Estimation of the 1995 Late Run Sockeye Salmon *(Oncorhynchus nerka)* Escapement to the Adams River Study Area

R. Houtman and B.P. Fanos

Fisheries and Oceans Canada
Science Branch, Pacific Region
100 Annacis Parkway, Unit 3
Delta, British Columbia
V3M 6A2

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ESTIMATION OF THE 1995 LATE RUN SOCKEYE SALMON (*Oncorhynchus nerka*) ESCAPEMENT TO THE ADAMS RIVER STUDY AREA

by

R. Houtman and B.P. Fanos

Fisheries and Oceans Canada

Science Branch, Pacific Region

100 Annacis Parkway, Unit 3

Delta, British Columbia

V3M 5P8

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In 1995, the Department of Fisheries and Oceans conducted a mark-recapture study to estimate the escapement of late run sockeye salmon (*Oncorhynchus nerka*) to the Adams River study area, which included the Adams River system, Little River, Scotch Creek and foreshores of Shuswap lake (3.1 km west and 10.5 km east of the Adams River mouth) and Little Shuswap lake. Sockeye were captured at seven sites in the lower Adams river; 4,291 were released with disk tags and secondary marks. The spawning grounds were surveyed through the period of spawning and die-off; 82,365 carcasses were recovered, of which 861 were marked. Analysis revealed that application was biased temporally, spatially and by sex, and that recovery was biased temporally and spatially; however, because the 95% confidence intervals of the pooled Petersen estimates overlapped those of the spatially and temporally stratified estimators, it was concluded that the pooled Petersen population estimates were not seriously biased. The 1995 escapement was estimated, using the pooled Petersen estimator, at 199,567 adult males, 205,795 adult females and 0 jacks. Study design changes, including changes in allocation of sampling effort, resurvey procedures and the assessment of disk tag loss, are recommended.

RÉSUMÉ

Houtman, R. and B.P. Fanos. 2000. Estimation of the 1995 late run sockeye salmon (*Oncorhynchus nerka*) escapement to the Adams River study area. Can. Manuscr. Rep. Fish. Aquat. Sci. 2533: 73 p.

En 1995, le ministère des Pêches et des Océans a mené une étude de marquage-recapture pour estimer l'échappée de la remonte tardive de saumon rouge (*Oncorhynchus nerka*) dans la zone d'étude de la rivière Adams, qui couvrait le réseau de la rivière Adams, la rivière Little, le crique Scotch et le littoral du lac Shuswap (sur 3,1 km à l'ouest et 10,5 km à l'est de l'embouchure de la rivière Adams), ainsi que le petit lac Shuswap. Les saumons ont été capturés à sept stations du cours inférieur de la rivière Adams; 4 291 spécimens ont été libérés après avoir été marqués avec des disques et des marques secondaires. Les frayères ont été surveillées pendant toute la période de fraye et de mortalité; 82 365 carcasses ont été récupérées, dont 861 étaient marquées. L'analyse a révélé que l'opération de marquage était biaisée temporellement, spatialement et par sexe, et que la récupération était biaisée temporellement et spatialement; toutefois, étant donné que les intervalles de confiance de 95 % des résultats obtenus avec l'estimateur multiple de Petersen chevauchaient ceux des estimateurs stratifiés spatialement et temporellement, il a été conclu que les estimations Petersen de la population n'étaient pas gravement biaisées. L'échappée de 1995 a été estimée, à l'aide de l'estimateur multiple de Petersen, à 199 567 mâles adultes, 205 795 femelles adultes et 0 mâle précoce. Il est recommandé d'apporter des modifications au plan d'étude, notamment des changements dans la répartition de l'effort d'échantillonnage, d'améliorer les procédures de deuxième relevé et d'évaluer la perte de disques.

INTRODUCTION

The Fraser River system supports the largest population of sockeye salmon (*Oncorhynchus nerka*) in the world (Northcote and Larkin 1989). Sockeye spawn in over 150 natal areas, ranging from small streams to large rivers and lakes, which are distributed throughout the accessible portion of the Fraser system. The Department of Fisheries and Oceans estimates the stock-specific annual abundance of Fraser River sockeye spawners using a two-tiered system originally developed by the International Pacific Salmon Fisheries Commission. Stocks with forecasted escapements above 25,000 are assessed using enumeration fences or mark-recapture studies, while stocks with smaller escapements are assessed using visual techniques.

The South Thompson River system supports two temporally and spatially distinct sockeye stock aggregates, the early summer and late runs. The early summer run spawns from late July to mid August, predominantly in streams tributary to Adams Lake (Cayenne creek and Momich and upper Adams Rivers) and Shuswap Lake (Anstey, Eagle and Seymour Rivers and Scotch Creek). Schubert (2000) and Houtman and Schubert (2000) describe the estimation of the 1995 escapement of this stock aggregate. The late run spawns from late September to late October, predominantly in Adams, Little and lower Shuswap rivers. Smaller populations spawn along the shores of and in small streams tributary to Adams, Shuswap and Little Shuswap lakes (Fig. 1). This report describes the estimation of the 1995 late run sockeye escapement to the Adams River system, Little River, Scotch Creek and foreshores of Shuswap lake (3.1 km west and 10.5 km east of the Adams River mouth) and Little Shuswap lake. Together, this area is referred to as the Adams River study area.

Escapements of late run sockeye stocks to the study area have been estimated since 1938 (Ward and Larkin 1964; Andrew and Webb MS 1987), and have exhibited a pronounced quadrennial cycle (Appendix 1). Since 1938, escapements have averaged approximately 1.73 million in the 1938-1994 dominant cycle-years, 320,000 in the 1939-1991 subdominant years (but with much higher escapements in recent years), and 6,000 and 70,000 in the 1940-1992 and 1941-1993 off-cycle years respectively. In dominant cycle-years, a relatively large proportion of the study area escapement (16% average over the last five cycles) has spawned outside of the lower Adams River, mainly in Little River. In sub-dominant cycle-years this proportion is much smaller (8% average over the last five cycles; Appendix 1).

A mark-recapture study was implemented to estimate the 1995 late run escapement to the study area because escapement forecasts exceeded 25,000. Schubert and Fanos (1997) described the mark-recapture study conducted in 1994. The 1995 study was similar, but included modifications designed to reduce sample selectivity and to facilitate assessment of tag loss and the effects of sub-acute and acute stress. This report describes the study's design, field methods and analysis. Estimates of the sex-specific escapement and average spawning success are provided for each of the study area creeks, rivers and lakeshore areas that support sockeye spawning. Estimates of the adult age and length distributions and average fecundities, based on samples collected in the lower Adams River, are also provided. Mark-recapture biases are evaluated, including a comparison of escapement estimates calculated using alternative models. The report concludes with a discussion of the results and recommendations for the design of future studies.

STUDY AREA

The study area is situated in the South Thompson River system, which originates in south-central British Columbia at the eastern-most portion of the mid-Fraser watershed (Fig. 1). The system includes Shuswap Lake, which accepts the flow of several rivers with significant sockeye populations. From Shuswap Lake, water drains west through Little River (3 km), Little Shuswap Lake and the South Thompson River (56 km) to its confluence with the North Thompson River at Kamloops. Here, the 'component' areas of the study area for which specific escapement estimates are made are described in detail.

LOWER ADAMS RIVER AND TRIBUTARIES

Portions of the Adams River downstream and upstream of Adams Lake are referred to as the lower and upper Adams Rivers, respectively. The lower Adams River (11 km) originates at the south end of Adams Lake and flows south-east, entering the north side of Shuswap Lake 1 km east of Little River (Fig. 2). The river has a

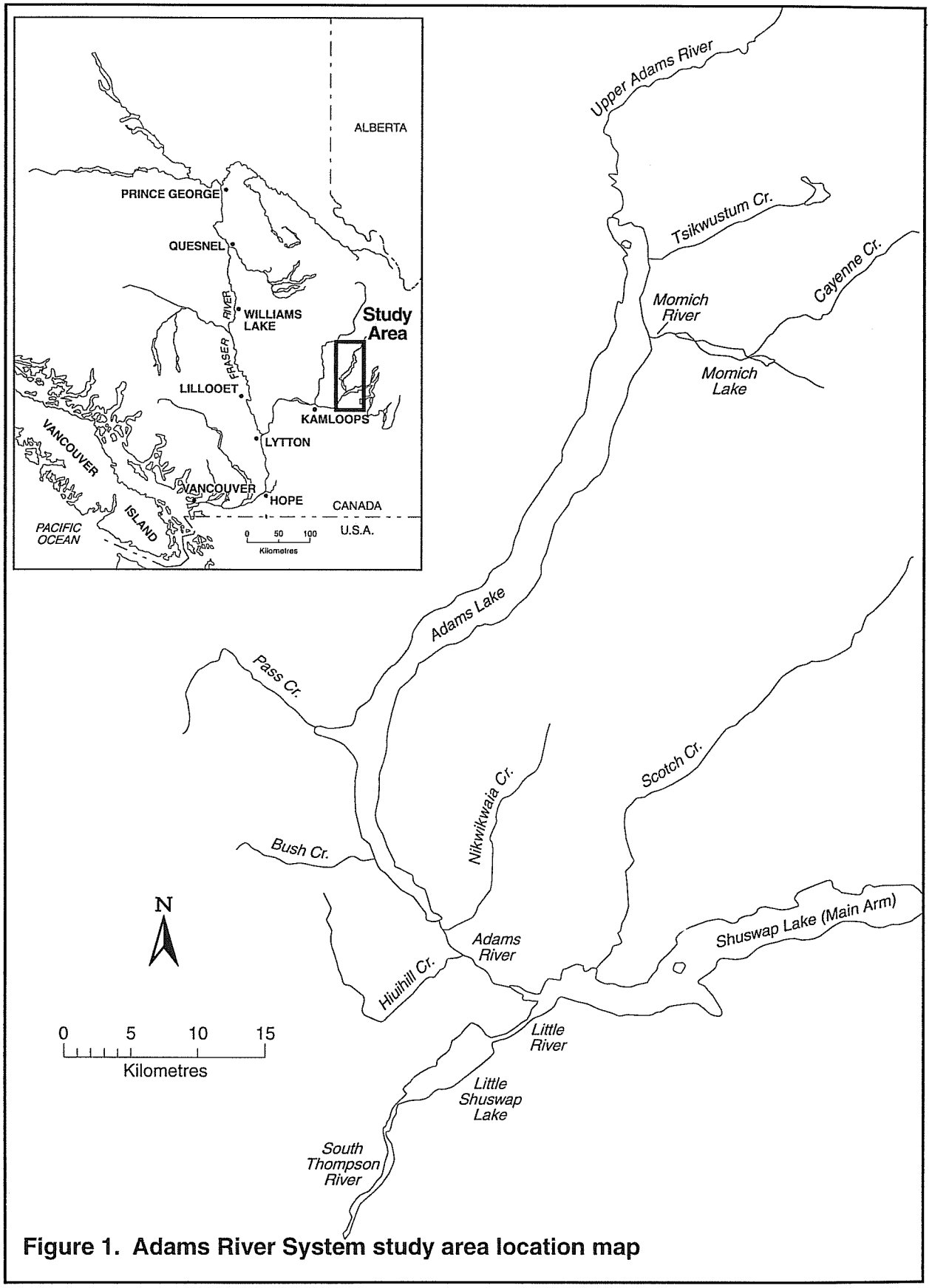

Figure 1. Adams River System study area location map

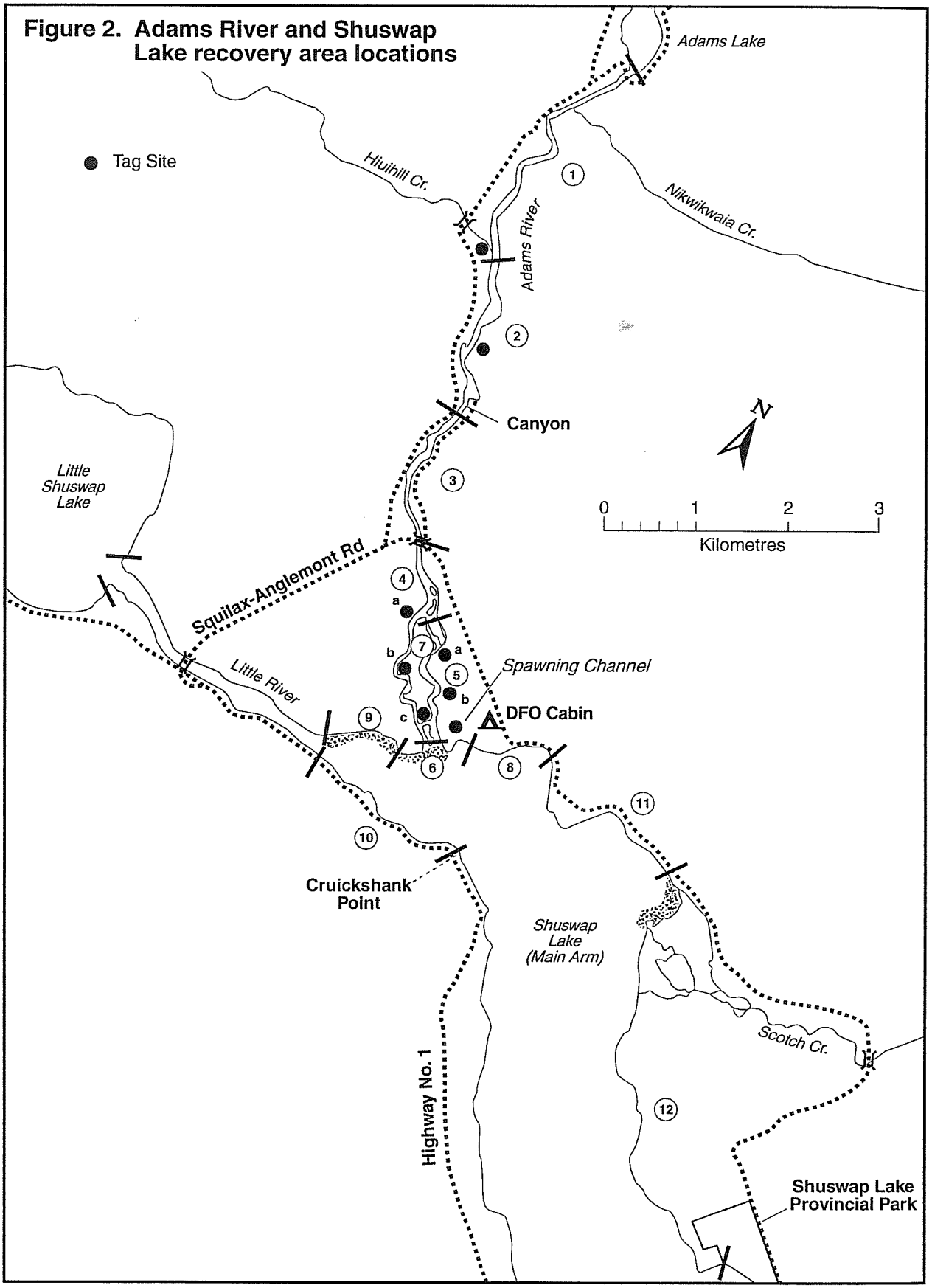
Figure 2. Adams River and Shuswap Lake recovery area locations
Tag Site
Adams Lake
Hiuihill Cr.
Nikwikwaia Cr.
Adams River
Canyon
N
0 1 2 3
Kilometres
Little Shuswap Lake
Squilax-Anglemont Rd
Little River
Spawning Channel
DFO Cabin
Cruickshank Point
Shuswap Lake (Main Arm)
Scotch Cr.
Highway No. 1
Shuswap Lake Provincial Park

mean daily discharge (1911-1990) of 71 $m^3 s^{-1}$ with mean daily maxima (198 $m^3 s^{-1}$) and minima (18 $m^3 s^{-1}$) occurring in June and February, respectively (Environment Canada 1991). The river is accessible by road at the highway bridge, the outlet of Adams Lake, and on the east side of the river 5 km below Adams Lake (Fig. 2). Roderick Haig-Brown Provincial Park, which borders the lower areas to the east, provides foot access to the river from a network of trails and viewing platforms. Enumeration activities were based at the Fisheries cabin located on the Scotch Creek Highway, adjacent to the park.

The river was divided into seven areas (Fig. 2) to provide the data aggregations required for bias testing and for population estimation using stratified models. Areas were established based on three criteria: homogeneity of physical characteristics such as gradient, channel morphology and substrate type; the ability of the crews to access and survey an area in one day; and the presence of easily identifiable land marks to delineate the areas.

For most of the upper 8 km (areas 1 to 3), the river is mainly a single channel with moderate flow and cobble/boulder substrate. Area 1 (3.6 km) extends from the outlet of Adams Lake downstream to a point 100 m below the mouth of Hiuihill (locally, "Bear") Creek. Area 2 (2.2 km) extends downstream to a 15 m wide by 100 m long canyon and has some braiding and riffles. Area 3 (2.2 km) extends downstream to the Scotch Creek Highway Bridge.

Late run sockeye spawn in both Hiuihill and Nikwikwaia (locally, "Gold") Creeks, which enter the Adams River in Area 1. Hiuihill Creek originates near Bruhn Ridge and flows south-east for 23 km. Nikwikwaia Creek originates on the Adams Plateau and flows south-west for 22 km, entering the Adams River 1 km below Adams Lake. Sockeye spawning is confined to the lower 0.8 and 1.2 km of Hiuihill and Nikwikwaia Creeks, respectively.

Most of the lower 3 km of the river (areas 4, 5 and 7) is flood plain. The channel splits into east and west channels 1.2 km below the bridge; each channel forms several subsidiary channels that flow around gravel bars and treed islands. In this section, gravel/cobble substrate predominates and water depth ranges from 0.5 to 3.0 m. Sockeye spawning is typically heavier here than in any other region of the study area. Area 4 (3 km) extends from the bridge downstream to the river mouth, including only the right bank of the west channel after the river splits. Small in-stream islands accessible on foot from the right bank were included in this area. Area 5 (2.0 km) extends from the split to the mouth, including only the left bank of the east channel. Area 7 (1.5 km) consists of all mid-channel islands that separate the east and west channels in areas 4 and 5. This section is a network of braided channels that range from a few metres to 50 m in width and are characterized by debris jams, riffles, chutes, and deep pools.

Area 6 includes the lower 50 m of the Adams River and 100 m of Shuswap lake shore on either side of the river mouth. The Adams River mouth is shifting and braided with a gravel/sand substrate. A small, groundwater-fed spawning channel enters the lake at the river mouth; this spawning channel was not treated as part of the study area (see below).

ADAMS LAKE AND TRIBUTARIES

Sockeye spawn in lakeshore areas of Adams Lake (13,120 ha) and in five of its tributaries: the upper Adams River (187 km), Bush Creek (11 km), Cayenne Creek (46 km), Momich River (17 km) and Pass Creek (21 km; Fig. 2). Although the majority of spawners in these areas are early run sockeye (Schubert 2000), late run fish also spawn there (Appendix 1). Known and potential late run spawning areas on Adams Lake and in these tributaries were therefore included in recovery surveys (see Methods). Most of these areas were accessed by boat.

LITTLE RIVER

The 3 km portion of the South Thompson River connecting Shuswap and Little Shuswap lakes is known locally (and hereafter) as Little River (Fig. 1). The flow characteristics of this river have not been measured; however, the South Thomson River just below Little Shuswap Lake is likely similar and has a mean daily discharge (1911-1990) of 289 $m^3 s^{-1}$ with mean daily maxima (855 $m^3 s^{-1}$) and minima (91 $m^3 s^{-1}$) occurring in June and March, respectively (Environment Canada 1991). The channel of Little River is 150-300 m wide and over two metres deep, with slow flow and gravel/sand substrate. This area was accessed by road and boat.

SCOTCH CREEK

Scotch Creek originates east of Adams Lake and flows southwest for 56 km, entering the main arm of Shuswap Lake at Little Shuswap In-

dian Band Reserve No. 4, 3 km east of the Adams River (Fig. 1). The creek has a mean daily discharge (1915, 1947-1948) of 11.1 $m^3 s^{-1}$ (incomplete records for March and April) with mean daily maxima (36.6 $m^3 s^{-1}$) and minima (1.2 $m^3 s^{-1}$) occurring in June and February, respectively (Environment Canada 1991).

Sockeye distribution extends 16 km upstream; this entire length was surveyed, with access by road. In the upper 12 km the creek is predominantly a single channel with numerous riffles and glides, a width of 10-20 m and a gravel/cobble substrate. In the lower 4 km, the creek flows across a broad floodplain with lower gradient and gravel/sand substrate and becomes increasingly meandering downstream. Debris jams cause frequent channel shifting and splitting, especially on the delta.

SHUSWAP LAKE

Shuswap Lake (31,000 ha), located in the Shuswap Highlands at an elevation of 348 m, is a multiple-basin lake with maximum and average depths of 162 m and 62 m, respectively (Goodlad *et al.* 1974). The lake is composed of the main arm and three smaller arms: Seymour, Anstey and Salmon. The main arm, with a length of 40 km and an average width of 3 km, extends from Cinnemousen Narrows to the lake outlet at Little River. Small populations of late run sockeye spawn in lakeshore areas on submerged beaches near creek mouths.

The study area includes the shore of the main arm extending east from the Little River outlet to Shuswap Lake Provincial Park on the north and Cruickshank Point on the south (Fig. 2). The shoreline was divided into five areas to facilitate the allocation of survey effort and the data aggregations required for bias testing (Fig. 2). Areas 8, 11 and 12 (2.5, 2.7 and 5.3 km, respectively) extend east from Adams River (Area 6) to Shuswap Lake Provincial Park. A log sorting area demarcates areas 8 and 11, and the mouth of Scotch Creek demarcates areas 11 and 12. Area 9 (0.9 km) extends west from Adams River to Little River and Area 10 (2.2 km) extends east from there to Cruickshank Point lighthouse. The entire shoreline in these areas was surveyed on foot; access to this area was by road and boat. Most carcasses recovered here were probably flushed from the Adams River.

LITTLE SHUSWAP LAKE

Little Shuswap Lake (1,820 ha; Fig. 1) has maximum and average depths of 64 m and 14 m, respectively (Goodlad *et al.* 1974). Late run sockeye spawn in low numbers on gravel bars near the outlet of Little River. Carcass recovery surveys extended west from the mouth of Little River, approximately 2 km on the north shore and 5 km on the south shore; these areas were accessed by road and boat.

FIELD METHODS

VISUAL COUNTS

Live sockeye (not discerning tagged and untagged fish) were counted in all component areas. Sockeye in lower Adams River areas 1-5 (including only the portion of Area 4 above the fork) were counted from an inflatable boat. These drift counts were recorded by area to aid setting daily tagging targets. Drift counts began when sockeye were first observed in the river and continued until high densities made them unreliable; thereafter, drift counts were less frequent and restricted to the lower areas of the lower Adams River. Sockeye spawning on Adams, Shuswap and Little Shuswap lakeshores were counted from a powerboat. Little River sockeye were counted from a helicopter during the estimated peak of spawning. Finally, sockeye were counted during carcass recovery surveys in all other component areas of the study system.

TAG APPLICATION

Capture and tagging procedures were designed to tag at least 1% of the escapement, and to distribute those tags among adult males, females and jacks in a spatially and temporally representative manner. Sockeye were captured by beach seine at sites located in areas 1, 2, 4 (three sites referred to as 4a-c) and 5 (two sites, 5a and 5b) in the lower Adams River (Fig. 2). The upper river tag sites (in Area 1 and 2) were added, as recommended by Schubert and Fanos (1997), to improve the distribution of tagged fish relative to the 1994 study. No reliable, independent estimate of daily abundance was available. To achieve temporally proportional tag application, therefore, similar daily effort was applied throughout the run; typically, one and two successful sets per day were made at upper and lower tag sites, respectively.

Sockeye were captured by a four-person crew using a 36.5 m x 3.8 m x 5 cm-mesh beach seine net. The net was set from a jet-powered boat in a downstream arc and withdrawn from the river to enclose an area of water along the riverbank. Captured fish were held in the net until removal for tagging. Previously tagged fish were identified upon recapture and immediately processed to minimize additional stress. The tag number was recorded and the tag checked; if damaged by recapture, it was replaced with a new tag. Other species and sockeye that were injured or showed advanced stages of maturation were released untagged.

Fish were tagged in a flexible plastic trough (12 cm x 20 cm x 100 cm) suspended in a wooden tray with a metre stick attached. In order to evaluate the susceptibility of this population to tagging-induced stress, standard and low-stress tagging procedures were alternated every fish. Standard procedures entailed tagging the fish with the tray elevated from the water surface and releasing it by throwing it the minimum necessary distance over the net's cork line. Low stress procedures entailed tagging the fish with the tray immersed in 15 cm of water and releasing it by lowering a section of the cork line; at no time was the fish removed from the water. Handling time for both procedures averaged 25-30 seconds. In addition, the following general fish handling guidelines were adopted in 1995 to reduce tagging-induced stress: activity within the net was minimized to reduce siltation; fish were removed from the water only when a tagger was ready and processed as quickly as possible; and, when removed from the water, the fish were cradled in two hands rather than dangled by the caudal peduncle.

The disk tags consisted of two red 15 mm diameter laminated cellulose acetate disks threaded through centrally punched holes onto a 77 mm long nickel pin. The pin was inserted with pliers through the musculature and pterygiophore bones approximately 12 mm below the anterior portion of the dorsal fin insertion. The disk tags, arranged with one on each side of the fish, were secured by twisting the pin into a double knot. One disk per pair was numbered with a unique code. Each tagged fish received a secondary mark to permit an assessment of tag loss. These consisted of one (males) or two (females) 7 mm diameter holes punched through the right operculum using a single hole punch. Care was taken to avoid gill tissue damage. Date and location of capture, disk tag number, nose-fork (NF) length (±0.5 cm), sex, number of opercular holes punched, tagging method, and marks (gill net, hook and lamprey) were recorded for each fish released with a disk tag. Males that looked like jacks (*i.e.*, fish substantially smaller than adults with secondary sex characteristics generally intermediate between those typical of adult males and females) were to be recorded as jacks. Condition at release was recorded as 1 (swam away vigorously), 2 (swam away sluggishly) or 3 (required ventilation).

SPAWNING GROUND SURVEYS

Recovery Survey

The goal of recovery surveys was to recover carcasses proportionately (relative to total carcass abundance) spatially and temporally, to achieve equal recovery probabilities in all recovery strata. In smaller study areas, this goal can be achieved by performing recovery surveys at similar frequencies in all areas, throughout the die-off period. Because of the size of the study area and low spawner (and carcass) density in large portions of the study area (relative to lower Adams and Little rivers), however, survey frequency varied by area with carcass abundance. This recovery policy may have led to disproportionate recovery, and should be reconsidered in future studies.

Shores were surveyed on foot by two-person crews, with up to five crews required at the peak of die-off. The crews were trained to recover carcasses independent of their tag status and, following recovery, to place a higher priority on the correct identification of tag and secondary mark status than on survey speed. All carcasses which were on shore or retrievable with a peough by wading into the river to knee depth were enumerated (except predator kills, which were excluded from the survey), and either chopped in two with a machete or thrown on the bank above the high water mark. Carcass recoveries were recorded by date, area, sex, suspected age class for males, tag and secondary mark status and carcass condition (fresh, tainted or rotten). Spawning success (0%, 50% or 100% spawned) was estimated, by incision, for every tagged and, until October 4, every untagged female recovery. Thereafter, spawning success was only estimated for, generally, two untagged female carcasses recovered after a tagged female recovery. If a disk tag was present, it was retrieved and the tag number was recorded before the carcass was processed.

In 1995, carcasses unavailable to standard recoveries were sampled using two "non-standard" methods, to allow a test of the assumption of equal recovery probabilities of marked and unmarked carcasses. First, carcasses in deep (> 1.5 m) pools (hereafter, "pool-recoveries") in lower Adams River were sampled opportunistically using a beach seine net or gaff and recorded by tag status, sex, date and area. Second, a stationary cargo net (61 m long x 5 cm mesh x 150 meshes deep) was used to collect carcasses (hereafter, "net-recoveries") as they drifted out of the lower Adams River. The net was anchored on the north shore of Shuswap Lake, 250 m west of Adams River, and recovered carcasses recorded as above.

Resurvey

In the lower Adams River and Shuswap Lake, previously processed carcasses were resampled through the recovery period to identify disk tagged carcasses that had been erroneously classified as untagged. Other parts of the study area were not resurveyed due to low carcass abundance. The resurvey, conducted by experienced technicians, recorded carcasses by date, area, sex and mark status. Schubert and Fanos (1997) identified deficiencies in the 1994 resurvey that were addressed by more frequent and extensive survey effort.

On the initial survey, tags were removed from carcasses identified as disk tagged, but those carcasses were not excluded from the resurvey. The number of fish with only secondary marks which were misclassified as unmarked, therefore, could not be determined.

BIOLOGICAL SAMPLING

Biological samples were obtained following a protocol provided by the Pacific Salmon Commission. One hundred and eighty sockeye carcasses of each sex were sampled for postorbital-hypural plate (POH) and nose-hypural plate (standard) lengths (±0.5 cm), otoliths and scales (one from each preferred region, as defined by Clutter and Whitesel (1956)). Samples were collected in three sets of 60 male and female carcasses collected approximately 10 days before, during, and 10 days after, peak die-off (based on the historic mean date). Sampled carcasses were selected randomly from fresh or tainted recovered carcasses in the lower Adams River. The age distribution in these samples was assumed representative of the entire late run study area escapement.

Near the peak of arrival, 50 randomly selected females were killed during tagging. Each was sampled as above, and the egg skeins and loose eggs were removed, placed in a cotton bag and preserved in a 10% formaldehyde solution. The number of eggs in each sample was estimated as the product of the total skein weight (grams) and the number of eggs per gram in a weighed subsample of the skein, plus a count of the loose eggs.

ANALYTIC PROCEDURES

Analytic procedures are presented in three sections. The first section describes the procedures by which the data were evaluated and corrected for sex and tag identification error, tag loss, and acute stress effects. The second explains the procedure used to evaluate potential sampling biases. The results of this analysis were used to guide evaluations of bias in the resulting population estimates and the need to adopt stratified estimators. The third section describes the procedures used to calculate population estimates, and to evaluate alternative estimates.

DATA ADJUSTMENTS

Sex Identification Error

The application data were corrected for sex identification error by comparing the sexes recorded at release and carcass recovery. All errors are assumed to be made at application, because the development of sexually dimorphic traits was less advanced at application, recording errors were more likely to occur during the hectic tagging process and carcasses of ambiguous sex could be incised and examined internally.

The corrected total number of adult males (defined as males with NF $\geq$ 50 cm; hereafter, 'males') tagged (M_m*) was estimated using an equation provided by Staley (1990). The corrected number of male sockeye tagged in a given application 'stratum' was estimated by multiplying the fraction of all fish released as males that were released in that stratum by M_m*. The corrected number of adult females (hereafter, females) tagged in that stratum was estimated as the total number of adults actually released minus M_m*.

Emigration

Tagged fish recovered in the spawning channel or outside of the study area are considered emigrants, and were removed from the application sample used for all subsequent analyses. The estimated number of unrecovered emigrant tagged fish was also removed from the application sample before calculating escapement estimates, proportionately from each sex and stratum (relative to the proportion of tags applied in a stratum) for stratified population models. All carcasses were removed from the spawning channel; therefore, all tagged emigrant fish were recovered. In surveys of shore areas outside the study area, however, only a fraction of the population was recovered; therefore, the total number of emigrants to these areas had to be estimated. This number was estimated as the product of the tag incidence among carcasses recovered in areas outside the study area and the population estimate in those areas.

Non-Standard Recoveries

Tagged and untagged pool and net recoveries were excluded from the application and recovery samples used in all subsequent analyses. These recoveries were opportunistic and consequently not representative of the population. Because their removal precluded subsequent recovery during standard surveys, they were not part of the study population. Consequently, they were added to the final population estimate.

Handling Stress

Tagging-induced stress can influence post-tagging behavior and the timing and probability of recovery. The data, therefore, were evaluated to determine whether specific tags should be excluded from the application sample. First, chi-square tests were used to test whether the proportion of tagged fish recovered was influenced by three potential stress factors: tagging method, release condition and the number of times tagged fish were recaptured in subsequent beach seine sets. When a test result was significant, the high stress group was excluded from subsequent analyses. Throughout this report, significant ($P<0.05$) and highly significant ($P<0.005$) test results are indicated with a single and double asterisk, respectively. Second, fish recovered less than five days after release were excluded. While five days is an arbitrary criterion, unusually short times between application and recovery are typically associated with poor spawning success and are assumed to result from tagging stress.

Tag Loss

Because all fish released with a tag also received a permanent secondary mark, the rate of tag loss between application and carcass recovery equals the ratio of recoveries with only secondary marks to those with disk tags and/or secondary marks. Fish recovered with only secondary marks were included as marked recoveries for the population estimates. For stratified population estimates, these fish were added to application strata in proportion to the fraction of total application sample applied in each stratum.

Tag Recognition Error

Resurvey data were used to correct the carcass recovery totals for tags that were missed on the initial survey. The number of missed tags was estimated, by sex, as the product of the tag incidence in the resurvey and the number of carcasses examined on the initial survey. For stratified population estimates, these recoveries were added to recovery strata in proportion to the fraction of total disk tagged carcasses recovered in each stratum.

TESTS OF SAMPLING ASSUMPTIONS

Statistical tests were performed to assess whether application and recovery were proportional and whether complete mixing occurred (Seber 1982; p 434-9; Schwarz and Taylor 1998). The data were examined for temporal, spatial and fish sex biases at application and recovery. Application bias (non-proportional application and incomplete mixing) was assessed by stratifying the recovery sample (not corrected for missed tags) and comparing the mark incidence (the proportion of carcasses with disk tags and/or secondary marks) among strata. Similarly, recovery bias (non-proportional recovery and incomplete mixing) was assessed by stratifying the application sample and comparing the proportion recovered among strata. The data used for the recovery bias tests are adjusted for sex identification error, recovered emigrant tags, handling stress and tags recovered by non-standard methods, but not for tag loss (the application stratum of fish with only a secondary mark could not be determined). Comparisons were made using chi-square tests (Sokal and Rohlf 1981).

For temporal bias tests, the application and recovery samples were stratified into five periods of approximately equal duration, total effort (numbers of sets or recovery surveys) and total numbers of sockeye marked or recovered. These three stratifications were used to examine the sensitivity of the tests to period start and end dates. For spatial bias tests, the application sample was stratified into five application areas (sites 1 and 2; Site 4a; Site 4b; Site 4c; and sites 5a and 5b) and the recovery sample was stratified into five recovery areas (Adams River system above Area 4; areas 4,5 and 7; Area 6; Shuswap Lake and Scotch Creek; and Little River and Little Shuswap Lake).

The data were also examined for a size bias in recovery; application bias could not be assessed because unmarked carcasses were not measured. The cumulative NF length frequency distributions of recovered and unrecovered portions of the application sample were compared using a Kolmogorov-Smirnov two-sample test (Sokal and Rohlf 1981). For the male test, all males were included. A significant difference would indicate that the recovery sample was not random with respect to fish size.

Normally, a chi-square test can be used to examine whether mark status influenced spawning success. The October 4 change of the fraction of untagged female recoveries sampled for spawning success (see above), however, makes such a test inappropriate because untagged females which died early are over-represented. The weighted average spawning successes of tagged and untagged female recoveries, therefore, are simply compared (without an inference test).

Finally, to test the assumption of equal recovery probabilities of marked and unmarked fish (discussed below), the mark incidence among pool and standard recoveries was compared using a chi-square test. For these tests, fish which were otherwise excluded from the application sample because of indications that handling stress influenced their recovery probability or timing were included, due to the possibility that stressed fish would be over- or under-represented among non-standard recoveries.

ESTIMATION OF SPAWNER POPULATION

Mark-Recapture

Adams River study area escapement was estimated using the simple or pooled Petersen estimator ("PPE"; Seber 1982) and two stratified estimators, the maximum likelihood Darroch estimator ("MLE"; Plante 1990; Arnason *et al.* 1996) and the Schaefer estimator (Seber 1982). The estimates were calculated using Stratified Population Analysis System software (Arnason *et al.* 1996), from mark-recapture data adjusted for sex and tag identification errors, emigration, non-standard recovery, handling stress effects and lost tags (Table 1).

Stratified population estimates were calculated using both temporal and spatial data arrays. The initial application and recovery strata were the same as those used in the bias tests (described above), for both temporal (periods of similar duration) and spatial data arrays. Selected strata were then pooled when necessary to generate an estimate and satisfy assumptions of the MLE as assessed by Plante's goodness-of-fit test (Arnason *et al.* 1996). This selective pooling also permitted an evaluation of model sensitivity and stability. For temporally stratified data, only temporally adjacent strata were pooled, and the stratum with the smallest number of tags applied or recovered was generally pooled. For spatial strata, the areas downstream of Adams River system were pooled first. The second pooling step aggregated application sites 4b and 4c. The last step aggregated application stratum 5a-b with the aggregated 4b-c stratum. Population estimates were calculated after each pooling step.

Sampling biases were addressed in two ways. First, population estimates were calculated for each sex because sex biases are common in mark-recapture studies. Second, spatial and temporal biases were evaluated by comparing the PPE and MLE estimates. The latter are considered most accurate, and therefore accepted, when the 95% confidence intervals of the two estimates did not overlap; otherwise, the PPE estimates are accepted, because their precision is generally higher. Schaefer estimates were only calculated for comparison; they were not considered for use as the final population estimate because no precision estimates are available.

Area-Specific Population Estimates

For each component area in the study area, excluding lower Adams River, the escapement was estimated as the product of the maximum ("peak") daily live count plus the cumulative recovery of all carcasses (males, females and

Table 1. The order in which analytical procedures were applied in estimating the 1995 late run sockeye salmon escapement to the Adams River study area.

	Procedure	Data adjustment
1.	Sex identification error adjustment	Adjusted application sample: 2 more males and 2 fewer females released
2.	Removal of emigrant tags recovered in associated studies	Removed 10 males and 5 females from application sample
3.	Removal of nonstandard recoveries	Removed 11 tagged males and 8 tagged females from application sample. Note, these recoveries were never included in the standard recovery sample
4.[a]	Stress tests:	
	Effect of application method	Not significant: no adjustment
	Effect of release condition	Not significant: no adjustment
	Effect of number of recaptures	Significant: 51 males and 48 females recaptured 2 or more times removed from application sample
5.	Removal of fish recovered less than 5 days after release	Removed 23 males and 14 females from application sample
6.	Bias tests	None intended
7.	Lost tag adjustment	1 male and 1 female recovered with only secondary marks added to marked recovery sample
8.	Tag identification error adjustment	Added 25 males and 30 females to the marked recovery sample
9.	Removal of estimated number of unrecovered emigrant tagged fish	Removed 6.6 males and 6.0 females from application sample
10.	Population estimates	None intended

[a] These tests were all performed using the application sample adjusted through step 3.

jacks) up to and including the date of that count, and an expansion factor of 1.8 (Andrew and Webb MS 1987). The latter was based on historic comparisons of visual data with mark-recapture and enumeration fence data (Woodey 1984). For areas where the entire carcass sample was 10% or more of the area-specific escapement estimate, the sex ratio in that carcass sample was used to estimate the sex ratio of that escapement. For other areas, the sex ratio of the study area escapement estimates was used. The escapement to the lower Adams River was estimated by subtracting each of these estimates from the study area mark-recapture estimate.

RESULTS

VISUAL COUNTS

Drift counts of the lower Adams River were made from September 19 to October 16 (Appendix 2). The first fish were counted on September 25; note that the previous count was made six days earlier. The peak live count (170,346) was recorded on October 14, with 6%, 12%, 7%, 47% and 28% of the sockeye in areas 1, 2, 3, 4 and 5, respectively. The aerial count of Little River, on October 14, was 4,900. Counts of other component areas are reported below.

TAG APPLICATION

Sockeye were tagged from September 25, up to five days after the first sockeye entered the Adams River, to October 30 (Appendix 3), after which almost no untagged and non-spawning sockeye were caught, indicating the end of immigration. A total of 4,461 sockeye were tagged, with 12%, 1%, 40%, 12%, 17%, 2% and 17% applied at sites 1, 2, 4a, 4b, 4c, 5a and 5b, respectively. No jacks were tagged. The sex of 15 (0.3%) recovered males and 15 (0.3%) recovered females were recorded incorrectly at the

Table 2. The influence of three potential stress factors on the proportion of tags recovered; test data and results for late run Adams River study area sockeye salmon, 1995. [a]

	Disk tags applied			Disk tags recovered					
	Male	Female	Jack	Male	Female	Jack	Male	Female	Jack
Tag application method									
Standard	1,124	1,091	-	226	231	-	20.1%	21.2%	-
Low-stress	1,190	1,022	-	236	207	-	19.8%	20.3%	-
Release condition [b]									
1	2,290	2,101	-	458	437	-	20.0%	20.8%	-
2	22	10	-	4	1	-	18.2%	10.0%	-
3	2	2	-	0	0	-	0.0%	0.0%	-
Number of recaptures									
0	2,136	1,988	-	408	403	-	19.1%	20.3%	-
1	127	77	-	30	18	-	23.6%	23.4%	-
2 or more	51	48	-	24	17	-	47.1%	35.4%	-

Chi-square test results

	Male			Female		
Stress factor	χ^2 value	df	*P*	χ^2 value	df	*P*
Tag application method	0.01	1	0.91	0.22	1	0.64
Release condition (1 vs 2+3):	0.02	1	0.88	0.50	1	0.48
Number of recaptures						
Comparing 0, 1 and ≥ 2:	25.49	2	0.00 **	6.88	2	0.03 *
Comparing 0 vs 1:	1.36	1	0.24	0.29	1	0.59
Comparing 0+1 vs ≥ 2 :	21.42	1	0.00 **	5.65	1	0.02 *

[a] Values are based on the final application and recovery data sets, after exclusion of certain tagged and untagged fish for several reasons, and correction for sex identification errors- see text.

[b] See text for description of release conditions.

time of tagging. When corrected for this error, an estimated 2,335 (52.3%) males and 2,126 (47.7%) females were marked.

Four sets of fish were removed from the application sample before performing bias tests (Table 1; Appendix 4). First, one tagged female recovered on Shuswap Lake outside of the study area and ten tagged males and four tagged females recovered in the spawning channel census were removed as emigrants. Second, 11 males and 8 females recovered using non-standard methods were removed. Third, 51 males and 48 females recaptured 2+ times were removed because their recovery rate was significantly different than that for fish recovered 0 or 1 times (Table 2; Zar 1984), indicating that recapture stress affected their recovery probability. (Significant differences in the fraction of these males recovered in lower Adams River (Chi-square=6.5, p=0.01, df=1), and the time between application and recovery of these females (*t*-test, *t*=1.76, p=0.05, df=15), relative to those for fish recaptured less than two times, support the decision to exclude these fish). The proportion of tagged fish recovered was not affected, significantly, by application method or release condition, for either sex (Table 2); thus, fish in the high-stress groups were retained. Finally, 23 males and 14 females recovered less than five days after application were removed from the application sample. After these removals, the application sample included 2,240 males and 2,051 females (Table 3; Appendix 3).

In the main arm of Shuswap Lake, outside of the study area, 118 carcasses were recovered, of which 1 female was tagged. The population estimate for this area was 1611 (Schubert 2000). Thus, the estimated total number of tagged emi-

Table 3. Sockeye tagged, total carcasses recovered and marked carcasses recovered, by sex, for late run Adams River study area sockeye salmon, 1995. [a]

	Sockeye tagged				Marked sockeye carcasses recovered					
Sex	Initial total	Estimated emigrants	Final total	Total recovery	Both marks	2° mark only	Resurvey adjustment	Total	Percent recovered	Tag incidence
Male	2,240	6.6	2,233.4	38,577	406	1	25	432	19.3%	1.1%
Female	2,051	6.0	2,045.0	43,788	398	1	30	429	20.9%	1.0%
Jack	0	-	-	0	-	-	-	-	-	-
Total	4,291	12.7	4,278.4	82,365	804	2	55	861	20.1%	1.0%

[a] Values are based on the final application and recovery data sets, after exclusion of certain tagged and untagged fish for several reasons, and correction for sex identification errors- see text.

grants to this area was 13.65. Applying the sex ratio in the application sample (original sample after correction for sex identification error), an estimated 6.62 tagged males and 6.03 tagged females emigrated but were not recovered (Table 3). The male and female application samples were reduced by those amounts before calculating mark recapture estimates.

The mean NF length of males and females in the application sample was 62.4cm and 58.1 cm, respectively; ageing samples (*i.e.*, otoliths and/or scales) were not obtained for any tagged fish. The incidence of net, lamprey and hook marks was 6.3%, 5.5% and 0.7% in males and 11.7%, 3.4% and 0.0% in females, respectively (Appendix 5).

SPAWNING GROUND SURVEYS

Recovery Survey

A total of 38,577 male, 43,788 female and no jack carcasses were recovered by standard methods in the study area from September 26 to November 9 (Table 3; Appendices 6 and 7). Areas of the lower Adams River were surveyed an average of 40 times, resulting in 68,501 recoveries, 83% of the total study area recovery. Most of these recoveries were made in areas 4 (35 %), 5 (14 %) and 7 (25 %) (Appendix 6). Surveys were run every second day in Shuswap Lake, Little River and Little Shuswap Lake from October 1 to November 9, resulting in 9,889, 1,898 and 1,502 recoveries, respectively (Appendix 7). Other parts of the study area were surveyed less frequently, resulting in 575 recoveries (Appendix 7).

Of the total recovery, 407 (1.05%) males and 399 (0.90%) females had disk tags and/or secondary marks; one male and one female had lost the disk tags, a tag loss rate of 0.25% in both sexes (Table 3). For lower Adams River and Shuswap Lake recoveries, average time between release and recovery was 12.0 days for males and 11.7 days for females, and was slightly longer among those tagged earlier in the study (Table 4). Average time between release and recovery ranged from 11.6 days in areas 4, 5 and 7, to 14.2 days in Little River and Little Shuswap Lake. Female carcasses recovered in lower Adams River and Shuswap Lake had an average spawning success of 94.5%, with lower success among the early spawners (Table 4). Average spawning success ranged from 60.3% for Scotch Creek, to 97.2% for lower Adams River areas 1-3.

A total of 603 male and 940 female carcasses were recovered in pools in areas 2, 3 and 5 from October 26 to November 1; 9 (1.5%) males and 9 (1.0%) females had disk tags (Appendix 8). As well, 1 tagged and 12 untagged male carcasses and 0 tagged and 6 untagged female carcasses were recovered in the net from October 5 to November 10.

Resurvey

The lower Adams River and areas 8-10 in Shuswap Lake were resurveyed an average six times from October 10 to November 10 (Appendix 9); 20,281 male and 20,289 female carcasses were re-examined, of which 13 males and 14 females had disk tags. An estimated 25 (5.8%) and 30 (7.0%) disk tagged male and female carcasses, respectively, processed during the main survey were not correctly identified as tagged fish. When corrected for this error, an estimated 432 (19.3% of application sample) tagged males and 429 (20.9%) tagged females were recovered (Table 3).

Table 4. Average elapsed time between tag application and recovery (for 'fresh' recoveries) and female spawning success, by recovery section, period and sex, for late run Adams River study area sockeye salmon, 1995.

		Mean time (days) between tag application and carcass recovery [a]				Female spawning success [a]		
Section	Period [b]	Male	(n)	Female	(n)	% [c]	(n_1)	(n_2)
Adams River System								
Adams Lake and Tributaries								
All	Early	-	(0)	-	(0)	-	(0)	(1)
	Late	-	(0)	-	(0)	94.4%	(9)	(9)
	Total	-	(0)	-	(0)	94.4%	(9)	(10)
Lower Adams River and Shuswap Lake								
Area 1-3	Early	11.9	(15)	13.9	(22)	95.2%	(109)	(2,596)
	Late	11.6	(11)	12.1	(14)	98.2%	(93)	(4,881)
	Total	11.8	(26)	13.2	(36)	97.2%	(202)	(7,477)
Area 4, 5 & 7	Early	12.5	(81)	12.4	(57)	92.1%	(403)	(10,581)
	Late	11.3	(77)	11.0	(126)	97.9%	(521)	(18,465)
	Total	11.9	(158)	11.4	(183)	95.8%	(924)	(29,046)
Area 6, 8-12 [d]	Early	13.7	(14)	12.2	(11)	83.6%	(162)	(1,733)
	Late	11.8	(15)	11.8	(8)	86.1%	(254)	(4,723)
	Total	12.7	(29)	12.0	(19)	85.5%	(416)	(6,456)
Total	Early	12.6	(110)	12.7	(90)	91.6%	(674)	(14,910)
	Late	11.4	(103)	11.1	(148)	96.0%	(868)	(28,069)
	Total	12.0	(213)	11.7	(238)	94.5%	(1,542)	(42,979)
Hiuihill and Nikwikwaia Creeks								
All	Early	-	(0)	-	(0)	-	(0)	(0)
	Late	-	(0)	14.5	(2)	97.5%	(61)	(61)
	Total	-	(0)	14.5	(2)	97.5%	(61)	(61)
Scotch Creek								
All	Early	-	(0)	-	(0)	60.5%	(19)	(19)
	Late	-	(0)	-	(0)	60.3%	(155)	(224)
	Total	-	(0)	-	(0)	60.3%	(174)	(243)
Little River and Little Shuswap Lake								
All	Early	18.5	(2)	12.0	(1)	75.8%	(33)	(266)
	Late	11.0	(2)	-	(0)	78.1%	(10)	(1,165)
	Total	14.8	(4)	12.0	(1)	77.7%	(43)	(1,431)

[a] Calculated using all recoveries except those recovered in the spawning channel, outside of the study area, by nonstandard methods, less than 5 days after application, and recoveries that had been recaptured 2 or more times.

[b] Time out to recovery: early= 25-Sep to 8-Oct releases. Female spawning success: early= 26-Sep to 20-Oct recoveries.

[c] Mean of tagged and untagged carcasses sampled for percent spawning success (n_1), weighted by the number of tagged and untagged carcasses recovered (n_2).

[d] Included in lower Adams River because the vast majority of carcasses recovered in this area were from the population that spawned in Adams River.

Table 5. Percent at age and mean POH length at age of late run Adams River study area sockeye carcasses sampled on the spawning grounds, 1995.

Recovery location	Sex	Percent at age					POH length (cm) at age				
		3_2	4_2	4_3	5_2	5_3	3_2	4_2	4_3	5_2	5_3
Lower Adams River	Male	-	88.3%	-	11.2%	0.6%	-	47.6	-	51.8	48.6
	Female	-	91.6%	-	7.8%	0.6%	-	46.7	-	50.4	45.3
	Jack [a]	-	-	-	-	-	-	-	-	-	-

[a] No jacks were sampled in 1995.

BIOLOGICAL SAMPLING

Fifty females were sampled for fecundity, 25 each at tagging sites 5b (October 6) and 4c (October 7); one sample was subsequently lost. Of the 49 remaining samples, 45 were age 4_2, 1 was age 5_2, and 3 were unaged (Appendix 10). Age 4_2 females had an average standard length of 52.5 cm (range 48.7-56.3 cm), and an average fecundity of 4,235 (range 3,178 to 5,546). The age 5_2 female was 62.1 cm, standard length, with a fecundity of 5,105 (Appendix 10).

Sixty carcasses of each sex, recovered in the lower Adams River, were sampled on each of three dates, October 15, October 24 and October 31. Age classes 4_2, 5_2 and 5_3 were present in the samples, with the majority age 4_2 in both sexes (88.3% in males and 91.6% in females; Table 5, Appendix 11). The age distributions (specifically, the proportion of each sample aged 4_2) did not differ between sampling dates (males: Chi-square = 1.01, df=2, $p > 0.05$; females: Chi-square = 1.39, df=2, $p > 0.05$). Age 4_2 male and female mean ($\pm$ S.D.) POH lengths were 47.6 (1.3) and 46.7 (1.5) cm, respectively (Appendix 11). Those for age 5_2 males and females were 51.8 (1.6) and 50.4 (1.5) cm, respectively. The POH length for the male carcass aged 5_3 was 48.6 cm; that for the female carcass aged 5_3 was 45.3 cm. No jacks were recovered.

SAMPLING ASSUMPTIONS

Temporal bias was present in the application sample for both sexes (Table 6), and in the recovery sample for females (Table 7). Mark incidence differed significantly among recovery periods in only one stratification in each sex; similar recovery effort in males, and similar numbers of recoveries in females (Table 6). In males, tag incidences ranged from 0.7% to 2.0% across periods of similar effort, with a high tag incidence in the first period; in females, tag incidences ranged from 0.7% to 1.1% across periods of similar numbers of recoveries, with low tag incidences in the first and last periods. The proportion of tags recovered differed significantly among application periods in two stratifications in females, periods of similar duration and of similar numbers of tags applied, but in none of the three stratifications examined in males (Table 7). Recovery rates of tagged females ranged from 11.5% to 22.5% across periods in these two stratifications. In both sexes and in all three stratifications, recovery rates in the first four periods were similar and higher than those in the final period (Table 7).

Spatial bias was present in the application sample for females (Table 8), and in the recovery sample for both sexes (Table 9). Mark incidence among recovered carcasses ranged from 0.7% to 1.3% in males and 0.1% to 1.0% in females; in both sexes, the lowest tag incidences were found in Little River and Little Shuswap Lake, while the highest tag incidences were found in areas 4-7. Mark incidence differed significantly, for females, between Shuswap Lake/ Scotch Creek versus Little River/ Little Shuswap Lake, and between Adams River system (all areas combined) versus areas outside Adams River system (Table 8). Mark incidence did not differ significantly, for either sex, among upper, lower and mouth sections of the Adams River system. The proportion of tags recovered for sockeye tagged at tag sites 1 and 2 was 31.8% (males) and 31.9% (females), much higher than for those tagged at the lower river tag sites (Table 9). For both sexes, recovery rates did not differ significantly among lower river tag sites, and did differ significantly between upper versus combined lower river tag sites (Table 9).

The male: female ratios among marked and unmarked recoveries, 50.4%: 49.6% and 46.8%: 53.2% respectively, differed significantly (Table 10). Mark incidence was greater among males

Table 6. Proportion of the late run Adams River study area sockeye recoveries that were marked with disk tags and/or secondary marks, by recovery period and sex, in 1995, for the three stratifcations used.

Recovery period	Number of surveys [a]	Marked carcasses recovered			Total recovery			Mark incidence		
		Male	Female	Jack	Male	Female	Jack	Male	Female	Jack
Equal recovery periods										
26-Sep to 04-Oct	5	9	2	-	365	228	-	2.5%	0.9%	-
05-Oct to 13-Oct	9	37	16	-	3,149	2,455	-	1.2%	0.7%	-
14-Oct to 22-Oct	9	174	181	-	16,617	18,096	-	1.0%	1.0%	-
23-Oct to 31-Oct	9	148	163	-	14,883	18,186	-	1.0%	0.9%	-
01-Nov to 09-Nov	9	38	36	-	3,562	4,822	-	1.1%	0.7%	-
Similar recovery effort										
26-Sep to 08-Oct	9	22	5	-	1,118	812	-	2.0%	0.6%	-
09-Oct to 16-Oct	8	42	41	-	5,902	5,381	-	0.7%	0.8%	-
17-Oct to 24-Oct	8	208	207	-	18,213	20,739	-	1.1%	1.0%	-
25-Oct to 01-Nov	8	100	115	-	10,184	12,689	-	1.0%	0.9%	-
02-Nov to 09-Nov	8	34	30	-	3,159	4,166	-	1.1%	0.7%	-
Similar total number of recoveries										
26-Sep to 17-Oct	18	83	59	-	8,866	8,173	-	0.9%	0.7%	-
18-Oct to 21-Oct	4	109	110	-	9,001	10,010	-	1.2%	1.1%	-
22-Oct to 24-Oct	3	80	84	-	7,366	8,749	-	1.1%	1.0%	-
25-Oct to 28-Oct	4	65	84	-	6,847	8,486	-	0.9%	1.0%	-
29-Oct to 09-Nov	12	69	61	-	6,496	8,369	-	1.1%	0.7%	-

Chi-square test results

Stratification scheme	Males			Females		
	χ^2 value	df	*P*	χ^2 value	df	*P*
Equal recovery periods	7.95	4	0.09	4.92	4	0.30
Similar recovery effort	17.49	4	0.00**	5.55	4	0.24
Similar total number of recoveries	4.11	4	0.39	11.07	4	0.03*

[a] Based on recoveries in the lower Adams River.

than females indicating that the application sample was selective toward males. In contrast, sex ratios among recovered and unrecovered tagged fish, 50.5%: 49.5% and 52.6%: 47.4%, respectively, did not differ significantly. The recovery sample, therefore, was not sex selective.

The size distributions of recovered and unrecovered tagged fish did not differ significantly in either sex (Table 11), indicating that the recovery sample was not size selective. Further, while recovery rates among size classes varied from 7.7% to 50.0% in males and 6.7% to 50.0% in females, no obvious trend of recovery rate with size was shown.

The weighted mean spawning success of marked and unmarked female recoveries was 96.6% and 94.2%, respectively.

Finally, the mark incidence among pool recoveries (1.5% in males and 1.0% in females) was not significantly different from that among all standard recoveries in the study (1.2% and 1.0%) or among those made in the lower Adams River (1.2% and 1.0%; Table 12). Due to the small sample size, no conclusions could be made regarding tag incidence among net recoveries relative to that among standard recoveries. The conclusions of all tests of sampling assumptions are summarized in Table 13.

Table 7. Proportion of disk tagged, late run sockeye recovered in the Adams River study area, by application period and sex, in 1995, for the three stratifications used.

Application period	Number of sets	Disk tags applied			Carcasses recovered with disk tags			Percent recovered		
		Male	Female	Jack	Male	Female	Jack	Male	Female	Jack
Equal application periods										
25-Sep to 01-Oct	13	197	102	-	43	23	-	21.8%	22.5%	-
02-Oct to 08-Oct	34	944	680	-	173	133	-	18.3%	19.6%	-
09-Oct to 15-Oct	24	767	848	-	143	185	-	18.6%	21.8%	-
16-Oct to 22-Oct	16	230	360	-	38	50	-	16.5%	13.9%	-
23-Oct to 30-Oct	21	102	61	-	9	7	-	8.8%	11.5%	-
Similar application effort										
25-Sep to 03-Oct	24	346	212	-	72	44	-	20.8%	20.8%	-
04-Oct to 07-Oct	20	699	459	-	128	92	-	18.3%	20.0%	-
08-Oct to 12-Oct	20	617	631	-	107	130	-	17.3%	20.6%	-
13-Oct to 21-Oct	22	476	685	-	90	125	-	18.9%	18.2%	-
22-Oct to 30-Oct	22	102	64	-	9	7	-	8.8%	10.9%	-
Similar number of tags applied										
25-Sep to 05-Oct	33	638	391	-	121	77	-	19.0%	19.7%	-
06-Oct to 08-Oct	14	503	391	-	95	79	-	18.9%	20.2%	-
09-Oct to 11-Oct	12	460	431	-	84	95	-	18.3%	22.0%	-
12-Oct to 16-Oct	14	362	500	-	71	103	-	19.6%	20.6%	-
17-Oct to 30-Oct	35	277	338	-	35	44	-	12.6%	13.0%	-

Chi-square test results

Stratification scheme	Males			Females		
	χ^2 value	df	*P*	χ^2 value	df	*P*
Equal application periods	8.33	4	0.08	13.26	4	0.01 *
Similar application effort	8.09	4	0.09	4.47	4	0.35
Similar number of tags applied	6.67	4	0.15	11.37	4	0.02 *

SPAWNING POPULATION ESTIMATES

Mark-Recapture

The 1995 Adams River study area sockeye escapement estimates, based on the pooled (Table 3) and stratified (Table 14, 15) mark-recapture data, are presented in Table 16. Recall that these estimates do not include 50 females sampled for fecundity, the spawning channel escapement, or the carcasses recovered by non-standard methods. The PPE estimates ± 95% confidence limits, are 199,070 ± 16,722 (8.4%) males, 208,350 ± 17,395 (8.3%) females and 0 jacks. The PPE estimate of the total escapement, produced by summing the sex-specific estimates, is 407,420 ± 24,129 (5.9%) adult sockeye. The age-specific estimates are based on the sex-specific age composition in the aged carcass sample (Table 5).

Selective pooling of strata (Table 14, 15) resulted in satisfaction of the MLE model assumptions for temporally and spatially stratified male and female data (Table 16). The MLE estimates calculated for the resulting temporal stratification differ from the PPE estimates by 0.2% (males) and 4.0% (females); the MLE estimates calculated for the resulting spatial stratification differ from the PPE estimates by 4.5% (males) and 9.6% (females).

Although Schaefer estimates were produced at all stratification scales, the reported values are

Table 8. Proportion of the late run Adams River study area sockeye recoveries that were marked with disk tags and/or secondary marks, by recovery location and sex, in 1995.

	Marked carcasses recovered			Total Recovery			Mark incidence		
Recovery section [a]	Male	Female	Jack	Male	Female	Jack	Male	Female	Jack
Adams River system									
Upper	44	57	-	5,574	7,019	-	0.8%	0.8%	-
Lower	236	280	-	21,651	28,644	-	1.1%	1.0%	-
Mouth	36	28	-	2,823	2,901	-	1.3%	1.0%	-
Outside of Adams River									
Shuswap Lake/ Scotch Creek	76	32	-	6,559	3,792	-	1.2%	0.8%	-
Little River/ Little Shus. Lake	14	1	-	1,969	1,431	-	0.7%	0.1%	-

Chi-square test results

	Males			Females		
Test comparing:	χ^2 value	df	*P*	χ^2 value	df	*P*
All sections:	8.26	4	0.08	13.69	4	0.01 *
Three Adams River system sections:	5.35	2	0.07	1.66	2	0.44
Two sections outside of Adams River:	2.49	1	0.11	8.72	1	0.00 **
Adams River (pooled) vs outside (pooled):	0.00	1	0.98	4.71	1	0.03 *

[a] Adams River system section definitions: Upper- Adams Lake, tributaries of Adams Lake and areas 1-3; Lower- Area 4, 5 and 7; Mouth- Area 6.

those produced at the same scale as the reported MLE estimate. All Schaefer estimates differ by less than 0.9% from the PPE estimates.

The sex-specific PPE estimates are accepted, because the 95% confidence intervals of all four MLE estimates overlap those of the PPE estimates extensively, and the discrepancies between the MLE and PPE estimates are relatively small.

Area-Specific Population Estimates

The escapement estimates for each component area of the study area are presented in Table 17. Also included are the non-standard recoveries in Adams River and estimates for the spawning channel (provided by the Salmonid Enhancement Program). The estimated escapement to the study area, including these two sets of fish, was 200,518 males and 209,974 females. An estimated 96.4% and 97.2% of study area males and females, respectively, spawned in the lower Adams River. Little River received the next largest escapement, 2.6% and 1.8% of study area males and females, respectively.

DISCUSSION

ASSUMPTIONS

The Petersen mark-recapture technique is based on the principle that, by tagging a random sample of fish, permitting them to redistribute through the population, and obtaining a second random sample of tagged and untagged individuals, the number of fish in the population can be estimated with known precision. The accuracy of an escapement estimate depends on how well the study meets the assumptions underlying the technique. These assumptions have been described in various forms by Ricker (1975), Otis *et al.* (1978), Eames *et al.* (1981), Seber (1982) and Arnason *et al.* (1996) and are discussed below in the context of the current study.

Population Closure

In a closed population the number of animals does not change during the study. The population did change during this study, through immigration, die-off and emigration; however, such factors will not violate the closure assumption if all components of the population are vul-

Table 9. Proportion of disk tagged, late run sockeye recovered in the Adams River study area, by tag site and sex, in 1995.

Tag site [a]	Number of days	Disk tags applied			Carcasses recovered with disk tags			Percent recovered		
		Male	Female	Jack	Male	Female	Jack	Male	Female	Jack
1 and 2	33	267	182	-	85	58	-	31.8%	31.9%	-
4a	31	828	926	-	149	188	-	18.0%	20.3%	-
4b	10	309	206	-	42	32	-	13.6%	15.5%	-
4c	15	383	338	-	51	54	-	13.3%	16.0%	-
5a and 5b	19	453	399	-	79	66	-	17.4%	16.5%	-

Chi-square test results

Test comparing:	Males			Females		
	χ^2 value	df	*P*	χ^2 value	df	*P*
All strata:	44.20	4	0.00**	25.16	4	0.00**
Lower river sites:	6.34	3	0.10	5.59	3	0.13
Upper vs lower sites:	37.35	1	0.00**	18.97	1	0.00**

[a] Tag site numbers reflect the area that the tag sites were in. Thus, tag sites 1 and 2 are in the upper portion of the lower Adams River; all other tag sites are in the lower portion.

Table 10. Sex composition of late run Adams River study area sockeye in the application and recovery samples, 1995.

Sex	Application sample, by recovery status [a]			Recovery sample, by mark status		
	Disk tags applied	Disk tags recovered	Percent recovered	Total recovery	Marked recoveries	Mark incidence
Male	2,240	406	18.1%	38,576	406	1.1%
Female	2,051	398	19.4%	43,787	398	0.9%
χ^2 value:	Recovery bias test:		1.07	Application bias test:		4.22
P (df=1):			0.30			0.04 *

[a] Corrected for sex identification error.

nerable to marking and/or carcass recovery, and death and emigration affect marked and unmarked fish equally (Arnason *et al.* 1996). This study was designed to meet the former requirement both temporally and spatially. Temporally, the application and recovery periods were intended to completely encompass the immigration and die-off, respectively. Unfortunately, application may have begun up to five days after the first immigrants entered the lower Adams River, and recovery may have ended several days before recoverable carcasses were no longer available. Because the number of animals missed during these 'tails' of immigration and recovery would have been relatively small, the influence of this violation would probably have been negligible. Spatially, the study area included most areas to which sockeye, tagged in the lower Adams River, were known to move (based on previous studies). Small numbers of sockeye tagged in the lower Adams River migrated to Shuswap Lake shoreline areas outside of the mark recapture study area, in 1994 (Schubert and Fanos 1997) and 1995. These areas were excluded from the study area because the majority of sockeye migrating to these areas would have been unavailable to tagging at sites in the lower Adams River (which would cause an extreme spatial application bias if this area was included).

The active emigration from the study area, to

Table 11. Proportion of disk tagged, late run sockeye recovered in the Adams River study area, by sex and 3 cm increments of nose-fork length, 1995.

Nose-fork length (cm)	Disk tags applied[a]			Carcasses recovered with disk tags			Percent recovered		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
46 - 48.9	1	2	3	0	0	0	0.0%	0.0%	0.0%
49 - 51.9	2	15	17	0	1	1	0.0%	6.7%	5.9%
52 - 54.9	13	124	137	1	16	17	7.7%	12.9%	12.4%
55 - 57.9	70	726	796	19	140	159	27.1%	19.3%	20.0%
58 - 60.9	387	948	1,335	56	193	249	14.5%	20.4%	18.7%
61 - 63.9	1,150	186	1,336	222	40	262	19.3%	21.5%	19.6%
64 - 66.9	497	39	536	85	4	89	17.1%	10.3%	16.6%
67 - 69.9	70	10	80	11	3	14	15.7%	30.0%	17.5%
70 - 72.9	43	2	45	10	1	11	23.3%	50.0%	24.4%
73 - 75.9	4	0	4	2	-	2	50.0%	-	50.0%
Kolmogorov-Smirnov 2-sample test Dmax (continuous data; see text):							0.030	0.035	0.018
Kolmogorov-Smirnov 2-sample test Dcritical (α = 0.05):							0.075	0.076	0.053

[a] Not corrected for sex identification error; excludes 1 male and 1 female not measured at release.

Table 12. Proportion of late run Adams River study area sockeye recoveries[a] that were marked with disk tags and/or secondary marks, by recovery method and sex, in 1995.

Recovery method	Marked carcasses recovered			Total recovery			Mark incidence		
	Male	Female	Jack	Male	Female	Jack	Male	Female	Jack
Standard:									
Study area	452	429	0	38,622	43,818	-	1.2%	1.0%	-
Lower Adams R.	359	396	-	30,091	38,595	-	1.2%	1.0%	-
Pool-recoveries	9	9	-	603	940	-	1.5%	1.0%	-
Net-recoveries	1	0	-	13	6	-	7.7%	0.0%	-

Chi-square test results

Test comparing:	Male			Female		
	χ^2 value	df	*P*	χ^2 value	df	*P*
Pool vs standard-study area:	0.29	1	0.59	0.01	1	0.92
Pool vs standard-lower Adams:	0.23	1	0.63	0.00	1	0.97

[a] Including fish recaptured 2 or more times, and carcasses recovered less than 5 days after application.

Shuswap Lake and its tributaries, was accounted for by removing the estimated number of tagged sockeye migrating to the main arm of Shuswap Lake from the application sample. This estimate was based on the tag incidence in recoveries at Ross Creek delta, only, but assumed representative of the entire main arm of Shuswap Lake and its tributaries. Thus, it is likely inaccurate. During future studies, carcasses should be recovered more representatively in this area.

Sockeye can become unavailable to recovery (emigrate from the study area) by several mechanisms, including carcass decomposition, predator activity and flushing downstream. The former were likely unimportant to the current study because inter-survey periods averaged only two days, there was little predator activity and no fisheries in the study area. Further, it is unlikely that marked fish were disproportionately affected by these mechanisms. Conversely, a

Table 13. Bias profile for the 1995 late run Adams River study area sockeye escapement estimation study.

Bias type	Test of:	Between	Test result[a]
Application sample			
Temporal	Tagged: untagged recoveries	Equal recovery periods	No bias
		Periods of similar rec. effort	Early period bias in males
		Periods of similar total recoveries	Middle period bias in females
Spatial	Tagged: untagged recoveries	Five recovery areas	Bias in females (see text)
Fish sex	Tagged: untagged recoveries	Sexes	Bias for males
Stress	Tagged: untagged recoveries	0+50% vs 100% spawned	Higher in tagged fish
Catchability	Tagged: untagged recoveries	Standard vs pool recoveries	No bias
Recovery sample			
Statistical	Minimum recovery of 5 tags:	-	No jack males recovered
Temporal	Recovered: unrecovered tags	Equal application periods	Bias in females (see text)
		Periods of similar application effort	No bias
		Periods of similar applications	Bias in females (see text)
Spatial	Recovered: unrecovered tags	Five application sites	Upper tag site bias in both sexes
Fish sex	Recovered: unrecovered tags	Sexes	No bias
Fish size	Size-frequency distrib:	Recovered: unrecovered tags	No bias

[a] A "no bias" test result indicates that bias was not detected; undetected bias may be present.

large number of carcasses probably became unrecoverable after flushing out of lower Adams River into Shuswap Lake, and marked fish may have been more or less likely to flush out due to application selectivity and/or tagging stress. For example, both selectivity for fish that spawned in the lower areas of the lower Adams River, and impaired swimming ability due to tagging stress, could have caused marked fish to flush out at higher rates than unmarked ones. In this study, care was taken to avoid application selectivity and tagging-induced stress. Based on the above, and our later evaluation of selectivity and stress, we conclude that the population closure assumption was reasonably well met in this study.

Unfortunately, the net deployed at the mouth of the lower Adams River collected an inadequate number of carcasses to directly test whether flushing-out rates of tagged and untagged fish were similar. Future studies should use more effective methods to sample carcasses as they flush out, and spend sufficient effort representatively throughout the die-off period, to adequately compare these rates.

Correct Identification of Tag Status

If uncorrected, misidentification of carcasses with a disk tag and/or secondary mark as unmarked results in an overestimate of escapement. Surveyor inexperience, fatigue and assigning a higher priority to recovery speed than to thoroughness can all contribute to this error. In the current study, a resurvey of 49.3% of the recovered carcasses showed that 6.4% of the disk tags present on the initial survey had been misidentified as unmarked. This error rate was low relative to the previous Adams River system study (13%; Schubert and Fanos 1997). This difference may be due to the implementation of recommendations made by Schubert and Fanos (1997), including emphasizing to crews the importance of complete accuracy in identification of carcass tag status (and the acceptability of the resulting decrease in survey speed) and more frequent resurveys allowing quicker feedback and retraining to staff who are missing tags. The error rate in the current study is still, however, much higher than that in other 1995 Fraser River sockeye salmon enumeration studies executed with the same attention to minimizing the number of missed tags. For example, error rates in

Table 14. Temporally stratified tag application-recovery matrices for the 1995 late run Adams River study area sockeye mark-recapture study. The finest scale stratifications (see text) are shown; bracketed strata were aggregated to produce an ML Darroch estimate and attempt to meet the assumptions of the ML Darroch model.

Male

Release period	Tags applied	Recovery period: [26-Sep to 04-Oct]	05-Oct to 13-Oct]	14-Oct to 22-Oct	23-Oct to 31-Oct	01-Nov to 09-Nov	Total recovered
25-Sep to 01-Oct	196.4	9.6	25.5	9.6	1.1	0.0	45.7
02-Oct to 08-Oct	941.2	0.0	13.8	122.7	42.5	5.3	184.3
09-Oct to 15-Oct	764.7	0.0	0.0	50.2	86.0	15.9	152.1
16-Oct to 22-Oct	229.3	0.0	0.0	3.2	25.5	11.7	40.4
23-Oct to 30-Oct	101.7	0.0	0.0	0.0	2.1	7.4	9.6
Total tags:	2,233.4	9.6	39.3	185.7	157.1	40.3	432.0
Total recovery:		365.0	3,149.0	16,618.0	14,883.0	3,562.0	38,577.0

Female

Release period	Tags applied	Recovery period: [26-Sep to 04-Oct]	05-Oct to 13-Oct]	14-Oct to 22-Oct	23-Oct to 31-Oct	01-Nov to 09-Nov	Total recovered
25-Sep to 01-Oct	101.7	2.2	10.8	10.8	1.1	0.0	24.8
02-Oct to 08-Oct	678.0	0.0	6.5	111.3	23.7	2.2	143.6
09-Oct to 15-Oct	845.5	0.0	0.0	72.4	109.7	17.2	199.3
16-Oct to 22-Oct	358.9	0.0	0.0	1.1	38.7	14.0	53.8
23-Oct to 30-Oct	60.8	0.0	0.0	0.0	2.2	5.4	7.5
Total tags:	2,045.0	2.2	17.2	195.6	175.3	38.7	429.0
Total recovery:		228.0	2,455.0	18,097.0	18,186.0	4,822.0	43,788.0

the 1995 Birkenhead and Seymour River studies were 0% and 1.1%, respectively (Houtman *et al.* 2000; Houtman and Schubert 2000). Thus, in future, recovery crews must exercise greater care.

The estimated rate of tag status misidentification may have been biased in the current study, for two reasons. First, only recoveries in lower Adams River and Shuswap Lake were resurveyed. In future studies, the resurvey should be made more spatially representative. Second, since most carcasses examined on the initial survey were not given an unambiguous mark, previously unexamined carcasses may have been added to the resurvey sample by predator actions or rising water levels. Such activity would cause an overestimate of the number of missed tags, and an underestimate of the population. Future studies, therefore, must ensure that all recovered carcasses are chopped.

Unfortunately, the only available method for incorporating the variance of the missed tag estimate into the population variance (Rajwani and Schwarz 1997) was not applicable to this study, because carcasses identified as tagged on the initial survey were included in the resurvey. The precision of the population estimates, therefore, is overestimated (*i.e.,* the 95% confidence intervals reported are too small). In future studies, carcasses identified on the recovery survey as marked should be excluded from the resurvey, so that the variance estimation procedures of Rajwani and Schwarz (1997) can be applied. This can be easily achieved either by making such carcasses identifiable (*e.g.*, by chopping them in three, with chops in front and behind the dorsal fin) or by throwing them far up the bank.

No Undetected Tag Loss

The undetected loss of disk tags between application and recovery would result in an underestimate of the proportion of the population with tags and an overestimate of escapement.

Table 15. Spatially stratified tag application-recovery matrices for the 1995 late run Adams River study area sockeye mark-recapture study. The finest scale stratifications (see text) are shown; bracketed strata were aggregated to produce an ML Darroch estimate and attempt to meet the assumptions of the ML Darroch model.

Male

		Recovery section[a]					
Tagging site	Tags applied	Above Area 4	Area 4, 5 & 7	Area 6	[Shuswap Lake	Little River]	Total recovered
1 & 2	266.2	32.5	51.0	3.2	4.2	0.0	90.9
4a	825.6	10.8	107.2	12.7	22.3	5.3	158.4
[4b	308.1	1.1	21.2	5.3	12.7	4.2	44.6
4c	381.9	2.2	22.3	5.3	20.2	4.2	54.2
5a & 5b]	451.7	1.1	48.8	11.7	21.2	1.1	83.9
Total tags:	2,233.4	47.7	250.5	38.2	80.7	14.9	432.0
Total recovery:		5,575.0	21,651.0	2,823.0	6,559.0	1,969.0	38,577.0

Female

		Recovery section[a]					
Tagging site	Tags applied	Above Area 4	Area 4, 5 & 7	Area 6	[Shuswap Lake	Little River]	Total recovered
1 & 2	181.5	31.2	31.3	0.0	0.0	0.0	62.5
4a	923.3	17.2	160.8	11.8	11.8	1.1	202.7
4b	205.4	0.0	27.0	2.2	5.4	0.0	34.5
4c	337.0	7.5	34.5	7.5	8.6	0.0	58.2
5a & 5b	397.8	5.4	48.6	8.6	8.6	0.0	71.1
Total tags:	2,045.0	61.3	302.1	30.1	34.4	1.1	429.0
Total recovery:		7,019.0	28,645.0	2,901.0	3,792.0	1,431.0	43,788.0

[a] Recovery section definitions: Above Area 4- Adams Lake, Adams Lake tributaries and Area 1-3; Shuswap Lake- includes Scotch Creek; Little River- includes Little Shuswap Lake.

Tag loss can result from poor tag application technique, tangling of the tag in the net after release, predator activity, or the fighting which is common among males during spawning. In the current study, tag loss was assessed by applying an opercular punch as a permanent secondary mark. The estimated rate was 0.25%, which is similar to that in contemporary studies (*e.g.*, Houtman *et al.* 2000; Houtman and Schubert 2000). Tag loss was probably underestimated, however, because fungus, decomposition and predator activity can hinder detection of the opercular punch, and the surveyors, who missed an estimated 6.4% of the more obvious disk tags, could easily have missed secondary marks on carcasses that had lost disk tags. No estimate of this error was possible because disk tags, but not secondary marks, were removed during the initial surveys. In future studies, the incidence of missed secondary marks can be determined if carcasses identified as disk tagged and/or secondary marked are excluded from the resurvey. Further, alternate secondary marks should be evaluated and available for use should the accurate detection of opercular punches prove untenable. Note, however, that had tag loss rates actually been 2.5% (10 times greater than estimated), the population estimate would only decrease by 2%. Thus, some uncertainty in this estimate is acceptable for the purposes of this study.

Equal Catchability

Average recovery probabilities of marked and unmarked sockeye must be equal for the PPE estimate to be unbiased. For stratified models to be unbiased, average recovery probabilities of these two groups can differ, but recovery probabilities within strata must be equal (Arnason *et al.* 1996). Note that even when recovery probabilities are equal within each strata, unequal average recovery probabilities can exist unless one or more of the following three condi-

Table 16. Escapement estimates [a] and 95% confidence limits, by age and sex, for late run Adams River study area sockeye, 1995. Asterisks indicate accepted estimates.

		Escapement at age						95% confidence limits on total	
Estimator	Sex	3_2	4_2	4_3	5_2	5_3	Total	Lower	Upper
Pooled	Male	0	175,716	0	22,242	1,112	199,070*	182,348*	215,792*
Petersen	Female	0	190,891	0	16,296	1,164	208,350*	190,955*	225,746*
	Total [b]	0	366,606	0	38,538	2,276	407,420*	383,291*	431,550*
	Total [c]	0	367,782	0	38,834	2,284	408,900	384,649	433,152
	Jack	-	-	-	-	-	0*	-	-
Application and recovery stratified temporally									
ML	Male [d,e]	-	-	-	-	-	198,612	179,671	217,553
Darroch	Female [d,e]	-	-	-	-	-	216,607	188,381	244,833
Schaeffer	Male [e]	-	-	-	-	-	199,987	-	-
	Female [e]	-	-	-	-	-	209,697	-	-
Application and recovery stratified spatially									
ML	Male [d,e]	-	-	-	-	-	190,030	169,863	210,197
Darroch	Female [d,e]	-	-	-	-	-	228,455	169,111	287,800
Schaeffer	Male [e]	-	-	-	-	-	197,324	-	-
	Female [e]	-	-	-	-	-	208,797	-	-

a. Does not include 50 females which were killed for fecundity samples, 616 male and 946 female nonstandard recoveries, and 832 male and 678 female spawning channel recoveries.

b. Sum of sex-specific estimates. Confidence intervals calculated as in Schubert and Fanos (1997).

c. Petersen estimate based on combined male and female data.

d. Model assumptions are satisfied (passes Plante's goodness-of-fit test (Arnason et al. 1996)).

e. Stratifications used to produce estimates are indicated in tables 14 and 15.

tions exist: i) proportional application, ii) proportional recovery, and iii) complete mixing. If recovery probabilities differ within strata, average recovery probabilities will rarely be equal.

Tagging-stress effects and selective application sampling can both influence where and when tagged carcasses become recoverable, potentially causing unequal recovery probabilities of tagged and untagged fish. Stress can influence the distance and duration of movements by impairing swimming ability and causing earlier death; application can favour fish with specific spawning ground distributions or spawning schedules. While the application bias tests should detect such differences, they do not indicate their cause. Application bias will not induce unequal recovery probabilities of marked and unmarked fish, however, if the recovery sample is unbiased or has an independent source of bias (Junge 1963; Seber 1982).

In the current study, tag application was designed to minimize tagging-stress (see above). Only four fish (0.1 %) required ventilation and 36 (0.8 %) were sluggish upon release, suggesting that application was reasonably stress-free. As well, tagged fish were excluded from the analysis if there were indications that they were stressed by application. One hundred fish recaptured two or more times were excluded, because the higher recovery rate of this group may have resulted from stress-induced behavioral changes. As well, 37 fish recovered less than five days after tagging were excluded, because of the likelihood that they suffered acute stress. These procedures, however, may not have eliminated the influence of tagging-stress on tagged fish.

Table 17. Escapement estimates of sockeye to component areas of the Adams River study area, by sex, for late run Adams River study area sockeye, 1995.

Section	Peak live count	Cumulative dead count	Adult escapement			Jack
			Male	Female	Total	
Adams River System						
Adams Lake and Tributaries						
Adams Lake [a]	65	1	58	61	119	0
Bush Creek	0	0	0	0	0	0
Cayenne Creek	0	0	0	0	0	0
Momich River [a]	1	0	1	1	2	0
Pass Creek	21	0	12	26	38	0
Upper Adams River	0	0	0	0	0	0
Lower Adams River						
Mark-recapture estimate [b]	n/a	n/a	191,074	201,614	392,688	0
Nonstandard recoveries	n/a	n/a	616	946	1,562	0
Total	n/a	n/a	191,690	202,560	394,250	0
Lower Adams River Tributaries						
Hiuihill Creek	217	19	226	199	425	0
Nikwikwaia Creek [a]	369	1	325	341	666	0
Adams River Spawning Channel						
All [c]	n/a	n/a	832	678	1,510	0
Shuswap Lake and Tributaries						
Scotch Creek	1,224	280	1,283	1,424	2,707	0
Shuswap Lake shore [a, d]	917	0	807	844	1,651	0
Little River and Little Shuswap Lake						
All	4,900	169	5,284	3,840	9,124	0
Study area total [e]	n/a	n/a	200,518	209,974	410,492	0

[a] Study area mark-recapture sex ratio used.

[b] Calculated as the difference between the mark-recapture estimate for the study area and all of the area-specific escapement estimates (not including the spawning channel escapement and nonstandard recoveries).

[c] Estimates provided by the Salmonid Enhancement Program.

[d] Carcass recoveries from the Shuswap Lake shore were not included in the population estimate for that area because the vast majority of those carcasses were from the population that spawned in Adams River.

[e] Does not include 50 females killed for fecundity samples.

The sampling methods were also designed to minimize selectivity through proportional application and recovery. To achieve application proportionality, fish were captured using a gear known to minimize selectivity, and a standardized daily tagging effort was applied throughout the run. Expending application effort evenly may not achieve proportional application, however, due to variability in: river conditions; the proportion of the fish which migrate at night; daily set times; the technique used during each set; and the daily size of the migration (large migrations may exceed the tagging capacity of the crew). Also, fish migrating at night (and other periods of the day in which application did not occur) may have differed, in behavior, sex ratio, size distribution or other aspects, leading to application selectivity for these attributes. Similarly, al-

though the recovery survey effort was applied relatively equally (spatially and temporally) throughout the die-off, sample selectivity may have persisted for a variety of reasons, including variable river conditions.

Here, evidence regarding the likelihood that recovery probabilities of tagged and untagged sockeye were equal (at either level), in this study, is examined. First, tag status affected spawning success, with higher average success among tagged females. This may indicate that the behavior of tagged and untagged fish differed, potentially resulting in different recovery probabilities. Sampling untagged carcasses disproportionately through the die-off, however, probably caused all or part of the difference in spawning success. This sampling bias resulted because the procedure for sampling spawning success of untagged carcasses changed during the recovery period: initially, every untagged carcass was sampled; near the midpoint of the recovery, the policy changed to sampling the first untagged carcass recovered after a tagged female recovery. Since spawning success of early recoveries was lower than for late recoveries (Table 4), this bias would cause lower average spawning success for the untagged group.

Second, the pool recoveries provide a direct comparison of the recovery probability (in standard recovery) of marked and unmarked carcasses, since they are sampled from the (typically large) component of the population which were not catchable by standard recovery methods. The tag incidence did not differ between the pool and standard recoveries, indicating similar recovery probabilities of marked and unmarked carcasses. Unfortunately, this test is weak, since the pool sample was relatively small and unrepresentative both spatially and temporally. Future studies should strive to collect a larger and more representative sample of carcasses in pools to provide a more powerful test of this assumption, and to allow stratification by recovery type for cases in which tag incidences differ. Tagging-stress is the most likely cause of different tag incidences in standard versus pool recoveries, because it may cause tagged fish to spawn in lower velocity, near-shore areas. The similar tag incidence in the two samples, therefore, supports the conclusion that application procedures were effectively stress-free.

Examination of the application and recovery samples indicated several biases: i) an application bias toward males, ii) a weak (one of three stratifications) temporal application bias in both sexes, iii) a temporal recovery bias in females, iv) a spatial application bias in females and v) a spatial recovery bias in both sexes (Table 13). Thus, application and/or recovery was proportional with respect to sex, size in both sexes, and time and space in males, and these factors should not have produced unequal recovery probabilities.

Note, however, that nonsignificant results of bias tests ($p>0.05$) do not prove that no bias exists. For example, the power of some or all of the bias tests may be low, and the stratification used in a bias test may hide an actual bias. Separate estimates, therefore, were calculated for males and females. Further, PPE estimates were compared with estimates produced by stratified models with temporally and spatially stratified data, to determine whether temporal and spatial biases influenced the estimates substantially.

In females, both application and recovery were biased temporally and spatially, and thus the female PPE estimate is potentially biased. As expected, the difference between the MLE and PPE estimates was greater for females than males. However, for the reasons discussed above, the PPE estimate was accepted for females as well as males.

GENERAL DISCUSSION

It is important to consider possible causes for the temporal and spatial biases found in this study, in order to direct future study design modifications to avoid such biases. It is unclear what may have caused the temporal application biases in males and females, especially because of the different patterns in the two sexes. In males, the mark incidence in the first recovery period (similar effort stratification) was higher than in subsequent periods. In females, mark incidence in the first period (similar number of recoveries stratification) and the last period was lower than the middle periods.

Recovery was temporally biased in females, with a low proportion recovered for fish tagged in the final one or two application periods. This bias probably resulted from ending recovery too early. Recovery ended nine days after tagging, while average time between tagging and recovery among later spawning females was 11 days (Table 4). Thus, it is likely that females tagged in the final few days of tagging were still alive when

recovery ended. Although the proportion recovered did not differ significantly among temporal strata in males, a similar pattern was shown (Table 7), supporting this explanation. Future studies must ensure that recovery continues until the end of die-off.

Application was spatially biased in females, with a low mark incidence in Little River and Little Shuswap Lake. A very similar pattern was shown in males, although the tests comparing mark incidences among strata were not significant. Schubert and Fanos (1997) reported a similar, but more extreme, pattern in the 1994 study, with low mark incidences in the upper section of the lower Adams River as well. The implementation of their recommendation of tagging sites throughout the lower Adams River was probably responsible for the increased mark incidence in the upper areas relative to the lower areas. Future studies should retain the dispersed tag sites, and apply more application effort in the lower river where tagging will be more selective for migrating fish. The low mark incidence below Shuswap Lake is clearly caused by spawners in Little River that never swim into the lower Adams River and thus are not vulnerable to tagging. Because some sockeye are believed to return to Little River to spawn after briefly entering the lower Adams River and dead and dying fish from the Adams River will drift there, this area was included in the study area to help meet the closure assumption. The spatial application bias is, in part, an undesirable consequence of this decision. Future studies should consider either excluding areas downstream of Shuswap Lake from the study area or applying tags on spawning grounds in Little River. This would give insight to the proportion of carcasses recovered in Little River that are vulnerable to tagging in Adams River.

Mark incidence was also very low in Scotch Creek (Appendix 7); for bias tests and stratified population estimates, this area was combined with Shuswap Lake due to the small number of recoveries made there. In the 1994 study, mark incidences in Scotch Creek were also relatively low. Thus, future studies should not include Scotch Creek in the Adams River study area. Weekly recovery surveys of Scotch Creek should be continued, however, to provide a reasonably accurate mark incidence and population estimate with which to account for emigration to this area.

Finally, recovery was spatially biased in both sexes, with the proportion recovered for fish tagged in the upper river substantially higher than of those tagged elsewhere. Fish tagged at the upstream tag sites probably tended to die further upstream than those tagged in the lower areas. Thus, these carcasses have a much larger area over which to deposit, leading to their higher recovery rates. A higher proportion of fish tagged at site 4a was recovered than for the other tag sites in areas 4 and 5, supporting this explanation.

RECOMMENDATIONS

The 1995 study was similar to that conducted in 1994 (Schubert and Fanos 1997), but included modifications designed to reduce sample selectivity and to facilitate assessment of tag loss and the effects of sub-acute and acute stress. Future studies should build on the 1995 study design, with the following modifications.

1. The following changes will improve the estimation of tag-status identification error rate:

- On the initial survey, all carcasses examined should be chopped in two, and only carcasses that have been chopped should be included in the resurvey. This procedure will ensure that the resurvey excludes unexamined carcasses deposited on the bank by predators or high water. When carcass abundance is high, chopping all carcasses may not be practicable due to surveyor fatigue and safety concerns. Resurveys in areas where some but not all recovered carcasses have been chopped should keep separate records for the two types of carcasses;
- The resurvey must be more spatially representative, including samples from areas outside of the lower Adams River;
- To allow for incorporation of the uncertainty in the misidentification error rate into population estimates, using formulas developed by Rajwani and Schwarz (1997), carcasses identified as disk tagged and/or secondary marked should be excluded from the resurvey, by chopping them in three (with chops in front and behind the dorsal fin). This change will also enable an estimation of the rate at which carcasses which had lost a disk tag but retained a secondary mark were misidentified as unmarked on the initial survey.

2. The following changes should be considered to improve the proportionality of recovery:

- Recovery surveys should cycle through all areas of the study area, including Adams Lake and its tributaries, and cycles should be short enough that few carcasses become unrecoverable due to decomposition, predator activity, or re-immersion between surveys of the same area. Using similar staffing levels as in this study and in 1994, a three-day cycle should be manageable, especially if other recommendations included here are followed;
- Ideally, recovery surveys should continue until live abundance is very low and no fresh fish are observed.

3. The following changes would help to reduce the severity of spatial application bias:

- Scotch Creek should be excluded from the study area. Tag incidences in this creek have been low (approximately one half the study area average) since tagging sites were moved from Shuswap Lake near the mouth of Adams River;
- If Little River is included in the study area, tags should be applied to fish spawning there, because most fish which spawn there are never vulnerable to the main tagging sites.

4. In order to make tests of important model assumptions more powerful, the following changes should be considered:

- More extensive and representative collection of carcasses as they drift out of the mouth of the Adams River would allow a more powerful comparison of 'emigration' rates of tagged and untagged carcasses, providing a test of the condition required for effective population closure. To achieve this, either the cargo net will need to be repositioned nearer the mouth, or alternative methods, such as dip netting and/or gaffing of carcasses, must be considered. If the latter are used, including this recovery procedure in the normal carcass recovery cycle will ensure temporal proportionality. Care must be taken to ensure that carcasses collected for this purpose would not otherwise become recoverable in Area 6;
- Recovery of deep-water carcasses that would not be recovered in the normal surveys allows testing of the assumption that tagged and untagged carcasses are equally likely to be recovered. In the current study, carcasses were collected from pools in areas 2, 3 and 5. In future studies, deep-pool recoveries should be made at these pools and, if possible, from pools in Area 4, during each recovery cycle, to improve proportionality. This change will likely result in collection of a larger sample and thus a more powerful test.

5. The spawning success data collected during these studies is primarily used to estimate the total egg deposition. As such, this data needs to be reasonably representative. Future studies should determine spawning success of a greater number of untagged carcasses. A sufficient, and practical, procedure is to sample the first 30 untagged carcasses recovered in each area on each survey.

6. In 1995, the only spawning population in the main arm of Shuswap Lake outside of the study area in which carcasses were sampled for tags was at Ross Creek Delta. To improve the estimation of the number of tagged fish which emigrate from the study area, examination of carcasses for tags during roving surveys should be done more representatively throughout the main arm of Shuswap Lake, and Scotch Creek if it is excluded (as recommended above).

7. The rate of sex-identification errors is estimated from the recovery sample (only a subsample of the application sample). The uncertainty in this estimate contributes to the uncertainty in the population estimates; currently, this contribution is unaccounted for. As recommended by Schubert and Fanos (1997), analytical methods should be developed to allow for the variance in these error rate estimates to be incorporated into the variance of the population estimates.

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APPENDICES

Appendix 1a. Late run Adams River study area[a] sockeye jack and adult escapement by sex, percent spawning success and the number of females which spawned effectively, 1938-1995.

Year	Escapement				Percent spawning success	Effective females
	Total	Jacks	Males	Females		
1938	797,039	2,279	439,791	354,969	85.4%	303,005
1939	31,887	297	14,197	17,393	95.0%	16,523
1940	10,724	8,407	1,158	1,159	99.0%	1,148
1941	61	27	17	17	100.0%	17
1942	2,572,690	0	1,218,398	1,354,292	91.2%	1,234,764
1943	94,325	0	47,162	47,163	95.0%	44,805
1944	1,604	18	407	1,179	96.7%	1,140
1945	68,280	67,208	360	712	100.0%	712
1946	2,258,105	5,866	856,572	1,395,667	86.2%	1,202,676
1947	204,207	2,450	72,297	129,460	100.0%	129,460
1948	16,899	6,543	1,854	8,502	100.0%	8,502
1949	21,329	17,736	1,316	2,277	88.0%	2,004
1950	1,285,941	32,960	647,930	605,051	94.6%	572,378
1951	145,104	1,606	57,882	85,616	95.9%	82,093
1952	10,753	3,436	2,978	4,339	97.1%	4,211
1953	204,221	201,035	1,548	1,638	94.2%	1,544
1954	1,939,930	4,044	799,990	1,135,896	89.4%	1,015,946
1955	64,561	725	18,829	45,007	99.1%	44,622
1956	4,500	1,179	1,120	2,201	95.6%	2,103
1957	306,188	303,386	1,026	1,776	92.7%	1,647
1958	3,279,949	8,555	1,509,180	1,762,214	92.6%	1,631,357
1959	134,809	264	45,256	89,289	99.8%	89,084
1960	1,914	7	544	1,363	97.0%	1,322
1961	65,508	64,390	236	882	95.1%	839
1962	1,079,243	6,162	448,246	624,835	97.8%	611,260
1963	156,567	113	76,565	79,889	99.2%	79,228
1964	716	112	257	347	99.4%	345
1965	58,507	56,712	619	1,176	98.7%	1,160
1966	1,262,715	39,090	546,855	676,770	93.2%	630,956
1967	839,459	976	380,753	457,730	87.2%	399,271
1968	3,998	312	810	2,876	94.3%	2,713
1969	53,466	48,491	2,240	2,735	96.6%	2,642
1970	1,476,745	27,510	633,023	816,212	91.7%	748,650
1971	283,322	101	127,525	155,696	99.5%	154,980
1972	4,406	253	2,014	2,139	99.8%	2,135
1973	40,546	39,532	511	503	99.6%	501
1974	1,030,975	6,084	442,406	582,485	94.1%	548,158
1975	155,637	1,163	73,403	81,071	97.4%	78,960
1976	5,188	438	1,697	3,053	100.0%	3,053
1977	67,080	60,929	3,672	2,479	99.7%	2,472
1978	1,591,869	2,830	725,066	863,973	99.5%	859,483
1979	286,520	266	127,914	158,340	97.9%	155,047
1980	2,592	112	669	1,811	100.0%	1,811
1981	39,549	33,331	2,016	4,202	99.0%	4,161
1982	2,391,380	959	1,138,770	1,251,651	98.0%	1,226,736
1983	201,717	59	106,496	95,162	99.7%	94,836
1984	4,243	0	1,891	2,352	100.0%	2,352
1985	11,687	11,227	230	230	100.0%	230

Continued

Appendix 1a. Late run Adams River study area[a] sockeye jack and adult escapement by sex, percent spawning success and the number of females which spawned effectively, 1938-1995.

Year	Escapement				Percent spawning success	Effective females
	Total	Jacks	Males	Females		
Continued						
1986	1,601,523	10,809	836,785	753,929	98.5%	742,289
1987	586,456	73	279,198	307,185	98.5%	302,520
1988	4,859	52	1,350	3,457	100.0%	3,457
1989	7,963	7,888	20	55	100.0%	55
1990	2,515,383	5,797	1,263,044	1,246,542	98.4%	1,227,002
1991	1,231,443	1	621,263	610,179	99.0%	603,864
1992	12,390	17	5,936	6,437	97.7%	6,291
1993	8,476	7,884	266	326	96.3%	314
1994	910,697	242	470,607	439,848 [b, c]	99.5%	437,784
1995	410,762	0	200,674	210,088 [b, c]	93.9%	197,333

[a] Stocks included:

Lower Adams River
Lower Adams River spawning channel
Adams Lake
Bush Creek
Hiuihill Creek
Little River
Nikwikwaia Creek
Momich River
Pass Creek
Scotch Creek
South Thompson River

[b] Excludes 50 females removed for fecundity sampling.

[c] Also includes sockeye that spawned in Shuswap Lake-Main Arm, west of Shuswap Lake Provincial Park.

Appendix 1b. Annual date of late run sockeye salmon arrival and peak spawning, jack and adult escapement by sex, percent spawning success and the number of females which had spawned effectively in the lower Adams River, 1938-1995.

Year	Arrival	Period of peak spawning	Escapement				Percent spawning success	Effective females
			Total	Jacks	Males	Females		
1938	-	15-Oct to 20-Oct	620,000	1,751	342,213	276,036	88.1%	243,160
1939	02-Oct	15-Oct to 20-Oct	16,200	151	7,213	8,836	95.0%	8,394
1940	03-Oct	21-Oct to 29-Oct	8,194	6,424	885	885	99.0%	876
1941	01-Oct	24-Oct	61	27	17	17	100.0%	17
1942	20-Sep	15-Oct to 20-Oct	1,967,553	0	940,711	1,026,842	91.2%	936,274
1943	20-Sep	15-Oct to 20-Oct	94,325	0	47,162	47,163	95.0%	44,805
1944	30-Sep	29-Oct to 01-Nov	1,404	16	356	1,032	96.7%	998
1945	25-Sep	15-Oct to 20-Oct	57,780	56,708	360	712	100.0%	712
1946	25-Sep	-	1,835,000	0	667,940	1,167,060	84.2%	982,665
1947	21-Sep	15-Oct to 20-Oct	187,798	2,254	66,480	119,064	100.0%	119,064
1948	23-Sep	15-Oct to 20-Oct	15,384	5,237	1,796	8,351	100.0%	8,351
1949	24-Sep	22-Oct	11,742	9,763	616	1,363	88.0%	1,199
1950	21-Sep	16-Oct to 20-Oct	1,100,081	25,302	557,741	517,038	94.6%	489,118
1951	25-Sep	14-Oct to 16-Oct	134,964	1,080	53,176	80,708	96.0%	77,480
1952	24-Sep	14-Oct to 16-Oct	8,692	2,563	2,375	3,754	97.8%	3,670
1953	25-Sep	10-Oct to 15-Oct	165,678	163,050	1,288	1,340	94.2%	1,263
1954	23-Sep	10-Oct to 20-Oct	1,740,067	2,830	733,153	1,004,084	89.4%	898,053
1955	-	18-Oct to 22-Oct	60,233	514	17,417	42,302	99.1%	41,917
1956	-	28-Oct to 30-Oct	3,245	850	808	1,587	95.6%	1,516
1957	01-Oct	27-Oct to 30-Oct	253,573	251,544	761	1,268	92.1%	1,168
1958	01-Oct	25-Oct to 05-Nov	1,730,609	3,461	930,722	796,426	97.7%	778,368
1959	30-Sep	25-Oct to 27-Oct	113,257	227	37,941	75,089	99.8%	74,916
1960	30-Sep	17-Oct to 19-Oct	1,848	7	522	1,319	97.0%	1,279
1961	-	21-Oct to 23-Oct	56,988	56,057	131	800	95.1%	761
1962	23-Sep	19-Oct to 26-Oct	991,728	5,359	403,385	582,984	97.8%	570,158
1963	30-Sep	21-Oct to 24-Oct	154,086	80	75,546	78,460	99.2%	77,832
1964	01-Oct	25-Oct to 30-Oct	716	112	257	347	99.4%	345
1965	22-Sep	15-Oct to 21-Oct	55,041	53,466	532	1,043	98.5%	1,027
1966	23-Sep	18-Oct to 20-Oct	1,197,336	37,246	515,913	644,177	93.1%	599,729
1967	20-Sep	15-Oct to 25-Oct	755,238	876	341,165	413,197	87.4%	360,928
1968	20-Sep	15-Oct to 18-Oct	3,983	312	803	2,868	94.3%	2,705
1969	23-Sep	14-Oct to 18-Oct	45,908	41,576	2,085	2,247	97.1%	2,182
1970	20-Sep	19-Oct to 30-Oct	1,297,990	26,774	572,042	699,174	91.7%	641,143
1971	15-Sep	17-Oct to 18-Oct	280,176	101	126,099	153,976	99.6%	153,360
1972	18-Sep	20-Oct to 23-Oct	4,325	247	1,978	2,100	99.8%	2,096
1973	25-Sep	12-Oct to 16-Oct	33,312	32,502	372	438	99.6%	436
1974	23-Sep	15-Oct to 17-Oct	889,613	5,357	398,148	486,108	94.5%	459,178
1975	-	12-Oct to 17-Oct	148,187	1,131	69,892	77,164	97.4%	75,119
1976	30-Sep	20-Oct to 22-Oct	5,013	423	1,640	2,950	100.0%	2,950
1977	-	15-Oct to 18-Oct	57,964	52,795	2,934	2,235	100.0%	2,235
1978	20-Sep	22-Oct to 25-Oct	1,493,473	2,135	687,554	803,784	99.5%	799,685
1979	-	17-Oct to 20-Oct	275,616	233	121,599	153,784	97.9%	150,570
1980	-	20-Oct to 24-Oct	2,560	96	661	1,803	100.0%	1,803
1981	-	12-Oct to 15-Oct	31,097	25,855	1,522	3,720	98.9%	3,679
1982	-	19-Oct to 30-Oct	2,070,813 [a]	834	990,420	1,079,559	97.9%	1,057,055
1983	-	10-Oct to 22-Oct	201,669 [a]	59	106,470	95,140	99.7%	94,814
1984	-	19-Oct to 22-Oct	4,183	0	1,864	2,319	100.0%	2,319
1985	-	23-Oct to 26-Oct	10,715	10,293	211	211	100.0%	211

Continued

Appendix 1b. Annual date of late run sockeye salmon arrival and peak spawning, jack and adult escapement by sex, percent spawning success and the number of females which had spawned effectively in the lower Adams River, 1938-1995.

Year	Arrival	Period of peak spawning	Escapement				Percent spawning success	Effective females
			Total	Jacks	Males	Females		
Continued								
1986	-	19-Oct to 02-Nov	1,334,590 [a]	9,501	702,559	622,530	98.5%	612,894
1987	-	22-Oct to 30-Oct	568,060 [a]	71	270,440	297,549	98.5%	292,967
1988	-	18-Oct to 23-Oct	4,630	52	1,273	3,305	100.0%	3,305
1989	-	14-Oct to 18-Oct	7,778	7,705	19	54	100.0%	54
1990	-	15-Oct to 03-Nov	2,073,212 [a]	4,834	1,039,580	1,028,798	98.4%	1,012,256
1991	-	16-Oct to 26-Oct	1,201,180 [a]	1	605,397	595,782	99.1%	590,619
1992	-	03-Oct to 10-Oct	12,287	17	5,886	6,384	97.7%	6,238
1993	-	10-Oct to 18-Oct	8,149	7,609	240	300	96.1%	288
1994	Mid Sep	15-Oct to 20-Oct	680,318 [a]	192	360,388	319,738	99.5%	318,139
1995	Mid Sep	15-Oct to 20-Oct	394,250 [a]	0	191,690	202,560	94.5%	191,346

[a] Includes fish removed for sampling.

Appendix 1c. Annual date of late run sockeye salmon arrival and peak spawning, jack and adult escapement by sex, percent spawning success and the number of females which had spawned effectively in the lower Adams River spawning channel, 1986-1995.

Year	Arrival	Period of peak spawning	Escapement				Percent spawning success	Effective females
			Total	Jacks	Males	Females		
1986	-	[a]	0	0	0	0	-	0
1987	-	[a]	0	0	0	0	-	0
1988	-	[a]	0	0	0	0	-	0
1989	-	[a]	0	0	0	0	-	0
1990	-	15-Oct to 03-Nov	6,840	16	3,429	3,395	98.4%	3,341
1991	-	26-Oct to 02-Nov	2,974	0	1,499	1,475	99.1%	1,462
1992	-	-	0	0	0	0	-	0
1993	-	-	0	0	0	0	-	0
1994 [b]	-	0-Jan	2,031	0	1,167	864	99.5%	860
1995 [c]	-	0-Jan	1,510	0	832	678	89.4%	606

[a] Channel was not in operation.

[b] Escapement estimated from total dead pitch plus remaining live; sex ratio from dead pitch was applied to total; spawning success estimated from lower Adams River.

[c] Escapement estimated from total dead pitch plus remaining live; sex ratio from dead pitch was applied to total.

Appendix 1d. Annual date of late run sockeye salmon arrival and peak spawning, jack and adult escapement by sex, percent spawning success and the number of females which had spawned effectively in Adams Lake, 1938-1995.

Year	Arrival	Period of peak spawning	Escapement				Percent spawning success	Effective females
			Total	Jacks	Males	Females		
1938	-	-	0	0	0	0	-	0
1939	-	-	0	0	0	0	-	0
1940	-	-	0	0	0	0	-	0
1941	-	-	0	0	0	0	-	0
1942	26-Sep	15-Oct to 20-Oct	200,000	0	84,080	115,920	91.2%	105,696
1943	-	-	0	0	0	0	-	0
1944	-	-	0	0	0	0	-	0
1945	-	-	0	0	0	0	-	0
1946	-	-	0	0	0	0	-	0
1947	-	-	0	0	0	0	-	0
1948	-	-	0	0	0	0	-	0
1949	-	-	0	0	0	0	-	0
1950	-	-	0	0	0	0	-	0
1951	-	-	0	0	0	0	-	0
1952	-	-	0	0	0	0	-	0
1953	-	-	0	0	0	0	-	0
1954	-	-	0	0	0	0	-	0
1955	-	-	0	0	0	0	-	0
1956	-	-	0	0	0	0	-	0
1957	-	-	0	0	0	0	-	0
1958	-	-	0	0	0	0	-	0
1959	-	-	0	0	0	0	-	0
1960	-	-	0	0	0	0	-	0
1961	-	-	0	0	0	0	-	0
1962	-	-	0	0	0	0	-	0
1963	-	-	0	0	0	0	-	0
1964	-	-	0	0	0	0	-	0
1965	-	-	0	0	0	0	-	0
1966	-	-	0	0	0	0	-	0
1967	-	-	0	0	0	0	-	0
1968	-	-	0	0	0	0	-	0
1969	-	-	0	0	0	0	-	0
1970	-	-	0	0	0	0	-	0
1971	-	-	0	0	0	0	-	0
1972	-	-	0	0	0	0	-	0
1973	-	-	0	0	0	0	-	0
1974	-	-	0	0	0	0	-	0
1975	-	-	0	0	0	0	-	0
1976	-	-	0	0	0	0	-	0
1977	-	-	0	0	0	0	-	0
1978	-	22-Oct to 25-Oct	749	0	342	407	99.2%	404
1979	-	-	0	0	0	0	-	0
1980	-	-	0	0	0	0	-	0
1981	-	-	0	0	0	0	-	0
1982	-	-	0	0	0	0	-	0
1983	-	-	0	0	0	0	-	0
1984	-	-	0	0	0	0	-	0
1985	-	-	0	0	0	0	-	0

Continued

Appendix 1d. Annual date of late run sockeye salmon arrival and peak spawning, jack and adult escapement by sex, percent spawning success and the number of females which had spawned effectively in Adams Lake, 1938-1995.

Year	Arrival	Period of peak spawning	Escapement				Percent spawning success	Effective females
			Total	Jacks	Males	Females		
Continued								
1986	-	Late Oct	2,965	20	1,549	1,396	98.5%	1,375
1987	-	Late Oct	47	0	22	25	98.5%	25
1988	-	-	0	0	0	0	-	0
1989	-	-	0	0	0	0	-	0
1990	-	15-Oct to 03-Nov	6,532	15	3,275	3,242	98.4%	3,190
1991	-	20-Oct to 28-Oct	419	0	211	208	99.1%	206
1992	-	-	0	0	0	0	-	0
1993	-	-	0	0	0	0	-	0
1994	-	15-Oct to 20-Oct	428	0	351	77	99.5%	77
1995	-	15-Oct to 20-Oct	119	0	58	61	94.4% [a]	58

[a] Mean spawning success of carcasses sampled in Adams Lake and tributaries to Adams Lake.

Appendix 1e. Annual date of late run sockeye salmon arrival and peak spawning, jack and adult escapement by sex, percent spawning success and the number of females which had spawned effectively in Bush Creek, 1986-1995.

Year	Arrival	Period of peak spawning	Escapement				Percent spawning success	Effective females
			Total	Jacks	Males	Females		
1986	-	Late Oct	104	1	54	49	98.5%	48
1987	-	-	0	0	0	0	-	0
1988	-	-	0	0	0	0	-	0
1989	-	-	0	0	0	0	-	0
1990	-	20-Oct to 25-Oct	76	0	38	38	100.0%	38
1991	-	-	0	0	0	0	-	0
1992	-	-	0	0	0	0	-	0
1993	-	-	0	0	0	0	-	0
1994	-	0-Jan	79	0	43	36	99.5%	36
1995		-	0	0	0	0	-	0

Appendix 1f. Annual date of late run sockeye salmon arrival and peak spawning, jack and adult escapement by sex, percent spawning success and the number of females which had spawned effectively in Hiuihill Creek, 1986-1995.

Year	Arrival	Period of peak spawning	Escapement				Percent spawning success	Effective females
			Total	Jacks	Males	Females		
1986	-	-	0	0	0	0	-	0
1987	-	-	0	0	0	0	-	0
1988	-	-	0	0	0	0	-	0
1989	-	-	0	0	0	0	-	0
1990	-	15-Oct to 03-Nov	2,925	7	1,467	1,451	99.7%	1,446
1991	-	16-Oct to 26-Oct	616	0	310	306	92.9%	284
1992	-	-	0	0	0	0	-	0
1993	-	-	0	0	0	0	-	0
1994	-	0-Jan	194	0	148	46	99.5%	46
1995	-	0-Jan	425	0	226	199	100.0%	199

Appendix 1g. Annual date of late run sockeye salmon arrival and peak spawning, jack and adult escapement by sex, percent spawning success and the number of females which had spawned effectively in Little River, 1938-1995.

Year	Arrival	Period of peak spawning	Escapement				Percent spawning success	Effective females
			Total	Jacks	Males	Females		
1938	-	15-Oct to 20-Oct	175,000	494	96,592	77,914	76.2%	59,355
1939	02-Oct	15-Oct to 20-Oct	15,687	146	6,984	8,557	95.0%	8,129
1940	03-Oct	19-Oct to 23-Oct	2,430	1,905	262	263	99.0%	260
1941	-	-	n/r	0	0	0	-	0
1942	20-Sep	15-Oct to 20-Oct	400,000	0	191,245	208,755	91.2%	190,343
1943	-	-	0	0	0	0	-	0
1944	-	-	200	2	51	147	96.7%	142
1945	-	-	6,000	6,000	0	0	-	0
1946	-	16-Oct to 20-Oct	419,000	5,866	187,293	225,841	96.2%	217,259
1947	07-Oct	01-Nov to 08-Nov	16,251	195	5,753	10,303	100.0%	10,303
1948	28-Sep	15-Oct to 20-Oct	1,313	1,254	16	43	100.0%	43
1949	06-Oct	22-Oct	9,571	7,959	700	912	88.0%	803
1950	-	16-Oct to 20-Oct	137,939	5,793	66,804	65,342	94.6%	61,814
1951	04-Oct	16-Oct to 17-Oct	9,690	523	4,497	4,670	94.0%	4,390
1952	16-Sep	10-Oct to 17-Oct	1,861	818	540	503	91.7%	461
1953	-	10-Oct to 16-Oct	37,659	37,102	259	298	94.2%	281
1954	20-Sep	10-Oct to 20-Oct	199,004	1,212	66,484	131,308	89.4%	117,442
1955	-	15-Oct to 20-Oct	4,328	211	1,412	2,705	100.0%	2,705
1956	-	25-Oct to 26-Oct	1,255	329	312	614	95.6%	587
1957	25-Sep	30-Oct to 05-Nov	34,964	34,580	174	210	87.2%	183
1958	07-Oct	01-Nov to 08-Nov	1,415,657[a]	4,885	531,421	879,351	96.8%	772,498
1959	30-Sep	28-Oct to 02-Nov	21,080	36	7,155	13,889	99.8%	13,857
1960	-	-	66	0	22	44	97.0%	43
1961	-	21-Oct to 23-Oct	8,253	8,070	104	79	95.1%	75
1962	-	19-Oct to 26-Oct	67,398	662	35,645	31,091	97.9%	30,429
1963	-	24-Oct to 27-Oct	2,436	33	997	1,406	97.7%	1,374
1964	-	-	0	0	0	0	-	0
1965	22-Sep	18-Oct to 24-Oct	3,274	3,126	50	98	100.0%	98
1966	-	19-Oct to 28-Oct	55,952	1,692	25,581	28,679	96.0%	27,532
1967	-	15-Oct to 20-Oct	74,490	89	35,188	39,213	85.7%	33,609
1968	-	-	0	0	0	0	-	0
1969	23-Sep	17-Oct to 20-Oct	6,842	6,261	125	456	94.3%	430
1970	20-Sep	19-Oct to 30-Oct	168,881	679	58,620	109,582	91.9%	100,706
1971	15-Sep	17-Oct to 18-Oct	2,821	0	1,264	1,557	93.6%	1,457
1972	25-Oct	28-Oct to 30-Oct	81	6	36	39	99.8%	39
1973	-	20-Oct to 24-Oct	6,689	6,499	132	58	99.6%	58
1974	-	21-Oct to 23-Oct	122,112	571	36,944	84,597	91.7%	77,550
1975	-	12-Oct to 17-Oct	7,268	31	3,424	3,813	98.3%	3,749
1976	-	20-Oct to 25-Oct	175	15	57	103	100.0%	103
1977	-	15-Oct to 18-Oct	8,684	7,742	714	228	97.0%	221
1978	-	25-Oct to 27-Oct	81,055	632	30,406	50,017	99.4%	49,692
1979	-	20-Oct to 25-Oct	10,443	33	6,111	4,299	98.2%	4,220
1980	-	20-Oct to 23-Oct	32	16	8	8	100.0%	8
1981	-	12-Oct to 15-Oct	8,169	7,231	478	460	100.0%	460
1982	-	26-Oct to 31-Oct	239,278	99	117,915	121,264	98.3%	119,227
1983	-	-	0[b]	0	0	0	-	0
1984	-	19-Oct to 22-Oct	49	0	22	27	100.0%	27
1985	-	19-Oct to 22-Oct	972	934	19	19	100.0%	19

Continued

Appendix 1g. Annual date of late run sockeye salmon arrival and peak spawning, jack and adult escapement by sex, percent spawning success and the number of females which had spawned effectively in Little River, 1938-1995.

Year	Arrival	Period of peak spawning	Escapement				Percent spawning success	Effective females
			Total	Jacks	Males	Females		
Continued								
1986	-	19-Oct to 02-Nov	227,919	1,141	118,142	108,636	98.5%	106,963
1987	-	19-Oct to 02-Nov	18,000	2	8,569	9,429	98.5%	9,346
1988	-	18-Oct to 23-Oct	225	0	75	150	100.0%	150
1989	-	-	167	165	1	1	100.0%	1
1990	-	-	360,000	828	180,504	178,668	98.4%	175,804
1991	-	16-Oct to 26-Oct	13,500	0	6,890	6,610	83.4%	5,515
1992	-	03-Oct to 10-Oct	83	0	40	43	100.0%	43
1993	-	10-Oct to 18-Oct	229	214	7	8	96.1%	8
1994	-	15-Oct to 20-Oct	198,204	44	96,076	102,084	99.6%	101,676
1995	-	15-Oct to 20-Oct	9,124	0	5,284	3,840	77.7% [c]	2,983

[a.] Includes the following fish which were diverted from the lower Adams River and spawned primarily in Little River, but also in South Thompson River and Shuswap Lake: 3,370 jacks; 389,045 males; 613,762 females; 515,451 effective females.

[b.] Included in the estimate for the lower Adams River.

[c.] Mean spawning success of carcasses sampled in Little River and Little Shuswap Lake.

Appendix 1h. Annual date of late run sockeye salmon arrival and peak spawning, jack and adult escapement by sex, percent spawning success and the number of females which had spawned effectively in Momich River, 1938-1995.

Year	Arrival	Period of peak spawning	Escapement				Percent spawning success	Effective females
			Total	Jacks	Males	Females		
1938	-	-	0	0	0	0	-	0
1939	-	-	0	0	0	0	-	0
1940	-	-	0	0	0	0	-	0
1941	-	-	0	0	0	0	-	0
1942	-	-	158	0	79	79	91.2%	72
1943	-	-	0	0	0	0	-	0
1944	-	-	0	0	0	0	-	0
1945	-	-	1,500	1,500	0	0	-	0
1946	-	-	58	0	29	29	100.0%	29
1947	-	-	0	0	0	0	-	0
1948	-	-	0	0	0	0	-	0
1949	-	-	0	0	0	0	-	0
1950	-	16-Oct to 20-Oct	150	3	76	71	94.6%	67
1951	-	-	0	0	0	0	-	0
1952	-	-	0	0	0	0	-	0
1953	-	-	45	45	0	0	-	0
1954	-	-	785	0	0	0	-	0
1955	-	-	0	0	0	0	-	0
1956	-	-	0	0	0	0	-	0
1957	-	-	n/r	0	0	0	-	0
1958	Mid Oct	01-Nov to 03-Nov	369	1	198	170	97.7%	166
1959	-	-	0	0	0	0	-	0
1960	-	-	0	0	0	0	-	0
1961	-	-	0	0	0	0	-	0
1962	-	24-Oct to 29-Oct	218	1	92	125	100.0%	125
1963	-	-	0	0	0	0	-	0
1964	-	-	0	0	0	0	-	0
1965	-	-	0	0	0	0	-	0
1966	-	-	0	0	0	0	-	0
1967	-	-	0	0	0	0	-	0
1968	-	-	0	0	0	0	-	0
1969	-	-	0	0	0	0	-	0
1970	8-Oct	19-Oct to 23-Oct	360	0	152	208	91.7%	191
1971	-	-	0	0	0	0	-	0
1972	-	-	0	0	0	0	-	0
1973	-	-	0	0	0	0	-	0
1974	-	-	0	0	0	0	-	0
1975	-	-	0	0	0	0	-	0
1976	-	-	0	0	0	0	-	0
1977	-	-	0	0	0	0	-	0
1978	-	22-Oct to 25-Oct	65	0	30	35	100.0%	35
1979	-	-	0	0	0	0	-	0
1980	-	-	0	0	0	0	-	0
1981	-	-	0	0	0	0	-	0
1982	-	18-Oct to 20-Oct	112	0	53	59	100.0%	59
1983	-	-	0	0	0	0	-	0
1984	-	-	0	0	0	0	-	0
1985	-	-	0	0	0	0	-	0

Continued

Appendix 1h. Annual date of late run sockeye salmon arrival and peak spawning, jack and adult escapement by sex, percent spawning success and the number of females which had spawned effectively in Momich River, 1938-1995.

Year	Arrival	Period of peak spawning	Escapement				Percent spawning success	Effective females
			Total	Jacks	Males	Females		
Continued								
1986	-	Late Oct	315	2	165	148	98.5%	146
1987	-	-	0	0	0	0	-	0
1988	-	-	0	0	0	0	-	0
1989	-	-	0	0	0	0	-	0
1990	-	20-Oct to 25-Oct	454	1	228	225	100.0%	225
1991	-	20-Oct to 28-Oct	25	0	13	12	99.1%	12
1992	-	-	0	0	0	0	-	0
1993	-	-	0	0	0	0	-	0
1994	-	-	76	0	41	35	99.5%	35
1995	-	-	2	0	1	1	94.4% [a]	1

[a] Mean spawning success of carcasses sampled in Adams Lake and tributaries to Adams Lake.

Appendix 1i. Annual date of late run sockeye salmon arrival and peak spawning, jack and adult escapement by sex, percent spawning success and the number of females which had spawned effectively in Nikwikwaia Creek, 1986-1995.

Year	Arrival	Period of peak spawning	Escapement				Percent spawning success	Effective females
			Total	Jacks	Males	Females		
1986	-	Late Oct	83	1	43	39	98.5%	38
1987	-	-	0	0	0	0	-	0
1988	-	-	0	0	0	0	-	0
1989	-	-	0	0	0	0	-	0
1990	-	15-Oct to 03-Nov	2,365	5	1,186	1,174	100.0%	1,174
1991	-	16-Oct to 26-Oct	2,095	0	1,056	1,039	100.0%	1,039
1992	-	-	0	0	0	0	-	0
1993	-	-	0	0	0	0	-	0
1994	-	0-Jan	272	0	138	134	99.5%	133
1995	-	0-Jan	666	0	325	341	95.2%	324

Appendix 1j. Annual date of late run sockeye salmon arrival and peak spawning, jack and adult escapement by sex, percent spawning success and the number of females which had spawned effectively in Pass Creek, 1938-1995.

Year	Arrival	Period of peak spawning	Escapement				Percent spawning success	Effective females
			Total	Jacks	Males	Females		
1938	-	-	0	0	0	0	-	0
1939	-	-	0	0	0	0	-	0
1940	-	-	0	0	0	0	-	0
1941	-	-	0	0	0	0	-	0
1942	-	-	607	0	354	253	91.2%	231
1943	-	-	0	0	0	0	-	0
1944	-	-	0	0	0	0	-	0
1945	-	-	250	250	0	0	-	0
1946	-	30-Oct	139	0	58	81	82.6%	67
1947	-	-	0	0	0	0	-	0
1948	-	-	0	0	0	0	-	0
1949	-	-	0	0	0	0	-	0
1950	-	16-Oct to 20-Oct	100	2	51	47	94.6%	44
1951	-	-	0	0	0	0	-	0
1952	-	-	0	0	0	0	-	0
1953	-	27-Oct to 30-Oct	839	838	1	0	-	0
1954	-	-	859	2	353	504	89.4%	451
1955	-	-	0	0	0	0	-	0
1956	-	-	0	0	0	0	-	0
1957	Mid Oct	27-Oct to 30-Oct	1,463	1,448	7	8	92.1%	7
1958	Mid Oct	10-Nov	403	1	217	185	97.7%	181
1959	-	-	0	0	0	0	-	0
1960	-	-	0	0	0	0	-	0
1961	-	-	13	13	0	0	-	0
1962	-	Late Oct	940	5	393	542	100.0%	542
1963	-	-	0	0	0	0	-	0
1964	-	-	0	0	0	0	-	0
1965	-	-	0	0	0	0	-	0
1966	-	-	344	10	151	183	92.1%	170
1967	-	-	n/r	0	0	0	-	0
1968	-	-	0	0	0	0	-	0
1969	-	-	86	78	4	4	100.0%	4
1970	10-Oct	19-Oct to 23-Oct	507	0	214	293	100.0%	293
1971	12-Oct	15-Oct to 16-Oct	2	0	1	1	100.0%	1
1972	-	-	0	0	0	0	-	0
1973	-	-	0	0	0	0	-	0
1974	14-Oct	20-Oct to 25-Oct	171	0	85	86	100.0%	86
1975	-	-	2	0	1	1	100.0%	1
1976	-	-	0	0	0	0	-	0
1977	-	-	0	0	0	0	-	0
1978	-	22-Oct to 25-Oct	547	0	250	297	100.0%	297
1979	-	20-Oct to 25-Oct	4	0	2	2	100.0%	2
1980	-	-	0	0	0	0	-	0
1981	-	Late Oct	101	84	5	12	100.0%	12
1982	-	26-Oct to 02-Nov	2,725	1	1,298	1,426	100.0%	1,426
1983	-	27-Oct	5	0	3	2	100.0%	2
1984	-	-	0	0	0	0	-	0
1985	-	-	0	0	0	0	-	0

Continued

Appendix 1j. Annual date of late run sockeye salmon arrival and peak spawning, jack and adult escapement by sex, percent spawning success and the number of females which had spawned effectively in Pass Creek, 1938-1995.

Year	Arrival	Period of peak spawning	Escapement				Percent spawning success	Effective females
			Total	Jacks	Males	Females		
Continued								
1986	-	Late Oct	585	4	306	275	98.5%	271
1987	-	Late Oct	14	0	7	7	98.5%	7
1988	-	-	0	0	0	0	-	0
1989	-	-	0	0	0	0	-	0
1990	-	20-Oct to 25-Oct	1,779	4	892	883	100.0%	883
1991	-	21-Oct to 26-Oct	29	0	15	14	99.1%	14
1992	-	-	0	0	0	0	-	0
1993	-	-	0	0	0	0	-	0
1994	-	-	495	0	264	231	99.5%	230
1995	-	-	38	0	12	26	94.4% [a]	25

[a] Mean spawning success of carcasses sampled in Adams Lake and tributaries to Adams Lake.

Appendix 1k. Annual date of late run sockeye salmon arrival and peak spawning, jack and adult escapement by sex, percent spawning success and the number of females which had spawned effectively in Scotch Creek, 1938-1995.

Year	Arrival	Period of peak spawning	Escapement				Percent spawning success	Effective females
			Total	Jacks	Males	Females		
1938	-	01-Nov to 05-Nov	2,039	34	986	1,019	48.1%	490
1939	-	-	0	0	0	0	-	0
1940	-	-	0	0	0	0	-	0
1941	-	-	0	0	0	0	-	0
1942	12-Oct	25-Oct to 30-Oct	4,372	0	1,929	2,443	88.0%	2,149
1943	-	-	0	0	0	0	-	0
1944	-	-	0	0	0	0	-	0
1945	-	-	1,750	1,750	0	0	-	0
1946	15-Oct	02-Oct to 05-Oct	3,908	0	1,252	2,656	100.0%	2,656
1947	-	-	58	0	29	29	100.0%	29
1948	-	-	0	0	0	0	-	0
1949	-	-	7	5	0	2	100.0%	2
1950	-	16-Oct to 20-Oct	7,500	173	3,803	3,524	94.6%	3,334
1951	-	-	0	0	0	0	-	0
1952	-	-	0	0	0	0	-	0
1953	-	-	0	0	0	0	-	0
1954	-	-	0	0	0	0	-	0
1955	-	-	0	0	0	0	-	0
1956	-	-	0	0	0	0	-	0
1957	1-Oct	27-Oct to 30-Oct	1,543	1,520	11	12	92.1%	11
1958	-	08-Nov to 20-Nov	9,047	9	3,344	5,694	92.6%	5,273
1959	-	-	0	0	0	0	-	0
1960	-	-	0	0	0	0	-	0
1961	-	-	0	0	0	0	-	0
1962	-	22-Oct to 28-Oct	4,518	26	1,887	2,605	97.8%	2,548
1963	-	-	0	0	0	0	-	0
1964	-	-	0	0	0	0	-	0
1965	-	-	0	0	0	0	-	0
1966	-	18-Oct to 28-Oct	4,770	142	2,095	2,533	93.1%	2,358
1967	5-Oct	15-Oct to 18-Oct	9,461	11	4,278	5,172	89.0%	4,605
1968	-	20-Oct to 25-Oct	15	0	7	8	100.0%	8
1969	-	-	0	0	0	0	-	0
1970	7-Oct	18-Oct to 21-Oct	3,076	57	1,328	1,691	87.5%	1,480
1971	10-Oct	26-Oct to 28-Oct	313	0	156	157	100.0%	157
1972	-	-	0	0	0	0	-	0
1973	-	-	0	0	0	0	-	0
1974	-	20-Oct to 25-Oct	4,613	24	2,333	2,256	96.6%	2,180
1975	-	26-Oct to 28-Oct	164	1	78	85	97.4%	83
1976	-	-	0	0	0	0	-	0
1977	-	-	0	0	0	0	-	0
1978	-	25-Oct to 27-Oct	5,994	6	2,735	3,253	99.3%	3,231
1979	-	28-Oct to 01-Nov	313	0	138	175	100.0%	175
1980	-	-	0	0	0	0	-	
1981	-	-	0	0	0	0	-	0
1982	-	20-Oct to 25-Oct	4,849	2	2,310	2,537	100.0%	2,537
1983	-	26-Oct to 30-Oct	43	0	23	20	100.0%	20
1984	-	-	0	0	0	0	-	0
1985	-	-	0	0	0	0	-	0

Continued

Appendix 1k. Annual date of late run sockeye salmon arrival and peak spawning, jack and adult escapement by sex, percent spawning success and the number of females which had spawned effectively in Scotch Creek, 1938-1995.

Year	Arrival	Period of peak spawning	Escapement				Percent spawning success	Effective females
			Total	Jacks	Males	Females		
Continued								
1986	-	Late Oct	4,232	26	2,351	1,855	98.5%	1,846
1987	-	22-Oct to 26-Oct	317	0	151	166	100.0%	166
1988	-	-	0	0	0	0	-	0
1989	-	-	0	0	0	0	-	0
1990	-	18-Oct to 23-Oct	28,800	12	16,200	12,588	100.0%	12,588
1991	-	20-Oct to 28-Oct	10,544	0	5,843	4,701	99.6%	4,681
1992	-	03-Oct to 10-Oct	20	0	10	10	100.0%	10
1993	-	10-Oct to 18-Oct	29	21	3	5	100.0%	5
1994	-	15-Oct to 25-Oct	3,520	6	1,817	1,697	97.9%	1,661
1995	-	15-Oct to 25-Oct	2,707	0	1,283	1,424	60.3%	859

Appendix 1l. Annual date of late run sockeye salmon arrival and peak spawning, jack and adult escapement by sex, percent spawning success and the number of females which had spawned effectively in Shuswap Lake-Main Arm, west of Shuswap Lake Provincial Park, 1986-1995.

Year	Arrival	Period of peak spawning	Escapement				Percent spawning success	Effective females
			Total	Jacks	Males	Females		
1994	-	-	0 [a]	0	0	0	-	0
1995	-	0-Jan	1,651	0	807	844	96.9% [b]	818

[a] Included in the estimate for lower Adams River.

[b] Mean spawning success of carcasses sampled in Shuswap Lake-Main Arm east of Shuswap Lake Provincial Park.

Appendix 1m. Annual date of late run sockeye salmon arrival and peak spawning, jack and adult escapement by sex, percent spawning success and the number of females which had spawned effectively in the South Thompson River, 1938-1995.

Year	Arrival	Period of peak spawning	Escapement				Percent spawning success	Effective females
			Total	Jacks	Males	Females		
1938	-	-	0	0	0	0	-	0
1939	-	-	0	0	0	0	-	0
1940	-	-	100	78	11	11	100.0%	11
1941	-	-	0	0	0	0	-	0
1942	-	-	n/r	0	0	0	-	0
1943	-	-	n/r	0	0	0	-	0
1944	-	-	n/r	0	0	0	-	0
1945	-	-	1,000	1000	0	0	-	0
1946	-	-	n/r	0	0	0	-	0
1947	-	-	100	1	35	64	100.0%	64
1948	-	-	202	52	42	108	100.0%	108
1949	-	-	9	9	0	0	-	0
1950	-	16-Oct to 20-Oct	40,171	1687	19,455	19,029	94.6%	18,002
1951	04-Oct	16-Oct to 17-Oct	450	3	209	238	94.0%	224
1952	04-Oct	16-Oct to 17-Oct	200	55	63	82	97.8%	80
1953	-	-	n/r	0	0	0	-	0
1954	-	-	n/r	0	0	0	-	0
1955	-	-	0	0	0	0	-	0
1956	-	-	0	0	0	0	-	0
1957	-	30-Oct to 05-Nov	14,645	14294	73	278	100.0%	278
1958	-	01-Nov to 08-Nov	123,864	198	43,278	80,388	93.1%	74,871
1959	05-Oct	28-Oct to 02-Nov	472	1	160	311	99.8%	310
1960	-	-	0	0	0	0	-	0
1961	-	21-Oct to 23-Oct	254	250	1	3	100.0%	3
1962	-	19-Oct to 24-Oct	14,441	109	6,844	7,488	99.6%	7,458
1963	-	24-Oct to 27-Oct	45	0	22	23	97.7%	22
1964	-	-	0	0	0	0	-	0
1965	25-Sep	20-Oct to 24-Oct	192	120	37	35	100.0%	35
1966	-	18-Oct to 28-Oct	4,313	0	3,115	1,198	97.4%	1,167
1967	-	15-Oct to 25-Oct	270	0	122	148	87.4%	129
1968	-	-	0	0	0	0	-	0
1969	23-Sep	17-Oct to 20-Oct	630	576	26	28	94.3%	26
1970	-	19-Oct to 30-Oct	5,931	0	667	5,264	91.9%	4,838
1971	15-Sep	17-Oct to 18-Oct	10	0	5	5	100.0%	5
1972	-	-	0	0	0	0	-	0
1973	-	18-Oct to 22-Oct	545	531	7	7	99.6%	7
1974	-	21-Oct to 23-Oct	14,466	132	4,896	9,438	97.1%	9,165
1975	-	12-Oct to 17-Oct	16	0	8	8	100.0%	8
1976	-	-	0	0	0	0	-	0
1977	-	03-Oct to 06-Oct	432	392	24	16	100.0%	16
1978	-	25-Oct to 27-Oct	9,986	57	3,749	6,180	99.4%	6,140
1979	-	20-Oct to 25-Oct	144	0	64	80	100.0%	80
1980	-	-	0	0	0	0	-	0
1981	-	12-Oct to 15-Oct	182	161	11	10	100.0%	10
1982	-	26-Oct to 31-Oct	73,603	23	26,774	46,806	99.2%	46,432
1983	-	-	0 [a]	0	0	0	-	0
1984	-	Late Oct	11	0	5	6	100.0%	6
1985	-	-	0	0	0	0	-	0

Continued

Appendix 1m. Annual date of late run sockeye salmon arrival and peak spawning, jack and adult escapement by sex, percent spawning success and the number of females which had spawned effectively in the South Thompson River, 1938-1995.

Year	Arrival	Period of peak spawning	Escapement				Percent spawning success	Effective females
			Total	Jacks	Males	Females		
Continued								
1986	-	20-Oct to 01-Nov	30,730	113	11,616	19,001	98.5%	18,708
1987	-	Late Oct	18	0	9	9	100.0%	9
1988	-	Late Oct	4	0	2	2	100.0%	2
1989	-	-	18	18	0	0	-	0
1990	-	18-Oct to 23-Oct	32,400	75	16,245	16,080	99.9%	16,057
1991	-	18-Oct to 26-Oct	61	0	29	32	100.0%	32
1992	-	-	0	0	0	0	-	0
1993	-	16-Oct to 21-Oct	69	40	16	13	100.0%	13
1994	-	15-Oct to 20-Oct	25,080	0	10,174	14,906	99.9%	14,891
1995	-	-	270	0	156	114	100.0%	114

[a] Included in the estimate for the lower Adams River.

Appendix 2. Daily counts of live adult, late run sockeye, by area, on drift surveys of the lower Adams River, 1995.

	Area							
Date	1	2	3	4 [a]	5	6	7	Total
19-Sep	0	0	0	0	0	0	-	0
25-Sep	125	114	15	172	311	50	-	787
26-Sep	326	182	21	765	1,336	3,000	-	5,630
27-Sep	560	480	130	795	2,540	2,000	-	6,505
28-Sep	1,161	1,120	420	1,510	1,750	4,000	-	9,961
29-Sep	643	730	471	2,320	1,986	3,400	-	9,550
30-Sep	1,730	1,320	1,250	5,388	4,540	4,000	-	18,228
1-Oct	1,830	2,200	1,610	5,990	2,580	5,500	-	19,710
2-Oct	5,590	2,850	8,840	6,040	-	-	-	23,320
3-Oct	7,570	3,210	1,170	9,600	-	-	-	21,550
4-Oct	4,120	4,540	2,430	13,700	9,880	9,000	-	43,670
5-Oct	4,880	7,640	5,060	34,020	16,360	-	-	67,960
6-Oct	9,020	8,680	7,410	36,200	17,710	-	-	79,020
7-Oct	10,560	10,220	7,600	53,030	19,850	-	-	101,260
8-Oct	11,850	11,170	6,440	51,400	28,620	-	-	109,480
9-Oct	13,190	15,320	7,760	59,660	28,460	-	-	124,390
10-Oct	14,420	12,120	10,130	69,780	37,650	-	-	144,100
11-Oct	14,030	16,970	8,080	75,580	44,900	-	-	159,560
12-Oct	11,630	13,570	9,380	81,640	51,220	-	-	167,440
13-Oct	-	-	-	-	-	-	-	-
14-Oct	10,370	20,220	12,596	79,170	47,990	-	-	170,346
15-Oct	9,320	18,340	11,910	83,300	42,200	-	-	165,070
16-Oct	10,000	17,700	11,540	75,240	45,430	-	-	159,910
Peak live count:								
14-Oct	10,370	20,220	12,596	79,170	47,990	-	-	170,346
% by reach	6%	12%	7%	46%	28%	-	-	100%

[a] Only the portion of reach 4 above the fork was included.

Appendix 3. Daily application of disk tags and secondary marks to late run sockeye salmon, by location and sex, in the lower Adams River, 1995.

Date	Tagging Site	Sets made	Original field estimate of disk tags applied			Final estimate of disk tags applied [a]			Recaptures		
			Male	Female	Total	Male	Female	Total	Male	Female	Total
25-Sep	5a	1	14	8	22	14	7	21	1	0	1
26-Sep	5b	1	19	12	31	19	12	31	1	0	1
27-Sep	1	1	19	11	30	19	10	29	3	1	4
	4a	1	7	3	10	7	3	10	1	0	1
28-Sep	4a	1	16	5	21	16	4	20	1	0	1
	5a	1	12	8	20	12	8	20	4	3	7
29-Sep	5a	1	30	19	49	30	19	49	0	1	1
30-Sep	1	1	14	9	23	12	8	20	3	1	4
	4b	1	1	1	2	1	1	2	0	0	0
	4c	1	31	22	53	31	22	53	1	1	2
1-Oct	1	2	5	2	7	3	0	3	2	2	4
	4a	1	34	8	42	33	8	41	2	2	4
2-Oct	1	1	16	11	27	11	9	20	6	2	8
	4b	1	6	6	12	6	6	12	1	0	1
	4c	1	21	19	40	21	19	40	0	0	0
	5b	1	11	3	14	11	3	14	0	0	0
3-Oct	1	2	15	10	25	12	7	19	6	5	11
	4c	2	55	33	88	52	32	84	3	0	3
	5b	3	37	36	73	36	34	70	2	1	3
4-Oct	1	1	1	5	6	1	3	4	0	2	2
	4a	2	24	13	37	24	13	37	2	0	2
	4b	1	10	10	20	9	10	19	0	0	0
5-Oct	1	1	31	17	48	27	13	40	8	6	14
	4c	2	106	70	176	105	69	174	10	5	15
	5b	2	127	72	199	126	71	197	4	5	9
6-Oct	1	2	31	15	46	26	10	36	9	7	16
	4a	2	63	69	132	62	68	130	3	2	5
	4b	1	69	37	106	68	36	104	7	0	7
	5b	1	26	24	50	26	24	50	0	0	0
7-Oct	1	1	37	20	57	31	19	50	9	3	12
	4a	1	54	54	108	54	54	108	1	0	1
	4b	2	74	46	120	73	44	117	3	1	4
	4c	1	69	25	94	67	25	92	9	0	9
8-Oct	1	1	7	5	12	6	5	11	1	0	1
	4a	1	70	71	141	68	70	138	5	1	6
	5b	1	22	36	58	22	36	58	0	0	0
9-Oct	1	1	26	24	50	19	18	37	10	12	22
	4a	1	76	77	153	76	77	153	0	2	2
	4b	2	61	30	91	61	30	91	1	0	1
10-Oct	1	1	16	4	20	15	3	18	1	1	2
	4a	2	74	71	145	73	70	143	3	5	8
	4b	1	60	49	109	60	48	108	0	3	3
	5b	1	15	29	44	14	29	43	0	1	1
11-Oct	2	1	9	16	25	9	16	25	0	0	0
	4a	1	92	71	163	92	71	163	1	1	2

Continued

Appendix 3. Daily application of disk tags and secondary marks to late run sockeye salmon, by location and sex, in the lower Adams River, 1995.

Date	Tagging Site	Sets made	Original field estimate of disk tags applied			Final estimate of disk tags applied [a]			Recaptures		
			Male	Female	Total	Male	Female	Total	Male	Female	Total
Continued											
11-Oct	5b	1	42	69	111	41	69	110	3	2	5
12-Oct	1	2	2	2	4	2	2	4	0	0	0
	4a	1	14	19	33	14	19	33	1	1	2
	4b	1	31	32	63	31	31	62	0	0	0
	4c	1	15	39	54	14	37	51	0	1	1
13-Oct	1	1	7	5	12	7	5	12	0	0	0
	4a	1	56	94	150	56	92	148	2	1	3
14-Oct	1	1	45	32	77	38	26	64	12	8	20
	4a	1	71	124	195	70	120	190	1	3	4
15-Oct	1	1	9	1	10	9	1	10	0	0	0
	4c	1	49	61	110	49	61	110	1	1	2
	5b	1	17	23	40	17	23	40	1	0	1
16-Oct	1	1	6	4	10	6	4	10	1	1	2
	4a	1	49	80	129	49	79	128	1	2	3
17-Oct	1	1	2	4	6	2	4	6	0	0	0
	4a	1	26	68	94	26	67	93	0	1	1
18-Oct	1	1	2	8	10	2	4	6	0	2	2
	4a	1	37	59	96	37	59	96	0	1	1
	5b	1	16	19	35	15	18	33	1	0	1
19-Oct	4a	2	16	39	55	15	38	53	1	0	1
	4c	1	7	36	43	7	35	42	0	0	0
20-Oct	1	1	1	3	4	0	3	3	1	0	1
	4a	1	7	2	9	7	2	9	1	0	1
	5b	1	38	22	60	37	21	58	3	4	7
21-Oct	1	1	4	2	6	4	2	6	0	0	0
	4a	1	5	1	6	3	0	3	0	0	0
	4c	1	20	22	42	20	21	41	0	1	1
22-Oct	1	1	3	3	6	0	3	3	0	0	0
23-Oct	1	1	3	2	5	1	2	3	1	0	1
	5b	1	33	25	58	31	25	56	2	2	4
24-Oct	1	1	3	0	3	3	0	3	1	0	1
	4a	1	21	7	28	17	4	21	6	6	12
	4c	1	7	3	10	5	2	7	2	2	4
25-Oct	1	1	0	1	1	0	1	1	0	0	0
	4a	1	16	3	19	12	2	14	8	1	9
26-Oct	1	1	3	3	6	1	3	4	1	0	1
	4a	1	7	5	12	7	2	9	2	4	6
	4c	1	3	6	9	3	6	9	0	3	3
27-Oct	1	1	2	0	2	1	0	1	0	0	0
	4a	1	7	2	9	5	2	7	1	0	1
	5b	1	3	0	3	2	0	2	0	0	0
28-Oct	1	1	0	1	1	0	1	1	0	0	0
	4c	1	5	8	13	5	8	13	1	1	2
29-Oct	4a	4	6	2	8	5	2	7	1	1	2
30-Oct	4c	1	4	1	5	4	1	5	0	0	0

Continued

Appendix 3. Daily application of disk tags and secondary marks to late run sockeye salmon, by location and sex, in the lower Adams River, 1995.

Date	Tagging Site	Sets made	Original field estimate of disk tags applied			Final estimate of disk tags applied [a]			Recaptures		
			Male	Female	Total	Male	Female	Total	Male	Female	Total
Continued											
Total	1	32	310	204	514	258	166	424	75	53	128
	2	1	9	16	25	9	16	25	0	0	0
	4a	31	848	947	1,795	828	926	1,754	44	34	78
	4b	10	312	211	523	309	206	515	12	4	16
	4c	15	392	345	737	383	338	721	27	15	42
	5a	3	56	35	91	56	34	90	5	4	9
	5b	16	406	370	776	397	365	762	17	15	32
	Total	108	2,333	2,128	4,461	2,240	2,051	4,291	180	125	305

[a] Corrected for sex identification error, and excluding fish for a variety of reasons (see Appendix 4).

Appendix 4. Removals of late run sockeye from the 1995 Adams River study area application sample, by sex, date and tagging site.

Date applied	Tagging site	Recovered in channel		Rec. outside study area		Non-standard recoveries		Rec. less than 5 days after app.		Recaptured 2 or more times		Totals	
		Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
25-Sep	5a	0	0	0	0	0	0	0	1	0	0	0	1
27-Sep	1	0	0	0	0	0	0	0	0	0	1	0	0
28-Sep	4a	0	0	0	0	0	1	0	0	0	0	0	1
30-Sep	1	0	0	0	0	0	0	0	0	2	1	2	0
1-Oct	1	0	0	0	0	0	0	0	0	2	2	2	0
	4a	0	0	0	0	0	0	1	0	0	0	1	0
2-Oct	1	0	0	0	0	0	0	0	0	5	2	5	0
3-Oct	1	0	0	0	0	0	0	0	0	3	3	3	0
	4c	3	1	0	0	0	0	0	0	0	0	3	1
	5b	0	1	0	0	0	1	1	0	0	0	1	2
4-Oct	1	0	0	0	0	0	0	0	0	0	2	0	0
	4b	1	0	0	0	0	0	0	0	0	0	1	0
5-Oct	1	0	0	0	0	0	0	0	1	4	3	4	1
	4c	1	0	0	0	0	0	0	0	0	1	1	0
	5b	1	0	0	0	0	0	1	0	0	0	2	0
6-Oct	1	0	0	0	0	2	0	0	0	3	5	6	0
	4a	0	0	0	0	0	0	1	0	0	1	1	0
	4b	0	0	0	0	0	0	0	1	1	0	1	1
7-Oct	1	0	0	0	0	2	0	0	0	4	1	6	0
	4b	1	0	0	0	0	1	0	0	1	0	2	1
	4c	0	0	0	0	0	0	0	0	2	0	2	0
8-Oct	1	0	0	0	0	0	0	0	0	1	0	1	0
	4a	0	0	0	0	2	0	0	1	0	0	2	1
9-Oct	1	0	0	0	0	0	0	0	0	7	6	7	0
10-Oct	1	0	0	0	0	0	0	0	0	1	1	1	0
	4a	0	0	0	0	1	0	0	1	0	0	1	1
	4b	0	1	0	0	0	0	0	0	0	0	0	1
	5b	0	0	0	0	1	0	0	0	0	0	1	0
11-Oct	5b	0	0	0	0	1	0	0	0	0	0	1	0
12-Oct	4b	0	0	0	0	0	0	0	1	0	0	0	1
	4c	1	0	0	0	0	1	0	0	0	1	1	1
13-Oct	4a	0	0	0	1	0	0	0	1	0	0	0	2
14-Oct	1	0	0	0	0	0	0	0	1	7	5	7	1
	4a	0	0	0	0	1	2	0	1	0	1	1	3
16-Oct	4a	0	0	0	0	0	0	0	1	0	0	0	1
17-Oct	4a	0	0	0	0	0	0	0	1	0	0	0	1
18-Oct	1	0	0	0	0	0	0	0	2	0	2	0	2
	5b	0	0	0	0	1	1	0	0	0	0	1	1
19-Oct	4a	1	0	0	0	0	1	0	0	0	0	1	1
	4c	0	1	0	0	0	0	0	0	0	0	0	1
20-Oct	1	0	0	0	0	0	0	1	0	0	0	1	0
	5b	0	0	0	0	0	0	1	0	0	1	1	0
21-Oct	4a	0	0	0	0	0	0	2	1	0	0	2	1
	4c	0	0	0	0	0	0	0	0	0	1	0	0
22-Oct	1	0	0	0	0	0	0	3	0	0	0	3	0
23-Oct	1	0	0	0	0	0	0	2	0	0	0	2	0
	5b	0	0	0	0	0	0	2	0	0	0	2	0

Continued

Appendix 4. Removals of late run sockeye from the 1995 Adams River study area application sample, by sex, date and tagging site.

Date applied	Tagging site	Recovered in channel		Rec. outside study area		Non-standard recoveries		Rec. less than 5 days after app.		Recaptured 2 or more times		Totals	
		Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Continued													
24-Oct	4a	0	0	0	0	0	0	2	0	2	3	4	0
	4c	1	0	0	0	0	0	0	0	1	1	2	0
25-Oct	4a	0	0	0	0	0	0	0	0	4	1	4	0
26-Oct	1	0	0	0	0	0	0	2	0	0	0	2	0
	4a	0	0	0	0	0	0	0	0	0	3	0	0
27-Oct	1	0	0	0	0	0	0	1	0	0	0	1	0
	4a	0	0	0	0	0	0	1	0	1	0	2	0
	5b	0	0	0	0	0	0	1	0	0	0	1	0
29-Oct	4a	0	0	0	0	0	0	1	0	0	0	1	0
Total	1	0	0	0	0	4	0	9	4	39	34	52	38
	2	0	0	0	0	0	0	0	0	0	0	0	0
	4a	1	0	0	1	4	4	8	7	7	9	20	21
	4b	2	1	0	0	0	1	0	2	2	0	4	4
	4c	6	2	0	0	0	1	0	0	3	4	9	7
	5a	0	0	0	0	0	0	0	1	0	0	0	1
	5b	1	1	0	0	3	2	6	0	0	1	10	4
	Total	10	4	0	1	11	8	23	14	51	48	95	75

Appendix 5a. Incidence of net, lamprey and hook marks and of *Flexibacter columnaris* lesions among all late run male sockeye examined at tag application in the lower Adams River, 1995.

Date	Number of males examined	Net marks		Lamprey marks		Hook marks		*F. columnaris* [a]	
		Number	Percent	Number	Percent	Number	Percent	Number	Percent
25-Sep	14	3	21.4%	0	0.0%	0	0.0%	-	-
26-Sep	19	0	0.0%	3	15.8%	0	0.0%	-	-
27-Sep	26	7	26.9%	1	3.8%	0	0.0%	-	-
28-Sep	28	7	25.0%	3	10.7%	2	7.1%	-	-
29-Sep	29	7	24.1%	4	13.8%	1	3.4%	-	-
30-Sep	46	4	8.7%	7	15.2%	0	0.0%	-	-
1-Oct	39	1	2.6%	3	7.7%	1	2.6%	-	-
2-Oct	54	7	13.0%	1	1.9%	1	1.9%	-	-
3-Oct	107	15	14.0%	11	10.3%	0	0.0%	-	-
4-Oct	35	1	2.9%	1	2.9%	0	0.0%	-	-
5-Oct	265	16	6.0%	26	9.8%	0	0.0%	-	-
6-Oct	189	13	6.9%	10	5.3%	2	1.1%	-	-
7-Oct	236	16	6.8%	5	2.1%	1	0.4%	-	-
8-Oct	101	4	4.0%	4	4.0%	1	1.0%	-	-
9-Oct	161	5	3.1%	3	1.9%	0	0.0%	-	-
10-Oct	165	7	4.2%	18	10.9%	3	1.8%	-	-
11-Oct	142	6	4.2%	7	4.9%	0	0.0%	-	-
12-Oct	62	3	4.8%	1	1.6%	0	0.0%	-	-
13-Oct	63	4	6.3%	3	4.8%	0	0.0%	-	-
14-Oct	116	3	2.6%	5	4.3%	0	0.0%	-	-
15-Oct	75	2	2.7%	3	4.0%	2	2.7%	-	-
16-Oct	55	3	5.5%	3	5.5%	0	0.0%	-	-
17-Oct	28	3	10.7%	1	3.6%	0	0.0%	-	-
18-Oct	55	2	3.6%	2	3.6%	0	0.0%	-	-
19-Oct	23	2	8.7%	0	0.0%	1	4.3%	-	-
20-Oct	46	2	4.3%	2	4.3%	0	0.0%	-	-
21-Oct	28	1	3.6%	0	0.0%	0	0.0%	-	-
22-Oct	3	0	0.0%	0	0.0%	0	0.0%	-	-
23-Oct	36	1	2.8%	0	0.0%	0	0.0%	-	-
24-Oct	31	1	3.2%	1	3.2%	1	3.2%	-	-
25-Oct	16	1	6.3%	0	0.0%	0	0.0%	-	-
26-Oct	13	0	0.0%	0	0.0%	0	0.0%	-	-
27-Oct	12	0	0.0%	0	0.0%	0	0.0%	-	-
28-Oct	5	0	0.0%	0	0.0%	0	0.0%	-	-
29-Oct	6	0	0.0%	0	0.0%	0	0.0%	-	-
30-Oct	4	0	0.0%	0	0.0%	0	0.0%	-	-
Total	2,333	147	6.3%	128	5.5%	16	0.7%	-	-

[a] *F. columnaris* incidence was not recorded in 1995.

Appendix 5b. Incidence of net, lamprey and hook marks and of *Flexibacter columnaris* lesions among all late run female sockeye examined at tag application in the lower Adams River, 1995.

Date	Number of females examined	Net marks		Lamprey marks		Hook marks		*F. columnaris* [a]	
		Number	Percent	Number	Percent	Number	Percent	Number	Percent
25-Sep	8	3	37.5%	1	12.5%	0	0.0%	-	-
26-Sep	12	3	25.0%	0	0.0%	0	0.0%	-	-
27-Sep	14	7	50.0%	0	0.0%	0	0.0%	-	-
28-Sep	13	5	38.5%	1	7.7%	0	0.0%	-	-
29-Sep	20	6	30.0%	1	5.0%	0	0.0%	-	-
30-Sep	32	5	15.6%	1	3.1%	0	0.0%	-	-
1-Oct	10	0	0.0%	0	0.0%	0	0.0%	-	-
2-Oct	39	4	10.3%	4	10.3%	0	0.0%	-	-
3-Oct	79	11	13.9%	3	3.8%	0	0.0%	-	-
4-Oct	28	2	7.1%	0	0.0%	0	0.0%	-	-
5-Oct	158	23	14.6%	8	5.1%	0	0.0%	-	-
6-Oct	145	17	11.7%	7	4.8%	0	0.0%	-	-
7-Oct	143	23	16.1%	5	3.5%	0	0.0%	-	-
8-Oct	110	13	11.8%	3	2.7%	0	0.0%	-	-
9-Oct	133	21	15.8%	1	0.8%	0	0.0%	-	-
10-Oct	153	19	12.4%	6	3.9%	0	0.0%	-	-
11-Oct	157	12	7.6%	10	6.4%	0	0.0%	-	-
12-Oct	92	9	9.8%	2	2.2%	0	0.0%	-	-
13-Oct	99	12	12.1%	7	7.1%	0	0.0%	-	-
14-Oct	156	9	5.8%	5	3.2%	0	0.0%	-	-
15-Oct	85	6	7.1%	2	2.4%	0	0.0%	-	-
16-Oct	84	5	6.0%	2	2.4%	0	0.0%	-	-
17-Oct	72	9	12.5%	3	4.2%	0	0.0%	-	-
18-Oct	86	5	5.8%	1	1.2%	0	0.0%	-	-
19-Oct	75	9	12.0%	0	0.0%	0	0.0%	-	-
20-Oct	27	2	7.4%	0	0.0%	0	0.0%	-	-
21-Oct	26	1	3.8%	0	0.0%	0	0.0%	-	-
22-Oct	3	1	33.3%	0	0.0%	0	0.0%	-	-
23-Oct	27	3	11.1%	0	0.0%	0	0.0%	-	-
24-Oct	10	2	20.0%	0	0.0%	0	0.0%	-	-
25-Oct	4	0	0.0%	0	0.0%	0	0.0%	-	-
26-Oct	14	0	0.0%	0	0.0%	0	0.0%	-	-
27-Oct	2	0	0.0%	0	0.0%	0	0.0%	-	-
28-Oct	9	2	22.2%	0	0.0%	0	0.0%	-	-
29-Oct	2	0	0.0%	0	0.0%	0	0.0%	-	-
30-Oct	1	0	0.0%	0	0.0%	0	0.0%	-	-
Total	2,128	249	11.7%	73	3.4%	0	0.0%	-	-

[a] *F. columnaris* incidence was not recorded in 1995.

Appendix 6. Daily late run sockeye carcass recoveries, by area, mark status and sex, in the lower Adams River, 1995.

Date	Area	Number of surveys	Disk tag and/or secondary mark present			Unmarked			Total		
			Male	Female	Total	Male	Female	Total	Male	Female	Total
26-Sep	6	-	0	0	0	10	2	12	10	2	12
27-Sep	6	-	0	0	0	6	1	7	6	1	7
28-Sep	6	-	0	0	0	0	1	1	0	1	1
29-Sep	2	-	0	0	0	1	0	1	1	0	1
	4	-	0	0	0	1	0	1	1	0	1
	6	-	0	0	0	2	0	2	2	0	2
30-Sep	1	-	0	0	0	0	1	1	0	1	1
	4	-	0	0	0	3	1	4	3	1	4
	6	-	0	0	0	3	4	7	3	4	7
1-Oct	1	-	0	0	0	0	1	1	0	1	1
	2	-	0	0	0	1	1	2	1	1	2
	4	-	0	0	0	0	1	1	0	1	1
	7	-	1	0	1	11	8	19	12	8	20
2-Oct	1	-	0	0	0	0	3	3	0	3	3
	4	-	0	0	0	1	1	2	1	1	2
	5	-	2	0	2	5	18	23	7	18	25
	6	-	0	0	0	4	0	4	4	0	4
	7	-	0	0	0	9	6	15	9	6	15
3-Oct	1	-	0	0	0	2	4	6	2	4	6
	2	-	0	0	0	2	3	5	2	3	5
	3	-	0	0	0	0	0	0	0	0	0
	4	-	0	0	0	16	10	26	16	10	26
	5	-	1	0	1	12	10	22	13	10	23
	6	-	1	0	1	12	10	22	13	10	23
	7	-	0	0	0	14	11	25	14	11	25
4-Oct	1	-	0	0	0	2	4	6	2	4	6
	2	-	0	1	1	7	7	14	7	8	15
	3	-	0	1	1	1	1	2	1	2	3
	4	-	0	0	0	5	8	13	5	8	13
	5	-	2	0	2	14	14	28	16	14	30
	7	-	2	0	2	16	6	22	18	6	24
5-Oct	1	-	0	0	0	6	7	13	6	7	13
	2	-	0	0	0	13	6	19	13	6	19
	3	-	0	0	0	2	1	3	2	1	3
	4	-	0	1	1	26	18	44	26	19	45
	5	-	1	0	1	19	22	41	20	22	42
	6	-	0	0	0	26	9	35	26	9	35
	7	-	1	0	1	48	45	93	49	45	94
6-Oct	1	-	0	0	0	6	7	13	6	7	13
	2	-	0	0	0	14	6	20	14	6	20
	3	-	0	0	0	11	1	12	11	1	12
	4	-	1	0	1	39	25	64	40	25	65
	5	-	0	1	1	10	17	27	10	18	28
	7	-	1	0	1	70	47	117	71	47	118
7-Oct	1	-	1	0	1	6	2	8	7	2	9
	2	-	0	0	0	42	20	62	42	20	62
	3	-	0	0	0	1	2	3	1	2	3
	4	-	1	1	2	4	25	29	5	26	31

Continued

Appendix 6. Daily late run sockeye carcass recoveries, by area, mark status and sex, in the lower Adams River, 1995.

Date	Area	Number of surveys	Disk tag and/or secondary mark present			Unmarked			Total		
			Male	Female	Total	Male	Female	Total	Male	Female	Total
Continued											
7-Oct	5	-	0	0	0	30	25	55	30	25	55
	7	-	2	0	2	29	40	69	31	40	71
8-Oct	1	-	0	0	0	7	17	24	7	17	24
	2	-	0	0	0	19	17	36	19	17	36
	3	-	1	0	1	9	17	26	10	17	27
	4	-	2	0	2	50	54	104	52	54	106
	5	-	0	0	0	32	52	84	32	52	84
	7	-	0	0	0	50	25	75	50	25	75
9-Oct	1	-	1	0	1	13	11	24	14	11	25
	2	-	0	0	0	55	27	82	55	27	82
	3	-	0	0	0	19	15	34	19	15	34
	4	-	0	0	0	52	46	98	52	46	98
	5	-	1	0	1	51	49	100	52	49	101
	6	-	0	0	0	34	20	54	34	20	54
	7	-	1	0	1	102	125	227	103	125	228
10-Oct	1	-	0	0	0	21	17	38	21	17	38
	2	-	2	0	2	57	26	83	59	26	85
	3	-	1	0	1	13	8	21	14	8	22
	4	-	0	0	0	91	78	169	91	78	169
	5	-	1	1	2	51	57	108	52	58	110
	6	-	0	1	1	26	22	48	26	23	49
	7	-	0	0	0	74	79	153	74	79	153
11-Oct	1	-	0	0	0	7	18	25	7	18	25
	2	-	0	3	3	34	34	68	34	37	71
	3	-	1	0	1	20	8	28	21	8	29
	4	-	0	0	0	94	63	157	94	63	157
	5	-	0	1	1	27	32	59	27	33	60
	6	-	0	0	0	38	22	60	38	22	60
	7	-	0	0	0	65	53	118	65	53	118
12-Oct	1	-	0	1	1	20	17	37	20	18	38
	2	-	1	0	1	47	44	91	48	44	92
	3	-	0	0	0	18	10	28	18	10	28
	4	-	1	0	1	136	97	233	137	97	234
	5	-	1	0	1	61	60	121	62	60	122
	6	-	1	1	2	56	33	89	57	34	91
	7	-	3	0	3	85	84	169	88	84	172
13-Oct	1	-	0	0	0	18	11	29	18	11	29
	2	-	0	1	1	81	61	142	81	62	143
	3	-	1	1	2	50	13	63	51	14	65
	4	-	3	0	3	169	142	311	172	142	314
	5	-	0	0	0	86	82	168	86	82	168
	6	-	0	1	1	48	45	93	48	46	94
	7	-	0	0	0	154	115	269	154	115	269

Continued

Appendix 6. Daily late run sockeye carcass recoveries, by area, mark status and sex, in the lower Adams River, 1995.

Date	Area	Number of surveys	Disk tag and/or secondary mark present			Unmarked			Total		
			Male	Female	Total	Male	Female	Total	Male	Female	Total
Continued											
14-Oct	1	-	0	1	1	34	23	57	34	24	58
	2	-	2	0	2	89	92	181	91	92	183
	3	-	1	0	1	45	18	63	46	18	64
	4	-	1	2	3	226	243	469	227	245	472
	5	-	1	2	3	102	122	224	103	124	227
	6	-	0	0	0	51	34	85	51	34	85
	7	-	0	2	2	223	241	464	223	243	466
15-Oct	1	-	0	0	0	37	32	69	37	32	69
	2	-	0	1	1	100	96	196	100	97	197
	3	-	0	0	0	37	27	64	37	27	64
	4	-	3	3	6	341	393	734	344	396	740
	5	-	2	1 [a]	3	166	145	311	168	146	314
	6	-	2	1	3	125	138	263	127	139	266
	7	-	2	4	6	284	297	581	286	301	587
16-Oct	1	-	1	1	2	73	73	146	74	74	148
	2	-	0	3	3	192	217	409	192	220	412
	3	-	0	0	0	55	25	80	55	25	80
	4	-	2	1	3	374	451	825	376	452	828
	5	-	0	0	0	206	200	406	206	200	406
	6	-	0	2	2	137	78	215	137	80	217
	7	-	0	4	4	290	363	653	290	367	657
17-Oct	1	-	1	1	2	83	75	158	84	76	160
	2	-	0	2	2	218	214	432	218	216	434
	3	-	0	1	1	51	66	117	51	67	118
	4	-	9	4	13	528	663	1,191	537	667	1,204
	5	-	3	1	4	225	217	442	228	218	446
	6	-	1	2	3	145	161	306	146	163	309
	7	-	4	2	6	362	434	796	366	436	802
18-Oct	1	-	0	0	0	77	69	146	77	69	146
	2	-	0	2	2	190	186	376	190	188	378
	3	-	0	0	0	27	21	48	27	21	48
	4	-	7	10	17	611	695	1,306	618	705	1,323
	5	-	2	4	6	202	227	429	204	231	435
	6	-	5	3	8	127	126	253	132	129	261
	7	-	7	6	13	421	441	862	428	447	875
19-Oct	1	-	0	1	1	96	103	199	96	104	200
	2	-	4	1	5	236	242	478	240	243	483
	3	-	1	1	2	81	89	170	82	90	172
	4	-	9	20	29	918	1,077	1,995	927	1,097	2,024
	5	-	3	4	7	256	250	506	259	254	513
	7	-	4	5	9	458	503	961	462	508	970
20-Oct	1	-	0	0	0	108	146	254	108	146	254
	2	-	3	0	3	208	252	460	211	252	463
	3	-	1	0	1	47	59	106	48	59	107
	4	-	8	10	18	721	921	1,642	729	931	1,660
	5	-	3	4	7	333	385	718	336	389	725

Continued

Appendix 6. Daily late run sockeye carcass recoveries, by area, mark status and sex, in the lower Adams River, 1995.

Date	Area	Number of surveys	Disk tag and/or secondary mark present			Unmarked			Total		
			Male	Female	Total	Male	Female	Total	Male	Female	Total
Continued											
20-Oct	6	-	3	1	4	177	159	336	180	160	340
	7	-	2	6	8	464	563	1,027	466	569	1,035
21-Oct	1	-	4 [a]	2	6	126	253	379	130	255	385
	2	-	0	2	2	165	190	355	165	192	357
	3	-	0	3	3	81	114	195	81	117	198
	4	-	7	6	13	790	1,033	1,823	797	1,039	1,836
	5	-	9	5	14	306	392	698	315	397	712
	6	-	3	1	4	232	257	489	235	258	493
	7	-	4	4	8	321	416	737	325	420	745
22-Oct	1	-	2	0	2	95	143	238	97	143	240
	2	-	1	4	5	257	313	570	258	317	575
	3	-	1	0	1	89	105	194	90	105	195
	4	-	10	12	22	648	827	1,475	658	839	1,497
	5	-	6	7	13	293	318	611	299	325	624
	6	-	2	0	2	104	92	196	106	92	198
	7	-	5	7	12	592	610	1,202	597	617	1,214
23-Oct	1	-	1	0	1	85	77	162	86	77	163
	2	-	1	0	1	97	195	292	98	195	293
	3	-	0	0	0	48	38	86	48	38	86
	4	-	10	16	26	966	1,139	2,105	976	1,155	2,131
	5	-	3	3	6	301	447	748	304	450	754
	6	-	1	2	3	200	243	443	201	245	446
	7	-	9	8	17	522	701	1,223	531	709	1,240
24-Oct	1	-	0	2	2	117	150	267	117	152	269
	2	-	5	0	5	169	265	434	174	265	439
	3	-	1	0	1	109	108	217	110	108	218
	4	-	2	8	10	614	896	1,510	616	904	1,520
	5	-	6	1	7	326	443	769	332	444	776
	6	-	2	3	5	274	297	571	276	300	576
	7	-	2	9	11	503	639	1,142	505	648	1,153
25-Oct	1	-	0	2	2	104	189	293	104	191	295
	2	-	1	3	4	138	223	361	139	226	365
	3	-	0	0	0	54	63	117	54	63	117
	4	-	4	7	11	551	852	1,403	555	859	1,414
	5	-	2	1	3	209	294	503	211	295	506
	6	-	2	0	2	169	139	308	171	139	310
	7	-	4	5	9	402	604	1,006	406	609	1,015
26-Oct	1	-	0	1	1	52	65	117	52	66	118
	2	-	0	3	3	101	135	236	101	138	239
	3	-	0	4	4	78	87	165	78	91	169
	4	-	8	8	16	527	944	1,471	535	952	1,487
	5	-	2	1	3	138	185	323	140	186	326
	6	-	3	4	7	179	172	351	182	176	358
	7	-	5	5	10	291	429	720	296	434	730

Continued

Appendix 6. Daily late run sockeye carcass recoveries, by area, mark status and sex, in the lower Adams River, 1995.

Date	Area	Number of surveys	Disk tag and/or secondary mark present			Unmarked			Total		
			Male	Female	Total	Male	Female	Total	Male	Female	Total
Continued											
27-Oct	1	-	1	0	1	90	139	229	91	139	230
	2	-	1	0	1	43	93	136	44	93	137
	3	-	0	0	0	27	31	58	27	31	58
	4	-	6	6	12	286	425	711	292	431	723
	5	-	0	3	3	133	224	357	133	227	360
	6	-	1	1	2	67	90	157	68	91	159
	7	-	1	6	7	246	310	556	247	316	563
28-Oct	1	-	0	0	0	49	77	126	49	77	126
	2	-	1	2	3	153	228	381	154	230	384
	3	-	0	0	0	29	47	76	29	47	76
	4	-	4	6	10	231	431	662	235	437	672
	5	-	1	4	5	123	192	315	124	196	320
	6	-	2	0	2	124	142	266	126	142	268
	7	-	1	3	4	226	342	568	227	345	572
29-Oct	1	-	0	0	0	13	34	47	13	34	47
	2	-	0	0	0	30	77	107	30	77	107
	3	-	0	1	1	41	28	69	41	29	70
	4	-	2	3	5	276	418	694	278	421	699
	5	-	1	1	2	88	145	233	89	146	235
	6	-	0	1	1	47	54	101	47	55	102
	7	-	2	2	4	218	339	557	220	341	561
30-Oct	1	-	0	0	0	35	67	102	35	67	102
	2	-	0	0	0	26	63	89	26	63	89
	3	-	0	0	0	27	31	58	27	31	58
	4	-	0	1	1	132	261	393	132	262	394
	5	-	1	1	2	38	82	120	39	83	122
	6	-	0	0	0	74	116	190	74	116	190
	7	-	2	2	4	123	270	393	125	272	397
31-Oct	1	-	0	1	1	11	21	32	11	22	33
	2	-	0	0	0	29	66	95	29	66	95
	3	-	0	0	0	20	32	52	20	32	52
	4	-	1	2	3	137	224	361	138	226	364
	5	-	0	2	2	70	147	217	70	149	219
	6	-	2	0	2	33	55	88	35	55	90
	7	-	0	0	0	104	185	289	104	185	289
1-Nov	1	-	0	0	0	13	17	30	13	17	30
	2	-	0	0	0	6	19	25	6	19	25
	3	-	0	0	0	7	9	16	7	9	16
	4	-	0	3	3	77	160	237	77	163	240
	5	-	0	0	0	6	55	61	6	55	61
	6	-	1	2	3	70	86	156	71	88	159
	7	-	0	1	1	50	112	162	50	113	163

Continued

Appendix 6. Daily late run sockeye carcass recoveries, by area, mark status and sex, in the lower Adams River, 1995.

Date	Area	Number of surveys	Disk tag and/or secondary mark present			Unmarked			Total		
			Male	Female	Total	Male	Female	Total	Male	Female	Total
Continued											
2-Nov	1	-	0	0	0	22	58	80	22	58	80
	2	-	0	0	0	4	26	30	4	26	30
	3	-	1	0	1	4	19	23	5	19	24
	4	-	0	2	2	60	157	217	60	159	219
	5	-	0	2	2	44	108	152	44	110	154
	6	-	3	0	3	25	21	46	28	21	49
	7	-	1	0	1	48	146	194	49	146	195
3-Nov	1	-	0	0	0	10	17	27	10	17	27
	2	-	0	0	0	16	27	43	16	27	43
	3	-	1	0	1	8	18	26	9	18	27
	4	-	1	4	5	112	126	238	113	130	243
	5	-	1	0	1	19	26	45	20	26	46
	6	-	0	2	2	49	76	125	49	78	127
	7	-	0	1	1	86	134	220	86	135	221
4-Nov	1	-	0	0	0	6	13	19	6	13	19
	2	-	0	0	0	11	30	41	11	30	41
	3	-	0	0	0	4	23	27	4	23	27
	4	-	2	1	3	74	214	288	76	215	291
	5	-	1	0	1	19	51	70	20	51	71
	6	-	1	0	1	52	44	96	53	44	97
	7	-	2	2	4	103	197	300	105	199	304
5-Nov	1	-	0	1	1	13	49	62	13	50	63
	2	-	0	0	0	8	41	49	8	41	49
	3	-	0	0	0	9	24	33	9	24	33
	4	-	1	0	1	68	171	239	69	171	240
	5	-	0	0	0	24	83	107	24	83	107
	6	-	0	0	0	13	37	50	13	37	50
	7	-	1	1	2	32	130	162	33	131	164
6-Nov	1	-	0	0	0	8	26	34	8	26	34
	2	-	0	0	0	5	39	44	5	39	44
	3	-	0	1	1	8	24	32	8	25	33
	4	-	3	3	6	99	172	271	102	175	277
	5	-	0	0	0	20	58	78	20	58	78
	6	-	0	0	0	6	17	23	6	17	23
	7	-	0	1	1	41	103	144	41	104	145
7-Nov	1	-	0	0	0	17	44	61	17	44	61
	2	-	0	0	0	4	24	28	4	24	28
	3	-	0	0	0	1	8	9	1	8	9
	4	-	0	2	2	35	118	153	35	120	155
	5	-	0	1	1	2	10	12	2	11	13
	6	-	0	0	0	29	37	66	29	37	66
	7	-	0	1	1	57	106	163	57	107	164

Continued

Appendix 6. Daily late run sockeye carcass recoveries, by area, mark status and sex, in the lower Adams River, 1995.

Date	Area	Number of surveys	Disk tag and/or secondary mark present			Unmarked			Total		
			Male	Female	Total	Male	Female	Total	Male	Female	Total
Continued											
8-Nov	1	-	0	0	0	0	3	3	0	3	3
	2	-	0	0	0	1	6	7	1	6	7
	3	-	0	0	0	3	4	7	3	4	7
	4	-	1	0	1	12	77	89	13	77	90
	5	-	0	0	0	6	19	25	6	19	25
	6	-	0	0	0	6	23	29	6	23	29
	7	-	2	1	3	62	122	184	64	123	187
9-Nov	1	-	0	0	0	1	3	4	1	3	4
	2	-	0	0	0	1	1	2	1	1	2
	3	-	0	0	0	1	1	2	1	1	2
	4	-	0	0	0	4	33	37	4	33	37
	5	-	0	0	0	1	7	8	1	7	8
	6	-	0	0	0	7	10	17	7	10	17
	7	-	0	0	0	0	23	23	0	23	23
Total	1	41	12 [a]	14	26	1,483	2,086	3,569	1,495	2,100	3,595
	2	40	22	28	50	2,870	3,612	6,482	2,892	3,640	6,532
	3	38	11	13	24	1,135	1,195	2,330	1,146	1,208	2,354
	4	42	109	142	251	10,105	13,690	23,795	10,214	13,832	24,046
	5	39	56	51 [a]	107	4,054	5,270	9,324	4,110	5,321	9,431
	6	39	36	28	64	2,787	2,873	5,660	2,823	2,901	5,724
	7	40	71	88	159	7,256	9,404	16,660	7,327	9,492	16,819
	Total	-	317 [a]	364 [a]	681	29,690	38,130	67,820	30,007	38,494	68,501

[a] One recovered carcass had a secondary mark only.

Appendix 7. Daily late run sockeye carcass recoveries, by area, mark status and sex, for component areas in the Adams River study area, excluding the lower Adams River, 1995.

Date	Area	Live count	Disk tag and/or secondary mark present			Unmarked			Total		
			Male	Female	Total	Male	Female	Total	Male	Female	Total
Adams Lake and Tributaries											
Adams Lake											
12-Oct	-	2	0	0	0	0	1	1	0	1	1
23-Oct	-	65	0	0	0	0	0	0	0	0	0
Bush Creek											
12-Oct	-	0	0	0	0	0	0	0	0	0	0
Cayenne Creek											
12-Oct	-	0	0	0	0	0	0	0	0	0	0
Momich River											
12-Oct	-	1	0	0	0	0	0	0	0	0	0
25-Oct	-	0	0	0	0	0	0	0	0	0	0
30-Oct	-	0	0	0	0	0	0	0	0	0	0
Pass Creek											
12-Oct	-	6	0	0	0	0	0	0	0	0	0
23-Oct	-	21	0	0	0	0	0	0	0	0	0
25-Oct	-	16	0	0	0	1	1	2	1	1	2
30-Oct	-	8	0	0	0	1	5	6	1	5	6
5-Nov	-	0	0	0	0	2	3	5	2	3	5
Upper Adams River											
12-Oct	-	0	0	0	0	0	0	0	0	0	0
30-Oct	-	0	0	0	0	0	0	0	0	0	0
Totals											
Adams Lake			0	0	0	0	1	1	0	1	1
Bush Creek			0	0	0	0	0	0	0	0	0
Cayenne Creek			0	0	0	0	0	0	0	0	0
Momich River			0	0	0	0	0	0	0	0	0
Pass Creek			0	0	0	4	9	13	4	9	13
Upper Adams River			0	0	0	0	0	0	0	0	0
Total			0	0	0	4	10	14	4	10	14
Lower Adams River Tributaries											
Hiuihill Creek											
12-Oct	-	12	0	0	0	0	0	0	0	0	0
19-Oct	-	211	0	0	0	1	0	1	1	0	1
24-Oct	-	217	0	0	0	15	3	18	15	3	18
29-Oct	-	112	0	2	2	11	12	23	11	14	25
8-Nov	-	20	0	0	0	7	13	20	7	13	20
Nikwikwaia Creek											
12-Oct	-	13	0	0	0	0	0	0	0	0	0
19-Oct	-	369	0	0	0	1	0	1	1	0	1
24-Oct	-	266	0	0	0	2	4	6	2	4	6
29-Oct	-	142	0	0	0	1	5	6	1	5	6
8-Nov	-	12	0	0	0	0	22	22	0	22	22
Totals											
Hiuihill Creek			0	2	2	34	28	62	34	30	64
Nikwikwaia Creek			0	0	0	4	31	35	4	31	35
Total			0	2	2	38	59	97	38	61	99

Continued

Appendix 7. Daily late run sockeye carcass recoveries, by area, mark status and sex, for component areas in the Adams River study area, excluding the lower Adams River, 1995.

Date	Area	Live count	Disk tag and/or secondary mark present			Unmarked			Total		
			Male	Female	Total	Male	Female	Total	Male	Female	Total
Continued											
Shuswap Lake and Tributaries											
Scotch Creek											
11-Oct	-	258	0	0	0	7	5	12	7	5	12
15-Oct	-	435	0	0	0	12	14	26	12	14	26
22-Oct	-	1,115	0	0	0	34	27	61	34	27	61
25-Oct	-	1,224	1	0	1	89	91	180	90	91	181
31-Oct	-	510	0	0	0	51	69	120	51	69	120
9-Nov	-	53	0	0	0	25	37	62	25	37	62
Shuswap Lake											
1-Oct	8	-	0	0	0	8	8	16	8	8	16
	9	-	0	0	0	45	10	55	45	10	55
2-Oct	8	-	0	0	0	4	7	11	4	7	11
	9	-	0	0	0	21	11	32	21	11	32
	10	-	0	0	0	33	17	50	33	17	50
3-Oct	8	-	0	0	0	13	4	17	13	4	17
	9	-	0	0	0	37	11	48	37	11	48
	10	-	0	0	0	19	4	23	19	4	23
5-Oct	8	-	0	0	0	14	10	24	14	10	24
	9	-	0	0	0	32	11	43	32	11	43
	10	-	1	0	1	27	10	37	28	10	38
7-Oct	8	-	0	0	0	35	16	51	35	16	51
	9	-	0	0	0	15	4	19	15	4	19
	10	-	0	0	0	32	13	45	32	13	45
9-Oct	8	-	0	0	0	44	25	69	44	25	69
	9	-	1	1	2	43	17	60	44	18	62
	10	-	0	0	0	20	12	32	20	12	32
11-Oct	8	-	0	0	0	39	34	73	39	34	73
	9	-	2	0	2	35	16	51	37	16	53
	10	-	0	0	0	28	11	39	28	11	39
13-Oct	8	31	0	0	0	66	41	107	66	41	107
	9	-	1	0	1	32	22	54	33	22	55
	10	-	0	1	1	25	10	35	25	11	36
	11	195	1	0	1	28	19	47	29	19	48
	12	691	-	-	-	-	-	-	-	-	-
15-Oct	8	-	1	1	2	72	34	106	73	35	108
	9	-	0	0	0	89	54	143	89	54	143
	10	-	0	0	0	48	27	75	48	27	75
	12	-	0	0	0	26	9	35	26	9	35
17-Oct	8	-	1	0	1	76	29	105	77	29	106
	9	-	0	0	0	65	52	117	65	52	117
	10	-	0	0	0	74	56	130	74	56	130
19-Oct	8	-	0	1	1	101	59	160	101	60	161
	9	-	3	3	6	131	96	227	134	99	233
	10	-	2	0	2	120	87	207	122	87	209
20-Oct	8	30	-	-	-	-	-	-	-	-	-
	11	398	-	-	-	-	-	-	-	-	-
	12	451	-	-	-	-	-	-	-	-	-

Continued

Appendix 7. Daily late run sockeye carcass recoveries, by area, mark status and sex, for component areas in the Adams River study area, excluding the lower Adams River, 1995.

Date	Area	Live count	Disk tag and/or secondary mark present			Unmarked			Total		
			Male	Female	Total	Male	Female	Total	Male	Female	Total
Continued											
21-Oct	8	-	5	0	5	160	74	234	165	74	239
	9	-	2	2	4	123	92	215	125	94	219
	10	-	4	0	4	139	82	221	143	82	225
	11	-	4	2	6	98	60	158	102	62	164
23-Oct	8	-	2	0	2	132	83	215	134	83	217
	9	-	1	2	3	130	111	241	131	113	244
	10	-	3	0	3	177	66	243	180	66	246
	12	-	2	0	2	68	48	116	70	48	118
25-Oct	8	-	1	1	2	205	102	307	206	103	309
	9	-	1	4	5	279	205	484	280	209	489
	10	-	2	1	3	243	115	358	245	116	361
	11	-	3	0	3	162	93	255	165	93	258
27-Oct	8	-	0	3	3	107	49	156	107	52	159
	9	-	0	0	0	179	148	327	179	148	327
	10	-	1	0	1	140	48	188	141	48	189
28-Oct	11	-	1	0	1	74	65	139	75	65	140
29-Oct	8	-	1	1	2	79	35	114	80	36	116
	9	-	2	3	5	164	139	303	166	142	308
	10	-	2	0	2	138	83	221	140	83	223
30-Oct	12	-	0	2	2	34	27	61	34	29	63
31-Oct	8	-	3	0	3	89	35	124	92	35	127
	9	-	5	0	5	140	58	198	145	58	203
	10	-	6	0	6	341	188	529	347	188	535
	11	-	1	0	1	92	30	122	93	30	123
2-Nov	8	-	0	0	0	87	31	118	87	31	118
	9	-	0	0	0	66	35	101	66	35	101
	10	-	3	1	4	157	103	260	160	104	264
4-Nov	8	-	0	0	0	97	35	132	97	35	132
	9	-	1	1	2	177	77	254	178	78	256
	10	-	4	0	4	148	53	201	152	53	205
	11	-	0	1	1	88	56	144	88	57	145
6-Nov	8	-	1	0	1	73	39	112	74	39	113
	9	-	0	0	0	23	30	53	23	30	53
	10	-	1	0	1	81	40	121	82	40	122
	11	29	-	-	-	-	-	-	-	-	-
	12	24	-	-	-	-	-	-	-	-	-
8-Nov	8	-	0	1	1	61	34	95	61	35	96
	9	-	0	0	0	62	31	93	62	31	93
	10	-	0	0	0	69	29	98	69	29	98
9-Nov	11	-	0	0	0	86	42	128	86	42	128

Continued

Appendix 7. Daily late run sockeye carcass recoveries, by area, mark status and sex, for component areas in the Adams River study area, excluding the lower Adams River, 1995.

Date	Area	Live count	Disk tag and/or secondary mark present			Unmarked			Total		
			Male	Female	Total	Male	Female	Total	Male	Female	Total
Continued											
Totals											
Scotch Creek			1	0	1	218	243	461	219	243	462
Shuswap Lake- 8			15	8	23	1,562	784	2,346	1,577	792	2,369
Shuswap Lake- 9			19	16	35	1,888	1,230	3,118	1,907	1,246	3,153
Shuswap Lake- 10			29	3	32	2,059	1,054	3,113	2,088	1,057	3,145
Shuswap Lake- 11			10	3	13	628	365	993	638	368	1,006
Shuswap Lake- 12			2	2	4	128	84	212	130	86	216
Shuswap Lake- Total			75	32	107	6,265	3,517	9,782	6,340	3,549	9,889
Total			76	32	108	6,483	3,760	10,243	6,559	3,792	10,351
Little River and Little Shuswap Lake											
Little River											
4-Oct	-	-	0	0	0	5	5	10	5	5	10
6-Oct	-	-	0	0	0	2	4	6	2	4	6
8-Oct	-	-	1	0	1	3	1	4	4	1	5
10-Oct	-	-	0	0	0	9	8	17	9	8	17
12-Oct	-	-	0	0	0	4	4	8	4	4	8
14-Oct	-	4,900	0	0	0	30	20	50	30	20	50
16-Oct	-	-	0	0	0	11	7	18	11	7	18
18-Oct	-	-	1	1	2	76	66	142	77	67	144
20-Oct	-	-	0	0	0	62	62	124	62	62	124
22-Oct	-	-	0	0	0	62	102	164	62	102	164
24-Oct	-	-	1	0	1	147	115	262	148	115	263
26-Oct	-	-	1	0	1	125	89	214	126	89	215
28-Oct	-	-	0	0	0	54	64	118	54	64	118
30-Oct	-	-	0	0	0	79	56	135	79	56	135
1-Nov	-	-	1	0	1	102	122	224	103	122	225
3-Nov	-	-	0	0	0	92	73	165	92	73	165
5-Nov	-	-	0	0	0	53	44	97	53	44	97
7-Nov	-	-	0	0	0	30	16	46	30	16	46
9-Nov	-	-	1	0	1	58	29	87	59	29	88
Little Shuswap Lake											
4-Oct	-	-	0	0	0	11	12	23	11	12	23
6-Oct	-	-	0	0	0	7	3	10	7	3	10
8-Oct	-	-	0	0	0	4	2	6	4	2	6
10-Oct	-	-	0	0	0	7	3	10	7	3	10
12-Oct	-	-	0	0	0	12	6	18	12	6	18
14-Oct	-	-	0	0	0	5	1	6	5	1	6
16-Oct	-	-	0	0	0	8	8	16	8	8	16
18-Oct	-	-	0	0	0	38	22	60	38	22	60
20-Oct	-	-	0	0	0	63	31	94	63	31	94
22-Oct	-	-	1	0	1	62	29	91	63	29	92
24-Oct	-	-	0	0	0	48	31	79	48	31	79
26-Oct	-	-	1	0	1	181	99	280	182	99	281
28-Oct	-	-	3	0	3	123	81	204	126	81	207
30-Oct	-	-	0	0	0	111	65	176	111	65	176

Continued

Appendix 7. Daily late run sockeye carcass recoveries, by area, mark status and sex, for component areas in the Adams River study area, excluding the lower Adams River, 1995.

Date	Area	Live count	Disk tag and/or secondary mark present			Unmarked			Total		
			Male	Female	Total	Male	Female	Total	Male	Female	Total
Continued											
1-Nov	-	-	2	0	2	68	70	138	70	70	140
3-Nov	-	-	1	0	1	40	17	57	41	17	58
5-Nov	-	-	0	0	0	94	31	125	94	31	125
7-Nov	-	-	0	0	0	38	21	59	38	21	59
9-Nov	-	-	0	0	0	31	11	42	31	11	42
Totals											
Little River			6	1	7	1,004	887	1,891	1,010	888	1,898
Little Shuswap Lake			8	0	8	951	543	1,494	959	543	1,502
Total			14	1	15	1,955	1,430	3,385	1,969	1,431	3,400
Totals For All Component Areas											
Adams Lake			0	0	0	0	1	1	0	1	1
Bush Creek			0	0	0	0	0	0	0	0	0
Cayenne Creek			0	0	0	0	0	0	0	0	0
Hiuihill Creek			0	2	2	34	28	62	34	30	64
Little River			6	1	7	1,004	887	1,891	1,010	888	1,898
Little Shuswap Lake			8	0	8	951	543	1,494	959	543	1,502
Momich River			0	0	0	0	0	0	0	0	0
Nikwikwaia Creek			0	0	0	4	31	35	4	31	35
Pass Creek			0	0	0	4	9	13	4	9	13
Scotch Creek			1	0	1	218	243	461	219	243	462
Shuswap Lake			75	32	107	6,265	3,517	9,782	6,340	3,549	9,889
Upper Adams River			0	0	0	0	0	0	0	0	0
Total			90	35	125	8,480	5,259	13,739	8,570	5,294	13,864

Appendix 8. Daily late run sockeye carcass pool and net-recoveries, by area, mark status and sex, in the lower Adams River, 1995.

Date	Area	Number of pools sampled	Disk tag and/or secondary mark present			Unmarked			Total		
			Male	Female	Total	Male	Female	Total	Male	Female	Total
Pool recoveries											
26-Oct	2	1	2	0	2	24	93	117	26	93	119
	3	1	0	0	0	45	51	96	45	51	96
27-Oct	5	2	5	6	11	389	552	941	394	558	952
30-Oct	2	1	0	0	0	17	59	76	17	59	76
	3	1	0	0	0	5	12	17	5	12	17
1-Nov	3	1	0	0	0	6	11	17	6	11	17
	5	1	2	3	5	108	153	261	110	156	266
Total	-	-	9	9	18	594	931	1,525	603	940	1,543
Net recoveries											
5-Oct	9	-	0	0	0	1	1	2	1	1	2
6-Oct	9	-	0	0	0	0	1	1	0	1	1
8-Oct	9	-	0	0	0	2	0	2	2	0	2
10-Oct	9	-	0	0	0	1	1	2	1	1	2
11-Oct	9	-	0	0	0	1	0	1	1	0	1
15-Oct	9	-	0	0	0	2	0	2	2	0	2
19-Oct	9	-	0	0	0	1	0	1	1	0	1
21-Oct	9	-	0	0	0	1	0	1	1	0	1
25-Oct	9	-	0	0	0	1	0	1	1	0	1
28-Oct	9	-	0	0	0	0	1	1	0	1	1
30-Oct	9	-	0	0	0	0	1	1	0	1	1
1-Nov	9	-	0	0	0	0	1	1	0	1	1
10-Nov	9	-	1	0	1	2	0	2	3	0	3
Total	-	-	1	0	1	12	6	18	13	6	19

Appendix 9. Daily number of late run sockeye carcasses examined and disk tags recovered, by area and sex, during the resurvey of the lower Adams River and Shuswap Lake, 1995.

Date	Area [a]	Number of surveys	Disk tag present			Total examined			Disk tag incidence		
			Male	Female	Total	Male	Female	Total	Male	Female	Total
10-Oct	1	-	0	0	0	44	51	95	0.00%	0.00%	0.00%
	2	-	0	0	0	128	61	189	0.00%	0.00%	0.00%
	3	-	0	0	0	16	6	22	0.00%	0.00%	0.00%
	4	-	0	0	0	36	17	53	0.00%	0.00%	0.00%
	5	-	0	0	0	103	102	205	0.00%	0.00%	0.00%
	6	-	0	0	0	40	34	74	0.00%	0.00%	0.00%
	7	-	0	0	0	62	59	121	0.00%	0.00%	0.00%
12-Oct	1	-	0	0	0	31	33	64	0.00%	0.00%	0.00%
	2	-	0	0	0	103	77	180	0.00%	0.00%	0.00%
	3	-	0	0	0	26	12	38	0.00%	0.00%	0.00%
	4	-	0	0	0	206	135	341	0.00%	0.00%	0.00%
	5	-	0	0	0	124	69	193	0.00%	0.00%	0.00%
	6	-	0	0	0	105	52	157	0.00%	0.00%	0.00%
	7	-	0	0	0	179	153	332	0.00%	0.00%	0.00%
13-Oct	6	-	0	0	0	54	25	79	0.00%	0.00%	0.00%
	8	-	0	0	0	155	89	244	0.00%	0.00%	0.00%
	9	-	0	0	0	29	20	49	0.00%	0.00%	0.00%
16-Oct	6	-	0	0	0	263	147	410	0.00%	0.00%	0.00%
	8	-	0	0	0	40	20	60	0.00%	0.00%	0.00%
17-Oct	4	-	1	0	1	496	500	996	0.20%	0.00%	0.10%
	7	-	0	0	0	145	135	280	0.00%	0.00%	0.00%
18-Oct	1	-	0	0	0	206	170	376	0.00%	0.00%	0.00%
	2	-	0	0	0	574	504	1,078	0.00%	0.00%	0.00%
	3	-	0	0	0	95	64	159	0.00%	0.00%	0.00%
	4	-	1	1	2	788	922	1,710	0.13%	0.11%	0.12%
	6	-	0	0	0	593	640	1,233	0.00%	0.00%	0.00%
21-Oct	1	-	0	0	0	228	215	443	0.00%	0.00%	0.00%
	2	-	0	0	0	397	431	828	0.00%	0.00%	0.00%
	3	-	0	0	0	186	161	347	0.00%	0.00%	0.00%
	5	-	0	1	1	773	683	1,456	0.00%	0.15%	0.07%
	7	-	0	0	0	385	320	705	0.00%	0.00%	0.00%
22-Oct	4	-	3	2	5	1,674	1,621	3,295	0.18%	0.12%	0.15%
	6	-	1	1	2	686	754	1,440	0.15%	0.13%	0.14%
	7	-	0	0	0	250	306	556	0.00%	0.00%	0.00%
	8	-	0	0	0	146	76	222	0.00%	0.00%	0.00%
24-Oct	6	-	0	0	0	310	303	613	0.00%	0.00%	0.00%
	9	-	1	0	1	203	134	337	0.49%	0.00%	0.30%
25-Oct	1	-	0	0	0	296	337	633	0.00%	0.00%	0.00%
	2	-	0	0	0	507	649	1,156	0.00%	0.00%	0.00%
	3	-	0	0	0	185	152	337	0.00%	0.00%	0.00%
	7	-	0	1	1	446	505	951	0.00%	0.20%	0.11%
26-Oct	4	-	1	3	4	1,716	2,099	3,815	0.06%	0.14%	0.10%
	5	-	0	1	1	1,430	1,793	3,223	0.00%	0.06%	0.03%
	7	-	0	1	1	1,116	1,402	2,518	0.00%	0.07%	0.04%

Continued

Appendix 9. Daily number of late run sockeye carcasses examined and disk tags recovered, by area and sex, during the resurvey of the lower Adams River and Shuswap Lake, 1995.

Date	Area [a]	Number of surveys	Disk tag present			Total examined			Disk tag incidence		
			Male	Female	Total	Male	Female	Total	Male	Female	Total
Continued											
27-Oct	4	-	3	1	4	533	486	1,019	0.56%	0.21%	0.39%
	5	-	1	1	2	139	151	290	0.72%	0.66%	0.69%
	6	-	0	0	0	7	8	15	0.00%	0.00%	0.00%
	6	-	0	0	0	505	498	1,003	0.00%	0.00%	0.00%
	7	-	0	0	0	198	241	439	0.00%	0.00%	0.00%
	8	-	0	0	0	548	337	885	0.00%	0.00%	0.00%
	9	-	0	1	1	441	264	705	0.00%	0.38%	0.14%
28-Oct	1	-	0	0	0	62	120	182	0.00%	0.00%	0.00%
	2	-	0	0	0	288	133	421	0.00%	0.00%	0.00%
	3	-	0	0	0	87	71	158	0.00%	0.00%	0.00%
	7	-	0	0	0	92	102	194	0.00%	0.00%	0.00%
30-Oct	4	-	0	0	0	47	63	110	0.00%	0.00%	0.00%
	5	-	0	0	0	477	655	1,132	0.00%	0.00%	0.00%
31-Oct	10	-	0	0	0	299	159	458	0.00%	0.00%	0.00%
2-Nov	4	-	0	0	0	22	22	44	0.00%	0.00%	0.00%
	5	-	0	0	0	72	137	209	0.00%	0.00%	0.00%
	6	-	0	0	0	324	375	699	0.00%	0.00%	0.00%
10-Nov	6	-	0	0	0	159	226	385	0.00%	0.00%	0.00%
	8	-	0	0	0	243	122	365	0.00%	0.00%	0.00%
	9	-	1	0	1	163	81	244	0.61%	0.00%	0.41%
Totals	1	6	0	0	0	867	926	1,793	0.00%	0.00%	0.00%
	2	6	0	0	0	1,997	1,855	3,852	0.00%	0.00%	0.00%
	3	6	0	0	0	595	466	1,061	0.00%	0.00%	0.00%
	4	9	9	7	16	5,518	5,865	11,383	0.16%	0.12%	0.14%
	5	7	1	3	4	3,118	3,590	6,708	0.03%	0.08%	0.06%
	6	11	1	1	2	3,046	3,062	6,108	0.03%	0.03%	0.03%
	7	9	0	2	2	2,873	3,223	6,096	0.00%	0.06%	0.03%
	8	5	0	0	0	1,132	644	1,776	0.00%	0.00%	0.00%
	9	4	2	1	3	836	499	1,335	0.24%	0.20%	0.22%
	10	1	0	0	0	299	159	458	0.00%	0.00%	0.00%
	Total	64	13	14	27	20,281	20,289	40,570	0.06%	0.07%	0.07%

[a] Reaches 1-7: lower Adams River; reaches 8-10: Shuswap Lake shores areas.

Appendix 10. Fecundity sampling results and analytic details for late run sockeye salmon captured in the lower Adams River, 1995.

Age	Standard length (cm) [a]	Skein weight (g)	Skein sub-sample		Estimated fecundity	Actual fecundity	Misc. eggs	Adjusted fecundity
			Weight (g)	Egg count				
4_2	55.9	413.1	140.3	1,707	5,026		0	5,026
4_2	52.0	353.0	119.1	1,832	5,430		0	5,430
4_2	51.6	484.4	164.1	1,345	3,970		0	3,970
4_2	52.6	400.2	136.6	1,370	4,014		0	4,014
4_2	51.9	413.3	244.9	2,160	3,645	3,675	0	3,675
4_2	51.7	391.3	133.0	1,162	3,419		0	3,419
4_2	51.0	361.0	123.1	1,124	3,296		0	3,296
4_2	52.9	440.1	148.8	1,488	4,401		0	4,401
4_2	54.6	543.7	184.7	1,884	5,546		0	5,546
4_2	51.2	347.4	181.7	2,268	4,336	4,418	0	4,418
4_2	52.3	410.6	140.3	1,371	4,012		0	4,012
4_2	54.1	396.6	135.4	1,551	4,543		0	4,543
4_2	52.7	429.7	146.2	1,250	3,674		0	3,674
4_2	51.0	403.2	137.1	1,266	3,723		0	3,723
4_2	55.6	514.0	272.6	2,453	4,625	4,636	0	4,636
4_2	53.8	437.9	149.0	1,402	4,120		0	4,120
4_2	54.2	390.8	133.1	1,350	3,964		0	3,964
4_2	50.8	364.0	124.3	1,311	3,839		0	3,839
4_2	51.0	380.7	194.7	2,165	4,233	4,165	0	4,165
4_2	52.6	391.6	133.5	1,620	4,752		0	4,752
4_2	50.2	344.8	117.1	1,228	3,616		0	3,616
4_2	52.9	415.9	141.6	1,335	3,921		0	3,921
4_2	51.1	423.5	225.5	2,005	3,765	3,749	0	3,749
4_2	54.4	387.8	132.5	1,306	3,822		0	3,822
4_2	50.4	346.2	118.3	1,240	3,629		0	3,629
4_2	50.4	346.5	117.7	1,341	3,948		0	3,948
4_2	54.8	465.9	158.7	1,458	4,280		0	4,280
4_2	52.6	469.4	221.9	2,322	4,912	4,867	0	4,867
4_2	52.3	376.4	128.6	1,347	3,943		0	3,943
4_2	51.4	427.3	146.3	1,453	4,244		0	4,244
4_2	52.5	389.6	132.1	1,390	4,100		0	4,100
4_2	51.9	386.4	132.5	1,541	4,494		0	4,494
4_2	49.3	293.9	142.0	2,393	4,953	4,890	0	4,890
4_2	52.6	430.5	147.0	1,335	3,910		0	3,910
4_2	53.6	425.9	143.4	1,642	4,877		0	4,877
4_2	51.4	449.8	152.6	1,462	4,309		0	4,309
4_2	54.2	475.3	161.7	1,635	4,806		0	4,806
4_2	52.4	361.4	166.8	1,467	3,179	3,178	0	3,178
4_2	56.3	536.3	182.7	1,539	4,518		0	4,518
4_2	50.8	444.1	152.0	1,618	4,727		0	4,727
4_2	53.3	400.7	135.6	1,289	3,809		0	3,809
4_2	52.8	501.9	245.2	2,393	4,898	4,890	0	4,890
4_2	53.5	470.7	161.0	1,603	4,687		0	4,687
4_2	48.7	322.8	110.2	1,232	3,609		0	3,609
4_2	55.5	450.7	153.9	1,758	5,148		0	5,148

Continued

Appendix 10. Fecundity sampling results and analytic details for late run sockeye salmon captured in the lower Adams River, 1995.

Age	Standard length (cm) [a]	Skein weight (g)	Skein sub-sample		Estimated fecundity	Actual fecundity	Misc. eggs	Adjusted fecundity
			Weight (g)	Egg count				
Continued								
5_2	62.1	549.3	188.3	1,750	5,105		0	5,105
-	54.8	458.4	156.2	1,259	3,695		0	3,695
-	52.9	429.3	146.7	1,517	4,439		0	4,439
-	54.1	378.0	128.6	1,446	4,250		0	4,250
Means								
4_2 (n=45)	52.5	413.6	154.9	1,587	4,237	4,274	0	4,235
5_2 (n=1)	62.1	549.3	188.3	1,750	5,105		0	5,105

[a] Not adjusted for shrinkage which occurs in carcass recoveries.

Appendix 11. Proportion at age and mean length (Standard and POH) at age, by sex and sample period, from the late run sockeye carcasses recovered on the lower Adams RIver, 1995.

						Standard length (cm)		POH length (cm)	
Location	Sex	Sampling date	Age	Sample size	Percent	Mean	Standard deviation	Mean	Standard deviation
Lower Adams River	Male	15-Oct	4_2	52	86.7%	56.1	1.4	47.9	1.1
			5_2	8	13.3%	61.5	1.2	52.5	1.4
		24-Oct	4_2	51	86.4%	56.1	1.5	47.8	1.3
			5_2	7	11.9%	60.3	1.7	51.8	1.6
			5_3	1	1.7%	56.4	-	48.6	-
			Unaged	1	-	-	-	-	-
		31-Oct	4_2	55	91.7%	55.7	1.7	47.3	1.5
			5_2	5	8.3%	59.9	1.2	50.6	1.3
		Total	4_2	158	88.3%	55.9	1.5	47.6	1.3
			5_2	20	11.2%	60.7	1.5	51.8	1.6
			5_3	1	0.6%	56.4	-	48.6	-
			Unaged	1	-	-	-	-	-
	Female	15-Oct	4_2	56	93.3%	52.2	1.9	46.9	1.6
			5_2	3	5.0%	56.8	2.8	51.2	2.5
			5_3	1	1.7%	50.9	-	45.3	-
		24-Oct	4_2	56	93.3%	52.3	1.6	46.7	1.4
			5_2	4	6.7%	56.4	1.5	50.6	1.2
		31-Oct	4_2	52	88.1%	52.2	1.8	46.5	1.6
			5_2	7	11.9%	56.8	1.3	50.0	1.2
			Unaged	1	-	-	-	-	-
		Total	4_2	164	91.6%	52.2	1.8	46.7	1.5
			5_2	14	7.8%	56.7	1.6	50.4	1.5
			5_3	1	0.6%	50.9	-	45.3	-
			Unaged	1	-	-	-	-	-