DISTRIBUTION, TIMING, FATE AND NUMBERS OF CHINOOK SALMON RETURNING TO THE NASS RIVER WATERSHED IN 1992

William R. Koski, Michael R. Link, and
Karl K. English

Department of Fisheries and Oceans
Room 202, 417-2nd Ave.
Prince Rupert, BC
V8J 1G8

1996

Canadian Technical Report of Fisheries and Aquatic Sciences No. 2129

Fisheries and Oceans Pêches et Océans

Canada

Canadian Technical Report of Fisheries and Aquatic Sciences

Technical reports contain scientific and technical information that contributes to existing knowledge but which is not normally appropriate for primary literature. Technical reports are directed primarily toward a worldwide audience and have an international distribution. No restriction is placed on subject matter and the series reflects the broad interests and policies of the Department of Fisheries and Oceans, namely, fisheries and aquatic sciences.

Technical reports may be cited as full publications. The correct citation appears above the abstract of each report. Each report is abstracted in *Aquatic Sciences and Fisheries Abstracts* and indexed in the Department's annual index to scientific and technical publications.

Numbers 1 - 456 in this series were issued as Technical reports of the Fisheries Research Board of Canada. Numbers 457 - 714 were issued as Department of the Environment, Fisheries and Marine Service Technical Reports. The current series name was changed with report number 925.

Technical reports are produced regionally but are numbered nationally. Requests for individual reports will be filled by the issuing establishment listed on the front cover and title page. Out-of-stock reports will be supplied for a fee by commercial agents.

Rapport technique canadien des sciences halieutiques et aquatiques

Les rapports techniques contiennent des renseignements scientifiques et techniques qui constituent une contribution aux connaissances actuelles, mais qui ne sont pas normalement appropriés pour la publication dans un journal scientifique. Les rapports techniques sont destinés essentiellement à un public international et ils sont distribués à cet échelon. Il n'y a aucune restriction quant au sujet; de fait, la série reflète la vaste gamme des intérêts et des politiques du ministère des Pêches et des Océans, c'est-à-dire les sciences halieutiques et aquatiques.

Les rapports techniques peuvent être cités comme des publications complètes. Le titre exact paraît au-dessus du résumé de chaque rapport. Les rapports techniques sont résumés dans la revue *Résumés des sciences aquatiques et halieutiques*, et ils sont classés dans l'index annual des publications scientifiques et techniques du Ministère.

Les numéros 1 à 456 de cette série ont été publiés à titre de rapports techniques de l'Office des recherches sur les pêcheries du Canada. Les numéros 457 à 714 sont parus à titre de rapports techniques de la Direction générale de la recherche et du développement, Service des pêches et de la mer, ministère de l'Environnement. Les numéros 715 à 924 ont été publiés à titre de rapports techniques du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom actuel de la série a été établi lors de la parution du numéro 925.

Les rapports techniques sont produits à l'échelon regional, mais numérotés à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page du titre. Les rapports épuisés seront fournis contre rétribution par des agents commerciaux.

Canadian Technical Report of

Fisheries and Aquatic Sciences 2129

1996

DISTRIBUTION, TIMING, FATE AND NUMBERS OF CHINOOK SALMON RETURNING TO THE NASS RIVER WATERSHED IN 1992

prepared by

William R. Koski[1], Michael R. Link[2], and Karl K. English[2],

LGL Limited
environmental research associates

for the

Nisga'a Tribal Council[3]

[1] LGL Limited environmental research associates, 22 Fisher St., King City, ON L7B 1A6

[2] LGL Limited environmental research associates, 9768 Second St., Sidney, BC V8L 3Y8

[3] P.O. Box 231, New Aiyansh, BC V0J 1A0

Cat. No. Fs 97-6/2129E ISSN 0706-6457

Correct citation for this publication:

Koski, William R., Michael R. Link, and Karl K. English. 1996. Distribution, timing, fate and numbers of chinook salmon returning to the Nass River Watershed in 1992. Can. Tech. Rep. Fish. Aquat. Sci. 2129: xi + 141 p.

TABLE OF CONTENTS

TABLE OF CONTENTS - Cont'd

LIST OF TABLES

LIST OF TABLES - Cont'd

LIST OF FIGURES

LIST OF FIGURES - Cont'd

LIST OF APPENDICES

LIST OF APPENDICES - Cont'd

LIST OF APPENDICES - Cont'd

Appendix E - Fishway and Fence Data

ABSTRACT

Koski, W. R., M. R. Link, and K. English. 1996. Distribution, timing, fate and numbers of chinook salmon returning to the Nass River watershed in 1992. Can. Tech. Rep. Fish. Aquat. Sci. 2129: 141 p.

Extensive radio-tagging and escapement surveys were conducted, as part of the 1992 Nisga'a Interim Measures Program (IMP), to obtain reliable run-timing and escapement estimates for all chinook salmon stocks in the Nass River watershed. A total of 360 radio tags were applied to adult chinook salmon in the lower Nass River and were tracked throughout the watershed using a combination of stationary receivers, and foot, boat, helicopter and truck-based telemetry surveys. Eight fixed-station receivers were established at strategic locations to automatically record upstream and downstream movements of radio-tagged fish. Multiple antennas were used to determine the direction of travel for fish passing the receivers stationed at the junction of major tributaries. We were able to determine spawning destinations for 81% of the fish tagged and 98% of the active tags that escaped lower-river fisheries. Extensive surveys of two major tributaries and brief surveys of several other tributaries provided the mark-recapture data required to compute reliable estimates of the number of chinook escaping to each area. The total adult chinook escapement to spawning areas was roughly 17,000 fish. An additional 1,342 chinook were caught by sport fishermen, 7,100 chinook were taken by the Nisga'a fishery, and approximately 730 chinook were suspected to have been removed by other First Nations fishermen. Thus the total chinook return to the Nass River in 1992, in-river catch plus escapement, was estimated to be about 26,000 fish.

RÉSUMÉ

Koski, W. R., M. R. Link, and K. English. 1996. Distribution, timing, fate and numbers of chinook salmon returning to the Nass River watershed in 1992. Can. Tech. Rep. Fish. Aquat. Sci. 2129: 141 p.

Une vaste campagne de radio-étiquetage et d'observation des taux d'échappée a été effectuée dans le cadre du Programme de mesures intérimaires des Nisga'a. Cette étude avait pour objet de recueillir des données fiables sur les temps de migration et les taux d'échappement des divers stocks de saumon quinnat du bassin de la rivière Nass. Au total, 350 radio-émetteurs ont été insérés sur des spécimens de saumons quinnats adultes dans le cours inférieur de la rivière Nass, et pistés à travers le bassin hydrographique au moyen de postes récepteurs fixes et de campagnes de télémesure conduites au sol (à pied et par camion), par bateau et par hélicoptère. Huit récepteurs fixes ont été installés dans divers points stratégiques pour suivre les déplacements anadromiques et catadromiques des spécimens radio-étiquetés. Plusieurs antennes ont été utilisées pour déterminer le sens de déplacement des poissons traversant les champs de captage des récepteurs situés aux points de confluence des principaux tributaires. Nous avons pu localiser les frayères de 67 % des poissons étiquetés et de 95 % des spécimens étiquetés ayant échappé aux opérations de pêche dans le cours inférieur de la rivière. Des recensements à grande échelle dans deux grands tributaires et à moindre échelle dans plusieurs autres tributaires ont permis de recueillir les données de récupération des spécimens marqués qui étaient requises pour estimer de manière fiable le nombre d'échappées de saumons quinnats pour chaque zone. Le nombre total d'échappées de saumons quinnats adultes vers les zones de frais a donc été établi à environ 17 000 individus. Un nombre additionnel de 1 342 saumons quinnats a été capturé par les pêcheurs sportifs; 7 100 saumons quinnats ont été pris par les pêcheurs Nisga'a et environ 730 auraient été prélevés par d'autres pêcheurs autochtones que les Nisga'a. On en a déduit que l'effectif de remonte global de saumons quinnats dans la rivière Nass en 1992 — nombre capturé et nombre d'échappées confondus — était d'environ 26 000 individus.

INTRODUCTION

The Nass River system is the third largest river system in British Columbia and is a significant producer of chinook salmon (*Oncorhynchus tshawytscha*). Chinook are heavily utilized by commercial, native and sport fisheries and many chinook populations along the Pacific coast, including the Nass River stocks, may be greatly reduced from their historic levels. Hence a high level of concern has been expressed for Nass River chinook populations.

The Nisga'a Tribal Council (NTC) is currently negotiating a land claim settlement with the federal and provincial governments that may include an allocation of a part of the fisheries resources of the Nass River System to the Nisga'a. Thus, all parties have a requirement to know the following:

1. the number of chinook salmon entering the Nass River and its tributaries;
2. where these fish spawn; and
3. the timing of runs of different stocks of chinook salmon.

The Department of Fisheries and Oceans (DFO) have conducted annual surveys of chinook spawners in some of the tributaries of the Nass River, but these surveys provide only partial estimates of total escapement because:

1. some fish cannot be counted in turbid systems;
2. counts are usually conducted only once or twice each year and may not always reflect the total or peak number of fish present in each system; and
3. not all spawning areas are surveyed.
4. only partial counts are conducted for most of the systems surveyed.

Although the DFO counts provide information on relative run sizes over long periods of time, they do not provide sufficiently detailed information to manage chinook stocks effectively over a shorter time frame.

In December 1991, the federal government and the NTC signed an agreement wherein the DFO would provide funding for a fisheries Interim Measures Program (IMP). The program included a wide variety of fisheries projects designed and directed by technical representatives of the NTC and the governments of Canada and British Columbia. Two of these projects, chinook radio-tagging and chinook escapement surveys, were specifically designed to address three data requirements outlined above. In this report we present a detailed description of the field and analytical methods used to derive chinook escapement estimates for the Nass River and its major tributaries.

The quality and completeness of our assessment of 1992 returns of chinook salmon to the Nass River was significantly enhanced by information and opportunities provided through other IMP projects. The in-river sport and native catch monitoring surveys provided information on the timing of fish movements in the lower river and reliable harvest estimates for all major fisheries. The Nass River fishwheel project provided an excellent supply of healthy adult chinook salmon for radio tagging, and field crews working at the Meziadin fishway and Kwinageese weir obtained daily counts of chinook passing these locations.

STUDY AREA

The Nass River drains 8000 km^2 and is the third largest watershed in British Columbia. The river originates in the Skeena Mountains and flows south and southwest for 400 km, entering the Pacific Ocean at Portland Inlet on the north coast of British Columbia (Fig. 1).

The Nass River supports significant populations of chinook, sockeye (*Oncorhynchus nerka*), coho (*O. kisutch*), chum (*O. keta*), and pink (*O. gorbuscha*) salmon, as well as steelhead (*O. mykiss*). Chinook salmon spawning areas are found throughout the Nass River watershed. Figure 1 shows 34 Nass River tributaries surveyed for chinook salmon in 1992. Sixteen of these have been identified by the DFO as containing chinook spawning areas (Table 1, L. Jantz, DFO, Prince Rupert, B.C., unpubl. data).

The life history information for chinook salmon is generally known for other systems and some stock specific data are available about the timing of movements into freshwater and about the timing of spawning in the Nass River system. Two life-history types of chinook salmon have been found in the Nass River (Godfrey 1968; Healey 1983, 1991). Godfrey (1968) indicates that 58% of the chinook spawning runs to the Nass River during 1964-66 were ocean-type fish and only 42% were stream-type. Studies in other areas have indicated that the contribution of stream- and ocean-type chinook to a spawning run can vary from year to year. Healey (1991) states that there is a tendency, at least in areas south of the Nass River, for stream-type chinook to enter the rivers earlier than ocean-type fish; however, he did not provide data on the entry dates of these two spawning types into the Nass River. Thus dates of entry and spawning for Nass River chinook stocks may vary from year to year depending on the contribution of the two life history types to the escapement for that year.

Data collected by DFO from 1950 to 1988 (L. Jantz, DFO, Prince Rupert, B.C., unpubl. data) suggests that chinook salmon begin to enter the Nass River system in early June and continue to enter until mid September with the peak period of entry being highly dependent on the stock. Spawning begins in late July and continues until early October with peak spawning occurring in mid August to early September. Die-off begins in early August and is usually completed by the end of September, but can be as late as mid November.

Chinook spawning escapement estimates have averaged 8,858 for the period 1982-91 and ranged from 3,309 in 1991 to 16,265 in 1986 (L. Jantz, DFO, Prince Rupert, B.C., unpubl. data). Table 1 provides a list of the escapement estimates by tributary for the period 1982-91. Four tributaries of the Nass River: the Damdochax, Kwinageese, Meziadin and Cranberry/Kiteen systems are reported to contain the majority of the chinook spawning areas. These four systems have been estimated to contain 46-86% of the estimated total annual Nass

River escapement from 1982-91 (Table 1). Based on the 10-yr average estimates to each system (including only years when the system was surveyed), the escapements have averaged 10,277 and the four major systems have contributed 67% to this total (Table 1).

METHODS

STUDY DESIGN

Data from several sources were integrated and used to monitor movements and numbers of chinook in various parts of the Nass River and its tributaries. The data presented here were obtained during a radio-tagging study, aerial and ground counts, fishway and weir counts, and carcass counts and examinations for mark-recapture estimates. We maximized our resources by restricting intensive aerial and ground surveys to locations and time periods that had previously been documented as important to chinook salmon. Surveys were conducted of less important areas primarily during the periods of peak spawning as indicated by historical data (L. Jantz, DFO, Prince Rupert, B.C., unpubl. data). The survey effort was also influenced by the distribution and timing data obtained from tracking radio-tagged fish.

RADIO-TAGGING STUDY

The radio-tagging study involved catching and tagging chinook salmon, steelhead and chum in the lower part of the river between Fishery Bay and Grease Harbour (Fig. 2) and tracking them using a combination of stationary radio-tag receivers; foot, boat and truck-based surveys; aerial surveys; and tag recoveries on the spawning areas after the fish had died. The information was integrated into one large database which archived the locations, dates and time when each tagged fish was tracked during field surveys.

Methods of Capturing Fish

Chinook salmon and steelhead trout were initially captured using set and drift tangle nets. Fishwheels became the primary fish capture method when it became apparent that they were going to catch sufficient numbers of chinook to meet our tagging requirements. Nets were used only to supplement catches when one or both of the fishwheels was not operating.

Set Nets: Stationary tangle nets (15 cm mesh, 3 m deep and 45 m long) were used at Sandy River and Grease Harbour to capture fish for radio tagging (Fig. 2). The nets were constantly attended, except during the brief periods when the taggers moved to the release site to tag and release fish, to minimize the time that fish spent tangled in the net and to minimize the likelihood of fish injury and mortality. When fish entered the net, the net was retrieved and the fish were removed and placed in a canvas holding tank. The net was reset and the fish were transported upstream or across the river about 200 m to the release site. The release site was a calm area where the tagged fish could recover from the handling.

During the initial stages of the project, a small number of fish were held in a 1.2 X 1.2 X 2.4 m holding pen for 0.6 to 9.1 h before being released. This permitted an evaluation of initial mortality rates of tagged fish and of regurgitation rates of tags. When we had determined that virtually all fish appeared to recover from the tagging and that few fish regurgitated tags, we stopped holding fish after tagging to eliminate any additional stress on the fish that might be associated with holding them.

Drift Nets: Along some sections of the river (i.e., near the sawmill at Gitwinksihlkw and near Gitlakdamix (Old Aiyansh, Fig. 2) it was more efficient to capture fish by drifting than by using stationary nets. The same nets were used for drift fishing and for sets. The net was set so that it would form a slight bow with the ends of the net being farther downstream than the middle. The net was allowed to drift downstream with one person holding one end of the net. When a fish entered the net, the net was retrieved. On several occasions two and occasionally three fish became entangled before the net could be recovered. The fish were lifted into the boat one at a time, removed from the net, and placed into the canvas holding pen. They were then handled as above for set nets.

Fishwheels: Large wooden fishwheels, similar to those used on the Yukon and Taku rivers (Meehan 1961; Donaldson and Cramer 1971; Milligan et al. 1985; McGregor et al. 1991), were used to capture salmon moving upstream and monitor the timing and relative numbers of anadromous fish species and stocks entering the Nass River. They are an ideal method of obtaining fish for tagging studies because fish are rarely injured during capture. In addition, they fish constantly and, therefore, provide a rate of capture that can be correlated with the numbers of fish moving through an area. Link et al. (1996) provide a complete description of the fishwheels and their use during 1992 on the Nass River.

Tagging Effort

The effort expended to capture fish varied due to water level changes, weather conditions and other duties. Table 2 summarizes the fishing effort using nets. Daily net fishing effort for specific sites are provided in Appendix Table A-1. Daily summaries of the hours fished by fishwheels are presented in Appendix A Table A-2 and Link et al. (1996) describe the fishing effort by the fishwheels.

The area that was fished changed during the season because of changes in chinook salmon distribution. Initially we attempted to capture fish using nets at Grease Harbour above the main in-river net fishery (Fig. 2). We reduced our effort with nets when the first fishwheel began to fish on 5 June near Gitwinksihlkw (Canyon City). Initial fishwheel catches were low, so capture efforts were augmented using nets near Gitwinksihlkw from 9-12 June. On 15 June it became apparent, through the catch monitoring program, that fish were holding in the lower part of the river (see week of 6-12 June, Table 6 in English and Bocking (1993). From 16-23 June our tagging efforts focused on the lower river, primarily at Sandy River (Fig. 2), in order to increase the number of fish that were being tagged. Starting 24 June the fishwheels started to catch chinook at a rate of more than 10/d so we stopped using nets except for a major effort on 26 June and brief tagging episodes during late June and early July.

We attempted to radio tag all healthy large (>72 cm long) chinook that were captured prior to 10 July when 338 of 400 radio tags had been applied. Some fish greater than 72 cm could not be radio-tagged because their stomach was too small to hold the radio tag without applying pressure to the back of the stomach. After 10 July, we limited radio tagging to large silvery-bright chinook caught to ensure that we would have sufficient radio tags to mark later run fish. We assumed that silvery-bright fish were new arrivals in the river. Another consideration was that our radio-tag data suggested that some fish were remaining in the lower river and were moving up and down the river past our radio-tagging sites. To avoid tagging these lingering fish at a higher rate than other fish, we decided to tag only new fish that were entering the river.

Radio-tagging Procedures

Two slightly different handling procedures were used depending on the method of capture of the fish. Chinook salmon that were caught in nets were removed from the canvas holding tank and placed in a 30-cm long sleeve that was suspended from a rigid pole resting on an aluminum frame. Fish caught in the fishwheels were removed from the holding pens with a dip net and placed in a V-shaped trough filled with water. Fish were not anaesthetized because some chinook were likely to be caught by the in-river net fishery or by sport fisherman and the effects of the available anaesthetics on the edibility of the fish are unknown. Processing included tagging the fish with an operculum tag, measuring the fish (nose-fork length), noting the presence of scars and marks and placing a radio tag down the throat of the fish and into the stomach with the antenna protruding from the corner of its mouth. The antenna was bent at the corner of the mouth so that the protruding part trailed along the side of the fish. The operculum tag number and the frequency and coded signal of the radio tag were recorded for each individual fish. The processing time (i.e., from removal from the holding tank to release) of each individual fish generally took less than thirty seconds and very rarely took more than two minutes.

The radio tag was the LOTEK model CFRT-7A digitally coded tag. This tag had a 180-d life and was 16 mm in diameter, 80 mm long and weighed 44 grams in air. Ten different frequencies (149.520 - 149.700) each containing up to 50 different digital codes were used to distinguish between 400 radio tags purchased for this study. Tags to be applied to fish were selected so that different codes, and not more than a few tags on each frequency, were applied to fish caught on the same date. This precaution was taken to increase the detection efficiency of the receivers if fish captured at the same time or place remained together.

<u>Spaghetti Tagging</u>

Chinook salmon captured in the fishwheels that were not required for the radio-tagging program were tagged with regular type spaghetti tags (FT-4 spaghetti tag, Floy Tag & Manufacturing Inc., Seattle, Washington, USA). The tagging procedures were similar to those described above for radio tagging and are described in more detail in Link et al. (1996). A total of 74 spaghetti tags were applied to chinook salmon (Table A-2).

<u>Tracking Methods</u>

We determined the movements of radio-tagged fish using data collected from tracking surveys conducted from boats, trucks, helicopters and on foot. In addition, we set up fixed-station receivers that automatically detected and recorded radio-tagged fish that passed them. The tracking effort by each of these methods is summarized in Table 3.

Radio-tag Receivers: The radio-tag receiver used during this study was the SRX_400 built by LOTEK Engineering Inc. of Newmarket, Ontario, with their CODE_LOG version W16 data processing and storage program. The radio tag that was used could be detected at 1 km from ground level if the fish was in 4-5 m of water and farther if the tag was in shallower water or the antenna was higher. When flying at 500 m above ground level (AGL) we were able to pick up transmitters on fish in shallow water (1-3 m) from 8-10 km.

During tracking surveys the receiver scanned each frequency (channel) for 6 s during which time one to two pulses would be transmitted by a tag (the pulses are 5 s apart). The receiver then searched the next frequency. If a signal was received, the receiver decoded the signal, reported the tag code and signal strength and stored the data in internal memory. As many as 12-15 different fish can be recorded on the same frequency during the same scan cycle (6 s) so that the probability of a fish not being detected is low if only a few fish are present on a single frequency. The probability of missing a signal increases with the number of tags being detected on the same frequency at the same time. If 12 fish were on the same frequency in the same area, there is a high probability that one or more of these 12 might not be identified. The receivers, fitted with a single antenna, could scan ten frequencies and decode over 100 different radio-tagged fish within a 60 second period. During aerial tracking surveys we optimized tag detection and recording by varying our altitude and speed.

Telemetry data were automatically stored in an internal memory in the receiver and were transferred to a computer file on a portable computer whenever a survey was completed or a fixed station was visited. The data stored for each signal received by the receiver included the following:

1. date;
2. time (h/min/s);
3. channel or frequency;
4. power level of signal;

5. antenna (if greater than one antenna was hooked up to the receiver);
6. signal code; and
7. code discrimination (variation from the actual code; this was used to distinguish false signals from fish).

Fixed Stations: Eight fixed-station (FS) receivers were established at strategic locations to automatically monitor the timing and the identities of fish moving up the Nass River (Fig. 1). The location of sites was selected to: 1) monitor fish entering known spawning systems (FS3 at the Cranberry River junction, FS2 at the Kiteen River junction, FS7 at the Damdochax Creek junction, FS9 at the Bell-Irving River junction); 2) monitor systems that might have spawning runs that have not been previously documented (FS8 at the White River junction); or 3) bracket rivers that might have spawning populations of chinook salmon (FS1 above Grease Harbour, FS5 at Sanskisoot Creek, FS6 at Sallysout Creek).

Each fixed-station consisted of one, two or three antennas and the SRX_400 receiver which was powered by a 12-V deep discharge (RV) battery. The battery and receiver were enclosed in a weather-proof container and could operate for 2-3 wk without servicing. We checked the operation of each station, replaced the 12-V battery and downloaded the data from the receiver once every 2 wk except during the peak of the run when we checked stations every 3-4 d (lower river) or 7 d (upper river). The more frequent visits were required to download data from the receivers internal memory which would have become full when many radio-tagged fish were present near the stations.

Multiple antennas (2 or 3) were used to determine the direction of travel of fish near fixed-stations that were established at the junctions of tributaries. Antennas were arranged so that number one antenna pointed up the Nass River, number two pointed up the tributary and number three, if present, pointed down the Nass River. The antennas were all connected to a peripheral device that controls and alters the scanning sequence of the receiver. It scans on a combined signal from all antennas. When a signal is received, the receiver records the data as being on antenna 0 and then switches sequentially to each antenna to determine which antenna is recording the tag. The time spent on a frequency, if a fish is present, is 24 s when the station has three antennas. If fish were recorded on all 10 frequencies, the scanner would take 4 min to return to the initial frequency; whereas, if no fish were detected, the scanner would take 1 min to return to the initial frequency. Fish passing the fixed stations were within receiving range of the antenna for at least 5-10 min. Therefore, failure to identify a passing fish was very unlikely, and most fish were recorded at least 7 times (and most often a few hundred times) before they passed a fixed station. This repetitive recording of individual fish permitted confirmation of signals as being from passing fish.

Tracking by fixed stations provided the most continuous coverage of fish movements of the five tracking methods that were used. A total of 736 site days of monitoring was obtained from the fixed stations (Table 3). The first station was set up near Grease Harbour (FS1) on 24 May and the last two stations were removed on 25 September. The data from the fixed stations provided precise data on the arrival and departure times and dates of fish past each station. These data could not have been obtained using the other tracking methods.

Aerial Tracking: Aerial tracking was conducted from a Bell 206 helicopter with a single Yagi antenna attached to the cargo skid on the right side of the aircraft. The aircraft flew along the river and its tributaries at 40-130 km/h and at 30-300 m AGL. Whenever large numbers of radio-tagged fish were located the helicopter reduced speed or hovered to permit identification of the position of the fish and to permit the receiver to scan the other frequencies. The location of each fish was determined in real time by a Global Positioning System (GPS) receiver and data logger and the approximate position and the identity of each fish that was located were recorded manually on data sheets, as well as automatically in the internal memories of the receiver and GPS. The position of the fish was later confirmed by comparing signal strengths and the GPS positions that were machine-recorded. During some surveys two receivers were operated on different frequencies so that the probability of passing a fish without recording it was reduced. Aerial tracking was conducted whenever we flew, but during aerial surveys dedicated to tracking, we maintained an air speed of 40-60 km/h and an altitude of 150 m to maximize our chances of recording each fish present.

Aerial tracking was most valuable to document the location and residence times of chinook after they had entered their spawning streams (Table 3). A list of aerial telemetry surveys conducted during the mid-July to late September period can be found in Appendix B.

Boat Tracking: The section of the lower Nass River from 5 km above Grease Harbour to Fishery Bay (Fig. 2) was tracked by boat once each week from late June to mid-September.

Boat-based tracking was conducted from a 5.8-m long welded aluminum boat that was powered by an outboard motor with a jet propulsion unit. The jet powered boat was required to access the numerous shallow side channels that were used by fish. The tracking antenna (4-element Yagi) was mounted at the top of a 3-m long aluminum pole that stood inside a PVC pipe mounted along the side of the console. The PVC pipe isolated the antenna from direct contact with the boat and facilitated its removal during transit or when tracking was not being conducted.

All boat surveys were conducted from upstream to downstream. The boat motor was turned off and the boat drifted while tracking was conducted because the outboard motor created electronic noise that interfered with signal reception by the receiver. When fish were present in an area, the boat was stopped or permitted to drift through that area until all fish were recorded. The boat was then moved 1-2 km downstream and the procedure was repeated. From late June to late July, when large numbers of fish were present in the areas tracked from the boat, we drifted from Grease Harbour (FS1) to Fishery Bay (Fig. 2).

As above, all radio-tag signals were recorded in the receiver and all position information was determined by and stored in the GPS. Fish identities, time, and approximate positions were also recorded manually on data sheets.

Truck and Foot Tracking: Tracking was also conducted from a truck and on foot on an opportunistic basis. Most foot surveys were conducted during ground-based counts of chinook salmon along the Damdochax, Bell-Irving and Kwinageese systems, but foot surveys were also conducted on the Seaskinnish and Cranberry systems. Truck surveys were conducted of the Tseax River and mainstem Nass River near Gitwinksihlkw. A four-element Yagi antenna was used for both boat and truck surveys. A collapsible three-element antenna was used during foot surveys. Data recording procedures were identical to those described above.

Data Processing

The data from each station or survey were screened for spurious signals using existing computer programs and were incorporated into the radio-tag database. Spurious signals were identified among the logged data by low signal strength and few or no repetitions. Using these criteria, personnel from the University of Idaho have been able to remove spurious signals from the raw data files without removing actual fish tag records (Ted Bjornn, pers. comm.).

The data (almost one million lines) were then converted into a Dbase format (Foxpro 2) and condensed to one record for each fish at each location on each day. Programs were written to identify implausible movements or positions, match survey times and locations with fish tracking records and summarize the data for presentation in tables and figures.

ESCAPEMENT SURVEYS

General Approach

The purpose of the escapement surveys was to count chinook salmon in a manner that would allow us to use the counts to estimate the chinook escapement to the Nass River and its tributaries. We designed the study to concentrate field survey effort on a few known, major chinook spawning areas, while remaining flexible about where to apply the remaining effort. By targeting the effort on the systems that historically contained large numbers of chinook salmon, the information that we gathered would allow us to estimate precisely a large proportion of the total Nass River chinook escapement. The remainder of the survey effort was to be allocated to surveying historically less abundant stocks and to any systems that the radio-telemetry information indicated were potentially important spawning areas.

The Damdochax, Kwinageese, Meziadin and Cranberry/Kiteen systems have historically contained the majority of the estimated spawning escapement of chinook salmon (Table 1). These systems were classified as major for the purposes of this study and were visually surveyed from a helicopter at intervals of 4-13 d from early August to mid-September. Ground surveys, a fishway, a weir and radio telemetry were also used to count fish in these systems.

By mid-August, the fixed-station radio receiver at the junction of the Bell-Irving and Nass rivers (FS9, Fig. 1) had identified that a substantial portion of the radio-tagged fish had entered the Bell-Irving River (approximately 25% of the 255 radio-tagged fish tracked to apparent destinations by that date). As a result, the Bell-Irving River was upgraded to a major spawning area and aerial and ground surveys were initiated in that system.

The remainder of the chinook spawning areas (minor systems) were surveyed less frequently using predominantly aerial visual surveys and aerial telemetry to count fish. The primary purpose of these surveys was to determine the distribution and abundance of radio-tagged fish which were then used to estimate the escapement of chinook with a mark-recapture method (see Analytical Techniques, below). The visual surveys also provided minimum estimates of the escapement. Occasionally ground surveys were conducted to verify or replace aerial surveys. At the start of each week beginning in early August a list of desirable surveys was compiled to determine if and when to survey minor systems. The priority of these surveys was defined using the following criteria (in descending order of importance):

1. the magnitude of the historical escapement (high escapement, high priority);
2. the number of radio tags determined to be in the area by fixed and mobile receivers (large number of tags, high priority);
3. the flight time required to survey the system, including the ferry time from base camp or from adjacent survey areas (little flight time required, high priority);
4. the abundance of fish and the degree to which spawning was complete. This was determined from previous surveys (high abundance, high priority; spawning near peak, high priority); and
5. the amount of potential spawning habitat. This was evaluated during other overflights (large amount of spawning habitat, high priority).

The number of surveys completed each week depended on the weather conditions, availability of aircraft and personnel, budget considerations and logistical constraints which included coordination with other studies.

Some systems were surveyed using several techniques. The variation among estimates obtained for the same system using these different techniques was used to evaluate the reliability of each technique for estimating chinook escapement on the Nass River.

Survey Procedures

Aerial and ground surveys were used extensively to count chinook salmon in 1992 and ground surveys were used to examine carcasses and recover radio and spaghetti tags. These techniques are described in detail below.

Aerial surveys: All aerial surveys were conducted from a Bell 206B helicopter equipped with a rear bubble window. A single surveyor visually counted fish from a rear window seat of the aircraft; the same individual (Michael Link) was the observer throughout the entire field season. He has nine years of experience counting salmonids from helicopters, boats and on foot. The aircraft was turned or oriented so that the observer could see along the stream ahead of the aircraft. The direction of flight (upstream or downstream) was chosen to minimize glare and strong tail winds. Trainees were also present on most surveys, but their counts were not used for any analyses although they were compared to those of the primary observer as part of the training process. The helicopter flew 30-200 m above the water and at air speeds of 0-150 km/h. The initial survey speed was usually 100 km/h and it was reduced when fish were encountered. The survey speed was then adjusted to allow the surveyor to comfortably and accurately count individual fish. Counts were usually conducted at air speeds of 10-60 km/h. Occasionally, groups of fish were too dense to count fish individually and group sizes had to be estimated. The number of fish in these groups was estimated by visually partitioning the group into strips containing approximately 10 fish and then counting the number of strips that comprised the group.

Each system was divided into reaches in order to stratify the counts. Boundaries of reaches were selected using both natural changes in the river (waterfalls, riffles, deep holes) and convenient landmarks (rock bluffs, bridges). Reach specific data were useful in monitoring upstream migration and comparing aerial and ground survey counts.

Live fish were categorized as either spawning or holding. Spawning fish were those fish that were on or within 5 m of redds. Fish that were not near redds, but showed obvious signs of advanced spawning condition, (i.e., worn and/or discoloured tails or fungus patches on their skin) were also categorized as spawning. All other live fish were assumed to be holding. Dead fish (carcasses) were not systematically enumerated during aerial surveys, but were recorded when time permitted. During aerial surveys, the time was usually recorded at the start and end of each reach. A GPS unit operated continuously during the surveys (see Aerial Tracking above) and the GPS position was occasionally used as a backup method to determine the location of the helicopter at a given time. This permitted us to assign counts to particular reaches even if the reach boundaries were not recorded during the survey. Summaries of numbers of fish that were spawning and holding in each reach were used to determine approximate locations of spawning areas and the timing for peak spawning activity.

Factors that might affect the ability of the surveyor to see or record fish (observer efficiency) were recorded on a survey form along with actual counts of fish by reach. Figure

D-1 shows the survey form used in the field and Table D-1 defines the codes that were used. Data recorded included: weather (cloud cover, precipitation and wind speed and direction); light conditions; water clarity, both airspeed and elevation (above the water of the survey aircrafts), direction of travel; water level (relative to previous surveys or to natural landmarks); and the names of the pilot and all surveyors. In addition, the surveyor kept notes on fish distribution, the degree to which overhanging vegetation interfered with counting, the aircraft speed when fish were being counted and the ability of the surveyor to concentrate. These data were recorded to provide information related to the potential biases in the aerial counts and to permit more accurate comparisons of the 1992 estimates with those from past and future surveys.

At the end of each survey, the surveyor attempted to estimate his efficiency (the percentage of fish present that were recorded). The estimate took into account all of the factors noted above and was subjective, but it was made to give an overall estimate of the reliability of the count that may not have been readily apparent from the description of the survey conditions.

Ground Surveys: Ground surveys were conducted to evaluate aerial counts and to examine carcasses of chinook salmon for radio, operculum and spaghetti tags (carcass counts). A crew of two or three surveyors walked alongside and through the stream to count live and dead fish. Small or dispersed groups of live fish were counted individually and classified as either spawning or holding. Dense groups of fish were estimated as described above for aerial counts. Ground survey counts were stratified into the same reaches as used during the most recent aerial survey of the area.

On two occasions, two surveyors used a 3 m rubber raft to conduct a float survey of Damdochax Creek. The same methods of counting and recording fish (as outlined above) were employed during float surveys. Carcasses were not encountered on the two float surveys.

During ground surveys, each carcass was examined for radio, operculum and spaghetti tags. Carcasses were counted and categorized as females, males (>50 cm, nose-fork length) or jacks (males <50 cm, nose-fork length). After carcasses were examined they were cut in two near the caudal peduncle to indicate that they had been examined and counted if they were encountered during later surveys. The processed carcasses were returned to the river bank because recent studies have shown that salmon carcasses may provide important nutrients for growth of young fish in salmon streams.

Carcasses of radio-tagged fish were examined for general physical condition, sex, spawning condition and the age of the carcass. The stomachs and digestive tracts of several fresh carcasses were examined to determine if radio-tag placement or retention resulted in any physical injury. Any physical abnormalities or injuries were recorded and these notes were compared to notes taken at the time of tagging to determine if they occurred after tagging. The spawning status of females was assessed by examining the gonads in carcasses;

they were recorded as fully spawned if the gonads were completely empty, partially spawned if some eggs remained and non spawners if the gonads were intact and all eggs appeared to be retained. The age of the carcass was estimated using the degree of deterioration of the carcass. The following characteristics were used to estimate the number of days (in parenthesis) since the fish died:

1. bright red gills, little or no *rigor mortis* (1 d);
2. gills dull red with white patches, carcass stiff or beginning to loosen, flesh firm (2-3 d);
3. gills white, fungus layer on skin, flesh very soft (4-5 d); and
4. gills white/grey, heavy covering of fungus, flesh mushy (6-7 d).

The rate of deterioration varied slightly among systems and throughout the period of the spawning run so that ages determined for particular systems or particular periods varied slightly from the above criteria. The estimated ages based on the above criteria varied by as much as 2 d. Carcasses that had been cut in half during the previous survey provided a basis for estimating the age of fish that had died between survey periods. These cut carcasses gave an indication of the rate of carcass deterioration that was specific to that time and that system. The date that a radio-tagged fish died was used in conjunction with the date that the fish entered that system to provide an estimate of its total residence time for the Area-Under-the-Curve (AUC) method of estimating escapement (see Analytical Techniques below).

<u>Systems Surveyed</u>

As mentioned previously, different methods and different amounts of effort were used to estimate chinook escapement to different tributaries or stocks of the Nass River system during 1992. This section describes the methods used to estimate escapement for each stock (Table 4). A summary of the quantity, timing and distribution of stream survey efforts is presented in Table 5.

Damdochax Creek: Both aerial and ground survey counts were used to obtain point estimates of the abundance of live fish and ground surveys were conducted to examine carcasses for the presence of radio, spaghetti and operculum tags. The live counts were converted into an escapement estimate using the AUC estimation technique. Carcass recovery data were combined with the number of radio-tagged chinook entering the creek to compute an independent mark-recapture estimate (Table 4; see Analytical Techniques, below).

Damdochax Creek was surveyed by helicopter at intervals of 4-7 d from 4 August to 10 September 1992. Visual counts of chinook salmon were obtained from seven surveys conducted between the confluence of Damdochax Creek at the Nass River and the outlet of Damdochax Lake (Fig. 3). Four Damdochax tributaries: Sansixmor, Slowmaldo, Yaza and Wiminasik creeks were also surveyed by helicopter on one or two occasions during the suspected peak of spawning at these locations (Table D-2).

Five ground surveys were conducted of Damdochax Creek between the outlet of Damdochax Lake and the confluence of Slowmaldo Creek (reaches 4 and 5, Fig. 3) from 10 August to 16 September 1992 (Table 5). This section of the stream contained the majority of spawning activity and was difficult to survey accurately from the air. Large numbers of fish were present in a relatively short stretch of stream. The stream channels were narrow, the water was turbulent and the helicopter frightened some fish both ahead of and behind the helicopter. It was difficult to count fish moving downstream among previously counted fish and to determine whether upstream moving fish were counted twice. Fish were difficult to see in turbulent water and other fish were under stream banks or tree branches where they could not be seen from the air. Consequently, the ground surveys conducted in these reaches obtained more accurate counts of chinook than could be obtained from aerial surveys.

For reaches 1-3, which are between Slowmaldo Creek and the Nass River, the aerial count was the best estimate. Initially, this section was surveyed on foot and from a raft. These survey techniques were unsuitable for counting fish in this area. This reach is characterized by wide (up to 20 m), slow moving channels and deep holes. Chinook were difficult to see when they were in deep water and more than 8 m to the side of the surveyor.

We estimated the total number of live fish in Damdochax Creek on each survey date as the sum of the ground counts for reaches 4 and 5 and the aerial counts for reaches 1-3 (i.e., we assumed an observer efficiency of 100% when we used the best survey technique).

Cranberry/Kiteen Rivers: The escapement to the Cranberry and Kiteen rivers was estimated using a mark-recapture method based on the number of radio-tagged fish tracked to these rivers and the overall radio-tagging rate for chinook in the Nass River system (see Analytical Techniques).

Initially, aerial surveys were conducted of the Cranberry River to count live fish. The counts were to be used to estimate the escapement using the AUC method. However, the Cranberry River was too muddy and deep to make accurate counts from the air. Because of the poor survey conditions, we reduced our survey effort, but we continued the surveys to determine the number of radio-tagged fish present and to obtain minimum counts of the numbers of fish present during each survey.

The Cranberry River was surveyed by helicopter at intervals of 6-9 d from 26 July to 2 September 1992 (Tables 5, D-2). Visual counts of chinook salmon were obtained from four surveys conducted on 13, 19 and 25 August and 2 September. The river was usually surveyed from its confluence with the Nass River to Weber Creek (approximately 60 km upstream, Fig. 4). For more detailed descriptions of the sections of the river surveyed on each date see Appendix Table D-2.

The Kiteen River was surveyed by helicopter on 13 and 19 August to determine the number of radio-tagged fish in the river and to obtain a minimum estimate of the number of chinook present. The mainstem Kiteen River was surveyed from its confluence with the

Cranberry River to Cohead Creek (approximately 38 km upstream, Fig. 4). The lower 8 km of Stenstrom Creek, a tributary of the Kiteen River, was surveyed on 19 August.

Kwinageese River: The escapement to the Kwinageese River was estimated using the mark-recapture method, the number of radio-tagged chinook in the Kwinageese system, and the mark rate obtained from examining carcasses in that system.

A wooden fish weir was also used to enumerate chinook salmon returning to the upper Kwinageese River. In addition, aerial and ground surveys were conducted to estimate the minimum number of fish spawning above and below the weir and ground surveys were conducted to examine carcasses for tags.

The weir was located on the Kwinageese River 4 km downstream of Fred Wright Lake (Fig. 1); it was operated from 17 July to 23 September 1992. The purpose of the weir was to enumerate migrating sockeye and chinook salmon. The weir was framed with 5 X 10 cm lumber (2" X 4") and covered with 2.5 cm X 2.5 cm (1") wire mesh. A trap (pen) was installed along the weir near the west bank of the river. Initially, fish were trapped, sampled and released upstream. On 30 July, an electronic tunnel counter was installed on the upstream end of the trap. This counter was used for most of the remainder of the project to estimate the number of fish passing the weir. Chinook were reluctant to pass through the counter. Therefore, when build-ups of chinook were observed below the weir, fish were allowed to pass (bypass counts) by removing one 1.2 X 1.2 m panel from the centre of the weir. Fish were visually counted as they passed.

Periodic visual counts (index counts) were made of the fish using the tunnel counter in order to determine the proportions of chinook and sockeye that passed through the tunnel counter and to derive a correction factor to adjust machine counts to actual counts. The index counts were conducted for periods of 1 to 4 h at intervals of 1 to 4 d. The time of day that index counts were made was varied to include all hours of the day. The number of chinook using the tunnel counter was then estimated based on the corrected electronic counter tally and the estimated proportion of chinook using the counter. The proportions used to estimate the daily chinook passage were determined by pooling the results from index counts conducted over 7 d. To estimate the number of chinook using the counter each day within the stratum, the average proportion from the 7-d period was multiplied by the corrected electronic counter tally. The biases associated with these estimates are discussed later with the presentation of the escapement estimate.

The Kwinageese River was surveyed by helicopter from its confluence with the Nass River to Fred Wright Lake at intervals of 4-13 d from 4 August to 15 September 1992. Radio tracking was conducted on 11 aerial surveys and visual counts of chinook were obtained from six of these surveys (Table 5). Shanalope Creek, a tributary of the Kwinageese River, was surveyed by helicopter on 18 and 26 August and 2 September. Additional information on the aerial surveys can be found in Table D-2.

Three complete ground surveys were conducted along the stretch of the Kwinageese River between the weir and Fred Wright Lake from 3 to 15 September and one partial ground survey was conducted below the weir on 22 August to count live fish and to examine carcasses for the presence of tags. In addition, the weir crew examined carcasses opportunistically while conducting sockeye studies (Table D-4). Chinook carcasses that drifted up against the weir were also examined for the presence of radio tags.

Meziadin River: The escapement to Meziadin River was estimated using the mark-recapture method, the number of radio-tagged fish tracked into Meziadin River, and the overall Nass River mark rate. The Meziadin fishway count provided a minimum estimate of the number of chinook salmon spawning above the fishway.

The Meziadin fishway is a vertical slot fishway. It was built in 1964 and its location, structure and operation are described in Southgate et al. (1988). Its primary purpose is to allow returning salmon to bypass a partially impassable series of waterfalls.

The fishway was operated by the Department of Fisheries and Oceans from 16 July to 5 October 1992; during this period, it was closed to fish passage when observers were not present so that all fish passing through the fishway could be counted. Salmonids passing through the fishway were counted as they swam through one of two counting chutes. A glass-bottom box was floated on the surface of the water inside the chute to provide good visibility into the water. All passage was done during daylight hours and the duration of the periods of passage depended on the numbers of fish that were present in the fishway.

Chinook salmon were identified as either adults or jacks and enumerated. Adult chinook were distinguished from other species (sockeye, coho and pink salmon and steelhead trout) and from chinook jacks (< 50 cm) primarily by their size. Chinook jacks were distinguished from other species by the number and patterns of their spots. Radio-tagged and spaghetti-tagged chinook salmon were enumerated and allowed to pass through the counting area.

A total of 13 radio-telemetry tracking flights were conducted over the Meziadin River at intervals of 1-9 d from 26 July to 24 September (Table 5). Some of these (2) were overflights where we did not systematically survey Meziadin River, but they provided data on an unknown fraction of the fish present at the time of the overflight. Visual counts were conducted from the helicopter on the 4 and 18 August and 6 September surveys.

Bell-Irving River: The escapement to the entire Bell-Irving River system was estimated using a mark-recapture estimate based on the number of radio-tagged fish tracked into the Bell-Irving River and the overall radio-tagging rate for chinook salmon in the Nass River system. To estimate the contributions of individual tributaries of the Bell-Irving River to the overall Bell-Irving escapement, separate mark-recapture estimates were also derived for all tributaries where radio-tagged fish were found (however, we did not survey all tributaries of the Bell-Irving River). In addition, the escapement contributions by the tributaries that were surveyed are minimum estimates because some fish that were recorded in the main river may have entered tributaries before, between or after our few surveys of the system.

A fixed-station receiver with three directional antennas was placed at the junction of the Nass and Bell-Irving rivers (FS9, Fig. 1) to record all radio-tagged fish passing this location and to distinguish fish entering the Bell-Irving River from those continuing up the Nass River. In addition, aerial tracking, aerial visual surveys and ground surveys were conducted on the Bell-Irving River and selected tributaries to determine the distribution of the tagged fish and to obtain minimum estimates of the escapement to the major spawning areas within the watershed.

The Bell-Irving system was surveyed by helicopter on 18 and 20 August and 5 and 6 September. Ground surveys were conducted on 23 and 29 August and 5 and 6 September. For details of these surveys see Appendix D.

Upper Nass Mainstem: The escapement to the upper Nass River (above Cranberry River) mainstem and minor tributaries was estimated using the mark-recapture method and was based on the number of radio-tagged fish recorded along the mainstem of the upper Nass River and the overall radio-tagging rate for chinook in the Nass River system. This estimate accounted for small numbers of chinook salmon that were spread throughout this part of the river system and that spawned either on or near the main river. Only a few of the many smaller tributaries that are included in this overall estimate were actually surveyed; Muskaboo, Kotsinta and Saladamis creeks were the tributaries surveyed.

Other sections of the mainstem and adjacent tributaries were surveyed opportunistically by helicopter from 13 July to 24 September. In addition, movements of some radio-tagged fish were monitored by the fixed stations.

Muskaboo Creek: The escapement to Muskaboo Creek was estimated using the count of fish observed during a single aerial survey of Muskaboo Creek on 17 August. The creek was visually surveyed and concurrently surveyed for radio tags from its headwaters to the Nass River (approximately 25 km).

Kotsinta Creek: The escapement to Kotsinta Creek was estimated using the count from a single aerial survey of Kotsinta Creek on 3 September. The creek was surveyed from its confluence at the Nass River to a large waterfall approximately 5 km upstream.

Saladamis Creek: A single aerial survey of Saladamis Creek was conducted on 27 August. The creek was surveyed from its confluence with the Nass River to approximately 4 km upstream.

Lower Nass Mainstem: The escapement to the lower Nass River (below Cranberry River) mainstem was estimated using the mark-recapture method and was based on the number of radio-tagged fish recorded along the mainstem of the lower Nass River and the overall radio-tagging rate for chinook in the Nass River system. This estimate may include a few fish that spawned in small tributaries adjacent to the Nass River.

Sections of the mainstem of the lower Nass River were surveyed opportunistically by helicopter from 13 July to 24 September and the section from Grease Harbour to Fishery Bay (Fig. 2) was surveyed weekly by boat from 13 July to 15 September.

Lower Nass Tributaries: The escapement to the lower Nass River (below Cranberry River) tributaries was estimated using the mark-recapture method and was based on the number of radio-tagged fish recorded in all of the lower Nass River tributaries and the overall radio-tagging rate for chinook in the Nass River system. This estimate may include a few fish that spawned on the mainstem Nass River, but that moved into a tributary for a short period of time and were tracked while in the tributary.

Estimates for individual tributaries were also made using the mark-recapture method, but we have less confidence in the individual estimates than in the overall estimate because the tagging effort of lower river fish appears to have been over-represented among the early arriving fish (primarily Seaskinnish and Tchitin systems) and under-represented among the late arriving fish (Tseax River and Slough). The recapture rate in the tributaries is also low and the estimates for each tributary are, therefore, less reliable than the pooled estimates.

Tchitin River: The escapement to the Tchitin River was estimated using a mark-recapture estimate based on the number of radio-tagged fish tracked into the Tchitin River and the overall radio-tagging rate for chinook in the Nass River system. The Tchitin River was surveyed by helicopter on 4 and 18 August from its confluence with the Nass River to approximately 18 km upstream. We systematically searched for radio-tagged fish and made visual counts on both surveys. In addition, radio-tagged fish were recorded during numerous ferry flights from Nass Camp to Meziadin Lake and during surveys of the mainstem of the Nass River near the Tchitin River.

Seaskinnish Creek: The escapement to the Seaskinnish Creek was estimated using a mark-recapture estimate based on the number of radio-tagged fish tracked into the Seaskinnish Creek and the overall radio-tagging rate for chinook in the Nass River system. It was also estimated indirectly as part of the entire lower river. We conducted six aerial telemetry surveys of Seaskinnish Creek from 19 August to 24 September, and an aerial count was also made during the 19 August survey. A foot survey was conducted on 28 August of the lower and middle section of the river as far upstream as the falls.

Tseax River and Slough: The escapement to the Tseax system was estimated using the mark-recapture method, but the last survey was conducted too early to detect some of the spawning fish that may have entered this system after our surveys were terminated. We conducted five aerial telemetry surveys of Tseax River and Slough from 14 August to 24

September. Peak spawning was in early October. We attempted to visually count fish during the 19 August survey, but turbid water made enumeration from the air ineffective.

Other Lower Nass Tributaries: Single aerial surveys were conducted of Kwinatahl, Zolzap, Anudol and Ksedin systems on 14 August. The delta of Anudol Creek was surveyed a second time by helicopter on 26 August. Shumal Creek was surveyed from the confluence of Nass River to 12 km up the creek on 10 September. Visual and telemetry surveys were conducted concurrently on all five systems.

Other Systems: The fish entering several of the tributaries on the lower Nass River would not have been radio tagged, or would have been tagged at a rate that was lower than their contributions to the Nass River escapement, because they were below the tagging sites. Two of these rivers, the Ishkeenickh and Kincolith rivers, were surveyed. Our escapement estimates for these rivers were obtained by dividing the actual counts by the estimate of observer efficiency. No escapement estimates could be made for the other systems.

Ishkeenickh River: The Ishkeenickh River enters the Nass River 25-30 km downstream of the closest radio-tagging site at Sandy River (Fig. 2). Ishkeenickh River fish were not subjected to the same tagging rate (i.e., few or no Ishkeenickh fish would have passed our tagging sites) as were the stocks that spawned farther up the Nass River. Therefore, we were unable to calculate a mark-recapture estimate based on our radio-tag data.

The escapement to the Ishkeenickh River was estimated using a single aerial count of live fish obtained on 14 August. The river was surveyed from its confluence with the Nass River to approximately 55 km upstream. Telemetry was conducted concurrently with the aerial count during the 14 August survey.

Kincolith River: The Kincolith River flows into the Portland Inlet 40 km downstream of the closest radio-tagging site (Fig. 2); therefore, for the reasons stated above, we were not able to use our radio-tag data to calculate escapement to this system. The escapement to the Kincolith River was estimated using a single aerial count of live fish obtained on 14 August. The river was surveyed from its mouth to approximately 60 km upstream. Telemetry was conducted concurrently with this survey.

ANALYTICAL TECHNIQUES

The analytical techniques used to estimate the Nass River chinook salmon escapement based on the data gathered during field surveys are outlined below. Table 4 summarizes which of these techniques were used to determine the escapement to each of the tributaries of the Nass River.

AUC Estimation

We estimated the escapement to Damdochax Creek using the area-under-the-curve (AUC) technique. The AUC technique is a method used to convert periodic counts of mature salmon into an estimate of the total escapement (Ames and Phinney 1977; English et al. 1992). Point estimates of fish abundance over time are connected by a contour line to form an escapement curve. The escapement estimate is obtained by dividing the area under the escapement curve (*auc*) by the stream residence time (*rt*). The stream residence time is the average period of time that fish spend in the survey area.

Escapement Curve: In this study, we used counts of live fish obtained from periodic aerial and ground survey counts to estimate the number of live fish in Damdochax Creek. Unless otherwise noted, we estimated the total number of live fish as the sum of the ground counts for the upper two reaches and the aerial counts for the lower three reaches.

The point estimates of the numbers of live fish (survey counts) were joined to form the escapement curve. The curve was temporally bounded by the date that fish first entered the survey area and the date that no live fish remained in the area. These two dates were estimated by extrapolating the ascending and descending slopes of the escapement curve beyond the first and last survey dates, respectively. The first two and last two data points were used to calculate the slopes of the ascending and descending slopes. For Damdochax Creek, the curve was extended 5 d before the first survey date and 5 d after the last survey date.

Residence Time: We used two methods to estimate the stream residence time (*rt*). The first method uses data from radio-tagged fish that were recovered during carcass surveys. The dates when these tagged fish entered Damdochax Creek were recorded by a fixed-station receiver (FS7, Fig. 3) positioned at the entrance to the stream. The dates that the recovered fish died were estimated during the carcass examinations that were conducted during ground surveys. The residence time for each fish was the difference between these two dates and *rt1* was the mean residence time for all fish. In the second method, stream residence time (*rt2*) was estimated as the interval between peak live and peak dead counts. Both techniques are reviewed in Perrin and Irvine (1990).

AUC Escapement Estimate: The area under the escapement curve (*auc*) was calculated using the equation from English et al. (1992):

$$auc = 0.5 \cdot \sum_{i=2}^{n} (t_i - t_{i-1}) \cdot (p_i + p_{i-1}) \tag{1}$$

where t_i is the number of days since the first fish entered the survey area, *n-2* is number of surveys, and p_i is the number of live fish present in the stream on the i^{th} day.

The AUC escapement estimate was obtained using the equation:

$$ESC = auc \cdot rt^{-1} \tag{2}$$

where rt is the stream residence time derived from the $rt1$ or $rt2$ method described above.

Originally, it was our intent to obtain AUC estimates for the Cranberry River. Unfortunately the Cranberry River was very turbid during most of the 1992 spawning period and we could not obtain accurate counts of live fish. The estimates of observer efficiency at the end of each survey ranged from unknown-but-low to 30-80% (Table D-2). On surveys, conducted on 25 August and 2 September, the surveyor was so uncertain of his efficiency that he could not quantify it.

The aerial counts of fish in the Cranberry River did, however, allow us an opportunity to independently verify the "reasonableness" of the adjusted Petersen estimate derived from the radio-tag information. To do this, we made the assumptions that fish in the Cranberry River had the same residence time as did the fish in Damdochax Creek, and then calculated the observer efficiency that would have been necessary on the aerial surveys in order to derive an AUC estimate comparable to the adjusted Petersen estimate.

The surveyor was confident that the observer efficiency on all surveys was less than 100% because the visibility into the water was poor. Thus, we can assume that not all fish were seen. If the calculated observer efficiency (using the method described above) was higher than 100%, this exercise would provide evidence that the adjusted Petersen estimate was an underestimate.

If the calculated observer efficiency was similar to what the surveyor had estimated, it would provide some additional confidence in both methods. If the calculated observer efficiency was much lower than the surveyor had estimated, the exercise would suggest either that some of the assumptions about fish distribution or residence times were wrong or that the adjusted Petersen estimate was an overestimate.

<u>Mark/Recapture Estimation</u>

Chinook escapement for the entire Nass River system and individual tributaries, where intensive carcass surveys were conducted, were estimated using the adjusted Petersen estimate from Ricker (1975):

$$N = \frac{(M+1) \cdot (C+1)}{R+1} \qquad \textbf{(3)}$$

where N is the population estimate, M is the number of tagged fish in the river system as determined by radio telemetry surveys and fixed-station receivers, C is the number of fish examined for tags during ground surveys in that system, and R is the number of tags recovered in the sample C.

For tributaries that were not intensively surveyed to determine tag rates, we prorated the remainder of the total Nass escapement estimate (i.e., total escapement estimate minus tributary specific estimates) using the portion of the total radio tags tracked to each tributary.

Where appropriate, the 95% confidence limits for the Petersen estimate were calculated by replacing the number of recoveries (R) in formula (1) with the fiducial limits taken from the Poisson distribution (p 79, Ricker 1975). The fiducial limits of R were obtained by substituting R for χ in Appendix II of Ricker (p 343, 1975).

Stratification of Data: Stratification of population estimates by stock and sub-stock (e.g., by tributary or by age and/or sex within tributaries) components can often reduce the potential for systematic biases (Bocking et al. 1991). Fish from different stocks may have passed our tagging sites at different times and consequently fish from different stocks may have been tagged at different rates. The data on the timing of movements of fish from different stocks suggest that this should not have been a serious source of bias for the stocks that moved up the river beyond Grease Harbour (see RESULTS - Upstream Movements).

Nevertheless, we minimized these biases by analyzing the data from different stocks separately whenever we had more than five tag recoveries during carcass examinations in a system.

The problem of accurately enumerating chinook jacks was largely avoided by the size limitations associated with the radio tagging. Jacks were defined as those chinook less than 50 cm in fork-length. Since radio tags could not be applied to any chinook less than 72 cm, no jacks were tagged. Consequently, our population estimates only represent adult chinook.

We were unable to stratify by sex because the sex of many of the tagged individuals was uncertain. It was difficult to determine the sex of the tagged fish at the lower-river tagging sites where the fish had only recently left the ocean. Fish were often silver-bright and secondary sexual characteristics, like a kype or a ridged back, had not developed.

Mark-Recapture Assumptions: Biases in Petersen estimates can occur when the principal assumptions of the estimation procedure are violated (p. 81-82, Ricker 1975). The relevant assumptions are:

1. The marked fish suffer the same natural and fishing mortality as the unmarked fish;
2. The marked fish are equally vulnerable to the recapture technique as are the unmarked fish;
3. The marked fish do not lose their marks;
4. The marks are applied randomly over the entire run; and/or marked fish become randomly mixed with the unmarked fish; and/or the recovery effort is proportional to the number of fish present in different reaches of the system; and
5. All marks are recognized and reported on recovery.

Our assessment of the validity of each of these assumptions is presented below (see DISCUSSION).

RESULTS

RADIO TAGGING

Tagging Success

Radio tags were placed in 360 chinook salmon during 1992. Tagging was conducted over a period of 3.5 months from 15 May to 29 August (Appendix A) but 89% of the fish (320) were tagged during a 5-w period from 13 June to 17 July 1992 (Table 6). Thirteen chinook were tagged in the upper section of the Upper Stratum (Greenville bridge to Grease Harbour) of the Nisga'a fishery area during May using a combination of set and drift nets to capture fish. Drift fishing was the most efficient method of capturing chinook during that period. From mid-to-late June set nets in the lower section of the Upper Stratum (primarily at Sandy River) were used to catch and tag fish until the fishwheels started to catch chinook starting the week of 20-26 June. From this period onward, virtually all of the tagged fish were caught in the fishwheels which were near Gitwinksihlkw (the middle section of the Upper Stratum, Fig. 2).

The number of active radio tags during each week was less than the total number of chinook that had been tagged to that date because fish were caught, fish died due to predation or handling, tags were regurgitated, or tags stopped transmitting. Table 7 shows the number of tags that we estimated were transmitting at the end of each period and could have been picked up during our surveys. A high proportion (50%) of the fish that were tagged in May and early June were removed from the list of active tags before they reached their destination; all but one of these were removed by 16 June.

<u>Tracking Summary</u>

During this study we obtained almost one million individual records of chinook salmon locations. These data were condensed to 4,149 records of chinook salmon locations (excluding recapture information and a few records of fish recorded more than once and at different locations on the same day) that were unique to fish, date and tracking method (Table 8). About half (47%) of the unique records were obtained from our fixed-station receivers and the other half (53%) from mobile tracking. As the fish moved up the main river, different tracking methods became important for documenting the movements. During June and early July, most fish were tracked from the boat, and as the fish moved up the river most tracking was done by the fixed-station receivers. Finally, as fish arrived on the spawning areas, most fish were tracked by helicopter and ground surveys.

Fate of Tagged Fish: We were able to determine the spawning destinations of 81% (291) of the 360 fish that were tagged (this was 98% of the 296 fish with active tags that escaped in-river fisheries, Table 9). Five other fish were alive and active, but we could not determine a spawning destination for them; one fish was moving up the Nass River north of Meziadin River on 24 September, two fish were tagged late in the study (12 and 24 Aug) and had not moved into their spawning areas, one fish appeared to be a non-spawner and the status of the last fish could not be determined. Seventeen radio-tags were returned from mainstem fisheries, 16 from Nisga'a net fishermen and one from an angler.

The fate of the 47 remaining radio tagged fish is not known for certain, but 24 tags were tracked at the location for several weeks. We suspect that 18 of these fish regurgitated their tags (11 at tagging sites and seven as a result of being caught by in-river net fisheries), and six fish died (tags were stationary, but not adjacent to a known fishing site). Our assessment of the fate of the remaining 23 tags was based on the movement patterns that were recorded for those tags; 10 were suspected to have been removed by native (nine) and sport fisheries (one); 10 were never tracked and may have been defective tags; and three tags stopped transmitting at sites upstream of the known fisheries (Table 9). Of the 16 tags suspected to have been removed by native fisheries, 10 were last tracked at fishing sites above Nass Bridge.

Up-river Movements: When the water levels declined in early July the fish from all stocks moved up-river together (Fig. 5).

Up-river movements were rapid and no particular stock seemed to lead or lag the general movement (Fig. 6 and 7). Most of the fish moving up-river by each of our fixed-station receivers passed a particular station over a period of about 10 d. Some of the fish that are shown to the far right on each panel in Figures 6 and 7 are fish that returned down river to spawning locations after migrating further upstream. Fishwheel data indicate that the peak movements of chinook past Gitwinksihlkw were from 24 June to 13 July. During this period there was a 4-d hiatus from 30 June to 3 July when rising water levels curtailed chinook migration (Fig. 5). This high-water event resulted in two distinct peaks of migration (27 June and 6 July).

Peak movements past FS1 were on 11 and 15 July, but the hiatus observed on the lower river was less pronounced at FS1 (Fig. 6). Rates of movement between these stations were 1-1.5 km/d (Table 10). By the time that the peak movement arrived at FS3 on 19 July the two distinct pulses of fish that were observed at Gitwinksihlkw had consolidated into one pulse. The average rate of movement increased to 5.7-6.5 km/d. After chinook passed FS3 their rates of movement increased to 8-18 km/d (Table 10). Single peaks of movement were observed at FS8, FS9, FS5 and FS7.

Fish that were entering a tributary that was a spawning destination tended to remain at the junction of that tributary and the mainstem Nass for a longer time than those continuing up the mainstem (Table 10). In addition, fish that overshot their destination tributary spent more time at each of the upstream tributary junctions than they did at downstream junctions. This latter observation results from fish passing the upstream junctions twice; once as they moved upstream and once as they returned downstream to their destination tributary.

Destinations: We were able to determine spawning destinations for 291 of the chinook that we radio tagged. The most important spawning tributaries were the Bell-Irving system (72 tags, 25%), Cranberry/Kiteen system (59 tags, 20%), Damdochax system (56 tags, 19%), Kwinageese (32 tags, 11%) and Meziadin River (26 tags, 9%; Table 9). Except for the large number of tags in the Bell-Irving system, these estimates are within the ranges of historical escapement proportions (Table 1).

Fish that were tagged on the lower river both early and late in the season were almost exclusively lower-river fish; whereas, those tagged during the main part of the run from mid-June to mid-July included all of the stocks.

Aerial Survey Efficiency: Efficiencies of aerial surveys from Damdochax Creek and Cranberry River range from 47-96% based on the number or radio-tags recorded during complete surveys of the systems versus the number of radio-tags known to have entered the system (Table 11). These efficiency estimates do not consider fish that may have temporarily left the system or radio tags that stopped transmitting; thus, these estimates may underestimate the true efficiency. In addition, most of these surveys were conducted secondary to visual counts and survey conditions were not always optimal.

Spawning-area Residence Time: The radio tags also permitted us to document the arrival date of individual fish into tributaries such as Damdochax Creek. A fixed-station receiver at the confluence of the Nass River and Damdochax Creek permitted us to determine the date and time when a radio-tagged fish entered, and in a few cases, left Damdochax Creek. When a radio-tagged fish was recovered and its date of death was estimated we were able to estimate the residence time of that fish in the system (Table 12). The departure date of a few live fish was also determined from the fixed-station data, but these fish are not included in Table 12. Female and male chinook salmon spent an average of 25.3 and 30.4 d, respectively, in Damdochax Creek before they died or left. These residence times were not significantly different (t=1.66, P=0.109).

Spaghetti-tagged Chinook

A total of 74 chinook salmon that were not needed for the radio-tagging component of the study were spaghetti-tagged at the fishwheels between 8 July and 13 August (Table A-5). Three, one, and two tags were recovered on Damdochax Creek, on Cranberry River, and at Meziadin River (one from the fishway and one from a sport fisherman), respectively. In addition, two spaghetti tags were counted, but not recovered, from chinook passing through the Meziadin fishway. Table A-5 summarizes the number of tags applied and the recoveries by area.

FIELD SURVEYS AND ESCAPEMENT ESTIMATES

A total of 56 aerial visual, 155 aerial telemetry (including the visual surveys), 16 ground count and 20 carcass recovery surveys were conducted from 13 July to 24 September 1992. The chinook escapement field survey effort and the radio-tracking effort are summarized in Table 5 and Appendix D. The Meziadin fishway (16 July to 5 October) and the Kwinageese weir (17 July to 23 September) were staffed for 82 and 67 d, respectively (Appendix E).

The majority of fish visually counted were seen in three systems (Damdochax, Kwinageese and Cranberry). The peak counts of live fish from combined aerial and ground surveys for these three systems were 2,175, 1,659 and 1,490, respectively (Table 13). The dates, survey conditions, aerial and ground counts, estimates of observer efficiency, and reach descriptions for the escapement field surveys are provided in Appendix D. Damdochax Creek was the most intensively and frequently surveyed area with seven aerial and five ground surveys conducted from 4 August to 16 September. The counts obtained during field surveys and the derivation of escapement estimates for each system that was surveyed are described below.

Damdochax Creek

Field Surveys: Damdochax Creek was divided into five reaches to stratify the survey counts and to monitor the upstream migration (Fig. 3). Counts of holding, spawning and total live chinook salmon for each of these reaches are given in Table 14 for each of the eight survey dates. The total counts of live chinook salmon (escapement curve) for all of Damdochax Creek and the counts of dead chinook for reaches 4 and 5 are plotted in Figure 8. Table 15 summarizes the live counts from the tributaries of Damdochax Creek which include Slowmaldo, Yaza, Sansixmor, and Wiminasik creeks. Table D-2 contains dates, survey conditions, aerial and ground counts, estimates of observer efficiency and reach descriptions for all visual surveys conducted on Damdochax Creek in 1992.

The peak estimate of live chinook salmon in Damdochax Creek was 2,175 on 21 August; this estimate was obtained from the ground survey count for reaches 4 and 5 and the aerial survey count for the remainder of the stream (Table 14). The peak aerial count of live chinook salmon in Damdochax Creek occurred on 27 August, when 2,090 fish were seen from the air (Table D-2), but the total live count was revised downward to 2,041 based on ground counts of reaches 4 and 5. The peak total count of chinook (2,199) was on this date when 158 dead chinook where counted. Peak counts of 1,495 holding fish, 923 spawning fish, and 617 dead fish (only reaches 4 & 5 were systematically surveyed for dead fish) were recorded on 10 August and 3 and 10 September, respectively (Tables 14 and D-3).

The spawning activity in Damdochax Creek exhibited two distinct, spatially and temporally separated peaks. For reaches 1-3, peak spawning activity occurred on 21 August when a total of 375 spawning fish were observed. For reaches 4 and 5, the peak occurred on 3 September when 809 spawning fish were observed (Fig. 8).

The spawning activity in Slowmaldo and Yaza creeks (tributaries of Damdochax Creek) appeared to occur earlier than the spawning activity in reaches 1-3 of Damdochax Creek. There were approximately 10 abandoned redds seen during the 17 August survey and the 16 live fish that were observed appeared to be in an advanced stage of spawning (i.e., fish had worn and discoloured tails and patches of fungus on the body).

The spawning activity in Wiminasik Creek appeared to be later than that observed in Slowmaldo and Yaza creeks. The peak count in Wiminasik Creek was on 26 August when 33 spawning fish were observed during a ground survey (M. Galesloot, Triton Environmental Consulting Ltd., Richmond, BC, pers. comm.)

It is uncertain whether or not chinook salmon spawned in Sansixmor Creek during 1992. It was surveyed once on 17 August; only one holding chinook was seen. The fish was 0.5 km upstream from the confluence of Sansixmor and Damdochax creeks.

A total of 56 radio-tagged chinook salmon were tracked to Damdochax Creek. Three of these were subsequently tracked to Slowmaldo Creek and one to Wiminasik Creek. A total of 1,382 adult chinook carcasses were examined for radio and spaghetti tags; most of these were in reaches 4 and 5 of Damdochax Creek, but a few fish (21) were examined in reach 3 on 3 September. A total of 23 radio tags and three spaghetti tags were recovered from carcasses. The peak carcass count was on the 10 September ground survey when 617 fish were examined for tags (Table D-3).

The observer efficiency during four aerial surveys of reaches 4 and 5 averaged 100% and ranged from 75 to 117% (Table 16). This assumed that the ground survey counts on the same date were the true counts.

The residence time estimated from the peak live count (21 August) and the peak dead count (10 September) was 20 d (Fig. 7). This was 29% less than the radio-tag-derived estimate of 28 d (Table 12).

Escapement Estimate: We calculated the escapement to Damdochax Creek to be 3,268 and 2,348 using the AUC technique and a stream residence time of 20 and 28 d, respectively. For the same area and using the carcass recovery data, we calculated an adjusted Petersen estimate of 3,054, with 95% confidence limits of 2,071 and 4,699 (Table 17). These bounds include the AUC estimates based on both estimates of residence time. For the entire Damdochax system we calculated an adjusted Petersen estimate of 3,283 with 95% confidence limits of 2,227 and 5,053.

Cranberry/Kiteen Rivers

Field Surveys: The turbid water in the Cranberry River made surveying from the air difficult in 1992. The visibility into the water was good when the first visual survey was conducted. By 19 August, the water had become cloudy and fish could not be seen in water deeper than 1.5 m. After the 19 August survey, the visibility into the water deteriorated further and only fish in shallow water (0.2 m) could be seen during the final survey on 2 September.

The peak visual count of chinook salmon on the Cranberry River was obtained on 19 August when 1,490 fish were recorded (Table 18). It is difficult to determine the precise timing of peak abundance because the poor visibility into the water disproportionately affects the counting of holding and spawning fish. Holding fish are in deeper water and, therefore, are more difficult to see than spawning fish.

Despite the biases noted above, the field survey data suggest that there were at least two temporal components to the spawning activity in the Cranberry River in 1992. When upper Cranberry River (upstream of the last logging bridge and upstream of Weber Creek) was surveyed on 13 August, numerous (>20) abandoned redds were observed and 128 of the remaining 133 live fish that were counted in this reach were classified as spawning. In addition, these fish were predominately lone males indicating that spawning activity was near completion. By 19 August, there were only 88 live fish observed in the same area, in comparison to 133 recorded the previous survey. Spawning activity in this upper reach contrasts sharply with that in the lower reaches of the Cranberry (downstream of the last logging bridge) where nearly 2.5 times more fish (1,490 vs 590) were seen on the 19 August survey than on the 13 August survey. This higher count on 19 August was made despite poorer visibility into the water because the turbidity had increased between the two surveys (Table D-2).

The aerial counts for the Kiteen River were 64 and 55 chinook for the 13 and 19 August surveys, respectively (Table D-2). The visibility into the water was limited on both surveys (<1.5 m) and made complete enumeration difficult. All fish observed during both surveys were classified as spawning, suggesting that spawning activity peaked on or before mid-August; this agrees with L. Jantz (DFO, Prince Rupert, B.C., unpubl. data) that the peak of spawning activity on the Kiteen River occurs during mid-August.

A total of 59 radio-tagged chinook entered Cranberry River (Table 9) based on data from the fixed-station receiver at the mouth of Cranberry River (FS3, Fig. 1) in combination with data from aerial telemetry surveys. Of these 59 fish, nine were subsequently tracked in the Kiteen River.

Escapement Estimate: Our minimum escapement estimates for the Cranberry and Kiteen rivers are 1,493 (1,490 live chinook counted on 19 August, plus three dead fish counted on 13 August and 64 on 13 August), respectively (Table 20). Both estimates are based on the counts after the completion of the sport fishery that occurred in July.

All radio-tagged fish that entered the Cranberry/Kiteen system were used to calculate the mark-recapture estimate. Thus, the estimate includes fish that were caught in the sport and native fisheries within the system. We calculated a single mark-recapture estimate for the entire system because some fish that were caught by sport fisherman were removed before they had a chance to enter Kiteen River. The net escapement to the Cranberry/Kiteen system was calculated by subtracting the sport fishery harvest of 556 chinook (Bocking and English 1993) and suspected native harvest of 122 fish (based on radio-tag tracking) and native fisheries within the system from the mark-recapture estimate of 3,603 (Table 20). Therefore, the net escapement estimate to the Cranberry/Kiteen system was 2,925.

We calculated separate mark-recapture estimates for the number of fish that entered Cranberry and Kiteen rivers, but we were unable to determine what proportion of each stock was represented among the radio tags that initially entered the system because of the removal of some Kiteen River fish before they reached the Kiteen River. The net escapement to Kiteen may be reflected in the prorated mark-recapture estimate (550) because most fish that were tracked in the Kiteen had already made it past the sport fishery. However, the extent of the sport fishery biases among our data are not known. Assuming that the mark-recapture estimate represents escapement to the Kiteen River, then escapement to Cranberry was 2,375 (3,603 less 550 less 678). This estimate may be low because some of the sport fishery catch was from the Kiteen.

To independently verify the validity of the mark-recapture estimate derived for the Cranberry River, we calculated the observer efficiency that would have been required during the aerial surveys to generate an AUC estimate similar to the mark-recapture estimate. Table 19 shows a series of AUC escapement estimates based on a range of mean residence times. Assuming a mean residence time of 28 d, an observer efficiency of approximately 45-50% was necessary across the four surveys to derive an AUC escapement estimate of 2,400 (Table 19). Given the turbid water conditions in the Cranberry River during most of the summer in 1992, it would be reasonable to expect this level of observer efficiency.

Kwinageese River

Field Surveys: The Kwinageese weir was operated from 17 July to 24 September in 1992. The adjusted electronic and visual counts of fish passing through the weir are presented in Tables E-2 and E-3. These data have been provided by Triton Environmental Consultants. Figure 9 shows the estimated daily counts of chinook salmon passing through the weir based on bypass and index counts and estimates extrapolated from index and electronic counts.

A total of six aerial count surveys, 11 aerial telemetry surveys, and four ground surveys were conducted on the Kwinageese River in 1992 (Table D-2). The peak count was made on 2 September when 1,659 live (1,354 above and 289 below the weir; 16 in Shanalope Creek) and 20 dead chinook were recorded (Table D-2). A total of 32 radio-tagged fish were tracked in the Kwinageese River; 23 moved above the Kwinageese weir, and nine remained below the weir.

Shanalope Creek, a tributary of the Kwinageese River, was surveyed three times (Fig. 1, Table D-2). Chinook salmon (primarily spawning fish) were observed in the first kilometre upstream of the mouth of the creek; seven, 21 and 16 fish were observed on 18 August, 26 August, and 2 September, respectively.

Escapement Estimate: The minimum estimate of the chinook escapement to the Kwinageese system (including Shanalope Creek) of 1,684 and is based on counts made during the 2 September (Kwinageese River) and 26 August (Shanalope Creek) aerial surveys. The minimum escapement estimate for above the weir is 1,354 based on the live count from the 2 September survey. The minimum escapement estimate for the area below the weir is 330 based on counts of live and dead fish during the same aerial survey below the weir and the 26 August survey of Shanalope Creek.

Triton Environmental Consultants, Richmond, BC (unpubl. data) derived an estimate of the chinook escapement above the weir on Kwinageese River using data obtained at the weir. The estimate is 1,799 adult fish and is composed of 686 chinook salmon observed passing through the bypass panel (includes fish sampled for length and scales and released alive above the fence) and 1,113 chinook estimated to have gone through the electronic counter when it was not staffed (Table E-2) and is based on actual counts of only 88 chinook during index counts (Table E-3).

We also calculated an adjusted Petersen estimate using our carcass recovery data from Kwinageese River and the total number of radio tags known to be in the system. This estimate is 2,132 adult chinook salmon; 600 and 1,532 of these were estimated to be below and above the weir, respectively. The 95% confidence limits of the overall estimate were 1,260 and 3,850.

We used the mark-recapture estimate based on the radio-tag data as the best estimate of chinook escapement to the Kwinageese River (2,132, Table 21) because of potential biases in the estimates from the weir (see Discussion).

Meziadin River

Field Surveys: The fishway was staffed and operated from 16 July to 5 October (82 d), including the start and end date. During this time, 870 adult and 85 jack chinook salmon were enumerated (Table E-1). Daily counts of adult and jack chinook at the fishway are presented in Figure 1. Although chinook were recorded moving through the fishway from 19 July to 2 October, 43% of the 870 adult chinook moved through the fishway during a 4-d period from 27-30 July and 63% were counted during a 11-d period from 26 July to 5 August.

A total of 13 telemetry and three visual surveys by helicopter were made of the Meziadin River (Table 5). A peak count was made on 6 September when 292 chinook were counted above and 40 chinook were counted below the fishway. Of the 292 fish observed above the fishway, 142 were holding and 150 were spawning (Table D-2). In addition, 30 chinook carcasses were counted above the fishway. All 40 fish observed below the fishway were spawning.

Surprise, Strohn and Hanna creeks (tributaries of Meziadin Lake) were surveyed by helicopter (visual and telemetry surveys were conducted concurrently) once in 1992. Surprise and Strohn creeks were surveyed on 14 August and Hanna Creek was surveyed on 18 August. Except for poor visibility into Surprise Creek, survey conditions were good and no chinook salmon were observed and no radio-tagged fish were detected.

Escapement Estimate: We derived a minimum estimate of the chinook escapement to Meziadin River of 910, based on the 870 fish through the fishway and the 40 fish observed spawning below the fishway during the 6 September aerial survey (Table 21).

We derived a prorated adjusted Petersen escapement estimate of 1,588 chinook based on the radio-tag data; 73% of these fish were estimated to have spawned above the fishway. This is our best estimate of the total escapement to the Meziadin River in 1992 (Table 21).

Bell-Irving River

Field Surveys: A total of 72 radio-tagged chinook were tracked moving toward a destination in the Bell-Irving system either by the fixed-station receiver located at the junction of the Bell-Irving and Nass Rivers or by surveys conducted in the system. The distribution of these tagged fish within the watershed was determined by four aerial and four ground surveys (Table D-2). All but seven radio-tagged fish that entered the Bell-Irving River were subsequently tracked to a specific spawning area.

The spawning destinations of radio-tagged fish in the Bell-Irving watershed are summarized in Table 20. The majority of the fish that were visually counted in the Bell-Irving watershed were observed in Teigen and Oweegee creeks where peak visual counts were 476 (475 live, 1 dead) and 450 fish, respectively. In addition, 40 and 12 radio-tagged fish were recorded in Teigen and Oweegee creeks. The remainder of the fish that were visually counted in the Bell-Irving watershed were observed in the mainstem of the Bell-Irving River (peak count of 58 fish), Snowbank Creek (29), Taft Creek (18), and Hodder Creek (5). In addition to Teigen and Oweegee creeks, radio-tagged fish were found in the mainstem of the Bell-Irving River (14) and Taft Creek (6). All systems that were surveyed except Teigen and Oweegee creeks were turbid and the fish that were counted probably represent a fraction of those that were present.

All of the fish that were observed in Snowbank and Teigen creeks on 18 August (first survey) were spawning and it appeared that the peak of spawning activity had occurred previous to the survey. By the 5 September survey, the die-off was nearly complete and only 45 fish were seen. The timing of the spawning activity in 1992 was earlier than historical data (L. Jantz, DFO, Prince Rupert, B.C., unpubl. data). These data suggest the following timing of activities for chinook in Teigen Creek: arrival in early August (mid-August for Teigen); start of spawning in late August; peak spawning in early September; and die-off in late September.

Spawning activity of chinook was later in Oweegee Creek than in Teigen and Snowbank creeks. During all surveys, including the last survey on 6 September, the majority of fish were holding (Table D-2). On the 20 August survey, only three of the 450 fish that were observed were spawning. The timing of spawning activity in Oweegee Creek in 1992 was similar to historical data (L. Jantz, DFO, Prince Rupert, B.C., unpubl. data). However, low water levels and log jams on Oweegee Creek during August, may have delayed the spawning activity in Oweegee Creek in 1992. Mature fish were observed holding in deep holes in the lower 200 metres of the stream and extremely heavy bear activity was seen throughout the creek. Most live fish found upstream of the delta of Oweegee Creek showed signs of bear predation (scrapes) and the few carcasses that were encountered were pre-spawn mortalities due to bear predation.

Survey conditions were poor for aerial surveys of Taft, Rochester, and Hodder creeks and we were unable to assess the stage of spawning activity. The visibility into Taft and Rochester creeks was severely limited (<0.2 m) and the tree canopy covered much of Hodder Creek.

Escapement Estimate: We determined the minimum escapement to the Bell-Irving watershed to be 1,036 based on the peak live counts from the field surveys conducted on 18 and 20 August (Table 20). The prorated adjusted Petersen estimate of escapement to the entire Bell-Irving watershed was 4,397 adult chinook based on the 72 radio-tagged fish tracked to the watershed and the overall Nass adjusted tag rate. Based on the different tag recovery rates recorded in different tributaries, the range of escapement estimates is 4,161 to 4,667 adult chinook salmon (Table 20).

The minimum escapement estimates for Teigen/Snowbank, Oweegee, Bell-Irving, Taft, and Hodder (based on visual surveys) were 505, 450, 18 and 5, respectively. Our best estimates for Teigen/Snowbank, Oweegee, and Taft based on the prorated mark-recapture data were 2,443; 733; and 366, respectively (Table 20).

The 14 radio-tagged chinook that were assigned to the mainstem included all fish that were detected in the Bell-Irving River, but not in any of its tributaries. Although we know that these fish spawned in the Bell-Irving watershed, we are unable to conclusively identify a final spawning location for many of these fish from the data collected during this study. Some spawning fish were observed on the Bell-Irving mainstem (33 of 58 counted on 20 August, but due to the limited survey effort, we could not determine if some of the radio-tagged fish present in the mainstem were headed to a tributary or if they had spawned in a tributary and subsequently dropped back into the mainstem. Given that much of the spawning activity appeared to have been completed in Teigen and Snowbank creeks, the latter scenario is quite possible. The 14 tagged fish represent an estimated 855 fish that may have spawned in the mainstem, any of the tributaries mentioned above or in streams not surveyed.

Upper Nass Mainstem

The Upper Nass Mainstem includes the mainstem Nass River from the Cranberry River mouth upstream to the headwaters and all minor tributaries along this section of the Nass River where fish were observed within 1-2 km of the river.

With the exception of the systems listed below, none of these areas were surveyed to obtain visual counts of chinook salmon. However, virtually all of the mainstem and adjacent tributaries as far north as Panorama Creek were surveyed for radio tags while we were transiting between survey areas, fixed stations, or fuel caches; thus most if not all, radio-tagged fish were present in this area were detected.

Six radio-tagged fish representing 366 chinook had spawning destinations in the Upper Nass Mainstem area. If the different tag rates observed in the different tributaries are used, rather than the overall rate, the estimates range between 347 and 389 fish (Table 20). Based on our visual and telemetry surveys, these fish were dispersed throughout the system in small groups.

Upper Nass Tributaries

Muskaboo Creek: A single aerial survey of Muskaboo Creek was conducted on 17 August. The survey conditions were moderate (visibility into the water approx. 0.5 m) and six fish were observed spawning in the lower 100 m of the stream. All of these fish were very large (> 16 kg) and appeared to be nearing completion of spawning. No radio-tagged fish were tracked in Muskaboo Creek, but the helicopter speed was too fast for efficient recording of radio tags. In addition, this area was north of our normal travel corridor so that radio tags could not be recorded during incidental surveys.

We estimated the minimum escapement to Muskaboo Creek as six fish. This count is likely an underestimate due to the relatively poor water visibility. There is no evidence, other than the observation of six spawning fish, about the timing of spawning activity in Muskaboo Creek.

Kotsinta Creek: A single aerial survey to conduct visual counts of Kotsinta Creek was conducted on 3 September. In addition, the lower portion of the creek was tracked opportunistically several times while the tracking aircraft was flying to and from Damdochax Creek (Fig. 1). Survey conditions were good on 3 September and 10 live and one dead fish were observed in the lower 0.5 km of the stream (Table D-2). In addition, eight abandoned redds were observed and the remaining live fish were predominately lone males. The spawning activity appeared to be near completion.

No radio-tagged fish were tracked during the 3 September survey, but one was tracked in Kotsinta Creek on 21 and 27 August while the survey crew was transiting to and from Damdochax Creek.

We estimated the minimum escapement to Kotsinta Creek as 12 fish based on the 10 live, one dead and one radio-tagged chinook recorded on the 27 August and 3 September surveys (Table 20). This count is an underestimate of the true escapement because the survey occurred after the peak of spawning activity, the remaining live fish were lone males and the eight abandoned redds that were recorded indicate that females had been present.

Saladamis Creek: An aerial survey of Saladamis Creek was conducted on 27 August. The survey conditions were good and no live fish, carcasses or signs of fish (redds) were observed (Table D-2). In addition, no radio-tagged fish were detected.

Lower Nass Mainstem

The Lower Nass mainstem includes the mainstem Nass River from Lakalzap to the mouth of the Cranberry River and all minor tributaries in this portion of the river where fish may have spawned within 1-2 km of this section of the main river. This area was surveyed opportunistically during surveys throughout the 1992 field season. No fish were observed in the mainstem of the Nass River. The river was very turbid and visibility into the water was usually less than 20 cm. Six radio-tagged fish that were tracked only in the mainstem and are believed to have spawned in the lower Nass River. If we assume that the mark rate for this group was similar to that derived from surveys of upper river stocks, these six tags represent an escapement estimate of 366 fish (Table 20). This estimate is likely to be an underestimate of the numbers of chinook in the area because many of the fish destined for this portion of the river would not have been available for capture at our primary tagging site at Gitwinksihlkw. Therefore, the actual mark rate (tagged fish/untagged fish) for these chinook was probably much lower than that estimated from carcass surveys of upper Nass stocks.

Lower Nass Tributaries

The Lower Nass tributary category includes all major or moderately important spawning streams in the lower Nass River between Lakalzap and the Cranberry River. Each of these streams in discussed below.

The total number of chinook in the lower Nass tributaries was estimated by prorating the overall mark-recapture estimate (18,117 in Table 20) by the portion of the radio tagged fish tracked to all lower Nass tributaries. This estimate was 2,077 adult chinook with a range of 1,965 to 2,204 based on different tag rates from different up-river tributaries. These estimates probably underestimate the number of fish entering lower Nass tributaries for the same reasons provided for the lower Nass mainstem spawners.

The above estimates represents escapement prior to removals by sport fishermen. Bocking and English (1993) estimated that 630 chinook were caught by sport fisherman on Tseax River and Slough. Thus, the net escapement to the lower river systems would be 1,444 adult chinook.

Tchitin River: The Tchitin River was surveyed by helicopter twice to count chinook in and near the river (i.e., holding at the mouth of the river). In addition, fish were tracked on several occasions while the survey crew was transiting to other locations. Conditions for visually surveying the stream were poor during both aerial surveys; only three and seven fish were observed during the 4 and 18 August surveys, respectively (Table D-2). The six radio-tagged fish that were tracked to the Tchitin River represent a prefishery escapement of 366 adult chinook.

Seaskinnish Creek: Three systematic and three opportunistic aerial telemetry surveys were conducted of Seaskinnish Creek. A total of 145 live chinook was counted during an aerial count on 19 August and 91 live fish and 16 carcasses were counted during a partial ground survey on 28 August. Radio tracking was conducted on both of these surveys (Table D-2). Conditions for visually counting fish were poor on the aerial survey due to the overhanging tree canopy along much of the stream. The minimum escapement estimate to the Seaskinnish Creek was 145 adult chinook based on the peak count on 19 August. The best total escapement estimate is 916 based on the 15 radio-tagged fish tracked to Seaskinnish Creek.

Tseax River: Five telemetry surveys were conducted of Tseax River and Slough. A visual count was attempted on the 19 August survey, but turbid water made counting from the air impossible and no chinook were observed. Nine radio-tagged chinook were tracked into this system which produces an escapement estimate of 551 chinook for the Tseax River and Slough before the sport fishery harvest. However, the estimate was lower than the estimated sport harvest of 630 from this system (Bocking and English 1993), and is clearly an underestimate for this system. The peak of spawning in this system (early October) was 2-3 wk after termination of this study and three of the radio-tagged fish (2 south of Tseax River and one tagged 29 August that was not tracked) may have entered Tseax after termination of our surveys. In addition, many of the fish that spawn in Tseax arrive in the Nass River late in the summer and may not be represented among our radio-tagged fish. Historical data (L. Jantz, DFO, Prince Rupert, B.C., unpubl. data) identifies the Tseax system as having the latest spawning run of Nass River chinook stocks. Therefore, the Tseax stock is the most susceptible stock to biases associated with our reduced tagging rates late in the season.

Miscellaneous Nass Tributaries: No fish were seen during combined visual/telemetry surveys of Kwinatahl, Shumal, Zolzap, Ksedin and Anudol creeks, but visibility into the water was severely restricted in all creeks except Zolzap which was clear. In addition, telemetry surveys were conducted of the mouth of these creeks each week throughout the summer by boat. No fish were observed in any of these creeks during the study, but three radio-tagged fish were detected in Anudol Creek and at least two of them appeared to spawn there (Table D-2).

Other Systems

Ishkeenickh River: One aerial survey was conducted of the Ishkeenickh River on 14 August. Survey conditions were reasonably good and the surveyor estimated that his counting efficiency was 50-80% (Table D-2). A total of eight holding and 67 spawning fish were observed and no radio-tagged fish were recorded in the system. Approximately 12 abandoned redds were observed and most of the spawning fish were in an advanced stage of spawning. Typically, the spawning activity of Ishkeenickh River chinook peaks in late August (L. Jantz, DFO, Prince Rupert, B.C., unpubl. data).

Based on the predominance of spawning fish observed during the 14 August survey, there are three scenarios that could describe the spawning activity in 1992: 1) the survey was done during the peak of spawning activity and the total escapement was very low; 2) the peak of spawning activity had already occurred and higher numbers of fish were present earlier; or 3) an early component of the run was at or past the peak of its spawning activity and a second run of fish would arrive later that was not present during the survey. From the single aerial survey results we are unable to determine which of these scenarios is correct.

We estimated the minimum escapement to the Ishkeenickh River as 75 adult chinook and our best estimate as 115 fish (adjusted for 65% average observer efficiency), recognizing that it is still an underestimate because it represents only a single live count. This estimate does not include an estimate of the number of fish that entered the stream, spawned and died prior to the survey date (i.e., those that spawned in the abandoned redds) or an estimate of the number of fish that entered the stream after the survey date.

Kincolith River: One aerial survey of the Kincolith River was conducted on 14 August. Survey conditions were reasonably good and the surveyor estimated the observer efficiency at 80% (Table D-2). A total of 32 spawning fish were observed and no radio-tagged fish were recorded in the system. Numerous (>50) abandoned redds were observed and the 32 spawning fish were in an advanced stage of spawning. Typically, the spawning activity of chinook run to the Kincolith River peaks in mid-August (L. Jantz, DFO, Prince Rupert, B.C., unpubl. data). Based on the predominance of spawning fish and the numerous abandoned redds, it appears that in 1992 the peak spawning activity had already occurred by mid-August.

We estimated the minimum escapement to the Kincolith River as 32 adult chinook and our best estimate as 40 (adjusted for 80% observer efficiency), recognizing that this is definitely an underestimate because it represents only a single live count conducted after the peak spawning activity. This estimate does not include an estimate of the number of fish that entered the stream, spawned and died prior to the survey date and the observation of greater than 50 abandoned redds suggests that larger numbers of fish were present earlier.

Total Nass River

Our best estimate of the numbers of chinook arriving at spawning destinations in the entire Nass River system is 16,809 (i.e., total escapement to tributaries less tributary specific harvests) (Table 21) with 95% confidence limits of 11,000-27,000. Escapement estimates for Damdochax and Kwinageese were derived from tributary specific mark rates (Table 20). Escapement to other spawning areas were prorated based on the system wide mark rate (Table 20).

DISCUSSION

Initially, the major goal of this program was to confirm the locations of major spawning areas for Nass River chinook stocks and collect information on in-river run timing. As the program developed, it became apparent that the combination of fisheries projects conducted in 1992 (fishwheels, fishway counts, weir counts and aerial surveys) could provide the data required to compute escapement estimates for all major chinook salmon stocks within the Nass watershed. In most areas, our best estimate is based entirely or partially on radio-tag tracking and a Petersen mark-recapture design. The mark-recapture design is not subject to many of the biases that were present in the methodologies. The biases present in the escapement methods used during this study are discussed below.

AUC ESTIMATES

An evaluation of the potential biases in each of the estimates made using different methodologies permits us to determine which estimate is most likely to represent the actual escapement. Two estimates are used to calculate AUC. The first is the number of fish present in the system and the second is the mean residence time of each fish. During this study we attempted to count the number of fish during each survey and used the method that we believed would give the most accurate count. However, we did not expand our counts to take into account fish that were not recorded by the observer because they were under stream banks or trees, in deep holes where fish were difficult to see, or because the observer did not see or count them. Numerous studies have been conducted concerning the biases involved in aerial and ground surveys and the consensus is that counts always underestimate the number of individuals present. Even for constantly visible large terrestrial species only 30-90% of animals present were counted by single observers during aerial surveys (Caugley 1974). The degree of underestimation varies according to a large number of environmental factors and the experience of the observer (Eberhardt et al. 1979). The observer that conducted the surveys (Michael Link) was very experienced so that the biases were likely minimized. However, all counts were underestimates of the total number of fish present. Link estimated his efficiency to have been 80% or less during the aerial surveys conducted 10-27 August when peak numbers of chinook salmon were counted in Damdochax Creek.

The estimates of residence time from the peak-live to peak-dead counts (based on visual counts) are subject to large errors because surveys are conducted about 4-7 d apart and considering the above-mentioned biases in individual count the actual peak live abundance may not be the apparent peak live count. For example, the observer efficiency during the 17 August aerial survey was estimated to be 50-80%, whereas the observer efficiency on 21 August (peak count) was 80%. Thus the peak abundance may have been on or near 17 August and the residence time based on peak-live to peak-dead counts could be 24 d.

The residence time determined from the combined telemetry and carcass recovery data should be less biased than those obtained from the count data. Since the exact time of arrival in the survey area is known and the date of death is estimated to within 1-3 d.

KWINAGEESE RIVER

One would normally expect counts obtained from a weir to provide an accurate estimate of escapement. However, in this case there were several factors that reduce the reliability of the estimates from the weir data. The index counts used to verify electronic counts and species composition only represented 8% of the fish passing through the counter. We were not given the statistical bounds around the species composition data, but suspect that they are large because fish movements were not steady but pulsive in nature. Another potential source of bias was the identification of jack chinook. M. Galesloot (Triton Environmental Consulting Ltd., Richmond, BC, pers. comm.) indicated that the counts of chinook included only adult fish because they were not able to distinguish jack chinook from other small salmonids. Some of the technicians working on the weir also worked on other studies with us and had no problems distinguishing jack chinook from other species. Thus it is possible that some jacks are included among the chinook counts and that the number of adult chinook is overestimated because their calculations include some jacks. This bias would be low because jacks made up only 9% of chinook that passed through the Meziadin fishway (Table E-1) and at most some fraction of the 9% of all chinook that were jacks might have been included in the total count of chinook.

MEZIADIN FISHWAY ESTIMATES

We used the actual counts of fish through the fishway as the minimum escapement estimate. These counts underestimate the true escapement because: 1) some fish bypassed the fishway by jumping over the falls; 2) some fish may have moved through the fishway before it was staffed; and 3) some fish may have moved through the fishway when it was left open after break-ins.

There is a falls adjacent to the entrance of the fishway that is believed to be impassable to most fish. This falls is approximately 65 m wide and varies between 1.5 and 5.0 m in height. During the salmon migration, numerous fish are seen jumping at the base of the falls and occasionally salmon are observed jumping over the falls (Stephan Jacob, LGL Limited, Sidney, BC, pers. comm.). The proportion of chinook that jumps over the falls has never been estimated, but it is believed to be small.

The fishway was left open and was not staffed from the autumn of 1991 until 16 July 1992. In 1992, chinook were first documented on the lower river in late April. There is a possibility that some chinook may have passed through the fishway before it was staffed. However, the first chinook salmon counted through the Meziadin fishway was on 19 July and only 18 chinook had been counted before 23 July. In addition, radio-tagged chinook were not detected at FS8 (just below Meziadin River) until 18 July although the station had been operating since 7 June (see Fig. 6 later). Based on this information, we believe that very few, if any, chinook passed through the fishway before it was staffed.

There were two instances between late July and early October, when vandals broke into the fishway during the day, probably took fish (primarily sockeye) from the holding pens below the counting chutes and left the gates open until the staff returned 1 to 2 h later (D. Southgate, DFO Prince Rupert, pers. comm.). We examined counts before and after the break-ins and determined that few chinook were likely to have passed through the fishway during these periods so we did not adjust the escapement estimate.

MARK-RECAPTURE ESTIMATES

Biases in Petersen estimates can occur when the principal assumptions of the estimation procedure are violated (p. 81-82, Ricker 1975). The relevant assumptions and how our study attempted to meet and/or test their validity are outlined below.

1. *The marked fish suffer the same natural and fishing mortality as the unmarked fish.*

The tagging and natural mortality rates can be estimated from the data. All but 10 of 360 radio-tagged chinook salmon were tracked and/or accounted for subsequent to release. There was a manufacturing flaw in a circuit in some of our tags that caused some tags to stop transmitting shortly after application. Based on the observed failure rate of tags that had not been applied, we believe that all or most of these 10 tags stopped transmitting. The major source of mortality among the radio-tagged fish was capture during the in-river net and sport fisheries. From the extensive tracking surveys, it was possible to monitor the behaviour of the tagged fish and to determine their mortality rate. We were also able to determine or guess at the causes of mortality of many of the radio-tagged fish for which the exact cause of death was unknown. For example, a few fish disappeared during late July in the vicinity of Nass Bridge (where the road to Alice Arm crosses the Nass River). Although no tags were returned by fisherman in this area, we suspect that most of these fish were caught by sport and native fishermen.

We assumed that any early mortality of radio-tagged fish was the result of tagging. Once fish had survived for more than a week we assumed any further mortality was due to natural causes or fishing. Studies of the effects of implanting ultrasonic tags in juveniles fish indicate that they recovered quickly (<4 h) and permanently (permanently was 1-4 wk in their study) if the tags were less than 5% of the body weight of the fish (Moser et al. 1990). During our study, tags were much less than 5% of the weight of the fish and only one radio-tagged fish (0.3%) died within a few days of being tagged. It was assumed to have died as a result of capture and handling.

The effects of any early tag mortality on the escapement estimates were eliminated by the data analysis methods that were used; only tagged fish that entered a specific stream were used in the estimation procedure. By the time that fish had entered their respective spawning streams, they had travelled for 2 to 10 wk and over distances of 20 to 300 km. Once the tagged fish had survived this upstream migration, we assumed that their mortality rate would be similar to unmarked fish. This seems reasonable given that only 1% (5 of 360) of the tagged fish died of unknown causes before they arrived at their spawning destinations and they died 3-8 wk after release.

2. *Marked fish and unmarked fish are equally vulnerable to the recapture technique.*

In this study, all of the recoveries came from carcass examinations. During ground surveys all dead fish were examined for tags. Since the operculum tag and transmitter antenna were not obvious unless the fish was examined quite closely, this recapture technique was non-selective. Other enumeration efforts at Meziadin fishway provided good estimates of chinook passage, but few observations of radio-tagged fish. Because our radio-tagged fish did not have conspicuous marks, it is likely that some radio-tagged fish passed the observers without being detected. Therefore, mark rate data from the Meziadin fishway counts have not been used in determining mark rates.

3. The marked fish do not lose their marks.

This assumption can be tested using our data and any biases can be reduced or eliminated. Radio-tagged chinook were marked with two tags, a radio transmitter and an operculum tag. We examined each carcass carefully for both tags. Surveyors opened the mouth of each carcass, peered down the throat and looked behind each operculum for the radio-transmitter antenna. The outside of the operculum was scraped clean with the sharp end of a fish pew and examined closely for a tag scar (which was readily apparent, if present). Thus our marked fish would have been identified even if they lost both tags.

The only form of tag loss that would affect our escapement estimates were tags that stopped transmitting. We suspect that a maximum of 15 of the 360 radio tags applied may have stopped transmitting shortly after release. One of these fish was recovered in the Damdochax system. If these tags had functioned properly and been tracked to a spawning stream they would have increase our total escapement estimate. Since 81% of the other radio-tagged chinook were tracked to spawning areas it is possible that 12 of these fish were not detected during spawning ground surveys. This would result in the total escapement number being underestimated by 732 fish (4.3%).

4. The marks are applied randomly over the entire run; and/or marked fish become randomly mixed with the unmarked fish; and/or the recovery effort is proportional to the number of fish present in different reaches of the system.

The best evidence that the radio tags were applied over the entire run comes from surveys of Damdochax Creek. Visual counts and radio-tag tracking data obtained from 7 surveys support the assumption that tagging was proportional to the run at least for this tributary (Figure 10). Migration timing data from the fishwheels indicated that most of the chinook run migrated upstream between 13 June and 17 July when 89% of the radio tags were applied. Analysis of daily recovery data from the Meziadin fishway for sockeye tags released from the fishwheels indicated that the fishwheels were catching a consistent portion of the total sockeye run during this period (Link et al. 1996). This information coupled with the observation that all stocks appeared to migrate together in 1992 (Fig. 5) supports the assumption that marks were applied randomly over the entire run.

This assumption is further supported by the potential for marked fish to mix with the unmarked population. The radio tags were applied to fish between 10 and 270 km from the spawning grounds, a distance that required 2-3 wk of travel time, and spawning was 2-10 wk after the fish were tagged. We believe this was sufficient time and distance for fish to have become randomly mixed.

Finally, we examined our data to determine if tagging was representative of all stocks by comparing marked-to-unmarked ratios among different tributaries. The marked-to-unmarked ratios for Damdochax and Kwinageese based on carcass examinations were 1:58 and 1:65, respectively. Thus it appears that marked-to-unmarked ratios at the two up-river locations were similar. We do not have sufficient data to compare marked-to-unmarked ratios of lower river stocks. However, lower river stocks may have been over-represented by tagging efforts in May and June and under-represented by tagging efforts in late July to September. Overall lower river stocks were probably under-represented, but made up a relatively small proportion of the overall run in 1992.

5. All marks are recognized and reported on recovery.

We did not re-examine carcasses for missed tags to test this assumption. However, the surveyors were very experienced at doing carcass recovery work and ample time was allocated to examining carcasses. Furthermore, because surveyors looked for two tags on each fish (radio and operculum tags), they were unlikely to overlook both tags.

CAPTURE METHODS

The proportion of fish that were tracked to their spawning destination did not appear to depend on the method of capture when all factors are considered. Seventy-five of 100 (75%) fish tagged from nets were tracked to their destination in comparison to 216 of 260 (83%) fish tagged from the fishwheels. However, 11 net-caught radio-tagged chinook were removed by the in-river net fishery or because the tags stopped transmitting by 25 June when the fishwheels started to catch chinook. Thus, 75 of 89 (84%) net-caught fish that were still active on 25 June were tracked to their spawning destination.

RUN TIMING

Data collected from the Meziadin fishway over the past 25 years provides a clear indication that the 1992 run began very late. The late beginning at Meziadin was compensated for by very high abundances moving up-river during the peak of the run such that the portion of the run passing through the fishway after the end of July was consistent with the 25 year mean. The compressed run timing in 1992 was probably caused by extremely high water during mid-to-late June and early July.

HARVEST RATES

Harvests of chinook salmon by the major in-river gillnet and sport fisheries were estimated during other studies. In-river and estuary gillnet fisheries harvested an estimated 7,100 chinook between Gingolx and Grease Harbour (English and Bocking 1993) and sport fisheries harvested 1342 chinook, primarily from the Cranberry and Tseax rivers (Bocking and English 1993). We estimated that the first nations fishery above Grease Harbour harvested 612 chinook, based on the disappearance of 10 radio tagged fish that were last tracked near known fishing sites within this portion of the river. Therefore, we estimated the total return to the river in 1992 to be roughly 26,000 chinook (Table 21). Based on this run size estimate, the Nisga'a in-river gillnet fishery harvested 27% of the fish that entered the Nass River. The sport fishery harvested only 5% of the total run, but harvested a much higher proportion of the Cranberry-Kiteen and Lower Nass stocks. The sport fishery rates were estimated at 11% (556 catch from a pre-fishery escapement of 5158 chinook) in the Cranberry-Kiteen and at 22% (630/2890) on the Lower Nass stocks.

The in-river net fishery harvest rate was modest given that the fishery was unregulated in 1992. The harvest rates would probably have been larger had river conditions in June been more favourable for fishing. The sport fishery harvest rates are the first rigorous estimates for this system. In the Cranberry-Kiteen watershed, we have no reason to suspect biases in either the catch or escapement estimates. The sport catch estimates appear reasonable, given the high level of effort expended on the Cranberry River in 1992, and the migration timing for this stock suggests that it was probably marked at a rate proportional to the up-river stocks. The same cannot be said for the Lower Nass stocks. The Tseax River is generally believed to support a large and later run chinook population. Given the timing of the peak sport fishery harvests on the lower Tseax (late August) it is possible that this run returned to the river later than the other stocks and was marked at a much lower rate. Therefore, it is likely that we have underestimated the escapement to Tseax and thus overestimated the sport and first nations fishery harvest rates for Lower Nass stocks.

ACKNOWLEDGEMENTS

The success of this study was a tribute to the hard work and diligence of a large number of people through the study initiation, planning, conduct and analysis stages. We thank the staff of Nisga'a Tribal Council and especially Harry Nyce for his support and encouragement throughout this program. R. C. Bocking, the IMP program manager, planned most of the peripheral studies that contributed data to this study and ably and efficiently coordinated all of the 1992 field programs.

P. Wainwright, R. Frith, C. Fleek, and T. Nelson assisted in data analysis or preparation of the report. R.C. Bocking and the members of the Pacific Stock Assessment Review Committee, particularly J. Eiler and B. Riddell, reviewed the report and made comments that improved it.

The radio tags and tracking equipment were provided by Lotek Engineering. Jim Lotimer and Ron Batton made the conduct of this study possible, despite our last-minute commitment to the radio-tagging component of the project. Cam Grant and Stewart Strathearn provided excellent technical support that maximized data collection from the radio-tagged fish. Ted Bjornn, Ken Tolotti and Rudy Ringe of the Idaho Cooperative Fish and Wildlife Research Unit graciously provided us with knowledge of the radio-tag tracking systems capabilities and their methods of collecting and processing data. Ian Swan of

Northern Mountain Helicopters piloted the helicopter during most flights and was ably replaced by Blair Savage.

Everyone working on the IMP project in 1992 contributed to the success of this study and we thank them all. Special contributions were made to the radio-tagging and tracking component by Richard Alexander, Clyde (William) Azak, Jennifer Azak and Terry Morven and to the escapement surveys by Courtney Fleek, George Gosnell, Jr., Carl Johansen, Arthur Nyce, Stephen Nyce, Brenda Nass, Dean Ryan, Leonard Squires and Barry Stevens.

Funding for this project was provided by the Canadian Government as part of the Nisga'a - Canada Interim Measures Program.

REFERENCES

Ames, J. and D. E. Phinney. 1977. 1977 Puget Sound summer-fall chinook methodology: escapement goals, run size forecasts, and in-season run size updates. Wash. Dep. Fish. Tech. Rep. No. 29:1-71.

Bocking, R.C. and K.K. English. 1993. Nass River sport fishery catch monitoring program, 1992. Report NF92-05 prepared by LGL Limited, Sidney, B.C., for Nisga'a Tribal Council, New Aiyansh, B.C.

Bocking, R.C. 1991. Abundance, age, size, sex and coded-wire tag recoveries for chinook salmon escapements of Campbell and Quinsam Rivers, 1989-1990. Can. Manuscr. Rep. Fish. Aquat. Sci. 2124:1-109.

Caughley, G. 1974. Bias in aerial survey. J. Wildl. Manage. 40:921-933.

Donaldson, I. J. and F. K. Cramer. 1971. Fishwheels of the Columbia. Binfords and Mort, Portland, Oregon. 124p.

Eberhardt, L. L., D. G. Chapman and J. R. Gilbert. 1979. A review of marine mammal census methods. Wildl. Monogr. No. 63:1-46.

English, K. K. and R. C. Bocking. 1993. Nisga'a catch monitoring program, 1992 Nisga'a fishery. Report NF92-03 prepared by LGL Limited, Sidney, B.C. for Nisga'a Tribal Council, New Aiyansh, B.C.

English, K. K., R. C. Bocking, and J. R. Irvine. 1992. A robust procedure for estimating salmon escapement based on the area-under-the-curve method. Can. J. Fish. Aquat. Sci. 49:1982-1989.

Godfrey, H. 1968. Ages and physical characteristics of maturing chinook salmon of the Nass, Skeena and Fraser Rivers in 1964, 1965 and 1966. Fish. Res. Board Can. Manuscr. Rep. 967:1-38.

Healey, M. C. 1983. Coastwide distribution and ocean migration patterns of stream- and ocean-type chinook salmon, *Oncorhynchus tshawytscha*. Can. Field-Nat. 97:427-433.

Healey, M. C. 1991. Life history of chinook salmon (*Oncorhynchus tshawytscha*). *In*: C. Groot and L. Margolis (eds), Pacific Salmon Life Histories, UBC press, Vancouver. 564 p.

Link, M. R., K. K. English and R. C. Bocking. 1996. The 1992 fishwheel project on the Nass River and an evaluation of fishwheels as an inseason management and stock assessment tool for the Nass River. Can. Manuscr. Rep. Fish. Aquat. Sci. 2372: x+ 82 p.

McGregor, A. J., P. A. Milligan and J. E. Clark. 1991. Adult mark-recapture studies of Taku River salmon stocks in 1989. Alaska Dep. Fish Game Tech. Fish. Rep. 91-05. 73p.

Meehan, W. R. 1961. Use of a fishwheel in salmon research and management. Trans. Amer. Fish. Soc. 90:490-494

Milligan, P. A., W. O. Rublee, D. D. Cornett and R. A. C. Johnston. 1985. The distribution and abundance of chinook salmon (*Oncorhynchus tshawytscha*) in the Upper Yukon River Basin as determined by a radio tagging and spaghetti tagging program: 1982-1983. Can. Tech. Rep. Fish. Aquat. Sci. No. 1352:1-161.

Moser, M. L., A. F. Olson and T. P. Quinn. 1990. Effects of dummy ultrasonic transmitters on juvenile coho salmon. Amer. Fish. Soc. Symp. 7:353-356.

Perrin, C. J., and J. R. Irvine. 1990. A review of survey life estimates as they apply to the area under the curve method for estimating spawning escapement for Pacific salmon. Can. Tech. Rep. Fish. Aquat. Sci. 1733:1-49.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Board Can. 191:1-382 p.

Southgate , D. R., M. J. Jakubowski, V. L. Craig and A. L. Jantz. 1988. A review of the Meziadin River fishway biological program for 1987 and 1988. Can. Tech. Rep. Fish. Aquat. Sci. 739:1-79.

TABLES

Table 1. Estimates of chinook salmon escapement to the Nass River and its tributaries, 1982-91; 1982-88 data from Jantz et al. (1989); 1989-91 data from Jantz (pers. comm.). Annual totals assume zero escapement to systems not surveyed.

System	Escapement estimates[a]											10-year average[b]
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991		
Damdochax River	600	950	1200	1000	4000		2000	2000	1000	750		1500
Cranberry River	600	2000	3500	3000	6000	4000		3000	4500	550		3017
Kiteen River	30	50	200		500	500		300	400	150		266
Kwinageese River	750	500	500		2500	500	1500	4000	2000	800		1450
Meziaden River	500	550	700	599	900	550	772	900	900	600		697
Oweegee Creek	350	200	400	400		50	100			12		216
Snowbank Creek				50								50
Teigen Creek				200	100	75			12	5		78
Hodder Creek					15							15
Tchitin River	20	25	20						50	50		33
Seaskinnish Creek	250	400	300	700	200	200	200	50	175	100		258
Tseax River	500	900	2100	350	1000	850	850	1200	1000	200		895
Tseax Slough	100	200	500	300	250			200	100	25		209
Ishkeenickh River	200	1000	1200	600	300	250	250	175	400	67		444
Kincolith River	500	300	500	200	300	300	300	250	800			383
Nass Mainstem	500	500	500									500
Brown Bear Creek				3								3
Iknouk River	500	P	300		200	P			50			263
Total Nass River	5400	7575	11920	7402	16265	7275	5972	12075	11387	3309	8858[c]	10277

[a] Blanks indicate system was not surveyed (chinook presence unknown); P indicates chinook present but escapement not estimated.
[b] Excludes years when the system was not surveyed.
[c] Average of Total Nass estimated chinook escapements 1982-91.

Table 2. Summary of tangle net effort applied to catch chinook salmon for a radio tagging study on the Nass River, 13 May - 27 July 1992. Effort is presented as the number of hours spent attempting to catch and tag fish by capture method and by section of the Upper Stratum of the Nisga'a in-river fishery.

	Hours					
	Capture method		Section of the Upper Stratum[a]			
Week ending	Set net	Drift net	Lower	Middle	Upper	Total effort
15-May	23.0	3.0	0.0	3.5	22.5	26.0
22-May	20.0	4.5	0.0	0.0	24.5	24.5
29-May	2.0	11.5	0.0	0.0	13.5	13.5
05-Jun	0.0	0.0	0.0	0.0	0.0	0.0
12-Jun	1.5	13.0	0.0	13.0	1.5	14.5
19-Jun	24.0	0.0	20.6[b]	0.0	0.0	20.6
26-Jun	24.0	11.0	23.0	12.0	0.0	35.0
03-Jul	0.0	4.5	0.0	4.5	0.0	4.5
10-Jul	0.0	2.0	0.0	2.0	0.0	2.0
17-Jul	0.0	0.0	0.0	0.0	0.0	0.0
24-Jul	0.0	0.0	0.0	0.0	0.0	0.0
31-Jul	1.5	0.0	0.0	0.0	1.5	1.5
Total	96.0	49.5	47.0	35.0	63.5	145.5

[a] Upper section is from Grease Harbour to the outflow of Tseax Slough; Middle section is from the outflow of Tseax Slough to the outflow of Zolzap Slough; Lower section is below the outflow of Zolzap Slough (primarily at or near Sandy River).

[b] An additional 3.4 h were spent in the Lower Stratum (Ginlulak and Fishery Bay) during this period.

Table 3. Summary of radio tag tracking effort on the Nass River, 1992. Effort is presented as the number of days or part days that tracking was conducted using each method.

	Days													
	Mobile tracking				Mainstem stations							Tributary stations		
Week ending	Boat	Aerial	Truck	Foot	FS1	FS3	FS8	FS9	FS5	FS6	FS7	FS2	FSK	Total
15-May	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22-May	2	0	0	0	0	0	0	0	0	0	0	0	0	2
29-May	0	0	0	0	5	0	0	0	0	0	0	3	0	8
05-Jun	1	1	0	0	7	0	0	0	2	0	0	7	0	18
12-Jun	0	0	0	0	7	0	6	6	7	0	0	7	0	33
19-Jun	1	1	0	0	7	0	7	7	7	0	0	7	0	37
26-Jun	0	0	0	0	7	0	3	2	2	3	0	7	0	24
03-Jul	2	0	0	0	7	0	7	7	5	7	4	7	0	46
10-Jul	1	0	0	0	7	3	7	7	4	7	7	7	0	50
17-Jul	3	1	1	0	7	7	7	7	7	7	7	7	0	61
24-Jul	4	0	2	0	4	7	7	7	7	7	7	7	0	59
31-Jul	2	1	2	0	7	7	7	7	7	7	7	7	0	61
07-Aug	2	2	0	0	7	7	7	7	7	7	7	7	0	60
14-Aug	3	3	1	1	7	7	7	7	7	7	7	7	0	64
21-Aug	2	5	0	1	7	7	7	7	7	7	7	7	0	64
28-Aug	2	3	0	4	7	7	7	7	7	7	7	4	0	62
04-Sep	2	3	1	3	7	7	7	7	7	3	7	0	5	59
11-Sep	2	4	0	2	7	6	4	3	7	0	7	0	7	49
18-Sep	2	1	0	2	7	0	7	7	4	0	2	0	5	37
25-Sep	0	1	0	0	6	0	6	6	0	0	0	0	0	19
Total	31	26	7	13	120	65	103	101	94	69	76	91	17	813

Table 4. Survey methods and population estimation techniques used to estimate chinook salmon escapement to different tributaries of the Nass River, 1992.

System	Survey methods	Population estimation techniques [a]
Damdochax	aerial and ground counts; telemetry; carcass examinations	AUC; MR
Cranberry	aerial and ground counts; telemetry	MR; AUC
Kiteen	aerial counts; telemetry	MR
Kwinageese	fishweir counts, aerial and ground counts; telemetry; carcass examinations	fishweir count; MR
Meziadin	fishway counts; aerial counts; telemetry	fishway count; MR
Bell-Irving	aerial and ground counts; telemetry	MR
Taft	telemetry	MR
Snowbank/Teigen	telemetry; carcass examination	MR
Oweegee	telemetry; carcass examination; ground counts	MR
mainstem	telemetry	MR
Upper Nass Mainstem	telemetry	MR
Muskaboo	aerial counts; telemetry	visual count
Kotsinta	aerial counts; telemetry	visual count
Saladamis	aerial counts; telemetry	visual count
Lower Nass Mainstem	telemetry	MR
Lower Nass Tributaries	telemetry	MR
Tchitin	aerial counts; telemetry	MR
Seaskinnish	aerial and ground counts; telemetry	MR
Tseax	telemetry	MR
Others	aerial counts; telemetry	MR
Other Systems		
Ishkeenickh	aerial counts; telemetry	visual count
Kincolith	aerial counts; telemetry	visual count

[a] AUC = area under the curve; MR = mark-recapture

Table 5. Summary of aerial and ground survey effort to estimate chinook salmon escapement to the Nass River, 1992. Effort is presented as the number of days or part days that tracking was conducted using each method.

		Days			
Stream	Survey period	Aerial	Foot/fence	Carcass recovery	Telemetry [a]
Damdochax	4 Aug - 16 Sep	7	5	5	7
Sansixmor	17-Aug	1	0	0	1
Slowmaldo	17-Aug	1	0	0	1
Yaza	17-Aug	1	0	0	1
Wiminasik	17 Aug - 9 Sep	2	3	0	2
Cranberry	26 Jul - 2 Sep	4	1	1	7
Kiteen	13 Aug - 19 Aug	2	0	0	3
Kwinageese River	4 Aug - 15 Sep	6	2	3	11
Shanalope	26 Aug - 2 Sep	3	0	0	2
Kwinageese weir	17 Jul - 23 Sep	NA	67 [b]	6	NA
Meziadin River	26 Jul - 24 Sep	3	0	0	13
Meziadin fishway	16 Jul - 5 Oct	NA	82	0	NA
Bell-Irving					
Mainstem	18 Aug - 6 Sep	2	0	0	5
Oweegee	18 Aug - 6 Sep	2	3	3	4
Taft	20-Aug	1	0	0	1
Snowbank/Teigen	18 Aug - 6 Sep	2	1	1	3
Hodder	20-Aug	1	0	0	1
Others	20-Aug	2	0	0	1
Upper Nass Mainstem					
Muskaboo	17-Aug	1	0	0	1
Kotsinta	3-Sep	1	0	0	1
Saladamis	27-Aug	1	0	0	1
Others	13 Jul - 24 Sep	4	0	0	18
Lower Nass Mainstem	13 Jul - 24 Sep	0	0	0	42
Lower Nass Tributaries					
Tchitin	26 Jul - 24 Sep	2	0	0	11
Seaskinnish	19 Aug - 24 Sep	1	1	1	6
Tseax	14 Aug - 24 Sep	0	0	0	5
Others	14-Aug	4	0	0	5
Ishkeenickh	14-Aug	1	0	0	1
Kincolith	14-Aug	1	0	0	1
Total		56	165	20	155

[a] Includes partial and opportunistic surveys.
[b] No counts were made on 17 August and 10 September.
NA = not applicable

Table 6. Numbers of chinook salmon radio tagged on the Nass River, 1992. Numbers are summarized by method of capture and section of the Upper Stratum for weekly periods, 9 May - 29 September 1992.

Week ending	Capture method				Section of the Upper Stratum [b]			Total fish tagged
	Set net	Drift net	FW1	FW2	Lower	Middle	Upper	
15-May	1 [a]	0	0	0	0	0	1	1
22-May	2	2	0	0	0	0	4	4
29-May	0	8	0	0	0	0	8	8
05-Jun	0	0	0	0	0	0	0	0
12-Jun	1	7	0	1	0	9	0	9
19-Jun	23	0	0	0	19 (4) [c]	0	0	23
26-Jun	29	18	18	23	29	59	0	88
03-Jul	0	5	38	23	0	66	0	66
10-Jul	0	3	94	31	0	128	0	128
17-Jul	0	0	7	8	0	15	0	15
24-Jul	0	0	2	2	0	4	0	4
31-Jul	1	0	0	1	0	1	1	2
07-Aug	0	0	4	0	0	4	0	4
14-Aug	0	0	5	1	0	6	0	6
21-Aug	0	0	0	0	0	0	0	0
28-Aug	0	0	1 [a]	0	0	1	0	1
04-Sep	0	0	1	0	0	1	0	1
11-Sep	0	0	0	0	0	0	0	0
18-Sep	0	0	0	0	0	0	0	0
25-Sep	0	0	0	0	0	0	0	0
29-Sep	0	0	0	0	0	0	0	0
Total	57	43	170	90	48 (4) [c]	294	14	360

a - The first chinook was tagged on 15 May and the last chinook was tagged on 29 August.

b - Upper section of the Upper Stratum is from Grease Harbour to the outflow of Tseax Slough; Middle section is from the outflow of Tseax Slough to the outflow of Zolzap Slough; Lower section is below the outflow of Zolzap Slough (primarily at or near Sandy River).

c - These fish were in the Lower Stratum (below the Greenville bridge).

Table 7. Numbers of chinook salmon tagged and recovered during bi-monthly periods, 14 May - 15 September 1992.

Period	Number tagged	Inactive or stationary tags	Number recaptured[a] From period	Number recaptured[a] During period	Total active tags
1-15 May	1	0	1	0	1
16-31 May	12	6	1	1	6
1-15 Jun	9	1	2	2	12
16-30 Jun	177	16	10	1	172
1-15 Jul	140	5	7	5	302
16-31 Jul	9	1	1	12	298
1-15 Aug	10	3	1	1	304
16-31 Aug	2	1	0	0	305
1-15 Sep	0	0	0	1	304
Total	360	33	23	23	

[a] Excludes a small number of tags that were probably caught and not reported and a few tags that stopped transmitting during the season.

Table 8. Summary of numbers of chinook salmon tracked using different tracking methods during radio tagging studies on the Nass River, 1992. For each day, an individual fish that was detected is included only once for each tracking method.

	Mobile tracking				Mainstem stations							Tributary stations		
Week ending	Boat	Aerial	Truck	Foot	FS1	FS3	FS8	FS9	FS5	FS6	FS7	FS2	FSK	Total
15-May	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22-May	1	0	0	0	0	0	0	0	0	0	0	0	0	1
29-May	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05-Jun	1	0	0	0	0	0	0	0	0	0	0	0	0	1
12-Jun	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19-Jun	0	10	0	0	0	0	0	0	0	0	0	0	0	10
26-Jun	2	0	0	0	0	0	0	0	0	0	0	0	0	2
03-Jul	164	0	0	0	7	0	0	0	0	0	0	0	0	171
10-Jul	22	0	0	0	24	0	0	0	0	0	0	0	0	46
17-Jul	197	56	7	0	257	81	0	0	0	0	0	5	0	603
24-Jul	67	0	1	0	61	212	128	16	1	0	0	41	0	527
31-Jul	4	158	11	0	24	70	112	176	34	21	11	46	0	667
07-Aug	12	113	0	0	8	26	38	99	17	45	82	30	0	470
14-Aug	12	152	3	0	3	12	20	33	8	8	61	8	0	320
21-Aug	16	358	0	49	1	3	4	0	8	14	20	16	0	489
28-Aug	12	181	0	47	1	1	2	1	1	3	17	6	0	272
04-Sep	18	146	0	58	1	1	0	0	0	0	10	0	5	239
11-Sep	10	159	0	45	1	2	0	1	0	0	3	0	7	228
18-Sep	12	8	0	23	0	0	1	1	0	0	2	0	5	52
25-Sep	0	46	0	0	1	0	4	0	0	0	0	0	0	51
Total	550	1387	22	222	389	408	309	327	69	91	206	152	17	4149

Table 9. Destination or fate of chinook salmon that were radio-tagged on the Nass River, 1992.

System Tributary of system	Number of fish tracked		Percent of fish tracked to their destination	
Damdochax Creek	56		19.2	
Cranberry River	59		20.3	
Kiteen River		9		3.1
Kwinageese River	32		11.0	
Meziadin River	26		8.9	
Bell-Irving River (All)	72		24.7	
Taft Creek		6		2.1
Snowbank-Teigen Creeks		40		13.7
Oweegee Creek		12		4.1
Upper Nass Mainstem	6		2.1	
Lower Nass Mainstem	6		2.1	
Lower Nass Tributaries	34		11.7	
Tchitin River		6		2.1
Seaskinnish River		15		5.2
Tseax River and Slough		9		3.1
Total tracked to destination	291		100	
Alive but no destination (wandered)	2			
Moving toward destination	3			
Native fishery	30	(32)[a]		
Recaptures before destination		16		
Suspected recaptures not reported[b]		7		
Suspected tags lost at capture[c]		9		
Sport fishery	2	(10)[a]		
Recaptures before destination		1		
Suspected recaptures not reported[b]		1		
Tagging losses	27			
Died shortly after tagging		1		
Regurgitations at tagging site		11		
Dead tags - fish never tracked		10		
Tag died en route to destination		3		
Non-tagging mortality	5			
Total number radio tagged	360			

[a] Numbers in parentheses include tags that were (or suspected to be) recaptured in a spawning tributary and are included among those tracked to their final destination.
[b] Tags disappeared at a fishery location.
[c] Tags became stationary at a fishery location.

Table 10. Average residence times of chinook salmon near fixed-station receiver sites on the Nass River, 1992, and average speeds of travel between those sites. Estimates provided where sample size exceeds 5 fish.

Destination	TS-FS1	FS1	FS1-FS3	FS3	FS3-FS8	FS8	FS8-FS9	FS9	FS9-FS5	FS5	FS5-FS6	FS6	FS6-FS7	FS7
Lower Nass River														
Time (d)	21.3	1.2												
Speed (km/d)	1.0													
Cranberry														
Time (d)	15.1	0.9	4.9	3.2	5.2	4.6								
Speed (km/d)	1.5		6.1		11.5									
Meziadin														
Time (d)	17.2	0.3	5.3	0.2	6.0	3.3								
Speed (km/d)	1.3		5.7		10.0									
Bell-Irving														
Time (d)	14.9	0.5	4.7	0.2	5.7	0.2	4.5	2.6						
Speed (km/d)	1.5		6.4		10.5		7.8							
Kwinageese														
Time (d)	16.2	0.1	4.6	0.1	5.8	0.4	3.9	1.3						
Speed (km/d)	1.4		6.5		10.3		9.0							
Damdochax														
Time (d)	15.3	0.4	4.8	0.2	6.3	0.2	4.1	0.2	1.1	0.0	2.5	0.2	2.8	4.0
Speed (km/d)	1.4		6.3		9.5		8.5		18.2		14.0		11.4	

TS - Indicates the tagging site near Gitwinksihlkw; see Figure 1 for the location of other sites.

Table 11. Comparisons of numbers of radio-tagged fish detected during aerial surveys of Damdochax Creek and Cranberry River with the total numbers present at the time of the survey.

Stream date	No. of tags tracked	Total tags present	Percent tracked
Damdochax			
4-Aug	8	12	67
10-Aug	26	28	93
17-Aug	31	45	69
21-Aug	43	46	93
27-Aug	45	52	87
3-Sep	46	48	96
10-Sep	33	35	94
Total	232	266	87
Cranberry			
13-Aug	23	49	47 [a]
19-Aug	49	51	96 [a]
25-Aug	36	42	86
2-Sep	30	42	71
Total	138	184	75

[a] Includes Kiteen River.

Table 12. Radio-tag data used to estimate residence times of chinook salmon in Damdochax Creek, 1992. Fish that were recovered incidentally to carcass surveys are included; three males that died after leaving Damdochax Creek with known residence times of 18, 21 and 23 days are excluded.

Date recovered	Operculum tag No.	Arrival date [a]	Date died	Residence time (d)
Females (n=16)				
21-Aug	32	05-Aug	16-Aug	11
03-Sep	113	06-Aug	31-Aug	25
03-Sep	267	08-Aug	28-Aug	20
03-Sep	168	15-Aug	30-Aug	12 [b]
10-Sep	264	04-Aug	08-Sep	30 [b]
10-Sep	294	14-Aug	09-Sep	26
10-Sep	375	05-Aug	05-Sep	31
10-Sep	308	04-Aug	11-Sep	38
10-Sep	193	13-Aug	01-Sep	19
10-Sep	280	14-Aug	08-Sep	25
10-Sep	142	06-Aug	10-Sep	35
10-Sep	189	14-Aug	09-Sep	26
16-Sep	343	12-Aug	13-Sep	32
16-Sep	62	07-Aug	10-Sep	34
16-Sep	361	30-Aug	13-Sep	14
16-Sep	304	20-Aug	15-Sep	26
			Mean	25.25
			SD	8.20
Males (n=10)				
03-Sep	22	06-Aug	30-Aug	24
10-Sep	357	12-Aug	07-Sep	26
10-Sep	330	15-Aug	09-Sep	25
10-Sep	176	06-Aug	05-Sep	30
16-Sep	370	24-Aug	13-Sep	20
16-Sep	195	03-Aug	12-Sep	40
16-Sep	348	03-Aug	11-Sep	39
16-Sep	275	11-Aug	10-Sep	30
16-Sep	225	07-Aug	10-Sep	34
16-Sep	93	07-Aug	12-Sep	36
			Mean	30.40
			SD	6.74
Males and females (n = 26)				
	Mean	27.83		
	SD	7.95		
	Upper 95% CL	30.88		
	Lower 95% CL	24.77		

[a] Arrival was determined by a fixed-station receiver positioned at the confluence of the Nass River and Damdochax Creek. A fish was considered to have entered Damdochax Creek when it moved upstream into the creek and was no longer recorded at the station.

[b] The fixed-station data indicated that fish (tag) No. 168 and No. 264 returned to the Nass River from Damdochax Creek for 3 and 5 days, respectively, before re-entering and committing themselves to Damdochax Creek.

Table 13. Peak counts of chinook salmon observed during aerial and ground surveys of Nass River tributaries, 1992.

	Live fish		Dead fish		Carcass Recovery		
					Carcasses	Tags	Adjusted [a]
Stream	Date	Count	Date	Count	examined	recovered	mark rate
Damdochax	21-Aug	2175	10-Sep	617	1382	23	58
Cranberry	19-Aug	1490	1-Sep	15	15	0	
Kiteen	13-Aug	64					
Kwinageese	2-Sep	1659	15-Sep	396	838	12	65
Meziadin	6-Sep	332					
Oweegee	20-Aug	450	6-Sep	24	33	1	
Snowbank/Teigen	18-Aug	490	5-Sep	32	32	1	
Tchitin	18-Aug	7					
Seaskinnish	19-Aug	145	28-Aug	16	16	0	
Ishkeenickh	14-Aug	75					
Kincolith	14-Aug	32					
Muskaboo	17-Aug	6					
Kotsinta	3-Sep	10					

[a] Adjusted for use in the Petersen estimate (C+1) / (R+1).

Table 14. Counts of holding and spawning chinook salmon, by reach, as determined from aerial and ground surveys of Damdochax Creek, 4 August - 17 September 1992. Unless otherwise noted, counts for reaches 1-3 are from aerial surveys and counts for reaches 4-5 are from ground surveys.

	Live count by reach					
Date	1	2	3	4	5	Total
Holding fish						
4-Aug	--------------count not stratified by reach (aerial count)---------------					720
10-Aug	189	453	261	----------592----------		1495
17-Aug	39	----------590----------		----------786[a]----------		1355
21-Aug	27	35	492	----------937----------		1491
27-Aug	0	0	233	540	473	1246
3-Sep	0	0	30	226	154	410
10-Sep	0	0	0	15	0	15
17-Sep [b]	-	-	-	0	0	0
Spawning fish						
4-Aug	--------------count not stratified by reach (aerial count)---------------					40
10-Aug	39	89	58	------------36----------		222
17-Aug	39	----------268---------		----------161[a]---------		468
21-Aug	34	23	318	----------309----------		684
27-Aug	23	1	246	136	389	795
3-Sep	6	5	103	192	617	923
10-Sep	0	1	34	58	617	710
17-Sep [b]	-	-	-	32	214	246
Total (spawning + holding)						
4-Aug	--------------count not stratified by reach (aerial count)---------------					760
10-Aug	228	542	319	----------628----------		1717
17-Aug	78	----------798----------		----------947[a]---------		1823
21-Aug	61	58	810	---------1246----------		2175
27-Aug	23	1	479	676	862	2041
3-Sep	6	5	133	418	771	1333
10-Sep	0	1	34	73	617	725
17-Sep [b]	-	-	-	32	214	300 [b]

[a] Numbers for reaches 4 and 5 were estimated from aerial counts using an assumed observer efficiency of 76% (this was based on the observer efficiency of the following survey which was conducted under similar survey conditions).

[b] Reaches 1,2 and 3 were not surveyed by helicopter; total live count was estimated assuming reaches 4 and 5 contained 82% of the total number of chinook in the creek (based on aerial and ground surveys on September 10).

Table 15. Counts of holding and spawning chinook salmon as determined by aerial and ground surveys of Slowmaldo, Yaza, Sansixmor and Wiminasik creeks, 1992.

System	Reach	Survey date	Survey type	Live count		
				Holding	Spawning	Total
Slowmaldo	6	17-Aug	aerial	0	9	9
Yaza	7	17-Aug	aerial	0	7	7
Sansixmor	8	17-Aug	aerial	1	0	1
Wiminasik	9	17-Aug	aerial	1	0	1
		20-Aug	ground	0	7	7
		26-Aug	ground	0	33	33
		3-Sep	aerial	0	11	11
		9-Sep	ground	0	3	0
Wiminasik	10	17-Aug, 3-Sep	aerial	0	0	0

Table 16. Estimates of observer efficiency during four aerial surveys to count chinook salmon in reaches 4 and 5 of Damdochax Creek, 1992. The ground survey counts were done immediately following the aerial counts and were assumed to be the actual numbers present.

Survey date	Aerial count	Ground count	Observer efficiency
21-Aug	939	1246	0.75
27-Aug	1587	1538	1.03
3-Sep	1394	1189	1.17
10-Sep	714	690	1.03
		Mean	1.00
		SD	0.18

Table 17. Estimates of chinook salmon escapement to Damdochax Creek, 1992.

Escapement estimation method	Residence time (d) Method	Residence time (d) Estimate	Escapement estimate	Range/bounds [a] Lower	Range/bounds [a] Upper
AUC	radio tag/ carcass data	27.8	2348	2116	2638
AUC	peak live/ peak dead	20.0	3268	n/a	n/a
Petersen	n/a	n/a	3054	2017	4699

[a] The range for the AUC estimate is derived from the upper and lower 95% confidence limits of the residence time estimate (see Table 12). The bounds for the Petersen estimate are the 95% confidence limits derived from the Poisson distribution (Ricker 1975).

Table 18. Counts of holding and spawning chinook salmon, by reach, as determined by aerial surveys of Cranberry River, 13 August - 2 September 1992.

	Reach [a]				
Date	1	2	3	4	Total
Holding fish					
13-Aug	46	11	20	5	82
19-Aug	120	57	374	0	551
25-Aug	18	10	1	NS	29
2-Sep	0	0	0	NS	0
Spawning fish					
13-Aug	69	52	259	128	508
19-Aug	130	139	582	88	939
25-Aug	299	151	627	NS	1077
2-Sep	198	196	137	NS	531
Total (spawning + holding)					
13-Aug	115	63	279	133	590
19-Aug	250	196	956	88	1490
25-Aug	317	161	628	NS	1106
2-Sep	198	196	137	NS	531

[a] Reaches:

1. Nass River to 1st highway bridge
2. First highway bridge to second highway bridge
3. Second highway bridge to last logging bridge
4. Last logging bridge to next valley above Weber Creek

NS - Reach was not surveyed.

Table 19. Estimates of chinook salmon escapement to the Cranberry River, 1992, based on the AUC method using assumed observer efficiencies and residence times.

Assumed observer efficiency (%)	Assumed residence times (d)							
	18	20	22	24	26	28	30	32
20	8158	7342	6674	6118	5648	5244	4895	4589
40	4079	3671	3337	3059	2824	2622	2447	2294
60	2719	2447	2225	2039	1883	1748	1632	1530
80	2039	1835	1669	1530	1412	1311	1224	1147
100	1632	1468	1335	1224	1130	1049	979	918

Table 20. Chinook salmon escapement estimates for the Nass River and its tributaries in 1992 (bold numbers are our best estimates).

System Tributary	Number of counts	Radio tags (M)	Percent of total tags	Highest count (live+dead)	Fish exam. (C)	Tags recov. (R)	Adjusted tag rate (C+1)/(R+1)	Petersen estimate (N)	Range of escapement estimates: Damdochax 57.6	Kwinageese 64.6	All systems 61.0	Best estimate of escapement
Upper Nass Mainstem		6	2	18					347	389	367	**366** [a]
Muskaboo	1	0	0	6					0	0	0	0
Kotsinta	1	1	0	12					58	65	61	61
Damdochax total		56	19	2248	1382	23	57.6	**3283**	3236	3630	3428	**3283**
Damdochax Cr	8	52	18	2199					3005	3371	3183	3049
Yaza/Slowmaldo	1	3	1	16					173	194	184	176
Wiminasik	3	1	0	33					58	65	61	59
Kwinageese total		32	11	1684	839	12	64.6	**2132**	1849	2074	1959	**2132**
Above weir	7	23	8	1354					1329	1491	1408	1532
Below weir	5	9	3	309					520	583	551	600
Shanalope	3	0	0	21					0	0	0	0
Bell-Irving total		72	24	1036					4161	4667	4407	**4397** [a]
Mainstem	2	14	5	58					809	907	857	855
Oweegee	4	12	4	450	33	1			694	778	734	733
Taft	1	6	2	18					347	389	367	366
Snowbank/Teigen	2	40	14	505	32	1			2312	2593	2448	2443
Hodder	1	0	0	5					0	0	0	0
Meziadin total		26	9	910					1503	1685	1591	**1588** [a]
Above fishway	3	19	6	870					1098	1232	1163	1160
Below fishway	3	7	2	40					405	454	428	428
Cranberry total		59	20	1557					3410 [b]	3824 [b]	3611 [b]	**3603** [a]
Cranberry R	5	50	17	1493	15	0			2890 [b]	3241 [b]	3060 [b]	3053
Kiteen R	2	9	3	64					520 [b]	583 [b]	551 [b]	550
Lower Nass Mainstem		6	2	6					347	389	367	**366** [a]
Lower Nass Tributaries		34	11	161					1965	2204	2081	**2077** [a]
Tchitin	2	6	2	7					347 [b]	389 [b]	367 [b]	366
Seaskinnish	2	15	5	145	16	0			867	972	918	915
Tseax	3	9	3	9					520	583	551	549
Ishkeenickh	1	0	0	**75**					0	0	0	0
Kincolith	1	0	0	**32**					0	0	0	0
Miscellaneous [c]	0	5	2	5					289	324	**306**	**305** [a]
Total for all systems	61	296	100	7732	2317	37	61.0	**18117**	17107	19186	18117	18117

[a] Estimates for tributaries with <4 recaptures were derived by prorating (using the portion of radio-tagged fish tracked there) the escapement not accounted for by tributaries with >3 recaptures.

[b] These estimates represent the escapement before sport fishery harvests on the Cranberry, Kiteen and Tchitin rivers.

[c] This category includes fish that did not reach their destination before the study ended.

Table 21. Best estimates of chinook salmon escapement and in-river harvest for various Nass River tributaries in 1992.

Tributary/section of the Nass River	Gross Escapement	Tributary Harvests	Net [a] Escapement	In-River Harvests: First Nations [b] Lower	Middle	Sport [c]	Other	Total	Total Return	In-River Harvest Rate
Upper Nass mainstem	366		366	144	15			159	525	30%
Damdochax	3283		3283	1287	131			1418	4701	30%
Kwinageese	2132		2132	835	85			920	3052	30%
Bell	4397		4397	1723	175			1898	6295	30%
Meziadin	1588		1588	622	63	156		841	2429	35%
Cranberry	3603	678	2925	1412	143	556	122	2233	5158	43%
Lower Nass tributaries	2076	630	1446	814		630		1444	2890	50%
Lower Nass mainstem	366		366	144				144	510	28%
Miscellaneous	305		305	120				120	425	28%
Total	18117	1308	16809	7100	612	1342	122	9177	25986	35%

[a] Escapement after removals by all fisheries.

[b] Based on the assumption that a stock's contribution to a mainstem harvest is proportional to its contribution to the gross escapement (from Table 20) for stocks in that fishery.

[c] Catch estimate derived from creel survey data (Bocking and English 1993a).

FIGURES

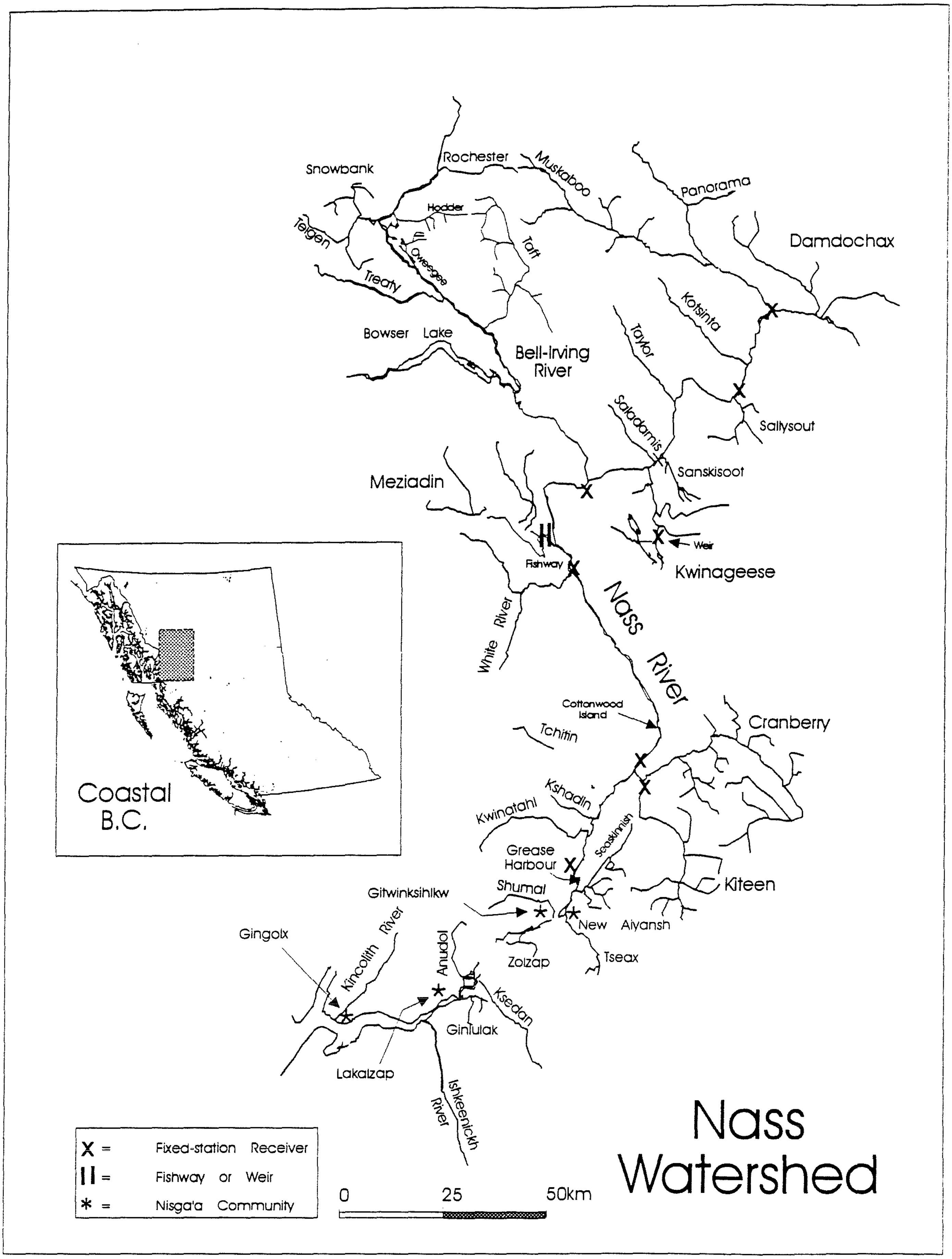


Figure 1. Map of the study area with locations of fixed-station receivers and the 34 chinook salmon spawning streams surveyed in 1992.

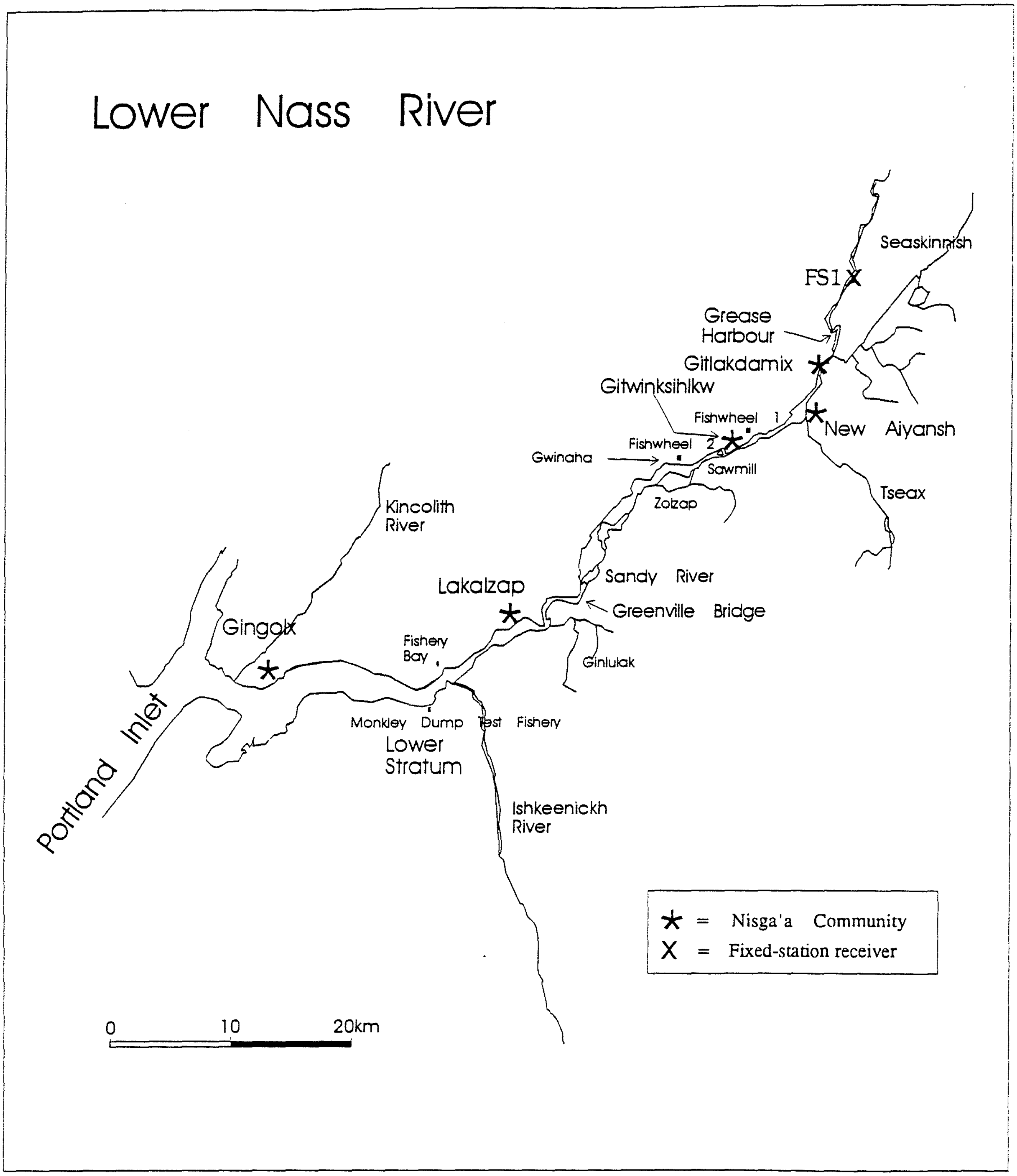


Figure 2. Map of lower Nass River with locations of fishwheels and tangle net fishing sites.

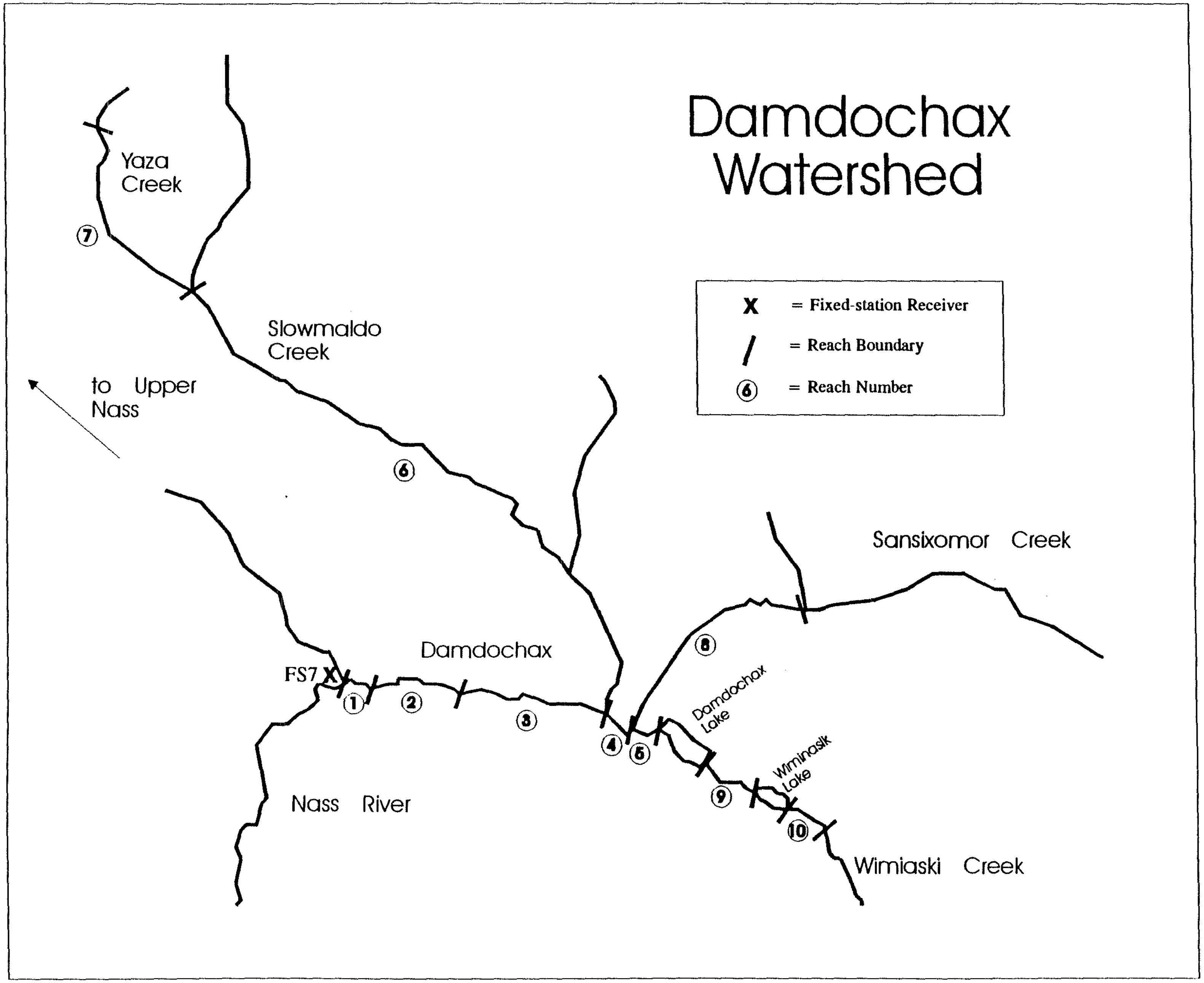


Figure 3. Reach boundries and landmarks on Damdochax Creek.

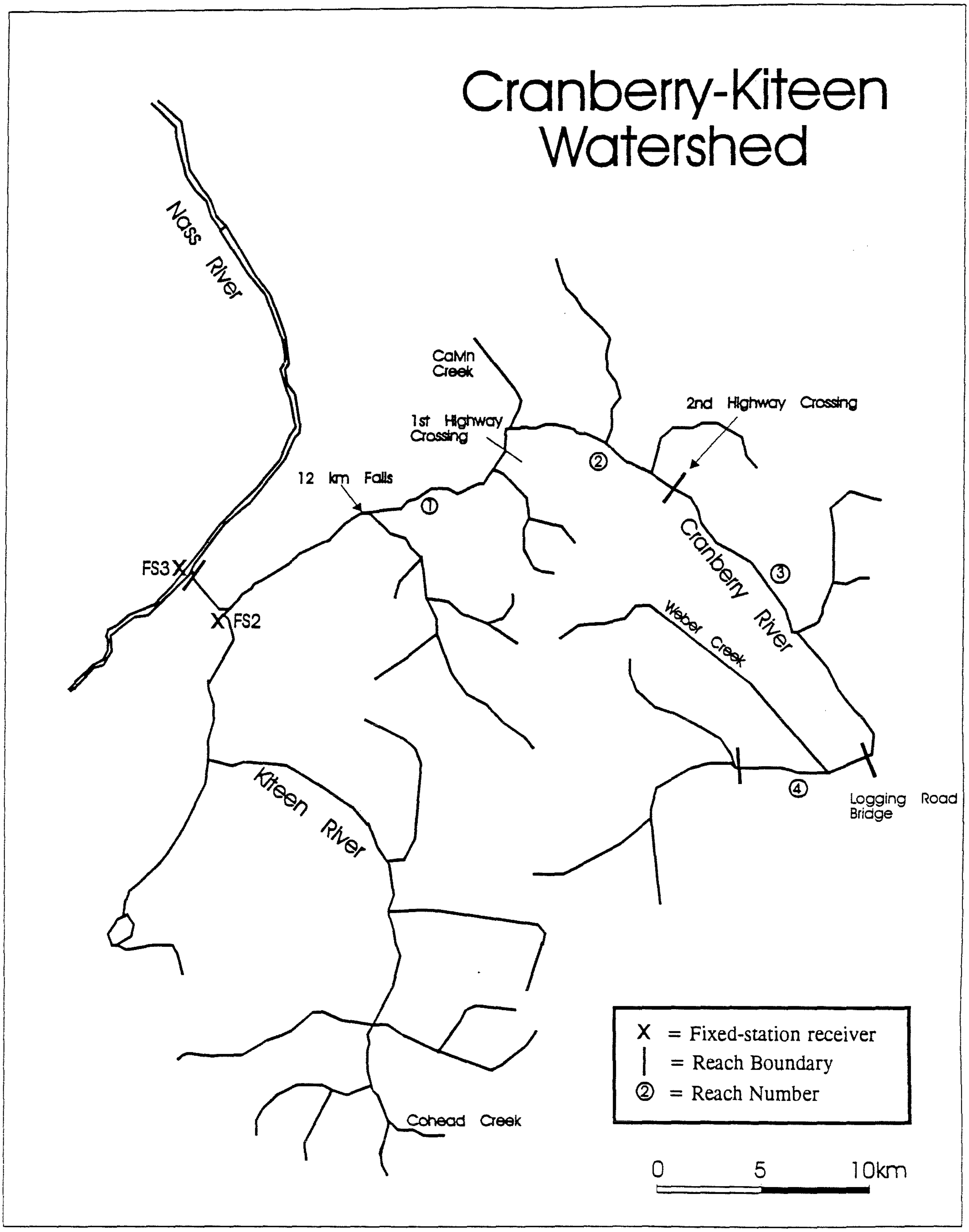


Figure 4. Reach boundaries and landmarks on the Cranberry and Kiteen rivers.

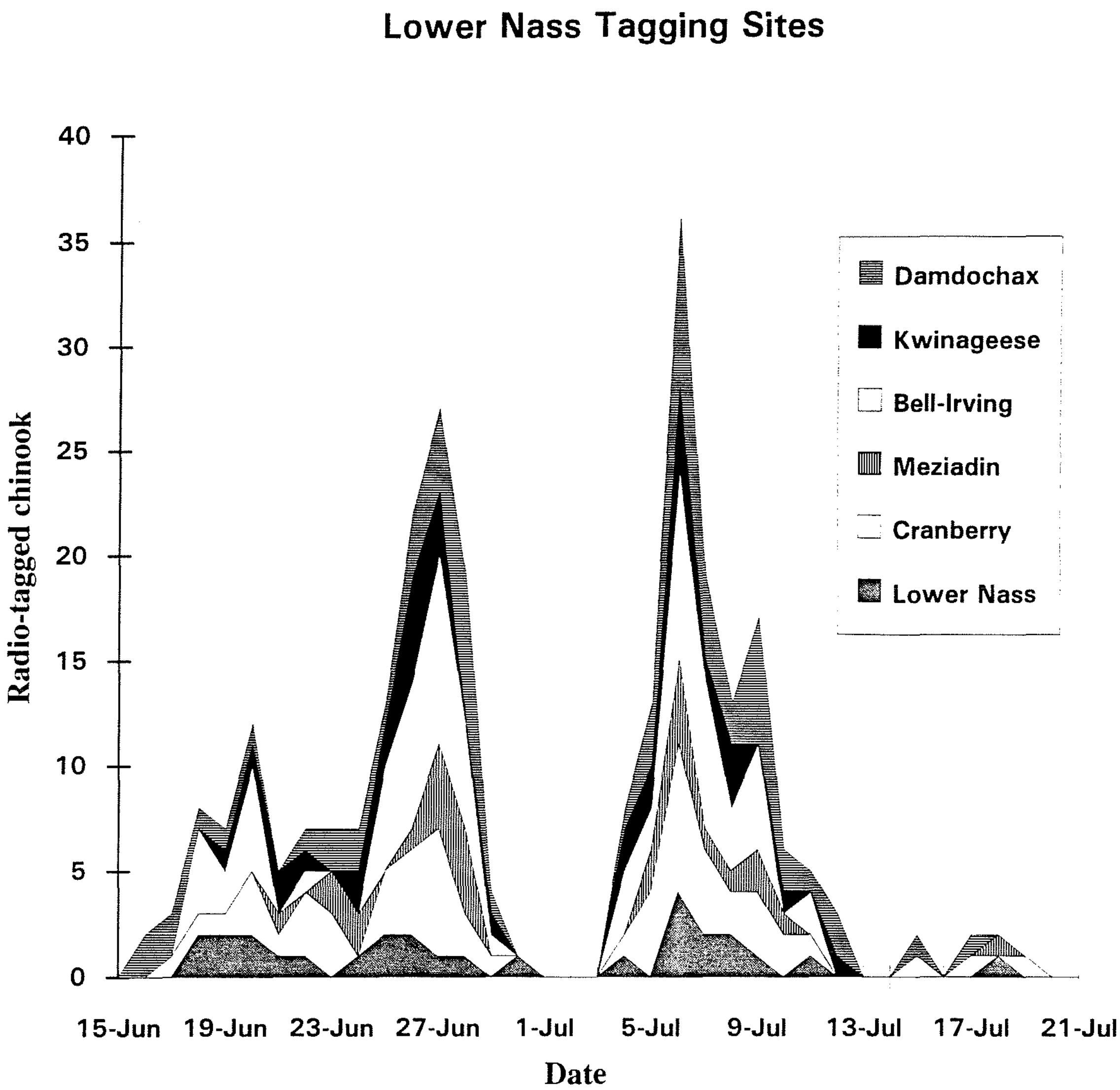
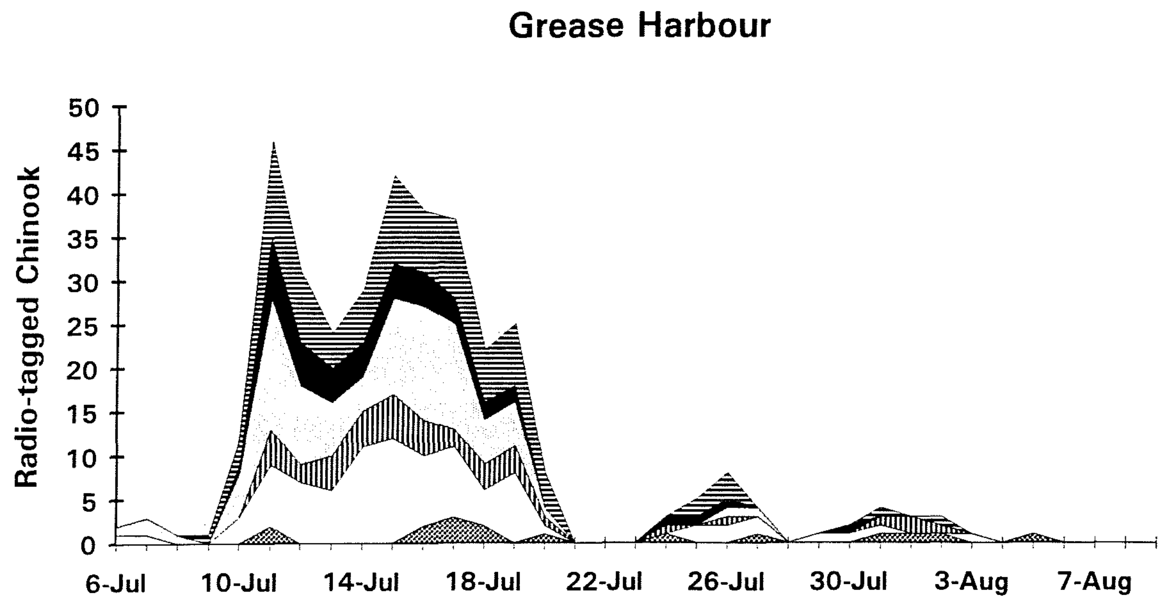


Figure 5. Spawning destinations of chinook salmon that were radio tagged on the lower Nass River during 1992 according to their date of capture.



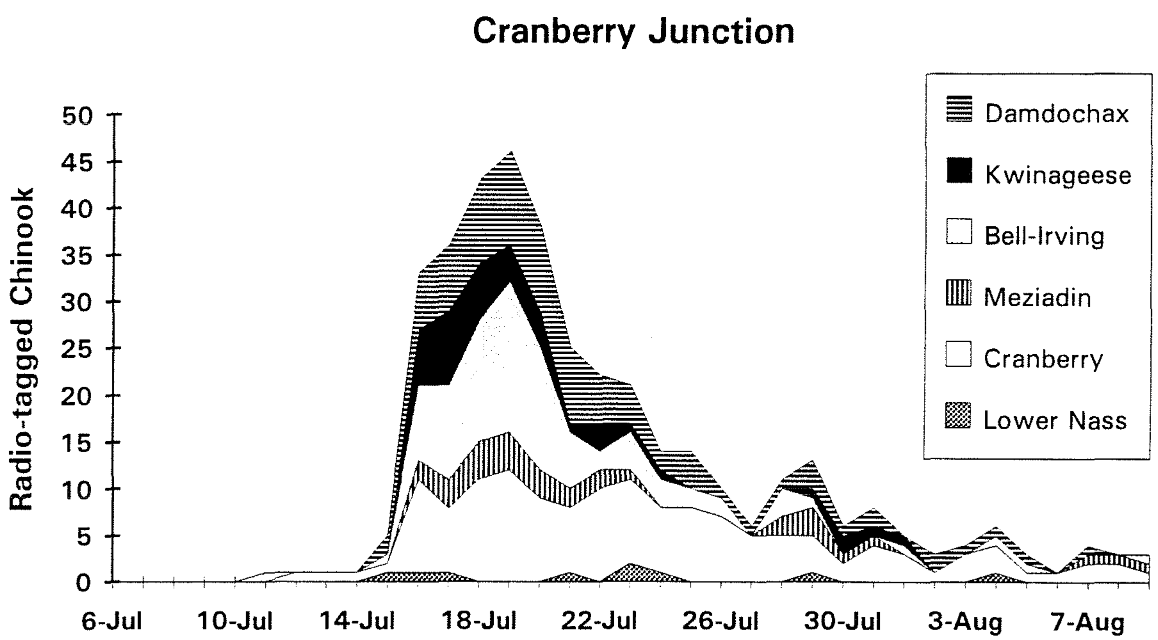


Figure 6. Timing of movement of radio-tagged fish of different stocks by fixed-station receivers at Grease Harbour (FS1) and Cranberry Junction (FS3). The receiver at FS1 was not operating from 11:00 on 20 July to 6:00 on 24 July. See Figure 2 for site locations.

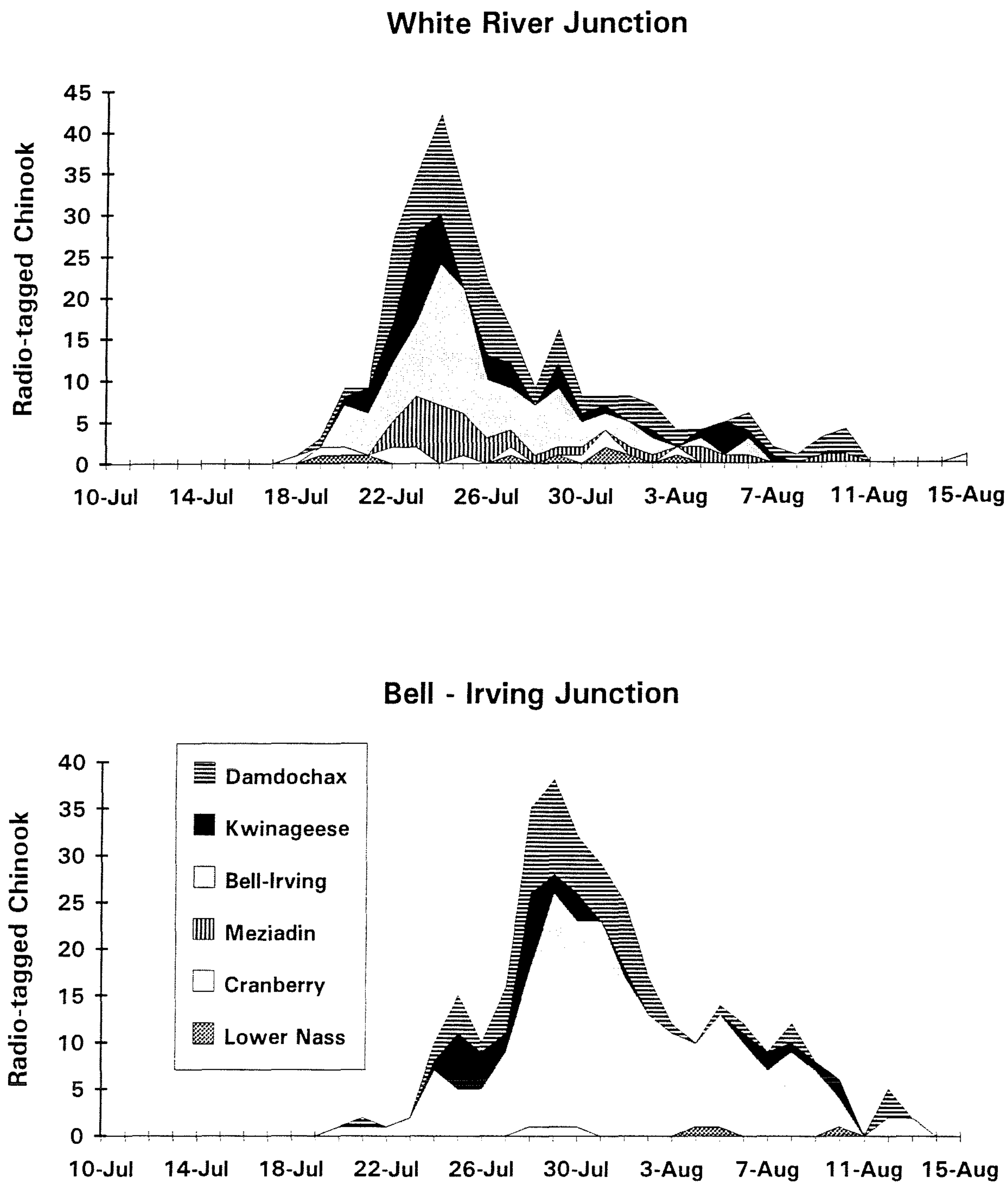


Figure 7. Timing of movement of radio-tagged fish of different stocks by fixed-station receivers at White River Junction (FS8) and Bell-Irving Junction (FS9). See Figure 2 for site locations.

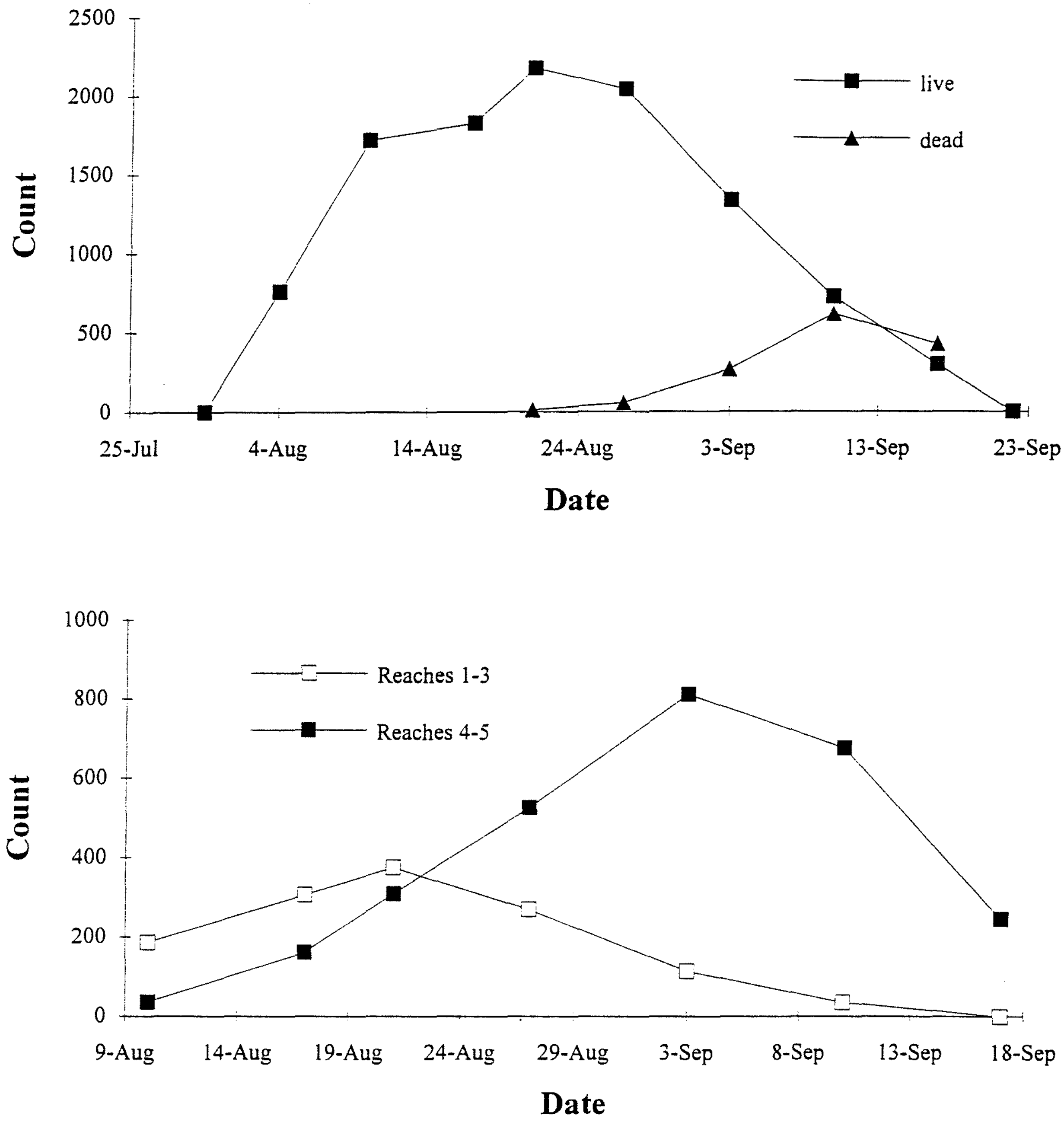


Figure 8. Counts of adult chinook salmon from aerial surveys of Damdochax Creek. Top panel - counts of live (all reaches) and dead (reaches 4 & 5). Bottom panel - counts of spawning chinook in different reaches.

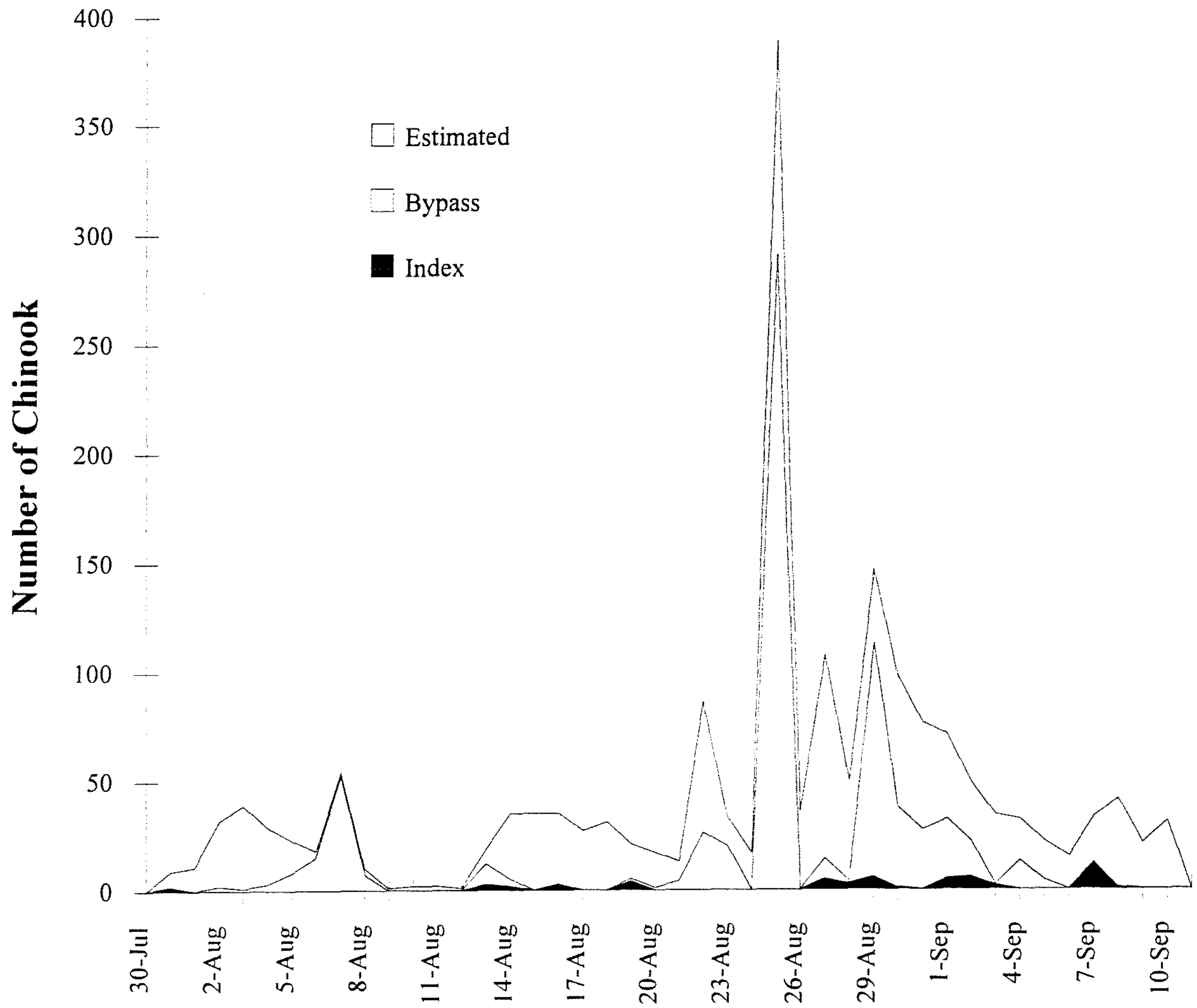


Figure 9. Estimates of the number of chinook salmon passing the Kwinageese weir each day during 1992. Estimates for each day are based on bypass counts, index counts and extrapolation of index counts to counts from electronic counters.

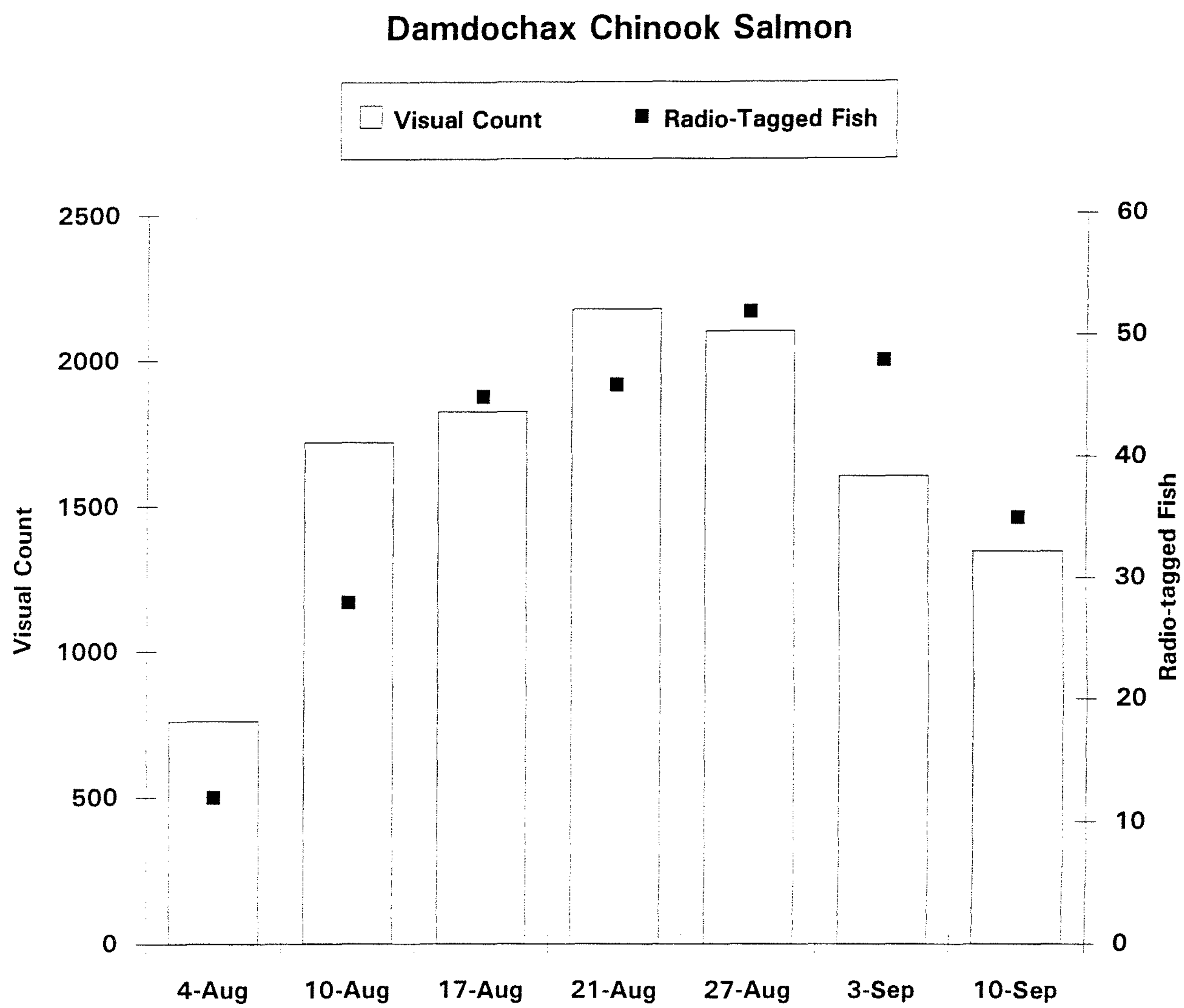


Figure 10. Comparison of aerial survey visual counts with total counts of radio-tagged fish for each survey of Damdochax Creek, 1992. Radio tags recovered during carcass examination surveys are not included after they are removed (see Table A-4 for recoveries).

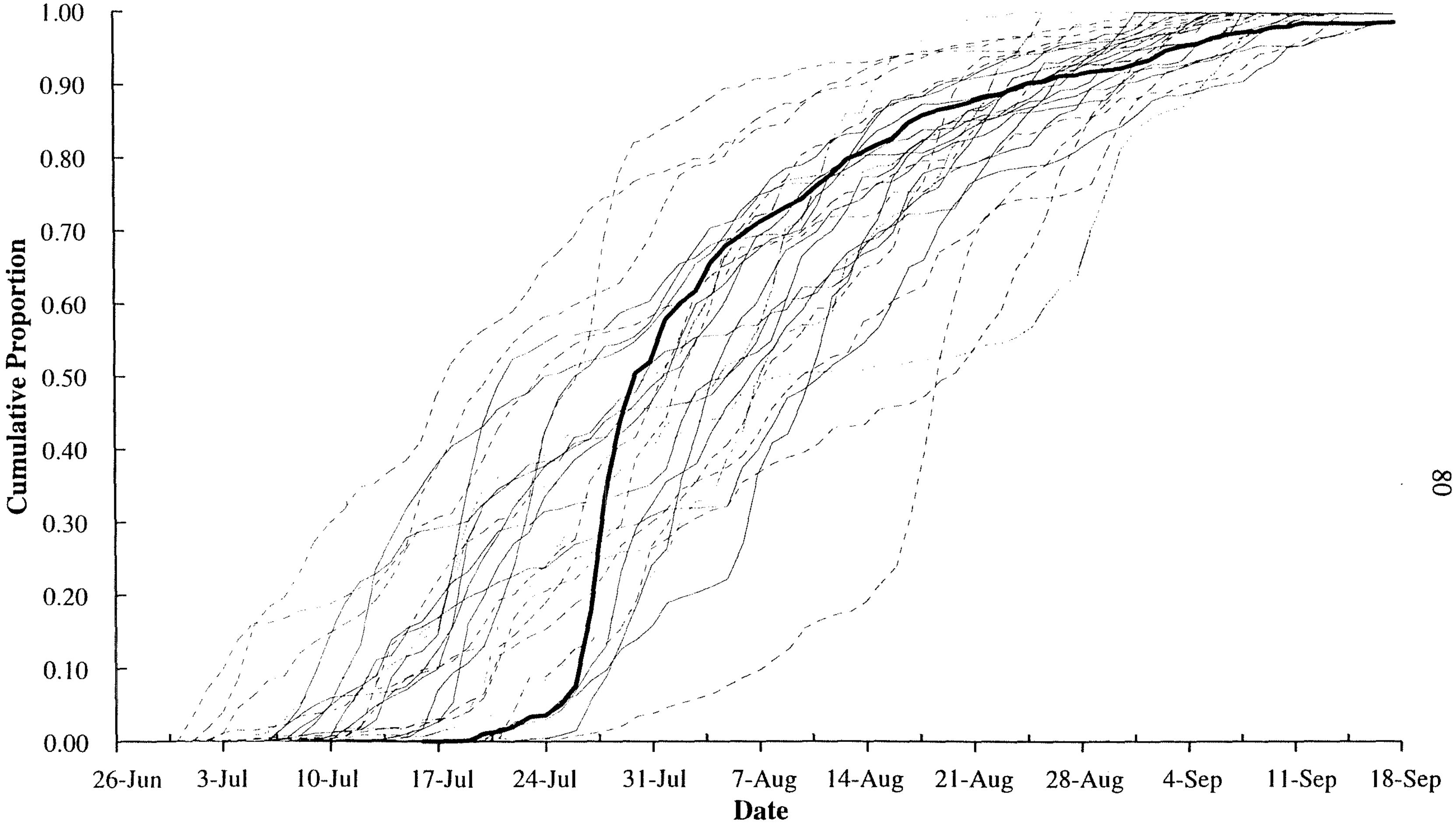


Figure 11. Run timing of chinook salmon through the Meziadin fishway expressed as a cumulative proportion of the total fishway count, 1966-92 (bold line is 1992).

APPENDICES

Table A-1. Fishing effort and numbers of chinook salmon caught in tangle nets and radio tagged on the lower Nass River, 13 May - 27 July 1992. Effort is the number of hours that the net was in the water attempting to catch fish.

		Set net				Drift net				
Date	Location	Time fished (h)	No. of adults	No. of jacks (<72 cm)	No. tagged	Time fished (h)	No. of sets	No. of adults	No. of jacks (<72 cm)	No. tagged
13-May	Grease Harbour	07:00	0	0	0					
14-May	Gwinaha	00:30	0	0	0	00:30	5	0	0	0
14-May	Grease Harbour	03:30	0	0	0					
15-May	Grease Harbour	06:15	1	0	1					
17-May	Grease Harbour	06:00	2	0	2					
19-May	Grease Harbour	07:15	0	0	0					
19-May	Gitlakdamix					00:23	2	0	0	0
21-May	Gitlakdamix					00:28	6	3	0	2
21-May	Grease Harbour	03:40	0	0	0					
24-May	Gitlakdamix					00:18	8	5	1	5
24-May	Grease Harbour	01:30	0	0	0					
25-May	Gitlakdamix					00:24	8	3	0	3
09-Jun	Gitlakdamix					00:15	3	0	0	0
09-Jun	Gwinaha	00:52	0	0	0	00:37	6	1	1	1
10-Jun	Gwinaha					00:27	5	3	0	3
11-Jun	Gwinaha/Zolzap					01:09	12	4	2	4
12-Jun	Gwinaha/Zolzap					00:35	9	0	0	0
16-Jun	Ginlulak	03:10	2	0	2					
16-Jun	Sandy River	01:35	0	0	0					
17-Jun	Fishery Bay	00:30	2	0	2					
17-Jun	Sandy River	01:30	1	0	1					
18-Jun	Sandy River	05:20	10	4	10					
19-Jun	Sandy River	04:30	9	3	8					
19-Jun	Ksedin Camp	00:40	0	0	0					
20-Jun	Sandy River	03:32	14	2	12					
20-Jun	Zolzap					00:06	2	3	1	2

Table A-1. Fishing effort and numbers of chinook salmon caught in tangle nets and radio tagged on the lower Nass River, 13 May - 27 July 1992. Effort is the number of hours that the net was in the water attempting to catch fish.

		Set net				Drift net				
Date	Location	Time fished (h)	No. of adults	No. of jacks (<72 cm)	No. tagged	Time fished (h)	No. of sets	No. of adults	No. of jacks (<72 cm)	No. tagged
21-Jun	Sandy River	04:45	6	2	6					
22-Jun	Sandy River	02:45	4	1	4					
22-Jun	Ksedin Camp	01:25	1	0	1					
22-Jun	Zolzap					00:08	3	2	0	2
23-Jun	Sawmill					00:14	5	2	1	2
23-Jun	Zolzap					00:15	4	2	2	2
23-Jun	Sandy River	02:10	9	2	6					
25-Jun	Sawmill	00:30	0	0	0	00:01	1	3	0	1
26-Jun	Gwinaha					00:34	13	7	5	7
26-Jun	Zolzap					00:08	2	2	1	2
27-Jun	Sawmill					00:06	3	9	1	5
28-Jun	Sawmill					00:21	8	2	4	0
04-Jul	Sawmill					00:06	3	3	0	3
27-Jul	Grease Harbour	01:00	1	0	1					
	Totals	69:54	62	14	56	07:05	108	54	19	44

Table A-2. Fishing effort and numbers of chinook salmon caught and tagged at two fishwheels operated near Gitwinksihlkw on the lower Nass River, 1992. Effort is the number of hours that the fishwheel was fishing.

	Number of Chinook			Tagged			Effort (h) [b]		
Date	Adults	Jacks [a]	Total	Radio	Spaghetti	Total	Wheel 1	Wheel 2	Total
05-Jun	0	0	0	0	0	0		8.0	8.0
06-Jun	0	0	0	0	0	0		18.0	18.0
07-Jun	1	0	1	0	0	0		24.0	24.0
08-Jun	1	0	1	1	0	1		24.0	24.0
09-Jun	0	0	0	0	0	0		24.0	24.0
10-Jun	0	0	0	0	0	0	24.0	24.0	48.0
11-Jun	1	0	1	0	0	0	24.0	10.5	34.5
12-Jun	0	0	0	0	0	0	24.0	7.0	31.0
13-Jun	0	0	0	0	0	0	24.0	0.0	24.0
14-Jun	0	0	0	0	0	0	24.0	0.0	24.0
15-Jun	0	0	0	0	0	0	24.0	0.0	24.0
16-Jun	0	0	0	0	0	0	24.0	0.0	24.0
17-Jun	0	0	0	0	0	0	24.0	0.0	24.0
18-Jun	0	0	0	0	0	0	24.0	0.0	24.0
19-Jun	0	0	0	0	0	0	22.5	0.0	22.5
20-Jun	0	0	0	0	0	0	13.8	0.0	13.8
21-Jun	0	0	0	0	0	0	24.0	0.0	24.0
22-Jun	0	0	0	0	0	0	22.5	0.0	22.5
23-Jun	1	0	1	1	0	1	23.6	11.4	35.0
24-Jun	8	4	12	8	0	8	22.4	21.1	43.5
25-Jun	17	4	21	17	0	17	21.9	22.8	44.6
26-Jun	16	10	26	15	0	15	21.3	21.9	43.3
27-Jun	31	8	39	29	0	29	21.3	20.8	42.2
28-Jun	27	13	40	23	0	23	20.5	21.5	42.0
29-Jun	8	2	10	8	0	8	22.9	20.9	43.8
30-Jun	2	1	3	1	0	1	23.5	8.4	31.9
01-Jul	0	0	0	0	0	0	23.8	0.0	23.8
02-Jul	0	0	0	0	0	0	17.2	0.0	17.2
03-Jul	0	0	0	0	0	0	18.0	0.0	18.0
04-Jul	8	1	9	6	0	6	22.8	4.4	27.2
05-Jul	22	4	26	17	0	17	23.5	11.1	34.5
06-Jul	38	5	43	38	0	38	23.8	9.7	33.5
07-Jul	21	10	31	20	0	20	24.0	12.0	36.0
08-Jul	25	11	36	18	12	30	24.0	11.6	35.6
09-Jul	23	10	33	20	11	31	19.5	14.4	33.9
10-Jul	17	13	30	6	24	30	24.0	24.0	48.0
11-Jul	10	10	20	6	12	18	24.0	24.0	48.0

Table A-2. Fishing effort and numbers of chinook salmon caught and tagged at two fishwheels operated near Gitwinksihlkw on the lower Nass River, 1992. Effort is the number of hours that the fishwheel was fishing.

	Number of Chinook			Tagged			Effort (h) [b]		
Date	Adults	Jacks [a]	Total	Radio	Spaghetti	Total	Wheel 1	Wheel 2	Total
12-Jul	6	2	8	4	4	8	24.0	24.0	48.0
13-Jul	0	1	1	0	0	0	24.0	24.0	48.0
14-Jul	0	1	1	0	0	0	23.8	23.3	47.1
15-Jul	2	0	2	2	0	2	20.0	24.0	44.0
16-Jul	2	4	6	0	0	0	24.0	24.0	48.0
17-Jul	3	1	4	3	1	4	24.0	24.0	48.0
18-Jul	4	3	7	3	2	5	23.3	24.0	47.3
19-Jul	1	1	2	1	0	1	24.0	24.0	48.0
20-Jul	0	0	0	0	0	0	23.8	24.0	47.8
21-Jul	0	0	0	0	0	0	24.0	24.0	48.0
22-Jul	0	1	1	0	0	0	24.0	24.0	48.0
23-Jul	1	1	2	0	1	1	24.0	24.0	48.0
24-Jul	0	1	1	0	0	0	24.0	23.7	47.7
25-Jul	0	0	0	0	0	0	24.0	24.0	48.0
26-Jul	1	1	2	0	1	1	24.0	24.0	48.0
27-Jul	1	0	1	1	0	1	24.0	24.0	48.0
28-Jul	0	0	0	0	0	0	23.0	24.0	47.0
29-Jul	0	0	0	0	0	0	24.0	24.0	48.0
30-Jul	0	0	0	0	0	0	24.0	24.0	48.0
31-Jul	0	0	0	0	0	0	23.6	24.0	47.6
01-Aug	1	0	1	1	0	1	24.0	8.2	32.2
02-Aug	2	2	4	1	2	3	24.0	0.0	24.0
03-Aug	1	0	1	1	0	1	23.9	0.0	23.9
04-Aug	1	0	1	1	0	1	23.8	0.0	23.8
05-Aug	0	0	0	0	0	0	23.6	0.0	23.6
06-Aug	1	1	2	0	1	1	22.8	9.8	32.6
07-Aug	1	0	1	0	1	1	23.0	21.0	44.0
08-Aug	0	0	0	0	0	0	24.0	24.0	48.0
09-Aug	1	0	1	0	1	1	23.3	23.8	47.1
10-Aug	2	0	2	1	0	1	24.0	24.0	48.0
11-Aug	2	0	2	2	0	2	24.0	24.0	48.0
12-Aug	3	0	3	3	0	3	23.5	24.0	47.5
13-Aug	1	0	1	0	1	1	18.6	24.0	42.6
14-Aug	2	0	2	0	0	0	23.1	24.0	47.1
15-Aug	0	0	0	0	0	0	0.0	24.0	24.0
16-Aug	0	0	0	0	0	0	0.0	24.0	24.0
17-Aug	0	0	0	0	0	0	0.0	24.0	24.0

Table A-2. Fishing effort and numbers of chinook salmon caught and tagged at two fishwheels operated near Gitwinksihlkw on the lower Nass River, 1992. Effort is the number of hours that the fishwheel was fishing.

	Number of Chinook			Tagged			Effort (h) [b]		
Date	Adults	Jacks [a]	Total	Radio	Spaghetti	Total	Wheel 1	Wheel 2	Total
18-Aug	0	0	0	0	0	0	0.0	24.0	24.0
19-Aug	0	0	0	0	0	0	0.0	24.0	24.0
20-Aug	0	0	0	0	0	0	0.0	24.0	24.0
21-Aug	0	0	0	0	0	0	0.0	24.0	24.0
22-Aug	0	0	0	0	0	0	0.0	24.0	24.0
23-Aug	0	0	0	0	0	0	5.5	24.0	29.5
24-Aug	1	0	1	1	0	1	24.0	24.0	48.0
25-Aug	0	0	0	0	0	0	24.0	24.0	48.0
26-Aug	0	0	0	0	0	0	24.0	24.0	48.0
27-Aug	0	0	0	0	0	0	15.5	24.0	39.5
28-Aug	0	0	0	0	0	0	23.8	24.0	47.8
29-Aug	1	0	1	1	0	1	24.0	24.0	48.0
30-Aug	0	0	0	0	0	0	23.9	24.0	47.9
31-Aug	0	0	0	0	0	0	24.0	24.0	48.0
01-Sep	0	0	0	0	0	0	24.0	24.0	48.0
02-Sep	0	0	0	0	0	0	22.6	24.0	46.6
03-Sep	0	0	0	0	0	0	23.7	24.0	47.7
04-Sep	0	0	0	0	0	0	23.5	10.5	34.0
Totals	318	126	444	260	74	334	1802.0	1575.7	3377.7

[a] Jacks were classified as all fish less than 72 cm; fish smaller than 72 cm were too small to radio tag.
[b] Wheel 1 fished intermittently from 5 to 29 September; wheel 2 only fished for 3 d between 5 and 29 September.

Table A-3. Information regarding chinook salmon, chum salmon and steelhead trout that were radio tagged on the lower Nass River, 1992.

Oper. tag no.	Radio tag Channel [a]	Radio tag Code	Nose-fork length (cm)	Sex	Method of capture	Tagging date	Release time	Release site Latitude	Release site Longitude
Chinook									
2	12	13	N/A	?	set	15-May	13:30	55.2968	129.0715
3	12	9	N/A	?	set	17-May	19:30	55.2968	129.0715
4	13	16	N/A	?	set	17-May	19:30	55.2968	129.0715
5	13	19	N/A	?	drift	21-May	13:30	55.2968	129.0715
6	12	4	N/A	?	drift	21-May	13:30	55.2968	129.0715
7	11	7	N/A	?	drift	24-May	14:25	55.2968	129.0715
8	12	13	>100	M	drift	24-May	14:25	55.2968	129.0715
9	11	12	100.0	M	drift	24-May	14:25	55.2968	129.0715
10	14	25	87.0	?	drift	24-May	14:25	55.2968	129.0715
11	14	30	76.0	?	drift	24-May	14:25	55.2968	129.0715
12	11	34	92.0	?	drift	25-May	17:20	55.2968	129.0715
13	14	28	97.0	?	drift	25-May	17:20	55.2968	129.0715
14	13	39	96.0	?	drift	25-May	17:20	55.2968	129.0715
15	14	3	88.0	?	wheel 2	8-Jun	17:06	55.1872	129.2412
16	11	37	95.0	F	drift	9-Jun	15:24	55.1872	129.2412
19	19	11	79.0	?	drift	10-Jun	17:36	55.1872	129.2412
20	15	45	98.0	?	drift	10-Jun	17:43	55.1872	129.2412
21	12	40	97.0	?	drift	10-Jun	17:47	55.1872	129.2412
22	18	29	92.0	M	drift	11-Jun	7:02	55.1647	129.2765
23	19	13	100.0	?	set	11-Jun	7:06	55.1647	129.2765
24	17	22	95.0	?	drift	11-Jun	7:10	55.1647	129.2765
25	17	18	100.0	F	drift	11-Jun	7:49	55.1647	129.2765
27	15	44	86.0	?	set	16-Jun	10:55	55.0450	129.4917
28	20	32	90.0	?	set	16-Jun	11:25	55.0450	129.4917
29	13	8	87.0	?	set	17-Jun	10:46	54.9942	129.6461
30	18	27	80.0	?	set	17-Jun	10:51	54.9942	129.6461
31	19	20	90.0	M	set	17-Jun	15:53	55.0917	129.4350
32	14	34	91.0	F	set	18-Jun	9:30	55.0917	129.4350
33	11	6	71.0	?	set	18-Jun	9:32	55.0917	129.4350
34	18	28	87.0	?	set	18-Jun	10:10	55.0917	129.4350
35	20	26	69.0	?	set	18-Jun	10:53	55.0917	129.4350
36	12	19	101.0	?	set	18-Jun	11:44	55.0917	129.4350
37	20	23	97.0	M	set	18-Jun	12:02	55.0917	129.4350
38	15	50	77.0	?	set	18-Jun	12:25	55.0917	129.4350
39	15	12	72.0	M	set	18-Jun	12:36	55.0917	129.4350
40	13	33	98.0	?	set	18-Jun	13:18	55.0917	129.4350
41	17	35	90.0	?	set	18-Jun	16:32	55.0917	129.4350
42	18	25	96.0	?	set	19-Jun	8:12	55.0917	129.4350
43	14	7	72.0	?	set	19-Jun	10:53	55.1034	129.4040

Table A-3. Information regarding chinook salmon, chum salmon and steelhead trout that were radio tagged on the lower Nass River, 1992.

Oper. tag no.	Radio tag Channel [a]	Radio tag Code	Nose-fork length (cm)	Sex	Method of capture	Tagging date	Release time	Release site Latitude	Release site Longitude
45	20	29	95.0	F	set	19-Jun	12:32	55.0917	129.4350
47	19	6	101.0	F	set	19-Jun	12:51	55.0917	129.4350
48	20	30	96.0	?	set	19-Jun	13:00	55.0917	129.4350
49	13	31	110.0	?	set	19-Jun	13:44	55.0917	129.4350
50	17	36	100.0	?	set	19-Jun	13:46	55.0917	129.4350
51	20	37	89.0	M	set	19-Jun	14:05	55.0917	129.4350
52	20	38	97.0	?	set	20-Jun	14:20	55.0917	129.4350
53	19	40	103.0	?	set	20-Jun	14:20	55.0917	129.4350
54	17	17	77.0	F	set	20-Jun	14:20	55.0917	129.4350
55	11	5	108.0	M	set	20-Jun	14:20	55.0917	129.4350
56	11	11	88.0	M	set	20-Jun	14:20	55.0917	129.4350
59	14	18	97.0	M	set	20-Jun	14:20	55.0917	129.4350
60	18	23	91.0	F	set	20-Jun	12:20	55.0917	129.4350
61	19	3	120.0	M	set	20-Jun	12:22	55.0917	129.4350
62	12	34	99.0	F	set	20-Jun	12:24	55.0917	129.4350
63	15	42	106.0	M	set	20-Jun	13:21	55.0917	129.4350
64	19	41	72.0	M	set	20-Jun	13:23	55.0917	129.4350
65	12	32	86.0	F	set	20-Jun	13:32	55.0917	129.4350
66	11	2	89.0	F	drift	20-Jun	16:10	55.1647	129.2765
67	19	39	96.0	?	drift	20-Jun	16:12	55.1647	129.2765
68	18	26	99.0	M	set	21-Jun	12:07	55.0917	129.4350
69	17	8	101.0	M	set	21-Jun	12:41	55.0917	129.4350
70	12	35	86.0	F	set	21-Jun	12:44	55.0917	129.4350
71	18	16	104.0	F	set	21-Jun	14:05	55.0917	129.4350
72	13	4	72.0	F	set	21-Jun	14:12	55.0917	129.4350
73	17	24	87.0	M	set	21-Jun	14:57	55.0917	129.4350
74	14	26	101.0	M	drift	22-Jun	8:05	55.1647	129.2765
75	12	31	94.0	F	drift	22-Jun	8:07	55.1647	129.2765
76	15	46	85.0	?	set	22-Jun	9:05	55.0917	129.4350
77	15	48	95.0	F	set	22-Jun	9:07	55.0917	129.4350
78	15	43	88.0	F	set	22-Jun	12:03	55.1034	129.4040
79	18	21	108.0	M	set	22-Jun	12:57	55.0917	129.4350
80	12	33	93.0	F	set	22-Jun	13:59	55.0917	129.4350
81	17	14	100.0	F	drift	23-Jun	9:04	55.1872	129.2412
82	14	6	97.0	M	drift	23-Jun	9:05	55.1872	129.2412
83	14	19	86.0	M	drift	23-Jun	10:28	55.1647	129.2765
84	17	10	93.0	M	drift	23-Jun	10:55	55.1647	129.2765
85	19	17	73.0	M	set	23-Jun	11:58	55.0917	129.4350
86	19	15	99.0	M	set	23-Jun	13:35	55.0917	129.4350
87	15	37	102.0	M	set	23-Jun	13:38	55.0917	129.4350
88	18	3	93.0	M	set	23-Jun	13:40	55.0917	129.4350

Table A-3. Information regarding chinook salmon, chum salmon and steelhead trout that were radio tagged on the lower Nass River, 1992.

Oper. tag no.	Radio tag Channel [a]	Radio tag Code	Nose-fork length (cm)	Sex	Method of capture	Tagging date	Release time	Release site Latitude	Release site Longitude
89	18	2	71.0	M	set	23-Jun	13:45	55.0917	129.4350
90	19	27	95.0	F	set	23-Jun	14:00	55.0917	129.4350
91	15	35	93.0	F	wheel 1	23-Jun	21:00	55.1967	129.2044
N/A	20	24	87.5	M	wheel 1	24-Jun	20:15	55.1967	129.2044
92	20	16	77.0	M	wheel 2	24-Jun	9:00	55.1907	129.2487
93	13	9	79.0	M	wheel 2	24-Jun	9:15	55.1907	129.2487
94	11	38	92.0	F	wheel 2	24-Jun	9:50	55.1907	129.2487
95	11	40	97.0	F	wheel 1	24-Jun	20:20	55.1967	129.2044
96	18	13	70.0	M	wheel 2	24-Jun	21:25	55.1907	129.2487
97	18	14	94.0	F	wheel 2	24-Jun	21:30	55.1907	129.2487
98	20	28	85.0	F	wheel 2	24-Jun	21:40	55.1907	129.2487
100	15	39	88.0	F	wheel 2	25-Jun	10:29	55.1872	129.2412
101	20	20	100.0	F	wheel 1	25-Jun	9:48	55.1996	129.1959
102	11	41	90.0	F	wheel 2	25-Jun	10:08	55.1872	129.2412
103	20	21	72.0	M	wheel 2	25-Jun	10:09	55.1872	129.2412
104	13	32	79.0	M	wheel 2	25-Jun	10:11	55.1872	129.2412
105	12	10	85.0	M	wheel 2	25-Jun	10:30	55.1872	129.2412
106	18	12	99.0	F	wheel 2	25-Jun	10:48	55.1872	129.2412
107	12	5	82.0	M	wheel 2	25-Jun	10:49	55.1872	129.2412
108	13	36	87.0	M	wheel 2	25-Jun	10:51	55.1872	129.2412
109	13	5	87.0	M	wheel 2	25-Jun	10:55	55.1872	129.2412
110	17	11	100.0	M	drift	25-Jun	11:24	55.1882	129.2370
111	14	33	96.0	F	wheel 1	25-Jun	21:02	55.1967	129.2044
112	17	1	103.0	F	wheel 1	25-Jun	21:05	55.1967	129.2044
113	19	19	95.0	F	wheel 1	25-Jun	21:08	55.1967	129.2044
114	15	47	91.0	?	wheel 1	25-Jun	21:11	55.1967	129.2044
115	12	8	86.0	M	wheel 2	25-Jun	21:48	55.1907	129.2487
116	14	31	101.0	M	wheel 2	25-Jun	21:50	55.1907	129.2487
117	17	15	98.0	M	wheel 2	25-Jun	21:52	55.1907	129.2487
118	20	9	88.0	M	drift	26-Jun	6:12	55.1647	129.2765
119	11	3	94.0	M	drift	26-Jun	6:47	55.1647	129.2765
120	11	14	99.0	F	drift	26-Jun	7:18	55.1882	129.2370
121	13	41	94.0	M	drift	26-Jun	7:20	55.1882	129.2370
122	13	29	86.0	M	drift	26-Jun	8:04	55.1882	129.2370
123	13	30	96.0	M	drift	26-Jun	8:06	55.1882	129.2370
124	14	25	74.0	M	wheel 2	26-Jun	8:30	55.1872	129.2412
125	15	49	92.0	F	drift	26-Jun	8:55	55.1882	129.2370
126	19	18	96.0	M	drift	26-Jun	9:09	55.1882	129.2370
127	12	23	101.0	F	wheel 1	26-Jun	13:40	55.1967	129.2044
128	20	12	77.0	M	drift	26-Jun	9:40	55.1882	129.2370
129	12	17	97.0	F	wheel 1	26-Jun	13:50	55.1967	129.2044

Table A-3. Information regarding chinook salmon, chum salmon and steelhead trout that were radio tagged on the lower Nass River, 1992.

Oper. tag no.	Radio tag Channel [a]	Radio tag Code	Nose-fork length (cm)	Sex	Method of capture	Tagging date	Release time	Release site Latitude	Release site Longitude
130	14	11	88.0	F	wheel 1	26-Jun	13:55	55.1967	129.2044
131	19	16	77.0	M	wheel 1	26-Jun	14:05	55.1967	129.2044
132	14	2	83.0	M	wheel 1	26-Jun	14:10	55.1967	129.2044
133	15	26	95.0	F	wheel 1	26-Jun	14:20	55.1967	129.2044
134	12	21	101.0	F	wheel 2	26-Jun	14:45	55.1907	129.2487
135	13	27	93.0	F	wheel 2	26-Jun	14:55	55.1907	129.2487
136	17	7	86.0	M	wheel 2	26-Jun	15:00	55.1907	129.2487
137	11	13	102.0	F	wheel 2	26-Jun	15:10	55.1907	129.2487
138	18	20	104.0	F	wheel 1	26-Jun	22:28	55.1967	129.2044
139	20	5	99.0	M	wheel 1	26-Jun	22:35	55.1967	129.2044
140	17	6	84.0	M	wheel 1	26-Jun	22:37	55.1967	129.2044
141	20	10	76.0	M	wheel 1	26-Jun	22:39	55.1967	129.2044
142	18	24	96.0	F	wheel 2	27-Jun	8:36	55.1907	129.2487
143	19	38	85.0	M	wheel 2	27-Jun	8:40	55.1907	129.2487
144	12	12	107.0	M	wheel 2	27-Jun	8:42	55.1907	129.2487
145	12	41	108.0	M	wheel 2	27-Jun	8:44	55.1907	129.2487
146	12	37	90.0	F	wheel 2	27-Jun	9:03	55.1907	129.2487
147	11	8	104.0	M	wheel 2	27-Jun	9:08	55.1907	129.2487
148	13	18	N/A	M	wheel 1	27-Jun	14:03	55.1996	129.1959
149	11	15	N/A	F	wheel 1	27-Jun	14:05	55.1996	129.1959
150	15	31	74.0	M	drift	27-Jun	14:33	55.1872	129.2412
151	13	14	93.0	F	drift	27-Jun	14:35	55.1872	129.2412
152	17	21	103.0	M	drift	27-Jun	14:38	55.1872	129.2412
153	17	19	81.0	M	drift	27-Jun	14:41	55.1872	129.2412
154	19	2	91.0	M	drift	27-Jun	15:05	55.1882	129.2370
155	17	5	85.0	F	wheel 2	27-Jun	21:16	55.1907	129.2487
156	19	24	97.0	F	wheel 2	27-Jun	21:24	55.1907	129.2487
157	18	6	99.0	M	wheel 2	27-Jun	21:26	55.1907	129.2487
158	15	23	93.0	F	wheel 1	27-Jun	21:48	55.1967	129.2044
159	12	38	84.0	F	wheel 1	27-Jun	21:52	55.1967	129.2044
160	15	16	85.0	M	wheel 1	27-Jun	21:59	55.1967	129.2044
161	19	37	99.0	F	wheel 1	27-Jun	22:01	55.1967	129.2044
162	15	30	84.0	M	wheel 1	27-Jun	22:03	55.1967	129.2044
164	13	12	89.0	M	wheel 1	27-Jun	22:05	55.1967	129.2044
165	15	20	91.0	F	wheel 1	27-Jun	22:07	55.1967	129.2044
166	19	35	72.0	M	wheel 1	27-Jun	22:11	55.1967	129.2044
167	11	9	94.0	F	wheel 1	27-Jun	22:13	55.1967	129.2044
168	14	4	103.0	F	wheel 1	27-Jun	22:15	55.1967	129.2044
169	13	34	92.0	F	wheel 1	27-Jun	22:18	55.1967	129.2044
170	18	22	96.0	F	wheel 1	27-Jun	22:21	55.1967	129.2044
171	14	36	82.0	M	wheel 1	27-Jun	22:25	55.1967	129.2044

Table A-3. Information regarding chinook salmon, chum salmon and steelhead trout that were radio tagged on the lower Nass River, 1992.

Oper. tag no.	Radio tag Channel [a]	Code	Nose-fork length (cm)	Sex	Method of capture	Tagging date	Release time	Release site Latitude	Longitude
172	14	29	72.0	M	wheel 1	27-Jun	22:29	55.1967	129.2044
173	17	3	80.0	F	wheel 1	27-Jun	22:32	55.1967	129.2044
174	14	40	74.0	M	wheel 1	27-Jun	22:36	55.1967	129.2044
175	11	33	90.0	F	wheel 1	27-Jun	22:41	55.1967	129.2044
176	11	39	92.0	M	wheel 1	27-Jun	22:44	55.1967	129.2044
177	20	14	97.0	F	wheel 1	28-Jun	7:40	55.1967	129.2044
178	13	21	93.0	F	wheel 1	28-Jun	7:42	55.1967	129.2044
179	20	2	102.5	M	wheel 2	28-Jun	8:01	55.1907	129.2487
180	20	7	83.0	M	wheel 2	28-Jun	8:05	55.1907	129.2487
181	17	31	86.0	M	wheel 1	28-Jun	14:36	55.1967	129.2044
182	15	32	78.0	F	wheel 1	28-Jun	14:39	55.1967	129.2044
183	11	18	89.0	F	wheel 1	28-Jun	14:42	55.1967	129.2044
184	20	17	95.0	F	wheel 1	28-Jun	14:46	55.1967	129.2044
185	18	11	87.5	F	wheel 1	28-Jun	14:49	55.1967	129.2044
186	18	8	91.0	F	wheel 1	28-Jun	14:55	55.1967	129.2044
187	17	27	100.0	F	wheel 1	28-Jun	15:00	55.1967	129.2044
188	20	15	90.0	M	wheel 2	28-Jun	15:35	55.1907	129.2487
189	19	26	94.0	F	wheel 1	28-Jun	21:15	55.1967	129.2044
190	18	10	93.0	F	wheel 1	28-Jun	21:19	55.1967	129.2044
191	11	16	95.0	F	wheel 1	28-Jun	21:23	55.1967	129.2044
192	14	41	94.0	F	wheel 1	28-Jun	21:43	55.1967	129.2044
193	13	22	92.0	F	wheel 1	28-Jun	21:48	55.1967	129.2044
194	11	35	92.0	F	wheel 1	28-Jun	21:53	55.1967	129.2044
195	14	9	90.0	F	wheel 2	28-Jun	22:14	55.1907	129.2487
196	14	23	88.0	M	wheel 2	28-Jun	22:30	55.1907	129.2487
197	11	19	97.0	M	wheel 2	28-Jun	22:35	55.1907	129.2487
198	17	13	91.0	F	wheel 2	28-Jun	22:38	55.1907	129.2487
199	13	6	81.0	M	wheel 2	28-Jun	22:41	55.1907	129.2487
200	14	5	75.0	M	wheel 1	29-Jun	7:51	55.1967	129.2044
201	12	36	93.0	M	wheel 1	29-Jun	7:54	55.1967	129.2044
202	15	4	98.0	F	wheel 2	29-Jun	8:26	55.1907	129.2487
203	15	24	87.0	M	wheel 2	29-Jun	8:32	55.1907	129.2487
204	13	40	100.0	F	wheel 2	29-Jun	8:37	55.1907	129.2487
205	15	38	71.0	M	wheel 2	29-Jun	8:41	55.1907	129.2487
207	13	13	96.0	?	wheel 1	29-Jun	14:37	55.1967	129.2044
208	19	22	98.0	F	wheel 2	29-Jun	21:36	55.1907	129.2487
209	18	9	102.0	F	wheel 2	30-Jun	8:30	55.1907	129.2487
210	11	17	99.0	F	drift	4-Jul	6:54	55.1882	129.2370
211	20	19	94.0	M	drift	4-Jul	7:11	55.1882	129.2370
212	18	7	80.0	M	drift	4-Jul	7:31	55.1882	129.2370
213	18	18	101.0	F	wheel 1	4-Jul	15:56	55.1967	129.2044

Table A-3. Information regarding chinook salmon, chum salmon and steelhead trout that were radio tagged on the lower Nass River, 1992.

Oper. tag no.	Radio tag Channel [a]	Code	Nose-fork length (cm)	Sex	Method of capture	Tagging date	Release time	Release site Latitude	Longitude
214	20	6	80.5	M	wheel 1	4-Jul	20:43	55.1967	129.2044
215	19	8	85.0	M	wheel 1	4-Jul	21:00	55.1967	129.2044
216	14	1	91.0	F	wheel 2	4-Jul	21:35	55.1907	129.2487
217	15	27	77.0	M	wheel 2	4-Jul	22:20	55.1907	129.2487
218	17	38	99.0	M	wheel 2	4-Jul	22:32	55.1907	129.2487
N/A	17	23	>90	F	wheel 1	5-Jul	15:46	55.1967	129.2044
219	15	14	88.0	F	wheel 1	5-Jul	5:56	55.1967	129.2044
220	12	16	87.0	F	wheel 1	5-Jul	6:11	55.1967	129.2044
222	14	15	89.0	F	wheel 1	5-Jul	14:57	55.1967	129.2044
223	18	4	101.0	F	wheel 1	5-Jul	15:09	55.1967	129.2044
224	11	31	89.0	F	wheel 1	5-Jul	15:12	55.1967	129.2044
225	20	35	90.0	M	wheel 1	5-Jul	15:19	55.1967	129.2044
251	14	32	103.0	M	wheel 1	5-Jul	15:25	55.1967	129.2044
252	15	41	85.0	M	wheel 1	5-Jul	15:37	55.1967	129.2044
253	14	21	93.5	M	wheel 1	5-Jul	16:43	55.1967	129.2044
254	11	22	111.0	M	wheel 1	5-Jul	17:15	55.1967	129.2044
255	15	9	100.0	M	wheel 1	5-Jul	17:25	55.1967	129.2044
256	12	26	88.0	M	wheel 1	5-Jul	18:42	55.1967	129.2044
257	15	40	78.0	M	wheel 1	5-Jul	19:05	55.1967	129.2044
258	14	13	91.0	M	wheel 1	5-Jul	19:07	55.1967	129.2044
259	20	34	88.5	F	wheel 2	5-Jul	22:38	55.1907	129.2487
276	19	36	91.0	F	wheel 2	5-Jul	14:49	55.1907	129.2487
N/A	14	35	101.0	F	wheel 2	6-Jul	14:18	55.1907	129.2487
260	12	18	102.0	M	wheel 2	6-Jul	6:11	55.1907	129.2487
261	11	36	94.0	F	wheel 2	6-Jul	6:14	55.1907	129.2487
262	17	40	83.0	F	wheel 2	6-Jul	6:20	55.1907	129.2487
263	18	19	94.0	M	wheel 2	6-Jul	6:22	55.1907	129.2487
264	19	12	91.0	F	wheel 1	6-Jul	11:00	55.1967	129.2044
265	13	37	97.0	F	wheel 1	6-Jul	11:03	55.1967	129.2044
266	19	33	81.0	F	wheel 1	6-Jul	12:01	55.1967	129.2044
267	12	6	103.0	F	wheel 1	6-Jul	12:14	55.1967	129.2044
268	20	8	80.0	M	wheel 2	6-Jul	14:12	55.1907	129.2487
269	17	26	89.0	F	wheel 2	6-Jul	14:27	55.1907	129.2487
270	11	27	98.0	F	wheel 1	6-Jul	16:28	55.1967	129.2044
271	18	5	102.5	F	wheel 1	6-Jul	16:30	55.1967	129.2044
272	17	29	96.0	F	wheel 1	6-Jul	17:12	55.1967	129.2044
273	12	22	104.0	M	wheel 1	6-Jul	17:20	55.1967	129.2044
274	17	41	94.0	M	wheel 1	6-Jul	17:32	55.1967	129.2044
275	17	39	78.0	M	wheel 1	6-Jul	18:29	55.1967	129.2044
277	12	20	86.0	M	wheel 1	6-Jul	14:24	55.1967	129.2044
278	12	3	97.0	M	wheel 1	6-Jul	14:30	55.1967	129.2044

Table A-3. Information regarding chinook salmon, chum salmon and steelhead trout that were radio tagged on the lower Nass River, 1992.

Oper. tag no.	Radio tag Channel [a]	Radio tag Code	Nose-fork length (cm)	Sex	Method of capture	Tagging date	Release time	Release site Latitude	Release site Longitude
280	13	23	96.0	F	wheel 1	6-Jul	14:35	55.1967	129.2044
281	11	21	92.0	M	wheel 1	6-Jul	14:40	55.1967	129.2044
282	17	32	87.0	M	wheel 1	6-Jul	14:42	55.1967	129.2044
283	18	15	98.0	F	wheel 1	6-Jul	14:59	55.1967	129.2044
284	13	7	98.0	F	wheel 1	6-Jul	15:22	55.1967	129.2044
285	13	17	95.0	M	wheel 1	6-Jul	16:47	55.1967	129.2044
286	13	25	83.0	M	wheel 1	6-Jul	18:46	55.1967	129.2044
287	14	14	96.5	F	wheel 1	6-Jul	19:51	55.1967	129.2044
288	15	2	97.0	F	wheel 1	6-Jul	19:53	55.1967	129.2044
289	14	10	82.0	M	wheel 1	6-Jul	20:06	55.1967	129.2044
290	18	30	95.0	M	wheel 1	6-Jul	20:11	55.1967	129.2044
291	17	16	105.0	M	wheel 2	6-Jul	20:56	55.1907	129.2487
292	15	13	78.0	M	wheel 2	6-Jul	20:58	55.1907	129.2487
294	12	11	90.5	F	wheel 2	6-Jul	21:01	55.1907	129.2487
295	17	9	93.0	M	wheel 2	6-Jul	21:06	55.1907	129.2487
296	13	1	90.0	M	wheel 2	6-Jul	21:09	55.1907	129.2487
297	19	31	89.5	M	wheel 2	6-Jul	21:12	55.1907	129.2487
298	19	4	85.0	F	wheel 1	6-Jul	21:45	55.1967	129.2044
299	14	12	91.0	F	wheel 1	6-Jul	21:50	55.1967	129.2044
300	19	5	101.0	M	wheel 1	7-Jul	8:49	55.1967	129.2044
301	17	33	97.0	F	wheel 2	7-Jul	11:48	55.1907	129.2487
302	13	24	91.5	M	wheel 2	7-Jul	11:51	55.1907	129.2487
303	11	20	98.0	M	wheel 2	7-Jul	11:53	55.1907	129.2487
304	13	10	103.0	F	wheel 2	7-Jul	11:55	55.1907	129.2487
305	17	2	97.5	F	wheel 2	7-Jul	11:57	55.1907	129.2487
306	20	11	86.0	F	wheel 1	7-Jul	12:17	55.1967	129.2044
307	20	3	110.5	M	wheel 1	7-Jul	12:19	55.1967	129.2044
308	17	37	89.0	F	wheel 1	7-Jul	12:23	55.1967	129.2044
309	17	30	94.0	F	wheel 1	7-Jul	12:25	55.1967	129.2044
310	12	39	91.0	F	wheel 1	7-Jul	12:27	55.1967	129.2044
311	15	34	94.0	M	wheel 1	7-Jul	12:29	55.1967	129.2044
312	11	25	82.0	F	wheel 1	7-Jul	13:03	55.1967	129.2044
313	13	28	82.0	F	wheel 1	7-Jul	13:14	55.1967	129.2044
314	19	29	75.0	F	wheel 1	7-Jul	13:50	55.1967	129.2044
315	16	24	97.0	F	wheel 1	7-Jul	13:55	55.1967	129.2044
316	13	26	96.5	F	wheel 1	7-Jul	16:37	55.1967	129.2044
317	12	14	77.0	F	wheel 2	7-Jul	17:20	55.1907	129.2487
318	11	23	91.0	F	wheel 1	7-Jul	17:26	55.1967	129.2044
319	11	4	90.0	M	wheel 1	7-Jul	18:05	55.1967	129.2044
320	20	13	90.0	F	wheel 1	8-Jul	14:00	55.1967	129.2044
321	19	9	99.5	M	wheel 1	8-Jul	14:03	55.1967	129.2044

Table A-3. Information regarding chinook salmon, chum salmon and steelhead trout that were radio tagged on the lower Nass River, 1992.

Oper. tag no.	Radio tag Channel [a]	Radio tag Code	Nose-fork length (cm)	Sex	Method of capture	Tagging date	Release time	Release site Latitude	Release site Longitude
322	15	6	100.0	F	wheel 1	8-Jul	14:12	55.1967	129.2044
323	19	21	87.0	M	wheel 1	8-Jul	14:15	55.1967	129.2044
324	13	35	90.0	F	wheel 1	8-Jul	14:17	55.1967	129.2044
325	15	19	74.5	M	wheel 1	8-Jul	14:37	55.1967	129.2044
326	18	17	96.0	M	wheel 1	8-Jul	14:38	55.1967	129.2044
327	14	16	93.0	F	wheel 1	8-Jul	14:40	55.1967	129.2044
328	20	1	75.0	F	wheel 1	8-Jul	14:43	55.1967	129.2044
329	14	27	82.0	F	wheel 2	8-Jul	15:26	55.1907	129.2487
330	14	22	73.5	M	wheel 2	8-Jul	15:29	55.1907	129.2487
331	19	32	92.0	F	wheel 2	8-Jul	15:32	55.1907	129.2487
332	13	15	91.0	F	wheel 1	8-Jul	17:12	55.1967	129.2044
333	12	7	95.0	F	wheel 1	8-Jul	17:18	55.1967	129.2044
334	13	20	79.0	F	wheel 1	8-Jul	17:22	55.1967	129.2044
335	13	2	92.0	M	wheel 1	8-Jul	17:32	55.1967	129.2044
336	13	3	101.0	M	wheel 1	8-Jul	17:39	55.1967	129.2044
337	20	18	84.0	M	wheel 1	8-Jul	17:48	55.1967	129.2044
N/A	19	10	99.0	?	wheel 1	9-Jul	9:37	55.1967	129.2044
N/A	19	14	N/A	?	wheel 1	9-Jul	9:58	55.1967	129.2044
339	16	36	85.0	F	wheel 1	9-Jul	9:35	55.1967	129.2044
340	14	17	103.0	M	wheel 1	9-Jul	9:41	55.1967	129.2044
341	11	29	98.0	F	wheel 1	9-Jul	9:43	55.1967	129.2044
342	16	23	89.0	F	wheel 1	9-Jul	9:50	55.1967	129.2044
343	20	27	93.0	F	wheel 1	9-Jul	9:52	55.1967	129.2044
344	16	41	90.0	F	wheel 1	9-Jul	9:55	55.1967	129.2044
345	14	37	88.0	M	wheel 1	9-Jul	10:05	55.1967	129.2044
346	17	25	88.0	M	wheel 1	9-Jul	11:31	55.1967	129.2044
347	16	32	88.0	F	wheel 1	9-Jul	13:05	55.1967	129.2044
348	16	19	73.0	M	wheel 1	9-Jul	13:08	55.1967	129.2044
349	16	35	100.0	F	wheel 1	9-Jul	13:10	55.1967	129.2044
350	18	1	87.0	F	wheel 1	9-Jul	20:24	55.1967	129.2044
351	17	34	91.0	F	wheel 1	9-Jul	20:28	55.1967	129.2044
352	11	24	84.0	M	wheel 1	9-Jul	20:40	55.1967	129.2044
353	11	26	91.0	F	wheel 1	9-Jul	20:47	55.1967	129.2044
354	20	4	96.0	F	wheel 1	9-Jul	20:54	55.1967	129.2044
355	16	18	81.0	M	wheel 1	9-Jul	20:55	55.1967	129.2044
356	14	39	90.0	F	wheel 2	9-Jul	21:22	55.1907	129.2487
357	16	20	95.5	M	wheel 1	10-Jul	10:30	55.1967	129.2044
358	16	40	88.5	F	wheel 1	10-Jul	10:51	55.1967	129.2044
359	19	30	88.0	M	wheel 1	10-Jul	11:23	55.1967	129.2044
360	16	22	96.0	F	wheel 2	10-Jul	14:35	55.1907	129.2487
361	16	21	99.0	F	wheel 2	10-Jul	14:48	55.1907	129.2487

Table A-3. Information regarding chinook salmon, chum salmon and steelhead trout that were radio tagged on the lower Nass River, 1992.

Oper. tag no.	Radio tag Channel [a]	Radio tag Code	Nose-fork length (cm)	Sex	Method of capture	Tagging date	Release time	Release site Latitude	Release site Longitude
362	16	28	103.0	F	wheel 1	10-Jul	16:26	55.1967	129.2044
363	15	11	91.0	M	wheel 1	11-Jul	7:43	55.1967	129.2044
364	16	31	99.0	F	wheel 2	11-Jul	8:40	55.1907	129.2487
365	16	6	84.0	M	wheel 2	11-Jul	9:05	55.1907	129.2487
366	15	10	95.0	F	wheel 1	11-Jul	15:45	55.1967	129.2044
367	12	2	102.0	M	wheel 1	11-Jul	20:35	55.1967	129.2044
368	15	15	85.0	M	wheel 2	11-Jul	21:30	55.1907	129.2487
369	12	25	99.0	F	wheel 1	12-Jul	13:46	55.1967	129.2044
370	12	29	88.0	M	wheel 1	12-Jul	13:55	55.1967	129.2044
371	16	38	78.0	F	wheel 2	12-Jul	14:37	55.1907	129.2487
373	12	27	96.0	F	wheel 2	12-Jul	14:42	55.1907	129.2487
372	15	7	81.0	F	wheel 2	15-Jul	8:35	55.1907	129.2487
374	15	5	94.0	F	wheel 1	15-Jul	15:30	55.1967	129.2044
375	15	3	85.0	F	wheel 1	17-Jul	8:14	55.1967	129.2044
376	14	24	90.5	F	wheel 2	17-Jul	9:49	55.1907	129.2487
377	16	37	96.0	M	wheel 2	17-Jul	9:54	55.1907	129.2487
N/A	19	34	97.0	M	wheel 2	18-Jul	9:34	55.1907	129.2487
378	11	30	74.0	M	wheel 2	18-Jul	9:12	55.1907	129.2487
380	16	26	97.0	F	wheel 1	18-Jul	20:48	55.1967	129.2044
381	16	17	84.0	M	wheel 1	19-Jul	7:40	55.1967	129.2044
382	11	24	102.0	F	set	27-Jul	11:06	55.3402	129.0371
401	11	28	75.0	M	wheel 2	27-Jul	8:24	55.1907	129.2487
383	14	19	99.0	F	wheel 1	1-Aug	19:48	55.1967	129.2044
384	14	20	95.5	F	wheel 1	2-Aug	20:20	55.1967	129.2044
N/A	12	15	92.0	F	wheel 1	3-Aug	14:36	55.1967	129.2044
385	12	30	92.0	F	wheel 1	4-Aug	8:21	55.1967	129.2044
388	19	25	98.0	F	wheel 1	10-Aug	14:55	55.1967	129.2044
389	16	39	84.0	F	wheel 1	11-Aug	11:00	55.1967	129.2044
392	17	28	107.0	F	wheel 1	11-Aug	21:00	55.1967	129.2044
394	15	25	104.0	F	wheel 1	12-Aug	9:45	55.1967	129.2044
395	17	20	109.0	F	wheel 1	12-Aug	16:00	55.1967	129.2044
396	16	11	86.0	F	wheel 2	12-Aug	21:15	55.1907	129.2487
398	11	37	93.0	F	wheel 1	24-Aug	9:25	55.1967	129.2044
400	16	3	89.0	F	wheel 1	29-Aug	9:49	55.1967	129.2044

Table A-3. Information regarding chinook salmon, chum salmon and steelhead trout that were radio tagged on the lower Nass River, 1992.

Oper.	Radio tag		Nose-fork		Method	Tagging	Release	Release site	
tag no.	Channel [a]	Code	length (cm)	Sex	of capture	date	time	Latitude	Longitude
Chum									
402	13	5	75.0	F	wheel 1	31-Aug	11:23	55.1967	129.2044
405	15	22	71.0	M	wheel 2	3-Sep	10:10	55.1907	129.2487
406	16	8	72.0	F	wheel 1	4-Sep	9:25	55.1967	129.2044
407	12	28	66.0	F	wheel 1	4-Sep	9:30	55.1967	129.2044
410	15	29	72.0	F	wheel 1	11-Sep	9:15	55.1967	129.2044
Steelhead									
1	16	15	N/A	?	drift	14-May	9:10	55.1872	129.2412
18	16	14	72.0	?	wheel 2	9-Jun	21:02	55.1872	129.2412
44	16	2	75.0	F	set	19-Jun	12:03	55.0917	129.4350
N/A	16	29	75.0	F	wheel 2	24-Jun	21:50	55.1907	129.2487
386	19	1	74.5	F	wheel 1	4-Aug	19:40	55.1967	129.2044
387	11	1	74.0	M	wheel 1	9-Aug	9:00	55.1967	129.2044
390	16	33	73.0	M	wheel 1	11-Aug	14:00	55.1967	129.2044
391	11	25	65.5	F	wheel 1	11-Aug	14:02	55.1967	129.2044
393	15	1	87.0	M	wheel 1	12-Aug	9:10	55.1967	129.2044
399	20	18	77.0	F	wheel 1	24-Aug	9:42	55.1967	129.2044
397	12	24	76.0	F	wheel 1	29-Aug	9:43	55.1967	129.2044
403	16	13	74.0	F	wheel 1	1-Sep	9:52	55.1967	129.2044
404	16	9	74.0	F	wheel 1	2-Sep	9:15	55.1967	129.2044
408	16	27	71.5	F	wheel 1	4-Sep	9:35	55.1967	129.2044

[a] Channel 11 = 149.520 MHz and channels increase by .02 MHz (i.e. channel 12 = 149.540; 13 = 149.560 etc)
NA = not applied; ? = unknown

Table A-4. Information concerning radio-tagged chinook salmon and steelhead trout recovered on the Nass River, 1992.

Recapture date	Radio tag Channel	Radio tag Code	Operculum tag No.	Operculum tag Present	Captured by	Tag recovered	Location[e]	Sex	Size (cm)	Date died	Arrival date	Days in system	Spawned
Chinook													
20-May	12	13	2	Y	Marcel Guno	Y	FF	?	100.0	NA			
25-Jun	14	3	15	Y	Henry McKay	N	FF	?	88.0	NA			
25-Jun	14	25	10	?	Phillip Stevens	Y	FF	?	87.0	NA			
20-Jun	17	36	50	Y	Gordon McKay	N	FF	?	100.0	NA			
09-Jun	19	2	154	Y	Mitch Morven	N	FF	M	91.0	NA			
10-Jul	14	19	83	?	Danny Smith	Y	FF	M	86.0	NA			
09-Jul	11	37	16	?	Peter Smith	Y	FF	F	95.0	NA			
12-Jul	11	25	312	?	Mitch Morven	Y	FF	F	82.0	NA			
12-Jul	12	36	201	Y	Mitch Morven	N	FF	M	93.0	NA			
16-Jul	11	24	352	?	Ruben Gunu	Y	FF	M	84.0	NA			
16-Jul	13	20	334	?	Ben Gunu	Y	FF	F	79.0	NA			
19-Jul	20	18	337	?	Kevin Azak	Y	FF	M	84.0	NA			
17-Jul	14	24	376	?	Peter Smith	Y	FF	F	90.5	NA			
17-Jul	14	39	356	?	Peter Smith	Y	FF	F	90.0	NA			
21-Jul	12	25	369	?	Sam Haizimsque	Y	FF	F	99.0	NA			
25-Jul	11	36	261	Y	Chester White	Y	FF	F	94.0	NA			
27-Jul	13	5	109	?	Siren Hansen	Y	SF	M	87.0	NA			
25-Jul	15	12	39	?	Joe Grandison	Y	FF	M	72.0	NA			
?-Jul	15	43	78	?	unknown	Y	C-SF	F	88.0	NA			
02-Aug	12	5	107	?	Patrick Clayton	Y	NMS	M	82.0	04-Aug			yes
18-Aug	11	3	119	N	Brenda Nass	Y	K	M	94.0	?	28-Jul		no
24-Aug	19	6	47	?	Mike Galesloot	Y	K	F	101.0	?			no

Table A-4. Information concerning radio-tagged chinook salmon and steelhead trout recovered on the Nass River, 1992.

Recapture	Radio tag		Operculum tag		Captured	Tag				Date	Arrival	Days in	
date	Channel	Code	No.	Present	by	recovered	Location[e]	Sex	Size (cm)	died	date	system	Spawned
21-Aug	14	34	32	?	Michael Link	Y	D	F	91.0	16-Aug	05-Aug	11	yes
29-Aug	13	41	121	?	Richard Alexander	Y	O	M	94.0	?[a]			?[a]
24-Jul	18	16	71	?	Stephan Erni	Y	C-SF	F	104.0	NA			
23-Jul	12	33	80	?	Parker Francis	Y	C-SF	F	93.0	NA			
03-Sep	19	19	113	Y	Michael Link	Y	D	F	95.0	31-Aug	06-Aug	25	yes
03-Sep	12	6	267	Y	Michael Link	Y	D	F	103.0	28-Aug	08-Aug	20	yes
03-Sep	18	29	22	N	Michael Link	Y	D	M	92.0	30-Aug	06-Aug	24	yes
03-Sep	14	4	168	N	Michael Link	Y	D	F	96.5	30-Aug	15-Aug	12[d]	yes
01-Sep	14	12	299	Y	Denis Olson	Y	C	F	91.0	30-Aug	29-Jul	32	yes
05-Sep	12	41	145	?	Richard Alexander	Y	T	M	108.0	?[a]		N/A	?[a]
05-Sep	17	26	269	N	Richard Alexander	Y	S	F	89.0	01-Sep	N/A	N/A	yes
06-Sep	15	39	100	Y	Richard Alexander	Y	O	F	100.0	30-Aug	N/A	N/A	yes
06-Sep	16	39	389	?	Mike Ravenscroft	Y	Ts	F	84.0	still alive		0	?[b]
10-Sep	19	12	264	N	Michael Link	Y	D	F	91.0	08-Sep	04-Aug	30	yes
10-Sep	12	11	294	Y	Michael Link	Y	D	F	90.5	09-Sep	14-Aug	26	yes
10-Sep	15	3	375	Y	Michael Link	Y	D	F	85.0	05-Sep	05-Aug	31	yes
10-Sep	17	37	308	Y	Michael Link	Y[c]	D	F	89.0	11-Sep	04-Aug	38	yes
10-Sep	13	22	193	Y	Mike Galesloot	Y	D	F	92.0	01-Sep	13-Aug	19	yes
10-Sep	13	23	280	N	Michael Link	Y	D	F	96.0	08-Sep	14-Aug	25	yes
10-Sep	16	20	357	Y	Ralph Tingle	Y	D	M	95.5	07-Sep	12-Aug	26	yes
10-Sep	14	22	330	Y	Mike Galesloot	Y	D	M	73.5	09-Sep	15-Aug	25	yes
10-Sep	11	39	176	Y	Michael Link	Y[c]	D	M	92.0	05-Sep	06-Aug	30	?[b]

Table A-4. Information concerning radio-tagged chinook salmon and steelhead trout recovered on the Nass River, 1992.

Recapture	Radio tag		Operculum tag		Captured	Tag				Date	Arrival	Days in	
date	Channel	Code	No.	Present	by	recovered	Location[e]	Sex	Size (cm)	died	date	system	Spawned
10-Sep	18	24	142	N	Michael Link	Y[c]	D	F	96.0	10-Sep	06-Aug	35	yes
10-Sep	18	18	213	Y	Mike Galesloot	Y[c]	D	F	101.0	08-Sep	N/A	N/A	yes
10-Sep	19	26	189	Y	Michael Link	Y	D	F	94.0	09-Sep	14-Aug	26	yes
11-Sep	20	16	92	?	Ralph Tingle	Y	D	M	77.0	? - Jack			?[b]
?-Sep	13	7	284	?	Arthur Nyce	Y	K	F	98.0				
15-Sep	17	32	282	N	Michael Link	Y	K	M	87.0	07-Sep	31-Jul	38	yes
14-Sep	20	27	343	N	Ken Belford	Y	D	F	93.0	13-Sep	12-Aug	32	yes
15-Sep	17	17	54	Y	Michael Link	Y	K	F	77.0	06-Sep	N/A	N/A	yes
15-Sep	12	37	146	Y	Michael Link	Y	K	F	90.0	07-Sep	28-Jul	41	yes
09-Sep	15	46	76	Y	Mike Galesloot	Y	K	?	85.0	?			?
09-Sep	20	19	211	Y	Mike Galesloot	Y	K	M	94.0	?			?
04-Sep	18	26	68	Y	Mike Galesloot	Y	K	M	99.0	?			?
04-Sep	11	38	94	N	Mike Galesloot	Y	K	F	92.0	?			?
02-Sep	12	10	105	Y	Mike Galesloot	Y	K	M	85.0	?			?
03-Sep	12	39	310	Y	Mike Galesloot	Y	K	F	91.0	?			?
09-Sep	20	1	328	Y	Mike Galesloot	Y	K	F	75.0	?			?
16-Sep	12	34	62	Y	Michael Link	Y	D	F	99.0	10-Sep	07-Aug	34	yes
16-Sep	12	29	370	Y	Michael Link	Y	D	M	88.0	13-Sep	24-Aug	20	yes
16-Sep	14	23	195	Y	Michael Link	Y	D	M	88.0	12-Sep	03-Aug	40	yes
16-Sep	16	19	348	Y	Michael Link	Y	D	M	73.0	11-Sep	03-Aug	39	yes
16-Sep	16	21	361	Y	Michael Link	Y	D	F	99.0	13-Sep	30-Aug	14	yes
16-Sep	17	39	275	Y	Michael Link	Y	D	M	78.0	10-Sep	11-Aug	30	yes

Table A-4. Information concerning radio-tagged chinook salmon and steelhead trout recovered on the Nass River, 1992.

Recapture	Radio tag		Operculum tag		Captured	Tag				Date	Arrival	Days in	
date	Channel	Code	No.	Present	by	recovered	Location[e]	Sex	Size (cm)	died	date	system	Spawned
16-Sep	13	10	304	Y	Michael Link	Y	D	F	103.0	15-Sep	20-Aug	26	yes
16-Sep	20	35	225	Y	Michael Link	Y	D	M	90.0	10-Sep	07-Aug	34	yes
16-Sep	13	9	93	Y	Michael Link	Y	D	M	79.0	12-Sep	07-Aug	36	yes
?-Sep	20	6	214	?	Arthur Nyce	Y	K	M	80.5				
06-Sep	17	33	301	Y	Dallas Campbell	Y	C	F	97.0	02-Sep	31-Jul	33	yes
29-Sep	19	30	359	Y	Tim Angus	Y	M	M	88.0	26-Sep	26-Jul	62	yes
25-Jul	15	42	63	Y	Michael Mallais	Y	C-SF	M	106.0				killed
27-Jul	17	18	25	?	Michael Mallais	Y	C-SF	F	100.0				?[b]
Steelhead													
24-Sep	20	18	399	Y	Joe Grandison	Y	FF	M	77.0				
19-Aug	16	2	44	?	Louis McKay	Y	P	F	75.0				yes

[a] Predated by bear, spawning condition unknown.

[b] Spawning condition unknown - fish released alive.

[c] Dead tag recovered.

[d] The fixed station receiver indicated that #168 dropped back into the Nass River for 3 days (and #268 for 5 days).

[e] FF=Nisga'a Fishery, SF=sport fishery, C=Cranberry, D=Damdochax, K=Kwinageese, M=Meziadin, O=Oweegee, S=Snowbank, T=Teigen, Ts=Tseax, P=Portland Inlet and NMS=Nass Mainstem.

? = unknown

Table A-5. Information about chinook salmon that were spaghetti tagged on the lower Nass River, 1992.

Date	Fishwheel [a]	Sex	Nose-fork Length (cm)	Tag No.	Recovery location/date
08-Jul	1	M	64.5	2178	
08-Jul	1	M	66.0	2207	
08-Jul	1	M	55.0	2210	
08-Jul	1	F	74.0	2311	
08-Jul	1	M	63.0	2325	
08-Jul	1	F	67.0	2326	
08-Jul	1	F	75.0	2347	
08-Jul	1	M	66.5	2389	Damdochax / 9-Sep
08-Jul	1	F	103.0	2390	
08-Jul	1	M	68.0	2393	
08-Jul	1	F	56.0	2422	
08-Jul	1	F	50.5	2442	
09-Jul	1	M	68.0	2453	
09-Jul	1	M	59.0	2591	
09-Jul	1	F	64.5	2655	
09-Jul	1	F	64.0	2656	
09-Jul	1	M	68.0	2680	
09-Jul	1	F	65.0	2685	
09-Jul	1	F	72.0	2686	
09-Jul	1	M	41.0	2691	
09-Jul	2	M	35.0	2661	
09-Jul	2	M	40.0	2664	
09-Jul	2	M	78.0	2666	
10-Jul	1	M	99.0	2724	
10-Jul	1	M	95.0	2725	
10-Jul	1	F	95.0	2733	
10-Jul	1	M	62.5	2773	
10-Jul	1	M	62.0	2776	
10-Jul	1	M	67.0	2778	
10-Jul	1	M	97.0	2780	
10-Jul	1	M	94.0	2784	
10-Jul	1	F	89.0	2787	
10-Jul	1	F	94.5	2788	
10-Jul	1	M	67.0	2789	Damdochax / 9-Sep
10-Jul	1	F	91.0	2790	
10-Jul	1	F	91.0	2791	
10-Jul	1	M	45.0	2810	
10-Jul	1	F	88.0	2813	
10-Jul	2	F	66.0	2742	
10-Jul	2	M	100.0	2770	
10-Jul	2	M	95.0	2826	

Table A-5. Information about chinook salmon that were spaghetti tagged on the lower Nass River, 1992.

Date	Fishwheel [a]	Sex	Nose-fork Length (cm)	Tag No.	Recovery location/date
10-Jul	2	M	40.0	2827	
10-Jul	2	M	41.5	2828	
10-Jul	2	M	69.0	2829	
10-Jul	2	F	65.0	2830	Cranberry / 1-Sep
10-Jul	2	F	63.0	2831	Meziadin sport fishery / 6-Aug
11-Jul	1	F	69.0	2835	
11-Jul	1	F	92.5	2872	
11-Jul	1	M	70.5	2873	
11-Jul	1	M	99.0	2881	
11-Jul	2	M	61.0	2858	
11-Jul	2	M	60.5	2862	
11-Jul	2	M	73.5	2866	Damdochax / 16-Sep
11-Jul	2	M	58.5	2868	
11-Jul	2	M	45.0	2871	
11-Jul	2	M	60.0	2874	Meziadin fishway / 9-Aug
11-Jul	2	F	58.5	2875	
11-Jul	2	M	52.5	2884	
12-Jul	1	F	90.0	2892	
12-Jul	1	M	55.0	2907	
12-Jul	2	M	61.0	2906	
12-Jul	2	F	73.0	2910	
17-Jul	2	M	63.5	3285	
18-Jul	1	F	65.0	3350	
18-Jul	1	M	108.0	3386	
23-Jul	1	M	60.0	3663	
24-Jul	1	F	49.0	3721	
26-Jul	1	F	59.0	3788	
02-Aug	1	M	66.5	4035	
02-Aug	1	M	41.0	4069	
06-Aug	1	M	71.0	4327	
07-Aug	1	F	60.4	4378	
09-Aug	1	F	93.0	4521	
13-Aug	1	M	91.5	4920	

[a] Fishwheel 1 was located at 55.1967 degrees north latitude and 129.2044 degrees west longitude; fishwheel 2 was located at 55.1907 degrees north latitude and 129.2487 degrees west longitude.

Table B-1. Systematic and incidental telemetry surveys conducted in the Nass River drainage, 1992. The primary purpose (priority), dates and times of each survey are listed.

System	Survey priority	Date	Start time	End time
Anudol Creek	Radio track	92/08/14	10:52	10:54
Anudol Creek	Radio track	92/08/26	10:31	10:31
Bell-Irving mainstem	Radio track	92/08/14	17:30	17:49
Bell-Irving mainstem	Radio track	92/08/18	08:59	09:36
Bell-Irving mainstem	Radio track	92/08/18	09:44	09:54
Bell-Irving mainstem	Radio track	92/08/18	11:16	12:48
Bell-Irving mainstem	Radio track	92/08/20	11:01	11:20
Bell-Irving mainstem	Radio track	92/08/20	13:43	13:47
Bell-Irving mainstem	Radio track	92/08/20	14:06	15:01
Bell-Irving mainstem	Escapement count	92/09/05	11:36	11:57
Bell-Irving mainstem	Escapement count	92/09/05	12:09	12:20
Bell-Irving mainstem	Opportunistic survey	92/09/05	12:28	12:35
Bell-Irving mainstem	Escapement count	92/09/05	16:39	16:43
Bell-Irving mainstem	Opportunistic survey	92/09/05	17:00	17:00
Bell-Irving mainstem	Escapement count	92/09/06	12:19	12:22
Tchitin River	Radio track	92/07/26	15:57	16:05
Tchitin River	Radio track	92/08/04	08:20	08:30
Tchitin River	Opportunistic survey	92/08/10	06:35	06:37
Tchitin River	Opportunistic survey	92/08/14	15:48	15:50
Tchitin River	Radio track	92/08/18	14:40	15:02
Tchitin River	Opportunistic survey	92/08/20	08:22	08:29
Tchitin River	Opportunistic survey	92/08/26	14:24	14:24
Tchitin River	Opportunistic survey	92/08/31	11:10	11:14
Tchitin River	Opportunistic survey	92/09/05	08:46	08:51
Tchitin River	Opportunistic survey	92/09/16	08:18	08:20
Tchitin River	Radio track	92/09/24	14:34	14:39
Cranberry River	Radio track	92/07/26	14:55	15:45
Cranberry River	Opportunistic survey	92/07/26	15:45	15:48
Cranberry River	Radio track	92/08/04	17:19	18:00
Cranberry River	Escapement count	92/08/13	08:48	08:52
Cranberry River	Opportunistic survey	92/08/13	10:08	10:10
Cranberry River	Escapement count	92/08/13	11:36	11:57
Cranberry River	Escapement count	92/08/13	11:58	12:15
Cranberry River	Escapement count	92/08/13	12:16	12:25
Cranberry River	Opportunistic survey	92/08/17	14:21	14:21
Cranberry River	Radio track	92/08/19	08:13	08:54
Cranberry River	Radio track	92/08/19	10:33	10:34
Cranberry River	Escapement count	92/08/19	12:28	14:23
Cranberry River	Escapement count	92/08/25	10:19	10:21
Cranberry River	Escapement count	92/08/25	10:26	13:42
Cranberry River	Escapement count	92/09/02	10:11	11:29
Damdochax Creek	Escapement count	92/08/04	11:11	12:17
Damdochax Creek	Escapement count	92/08/10	10:22	11:14
Damdochax Creek	Radio track	92/08/10	15:55	15:56

Table B-1. Systematic and incidental telemetry surveys conducted in the Nass River drainage, 1992. The primary purpose (priority), dates and times of each survey are listed.

System	Survey priority	Date	Start time	End time
Damdochax Creek	Opportunistic survey	92/08/13	18:16	18:21
Damdochax Creek	Radio track	92/08/17	10:09	10:33
Damdochax Creek	Opportunistic survey	92/08/27	08:53	08:54
Damdochax Creek	Escapement count	92/08/27	12:50	13:30
Damdochax Creek	Opportunistic survey	92/08/27	13:48	13:53
Damdochax Creek	Opportunistic survey	92/08/27	15:56	16:05
Damdochax Creek	Opportunistic survey	92/09/03	08:35	08:41
Damdochax Creek	Escapement count	92/09/03	12:33	13:15
Damdochax Creek	Escapement count	92/09/03	15:49	15:59
Damdochax Creek	Opportunistic survey	92/09/03	17:31	17:34
Damdochax Creek	Opportunistic survey	92/09/16	12:34	12:36
Damdochax Creek	Opportunistic survey	92/09/16	17:14	17:16
Hodder Creek	Escapement count	92/08/20	11:20	11:22
Ishkheenickh River	Escapement count	92/08/14	08:10	08:22
Kincolith River	Escapement count	92/08/14	09:10	09:30
Kiteen River	Escapement count	92/08/13	08:53	09:40
Kiteen River	Radio track	92/08/19	09:25	10:32
Kiteen River	Opportunistic survey	92/08/19	14:36	14:38
Kiteen River	Opportunistic survey	92/08/25	10:21	10:25
Kotsinta Creek	Escapement count	92/09/03	17:43	18:00
Ksedin River	Escapement count	92/08/14	10:05	10:10
Kwinageese River	Radio track	92/08/04	14:50	15:53
Kwinageese River	Opportunistic survey	92/08/07	17:56	18:03
Kwinageese River	Opportunistic survey	92/08/13	16:07	16:09
Kwinageese River	Radio track	92/08/13	16:39	16:56
Kwinageese River	Opportunistic survey	92/08/13	19:55	19:57
Kwinageese River	Opportunistic survey	92/08/17	08:01	08:09
Kwinageese River	Radio track	92/08/18	13:05	13:49
Kwinageese River	Opportunistic survey	92/08/21	18:00	18:04
Kwinageese River	Escapement count	92/08/26	12:11	12:19
Kwinageese River	Escapement count	92/08/26	12:20	12:22
Kwinageese River	Escapement count	92/08/26	12:23	13:01
Kwinageese River	Escapement count	92/08/26	13:02	13:07
Kwinageese River	Escapement count	92/08/26	13:07	13:12
Kwinageese River	Opportunistic survey	92/08/26	14:02	14:04
Kwinageese River	Opportunistic survey	92/08/27	08:08	08:20
Kwinageese River	Opportunistic survey	92/08/27	08:30	08:34
Kwinageese River	Opportunistic survey	92/08/27	16:25	16:31
Kwinageese River	Opportunistic survey	92/08/27	16:32	16:47
Kwinageese River	Opportunistic survey	92/08/31	14:32	14:39
Kwinageese River	Opportunistic survey	92/08/31	14:40	14:44
Kwinageese River	Opportunistic survey	92/08/31	16:19	16:30
Kwinageese River	Escapement count	92/09/02	12:52	13:09
Kwinageese River	Escapement count	92/09/02	13:11	13:13

Table B-1. Systematic and incidental telemetry surveys conducted in the Nass River drainage, 1992. The primary purpose (priority), dates and times of each survey are listed.

System	Survey priority	Date	Start time	End time
Kwinageese River	Escapement count	92/09/02	13:14	13:54
Kwinageese River	Opportunistic survey	92/09/02	14:35	14:40
Kwinageese River	Opportunistic survey	92/09/16	08:58	09:05
Kwinageese River	Opportunistic survey	92/09/16	10:50	10:54
Kwinatahl River	Escapement count	92/08/14	18:32	18:38
Meziadin River	Radio track	92/07/26	11:23	11:26
Meziadin River	Radio track	92/07/26	11:26	11:28
Meziadin River	Radio track	92/07/26	11:28	11:31
Meziadin River	Opportunistic survey	92/07/26	12:22	12:23
Meziadin River	Opportunistic survey	92/07/26	12:24	12:24
Meziadin River	Opportunistic survey	92/07/26	12:25	12:26
Meziadin River	Radio track	92/08/04	09:58	10:38
Meziadin River	Opportunistic survey	92/08/04	13:58	14:03
Meziadin River	Radio track	92/08/07	13:46	13:56
Meziadin River	Radio track	92/08/10	14:47	15:10
Meziadin River	Radio track	92/08/14	16:00	16:19
Meziadin River	Radio track	92/08/14	16:20	16:22
Meziadin River	Radio track	92/08/14	16:23	16:26
Meziadin River	Opportunistic survey	92/08/14	17:57	18:02
Meziadin River	Radio track	92/08/18	08:17	08:38
Meziadin River	Radio track	92/08/20	08:46	08:58
Meziadin River	Radio track	92/08/20	15:47	15:51
Meziadin River	Radio track	92/08/25	08:47	08:53
Meziadin River	Radio track	92/08/25	08:54	08:58
Meziadin River	Radio track	92/08/25	08:59	09:06
Meziadin River	Radio track	92/08/31	11:37	11:39
Meziadin River	Radio track	92/08/31	11:40	11:44
Meziadin River	Radio track	92/08/31	11:45	11:51
Meziadin River	Opportunistic survey	92/09/05	09:22	10:16
Meziadin River	Opportunistic survey	92/09/05	10:50	10:53
Meziadin River	Escapement count	92/09/06	13:07	13:15
Meziadin River	Escapement count	92/09/06	13:16	13:21
Meziadin River	Radio track	92/09/10	12:37	13:24
Meziadin River	Radio track	92/09/24	12:06	12:15
Muskaboo Creek	Escapement count	92/08/17	11:05	11:20
Nass River mainstem	Radio track	92/07/13	08:28	08:31
Nass River mainstem	Radio track	92/07/13	12:17	12:20
Nass River mainstem	Radio track	92/07/13	12:22	13:25
Nass River mainstem	Radio track	92/07/13	13:26	13:30
Nass River mainstem	Opportunistic survey	92/07/26	08:40	08:48
Nass River mainstem	Opportunistic survey	92/07/26	08:49	08:58
Nass River mainstem	Opportunistic survey	92/07/26	10:23	10:25
Nass River mainstem	Opportunistic survey	92/07/26	10:26	10:31
Nass River mainstem	Opportunistic survey	92/07/26	11:15	11:22

Table B-1. Systematic and incidental telemetry surveys conducted in the Nass River drainage, 1992. The primary purpose (priority), dates and times of each survey are listed.

System	Survey priority	Date	Start time	End time
Nass River mainstem	Opportunistic survey	92/07/26	13:30	13:31
Nass River mainstem	Opportunistic survey	92/07/26	13:32	13:59
Nass River mainstem	Opportunistic survey	92/07/26	15:49	15:56
Nass River mainstem	Opportunistic survey	92/07/26	16:06	16:18
Nass River mainstem	Opportunistic survey	92/08/04	08:16	08:19
Nass River mainstem	Opportunistic survey	92/08/04	11:00	11:01
Nass River mainstem	Radio track	92/08/04	11:38	12:17
Nass River mainstem	Opportunistic survey	92/08/04	12:20	12:31
Nass River mainstem	Opportunistic survey	92/08/04	13:53	13:58
Nass River mainstem	Opportunistic survey	92/08/04	15:55	15:55
Nass River mainstem	Opportunistic survey	92/08/04	18:01	18:19
Nass River mainstem	Opportunistic survey	92/08/07	13:15	13:25
Nass River mainstem	Opportunistic survey	92/08/07	13:26	13:45
Nass River mainstem	Opportunistic survey	92/08/07	14:26	14:32
Nass River mainstem	Opportunistic survey	92/08/07	15:31	15:39
Nass River mainstem	Opportunistic survey	92/08/07	16:00	16:05
Nass River mainstem	Opportunistic survey	92/08/07	16:06	16:15
Nass River mainstem	Opportunistic survey	92/08/07	17:28	17:38
Nass River mainstem	Opportunistic survey	92/08/07	17:39	17:40
Nass River mainstem	Opportunistic survey	92/08/07	19:12	19:25
Nass River mainstem	Radio track	92/08/10	06:31	06:34
Nass River mainstem	Radio track	92/08/10	12:06	12:15
Nass River mainstem	Radio track	92/08/10	12:36	12:37
Nass River mainstem	Radio track	92/08/10	15:11	15:19
Nass River mainstem	Radio track	92/08/10	15:20	15:24
Nass River mainstem	Radio track	92/08/10	15:25	15:26
Nass River mainstem	Radio track	92/08/10	15:27	15:40
Nass River mainstem	Radio track	92/08/10	15:40	15:54
Nass River mainstem	Opportunistic survey	92/08/13	08:02	08:10
Nass River mainstem	Opportunistic survey	92/08/13	12:26	12:52
Nass River mainstem	Opportunistic survey	92/08/13	14:57	14:58
Nass River mainstem	Opportunistic survey	92/08/13	19:33	19:43
Nass River mainstem	Opportunistic survey	92/08/13	19:50	19:51
Nass River mainstem	Opportunistic survey	92/08/13	20:36	20:43
Nass River mainstem	Radio track	92/08/14	07:32	07:38
Nass River mainstem	Radio track	92/08/14	07:39	07:53
Nass River mainstem	Radio track	92/08/14	07:54	08:00
Nass River mainstem	Radio track	92/08/14	09:43	10:00
Nass River mainstem	Radio track	92/08/14	10:01	10:15
Nass River mainstem	Radio track	92/08/14	10:16	10:24
Nass River mainstem	Radio track	92/08/14	10:28	10:36
Nass River mainstem	Radio track	92/08/14	17:50	17:56
Nass River mainstem	Radio track	92/08/14	18:03	18:04
Nass River mainstem	Radio track	92/08/14	18:05	18:25

Table B-1. Systematic and incidental telemetry surveys conducted in the Nass River drainage, 1992. The primary purpose (priority), dates and times of each survey are listed.

System	Survey priority	Date	Start time	End time
Nass River mainstem	Radio track	92/08/14	18:26	18:57
Nass River mainstem	Opportunistic survey	92/08/17	08:40	08:42
Nass River mainstem	Opportunistic survey	92/08/17	14:15	14:19
Nass River mainstem	Opportunistic survey	92/08/19	08:02	08:12
Nass River mainstem	Radio track	92/08/19	10:50	10:54
Nass River mainstem	Opportunistic survey	92/08/19	14:42	15:08
Nass River mainstem	Opportunistic survey	92/08/20	08:16	08:21
Nass River mainstem	Radio track	92/08/20	15:02	15:10
Nass River mainstem	Opportunistic survey	92/08/20	16:13	16:24
Nass River mainstem	Opportunistic survey	92/08/21	17:45	17:50
Nass River mainstem	Opportunistic survey	92/08/21	18:19	18:28
Nass River mainstem	Opportunistic survey	92/08/25	09:56	10:18
Nass River mainstem	Opportunistic survey	92/08/25	13:43	13:53
Nass River mainstem	Radio track	92/08/26	09:38	09:47
Nass River mainstem	Radio track	92/08/26	10:17	10:30
Nass River mainstem	Radio track	92/08/26	10:32	10:53
Nass River mainstem	Opportunistic survey	92/08/26	11:50	11:54
Nass River mainstem	Opportunistic survey	92/08/26	14:20	14:23
Nass River mainstem	Opportunistic survey	92/08/26	14:25	14:32
Nass River mainstem	Opportunistic survey	92/08/27	07:48	07:54
Nass River mainstem	Opportunistic survey	92/08/27	08:46	08:50
Nass River mainstem	Opportunistic survey	92/08/31	11:02	11:09
Nass River mainstem	Opportunistic survey	92/08/31	13:39	13:44
Nass River mainstem	Opportunistic survey	92/08/31	16:42	16:50
Nass River mainstem	Opportunistic survey	92/08/31	16:51	16:52
Nass River mainstem	Opportunistic survey	92/09/02	14:49	14:57
Nass River mainstem	Opportunistic survey	92/09/05	08:43	08:45
Nass River mainstem	Opportunistic survey	92/09/05	11:25	11:27
Nass River mainstem	Radio track	92/09/06	13:22	13:28
Nass River mainstem	Radio track	92/09/06	13:29	13:52
Nass River mainstem	Radio track	92/09/06	13:53	14:03
Nass River mainstem	Opportunistic survey	92/09/10	08:00	08:05
Nass River mainstem	Opportunistic survey	92/09/10	08:18	08:19
Nass River mainstem	Opportunistic survey	92/09/10	08:28	08:28
Nass River mainstem	Opportunistic survey	92/09/10	11:00	11:04
Nass River mainstem	Opportunistic survey	92/09/10	13:27	13:30
Nass River mainstem	Opportunistic survey	92/09/10	16:55	17:10
Nass River mainstem	Radio track	92/09/24	10:04	10:08
Nass River mainstem	Radio track	92/09/24	10:09	10:26
Nass River mainstem	Radio track	92/09/24	10:27	10:27
Nass River mainstem	Radio track	92/09/24	10:43	10:50
Nass River mainstem	Radio track	92/09/24	11:33	11:40
Nass River mainstem	Radio track	92/09/24	11:41	12:03
Nass River mainstem	Radio track	92/09/24	12:04	12:05

Table B-1. Systematic and incidental telemetry surveys conducted in the Nass River drainage, 1992. The primary purpose (priority), dates and times of each survey are listed.

System	Survey priority	Date	Start time	End time
Nass River mainstem	Radio track	92/09/24	12:16	12:33
Nass River mainstem	Radio track	92/09/24	13:24	13:27
Nass River mainstem	Radio track	92/09/24	14:40	14:47
Oweegee Creek	Radio track	92/08/18	09:37	09:43
Oweegee Creek	Radio track	92/08/20	13:48	14:05
Oweegee Creek	Escapement count	92/09/05	11:58	12:05
Oweegee Creek	Opportunistic survey	92/09/05	16:38	16:38
Oweegee Creek	Opportunistic survey	92/09/05	18:30	18:39
Oweegee Creek	Escapement count	92/09/06	10:36	12:18
Rochester Creek	Escapement count	92/08/20	10:10	10:17
Saladamis Creek	Escapement count	92/08/27	08:40	08:42
Sansixmor	Escapement count	92/08/17	12:12	12:16
Seaskinnish Creek	Radio track	92/08/19	14:56	15:04
Seaskinnish Creek	Opportunistic survey	92/08/25	13:56	13:58
Seaskinnish Creek	Radio track	92/08/26	09:14	09:37
Seaskinnish Creek	Opportunistic survey	92/09/10	16:51	16:54
Seaskinnish Creek	Opportunistic survey	92/09/24	10:00	10:02
Seaskinnish Creek	Radio track	92/09/24	14:48	14:56
Snowbank/Teigen creeks	Radio track	92/08/20	12:12	13:08
Snowbank/Teigen creeks	Escapement count	92/09/05	13:01	16:34
Snowbank/Teigen creeks	Radio track	92/08/18	09:55	11:15
Strohn Creek	Escapement count	92/08/14	16:38	16:42
Surprise Creek	Escapement count	92/08/14	16:25	16:36
Taft Creek	Radio track	92/08/20	09:54	10:08
Tseax River	Radio track	92/08/19	10:55	11:23
Tseax River	Radio track	92/08/19	16:19	17:15
Tseax River	Radio track	92/08/26	09:50	10:12
Tseax River	Opportunistic survey	92/09/10	17:11	17:20
Tseax River	Radio track	92/09/24	10:28	10:42
Tseax Slough	Opportunistic survey	92/08/14	10:25	10:27
Tseax Slough	Radio track	92/08/26	09:49	09:49
Tseax Slough	Radio track	92/08/26	10:13	10:15
Tseax Slough	Opportunistic survey	92/08/26	10:54	10:57
Tseax Slough	Opportunistic survey	92/09/10	17:02	17:10
Wiminasik Creek	Escapement count	92/08/17	12:00	12:03
Wiminasik Creek	Escapement count	92/09/03	12:27	12:30
Yaza/Slowmaldo creeks	Radio track	92/08/17	10:34	12:34
Zolzap Creek	Escapement count	92/08/14	10:21	10:23

Table C-1. Daily numbers of chinook salmon of different stocks recorded at fixed-station receiver sites on the mainstem Nass River, 1 July - 24 September 1992. See Figure 1 for receiver locations. Shaded dates indicate that the receiver was not operating.

	Stocks								
Date	Lower Nass	Cranberry	Meziadin	Taft-Oweegee	Middle Bell-Irving	Upper Bell-Irving	Kwinageese	Damdochax	All stocks
Fixed-station 1 (Grease Harbour)									
1-Jul		2		1	1				4
2-Jul		1						1	2
3-Jul									0
4-Jul									0
5-Jul		1							1
6-Jul		1			1				2
7-Jul		1			1	1			3
8-Jul					1				1
9-Jul								1	1
10-Jul		3			2	3	1	3	12
11-Jul	1	7	4	2	3	10	7	11	45
12-Jul		7	2	4	1	4	5	8	31
13-Jul		6	4	3		3	4	4	24
14-Jul		11	4	1		3	4	6	29
15-Jul		12	5	3	3	5	4	10	42
16-Jul	2	8	4	2	2	9	4	7	38
17-Jul	3	8	2	1	4	7	3	9	37
18-Jul	2	4	3	2	2	1	2	6	22
19-Jul		8	3	3		2	2	6	24
20-Jul	1	1	1	1				4	8
21-Jul									0
22-Jul									0
23-Jul									0
24-Jul	1		1				1		3
25-Jul		2					1	2	5
26-Jul		2	1			1	1	3	8
27-Jul	1	2				1			4
28-Jul									0
29-Jul		1							1
30-Jul		1					1		2
31-Jul	1	1	1					1	4
1-Aug	1		2						3
2-Aug	1		1					1	3
3-Aug		1							1
4-Aug									0
5-Aug	1								1
6-Aug									0
7-Aug									0
8-Aug									0
9-Aug									0
10-Aug							1		1
11-Aug									0
12-Aug	2								2
13-Aug									0
14-Aug									0
15-Aug									0
16-Aug									0
17-Aug									0
18-Aug									0

Table C-1. Daily numbers of chinook salmon of different stocks recorded at fixed-station receiver sites on the mainstem Nass River, 1 July - 24 September 1992. See Figure 1 for receiver locations. Shaded dates indicate that the receiver was not operating.

	Stocks								
Date	Lower Nass	Cranberry	Meziadin	Taft-Oweegee	Middle Bell-Irving	Upper Bell-Irving	Kwinageese	Damdochax	All stocks
Fixed-station 1 (cont)									
19-Aug									0
20-Aug									0
21-Aug									0
22-Aug									0
23-Aug									0
24-Aug									0
25-Aug									0
26-Aug									0
27-Aug									0
28-Aug		1							1
29-Aug									0
30-Aug									0
31-Aug									0
1-Sep									0
2-Sep									0
3-Sep		1							1
4-Sep									0
5-Sep									0
6-Sep									0
7-Sep		1							1
8-Sep									0
9-Sep									0
10-Sep									0
11-Sep									0
12-Sep									0
13-Sep									0
14-Sep									0
15-Sep									0
16-Sep									0
17-Sep									0
18-Sep									0
19-Sep									0
20-Sep	1								1
21-Sep									0
22-Sep									0
23-Sep									0
24-Sep									0

Table C-1. Daily numbers of chinook salmon of different stocks recorded at fixed-station receiver sites on the mainstem Nass River, 1 July - 24 September 1992. See Figure 1 for receiver locations. Shaded dates indicate that the receiver was not operating.

Date	Stocks: Lower Nass	Cranberry	Meziadin	Taft-Oweegee	Middle Bell-Irving	Upper Bell-Irving	Kwinageese	Damdochax	All stocks
Fixed-station 3 (Cranberry River mouth)									
1-Jul									0
2-Jul									0
3-Jul									0
4-Jul									0
5-Jul									0
6-Jul									0
7-Jul									0
8-Jul									0
9-Jul									0
10-Jul									0
11-Jul					1				1
12-Jul		1							1
13-Jul		1							1
14-Jul		1							1
15-Jul	1	1			1			2	5
16-Jul	1	10	2	1	3	4	6	6	33
17-Jul		7	3	2	1	7	8	7	35
18-Jul		11	4	7	1	5	6	9	43
19-Jul		12	4	2	2	12	4	10	46
20-Jul		9	3	1	5	7	4	9	38
21-Jul	1	7	2	1	3	2	1	8	25
22-Jul		10	2	1		1	3	5	22
23-Jul	2	9	1	1	1	2	1	4	21
24-Jul	1	7				3	1	2	14
25-Jul		8		1		1		4	14
26-Jul		7		2				1	10
27-Jul		5						1	6
28-Jul		5	2	1		2		1	11
29-Jul	1	4	3	1			1	2	12
30-Jul		2	1				2		5
31-Jul		4	1				1	1	7
1-Aug		3		1			1		5
2-Aug		1						2	3
3-Aug		3						1	4
4-Aug	1	3				1		1	6
5-Aug		1				1		1	3
6-Aug		1							1
7-Aug		2	1					1	4
8-Aug		2	1						3
9-Aug		1	1			1			3
10-Aug									0
11-Aug	1		1						2
12-Aug	2	1							3
13-Aug									0
14-Aug		1							1
15-Aug							1		1
16-Aug							1		1
17-Aug									0
18-Aug									0
19-Aug									0

Table C-1. Daily numbers of chinook salmon of different stocks recorded at fixed-station receiver sites on the mainstem Nass River, 1 July - 24 September 1992. See Figure 1 for receiver locations. Shaded dates indicate that the receiver was not operating.

	Stocks								
Date	Lower Nass	Cranberry	Meziadin	Taft-Oweegee	Middle Bell-Irving	Upper Bell-Irving	Kwinageese	Damdochax	All stocks
Fixed-station 3 (cont)									
20-Aug									0
21-Aug									0
22-Aug									0
23-Aug									0
24-Aug									0
25-Aug									0
26-Aug									0
27-Aug		1							1
28-Aug									0
29-Aug									0
30-Aug									0
31-Aug									0
1-Sep									0
2-Sep		1							1
3-Sep									0
4-Sep									0
5-Sep		1							1
6-Sep		1							1
7-Sep									0
8-Sep									0
9-Sep									0
10-Sep									0
11-Sep									0
12-Sep									0
13-Sep									0
14-Sep									0
15-Sep									0
16-Sep									0
17-Sep									0
18-Sep									0
19-Sep									0
20-Sep									0
21-Sep									0
22-Sep									0
23-Sep									0
24-Sep									0

Table C-1. Daily numbers of chinook salmon of different stocks recorded at fixed-station receiver sites on the mainstem Nass River, 1 July - 24 September 1992. See Figure 1 for receiver locations. Shaded dates indicate that the receiver was not operating.

Date	Stocks								All stocks
	Lower Nass	Cranberry	Meziadin	Taft-Oweegee	Middle Bell-Irving	Upper Bell-Irving	Kwinageese	Damdochax	
Fixed-station 8 (White River mouth)									
1-Jul									0
2-Jul									0
3-Jul									0
4-Jul									0
5-Jul									0
6-Jul									0
7-Jul									0
8-Jul									0
9-Jul									0
10-Jul									0
11-Jul									0
12-Jul									0
13-Jul									0
14-Jul									0
15-Jul									0
16-Jul									0
17-Jul									0
18-Jul					1				1
19-Jul	1	1						1	3
20-Jul	1	1		1	2	2	1	1	9
21-Jul	1			1	2	2	3		9
22-Jul		2	3	4	1	2	5	10	27
23-Jul		2	6	3	1	5	11	7	35
24-Jul			7	4	1	12	6	12	42
25-Jul		1	5	2	4	9		11	32
26-Jul			3	1	2	4	3	9	22
27-Jul	1	1	2		1	4	3	4	16
28-Jul			1	2	2	2		2	9
29-Jul	1		1	1	3	3	3	4	16
30-Jul		1	1	1	1	1	1	2	8
31-Jul	2	2		2			1	1	8
1-Aug	1		1			3		3	8
2-Aug			1			2	1	3	7
3-Aug	1	1						2	4
4-Aug			2			1	1		4
5-Aug			1				4		5
6-Aug			1	2			1	2	6
7-Aug							1	1	2
8-Aug								1	1
9-Aug			1					1	2
10-Aug			2				1	2	5
11-Aug	1		1				1	2	5
12-Aug								2	2
13-Aug								3	3
14-Aug									0
15-Aug						1			1
16-Aug									0
17-Aug									0
18-Aug			1						1
19-Aug			1						1

Table C-1. Daily numbers of chinook salmon of different stocks recorded at fixed-station receiver sites on the mainstem Nass River, 1 July - 24 September 1992. See Figure 1 for receiver locations. Shaded dates indicate that the receiver was not operating.

Date	Lower Nass	Cranberry	Meziadin	Taft-Oweegee	Middle Bell-Irving	Upper Bell-Irving	Kwinageese	Damdochax	All stocks
	Stocks								
Fixed-station 8 (cont)									
20-Aug									0
21-Aug									0
22-Aug									0
23-Aug									0
24-Aug									0
25-Aug							1		1
26-Aug			1						1
27-Aug									0
28-Aug									0
29-Aug									0
30-Aug									0
31-Aug									0
1-Sep									0
2-Sep									0
3-Sep									0
4-Sep									0
5-Sep									0
6-Sep									0
7-Sep									0
8-Sep									0
9-Sep									0
10-Sep									0
11-Sep									0
12-Sep									0
13-Sep									0
14-Sep									0
15-Sep							1		1
16-Sep									0
17-Sep									0
18-Sep									0
19-Sep									0
20-Sep			1						1
21-Sep									0
22-Sep									0
23-Sep							1		1
24-Sep									0

Table C-1. Daily numbers of chinook salmon of different stocks recorded at fixed-station receiver sites on the mainstem Nass River, 1 July - 24 September 1992. See Figure 1 for receiver locations. Shaded dates indicate that the receiver was not operating.

	Stocks								
Date	Lower Nass	Cranberry	Meziadin	Taft-Oweegee	Middle Bell-Irving	Upper Bell-Irving	Kwinageese	Damdochax	All stocks
Fixed-station 9 (Bell-Irving River mouth)									
1-Jul									0
2-Jul									0
3-Jul									0
4-Jul									0
5-Jul									0
6-Jul									0
7-Jul									0
8-Jul									0
9-Jul									0
10-Jul									0
11-Jul									0
12-Jul									0
13-Jul									0
14-Jul									0
15-Jul									0
16-Jul									0
17-Jul									0
18-Jul									0
19-Jul									0
20-Jul					1				1
21-Jul					1			1	2
22-Jul					1				1
23-Jul					1	1			2
24-Jul				2	3	2	1	2	10
25-Jul				1	3	1	6	4	15
26-Jul				1	3	1	4	1	10
27-Jul				1	4	4	2	5	16
28-Jul		1		2	1	14	8	9	35
29-Jul		1		6	4	15	2	10	38
30-Jul		1		8	4	10	3	6	32
31-Jul				5	3	15		6	29
1-Aug					7	10	1	7	25
2-Aug				2	5	6		4	17
3-Aug				2	4	5		1	12
4-Aug	1				4	5			10
5-Aug	1			2	4	6		1	14
6-Aug				2	3	5	1	1	12
7-Aug				2	3	2	2		9
8-Aug				2	4	3	1	2	12
9-Aug				1	3	3	1		8
10-Aug	1			1	1	1	2		6
11-Aug									0
12-Aug					2			2	4
13-Aug				2					2
14-Aug									0
15-Aug									0
16-Aug									0
17-Aug									0
18-Aug									0

Table C-1. Daily numbers of chinook salmon of different stocks recorded at fixed-station receiver sites on the mainstem Nass River, 1 July - 24 September 1992. See Figure 1 for receiver locations. Shaded dates indicate that the receiver was not operating.

	Stocks								
Date	Lower Nass	Cranberry	Meziadin	Taft-Oweegee	Middle Bell-Irving	Upper Bell-Irving	Kwinageese	Damdochax	All stocks
Fixed-station 9 (cont)									
19-Aug									0
20-Aug									0
21-Aug									0
22-Aug									0
23-Aug									0
24-Aug									0
25-Aug									0
26-Aug									0
27-Aug									0
28-Aug							1		1
29-Aug									0
30-Aug									0
31-Aug									0
1-Sep									0
2-Sep									0
3-Sep									0
4-Sep									0
5-Sep									0
6-Sep									0
7-Sep									0
8-Sep									0
9-Sep									0
10-Sep					1				1
11-Sep									0
12-Sep									0
13-Sep									0
14-Sep							1		1
15-Sep									0
16-Sep									0
17-Sep									0
18-Sep									0
19-Sep									0
20-Sep									0
21-Sep									0
22-Sep									0
23-Sep									0
24-Sep									0

Table C-1. Daily numbers of chinook salmon of different stocks recorded at fixed-station receiver sites on the mainstem Nass River, 1 July - 24 September 1992. See Figure 1 for receiver locations. Shaded dates indicate that the receiver was not operating.

	Stocks								
Date	Lower Nass	Cranberry	Meziadin	Taft-Oweegee	Middle Bell-Irving	Upper Bell-Irving	Kwinageese	Damdochax	All stocks
Fixed-station 5 (Sanskisoot Creek mouth)									
1-Jul									0
2-Jul									0
3-Jul									0
4-Jul									0
5-Jul									0
6-Jul									0
7-Jul									0
8-Jul									0
9-Jul									0
10-Jul									0
11-Jul									0
12-Jul									0
13-Jul									0
14-Jul									0
15-Jul									0
16-Jul									0
17-Jul									0
18-Jul									0
19-Jul									0
20-Jul									0
21-Jul									0
22-Jul								1	1
23-Jul									0
24-Jul									0
25-Jul								2	2
26-Jul								5	5
27-Jul									0
28-Jul								5	5
29-Jul								5	5
30-Jul								11	11
31-Jul							1	5	6
1-Aug						1	1	3	5
2-Aug								6	6
3-Aug								4	4
4-Aug									0
5-Aug								1	1
6-Aug									0
7-Aug								1	1
8-Aug							1		1
9-Aug								1	1
10-Aug								1	1
11-Aug									0
12-Aug						1		1	2
13-Aug								2	2
14-Aug									0
15-Aug								3	3
16-Aug									0
17-Aug								2	2
18-Aug								1	1
19-Aug								1	1

Table C-1. Daily numbers of chinook salmon of different stocks recorded at fixed-station receiver sites on the mainstem Nass River, 1 July - 24 September 1992. See Figure 1 for receiver locations. Shaded dates indicate that the receiver was not operating.

	Stocks								
Date	Lower Nass	Cranberry	Meziadin	Taft-Oweegee	Middle Bell-Irving	Upper Bell-Irving	Kwinageese	Damdochax	All stocks
Fixed-station 5 (cont)									
20-Aug								1	1
21-Aug									0
22-Aug									0
23-Aug									0
24-Aug									0
25-Aug								1	1
26-Aug									0
27-Aug									0
28-Aug									0
29-Aug									0
30-Aug									0
31-Aug									0
1-Sep									0
2-Sep									0
3-Sep									0
4-Sep									0
5-Sep									0
6-Sep									0
7-Sep									0
8-Sep									0
9-Sep									0
10-Sep									0
11-Sep									0
12-Sep									0
13-Sep									0
14-Sep									0
15-Sep									0
16-Sep									0
17-Sep									0
18-Sep									0
19-Sep									0
20-Sep									0
21-Sep									0
22-Sep									0
23-Sep									0
24-Sep									0

Table C-1. Daily numbers of chinook salmon of different stocks recorded at fixed-station receiver sites on the mainstem Nass River, 1 July - 24 September 1992. See Figure 1 for receiver locations. Shaded dates indicate that the receiver was not operating.

	Stocks								
Date	Lower Nass	Cranberry	Meziadin	Taft-Oweegee	Middle Bell-Irving	Upper Bell-Irving	Kwinageese	Damdochax	All stocks
Fixed-station 6 (Sallysout Creek mouth)									
1-Jul									0
2-Jul									0
3-Jul									0
4-Jul									0
5-Jul									0
6-Jul									0
7-Jul									0
8-Jul									0
9-Jul									0
10-Jul									0
11-Jul									0
12-Jul									0
13-Jul									0
14-Jul									0
15-Jul									0
16-Jul									0
17-Jul									0
18-Jul									0
19-Jul									0
20-Jul									0
21-Jul									0
22-Jul									0
23-Jul									0
24-Jul									0
25-Jul								1	1
26-Jul								1	1
27-Jul								1	1
28-Jul								4	4
29-Jul								3	3
30-Jul								4	4
31-Jul								7	7
1-Aug								11	11
2-Aug							1	5	6
3-Aug						1	1	8	10
4-Aug							1	4	5
5-Aug								7	7
6-Aug								4	4
7-Aug							1	1	2
8-Aug						1			1
9-Aug						1			1
10-Aug								1	1
11-Aug								2	2
12-Aug								1	1
13-Aug								1	1
14-Aug								1	1
15-Aug								2	2
16-Aug								1	1
17-Aug								2	2
18-Aug								3	3

Table C-1. Daily numbers of chinook salmon of different stocks recorded at fixed-station receiver sites on the mainstem Nass River, 1 July - 24 September 1992. See Figure 1 for receiver locations. Shaded dates indicate that the receiver was not operating.

	Stocks								
Date	Lower Nass	Cranberry	Meziadin	Taft-Oweegee	Middle Bell-Irving	Upper Bell-Irving	Kwinageese	Damdochax	All stocks
Fixed-station 6 (cont)									
19-Aug								2	2
20-Aug								1	1
21-Aug								2	2
22-Aug								1	1
23-Aug									0
24-Aug									0
25-Aug								1	1
26-Aug									0
27-Aug								1	1
28-Aug									0
29-Aug									0
30-Aug									0
31-Aug									0
1-Sep									0
2-Sep									0
3-Sep									0
4-Sep									0
5-Sep									0
6-Sep									0
7-Sep									0
8-Sep									0
9-Sep									0
10-Sep									0
11-Sep									0
12-Sep									0
13-Sep									0
14-Sep									0
15-Sep									0
16-Sep									0
17-Sep									0
18-Sep									0
19-Sep									0
20-Sep									0
21-Sep									0
22-Sep									0
23-Sep									0
24-Sep									0

Table C-1. Daily numbers of chinook salmon of different stocks recorded at fixed-station receiver sites on the mainstem Nass River, 1 July - 24 September 1992. See Figure 1 for receiver locations. Shaded dates indicate that the receiver was not operating.

	Stocks								
Date	Lower Nass	Cranberry	Meziadin	Taft-Oweegee	Middle Bell-Irving	Upper Bell-Irving	Kwinageese	Damdochax	All stocks
Fixed-station 7 (Damdochax River mouth)									
1-Jul									0
2-Jul									0
3-Jul									0
4-Jul									0
5-Jul									0
6-Jul									0
7-Jul									0
8-Jul									0
9-Jul									0
10-Jul									0
11-Jul									0
12-Jul									0
13-Jul									0
14-Jul									0
15-Jul									0
16-Jul									0
17-Jul									0
18-Jul									0
19-Jul									0
20-Jul									0
21-Jul									0
22-Jul									0
23-Jul									0
24-Jul									0
25-Jul									0
26-Jul									0
27-Jul								1	1
28-Jul								1	1
29-Jul								1	1
30-Jul								3	3
31-Jul								5	5
1-Aug								4	4
2-Aug								9	9
3-Aug								14	14
4-Aug								11	11
5-Aug								13	13
6-Aug						1		16	17
7-Aug						1		13	14
8-Aug								10	10
9-Aug								8	8
10-Aug								8	8
11-Aug								11	11
12-Aug								9	9
13-Aug								8	8
14-Aug								7	7
15-Aug								5	5
16-Aug								1	1
17-Aug								2	2
18-Aug									0

Table C-1. Daily numbers of chinook salmon of different stocks recorded at fixed-station receiver sites on the mainstem Nass River, 1 July - 24 September 1992. See Figure 1 for receiver locations. Shaded dates indicate that the receiver was not operating.

	Stocks								
Date	Lower Nass	Cranberry	Meziadin	Taft-Oweegee	Middle Bell-Irving	Upper Bell-Irving	Kwinageese	Damdochax	All stocks
Fixed-station 7 (cont)									
19-Aug								2	2
20-Aug								3	3
21-Aug								5	5
22-Aug								4	4
23-Aug								1	1
24-Aug								4	4
25-Aug								3	3
26-Aug									0
27-Aug									0
28-Aug								2	2
29-Aug								4	4
30-Aug								4	4
31-Aug								1	1
1-Sep								1	1
2-Sep									0
3-Sep									0
4-Sep									0
5-Sep								1	1
6-Sep									0
7-Sep								1	1
8-Sep									0
9-Sep								1	1
10-Sep									0
11-Sep									0
12-Sep								1	1
13-Sep								1	1
14-Sep									0
15-Sep									0
16-Sep									0
17-Sep									0
18-Sep									0
19-Sep									0
20-Sep									0
21-Sep									0
22-Sep									0
23-Sep									0
24-Sep									0

Table C-2. Daily numbers of chinook salmon of different stocks passing fixed-station receiver sites on tributaries to the Nass River, 13 July - 16 September 1992. See Figure 1 for receiver locations.

	Stocks								
Date	Lower Nass	Cranberry	Meziadin	Taft-Oweegee	Middle Bell-Irving	Upper Bell-Irving	Kwinageese	Damdochax	All stocks
Fixed-station 2 (Kiteen River mouth)									
13-Jul									0
14-Jul									0
15-Jul									0
16-Jul									0
17-Jul		5							5
18-Jul		4							4
19-Jul		3							3
20-Jul		7							7
21-Jul		6							6
22-Jul		9							9
23-Jul		7							7
24-Jul		5							5
25-Jul		3							3
26-Jul		6							6
27-Jul		8							8
28-Jul		7							7
29-Jul		9							9
30-Jul		8							8
31-Jul		5							5
1-Aug		8							8
2-Aug		5							5
3-Aug		4							4
4-Aug		1							1
5-Aug		3							3
6-Aug		5							5
7-Aug		4							4
8-Aug		1							1
9-Aug		1							1
10-Aug		1							1
11-Aug		1							1
12-Aug									0
13-Aug		1							1
14-Aug		3							3
15-Aug		3							3
16-Aug		4							4
17-Aug		4							4
18-Aug		2							2
19-Aug									0
20-Aug		2							2
21-Aug		1							1
22-Aug		2							2
23-Aug		1							1
24-Aug		2							2
25-Aug		1							1
26-Aug									0
27-Aug									0

Table C-2. Daily numbers of chinook salmon of different stocks passing fixed-station receiver sites on tributaries to the Nass River, 13 July - 16 September 1992. See Figure 1 for receiver locations.

	Stocks								
Date	Lower Nass	Cranberry	Meziadin	Taft-Oweegee	Middle Bell-Irving	Upper Bell-Irving	Kwinageese	Damdochax	All stocks
Fixed-station K (Kwinageese River weir)									
31-Aug									0
1-Sep									0
2-Sep							1		1
3-Sep							2		2
4-Sep							2		2
5-Sep							1		1
6-Sep									0
7-Sep									0
8-Sep									0
9-Sep							4		4
10-Sep							1		1
11-Sep							1		1
12-Sep							1		1
13-Sep							1		1
14-Sep							1		1
15-Sep							2		2
16-Sep									0

Nass River Chinook Escapement Monitoring 1992

Aerial / Ground survey form

Surveyors:________________ Date:____________

Pilot:________________

							Chinook			Sockeye
System	Reach	Time	water vis.	light cond.	method	radios	holding	on redds	dead	
	1	start:								
		stop:								
	2	start:								
		stop:								
	3	start:								
		stop:								
	4	start:								
		stop:								
	5	start:								
		stop:								
totals:										

elevation above water:

air speed:

direction of travel: up river / down river

wind direction and speed: tail cross head: 0-5 5-10 10-20 20+ knots

weather:

air temperature:

water level:

Comments:

Personal estimate of the percentage of live fish that were counted:

Figure D-1. The data sheet used during ground and aerial escapement surveys for chinook salmon on the Nass River, 1992.

Table D-1. Definitions of codes used with the data sheet used during escapement surveys on the Nass River, 1992.

Water visibility:	1 = clear, can see bottom and fish clearly. 2 = cloudy, still can see fish in shallow water (<1.5m) 3 = cloudy, can see fish in 0.5 m of water 4 = very cloudy, cannot see fish in water unless they are on very shallow riffles. 5 = can only count jumpers.
Light conditions:	A = no glare, sun behind clouds or mountains, no shadows. B = sun high in sky, few shadows, very bright, good light penetration through water. C = sun low in sky, extensive shadows and glare. D = windy, ripples or chop on water. E = low overcast and extensive glare
Count method:	The number in this column refers to the largest group of fish whose abundance was estimated. For example, a 50 in this column means the largest group whose size was estimated was 50 fish. In all cases, the group estimate was arrived at as outlined in the methods section of the text.
Ground speed:	If no wind - the air speed of the helicopter. If a tail wind - calculated by adding airspeed and windspeed. If a head wind - calculated by subtracting wind speed from airspeed.
Observer efficiency:	The surveyor's estimate of his counting efficiency (see text for an explanation).

Table D-2. Survey methods, survey conditions and counts of live and dead adult chinook salmon in the Nass River drainage, 1992.

System	Survey date	Survey method	Survey location: Start	Survey location: Finish	Visibility	Light cond	Ground speed (mph)	Counting groups [a]	Live survey count: No. holding	Live survey count: No. spawning	Live survey count: Total live	Carcass count [b]	Observer efficiency estimate
Damdochax River													
	4-Aug	aerial	Damdochax Lk	Nass R	1.0	B		1	720	40	760	0	-
	10-Aug	aerial	Damdochax Lk	Slowmaldo Crk	1.0	B		125	617	38	655	0	
	10-Aug	aerial	Slowmaldo Crk	3 km from Nass	1.0	B		30	261	58	319	0	
	10-Aug	aerial	3 km from Nass	1 km from Nass	1.0	B		40	453	89	542	0	
	10-Aug	aerial	1 km from Nass	Nass R	2.0	B		1	189	39	228	0	
	Total						25		1520	224	1744	0	80-90
	10-Aug	ground	Damdochax Lk	Slowmaldo Crk	1.0	B		125	592	36	628	0	
	10-Aug	float	Slowmaldo Crk	1 km from Nass	1.0	B		10	611	96	707	0	
	10-Aug	float	1 km from Nass	0.8 km from Nass	1.0	B		10	69	2	71	0	
	10-Aug	float	0.8 km from Nass	Nass R	2.0	B		1	29	0	29	0	
	Total						NA		1301	134	1435	0	80
	17-Aug	aerial	Nass R	1 km upstream	1.0	B		1	39	39	78	0	
	17-Aug	aerial	1 km upstream	Slowmaldo Crk.	1.0	B/C		10	530	268	798	0	
	17-Aug	aerial	Slowmaldo Crk	Damdochax Lk	1.0	C		10	600	123	723	0	
	Total						0-95		1169	430	1599	0	50-80
	21-Aug	aerial	Nass R	1 km upstream	2.0	B/C		1	27	34	61	unk	
	21-Aug	aerial	1 km upstream	3 km from Nass	1.0	B/C		1	35	23	58	unk	
	21-Aug	aerial	3 km from Nass	Tobacco Crk	1.0	B/C		10	145	125	270	unk	
	21-Aug	aerial	Tobacco Crk	Slowmaldo Crk	1.0	B/C		10	347	193	540	unk	
	21-Aug	aerial	Slowmaldo Crk	Damdochax Lk	1.0	B/C		50	709	220	929	unk	
	21-Aug	aerial	Damdochax Lk outlet		1.0	B/C		1	10	0	10	unk	
	Total						0-25		1273	595	1868	5	80
	21-Aug	ground	Damdochax Lk	Slomaldo	1.0	A	NA	50	937	309	1246	12	
	27-Aug	aerial	Damdochax Lk	Sansixmor Crk	1.0	C&D		10	398	269	667	unk	
	27-Aug	aerial	Sansixmor Crk	Slowmaldo Crk	1.0	C&D		180	810	110	920	unk	
	27-Aug	aerial	Slowmaldo Crk	3 km from Nass	1.0	C&D		1	233	246	479	unk	
	27-Aug	aerial	3 km from Nass	1 km from Nass	1.0	C&D		1	0	1	1	unk	
	27-Aug	aerial	1 km from Nass	Nass R	1.0	C&D		1	0	23	23	unk	
	Total						0-25		1441	649	2090	100	unk

Table D-2. Survey methods, survey conditions and counts of live and dead adult chinook salmon in the Nass River drainage, 1992.

System	Survey date	Survey method	Survey location: Start	Survey location: Finish	Visibility	Light cond	Ground speed (mph)	Counting groups [a]	Live survey count: No. holding	Live survey count: No. spawning	Live survey count: Total live	Carcass count [b]	Observer efficiency estimate
	27-Aug	ground	Damdochax Lk	Sansixmor Crk	1.0	C		1	473	389	862	31	
	27-Aug	ground	Sansixmor Crk	Slowmaldo	1.0	C		10	540	136	676	27	
	Total						NA		1013	525	1538	58	90-100
	3-Sep	aerial	Nass R	1 km from Nass	2.0	B		1	0	6	6	4	
	3-Sep	aerial	1 km from Nass	3 km from Nass	1.0	B		1	0	5	5	2	
	3-Sep	aerial	3 km from Nass	Slowmaldo Crk	1.0	B		1	30	103	133	NA	
	3-Sep	aerial	Slowmaldo Crk	Sansixmor Crk	1.0	B		10	287	204	491	NA	
	3-Sep	aerial	Sansixmor Crk	Damdochax Lk	1.0	B		10	unk	unk	903	NA	
	Total						0-50		317	318	1538	NA	80-120
	3-Sep	ground	Damdochax Lk	Sansixmor Crk	1.0	A		10	unk	unk	771	212	
	3-Sep	ground	Sansixmor Crk	Slowmaldo Crk	1.0	A		10	226	192	418	34	
	3-Sep	ground	Slomaldo Crk	1-2 km downstream	1.0	A		1	NA	NA	NA	21	
	Total						NA		226	192	1189	267	80-120
	10-Sep	aerial	Nass R	3 km upstream	1.0	A		1	0	1	1	3	
	10-Sep	aerial	3 km from Nass	Slowmaldo Crk	1.0	A		1	0	34	34	39	
	10-Sep	aerial	Slowmaldo Crk	Sansixmor Crk	1.0	A		1	43	124	167	200	
	10-Sep	aerial	Sansixmor Crk	Damdochax Lk	1.0	A		1	15	532	547	281	
							30-80		58	691	749	523	90-100
	10-Sep	ground	Damdochax Lk	Sansixmor Crk	1.0	C		1	0	617	617	582	
	10-Sep	ground	Sansixmor Crk	Slowmaldo Crk	1.0	C		1	15	58	73	35	
	Total						NA		15	675	690	617	90-110
	16-Sep	ground	Damdochax Lk.	Sansixmor Crk	1.0	A		1	0	214	214	337	
	16-Sep	ground	Sansixmor Crk	Slowmaldo Crk	1.0	A		1	0	32	32	91	
	Total						NA		0	246	246	428	95-105

Table D-2. Survey methods, survey conditions and counts of live and dead adult chinook salmon in the Nass River drainage, 1992.

System	Survey date	Survey method	Survey location: Start	Survey location: Finish	Visibility	Light cond	Ground speed (mph)	Counting groups [a]	Live survey count: No. holding	Live survey count: No. spawning	Live survey count: Total live	Carcass count [b]	Observer efficiency estimate
Damdochax Tributaries													
Slowmaldo	17-Aug	aerial	Damdochax Crk	Yaza Crk	1.0	B/C	40-100	1	0	9	9	0	75
Yaza	17-Aug	aerial	Slowmaldo	7 km upstream	1.0	B/C	40-100	1	0	7	7	0	75
Sansixmor	17-Aug	aerial	Damdochax Crk	4 km upstream	1.0	B/C	80	1	0	1	1	0	100
Winamasik	17-Aug	aerial	Damdochax Lk	Wiminasik Lk	1.0	B	0-50	1	1	0	1	0	100
	17-Aug	aerial	Wiminasik Lk	3 km above lake	1.0	B	0-50	1	0	0	0	0	100
	20-Aug	ground	Damdochax Lk	Wiminasik Lk	1.0		NA	1	0	7	7	NA	
	26-Aug	ground	Damdochax Lk	Wiminasik Lk	1.0		NA	1	0	33	33	NA	
	3-Sep	aerial	Damdochax Lk	Wiminasik Lk	1.0	B	0-50	1	0	11	11	0	
	3-Sep	aerial	Wiminasik Lk	3 km above lake	1.0	B	0-50	1	0	0	0	0	100
	9-Sep	ground	Damdochax Lk	Wiminasik Lk	1.0		NA	1	0	3	3	19 [c]	
Kwinageese River													
	4-Aug	aerial	Fred Wright Lk	Nass R	1.0	C	100	1	168	0	168	0	50-80
	13-Aug	aerial	Fred Wright Lk	56.136 N 128.783 W	1.0	C		10	590	0	590	0	
	13-Aug	aerial	Nass R	56.136 N 128.783 W	1.0	C		1	5	0	5	0	
	Total						65		595	0	595	0	30-50
	18-Aug	aerial	Nass R	56.136 N 128.783 W	1.0	B/C		1	2	2	4	0	
	18-Aug	aerial	56.136 N 128.783 W	56.098 N 128.764 W	1.0	B/C		1	12	17	29	0	
	18-Aug	aerial	56.096 N 128.750 W	56.063 N 128.760 W	1.0	B/C		1	230	20	250	0	
	18-Aug	aerial	56.063 N 128.760 W	weir	1.0	B/C		1	260	51	311	0	
	18-Aug	aerial	weir	Halfway Lk	1.0	B/C		1	68	0	68	0	
	18-Aug	aerial	Halfway Lk	Fred Wright Lk	1.0	B/C		1	8	0	8	0	
	18-Aug	aerial	Fred Wright Lk	Kwinageese Lk	1.0	B/C		1	0	0	0	0	
	18-Aug	aerial	Kwinageese Lk	falls	1.0	B/C		1	0	0	0	0	
	Total						65		580	90	670	0	50-70
	22-Aug	ground	5 km below weir	15 km below weir	1.0	B	NA	1	221	138	359	1	70-90
	26-Aug	aerial	Fred Wright Lk	Halfway Lk	1.0	A		1	66	0	66	3	
	26-Aug	aerial	weir	Halfway Lk	1.0	A		10	242	141	383	2	
	Total						0-50		308	141	449	5	unk

Table D-2. Survey methods, survey conditions and counts of live and dead adult chinook salmon in the Nass River drainage, 1992.

System	Survey date	Survey method	Survey location: Start	Survey location: Finish	Visibility	Light cond	Ground speed (mph)	Counting groups [a]	Live survey count: No. holding	Live survey count: No. spawning	Live survey count: Total live	Carcass count [b]	Observer efficiency estimate
	2-Sep	aerial	Fred Wright Lk	Halfway Lk	1.0	D		120	414	190	604	NA	
	2-Sep	aerial	Halfway Lk	weir	1.0	D		80	170	580	750	NA	
	2-Sep	aerial	weir	Shanalope Crk	1.0	D		1	104	182	286	20	
	2-Sep	aerial	Shanalope Crk	Nass R	1.0	D		1	0	3	3	0	
	Total						0-50		688	955	1643	NA	>70
	3-Sep	ground	weir	Fred Wright Lk	1.0	A		1	NA	NA	794	65	
	9-Sep	ground	weir	Fred Wright Lk	1.0	A		1	NA	NA	NA	245	
	15-Sep	aerial	weir	Fred Wright Lk	1.0	A	0-50	1	0	147	147	NA	
	15-Sep	ground	weir	Fred Wright Lk	1.0	A		1	NA	NA	NA	396	
Kwinageese Tributaries													
Shanalope	18-Aug	aerial	Kwinageese R	2 km upstream	1.0	B	40	1	2	5	7	0	
Shanalope	26-Aug	aerial	Kwinageese R	2 km upstream	1.0	A		1	6	15	21	0	
Shanalope	2-Sep	aerial	Kwinageese R	5 km upstream	1.0	D		1	0	16	16	0	
Cranberry River													
	13-Aug	aerial	Nass R	Kiteen junction	2.0	A		1	0	0	0	0	
	13-Aug	aerial	55.415 N 128.411W	55.434 N 128.285 W	1.0	A/B		1	0	45	45	1	
	13-Aug	aerial	55.424 N 128.294 W	Weber Crk	1.0	A/B		1	0	32	32	1	
	13-Aug	aerial	Weber Crk	3 km up Weber	1.0	A/B		1	0	2	2	0	
	13-Aug	aerial	Weber Crk	last logging bridge	1.0	A/B		1	5	49	54	1	
	13-Aug	aerial	last logging bridge	2nd hwy bridge	1.0	B		1	20	259	279	0	
	13-Aug	aerial	2nd hwy bridge	1st hwy bridge	1.0	B		1	11	52	63	0	
	13-Aug	aerial	1st hwy bridge	12 km falls	1.0	B		1	40	36	76	0	
	13-Aug	aerial	12 km falls	Kiteen junction	1.0	B		1	6	33	39	0	
	Total						50-110		82	508	590	3	30-60

Table D-2. Survey methods, survey conditions and counts of live and dead adult chinook salmon in the Nass River drainage, 1992.

			Survey location				Ground		Live survey count				Observer
System	Survey date	Survey method	Start	Finish	Visibility	Light cond	speed (mph)	Counting groups[a]	No. holding	No. spawning	Total live	Carcass count[b]	efficiency estimate
	19-Aug	aerial	Nass R	falls at km 12	1.5	B		1	81	83	164	0	
	19-Aug	aerial	km 12 falls	1st hwy bridge	1.5	B		1	39	47	86	0	
	19-Aug	aerial	1st hwy bridge	gravel rd bridge	1.5	B		1	24	30	54	0	
	19-Aug	aerial	gravel rd bridge	2nd hwy bridge	1.5	B		1	33	109	142	0	
	19-Aug	aerial	2 hwy bridge	last logging bridge	1.5	B		1	374	582	956	NA	
	19-Aug	aerial	last logging bridge	Weber Crk junct	1.5	B		1	0	66	66	0	
	19-Aug	aerial	Weber Crk	next valley above	1.5	B		1	0	22	22	0	
	Total								551	939	1490	0	70-80
	25-Aug	aerial	Nass R	Kiteen junction	2.0	A		1	0	0	0	0	
	25-Aug	aerial	Kiteen junction	km 12 falls	2.0	A		1	9	163	172	0	
	25-Aug	aerial	km 12 falls	1st hwy bridge	2.0	A		1	9	136	145	1	
	25-Aug	aerial	1st hwy bridge	gravel rd bridge	2.0	A		1	5	129	134	0	
	25-Aug	aerial	gravel rd bridge	2nd hwy bridge	2.0	A		1	5	22	27	2	
	25-Aug	aerial	2nd hwy bridge	last logging bridge	2.0	A		1	1	627	628	27	
	Total								29	1077	1106		unk
	1-Sep	ground	55 529 N 128.311 W	500 m downstream	3.5	E	NA	1	0	15	15	0	
	2-Sep	aerial	Nass R	km 12 falls	3.5	E		1	0	96	96	5	
	2-Sep	aerial	km 12 falls	1st hwy bridge	3.5	E		1	0	102	102	12	
	2-Sep	aerial	1st hwy bridge	gravel rd bridge	3.5	E		1	0	85	85	2	
	2-Sep	aerial	gravel rd bridge	2nd hwy bridge	3.5	E		1	0	111	111	8	
	2-Sep	aerial	2nd hwy bridge	last logging bridge	3.5	E		1	0	137	137	15	
	Total						0-60		0	531	531	42	unk
Cranberry Tributaries													
Kiteen	13-Aug	aerial	Cranberry R	Logging bridge	2.5	A		1	0	14	14	0	
	13-Aug	aerial	Logging bridge	55.422 N 128.733 W	2.5	A		1	0	0	0	0	
	13-Aug	aerial	55.422 N 128.733 W	55.329 N 128 657 W	2.5	A		1	0	2	2	0	
	13-Aug	aerial	55 329 N 128 657 W	55.176 N 128.698 W	2.5	A		1	0	48	48	0	
		total					60-80		0	64	64	0	10

Table D-2. Survey methods, survey conditions and counts of live and dead adult chinook salmon in the Nass River drainage, 1992.

System	Survey date	Survey method	Survey location: Start	Survey location: Finish	Visibility	Light cond	Ground speed (mph)	Counting groups [a]	Live survey count: No. holding	Live survey count: No. spawning	Live survey count: Total live	Carcass count [b]	Observer efficiency estimate
Kiteen	19-Aug	aerial	Stenstrom Crk	8 km up Stenstrom	1.0	A		1	0	0	0	0	
	19-Aug	aerial	Stenstrom Crk	up Kiteen to Cohead	2.0	A		1	0	0	0	0	
	19-Aug	aerial	Cohead Crk	falls at km 10	1.0	A		1	0	0	0	0	
	19-Aug	aerial	Stenstrom Crk	55.278 N 128.678 W	2.0	A		1	0	6	6	0	
	19-Aug	aerial	55.293 N 128.671 W	55.432 N 128.820 W	2.0	A		1	0	15	15	0	
	19-Aug	aerial	55.430 N 128.800 W	Cranberry R	2.0	A		1	0	34	34	0	
	Total						15-60		0	55	55	0	unk
Meziadin River													
	4-Aug	aerial	Nass R	Meziadin Lk	1.5	B	0-50	1	55	0	55	0	10
	18-Aug	aerial	Fishway	rapids (below lk)	1.0	A		1	0	0	0	0	
	18-Aug	aerial	rapids	just above rapids	1.0	A		1	42	0	42	0	
	18-Aug	aerial	just above rapids	Meziadin Lk	1.0	A		10	60	0	60	0	
	Total							0-20	102	0	102	0	10-20
	6-Sep	aerial	Meziadin Lk	just below rapids	2.0	A		10	49	118	167	18	
	6-Sep	aerial	below rapids	fishway	2.0	A		1	93	32	125	12	
	6-Sep	aerial	fishway	Nass R	2.0	A		10	0	40	40	0	
	Total						0-30		142	190	332	30	10-30
Meziadin Tributaries													
Hanna Crk	18-Aug	aerial	Meziadin Lk	Hwy Bridge	1.0	A	0-50	1	0	0	0	0	70-90
Surprise Crk	14-Aug	aerial	Meziadin Lk	km 6	4.0	A	0-60	1	0	0	0	0	unk
Strohn Crk	14-Aug	aerial	Meziadin Lk	km 4	1.0	A	0-30	1	0	0	0	0	90+

Table D-2. Survey methods, survey conditions and counts of live and dead adult chinook salmon in the Nass River drainage, 1992.

System	Survey date	Survey method	Survey location: Start	Survey location: Finish	Visibility	Light cond	Ground speed (mph)	Counting groups [a]	Live survey count: No. holding	Live survey count: No. spawning	Live survey count: Total live	Carcass count [b]	Observer efficiency estimate
Bell-Irving River (mainstem)													
	20-Aug	aerial	Bell II	Rochester Crk	3.5	B		1	25	26	51	0	10
	20-Aug	aerial	Oweegee Crk	Snowbank Crk	3.5	B		1	0	7	7	0	<10
	Total						0-100		25	33	58	0	
	5-Sep	aerial	Treaty Crk	Snowbank Crk	3.0	A	0-80	1	0	27	27	0	20-30
	5-Sep	aerial	Bell 2	Rochester Crk	3.0	A	20-120	1	0	2	2	0	50
	Total								0	29	29	0	
Bell-Irving Tributaries													
Snowbank/	18-Aug	aerial	Bell-Irving R	Teigen Crk	2.0	A		1	0	29	29	0	
Teigen	18-Aug	aerial	Snowbank junct	km 2	1.0	A		1	0	121	121	0	
	18-Aug	aerial	km 2	km 4	1.0	A		1	0	77	77	0	
	18-Aug	aerial	km 4	Canyon Crk	1.0	A		1	0	137	137	0	
	18-Aug	aerial	Canyon Crk	Teigan Lk	1.0	A		1	0	140	140	1	
	18-Aug	aerial	entire Canyon Creek		1.0	A		1	0	0	0	0	
	Total						0-50		0	504	504	1	70-100
Snowbank/	5-Sep	aerial	Bell-Irving R	Teigen Crk	1.0	A		1	0	26	26	4	
Teigen	5-Sep	aerial	Teigen Crk	km 2	1.0	A		1	0	18	18	27	
	5-Sep	aerial	km 2	Teigan Lk	1.0	A		1	0	1	1	0	
	Total						10-50		0	45	45	31	70-100
Snowbank	5-Sep	ground	km 2	Teigen Crk	1.0	A		1	NA	NA	NA	32	
Oweegee	20-Aug	aerial	mouth	1 km upstream	1.0	A	0-10	200	447	3	450	0	unk
Oweegee	23-Aug	ground	Oweegee Lk	0.5 km downstream	1.0	A	NA	1	20	0	20	0	100
Oweegee	29-Aug	ground	Oweegee Lk	start of delta	1.0	A		1	50	34	84	9	
	29-Aug	ground	delta	Bell-Irving R	1.0	A			220	50	270	0	
	Total						NA		270	84	354	9	80-110
Oweegee	5&6-Sep	ground	Bell-Irving R	0.5 km upstream	1.0	A	NA	1	70	40	120	33	60-100

Table D-2. Survey methods, survey conditions and counts of live and dead adult chinook salmon in the Nass River drainage, 1992.

System	Survey date	Survey method	Survey location: Start	Survey location: Finish	Visibility	Light cond	Ground speed (mph)	Counting groups [a]	Live survey count: No. holding	Live survey count: No. spawning	Live survey count: Total live	Carcass count [b]	Observer efficiency estimate
Oweegee	6-Sep	aerial	Bell-Irving R	0.5 km upstream	1.0	A	0-10	40	110	55	165	0	90-110
Taft	20-Aug	aerial	Bell-Irving R	headwaters	3.0	B	50	1	2	16	18	0	<30
Rochester	20-Aug	aerial	Bell-Irving R	5 km upstream			30-100		0	0	0	0	
Hodder	20-Aug	aerial	headwaters	Bell-Irving R	1.0	B	60-100	1	0	5	5	0	<10
Lower Nass Systems													
Kwinatahl	14-Aug	aerial	Nass R	headwaters	5.0	A	50-100		0	0	0	0	0+
Tchitin	4-Aug	aerial	Nass R	headwaters	3.0	A	50-100	1	3	0	3	0	<10
Tchitin	18-Aug	aerial	Headwaters	Nass R	3.0	B	60	1	0	7	7	0	<10
Seaskinnish	19-Aug	aerial	Nass Road bridge	Nass R	1.0	C	15	10	84	61	145	0	20-40
Seaskinnish	28-Aug	ground	Nass R	km 0.5	1.0	A		1	5	10	15	6	
	28-Aug	ground	km 0.5	canyon chute	1.0	A		1	9	14	23	0	
	28-Aug	ground	chute	large pool upstream	1.0	A		1	23	12	35	2	
	28-Aug	ground	pool	falls area upstream	1.0	A		1	0	18	18	8	
	Total						NA		37	54	91	16	90+
Tseax	19-Aug	aerial	Nass R	Lava Lk	3.0	B	30-80		0	0	0	0	0+
Zolzap	14-Aug	aerial	Nass R	headwaters	1.0	A	50		0	0	0	0	0+
Anudol	14-Aug	aerial	Nass R	large falls at km 5	4.0	A	0-50		0	0	0	0	0+
Ksedin	14-Aug	aerial	Nass R	headwaters	2.0	A	30-100		0	0	0	0	0+
Kincolith	14-Aug	aerial	Kincolith	km 15	1.5	C	30-60	1	0	32	32	0	80
Ishkeenickh	14-Aug	aerial	Nass R	km 25	1.0	C	30-80	1	8	67	75	0	50-80

Table D-2. Survey methods, survey conditions and counts of live and dead adult chinook salmon in the Nass River drainage, 1992.

System	Survey date	Survey method	Survey location: Start	Survey location: Finish	Visibility	Light cond	Ground speed (mph)	Counting groups [a]	Live survey count: No. holding	Live survey count: No. spawning	Live survey count: Total live	Carcass count [b]	Observer efficiency estimate
Upper Nass Systems													
Mainstem	17-Aug	aerial	Damdochax Crk	Konigus Creek	4.0	B	120-150	1	0	0	0	0	<10
Muskaboo	17-Aug	aerial	headwaters	Nass R	3.0	B	120-150	1	0	6	6	0	<10
Kotsinta	3-Sep	aerial	Nass R	to falls (km 0.5)	1.0	C	20-80	1	0	10	10	1	80-90
Saladamis	27-Aug	aerial	Nass R	km 3	1.0	A	30-60		0	0	0	0	80-100

[a] Counting group indicates the largest group of fish in which individual fish could not be counted.
[b] Carcasses were not systematically counted during aerial surveys.
[c] These carcasses are not included in mark recapture estimates.

Table D-3. Summary of counts of chinook salmon carcasses in Damdochax Creek, 1992.

		Carcasses examined				Recovery of radio-tagged carcasses			Fish missing tags		Recovered spaghetti tags
Reach [a]	Date	Males	Females	Jacks	Total adults	Males	Females	Total	Radio	Operculum	
5	21-Aug	0	12	0	12	0	0	0	0	0	0
5	27-Aug	5	26	0	31	0	0	0	0	0	0
4	27-Aug	7	20	0	27	0	0	0	0	0	0
	Total				58						
5	3-Sep	96	116	5	212	1	2	3	0	2	0
4	3-Sep	17	17	1	34	0	1	1	0	0	0
3	3-Sep	8	13	0	21	0	0	0	0	0	0
	Total				267						
5	10-Sep	271	311	6	582	1	7	8	0	3	2
4	10-Sep	16	19	0	35	0	1	1	0	0	0
	Total				617						
5	16-Sep	191	146	5	337	6	4	10	0	0	0
4	16-Sep	47	44	0	91	0	0	0	0	0	1
	Total				428						
All surveys		658	724	17	1382	8	15	23	0	5	3

[a] Reach 5: Damdochax Lake to Sansixmor Creek; reach 4: Sansixmor to Slowmaldo Creek; reach 3: Slowmaldo to 3 km downstream.

Table D-4. Summary of counts of chinook salmon carcasses at the Kwinageese River weir and upstream of the weir, 1992.

		Carcasses examined					Recovery of radio-tagged carcasses				Fish missing tags		Recovered spaghetti tags
Reach [a]	Date	Male	Female	Adult unknown	Jack	Total adult	Male	Female	Unknown	Total	Radio	Operculum	
2 [b]	24-Aug	0	0	1	0	1	0	0	1	1	0	0	0
2 [b]	28-Aug	0	0	6	0	6	0	0	0	0	0	0	0
2	3-Sep	38	22	5	0	65	0	0	4	4	0	1	0
3	8-Sep	0	0	4	0	4	0	0	0	0	0	0	0
3	9-Sep	4	0	0	0	4	0	0	0	0	0	0	0
2	9-Sep	117	128	0	0	245	0	0	3	3	0	0	0
1	9-Sep	44	21	0	0	65	0	0	0	0	0	0	0
3	11-Sep	0	0	16	0	16	0	1	0	1	0	0	0
3	12-Sep	14	1	0	0	15	0	0	0	0	0	0	0
3	13-Sep	11	1	0	0	12	0	0	0	0	0	0	0
3	14-Sep	10	0	0	0	10	0	0	0	0	0	3	0
1	15-Sep	60	36	0	0	96	1	1	0	2	1	0	0
2	15-Sep	169	131	0	1	300	0	1	0	1	1	0	0
Totals		467	340	32	1	839	1	3	8	12	2	4	0

[a] Reach 1: Fred Wright Lake to Halfway Lake; reach 2: Halfway to Kwinageese weir; reach 3: carcasses recovered from the weir.

[b] Carcasses were examined incidentally to other work and were not part of a systematic survey.

Table E-1. Summary of daily counts of, and tag recoveries from, chinook salmon that passed through the Meziadin fishway, 16 July- 5 October 1992.

Date	Daily count		Tag		Date	Daily count		Tag	
	Jacks	Adults	Recoveries	Type [a]		Jacks	Adults	Recoveries	Type [a]
16-Jul	0	0	0		26-Aug	1	1	0	
17-Jul	0	0	0		27-Aug	0	7	0	
18-Jul	0	0	0		28-Aug	0	1	0	
19-Jul	0	1	0		29-Aug	0	4	0	
20-Jul	0	8	0		30-Aug	0	2	0	
21-Jul	1	3	0		31-Aug	0	2	0	
22-Jul	0	6	0		01-Sep	1	6	0	
23-Jul	0	11	1	R	02-Sep	0	5	0	
24-Jul	0	2	0		03-Sep	0	11	0	
25-Jul	0	12	0		04-Sep	0	5	0	
26-Jul	1	23	0		05-Sep	0	2	0	
27-Jul	9	88	2	R&S	06-Sep	1	8	0	
28-Jul	15	139	0		07-Sep	0	4	0	
29-Jul	3	89	0		08-Sep	0	3	0	
30-Jul	4	57	0		09-Sep	0	1	0	
31-Jul	2	14	0		10-Sep	0	5	0	
01-Aug	10	50	1	R	11-Sep	0	1	0	
02-Aug	0	20	0		12-Sep	0	4	0	
03-Aug	0	14	0		13-Sep	0	0	0	
04-Aug	1	34	0		14-Sep	0	0	0	
05-Aug	1	20	0		15-Sep	0	0	0	
06-Aug	3	13	0		16-Sep	0	0	0	
07-Aug	1	13	0		17-Sep	0	1	0	
08-Aug	0	10	0		18-Sep	0	1	0	
09-Aug	2	11	1	S	19-Sep	0	0	0	
10-Aug	2	9	0		20-Sep	0	0	0	
11-Aug	2	16	1	S	21-Sep	0	1	0	
12-Aug	2	14	0		22-Sep	0	1	0	
13-Aug	2	18	1	R	23-Sep	0	1	0	
14-Aug	0	8	0		24-Sep	0	2	0	
15-Aug	4	9	0		25-Sep	0	0	0	
16-Aug	0	8	0		26-Sep	0	0	0	
17-Aug	4	17	0		27-Sep	0	3	0	
18-Aug	6	10	0		28-Sep	0	0	0	
19-Aug	4	6	0		29-Sep	0	1	0	
20-Aug	2	4	0		30-Sep	0	0	0	
21-Aug	2	5	0		01-Oct	0	0	0	
22-Aug	0	6	1	R	02-Oct	0	1	0	
23-Aug	0	4	0		03-Oct	0	0	0	
24-Aug	0	7	0		04-Oct	0	0	0	
25-Aug	0	7	0		05-Oct	0	0	0	
					Total	**85**	**870**	**8**	

[a] Tag type: R=radio tag, S=spaghetti tag.

Table E-2. Estimated numbers of fish of each species that passed through the Kwinageese weir, 17 July - 23 September 1992.

	Electronic	Estimated species composition [a]			Visual observations through the bypass panel [b]						Overall total by species			
Date	observations	Sockeye	Chinook	Other	Sockeye	Chinook	DV	WF	RB	Coho	Sockeye	Chinook	Other	Comments
17-Jul	0	0	0	0							0	0	0	
18-Jul	0	0	0	0			1	8	1		0	0	10	
19-Jul	0	0	0	0			2	2	1		0	0	5	
20-Jul	0	0	0	0			1	13			0	0	14	
21-Jul	0	0	0	0			5	61			0	0	66	
22-Jul	0	0	0	0			3	34			0	0	37	
23-Jul	0	0	0	0			2	18	2		0	0	22	
24-Jul	0	0	0	0	1		1	35			1	0	36	
25-Jul	0	0	0	0			2	29	1		0	0	32	
26-Jul	0	0	0	0			1	18			0	0	19	
27-Jul	0	0	0	0				18	1		0	0	19	
28-Jul	0	0	0	0		4		23			0	4	23	
29-Jul	0	0	0	0				14	2		0	0	16	
30-Jul	0	0	0	0			1	8			0	0	9	
31-Jul	212	190	7	15							190	7	15	First electronic count
1-Aug	332	298	11	23	18						316	11	23	
2-Aug	884	793	30	61	15	2					808	32	61	
3-Aug	1118	1003	38	77	22	1					1025	39	77	
4-Aug	778	698	26	54	64	3		2			762	29	56	Avg. of preceeding 3 days
5-Aug	431	386	15	30	4	8					390	23	30	Avg. of prior & post day
6-Aug	83	75	3	6	31	15					106	18	6	Avg. of following 3 days
7-Aug	91	87	2	1	172	52					259	54	1	
8-Aug	110	106	3	2	99	7					205	10	2	
9-Aug	49	47	1	1							47	1	1	
10-Aug	75	72	2	1							72	2	1	
11-Aug	88	85	2	1							85	2	1	
12-Aug	47	45	1	1							45	1	1	
13-Aug	291	280	7	5	143	9					423	16	5	
14-Aug	219	177	30	11	10	3					187	33	11	
15-Aug	249	202	35	13	8						210	35	13	
16-Aug	233	189	32	12	5						194	32	12	
17-Aug	192	155	27	10							155	27	10	Avg. of prior & post 3 days
18-Aug	221	179	31	11							179	31	11	
19-Aug	113	92	16	6	1	1					93	17	6	
20-Aug	114	92	16	6		1					92	17	6	
21-Aug	42	25	9	8		4					25	13	8	
22-Aug	133	57	60	17	17	26					74	86	17	
23-Aug	24	9	13	2	7	20					16	33	2	
24-Aug	51	26	17	8	12						38	17	8	
25-Aug	184	66	98	19		289					66	387	19	

Table E-2. Estimated numbers of fish of each species that passed through the Kwinageese weir, 17 July - 23 September 1992.

Date	Electronic observations	Estimated species composition[a]			Visual observations through the bypass panel[b]						Overall total by species			Comments
		Sockeye	Chinook	Other	Sockeye	Chinook	DV	WF	RB	Coho	Sockeye	Chinook	Other	
26-Aug	80	34	36	10							34	36	10	
27-Aug	164	55	93	16	2	9					57	102	16	
28-Aug	86	20	46	19	1	1					21	47	19	
29-Aug	74	20	34	20		106					20	140	20	
30-Aug	116	28	60	27	12	36					40	96	27	
31-Aug	110	30	49	31	7	27					37	76	31	
1-Sep	96	28	39	29	2	27					30	66	29	
2-Sep	71	21	27	23	1	16					22	43	23	
3-Sep	68	18	32	18							18	32	18	
4-Sep	88	39	19	30		13					39	32	30	
5-Sep	81	35	18	28		4					35	22	28	
6-Sep	70	31	15	24	28						59	15	24	
7-Sep	95	42	21	33							42	21	33	
8-Sep	181	79	40	62	9						88	40	62	
9-Sep	95	42	21	33							42	21	33	
10-Sep	142	62	31	49							62	31	49	Avg. of missing h from prior
11-Sep	163	22	0	141							22	0	141	and following 3 days.
12-Sep	121	16	0	105							16	0	105	
13-Sep	43	6	0	37							6	0	37	
14-Sep	87	12	0	75							12	0	75	
15-Sep	61	8	0	53							8	0	53	
16-Sep	45	6	0	39							6	0	39	
17-Sep	52	7	0	45							7	0	45	
18-Sep	32	0	0	32							0	0	32	
19-Sep	0	0	0	0							0	0	0	Counter down for modifications
20-Sep	0	0	0	0		2		15			0	2	15	Counter down for modifications
21-Sep	0	0	0	0							0	0	0	Counter down for modifications
22-Sep	0	0	0	0						4	0	0	4	Counter down for modifications
23-Sep	0	0	0	0						5	0	0	5	Fence washed out.
Total	8,585	6,094	1,113	1,378	691	686	19	298	8	9	6,785	1,799	1,712	

a Shaded areas indicate periods when the electronic counter was not operating for which data were extrapolated using counts from adjacent days.

b Based on proportions calculated from index counts (presented in Table E-3).

Counts include sockeye tagged and sampled and chinook sampled that were released upstream without passing through counter. DV=dolly varden; WF=whitefish; RB=rainbow trout.

Table E-3. Species composition of fish that passsed through the Kwinageese weir based on index counts, 31 July - 27 September 1992.

	Visual observations through electronic counter							Visual observations through bypass panel						
	Index counts				Species proportions			Bypass counts				Species proportions		
Period	Chinook	Sockeye	Other	Total	Chinook	Sockeye	Other	Chinook	Sockeye	Other	Total	Chinook	Sockeye	Other
31 Jul - 6 Aug	7	182	14	203	0.034	0.897	0.069	8	4	0	12	0.667	0.333	0.000
7 Aug - 13 Aug	3	124	2	129	0.023	0.961	0.016	76	400	0	476	0.160	0.840	0.000
14 Aug - 26 Aug	19	111	7	137	0.139	0.810	0.051	0	0	0	0	NA	NA	NA
21 Aug - 27 Aug	12	35	11	58	0.207	0.603	0.190	342	24	0	366	0.934	0.066	0.000
28 Aug - 3 Sep	24	21	23	68	0.353	0.309	0.338	207	21	0	228	0.908	0.092	0.000
4 Sep - 10 Sep	23	46	36	105	0.219	0.438	0.343	30	20	0	50	0.600	0.400	0.000
11 Sep - 17 Sep	0	19	121	140	0.000	0.136	0.864	0	0	0	0	NA	NA	NA
18 Sep - 27 Sep	0	0	5	5	0.000	0.000	1.000	2	0	19	21	0.095	0.000	0.905
Total	88	538	219	914	0.096	0.588	0.239	663	469	0	1132	0.586	0.414	0.000