spill (%)										
30% 1	-0.032	0.0 21	0.9 69	0.021	134	1.98	-0.07	0.01	0.929	1.011
64% 2	-0.12	0.0 16	0.8 87	0.015	134	1.98	-0.15	- 0.09	0.859	0.916
Diel										
Day 1	-0.125	0.0 18	0.8 83	0.016	134	1.98	-0.16	- 0.09	0.852	0.915
Nite 2	-0.027	0.02	0.9 74	0.019	134	1.98	-0.07	0.01	0.936	1.013
Spill (%) x Diel										
30% x Day	-0.0990.	028	0.9 06	0.025	134	1.98	-0.15	- 0.04	0.857	0.957
30% x Nite	0.0357	0.0 33	1.0 36	0.034	134	1.98	-0.03	0.10	0.972	1.105
64% x Day	- 0.15	0.0 23	0.8 61	0.020	134	1.98	-0.20	- 0.10	0.822	0.901
64% x Nite	-0.0890.	023	0.9 15	0.021	134	1.98	-0.13	- 0.04	0.874	0.957

Appendix Table B11. Analysis of variance for Ln transformed relative survival proportions derived for spring and summer migrants passing through The Dalles Spillway; 1998 & 1999.

Analysis of Variance

Spring Migrants -- Ln Combined Data

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Julian	1	0.008	0.007	0.007	0.5	0.49
Spill (%)	1	0.045	0.054	0.054	4 0	.05
Diel	1	0.079	0.080	0.080	5.9	0.02
Spill (%) x Diel	1	0.002	0.002	0.002	0.1	0.74
Error	50	0.683	0.683	0.014		
Total	54	0.817				

Adjusted Means & CI

Spill (%)	Ln Mean	Ln SE		Back transformed Mean	SE	df	*t* statist at df	CI -	CI +	Back transformed CI -	CI +
30% 1	-0.020	0.0	23	0.980	0.022	50	2.01	-0.07	0.03	0.936	1.026
64% 2	-0.083	0.0	22	0.920	0.020	50	2.01	-0.13	-0.04	0.880	0.962
Diel											
Day 1	-0.090	0.0	21	0.914	0.019	50	2.01	-0.13	-0.05	0.876	0.953
Nite 2	-0.013	0.0	24	0.987	0.024	50	2.01	-0.06	0.04	0.941	1.036
Spill (%) x Diel											
30% x Day	-0.0640.		029	0.938	0.027	50	2.01	-0.12	-0.01	0.885	0.995
30% x Nite	0.0241	0.0	35	1.024	0.036	50	2.01	-0.05	0.09	0.954	1.100
64% x Day	-0.1160.		030	0.890	0.027	50	2.01	-0.18	-0.06	0.838	0.946
64% x Nite	-0.0500.		032	0.951	0.031	50	2.01	-0.12	0.02	0.891	1.015

Summer Migrants -- Ln Combined Data

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Julian	1	0.367	0.36	0.36	13	<0.01
Spill (%)	1	0.101 0	.12 0	.12	4.4 0	.04
Diel	1	0.179	0.18	0.18	6.4	0.02
Spill (%) x Diel	1	0.044	0.04	0.04	1.6	0.22
Error	45	1.264	1.26	0.03		
Total	49	1.954				

Adjusted Means & CI

Spill (%)	Ln Mean	Ln SD		Back transformed Mean	SE	df	*t* statist at df	CI -	CI +	Back transformed CI -	CI +
30% 1	-0.047	0.0	34	0.954	0.032	45	2.01	-0.11	0.02	0.892	1.022
64% 2	-0.146	0.0	34	0.864	0.029	45	2.01	-0.21	-0.08	0.808	0.924
Diel											
Day 1	-0.157	0.0	32	0.855	0.028	45	2.01	-0.22	-0.09	0.801	0.912
Nite 2	-0.036	0.0	35	0.964	0.034	45	2.01	-0.11	0.03	0.899	1.035
Spill (%) x Diel											
30% x Day	-0.1370.		045	0.872	0.039	45	2.01	-0.23	-0.05	0.797	0.955
30% x Nite	0.0431	0.0	51	1.044	0.053	45	2.01	-0.06	0.14	0.943	1.156
64% x Day	-0.1770.		046	0.838	0.039	45	2.01	-0.27	-0.08	0.763	0.920
64% x Nite	-0.1160.		048	0.891	0.043	45	2.01	-0.21	-0.02	0.808	0.982

Spring & Summer -- Ln Combined Data

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Julian	1	0.149	0.16	0.16	7.1	0.01
Spill (%)	1	0.137 0	.17 0	.17	7.5 0	.01
Diel	1	0.253	0.26	0.26	11	<0.01
Spill (%) x Diel	1	0.033	0.03	0.03	1.5	0.23
Error	100	2.253	2.25	0.02		
Total	104	2.825				

Adjusted Means & CI

Spill (%)	Ln Mean	Ln SD		Back transformed Mean	SE	df	*t* statist at df	CI -	CI +	Back transformed CI -	CI +
30% 1	-0.032	0.0	21	0.969	0.020	100	1.98	-0.07	0.01	0.929	1.010
64% 2	-0.113	0.0	21	0.893	0.018	100	1.98	-0.15	-0.07	0.857	0.931
Diel											
Day 1	-0.122	0.0	20	0.885	0.017	100	1.98	-0.16	-0.08	0.851	0.920
Nite 2	-0.023	0.0	22	0.978	0.021	100	1.98	-0.07	0.02	0.936	1.021
Spill (%) x Diel											
30% x Day	-0.1000.		027	0.905	0.025	100	1.98	-0.15	-0.05	0.857	0.956
30% x Nite	0.0357	0.0	32	1.036	0.033	100	1.98	-0.03	0.10	0.973	1.104
64% x Day	-0.1450.		028	0.865	0.025	100	1.98	-0.20	-0.09	0.818	0.915
64% x Nite	-0.0810.		030	0.922	0.028	100	1.98	-0.14	-0.02	0.869	0.979

Appendix Table B12. Correlation of relative spill passage survival of yearling coho and chinook salmon to conditions during passage[a]; combined data 1997-1999.

Date	Julian date	Spill %	Diel index*	Spillbay location*	Surv. %	Temp. ºC	Spill kcfs	R.flow kcfs	TW El. ft.
4/27/99	118	30	1	3	60.6	10.8	96	315	83.6
4/30/99	120	64	1	3	60.6	10.7	178	283	81.7
5/10/97	130	64	1		66.2	11.1	270	420	85
5/5/99	125	64	1	3	67.1	10.6	195	327	82.0
5/7/97	127	67	2		68.5	11.1	250	375	84
4/30/98	120	64	2	1	68.8	12.3	138	218	79.4
5/23/98	143	30	1	3	72.1	12.6	94	310	82.1
5/8/99	128	30	1	2	72.4	10.6	75	241	80
5/13/97	133	69	2		73.5	12.2	340	495	88
5/20/98	140	64	1	2	73.8	12.3	208	327	82
5/7/97	127	64	1		74.0	11.1	250	388	86
5/8/98	128	64	1	3	74.4	14	240	372	84.4
4/27/99	118	30	1	2	77.4	10.8	96	315	83.6
5/8/97	128	63	2		77.7	11.1	253	400	85
5/3/97	123	63	1		77.9	10.0	260	415	85
5/2/99	122	30	1	3	78.0	10.9	96	321	82.7
4/30/99	120	64	1	2	78.3	10.7	178	283	81.7
5/16/98	136	64	2	1	78.5	12.5	205	318	82.3
5/9/99	130	30	1	3	78.9	10.7	78	267	80.1
5/12/99	132	64	1	1	79.6	10.8	170	273	79.7
5/15/99	135	30	1	2	80.8	11.0	80	273	81.2
4/29/99	119	64	1	2	81.3	10.5	158	82	81
5/27/98	147	30	1	2	81.4	13	130	398	86
5/29/99	149	64	1	3	81.6	14.5	210	344	83.4
5/8/99	128	30	1	3	81.7	10.6	75	241	80
5/6/97	126	55	2		81.9	11.1	230	415	85
5/11/97	131	64	1		82.0	11.7	245	380	84
4/23/99	113	64	1	2	82.2	9.8	210	325	82.2
5/12/97	132	64	2		82.3	12.2	332	520	88
5/16/98	136	64	2	2	82.3	12.5	205	318	82.2
5/14/98	134	64	1	2	82.6	12.8	230	373	83.9
5/24/99	144	64	1	3	83.0	13.3	154	247	79.3
5/15/99	135	30	1	3	83.2	11.0	80	273	81.2
5/5/99	125	64	1	2	83.8	10.6	195	327	82.0
5/15/97	135	65	2		84.0	13.3	280	430	86
5/18/99	138	64	1	1	84.6	11.5	178	284	80.3
5/12/99	133	64	2	2	85.1	10.9	155	244	78.9

Appendix Table B12. Continued.

Date	Julian date	Spill %	Diel index*	Spillbay location*	Surv. %	Temp. °C	Spill kcfs	R.flow kcfs	TW El. ft.
5/29/99	149	64	1	2	85.5	14.5	210	344	83.4
5/21/97	141	62	2		85.8	13.3	320	520	89
4/23/99	113	64	1	1	86.0	9.8	210	325	82.2
4/23/99	113	64	1	3	86.5	9.8	210	325	82.2
5/26/98	146	64	1	2	86.8	12.9	189	296	81.3
5/2/99	122	30	1	1	87.0	10.9	96	321	82.7
5/14/97	134	64	2		87.2	12.8	300	470	87
5/2/99	122	30	1	2	87.2	10.9	96	321	82.7
5/27/99	148	30	2	2	87.5	14.4	104	347	84
5/27/99	148	30	2	1	87.5	14.4	104	347	84
5/12/98	132	64	2	3	87.9	13.2	197	298	82
5/18/99	138	64	1	3	88.0	11.5	178	284	80.3
4/28/97	118	63	1		88.3	10.6	220	348	84
5/5/99	126	64	2	2	88.4	11.0	195	312	82.3
5/9/99	130	30	1	2	88.6	10.7	78	267	80.1
5/9/98	129	30	1	2	88.9	13.8	109	382	85.7
5/9/97	129	63	1		89.0	11.1	253	400	85
5/24/99	144	64	1	2	89.4	13.4	154	245	79.3
5/26/99	146	30	1	3	89.4	13.6	98	333	83.9
5/7/98	127	30	2	3	89.4	14.3	83	280	83.4
5/10/98	130	64	1	1	89.5	13.6	224	346	84.1
5/9/99	129	30	2	2	89.8	10.5	81	267	80.4
5/13/98	133	30	2	2	90.5	13.3	104	343	83.8
5/2/99	123	30	2	1	90.7	11.0	108	359	84.2
4/29/99	119	64	1	3	90.8	10.5	158	82	80
5/21/99	142	30	2	2	90.8	12.7	80	269	81
5/27/98	147	64	2	1	90.8	13.3	250	376	84.2
5/12/99	132	64	1	2	90.9	10.8	170	273	79.7
5/26/98	146	64	1	3	91.0	12.9	189	298	81.2
5/8/98	128	64	1	2	91.1	14	240	375	84.5
5/18/99	138	64	1	2	91.4	11.5	178	284	80.3
5/27/98	147	30	2	2	91.6	13.3	140	340	84.6
5/25/98	145	64	1	1	91.6	13	105	302	82.3
5/25/98	145	64	1	2	91.7	13	105	302	82.3
5/20/97	140	64	2		92.1	13.3	335	525	89
6/4/98	155	64	2	3	92.2	14.4	288	456	86.2
5/29/99	149	64	1	1	92.4	14.5	210	347	83.2

Appendix Table B12. Continued.

Date	Julian date	Spill %	Diel index*	Spillbay location*	Surv. %	Temp. °C	Spill kcfs	R.flow kcfs	TW El. ft.
5/27/99	148	30	2	3	94.3	14.4	104	347	84
4/30/99	121	64	2	3	94.4	11.1	200	319	81.7
4/27/99	118	30	1	1	94.4	10.8	96	315	83.6
5/8/99	129	30	1	1	94.6	10.6	75	241	80
5/24/99	144	64	1	1	94.6	13.3	154	247	79.3
4/23/99	114	64	2	1	94.8	10.2	225	346	82.6
5/20/99	140	30	1	1	94.9	12.1	87	296	81.9
5/29/99	150	64	2	3	95.2	15.0	210	345	82.5
4/30/99	121	64	2	2	95.3	11.1	200	319	81.7
5/7/98	127	30	2	1	95.8	14.3	98	322	83.7
4/30/99	120	64	1	1	96.0	10.7	178	283	81.7
5/20/98	140	64	1	1	96.9	12.2	208	326	82
4/22/99	112	30	2	2	97.2	9.8	87	299	81.8
5/5/99	126	64	2	3	97.3	11.0	195	312	82.3
5/13/99	134	30	2	1	97.5	11.0	75	268	79.2
5/5/99	125	64	1	1	98.4	10.6	195	327	82
4/23/99	114	64	2	2	98.5	10.2	225	346	82.6
5/21/99	142	30	2	1	98.7	12.7	80	269	81
4/22/99	112	30	2	1	99.3	9.8	87	299	81.8
4/29/99	119	64	1	1	99.5	10.5	158	82	82
5/9/99	130	30	1	1	99.5	10.7	78	267	80
4/23/99	114	64	2	3	100.0	10.2	225	346	82.6
5/26/99	146	30	1	1	100.2	13.6	98	333	83.9
5/22/99	143	64	2	2	100.4	13.0	180	286	80.9
5/29/99	150	64	2	2	100.7	15.0	210	345	82.5
5/12/99	133	64	2	3	101.3	10.9	155	244	78.9
5/22/99	143	64	2	3	101.7	13.0	180	286	80.9
5/14/97	134	63	1		102.2	12.2	320	510	89
5/13/99	134	30	2	3	102.3	11.0	75	268	79.2
5/29/99	150	64	2	1	102.5	15.0	210	345	82.5
5/6/98	126	64	2	3	102.9	14.2	220	347	83.6
4/27/99	117	30	2	1	103.0	10.5	90	300	82.3
4/22/99	112	30	2	3	103.2	9.8	87	299	81.8
5/15/98	135	30	1	2	103.5	12.7	100	360	84.2
5/6/99	127	64	2	1	103.6	11.0	210	372	82.3
5/6/98	126	64	2	1	104.1	14.2	209	328	83.0

Appendix Table B12. Continued.

Date	Julian date	Spill %	Diel index*	Spillbay location*	Surv. %	Temp. °C	Spill kcfs	R.flow kcfs	TW El. ft.
5/20/99	141	30	2	3	104.3	12.4	84	271	80.5
5/18/99	139	64	2	3	105.9	11.9	160	257	79.1
5/15/98	135	30	1	1	106.2	12.7	100	333	83.6
5/12/99	133	64	2	1	106.5	10.9	155	244	78.9
5/20/99	141	30	2	1	106.6	12.4	84	271	80.5
5/27/99	147	30	1	1	106.9	13.9	145	389	84.8
4/27/99	117	30	2	3	107.9	10.5	90	300	82.3
5/18/99	139	64	2	2	109.2	11.9	160	257	79.1
5/2/99	123	30	2	2	109.6	11.0	108	359	84.2
5/22/99	143	64	2	1	110.5	13.0	180	286	80.9
5/6/99	127	64	2	2	110.7	11.0	210	372	82.3
4/30/99	121	64	2	1	110.7	11.1	200	319	81.7
5/21/98	141	30	1	3	111.4	12.3	96	326	83.6
4/29/98	119	30	1	3	111.4	11.9	54	180	78.3
5/9/99	129	30	2	3	111.5	10.5	81	267	80.4
5/20/99	141	30	2	2	111.6	12.4	84	271	80.5
5/18/99	139	64	2	1	112.2	11.9	160	257	79.1
5/13/99	134	30	2	2	112.4	11.0	75	268	79.2
5/5/98	125	30	1	2	112.4	13.6	90	326	83.4
5/27/99	147	30	1	2	113.1	13.9	145	389	84.8
5/6/99	127	64	2	3	113.6	11.0	210	372	82.3
5/21/98	141	30	1	1	114.3	12.3	96	326	83.6
5/9/99	129	30	2	1	115.4	10.5	81	267	80.4
5/2/97	122	77	2		116.6	10.0	363	470	87
4/30/97	120	65	2		117.6	10.6	319	490	88
5/1/98	121	30	1	1	117.7	12.5	75	255	80.8
4/27/99	117	30	2	2	119.0	10.5	90	300	82.3
5/21/99	142	30	2	3	119.2	12.7	80	269	81
4/28/98	118	64	1	3	124.7	11.7	125	194	79
5/27/99	147	30	1	3	125.5	13.9	145	389	84.8
5/2/99	123	30	2	3	137.4	11.0	108	359	84.2
				Correlation coefficient: r =		0.04	-0.21	-0.08	-0.13

Linear regression $R^2 = 0.15$: Ln Surv %. = -0.1357 -0.00054(Spill kcfs) + 0.100(Diel index)

[a] Correlations were not calculated for Julian date, Spill %, Diel index, and Spillbay location because of interaction, the best evaluation was to use ANOVA.

[b] Diel index, where 1 represents daytime releases and 2 represents nighttime releases.
Spillbay location where 1=North, 2=Middle and 3=South.

Appendix Table B13. Comparisons of average of hourly fish counts multiplied by percent flow at Bonneville Dam First or Second Powerhouse, in relation to total turbine discharge or total river flow, for test fish released at The Dalles Dam Spillway or Tailrace, 1997.

		Bonneville Dam First Powerhouse						Bonneville Dam Second Powerhouse					
	Spill (%) /diel index[e]	The Dalles spillway groups		The Dalles tailrace groups		D ifference		The Dalles spillway groups		The Dalles tailrace groups		D ifference	
Date		Avg (%)[a] PH flow/fish	Avg (%)[b] Tot flow/fish	Avg (%)[a] PH flow/fish	Avg (%)[b] Tot flow/fish	PH[c] Diff	Total[d] Diff	Avg (%)[a] PH flow/fish	Avg (%)[b] Tot flow/fish	Avg (%)[a] PH flow/fish	Avg (%)[b] Tot flow/fish	PH[c] Diff	Total[d] Diff
						Spring migration							
4/27	64D	40.5	18.3	40.4	18.1	0.1	0.3	59.9	27.3	59.3	28.2	0.6	-0.9
4/28	64D	39.6	18.0	39.6	17.7	0.0	0.3	59.5	27.1	59.4	27.9	0.1	-0.9
4/29	64DN	39.7	17.8	39.4	17.5	0.3	0.3	58.7	27.9	60.2	27.5	-1.5	0.4
5/1	64N	40.7	18.2	41.5	18.2	-0.7	0.0	59.8	28.7	58.0	26.8	1.8	1.9
5/2	64N	40.9	19.0	42.8	19.6	-1.9	-0.6	59.2	29.1	60.2	28.8	-1.0	0.4
5/3	64D	40.6	19.4	40.2	19.6	0.4	-0.1	60.9	30.9	60.3	29.5	0.5	1.4
5/6	64N	40.1	19.6	40.3	20.0	-0.2	-0.4	60.2	29.2	59.9	29.0	0.3	0.2
5/7	64DN	39.8	19.3	39.7	19.7	0.1	-0.4	59.9	29.0	60.4	29.5	-0.5	-0.4
5/8	64N	40.3	19.4	39.9	19.2	0.4	0.2	59.7	28.4	60.0	29.4	-0.4	-1.0
5/9	64N	41.8	19.4	41.7	19.3	0.1	0.1	59.2	28.7	59.5	28.8	-0.4	-0.2
5/10	64D	[e]40.4	18.1	41.9	18.2	-1.5	-0.1	58.9	27.4	58.7	27.5	0.3	0.0
5/11	64D	39.8	16.9	39.3	16.5	0.5	0.4	60.2	25.9	60.0	26.0	0.2	-0.1
5/12	64N	38.9	16.3	39.1	16.5	-0.2	-0.2	60.3	25.7	60.6	25.6	-0.3	0.1
5/13	64N	40.0	17.3	40.5	17.6	-0.5	-0.3	59.2	25.7	60.4	25.9	-1.1	-0.2
5/14	64D	40.9	18.4	40.4	18.3	0.5	0.1	59.0	26.1	59.4	26.6	-0.4	-0.6
5/14	64N	41.0	18.6	40.6	18.4	0.3	0.2	60.2	26.2	59.1	26.3	1.1	-0.1
5/15	64N	[e]39.8	17.1	40.1	17.5	-0.3	-0.4	61.1	25.4	60.3	25.9	0.8	-0.4
5/20	64N	40.9	16.7	41.0	16.7	-0.1	-0.1	59.8	23.7	60.0	24.3	-0.3	-0.6
5/21	64N	40.0	16.0	38.2	15.4	1.7	0.7	59.9	23.2	62.9	24.8	-2.9	-1.7
5/22	64N	38.6	14.9	38.7	15.6	-0.1	-0.7	59.5	21.4	56.9	21.4	2.6	0.0
Average		40.2	17.9	40.3	18.0	-0.1	0.0	59.8	26.8	59.8	27.0	0.0	-0.1

Appendix Table B13. Continued.

Date	Spill (%)/diel index[e]		Bonneville Dam First Powerhouse: The Dalles spillway groups Avg (%)[a] PH flow/fish	The Dalles spillway groups Avg (%)[b] Tot flow/fish	The Dalles tailrace groups Avg (%)[a] PH flow/fish	The Dalles tailrace groups Avg (%)[b] Tot flow/fish	Difference PH[c] Diff	Difference Total[d] Diff	Bonneville Dam Second Powerhouse: The Dalles spillway groups Avg (%)[a] PH flow/fish	The Dalles spillway groups Avg (%)[b] Tot flow/fish	The Dalles tailrace groups Avg (%)[a] PH flow/fish	The Dalles tailrace groups Avg (%)[b] Tot flow/fish	Difference PH[c] Diff	Difference Total[d] Diff
							Summer migration							
6/19	64D		45.4	19.6	43.6	17.0	1.8	2.6	55.4	19.1	58.5	41.2	-3.1	-22.0
6/20	64N		48.0	20.2	44.7	17.3	3.3	2.9	53.3	22.8	57.5	27.5	-4.2	-4.8
6/21	64D		43.5	19.9	45.3	19.3	-1.8	0.5	59.2	33.4	58.5	27.8	0.6	5.6
6/24	64N		48.9	25.9	46.2	26.5	2.7	-0.6	58.2	34.7	58.5	34.1	-0.3	0.6
6/25	64D		46.9	27.1	46.9	26.2	0.0	0.9	57.0	34.6	58.3	35.6	-1.3	-1.0
6/26	64N		46.6	27.5	48.3	27.7	-1.8	-0.1	58.1	36.8	56.8	35.2	1.2	1.6
6/27	64D		47.8	28.2	44.2	27.2	3.7	1.0	58.2	36.1	57.9	35.9	0.4	0.2
6/28	64N		44.6	28.1	43.8	28.0	0.7	0.1	57.5	37.7	57.5	37.8	0.0	-0.1
7/1	64N		42.4	28.1	43.2	27.4	-0.8	0.7	58.4	38.4	58.7	38.8	-0.2	-0.3
7/2	64D		45.7	29.2	45.0	28.6	0.7	0.6	58.0	37.6	57.9	37.4	0.1	0.2
7/3	64N	e	46.7	28.7	44.7	28.0	2.0	0.8	57.3	37.1	56.9	36.5	0.4	0.5
7/4	64D		45.0	29.6	46.0	28.9	-1.0	0.7	57.8	37.1	57.9	37.0	-0.1	0.1
7/8	64D		55.6	28.4	50.6	31.0	4.9	-2.6	54.4	35.7	55.6	37.0	-1.1	-1.3
7/9	64D		52.5	30.1	47.8	28.3	4.7	1.8	57.6	36.5	57.9	37.7	-0.3	-1.2
7/10	64N	e	48.4	29.2	50.9	30.9	-2.5	-1.7	56.7	37.4	56.7	37.5	0.0	-0.1
7/12	64D		48.6	29.7	50.5	29.8	-1.9	-0.1	54.8	31.9	53.6	31.9	1.2	0.1
7/15	64N		41.2	27.0	41.4	27.1	-0.2	-0.1	59.8	40.2	60.1	40.8	-0.2	-0.6
7/16	64N		43.6	27.0	40.2	26.6	3.4	0.4	59.7	39.3	60.3	40.0	-0.6	-0.7
	Average		46.7	26.9	45.7	26.4	1.0	0.4	57.3	34.8	57.7	36.1	-0.4	-1.3

[a] Average of hourly data weighted by fish number for counts of fish detected at the designated powerhouse multiplied by percentage of designated powerhouse flow of the total powerhouse flow or of total river flow.

[b] Spillway Fish x PH % of PH flow minus Tailrace Fish x PH % of PH flow. Probability of mean difference = 0: 0.75 and 0.93 for spring and 0.10 and 0.21 for summer at first and second powerhouse, respectively.

[c] Spillway Fish x PH % of Total flow minus Tailrace Fish x PH % of Total flow. Probability of mean difference = 0: 0.67 and 0.46 for spring and 0.18 and 0.34 for summer at first and second powerhouse, respectively.

[d] Index for spill percent (64 or 30) and day or night (D or N) for condition and period of fish releases at The Dalles Dam.

[e] Indicates fish releases that were not mixed according to the Monte Carlo approximation of the exact method.

Appendix Table B14. Comparisons of average of hourly fish counts multiplied by percent flow at Bonneville Dam First or Second Powerhouse, in relation to total turbine discharge or total river flow, for test fish released at The Dalles Dam Spillway or Tailrace, 1998.

		Bonneville Dam First Powerhouse						Bonneville Dam Second Powerhouse					
	Spill (%) /diel index[e]	The Dalles spillway groups		The Dalles tailrace groups		D ifference		The Dalles spillway groups		The Dalles tailrace groups		D ifference	
Date		Avg (%)[a] PH flow/fish	Avg (%)[b] Tot flow/fish	Avg (%)[a] PH flow/fish	Avg (%)[b] Tot flow/fish	PH[c] Diff	Total[d] Diff	Avg (%)[a] PH flow/fish	Avg (%)[b] Tot flow/fish	Avg (%)[a] PH flow/fish	Avg (%)[b] Tot flow/fish	PH[c] Diff	Total[d] Diff
Spring migrants													
4/28	64D	44.9	28.7	42.2	27.1	2.7	1.6	58.8	37.9	59.7	37.1	-0.9	0.8
4/29	30D	41.9	26.9	40.8	24.7	1.1	2.2	59.4	37.9	57.1	38.3	2.2	-0.5
4/30	64N	39.7	27.0	40.5	27.5	-0.8	-0.4	60.5	41.0	59.8	41.3	0.7	-0.3
5/1	30D	38.5	25.2	38.2	26.4	0.4	-1.2	61.7	41.0	61.8	40.2	0.0	0.8
5/5	30D	36.3	21.1	37.8	22.4	-1.5	-1.3	63.0	36.6	63.7	37.1	-0.7	-0.5
5/6	64N	37.7	21.5	37.9	21.2	-0.2	0.3	63.2	34.3	62.5	34.4	0.7	-0.1
5/6	64N	37.8	22.0	37.7	22.0	0.1	0.0	62.8	35.5	61.0	33.9	1.8	1.5
5/6	64N	37.6	22.0	38.0	22.0	-0.4	0.0	62.4	35.3	62.3	34.3	0.2	1.0
5/6	64N	37.4	21.7	37.6	21.2	-0.2	0.5	62.9	36.1	62.4	35.4	0.4	0.7
5/8	64D	37.6	21.9	37.7	22.2	-0.1	-0.3	62.5	35.5	62.6	34.4	-0.1	1.1
5/9	30D	37.5	22.7	38.0	22.2	-0.5	0.5	62.6	38.6	61.8	37.2	0.9	1.4
5/10	64D	37.3	23.0	37.7	22.8	-0.4	0.2	63.5	38.2	63.2	38.3	0.3	-0.1
5/12	64N	37.8	23.1	37.6	23.2	0.2	-0.1	61.8	37.8	61.6	35.9	0.2	2.0
5/13	30N	38.6	22.3	38.3	22.2	0.3	0.2	61.6	35.6	61.5	35.0	0.1	0.7
5/14	64D	36.6	21.3	36.9	21.7	-0.3	-0.4	61.6	38.8	62.4	37.9	-0.8	0.9
5/15	30D	39.0	23.4	39.9	22.9	-0.9	0.5	60.0	37.1	59.1	35.0	0.9	2.0
5/16	64N	45.3	23.8	42.6	23.9	2.6	-0.1	57.3	30.8	58.4	31.4	-1.1	-0.5
5/20	64D	39.0	21.7	38.0	22.5	1.0	-0.8	63.0	37.3	63.3	38.1	-0.2	-0.9
5/21	30D	36.5	20.7	37.1	21.0	-0.6	-0.4	63.8	33.9	62.2	36.5	1.6	-2.6
5/23	30D	40.0	18.1	36.8	18.3	3.2	-0.2	64.1	31.5	64.5	31.3	-0.4	0.1
5/25	64D	36.8	19.6	37.3	19.6	-0.5	0.0	62.5	35.3	62.4	35.0	0.1	0.4
5/25	64D	36.9	19.3	36.2	19.1	0.7	0.2	62.7	35.6	62.3	36.0	0.4	-0.4
5/26	64D	37.9	19.3	37.2	19.3	0.7	0.0	62.7	32.9	62.8	32.9	-0.1	0.0

Appendix Table B14. Continued.

Date	Spill (%) /diel index[e]	Bonneville Dam First Powerhouse: The Dalles spillway groups Avg (%)[a] PH flow/fish	The Dalles spillway groups Avg (%)[b] Tot flow/fish	The Dalles tailrace groups Avg (%)[a] PH flow/fish	The Dalles tailrace groups Avg (%)[b] Tot flow/fish	Difference PH[c] Diff	Difference Total[d] Diff	Bonneville Dam Second Powerhouse: The Dalles spillway groups Avg (%)[a] PH flow/fish	The Dalles spillway groups Avg (%)[b] Tot flow/fish	The Dalles tailrace groups Avg (%)[a] PH flow/fish	The Dalles tailrace groups Avg (%)[b] Tot flow/fish	Difference PH[c] Diff	Difference Total[d] Diff
Spring migrants													
5/26	64D	36.8	18.3	37.2	19.2	-0.4	-0.9	63.2	33.2	63.2	33.3	0.0	-0.1
5/27	30D	37.2	18.7	37.0	19.4	0.2	-0.7	62.3	32.5	62.4	32.7	-0.2	-0.2
5/27	30D	37.1	18.3	37.1	18.2	0.0	0.1	62.4	30.4	62.9	30.7	-0.5	-0.3
5/27	30D	37.2	18.2	37.2	18.5	0.0	-0.3	62.3	30.4	62.8	30.7	-0.5	-0.3
6/4	64N	37.8	20.9	38.5	21.2	-0.7	-0.2	62.1	34.8	61.9	34.9	0.2	-0.2
Average		38.4	21.8	38.2	21.8	0.2	0.0	62.0	35.6	61.8	35.3	0.2	0.2
Summer migrants													
6/23	64D	41.7	25.6	42.5	26.3	-0.9	-0.7	59.6	35.4	57.6	33.7	2.0	1.6
6/24	30D [e]	43.5	29.0	44.4	28.9	-0.9	0.1	55.0	36.1	55.4	35.2	-0.4	0.9
6/25	64N	46.5	28.0	48.9	28.3	-2.3	-0.3	55.2	32.3	56.4	32.0	-1.2	0.3
6/25	64N	48.4	28.8	47.3	27.7	1.1	1.1	53.0	31.1	54.2	31.2	-1.2	-0.1
6/26	30N	55.5	31.7	54.3	31.9	1.1	-0.2	48.9	27.3	50.5	28.3	-1.6	-0.9
6/26	30N	52.7	30.3	48.5	29.3	4.1	0.9	51.5	31.0	53.2	29.8	-1.6	1.2
6/30	30D	56.2	28.1	51.9	29.0	4.3	-0.9	55.9	30.9	56.3	31.9	-0.5	-1.0
6/30	30D	58.2	27.5	60.0	28.4	-1.8	-0.9	54.3	30.8	56.1	31.9	-1.8	-1.1
7/1	64N	63.9	30.9	64.5	32.7	-0.7	-1.8	33.6	18.0	36.0	18.2	-2.4	-0.2
7/1	64N	81.6	30.6	91.2	26.8	-9.6	3.8	40.4	22.6	40.2	25.7	0.2	-3.2
7/2	30N	65.6	33.1	64.0	33.9	1.7	-0.8	47.0	27.3	44.5	28.9	2.4	-1.6
7/2	30N	61.1	30.7	63.0	31.7	-1.9	-1.1	42.1	24.3	49.4	31.5	-7.3	-7.2
7/3	64D	62.5	31.6	56.0	30.6	6.5	1.0	39.7	21.2	40.1	22.8	-0.5	-1.6
7/3	64D	55.9	28.7	55.3	29.8	0.6	-1.1	39.5	21.4	42.4	25.6	-2.9	-4.2
7/8	30D	66.8	30.2	78.3	26.2	-11.5	4.1	25.2	13.3	31.1	17.0	-5.9	-3.7
7/8	30D	67.9	26.3	78.6	28.5	-10.8	-2.2	29.9	15.9	30.0	17.1	-0.1	-1.2
7/9	64D [e]	73.9	23.2	87.6	24.8	-13.7	-1.6	16.7	5.6	18.6	8.1	-2.0	-2.5
7/10	30D	73.3	30.9	67.9	31.4	5.3	-0.5	30.3	15.6	35.3	18.4	-5.1	-2.8

Appendix Table B14. Continued

Date	Spill (%) /diel index[e]	Bonneville Dam First Powerhouse						Bonneville Dam Second Powerhouse					
		The Dalles spillway groups		The Dalles tailrace groups		D ifference		The Dalles spillway groups		The Dalles tailrace groups		D ifference	
		Avg (%)[a] PH flow/fish	Avg (%)[b] Tot flow/fish	Avg (%)[a] PH flow/fish	Avg (%)[b] Tot flow/fish	PH[c] Diff	Total[d] Diff	Avg (%)[a] PH flow/fish	Avg (%)[b] Tot flow/fish	Avg (%)[a] PH flow/fish	Avg (%)[b] Tot flow/fish	PH[c] Diff	Total[d] Diff
Summer Migrants													
7/10	30D	65.5	31.2	65.7	31.2	-0.2	0.0	34.9	19.2	30.2	15.1	4.8	4.2
7/14	30D	65.2	29.5	57.7	32.1	7.4	-2.5	37.5	18.4	39.6	21.5	-2.1	-3.1
7/15	64D	64.4	30.1	66.6	29.9	-2.2	0.2	27.7	15.4	22.4	11.0	5.3	4.4
7/15	64N	69.6	33.4	66.7	34.9	2.8	-1.4	20.7	10.6	32.3	18.2	-11.6	-7.6
7/16	30N	61.9	31.1	63.5	31.4	-1.6	-0.3	31.6	17.1	30.7	16.2	0.9	0.9
7/16	30N	66.6	33.1	66.9	33.0	-0.3	0.1	36.2	20.8	28.1	13.6	8.0	7.3
7/17	64D	60.2	32.8	66.1	31.1	-5.9	1.6	15.6	6.8	22.5	11.5	-6.9	-4.8
7/17	64N	55.8	32.1	67.4	30.6	-11.7	1.5	26.7	13.5	22.7	11.2	4.0	2.3
7/21	64N	52.8	27.8	54.2	29.4	-1.4	-1.6	40.9	21.2	40.3	20.8	0.6	0.3
7/21	64N	63.0	27.7	53.5	28.2	9.5	-0.5	43.1	23.2	40.0	21.1	3.1	2.1
7/22	30D [e]	59.5	34.7	59.8	35.0	-0.4	-0.3	39.6	19.7	38.3	19.5	1.3	0.2
7/22	30D [e]	68.1	33.7	67.5	32.1	0.5	1.6	28.6	15.0	36.8	18.4	-8.2	-3.4
7/23	64D	72.6	34.0	68.2	34.2	4.4	-0.1	34.2	15.7	36.3	18.5	-2.1	-2.8
7/23	64D	81.8	34.9	69.7	34.1	12.1	0.7	43.1	21.5	35.9	19.0	7.2	2.6
7/23	64D	75.4	34.5	73.2	34.4	2.3	0.1	29.9	14.2	30.0	15.0	-0.1	-0.8
7/24	30D	78.6	33.4	80.2	35.2	-1.6	-1.8	30.2	14.4	22.7	11.2	7.5	3.2
7/24	30N	86.2	41.0	81.3	37.3	4.9	3.7						
Average		67.1	31.4	67.7	31.4	-0.6	0.0	34.0	17.9	34.5	18.8	-0.5	-0.9

[a] Average of hourly data weighted by fish number for counts of fish detected at the designated powerhouse multiplied by percentage of designated powerhouse flow of the total powerhouse flow or of total river flow.

[b] Spillway Fish x PH % of PH flow minus Tailrace Fish x PH % of PH flow. Probability of mean difference = 0: 0.33 and 0.22 for spring and 0.76 and 0.49 for summer at first and second powerhouse, respectively.

[c] Spillway Fish x PH % of Total flow minus Tailrace Fish x PH % of Total flow. Probability of mean difference = 0: 0.80 and 0.22 for spring and 0.99 and 0.24 for summer at first and second powerhouse, respectively.

[d] Index for spill percent (64 or 30) and day or night (D or N) for condition and period of fish releases at The Dalles Dam.

[e] Indicates fish releases that were not mixed according to the Monte Carlo approximation of the exact method.

Appendix Table B15. Means, Confidence Intervals (CI), *t*-tests, and Analysis of Variance for PIT-tag interrogations of The Dalles Dam passage survival study for summer migrating juvenile salmon at Bonneville Dam, bird colonies, and combined data 1999.

Paired t-tests

Bonneville Powerhouse 1 vs. Bonneville Powerhouse 2

Total detections (n = 3,400) vs. (n = 17,064)

	N	Mean	SD	SE Mean
Ln Bon PH1 Surv.	84	-0.1127 0	.3356	0
Ln Bon PH2 Surv.	84	-0.0185 0	.1651	0
Back Transformed				
Bon. PH1		0.89345	2.748	0.300
Bon. PH2		0.98165	1.485	0.162

t = -2.37 P = 0.02

Bonneville Subtotal vs. Bird Colony

Total detections (n = 20,464) vs. (n = 2,580)

	N	Mean	SD	SE Mean
Ln Bon Surv.	84	-0.028	0.152	0.02
Ln Brd. Col. Srv.	84	0.007	0.321	0.04
Back transformed				
Bonneville		0.972	1.356	0.148
Bird Colony		1.008	2.968	0.324

t = -0.93 P = 0.36

Analysis of Variance

Ln Combined Data

Source	DF	Seq SS	Adj SS	MS	F	P
Julian	1	0.06842	0.0704	0.0704	3.9	0.05
Spill (%)	1	0.03031	0.0303	0.0303	1.7	0.20
Diel	1	0.10607	0.1061	0.1061	5.9	0.02
Loc.	2	0.00124	0.0012	0.0006	0.0	0.97
Spill (%) x Diel	1	0.0170	0.0170	0.0170	0.9	0.34
Spill (%) x Loc.	2	0.01166	0.0117	0.0058	0.3	0.73
Diel x Loc.	2	0.03117	0.0312	0.0156	0.9	0.43
Error	73	1.31964	1.3196	0.0181		
Total	83	1.58552				

Adj. Means & CI			Back Transformed			T statist			Back Transfor.	
Spill (%)	Ln Mean	Ln SE	Mean	SE	df	at df	CI -	CI +	CI -	CI +
30% 1	-0.004	0.021	0.996	0.0207	73	1.993	-0.046	0.037	0.955	1.038
64% 2	-0.042	0.021	0.958	0.0199	73	1.993	-0.084	-0.001	0.920	0.999
Diel										
Day 1	-0.059	0.021	0.943	0.0196	73	1.993	-0.100	-0.018	0.905	0.983
Nite 2	0.012	0.021	1.012	0.0210	73	1.993	-0.029	0.053	0.971	1.055
Location										
North 1	-0.027	0.025	0.973	0.0247	73	1.993	-0.078	0.024	0.925	1.024
Mid 2	-0.018	0.025	0.982	0.0250	73	1.993	-0.069	0.033	0.934	1.033
South 3	-0.025	0.025	0.975	0.0248	73	1.993	-0.076	0.025	0.927	1.026

Ln Bonn Subtotal Data

Source	DF	Seq SS	Adj SS	MS	F	P
Julian	1	0.07225	0.0750	0.0750	3.5	0.07
Spill (%)	1	0.05535	0.0554	0.0554	2.6	0.11
Diel	1	0.13456	0.1346	0.1346	6.3	0.02
Loc.	2	0.00118	0.0012	0.0006	0.0	0.97
Spill (%) x Diel	1	0.04013	0.0401	0.0401	1.9	0.18
Spill (%) x Loc.	2	0.00711	0.0071	0.0036	0.2	0.85
Diel x Loc.	2	0.04074	0.0407	0.0204	1.0	0.39
Error	73	1.57104	1.5710	0.0215		
Total	83	1.92237				

Adj. Means & CI			Back Transformed			T statist			Back Transfor.	
Spill (%)	Mean	LnSE	Mean	SE	df	at df	CI -	CI +	CI -	CI +
30% 1	-0.003	0.023	0.997	0.0226	73	1.993	-0.048	0.042	0.953	1.043
64% 2	-0.054	0.023	0.947	0.0214	73	1.993	-0.099	-0.009	0.906	0.991
Diel										
Day 1	-0.068	0.023	0.934	0.0211	73	1.993	-0.114	-0.023	0.893	0.977
Nite 2	0.012	0.023	1.012	0.0229	73	1.993	-0.033	0.057	0.967	1.058
Location										
North 1	-0.028	0.028	0.972	0.0269	73	1.993	-0.084	0.027	0.920	1.027
Mid 2	-0.024	0.028	0.976	0.0271	73	1.993	-0.079	0.031	0.924	1.032
South 3	-0.033	0.028	0.968	0.0268	73	1.993	-0.088	0.022	0.916	1.022

Appendix Table B15. Continued.

Ln Bird Colony Data

							Adj. Means & CI			Back Transformed			T statist			Back Transfor.	
Source	DF	Seq SS	Adj SS	MS	F	P	Spill (%)	Ln Mean	Ln SE	Mean	SE	df	at df	CI -	CI +	CI -	CI +
Julian	1	0.050	0.046	0.046	0.4	0.51	30% 1	-0.045	0.050	0.956	0.0480	73	1.993	-0.145	0.055	0.865	1.057
Spill (%)	1	0.232	0.232	0.232	2.2	0.14	64% 2	0.060	0.050	1.062	0.0533	73	1.993	-0.040	0.160	0.961	1.174
Diel	1	0.015	0.015	0.015	0.1	0.71	Diel										
Loc.	2	0.114	0.114	0.057	0.5	0.59	Day 1	0.021	0.050	1.021	0.0513	73	1.993	-0.079	0.121	0.924	1.128
Spill (%) x Diel	1	0.020	0.020	0.020	0.2	0.67	Nite 2	-0.006	0.050	0.994	0.0499	73	1.993	-0.106	0.094	0.900	1.099
Spill (%) x Loc.	2	0.389	0.389	0.194	1.8	0.17	Location										
Diel x Loc.	2	0.020	0.020	0.010	0.1	0.91	North 1	-0.037	0.062	0.963	0.0592	73	1.993	-0.160	0.085	0.852	1.089
Error	73	7.731	7.731	0.106			Mid 2	0.007	0.062	1.007	0.0619	73	1.993	-0.116	0.129	0.891	1.138
Total	83	8.570					South 3	0.053	0.0615	1.054	0.0648	73	1.993	-0.070	0.176	0.933	1.192

Appendix Table B16. PIT-tag detections in relation to size at release comparing proportions above and below the critical size for radio telemetry evaluations; subyearling chinook salmon from The Dalles Dam passage survival study, summer 1999.

	Fork length <=110 mm					Fork length >110 mm				
		Detections [a]					Detections [a]			
Release		Bonneville		Estuary [b]		Release	Bonneville		Estuary [b]	
date	no. [c]	no.	proport.	no.	proport.	no. [c]	no.	proport.	no.	proport.
6/17	635	57	0.090	6	0.009	111	30	0.270	8	0.072
6/19	974	69	0.071	21	0.022	116	23	0.198	5	0.043
6/22	538	48	0.089	7	0.013	47	14	0.298	3	0.064
6/23	924	68	0.074	10	0.011	161	24	0.149	7	0.043
6/25	795	79	0.099	16	0.020	211	35	0.166	6	0.028
6/27	770	86	0.112	9	0.012	214	56	0.262	11	0.051
6/30	777	113	0.145	19	0.024	183	75	0.410	5	0.027
7/2	773	101	0.131	14	0.018	196	42	0.214	8	0.041
7/4	832	122	0.147	27	0.032	375	53	0.141	9	0.024
7/8	694	98	0.141	11	0.016	259	67	0.259	5	0.019
7/10	382	64	0.168	6	0.016	130	33	0.254	2	0.015
7/11	608	100	0.164	6	0.010	326	100	0.307	7	0.021
7/14	604	80	0.132	5	0.008	278	85	0.306	7	0.025
7/15	265	35	0.132	4	0.015	176	27	0.153	2	0.011
7/17	635	89	0.140	17	0.027	303	59	0.195	15	0.050
7/19	561	73	0.130	7	0.012	622	59	0.095	7	0.011
Total	10,767	1,282	0.119	185	0.017	3,708	782	0.211	107	0.029

Bonneville ratio: <=110 to >110mm			Ln
Wt.Geomean:	0.551		-0.596
SE:	0.064		0.116
95% CI:	0.435	0.70	
t:			-5.16
df:			30
p:			0.000

Estuary ratio: <=110 to >110mm			Ln
Wt.Geomean:	0.52		-0.653
SE:	0.091		0.175
95% CI:	0.364	0.744	
t:			-3.73
df:			30
p:			0.001

[a] In instances where detections/recoveries were few, proportions were based on cumulative data for several release days. For analysis, the minimum detections was five fish for size category with the least number.
[b] Detections from Rice Island, Sand Island, or Jones Beach.
[c] All release sites combined by day.

Appendix Table B17. Comparisons of median travel time in days from The Dalles Dam to Bonneville Dam for daily release groups, diel groups, and treatment groups of summer migrant subyearling chinook salmon.

		Spillway												Tailrace			Combined			
		Bonneville First PH				Bonneville Second PH				Bonneville Dam				Bon1	Bon2	Bonn	Bon1	Bon2	Bonn	River
Release		North	Mid	South	avg	North	Mid	South	avg	North	Mid	South	avg	avg.	avg.	avg.	avg.	avg.	avg.	flow
Date	Period	days	days	days	days	days	days	days	days	days	days	days	days	days	days	days	days	days	days	kcfs [c]
6/17	Night	1.5	1.3	1.4	1.4	1.7	1.5	1.8	1.7	1.6	1.5	1.7	1.6	1.4	1.6	1.5	1.4	1.6	1.6	369
6/19	Day	1.7	1.8	2.0	1.8	1.6	1.6	1.5	1.6	1.6	1.6	1.7	1.6	1.7	1.5	1.6	1.8	1.5	1.6	350
6/19	Night	1.5	1.4	1.7	1.5	1.7	1.7	1.7	1.7	1.6	1.6	1.7	1.7	1.6	1.5	1.5	1.6	1.6	1.6	350
6/22	Day	1.6	1.6	1.6	1.6	1.5	1.5	1.4	1.5	1.5	1.6	1.4	1.5	1.8	1.4	1.5	1.7	1.4	1.5	324
6/23	Day	1.7	1.6	1.6	1.6	1.5	1.7	1.7	1.6	1.6	1.6	1.6	1.6	1.8	1.5	1.7	1.7	1.6	1.6	351
6/23	Night	1.8	1.8	1.5	1.8	1.4	1.4	1.8	1.6	1.5	1.6	1.8	1.6	1.6	1.4	1.4	1.7	1.5	1.5	351
6/25	Day	1.5	1.6	2.1	1.7	1.6	1.7	1.6	1.6	1.6	1.7	1.8	1.7	1.8	1.6	1.6	1.7	1.6	1.6	313
6/25	Night	1.9	1.7	1.3	1.6	1.7	1.7	1.7	1.7	1.7	1.7	1.6	1.7	1.5	1.5	1.5	1.6	1.6	1.6	313
6/27	Day	1.9	2.3	1.7	2.0	1.5	1.6	1.6	1.6	1.6	1.7	1.6	1.7	2.0	1.5	1.6	2.0	1.5	1.6	314
6/27	Night	2.4	1.7	1.5	1.8	1.7	1.7	1.6	1.7	1.7	1.7	1.6	1.7	1.8	1.6	1.6	1.8	1.6	1.7	314
6/30	Day	1.7	1.9	2.4	2.0	1.5	1.5	1.5	1.5	1.6	1.6	1.7	1.6	1.8	1.4	1.5	1.9	1.5	1.5	312
6/30	Night	1.5	2.7	1.3	1.7	1.7	1.7	1.6	1.7	1.7	1.8	1.6	1.7	1.5	1.5	1.5	1.6	1.6	1.6	312
7/2	Day	2.0	1.7	2.0	1.9	1.7	1.8	1.7	1.7	1.7	1.7	1.7	1.7	1.8	1.6	1.6	1.9	1.6	1.7	302
7/2	Night	1.7	2.1	2.0	2.0	1.9	1.8	1.8	1.8	1.9	1.9	1.8	1.9	1.9	1.7	1.8	1.9	1.8	1.8	302
7/4	Day	1.9	2.0	1.7	1.9	1.6	1.8	2.0	1.8	1.7	1.8	1.9	1.8	1.7	1.6	1.6	1.8	1.7	1.7	262
7/4	Night	2.5	1.9	2.1	2.2	2.0	2.2	2.2	2.2	2.1	2.2	2.2	2.2	2.2	2.0	2.0	2.2	2.1	2.1	262
7/8	Day	1.7	2.3	2.0	2.0	1.9	1.7	1.6	1.7	1.9	1.8	1.7	1.8	1.6	1.6	1.6	1.8	1.7	1.7	263
7/8	Night	2.6	3.0	2.4	2.7	2.2	2.3	2.3	2.3	2.2	2.3	2.3	2.3	2.1	2.1	2.1	2.3	2.2	2.2	263
7/10	Day	2.3	2.2	2.0	2.1	2.2	2.0	2.1	2.1	2.2	2.0	2.1	2.1	2.4	2.0	2.1	2.3	2.1	2.1	221
7/11	Day	1.9	1.8	2.0	1.9	2.1	1.8	1.8	1.9	2.1	1.8	1.9	1.9	1.9	1.6	1.7	1.9	1.7	1.8	281
7/11	Night	2.3	1.8	2.0	2.1	1.9	1.9	2.0	1.9	2.0	1.9	2.0	1.9	2.1	1.8	1.8	2.1	1.9	1.9	281
7/14	Day	2.0	1.8	1.6	1.8	1.5	1.6	1.7	1.6	1.6	1.6	1.7	1.6	1.8	1.5	1.5	1.8	1.5	1.5	285
7/14	Night	1.8	1.9	2.0	1.9	2.0	1.8	1.8	1.9	2.0	1.8	1.8	1.9	1.5	1.7	1.7	1.7	1.8	1.8	285
7/15	Night	1.9	2.0	1.8	1.9	2.0	2.3	1.9	2.0	2.0	2.2	1.9	2.0	1.6	1.8	1.8	1.8	1.9	1.9	298
7/17	Day	1.8	1.7	1.5	1.7	1.6	1.7	1.8	1.7	1.6	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	246
7/17	Night	2.0	1.9	2.0	1.9	1.7	1.7	2.0	1.8	1.7	1.8	2.0	1.8	1.8	1.6	1.6	1.9	1.7	1.7	246
7/19	Day	1.9	1.8	1.7	1.8	1.8	1.8	1.7	1.8	1.8	1.8	1.7	1.8	1.7	1.6	1.7	1.8	1.7	1.7	247
7/19	Night	2.3	2.1	2.5	2.3	2.1	2.2	2.1	2.2	2.2	2.2	2.2	2.2	2.1	2.0	2.1	2.2	2.1	2.1	247

Appendix Table B17. Continued.

		Spillway												Tailrace			Combined			
		Bonneville First PH				Bonneville Second PH				Bonneville Dam				Bon1	Bon2	Bonn	Bon1	Bon2	Bonn	River
Release		North	Mid	South	avg	North	Mid	South	avg	North	Mid	South	avg	avg.	avg.	avg.	avg.	avg.	avg.	flow
Date	Period	days	days	days	days	days	days	days	days	days	days	days	days	days	days	days	days	days	days	kcfs [c]
Avg	Day	1.82	1.86	1.85	1.84	1.69	1.69	1.69	1.69	1.72	1.71	1.72	1.72	1.83	1.58	1.63	1.83	1.63	1.67	291
Avg	Night	1.97	1.96	1.82	1.91	1.83	1.85	1.88	1.86	1.85	1.87	1.87	1.86	1.77	1.70	1.71	1.84	1.78	1.79	300
Avg		1.90	1.91	1.83	1.88	1.76	1.77	1.78	1.77	1.78	1.79	1.80	1.79	1.80	1.64	1.67	1.84	1.71	1.73	295
Diff (N-D)		0.16	0.10	-0.03	0.07	0.14	0.17	0.19	0.17	0.13	0.16	0.15	0.15	-0.05	0.12	0.08	0.00	0.15	0.12	8.7

[a] No significant difference in travel time was detected for north vs. middle vs. south released spillway groups (P = 0.60-0.77). Mean travel time of spillway groups was significantly different from tailrace released groups (P = 0.0001; spillway groups averaged 0.12 day longer). Mean travel time for fish groups detected at Bonneville First Powerhouse was significantly different from those detected at Bonneville Second Powerhouse (P = 0.001; PH 1 averaged 0.12 day longer). Mean travel time for nighttime releases was significantly different from daytime releases (P = 0.05; nighttime releases averaged 0.12 day longer).

[b] Average travel time to Bonneville Dam increased through time, but was not strongly correlated with Julian date, r = 0.55.

[c] River flow in thousand ft^3/second by COE convention; 1,000 ft^3/second = 28.3 m^3/second. Average travel time to Bonneville Dam was not strongly correlated to flow, r = -0.64

Appendix Table B18. Comparisons of average of hourly fish counts multiplied by percent flow at Bonneville Dam First or Second Powerhouse, in relation to total turbine discharge or total river flow, for test fish released at The Dalles Dam Spillway or Tailrace, summer 1999.

		Bonneville First Powerhouse							Bonneville Second Powerhouse						
		The Dalles spillway groups		The Dalles tailrace groups		Difference			The Dalles spillway groups		The Dalles tailrace groups		Difference		
	Cond	Avg (%)[a]	Avg (%)[b]	Avg (%)[a]	Avg (%)[b]	PH [c]	Total [d]		Avg (%)[a]	Avg (%)[b]	Avg (%)[a]	Avg (%)[b]	PH [c]	Total [d]	
Date	& Diel[e]	PH flow/fish	Tot flow/fish	PH flow/fish	Tot flow/fish	Diff	Diff		PH flow/fish	Tot flow/fish	PH flow/fish	Tot flow/fish	Diff	Diff	
6/17	64N	38.6	24.1	38.7	24.0	-0.1	0.1		61.7	38.9	61.6	38.6	0.0	0.3	
6/19	30D	39.0	24.5	38.7	24.3	0.3	0.1		61.1	38.5	61.0	38.5	0.0	0.0	
6/19	30N	39.0	24.4	39.0	24.5	0.0	-0.2		60.7	37.9	61.0	38.1	-0.3	-0.3	
6/22	64D	39.2	24.1	39.1	24.1	0.1	0.0	[f]	60.2	37.3	59.8	37.2	0.4	0.1	[f]
6/23	64D	39.3	23.8	39.5	24.0	-0.1	-0.2		60.5	37.1	60.0	36.4	0.5	0.6	
6/23	64N	39.0	24.2	38.9	23.9	0.0	0.4		61.1	37.7	61.2	37.7	-0.1	0.0	
6/25	30D	38.3	24.8	38.3	24.8	0.0	0.0		61.7	40.1	61.8	40.1	-0.1	0.0	
6/25	30N	38.6	25.0	38.4	25.1	0.2	0.0	[f]	61.5	40.4	61.7	40.5	-0.2	-0.1	[f]
6/27	64D	40.5	27.7	40.8	27.7	-0.3	-0.1		60.5	42.5	60.7	43.1	-0.2	-0.6	
6/27	64N	41.7	27.2	41.5	27.3	0.2	-0.1		59.6	41.1	59.6	41.1	0.0	0.0	
6/30	30D	41.6	27.9	40.7	27.8	0.9	0.1	[f]	59.1	40.8	59.3	41.2	-0.1	-0.4	[f]
6/30	30N	41.3	27.0	41.4	26.9	-0.1	0.1	[f]	60.5	41.6	60.3	41.5	0.2	0.1	[f]
7/2	30D	41.8	27.1	41.2	27.3	0.6	-0.2		59.4	40.8	59.4	40.7	0.0	0.0	
7/2	30N	47.9	29.1	45.2	28.4	2.7	0.8	[f]	56.5	37.9	56.5	37.9	0.0	0.0	[f]
7/4	64D	46.2	29.4	44.6	29.0	1.6	0.4		55.8	37.4	56.2	38.0	-0.4	-0.6	
7/4	64N	49.0	29.8	50.3	30.0	-1.3	-0.2		51.6	33.2	51.3	33.0	0.2	0.2	
7/8	30D	45.9	28.5	45.3	28.8	0.7	-0.3	[f]	55.6	36.6	56.5	37.5	-0.9	-0.8	[f]
7/8	30N	46.7	29.8	50.8	29.4	-4.1	0.4	[f]	52.4	33.9	51.6	33.0	0.8	0.9	[f]
7/10	64N	42.7	27.5	42.4	27.9	0.3	-0.4		58.1	39.7	57.9	39.4	0.2	0.2	
7/11	64D	44.8	29.0	46.2	29.5	-1.4	-0.5	[f]	57.3	38.6	58.2	39.9	-0.9	-1.3	[f]

Appendix Table B18. Continued.

		Bonneville First Powerhouse							Bonneville Second Powerhouse						
		The Dalles spillway groups		The Dalles tailrace groups		Difference			The Dalles spillway groups		The Dalles tailrace groups		Difference		
Date	Cond & Diel[e]	Avg (%)[a] PH flow/fish	Avg (%)[b] Tot flow/fish	Avg (%)[a] PH flow/fish	Avg (%)[b] Tot flow/fish	PH [c] Diff	Total [d] Diff		Avg (%)[a] PH flow/fish	Avg (%)[b] Tot flow/fish	Avg (%)[a] PH flow/fish	Avg (%)[b] Tot flow/fish	PH [c] Diff	Total [d] Diff	
7/11	64N	47.3	29.0	48.2	29.3	-0.8	-0.3		54.1	35.0	54.3	35.3	-0.2	-0.3	
7/14	30D	42.7	27.1	41.9	25.7	0.9	1.4	[f]	58.8	37.0	59.0	37.4	-0.2	-0.3	[f]
7/14	30N	45.1	28.0	43.0	26.7	2.1	1.3	[f]	56.2	36.6	57.2	37.0	-1.0	-0.3	[f]
7/15	64N	47.9	30.2	46.6	29.6	1.2	0.6	[f]	52.9	34.2	53.3	34.6	-0.5	-0.4	[f]
7/17	30D	42.9	29.1	43.7	29.0	-0.8	0.2		56.6	38.9	56.8	39.1	-0.2	-0.1	
7/17	30N	49.5	30.8	50.9	30.6	-1.4	0.2		51.3	33.4	52.4	34.3	-1.0	-0.9	
7/19	30D	53.0	32.2	53.3	31.9	-0.3	0.3		51.5	33.6	50.6	33.1	0.9	0.5	
7/19	30N	47.4	29.0	48.0	29.5	-0.6	-0.5		52.6	34.3	52.4	34.4	0.2	-0.1	
Mean		43.5	27.5	43.5	27.4	0.0	0.1		57.5	37.7	57.6	37.8	-0.1	-0.1	

[a] Average of hourly data weighted by fish number for counts of fish detected at the designated powerhouse multiplied by percentage of designated powerhouse flow of the total powerhouse flow.

[b] Average of hourly data weighted by fish number for counts of fish detected at the designated powerhouse multiplied by percentage of designated powerhouse flow of total river flow.

[c] Spillway Fish x PH % of PH flow minus Tailrace Fish x PH % of PH flow.

[d] Spillway Fish x PH % of Total flow minus Tailrace Fish x PH % of Total flow.

[e] Index for spill percent (64 or 30) and day or night (D or N) for condition and period of fish releases at The Dalles Dam.

[j] Indicates fish releases that were not mixed according to the Monte Carlo approximation of the exact method. A two-sample *t*-test was conducted on PH Difference and Total Difference for both Bonneville First and Second Powerhouses for fish releases that were not mixed compared to those that were mixed and there was no significant difference between them; P = 0.13-0.92.

Appendix Table B19. Correlation of relative spill passage survival of subyearling chinook salmon to conditions during passage[a]; combined data 1997-1999.

Date	Julian date	Spill %	Diel index*	Spillbay location*	Surv. %	Temp. °C	Spill kcfs	R.flow kcfs	TW El. ft.
7/24/98	205	30	1	3	31.4	21.9	45	157	78
7/15/98	196	64	1	2	45.6	20.5	141	211	78.6
7/23/98	204	64	1	2	45.6	22.1	100	163	77.9
7/17/98	198	64	2	2	47.0	20.9	144	223	78.6
7/21/98	202	64	2	2	59.1	21.9	128	199	78.3
7/24/98	205	30	2	2	60.3	21.7	54	171	77.5
7/21/98	202	64	2	3	62.2	21.9	128	199	78.3
7/15/98	196	64	2	3	63.4	20.6	140	220	78.7
6/23/99	174	64	1	3	65.1	16.6	210	369	83.5
7/17/98	198	64	2	1	65.8	20.9	144	223	78.6
7/16/98	197	30	2	3	67.9	20.7	66	224	79.2
6/30/98	181	30	1	3	68.1	18.1	60	202	78.7
7/23/98	204	64	1	3	69.1	22.1	100	164	77.8
7/1/98	182	64	2	1	69.5	17.8	192	301	81.1
7/14/99	195	30	1	1	70.4	17.9	83	282	81.2
7/2/97	183	60	1		70.6	17.2	177	293	81
7/9/98	190	64	1	1	71.2	19.4	130	212	78.8
7/14/98	195	30	1	3	73.7	20.3	60	202	78.5
7/2/98	183	30	2	3	75.3	17.8	81	264	80.7
7/8/99	189	30	2	1	76.1	16.9	82	266	80.5
7/11/97	192	63	1		76.5	18.9	176	280	82
7/3/97	184	65	2		79.1	17.2	195	300	82
7/8/99	189	30	1	1	79.1	16.5	72	236	79.2
7/11/99	192	64	1	3	79.4	17.2	162	269	79.9
7/9/98	190	64	1	2	80.7	19.4	130	212	78.8
7/23/98	204	64	1	1	80.8	22.1	100	163	77.9
7/19/99	200	30	2	3	81.0	18.9	74	267	79.5
7/8/99	189	30	1	3	81.2	16.5	72	236	79.2
7/19/99	200	30	1	1	81.3	18.5	74	242	78.1
7/17/99	198	64	1	2	81.3	18.2	140	221	78.5
7/10/98	191	30	1	1	81.8	19.8	66	217	78.7
7/8/99	189	30	1	2	81.8	16.5	72	236	79.2
7/4/97	185	65	1		82.7	17.8	150	230	79
7/1/98	182	64	2	3	83.1	17.8	192	301	81.1
6/25/97	176	64	1		83.1	16.7	261	408	85
7/8/99	189	30	2	3	83.6	16.9	82	266	80.5
7/11/99	192	64	1	1	83.9	17.2	162	269	79.9

Appendix Table B19. Continued.

Date	Julian date	Spill %	Diel index*	Spillbay location*	Surv. %	Temp. °C	Spill kcfs	R.flow kcfs	TW El. ft.
6/17/99	168	64	2	2	84.3	15.9	210	396	84.4
7/12/97	193	64	1		84.4	18.9	164	256	80
7/11/99	192	64	1	2	85.0	17.2	162	269	79.9
6/23/99	174	64	2	3	85.0	17	210	389	84.1
7/4/99	185	64	1	3	85.4	16.3	166	264	80.8
6/27/99	178	64	1	3	85.8	16.2	200	318	83
7/3/98	184	64	1	3	85.9	17.8	102	160	78.7
7/2/99	183	30	2	1	86.0	16.5	90	281	81.1
7/4/99	185	64	2	2	86.2	16.5	166	260	79.5
7/16/98	197	30	2	1	86.2	20.7	66	224	79.2
7/8/97	189	59	1		86.8	18.3	170	290	81
6/23/98	174	64	1	3	86.9	17.5	140	219	78.7
6/26/97	177	60	2		88.0	16.7	240	400	84
7/14/99	195	30	1	3	88.2	17.9	83	282	81.2
7/11/99	192	64	2	2	89.1	17.6	180	285	80.9
7/14/99	195	30	1	2	89.8	17.9	83	282	81.2
6/30/99	181	30	1	3	89.8	16.1	95	322	82.8
6/25/99	176	30	1	3	90.3	16.5	100	325	82.4
7/4/99	185	64	2	3	90.3	16.5	166	260	79.5
6/23/99	174	64	2	1	90.8	17	210	389	84.1
6/27/99	178	64	2	1	90.9	16.4	192	303	81.5
7/11/99	192	64	2	1	91.3	17.6	180	285	80.9
6/25/98	176	64	2	3	91.3	17.6	144	223	79
7/10/99	191	64	1	2	91.9	17	140	225	78.1
6/24/97	175	59	2		92.0	16.1	240	404	84
6/27/99	178	64	2	2	92.4	16.4	192	303	81.5
7/4/99	185	64	2	1	93.0	16.5	166	260	79.5
6/30/98	181	30	1	1	93.0	18.2	60	207	79.5
7/10/99	191	64	1	1	93.1	17	140	225	78.1
7/15/99	196	64	2	1	94.0	18.6	185	297	81.1
7/10/99	191	64	1	3	94.4	17	140	225	78.1
7/10/97	191	64	2		95.8	18.9	182	285	81
7/15/99	196	64	2	2	96.0	18.6	185	297	81.1
6/26/98	177	30	2	1	96.1	17.7	90	309	82.2
6/19/99	170	30	1	2	97.5	16	105	357	85
7/19/99	200	30	2	2	97.6	18.9	74	267	79.5

Appendix Table B19. Continued.

Date	Julian date	Spill %	Diel index*	Spillbay location*	Surv. %	Temp. °C	Spill kcfs	R.flow kcfs	TW El. ft.
6/24/98	175	30	1	3	97.7	17.5	75	251	80
6/30/99	181	30	1	2	97.8	16.1	95	322	82.8
7/22/98	203	30	1	2	98.0	22	61	203	78.9
7/19/99	200	30	1	2	98.3	18.5	74	242	78.1
7/19/99	200	30	2	1	98.4	18.9	74	267	79.5
7/2/99	183	30	2	2	98.4	16.5	90	281	81.1
6/27/99	178	64	1	1	98.8	16.2	200	318	83
6/26/98	177	30	2	3	98.9	17.7	80	273	81.8
6/22/99	173	64	1	2	99.2	16.3	205	331	82.2
7/19/99	200	30	1	3	99.2	18.5	74	242	78.1
7/2/99	183	30	1	3	99.5	16.2	82	301	81.9
6/23/98	174	64	1	1	100.0	17.5	140	219	78.7
6/22/99	173	64	1	1	100.5	16.3	205	331	82.2
6/23/99	174	64	1	1	100.7	16.6	210	369	83.5
7/4/99	185	64	1	1	100.8	16.3	166	264	80.8
6/25/99	176	30	2	2	101.1	16.8	100	323	82.3
6/23/99	174	64	2	2	101.6	17	210	389	84.1
7/2/99	183	30	2	3	102.3	16.5	90	281	81.1
7/15/97	196	65	2		102.4	19.4	227	350	82
6/30/99	181	30	1	1	103.0	16.2	95	327	83.1
6/30/99	181	30	2	2	103.1	16.6	100	343	82.4
7/3/98	184	64	1	1	103.1	17.8	102	160	78.7
6/22/99	173	64	1	3	103.1	16.3	205	331	82.2
7/10/98	191	30	1	2	103.2	19.8	66	217	78.7
7/24/98	205	30	1	1	103.4	21.9	45	157	78
6/25/99	176	30	1	2	103.4	16.5	100	325	82.4
7/17/99	198	64	2	3	103.5	18.3	165	263	79.4
6/28/97	179	64	2		103.5	16.1	228	355	83
6/25/99	176	30	2	3	103.6	16.8	100	323	82.3
6/25/99	176	30	2	1	104.4	16.8	100	323	82.3
7/4/99	185	64	1	2	104.5	16.3	166	265	80.6
7/8/98	189	30	1	2	104.9	19.2	72	242	79.9
6/27/99	178	64	1	2	105.7	16.2	200	318	83
6/19/99	170	30	1	1	106.4	16	105	357	85
7/17/98	198	64	1	3	106.5	20.8	122	196	77.8
7/2/99	183	30	1	2	106.6	16.2	82	301	81.9

Appendix Table B19. Continued

Date	Julian date	Spill %	Diel index*	Spillbay location*	Surv. %	Temp. °C	Spill kcfs	R.flow kcfs	TW El. ft.
6/25/99	176	30	1	1	106.7	16.5	100	325	82.4
7/16/97	197	65	2		106.9	19.4	212	325	82
7/11/99	192	64	2	3	107.0	17.6	180	285	80.9
7/1/97	182	63	2		107.2	16.7	180	285	81
6/25/98	176	64	2	1	107.3	17.6	144	223	79
7/17/99	198	64	1	1	107.3	18.2	140	221	78.5
6/17/99	168	64	2	3	107.4	15.9	210	396	84.4
7/8/99	189	30	2	2	107.5	16.9	82	266	80.5
7/17/99	198	64	2	1	107.5	18.3	165	263	79.4
7/15/99	196	64	2	3	109.0	18.6	185	297	81.1
6/27/97	178	62	1		109.7	16.1	245	398	85
6/23/99	174	64	1	2	110.1	16.6	210	369	83.5
6/24/98	175	30	1	1	110.4	17.5	75	251	80
7/2/99	183	30	1	1	111.0	16.2	90	309	82.3
7/17/99	198	64	1	3	111.1	18.2	140	221	78.5
6/17/99	168	64	2	1	111.6	15.9	210	376	83.8
6/19/99	170	30	2	1	112.6	16.5	102	340	83.9
7/14/99	195	30	2	2	113.2	18.1	87	299	81.9
6/27/99	178	64	2	3	115.0	16.4	192	303	81.5
7/2/98	183	30	2	1	116.6	17.8	81	264	80.7
7/8/98	189	30	1	1	117.4	19.2	72	243	80
6/21/97	172	63	1		117.4	15.6	330	520	90
6/19/99	170	30	2	2	118.6	16.5	102	340	83.9
7/14/99	195	30	2	3	121.5	18.1	87	299	81.9
7/14/99	195	30	2	1	123.0	18.1	87	299	81.9
7/17/99	198	64	2	2	123.4	18.3	165	263	79.4
6/19/99	170	30	1	3	123.8	16	105	357	85
6/30/99	181	30	2	3	126.5	16.6	100	343	82.4
6/30/99	181	30	2	1	128.7	16.6	100	343	82.4
6/19/99	170	30	2	3	133.9	16.5	102	340	83.9
				Correlation coefficient: r =		-0.49	0.08	0.44	0.44

Linear regression $R^2 = 0.32$: Ln Surv %=0.7870 -0.0531(Temp) -0.00194(Spill %) + 0.00058(R.flow)

[a] Correlations were not calculated for Julian date, Spill %, Diel index, and Spillbay location because of interaction, the best evaluation was to use ANOVA.

[b] Diel index, where 1 represents daytime releases and 2 represents nighttime releases. Spillbay location where 1 = North, 2 = Middle and 3 = South.