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THE DESIGN AND ANALYSIS OF SALMONID TAGGING STUDIES IN THE COLUMBIA BASIN

Volume XIV: Appraisal of the Relationship between Tag Detection Efficiency at Bonneville Dam and the Precision in Estuarine and Marine Survival Estimates of Returning PIT tagged Chinook Salmon

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The Design and Analysis of Salmonid Tagging Studies in the Columbia Basin

Volume XIV

Appraisal of the Relationship between Tag Detection Efficiency at Bonneville Dam and the Precision in Estuarine and Marine Survival Estimates of Returning PIT-tagged Chinook Salmon

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PREFACE

Project 8910700, Epidemiological Survival Methods, was developed to provide statistical guidance on design and analysis of PIT-tag (Passive Integrated Transponder) survival studies to the Northwest fisheries community. Studies under this project have determined the statistical feasibility of conducting PIT-tag smolt survival studies, assessed analytical capabilities for analyzing the tagging experiments, and made recommendations on study design. As PIT-tag capabilities developed and research interests increased, the project has been instrumental in maintaining the statistical capabilities for designing and analyzing tagging studies to meet these expanded objectives.

In the advent of the installation of a PIT-tag interrogation system in the Cascades Island fish ladder at Bonneville Dam, this report provides guidance on the anticipated precision of salmonid estuarine and marine survival estimates, for various levels of system-wide adult detection probability at Bonneville Dam. This report evaluates the overall detection probability needed for a PIT-tag adult detection system at Bonneville Dam, powerhouses 1 and 2. It calculates precision based on anticipated downstream survival and detection probabilities of chinook salmon smolts and their anticipated ocean and in-river survival back to Bonneville and Lower Granite Dam.

ABSTRACT

In the advent of the installation of a PIT-tag interrogation system in the Cascades Island fish ladder at Bonneville Dam, this report provides guidance on the anticipated precision of salmonid estuarine and marine survival estimates, for various levels of system-wide adult detection probability at Bonneville Dam. Precision was characterized by the standard error of the survival estimates and the coefficient of variation of the survival estimates. The anticipated precision of salmonid estuarine and marine survival estimates was directly proportional to the number of PIT-tagged smolts released and to the system-wide adult detection efficiency at Bonneville Dam, as well as to the in-river juvenile survival above Lower Granite Dam. Moreover, for a given release size and system-wide adult detection efficiency, higher estuarine and marine survivals did also produce more precise survival estimates. With a system-wide detection probability of $P_{\text{BA}} = 1$ at Bonneville Dam, the anticipated *CV*s for the estuarine and marine survival ranged between 41 and 88% with release sizes of 10,000 smolts. Only with the 55,000 smolts being released from sites close to Lower Granite Dam and under high estuarine and marine survival, could *CV*s of 20% be attained with system detection efficiencies of less than perfect detection (i.e., $P_{\text{BA}} < 1$).

EXECUTIVE SUMMARY

Objectives

The overall detection probability needed for a PIT-tag adult detection system at Bonneville Dam, powerhouses 1 and 2, was evaluated in this report. The anticipated precision of salmonid survival estimates between the downstream passage of smolts at Bonneville Dam and the return of adults to the Bonneville adult ladders was calculated. Precision was characterized by the standard error of the survival estimates $\left(\text{i.e., } S\hat{E}\left(\hat{S}_{\text{BON-BA}}\right)\right)$ and the coefficient of variation of the survival estimates $\left(\text{i.e., } CV\left(\hat{S}_{\text{BON-BA}}\right)=S\hat{E}\left(\hat{S}_{\text{BON-BA}}\right)/\hat{S}_{\text{BON-BA}}\right)$. Precision was calculated based on anticipated downstream survival and detection probabilities of chinook salmon smolts and their anticipated ocean and in-river survival back to Bonneville and Lower Granite Dam.

Results

There was a direct proportionality between precision and release size, and between precision and system-wide adult detection efficiency at Bonneville Dam (Fig. 4-6). The anticipated precision (i.e., *CV*) of estuarine and marine survival estimates was directly proportional to the in-river juvenile survival $S_{\text{R-LGR}}$. Moreover, for a given release size and system-wide adult detection efficiency, higher estuarine and marine survivals did also produce more precise survival estimates.

With a system-wide detection probability of $P_{\text{BA}} = 1$ at Bonneville Dam, the anticipated *CV*s for the estuarine and marine survival ranged between 41 and 88% with release sizes of 10,000 smolts above Lower Granite Dam. With release sizes of 30,000 smolts the *CV* for the estuarine and marine survival decreased to 24-51%. Only with juvenile PIT-tag releases of 55,000 did the *CV*s approach 20% (i.e., 18-37%). Only under scenarios with releases of 55,000 or more tagged smolts from sites close to Lower Granite Dam and high estuarine and marine survival (Table 2), could *CV*s of 20% be attained with system detection efficiencies of less than perfect detection (i.e., $P_{\text{BA}} < 1$).

Recommendations

Based on the precision calculations performed, the PIT-tag detection system to be installed at the adult ladders of Bonneville Dam should be designed for maximum attainable detection efficiency. Furthermore, the detection system at Bonneville Dam should be designed with both powerhouses 1 and 2 in mind. A detection facility at only one powerhouse will produce overall detection probabilities at Bonneville Dam that are likely too low to provide precise studies of ocean survival of Snake-Columbia River salmonids.

ACKNOWLEDGMENTS

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1. INTRODUCTION

Since 1993, the National Marine Fisheries Service (NMFS) and the University of Washington have applied a marked-recapture single-release model (Cormack 1964, Jolly 1965, Seber 1965) to produce reliable survival estimates for specific groups of PIT[1]-tagged yearling salmonids (Iwamoto et al. 1994). The majority of these estimates correspond to juvenile salmonids passing through Snake River dams and reservoirs during their downstream migration. Very little has been published in terms of juvenile survival through the reaches between McNary and Bonneville Dams (e.g., Smith et al., 2000; Perez-Comas and Skalski, 2000), and, to our knowledge, no estimation of estuarine and marine survival ($S_{\text{BON-B2A}}$) based on PIT-tagged salmonids has been attempted yet. Currently, adult salmon are only being interrogated in 31-cm pipes at the adult monitoring facilities of Lower Granite and Bonneville Dams.

BPA project 8331900 attempts to change the present situation by replacing the current network of 400-kHz PIT-tag interrogation systems with a 134.2-kHz ISO-based system. The longer read range of the 134.2-kHz tags, and the new data recovery scheme and silicon technology of the ISO-based system will enable the detection of returning adult salmon at several locations associated with fish ladders. By taking advantage of the enhanced performance of the ISO-based system, the NMFS is developing interrogation systems in a variety of locations in fish ladders. Its initial work has concentrated on the detection in fish ladder orifices, and the installation of a PIT-tag interrogation system that covers orifices in a maximum of four weirs in the Cascades Island fish ladder at Bonneville Dam is expected for 2001. Determining tag-reading efficiency using a suite of tools, including neutrally buoyant fish surrogates, PIT-tags, radio tags and video is among the tasks associated with the installation of this new adult detection system at Bonneville Dam.

In this report we provide guidance on what could be the expected precision on estimates of estuarine and marine survival of returning adult PIT-tagged chinook salmon associated with various levels of adult detection efficiency at Bonneville Dam. Our analysis was based on six simulated scenarios that summarized our best knowledge on survival and detection probabilities for the various reaches and dams in the Snake-Columbia River Basin. Our main goal was to address the question of what the detection efficiency at the new Bonneville adult PIT-tag detection facility must be to attain desired levels of precision in the survival estimates of returning adult salmon. We appraised the

[1] Passive Integrated Transponder.

relationship between tag detection efficiency at Bonneville Dam and precision in adult survival estimates in terms of:

1. number of PIT-tagged fish released,
2. juvenile survival to Lower Granite Dam, and
3. survival during the estuarine and marine period of chinook's life-cycle.

2. MATERIAL AND METHODS

2.1 Analytical procedure

The appraisal of the relationship between tag detection efficiency at Bonneville Dam (P_{B2A}) and the precision in estuarine and marine survival estimates of returning PIT-tagged chinook salmon requires the calculation of the standard errors expected in the estimation of estuarine and marine survival estimates ($S_{\text{BON-BA}}$) for different values of P_{BA} and release sizes of PIT-tagged chinook smolts travelling in a particular river system. In our analysis, whenever we refer to tag detection efficiency at Bonneville Dam we mean the probability of adult PIT-tag detection across the entire Bonneville Dam powerhouses 1 and 2 complex. That is, although in 2001 the new Bonneville PIT-tag interrogation system will only cover orifices in a maximum of four weirs in the Cascades Island fish ladder at Bonneville Dam, our analysis assumed that the new Bonneville PIT-tag interrogation system was operational at both fish ladders (Fig. 1) with system-wide detection efficiency P_{BA}.

In our analysis, the precision in estuarine and marine survival estimates was measured as standard errors $\left(\text{i.e., } SE\left(\hat{\theta}\right)\right)$ and as coefficients of variation $\left(\text{i.e., } CV\text{, where } CV\left(\hat{\theta}\right) = SE\left(\hat{\theta}\right)/\hat{\theta}\right)$, the latter expressed as percentage. For example, a 95% confidence interval (*CI*) is calculated as approximately $\pm 2 \times SE\left(\hat{\theta}\right)$. With knowledge of the attempted size of the standard error in estimation, the reader can readily calculate the anticipated width of a 95%*CI*. On the other hand, the value of *CV* has a somewhat different interpretation on precision. Asymptotically, an estimate will be within $\pm 1 \times CV\left(\hat{\theta}\right)$ of the true value of the parameter 68% of the time, and an estimate will be within $\pm 2 \times CV\left(\hat{\theta}\right)$ of the true value of the parameter 95% of the time. For example, if the *CV* was 25%, then we can conclude that our estimate is within ± 50% of the true value 95% of the time. Thus, both *SE* and *CV* provide useful measures of precision.

The river system selected for the analysis consists of the Snake-Columbia system as sketched in Figure 2. This system has six PIT-tag detection dams: Lower Granite Dam (LGR), Little Goose Dam (LGS),

Figure 1: Map of Bonneville Dam, showing fish ladder locations on Cascades and Bradford Islands.

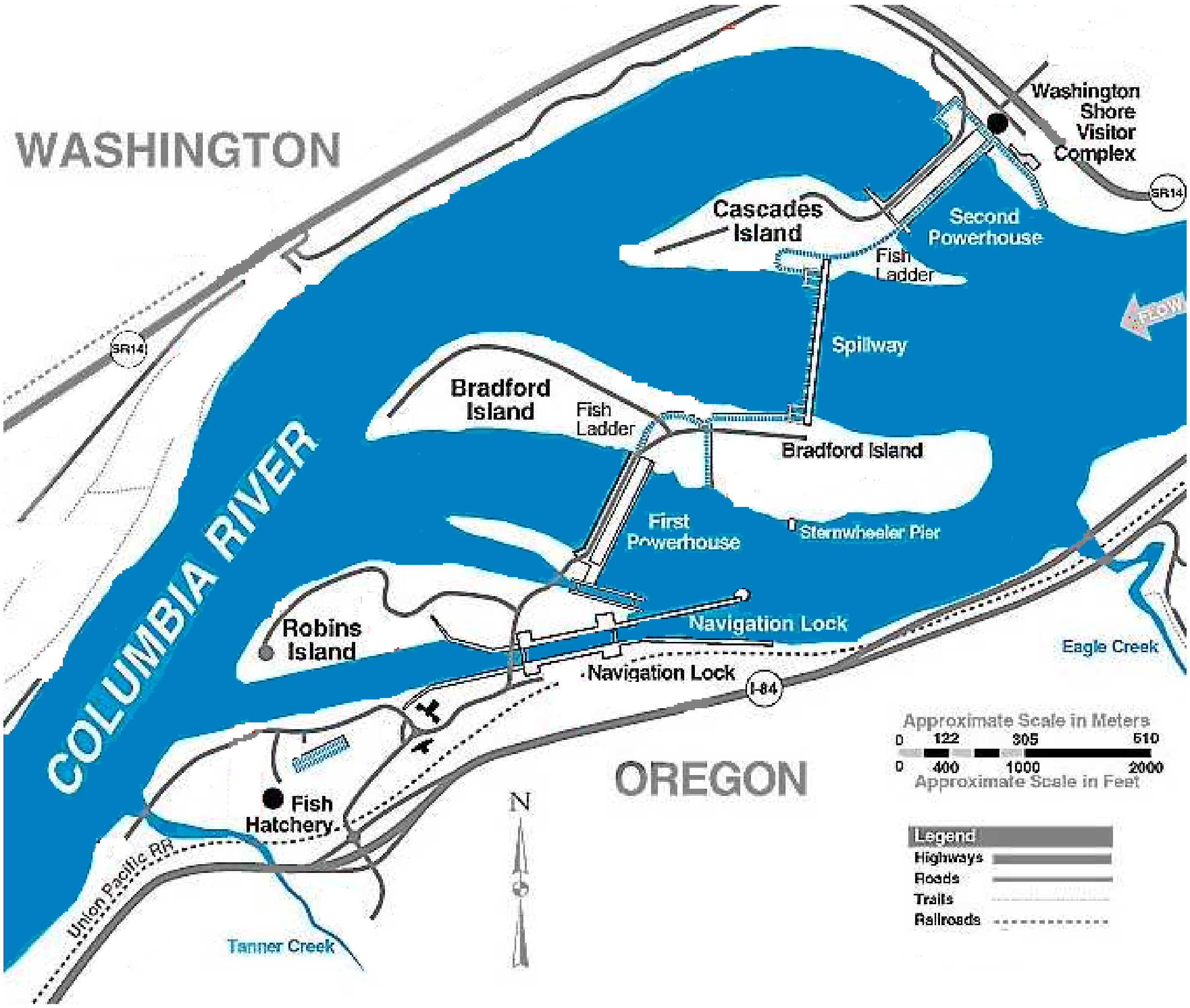
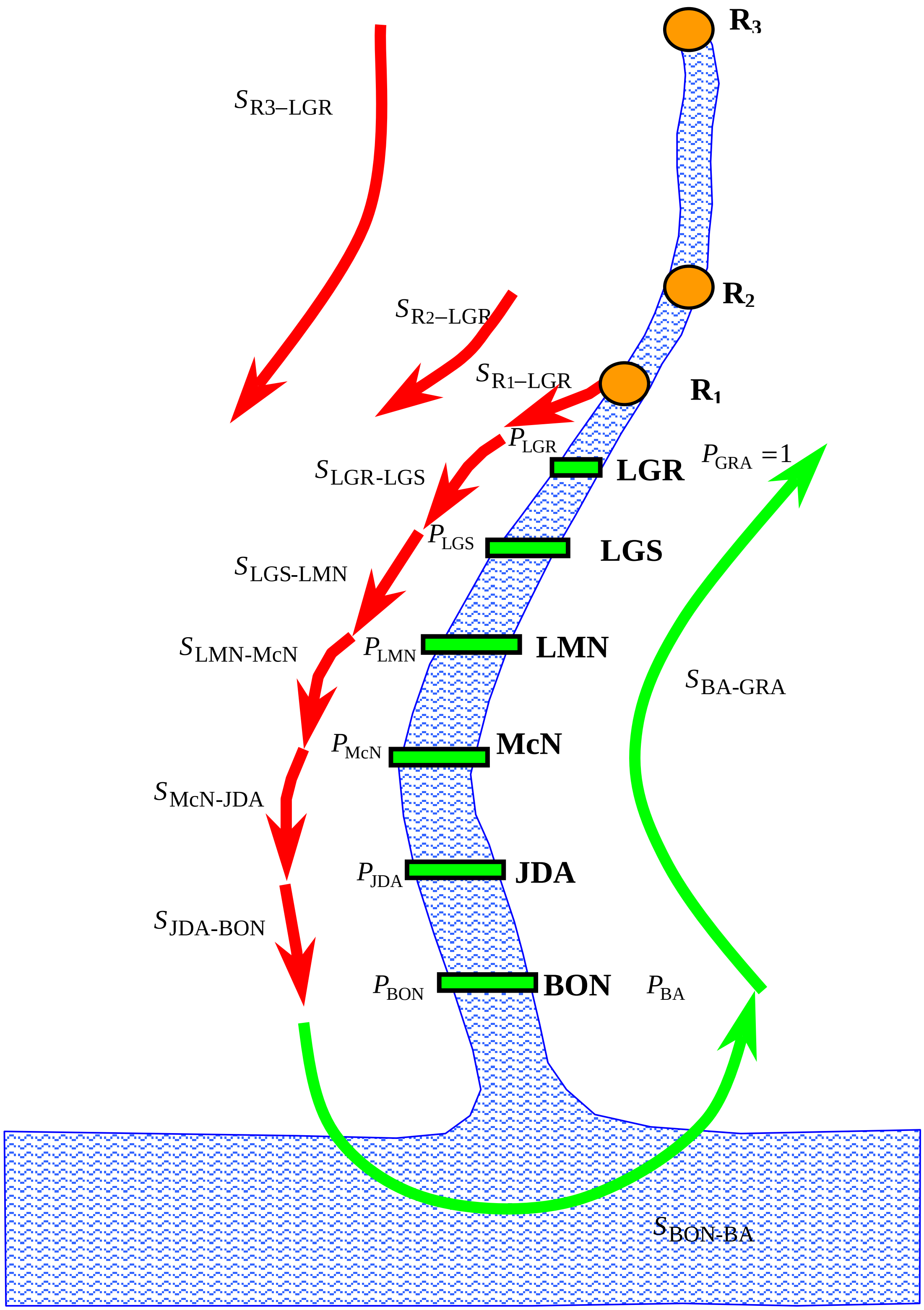


Figure 2: Reach survivals (S) and capture probabilities (P) required for an eight-event system describing the survival history of four releases of PIT-tagged chinook salmon (R_1, R_2 and R_3) that return as adults to be detected at Bonneville Dam and Lower Granite Dam.



Lower Monumental Dam (LMN), McNary Dam (McN), John Day Dam (JDA) and Bonneville Dam (BON). These six dams have PIT-tag detection systems for PIT-tagged juvenile fish operating with detection efficiencies denoted by: P_{LGR}, P_{LGS}, P_{LMN}, P_{McN}, P_{JDA} and P_{BON}. Only two dams, BON and LGR have PIT-tag detection systems for PIT-tagged adult fish that operate with detection efficiencies denoted by: P_{BA} and P_{GRA}. Thus, if a group of PIT-tagged chinook smolts of known sample size is released above LGR, the single-release model (Cormack 1964, Jolly 1965, Seber 1965) as implemented in *SURPH.1* (Smith et al., 1994) will produce estimates of seven reach survivals for the marked fish in the release group. Six out the seven reach survivals ($S_{\text{R}_i-\text{LGR}}$, $S_{\text{LGR-LGS}}$, $S_{\text{LGS-LMN}}$, $S_{\text{LMN-McN}}$, $S_{\text{McN-JDA}}$ and $S_{\text{JDA-BON}}$) are estimated on juvenile fish migrating down the river system. $S_{\text{BON-BA}}$ is the survival of juvenile fish that left the tailrace of BON to enter the Columbia River estuary and spend one to four years feeding and growing at sea, to finally return as spawning adults to the tailrace of BON. Finally, $S_{\text{BA-GRA}}$, is the survival of adult fish between Bonneville and Lower Granite Dams that can only be estimated if $P_{\text{GRA}} = 1$.

We calculated the standard errors for $S_{\text{BON-BA}}$ by applying the equation in Cormack (1964) for the variance of survival estimates (Cormack, 1994; equation 9), assuming we knew the values of the six juvenile PIT-tag detection efficiencies, the adult PIT-tag detection efficiency at LGR (P_{GRA}) and the eight reach survivals. The analysis consisted of 3,000 standard error calculations, corresponding to six scenarios. A scenario was defined by the values assigned to the juvenile survival to LGR ($S_{\text{R}_i-\text{LGR}}$), and the value assigned to $S_{\text{BON-BA}}$.

We simulated releases from three sites whose locations were various distances upstream of LGR. The number of PIT-tagged fish in each release group was varied from 1,000 to 100,000 fish, in increments of 1,000 fish. Finally, for the adult PIT-tag detection efficiency at BON (P_{BA}) we tried five values ranging from one to 0.1, such that $P_{\text{BA}} = \{1, 0.75, 0.5, 0.2, 0.1\}$. We assumed that $P_{\text{GRA}} = 1$ for all groups of PIT-tagged fish. Similarly, all releases were given two alternative values of estuarine and marine survival $S_{\text{BON-BA}}$.

2.2 Collection and manipulation of data

The values for the six juvenile PIT-tag detection efficiencies and the eight reach survivals required by our standard error calculations were obtained from published reports on survival and capture probability estimates for PIT-tagged chinook salmon releases (Eppard et al., 1999; Hockersmith et al., 1999; Iwamoto et al., 1994; Muir et al., 1995 and 1996; Perez-Comas and Skalski, 2000; Smith et al., 1998 and 2000) and results from radio-telemetry experiments on returning adult chinook salmon (Bjornn et al., 2000). In all cases, when more than one estimate of a particular reach survival or capture probability estimate was available, the estimates were averaged to produce a unique value that was used as the required survival or PIT-tag detection efficiency. To average the reported estimates ($\hat{\theta}_i$) we used weights calculated as $\frac{1}{CV\left(\hat{\theta}\right)^2}$, where CV is the coefficient of variation of the estimate.

The available information on PIT-tag detection efficiencies and the reach survivals was reported in five corresponding appendices:

1) Reach survival and detection probability estimates of juvenile chinook salmon at dams and reservoirs of the Snake River (Appendix I)
2) Reach survival and detection probability estimates of juvenile chinook salmon at dams and reservoirs of the Lower Columbia River (Appendix II)
3) In-river survival estimates for chinook salmon adults returning to Lower Granite Dam (Appendix III)
4) Estuary and marine survival estimates for chinook salmon adults returning to Bonneville Dam (Appendix IV)
5) Survival estimates to Lower Granite Dam of hatchery releases of juvenile chinook salmon (Appendix V)

The information gathered in Appendix I provided 236 estimates of $S_{\text{LGR}-\text{LGS}}$, 218 estimates of $S_{\text{LGS}-\text{LMN}}$, 91 estimates of $S_{\text{LMN}-\text{McN}}$, 81 estimates of P_{LGR}, 112 estimates of P_{LGS}, 96 estimates of P_{LMN} and 109 estimates of P_{McN}. Appendix II provides 64 estimates of $S_{\text{McN}-\text{JDA}}$ and P_{JDA}, and 12 estimates of $S_{\text{JDA}-\text{BON}}$, and P_{BON}. Appendix V displays the survival estimates to Lower Granite Dam of hatchery releases of juvenile chinook salmon used to obtain reasonable values for $S_{\text{R}_i-\text{LGR}}$ (i =1, 2, 3).

The three Snake River release sites chosen for the precision calculations were:

1) R_1 = Nisqually John Boat Landing, located on the Snake River 31 km upstream of LGR ($\hat{S}_{\text{R-LGR}} = 0.9018$),

2) R_2 = Lookingglass Hatchery, 238 km upstream of LGR ($\hat{S}_{\text{R-LGR}} = 0.685$),

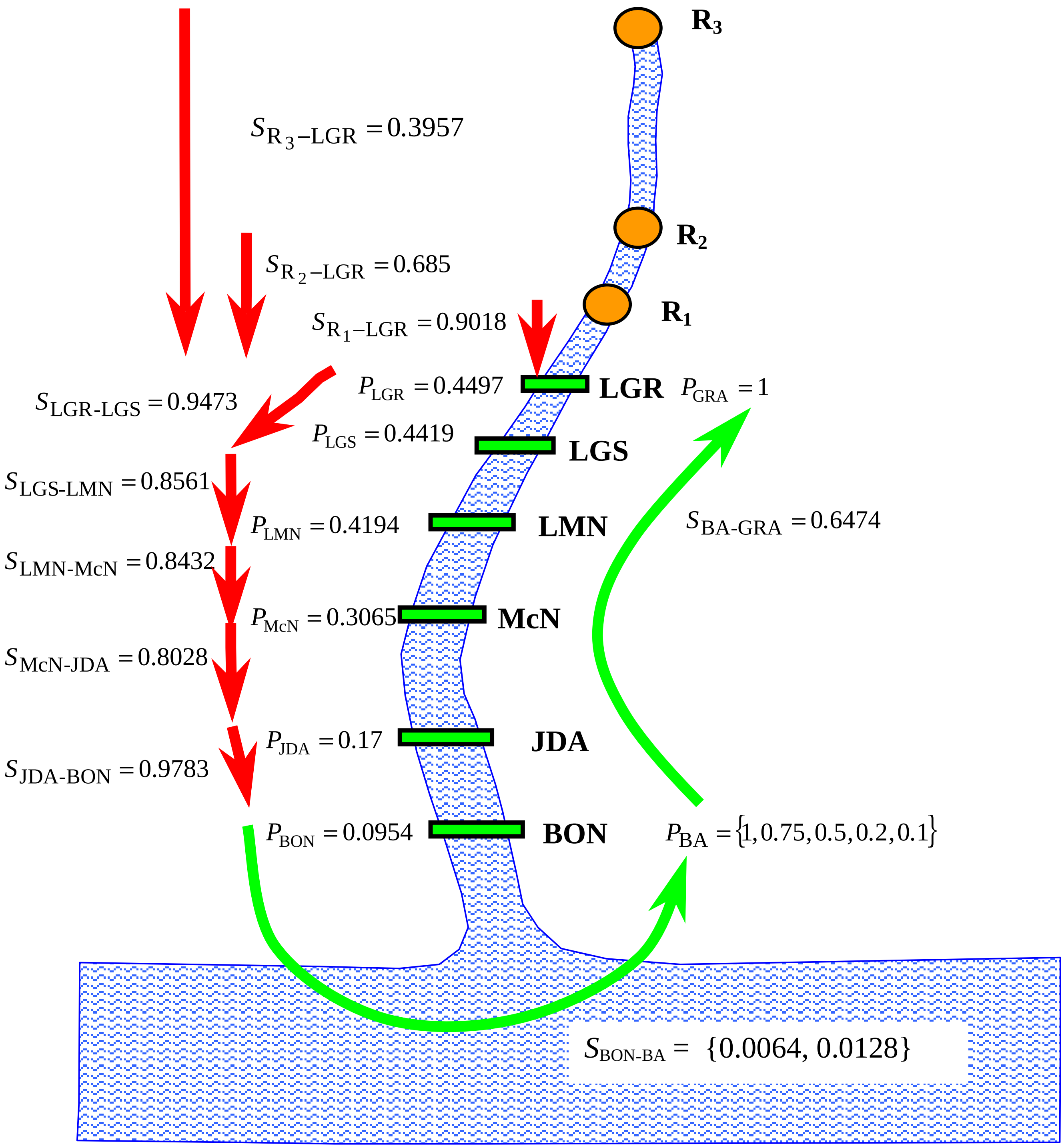
3) R_3 = Sawtooth Hatchery, 747 km upstream LGR ($\hat{S}_{\text{R-LGR}} = 0.3957$).

To produce an in-river survival estimate for chinook salmon adults returning to LGR ($\hat{S}_{\text{BA-GRA}}$), radio-tag data (Bjorn et al., 2000) was reinterpreted. Details of the calculation and its results are shown in Appendix III. Finally, in Appendix IV we used *SUPH.1* to estimate reach survival, capture and terminal probabilities (λ) for ten releases of PIT-tagged chinook salmon that were detected at Lower Granite Dam adult trap in 1994-2000 (Table A.IV.1). Estimates of the estuary and marine survival estimates for chinook salmon adults returning to Bonneville ($S_{\text{BON-BA}}$) were obtained by making assumptions on the values of $S_{\text{McN-JDA}}$, $S_{\text{JDA-BON}}$, $S_{\text{BA-GRA}}$ and P_{GRA} during the 1994-2000 period (See Appendix IV for calculation details).

The values for the PIT-tag detection efficiencies and the reach survivals used in the 3,000 standard error calculations are displayed in Figure 3. Since the values for survivals $S_{\text{LGR-LGS}}$, $S_{\text{LGS-LMN}}$, $S_{\text{LMN-McN}}$, $S_{\text{McN-JDA}}$, $S_{\text{JDA-BON}}$ and $S_{\text{BA-GRA}}$ were kept constant in the 27,840 standard error calculations, six scenarios were defined on the basis of the values assigned to the juvenile survival to LGR ($S_{\text{R}_i\text{-LGR}}$) and the estuarine and marine survival $S_{\text{BON-BA}}$:

Scenario	Release Site	$S_{\text{R-LGR}}$	$S_{\text{BON-BA}}$
1	Nisqually John Boat Landing	*0.9018*	*0.0064*
2	Nisqually John Boat Landing	*0.9018*	*0.0128*
3	Lookingglass Hatchery	*0.6850*	*0.0064*
4	Lookingglass Hatchery	*0.6850*	*0.0128*
5	Sawtooth Hatchery	*0.3957*	*0.0064*
6	Sawtooth Hatchery	*0.3957*	*0.0128*

Figure 3: Reach survivals (*S*) and capture probabilities (*P*) utilized in the appraisal of the relationship between tag detection efficiency at Bonneville Dam and precision of estuarine and marine survival estimates of returning PIT-tagged chinook salmon.



3. RESULTS

3.1 Effects of Bonneville Dam detection efficiency and release size on precision

Figures 4-6 depict the effects of Bonneville Dam detection efficiency and release size on precision, expressed as standard errors and coefficient of variation of $S_{\text{BON-BA}}$ estimates $\left(\text{i.e., } SE\left(\hat{S}_{\text{BON-BA}}\right) \text{and } CV\left(\hat{S}_{\text{BON-BA}}\right)\right)$, for a given release site. Each figure contrasts the influence of estuarine and marine survival on the relationship among Bonneville adult detection efficiency, release size and precision. In general, for releases from a particular site, an increase in estuarine and marine survival produces a general increase in the precision of the survival estimates (i.e., a general shift upward of the standard error curves). For example, if 30,000 PIT-tagged fish were to be released from Nisqually John Boat Landing, *CV*s of 33.5 to 37.4% would be expected with Bonneville adult detection efficiencies of 1 to 0.5 when $S_{\text{BON-BA}}$ is 0.0064 (Fig. 4*a*). However, *CV*s of 23.6 to 26.4% would be obtained if $S_{\text{BON-BA}}$ was 0.0128 (Fig. 4*b*). Similarly, for 30,000 fish released from Lookingglass Hatchery *CV*s would decrease from 38.4 - 42.9% ($S_{\text{BON-BA}} = 0.0064$, Fig. 5*a*) to 27.1 - 30.2% ($S_{\text{BON-BA}} = 0.0128$, Fig. 5*b*) when estuarine and marine survival changed from 0.0064 to 0.0128.

As detection efficiency decreased from $P_{\text{BA}} = 1$ to $P_{\text{BA}} = 0.1$, larger release sizes are required to achieve the same standard error. For example, in Figure 4*a* (scenario 1), to achieve a standard error of 0.00228 that corresponds to a coefficient of variation (*CV*) of 35.6%, a release of 26,400 PIT-tagged fish would be required with Bonneville adult PIT-tag detection efficiencies of 1. However, if P_{BA} were between 0.5 and 0.1, the required release sizes would be in the range of 32,900 to 50,000 fish.

Figures 4-6 also illustrate the effects of release site, or more concretely of the related juvenile survival to LGR (i.e., $S_{\text{R-LGR}}$). In general, for a given release size and Bonneville adult detection efficiency, the higher $S_{\text{R-LGR}}$ is, the lower the standard error and coefficient of variation are (i.e., the higher the precision is). In addition, the further upstream of LGR the release site is, the higher the anticipated standard error and coefficient of variation in $S_{\text{BON-BA}}$ estimates are. For example, if we compare the expected precision of estuarine and marine survival estimates for 30,000 PIT-tagged chinook salmon released from Nisqually John Boat Landing, Lookingglass Hatchery and Sawtooth Hatchery, when $S_{\text{BON-BA}} = 0.0128$ and $P_{\text{BA}} = 1$, the anticipated *CV*s are 23.6, 27.1 and 35.6%, respectively (Fig. 4*b*, Fig. 5*b* and Fig. 6*b*).

Figure 4: Standard error (SE) and coefficient of variation (CV) of estuary and marine survival estimates ($\hat{S}_{\text{BON-BA}}$) as functions of the number of fish released from Nisqually John Boat Landing $\left(S_{\text{Rel.-LGR}} = 0.9014\right)$ for various values of tag detection efficiency at Bonneville Dam $\left(P_{\text{BA}}\right)$, when estuarine and marine survival is: (***a***) $\hat{S}_{\text{BON-BA}} = 0.0064$ and (***b***) $\hat{S}_{\text{BON-BA}} = 0.0128$.

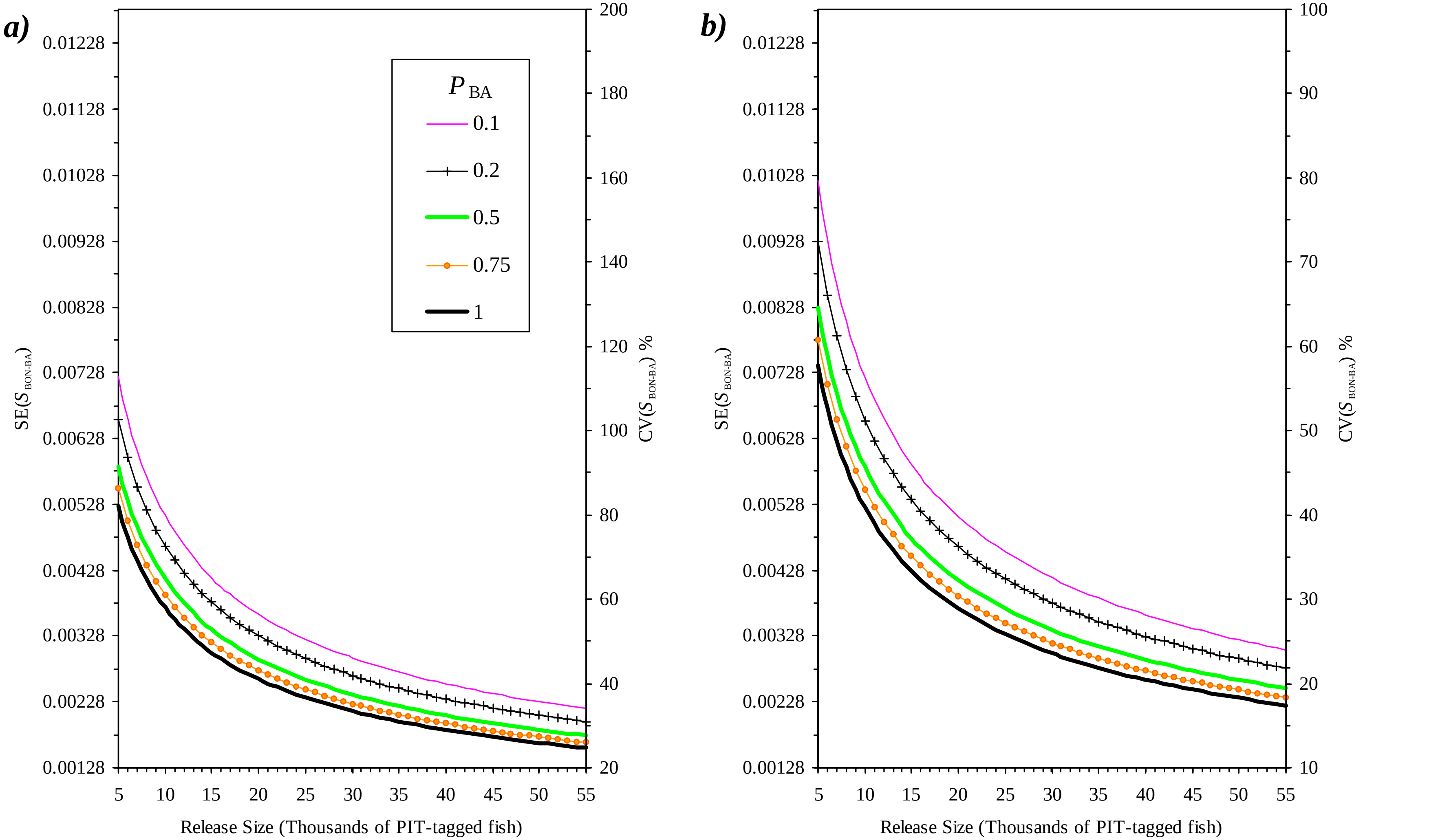


Figure 5: Standard error (SE) and coefficient of variation (CV) of estuary and marine survival estimates ($\hat{S}_{\text{BON-BA}}$) as functions of the number of fish released from Lookingglass Hatchery $\left(S_{\text{Rel.-LGR}} = 0.685\right)$ for various values of tag detection efficiency at Bonneville Dam $\left(P_{\text{BA}}\right)$, when estuarine and marine survival is: (***a***) $\hat{S}_{\text{BON-BA}} = 0.0064$ and (***b***) $\hat{S}_{\text{BON-BA}} = 0.0128$.

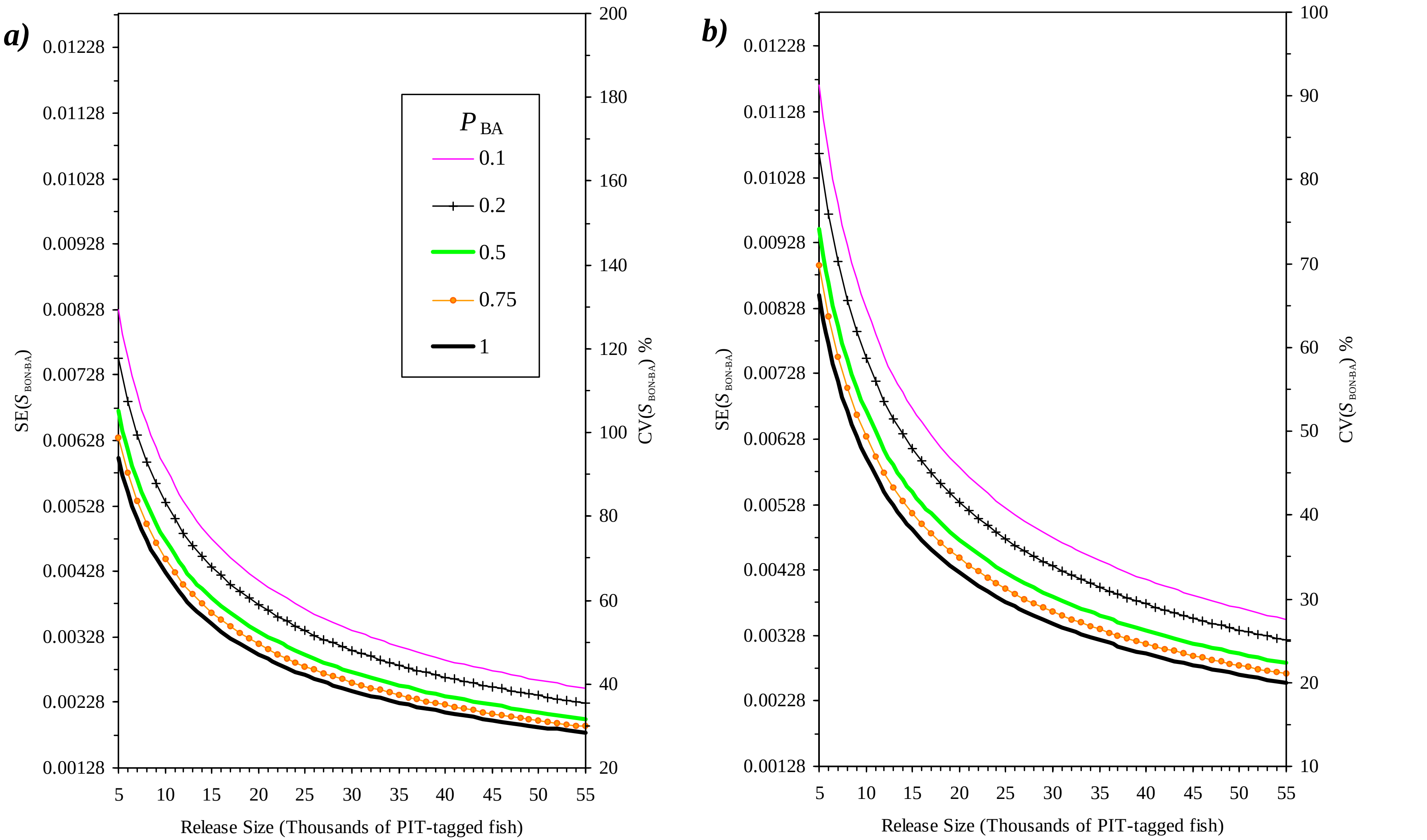
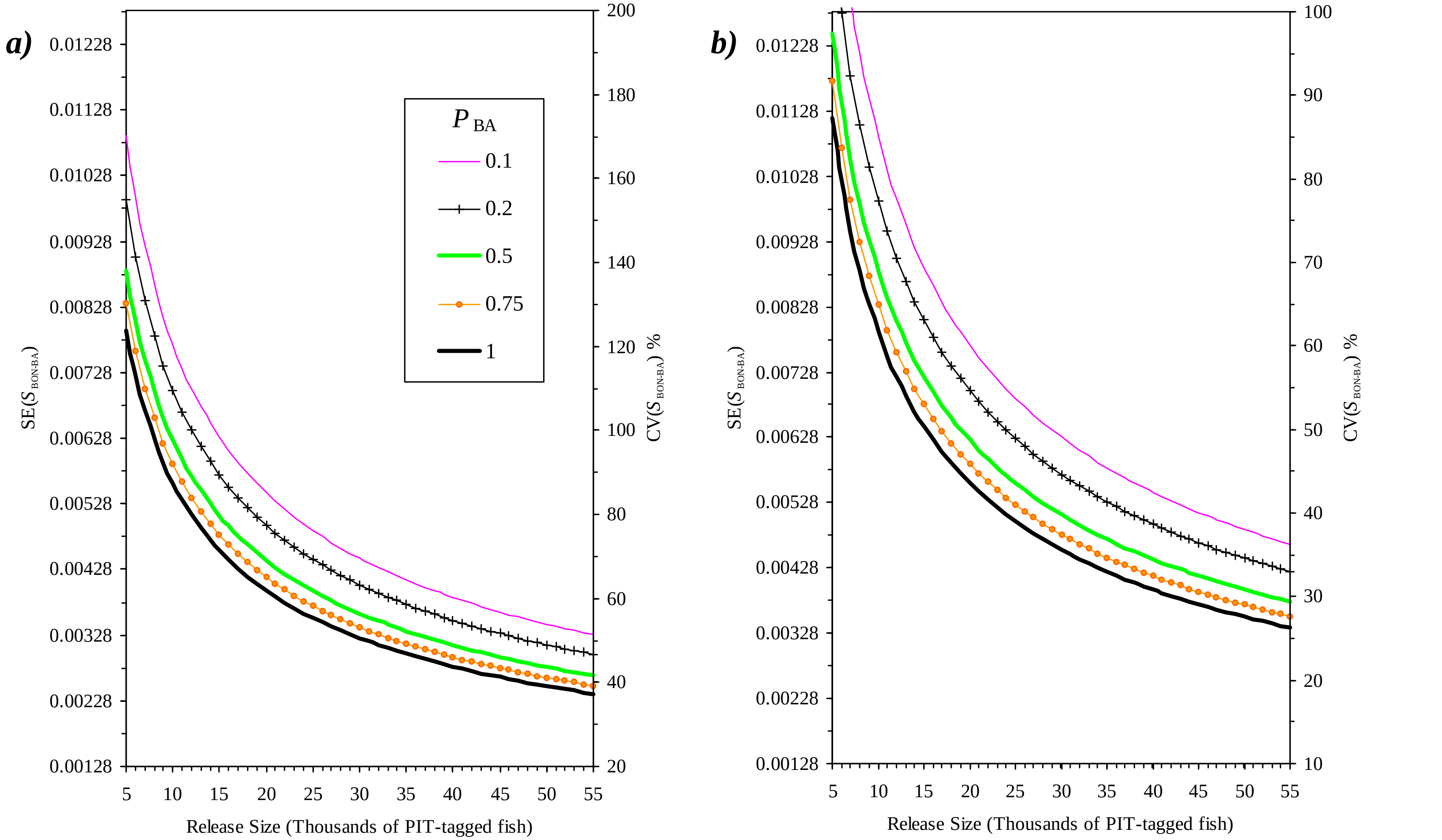


Figure 6: Standard error (SE) and coefficient of variation (CV) of estuary and marine survival estimates ($\hat{S}_{\text{BON-BA}}$) as functions of the number of fish released from Sawtooth Hatchery $\left(S_{\text{Rel.-LGR}} = 0.3957\right)$ for various values of tag detection efficiency at Bonneville Dam $\left(P_{\text{BA}}\right)$, when estuarine and marine survival is: (***a***) $\hat{S}_{\text{BON-BA}} = 0.0064$ and (***b***) $\hat{S}_{\text{BON-BA}} = 0.0128$.



3.2 Required Bonneville detection efficiency at the adult PIT-tag detection facility

Table 1 shows the maximum precision attainable by various release-recapture scenarios, if the adult detection efficiency at Bonneville adult PIT-tag detection facility were maximal (i.e., $P_{\text{BA}} = 1$). Release sizes of 55,000 (larger than the currently largest release[2]) or more PIT-tagged fish are required to produce *CV*s for $\hat{S}_{\text{BON-BA}}$ ranging from 14.9% to 37.3%, depending on the scenario specifications. If releases were as low as 10,000 fish, a common release size for the past nine years, we expect much lower precision (*CV*s of 40.9-87.5%), even with the Bonneville project operating at full detection efficiency (i.e., $P_{\text{BA}} = 1$).

Table 2 attempts to address the question of what detection efficiency is needed at the Bonneville project to achieve an adequate precision in $\hat{S}_{\text{BON-BA}}$. We chose a precision of *CV* = 20% for the survival estimates. A *CV* = 20% implies that the survival estimate $\hat{S}_{\text{BON-BA}}$ would be within ± 40% of the true estuarine and marine survival, 95% of the times. Table 2 shows that under most scenarios with release sizes of 10,000-30,000 fish, the required precision of *CV* = 20% could not be obtained, even if the detection efficiency at entire Bonneville project was 100%. Only with 55,000 or more fish in a release from a site close to LGR and high estuarine and marine survival, can a *CV* of 20% be achieved, with a detection efficiency at the Bonneville project less than perfect.

4. DISCUSSION

The present appraisal provides guidance on the expected relationship between the detection efficiency at the Bonneville adult PIT-tag detection facility and the attempted precision in estuarine and marine survival estimates of returning adult salmon for hypothetical releases of PIT-tagged yearlings from sites upstream of Lower Granite Dam. The precision calculations on which our analysis was based rely upon current estimates of survival and detection probabilities for the various reaches and dams of the Snake-Columbia River Basin. As such, they are constrained by the quality of available information, in particular, by the scarce information on in-river survival estimates for adult salmon in the BON-LGR reach (Appendix III), and on estuarine and marine survival estimates for returning salmon adults (Appendix IV).

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[2] From 1998 to 2000, the range of spring chinook juveniles released from hatcheries on the Snake River or tributaries was 112 - 52,195 PIT-tagged fish, with an average of 10,381fish by release. The maximum of 52,195 PIT-tagged spring juveniles was released from Rapid River Hatchery, on April 2, 1999.

Table 1: Maximum attainable precision in estuarine and marine survival estimates ($\hat{S}_{BON-BA}$) for various release-recapture scenarios, when the adult detection efficiency at both Lower Granite and Bonneville adult PIT-tag detection facilities were maximal (i.e., $P_{BA}=1$ and $P_{GRA}=1$). Precision is expressed as coefficient of variation, in percent (*CV*).

Release Site	$S_{BON\text{-}BA}$	Release Size (Thousands of fish)			
		10	*30*	*55*	*75*
Nisqually John ($S_{R\text{-}LGR}$ = *0.9018*)	*0.0064*	57.97	33.47	24.72	21.17
	0.0128	40.86	23.59	17.42	14.92
Lookingglass ($S_{R\text{-}LGR}$ = *0.685*)	*0.0064*	66.51	38.40	28.36	24.29
	0.0128	46.88	27.06	20.00	17.12
Sawtooth ($S_{R\text{-}LGR}$ = *0.3957*)	*0.0064*	87.51	50.52	37.31	31.95
	0.0128	61.68	35.61	26.30	22.52

Table 2: Required detection efficiencies at the Bonneville adult PIT-tag detection facility (i.e., P_{BA}) to attain a precision of *CV* = 20% for various release-recapture scenarios, when the adult detection efficiency at Lower Granite Dam is maximal (i.e., $P_{GRA}=1$).

Release Site	$S_{BON\text{-}BA}$	Release Size (Thousands of fish)			
		10	*30*	*55*	*75*
Nisqually John ($S_{R\text{-}LGR}$ = *0.9018*)	*0.0064*	1*	1*	1*	1*
	0.0128	1*	1*	0.4	0.1
Lookingglass ($S_{R\text{-}LGR}$ = *0.685*)	*0.0064*	1*	1*	1*	1*
	0.0128	1*	1*	1.0	0.4
Sawtooth ($S_{R\text{-}LGR}$ = *0.3957*)	*0.0064*	1*	1*	1*	1*
	0.0128	1*	1*	1*	1*

* The required precision of *CV* = 20% could not be obtained under the particular scenario and release size, even when the detection efficiency at Bonneville adult PIT-tag detection facility was 100%.

Besides the rather obvious direct proportionality between precision and release size, and between precision and adult detection efficiency at Bonneville Dam (Fig. 4-6), the expected precision (i.e., *CV*) of estuarine and marine survival estimates appeared to be directly proportional to the in-river juvenile survival $S_{\text{R-LGR}}$. For a given release size and adult detection efficiency, the precision of estuarine and marine survival estimates will increase as $S_{\text{R-LGR}}$ increases (Fig. 4*a*-6*a*). Moreover, for a given release size and adult detection efficiency, higher estuarine and marine survivals will also produce more precise survival estimates (Fig. 4*b*-6*b*). The implication is obvious, if a precise adult PIT-tag study is desired, releases of PIT-tagged smolts should be as large and as down river as possible.

The precision results presented in this report can be viewed as the proverbial glass of water, either "half full" or "half empty." The expected standard errors for the ocean survival estimates in Figures 4-6 are typically quite small (e.g., $0.002 < SE < 0.012$). Hence, confidence interval widths will be as narrow or narrower than most in-river smolt survival estimates currently generated. However, this confidence interval width ignores the relative magnitude of the signal-to-noise ratio of the survival estimates. An in-river smolt survival estimate of 0.95, with a confidence interval width of ± 0.02, 95% of the time, is estimated precisely on both an absolute and relative scale. On the other hand, an ocean survival estimate of 0.01, with a confidence interval width of ± 0.02, 95% of the time, is precise on an absolute scale but not on a relative scale. In this latter situation, the coefficient of variation $\left(CV = SE(\hat{S})/\hat{S}\right)$ would be 100%. For two annual survival estimates to be significantly different ($\alpha = 0.05$) in this case, the point estimates would have to differ by at least 400% between years. For this reason, the CV is a more useful measure of sampling precision and the focus of our discussion.

Based on our analyses, we conclude that currently common release sizes of 10,000-30,000 PIT-tagged fish will not produce estuarine and marine survival estimates with a precision of *CV* = 20%, even if the adult detection system at Bonneville is to operate at a 100% efficiency. However, less than a 100% detection efficiency might be required with releases of 55,000 or more fish, if the release site is close to LGR and the estuarine and marine survival is high (Table 2).

Finally, we want to emphasize once more that our results are based on the detection efficiency P_{BA}, that is the detection efficiency for the entire Bonneville system, powerhouses 1 and 2. In 1999, 41.4% of the adult chinook detected at Bonneville were detected at Powerhouse 1, while 58.6% were detected at Powerhouse 2. Hence, if only the Powerhouse 2 had an adult PIT-tag detector operating at a 90% efficiency, the overall detection efficiency for the Bonneville project would be $0.586 \times 0.9 = 0.527$. This adjusted probability of detection, with adult detection occurring only at the Cascades Island fish ladder, could be used in conjunction with Figures 4-6 to determine anticipated precision. With overall detection rates of 50% at the Bonneville project, the precision of adult PIT-tag studies would be too low to provide useful estimates of estuarine and marine survival. This further implies that the design of the Bonneville adult PIT-tag detection system must consider both powerhouses before an effective system can be established.

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APPENDIX I: Reach survival and detection probability estimates of juvenile chinook salmon at dams and reservoirs of the Snake River

Estimates for reach survivals between and detection probabilities at Lower Granite Dam (LGR), Little Goose Dam (LGS), Lower Monumental Dam (LMN) and McNary Dam (McN) were obtained by averaging all estimates that have been published in recent years. Estimates were all obtained using the Cormack-Jolly-Seber (CJS) capture-recapture model (Cormack 1964, Jolly 1965, Seber 1965) as implemented in the statistical computer program *SURPH.1* (Smith et al., 1994). Table A.I.1 lists the names and code names for all the release sites whose releases provided the survival and detection probability estimates. Tables A.I.2-A.I.8 display the reported survival or detection probability estimates and estimated standard errors together with the corresponding release-site code names, release dates, release size and reference.

Table A.I.1: List of names, code names and total river kilometers (*RKm*) for all the release sites cited in following tables.

Code	*Release Site*	*RKm*
BIGCAC	*Big Canyon Creek*	*803*
CATHEC	*Catherine Creek*	*1,025*
CLEARC	*Clear Creek*	*870*
CLWH	*Clearwater Hatchery*	*746*
CLWR	*Clearwater River*	*746*
CLWRNF	*North Fork Clearwater River*	*811*
CROOKP	*Crooked River Pond*	*975*
DWOR	*Dworshak National Fish Hatchery*	*811*
HCD	*Hell's Canyon Dam*	*919*
IMNAHR	*Imnaha River*	*830*
IMNAHW	*Imnaha River Weir*	*904*
KNOXB	*Knox Bridge*	*1,152*
KOOS	*Kooskia National Fish Hatchery*	*871*
LEMHIW	*Lemhi River Weir*	*1,290*
LGR	*Lower Granite Dam*	*695*
LGRRRR	*Lower Granite Dam below Diversion System Gate*	*695*
LGRTAL	*Lower Granite Dam Tailrace*	*695*
LGS	*Little Goose Dam*	*635*
LMN	*Lower Monumental Dam*	*589*
LOOH	*Lookingglass Hatchery*	*933*

Code	*Release Site*	*RKm*
MARTRP	*Marsh Creek Trap*	*1,325*
MCCA	*McCall Hatchery*	*970 ?*
MCNTAL	*McNary Dam Tailrace*	*470*
PAHP	*Pahsimeroi Pond*	*1,325*
POWP	*Powell Rearing Pond*	*1,016*
RAPH	*Rapid River Hatchery*	*978*
REDP	*Red River Rearing Pond*	*994*
RISTAL	*Rocky Island Tailrace*	*730*
RREFBY	*Rocky Reach Dam Forebay*	*763*
RRETAL	*Rocky Reach Dam Tailrace*	*763*
SALR	*Salmon River*	*825*
SALTRP	*Salmon River Trap*	*910*
SAWT	*Sawtooth Hatchery*	*1,442*
SNAKER	*Snake River*	*522*
SNAKER$_1$	*Snake River, near Couse Creek*	*776*
SNAKER$_2$	*Snake River, at Port of Wilma*	*744*
SNAKER$_3$	*Snake River, at Silcott Island*	*732*
SNAKER$_4$	*Snake River, at Nisqually John Boat Landing*	*726*
SNKTRP	*Snake River Trap*	*747*
WELTAL	*Wells Dam Tailrace*	*830*

Table A.I.2: Survival estimates and standard errors for PIT-tagged juvenile chinook releases in the LGR-LGS reach. H indicates hatchery releases and W, wild releases.

Run	Rear	Site	Release Numbers	Date	$\hat{S}_{\text{LGR}-\text{LGS}}$	SE	Reference
Spring	H	BIGCAC	*114*	4/21/95	*0.876*	*0.123*	Muir et al., 1996
Spring	W	CATHEC	*1,025*	9/12/94 - 12/1/94	*1.000*	*0.085*	Table A.IV.1, this report
Spring	H	CLEARC	*494*	4/12/95	*0.783*	*0.080*	Muir et al., 1996
Spring	H	CLEARC	*1,607*	4/12/96	*0.915*	*0.067*	Smith et al., 1998
Spring	H	CLEARC	*503*	4/12/96	*0.905*	*0.117*	Smith et al., 1998
Spring	H	CLEARC	*14,551*	4/12/96	*0.932*	*0.020*	Smith et al., 1998
Spring	H	CLWH	*2,010*	4/8/98	*0.970*	*0.034*	Smith et al., 2000
Spring	H	CLWH	*499*	4/8/98	*0.938*	*0.059*	Smith et al., 2000
Spring	H	CLWH	*500*	4/8/98	*0.935*	*0.060*	Smith et al., 2000
Spring	H	CLWH	*500*	4/13/98	*0.930*	*0.056*	Smith et al., 2000
Spring	H	CLWH	*300*	4/22/98	*1.000*	*0.092*	Smith et al., 2000
Spring	H	CLWR	*1,578*	4/9/95-5/3/95	*0.863*	*0.036*	Muir et al., 1996
Spring	W	CLWR	*511*	4/9/95-5/3/95	*0.947*	*0.068*	Muir et al., 1996
Fall	H	CLWR	*7,453*	4/13/98-4/16/98	*0.892*	*0.024*	Table A.II.1, this report
Spring	H	CLWRNF	*1,204*	4/11/96	*1.000*	*0.129*	Smith et al., 1998
Spring	H	CLWRNF	*3,853*	4/11/96	*0.923*	*0.039*	Smith et al., 1998
Spring	H	CLWRNF	*48,575*	3/25/98-3/26/98	*1.000*	*0.015*	Perez-Comas & Skalski, 2000
Spring	H	CROOKP	*500*	4/10/96	*1.000*	*0.240*	Smith et al., 1998
Spring	H	DWOR	*1,467*	4/8/93	*0.746*	*0.048*	Iwamoto et al., 1994
Spring	H	DWOR	*1,460*	4/22/93	*0.790*	*0.065*	Iwamoto et al., 1994
Spring	H	DWOR	*1,445*	5/6/93	*0.616*	*0.074*	Iwamoto et al., 1994
Spring	H	DWOR	*5,987*	4/8/94	*0.846*	*0.033*	Muir et al., 1995
Spring	H	DWOR	*1,198*	4/14/94	*0.848*	*0.053*	Muir et al., 1995
Spring	H	DWOR	*1,200*	4/15/94	*0.788*	*0.058*	Muir et al., 1995
Spring	H	DWOR	*5,992*	4/22/94	*0.861*	*0.041*	Muir et al., 1995
Spring	H	DWOR	*20,133*	4/8/94 - 5/6/94	*0.980*	*0.024*	Table A.IV.1, this report
Spring	H	DWOR	*5,985*	5/6/94	*0.856*	*0.042*	Muir et al., 1995
Spring	H	DWOR	*800*	4/14/95	*0.900*	*0.064*	Muir et al., 1996
Spring	H	DWOR	*14,080*	4/7/97	*1.000*	*0.046*	Hockersmith et al., 1999
Spring	H	DWOR	*47,704*	3/25/98-3/26/98	*1.000*	*0.015*	Smith et al., 2000
Spring	H	HCD	*499*	3/30/95	*1.000*	*0.088*	Muir et al., 1996
Spring	H	IMNAHR	*1,991*	4/12/93	*0.759*	*0.047*	Iwamoto et al., 1994
Spring	H	IMNAHR	*2,973*	4/11/94	*0.840*	*0.046*	Muir et al., 1995
Spring	H	IMNAHR	*663*	4/5/96-5/15/96	*0.857*	*0.102*	Smith et al., 1998
Spring	W	IMNAHR	*844*	4/5/96-5/15/96	*0.918*	*0.064*	Smith et al., 1998
Spring	W	IMNAHR	*238*	3/12/97-5/7/97	*0.994*	*0.122*	Hockersmith et al., 1999

Table A.I.2 (Cont.)

Run	Rear	Site	Release Numbers	Date	$\hat{S}_{LGR-LGS}$	*SE*	Reference
Spring	H	IMNAHR	*955*	4/10/97-5/3/97	*0.874*	*0.076*	Hockersmith et al., 1999
Spring	W	IMNAHR	*3,956*	2/27/98-6/16/98	*1.000*	*0.020*	Smith et al., 2000
Spring	H	IMNAHR	*2,000*	4/7/98-4/23/98	*0.994*	*0.031*	Smith et al., 2000
Spring	H	IMNAHW	*2,487*	3/28/95	*0.927*	*0.037*	Muir et al., 1996
Spring	H	IMNAHW	*493*	4/5/95	*0.775*	*0.092*	Muir et al., 1996
Spring	H	IMNAHW	*983*	4/24/95-4/26/95	*0.845*	*0.123*	Muir et al., 1996
Spring	H	IMNAHW	*4,714*	4/2/96	*0.894*	*0.037*	Smith et al., 1998
Spring	H	IMNAHW	*13,378*	4/7/97	*0.986*	*0.024*	Hockersmith et al., 1999
Spring	H	IMNAHW	*19,174*	4/6/98	*0.982*	*0.014*	Perez-Comas & Skalski, 2000
Spring	H	IMNAHW	*19,169*	4/6/98	*0.978*	*0.015*	Smith et al., 2000
Spring	H	KNOXB	*2,993*	4/3/93	*0.804*	*0.044*	Iwamoto et al., 1994
Spring	H	KNOXB	*1,501*	4/9/93-5/5/93	*0.731*	*0.052*	Iwamoto et al., 1994
Spring	H	KNOXB	*1,295*	4/9/94-4/14/94	*0.756*	*0.075*	Muir et al., 1995
Spring	H	KNOXB	*1,498*	4/11/94	*0.918*	*0.096*	Muir et al., 1995
Spring	H	KNOXB	*1,497*	4/11/94	*0.862*	*0.096*	Muir et al., 1995
Spring	H	KNOXB	*797*	4/22/94-4/28/94	*0.657*	*0.108*	Muir et al., 1995
Spring	H	KNOXB	*6,298*	4/6/95-4/7/95	*0.894*	*0.026*	Muir et al., 1996
Spring	H	KNOXB	*800*	4/19/95	*0.855*	*0.072*	Muir et al., 1996
Spring	H	KNOXB	*400*	4/24/95	*0.954*	*0.122*	Muir et al., 1996
Spring	H	KNOXB	*27,527*	4/11/96	*0.936*	*0.022*	Smith et al., 1998
Spring	H	KNOXB	*2,000*	4/13/96	*0.856*	*0.078*	Smith et al., 1998
Spring	H	KNOXB	*52,734*	3/20/97	*0.927*	*0.026*	Perez-Comas & Skalski, 2000
Spring	H	KNOXB	*47,474*	3/30/98	*0.984*	*0.010*	Perez-Comas & Skalski, 2000
Spring	H	KOOS	*1,171*	4/19/93	*0.708*	*0.086*	Iwamoto et al., 1994
Spring	H	KOOS	*600*	4/18/94	*0.845*	*0.109*	Muir et al., 1995
Spring	H	KOOS	*1,201*	4/12/95	*0.871*	*0.042*	Muir et al., 1996
Spring	H	KOOS	*4,075*	4/8/97	*1.000*	*0.137*	Hockersmith et al., 1999
Spring	H	KOOS	*1,001*	4/1/98	*0.946*	*0.050*	Smith et al., 2000
Spring	W	LEMHIW	*1,290*	9/5/94 - 11/15/94	*0.962*	*0.081*	Table A.IV.1, this report
Spring	H	LGR	*16,322*	4/21/94 - 4/30/94	*0.768*	*0.010*	Table A.IV.1, this report
	H+W	LGRRRR	*52,194*	4/7/98-4/30/98	*1.000*	*0.005*	Table A.II.1, this report
	H+W	LGRRRR	*17,490*	5/1/98-5/31/98	*0.975*	*0.006*	Table A.II.1, this report
Spring	H	LGRTAL	*1,871*	4/9/95-4/15/95	*0.850*	*0.038*	Muir et al., 1996
Spring	H	LGRTAL	*14,461*	4/16/95-4/22/95	*0.881*	*0.015*	Muir et al., 1996
Spring	H	LGRTAL	*24,378*	4/23/95-4/29/95	*0.872*	*0.008*	Muir et al., 1996
Spring	H	LGRTAL	*36,608*	4/30/95-5/6/95	*0.901*	*0.006*	Muir et al., 1996

Table A.I.2 (Cont.)

Run	Rear	Site	Release Numbers	Date	$\hat{S}_{LGR-LGS}$	*SE*	Reference
Spring	W	LGRTAL	*3,858*	4/9/95-4/15/95	*0.838*	*0.015*	Muir et al., 1996
Spring	W	LGRTAL	*9,555*	4/16/95-4/22/95	*0.872*	*0.023*	Muir et al., 1996
Spring	W	LGRTAL	*5,154*	4/23/95-4/29/95	*0.876*	*0.016*	Muir et al., 1996
Spring	W	LGRTAL	*5,200*	4/30/95-5/6/95	*0.916*	*0.012*	Muir et al., 1996
Spring	H	LGRTAL	*18,578*	5/7/95-5/13/95	*0.871*	*0.009*	Muir et al., 1996
Spring	H	LGRTAL	*4,176*	5/14/95-5/20/95	*0.856*	*0.022*	Muir et al., 1996
Spring	H	LGRTAL	*1,377*	5/21/95-5/27/95	*0.868*	*0.036*	Muir et al., 1996
Spring	H	LGRTAL	*1,234*	5/28/95-6/3/95	*0.895*	*0.049*	Muir et al., 1996
Spring	W	LGRTAL	*2,857*	5/7/95-5/13/95	*0.867*	*0.017*	Muir et al., 1996
Spring	W	LGRTAL	*1,033*	5/14/95-5/20/95	*0.956*	*0.040*	Muir et al., 1996
Spring	W	LGRTAL	*677*	5/21/95-5/27/95	*0.895*	*0.034*	Muir et al., 1996
Spring	W	LGRTAL	*920*	5/28/95-6/3/95	*0.855*	*0.027*	Muir et al., 1996
Spring	H	LGRTAL	*1,004*	6/4/95-6/10/95	*0.865*	*0.023*	Muir et al., 1996
Spring	H	LGRTAL	*250*	6/11/95-6/17/95	*0.987*	*0.051*	Muir et al., 1996
Spring	H	LGRTAL	*251*	6/18/95-6/24/95	*0.781*	*0.046*	Muir et al., 1996
Spring	H	LGRTAL	*108*	6/25/95-7/1/95	*0.723*	*0.084*	Muir et al., 1996
Spring	W	LGRTAL	*1,222*	6/4/95-6/10/95	*0.907*	*0.015*	Muir et al., 1996
Spring	W	LGRTAL	*494*	6/11/95-6/17/95	*0.875*	*0.027*	Muir et al., 1996
Spring	W	LGRTAL	*571*	6/18/95-6/24/95	*0.806*	*0.025*	Muir et al., 1996
Spring	W	LGRTAL	*242*	6/25/95-7/1/95	*0.696*	*0.043*	Muir et al., 1996
Spring	H	LGRTAL	*347*	4/9/96-4/15/96	*0.809*	*0.063*	Smith et al., 1998
Spring	H	LGRTAL	*4,045*	4/16/96-4/22/96	*0.881*	*0.020*	Smith et al., 1998
Spring	H	LGRTAL	*9,017*	4/23/96-4/29/96	*0.924*	*0.015*	Smith et al., 1998
Spring	H	LGRTAL	*12,464*	4/30/96-5/6/96	*0.915*	*0.013*	Smith et al., 1998
Spring	W	LGRTAL	*291*	4/9/96-4/15/96	*0.955*	*0.072*	Smith et al., 1998
Spring	W	LGRTAL	*5,728*	4/16/96-4/22/96	*0.937*	*0.016*	Smith et al., 1998
Spring	W	LGRTAL	*4,263*	4/23/96-4/29/96	*0.937*	*0.022*	Smith et al., 1998
Spring	W	LGRTAL	*1,205*	4/30/96-5/6/96	*0.944*	*0.041*	Smith et al., 1998
Spring	H	LGRTAL	*15,907*	5/7/96-5/13/96	*0.910*	*0.014*	Smith et al., 1998
Spring	H	LGRTAL	*10,418*	5/17/96-5/20/96	*0.960*	*0.025*	Smith et al., 1998
Spring	H	LGRTAL	*655*	5/21/96-5/27/96	*0.947*	*0.169*	Smith et al., 1998
Spring	H	LGRTAL	*618*	5/28/96-6/3/96	*0.967*	*0.198*	Smith et al., 1998
Spring	W	LGRTAL	*1,257*	5/7/96-5/13/96	*0.947*	*0.044*	Smith et al., 1998
Spring	W	LGRTAL	*1,124*	5/17/96-5/20/96	*0.993*	*0.070*	Smith et al., 1998
Spring	W	LGRTAL	*150*	5/21/96-5/27/96	*0.951*	*0.229*	Smith et al., 1998
Spring	H	LGRTAL	*324*	6/4/96-6/10/96	*0.762*	*0.235*	Smith et al., 1998

Table A.I.2 (Cont.)

Run	Rear	Site	Release Numbers	Date	$\hat{S}_{\text{LGR-LGS}}$	*SE*	Reference
Spring	H	LGRTAL	*93*	6/11/96-6/17/96	*0.968*	*0.854*	Smith et al., 1998
Spring	H+W	LGRTAL	*201*	4/6/97-4/12/97	*0.806*	*0.060*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*539*	4/13/97-4/19/97	*0.978*	*0.060*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*1,277*	4/20/97-4/26/97	*0.924*	*0.039*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*1,714*	4/27/97-5/3/97	*0.960*	*0.033*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*1,340*	5/4/97-5/10/97	*1.000*	*0.053*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*1,822*	5/11/97-5/17/97	*0.990*	*0.061*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*533*	5/18/97-5/24/97	*0.942*	*0.078*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*162*	5/25/97-5/31/97	*0.994*	*0.195*	Hockersmith et al., 1999
Spring	H	LGRTAL	*6,821*	4/6/98-4/12/98	*1.000*	*0.021*	Smith et al., 2000
Spring	H	LGRTAL	*16,147*	4/13/98-4/19/98	*1.000*	*0.012*	Smith et al., 2000
Spring	H	LGRTAL	*22,820*	4/20/98-4/26/98	*1.000*	*0.008*	Smith et al., 2000
Spring	H	LGRTAL	*17,400*	4/27/98-5/3/98	*0.972*	*0.007*	Smith et al., 2000
Spring	W	LGRTAL	*2,697*	4/6/98-4/12/98	*0.990*	*0.025*	Smith et al., 2000
Spring	W	LGRTAL	*3,263*	4/13/98-4/19/98	*1.000*	*0.021*	Smith et al., 2000
Spring	W	LGRTAL	*3,615*	4/20/98-4/26/98	*0.989*	*0.015*	Smith et al., 2000
Spring	W	LGRTAL	*2,564*	4/27/98-5/3/98	*0.955*	*0.014*	Smith et al., 2000
Spring	H	LGRTAL	*13,424*	5/4/98-5/10/98	*0.967*	*0.007*	Smith et al., 2000
Spring	H	LGRTAL	*4,029*	5/11/98-5/17/98	*1.000*	*0.015*	Smith et al., 2000
Spring	H	LGRTAL	*880*	5/18/98-5/24/98	*0.899*	*0.056*	Smith et al., 2000
Spring	H	LGRTAL	*167*	5/25/98-5/31/98	*1.000*	*0.205*	Smith et al., 2000
Spring	W	LGRTAL	*2,233*	5/4/98-5/10/98	*0.961*	*0.015*	Smith et al., 2000
Spring	W	LGRTAL	*909*	5/11/98-5/17/98	*1.000*	*0.028*	Smith et al., 2000
Spring	W	LGRTAL	*538*	5/18/98-5/24/98	*0.926*	*0.056*	Smith et al., 2000
Spring	W	LGRTAL	*321*	5/25/98-5/31/98	*0.950*	*0.095*	Smith et al., 2000
Spring	H	LGRTAL	*51*	6/1/98-6/7/98	*0.608*	*0.282*	Smith et al., 2000
Spring	H	LGRTAL	*43*	6/8/98-6/14/98	*0.767*	*0.141*	Smith et al., 2000
Spring	W	LGRTAL	*71*	6/1/98-6/7/98	*1.000*	*0.274*	Smith et al., 2000
Spring	W	LGRTAL	*71*	6/8/98-6/14/98	*1.000*	*0.163*	Smith et al., 2000
Spring	H	LOOH	*999*	4/7/93	*0.870*	*0.041*	Iwamoto et al., 1994
Spring	H	LOOH	*1,993*	4/10/94	*0.770*	*0.036*	Muir et al., 1995
Spring	H	LOOH	*1,983*	4/6/95	*0.925*	*0.037*	Muir et al., 1996
Spring	H	LOOH	*7,154*	4/4/96	*0.916*	*0.027*	Smith et al., 1998
Spring	H	LOOH	*40,401*	4/7/97	*0.922*	*0.022*	Perez-Comas & Skalski, 2000
Spring	H	LOOH	*40,042*	4/7/97	*0.927*	*0.022*	Hockersmith et al., 1999
Spring	H	LOOH	*45,122*	4/6/98	*0.972*	*0.011*	Perez-Comas & Skalski, 2000

Table A.I.2 (Cont.)

Run	Rear	Site	Release Numbers	Date	$\hat{S}_{\mathrm{LGR-LGS}}$	*SE*	Reference
Spring	H	LOOH	*43,939*	4/6/98	*0.973*	*0.012*	Smith et al., 2000
Spring	W	MARTRP	*1,325*	8/19/94 - 11/2/94	*0.933*	*0.040*	Table A.IV.1, this report
Spring	H	MCCA	*52,687*	3/20/97	*0.927*	*0.026*	Hockersmith et al., 1999
Spring	H	MCCA	*47,460*	4/10/98	*0.987*	*0.011*	Smith et al., 2000
Spring	H	PAHP	*997*	4/12/94	*0.721*	*0.126*	Muir et al., 1995
Spring	H	PAHP	*493*	4/12/95	*0.945*	*0.147*	Muir et al., 1996
Spring	H	PAHP	*33,326*	4/7/97	*0.957*	*0.026*	Perez-Comas & Skalski, 2000
Spring	H	PAHP	*33,479*	4/7/97	*0.957*	*0.027*	Hockersmith et al., 1999
Spring	H	PAHP	*993*	4/4/98	*1.000*	*0.075*	Smith et al., 2000
Spring	H	POWP	*1,016*	4/13/94 - 4/14/94	*0.850*	*0.074*	Table A.IV.1, this report
Spring	H	POWP	*9,285*	4/11/96	*0.842*	*0.036*	Smith et al., 1998
Spring	H	RAPH	*2,985*	4/17/93	*0.866*	*0.041*	Iwamoto et al., 1994
Spring	H	RAPH	*1,498*	4/12/94	*0.873*	*0.114*	Muir et al., 1995
Spring	H	RAPH	*1,497*	4/12/94	*0.802*	*0.134*	Muir et al., 1995
Spring	H	RAPH	*999*	3/31/95	*0.927*	*0.046*	Muir et al., 1996
Spring	H	RAPH	*990*	3/31/95	*0.852*	*0.047*	Muir et al., 1996
Spring	H	RAPH	*17,181*	3/19/96	*0.907*	*0.019*	Smith et al., 1998
Spring	H	RAPH	*2,003*	4/2/96-4/5/96	*0.916*	*0.059*	Smith et al., 1998
Spring	H	RAPH	*40,493*	4/1/97	*0.971*	*0.030*	Hockersmith et al., 1999
Spring	H	RAPH	*48,348*	4/13/98	*1.000*	*0.009*	Perez-Comas & Skalski, 2000
Spring	H	RAPH	*48,192*	4/13/98	*1.000*	*0.010*	Smith et al., 2000
Spring	H	REDP	*1,211*	4/10/96	*0.809*	*0.152*	Smith et al., 1998
Spring	H	SALTRP	*1,289*	3/27/95-3/28/95	*0.999*	*0.231*	Muir et al., 1996
Spring	W	SALTRP	*1,643*	3/27/95-3/28/95	*0.904*	*0.025*	Muir et al., 1996
Spring	H	SALTRP	*2,186*	4/10/95-3/5/95	*0.884*	*0.033*	Muir et al., 1996
Spring	H	SALTRP	*1,257*	3/26/96	*1.000*	*0.246*	Smith et al., 1998
Spring	H	SALTRP	*198*	3/18/96-3/24/96	*0.779*	*0.148*	Smith et al., 1998
Spring	H	SALTRP	*300*	3/25/96-3/31/96	*0.802*	*0.128*	Smith et al., 1998
Spring	H	SALTRP	*1,674*	4/5/96-5/15/96	*0.897*	*0.066*	Smith et al., 1998
Spring	W	SALTRP	*791*	4/5/96-5/15/96	*0.868*	*0.066*	Smith et al., 1998
Spring	H	SALTRP	*670*	4/1/96-4/7/96	*0.920*	*0.087*	Smith et al., 1998
Spring	H	SALTRP	*199*	4/8/96-4/14/96	*0.869*	*0.171*	Smith et al., 1998
Spring	H	SALTRP	*452*	4/15/96-4/21/96	*0.835*	*0.134*	Smith et al., 1998
Spring	H	SALTRP	*419*	4/22/96-4/28/96	*0.904*	*0.130*	Smith et al., 1998
Spring	H	SALTRP	*137*	4/29/96-5/5/96	*1.000*	*0.389*	Smith et al., 1998
Spring	H	SALTRP	*128*	5/6/96-5/12/96	*1.000*	*0.348*	Smith et al., 1998

Table A.I.2 (Cont.)

Run	Rear	Site	Release Numbers	Date	$\hat{S}_{\mathrm{LGR-LGS}}$	*SE*	Reference
Spring	H	SALTRP	*50*	5/13/96-5/19/96	*0.696*	*0.378*	Smith et al., 1998
Spring	H	SALTRP	*3,025*	3/17/98-5/5/98	*0.995*	*0.023*	Smith et al., 2000
Spring	W	SALTRP	*1,416*	3/17/98-5/1/98	*1.000*	*0.035*	Smith et al., 2000
Spring	H	SAWT	*799*	4/20/93	*1.000*	*0.147*	Iwamoto et al., 1994
Spring	H	SAWT	*2,155*	4/8/94-4/11/94	*0.816*	*0.115*	Muir et al., 1995
Spring	H	SAWT	*1,499*	4/5/95-4/7/95	*0.916*	*0.071*	Muir et al., 1996
Spring	H	SAWT	*499*	4/21/98	*0.931*	*0.073*	Smith et al., 2000
Spring	H	SNAKER	*2,481*	4/16/94 - 4/17/94	*0.929*	*0.033*	Table A.IV.1, this report
Spring	H	SNAKER	*2,510*	4/16/93 - 4/17/93	*0.933*	*0.024*	Table A.IV.1, this report
Spring	H	$SNAKER_1$	*581*	4/5/96-4/12/96	*0.915*	*0.087*	Smith et al., 1998
Spring	H	$SNAKER_1$	*534*	4/15/96-4/18/96	*0.902*	*0.088*	Smith et al., 1998
Spring	H	$SNAKER_1$	*335*	4/23/96-4/24/96	*1.000*	*0.156*	Smith et al., 1998
Spring	H	$SNAKER_1$	*369*	4/29/96-5/2/96	*0.919*	*0.155*	Smith et al., 1998
Spring	H	$SNAKER_1$	*178*	5/6/96-5/9/96	*0.758*	*0.175*	Smith et al., 1998
Spring	H	$SNAKER_1$	*307*	5/13/96-5/15/96	*0.694*	*0.151*	Smith et al., 1998
Spring	H	$SNAKER_2$	*1,258*	4/9/95	*0.801*	*0.043*	Muir et al., 1996
Spring	H	$SNAKER_2$	*784*	4/11/95	*0.856*	*0.055*	Muir et al., 1996
Spring	H	$SNAKER_2$	*1,218*	4/15/95	*0.952*	*0.051*	Muir et al., 1996
Spring	H	$SNAKER_2$	*579*	4/18/95	*0.875*	*0.071*	Muir et al., 1996
Spring	H	$SNAKER_2$	*701*	4/20/95	*0.931*	*0.053*	Muir et al., 1996
Spring	H	$SNAKER_2$	*1,529*	4/23/95	*0.956*	*0.038*	Muir et al., 1996
Spring	H	$SNAKER_2$	*1,615*	4/25/95	*0.899*	*0.037*	Muir et al., 1996
Spring	H	$SNAKER_2$	*2,049*	4/27/95	*0.913*	*0.039*	Muir et al., 1996
Spring	H	$SNAKER_2$	*1,505*	4/29/95	*0.860*	*0.045*	Muir et al., 1996
Spring	H	$SNAKER_2$	*2,098*	5/1/95	*0.943*	*0.049*	Muir et al., 1996
Spring	H	$SNAKER_2$	*544*	5/3/95	*0.953*	*0.104*	Muir et al., 1996
Spring	H	$SNAKER_2$	*142*	5/5/95	*0.743*	*0.137*	Muir et al., 1996
Spring	H	$SNAKER_3$	*1,189*	4/16/94	*0.882*	*0.038*	Muir et al., 1995
Spring	H	$SNAKER_3$	*1,196*	4/17/94	*0.739*	*0.038*	Muir et al., 1995
Spring	H	$SNAKER_3$	*1,194*	4/18/94	*0.782*	*0.045*	Muir et al., 1995
Spring	H	$SNAKER_3$	*1,190*	4/21/94	*0.723*	*0.047*	Muir et al., 1995
Spring	H	$SNAKER_3$	*776*	4/23/94	*0.723*	*0.085*	Muir et al., 1995
Spring	H	$SNAKER_3$	*1,032*	4/26/94	*0.913*	*0.101*	Muir et al., 1995
Spring	H	$SNAKER_3$	*643*	4/29/94	*0.756*	*0.081*	Muir et al., 1995
Spring	H	$SNAKER_3$	*1,069*	5/1/94	*0.963*	*0.098*	Muir et al., 1995
Spring	H	$SNAKER_3$	*542*	5/4/94	*0.688*	*0.110*	Muir et al., 1995

Table A.I.2 (Cont.)

Run	Rear	Site	Release Numbers	Date	$\hat{S}_{\text{LGR-LGS}}$	*SE*	Reference
Spring	H	$SNAKER_3$	*1,048*	5/10/94	*1.000*	*0.146*	Muir et al., 1995
Spring	H	$SNAKER_4$	*1,015*	4/15/93	*0.888*	*0.039*	Iwamoto et al., 1994
Spring	H	$SNAKER_4$	*1,305*	4/16/93	*0.889*	*0.029*	Iwamoto et al., 1994
Spring	H	$SNAKER_4$	*1,152*	4/17/93	*0.831*	*0.031*	Iwamoto et al., 1994
Spring	H	$SNAKER_4$	*1,208*	4/18/93	*0.818*	*0.034*	Iwamoto et al., 1994
Spring	H	$SNAKER_4$	*1,113*	4/19/93	*0.831*	*0.037*	Iwamoto et al., 1994
Spring	H	$SNAKER_4$	*797*	4/20/93	*0.902*	*0.044*	Iwamoto et al., 1994
Spring	H	$SNAKER_4$	*1,405*	4/21/93	*0.869*	*0.036*	Iwamoto et al., 1994
Spring	H	SNKTRP	*2,343*	4/9/95-3/5/95	*0.900*	*0.028*	Muir et al., 1996
Spring	W	SNKTRP	*1,122*	4/9/95-3/5/95	*0.903*	*0.037*	Muir et al., 1996
Spring	H	SNKTRP	*1,376*	4/8/96-5/15/96	*0.907*	*0.062*	Smith et al., 1998
Spring	W	SNKTRP	*787*	4/5/96-5/15/96	*0.980*	*0.066*	Smith et al., 1998
Spring	H	SNKTRP	*131*	4/8/96-4/14/96	*1.000*	*0.162*	Smith et al., 1998
Spring	H	SNKTRP	*445*	4/15/96-4/21/96	*0.918*	*0.100*	Smith et al., 1998
Spring	H	SNKTRP	*325*	4/22/96-4/28/96	*0.905*	*0.116*	Smith et al., 1998
Spring	H	SNKTRP	*80*	4/29/96-5/5/96	*1.000*	*0.338*	Smith et al., 1998
Spring	H	SNKTRP	*48*	5/6/96-5/12/96	*0.561*	*0.270*	Smith et al., 1998
Spring	H	SNKTRP	*422*	5/13/96-5/19/96	*0.953*	*0.176*	Smith et al., 1998
Spring	H	SNKTRP	*2,303*	3/25/98-5/23/98	*0.992*	*0.025*	Smith et al., 2000
Spring	W	SNKTRP	*961*	3/25/98-5/23/98	*1.000*	*0.040*	Smith et al., 2000

Table A.I.3: Survival estimates and standard errors for PIT-tagged juvenile chinook releases in the LGS-LMN reach. H indicates hatchery releases and W, wild releases.

Run	Rear	Site	Release Numbers	Date	$\hat{S}_{\text{LGS-LMN}}$	*SE*	Reference
Spring	H	BIGCAC	*114*	4/21/95	*0.890*	*0.202*	Muir et al., 1996
Spring	W	CATHEC	*1,025*	9/12/94 - 12/1/94	*0.692*	*0.078*	Table A.IV.1, this report
Spring	H	CLEARC	*494*	4/12/95	*1.000*	*0.114*	Muir et al., 1996
Spring	H	CLEARC	*1,607*	4/12/96	*0.946*	*0.114*	Smith et al., 1998
Spring	H	CLEARC	*503*	4/12/96	*1.000*	*0.226*	Smith et al., 1998
Spring	H	CLEARC	*14,551*	4/12/96	*0.874*	*0.029*	Smith et al., 1998
Spring	H	CLWH	*2,010*	4/8/98	*0.883*	*0.051*	Smith et al., 2000
Spring	H	CLWH	*499*	4/8/98	*0.917*	*0.092*	Smith et al., 2000
Spring	H	CLWH	*500*	4/8/98	*0.919*	*0.106*	Smith et al., 2000
Spring	H	CLWH	*500*	4/13/98	*0.907*	*0.093*	Smith et al., 2000
Spring	H	CLWH	*300*	4/22/98	*0.667*	*0.077*	Smith et al., 2000
Spring	H	CLWR	*1,578*	4/9/95-5/3/95	*0.976*	*0.058*	Muir et al., 1996
Spring	W	CLWR	*511*	4/9/95-5/3/95	*0.902*	*0.098*	Muir et al., 1996
Fall	H	CLWR	*7,453*	4/13/98-4/16/98	*0.810*	*0.034*	Table A.II.1, this report
Spring	H	CLWRNF	*1,204*	4/11/96	*0.640*	*0.112*	Smith et al., 1998
Spring	H	CLWRNF	*3,853*	4/11/96	*0.938*	*0.070*	Smith et al., 1998
Spring	H	CLWRNF	*48,575*	3/25/98-3/26/98	*0.766*	*0.013*	Perez-Comas & Skalski, 2000
Spring	H	CROOKP	*500*	4/10/96	*0.759*	*0.260*	Smith et al., 1998
Spring	H	DWOR	*5,987*	4/8/94	*0.887*	*0.039*	Muir et al., 1995
Spring	H	DWOR	*1,198*	4/14/94	*0.872*	*0.057*	Muir et al., 1995
Spring	H	DWOR	*1,200*	4/15/94	*0.993*	*0.083*	Muir et al., 1995
Spring	H	DWOR	*5,992*	4/22/94	*0.836*	*0.047*	Muir et al., 1995
Spring	H	DWOR	*20,133*	4/8/94 - 5/6/94	*0.739*	*0.020*	Table A.IV.1, this report
Spring	H	DWOR	*5,985*	5/6/94	*0.905*	*0.053*	Muir et al., 1995
Spring	H	DWOR	*800*	4/14/95	*0.903*	*0.084*	Muir et al., 1996
Spring	H	DWOR	*14,080*	4/7/97	*0.819*	*0.048*	Hockersmith et al., 1999
Spring	H	DWOR	*47,704*	3/25/98-3/26/98	*0.761*	*0.013*	Smith et al., 2000
Spring	H	HCD	*499*	3/30/95	*0.984*	*0.149*	Muir et al., 1996
Spring	H	IMNAHR	*2,973*	4/11/94	*0.899*	*0.062*	Muir et al., 1995
Spring	H	IMNAHR	*663*	4/5/96-5/15/96	*0.659*	*0.101*	Smith et al., 1998
Spring	W	IMNAHR	*844*	4/5/96-5/15/96	*0.946*	*0.112*	Smith et al., 1998
Spring	W	IMNAHR	*238*	3/12/97-5/7/97	*0.946*	*0.195*	Hockersmith et al., 1999
Spring	H	IMNAHR	*955*	4/10/97-5/3/97	*1.000*	*0.190*	Hockersmith et al., 1999
Spring	W	IMNAHR	*3,956*	2/27/98-6/16/98	*0.846*	*0.028*	Smith et al., 2000
Spring	H	IMNAHR	*2,000*	4/7/98-4/23/98	*0.853*	*0.047*	Smith et al., 2000
Spring	H	IMNAHW	*2,487*	3/28/95	*0.905*	*0.056*	Muir et al., 1996

Table A.I.3 (Cont.)

Run	Rear	Site	Release Numbers	Date	$\hat{S}_{\text{LGS-LMN}}$	*SE*	Reference
Spring	H	IMNAHW	*493*	4/5/95	*0.864*	*0.133*	Muir et al., 1996
Spring	H	IMNAHW	*983*	4/24/95-4/26/95	*0.949*	*0.114*	Muir et al., 1996
Spring	H	IMNAHW	*4,714*	4/2/96	*0.912*	*0.061*	Smith et al., 1998
Spring	H	IMNAHW	*13,378*	4/7/97	*0.777*	*0.042*	Hockersmith et al., 1999
Spring	H	IMNAHW	*19,169*	4/6/98	*0.845*	*0.016*	Smith et al., 2000
Spring	H	IMNAHW	*19,174*	4/6/98	*0.848*	*0.016*	Perez-Comas & Skalski, 2000
Spring	H	KNOXB	*1,295*	4/9/94-4/14/94	*1.000*	*0.163*	Muir et al., 1995
Spring	H	KNOXB	*1,498*	4/11/94	*0.796*	*0.109*	Muir et al., 1995
Spring	H	KNOXB	*1,497*	4/11/94	*0.640*	*0.078*	Muir et al., 1995
Spring	H	KNOXB	*797*	4/22/94-4/28/94	*1.000*	*0.216*	Muir et al., 1995
Spring	H	KNOXB	*6,298*	4/6/95-4/7/95	*0.875*	*0.033*	Muir et al., 1996
Spring	H	KNOXB	*800*	4/19/95	*0.904*	*0.099*	Muir et al., 1996
Spring	H	KNOXB	*400*	4/24/95	*1.000*	*0.272*	Muir et al., 1996
Spring	H	KNOXB	*27,527*	4/11/96	*0.979*	*0.043*	Smith et al., 1998
Spring	H	KNOXB	*2,000*	4/13/96	*0.730*	*0.098*	Smith et al., 1998
Spring	H	KNOXB	*52,734*	3/20/97	*0.888*	*0.033*	Perez-Comas & Skalski, 2000
Spring	H	KNOXB	*47,474*	3/30/98	*0.850*	*0.011*	Perez-Comas & Skalski, 2000
Spring	H	KOOS	*600*	4/18/94	*0.913*	*0.150*	Muir et al., 1995
Spring	H	KOOS	*1,201*	4/12/95	*0.898*	*0.057*	Muir et al., 1996
Spring	H	KOOS	*4,075*	4/8/97	*0.557*	*0.078*	Hockersmith et al., 1999
Spring	H	KOOS	*1,001*	4/1/98	*0.805*	*0.065*	Smith et al., 2000
Spring	W	LEMHIW	*1,290*	9/5/94 - 11/15/94	*0.819*	*0.107*	Table A.IV.1, this report
Spring	H	LGR	*16,322*	4/21/94 - 4/30/94	*0.717*	*0.013*	Table A.IV.1, this report
	H+W	LGRRRR	*52,194*	4/7/98-4/30/98	*0.851*	*0.011*	Table A.II.1, this report
	H+W	LGRRRR	*17,490*	5/1/98-5/31/98	*0.839*	*0.008*	Table A.II.1, this report
Spring	H	LGRTAL	*1,871*	4/9/95-4/15/95	*0.950*	*0.067*	Muir et al., 1996
Spring	H	LGRTAL	*14,461*	4/16/95-4/22/95	*0.961*	*0.025*	Muir et al., 1996
Spring	H	LGRTAL	*24,378*	4/23/95-4/29/95	*0.962*	*0.016*	Muir et al., 1996
Spring	H	LGRTAL	*36,608*	4/30/95-5/6/95	*0.915*	*0.010*	Muir et al., 1996
Spring	W	LGRTAL	*3,858*	4/9/95-4/15/95	*0.945*	*0.034*	Muir et al., 1996
Spring	W	LGRTAL	*9,555*	4/16/95-4/22/95	*0.990*	*0.037*	Muir et al., 1996
Spring	W	LGRTAL	*5,154*	4/23/95-4/29/95	*0.951*	*0.032*	Muir et al., 1996
Spring	W	LGRTAL	*5,200*	4/30/95-5/6/95	*0.879*	*0.020*	Muir et al., 1996
Spring	H	LGRTAL	*18,578*	5/7/95-5/13/95	*0.922*	*0.015*	Muir et al., 1996
Spring	H	LGRTAL	*4,176*	5/14/95-5/20/95	*0.967*	*0.045*	Muir et al., 1996
Spring	H	LGRTAL	*1,377*	5/21/95-5/27/95	*0.866*	*0.076*	Muir et al., 1996

Table A.I.3 (Cont.)

Run	Rear	Site	Release Numbers	Date	$\hat{S}_{\text{LGS-LMN}}$	*SE*	Reference
Spring	H	LGRTAL	*1,234*	5/28/95-6/3/95	*0.848*	*0.088*	Muir et al., 1996
Spring	W	LGRTAL	*2,857*	5/7/95-5/13/95	*0.952*	*0.031*	Muir et al., 1996
Spring	W	LGRTAL	*1,033*	5/14/95-5/20/95	*0.835*	*0.059*	Muir et al., 1996
Spring	W	LGRTAL	*677*	5/21/95-5/27/95	*0.889*	*0.070*	Muir et al., 1996
Spring	W	LGRTAL	*920*	5/28/95-6/3/95	*0.838*	*0.048*	Muir et al., 1996
Spring	H	LGRTAL	*1,004*	6/4/95-6/10/95	*0.916*	*0.051*	Muir et al., 1996
Spring	H	LGRTAL	*250*	6/11/95-6/17/95	*0.863*	*0.156*	Muir et al., 1996
Spring	H	LGRTAL	*251*	6/18/95-6/24/95	*0.790*	*0.091*	Muir et al., 1996
Spring	H	LGRTAL	*108*	6/25/95-7/1/95	*0.873*	*0.221*	Muir et al., 1996
Spring	W	LGRTAL	*1,222*	6/4/95-6/10/95	*0.875*	*0.030*	Muir et al., 1996
Spring	W	LGRTAL	*494*	6/11/95-6/17/95	*0.792*	*0.051*	Muir et al., 1996
Spring	W	LGRTAL	*571*	6/18/95-6/24/95	*0.808*	*0.040*	Muir et al., 1996
Spring	W	LGRTAL	*242*	6/25/95-7/1/95	*0.772*	*0.082*	Muir et al., 1996
Spring	H	LGRTAL	*347*	4/9/96-4/15/96	*1.000*	*0.292*	Smith et al., 1998
Spring	H	LGRTAL	*4,045*	4/16/96-4/22/96	*0.975*	*0.052*	Smith et al., 1998
Spring	H	LGRTAL	*9,017*	4/23/96-4/29/96	*0.910*	*0.026*	Smith et al., 1998
Spring	H	LGRTAL	*12,464*	4/30/96-5/6/96	*0.956*	*0.026*	Smith et al., 1998
Spring	W	LGRTAL	*291*	4/9/96-4/15/96	*0.681*	*0.091*	Smith et al., 1998
Spring	W	LGRTAL	*5,728*	4/16/96-4/22/96	*0.961*	*0.038*	Smith et al., 1998
Spring	W	LGRTAL	*4,263*	4/23/96-4/29/96	*0.867*	*0.040*	Smith et al., 1998
Spring	W	LGRTAL	*1,205*	4/30/96-5/6/96	*0.831*	*0.067*	Smith et al., 1998
Spring	H	LGRTAL	*15,907*	5/7/96-5/13/96	*0.979*	*0.034*	Smith et al., 1998
Spring	H	LGRTAL	*10,418*	5/17/96-5/20/96	*0.916*	*0.049*	Smith et al., 1998
Spring	H	LGRTAL	*655*	5/21/96-5/27/96	*1.000*	*0.452*	Smith et al., 1998
Spring	H	LGRTAL	*618*	5/28/96-6/3/96	*0.436*	*0.165*	Smith et al., 1998
Spring	W	LGRTAL	*1,257*	5/7/96-5/13/96	*1.000*	*0.116*	Smith et al., 1998
Spring	W	LGRTAL	*1,124*	5/17/96-5/20/96	*0.742*	*0.090*	Smith et al., 1998
Spring	W	LGRTAL	*150*	5/21/96-5/27/96	*0.755*	*0.305*	Smith et al., 1998
Spring	U	LGRTAL	*201*	4/6/97-4/12/97	*1.000*	*0.162*	Hockersmith et al., 1999
Spring	U	LGRTAL	*539*	4/13/97-4/19/97	*1.000*	*0.273*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*1,277*	4/20/97-4/26/97	*0.856*	*0.071*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*1,714*	4/27/97-5/3/97	*0.818*	*0.062*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*1,340*	5/4/97-5/10/97	*0.977*	*0.142*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*1,822*	5/11/97-5/17/97	*0.952*	*0.166*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*533*	5/18/97-5/24/97	*0.997*	*0.219*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*162*	5/25/97-5/31/97	*0.892*	*0.399*	Hockersmith et al., 1999

Table A.I.3 (Cont.)

Run	Rear	Site	Release Numbers	Date	$\hat{S}_{\text{LGS-LMN}}$	*SE*	Reference
Spring	H	LGRTAL	*6,821*	4/6/98-4/12/98	*0.783*	*0.023*	Smith et al., 2000
Spring	H	LGRTAL	*16,147*	4/13/98-4/19/98	*0.779*	*0.014*	Smith et al., 2000
Spring	H	LGRTAL	*22,820*	4/20/98-4/26/98	*0.894*	*0.014*	Smith et al., 2000
Spring	H	LGRTAL	*17,400*	4/27/98-5/3/98	*0.858*	*0.014*	Smith et al., 2000
Spring	W	LGRTAL	*2,697*	4/6/98-4/12/98	*0.847*	*0.034*	Smith et al., 2000
Spring	W	LGRTAL	*3,263*	4/13/98-4/19/98	*0.768*	*0.027*	Smith et al., 2000
Spring	W	LGRTAL	*3,615*	4/20/98-4/26/98	*0.935*	*0.033*	Smith et al., 2000
Spring	W	LGRTAL	*2,564*	4/27/98-5/3/98	*0.836*	*0.028*	Smith et al., 2000
Spring	H	LGRTAL	*13,424*	5/4/98-5/10/98	*0.879*	*0.012*	Smith et al., 2000
Spring	H	LGRTAL	*4,029*	5/11/98-5/17/98	*0.878*	*0.030*	Smith et al., 2000
Spring	H	LGRTAL	*880*	5/18/98-5/24/98	*0.858*	*0.119*	Smith et al., 2000
Spring	H	LGRTAL	*167*	5/25/98-5/31/98	*0.661*	*0.166*	Smith et al., 2000
Spring	W	LGRTAL	*2,233*	5/4/98-5/10/98	*0.842*	*0.025*	Smith et al., 2000
Spring	W	LGRTAL	*909*	5/11/98-5/17/98	*0.792*	*0.048*	Smith et al., 2000
Spring	W	LGRTAL	*538*	5/18/98-5/24/98	*0.830*	*0.101*	Smith et al., 2000
Spring	W	LGRTAL	*321*	5/25/98-5/31/98	*0.783*	*0.114*	Smith et al., 2000
Spring	H	LGRTAL	*51*	6/1/98-6/7/98	*0.700*	*0.385*	Smith et al., 2000
Spring	H	LGRTAL	*43*	6/8/98-6/14/98	*1.000*	*0.380*	Smith et al., 2000
Spring	W	LGRTAL	*71*	6/1/98-6/7/98	*1.000*	*0.428*	Smith et al., 2000
Spring	W	LGRTAL	*71*	6/8/98-6/14/98	*1.000*	*0.497*	Smith et al., 2000
Spring	H	LGS	*16,696*	4/27/94 - 5/10/94	*0.774*	*0.007*	Table A.IV.1, this report
Spring	H	LOOH	*1,993*	4/10/94	*0.989*	*0.057*	Muir et al., 1995
Spring	H	LOOH	*1,983*	4/6/95	*0.913*	*0.055*	Muir et al., 1996
Spring	H	LOOH	*7,154*	4/4/96	*0.939*	*0.042*	Smith et al., 1998
Spring	H	LOOH	*40,042*	4/7/97	*0.833*	*0.022*	Hockersmith et al., 1999
Spring	H	LOOH	*40,401*	4/7/97	*0.837*	*0.021*	Perez-Comas & Skalski, 2000
Spring	H	LOOH	*43,939*	4/6/98	*0.826*	*0.014*	Smith et al., 2000
Spring	H	LOOH	*45,122*	4/6/98	*0.829*	*0.014*	Perez-Comas & Skalski, 2000
Spring	W	MARTRP	*1,325*	8/19/94 - 11/2/94	*0.891*	*0.059*	Table A.IV.1, this report
Spring	H	MCCA	*52,687*	3/20/97	*0.887*	*0.035*	Hockersmith et al., 1999
Spring	H	MCCA	*47,460*	4/?/98	*0.847*	*0.012*	Smith et al., 2000
Spring	H	PAHP	*997*	4/12/94	*0.758*	*0.148*	Muir et al., 1995
Spring	H	PAHP	*493*	4/12/95	*0.682*	*0.138*	Muir et al., 1996
Spring	H	PAHP	*33,479*	4/7/97	*0.862*	*0.033*	Hockersmith et al., 1999
Spring	H	PAHP	*33,326*	4/7/97	*0.876*	*0.032*	Perez-Comas & Skalski, 2000
Spring	H	PAHP	*993*	4/4/98	*0.839*	*0.117*	Smith et al., 2000

Table A.I.3 (Cont.)

Run	Rear	Site	Release Numbers	Date	$\hat{S}_{\text{LGS-LMN}}$	*SE*	Reference
Spring	H	POWP	*1,016*	4/13/94 - 4/14/94	*0.849*	*0.086*	Table A.IV.1, this report
Spring	H	POWP	*9,285*	4/11/96	*0.981*	*0.071*	Smith et al., 1998
Spring	H	RAPH	*1,498*	4/12/94	*0.644*	*0.103*	Muir et al., 1995
Spring	H	RAPH	*1,497*	4/12/94	*0.787*	*0.172*	Muir et al., 1995
Spring	H	RAPH	*999*	3/31/95	*0.896*	*0.062*	Muir et al., 1996
Spring	H	RAPH	*990*	3/31/95	*0.806*	*0.057*	Muir et al., 1996
Spring	H	RAPH	*17,181*	3/19/96	*0.914*	*0.030*	Smith et al., 1998
Spring	H	RAPH	*2,003*	4/2/96-4/5/96	*0.974*	*0.107*	Smith et al., 1998
Spring	H	RAPH	*40,493*	4/1/97	*0.804*	*0.030*	Hockersmith et al., 1999
Spring	H	RAPH	*48,192*	4/13/98	*0.850*	*0.011*	Smith et al., 2000
Spring	H	RAPH	*48,348*	4/13/98	*0.853*	*0.011*	Perez-Comas & Skalski, 2000
Spring	H	REDP	*1,211*	4/10/96	*1.000*	*0.488*	Smith et al., 1998
Spring	H	SALTRP	*1,289*	3/27/95-3/28/95	*0.699*	*0.162*	Muir et al., 1996
Spring	W	SALTRP	*1,643*	3/27/95-3/28/95	*0.965*	*0.038*	Muir et al., 1996
Spring	H	SALTRP	*2,186*	4/10/95-3/5/95	*0.904*	*0.043*	Muir et al., 1996
Spring	H	SALTRP	*1,257*	3/26/96	*0.738*	*0.244*	Smith et al., 1998
Spring	H	SALTRP	*198*	3/18/96-3/24/96	*1.000*	*0.274*	Smith et al., 1998
Spring	H	SALTRP	*300*	3/25/96-3/31/96	*1.000*	*0.301*	Smith et al., 1998
Spring	H	SALTRP	*1,674*	4/5/96-5/15/96	*0.996*	*0.121*	Smith et al., 1998
Spring	W	SALTRP	*791*	4/5/96-5/15/96	*0.989*	*0.122*	Smith et al., 1998
Spring	H	SALTRP	*670*	4/1/96-4/7/96	*0.995*	*0.161*	Smith et al., 1998
Spring	H	SALTRP	*199*	4/8/96-4/14/96	*0.727*	*0.156*	Smith et al., 1998
Spring	H	SALTRP	*452*	4/15/96-4/21/96	*1.000*	*0.395*	Smith et al., 1998
Spring	H	SALTRP	*419*	4/22/96-4/28/96	*1.000*	*0.292*	Smith et al., 1998
Spring	H	SALTRP	*137*	4/29/96-5/5/96	*0.490*	*0.188*	Smith et al., 1998
Spring	H	SALTRP	*128*	5/6/96-5/12/96	*1.000*	*0.657*	Smith et al., 1998
Spring	H	SALTRP	*50*	5/13/96-5/19/96	*0.885*	*0.656*	Smith et al., 1998
Spring	H	SALTRP	*3,025*	3/17/98-5/5/98	*0.917*	*0.041*	Smith et al., 2000
Spring	W	SALTRP	*1,416*	3/17/98-5/1/98	*0.813*	*0.047*	Smith et al., 2000
Spring	H	SAWT	*2,155*	4/8/94-4/11/94	*0.689*	*0.100*	Muir et al., 1995
Spring	H	SAWT	*1,499*	4/5/95-4/7/95	*1.000*	*0.105*	Muir et al., 1996
Spring	H	SAWT	*499*	4/21/98	*0.875*	*0.099*	Smith et al., 2000
Spring	H	SNAKER	*2,510*	4/16/93 - 4/17/93	*1.000*	*0.414*	Table A.IV.1, this report
Spring	H	SNAKER	*2,481*	4/16/94 - 4/17/94	*0.759*	*0.031*	Table A.IV.1, this report
Spring	H	SNAKER_1	*581*	4/5/96-4/12/96	*1.000*	*0.177*	Smith et al., 1998
Spring	H	SNAKER_1	*534*	4/15/96-4/18/96	*0.824*	*0.126*	Smith et al., 1998

Table A.I.3 (Cont.)

Run	Rear	Site	Release Numbers	Date	$\hat{S}_{LGS-LMN}$	SE	Reference
Spring	H	$SNAKER_1$	*335*	4/23/96-4/24/96	*0.759*	*0.181*	Smith et al., 1998
Spring	H	$SNAKER_1$	*369*	4/29/96-5/2/96	*0.896*	*0.255*	Smith et al., 1998
Spring	H	$SNAKER_1$	*178*	5/6/96-5/9/96	*0.907*	*0.314*	Smith et al., 1998
Spring	H	$SNAKER_1$	*307*	5/13/96-5/15/96	*1.000*	*0.576*	Smith et al., 1998
Spring	H	$SNAKER_2$	*1,258*	4/9/95	*0.974*	*0.072*	Muir et al., 1996
Spring	H	$SNAKER_2$	*784*	4/11/95	*0.954*	*0.083*	Muir et al., 1996
Spring	H	$SNAKER_2$	*1,218*	4/15/95	*1.000*	*0.089*	Muir et al., 1996
Spring	H	$SNAKER_2$	*579*	4/18/95	*0.899*	*0.099*	Muir et al., 1996
Spring	H	$SNAKER_2$	*701*	4/20/95	*0.899*	*0.074*	Muir et al., 1996
Spring	H	$SNAKER_2$	*1,529*	4/23/95	*0.905*	*0.053*	Muir et al., 1996
Spring	H	$SNAKER_2$	*1,615*	4/25/95	*0.895*	*0.053*	Muir et al., 1996
Spring	H	$SNAKER_2$	*2,049*	4/27/95	*1.000*	*0.069*	Muir et al., 1996
Spring	H	$SNAKER_2$	*1,505*	4/29/95	*0.980*	*0.069*	Muir et al., 1996
Spring	H	$SNAKER_2$	*2,098*	5/1/95	*0.911*	*0.062*	Muir et al., 1996
Spring	H	$SNAKER_2$	*544*	5/3/95	*0.878*	*0.117*	Muir et al., 1996
Spring	H	$SNAKER_2$	*142*	5/5/95	*0.916*	*0.179*	Muir et al., 1996
Spring	H	$SNAKER_3$	*1,189*	4/16/94	*0.874*	*0.045*	Muir et al., 1995
Spring	H	$SNAKER_3$	*1,196*	4/17/94	*0.950*	*0.049*	Muir et al., 1995
Spring	H	$SNAKER_3$	*1,194*	4/18/94	*0.876*	*0.053*	Muir et al., 1995
Spring	H	$SNAKER_3$	*1,190*	4/21/94	*1.000*	*0.076*	Muir et al., 1995
Spring	H	$SNAKER_3$	*776*	4/23/94	*0.816*	*0.103*	Muir et al., 1995
Spring	H	$SNAKER_3$	*1,032*	4/26/94	*0.744*	*0.095*	Muir et al., 1995
Spring	H	$SNAKER_3$	*643*	4/29/94	*0.919*	*0.131*	Muir et al., 1995
Spring	H	$SNAKER_3$	*1,069*	5/1/94	*0.777*	*0.098*	Muir et al., 1995
Spring	H	$SNAKER_3$	*542*	5/4/94	*1.000*	*0.199*	Muir et al., 1995
Spring	H	$SNAKER_3$	*1,048*	5/10/94	*0.839*	*0.148*	Muir et al., 1995
Spring	H	SNKTRP	*2,343*	4/9/95-3/5/95	*0.885*	*0.039*	Muir et al., 1996
Spring	W	SNKTRP	*1,122*	4/9/95-3/5/95	*0.945*	*0.057*	Muir et al., 1996
Spring	H	SNKTRP	*1,376*	4/8/96-5/15/96	*0.784*	*0.079*	Smith et al., 1998
Spring	W	SNKTRP	*787*	4/5/96-5/15/96	*1.000*	*0.122*	Smith et al., 1998
Spring	H	SNKTRP	*131*	4/8/96-4/14/96	*0.798*	*0.183*	Smith et al., 1998
Spring	H	SNKTRP	*445*	4/15/96-4/21/96	*0.959*	*0.174*	Smith et al., 1998
Spring	H	SNKTRP	*325*	4/22/96-4/28/96	*0.756*	*0.124*	Smith et al., 1998
Spring	H	SNKTRP	*80*	4/29/96-5/5/96	*0.426*	*0.155*	Smith et al., 1998
Spring	H	SNKTRP	*48*	5/6/96-5/12/96	*0.600*	*0.359*	Smith et al., 1998
Spring	H	SNKTRP	*422*	5/13/96-5/19/96	*0.857*	*0.313*	Smith et al., 1998
Spring	H	SNKTRP	*2,303*	3/25/98-5/23/98	*0.855*	*0.037*	Smith et al., 2000
Spring	W	SNKTRP	*961*	3/25/98-5/23/98	*0.869*	*0.057*	Smith et al., 2000

Table A.I.4: Survival estimates and standard errors for PIT-tagged juvenile chinook releases in the LMN-McN reach. H indicates hatchery releases and W, wild releases.

Run	Rear	Site	Release Numbers	Date	$\hat{S}_{\text{LMN-McN}}$	*SE*	Reference
Spring	W	CATHEC	*1,025*	9/12/94 - 12/1/94	*0.731*	*0.516*	Table A.IV.1, this report
Spring	H	CLWH	*2,010*	4/8/98	*1.000*	*0.151*	Smith et al., 2000
Spring	H	CLWH	*499*	4/8/98	*0.895*	*0.184*	Smith et al., 2000
Spring	H	CLWH	*500*	4/8/98	*0.820*	*0.200*	Smith et al., 2000
Spring	H	CLWH	*500*	4/13/98	*0.723*	*0.160*	Smith et al., 2000
Spring	H	CLWH	*300*	4/22/98	*0.883*	*0.174*	Smith et al., 2000
Fall	H	CLWR	*7,453*	4/13/98-4/16/98	*0.785*	*0.062*	Table A.II.1, this report
Spring	H	CLWRNF	*48,575*	3/25/98-3/26/98	*0.937*	*0.023*	Perez-Comas & Skalski, 2000
Spring	H	DWOR	*20,133*	4/8/94 - 5/6/94	*1.000*	*0.399*	Table A.IV.1, this report
Spring	H	DWOR	*14,080*	4/7/97	*0.655*	*0.109*	Hockersmith et al., 1999
Spring	H	DWOR	*47,704*	3/25/98-3/26/98	*0.928*	*0.023*	Smith et al., 2000
Spring	W	IMNAHR	*3,956*	2/27/98-6/16/98	*0.982*	*0.064*	Smith et al., 2000
Spring	H	IMNAHR	*2,000*	4/7/98-4/23/98	*0.809*	*0.079*	Smith et al., 2000
Spring	H	IMNAHW	*13,378*	4/7/97	*0.986*	*0.200*	Hockersmith et al., 1999
Spring	H	IMNAHW	*19,169*	4/6/98	*0.937*	*0.038*	Smith et al., 2000
Spring	H	IMNAHW	*19,174*	4/6/98	*0.948*	*0.037*	Perez-Comas & Skalski, 2000
Spring	H	KNOXB	*52,734*	3/20/97	*0.946*	*0.102*	Perez-Comas & Skalski, 2000
Spring	H	KNOXB	*47,474*	3/30/98	*0.966*	*0.030*	Perez-Comas & Skalski, 2000
Spring	H	KOOS	*4,075*	4/8/97	*0.630*	*0.207*	Hockersmith et al., 1999
Spring	H	KOOS	*1,001*	4/1/98	*1.000*	*0.205*	Smith et al., 2000
Spring	W	LEMHIW	*1,290*	9/5/94 - 11/15/94	*1.000*	*1.200*	Table A.IV.1, this report
Spring	H	LGR	*16,322*	4/21/94 - 4/30/94	*1.000*	*1.185*	Table A.IV.1, this report
	H+W	LGRRRR	*52,194*	4/7/98-4/30/98	*0.979*	*0.029*	Table A.II.1, this report
	H+W	LGRRRR	*17,490*	5/1/98-5/31/98	*0.927*	*0.015*	Table A.II.1, this report
Spring	H	LGRTAL	*1,871*	4/9/95-4/15/95	*0.802*	*0.223*	Muir et al., 1996
Spring	H	LGRTAL	*14,461*	4/16/95-4/22/95	*0.754*	*0.091*	Muir et al., 1996
Spring	H	LGRTAL	*24,378*	4/23/95-4/29/95	*0.787*	*0.079*	Muir et al., 1996
Spring	H	LGRTAL	*36,608*	4/30/95-5/6/95	*0.893*	*0.060*	Muir et al., 1996
Spring	W	LGRTAL	*3,858*	4/9/95-4/15/95	*1.000*	*0.195*	Muir et al., 1996
Spring	W	LGRTAL	*9,555*	4/16/95-4/22/95	*0.769*	*0.079*	Muir et al., 1996
Spring	W	LGRTAL	*5,154*	4/23/95-4/29/95	*0.857*	*0.187*	Muir et al., 1996
Spring	W	LGRTAL	*5,200*	4/30/95-5/6/95	*0.879*	*0.129*	Muir et al., 1996
Spring	H	LGRTAL	*18,578*	5/7/95-5/13/95	*1.000*	*0.166*	Muir et al., 1996
Spring	W	LGRTAL	*2,857*	5/7/95-5/13/95	*0.920*	*0.230*	Muir et al., 1996
Spring	H	LGRTAL	*4,045*	4/16/96-4/22/96	*0.643*	*0.114*	Smith et al., 1998
Spring	H	LGRTAL	*9,017*	4/23/96-4/29/96	*0.786*	*0.062*	Smith et al., 1998

Table A.I.4 (Cont.)

Run	Rear	Site	Release Numbers	Date	$\hat{S}_{\text{LMN}-\text{McN}}$	*SE*	Reference
Spring	H	LGRTAL	*12,464*	4/30/96-5/6/96	*0.728*	*0.060*	Smith et al., 1998
Spring	W	LGRTAL	*5,728*	4/16/96-4/22/96	*0.758*	*0.127*	Smith et al., 1998
Spring	W	LGRTAL	*4,263*	4/23/96-4/29/96	*0.582*	*0.077*	Smith et al., 1998
Spring	W	LGRTAL	*1,205*	4/30/96-5/6/96	*0.618*	*0.145*	Smith et al., 1998
Spring	H	LGRTAL	*15,907*	5/7/96-5/13/96	*0.881*	*0.110*	Smith et al., 1998
Spring	H	LGRTAL	*10,418*	5/17/96-5/20/96	*0.697*	*0.132*	Smith et al., 1998
Spring	W	LGRTAL	*1,257*	5/7/96-5/13/96	*0.868*	*0.337*	Smith et al., 1998
Spring	W	LGRTAL	*1,124*	5/17/96-5/20/96	*0.840*	*0.388*	Smith et al., 1998
Spring	H+W	LGRTAL	*201*	4/6/97-4/12/97	*0.911*	*0.554*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*539*	4/13/97-4/19/97	*0.532*	*0.297*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*1,277*	4/20/97-4/26/97	*1.000*	*0.357*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*1,714*	4/27/97-5/3/97	*0.789*	*0.206*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*1,340*	5/4/97-5/10/97	*0.481*	*0.173*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*1,822*	5/11/97-5/17/97	*0.703*	*0.290*	Hockersmith et al., 1999
Spring	H	LGRTAL	*6,821*	4/6/98-4/12/98	*0.882*	*0.031*	Smith et al., 2000
Spring	H	LGRTAL	*16,147*	4/13/98-4/19/98	*0.894*	*0.024*	Smith et al., 2000
Spring	H	LGRTAL	*22,820*	4/20/98-4/26/98	*0.891*	*0.024*	Smith et al., 2000
Spring	H	LGRTAL	*17,400*	4/27/98-5/3/98	*0.938*	*0.035*	Smith et al., 2000
Spring	W	LGRTAL	*2,697*	4/6/98-4/12/98	*0.896*	*0.049*	Smith et al., 2000
Spring	W	LGRTAL	*3,263*	4/13/98-4/19/98	*0.964*	*0.052*	Smith et al., 2000
Spring	W	LGRTAL	*3,615*	4/20/98-4/26/98	*0.817*	*0.050*	Smith et al., 2000
Spring	W	LGRTAL	*2,564*	4/27/98-5/3/98	*1.000*	*0.105*	Smith et al., 2000
Spring	H	LGRTAL	*13,424*	5/4/98-5/10/98	*0.957*	*0.031*	Smith et al., 2000
Spring	H	LGRTAL	*4,029*	5/11/98-5/17/98	*0.939*	*0.084*	Smith et al., 2000
Spring	H	LGRTAL	*880*	5/18/98-5/24/98	*1.000*	*0.346*	Smith et al., 2000
Spring	H	LGRTAL	*167*	5/25/98-5/31/98	*0.895*	*0.383*	Smith et al., 2000
Spring	W	LGRTAL	*2,233*	5/4/98-5/10/98	*0.962*	*0.069*	Smith et al., 2000
Spring	W	LGRTAL	*909*	5/11/98-5/17/98	*0.967*	*0.157*	Smith et al., 2000
Spring	W	LGRTAL	*538*	5/18/98-5/24/98	*0.864*	*0.197*	Smith et al., 2000
Spring	W	LGRTAL	*321*	5/25/98-5/31/98	*0.831*	*0.202*	Smith et al., 2000
Spring	H	LGRTAL	*51*	6/1/98-6/7/98	*0.571*	*0.414*	Smith et al., 2000
Spring	W	LGRTAL	*71*	6/1/98-6/7/98	*0.873*	*0.562*	Smith et al., 2000
Spring	H	LGS	*16,696*	4/27/94 - 5/10/94	*0.500*	*0.007*	Table A.IV.1, this report
Spring	H	LMN	*20,183*	5/4/94 - 5/17/94	*0.645*	*0.181*	Table A.IV.1, this report
Spring	H	LOOH	*40,042*	4/7/97	*0.839*	*0.069*	Hockersmith et al., 1999
Spring	H	LOOH	*40,401*	4/7/97	*0.816*	*0.057*	Perez-Comas & Skalski, 2000

Table A.I.4 (Cont.)

Run	Rear	Site	Release Numbers	Date	$\hat{S}_{\text{LMN-McN}}$	*SE*	Reference
Spring	H	LOOH	*43,939*	4/6/98	*0.860*	*0.029*	Smith et al., 2000
Spring	H	LOOH	*45,122*	4/6/98	*0.882*	*0.029*	Perez-Comas & Skalski, 2000
Spring	W	MARTRP	*1,325*	8/19/94 - 11/2/94	*1.000*	*0.901*	Table A.IV.1, this report
Spring	H	MCCA	*52,687*	3/20/97	*0.895*	*0.110*	Hockersmith et al., 1999
Spring	H	MCCA	*47,460*	4/?/98	*0.945*	*0.031*	Smith et al., 2000
Spring	H	PAHP	*33,479*	4/7/97	*1.000*	*0.146*	Hockersmith et al., 1999
Spring	H	PAHP	*33,326*	4/7/97	*1.000*	*0.132*	Perez-Comas & Skalski, 2000
Spring	H	PAHP	*993*	4/4/98	*0.765*	*0.215*	Smith et al., 2000
Spring	H	POWP	*1,016*	4/13/94 - 4/14/94	*0.620*	*0.182*	Table A.IV.1, this report
Spring	H	RAPH	*40,493*	4/1/97	*1.000*	*0.135*	Hockersmith et al., 1999
Spring	H	RAPH	*48,192*	4/13/98	*0.979*	*0.030*	Smith et al., 2000
Spring	H	RAPH	*48,348*	4/13/98	*0.977*	*0.029*	Perez-Comas & Skalski, 2000
Spring	H	SALTRP	*3,025*	3/17/98-5/5/98	*0.951*	*0.094*	Smith et al., 2000
Spring	W	SALTRP	*1,416*	3/17/98-5/1/98	*0.963*	*0.100*	Smith et al., 2000
Spring	H	SAWT	*499*	4/21/98	*1.000*	*0.273*	Smith et al., 2000
Spring	H	SNAKER	*2,510*	4/16/93 - 4/17/93	*0.148*	*0.104*	Table A.IV.1, this report
Spring	H	SNAKER	*2,481*	4/16/94 - 4/17/94	*1.000*	*1.305*	Table A.IV.1, this report
Spring	H	SNKTRP	*2,303*	3/25/98-5/23/98	*0.944*	*0.090*	Smith et al., 2000
Spring	W	SNKTRP	*961*	3/25/98-5/23/98	*1.000*	*0.207*	Smith et al., 2000

Table A.I.5: Detection probability estimates and standard errors for PIT-tagged juvenile chinook releases at LGR. H indicates hatchery releases and W, wild releases.

Run	Rear	Site	Release Numbers	Date	$\hat{P}_{LGR}$	*SE*	Reference
Spring	W	CATHEC	*1,025*	9/12/94 - 12/1/94	*0.491*	*0.029*	Table A.IV.1, this report
Spring	H	CLWH	*2,010*	4/8/98	*0.479*	*0.010*	Smith et al., 2000
Spring	H	CLWH	*499*	4/8/98	*0.463*	*0.033*	Smith et al., 2000
Spring	H	CLWH	*500*	4/8/98	*0.515*	*0.031*	Smith et al., 2000
Spring	H	CLWH	*500*	4/13/98	*0.462*	*0.031*	Smith et al., 2000
Spring	H	CLWH	*300*	4/22/98	*0.368*	*0.037*	Smith et al., 2000
Fall	H	CLWR	*7,453*	4/13/98-4/16/98	*0.420*	*0.009*	Table A.II.1, this report
Spring	H	CLWRNF	*48,575*	3/25/98-3/26/98	*0.397*	*0.004*	Perez-Comas & Skalski, 2000
Spring	H	DWOR	*1,467*	4/8/93	*0.438*	*0.023*	Iwamoto et al., 1994
Spring	H	DWOR	*1,460*	4/22/93	*0.476*	*0.024*	Iwamoto et al., 1994
Spring	H	DWOR	*1,445*	5/6/93	*0.334*	*0.028*	Iwamoto et al., 1994
Spring	H	DWOR	*20,133*	4/8/94 - 5/6/94	*0.279*	*0.005*	Table A.IV.1, this report
Spring	H	DWOR	*14,080*	4/7/97	*0.290*	*0.010*	Hockersmith et al., 1999
Spring	H	DWOR	*47,704*	3/25/98-3/26/98	*0.383*	*0.004*	Smith et al., 2000
Spring	H	IMNAHR	*1,991*	4/12/93	*0.432*	*0.020*	Iwamoto et al., 1994
Spring	H	IMNAHW	*13,378*	4/7/97	*0.318*	*0.010*	Hockersmith et al., 1999
Spring	H	IMNAHW	*19,174*	4/6/98	*0.447*	*0.006*	Perez-Comas & Skalski, 2000
Spring	H	IMNAHW	*19,169*	4/6/98	*0.446*	*0.006*	Smith et al., 2000
Spring	H	KNOXB	*2,993*	4/3/93	*0.457*	*0.018*	Iwamoto et al., 1994
Spring	H	KNOXB	*1,501*	4/9/93-5/5/93	*0.403*	*0.024*	Iwamoto et al., 1994
Spring	H	KNOXB	*52,734*	3/20/97	*0.336*	*0.007*	Perez-Comas & Skalski, 2000
Spring	H	KNOXB	*47,474*	3/30/98	*0.470*	*0.004*	Perez-Comas & Skalski, 2000
Spring	H	KOOS	*1,171*	4/19/93	*0.436*	*0.032*	Iwamoto et al., 1994
Spring	H	KOOS	*4,075*	4/8/97	*0.265*	*0.022*	Hockersmith et al., 1999
Spring	H	KOOS	*1,001*	4/1/98	*0.437*	*0.023*	Smith et al., 2000
Spring	W	LEMHIW	*1,290*	9/5/94 - 11/15/94	*0.579*	*0.028*	Table A.IV.1, this report
Spring	H	LOOH	*999*	4/7/93	*0.492*	*0.023*	Iwamoto et al., 1994
Spring	H	LOOH	*40,401*	4/7/97	*0.320*	*0.006*	Perez-Comas & Skalski, 2000
Spring	H	LOOH	*40,042*	4/7/97	*0.318*	*0.006*	Hockersmith et al., 1999
Spring	H	LOOH	*45,122*	4/6/98	*0.493*	*0.004*	Perez-Comas & Skalski, 2000
Spring	H	LOOH	*43,939*	4/6/98	*0.487*	*0.004*	Smith et al., 2000
Spring	W	MARTRP	*1,325*	8/19/94 - 11/2/94	*0.543*	*0.020*	Table A.IV.1, this report
Spring	H	MCCA	*52,687*	3/20/97	*0.333*	*0.007*	Hockersmith et al., 1999
Spring	H	MCCA	*47,460*	4/?/98	*0.469*	*0.004*	Smith et al., 2000
Spring	H	PAHP	*33,326*	4/7/97	*0.385*	*0.007*	Perez-Comas & Skalski, 2000
Spring	H	PAHP	*33,479*	4/7/97	*0.380*	*0.007*	Hockersmith et al., 1999

Table A.I.5 (Cont.)

Run	Rear	Site	Release Numbers	Date	$\hat{P}_{LGR}$	*SE*	Reference
Spring	H	PAHP	*993*	4/4/98	*0.437*	*0.028*	Smith et al., 2000
Spring	H	POWP	*1,016*	4/13/94 - 4/14/94	*0.261*	*0.017*	Table A.IV.1, this report
Spring	H	RAPH	*2,985*	4/17/93	*0.494*	*0.015*	Iwamoto et al., 1994
Spring	H	RAPH	*40,493*	4/1/97	*0.340*	*0.007*	Hockersmith et al., 1999
Spring	H	RAPH	*48,348*	4/13/98	*0.511*	*0.004*	Perez-Comas & Skalski, 2000
Spring	H	RAPH	*48,192*	4/13/98	*0.508*	*0.004*	Smith et al., 2000
Spring	H	SAWT	*799*	4/20/93	*0.440*	*0.042*	Iwamoto et al., 1994
Spring	H	SAWT	*499*	4/21/98	*0.464*	*0.035*	Smith et al., 2000
Spring	H	SNAKER	*2,510*	4/16/93 - 4/17/93	*0.479*	*0.012*	Table A.IV.1, this report
Spring	H	SNAKER	*2,481*	4/16/94 - 4/17/94	*0.399*	*0.013*	Table A.IV.1, this report
Spring	H	$SNAKER_1$	*581*	4/5/96-4/12/96	*0.415*	*0.031*	Smith et al., 1998
Spring	H	$SNAKER_1$	*534*	4/15/96-4/18/96	*0.423*	*0.032*	Smith et al., 1998
Spring	H	$SNAKER_1$	*335*	4/23/96-4/24/96	*0.362*	*0.037*	Smith et al., 1998
Spring	H	$SNAKER_1$	*369*	4/29/96-5/2/96	*0.334*	*0.038*	Smith et al., 1998
Spring	H	$SNAKER_1$	*178*	5/6/96-5/9/96	*0.362*	*0.059*	Smith et al., 1998
Spring	H	$SNAKER_1$	*307*	5/13/96-5/15/96	*0.216*	*0.039*	Smith et al., 1998
Spring	H	$SNAKER_2$	*1,258*	4/9/95	*0.428*	*0.019*	Muir et al., 1996
Spring	H	$SNAKER_2$	*784*	4/11/95	*0.496*	*0.024*	Muir et al., 1996
Spring	H	$SNAKER_2$	*1,218*	4/15/95	*0.421*	*0.019*	Muir et al., 1996
Spring	H	$SNAKER_2$	*579*	4/18/95	*0.491*	*0.029*	Muir et al., 1996
Spring	H	$SNAKER_2$	*701*	4/20/95	*0.524*	*0.024*	Muir et al., 1996
Spring	H	$SNAKER_2$	*1,529*	4/23/95	*0.518*	*0.018*	Muir et al., 1996
Spring	H	$SNAKER_2$	*1,615*	4/25/95	*0.507*	*0.018*	Muir et al., 1996
Spring	H	$SNAKER_2$	*2,049*	4/27/95	*0.439*	*0.018*	Muir et al., 1996
Spring	H	$SNAKER_2$	*1,505*	4/29/95	*0.376*	*0.019*	Muir et al., 1996
Spring	H	$SNAKER_2$	*2,098*	5/1/95	*0.374*	*0.018*	Muir et al., 1996
Spring	H	$SNAKER_2$	*544*	5/3/95	*0.315*	*0.030*	Muir et al., 1996
Spring	H	$SNAKER_2$	*142*	5/5/95	*0.307*	*0.057*	Muir et al., 1996
Spring	H	$SNAKER_3$	*1,189*	4/16/94	*0.400*	*0.018*	Muir et al., 1995
Spring	H	$SNAKER_3$	*1,196*	4/17/94	*0.398*	*0.019*	Muir et al., 1995
Spring	H	$SNAKER_3$	*1,194*	4/18/94	*0.420*	*0.020*	Muir et al., 1995
Spring	H	$SNAKER_3$	*1,190*	4/21/94	*0.402*	*0.020*	Muir et al., 1995
Spring	H	$SNAKER_3$	*776*	4/23/94	*0.333*	*0.026*	Muir et al., 1995
Spring	H	$SNAKER_3$	*1,032*	4/26/94	*0.403*	*0.023*	Muir et al., 1995
Spring	H	$SNAKER_3$	*643*	4/29/94	*0.436*	*0.030*	Muir et al., 1995
Spring	H	$SNAKER_3$	*1,069*	5/1/94	*0.377*	*0.022*	Muir et al., 1995

Table A.I.5 (Cont.)

Run	Rear	Site	Release Numbers	Date	$\hat{P}_{LGR}$	*SE*	Reference
Spring	H	$SNAKER_3$	*542*	5/4/94	*0.307*	*0.032*	Muir et al., 1995
Spring	H	$SNAKER_3$	*1,048*	5/10/94	*0.128*	*0.017*	Muir et al., 1995
Spring	H	$SNAKER_4$	*1,015*	4/15/93	*0.458*	*0.020*	Iwamoto et al., 1994
Spring	H	$SNAKER_4$	*1,305*	4/16/93	*0.488*	*0.017*	Iwamoto et al., 1994
Spring	H	$SNAKER_4$	*1,152*	4/17/93	*0.475*	*0.019*	Iwamoto et al., 1994
Spring	H	$SNAKER_4$	*1,208*	4/18/93	*0.474*	*0.019*	Iwamoto et al., 1994
Spring	H	$SNAKER_4$	*1,113*	4/19/93	*0.532*	*0.020*	Iwamoto et al., 1994
Spring	H	$SNAKER_4$	*797*	4/20/93	*0.507*	*0.022*	Iwamoto et al., 1994
Spring	H	$SNAKER_4$	*1,405*	4/21/93	*0.531*	*0.018*	Iwamoto et al., 1994

Table A.I.6: Detection probability estimates and standard errors for PIT-tagged juvenile chinook releases at LGS. H indicates hatchery releases and W, wild releases.

Run	Rear	Site	Release Numbers	Date	$\hat{P}_{LGS}$	*SE*	Reference
Spring	W	CATHEC	*1,025*	9/12/94 - 12/1/94	*0.357*	*0.034*	Table A.IV.1, this report
Spring	H	CLWH	*2,010*	4/8/98	*0.419*	*0.018*	Smith et al., 2000
Spring	H	CLWH	*499*	4/8/98	*0.494*	*0.039*	Smith et al., 2000
Spring	H	CLWH	*500*	4/8/98	*0.460*	*0.037*	Smith et al., 2000
Spring	H	CLWH	*500*	4/13/98	*0.519*	*0.037*	Smith et al., 2000
Spring	H	CLWH	*300*	4/22/98	*0.450*	*0.047*	Smith et al., 2000
Fall	H	CLWR	*7,453*	4/13/98-4/16/98	*0.356*	*0.010*	Table A.II.1, this report
Spring	H	CLWRNF	*48,575*	3/25/98-3/26/98	*0.359*	*0.004*	Perez-Comas & Skalski, 2000
Spring	H	DWOR	*1,467*	4/8/93	*0.497*	*0.028*	Iwamoto et al., 1994
Spring	H	DWOR	*1,460*	4/22/93	*0.330*	*0.028*	Iwamoto et al., 1994
Spring	H	DWOR	*1,445*	5/6/93	*0.283*	*0.029*	Iwamoto et al., 1994
Spring	H	DWOR	*20,133*	4/8/94 - 5/6/94	*0.170*	*0.005*	Table A.IV.1, this report
Spring	H	DWOR	*14,080*	4/7/97	*0.361*	*0.010*	Hockersmith et al., 1999
Spring	H	DWOR	*47,704*	3/25/98-3/26/98	*0.358*	*0.004*	Smith et al., 2000
Spring	H	IMNAHR	*1,991*	4/12/93	*0.405*	*0.024*	Iwamoto et al., 1994
Spring	H	IMNAHW	*13,378*	4/7/97	*0.387*	*0.011*	Hockersmith et al., 1999
Spring	H	IMNAHW	*19,169*	4/6/98	*0.517*	*0.007*	Smith et al., 2000
Spring	H	IMNAHW	*19,174*	4/6/98	*0.518*	*0.007*	Perez-Comas & Skalski, 2000
Spring	H	KNOXB	*2,993*	4/3/93	*0.399*	*0.022*	Iwamoto et al., 1994
Spring	H	KNOXB	*1,501*	4/9/93-5/5/93	*0.468*	*0.029*	Iwamoto et al., 1994
Spring	H	KNOXB	*52,734*	3/20/97	*0.364*	*0.007*	Perez-Comas & Skalski, 2000
Spring	H	KNOXB	*47,474*	3/30/98	*0.487*	*0.005*	Perez-Comas & Skalski, 2000
Spring	H	KOOS	*1,171*	4/19/93	*0.299*	*0.034*	Iwamoto et al., 1994
Spring	H	KOOS	*4,075*	4/8/97	*0.264*	*0.022*	Hockersmith et al., 1999
Spring	H	KOOS	*1,001*	4/1/98	*0.457*	*0.028*	Smith et al., 2000
Spring	W	LEMHIW	*1,290*	9/5/94 - 11/15/94	*0.298*	*0.031*	Table A.IV.1, this report
Spring	H	LGR	*16,322*	4/21/94 - 4/30/94	*0.302*	*0.006*	Table A.IV.1, this report
	H+W	LGRRRR	*52,194*	4/7/98-4/30/98	*0.511*	*0.005*	Table A.II.1, this report
	H+W	LGRRRR	*17,490*	5/1/98-5/31/98	*0.392*	*0.003*	Table A.II.1, this report
Spring	H+W	LGRTAL	*201*	4/6/97-4/12/97	*0.488*	*0.051*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*539*	4/13/97-4/19/97	*0.450*	*0.035*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*1,277*	4/20/97-4/26/97	*0.376*	*0.021*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*1,714*	4/27/97-5/3/97	*0.409*	*0.018*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*1,340*	5/4/97-5/10/97	*0.359*	*0.023*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*1,822*	5/11/97-5/17/97	*0.321*	*0.023*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*533*	5/18/97-5/24/97	*0.340*	*0.035*	Hockersmith et al., 1999

Table A.I.6 (Cont.)

Run	Rear	Site	Release Numbers	Date	$\hat{P}_{LGS}$	*SE*	Reference
Spring	H+W	LGRTAL	*162*	5/25/97-5/31/97	*0.273*	*0.064*	Hockersmith et al., 1999
Spring	H	LGRTAL	*6,821*	4/6/98-4/12/98	*0.249*	*0.007*	Smith et al., 2000
Spring	H	LGRTAL	*16,147*	4/13/98-4/19/98	*0.340*	*0.005*	Smith et al., 2000
Spring	H	LGRTAL	*22,820*	4/20/98-4/26/98	*0.430*	*0.005*	Smith et al., 2000
Spring	H	LGRTAL	*17,400*	4/27/98-5/3/98	*0.519*	*0.005*	Smith et al., 2000
Spring	W	LGRTAL	*2,697*	4/6/98-4/12/98	*0.306*	*0.012*	Smith et al., 2000
Spring	W	LGRTAL	*3,263*	4/13/98-4/19/98	*0.390*	*0.012*	Smith et al., 2000
Spring	W	LGRTAL	*3,615*	4/20/98-4/26/98	*0.513*	*0.011*	Smith et al., 2000
Spring	W	LGRTAL	*2,564*	4/27/98-5/3/98	*0.614*	*0.013*	Smith et al., 2000
Spring	H	LGRTAL	*13,424*	5/4/98-5/10/98	*0.509*	*0.006*	Smith et al., 2000
Spring	H	LGRTAL	*4,029*	5/11/98-5/17/98	*0.511*	*0.011*	Smith et al., 2000
Spring	H	LGRTAL	*880*	5/18/98-5/24/98	*0.377*	*0.029*	Smith et al., 2000
Spring	H	LGRTAL	*167*	5/25/98-5/31/98	*0.198*	*0.047*	Smith et al., 2000
Spring	W	LGRTAL	*2,233*	5/4/98-5/10/98	*0.549*	*0.013*	Smith et al., 2000
Spring	W	LGRTAL	*909*	5/11/98-5/17/98	*0.544*	*0.022*	Smith et al., 2000
Spring	W	LGRTAL	*538*	5/18/98-5/24/98	*0.415*	*0.033*	Smith et al., 2000
Spring	W	LGRTAL	*321*	5/25/98-5/31/98	*0.259*	*0.036*	Smith et al., 2000
Spring	H	LGRTAL	*51*	6/1/98-6/7/98	*0.161*	*0.098*	Smith et al., 2000
Spring	H	LGRTAL	*43*	6/8/98-6/14/98	*0.364*	*0.103*	Smith et al., 2000
Spring	W	LGRTAL	*71*	6/1/98-6/7/98	*0.175*	*0.064*	Smith et al., 2000
Spring	W	LGRTAL	*71*	6/8/98-6/14/98	*0.308*	*0.074*	Smith et al., 2000
Spring	H	LOOH	*999*	4/7/93	*0.574*	*0.028*	Iwamoto et al., 1994
Spring	H	LOOH	*40,042*	4/7/97	*0.377*	*0.006*	Hockersmith et al., 1999
Spring	H	LOOH	*40,401*	4/7/97	*0.379*	*0.006*	Perez-Comas & Skalski, 2000
Spring	H	LOOH	*43,939*	4/6/98	*0.469*	*0.005*	Smith et al., 2000
Spring	H	LOOH	*45,122*	4/6/98	*0.470*	*0.005*	Perez-Comas & Skalski, 2000
Spring	W	MARTRP	*1,325*	8/19/94 - 11/2/94	*0.423*	*0.023*	Table A.IV.1, this report
Spring	H	MCCA	*52,687*	3/20/97	*0.363*	*0.007*	Hockersmith et al., 1999
Spring	H	MCCA	*47,460*	4/?/98	*0.485*	*0.005*	Smith et al., 2000
Spring	H	PAHP	*33,479*	4/7/97	*0.386*	*0.008*	Hockersmith et al., 1999
Spring	H	PAHP	*33,326*	4/7/97	*0.386*	*0.008*	Perez-Comas & Skalski, 2000
Spring	H	PAHP	*993*	4/4/98	*0.445*	*0.036*	Smith et al., 2000
Spring	H	POWP	*1,016*	4/13/94 - 4/14/94	*0.151*	*0.015*	Table A.IV.1, this report
Spring	H	RAPH	*2,985*	4/17/93	*0.355*	*0.019*	Iwamoto et al., 1994
Spring	H	RAPH	*40,493*	4/1/97	*0.365*	*0.008*	Hockersmith et al., 1999
Spring	H	RAPH	*48,192*	4/13/98	*0.487*	*0.005*	Smith et al., 2000
Spring	H	RAPH	*48,348*	4/13/98	*0.487*	*0.005*	Perez-Comas & Skalski, 2000
Spring	H	SAWT	*799*	4/20/93	*0.248*	*0.028*	Iwamoto et al., 1994

Table A.I.6 (Cont.)

Run	Rear	Site	Release Numbers	Date	$\hat{P}_{LGS}$	*SE*	Reference
Spring	H	SAWT	*499*	4/21/98	*0.398*	*0.039*	Smith et al., 2000
Spring	H	SNAKER	*2,510*	4/16/93 - 4/17/93	*0.513*	*0.015*	Table A.IV.1, this report
Spring	H	SNAKER	*2,481*	4/16/94 - 4/17/94	*0.304*	*0.014*	Table A.IV.1, this report
Spring	H	$SNAKER_1$	*581*	4/5/96-4/12/96	*0.327*	*0.035*	Smith et al., 1998
Spring	H	$SNAKER_1$	*534*	4/15/96-4/18/96	*0.342*	*0.037*	Smith et al., 1998
Spring	H	$SNAKER_1$	*335*	4/23/96-4/24/96	*0.255*	*0.042*	Smith et al., 1998
Spring	H	$SNAKER_1$	*369*	4/29/96-5/2/96	*0.243*	*0.043*	Smith et al., 1998
Spring	H	$SNAKER_1$	*178*	5/6/96-5/9/96	*0.252*	*0.063*	Smith et al., 1998
Spring	H	$SNAKER_1$	*307*	5/13/96-5/15/96	*0.248*	*0.048*	Smith et al., 1998
Spring	H	$SNAKER_2$	*1,258*	4/9/95	*0.360*	*0.022*	Muir et al., 1996
Spring	H	$SNAKER_2$	*784*	4/11/95	*0.317*	*0.026*	Muir et al., 1996
Spring	H	$SNAKER_2$	*1,218*	4/15/95	*0.323*	*0.021*	Muir et al., 1996
Spring	H	$SNAKER_2$	*579*	4/18/95	*0.305*	*0.031*	Muir et al., 1996
Spring	H	$SNAKER_2$	*701*	4/20/95	*0.374*	*0.028*	Muir et al., 1996
Spring	H	$SNAKER_2$	*1,529*	4/23/95	*0.380*	*0.020*	Muir et al., 1996
Spring	H	$SNAKER_2$	*1,615*	4/25/95	*0.406*	*0.021*	Muir et al., 1996
Spring	H	$SNAKER_2$	*2,049*	4/27/95	*0.386*	*0.021*	Muir et al., 1996
Spring	H	$SNAKER_2$	*1,505*	4/29/95	*0.388*	*0.023*	Muir et al., 1996
Spring	H	$SNAKER_2$	*2,098*	5/1/95	*0.344*	*0.021*	Muir et al., 1996
Spring	H	$SNAKER_2$	*544*	5/3/95	*0.271*	*0.033*	Muir et al., 1996
Spring	H	$SNAKER_2$	*142*	5/5/95	*0.395*	*0.069*	Muir et al., 1996
Spring	H	$SNAKER_3$	*1,189*	4/16/94	*0.368*	*0.020*	Muir et al., 1995
Spring	H	$SNAKER_3$	*1,196*	4/17/94	*0.320*	*0.020*	Muir et al., 1995
Spring	H	$SNAKER_3$	*1,194*	4/18/94	*0.259*	*0.019*	Muir et al., 1995
Spring	H	$SNAKER_3$	*1,190*	4/21/94	*0.241*	*0.019*	Muir et al., 1995
Spring	H	$SNAKER_3$	*776*	4/23/94	*0.170*	*0.023*	Muir et al., 1995
Spring	H	$SNAKER_3$	*1,032*	4/26/94	*0.138*	*0.018*	Muir et al., 1995
Spring	H	$SNAKER_3$	*643*	4/29/94	*0.192*	*0.026*	Muir et al., 1995
Spring	H	$SNAKER_3$	*1,069*	5/1/94	*0.152*	*0.019*	Muir et al., 1995
Spring	H	$SNAKER_3$	*542*	5/4/94	*0.134*	*0.026*	Muir et al., 1995
Spring	H	$SNAKER_3$	*1,048*	5/10/94	*0.151*	*0.020*	Muir et al., 1995
Spring	H	$SNAKER_4$	*1,015*	4/15/93	*0.520*	*0.025*	Iwamoto et al., 1994
Spring	H	$SNAKER_4$	*1,305*	4/16/93	*0.564*	*0.021*	Iwamoto et al., 1994
Spring	H	$SNAKER_4$	*1,152*	4/17/93	*0.557*	*0.022*	Iwamoto et al., 1994
Spring	H	$SNAKER_4$	*1,208*	4/18/93	*0.492*	*0.022*	Iwamoto et al., 1994
Spring	H	$SNAKER_4$	*1,113*	4/19/93	*0.465*	*0.024*	Iwamoto et al., 1994
Spring	H	$SNAKER_4$	*797*	4/20/93	*0.463*	*0.027*	Iwamoto et al., 1994
Spring	H	$SNAKER_4$	*1,405*	4/21/93	*0.449*	*0.022*	Iwamoto et al., 1994

Table A.I.7: Detection probability estimates and standard errors for PIT-tagged juvenile chinook releases at LMN. H indicates hatchery releases and W, wild releases.

Run	Rear	Site	Release Numbers	Date	$\hat{P}_{\text{LMN}}$	*SE*	Reference
Spring	W	CATHEC	*1,025*	9/12/94 - 12/1/94	*0.535*	*0.053*	Table A.IV.1, this report
Spring	H	CLWH	*2,010*	4/8/98	*0.430*	*0.025*	Smith et al., 2000
Spring	H	CLWH	*499*	4/8/98	*0.462*	*0.051*	Smith et al., 2000
Spring	H	CLWH	*500*	4/8/98	*0.425*	*0.051*	Smith et al., 2000
Spring	H	CLWH	*500*	4/13/98	*0.486*	*0.053*	Smith et al., 2000
Spring	H	CLWH	*300*	4/22/98	*0.578*	*0.059*	Smith et al., 2000
Fall	H	CLWR	*7,453*	4/13/98-4/16/98	*0.352*	*0.014*	Table A.II.1, this report
Spring	H	CLWRNF	*48,575*	3/25/98-3/26/98	*0.316*	*0.005*	Perez-Comas & Skalski, 2000
Spring	H	DWOR	*20,133*	4/8/94 - 5/6/94	*0.256*	*0.006*	Table A.IV.1, this report
Spring	H	DWOR	*14,080*	4/7/97	*0.317*	*0.018*	Hockersmith et al., 1999
Spring	H	DWOR	*47,704*	3/25/98-3/26/98	*0.315*	*0.005*	Smith et al., 2000
Spring	H	IMNAHW	*13,378*	4/7/97	*0.358*	*0.019*	Hockersmith et al., 1999
Spring	H	IMNAHW	*19,169*	4/6/98	*0.470*	*0.009*	Smith et al., 2000
Spring	H	IMNAHW	*19,174*	4/6/98	*0.470*	*0.009*	Perez-Comas & Skalski, 2000
Spring	H	KNOXB	*52,734*	3/20/97	*0.284*	*0.010*	Perez-Comas & Skalski, 2000
Spring	H	KNOXB	*47,474*	3/30/98	*0.488*	*0.007*	Perez-Comas & Skalski, 2000
Spring	H	KOOS	*4,075*	4/8/97	*0.338*	*0.040*	Hockersmith et al., 1999
Spring	H	KOOS	*1,001*	4/1/98	*0.451*	*0.037*	Smith et al., 2000
Spring	W	LEMHIW	*1,290*	9/5/94 - 11/15/94	*0.323*	*0.041*	Table A.IV.1, this report
Spring	H	LGR	*16,322*	4/21/94 - 4/30/94	*0.510*	*0.008*	Table A.IV.1, this report
	H+W	LGRRRR	*52,194*	4/7/98-4/30/98	*0.482*	*0.007*	Table A.II.1, this report
	H+W	LGRRRR	*17,490*	5/1/98-5/31/98	*0.316*	*0.003*	Table A.II.1, this report
Spring	H+W	LGRTAL	*201*	4/6/97-4/12/97	*0.456*	*0.077*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*539*	4/13/97-4/19/97	*0.239*	*0.053*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*1,277*	4/20/97-4/26/97	*0.392*	*0.032*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*1,714*	4/27/97-5/3/97	*0.427*	*0.031*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*1,340*	5/4/97-5/10/97	*0.253*	*0.036*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*1,822*	5/11/97-5/17/97	*0.179*	*0.030*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*533*	5/18/97-5/24/97	*0.309*	*0.066*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*162*	5/25/97-5/31/97	*0.308*	*0.128*	Hockersmith et al., 1999
Spring	H	LGRTAL	*6,821*	4/6/98-4/12/98	*0.314*	*0.009*	Smith et al., 2000
Spring	H	LGRTAL	*16,147*	4/13/98-4/19/98	*0.296*	*0.006*	Smith et al., 2000
Spring	H	LGRTAL	*22,820*	4/20/98-4/26/98	*0.300*	*0.005*	Smith et al., 2000
Spring	H	LGRTAL	*17,400*	4/27/98-5/3/98	*0.429*	*0.007*	Smith et al., 2000
Spring	W	LGRTAL	*2,697*	4/6/98-4/12/98	*0.336*	*0.014*	Smith et al., 2000
Spring	W	LGRTAL	*3,263*	4/13/98-4/19/98	*0.336*	*0.013*	Smith et al., 2000

Table A.I.7 (Cont.)

Run	Rear	Site	Release Numbers	Date	$\hat{P}_{\text{LMN}}$	*SE*	Reference
Spring	W	LGRTAL	*3,615*	4/20/98-4/26/98	*0.325*	*0.013*	Smith et al., 2000
Spring	W	LGRTAL	*2,564*	4/27/98-5/3/98	*0.493*	*0.018*	Smith et al., 2000
Spring	H	LGRTAL	*13,424*	5/4/98-5/10/98	*0.508*	*0.008*	Smith et al., 2000
Spring	H	LGRTAL	*4,029*	5/11/98-5/17/98	*0.424*	*0.015*	Smith et al., 2000
Spring	H	LGRTAL	*880*	5/18/98-5/24/98	*0.226*	*0.032*	Smith et al., 2000
Spring	H	LGRTAL	*167*	5/25/98-5/31/98	*0.401*	*0.078*	Smith et al., 2000
Spring	W	LGRTAL	*2,233*	5/4/98-5/10/98	*0.593*	*0.018*	Smith et al., 2000
Spring	W	LGRTAL	*909*	5/11/98-5/17/98	*0.509*	*0.031*	Smith et al., 2000
Spring	W	LGRTAL	*538*	5/18/98-5/24/98	*0.322*	*0.040*	Smith et al., 2000
Spring	W	LGRTAL	*321*	5/25/98-5/31/98	*0.405*	*0.052*	Smith et al., 2000
Spring	H	LGRTAL	*51*	6/1/98-6/7/98	*0.571*	*0.187*	Smith et al., 2000
Spring	H	LGRTAL	*43*	6/8/98-6/14/98	*0.500*	*0.177*	Smith et al., 2000
Spring	W	LGRTAL	*71*	6/1/98-6/7/98	*0.301*	*0.099*	Smith et al., 2000
Spring	W	LGRTAL	*71*	6/8/98-6/14/98	*0.364*	*0.145*	Smith et al., 2000
Spring	H	LGS	*16,696*	4/27/94 - 5/10/94	*0.533*	*0.006*	Table A.IV.1, this report
Spring	H	LOOH	*40,042*	4/7/97	*0.377*	*0.010*	Hockersmith et al., 1999
Spring	H	LOOH	*40,401*	4/7/97	*0.377*	*0.009*	Perez-Comas & Skalski, 2000
Spring	H	LOOH	*43,939*	4/6/98	*0.417*	*0.007*	Smith et al., 2000
Spring	H	LOOH	*45,122*	4/6/98	*0.417*	*0.007*	Perez-Comas & Skalski, 2000
Spring	W	MARTRP	*1,325*	8/19/94 - 11/2/94	*0.509*	*0.034*	Table A.IV.1, this report
Spring	H	MCCA	*52,687*	3/20/97	*0.284*	*0.011*	Hockersmith et al., 1999
Spring	H	MCCA	*47,460*	4/?/98	*0.487*	*0.007*	Smith et al., 2000
Spring	H	PAHP	*33,479*	4/7/97	*0.315*	*0.012*	Hockersmith et al., 1999
Spring	H	PAHP	*33,326*	4/7/97	*0.309*	*0.011*	Perez-Comas & Skalski, 2000
Spring	H	PAHP	*993*	4/4/98	*0.358*	*0.050*	Smith et al., 2000
Spring	H	POWP	*1,016*	4/13/94 - 4/14/94	*0.201*	*0.019*	Table A.IV.1, this report
Spring	H	RAPH	*40,493*	4/1/97	*0.362*	*0.013*	Hockersmith et al., 1999
Spring	H	RAPH	*48,192*	4/13/98	*0.464*	*0.006*	Smith et al., 2000
Spring	H	RAPH	*48,348*	4/13/98	*0.462*	*0.006*	Perez-Comas & Skalski, 2000
Spring	H	SAWT	*499*	4/21/98	*0.457*	*0.052*	Smith et al., 2000
Spring	H	SNAKER	*2,510*	4/16/93 - 4/17/93	*0.112*	*0.015*	Table A.IV.1, this report
Spring	H	SNAKER	*2,481*	4/16/94 - 4/17/94	*0.503*	*0.018*	Table A.IV.1, this report
Spring	H	SNAKER_1	*581*	4/5/96-4/12/96	*0.298*	*0.050*	Smith et al., 1998
Spring	H	SNAKER_1	*534*	4/15/96-4/18/96	*0.425*	*0.061*	Smith et al., 1998
Spring	H	SNAKER_1	*335*	4/23/96-4/24/96	*0.345*	*0.074*	Smith et al., 1998
Spring	H	SNAKER_1	*369*	4/29/96-5/2/96	*0.283*	*0.074*	Smith et al., 1998

Table A.I.7 (Cont.)

Run	Rear	Site	Release Numbers	Date	$\hat{P}_{LMN}$	*SE*	Reference
Spring	H	$SNAKER_1$	*178*	5/6/96-5/9/96	*0.412*	*0.127*	Smith et al., 1998
Spring	H	$SNAKER_1$	*307*	5/13/96-5/15/96	*0.249*	*0.107*	Smith et al., 1998
Spring	H	$SNAKER_2$	*1,258*	4/9/95	*0.378*	*0.030*	Muir et al., 1996
Spring	H	$SNAKER_2$	*784*	4/11/95	*0.390*	*0.035*	Muir et al., 1996
Spring	H	$SNAKER_2$	*1,218*	4/15/95	*0.342*	*0.031*	Muir et al., 1996
Spring	H	$SNAKER_2$	*579*	4/18/95	*0.410*	*0.045*	Muir et al., 1996
Spring	H	$SNAKER_2$	*701*	4/20/95	*0.472*	*0.040*	Muir et al., 1996
Spring	H	$SNAKER_2$	*1,529*	4/23/95	*0.467*	*0.029*	Muir et al., 1996
Spring	H	$SNAKER_2$	*1,615*	4/25/95	*0.475*	*0.030*	Muir et al., 1996
Spring	H	$SNAKER_2$	*2,049*	4/27/95	*0.435*	*0.032*	Muir et al., 1996
Spring	H	$SNAKER_2$	*1,505*	4/29/95	*0.444*	*0.034*	Muir et al., 1996
Spring	H	$SNAKER_2$	*2,098*	5/1/95	*0.474*	*0.032*	Muir et al., 1996
Spring	H	$SNAKER_2$	*544*	5/3/95	*0.432*	*0.053*	Muir et al., 1996
Spring	H	$SNAKER_2$	*142*	5/5/95	*0.653*	*0.142*	Muir et al., 1996
Spring	H	$SNAKER_3$	*1,189*	4/16/94	*0.536*	*0.027*	Muir et al., 1995
Spring	H	$SNAKER_3$	*1,196*	4/17/94	*0.476*	*0.026*	Muir et al., 1995
Spring	H	$SNAKER_3$	*1,194*	4/18/94	*0.474*	*0.026*	Muir et al., 1995
Spring	H	$SNAKER_3$	*1,190*	4/21/94	*0.340*	*0.026*	Muir et al., 1995
Spring	H	$SNAKER_3$	*776*	4/23/94	*0.314*	*0.032*	Muir et al., 1995
Spring	H	$SNAKER_3$	*1,032*	4/26/94	*0.256*	*0.026*	Muir et al., 1995
Spring	H	$SNAKER_3$	*643*	4/29/94	*0.191*	*0.029*	Muir et al., 1995
Spring	H	$SNAKER_3$	*1,069*	5/1/94	*0.223*	*0.024*	Muir et al., 1995
Spring	H	$SNAKER_3$	*542*	5/4/94	*0.177*	*0.032*	Muir et al., 1995
Spring	H	$SNAKER_3$	*1,048*	5/10/94	*0.112*	*0.020*	Muir et al., 1995

Table A.I.8: Detection probability estimates and standard errors for PIT-tagged juvenile chinook releases at McN. H indicates hatchery releases and W, wild releases.

Run	Rear	Site	Release Numbers	Date	$\hat{P}_{McN}$	*SE*	Reference
Spring	W	CATHEC	*1,025*	9/12/94 - 12/1/94	*0.424*	*0.299*	Table A.IV.1, this report
Spring	H	CLWH	*2,010*	4/8/98	*0.175*	*0.026*	Smith et al., 2000
Spring	H	CLWH	*499*	4/8/98	*0.290*	*0.063*	Smith et al., 2000
Spring	H	CLWH	*500*	4/8/98	*0.233*	*0.058*	Smith et al., 2000
Spring	H	CLWH	*500*	4/13/98	*0.237*	*0.056*	Smith et al., 2000
Spring	H	CLWH	*300*	4/22/98	*0.266*	*0.063*	Smith et al., 2000
Fall	H	CLWR	*7,453*	4/13/98-4/16/98	*0.205*	*0.016*	Table A.II.1, this report
Spring	H	CLWRNF	*48,575*	3/25/98-3/26/98	*0.349*	*0.008*	Perez-Comas & Skalski, 2000
Spring	H	DWOR	*20,133*	4/8/94 - 5/6/94	*0.422*	*0.143*	Table A.IV.1, this report
Spring	H	DWOR	*14,080*	4/7/97	*0.144*	*0.024*	Hockersmith et al., 1999
Spring	H	DWOR	*47,704*	3/25/98-3/26/98	*0.350*	*0.008*	Smith et al., 2000
Spring	H	IMNAHW	*13,378*	4/7/97	*0.104*	*0.021*	Hockersmith et al., 1999
Spring	H	IMNAHW	*19,169*	4/6/98	*0.267*	*0.011*	Smith et al., 2000
Spring	H	IMNAHW	*19,174*	4/6/98	*0.266*	*0.011*	Perez-Comas & Skalski, 2000
Spring	H	KNOXB	*52,734*	3/20/97	*0.090*	*0.010*	Perez-Comas & Skalski, 2000
Spring	H	KNOXB	*47,474*	3/30/98	*0.216*	*0.007*	Perez-Comas & Skalski, 2000
Spring	H	KOOS	*4,075*	4/8/97	*0.171*	*0.055*	Hockersmith et al., 1999
Spring	H	KOOS	*1,001*	4/1/98	*0.219*	*0.043*	Smith et al., 2000
Spring	W	LEMHIW	*1,290*	9/5/94 - 11/15/94	*0.262*	*0.223*	Table A.IV.1, this report
Spring	H	LGR	*16,322*	4/21/94 - 4/30/94	*0.341*	*0.275*	Table A.IV.1, this report
	H+W	LGRRRR	*52,194*	4/7/98-4/30/98	*0.234*	*0.007*	Table A.II.1, this report
	H+W	LGRRRR	*17,490*	5/1/98-5/31/98	*0.371*	*0.006*	Table A.II.1, this report
Spring	H+W	LGRTAL	*201*	4/6/97-4/12/97	*0.255*	*0.155*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*539*	4/13/97-4/19/97	*0.153*	*0.081*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*1,277*	4/20/97-4/26/97	*0.155*	*0.045*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*1,714*	4/27/97-5/3/97	*0.188*	*0.049*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*1,340*	5/4/97-5/10/97	*0.167*	*0.057*	Hockersmith et al., 1999
Spring	H+W	LGRTAL	*1,822*	5/11/97-5/17/97	*0.078*	*0.030*	Hockersmith et al., 1999
Spring	H	LGRTAL	*6,821*	4/6/98-4/12/98	*0.490*	*0.016*	Smith et al., 2000
Spring	H	LGRTAL	*16,147*	4/13/98-4/19/98	*0.454*	*0.011*	Smith et al., 2000
Spring	H	LGRTAL	*22,820*	4/20/98-4/26/98	*0.327*	*0.008*	Smith et al., 2000
Spring	H	LGRTAL	*17,400*	4/27/98-5/3/98	*0.202*	*0.008*	Smith et al., 2000
Spring	W	LGRTAL	*2,697*	4/6/98-4/12/98	*0.478*	*0.024*	Smith et al., 2000
Spring	W	LGRTAL	*3,263*	4/13/98-4/19/98	*0.452*	*0.023*	Smith et al., 2000
Spring	W	LGRTAL	*3,615*	4/20/98-4/26/98	*0.337*	*0.020*	Smith et al., 2000
Spring	W	LGRTAL	*2,564*	4/27/98-5/3/98	*0.173*	*0.018*	Smith et al., 2000

Table A.I.8 (Cont.)

Run	Rear	Site	Release Numbers	Date	$\hat{P}_{McN}$	*SE*	Reference
Spring	H	LGRTAL	*13,424*	5/4/98-5/10/98	*0.264*	*0.009*	Smith et al., 2000
Spring	H	LGRTAL	*4,029*	5/11/98-5/17/98	*0.180*	*0.017*	Smith et al., 2000
Spring	H	LGRTAL	*880*	5/18/98-5/24/98	*0.089*	*0.027*	Smith et al., 2000
Spring	H	LGRTAL	*167*	5/25/98-5/31/98	*0.133*	*0.062*	Smith et al., 2000
Spring	W	LGRTAL	*2,233*	5/4/98-5/10/98	*0.272*	*0.022*	Smith et al., 2000
Spring	W	LGRTAL	*909*	5/11/98-5/17/98	*0.175*	*0.031*	Smith et al., 2000
Spring	W	LGRTAL	*538*	5/18/98-5/24/98	*0.165*	*0.039*	Smith et al., 2000
Spring	W	LGRTAL	*321*	5/25/98-5/31/98	*0.168*	*0.046*	Smith et al., 2000
Spring	H	LGRTAL	*51*	6/1/98-6/7/98	*0.167*	*0.152*	Smith et al., 2000
Spring	W	LGRTAL	*71*	6/1/98-6/7/98	*0.125*	*0.083*	Smith et al., 2000
Spring	H	LMN	*20,183*	5/4/94 - 5/17/94	*0.757*	*0.213*	Table A.IV.1, this report
Spring	H	LOOH	*40,042*	4/7/97	*0.183*	*0.015*	Hockersmith et al., 1999
Spring	H	LOOH	*40,401*	4/7/97	*0.188*	*0.013*	Perez-Comas & Skalski, 2000
Spring	H	LOOH	*43,939*	4/6/98	*0.262*	*0.009*	Smith et al., 2000
Spring	H	LOOH	*45,122*	4/6/98	*0.258*	*0.009*	Perez-Comas & Skalski, 2000
Spring	W	MARTRP	*1,325*	8/19/94 - 11/2/94	*0.298*	*0.241*	Table A.IV.1, this report
Spring	H	MCCA	*52,687*	3/20/97	*0.095*	*0.011*	Hockersmith et al., 1999
Spring	H	MCCA	*47,460*	4/?/98	*0.219*	*0.008*	Smith et al., 2000
Spring	H	PAHP	*33,479*	4/7/97	*0.122*	*0.016*	Hockersmith et al., 1999
Spring	H	PAHP	*33,326*	4/7/97	*0.116*	*0.013*	Perez-Comas & Skalski, 2000
Spring	H	PAHP	*993*	4/4/98	*0.206*	*0.058*	Smith et al., 2000
Spring	H	POWP	*1,016*	4/13/94 - 4/14/94	*0.754*	*0.214*	Table A.IV.1, this report
Spring	H	RAPH	*40,493*	4/1/97	*0.108*	*0.014*	Hockersmith et al., 1999
Spring	H	RAPH	*48,192*	4/13/98	*0.242*	*0.008*	Smith et al., 2000
Spring	H	RAPH	*48,348*	4/13/98	*0.244*	*0.007*	Perez-Comas & Skalski, 2000
Fall	H+W	RISTAL	*1,472*	4/15/98	*0.165*	*0.023*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,498*	4/16/98	*0.169*	*0.022*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,499*	4/17/98	*0.159*	*0.024*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,499*	4/18/98	*0.205*	*0.025*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,483*	4/21/98	*0.181*	*0.024*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,456*	4/22/98	*0.144*	*0.021*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,421*	4/23/98	*0.156*	*0.023*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,477*	4/24/98	*0.167*	*0.022*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,498*	4/25/98	*0.106*	*0.020*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,487*	4/28/98	*0.135*	*0.022*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,499*	4/29/98	*0.125*	*0.021*	Eppard et al., 1999

Table A.I.8 (Cont.)

Run	Rear	Site	Release Numbers	Date	$\hat{P}_{\text{McN}}$	*SE*	Reference
Fall	H+W	RISTAL	*1,486*	4/30/98	*0.128*	*0.022*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,493*	5/1/98	*0.145*	*0.026*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,487*	5/2/98	*0.119*	*0.021*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,488*	5/5/98	*0.139*	*0.025*	Eppard et al., 1999
Fall	H+W	RREFBY	*1,494*	4/17/98	*0.208*	*0.028*	Eppard et al., 1999
Fall	H+W	RREFBY	*1,498*	4/22/98	*0.150*	*0.024*	Eppard et al., 1999
Fall	H+W	RREFBY	*1,399*	4/25/98	*0.108*	*0.022*	Eppard et al., 1999
Fall	H+W	RREFBY	*1,494*	4/30/98	*0.179*	*0.026*	Eppard et al., 1999
Fall	H+W	RREFBY	*1,495*	5/5/98	*0.149*	*0.030*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,474*	4/15/98	*0.198*	*0.025*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,495*	4/16/98	*0.162*	*0.026*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,493*	4/17/98	*0.205*	*0.027*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,497*	4/18/98	*0.133*	*0.023*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,501*	4/21/98	*0.205*	*0.026*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,451*	4/22/98	*0.195*	*0.028*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,413*	4/23/98	*0.153*	*0.023*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,421*	4/24/98	*0.154*	*0.026*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,498*	4/25/98	*0.126*	*0.022*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,485*	4/28/98	*0.161*	*0.026*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,492*	4/29/98	*0.136*	*0.023*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,490*	4/30/98	*0.064*	*0.019*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,477*	5/1/98	*0.117*	*0.023*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,486*	5/2/98	*0.150*	*0.025*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,474*	5/5/98	*0.179*	*0.029*	Eppard et al., 1999
Spring	H	SAWT	*499*	4/21/98	*0.199*	*0.055*	Smith et al., 2000
Spring	H	SNAKER	*2,510*	4/16/93 - 4/17/93	*0.514*	*0.353*	Table A.IV.1, this report
Spring	H	SNAKER	*2,481*	4/16/94 - 4/17/94	*0.337*	*0.274*	Table A.IV.1, this report
Fall	H+W	WELTAL	*1,499*	4/15/98	*0.196*	*0.027*	Eppard et al., 1999
Fall	H+W	WELTAL	*1,498*	4/16/98	*0.123*	*0.022*	Eppard et al., 1999
Fall	H+W	WELTAL	*1,498*	4/18/98	*0.147*	*0.027*	Eppard et al., 1999
Fall	H+W	WELTAL	*1,499*	4/21/98	*0.078*	*0.023*	Eppard et al., 1999
Fall	H+W	WELTAL	*1,424*	4/23/98	*0.150*	*0.028*	Eppard et al., 1999
Fall	H+W	WELTAL	*1,481*	4/24/98	*0.112*	*0.024*	Eppard et al., 1999
Fall	H+W	WELTAL	*1,495*	4/28/98	*0.107*	*0.024*	Eppard et al., 1999
Fall	H+W	WELTAL	*1,487*	4/29/98	*0.091*	*0.022*	Eppard et al., 1999
Fall	H+W	WELTAL	*1,487*	5/1/98	*0.114*	*0.025*	Eppard et al., 1999
Fall	H+W	WELTAL	*1,487*	5/2/98	*0.060*	*0.018*	Eppard et al., 1999

APPENDIX II: Reach survival and detection probability estimates of juvenile chinook salmon at dams and reservoirs of the Lower Columbia River

Estimates for reach survivals between and detection probabilities at John Day Dam (JDA) and Bonneville Dam (BON) were obtained by averaging all estimates that have been published in recent years. As with previous tables all estimates were obtained using the CJS capture-recapture model as implemented in the statistical computer program *SURPH.1*. Given that the number of reported estimates of $S_{\text{JDA}-\text{BON}}$ was considerably small, four PIT-tagged chinook salmon releases of 1998 with tags detected at Rice Island (Rice) were used to increase the number of available estimates. These results are reported in Table A.II.1. The remaining tables display the reported survival or detection probability estimates and estimated standard errors that produced the averages used in the report.

Table A.II.1: Reach survival (*S*), capture (*P*) and terminal (λ) probabilities, and corresponding standard errors (*SE*) estimated using PIT-tagged chinook salmon released in 1998 and detected at Rice Island (Rice). *N* indicates numbers released.

Run	Spring		Spring		Spring		Fall	
Rear	H+W		H+W		H+W		H	
Site	LGRRRR		LGRRRR		MCNTAL		CLWR	
Release Dates	4/7/98-4/30/98		5/1/98-5/31/98		5/2/98-5/17/98		4/13/98-4/16/98	
N	*52,194*		*17,490*		*8,340*		*7,453*	
	S	*SE*	*S*	*SE*	*S*	*SE*	*S*	*SE*
Release-LGR							*0.772*	*0.012*
LGR-LGS	*1.025*	*0.005*	*0.975*	*0.006*			*0.892*	*0.024*
LGS-LMN	*0.839*	*0.008*	*0.851*	*0.011*			*0.810*	*0.034*
LMN-McN	*0.927*	*0.015*	*0.979*	*0.029*			*0.785*	*0.062*
McN-JDA	*0.761*	*0.031*	*0.875*	*0.051*	*0.870*	*0.054*	*1.020*	*0.170*
JDA-BON	*1.358*	*0.167*	*0.935*	*0.150*	*0.943*	*0.214*	*0.977*	*0.408*
	P	*SE*	*P*	*SE*	*P*	*SE*	*P*	*SE*
LGR							*0.420*	*0.009*
LGS	*0.392*	*0.003*	*0.511*	*0.005*			*0.356*	*0.010*
LMN	*0.316*	*0.003*	*0.482*	*0.007*			*0.352*	*0.014*
McN	*0.371*	*0.006*	*0.234*	*0.007*			*0.205*	*0.016*
JDA	*0.123*	*0.005*	*0.178*	*0.010*	*0.189*	*0.013*	*0.130*	*0.021*
BON	*0.093*	*0.011*	*0.124*	*0.019*	*0.123*	*0.027*	*0.059*	*0.024*
	λ	*SE*	λ	*SE*	λ	*SE*	λ	*SE*
BON-Rice	*0.0176*	*0.0022*	*0.0287*	*0.0046*	*0.0215*	*0.005*	*0.0345*	*0.0138*

Table A.II.2: Survival estimates and standard errors for PIT-tagged juvenile chinook releases in the McN-JDA reach. H indicates hatchery releases and W, wild releases.

Run	Rear	Site	Release Numbers	Date	$\hat{S}_{\text{McN-JDA}}$	*SE*	Reference
Fall	H	CLWR	*7,453*	4/13/98-4/16/98	*1.000*	*0.170*	Table A.II.1, this report
Spring	H	CLWRNF	*48,575*	3/25/98-3/26/98	*0.763*	*0.046*	Perez-Comas & Skalski, 2000
Spring	H	IMNAHW	*19,174*	4/6/98	*0.831*	*0.062*	Perez-Comas & Skalski, 2000
Spring	H	KNOXB	*52,734*	3/20/97	*1.000*	*2.133*	Perez-Comas & Skalski, 2000
Spring	H	KNOXB	*47,474*	3/30/98	*0.837*	*0.048*	Perez-Comas & Skalski, 2000
	H+W	LGRRRR	*52,194*	4/7/98-4/30/98	*0.875*	*0.051*	Table A.II.1, this report
	H+W	LGRRRR	*17,490*	5/1/98-5/31/98	*0.761*	*0.031*	Table A.II.1, this report
Spring	H	LOOH	*40,401*	4/7/97	*0.446*	*0.203*	Perez-Comas & Skalski, 2000
Spring	H	LOOH	*45,122*	4/6/98	*0.719*	*0.045*	Perez-Comas & Skalski, 2000
Spring	H+W	MCNTAL	*1,868*	4/20/98-4/26/98	*0.694*	*0.094*	Smith et al., 2000
Spring	H+W	MCNTAL	*14,154*	4/27/98-5/3/98	*0.815*	*0.056*	Smith et al., 2000
Spring	H+W	MCNTAL	*9,741*	5/4/98-5/10/98	*0.889*	*0.062*	Smith et al., 2000
Spring	H+W	MCNTAL	*7,295*	5/11/98-5/17/98	*0.762*	*0.042*	Smith et al., 2000
Spring	H+W	MCNTAL	*4,977*	5/18/98-5/24/98	*0.976*	*0.098*	Smith et al., 2000
Spring	H+W	MCNTAL	*982*	5/25/98-5/31/98	*0.898*	*0.210*	Smith et al., 2000
	H+W	MCNTAL	*8,340*	5/2/98-5/17/98	*0.870*	*0.054*	Table A.II.1, this report
Spring	H+W	MCNTAL	*166*	6/1/98-6/7/98	*0.614*	*0.188*	Smith et al., 2000
Spring	H	PAHP	*33,326*	4/7/97	*0.604*	*0.413*	Perez-Comas & Skalski, 2000
Spring	H	RAPH	*48,348*	4/13/98	*0.824*	*0.048*	Perez-Comas & Skalski, 2000
Fall	H+W	RISTAL	*1,472*	4/15/98	*0.675*	*0.155*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,498*	4/16/98	*0.783*	*0.169*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,499*	4/17/98	*0.773*	*0.190*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,499*	4/18/98	*1.000*	*0.246*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,483*	4/21/98	*0.826*	*0.170*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,456*	4/22/98	*0.633*	*0.142*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,421*	4/23/98	*0.834*	*0.210*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,477*	4/24/98	*0.608*	*0.109*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,498*	4/25/98	*0.479*	*0.127*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,487*	4/28/98	*0.696*	*0.179*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,499*	4/29/98	*0.778*	*0.203*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,486*	4/30/98	*0.537*	*0.133*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,493*	5/1/98	*0.754*	*0.233*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,487*	5/2/98	*0.639*	*0.175*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,488*	5/5/98	*1.000*	*0.630*	Eppard et al., 1999
Fall	H+W	RREFBY	*1,494*	4/17/98	*1.000*	*0.306*	Eppard et al., 1999
Fall	H+W	RREFBY	*1,498*	4/22/98	*0.626*	*0.138*	Eppard et al., 1999

Table A.II.2 (Cont.)

Run	Rear	Site	Release Numbers	Date	$\hat{S}_{\text{McN-JDA}}$	*SE*	Reference
Fall	H+W	RREFBY	*1,399*	4/25/98	*1.000*	*0.463*	Eppard et al., 1999
Fall	H+W	RREFBY	*1,494*	4/30/98	*0.925*	*0.216*	Eppard et al., 1999
Fall	H+W	RREFBY	*1,495*	5/5/98	*0.841*	*0.349*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,474*	4/15/98	*1.000*	*0.269*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,495*	4/16/98	*0.552*	*0.132*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,493*	4/17/98	*0.895*	*0.223*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,497*	4/18/98	*0.778*	*0.228*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,501*	4/21/98	*1.000*	*0.253*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,451*	4/22/98	*0.749*	*0.184*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,413*	4/23/98	*0.777*	*0.179*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,421*	4/24/98	*0.867*	*0.256*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,498*	4/25/98	*0.879*	*0.232*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,485*	4/28/98	*0.687*	*0.161*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,492*	4/29/98	*0.525*	*0.120*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,490*	4/30/98	*0.442*	*0.180*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,477*	5/1/98	*1.000*	*0.378*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,486*	5/2/98	*1.000*	*1.183*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,474*	5/5/98	*0.859*	*0.246*	Eppard et al., 1999
Fall	H+W	WELTAL	*1,499*	4/15/98	*1.000*	*0.300*	Eppard et al., 1999
Fall	H+W	WELTAL	*1,498*	4/16/98	*0.970*	*0.305*	Eppard et al., 1999
Fall	H+W	WELTAL	*1,498*	4/18/98	*1.000*	*0.479*	Eppard et al., 1999
Fall	H+W	WELTAL	*1,499*	4/21/98	*0.425*	*0.162*	Eppard et al., 1999
Fall	H+W	WELTAL	*1,424*	4/23/98	*1.000*	*0.578*	Eppard et al., 1999
Fall	H+W	WELTAL	*1,481*	4/24/98	*0.863*	*0.322*	Eppard et al., 1999
Fall	H+W	WELTAL	*1,495*	4/28/98	*0.989*	*0.396*	Eppard et al., 1999
Fall	H+W	WELTAL	*1,487*	4/29/98	*0.728*	*0.257*	Eppard et al., 1999
Fall	H+W	WELTAL	*1,487*	5/1/98	*0.624*	*0.188*	Eppard et al., 1999
Fall	H+W	WELTAL	*1,487*	5/2/98	*0.514*	*0.180*	Eppard et al., 1999

Table A.II.3: Survival estimates and standard errors for PIT-tagged juvenile chinook releases in the JDA-BON reach. H indicates hatchery releases and W, wild releases.

Run	Rear	Site	Release Numbers	Date	$\hat{S}_{\text{JDA-BON}}$	*SE*	Reference
Fall	H	CLWR	*7,453*	4/13/98-4/16/98	*0.977*	*0.408*	Table A.II.1, this report
Spring	H	CLWRNF	*48,575*	3/25/98-3/26/98	*1.000*	*0.263*	Perez-Comas & Skalski, 2000
Spring	H	IMNAHW	*19,174*	4/6/98	*1.000*	*0.232*	Perez-Comas & Skalski, 2000
Spring	H	KNOXB	*52,734*	3/20/97	*0.780*	*0.820*	Perez-Comas & Skalski, 2000
Spring	H	KNOXB	*47,474*	3/30/98	*1.000*	*0.253*	Perez-Comas & Skalski, 2000
	H+W	LGRRRR	*52,194*	4/7/98-4/30/98	*0.935*	*0.150*	Table A.II.1, this report
	H+W	LGRRRR	*17,490*	5/1/98-5/31/98	*1.000*	*0.167*	Table A.II.1, this report
Spring	H	LOOH	*40,401*	4/7/97	*1.000*	*1.241*	Perez-Comas & Skalski, 2000
Spring	H	LOOH	*45,122*	4/6/98	*0.992*	*0.160*	Perez-Comas & Skalski, 2000
	H+W	MCNTAL	*8,340*	5/2/98-5/17/98	*0.943*	*0.214*	Table A.II.1, this report
Spring	H	PAHP	*33,326*	4/7/97	*1.000*	*0.845*	Perez-Comas & Skalski, 2000
Spring	H	RAPH	*48,348*	4/13/98	*1.000*	*0.393*	Perez-Comas & Skalski, 2000

Table A.II.4: Detection probability estimates and standard errors for PIT-tagged juvenile chinook releases at JDA. H indicates hatchery releases and W, wild releases.

Run	Rear	Site	Release Numbers	Date	$\hat{P}_{\mathrm{JDA}}$	*SE*	Reference
Fall	H	CLWR	*7,453*	4/13/98-4/16/98	*0.130*	*0.021*	Table A.II.1, this report
Spring	H	CLWRNF	*48,575*	3/25/98-3/26/98	*0.123*	*0.007*	Perez-Comas & Skalski, 2000
Spring	H	IMNAHW	*19,174*	4/6/98	*0.189*	*0.013*	Perez-Comas & Skalski, 2000
Spring	H	KNOXB	*52,734*	3/20/97	*0.001*	*0.001*	Perez-Comas & Skalski, 2000
Spring	H	KNOXB	*47,474*	3/30/98	*0.176*	*0.009*	Perez-Comas & Skalski, 2000
	H+W	LGRRRR	*52,194*	4/7/98-4/30/98	*0.178*	*0.010*	Table A.II.1, this report
	H+W	LGRRRR	*17,490*	5/1/98-5/31/98	*0.123*	*0.005*	Table A.II.1, this report
Spring	H	LOOH	*40,401*	4/7/97	*0.005*	*0.002*	Perez-Comas & Skalski, 2000
Spring	H	LOOH	*45,122*	4/6/98	*0.188*	*0.011*	Perez-Comas & Skalski, 2000
Spring	H+W	MCNTAL	*1,868*	4/20/98-4/26/98	*0.125*	*0.019*	Smith et al., 2000
Spring	H+W	MCNTAL	*14,154*	4/27/98-5/3/98	*0.088*	*0.007*	Smith et al., 2000
Spring	H+W	MCNTAL	*9,741*	5/4/98-5/10/98	*0.134*	*0.010*	Smith et al., 2000
Spring	H+W	MCNTAL	*7,295*	5/11/98-5/17/98	*0.228*	*0.014*	Smith et al., 2000
Spring	H+W	MCNTAL	*4,977*	5/18/98-5/24/98	*0.129*	*0.014*	Smith et al., 2000
Spring	H+W	MCNTAL	*982*	5/25/98-5/31/98	*0.137*	*0.034*	Smith et al., 2000
	H+W	MCNTAL	*8,340*	5/2/98-5/17/98	*0.189*	*0.013*	Table A.II.1, this report
Spring	H+W	MCNTAL	*166*	6/1/98-6/7/98	*0.353*	*0.116*	Smith et al., 2000
Spring	H	PAHP	*33,326*	4/7/97	*0.004*	*0.003*	Perez-Comas & Skalski, 2000
Spring	H	RAPH	*48,348*	4/13/98	*0.164*	*0.009*	Perez-Comas & Skalski, 2000
Fall	H+W	RISTAL	*1,472*	4/15/98	*0.224*	*0.045*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,498*	4/16/98	*0.200*	*0.038*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,499*	4/17/98	*0.218*	*0.047*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,499*	4/18/98	*0.202*	*0.044*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,483*	4/21/98	*0.237*	*0.043*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,456*	4/22/98	*0.232*	*0.043*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,421*	4/23/98	*0.208*	*0.046*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,477*	4/24/98	*0.311*	*0.046*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,498*	4/25/98	*0.202*	*0.041*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,487*	4/28/98	*0.242*	*0.053*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,499*	4/29/98	*0.213*	*0.047*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,486*	4/30/98	*0.250*	*0.050*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,493*	5/1/98	*0.193*	*0.052*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,487*	5/2/98	*0.211*	*0.048*	Eppard et al., 1999
Fall	H+W	RISTAL	*1,488*	5/5/98	*0.088*	*0.037*	Eppard et al., 1999
Fall	H+W	RREFBY	*1,494*	4/17/98	*0.182*	*0.047*	Eppard et al., 1999
Fall	H+W	RREFBY	*1,498*	4/22/98	*0.253*	*0.046*	Eppard et al., 1999

Table A.II.4 (Cont.)

Run	Rear	Site	Release Numbers	Date	$\hat{P}_{JDA}$	*SE*	Reference
Fall	H+W	RREFBY	*1,399*	4/25/98	*0.113*	*0.040*	Eppard et al., 1999
Fall	H+W	RREFBY	*1,494*	4/30/98	*0.217*	*0.045*	Eppard et al., 1999
Fall	H+W	RREFBY	*1,495*	5/5/98	*0.136*	*0.052*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,474*	4/15/98	*0.163*	*0.037*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,495*	4/16/98	*0.250*	*0.050*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,493*	4/17/98	*0.211*	*0.048*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,497*	4/18/98	*0.149*	*0.038*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,501*	4/21/98	*0.186*	*0.042*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,451*	4/22/98	*0.219*	*0.048*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,413*	4/23/98	*0.260*	*0.051*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,421*	4/24/98	*0.169*	*0.044*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,498*	4/25/98	*0.190*	*0.043*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,485*	4/28/98	*0.241*	*0.048*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,492*	4/29/98	*0.319*	*0.056*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,490*	4/30/98	*0.143*	*0.044*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,477*	5/1/98	*0.131*	*0.043*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,486*	5/2/98	*0.067*	*0.032*	Eppard et al., 1999
Fall	H+W	RRETAL	*1,474*	5/5/98	*0.194*	*0.050*	Eppard et al., 1999
Fall	H+W	WELTAL	*1,499*	4/15/98	*0.179*	*0.042*	Eppard et al., 1999
Fall	H+W	WELTAL	*1,498*	4/16/98	*0.153*	*0.042*	Eppard et al., 1999
Fall	H+W	WELTAL	*1,498*	4/18/98	*0.116*	*0.039*	Eppard et al., 1999
Fall	H+W	WELTAL	*1,499*	4/21/98	*0.227*	*0.063*	Eppard et al., 1999
Fall	H+W	WELTAL	*1,424*	4/23/98	*0.107*	*0.041*	Eppard et al., 1999
Fall	H+W	WELTAL	*1,481*	4/24/98	*0.145*	*0.048*	Eppard et al., 1999
Fall	H+W	WELTAL	*1,495*	4/28/98	*0.113*	*0.040*	Eppard et al., 1999
Fall	H+W	WELTAL	*1,487*	4/29/98	*0.167*	*0.048*	Eppard et al., 1999
Fall	H+W	WELTAL	*1,487*	5/1/98	*0.271*	*0.064*	Eppard et al., 1999
Fall	H+W	WELTAL	*1,487*	5/2/98	*0.230*	*0.054*	Eppard et al., 1999

Table A.II.5: Detection probability estimates and standard errors for PIT-tagged juvenile chinook releases at BON. H indicates hatchery releases and W, wild releases.

Run	Rear	Site	Release Numbers	Date	$\hat{P}_{BON}$	*SE*	Reference
Fall	H	CLWR	*7,453*	4/13/98-4/16/98	*0.059*	*0.024*	Table A.II.1, this report
Spring	H	CLWRNF	*48,575*	3/25/98-3/26/98	*0.085*	*0.015*	Perez-Comas & Skalski, 2000
Spring	H	IMNAHW	*19,174*	4/6/98	*0.126*	*0.025*	Perez-Comas & Skalski, 2000
Spring	H	KNOXB	*52,734*	3/20/97	*0.031*	*0.011*	Perez-Comas & Skalski, 2000
Spring	H	KNOXB	*47,474*	3/30/98	*0.086*	*0.015*	Perez-Comas & Skalski, 2000
	H+W	LGRRRR	*52,194*	4/7/98-4/30/98	*0.124*	*0.019*	Table A.II.1, this report
	H+W	LGRRRR	*17,490*	5/1/98-5/31/98	*0.093*	*0.011*	Table A.II.1, this report
Spring	H	LOOH	*40,401*	4/7/97	*0.058*	*0.016*	Perez-Comas & Skalski, 2000
Spring	H	LOOH	*45,122*	4/6/98	*0.111*	*0.017*	Perez-Comas & Skalski, 2000
	H+W	MCNTAL	*8,340*	5/2/98-5/17/98	*0.123*	*0.027*	Table A.II.1, this report
Spring	H	PAHP	*33,326*	4/7/97	*0.055*	*0.018*	Perez-Comas & Skalski, 2000
Spring	H	RAPH	*48,348*	4/13/98	*0.063*	*0.013*	Perez-Comas & Skalski, 2000

APPENDIX III: In-river survival estimates for chinook salmon adults returning to Lower Granite Dam

Until now, there are no CJS estimates of reach survivals for chinook salmon adults returning from Bonneville Dam (BON) to Lower Granite Dam (LGR), because, with the exception of LGR, no PIT-tag detection system for adult fish has been installed at BON and other dams of the Columbia-Snake River Basin. However, radio-telemetry studies have been performed on returning adult salmon (Bjorn et al., 2000), whose reported data were used to estimate the reach survival between BON and LGR ($\hat{S}_{\mathrm{B2A-GRA}}$), by using the CJS capture-recapture model.

The original data was reported as Table 6 in Bjorn et al. (2000). It consists of 838 radio-tagged adult chinook that were released below Bonneville Dam (BON) and subsequently detected at BON, The Dalles Dam (TDA), John Day Dam (JDA), McNary Dam (McN), Ice Harbor Dam (IHR) and LGR by tailrace and/or top-of-ladder detectors. The experimental results were reported as number of chinook that passed the tailrace of each dam and number of chinook that passed each dam. These numbers were reinterpreted to supply values for the variables of formula 4 (Cormack, 1964) that allows the estimation of reach survivals ($\hat{S}$). Cormack's formula 4 specifies that:

$$\hat{S}_i = \frac{t_i \times v_i \times r_{i+1} - t_i \times a_{i+1} \times c_{i+1}}{r_i \times v_i \times t_{i+1}},$$

where i is the sampling event number (i = 1, 2, ..., 7). The terms in the equation are defined as:

a_i = Number of previously marked fish detected on event i

b_i = Number of fish marked on event i

c_i = Number of previously marked fish detected for the last time on event i

v_i = Number of fish marked on or prior to event k known to be alive at event (i + 1)

r_i = Total number of fish detected on event i

t_i = Total number of fish detected on event i and on a later event.

Once the reach survivals were calculated the desired $\hat{S}_{\mathrm{B2A-GRA}}$ was obtained as their product.

Table A.III.1: Data from radio-tagged chinook released in 1996 (Table 6 in Bjorn et al., 2000) and estimates of reach survivals ($\hat{S}$) obtained using formula 4 in Cormack (1964).

	Release	BON	TDA	JDA	McN	IHR	LGR
Fish that passed tailrace		*830*	*553*	*384*	*307*	*132*	*114*
Fish that passed dam		*809*	*497*	*377*	*301*	*120*	*114*
i	*1*	*2*	*3*	*4*	*5*	*6*	*7*
a		*830*	*553*	*384*	*307*	*132*	*114*
b	*838*	*0*	*0*	*0*	*0*	*0*	*0*
c		*21*	*56*	*7*	*6*	*12*	*0*
v	*809*	*497*	*377*	*301*	*120*	*114*	*113*
r	*838*	*830*	*553*	*384*	*307*	*132*	*114*
t	*838*	*809*	*497*	*377*	*301*	*120*	*114*

$\hat{S}_1$	$\hat{S}_2$	$\hat{S}_3$	$\hat{S}_4$	$\hat{S}_5$	$\hat{S}_6$
$\hat{S}_{\text{Rel.–BON}}$	$\hat{S}_{\text{BON–TDA}}$	$\hat{S}_{\text{TDA–JDA}}$	$\hat{S}_{\text{JDA–McN}}$	$\hat{S}_{\text{McN–IHR}}$	$\hat{S}_{\text{IHR–LGR}}$
1.0002	*0.9623*	*0.8817*	*0.9618*	*0.8726*	*0.9091*

$$\hat{S}_{\text{BA–GRA}} = \hat{S}_{\text{BON–TDA}} \times \hat{S}_{\text{TDA–JDA}} \times \hat{S}_{\text{JDA–McN}} \times \hat{S}_{\text{McN–IHR}} \times \hat{S}_{\text{IHR–LGR}} = 0.6474$$

APPENDIX IV: Estuarine and marine survival estimates for chinook salmon adults returning to Bonneville Dam

As with the case of in-river survival estimates for chinook salmon adults returning to Lower Granite Dam, no CJS estimates of estuarine and marine survival for chinook salmon returning to Bonneville Dam ($\hat{S}_{\text{BON–BA}}$) has been reported yet. However, *SUPH.1* estimates of survival (*S*), capture (*P*) and terminal (λ) probabilities were obtained for ten releases of PITtagged chinook salmon that were detected at Lower Granite Dam adult trap (GRA) in 1994-2000 (Table A.IV.1).

The estimates in Table A.IV.1 do not provide per-se the required $\hat{S}_{\text{BON–BA}}$. Nevertheless, the terminal probability estimates ($\hat{\lambda}$) that correspond to the product of $S_{\text{McN–GRA}}$ and the detection probability at GRA (P_{GRA}) can be used to calculate $\hat{S}_{\text{BON–B2A}}$ if values for P_{GRA}, $S_{\text{McN–JDA}}$, $S_{\text{JDA–BON}}$ and $S_{\text{BA-GRA}}$ are provided.

The ten values of $\hat{\lambda}$ were averaged using weights equal to $\hat{\lambda}_i^2 \big/ Var\left(\hat{\lambda}_i \middle| \lambda_i\right)$. The resulting average $\bar{\hat{\lambda}}$ was 0.003264, with an standard error of 0.001402. Six survival estimates were then obtained by introducing $\bar{\hat{\lambda}}$ into $\hat{S}_{\text{BON–BA}_i} = \dfrac{\bar{\hat{\lambda}}}{\hat{S}_{\text{McN–JDA}} \times \hat{S}_{\text{JDA-BON}} \times \hat{S}_{\text{B2A-GRA}} \times \hat{P}_{\text{GRA}_i}}$,

where $\hat{P}_{\text{GRA}_i} = \{1,\ 0.5\}$, $\hat{S}_{\text{McN–JDA}} = 0.8028$ (weighted averages of the survival estimates in Table A.II.2), $\hat{S}_{\text{JDA–BON}} = 0.9783$ (weighted averages of the survival estimates in Table A.II.3) and $S_{\text{BA-GRA}} = 0.6474$ (Table A.III.1). The resulting values were:

$\hat{P}_{\text{GRA}}$	$\hat{S}_{\text{BON–BA}}$
1.0	*0.0064*
0.5	*0.0128*

Table A.IV.1: Reach survival (*S*), capture (*P*) and terminal (λ) probabilities, and corresponding standard errors (*SE*) estimated using PITtagged chinook salmon released in 1993 and 1994 and detected at Lower Granite Dam adult trap (GRA) in 1994-2000. N indicates numbers released or observed at each detection site. H indicates hatchery releases and W, wild releases.

Year	1994		1994		1994		1994		1994	
Run	Spring		Spring		Spring		Spring		Spring	
Rear	H		H		H		H		H	
Site	DWOR		LGR		LGS		LMN		POWP	
River Km	*811*		*695*		*635*		*589*		*1,016*	
Dates	4/8/94 - 5/6/94		4/21/94 - 4/30/94		4/27/94 - 5/10/94		5/4/94 - 5/17/94		4/13/94 - 4/14/94	
N Release	*20,133*		*16,322*		*16,696*		*20,183*		*1,985*	
N LGR	*4,304*								*386*	
N LGS	*2,457*		*3,780*						*183*	
N LMN	*2,710*		*4,452*		*6,887*				*205*	
N McN	*5,022*		*3,964*		*5,862*		*9,853*		*464*	
N GRA	*12*		*3*		*2*		*4*		*4*	
	S	*SE*	*S*	*SE*	*S*	*SE*	*S*	*SE*	*S*	*SE*
Release-LGR	*0.767*	*0.010*							*0.745*	*0.037*
LGR-LGS	*0.980*	*0.024*	*0.768*	*0.010*					*0.850*	*0.074*
LGS-LMN	*0.739*	*0.020*	*0.717*	*0.013*	*0.774*	*0.007*			*0.849*	*0.086*
LMN-McN	*1.178*	*0.399*	*1.468*	*1.185*	*0.500*	*0.007*	*0.645*	*0.181*	*0.620*	*0.182*
	P	*SE*	*P*	*SE*	*P*	*SE*	*P*	*SE*	*P*	*SE*
LGR	*0.279*	*0.005*							*0.261*	*0.017*
LGS	*0.170*	*0.005*	*0.302*	*0.006*					*0.151*	*0.015*
LMN	*0.256*	*0.006*	*0.510*	*0.008*	*0.533*	*0.006*			*0.201*	*0.019*
McN	*0.422*	*0.143*	*0.341*	*0.275*	*1.000*	*0.000*	*0.757*	*0.213*	*0.754*	*0.214*
	λ	*SE*	λ	*SE*	λ	*SE*	λ	*SE*	λ	*SE*
McN-GRA	*0.001*	*0.0006*	*0.0003*	*0.0003*	*0.0004*	*0.0003*	*0.0003*	*0.0002*	*0.0066*	*0.0038*

Table A.IV.1 (Cont.)

Year	1994		19993		1994		1994		1994	
Run	Spring		Spring		Spring		Spring		Spring	
Rear	H		H		W		W		W	
Site	SNAKER		SNAKER		LEMHIW		MARTRP		CATHEC	
River Km	*522*		*522*		*1,290*		*1,325*		*1,025*	
Dates	4/16/94 - 4/17/94		4/16/93 - 4/17/93		9/5/94 - 11/15/94		8/19/94 - 11/2/94		9/12/94 - 12/1/94	
N Release	*2,481*		*2,510*		*1,494*		*3,445*		*1,978*	
N LGR	*906*		*1,093*		*315*		*473*		*201*	
N LGS	*608*		*963*		*140*		*318*		*148*	
N LMN	*748*		*640*		*122*		*337*		*152*	
N McN	*719*		*435*		*131*		*211*		*87*	
N GRA	*3*		*2*		*4*		*4*		*3*	
	S	*SE*	*S*	*SE*	*S*	*SE*	*S*	*SE*	*S*	*SE*
Release-LGR	*0.916*	*0.018*	*0.909*	*0.014*	*0.364*	*0.017*	*0.253*	*0.009*	*0.207*	*0.011*
LGR-LGS	*0.929*	*0.033*	*0.933*	*0.024*	*0.962*	*0.081*	*0.933*	*0.040*	*1.095*	*0.085*
LGS-LMN	*0.759*	*0.031*	*3.168*	*0.414*	*0.819*	*0.107*	*0.891*	*0.059*	*0.692*	*0.078*
LMN-McN	*1.608*	*1.305*	*0.148*	*0.104*	*1.404*	*1.200*	*1.111*	*0.901*	*0.731*	*0.516*
	P	*SE*	*P*	*SE*	*P*	*SE*	*P*	*SE*	*P*	*SE*
LGR	*0.399*	*0.013*	*0.479*	*0.012*	*0.579*	*0.028*	*0.543*	*0.020*	*0.491*	*0.029*
LGS	*0.304*	*0.014*	*0.513*	*0.015*	*0.298*	*0.031*	*0.423*	*0.023*	*0.357*	*0.034*
LMN	*0.503*	*0.018*	*0.112*	*0.015*	*0.323*	*0.041*	*0.509*	*0.034*	*0.535*	*0.053*
McN	*0.337*	*0.274*	*0.514*	*0.353*	*0.262*	*0.223*	*0.298*	*0.241*	*0.424*	*0.299*
	λ	*SE*	*λ*	*SE*	*λ*	*SE*	*λ*	*SE*	*λ*	*SE*
McN-GRA	*0.001414*	*0.001413*	*0.0024*	*0.0024*	*0.0081*	*0.0081*	*0.006*	*0.006*	*0.0169*	*0.0168*

APPENDIX V: Survival estimates to Lower Granite Dam

Since 1993 at least 164 estimates of juvenile survival from release site to LGR ($\hat{S}_{\text{Rel.–LGR}}$) has been reported. These estimates involve some 28 different release locations and a rather broad range of distances to LGR. Consequently, for our study, we decided to restrict the number of release sites to three. The juvenile survival estimates from these four locations (Table A.V.1), once averaged, provided values ($\overline{\hat{S}_{\text{Rel.–LGR}}}$) representing the expected survival to LGR of hatchery chinook yearlings released from four sites that were further and further apart from LGR:

Release Site	*River Km*	$\overline{\hat{S}_{\text{Rel.–LGR}}}$
SNAKER_4	*726*	*0.9018*
LOOH	*933*	*0.6850*
SAWT	*1,442*	*0.3957*

Table A.V.1: Estimates of survival to LGR and standard errors for PIT-tagged juvenile hatchery chinook released from four different locations.

Site	Release Numbers	Date	$\hat{S}_{\text{Rel.–LGR}}$	*SE*	Reference
SNAKER_4	*1,015*	4/15/93	*0.920*	*0.024*	Iwamoto et al., 1994
SNAKER_4	*1,305*	4/16/93	*0.900*	*0.019*	Iwamoto et al., 1994
SNAKER_4	*1,152*	4/17/93	*0.911*	*0.022*	Iwamoto et al., 1994
SNAKER_4	*1,208*	4/18/93	*0.904*	*0.023*	Iwamoto et al., 1994
SNAKER_4	*1,113*	4/19/93	*0.901*	*0.022*	Iwamoto et al., 1994
SNAKER_4	*797*	4/20/93	*0.895*	*0.024*	Iwamoto et al., 1994
SNAKER_4	*1,405*	4/21/93	*0.886*	*0.020*	Iwamoto et al., 1994
LOOH	*999*	4/7/93	*0.672*	*0.023*	Iwamoto et al., 1994
LOOH	*1,993*	4/10/94	*0.758*	*0.024*	Muir et al., 1995
LOOH	*1,983*	4/6/95	*0.758*	*0.019*	Muir et al., 1996
LOOH	*7,154*	4/4/96	*0.598*	*0.011*	Smith et al., 1998
LOOH	*40,042*	4/7/97	*0.598*	*0.010*	Hockersmith et al., 1999
LOOH	*43,939*	4/6/98	*0.704*	*0.005*	Smith et al., 2000
LOOH	*45,122*	4/6/98	*0.698*	*0.004*	Perez-Comas & Skalski, 2000
LOOH	*40,401*	4/7/97	*0.599*	*0.009*	Perez-Comas & Skalski, 2000
SAWT	*799*	4/20/93	*0.264*	*0.021*	Iwamoto et al., 1994
SAWT	*2,155*	4/8/94-4/11/94	*0.213*	*0.019*	Muir et al., 1995
SAWT	*1,499*	4/5/95-4/7/95	*0.231*	*0.019*	Muir et al., 1996
SAWT	*499*	4/21/98	*0.601*	*0.033*	Smith et al., 2000