

**EVALUATION OF TRAINING WALL ON FISH
CONDITION AT THE DALLES DAM SPILLWAY,
COLUMBIA RIVER, 2004**

Contract No. DACW68-02-D-0002
Task Order DT06

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EXECUTIVE SUMMARY

Results of some recent juvenile salmonid spillway passage investigations at The Dalles Dam on the lower Columbia River have shown lower than expected survival estimates under certain hydraulic conditions and for certain spillbays. To improve the hydraulic conditions for fish egress a “water barrier wall” produced by a high discharge volume from spillbays adjacent to Spillbay 6 simulated a training wall and its effects on the survival and egress conditions for fish released through Spillbays 2 and 4 were evaluated in 2003; that evaluation indicated improved fish survival and condition. Consequently, a concrete diversion wall was constructed between Spillbays 6 and 7 during the fall and winter of 2003 to provide favorable fish egress conditions. However, the effects of this concrete diversion wall on condition, survival, and egress of fish needed to be assessed. A study was designed in April-June 2004 to (1) estimate direct passage survival of hatchery reared Chinook salmon *Oncorhynchus tshawytscha*, smolts within ≤ 0.03 , 90% of the time at Spillbays 2 and 4 under low (April) and high (May-June) Tailwater conditions; (2) determine whether injury types and rates differed from those prior to the installation of the diversion wall; and (3) assess post-passage fish distribution.

Nested within the overall study were two factorial treatment designs. The first design allowed an evaluation of the effects of spillbays (Spillbays 2 and 4), two Tailwater elevations (low and high), and two entrainment depths (fish released 10 ft and 15 ft above the ogee). The second factorial set of treatments allowed an evaluation of the effects of two internal release locations (mid-bay and off-center) within Spillbay 4, two Tailwater elevations (low and high), and two vertical entrainment depths (10 ft and 15 ft above the ogee). The fish release conditions in April 2004 (low Tailwater elevation) were: spill volumes of 10.2 to 14.7 kcfs through Spillbays 2 and 4 and 14 to 20.6 kcfs through Spillbays 2 and 4 in May-June (high Tailwater elevation). Release pipes were positioned 10 ft (deep) and 15 ft (shallow) above the ogee and at mid-bay or off-center positions (Spillbay 4 only). The off-center releases in Spillbay 4 were made to test the assumption, based on results of Computational Fluid Dynamic model predictions, that fish released off-center within Spillbay 4 were more likely to collide with the downstream baffle blocks and suffer higher injury/mortality rates than those released mid-bay. Although the placement of the off-center pipe was controlled to maximize the probability of collision with the downstream baffle blocks, the post-passage dispersal fish path could not be controlled in the field primarily due to non-uniform flow conditions (e.g., surges within the stilling basin).

Upon achieving the prespecified precision level (ϵ) with the release of fewer than the initial allocation of fish, the remainder of the fish was used to evaluate other treatment conditions of interest. Field observations in April 2004 suggested that the post-passage fate of fish entrained in the Spillbay 6 vortex may differ from those of other entrained locations. Consequently, fish were hand released into the surface vortex in the forebay above the Spillbay 6 tainter gate to validate these field observations.

Fish lengths were similar for all the treatment combinations; average total fish length was 145 mm in April and 140 mm in May-June 2004. Water temperatures ranged from 9.5 to 10.5°C (49.1 to 50.9°F) in April and 13.4 to 14.8°C (56.2 to 58.7°F) in May-June. Post-passage fish retrieval locations were recorded by a Global Positioning System.

Recapture rates (physical retrieval of alive and dead fish) were high for Spillbays 2 and 4 fish (0.97 to 1.00). However, recapture rates of Spillbay 6 were lower (0.892 in May-June and 0.923 in April). The lower recapture rates for Spillbay 6 vortex released fish were attributed to predation losses, particularly at the higher water temperature conditions in May-June. Most Spillbay 6 vortex fish, as indicated by GPS, were swept towards a downstream shallow rock shelf or in the south channel, areas thought to be conducive for predator concentration.

The effects of Tailwater elevation or entrainment depth on survival were not evident on Spillbays 2 and 4 fish. The estimated survival probability for Spillbay 2 fish was 0.986 (SE=0.006) at low Tailwater elevation and 0.984 (SE=0.006) at high Tailwater elevation. As indicated by results of analysis of deviance these values were not significantly different (P-value=0.854). Likewise, the estimated survival probabilities for fish entrained at 10 ft ($\hat{\tau}$ =0.987, SE=0.006) and 15 ft ($\hat{\tau}$ =0.984, SE=0.006) depths were virtually identical (P-value=0.854); Precision (ϵ) on survival estimates was within $\leq \pm 0.03$, 90% of the time and fulfilled the statistical objective of the study.

The estimated survival probabilities for Spillbay 6 vortex released fish were lower than those for Spillbay 2 and 4 fish at both Tailwater elevations. They were 0.959 (SE=0.038) and 0.851 (SE=0.031). The lower survival for Spillbay 6 vortex, particularly in May-June, could be attributed to greater vulnerability of fish to predation (fish assumed dead in survival estimation); predation losses were estimated at about 0.026 at low Tailwater elevation and 0.086 at high Tailwater elevation. Coincident to losses to predation was an increase in water temperature from about 10.0°C (50°F) in April to an average of about 14.1°C (57.4°F) in May-June. Past studies have shown that predation on juvenile salmonids generally increases at water temperatures exceeding about 14.0°C (57.2°F).

The CFD model prediction that off-center released fish may have a lower survival than those released at mid-bay in Spillbay 4, due to potential collisions with downstream baffles, was not validated. The estimated survival probability for the mid-bay released fish was 0.987 (SE=0.006) and for the off-center fish it was 1.00 (SE=0.006); the analysis of deviance did not show this difference to be significant (P-value=0.217).

“Clean Fish” estimates (recaptured fish without passage-related maladies) for Spillbay 2 were relatively high (0.975 to 0.981) at both Tailwater elevations. However, Spillbay 4 clean fish estimates varied between 0.940 to 0.983 at low Tailwater elevation and from 0.958 to 0.982 at high Tailwater elevation. Clean fish estimates for Spillbay 6 vortex fish were lower, (0.920, SE=0.046) at low Tailwater elevation and 0.947 (SE=0.024) at high Tailwater elevation.

Unlike survival, clean fish metric exhibited some evidence of potential adverse effects on off-center released fish within Spillbay 4, particularly at low Tailwater elevation for both depths. Clean fish estimates were 0.014 lower for 15 ft off-center released fish (0.969, 90% CI=0.943-0.995) than for mid-bay released fish (0.983, 90% CI=0.962-1.00). For the 10 ft released fish, the difference (0.035) was greater for off-center released fish (0.940, 90% CI=0.906-0.974) than for mid-bay released fish (0.975, 90% CI=0.952-0.999). At high Tailwater elevation, however, the trend reversed particularly for 15 ft off-center released fish. It was 0.024 higher for off-center 15 ft released fish (0.982, 90% CI=0.959-1.00) than for mid-bay released fish (0.958, 90% CI=0.929-0.987); for the 10 ft released fish the difference was small (0.006) in favor of the mid-bay released fish (0.973, 90% CI=0.947-0.999; 0.967, 90% CI=0.939-0.995 for off-center fish).

Eye damage was the most prevalent (0.3-5.6% of recaptured treatment fish) visible injury type at both Tailwater elevations at all three spillbays. Other common injuries were operculum and gill damage and bruises and scrapes (0.0-2.8%). Shear forces are believed to be the cause of most observed injuries.

A comparison of fish survival between the concrete diversion wall in place and without the wall or with a simulated water barrier wall did not reveal consistent pattern of effects across spillbays or entrainment depths. In general, the survival probabilities with the diversion wall in place (range 0.961 to 1.00) were within the range of those estimated without the wall (range 0.967 to 1.00) or with the simulated water barrier wall (range 0.951 to 1.00).

A comparison of clean fish estimates between the concrete diversion wall in place and without the wall or with a simulated water barrier wall showed some improvement in fish condition, with one

exception (0.958 at Spillbay 4 spill volume of >15kcfs for shallow released fish) all clean fish estimates (7 of 8) exceeded 0.970; estimates ranged from 0.906 to 1.00 prior to the wall installation.

Due to lack of historical data Spillbay 6 vortex survival and clean fish estimates could not be compared directly to results of prior tests. However, the relatively low estimates of both metrics in the present investigation illustrate an adverse effect of entrainment of fish in a unique hydraulic condition and/or the effects of fish passed near the south end spillbays. Most fish exiting through Spillbay 6 vortex, as determined by GPS, were swept towards a downstream shallow rock shelf or into the south channel. These areas are thought to be conducive for predator concentration.

In summary, results of the study indicate that the concrete diversion wall had an overall positive effect on post-passage distribution (egress) of Spillbays 2 and 4 fish; most fish remained within or near the main channel and thus avoided the predator-rich rock shelf area downstream of the spillway. If the results of the present study are to be extended to the fate of naturally entrained fish, it may be surmised that with most of the spill passing north of the diversion wall (Spillbays 1-6) direct spillway passage survival may be ≥ 0.98 and clean fish estimate to be ≥ 0.96 provided emigrating fish are uniformly dispersed across the six spillbays. However, if a disproportionate number of fish are entrained in Spillbay 6 with its present hydraulic conditions; both these values would likely be lower particularly as water temperature increases.

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1.0 INTRODUCTION

Juvenile salmonids on their seaward journey encounter any or all of the following exit routes at hydro dams: turbines, spillways, and bypasses. There are two inter-related concerns associated with passage through any of these routes for overall survival. One is the proportion of fish utilizing any of these routes during emigration and the other is their subsequent post-passage condition and survival. A spill volume of varying magnitude and duration is used at most hydro dams on the Columbia River Basin to enhance passage effectiveness and overall survival of juvenile salmonids. However, there are considerable physical and hydraulic differences among dams which may influence spill effectiveness, fish survival, or both. Bell *et al.* (1972) and Heisey *et al.* (2003) have reported survival rates ranging from 83 to 100% in passage through spillways at hydroelectric dams on the Columbia River Basin.

Results of some recent studies at The Dalles Dam (Figure 1-1) on the lower Columbia River indicate that spill effectiveness and fish passage survival vary with spill volume (expressed as a proportion to river flow), duration (continuous, day or nighttime), spillbays, and season (Normandeau Associates *et al.* 1996a, 2003; Dawley *et al.* 1998, 2000a,b). Although fish passage efficiency (FPE) at The Dalles Dam spillway is relatively high, passage survival is unacceptable (98%) under certain hydraulic conditions. The contributory factors deemed responsible for lower survival and high injury rates were probable collisions with stilling basin structures (*e.g.*, dentate or baffle blocks downstream of the spillbays), long exposure duration to stilling basin turbulence, shallower “water cushion” depths (particularly at low Tailwater elevation), and lateral flow transporting entrained fish from the south to the north side of the stilling basin (Normandeau Associates *et al.* 2003). Table 1-1 summarizes recent survival estimates (direct effects) of Chinook salmon, *Oncorhynchus tshawytscha* smolts in passage through The Dalles Dam spillway at various hydraulic conditions

To further the efforts in finding solutions for improving fish passage conditions at The Dalles Dam spillway, the Corps initiated a series of investigations utilizing physical, hydraulic, and computational fluid dynamics (CFD) models. Preliminary results of these models suggested that an installation of a “training” wall downstream of the spillbays could minimize lateral transport of spilled water in the stilling basin and thus improve fish passage conditions by reducing fish exposure time to the complex turbulence of the stilling basin. An experiment in May-June 2003 was designed to simulate a training wall barrier by creating a “water wall barrier” with spill from adjacent spillbays. Results from this experiment indicated that the “water wall barrier” simulated at Spillbay 6 appeared to minimize lateral transport of fish and improved egress times of entrained fish (Normandeau Associates *et al.* 2004). The study also reported that spill volumes of 12 to 18k cfs per spillbay accompanied with some spill from adjacent spillbays could provide fish survival exceeding 97%. Consequently, a concrete barrier wall was installed by the corps between Spillbays 6 and 7 in early 2004 (Figure 1-2). However, the effects of the concrete diversion wall on survival, post-passage condition, and fish distribution or egress were unknown. The objectives of this study were to assess the effects of the concrete wall on post-passage condition, survival, and egress of juvenile Chinook salmon. The survival estimates were to be within 0.03, 90% of the time.

1.1 Project Description

The Dalles Dam is the second dam upriver (river mile 191.5 or rkm 306) on the main stem Columbia River (Figure 1-1). The powerhouse was completed in 1957 and is located between Oregon and Washington. The Dalles Dam consists of a powerhouse, a spillway, and a navigation lock. The configuration of this facility is such that the spillway is perpendicular to the river, while the powerhouse is parallel to the river (Figure 1-1). The spillway has an overall length of 1,370 ft and contains 23 gates, each 50 ft wide. Spill is regulated by bottom opening tainter gates that pass water at

a maximum depth of approximately 40 ft below the upstream water surface. Each tainter gate passes approximately 1.5 kcfs for each foot the gate is lifted. The typical station hydraulic head is approximately 80 ft (Figure 1-3).

A single row of 9 ft high by 10 ft wide concrete baffles are located in the stilling basin to dissipate energy (Figure 1-4). Three baffles lie downstream of each spillbay approximately 11 ft below normal tailrace elevation. An end sill, another energy dissipation structure, lies about 45 ft downstream of the baffles. This structure is a 13 ft high continuous vertical wall and lies approximately 7 ft below normal tailrace elevation.

2.0 STUDY DESIGN

This study has as its purpose the comparison of direct fish survival rates and condition between spillbays under different discharge levels and release conditions. The treatment design is a complex set of alternative conditions that do not directly lend themselves to planned comparisons but instead to *a posteriori* examination of trends. The overall treatment design is depicted below:

Tailwater Elevation	A.			B.
	Spillbay 2	Spillbay 4		Spillbay 6
	Mid	Mid	Off center	Vortex
Low (April)	10 ft	10 ft	10 ft	Surface
	15 ft	15 ft	15 ft	
High (May-June)	10 ft	10 ft	10 ft	Surface
	15 ft	15 ft	15 ft	

Nested within the overall set of treatment combinations are two factorial treatment designs that lend themselves to more formal comparison. The first (A) is a 2 (spillbays) x 2 (Tailwater elevations) x 2 (depths) factorial design. These eight treatment combinations were used to make general inferences regarding the comparison of Spillbays 2 vs. 4, low vs. high elevations, and 10 ft vs. 15 ft release depths. The second is a 2 (release locations, mid-bay or off-center in Spillbay 4) x 2 (Tailwater elevations) x 2 (depths) factorial design. These eight treatment combinations were used to make general inferences regarding the comparison of mid vs. off center release locations within Spillbay 4, as well as low vs. high Tailwater elevations and 10 ft vs. 15 ft release depths.

Although the primary emphasis was to obtain estimates of overall passage survival (direct effects) through two spillbays, fish releases were made at multiple locations (Figures 2-1 and 2-2) within each

spillbay (laterally and vertically) to evaluate trends, not to detect statistical differences, *per sé*. Fish releases in April represent low Tailwater elevation and those in May-June represent high Tailwater elevation. Unlike most balloon-tag studies, the control releases were not directly matched to the treatment conditions in several respects. First, control releases were made downstream of Spillbay 1 while treatments were performed at Spillbays 2, 4, and 6. In addition, treatment fish were released by induction pipe, while some control fish were hand tossed from the shore. Later, a test of homogeneity between pipe released and hand tossed controls was performed and found to be non significant (see Section 3.1). The difference in control fish release locations was necessitated by the hydraulic spill conditions. As the study progressed and spill volume increased water spilled over the wall downstream of Spillbay 1 and made this release location impractical to use. Consequently, fish were hand tossed from shore downstream of Spillbay 1; it was assumed that these fish experienced similar environmental conditions as those released through the control release pipe.

There are two primary components of effects on fish using any exit route: direct and indirect effects (Normandeau Associates and Skalski 1998). Direct effects are manifested immediately after passage (*e.g.*, instantaneous fish mortality, injury, loss of equilibrium); indirect effects (*e.g.*, predation, disease, physiological stress) may occur over an extended period or distance after passage. The present study was designed to estimate direct effects of passage by a straightforward approach of introducing a known number of balloon tagged alive fish into each spillbay (treatment), recapturing them immediately after passage, enumerating the alive and dead fish, and then carefully examining the condition of each fish. The latter provides an avenue to assess the probable causal mechanisms for injury/mortality and use the resulting information for potential mitigative measures that improve fish passage conditions. Appendix A lists the spillway passage survival investigations conducted elsewhere using the balloon tags.

Additionally, field observations indicated that a “vortex” formed at Spillbay 6 may create less than desirable hydraulic conditions for fish using this passage route. Consequently, fish were released into Spillbay 6 vortex to assess its potential passage effects (Figure 2-3). Table 2-1 presents the fish release schedule along with river flow and spill conditions for the present investigation. Appendix B provides prevailing hydrological conditions during individual fish release trial.

2.1 Source and Maintenance of Specimens

Juvenile Chinook salmon smolts were obtained from the Carson National Fish Hatchery, Bingen, Washington. Lots of 500 to 800 fish were transported from the hatchery via truck to the headworks of The Dalles Dam and were held in two tanks with a 200 or 600 gal capacity. The fish transport tank was equipped with a recirculation system and supplemental oxygen supply. The approximate transport time from the hatchery to the study site was 0.5 h. Approximately 24 h prior to tagging 150 fish were transferred to a 200 gal holding tank on the upper spillway deck. All fish holding tanks/pools were supplied continuously with ambient river water and were equipped with degassing units (spring only). Fish were held a minimum of 24 h prior to tagging to alleviate handling stress and to acclimate them to ambient river conditions. Ambient river temperature ranged from 9.5 to 10.5°C (49.1 to 50.9°F) in April and from 13.4 to 14.8°C (56.1 to 58.6°F) in May 2004.

Lots of 5 to 10 treatment fish on any given day were netted from the supply tank on the upper spillway deck and transferred to the adjacent tagging site with a water-sanctuary equipped net. Fish displaying abnormal behavior, severe injury, fungal infection, or descaling (>20% per side) were not used. The same fish selection criteria were applied to control groups.

Chinook salmon smolts averaged from 145 to 148 mm TL. Figure 2-4 shows the length frequency distribution of the treatment and control fish groups; sizes were similar for both groups.

2.2 Sample Size Requirements

One of the main considerations of the present study was to release an adequate number of fish such that the resulting survival probabilities for each spill volume within a tested spillbay would be within 0.03, 90% of the time. However, the sample size was not pre-selected to detect differences (*i.e.*, for test of hypothesis) in survival between spillbays or spill volumes though *a posteriori* comparisons were made. The sample size is a function of the recapture rate (P), expected passage survival ($\hat{\tau}$) or mortality ($1 - \hat{\tau}$), survival of control fish (S), and the desired precision (δ) at a given probability of significance (α). In general, sample size requirements decrease with an increase in control survival and recapture rates (Figure 2-5). Only precision (δ) and α levels can be strictly controlled by an investigator.

In performing the sample size calculations, we assumed capture data from replicate daily releases could be pooled (*i.e.*, natural variability $\sigma_{\tau}^2 = 0$). We calculated that with the following assumptions: a recapture rate of 0.98, control survival rate (S) of 0.99, and spillbay passage survival ($\hat{\tau}$) of 0.97, a precision (δ) level of 0.03, 90% of the time may be achievable with releasing 264 fish per treatment (Table 2-3).

Based on the results of recent spillway passage survival (direct effects) experiments at several hydroelectric dams including The Dalles Dam (Table 2-2), a sample size of approximately 325 fish (assuming 98% control survival, recapture rate of 98%, and expected passage survival of 97%) per treatment spillbay and spill volume was deemed sufficient to attain a prespecified precision level (δ) of 0.03, 90% of the time (Table 2-3). Although survival estimates, along with their associated precision (δ) levels for fish released through each release pipe were generated, they were used only to examine trends. As stated above, the primary emphasis was to release an adequate number of fish such that the resulting survival estimates of entrained fish through each spillbay at specific spill volumes would be within the prespecified precision (δ) criterion.

Past experience has suggested that the sample sizes can be adjusted as a study progresses because the results are available daily. If recapture and control survival rates are higher than initially assumed, sample size can be reduced. Conversely, if the values of these parameters are lower than initially assumed, then sample size must be increased to achieve the pre-specified statistical precision.

2.3 Release Conditions

Treatment fish releases were made in Spillbays 2, 4, and 6 (vortex). Two (Spillbay 2) to four (Spillbay 4) release pipes (6 in diameter) were installed approximately 10 ft upstream of the tainter gate of each spillbay and secured with guide wires and/or brackets to ensure that they remained at the desired depth, did not rotate, or were not drawn toward the spill gate (Figures 2-1 and 2-2). Fish were hand tossed into the vortex at Spillbay 6. A four inch diameter flexible hose was threaded inside the steel pipe. The terminus of each treatment release hose was secured inside a 6 in sweep elbow oriented downstream. Control fish were released in the Tailwater below Spillbay 1 by a pipe secured to a diversion wall between the adult fish way entrance and Spillbay 1. However, as stated earlier some fish had to be hand tossed from shore downstream of Spillbay 1 because the increased spill volume during the study caused the water to spill over the wall and dislodged the control release pipe.

Pipes were positioned 10 ft (deep) and 15 ft (shallow) above the ogee (Figure 2-2). A set of pipes was placed near mid-bay in both Spillbays 2 and 4. An additional set of pipes was placed off-center of mid-bay in Spillbay 4 (Figure 2-1). The placement of off-center pipe in Spillbay 4 was based on the predictions of simulated particles (neutrally buoyant spheres) experiment using Computational Fluid Dynamic model of The Dalles Dam spillway (Serkowski *et al.* 2004); the CFD model results indicated that fish exiting the off-center release pipes would encounter a higher risk of collisions with the downstream baffle blocks at velocity exceeding 20 ft/s; impact velocity exceeding 20 ft/s produce an elevated risk of fish injury (Figure 2-2). In contrast, the fish exiting mid-bay release pipes would encounter lower risk of collisions with baffle blocks because the fish carried with the flow would pass between baffle blocks. Thus, strict attention was given in the field to conform the locations predicted by the CFD model. The exit velocity of the discharge pipe was generally close to the velocity of the river water approaching the tainter gate opening.

The investigation was conducted at Spillbays 2, 4, and 6 at spill volumes of 7 to 12 kcfs low Tailwater elevation and at 15 to 21 kcfs at high Tailwater elevation. The total spill volume through Spillbays 1 to 6 ranged from 45 to 90 kcfs at low Tailwater elevation and from 88 to 130 kcfs at high Tailwater elevation and represented about 40% of the river flow. The Tailwater elevation in April ranged from 76 to 80 ft and from 80 to 83 ft in May-June (Table 2-4). Appendix B provides detailed hydrological-physical data for each release scenario.

2.4 Tagging and Release

The balloon tagging-recapture technique (Heisey *et al.* 1992) followed that used earlier at The Dalles Dam and other hydroelectric projects on the Columbia River Basin (Normandeau Associates *et al.* 1996a,b,c, 2004). Briefly, lots of 5 to 10 fish were randomly removed from holding tanks and taken to the adjacent tagging site using a water sanctuary equipped net. Fish displaying abnormal behavior, severe injury, fungal infection, or descaling (>20% per side) were not used. The same fish selection criteria were applied to both treatment and control groups. Fish selected for tagging were anesthetized in a 0.5% MS 222 solution (<5 min) and equipped with two uninflated balloon tags and a miniature radio tag with the dorsal balloon tag (Heisey *et al.* 1992). Some of the assumptions associated with the use of balloon tag-recapture technique to estimate direct effects of passage have been outlined in a recent publication by Peven *et al.* (2005).

Balloon tags were attached via a stainless steel pin inserted through the musculature beneath the dorsal and adipose fins. A uniquely numbered VI tag (Visual Implant, Northwest Marine Technology, Inc., Shaw Island, Washington) was also be inserted in the post ocular tissue for use in tracking 48 h survival of individual recaptured fish. Fish also received a fin clip in the event the VI tag became dislodged. Balloon tagged fish were placed in a covered, 20 gal container continually supplied with ambient river water until fully recovered from anesthesia (generally 30 to 45 min, minimum 20 min). After full recovery from anesthesia, fish were individually placed into the induction system, tags were activated, and the fish was released. Inflation time of the tags was partially regulated by the temperature and amount of water injected into the tags just prior to release.

All treatment and control fish were released through an induction apparatus that consisted of a small holding basin attached to a 4 in diameter flexible hose (Normandeau Associates and Skalski 1999, 2000a; Normandeau Associates *et al.* 2004). The release hose was supplied with river water to ensure fish were transported quickly within a continuous flow of water to the desired release point (see Section 2.3). This release scheme proved logistically effective and provided some economy and utilized a relatively smaller number of fish without sacrificing precision. Some 1,199 treatment fish

and 290 control fish were released in April; in May-June 1,340 treatment and 272 control fish were released (Table 2-1).

2.5 Fish Recapture

Upon exiting the induction hose, fish were tracked and retrieved when buoyed to the surface downstream of the spillbays by one of three or four recapture boat crews. Boat crews were notified of the radio tag frequency of each fish upon its release. Only crew members trained in fish handling were used to retrieve tagged fish. To minimize crew bias, no crew was specifically assigned to retrieve either control or treatment fish.

Radio signals were received on a 5-element Yagi antenna coupled to an Advanced Telemetry receiver. The radio signal transmission enabled the boat crew(s) to follow the movement of each fish after passage and position the boats downstream for retrieval when the balloon tag buoyed the fish to the surface; the boats were required to remain a safe distance downstream of the turbulent discharge. Active radio tags which failed to surface were tracked for a minimum of 30 minutes and then checked periodically thereafter to ascertain if fish displayed movement patterns typical of emigrating smolts or that of a predator. Recaptured fish were placed into an on-board holding facility, and tags were removed (Heisey *et al.* 1992). Each fish was examined for descaling and injuries and assigned appropriate condition codes, if necessary, per the descriptions presented in Table 2-5. Tagging and data recording personnel were notified via a two-way radio system of each fish's recovery time and condition. The retrieval location of each recaptured fish was recorded by a Global Positioning System (GPS).

Each recaptured fish was immediately examined for visible injuries and later a likely causal mechanism was assigned. Limited controlled experiments (Neitzel *et al.* 2000; Pacific Northwest National Laboratory (PNNL) *et al.* 2001) to replicate and correlate injury type and characteristic to a specific causative mechanism provides some indication of the cause of observed injuries in the field. However, some injury symptoms can be manifested by two different sources which may lessen the probability of accurate delineation of a cause and effect relationship (Eicher Associates 1987). Detailed descriptions of all injured fish were recorded. To minimize bias, injuries which were known or suspected to be caused by predators and those attributed to the tag (tearing at tag site) were not included in quantifying spillbay passage-related afflictions.

All fish recaptured alive were transferred in 5 gal pails to an on-shore holding pool for assessment of delayed effects (48 h). Pools were continuously supplied with ambient river water and shielded to prevent potential fish escape and avian predation. Each day's treatment and control fish were held together in the same pool for 48 h.

As a precautionary measure, the Corps secured the services of personnel from the U. S. Department of Agriculture to scare gulls from the tailrace. Past experience has shown that the hazing of gulls minimizes the potential loss of buoyed experimental fish, and thus maintains the use of prespecified sample sizes. However, predation by piscivores (*e.g.*, northern pike minnow and smallmouth bass) on tagged fish could not be controlled.

2.6 Classification of Recaptured Fish

As in previous similar investigations (Normandeau Associates *et al.* 1996a,b,c, 1997; 2004; Normandeau Associates and Skalski 1998, 1999, 2000a,b,c; Heisey *et al.* 2003) the immediate post-passage status of an individual recaptured fish and recovery of inflated tags dislodged from fish was

classified as alive, dead, inflated tag(s) recovered, unknown, or predation. The following criteria have been established to make these designations: (1) alive--recaptured alive and remaining so for 1 h; (2) alive--fish does not surface but radio signals indicate movement patterns typical of emigrating juveniles; (3) dead--recaptured dead or dead within 1 h of release; (4) dead--only inflated tag(s) without fish are recovered and telemetric tracking, or the manner in which inflated tags surfaced, is not indicative of predation; (5) unknown--no fish or dislodged tags are recaptured, or radio signals are received only briefly, and the subsequent status cannot be ascertained; and (6) predation--fish are either observed being preyed upon, the predator is buoyed to the surface, or subsequent radio telemetric tracking indicates predation (*i.e.*, rapid movements of tagged fish in and out of turbulent waters or sudden appearance of fully inflated tags). Preyed upon fish are assumed dead in the survival calculations. The status of unknown fish was assigned alive or dead proportional to the fish of known status. Appendix C provides daily trial summaries, disposition of individual fish, and fish injury data.

Mortalities of recaptured fish occurring after 1 h were assigned to 48 h although fish were observed at approximately 12 h intervals. Specimens were examined for descaling and injury, and those that died were necropsies to determine the probable cause of death. Additionally, all specimens alive at 48 h were re-anesthetized and closely examined for injury and descaling. The re-examination of immobilized fish minimizes the need for extensive handling and associated stress upon immediate recapture. The initial examination allows detection of some injuries, such as bleeding and minor bruising that may not be evident after 48 h due to natural healing processes (Normandeau Associates *et al.* 1996a,b,c). Injury and descaling were categorized by type, extent, and area of body (Table 2-5).

Fish without any visible injuries that were not actively swimming or swimming erratically at recapture were classified as “loss of equilibrium”. This condition has been noted in most past studies and often disappears within 10 to 15 min after recapture if the fish is not injured (Normandeau Associates *et al.* 1996a,b,c). A malady category was established to include fish with visible injuries, major scale loss (greater than 20% on either side), or loss of equilibrium. Dead fish without any of these symptoms were not included in this category. Fish without maladies were designated “clean fish”.

This clean fish metric was developed to standardize depiction of passage-related injury rate and is based solely on fish physically recaptured and examined. Additionally, the clean fish metric in concert with site-specific hydraulic and physical data may provide comparative insights into safer fish passage conditions.

2.7 Survival and Clean Fish Estimation and Data Analysis

Passage survival probabilities for each spillbay were estimated relative to the control fish survival (Heisey *et al.* 2003; Mathur *et al.* 1999). The two treatment conditions (e.g., spillbays, entrainment depths or release locations within spillbay) and one control condition were simultaneously analyzed and modeled by joint likelihood (Normandeau Associates *et al.* 2000). A likelihood ratio test was used to determine whether recapture probabilities were similar for live (P_a) and dead (P_d) fish. The statistic tested the null hypothesis of the simplified model ($H_0: P_a = P_d$) versus the alternative of the generalized model ($H_a: P_a \neq P_d$). Depending upon the outcome of this analysis for the 1 h survival the parameters and their associated standard errors were calculated using that model for the 48 h estimation as well. Appendix D provides statistical derivation of precision, sample size calculations, and likelihood parameters and statistical outputs.

Separate chi-square contingency tests (Burnham *et al.* 1987) were performed to detect homogeneity ($P=0.05$) between daily trials of each treatment and control group with respect to the frequency of

alive, dead, and unknown fish; the statistical outputs of these tests are given in Appendix D along with other chi-square tests and exact probabilities. Contingency tests allow for checking for homogeneity and suggest subsets of data to be pooled in the final estimates (Burnham *et al.* 1987). If heterogeneity ($P < 0.05$) is detected, separate survival estimates (weighted by the inverse of their respective variance) were to be calculated for each trial and results summarized as weighted average.

The clean fish estimate (CFE) was calculated from only recaptured fish. Fish with injuries attributed solely to predator attack or tag induced (tear at tag insertion site) were not included with those having passage related maladies. CFE probabilities for each spillbay were estimated relative to control fish that were free of any maladies using a general linear model (GLM) based on a binomial error and log-link.

The 90% confidence intervals were calculated using the profile likelihood method (Normandeau Associates *et al.* 1996a,b,c). Differences in fish survival and clean fish estimates between spillbays, spill volumes, or fish release locations were tested, *a posteriori*. These tests allowed the examination of trends and not as hypothesis testing. As indicated earlier, sample sizes for the study were selected to achieve a prespecified precision () level at a given probabilities level. Analysis of deviance (ANODEV) was used to assess the differences in survival as a function of spillbay entrainment depth, lateral release location, and Tailwater elevation. For these analyses, daily estimates of survival were utilized. Appendix Tables C-1 and C-2 provide the disposition of daily trials.

The statistical outputs are provided in Appendix D (output discussed in the report are highlighted). Only summarized information is discussed in the main body of the report. Appendix E provides disposition of individual fish released along with the release time, locations, etc. This report generally follows the guidelines and recommendations for survival studies made by Peven *et al.* (2005).

2.8 Autonomous Sensor Fish

Sensor fish, an instrumented package designed to determine exposure histories to turbulence and pressure during passage (PNNL *et al.* 2001) were also equipped with two or three balloon tags and a miniature radio tag. These were released using the identical induction release hose into the same spillbays as used for the alive treatment fish and downstream of spillbays as control alive fish. A total of 96 and 111 treatment sensor fish were released in April and the May-June, respectively. Some 11 and 8 control sensor fish were released during the respective study periods. The results of sensor fish passage will be provided by PNNL in a separate report.

3.0 RESULTS

3.1 RECAPTURE RATES

Recapture rates (physical retrieval of both alive and dead fish), except for Spillbay 6 vortex released fish were high for all other release groups (Table 3-1). Recapture rates of Spillbays 2 and 4 treatment fish were $>97\%$ (range 97.3 to 100%) and for control groups they were $\geq 98.9\%$ (range 98.9 to 99.0%). Recapture rates for Spillbay 6 fish were lower, 89.2 to 92.3%. The lower recapture rates, particularly at Tailwater elevation, were primarily due to predation on tagged fish that were swept towards a downstream rock shelf, an area known to be inhabited by predators. Most of the recaptured fish in all the groups were alive.

Chi-square tests indicated homogeneity ($P > 0.05$) between daily trials within each treatment group suggesting the daily trial data could be pooled. Chi-square test was also performed to examine differences between control fish released through the release pipe downstream of Spillbay 1 and those tossed by hand (See Section 2.0) when it became impractical to use the release pipe at high Tailwater elevation as the study progressed. No differences ($P > 0.10$) were noted and thus these data were also pooled.

Likelihood ratio tests indicated no significant differences ($P > 0.05$) between the simplified ($H_0: P_a = P_d$) and generalized $H_0: P_a \neq P_d$) models. Thus, survival probabilities and their associated standard errors using the reduced model are presented. These values are highlighted in Appendix D (statistical outputs).

3.2 Retrieval Times

Retrieval times (the time interval between release through the induction system until the fish was retrieved) varied between Tailwater elevations (Figures 3-1 and 3-2). Retrieval times, in general, were shorter for fish released at higher Tailwater elevation than at low Tailwater elevation. The spill volumes per spillbay were also higher at high Tailwater elevation, which may have assisted in quicker egress of tagged fish. Retrieval times were generally shorter for control and Spillbays 2 and 4 fish (most ≤ 10 min); longer retrieval times (average > 10 min) were associated with Spillbay 6 vortex released fish. Many Spillbay 6 fish were swept towards the shallow rock shelf downstream of the spillway which impeded the boat crews from rapidly retrieving these fish, particularly at low Tailwater elevation (mean 15.8 min in April, and 10.3 min in June). Although the Spillbay 6 vortex entrained fish were observed on the surface within the same time frame as fish from other spillbays, field observations indicated that at times it was essentially a “race” between the boat crews and predators to retrieve the buoyed fish. However, boat crews had to cope with safety issues and obviously the predators did not. Thus, the retrieval times are best used herein to observe only trends in fish egress rather than in strict quantitative sense. Most of the fish entrained in Spillbay 2 tended to follow the main river channel and quickly moved downstream (Figures 3-1 and 3-2).

3.2.1 Retrieval Locations

Retrieval locations of each fish were determined by a GPS system. These locations are shown as a function of tailrace depth contours in Figures 3-3 to 3-6 for April releases and in Figures 3-7 to 3-10 for May-June releases. Frequency distributions by depth are also shown as insets in these figures. Differences in retrieval locations of treatment fish were observed between spillbays. Most Spillbay 2 and control fish were recaptured within or close to the main river channel. This was less evident for Spillbay 4 fish and few of the fish from Spillbay 6 were recaptured from the main channel. Many of Spillbay 6 fish were swept towards the rock shelf. Additionally, most (72 to 85%) of the Spillbays 4 and 6 released fish (Figures 3-3 to 3-5 and 3-7 to 3-9) were recaptured in areas with depths ≤ 50 ft. On the other hand, some 54% of Spillbay 2 fish were recaptured in areas with depth ≤ 50 ft at low Tailwater elevation and 48% at high Tailwater elevation. Retrieval depth locations of control fish also differed between releases (Figures 3-6 and 3-10). Most (69%) control fish released at low Tailwater elevation were recaptured at locations with depth ≤ 50 ft while those released at high Tailwater elevation were mostly (65%) recaptured from areas with depths of 50-150 ft; 29% were recaptured at depth ≤ 50 ft.

3.3 SURVIVAL PROBABILITIES (48 H)

Except for special releases made in Spillbay 6 vortex the individual survival probabilities for Spillbays 2 and 4 were relatively high (>0.96 , $SE=0.007$ to 0.018) with no discernible consistent trends with respect to Tailwater elevations, entrainment depths, and release locations (Table 3-2). At comparable entrainment depths, survival of mid-bay and off-center releases was identical at low Tailwater elevation for Spillbay 4 mid-bay fish released at 10 ft depth (0.986 , $SE=0.016$) or for off-center 15 ft depth released fish (1.00 , $SE=0.010$). At high Tailwater elevation, patterns were different within Spillbays 2 and 4 than at low Tailwater elevation (Table 3-2). The precision (ϵ) was ± 0.03 , 90% of the time.

The survival of Spillbay 6 vortex released was lower than those of Spillbays 2 and 4 released fish at both Tailwater elevations (Table 3-2). It was 0.959 ($SE=0.038$) at low Tailwater elevation and 0.851 ($SE=0.030$) at high Tailwater elevation. The precision (ϵ) was lower on these estimates because of smaller sample size ($N=39$ at low Tailwater and 149 at high Tailwater elevation) and lower recapture rates of alive fish (0.987 in April and 0.832 in May-June). Increased predation (fish assumed dead in survival estimation) on treatment fish at high Tailwater elevation (0.086) coincident with higher water temperature then (0.026) lowered the survival rates at high Tailwater elevation (Table 3-1).

Analysis of deviance was run separately for fish in treatment blocks A and B (see Section 2.0) to statistically evaluate the effects of Tailwater elevations, entrainment depths or spillbays on fish survival (Table 3-3). Only the data from Spillbays 2 and 4 as outlined in Section 2.0 were analyzed for this evaluation. Results of analysis of deviance for treatment blocks A and B along with the overall survival for each main effect is summarized in Table 3-3. For the factorial treatment design A, no significant differences (p -values ranged from 0.788 to 0.888) were noted between any main effects; all survival probabilities exceeded 0.98 ($SE=0.006$). Similar results were obtained from the analysis of treatment design B data (Table 3-3). However, the overall estimated survival for off-center released fish ($\hat{\tau}=1.00$, $SE=0.006$) was slightly higher than for mid-bay released fish ($\hat{\tau}=0.987$, $SE=0.006$).

3.3.1 Effects of Diversion Wall on Survival

A general indication of the effects of the concrete diversion wall was gleaned from a comparison of estimated survival probabilities generated from previous investigations at The Dalles Dam. For this comparison, data from Spillbays 2 and 4 were separated into two categories: passage survival estimates at comparable spillbay volumes of 9 to 15 kcfs and those obtained at spill volumes >15 kcfs (Tables 3-4 and 3-5). This was done to lessen the confounding effects of spill volume on survival and fish condition (Normandeau Associates et al. 2004). However, it should be noted that since the hydraulic conditions (e.g., spill patterns) were not identical or “controlled”, or all comparable treatments were tested at the same time, estimates presented in Tables 3-4 and 3-5 lend themselves to only qualitative comparisons at this time. As example, no data were collected at spill volume of >15 kcfs per spillbay without the diversion wall in place, thus comparisons may be made between estimates with the simulated water barrier wall and the concrete diversion wall. Also, virtually all the estimates available for comparison were from mid-bay deep releases.

A consistent pattern was not evident across all test conditions in either spillbay (Tables 3-4 and 3-5). Survival of mid-bay, deep released fish at Spillbay 2 without the diversion wall ranged from 0.967 ($90\% CI=0.915-1.018$) to 1.00 ($90\% CI=1.004-1.019$) at spill volume of <15 kcfs per spillbay; survival ranged from 0.975 ($90\% CI=0.951-0.978$) to 0.985 ($90\% CI=0.958-1.011$) with water barrier wall and was 0.993 with the diversion wall. At spill volume per spillbay of >15 kcfs, survival of

Spillbay 2 mid-bay deep released fish ranged from 0.982 (90% CI=0.953-1.011) to 1.000 (90% CI=1.005-1.019) with a simulated water barrier wall and 0.977 (90% CI=0.954-1.00) with the concrete wall in place.

A similar pattern in survival was observed at Spillbay 4 for the mid-bay, deep releases (Tables 3-4 and 3-5). At spill volume of ≤ 15 kcfs, survival was 0.995 (90% CI=0.974-1.016) without the wall; it ranged from 0.966 (90% CI=0.943-0.989) to 0.999 (90% CI=0.983-1.016) with the simulated water barrier wall and 0.986 (90% CI=0.960-1.00) with the concrete wall. At spill volumes of >15 kcfs little differences in survival probabilities were observed between simulated water barrier wall (0.997, 90% CI=0.981-1.013) and concrete diversion wall (0.990, 90% CI=0.973-1.007).

3.3.2 Injury Classification, Rates, and Probable Causal Mechanisms

A relatively high percentage (97.2 to 100%) of the fish released through Spillbays 2 and 4 was recaptured and examined for injuries (Tables 3-6 and 3-7). The recapture rates for Spillbay 6 vortex fish were lower (89.3 to 92.3%), however. Injury percentages discussed below are based on the total number of recaptured treatment fish examined, adjusted for injured controls, and not on the total number of fish released. Only 4 of 272 (0.7%) control fish displayed visible injuries, all in May-June (Tables 3-6 and 3-7).

Visible injury rates differed between spillbays, release locations, and Tailwater elevations (Tables 3-6 and 3-7). Overall, the highest injury rate (5.3%-8.3%) was suffered by fish entrained in the Spillbay 6 vortex. Spillbay 4 fish generally suffered a higher injury rate (1.8-6.3%) than those entrained in Spillbay 2 (0.6-2.8%). Injury rates at Spillbays 2 and 4 were higher (2.1 to 6.3%) at low Tailwater elevation than at high Tailwater elevation (0.6 to 4.2%).

With respect to release locations (mid-bay versus off-center) within Spillbay 4, Tailwater elevations may have affected injury rates depending upon the entrainment depth (Tables 3-6 and 3-7). At low Tailwater elevation, off-center released fish in Spillbay 4 at both depths had higher injury rates (3.4 to 6.3%) than those released in mid-bay (2.1%). At high Tailwater elevation, however, the only notable difference was a higher injury rate (4.2%) for mid-bay released fish at 15 ft above the ogee than for the off-center fish (1.8%); little difference was noted between off-center (2.6%) and mid-bay (2.7%) released fish at 10 ft above the ogee (Tables 3-6 and 3-7).

Visible injuries observed included eye damage (hemorrhaged or ruptured), opercula damage (scrapes and tears), bruises and/or scrapes on the head or body, lacerations on the head and/or body, and internal hemorrhage (Table 3-6 and 3-7). Eye damage (0 to 4.9%) bruises/scrapes to the body/head (0 to 2.8%) and opercula damage (0 to 1.4%) accounted for the most of the injuries observed; few fish exhibited internal injuries and they were mostly limited to fish entrained at 10 ft above the ogee in Spillbays 2 and 4. Only a few, 6 of 194 (0.3%) fish exhibited loss of equilibrium (Table 3-8).

Shear and physical contact with spillway structures were the probable causes of most injuries. Shear was the probable cause of many eye and opercula injuries (especially tears at the dorsal insertion). Physical contact with spillbay surfaces or Tailwater structures in the stilling basin was the probable cause of most scrapes and bruises.

3.3.3 Clean Fish Estimated Probabilities

Estimates of clean fish (i.e., fish without visible injury, scale loss, or loss of equilibrium) were based on recaptured fish examined (Table 3-9). Within Spillbay 2 (only mid-bay releases), little variation was noted between entrainment depth or Tailwater elevations; all estimates were within 0.006 (estimates ranged from 0.975 to 0.985) 90% confidence intervals one-half width were $\leq \pm 0.02$, 90% of the time. However, lower clean fish estimates (0.940 to 0.969) for off-center released fish within Spillbay 4 were coincident with low Tailwater elevation at both entrainment depths; the difference between the two release locations was as high as 0.035 at 10 ft and 0.014 at 15 ft depth in favor of the mid-bay released fish. However, at high Tailwater elevation the off-center released fish (0.982, 90% CI=0.959-1.00) was about 0.024 higher than for the mid-bay released fish (0.958, 90% CI=0.929-0.987); the difference at 10 ft depth was negligible between the two release locations.

The clean fish estimates for Spillbay 6 vortex were low (Table 3-9).

3.3.4 Effects of Diversion Wall on Clean Fish Estimates

As for the case of qualitative assessment of the potential effects of diversion wall on fish survival clean fish estimates were compared at spill volume of ≤ 15 kcfs (Table 3-10) and > 15 kcfs per spillbay (Table 3-11). Although the clean fish estimates with the concrete wall in place were within the range of those obtained without the wall or with the simulated water barrier they were mostly ≥ 0.975 particularly at Spillbay 2. Only 1 of 8 estimates (shallow released fish) at Spillbay 4 with spill volume > 15 kcfs was 0.958 (90% CI=0.929-0.987); it was not significantly lower than occur ($P > 0.10$).

4.0 DISCUSSION

The primary objectives established for the experiment were met. Also, the embedded flexibility in the study design allowed evaluation of additional treatment conditions though with smaller sample releases. After the prespecified precision (ϵ) level of ≤ 0.03 , 90% of the time, on the estimated survival probabilities at Spillbays 2 and 4 had been achieved with fewer than the initial fish allocation, the remaining fish were used to assess the potential effects of fish passage through the Spillbay 6 vortex above the tainter gate. Field observations suggested that post-passage distribution and there by the fate of fish entrained in this vortex may not be similar to those entrained in a more uniform flow field above the spillbay tainter gates. Additionally, earlier direct survival investigations at The Dalles Dam spillway (Normandeau Associates and Mid Columbia Consulting 2001; Normandeau Associates et al. 2004) indicated that fish entrained in southern spillbays tended to be carried into the south channel and downstream shallow rock shelves at certain spill patterns; areas near these rock shelves were deemed conducive for the concentration of predators and thus increased vulnerability of post-passage fish to predation. Consequently, the extra fish available provided an opportunity to test the above observations. Indeed, the field observations were corroborated by the survival estimates obtained for the Spillbay 6 vortex released fish. Spillbay 6 vortex fish had the lowest estimated survival probabilities (0.959, SE=0.038 in April and 0.851, SE=0.030 in May-June). These lower survival estimates were attributed to predation losses, up to 8% Spillbay 6 vortex released fish were preyed upon and a relatively large proportion of released fish were swept into shallow rock shelf areas where predators are known to concentrate.

As indexed by clean fish estimates, the CFD model prediction (Serkowski *et al.* 2004) of higher collision probability (resulting in injury/mortality) with downstream baffle blocks for the off-center released fish in Spillbay 4 was not entirely validated, for all treatment conditions. At low Tailwater

elevation, the two clean fish estimates for off-center released fish (0.940, 90% CI=0.906-0.974 and 0.969, 90% CI=0.943-0.995) were lower than those for the mid-bay released fish (0.975, 90% CI=0.952-0.999 and 0.983, 90% CI=0.962-1.00). However, this difference, though non-significant ($P>0.10$) did not hold at high Tailwater elevation at both release depths. Clean fish estimate for off-center fish released 15 ft above the ogee was highest (0.982, 90% CI=0.959-1.00) and for mid-bay released fish it was lowest (0.958, 90% CI=0.929-0.987). The deviation of the field estimates from model prediction may in part arise from fluctuating flow conditions (e.g., surges) in the stilling basin and position of the fish within the jet discharge at the time of passage. The CFD model predictions are based on distribution and collision probability of simulated-particle (virtual) in a more uniform flow field. If the fish is well water “cushioned” within the jet discharge it may escape collision with downstream baffle blocks and not suffer injury. However, if the fish is not as well water “cushioned” in the discharge and passes near the solid structures, the collision probability likely increases resulting in injury. It appears a small proportion of off-center released fish, particularly deep released fish at low Tailwater elevation, may have encountered this fate.

There was, however, little indication from examination of survival estimates that off-center released fish suffered disproportionately higher mortality in Spillbay 4. All the four survival estimates (two at low Tailwater and two at high Tailwater elevation) for off-center released fish exceeded 0.977 (range 0.978 to 1.00) irrespective of release depth.

Identifying the spill volumes and spill patterns may provide avenues to enhance survival of downstream migrants utilizing the spillway as passage route at The Dalles Dam. The present study succeeded to a large extent in identifying some hydraulic conditions that appear safer than others. Except for a unique hydraulic characteristic identified at Spillbay 6, fish passage at Spillbays 2 and 4 generally exceeded or equaled the desired direct survival and clean fish estimates of ≥ 0.98 and ≥ 0.96 , respectively with spill volumes of 10-20 kcfs per spillbay. The lowest survival 0.961 was obtained for shallow released fish at Spillbay 4 mid-bay at high Tailwater elevation. The remaining survival estimates were 0.972 to 1.00. Similarly, clean fish estimates equaled or exceeded 0.96 in passage through the same locations; except for one low estimate (0.940) for off-center deep released fish in Spillbay 4 all other estimates ranged from 0.958 to 0.983.

An interaction release depth and Tailwater elevation appeared to affect survival, though not statistically, to same extent in Spillbay 2. At low Tailwater elevation, survival ($\hat{\tau}=0.993$, SE=0.014) for deep released fish (mid-bay) was about 0.021 higher than for shallow released fish ($\hat{\tau}=0.972$, SE=0.018). At high Tailwater elevation, however, this trend was reversed; the survival of shallow released fish ($\hat{\tau}=0.990$, SE=0.010) was about 0.013 higher than for the deep released fish ($\hat{\tau}=0.977$, SE=0.014). Little variability in clean fish estimates occurred for fish released in Spillbay 2; all estimates were within 0.006 (range 0.975 to 0.981). The slightly higher estimates occurred at to high Tailwater elevation.

Although the direct effects of the concrete diversion wall on survival and clean fish estimates were not clearly discernible the post-passage distribution of fish appeared favorably affected with the installation of the wall. It appeared that most Spillbays 2 and 4 fish egressed with minimal lateral transport within the stilling basin. This observation corroborates The Dalles spillway model predictions. Model studies with physical and “water wall barriers” had indicated that a lateral transport across the stilling basin may be reduced by a training wall and thus enhance egress of spillway entrained fish with a decreased level of potential injury/mortality. As entrainment duration within the stilling basin increases, probability of collisions with downstream hard objects and exposure to shear forces increases. As indexed by clean fish metric, it appears that a relatively high proportion of Spillbays 2 and 4 escaped potential collisions with downstream baffles; however, a

small proportion of off-center deep released fish in Spillbay 4 suffered a greater rate of injury than other groups.

Survival is lower when a fish strikes a solid object, even at lower velocities, than when they enter standing water without obstructions. A variable mortality rate was observed by Bell et al. (1972) when fish struck a solid object at a velocity exceeding 20 fps. No fish injury was observed when fish impacted flowing water at a velocity of about 60 fps. They concluded that fish could be injured in any high-energy flow situation that creates momentarily localized sharp velocity changes. Based on field and laboratory tests on fish little to no injury (<1%) was observed on juvenile salmon subjected to entry velocities as high as 50 fps (PNNL et al. 2001). The estimated impact velocity of the discharge jet upon tailrace interception exceeded 60 fps. However, unlike a laboratory experiment post-passage dispersal of all the released tagged fish is not the same due to “surging” spill flow patterns which may affect the travel path of each fish. Thus, only a small proportion of released fish may actually encounter solid objects and get injured. A variable injury rate observed across the test conditions may be reflective of this flow pattern. The concurrent releases of “sensor fish” may provide more insight for this hypothesis.

5.0 CONCLUSIONS

Survival rates and fish condition were spillbay-specific. Survival probabilities of Spillbay 6 fish were lowest (0.85 to 0.96); for Spillbays 2 and 4 fish they were ≥ 0.97 (0.971 to 1.00). Clean fish estimates (CFE) showed the same trend as survival with Spillbays 2 and 4 fish having CFE's 0.94 to 0.982 (most were ≥ 0.97) and CFE's for Spillbay 6 fish of 0.92 to 0.947.

Diversion wall in concert with most spill passing through Spillbays 1 to 5 can be expected to produce fish survival ≥ 0.98 and clean fish (without maladies) estimates ≥ 0.96 . However, passage at Spillbay 6 with its present hydraulic condition appears to be less “fish friendly.” Fish exiting along the south side of Spillbay 6 vortex tended to be swept towards shallow rock shelf areas where vulnerability to predation increased.

Although the effects of the diversion wall on Spillbays 2 and 4 survival and clean fish estimates were not clearly discernible when compared to earlier data the post-passage distribution of fish exiting these spillbays appeared to be favorably affected. Fish exiting Spillbays 2 and 4 tended to be swept into the main channel with its attendant high velocity. Thus, directing spill through Spillbays 1-6 should guide a greater proportion of emigrants towards the main channel. The diversion wall did not produce adverse effects.

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TABLES

FIGURES

APPENDIX A

SUMMARY OF SURVIVAL RATES AT OTHER HYDROELECTRIC DAMS ON THE COLUMBIA RIVER BASIN

APPENDIX B

HYDRAULIC/PHYSICAL CONDITIONS DURING TESTING; IMPACT VELOCITY DATA

APPENDIX C

INDIVIDUAL TRIAL DATA; FISH INJURY DATA; AND DAILY FISH DISPOSITION DATA

APPENDIX D

DERIVATION OF PRECISION, SAMPLE SIZE, AND MAXIMUM LIKELIHOOD PARAMETERS, AND STATISTICAL OUTPUTS

DERIVATION OF PRECISION, SAMPLE SIZE, AND MAXIMUM LIKELIHOOD PARAMETERS

The statistical description below is excerpted from Normandeau Associates and Skalski (2000a). For the sake of brevity, references within the text have been removed. However, interested readers can look up these citations in the report prepared by Normandeau Associates and Skalski (2000a).

The estimation for the likelihood model parameters and sample size requirements discussed in the text are given herein. Additionally, the results of statistical analyses for evaluating homogeneity in recapture and survival probabilities, and in testing hypotheses of equality in parameter estimates under the simplified ($H_0: P_A = P_D$) versus the most generalized model ($H_A: P_A \neq P_D$) are given.

The following terms are defined for the equations and likelihood functions which follow:

R_C	=	Number of control fish released
R_T	=	Number of treatment fish released
R	=	$R_C = R_T$
n	=	Number of replicate estimates $\hat{\tau}_i$ ($i=1, \dots, n$)
a_C	=	Number of control fish recaptured alive
d_C	=	Number of control fish recaptured dead
a_T	=	Number of treatment fish recaptured alive
d_T	=	Number of treatment fish recaptured dead
S	=	Probability fish survive from the release point of the controls to recapture
P_A	=	Probability an alive fish is recaptured
P_D	=	Probability a dead fish is recaptured
	=	Probability a treatment fish survives to the point of the control releases (<i>i.e.</i> , passage survival)
$1 -$	=	Passage-related mortality.

The precision of the estimate was defined as:

$$P(-\epsilon < \hat{\tau} - \tau < \epsilon) = 1 - \alpha$$

or equivalently

$$P(-\epsilon < |\hat{\tau} - \tau| < \epsilon) = 1 - \alpha$$

where the absolute errors in estimation, *i.e.*, $|\hat{\tau} - \tau|$, is $< (1 - \alpha) 100\%$ of the time, $\hat{\tau}$ is the estimated passage survival, and ϵ is the half-width of a $(1 - \alpha) 100\%$ confidence interval for $\hat{\tau}$ or $1 - \hat{\tau}$. A precision of $\pm 5\%$, 90% of the time is expressed as $P(|\hat{\tau} - \tau| < 0.05) = 0.90$.

Using the above precision definition and assuming normality of $\hat{\tau} - \tau$, the required total sample size (R) is as follows:

$$P\left(\frac{-\epsilon}{\sqrt{\text{Var}(\hat{\tau})}} < Z < \frac{\epsilon}{\sqrt{\text{Var}(\hat{\tau})}}\right) = 1 - \alpha$$

$$P\left(Z < \frac{-\varepsilon}{\sqrt{\text{Var}(\hat{\tau})}}\right) = \alpha/2$$

$$\Phi\left(\frac{-\varepsilon}{\sqrt{\text{Var}(\hat{\tau})}}\right) = \alpha/2$$

$$\frac{-\varepsilon}{\sqrt{\text{Var}(\hat{\tau})}} = Z_{\alpha/2}$$

$$\text{Var}(\hat{\tau}) = \frac{\varepsilon^2}{Z_{1-\frac{\alpha}{2}}^2}$$

$$\frac{\tau}{SP_A} \left[\frac{(1 - SP_A)\tau}{R_T} + \frac{(1 - SP_A)\tau}{R_C} \right] = \frac{\varepsilon^2}{Z_{1-\frac{\alpha}{2}}^2}$$

where Z is a standard normal deviate satisfying the relationship $P(Z > Z_{1-\alpha/2}) = \alpha/2$, and Φ is the cumulative distribution function for a standard normal deviate.

If data can be pooled across trials and letting $R_C = R_T = R$, the sample size for each release is

$$R = \frac{\tau}{SP_A} \left[1 + \tau - 2SP_A \right] \frac{Z_{1-\alpha/2}^2}{\varepsilon^2}$$

By rearranging, this equation can be solved to predetermine the anticipated precision given the available number of fish for a study. In most previous investigations (Normandeau Associates and Skalski 2000a) this equation has been used to calculate sample sizes because of homogeneity between trials; in the present investigation sample size was predetermined using this equation.

If data cannot be pooled across trials the precision is based on

$$\sum_{i=1}^n (1 - \hat{\tau}_i) / n = 1 - \sum_{i=1}^n \hat{\tau}_i / n = 1 - \bar{\hat{\tau}}$$

Precision is defined as

$$P(|\bar{\hat{\tau}} - \bar{\tau}| < \varepsilon) = 1 - \alpha$$

$$P(-\varepsilon < \bar{\hat{\tau}} - \bar{\tau} < \varepsilon) = 1 - \alpha$$

$$P\left(\frac{-\varepsilon}{\sqrt{\text{Var}(\bar{\hat{\tau}})}} < t_{n-1} < \frac{\varepsilon}{\sqrt{\text{Var}(\bar{\hat{\tau}})}}\right) = 1 - \alpha$$

$$P\left(t_{n-1} < \frac{-\varepsilon}{\sqrt{\text{Var}(\hat{\tau})}}\right) = \alpha/2$$

$$\Phi\left(\frac{-\varepsilon}{\sqrt{\text{Var}(\hat{\tau})}}\right) = \alpha/2$$

$$\frac{-\varepsilon}{\sqrt{\text{Var}(\hat{\tau})}} = t_{\alpha/2, n-1}$$

$$\text{Var}(\hat{\tau}) = \frac{\varepsilon^2}{t_{1-\alpha/2, n-1}^2}$$

$$\frac{\sigma_\tau^2 + \frac{\tau}{SP_A} \left[\frac{(1 - S\tau P_A)}{R_T} + \frac{(1 - SP_A)\tau}{R_C} \right]}{n} = \frac{\varepsilon^2}{t_{1-\alpha/2, n-1}^2}$$

where ε^2 = natural variation in passage-related mortality.

Now letting $R_T = R_C$

$$\frac{\sigma_\tau^2 + \frac{\tau}{SP_A} \left[\frac{(1 - S\tau P_A)}{R} + \frac{(1 - SP_A)\tau}{R} \right]}{n} = \frac{\varepsilon^2}{t_{1-\alpha/2, n-1}^2}$$

which must be iteratively solved for n given R. Or R given n where

$$R = \frac{\frac{\tau}{SP_A} [(1 - S\tau P_A) + (1 - SP_A)\tau]}{\left[\frac{n\varepsilon^2}{t_{1-\alpha/2, n-1}^2} - \sigma_\tau^2 \right]}$$

$$R = \frac{\frac{\tau(1 + \tau)}{SP_A}}{\left[\frac{n\varepsilon^2}{t_{1-\alpha/2, n-1}^2} - \sigma_\tau^2 \right]}$$

$$R = \frac{\tau(1 + \tau)}{SP_A} \left[\frac{t_{1-\alpha/2, n-1}^2}{n\varepsilon^2 - \sigma_\tau^2 t_{1-\alpha/2, n-1}^2} \right]$$

The joint likelihood for the passage-related mortality is:

$$L(S, \tau, P_A, P_D | R_C, R_T, a_C, a_T, d_C, d_T) = \\ \binom{R_C}{a_C d_C} (S P_A)^{a_C} ((1-S)P_D)^{d_C} (1 - S P_A - (1-S)P_D)^{R_C - a_C - d_C} \\ \times \binom{R_T}{a_T d_T} (S \tau P_A)^{a_T} ((1-S\tau)P_D)^{d_T} (1 - S \tau P_A - (1-S\tau)P_D)^{R_T - a_T - d_T} .$$

The likelihood model is based on the following assumptions: (1) fate of each fish is independent, (2) the control and treatment fish come from the same population of inference and share that same survival probability, (3) all alive fish have the same probability, P_A , of recapture, (4) all dead fish have the same probability, P_D , of recapture, and (5) passage survival () and survival (S) to the recapture point are conditionally independent. The likelihood model has four parameters (P_A , P_D , S,) and four minimum sufficient statistics (a_C , d_C , a_T , d_T).

Because any two treatment releases were made concurrently with a single shared control group we used the likelihood model which took into account dependencies within the study design (Normandeau Associates *et al.* 1995). For any two treatment groups (denoted T_1 and T_2), the likelihood model is as follows:

$$L(S, \tau_1, \tau_2, P_A, P_D | R_C, R_{T_1}, R_{T_2}, a_C, d_C, a_{T_1}, d_{T_1}, a_{T_2}, d_{T_2}) = \\ \binom{R_C}{a_C d_C} (S P_A)^{a_C} ((1-S)P_D)^{d_C} (1 - S P_A - (1-S)P_D)^{R_C - a_C - d_C} \\ \times \binom{R_{T_1}}{a_{T_1} d_{T_1}} (S \tau_1 P_A)^{a_{T_1}} ((1-S\tau_1)P_D)^{d_{T_1}} (1 - S \tau_1 P_A - (1-S\tau_1)P_D)^{R_{T_1} - a_{T_1} - d_{T_1}} \\ \times \binom{R_{T_2}}{a_{T_2} d_{T_2}} (S \tau_2 P_A)^{a_{T_2}} ((1-S\tau_2)P_D)^{d_{T_2}} (1 - S \tau_2 P_A - (1-S\tau_2)P_D)^{R_{T_2} - a_{T_2} - d_{T_2}} .$$

This likelihood model has the same assumptions as stated in Normandeau Associates and Skalski (2000a) but has five estimable parameters (S, τ_1 , τ_2 , P_A , and P_D). The survival rate for treatment T_1 is estimated by τ_1 and for treatment T_2 , by τ_2 . A likelihood ratio test with 1 degree of freedom was used to test for equality in survival rates between treatments τ_1 and τ_2 based on the hypothesis $H_0: \tau_1 = \tau_2$ versus $H_a: \tau_1 \neq \tau_2$.

Likelihood models are based on the following assumptions: (a) the fate of each fish is independent; (b) the control and treatment fish come from the same population of inference and share the same natural survival probability, S; (c) all alive fish have the same probability, P_A , of recapture; (d) all dead fish have the same probability, P_D , of recapture; and (e) passage survival () and natural survival (S) to the recapture point are conditionally independent.

The estimators associated with the likelihood model are:

$$\hat{\tau} = \frac{a_T R_C}{R_T a_C}$$

$$\hat{S} = \frac{R_T d_C a_C - R_C d_T a_C}{R_C d_C a_T - R_C d_T a_C}$$

$$\hat{P}_A = \frac{d_C a_T - d_T a_C}{R_T d_C - R_C d_T}$$

$$\hat{P}_D = \frac{d_C a_T - d_T a_C}{R_C a_T - R_T a_C} .$$

The variance (Var) and standard error (SE) of the estimated passage mortality ($1 - \hat{\tau}$) or survival ($\hat{\tau}$) are:

$$Var(1 - \hat{\tau}) = Var(\hat{\tau}) = \frac{\tau}{SP_A} \left[\frac{(1 - S\tau P_A)}{R_T} + \frac{(1 - SP_A)\tau}{R_C} \right]$$

$$SE(1 - \hat{\tau}) = SE(\hat{\tau}) = \sqrt{Var(1 - \hat{\tau})} .$$

DERIVATION OF VARIANCE FOR WEIGHTED AVERAGE SURVIVAL ESTIMATE

The variance of a weighted average is estimated by the formula

$$\hat{\theta}_w = \frac{\sum_{i=1}^n W_i \hat{\theta}_i}{\sum_{i=1}^n W_i}$$

with

$$\text{Var}(\hat{\theta}_w) = \frac{\sum_{i=1}^n W_i (\hat{\theta}_i - \hat{\theta}_w)^2}{(n-1) \sum_{i=1}^n W_i}$$

where $\hat{\theta}_w$ = the weighted average,

$\hat{\theta}_i$ = the parameter estimate for the i th replicate,

W_i = weight.

Appendix D

Chi square tests of homogeneity for the recovery of Chinook salmon juveniles released through units at the Dalles Dam, October 2002.

----- sbay=CTL flow=_45 position=c -----

The FREQ Procedure
Table of desc by cond

desc	cond			Total
Frequency	alive	dead	unkn	
c1_45	42	1	2	45
	43.941	0.7941	0.2647	
	0.0858	0.0534	11.376	
c2_45	45	0	0	45
	43.941	0.7941	0.2647	
	0.0255	0.7941	0.2647	
c3_45	57	3	0	60
	58.588	1.0588	0.3529	
	0.0431	3.5588	0.3529	
c4_45	43	2	0	45
	43.941	0.7941	0.2647	
	0.0202	1.8312	0.2647	
c5_45	45	0	0	45
	43.941	0.7941	0.2647	
	0.0255	0.7941	0.2647	
c6_45	20	0	0	20
	19.529	0.3529	0.1176	
	0.0113	0.3529	0.1176	
c7_45	60	0	0	60
	58.588	1.0588	0.3529	
	0.034	1.0588	0.3529	
c8_45	20	0	0	20
	19.529	0.3529	0.1176	
	0.0113	0.3529	0.1176	
Total	332	6	2	340

Statistics for Table of desc by cond

Statistic	DF	Value	Prob
Chi-Square	14	22.1641	0.0753
Likelihood Ratio Chi-Square	14	18.7513	0.1747
Mantel-Haenszel Chi-Square	1	5.9665	0.0146
Phi Coefficient		0.2553	
Contingency Coefficient		0.2474	
Cramer's V		0.1805	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 340

Appendix D

Chi square tests of homogeneity for the recovery of Chinook salmon juveniles released through units at the Dalles Dam, October 2002.

----- sbay=SB2 flow=_45 position=d -----

The FREQ Procedure
Table of desc by cond

desc	cond			Total
Frequency	alive	dead	unkn	
Expected				
Cell Chi-Square				
d1_45	52	8	0	60
	56.696	2.6087	0.6957	
	0.3889	11.142	0.6957	
d2_45	40	2	3	45
	42.522	1.9565	0.5217	
	0.1496	0.001	11.772	
d3_45	43	2	0	45
	42.522	1.9565	0.5217	
	0.0054	0.001	0.5217	
d4_45	57	3	0	60
	56.696	2.6087	0.6957	
	0.0016	0.0587	0.6957	
d5_45	44	0	1	45
	42.522	1.9565	0.5217	
	0.0514	1.9565	0.4384	
d6_45	45	0	0	45
	42.522	1.9565	0.5217	
	0.1444	1.9565	0.5217	
d7_45	45	0	0	45
	42.522	1.9565	0.5217	
	0.1444	1.9565	0.5217	
Total	326	15	4	345

Statistics for Table of desc by cond

Statistic	DF	Value	Prob
Chi-Square	12	33.1246	0.0009
Likelihood Ratio Chi-Square	12	31.6342	0.0016
Mantel-Haenszel Chi-Square	1	11.5050	0.0007
Phi Coefficient		0.3099	
Contingency Coefficient		0.2960	
Cramer's V		0.2191	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 345

Appendix D

Chi square tests of homogeneity for the recovery of Chinook salmon juveniles released through units at the Dalles Dam, October 2002.

----- sbay=SB4 flow=_45 position=d -----

The FREQ Procedure
Table of desc by cond

desc	cond			Total
Frequency	alive	dead	unkn	
Expected				
Cell Chi-Square				
d1_45	44	1	0	45
	44.087	0.7826	0.1304	
	0.0002	0.0604	0.1304	
d2_45	57	3	0	60
	58.783	1.0435	0.1739	
	0.0541	3.6685	0.1739	
d3_45	44	1	0	45
	44.087	0.7826	0.1304	
	0.0002	0.0604	0.1304	
d4_45	44	0	1	45
	44.087	0.7826	0.1304	
	0.0002	0.7826	5.7971	
d5_45	59	1	0	60
	58.783	1.0435	0.1739	
	0.0008	0.0018	0.1739	
d6_45	45	0	0	45
	44.087	0.7826	0.1304	
	0.0189	0.7826	0.1304	
d7_45	45	0	0	45
	44.087	0.7826	0.1304	
	0.0189	0.7826	0.1304	
Total	338	6	1	345

Statistics for Table of desc by cond

Statistic	DF	Value	Prob
Chi-Square	12	12.8988	0.3764
Likelihood Ratio Chi-Square	12	11.3989	0.4951
Mantel-Haenszel Chi-Square	1	1.9664	0.1608
Phi Coefficient		0.1934	
Contingency Coefficient		0.1898	
Cramer's V		0.1367	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 345

Appendix D

Chi square tests of homogeneity for the recovery of Chinook salmon juveniles released through units at the Dalles Dam, October 2002.

----- sbay=SB2 flow=_12 position=d -----

The FREQ Procedure
Table of desc by cond

desc	cond		Total
Frequency	alive	unkn	
d1_12	30	0	30
	29.75	0.25	
	0.0021	0.25	
d2_12	45	0	45
	44.625	0.375	
	0.0032	0.375	
d3_12	29	1	30
	29.75	0.25	
	0.0189	2.25	
d4_12	15	0	15
	14.875	0.125	
	0.0011	0.125	
Total	119	1	120

Statistics for Table of desc by cond

Statistic	DF	Value	Prob
Chi-Square	3	3.0252	0.3878
Likelihood Ratio Chi-Square	3	2.7979	0.4238
Mantel-Haenszel Chi-Square	1	0.6000	0.4386
Phi Coefficient		0.1588	
Contingency Coefficient		0.1568	
Cramer's V		0.1588	

WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 120

Appendix D

Chi square tests of homogeneity for the recovery of Chinook salmon juveniles released through units at the Dalles Dam, October 2002.

----- sbay=SB2 flow=_12 position=s -----

The FREQ Procedure
Table of desc by cond

desc	cond			Total
Frequency	alive	dead	unkn	
s1_12	30	0	0	30
	29.25	0.25	0.5	
	0.0192	0.25	0.5	
s2_12	42	1	2	45
	43.875	0.375	0.75	
	0.0801	1.0417	2.0833	
s3_12	30	0	0	30
	29.25	0.25	0.5	
	0.0192	0.25	0.5	
s4_12	15	0	0	15
	14.625	0.125	0.25	
	0.0096	0.125	0.25	
Total	117	1	2	120

Statistics for Table of desc by cond

Statistic	DF	Value	Prob
Chi-Square	6	5.1282	0.5275
Likelihood Ratio Chi-Square	6	6.0139	0.4216
Mantel-Haenszel Chi-Square	1	0.1880	0.6646
Phi Coefficient		0.2067	
Contingency Coefficient		0.2024	
Cramer's V		0.1462	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 120

Appendix D

Chi square tests of homogeneity for the recovery of Chinook salmon juveniles released through units at the Dalles Dam, October 2002.

----- sbay=SB4 flow=_12 position=d -----

The FREQ Procedure
Table of desc by cond

desc	cond		Total
Frequency	alive	dead	
d1_12	29	1	30
	29.5	0.5	
	0.0085	0.5	
d2_12	44	1	45
	44.25	0.75	
	0.0014	0.0833	
d3_12	30	0	30
	29.5	0.5	
	0.0085	0.5	
d4_12	15	0	15
	14.75	0.25	
	0.0042	0.25	
Total	118	2	120

Statistics for Table of desc by cond

Statistic	DF	Value	Prob
Chi-Square	3	1.3559	0.7159
Likelihood Ratio Chi-Square	3	1.9842	0.5757
Mantel-Haenszel Chi-Square	1	1.2102	0.2713
Phi Coefficient		0.1063	
Contingency Coefficient		0.1057	
Cramer's V		0.1063	

WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 120

Appendix D

Chi square tests of homogeneity for the recovery of Chinook salmon juveniles released through units at the Dalles Dam, October 2002.

----- sbay=SB4 flow=_12 position=s -----

The FREQ Procedure
Table of desc by cond

desc	cond		Total
Frequency	alive	dead	
s1_12	44	1	45
	44.625	0.375	
	0.0088	1.0417	
s2_12	30	0	30
	29.75	0.25	
	0.0021	0.25	
s3_12	30	0	30
	29.75	0.25	
	0.0021	0.25	
s4_12	15	0	15
	14.875	0.125	
	0.0011	0.125	
Total	119	1	120

Statistics for Table of desc by cond

Statistic	DF	Value	Prob
Chi-Square	3	1.6807	0.6412
Likelihood Ratio Chi-Square	3	1.9757	0.5775
Mantel-Haenszel Chi-Square	1	1.1408	0.2855
Phi Coefficient		0.1183	
Contingency Coefficient		0.1175	
Cramer's V		0.1183	

WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 120

Appendix D

Chi square tests of homogeneity for the recovery of Chinook salmon juveniles released through units at the Dalles Dam, October 2002.

----- sbay=CTL -----

The FREQ Procedure
Table of desc by cond

desc	cond			Total
Frequency	alive	dead	unkn	
Expected				
Cell Chi-Square				
c1_12	45	0	0	45
	44.151	0.5094	0.3396	
	0.0163	0.5094	0.3396	
c1_45	42	1	2	45
	44.151	0.5094	0.3396	
	0.1048	0.4724	8.1174	
c2_12	45	0	0	45
	44.151	0.5094	0.3396	
	0.0163	0.5094	0.3396	
c2_45	45	0	0	45
	44.151	0.5094	0.3396	
	0.0163	0.5094	0.3396	
c3_12	59	0	1	60
	58.868	0.6792	0.4528	
	0.0003	0.6792	0.6612	
c3_45	57	3	0	60
	58.868	0.6792	0.4528	
	0.0593	7.9292	0.4528	
c4_12	29	0	1	30
	29.434	0.3396	0.2264	
	0.0064	0.3396	2.6431	
Total	520	6	4	530

(Continued)

Appendix D

Chi square tests of homogeneity for the recovery of Chinook salmon juveniles released through units at the Dalles Dam, October 2002.

----- sbay=CTL -----

The FREQ Procedure
Table of desc by cond

desc	cond			Total
Frequency	alive	dead	unkn	
c4_45	43	2	0	45
	44.151	0.5094	0.3396	
	0.03	4.3613	0.3396	
c5_12	10	0	0	10
	9.8113	0.1132	0.0755	
	0.0036	0.1132	0.0755	
c5_45	45	0	0	45
	44.151	0.5094	0.3396	
	0.0163	0.5094	0.3396	
c6_45	20	0	0	20
	19.623	0.2264	0.1509	
	0.0073	0.2264	0.1509	
c7_45	60	0	0	60
	58.868	0.6792	0.4528	
	0.0218	0.6792	0.4528	
c8_45	20	0	0	20
	19.623	0.2264	0.1509	
	0.0073	0.2264	0.1509	
Total	520	6	4	530

Statistics for Table of desc by cond

Statistic	DF	Value	Prob
Chi-Square	24	31.7736	0.1327
Likelihood Ratio Chi-Square	24	27.6871	0.2735
Mantel-Haenszel Chi-Square	1	1.7334	0.1880
Phi Coefficient		0.2448	
Contingency Coefficient		0.2378	
Cramer's V		0.1731	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 530

Appendix D

Chi square tests of homogeneity for the recovery of Chinook salmon juveniles released through units at the Dalles Dam, October 2002.

----- sbay=CTL -----

The FREQ Procedure
Table of desc by cond

desc	cond		Total
Frequency	alive	unkn	
c1_12	45	0	45
	44.526	0.4737	
	0.005	0.4737	
c2_12	45	0	45
	44.526	0.4737	
	0.005	0.4737	
c3_12	59	1	60
	59.368	0.6316	
	0.0023	0.2149	
c4_12	29	1	30
	29.684	0.3158	
	0.0158	1.4825	
c5_12	10	0	10
	9.8947	0.1053	
	0.0011	0.1053	
Total	188	2	190

Statistics for Table of desc by cond

Statistic	DF	Value	Prob
Chi-Square	4	2.7793	0.5954
Likelihood Ratio Chi-Square	4	3.2538	0.5163
Mantel-Haenszel Chi-Square	1	1.3342	0.2481
Phi Coefficient		0.1209	
Contingency Coefficient		0.1201	
Cramer's V		0.1209	

WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Fisher's Exact Test

Table Probability (P)	0.1003
Pr <= P	0.5865
Sample Size =	190

Appendix D

Chi square tests of homogeneity for the recovery of Chinook salmon juveniles released through units at the Dalles Dam, October 2002.

----- sbay=SB2 -----

The FREQ Procedure
Table of desc by cond

desc	cond			Total
Frequency	alive	dead	unkn	
Expected				
Cell Chi-Square				
d1_12	30	0	0	30
	29.5	0.125	0.375	
	0.0085	0.125	0.375	
d2_12	45	0	0	45
	44.25	0.1875	0.5625	
	0.0127	0.1875	0.5625	
d3_12	29	0	1	30
	29.5	0.125	0.375	
	0.0085	0.125	1.0417	
d4_12	15	0	0	15
	14.75	0.0625	0.1875	
	0.0042	0.0625	0.1875	
s1_12	30	0	0	30
	29.5	0.125	0.375	
	0.0085	0.125	0.375	
s2_12	42	1	2	45
	44.25	0.1875	0.5625	
	0.1144	3.5208	3.6736	
s3_12	30	0	0	30
	29.5	0.125	0.375	
	0.0085	0.125	0.375	
s4_12	15	0	0	15
	14.75	0.0625	0.1875	
	0.0042	0.0625	0.1875	
Total	236	1	3	240

Statistics for Table of desc by cond

Statistic	DF	Value	Prob
Chi-Square	14	11.2806	0.6639
Likelihood Ratio Chi-Square	14	10.5549	0.7206
Mantel-Haenszel Chi-Square	1	0.6157	0.4326
Phi Coefficient		0.2168	
Contingency Coefficient		0.2119	
Cramer's V		0.1533	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

The FREQ Procedure
Statistics for Table of desc by cond
Fisher's Exact Test

Table Probability (P)	0.0024
Pr <= P	0.7626

Sample Size = 240

Appendix D

Chi square tests of homogeneity for the recovery of Chinook salmon juveniles released through units at the Dalles Dam, October 2002.

----- sbay=SB4 -----

The FREQ Procedure
Table of desc by cond

desc	cond		Total
Frequency	alive	dead	
d1_12	29	1	30
	29.625	0.375	
	0.0132	1.0417	
d2_12	44	1	45
	44.438	0.5625	
	0.0043	0.3403	
d3_12	30	0	30
	29.625	0.375	
	0.0047	0.375	
d4_12	15	0	15
	14.813	0.1875	
	0.0024	0.1875	
s1_12	44	1	45
	44.438	0.5625	
	0.0043	0.3403	
s2_12	30	0	30
	29.625	0.375	
	0.0047	0.375	
s3_12	30	0	30
	29.625	0.375	
	0.0047	0.375	
s4_12	15	0	15
	14.813	0.1875	
	0.0024	0.1875	
Total	237	3	240

Statistics for Table of desc by cond

Statistic	DF	Value	Prob
Chi-Square	7	3.2630	0.8597
Likelihood Ratio Chi-Square	7	4.3039	0.7442
Mantel-Haenszel Chi-Square	1	1.4647	0.2262
Phi Coefficient		0.1166	
Contingency Coefficient		0.1158	
Cramer's V		0.1166	

WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

The FREQ Procedure
Statistics for Table of desc by cond
Fisher's Exact Test

Table Probability (P)	0.0267
Pr <= P	1.0000

Sample Size = 240

Appendix D

One hour survival estimates for juvenile Chinook salmon released by a deep pipe through Spillbay 2 at 4.5 kcfs through the spillbay and 4.5 kcfs total spill at the Dalles Dam, October-November 2002.

Controls: 530 released, 520 alive, 6 dead. Spillbay 2 test release: 345 released, 326 alive, 15 dead.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S = 0.9872 (0.0059) Control group survival
Pa = 0.9939 (0.0056) Live recovery probability
Pd = 0.8828 (0.1684) Dead recovery probability
Tau = 0.9631 (0.0138) Spillbay 2 survival
1-Tau = 0.0369 (0.0138) Spillbay 2 mortality

log-likelihood : -139.666444

Variance-Covariance matrix for estimated probabilities:

0.00004 -0.00002 0.00049 -0.00001
-0.00002 0.00003 -0.00076 -0.00002
0.00049 -0.00076 0.02836 0.00067
-0.00001 -0.00002 0.00067 0.00019

Profile likelihood intervals:

	Spillbay 2 survival	Spillbay 2 mortality
90 percent:	(0.9386, 0.9843)	(0.0157, 0.0614)
95 percent:	(0.9335, 0.9879)	(0.0121, 0.0665)
99 percent:	(0.9230, 0.9946)	(0.0054, 0.0770)

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S = 0.9886 (0.0046) Control group survival
Pa = Pd 0.9909 (0.0032) Recovery probability
Tau = 0.9670 (0.0121) Spillbay 2 survival
1-Tau = 0.0330 (0.0121) Spillbay 2 mortality

log-likelihood : -139.851100

Variance-Covariance matrix for estimated probabilities:

0.00002 0.00000 -0.00002
0.00000 0.00001 0.00000
-0.00002 0.00000 0.00015

Profile likelihood intervals:

	Spillbay 2 survival	Spillbay 2 mortality
90 percent:	(0.9451, 0.9855)	(0.0145, 0.0549)
95 percent:	(0.9404, 0.9888)	(0.0112, 0.0596)
99 percent:	(0.9307, 0.9953)	(0.0047, 0.0693)

Likelihood ratio statistic for equality of recovery probabilities: 0.369311

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Forty-eight hour survival estimates for juvenile Chinook salmon released by a deep pipe through Spillbay 2 at 4.5 kcfs through the spillbay and 4.5 kcfs total spill at the Dalles Dam, October-November 2002.

Controls: 530 released, 520 alive, 6 dead. Spillbay 2 test release: 345 released, 313 alive, 28 dead.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S = 0.9879 (0.0051) Control group survival
Pa = 0.9931 (0.0045) Live recovery probability
Pd = 0.9387 (0.0855) Dead recovery probability
Tau = 0.9247 (0.0169) Spillbay 2 survival
1-Tau = 0.0753 (0.0169) Spillbay 2 mortality

log-likelihood : -174.952419

Variance-Covariance matrix for estimated probabilities:

0.00003 -0.00001 0.00011 -0.00002
-0.00001 0.00002 -0.00026 -0.00002
0.00011 -0.00026 0.00731 0.00037
-0.00002 -0.00002 0.00037 0.00028

Profile likelihood intervals:

	Spillbay 2 survival	Spillbay 2 mortality
90 percent:	(0.8952, 0.9509)	(0.0491, 0.1048)
95 percent:	(0.8891, 0.9555)	(0.0445, 0.1109)
99 percent:	(0.8769, 0.9640)	(0.0360, 0.1231)

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S = 0.9886 (0.0046) Control group survival
Pa = Pd 0.9909 (0.0032) Recovery probability
Tau = 0.9285 (0.0157) Spillbay 2 survival
1-Tau = 0.0715 (0.0157) Spillbay 2 mortality

log-likelihood : -175.137074

Variance-Covariance matrix for estimated probabilities:

0.00002 0.00000 -0.00002
0.00000 0.00001 0.00000
-0.00002 0.00000 0.00025

Profile likelihood intervals:

	Spillbay 2 survival	Spillbay 2 mortality
90 percent:	(0.9008, 0.9525)	(0.0475, 0.0992)
95 percent:	(0.8950, 0.9567)	(0.0433, 0.1050)
99 percent:	(0.8833, 0.9648)	(0.0352, 0.1167)

Likelihood ratio statistic for equality of recovery probabilities: 0.369311

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Forty-eight hour survival estimates for juvenile Chinook salmon released by a deep pipe through Spillbay 2 at 4.5 and 12 kcfs with total spill through the spillbay at the Dalles Dam, October-November 2002.

Controls: 530 released, 520 alive, 6 dead. Spillbay 2, 4.5 kcfs release: 345 released, 313 alive, 28 dead. Spillbay 2, 12 kcfs release: 45 released, 43 alive, 2 dead.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9880 (0.0051) Control group survival
Pa = 0.9934 (0.0043) Live recovery probability
Pd = 0.9427 (0.0819) Dead recovery probability
S2 = 0.9136 (0.0165) Spillbay 2, 4.5/4.5 survival
S3 = 0.9556 (0.0307) Spillbay 2, deep, 12/12 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -183.5472

Tau = 0.9247 (0.0169) Spillbay 2, 4.5 kcfs/Control ratio
Tau = 0.9672 (0.0315) Spillbay 2, deep, 12/12/Control ratio

Z statistic for the equality of equal turbine survivals: 1.1883

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00002555	-0.00000485	0.00010623	0.00000772	0.00000000
-0.00000485	0.00001844	-0.00024126	-0.00002088	0.00000000
0.00010623	-0.00024126	0.00670086	0.00045755	0.00000000
0.00000772	-0.00002088	0.00045755	0.00027064	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00094376

Confidence intervals:

Spillbay 2, deep, 4.5/4.5 Tau	Spillbay 2, deep, 12/12 Tau
90 percent: (0.8970, 0.9525)	(0.9154, 1.0190)
95 percent: (0.8917, 0.9578)	(0.9055, 1.0289)
99 percent: (0.8813, 0.9682)	(0.8861, 1.0483)

Appendix D

Forty-eight hour survival estimates for juvenile Chinook salmon released by a deep pipe through Spillbay 2 at 4.5 and 12 kcfs with total spill through the spillbay at the Dalles Dam, October-November 2002.

Controls: 530 released, 520 alive, 6 dead. Spillbay 2, 4.5 kcfs release: 345 released, 313 alive, 28 dead. Spillbay 2, 12 kcfs release: 45 released, 43 alive, 2 dead.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9886 (0.0046) Control group survival
Pa = Pd 0.9913 (0.0031) Recovery probability
S2 = 0.9179 (0.0149) Spillbay 2, 4.5 kcfs survival
S3 = 0.9556 (0.0307) Spillbay 2, deep, 12/12 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -183.7220

Tau = 0.9285 (0.0157) Spillbay 2, 4.5/4.5 /Control ratio
Tau = 0.9666 (0.0314) Spillbay 2, deep, 12/12 /Control ratio

Z statistic for the equality of equal turbine survivals: 1.0859

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00002144	0.00000000	0.00000000	0.00000000
0.00000000	0.00000937	0.00000000	0.00000000
0.00000000	0.00000000	0.00022102	0.00000000
0.00000000	0.00000000	0.00000000	0.00094376

Confidence intervals:

Spillbay 2, deep, 4.5/4.5 Tau	Spillbay 2, deep, 12/12 Tau
90 percent: (0.9027, 0.9542)	(0.9149, 1.0182)
95 percent: (0.8978, 0.9592)	(0.9050, 1.0281)
99 percent: (0.8882, 0.9688)	(0.8857, 1.0474)

Likelihood ratio statistic for equality of recovery probabilities: 0.3495

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Forty-eight hour survival estimates for juvenile Chinook salmon released at shallow and deep release sites through Spillbay 2 at 12 kcfs spill and 12 total spill at the Dalles Dam, October-November 2002.

Control fish: 530 released, 520 alive, 6 dead. Spillbay 2 shallow: 45 released, 45 alive, 0 dead.

Spillbay 2 deep: 45 released, 43 alive, 2 dead.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

	estim.	std. err.	
S1 =	0.9887	(+NAN)	Control group survival
Pa =	0.9935	(+NAN)	Live recovery probability
Pd =	1.0	N/A	Dead recovery probability*
S2 =	1.0	N/A	Spillbay 2, shallow, 12/12 kcfs survival*
S3 =	0.9556	(0.0307)	Spillbay 2, deep, 12/12 kcfs survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -65.1432

Tau = 1.0115 (+NAN) Spillbay 2, shallow, 12/12 kcfs/Control ratio

Tau = 0.9665 (0.0291) Spillbay 2, deep, 12/12 kcfs/Control ratio

Z statistic for the equality of equal turbine survivals: +NAN

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

-0.00012527	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	-0.00004216	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00094376

Confidence intervals:

Spillbay 2, shallow, 12/12 kcfs Tau	Spillbay 2, deep, 12/12 kcfs Tau
90 percent: (+NAN, +NAN)	(0.9187, 1.0143)
95 percent: (+NAN, +NAN)	(0.9095, 1.0235)
99 percent: (+NAN, +NAN)	(0.8916, 1.0414)

Appendix D

Forty-eight hour survival estimates for juvenile Chinook salmon released at shallow and deep release sites through Spillbay 2 at 12 kcfs spill and 12 total spill at the Dalles Dam, October-November 2002.

Control fish: 530 released, 520 alive, 6 dead. Spillbay 2 shallow: 45 released, 45 alive, 0 dead.

Spillbay 2 deep: 45 released, 43 alive, 2 dead.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9886 (0.0046) Control group survival
Pa = Pd 0.9935 (0.0032) Recovery probability
S2 = 1.0 N/A Spillbay 2, shallow, 12/12 kcfs survival*
S3 = 0.9556 (0.0307) Spillbay 2, deep, 12/12 kcfs survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -65.1496

Tau = 1.0115 (0.0047) Spillbay 2, shallow, 12/12 kcfs/Control ratio

Tau = 0.9666 (0.0314) Spillbay 2, deep, 12/12 kcfs/Control ratio

Z statistic for the equality of equal turbine survivals: 1.4156

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00002144	0.00000000	0.00000000	0.00000000
0.00000000	0.00001034	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00094376

Confidence intervals:

Spillbay 2, shallow, 12/12 kcfs Tau	Spillbay 2, deep, 12/12 kcfs Tau
90 percent: (1.0037, 1.0193)	(0.9149, 1.0182)
95 percent: (1.0023, 1.0208)	(0.9050, 1.0281)
99 percent: (0.9993, 1.0237)	(0.8857, 1.0474)

Likelihood ratio statistic for equality of recovery probabilities: 0.0128

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

One hour survival estimates for juvenile Chinook salmon released by a deep pipe through Spillbay 4 at 4.5 kcfs through the spillbay and 33 kcfs total spill at the Dalles Dam, October-November 2002.

Controls: 530 released, 520 alive, 6 dead. Spillbay 4 test release: 345 released, 338 alive, 6 dead.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

	estim.	std. err.	
S =	0.9887	(0.0046)	Control group survival
Pa =	0.9942	(0.0026)	Live recovery probability
Pd =	1.0	N/A	Dead recovery probability*
Tau =	0.9939	(0.0085)	Spillbay 4 survival
1-Tau =	0.0061	(0.0085)	Spillbay 4 mortality

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -93.851216

Variance-Covariance matrix for estimated probabilities:

0.00002	-0.00000	-0.00002
-0.00000	0.00001	0.00000
-0.00002	0.00000	0.00007

Profile likelihood intervals:

	Spillbay 4 survival	Spillbay 4 mortality
90 percent:	(0.9782, 1.0000)	(0.0000, 0.0218)
95 percent:	(0.9746, 1.0000)	(0.0000, 0.0254)
99 percent:	(0.9672, 1.0000)	(0.0000, 0.0328)

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

	estim.	std. err.	
S =	0.9886	(0.0046)	Control group survival
Pa = Pd	0.9943	(0.0025)	Recovery probability
Tau =	0.9939	(0.0085)	Spillbay 4 survival
1-Tau =	0.0061	(0.0085)	Spillbay 4 mortality

log-likelihood : -93.857177

Variance-Covariance matrix for estimated probabilities:

0.00002	0.00000	-0.00002
0.00000	0.00001	-0.00000
-0.00002	-0.00000	0.00007

Profile likelihood intervals:

	Spillbay 4 survival	Spillbay 4 mortality
90 percent:	(0.9781, 1.0000)	(0.0000, 0.0219)
95 percent:	(0.9746, 1.0000)	(0.0000, 0.0254)
99 percent:	(0.9672, 1.0000)	(0.0000, 0.0328)

Likelihood ratio statistic for equality of recovery probabilities: 0.011921

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10:	2.706
For significance level 0.05:	3.841
For significance level 0.01:	6.635

Appendix D

Forty-eight hour survival estimates for juvenile Chinook salmon released by a deep pipe through Spillbay 4 at 4.5 kcfs through the spillbay and 33 kcfs total spill at the Dalles Dam, October-November 2002.

Controls: 530 released, 520 alive, 6 dead. Spillbay 4 test release: 345 released, 328 alive, 16 dead.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

	estim.	std. err.	
S =	0.9887	(0.0046)	Control group survival
Pa =	0.9941	(0.0026)	Live recovery probability
Pd =	1.0	N/A	Dead recovery probability*
Tau =	0.9645	(0.0123)	Spillbay 4 survival
1-Tau =	0.0355	(0.0123)	Spillbay 4 mortality

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -128.292944

Variance-Covariance matrix for estimated probabilities:

0.00002	-0.00000	-0.00002
-0.00000	0.00001	0.00000
-0.00002	0.00000	0.00015

Profile likelihood intervals:

	Spillbay 4 survival	Spillbay 4 mortality
90 percent:	(0.9423, 0.9833)	(0.0167, 0.0577)
95 percent:	(0.9376, 0.9866)	(0.0134, 0.0624)
99 percent:	(0.9278, 0.9932)	(0.0068, 0.0722)

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

	estim.	std. err.	
S =	0.9886	(0.0046)	Control group survival
Pa = Pd	0.9943	(0.0025)	Recovery probability
Tau =	0.9645	(0.0123)	Spillbay 4 survival
1-Tau =	0.0355	(0.0123)	Spillbay 4 mortality

log-likelihood : -128.327363

Variance-Covariance matrix for estimated probabilities:

0.00002	-0.00000	-0.00002
-0.00000	0.00001	0.00000
-0.00002	0.00000	0.00015

Profile likelihood intervals:

	Spillbay 4 survival	Spillbay 4 mortality
90 percent:	(0.9422, 0.9833)	(0.0167, 0.0578)
95 percent:	(0.9374, 0.9867)	(0.0133, 0.0626)
99 percent:	(0.9276, 0.9933)	(0.0067, 0.0724)

Likelihood ratio statistic for equality of recovery probabilities: 0.068839

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10:	2.706
For significance level 0.05:	3.841
For significance level 0.01:	6.635

Appendix D

One hour survival estimates for juvenile Chinook salmon released by a deep pipe through Spillbays 2 and 4 at 12 kcfs through the spillbay and 72 kcfs total spill at the Dalles Dam, October-November 2002.

Controls: 530 released, 520 alive, 6 dead. Spillbay 2 test release: 120 released, 119 alive, 0 dead.

Spillbay 4 test release: 120 released, 118 alive, 2 dead.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9887 (+NAN) Control group survival
Pa = 0.9934 (+NAN) Live recovery probability
Pd = 1.0 N/A Dead recovery probability*
S2 = 1.0 N/A Spillbay 2 deep, 12/72 spill survival*
S3 = 0.9833 (0.0117) Spillbay 4 deep, 12/72 spill survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -73.1406

Tau = 1.0115 (+NAN) Spillbay 2 deep, 12/72 spill/Control ratio

Tau = 0.9946 (0.0036) Spillbay 4 deep, 12/72 spill/Control ratio

Z statistic for the equality of equal turbine survivals: +NAN

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

-0.00012527	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	-0.00004249	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00013657

Confidence intervals:

Spillbay 2 deep, 12/72 spill Tau	Spillbay 4 deep, 12/72 spill Tau
90 percent: (+NAN, +NAN)	(0.9887, 1.0005)
95 percent: (+NAN, +NAN)	(0.9875, 1.0016)
99 percent: (+NAN, +NAN)	(0.9853, 1.0039)

Appendix D

One hour survival estimates for juvenile Chinook salmon released by a deep pipe through Spillbays 2 and 4 at 12 kcfs through the spillbay and 72 kcfs total spill at the Dalles Dam, October-November 2002.

Controls: 530 released, 520 alive, 6 dead. Spillbay 2 test release: 120 released, 119 alive, 0 dead.

Spillbay 4 test release: 120 released, 118 alive, 2 dead.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

 estim. std. err.
S1 = 0.9886 (0.0046) Control group survival
Pa = Pd 0.9935 (0.0029) Recovery probability
S2 = 1.0 N/A Spillbay 2 deep, 12/72 spill survival*
S3 = 0.9833 (0.0117) Spillbay 4 deep, 12/72 spill survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -73.1473

Tau = 1.0115 (0.0047) Spillbay 2 deep, 12/72 spill/Control ratio

Tau = 0.9947 (0.0127) Spillbay 4 deep, 12/72 spill/Control ratio

Z statistic for the equality of equal turbine survivals: 1.2432

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00002144	0.00000000	0.00000000	0.00000000
0.00000000	0.00000838	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00013657

Confidence intervals:

Spillbay 2 deep, 12/72 spill Tau	Spillbay 4 deep, 12/72 spill Tau
90 percent: (1.0037, 1.0193)	(0.9738, 1.0156)
95 percent: (1.0023, 1.0208)	(0.9698, 1.0196)
99 percent: (0.9993, 1.0237)	(0.9620, 1.0274)

Likelihood ratio statistic for equality of recovery probabilities: 0.0134

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Forty-eight hour survival estimates for juvenile Chinook salmon released by a deep pipe through Spillbays 2 and 4 at 12 kcfs through the spillbay and 72 kcfs total spill at the Dalles Dam, October-November 2002.

Controls: 530 released, 520 alive, 6 dead. Spillbay 2 test release: 120 released, 118 alive, 1 dead.

Spillbay 4 test release: 120 released, 118 alive, 2 dead.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9887 (0.0046) Control group survival
Pa = 0.9934 (0.0029) Live recovery probability
Pd = 1.0 N/A Dead recovery probability*
S2 = 0.9917 (0.0083) Spillbay 2 deep, 12/72 spill survival
S3 = 0.9833 (0.0117) Spillbay 4 deep, 12/72 spill survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -78.9174

Tau = 1.0030 (0.0096) Spillbay 2 deep, 12/72 spill/Control ratio

Tau = 0.9946 (0.0127) Spillbay 4 deep, 12/72 spill/Control ratio

Z statistic for the equality of equal turbine survivals: 0.5296

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00002112	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000858	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00006887	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00013657

Confidence intervals:

Spillbay 2 deep, 12/72 spill Tau	Spillbay 4 deep, 12/72 spill Tau
90 percent: (0.9872, 1.0188)	(0.9737, 1.0155)
95 percent: (0.9842, 1.0218)	(0.9697, 1.0195)
99 percent: (0.9783, 1.0277)	(0.9619, 1.0273)

Appendix D

Forty-eight hour survival estimates for juvenile Chinook salmon released by a deep pipe through Spillbays 2 and 4 at 12 kcfs through the spillbay and 72 kcfs total spill at the Dalles Dam, October-November 2002.

Controls: 530 released, 520 alive, 6 dead. Spillbay 2 test release: 120 released, 118 alive, 1 dead.

Spillbay 4 test release: 120 released, 118 alive, 2 dead.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9886 (0.0046) Control group survival
Pa = Pd 0.9935 (0.0029) Recovery probability
S2 = 0.9916 (0.0084) Spillbay 2 deep, 12/72 spill survival
S3 = 0.9833 (0.0117) Spillbay 4 deep, 12/72 spill survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -78.9222

Tau = 1.0030 (0.0097) Spillbay 2 deep, 12/72 spill/Control ratio

Tau = 0.9947 (0.0127) Spillbay 4 deep, 12/72 spill/Control ratio

Z statistic for the equality of equal turbine survivals: 0.5233

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00002144	0.00000000	0.00000000	0.00000000
0.00000000	0.00000838	0.00000000	0.00000000
0.00000000	0.00000000	0.00007002	0.00000000
0.00000000	0.00000000	0.00000000	0.00013657

Confidence intervals:

Spillbay 2 deep, 12/72 spill Tau Spillbay 4 deep, 12/72 spill Tau

90 percent: (0.9871, 1.0190) (0.9738, 1.0156)

95 percent: (0.9841, 1.0220) (0.9698, 1.0196)

99 percent: (0.9781, 1.0280) (0.9620, 1.0274)

Likelihood ratio statistic for equality of recovery probabilities: 0.0097

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706

For significance level 0.05: 3.841

For significance level 0.01: 6.635

Appendix D

One hour survival estimates for juvenile Chinook salmon released by a shallow pipe through Spillbays 2 and 4 at 12 kcfs through the spillbay and 72 kcfs total spill at the Dalles Dam, October-November 2002.

Controls: 530 released, 520 alive, 6 dead. Spillbay 2 test release: 120 released, 117 alive, 1 dead.

Spillbay 4 test release: 120 released, 119 alive, 1 dead.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9811 (0.0059) Control group survival
Pa = 1.0 N/A Live recovery probability*
Pd = 0.5714 (0.1323) Dead recovery probability
S2 = 0.9750 (0.0143) Spillbay 2 shallow, 12/72 spill survival
S3 = 0.9917 (0.0083) Spillbay 4 shallow, 12/72 spill survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -78.9808

Tau = 0.9938 (0.0157) Spillbay 2 shallow, 12/72 spill/Control ratio

Tau = 1.0107 (0.0104) Spillbay 4 shallow, 12/72 spill/Control ratio

Z statistic for the equality of equal turbine survivals: 0.9010

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00003493	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.01749262	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00020312	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00006887

Confidence intervals:

Spillbay 2 shallow, 12/72 spill Tau	Spillbay 4 shallow, 12/72 spill Tau
90 percent: (0.9679, 1.0196)	(0.9936, 1.0279)
95 percent: (0.9630, 1.0245)	(0.9903, 1.0312)
99 percent: (0.9533, 1.0342)	(0.9839, 1.0376)

Appendix D

One hour survival estimates for juvenile Chinook salmon released by a shallow pipe through Spillbays 2 and 4 at 12 kcfs through the spillbay and 72 kcfs total spill at the Dalles Dam, October-November 2002.

Controls: 530 released, 520 alive, 6 dead. Spillbay 2 test release: 120 released, 117 alive, 1 dead.

Spillbay 4 test release: 120 released, 119 alive, 1 dead.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std. err.

S1 = 0.9886 (0.0046) Control group survival

Pa = Pd 0.9922 (0.0032) Recovery probability

S2 = 0.9915 (0.0084) Spillbay 2 shallow, 12/72 spill survival

S3 = 0.9917 (0.0083) Spillbay 4 shallow, 12/72 spill survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -79.4610

Tau = 1.0030 (0.0097) Spillbay 2 shallow, 12/72 spill/Control ratio

Tau = 1.0031 (0.0096) Spillbay 4 shallow, 12/72 spill/Control ratio

Z statistic for the equality of equal turbine survivals: 0.0104

Compare with quantiles of the normal distribution:

1-tailed 2-tailed

For significance level 0.10: 1.2816 1.6449

For significance level 0.05: 1.6449 1.9600

For significance level 0.01: 2.3263 2.5758

Variance-Covariance matrix for estimated probabilities:

0.00002144 0.00000000 0.00000000 0.00000000

0.00000000 0.00001004 0.00000000 0.00000000

0.00000000 0.00000000 0.00007121 0.00000000

0.00000000 0.00000000 0.00000000 0.00006887

Confidence intervals:

Spillbay 2 shallow, 12/72 spill Tau Spillbay 4 shallow, 12/72 spill Tau

90 percent: (0.9869, 1.0190) (0.9873, 1.0189)

95 percent: (0.9839, 1.0221) (0.9843, 1.0220)

99 percent: (0.9779, 1.0281) (0.9783, 1.0279)

Likelihood ratio statistic for equality of recovery probabilities: 0.9603

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706

For significance level 0.05: 3.841

For significance level 0.01: 6.635

Appendix D

Forty-eight hour survival estimates for juvenile Chinook salmon released by a shallow pipe through Spillbays 2 and 4 at 12 kcfs through the spillbay and 72 kcfs total spill at the Dalles Dam, October-November 2002.

Controls: 530 released, 520 alive, 6 dead. Spillbay 2 test release: 120 released, 113 alive, 5 dead.

Spillbay 4 test release: 120 released, 117 alive, 3 dead.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9859 (0.0079) Control group survival
Pa = 0.9959 (0.0064) Live recovery probability
Pd = 0.8284 (0.2380) Dead recovery probability
S2 = 0.9466 (0.0238) Spillbay 2 shallow, 12/72 spill survival
S3 = 0.9750 (0.0143) Spillbay 4 shallow, 12/72 spill survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -102.3966

Tau = 0.9602 (0.0228) Spillbay 2 shallow, 12/72 spill/Control ratio

Tau = 0.9890 (0.0165) Spillbay 4 shallow, 12/72 spill/Control ratio

Z statistic for the equality of equal turbine survivals: 1.0215

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00006290	-0.00003528	0.00130751	0.00006069	0.00000000
-0.00003528	0.00004053	-0.00130065	-0.00006533	0.00000000
0.00130751	-0.00130065	0.05662176	0.00242152	0.00000000
0.00006069	-0.00006533	0.00242152	0.00056457	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00020312

Confidence intervals:

Spillbay 2 shallow, 12/72 spill Tau	Spillbay 4 shallow, 12/72 spill Tau
90 percent: (0.9227, 0.9978)	(0.9618, 1.0161)
95 percent: (0.9155, 1.0049)	(0.9566, 1.0213)
99 percent: (0.9015, 1.0190)	(0.9465, 1.0315)

Appendix D

Forty-eight hour survival estimates for juvenile Chinook salmon released by a shallow pipe through Spillbays 2 and 4 at 12 kcfs through the spillbay and 72 kcfs total spill at the Dalles Dam, October-November 2002.

Controls: 530 released, 520 alive, 6 dead. Spillbay 2 test release: 120 released, 113 alive, 5 dead.

Spillbay 4 test release: 120 released, 117 alive, 3 dead.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9886 (0.0046) Control group survival
Pa = Pd 0.9922 (0.0032) Recovery probability
S2 = 0.9576 (0.0185) Spillbay 2 shallow, 12/72 spill survival
S3 = 0.9750 (0.0143) Spillbay 4 shallow, 12/72 spill survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -102.6388

Tau = 0.9687 (0.0193) Spillbay 2 shallow, 12/72 spill/Control ratio

Tau = 0.9862 (0.0151) Spillbay 4 shallow, 12/72 spill/Control ratio

Z statistic for the equality of equal turbine survivals: 0.7165

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00002144	0.00000000	0.00000000	0.00000000
0.00000000	0.00001004	0.00000000	0.00000000
0.00000000	0.00000000	0.00034388	0.00000000
0.00000000	0.00000000	0.00000000	0.00020313

Confidence intervals:

Spillbay 2 shallow, 12/72 spill Tau	Spillbay 4 shallow, 12/72 spill Tau
90 percent: (0.9369, 1.0004)	(0.9613, 1.0112)
95 percent: (0.9309, 1.0065)	(0.9566, 1.0159)
99 percent: (0.9190, 1.0184)	(0.9473, 1.0252)

Likelihood ratio statistic for equality of recovery probabilities: 0.4845

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Chi square tests of homogeneity for the recovery of Chinook salmon juveniles released through units at the Dalles Dam, May-June 2003.

----- sbay=CTL -----

The FREQ Procedure
Table of desc by cond

desc	cond		Total
Frequency	alive	dead	
Expected			
Cell Chi-Square			
c1_12	40	0	40
	39.627	0.3733	
	0.0035	0.3733	
c1_18	30	0	30
	29.72	0.28	
	0.0026	0.28	
c1_21	50	0	50
	49.533	0.4667	
	0.0044	0.4667	
c1_9	40	0	40
	39.627	0.3733	
	0.0035	0.3733	
c2_12	40	0	40
	39.627	0.3733	
	0.0035	0.3733	
c2_18	37	3	40
	39.627	0.3733	
	0.1741	18.48	
c2_21	50	0	50
	49.533	0.4667	
	0.0044	0.4667	
c2_9	40	0	40
	39.627	0.3733	
	0.0035	0.3733	
c3_12	39	1	40
	39.627	0.3733	
	0.0099	1.0519	
c3_18	40	0	40
	39.627	0.3733	
	0.0035	0.3733	
Total	743	7	750

(Continued)

Appendix D

Chi square tests of homogeneity for the recovery of Chinook salmon juveniles released through units at the Dalles Dam, May-June 2003.

----- sbay=CTL -----

The FREQ Procedure
Table of desc by cond

desc	cond		Total
Frequency	alive	dead	
c3_21	49	1	50
	49.533	0.4667	
	0.0057	0.6095	
c3_9	30	0	30
	29.72	0.28	
	0.0026	0.28	
c4_18	29	1	30
	29.72	0.28	
	0.0174	1.8514	
c4_21	20	0	20
	19.813	0.1867	
	0.0018	0.1867	
c4_9	40	0	40
	39.627	0.3733	
	0.0035	0.3733	
c5_18	30	0	30
	29.72	0.28	
	0.0026	0.28	
c5_9	30	0	30
	29.72	0.28	
	0.0026	0.28	
c6_18	30	0	30
	29.72	0.28	
	0.0026	0.28	
c7_18	40	0	40
	39.627	0.3733	
	0.0035	0.3733	
c8_18	39	1	40
	39.627	0.3733	
	0.0099	1.0519	
Total	743	7	750

The FREQ Procedure
Statistics for Table of desc by cond

Statistic	DF	Value	Prob
Chi-Square	19	28.4440	0.0752
Likelihood Ratio Chi-Square	19	20.7843	0.3488
Mantel-Haenszel Chi-Square	1	0.0012	0.9719
Phi Coefficient		0.1947	
Contingency Coefficient		0.1912	
Cramer's V		0.1947	

WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 750

Appendix D

Chi square tests of homogeneity for the recovery of Chinook salmon juveniles released through units at the Dalles Dam, May-June 2003.

----- sbay=SB2 -----

The FREQ Procedure
Table of desc by cond

desc	cond			Total
Frequency	alive	dead	unkn	
Expected				
Cell Chi-Square				
de1_12	29	1	0	30
	29.304	0.6207	0.0752	
	0.0032	0.2318	0.0752	
de1_18	30	0	0	30
	29.304	0.6207	0.0752	
	0.0165	0.6207	0.0752	
de1_21	47	3	0	50
	48.84	1.0345	0.1254	
	0.0693	3.7345	0.1254	
de1_9	37	2	1	40
	39.072	0.8276	0.1003	
	0.1099	1.6609	8.0691	
de2_12	38	1	0	39
	38.095	0.8069	0.0978	
	0.0002	0.0462	0.0978	
de2_18	40	0	0	40
	39.072	0.8276	0.1003	
	0.022	0.8276	0.1003	
de2_21	48	2	0	50
	48.84	1.0345	0.1254	
	0.0145	0.9011	0.1254	
de2_9	37	3	0	40
	39.072	0.8276	0.1003	
	0.1099	5.7026	0.1003	
de3_12	39	0	0	39
	38.095	0.8069	0.0978	
	0.0215	0.8069	0.0978	
de3_18	40	0	0	40
	39.072	0.8276	0.1003	
	0.022	0.8276	0.1003	
Total	1558	33	4	1595

(Continued)

Appendix D

Chi square tests of homogeneity for the recovery of Chinook salmon juveniles released through units at the Dalles Dam, May-June 2003.

----- sbay=SB2 -----

The FREQ Procedure
Table of desc by cond

desc	cond			Total
Frequency	alive	dead	unkn	
Expected	Chi-Square			
de3_9	29	1	0	30
	29.304	0.6207	0.0752	
	0.0032	0.2318	0.0752	
de4_18	40	0	0	40
	39.072	0.8276	0.1003	
	0.022	0.8276	0.1003	
de4_9	37	2	0	39
	38.095	0.8069	0.0978	
	0.0315	1.7642	0.0978	
de5_9	38	2	0	40
	39.072	0.8276	0.1003	
	0.0294	1.6609	0.1003	
dm1_12	30	0	0	30
	29.304	0.6207	0.0752	
	0.0165	0.6207	0.0752	
dm1_18	30	0	0	30
	29.304	0.6207	0.0752	
	0.0165	0.6207	0.0752	
dm1_21	49	1	0	50
	48.84	1.0345	0.1254	
	0.0005	0.0011	0.1254	
dm1_9	39	1	0	40
	39.072	0.8276	0.1003	
	0.0001	0.0359	0.1003	
dm2_12	39	1	0	40
	39.072	0.8276	0.1003	
	0.0001	0.0359	0.1003	
dm2_18	29	0	0	29
	28.327	0.6	0.0727	
	0.016	0.6	0.0727	
Total	1558	33	4	1595

(Continued)

Appendix D

Chi square tests of homogeneity for the recovery of Chinook salmon juveniles released through units at the Dalles Dam, May-June 2003.

----- sbay=SB2 -----

The FREQ Procedure
Table of desc by cond

desc	cond			Total
Frequency	alive	dead	unkn	
Expected				
Cell Chi-Square				
dm2_21	48	2	0	50
	48.84	1.0345	0.1254	
	0.0145	0.9011	0.1254	
dm2_9	40	0	0	40
	39.072	0.8276	0.1003	
	0.022	0.8276	0.1003	
dm3_12	39	1	0	40
	39.072	0.8276	0.1003	
	0.0001	0.0359	0.1003	
dm3_18	50	0	0	50
	48.84	1.0345	0.1254	
	0.0275	1.0345	0.1254	
dm3_9	29	1	0	30
	29.304	0.6207	0.0752	
	0.0032	0.2318	0.0752	
dm4_18	40	0	0	40
	39.072	0.8276	0.1003	
	0.022	0.8276	0.1003	
dm4_9	39	1	0	40
	39.072	0.8276	0.1003	
	0.0001	0.0359	0.1003	
dm5_9	40	0	0	40
	39.072	0.8276	0.1003	
	0.022	0.8276	0.1003	
se1_18	30	0	0	30
	29.304	0.6207	0.0752	
	0.0165	0.6207	0.0752	
se1_21	49	1	0	50
	48.84	1.0345	0.1254	
	0.0005	0.0011	0.1254	
Total	1558	33	4	1595

(Continued)

Appendix D

Chi square tests of homogeneity for the recovery of Chinook salmon juveniles released through units at the Dalles Dam, May-June 2003.

----- sbay=SB2 -----

The FREQ Procedure
Table of desc by cond

desc	cond			Total
Frequency	alive	dead	unkn	
se2_18	37	2	1	40
	39.072	0.8276	0.1003	
	0.1099	1.6609	8.0691	
se2_21	49	1	0	50
	48.84	1.0345	0.1254	
	0.0005	0.0011	0.1254	
se3_18	39	1	0	40
	39.072	0.8276	0.1003	
	0.0001	0.0359	0.1003	
se4_18	40	0	0	40
	39.072	0.8276	0.1003	
	0.022	0.8276	0.1003	
sm1_18	38	1	0	39
	38.095	0.8069	0.0978	
	0.0002	0.0462	0.0978	
sm1_21	49	1	0	50
	48.84	1.0345	0.1254	
	0.0005	0.0011	0.1254	
sm2_18	30	0	0	30
	29.304	0.6207	0.0752	
	0.0165	0.6207	0.0752	
sm2_21	48	0	2	50
	48.84	1.0345	0.1254	
	0.0145	1.0345	28.025	
sm3_18	39	1	0	40
	39.072	0.8276	0.1003	
	0.0001	0.0359	0.1003	
sm4_18	40	0	0	40
	39.072	0.8276	0.1003	
	0.022	0.8276	0.1003	
Total	1558	33	4	1595

The FREQ Procedure
Statistics for Table of desc by cond

Statistic	DF	Value	Prob
Chi-Square	78	80.8718	0.3896
Likelihood Ratio Chi-Square	78	60.4492	0.9296
Mantel-Haenszel Chi-Square	1	0.7304	0.3928
Phi Coefficient		0.2252	
Contingency Coefficient		0.2197	
Cramer's V		0.1592	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 1595

Appendix D

Chi square tests of homogeneity for the recovery of Chinook salmon juveniles released through units at the Dalles Dam, May-June 2003.

----- sbay=SB4 -----

The FREQ Procedure
Table of desc by cond

desc	cond			Total
Frequency	alive	dead	unkn	
Expected				
Cell Chi-Square				
dm1_12	59	0	1	60
	58.444	1.4815	0.0741	
	0.0053	1.4815	11.574	
dm1_18	40	0	0	40
	38.963	0.9877	0.0494	
	0.0276	0.9877	0.0494	
dm1_9	46	4	0	50
	48.704	1.2346	0.0617	
	0.1501	6.1946	0.0617	
dm2_12	49	1	0	50
	48.704	1.2346	0.0617	
	0.0018	0.0446	0.0617	
dm2_18	40	0	0	40
	38.963	0.9877	0.0494	
	0.0276	0.9877	0.0494	
dm2_9	50	1	0	51
	49.678	1.2593	0.063	
	0.0021	0.0534	0.063	
dm3_12	49	1	0	50
	48.704	1.2346	0.0617	
	0.0018	0.0446	0.0617	
dm3_18	47	1	0	48
	46.756	1.1852	0.0593	
	0.0013	0.0289	0.0593	
dm3_9	50	0	0	50
	48.704	1.2346	0.0617	
	0.0345	1.2346	0.0617	
Total	789	20	1	810

(Continued)

Appendix D

Chi square tests of homogeneity for the recovery of Chinook salmon juveniles released through units at the Dalles Dam, May-June 2003.

----- sbay=SB4 -----

The FREQ Procedure
Table of desc by cond

desc	cond			Total
Frequency	alive	dead	unkn	
dm4_18	29	1	0	30
	29.222	0.7407	0.037	
	0.0017	0.0907	0.037	
dm4_9	47	3	0	50
	48.704	1.2346	0.0617	
	0.0596	2.5246	0.0617	
dm5_18	41	1	0	42
	40.911	1.037	0.0519	
	0.0002	0.0013	0.0519	
dm5_9	39	1	0	40
	38.963	0.9877	0.0494	
	352E-7	0.0002	0.0494	
sm1_18	30	0	0	30
	29.222	0.7407	0.037	
	0.0207	0.7407	0.037	
sm2_18	46	3	0	49
	47.73	1.2099	0.0605	
	0.0627	2.6487	0.0605	
sm3_18	48	2	0	50
	48.704	1.2346	0.0617	
	0.0102	0.4746	0.0617	
sm4_18	40	0	0	40
	38.963	0.9877	0.0494	
	0.0276	0.9877	0.0494	
sm5_18	39	1	0	40
	38.963	0.9877	0.0494	
	352E-7	0.0002	0.0494	
Total	789	20	1	810

The FREQ Procedure

Statistics for Table of desc by cond

Statistic	DF	Value	Prob
Chi-Square	34	31.4607	0.5927
Likelihood Ratio Chi-Square	34	26.6869	0.8098
Mantel-Haenszel Chi-Square	1	0.0009	0.9758
Phi Coefficient		0.1971	
Contingency Coefficient		0.1934	
Cramer's V		0.1394	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 810

Appendix D

One hour survival estimates for juvenile Chinook salmon released at both the center and off-center of a deep pipe through Spillbay 2 at 9 kcfs through the spillbay and 113 kcfs total spill at the Dalles Dam, May-June 2003.

Controls: 750 released, 743 alive, 7 dead. Spillbay 2 center release: 190 released, 187 alive, 3 dead.

Spillbay 2 off-center release: 189 released, 178 alive, 10 dead.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9907 (0.0035) Control group survival
Pa = 1.0 N/A Live recovery probability*
Pd = 0.9524 (0.0465) Dead recovery probability
S2 = 0.9842 (0.0090) Spillbay 2, center-deep, 9/113 survival
S3 = 0.9418 (0.0170) Spillbay 2, off-center-deep, 9/113 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -101.0840

Tau = 0.9935 (0.0098) Spillbay 2, center-deep, 9/113 /Control ratio

Tau = 0.9507 (0.0175) Spillbay 2, off-center-deep, 9/113 /Control ratio

Z statistic for the equality of equal turbine survivals: 2.1336

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001233	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00215959	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00008179	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00029002

Confidence intervals:

	Spillbay 2, center-deep, 9/113 Tau	Spillbay 2, off-center-deep, 9/113 Tau
90 percent:	(0.9774, 1.0096)	(0.9219, 0.9795)
95 percent:	(0.9743, 1.0127)	(0.9163, 0.9850)
99 percent:	(0.9683, 1.0187)	(0.9056, 0.9958)

Appendix D

One hour survival estimates for juvenile Chinook salmon released at both the center and off-center of a deep pipe through Spillbay 2 at 9 kcfs through the spillbay and 113 kcfs total spill at the Dalles Dam, May-June 2003.

Controls: 750 released, 743 alive, 7 dead. Spillbay 2 center release: 190 released, 187 alive, 3 dead.

Spillbay 2 off-center release: 189 released, 178 alive, 10 dead.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9907 (0.0035) Control group survival
Pa = Pd 0.9991 (0.0009) Recovery probability
S2 = 0.9842 (0.0090) Spillbay 2, center-deep, 9/113 survival
S3 = 0.9468 (0.0164) Spillbay 2, off-center-deep, 9/113 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -102.2042

Tau = 0.9935 (0.0098) Spillbay 2, center-deep, 9/113 /Control ratio

Tau = 0.9557 (0.0169) Spillbay 2, off-center-deep, 9/113 /Control ratio

Z statistic for the equality of equal turbine survivals: 1.9363

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001233	0.00000000	0.00000000	0.00000000
0.00000000	0.00000078	0.00000000	0.00000000
0.00000000	0.00000000	0.00008179	0.00000000
0.00000000	0.00000000	0.00000000	0.00026788

Confidence intervals:

Spillbay 2, center-deep, 9/113	Tau	Spillbay 2, off-center-deep, 9/113	Tau
90 percent:	(0.9774, 1.0096)	(0.9280, 0.9835)	
95 percent:	(0.9743, 1.0127)	(0.9227, 0.9888)	
99 percent:	(0.9683, 1.0187)	(0.9123, 0.9992)	

Likelihood ratio statistic for equality of recovery probabilities: 2.2404

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Forty-eight hour survival estimates for juvenile Chinook salmon released at both the center and off-center of a deep pipe through Spillbay 2 at 9 kcfs through the spillbay and 113 kcfs total spill at the Dalles Dam, May-June 2003. Controls: 750 released, 741 alive, 9 dead. Spillbay 2 center release: 190 released, 183 alive, 7 dead. Spillbay 2 off-center release: 189 released, 173 alive, 15 dead.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9880 (0.0040) Control group survival
Pa = 1.0 N/A Live recovery probability*
Pd = 0.9688 (0.0308) Dead recovery probability
S2 = 0.9632 (0.0137) Spillbay 2, center-deep, 9/113 survival
S3 = 0.9153 (0.0202) Spillbay 2, off-center-deep, 9/113 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -137.9879

Tau = 0.9749 (0.0144) Spillbay 2, center-deep, 9/113 /Control ratio
Tau = 0.9265 (0.0208) Spillbay 2, off-center-deep, 9/113 /Control ratio

Z statistic for the equality of equal turbine survivals: 1.9120

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001581	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00094605	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00018676	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00041000

Confidence intervals:

	Spillbay 2, center-deep, 9/113 Tau	Spillbay 2, off-center-deep, 9/113 Tau
90 percent:	(0.9512, 0.9985)	(0.8922, 0.9607)
95 percent:	(0.9467, 1.0030)	(0.8856, 0.9673)
99 percent:	(0.9378, 1.0119)	(0.8728, 0.9801)

Appendix D

Forty-eight hour survival estimates for juvenile Chinook salmon released at both the center and off-center of a deep pipe through Spillbay 2 at 9 kcfs through the spillbay and 113 kcfs total spill at the Dalles Dam, May-June 2003. Controls: 750 released, 741 alive, 9 dead. Spillbay 2 center release: 190 released, 183 alive, 7 dead. Spillbay 2 off-center release: 189 released, 173 alive, 15 dead.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9880 (0.0040) Control group survival
Pa = Pd 0.9991 (0.0009) Recovery probability
S2 = 0.9632 (0.0137) Spillbay 2, center-deep, 9/113 survival
S3 = 0.9202 (0.0198) Spillbay 2, off-center-deep, 9/113 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -139.0682

Tau = 0.9749 (0.0144) Spillbay 2, center-deep, 9/113 /Control ratio
Tau = 0.9314 (0.0204) Spillbay 2, off-center-deep, 9/113 /Control ratio

Z statistic for the equality of equal turbine survivals: 1.7445

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001581	0.00000000	0.00000000	0.00000000
0.00000000	0.00000078	0.00000000	0.00000000
0.00000000	0.00000000	0.00018676	0.00000000
0.00000000	0.00000000	0.00000000	0.00039054

Confidence intervals:

Spillbay 2, center-deep, 9/113 Tau	Spillbay 2, off-center-deep, 9/113 Tau
90 percent: (0.9512, 0.9985)	(0.8979, 0.9649)
95 percent: (0.9467, 1.0030)	(0.8915, 0.9713)
99 percent: (0.9378, 1.0119)	(0.8790, 0.9838)

Likelihood ratio statistic for equality of recovery probabilities: 2.1605

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

One hour survival estimates for juvenile Chinook salmon released at the center of a deep pipe through Spillbays 2 and 4 at 9 kcfs through the spillbay and 113 kcfs total spill at the Dalles Dam, May-June 2003.

Controls: 750 released, 743 alive, 7 dead. Spillbay 2 test release: 190 released, 187 alive, 3 dead.

Spillbay 4 test release: 241 released, 232 alive, 9 dead.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9907 (+NAN) Control group survival
Pa = 1.0 N/A Live recovery probability*
Pd = 1.0 N/A Dead recovery probability*
S2 = 0.9842 (0.0090) Spillbay 2, center-deep, 9/113 survival
S3 = 0.9627 (0.0122) Spillbay 4, center-deep, 9/113 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -93.5259

Tau = 0.9935 (+NAN) Spillbay 2, center-deep, 9/113 /Control ratio

Tau = 0.9717 (0.0084) Spillbay 4, center-deep, 9/113 /Control ratio

Z statistic for the equality of equal turbine survivals: +NAN

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

-0.00008549	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00008179	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00014917

Confidence intervals:

	Spillbay 2, center-deep, 9/113 Tau	Spillbay 4, center-deep, 9/113 Tau
90 percent:	(+NAN, +NAN)	(0.9580, 0.9855)
95 percent:	(+NAN, +NAN)	(0.9554, 0.9881)
99 percent:	(+NAN, +NAN)	(0.9502, 0.9932)

Appendix D

One hour survival estimates for juvenile Chinook salmon released at the center of a deep pipe through Spillbays 2 and 4 at 9 kcfs through the spillbay and 113 kcfs total spill at the Dalles Dam, May-June 2003.

Controls: 750 released, 743 alive, 7 dead. Spillbay 2 test release: 190 released, 187 alive, 3 dead.

Spillbay 4 test release: 241 released, 232 alive, 9 dead.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9907 (0.0035) Control group survival
Pa = Pd 1.0 N/A Recovery probability*
S2 = 0.9842 (0.0090) Spillbay 2, center-deep, 9/113 survival
S3 = 0.9627 (0.0122) Spillbay 4, center-deep, 9/113 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -93.5258

Tau = 0.9935 (0.0098) Spillbay 2, center-deep, 9/113 /Control ratio

Tau = 0.9717 (0.0128) Spillbay 4, center-deep, 9/113 /Control ratio

Z statistic for the equality of equal turbine survivals: 1.3504

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001233	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00008179	0.00000000
0.00000000	0.00000000	0.00000000	0.00014917

Confidence intervals:

Spillbay 2, center-deep, 9/113	Tau	Spillbay 4, center-deep, 9/113	Tau
90 percent:	(0.9774, 1.0096)	(0.9507, 0.9928)	
95 percent:	(0.9743, 1.0127)	(0.9466, 0.9968)	
99 percent:	(0.9683, 1.0187)	(0.9388, 1.0047)	

Likelihood ratio statistic for equality of recovery probabilities: -0.0002

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Forty-eight hour survival estimates for juvenile Chinook salmon released at the center of a deep pipe through Spillbays 2 and 4 at 9 kcfs through the spillbay and 113 kcfs total spill at the Dalles Dam, May-June 2003. Controls: 750 released, 741 alive, 9 dead. Spillbay 2 test release: 190 released, 183 alive, 7 dead. Spillbay 4 test release: 241 released, 230 alive, 11 dead.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9880 (+NAN) Control group survival
Pa = 1.0 N/A Live recovery probability*
Pd = 1.0 N/A Dead recovery probability*
S2 = 0.9632 (0.0137) Spillbay 2, center-deep, 9/113 survival
S3 = 0.9544 (0.0134) Spillbay 4, center-deep, 9/113 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -123.4297

Tau = 0.9749 (0.0074) Spillbay 2, center-deep, 9/113 /Control ratio
Tau = 0.9659 (0.0071) Spillbay 4, center-deep, 9/113 /Control ratio

Z statistic for the equality of equal turbine survivals: 0.8682

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

-0.00014056	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00018676	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00018075

Confidence intervals:

Spillbay 2, center-deep, 9/113	Tau	Spillbay 4, center-deep, 9/113	Tau
90 percent:	(0.9627, 0.9870)	(0.9542, 0.9777)	
95 percent:	(0.9604, 0.9893)	(0.9520, 0.9799)	
99 percent:	(0.9559, 0.9939)	(0.9476, 0.9843)	

Appendix D

Forty-eight hour survival estimates for juvenile Chinook salmon released at the center of a deep pipe through Spillbays and 4 at 9 kcfs through the spillbay and 113 kcfs total spill at the Dalles Dam, May-June 2003. Controls: 750 released, 741 alive, 9 dead. Spillbay 2 test release: 190 released, 183 alive, 7 dead. Spillbay 4 test release: 241 released, 230 alive, 11 dead.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9880 (0.0040) Control group survival
Pa = Pd 1.0 N/A Recovery probability*
S2 = 0.9632 (0.0137) Spillbay 2, center-deep, 9/113 survival
S3 = 0.9544 (0.0134) Spillbay 4, center-deep, 9/113 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -123.4296

Tau = 0.9749 (0.0144) Spillbay 2, center-deep, 9/113 /Control ratio
Tau = 0.9659 (0.0142) Spillbay 4, center-deep, 9/113 /Control ratio

Z statistic for the equality of equal turbine survivals: 0.4416

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001581	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00018676	0.00000000
0.00000000	0.00000000	0.00000000	0.00018075

Confidence intervals:

Spillbay 2, center-deep, 9/113	Tau	Spillbay 4, center-deep, 9/113	Tau
90 percent:	(0.9512, 0.9985)	(0.9427, 0.9892)	
95 percent:	(0.9467, 1.0030)	(0.9382, 0.9937)	
99 percent:	(0.9378, 1.0119)	(0.9295, 1.0024)	

Likelihood ratio statistic for equality of recovery probabilities: -0.0002

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

One hour survival estimates for juvenile Chinook salmon released at the center and off-center of a deep pipe through Spillbay 2 at 12 kcfs through the spillbay and 108 kcfs total spill at the Dalles Dam, May-June 2003.

Controls: 750 released, 743 alive, 7 dead. Spillbay 2 off-center release: 108 released, 106 alive, 2 dead.

Spillbay 2 center release: 110 released, 108 alive, 2 dead.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9907 (+NAN) Control group survival
Pa = 1.0 N/A Live recovery probability*
Pd = 1.0 N/A Dead recovery probability*
S2 = 0.9818 (0.0127) Spillbay 2, center-deep, 12/108 survival
S3 = 0.9815 (0.0130) Spillbay 2, off-center-deep, 12/108 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -59.6422

Tau = 0.9911 (0.0089) Spillbay 2, center-deep, 12/108 /Control ratio

Tau = 0.9907 (0.0093) Spillbay 2, off-center-deep, 12/108 /Control ratio

Z statistic for the equality of equal turbine survivals: 0.0264

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

-0.00008549	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00016228	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00016829

Confidence intervals:

Spillbay 2, center-deep, 12/108 Tau	Spillbay 2, off-center-deep, 12/108 Tau
90 percent: (0.9764, 1.0058)	(0.9755, 1.0060)
95 percent: (0.9736, 1.0086)	(0.9726, 1.0089)
99 percent: (0.9681, 1.0141)	(0.9669, 1.0146)

Appendix D

One hour survival estimates for juvenile Chinook salmon released at the center and off-center of a deep pipe through Spillbay 2 at 12 kcfs through the spillbay and 108 kcfs total spill at the Dalles Dam, May-June 2003.

Controls: 750 released, 743 alive, 7 dead. Spillbay 2 off-center release: 108 released, 106 alive, 2 dead.

Spillbay 2 center release: 110 released, 108 alive, 2 dead.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9907 (0.0035) Control group survival
Pa = Pd 1.0 N/A Recovery probability*
S2 = 0.9818 (0.0127) Spillbay 2, center-deep, 12/108 survival
S3 = 0.9815 (0.0130) Spillbay 2, off-center-deep, 12/108 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -59.6421

Tau = 0.9911 (0.0133) Spillbay 2, center-deep, 12/108 /Control ratio

Tau = 0.9907 (0.0136) Spillbay 2, off-center-deep, 12/108 /Control ratio

Z statistic for the equality of equal turbine survivals: 0.0179

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001233	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00016228	0.00000000
0.00000000	0.00000000	0.00000000	0.00016829

Confidence intervals:

Spillbay 2, center-deep, 12/108 Tau	Spillbay 2, off-center-deep, 12/108 Tau
90 percent: (0.9691, 1.0130)	(0.9684, 1.0130)
95 percent: (0.9649, 1.0172)	(0.9642, 1.0173)
99 percent: (0.9567, 1.0254)	(0.9558, 1.0256)

Likelihood ratio statistic for equality of recovery probabilities: -0.0002

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Forty-eight hour survival estimates for juvenile Chinook salmon released at the center and off-center of a deep pipe through Spillbay 2 at 12 kcfs through the spillbay and 108 kcfs total spill at the Dalles Dam, May-June 2003.

Controls: 750 released, 741 alive, 9 dead. Spillbay 2 off-center release: 108 released, 106 alive, 2 dead.

Spillbay 2 center release: 110 released, 107 alive, 3 dead.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9880 (+NAN) Control group survival
Pa = 1.0 N/A Live recovery probability*
Pd = 1.0 N/A Dead recovery probability*
S2 = 0.9727 (0.0155) Spillbay 2, center-deep, 12/108 survival
S3 = 0.9815 (0.0130) Spillbay 2, off-center-deep, 12/108 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -72.4752

Tau = 0.9845 (0.0104) Spillbay 2, center-deep, 12/108 /Control ratio

Tau = 0.9934 (0.0055) Spillbay 2, off-center-deep, 12/108 /Control ratio

Z statistic for the equality of equal turbine survivals: 0.7549

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

-0.00014056	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00024117	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00016829

Confidence intervals:

Spillbay 2, center-deep, 12/108 Tau	Spillbay 2, off-center-deep, 12/108 Tau
90 percent: (0.9675, 1.0016)	(0.9843, 1.0025)
95 percent: (0.9642, 1.0049)	(0.9826, 1.0042)
99 percent: (0.9578, 1.0112)	(0.9792, 1.0076)

Appendix D

Forty-eight hour survival estimates for juvenile Chinook salmon released at the center and off-center of a deep pipe through Spillbay 2 at 12 kcfs through the spillbay and 108 kcfs total spill at the Dalles Dam, May-June 2003.

Controls: 750 released, 741 alive, 9 dead. Spillbay 2 off-center release: 108 released, 106 alive, 2 dead.

Spillbay 2 center release: 110 released, 107 alive, 3 dead.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9880 (0.0040) Control group survival
Pa = Pd 1.0 N/A Recovery probability*
S2 = 0.9727 (0.0155) Spillbay 2, center-deep, 12/108 survival
S3 = 0.9815 (0.0130) Spillbay 2, off-center-deep, 12/108 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -72.4751

Tau = 0.9845 (0.0162) Spillbay 2, center-deep, 12/108 /Control ratio
Tau = 0.9934 (0.0137) Spillbay 2, off-center-deep, 12/108 /Control ratio

Z statistic for the equality of equal turbine survivals: 0.4172

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001581	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00024117	0.00000000
0.00000000	0.00000000	0.00000000	0.00016829

Confidence intervals:

Spillbay 2, center-deep, 12/108 Tau	Spillbay 2, off-center-deep, 12/108 Tau
90 percent: (0.9579, 1.0112)	(0.9708, 1.0160)
95 percent: (0.9528, 1.0163)	(0.9665, 1.0203)
99 percent: (0.9428, 1.0263)	(0.9581, 1.0287)

Likelihood ratio statistic for equality of recovery probabilities: -0.0002

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

One hour survival estimates for juvenile Chinook salmon released at the center of a deep pipe through Spillbays 2 and 4 at 12 kcfs through the spillbay and 108 kcfs total spill at the Dalles Dam, May-June 2003.
Controls: 750 released, 743 alive, 7 dead. Spillbay 2 test release: 110 released, 108 alive, 2 dead.
Spillbay 4 test release: 160 released, 157 alive, 2 dead.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9907 (0.0035) Control group survival
Pa = 1.0 N/A Live recovery probability*
Pd = 0.9167 (0.0798) Dead recovery probability
S2 = 0.9818 (0.0127) Spillbay 2, center-deep, 12/108 survival
S3 = 0.9813 (0.0107) Spillbay 4, center-deep, 12/108 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -68.0262

Tau = 0.9911 (0.0133) Spillbay 2, center-deep, 12/108 /Control ratio
Tau = 0.9905 (0.0114) Spillbay 4, center-deep, 12/108 /Control ratio

Z statistic for the equality of equal turbine survivals: 0.0327

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001233	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00636574	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00016228	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00011499

Confidence intervals:

	Spillbay 2, center-deep, 12/108	Tau	Spillbay 4, center-deep, 12/108	Tau
90 percent:	(0.9691, 1.0130)		(0.9718, 1.0092)	
95 percent:	(0.9649, 1.0172)		(0.9682, 1.0128)	
99 percent:	(0.9567, 1.0254)		(0.9612, 1.0198)	

Appendix D

One hour survival estimates for juvenile Chinook salmon released at the center of a deep pipe through Spillbays 2 and 4 at 12 kcfs through the spillbay and 108 kcfs total spill at the Dalles Dam, May-June 2003.
Controls: 750 released, 743 alive, 7 dead. Spillbay 2 test release: 110 released, 108 alive, 2 dead.
Spillbay 4 test release: 160 released, 157 alive, 2 dead.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9907 (0.0035) Control group survival
Pa = Pd 0.9990 (0.0010) Recovery probability
S2 = 0.9818 (0.0127) Spillbay 2, center-deep, 12/108 survival
S3 = 0.9874 (0.0088) Spillbay 4, center-deep, 12/108 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -68.3487

Tau = 0.9911 (0.0133) Spillbay 2, center-deep, 12/108 /Control ratio
Tau = 0.9967 (0.0096) Spillbay 4, center-deep, 12/108 /Control ratio

Z statistic for the equality of equal turbine survivals: 0.3444

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001233	0.00000000	0.00000000	0.00000000
0.00000000	0.00000096	0.00000000	0.00000000
0.00000000	0.00000000	0.00016228	0.00000000
0.00000000	0.00000000	0.00000000	0.00007812

Confidence intervals:

Spillbay 2, center-deep, 12/108	Tau	Spillbay 4, center-deep, 12/108	Tau
90 percent:	(0.9691, 1.0130)	(0.9809, 1.0125)	
95 percent:	(0.9649, 1.0172)	(0.9779, 1.0155)	
99 percent:	(0.9567, 1.0254)	(0.9720, 1.0214)	

Likelihood ratio statistic for equality of recovery probabilities: 0.6451

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Forty-eight hour survival estimates for juvenile Chinook salmon released at the center of a deep pipe through Spillbays 2 and 4 at 12 kcfs through the spillbay and 108 kcfs total spill at the Dalles Dam, May-June 2003. Controls: 750 released, 741 alive, 9 dead. Spillbay 2 test release: 110 released, 107 alive, 3 dead. Spillbay 4 test release: 160 released, 157 alive, 2 dead.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9880 (0.0040) Control group survival
Pa = 1.0 N/A Live recovery probability*
Pd = 0.9333 (0.0644) Dead recovery probability
S2 = 0.9727 (0.0155) Spillbay 2, center-deep, 12/108 survival
S3 = 0.9812 (0.0107) Spillbay 4, center-deep, 12/108 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -81.0911

Tau = 0.9845 (0.0162) Spillbay 2, center-deep, 12/108 /Control ratio
Tau = 0.9932 (0.0116) Spillbay 4, center-deep, 12/108 /Control ratio

Z statistic for the equality of equal turbine survivals: 0.4332

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001581	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00414818	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00024117	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00011499

Confidence intervals:

	Spillbay 2, center-deep, 12/108 Tau	Spillbay 4, center-deep, 12/108 Tau
90 percent:	(0.9579, 1.0112)	(0.9741, 1.0122)
95 percent:	(0.9528, 1.0163)	(0.9705, 1.0158)
99 percent:	(0.9428, 1.0263)	(0.9634, 1.0230)

Appendix D

Forty-eight hour survival estimates for juvenile Chinook salmon released at the center of a deep pipe through Spillbays 2 and 4 at 12 kcfs through the spillbay and 108 kcfs total spill at the Dalles Dam, May-June 2003. Controls: 750 released, 741 alive, 9 dead. Spillbay 2 test release: 110 released, 107 alive, 3 dead. Spillbay 4 test release: 160 released, 157 alive, 2 dead.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9880 (0.0040) Control group survival
Pa = Pd 0.9990 (0.0010) Recovery probability
S2 = 0.9727 (0.0155) Spillbay 2, center-deep, 12/108 survival
S3 = 0.9874 (0.0088) Spillbay 4, center-deep, 12/108 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -81.1817

Tau = 0.9845 (0.0162) Spillbay 2, center-deep, 12/108 /Control ratio
Tau = 0.9994 (0.0098) Spillbay 4, center-deep, 12/108 /Control ratio

Z statistic for the equality of equal turbine survivals: 0.7850

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001581	0.00000000	0.00000000	0.00000000
0.00000000	0.00000096	0.00000000	0.00000000
0.00000000	0.00000000	0.00024117	0.00000000
0.00000000	0.00000000	0.00000000	0.00007812

Confidence intervals:

Spillbay 2, center-deep, 12/108 Tau	Spillbay 4, center-deep, 12/108 Tau
90 percent: (0.9579, 1.0112)	(0.9833, 1.0155)
95 percent: (0.9528, 1.0163)	(0.9802, 1.0186)
99 percent: (0.9428, 1.0263)	(0.9742, 1.0247)

Likelihood ratio statistic for equality of recovery probabilities: 0.1812

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

One hour survival estimates for juvenile Chinook salmon released off-center of shallow and deep pipes through Spillbay 2 at 18 kcfs through the spillbay and 102 kcfs total spill at the Dalles Dam, May-June 2003.

Controls: 750 released, 743 alive, 7 dead. Spillbay 2 deep test release: 150 released, 150 alive, 0 dead.

Spillbay 2 shallow test release: 150 released, 146 alive, 3 dead.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

stim. std. err.
S1 = 0.9907 (+NAN) Control group survival
Pa = 1.0 N/A Live recovery probability*
Pd = 0.9091 (0.0867) Dead recovery probability
S2 = 1.0 N/A Spillbay 2, off-center-deep, 18/102 survival*
S3 = 0.9733 (0.0132) Spillbay 2, off-center-shallow, 18/102 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -61.4810

Tau = 1.0094 (+NAN) Spillbay 2, off-center-deep, 18/102 /Control ratio

Tau = 0.9825 (0.0096) Spillbay 2, off-center-shallow, 18/102 /Control ratio

Z statistic for the equality of equal turbine survivals: +NAN

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

-0.00008549	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00751320	0.00000000	0.00000002
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000002	0.00000000	0.00017304

Confidence intervals:

Spillbay 2, off-center-deep, 18/102 Tau Spillbay 2, off-center-shallow, 18/102 Tau

90 percent: (+NAN, +NAN) (0.9667, 0.9983)

95 percent: (+NAN, +NAN) (0.9637, 1.0013)

99 percent: (+NAN, +NAN) (0.9578, 1.0072)

Appendix D

One hour survival estimates for juvenile Chinook salmon released off-center of shallow and deep pipes through Spillbay 2 at 18 kcfs through the spillbay and 102 kcfs total spill at the Dalles Dam, May-June 2003.

Controls: 750 released, 743 alive, 7 dead. Spillbay 2 deep test release: 150 released, 150 alive, 0 dead.

Spillbay 2 shallow test release: 150 released, 146 alive, 3 dead.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9907 (0.0035) Control group survival
Pa = Pd 0.9990 (0.0010) Recovery probability
S2 = 1.0 N/A Spillbay 2, off-center-deep, 18/102 survival*
S3 = 0.9799 (0.0115) Spillbay 2, off-center-shallow, 18/102 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -62.3280

Tau = 1.0094 (0.0036) Spillbay 2, off-center-deep, 18/102 /Control ratio

Tau = 0.9891 (0.0121) Spillbay 2, off-center-shallow, 18/102 /Control ratio

Z statistic for the equality of equal turbine survivals: 1.6067

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001233	0.00000000	0.00000000	0.00000000
0.00000000	0.00000091	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00013241

Confidence intervals:

Spillbay 2, off-center-deep, 18/102 Tau	Spillbay 2, off-center-shallow, 18/102 Tau
90 percent: (1.0035, 1.0153)	(0.9691, 1.0091)
95 percent: (1.0024, 1.0164)	(0.9653, 1.0129)
99 percent: (1.0002, 1.0186)	(0.9579, 1.0203)

Likelihood ratio statistic for equality of recovery probabilities: 1.6941

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Forty-eight hour survival estimates for juvenile Chinook salmon released off-center of deep and shallow pipes through Spillbay 2 at 18 kcfs through the spillbay and 102 kcfs total spill at the Dalles Dam, May-June 2003. Controls: 750 released, 741 alive, 9 dead. Spillbay 2 deep test release: 150 released, 147 alive, 3 dead. Spillbay 2 shallow test release: 150 released, 144 alive, 5 dead.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9880 (0.0040) Control group survival
Pa = 1.0 N/A Live recovery probability*
Pd = 0.9444 (0.0540) Dead recovery probability
S2 = 0.9800 (0.0114) Spillbay 2,off-center-deep, 18/102 survival
S3 = 0.9600 (0.0160) Spillbay 2,off-center-shallow, 18/102 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -92.5110

Tau = 0.9919 (0.0122) Spillbay 2,off-center-deep, 18/102 /Control ratio
Tau = 0.9717 (0.0167) Spillbay 2,off-center-shallow, 18/102 /Control ratio

Z statistic for the equality of equal turbine survivals: 0.9792

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001581	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00291495	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00013067	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00025600

Confidence intervals:

	Spillbay 2,off-center-deep, 18/102 Tau	Spillbay 2,off-center-shallow, 18/102 Tau
90 percent:	(0.9718, 1.0120)	(0.9443, 0.9991)
95 percent:	(0.9679, 1.0159)	(0.9390, 1.0043)
99 percent:	(0.9604, 1.0234)	(0.9288, 1.0146)

Appendix D

Forty-eight hour survival estimates for juvenile Chinook salmon released off-center of deep and shallow pipes through Spillbay 2 at 18 kcfs through the spillbay and 102 kcfs total spill at the Dalles Dam, May-June 2003. Controls: 750 released, 741 alive, 9 dead. Spillbay 2 deep test release: 150 released, 147 alive, 3 dead. Spillbay 2 shallow test release: 150 released, 144 alive, 5 dead.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9880 (0.0040) Control group survival
Pa = Pd 0.9990 (0.0010) Recovery probability
S2 = 0.9800 (0.0114) Spillbay 2,off-center-deep, 18/102 survival
S3 = 0.9664 (0.0148) Spillbay 2,off-center-shallow, 18/102 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -93.3011

Tau = 0.9919 (0.0122) Spillbay 2,off-center-deep, 18/102 /Control ratio
Tau = 0.9782 (0.0154) Spillbay 2,off-center-shallow, 18/102 /Control ratio

Z statistic for the equality of equal turbine survivals: 0.6964

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001581	0.00000000	0.00000000	0.00000000
0.00000000	0.00000091	0.00000000	0.00000000
0.00000000	0.00000000	0.00013067	0.00000000
0.00000000	0.00000000	0.00000000	0.00021766

Confidence intervals:

Spillbay 2,off-center-deep, 18/102 Tau	Spillbay 2,off-center-shallow, 18/102 Tau
90 percent: (0.9718, 1.0120)	(0.9528, 1.0036)
95 percent: (0.9679, 1.0159)	(0.9479, 1.0084)
99 percent: (0.9604, 1.0234)	(0.9384, 1.0179)

Likelihood ratio statistic for equality of recovery probabilities: 1.5802

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

One hour survival estimates for juvenile Chinook salmon released at the center of a deep pipe through Spillbays 2 and 4 at 18 kcfs through the spillbay and 102 kcfs total spill at the Dalles Dam, May-June 2003.

Controls: 750 released, 743 alive, 7 dead. Spillbay 2 test release: 149 released, 149 alive, 0 dead.

Spillbay 4 test release: 200 released, 197 alive, 3 dead.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9907 (+NAN) Control group survival
Pa = 1.0 N/A Live recovery probability*
Pd = 1.0 N/A Dead recovery probability*
S2 = 1.0 N/A Spillbay 2, center-deep, 18/102 survival*
S3 = 0.9850 (0.0086) Spillbay 4, center-deep, 18/102 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -55.2630

Tau = 1.0094 (+NAN) Spillbay 2, center-deep, 18/102 /Control ratio

Tau = 0.9943 (+NAN) Spillbay 4, center-deep, 18/102 /Control ratio

Z statistic for the equality of equal turbine survivals: +NAN

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

-0.00008549	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00007388

Confidence intervals:

Spillbay 2, center-deep, 18/102 Tau	Spillbay 4, center-deep, 18/102 Tau
90 percent: (+NAN, +NAN)	(+NAN, +NAN)
95 percent: (+NAN, +NAN)	(+NAN, +NAN)
99 percent: (+NAN, +NAN)	(+NAN, +NAN)

Appendix D

One hour survival estimates for juvenile Chinook salmon released at the center of a deep pipe through Spillbays 2 and 4 at 18 kcfs through the spillbay and 102 kcfs total spill at the Dalles Dam, May-June 2003.

Controls: 750 released, 743 alive, 7 dead. Spillbay 2 test release: 149 released, 149 alive, 0 dead.

Spillbay 4 test release: 200 released, 197 alive, 3 dead.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9907 (0.0035) Control group survival
Pa = Pd 1.0 N/A Recovery probability*
S2 = 1.0 N/A Spillbay 2, center-deep, 18/102 survival*
S3 = 0.9850 (0.0086) Spillbay 4, center-deep, 18/102 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -55.2629

Tau = 1.0094 (0.0036) Spillbay 2, center-deep, 18/102 /Control ratio

Tau = 0.9943 (0.0094) Spillbay 4, center-deep, 18/102 /Control ratio

Z statistic for the equality of equal turbine survivals: 1.5098

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001234	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00007385

Confidence intervals:

Spillbay 2, center-deep, 18/102 Tau	Spillbay 4, center-deep, 18/102 Tau
90 percent: (1.0035, 1.0153)	(0.9789, 1.0097)
95 percent: (1.0024, 1.0164)	(0.9759, 1.0126)
99 percent: (1.0002, 1.0186)	(0.9702, 1.0184)

Likelihood ratio statistic for equality of recovery probabilities: -0.0001

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10:	2.706
For significance level 0.05:	3.841
For significance level 0.01:	6.635

Appendix D

Forty-eight hour survival estimates for juvenile Chinook salmon released at the center of a deep pipe through Spillbays 2 and 4 at 18 kcfs through the spillbay and 102 kcfs total spill at the Dalles Dam, May-June 2003. Controls: 750 released, 741 alive, 9 dead. Spillbay 2 test release: 149 released, 149 alive, 0 dead. Spillbay 4 test release: 200 released, 197 alive, 3 dead.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9880 (+NAN) Control group survival
Pa = 1.0 N/A Live recovery probability*
Pd = 1.0 N/A Dead recovery probability*
S2 = 1.0 N/A Spillbay 2, center-deep, 18/102 survival*
S3 = 0.9850 (0.0086) Spillbay 4, center-deep, 18/102 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -64.3280

Tau = 1.0121 (+NAN) Spillbay 2, center-deep, 18/102 /Control ratio
Tau = 0.9970 (+NAN) Spillbay 4, center-deep, 18/102 /Control ratio

Z statistic for the equality of equal turbine survivals: +NAN

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

-0.00014056	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00007388

Confidence intervals:

Spillbay 2, center-deep, 18/102 Tau	Spillbay 4, center-deep, 18/102 Tau
90 percent: (+NAN, +NAN)	(+NAN, +NAN)
95 percent: (+NAN, +NAN)	(+NAN, +NAN)
99 percent: (+NAN, +NAN)	(+NAN, +NAN)

Appendix D

Forty-eight hour survival estimates for juvenile Chinook salmon released at the center of a deep pipe through Spillbays 2 and 4 at 18 kcfs through the spillbay and 102 kcfs total spill at the Dalles Dam, May-June 2003. Controls: 750 released, 741 alive, 9 dead. Spillbay 2 test release: 149 released, 149 alive, 0 dead. Spillbay 4 test release: 200 released, 197 alive, 3 dead.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9880 (0.0040) Control group survival
Pa = Pd 1.0 N/A Recovery probability*
S2 = 1.0 N/A Spillbay 2, center-deep, 18/102 survival*
S3 = 0.9850 (0.0086) Spillbay 4, center-deep, 18/102 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -64.3280

Tau = 1.0121 (0.0041) Spillbay 2, center-deep, 18/102 /Control ratio
Tau = 0.9970 (0.0096) Spillbay 4, center-deep, 18/102 /Control ratio

Z statistic for the equality of equal turbine survivals: 1.4589

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001581	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00007392

Confidence intervals:

Spillbay 2, center-deep, 18/102 Tau	Spillbay 4, center-deep, 18/102 Tau
90 percent: (1.0054, 1.0188)	(0.9812, 1.0127)
95 percent: (1.0042, 1.0201)	(0.9782, 1.0157)
99 percent: (1.0017, 1.0226)	(0.9723, 1.0216)

Likelihood ratio statistic for equality of recovery probabilities: -0.0001

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

One hour survival estimates for juvenile Chinook salmon released at the center of a shallow pipe through Spillbays 2 and 4 at 18 kcfs through the spillbay and 102 kcfs total spill at the Dalles Dam, May-June 2003.

Controls: 750 released, 743 alive, 7 dead. Spillbay 2 test release: 149 released, 147 alive, 2 dead.

Spillbay 4 test release: 209 released, 203 alive, 6 dead.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9907 (+NAN) Control group survival
Pa = 1.0 N/A Live recovery probability*
Pd = 1.0 N/A Dead recovery probability*
S2 = 0.9866 (0.0094) Spillbay 2, center-shallow,18/102 survival
S3 = 0.9713 (0.0116) Spillbay 4, center-shallow,18/102 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -77.5111

Tau = 0.9959 (0.0020) Spillbay 2, center-shallow,18/102 /Control ratio

Tau = 0.9804 (0.0072) Spillbay 4, center-shallow,18/102 /Control ratio

Z statistic for the equality of equal turbine survivals: 2.0550

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

-0.00008549	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00008888	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00013342

Confidence intervals:

Spillbay 2, center-shallow,18/102 Tau	Spillbay 4, center-shallow,18/102 Tau
90 percent: (0.9925, 0.9992)	(0.9686, 0.9923)
95 percent: (0.9919, 0.9999)	(0.9663, 0.9946)
99 percent: (0.9906, 1.0011)	(0.9618, 0.9990)

Appendix D

One hour survival estimates for juvenile Chinook salmon released at the center of a shallow pipe through Spillbays 2 and 4 at 18 kcfs through the spillbay and 102 kcfs total spill at the Dalles Dam, May-June 2003.

Controls: 750 released, 743 alive, 7 dead. Spillbay 2 test release: 149 released, 147 alive, 2 dead.

Spillbay 4 test release: 209 released, 203 alive, 6 dead.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9907 (0.0035) Control group survival
Pa = Pd 1.0 N/A Recovery probability*
S2 = 0.9866 (0.0094) Spillbay 2, center-shallow,18/102 survival
S3 = 0.9713 (0.0116) Spillbay 4, center-shallow,18/102 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -77.5110

Tau = 0.9959 (0.0101) Spillbay 2, center-shallow,18/102 /Control ratio

Tau = 0.9804 (0.0122) Spillbay 4, center-shallow,18/102 /Control ratio

Z statistic for the equality of equal turbine survivals: 0.9738

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001233	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00008888	0.00000000
0.00000000	0.00000000	0.00000000	0.00013342

Confidence intervals:

Spillbay 2, center-shallow,18/102	Tau	Spillbay 4, center-shallow,18/102	Tau
90 percent:	(0.9792, 1.0126)	(0.9604, 1.0005)	
95 percent:	(0.9760, 1.0158)	(0.9566, 1.0043)	
99 percent:	(0.9697, 1.0220)	(0.9491, 1.0118)	

Likelihood ratio statistic for equality of recovery probabilities: -0.0002

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Forty-eight hour survival estimates for juvenile Chinook salmon released at the center of a shallow pipe through Spillbays 2 and 4 at 18 kcfs through the spillbay and 102 kcfs total spill at the Dalles Dam, May-June 2003. Controls: 750 released, 741 alive, 9 dead. Spillbay 2 test release: 149 released, 146 alive, 3 dead. Spillbay 4 test release: 209 released, 201 alive, 8 dead.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9880 (+NAN) Control group survival
Pa = 1.0 N/A Live recovery probability*
Pd = 1.0 N/A Dead recovery probability*
S2 = 0.9799 (0.0115) Spillbay 2, 18/102 survival
S3 = 0.9617 (0.0133) Spillbay 4, 18/102 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -97.3852

Tau = 0.9918 (+NAN) Spillbay 2, 18/102 /Control ratio
Tau = 0.9734 (0.0066) Spillbay 4, 18/102 /Control ratio

Z statistic for the equality of equal turbine survivals: +NAN

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

-0.00014056	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00013241	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00017614

Confidence intervals:

	Spillbay 2, 18/102 Tau	Spillbay 4, 18/102 Tau
90 percent:	(+NAN, +NAN)	(0.9625, 0.9843)
95 percent:	(+NAN, +NAN)	(0.9604, 0.9864)
99 percent:	(+NAN, +NAN)	(0.9563, 0.9905)

Appendix D

Forty-eight hour survival estimates for juvenile Chinook salmon released at the center of a shallow pipe through Spillbays 2 and 4 at 18 kcfs through the spillbay and 102 kcfs total spill at the Dalles Dam, May-June 2003. Controls: 750 released, 741 alive, 9 dead. Spillbay 2 test release: 149 released, 146 alive, 3 dead. Spillbay 4 test release: 209 released, 201 alive, 8 dead.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9880 (0.0040) Control group survival
Pa = Pd 1.0 N/A Recovery probability*
S2 = 0.9799 (0.0115) Spillbay 2, 18/102 survival
S3 = 0.9617 (0.0133) Spillbay 4, 18/102 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -97.3851

Tau = 0.9918 (0.0123) Spillbay 2, 18/102 /Control ratio
Tau = 0.9734 (0.0140) Spillbay 4, 18/102 /Control ratio

Z statistic for the equality of equal turbine survivals: 0.9853

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001581	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00013241	0.00000000
0.00000000	0.00000000	0.00000000	0.00017614

Confidence intervals:

Spillbay 2, 18/102 Tau	Spillbay 4, 18/102 Tau
90 percent: (0.9715, 1.0120)	(0.9504, 0.9964)
95 percent: (0.9676, 1.0159)	(0.9460, 1.0008)
99 percent: (0.9601, 1.0235)	(0.9374, 1.0094)

Likelihood ratio statistic for equality of recovery probabilities: -0.0002

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10:	2.706
For significance level 0.05:	3.841
For significance level 0.01:	6.635

Appendix D

One hour survival estimates for juvenile Chinook salmon released at the center of shallow and deep pipes through Spillbay 2 at 21 kcfs through the spillbay and 98.5 kcfs total spill at the Dalles Dam, May-June 2003.
Controls: 750 released, 743 alive, 7 dead. Spillbay 2 deep test release: 100 released, 97 alive, 3 dead.
Spillbay 2 shallow test release: 100 released, 97 alive, 1 dead.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9907 (0.0035) Control group survival
Pa = 1.0 N/A Live recovery probability*
Pd = 0.8462 (0.1001) Dead recovery probability
S2 = 0.9700 (0.0171) Spillbay 2, center-deep, 21/98.5 survival
S3 = 0.9700 (0.0171) Spillbay 2, center-shallow, 21/98.5 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -72.2160

Tau = 0.9791 (0.0176) Spillbay 2, center-deep, 21/98.5 /Control ratio
Tau = 0.9791 (0.0176) Spillbay 2, center-shallow, 21/98.5 /Control ratio

Z statistic for the equality of equal turbine survivals: 0.0000

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001233	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.01001365	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00029100	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00029100

Confidence intervals:

Spillbay 2, center-deep, 21/98.5	Tau	Spillbay 2, center-shallow, 21/98.5	Tau
90 percent:	(0.9502, 1.0080)	(0.9502, 1.0080)	
95 percent:	(0.9447, 1.0136)	(0.9447, 1.0136)	
99 percent:	(0.9339, 1.0244)	(0.9339, 1.0244)	

Appendix D

One hour survival estimates for juvenile Chinook salmon released at the center of shallow and deep pipes through Spillbay 2 at 21 kcfs through the spillbay and 98.5 kcfs total spill at the Dalles Dam, May-June 2003.
Controls: 750 released, 743 alive, 7 dead. Spillbay 2 deep test release: 100 released, 97 alive, 3 dead.
Spillbay 2 shallow test release: 100 released, 97 alive, 1 dead.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9907 (0.0035) Control group survival
Pa = Pd 0.9979 (0.0015) Recovery probability
S2 = 0.9700 (0.0171) Spillbay 2, center-deep, 21/98.5 survival
S3 = 0.9898 (0.0102) Spillbay 2, center-shallow, 21/98.5 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -73.0650

Tau = 0.9791 (0.0176) Spillbay 2, center-deep, 21/98.5 /Control ratio
Tau = 0.9991 (0.0108) Spillbay 2, center-shallow, 21/98.5 /Control ratio

Z statistic for the equality of equal turbine survivals: 0.9680

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001233	0.00000000	0.00000000	0.00000000
0.00000000	0.00000221	0.00000000	0.00000000
0.00000000	0.00000000	0.00029100	0.00000000
0.00000000	0.00000000	0.00000000	0.00010306

Confidence intervals:

Spillbay 2, center-deep, 21/98.5 Tau	Spillbay 2, center-shallow, 21/98.5 Tau
90 percent: (0.9502, 1.0080)	(0.9813, 1.0170)
95 percent: (0.9447, 1.0136)	(0.9779, 1.0204)
99 percent: (0.9339, 1.0244)	(0.9712, 1.0270)

Likelihood ratio statistic for equality of recovery probabilities: 1.6979

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Forty-eight hour survival estimates for juvenile Chinook salmon released at the center of deep and shallow pipes through Spillbay 2 at 21 kcfs through the spillbay and 98.5 kcfs total spill at the Dalles Dam, May-June 2003. Controls: 750 released, 741 alive, 9 dead. Spillbay 2 deep test release: 100 released, 97 alive, 3 dead. Spillbay 2 shallow test release: 100 released, 94 alive, 4 dead.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9880 (0.0040) Control group survival
Pa = 1.0 N/A Live recovery probability*
Pd = 0.8889 (0.0741) Dead recovery probability
S2 = 0.9700 (0.0171) Spillbay 2, center-deep, 21/98.5 survival
S3 = 0.9400 (0.0237) Spillbay 2, center-shallow, 21/98.5 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -91.2014

Tau = 0.9818 (0.0177) Spillbay 2, center-deep, 21/98.5 /Control ratio
Tau = 0.9514 (0.0243) Spillbay 2, center-shallow, 21/98.5 /Control ratio

Z statistic for the equality of equal turbine survivals: 1.0087

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001581	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00548697	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00029100	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00056400

Confidence intervals:

Spillbay 2, center-deep, 21/98.5 Tau	Spillbay 2, center-shallow, 21/98.5 Tau
90 percent: (0.9526, 1.0109)	(0.9114, 0.9915)
95 percent: (0.9471, 1.0165)	(0.9037, 0.9991)
99 percent: (0.9362, 1.0274)	(0.8887, 1.0141)

Appendix D

Forty-eight hour survival estimates for juvenile Chinook salmon released at the center of deep and shallow pipes through Spillbay 2 at 21 kcfs through the spillbay and 98.5 kcfs total spill at the Dalles Dam, May-June 2003. Controls: 750 released, 741 alive, 9 dead. Spillbay 2 deep test release: 100 released, 97 alive, 3 dead. Spillbay 2 shallow test release: 100 released, 94 alive, 4 dead.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9880 (0.0040) Control group survival
Pa = Pd 0.9979 (0.0015) Recovery probability
S2 = 0.9700 (0.0171) Spillbay 2, center-deep, 21/98.5 survival
S3 = 0.9592 (0.0200) Spillbay 2, center-shallow, 21/98.5 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -93.2621

Tau = 0.9818 (0.0177) Spillbay 2, center-deep, 21/98.5 /Control ratio
Tau = 0.9708 (0.0206) Spillbay 2, center-shallow, 21/98.5 /Control ratio

Z statistic for the equality of equal turbine survivals: 0.4029

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001581	0.00000000	0.00000000	0.00000000
0.00000000	0.00000221	0.00000000	0.00000000
0.00000000	0.00000000	0.00029100	0.00000000
0.00000000	0.00000000	0.00000000	0.00039949

Confidence intervals:

Spillbay 2, center-deep, 21/98.5 Tau	Spillbay 2, center-shallow, 21/98.5 Tau
90 percent: (0.9526, 1.0109)	(0.9369, 1.0047)
95 percent: (0.9471, 1.0165)	(0.9305, 1.0112)
99 percent: (0.9362, 1.0274)	(0.9178, 1.0239)

Likelihood ratio statistic for equality of recovery probabilities: 4.1214

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

One hour survival estimates for juvenile Chinook salmon released off-center of shallow and deep pipes through Spillbay 2 at 21 kcfs through the spillbay and 98.5 kcfs total spill at the Dalles Dam, May-June 2003.
Controls: 750 released, 743 alive, 7 dead. Spillbay 2 deep test release: 100 released, 95 alive, 5 dead.
Spillbay 2 shallow test release: 100 released, 98 alive, 2 dead.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9907 (+NAN) Control group survival
Pa = 1.0 N/A Live recovery probability*
Pd = 1.0 N/A Dead recovery probability*
S2 = 0.9500 (0.0218) Spillbay 2, off-center-deep, 21/98.5 survival
S3 = 0.9800 (0.0140) Spillbay 2, off-center-shallow, 21/98.5 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -69.3419

Tau = 0.9590 (0.0201) Spillbay 2, off-center-deep, 21/98.5 /Control ratio
Tau = 0.9892 (0.0107) Spillbay 2, off-center-shallow, 21/98.5 /Control ratio

Z statistic for the equality of equal turbine survivals: 1.3301

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

-0.00008549	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00047500	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00019600

Confidence intervals:

	Spillbay 2, off-center-deep, 21/98.5 Tau	Spillbay 2, off-center-shallow, 21/98.5 Tau
90 percent:	(0.9259, 0.9920)	(0.9716, 1.0068)
95 percent:	(0.9196, 0.9983)	(0.9683, 1.0102)
99 percent:	(0.9072, 1.0107)	(0.9617, 1.0168)

Appendix D

One hour survival estimates for juvenile Chinook salmon released off-center of shallow and deep pipes through Spillbay 2 at 21 kcfs through the spillbay and 98.5 kcfs total spill at the Dalles Dam, May-June 2003.
Controls: 750 released, 743 alive, 7 dead. Spillbay 2 deep test release: 100 released, 95 alive, 5 dead.
Spillbay 2 shallow test release: 100 released, 98 alive, 2 dead.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9907 (0.0035) Control group survival
Pa = Pd 1.0 N/A Recovery probability*
S2 = 0.9500 (0.0218) Spillbay 2, off-center-deep, 21/98.5 survival
S3 = 0.9800 (0.0140) Spillbay 2, off-center-shallow, 21/98.5 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -69.3418

Tau = 0.9590 (0.0223) Spillbay 2, off-center-deep, 21/98.5 /Control ratio
Tau = 0.9892 (0.0146) Spillbay 2, off-center-shallow, 21/98.5 /Control ratio

Z statistic for the equality of equal turbine survivals: 1.1385

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001233	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00047500	0.00000000
0.00000000	0.00000000	0.00000000	0.00019600

Confidence intervals:

Spillbay 2, off-center-deep, 21/98.5	Tau	Spillbay 2, off-center-shallow, 21/98.5	Tau
90 percent:	(0.9223, 0.9956)		(0.9653, 1.0132)
95 percent:	(0.9153, 1.0026)		(0.9607, 1.0178)
99 percent:	(0.9016, 1.0163)		(0.9517, 1.0267)

Likelihood ratio statistic for equality of recovery probabilities: -0.0002

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Forty-eight hour survival estimates for juvenile Chinook salmon released off-center of deep and shallow pipes through Spillbay 2 at 21 kcfs through the spillbay and 98.5 kcfs total spill at the Dalles Dam, May-June 2003. Controls: 750 released, 741 alive, 9 dead. Spillbay 2 deep test release: 100 released, 92 alive, 8 dead. Spillbay 2 shallow test release: 100 released, 97 alive, 3 dead.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9880 (+NAN) Control group survival
Pa = 1.0 N/A Live recovery probability*
Pd = 1.0 N/A Dead recovery probability*
S2 = 0.9200 (0.0271) Spillbay 2, off-center-deep, 21/98.5 survival
S3 = 0.9700 (0.0171) Spillbay 2, off-center-shallow, 21/98.5 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -90.1027

Tau = 0.9312 (0.0251) Spillbay 2, off-center-deep, 21/98.5 /Control ratio
Tau = 0.9818 (0.0126) Spillbay 2, off-center-shallow, 21/98.5 /Control ratio

Z statistic for the equality of equal turbine survivals: 1.8023

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

-0.00014056	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00073600	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00029100

Confidence intervals:

	Spillbay 2, off-center-deep, 21/98.5 Tau	Spillbay 2, off-center-shallow, 21/98.5 Tau
90 percent:	(0.8899, 0.9724)	(0.9610, 1.0025)
95 percent:	(0.8820, 0.9803)	(0.9570, 1.0065)
99 percent:	(0.8666, 0.9958)	(0.9493, 1.0143)

Appendix D

Forty-eight hour survival estimates for juvenile Chinook salmon released off-center of deep and shallow pipes through Spillbay 2 at 21 kcfs through the spillbay and 98.5 kcfs total spill at the Dalles Dam, May-June 2003. Controls: 750 released, 741 alive, 9 dead. Spillbay 2 deep test release: 100 released, 92 alive, 8 dead. Spillbay 2 shallow test release: 100 released, 97 alive, 3 dead.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std. err.
S1 = 0.9880 (0.0040) Control group survival
Pa = Pd 1.0 N/A Recovery probability*
S2 = 0.9200 (0.0271) Spillbay 2, off-center-deep, 21/98.5 survival
S3 = 0.9700 (0.0171) Spillbay 2, off-center-shallow, 21/98.5 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -90.1026

Tau = 0.9312 (0.0277) Spillbay 2, off-center-deep, 21/98.5 /Control ratio
Tau = 0.9818 (0.0177) Spillbay 2, off-center-shallow, 21/98.5 /Control ratio

Z statistic for the equality of equal turbine survivals: 1.5387

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001581	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00073600	0.00000000
0.00000000	0.00000000	0.00000000	0.00029100

Confidence intervals:

Spillbay 2, off-center-deep, 21/98.5	Tau	Spillbay 2, off-center-shallow, 21/98.5	Tau
90 percent: (0.8856, 0.9768)		(0.9526, 1.0109)	
95 percent: (0.8769, 0.9855)		(0.9471, 1.0165)	
99 percent: (0.8598, 1.0025)		(0.9362, 1.0274)	

Likelihood ratio statistic for equality of recovery probabilities: -0.0002

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Clean fish rates for juvenile Chinook salmon released mid-bay and off-center through deep pipes at Spillbay 2 at 9 kcfs through the spillbay and 113 kcfs total spill at the Dalles Dam, May-June, 2003. Controls: 744 examined, 743 without maladies (clean), 1 with maladies. Spillbay 2 mid-bay release: 188 examined, 182 without maladies (clean), 6 with maladies. Spillbay 2 off-center release: 181 examined, 166 without maladies (clean), 15 with maladies. (Values from Table 3-9.)

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9987 (0.0013) Control group without maladies (clean)
Pa = Pd 1.0 N/A Recovery probability*
S2 = 0.9681 (0.0128) Spillbay 2, mid-bay deep, 9/113 kcfs without maladies (clean)
S3 = 0.9171 (0.0205) Spillbay 2, off-center deep, 9/113 kcfs without maladies (clean)

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -85.8999

Tau = 0.9694 (0.0129) Spillbay 2, mid-bay deep, 9/113 kcfs/Control ratio
Tau = 0.9184 (0.0206) Spillbay 2, off-center deep, 9/113 kcfs/Control ratio

Z statistic for the equality of equal rates without maladies (clean): 2.1024

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00000180	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00016434	0.00000000
0.00000000	0.00000000	0.00000000	0.00041992

Confidence intervals:

Spillbay 2, mid-bay deep, 9/113 kcfs Tau	Spillbay 2, off-center deep, 9/113 kcfs Tau
90 percent: (0.9482, 0.9906)	(0.8845, 0.9522)
95 percent: (0.9441, 0.9947)	(0.8781, 0.9587)
99 percent: (0.9362, 1.0026)	(0.8654, 0.9713)

Likelihood ratio statistic for equality of recovery probabilities: -0.0002

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Clean fish rates for juvenile Chinook salmon released mid-bay through deep pipes at Spillbays 2 and 4 at 9 kcfs through the spillbay and 113 kcfs total spill at the Dalles Dam, May-June, 2003. Controls: 744 examined, 743 without maladies (clean), 1 with maladies. Spillbay 2 mid-bay release: 188 examined, 182 without maladies (clean), 6 with maladies. Spillbay 4 mid-bay release: 235 examined, 225 without maladies (clean), 10 with maladies. (Values from Table 3-9.)

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9987 (0.0013) Control group without maladies (clean)
Pa = Pd 1.0 N/A Recovery probability*
S2 = 0.9681 (0.0128) Spillbay 2, mid-bay deep, 9/113 kcfs without maladies (clean)
S3 = 0.9574 (0.0132) Spillbay 4, mid-bay deep, 9/113 kcfs without maladies (clean)

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -75.5368

Tau = 0.9694 (0.0129) Spillbay 2, mid-bay deep, 9/113 kcfs/Control ratio
Tau = 0.9587 (0.0132) Spillbay 4, mid-bay deep, 9/113 kcfs/Control ratio

Z statistic for the equality of equal rates without maladies (clean): 0.5760

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00000180	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00016434	0.00000000
0.00000000	0.00000000	0.00000000	0.00017337

Confidence intervals:

Spillbay 2, mid-bay deep, 9/113 kcfs Tau	Spillbay 4, mid-bay deep, 9/113 kcfs Tau
90 percent: (0.9482, 0.9906)	(0.9369, 0.9805)
95 percent: (0.9441, 0.9947)	(0.9328, 0.9847)
99 percent: (0.9362, 1.0026)	(0.9246, 0.9928)

Likelihood ratio statistic for equality of recovery probabilities: -0.0002

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Clean fish rates for juvenile Chinook salmon released mid-bay and off-center through deep pipes at Spillbay 2 at 12 kcfs through the spillbay and 108 kcfs total spill at the Dalles Dam, May-June, 2003. Controls: 744 examined, 743 without maladies (clean), 1 with maladies. Spillbay 2 mid-bay release: 110 examined, 103 without maladies (clean), 7 with maladies. Spillbay 2 off-center release: 108 examined, 105 without maladies (clean), 3 with maladies. (Values from Table 3-9.)

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9987 (0.0013) Control group without maladies (clean)
Pa = Pd 1.0 N/A Recovery probability*
S2 = 0.9364 (0.0000) Spillbay 2 mid-bay deep, 12/108 kcfs without maladies (clean)
S3 = 0.9722 (0.0158) Spillbay 2 off-center deep, 12/108 kcfs without maladies (clean)

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -47.3743

Tau = 0.9376 (0.0013) Spillbay 2 mid-bay deep, 12/108 kcfs/Control ratio
Tau = 0.9735 (0.0159) Spillbay 2 off-center deep, 12/108 kcfs/Control ratio

Z statistic for the equality of equal rates without maladies (clean): 2.2528

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00000180	0.00000000	0.00000000	0.00000000
0.00000000	-0.00000037	0.00001408	0.00000000
0.00000000	0.00001408	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00025006

Confidence intervals:

Spillbay 2 mid-bay deep, 12/108 kcfs Tau	Spillbay 2 off-center deep, 12/108 kcfs Tau
90 percent: (0.9355, 0.9397)	(0.9474, 0.9997)
95 percent: (0.9352, 0.9401)	(0.9424, 1.0047)
99 percent: (0.9344, 0.9409)	(0.9326, 1.0144)

Likelihood ratio statistic for equality of recovery probabilities: -0.0002

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Clean fish rates for juvenile Chinook salmon released mid-bay through deep pipes at Spillbays 2 and 4 at 12 kcfs through the spillbay and 108 kcfs total spill at the Dalles Dam, May-June, 2003. Controls: 744 examined, 743 without maladies (clean), 1 with maladies. Spillbay 2 mid-bay release: 110 examined, 103 without maladies (clean), 7 with maladies. Spillbay 4 mid-bay release: 158 examined, 155 without maladies (clean), 3 with maladies. (Values from Table 3-9.)

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9987 (0.0013) Control group without maladies (clean)
Pa = Pd 1.0 N/A Recovery probability*
S2 = 0.9364 (0.0233) Spillbay 2, mid-bay deep, 12/108 kcfs without maladies (clean)
S3 = 0.9810 (0.0000) Spillbay 4, mid-bay deep, 12/108 kcfs without maladies (clean)

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -48.5290

Tau = 0.9376 (0.0233) Spillbay 2, mid-bay deep, 12/108 kcfs/Control ratio
Tau = 0.9823 (0.0013) Spillbay 4, mid-bay deep, 12/108 kcfs/Control ratio

Z statistic for the equality of equal rates without maladies (clean): 1.9125

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00000180	0.00000000	0.00000000	0.00000000
0.00000000	-0.00034502	0.00000000	-0.00020168
0.00000000	0.00000000	0.00054170	0.00000000
0.00000000	-0.00020168	0.00000000	0.00000000

Confidence intervals:

Spillbay 2, mid-bay deep, 12/108 kcfs Tau	Spillbay 4, mid-bay deep, 12/108 kcfs Tau
90 percent: (0.8992, 0.9760)	(0.9802, 0.9845)
95 percent: (0.8919, 0.9834)	(0.9797, 0.9849)
99 percent: (0.8775, 0.9977)	(0.9789, 0.9857)

Likelihood ratio statistic for equality of recovery probabilities: -0.0002

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Clean fish rates for juvenile Chinook salmon released mid-bay through deep and shallow pipes at Spillbay 2 at 18 kcfs through the spillbay and 102 kcfs total spill at the Dalles Dam, May-June, 2003. Controls: 744 examined, 743 without maladies (clean), 1 with maladies. Spillbay 2 deep release: 149 examined, 147 without maladies (clean), 2 with maladies. Spillbay 2 shallow release: 148 examined, 144 without maladies (clean), 4 with maladies. (Values from Table 3-9.)

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9987 (0.0013) Control group without maladies (clean)
Pa = Pd 1.0 N/A Recovery probability*
S2 = 0.9866 (0.0094) Spillbay 2, mid-bay deep, 18/102 kcfs without maladies (clean)
S3 = 0.9730 (0.0133) Spillbay 2, mid-bay shallow, 18/102 kcfs without maladies (clean)

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -36.6086

Tau = 0.9879 (0.0095) Spillbay 2, mid-bay deep, 18/102 kcfs/Control ratio
Tau = 0.9743 (0.0134) Spillbay 2, mid-bay shallow, 18/102 kcfs/Control ratio

Z statistic for the equality of equal rates without maladies (clean): 0.8279

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00000180	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00008888	0.00000000
0.00000000	0.00000000	0.00000000	0.00017768

Confidence intervals:

Spillbay 2, mid-bay deep, 18/102 kcfs Tau	Spillbay 2, mid-bay shallow, 18/102 kcfs Tau
90 percent: (0.9722, 1.0036)	(0.9522, 0.9963)
95 percent: (0.9692, 1.0066)	(0.9480, 1.0006)
99 percent: (0.9634, 1.0125)	(0.9397, 1.0088)

Likelihood ratio statistic for equality of recovery probabilities: -0.0002

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Clean fish rates for juvenile Chinook salmon released off-center through deep and shallow pipes at Spillbay 2 at 18 kcfs through the spillbay and 102 kcfs total spill at the Dalles Dam, May-June, 2003. Controls: 744 examined, 743 without maladies (clean), 1 with maladies. Spillbay 2 deep release: 150 examined, 142 without maladies (clean), 8 with maladies. Spillbay 2 shallow release: 148 examined, 143 without maladies (clean), 5 with maladies. (Values from Table 3-9.)

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9987 (0.0013) Control group without maladies (clean)
Pa = Pd 1.0 N/A Recovery probability*
S2 = 0.9467 (0.0183) Spillbay 2, off-center deep, 18/102 kcfs without maladies (clean)
S3 = 0.9662 (0.0149) Spillbay 2, off-center shallow, 18/102 kcfs without maladies (clean)

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -60.6971

Tau = 0.9479 (0.0184) Spillbay 2, off-center deep, 18/102 kcfs/Control ratio
Tau = 0.9675 (0.0149) Spillbay 2, off-center shallow, 18/102 kcfs/Control ratio

Z statistic for the equality of equal rates without maladies (clean)s: 0.8258

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00000180	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00033659	0.00000000
0.00000000	0.00000000	0.00000000	0.00022056

Confidence intervals:

Spillbay 2, off-center deep, 18/102 kcfs Tau	Spillbay 2, off-center shallow, 18/102 kcfs Tau
90 percent: (0.9176, 0.9782)	(0.9430, 0.9921)
95 percent: (0.9118, 0.9840)	(0.9383, 0.9968)
99 percent: (0.9005, 0.9954)	(0.9291, 1.0060)

Likelihood ratio statistic for equality of recovery probabilities: -0.0002

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Clean fish rates for juvenile Chinook salmon released off-center through deep and shallow pipes at Spillbay 4 at 18 kcfs through the spillbay and 102 kcfs total spill at the Dalles Dam, May-June, 2003. Controls: 744 examined, 743 without maladies (clean), 1 with maladies. Spillbay 4 deep release: 200 examined, 194 without maladies (clean), 6 with maladies. Spillbay 4 shallow release: 205 examined, 196 without maladies (clean), 9 with maladies. (Values from Table 3-9.)

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9987 (0.0013) Control group without maladies (clean)
Pa = Pd 1.0 N/A Recovery probability*
S2 = 0.9700 (0.0121) Spillbay 4, mid-bay deep, 18/102 kcfs without maladies (clean)
S3 = 0.9561 (0.0143) Spillbay 4, mid-bay shallow, 18/102 kcfs without maladies (clean)

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -71.4914

Tau = 0.9713 (0.0121) Spillbay 4, mid-bay deep, 18/102 kcfs/Control ratio
Tau = 0.9574 (0.0144) Spillbay 4, mid-bay shallow, 18/102 kcfs/Control ratio

Z statistic for the equality of equal rates without maladies (clean): 0.7393

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00000180	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00014550	0.00000000
0.00000000	0.00000000	0.00000000	0.00020476

Confidence intervals:

Spillbay 4, mid-bay deep, 18/102 kcfs Tau	Spillbay 4, mid-bay shallow, 18/102 kcfs Tau
90 percent: (0.9513, 0.9913)	(0.9337, 0.9810)
95 percent: (0.9475, 0.9951)	(0.9292, 0.9856)
99 percent: (0.9400, 1.0026)	(0.9203, 0.9944)

Likelihood ratio statistic for equality of recovery probabilities: -0.0002

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Clean fish rates for juvenile Chinook salmon released mid-bay through deep pipes at Spillbays 2 and 4 at 18 kcfs through the spillbay and 102 kcfs total spill at the Dalles Dam, May-June, 2003. Controls: 744 examined, 743 without maladies (clean), 1 with maladies. Spillbay 2 release: 149 examined, 147 without maladies (clean), 2 with maladies. Spillbay 4 release: 200 examined, 194 without maladies (clean), 6 with maladies. (Values from Table 3-9.)

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9987 (0.0013) Control group survival
Pa = Pd 1.0 N/A Recovery probability*
S2 = 0.9866 (0.0094) Spillbay 2, mid-bay deep, 18/102 kcfs survival
S3 = 0.9700 (0.0121) Spillbay 4, mid-bay deep, 18/102 kcfs survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -45.1679

Tau = 0.9879 (0.0095) Spillbay 2, mid-bay deep, 18/102 kcfs/Control ratio
Tau = 0.9713 (0.0121) Spillbay 4, mid-bay deep, 18/102 kcfs/Control ratio

Z statistic for the equality of equal turbine survivals: 1.0749

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00000180	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00008888	0.00000000
0.00000000	0.00000000	0.00000000	0.00014550

Confidence intervals:

Spillbay 2, mid-bay deep, 18/102 kcfs Tau	Spillbay 4, mid-bay deep, 18/102 kcfs Tau
90 percent: (0.9722, 1.0036)	(0.9513, 0.9913)
95 percent: (0.9692, 1.0066)	(0.9475, 0.9951)
99 percent: (0.9634, 1.0125)	(0.9400, 1.0026)

Likelihood ratio statistic for equality of recovery probabilities: -0.0002

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Clean fish rates for juvenile Chinook salmon released off-center through a deep and shallow pipes at Spillbay 2 at 21 kcfs through the spillbay and 98.5 kcfs total spill at the Dalles Dam, May-June, 2003. Controls: 744 examined, 743 without maladies (clean), 1 with maladies. Spillbay 2 deep release: 100 examined, 83 without maladies (clean), 17 with maladies. Spillbay 2 shallow release: 100 examined, 95 without maladies (clean), 5 with maladies. (Values from Table 3-9.)

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9987 (0.0013) Control group without maladies (clean)
Pa = Pd 1.0 N/A Recovery probability*
S2 = 0.8300 (0.0376) Spillbay 2, deep off-center, 21/98.5 kcfs without maladies (clean)
S3 = 0.9500 (0.0218) Spillbay 2, shallow off-center, 21/98.5 kcfs without maladies (clean)

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -73.0515

Tau = 0.8311 (0.0376) Spillbay 2, deep off-center, 21/98.5 kcfs/Control ratio
Tau = 0.9513 (0.0219) Spillbay 2, shallow off-center, 21/98.5 kcfs/Control ratio

Z statistic for the equality of equal rates without maladies (clean): 2.7611

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00000180	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00141100	0.00000000
0.00000000	0.00000000	0.00000000	0.00047500

Confidence intervals:

Spillbay 2, deep off-center, 21/98.5 kcfs Tau	Spillbay 2, shallow off-center, 21/98.5 kcfs Tau
90 percent: (0.7692, 0.8930)	(0.9153, 0.9872)
95 percent: (0.7574, 0.9049)	(0.9084, 0.9941)
99 percent: (0.7342, 0.9280)	(0.8950, 1.0076)

Likelihood ratio statistic for equality of recovery probabilities: -0.0002

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Spillbay 2 at 21 kcfs through the spillbay and 98.5 kcfs total spill at the Dalles Dam, May-June, 2003. Controls: 744 examined, 743 without maladies (clean), 1 with maladies. Spillbay 2 mid-bay release: 100 examined, 90 without maladies (clean), 10 with maladies. Spillbay 2 shallow release: 100 examined, 83 without maladies (clean), 17 with maladies. (Values from Table 3-9.)

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9987 (0.0013) Control group without maladies (clean)
Pa = Pd 1.0 N/A Recovery probability*
S2 = 0.9000 (0.0300) Spillbay 2, mid-bay deep, 21/98.5 kcfs without maladies (clean)
S3 = 0.8300 (0.0376) Spillbay 2, off-center deep, 21/98.5 kcfs without maladies (clean)

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -85.7083

Tau = 0.9012 (0.0301) Spillbay 2, mid-bay deep, 21/98.5 kcfs/Control ratio
Tau = 0.8311 (0.0376) Spillbay 2, off-center deep, 21/98.5 kcfs/Control ratio

Z statistic for the equality of equal rates without maladies (clean): 1.4553

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00000180	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00090000	0.00000000
0.00000000	0.00000000	0.00000000	0.00141101

Confidence intervals:

Spillbay 2, mid-bay deep, 21/98.5 kcfs Tau	Spillbay 2, off-center deep, 21/98.5 kcfs Tau
90 percent: (0.8518, 0.9507)	(0.7692, 0.8930)
95 percent: (0.8423, 0.9601)	(0.7574, 0.9049)
99 percent: (0.8238, 0.9786)	(0.7342, 0.9280)

Likelihood ratio statistic for equality of recovery probabilities: -0.0002

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Table 1-1

Sample size, recapture and control survival rates, and estimated 48 h survival (direct effects) of juvenile chinook salmon at various hydraulic conditions in previous balloon tag-recapture (Heisey et al. 1992) studies at The Dalles Dam spillway. Reproduced from Normandeau Associates *et al.* (2004).

Water Temperature (°C)	Treatment		Test Spill Volume (kcfs)	Recapture Rates (%)		Control Survival (%)	Passage Survival (%)
	Sample Size	Head (ft)		Control	Treatment		
<i>Spillbay 2</i>							
9-15	345	80-84	4.5	97.6	95.1	97.1	92.5
9-15	45	80-84	12.0	N/A	95.6	N/A	96.7
9-15	45	80-84	12.0	N/A	100.0	N/A	100.0
9-15	120	80-84	12.0	98.9	99.2	98.9	100.0
9-15	120	80-84	12.0	98.9	98.3	98.9	96.9
13-16	190	75-79	9.0	100.0	98.9	98.9	97.5
13-16	189	75-79	9.0	100.0	95.8	98.9	93.1
13-16	110	74-80	12.0	99.2	100.0	99.2	98.5
13-16	108	74-80	12.0	99.2	98.1	99.2	99.3
13-16	149	76-79	18.0	98.6	100.0	98.2	100.0
13-16	150	76-79	18.0	98.6	100.0	98.2	99.2
13-16	149	75-80	18.0	98.6	99.3	98.2	99.2
13-16	150	75-79	18.0	98.6	98.7	98.2	97.8
13-16	100	77-78	21.0	99.4	100.0	99.4	98.2
13-16	100	77-80	21.0	99.4	100.0	99.4	93.1
13-16	100	76-77	21.0	99.4	98.0	99.4	95.1
13-16	100	76-78	21.0	99.4	100.0	99.4	98.2
10-11	145	79-84	10.2-12.4	99.3	97.2	98.6	97.2
10-11	145	79-84	11.0-13.2	99.3	97.9	98.6	99.3
14-15	150	76-81	15.2-20.1	98.9	99.3	99.6	99.0
14-15	150	76-81	17.6-20.6	98.9	100.0	99.6	97.7
<i>Spillbay 3</i>							
15-17	270	81	10.5	97.0	94.1	97.0	95.5
<i>Spillbay 4</i>							
15-17 ^a	271	81	10.5	97.0	97.4	97.0	99.3
10-14	391	75-80	7.5-10.5	98.7	96.7	98.0	97.4
9-15	345	80-84	4.5	98.2	98.3	98.2	96.5
9-15	120	80-84	12.0	98.9	98.3	98.9	99.5
9-15	120	80-84	12.0	98.9	99.2	98.9	98.6
13-16	241	74-78	9.0	100.0	97.5	98.9	96.6
13-16	160	74-79	12.0	99.2	98.8	99.2	99.9
13-16	200	77-79	18.0	98.6	100.0	98.2	99.7
13-16	209	75-79	18.0	98.6	98.1	98.2	97.3
10-11	146	79-84	10.2-12.4	99.3	98.6	98.6	100.0

Table 1-1

continued.

Water Temperature (°C)	Treatment			Recapture Rates (%)		Control Survival (%)	Passage Survival (%)
	Sample Size	Head (ft)	Test Spill Volume (kcfs)	Control	Treatment		
10-11	145	79-84	11.0-14.7	99.3	97.9	98.6	98.6
10-11	145	79-84	10.3-11.0	99.3	100.0	98.6	100.0
10-11	144	79-84	11.0-14.7	99.3	99.3	98.6	98.6
14-15	165	76-81	15.2-20.4	98.9	98.8	99.6	96.1
14-15	149	76-81	17.5-20.5	98.9	98.7	99.6	99.0
<i>Spillbay 4</i>							
14-15	155	76-81	15.2-20.4	98.9	100.0	99.6	97.8
14-15	150	76-81	14.0-20.5	98.9	100.0	99.6	99.7
<i>Spillbay 6</i>							
15-17 ^a	210	81	4.5	96.2	94.3	96.2	99.0
10-11	39	79-84	7.4-12.4	99.3	92.3	98.6	95.9
14-15	149	76-81	13.9-17.5	98.9	89.5	99.6	85.1
<i>Spillbay 9</i>							
10-14	396	75-80	4.5-7.5	98.7	95.4	98.0	97.4
<i>Spillbay 13</i>							
10-14	405	75-80	3.0-6.0	98.7	93.8	98.0	93.8

a Overflow weir or slot to attract surface oriented juvenile salmonids.

Table 2-1

Daily river temperature and release schedule for juvenile chinook salmon and Sensor Fish passed through Spillbays 2, 4¹, 6², and downstream of Spillbay 1 (control)³ at 40% of river flow spill (primarily through Spillbays 1-6) with spillway diversion wall in place, The Dalles Dam, April-May 2004. Spill per bay (kcfs) shown in parentheses.

Date	River Temperature (°C)	Test Spill (kcfs)	Spillbay 2		Spillbay 4				Spillbay 6	Control	Total Fish	Sensor Fish
			(10.2-12.4)	(11-13.2)	(10.2-12.4)	(11-14.7)	(10.3-11)	(11-14.7)	(7.4-12.4)	(6.5-12.4)		
			Mid 15 ft above ogee	Mid 10 ft above ogee	Mid 15 ft above ogee	Mid 10 ft above ogee	Off center 15 ft above ogee	Off center 10 ft above ogee	Vortex	Below Spillbay 1		
14 Apr	10.0		30		30		29			30	119	10
15 Apr	10.0			30		30		30		30	120	12
16 Apr	9.5		40		40		41			40	161	14
17 Apr	9.5			40		40		40		39	159	14
19 Apr	10.0			40		40		39		41	160	14
20 Apr	10.0		40		40		40			39	159	13
21 Apr	10.5			35		35		35	23	35	163	0
22 Apr	10.0		35		36		35		16	36	158	15
Totals			145	145	146	145	145	144	39	290	1,199	92
										Below Spillbay 1		
			(15.2-20.1)	(17.6-20.6)	(15.2-20.4)	(17.5-20.5)	(15.2-20.4)	(14.0-20.5)	(13.9-17.5)	(15.5-18.3)		
26 May	13.9		30		30		30			27	117	10
27 May	14.0			55		55		55		56	221	17
28 May	13.8		50		50		50			50	200	18
29 May	13.7		30	45	30	45	30	45			225	33
31 May	14.8									45	45	
01 Jun	14.1			50		49		50	30	49	228	19
02 Jun	13.4		40		55		45		50	45	235	17
03 Jun	14.2								69		69	5
Totals			150	150	165	149	155	150	149	272	1,340	119

1 Fish released mid bay (mid) and off center (8.5 ft offset from mid bay, 15 ft (shallow) and 10 ft (deep) above ogee.

2 Fish hand tossed into surface vortex near tainter gate.

3 Fish released via pipe downstream of Spillbay 1 or hand tossed downstream of fishway entrance.

Table 2-2

Sample size, recapture and control survival rates, and estimated 48 h survival (direct effects) of juvenile salmonids in passage through non-turbine exit routes at hydroelectric dams on the Columbia River Basin. Estimates based on balloon tag-recapture methodology (Heisey *et al.* 1992). Source: Normandeau Associates et al (2004).

Station	Exit Route	Species	Water Temp. (°C)	Sample Size	Head (ft)	Test Spill Volume (kcf)	Recapture Rates (%)		Control Survival (%)	Passage Survival (%)
							Control	Treatment		
The Dalles, WA	Spillbay 3	Chinook salmon	15-17	270	81	10.5	97.0	94.1	97.0	95.5
	Spillbay 4 ^b	Chinook salmon	15-17	271	81	10.5	97.0	97.4	97.0	99.3
	Spillbay 6 ^b	Chinook salmon	15-17	210	81	4.5	96.2	94.3	96.2	99.0
	Spillbay 4	Chinook salmon	10-14	391	75-80	7.5-10.5	98.7	96.7	98.0	97.4
	Spillbay 9	Chinook salmon	10-14	396	75-80	4.5-7.5	98.7	95.4	98.0	97.4
	Spillbay 13	Chinook salmon	10-14	405	75-80	3.0-6.0	98.7	93.8	98.0	93.8
	Spillbay 2 ^g	Chinook salmon	9-15	345	80-84	4.5	97.6	95.1	97.1	92.5
	Spillbay 2 ^g	Chinook salmon	9-15	45	80-84	12.0	N/A	95.6	N/A	96.7
	Spillbay 2 ^h	Chinook salmon	9-15	45	80-84	12.0	N/A	100.0	N/A	100.0
	Spillbay 2 ^g	Chinook salmon	9-15	120	80-84	12.0	98.9	99.2	98.9	100.0
	Spillbay 2 ^h	Chinook salmon	9-15	120	80-84	12.0	98.9	98.3	98.9	96.9
	Spillbay 4 ^g	Chinook salmon	9-15	345	80-84	4.5	98.2	98.3	98.2	96.5
	Spillbay 4 ^g	Chinook salmon	9-15	120	80-84	12.0	98.9	98.3	98.9	99.5
	Spillbay 4 ^h	Chinook salmon	9-15	120	80-84	12.0	98.9	99.2	98.9	98.6
	Spillbay 2 ^g	Chinook salmon	13-16	190	75-79	9.0	100	98.9	98.9	97.5
	Spillbay 2 ^{f,g}	Chinook salmon	13-16	189	75-79	9.0	100.0	95.8	98.9	93.1
	Spillbay 2 ^g	Chinook salmon	13-16	110	74-80	12.0	99.2	100.0	99.2	98.5
	Spillbay 2 ^{f,g}	Chinook salmon	13-16	108	74-80	12.0	99.2	98.1	99.2	99.3
	Spillbay 2 ^g	Chinook salmon	13-16	149	76-79	18.0	98.6	100.0	98.2	100.0
	Spillbay 2 ^{f,g}	Chinook salmon	13-16	150	76-79	18.0	98.6	100.0	98.2	99.2
	Spillbay 2 ^h	Chinook salmon	13-16	149	75-80	18.0	98.6	99.3	98.2	99.2
	Spillbay 2 ^{f,h}	Chinook salmon	13-16	150	75-79	18.0	98.6	98.7	98.2	97.8
	Spillbay 2 ^g	Chinook salmon	13-16	100	77-78	21.0	99.4	100.0	99.4	98.2
	Spillbay 2 ^{f,g}	Chinook salmon	13-16	100	77-80	21.0	99.4	100.0	99.4	93.1
	Spillbay 2 ^h	Chinook salmon	13-16	100	76-77	21.0	99.4	98.0	99.4	95.1
	Spillbay 2 ^{f,h}	Chinook salmon	13-16	100	76-78	21.0	99.4	100.0	99.4	98.2
	Spillbay 4 ^g	Chinook salmon	13-16	241	74-78	9.0	100.0	97.5	98.9	96.6
	Spillbay 4 ^g	Chinook salmon	13-16	160	74-79	12.0	99.2	98.8	99.2	99.9

Table 2-2

Continued.

Station	Exit Route	Species	Water Temperature (°F)	Sample Size	Head (ft)	Test Spill Volume (kcf)	Recapture Rates (%)		Control Survival (%)	Passage Survival (%)
							Control	Treatment		
The Dalles, WA	Spillbay 4 ^g	Chinook salmon	13-16	200	77-79	18.0	98.6	100.0	98.2	99.7
	Spillbay 4 ^h	Chinook salmon	13-16	209	75-79	18.0	98.6	98.1	98.2	97.3
	Spillbay 2	Chinook salmon	10-11	145	79-84	10.2-12.4	99.3	97.2	98.6	97.2
	Spillbay 2	Chinook salmon	10-11	145	79-84	11.0-13.2	99.3	97.9	98.6	99.3
	Spillbay 4	Chinook salmon	10-11	146	79-84	10.2-12.4	99.3	98.6	98.6	100
	Spillbay 4	Chinook salmon	10-11	145	79-84	11.0-14.7	99.3	97.9	98.6	98.6
	Spillbay 4 ^f	Chinook salmon	10-11	145	79-84	10.3-11.0	99.3	100.0	98.6	100
	Spillbay 4 ^f	Chinook salmon	10-11	144	79-84	11.0-14.7	99.3	99.3	98.6	98.6
	Spillbay 6 ^c	Chinook salmon	10-11	39	79-84	7.4-12.4	99.3	92.3	98.6	95.9
	Spillbay 2	Chinook salmon	14-15	150	76-81	15.2-20.1	98.9	99.3	99.6	99.0
	Spillbay 2	Chinook salmon	14-15	150	76-81	17.6-20.6	98.9	100.0	99.6	97.7
	Spillbay 4	Chinook salmon	14-15	165	76-81	15.2-20.4	98.9	98.8	99.6	96.1
	Spillbay 4	Chinook salmon	14-15	149	76-81	17.5-20.5	98.9	98.7	99.6	99.0
	Spillbay 4 ^f	Chinook salmon	14-15	155	76-81	15.2-20.4	98.9	100.0	99.6	97.8
	Spillbay 4 ^f	Chinook salmon	14-15	150	76-81	14.0-20.5	98.9	100.0	99.6	99.7
	Spillbay 6 ^c	Chinook salmon	14-15	149	76-81	13.9-17.5	98.9	89.5	99.6	85.1
Wanapum, WA	Sluice	Chinook salmon	5-8	195	79	2.0	100.0	97.9	100.0	97.4
	Spillbay 2	Chinook salmon	5-8	235	79	4.3	100.0	99.6	99.6	99.6
	Spillbay 3 ^a	Chinook salmon	5-8	235	79	4.3	100.0	97.9	99.6	95.7
	Spillbay 12 ^b	Chinook salmon	5-8	155	79	2.0	100.0	97.4	100.0	92.0
	Spillbay 12 ^b	Chinook salmon	5-8	160	79	4.0	96.7	98.8	96.7	96.9
	Spillbay 3	Chinook salmon	17-18	180	82	2.8	100.0	100.0	94.5	100.0
	Spillbay 4	Chinook salmon	17-18	244	82	6.0	100.0	99.6	95.8	99.3
	Spillbay 5	Chinook salmon	17-18	130	82	11.5	98.4	99.2	94.3	94.6
	Spillbay 4 ^a	Chinook salmon	17-18	200	82	2.8	100.0	100.0	96.5	99.0
	Spillbay 4 ^a	Chinook salmon	17-18	199	82	6.0	100.0	98.5	95.3	97.6
	Spillbay 4 ^a	Chinook salmon	17-18	191	82	11.5	98.4	96.7	94.3	92.8
	Spillbay 3	Chinook salmon	16	180	82	2.8	100.0	100.0	97.5	99.4

Table 2-2

Continued.

Station	Exit Route	Species	Water Temperature (°F)	Sample Size	Head (ft)	Test Spill Volume (kfs)	Recapture Rates (%)		Control Survival (%)	Passage Survival (%)
							Control	Treatment		
Wanapum, WA	Spillbay 3	Chinook salmon	16	169	82	6.0	100.0	100.0	95.8	97.6
	Spillbay 3	Chinook salmon	16	198	82	7.5	100.0	100.0	94.3	99.5
	Spillbay 3 ^a	Chinook salmon	16	180	82	2.8	100.0	100.0	96.5	98.3
	Spillbay 5 ^a	Chinook salmon	16	170	82	6.0	100.0	98.8	95.3	98.2
	Spillbay 5 ^a	Chinook salmon	16	210	82	7.5	100.0	99.0	82.3	97.6
	Bypass Pipe	Chinook salmon	16	500	76-80	0.4	99.6	99.8	99.6	100.0
	Spillbay 12 ^{a,b}	Chinook salmon	5-6	300	81-82	10.4-12.5	100.0	99.0	97.3	99.0
Bonneville, WA	Spillbay 2	Chinook salmon	15-17	280	60	12.0	96.1	96.8	96.1	100.0
	Spillbay 4 ^a	Chinook salmon	15-17	280	60	12.0	96.1	99.3	96.1	100.0
	Spillbay 14 ^a	Chinook salmon	12-14	130	54-58	3.2-4.8	100.0	97.7	97.7	97.9
	Spillbay 16 [*]	Chinook salmon	12-14	166	54-58	3.2-6.4	100.0	95.8	97.7	95.9
	Spillbay 14 ^a	Chinook salmon	12-14	238	50-55	5.1-7.9	95.4	98.3	97.7	98.6
	Spillbay 16 [*]	Chinook salmon	12-14	241	50-55	7.1-9.8	95.4	97.1	97.7	99.0
	Spillbay 16 [*]	Chinook salmon	20-21	166	60-65	4.0-4.1	86.9	83.7	82.6	90.5
	Spillbay 16 [*]	Chinook salmon	20-21	185	60-65	5.0-6.0	86.9	88.1	82.6	88.6
	Spillbay 14 ^a	Chinook salmon	20-21	250	60-64	5.0-6.0	87.6	87.6	82.6	100.0
	Spillbay 16 [*]	Chinook salmon	20-21	250	60-64	6.9-7.9	87.6	89.6	82.6	100.0
	Powerhouse I sluice	Chinook salmon	15-17	100	60	0.2-0.3	NA	93.0	NA	93.0
	Powerhouse II sluice	Chinook salmon	15-17	100	60	0.7	NA	90.0	NA	89.0
	Powerhouse II sluice	Chinook salmon	14-16	250	50-58	1.0	99.6	100.0	99.6	99.6
	Powerhouse II sluice	Chinook salmon	14-16	251	50-58	2.5	99.6	100.0	99.6	100.0
	Powerhouse II sluice	Chinook salmon	16-18	348	63-67	1.0	99.4	100.0	99.4	100.0
	Powerhouse II sluice	Chinook salmon	16-18	345	63-67	2.5	99.4	100.0	99.4	99.4
Lower Granite, WA	Spillbay 2 ^a	Chinook salmon	9-10	120	90	3.4	100.0	100.0	100.0	97.5
	Surface Bypass Collector ^a	Chinook salmon	9-10	120	90	3.4	100.0	99.2	100.0	95.8
	Spillbay 2 ^a	Chinook salmon	8-10	130	90	3.4	92.1	94.6	92.1	97.6
	Surface Bypass Collector ^a	Chinook salmon	8-10	133	90	3.4	92.1	97.8	92.1	97.0
	Spillbay 2 ^a	Chinook salmon	10-11	130	97-98	5.7	100.0	100.0	100.0	100.0
	Spillbay 1 ^{a,b} (RSW)	Chinook salmon	10-11	260	97-99	7.0	100.0	99.2	100.0	98.1

Table 2-2

Continued.

Station	Exit Route	Species	Water Temperature (°C)	Sample Size	Head (ft)	Test Spill Volume (kcf)	Recapture Rates (%)		Control Survival (%)	Passage Survival (%)
							Control	Treatment		
Little Goose, WA	Spillbay 1	Steelhead	8-9	150	90	5.6	100.0	100.0	100.0	100.0
	Spillbay 1	Steelhead	8-9	150	90	9.5	100.0	100.0	100.0	100.0
	Spillbay 1	Steelhead	8-9	100	90	1.8	99.0	100.0	99.0	100.0
	Spillbay 3 ^c	Steelhead	8-9	40	90	5.6	100.0	98.0	100.0	100.0
	Spillbay 3 ^c	Steelhead	8-9	120	90	9.5	100.0	99.0	100.0	98.3
	Spillbay 3 ^a	Steelhead	8-9	150	90	5.6	100.0	99.0	100.0	98.0
	Spillbay 1 ^a	Steelhead	8-9	150	90	9.5	100.0	100.0	100.0	100.0
	Spillbay 1 ^a	Steelhead	8-9	100	90	1.8	99.0	100.0	99.0	99.0
	Spillbay 3 ^{a,c}	Steelhead	8-9	39	90	5.6	100.0	100.0	100.0	100.0
	Spillbay 3 ^{a,c}	Steelhead	8-9	120	90	9.5	100.0	99.0	100.0	99.2
Ice Harbor, WA	Spillbay 5 ^a	Chinook salmon	10-12	310	93-96	3.4-5.1	99.3	99.7	99.3	98.7
	Spillbay 5 ^a	Chinook salmon	10-12	225	94-96	4.3-8.5	99.3	99.1	99.3	99.5
	Spillbay 5 ^a	Chinook salmon	10-12	120	96-97	8.5	99.3	100.0	99.3	98.7
	Spillbay 1 ^{a,g}	Chinook salmon	6-7	105	95-97	3.4	98.0	98.1	100.0	99.7
	Spillbay 1 ^{a,g}	Chinook salmon	6-7	105	95-96	3.4	98.0	97.1	100.0	98.8
	Spillbay 1 ^{a,h}	Chinook salmon	6-7	250	94-98	5.1	97.5	98.4	100.0	97.9
	Spillbay 1 ^{a,g}	Chinook salmon	6-7	250	93-99	5.1	97.5	97.2	100.0	98.6
	Spillbay 5 ^{a,g}	Chinook salmon	6-7	200	94-97	11.9	97.5	98.5	100.0	99.7
	Spillbay 5 ^{a,g}	Chinook salmon	6-7	200	95-100	11.9	97.5	98.0	100.0	99.7
	Spillbay 5 ^{a,h}	Chinook salmon	6-7	50	94	11.9	100.0	100.0	100.0	100.0
	Spillbay 5 ^{a,g}	Chinook salmon	6-7	40	99-100	11.9	100.0	100.0	100.0	100.0
	Spillbay 5 ^{a,g}	Chinook salmon	13-14	321	93-96	4.3	96.7	97.8	96.7	93.7
	Spillbay 5 ^{a,g}	Chinook salmon	13-14	287	92-96	4.3	96.7	99.0	96.7	100.0
	Spillbay 5 ^{a,g}	Chinook salmon	13-14	362	94-97	11.9	96.7	95.9	96.7	96.2
	Spillbay 5 ^{a,h}	Chinook salmon	13-14	350	94-97	11.9	96.7	96.0	96.7	95.0

Table 2-2

Continued.

Station	Exit Route	Species	Water Temperature (°C)	Sample Size	Head (ft)	Test Spill Volume (kcf)	Recapture Rates (%)		Control Survival (%)	Passage Survival (%)
							Control	Treatment		
Rock Island, WA	Spillbay 21 ^{b,h}	Chinook salmon	4	250	41	1.9	NA	98.0	NA	95.1
	Spillbay 23 ^b	Chinook salmon	4	250	41	10.0	NA	100.0	NA	98.4
	Spillbay 31 ^b	Chinook salmon	13-14	200	41-49	2.5	100.0	99.5	99.5	99.5
	Spillbay 31 ^b	Chinook salmon	13-14	200	41-49	10.0	100.0	100.0	99.5	99.5
	Spillbay 29 ^{a,b,e}	Chinook salmon	14-15	200	40-43	2.5	100.0	99.5	100.0	99.0
	Spillbay 29 ^{a,b}	Chinook salmon	14-15	200	40-43	2.5	100.0	100.0	100.0	100.0
	Spillbay 16 ^{a,b,e}	Chinook salmon	9-10	200	39-43	2.5	100.0	99.5	100.0	99.0
	Spillbay 16 ^{a,b}	Chinook salmon	9-10	200	39-43	2.5	100.0	100.0	100.0	99.0
North Fork, OR	Spillway	Chinook/coho	9-11	126	135	0.7	100.0	100.0	93.6	87.3
	Spillway	Chinook/coho	9-11	129	135	2.0	100.0	99.2	86.1	80.1
	Spillway	Steelhead	9-11	129	135	0.7	100.0	100.0	98.4	85.6
	Spillway	Steelhead	9-11	128	135	2.0	100.0	100.0	92.3	96.5

a Spillbay with flow deflector.

a* Spillbay with deep flow deflector.

b Overflow weir or slot to attract surface oriented juvenile salmonids.

c Fish released into head pond vortices upstream of tainter gates.

d Spill directed onto concrete slab; survival is relative to survival at another spillbay.

e Periphery release.

f Off-center release.

g Deep release.

h Shallow release.

l Spring tests only.

Table 2-3

Required sample sizes (R) if control survival (S) is 0.99, 0.98, or 0.95, recapture rate (P_A) is 0.99, 0.98, or 0.95, and expected survival probability ($\hat{\tau}$) of treatment fish passed is 0.95, 0.97, and 0.99 to achieve a precision level (ϵ) of $\leq \pm 0.03$ or $\leq \pm 0.05$, 90% of the time. Highlighted values are discussed within the text.

Control Survival (S)	Expected Survival ($\hat{\tau}$)		
	0.95	0.97	0.99
Precision (ϵ) $\leq \pm 0.03$			
<i>Recapture Rate=0.99</i>			
0.99	256	205	150
0.98	314	264	212
0.95	496	451	405
<i>Recapture Rate=0.98</i>			
0.99	314	264	218
0.98	373	325	274
0.95	556	514	469
<i>Recapture Rate=0.95</i>			
0.99	496	451	405
0.98	556	514	469
0.95	745	709	670
Precision (ϵ) $\leq \pm 0.05$			
<i>Recapture Rate=0.99</i>			
0.99	113	95	76
0.98	134	117	99
0.95	200	185	169
<i>Recapture Rate=0.98</i>			
0.99	134	117	99
0.98	156	139	122
0.95	222	208	192
<i>Recapture Rate=0.95</i>			
0.99	178	162	146
0.98	200	185	169
0.95	268	255	241

Table 2-4**Daily summary of physical-hydrological conditions during release of juvenile Chinook salmon smolts through Spillbays 2, 4, and 6 at The Dalles Dam , April- June 2004.**

Date	Average River Flow (kcfs)	Average Elevation (ft)		Average Net Head (ft)
		Forebay	Tailwater	
14 Apr	150	158.6	77.2	81.4
15 Apr	150	158.6	77.2	81.4
16 Apr	189	158.2	78.1	80.2
17 Apr	169	158.8	78.0	80.8
19 Apr	168	158.5	78.2	80.3
20 Apr	168	159.0	77.6	81.4
21 Apr	205	158.7	79.7	79.1
22 Apr	152	159.1	77.3	81.8
26-May	234	158.6	80.3	78.2
27-May	270	158.8	81.5	77.3
28-May	242	159.1	80.7	78.4
29-May	298	159.4	82.5	76.9
31-May	242	158.4	81.7	76.7
1-Jun	265	159.3	80.8	78.5
2-Jun	100	159.3	81.1	78.3
3-Jun	88	158.6	80.4	78.2

Table 3-1

Summary of tag-recapture data for juvenile Chinook salmon passed through Spillbays 2, 4, and 6 (treatment) and downstream of Spillbay 1 (control) at 40% of river flow spill (primarily through Spillbays 1-6) with spillway diversion wall in place, The Dalles Dam, April-June 2004. Proportions given in parentheses.

Discharge (kcfs) each bay	Spillbay 2		Spillbay 4				Spillbay 6	Control
	10.2-12.4	11-13.2	10.2-12.4	11-14.7	10.3-11	11-14.7	7.4-12.4	(6.5-12.4)
	Mid, 15 ft above ogee	Mid, 10 ft above ogee	Mid, 15 ft above ogee	Mid, 10 ft above ogee	Off center, 15 ft above ogee**	Off center, 10 ft above ogee**	Vortex***	
Number released	145	145	146	145	145	144	39	290
Number recaptured alive	139 (0.959)	141 (0.972)	144 (0.986)	142 (0.979)	145 (1.000)	141 (0.979)	35 (0.897)	285 (0.983)
Number recaptured dead	2 (0.014)	1 (0.007)	0 (0.000)	0 (0.000)	0 (0.000)	2 (0.014)	1 (0.026)	3 (0.010)
Number assigned dead*	4 (0.028)	1 (0.007)	0 (0.000)	2 (0.014)	0 (0.000)	0 (0.000)	1 (0.026)	0 (0.000)
Unknown	0 (0.000)	2 (0.014)	2 (0.014)	1 (0.007)	0 (0.000)	1 (0.007)	2 (0.051)	2 (0.007)
Number held	139 (0.959)	141 (0.972)	144 (0.986)	142 (0.979)	145 (1.000)	141 (0.979)	35 (0.897)	285 (0.983)
Number alive at 48 h	139 (0.959)	140 (0.966)	144 (0.986)	140 (0.966)	144 (0.993)	139 (0.965)	35 (0.897)	284 (0.979)
	<i>May-June</i>							
Discharge (kcfs) each bay	15.2-20.1	17.6-20.6	15.2-20.4	17.5-20.5	15.2-20.4	14.0-20.5	13.9-17.5	15.5-18.3
Number released	150	150	165	149	155	150	149	272
Number recaptured alive	147 (0.980)	148 (0.987)	159 (0.964)	146 (0.980)	152 (0.981)	150 (1.000)	124 (0.832)	269 (0.989)
Number recaptured dead	2 (0.013)	2 (0.013)	4 (0.024)	1 (0.007)	3 (0.019)	0 (0.000)	9 (0.060)	0 (0.000)
Number assigned dead	0 (0.000)	0 (0.000)	1 (0.006)	1 (0.007)	0 (0.000)	0 (0.000)	12 (0.081)	1 (0.004)
Unknown	1 (0.007)	0 (0.000)	1 (0.006)	1 (0.007)	0 (0.000)	0 (0.000)	4 (0.027)	2 (0.007)
Number held	147 (0.980)	148 (0.987)	159 (0.964)	146 (0.980)	152 (0.981)	150 (1.000)	124 (0.832)	269 (0.989)
Number alive at 48 h	147 (0.980)	146 (0.973)	157 (0.952)	146 (0.980)	151 (0.974)	149 (0.993)	123 (0.826)	269 (0.989)

*Only balloon tag(s) recaptured or telemetry signals indicative of stationary fish

** Release hose was offset 8.5ft. from midbay

***Fish hand tossed into surface vortex near Spillbay 6 tainter gate

Table 3-2

Forty-eight hour survival estimates ($\hat{\tau}$) with the 90% profile confidence intervals (CI) of juvenile chinook salmon passed through Spillbays 2, 4, and 6 (treatment), and downstream of Spillbay 1 (control) at 40% of river flow spill (primarily through Spillbays 1-6) with the spillway diversion wall in place, The Dalles Dam, April-June 2004. SE = standard error.

Entrainment Location*		Discharge (kcfs) Each Spillbay	Survival ($\hat{\tau}$)	SE	90% Profile CI
<i>April</i>					
Spillbay 2	Mid, 15 ft above ogee	10.2-12.4	0.972	0.018	0.942-1.000
	Mid, 10 ft above ogee	11.0-13.2	0.993	0.014	0.970-1.020
Spillbay 4	Mid, 15 ft above ogee	10.2-12.4	1.014	0.007	1.000-1.030
	Mid, 10 ft above ogee	11.0-14.7	0.986	0.016	0.960-1.000
	Off-center, 15 ft above ogee	10.3-11.0	1.007	0.010	0.991-1.023
	Off-center, 10 ft above ogee	11.0-14.7	0.986	0.016	0.960-1.011
Controls		6.5-12.4			
Spillbay 6	Vortex**	7.4-12.4	0.959	0.038	0.975-1.000
<i>May-June</i>					
Spillbay 2	Mid, 15 ft above ogee	15.2 - 20.1	0.990	0.010	0.974-1.007
	Mid, 10 ft above ogee	17.6 - 20.6	0.977	0.014	0.954-1.000
Spillbay 4	Mid, 15 ft above ogee	15.2 - 20.4	0.961	0.016	0.934-0.988
	Mid, 10 ft above ogee	17.5 - 20.5	0.990	0.010	0.973-1.007
	Off-center, 15 ft above ogee	15.2 - 20.4	0.978	0.013	0.956-1.000
	Off-center, 10 ft above ogee	14.0 - 20.5	0.997	0.007	0.984-1.000
Spillbay 6	vortex**	13.9 - 17.5	0.851	0.030	0.798-0.897
Control		15.2 - 18.3			

*Off-center releases were offset 8.5 ft from mid-bay.

**fish hand tossed into surface vortex near tainter gate.

Table 3-3

Results of analysis of deviance for treatment blocks A (2 spillbays x 2 depths x 2 Tailwater elevations) and B (2 Tailwater elevations x 2 entrainment depths x 2 release locations). See Section 2.0 for explanation. SE= standard errors in parentheses; p= exact probability of differences for comparisons within each main effect.

Source	df	Dev	Mdev	F	P-Value
<i>Treatment Block A</i>					
Total_{cov}	7	10.152			
Tailwater Elevation	1	0.202	0.202	0.083	0.788
Spillbay	1	0.055	0.055	0.023	0.888
Depth	1	0.094	0.094	0.038	0.854
Error	4	9.801	2.45		
<i>Survival Summary</i>					
Tailwater Elevation					
Low		0.983 (SE=0.006)			
High		0.987 (SE=0.006)			
P-value		0.788			
Spillbays					
Spillbay 2		0.986 SE=(0.006)			
Spillbay 4		0.984 (SE=0.006)			
P-value		0.888			
Depth					
10 ft		0.987 (SE=0.006)			
15 ft		0.984 (SE=0.006)			
P-value		0.854			
<i>Treatment Block B</i>					
Total_{cov}	7	14.529			
Tailwater Elevation	1	3.637	3.673	2.828	0.168
Depth	1	2.877	2.877	2.215	0.211
Release Location (mid vs. off-center)	1	2.784	2.784	2.144	0.217
Error	4	5.195	1.299		
<i>Survival Summary</i>					
Tailwater Elevation					
Low		0.993 (SE=0.005)			
High		0.986 (SE=0.006)			
P-value		0.168			
Depth					
10 ft		0.990 (SE=0.006)			
15 ft		0.989 (SE=0.006)			
P-value		0.211			
Release Locations					
Mid		0.987 SE=(0.006)			
Off-center		1.00 (SE=0.006)			
P-value		0.217			

Table 3-4

Comparison of estimated 48 h survival probabilities of juvenile chinook salmon in passage through Spillbays 2 and 4 (mid-bay releases only) before and after "simulated water barrier" wall and installation of a concrete wall at Spillbay 6 at the Dalles Dam, 2002-2004 with spill volume per spillbay of ≤ 15 kcfs. The 90% profile confidence intervals are shown in parenthesis.

	Spillbay 2		Spillbay 4	
	Deep	Shallow	Deep	Shallow
Pre-Diversion Wall				
Spring 2002	--	--	--	0.974 (0.957-0.990)
Fall 2002	--	--	--	--
	1.003 (0.987-1.019)	0.969 (0.937-1.00)	0.995 (0.974-1.016)	0.986 (0.961-1.011)
	0.967 (0.915-1.018)	1.012 (1.004-1.019)	--	--
Simulated Water Barrier Wall				
Spring 2003	0.975 (0.951-0.998)	--	0.966 (0.943-0.989)	--
	0.985 (0.958-1.011)	--	0.999 (0.983-1.016)	--
Diversion Wall in Place				
April 2004	0.993 (0.970-1.020)	0.972 (0.942-1.00)	0.986 (0.960-1.00)	1.014 (1.00-1.030)

Table 3-5

Comparison of estimated 48 h survival probabilities of juvenile chinook salmon in passage through Spillbays 2 and 4 (mid-bay releases only) between "simulated water barrier" wall and installation of a concrete wall at Spillbay 6 at The Dalles Dam, 2002-2004 with spill volume per spillbay of greater than 15 kcfs. The 90% profile confidence intervals are shown in parentheses. No data were collected at spillbay volume of > 15 kcfs in spring 2002 without the diversion wall.

	Spillbay 2		Spillbay 4	
	Deep	Shallow	Deep	Shallow
Simulated Water Barrier Wall				
Spring 2003	1.009 (1.005-1.019)	0.992 (0.972-1.012)	0.997 (0.981-1.013)	0.973 (0.950-0.996)
	0.982 (0.953-1.011)	0.951 (0.911-0.992)	--	--
Diversion Wall in Place				
May-June 2004	0.977 (0.954-1.00)	0.990 (0.974-1.00)	0.990 (0.973-1.007)	0.961 (0.934-0.988)

Table 3-6

Summary of the types of visible injuries (excluding predator-related) observed on recaptured juvenile chinook salmon passed through Spillbays 2, 4 and 6 (treatment) and downstream of Spillbay 1 (control) at 40% of river flow spill (primarily through Spillbays 1-6) with spillway diversion wall in place at The Dalles Dam, April 2004. Percentage of treatment injuries adjusted for pooled controls. Some fish had multiple injuries.

Spill Volume (kcfs) per spillbay	Entrainment Depth (ft above ogee)	Number Released	Number Examined	Visible Injuries Related to Passage	Injury Type				
					Damaged/Hemorrhage Eye(s)	Operculum Damage	Bruise/Scrapes on Body/Head	Lacerations Body/Head	Internal Injury
<i>Spillbay 2</i>									
10.2-12.4	Mid, 15 ft	145	141 (97.2%)	4 (2.8%)	3 (2.1%)	1 (0.7%)	1 (0.7%)	0 (0.0%)	0 (0.0%)
11.0-13.2	Mid, 10 ft	145	142 (97.9%)	4 (2.8%)	3 (2.1%)	0 (0.0%)	1 (0.7%)	1 (0.7%)	0 (0.0%)
<i>Spillbay 4</i>									
10.2-12.4	Mid, 15 ft	146	144 (98.6%)	3 (2.1%)	1 (0.7%)	0 (0.0%)	2 (1.4%)	0 (0.0%)	0 (0.0%)
11.0-14.7	Mid, 10 ft	145	142 (97.9%)	3 (2.1%)	1 (0.7%)	2 (1.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
10.3-11	Off-center* 15 ft	145	145 (100.0%)	5 (3.4%)	3 (2.1%)	2 (1.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
11.4-14.7	Off-center* 10 ft	144	143 (99.3%)	9 (6.3%)	7 (4.9%)	0 (0.0%)	3 (2.1%)	0 (0.0%)	2 (1.4%)
<i>Spillbay 6</i>									
7.4-12.4	Vortex**	39	36 (92.3%)	3 (8.3%)	2 (5.6%)	0 (0.0%)	1 (2.8%)	0 (0.0%)	0 (0.0%)
<i>Control (downstream of Spillbay 2)</i>									
6.5-12.4		290	288 (99.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)

**Off-center releases were offset 8.5 ft from mid-bay.

**Fish hand tossed into vortex near tainter gate

Table 3-7

Summary of the types of visible injuries (excluding predator and tag-related) observed on recaptured juvenile chinook salmon passed through Spillbays 2, 4, and 6 and downstream of Spillbay 1 (control) at 40% of river flow spill (primarily through Spillbays 1-6) with spillway diversion wall in place at The Dalles Dam, May-June 2004. Percentage of treatment injuries adjusted for pooled controls. Some fish had multiple injuries.

Spill Volume (kcfs) each spillbay	Entrainment Depth (ft above ogee)	Number Released	Number Examined	Visible Injuries Related to Passage	Injury Type					
					Damaged/Hemorrhaged Eye(s)	Operculum/Gill Damage	Bruise Scrapes on Body/Head	Lacerations Body/Head	Internal Injury	
<i>Spillbay 2</i>										
15.2-20.1	Mid, 15 ft	150	149 (99.3%)	2 (0.6%)	2 (1.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
17.6-20.6	Mid, 10 ft	150	150 (100.0%)	3 (1.3%)	1 (0.3%)	1 (0.3%)	1 (0.7%)	0 (0.0%)	0 (0.0%)	1 (0.7%)
<i>Spillbay 4</i>										
15.2-20.4	Mid, 15 ft	165	163 (98.8%)	8 (4.2%)	4 (2.1%)	3 (1.5%)	3 (1.8%)	0 (0.0%)	0 (0.0%)	1 (0.6%)
17.5-20.5	Mid, 10 ft	149	147 (98.7%)	5 (2.7%)	4 (2.3%)	2 (1.0%)	0 (0.0%)	1 (0.7%)	0 (0.0%)	1 (0.7%)
15.2-20.4	Off-center* 15 ft	155	155 (100.0%)	4 (1.8%)	3 (1.6%)	1 (0.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
14.0-20.5	Off-center* 10 ft	150	150 (100.0%)	5 (2.6%)	3 (1.6%)	3 (1.6%)	1 (0.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
<i>Spillbay 6</i>										
13.9-17.5	Vortex**	149	133 (89.3%)	8 (5.3%)	4 (2.6%)	2 (1.1%)	2 (1.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
<i>Control***</i>										
Downstream Spillbay 1		133	131 (98.5%)	2 (1.5%)	1 (0.8%)	1 (0.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Downstream Spillbay 1		139	138 (99.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
<i>Control pooled</i>		272	269 (98.9%)	2 (0.7%)	1 (0.4%)	1 (0.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)

*Off-center releases were offset 8.5 ft from mid-bay.

**Fish hand tossed into vortex near tainter gate

***Fish released via induction system downstream of discharge from Spillbay 1 (top row) and fish hand tossed from shore downstream of Spillbay 1 (bottom row)

Table 3-8

Passage related injury and loss of equilibrium (LOE) of juvenile chinook salmon smolts passed through Spillbays 2, 4, and 6 (treatment) and downstream of Spillbay 1 (control) at 40% of river flow spill (primarily through Spillbays 1-6) with spillway diversion wall in place at The Dalles Dam, April-June 2004. Percentages of treatment fish with LOE and maladies adjusted for pooled controls.

	Entrainment Depth (ft above ogee)	Number Examined	Exclusively LOE	(%)	Visibly injured (%)	Total Maladies (%)
<i>April</i>						
Spillbay 2	Mid, 15 ft	141	0	(0.0%)	4 (2.8%)	4 (2.5%)
	Mid, 10 ft	142	0	(0.0%)	4 (2.8%)	4 (2.5%)
Spillbay 4	Mid, 15 ft	144	0	(0.0%)	3 (2.1%)	3 (1.7%)
	Mid, 10 ft	142	1	(0.4%)	3 (2.1%)	4 (2.5%)
	Off-center* 15 ft	145	0	(0.0%)	5 (3.4%)	5 (3.1%)
	Off-center* 10 ft	143	0	(0.0%)	9 (6.3%)	9 (5.9%)
Spillbay 6	Vortex**	36	0	(0.0%)	3 (8.3%)	3 (8.0%)
Control		288	1	(0.3%)	0 (0.0%)	1 (0.3%)
<i>May-June</i>						
Spillbay 2	Mid, 15 ft	149	2	(1.3)	2 (1.3)	4 (2.7)
	Mid, 10 ft	150	1	(0.7)	3 (2.0)	4 (2.7)
Spillbay 4	Mid, 15 ft	163	0	(0.0)	8 (4.9)	8 (4.9)
	Mid, 10 ft	147	0	(0.0)	5 (3.4)	5 (3.4)
	Off-center* 15 ft	155	0	(0.0)	4 (2.6)	4 (2.6)
	Off-center* 10 ft	150	1	(0.7)	5 (3.3)	6 (4.0)
Spillbay 6	Vortex**	133	0	(0.0)	8 (6.0)	8 (6.0)
Control		269	0	(0.0)	2 (0.7)	2 (0.7)

*Off-center releases were offset 8.5 ft from mid-bay.

** Fish hand tossed into surface vortex near tainter gate.

Table 3-9

Estimated clean fish probabilities of juvenile chinook salmon in passage through Spillbays 2, 4, and 6 at 40% river flow (primarily through Spillbays 1-6) with the diversion wall in place at The Dalles Dam, April-June 2004. The 90% profile confidence intervals are shown in parentheses.

Entrainment Depth Above Ogee	Spillbay 2	Spillbay 4		Spillbay 6
	Mid-bay	Mid-bay	Off-Center*	Vortex**
April				
10 ft, deep	0.975 (0.951-0.999)	0.975 (0.952-0.999)	0.940 (0.906-0.974)	0.920** (0.823-0.976)
15 ft, shallow	0.975 (0.951-0.991)	0.983 (0.962-1.003)	0.969 (0.943-0.995)	
May-June				
10 ft, deep	0.981 (0.959-1.002)	0.973 (0.947-0.999)	0.967 (0.939-0.995)	0.947*** (0.903-0.977)
15 ft, shallow	0.980 (0.958-1.002)	0.958 (0.929-0.987)	0.982 (0.959-1.004)	

* Release hose was offset 8.5 ft from midbay

** Thirty-nine (39) fish hand tossed into surface vortex near tainter gate

*** One hundred forty-nine (149) fish hand tossed into surface vortex near tainter gate of Spillbay 6

Table 3-10

Comparison of clean fish probabilities of juvenile chinook salmon in passage through Spillbays 2 and 4 (mid-bay releases only) before and after "simulated water barrier" wall and installation of a concrete wall at Spillbay 6 at the Dalles Dam, 2002-2004 with spill volumes per spillbay of ≤ 15 kcfs. The 90% profile confidence intervals are shown in parentheses.

	Spillbay 2		Spillbay 4	
	Deep	Shallow	Deep	Shallow
Pre-Diversion Wall				
Spring 2002	--	--	--	0.944 (0.919-0.965)
Fall 2002	0.928 (0.898-0.954)	0.983 (0.953-1.00)	0.991 (0.972-1.00)	0.975 (0.936-1.00)
	0.994 (0.933-1.00)	1.00 (0.970-1.00)	0.974 (0.935-1.00)	--
	0.906 (0.856-0.955)	--	--	--
Simulated Water Barrier Wall				
Spring 2003	0.969 (0.948-0.991)	--	0.959 (0.937-0.980)	--
	0.938 (0.899-0.976)	--	0.982 (0.980-0.984)	--
Diversion Wall in Place				
April 2004	0.975 (0.951-0.999)	0.975 (0.951-0.999)	0.975 (0.952-0.999)	0.983 (0.962-1.003)

Table 3-11

Comparison of clean fish probabilities of juvenile chinook salmon in passage through Spillbays 2 and 4 (mid-bay releases only) between "simulated water barrier" wall and installation of a concrete wall at Spillbay 6 at the Dalles Dam, 2002-2004 with spill volume per spillbay of greater than 15 kcfs. The 90% profile intervals are shown in parentheses. No data were collected at spillbay volume of > 15 kcfs in spring 2002 without the diversion wall.

	Spillbay 2		Spillbay 4	
	Deep	Shallow	Deep	Shallow
	Simulated Water Barrier Wall			
Spring 2003	0.988 (0.972-1.00)	0.974 (0.952-0.996) 0.940 (0.900-0.980)	0.971 (0.951-0.991) --	0.957 (0.933-0.981) --
	Diversion Wall in Place			
May-June 2004	0.981 (0.959-1.002)	0.980 (0.958-1.002)	0.973 (0.947-0.999)	0.958 (0.929-0.987)

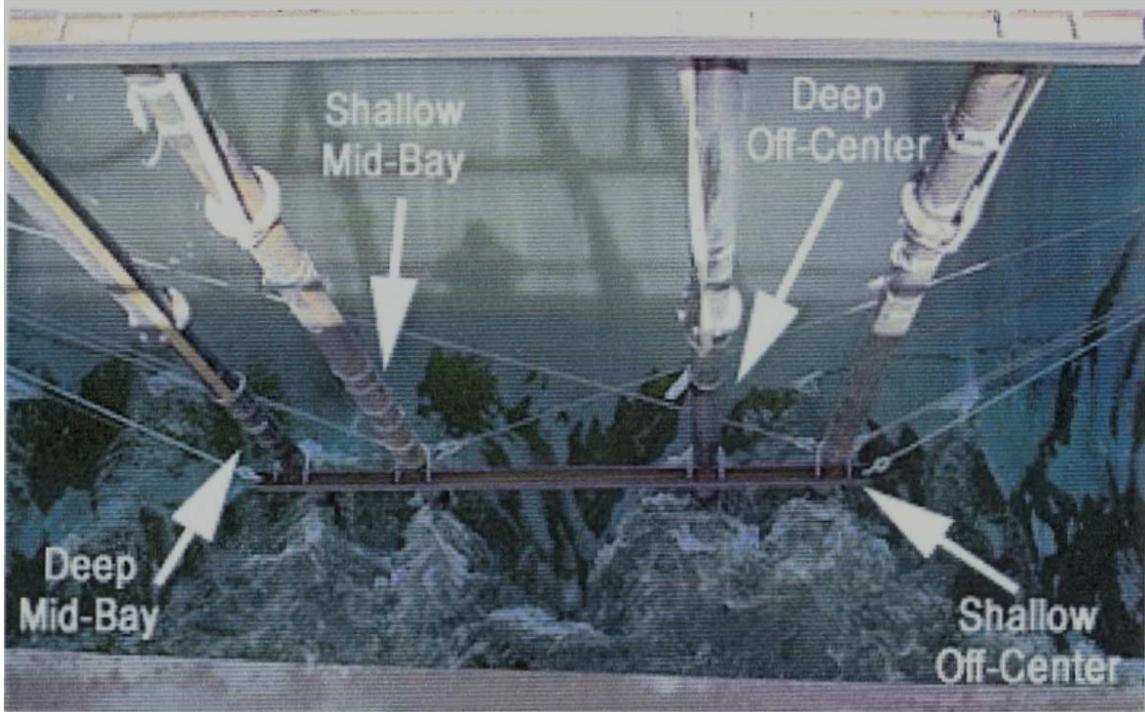


Figure 2-1

Pipes (multiple system at Spillbay 4) to release treatment juvenile salmonids into Spillbays 2 and 4 at The Dalles Dam, 2004.

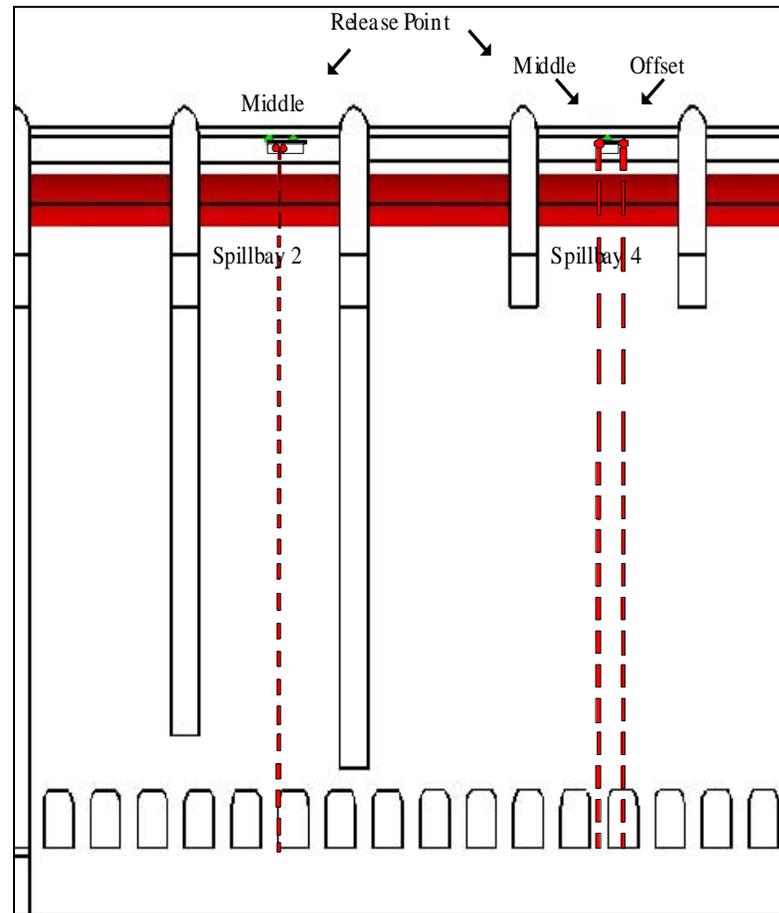
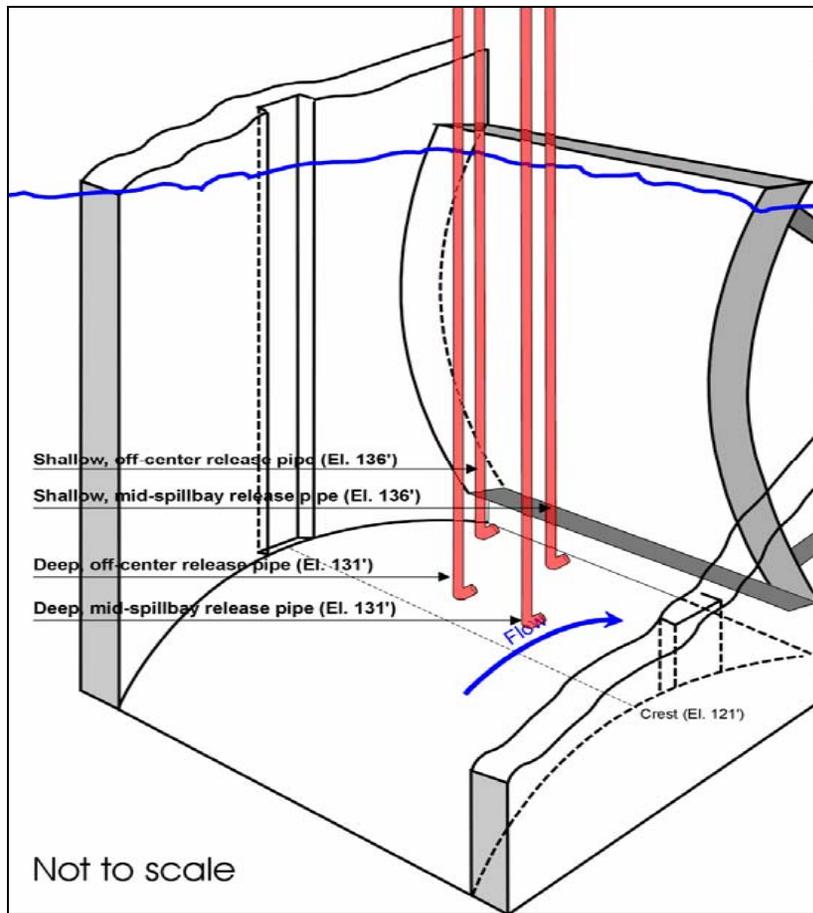


Figure 2-2

Release pipe locations in Spillbays 2 (two pipes) and 4 (four pipes) with potential trajectory of treatment fish (dashed line) at The Dalles Dam, 2004.

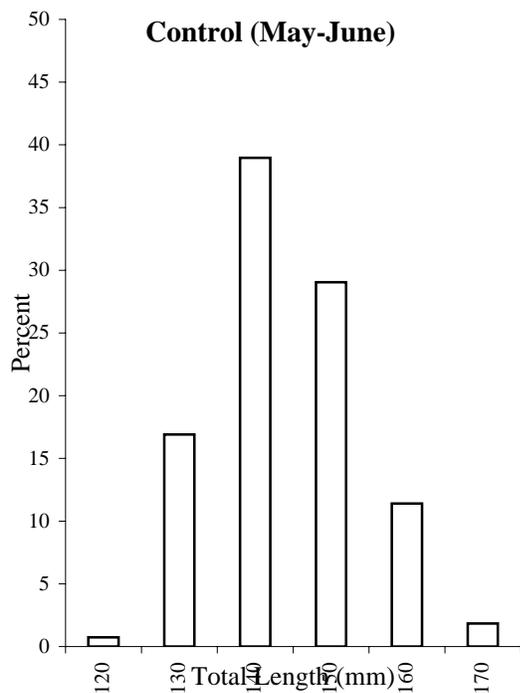
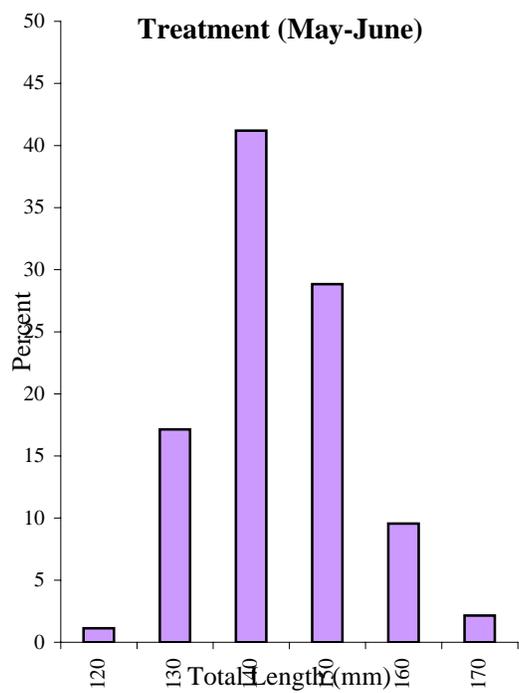
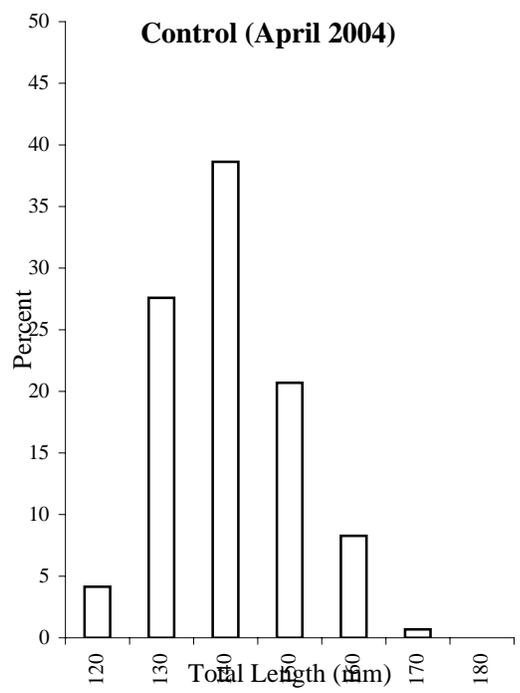
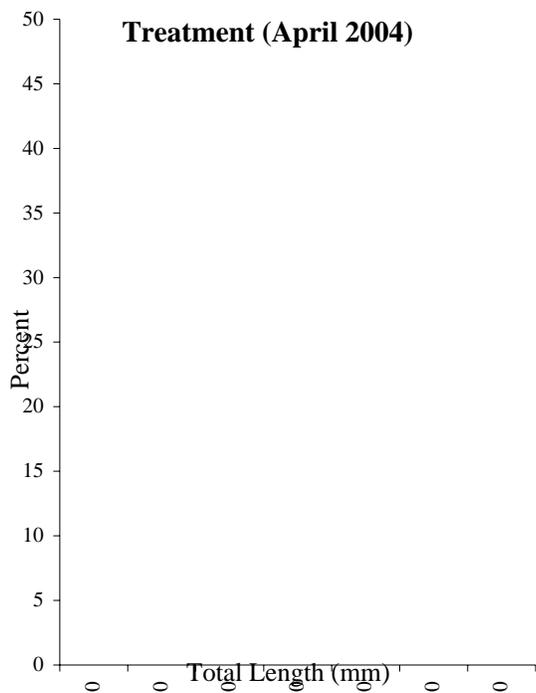


Figure 2-4
Length frequency distribution of treatment and control juvenile chinook salmon released for passage survival estimates at Spillbays 2, 4, and 6 (vortex) at The Dalles Dam, April, and May-June 2004.

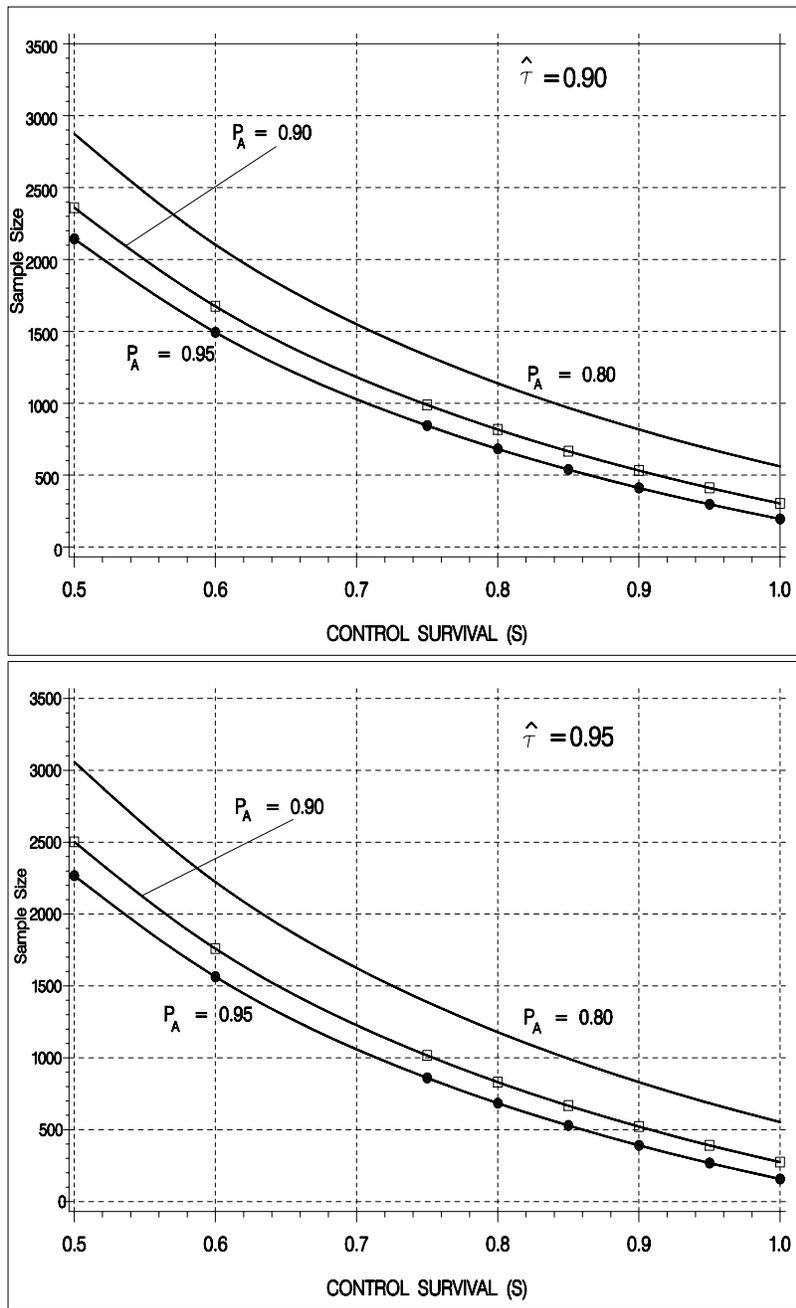


Figure 2-5 Example of sample size dependence on control survival (S) and recapture (P_A) to achieve precision(ϵ) of 0.05 at $1-\alpha=0.90$ for two expected survival rates ($\hat{\tau}$).

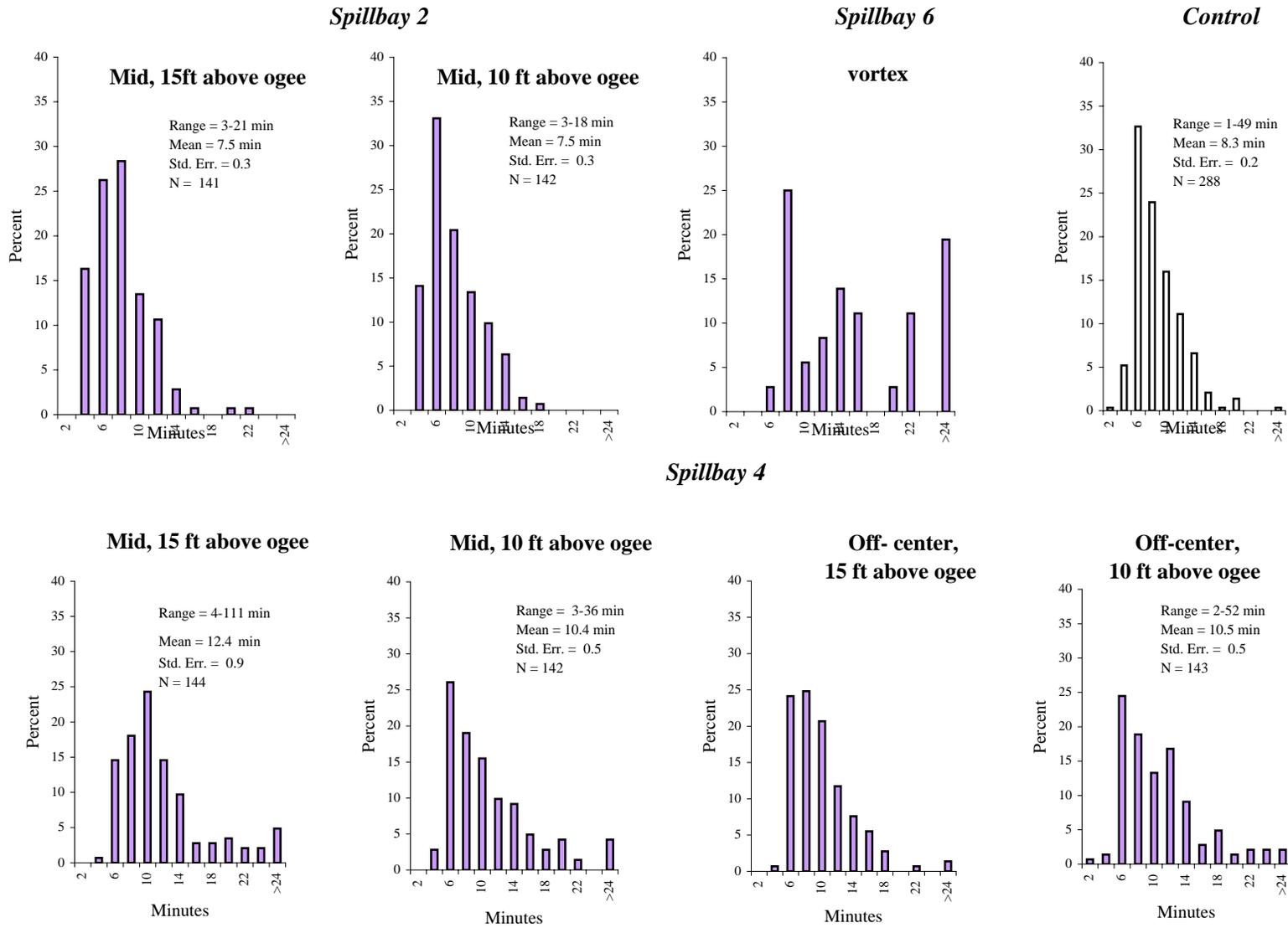
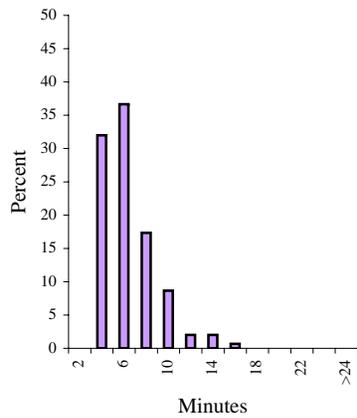


Figure 3-1

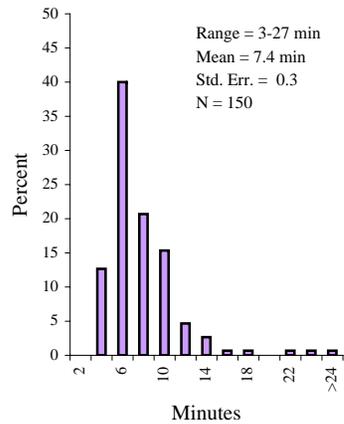
Frequency distribution of recapture times (minutes) of treatment and control juvenile chinook salmon released for passage survival estimates at Spillbays 2, 4, and 6 (vortex) at The Dalles Dam, April 2004.

Spillbay 2

Mid, 15 ft above ogee

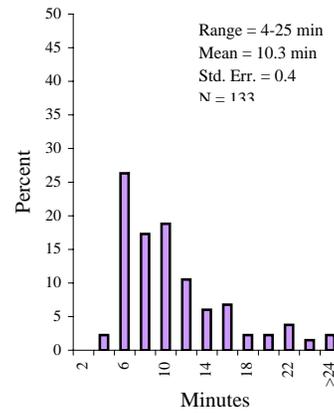


Mid, 10 ft above ogee

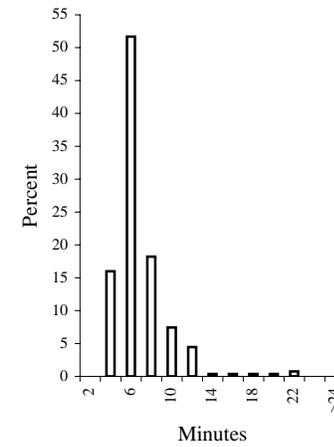


Spillbay 6

vortex

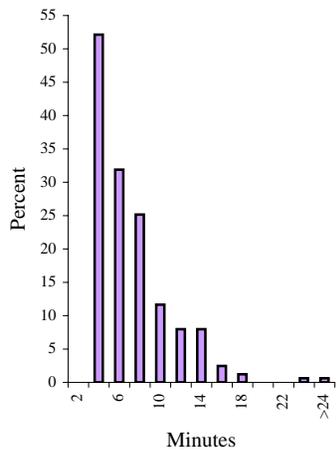


Control

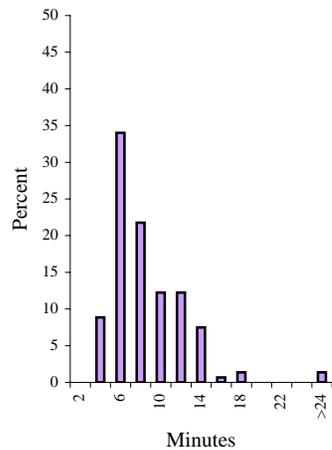


Spillbay 4

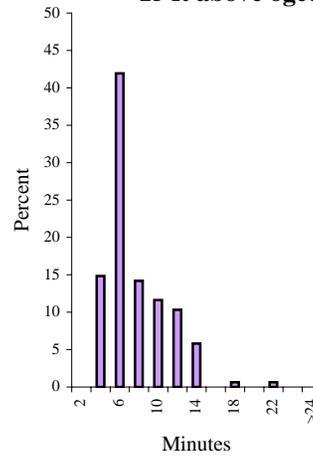
Mid, 15 ft above ogee



Mid, 10 ft above ogee



**Off-center,
15 ft above ogee**



**Off-center,
10 ft above ogee**

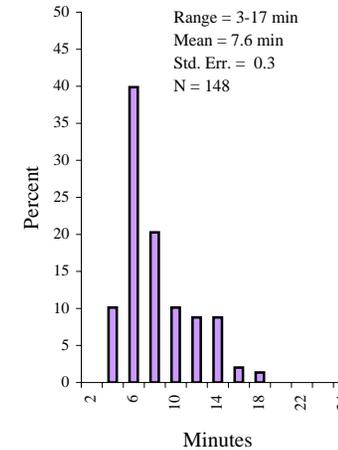
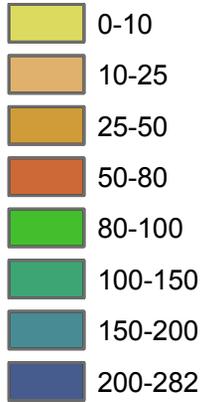


Figure 3-2

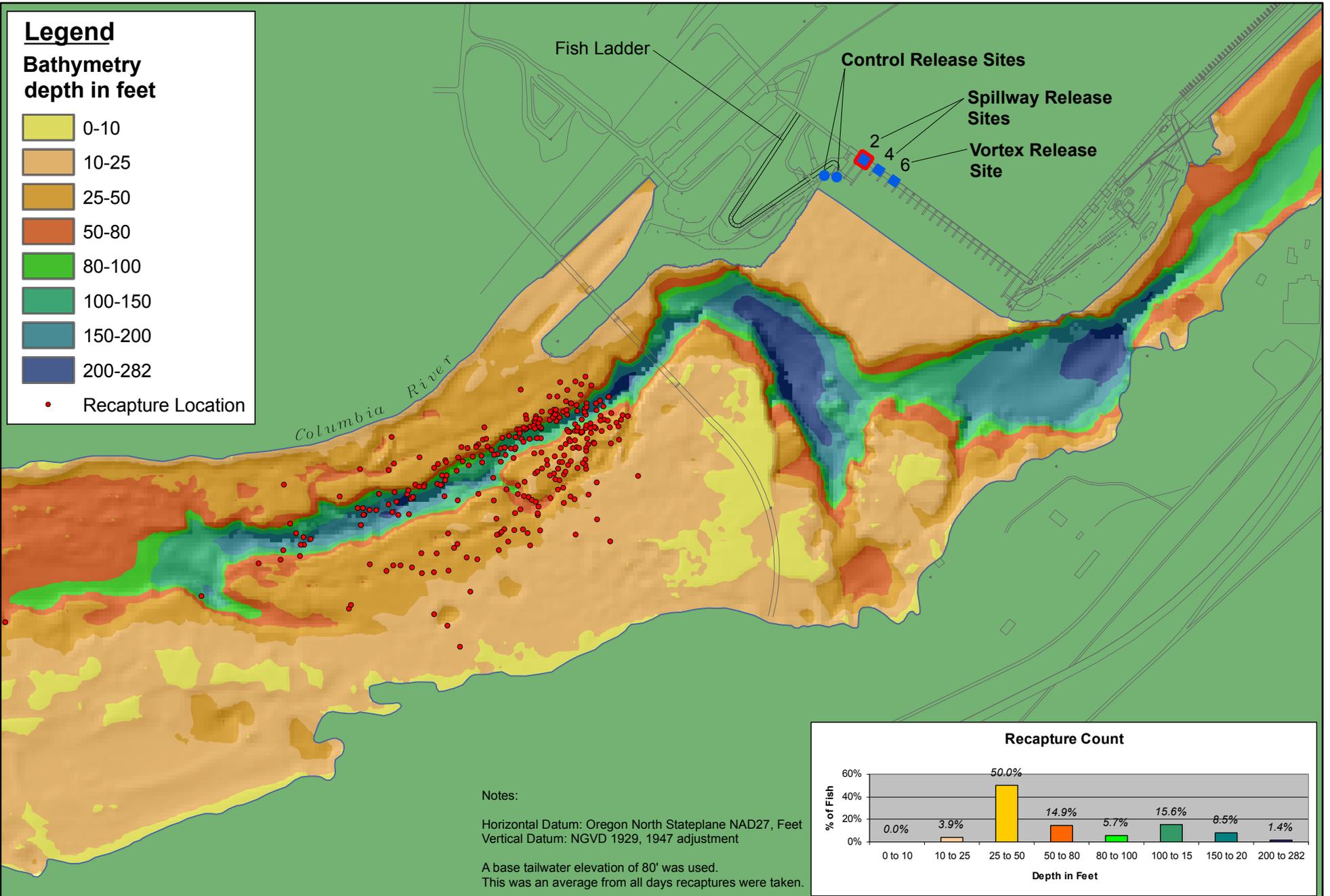
Frequency distribution of recapture times (minutes) of treatment and control juvenile chinook salmon released for passage survival estimates at Spillbays 2, 4, and 6 (vortex) at The Dalles Dam, May - June 2004.

Legend

Bathymetry depth in feet



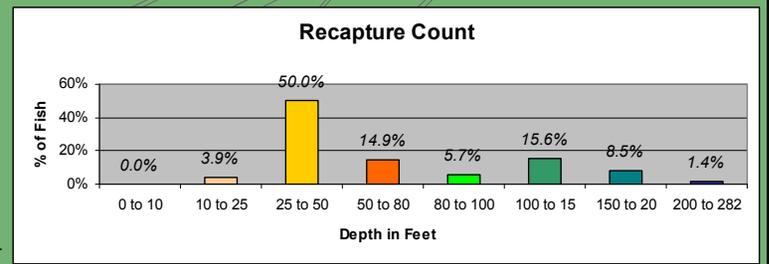
• Recapture Location



Notes:

Horizontal Datum: Oregon North Stateplane NAD27, Feet
 Vertical Datum: NGVD 1929, 1947 adjustment

A base tailwater elevation of 80' was used.
 This was an average from all days recaptures were taken.



NORMANDEAU ASSOCIATES
 ENVIRONMENTAL CONSULTANTS

Date:
 February 2005

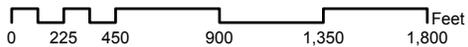
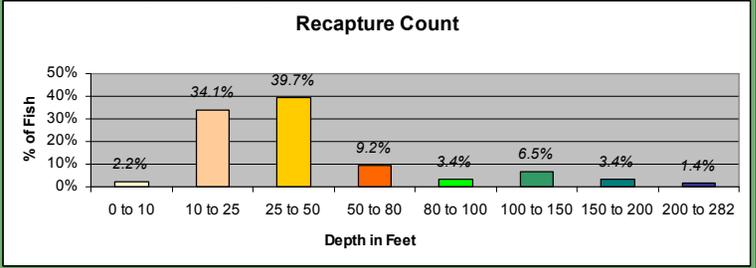
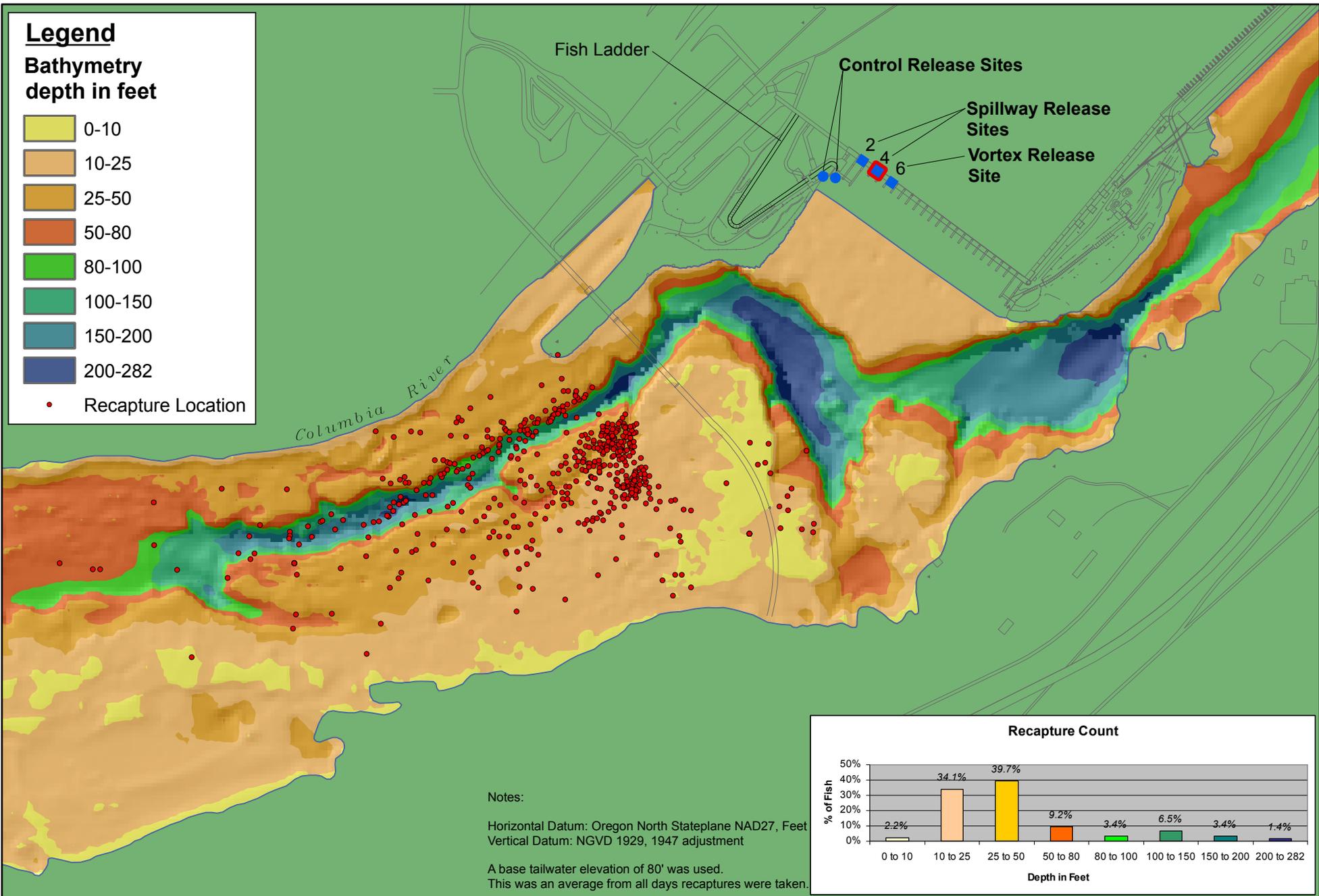
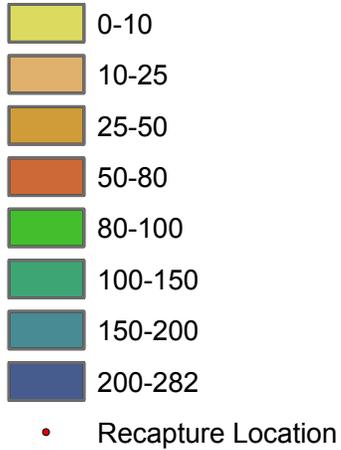


Figure 3-3.

Recapture locations of juvenile Chinook salmon passed through Spillway 2 at the Dalles Dam Spillway April 2004

Legend

Bathymetry depth in feet



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Date:
February 2005

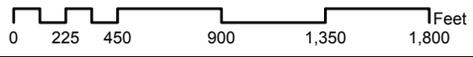
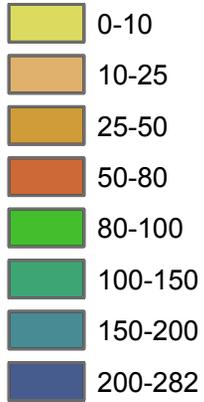


Figure 3-4.

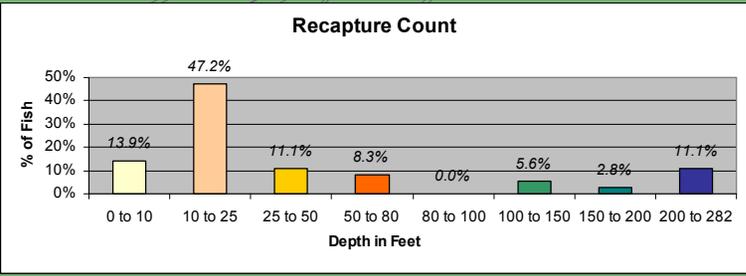
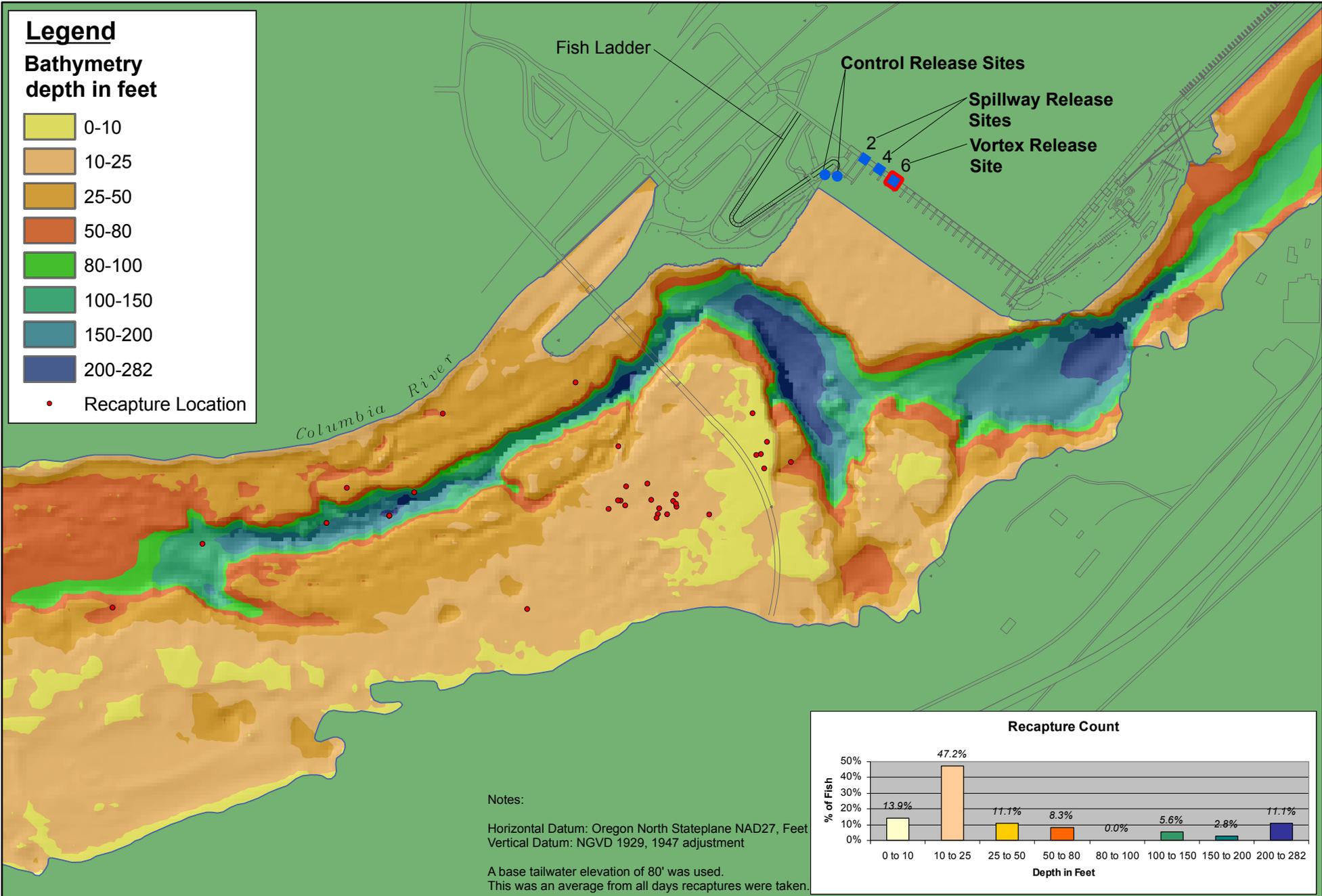
Recapture locations of juvenile Chinook salmon passed through Spillway 4 at the Dalles Dam Spillway April 2004

Legend

Bathymetry depth in feet



• Recapture Location



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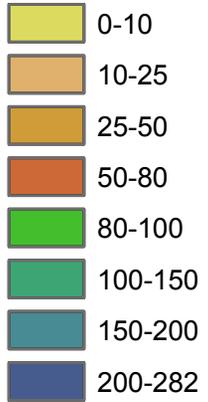


Figure 3-5.

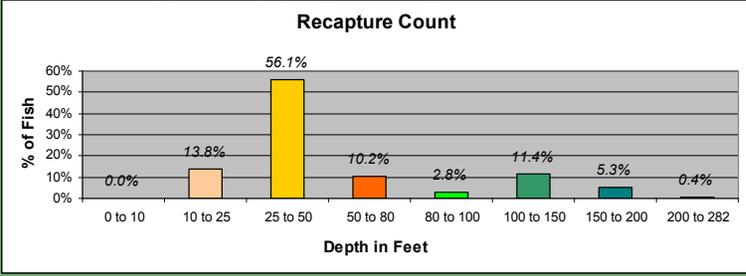
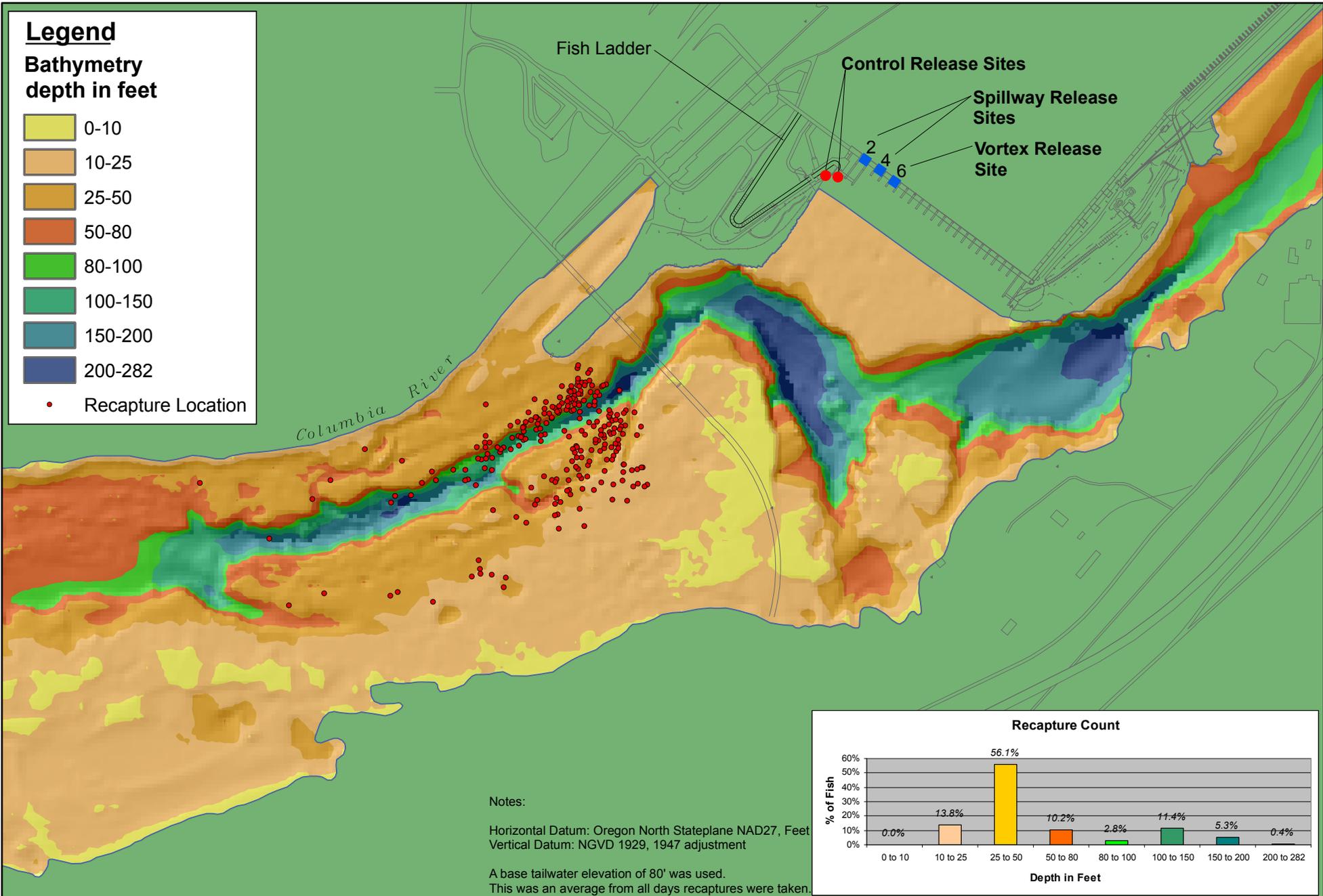
Recapture locations of juvenile Chinook salmon passed through the Vortex at the Dalles Dam Spillway April 2004

Legend

Bathymetry depth in feet



• Recapture Location



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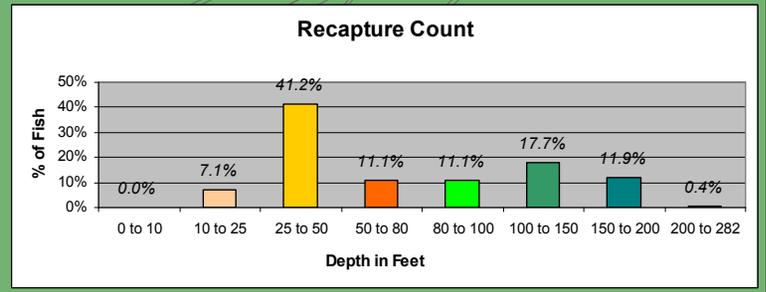
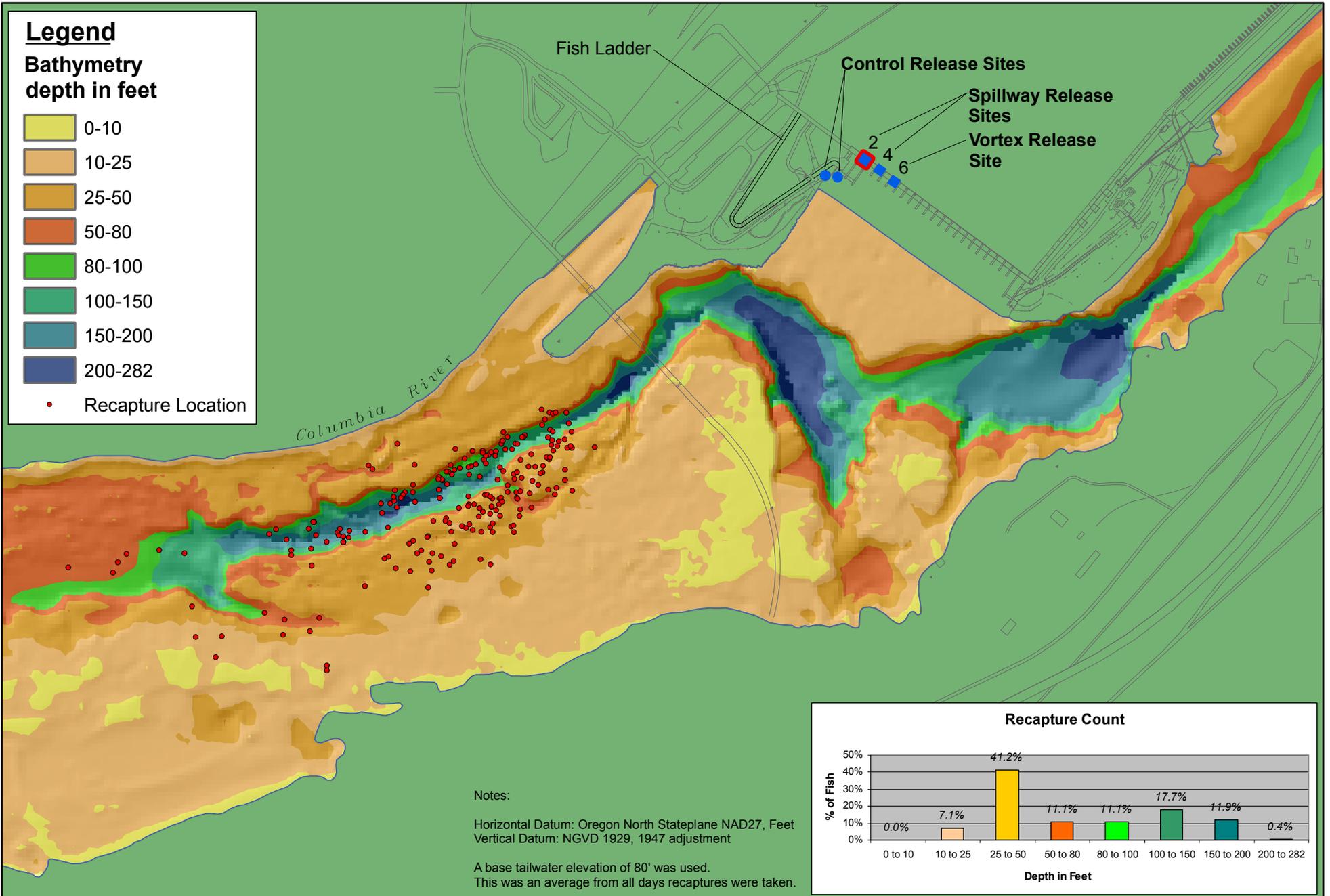
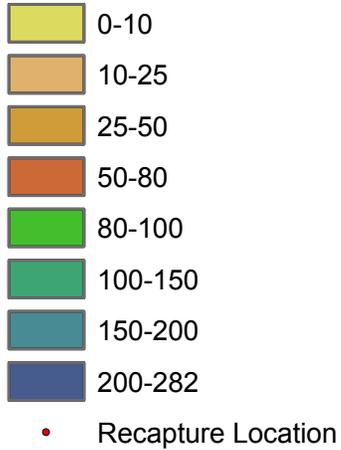


Figure 3-6.

Recapture locations of juvenile Chinook salmon passed through the Control Site at the Dalles Dam Spillway April 2004

Legend

Bathymetry depth in feet



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Date:
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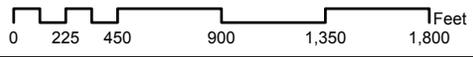
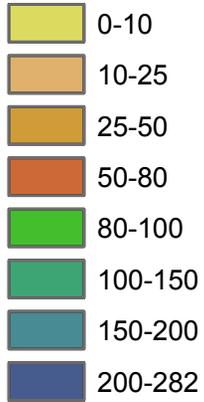


Figure 3-7.

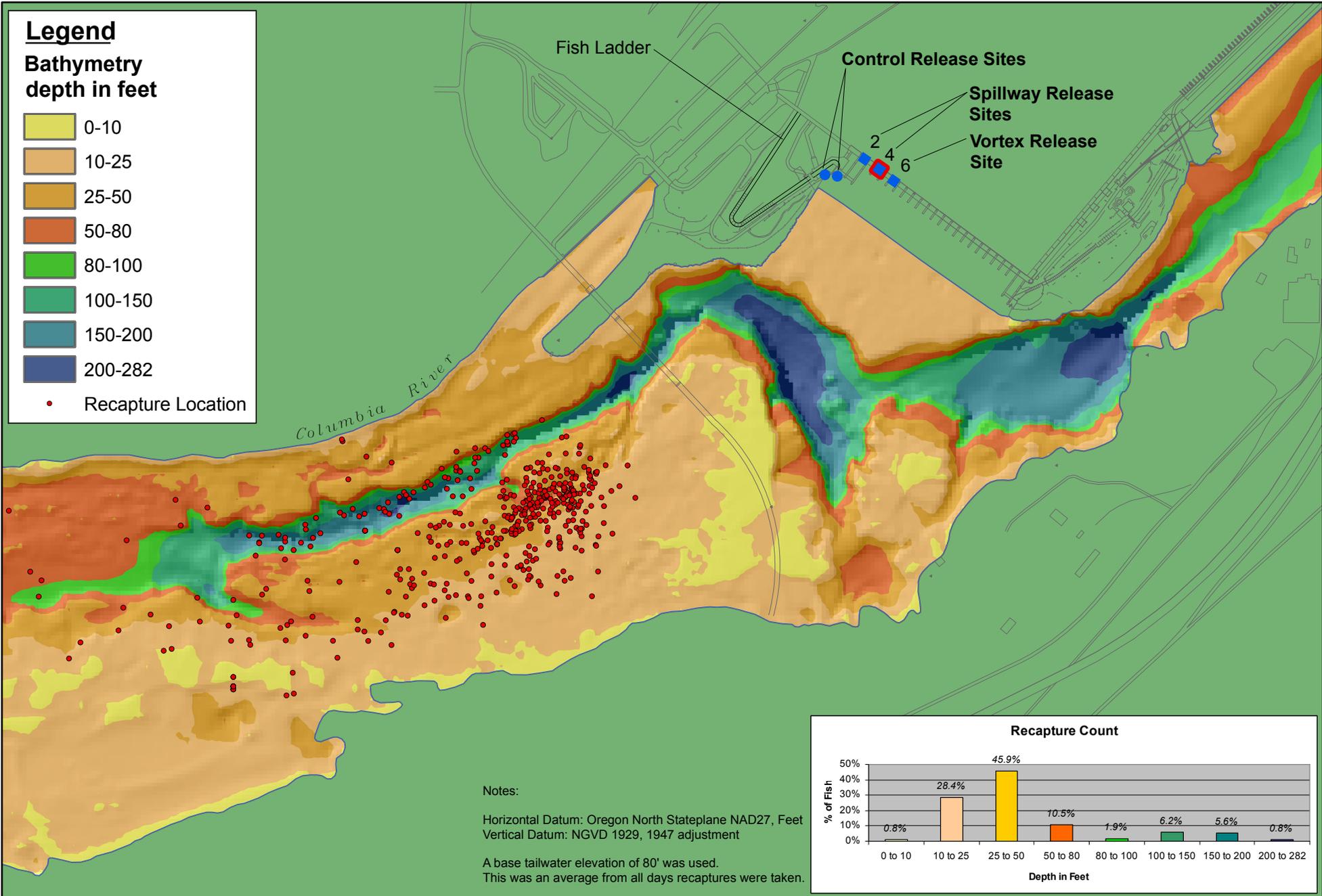
Recapture locations of juvenile Chinook salmon passed through Spillway 2 at the Dalles Dam Spillway May/June 2004

Legend

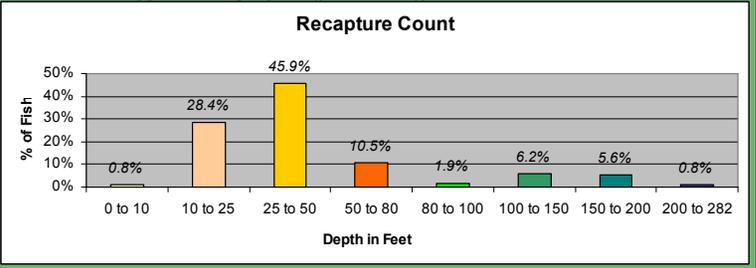
Bathymetry depth in feet



• Recapture Location



Notes:
 Horizontal Datum: Oregon North Stateplane NAD27, Feet
 Vertical Datum: NGVD 1929, 1947 adjustment
 A base tailwater elevation of 80' was used.
 This was an average from all days recaptures were taken.



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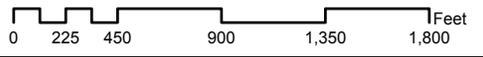
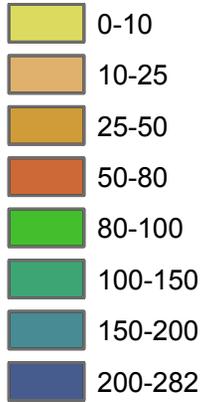


Figure 3-8.

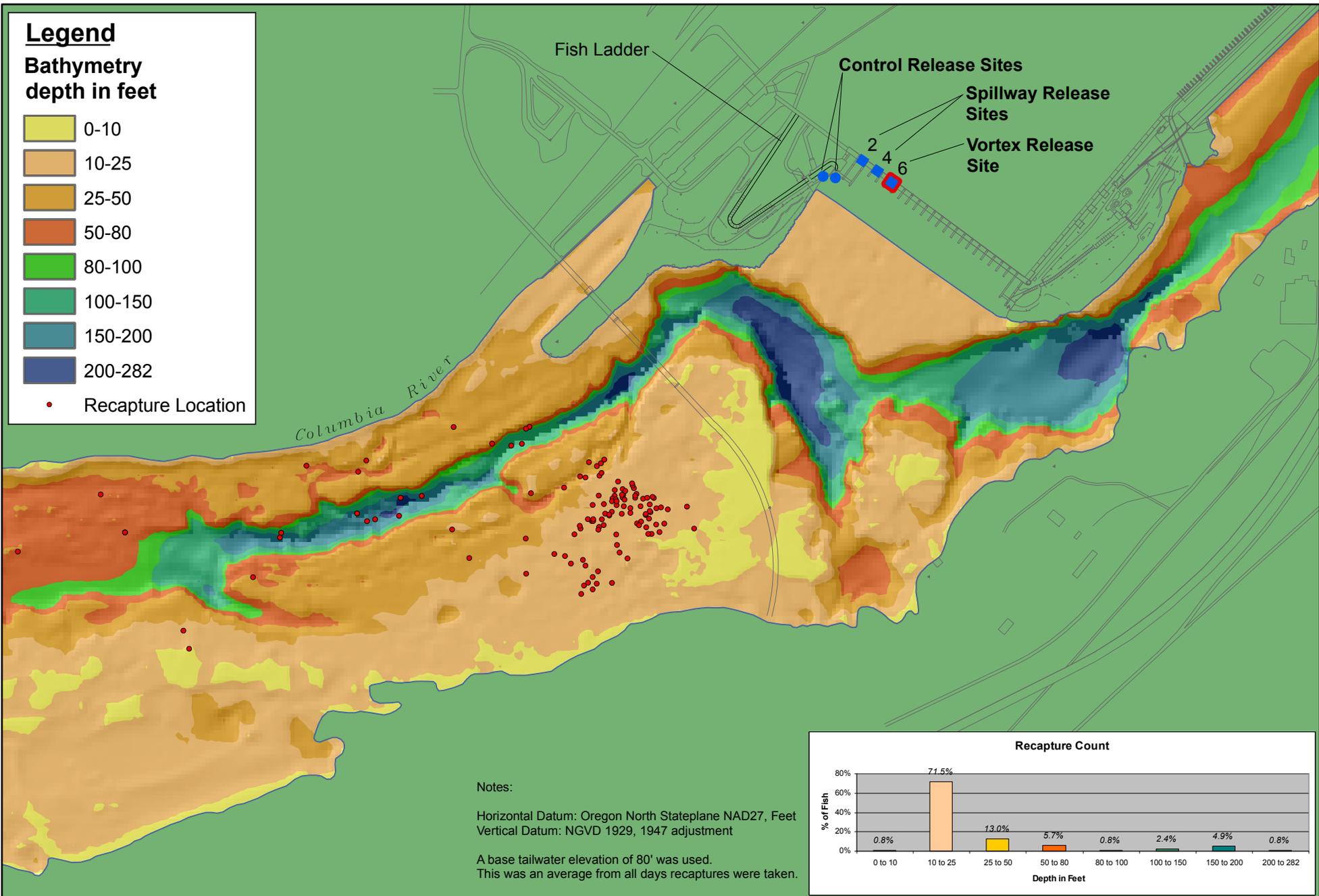
Recapture locations of juvenile Chinook salmon passed through Spillway 4 at the Dalles Dam Spillway May/June 2004

Legend

Bathymetry depth in feet



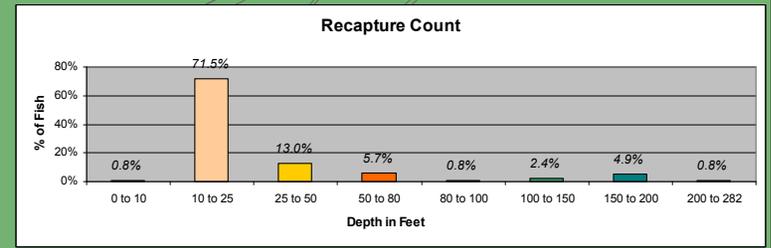
• Recapture Location



Notes:

Horizontal Datum: Oregon North Stateplane NAD27, Feet
Vertical Datum: NGVD 1929, 1947 adjustment

A base tailwater elevation of 80' was used.
This was an average from all days recaptures were taken.



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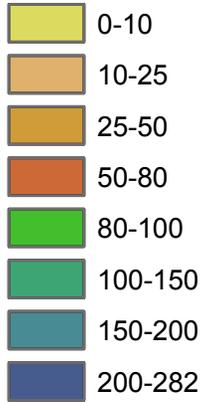


Figure 3-9.

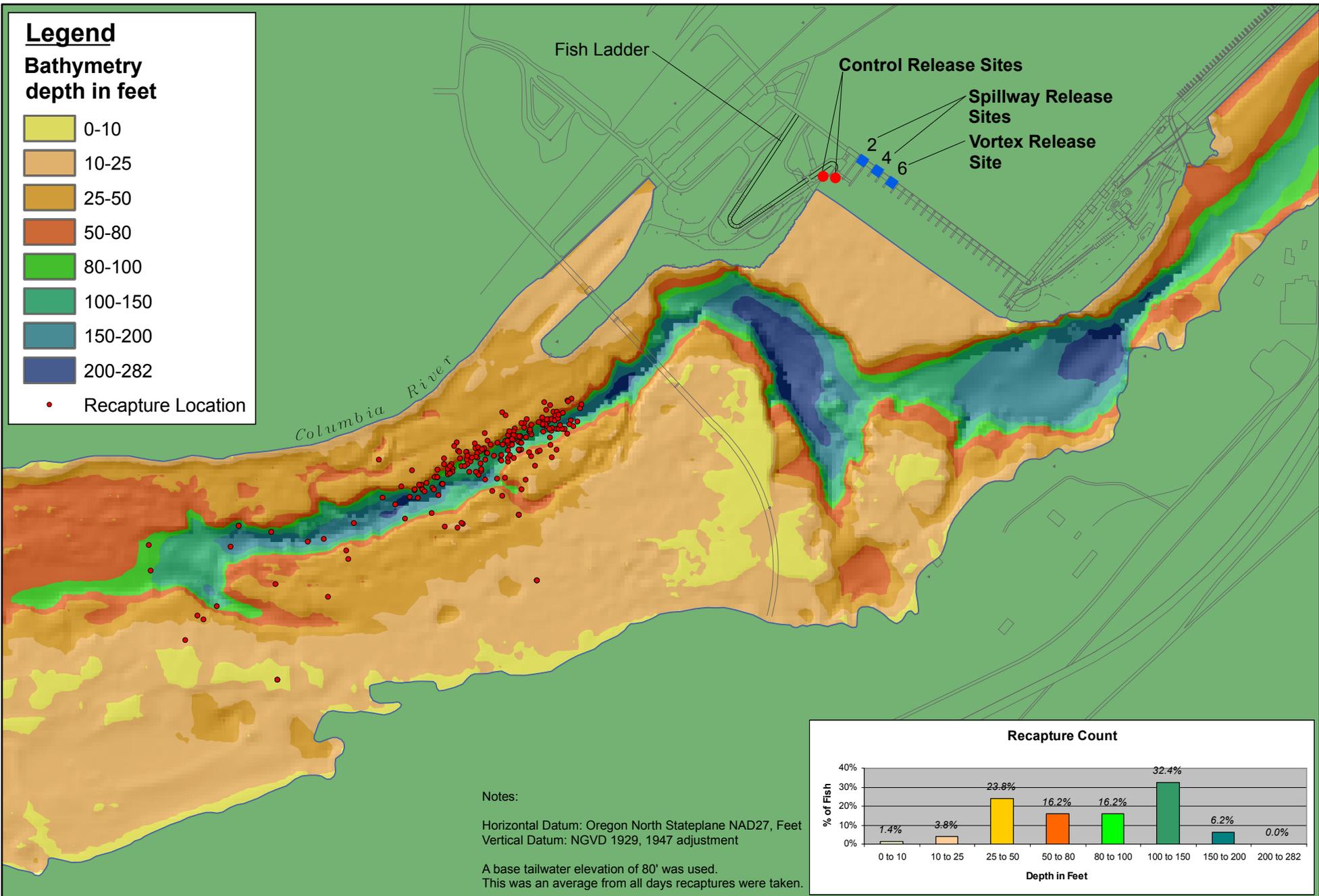
Recapture locations of juvenile Chinook salmon passed through the Vortex at the Dalles Dam Spillway May/June 2004

Legend

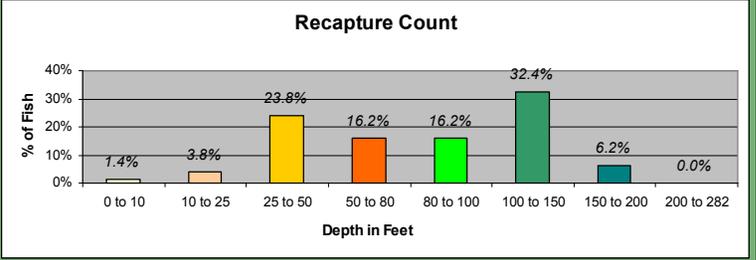
Bathymetry depth in feet



• Recapture Location



Notes:
 Horizontal Datum: Oregon North Stateplane NAD27, Feet
 Vertical Datum: NGVD 1929, 1947 adjustment
 A base tailwater elevation of 80' was used.
 This was an average from all days recaptures were taken.



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Figure 3-10.

Recapture locations of juvenile Chinook salmon passed through the Control Site at the Dalles Dam Spillway May/June 2004

Appendix Table A-1

Sample size, recapture and control survival rates, and estimated 48 h survival (direct effects) of juvenile salmonids in passage through non-turbine exit route at hydroelectric dams on the Columbia River Basin. Estimates based on balloon tag-recapture methodology (Heisey *et al.* 1992). Source: Normandeau Associates et al.

Station	Exit Route	Species	Water Temp. (°C)	Sample Size	Head (ft)	Test Spill Volume (kcfs)	Recapture Rates (%)		Control Survival (%)	Passage Survival (%)
							Control	Treatment		
The Dalles, WA	Spillbay 3	Chinook salmon	15-17	270	81	10.5	97.0	94.1	97.0	95.5
	Spillbay 4 ^b	Chinook salmon	15-17	271	81	10.5	97.0	97.4	97.0	99.3
	Spillbay 6 ^b	Chinook salmon	15-17	210	81	4.5	96.2	94.3	96.2	99.0
	Spillbay 4	Chinook salmon	10-14	391	75-80	7.5-10.5	98.7	96.7	98.0	97.4
	Spillbay 9	Chinook salmon	10-14	396	75-80	4.5-7.5	98.7	95.4	98.0	97.4
	Spillbay 13	Chinook salmon	10-14	405	75-80	3.0-6.0	98.7	93.8	98.0	93.8
	Spillbay 2 ^g	Chinook salmon	9-15	345	80-84	4.5	97.6	95.1	97.1	92.5
	Spillbay 2 ^g	Chinook salmon	9-15	45	80-84	12.0	N/A	95.6	N/A	96.7
	Spillbay 2 ^h	Chinook salmon	9-15	45	80-84	12.0	N/A	100.0	N/A	100.0
	Spillbay 2 ^g	Chinook salmon	9-15	120	80-84	12.0	98.9	99.2	98.9	100.0
	Spillbay 2 ^h	Chinook salmon	9-15	120	80-84	12.0	98.9	98.3	98.9	96.9
	Spillbay 4 ^g	Chinook salmon	9-15	345	80-84	4.5	98.2	98.3	98.2	96.5
	Spillbay 4 ^g	Chinook salmon	9-15	120	80-84	12.0	98.9	98.3	98.9	99.5
	Spillbay 4 ^h	Chinook salmon	9-15	120	80-84	12.0	98.9	99.2	98.9	98.6
	Spillbay 2 ^g	Chinook salmon	13-16	190	75-79	9.0	100	98.9	98.9	97.5
	Spillbay 2 ^{f,g}	Chinook salmon	13-16	189	75-79	9.0	100.0	95.8	98.9	93.1
	Spillbay 2 ^g	Chinook salmon	13-16	110	74-80	12.0	99.2	100.0	99.2	98.5
	Spillbay 2 ^{f,g}	Chinook salmon	13-16	108	74-80	12.0	99.2	98.1	99.2	99.3
	Spillbay 2 ^g	Chinook salmon	13-16	149	76-79	18.0	98.6	100.0	98.2	100.0
	Spillbay 2 ^{f,g}	Chinook salmon	13-16	150	76-79	18.0	98.6	100.0	98.2	99.2
	Spillbay 2 ^h	Chinook salmon	13-16	149	75-80	18.0	98.6	99.3	98.2	99.2
	Spillbay 2 ^{f,h}	Chinook salmon	13-16	150	75-79	18.0	98.6	98.7	98.2	97.8
	Spillbay 2 ^g	Chinook salmon	13-16	100	77-78	21.0	99.4	100.0	99.4	98.2
	Spillbay 2 ^{f,g}	Chinook salmon	13-16	100	77-80	21.0	99.4	100.0	99.4	93.1
	Spillbay 2 ^h	Chinook salmon	13-16	100	76-77	21.0	99.4	98.0	99.4	95.1

Appendix Table A-1

Continued.

Station	Exit Route	Species	Water Temperature (°C)	Sample Size	Head (ft)	Test Spill Volume (kcfs)	Recapture Rates (%)		Control Survival (%)	Passage Survival (%)
							Control	Treatment		
The Dalles, WA	Spillbay 2 ^{f,h}	Chinook salmon	13-16	100	76-78	21.0	99.4	100.0	99.4	98.2
	Spillbay 4 ^g	Chinook salmon	13-16	241	74-78	9.0	100.0	97.5	98.9	96.6
	Spillbay 4 ^g	Chinook salmon	13-16	160	74-79	12.0	99.2	98.8	99.2	99.9
	Spillbay 4 ^g	Chinook salmon	13-16	200	77-79	18.0	98.6	100.0	98.2	99.7
	Spillbay 4 ^h	Chinook salmon	13-16	209	75-79	18.0	98.6	98.1	98.2	97.3
	Spillbay 2	Chinook salmon	10-11	145	79-84	10.2-12.4	99.3	97.2	98.6	0.972
	Spillbay 2	Chinook salmon	10-11	145	79-84	11.0-13.2	99.3	97.9	98.6	0.993
	Spillbay 4	Chinook salmon	10-11	146	79-84	10.2-12.4	99.3	98.6	98.6	1.000
	Spillbay 4	Chinook salmon	10-11	145	79-84	11.0-14.7	99.3	97.9	98.6	0.986
	Spillbay 4 ^f	Chinook salmon	10-11	145	79-84	10.3-11.0	99.3	100.0	98.6	1.000
	Spillbay 4 ^f	Chinook salmon	10-11	144	79-84	11.0-14.7	99.3	99.3	98.6	0.986
	Spillbay 6 ^c	Chinook salmon	10-11	39	79-84	7.4-12.4	99.3	92.3	98.6	0.959
	Spillbay 2	Chinook salmon	14-15	150	76-81	15.2-20.1	98.9	99.3	99.6	0.99
	Spillbay 2	Chinook salmon	14-15	150	76-81	17.6-20.6	98.9	100.0	99.6	0.977
	Spillbay 4	Chinook salmon	14-15	165	76-81	15.2-20.4	98.9	98.8	99.6	0.961
	Spillbay 4	Chinook salmon	14-15	149	76-81	17.5-20.5	98.9	98.7	99.6	0.990
	Spillbay 4 ^f	Chinook salmon	14-15	155	76-81	15.2-20.4	98.9	100.0	99.6	0.978
	Spillbay 4 ^f	Chinook salmon	14-15	150	76-81	14.0-20.5	98.9	100.0	99.6	0.997
	Spillbay 6 ^c	Chinook salmon	14-15	149	76-81	13.9-17.5	98.9	89.5	99.6	0.851
	Wanapum, WA	Sluice	Chinook salmon	5-8	195	79	2.0	100.0	97.9	100.0
Spillbay 2		Chinook salmon	5-8	235	79	4.3	100.0	99.6	99.6	99.6
Spillbay 3 ^a		Chinook salmon	5-8	235	79	4.3	100.0	97.9	99.6	95.7
Spillbay 12 ^b		Chinook salmon	5-8	155	79	2.0	100.0	97.4	100.0	92.0
Spillbay 12 ^b		Chinook salmon	5-8	160	79	4.0	96.7	98.8	96.7	96.9
Spillbay 3		Chinook salmon	17-18	180	82	2.8	100.0	100.0	94.5	100.0
Spillbay 4		Chinook salmon	17-18	244	82	6.0	100.0	99.6	95.8	99.3
Spillbay 5		Chinook salmon	17-18	130	82	11.5	98.4	99.2	94.3	94.6
Spillbay 4 ^a		Chinook salmon	17-18	200	82	2.8	100.0	100.0	96.5	99.0

Appendix Table A-1

Continued.

Station	Exit Route	Species	Water Temperature (°C)	Sample Size	Head (ft)	Test Spill Volume (kcfs)	Recapture Rates (%)		Control Survival (%)	Passage Survival (%)
							Control	Treatment		
Wanapum, WA	Spillbay 4 ^a	Chinook salmon	17-18	199	82	6.0	100.0	98.5	95.3	97.6
	Spillbay 4 ^a	Chinook salmon	17-18	191	82	11.5	98.4	96.7	94.3	92.8
	Spillbay 3	Chinook salmon	16	180	82	2.8	100.0	100.0	97.5	99.4
	Spillbay 3	Chinook salmon	16	169	82	6.0	100.0	100.0	95.8	97.6
	Spillbay 3	Chinook salmon	16	198	82	7.5	100.0	100.0	94.3	99.5
	Spillbay 3 ^a	Chinook salmon	16	180	82	2.8	100.0	100.0	96.5	98.3
	Spillbay 5 ^a	Chinook salmon	16	170	82	6.0	100.0	98.8	95.3	98.2
	Spillbay 5 ^a	Chinook salmon	16	210	82	7.5	100.0	99.0	82.3	97.6
	Bypass Pipe	Chinook salmon	16	500	76-80	0.4	99.6	99.8	99.6	100.0
	Spillbay 12 ^{a,b}	Chinook salmon	5-6	300	81-82	10.4-12.5	100.0	99.0	97.3	99.0
Bonneville, WA	Spillbay 2	Chinook salmon	15-17	280	60	12.0	96.1	96.8	96.1	100.0
	Spillbay 4 ^a	Chinook salmon	15-17	280	60	12.0	96.1	99.3	96.1	100.0
	Spillbay 14 ^a	Chinook salmon	12-14	130	54-58	3.2-4.8	100.0	97.7	97.7	97.9
	Spillbay 16 ^{a*}	Chinook salmon	12-14	166	54-58	3.2-6.4	100.0	95.8	97.7	95.9
	Spillbay 14 ^a	Chinook salmon	12-14	238	50-55	5.1-7.9	95.4	98.3	97.7	98.6
	Spillbay 16 ^{a*}	Chinook salmon	12-14	241	50-55	7.1-9.8	95.4	97.1	97.7	99.0
	Spillbay 16 ^{a*}	Chinook salmon	20-21	166	60-65	4.0-4.1	86.9	83.7	82.6	90.5
	Spillbay 16 ^{a*}	Chinook salmon	20-21	185	60-65	5.0-6.0	86.9	88.1	82.6	88.6
	Spillbay 14 ^a	Chinook salmon	20-21	250	60-64	5.0-6.0	87.6	87.6	82.6	100.0
	Spillbay 16 ^{a*}	Chinook salmon	20-21	250	60-64	6.9-7.9	87.6	89.6	82.6	100.0
	Powerhouse I sluice	Chinook salmon	15-17	100	60	0.2-0.3	NA	93.0	NA	93.0
	Powerhouse II sluice	Chinook salmon	15-17	100	60	0.7	NA	90.0	NA	89.0
	Powerhouse II sluice	Chinook salmon	14-16	250	50-58	1.0	99.6	100.0	99.6	99.6
	Powerhouse II sluice	Chinook salmon	14-16	251	50-58	2.5	99.6	100.0	99.6	100.0
Powerhouse II sluice	Chinook salmon	16-18	348	63-67	1.0	99.4	100.0	99.4	100.0	
Powerhouse II sluice	Chinook salmon	16-18	345	63-67	2.5	99.4	100.0	99.4	99.4	
Lower Granite, WA	Spillbay 2 ^a	Chinook salmon	9-10	120	90	3.4	100.0	100.0	100.0	97.5
	Surface Bypass Collector ^a	Chinook salmon	9-10	120	90	3.4	100.0	99.2	100.0	95.8

Appendix Table A-1

Continued.

Station	Exit Route	Species	Water Temperature (°C)	Sample Size	Head (ft)	Test Spill Volume (kcfs)	Recapture Rates (%)		Control Survival (%)	Passage Survival (%)
							Control	Treatment		
Lower Granite, WA	Spillbay 2 ^a	Chinook salmon	8-10	130	90	3.4	92.1	94.6	92.1	97.6
	Surface Bypass Collector ^a	Chinook salmon	8-10	133	90	3.4	92.1	97.8	92.1	97.0
	Spillbay 2 ^a	Chinook salmon	10-11	130	97-98	5.7	100.0	100.0	100.0	100.0
	Spillbay 1 ^{a,b} (RSW)	Chinook salmon	10-11	260	97-99	7.0	100.0	99.2	100.0	98.1
Little Goose, WA	Spillbay 1	Steelhead	8-9	150	90	5.6	100.0	100.0	100.0	100.0
	Spillbay 1	Steelhead	8-9	150	90	9.5	100.0	100.0	100.0	100.0
	Spillbay 1	Steelhead	8-9	100	90	1.8	99.0	100.0	99.0	100.0
	Spillbay 3 ^c	Steelhead	8-9	40	90	5.6	100.0	98.0	100.0	100.0
	Spillbay 3 ^c	Steelhead	8-9	120	90	9.5	100.0	99.0	100.0	98.3
	Spillbay 3 ^a	Steelhead	8-9	150	90	5.6	100.0	99.0	100.0	98.0
	Spillbay 1 ^a	Steelhead	8-9	150	90	9.5	100.0	100.0	100.0	100.0
	Spillbay 1 ^a	Steelhead	8-9	100	90	1.8	99.0	100.0	99.0	99.0
	Spillbay 3 ^{a,c}	Steelhead	8-9	39	90	5.6	100.0	100.0	100.0	100.0
	Spillbay 3 ^{a,c}	Steelhead	8-9	120	90	9.5	100.0	99.0	100.0	99.2
Ice Harbor, WA	Spillbay 5 ^a	Chinook salmon	10-12	310	93-96	3.4-5.1	99.3	99.7	99.3	98.7
	Spillbay 5 ^a	Chinook salmon	10-12	225	94-96	4.3-8.5	99.3	99.1	99.3	99.5
	Spillbay 5 ^a	Chinook salmon	10-12	120	96-97	8.5	99.3	100.0	99.3	98.7
	Spillbay 1 ^{a,g}	Chinook salmon	6-7	105	95-97	3.4	98.0	98.1	100.0	99.7
	Spillbay 1 ^{a,g}	Chinook salmon	6-7	105	95-96	3.4	98.0	97.1	100.0	98.8
	Spillbay 1 ^{a,h}	Chinook salmon	6-7	250	94-98	5.1	97.5	98.4	100.0	97.9
	Spillbay 1 ^{a,g}	Chinook salmon	6-7	250	93-99	5.1	97.5	97.2	100.0	98.6
	Spillbay 5 ^{a,g}	Chinook salmon	6-7	200	94-97	11.9	97.5	98.5	100.0	99.7
	Spillbay 5 ^{a,g}	Chinook salmon	6-7	200	95-100	11.9	97.5	98.0	100.0	99.7
	Spillbay 5 ^{a,h}	Chinook salmon	6-7	50	94	11.9	100.0	100.0	100.0	100.0
	Spillbay 5 ^{a,g}	Chinook salmon	6-7	40	99-100	11.9	100.0	100.0	100.0	100.0
	Spillbay 5 ^{a,g}	Chinook salmon	13-14	321	93-96	4.3	96.7	97.8	96.7	93.7
	Spillbay 5 ^{a,g}	Chinook salmon	13-14	287	92-96	4.3	96.7	99.0	96.7	100.0

Appendix Table A-1

Continued.

Station	Exit Route	Species	Water Temperature (°C)	Sample Size	Head (ft)	Test Spill Volume (kcf)	Recapture Rates (%)		Control Survival (%)	Passage Survival (%)
							Control	Treatment		
Ice Harbor, WA	Spillbay 5 ^{a,g}	Chinook salmon	13-14	362	94-97	11.9	96.7	95.9	96.7	96.2
Rock Island, WA	Spillbay 21 ^{b,h}	Chinook salmon	4	250	41	1.9	NA	98.0	NA	95.1
	Spillbay 23 ^b	Chinook salmon	4	250	41	10.0	NA	100.0	NA	98.4
	Spillbay 31 ^b	Chinook salmon	13-14	200	41-49	2.5	100.0	99.5	99.5	99.5
	Spillbay 31 ^b	Chinook salmon	13-14	200	41-49	10.0	100.0	100.0	99.5	99.5
	Spillbay 29 ^{a,b,e}	Chinook salmon	14-15	200	40-43	2.5	100.0	99.5	100.0	99.0
	Spillbay 29 ^{a,b}	Chinook salmon	14-15	200	40-43	2.5	100.0	100.0	100.0	100.0
	Spillbay 16 ^{a,b,e}	Chinook salmon	9-10	200	39-43	2.5	100.0	99.5	100.0	99.0
	Spillbay 16 ^{a,b}	Chinook salmon	9-10	200	39-43	2.5	100.0	100.0	100.0	99.0
North Fork, OR	Spillway	Chinook/coho	9-11	126	135	0.7	100.0	100.0	93.6	87.3
	Spillway	Chinook/coho	9-11	129	135	2.0	100.0	99.2	86.1	80.1
	Spillway	Steelhead	9-11	129	135	0.7	100.0	100.0	98.4	85.6
	Spillway	Steelhead	9-11	128	135	2.0	100.0	100.0	92.3	96.5

a Spillbay with flow deflector.

a* Spillbay with deep flow deflector.

b Overflow weir or slot to attract surface oriented juvenile salmonids.

c Fish released into head pond vortices upstream of tainter gates.

d Spill directed onto concrete slab; survival is relative to survival at another spillbay.

e Periphery release.

f Off-center release.

g Deep release.

h Shallow release.

l Spring tests only.

Appendix Table B-1

Average forebay, Tailwater, head (ft) and spill conditions at Spillbays 2, 4, and 6 during conduct of passage survival and condition investigation with juvenile chinook salmon at The Dalles Dam, 14-22 April 2004.

Date	Time	Entrainment			Discharge				
		Location ¹ and Depth (ft above ogee)	Elevation (ft)		Net Head (ft)	Est.Impact Velocity ² (fps)	Each Spillbay (1-6) (kcfs)	Total Spill Discharge (kcfs)	River Flow (kcfs)
			Forebay	Tailwater					
14-Apr	1005	2, Mid, 15 ft	158.5	77.4	81.1	64.8	10.2	60	150
14-Apr	1235	4, Mid, 15 ft	158.5	77.4	81.1	64.8	10.2	60	150
14-Apr	1445	4, OC, 15 ft	158.7	77.3	81.4	65.0	10.3	60	150
14-Apr	1630	control	158.7	76.7	82	65.2	9.5	60	150
		<i>Average</i>	<i>158.6</i>	<i>77.2</i>	<i>81.4</i>	<i>65.0</i>	<i>10.1</i>	<i>60</i>	<i>150</i>
15-Apr	925	2, Mid, 10ft	158.4	78.2	80.2	64.5	12.4*	80	208
15-Apr	1115	control	158.2	78	80.2	64.5	11.6**	74	185
15-Apr	1300	4, OC, 10ft	158.2	78	80.2	64.5	11.6	72	182
15-Apr	1435	4, Mid, 10 ft	158.1	78	80.1	64.4	12.3	72	181
		<i>Average</i>	<i>158.2</i>	<i>78.1</i>	<i>80.2</i>	<i>64.5</i>	<i>12.0</i>	<i>75</i>	<i>189</i>
16-Apr	925	2, Mid, 15 ft	158.9	78	80.9	64.8	11.7	72	182.5
16-Apr	1120	4, Mid, 15 ft	159	78	81	64.8	11.7	72	180.7
16-Apr	1255	control	158.7	78	80.7	64.7	10.3	60	161.7
16-Apr	1425	4, OC, 15 ft	158.7	78	80.7	64.7	10.3	60	151
		<i>Average</i>	<i>158.8</i>	<i>78.0</i>	<i>80.8</i>	<i>64.7</i>	<i>11.0</i>	<i>66</i>	<i>169</i>
17-Apr	925	control	158.6	78.2	80.4	64.6	11.7	68	168
17-Apr	1125	4, Mid, 10 ft	158.5	78.2	80.3	64.5	11.7	68	168
17-Apr	1305	4, OC, 10 ft	158.4	78.2	80.2	64.5	11.6	68	169
17-Apr	1445	2, Mid, 10 ft	158.4	78.1	80.3	64.5	11.6	68	168
		<i>Average</i>	<i>158.5</i>	<i>78.2</i>	<i>80.3</i>	<i>64.5</i>	<i>11.7</i>	<i>68</i>	<i>168</i>
19-Apr	930	2, Mid, 10 ft	159	77.6	81.4	65.0	11	65	170
19-Apr	1145	4, Mid, 10 ft	159.1	77.6	81.5	65.0	11	65	172
19-Apr	1415	4, OC, 10 ft	158.9	77.6	81.3	64.9	11	65	165
19-Apr	1630	control	158.9	77.6	81.3	64.9	11	65	165
		<i>Average</i>	<i>159.0</i>	<i>77.6</i>	<i>81.4</i>	<i>64.9</i>	<i>11.0</i>	<i>65</i>	<i>168</i>
20-Apr	945	control	158.6	77.3	81.3	64.9	6.5***	72	181
20-Apr	1600	4, Mid, 15 ft	158.6	77.9	80.7	64.7	11.7	72	180
20-Apr	1340	4, OC, 15 ft	158.6	77.5	81.1	64.8	11	72	180
20-Apr	1520	2, Mid, 15 ft	158.6	77.9	80.7	64.7	11.7	72	180
		<i>Average</i>	<i>158.6</i>	<i>77.7</i>	<i>81.0</i>	<i>64.8</i>	<i>10</i>	<i>72</i>	<i>180</i>
21-Apr	925	4, Mid, 10 ft	159	79.9	79.1	64.0	14.7	90	225
21-Apr	1105	4, OC, 10 ft	159	80	79	64.0	14.7	90	225
21-Apr	1250	2, Mid, 10 ft	158.8	79.8	79	64.0	13.2	80	200
21-Apr	1450	control	158.4	79.3	79.1	64.0	12.4	75	187
21-Apr	1640	6, vortex	158.4	79.3	79.1	64.0	12.4	75	187
		<i>Average</i>	<i>158.7</i>	<i>79.7</i>	<i>79.1</i>	<i>64.0</i>	<i>13.5</i>	<i>82</i>	<i>205</i>

Appendix Table B-1

Continued.

Date	Time	Entrainment			Discharge				
		Location ¹ and		Elevation (ft)	Net Head (ft)	Est.Impact Velocity ² (fps)	Each Spillbay (1-6) (kcfs)	Total Spill Discharge (kcfs)	River Flow (kcfs)
		Depth (ft above ogee)	Forebay						
22-Apr	900	2, Mid, 15 ft	158.3	78.3	80	64.4	12.4	76	190
22-Apr	1055	4, Mid, 15 ft	158.5	78.4	80.1	64.4	12.4	76	190
22-Apr	1245	4, OC, 15 ft	158.8	77.8	81	64.8	11	64	160
22-Apr	1315	6, vortex	159.7	76.2	83.5	65.8	7.4	45	110
22-Apr	1530	control	160	75.8	84.2	66.1	7.5	45	112
<i>Average</i>			<i>159.1</i>	<i>77.3</i>	<i>81.8</i>	<i>65.1</i>	<i>10.1</i>	<i>61</i>	<i>152</i>

1) 2, 4, 6 = Test Spillbay, M = mid spillbay release, OC = off-center release, 10 ft, 15 ft = distance above ogee.

2) Impact velocity estimate from formula $V = \text{SQRT of } 2gh \times 0.9$ ($g=32$, $h=\text{head}$, $0.9=\text{approx. correction for friction losses}$)

*12.4 kcfs through Spillbays 1-6 and 5.8 kcfs through Spillbay 7

**11.6 kcfs through Spillbays 1-6 and 5.8 kcfs through Spillbay 7

*** 6.5 kcfs through spillbays 1-7 and 4 kcfs through spillbay 8

Appendix Table B-2

Average forebay, Tailwater, head (ft) and spill conditions at Spillbays 2, 4, and 6 during conduct of passage survival and condition investigation with juvenile chinook salmon at The Dalles Dam, 26 May - 3 June 2004.

Date	Time	Entrainment			Discharge				River Flow (kcfs)
		Location ¹ and Depth (ft) above ogee)	Elevation (ft)		Net Head (ft)	Est. Impact Velocity ² (fps)	Each Spillbay (1-6) (kcfs)	Total Spill Discharge (kcfs)	
			Forebay	Tailwater					
26-May	1005	2, Mid, 15 ft	158.4	80.2	78.2	63.7	15.2	92	231
26-May	1030	2, Mid, 15 ft	158.4	80.2	78.2	63.7	15.2	92	231
26-May	1055	2, Mid, 15 ft	158.4	80.2	78.2	63.7	15.2	92	231
26-May	1125	4, Mid, 15 ft	158.5	80.3	78.2	63.7	15.2	92	230
26-May	1200	4, Mid, 15 ft	158.5	80.3	78.2	63.7	15.2	92	230
26-May	1220	4, Mid, 15 ft	158.5	80.3	78.2	63.7	15.2	92	230
26-May	1250	4, OC, 15 ft	158.5	80.3	78.2	63.7	15.2	92	230
26-May	1311	4, OC, 15 ft	158.5	80.3	78.2	63.7	15.2	92	230
26-May	1335	4, OC, 15 ft	158.5	80.3	78.2	63.7	15.2	92	230
26-May	1405	control	158.8	80.5	78.3	63.7	16.0	98	245
26-May	1430	control	158.8	80.5	78.3	63.7	16.0	98	245
26-May	1450	control	158.8	80.5	78.3	63.7	16.0	98	245
		<i>Average</i>	<i>158.6</i>	<i>80.3</i>	<i>78.2</i>	<i>63.7</i>	<i>15.4</i>	<i>94</i>	<i>234</i>
27-May	815	control	159.2	80.9	78.3	63.7	16.8	100	254
27-May	845	control	159.6	80.9	78.7	63.9	17.0	100	249
27-May	935	control	159.3	81.5	77.8	63.5	18.3	110	274
27-May	1015	4, OC, 10 ft	159.3	81.5	77.8	63.5	18.3	110	275
27-May	1050	4, OC, 10 ft	159.3	81.5	77.8	63.5	18.3	110	275
27-May	1125	4, OC, 10 ft	159.3	81.5	77.8	63.5	18.3	110	275
27-May	1145	4, Mid, 10 ft	159.0	81.5	77.5	63.4	18.2	110	274
27-May	1215	4, Mid, 10 ft	159.0	81.5	77.5	63.4	18.2	110	274
27-May	1245	4, Mid, 10 ft	159.0	81.5	77.5	63.4	18.2	110	274
27-May	1310	4, Mid, 10 ft	159.0	81.5	77.5	63.4	18.2	110	274
27-May	1340	2, Mid, 10 ft	158.5	82.1	76.4	62.9	18.1	110	276
27-May	1410	2, Mid, 10 ft	158.5	82.1	76.4	62.9	18.1	110	276
27-May	1450	2, Mid, 10 ft	158.1	81.6	76.5	63.0	18.7	110	273
27-May	1525	2, Mid, 10 ft	158.1	81.6	76.5	63.0	18.7	110	273
27-May	1600	4, OC, 10 ft	158.1	81.6	76.5	63.0	18.7	110	273
27-May	1625	control	158.2	81.5	76.7	63.1	16.6	100	249
		<i>Average</i>	<i>158.8</i>	<i>81.5</i>	<i>77.3</i>	<i>63.3</i>	<i>18.0</i>	<i>108</i>	<i>270</i>
28-May	820	4, OC, 15 ft	159.1	81.2	77.9	63.5	18.2	108	269
28-May	850	4, OC, 15 ft	159.3	81.2	78.1	63.6	18.3	108	267
28-May	930	4, OC, 15 ft	159.4	81.2	78.2	63.7	18.3	108	266
28-May	950	4, OC, 15 ft	159.4	81.2	78.2	63.7	18.3	108	265
28-May	1030	control	159.7	80.5	79.2	64.1	16.1	96	231
28-May	1100	control	159.7	80.5	79.2	64.1	16.1	96	231
28-May	1145	control	159.7	80.5	79.2	64.1	16.1	96	231
28-May	1245	4, Mid, 15 ft	159.1	80.6	78.5	63.8	16.1	96	233

Appendix Table B-2

Continued.

Date	Time	Entrainment			Discharge				
		Location ¹ and		Elevation (ft)	Net Head (ft)	Est. Impact Velocity ² (fps)	Each Spillbay (1-6) (kcfs)	Total Spill Discharge (kcfs)	River Flow (kcfs)
		Depth (ft above ogee)	Forebay						
28-May	1315	4, Mid, 15 ft	159.0	80.4	78.6	63.8	16.1	96	231
28-May	1350	4, Mid, 15 ft	159.0	80.4	78.6	63.8	16.1	96	231
28-May	1440	2, Mid, 15 ft	158.4	80.4	78.0	63.6	15.9	96	233
28-May	1500	2, Mid, 15 ft	158.3	80.4	77.9	63.5	15.9	96	232
28-May	1530	2, Mid, 15 ft	158.3	80.4	77.9	63.5	15.9	96	232
<i>Average</i>			<i>159.1</i>	<i>80.7</i>	<i>78.4</i>	<i>63.8</i>	<i>16.7</i>	<i>100</i>	<i>242</i>
29-May	810	2, Mid, 10 ft	159.9	82.3	77.6	63.4	20.6	125	300
29-May	835	2, Mid, 10 ft	159.9	82.3	77.6	63.4	20.6	125	300
29-May	905	2, Mid, 10 ft	159.8	82.3	77.5	63.4	20.6	130	300
29-May	935	2, Mid, 10 ft	159.7	82.4	77.3	63.3	20.5	130	204
29-May	1010	4, Mid, 10 ft	159.7	82.5	77.2	63.3	20.5	130	306
29-May	1040	4, Mid, 10 ft	159.7	82.5	77.2	63.3	20.5	130	306
29-May	1115	4, Mid, 10 ft	159.6	82.5	77.1	63.2	20.5*	130	304
29-May	1230	4, OC, 10 ft	159.6	82.5	77.1	63.2	20.5	130	304
29-May	1300	4, OC, 10 ft	159.5	82.5	77.0	63.2	20.5	130	304
29-May	1330	4, OC, 10 ft	159.4	82.5	76.9	63.1	20.4	130	306
29-May	1405	4, OC, 15 ft	159.4	82.5	76.9	63.1	20.4	130	306
29-May	1435	4, OC, 15 ft	159.3	82.5	76.8	63.1	20.4	130	306
29-May	1505	4, Mid, 15 ft	159.2	82.5	76.7	63.1	20.4	130	306
29-May	1536	4, Mid, 15 ft	158.9	82.5	76.4	62.9	20.4	130	306
29-May	1625	2, Mid, 15 ft	158.5	82.5	76.0	62.8	20.1**	130	306
29-May	1700	2, Mid, 15 ft	158.3	82.5	75.8	62.7	20.1	130	306
<i>Average</i>			<i>159.4</i>	<i>82.5</i>	<i>76.9</i>	<i>63.2</i>	<i>20.4</i>	<i>129</i>	<i>298</i>
31-May	1530	control	158.4	82.0	76.4	62.9	17.4	104	248
31-May	1605	control	158.4	81.9	76.5	63.0	17.4	104	248
31-May	1650	control	158.3	81.2	77.1	63.2	15.2	92	230
<i>Average</i>			<i>158.4</i>	<i>81.7</i>	<i>76.7</i>	<i>63.0</i>	<i>16.7</i>	<i>100</i>	<i>242</i>
1-Jun	825	4, OC, 10 ft	159.9	79.2	80.7	64.7	14.0	106	265
1-Jun	900	4, OC, 10 ft	159.9	80.8	79.1	64.0	17.7	106	264
1-Jun	930	4, OC, 10 ft	159.6	80.7	78.9	64.0	17.0	106	261
1-Jun	1000	2, Mid, 10 ft	159.6	80.8	78.8	63.9	17.7	106	265
1-Jun	1030	2, Mid, 10 ft	159.6	80.8	78.8	63.9	17.7	106	265
1-Jun	1055	2, Mid, 10 ft	159.6	80.8	78.8	63.9	17.7	106	267
1-Jun	1115	2, Mid, 10 ft	159.4	80.8	78.6	63.8	17.6	106	264
1-Jun	1140	4, Mid, 10 ft	159.4	80.8	78.6	63.8	17.6	106	264
1-Jun	1225	4, Mid, 10 ft	159.1	81.0	78.1	63.6	17.5	106	266
1-Jun	1305	4, Mid, 10 ft	158.9	81.0	77.9	63.5	17.5	106	267
1-Jun	1400	control	158.8	81.0	77.8	63.5	17.5	106	266
1-Jun	1430	control	158.9	81.0	77.9	63.5	17.5	106	262

Appendix Table B-2

Continued.

Date	Time	Entrainment			Discharge				
		Location ¹ and Depth (ft above ogee)	Elevation (ft)		Net Head (ft)	Est. Impact Velocity ² (fps)	Each Spillbay (1-6) (kcfs)	Total Spill Discharge (kcfs)	River Flow (kcfs)
			Forebay	Tailwater					
1-Jun	1600	6, vortex	158.8	81.0	77.8	63.5	17.5	106	265
1-Jun	1640	6, vortex	158.8	81.0	77.8	63.5	17.5	106	265
		<i>Average</i>	<i>159.3</i>	<i>80.8</i>	<i>78.5</i>	<i>63.8</i>	<i>17.3</i>	<i>106</i>	<i>265</i>
2-Jun	810	4, Mid, 15 ft	159.4	81.1	78.3	63.7	17.6	105	258
2-Jun	840	4, Mid, 15 ft	159.6	81.0	78.6	63.8	17.7	105	257
2-Jun	910	4, Mid, 15 ft	159.7	81.1	78.6	63.8	17.7	105	265
2-Jun	940	4, Mid, 15 ft	159.9	81.1	78.8	63.9	17.8	105	268
2-Jun	1030	control	160.0	81.6	78.4	63.8	18.0	113	265
2-Jun	1115	control	159.6	81.6	78.0	63.6	18.0	113	275
2-Jun	1200	4, OC, 15 ft	159.6	81.6	78.0	63.6	18.0	113	275
2-Jun	1230	4, OC, 15 ft	159.3	80.8	78.5	63.8	15.4	92	208
2-Jun	1310	4, OC, 15 ft	159.1	80.6	78.5	63.8	15.4	92	230
2-Jun	1350	2, Mid, 15 ft	159.0	80.4	78.6	63.8	15.4	92	227
2-Jun	1440	2, Mid, 15 ft	159.0	80.4	78.6	63.8	15.4	92	226
2-Jun	1520	6, vortex	158.9	80.6	78.3	63.7	15.3	92	238
2-Jun	1600	6, vortex	158.8	81.4	77.4	63.3	15.3	92	279
2-Jun	1640	6, vortex	158.6	81.4	77.2	63.3	15.4	92	267
		<i>Average</i>	<i>159.3</i>	<i>81.1</i>	<i>78.3</i>	<i>63.7</i>	<i>16.6</i>	<i>100</i>	<i>253</i>
3-Jun	820	6, vortex	158.3	80.9	77.4	63.3	16.6	254	101
3-Jun	915	6, vortex	158.6	80.9	77.7	63.5	13.9	253	84
3-Jun	1010	6, vortex	158.8	80.0	78.8	63.9	13.9	253	84
3-Jun	1100	6, vortex	158.8	79.8	79.0	64.0	13.9	216	84
		<i>Average</i>	<i>158.6</i>	<i>80.4</i>	<i>78.2</i>	<i>63.7</i>	<i>14.6</i>	<i>244</i>	<i>88</i>

1) 2, 4, 6 = Test Spillbay, M=mid spillbay release, OC = off-center release, 10 ft, 15 ft = distance above ogee.

2) Impact velocity estimate from formula $V = \text{SQRT of } 2gh \times 0.9$ ($g=32$, h =head, 0.9 =approx. correction for friction losses)

*20.5 kcfs through Spillbays 1-6 and 6.7 kcfs through Spillbay 7

**20.1 kcfs through Spillbays 1-6 and 9.5 kcfs through Spillbay 7

Appendix Table C-1

Daily tag-recapture data for juvenile chinook salmon passed through Spillbays 2, 4, 6 and downstream of Spillbay 1 (control) at 40% of river flow spill (primarily through Spillbays 1-6) with spillbay diversion wall in place. The Dalles Dam, April, 2004. Injuries due to predation or unrecovered fish presumed ingested by a predator are shown in parentheses.

	4/14	4/15	4/16	4/17	4/19	4/20	4/21	4/22	Total
<i>Spillbay 2 (10.2-12.4 kcfs) Mid, 15 ft above ogee</i>									
Released	30	--	40	--	--	40	--	35	145
Recovered alive	28	--	40	--	--	36	--	35(1)	139(1)
Recovered dead	1	--	0	--	--	1	--	0	2
Assigned dead*	1	--	0	--	--	3	--	0	4
Dislodged tags	0	--	0	--	--	3	--	0	3
Stationary radio signals	1	--	0	--	--	0	--	0	1
Unknown	0	--	0	--	--	0	--	0	0
Held	28	--	40	--	--	36	--	35	139
Alive - 48 h	28	--	40	--	--	36	--	35	139
<i>Spillbay 2 (11-13.2 kcfs) Mid, 10 ft above ogee</i>									
Released	--	30	--	40	40	--	35	--	145
Recovered alive	--	29	--	39	39	--	34	--	141
Recovered dead	--	0	--	1	0	--	0	--	1
Assigned dead*	--	1	--	0	0	--	0	--	1
Dislodged tags	--	0	--	0	0	--	0	--	0
Stationary radio signals	--	1	--	0	0	--	0	--	1
Unknown	--	0	--	0	1	--	1	--	2
Held	--	29	--	39	39	--	34	--	141
Alive - 48 h	--	28	--	39	39	--	34	--	140
<i>Spillbay 4 (10.2-12.4 kcfs) Mid, 15 ft above ogee</i>									
Released	30	--	40	--	--	40	--	36	146
Recovered alive	30	--	40	--	--	39	--	35	144
Recovered dead	0	--	0	--	--	0	--	0	0
Assigned dead*	0	--	0	--	--	0	--	0	0
Dislodged tags	0	--	0	--	--	0	--	0	0
Stationary radio signals	0	--	0	--	--	0	--	0	0
Unknown	0	--	0	--	--	1	--	1	2
Held	30	--	40	--	--	39	--	35	144
Alive - 48 h	30	--	40	--	--	39	--	35	144
<i>Spillbay 4 (11-14.7 kcfs) Mid, 10 ft above ogee</i>									
Released	--	30	--	40	40	--	35	--	145
Recovered alive	--	30	--	38	40(1)	--	34	--	142(1)
Recovered dead	--	0	--	0	0	--	0	--	0
Assigned dead*	--	0	--	2(1)	0	--	0	--	2(1)
Dislodged tags	--	0	--	1	0	--	0	--	1
Stationary radio signals	--	0	--	1(1)	0	--	0	--	1(1)
Unknown	--	0	--	0	0	--	1	--	1
Held	--	30	--	38	40	--	34	--	142
Alive - 48 h	--	30	--	38	38	--	34	--	140

Appendix Table C-1

Continued.

	4/14	4/15	4/16	4/17	4/19	4/20	4/21	4/22	Total
<i>Spillbay 4 (10.3-11 kcfs) Off-center,** 15 ft above ogee</i>									
Released	29	--	41	--	--	40	--	35	145
Recovered alive	29	--	41	--	--	40	--	35	145
Recovered dead	0	--	0	--	--	0	--	0	0
Assigned dead*	0	--	0	--	--	0	--	0	0
Dislodged tags	0	--	0	--	--	0	--	0	0
Stationary radio signals	0	--	0	--	--	0	--	0	0
Unknown	0	--	0	--	--	0	--	0	0
Held	29	--	41	--	--	40	--	35	145
Alive - 48 h	29	--	40	--	--	40	--	35	144
<i>Spillbay 4 (11-14.7 kcfs) Off-center,** 10 ft above ogee</i>									
Released	--	30	--	40	39	--	35	--	144
Recovered alive	--	29	--	39	39	--	34	--	141
Recovered dead	--	1	--	1	0	--	0	--	2
Assigned dead*	--	0	--	0	0	--	0	--	0
Dislodged tags	--	0	--	0	0	--	0	--	0
Stationary radio signals	--	0	--	0	0	--	0	--	0
Unknown	--	0	--	0	0	--	1	--	1
Held	--	29	--	39	39	--	34	--	141
Alive - 48 h	--	29	--	39	38	--	33	--	139
<i>Spillbay 6 (7.4-12.4 kcfs) Vortex ***</i>									
Released	--	--	--	--	--	--	23	16	39
Recovered alive	--	--	--	--	--	--	22	13	35
Recovered dead	--	--	--	--	--	--	1(1)	0	1(1)
Assigned dead*	--	--	--	--	--	--	0	1	1
Dislodged tags	--	--	--	--	--	--	0	0	0
Stationary radio signals	--	--	--	--	--	--	0	1	1
Unknown	--	--	--	--	--	--	0	2	2
Held	--	--	--	--	--	--	22	13	35
Alive - 48 h	--	--	--	--	--	--	22	13	35
<i>Control (6.5-12.4 kcfs)</i>									
Released	30	30	40	39	41	39	35	36	290
Recovered alive	30	30	39	39	40	38	35	34	285
Recovered dead	0	0	1(1)	0	1(1)	1(1)	0	0	3(3)
Assigned dead*	0	0	0	0	0	0	0	0	0
Dislodged tags	0	0	0	0	0	0	0	0	0
Stationary radio signals	0	0	0	0	0	0	0	0	0
Unknown	0	0	0	0	0	0	0	2	2
Held	30	30	39	39	40	38	35	34	285
Alive - 48 h	30	30	39	39	40	37	35	34	284

* Fish assigned dead in survival estimation.

**Off-center releases were offset 8.5 ft from mid-bay.

*** Spillbay 6 fish hand tossed into surface vortex near tainter gate

Appendix Table C-2

Daily tag-recapture data for juvenile chinook salmon passed through Spillbays 2, 4, 6 and downstream of Spillbay 1 (control) at 40% of river flow spill (primarily through Spillbays 1-6) with spillway diversion wall in place. The Dalles Dam, May-June, 2004. Injuries due to predation or unrecovered fish presumed ingested by a predator are shown in parentheses.

	5/26	5/27	5/28	5/29	5/31	6/01	6/02	6/03	Total
<i>Spillbay 2 (15.2-20.1 kcfs) Mid, 15 ft above ogee</i>									
Released	30	--	50	30	--	--	40	--	150
Recovered alive	29	--	50	30	--	--	38(1)	--	147(1)
Recovered dead	1	--	0	0	--	--	1	--	2
Assigned dead*	0	--	0	0	--	--	0	--	0
Dislodged tags	0	--	0	0	--	--	0	--	0
Stationary radio signals	0	--	0	0	--	--	0	--	0
Unknown	0	--	0	0	--	--	1	--	1
Held	29	--	50	30	--	--	38	--	147
Alive - 48 h	29	--	50	30	--	--	38	--	147
<i>Spillbay 2 (17.6-20.6 kcfs) Mid, 10 ft above ogee</i>									
Released	--	55	--	45	--	50	--	--	150
Recovered alive	--	55	--	43	--	50	--	--	148
Recovered dead	--	0	--	2	--	0	--	--	2
Assigned dead*	--	0	--	0	--	0	--	--	0
Dislodged tags	--	0	--	0	--	0	--	--	0
Stationary radio signals	--	0	--	0	--	0	--	--	0
Unknown	--	0	--	0	--	0	--	--	0
Held	--	55	--	43	--	50	--	--	148
Alive - 48 h	--	54	--	42	--	50	--	--	146
<i>Spillbay 4 (15.2-20.4 kcfs) Mid, 15 ft above ogee</i>									
Released	30	--	50	30	--	--	55	--	165
Recovered alive	27	--	49	28	--	--	55	--	159
Recovered dead	1	--	1	2	--	--	0	--	4
Assigned dead*	1	--	0	0	--	--	0	--	1
Dislodged tags	--	--	0	0	--	--	0	--	0
Stationary radio signals	1	--	0	0	--	--	0	--	1(1)
Unknown	1	--	0	0	--	--	0	--	1
Held	27	--	49	28	--	--	55	--	159
Alive - 48 h	26	--	49	28	--	--	54	--	157
<i>Spillbay 4 (17.5-20.5 kcfs) Mid, 10 ft above ogee</i>									
Released	--	55	--	45	--	49	--	--	149
Recovered alive	--	55	--	43	--	48	--	--	146
Recovered dead	--	0	--	1	--	0	--	--	1
Assigned dead*	--	0	--	1	--	0	--	--	1
Dislodged tags	--	0	--	1	--	0	--	--	1
Stationary radio signals	--	0	--	0	--	0	--	--	0
Unknown	--	0	--	0	--	1	--	--	1
Held	--	55	--	43	--	48	--	--	146
Alive - 48 h	--	55	--	43	--	48	--	--	146

Appendix Table C-2

Continued.

	5/26	5/27	5/28	5/29	5/31	6/01	6/02	6/03	Total
<i>Spillbay 4 (15.2-20.4 kcfs) Off-center, ** 15 ft above ogee</i>									
Released	30	--	50	30	--	--	45	--	155
Recovered alive	30	--	50	30(1)	--	--	42	--	152(1)
Recovered dead	0	--	0	0	--	--	3(1)	--	3(1)
Assigned dead*	0	--	0	0	--	--	0	--	0
Dislodged tags	0	--	0	0	--	--	0	--	0
Stationary radio signals	0	--	0	0	--	--	0	--	0
Unknown	0	--	0	0	--	--	0	--	0
Held	30	--	50	30	--	--	42	--	152
Alive - 48 h	30	--	49	30	--	--	42	--	151
<i>Spillbay 4 (14.0-20.5 kcfs) Off-center, ** 10 ft above ogee</i>									
Released	--	55	--	45	--	50	--	--	150
Recovered alive	--	55	--	45	--	50	--	--	150
Recovered dead	--	0	--	0	--	0	--	--	0
Assigned dead*	--	0	--	0	--	0	--	--	0
Dislodged tags	--	0	--	0	--	0	--	--	0
Stationary radio signals	--	0	--	0	--	0	--	--	0
Unknown	--	0	--	0	--	0	--	--	0
Held	--	55	--	45	--	50	--	--	150
Alive - 48 h	--	55	--	44	--	50	--	--	149
<i>Spillbay 6 (13.9-17.5 kcfs) Vortex***</i>									
Released	--	--	--	--	--	30	50	69	149
Recovered alive	--	--	--	--	--	28	44	52(2)	124(2)
Recovered dead	--	--	--	--	--	0	4(2)	5	9(2)
Assigned dead*	--	--	--	--	--	1	1	10	12
Dislodged tags	--	--	--	--	--	--	1	1	2(1)
Stationary radio signals	--	--	--	--	--	1	0	9	10(9)
Unknown	--	--	--	--	--	1	1	2	4
Held	--	--	--	--	--	28	44	52	124
Alive - 48 h	--	--	--	--	--	28	43	52	123
<i>Control (15.5-18.3 kcfs)</i>									
Released	27	56	50	--	45	49	45	--	272
Recovered alive	27	55	49	--	45	49	44	--	269
Recovered dead	0	0	0	--	0	0	0	--	0
Assigned dead*	0	0	1	--	0	0	0	--	1
Dislodged tags	0	0	0	--	0	0	0	--	0
Stationary radio signals	0	0	1	--	0	0	0	--	1(1)
Unknown	0	1	0	--	0	0	1	--	2
Held	27	55	49	--	45	49	44	--	269
Alive - 48 h	27	55	49	--	45	49	44	--	269

* Fish assigned dead in survival estimation.

**Off-center releases were offset 8.5 ft from mid-bay.

***Spillbay 6 fish hand tossed into surface vortex near tainter gate

Appendix Table C-3

Incidence of injury, scale loss, and temporary loss of equilibrium (LOE) observed on juvenile salmonids passed through Spillbays 2, 4^l, 6 and downstream of Spillbay 1 (control) at 40% of river flow spill (primarily through Spillbays 1-6) with spillway diversion wall in place. The Dalles Dam, April, 2004 .

Date	Discharge (kcfs)**	Test Lot	Fish ID	Live/Dead	Malady Description	Probable Cause of Injury	Injury Designation	Photo Taken
<i>Control</i>								
16-Apr	9.5	4	K15	dead 1h	predator marks	predator		Yes
19-Apr	11	6	X75	dead 1h	predator marks	predator		No
20-Apr	6.5	7	XB1	dead 1h	predator marks	predator		Yes
20-Apr	6.5	7	XA6	dead 24h	LOE, no apparent injuries internal or external			No
<i>Spillbay 2 mid, 15 ft above ogee (shallow)</i>								
14-Apr	10.2	2	J29	dead 1h	hemorrhaged right eye	shear	major	Yes
14-Apr	10.2	2	J14	alive 48h	LOE, slight hemorrhaged right eye, torn left operculum	shear	major	No
20-Apr	11.7	7	XN5	dead 1h	bruised left side	contact	major	No
20-Apr	11.7	7	XP5	alive 48h	LOE, bulged right eye	shear	major	Yes
22-Apr	12.4	7	YE4	alive 48h	predator marks	predator	major	No
<i>Spillbay 4 mid, 15 ft above ogee (shallow)</i>								
14-Apr	10.2	2	J50	alive 48h	LOE, bruise on head,	contact	minor	No
14-Apr	10.2	2	J43	alive 48h	slight hemorrhaged left eye	shear	minor	No
16-Apr	11.7	4	K08	alive 48h	LOE, abrasion / scrape on jaw	contact	minor	No
<i>Spillbay 2 mid, 10 ft above ogee (deep)</i>								
15-Apr	12.4	3	JD9	dead 24h	LOE, cut on head, bulged left eye	contact/shear	major	Yes
17-Apr	11.6	5	KR3	alive 48h	scrape marks right side	contact	minor	No

Appendix Table C-3

Continued.

Date	Discharge (kcfs)	Test Lot	Fish ID	Live/Dead	Malady Description	Probable Cause of Injury	Injury Designation	Photo Taken
17-Apr	11.6	5	KR7	dead 1h	bulged left eye	shear	major	Yes
21-Apr	13.2	8	L04	alive 48h	LOE, major hemorrhaged left eye/pupil damage	shear	major	No
<i>Spillbay 4 mid, 10 ft above ogee (deep)</i>								
15-Apr	12.3	3	JN7	alive 48h	LOE, torn right operculum	shear	major	No
15-Apr	12.3	3	JN0	alive 48h	hemorrhaged left eye	shear	minor	No
15-Apr	12.3	3	JP7	alive 48h	bent, slight tear right operculum	shear	major	Yes
19-Apr	11	6	KY9	dead 24h	predator marks	predation		Yes
19-Apr	11	6	KZ6	dead 48h	LOE, no visible marks internal or external			No
<i>Spillbay 4 off center, 15 ft above ogee (shallow)***</i>								
14-Apr	10.3	2	J67	alive 48h	torn left operculum	shear	major	No
16-Apr	10.3	4	K88	dead 24h	hemorrhaged right eye, slightly damaged pupil	shear	major	No
16-Apr	10.3	4	K55	alive 48h	slight hemorrhaged left eye	shear	minor	No
16-Apr	10.3	4	K58	alive 48h	slight hemorrhaged right eye	shear	minor	No
20-Apr	11	7	XK8	alive 48h	hemorrhaged right gill	shear	major	Yes
<i>Spillbay 4 off center, 10 ft above ogee (deep)***</i>								
15-Apr	11.6	3	JL8	alive 48h	LOE, major (50%) bruise left side, left eye popped out	contact/shear	major	No
15-Apr	11.6	3	JM8	dead 1h	major tear at tag site*, hemorrhaged internally/organ displacement	tag/contact	major	No
17-Apr	11.6	5	KJ0	alive 48h	LOE, minor hemorrhaged snout & nape	contact	minor	No
17-Apr	11.6	5	KM9	dead 1h	popped eye	shear	major	No
19-Apr	11	6	X35	dead 24h	hemorrhaged left eye, ruptured	shear	major	Yes

Appendix Table C-3

Continued.

Date	Discharge (kcfs)	Test Lot	Fish ID	Live/Dead	Malady Description	Probable Cause of Injury	Injury Designation	Photo Taken
19-Apr	11	6	X17	alive 48h	minor Hemorrhaged left eye	shear	minor	Yes
19-Apr	11	6	X42	alive 48h	minor hemorrhaged left eye	shear	minor	No
21-Apr	14.7	8	XZ2	dead 24h	LOE, bruise from anal fin to pectoral fin, hemorrhaged internally, hemorrhaged left eye, severe tear at tag site*	contact/shear	major	No
21-Apr	14.7	8	XV8	alive 48h	slight hemorrhaged right eye	shear	minor	No
<i>Spillbay 6 vortex</i>								
21-Apr	12.4	8	L73	dead 1h	predator marks on left side, bruise on head	predator/contact	major	No
22-Apr	7.4	9	H05	alive 48h	slight hemorrhaged right eye	shear	minor	No
22-Apr	7.4	9	H14	alive 48h	slight hemorrhaged left eye	shear	minor	No

1) Bay 6 fish hand tossed into surface vortex near tainter gate.

*Not related to passage.

** discharge per tested spillbay

***Off-center releases were offset 8.5 ft from mid-bay.

Appendix Table C-4

Incidence of injury, scale loss, and temporary loss of equilibrium (LOE) observed on juvenile salmonids passed through Spillbays 2, 4^l, 6 and downstream of Spillbay 1 (control) at 40% of river flow spill (primarily through Spillbays 1-6) with spillway diversion wall in place. The Dalles Dam, May-June 2004.

Date	Discharge (kcfs)	Test Lot	Fish ID	Live/Dead	Malady Description	Probable Cause of Injury	Injury Designation	Photo Taken
<i>Control</i>								
26-May	16	1	BY5	alive 48h	15% hemorrhaged left eye	shear	minor	no
28-May	16.1	3	DV5	alive 48h	crushed left operculum	contact	major	no
<i>Spillbay 2, mid, 15 ft above ogee (shallow)</i>								
26-May	15.2	1	BM1	dead 1h	hemorrhaged left eye, major scale loss	shear/contact	major	no
28-May	15.9	3	FT9	alive 48h	LOE			no
28-May	15.9	3	FR5	alive 48h	LOE, 90% hemorrhaged/ruptured right eye	shear	major	no
2-Jun	15.4	7	PV5	dead 1h	LOE, no obvious injuries internal or external			no
2-Jun	15.4	7	PT8	alive 48h	predator marks*	predation		no
<i>Spillbay 4, mid, 15 ft above ogee (shallow)</i>								
26-May	15.2	1	BT8	dead 1h	scrape on left operculum, hemorrhaged left gill	contact	major	no
26-May	15.2	1	BR0	dead 24h	minor hemorrhage behind left eye	shear	major	no
28-May	16.1	3	FN0	alive 48h	LOE, Flesh tear at tag site*			no
28-May	16.1	3	DY0	dead 1h	scrape across back, slight tear at right operculum	contact/shear	major	no
29-May	20.4	4	ZB3	dead 1h	bruise on right side of body, damaged eye & tears on left side of head	contact	major	no
29-May	20.4	4	ZB8	dead 1h	backbone broken at head	contact	major	no
2-Jun	17.6	7	KT6	dead 48h	blood clots at gills and back of mouth, bruise along top of back	contact	major	no

Appendix Table C-4

Continued.

Date	Discharge (kcfs)	Test Lot	Fish ID	Live/Dead	Malady Description	Probable Cause of Injury	Injury Designation	Photo Taken
2-Jun	17.7	7	KU6	alive 48h	50% hemorrhaged/bulged right eye, ruptured pupil in left eye	shear	major	no
2-Jun	17.8	7	KW4	alive 48h	LOE, 10% hemorrhaged/bulged left eye	shear	major	no
<i>Spillbay 2, mid, 10 ft above ogee (deep)</i>								
27-May	18.2	2	CS4	dead 24h	slight tear right operculum, minor hemorrhaged at tear site		major	no
29-May	20.6	4	FX3	dead 1h	LOE, both eyes bulged, hemorrhaged right eye	shear	major	no
29-May	20.6	4	FX6	dead 1h	bruise on top of head, brain damaged	contact	major	no
29-May	20.6	4	FY2	dead 48h	no obvious injuries internal or external			no
1-Jun	17.7	6	JY1	alive 48h	LOE			no
<i>Spillbay 4, mid, 10 ft above ogee (deep)</i>								
27-May	18.2	2	CM5	alive 48h	hemorrhaged left eye	shear	minor	no
27-May	18.2	2	CN8	alive 48h	hemorrhaged right eye	shear	minor	no
27-May	18.2	2	BK2	alive 48h	both eyes bulged	shear	major	no
29-May	20.5	4	HR4	dead 1h	LOE, small hole in top of head, blood clot inside cranial cavity, bulged right eye, bruise on operculum	contact	major	no
29-May	20.5	4	HM5	alive 48h	bruise left operculum	contact	minor	no
<i>Spillbay 4, off center, 15 ft above ogee (shallow)</i>								
26-May	15.2	1	BU8	alive 48h	hemorrhaged right eye	shear	minor	no
28-May	18.3	3	WE3	dead 24h	no obvious injuries internal or external			no
29-May	20.4	4	HX5	alive 48h	predator marks*	predation		no

Appendix Table C-4

Continued.

Date	Discharge (kcfs)	Test Lot	Fish ID	Live/Dead	Malady Description	Probable Cause of Injury	Injury Designation	Photo Taken
2-Jun	18	7	PN8	alive 48h	50% hemorrhaged right eye	shear	major	no
2-Jun	15.4	7	PP8	dead 1h	flesh tear at tag site*major scale loss due to tag,	tag		no
2-Jun	15.4	7	PR8	dead 1h	LOE, minor tear/hemorrhaged right and left sides of operculum insertion	shear	major	no
2-Jun	15.4	7	PS8	dead 1h	Predator marks*	predation		no
2-Jun	18	7	PN5	alive 48h	40% hemorrhaged right eye	shear	minor	no
<i>Spillbay 4, off center, 10 ft above ogee (deep)</i>								
27-May	18.3	2	BF0	alive 48h	LOE, hemorrhaged left eye, scrape left operculum and mark in dorsal area	shear/contact	minor	no
27-May	18.3	2	BF6	alive 48h	5% hemorrhaged/bulged right eye	shear	major	no
29-May	20.5	4	HV3	alive 48h	LOE			no
29-May	20.5	4	HU0	dead 24h	slight tear right operculum	shear	major	no
1-Jun	14	6	JP1	alive 48h	5% hemorrhaged right eye	shear	minor	no
1-Jun	14	6	JR4	alive 48h	torn right operculum	shear	major	no
<i>Spillbay 6, Vortex</i>								
1-Jun	17.5	6	KM8	alive 48h	5% hemorrhaged right eye	shear	minor	no
1-Jun	17.5	6	KP6	alive 48h	40% hemorrhaged left eye	shear	minor	no
2-Jun	15.3	7	PX8	dead 1h	hemorrhaged left gills	shear	major	no
2-Jun	15.3	7	PZ4	alive 48h	LOE, ruptured left eye	shear	major	no
2-Jun	15.3	7	PZ9	dead 1h	no obvious injuries internal or external			no
2-Jun	15.3	7	UM0	dead 1h	LOE, bruise on left side head predator marks on tail*	predation/contact	minor	no
2-Jun	15.4	7	UN1	dead 1h	LOE, predator marks*	predation		no
2-Jun	15.3	7	PZ5	dead 24h	LOE, hemorrhaged/ruptured left eye	shear	major	no

Appendix Table C-4

Continued.

Date	Discharge (kcfs)	Test Lot	Fish ID	Live/Dead	Malady Description	Probable Cause of Injury	Injury Designation	Photo Taken
3-Jun	16.6	8	UP6	dead 1h	predator marks*	predation		no
3-Jun	16.6	8	UP9	dead 1h	LOE, hemorrhaged/bruised right side	contact	major	no
3-Jun	13.9	8	UW0	dead 1h	predator marks*	predation		no
3-Jun	13.9	8	UW2	dead 1h	LOE, severe tear at both tag sites*	tag		no
3-Jun	13.9	8	UW8	dead 1h	left operculum bent, hemorrhaged left gills	shear	major	no

1) Spillbay 6 fish hand tossed into surface vortex near tainter gate.

* Not related to passage.

** discharge per tested spillbay

***Off-center releases were offset 8.5 ft from mid-bay.

Appendix Table C-5

Daily malady data for juvenile chinook salmon passed through Spillbays 2, 4, 6¹ and downstream of Spillbay 1 (control) at 40% of river flow spill (primarily through Spillbays 1-6) with spillway diversion wall in place, The Dall Dam, April, 2004.

	4/14	4/15	4/16	4/17	4/19	4/20	4/21	4/22	Total
<i>Spillbay 2 (10.2-12.4 kcfs) Mid, 15 ft above ogee</i>									
Released	30	--	40	--	--	40	--	35	145
Examined	29	--	40	--	--	37	--	35	141
With passage related maladies	2	--	0	--	--	2	--	0	4
Visible injuries	2	--	0	--	--	2	--	0	4
Scale loss only	0	--	0	--	--	0	--	0	0
Loss of equilibrium only	0	--	0	--	--	0	--	0	0
Without maladies	27	--	40	--	--	35	--	35	137
Dead from no apparent cause	0	--	0	--	--	0	--	0	0
<i>Spillbay 2 (11-13.2 kcfs) Mid, 10 ft above ogee</i>									
Released	--	30	--	40	40	--	35	--	145
Examined	--	29	--	40	39	--	34	--	142
With passage related maladies	--	1	--	2	0	--	1	--	4
Visible injuries	--	1	--	2	0	--	1	--	4
Scale loss only	--	0	--	0	0	--	0	--	0
Loss of equilibrium only	--	0	--	0	0	--	0	--	0
Without maladies	--	28	--	38	39	--	33	--	138
Dead from no apparent cause	--	0	--	0	0	--	0	--	0
<i>Spillbay 4 (10.2-12.4 kcfs) Mid, 15 ft above ogee</i>									
Released	30	--	40	--	--	40	--	36	146
Examined	30	--	40	--	--	39	--	35	144
With passage related maladies	2	--	1	--	--	0	--	0	3
Visible injuries	2	--	1	--	--	0	--	0	3
Scale loss only	0	--	0	--	--	0	--	0	0
Loss of equilibrium only	0	--	0	--	--	0	--	0	0
Without maladies	28	--	39	--	--	39	--	35	141
Dead from no apparent cause	0	--	0	--	--	0	--	0	0
<i>Spillbay 4 (11-14.7 kcfs) Mid, 10 ft above ogee</i>									
Released	--	30	--	40	40	--	35	--	145
Examined	--	30	--	38	40	--	34	--	142
With passage related maladies	--	3	--	0	1	--	0	--	4
Visible injuries	--	3	--	0	0	--	0	--	3
Scale loss only	--	0	--	0	0	--	0	--	0
Loss of equilibrium only	--	0	--	0	1	--	0	--	1
Without maladies	--	27	--	38	39	--	34	--	138
Dead from no apparent cause	--	0	--	0	0	--	0	--	0

Appendix Table C-5

Continued.

	4/14	4/15	4/16	4/17	4/19	4/20	4/21	4/22	Total
<i>Spillbay 4 (10.3-11 kcfs) Off-center,* 15 ft above ogee</i>									
Released	29	--	41	--	--	40	--	35	145
Examined	29	--	41	--	--	40	--	35	145
With passage related maladies	1	--	3	--	--	1	--	0	5
Visible injuries	1	--	3	--	--	1	--	0	5
Scale loss only	0	--	0	--	--	0	--	0	0
Loss of equilibrium only	0	--	0	--	--	0	--	0	0
Without maladies	28	--	38	--	--	39	--	35	140
Dead from no apparent cause	0	--	0	--	--	0	--	0	0
<i>Spillbay 4 (11-14.7 kcfs) Off-center,* 10 ft above ogee</i>									
Released	--	30	--	40	39	--	35	--	144
Examined	--	30	--	40	39	--	34	--	143
With passage related maladies	--	2	--	2	3	--	2	--	9
Visible injuries	--	2	--	2	3	--	2	--	9
Scale loss only	--	0	--	0	0	--	0	--	0
Loss of equilibrium only	--	0	--	0	0	--	0	--	0
Without maladies	--	28	--	38	36	--	32	--	134
Dead from no apparent cause	--	0	--	0	0	--	0	--	0
<i>Spillbay 6 (7.4-12.4 kcfs) Vortex</i>									
Released	--	--	--	--	--	--	23	16	39
Examined	--	--	--	--	--	--	23	13	36
With passage related maladies	--	--	--	--	--	--	1	2	3
Visible injuries	--	--	--	--	--	--	1	2	3
Scale loss only	--	--	--	--	--	--	--	--	0
Loss of equilibrium only	--	--	--	--	--	--	--	--	0
Without maladies	--	--	--	--	--	--	22	11	33
Dead from no apparent cause	--	--	--	--	--	--	--	--	0
<i>Control (6.5-12.4 kcfs)</i>									
Released	30	30	40	39	41	39	35	36	290
Examined	30	30	40	39	41	39	35	34	288
With passage related maladies	0	0	0	0	0	1	0	0	1
Visible injuries	0	0	0	0	0	0	0	0	0
Scale loss only	0	0	0	0	0	0	0	0	0
Loss of equilibrium only	0	0	0	0	0	1	0	0	1
Without maladies	30	30	40	39	41	38	35	34	287
Dead from no apparent cause	0	0	0	0	0	0	0	0	0

1) Spillbay 6 fish hand tossed into surface vortex near tainter gate

*Off-center releases were offset 8.5 ft from mid-bay.

Appendix Table C-6

Daily malady data for juvenile chinook salmon passed through Spillbays 2, 4, 6¹ and downstream of Spillbay 1 (control) at 40% of river flow spill (primarily through Spillbays 1-6) with spillway diversion wall in place. The Dalles Dam, May-June 2004.

	5/26	5/27	5/28	5/29	5/31	6/01	6/02	6/03	Total
<i>Spillbay 2 (15.2-20.1 kcfs) Mid, 15 ft above ogee</i>									
Released	30	--	50	30	--	--	40	--	150
Examined	30	--	50	30	--	--	39	--	149
With passage related maladies	1	--	2	0	--	--	1	--	4
Visible injuries	1	--	1	0	--	--	0	--	2
Scale loss only	0	--	0	0	--	--	0	--	0
Loss of equilibrium only	0	--	1	0	--	--	1	--	2
Without maladies	29	--	48	30	--	--	38	--	145
Dead from no apparent cause	0	--	0	0	--	--	0	--	0
<i>Spillbay 2 17.6-20.6 kcfs) Mid, 10 ft above ogee</i>									
Released	--	55	--	45	--	50	--	--	150
Examined	--	55	--	45	--	50	--	--	150
With passage related maladies	--	1	--	2	--	1	--	--	4
Visible injuries	--	1	--	2	--	0	--	--	3
Scale loss only	--	0	--	0	--	0	--	--	0
Loss of equilibrium only	--	0	--	0	--	1	--	--	1
Without maladies	--	54	--	43	--	49	--	--	146
Dead from no apparent cause	--	0	--	1	--	0	--	--	1
<i>Spillbay 4 (15.2-20.4kcfs) Mid, 15 ft above ogee</i>									
Released	30	--	50	30	--	--	55	--	165
Examined	28	--	50	30	--	--	55	--	163
With passage related maladies	2	--	1	2	--	--	3	--	8
Visible injuries	2	--	1	2	--	--	3	--	8
Scale loss only	0	--	0	0	--	--	0	--	0
Loss of equilibrium only	0	--	0	0	--	--	0	--	0
Without maladies	26	--	49	28	--	--	52	--	155
Dead from no apparent cause	0	--	0	0	--	--	0	--	0
<i>Spillbay 4 (17.5-20.5 kcfs) Mid, 10 ft above ogee</i>									
Released	--	55	--	45	--	49	--	--	149
Examined	--	55	--	44	--	48	--	--	147
With passage related maladies	--	3	--	2	--	0	--	--	5
Visible injuries	--	3	--	2	--	0	--	--	5
Scale loss only	--	0	--	0	--	0	--	--	0
Loss of equilibrium only	--	0	--	0	--	0	--	--	0
Without maladies	--	52	--	42	--	48	--	--	142
Dead from no apparent cause	--	0	--	0	--	0	--	--	0

Appendix Table C-6

Continued.

	5/26	5/27	5/28	5/29	5/31	6/01	6/02	6/03	Total
<i>Spillbay 4 (15.2-20.4 kcfs) Off-center,* 15 ft above ogee</i>									
Released	30	--	50	30	--	--	45	--	155
Examined	30	--	50	30	--	--	45	--	155
With passage related maladies	1	--	0	0	--	--	3	--	4
Visible injuries	1	--	0	0	--	--	3	--	4
Scale loss only	0	--	0	0	--	--	0	--	0
Loss of equilibrium only	0	--	0	0	--	--	0	--	0
Without maladies	29	--	50	30	--	--	42	--	151
Dead from no apparent cause	0	--	1	0	--	--	0	--	1
<i>Spillbay 4 (14.0-20.5 kcfs) Off-center,* 10 ft above ogee</i>									
Released	--	55	--	45	--	50	--	--	150
Examined	--	55	--	45	--	50	--	--	150
With passage related maladies	--	2	--	2	--	2	--	--	6
Visible injuries	--	2	--	1	--	2	--	--	5
Scale loss only	--	0	--	0	--	0	--	--	0
Loss of equilibrium only	--	0	--	1	--	0	--	--	1
Without maladies	--	53	--	43	--	48	--	--	144
Dead from no apparent cause	--	0	--	0	--	0	--	--	0
<i>Spillbay 6 (13.9-17.5 kcfs) Vortex</i>									
Released	--	--	--	--	--	30	50	69	149
Examined	--	--	--	--	--	28	48	57	133
With passage related maladies	--	--	--	--	--	2	4	2	8
Visible injuries	--	--	--	--	--	2	4	2	8
Scale loss only	--	--	--	--	--	0	0	0	0
Loss of equilibrium only	--	--	--	--	--	0	0	0	0
Without maladies	--	--	--	--	--	26	44	55	125
Dead from no apparent cause	--	--	--	--	--	0	1	0	1
<i>Control (15.5-18.3 kcfs)</i>									
Released	27	56	50	--	45	49	45	--	272
Examined	27	55	49	--	45	49	44	--	269
With passage related maladies	1	0	1	--	0	0	0	--	2
Visible injuries	1	0	1	--	0	0	0	--	2
Scale loss only	0	0	0	--	0	0	0	--	0
Loss of equilibrium only	0	0	0	--	0	0	0	--	0
Without maladies	26	55	48	--	45	49	44	--	267
Dead from no apparent cause	0	0	0	--	0	0	0	--	0

1) Spillbay 6 fish hand tossed into surface vortex near tainter gate

*Off-center releases were offset 8.5 ft from mid-bay.

Appendix D

Chi square tests of homogeneity for releases of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

----- Scenario=control (bay 2) -----

The FREQ Procedure
Table of testdate by cond

testdate	cond(Recovery condition)			Total
Frequency	Alive	dead	unkwn	
14APR	30	0	0	30
	29.483	0.3103	0.2069	
	0.0091	0.3103	0.2069	
15APR	30	0	0	30
	29.483	0.3103	0.2069	
	0.0091	0.3103	0.2069	
16APR	39	1	0	40
	39.31	0.4138	0.2759	
	0.0025	0.8305	0.2759	
17APR	39	0	0	39
	38.328	0.4034	0.269	
	0.0118	0.4034	0.269	
19APR	40	1	0	41
	40.293	0.4241	0.2828	
	0.0021	0.7819	0.2828	
20APR	38	1	0	39
	38.328	0.4034	0.269	
	0.0028	0.8821	0.269	
21APR	35	0	0	35
	34.397	0.3621	0.2414	
	0.0106	0.3621	0.2414	
22APR	34	0	2	36
	35.379	0.3724	0.2483	
	0.0538	0.3724	12.359	
Total	285	3	2	290

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	14	18.4658	0.1864
Likelihood Ratio Chi-Square	14	13.7432	0.4690
Mantel-Haenszel Chi-Square	1	3.3867	0.0657
Phi Coefficient		0.2523	
Contingency Coefficient		0.2447	
Cramer's V		0.1784	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.
Sample Size = 290

Appendix D

Chi square tests of homogeneity for releases of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

----- Scenario=spillbay 2 (mid/deep) -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)			Total
Frequency	Alive	dead	unkwn	
15APR	29	1	0	30
	29.172	0.4138	0.4138	
	0.001	0.8305	0.4138	
17APR	39	1	0	40
	38.897	0.5517	0.5517	
	0.0003	0.3642	0.5517	
19APR	39	0	1	40
	38.897	0.5517	0.5517	
	0.0003	0.5517	0.3642	
21APR	34	0	1	35
	34.034	0.4828	0.4828	
	349E-7	0.4828	0.5542	
Total	141	2	2	145

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	6	4.1147	0.6612
Likelihood Ratio Chi-Square	6	5.6017	0.4693
Mantel-Haenszel Chi-Square	1	0.2542	0.6142
Phi Coefficient		0.1685	
Contingency Coefficient		0.1661	
Cramer's V		0.1191	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 145

Appendix D

Chi square tests of homogeneity for releases of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

----- Scenario=spillbay 4 mid/deep -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)			Total
Frequency	Alive	dead	unkwn	
15APR	30	0	0	30
	29.379	0.4138	0.2069	
	0.0131	0.4138	0.2069	
17APR	38	2	0	40
	39.172	0.5517	0.2759	
	0.0351	3.8017	0.2759	
19APR	40	0	0	40
	39.172	0.5517	0.2759	
	0.0175	0.5517	0.2759	
21APR	34	0	1	35
	34.276	0.4828	0.2414	
	0.0022	0.4828	2.3842	
Total	142	2	1	145

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	6	8.4608	0.2063
Likelihood Ratio Chi-Square	6	8.0622	0.2336
Mantel-Haenszel Chi-Square	1	0.4740	0.4912
Phi Coefficient		0.2416	
Contingency Coefficient		0.2348	
Cramer's V		0.1708	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 145

Appendix D

Chi square tests of homogeneity for releases of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

----- Scenario=spillbay 4 mid/shallow -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)			Total
Frequency				
Expected				
Cell Chi-Square	Alive	unkwn		Total
14APR	30	0		30
	29.589	0.411		
	0.0057	0.411		
16APR	40	0		40
	39.452	0.5479		
	0.0076	0.5479		
20APR	39	1		40
	39.452	0.5479		
	0.0052	0.3729		
22APR	35	1		36
	35.507	0.4932		
	0.0072	0.5209		
Total	144	2		146

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	3	1.8785	0.5980
Likelihood Ratio Chi-Square	3	2.6428	0.4500
Mantel-Haenszel Chi-Square	1	1.7231	0.1893
Phi Coefficient		0.1134	
Contingency Coefficient		0.1127	
Cramer's V		0.1134	

WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 146

Appendix D

Chi square tests of homogeneity for releases of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

----- Scenario=spillbay 4 off center/deep -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)			Total
Frequency	Alive	dead	unkwn	
15APR	29	1	0	30
	29.375	0.4167	0.2083	
	0.0048	0.8167	0.2083	
17APR	39	1	0	40
	39.167	0.5556	0.2778	
	0.0007	0.3556	0.2778	
19APR	39	0	0	39
	38.188	0.5417	0.2708	
	0.0173	0.5417	0.2708	
21APR	34	0	1	35
	34.271	0.4861	0.2431	
	0.0021	0.4861	2.3573	
Total	141	2	1	144

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	6	5.3392	0.5011
Likelihood Ratio Chi-Square	6	5.7803	0.4482
Mantel-Haenszel Chi-Square	1	0.0951	0.7578
Phi Coefficient		0.1926	
Contingency Coefficient		0.1891	
Cramer's V		0.1362	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 144

Appendix D

Chi square tests of homogeneity for releases of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

----- Scenario=spillbay 4 off center/shallow -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)	
Frequency	,	
Expected	,	
Cell Chi-Square	,Alive	Total
^^^^^^^^^^^^^^^^	^^^^^^^^	
14APR	29	29
	29	
	0	
^^^^^^^^^^^^^^^^	^^^^^^^^	
16APR	41	41
	41	
	0	
^^^^^^^^^^^^^^^^	^^^^^^^^	
20APR	40	40
	40	
	0	
^^^^^^^^^^^^^^^^	^^^^^^^^	
22APR	35	35
	35	
	0	
^^^^^^^^^^^^^^^^	^^^^^^^^	
Total	145	145

Appendix D

Chi square tests of homogeneity for releases of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

----- Scenario=vortex release -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)			Total
Frequency	Alive	dead	unkwn	
Expected				
Cell Chi-Square				
21APR	22	1	0	23
	20.641	1.1795	1.1795	
	0.0895	0.0273	1.1795	
22APR	13	1	2	16
	14.359	0.8205	0.8205	
	0.1286	0.0393	1.6955	
Total	35	2	2	39

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	2	3.1597	0.2060
Likelihood Ratio Chi-Square	2	3.8498	0.1459
Mantel-Haenszel Chi-Square	1	2.8589	0.0909
Phi Coefficient		0.2846	
Contingency Coefficient		0.2738	
Cramer's V		0.2846	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 39

Appendix D

Chi square tests of homogeneity for releases of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

----- loc=Spillbay 6 -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)			Total
Frequency	Alive	dead	unkwn	
Expected				
Cell Chi-Square				
21APR	22	1	0	23
	20.641	1.1795	1.1795	
	0.0895	0.0273	1.1795	
22APR	13	1	2	16
	14.359	0.8205	0.8205	
	0.1286	0.0393	1.6955	
Total	35	2	2	39

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	2	3.1597	0.2060
Likelihood Ratio Chi-Square	2	3.8498	0.1459
Mantel-Haenszel Chi-Square	1	2.8589	0.0909
Phi Coefficient		0.2846	
Contingency Coefficient		0.2738	
Cramer's V		0.2846	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 39

Appendix D

Chi square tests of homogeneity for releases of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

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----- loc=control -----
The FREQ Procedure
Table of testdate by cond

testdate      cond(Recovery condition)

Frequency     ,
Expected      ,
Cell Chi-Square,Alive  ,dead  ,unkwn  , Total
-----
14APR ,      30 ,      0 ,      0 ,      30
      , 29.483 , 0.3103 , 0.2069 ,
      , 0.0091 , 0.3103 , 0.2069 ,
-----
15APR ,      30 ,      0 ,      0 ,      30
      , 29.483 , 0.3103 , 0.2069 ,
      , 0.0091 , 0.3103 , 0.2069 ,
-----
16APR ,      39 ,      1 ,      0 ,      40
      , 39.31 , 0.4138 , 0.2759 ,
      , 0.0025 , 0.8305 , 0.2759 ,
-----
17APR ,      39 ,      0 ,      0 ,      39
      , 38.328 , 0.4034 , 0.269 ,
      , 0.0118 , 0.4034 , 0.269 ,
-----
19APR ,      40 ,      1 ,      0 ,      41
      , 40.293 , 0.4241 , 0.2828 ,
      , 0.0021 , 0.7819 , 0.2828 ,
-----
20APR ,      38 ,      1 ,      0 ,      39
      , 38.328 , 0.4034 , 0.269 ,
      , 0.0028 , 0.8821 , 0.269 ,
-----
21APR ,      35 ,      0 ,      0 ,      35
      , 34.397 , 0.3621 , 0.2414 ,
      , 0.0106 , 0.3621 , 0.2414 ,
-----
22APR ,      34 ,      0 ,      2 ,      36
      , 35.379 , 0.3724 , 0.2483 ,
      , 0.0538 , 0.3724 , 12.359 ,
-----
Total      285      3      2      290

Statistics for Table of testdate by cond

Statistic      DF      Value      Prob
-----
Chi-Square      14      18.4658      0.1864
Likelihood Ratio Chi-Square  14      13.7432      0.4690
Mantel-Haenszel Chi-Square   1      3.3867      0.0657
Phi Coefficient
Contingency Coefficient
Cramer's V
WARNING: 67% of the cells have expected counts less
than 5. Chi-Square may not be a valid test.
Sample Size = 290

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Appendix D

Chi square tests of homogeneity for releases of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

----- loc=spillbay 2 -----
 The FREQ Procedure
 Table of testdate by cond

testdate	cond(Recovery condition)			
Frequency	Alive	dead	unkwn	Total
14APR	28	2	0	30
	28.966	0.8276	0.2069	
	0.0322	1.6609	0.2069	
15APR	29	1	0	30
	28.966	0.8276	0.2069	
	411E-7	0.0359	0.2069	
16APR	40	0	0	40
	38.621	1.1034	0.2759	
	0.0493	1.1034	0.2759	
17APR	39	1	0	40
	38.621	1.1034	0.2759	
	0.0037	0.0097	0.2759	
19APR	39	0	1	40
	38.621	1.1034	0.2759	
	0.0037	1.1034	1.9009	
20APR	36	4	0	40
	38.621	1.1034	0.2759	
	0.1778	7.6034	0.2759	
21APR	34	0	1	35
	33.793	0.9655	0.2414	
	0.0013	0.9655	2.3842	
22APR	35	0	0	35
	33.793	0.9655	0.2414	
	0.0431	0.9655	0.2414	
Total	280	8	2	290

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	14	19.5269	0.1458
Likelihood Ratio Chi-Square	14	19.7470	0.1383
Mantel-Haenszel Chi-Square	1	0.0601	0.8064
Phi Coefficient		0.2595	
Contingency Coefficient		0.2512	
Cramer's V		0.1835	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.
 Sample Size = 290

Appendix D

Chi square tests of homogeneity for releases of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

----- loc=spillbay 4 -----
 The FREQ Procedure
 Table of testdate by cond

testdate	cond(Recovery condition)			Total
Frequency	Alive	dead	unkwn	
14APR	59	0	0	59
	58.186	0.4069	0.4069	
	0.0114	0.4069	0.4069	
15APR	59	1	0	60
	59.172	0.4138	0.4138	
	0.0005	0.8305	0.4138	
16APR	81	0	0	81
	79.883	0.5586	0.5586	
	0.0156	0.5586	0.5586	
17APR	77	3	0	80
	78.897	0.5517	0.5517	
	0.0456	10.864	0.5517	
19APR	79	0	0	79
	77.91	0.5448	0.5448	
	0.0152	0.5448	0.5448	
20APR	79	0	1	80
	78.897	0.5517	0.5517	
	0.0001	0.5517	0.3642	
21APR	68	0	2	70
	69.034	0.4828	0.4828	
	0.0155	0.4828	4.7685	
22APR	70	0	1	71
	70.021	0.4897	0.4897	
	611E-8	0.4897	0.5319	
Total	572	4	4	580

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	14	22.9736	0.0607
Likelihood Ratio Chi-Square	14	20.3320	0.1200
Mantel-Haenszel Chi-Square	1	1.9615	0.1614
Phi Coefficient		0.1990	
Contingency Coefficient		0.1952	
Cramer's V		0.1407	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.
 Sample Size = 580

Appendix D

Chi square tests of homogeneity for 48 h survival of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

```

----- Scenario=control (bay 2) -----
                The FREQ Procedure
                Table of testdate by cond
                testdate          cond(Recovery condition)

Frequency      ,
Expected       ,
Cell Chi-Square,alive48 ,dead48 ,unkwn , Total
fffffffffffffff^fffffffff^fffffffff^fffffffff^
14APR , 30 , 0 , 0 , 30
, 29.379 , 0.4138 , 0.2069 ,
, 0.0131 , 0.4138 , 0.2069 ,
fffffffffffffff^fffffffff^fffffffff^fffffffff^
15APR , 30 , 0 , 0 , 30
, 29.379 , 0.4138 , 0.2069 ,
, 0.0131 , 0.4138 , 0.2069 ,
fffffffffffffff^fffffffff^fffffffff^fffffffff^
16APR , 39 , 1 , 0 , 40
, 39.172 , 0.5517 , 0.2759 ,
, 0.0008 , 0.3642 , 0.2759 ,
fffffffffffffff^fffffffff^fffffffff^fffffffff^
17APR , 39 , 0 , 0 , 39
, 38.193 , 0.5379 , 0.269 ,
, 0.017 , 0.5379 , 0.269 ,
fffffffffffffff^fffffffff^fffffffff^fffffffff^
19APR , 40 , 1 , 0 , 41
, 40.152 , 0.5655 , 0.2828 ,
, 0.0006 , 0.3338 , 0.2828 ,
fffffffffffffff^fffffffff^fffffffff^fffffffff^
20APR , 37 , 2 , 0 , 39
, 38.193 , 0.5379 , 0.269 ,
, 0.0373 , 3.9738 , 0.269 ,
fffffffffffffff^fffffffff^fffffffff^fffffffff^
21APR , 35 , 0 , 0 , 35
, 34.276 , 0.4828 , 0.2414 ,
, 0.0153 , 0.4828 , 0.2414 ,
fffffffffffffff^fffffffff^fffffffff^fffffffff^
22APR , 34 , 0 , 2 , 36
, 35.255 , 0.4966 , 0.2483 ,
, 0.0447 , 0.4966 , 12.359 ,
fffffffffffffff^fffffffff^fffffffff^fffffffff^
Total          284          4          2          290

                Statistics for Table of testdate by cond

Statistic          DF          Value          Prob
fffffffffffffff^
Chi-Square          14          21.2697          0.0949
Likelihood Ratio Chi-Square  14          16.0700          0.3091
Mantel-Haenszel Chi-Square   1          3.8796          0.0489
Phi Coefficient          0.2708
Contingency Coefficient          0.2614
Cramer's V          0.1915

```

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.
Sample Size = 290

Appendix D

Chi square tests of homogeneity for 48 h survival of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

----- Scenario=spillbay 2 (mid/deep) -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)			Total
Frequency				
Expected				
Cell Chi-Square	alive48	dead48	unkwn	
15APR	28	2	0	30
	28.966	0.6207	0.4138	
	0.0322	3.0651	0.4138	
17APR	39	1	0	40
	38.621	0.8276	0.5517	
	0.0037	0.0359	0.5517	
19APR	39	0	1	40
	38.621	0.8276	0.5517	
	0.0037	0.8276	0.3642	
21APR	34	0	1	35
	33.793	0.7241	0.4828	
	0.0013	0.7241	0.5542	
Total	140	3	2	145

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	6	6.5776	0.3617
Likelihood Ratio Chi-Square	6	7.7459	0.2573
Mantel-Haenszel Chi-Square	1	0.0015	0.9686
Phi Coefficient		0.2130	
Contingency Coefficient		0.2083	
Cramer's V		0.1506	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 145

Appendix D

Chi square tests of homogeneity for 48 h survival of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

----- Scenario=spillbay 4 (mid/deep) -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)			Total
Frequency				
Expected				
Cell Chi-Square	alive48	dead48	unkwn	
15APR	30	0	0	30
	28.966	0.8276	0.2069	
	0.0369	0.8276	0.2069	
17APR	38	2	0	40
	38.621	1.1034	0.2759	
	0.01	0.7284	0.2759	
19APR	38	2	0	40
	38.621	1.1034	0.2759	
	0.01	0.7284	0.2759	
21APR	34	0	1	35
	33.793	0.9655	0.2414	
	0.0013	0.9655	2.3842	
Total	140	4	1	145

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	6	6.4510	0.3746
Likelihood Ratio Chi-Square	6	7.6583	0.2642
Mantel-Haenszel Chi-Square	1	0.8102	0.3681
Phi Coefficient		0.2109	
Contingency Coefficient		0.2064	
Cramer's V		0.1491	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 145

Appendix D

Chi square tests of homogeneity for 48 h survival of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

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10:45 Tuesday, July 27, 2004

----- Scenario=spillbay 4 (off center/deep) -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)			Total
Frequency				
Expected				
Cell Chi-Square	alive48	dead48	unkwn	
15APR	29	1	0	30
	28.958	0.8333	0.2083	
	6E-5	0.0333	0.2083	
17APR	39	1	0	40
	38.611	1.1111	0.2778	
	0.0039	0.0111	0.2778	
19APR	38	1	0	39
	37.646	1.0833	0.2708	
	0.0033	0.0064	0.2708	
21APR	33	1	1	35
	33.785	0.9722	0.2431	
	0.0182	0.0008	2.3573	
Total	139	4	1	144

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	6	3.1915	0.7845
Likelihood Ratio Chi-Square	6	2.9048	0.8207
Mantel-Haenszel Chi-Square	1	0.8170	0.3661
Phi Coefficient		0.1489	
Contingency Coefficient		0.1472	
Cramer's V		0.1053	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 144

Appendix D

Chi square tests of homogeneity for 48 h survival of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

----- Scenario=vortex release -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)			Total
Frequency				
Expected				
Cell Chi-Square	alive48	dead48	unkwn	
21APR	22	1	0	23
	20.641	1.1795	1.1795	
	0.0895	0.0273	1.1795	
22APR	13	1	2	16
	14.359	0.8205	0.8205	
	0.1286	0.0393	1.6955	
Total	35	2	2	39

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	2	3.1597	0.2060
Likelihood Ratio Chi-Square	2	3.8498	0.1459
Mantel-Haenszel Chi-Square	1	2.8589	0.0909
Phi Coefficient		0.2846	
Contingency Coefficient		0.2738	
Cramer's V		0.2846	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 39

Appendix D

Chi square tests of homogeneity for 48 h survival of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

----- loc=Spillbay 6 -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)			Total
Frequency				
Expected				
Cell Chi-Square	alive48	dead48	unkwn	
21APR	22	1	0	23
	20.641	1.1795	1.1795	
	0.0895	0.0273	1.1795	
22APR	13	1	2	16
	14.359	0.8205	0.8205	
	0.1286	0.0393	1.6955	
Total	35	2	2	39

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	2	3.1597	0.2060
Likelihood Ratio Chi-Square	2	3.8498	0.1459
Mantel-Haenszel Chi-Square	1	2.8589	0.0909
Phi Coefficient		0.2846	
Contingency Coefficient		0.2738	
Cramer's V		0.2846	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 39

Appendix D

Chi square tests of homogeneity for 48 h survival of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

----- loc=control -----
 The FREQ Procedure
 Table of testdate by cond

testdate	cond(Recovery condition)			Total
Frequency	alive48	dead48	unkwn	
14APR	30	0	0	30
	29.379	0.4138	0.2069	
	0.0131	0.4138	0.2069	
15APR	30	0	0	30
	29.379	0.4138	0.2069	
	0.0131	0.4138	0.2069	
16APR	39	1	0	40
	39.172	0.5517	0.2759	
	0.0008	0.3642	0.2759	
17APR	39	0	0	39
	38.193	0.5379	0.269	
	0.017	0.5379	0.269	
19APR	40	1	0	41
	40.152	0.5655	0.2828	
	0.0006	0.3338	0.2828	
20APR	37	2	0	39
	38.193	0.5379	0.269	
	0.0373	3.9738	0.269	
21APR	35	0	0	35
	34.276	0.4828	0.2414	
	0.0153	0.4828	0.2414	
22APR	34	0	2	36
	35.255	0.4966	0.2483	
	0.0447	0.4966	12.359	
Total	284	4	2	290

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	14	21.2697	0.0949
Likelihood Ratio Chi-Square	14	16.0700	0.3091
Mantel-Haenszel Chi-Square	1	3.8796	0.0489
Phi Coefficient		0.2708	
Contingency Coefficient		0.2614	
Cramer's V		0.1915	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.
 Sample Size = 290

Appendix D

Chi square tests of homogeneity for 48 h survival of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

----- loc=spillbay 2 -----
 Table of testdate by cond

testdate	cond(Recovery condition)			Total
Frequency				
Expected				
Cell Chi-Square	alive48	dead48	unkwn	
-----	-----	-----	-----	-----
14APR	28	2	0	30
	28.862	0.931	0.2069	
	0.0257	1.2273	0.2069	
15APR	28	2	0	30
	28.862	0.931	0.2069	
	0.0257	1.2273	0.2069	
16APR	40	0	0	40
	38.483	1.2414	0.2759	
	0.0598	1.2414	0.2759	
17APR	39	1	0	40
	38.483	1.2414	0.2759	
	0.007	0.0469	0.2759	
19APR	39	0	1	40
	38.483	1.2414	0.2759	
	0.007	1.2414	1.9009	
20APR	36	4	0	40
	38.483	1.2414	0.2759	
	0.1602	6.1303	0.2759	
21APR	34	0	1	35
	33.672	1.0862	0.2414	
	0.0032	1.0862	2.3842	
22APR	35	0	0	35
	33.672	1.0862	0.2414	
	0.0523	1.0862	0.2414	
Total	279	9	2	290

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	14	19.3958	0.1504
Likelihood Ratio Chi-Square	14	20.8069	0.1067
Mantel-Haenszel Chi-Square	1	0.0028	0.9576
Phi Coefficient		0.2586	
Contingency Coefficient		0.2504	
Cramer's V		0.1829	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.
 Sample Size = 290

Appendix D

Chi square tests of homogeneity for 48 h survival of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

----- loc=spillbay 4 -----
 The FREQ Procedure
 Table of testdate by cond

testdate	cond(Recovery condition)			Total
Frequency	alive48	dead48	unkwn	
14APR	59	0	0	59
	57.678	0.9155	0.4069	
	0.0303	0.9155	0.4069	
15APR	59	1	0	60
	58.655	0.931	0.4138	
	0.002	0.0051	0.4138	
16APR	80	1	0	81
	79.184	1.2569	0.5586	
	0.0084	0.0525	0.5586	
17APR	77	3	0	80
	78.207	1.2414	0.5517	
	0.0186	2.4914	0.5517	
19APR	76	3	0	79
	77.229	1.2259	0.5448	
	0.0196	2.5676	0.5448	
20APR	79	0	1	80
	78.207	1.2414	0.5517	
	0.008	1.2414	0.3642	
21APR	67	1	2	70
	68.431	1.0862	0.4828	
	0.0299	0.0068	4.7685	
22APR	70	0	1	71
	69.409	1.1017	0.4897	
	0.005	1.1017	0.5319	
Total	567	9	4	580

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	14	16.6445	0.2756
Likelihood Ratio Chi-Square	14	18.6095	0.1804
Mantel-Haenszel Chi-Square	1	2.2917	0.1301
Phi Coefficient		0.1694	
Contingency Coefficient		0.1670	
Cramer's V		0.1198	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.
 Sample Size = 580

Appendix D

Chi square tests of clean fish conditions of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

----- Scenario=control -----

Table of testdate by cond

testdate	cond(Recovery condition)		Total
Frequency			
Expected			
Cell Chi-Square	clean	maladies	Total
14APR	30	0	30
	29.896	0.1042	
	0.0004	0.1042	
15APR	30	0	30
	29.896	0.1042	
	0.0004	0.1042	
16APR	40	0	40
	39.861	0.1389	
	0.0005	0.1389	
17APR	39	0	39
	38.865	0.1354	
	0.0005	0.1354	
19APR	41	0	41
	40.858	0.1424	
	0.0005	0.1424	
20APR	38	1	39
	38.865	0.1354	
	0.0192	5.52	
21APR	35	0	35
	34.878	0.1215	
	0.0004	0.1215	
22APR	34	0	34
	33.882	0.1181	
	0.0004	0.1181	
Total	287	1	288

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	7	6.4069	0.4931
Likelihood Ratio Chi-Square	7	4.0212	0.7773
Mantel-Haenszel Chi-Square	1	0.5152	0.4729
Phi Coefficient		0.1492	
Contingency Coefficient		0.1475	
Cramer's V		0.1492	

WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.
Sample Size = 288

Appendix D

Chi square tests of clean fish conditions of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

----- Scenario=spillbay 2 mid/shallow -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)			
Frequency				
Expected				
Cell Chi-Square	clean	maladies		Total
14APR	27	2		29
	28.177	0.8227		
	0.0492	1.6848		
16APR	40	0		40
	38.865	1.1348		
	0.0331	1.1348		
20APR	35	2		37
	35.95	1.0496		
	0.0251	0.8605		
22APR	35	0		35
	34.007	0.9929		
	0.029	0.9929		
Total	137	4		141

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	3	4.8093	0.1863
Likelihood Ratio Chi-Square	3	6.2688	0.0992
Mantel-Haenszel Chi-Square	1	0.5512	0.4578
Phi Coefficient		0.1847	
Contingency Coefficient		0.1816	
Cramer's V		0.1847	

WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 141

Appendix D

Chi square tests of clean fish conditions of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

----- Scenario=spillbay 2 mid/deep -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)			
Frequency				
Expected				
Cell Chi-Square	clean	maladies		Total
15APR	28	1		29
	28.183	0.8169		
	0.0012	0.041		
17APR	38	2		40
	38.873	1.1268		
	0.0196	0.6768		
19APR	39	0		39
	37.901	1.0986		
	0.0318	1.0986		
21APR	33	1		34
	33.042	0.9577		
	54E-6	0.0019		
Total	138	4		142

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	3	1.8710	0.5996
Likelihood Ratio Chi-Square	3	2.8386	0.4172
Mantel-Haenszel Chi-Square	1	0.3226	0.5701
Phi Coefficient		0.1148	
Contingency Coefficient		0.1140	
Cramer's V		0.1148	

WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 142

Appendix D

Chi square tests of clean fish conditions of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

----- Scenario=spillbay 4 mid/deep -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)			
Frequency				
Expected				
Cell Chi-Square	clean	maladies		Total
15APR	27	3		30
	29.155	0.8451		
	0.1593	5.4951		
17APR	38	0		38
	36.93	1.0704		
	0.031	1.0704		
19APR	39	1		40
	38.873	1.1268		
	0.0004	0.0143		
21APR	34	0		34
	33.042	0.9577		
	0.0278	0.9577		
Total	138	4		142

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	3	7.7560	0.0513
Likelihood Ratio Chi-Square	3	7.5850	0.0554
Mantel-Haenszel Chi-Square	1	3.9164	0.0478
Phi Coefficient		0.2337	
Contingency Coefficient		0.2276	
Cramer's V		0.2337	

WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 142

Appendix D

Chi square tests of clean fish conditions of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

----- Scenario=spillbay 4 (mid/shallow) -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)		Total
Frequency			
Expected			
Cell Chi-Square	clean	maladies	Total
14APR	28	2	30
	29.375	0.625	
	0.0644	3.025	
16APR	39	1	40
	39.167	0.8333	
	0.0007	0.0333	
20APR	39	0	39
	38.188	0.8125	
	0.0173	0.8125	
22APR	35	0	35
	34.271	0.7292	
	0.0155	0.7292	
Total	141	3	144

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	3	4.6979	0.1953
Likelihood Ratio Chi-Square	3	5.1159	0.1635
Mantel-Haenszel Chi-Square	1	3.8708	0.0491
Phi Coefficient		0.1806	
Contingency Coefficient		0.1777	
Cramer's V		0.1806	

WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 144

Appendix D

Chi square tests of clean fish conditions of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

----- Scenario=spillbay 4 off center/deep -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)			
Frequency				
Expected				
Cell Chi-Square	clean	maladies		Total
15APR	28	2		30
	28.112	1.8881		
	0.0004	0.0066		
17APR	38	2		40
	37.483	2.5175		
	0.0071	0.1064		
19APR	36	3		39
	36.545	2.4545		
	0.0081	0.1212		
21APR	32	2		34
	31.86	2.1399		
	0.0006	0.0091		
Total	134	9		143

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	3	0.2597	0.9674
Likelihood Ratio Chi-Square	3	0.2598	0.9674
Mantel-Haenszel Chi-Square	1	0.0024	0.9606
Phi Coefficient		0.0426	
Contingency Coefficient		0.0426	
Cramer's V		0.0426	

WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 143

Appendix D

Chi square tests of clean fish conditions of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

----- Scenario=spillbay 4 (off center/shallow) -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)			
Frequency				
Expected				
Cell Chi-Square	clean	maladies		Total
14APR	28	1		29
	28	1		
	0	0		
16APR	38	3		41
	39.586	1.4138		
	0.0636	1.7796		
20APR	39	1		40
	38.621	1.3793		
	0.0037	0.1043		
22APR	35	0		35
	33.793	1.2069		
	0.0431	1.2069		
Total	140	5		145

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	3	3.2012	0.3616
Likelihood Ratio Chi-Square	3	3.9816	0.2635
Mantel-Haenszel Chi-Square	1	1.7017	0.1921
Phi Coefficient		0.1486	
Contingency Coefficient		0.1470	
Cramer's V		0.1486	

WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 145

Appendix D

Chi square tests of clean fish conditions of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

----- Scenario=vortex release -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)			Total
Frequency				
Expected				
Cell Chi-Square	clean	maladies		Total
21APR	22	1		23
	21.083	1.9167		
	0.0399	0.4384		
22APR	11	2		13
	11.917	1.0833		
	0.0705	0.7756		
Total	33	3		36

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	1	1.3244	0.2498
Likelihood Ratio Chi-Square	1	1.2629	0.2611
Continuity Adj. Chi-Square	1	0.2736	0.6009
Mantel-Haenszel Chi-Square	1	1.2876	0.2565
Phi Coefficient		0.1918	
Contingency Coefficient		0.1884	
Cramer's V		0.1918	

WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Fisher's Exact Test

Cell (1,1) Frequency (F)	22
Left-sided Pr <= F	0.9599
Right-sided Pr >= F	0.2913
Table Probability (P)	0.2513
Two-sided Pr <= P	0.5394

Sample Size = 36

Chi square tests of clean fish conditions of chinook salmon juveniles
 released through Spillbays at the Dalles Dam, April 2004.

----- loc=Spillbay 6 -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)			Total
Frequency				
Expected				
Cell Chi-Square	clean	maladies		Total
21APR	22	1		23
	21.083	1.9167		
	0.0399	0.4384		
22APR	11	2		13
	11.917	1.0833		
	0.0705	0.7756		
Total	33	3		36

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	1	1.3244	0.2498
Likelihood Ratio Chi-Square	1	1.2629	0.2611
Continuity Adj. Chi-Square	1	0.2736	0.6009
Mantel-Haenszel Chi-Square	1	1.2876	0.2565
Phi Coefficient		0.1918	
Contingency Coefficient		0.1884	
Cramer's V		0.1918	

WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Fisher's Exact Test

Cell (1,1) Frequency (F)	22
Left-sided Pr <= F	0.9599
Right-sided Pr >= F	0.2913
Table Probability (P)	0.2513
Two-sided Pr <= P	0.5394

Sample Size = 36

Appendix D

Chi square tests of clean fish conditions of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

----- loc=control -----
 Table of testdate by cond

testdate	cond(Recovery condition)		Total
Frequency	,		
Expected	,		
Cell Chi-Square	,clean	,maladies,	Total
14APR	, 30	, 0	30
	, 29.896	, 0.1042	
	, 0.0004	, 0.1042	
15APR	, 30	, 0	30
	, 29.896	, 0.1042	
	, 0.0004	, 0.1042	
16APR	, 40	, 0	40
	, 39.861	, 0.1389	
	, 0.0005	, 0.1389	
17APR	, 39	, 0	39
	, 38.865	, 0.1354	
	, 0.0005	, 0.1354	
19APR	, 41	, 0	41
	, 40.858	, 0.1424	
	, 0.0005	, 0.1424	
20APR	, 38	, 1	39
	, 38.865	, 0.1354	
	, 0.0192	, 5.52	
21APR	, 35	, 0	35
	, 34.878	, 0.1215	
	, 0.0004	, 0.1215	
22APR	, 34	, 0	34
	, 33.882	, 0.1181	
	, 0.0004	, 0.1181	
Total	287	1	288

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	7	6.4069	0.4931
Likelihood Ratio Chi-Square	7	4.0212	0.7773
Mantel-Haenszel Chi-Square	1	0.5152	0.4729
Phi Coefficient		0.1492	
Contingency Coefficient		0.1475	
Cramer's V		0.1492	

WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.
 Sample Size = 288

Appendix D

Chi square tests of clean fish conditions of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

----- loc=spillbay 2 -----

The FREQ Procedure
Table of testdate by cond

testdate	cond(Recovery condition)		Total
Frequency	,		
Expected	,		
Cell Chi-Square	clean	maladies	Total
14APR	27	2	29
	28.18	0.8198	
	0.0494	1.6991	
15APR	28	1	29
	28.18	0.8198	
	0.0012	0.0396	
16APR	40	0	40
	38.869	1.1307	
	0.0329	1.1307	
17APR	38	2	40
	38.869	1.1307	
	0.0194	0.6682	
19APR	39	0	39
	37.898	1.1025	
	0.0321	1.1025	
20APR	35	2	37
	35.954	1.0459	
	0.0253	0.8703	
21APR	33	1	34
	33.039	0.9611	
	457E-7	0.0016	
22APR	35	0	35
	34.011	0.9894	
	0.0288	0.9894	
Total	275	8	283

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	7	6.6905	0.4618
Likelihood Ratio Chi-Square	7	9.1075	0.2450
Mantel-Haenszel Chi-Square	1	0.8759	0.3493
Phi Coefficient		0.1538	
Contingency Coefficient		0.1520	
Cramer's V		0.1538	

WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.
Sample Size = 283

Appendix D

Chi square tests of clean fish conditions of chinook salmon juveniles released through Spillbays at the Dalles Dam, April 2004.

----- loc=spillbay 4 -----

Table of testdate by cond

testdate	cond(Recovery condition)		
Frequency	clean	maladies	Total
14APR	56	3	59
	56.841	2.1585	
	0.0125	0.328	
15APR	55	5	60
	57.805	2.1951	
	0.1361	3.584	
16APR	77	4	81
	78.037	2.9634	
	0.0138	0.3626	
17APR	76	2	78
	75.146	2.8537	
	0.0097	0.2554	
19APR	75	4	79
	76.11	2.8902	
	0.0162	0.4261	
20APR	78	1	79
	76.11	2.8902	
	0.0469	1.2362	
21APR	66	2	68
	65.512	2.4878	
	0.0036	0.0956	
22APR	70	0	70
	67.439	2.561	
	0.0973	2.561	
Total	553	21	574

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	7	9.1850	0.2396
Likelihood Ratio Chi-Square	7	11.1257	0.1332
Mantel-Haenszel Chi-Square	1	5.2997	0.0213
Phi Coefficient		0.1265	
Contingency Coefficient		0.1255	
Cramer's V		0.1265	

WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.
Sample Size = 574

Appendix D

Chi square tests of homogeneity for control releases of chinook salmon juveniles released through Spillbays at the Dalles Dam, May-June 2004.

----- Scenario=control -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(NAME OF FORMER VARIABLE)			Total
Frequency				
Expected				
Cell Chi-Square	Alive	dead	unkwn	
26MAY	27	0	0	27
	26.702	0.0993	0.1985	
	0.0033	0.0993	0.1985	
27MAY	55	0	1	56
	55.382	0.2059	0.4118	
	0.0026	0.2059	0.8403	
28MAY	49	1	0	50
	49.449	0.1838	0.3676	
	0.0041	3.6238	0.3676	
31MAY	45	0	0	45
	44.504	0.1654	0.3309	
	0.0055	0.1654	0.3309	
01JUN	49	0	0	49
	48.46	0.1801	0.3603	
	0.006	0.1801	0.3603	
02JUN	44	0	1	45
	44.504	0.1654	0.3309	
	0.0057	0.1654	1.3531	
Total	269	1	2	272

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	10	7.9181	0.6368
Likelihood Ratio Chi-Square	10	7.4014	0.6871
Mantel-Haenszel Chi-Square	1	0.0007	0.9791
Phi Coefficient		0.1706	
Contingency Coefficient		0.1682	
Cramer's V		0.1206	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.
Sample Size = 272

Appendix D

Chi square tests of homogeneity for control releases of chinook salmon juveniles released through Spillbays at the Dalles Dam, May-June 2004.

----- Scenario=spillbay 2 mid/deep -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(NAME OF FORMER VARIABLE)			Total
Frequency				
Expected				
Cell Chi-Square	Alive	dead		
-----	-----	-----	-----	-----
27MAY	55	0		55
	54.267	0.7333		
	0.0099	0.7333		
-----	-----	-----	-----	-----
29MAY	43	2		45
	44.4	0.6		
	0.0441	3.2667		
-----	-----	-----	-----	-----
01JUN	50	0		50
	49.333	0.6667		
	0.009	0.6667		
-----	-----	-----	-----	-----
Total	148	2		150

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	2	4.7297	0.0940
Likelihood Ratio Chi-Square	2	4.8793	0.0872
Mantel-Haenszel Chi-Square	1	0.0326	0.8568
Phi Coefficient		0.1776	
Contingency Coefficient		0.1748	
Cramer's V		0.1776	

WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 150

Appendix D

Chi square tests of homogeneity for control releases of chinook salmon juveniles released through Spillbays at the Dalles Dam, May-June 2004.

----- Scenario=spillbay 2 mid/shallow release -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(NAME OF FORMER VARIABLE)				Total
Frequency	Alive	dead	unkwn		
Expected					
Cell Chi-Square					
26MAY	29	1	0		30
	29.4	0.4	0.2		
	0.0054	0.9	0.2		
28MAY	50	0	0		50
	49	0.6667	0.3333		
	0.0204	0.6667	0.3333		
29MAY	30	0	0		30
	29.4	0.4	0.2		
	0.0122	0.4	0.2		
02JUN	38	1	1		40
	39.2	0.5333	0.2667		
	0.0367	0.4083	2.0167		
Total	147	2	1		150

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	6	5.1998	0.5185
Likelihood Ratio Chi-Square	6	5.8083	0.4450
Mantel-Haenszel Chi-Square	1	1.8932	0.1688
Phi Coefficient		0.1862	
Contingency Coefficient		0.1830	
Cramer's V		0.1317	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 150

Appendix D

Chi square tests of homogeneity for control releases of chinook salmon juveniles released through Spillbays at the Dalles Dam, May-June 2004.

----- Scenario=spillbay 4 mid/deep release -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(NAME OF FORMER VARIABLE)				Total
Frequency	Alive	dead	unkwn		
Expected					
Cell Chi-Square					
27MAY	55	0	0		55
	53.893	0.7383	0.3691		
	0.0228	0.7383	0.3691		
29MAY	43	2	0		45
	44.094	0.604	0.302		
	0.0271	3.2262	0.302		
01JUN	48	0	1		49
	48.013	0.6577	0.3289		
	3.75E-8	0.6577	1.3697		
Total	146	2	1		149

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	4	6.7129	0.1519
Likelihood Ratio Chi-Square	4	7.0634	0.1326
Mantel-Haenszel Chi-Square	1	0.9659	0.3257
Phi Coefficient		0.2123	
Contingency Coefficient		0.2076	
Cramer's V		0.1501	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 149

Appendix D

Chi square tests of homogeneity for control releases of chinook salmon juveniles released through Spillbays at the Dalles Dam, May-June 2004.

----- Scenario=spillbay 4 mid/shallow pipe release -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(NAME OF FORMER VARIABLE)			Total
Frequency	Alive	dead	unkwn	
Expected				
Cell Chi-Square				
26MAY	27	2	1	30
	28.909	0.9091	0.1818	
	0.1261	1.3091	3.6818	
28MAY	49	1	0	50
	48.182	1.5152	0.303	
	0.0139	0.1752	0.303	
29MAY	28	2	0	30
	28.909	0.9091	0.1818	
	0.0286	1.3091	0.1818	
02JUN	55	0	0	55
	53	1.6667	0.3333	
	0.0755	1.6667	0.3333	
Total	159	5	1	165

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	6	9.2040	0.1624
Likelihood Ratio Chi-Square	6	9.1323	0.1663
Mantel-Haenszel Chi-Square	1	4.3614	0.0368
Phi Coefficient		0.2362	
Contingency Coefficient		0.2299	
Cramer's V		0.1670	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 165

Appendix D

Chi square tests of homogeneity for control releases of chinook salmon juveniles released through Spillbays at the Dalles Dam, May-June 2004.

----- Scenario=spillbay 4 off center/deep release -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(NAME OF FORMER VARIABLE)		Total
Frequency			
Expected			
Cell Chi-Square	Alive		
^^^^^^^^^^^^^^^^^^^^	^^^^^^^^^^		
27MAY	55		55
	55		
	0		
^^^^^^^^^^^^^^^^^^^^	^^^^^^^^^^		
29MAY	45		45
	45		
	0		
^^^^^^^^^^^^^^^^^^^^	^^^^^^^^^^		
01JUN	50		50
	50		
	0		
^^^^^^^^^^^^^^^^^^^^	^^^^^^^^^^		
Total	150		150

Appendix D

Chi square tests of homogeneity for control releases of chinook salmon juveniles released through Spillbays at the Dalles Dam, May-June 2004.

----- Scenario=spillbay 4 off center/shallow release -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(NAME OF FORMER VARIABLE)			
Frequency				
Expected				
Cell Chi-Square	Alive	dead		Total
-----	-----	-----	-----	-----
26MAY	30	0		30
	29.419	0.5806		
	0.0115	0.5806		
-----	-----	-----	-----	-----
28MAY	50	0		50
	49.032	0.9677		
	0.0191	0.9677		
-----	-----	-----	-----	-----
29MAY	30	0		30
	29.419	0.5806		
	0.0115	0.5806		
-----	-----	-----	-----	-----
02JUN	42	3		45
	44.129	0.871		
	0.1027	5.2043		
-----	-----	-----	-----	-----
Total	152	3		155

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
-----	-----	-----	-----
Chi-Square	3	7.4781	0.0581
Likelihood Ratio Chi-Square	3	7.5667	0.0559
Mantel-Haenszel Chi-Square	1	6.4065	0.0114
Phi Coefficient		0.2196	
Contingency Coefficient		0.2145	
Cramer's V		0.2196	

WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 155

Appendix D

Chi square tests of homogeneity for control releases of chinook salmon juveniles released through Spillbays at the Dalles Dam, May-June 2004.

----- Scenario=vortex release -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(NAME OF FORMER VARIABLE)			Total
Frequency				
Expected				
Cell Chi-Square	Alive	dead	unkwn	
01JUN	28	1	1	30
	24.966	4.2282	0.8054	
	0.3686	2.4647	0.047	
02JUN	44	5	1	50
	41.611	7.047	1.3423	
	0.1372	0.5946	0.0873	
03JUN	52	15	2	69
	57.423	9.7248	1.8523	
	0.5121	2.8615	0.0118	
Total	124	21	4	149

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	4	7.0848	0.1315
Likelihood Ratio Chi-Square	4	7.8550	0.0970
Mantel-Haenszel Chi-Square	1	3.7592	0.0525
Phi Coefficient		0.2181	
Contingency Coefficient		0.2131	
Cramer's V		0.1542	

WARNING: 44% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 149

Appendix D

Chi square tests of homogeneity for control releases of chinook salmon juveniles released through Spillbays at the Dalles Dam, May-June 2004.

----- loc=control -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)			Total
Frequency	Alive	dead	unkwn	
26MAY	27	0	0	27
	26.702	0.0993	0.1985	
	0.0033	0.0993	0.1985	
27MAY	55	0	1	56
	55.382	0.2059	0.4118	
	0.0026	0.2059	0.8403	
28MAY	49	1	0	50
	49.449	0.1838	0.3676	
	0.0041	3.6238	0.3676	
31MAY	45	0	0	45
	44.504	0.1654	0.3309	
	0.0055	0.1654	0.3309	
01JUN	49	0	0	49
	48.46	0.1801	0.3603	
	0.006	0.1801	0.3603	
02JUN	44	0	1	45
	44.504	0.1654	0.3309	
	0.0057	0.1654	1.3531	
Total	269	1	2	272

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	10	7.9181	0.6368
Likelihood Ratio Chi-Square	10	7.4014	0.6871
Mantel-Haenszel Chi-Square	1	0.0007	0.9791
Phi Coefficient		0.1706	
Contingency Coefficient		0.1682	
Cramer's V		0.1206	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.
Sample Size = 272

Appendix D

Chi square tests of homogeneity for control releases of chinook salmon juveniles released through Spillbays at the Dalles Dam, May-June 2004.

----- loc=spillbay 2 -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)			Total
Frequency	Alive	dead	unkwn	
26MAY	29	1	0	30
	29.5	0.4	0.1	
	0.0085	0.9	0.1	
27MAY	55	0	0	55
	54.083	0.7333	0.1833	
	0.0155	0.7333	0.1833	
28MAY	50	0	0	50
	49.167	0.6667	0.1667	
	0.0141	0.6667	0.1667	
29MAY	73	2	0	75
	73.75	1	0.25	
	0.0076	1	0.25	
01JUN	50	0	0	50
	49.167	0.6667	0.1667	
	0.0141	0.6667	0.1667	
02JUN	38	1	1	40
	39.333	0.5333	0.1333	
	0.0452	0.4083	5.6333	
Total	295	4	1	300

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	10	10.9801	0.3591
Likelihood Ratio Chi-Square	10	9.9976	0.4407
Mantel-Haenszel Chi-Square	1	1.4268	0.2323
Phi Coefficient		0.1913	
Contingency Coefficient		0.1879	
Cramer's V		0.1353	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.
Sample Size = 300

Appendix D

Chi square tests of homogeneity for control releases of chinook salmon juveniles released through Spillbays at the Dalles Dam, May-June 2004.

----- loc=spillbay 4 -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)			Total
Frequency	Alive	dead	unkwn	
26MAY	57	2	1	60
27MAY	110	0	0	110
28MAY	99	1	0	100
29MAY	146	4	0	150
01JUN	98	0	1	99
02JUN	97	3	0	100
Total	607	10	2	619

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	10	13.3407	0.2052
Likelihood Ratio Chi-Square	10	15.3592	0.1195
Mantel-Haenszel Chi-Square	1	0.0030	0.9567
Phi Coefficient		0.1468	
Contingency Coefficient		0.1452	
Cramer's V		0.1038	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.
Sample Size = 619

Appendix D

Chi square tests of homogeneity for control releases of chinook salmon juveniles released through Spillbays at the Dalles Dam, May-June 2004.

----- loc=vortex release -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)			Total
Frequency	Alive	dead	unkwn	
Expected				
Cell Chi-Square				
01JUN	28	1	1	30
	24.966	4.2282	0.8054	
	0.3686	2.4647	0.047	
02JUN	44	5	1	50
	41.611	7.047	1.3423	
	0.1372	0.5946	0.0873	
03JUN	52	15	2	69
	57.423	9.7248	1.8523	
	0.5121	2.8615	0.0118	
Total	124	21	4	149

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	4	7.0848	0.1315
Likelihood Ratio Chi-Square	4	7.8550	0.0970
Mantel-Haenszel Chi-Square	1	3.7592	0.0525
Phi Coefficient		0.2181	
Contingency Coefficient		0.2131	
Cramer's V		0.1542	

WARNING: 44% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 149

Appendix D

Chi square tests of homogeneity for 48 h survival of chinook salmon juveniles released through Spillbays at the Dalles Dam, May-June 2004.

----- Scenario=control -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)			Total
Frequency				
Expected				
Cell Chi-Square	alive48	dead48	unkwn	
26MAY	27	0	0	27
	26.702	0.0993	0.1985	
	0.0033	0.0993	0.1985	
27MAY	55	0	1	56
	55.382	0.2059	0.4118	
	0.0026	0.2059	0.8403	
28MAY	49	1	0	50
	49.449	0.1838	0.3676	
	0.0041	3.6238	0.3676	
31MAY	45	0	0	45
	44.504	0.1654	0.3309	
	0.0055	0.1654	0.3309	
01JUN	49	0	0	49
	48.46	0.1801	0.3603	
	0.006	0.1801	0.3603	
02JUN	44	0	1	45
	44.504	0.1654	0.3309	
	0.0057	0.1654	1.3531	
Total	269	1	2	272

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	10	7.9181	0.6368
Likelihood Ratio Chi-Square	10	7.4014	0.6871
Mantel-Haenszel Chi-Square	1	0.0007	0.9791
Phi Coefficient		0.1706	
Contingency Coefficient		0.1682	
Cramer's V		0.1206	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.
Sample Size = 272

Appendix D

Chi square tests of homogeneity for 48 h survival of chinook salmon juveniles released through Spillbays at the Dalles Dam, May-June 2004.

----- Scenario=spillbay 2 mid/deep -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)		Total
Frequency			
Expected			
Cell Chi-Square	alive48	dead48	Total
-----	-----	-----	-----
27MAY	54	1	55
	53.533	1.4667	
	0.0041	0.1485	
-----	-----	-----	-----
29MAY	42	3	45
	43.8	1.2	
	0.074	2.7	
-----	-----	-----	-----
01JUN	50	0	50
	48.667	1.3333	
	0.0365	1.3333	
-----	-----	-----	-----
Total	146	4	150

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
-----	-----	-----	-----
Chi-Square	2	4.2964	0.1167
Likelihood Ratio Chi-Square	2	4.8470	0.0886
Mantel-Haenszel Chi-Square	1	0.5459	0.4600
Phi Coefficient		0.1692	
Contingency Coefficient		0.1669	
Cramer's V		0.1692	

WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 150

Appendix D

Chi square tests of homogeneity for 48 h survival of chinook salmon juveniles released through Spillbays at the Dalles Dam, May-June 2004.

----- Scenario=spillbay 2 mid/shallow release -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)			Total
Frequency				
Expected				
Cell Chi-Square	alive48	dead48	unkwn	
26MAY	29	1	0	30
	29.4	0.4	0.2	
	0.0054	0.9	0.2	
28MAY	50	0	0	50
	49	0.6667	0.3333	
	0.0204	0.6667	0.3333	
29MAY	30	0	0	30
	29.4	0.4	0.2	
	0.0122	0.4	0.2	
02JUN	38	1	1	40
	39.2	0.5333	0.2667	
	0.0367	0.4083	2.0167	
Total	147	2	1	150

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	6	5.1998	0.5185
Likelihood Ratio Chi-Square	6	5.8083	0.4450
Mantel-Haenszel Chi-Square	1	1.8932	0.1688
Phi Coefficient		0.1862	
Contingency Coefficient		0.1830	
Cramer's V		0.1317	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 150

Appendix D

Chi square tests of homogeneity for 48 h survival of chinook salmon juveniles released through Spillbays at the Dalles Dam, May-June 2004.

----- Scenario=spillbay 4 mid/deep release -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)			Total
Frequency				
Expected				
Cell Chi-Square	alive48	dead48	unkwn	
27MAY	55	0	0	55
	53.893	0.7383	0.3691	
	0.0228	0.7383	0.3691	
29MAY	43	2	0	45
	44.094	0.604	0.302	
	0.0271	3.2262	0.302	
01JUN	48	0	1	49
	48.013	0.6577	0.3289	
	3.75E-8	0.6577	1.3697	
Total	146	2	1	149

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	4	6.7129	0.1519
Likelihood Ratio Chi-Square	4	7.0634	0.1326
Mantel-Haenszel Chi-Square	1	0.9659	0.3257
Phi Coefficient		0.2123	
Contingency Coefficient		0.2076	
Cramer's V		0.1501	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 149

Appendix D

Chi square tests of homogeneity for 48 h survival of chinook salmon juveniles released through Spillbays at the Dalles Dam, May-June 2004.

----- Scenario=spillbay 4 mid/shallow pipe release -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)			Total
Frequency				
Expected				
Cell Chi-Square	alive48	dead48	unkwn	
26MAY	26	3	1	30
	28.545	1.2727	0.1818	
	0.227	2.3442	3.6818	
28MAY	49	1	0	50
	47.576	2.1212	0.303	
	0.0426	0.5926	0.303	
29MAY	28	2	0	30
	28.545	1.2727	0.1818	
	0.0104	0.4156	0.1818	
02JUN	54	1	0	55
	52.333	2.3333	0.3333	
	0.0531	0.7619	0.3333	
Total	157	7	1	165

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	6	8.9474	0.1766
Likelihood Ratio Chi-Square	6	7.5028	0.2768
Mantel-Haenszel Chi-Square	1	3.5985	0.0578
Phi Coefficient		0.2329	
Contingency Coefficient		0.2268	
Cramer's V		0.1647	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 165

Appendix D

Chi square tests of homogeneity for 48 h survival of chinook salmon juveniles released through Spillbays at the Dalles Dam, May-June 2004.

----- Scenario=spillbay 4 off center/shallow release -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)			
Frequency				
Expected				
Cell Chi-Square	alive48	dead48		Total
-----	-----	-----	-----	-----
26MAY	30	0		30
	29.226	0.7742		
	0.0205	0.7742		
-----	-----	-----	-----	-----
28MAY	49	1		50
	48.71	1.2903		
	0.0017	0.0653		
-----	-----	-----	-----	-----
29MAY	30	0		30
	29.226	0.7742		
	0.0205	0.7742		
-----	-----	-----	-----	-----
02JUN	42	3		45
	43.839	1.1613		
	0.0771	2.9113		
-----	-----	-----	-----	-----
Total	151	4		155

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
-----	-----	-----	-----
Chi-Square	3	4.6449	0.1997
Likelihood Ratio Chi-Square	3	5.3053	0.1508
Mantel-Haenszel Chi-Square	1	3.8134	0.0508
Phi Coefficient		0.1731	
Contingency Coefficient		0.1706	
Cramer's V		0.1731	

WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 155

Appendix D

Chi square tests of homogeneity for 48 h survival of chinook salmon juveniles released through Spillbays at the Dalles Dam, May-June 2004.

----- Scenario=vortex release -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)			Total
Frequency				
Expected				
Cell Chi-Square	alive48	dead48	unkwn	
01JUN	28	1	1	30
	24.765	4.4295	0.8054	
	0.4226	2.6553	0.047	
02JUN	43	6	1	50
	41.275	7.3826	1.3423	
	0.0721	0.2589	0.0873	
03JUN	52	15	2	69
	56.96	10.188	1.8523	
	0.4319	2.2729	0.0118	
Total	123	22	4	149

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	4	6.2597	0.1806
Likelihood Ratio Chi-Square	4	7.2128	0.1251
Mantel-Haenszel Chi-Square	1	3.4622	0.0628
Phi Coefficient		0.2050	
Contingency Coefficient		0.2008	
Cramer's V		0.1449	

WARNING: 44% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 149

Appendix D

Chi square tests of homogeneity for control releases of chinook salmon juveniles released through Spillbays at the Dalles Dam, May-June 2004.

----- cgroup=ByHand Scenario=control -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)			Total
Frequency				
Expected				
Cell Chi-Square	Alive	unkwn		Total
-----	-----	-----	-----	-----
31MAY	45	0		45
	44.676	0.3237		
	0.0023	0.3237		
-----	-----	-----	-----	-----
01JUN	49	0		49
	48.647	0.3525		
	0.0026	0.3525		
-----	-----	-----	-----	-----
02JUN	44	1		45
	44.676	0.3237		
	0.0102	1.4126		
-----	-----	-----	-----	-----
Total	138	1		139

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
-----	-----	-----	-----
Chi-Square	2	2.1040	0.3492
Likelihood Ratio Chi-Square	2	2.2708	0.3213
Mantel-Haenszel Chi-Square	1	1.5444	0.2140
Phi Coefficient		0.1230	
Contingency Coefficient		0.1221	
Cramer's V		0.1230	

WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 139

Appendix D

Chi square tests of homogeneity for control releases of chinook salmon juveniles released through Spillbays at the Dalles Dam, May-June 2004.

----- cgroup=Pipe Scenario=control -----

The FREQ Procedure

Table of testdate by cond

testdate	cond(Recovery condition)			Total
Frequency	Alive	dead	unkwn	
Expected				
Cell Chi-Square				
26MAY	27	0	0	27
	26.594	0.203	0.203	
	0.0062	0.203	0.203	
27MAY	55	0	1	56
	55.158	0.4211	0.4211	
	0.0005	0.4211	0.7961	
28MAY	49	1	0	50
	49.248	0.3759	0.3759	
	0.0013	1.0359	0.3759	
Total	131	1	1	133

Statistics for Table of testdate by cond

Statistic	DF	Value	Prob
Chi-Square	4	3.0429	0.5507
Likelihood Ratio Chi-Square	4	3.6945	0.4489
Mantel-Haenszel Chi-Square	1	0.0849	0.7708
Phi Coefficient		0.1513	
Contingency Coefficient		0.1496	
Cramer's V		0.1070	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 133

Appendix D

Chi square tests of homogeneity for control releases of chinook salmon juveniles released through Spillbays at the Dalles Dam, May-June 2004.

The FREQ Procedure

Table of cgroup by cond

cgroup	cond(Recovery condition)			Total
Frequency				
Expected				
Cell Chi-Square	Alive	dead	unkwn	
ByHand	138	0	1	139
	137.47	0.511	1.0221	
	0.0021	0.511	0.0005	
Pipe	131	1	1	133
	131.53	0.489	0.9779	
	0.0022	0.5341	0.0005	
Total	269	1	2	272

Statistics for Table of cgroup by cond

Statistic	DF	Value	Prob
Chi-Square	2	1.0503	0.5915
Likelihood Ratio Chi-Square	2	1.4361	0.4877
Mantel-Haenszel Chi-Square	1	0.1379	0.7103
Phi Coefficient		0.0621	
Contingency Coefficient		0.0620	
Cramer's V		0.0621	

WARNING: 67% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 272

Appendix D

Forty-eight hour survival estimates for juvenile chinook salmon released through Spillbay 2 at shallow and deep mid release sites at the Dalles Dam, April 2004. Controls: 290 released, 284 alive, 4 dead. Shallow release: 145 released, 139 alive, 6 dead. Deep release: 145 released, 140 alive, 3 dead.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9862 (0.0062) Control group survival
Pa = 0.9929 (0.0024) Live recovery probability
Pd = 1.0 N/A Dead recovery probability*
S2 = 0.9586 (0.0165) Spillbay 2, mid shallow survival
S3 = 0.9793 (0.0099) Spillbay 2, mid deep survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -84.4958

Tau = 0.9720 (0.0179) Spillbay 2, mid shallow/Control ratio
Tau = 0.9930 (0.0101) Spillbay 2, mid deep/Control ratio

Z statistic for the equality of equal turbine survivals: 1.0219

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00003854	0.00000739	-0.00009966	0.00000000	0.00001853
0.00000739	0.00000583	0.00008799	0.00000000	-0.00001636
-0.00009966	0.00008799	-0.00118682	0.00000000	0.00022064
0.00000000	0.00000000	0.00000000	0.00027357	0.00000000
0.00001853	-0.00001636	0.00022064	0.00000000	0.00009872

Confidence intervals:

	Spillbay 2, mid shallow Tau	Spillbay 2, mid deep Tau
90 percent:	(0.9427, 1.0014)	(0.9763, 1.0097)
95 percent:	(0.9370, 1.0070)	(0.9731, 1.0129)
99 percent:	(0.9261, 1.0180)	(0.9669, 1.0191)

Appendix D

Forty-eight hour survival estimates for juvenile chinook salmon released through Spillbay 2 at shallow and deep mid release sites at the Dalles Dam, April 2004. Controls: 290 released, 284 alive, 4 dead. Shallow release: 145 released, 139 alive, 6 dead. Deep release: 145 released, 140 alive, 3 dead.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9861 (0.0069) Control group survival
Pa = Pd 0.9931 (0.0034) Recovery probability
S2 = 0.9586 (0.0165) Spillbay 2, mid shallow survival
S3 = 0.9790 (0.0120) Spillbay 2, mid deep survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -84.5168

Tau = 0.9721 (0.0181) Spillbay 2, mid shallow/Control ratio
Tau = 0.9928 (0.0140) Spillbay 2, mid deep/Control ratio

Z statistic for the equality of equal turbine survivals: 0.9042

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00004756	0.00000000	0.00000000	0.00000000
0.00000000	0.00001181	0.00000000	0.00000000
0.00000000	0.00000000	0.00027357	0.00000000
0.00000000	0.00000000	0.00000000	0.00014363

Confidence intervals:

	Spillbay 2, mid shallow Tau	Spillbay 2, mid deep Tau
90 percent:	(0.9424, 1.0019)	(0.9698, 1.0158)
95 percent:	(0.9367, 1.0076)	(0.9654, 1.0202)
99 percent:	(0.9255, 1.0187)	(0.9568, 1.0289)

Likelihood ratio statistic for equality of recovery probabilities: 0.0420

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Forty-eight hour survival estimates for juvenile chinook salmon released through Spillbay 2 at mid deep and shallow release sites at the Dalles Dam May 2004. Controls: 272 released, 269 alive, 1 dead. Shallow release: 150 released, 147 alive, 2 dead. Deep release: 150 released, 146 alive, 4 dead.

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RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9963 (0.0037) Control group survival
Pa = 0.9947 (0.0031) Live recovery probability
Pd = 1.0 N/A Dead recovery probability*
S2 = 0.9867 (0.0094) Spillbay 2, shallow, mid survival
S3 = 0.9733 (0.0132) Spillbay 2, deep, mid survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -54.3758

Tau = 0.9903 (0.0101) Spillbay 2, shallow, mid/Control ratio
Tau = 0.9769 (0.0137) Spillbay 2, deep, mid/Control ratio

Z statistic for the equality of equal turbine survivals: 0.7873

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001347	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000935	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00008770	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00017304

Confidence intervals:

Spillbay 2, shallow, mid Tau	Spillbay 2, deep, mid Tau
90 percent: (0.9737, 1.0069)	(0.9544, 0.9994)
95 percent: (0.9705, 1.0101)	(0.9501, 1.0037)
99 percent: (0.9643, 1.0163)	(0.9417, 1.0122)

Appendix D

Forty-eight hour survival estimates for juvenile chinook salmon released through Spillbay 2 at mid deep and shallow release sites at the Dalles Dam May 2004. Controls: 272 released, 269 alive, 1 dead. Shallow release: 150 released, 147 alive, 2 dead. Deep release: 150 released, 146 alive, 4 dead.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9963 (0.0037) Control group survival
Pa = Pd 0.9948 (0.0030) Recovery probability
S2 = 0.9866 (0.0094) Spillbay 2, shallow, mid survival
S3 = 0.9733 (0.0132) Spillbay 2, deep, mid survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -54.3919

Tau = 0.9902 (0.0102) Spillbay 2, shallow, mid/Control ratio
Tau = 0.9770 (0.0137) Spillbay 2, deep, mid/Control ratio

Z statistic for the equality of equal turbine survivals: 0.7799

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001367	0.00000000	0.00000000	0.00000000
0.00000000	0.00000912	0.00000000	0.00000000
0.00000000	0.00000000	0.00008888	0.00000000
0.00000000	0.00000000	0.00000000	0.00017304

Confidence intervals:

Spillbay 2, shallow, mid Tau	Spillbay 2, deep, mid Tau
90 percent: (0.9735, 1.0069)	(0.9544, 0.9995)
95 percent: (0.9703, 1.0101)	(0.9501, 1.0038)
99 percent: (0.9641, 1.0164)	(0.9417, 1.0122)

Likelihood ratio statistic for equality of recovery probabilities: 0.0324

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Forty-eight hour survival estimates for juvenile chinook salmon released through Spillbay 4 at shallow and deep mid release sites at the Dalles Dam, April 2004. Controls: 290 released, 284 alive, 4 dead. Shallow release: 146 released, 144 alive, 0 dead. Deep release: 145 released, 140 alive, 4 dead.

=====

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9862 (+NAN) Control group survival
Pa = 0.9913 (+NAN) Live recovery probability
Pd = 1.0 N/A Dead recovery probability*
S2 = 1.0 N/A Spillbay 4, shallow mid survival*
S3 = 0.9724 (0.0136) Spillbay 4, deep mid survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -68.0981

Tau = 1.0140 (+NAN) Spillbay 4, shallow mid/Control ratio

Tau = 0.9860 (0.0023) Spillbay 4, deep mid/Control ratio

Z statistic for the equality of equal turbine survivals: +NAN

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

-0.00018504	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	-0.00007482	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00018500

Confidence intervals:

	Spillbay 4, shallow mid Tau	Spillbay 4, deep mid Tau
90 percent:	(+NAN, +NAN)	(0.9822, 0.9898)
95 percent:	(+NAN, +NAN)	(0.9815, 0.9905)
99 percent:	(+NAN, +NAN)	(0.9801, 0.9919)

Appendix D

Forty-eight hour survival estimates for juvenile chinook salmon released through Spillbay 4 at shallow and deep mid release sites at the Dalles Dam, April 2004. Controls: 290 released, 284 alive, 4 dead. Shallow release: 146 released, 144 alive, 0 dead. Deep release: 145 released, 140 alive, 4 dead.

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RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9861 (0.0069) Control group survival
Pa = Pd 0.9914 (0.0038) Recovery probability
S2 = 1.0 N/A Spillbay 4, shallow mid survival*
S3 = 0.9722 (0.0137) Spillbay 4, deep mid survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -68.1117

Tau = 1.0141 (0.0071) Spillbay 4, shallow mid/Control ratio
Tau = 0.9859 (0.0155) Spillbay 4, deep mid/Control ratio

Z statistic for the equality of equal turbine survivals: 1.6522

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00004756	0.00000000	0.00000000	0.00000000
0.00000000	0.00001468	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00018754

Confidence intervals:

	Spillbay 4, shallow mid Tau	Spillbay 4, deep mid Tau
90 percent:	(1.0024, 1.0258)	(0.9604, 1.0114)
95 percent:	(1.0002, 1.0280)	(0.9555, 1.0163)
99 percent:	(0.9958, 1.0323)	(0.9460, 1.0258)

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Likelihood ratio statistic for equality of recovery probabilities: 0.0274

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Forty-eight hour survival estimates for juvenile chinook salmon released through Spillbay 4 at shallow and deep off-center release sites at the Dalles Dam, April 2004. Controls: 290 released, 284 alive, 4 dead. Shallow release: 145 released, 144 alive, 1 dead. Deep release: 144 released, 139 alive, 4 dead.

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RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9793 (0.0084) Control group survival
Pa = 1.0 N/A Live recovery probability*
Pd = 0.7500 (0.1250) Dead recovery probability
S2 = 0.9931 (0.0069) Spillbay 4, shallow off-center survival
S3 = 0.9653 (0.0153) Spillbay 4, deep off-center survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -63.6416

Tau = 1.0141 (0.0111) Spillbay 4, shallow off-center/Control ratio
Tau = 0.9857 (0.0177) Spillbay 4, deep off-center/Control ratio

Z statistic for the equality of equal turbine survivals: 1.3582

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00006987	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.01562500	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00004723	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00023275

Confidence intervals:

	Spillbay 4, shallow off-center Tau	Spillbay 4, deep off-center Tau
90 percent:	(0.9958, 1.0324)	(0.9565, 1.0148)
95 percent:	(0.9922, 1.0359)	(0.9510, 1.0204)
99 percent:	(0.9854, 1.0428)	(0.9401, 1.0313)

Appendix D

Forty-eight hour survival estimates for juvenile chinook salmon released through Spillbay 4 at shallow and deep off-center release sites at the Dalles Dam, April 2004. Controls: 290 released, 284 alive, 4 dead. Shallow release: 145 released, 144 alive, 1 dead. Deep release: 144 released, 139 alive, 4 dead.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

	estim.	std.err.	
S1 =	0.9861	(0.0069)	Control group survival
Pa = Pd	0.9948	(0.0030)	Recovery probability
S2 =	0.9931	(0.0069)	Spillbay 4, shallow off-center survival
S3 =	0.9720	(0.0138)	Spillbay 4, deep off-center survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -64.0820

Tau = 1.0071 (0.0099) Spillbay 4, shallow off-center/Control ratio
Tau = 0.9857 (0.0156) Spillbay 4, deep off-center/Control ratio

Z statistic for the equality of equal turbine survivals: 1.1570

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00004756	0.00000000	0.00000000	0.00000000
0.00000000	0.00000890	0.00000000	0.00000000
0.00000000	0.00000000	0.00004723	0.00000000
0.00000000	0.00000000	0.00000000	0.00019014

Confidence intervals:

	Spillbay 4, shallow off-center Tau	Spillbay 4, deep off-center Tau
90 percent:	(0.9908, 1.0234)	(0.9601, 1.0114)
95 percent:	(0.9877, 1.0265)	(0.9552, 1.0163)
99 percent:	(0.9816, 1.0326)	(0.9456, 1.0259)

Likelihood ratio statistic for equality of recovery probabilities: 0.8809

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Forty-eight hour survival estimates for juvenile chinook salmon released through Spillbay 4 at off-center deep and shallow release sites at the Dalles Dam May 2004. Controls: 272 released, 269 alive, 1 dead. Shallow release: 155 released, 151 alive, 4 dead. Deep release: 150 released, 149 alive, 1 dead.

=====

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9963 (0.0037) Control group survival
Pa = 0.9965 (0.0025) Live recovery probability
Pd = 1.0 N/A Dead recovery probability*
S2 = 0.9742 (0.0127) Spillbay 4, shallow, off-center survival
S3 = 0.9933 (0.0066) Spillbay 4, deep, off-center survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -44.4927

Tau = 0.9778 (0.0133) Spillbay 4, shallow, off-center/Control ratio
Tau = 0.9970 (0.0076) Spillbay 4, deep, off-center/Control ratio

Z statistic for the equality of equal turbine survivals: 1.2550

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001347	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000611	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00016220	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00004415

Confidence intervals:

Spillbay 4, shallow, off-center Tau	Spillbay 4, deep, off-center Tau
90 percent: (0.9559, 0.9996)	(0.9845, 1.0095)
95 percent: (0.9518, 1.0038)	(0.9821, 1.0119)
99 percent: (0.9436, 1.0120)	(0.9774, 1.0166)

Appendix D

Forty-eight hour survival estimates for juvenile chinook salmon released through Spillbay 4 at off-center deep and shallow release sites at the Dalles Dam May 2004. Controls: 272 released, 269 alive, 1 dead. Shallow release: 155 released, 151 alive, 4 dead. Deep release: 150 released, 149 alive, 1 dead.

=====

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9963 (0.0037) Control group survival
Pa = Pd 0.9965 (0.0024) Recovery probability
S2 = 0.9742 (0.0127) Spillbay 4, shallow, off-center survival
S3 = 0.9933 (0.0066) Spillbay 4, deep, off-center survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -44.5062

Tau = 0.9778 (0.0133) Spillbay 4, shallow, off-center/Control ratio
Tau = 0.9970 (0.0076) Spillbay 4, deep, off-center/Control ratio

Z statistic for the equality of equal turbine survivals: 1.2539

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001367	0.00000000	0.00000000	0.00000000
0.00000000	0.00000599	0.00000000	0.00000000
0.00000000	0.00000000	0.00016220	0.00000000
0.00000000	0.00000000	0.00000000	0.00004415

Confidence intervals:

Spillbay 4, shallow, off-center Tau	Spillbay 4, deep, off-center Tau
90 percent: (0.9560, 0.9997)	(0.9845, 1.0096)
95 percent: (0.9518, 1.0039)	(0.9821, 1.0120)
99 percent: (0.9436, 1.0120)	(0.9774, 1.0167)

=====

Likelihood ratio statistic for equality of recovery probabilities: 0.0271

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Forty-eight hour survival estimates for juvenile chinook salmon released through Spillbay 4 at mid deep and shallow release sites at the Dalles Dam May 2004. Controls: 272 released, 269 alive, 1 dead. Shallow release: 165 released, 157 alive, 7 dead. Deep release: 149 released, 146 alive, 2 dead.

=====

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9963 (0.0037) Control group survival
Pa = 0.9931 (0.0035) Live recovery probability
Pd = 1.0 N/A Dead recovery probability*
S2 = 0.9576 (0.0157) Spillbay 4, shallow, mid survival
S3 = 0.9866 (0.0094) Spillbay 4, deep, mid survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -70.0470

Tau = 0.9611 (0.0161) Spillbay 4, shallow, mid/Control ratio
Tau = 0.9902 (0.0101) Spillbay 4, deep, mid/Control ratio

Z statistic for the equality of equal turbine survivals: 1.5269

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001347	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00001197	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00024621	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00008888

Confidence intervals:

Spillbay 4, shallow, mid Tau	Spillbay 4, deep, mid Tau
90 percent: (0.9346, 0.9877)	(0.9735, 1.0069)
95 percent: (0.9295, 0.9927)	(0.9703, 1.0101)
99 percent: (0.9195, 1.0027)	(0.9641, 1.0163)

Appendix D

Forty-eight hour survival estimates for juvenile chinook salmon released through Spillbay 4 at mid deep and shallow release sites at the Dalles Dam May 2004. Controls: 272 released, 269 alive, 1 dead. Shallow release: 165 released, 157 alive, 7 dead. Deep release: 149 released, 146 alive, 2 dead.

=====

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9963 (0.0037) Control group survival
Pa = Pd 0.9932 (0.0034) Recovery probability
S2 = 0.9573 (0.0158) Spillbay 4, shallow, mid survival
S3 = 0.9865 (0.0095) Spillbay 4, deep, mid survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -70.0517

Tau = 0.9609 (0.0162) Spillbay 4, shallow, mid/Control ratio
Tau = 0.9902 (0.0102) Spillbay 4, deep, mid/Control ratio

Z statistic for the equality of equal turbine survivals: 1.5263

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001367	0.00000000	0.00000000	0.00000000
0.00000000	0.00001157	0.00000000	0.00000000
0.00000000	0.00000000	0.00024915	0.00000000
0.00000000	0.00000000	0.00000000	0.00009007

Confidence intervals:

Spillbay 4, shallow, mid Tau	Spillbay 4, deep, mid Tau
90 percent: (0.9342, 0.9876)	(0.9734, 1.0069)
95 percent: (0.9290, 0.9927)	(0.9701, 1.0102)
99 percent: (0.9191, 1.0027)	(0.9639, 1.0164)

=====

Likelihood ratio statistic for equality of recovery probabilities: 0.0093

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Forty-eight hour survival estimates for juvenile chinook salmon released through Spillbays 2 and 4 at various release sites at the Dalles Dam May 2004. Pooled results. Controls: 272 released, 269 alive, 1 dead. Spillbay 2 release: 300 released, 293 alive, 6 dead. Spillbay 4 release: 619 released, 603 alive, 14 dead.

=====

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9963 (0.0037) Control group survival
Pa = 0.9957 (0.0019) Live recovery probability
Pd = 1.0 N/A Dead recovery probability*
S2 = 0.9800 (0.0081) Spillbay 2 survival
S3 = 0.9774 (0.0060) Spillbay 4 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -135.1687

Tau = 0.9836 (0.0089) Spillbay 2/Control ratio
Tau = 0.9810 (0.0070) Spillbay 4/Control ratio

Z statistic for the equality of equal turbine survivals: 0.2322

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001347	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000364	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00006533	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00003571

Confidence intervals:

Spillbay 2 Tau	Spillbay 4 Tau
90 percent: (0.9690, 0.9982)	(0.9695, 0.9925)
95 percent: (0.9662, 1.0010)	(0.9673, 0.9947)
99 percent: (0.9607, 1.0065)	(0.9630, 0.9990)

Appendix D

Forty-eight hour survival estimates for juvenile chinook salmon released through Spillbays 2 and 4 at various release sites at the Dalles Dam May 2004. Pooled results. Controls: 272 released, 269 alive, 1 dead. Spillbay 2 release: 300 released, 293 alive, 6 dead. Spillbay 4 release: 619 released, 603 alive, 14 dead.

=====

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9963 (0.0037) Control group survival
Pa = Pd 0.9958 (0.0019) Recovery probability
S2 = 0.9799 (0.0081) Spillbay 2 survival
S3 = 0.9773 (0.0060) Spillbay 4 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -135.1844

Tau = 0.9836 (0.0089) Spillbay 2/Control ratio
Tau = 0.9809 (0.0070) Spillbay 4/Control ratio

Z statistic for the equality of equal turbine survivals: 0.2318

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001367	0.00000000	0.00000000	0.00000000
0.00000000	0.00000351	0.00000000	0.00000000
0.00000000	0.00000000	0.00006577	0.00000000
0.00000000	0.00000000	0.00000000	0.00003594

Confidence intervals:

	Spillbay 2 Tau	Spillbay 4 Tau
90 percent:	(0.9689, 0.9983)	(0.9694, 0.9925)
95 percent:	(0.9661, 1.0011)	(0.9672, 0.9947)
99 percent:	(0.9606, 1.0065)	(0.9628, 0.9991)

=====

Likelihood ratio statistic for equality of recovery probabilities: 0.0314

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Forty-eight hour survival estimates for juvenile chinook salmon released through Spillbay 6 at vortex release site at the Dalles Dam May 2004. Controls: 272 released, 269 alive, 1 dead. Vortex release: 149 released, 123 alive, 22 dead.

=====

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S = 0.9958 (0.0042) Control group survival
Pa = 0.9931 (0.0054) Live recovery probability
Pd = 0.8747 (0.0785) Dead recovery probability
Tau = 0.8347 (0.0319) Spillbay 6, vortex survival
1-Tau = 0.1653 (0.0319) Spillbay 6, vortex mortality

log-likelihood : -98.555719

Variance-Covariance matrix for estimated probabilities:

0.00002	-0.00000	0.00004	-0.00001
-0.00000	0.00003	-0.00015	-0.00002
0.00004	-0.00015	0.00616	0.00030
-0.00001	-0.00002	0.00030	0.00102

Profile likelihood intervals:

90 percent:	(0.7787, 0.8834)	(0.1166, 0.2213)
95 percent:	(0.7672, 0.8919)	(0.1081, 0.2328)
99 percent:	(0.7440, 0.9078)	(0.0922, 0.2560)

Appendix D

Forty-eight hour survival estimates for juvenile chinook salmon released through Spillbay 6 at vortex release site at the Dalles Dam May 2004. Controls: 272 released, 269 alive, 1 dead. Vortex release: 149 released, 123 alive, 22 dead.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

 estim. std.err.
S = 0.9963 (0.0037) Control group survival
Pa = Pd 0.9857 (0.0058) Recovery probability
Tau = 0.8514 (0.0301) Spillbay 6, vortex survival
1-Tau = 0.1486 (0.0301) Spillbay 6, vortex mortality

log-likelihood : -99.783631

Variance-Covariance matrix for estimated probabilities:
0.00001 0.00000 -0.00001
0.00000 0.00003 0.00000
-0.00001 0.00000 0.00090

Profile likelihood intervals:
Spillbay 6, vortex survival Spillbay 6, vortex mortality
90 percent: (0.7979, 0.8966) (0.1034, 0.2021)
95 percent: (0.7867, 0.9043) (0.0957, 0.2133)
99 percent: (0.7642, 0.9184) (0.0816, 0.2358)

Likelihood ratio statistic for equality of recovery probabilities: 2.455824
Compare with quantiles of the chi-squared distribution with 1 d.f.:
For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Forty-eight hour survival estimates for juvenile chinook salmon released through Spillbay 6 at the vortex release site at the Dalles Dam, April 2004. Controls: 290 released, 284 alive, 4 dead. Vortex release: 39 released, 35 alive, 2 dead.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S = 0.9793 (0.0084) Control group survival
Pa = 1.0 N/A Live recovery probability*
Pd = 0.6000 (0.1549) Dead recovery probability
Tau = 0.9164 (0.0502) Spillbay 6, vortex release survival
1-Tau = 0.0836 (0.0502) Spillbay 6, vortex release mortality

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -48.832888

Variance-Covariance matrix for estimated probabilities:

0.00007 0.00000 -0.00007
0.00000 0.02400 0.00000
-0.00007 0.00000 0.00252

Profile likelihood intervals:

	Spillbay 6, vortex release survival	Spillbay 6, vortex release mortality
90 percent:	(0.8163, 0.9817)	(0.0183, 0.1837)
95 percent:	(0.7934, 0.9907)	(0.0093, 0.2066)
99 percent:	(0.7460, 1.0000)	(0.0000, 0.2540)

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S = 0.9861 (0.0069) Control group survival
Pa = Pd 0.9878 (0.0060) Recovery probability
Tau = 0.9593 (0.0383) Spillbay 6, vortex release survival
1-Tau = 0.0407 (0.0383) Spillbay 6, vortex release mortality

log-likelihood : -50.473882

Variance-Covariance matrix for estimated probabilities:

0.00005 -0.00000 -0.00005
-0.00000 0.00004 0.00000
-0.00005 0.00000 0.00147

Profile likelihood intervals:

	Spillbay 6, vortex release survival	Spillbay 6, vortex release mortality
90 percent:	(0.8747, 1.0000)	(0.0000, 0.1253)
95 percent:	(0.8537, 1.0000)	(0.0000, 0.1463)
99 percent:	(0.8087, 1.0000)	(0.0000, 0.1913)

Likelihood ratio statistic for equality of recovery probabilities: 3.281987

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Clean fish estimates for juvenile chinook salmon released through Spillbay 2 at shallow and deep mid release sites at the Dalles Dam, April 2004. Controls: 288 examined, 287 without maladies (clean), 1 with maladies. Shallow release: 141 examined, 137 without maladies (clean), 4 with maladies. Deep release: 142 examined, 138 without maladies (clean), 4 with maladies.

=====

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9965 (+NAN) Control group clean fish rate
Pa = 1.0 N/A Live recovery probability*
Pd = 1.0 N/A Dead recovery probability*
S2 = 0.9716 (0.0140) Spillbay 2, mid shallow clean fish rate
S3 = 0.9718 (0.0139) Spillbay 2, mid deep clean fish rate

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -43.0751

Tau = 0.9750 (0.0136) Spillbay 2, mid shallow/Control ratio
Tau = 0.9752 (0.0135) Spillbay 2, mid deep/Control ratio

Z statistic for the equality of equal release site clean fish rates: 0.0104

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

```
-0.00001197 0.00000000 0.00000000 0.00000000 0.00000000
0.00000000 0.00000000 0.00000000 0.00000000 0.00000000
0.00000000 0.00000000 0.00000000 0.00000000 0.00000000
0.00000000 0.00000000 0.00000000 0.00019549 0.00000000
0.00000000 0.00000000 0.00000000 0.00000000 0.00019279
```

Confidence intervals:

	Spillbay 2, mid shallow Tau	Spillbay 2, mid deep Tau
90 percent:	(0.9526, 0.9974)	(0.9530, 0.9974)
95 percent:	(0.9483, 1.0017)	(0.9487, 1.0017)
99 percent:	(0.9400, 1.0101)	(0.9404, 1.0100)

Appendix D

Clean fish estimates for juvenile chinook salmon released through Spillbay 2 at shallow and deep mid release sites at the Dalles Dam, April 2004. Controls: 288 examined, 287 without maladies (clean), 1 with maladies. Shallow release: 141 examined, 137 without maladies (clean), 4 with maladies. Deep release: 142 examined, 138 without maladies (clean), 4 with maladies.

=====

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9965 (0.0035) Control group clean fish rate
Pa = Pd 1.0 N/A Recovery probability*
S2 = 0.9716 (0.0140) Spillbay 2, mid shallow clean fish rate
S3 = 0.9718 (0.0139) Spillbay 2, mid deep clean fish rate

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -43.0751

Tau = 0.9750 (0.0144) Spillbay 2, mid shallow/Control ratio
Tau = 0.9752 (0.0143) Spillbay 2, mid deep/Control ratio

Z statistic for the equality of equal release site clean fish rates: 0.0099

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001201	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00019549	0.00000000
0.00000000	0.00000000	0.00000000	0.00019279

Confidence intervals:

	Spillbay 2, mid shallow Tau	Spillbay 2, mid deep Tau
90 percent:	(0.9513, 0.9988)	(0.9516, 0.9988)
95 percent:	(0.9467, 1.0033)	(0.9471, 1.0033)
99 percent:	(0.9378, 1.0122)	(0.9383, 1.0121)

=====

Likelihood ratio statistic for equality of recovery probabilities: -0.0001

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Clean fish estimates for juvenile chinook salmon released through Spillbay 2 at mid deep and shallow release sites at the Dalles Dam, May 2004. Controls: 269 examined, 267 without maladies (clean fish), 2 with maladies. Shallow release: 149 examined, 145 without maladies (clean fish), 4 with maladies. Deep release: 150 examined, 146 without maladies (clean fish), 4 with maladies.

=====

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9926 (+NAN) Control group without maladies (clean fish)
Pa = 1.0 N/A Live recovery probability*
Pd = 1.0 N/A Dead recovery probability*
S2 = 0.9732 (0.0132) Spillbay 2, mid shallow without maladies (clean fish)
S3 = 0.9733 (0.0132) Spillbay 2, mid deep without maladies (clean fish)

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -48.6557

Tau = 0.9804 (0.0112) Spillbay 2, mid shallow/Control ratio
Tau = 0.9806 (0.0111) Spillbay 2, mid deep/Control ratio

Z statistic for the equality of equal (clean fish): 0.0115

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

-0.00005446	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00017534	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00017304

Confidence intervals:

	Spillbay 2, mid shallow Tau	Spillbay 2, mid deep Tau
90 percent:	(0.9621, 0.9988)	(0.9624, 0.9988)
95 percent:	(0.9585, 1.0023)	(0.9589, 1.0023)
99 percent:	(0.9517, 1.0092)	(0.9521, 1.0091)

Appendix D

Clean fish estimates for juvenile chinook salmon released through Spillbay 2 at mid deep and shallow release sites at the Dalles Dam, May 2004. Controls: 269 examined, 267 without maladies (clean fish), 2 with maladies. Shallow release: 149 examined, 145 without maladies (clean fish), 4 with maladies. Deep release: 150 examined, 146 without maladies (clean fish), 4 with maladies.

=====

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9926 (0.0000) Control group without maladies (clean fish)
Pa = Pd 1.0 N/A Recovery probability*
S2 = 0.9732 (0.0132) Spillbay 2, mid shallow without maladies (clean fish)
S3 = 0.9733 (0.0132) Spillbay 2, mid deep without maladies (clean fish)

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -48.6557

Tau = 0.9804 (0.0133) Spillbay 2, mid shallow/Control ratio
Tau = 0.9806 (0.0133) Spillbay 2, mid deep/Control ratio

Z statistic for the equality of equal (clean fish): 0.0096

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00000000	0.00000854	0.00000000	0.00000000
0.00000854	-0.0000266	0.00000000	0.00000000
0.00000000	0.00000000	0.00017534	0.00000000
0.00000000	0.00000000	0.00000000	0.00017304

Confidence intervals:

	Spillbay 2, mid shallow Tau	Spillbay 2, mid deep Tau
90 percent:	(0.9585, 1.0024)	(0.9588, 1.0024)
95 percent:	(0.9543, 1.0066)	(0.9546, 1.0066)
99 percent:	(0.9461, 1.0148)	(0.9465, 1.0148)

=====

Likelihood ratio statistic for equality of recovery probabilities: -0.0001

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Clean fish estimates for juvenile chinook salmon released through Spillbay 4 at shallow and deep mid release sites at the Dalles Dam, April 2004. Controls: 288 examined, 287 without maladies (clean), 1 with maladies. Shallow release: 144 examined, 141 without maladies (clean), 3 with maladies. Deep release: 142 examined, 138 without maladies (clean), 4 with maladies.

=====

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9965 (+NAN) Control group clean fish rate
Pa = 1.0 N/A Live recovery probability*
Pd = 1.0 N/A Dead recovery probability*
S2 = 0.9792 (0.0119) Spillbay 4, mid shallow site clean fish rate
S3 = 0.9718 (0.0139) Spillbay 4, mid deep site clean fish rate

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -39.4647

Tau = 0.9826 (0.0114) Spillbay 4, mid shallow site/Control ratio
Tau = 0.9752 (0.0135) Spillbay 4, mid deep site/Control ratio

Z statistic for the equality of equal release site clean fish rates: 0.4156

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

```
-0.00001197 0.00000000 0.00000000 0.00000000 0.00000000
0.00000000 0.00000000 0.00000000 0.00000000 0.00000000
0.00000000 0.00000000 0.00000000 0.00000000 0.00000000
0.00000000 0.00000000 0.00000000 0.00014166 0.00000000
0.00000000 0.00000000 0.00000000 0.00000000 0.00019279
```

Confidence intervals:

Spillbay 4, mid shallow Tau	Spillbay 4, mid deep Tau
90 percent: (0.9637, 1.0014)	(0.9530, 0.9974)
95 percent: (0.9601, 1.0050)	(0.9487, 1.0017)
99 percent: (0.9531, 1.0121)	(0.9404, 1.0100)

Appendix D

Clean fish estimates for juvenile chinook salmon released through Spillbay 4 at shallow and deep mid release sites at the Dalles Dam, April 2004. Controls: 288 examined, 287 without maladies (clean), 1 with maladies. Shallow release: 144 examined, 141 without maladies (clean), 3 with maladies. Deep release: 142 examined, 138 without maladies (clean), 4 with maladies.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9965 (0.0035) Control group clean fish rate
Pa = Pd 1.0 N/A Recovery probability*
S2 = 0.9792 (0.0119) Spillbay 4, mid shallow site clean fish rate
S3 = 0.9718 (0.0139) Spillbay 4, mid deep site clean fish rate

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -39.4646

Tau = 0.9826 (0.0124) Spillbay 4, mid shallow site/Control ratio
Tau = 0.9752 (0.0143) Spillbay 4, mid deep site/Control ratio

Z statistic for the equality of equal release site clean fish rates: 0.3880

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001201	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00014166	0.00000000
0.00000000	0.00000000	0.00000000	0.00019279

Confidence intervals:

	Spillbay 4, mid shallow Tau	Spillbay 4, mid deep Tau
90 percent:	(0.9621, 1.0030)	(0.9516, 0.9988)
95 percent:	(0.9582, 1.0069)	(0.9471, 1.0033)
99 percent:	(0.9506, 1.0146)	(0.9383, 1.0121)

Likelihood ratio statistic for equality of recovery probabilities: -0.0001

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Clean fish estimates for juvenile chinook salmon released through Spillbay 4 at shallow and deep off-center release sites at the Dalles Dam, April 2004. Controls: 288 examined, 287 without maladies (clean), 1 with maladies. Shallow release: 145 examined, 140 without maladies (clean), 5 with maladies. Deep release: 143 examined, 134 without maladies (clean), 9 with maladies.

=====

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9965 (+NAN) Control group clean fish rate
Pa = 1.0 N/A Live recovery probability*
Pd = 1.0 N/A Dead recovery probability*
S2 = 0.9655 (0.0152) Spillbay 4, off-center shallow clean fish rate
S3 = 0.9371 (0.0203) Spillbay 4, off-center deep clean fish rate

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -62.0118

Tau = 0.9689 (0.0148) Spillbay 4, off-center shallow/Control ratio
Tau = 0.9403 (0.0201) Spillbay 4, off-center deep/Control ratio

Z statistic for the equality of equal release site clean fish rates: 1.1426

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

```
-0.00001197 0.00000000 0.00000000 0.00000000 0.00000000
0.00000000 0.00000000 0.00000000 0.00000000 0.00000000
0.00000000 0.00000000 0.00000000 0.00000000 0.00000000
0.00000000 0.00000000 0.00000000 0.00022961 0.00000000
0.00000000 0.00000000 0.00000000 0.00000000 0.00041242
```

Confidence intervals:

	Spillbay 4, off-center shallow Tau	Spillbay 4, off-center deep Tau
90 percent:	(0.9445, 0.9933)	(0.9072, 0.9734)
95 percent:	(0.9398, 0.9979)	(0.9009, 0.9798)
99 percent:	(0.9307, 1.0071)	(0.8885, 0.9921)

Appendix D

Clean fish estimates for juvenile chinook salmon released through Spillbay 4 at shallow and deep off-center release sites at the Dalles Dam, April 2004. Controls: 288 examined, 287 without maladies (clean), 1 with maladies. Shallow release: 145 examined, 140 without maladies (clean), 5 with maladies. Deep release: 143 examined, 134 without maladies (clean), 9 with maladies.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9965 (0.0035) Control group clean fish rate
Pa = Pd 1.0 N/A Recovery probability*
S2 = 0.9655 (0.0152) Spillbay 4, off-center shallow clean fish rate
S3 = 0.9371 (0.0203) Spillbay 4, off-center deep clean fish rate

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -62.0117

Tau = 0.9689 (0.0156) Spillbay 4, off-center shallow/Control ratio
Tau = 0.9403 (0.0206) Spillbay 4, off-center deep/Control ratio

Z statistic for the equality of equal release site clean fish rates: 1.1043

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001201	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00022961	0.00000000
0.00000000	0.00000000	0.00000000	0.00041242

Confidence intervals:

	Spillbay 4, off-center shallow Tau	Spillbay 4, off-center deep Tau
90 percent:	(0.9433, 0.9945)	(0.9064, 0.9743)
95 percent:	(0.9384, 0.9994)	(0.8999, 0.9808)
99 percent:	(0.9288, 1.0090)	(0.8872, 0.9935)

Likelihood ratio statistic for equality of recovery probabilities: -0.0001

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Clean fish estimates for juvenile chinook salmon released through Spillbay 4 at mid deep and shallow release sites at the Dalles Dam, May 2004. Controls: 269 examined, 267 without maladies (clean fish), 2 with maladies. Shallow release: 163 examined, 155 without maladies (clean fish), 8 with maladies. Deep release: 147 examined, 142 without maladies (clean fish), 5 with maladies.

=====

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std.err.
 S1 = 0.9926 (+NAN) Control group without maladies (clean fish)
 Pa = 1.0 N/A Live recovery probability*
 Pd = 1.0 N/A Dead recovery probability*
 S2 = 0.9509 (0.0169) Spillbay 4, mid shallow without maladies (clean fish)
 S3 = 0.9660 (0.0150) Spillbay 4, mid deep without maladies (clean fish)

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -65.5295

Tau = 0.9580 (0.0155) Spillbay 4, mid shallow/Control ratio
 Tau = 0.9732 (0.0132) Spillbay 4, mid deep/Control ratio

Z statistic for the equality of equal (clean fish): 0.7456

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

```
-0.00005446 0.00000000 0.00000000 0.00000000 0.00000000
0.00000000 0.00000000 0.00000000 0.00000000 0.00000000
0.00000000 0.00000000 0.00000000 0.00000000 0.00000000
0.00000000 0.00000000 0.00000000 0.00028632 0.00000000
0.00000000 0.00000000 0.00000000 0.00000000 0.00022351
```

Confidence intervals:

Spillbay 4, mid shallow Tau	Spillbay 4, mid deep Tau
90 percent: (0.9326, 0.9835)	(0.9515, 0.9950)
95 percent: (0.9277, 0.9884)	(0.9473, 0.9991)
99 percent: (0.9182, 0.9979)	(0.9392, 1.0072)

Appendix D

Clean fish estimates for juvenile chinook salmon released through Spillbay 4 at mid deep and shallow release sites at the Dalles Dam, May 2004. Controls: 269 examined, 267 without maladies (clean fish), 2 with maladies. Shallow release: 163 examined, 155 without maladies (clean fish), 8 with maladies. Deep release: 147 examined, 142 without maladies (clean fish), 5 with maladies.

=====

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

	estim.	std.err.	
S1 =	0.9926	(0.0052)	Control group without maladies (clean fish)
Pa = Pd	1.0	N/A	Recovery probability*
S2 =	0.9509	(0.0169)	Spillbay 4, mid shallow without maladies (clean fish)
S3 =	0.9660	(0.0150)	Spillbay 4, mid deep without maladies (clean fish)

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -65.5295

Tau = 0.9580 (0.0178) Spillbay 4, mid shallow/Control ratio
Tau = 0.9732 (0.0159) Spillbay 4, mid deep/Control ratio

Z statistic for the equality of equal (clean fish): 0.6361

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00002743	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00028632	0.00000000
0.00000000	0.00000000	0.00000000	0.00022351

Confidence intervals:

Spillbay 4, mid shallow Tau	Spillbay 4, mid deep Tau
90 percent: (0.9288, 0.9873)	(0.9470, 0.9994)
95 percent: (0.9232, 0.9929)	(0.9420, 1.0044)
99 percent: (0.9123, 1.0038)	(0.9322, 1.0142)

=====

Likelihood ratio statistic for equality of recovery probabilities: -0.0001

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Clean fish estimates for juvenile chinook salmon released through Spillbay 4 at off-center deep and shallow release sites at the Dalles Dam, May 2004. Controls: 269 examined, 267 without maladies (clean fish), 2 with maladies. Shallow release: 155 examined, 151 without maladies (clean fish), 4 with maladies. Deep release: 150 examined, 144 without maladies (clean fish), 6 with maladies.

=====

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9926 (+NAN) Control group without maladies (clean fish)
Pa = 1.0 N/A Live recovery probability*
Pd = 1.0 N/A Dead recovery probability*
S2 = 0.9742 (0.0127) Spillbay 4, off-center shallow without maladies (clean fish)
S3 = 0.9600 (0.0160) Spillbay 4, off-center deep without maladies (clean fish)

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -55.5638

Tau = 0.9815 (0.0106) Spillbay 4, off-center shallow/Control ratio
Tau = 0.9672 (0.0144) Spillbay 4, off-center deep/Control ratio

Z statistic for the equality of equal (clean fish): 0.8000

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

-0.00005446	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00016220	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00025600

Confidence intervals:

Spillbay 4, off-center shallow Tau	Spillbay 4, off-center deep Tau
90 percent: (0.9641, 0.9989)	(0.9435, 0.9909)
95 percent: (0.9608, 1.0022)	(0.9389, 0.9955)
99 percent: (0.9543, 1.0087)	(0.9300, 1.0043)

Appendix D

Clean fish estimates for juvenile chinook salmon released through Spillbay 4 at off-center deep and shallow release sites at the Dalles Dam, May 2004. Controls: 269 examined, 267 without maladies (clean fish), 2 with maladies. Shallow release: 155 examined, 151 without maladies (clean fish), 4 with maladies. Deep release: 150 examined, 144 without maladies (clean fish), 6 with maladies.

=====

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9926 (0.0052) Control group without maladies (clean fish)
Pa = Pd 1.0 N/A Recovery probability*
S2 = 0.9742 (0.0127) Spillbay 4, off-center shallow without maladies (clean fish)
S3 = 0.9600 (0.0160) Spillbay 4, off-center deep without maladies (clean fish)

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -55.5638

Tau = 0.9815 (0.0138) Spillbay 4, off-center shallow/Control ratio
Tau = 0.9672 (0.0169) Spillbay 4, off-center deep/Control ratio

Z statistic for the equality of equal (clean fish): 0.6545

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00002743	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00016220	0.00000000
0.00000000	0.00000000	0.00000000	0.00025600

Confidence intervals:

Spillbay 4, off-center shallow Tau	Spillbay 4, off-center deep Tau
90 percent: (0.9587, 1.0043)	(0.9394, 0.9950)
95 percent: (0.9544, 1.0086)	(0.9341, 1.0003)
99 percent: (0.9459, 1.0171)	(0.9237, 1.0107)

=====

Likelihood ratio statistic for equality of recovery probabilities: -0.0001

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Forty-eight hour survival estimates for juvenile chinook salmon released through Spillbays 2 and 4 at various release sites at the Dalles Dam May 2004. Pooled results. Controls: 272 released, 269 alive, 1 dead. Spillbay 2 release: 300 released, 293 alive, 6 dead. Spillbay 4 release: 619 released, 603 alive, 14 dead.

=====

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9963 (0.0037) Control group survival
Pa = 0.9957 (0.0019) Live recovery probability
Pd = 1.0 N/A Dead recovery probability*
S2 = 0.9800 (0.0081) Spillbay 2 survival
S3 = 0.9774 (0.0060) Spillbay 4 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -135.1687

Tau = 0.9836 (0.0089) Spillbay 2/Control ratio
Tau = 0.9810 (0.0070) Spillbay 4/Control ratio

Z statistic for the equality of equal turbine survivals: 0.2322

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001347	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000364	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00006533	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000	0.00003571

Confidence intervals:

Spillbay 2 Tau	Spillbay 4 Tau
90 percent: (0.9690, 0.9982)	(0.9695, 0.9925)
95 percent: (0.9662, 1.0010)	(0.9673, 0.9947)
99 percent: (0.9607, 1.0065)	(0.9630, 0.9990)

Appendix D

Forty-eight hour survival estimates for juvenile chinook salmon released through Spillbays 2 and 4 at various release sites at the Dalles Dam May 2004. Pooled results. Controls: 272 released, 269 alive, 1 dead. Spillbay 2 release: 300 released, 293 alive, 6 dead. Spillbay 4 release: 619 released, 603 alive, 14 dead.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9963 (0.0037) Control group survival
Pa = Pd 0.9958 (0.0019) Recovery probability
S2 = 0.9799 (0.0081) Spillbay 2 survival
S3 = 0.9773 (0.0060) Spillbay 4 survival

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -135.1844

Tau = 0.9836 (0.0089) Spillbay 2/Control ratio
Tau = 0.9809 (0.0070) Spillbay 4/Control ratio

Z statistic for the equality of equal turbine survivals: 0.2318

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00001367	0.00000000	0.00000000	0.00000000
0.00000000	0.00000351	0.00000000	0.00000000
0.00000000	0.00000000	0.00006577	0.00000000
0.00000000	0.00000000	0.00000000	0.00003594

Confidence intervals:

	Spillbay 2 Tau	Spillbay 4 Tau
90 percent:	(0.9689, 0.9983)	(0.9694, 0.9925)
95 percent:	(0.9661, 1.0011)	(0.9672, 0.9947)
99 percent:	(0.9606, 1.0065)	(0.9628, 0.9991)

Likelihood ratio statistic for equality of recovery probabilities: 0.0314

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706
For significance level 0.05: 3.841
For significance level 0.01: 6.635

Appendix D

Clean fish rates for juvenile chinook salmon released through Spillbays 2 and 4 at the Dalles Dam, May – June 2004. Pooled results. Controls: 269 examined, 267 without maladies (clean fish), 2 with maladies. Spillbay 2: 299 examined, 291 without maladies (clean fish), 8 with maladies. Spillbay 4: 615 examined, 592 without maladies (clean fish), 23 with maladies.

=====

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

estim. std.err.
S1 = 0.9926 (+NAN) Control group without maladies (clean fish)
Pa = 1.0 N/A Live recovery probability*
Pd = 1.0 N/A Dead recovery probability*
S2 = 0.9732 (0.0093) Spillbay 2, pooled results without maladies (clean fish)
S3 = 0.9626 (0.0077) Spillbay 4, pooled results without maladies (clean fish)

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -146.8012

Tau = 0.9805 (0.0059) Spillbay 2, pooled results/Control ratio

Tau = 0.9698 (0.0027) Spillbay 4, pooled results/Control ratio

Z statistic for the equality of equal (clean fish): 1.6413

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

```
-0.00005446 0.00000000 0.00000000 0.00000000 0.00000000
0.00000000 0.00000000 0.00000000 0.00000000 0.00000000
0.00000000 0.00000000 0.00000000 0.00000000 0.00000000
0.00000000 0.00000000 0.00000000 0.00008709 0.00000000
0.00000000 0.00000000 0.00000000 0.00000000 0.00005854
```

Confidence intervals:

	Spillbay 2, pooled results Tau	Spillbay 4, pooled results Tau
90 percent:	(0.9708, 0.9903)	(0.9653, 0.9743)
95 percent:	(0.9689, 0.9922)	(0.9645, 0.9752)
99 percent:	(0.9652, 0.9958)	(0.9628, 0.9768)

Appendix D

Clean fish rates for juvenile chinook salmon released through Spillbays 2 and 4 at the Dalles Dam, May – June 2004. Pooled results. Controls: 269 examined, 267 without maladies (clean fish), 2 with maladies. Spillbay 2: 299 examined, 291 without maladies (clean fish), 8 with maladies. Spillbay 4: 615 examined, 592 without maladies (clean fish), 23 with maladies.

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

	estim.	std.err.	
S1 =	0.9926	(0.0052)	Control group without maladies (clean fish)
Pa = Pd	1.0	N/A	Recovery probability*
S2 =	0.9732	(0.0093)	Spillbay 2, pooled results without maladies (clean fish)
S3 =	0.9626	(0.0077)	Spillbay 4, pooled results without maladies (clean fish)

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -146.8011

Tau = 0.9805 (0.0107) Spillbay 2, pooled results/Control ratio

Tau = 0.9698 (0.0093) Spillbay 4, pooled results/Control ratio

Z statistic for the equality of equal (clean fish): 0.7567

Compare with quantiles of the normal distribution:

	1-tailed	2-tailed
For significance level 0.10:	1.2816	1.6449
For significance level 0.05:	1.6449	1.9600
For significance level 0.01:	2.3263	2.5758

Variance-Covariance matrix for estimated probabilities:

0.00002743	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00000000	0.00000000
0.00000000	0.00000000	0.00008709	0.00000000
0.00000000	0.00000000	0.00000000	0.00005854

Confidence intervals:

	Spillbay 2, pooled results Tau	Spillbay 4, pooled results Tau
90 percent:	(0.9629, 0.9982)	(0.9546, 0.9850)
95 percent:	(0.9595, 1.0016)	(0.9517, 0.9879)
99 percent:	(0.9529, 1.0082)	(0.9460, 0.9936)

Likelihood ratio statistic for equality of recovery probabilities: -0.0002

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10:	2.706
For significance level 0.05:	3.841
For significance level 0.01:	6.635

Appendix D

Clean fish estimates for juvenile chinook salmon released through Spillbay 6 at the vortex release site at the Dalles Dam, May 2004. Controls: 269 examined, 267 without maladies (clean fish), 2 with maladies. Shallow release: 149 examined, 145 without maladies (clean fish), 4 with maladies. Vortex release: 133 examined, 123 without maladies (clean fish), 10 with maladies.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

	estim.	std.err.	
S =	0.9926	(0.0052)	Control group without maladies (clean fish)
Pa =	1.0	N/A	Live recovery probability*
Pd =	1.0	N/A	Dead recovery probability*
Tau =	0.9317	(0.0236)	Spillbay 6, vortex without maladies (clean fish)
1-Tau =	0.0683	(0.0236)	Spillbay 6, vortex with maladies

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -47.287582

Variance-Covariance matrix for estimated probabilities:

0.00003	-0.00003
-0.00003	0.00055

Profile likelihood intervals:

	Spillbay 6, vortex without maladies (clean fish)	Spillbay 6, vortex with maladies
90 percent:	(0.8875, 0.9655)	(0.0345, 0.1125)
95 percent:	(0.8778, 0.9711)	(0.0289, 0.1222)
99 percent:	(0.8577, 0.9815)	(0.0185, 0.1423)

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

	estim.	std.err.	
S =	0.9926	(0.0052)	Control group without maladies (clean fish)
Pa = Pd	1.0	N/A	Recovery probability*
Tau =	0.9317	(0.0236)	Spillbay 6, vortex without maladies (clean fish)
1-Tau =	0.0683	(0.0236)	Spillbay 6, vortex with maladies

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -47.287582

Variance-Covariance matrix for estimated probabilities:

0.00003	-0.00003
-0.00003	0.00055

Profile likelihood intervals:

	Spillbay 6, vortex without maladies (clean fish)	Spillbay 6, vortex with maladies
90 percent:	(0.8875, 0.9655)	(0.0345, 0.1125)
95 percent:	(0.8778, 0.9711)	(0.0289, 0.1222)
99 percent:	(0.8577, 0.9815)	(0.0185, 0.1423)

Likelihood ratio statistic for equality of recovery probabilities: -0.000000

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10: 2.706

For significance level 0.05: 3.841

For significance level 0.01: 6.635

Appendix D

Clean fish rates for juvenile chinook salmon released through Spillbay 6 with the vortex release at the Dalles Dam, April, 2004. Controls: 288 examined, 287 without maladies (clean), 1 with maladies. Spillbay 6 release: 36 examined, 33 without maladies (clean), 3 with maladies.

RESULTS FOR FULL MODEL (UNEQUAL LIVE/DEAD RECOVERY)

	estim.	std.err.	
S =	0.9965	(0.0035)	Control group clean fish rate
Pa =	1.0	N/A	Live recovery probability*
Pd =	1.0	N/A	Dead recovery probability*
Tau =	0.9199	(0.0463)	Spillbay 6, vortex clean fish rate
1-Tau =	0.0801	(0.0463)	Spillbay 6, vortex maladies rate

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -16.987318

Variance-Covariance matrix for estimated probabilities:

0.00001	-0.00001
-0.00001	0.00215

Profile likelihood intervals:

	Spillbay 6, vortex clean fish rate	Spillbay 6, vortex maladies rate
90 percent:	(0.8234, 0.9761)	(0.0239, 0.1766)
95 percent:	(0.8006, 0.9828)	(0.0172, 0.1994)
99 percent:	(0.7528, 0.9934)	(0.0066, 0.2472)

RESULTS FOR REDUCED MODEL (EQUAL LIVE/DEAD RECOVERY)

	estim.	std.err.	
S =	0.9965	(0.0035)	Control group clean fish rate
Pa = Pd	1.0	N/A	Recovery probability*
Tau =	0.9199	(0.0463)	Spillbay 6, vortex clean fish rate
1-Tau =	0.0801	(0.0463)	Spillbay 6, vortex maladies rate

* -- Because of constraints in the data set, this probability is assumed equal to 1.0; not estimated.

log-likelihood : -16.987318

Variance-Covariance matrix for estimated probabilities:

0.00001	-0.00001
-0.00001	0.00215

Profile likelihood intervals:

	Spillbay 6, vortex clean fish rate	Spillbay 6, vortex maladies rate
90 percent:	(0.8234, 0.9761)	(0.0239, 0.1766)
95 percent:	(0.8006, 0.9828)	(0.0172, 0.1994)
99 percent:	(0.7528, 0.9934)	(0.0066, 0.2472)

Likelihood ratio statistic for equality of recovery probabilities: 0.000000

Compare with quantiles of the chi-squared distribution with 1 d.f.:

For significance level 0.10:	2.706
For significance level 0.05:	3.841
For significance level 0.01:	6.635