

**Radio Telemetry Observations of Sockeye
Salmon (*Oncorhynchus nerka*) Spawners
in Chilko River and Chilko Lake: Investigation
of the Role of Stress in a Mark-Recapture
Study**

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OF STRESS IN A MARK-RECAPTURE STUDY

by

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ABSTRACT

Schubert, N.D. and G.C. Scarborough. 1996. Radio telemetry observations of sockeye salmon (*Oncorhynchus nerka*) spawners in Chilko River and Chilko Lake: investigation of the role of stress in a mark-recapture study. Can. Tech. Rep. Fish. Aquat. Sci. 2131: 66 p.

A radio telemetry study of spawning sockeye salmon (*Oncorhynchus nerka*) was conducted in Chilko River and Chilko Lake from August to October, 1995. The study had three objectives: a) to determine whether handling stress introduced bias in the annual mark-recapture study conducted on this population; b) describe the fish movement patterns between the tagging site and the spawning grounds; and c) estimate the proportion of the stock which spawned in the south end of Chilko Lake. One hundred and sixty-eight transmitters were applied internally and tracked with a combination of two remote receivers and one mobile receiver. The application of radio transmitters was more stressful to fish than the application of Petersen disks; the former caused lower spawning success, shorter times between release and carcass recovery, and stomach ruptures. There was no evidence, however, that such stress would result in immediate mortality, would impede the fish's ability to migrate to the spawning grounds, or cause the fish to drop out of the study area. We concluded, therefore, that handling stress was unlikely to introduce substantial bias in the annual mark-recapture population estimate.

We identified three distinct movement patterns: a) fish in the early part of the study migrated very quickly through the river and into the south end of the lake; b) there were fish which migrated more slowly through the river to the Narrows where they either remained for several days or moved back and forth between the upper river and north lake, then either moved back into the river or the north lake to spawn. Most of the river spawners dropped back into the river in two groups, on about September 10 and September 16. After spawning, some then migrated into the lake and were not subsequently recorded; and c) there was a group of slow moving late migrants which spawned in the river, often without ever reaching the Narrows. In all three groups, migration speed declined as the run progressed. The sockeye which held at the Narrows also exhibited a distinct diurnal movement pattern by holding more often during the daylight hours.

The study estimated that 18% (35,900) of the adult males and 14% (47,500) of the adult females spawned in the south end of Chilko Lake. We were unable to verify this estimate, however, through direct observations.

RÉSUMÉ

Schubert, N.D. and G.C. Scarborough. 1996. Radio telemetry observations of sockeye salmon (*Oncorhynchus nerka*) spawners in Chilko River and Chilko Lake: investigation of the role of stress in a mark-recapture study. Can. Tech. Rep. Fish. Aquat. Sci. 2131: 66 p.

Nous avons effectué une étude par radiopistage, d'août à octobre 1995, sur des géniteurs de saumon rouge (*Oncorhynchus nerka*) dans la rivière Chilko et le lac du même nom. L'étude visait trois objectifs : a) déterminer si le stress de la manipulation introduisait un biais dans l'étude de marquage-recapture effectuée chaque année sur cette population; b) décrire les schémas de déplacement des poissons entre le lieu de marquage et les frayères; c) estimer la proportion du stock qui frayait dans l'extrémité sud du lac Chilko. Nous avons implanté 168 émetteurs chez les poissons, et nous les avons pistés en combinant deux récepteurs à distance et un récepteur mobile. L'implantation des radioémetteurs a causé davantage de stress que l'application des disques Petersen : elle a occasionné une baisse du succès de reproduction, a réduit la durée de la période entre le marquage et la récupération des carcasses, et a causé des déchirements de l'estomac. Rien ne prouve toutefois que ce stress puisse déboucher sur une mortalité immédiate, réduire l'aptitude du poisson à migrer vers ses frayères, ni le pousser à sortir de la zone d'étude. Nous concluons donc que le stress de la manipulation n'introduit vraisemblablement pas de biais important dans les estimations annuelles de la population obtenues par marquage-recapture.

Nous avons repéré trois schémas distincts de déplacement : a) dans la première partie de l'étude, les poissons migraient très rapidement dans la rivière pour aller à la portion sud du lac; b) certains poissons migraient plus lentement dans la rivière jusqu'au passage des Narrows, et soit ils y restaient quelques jours, soit ils faisaient la navette entre le cours supérieur de la rivière et la partie nord du lac, puis ils retournaient soit dans la rivière soit dans la partie nord du lac pour frayer; la plupart des géniteurs de la rivière y revenaient en deux groupes, vers le 10 et le 16 septembre. Après la fraye, certains sont entrés dans le lac et n'ont plus été pistés; enfin, c) un groupe de migrants lents et tardifs migrait dans la rivière, parfois sans même atteindre les Narrows. Dans les trois groupes, la vitesse de migration déclinait au fur et à mesure de la remonte. Les saumons rouges qui restaient dans les Narrows présentaient aussi un schéma particulier de déplacement diurne car ils s'y maintenaient plus souvent pendant les heures de jour.

L'étude a permis d'estimer à 18 % (36 900) la proportion des mâles adultes et à 14 % (47 500) la proportion des femelles adultes qui frayaient dans la partie sud du lac Chilko. Nous n'avons toutefois pas été en mesure de vérifier par l'observation directe la justesse de ces estimations.

INTRODUCTION

The Chilko River system supports the third largest sockeye salmon (*Oncorhynchus nerka*) stock in the Fraser River system. Escapements to the Chilko River and the north and south ends of Chilko Lake (Fig. 1) have been documented since 1909 (Babcock 1910). Early escapements were estimated on foot using visual techniques; however, because of the size and importance of this stock, mark-recapture studies have been used almost every year since 1940. In 1994, the Chilko mark-recapture study was assessed by the Spawning Escapement Estimation Working Group, which was established by the Fraser River Sockeye Public Review Board (Anon. 1995a). The Review Board was formed to investigate the apparent disappearance of more than one million sockeye salmon which had been expected to return to the Fraser River spawning grounds. The Working Group identified a number of potential biases in escapement estimation procedures, one of which was the role of handling stress in the Chilko River system mark-recapture study (Anon. 1995b). The Working Group recommended field tests to investigate whether handling and tagging stress caused mortality or behavioral changes which would bias the population estimates. The current radio telemetry study arose from that recommendation.

Since its first application in studies of fish behaviour in 1956 (Trefethen (1956) in Stasko and Pincock (1977)), telemetry has been used to study salmon homing and migration (Eiler 1995; Ogura and Ishida 1995; Fretwell 1981; Groot *et al.* 1975; Stasko 1975; Madison *et al.* 1972), muscle activity (Hinch *et al.* 1996), and marine migration (Ogura and Ishida 1992). These studies employed one of two telemetry techniques: radio or ultrasonic. Ultrasonic transmitters produce coded acoustic pressure waves at ultrasonic frequencies (20-300 kHz) which are detected by underwater receivers. Radio transmitters emit pulse coded radio signals at frequencies between 20 and 300 MHz which are detected by above-water receivers. Both are manufactured in units small enough for fish behaviour studies.

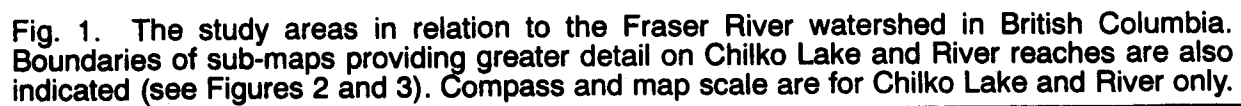
Ultrasonic telemetry performs best in salt or fresh water where a combination of high conductivity and depth attenuates radio signals (Stasko and Pincock 1977). It is less useful, however, in turbulent or shallow water, or where algae,

weeds or silt obstruct a direct path between the transmitter and receiver (Scheifer and Power 1972; Stasko and Pincock 1977). Radio telemetry is virtually impossible in sea water because the high conductivity rapidly attenuates radio signals. In freshwater with negligible conductivity, the advantages of radio over ultrasonic telemetry are that weeds and algae do not obstruct the signals, and the wider bandwidth allows higher data conveyance rates and the easy identification of a large number of transmitters through pulse coding and multiple frequencies (Stasko and Pincock 1977). Because water conductivity in the Chilko system averages only $54 \mu\text{S}\cdot\text{cm}^{-1}$ (Elson *et al.* MS 1986), radio telemetry was selected for the 1995 study.

The 1995 study investigated the post-tagging behaviour of sockeye salmon which were tagged in the Chilko River and spawned in the river and Chilko Lake. The objectives of the study were to: a) determine whether handling stress caused tagged fish to either drop downstream and out of the study area or exhibit differential behaviour which would result in a lower probability of recapture; b) describe the movement patterns between the tagging site and the spawning grounds; and c) estimate the relative proportion of the stock which spawned in the south end of Chilko Lake. The current report documents the study design, field methods, and results of the telemetry study, including descriptions of the diel and intrasystem movement patterns, the identification of lake spawning areas, and an assessment of stress related loss from the study population. The report concludes with a discussion of the results and recommendations for the design of future radio telemetry studies.

STUDY AREA

The Chilko system, consisting of Chilko River and Lake, Taseko River and Lake, and a number of smaller tributaries, is located on the eastern edge of the Coast Mountain Range in central British Columbia (Fig. 1). Chilko Lake is 65 km long and is located, at an elevation of 1,170 m, in a glacial trench surrounded by steep mountains. It is situated in Ts'ylos Provincial Park, a 233,200 hectare Class A park established in 1994. The lake is drained by the Chilko River, which flows northeast for 82 km, entering the Chilcotin River 106 km upstream from the Fraser River. The Chilcotin River then flows southeast,



joining the Fraser River west of Williams Lake, about 440 km upstream from the ocean. The Chilko River at the Chilko Lake outlet has a mean daily discharge of $41 \text{ m}^3\text{s}^{-1}$ (1928-1990) with mean daily maxima ($110 \text{ m}^3\text{s}^{-1}$) and minima ($9 \text{ m}^3\text{s}^{-1}$) occurring in July and March, respectively (Environment Canada 1991).

The 1995 study area included all of Chilko Lake, and the Chilko River from the lake outlet downstream for 19.9 km to the lower stationary receiver site (Fig. 1). Chilko Lake lies entirely in a remote park and, except for roads near Nemiah and Tsuniah creeks, is accessible only by aircraft or boat. Sockeye migrate along the lake shores and spawn on submerged beaches, most of which are near creek mouths or along debris slides. Spawning is scattered at localized sites along the lake periphery; however, three areas are known to support heavy spawning: south of Franklyn Arm, especially on the east shore across from Farrow Creek; on the north shore of Franklyn Arm; and on the east shore north of Tsuniah Creek (Fig. 2). The lake was divided into north and south areas delineated by a line drawn from Stiklon Point on the west shore to Canoe Point on the east shore (Fig. 2). The north and south areas were further divided into mobile tracking areas based on: a) an emphasis on known spawning areas and migratory routes; b) coordination with existing mark-recapture areas to facilitate comparisons of radio transmitter and disk tag recoveries; and c) receiver range and spawner density. Additional stations were added to some areas because new data collected by the current study and the mark-recapture study (Fanos and Schubert 1996) showed heavy spawning in areas where spawning was previously thought to be negligible.

The majority of the study area's sockeye population spawns in the upper reaches of the Chilko River. River access is provided, at the downstream receiver site, Henry's Bridge, Lingfield Creek, and along areas 1-5, by a gravel road which parallels the river to the west. The river was divided into nine monitoring or tracking areas (Fig. 3) which were consistent with the reaches used in the mark-recapture study (Fanos and Schubert 1996). Some areas included several stations which are denoted alphabetically.

Areas 1-4 support the bulk of sockeye spawning in the Chilko River. Area 1 (1.2 km)

extends from the lake downstream to the fisheries camp. This area is separated from Chilko Lake by a short narrows which has an average width of 20 m and a maximum depth of 13 m. The upstream receiver station was located on a peninsula on the east side of the Narrows. Below the Narrows, there is a broad basin with a width of 500 m and a depth of 2-4 m; the substrate is sand and mud with scattered gravel deposits. The remainder of the area has a depth of 1-2 m and a cobble substrate. A 300 m long island splits the middle part of the area into two channels, and a 20-50 m wide shelf extends along the east shore from the island downstream to the end of the area. Area 1 includes five mobile tracking stations (1a to 1e), with Station 1b divided into two by the north tip of the island (Fig. 3).

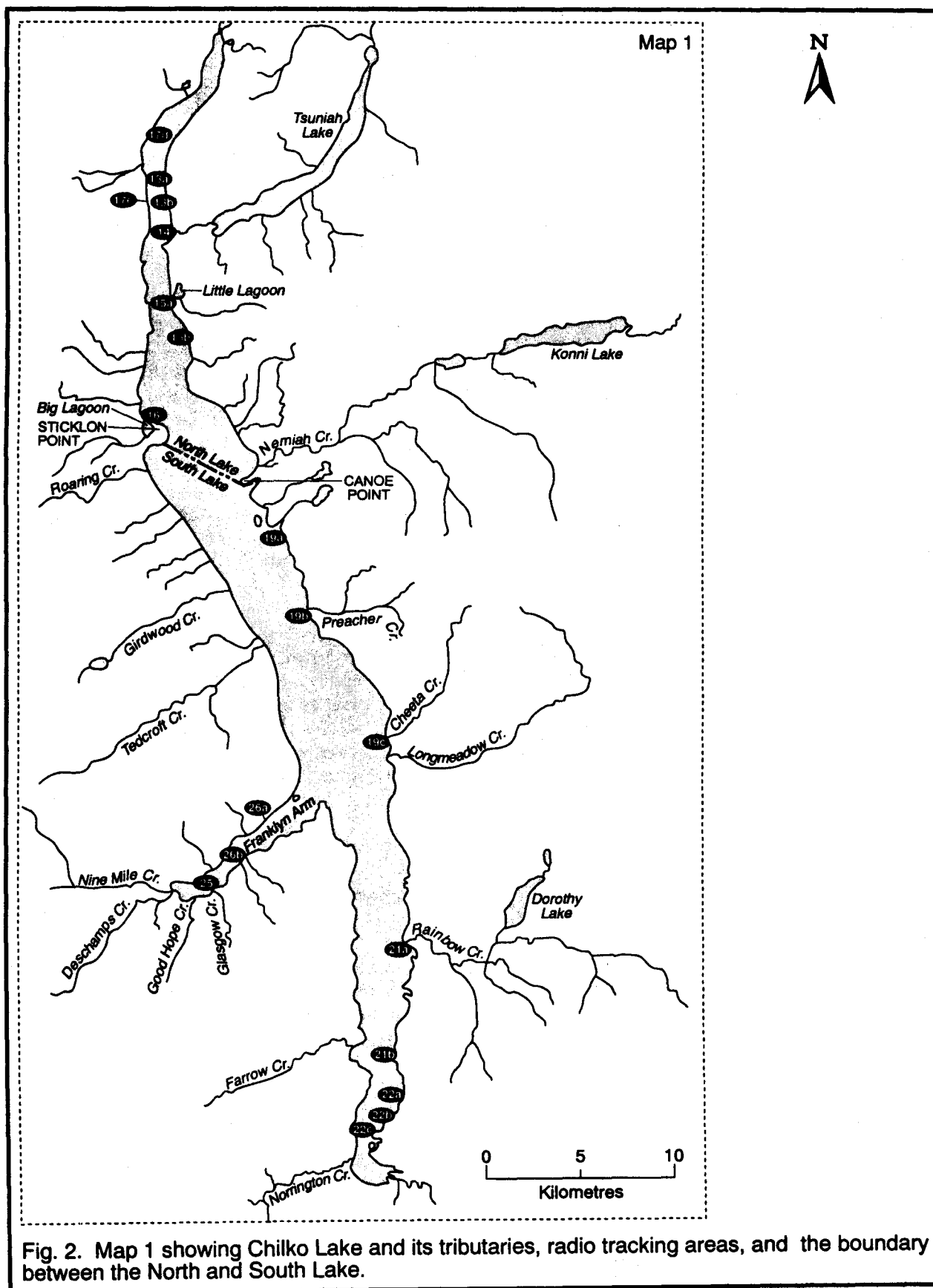
Area 2 (0.6 km) extends from the fisheries camp to immediately above a large pool, locally known as the Blue Pool. This area has a depth of 1-2 m and a substrate of cobble and scattered boulders.

Area 3 includes a short section of main river (Station 3a), a 50 m diameter, 4 m deep pool (Blue Pool; Station 3a), which is separated from the main channel by a small island, and the Chilko River spawning channel (Station 3b). The spawning channel has a length of 835 m, a width of 12 m and an average depth of 0.5 m.

Area 4 (0.9 km) extends from the Blue Pool to a bend in the river 500 m below the spawning channel outlet. This area is similar to Area 2 in river morphology and sockeye spawning density.

Area 5 (0.6 km) extends downstream to a lake-like area locally known as Canoe Cross. Area 5 is a transition area where the gradient declines and the substrate changes from cobble to gravel, sand and mud; sockeye spawning is relatively light.

Area 6 (1.9 km) is Canoe Cross. The river here has a width of 300 m, a water velocity of almost zero and a substrate of sand and mud, with gravel and cobble in isolated areas. Although some spawning occurs along the shores, most of the carcasses drift into this area. At the peak of die-off, the carcass accumulations are so dense in many places that the river bottom cannot be seen. Area 6 was divided into two sta-



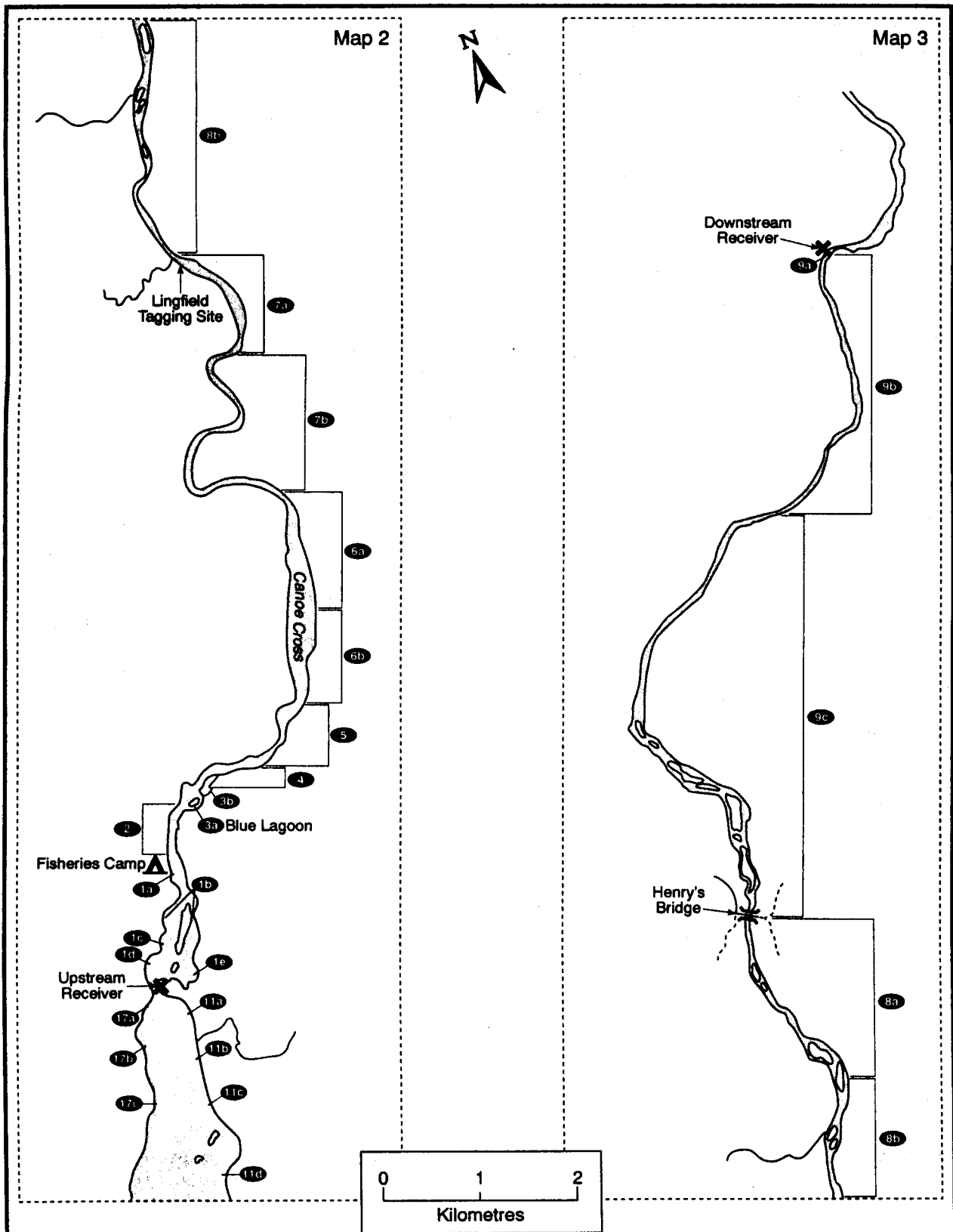


Fig. 3. Maps 2 and 3 showing Chilko River, the North Lake, radio tracking areas, and locations of the upstream and downstream remote receivers.

tions (6a and 6b); however, because the current was negligible and the area was large, each was further divided into three smaller stations.

Area 7 (4.5 km) and Area 8 (4.4 km) extend from Canoe Cross to Lingfield Creek, and to Henry's Bridge, respectively; the former includes the tagging site. The channel gradient here is higher and the river is characterised by riffles, boulder and cobble; sockeye spawning is light. Each area includes two mobile tracking stations (7a, 7b, 8a and 8b).

Area 9 (5.8 km), which extends from Henry's Bridge to the downstream receiver, includes an area locally known as The Islands. The flood plain is wider and the river braids to form several side channels. Sockeye spawning is light. The area includes two mobile tracking stations (9b and 9c). Station 9a was scanned continuously by the downstream receiver which was located on the west shore at a bend in the river (Fig. 3).

METHODS

RADIO TELEMETRY EQUIPMENT

Radio Transmitters

The pulse-coded transmitters (Lotek Engineering Inc., Newmarket, Ontario, Canada) were embedded in a smooth acrylic resin tube measuring 4.2 cm long and 1.4 cm in diameter, and weighing 10 g. A 43 cm long flexible antenna coated in a plastic sheath protruded from the flat end of the transmitter; the opposite end was rounded to facilitate application. The transmitters were controlled by a magnetic reed switch and were activated by removing an external magnet. Each transmitter was identified by frequency (channel) and a pulse rate of 11 per minute which was modulated to produce a unique pulse code. Nine channels (149.50 MHz to 149.68 MHz) were used, each separated by 20 kHz. Eight of the channels were assigned between 18 and 21 unique transmitters; the remaining channel was assigned eight transmitters.

Telemetry Receivers

Three identical telemetry receivers (SRX 400 version, Lotek Engineering Inc.) were used in this study, one for mobile tracking and two as remote receivers. The receivers were data logging,

tracking and telecommunications devices controlled by a microcomputer with 64 kbytes of program memory and 64 kbytes of data memory (expandable to 1 Mbyte). Power for the mobile receiver was provided by a built-in NiCad battery capable of supporting continuous receiver operation for up to 16 hours. Power for the remote receivers was provided by an external 12 V battery capable of supporting continuous receiver operation for up to 125 hours. The remote receivers and their batteries were housed in weather resistant, locked wood boxes which protected the equipment from both the elements and vandals. The receivers scanned each channel for six seconds before moving to the next available channel. The number of channels scanned in a cycle depended on the number currently in use and, consequently, increased as the study progressed. Pulsed signals detected by the receivers were analyzed by a code discrimination algorithm (Code Log program, Version 3.4, © Lotek Engineering Inc.) to determine whether valid code signatures were present. When the program recognized a valid signal, the receivers recorded the date, time, channel number, signal strength, gain and transmitter channel and code. These records were stored consecutively in memory until they were downloaded as a text file onto a laptop computer.

Antennae

The Yagi antennae used in this study consisted of a central aluminum pole from which smaller aluminum poles (the elements) radiated in a plane perpendicular to the central pole. Yagi antennae are directional with the strongest signals received when the central pole is aimed parallel to the water surface within $\pm 20^\circ$ of the transmitter. The mobile receiver used a three element Yagi antenna while the upstream and downstream receivers used six and four element antennae, respectively. The number of elements is inversely proportional to the gain sensitivity and directly proportional to the receiver range. The four and six element antennae were used at the remote receivers to maximize detection range while the three element antenna was used with the mobile receiver for ease of handling because range was not as important when using a mobile boat. Antennae signals were conveyed to the telemetry receivers through a 50 ohm coaxial cable connected to a jack on the front of each receiver.

TELEMETRY EQUIPMENT TESTS

Transmitter Function

Before application, each transmitter was activated and the mobile receiver was used to verify that the transmitter signal could be detected and was the same channel-code combination indicated on the transmitter. This ensured that only active, correctly coded transmitters were applied.

Antenna Orientation

Antenna orientation at each remote station was tested by placing the test transmitter at different locations to ensure that an actively migrating sockeye would be detected within the maximum receiver scan time (54 seconds). For these tests, we assumed an average swimming speed of $1 \text{ m}\cdot\text{s}^{-1}$ for migrating sockeye adults (Ellis 1962). At the upstream receiver, where the current was negligible, a sockeye could migrate 54 m during a receiver scan cycle. We tested receiver function, therefore, over a 60 m long range with the receiver near the midpoint of the range. A test transmitter was lowered from a boat on a weighted line at various locations along the shore opposite the receiver. Transmitter signal strength was recorded at each location.

The current at the downstream receiver was faster than at the upstream receiver. Although the speed of sockeye swimming against the current would be slower than that assumed at the upstream receiver, the speed of a sockeye actively swimming with the current would be considerable greater. We assumed an average speed of $3 \text{ m}\cdot\text{s}^{-1}$ for sockeye at this location. Since the maximum scan time at this receiver was also 54 seconds, a fish could move 162 m in a single scan cycle; therefore, we tested receiver function over a range of 170 m with the receiver located near the midpoint of the range. A test transmitter attached to a fishing line was cast into deep water at various locations along the shore opposite the receiver. The transmitter signal strength was recorded at each location.

Receiver Function

Test transmitters were used for the duration of the study to monitor the performance of the remote receivers and to ensure the integrity of the antennae and connector cables. At the

downstream receiver, an active transmitter was placed in the water at a depth of 0.5 m, 25 m upstream from the receiver. At the upstream receiver, a test transmitter was placed in the Narrows each day at a depth of 5 m approximately 25 m south from the antenna. Both test transmitters were also used to evaluate the affect of time on transmitter signal strength.

Receiver Range

Receiver range is dependent on transmitter power, water depth, water conductivity, signal frequency, reflection, and noise (Winter 1983; Stasko and Pincock 1977). Range is site specific and must be evaluated and documented, therefore, on a system specific basis. Range tests were conducted in the north end of Chilko Lake along a steep 1.8 km long rock slide (areas 13a and 13b; Fig 2) where the nearly linear shore facilitated a straight trajectory and the steep drop-off allowed testing at depths of 10 m without moving far from shore. The signal strengths of five transmitters were measured at eight ranges (25 m to 350 m), five depths (0 m to 10 m) and two receiver gain settings (70 and 90) for a total of 80 different depth-range-gain combinations. The transmitters (channels 149.66 MHz ($n = 2$) and 149.58 Mhz ($n = 3$)) were arranged in a cluster and suspended from a boat on a weighted line. The transmitter cluster was suspended at a given range and depth and each frequency was scanned for nine seconds. The antenna was fixed 2 m from the water surface and was aimed along the test range. The signal strength of all five transmitters was then averaged for each depth-range-gain combination.

TRANSMITTER APPLICATION

Transmitters were applied in the Chilko River near Lingfield Creek (Fig. 3) by the mark-recapture study crew (Fanos and Schubert 1996). Daily transmitter application targets were set at six in August and four in September; approximately equal numbers were applied to each sex. Sockeye were captured using a beach seine net which was set by power boat in a downstream arc and withdrawn from the river to enclose a small area of water along the river bank. Captured fish were removed from the net and placed in a wooden tray (12 cm x 20 cm x 100 cm) constructed with a flexible plastic bottom and a metre stick recessed in one side. The tray was

set in a stand elevated above the water surface. The fish were not anaesthetized nor were their gills irrigated during tagging. Most received a disk tag only. A representative sample with a nose-fork (NF) length of greater than 50 cm received a radio transmitter; none received both. Transmitters were lubricated with olive oil and inserted through the mouth and into the stomach using a 0.7 cm diameter plastic tube. Approximately 25 cm of the antenna protruded from the mouth and trailed alongside the body. Each fish received three 7 mm diameter holes which were punched through the right operculum to identify that fish as one which had received a transmitter. Date of capture, transmitter channel and code, sex, NF length (± 0.1 cm), marks (hook, net or lamprey) and condition at release (swam away vigorously, swam away sluggishly, or required ventilation) were recorded for each fish. Total processing time averaged about 30 seconds for each fish. Except for transmitter application and the number of opercular punches, handling procedures for disk tag and transmitter application were identical.

Internal damage caused by transmitter application was evaluated by incising the abdomens of 25 radio tagged females which had been killed for fecundity assessment. The status of the stomach was recorded as either intact or ruptured.

MOBILE TRACKING

Mobile tracking was conducted using a three element Yagi antenna held 2 m above the water surface. The spawning channel (Station 3b) was surveyed by walking its length carrying the mobile receiver. The river and lake were surveyed in a boat which moved from station to station. At each station, the motor was turned off to reduce interference. The receiver scanned as many frequencies as were released into the system and scanning was stopped upon receiving a code until the source direction and maximum signal strength of that code was determined. Transmitter location was roughly determined as the area of maximum continuous signal strength for that transmitter on that day. The receiver then moved on to the next available frequency. The receiver was downloaded onto a laptop computer daily and the battery was charged when necessary. Data recorded included transmitter channel and code, time and date detected, location, and maximum and minimum signal strength.

The Chilko system is very large and mobile tracking of all lake and river areas on a daily basis would be difficult and expensive. In the current study, the dense sockeye populations in the river (areas 1-3) were monitored daily, with the north and south lake surveyed once or twice per week, weather permitting. The spawning channel was surveyed only once per week because it was a closed system, i.e. carcass recovery was simple because fish could not leave the channel after spawning. The mid/lower river areas (4-7) were surveyed only after die-off began because spawning in these areas is light. The extreme lower river (areas 8-9) were surveyed on three occasions after the peak of die off.

REMOTE TRACKING STATIONS

The remote receivers were located at the lake-river boundary and below the lower limit of the mark-recapture study area (Fig. 3). The downstream receiver was located 10.2 km below the tagging site and was accessible by road. The river here has a maximum width of 50-75 m and a maximum depth of 2.5 m. The receiver was positioned on a river bend with the antenna, positioned 5 m above the water surface, aimed upstream along a straight 2 km long river section. The purpose of this station was to detect radio tagged sockeye leaving the system after release. The station was serviced every two to five days as follows: data stored in the receiver were downloaded to a microcomputer; the battery was checked and replaced when necessary; the antenna mounts and cable integrity was tested; the receiver time clock was tested; and the receiver frequency and code detection was checked using a test transmitter. During the downloading and equipment testing procedure, the station continued to function through the use of a back-up receiver.

The upstream receiver was located on the east side of the Narrows, 9.7 km upstream from the transmitter application site (Fig. 3). The river here is approximately 20 m wide with a maximum depth of 13 m. The receiver antenna was located approximately 6 m above the water surface and aimed at an oblique angle upstream across the narrows. The purpose of this station was to detect tagged sockeye moving between the lake and river. Receiver downloading and daily maintenance procedures, identical to those described above, were performed daily.

DATA PROCESSING

When a sockeye bearing a radio transmitter breaches the water surface and the antenna is exposed to air, the signal from that transmitter can carry for several kilometers. Data of this nature are spurious because, although the transmitter signal can be recorded, the fish could be anywhere within several kilometers of the receiver. The data were manually screened for these spurious records which were distinguished by a single recording of a code accompanied by a weak signal strength. Such records were deleted from the database.

Mobile tracking information (channel, code and signal strength) were viewed on a monitor built into the front of the mobile receiver. When a transmitter was located, the maximum and minimum signal strengths of that transmitter were manually recorded on paper as were the channel and code and the area where tracking occurred. At the end of each day, the data were reviewed and if a channel-code combination was recorded in several proximal areas in a short time span, all of the data were deleted except for the area where the highest signal strength was recorded. Interference signals (e.g. from aircraft or boat engines) were also identified and deleted.

TRANSMITTER RECOVERY

Transmitters were recovered in conjunction with the mark-recapture program (Fanos and Schubert 1996) and with the aid of the mobile receiver. In the latter case, when a transmitter was detected, the source was localized to determine whether the fish was dead. The following was recorded for carcasses recovered with radio transmitters: survey area; sex; number of operculum punches; carcass condition (fresh, tainted, rotten); and spawning success (0%, 50%, 100%). The abdomen was incised and the stomach condition was recorded as intact or ruptured. The transmitter was then removed and deactivated to prevent further detection by the receivers.

MOVEMENT INDEX

Although we did not actively track individual fish, the mobile tracking data could be used to develop a movement index for each fish. The index is the ratio of the sum of a transmitter's between area movements and the number of days

that it was detected. For example, if a transmitter was recorded in Area 1e on Day 1 then in Area 1a on Day 2, it had a between area movement value of 2 (the minimum number of areas between 1e and 1a, including 1a) and a movement index of 1 (movement value of 2 divided by the number of days detected). The actual linear distance between areas was not used because the exact location of a transmitter within an area was unknown. Because ratios tend to reduce the variation in data, we used the criteria that a transmitter must be recorded on six or more separate days before its movement index could be calculated. Transmitters recorded in south lake areas were excluded because surveys were infrequent.

DATE OF DEATH

The date of death of each radio tagged sockeye was estimated by evaluating the condition of the carcass upon recovery in conjunction with the characteristics of the recovery area. We assumed that fresh, tainted and rotten carcasses had been dead for less than one day, one to ten days, and more than ten days, respectively. Carcasses found well above the high water mark rotted faster in the air; therefore, the above criteria were reduced to three days for tainted and six days for rotten carcasses. Carcass condition was considered in conjunction with the fish's tracking history. For example, if a fish was recorded for ten days in Area 1a, a known spawning area, and then for six days in Area 6b, a carcass collection area, we assumed that it had died on its tenth day in Area 1a, and its carcass had drifted into Area 6b.

ESCAPEMENT BY AREA

We developed four step process using the radio transmitter, Henry's Bridge counts and mark-recapture data (Fanos and Schubert 1996) to generate a gross estimate of escapement by area. First, we stratified by week the daily total counts of sockeye migrating past Henry's Bridge. Second, we estimated the weekly escapement past Henry's Bridge as the product of the total weekly count and the ratio of the total mark recapture escapement estimate and the total Henry's Bridge count. Third, we stratified the weekly escapement estimate by sex based on the sex ratio in that week's disk tag application sample. Fourth, we stratified by spawning location the sex

specific weekly escapement estimate from the spawning locations in that week's radio transmitter sample.

RESULTS

EQUIPMENT TESTS

Transmitter And Receiver Function

All of the transmitters applied in 1995 were correctly encoded and functioned normally. Data collected from the test transmitters placed at the upstream and downstream receivers showed no trend in signal strength versus date ($P > 0.05$; regression). If their batteries were representative of those in the other transmitters, then the probability of signal detection was independent of battery life for the duration of the study.

The August 17 receiver function test revealed a faulty antenna cable on the upstream receiver. The cable was replaced and the receiver functioned normally after that date.

Tests of the ability of the receivers to detect transmitters applied to actively migrating sockeye yielded strong signals throughout the 60 m and 170 m ranges at the upstream and downstream receivers, respectively. This indicated that the remote receivers would detect a tagged sockeye moving at respective speeds of up to $1 \text{ m}\cdot\text{s}^{-1}$ and $3 \text{ m}\cdot\text{s}^{-1}$ at these sites.

Receiver Range Tests

Receiver range tests were conducted on October 11 in the north end of Chilko Lake (Appendix 1). Figures 4a and 4b show the average signal strengths of five transmitters at six depths and eight distances with receiver gains of 70 and 90, respectively. The normal threshold signal strength at which the receivers recognized a transmitter was 60 dB; therefore, without taking depth into consideration, the test results suggest that our transmitters could be detected up to at least 350 m away. Depth, however, did affect the range at which the transmitter was detected. With the receiver gain set at 70, the transmitter cluster could be detected at distances up to 100 m at a depth of 10 m, 200 m at a depth of 5 m, and 250 m at depths of 2 m and 3 m. With the receiver gain set at 90, the test transmitter cluster was detected at up to 150 m at a depth of 10

m, and 250 m at depths of 2, 3 and 5 m. With the gain set at both 70 and 90, transmitters were detected at the experimental maximum of 350 m at depths of 0 m and 1 m.

Noise Effects

The upstream and downstream receivers recorded 6,961 and 21 false channel-code combinations, respectively. There was no diurnal trend in the number of false channel-code recordings at the downstream receiver (ANOVA; $P > 0.05$); however, the upstream receiver showed a pronounced trend with most of the false recordings occurring from 5 a.m. to 8 p.m. (ANOVA; $P < 0.05$). This could reflect the increased aircraft, vehicle and boat traffic during the day. Specific channels were more prone to false code recordings: the channels at 149.50, 149.54, 149.56, and 149.58 MHz had significantly more false code recordings than the other five channels (ANOVA; $P < 0.001$).

TRANSMITTER APPLICATION

Transmitters ($n = 168$) were applied from August 10 to September 21, 1995 (Appendices 2-3). Thirty-two carcasses were recovered with transmitters. Of the 31 which could be identified to sex, one female (4.5%) (No. 35; Appendix 5) had been misidentified as a male at release. The mark-recapture study, which used the same tagging crew, reported 1.6% of the males and 3.7% of the females had been misidentified at release (Fanos and Schubert 1996). Neither of these estimates were applied to the transmitter data because they were fish specific. If a similar error rate occurred in this study, however, only four of the males and two of the females would have been incorrectly sexed at release, one of which was detected at recovery. Because these numbers were small relative to the release total, this error was unlikely to have biased the sex-specific analyses. Correction for sex identification error, therefore, was limited to the observed data. The final estimate of the number of transmitters released was 90 females and 78 males.

The NF length of radio tagged sockeye averaged 59.0 cm (range 52.3 cm to 68.8 cm) in males and 57.1 cm (range 51.2 cm to 68.0 cm) in females. This compares to an average NF length of 58.9 cm (range 47.6 cm to 72.5 cm)

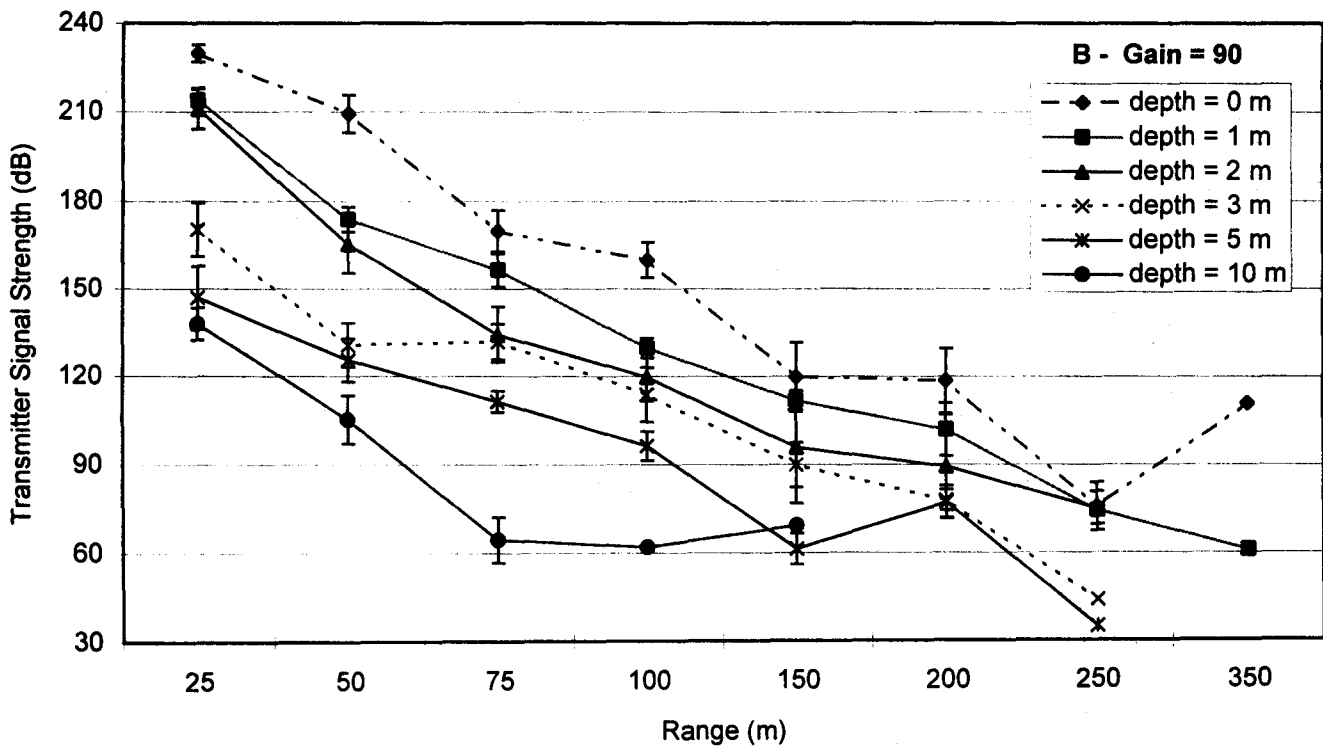
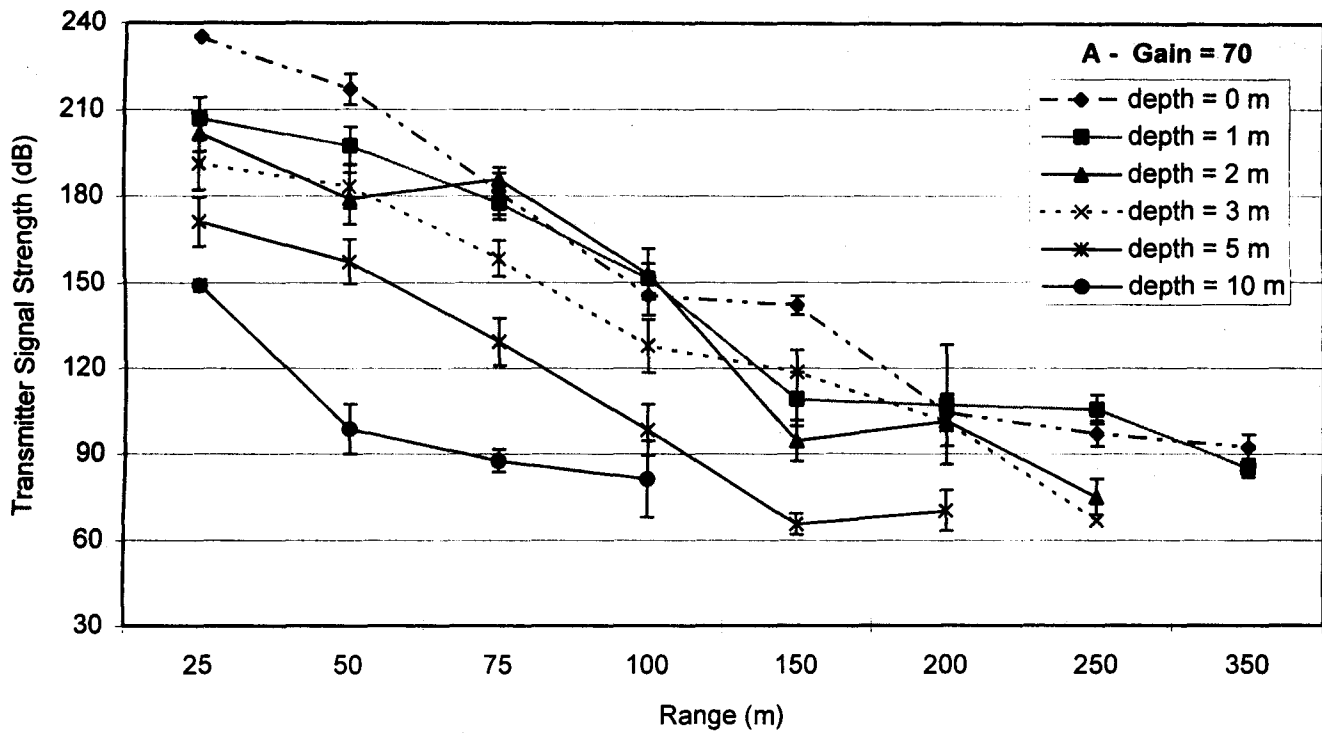


Fig. 4. Transmitter signal strengths at 40 combinations of transmitter depth and distance from the receiver at receiver gain settings of 70 (A) and 90 (B).

and 57.2 cm (range 49 cm to 67.5 cm) among disk tagged males and females, respectively. The average incidence of net, lamprey and hook marks among fish that received radio transmitters was 21.5%, 1.3% and 1.3% in males and 32.6%, 0% and 5.6% in females, respectively. This compares to the average incidence of net, lamprey and hook marks among disk tagged fish of 16.9%, 6.2% and 3.4% in males and 30.0%, 3.2% and 3.2% in females, respectively.

On September 6, 25 females were sacrificed following radio transmitter application. Dissection of the stomachs showed that none had ruptured immediately after transmitter application.

TRANSMITTER DETECTION

Of the 168 transmitters applied in this study, 9 were neither recorded by the receivers nor recovered after death. Four transmitters likely passed into the lake before the upstream receiver's antenna cable was repaired on August 17; all were designated destination unknown. A further 28 transmitters were recorded only by the upstream receiver (Appendices 3-4), of which two were later recovered. The final destinations of the remainder of these transmitters were determined based on an analysis of their behaviour at the upstream receiver (discussed later).

Downstream Receiver

Four transmitters were recorded at the downstream receiver; one swam back upstream into the lake and three were not subsequently recorded in the river or lake. The latter three were assumed to have moved downstream and out of the study area. Their histories are detailed in Appendix 4 and are described below:

- No. 120 was a male which was released on September 5. It reached the upstream receiver four days later, moved to the downstream receiver where it remained for three days, then swam upstream to Chilko Lake;
- No. 145 was a female which was released on September 12. It was recorded in Area 2 two days after release, then moved among areas 1b and 1a for ten days. It moved past the downstream receiver on September 24, 12 days after release. The average time between release and death for fish released on September 12 was 10.7 days (discussed

later).

- No. 153 was a female which was released on September 16. It reached the upstream receiver in less than a day, where it held near the receiver and in areas 11a and 1e for five days. It then moved past the downstream receiver on September 22, six days after release. The average time between release and death for fish released on September 16 was 7.7 days.
- No. 154 was a female which was released on September 16. It reached Area 1a and the upstream receiver a day after release. It remained in the river for three days, and was recorded moving past the downstream receiver on September 20, four days after release. The average time between release and death for fish released on September 16 was 7.7 days.

Upstream Receiver

The upstream receiver recorded all but 19 of the transmitters released in this study. Six of these transmitters were late river spawners which were unlikely to have reached the Narrows. The remaining 13 transmitters moved undetected past the receiver; however, four and one were later detected in the south and north lake, respectively. We note that this receiver was located in an area of excessive electronic noise, as demonstrated by the 6,961 false channel-code recordings. This, in conjunction with the faulty antenna cable, likely contributed to the receiver's failure to detect these transmitters.

The upstream receiver provided information on migration time between Lingfield Creek and the Narrows, the diel holding pattern of migrating sockeye and the movements of fish between the river and lake. These data are detailed in later sections.

Mobile Receiver

Mobile tracking was conducted on 37 days with an emphasis on the upper river and north lake (Table 1). The upper river and parts of the north lake (areas 11 and 17) were monitored up to 31 times from August 21 to October 6. The middle river (areas 4-6) was not monitored consistently until September 20, after which it was monitored almost every day (10 times). The lower river (areas 7-9) was monitored three times

Table 1. Survey frequency and daily number of transmitters detected, by survey location and date. ^a

Survey date	Number of transmitters detected ^b								Total transmitters
	South lake		North lake		Upper river		Middle river	Lower river	
	Areas 21-22	Areas 19, 25, 26	Areas 13, 14, 16	Areas 11, 17	Area 1	Areas 2-3	Areas 4-7	Areas 8-9	
21-Aug	-	-	-	-	0	1	-	-	1
22-Aug	-	-	-	-	1	2	-	-	3
24-Aug	-	-	-	1	0	0	-	-	1
25-Aug	-	-	-	2	0	0	-	-	2
26-Aug	1	1	1	5	2	1	-	-	11
27-Aug	-	-	-	-	2	4	3	-	9
28-Aug	-	-	-	2	2	0	-	-	4
30-Aug	4	2	0	0	-	-	-	-	6
31-Aug	-	-	-	13	5	0	-	-	18
1-Sep	-	-	-	4	18	2	-	-	24
3-Sep	-	-	-	12	11	0	-	-	23
4-Sep	-	-	-	8	16	1	-	-	25
5-Sep	-	-	-	6	21	3	-	-	30
6-Sep	-	-	-	7	19	0	-	-	26
7-Sep	6	4	5	17	-	-	-	-	32
9-Sep	-	-	-	-	19	8	-	-	27
11-Sep	-	-	5	1	11	0	-	-	17
12-Sep	-	-	3	1	31	11	-	-	46
13-Sep	4	2	1	2	33	9	-	-	51
14-Sep	-	-	-	12	20	7	-	-	39
15-Sep	-	-	-	6	25	9	-	-	40
16-Sep	3	2	4	0	-	-	-	-	9
17-Sep	-	-	-	4	21	15	-	-	40
18-Sep	-	-	-	5	26	10	-	-	41
19-Sep	-	-	3	3	2	0	-	-	8
20-Sep	-	-	-	-	30	11	11	2	54
21-Sep	-	-	2	0	0	-	-	3	5
22-Sep	4	1	2	0	-	-	-	-	7
25-Sep	-	-	-	2	18	12	21	-	53
26-Sep	-	-	-	-	12	3	24	-	39
27-Sep	-	-	-	3	16	6	20	-	45
28-Sep	-	-	-	-	13	7	1	-	21
29-Sep	-	-	-	1	12	6	22	-	41
30-Sep	-	-	-	-	-	-	14	3	17
2-Oct	-	-	-	-	7	6	18	-	31
5-Oct	-	-	-	-	2	7	3	-	12
6-Oct	-	-	-	-	-	-	10	-	10
No. transmitters:	22	12	26	117	395	141	147	8	868
No. surveys	6	6	10	26	31	30	11	3	-

^a Unique transmitters each survey day; duplicate detections were deleted.

^b See figures 2-3 for area locations; areas not surveyed are indicated by -.

Table 2. Average time between tag application and recovery, incidence of ruptured stomachs, and female spawning success among untagged Chilko sockeye salmon and those with radio transmitters or disk tags.

Tag type	Recovery location ^a	Days between tag application and carcass recovery ^b				Carcasses with ruptured stomachs ^c				Female spawning success	
		Male	(n)	Female	(n)	Male	(n)	Female	(n)	%	(n)
Radio transmitter	Spawning channel	9.0	(1)	20.3	(6)	100.0%	(1)	33.3%	(2)	50.0%	(6)
	Chilko River and Lake	28.3	(21)	25.7	(16)	15.4%	(2)	55.6%	(5)	66.7%	(9)
	Total	27.4	(22)	24.2	(22)	21.4%	(3)	46.7%	(7)	60.0%	(15)
Disk tag	Spawning channel	22.8	(17)	26.1	(20)	-		-		95.0%	(20)
	Chilko River and Lake	31.7	(556)	31.7	(782)	-		-		95.3%	(782)
	Total	31.5	(573)	31.6	(802)	-		-		95.3%	(802)
Untagged	Spawning channel	-		-		-		-		77.9%	(4423)
	Chilko River and Lake	-		-		-		-		93.5%	(102356)
	Total	-		-		-		-		92.9%	(106779)

^a Small number of radio transmitter recoveries in Chilko Lake did not permit further stratification.

^b Recorded for sockeye with radio transmitters and disk tags only.

^c Recorded for sockeye with radio transmitters only.

late in the study, and the south lake was monitored six times throughout the study. The south part of the north lake was also monitored during the south lake surveys, and on an additional four days for a total of ten surveys (Table 1). Results from the mobile surveys and stationary receivers are detailed in Appendix 4.

TRANSMITTER RECOVERY

Forty-four transmitters were recovered from September 8 to October 12 (Appendix 5), 12 of which were recovered without a carcass. Telemetry was essential to the recovery of: all transmitters which were recovered without a carcass, including four recovered downstream from Henry's Bridge; one carcass which had been dragged far above the high water mark; and two carcasses which were recovered from deep pools. The balance were recovered by the mark-recapture crew. The antennae from two of the transmitters recovered without a carcass had part of their insulating plastic sheath removed, possibly a result of bear activity.

No difference was noted ($P > 0.05$; t-test) in the elapsed time between release and recovery of transmitters recovered with (24 days) and without (30 days) carcasses; therefore, the 44 re-

coveries were pooled. No difference was noted ($P > 0.05$; t-test) in the elapsed time between males (27 days) and females (24 days), although the elapsed time and was longer among river and lake versus spawning channel recoveries of both sexes (Table 2). The elapsed time for male and female sockeye with disk tags both averaged 32 days and, although longer than for fish with transmitters, the difference was not significant ($P > 0.05$; t-test).

Stomach condition was examined in 29 of the 32 carcasses recovered with radio transmitters. Three (21.4%) of the males and 7 (46.7%) of the females had ruptured stomachs (Table 2). Fish with ruptured stomachs tended to be recovered sooner and were less successful spawners than the remaining radio tagged fish. For example, the elapsed time between release and recovery among fish with ruptured stomachs was shorter (21.0 days in males and 18.9 days in females), although not significantly so ($P > 0.05$; t-test), than among those with intact stomachs (25.9 days for both sexes). Furthermore, spawning success in females with ruptured stomachs averaged 35.7%, in comparison to 81.3% in those with intact stomachs; however, again the difference was not significant ($P > 0.05$; chi-square). Male and female spawning

channel recoveries also had a higher overall incidence of ruptured stomachs (42.9% versus 31.8%), although the incidence was lower among females (33.0% versus 55.6%). Again, these differences were not significant ($P > 0.05$; chi-square).

Spawning success among females with transmitters averaged 60.0% and was lower among spawning channel recoveries (50.0%) than river and lake recoveries (66.7%); however, the difference was not significant ($P > 0.05$; chi-square). Spawning success was significantly higher ($P < 0.05$; chi-square) among disk tagged females (95.3%) than among those with transmitters (60.0%) regardless of spawning location. No difference in spawning success was noted ($P > 0.05$; chi-square) among disk tagged (95.3%) and untagged (92.9%) females.

FISH MOVEMENT PATTERNS

Migration Time To The Narrows

The migration time from the release site to the upstream receiver, a distance of 9.7 km, averaged 35.1 h (range 5.6 h to 249.0 h) (Appendix 3). There was no between-sex difference (ANOVA; $P > 0.05$) in migration times; however, there was a pronounced difference between south lake, north lake and river spawners and migration time tended to increase over the study period (Fig. 5).

When migration times, \log_e transformed to normalize their variance and standardize their residuals, were regressed against release date, there was a positive but weak relationship; 35% of the variability was explained by release date (Fig. 6). Migration times averaged 18.6 h (range 6 h to 172 h) for the August 10-27 releases, 39.9 h (range 8 h to 95 h) for the August 28 to September 7 releases, and 62.4 h (range 9 h to 249 h) for the September 8-21 releases (Appendix 3). These times were equivalent to average velocities of $0.52 \text{ km}\cdot\text{h}^{-1}$ (range $0.1 \text{ km}\cdot\text{h}^{-1}$ to $1.6 \text{ km}\cdot\text{h}^{-1}$), $0.24 \text{ km}\cdot\text{h}^{-1}$ (range $0.1 \text{ km}\cdot\text{h}^{-1}$ to $1.2 \text{ km}\cdot\text{h}^{-1}$), and $0.16 \text{ km}\cdot\text{h}^{-1}$ (range $0.04 \text{ km}\cdot\text{h}^{-1}$ to $1.1 \text{ km}\cdot\text{h}^{-1}$), respectively. Migration times of up to ten days among the late migrants suggests that at least part of this group was holding and perhaps spawning in the river before being detected at the upstream receiver.

Diurnal Holding Pattern

A sockeye was classified as holding at the Narrows if the upstream receiver detected its transmitter during one-half of the receiver's cycles in an hour. Daily recordings were grouped by hour to estimate the diurnal holding pattern over the study period (Table 3). Because the number of active channels increased as the study progressed, the hourly number of complete cycles per channel decreased with time. To be classified as holding, therefore, a given transmitter would be detected fewer times per hour as the study progressed.

Data collected at the upstream receiver show two patterns. First, there were significantly fewer (ANOVA; $P < 0.005$) transmitters detected at the Narrows during the daylight relative to at night (Table 3). This suggests that the fish were more likely to hold during the day and to migrate at night. Second, the daily number of transmitters detected holding at the Narrows was large from August 31 to September 10, dropped sharply for three days, then increased from September 13 to September 16. This suggests that two groups of fish held at the Narrows before migrating onto the spawning grounds. The latter components of these groups corresponded to river spawners, released August 1 to September 6 and September 7-21, which then migrated from the Narrows and north lake back into the river (Appendix 4).

Fish Destination

The final destination of a sockeye with a radio transmitter was defined as the most probable spawning location of that fish. Final destinations were largely inferred from the mobile and stationary receiver records because only 26% of the transmitters were recovered and, in some cases, the spawning and final detection or recovery locations were different. For example, Transmitter No. 132 spent four days in a river spawning area during its expected spawning period (defined as the six day period before the average date of death for a fish released on a given date). The next observation of the fish was as a carcass in the north lake. We assumed, therefore, that it was a river spawner which had migrated into the north lake to die. The six final destinations for fish in this study are described below.

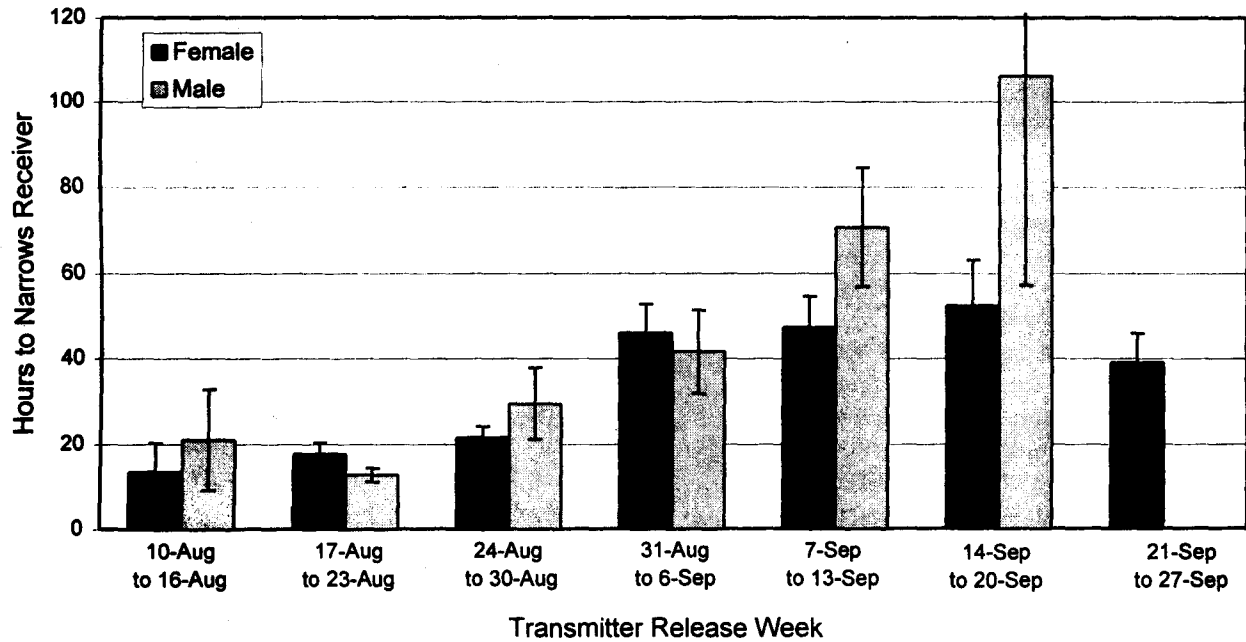


Fig. 5. Migration time in hours for male and female sockeye migrating from Lingfield Creek to the Narrows. Vertical bars represent the standard error of each estimate.

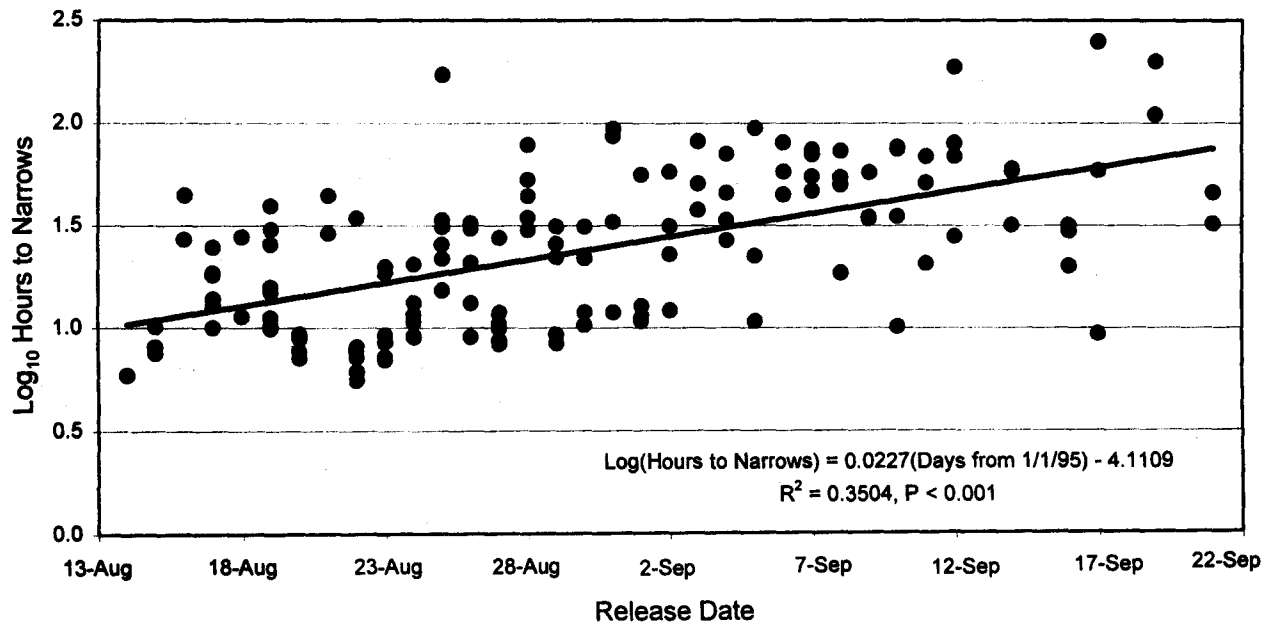


Fig. 6. Regression of release date and migration time between Lingfield Creek and the Narrows for radio tagged Chilko system sockeye.

Table 3. Hourly estimates of the number of sockeye with transmitters holding at the Narrows, by date. The times of sunrise and sunset are indicated by the two slanted lines.

Number of transmitters holding by hour of day																									
Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Totals
17-Aug																1	1	1	1	1	1			1	7
18-Aug	1	1	1																						3
21-Aug					1																				1
23-Aug																								1	1
24-Aug	1	1	1	2	1													1					1		8
25-Aug		1	1										2	1	2					1				1	9
26-Aug	1			2				1				1	2	1		1				1					10
27-Aug											1	1				2	3	1	1	1	1	1	1		13
28-Aug				1	1	1		1		1	1	1	1		1	1	1	1	1						13
29-Aug							1				1				1					2					5
30-Aug		1										1	1	1				1			3				8
31-Aug				1	1	1		1	2	1	1	1		1					2	2	1	2	2	1	20
1-Sep	2	2			1	2		1	1	1	2	1	2	1		2		1	2	2	1		1	1	26
2-Sep		1	1			2	1	2				2	4	4	2	1	2								22
3-Sep								2	2	3	6	1	1	2	2	2	1	3	1	4	3	1			34
4-Sep		1		1			1	3	2	1	4	4	6	8	3	4	5	2	3	3	4	1	1	1	58
5-Sep	1	2	1					4	4	1	4	4	6	7	5	5	5	4	6	5	2	1	1		68
6-Sep		1		1	2			4	5	1	2	2	1	1	2	2	2	1	2	4	5	3	2		43
7-Sep	1						3	1	2	2	5	5	3	1		1	3	1	2	3	2	1	2	2	40
8-Sep	1	1	1	1				2	2	2	1	1	2	3	3	2	2	1	1	3	2	2	1	1	26
9-Sep			1					2	2	3	2	1	1	3	3	3	3	3	2	3	2	2	1	1	38
10-Sep		1	1	1	1	1		1	2	1	1	1	3	3	3	1		1	1	2	1	1	1		28
11-Sep							1	1	1	1	1						1	1	1						8
12-Sep						1																			1
13-Sep																			2			2	1	2	7
14-Sep	2	1							1			1	1								1	2	1		10
15-Sep									1	1	4	3	1	2	3	3			1	2	2	2	3	3	31
16-Sep	2	1	1	1	1	1	1		1	1					1	1	1	1	1	1	1	2	1	1	21
17-Sep	1	1						1										1							4
18-Sep			1	1					1	1	1	1	1	1											8
19-Sep																	1		1	1	1	1	1	1	7
20-Sep	1	1	1	1	1																	1	1	1	8
21-Sep	1							1	1			1	1	1											6
23-Sep																				1					1
25-Sep									1																1
Total	15	17	11	13	10	9	8	28	31	21	37	33	39	41	31	32	31	25	31	39	30	22	22	18	594

South lake spawners accounted for 19% of the males and 24% of the females released with transmitters (Table 4). A fish was assigned to this group if it: a) was recovered in the south lake; b) was last detected holding or spawning in the south lake; or c) exhibited a south lake pattern when last detected at the upstream receiver. South lake fish typically moved quickly through the river and into the lake. Migration time between the tagging site and the Narrows averaged 13.2 h (range 5.6 h to 39.7 h) and was relatively constant through the study. Migration time through the Narrows, as indicated by the average

time of detection at the upstream receiver, was less than 30 minutes, and many were through the area in five minutes or less (Appendix 4). South lake spawners predominated in the early part of the run (10-Aug to 27-Aug), accounting for 38% of the males and 44% of the females. This proportion declined to 4% during the peak period (28-Aug to 07-Sep) and remained low for the balance of the run.

North lake spawners accounted for 11% of the males and 22% of the females released with transmitters (Table 4). A fish was assigned to

Table 4. Final destination of radio transmitters by application period^a and sex.^b

Sex	Destination	Early releases		Peak releases		Late releases		Total	
		No.	%	No.	%	No.	%	No.	%
Male	South lake	13	38%	1	4%	0	0%	14	19%
	North lake	6	18%	1	4%	1	6%	8	11%
	Unknown lake	4	12%	0	0%	0	0%	4	5%
	River	11	32%	22	92%	14	88%	47	64%
	Spawning channel	0	0%	0	0%	1	6%	1	1%
	Never detected	3	-	0	-	1	-	4	-
	Total	37	-	24	-	17	-	78	-
Female	South lake	17	44%	1	4%	2	9%	20	24%
	North lake	12	31%	4	17%	3	14%	19	22%
	Unknown lake	2	5%	0	0%	1	5%	3	4%
	River	5	13%	16	67%	16	73%	37	44%
	Spawning channel	3	8%	3	13%	0	0%	6	7%
	Never detected	3	-	1	-	1	-	5	-
	Total	42	-	25	-	23	-	90	-

^a Application strata are: early - 10-Aug to 27-Aug; peak - 28-Aug to 07-Sep; late - 08-Sep to 21-Sep.

^b Sex was corrected for one fish.

this group if it: a) was observed predominantly in the north lake and was detected there during the expected spawning period for a fish released on that date; b) was last observed holding for extended periods near the Narrows well before the spawning period but was not detected spawning. We assumed that, had the fish spawned in the river, it would have been detected by the frequent river surveys. The fish, therefore, most likely spawned in the north lake; and c) exhibited a north lake pattern when last detected at the upstream receiver. Migration time between the tagging site and the Narrows was longer than for south lake fish, averaging 22.7 h (range 7.1 h to 74.8 h), and was longer among the later migrants (Appendix 4). North lake fish also held at the Narrows for extended periods or migrated through the Narrows more slowly than south lake fish. They were commonly detected at the upstream receiver for several periods of over two or more days each. The average time of detection during each period almost always exceeded one hour and in some cases approached 24 hours (Appendix 4). The proportion of north lake spawners was highest in the early part of the run, accounting for 18% of the males and 31% of the females (Table 4). These proportions declined for the balance of the run, especially among males.

Unknown lake spawners accounted for 5% of the males and 4% of the females released with transmitters (Table 4). A fish was assigned to this group if its behaviour at the Narrows was ambiguous. Examples are: transmitters 11-12 exhibited a north lake behaviour pattern at the upstream receiver; however, because they were not detected during the north lake surveys which were conducted during the expected holding and spawning period, these fish may have migrated to the south lake; Transmitter 49 was detected twice at the Narrows (like a north lake fish), but the detection periods were brief (like a south lake fish); and Transmitter 32 moved quickly through the Narrows, was detected in the south lake, then moved back to the upstream receiver and north lake before disappearing into the lake. Most of the fish in this group were in the early part of the run.

River spawners accounted for 64% of the males and 44% of the females released with transmitters (Table 4). A fish was assigned to this group if it was detected in the river or near the Narrows during the expected period of spawning. This group exhibited a variety of behaviours in the river and at the Narrows (described in a later section). In general, their migration time between the tagging site and the Narrows

was long, averaging 49.0 h (range 9.1 to 249.0 h), and was longer later in the study. They also tended to hold near the Narrows for extended periods. River spawners predominated during the peak (92% of the males and 67% of the females) and late (88% and 73%) parts of the run.

Spawning channel spawners accounted for 1% of the males and 7% of the females released with transmitters (Table 4). A fish was assigned to this group if it was recovered in the spawning channel. Some of these fish may have previously spawned in the river. Spawning channel fish were present throughout the run.

Additional to the above, four males and five females were not detected after release. These fish likely passed the upstream receiver before the antenna cable was repaired, or in early/mid September when the maximum number of transmitters were holding at the Narrows. This implies that their transit time was short and that they were bound for the south lake; however, we were unable to assign a probable destination for these fish.

Intrasystem Movement

Intrasystem movement patterns among the above five groups are detailed in Appendix 4 and summarized in Table 5. Table 5 is an iterative table where the sequence of observations for a group of fish can be followed by moving from the *Preceding Observation* rows to the *Following Observation* columns. Using the south lake group as an example, the first observation after release can be determined from the *Release Site* row: 26 were observed at the upstream receiver, three holding in or migrating through the south lake, and five holding in or migrating through the river. For the next observation of the 26 fish first observed at the upstream receiver, refer to the *Upstream Receiver* row: 24 were next observed holding in or migrating through the south lake, one was holding in or migrating through the north lake and one was spawning in the south lake. For the next observation of the 24 holding in or migrating through the south lake, refer to the *South Lake Hold/Migrate: First Time*: most or all of these fish were next observed spawning in the south lake. What cannot be determined from this table, however, is that of the 31 fish which were next observed spawning in the south lake

after holding there for the first time, four had been previously detected holding in or migrating through the river, three had proceeded immediately to the south lake without detection at the upstream receiver, one had been detected at the upstream receiver and in the north lake before moving to the south lake, and 23 had been detected only at the upstream receiver. For this level of detail, the reader must refer to Appendix 4. The purpose of this table, therefore, is to provide the reader with an indication of the complexity of behaviours among a given group of fish and the most likely subsequent observation following a given observation. The latter can be independent of the previous history of the fish if sequences overlap, and it is not always possible to follow the movement of an individual or a group of fish from release until recovery. The predominant behaviour patterns among each group are discussed below.

South lake spawners typically moved quickly through the river and Narrows to the south end of the lake (Table 5). Of those detected at the receiver, 96% had been released on the same or previous day. After entering the lake, 82% were next detected either holding or spawning in the south lake (or were not subsequently detected). Three fish (Nos. 4, 61 and 78) were atypical in that, after clearing the upstream receiver, they migrated into the lake (as far as the south lake, in one case), returned to the receiver, then migrated to the south lake spawning grounds.

North lake spawners typically migrated to the Narrows and tended to hold in the north lake or upper river until ready to spawn (Table 5). The largest proportion (56%) moved directly into the north lake and either held near the Narrows where they were detected repeatedly or moved into the lake and were not detected until they spawned. The remainder were detected in the river at least part of the time before they spawned. Two fish (Nos. 64 and 85) moved several times between the river and lake.

River spawners exhibited several behaviour patterns, including: a) migrating to the Narrows, holding near the Narrows or in the north lake, and migrating back into the river to spawn (51% of total); b) migrating to the Narrows, moving between the north lake and river several times before dropping back into the river (21%); c) both of the above, except migrating back into the lake

Table 5. Transition matrix showing the temporal sequence of transmitter observations in the Chilko River system, by sockeye spawning location. See the text for instructions regarding the interpretation of this table.

Preceding observation	Up-stream receiver	Following observation											
		Holding or migrating ^a									Spawning		
		S. Lake ^b			North lake ^b			River ^b			South lake	North lake	Spawning channel
		1st	2nd	3d	1st	2nd	3d	1st	2nd	3d	lake	lake	River
A. South Lake Spawners:													
Release site	26	3	0	0	0	0	5	0	0	0	0	0	0
Upstream receiver	0	24	0	1	0	0	0	0	0	1	0	0	0
South lake hold/migrate:													
First time	0	0	0	1	0	0	0	0	0	31	0	0	0
Second time	0	0	0	0	0	0	0	0	0	1	0	0	0
North lake hold/migrate	0	1	1	0	0	0	0	1	0	0	0	0	0
River hold/migrate:													
First time	0	4	0	1	0	0	0	0	0	1	0	0	0
Second time	0	0	0	0	0	0	0	0	0	1	0	0	0
B. North Lake Spawners:													
Release site	22	0	0	0	0	0	4	0	0	0	1	0	0
Upstream receiver	0	0	0	13	0	0	8	0	0	0	1	0	0
North lake hold/migrate:													
First time	0	0	0	0	0	0	0	2	0	0	22	0	0
Second time	0	0	0	0	0	0	0	0	0	0	2	0	0
River hold/migrate:													
First time	0	0	0	11	0	0	0	0	0	0	1	0	0
Second time	0	0	0	0	2	0	0	0	0	0	0	0	0
North Lake Spawning	0	0	0	0	0	0	1	0	0	0	0	0	0
C. Unknown Lake Spawners:													
Release site	7	0	0	0	0	0	0	0	0	0	0	0	0
Upstream receiver	0	1	0	0	0	0	0	0	0	0	0	0	0
South lake hold/migrate	0	0	0	1	0	0	0	0	0	0	0	0	0
D. Chilko River Spawners													
Release site	53	0	0	0	0	0	26	0	0	0	0	6	0
Upstream receiver	0	0	0	28	0	0	23	7	0	0	0	10	0
North lake hold/migrate:													
First time	0	0	0	0	0	0	24	14	0	0	0	10	0
Second time	0	0	0	0	0	0	0	6	1	0	0	4	0
Third time	0	0	0	0	0	0	0	0	1	0	0	2	0
River hold/migrate:													
First time	13	0	0	19	9	0	0	0	0	0	0	30	0
Second time	0	0	0	0	1	2	0	0	0	0	0	23	0
Third time	0	0	0	0	0	0	0	0	0	0	0	1	0
River spawning	2	0	0	11	9	1	0	2	0	0	0	0	0

^a Upstream receiver records were reported only for the first or last record of an individual fish; see Appendix 4.

Continued

^b 1st, 2nd and 3d indicate the number of times a sockeye was observed in that area but was recorded in at least one other area in the intervening period.

Table 5 continued. Transition matrix showing the temporal sequence of transmitter observations in the Chilko River system, by sockeye spawning location. See the text for instructions regarding the interpretation of this table.

		Following observation												
		Holding or migrating ^a									Spawning			
Preceding observation	Up- stream receiver	S. Lake ^b		North lake ^b			River ^b			South lake	North lake	River	Spawn- ing channel	
		1st	2nd	1st	2nd	3d	1st	2nd	3d					
E. Spawning Channel Spawners														
Release site	4	0	0	0	0	0	2	0	0	0	0	0	0	
Upstream receiver	0	0	0	1	0	0	3	0	0	0	0	0	0	
North lake hold/migrate:	0	0	0	0	0	0	1	3	0	0	0	0	1	
River hold/migrate:														
First time	0	0	0	4	0	0	0	0	0	0	0	0	2	
Second time	0	0	0	0	0	0	0	0	0	0	0	2	1	
River spawning	0	0	0	0	0	0	0	0	0	0	0	0	2	

^a Upstream receiver records were reported only for the first or last record of an individual fish; see Appendix 4 for detailed records.

^b 1st, 2nd and 3d indicate the number of times a sockeye was observed in that area but was recorded in at least one other area in the intervening period.

to die after spawning (21%); and d) spawning in the river without ever reaching the Narrows (7%).

All of the spawning channel recoveries had been detected in the river or lake, and two (Nos. 70 and 90) may have began spawning in the river before moving into the spawning channel.

A small number of fish showed confused or seaching behaviour. One (No. 32) was detected in the south lake and returned to the Narrows before disappearing into the lake. Another (No. 120) migrated to the upstream receiver, moved back to the downstream receiver, then migrated into the lake. A third (No. 61) migrated to the south lake, returned to the Narrows, and was later detected spawning in the south lake.

Sex Specific Movement

The mobility index detected no significant difference in the movement pattern of males and females (*t*-test, $P > 0.05$).

TIME TO DEATH

There was a strong negative relationship between the time that a fish remained alive following transmitter application and the date of transmitter application (Fig. 7; Appendix 4). This sug-

gests that fish arriving at the Chilko system late in the run were at more advanced stages of maturation and thus had shorter remaining life spans than fish that arrived early in the run. The regression data were not log transformed because the raw data approximate linearity.

ESCAPEMENT BY AREA

The adult male escapement was estimated at 35,900 (18%) in the south lake, 44,500 (22%) in the north lake and 114,800 (58%) in the river or spawning channel; an additional 2,900 (1%) were designated as unknown lake. The adult female escapement was estimated at 47,500 (14%) in the south lake, 26,583 (8%) in the north lake and 247,100 (75%) in the river or spawning channel; an additional 7,000 (2%) were designated as unknown lake.

DISCUSSION

RECEIVER EFFECTIVENESS

The objectives of the 1995 radio telemetry study were to: a) determine whether handling stress caused tagged fish to either drop downstream and out of the study area or exhibit differential behaviour which would result in a lower probability of recapture; b) describe the move-

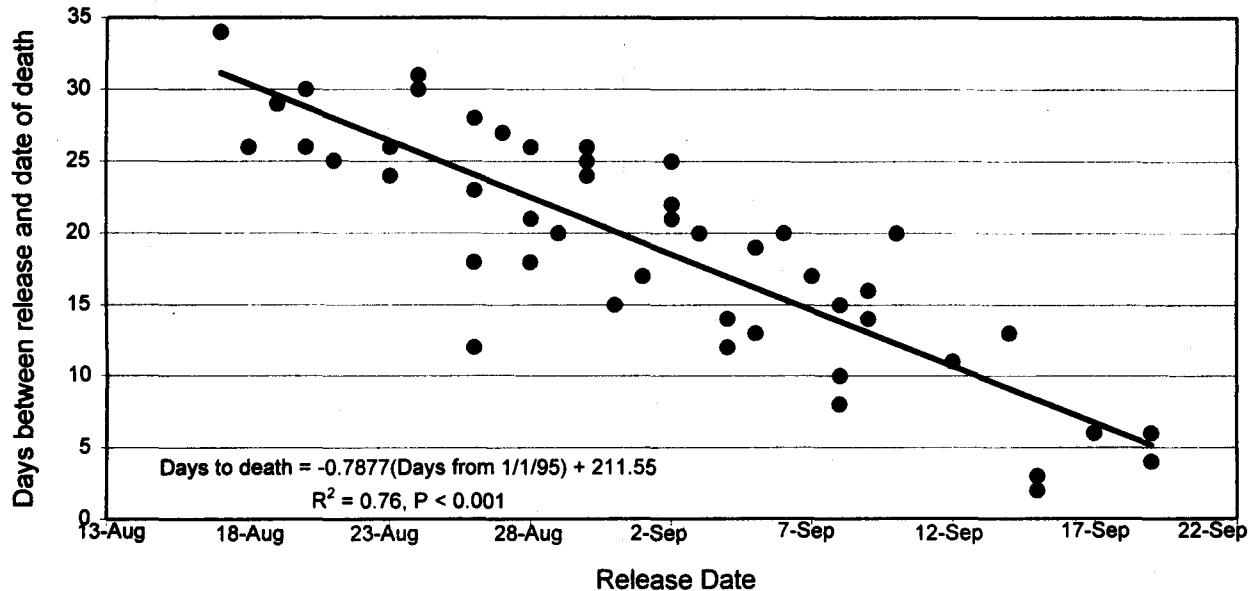


Fig. 7. Regression of release date and time between release and the estimated date of death for radio tagged Chilko system sockeye.

ment patterns between the tagging site and the spawning grounds; and c) estimate the relative proportion of the stock which spawned in the south end of Chilko Lake. Before addressing the first objective, it was necessary to determine whether the telemetry equipment could provide the required level of information.

The downstream receiver functioned normally throughout the study period and, consequently, was capable of detecting a transmitter if: a) electronic noise did not interfere with the signal; and b) the transmitter remained in range for the maximum receiver scan time. Electronic noise produced largely by motors can hinder receiver performance (Winter 1983; Kuechle *et al.* 1982; Stasko and Pincock 1977). The downstream receiver was sited in a relatively noise-free environment which was unlikely to have interfered with the receiver's performance. We tested the receiver's ability to detect a transmitter over a 170 m range which simulated the maximum distance a sockeye moving at $3 \text{ m}\cdot\text{s}^{-1}$ would travel during one scan cycle when all transmitter frequencies were in use. Transmitters were detected throughout this range. Consequently, we concluded that the downstream receiver was capable of detecting any radio tagged fish which passively or actively migrated downstream past the site; it would have detected any fish suffering

from severe acute tagging stress which dropped downstream and emigrated from the study area.

In contrast, the upstream receiver was sited in an electronically noisy environment. It was 60 m from a campground and was near an airfield, an international lodge, and heavily trolled waters, an environment with excessive electronic noise from motor vehicles, airplanes, generators and voiceband transmissions. Motor noise, referred to as impulsive noise, is characterized by repetitive but very narrow pulses while voiceband transmissions are typically bursty (Anon. 1994). The combination of both forms of noise in the same environment makes transmitter signal recognition difficult and can result in error messages and the incorrect identification of transmitters through false channel-code combinations. Of the 168 transmitters applied in this study, 19 were undetected when they moved past the receiver into the lake. Except for four fish that moved past the receiver before the faulty antenna cable was repaired on August 17 and six fish that were late river spawners which did not reach the Narrows, the failure to detect these transmitters was probably due to a combination of noise and the mutual interference of multiple transmitters in the local area rather than transmitter or receiver failure (McCleave *et al.* 1978). False channel-code recordings can result when two or

more transmitters are in close proximity to each other and their signals interfere (McCleave *et al.* 1978). Because the frequencies that were most prone to false channel-code were used on the early sockeye migrants which were more likely to be recorded at the Narrows than later fish, the bias in higher false recordings on these frequencies was likely a result of multiple transmitter interference rather than faulty transmitters. There are two ways to avoid these problems in the future: transmitter activation on each frequency could be staggered to reduce the likelihood that signals from two or more transmitters would simultaneously peak and block out each others signals; and the ambient noise level could be evaluated before the start of the study and compensated for through the receiver's noise blanking algorithms.

None of the river areas in this study had a depth greater than 5 m and adjacent survey areas were no more than 500 m apart. Based on the effective range of the mobile receiver in waters less than 5 m (Fig. 1; Appendix 1), it is unlikely that the combination of maximum depth and range in the river tracking areas would result in undetected transmitters. Mutual interference could have resulted in undetected transmitters in some river areas on some surveys; however, the frequency of the river surveys made unlikely the failure to detect the same transmitter on consecutive surveys. The combination of extreme depth and range in the lake tracking areas could have resulted in transmitters being missed by the mobile receiver. Furthermore, the south lake was only surveyed six times, leaving long gaps between surveys when fish movements would be undetected. This explains in part why the exact location of 45 transmitters (27% of the total number released) could not be determined. Clearly, because the lake perimeter is large and fish can technically occupy any of it, future lake telemetry studies should an aircraft.

Transmitter regurgitation in deep lake waters could not be ruled out as a factor contributing to the failure to detect some transmitters because, even if transmitters contained motion detectors (Eiler 1995), extreme water depth would prevent the reception of transmitter signals. It is unlikely, however, that transmitters were regurgitated in this study because: a) sockeye salmon have not been shown to regurgitate transmitters in other studies (McCleave *et al.* 1978; Stasko and Pin-

cock 1977); b) none of the detected transmitters were stationary as would be expected if they had been regurgitated; c) the advanced stages of maturation result in the atrophy of muscle tissue in the stomach wall to an extent which would make regurgitation difficult; and d) the mark-recapture crews did not recover fish with a secondary mark but without a transmitter. Other studies (McCleave *et al.* 1978; Fretwell 1981) reported similar findings, suggesting that this is a normal drawback in studies of this nature.

TAGGING EFFECTS

Schubert and Fanos (1996) reported that two tagging effects could potentially bias the Chilko River system mark-recapture study: a) stress induced behavioral changes which could violate the assumption of constant and equal probability of capture and recapture; and b) acute stress induced mortality which could cause disk tagged fish to emigrate from the study area. The latter would violate of the closure assumption and result in an overestimate of the escapement. Our first objective in the current study, therefore, was to determine whether handling stress caused disk tagged fish to drop downstream and out of the study area. Because the application of radio transmitters is an invasive process, we assumed that the resultant stress would be at least as severe as that caused by the application of disk tags. The impact of stress on radio tagged fish, therefore, would be at least equal to and probably more severe than on disk tagged fish. To test this assumption, we examined measurable behavioral factors such as female spawning success and the average time between release and recovery. Although the sample size was small, spawning success was substantially lower among radio tagged females than among either disk tagged or untagged females (Table 2). Further, the time between tag application and recovery was shorter among radio tagged versus disk tagged fish, and the incidence of ruptured stomachs was high in both sexes. The latter was surprising because our internal examination of fifty fish immediately after tag insertion did not detect any ruptured stomachs. Apparently, rupturing occurred well after tag insertion. Gray and Haynes (1979) also reported ruptured stomachs and concluded that internally applied transmitters may not be suitable for telemetry studies of salmon under starvation conditions. Although the stomachs of spawning sockeye atrophy beyond

use as an internal organ, a ruptured stomach could lead to water hardening of the eggs in females which could lead to additional physiological stress. On the basis of these results, we concluded that the application of radio transmitters was more stressful to fish than the application of disk tags. Any stress induced changes in behaviour observed in radio tagged fish, therefore, would be equivalent to an extreme case of the stress induced by disk tagging. Conversely, the failure to detect acute stress effects among radio tagged fish would suggest that disk tag application was unlikely to result in a level of stress which would introduce bias into the mark-recapture study.

We would expect a severely stressed fish to exhibit one of two behaviours: a) to die unspawned within a few days of release; or b) to move passively downstream and out of the study area. There was little evidence of such behaviours in the current study. Virtually all of the fish released with radio transmitters easily migrated to the Narrows within a few days at average velocities ranging from $0.16 \text{ km}\cdot\text{h}^{-1}$ to $0.52 \text{ km}\cdot\text{h}^{-1}$. Although we could not establish the status of seven fish that were last detected moving into the lake, all were able to swim 9.7 km in one day before entering the lake. One fish (No. 128) died within two days of release; however, this reflected predation rather than stress induced mortality. Four transmitters were detected at the downstream receiver. One (No. 120) migrated to the lake, dropped downstream to the receiver, then migrated back into the lake. We interpreted this as seaching behaviour rather than a stress effect. Two fish (Nos. 145 and 153) migrated to the lake, held in spawning areas during their expected period of spawning, then moved past the downstream receiver. These fish probably spawned normally and were flushed out of the system either when moribund or after death. One fish (No. 154) migrated to the lake then moved downstream past the receiver three days later. While we could not rule out a stress effect for this fish, the fact that it was able to migrate to the Narrows in 32 hours suggests that the stress was not particularly acute. This observation may reflect stomach rupture which occurred well after transmitter insertion.

Stress also did not impair the ability of a substantial number of fish to reach the south end of Chilko Lake. Thirty-four (20%) of the radio

tagged fish either were detected at the south end or were last detected migrating quickly past the Narrows. We could not rule out stress impacts which might have caused south end spawners to remain in the north lake or the river. The above proportion, however, is higher than the proportion of the stock (15%) aggregate which was estimated to have spawned in the south lake in 1971-1989 (Schubert and Fanos 1996).

In summary, we were unable to detect any substantial evidence of severe acute stress resulting from the application of radio transmitters. While the differences in spawning success and time between release and recovery suggest that radio tagging was more stressful than disk tagging, there was no evidence that the stress would result in immediate mortality, impede a fish's ability to swim upstream and through the lake, or cause the fish to drop out of the study area. Because the stress from radio transmitter application was incrementally greater than from disk tagging, this suggests that acute stress was unlikely to have introduced bias into the mark-recapture population estimate. Further study is recommended, however, to replicate this result.

FISH MOVEMENT PATTERNS

Some researchers have noted diurnal movement patterns for salmon species in the open sea (Ogura and Ishida 1992; Ogura and Ishida 1995) and during migration (Madison *et al.* 1972), while others did not detect a diurnal patterns (Fretwell 1981; Stasko 1975). Chilko River sockeye were reported migrating through the river during daylight hours (Fanos and Schubert 1996); nocturnal migrations were not monitored but may also have occurred. In contrast, the current study reported fish holding at the Narrows during daylight and moving at night (Table 3). We speculate that this change in behaviour may have reflected fish which held in deep water to avoid predators during the daylight hours, then moved into the river to spawn at night.

Radio tagged fish tended to exhibit one of three general movement patterns. First, fish in the early part of the study migrated very quickly through the river and into the lake. These fish were often not detected in the river by the mobile receiver and were detected at the Narrows for 30 minutes or less. They were then either never detected again or were detected in the south lake.

Second, there were fish which migrated more slowly through the river to the Narrows where they either remained for several days or moved back and forth between the upper river and north lake, then either moved back into the river or the north lake to spawn. Most of the river spawners dropped back into the river in two groups, on about September 10 and September 16. After spawning, some then migrated into the lake and were not subsequently recorded. Third, there was a group of slow moving late migrants which spawned in the river, often without ever reaching the Narrows.

POPULATION ESTIMATES

The study estimate of the number of sockeye spawning in each of the south lake, north lake and river areas was based on a number of assumptions. First, we assumed that the Henry's Bridge count provided an unbiased estimate of the relative daily migration. This would not be the case if, for example, water clarity or the daily proportion of nocturnal migrants varied through the study period. While water clarity did not vary over the study period (Fanos and Schubert 1996), we could not evaluate the proportion of the migrants which were nocturnal because the migration was not monitored at night. Second, because sex could not be determined from the Henry's Bridge counts, and because arrival timing is sex specific (Killick 1955), we estimated the sex composition by period from the daily beach seine catches. The assumption that these catches provided an unbiased estimate of sex composition was unlikely to have been violated because Fanos and Schubert (1996) did not detect a sex bias in the application sample. Third, we assumed that the radio tagged fish provided an unbiased estimate of fish destination and that our assignment of the final spawning destinations were correct. The latter was frequently based on subjective criteria and likely introduced error.

The large number of assumptions coupled with the relatively small number of radio transmitters applied in each period make the area-specific population estimates suspect. We were unable to verify these estimates because, although Fanos and Schubert (1996) reported the results of an overflight of the lake, a population estimate could not be calculated because the flight occurred well after the peak of spawning. Further effort is required to apply radio tags in a

manner which would facilitate a better population estimate and to schedule the aerial surveys in a manner which would permit verification of the subsequent estimates.

RECOMMENDATIONS

1. On the basis of the radio telemetry data collected in 1995, we concluded that the acute stress which may result from the handling associated with disk tag application was unlikely to have introduced bias into the mark-recapture population estimate. We have two recommendations, however, that would enable the confirmation this result:

- the study should be repeated to confirm this result under different environmental conditions;
- each transmitter should be monitoring immediately after release. This could be accomplished by: actively tracking each transmitter for several hours; or installing a stationary receiver at Henry's Bridge to detect fish which move downstream following transmitter application before moving back upstream.

2. Our estimates of the proportion of the stock which spawned in the south end of Chilko Lake were in many cases based on our subjective assignment of final spawning destinations. Three study design changes are recommended to improve our ability to accurately determine final spawning destinations and to better define the geographic extent of the south lake group:

- the use of fixed wing aircraft is recommended to improve the extent and frequency of the lake surveys, especially early in the study;
- two additional stationary receivers should be located at Canoe and Stiklon points, the boundary between the north and south lake areas;
- sampling effort should be increased for lake spawners, and during disk tag application, to more accurately define the extent of the south lake fish.

3. We have two recommendations regarding the design of future studies:

- because the interference resulting from transmitters emitting signals on the same fre-

quency can compromise their detection by a receiver, all of the transmitters on a given frequency should be synchronized to stagger their signals. This may mean that fewer transmitters occupy a frequency or that the transmitter pulse rate be decreased from 11 per minute to 5-6 per minute. This would facilitate the recording of several transmitters simultaneously if they are all localized in one area. Further, multiple antennae should be used at the upstream receiver to reduce interference and noise blocking events;

- because receiver range is dependent on annually variable factors such as transmitter power, water depth, water conductivity and signal frequency, receiver range tests should be conducted each year.

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The 1995 Chilko River radio telemetry study was conducted under the supervision of Brad Fanos. We thank Ron Diewert for his advice in the design of the study and his assistance in setting up the telemetry equipment. We also acknowledge the contribution of the mark-recapture crew consisting of T. Abbott, Ian Barnes, O. Brockwell Jr., F. Gilpin, E. Gross, B. Nutton, M. McIntyre, T. McIntyre, G. Schuler and L. Stump working under the supervision of Brad Fanos and Ian Barnes. Review comments from Brad Fanos and Ron Diewert improved the quality of the final report.

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Appendices

Appendix 1a. Mean signal strength of the five transmitter cluster at six depths and eight ranges at a receiver gain of 70.

Signal strength at depth												
Horizontal distance (meters)	Surface		1 meter		2 meter		3 meter		5 meter		10 meter	
	Signal strength	s.e.	Signal strength	s.e.	Signal strength	s.e.	Signal strength	s.e.	Signal strength	s.e.	Signal strength	s.e.
25	235	(0.3)	207	(7.4)	202	(7.4)	191	(9.1)	171	(8.4)	149	(1.9)
50	217	(5.4)	197	(6.7)	179	(9.0)	183	(7.6)	157	(7.7)	99	(8.7)
75	182	(8.2)	178	(5.7)	186	(2.2)	158	(6.2)	129	(8.3)	88	(3.9)
100	145	(6.9)	151	(5.2)	153	(8.9)	128	(9.3)	99	(9.0)	81	(13.3)
150	142	(3.3)	109	(9.4)	95	(7.1)	119	(7.6)	66	(3.7)	0	-
200	105	(6.4)	107	(20.8)	102	(8.9)	102	(3.5)	70	(7.1)	0	-
250	97	(4.5)	106	(5.1)	75	(6.2)	67	(0.0)	0	-	0	-
350	92	(4.4)	85	(3.2)	0	-	0	-	0	-	0	-

Appendix 1b. Mean signal strength of the five transmitter cluster at six depths and eight ranges at a receiver gain of 90.

Signal strength at depth												
Horizontal distance (meters)	Surface		1 meter		2 meter		3 meter		5 meter		10 meter	
	Signal strength	s.e.	Signal strength	s.e.	Signal strength	s.e.	Signal strength	s.e.	Signal strength	s.e.	Signal strength	s.e.
25	230	(2.9)	214	(4.2)	211	(6.7)	170	(7.0)	147	(10.8)	138	(5.6)
50	209	(6.3)	174	(4.2)	165	(9.9)	131	(6.0)	126	(7.5)	105	(8.1)
75	170	(7.0)	157	(5.7)	134	(9.6)	132	(4.8)	111	(3.6)	65	(7.8)
100	160	(6.1)	130	(3.4)	120	(8.2)	114	(8.2)	96	(5.0)	62	(0.0)
150	120	(11.8)	112	(3.2)	96	(19.0)	90	(0.0)	61	(5.3)	70	(0.5)
200	119	(11.1)	102	(9.0)	90	(17.5)	78	(21.0)	77	(5.6)	0	-
250	76	(8.3)	75	(2.2)	75	(5.6)	44	(0.0)	35	(0.0)	0	-
350	111	(0.0)	61	(0.0)	0	-	0	-	0	-	0	-

Appendix 2. Daily number of disk tags and radio transmitters applied to male and female sockeye salmon in the Chilko River near Lingfield Creek, 1995.

Date	Disk tags applied			Radio transmitters applied		
	Male	Female	Total	Male	Female	Total
10-Aug	4	3	7	1	1	2
11-Aug	0	1	1	1	0	1
12-Aug	0	0	0	0	0	0
13-Aug	0	0	0	0	0	0
14-Aug	15	19	34	0	2	2
15-Aug	47	39	86	2	1	3
16-Aug	37	51	88	2	3	5
17-Aug	11	18	29	2	4	6
18-Aug	3	3	6	1	1	2
19-Aug	22	20	42	5	5	10
20-Aug	23	29	52	3	3	6 ^a
21-Aug	43	39	82	3	3	6
22-Aug	46	61	107	3	3	6
23-Aug	78	87	165	3	3	6
24-Aug	88	118	206	3	3	6
25-Aug	83	132	215	3	3	6
26-Aug	64	87	151	3	3	6
27-Aug	115	136	251	3	3	6
28-Aug	81	92	173	3	3	6
29-Aug	137	167	304	3	3	6
30-Aug	124	174	298	2	3	5
31-Aug	143	228	371	2	2	4
1-Sep	149	200	349	2	2	4
2-Sep	80	136	216	2	2	4
3-Sep	41	100	141	2	2	4
4-Sep	38	129	167	2	2	4
5-Sep	42	126	168	2	2	4
6-Sep	31	40	71	2	2	4
7-Sep	22	70	92	2	2	4
8-Sep	40	74	114	0	4	4
9-Sep	19	41	60	2	2	4
10-Sep	7	32	39	2	2	4
11-Sep	10	47	57	2	2	4
12-Sep	3	17	20	2	2	4
13-Sep	0	0	0	0	0	0
14-Sep	2	25	27	1	3	4
15-Sep	0	0	0	0	0	0
16-Sep	12	50	62	2	2	4
17-Sep	9	43	52	2	2	4
18-Sep	13	51	64	0	0	0
19-Sep	3	10	13	2	2	4
20-Sep	0	0	0	0	0	0
21-Sep	0	0	0	2	2	4
Total	1,685	2,695	4,380	77	87	164

^a Not corrected for sex identification error.

Appendix 3. Transmitter application and sampling results, migration time between Lingfield Creek and the Narrows, tracking method, and recovery date, location and elapsed time between release and recovery, by transmitter number, release date and sex.

Transmitter No.	Release date	Sex	NF length (cm)	Marks	Release code ^a	Time to Narrows (hours) ^b	Final Destination	Tracked by ^c	Transmitter recovery		
									Location	Date	Elapsed time (days)
1	10-Aug	Male	-	Net	1	-	River	1	8a	20-Sep	41
2	10-Aug	Female	-	Net	1	-	Unknown	-			
3	11-Aug	Male	-	Net	1	-	South Lake	1			
4	14-Aug	Female	-	Hook	1	5.9	South Lake	1,2			
5	14-Aug	Female	-	-	1	-	Unknown	-			
6	15-Aug	Male	-	-	1	10.2	South Lake	1,2			
7	15-Aug	Male	-	-	1	8.1	South Lake	2			
8	15-Aug	Female	-	-	1	7.5	North Lake	2	13a	14-Sep	30
9	16-Aug	Female	56.6	-	1	-	South Lake	1			
10	16-Aug	Female	57.7	-	1	-	Unknown	-			
11	16-Aug	Female	52.2	-	1	27.2	Lake	2			
12	16-Aug	Male	57.4	-	2	44.8	Lake	2			
13	16-Aug	Male	58.5	-	1	-	Unknown	-			
14	17-Aug	Female	56.3	-	1	24.8	South Lake	1,2			
15	17-Aug	Female	55.0	-	1	10.0	South Lake	2			
16	17-Aug	Male	57.8	-	1	12.9	River	1,2	5	27-Sep	41
17	17-Aug	Female	64.0	-	1	18.1	North Lake	2			
18	17-Aug	Female	60.6	-	1	13.8	River	1,2			
19	17-Aug	Male	60.3	-	1	18.6	River	1,2			
20	18-Aug	Male	61.3	-	1	27.9	River	1,2	2	29-Sep	42
21	18-Aug	Female	54.6	-	1	11.4	South Lake	2			
22	19-Aug	Male	58.7	-	1	10.2	South Lake	1,2			
23	19-Aug	Female	56.0	-	1	39.7	South Lake	1,2			
24	19-Aug	Female	60.0	-	1	30.4	North Lake	1,2			
25	19-Aug	Male	64.6	Lamprey	1	9.9	River	1,2			
26	19-Aug	Female	58.9	-	1	10.1	North Lake	1,2			
27	19-Aug	Male	57.1	-	1	11.2	South Lake	1,2			
28	19-Aug	Female	56.1	-	1	14.9	South Lake	1,2	22c	24-Sep	36
29	19-Aug	Male	56.5	-	1	15.9	South Lake	2			
30	19-Aug	Female	57.3	-	1	25.6	North Lake	1,2			
31	19-Aug	Male	55.7	-	1	15.3	North Lake	2			
32	20-Aug	Female	64.5	-	1	9.3	Lake	1,2			
33	20-Aug	Male	62.1	-	1	9.1	River	1,2	3a	18-Sep	29
34	20-Aug	Female	55.6	Net	2	7.7	South Lake	2			
35	20-Aug	Female ^d	55.6	-	1	9.3	North Lake	1,2	13a	24-Sep	35
36	20-Aug	Male	66.9	-	1	7.1	North Lake	1,2			
37	20-Aug	Female	57.2	-	1	8.9	North Lake	2			
38	21-Aug	Female	66.9	-	1	-	River	1,2			
39	21-Aug	Female	53.2	-	1	-	South Lake	1	22b	18-Sep	28
40	21-Aug	Male	57.1	-	1	29.0	North Lake	1,2			
41	21-Aug	Male	55.0	Net	1	-	Unknown	-			
42	21-Aug	Female	66.6	-	1	44.4	River	1,2	1a	29-Sep	39
43	21-Aug	Male	54.2	-	1	-	Unknown	-			
44	22-Aug	Female	55.3	-	1	7.2	North Lake	1,2			
45	22-Aug	Female	58.1	Net	1	34.5	River	2	9b	21-Sep	30
46	22-Aug	Female	54.4	Net	1	8.1	South Lake	2			
47	22-Aug	Male	56.5	-	1	7.7	North Lake	1,2			
48	22-Aug	Male	54.5	Net	1	5.6	South Lake	1,2			
49	22-Aug	Male	55.8	-	1	6.1	Lake	2			
50	23-Aug	Female	54.5	-	1	7.2	South Lake	2			

Continued

Appendix 3. Transmitter application and sampling results, migration time between Lingfield Creek and the Narrows, tracking method, and recovery date, location and elapsed time between release and recovery, by transmitter number, release date and sex, continued.

Transmitter No.	Release date	Sex	Marks	Release code ^a	Time to Narrows (hours) ^b	Final Destination	Tracked by ^c	Transmitter recovery			
								Location	Date	Elapsed time (days)	
51	23-Aug	Male	64.5	-	1	9.2	River	1,2	5	27-Sep	35
52	23-Aug	Female	56.4	-	1	20.0	South Lake	2			
53	23-Aug	Male	57.5	-	1	7.0	South Lake	2			
54	23-Aug	Female	55.5	Net	1	8.5	South Lake	1,2			
55	23-Aug	Male	58.9	-	1	18.6	Lake	2			
56	24-Aug	Male	54.3	-	1	11.7	Lake	2			
57	24-Aug	Male	57.6	-	1	9.2	South Lake	1,2			
58	24-Aug	Female	57.9	-	1	13.3	Sp. Channel	1,2	3b	12-Sep	19
59	24-Aug	Male	53.0	Net	1	9.0	North Lake	1,2	7a	23-Sep	30
60	24-Aug	Female	52.1	-	1	10.7	North Lake	2			
61	24-Aug	Female	55.0	Net	1	20.5	South Lake	1,2			
62	25-Aug	Female	58.5	-	1	21.8	River	1,2	4	8-Oct	44
63	25-Aug	Male	59.6	-	1	171.9	River	1,2			
64	25-Aug	Female	58.7	-	1	31.2	North Lake	1,2			
65	25-Aug	Male	58.1	-	1	15.2	River	1,2			
66	25-Aug	Female	54.6	-	1	33.8	Sp. Channel	1,2	3b	19-Sep	25
67	25-Aug	Male	63.2	-	1	25.5	River	1,2	6a	15-Sep	21
68	26-Aug	Male	54.0	-	1	20.7	River	1,2			
69	26-Aug	Male	59.0	-	1	9.0	South Lake	1,2			
70	26-Aug	Female	59.1	-	1	32.6	Sp. Channel	1,2	3b	27-Sep	32
71	26-Aug	Female	57.4	-	1	13.2	South Lake	1,2			
72	26-Aug	Female	56.2	-	1	30.7	North Lake	1,2			
73	26-Aug	Male	60.9	-	1	20.9	North Lake	1,2			
74	27-Aug	Male	52.4	-	1	9.9	South Lake	1,2			
75	27-Aug	Female	54.2	-	1	11.9	South Lake	1,2			
76	27-Aug	Male	57.8	Net	1	8.7	South Lake	1,2			
77	27-Aug	Male	54.6	Net	1	10.5	South Lake	1,2			
78	27-Aug	Female	56.1	-	1	27.6	South Lake	1,2			
79	27-Aug	Female	59.6	Hook	1	8.3	North Lake	1,2			
80	28-Aug	Female	59.1	-	1	-	Unknown	-			
81	28-Aug	Male	59.6	-	1	79.1	River	1,2			
82	28-Aug	Female	66.0	-	1	53.4	River	1,2			
83	28-Aug	Male	61.0	-	1	30.2	River	1,2			
84	28-Aug	Male	60.1	-	1	44.4	River	1,2			
85	28-Aug	Female	57.2	-	1	34.8	North Lake	1,2			
86	29-Aug	Male	68.1	-	1	31.5	River	1,2	6a	20-Sep	22
87	29-Aug	Male	57.5	-	1	22.2	River	1,2	6b	5-Oct	37
88	29-Aug	Male	58.1	-	1	8.4	South Lake	2			
89	29-Aug	Female	57.2	-	1	9.3	Sp. Channel	1,2	3b	15-Sep	17
90	29-Aug	Female	54.5	-	1	9.3	Sp. Channel	1,2	3b	19-Sep	21
91	29-Aug	Female	57.0	-	1	25.8	River	1,2			
92	30-Aug	Female	58.1	-	1	21.9	River	1,2	1a	27-Sep	28
93	30-Aug	Female	62.2	-	1	11.9	River	1,2			
94	30-Aug	Female	64.0	-	1	10.3	River	1,2			
95	30-Aug	Male	59.6	-	1	31.4	River	1,2			
96	30-Aug	Male	58.7	-	1	22.2	River	1,2			
97	31-Aug	Female	55.0	Hook	1	33.1	Sp. Channel	1,2	3b	8-Sep	8
98	31-Aug	Male	65.7	-	1	11.9	River	1,2	6a	10-Oct	40
99	31-Aug	Female	59.2	Hook	1	87.0	River	1,2			
100	31-Aug	Male	58.2	Hook	1	94.1	River	1,2			
101	1-Sep	Male	66.8	-	1	11.4	North Lake	1,2			

Continued

Appendix 3. Transmitter application and sampling results, migration time between Lingfield Creek and the Narrows, tracking method, and recovery date, location and elapsed time between release and recovery, by transmitter number, release date and sex, continued.

Transmitter No.	Release date	Sex	Marks	Release code ^a	Time to Narrows (hours) ^b	Final Destination	Tracked by ^c	Transmitter recovery		
								Location	Date	Elapsed time (days)
102	1-Sep	Female	55.2	Net	1	12.8	River			
103	1-Sep	Female	64.5	-	1	56.3	River			
104	1-Sep	Male	64.2	-	1	10.8	River	5	8-Oct	37
105	2-Sep	Male	55.5	-	1	23.0	River			
106	2-Sep	Female	60.0	-	1	58.4	River	9a	21-Sep	19
107	2-Sep	Male	62.6	-	1	12.2	River			
108	2-Sep	Female	54.8	-	1	31.4	River	9b	21-Sep	19
109	3-Sep	Female	60.0	-	1	50.9	River			
110	3-Sep	Male	67.1	-	1	37.7	River	6a	25-Sep	22
111	3-Sep	Female	57.8	-	1	81.9	River			
112	3-Sep	Male	58.1	-	1	-	River			
113	4-Sep	Female	68.0	-	1	33.8	River			
114	4-Sep	Male	59.8	-	1	45.9	River	7a	6-Oct	32
115	4-Sep	Female	55.5	Net	1	26.9	River	9b	20-Sep	16
116	4-Sep	Male	59.5	-	1	71.2	River			
117	5-Sep	Female	63.7	Net	1	10.8	North Lake	13b	16-Sep	11
118	5-Sep	Male	57.0	-	1	-	River			
119	5-Sep	Female	55.6	-	1	22.5	South Lake			
120	5-Sep	Male	68.8	-	1	94.9	River			
121	6-Sep	Female	55.0	Net	1	58.4	North Lake	13a	20-Sep	14
122	6-Sep	Female	53.5	Net	1	81.0	River			
123	6-Sep	Male	65.5	-	1	-	River			
124	6-Sep	Male	67.6	-	1	45.1	River			
125	7-Sep	Male	57.5	-	1	71.0	River	6b	4-Oct	27
126	7-Sep	Female	51.8	-	1	74.8	North Lake			
127	7-Sep	Female	58.4	Net	1	46.7	River			
128	7-Sep	Male	54.7	Net	1	54.8	River	7a	9-Sep	2
129	8-Sep	Female	54.4	Net	2	50.1	River			
130	8-Sep	Female	55.4	-	1	18.6	River			
131	8-Sep	Female	52.8	Net	1	54.5	North Lake			
132	8-Sep	Female	56.8	Net	1	73.6	River	17d	25-Sep	17
133	9-Sep	Female	66.1	-	1	-	River			
134	9-Sep	Female	58.8	Net	1	34.3	River			
135	9-Sep	Male	57.9	-	1	57.8	River	6a	6-Oct	27
136	9-Sep	Male	58.4	Net	1	35.0	River			
137	10-Sep	Male	63.0	-	1	75.3	River			
138	10-Sep	Male	62.0	-	1	35.3	River	6b	4-Oct	24
139	10-Sep	Female	55.2	-	1	77.1	River	6b	27-Sep	17
140	10-Sep	Female	54.1	Net	2	10.2	South Lake			
141	11-Sep	Female	53.9	Net	1	20.7	South Lake			
142	11-Sep	Female	53.1	Net/Hook	1	-	Unknown			
143	11-Sep	Male	59.5	-	1	51.5	River	2	5-Oct	24
144	11-Sep	Male	54.0	Net	1	69.4	River			
145	12-Sep	Female	55.7	Net	1	80.2	River ^d			
146	12-Sep	Male	54.6	Net	1	69.1	River	6a	8-Oct	26
147	12-Sep	Male	54.7	Net	1	188.1	River			
148	12-Sep	Female	54.0	Net	1	28.1	North Lake			
149	14-Sep	Female	58.5	Net	1	60.2	River			
150	14-Sep	Female	52.6	-	1	58.5	River	6a	12-Oct	28
151	14-Sep	Male	57.4	Net	1	31.9	North Lake			

Continued

Appendix 3. Transmitter application and sampling results, migration time between Lingfield Creek and the Narrows, tracking method, and recovery date, location and elapsed time between release and recovery, by transmitter number, release date and sex, continued.

Transmitter No.	Release date	Sex	Marks	Release code ^a	Time to Narrows (hours) ^b	Final Destination	Tracked by ^c	Transmitter recovery		
								Location	Date	Elapsed time (days)
152	14-Sep	Female	53.1	-	1	60.3	River	1,2		
153	16-Sep	Female	52.0	Net	1	30.4	River ^e	1,2,3		
154	16-Sep	Female	52.5	Net	2	31.8	River ^e	1,2,3		
155	16-Sep	Male	59.1	Net	1	20.1	River	1,2		
156	16-Sep	Male	53.1	-	1	29.8	River	1,2		
157	17-Sep	Female	54.6	Net	1	9.4	River	1,2		
158	17-Sep	Male	52.3	Net	1	-	Sp. Channel	1,2	3b	26-Sep
159	17-Sep	Female	51.2	Net	1	58.9	River	1,2		
160	17-Sep	Male	54.1	-	1	249.0	River	1,2		
161	19-Sep	Male	62.0	-	1	200.3	River	1,2		
162	19-Sep	Male	59.6	Net	1	-	River	1	4	9-Oct
163	19-Sep	Female	55.0	-	1	110.3	Lake	2		20
164	19-Sep	Female	52.0	Net	1	-	North Lake	1		
165	21-Sep	Male	57.0	Net	1	-	River	1	7a	6-Oct
166	21-Sep	Female	56.7	Net	1	32.2	River	1,2		
167	21-Sep	Female	55.2	Net	1	46.0	River	1,2		
168	21-Sep	Male	62.4	-	1	-	Unknown	-		

^a Codes are: 1- swam away vigorously; 2 - swam away sluggishly.

^b If blank, the fish either did not reach the upstream receiver or passed the receiver without detection.

^c Codes are: 1 - mobile receiver; 2 - upstream receiver; 3 - downstream receiver. If blank, the fish was not detected by any of the receivers.

^d Corrected sex; sex was recorded incorrectly at release.

^e Fish was last detected moving downstream past the downstream receiver.

Appendix 4. Transmitter tracking histories, including date, time, location, signal strength range, sex and movement index.

Transmitter No.	Tracking date ^a	Tracking time	Signal - strength		Area ^b	Action or area description ^c	No. records at upstream receiver	Final destination	Sex	Movement index ^d
			Min	Max						
1	10-Aug	14:00	-	-	-	Application	-	River	Male	-
	20-Sep	11:00	-	-	8a	Recovery	-			
2	10-Aug	14:00	-	-	-	Application	-	Unknown	Female	-
3	11-Aug	14:00	-	-	-	Application	-	South Lake	Male	-
	26-Aug	13:30	100	130	22a	Spawning	-			
4	14-Aug	14:00	-	-	-	Application	-	South Lake	Female	-
	14-Aug	19:54 - 19:56	65	174	Receiver	Holding/migrating	11			
	21-Aug	04:06 - 14:59	57	217	Receiver	Holding/migrating	282			
	26-Aug	15:30	100	130	19b	Spawning	-			
5	14-Aug	14:00	-	-	-	Application	-	Unknown	Female	-
6	15-Aug	10:10	-	-	-	Application	-	South Lake	Male	-
	15-Aug	20:18 - 20:21	53	142	Receiver	Holding/migrating	21			
	7-Sep	15:40	120	150	22a	Spawning	-			
	22-Sep*	13:19	60	93	22a	Spawning	-			
7	15-Aug	10:00	-	-	-	Application	-	South Lake	Male	-
	15-Aug	18:03 - 18:03	83	83	Receiver	Holding/migrating	1			
8	15-Aug	14:00	-	-	-	Application	-	North Lake	Female	-
	15-Aug	21:31 - 21:36	75	80	Receiver	Holding/migrating	3			
	28-Aug	18:43 - 18:48	64	78	Receiver	Holding/migrating	4			
	14-Sep*	13:30	-	-	13a	Recovery	-			
9	16-Aug	09:10	-	-	-	Application	-	South Lake	Female	-
	7-Sep	15:40	120	150	22a	Spawning	-			
10	16-Aug	11:43	-	-	-	Application	-	Unknown	Female	-
11	16-Aug	11:43	-	-	-	Application	-	Lake	Female	-
	17-Aug	11:30 - 23:49	24	236	Receiver	Holding/migrating	3,577			
	18-Aug	00:05 - 03:30	31	236	Receiver	Holding/migrating	1,408			
12	16-Aug	14:55	-	-	-	Application	-	Lake	Male	-
	18-Aug	11:39 - 20:10	38	236	Receiver	Holding/migrating	819			
13	16-Aug	15:00	-	-	-	Application	-	Unknown	Male	-
14	17-Aug	09:08	-	-	-	Application	-	South Lake	Female	-
	18-Aug	09:48 - 10:03	44	236	Receiver	Holding/migrating	95			
	7-Sep	16:40	140	200	19b	Spawning	-			
15	17-Aug	09:08	-	-	-	Application	-	South Lake	Female	-
	17-Aug	18:35 - 19:27	45	236	Receiver	Holding/migrating	84			
16	17-Aug	12:15	-	-	-	Application	-	River	Male	1.13
	18-Aug	01:04 - 02:25	33	236	Receiver	Holding/migrating	91			
	20-Aug	09:50 - 13:40	58	131	Receiver	Holding/migrating	183			
	22-Aug	12:39 - 12:39	64	64	Receiver	Holding/migrating	1			
	26-Aug	16:30	90	90	17d	Spawning	-			
	30-Aug	11:35 - 22:46	54	231	Receiver	Holding/migrating	253			
	31-Aug	06:13 - 14:15	51	194	Receiver	Holding/migrating	321			
	31-Aug	09:25	210	235	17a	Holding/migrating	-			
	1-Sep	07:15 - 22:18	71	229	Receiver	Holding/migrating	53			
	2-Sep	06:40 - 21:27	55	209	Receiver	Holding/migrating	159			
	3-Sep	06:39 - 21:29	61	215	Receiver	Holding/migrating	322			
	3-Sep	19:00	-	-	17a	Holding/migrating	-			
	4-Sep	15:35	153	170	1b	Spawning	-			

Continued

Appendix 4. Continued.

Trans- mitter No.	Tracking date ^a	Tracking time	Signal - strength		Area ^b	Action or area description ^c	No. records at upstream receiver	Final destination	Sex	Move- ment index ^d
			Min	Max						
16	5-Sep	10:10	235	235	1d	Holding/Migrating	-			
	5-Sep	22:45 - 23:55	62	232	Receiver	Holding/Migrating	59			
	6-Sep	00:08 - 01:51	62	162	Receiver	Holding/Migrating	60			
	6-Sep	14:30	79	216	1b	Spawning	-			
	9-Sep	10:43	110	135	2	Spawning	-			
	10-Sep*	19:14 - 23:19	73	194	Receiver	Holding/Migrating	6			
	20-Sep**	12:34	99	232	4	Spawning	-			
	25-Sep to 26-Sep		81	212	5	Spawning	-			
	27-Sep	13:30	-	-	5	Recovery	-			
17	17-Aug	12:15	-	-	-	Application	-	North Lake	Female	-
	18-Aug	06:11 - 23:59	44	203	Receiver	Holding/Migrating	248			
	19-Aug	00:00 - 10:20	44	236	Receiver	Holding/Migrating	226			
	22-Aug	11:44 - 13:17	64	199	Receiver	Holding/Migrating	41			
	26-Aug	17:11 - 18:12	57	180	Receiver	Holding/Migrating	41			
18	17-Aug	12:15	-	-	-	Application	-	River	Female	1.00
	18-Aug	00:40 - 02:47	36	234	Receiver	Holding/Migrating	160			
	20-Aug	20:16 - 22:38	60	130	Receiver	Holding/Migrating	12			
	25-Aug	11:30 - 21:14	59	189	Receiver	Holding/Migrating	689			
	26-Aug	05:57 - 15:31	58	167	Receiver	Holding/Migrating	436			
	26-Aug	10:10	90	180	1d	Holding/Migrating	-			
	27-Aug	06:37 - 23:26	58	234	Receiver	Holding/Migrating	1,188			
	28-Aug	00:40 - 19:34	55	234	Receiver	Holding/Migrating	1,200			
	28-Aug	12:40	70	160	17a	Holding/Migrating	-			
	30-Aug	19:38 - 23:33	63	196	Receiver	Holding/Migrating	239			
	31-Aug	04:21 - 23:59	63	234	Receiver	Holding/Migrating	391			
	1-Sep	00:00 - 03:06	60	225	Receiver	Holding/Migrating	135			
	1-Sep	14:30	235	235	1e	Holding/Migrating	-			
	2-Sep	05:00 - 14:05	17	191	Receiver	Holding/Migrating	238			
	3-Sep	19:50	-	-	1e	Holding/Migrating	-			
	4-Sep	15:45	196	212	2	Spawning	-			
	5-Sep	10:40	173	235	3a	Holding/Migrating	-			
	5-Sep	21:12 - 21:19	70	107	Receiver	Holding/Migrating	2			
19	17-Aug	14:10	-	-	-	Application	-	River	Male	1.29
	18-Aug	08:16 - 08:55	55	236	Receiver	Holding/Migrating	179			
	23-Aug	15:54 - 17:31	66	112	Receiver	Holding/Migrating	12			
	24-Aug	12:30	60	80	11b	Holding/Migrating	-			
	24-Aug	14:03 - 23:47	59	233	Receiver	Holding/Migrating	288			
	25-Aug	00:00 - 19:35	53	182	Receiver	Holding/Migrating	370			
	25-Aug	12:15	86	130	11a	Spawning	-			
	26-Aug	04:35 - 23:47	60	165	Receiver	Holding/Migrating	58			
	27-Aug	01:05 - 23:11	64	232	Receiver	Holding/Migrating	101			
	30-Aug	15:26 - 20:44	61	234	Receiver	Holding/Migrating	54			
	31-Aug	01:08 - 20:46	64	232	Receiver	Holding/Migrating	23			
	31-Aug	10:15	90	155	1b	Spawning	-			
	1-Sep	16:33 - 17:01	65	194	Receiver	Holding/Migrating	24			
	2-Sep	02:18 - 18:06	33	232	Receiver	Holding/Migrating	131			
	3-Sep	05:03 - 21:23	63	234	Receiver	Holding/Migrating	63			
	4-Sep	01:35 - 06:11	64	228	Receiver	Holding/Migrating	27			
	6-Sep	14:50	150	168	1b	Spawning	-			
	13-Sep*	12:10	88	183	1a	Spawning	-			
	15-Sep	15:27	136	183	1b	Spawning	-			
	15-Sep	17:08 - 22:23	62	153	Receiver	Holding/Migrating	19			
	16-Sep	02:13 - 13:15	80	195	Receiver	Holding/Migrating	20			
	20-Sep**	12:34	83	174	4	Spawning	-			
	30-Sep to 5-Oct		200	236	6b	Holding	-			

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Appendix 4. Continued.

Trans- mitter No.	Tracking date ^a	Tracking time	Signal - strength		Area ^b	Action or area description ^c	No. records at upstream receiver	Final destination	Sex	Move- ment index ^d
			Min	Max						
20	18-Aug	09:05	-	-	-	Application	-	River	Male	0.33
	19-Aug	12:58 - 15:34	67	229	Receiver	Holding/Migrating	33			
	21-Aug	11:40 - 14:29	59	234	Receiver	Holding/Migrating	175			
	23-Aug	17:22 - 22:33	68	156	Receiver	Holding/Migrating	34			
	24-Aug	02:28 - 14:27	61	196	Receiver	Holding/Migrating	78			
	30-Aug	08:59 - 21:13	59	225	Receiver	Holding/Migrating	306			
	31-Aug	04:07 - 23:50	33	241	Receiver	Holding/Migrating	407			
	31-Aug	09:25	140	160	17a	Holding/Migrating	-			
	1-Sep	08:30	130	168	17a	Holding/Migrating	-			
	1-Sep	13:45	150	163	17a	Holding/Migrating	-			
	1-Sep	00:01 - 23:51	54	172	Receiver	Holding/Migrating	245			
	2-Sep	00:00 - 03:16	65	234	Receiver	Holding/Migrating	156			
	3-Sep	04:16 - 05:23	64	75	Receiver	Holding/Migrating	4			
	3-Sep	19:50	-	-	1e	Holding/Migrating	-			
	4-Sep	15:15	168	188	1e	Holding/Migrating	-			
	5-Sep	10:25	153	160	1b	Spawning	-			
	6-Sep	14:35	67	147	1b	Spawning	-			
	9-Sep	10:51	170	200	1a	Spawning	-			
	12-Sep*	15:14	94	130	1a	Spawning	-			
	13-Sep**	12:22	107	132	1a	Spawning	-			
	15-Sep to 29-Sep		166	222	2	Spawning	-			
	29-Sep	12:00	-	-	2	Recovery	-			
21	18-Aug	09:05	-	-	-	Application	-	South Lake	Female	-
	18-Aug	20:23 - 20:30	68	169	Receiver	Holding/Migrating	21			
22	19-Aug	09:05	-	-	-	Application	-	South Lake	Male	-
	19-Aug	19:17 - 19:32	70	147	Receiver	Holding/Migrating	42			
	7-Sep	15:40	120	150	22a	Spawning	-			
	16-Sep*	11:35	65	65	21b	Spawning	-			
	22-Sep	13:10	60	74	22a	Spawning	-			
23	19-Aug	09:05	-	-	-	Application	-	South Lake	Female	-
	21-Aug	00:10 - 01:50	58	218	Receiver	Holding/Migrating	65			
	7-Sep	14:15	120	150	26a	Holding/Migrating	-			
24	19-Aug	10:40	-	-	-	Application	-	North Lake	Female	-
	20-Aug	16:58 - 17:06	72	234	Receiver	Holding/Migrating	26			
	25-Aug	17:36 - 23:59	56	201	Receiver	Holding/Migrating	268			
	26-Aug	00:00 - 22:17	58	169	Receiver	Holding/Migrating	873			
	26-Aug	09:40	60	120	17a	Holding/Migrating	-			
	27-Aug	05:34 - 19:08	54	211	Receiver	Holding/Migrating	355			
25	19-Aug	10:40	-	-	-	Application	-	River	Male	1.00
	19-Aug	20:34 - 20:46	69	182	Receiver	Holding/Migrating	16			
	30-Aug	13:10 - 13:10	63	63	Receiver	Holding/Migrating	1			
	3-Sep	22:09 - 23:58	60	101	Receiver	Holding/Migrating	46			
	4-Sep	00:00 - 23:59	9	232	Receiver	Holding/Migrating	1,367			
	4-Sep	15:10	150	163	1d	Holding/Migrating	-			
	5-Sep	00:01 - 22:43	59	233	Receiver	Holding/Migrating	1,174			
	5-Sep	09:20	80	110	17a	Holding/Migrating	-			
	6-Sep	06:49 - 08:10	60	168	Receiver	Holding/Migrating	76			
	7-Sep	07:42 - 09:15	65	232	Receiver	Holding/Migrating	115			
	9-Sep	00:47 - 01:28	66	203	Receiver	Holding/Migrating	34			
	9-Sep	11:00	150	200	1b	Spawning	-			
	12-Sep*	15:14	65	98	1a	Spawning	-			
	13-Sep	12:22	86	171	1b	Spawning	-			
	13-Sep	21:05 - 23:59	67	212	Receiver	Holding/Migrating	41			
	14-Sep	00:12 - 19:32	64	205	Receiver	Holding/Migrating	24			
	15-Sep	15:20	43	129	1e	Holding/Migrating	-			

Continued

Appendix 4. Continued.

Trans- mitter No.	Tracking date ^a	Tracking time	Signal - strength		Area ^b	Action or area description ^c	No. records at upstream receiver	Final destination	Sex	Move- ment index ^d
			Min	Max						
25	15-Sep	15:17 - 15:44	69	144	Receiver	Holding/Migrating	16			
	17-Sep**	15:25	67	115	1d	Holding/Migrating	-			
	18-Sep to 02-Oct		74	223	1c	Holding	-			
26	19-Aug	10:40	-	-	-	Application	-	North Lake	Female	-
	19-Aug	20:43 - 20:53	68	199	Receiver	Holding/Migrating	30			
	16-Sep*	09:35	153	212	13a	Spawning	-			
27	19-Aug	12:24	-	-	-	Application	-	South Lake	Male	-
	19-Aug	23:33 - 23:59	66	234	Receiver	Holding/Migrating	71			
	20-Aug	00:00 - 17:01	57	186	Receiver	Holding/Migrating	478			
	7-Sep	16:20	200	210	19c	Spawning	-			
	13-Sep*	13:55	30	60	19c	Spawning	-			
	16-Sep	14:30	98	147	19c	Spawning	-			
28	19-Aug	12:24	-	-	-	Application	-	South Lake	Female	-
	20-Aug	03:13 - 05:58	58	167	Receiver	Holding/Migrating	260			
	7-Sep	15:40	120	150	22a	Spawning	-			
	13-Sep*	11:00	90	90	22c	Spawning	-			
	16-Sep	11:35	65	129	21b	Spawning	-			
	22-Sep	15:28	56	114	22c	Spawning	-			
	24-Sep	10:30	-	-	22c	Recovery	-			
29	19-Aug	13:57	-	-	-	Application	-	South Lake	Male	-
	20-Aug	05:47 - 06:08	62	181	Receiver	Holding/Migrating	45			
30	19-Aug	13:57	-	-	-	Application	-	North Lake	Female	-
	20-Aug	05:49 - 16:16	62	163	Receiver	Holding/Migrating	124			
	21-Aug	15:38	116	162	2	Spawning	-			
	22-Aug	17:16 - 17:21	66	179	Receiver	Holding/Migrating	14			
31	19-Aug	13:57	-	-	-	Application	-	North Lake	Male	-
	20-Aug	05:09 - 05:31	63	168	Receiver	Holding/Migrating	29			
	25-Aug	05:21 - 06:29	66	233	Receiver	Holding/Migrating	51			
32	20-Aug	09:20	-	-	-	Application	-	Lake	Female	-
	20-Aug	18:22 - 19:14	60	144	Receiver	Holding/Migrating	58			
	30-Aug	15:00	90	100	26a	Holding/Migrating	-			
	4-Sep	14:29 - 17:38	64	228	Receiver	Holding/Migrating	46			
	4-Sep	14:30	158	167	17a	Holding/Migrating	-			
	5-Sep	00:17 - 00:56	54	204	Receiver	Holding/Migrating	20			
	6-Sep	01:08 - 01:10	131	217	Receiver	Holding/Migrating	3			
33	20-Aug	09:20	-	-	-	Application	-	River	Male	1.00
	20-Aug	18:10 - 18:29	69	231	Receiver	Holding/Migrating	74			
	24-Aug	02:37 - 22:36	63	219	Receiver	Holding/Migrating	109			
	25-Aug	04:03 - 06:26	54	229	Receiver	Holding/Migrating	106			
	26-Aug	04:44 - 20:10	62	234	Receiver	Holding/Migrating	151			
	27-Aug	00:50 - 18:56	58	152	Receiver	Holding/Migrating	43			
	28-Aug	08:42 - 13:07	61	234	Receiver	Holding/Migrating	192			
	28-Aug	12:50	110	163	17a	Holding/Migrating	-			
	30-Aug	09:02 - 13:34	33	227	Receiver	Holding/Migrating	453			
	31-Aug	10:15	87	130	1b	Spawning	-			
	1-Sep	8:30	100	115	1d	Holding/Migrating	-			
	2-Sep	19:18 - 20:31	59	182	Receiver	Holding/Migrating	24			
	3-Sep	08:55 - 19:15	64	217	Receiver	Holding/Migrating	315			
	3-Sep	19:05	-	-	17a	Holding/Migrating	-			
	4-Sep	06:18 - 07:10	63	222	Receiver	Holding/Migrating	32			
	9-Sep	11:00	160	183	1b	Spawning	-			
	11-Sep*	12:30	174	200	1b	Spawning	-			
	12-Sep	16:06	106	184	1b	Spawning	-			

Continued

Appendix 4. Continued.

Transmitter No.	Tracking date ^a	Tracking time	Signal - strength		Area ^b	Action or area description ^c	No. records at upstream receiver	Final destination	Sex	Movement index ^d
			Min	Max						
33	13-Sep	12:58	99	150	1b	Spawning	-			
	14-Sep	12:50	113	113	17a	Holding/Migrating	-			
	15-Sep	15:10	62	100	1c	Holding/Migrating	-			
	16-Sep	08:11 - 15:33	64	229	Receiver	Holding/Migrating	29			
	17-Sep**	16:24	168	219	3a	Holding/Migrating	-			
	18-Sep	10:00	-	-	3a	Recovery	-			
34	20-Aug	10:28	-	-	-	Application	-	South Lake	Female	-
	20-Aug	18:05 - 18:18	71	208	Receiver	Holding/Migrating	30			
35	20-Aug	10:28	-	-	-	Application	-	North Lake	Female	-
	20-Aug	19:43 - 19:49	75	181	Receiver	Holding/Migrating	9		e.f.	
	22-Aug	11:09 - 19:16	62	208	Receiver	Holding/Migrating	161			
	19-Sep*	13:54	77	142	13a	Spawning	-			
	21-Sep	12:53	79	149	13a	Spawning	-			
	24-Sep	15:00	-	-	13a	Recovery	-			
36	20-Aug	11:25	-	-	-	Application	-	North Lake	Male	-
	20-Aug	18:30 - 19:09	61	232	Receiver	Holding/Migrating	42			
	21-Aug	01:18 - 02:40	64	106	Receiver	Holding/Migrating	21			
	27-Aug	18:05 - 19:57	64	198	Receiver	Holding/Migrating	79			
	28-Aug	19:35 - 19:51	77	176	Receiver	Holding/Migrating	35			
	30-Aug	09:19 - 23:59	59	233	Receiver	Holding/Migrating	260			
	31-Aug	00:00 - 14:32	61	229	Receiver	Holding/Migrating	230			
	1-Sep	08:30	90	168	1d	Holding/Migrating	-			
	1-Sep	14:40	160	183	1b	Spawning	-			
	3-Sep	20:29 - 23:48	62	117	Receiver	Holding/Migrating	17			
	4-Sep	01:01 - 11:11	63	230	Receiver	Holding/Migrating	42			
	7-Sep	17:05	60	122	14	Spawning	-			
	11-Sep*	12:04	180	190	15a	Holding/Migrating	-			
	12-Sep	09:43	150	200	15b	Holding/Migrating	-			
	16-Sep	15:20	47	112	15b	Holding/Migrating	-			
	19-Sep	13:31	73	73	13b	Spawning	-			
37	20-Aug	11:25	-	-	-	Application	-	North Lake	Female	-
	20-Aug	20:04 - 20:28	57	234	Receiver	Holding/Migrating	80			
	21-Aug	02:15 - 06:29	55	184	Receiver	Holding/Migrating	402			
38	21-Aug	08:50	-	-	-	Application	-	River	Female	1.67
	3-Sep	05:40 - 06:54	70	218	Receiver	Holding/Migrating	29			
	3-Sep	19:00	-	-	17a	Holding/Migrating	-			
	4-Sep	14:05	124	152	11c	Spawning	-			
	4-Sep	17:14 - 19:40	66	153	Receiver	Holding/Migrating	7			
	5-Sep	01:39 - 23:42	61	233	Receiver	Holding/Migrating	992			
	5-Sep	09:20	132	202	17a	Holding/Migrating	-			
	6-Sep	06:46 - 21:20	54	232	Receiver	Holding/Migrating	1,087			
	7-Sep	05:58 - 22:07	62	218	Receiver	Holding/Migrating	824			
	7-Sep	11:22	107	138	17a	Holding/Migrating	-			
	9-Sep	02:57 - 23:31	56	232	Receiver	Holding/Migrating	498			
	10-Sep	14:41 - 15:05	64	197	Receiver	Holding/Migrating	27			
	11-Sep*	20:35 - 21:22	71	225	Receiver	Holding/Migrating	39			
	12-Sep	16:00	69	117	1c	Holding/Migrating	-			
	13-Sep	12:22	108	166	1b	Spawning	-			
	13-Sep	19:18 - 19:24	81	187	Receiver	Holding/Migrating	8			
39	21-Aug	08:50	-	-	-	Application	-	South Lake	Female	-
	30-Aug	13:30	119	180	22a	Spawning	-			
	18-Sep*	01:35	-	-	22b	Recovery	-			
40	21-Aug	08:50	-	-	-	Application	-	North Lake	Male	-
	22-Aug	11:56 - 14:32	65	179	Receiver	Holding/Migrating	42			

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Appendix 4. Continued.

Transmitter No.	Tracking date ^a	Tracking time	Signal - strength		Area ^b	Action or area description ^c	No. records at upstream receiver	Final destination	Sex	Movement index ^d
			Min	Max						
40	22-Aug	10:40	67	177	1a	Spawning	-			
	24-Aug	02:19 - 04:08	66	157	Receiver	Holding/Migrating	44			
	7-Sep	17:20	120	150	13b	Spawning	-			
41	21-Aug	08:50	-	-	-	Application	-	Unknown	Male	-
42	21-Aug	08:50	-	-	-	Application	-	River	Female	1.29
	23-Aug	05:09 - 08:32	77	191	Receiver	Holding/Migrating	14			
	27-Aug	17:24 - 18:17	65	212	Receiver	Holding/Migrating	41			
	28-Aug	06:30 - 06:44	66	162	Receiver	Holding/Migrating	15			
	2-Sep	03:17 - 21:05	61	139	Receiver	Holding/Migrating	55			
	3-Sep	01:11 - 01:27	66	155	Receiver	Holding/Migrating	12			
	3-Sep	19:50	-	-	1e	Holding/Migrating	-			
	4-Sep	07:04 - 23:12	67	81	Receiver	Holding/Migrating	5			
	4-Sep	15:15	106	163	1e	Holding/Migrating	-			
	5-Sep	10:10	210	223	1d	Holding/Migrating	-			
	6-Sep	02:31 - 19:10	60	205	Receiver	Holding/Migrating	70			
	6-Sep	12:00	72	170	17a	Holding/Migrating	-			
	7-Sep	03:07 - 05:40	72	181	Receiver	Holding/Migrating	16			
	12-Sep*	15:14	210	235	1a	Spawning	-			
	13-Sep	12:51	51	76	1c	Holding/Migrating	-			
	14-Sep	13:46	157	232	1a	Spawning	-			
	15-Sep**	15:48	98	173	1a	Spawning	-			
	17-Sep to 29-Sep		162	236	1a	Spawning	-			
	29-Sep	10:30	-	-	1a	Recovery	-			
43	21-Aug	08:50	-	-	-	Application	-	Unknown	Male	-
44	22-Aug	09:12	-	-	-	Application	-	North Lake	Female	-
	22-Aug	15:23	69	235	2	Spawning	-			
	22-Aug	16:24 - 16:25	107	185	Receiver	Holding/Migrating	4			
	25-Aug	12:27 - 16:51	63	232	Receiver	Holding/Migrating	94			
	28-Aug	05:17 - 11:41	57	230	Receiver	Holding/Migrating	267			
	28-Aug	13:00	235	235	1e	Holding/Migrating	-			
	29-Aug	06:01 - 07:08	62	210	Receiver	Holding/Migrating	64			
45	31-Aug	17:04 - 17:31	61	234	Receiver	Holding/Migrating	7			
	22-Aug	09:12	-	-	-	Application	-	River	Female	-
	23-Aug	19:38 - 19:49	73	117	Receiver	Holding/Migrating	9			
	24-Aug	16:48 - 18:31	60	218	Receiver	Holding/Migrating	146			
	26-Aug	17:17 - 22:15	59	231	Receiver	Holding/Migrating	114			
	27-Aug	00:05 - 19:03	61	231	Receiver	Holding/Migrating	146			
	21-Sep*	10:40	-	-	9b	Recovery	-			
46	22-Aug	09:12	-	-	-	Application	-	South Lake	Female	-
	22-Aug	17:14 - 17:17	69	201	Receiver	Holding/Migrating	14			
47	22-Aug	09:12	-	-	-	Application	-	North Lake	Male	-
	22-Aug	15:23	64	235	2	Spawning	-			
	22-Aug	16:43 - 16:55	72	135	Receiver	Holding/Migrating	7			
	23-Aug	13:18 - 18:42	61	234	Receiver	Holding/Migrating	320			
	24-Aug	08:00 - 08:27	67	95	Receiver	Holding/Migrating	10			
48	31-Aug	14:45 - 17:11	49	241	Receiver	Holding/Migrating	43			
	22-Aug	11:22	-	-	-	Application	-	South Lake	Male	-
	22-Aug	16:53 - 17:05	71	165	Receiver	Holding/Migrating	13			
	24-Aug	15:22 - 15:52	59	181	Receiver	Holding/Migrating	13			
	30-Aug	13:30	80	120	22a	Spawning	-			
49	13-Sep*	12:06	70	70	22b	Spawning	-			
	22-Aug	11:22	-	-	-	Application	-	Lake	Male	-
	22-Aug	17:25 - 17:32	68	160	Receiver	Holding/Migrating	14			

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Appendix 4. Continued.

Trans- mitter No.	Tracking date ^a	Tracking time	Signal - strength		Area ^b	Action or area description ^c	No. records at upstream receiver	Final destination	Sex	Move- ment index ^d
			Min	Max						
49	23-Aug	12:15 - 14:37	66	188	Receiver	Holding/Migrating	34			
50	23-Aug	09:50	-	-	-	Application	-	South	Female	-
	23-Aug	17:01 - 17:05	89	182	Receiver	Holding/Migrating	6	Lake		
51	23-Aug	09:50	-	-	-	Application	-	River	Male	1.00
	23-Aug	19:01 - 23:59	63	234	Receiver	Holding/Migrating	198			
	24-Aug	00:00 - 06:20	64	230	Receiver	Holding/Migrating	625			
	25-Aug	03:54 - 18:26	60	109	Receiver	Holding/Migrating	17			
	26-Aug	00:37 - 19:44	59	231	Receiver	Holding/Migrating	271			
	27-Aug	02:05 - 18:34	64	105	Receiver	Holding/Migrating	5			
	29-Aug	00:17 - 05:18	66	233	Receiver	Holding/Migrating	47			
	30-Aug	18:51 - 18:51	81	82	Receiver	Holding/Migrating	3			
	31-Aug	07:49 - 19:16	1	189	Receiver	Holding/Migrating	52			
	31-Aug	09:25	110	183	17a	Holding/Migrating	-			
	1-Sep	01:54 - 21:15	53	234	Receiver	Holding/Migrating	409			
	1-Sep	14:30	73	92	1e	Holding/Migrating	-			
	2-Sep	05:38 - 06:38	72	207	Receiver	Holding/Migrating	16			
	3-Sep	03:10 - 21:39	58	187	Receiver	Holding/Migrating	296			
	3-Sep	19:05	-	-	17a	Holding/Migrating	-			
	4-Sep	05:28 - 18:42	52	233	Receiver	Holding/Migrating	331			
	6-Sep	06:55 - 09:24	64	186	Receiver	Holding/Migrating	174			
	11-Sep*	16:08 - 16:14	81	198	Receiver	Holding/Migrating	5			
	13-Sep	11:45	43	138	2	Spawning	-			
	14-Sep	09:15 - 21:15	64	217	Receiver	Holding/Migrating	69			
	14-Sep	12:10	236	236	2	Spawning	-			
	15-Sep	01:02 - 01:14	73	179	Receiver	Holding/Migrating	8			
	18-Sep**	15:27	56	56	2	Spawning	-			
	20-Sep to 27-Sep		60	228	5	Spawning	-			
	27-Sep	13:30	-	-	5	Recovery	-			
52	23-Aug	09:50	-	-	-	Application	-	South	Female	-
	24-Aug	05:10 - 06:17	66	220	Receiver	Holding/Migrating	86	Lake		
53	23-Aug	09:50	-	-	-	Application	-	South	Male	-
	23-Aug	16:41 - 16:51	62	85	Receiver	Holding/Migrating	4	Lake		
54	23-Aug	09:50	-	-	-	Application	-	South	Female	-
	23-Aug	18:18 - 18:23	78	217	Receiver	Holding/Migrating	17	Lake		
	24-Aug	02:12 - 05:49	62	230	Receiver	Holding/Migrating	284			
	7-Sep	16:00	120	150	22a	Spawning	-			
	13-Sep*	12:20	60	200	22a	Spawning	-			
	16-Sep	12:20	96	168	21b	Spawning	-			
	22-Sep	13:21	51	234	22a	Spawning	-			
55	23-Aug	09:50	-	-	-	Application	-	Lake	Male	-
	24-Aug	04:24 - 04:29	87	217	Receiver	Holding/Migrating	16			
	25-Aug	04:39 - 05:18	64	96	Receiver	Holding/Migrating	9			
56	24-Aug	09:40	-	-	-	Application	-	Lake	Male	-
	24-Aug	18:35 - 23:59	65	113	Receiver	Holding/Migrating	16			
	25-Aug	00:09 - 06:12	57	211	Receiver	Holding/Migrating	231			
57	24-Aug	09:40	-	-	-	Application	-	South	Male	-
	24-Aug	18:47 - 19:07	74	232	Receiver	Holding/Migrating	26	Lake		
	26-Aug	16:00	100	130	14	Spawning	-			
58	24-Aug	09:40	-	-	-	Application	-	Spawning	Female	-
	24-Aug	21:17 - 22:56	68	73	Receiver	Holding/Migrating	3	Channel		
	25-Aug	01:07 - 15:38	59	193	Receiver	Holding/Migrating	188			
	26-Aug	00:18 - 17:57	57	189	Receiver	Holding/Migrating	116			
	28-Aug	20:48 - 22:40	61	172	Receiver	Holding/Migrating	5			

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Appendix 4. Continued.

Trans- mitter No.	Tracking date ^a	Tracking time	Signal - strength		Area ^b	Action or area description ^c	No. records at upstream receiver	Final destination	Sex	Move- ment index ^d
			Min	Max						
58	29-Aug	07:30 - 08:12	65	161	Receiver	Holding/Migrating	70			
	31-Aug	19:01 - 23:52	56	234	Receiver	Holding/Migrating	206			
	1-Sep	00:01 - 19:53	59	93	Receiver	Holding/Migrating	28			
	1-Sep	14:30	235	235	1e	Holding/Migrating	-			
	3-Sep	19:50	-	-	1e	Holding/Migrating	-			
	4-Sep	09:02 - 09:04	67	74	Receiver	Holding/Migrating	2			
	5-Sep	10:10	180	211	1d	Holding/Migrating	-			
	7-Sep	11:10	90	132	11b	Holding/Migrating	-			
	8-Sep	18:32 - 18:39	77	184	Receiver	Holding/Migrating	10			
	12-Sep*	12:00	-	-	3b	Recovery	-			
59	24-Aug	09:40	-	-	-	Application	-	North Lake	Male ^f	-
	24-Aug	18:31 - 20:06	57	169	Receiver	Holding/Migrating	57			
	25-Aug	03:48 - 06:36	72	164	Receiver	Holding/Migrating	24			
	25-Aug	12:05	117	170	17b	Holding/Migrating	-			
	26-Aug	10:00	90	136	11a	Spawning	-			
	26-Aug	17:53 - 18:12	72	86	Receiver	Holding/Migrating	5			
	22-Sep*	19:14 - 19:35	75	161	Receiver	Holding/Migrating	28			
	23-Sep	09:10	-	-	7a	Recovery	-			
60	24-Aug	09:40	-	-	-	Application	-	North Lake	Female	-
	24-Aug	20:06 - 23:58	52	229	Receiver	Holding/Migrating	199			
	25-Aug	00:02 - 06:45	56	234	Receiver	Holding/Migrating	276			
61	24-Aug	09:40	-	-	-	Application	-	South Lake	Female	-
	25-Aug	05:50 - 13:00	62	218	Receiver	Holding/Migrating	127			
	30-Aug	15:10	130	130	26a	Holding/Migrating	-			
	31-Aug	15:33 - 17:15	1	241	Receiver	Holding/Migrating	59			
	7-Sep	14:15	120	150	25	Spawning	-			
	13-Sep*	14:20	90	90	26b	Holding/Migrating	-			
	22-Sep	10:27	79	167	25	Spawning	-			
62	25-Aug	08:35	-	-	-	Application	-	River	Female	0.50
	26-Aug	06:16 - 18:02	62	150	Receiver	Holding/Migrating	31			
	27-Aug	02:34 - 21:09	60	234	Receiver	Holding/Migrating	144			
	28-Aug	02:25 - 07:16	61	165	Receiver	Holding/Migrating	73			
	30-Aug	19:07 - 22:14	54	231	Receiver	Holding/Migrating	194			
	31-Aug	06:40 - 19:22	1	232	Receiver	Holding/Migrating	210			
	31-Aug	09:25	80	169	17a	Holding/Migrating	-			
	2-Sep	19:47 - 20:35	56	183	Receiver	Holding/Migrating	25			
	3-Sep	06:45 - 20:40	58	186	Receiver	Holding/Migrating	135			
	3-Sep	19:15	-	-	17a	Holding/Migrating	-			
	4-Sep	06:47 - 23:51	62	224	Receiver	Holding/Migrating	111			
	4-Sep	15:15	180	220	1e	Holding/Migrating	-			
	5-Sep	00:34 - 08:00	58	171	Receiver	Holding/Migrating	45			
	9-Sep	10:43	170	235	2	Spawning	-			
	9-Sep	19:54 - 20:08	71	146	Receiver	Holding/Migrating	15			
	13-Sep*	11:45	68	69	2	Spawning	-			
	14-Sep	13:57	120	151	2	Spawning	-			
	15-Sep	15:54	69	116	2	Spawning	-			
	17-Sep**	16:09	125	125	2	Spawning	-			
	18-Sep to 7-Oct		99	231	3a	Holding	-			
	8-Oct	15:48	-	-	4	Recovery	-			
63	25-Aug	08:35	-	-	-	Application	-	River	Male	1.50
	26-Aug	10:40	110	170	3a	Holding/Migrating	-			
	27-Aug	16:20	140	140	2	Spawning	-			
	31-Aug	10:05	170	213	1e	Holding/Migrating	-			
	1-Sep	09:15	180	210	1b	Spawning	-			

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Appendix 4. Continued.

Trans- mitter No.	Tracking date ^a	Tracking time	Signal - strength		Area ^b	Action or area description ^c	No. records at upstream receiver	Final destination	Sex	Move- ment index ^d
			Min	Max						
63	1-Sep	06:42 - 20:51	49	230	Receiver	Holding/Migrating	251			
	2-Sep	07:30 - 23:33	17	193	Receiver	Holding/Migrating	521			
	3-Sep	01:07 - 05:12	63	140	Receiver	Holding/Migrating	41			
	4-Sep	04:18 - 21:08	74	106	Receiver	Holding/Migrating	8			
	5-Sep	10:20	161	161	1b	Spawning	-			
	9-Sep	09:46	56	130	3a	Holding/Migrating	-			
	10-Sep	10:00 - 10:38	60	212	Receiver	Holding/Migrating	28			
	12-Sep*	14:55	130	165	3a	Holding/Migrating	-			
64	25-Aug	08:35	-	-	-	Application	-	North Lake	Female	-
	26-Aug	10:30	100	180	1e	Holding/Migrating	-			
	26-Aug	13:57 - 19:23	60	234	Receiver	Holding/Migrating	235			
	30-Aug	21:23 - 23:25	66	233	Receiver	Holding/Migrating	73			
	31-Aug	00:12 - 23:59	59	241	Receiver	Holding/Migrating	355			
	31-Aug	10:15	110	183	1b	Spawning	-			
	1-Sep	00:00 - 23:59	58	234	Receiver	Holding/Migrating	797			
	1-Sep	14:25	160	170	1c	Holding/Migrating	-			
	2-Sep	00:13 - 06:30	58	232	Receiver	Holding/Migrating	244			
	3-Sep	19:10	-	-	11a	Spawning	-			
	4-Sep	06:24 - 23:57	58	205	Receiver	Holding/Migrating	116			
	5-Sep	00:00 - 10:28	55	230	Receiver	Holding/Migrating	145			
	5-Sep	10:10	180	210	1d	Holding/Migrating	-			
	6-Sep	00:45 - 19:01	58	234	Receiver	Holding/Migrating	392			
	7-Sep	01:54 - 17:11	64	195	Receiver	Holding/Migrating	80			
65	25-Aug	08:35	-	-	-	Application	-	River	Male	1.69
	25-Aug	19:58 - 23:59	58	234	Receiver	Holding/Migrating	109			
	26-Aug	06:52 - 17:31	54	220	Receiver	Holding/Migrating	387			
	26-Aug	09:30	80	130	11a	Spawning	-			
	27-Aug	09:19 - 10:11	66	231	Receiver	Holding/Migrating	53			
	27-Aug	16:20	160	160	2	Spawning	-			
	28-Aug	06:11 - 06:42	59	181	Receiver	Holding/Migrating	37			
	30-Aug	17:47 - 23:56	59	213	Receiver	Holding/Migrating	73			
	31-Aug	00:02 - 23:59	61	177	Receiver	Holding/Migrating	39			
	31-Aug	08:40	80	110	17c	Holding/Migrating	-			
	1-Sep	00:02 - 23:59	58	234	Receiver	Holding/Migrating	285			
	1-Sep	14:45	150	165	1b	Spawning	-			
	2-Sep	06:03 - 06:34	61	144	Receiver	Holding/Migrating	18			
	4-Sep	02:58 - 21:06	60	232	Receiver	Holding/Migrating	175			
	5-Sep	01:18 - 01:18	68	68	Receiver	Holding/Migrating	1			
	5-Sep	10:10	180	210	1d	Holding/Migrating	-			
	6-Sep	14:25	112	112	1e	Holding/Migrating	-			
	9-Sep	10:45 - 21:55	59	215	Receiver	Holding/Migrating	392			
	9-Sep	11:32	100	139	1d	Holding/Migrating	-			
	11-Sep	12:30	130	150	1b	Spawning	-			
	12-Sep*	15:35	116	174	1b	Spawning	-			
	13-Sep	12:22	47	121	1b	Spawning	-			
	13-Sep	21:41 - 21:51	76	182	Receiver	Holding/Migrating	11			
	15-Sep	20:36 - 23:59	75	214	Receiver	Holding/Migrating	115			
	16-Sep	00:00 - 01:09	69	197	Receiver	Holding/Migrating	52			
	17-Sep	15:57	160	216	1b	Spawning	-			
	18-Sep	15:05	115	188	1b	Spawning	-			
	20-Sep	15:48	56	236	1b	Spawning	-			
	23-Sep	08:56 - 09:03	94	145	Receiver	Holding/Migrating	5			
66	25-Aug	08:35	-	-	-	Application	-	Spawning Channel	Female	1.00
	26-Aug	06:45 - 20:39	56	234	Receiver	Holding/Migrating	254			
	26-Aug	09:30	60	90	11a	Spawning	-			

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Appendix 4. Continued.

Trans- mitter No.	Tracking date ^a	Tracking time	Signal - strength		Area ^b	Action or area description ^c	No. records at upstream receiver	Final destination	Sex	Move- ment index ^d
			Min	Max						
66	27-Aug	04:03 - 18:21	60	234	Receiver	Holding/Migrating	334			
	28-Aug	06:22 - 13:00	56	234	Receiver	Holding/Migrating	156			
	30-Aug	14:22 - 15:21	59	193	Receiver	Holding/Migrating	30			
	31-Aug	09:55 - 18:50	62	187	Receiver	Holding/Migrating	77			
	1-Sep	05:12 - 17:46	67	231	Receiver	Holding/Migrating	51			
	1-Sep	14:25	90	110	1c	Holding/Migrating	-			
	2-Sep	05:25 - 23:58	1	231	Receiver	Holding/Migrating	282			
	3-Sep	00:25 - 17:23	57	213	Receiver	Holding/Migrating	108			
	4-Sep	03:21 - 22:38	57	233	Receiver	Holding/Migrating	809			
	5-Sep	10:10	180	210	1d	Holding/Migrating	-			
	5-Sep	10:25 - 11:37	62	216	Receiver	Holding/Migrating	82			
	6-Sep	15:00	140	153	1a	Spawning	-			
	9-Sep	09:21	235	236	3b	Spawning	-			
	12-Sep*	14:55	63	195	3b	Spawning	-			
	13-Sep	12:01	71	71	3b	Spawning	-			
	14-Sep	13:57	157	157	3b	Spawning	-			
	17-Sep	16:24	208	216	3b	Spawning	-			
	19-Sep	17:00	-	-	3b	Recovery	-			
67	25-Aug	08:35	-	-	-	Application	-	River	Male	-
	26-Aug	10:05 - 18:54	62	222	Receiver	Holding/Migrating	187			
	27-Aug	11:52 - 18:53	59	233	Receiver	Holding/Migrating	404			
	30-Aug	20:47 - 20:47	66	66	Receiver	Holding/Migrating	2			
	31-Aug	14:18 - 23:46	33	225	Receiver	Holding/Migrating	207			
	1-Sep	00:17 - 23:57	40	230	Receiver	Holding/Migrating	813			
	1-Sep	13:45	120	190	17a	Holding/Migrating	-			
	2-Sep	00:00 - 21:02	17	216	Receiver	Holding/Migrating	465			
	3-Sep	05:12 - 05:56	64	73	Receiver	Holding/Migrating	7			
	3-Sep	19:50	-	-	1e	Holding/Migrating	-			
	5-Sep	08:15 - 08:15	63	63	Receiver	Holding/Migrating	1			
	5-Sep	10:35	110	135	2	Spawning	-			
	15-Sep*	12:00	-	-	6a	Recovery	-			
68	26-Aug	09:25	-	-	-	Application	-	River	Male	1.25
	27-Aug	06:06 - 06:12	73	168	Receiver	Holding/Migrating	13			
	29-Aug	10:01 - 11:34	61	232	Receiver	Holding/Migrating	100			
	30-Aug	09:13 - 23:52	57	222	Receiver	Holding/Migrating	206			
	31-Aug	00:06 - 20:22	55	228	Receiver	Holding/Migrating	557			
	1-Sep	09:10	81	156	1e	Holding/Migrating	-			
	1-Sep	14:55	162	186	2	Spawning	-			
	2-Sep	07:02 - 07:10	77	97	Receiver	Holding/Migrating	4			
	3-Sep	19:00 - 21:43	55	170	Receiver	Holding/Migrating	145			
	4-Sep	03:06 - 20:10	55	175	Receiver	Holding/Migrating	541			
	5-Sep	06:35 - 06:35	90	90	Receiver	Holding/Migrating	1			
	5-Sep	10:20	130	142	1b	Spawning	-			
	6-Sep	15:00	74	80	1a	Spawning	-			
	9-Sep	11:00	130	160	1b	Spawning	-			
	12-Sep*	15:06	130	176	2	Spawning	-			
	13-Sep	12:22	109	139	1b	Spawning	-			
	14-Sep	13:46	133	227	1a	Spawning	-			
	17-Sep	16:09	159	166	2	Spawning	-			
	18-Sep	15:27	122	184	2	Spawning	-			
	19-Sep	15:37	86	140	1c	Holding/Migrating	-			
	19-Sep	16:53 - 16:53	150	150	Receiver	Holding/Migrating	1			
	20-Sep	16:28 - 16:38	78	224	Receiver	Holding/Migrating	9			
	25-Sep**	13:10	83	234	1a	Spawning	-			
	26-Sep to 2-Oct		106	221	6b	Holding	-			

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Appendix 4. Continued.

Trans- mitter No.	Tracking date ^a	Tracking time	Signal - strength		Area ^b	Action or area description ^c	No. records at upstream receiver	Final destination	Sex	Move- ment index ^d
			Min	Max						
69	26-Aug	09:25	-	-	-	Application	-	South Lake	Male	-
	26-Aug	18:26 - 18:30	83	147	Receiver	Holding/Migrating	5			
	30-Aug	13:30	120	210	22a	Spawning	-			
	13-Sep*	12:12	180	180	22b	Spawning	-			
70	26-Aug	09:25	-	-	-	Application	-	Spawning Channel	Female	1.40
	27-Aug	17:23 - 20:49	62	231	Receiver	Holding/Migrating	111			
	28-Aug	05:59 - 08:03	57	229	Receiver	Holding/Migrating	118			
	30-Aug	11:22 - 19:00	62	188	Receiver	Holding/Migrating	73			
	31-Aug	00:35 - 21:03	59	231	Receiver	Holding/Migrating	432			
	1-Sep	11:26 - 20:00	63	147	Receiver	Holding/Migrating	33			
	2-Sep	09:20	80	180	1b	Spawning	-			
	2-Sep	18:59 - 20:38	1	233	Receiver	Holding/Migrating	71			
	3-Sep	07:50 - 20:47	62	232	Receiver	Holding/Migrating	144			
	4-Sep	06:49 - 18:38	86	232	Receiver	Holding/Migrating	29			
	4-Sep	14:05	168	199	11c	Spawning	-			
	6-Sep	14:55 - 23:13	59	232	Receiver	Holding/Migrating	250			
	7-Sep	00:06 - 11:56	59	197	Receiver	Holding/Migrating	168			
	7-Sep	10:05	235	236	17b	Holding/Migrating	-			
	9-Sep	11:14	174	180	1e	Holding/Migrating	-			
	10-Sep	15:55 - 22:00	70	196	Receiver	Holding/Migrating	22			
	11-Sep	12:35	170	200	1a	Spawning	-			
	12-Sep*	15:35	100	156	1b	Spawning	-			
	13-Sep	12:22	74	166	1b	Spawning	-			
	13-Sep	21:03 - 23:47	65	154	Receiver	Holding/Migrating	19			
	17-Sep	16:24	105	236	3b	Spawning	-			
	20-Sep	16:11	73	153	3b	Spawning	-			
	25-Sep	13:39	57	230	3b	Spawning	-			
	26-Sep**	14:06	69	230	3b	Spawning	-			
	27-Sep	16:00	-	-	3b	Recovery	-			
71	26-Aug	09:25	-	-	-	Application	-	South Lake	Female	-
	26-Aug	22:37 - 22:50	66	90	Receiver	Holding/Migrating	2			
	27-Aug	06:40 - 06:54	71	167	Receiver	Holding/Migrating	24			
	7-Sep	16:00	120	150	22a	Spawning	-			
72	26-Aug	09:25	-	-	-	Application	-	North Lake	Female	-
	27-Aug	07:09 - 17:35	60	234	Receiver	Holding/Migrating	273			
	31-Aug	08:02 - 16:24	63	94	Receiver	Holding/Migrating	27			
	31-Aug	09:15	90	110	11a	Spawning	-			
	7-Sep	17:20	120	150	13b	Spawning	-			
	11-Sep	13:04	130	160	13b	Spawning	-			
	12-Sep*	08:50	170	235	13b	Spawning	-			
	13-Sep	16:20	77	77	13b	Spawning	-			
	16-Sep	09:48	113	148	13b	Spawning	-			
	22-Sep	14:37	94	137	13b	Spawning	-			
73	26-Aug	09:25	-	-	-	Application	-	North Lake	Male	-
	27-Aug	06:13 - 06:24	64	156	Receiver	Holding/Migrating	13			
	29-Aug	09:06 - 09:32	66	174	Receiver	Holding/Migrating	33			
	31-Aug	14:29 - 19:16	58	164	Receiver	Holding/Migrating	18			
	1-Sep	01:54 - 03:30	63	234	Receiver	Holding/Migrating	77			
	11-Sep	12:35	50	60	1a	Spawning	-			
74	27-Aug	09:00	-	-	-	Application	-	South Lake	Male	-
	27-Aug	13:40	7	146	5	Spawning	-			
	27-Aug	18:43 - 19:06	65	146	Receiver	Holding/Migrating	18			
75	27-Aug	09:00	-	-	-	Application	-	South Lake	Female	-
	27-Aug	13:50	7	30	4	Spawning	-			

Continued

Appendix 4. Continued.

Trans-mitter No.	Tracking date ^a	Tracking time	Signal - strength		Area ^b	Action or area description ^c	No. records at upstream receiver	Final destination	Sex	Move-ment index ^d
			Min	Max						
75	27-Aug	20:28 - 21:23	63	181	Receiver	Holding/Migrating	69			
	28-Aug	05:54 - 07:04	63	217	Receiver	Holding/Migrating	70			
76	27-Aug	09:00	-	-	-	Application	-	South Lake	Male	-
	27-Aug	16:20	30	148	2	Spawning	-			
	27-Aug	17:36 - 17:53	64	202	Receiver	Holding/Migrating	30			
	30-Aug	14:20	83	230	21a	Spawning	-			
77	27-Aug	09:00	-	-	-	Application	-	South Lake	Male	-
	27-Aug	13:50	7	28	4	Spawning	-			
	27-Aug	18:21 - 19:39	62	162	Receiver	Holding/Migrating	15			
	28-Aug	02:58 - 05:46	49	215	Receiver	Holding/Migrating	103			
78	27-Aug	09:00	-	-	-	Application	-	South Lake	Female	-
	27-Aug	13:00	235	235	1e	Holding/Migrating	-			
	28-Aug	12:33 - 12:39	63	86	Receiver	Holding/Migrating	9			
	28-Aug	12:55	90	162	1d	Holding/Migrating	-			
	30-Aug	16:54 - 17:23	59	223	Receiver	Holding/Migrating	45			
	31-Aug	09:25	210	232	17a	Holding/Migrating	-			
	31-Aug	09:25 - 19:20	59	190	Receiver	Holding/Migrating	54			
	1-Sep	06:27 - 07:31	77	176	Receiver	Holding/Migrating	77			
	1-Sep	08:25	180	223	1b	Spawning	-			
	16-Sep*	14:55	81	122	19a	Holding/Migrating	-			
79	27-Aug	09:00	-	-	-	Application	-	North Lake	Female	-
	27-Aug	16:20	130	140	2	Spawning	-			
	27-Aug	17:15 - 17:29	68	172	Receiver	Holding/Migrating	23			
	29-Sep	08:12 - 10:32	58	157	Receiver	Holding/Migrating	114			
	30-Aug	18:08 - 21:22	60	218	Receiver	Holding/Migrating	128			
	31-Aug	06:00 - 23:00	56	234	Receiver	Holding/Migrating	259			
	31-Aug	09:25	210	235	17a	Holding/Migrating	-			
	1-Sep	00:01 - 23:52	64	92	Receiver	Holding/Migrating	41			
80	28-Aug	09:15	-	-	-	Application	-	Unknown	Female	-
81	28-Aug	09:15	-	-	-	Application	-	River	Male	1.14
	31-Aug	06:26 - 18:30	1	241	Receiver	Holding/Migrating	108			
	31-Aug	08:40	90	165	17c	Holding/Migrating	-			
	1-Sep	04:50 - 23:22	60	234	Receiver	Holding/Migrating	127			
	1-Sep	09:15	180	218	1b	Spawning	-			
	1-Sep	13:45	180	190	17a	Holding/Migrating	-			
	2-Sep	00:02 - 01:43	62	231	Receiver	Holding/Migrating	40			
	3-Sep	06:49 - 19:50	58	219	Receiver	Holding/Migrating	73			
	3-Sep	19:50	-	-	1e	Holding/Migrating	-			
	4-Sep	05:55 - 15:47	59	231	Receiver	Holding/Migrating	246			
	4-Sep	14:20	160	178	17a	Holding/Migrating	-			
	5-Sep	00:25 - 19:21	61	182	Receiver	Holding/Migrating	799			
	5-Sep	09:20	202	211	17a	Holding/Migrating	-			
	6-Sep	06:49 - 23:58	54	205	Receiver	Holding/Migrating	214			
	7-Sep	00:01 - 06:50	29	234	Receiver	Holding/Migrating	155			
	11-Sep	08:17 - 20:39	66	160	Receiver	Holding/Migrating	30			
	12-Sep*	15:35	68	100	1b	Spawning	-			
	13-Sep	12:22	49	183	1b	Spawning	-			
	13-Sep	20:56 - 21:31	75	193	Receiver	Holding/Migrating	43			
	14-Sep	12:50	49	122	17a	Holding/Migrating	-			
	14-Sep	13:50	79	79	1d	Holding/Migrating	-			
	15-Sep	15:54	60	234	2	Spawning	-			
	17-Sep	16:09	139	139	2	Spawning	-			
	18-Sep	15:27	80	146	2	Spawning	-			
	20-Sep**	12:26	70	70	5	Spawning	-			

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Appendix 4. Continued.

Transmitter No.	Tracking date ^a	Tracking time	Signal - strength		Area ^b	Action or area description ^c	No. records at upstream receiver	Final destination	Sex	Movement index ^d
			Min	Max						
81	25-Sep to 5-Oct		87	235	3a	Holding	-			
82	28-Aug	09:15	-	-	-	Application	-	River	Female	1.57
	30-Aug	14:33 - 19:02	59	190	Receiver	Holding/Migrating	53			
	31-Aug	08:30	90	118	17b	Holding/Migrating	-			
	31-Aug	20:01 - 20:46	59	228	Receiver	Holding/Migrating	35			
	1-Sep	11:22 - 18:34	58	92	Receiver	Holding/Migrating	58			
	1-Sep	14:30	180	208	1e	Holding/Migrating	-			
	2-Sep	05:56 - 14:22	60	233	Receiver	Holding/Migrating	280			
	3-Sep	03:12 - 20:51	58	203	Receiver	Holding/Migrating	437			
	3-Sep	19:20	-	-	17a	Holding/Migrating	-			
	4-Sep	15:30	160	203	1b	Spawning	-			
	5-Sep	10:10	150	210	1d	Holding/Migrating	-			
	6-Sep	08:12 - 09:10	61	119	Receiver	Holding/Migrating	25			
	9-Sep**	11:00	120	170	1b	Spawning	-			
	10-Sep	04:23 - 04:28	72	111	Receiver	Holding/Migrating	5			
	11-Sep	09:16 - 13:55	63	132	Receiver	Holding/Migrating	93			
	20-Sep to 6-Oct*		54	210	6b	Holding	-			
83	28-Aug	09:15	-	-	-	Application	-	River	Male	0.40
	29-Aug	15:20 - 15:41	72	145	Receiver	Holding/Migrating	7			
	2-Sep	20:16 - 20:43	67	231	Receiver	Holding/Migrating	13			
	3-Sep	06:49 - 17:55	56	241	Receiver	Holding/Migrating	671			
	6-Sep	14:25	69	119	1e	Holding/Migrating	-			
	8-Sep	08:46 - 20:18	64	197	Receiver	Holding/Migrating	153			
	9-Sep	11:37	100	130	1c	Holding/Migrating	-			
	11-Sep	12:22	70	100	1b	Spawning	-			
	12-Sep*	04:03 - 04:08	95	185	Receiver	Holding/Migrating	6			
	12-Sep	15:14	61	128	1a	Spawning	-			
	14-Sep	13:46	47	47	1a	Spawning	-			
	15-Sep	15:54	105	105	2	Spawning	-			
	17-Sep	16:09	82	210	2	Spawning	-			
	18-Sep	15:27	233	234	2	Spawning	-			
	20-Sep	16:06	85	228	2	Spawning	-			
	25-Sep**	13:18	58	198	2	Spawning	-			
	27-Sep to 5-Oct		88	234	6b	Holding	-			
84	28-Aug	09:15	-	-	-	Application	-	River	Male	1.11
	30-Aug	03:50 - 22:54	57	234	Receiver	Holding/Migrating	526			
	31-Aug	07:51 - 16:32	49	234	Receiver	Holding/Migrating	355			
	31-Aug	08:30	110	110	17b	Holding/Migrating	-			
	1-Sep	05:30 - 06:59	61	212	Receiver	Holding/Migrating	39			
	2-Sep	11:07 - 20:50	62	232	Receiver	Holding/Migrating	73			
	3-Sep	07:32 - 23:56	59	169	Receiver	Holding/Migrating	145			
	3-Sep	19:15	-	-	17a	Holding/Migrating	-			
	4-Sep	00:06 - 23:59	58	231	Receiver	Holding/Migrating	317			
	4-Sep	15:10	160	183	1d	Holding/Migrating	-			
	5-Sep	00:02 - 15:03	64	216	Receiver	Holding/Migrating	257			
	5-Sep	10:10	150	210	1d	Holding/Migrating	-			
	6-Sep	00:51 - 09:18	59	234	Receiver	Holding/Migrating	108			
	6-Sep	14:30	77	135	1b	Spawning	-			
	8-Sep	07:21 - 19:29	63	183	Receiver	Holding/Migrating	181			
	10-Sep	16:31 - 16:35	66	110	Receiver	Holding/Migrating	4			
	11-Sep	09:38 - 11:29	67	224	Receiver	Holding/Migrating	44			
	12-Sep*	15:44	84	107	1e	Holding/Migrating	-			
	13-Sep	12:22	185	222	1b	Spawning	-			
	14-Sep	11:10 - 13:27	63	165	Receiver	Holding/Migrating	90			
	14-Sep	12:50	122	236	17a	Holding/Migrating	-			

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Appendix 4. Continued.

Trans- mitter No.	Tracking date ^a	Tracking time	Signal - strength		Area ^b	Action or area description ^c	No. records at upstream receiver	Final destination	Sex	Move- ment index ^d
			Min	Max						
84	15-Sep**	15:27	52	232	1b	Spawning	-			
	17-Sep to 5-Oct		133	233	1a	Spawning	-			
85	28-Aug	09:15	-	-	-	Application	-	North Lake	Female	-
	29-Aug	13:48 - 23:14	1	230	Receiver	Holding/Migrating	309			
	30-Aug	06:07 - 06:18	69	126	Receiver	Holding/Migrating	9			
	31-Aug	02:00 - 22:59	17	231	Receiver	Holding/Migrating	301			
	1-Sep	08:19 - 17:30	58	231	Receiver	Holding/Migrating	190			
	1-Sep	14:20	170	180	1d	Holding/Migrating	-			
	2-Sep	03:04 - 23:03	33	232	Receiver	Holding/Migrating	412			
	3-Sep	07:10 - 07:36	72	183	Receiver	Holding/Migrating	8			
	4-Sep	14:00	162	190	17c	Migration	-			
	5-Sep	00:48 - 10:47	61	171	Receiver	Holding/Migrating	29			
	5-Sep	10:20	132	162	1b	Spawning	-			
	6-Sep	14:30	95	151	1b	Spawning	-			
	6-Sep	21:19 - 22:47	64	213	Receiver	Holding/Migrating	40			
	7-Sep	10:15	102	102	17c	Holding/Migrating	-			
	7-Sep	22:28 - 23:37	69	226	Receiver	Holding/Migrating	36			
	11-Sep	10:57	170	220	16	Spawning	-			
86	29-Aug	08:45	-	-	-	Application	-	River	Male	-
	30-Aug	07:32 - 21:42	1	233	Receiver	Holding/Migrating	141			
	3-Sep	03:22 - 20:26	11	230	Receiver	Holding/Migrating	121			
	3-Sep	19:20	-	-	17a	Holding/Migrating	-			
	4-Sep	15:42	88	168	1a	Spawning	-			
	6-Sep	14:30	143	143	1b	Spawning	-			
	20-Sep*	09:34	-	-	6a	Recovery	-			
87	29-Aug	08:45	-	-	-	Application	-	River	Male	0.89
	30-Aug	06:57 - 07:04	65	145	Receiver	Holding/Migrating	8			
	31-Aug	15:06 - 23:53	58	214	Receiver	Holding/Migrating	62			
	1-Sep	00:15 - 22:12	63	231	Receiver	Holding/Migrating	44			
	2-Sep	06:40 - 09:17	107	241	Receiver	Holding/Migrating	10			
	3-Sep	06:37 - 14:28	60	233	Receiver	Holding/Migrating	248			
	4-Sep	14:13 - 20:22	7	217	Receiver	Holding/Migrating	311			
	5-Sep	10:10	150	210	1d	Holding/Migrating	-			
	6-Sep	21:50 - 22:19	76	216	Receiver	Holding/Migrating	5			
	7-Sep	02:10 - 02:40	69	233	Receiver	Holding/Migrating	20			
	9-Sep	10:43	44	140	2	Spawning	-			
	12-Sep	14:55	65	65	3a	Holding/Migrating	-			
	13-Sep*	12:10	90	156	1a	Spawning	-			
	14-Sep	13:46	75	75	1a	Spawning	-			
	15-Sep	15:54	113	113	2	Spawning	-			
	17-Sep	16:09	65	216	2	Spawning	-			
	18-Sep	15:27	139	179	2	Spawning	-			
	20-Sep**	16:06	120	149	2	Spawning	-			
	25-Sep to 5-Oct		61	220	6b	Holding	-			
	5-Oct	-	-	-	6b	Recovery	-			
88	29-Aug	08:45	-	-	-	Application	-	South Lake	Male	-
	29-Aug	17:06 - 17:23	71	165	Receiver	Holding/Migrating	10			
89	29-Aug	08:45	-	-	-	Application	-	Spawning Channel	Female ¹	-
	29-Aug	18:01 - 18:52	65	193	Receiver	Holding/Migrating	10			
	30-Aug	02:13 - 05:01	62	117	Receiver	Holding/Migrating	59			
	3-Sep	05:39 - 13:44	56	241	Receiver	Holding/Migrating	64			
	4-Sep	12:37 - 14:09	66	230	Receiver	Holding/Migrating	84			
	4-Sep	15:15	160	210	1e	Holding/Migrating	-			
	5-Sep	11:13 - 23:58	57	125	Receiver	Holding/Migrating	60			
	6-Sep	00:01 - 21:55	58	153	Receiver	Holding/Migrating	95			

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Appendix 4. Continued.

Trans- mitter No.	Tracking date ^a	Tracking time	Signal - strength		Area ^b	Action or area description ^c	No. records at upstream receiver	Final destination	Sex	Move- ment index ^d
			Min	Max						
89	8-Sep	15:31 - 17:27	66	183	Receiver	Holding/Migrating	95			
	9-Sep	08:08 - 08:52	70	212	Receiver	Holding/Migrating	34			
	12-Sep	14:55	120	150	3b	Spawning	-			
	*13-Sep**	12:01	67	136	3b	Spawning	-			
	15-Sep	12:00	-	-	3b	Recovery	-			
90	29-Aug	08:45	-	-	-	Application	-	Spawning channel	Female ^f	1.00
	29-Aug	17:54 - 23:52	57	234	Receiver	Holding/Migrating	175			
	30-Aug	00:04 - 23:22	63	232	Receiver	Holding/Migrating	183			
	31-Aug	00:40 - 16:00	60	204	Receiver	Holding/Migrating	14			
	31-Aug	10:15	136	187	1b	Spawning	-			
	1-Sep	11:26 - 11:31	63	131	Receiver	Holding/Migrating	5			
	5-Sep	07:54 - 14:57	60	204	Receiver	Holding/Migrating	82			
	5-Sep	09:20	235	235	17a	Holding/Migrating	-			
	7-Sep	08:59 - 08:59	67	67	Receiver	Holding/Migrating	1			
	7-Sep	11:10	90	140	11a	Spawning	-			
	9-Sep	11:05	63	158	1b	Spawning	-			
	11-Sep	12:22	200	235	1b	Spawning	-			
	11-Sep	20:36 - 21:13	70	136	Receiver	Holding/Migrating	16			
	12-Sep	15:35	88	108	1b	Spawning	-			
	13-Sep*	12:22	67	67	1b	Spawning	-			
	14-Sep	13:22	52	83	1e	Holding/Migrating	-			
	19-Sep	17:00	-	-	3b	Recovery	-			
91	29-Aug	08:45	-	-	-	Application	-	River	Female	1.77
	30-Aug	06:57 - 11:17	33	202	Receiver	Holding/Migrating	169			
	31-Aug	06:23 - 18:25	56	233	Receiver	Holding/Migrating	168			
	1-Sep	01:04 - 19:06	64	231	Receiver	Holding/Migrating	134			
	1-Sep	08:30	100	143	17a	Holding/Migrating	-			
	2-Sep	06:10 - 21:08	1	233	Receiver	Holding/Migrating	121			
	3-Sep	07:22 - 21:58	59	218	Receiver	Holding/Migrating	460			
	3-Sep	19:30	-	-	17a	Holding/Migrating	-			
	4-Sep	04:07 - 20:51	59	213	Receiver	Holding/Migrating	232			
	5-Sep	10:18 - 17:39	62	233	Receiver	Holding/Migrating	322			
	7-Sep	10:50	85	101	11d	Spawning	-			
	9-Sep	07:15 - 17:26	58	218	Receiver	Holding/Migrating	428			
	9-Sep	11:32	100	140	1d	Holding/Migrating	-			
	11-Sep	12:22	200	235	1b	Spawning	-			
	12-Sep	16:06	69	100	1b	Spawning	-			
	13-Sep*	12:58	86	224	1b	Spawning	-			
	14-Sep	13:22	83	100	1e	Holding/Migrating	-			
	15-Sep	15:27	103	164	1b	Spawning	-			
	16-Sep	07:40 - 13:45	60	212	Receiver	Holding/Migrating	164			
	17-Sep	15:25	65	136	1d	Holding	-			
	20-Sep	15:56	54	141	1b	Spawning	-			
	25-Sep	12:47	70	160	1c	Holding/Migrating	-			
	25-Sep	13:24 - 18:07	70	182	Receiver	Holding/Migrating	7			
	27-Sep	11:24	86	172	11c	Spawning	-			
92	30-Aug	08:45	-	-	-	Application	-	River	Female	0.67
	31-Aug	06:32 - 07:46	71	233	Receiver	Holding/Migrating	72			
	1-Sep	07:04 - 07:16	64	233	Receiver	Holding/Migrating	15			
	1-Sep	14:40	160	186	1b	Spawning	-			
	3-Sep	07:17 - 12:49	60	195	Receiver	Holding/Migrating	153			
	4-Sep	07:08 - 23:59	60	218	Receiver	Holding/Migrating	161			
	5-Sep	00:00 - 13:46	62	185	Receiver	Holding/Migrating	29			
	5-Sep	10:20	188	210	1b	Spawning	-			
	6-Sep	14:25	88	136	1e	Holding/Migrating	-			

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Appendix 4. Continued.

Trans- mitter No.	Tracking date ^a	Tracking time	Signal - strength		Area ^b	Action or area description ^c	No. records at upstream receiver	Final destination	Sex	Move- ment index ^d
			Min	Max						
92	9-Sep	11:37	180	200	1c	Holding/Migrating	-			
	13-Sep*	12:10	102	113	1a	Spawning	-			
	14-Sep	13:38	50	171	1b	Spawning	-			
	15-Sep	15:54	90	135	2	Spawning	-			
	15-Sep	18:56	111	124	2	Spawning	-			
	17-Sep	16:09	125	148	2	Spawning	-			
	18-Sep	15:20	90	90	1a	Spawning	-			
	20-Sep	16:02	74	164	1a	Spawning	-			
	25-Sep**	13:13	66	161	1a	Spawning	-			
	27-Sep	11:00	-	-	1a	Recovery	-			
93	30-Aug	08:45	-	-	-	Application	-	River	Female	0.82
	30-Aug	19:50 - 20:47	71	230	Receiver	Holding/Migrating	138			
	31-Aug	07:02 - 08:07	66	166	Receiver	Holding/Migrating	80			
	31-Aug	09:07	235	235	11b	Holding/Migrating	-			
	1-Sep	05:36 - 05:43	70	218	Receiver	Holding/Migrating	12			
	2-Sep	06:55 - 17:05	58	194	Receiver	Holding/Migrating	150			
	4-Sep	08:53 - 22:16	58	226	Receiver	Holding/Migrating	627			
	5-Sep	10:30	160	173	1a	Spawning	-			
	6-Sep	15:00	162	181	1a	Spawning	-			
	13-Sep*	12:22	100	100	1b	Spawning	-			
	14-Sep	13:38	140	164	1b	Spawning	-			
	15-Sep	15:48	129	129	1a	Spawning	-			
	17-Sep	15:57	74	118	1b	Spawning	-			
	18-Sep	15:15	61	129	1b	Spawning	-			
	20-Sep	15:48	90	147	1b	Spawning	-			
	25-Sep**	13:02	68	196	1b	Spawning	-			
	26-Sep to 5-Oct		78	236	1b	Spawning	-			
94	30-Aug	08:45	-	-	-	Application	-	River	Female	0.64
	30-Aug	18:57 - 19:26	62	155	Receiver	Holding/Migrating	15			
	1-Sep	21:16 - 21:20	120	230	Receiver	Holding/Migrating	6			
	2-Sep	06:55 - 17:47	55	234	Receiver	Holding/Migrating	81			
	3-Sep	17:19 - 17:22	125	231	Receiver	Holding/Migrating	6			
	3-Sep	19:50	-	-	1e	Holding/Migrating	-			
	4-Sep	15:15	195	235	1e	Holding/Migrating	-			
	5-Sep	10:10	150	210	1d	Holding/Migrating	-			
	6-Sep	12:00	108	124	17a	Holding/Migrating	-			
	6-Sep	14:25	88	136	1e	Holding/Migrating	-			
	6-Sep	15:22 - 23:53	55	202	Receiver	Holding/Migrating	270			
	7-Sep	00:01 - 06:52	56	213	Receiver	Holding/Migrating	188			
	7-Sep	11:10	128	128	11a	Spawning	-			
	8-Sep	12:38 - 23:56	64	213	Receiver	Holding/Migrating	95			
	9-Sep	00:31 - 09:48	65	204	Receiver	Holding/Migrating	93			
	9-Sep	11:14	108	184	1e	Holding/Migrating	-			
	10-Sep	06:40 - 07:24	82	220	Receiver	Holding/Migrating	58			
	12-Sep	14:49	74	207	1e	Holding/Migrating	-			
	13-Sep*	14:23 - 14:24	85	94	Receiver	Holding/Migrating	2			
	14-Sep	13:33	62	149	1b	Spawning	-			
	15-Sep	15:27	100	136	1b	Spawning	-			
	15-Sep	18:42 - 21:24	65	195	Receiver	Holding/Migrating	74			
	17-Sep	15:57	121	235	1b	Spawning	-			
	18-Sep	09:37 - 09:37	94	103	Receiver	Holding/Migrating	2			
	18-Sep	15:05	152	181	1b	Spawning	-			
	20-Sep**	15:48	91	219	1b	Spawning	-			
	25-Sep to 5-Oct		73	211	1b	Spawning	-			
95	30-Aug	08:45	-	-	-	Application	-	River	Male	1.15
	31-Aug	06:44 - 16:28	17	225	Receiver	Holding/Migrating	415			

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Appendix 4. Continued.

Trans- mitter No.	Tracking date ^a	Tracking time	Signal - strength		Area ^b	Action or area description ^c	No. records at upstream receiver	Final destination	Sex	Move- ment index ^d
			Min	Max						
95	1-Sep	03:38 - 23:13	60	213	Receiver	Holding/Migrating	94			
	2-Sep	08:11 - 18:20	72	193	Receiver	Holding/Migrating	22			
	3-Sep	09:59 - 17:44	8	202	Receiver	Holding/Migrating	141			
	4-Sep	02:54 - 07:11	68	233	Receiver	Holding/Migrating	41			
	4-Sep	15:10	150	150	1d	Holding/Migrating	-			
	4-Sep	15:35	160	173	1b	Spawning	-			
	5-Sep	02:20 - 07:34	61	156	Receiver	Holding/Migrating	13			
	5-Sep	10:10	150	210	1d	Holding/Migrating	-			
	8-Sep	08:28 - 19:52	64	218	Receiver	Holding/Migrating	78			
	10-Sep	21:08 - 21:09	98	123	Receiver	Holding/Migrating	2			
	12-Sep	15:06	180	235	2	Spawning	-			
	13-Sep*	11:45	76	119	2	Spawning	-			
	15-Sep	15:54	48	50	2	Spawning	-			
	17-Sep	16:02	114	114	1a	Spawning	-			
	20-Sep	16:06	77	119	2	Spawning	-			
	25-Sep	13:13	100	193	1a	Spawning	-			
	26-Sep**	12:30	104	104	1a	Spawning	-			
	26-Sep to 7-Oct		71	177	Receiver	Holding	10,753			
96	30-Aug	08:45	-	-	-	Application	-	River	Male	1.00
	31-Aug	06:49 - 07:14	68	176	Receiver	Holding/Migrating	44			
	31-Aug	08:50	80	180	11b	Holding/Migrating	-			
	1-Sep	14:30 - 15:29	62	195	Receiver	Holding/Migrating	43			
	3-Sep	19:50	-	-	1e	Holding/Migrating	-			
	4-Sep	15:15	160	223	1e	Holding/Migrating	-			
	6-Sep	14:30	67	138	1b	Spawning	-			
	8-Sep	20:27 - 22:29	68	101	Receiver	Holding/Migrating	16			
	9-Sep	01:21 - 02:55	67	133	Receiver	Holding/Migrating	80			
	10-Sep	07:57 - 17:05	57	197	Receiver	Holding/Migrating	653			
	11-Sep	17:48 - 23:15	63	177	Receiver	Holding/Migrating	99			
	12-Sep	15:35	61	164	1b	Spawning	-			
	13-Sep*	12:22	112	135	1b	Spawning	-			
	14-Sep	13:22	74	74	1e	Holding/Migrating	-			
	15-Sep	15:27	113	151	1b	Spawning	-			
	18-Sep	06:32 - 06:33	134	150	Receiver	Holding/Migrating	-			
	18-Sep	14:44	80	113	1c	Holding/Migrating	-			
	20-Sep	15:56	138	167	1b	Spawning	-			
	25-Sep	13:11	103	103	1a	Spawning	-			
	26-Sep	14:06	106	106	4	Spawning	-			
	27-Sep	09:15 - 09:16	159	173	Receiver	Holding/Migrating	2			
97	31-Aug	08:45	-	-	-	Application	-	Spawning Channel	Female	-
	1-Sep	14:25	130	186	1c	Holding/Migrating	-			
	1-Sep	16:40 - 21:28	59	220	Receiver	Holding/Migrating	308			
	2-Sep	06:59 - 07:40	65	186	Receiver	Holding/Migrating	17			
	4-Sep	13:02 - 15:43	60	180	Receiver	Holding/Migrating	43			
	4-Sep	14:20	169	199	17a	Holding/Migrating	-			
	5-Sep	10:40	135	140	3a	Holding/Migrating	-			
	8-Sep	14:00	-	-	3b	Recovery	-			
98	31-Aug	08:45	-	-	-	Application	-	River	Male	1.88
	31-Aug	20:36 - 23:51	66	213	Receiver	Holding/Migrating	43			
	1-Sep	04:29 - 15:24	64	233	Receiver	Holding/Migrating	79			
	1-Sep	14:25	120	140	1c	Holding/Migrating	-			
	2-Sep	01:03 - 23:27	61	181	Receiver	Holding/Migrating	29			
	3-Sep	04:00 - 05:13	60	157	Receiver	Holding/Migrating	47			
	7-Sep	10:33	150	236	11d	Spawning	-			
	8-Sep	10:17 - 16:39	63	200	Receiver	Holding/Migrating	335			

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Appendix 4. Continued.

Trans- mitter No.	Tracking date ^a	Tracking time	Signal - strength		Area ^b	Action or area description ^c	No. records at upstream receiver	Final destination	Sex	Move- ment index ^d
			Min	Max						
98	12-Sep	15:44	49	153	1e	Holding/Migrating	-			
	13-Sep*	12:22	109	113	1b	Spawning	-			
	14-Sep	13:57	111	189	2	Spawning	-			
	15-Sep	15:54	137	172	2	Spawning	-			
	16-Sep	20:56 - 23:08	75	177	Receiver	Holding/Migrating	48			
	18-Sep	15:27	169	169	2	Spawning	-			
	20-Sep**	16:11	51	51	2	Spawning	-			
	25-Sep to 6-Oct		132	234	6b	Holding	-			
	10-Oct	12:00	-	-	6a	Recovery	-			
99	31-Aug	08:45	-	-	-	Application	-	River	Female	1.75
	1-Sep	14:55	235	235	2	Spawning	-			
	3-Sep	06:45 - 23:58	61	129	Receiver	Holding/Migrating	18			
	4-Sep	00:00 - 23:48	58	208	Receiver	Holding/Migrating	292			
	4-Sep	13:55	199	213	17b	Holding/Migrating	-			
	5-Sep	00:03 - 23:42	60	233	Receiver	Holding/Migrating	207			
	5-Sep	09:20	114	132	17a	Holding/Migrating	-			
	6-Sep	00:12 - 21:16	58	234	Receiver	Holding/Migrating	466			
	6-Sep	12:00	180	188	17a	Holding/Migrating	-			
	7-Sep	06:09 - 20:10	66	215	Receiver	Holding/Migrating	708			
	9-Sep	09:30	80	130	3a	Holding/Migrating	-			
	11-Sep	12:30	150	200	1b	Spawning	-			
	12-Sep	16:06	111	153	1b	Spawning	-			
100	31-Aug	08:45	-	-	-	Application	-	River	Male	0.71
	3-Sep	19:50	-	-	1e	Holding/Migrating	-			
	4-Sep	06:49 - 23:28	80	229	Receiver	Holding/Migrating	36			
	5-Sep	06:49 - 20:12	64	231	Receiver	Holding/Migrating	88			
	6-Sep	14:30	71	109	1b	Spawning	-			
	7-Sep	08:19 - 08:42	66	92	Receiver	Holding/Migrating	7			
	8-Sep	20:00 - 21:11	68	175	Receiver	Holding/Migrating	32			
	12-Sep	15:14	98	130	1a	Spawning	-			
	13-Sep*	12:10	121	140	1a	Spawning	-			
	15-Sep	15:48	92	183	1a	Spawning	-			
	18-Sep	15:05	176	176	1b	Spawning	-			
	19-Sep	15:21	42	132	17a	Holding/Migrating	-			
	19-Sep	15:36 - 23:57	73	128	Receiver	Holding/Migrating	20			
	20-Sep	00:01 - 14:31	20	132	Receiver	Holding/Migrating	23			
101	1-Sep	09:35	-	-	-	Application	-	North Lake	Male	-
	1-Sep	20:47 - 21:01	68	204	Receiver	Holding/Migrating	13			
	2-Sep	00:37 - 06:37	64	199	Receiver	Holding/Migrating	41			
	3-Sep	04:46 - 20:24	59	230	Receiver	Holding/Migrating	83			
	3-Sep	19:25	-	-	17a	Holding/Migrating	-			
	4-Sep	01:17 - 06:53	58	159	Receiver	Holding/Migrating	116			
	7-Sep	17:40	120	150	17d	Spawning	-			
	11-Sep	13:04	130	150	13b	Spawning	-			
	12-Sep	08:50	45	65	13b	Spawning	-			
	16-Sep*	09:35	93	140	13a	Spawning	-			
	19-Sep	13:54	56	220	13a	Spawning	-			
	21-Sep	14:42	70	199	13a	Spawning	-			
102	1-Sep	09:35	-	-	-	Application	-	River	Female	-
	1-Sep	19:36 - 23:07	65	184	Receiver	Holding/Migrating	131			
	2-Sep	01:11 - 07:07	65	139	Receiver	Holding/Migrating	10			
	3-Sep	13:09 - 13:09	71	71	Receiver	Holding/Migrating	1			
	7-Sep	17:20	70	115	13a	Spawning	-			
	11-Sep	18:34 - 19:08	66	176	Receiver	Holding/Migrating	25			
	13-Sep*	12:22	72	118	1b	Spawning	-			

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Appendix 4. Continued.

Transmitter No.	Tracking date ^a	Tracking time	Signal - strength		Area ^b	Action or area description ^c	No. records at upstream receiver	Final destination	Sex	Movement index ^d
			Min	Max						
102	15-Sep	08:49 - 16:21	59	109	Receiver	Holding/Migrating	68			
	15-Sep	14:21	94	94	17a	Holding/Migrating	-			
	17-Sep	15:57 - 17:42	9	72	Receiver	Holding/Migrating	2			
	18-Sep	15:15	150	150	1b	Spawning	-			
	20-Sep	16:02	87	87	1a	Spawning	-			
	25-Sep	13:02	67	158	1b	Spawning	-			
	26-Sep**	14:05	80	80	4	Spawning	-			
	29-Sep to 5-Oct		114	233	6b	Holding	-			
103	1-Sep	09:35	-	-	-	Application	-	River	Female	1.40
	3-Sep	06:50 - 21:32	17	230	Receiver	Holding/Migrating	577			
	4-Sep	08:45 - 17:25	63	208	Receiver	Holding/Migrating	473			
	4-Sep	14:30	169	188	17a	Holding/Migrating	-			
	5-Sep	10:05	144	186	1c	Holding/Migrating	-			
	5-Sep	16:56 - 23:32	57	180	Receiver	Holding/Migrating	414			
	6-Sep	05:36 - 12:08	67	234	Receiver	Holding/Migrating	47			
	6-Sep	11:50	201	201	11a	Spawning	-			
	9-Sep	11:05	160	180	1b	Spawning	-			
	12-Sep	15:06	180	210	2	Spawning	-			
	13-Sep*	12:01	46	117	3a	Holding/Migrating	-			
	14-Sep	13:57	68	163	2	Spawning	-			
	17-Sep	16:09	118	123	2	Spawning	-			
	20-Sep	16:11	76	148	3a	Holding/Migrating	-			
	25-Sep**	13:23	72	125	3a	Holding/Migrating	-			
	26-Sep to 5-Oct		81	211	6b	Holding	-			
104	1-Sep	09:35	-	-	-	Application	-	River	Male	1.36
	1-Sep	20:21 - 20:40	58	218	Receiver	Holding/Migrating	20			
	2-Sep	05:52 - 18:25	62	193	Receiver	Holding/Migrating	40			
	3-Sep	03:37 - 18:46	61	233	Receiver	Holding/Migrating	80			
	3-Sep	19:40	-	-	17a	Holding/Migrating	-			
	4-Sep	05:09 - 23:24	59	172	Receiver	Holding/Migrating	150			
	5-Sep	01:12 - 23:57	56	183	Receiver	Holding/Migrating	687			
	5-Sep	10:10	153	170	1e	Holding/Migrating	-			
	6-Sep	00:03 - 12:13	65	233	Receiver	Holding/Migrating	48			
	6-Sep	11:50	124	149	11a	Spawning	-			
	7-Sep	07:15 - 19:48	63	208	Receiver	Holding/Migrating	276			
	7-Sep	11:25	128	128	17a	Holding/Migrating	-			
	12-Sep	15:14	109	135	1a	Spawning	-			
	13-Sep*	12:51	61	175	1c	Holding/Migrating	-			
	14-Sep	12:38	59	59	11a	Spawning	-			
	15-Sep	15:27	102	187	1b	Spawning	-			
	17-Sep	16:09	91	132	2	Spawning	-			
	18-Sep	15:20	102	152	1a	Spawning	-			
	20-Sep	16:02	159	190	1a	Spawning	-			
	25-Sep	13:11	218	228	1a	Spawning	-			
	26-Sep	12:22	146	146	1b	Spawning	-			
	27-Sep**	12:33	49	234	1b	Spawning	-			
	28-Sep to 5-Oct		75	218	3a	Holding	-			
	8-Oct	13:30	-	-	5	Recovery	-			
105	2-Sep	09:15	-	-	-	Application	-	River	Male	1.67
	3-Sep	08:14 - 08:14	76	80	Receiver	Holding/Migrating	2			
	3-Sep	19:50	-	-	1e	Holding/Migrating	-			
	4-Sep	15:30	171	177	1b	Spawning	-			
	5-Sep	08:04 - 08:06	71	86	Receiver	Holding/Migrating	3			
	6-Sep	04:09 - 07:25	61	232	Receiver	Holding/Migrating	112			
	6-Sep	11:50	60	113	11a	Spawning	-			

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Appendix 4. Continued.

Trans-mitter No.	Tracking date ^a	Tracking time	Signal - strength		Area ^b	Action or area description ^c	No. records at upstream receiver	Final destination	Sex	Move-ment index ^d
			Min	Max						
105	9-Sep	07:52 - 12:04	79	151	Receiver	Holding/Migrating	10			
	9-Sep	11:37	100	140	1c	Holding/Migrating	-			
	10-Sep	02:47 - 18:41	70	180	Receiver	Holding/Migrating	28			
	11-Sep	12:30	150	175	1b	Spawning	-			
	12-Sep	15:14	178	232	1a	Spawning	-			
	14-Sep*	12:38	83	229	11a	Spawning	-			
	15-Sep	14:07	46	163	11b	Holding/Migrating	-			
	17-Sep**	14:47	76	151	11a	Spawning	-			
18-Sep to 30-Sep			104	216	11b	Holding	-			
106	2-Sep	09:17	-	-	-	Application	-	River	Female	-
	3-Sep	19:50	-	-	1e	Holding/Migrating	-			
	4-Sep	08:18 - 23:59	59	212	Receiver	Holding/Migrating	569			
	4-Sep	15:20	210	235	1e	Holding/Migrating	-			
	5-Sep	00:00 - 11:02	61	185	Receiver	Holding/Migrating	269			
	6-Sep	06:37 - 09:01	59	183	Receiver	Holding/Migrating	106			
	7-Sep	05:52 - 06:07	77	169	Receiver	Holding/Migrating	22			
	7-Sep	17:40	120	150	17d	Spawning	-			
	8-Sep	00:32 - 17:45	61	194	Receiver	Holding/Migrating	653			
	9-Sep	04:46 - 04:51	77	144	Receiver	Holding/Migrating	4			
	11-Sep	12:58	80	140	17e	Spawning	-			
	13-Sep	12:22	64	88	1b	Spawning	-			
	13-Sep	17:52 - 19:09	64	216	Receiver	Holding/Migrating	25			
	21-Sep*	10:10	-	-	9a	Recovery	-			
107	2-Sep	09:18	-	-	-	Application	-	River	Male	-
	2-Sep	20:07 - 21:35	76	234	Receiver	Holding/Migrating	32			
	3-Sep	06:49 - 07:06	73	171	Receiver	Holding/Migrating	9			
	4-Sep	12:32 - 19:36	64	233	Receiver	Holding/Migrating	95			
	4-Sep	15:20	160	195	1e	Holding/Migrating	-			
	5-Sep	00:38 - 13:45	58	228	Receiver	Holding/Migrating	128			
	6-Sep	00:27 - 09:52	64	234	Receiver	Holding/Migrating	98			
	6-Sep	14:35	180	200	1b	Spawning	-			
	7-Sep	06:55 - 20:34	64	169	Receiver	Holding/Migrating	173			
	7-Sep	11:25	100	233	17a	Holding/Migrating	-			
	8-Sep	07:37 - 11:33	62	192	Receiver	Holding/Migrating	89			
	9-Sep	19:17 - 21:24	62	194	Receiver	Holding/Migrating	53			
	10-Sep	06:34 - 23:59	55	208	Receiver	Holding/Migrating	351			
	11-Sep	06:53 - 15:39	63	133	Receiver	Holding/Migrating	75			
	12-Sep	06:43 - 08:44	67	217	Receiver	Holding/Migrating	65			
	13-Sep	12:22	75	155	1b	Spawning	-			
	14-Sep*	13:33	120	159	1b	Spawning	-			
	15-Sep	08:36 - 08:36	105	105	Receiver	Holding/Spawning	1			
108	2-Sep	09:20	-	-	-	Application	-	River	Female	-
	3-Sep	11:10 - 16:59	7	233	Receiver	Holding/Migrating	118			
	6-Sep	18:53 - 20:28	67	233	Receiver	Holding/Migrating	127			
	7-Sep	06:52 - 17:03	69	189	Receiver	Holding/Migrating	82			
	7-Sep	11:25	97	100	17a	Holding/Migrating	-			
	8-Sep	01:27 - 15:43	67	163	Receiver	Holding/Migrating	53			
	9-Sep	06:51 - 21:41	56	216	Receiver	Holding/Migrating	1,097			
	11-Sep	07:39 - 20:16	61	129	Receiver	Holding/Migrating	114			
	13-Sep	12:12 - 23:59	61	207	Receiver	Holding/Migrating	324			
	14-Sep*	00:01 - 02:19	74	192	Receiver	Holding/Migrating	183			
	14-Sep	13:22	114	150	1e	Holding/Migrating	-			
	15-Sep	15:27	118	127	1b	Spawning	-			
	15-Sep	17:47 - 17:48	68	79	Receiver	Holding/Migrating	2			
	16-Sep	15:50 - 16:13	80	198	Receiver	Holding/Migrating	25			

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Appendix 4. Continued.

Transmitter No.	Tracking date ^a	Tracking time	Signal - strength		Area ^b	Action or area description ^c	No. records at upstream receiver	Final destination	Sex	Movement index ^d
			Min	Max						
108	21-Sep	11:00	-	-	9b	Recovery	-			
109	3-Sep	09:15	-	-	-	Application	-	River	Female	1.55
	5-Sep	10:10	235	235	1e	Holding/Migrating	-			
	5-Sep	12:05 - 20:19	59	234	Receiver	Holding/Migrating	556			
	6-Sep	10:20 - 10:24	63	65	Receiver	Holding/Migrating	2			
	6-Sep	11:50	160	173	11a	Spawning	-			
	7-Sep	05:18 - 23:59	63	222	Receiver	Holding/Spawning	297			
	8-Sep	00:00 - 19:29	61	176	Receiver	Holding/Migrating	271			
	9-Sep	07:47 - 16:45	64	157	Receiver	Holding/Migrating	22			
	10-Sep	19:43 - 19:52	66	121	Receiver	Holding/Migrating	7			
	11-Sep	09:19 - 21:29	67	200	Receiver	Holding/Migrating	79			
	12-Sep	08:56 - 09:01	68	165	Receiver	Holding/Migrating	4			
	12-Sep	10:30	170	200	11d	Spawning	-			
	13-Sep	17:54 - 18:42	61	201	Receiver	Holding/Migrating	46			
	14-Sep*	20:47 - 23:59	64	197	Receiver	Holding/Migrating	179			
	15-Sep	00:00 - 23:45	58	217	Receiver	Holding/Migrating	559			
	15-Sep	14:21	60	98	17a	Holding/Migrating	-			
	16-Sep	07:05 - 07:55	81	216	Receiver	Holding/Migrating	27			
	18-Sep	08:07 - 08:37	75	94	Receiver	Holding/Migrating	9			
	18-Sep	14:44	64	64	1c	Holding/Migrating	-			
	20-Sep	15:56	81	126	1b	Spawning	-			
	25-Sep	13:05	88	88	1b	Spawning	-			
	26-Sep	12:04	89	113	1c	Holding/Migrating	-			
	27-Sep	12:37	119	183	1a	Spawning	-			
	28-Sep	16:05	100	185	1b	Spawning	-			
	29-Sep	12:09	66	130	1e	Holding/Migrating	-			
	29-Sep	14:42 - 16:08	69	183	Receiver	Holding/Migrating	40			
110	3-Sep	09:15	-	-	-	Application	-	River	Male	1.33
	4-Sep	15:35	235	235	1b	Spawning	-			
	4-Sep	18:15 - 23:08	59	188	Receiver	Holding/Migrating	33			
	5-Sep	02:11 - 20:48	49	215	Receiver	Holding/Migrating	252			
	6-Sep	06:53 - 23:59	59	145	Receiver	Holding/Migrating	28			
	7-Sep	00:06 - 20:23	64	231	Receiver	Holding/Migrating	392			
	7-Sep	10:07	80	127	17b	Holding/Migrating	-			
	7-Sep	11:25	70	70	17a	Holding/Migrating	-			
	8-Sep	00:37 - 00:46	74	228	Receiver	Holding/Migrating	12			
	9-Sep	11:05	80	130	1b	Spawning	-			
	17-Sep*	16:09	62	62	2	Spawning	-			
	20-Sep	16:06	64	86	2	Spawning	-			
	25-Sep	11:30	-	-	6a	Recovery	-			
111	3-Sep	09:15	-	-	-	Application	-	River	Female	0.89
	5-Sep	10:10	105	105	1e	Holding/Migrating	-			
	6-Sep	14:35	105	159	1b	Spawning	-			
	6-Sep	19:02 - 22:19	59	229	Receiver	Holding/Migrating	64			
	7-Sep	07:01 - 07:14	62	153	Receiver	Holding/Migrating	11			
	8-Sep	11:01 - 11:31	73	133	Receiver	Holding/Migrating	7			
	9-Sep	11:14	100	138	1e	Holding/Migrating	-			
	11-Sep	08:27 - 08:36	68	114	Receiver	Holding/Migrating	8			
	12-Sep	07:08 - 10:34	64	211	Receiver	Holding/Migrating	65			
	12-Sep	16:00	52	210	1c	Holding/Migrating	-			
	14-Sep*	06:37 - 18:39	61	117	Receiver	Holding/Migrating	19			
	14-Sep	13:22	47	136	1e	Holding/Migrating	-			
	15-Sep	15:27	67	168	1b	Spawning	-			
	17-Sep	15:31	80	122	1c	Holding	-			
	18-Sep	15:05	60	60	1b	Spawning	-			

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Appendix 4. Continued.

Trans- mitter No.	Tracking date ^a	Tracking time	Signal - strength		Area ^b	Action or area description ^c	No. records at upstream receiver	Final destination	Sex	Move- ment index ^d
			Min	Max						
111	20-Sep**	15:37	96	96	1c	Holding/Migrating	-			
	21-Sep	20:59 - 21:05	85	137	Receiver	Holding/Migrating	5			
	25-Sep to 6-Oct		73	234	6b	Holding	-			
112	3-Sep	09:15	-	-	-	Application	-	River	Male	-
	16-Sep*	08:27 - 16:39	61	164	Receiver	Holding/Migrating	26			
113	4-Sep	09:25	-	-	-	Application	-	River	Female	1.67
	5-Sep	07:01 - 20:26	64	231	Receiver	Holding/Migrating	188			
	5-Sep	09:15	122	136	11a	Spawning	-			
	6-Sep	07:02 - 22:22	59	171	Receiver	Holding/Migrating	129			
	9-Sep	11:05	235	236	1b	Spawning	-			
	11-Sep	12:30	150	167	1b	Spawning	-			
	12-Sep	16:06	95	167	1b	Spawning	-			
	13-Sep	12:58	83	218	1b	Spawning	-			
	14-Sep*	12:50	85	85	17a	Holding/Migrating	-			
	15-Sep	15:10	62	80	1c	Holding/Migrating	-			
	17-Sep	15:31	80	80	1c	Holding/Migrating	-			
	18-Sep	15:15	220	233	1b	Spawning	-			
	20-Sep	15:56	73	234	1b	Spawning	-			
	25-Sep**	13:05	89	181	1b	Spawning	-			
	26-Sep to 5-Oct		60	234	1b	Spawning	-			
114	4-Sep	09:25	-	-	-	Application	-	River	Male	1.00
	6-Sep	06:55 - 19:02	58	234	Receiver	Holding/Migrating	429			
	7-Sep	00:25 - 22:11	58	231	Receiver	Holding/Migrating	275			
	7-Sep	11:25	60	86	17a	Holding/Migrating	-			
	8-Sep	08:40 - 19:53	72	217	Receiver	Holding/Migrating	39			
	9-Sep	03:20 - 03:24	75	203	Receiver	Holding/Migrating	7			
	9-Sep	10:35	110	144	3a	Holding/Migrating	-			
	12-Sep	14:55	61	67	3a	Holding/Migrating	-			
	20-Sep*	12:34	59	59	4	Spawning	-			
	25-Sep	14:01	60	230	4	Spawning	-			
	26-Sep**	14:05	129	129	4	Spawning	-			
	27-Sep to 5-Oct		68	236	6b	Holding	-			
115	6-Oct	16:20	-	-	7a	Recovery	-			
	4-Sep	09:25	-	-	-	Application	-	River	Female	-
	5-Sep	08:01 - 21:04	64	188	Receiver	Holding/Migrating	33			
	6-Sep	07:38 - 07:59	67	177	Receiver	Holding/Migrating	22			
	7-Sep	10:42	235	236	11d	Spawning	-			
	8-Sep	13:46 - 14:56	65	196	Receiver	Holding/Migrating	63			
	12-Sep	15:35	104	200	1b	Spawning	-			
116	20-Sep*	11:00	-	-	9b	Recovery	-			
	4-Sep	09:25	-	-	-	Application	-	River	Male	-
	6-Sep	14:35	94	158	1b	Spawning	-			
	7-Sep	07:59 - 23:59	66	230	Receiver	Holding/Migrating	317			
	7-Sep	10:33	80	231	11d	Spawning	-			
	8-Sep	00:00 - 03:56	70	150	Receiver	Holding/Migrating	243			
	12-Sep	16:06	52	52	1b	Spawning	-			
	13-Sep	12:22	52	157	1b	Spawning	-			
	14-Sep*	13:22	90	90	1e	Holding/Migrating	-			
	14-Sep	21:00 - 22:40	70	214	Receiver	Holding/Migrating	123			
	20-Sep	12:26	79	79	5	Spawning	-			
	25-Sep	14:06	7	176	4	Spawning	-			
	26-Sep	14:11	99	146	5	Spawning	-			
	27-Sep	13:10	112	176	5	Spawning	-			
	29-Sep**	13:42	7	144	4	Spawning	-			
	30-Sep to 5-Oct		200	230	6b	Holding	-			

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Appendix 4. Continued.

Transmitter No.	Tracking date ^a	Tracking time	Signal - strength		Area ^b	Action or area description ^c	No. records at upstream receiver	Final destination	Sex	Movement index ^d
			Min	Max						
117	5-Sep	09:20	-	-	-	Application	-	North Lake	Female ^f	1.91
	5-Sep	19:29 - 20:21	70	181	Receiver	Holding/Migrating	21			
	6-Sep	03:10 - 11:03	63	234	Receiver	Holding/Migrating	103			
	6-Sep	14:35	85	88	1b	Spawning	-			
	7-Sep	17:20	120	150	13b	Spawning	-			
	16-Sep*	10:00	-	-	13b	Recovery	-			
118	5-Sep	09:20	-	-	-	Application	-	River	Male	-
	9-Sep	10:43	173	236	2	Spawning	-			
	20-Sep*	12:26	98	236	5	Spawning	-			
	25-Sep**	14:10	69	154	5	Spawning	-			
	26-Sep to 5-Oct		61	200	6b	Holding	-			
119	5-Sep	09:20	-	-	-	Application	-	South Lake	Female	-
	6-Sep	07:44 - 16:04	68	208	Receiver	Holding/Migrating	18			
120	5-Sep	09:20	-	-	-	Application	-	River	Male	-
	9-Sep	06:33 - 08:13	71	214	Receiver	Holding/Migrating	19			
	14-Sep*	20:44	149	149	9a	Holding/Migrating	-			
	15-Sep	23:30	76	236	9a	Holding/Migrating	-			
	16-Sep	00:20	90	236	9a	Holding/Migrating	-			
	17-Sep	15:57	119	149	1b	Spawning	-			
	18-Sep	00:57 - 04:02	69	134	Receiver	Holding/Migrating	115			
121	6-Sep	09:10	-	-	-	Application	-	North Lake	Female ^f	-
	8-Sep	19:31 - 19:39	68	114	Receiver	Holding/Migrating	6			
	20-Sep*	14:30	-	-	13a	Recovery	-			
122	6-Sep	09:10	-	-	-	Application	-	River	Female	-
	9-Sep	18:04 - 18:11	65	141	Receiver	Holding/Migrating	7			
	10-Sep	01:54 - 20:25	64	210	Receiver	Holding/Migrating	135			
	11-Sep	03:00 - 15:21	61	154	Receiver	Holding/Migrating	122			
	12-Sep	14:55	60	124	3a	Holding/Migrating	-			
	13-Sep	12:10	56	124	1a	Spawning	-			
	14-Sep	00:03 - 10:29	68	213	Receiver	Holding/Migrating	153			
	14-Sep	13:22	149	163	1e	Holding/Migrating	-			
	15-Sep*	10:01 - 16:18	63	218	Receiver	Holding/Migrating	238			
	15-Sep	14:21	170	209	17a	Holding/Migrating	-			
123	6-Sep	12:45	-	-	-	Application	-	River	Male	0.17
	12-Sep	15:14	63	109	1a	Spawning	-			
	13-Sep	12:10	123	201	1a	Spawning	-			
	14-Sep	13:46	71	173	1a	Spawning	-			
	15-Sep*	15:48	51	190	1a	Spawning	-			
	17-Sep	16:02	126	158	1a	Spawning	-			
	18-Sep**	15:20	214	233	1a	Spawning	-			
	20-Sep to 5-Oct		157	197	3a	Holding	-			
124	6-Sep	12:45	-	-	-	Application	-	River	Male	0.57
	8-Sep	07:28 - 17:35	68	211	Receiver	Holding/Migrating	230			
	9-Sep	14:36 - 19:53	62	199	Receiver	Holding/Migrating	29			
	12-Sep	15:06	190	220	2	Spawning	-			
	13-Sep	11:45	63	198	2	Spawning	-			
	14-Sep	13:46	48	127	1a	Spawning	-			
	17-Sep*	16:09	228	234	2	Spawning	-			
	18-Sep	15:27	234	236	2	Spawning	-			
	20-Sep**	16:06	86	235	2	Spawning	-			
	25-Sep to 2-Oct		83	234	1c	Holding	-			
125	7-Sep	09:35	-	-	-	Application	-	River	Male	0.83
	9-Sep	11:14	235	236	1e	Holding/Migrating	-			

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Appendix 4. Continued.

Trans- mitter No.	Tracking date ^a	Tracking time	Signal - strength		Area ^b	Action or area description ^c	No. records at upstream receiver	Final destination	Sex	Move- ment index ^d
			Min	Max						
125	10-Sep	07:39 - 14:13	66	209	Receiver	Holding/Migrating	28			
	12-Sep	07:51 - 08:25	67	211	Receiver	Holding/Migrating	30			
	12-Sep	15:14	56	65	1a	Spawning	-			
	13-Sep	12:10	65	87	1a	Spawning	-			
	20-Sep*	12:34	81	211	4	Spawning	-			
	25-Sep	14:05	84	84	4	Spawning	-			
	26-Sep**	14:11	111	232	5	Spawning	-			
	27-Sep to 4-Oct		68	204	6b	Holding	-			
	4-Oct	14:15	-	-	6b	Recovery	-			
126	7-Sep	09:35	-	-	-	Application	-	North	Female	-
	10-Sep	08:23 - 21:41	59	221	Receiver	Holding/Migrating	254	Lake		
	11-Sep	14:27 - 14:53	66	135	Receiver	Holding/Migrating	22			
127	7-Sep	09:35	-	-	-	Application	-	River	Female	-
	9-Sep	08:16 - 19:47	69	214	Receiver	Holding/Migrating	23			
	9-Sep	11:37	80	130	1c	Holding/Migrating	-			
	10-Sep	00:53 - 23:20	65	180	Receiver	Holding/Migrating	53			
	17-Sep*	16:09	125	183	2	Spawning	-			
	18-Sep	15:27	99	146	2	Spawning	-			
	20-Sep**	16:06	58	218	2	Spawning	-			
	25-Sep to 6-Oct		85	231	6b	Holding	-			
128	7-Sep	09:35	-	-	-	Application	-	River	Male	-
	9-Sep	13:00	-	-	7a	Recovery	-			
129	8-Sep	09:19	-	-	-	Application	-	River	Female	1.00
	10-Sep	11:19 - 11:36	67	126	Receiver	Holding/Migrating	20			
	14-Sep	09:14 - 10:06	71	134	Receiver	Holding/Migrating	10			
	14-Sep	12:10	130	231	11d	Spawning	-			
	15-Sep	02:20 - 23:59	61	218	Receiver	Holding/Migrating	832			
	15-Sep	14:21	47	127	17a	Holding/Migrating	-			
	16-Sep	00:00 - 22:15	62	228	Receiver	Holding/Migrating	1,224			
	17-Sep*	03:53 - 20:09	64	193	Receiver	Holding/Migrating	418			
	17-Sep	14:52	71	102	17a	Holding/Migrating	-			
	18-Sep	03:25 - 14:29	66	200	Receiver	Holding/Migrating	367			
	18-Sep	14:11	80	80	11a	Spawning	-			
	20-Sep	15:37	69	147	1c	Holding/Migrating	-			
	22-Sep	21:13 - 22:07	74	137	Receiver	Holding/Migrating	29			
	23-Sep	06:47 - 19:58	66	214	Receiver	Holding/Migrating	66			
	25-Sep	12:56	71	201	1b	Spawning	-			
	26-Sep	12:18	162	222	1b	Spawning	-			
	27-Sep	12:28	63	160	1b	Spawning	-			
	28-Sep**	16:04	72	200	1b	Spawning	-			
	29-Sep to 5-Oct		79	200	6b	Holding	-			
130	8-Sep	09:19	-	-	-	Application	-	River	Female	-
	9-Sep	03:45 - 23:48	59	199	Receiver	Holding/Migrating	394			
	10-Sep	00:37 - 23:53	55	156	Receiver	Holding/Migrating	1,094			
	11-Sep	00:03 - 21:15	58	213	Receiver	Holding/Migrating	523			
	12-Sep	04:34 - 07:24	70	190	Receiver	Holding/Migrating	76			
	12-Sep	15:55	108	111	1d	Holding/Migrating	-			
	13-Sep	12:51	121	184	1c	Holding/Migrating	-			
	13-Sep	20:18 - 23:59	71	198	Receiver	Holding/Migrating	56			
	14-Sep	00:00 - 07:31	77	201	Receiver	Holding/Migrating	63			
	15-Sep	15:10	61	119	1c	Holding/Migrating	-			
	15-Sep	18:56	145	170	2	Spawning	-			
	15-Sep	06:06 - 09:15	69	152	Receiver	Holding/Migrating	94			
	16-Sep	02:54 - 07:26	78	145	Receiver	Holding/Migrating	32			

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Appendix 4. Continued.

Transmitter No.	Tracking date ^a	Tracking time	Signal - strength		Area ^b	Action or area description ^c	No. records at upstream receiver	Final destination	Sex	Movement index ^d
			Min	Max						
131	8-Sep	09:19	-	-	-	Application	-	North Lake	Female	-
	10-Sep	15:47 - 15:59	71	164	Receiver	Holding/Migrating	8			
	11-Sep	13:04	80	140	13a	Spawning	-			
132	8-Sep	09:50	-	-	-	Application	-	River	Female ^f	-
	11-Sep	11:24 - 12:07	84	172	Receiver	Holding/Migrating	6			
	14-Sep	07:18 - 18:29	62	204	Receiver	Holding/Migrating	41			
	14-Sep	12:50	69	69	17a	Holding/Migrating	-			
	14-Sep	13:22	184	236	1e	Holding/Migrating	-			
	15-Sep	00:30 - 19:54	69	232	Receiver	Holding/Migrating	59			
	15-Sep	15:27	64	130	1b	Spawning	-			
	20-Sep*	15:56	76	150	1b	Spawning	-			
	21-Sep	11:30 - 21:32	67	216	Receiver	Holding/Migrating	35			
	22-Sep	07:41 - 13:44	66	152	Receiver	Holding/Migrating	54			
	25-Sep	12:15	-	-	17d	Recovery	-			
133	9-Sep	09:23	-	-	-	Application	-	River	Female	-
	12-Sep	16:06	53	81	1b	Spawning	-			
	20-Sep*	20:24 - 20:47	76	166	Receiver	Holding/Migrating	16			
134	9-Sep	09:23	-	-	-	Application	-	River	Female	-
	10-Sep	19:32 - 19:47	72	152	Receiver	Holding/Migrating	11			
	13-Sep	17:17 - 17:17	73	73	Receiver	Holding/Migrating	1			
	14-Sep	12:38	68	132	11a	Spawning	-			
	14-Sep	16:14 - 19:40	62	167	Receiver	Holding/Migrating	25			
	15-Sep	04:10 - 09:26	67	191	Receiver	Holding/Migrating	38			
	15-Sep	15:10	124	165	1c	Holding/Migrating	-			
	16-Sep	07:23 - 10:52	68	142	Receiver	Holding/Migrating	95			
	17-Sep*	15:31	71	113	1c	Holding/Migrating	-			
	18-Sep	07:39 - 14:19	73	208	Receiver	Holding/Migrating	30			
	18-Sep	14:49	168	234	1e	Holding/Migrating	-			
	20-Sep	15:56	61	155	1b	Spawning	-			
	20-Sep	20:44 - 20:55	70	119	Receiver	Holding/Migrating	3			
	21-Sep	12:32 - 14:19	67	146	Receiver	Holding/Migrating	63			
	22-Sep	20:58 - 23:55	75	104	Receiver	Holding/Migrating	13			
	23-Sep	00:03 - 18:06	68	140	Receiver	Holding/Migrating	45			
135	9-Sep	09:23	-	-	-	Application	-	River	Male	0.44
	11-Sep	12:15	90	150	1e	Holding/Migrating	-			
	11-Sep	19:09 - 19:15	83	137	Receiver	Holding/Migrating	6			
	12-Sep	09:43 - 09:47	79	200	Receiver	Holding/Migrating	6			
	12-Sep	16:06	110	185	1b	Spawning	-			
	13-Sep	21:12 - 23:00	70	224	Receiver	Holding/Migrating	50			
	15-Sep	15:27	102	153	1b	Spawning	-			
	17-Sep*	15:46	62	236	1b	Spawning	-			
	18-Sep	15:15	97	97	1b	Spawning	-			
	20-Sep	06:44 - 06:49	112	158	Receiver	Holding/Migrating	2			
	20-Sep	15:56	168	177	1b	Spawning	-			
	25-Sep	13:19	78	167	2	Spawning	-			
	26-Sep**	12:29	76	131	1a	Spawning	-			
	27-Sep	01:14 - 03:37	81	197	Receiver	Holding/Migrating	10			
	27-Sep to 5-Oct		97	223	1b	Spawning	-			
	6-Oct	14:00	-	-	6a	Recovery	-			
136	9-Sep	09:23	-	-	-	Application	-	River	Male	-
	10-Sep	20:20 - 20:20	86	86	Receiver	Holding/Migrating	1			
	12-Sep	16:00	121	229	1c	Holding/Migrating	-			
	13-Sep	12:58	59	149	1b	Spawning	-			
	14-Sep	09:21 - 23:13	64	187	Receiver	Holding/Migrating	30			
	14-Sep	12:50	84	144	17a	Holding/Migrating	-			

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Appendix 4. Continued.

Trans-mitter No.	Tracking date ^a	Tracking time	Signal - strength		Area ^b	Action or area description ^c	No. records at upstream receiver	Final destination	Sex	Move-ment index ^d
			Min	Max						
136	15-Sep	15:10	120	232	1e	Holding/Migrating	-			
	15-Sep	15:32 - 15:55	67	184	Receiver	Holding/Migrating	9			
137	10-Sep	08:45	-	-	-	Application	-	River	Male	1.86
	12-Sep	14:55	236	236	3a	Holding/Migrating	-			
	13-Sep	11:57 - 12:11	67	159	Receiver	Holding/Migrating	19			
	13-Sep	13:50	58	106	17b	Holding/Migrating	-			
	17-Sep	05:47 - 18:31	72	169	Receiver	Holding/Migrating	16			
	18-Sep*	15:15	162	233	1b	Spawning	-			
	19-Sep	17:39 - 18:16	73	158	Receiver	Holding/Migrating	12			
	20-Sep	06:40 - 21:01	73	193	Receiver	Holding/Migrating	41			
	20-Sep**	15:44	64	140	1e	Holding/Migrating	-			
	21-Sep	00:08 - 12:47	71	234	Receiver	Holding/Migrating	233			
	25-Sep to 6-Oct		85	211	6b	Holding	-			
138	10-Sep	08:45	-	-	-	Application	-	River	Male ^f	-
	11-Sep	19:51 - 20:06	70	175	Receiver	Holding/Migrating	14			
	13-Sep	12:58	71	218	1b	Spawning	-			
	14-Sep	10:13 - 13:19	69	199	Receiver	Holding/Migrating	16			
	14-Sep	12:50	72	146	17a	Holding/Migrating	-			
	16-Sep	18:08 - 18:37	69	126	Receiver	Holding/Migrating	15			
	17-Sep	02:15 - 02:22	80	179	Receiver	Holding/Migrating	9			
	17-Sep	15:31	69	82	1c	Holding/Migrating	-			
	20-Sep*	15:48	53	81	1b	Spawning	-			
	25-Sep**	14:03	7	232	4	Spawning	-			
	26-Sep to 2-Oct		80	230	4	Spawning	-			
139	4-Oct	14:00	-	-	6b	Recovery	-			
	10-Sep	08:45	-	-	-	Application	-	River	Female ^f	-
	13-Sep	12:37	75	226	1e	Holding/Migrating	-			
	13-Sep	13:47 - 13:50	88	111	Receiver	Holding/Migrating	4			
	15-Sep	22:02 - 22:48	71	200	Receiver	Holding/Migrating	19			
	17-Sep	15:46	91	236	1b	Spawning	-			
	*18-Sep**	15:20	82	82	1a	Spawning	-			
	20-Sep	15:48	82	233	1b	Spawning	-			
	25-Sep to 27-Sep		66	196	6b	Holding	-			
	27-Sep	14:44	-	-	6b	Recovery	-			
140	10-Sep	08:45	-	-	-	Application	-	South Lake	Female	-
	10-Sep	18:54 - 18:56	80	124	Receiver	Holding/Migrating	4			
141	11-Sep	09:20	-	-	-	Application	-	South Lake	Female	-
	12-Sep	05:51 - 06:06	71	216	Receiver	Holding/Migrating	16			
142	11-Sep	09:20	-	-	-	Application	-	Unknown	Female	-
143	11-Sep	10:00	-	-	-	Application	-	River	Male	1.71
	12-Sep	15:44	89	119	1e	Holding/Migrating	-			
	13-Sep	13:09 - 13:51	68	193	Receiver	Holding/Migrating	32			
	13-Sep	13:50	76	80	17b	Holding/Migrating	-			
	14-Sep	11:40	31	93	17c	Holding/Migrating	-			
	14-Sep	21:10 - 21:35	71	233	Receiver	Holding/Migrating	28			
	15-Sep	00:06 - 20:39	72	226	Receiver	Holding/Migrating	63			
	15-Sep	15:48	51	51	1a	Spawning	-			
	16-Sep	06:33 - 11:09	63	224	Receiver	Holding/Migrating	89			
	18-Sep*	11:57 - 12:04	76	155	Receiver	Holding/Migrating	8			
	18-Sep	14:44	60	60	1c	Holding	-			
	20-Sep	15:56	60	173	1b	Spawning	-			
	25-Sep**	13:14	86	158	1a	Spawning	-			
	27-Sep to 5-Oct		68	198	1a	Spawning	-			
	5-Oct	14:00	-	-	2	Recovery	-			

Continued

Appendix 4. Continued.

Transmitter No.	Tracking date ^a	Tracking time	Signal - strength		Area ^b	Action or area description ^c	No. records at upstream receiver	Final destination	Sex	Movement index ^d
			Min	Max						
144	11-Sep	10:00	-	-	-	Application	-	River	Male	1.78
	13-Sep	12:01	51	143	3a	Holding/Migrating	-			
	14-Sep	07:19 - 07:28	80	150	Receiver	Holding/Migrating	8			
	16-Sep	06:43 - 22:47	74	189	Receiver	Holding/Migrating	26			
	17-Sep	01:13 - 05:51	80	85	Receiver	Holding/Migrating	6			
	17-Sep	15:57	89	157	1b	Spawning	-			
	18-Sep*	15:15	153	214	1b	Spawning	-			
	20-Sep	15:56	151	233	1b	Spawning	-			
	25-Sep	13:17	123	176	2	Spawning	-			
	26-Sep	12:30	199	199	1a	Spawning	-			
	27-Sep**	12:33	69	163	1b	Spawning	-			
	28-Sep to 5-Oct		171	211	3a	Holding	-			
145	12-Sep	10:30	-	-	-	Application	-	River	Female	-
	14-Sep	13:57	119	130	2	Spawning	-			
	15-Sep	15:27	55	151	1b	Spawning	-			
	15-Sep	18:37 - 18:45	64	110	Receiver	Holding/Migrating	10			
	20-Sep*	13:44 - 17:25	71	189	Receiver	Holding/Migrating	61			
	20-Sep	15:48	133	196	1b	Spawning	-			
	24-Sep	00:44	153	224	9a	Migrating	-			
146	12-Sep	10:30	-	-	-	Application	-	River	Male	0.92
	13-Sep	12:01	66	66	3a	Holding/Migrating	-			
	14-Sep	13:57	165	226	2	Spawning	-			
	15-Sep	07:35 - 18:40	63	171	Receiver	Holding/Migrating	296			
	15-Sep	14:21	81	124	17a	Holding/Migrating	-			
	16-Sep	05:04 - 05:06	90	163	Receiver	Holding/Migrating	4			
	17-Sep	15:31	122	161	1c	Holding/Migrating	-			
	18-Sep*	07:15 - 14:28	68	146	Receiver	Holding/Migrating	165			
	20-Sep	15:56	104	145	1b	Spawning	-			
	25-Sep	13:37	70	138	4	Spawning	-			
	26-Sep	14:05	103	103	4	Spawning	-			
	27-Sep	13:03	85	99	4	Spawning	-			
	28-Sep	16:29	124	124	4	Spawning	-			
	29-Sep	13:41	78	155	4	Spawning	-			
	2-Oct**	12:33	43	102	4	Spawning	-			
	8-Oct	14:10	-	-	6a	Recovery	-			
147	12-Sep	10:30	-	-	-	Application	-	River	Male	-
	20-Sep*	06:27 - 06:34	101	136	Receiver	Holding/Migrating	2			
148	12-Sep	10:45	-	-	-	Application	-	North Lake	Female	-
	13-Sep	12:22	47	196	1b	Spawning	-			
	13-Sep	14:48 - 14:52	66	167	Receiver	Holding/Migrating	6			
149	14-Sep	08:40	-	-	-	Application	-	River	Female	-
	15-Sep	15:10	43	43	1e	Holding/Migrating	-			
	16-Sep	10:14 - 21:01	71	189	Receiver	Holding/Migrating	26			
	17-Sep	17:56 - 18:02	75	169	Receiver	Holding/Migrating	10			
	20-Sep*	12:34	99	175	4	Spawning	-			
	23-Sep	04:47 - 04:58	93	172	Receiver	Holding/Migrating	10			
150	14-Sep	08:40	-	-	-	Application	-	River	Female	-
	16-Sep	18:56 - 19:19	68	163	Receiver	Holding/Migrating	21			
	18-Sep	13:08 - 13:14	82	170	Receiver	Holding/Migrating	7			
	18-Sep	15:20	58	147	1a	Spawning	-			
	20-Sep*	07:08 - 09:15	86	136	Receiver	Holding/Migrating	22			
	20-Sep	15:44	127	195	1e	Holding	-			
	25-Sep**	14:12	118	158	5	Spawning	-			
	26-Sep to 6-Oct		70	205	6b	Holding	-			

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Appendix 4. Continued.

Transmitter No.	Tracking date ^a	Tracking time	Signal - strength		Area ^b	Action or area description ^c	No. records at upstream receiver	Final destination	Sex	Movement index ^d
			Min	Max						
150	12-Oct	12:00	-	-	6a	Recovery	-			
151	14-Sep	09:25	-	-	-	Application	-	North Lake	Male	-
	15-Sep	09:08 - 17:25	69	195	Receiver	Holding/Migrating	31			
	15-Sep	15:27	133	176	1b	Spawning	-			
152	14-Sep	09:25	-	-	-	Application	-	River	Female	-
	15-Sep	15:27	77	147	1b	Spawning	-			
	16-Sep	03:00 - 23:58	69	164	Receiver	Holding/Migrating	180			
	17-Sep	00:00 - 22:21	75	218	Receiver	Holding/Migrating	124			
	18-Sep	15:05	112	135	1b	Spawning	-			
	20-Sep*	15:48	46	203	1b	Spawning	-			
	21-Sep	08:47 - 12:46	74	180	Receiver	Holding/Migrating	42			
	25-Sep**	13:19	116	211	2	Spawning	-			
	27-Sep to 2-Oct		75	211	7a	Holding	-			
153	16-Sep	10:20	-	-	-	Application	-	River	Female	-
	17-Sep	08:39 - 18:28	74	213	Receiver	Holding/Migrating	56			
	17-Sep	15:38	75	122	1e	Holding/Migrating	-			
	18-Sep	13:41 - 13:44	70	107	Receiver	Holding/Migrating	3			
	18-Sep	14:11	80	236	11a	Spawning	-			
	20-Sep*	06:21 - 06:45	99	165	Receiver	Holding/Migrating	5			
	21-Sep	15:03 - 15:31	79	141	Receiver	Holding/Migrating	11			
	22-Sep	13:32	124	215	9a	Migrating	-			
154	16-Sep	10:20	-	-	-	Application	-	River	Female	-
	17-Sep	16:02	79	201	1a	Spawning	-			
	17-Sep	18:05 - 18:15	76	175	Receiver	Holding/Migrating	9			
	20-Sep*	13:28	89	210	9a	Migrating	-			
155	16-Sep	11:20	-	-	-	Application	-	River	Male	0.83
	17-Sep	07:27 - 07:35	88	166	Receiver	Holding/Migrating	9			
	18-Sep	11:49 - 11:52	90	144	Receiver	Holding/Migrating	5			
	18-Sep	15:15	185	185	1b	Spawning	-			
	19-Sep*	15:30	93	142	1d	Holding/Migrating	-			
	19-Sep	15:36 - 23:58	77	203	Receiver	Holding/Migrating	356			
	20-Sep	00:09 - 06:14	84	187	Receiver	Holding/Migrating	320			
	22-Sep	19:39 - 20:25	75	179	Receiver	Holding/Migrating	23			
	25-Sep	13:12	99	229	1a	Spawning	-			
	27-Sep	12:49	86	187	1a	Spawning	-			
	28-Sep	16:21	63	173	1a	Spawning	-			
	29-Sep	12:26	64	192	1a	Spawning	-			
	30-Sep	03:29 - 04:15	77	195	Receiver	Holding/Migrating	9			
	6-Oct	13:44	121	179	6b	Holding/Migrating	-			
156	16-Sep	11:20	-	-	-	Application	-	River	Male	-
	17-Sep	15:46	69	165	1b	Spawning	-			
	17-Sep	17:07 - 17:13	80	136	Receiver	Holding/Migrating	7			
	18-Sep	03:21 - 04:10	84	211	Receiver	Holding/Migrating	8			
	20-Sep*	15:56	121	216	1b	Spawning	-			
	27-Sep	12:45	84	111	2	Spawning	-			
	28-Sep	16:29	101	101	3a	Holding/Migrating	-			
	1-Oct	18:22 - 18:51	86	187	Receiver	Holding/Migrating	12			
157	17-Sep	09:37	-	-	-	Application	-	River	Female	-
	17-Sep	18:56 - 19:10	66	171	Receiver	Holding/Migrating	14			
	18-Sep	05:42 - 06:54	80	155	Receiver	Holding/Migrating	42			
	18-Sep	14:44	93	104	1c	Holding/Migrating	-			
	19-Sep	15:21	47	47	17a	Holding/Migrating	-			
	19-Sep	20:07 - 20:33	77	218	Receiver	Holding/Migrating	21			
	25-Sep to 5-Oct		63	213	6b	Holding	-			

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Appendix 4. Continued.

Transmitter No.	Tracking date ^a	Tracking time	Signal - strength		Area ^b	Action or area description ^c	No. records at upstream receiver	Final destination	Sex	Movement index ^d
			Min	Max						
158	17-Sep	09:37	-	-	-	Application	-	Spawning Channel	Male ^f	-
	18-Sep	15:27	70	172	2	Spawning	-			
	19-Sep*	13:02	141	158	17d	Spawning	-			
	20-Sep	08:35 - 09:49	92	159	Receiver	Holding/Migrating	15			
	25-Sep	13:41	65	217	3b	Spawning	-			
	26-Sep	19:45	-	-	3b	Recovery	-			
159	17-Sep	09:37	-	-	-	Application	-	River	Female	-
	18-Sep	15:05	104	233	1b	Spawning	-			
	19-Sep*	20:04 - 20:30	90	213	Receiver	Holding/Migrating	13			
	20-Sep	04:28 - 23:25	75	235	Receiver	Holding/Migrating	253			
	20-Sep	15:37	78	148	1c	Holding/Migrating	-			
	22-Sep	04:49 - 04:49	133	133	Receiver	Holding/Migrating	1			
	25-Sep**	04:20 - 06:28	95	179	Receiver	Holding/Migrating	12			
	26-Sep to 2-Oct		185	234	7a	Holding	-			
	26-Sep to 2-Oct									
160	17-Sep	10:40	-	-	-	Application	-	River	Male	0.57
	20-Sep*	16:02	42	132	1a	Spawning	-			
	25-Sep	14:02	61	229	4	Spawning	-			
	26-Sep	14:06	179	199	4	Spawning	-			
	27-Sep	12:42	100	180	2	Spawning	-			
	27-Sep	19:40 - 20:54	82	233	Receiver	Holding/Migrating	12			
	28-Sep	16:20	136	199	1a	Spawning	-			
	29-Sep	12:26	82	233	1a	Spawning	-			
	2-Oct	12:30	56	215	1a	Spawning	-			
161	19-Sep	09:12	-	-	-	Application	-	River	Male	-
	25-Sep*	13:19	68	232	2	Spawning	-			
	27-Sep	12:42	94	160	2	Spawning	-			
	27-Sep	17:28 - 20:36	80	143	Receiver	Holding/Migrating	4			
	29-Sep	14:27	101	161	6a	Holding/Migrating	-			
162	19-Sep	09:12	-	-	-	Application	-	River	Male	-
	*25-Sep**	13:23	116	166	3a	Holding/Migrating	-			
	27-Sep to 7-Oct		69	230	4	Spawning	-			
	9-Oct	15:49	-	-	4	Recovery	-			
163	19-Sep	09:12	-	-	-	Application	-	Lake	Female	-
	23-Sep*	21:59 - 23:31	92	196	Receiver	Holding/Migrating	10			
	24-Sep	00:13 - 00:24	78	153	Receiver	Holding/Migrating	10			
164	19-Sep	10:33	-	-	-	Application	-	North Lake	Female	-
	22-Sep*	14:43	76	182	13a	Spawning	-			
165	21-Sep	09:10	-	-	-	Application	-	River	Male	-
	25-Sep* to 5-Oct**		101	233	6b	Holding	-			
	6-Oct	15:47	-	-	7a	Recovery	-			
166	21-Sep	09:10	-	-	-	Application	-	River	Female	3.00
	22-Sep*	16:17 - 20:39	69	234	Receiver	Holding/Migrating	67			
	23-Sep	00:49 - 01:21	95	230	Receiver	Holding/Migrating	40			
	25-Sep	08:04 - 11:48	69	223	Receiver	Holding/Migrating	41			
	25-Sep	12:48	56	125	1c	Holding/Migrating	-			
	26-Sep	14:06	88	104	4	Spawning	-			
	27-Sep	15:05	103	225	7b	Holding/Migrating	-			
	28-Sep	16:06	91	212	1b	Spawning	-			
	28-Sep	18:16 - 18:21	69	152	Receiver	Holding/Migrating	6			
	29-Sep	11:26 - 11:31	80	191	Receiver	Holding/Migrating	6			
	29-Sep	12:22	68	172	1b	Spawning	-			
	2-Oct	13:49	53	132	5	Spawning	-			
	5-Oct	14:44	235	235	2	Spawning	-			

Continued

Appendix 4. Continued.

Trans- mitter No.	Tracking date ^a	Tracking time	Signal - strength		Area ^b	Action or area description ^c	No. records at upstream receiver	Final destination	Sex	Move- ment index ^d
			Min	Max						
167	21-Sep	11:43	-	-	-	Application	-	River	Female	-
	23-Sep*	07:11 - 09:43	96	198	Receiver	Holding/Migrating	14			
	25-Sep	07:19 - 11:52	68	182	Receiver	Holding/Migrating	39			
	25-Sep	12:14	82	82	11a	Spawning	-			
	26-Sep	12:23	68	141	1b	Spawning	-			
	27-Sep**	12:33	81	142	1b	Spawning	-			
	27-Sep	16:26 - 22:04	67	136	Receiver	Holding/Migrating	90			
	28-Sep to 5-Oct		77	223	1b	Spawning	-			
168	21-Sep	11:43	-	-	-	Application	-	Unknown	Male	-

^a Estimated date of death and start of spawning are designated as follows:

** - Estimated date of death (see Methods for derivation);

* - Start of spawning estimated from the date of death regression for a fish released on that date. We assumed an average time between spawning and death of six days for fish released from 10-Aug to 6-Sep and four days for fish released after 6-Sep. This symbol designates (on average) the earliest date on which a fish was detected that it was likely to have been spawning. It is provided as a general guide to help the reader to interpret fish movement patterns rather than a rigorous estimate of the true start of spawning for an individual fish.

^b See Figs. 2-3 for area locations; receiver indicates that transmitter was recorded at upstream receiver.

^c Definitions: Application - transmitter was applied on that date;
Recovery - transmitter was recovered on that date;
Spawning - river or lake areas known to have spawning gravel and support sockeye spawning. This designation does not presume that a given fish actually spawned in that area on the date of the observation.
Holding/Migrating - river or lake areas which have little or no spawning gravel and are not known to support sockeye spawning.

^d Only for river fish tracked six or more times before estimated date of death. See Methods for estimation procedures.

^e Corrected sex; sex was recorded incorrectly at release.

^f The recovered fish had a ruptured stomach.

Appendix 5. Recovered radio transmitters, by transmitter number, date and location of recovery, sex, spawning success, carcass and stomach condition. See figures 2-3 for recovery area locations.

Tag No.	Application date	Recovery date	Days out to recovery	Recovery area	Sex ^a	Spawning success	Carcass condition ^b	Internal examination
1	10-Aug	20-Sep	41	8a	Male	-	-	-
8	15-Aug	14-Sep	30	13a	Female	-	Fresh, predator kill	-
16	17-Aug	27-Sep	41	5	Male	-	-	-
20	18-Aug	29-Sep	42	2	Male	-	-	-
28	19-Aug	24-Sep	36	22c	Female ^c	-	Rotten, predator kill	-
33	20-Aug	18-Sep	29	3a	Male	-	Fresh	Intact stomach
35	20-Aug	24-Sep	35	13a	Female	100%	Tainted	Ruptured stomach
39	21-Aug	18-Sep	28	22b	Female	100%	Rotten	Intact stomach
42	21-Aug	29-Sep	39	1a	Female	100%	Rotten	Intact stomach
45	22-Aug	21-Sep	30	9b	Female	-	-	-
51	23-Aug	27-Sep	35	5	Male	-	-	-
58	24-Aug	12-Sep	19	3b	Female	0%	Fresh	Intact stomach
59	24-Aug	23-Sep	30	7a	Male	-	Tainted	Ruptured stomach
62	25-Aug	8-Oct	44	4	Female	-	-	-
66	25-Aug	19-Sep	25	3b	Female	50%	Fresh	Intact stomach
67	25-Aug	15-Sep	21	6a	Male	-	Rotten, predator kill	-
70	26-Aug	27-Sep	32	3b	Female	100%	Fresh	Intact stomach
86	29-Aug	20-Sep	22	6a	Male	-	Rotten	Intact stomach
87	29-Aug	5-Oct	37	6b	Male	-	Rotten	Intact stomach
89	29-Aug	15-Sep	17	3b	Female	0%	Fresh	Ruptured stomach
90	29-Aug	19-Sep	21	3b	Female	50%	Fresh	Ruptured stomach
92	30-Aug	27-Sep	28	1a	Female	100%	Fresh	Intact stomach
97	31-Aug	8-Sep	8	3b	Female	100%	Fresh	Intact stomach
98	31-Aug	10-Oct	40	6a	Male	-	-	-
104	1-Sep	8-Oct	37	5	Male	-	Tainted	Intact stomach
106	2-Sep	21-Sep	19	9a	Female	-	-	-
108	2-Sep	21-Sep	19	9b	Female	-	-	-
110	3-Sep	25-Sep	22	6a	Male	-	Fresh	Intact stomach
114	4-Sep	6-Oct	32	7a	Male	-	Tainted	Intact stomach
115	4-Sep	20-Sep	16	9b	Female	-	-	-
117	5-Sep	16-Sep	11	13b	Female	0%	Fresh	Ruptured stomach
121	6-Sep	20-Sep	14	13a	Female	100%	Fresh	Ruptured stomach
125	7-Sep	4-Oct	27	6b	Male	-	Rotten	Intact stomach
128	7-Sep	9-Sep	2	7a	Male	-	Fresh, predator kill	Intact stomach
132	8-Sep	25-Sep	17	17d	Female	0%	Fresh	Ruptured stomach
135	9-Sep	6-Oct	27	6a	Male	-	Rotten	Intact stomach
138	10-Sep	4-Oct	24	6b	Male	-	Rotten	Ruptured stomach
139	10-Sep	27-Sep	17	6b	Female	0%	Tainted	Ruptured stomach
143	11-Sep	5-Oct	24	2	Male	-	Rotten	Intact stomach
146	12-Sep	8-Oct	26	6a	Male	-	Tainted	Intact stomach
150	14-Sep	12-Oct	28	6a	Female	100%	Rotten	Intact stomach
158	17-Sep	26-Sep	9	3b	Male	-	Fresh	Ruptured stomach
162	19-Sep	9-Oct	20	4	Male	-	-	-
165	21-Sep	6-Oct	15	7a	Male	-	-	-

^a Sex at recovery except, when transmitter was recovered without a carcass, sex at application.

^b The symbol "-" indicates that the transmitter was recovered without a carcass.

^c Could not determine sex at recovery.