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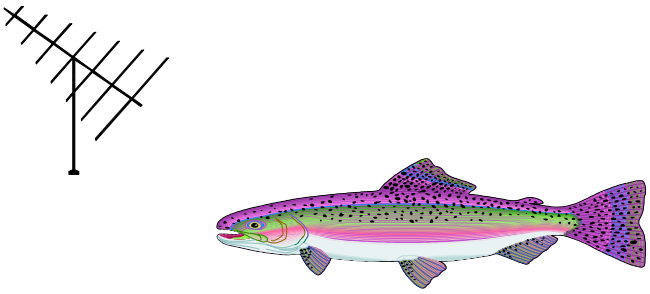
RUN TIMING, MIGRATION, DISTRIBUTION, SPAWNING LOCATIONS, SURVIVAL-TO-SPAWNING, AND SURVIVAL-TO-KELT OF ANGLER-CAUGHT WILD AND HATCHERY ADULT STEELHEAD IN THE VEDDER/CHILLIWACK RIVER, BC

BY

TROY C. NELSON[1]
MARVIN L. ROSENAU[2]
JIM RISSLING[1]
CEJ MUSSELL[1]
AND
PETER A. CAVERHILL[3]

FOR

MINISTRY OF WATER, LAND AND AIR PROTECTION
LOWER MAINLAND REGION
FISH, WILDLIFE AND HABITAT PROTECTION
FISHERIES SECTION
10470 152ND STREET
SURREY, BC V3R 0Y3



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1 LGL Limited environmental research associates, 9768 Second Street, Sidney, BC V8L 3Y8
2 Visiting Scientist, UBC Fisheries Center, 2259 Lower Mall, UBC, Vancouver, BC V6T 1ZY
3 Ministry of Water, Land and Air Protection, Lower Mainland Region (retired)

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EXECUTIVE SUMMARY

This report presents the results of a two-year biotelemetry study designed to collect reliable information regarding the in-river temporal and spatial distribution of wild and hatchery adult steelhead related to migration and spawning activities in the Vedder/Chilliwack River, British Columbia. The study was also designed to provide estimates of mortality rates following release from conventional angling methods, plus estimates of survival-to-spawning and survival-to-kelt for these same fish. Additionally, estimates of (minimum) recapture rates were determined through the establishment of an angler reporting process that included tag returns and a dedicated telephone line (phone-in reporting). The study was conducted in the winter and spring of both 1999 and 2000, and thus monitored two separate year-runs of returning adult steelhead.

Advanced radio telemetry techniques were used as the primary method of data collection. Radio tags were applied (esophageal implants) to steelhead, mostly in the lower section of the river, in line with a pre-determined schedule that specified run timing group (by month), origin (hatchery or wild), and sex (male or female). Steelhead were determined to be of hatchery origin if the adipose fin was missing (all steelhead smolts released from Chilliwack River Hatchery are marked with an adipose clip). All radio-tagged steelhead monitored in this study were captured by angling using conventional angling gear and common methods/baits utilized in the recreational fishery on the system.

For analysis purposes, the Vedder/Chilliwack River watershed was divided into 13 "zones" over the 61 km of its mainstem length, from the exit confluence at the Fraser River upstream to the outlet of Chilliwack Lake. Four fixed-station telemetry receivers were established at strategic locations on the mainstem of the river. The station furthest down the system was established near the confluence of the Vedder/Chilliwack River and the Fraser River to determine if and when tagged steelhead left the system. The telemetry station furthest up the system was established at the outlet of Chilliwack Lake (the upper end of the system), with two additional telemetry stations established at strategic mid-river areas (one of these near the entrance to the Chilliwack River Hatchery). All radio-tagged steelhead were released upstream of the lowest telemetry station. Telemetry data (fish passage) were downloaded from the fixed stations on a weekly basis. Extensive mobile tracking (by vehicle, foot, helicopter, and raft) was conducted to document fish (tag) presence in areas between fixed stations.

All release and detection data, and reported or observed recapture data, were summarized on an individual (per fish) basis to produce a complete timeline of spatial and temporal information for each radio-tagged steelhead. These data were then analyzed to identify among-group averages and extreme ranges of observed/interpreted behaviors for specified groups of steelhead (these groups being hatchery or wild, male or female, and run timing/tag application month) in order to make comparisons which were part of the stated objectives of the project.

In winter/spring of 1999, a total of 72 steelhead (31 hatchery and 41 wild) were radio tagged and released from January through May. The following year, a total of 154 steelhead (70 hatchery and 84 wild) were radio tagged and released from December 1999 through April 2000. The total sample size of radio-tagged steelhead for both years was 226 (101 hatchery, 125 wild). Minimum (reported) recapture rates were high (up to 55.7% for hatchery and 45.0% for wild steelhead).

In-river locations (to the "zone" level) of holding (pre-spawning staging) and spawning were determined (observed or interpreted) for a high percentage of radio-tagged steelhead in both years. Comparisons of holding and spawning locations were made for both hatchery and wild fish and for run-timing (month of river entry/tagging) groups. Results indicate spatial overlap of both holding and spawning locations for all groups. However, whereas wild fish were observed to hold and spawn throughout the watershed, there was a tendency for hatchery-origin fish to hold and spawn in more downstream zones than wild fish, and closer to the hatchery facility at Slesse Creek.

The timing of spawning events for all groups was also determined. The estimated timing of peak spawning activity of hatchery and wild steelhead overlapped in both 1999 and 2000. In both years, spawning activities for both hatchery and wild steelhead commenced in early to mid-March, peaked during the second and third week in May, and were completed the third week in June.

Survival rates of radio-tagged steelhead at release, to spawning locations and to kelt, were determined for groups for each study year. All radio-tagged steelhead survived the initial capture and tagging events in both years and were released alive and in excellent condition. Due to this high survivability at release, this report uses "survival to spawning" as a measure of post-release survival. There were no confirmed post-release mortalities that could be positively linked to the capture and sampling/tagging events, but a small number of tags (one in 1999 and three in 2000) were determined not to have reached spawning locations (percentage of possible post-release mortality was 1.1%). It is possible that these four tags were not associated with a mortality (resulting from the capture and tagging event); there were confirmed instances during the study where tags were removed by anglers following a recapture event and the tags discarded into the river.

Survival-to-kelt (a live, post-spawning exit from the Vedder River) rates were determined for radio-tagged hatchery and wild steelhead, by sex and tagging month, for both 1999 and 2000. In 1999, a total of 60 radio-tagged spawners (23 hatchery and 37 wild) could be evaluated; 45 (75.0%) survived to kelt. In 2000, a total of 109 radio-tagged spawners (38 hatchery and 71 wild) could be evaluated; 87 (77.1%) survived to kelt. For both years, males had a lower survival-to-kelt rate (63.8%) than females (82.0%). Hatchery and wild fish had similar survival-to-kelt rates between years (average 76.3%).

Because the goals and objectives of the study were not achievable unless reliable information was obtained, emphases were placed on intelligent study design, thorough application of methods, meticulous data collections, data security, and objective analyses. To these ends, applications of quality control and quality assurance during the project were both rigorous and consistent. In summary, thoughtful and thorough technical and data collection procedures, applied by highly competent and dedicated project staff, allowed for one of the first-ever in-river behavioral comparisons of wild and hatchery-origin steelhead from the same stock using biotelemetry techniques.

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INTRODUCTION

Fisheries Management staff require reliable information regarding the run timing, migration, spawning locations, and survival of adult steelhead, *Oncorhynchus mykiss*, in the Vedder/Chilliwack River. Comparative information, as it pertains to wild and hatchery steelhead, is of primary interest and importance. In order to document the similarities and differences in behavior and distribution between returning wild and hatchery steelhead during the same year, a study that incorporates the latest in biotelemetry technology was proposed by fisheries managers of the Ministry of Environment, Lands and Parks, Lower Mainland Region, for implementation in the winter-spring of 1999 and 2000.

Scope and Objectives

The objectives of the 1999-2000 project were to radio tag and track adult steelhead in the Vedder/Chilliwack River from January to June (1999) and December to June (2000). The subsequent movements of these radio-tagged steelhead were monitored using a combination of fixed-station telemetry receivers and directed mobile telemetry surveys to determine if:

1) early-migrating fish have different migration patterns and spawning distributions than late-migrating fish;
2) wild fish have different migration patterns and spawning distributions than hatchery fish;
3) males have different pre- and/or post-spawning migration patterns than females.
4) multiple recaptures of fish by anglers occurs and if there is an incidental mortality as a result of angling; and
5) spawning occurs in the vicinity of Vedder Floodway gravel-removal pits (near Yarrow).

LGL Limited environmental research associates of Sidney, BC, was awarded a contract to finalize the study design, mobilize the necessary equipment and personnel, manage day-to-day activities of the program, compile and analyze the data collected, and report the findings. This report provides an overview of the telemetry program, presents the results of the telemetry data analyses, and discusses these results in the context of the scope and objectives for the program.

Study Area

<u>The Fraser River Watershed</u>

The Fraser River watershed drains about one-quarter of British Columbia and is the largest watershed in the province. The river's mainstem originates in the Rocky Mountains near the Alberta border and flows northwest for approximately 350 km before turning south near the city of Prince George (Figure 1). At this point the mainstem flows

in a southerly direction approximately 650 km to the town of Hope, where the river flows in a west/southwest direction for approximately 150 km to marine waters in the Strait of Georgia near Vancouver. The annual average discharge of the Fraser River at Hope is about 2,800 m^3/s, but flows can be as high as 15,000 m^3/s during spring freshet and as low as 400 m^3/s in winter (BC Ministry of Environment 1992).

The Fraser River supports significant populations of chinook (*O. tshawytscha*), sockeye (*O. nerka*), coho (*O. kisutch*), chum (*O. keta*), and pink salmon (*O. gorbuscha*), and steelhead. Steelhead spawn in several tributaries to both the lower Fraser River (downstream of Hope), and the middle Fraser River (from Hope upstream to the Chilcotin River watershed, including the Thompson and Nicola river watersheds). Few steelhead are believed to spawn in the Fraser River or its tributaries upstream of the Chilcotin River confluence, although there have been reports of possible observations of steelhead in the Quesnel and Blackwater rivers (pers. comm., M. Lirette, MWLAP, Williams Lake, BC; see Figure 1).

Fraser River steelhead are considered to be either "coastal" or "interior" stocks, based on stock location. Coastal steelhead stocks, which include the Chilliwack River system stock, include all tributaries of the Fraser River downstream of Hope, and may include the Nahatlatch River (Nelson et al. 1998a). Coastal stocks enter the Fraser River in either mid-summer ("summer run") or November through May ("winter run"). Interior Fraser River steelhead stocks enter the Fraser River in the fall ("fall run"), typically from mid-September through mid-November (Nelson and Gaboury 2001). Regardless of the timing of entry into the Fraser River, all Fraser River steelhead stocks spawn in the spring. The peak timing of spawning activity occurs from mid-April through the end of May (McGregor 1986; Bison 1991; Nelson et al. 1998a; Renn et al. 2002).

The Chilliwack River Watershed

The Vedder/Chilliwack River watershed (approximately 1230 km^2) is located 100 km east of the largest of the urban centers on the Lower Mainland (Figure 2). The river originates in the Cascade Mountains of Washington State and flows north across the U.S. border into Chilliwack Lake, then continues westerly for 50 km where it becomes the Vedder River. Approximately 3.5 km from the Fraser River, the Vedder River enters the Sumas River, which then joins the Fraser River (see Figure 2). The Vedder/Chilliwack River system supports populations of chinook, sockeye, coho, chum, and pink salmon, and steelhead. In addition, anadromous Dolly Varden char (*Salvelinus malma*) and resident bull trout (*S. confluentus*) are present in the Chilliwack River watershed; Chilliwack Lake is home to the major component of the bull trout population (Nelson and Caverhill 1999). Steelhead that spawn in the Chilliwack River watershed enter the river system between November and May, and spawn as far upstream as tributaries to Chilliwack Lake.

The Vedder River is an area of both sediment aggradation and floodplain development. Dyking has occurred along this portion of the waterway, which is reviewed every two years for flood control. The Vedder Floodway gravel removal pits (a set of flood control sites in the mainstem Vedder River) are located in close proximity to the railway crossing

near Yarrow (Figure 2). Of particular interest here was if the telemetry study could determine if steelhead spawned near the gravel extraction areas. Chilliwack River Hatchery (operated by Fisheries and Oceans Canada), located at the outlet of Slesse Creek (Figure 2), has operated a steelhead enhancement program since 1972. Currently, all steelhead raised at Chilliwack River Hatchery have their adipose fin removed prior to release (Bob Stanton, Manager, Chilliwack River Hatchery, pers. comm.).

Steelhead Life History

In the Fraser River, coastal winter-run steelhead are believed to enter the river from November to May. Studies of summer- and fall-run steelhead using radio telemetry on the Nass River (Koski and English 1996), Skeena River (Alexander et al. 1996), Bella Coola River (English et al. 1999) and Fraser River (Nelson et al. 1998a) have shown that overwintering or "holding" locations for steelhead destined for specific tributaries, or upper reaches of a major tributary, can occur in mainstem river locations several kilometers downstream from eventual spawning locations. Following overwintering/ holding, steelhead spawn generally in the spring (mid-April through May); the approximate time of spawning is believed to be inherited, and has evolved to be stream/stock specific. The exact time of spawning is controlled by photoperiod (Bromage et al. 1982; Bromage and Duston 1986), and possibly by water temperature (Lough 1983). Unlike other species of *Oncorhynchus*, steelhead are repeat spawners and many do not die after they spawn. Thus, a proportion of steelhead that survive spawning return to the ocean to feed, and may return to their natal stream to spawn again. Repeat spawning of an individual steelhead may occur in consecutive years or in alternating years, and has been documented (in the Bella Coola River, BC) to occur up to five times in the life of an individual steelhead (Nelson et al. 1998b).

The following steelhead life history information, partitioned between freshwater and saltwater life stages, is included in order to provide the reader with an overview of general biological, environmental, and temporal knowledge for steelhead in the Pacific Northwest.

Freshwater

Young steelhead hatch 18 days (at 15.5°C) to 101 days (at 3.2°C) after spawning (Morrow 1980) but most hatch in 28-49 days from mid-July to mid-August (Scott and Crossman 1973). The size of juvenile steelhead at hatching can be variable and is closely correlated with both egg size and (mature) fish size (R. Ptolemy, MWLAP Victoria, pers. comm.). Steelhead from the Anchor River, Alaska, are about 25 mm long when they hatch (Ballard 1985), whereas juvenile steelhead from the Bella Coola River system are closer to 30 mm at hatching (MWLAP fish culture records). For comparison, resident rainbow trout are typically about 20 mm at hatching (R. Ptolemy, pers. comm.). Survival of eggs is directly related to the velocity of ground water through the redd and to the amount of dissolved oxygen in the ground water (Coble 1961). The fry begin feeding about 15 days after emergence. Juvenile steelhead tend to occupy riffles and pools, and

prefer water temperatures that range from 10-13°C (Bjornn and Reiser 1991), with high velocities (Bisson et al. 1988) and nearby overhead cover (Shirvell 1990; Fausch and Northcote 1992). Larger juveniles prefer higher velocity and deeper water than small juveniles (Bisson et al. 1988; Bjornn and Reiser 1991). During the winter, juveniles move into overwintering areas with either large rubble substrate (Bjornn 1971) or other types of cover (Bustard and Narver 1975).

Movement and growth of juveniles varies greatly according to the environmental conditions and the genetic makeup of the population (Morrow 1980). In cold-water streams where growth is very slow juveniles may spend as many as seven years in freshwater before they smolt (most frequently 3-5 years, Pevan et al. 1994). However, in southern streams juvenile steelhead generally remain in fresh water from 1 to 4 years (most frequently 2 or 3 years) before they migrate downstream to the ocean. Juvenile steelhead begin to smolt when they attain a size of about 150 mm (range 130-270 mm, Ballard 1985; Peven et al. 1994) and smolt migrations appear to be initiated by a combination of size and photoperiod (Bjornn 1971). Most freshwater movement, both downstream and upstream, occurs at night (French and Wahle 1959). At the time of their downstream migration fish loose their parr marks and become silvery, reaching the smolt stage. Most steelhead smolts enter saltwater from April through June (Burgner et al. 1992).

After spending a few months to four years in saltwater feeding, adult steelhead return to freshwater in either June to October (summer/fall runs) or November to May (winter/spring runs) to spawn. Summer-run fish spend almost a year in freshwater before they spawn and are in an early stage of reproductive development when they enter fresh water. Winter- and spring-run fish, in comparison, can be nearly ripe when they enter freshwater and can spawn within a few months, or days, of stream entry. In most large river systems fish entering upper-river tributaries are summer or fall run, and those entering coastal tributaries are winter run. Tributaries on the lower sections of rivers may have both summer- and winter-run fish. It is believed that the evolution of discrete summer and winter runs resulted as a response to the presence of in-stream barriers which may be passable only during periods of high flow and optimal stream temperature (Withler 1966). Summer-run fish move upstream to overwintering areas that are generally near their spawning locations. However, in some systems (notably larger river systems), steelhead are known to overwinter (in some cases for up to eight months) in suitable sections of the mainstem typically downstream of terminal spawning locations prior to a final accent to these terminal areas in the spring (Spence 1981; Burger et al. 1983; Lough 1983; Wallis and Ballard 1984; Alexander and Koski 1995; English et al. 1999; Nelson et al. 1998a).

Steelhead spawn between February (in the southern extent of their range) and June (in the northern extent of their range). The spawning time of individual females appears to be inherited from their mothers (Danzmann et al. 1994) and is controlled by photoperiod (Bromage et al. 1982; Bromage and Duston 1986); however, water temperature may influence the exact spawning time within a season (Lough 1983). Water temperature during spawning normally ranges from 3.9-9.4°C (Bell 1973), but successful spawning

has been documented at temperatures as low as 0.3°C (Dodge and MacCrimmon 1971) and as high as 20°C (Cederholm 1984). Unlike most *Oncorhynchus*, many steelhead do not die after they spawn. The proportion that repeat spawn is believed to be inversely related to the age of the fish and the number of spawners entering a stream (Hartman 1959; Withler 1966) and directly to the environmental conditions. Preferential survival of females over males has also been documented for many populations (Hartman 1959; Withler 1966).

Few steelhead live longer than nine years (Scott and Crossman 1973), but the maximum age is at least 13 year based on a recovery of a tagged fish (Bob Hooton, MWLAP, Smithers, pers. comm.). Few steelhead are longer than 120 cm and heavier than 16.4 kg (Scott and Crossman 1973) and the average size of adult steelhead returning to freshwater to spawn is 625-750 mm (Burgner et al. 1992). However, the world record steelhead is 19 kg and a larger steelhead has been reported to have been caught, but its weight has not been confirmed (Bob Hooton, pers. comm.).

Saltwater

Steelhead smolts disperse directly offshore from their natal streams (Hartt and Dell 1986; Burgner et al. 1992), whereas other juvenile salmonids follow the coastal belt of northern British Columbia and the Gulf of Alaska north and west. Dispersal from freshwater to saltwater starts in May. All North American steelhead stocks undergo substantial marine migrations and intermingle extensively during their ocean residence (Light et al. 1988). There appears, however, to be different seasonal patterns of marine distribution for summer-, fall-, and winter/spring-run steelhead that are likely related to their wide difference in time of return to freshwater (Burgner et al. 1992). The oceanic distribution of steelhead appears to be related to water temperature (Sutherland 1973; Barnhart 1986) and probably food; they are found between the 5°C isotherm in the north and the 15°C isotherm in the south. This includes most of the north Pacific Ocean north of 42°N latitude. There is evidence of movements to the north and west during late winter and spring, and to the southeast during late summer and fall (Sutherland 1973; Burgner et al. 1992). Steelhead feed primarily on fish and crustaceans and apparently feed near the surface even when far offshore (Taylor and LeBrasseur 1957; Godfrey et al. 1975).

Steelhead spend a few months to 4 years (most often 1 or 2 years) in the ocean before they return to spawn (Morrow 1980). Time spent at sea before returning to freshwater to spawn appears to be independent of their freshwater residence (Sutherland 1973). Limited data suggest that steelhead travel near the surface as they approach freshwater streams through coastal areas (Ruggerone et al. 1990). This behavior may make them more susceptible to interception by fisheries than other salmonid species.

Coastal Fraser River Steelhead

As a group, coastal Fraser River steelhead are those steelhead from the Fraser River watershed downstream of the Fraser Canyon (upstream stocks are defined as interior Fraser River steelhead). Behnke (1992) suggests that all Fraser River steelhead stocks

downstream of Hell's Gate are of coastal origin. Interior Fraser River steelhead are thought to have originated from the central Columbia River basin, east of the Cascade Mountains, and are considered to be redband rainbow trout (Behnke 1992). This makes them unique in that they are the only anadromous populations of redband trout in BC. Parkinson (1984) used electrophoresis to examine the relative quantities of three different enzymes (SOD, LDH, and AGP) in summer-, fall-, and winter-run steelhead stocks throughout the province. His findings showed considerable difference in the relative quantities of SOD, LDH, and AGP between interior Fraser River stocks and coastal summer-run stocks; this supports the idea that interior Fraser steelhead are unique in their evolutionary history. Parkinson's work, however, suggests that Nahatlatch River (upstream of Hell's Gate) steelhead have enzyme concentrations more similar to coastal summer-run stocks (high SOD and low LDH), which suggests that the boundary for redband and coastal steelhead may be further upstream than previously thought. Even though it is possible Nahatlatch River steelhead are fall run, they may be of coastal origin. Parkinson's work also demonstrated the uniqueness of Chilcotin River steelhead, which have high concentrations of LDH and low concentrations of SOD (similar to other interior Fraser River stocks) combined with levels of AGP not found in any other summer-, fall-, or winter-run steelhead population.

Chilliwack River Hatchery

Steelhead culture activities in the Chilliwack River are documented back to 1929 and continued sporadically into the 1930s (Ken Scheer, Fraser Valley Hatchery, pers. comm.). These initial releases of steelhead fry into the Chilliwack River were from broodstock collected outside of the Chilliwack River watershed; some of the broodstock are believed to be from California. Steelhead releases into the Chilliwack River commenced again in the mid-1970s. In 1979 and 1980, steelhead culture activities for the Chilliwack River were coordinated through the Research and Development Section of the BC Fish and Wildlife Branch. In 1981, eggs from steelhead broodstock collected from the Chilliwack River were cultured and reared at the Chilliwack River Hatchery (operated by Fisheries and Oceans Canada), located on the mid Chilliwack River at the confluence of Slesse Creek (see Figure 2). The first steelhead smolt releases from the Chilliwack River Hatchery facility (the 1981 brood) were released in May 1992 (Bob Stanton, Manager, Chilliwack River Hatchery, pers. comm.). The first adult steelhead to return to the Chilliwack River from the 1982 release from Chilliwack River Hatchery could have returned in 1983 (after spending 1 year in marine waters), but it is likely that the majority of the adult returns from this first release occurred in 1984 (most steelhead stocks spend at least 2 years in the ocean prior to their first or "maiden" return to freshwater (Wilkinson 1981).

The current steelhead culture program at Chilliwack River Hatchery has a broodstock target of 36 male and 36 female steelhead, and an egg target of 200,000. This egg number has resulted in typical releases of 125,000-135,000 smolts. Broodstock is captured by hook and line, by volunteer anglers, from mid-January through April. Brood steelhead are held at Chilliwack River hatchery until they are ready for spawning. Attempts are made to spawn males and females in a 1:1 ratio.

Juvenile steelhead are raised at the hatchery until the following spring, at which time they weigh 80-100 g. Currently, steelhead smolts are transported and released into the lower Chilliwack River (below Vedder Crossing), usually during the first week in May. All hatchery-raised steelhead have their adipose fin removed prior to release (Bob Stanton, Manager, Chilliwack River Hatchery, pers. comm.). All steelhead culture protocol and release activities conducted from the Chilliwack River Hatchery have been overseen by BC provincial fisheries staff.

METHODS

Study Design

The Vedder/Chilliwack River steelhead telemetry study was initially proposed as a one-year study with the option of a second year (to be determined based on the successes of the first year). The project was highly successful during the first year of study (1999); thus, the scientific authority and contract monitor (MWLAP/MWLAP) decided to propose a second year of activities (2000). Field activities in 1999 commenced in early January 1999, and targeted steelhead that entered the Chilliwack River watershed from November 1998 through May 1999; in this report this group of steelhead will be referred to as the “1999" run, and activities related to the study of this group will be called the “1999" study. Field activities for the second year of study (2000) commenced in December of 1999, and targeted steelhead that entered the river from November 1999 through April 2000; in this report this group of steelhead will be referred to as the “2000" run, and activities related to the study of this group will be called the “2000" study.

Radio Telemetry

Telemetry Receivers and Radio Tags

The telemetry receivers used for this study were the model SRX_400 built by LOTEK Engineering Inc. of Newmarket, Ontario, with their CODE_LOG version W16 data processing and storage program. The radio tags used were of two types:

1) LOTEK model MCFT-3A digitally coded radio tags (1999 and 2000). These tags have a 732-day battery life, are 16.2 mm in diameter, 50 mm long, weigh 16.0 g in air and 6.2 g in water. The burst rate of signal transmission in every 5 seconds.

2) LOTEK model CFRT-7A digitally coded radio tags (2000, for fish over 70 cm FL). These tags have a 238-day battery life, are 16.2 g in diameter, 82 mm long, weigh 33.0 g in air and 12.8 g in water. The burst rate of signal transmission is every 5 seconds.

Two-digit codes (unique for each frequency) were assigned to each radio tag by the manufacturer. Channel and code combinations were unique to all individual radio tags deployed during the program. During all tracking the receiver was set to scan each

frequency for six seconds, during which time one to two pulses were be transmitted by a tag (the pulses are 5 seconds apart); the receiver then searched the next frequency. If a signal was received, the receiver decoded the signal, reported the tag code and signal strength and stored these data in internal memory. As many as 12-15 different tag codes can be decoded at the same time on a single channel. The receivers, fitted with a single antenna, can scan over 13 frequencies and decode over 150 different radio-tagged fish within a 78-second period.

Fixed-Station Receiver Sites

Four fixed-station receiver sites were established for this study (Figure 3). The first station (Station 1) was located near the Fraser River confluence. This location on the Fraser River is approximately 94 kms upstream from the mouth of the Fraser River at the Strait of Georgia, and about 67 kms upstream from the furthest measurable salinity (marine) in the lower Fraser River; thus, salinity considerations for radio telemetry applications were not an issue (Nelson and Alexander 1995). The next station (Station 3) was located near the Tamihi Bridge. Station 6 (1999) and 7 (2000) were located upstream and close to Slesse Creek, and the last station (Station 9) was located near the outlet of Chilliwack Lake. The receivers at these sites monitored and logged the passage of radio-tagged steelhead on a continuous basis, 24 h per day, during the entire study. Final positions of fixed-station receiver sites were determined based on the following criteria:

1. secure location with easy access;
2. adjacent to a section of confined river channel such that signals can be detected from all radio-tagged fish passing the location; and
3. access to a tall tree for antenna placement (antennae located 50-100 feet above the water have much greater detection ranges than those near water level).

Each receiver and antenna switcher was enclosed in a weather-proof container and powered by a 12-v, deep-cycle RV battery. During winter and spring, a 130 amp-h battery will operate the system for 8-12 days without changing or recharging. Field staff downloaded data and replaced RV batteries at both fixed-station sites every 5-7 days, well within the operable range of battery life.

Each stationary receiver had two antennae coupled to it in order to determine the direction of movement of the fish and to maximize the probability of detecting each fish (two antennae cover almost twice the area of one). One antenna was pointed upstream, and the other pointed downstream; this allowed the determination of the direction of movement of each individual fish and ensured that even rapidly moving fish were recorded on at least one antenna.

Differentiation of directionality was tested at the time each station was established. Following the basic set up of the telemetry station (antennas in tree, cables connected to receiver secured in waterproof enclosure), a technician would walk upstream and

downstream (approximately 100-200 yards) from the station, and place an activated radio tag (of the type used in the study) in the water. Using 2-way radios for communication, a technician at the receiver site would then check that the comparative power levels of the tag detection for each antenna indicated the position/direction of the radio tag (upstream or downstream of the station).

Data retrieval from fixed-station receivers
Routine data downloading was accomplished by connecting the receiver to a portable notebook computer and executing the LOTEK data downloading routines. All data were downloaded in hexadecimal format and then converted to readable (text) format and browsed for data errors. Once the data were secure, the receiver memory was erased and scanning was continued.

Data Collection from Mobile Tracking

Tracking between fixed station receiver sites was conducted by vehicle, foot, helicopter (1999 only), and raft (2000 only) during the study. Mobile tracking surveys by vehicle and foot were scheduled to occur in conjunction with most download events, especially when downloading the upstream telemetry stations. Foot and vehicle tracking was conducted using either a hand-held, 2-element, H-style antenna. Vehicle tracking was done using two methods: 1) driving along the river and scanning for radio tag signals, and stopping to confirm any detected signals and location of the tag; and 2) walking with the receiver and antenna along the river (from the road or from a fishing site) and scanning for radio tags. In both cases, when radio-tagged fish were located, the position of the fish was recorded in relation to known reference points on the river. Aerial tracking in 1999 was conducted from a Bell 47 helicopter (Chinook Helicopters, Abbotsford) with an H-style antenna attached to the cargo skids. An SRX-400 receiver was used to identify individual radio-tags, and the position of these tags was recorded on a data sheet and a map, in addition to being recorded in the memory of the receiver.

Data Management and Security

Data collected by receivers were automatically stored in an internal memory in the receiver and was downloaded to a computer file whenever a fixed-station receiver site was visited. Downloaded data were backed up on diskette, and sent (via e-mail or courier) to the project manager. Verified data received by the project manager was backed up and loaded into a raw database for analysis.

The data stored for each signal received by the SRX-400 receiver include the following:

a) date;
b) time (h/min/sec);
c) channel or frequency;
d) power lever of signal;
e) antenna (combined+0, #1, #2); and
f) signal code.

The project manager and project fisheries technicians analyzed data downloaded from fixed station receivers and summarized tag detections in an electronic database and on hard copy summary sheets. In addition, a binder was maintained with copies of study area maps (one for each radio tag released). Following fixed-station downloads and mobile tracking surveys, detection information (date and location) was entered on these maps; this system provided current knowledge of the most recent locations of individual radio-tagged steelhead throughout the program. For security, all electronic data were backed up on diskette and sent via e-mail from the project site to the office of the Project Manager.

Survey Zones and River Kilometers

Survey Zones

A total of 13 telemetry "survey zones" were established on the Chilliwack River watershed in order to document interim and final positions of radio-tagged steelhead (Table 1, Figure 3). Survey zones 11-13 (tributaries to the mainstem Chilliwack River) were not used during the 1999 study. Survey zone boundaries were established at key geographical landmarks (bridge crossings, creek outlets, telemetry stations). Results for location information presented in this report are in many cases summarized by survey zone.

River Kilometers

A scale of on-water river kilometers (rkm) was established for the mainstem Vedder/Chilliwack River at the commencement of the 1999 study and used to document the locations of steelhead releases, recaptures, and telemetry detections. The rkm scale starts with rkm 0.0 at the outlet of the Sumas River (at the Fraser River) and continues upstream to the outlet of Chilliwack Lake (rkm 61.0). All rkms used during the study were unique to particular survey zones (Table 1, Figure 3).

Radio Tag Application Schedules

The basic study design was structured around the need to evaluate the similarities and differences in behavior of various "groups" of steelhead, ordered by:

1) Run timing group, by:
   a) month of tag application (December, January, February, March, April, May); and
   b) "early" (November-February) and "late" (March-May) groups
2) Origin (hatchery or wild stock); and
3) Sex (male or female).

In order to achieve this level of stratification, a tag application schedule was established for each study year, based on the number of tags available and the anticipated run size of steelhead in each given month. Ideally, radio tags were to be applied only to "bright"

steelhead (recent arrivals from marine waters), and the tagging effort would be focused in the lower sections of the river (to maximize the amount of potential upstream movement information for individual steelhead). Thus, in 1999, the initial tag application schedule for the 68 radio tags available was as follows:

1999 Radio Tag Application Schedule

Month	Hatchery	Wild	Total
January	6	6	12
February	7	7	14
March	7	7	14
April	7	7	14
May	7	7	14
Total	34	34	68

In 2000, a total of 130 radio tags were available, and a similar schedule was created to partition tag applications by month, origin, and sex. The 2000 study included the application of radio tags to upstream-migrating steelhead in December 1999; these early-run winter steelhead, which entered the Chilliwack River watershed in either November or December of 1999, are referred to in this report as being part of the 2000 study. In both study years, attempts were made to radio tag steelhead that entered the river in November and December by directing angling efforts to upstream sections of the river in December (2000 study) and January (1999 and 2000 studies). Due to poor angling conditions in the lower river during these months, the decision to apply radio tags to steelhead in the mid and upper sections of the river was warranted, as these “bright” fish had likely entered the Chilliwack River watershed in either November or December, and would provide representative information for these run timing groups that would have been foregone if all angling efforts had been applied in the lower river.

In both years, some radio-tagged steelhead were recaptured (following release) by recreational anglers; many of these radio tags removed from the fish, and the tags returned to project staff. These radio tags were in all cases redeployed in a different fish. Tag application schedules could not anticipate the rates of recapture, tag return, and subsequent redeployment of tags.

Methods of Capturing Fish for Tagging

All adult steelhead radio-tagged in the Vedder/Chilliwack rivers in 1999 and 2000 were captured using conventional angling techniques. Virtually all of the angling by project fisheries technicians was conducted using bait (salmon roe or ghost shrimp) or a bait and colored yarn/wool combination. Although the majority of the steelhead captured by volunteer anglers for radio-tagging were captured on bait, some were likely captured on colored yarn/wood only. The fishing equipment (rod, reels, line, terminal gear) bait, and angling techniques used by project fisheries technicians to capture steelhead for radio-

tagging were typical of the respective gear, bait, and techniques used by the majority of recreational anglers fishing for steelhead on the Vedder and Chilliwack rivers in 1999 and 2000. An attempt was made (January 1999) to capture adult steelhead using a fyke net (trap) in the Vedder Canal. The fyke net was fished for approximately 12 hours and did not capture any adult steelhead (juvenile chinook only). Due to water high conditions, and the successful capture rates using angling methods, the fyke net was not redeployed.

Angling

Although directed steelhead angling for the study was conducted by project technicians, the majority of steelhead tagged in both project years were angled by recreational anglers and provided to project technicians for tagging. When fisheries technicians encountered recreational anglers on the river, they asked the anglers if they could tag and release any unwanted hatchery steelhead and any wild steelhead. If a recreational angler hooked a steelhead, the technician would assist with the capture as needed; following capture, the steelhead would be provided to the technician, who would then tag and release the steelhead using the standard procedures. The standard procedure following capture and prior to tagging was to place the steelhead into a cylindrical holding/recovery tube (constructed of heavy black fabric, with a zipper along the top and mesh at both ends). The holding tubes greatly assisted the process of hook removal, tagging, and biosampling prior to release, and provided a secure location for the steelhead to recover prior to release.

Assessment, Handling, Sampling, and Tagging of Steelhead

Once captured and secured in a zippered holding tube, all steelhead were assessed "type" (hatchery or wild) and sex. Steelhead were determined to be of hatchery origin if the adipose fin was absent (clipped off). Sex was determined by an external examination of the characteristics of the face, jaw, and body form. If the steelhead was of the type and sex required for tagging (under the tag application schedule), it was then assessed for tagging condition. Fish that exhibited darkened or spawning coloration were typically not tagged (in 1999, a few darkening steelhead were tagged in May). Due to cool water temperatures, steelhead were not anaesthetized prior to tagging or sampling (water temperatures ranged from 4-7 °C during the period of tagging in both years). Processing included: tagging the fish with a colored and uniquely numbered spaghetti tag (attached using a spaghetti tag needle behind to dorsal fin); measuring the fish (nose-fork length); noting the sex, collection of scales (for ageing, 2000 only), noting the presence of scars/wounds; and applying the radio tag. Prior to tag applications, the channel and code of the radio tag, and the 3-digit number and color of the spaghetti tag, were recorded on the tag release data form.

Radio Tag Application Procedure

The radio tag was activated (by removing a small magnet from the body of the tag), and the 40-cm wire antenna inserted through a plastic applicator tube. The radio tag was then inserted into the mouth of the steelhead and pushed into the stomach with the aid of the applicator tube, which was removed when the tag was positioned correctly. The antenna exited through corner of the mouth and trailed back alongside the steelhead (Figure 4). The "esophageal" or "gastro" application of radio tags (applied without the use of anesthetic) was the method chosen at the beginning of this study based on the successes observed using this type of application in other radio telemetry studies for adult steelhead and chinook (Nelson et al. 1998a; English et al. 1999; Nelson et al. 2001). An alternative method of radio tag application that involves anesthetic and surgery was considered as this study required long-term tag monitoring (up to 7 months per year); although the surgical method is perhaps the preferred method for long-term monitoring studies for species such as char (Nelson et al. 2003), this method has the potential to alter the natural behavior of fish tagged, typically for at least a few days following release, and was dismissed as an option for the Vedder/Chilliwack study.

Spaghetti Tag Applications

1999
All steelhead radio-tagged in 1999 were also tagged with a bright colored (orange), uniquely numbered spaghetti tag. Each tag was applied with a specialized needle and attached about 0.5 cm anterior of the posterior insertion of the dorsal fin. Additionally in 1999, wild steelhead that were captured but not required for radio-tagging were tagged with a spaghetti tag. The purpose for this additional tagging was to increase the release sample for voluntary reporting (in anticipation of recapture rate analyses). Hatchery steelhead not required for radio-tagging were not tagged with a spaghetti tag.

2000
All steelhead radio-tagged in 2000 were also tagged with a colored, uniquely numbered spaghetti tag, using the same procedures as in 1999. In 2000, in anticipation of swim surveys and to provide an opportunity to calculate observer efficiencies, 4 unique colors were applied to indicate early (prior to February) hatchery and wild (yellow and white, respectively) and late (February and later) hatchery and wild (pink and blue). Based on a low reporting rate for spaghetti-tag-only steelhead released in 1999, steelhead captured by project technicians in 2000 that were not required for radio-tagging were released without a spaghetti tag.

Public Awareness and Involvement

In order for several elements of the telemetry program and mark-recapture component of the study to be successful, public compliance and involvement with the study were necessary. Efforts to communicate the program commenced at the beginning of the project in 1999. The project manager and fisheries technicians contacted local fishing groups, rod and gun clubs, tackle shops, provincial Conservation Officers, hatchery

personnel, and other individuals involved with the steelhead fishery on the Chilliwack River, and provided information regarding the study. In addition, a hard-copy announcement ("flyer") was developed and posted at numerous fishing locations near the Vedder and Chilliwack rivers (parking lot kiosks, public notice boards, bridge pilings, etc.; Figure 5). Copies of this announcement were provided to local tackle shops for posting and for hand outs to interested anglers. The announcement was also run as an advertisement in local newspapers and fishing news periodicals. As the study progressed and information was available, the Program Manager prepared articles for publication in local newspaper and periodical media.

Tagging of Steelhead Captured by Recreational Anglers

In both 1999 and 2000, recreational angling for steelhead in the mainstem Chilliwack River downstream of the confluence with Slesse Creek was allowed (by regulation) from July 1 through April 30 (single barbless hook, bait or artificial lure). In addition, the mainstem Chilliwack River downstream of the Vedder Crossing Bridge was opened to fly fishing only from May 1-31. In an effort to involve recreational anglers in the telemetry study, project fisheries technicians approached recreational anglers in the field and requested permission to tag any captured steelhead (if required within the tagging schedule). Fisheries technicians tagged steelhead captured by recreational anglers opportunistically and as required. Anglers that provided steelhead for tagging were rewarded with a project hat, and their names were entered in a prize draw for all participants; prizes were donated by local fishing tackle retailers, and winners were drawn from the list of all volunteer participants at the end of each year's field program. All tagging and sampling activities for steelhead captured by recreational anglers were conducted by project staff.

Reporting of Recaptured Tagged Steelhead

Two of the objectives of the study were to determine if multiple recaptures of individual steelhead occurs, and if there is a measurable incidental mortality as a result of angling. In order to assess the recapture rate of tagged steelhead, recaptures needed to be reported voluntarily by recreational anglers. In order to encourage and simplify the reporting process for recreational anglers that did capture a tagged steelhead, a toll-free phone number was set up (with a voice message answering service, with a voice prompt and instructions). In all communications with recreational anglers (announcements, media releases, and personal contact), the request was made to record the tag number on the spaghetti tag and call in (to the toll-free number) to report the tag number, the date of capture, the location of capture (to the nearest landmark), if the fish was released or killed, and provide a contact name and phone number. Additional incentive for the reporting of recaptured tagged steelhead was provided by entering the names of participating anglers in a draw for prizes (donated by local retail shops) held at the end of each year's field program.

Recapture Analyses

This report presents estimated recapture rates of individual steelhead, based on information reported by recreational anglers, and stratified by hatchery and wild, male and female, for both 1999 and 2000. The percentages of reported steelhead recaptures in based on the sample of radio-tagged steelhead that were available for recapture only.

Determination of Holding and Spawning Locations and Timing

Holding

For the purpose of this report we define steelhead "holding" as observed pre-spawning staging behavior that occurs most typically downstream of eventual spawning locations, sometimes for extended periods of time in the same relative location. Holding areas are usually mid-depth runs or pools that provide sufficient water levels and cover (during most river stages) during the period of time prior to spawning (Nelson et al. 1998a; English et al. 1999). For this study we examined the time and location information for each radio-tagged steelhead, and in most cases assigned to each a specific holding rkm and survey zone.

Spawning Locations and Timing

Determinations of estimated spawning location and timing information for each radio-tagged steelhead were based on evaluation of all available information on a tag-by-tag basis. Information considered during these evaluations included the location and duration of observed holding events, the extent, duration, and timing of upstream migrations subsequent to holding, the specific habitat type at the spawning location, and the timing of the spawning event. While actual spawning activity was not observed in all cases, a consensus between project technical and biological staff was reached prior to assigning spawning designations.

Following the information analyses, individual radio-tagged fish (that spawned) were assigned spawning locations (rkm and survey zone), and the estimated number of days on the spawning ground. A few male steelhead (that eventually kelted) appeared to stage downstream of the area believed to be where an initial spawning event occurred (this could indicate subsequent spawning events), in these cases only the first spawning event is presented.

Survival to Kelt

For the purpose of this study, a "kelt" is defined as a steelhead that was assessed as a successful spawner and later migrated downstream past fixed-station 1 and entered the Fraser River. In this study, the subsequent survival and fate of steelhead kelts to marine waters (approximately 95 km down the Fraser River from fixed-station 1) could not be determined. Analyses of survival-to-kelt rates are presented for both 1999 and 2000, and are based on the sample of radio-tagged steelhead that could be assessed. All individual

samples used in the survival-to-kelt analyses were considered to be successful spawners, and adequate telemetry data was required to determine if the fish kelted successfully (detections past station 1) or died at the spawning location or during the post-spawning downstream migration.

Analyses of Post-Release Behavior of Air-Spawned Steelhead Broodstock

At the request of the Scientific Authorities for the program an associated steelhead study using the telemetry infrastructure established for the core program was conducted. The objectives of this ancillary study were to determine the post-release behavior and survival of "air-spawned" female steelhead, spawned at Chilliwack River Hatchery (see location, Figure 2). The results of this work are presented in this report.

RESULTS AND DISCUSSION

Steelhead Capture Activities

Selection of Steelhead for Radio-tagging

Only steelhead in excellent condition (no open wounds, bleeding, or abnormal behavior) were radio-tagged. In addition, fish that exhibited darkened or spawning coloration were typically not tagged (in 1999, a few darkening steelhead were tagged in May). A review of data comments regarding the release of steelhead not radio-tagged indicates that there were no steelhead in either 1999 or 2000 that were rejected based on a negative condition (bleeding, wound, etc.) that was inflicted by the capture (angling) event. The majority of steelhead rejected for radio-tagging were rejected on the basis of their type (hatchery or wild) and sex (in respect to monthly tagging quotas) or on the basis of their coloration (dark or darkening fish were avoided if possible). Two fish were rejected in 1999 due to pre-existing open wounds (seal bite or other).

Potential Biases

The fishing equipment (rods, reels, line, terminal gear) bait, and angling techniques used by project fisheries technicians to capture steelhead for radio-tagging were all typical of the respective gear, bait, and techniques used by the majority of recreational anglers fishing for steelhead on the Vedder and Chilliwack rivers in 1999 and 2000. Thus, following release, subsequent observed behaviors, and estimates of survival to spawning and survival to kelt, were expected to represent respective behaviors and survivals for steelhead captured and released by the majority of recreational anglers that fish the Vedder and Chilliwack rivers in 1999 and 2000.

Biases to the behavior and survival results of steelhead in this study, compared to steelhead released by the general angling public, include:

1) *Steelhead capture for the telemetry study were handled by trained, experienced fisheries technicians, and in most cases holding tubes were used to secure steelhead for sampling and tagging; in addition, all radio-tagged steelhead were fully revived prior to release.*

We have assumed that steelhead handled and released by trained professionals could introduce a bias toward better condition at release (as compared to handling and release by the general recreational angling public). This bias would result in higher observed survival estimates to spawning (and possibly to kelt) for the group handled by trained professionals than those handled by the general recreational fisher.

2) *All radio-tagged steelhead were exposed to stressful conditions not experienced by released steelhead that were not radio-tagged (i.e., typical capture and release by recreational anglers). Comparatively, for all steelhead captured and released by angling, the tagged group would be exposed to additional stresses not experienced by the group that was simply released by the average recreational angler.*

Under this scenario, the condition at release of tagged fish might be poorer than the condition at release for fish that were not tagged. This assumption is based on the potential for additional stresses that might be applied to the fish as a result of the sampling and tagging process (holding, length measurements, radio tag application, and spaghetti tag application). This bias could result in lower observed survival estimates to spawning (and possible to kelt) for the tagged group as compared with the untagged group.

At this juncture, we have not resolved if there is a positive or negative bias under the two scenarios outlined above. However, due to the high survival rates of radio-tagged steelhead to spawning presented further in this report, it is our view that any bias has a negligible effect on survival.

Use of bait

All adult steelhead radio-tagged in the Vedder/Chilliwack River in 1999 and 2000 were captured using conventional “drift fishing” angling techniques. Virtually all of the angling conducted by project fisheries technicians employed bait (roe or ghost shrimp) or a bait and colored yarn/wool combination; virtually all recreational anglers that provided steelhead for tagging also used bait and/or wool. Quantitative information regarding the type of bait or other attractant employed by each angler was not collected during the program; however, technical staff were queried and the conclusion was that the majority (at least 70%) of the steelhead captured by recreational anglers and provided to project fisheries technicians for tagging were captured on bait, the balance being captured mostly on yarn/wool only.

Public Awareness and Involvement

Angler Participation

Appendices C and D present a summary of tagging, holding, spawning, and survival-to-kelt data, and fates for all steelhead radio-tagged in 1999 and 2000, respectively. Anglers that provided fish to the study for radio-tagging can determine the fates of "their' fish by cross referencing the Fish Numbers for Appendices A and B (identifies angler) with respective numbers in Appendices C and D.

Tag Applications and Deployment

Summaries of all tag and release information for all steelhead radio-tagged in the Vedder/Chilliwack River in 1999 and 2000 are presented in Appendix A and Appendix B, respectively. These summaries include the date, fish type (hatchery or wild), sex, fork length, tagging location, tag numbers, angler name, tagger name, and condition of the steelhead at release. The unique "Fish Number" provides an efficient means for tracking the holding/spawning activities and fate of individual fish in subsequent appendices.

Radio Tag Releases

1999

Table 2 presents the number of radio-tagged hatchery and wild steelhead released, by tagging month, survey zone, and sex, in 1999. A total of 72 steelhead (31 hatchery and 41 wild) were radio-tagged and released. The difference (4 tags) between the number of tags available for the study (68) and the number of tags applied (72) is due to the return of 4 radio tags by anglers that recaptured a radio-tagged fish (and either killed the fish or removed the tag and released the fish); the 4 returned tags were reapplied to steelhead during the course of the study. Of the 31 hatchery steelhead released, 16 were male and 15 were female. Of the 41 wild steelhead released, 14 were male and 27 were female. In 1999 steelhead were radio-tagged and released between 5 January and 11 May 1999 (Appendix A). Of the 72 radio tags released, 28 (39%) were captured (angled) by one of the project telemetry technicians; the balance (44 fish; 61%) were angled by a variety of recreational anglers. Figure 6 presents illustrations of the numbers of hatchery and wild radio-tagged steelhead released, by month, in 1999.

2000

Table 3 presents the number of radio-tagged hatchery and wild steelhead released, by tagging month, survey zone, and sex, in 2000. A total of 154 steelhead (70 hatchery and 84 wild) were radio-tagged and released. The difference (24 tags) between the number of tags available for the study (130) and the number of tags applied (154) is due to the return of 24 radio tags by anglers that recaptured a radio-tagged fish (and either killed the fish or removed the tag and released the fish); the 24 returned tags were reapplied to steelhead during the course of the study. Of the 70 hatchery steelhead released, 14 were male and 56 were female. Of the 84 wild steelhead released, 38 were male and 46 were female. In 2000, steelhead were radio-tagged and released between 23 December

1999 and 30 April 2000 (Appendix B). Of the 154 radio tags released, 17 (11%) were captured (angled) by one of the project telemetry technicians; the balance (137 fish; 89%) were angled by a variety of recreational anglers. Figure 6 presents illustrations of the numbers of hatchery and wild radio-tagged steelhead released, by month, in 2000.

Spaghetti-Tag-Only Applications (1999)

In 1999, wild steelhead that were captured but not required for radio-tagging were tagged with a spaghetti tag. The purpose of this additional tagging was to increase the release sample for voluntary reporting (in anticipation of recapture rate analyses). Hatchery steelhead not required for radio-tagging were not tagged with a spaghetti tag. A total of 69 wild steelhead (30 males and 39 females) were released with a spaghetti tag only (no radio tag) from 8 March to 15 April 1999.

Comments Regarding Tag Deployment

The number of hatchery and wild steelhead radio-tagged and released, by month, provided good representation of run-timing groups for the telemetry study in both 1999 and 2000 (Figure 6). The number of female steelhead radio-tagged in 2000 was almost double that of males, which may be a reflection of a skewed sex representation in the escapement. The opportunity to tag steelhead in December 1999 for the 2000 study provided additional insight into this run timing group. The decision to stop applying radio tags by the end of April 2000 was valid based on marginal data gained from the tagging of maturing steelhead in May 1999.

Recaptures

Tables 4 and 5 provide summaries of the numbers of individual radio-tagged steelhead that were reported as being recaptured in 1999 and 2000, respectively; included in these tables are the respective percentages of individual steelhead recaptured (stratified by hatchery, wild, male, and female) from the samples of radio-tagged steelhead that were available for recapture. In 1999, 12 of the 30 radio-tagged hatchery steelhead (40.0%) that were available for recapture were reported as being recaptured, and 11 of the 40 radio-tagged wild steelhead (27.5%) that were available for recapture were reported as being recaptured (Table 4). In 2000, 33 of the 70 radio-tagged hatchery steelhead (47.1%) that were available for recapture were reported as being recaptured, and 16 of the 84 radio-tagged wild steelhead (19.0%) that were available for recapture were reported as being recaptured.

In addition to the summary of reported recapture data for individual radio-tagged steelhead, Tables 4 and 5 also present respective summaries of the total number of recaptures (the difference being that some individual tagged fish were reported as being recaptured more than once). For this analysis, recapture rates are calculated using the total number of recaptures (the assumption is that each recapture event is a unique event). Thus, in 1999, the total reported recapture rate was 43.3% for hatchery fish and

45.0% for wild fish. In 2000, the total reported recapture rate was 55.7% for hatchery fish and 28.6% for wild fish.

Biases in Reported Recapture Rates

The percentages of reported steelhead recaptures is based on the sample of radio-tagged steelhead that were available for recapture only. For example, steelhead radio-tagged in May 1999 were not included in the sample size because the recreational fishery closed on 30 April (Tables 4 and 5 provide detailed footnotes regarding the sample sizes used to estimate the reported recapture rates). It is important to note that, because the sample size is relatively fixed and the recapture data is based on volunteer reporting, the recapture rates presented represent the *minimum* rates. Based on the likelihood of under reporting of all recaptures by recreational anglers, is likely that the true recapture rates are higher than those presented. This under reporting of recaptures is evidenced in both years by the differences in overall recapture rates for hatchery and wild radio-tagged steelhead (in both years the estimated recapture rates were considerably higher for hatchery fish). Several hatchery steelhead that were recaptured were killed, and thus the reporting of the recapture event was prompted by the physical presence of the spaghetti and radio tags retrieved. Wild steelhead, on the other hand, must be released alive, and thus the angler must not only record the spaghetti tag number but also remember to call in the information (without the retrieved tag as a physical prompt). We do not have an estimate of the rate of non-reporting of tagged steelhead during the study; however, field interviews with anglers indicate that radio-tagged steelhead were recaptured by anglers in both 1999 and 2000 and these events were never reported.

Recaptures of Spaghetti-Tag-Only applications (1999)

A total of 69 wild steelhead (30 males and 39 females) were released with a spaghetti tag only (no radio tag) from 8 March to 15 April 1999. Of the total release group, 26 individual steelhead (37.7%) were reported as being recaptured. The total number of recaptures reported for the group was 38, and included 6 double (same fish) and 3 triple (same fish) reported recaptures.

Holding

Holding (pre-spawning staging behavior) locations, by rkm and survey zone, were assigned to all radio-tagged steelhead in both 1999 and 2000 that exhibited holding behavior prior to spawning (Appendix C and D, respectively). Illustrations of holding locations, by survey zone, of hatchery and wild radio-tagged steelhead that exhibited holding behavior in 1999 and 2000 are provided in Figures 7 and 8, respectively.

Prior to spawning, several radio-tagged steelhead did not hold for extended periods of time in a specific location, but moved in short pulses that may be been associated with rain events and/or changes in the water level of the river. Steelhead that entered the river in April (1999 and 2000) and May (1999) tended to have less-defined holding locations than fish that entered the river prior to April; we interpret this behavior as being due to the shorter time period between river entry and spawning.

Spawning Locations

1999 Spawning Locations

All steelhead radio-tagged in 1999 that provided reliable indications of spawning behavior at a specific location were assigned spawning locations, by rkm and survey zone (Appendix C). A summary of these data, stratified by type (hatchery or wild), tagging month, sex, and spawning location (by survey zone) is presented in Table 6. In 1999, a total of 57 radio-tagged steelhead (24 hatchery and 33 wild) provided reliable spawning location information. An illustration of the numbers of hatchery and wild radio-tagged spawners in 1999, by survey zone, is provided in Figure 9.

2000 Spawning Locations

All steelhead radio-tagged in 2000 that provided reliable indications of spawning behavior at a specific location were assigned spawning locations, by rkm and survey zone (Appendix D). A summary of these data, stratified by type (hatchery or wild), tagging month, sex, and spawning location (by survey zone) is presented in Table 7. In 2000, a total of 109 radio-tagged steelhead (38 hatchery and 71 wild) provided reliable spawning location information. An illustration of the numbers of hatchery and wild radio-tagged spawners in 2000, by survey zone, is provided in Figure 10.

Spawning Locations of Hatchery and Wild Steelhead

Data from the telemetry program indicated that hatchery and wild steelhead can spawn in the same spawning areas in the Chilliwack River watershed. The degree to which this overlap occurs is likely based on the relative run strengths of hatchery and wild fish in a given year. A higher proportion of radio-tagged wild steelhead were observed farther upstream in the watershed than hatchery steelhead in both 1999 and 2000. In addition, in both 1999 and 2000, radio-tagged hatchery steelhead spawned in the mainstem Chilliwack River upstream of the outlet of Slesse Creek in both (this area is closed to recreational angling).

In 1999, radio-tagged wild steelhead spawned in the mainstem Vedder and Chilliwack rivers from survey zones 3-5 and 7-9 (Figure 9). Radio-tagged hatchery steelhead spawned from survey zone 3 to survey zone 7; hatchery steelhead were not detected upstream of survey zone 7 in 1999.

In 2000, radio-tagged wild steelhead spawned in the mainstem Vedder and Chilliwack rivers from survey zones 3-5 and 7-9, and in tributaries to Chilliwack Lake (survey zone 11), Slesse Creek (survey zone 12), in upstream tributary (survey zone 13), and the river's mainstem from survey zone 3 to survey zone 8 (Figure 10). Radio-tagged hatchery steelhead spawned from survey zone 3 to survey zone 8, and in a tributary (Slesse Creek).

In both 1999 and 2000, the highest concentrations of spawning of radio-tagged hatchery steelhead occurred in survey zone 5 (Figures 9 and 10). For management considerations, this is important as zone 5 is currently open to recreational angling (that allows the retention of hatchery steelhead) through the month of April; the removal of hatchery steelhead prior to spawning is encouraged by provincial steelhead management authorities (S. Pollard, MWLAP Victoria, pers. comm.).

Spawning locations by run-timing group

In both 1999 and 2000, steelhead spawned in upper, middle, and lower survey zones, and there does not seem to be a strong correlation between river entrance (run) timing groups and tenancies to spawn in upper or lower sections of the river. We have prepared a set of illustrations to show the distribution of spawning locations, by tagging month (Appendix E); the data used to produce these illustrations is also presented in Table 7. A review of the illustrations in Appendix E shows that for most monthly tag-release groups (December 1999 through April 2000), there is a rather broad distribution of steelhead spawning locations across the watershed. For example, wild steelhead tagged in January spawned from the Vedder River (survey zone 3) to the tributaries of Chilliwack Lake (survey zone 11); similarly, wild steelhead tagged in April spawned from the Vedder River to the tributaries of the upper Chilliwack River (survey zones 12 and 13). Low sample sizes of successful spawners for steelhead tagged in December 1999 indicate spawning locations for this group are in the mid and upper sections of the river. For steelhead radio-tagged in February 2000, there is no representation of spawning downstream of survey zone 5, but this could be due to a low sample size for this group (n=14).

Spawning versus holding locations

The high majority of radio-tagged steelhead that spawned did not spawn in their respective holding location (defined by rkm). In both 1999 and 2000, most of the radio-tagged steelhead that spawned moved upstream at least one survey zone from their observed holding location to their respective spawning location (Figures 11 and 12, respectively).

Steelhead spawning near the gravel removal pits (Yarrow)
One of the key objectives of the study was to determine if steelhead spawning occurs in the Vedder River in the vicinity of Vedder Floodway gravel-removal pits (near Yarrow). During the time of the study, there were three main areas of active gravel extraction (rkm 9.0, 9.5, and 11.0); all were in close proximity of the railroad bridge crossing (rkm 10.0), which was the survey zone boundary between survey zone 2 and survey zone 3. In both 1999 and 2000, the lowest (most downstream) survey zone in which radio-tagged steelhead were determined to spawn was survey zone 3.

In 1999, a total of 4 steelhead spawned in survey zone 3 (2 wild females, 1 hatchery female, and 1 hatchery male). The closest spawning location to the gravel extraction areas was at rkm 12.5 (wild female), which is approximately 1.5 km upstream of the gravel extraction area at rkm 11.0. Other spawning locations in survey zone 3 were at rkm 14.0 (hatchery male) and 14.5 (hatchery female, wild female). It is important to note that, prior to spawning, several radio-tagged steelhead did use both survey zone 2 and 3 to hold for extended periods of time, and that some of this extended holding activity was at or in close proximity to the gravel extraction locations. Of the 65 radio-tagged fish that could be assessed for positive holding locations in 1999, 29 (45%) held in survey zones 2 and 3 prior to their upstream spawning migration. Of the 29 steelhead that held in survey zones 2 and 3, 15 (23% of the total sample) held at or within 0.5 km of the gravel extraction locations (rkm 9.5-11.5). The gravel extraction location area at rkm 11.0 was a very popular recreational fishing location, mostly because at low water steelhead would hold in the gravel extraction "pit" and thus be accessible to anglers. The section of river directly upstream from this pit was very shallow and thus steelhead tended to concentrate in the deeper water of the extraction pit. Of the 11 radio-tagged steelhead that held between rkm 11.0 and 11.5, 7 individual steelhead (64%) were reported as being recaptured. In addition, there were 13 reported recapture events of these 7 individual steelhead.

In 2000 we determined that a total of 4 radio-tagged steelhead spawned in survey zone 3 (3 wild males and 1 hatchery female). The spawning location closest to the gravel extraction areas was at rkm 12.0 (1 wild male, 1 hatchery female), which is approximately 1.0 km upstream of the gravel extraction area at rkm 11.0. The other spawning locations in survey zone 3 were at rkm 14.0 (2 wild males). Of the 118 radio-tagged fished that could be assessed for positive holding locations, 35 (30%) held in survey zones 2 and 3 prior to the upstream spawning migration. Of the 35 steelhead that held in survey zones 2 and 3, 17 (14% of the total sample of 118) held at or within 1.0 km of the gravel extraction locations (rkm 9.0-12.0). River bed and water conditions at the gravel extraction location area at rkm 11.0 were different in 2000 from the conditions in 1999; steelhead did not tend to "stack up" in this location for extended periods of time in 2000, and thus reported recaptures (3) were much lower than in 1999.

Timing of Spawning

1999 Estimated Weeks of Spawning

All radio-tagged steelhead that were designated as spawners in 1999 were assigned an estimated week of (peak) spawning activity. Appendix C provides the estimated spawning week (week ending date) and the estimated number of days on the spawning ground (initial spawning only for males that exhibited additional spawning behaviors). In 1999, a total of 57 radio-tagged steelhead (24 hatchery and 33 wild could be assessed for the timing of spawning events. An illustration of the estimated timing of spawning events of radio-tagged hatchery and wild steelhead in 1999 is presented in Figure 13. Telemetry data from 1999 indicate that spawning activities for both hatchery and wild steelhead in the Vedder/Chilliwack River commenced during the first week in March, peaked during the second and third week in May, and were completed the third week in June (Figure 13).

2000 Estimated Weeks of Spawning

All radio-tagged that were designated as spawners in 2000 were assigned an estimated week of (peak) spawning activity. Appendix D provides the estimated spawning week (week ending date) and the estimated number of days on the spawning ground (initial spawning only for males that exhibited additional spawning behaviors). In 2000, a total of 108 radio-tagged steelhead (38 hatchery and 70 wild could be assessed for the timing of spawning events. An illustration of the estimated timing of spawning events of radio-tagged hatchery and wild steelhead in 2000 is presented in Figure 13. Telemetry data from 1999 indicate that spawning activities for both hatchery and wild steelhead in the Vedder/Chilliwack River commenced during the third week in March, peaked during the second and third week in May, and were completed the third week in June (Figure 13).

Comments Regarding Timing of Spawning

The estimated timing of peak spawning activity of hatchery and wild steelhead overlapped in both 1999 and 2000. In both years, spawning activities for both hatchery and wild steelhead commenced in early to mid-March, peaked during the second and third week in May, and were completed the third week in June (Figure 13). Hatchery and wild steelhead commenced spawning activities and peaked in activity at approximately the same time; a lower proportion of wild steelhead were observed to spawn later in both years (second and third week of June) compared to observed spawning events by hatchery steelhead, but this may have been due to low sample sizes (Figure 13).

Recent studies by the Oregon Department of Fish and Wildlife focused on reducing the risks/effects of winter steelhead hatchery programs on the genetic characteristics of wild steelhead. These studies examined the interactions of hatchery and wild steelhead in six Oregon coastal watersheds and found considerable overlap in spawn timing between hatchery and wild steelhead (Lindsay et al. 2000).

Water temperature and timing of spawning
Daily average water temperature data (from Water Survey Canada), taken in the Chilliwack River near the outlet of Slesse Creek, for the years 1999 and 2000 are presented in Figure 14. Temperature data for 1999 and 2000 for the period from March through June are presented in Figure 15. Note that the average daily temperatures in 2000 are slightly higher than in 1999 during the same periods. In 1999, a moderately heavy snow pack at higher elevations in the Chilliwack River watershed may have maintained cooler water temperatures later into the spring. In 2000, the snowpack was comparatively lighter likely resulted in water temperatures that were slightly higher during the same period.

Figure 16 presents illustrations of the estimated timing of steelhead spawning events and daily average water temperatures during these periods for both 1999 and 2000. Note that in both years most of the observed spawning activities commenced when water temperatures reached approximately 6°C and peaked when temperatures reached approximately 7.5-8.0°C. The exact time of spawning is controlled mostly by photoperiod (Bromage et al. 1982; Bromage and Duston 1986), but water temperature can also affect the time of spawning (Lough 1983). In both years, over 88% of the observed spawning occurred between the third week in April and the fourth week in May when water temperatures were between 6.1°C and 8.5°C.

Post-Release Survivals

Catch-and-Release Effects on Survival to Spawning

All steelhead captured (by angling), sampled, and radio-tagged during the 2-year telemetry study were released alive and in excellent condition. Due to the low number of radio-tagged steelhead that exhibited any post-release behaviors indicating death during the 2-year study, we made an assessment of "mortality level" to spawning for radio-tagged steelhead. We felt that a measurement of successful upstream migration to spawning areas was a better measure of the proportion of the released sample that was potentially affected by the capture and release activities. The criteria that we set for a radio-tagged steelhead to be considered as a "survivor" to spawning is that the fish had to move upstream to likely spawning habitat during the spawning period, and maintain this location for several days, and then either kelt (migrate downstream) or die (determined by stationary radio tag at or near the spawning location) following the event. Key in the interpretation of "survival" from the capture and release event was the observed upstream migration by the fish following radio tag application and release.

Estimates of post-release survival to spawning of radio-tagged hatchery and wild steelhead, by sex, for 1999 and 2000 are presented in Tables 8 and 9, respectively. The purpose of these analyses is to provide estimates of the levels of post release "mortality" associated with catch and release activities by conventional angling methods; the evaluation criteria used for these estimates is based on post-release survival (to spawning). Included in the analysis is the effect of not only catch and release activities, but the activities associated with the application of the radio tag, the spaghetti tag, and

sampling (length measurements, scale samples). Due to the added stress and potential negative condition impacts associated with the tagging and sampling process, estimated survival-to-spawning rates would likely be the minimum rates (i.e., steelhead captured and released without the additional applied stress of tagging and sampling should survive at rates higher than those for the tagged group).

In 1999, a total of 63 radio-tagged steelhead could be assessed for survival to spawning; of these, a single radio-tagged steelhead (a hatchery male) could have been a mortality as a result of the initial capture/tagging event. This would produce a minimum survival-to-spawning level for the sample of 98.4% (Table 8). The tag signal from this single radio-tagged steelhead was stationary near the release site.

In 2000, a total of 112 radio-tagged steelhead could be assessed for survival to spawning; of these, 3 radio-tagged steelhead (all wild males) could have been mortalities as a result of the initial capture/tagging event. This would produce a minimum survival-to-spawning level for the sample of 97.3% (Table 9). Of the 3 possible tag mortalities, 2 tags (steelhead) migrated over 2 kms upstream from the release location following release; the remaining tag signal was stationary near the release site following release.

For both years combined (total radio tag release sample of 175 steelhead), a total of 2 radio tags (steelhead) were not detected upstream from the release location. Although there are several possible reasons why this could have occurred, if these steelhead releases did result in mortality as a result of the capture event, the overall mortality level associated with catch-and-release angling in this study would be 1.1%.

Survival to Kelt

Survival-to-kelt rates were determined for radio-tagged hatchery and wild steelhead, by sex and tagging month, for both 1999 and 2000. All individual samples used in the survival-to-kelt analyses were assessed as successful spawners. Adequate telemetry data was required to determine if the fish kelted successfully (detections past station 1) or died following spawning (either at the spawning location, or during the post-spawning downstream migration).

1999

Each radio-tagged steelhead with a positive spawning designation was evaluated for its survival to kelt; the results of these evaluations are presented for individual steelhead in Appendix C. If a radio-tagged steelhead did survive to kelt, the date that it passed station 1 and entered the Fraser River is also provided (Appendix C). A total of 60 radio-tagged spawners (23 hatchery and 37 wild) could be evaluated for survival to kelt in 1999 (Table 10). Of these the 60 spawners, 45 (75.0%) survived to kelt. Table 10 provides a breakdown of these data by hatchery and wild, sex, and tagging month.

2000

Each radio-tagged steelhead with a positive spawning designation was evaluated for its survival to kelt; the results of these evaluations are presented for individual steelhead in Appendix D. If a radio-tagged steelhead did survive to kelt, the date that it passed station 1 and entered the Fraser River is also provided (Appendix D). A total of 109 radio-tagged spawners (38 hatchery and 71 wild) could be evaluated for survival to kelt in 2000 (Table 11). Of these the 109 spawners, 87 (77.1%) survived to kelt. Table 11 provides a breakdown of these data by hatchery and wild, sex, and tagging month.

For both years, males had a lower survival-to-kelt rate (63.8%) than females (82.0%). Hatchery and wild fish had similar survival-to-kelt rates between years (average 76.3%).

Catch-and-Release Effects on Survival to Kelt

In an effort to further identify and quantify the potential effects of capture and release effects (by angling) on the behavior and/or condition of released steelhead, we compared the survival-to-kelt rates between two groups of steelhead radio-tagged in 2000:

1) radio-tagged steelhead exposed to a known single capture event (that being the initial capture and tag application); and

2) radio-tagged steelhead exposed to known multiple capture events (based on reported recaptures of individual fish, identified by spaghetti tag number).

Only steelhead that survived to kelt were used in the analysis (Table 12); all samples had spawned, and reliable information was available to determine either survival to kelt (migration past station 1) or death following spawning. The data used in the analysis were the same data used to produce Table 11 (survival to kelt rates for 2000). We did not conduct similar analyses for data from 1999 due to the low sample size available for 1999.

Table 12 provides a comparison of survival-to-kelt rates for radio-tagged steelhead (2000) captured once (the initial capture and tagging event) and steelhead captured multiple (2 or more) times (based on reporting of recaptures), stratified by hatchery and wild, and sex. Steelhead that did not survive to kelt were assumed to have died following respective spawning events. For the single-capture group, 71 steelhead survived to kelt from a total sample (hatchery and wild) of 90 steelhead (78.9% survival). For the multiple-capture group, 13 steelhead survived to kelt from a total sample (hatchery and wild) of 19 steelhead (68.4% survival). This difference is not significant ($_X^2$, P = 0.324).

Fates and Survival-to-Kelt Rates for Recaptured Steelhead

We summarized the fates and analyzed the survival-to-kelt rates for all radio-tagged steelhead reported as being recaptured in 1999 and 2000 (Table 13). In 1999, 23 steelhead were reported as being recaptured from 1-4 times. Of the 15 recaptured fish

that spawned successfully, 11 (73.3%) survived to kelt. In 2000, 49 steelhead were reported as being recaptured 1-3 times. Of the 19 recaptured fish that spawned successfully, 13 (68.4%) survived to kelt.

Post-Release Behavior of Air-Spawned Steelhead Broodstock

A total of 7 air-spawned, wild female steelhead were radio-tagged at Chilliwack River Hatchery 1-2 days following the air-spawning event and released into the Chilliwack River (near the hatchery intake; Table 14). Following release, 3 of the 7 fish migrated 3-5 km upstream of the hatchery. A total of 5 of the 7 air-spawned steelhead (71%) survived to kelt (past station 1). A summary of air-spawning process, and the results of the telemetry monitoring for each radio-tagged steelhead, are provided in Table 14.

REFERENCES

Alexander, R.F., K.K. English, and W.R. Koski. 1996. Distribution, timing and numbers of steelhead returning to the Skeena watershed in 1995. Report by LGL Limited, Sidney, BC, for Fisheries Branch, BC Ministry of Environment, Lands and Parks, Victoria, BC.

Alexander, R. F., and W. R. Koski. 1995. Distribution, timing and fate of steelhead returning to the Nass River watershed in 1993. Report by LGL Limited, Sidney, BC to the Nisga'a Tribal Council, New Aiyansh, BC. Nisga'a Fisheries Report NF93-10.

Ballard, T. 1985. Anchor River steelhead. Pages 64-67. *In*: F. Van Hulle (ed.). Alaska steelhead workshop. Alaska Department of Fish and Game, Div. of Sport Fisheries, Juneau, AK. 134 p.

Barnhart, R. A. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest) -- steelhead. U.S. Fish. and Wild. Serv. Biol. Rep. 82.

BC Ministry of Environment. 1992. State of the Environment for the lower Fraser River basin. SOE report No. 92-1. 79 p.

Behnke, R.J. 1992. Native trout of western North America. Amer. Fish. Soc. Monograph 6.

Bell, M. C. 1973. Fisheries handbook of engineering requirements and biological criteria. U.S. Army Corps of Engineers, Portland. Contract No. DACW57-68-C-0086. 425 p.

Bison, R. B. 1991. The reproductive biology of steelhead trout *(0. mykiss)* in the Bonaparte River, 1991. Unpublished manuscript prepared for BC Environment, Lands and Parks, Fisheries Branch, Kamloops, BC. 32 p.

Bisson, P. A., K. Sullivan, and J. L. Nielsen. 1988. Channel hydraulics, habitat use, and body form of juvenile coho salmon, steelhead, and cutthroat trout in streams. Trans. Amer. Fish. Soc. 117:262-273.

Bjornn, T. C. 1971. Trout and salmon movements in two Idaho streams as related to temperature, food, stream flow, cover and population density. Trans. Amer. Fish. Soc. 100:423-438.

Bjornn, T. C. and D. W. Reiser. 1991. Habitat requirements of salmonids in streams. Chapter 4. Pages 83-138. *In*: W.R Meehan (ed.). Influences of forest and rangeland management on salmonid fishes and their habitats. Amer. Fish. Soc. Special Publ. 19, Bethesda, Maryland.

Bromage, N., and J. Duston. 1986. The control of spawning in the rainbow trout using photoperiod techniques. Rep. Inst. Fresh. Res. Drottningholm 63:26-35.

Bromage, N., C. Whitehead, J. Elliot, B. Breton and A. Matty. 1982. Investigations in the importance of day length on the photoperiod control of reproduction in the female rainbow trout. Pages 233-236. *In*: C. Richter and H.T. Goos (eds). Reproductive physiology of fish. Pudoc, Wageningen, Netherlands.

Burger, C. V., M. Scott, M. Small and W. Potterville. 1983. Overwintering and spawning areas of steelhead trout (*Salmo gairdneri*) in tributaries of the Upper Copper River, Alaska. U.S. Fish. and Wild. Serv., Anchorage. 24 p.

Burgner, R. T., J. T. Light, L. Margolis, T. Okazaki, A. Tautz and S. Ito. 1992. Distribution and origins of steelhead trout (*Oncorhynchus mykiss*) in offshore waters of the North Pacific Ocean. Inter. N. Pacific Fish. Comm. Bull. No. 51. 92 p.

Bustard, D. R. and D. W. Narver. 1975. Aspects of the winter ecology of juvenile coho salmon (*Oncorhynchus kisutch*) and steelhead trout (*Salmo gairdneri*). J. Fish. Res. Board Can. 32:667-680.

Cederholm, C. J. 1984. Clearwater River wild steelhead spawning timing. Pages 257-268. *In*: J.M. Walton and D.B. Houston (eds). Proceedings of the Olympic wild fish conference, March 23-25, 1983. Port Angeles, WA.

Coble, D. W. 1961. Influence of water exchange and dissolved oxygen in redds on survival of steelhead trout embryos. Trans. Amer. Fish Soc. 90:469-474.

Danzmann, R. G., M. M. Ferguson and D. M. Heculuck. 1994. Heterogeneity in the distribution of mitochondrial DNA haplotypes in female rainbow trout spawning in different seasons. Can. J. Fish. Aquat. Sci. 51(Suppl. 1):284-289.

Dodge, D. P. and H. R. MacCrimmon. 1971. Environmental influences on extended spawning of rainbow trout (*Salmo gairdneri*). Trans. Amer. Fish. Soc. 100:312-318.

English, K. K., R. F. Alexander, T. C. Nelson, and M. K. Ramsay. 1999. Assessment of the distribution, timing, and abundance of adult steelhead returns to the Bella Coola River watershed in 1997 and 1998. Report for Ministry of Environment, Lands and Parks, Williams Lake, BC and Ministry of Fisheries, Victoria, BC by LGL Limited, Sidney, BC.

Fausch, K. D. and T. G. Northcote. 1992. Large woody debris and salmonid habitat in a small coastal British Columbia stream. Can. J. Fish. Aquat. Sci. 49:682-693.

French, R. R. and R. J. Wahle. 1959. Biology of chinook and blueback salmon and steelhead in the Wenatchee River system. U.S. Fish and Wild. Spec. Sci. Rep. Fish. 304: 1-17.

Godfrey, H., K. A. Henry and S. Machidori. 1975. Distribution and abundance of coho salmon in offshore waters of the North Pacific Ocean. Inter. N. Pacific Fish. Comm. Bull. 31:1-80.

Hartman, W. L. 1959. Biological and vital statistics of rainbow trout in the Finger Lakes region, New York. N.Y. Fish and Game J. 6:121-178.

Hartt, A. C . and M. B. Dell. 1986. Early oceanic migrations and growth of juvenile Pacific salmon and steelhead trout. Inter. N. Pac. Fish. Comm., Bull No. 46. 105 p.

Koski, W. R., and K. K. English. 1996. Status of Nass River steelhead. Report by LGL Limited, Sidney, BC, for Fisheries Branch, BC Ministry of Environment, Lands and Parks, Victoria, BC 95 p.

Light, J. T., S. Fowler and M. L. Dahlberg. 1988. High seas distribution of North American steelhead as evidenced by recoveries of marked or tagged fish. (Document to International Northern Pacific Fisheries Commission), Fisheries Research Institute, University of Washington, Seattle. FRI-UW-8816. 21 p.

Lindsay, R. B., K. R. Kenaston, and R. K. Schroeder. 2001. Reducing impacts of hatchery steelhead programs. Report by Oregon Department of Fish and Wildlife. 88 p.

Lough, M. J. 1983. Radio-telemetry studies of summer steelhead trout in the Cranberry, Kispiox, Kitwanga and Zymoetz rivers and Toboggan Creek, 1980. BC Fish and Wildlife Branch, Ministry of the Environment, Lands and Parks. Smithers. Skeena Fisheries Report SK-33 [#80-04]. 72 p.

McGregor, I.A. 1986. Freshwater biology of Thompson River steelhead (*Salmo gairdneri*). Masters Thesis. University of Victoria. 151 p.

Morrow, J. E. 1980. Freshwater fishes of Alaska. Northwest Publishing Company, Anchorage. 248 p.

Nelson, T. C., C. Mussell, J. Rissling. 2004. Upper Skagit watershed native char project: Progress Report 2003. Report prepared for Ministry of Water, Land and Air Protection, Victoria, BC, by LGL Limited, Crescent Beach, BC.

Nelson, T. C., R. J. Bussanich, K. K. English, and R. E. McNicol. 2001. Chinook escapement to the Wannock River 2000 – An assessment of run timing, behavior, abundance, and fate using biotelemetry and mark-recapture techniques. Report prepared for Fisheries and Oceans Canada, Salmon Section, Stock Assessment Division, Nanaimo, BC, by LGL Limited, Sidney, BC.

Nelson, T. C., and M. Gaboury. 2001. Coldwater River Watershed Recovery Plan. Report prepared for the Pacific Salmon Endowment Fund Society, Vancouver, BC, by LGL Limited, Sidney, BC. 47 p.

Nelson, T. C., and P. A. Caverhill. 1999. Chilliwack Lake char angler survey 1998. Report for Ministry of Environment, Lands and Parks, Fish, Wildlife and Habitat Protection, Lower Mainland Region, Surrey, BC, by LGL Limited, Sidney, BC 65 p.

Nelson, T. C., R. G. Bison, and J. R. Renn. 1998(a). Fraser River steelhead telemetry program 1996-97. Report for Ministry of Environment, Lands and Parks, Southern Interior Region, Kamloops, BC and Ministry of Fisheries, Victoria, BC, by LGL Limited, Sidney, BC. 112 p.

Nelson, T. C., R. F. Alexander, K. K. English, and R. A. Ptolemy. 1998(b). Compilation of stock assessment information for Bella Coola River steelhead. Report for Ministry of Environment, Lands and Parks, Williams Lake, BC and Ministry of Fisheries, Victoria, BC by LGL Limited, Sidney, BC 125 p.

Nelson, T. C. and R. F. Alexander. 1995. Radio Biotelemetry of movements of sub-mature starry flounder (*Platichthys stellatus*) in the Fraser River Estuary during March and April 1994. Part II *In*: T. C. Nelson (editor). Studies of the starry flounder in the Fraser River, 1992-94. Report prepared for Fraser River Estuary Management Program, Water Quality/Waste Management Committee. Technical Report WQM 95-02. v + 71 p.

Parkinson, E. A. 1984. Genetic variation in populations of steelhead trout (*Salmo gairdneri*) in British Columbia. Can. J. Fish. Aquat. Sci. 41:1412-1420.

Peven, C. M., R. R. Whitney, and K. R. Williams. 1994. Age and length of steelhead smolts from the mid-Columbia River basin, Washington. N. Amer. J. Fish. Manag. 14:77-86.

Renn, J. R., R. G. Bison, J. Hagen, and T. C. Nelson. 2002. Migration characteristics and stock composition of interior Fraser steelhead as determined by radio telemetry, 1996-1999. In: The interior Fraser steelhead telemetry program, 1996-2000. Report for Ministry of Water, Land and Air Protection, Southern Interior Region, Kamloops, BC.

Ruggerone, G. T., T. P. Quinn, I. A. McGregor, and T. D. Wilkinson. 1990. Horizontal and vertical movements of adult steelhead trout. *Oncorhynchus mykiss*, in Dean and Fisher channels, British Columbia. Can. J. Fish. Aquat. Sci. 47:1963-1969.

Scott, W. B. and E. J. Crossman. 1973. Freshwater fishes of Canada. Bull. Fish. Res. Board Can. 184. 196 p.

Shirvell, C. S. 1990. Role of instream rootwads as juvenile coho salmon (*Oncorhynchus kisutch*) and steelhead trout (*O. mysiss*) cover habitat under varying streamflows. Can. J. Fish. Aquat. Sci. 47:852-861.

Spence, C. R. 1981. Radio telemetry and mark-recovery assessment of adult summer-run steelhead in the Chilcotin River system, 1979-80. Ministry of Environment (Williams Lake, BC) Tech. Rep. No. F-81-5. 55 p.

Sutherland, D. F. 1973. Distribution, seasonal abundance, and some biological features of steelhead trout, *Salmo gairdneri*, in the North Pacific Ocean. Fish. Bull. (U.S) 71(3):787-807.

Taylor, G. T. and R. J. LeBrasseur. 1957. Distribution, age and food of steelhead trout *Salmo gairdneri* caught in the northeast Pacific Ocean, 1956. Fish. Res. Board Can. Pac. Prog. Rep. 109:9-11.

Wilkinson, T. D. 1981. Investigation of Steelhead Trout (*Salmo gairdneri*) and other fish species in Camera Channel (Atnarko River) with recommendations for enhancement: Data record and progress report, 1980. Ministry of Environment, Williams Lake, BC

Wallis, J. and D. T. Balland. 1984. Anchor River steelhead study. Alaska Dept. Fish Game. Fed. Aid in Fish Restoration. AFS-48. 48 p.

Withler, I. L. 1966. Variability in life history characteristics of steelhead trout (*Salmo gairdneri*) along the Pacific coast of North America. J. Fish. Res. Bd Can. 23:365-392.

TABLES

Table 1. Survey zone designations and locations, by river kilometer, in the Vedder/Chilliwack River, used during the 1999* and 2000 Vedder/Chilliwack River steelhead telemetry programs.

Survey Zone Number	River Kilometer From	River Kilometer To	Zone Length (km)	Location From	Location To
1	0.0	3.0	3.0	Mouth of Fraser River	Telemetry Station 1
2	3.0	10.0	7.0	Telemetry Station 1	Railroad Bridge
3	10.0	15.5	5.5	Railroad Bridge	Vedder Crossing (bridge)
4	15.5	26.5	11.0	Vedder Crossing (bridge)	Tamihi Creek Bridge
5	26.5	38.0	11.5	Tamihi Creek Bridge	Mouth of Slesse Creek
6				Chilliwack River Hatchery	Chilliwack River Hatchery
7	38.0	46.5	8.5	Mouth of Slesse Creek	Bridge over Chilliwack River
8	46.5	58.5	12.0	Bridge over Chilliwack River	Telemetry Station 9
9	58.5	61.0	2.5	Telemetry Station 9	Outlet of Chilliwack Lake
10	61.0	(lake)		Outlet of Chilliwack Lake	(Chilliwack Lake)
11				Tributaries of Chilliwack Lake	(Upper Chilliwack, Paleface, Depot creeks)
12				Slesse Creek (outlet)	Slesse Creek (upstream reaches)
13				Upstream Tributaries	(Foley, Chipmunk, Center creeks)

* Survey zones 11-13 were not used during the 1999 study

Table 2. Number of hatchery and wild steelhead radio tagged, by month, survey zone[1], and sex, during the Vedder/Chilliwack steelhead telemetry program, 1999.

Hatchery or Wild	Tagging Month	NUMBER OF STEELHEAD RADIO TAGGED 1999												
		Zone 2		**Zone 3**		**Zone 4**		**Zone 5**		**Zone 7**		Total (all zones)		
		Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	M + F
Hatchery														
	January		2							2	1	2	3	5
	February		1	2	1	2	1				2	4	5	9
	March	1		3	2							4	2	6
	April	3		2	2							5	2	7
	May						1			1	2	1	3	4
Total Hatchery		4	3	7	5	2	2	0	0	3	5	**16**	**15**	**31**
Wild														
	January			2	1					3	1	5	2	7
	February			2	5	1						3	5	8
	March			4	8		1					4	9	13
	April		2		2	1	2			1	1	2	7	9
	May								2		2	0	4	4
Total Wild		0	2	8	16	2	3	0	2	4	4	**14**	**27**	**41**
Total Number of Radio-Tagged Hatchery and Wild Steelhead (all zones)												**30**	**42**	**72**

[1] Radio tags were not deployed in river zones 1, 6, 8, 9, or 10. See Figure 3 for an illustration of river zone locations.

Table 3. Number of hatchery and wild steelhead radio tagged, by month, survey zone[1], and sex, during the Vedder/Chilliwack River steelhead telemetry program, 2000.

Hatchery or Wild	Tagging Month	NUMBER OF STEELHEAD RADIO TAGGED 2000												
		Zone 2		**Zone 3**		**Zone 4**		**Zone 5**		**Zone 7**		Total (all zones)		
		Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	M + F
Hatchery														
	December			1	2					1	1	2	3	5
	January	1	5	2	11		4				3	3	23	26
	February		2	3	3							3	5	8
	March		1	3	4	1						4	5	9
	April			2	18		2					2	20	22
	Total Hatchery	1	8	11	38	1	6	0	0	1	4	**14**	**56**	**70**
Wild														
	December	3					1					3	1	4
	January	2	1	6	12	1	2				1	9	16	25
	February	1		8	2	1	1	1				11	3	14
	March		1	6	11	2	2					8	14	22
	April			6	11	1	1					7	12	19
	Total Wild	6	2	26	36	5	7	1	0	0	1	**38**	**46**	**84**
	Total Number of Radio-Tagged Hatchery and Wild Steelhead (all zones)											**52**	**102**	**154**

[1] Radio tags were not deployed in survey zones 1, 6, 8, 9, or 10. See Figure 3 for an illustration of survey zone locations.

Table 4. Summary of reported recaptures of individual radio-tagged steelhead, and the total number of recaptures of radio-tagged steelhead (includes multiple recaptures of individual steelhead), following release and prior to spawning, in the Vedder/Chilliwack River, 1999.

NUMBER OF INDIVIDUAL STEELHEAD REPORTED BEING RECAPTURED 1999

	Male			Female			Total Male and Female		
Hatchery or Wild	Radio-tagged Steelhead Sample Size *(n)*	Number of Individual Steelhead Recaptured by Anglers Prior to Spawning	Percent of Individual Steelhead Recaptured by Anglers	Radio-tagged Steelhead Sample Size *(n)*	Number of Individual Steelhead Recaptured by Anglers Prior to Spawning	Percent of Individual Steelhead Recaptured by Anglers	Radio-tagged Steelhead Sample Size *(n)*	Number of Individual Steelhead Recaptured by Anglers Prior to Spawning	Percent of Individual Steelhead Recaptured by Anglers
Hatchery	15	5	33.3%	15	7	46.7%	30	12	40.0%
Wild	13	6	46.2%	27	5	18.5%	40	11	27.5%

TOTAL NUMBER OF REPORTED RECAPTURES OF STEELHEAD 1999[1]

	Male			Female			Total Male and Female[2]		
Hatchery or Wild	Radio-tagged Steelhead Sample Size *(n)*	Number of Unique Recapture Events by Anglers Prior to Spawning	Percent of Radio-tagged Steelhead Recaptured by Anglers[3]	Radio-tagged Steelhead Sample Size *(n)*	Number of Unique Recapture Events by Anglers Prior to Spawning	Percent of Radio-tagged Steelhead Recaptured by Anglers[3]	Radio-tagged Steelhead Sample Size *(n)*[3]	Number of Unique Recapture Events by Anglers Prior to Spawning	Percent of Radio-tagged Steelhead Recaptured by Anglers[3]
Hatchery	15	6	40.0%	15	7	46.7%	30	13	43.3%
Wild	13	11	84.6%	27	7	25.9%	40	18	45.0%

[1] All recaptures presented for individual fish are single recaptures, with the exception of 4 double recaptures (same fish) and 1 quadruple recapture (same fish) for a total of 8 additional reported (minimum) recapture events

[2] The total number of radio-tagged fish used in this analysis (n = 70) is 2 tags less than the total number of tags released (n = 72); two tags (Fish Nos. 36 and 51) could not be included in the analysis (tag 36 disappeared in a popular fishing area, and tag 51 was stationary at the point of release); neither tag was reported as a recapture; see Appendix C for additional information

[3] This recapture rate assumes that each recapture of a radio-tagged steelhead is a unique event; given accurate recapture reporting, the sum of these events represent the minimum (known) recapture rates for respective groups; however, it is likely that there is an under reporting of recaptures, especially for wild steelhead

Table 5. Summary of reported recaptures of individual radio-tagged steelhead, and the total number of recaptures of radio-tagged steelhead (includes multiple recaptures of individual steelhead), following release and prior to spawning, in the Vedder/Chilliwack River, 2000.

NUMBER OF INDIVIDUAL STEELHEAD REPORTED BEING RECAPTURED 2000

	Male			Female			Total Male and Female		
Hatchery or Wild	Radio-tagged Steelhead Sample Size *(n)*	Number of Individual Steelhead Recaptured by Anglers Prior to Spawning	Percent of Individual Steelhead Recaptured by Anglers	Radio-tagged Steelhead Sample Size *(n)*	Number of Individual Steelhead Recaptured by Anglers Prior to Spawning	Percent of Individual Steelhead Recaptured by Anglers	Radio-tagged Steelhead Sample Size *(n)*	Number of Individual Steelhead Recaptured by Anglers Prior to Spawning	Percent of Individual Steelhead Recaptured by Anglers
Hatchery	14	6	42.9%	56	27	48.2%	70	33	47.1%
Wild	38	11	28.9%	46	5	10.9%	84	16	19.0%

TOTAL NUMBER OF REPORTED RECAPTURES OF STEELHEAD 2000[1]

	Male			Female			Total Male and Female		
Hatchery or Wild	Radio-tagged Steelhead Sample Size *(n)*	Number of Unique Recapture Events by Anglers Prior to Spawning	Percent of Radio-tagged Steelhead Recaptured by Anglers[2]	Radio-tagged Steelhead Sample Size *(n)*	Number of Unique Recapture Events by Anglers Prior to Spawning	Percent of Radio-tagged Steelhead Recaptured by Anglers[2]	Radio-tagged Steelhead Sample Size *(n)*	Number of Unique Recapture Events by Anglers Prior to Spawning	Percent of Radio-tagged Steelhead Recaptured by Anglers[2]
Hatchery	14	8	57.1%	56	31	55.4%	70	39	55.7%
Wild	38	17	44.7%	46	7	15.2%	84	24	28.6%

[1] All recaptures presented for individual fish are single recaptures, with the exception of 8 double recaptures (same fish) and 3 triple recaptures (same fish) for a total of 14 additional reported (minimum) recapture events

[2] This recapture rate assumes that each recapture of a radio-tagged steelhead is a unique event; given accurate recapture reporting, the sum of these events represent the minimum (known) recapture rates for respective groups; however, it is likely that there is an under reporting of recaptures, especially for wild steelhead

Table 6. Spawning location (by survey zone[1]) of hatchery and wild radio-tagged steelhead, by sex, that spawned in the Chilliwack River watershed, by tagging month, during the Vedder/Chilliwack River steelhead telemetry program, 1999.

SPAWNING LOCATION (SURVEY ZONE) OF RADIO-TAGGED STEELHEAD THAT SPAWNED 1999

Hatchery or Wild	Tagging Month	*Downstream of Hatchery*								*Hatchery Outfall*		*Upstream of Hatchery*						Total (all zones)		
		Zone 2		Zone 3		Zone 4		Zone 5		Zone 6		Zone 7		Zone 8		Zone 9				
		Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	M + F
Hatchery																				
	January						1		2	1								1	3	4
	February							1	3	1	2							2	5	7
	March							1		2			2					3	2	5
	April			1				1	1	1								3	1	4
	May				1		1					1	1					1	3	4
Total Hatchery		0	0	1	1	0	2	3	6	5	2	1	3	0	0	0	0	**10**	**14**	**24**
Wild																				
	January							1					1	2		2	1	5	2	7
	February				1	1	1		1				1	1	1	1		3	5	8
	March					1	1	1	2			1	1		4			3	8	11
	April				1	1	1		1				3					1	6	7
	May																	0	0	0
Total Wild		0	0	0	2	3	3	2	4	0	0	1	6	3	5	3	1	**12**	**21**	**33**
Total Numbers of Radio-Tagged Hatchery and Wild Steelhead that Spawned[2]																		**22**	**35**	**57**

[1] See Figure 3 for an illustration of survey zone locations.

[2] Totals do not include 5 steelhead that spawned and kelted with unknown spawning locations (these fish left the system soon after tagging and did not exhibit typical spawning behavior; it is possible that these fish were tagged as post-spawning kelts)

Table 7. Spawning location (by survey zone[1]) of hatchery and wild radio-tagged steelhead, by sex, that spawned in the Chilliwack River watershed, by tagging month, during the Vedder/Chilliwack River steelhead telemetry program, 2000.

SPAWNING LOCATION (SURVEY ZONE) OF RADIO-TAGGED STEELHEAD THAT SPAWNED 2000

Hatchery or Wild	Tagging Month	*Downstream of Hatchery*								*Hatchery Outfall*		*Upstream of Hatchery*											
		Zone 2		**Zone 3**		**Zone 4**		**Zone 5**		**Zone 6**		**Zone 7**		**Zone 8**		**Zone 9**		**Tributary**		**Total (all zones)**		
		Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	M + F
Hatchery																						
	December							1			2									1	2	3
	January						1	1	1		2		2						1	1	7	8
	February							1	1					1						2	1	3
	March				1			2	2	1	1									3	4	7
	April						2	1	7		4	1	2							2	15	17
	Total Hatchery	0	0	0	1	0	3	6	11	1	9	1	4	1	0	0	0	0	1	**9**	**29**	**38**
Wild																						
	December													1	1	1				2	1	3
	January			1				2	3			1	7	1	2			1	4	6	16	22
	February							2	3			1		2		1		2		8	3	11
	March						1	1	2			3	5		2	1	1	1	1	6	12	18
	April			2		1	1		2				8	1				2		6	11	17
	Total Wild	0	0	3	0	1	2	5	10	0	0	5	20	5	5	3	1	6	5	**28**	**43**	**71**
	Total Numbers of Radio-Tagged Hatchery and Wild Steelhead that Spawned																			**37**	**72**	**109**

[1] See Figure 3 for an illustration of survey zone locations.

Table 8. Number and percent of radio-tagged hatchery and wild steelhead that were assessed to have spawned successfully following release (from the 1999 Vedder/Chilliwack River steelhead telemetry program). Only those steelhead that could be assessed for survival to spawning were used in this analysis (steelhead that were recaptured and killed, or disappeared from the study area, were not included in this assessment).[1]

POST-RELEASE SURVIVAL TO SPAWNING 1999

Hatchery or Wild	Male				Female				Male and Female			
	n	No. Reported Recapture Events	No. Successful Spawners	Percent Successful Spawners	*n*	No. Reported Recapture Events	No. Successful Spawners	Percent Successful Spawners	*n*	No. Reported Recapture Events	No. Successful Spawners	Percent Successful Spawners
Hatchery	11	6	10	90.9%	14	7	14	100.0%	25	13	24	96.0%
Wild	12	11	12	100.0%	26	7	26	100.0%	38	18	38	100.0%
Hatchery and Wild	23	17	22	95.7%	40	14	40	100.0%	**63**	**31**	**62**	**98.4%**

[1] A total of 63 radio-tagged steelhead could be assessed for survival to spawning from the total radio-tag release group of 72 steelhead; the remaining 9 steelhead could not be assessed for survival to spawning for the following reasons:

- hatchery steelhead killed by anglers (tag returned, $n = 5$)
- suspected to have been killed by anglers (tag disappeared in popular fishing area following period of normal signal transmission, $n = 2$)
- fish left system 7 days after tagging (could have spawned and kelted, but uncertain fate, possible that the fish was a kelt when tagged, $n = 1$)
- tag removed by angler and fish released alive, tag returned ($n = 1$).

Possible tagging moralities

71 of the 72 radio tag releases moved various distances upstream following release, which indicates survival from the capture and tagging events. Available information for the fate of one radio-tagged steelhead (Fish No. 5, a hatchery male) could not positively rule out the possibility of mortality as a result of the initial capture/tagging event; this fish was in excellent condition at the time of release, but the tag was detected a the point of release for the remainder of the study:

Table 9. Number and percent of radio-tagged hatchery and wild steelhead that were assessed to have spawned successfully following release (from the 2000 Vedder/Chilliwack River steelhead telemetry program). Only those steelhead that could be assessed for survival to spawning were used in this analysis (steelhead that were recaptured and killed, or disappeared from the study area, were not included in this assessment).[1]

POST-RELEASE SURVIVAL TO SPAWNING 2000

	Male				Female				Male and Female			
Hatchery or Wild	*n*	No. Reported Recapture Events	No. Successful Spawners	Percent Successful Spawners	*n*	No. Reported Recapture Events	No. Successful Spawners	Percent Successful Spawners	*n*	No. Reported Recapture Events	No. Successful Spawners	Percent Successful Spawners
Hatchery	9	4	9	100.0%	29	7	29	100.0%	38	11	38	100.0%
Wild	31	5	28	90.3%	43	7	43	100.0%	74	12	71	95.9%
Hatchery and Wild	40	9	37	92.5%	72	14	72	100.0%	**112**	**23**	**109**	**97.3%**

[1] A total of 112 radio-tagged steelhead could be assessed for survival to spawning from the total radio-tag release group of 154 steelhead; the remaining 42 steelhead that could not be assessed for survival to spawning for the following reasons:

- hatchery steelhead killed by anglers (tag returned, *n* = 24)
- suspected to have been killed by anglers (tag disappeared in popular fishing area following period of normal signal transmission, *n* = 8)
- radio-tagged fish likely recaptured and either killed or released (tag found in water or on beach, tag turned in with no information *n* = 6)
- tag stationary in popular fishing area following a period of normal upstream migration and behavior (fish could have been recaptured and released, tag regurgitation, spawned/died, or recaptured by angler and tag removed and left in river; *n* = 4)

Possible tagging moralities

Available information for the fates 3 of radio-tagged steelhead (all wild males) could not positively rule out the possibility of mortality as a result of the initial capture/tagging event; note that following release, 2 of these fish moved upstream of release locations (indicates initial survival from capture and tagging events):

1) Fish No. 67 was found dead near the release location and the radio tag antenna appeared to have been tampered with, which suggests a recapture following release; however, because there was no reporting of this fish as a recapture, this fish could be considered a mortality as a result of the initial capture/tagging event
2) The radio tags for Fish Nos. 94 and 95 became stationary in a popular fishing location about 2 km upstream from the tag release site 5-7 days following tagging (these fish could have spawned and died, or regurgitated the tag, or were recaptured and the tag removed and left in the river, or recaptured and died following release, or died with no recapture and thus could be considered a mortality as a result of the initial capture/tagging event).

Table 10. Number and percent of radio-tagged hatchery and wild steelhead that spawned successfully and then survived to kelt[1], by tagging month and sex, during the Vedder/Chilliwack River steelhead telemetry program, 1999.

Note: Unless otherwise noted,[2] successful spawners presented in this analysis that did not survive to kelt were determined to have died in the Chilliwack River watershed after respective spawning events.

SURVIVAL TO KELT 1999

		Male			Female			Male and Female		
Hatchery or Wild	Tagging Month	No. Spawners	No. Survived to Kelt	Survived to Kelt (%)	No. Spawners	No. Survived to Kelt	Survived to Kelt (%)	No. Spawners	No. Survived to Kelt	Survived to Kelt (%)
Hatchery										
	January	-	-	-	3	2	66.7%	3	2	66.7%
	February	2	1	50.0%	5	5	100.0%	7	6	85.7%
	March	3	2	66.7%	2	2	100.0%	5	4	80.0%
	April	3	2	66.7%	1	1	100.0%	4	3	75.0%
	May	1	1	100.0%	3	2	66.7%	4	3	75.0%
Total Hatchery		**9**	**6**	**66.7%**	**14**	**12**	**85.7%**	**23**	**18**	**78.3%**
Wild										
	January	5	2	40.0%	2	1	50.0%	7	3	42.9%
	February	3	1	33.3%	5	3	60.0%	8	4	50.0%
	March	3	1	33.3%	9	9	100.0%	12	10	83.3%
	April	1	1	100.0%	5	5	100.0%	6	6	100.0%
	May	-	-	-	4	4	100.0%	4	4	100.0%
Total Wild		**12**	**5**	**41.7%**	**25**	**22**	**88.0%**	**37**	**27**	**73.0%**
Hatchery and Wild[2]										
(all months)		**21**	**11**	**52.4%**	**39**	**34**	**87.2%**	**60**	**45**	**75.0%**

[1] Kelts are defined as steelhead that survived spawning (in this study, fish that were assessed as successful spawners and later migrated downstream past fixed-station 1 and entered the Fraser River). Sample size includes all steelhead that could be assessed for survival-to-kelt or death following spawning (does not include radio-tagged fish with unknown fates or fish that were killed by anglers).

[2] Two fish that spawned (Fish Nos. 2 and 60) were not included in this analysis because there was no record of them passing Station 1 and entering the Fraser River (the definition of "kelt" in this analysis; both of these fish spawned, but the tags stopped transmitting (or the fish were removed from the river); thus, a positive fate of "death following spawning" or "kelt" could not be assigned

Table 11. Number and percent of radio-tagged hatchery and wild steelhead that spawned successfully and then survived to kelt[1], by tagging month and sex, during the Vedder/Chilliwack River steelhead telemetry program, 2000.

Note: Successful spawners presented in this analysis that did not survive to kelt were determined to have died in the Chilliwack River watershed after respective spawning events.

SURVIVAL TO KELT 2000										
		Male			Female			Male and Female		
Hatchery or Wild	Tagging Month	No. Spawners	No. Survived to Kelt	Survived to Kelt (%)	No. Spawners	No. Survived to Kelt	Survived to Kelt (%)	No. Spawners	No. Survived to Kelt	Survived to Kelt (%)
Hatchery										
	December	1	1	100.0%	2	2	100.0%	3	3	100.0%
	January	1	1	100.0%	7	5	71.4%	8	6	75.0%
	February	2	1	50.0%	1	1	100.0%	3	2	66.7%
	March	3	3	100.0%	4	3	75.0%	7	6	85.7%
	April	2	2	100.0%	15	10	66.7%	17	12	70.6%
	Total Hatchery	**9**	**8**	**88.9%**	**29**	**21**	**72.4%**	**38**	**29**	**76.3%**
Wild										
	December	2	0	0.0%	1	1	100.0%	3	1	33.3%
	January	6	6	100.0%	16	13	81.3%	22	19	86.4%
	February	8	5	62.5%	3	2	66.7%	11	7	63.6%
	March	6	3	50.0%	12	11	91.7%	18	14	77.8%
	April	6	4	66.7%	11	10	90.9%	17	14	82.4%
	Total Wild	**28**	**18**	**64.3%**	**43**	**37**	**86.0%**	**71**	**55**	**77.5%**
Hatchery and Wild										
	(all months)	**37**	**26**	**70.3%**	**72**	**58**	**80.6%**	**109**	**84**	**77.1%**

[1] Kelts are defined as steelhead that survived spawning (in this study, fish that were assessed as successful spawners and later migrated downstream past fixed-station 1 and entered the Fraser River). Sample size includes all steelhead that could be assessed for survival-to-kelt or death following spawning (does not include radio-tagged fish with unknown fates or fish that were killed by anglers).

Table 12. Comparison of survival-to-kelt rates among groups of radio-tagged steelhead captured once (initial capture for tagging) and groups of steelhead reported to be recaptured (and released) by recreational anglers following the initial release, 2000. Only those steelhead that could be assessed for survival to kelt* were used in this analysis (steelhead that were recaptured and killed, or disappeared from the study area were not included in this assessment). Data from Vedder/Chilliwack River steelhead telemetry program 2000.

SURVIVAL TO KELT - SINGLE vs. MULTIPLE CAPTURE EVENTS 2000

	Single Captures (No Reported Recaps)			Multiple Captures (Reported Recaps)			Single and Multiple Captures[1]		
		Survival to Kelt			Survival to Kelt			Survival to Kelt	
	n	No.	%	*n*	No.	%	*n*	No.	%
Hatchery									
Male	6	5	83.3%	3	3	100.0%	9	8	88.9%
Female	23	17	73.9%	6	4	66.7%	29	21	72.4%
Male and Female	29	22	**75.9%**	9	7	**77.8%**	38	29	**76.3%**
Wild									
Male	23	16	69.6%	5	2	40.0%	28	18	64.3%
Female	38	33	86.8%	5	4	80.0%	43	37	86.0%
Male and Female	61	49	**80.3%**	10	6	**60.0%**	71	55	**77.5%**
Hatchery and Wild									
Male	29	21	72.4%	8	5	62.5%	37	26	70.3%
Female	61	50	82.0%	11	8	72.7%	72	58	80.6%
Male and Female	90	71	**78.9%** [2]	19	13	**68.4%** [2]	109	84	**77.1%**

* Survival to kelt is defined as the observed (detected via telemetry) outmigration of radio-tagged steelhead past station 1 (at the Fraser River confluence) following spawning

[1] See Table 9 for survival-to-kelt information for all captures (single and multiple), by tagging month

[2] A comparative analysis was conducted as a measure of delayed mortality from additional stress associated with multiple capture events; comparison of pooled values showed no significant difference between the survival-to-kelt rates of single vs. multiple recaptures (x^2, P>0.32)

Table 13. Fates of radio-tagged steelhead recaptured by recreational anglers during the Vedder/Chilliwack River steelhead telemetry project, 1999 and 2000.

Note: All radio-tagged steelhead (1999: n = 72; 2000: n = 154) were captured by conventional sport angling methods; this analysis looks at the fate of radio tagged steelhead that were recaptured by sport anglers on the Chilliwack River. In 1999, of the 23 reported recaptures of individual steelhead, (identified by spaghetti tag number), 8 of these were recaptured 2-4 times. In 2000, of the 49 reported recaptures of individual steelhead, 14 of these were recaptured 2-3 times. In addition, the percentage of radio-tagged hatchery steelhead killed by anglers is not representative of the proportional harvest of hatchery steelhead, in that anglers were encouraged to release tagged steelhead for the purpose of this study. Recapture estimates are minimum estimates based on known under reporting (see text).

Recaptured (Reported) Radio-Tagged Steelhead 1999

	Number	Percent
Total number of individual steelhead recaptured (1-4 times)	**23**	
Recaptures that spawned, kelted	11	22.4%
Recaptures that spawned, died	4	8.2%
Spawned, unknown kelt status [1]	2	4.1%
Recaptures killed by angler (all hatchery fish)	5	10.2%
Tag removed by angler	1	2.0%
	Number	Percent
Recaptured and released steelhead that spawned [2]	**15**	
Recaptured and released steelhead that spawned and kelted	11	73.3%
Recaptured and released steelhead that spawned and died	4	26.7%

Recaptured (Reported) Radio-Tagged Steelhead 2000

	Number	Percent
Total number of individual steelhead recaptured (1-3 times)	**49**	
Recaptures that spawned, kelted	13	26.5%
Recaptures that spawned, died	6	12.2%
Recaptures killed by angler (all hatchery)	24	49.0%
Tag removed by angler, fish released	5	10.2%
Unknown fate (possible tag removal)	1	2.0%
	Number	Percent
Recaptured and released steelhead that spawned [2]	**19**	
Recaptured and released steelhead that spawned and kelted	13	68.4%
Recaptured and released steelhead that spawned and died	6	31.6%

[1] After spawning, fish moved downstream, but tag battery died or fish removed (June); not detected at Station 1

[2] Uses fish with known kelt status (kelted or died) only; does not include the 2 spawners not detected at Station 1

Table 14. Summary of post-release information for 7 air-spawned wild female steelhead, radio tagged at Chilliwack River Hatchery on 19 April 2000.

Fish No.	Tag Date	Radio Tag Channel	Radio Tag Code	Fork Length (cm)	Final Detection Location	Final Detection Rkm	Fate	Date Past Station 1	No. Days to Station 1
1	19-Apr-00	1	114	80.5	Hatchery Outlet	39.5	Died near hatchery	-	
2	19-Apr-00	1	117	67.0	Station 1	3.0	Kelted past Station 1	08-May-00	19
3	19-Apr-00	1	120	78.5	Station 1	3.0	Kelted past Station 1	29-Apr-00	9
4	19-Apr-00	1	121	86.5	Station 1	3.0	Kelted past Station 1	28-Apr-00	8
5	19-Apr-00	1	123	75.0	Chipmunk Cr.	43.0	Died upstream of hatchery	-	
6	19-Apr-00	1	124	76.5	Station 1	3.0	Kelted past Station 1	23-Apr-00	3
7	19-Apr-00	1	129	76.5	Station 1	3.0	Kelted past Station 1	27-Apr-00	6

Air-Spawn Summary

- 7 wild female steelhead, 67-86 cm FL, were captured by hatchery staff using angling gear (near hatchery)
- All steelhead were held at the hatchery 80-90 days prior to air spawning
- All steelhead were anaesthetized prior to air spawning
- Air spawning was performed by hatchery staff (by hand); a needle was inserted below pectoral fin and air was injected in to body cavity; hand pressure used to force eggs out (total processing time 6-7 minutes)
- Following air spawning, all steelhead were held for 1-2 days prior to tagging
- All steelhead were radio tagged at hatchery on 19 April
- Following tagging, all steelhead were held at the hatchery for 2 days prior to release
- All steelhead were transported by truck to the hatchery intake and released into the Chilliwack River

Following Release

- 5 air-spawned steelhead survived to kelt (past Station 1 to Fraser River); this represents 71% of sample
- 2 air-spawned steelhead died in the Chilliwack River (one near hatchery, one 4 km upstream of hatchery)
- 3 air-spawned steelhead moved upstream (3-5 kms) from hatchery outlet after release
- 5 air-spawned steelhead kelts passed Station 1 (to Fraser River) from 3-19 days following release

FIGURES

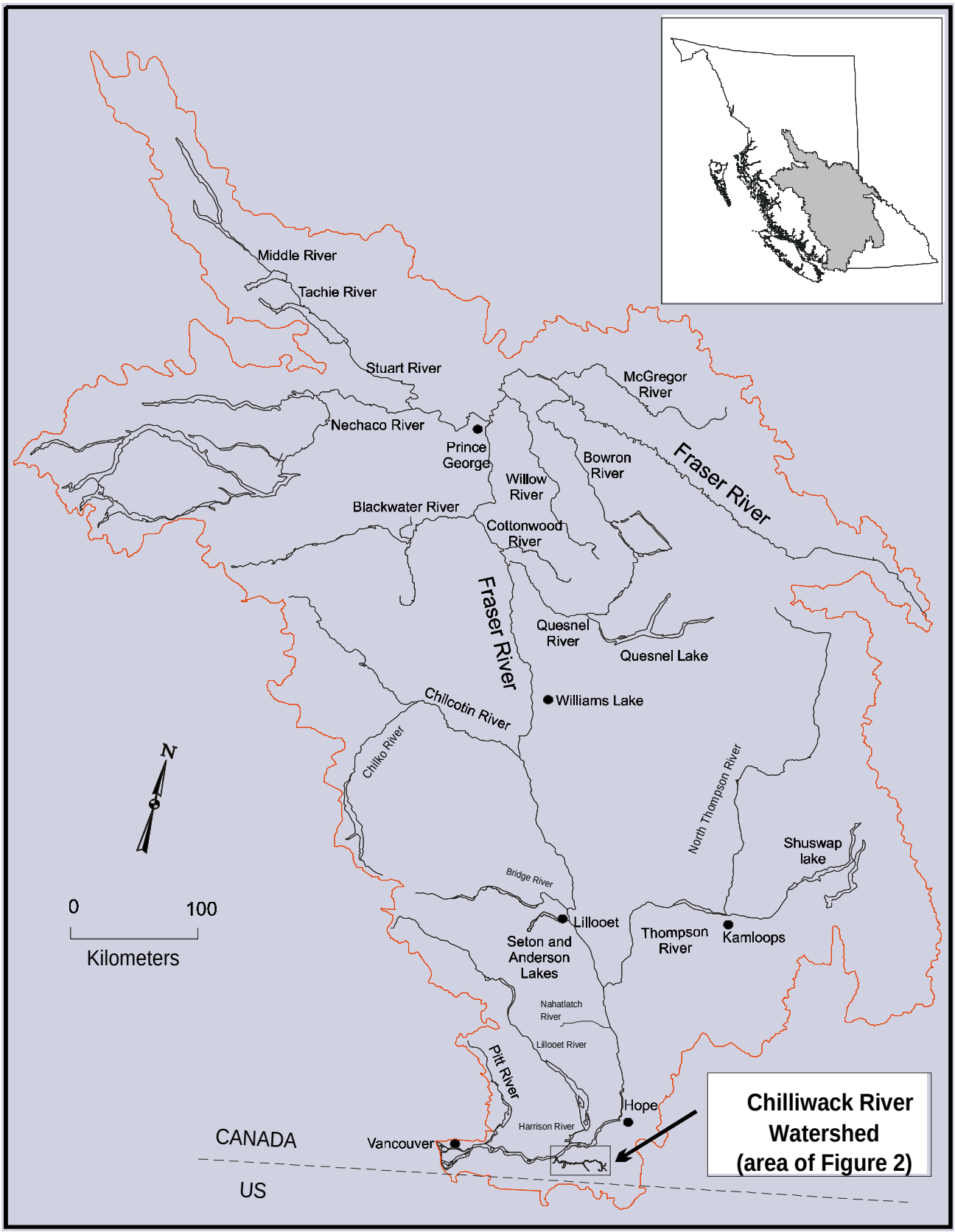


Figure 1. Map of the Fraser River watershed and its location in British Columbia, and the location of the Chilliwack River watershed (see Figure 2).

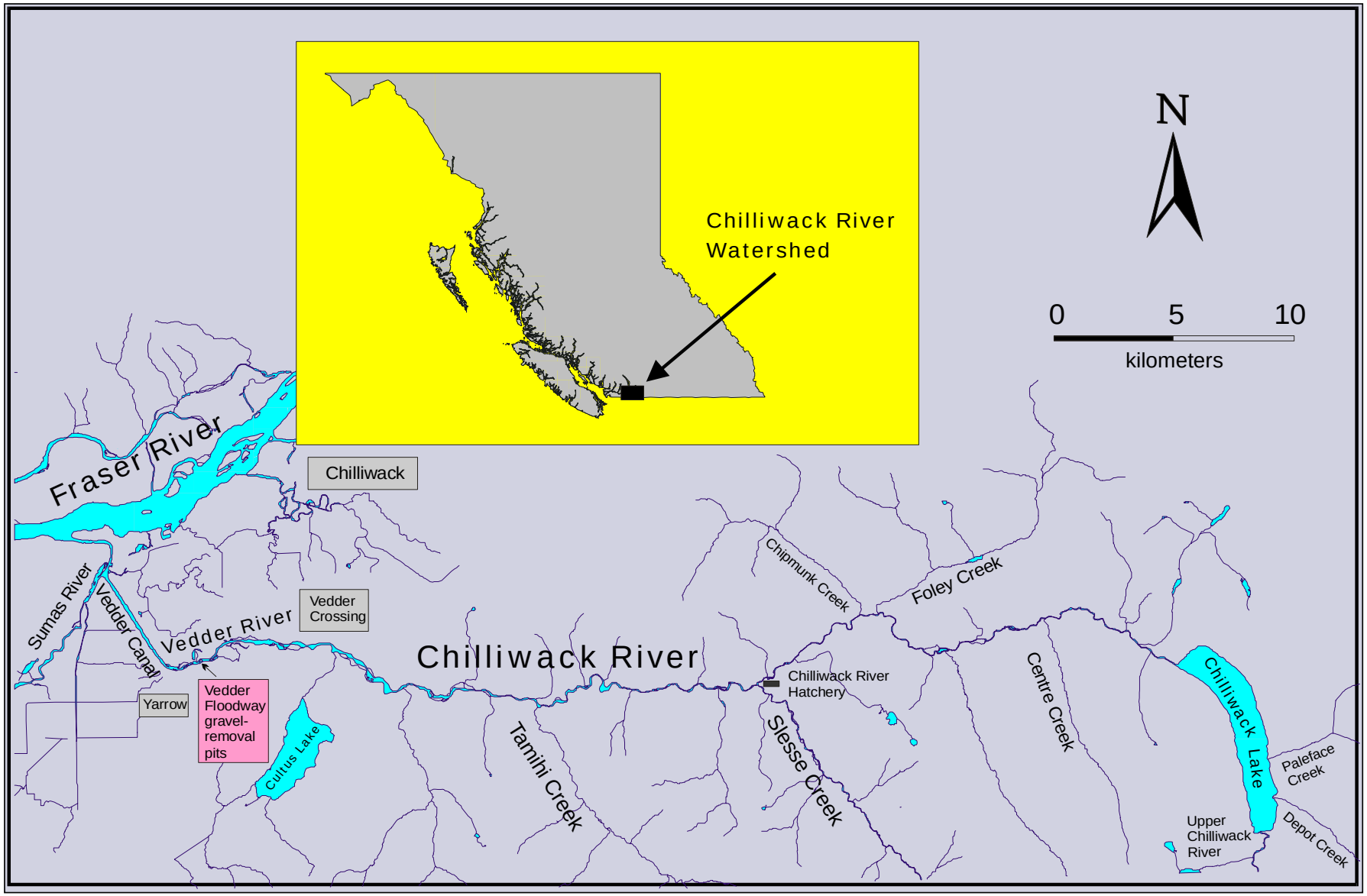
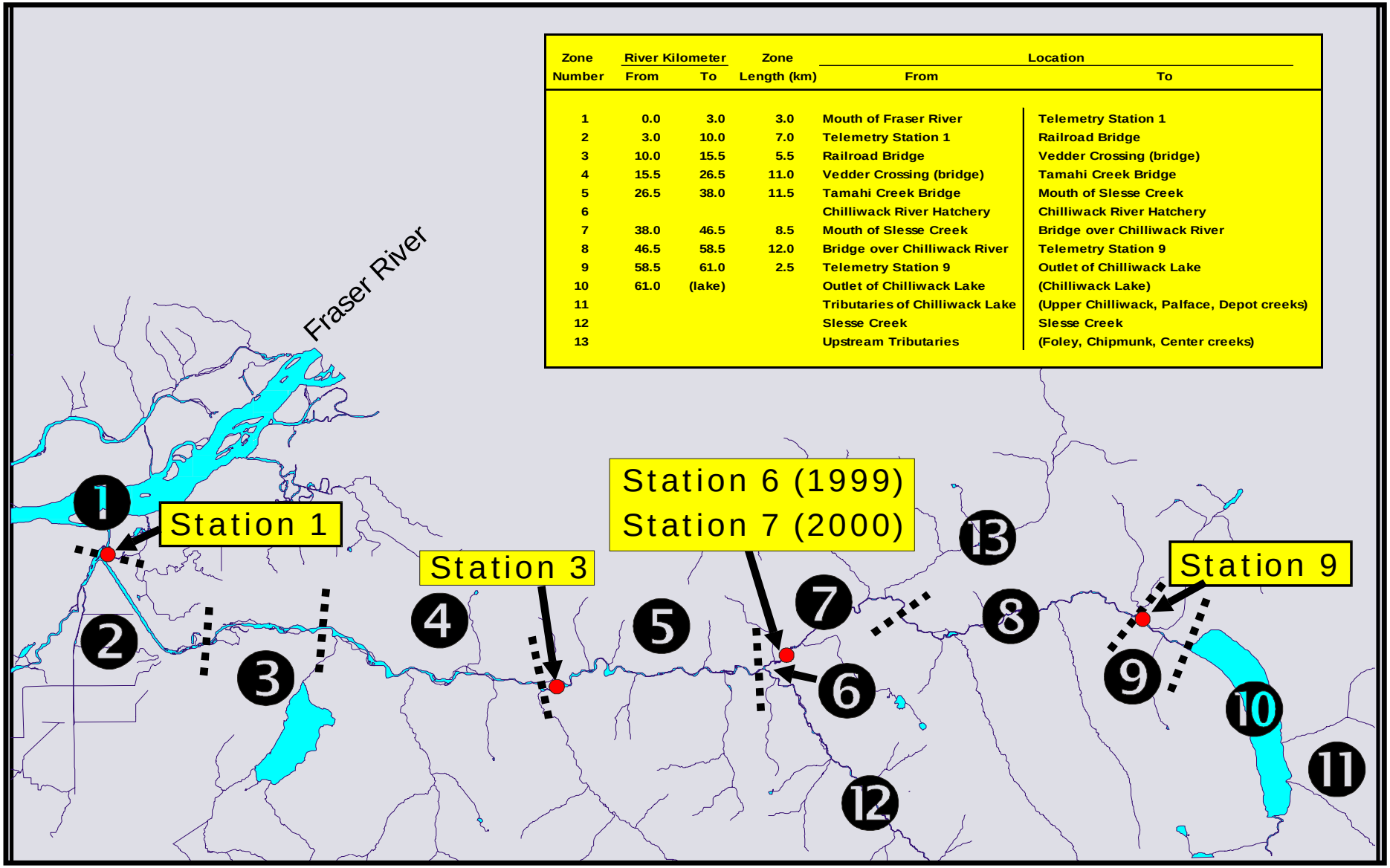


Figure 2. Map of the Chilliwack River watershed and its location in BC.



Zone Number	River Kilometer From	River Kilometer To	Zone Length (km)	Location From	Location To
1	0.0	3.0	3.0	Mouth of Fraser River	Telemetry Station 1
2	3.0	10.0	7.0	Telemetry Station 1	Railroad Bridge
3	10.0	15.5	5.5	Railroad Bridge	Vedder Crossing (bridge)
4	15.5	26.5	11.0	Vedder Crossing (bridge)	Tamahi Creek Bridge
5	26.5	38.0	11.5	Tamahi Creek Bridge	Mouth of Slesse Creek
6				Chilliwack River Hatchery	Chilliwack River Hatchery
7	38.0	46.5	8.5	Mouth of Slesse Creek	Bridge over Chilliwack River
8	46.5	58.5	12.0	Bridge over Chilliwack River	Telemetry Station 9
9	58.5	61.0	2.5	Telemetry Station 9	Outlet of Chilliwack Lake
10	61.0	(lake)		Outlet of Chilliwack Lake	(Chilliwack Lake)
11				Tributaries of Chilliwack Lake	(Upper Chilliwack, Palface, Depot creeks)
12				Slesse Creek	Slesse Creek
13				Upstream Tributaries	(Foley, Chipmunk, Center creeks)

Figure 3. Locations of survey zones (zones 1-13) and fixed-station receiver sites (stations 1, 3, 6, 7, and 9) used during the Vedder/Chilliwack River steelhead telemetry program 1999-2000. Survey zone boundaries are shown as dashed lines.

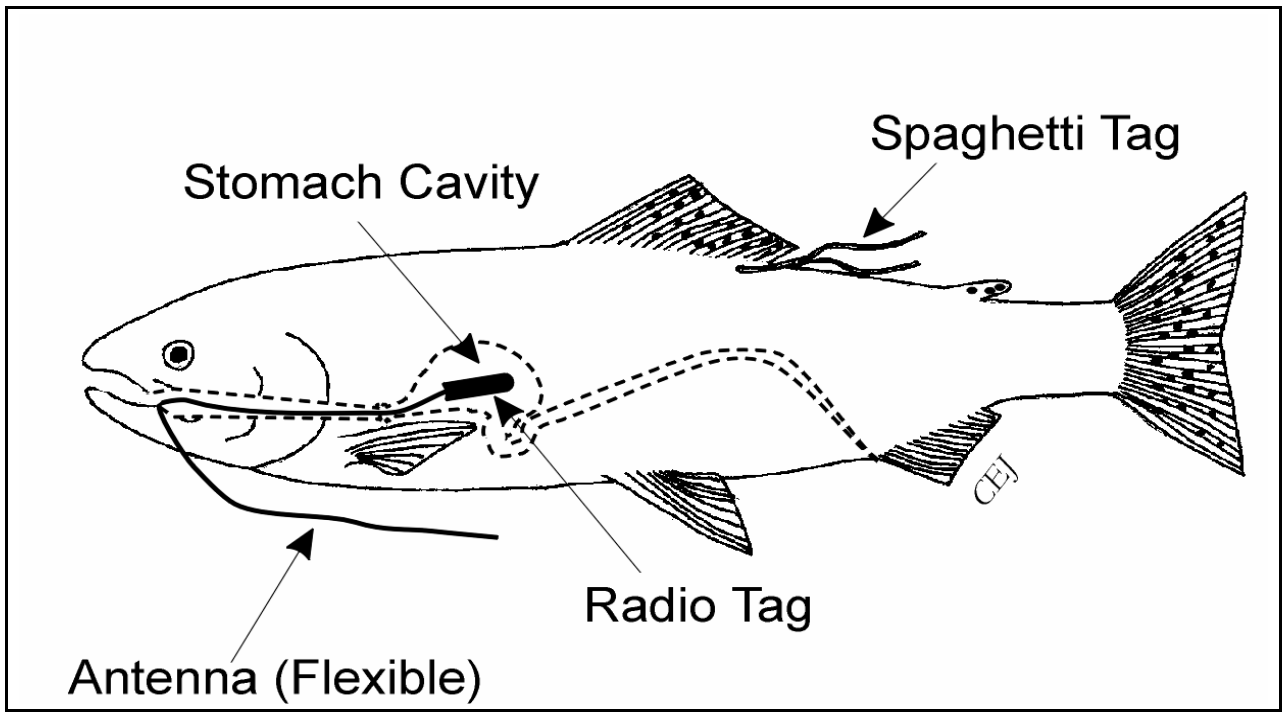


Figure 4. Illustration of a radio-tagged steelhead, showing the location of the radio tag (in the stomach) and the spaghetti tag (behind the dorsal fin). Spaghetti tags were labelled with a unique 3-digit tag number and a toll-free number (to encourage voluntary reporting of recaptures).

ATTENTION ANGLERS

The Ministry of Environment, Lands and Parks,
Fish and Wildlife Management,
is studying the behavior of both wild and hatchery

STEELHEAD

in the Vedder/Chilliwack River watershed in 1999-2000.

As part of this 2-year study, fisheries technicians will be applying radio transmitters to equal numbers of wild and hatchery steelhead from December 1999 through May 2000. Following release, radio-tagged steelhead will be tracked to upstream holding and spawning areas with the use of mobile and stationary telemetry receivers. Information collected during this study will provide a better understanding of the migration and spawning behavior of wild and hatchery steelhead, and allow a comparative analysis between groups regarding spawning location and timing, and post-spawning survival.

Steelhead will also be tagged with a brightly colored "spaghetti" tag (attached behind the dorsal fin). Printed on each spaghetti tag is a toll-free phone number (1-888-550-0049) and a unique 3-digit tag number (i.e., tag number 457). Anglers that capture any tagged steelhead are requested to:

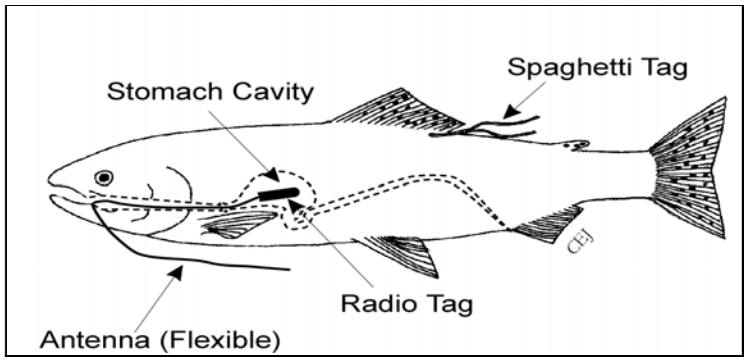
document (write down) the 3-digit spaghetti tag number and the toll-free phone number;
1) when convenient, call the toll-free phone number and report:

1) the 3-digit tag number;
    a) the date of capture;
2) the location of capture (nearest landmark);
3) if the fish was released;
4) a contact name and phone number (optional; see footnote regarding prize draw below).*

By regulation, all wild steelhead must be released. Anglers are requested to release radio-tagged hatchery steelhead. Radio tags, inserted through the mouth and into the stomach of steelhead, have a thin plastic-coated wire antenna that exits through the mouth; please do not pull on this wire or remove the radio tag. If a radio tag is removed, or the steelhead dies, please return the tag to your nearest Conservation Officer Service office; the returned radio tags can be redeployed during this study.

THANK YOU FOR YOUR INTEREST AND SUPPORT

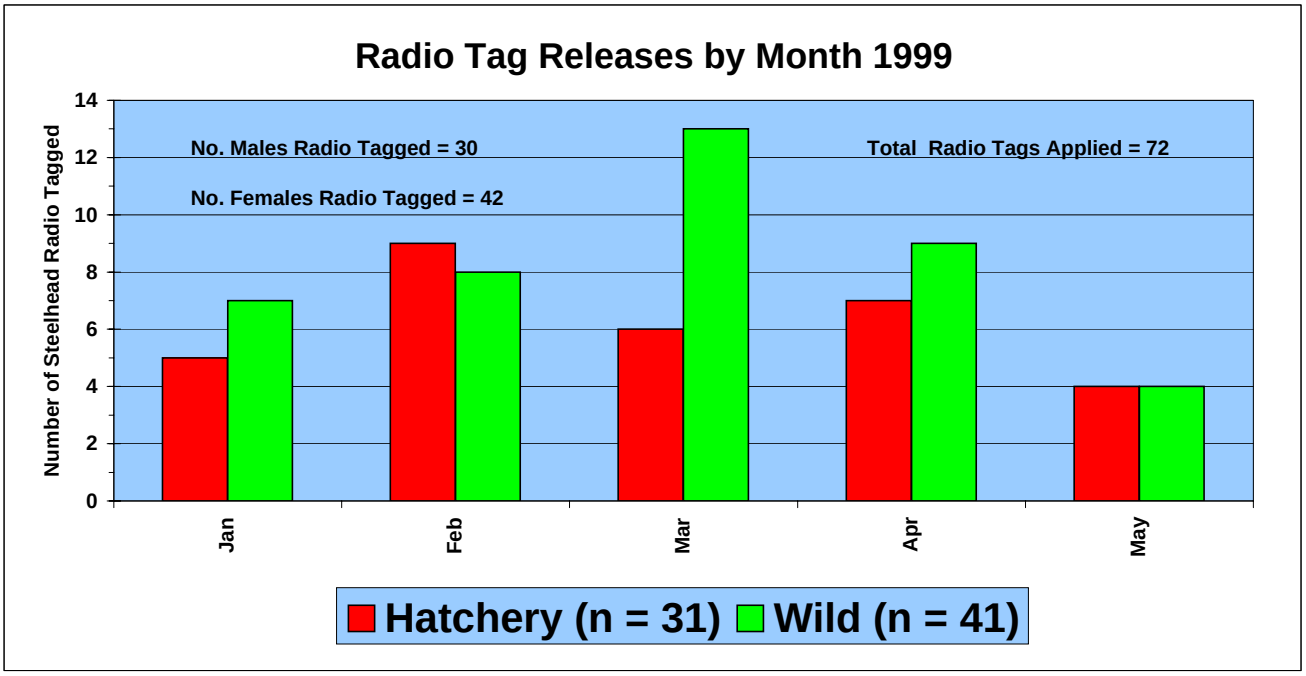
This study is supported by:
- Habitat Conservation Trust Fund
- BC Ministry of Fisheries
- Science Council of BC
- Fisheries Renewal BC
- Public Conservation Assistance Fund
- Chilliwack Fish and Game Protective Association
- BC Federation of Drift Fishers
- Sapperton Fish and Game
- Steelhead Society of BC
- Fraser River Salmon Society
- Chilliwack River Hatchery (DFO)
- Fraser Valley Regional Watersheds Coalition



The project is administered by the Ministry of Environment, Lands and Parks, Fish and Wildlife Management, Surrey, BC (contact Marvin Rosenau or Peter Caverhill; 604-582-5200). Project management and biotelemetry expertise provided by LGL Limited environmental research associates, Sidney, BC (contact Troy Nelson; 604-535-1768).

* Names and phone numbers of anglers that provide capture information for tagged steelhead will be entered in a draw for prizes donated by local merchants (drawing in June; see local newspapers for details).

Figure 5. Illustration of public awareness poster/handout distributed during the Vedder/Chilliwack River steelhead telemetry program 1999-2000.



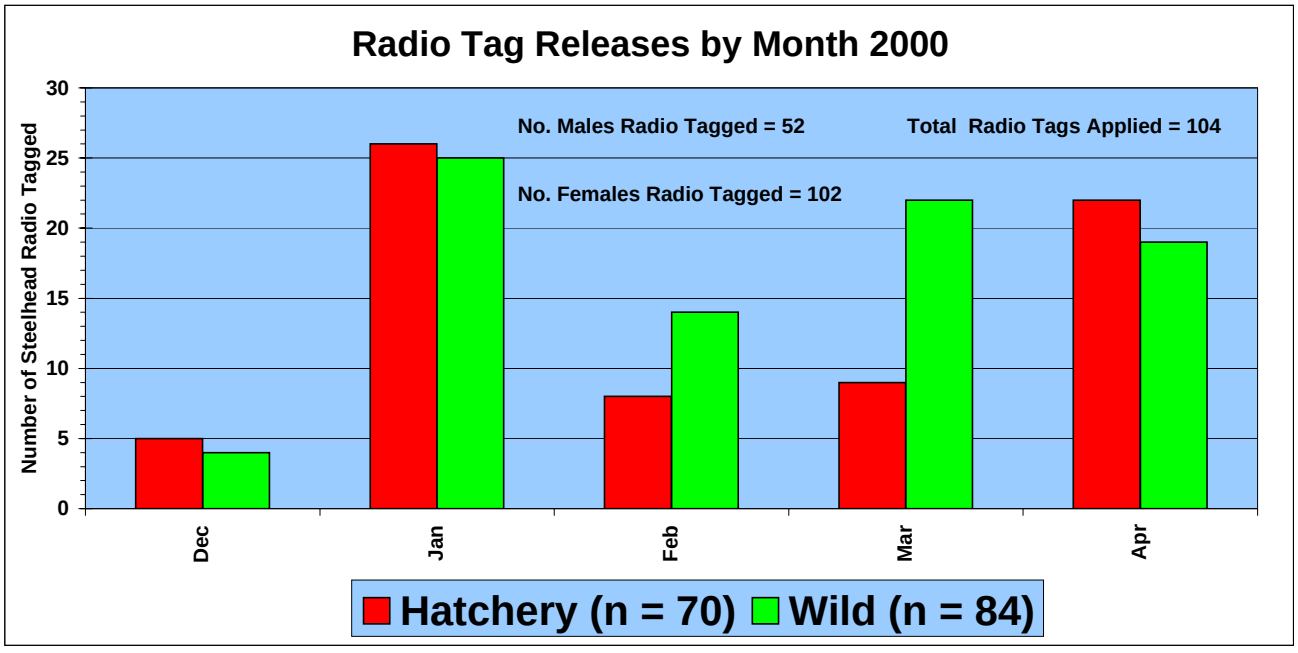


Figure 6. Numbers of hatchery and wild radio-tagged steelhead released, by month, in the Vedder/Chilliwack River, during the 1999 and 2000 steelhead telemetry programs.

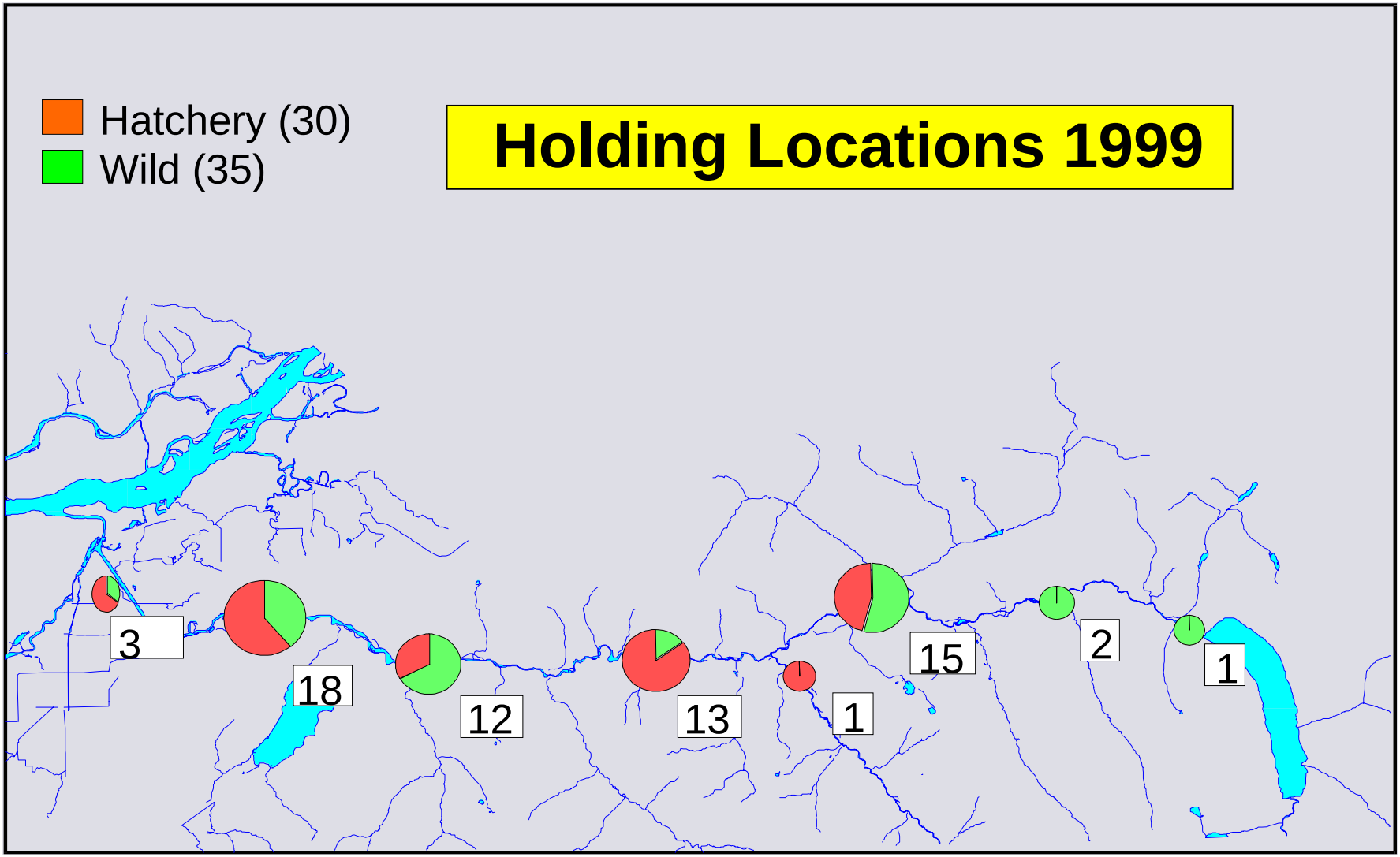


Figure 7. Holding locations prior to spawning, by survey zone, of radio-tagged hatchery and wild steelhead, in the Chilliwack River watershed, 1999. The numbers of radio-tagged steelhead that were observed holding in each zone are presented in boxes. See Figure 3 for an illustration of survey zone boundaries.

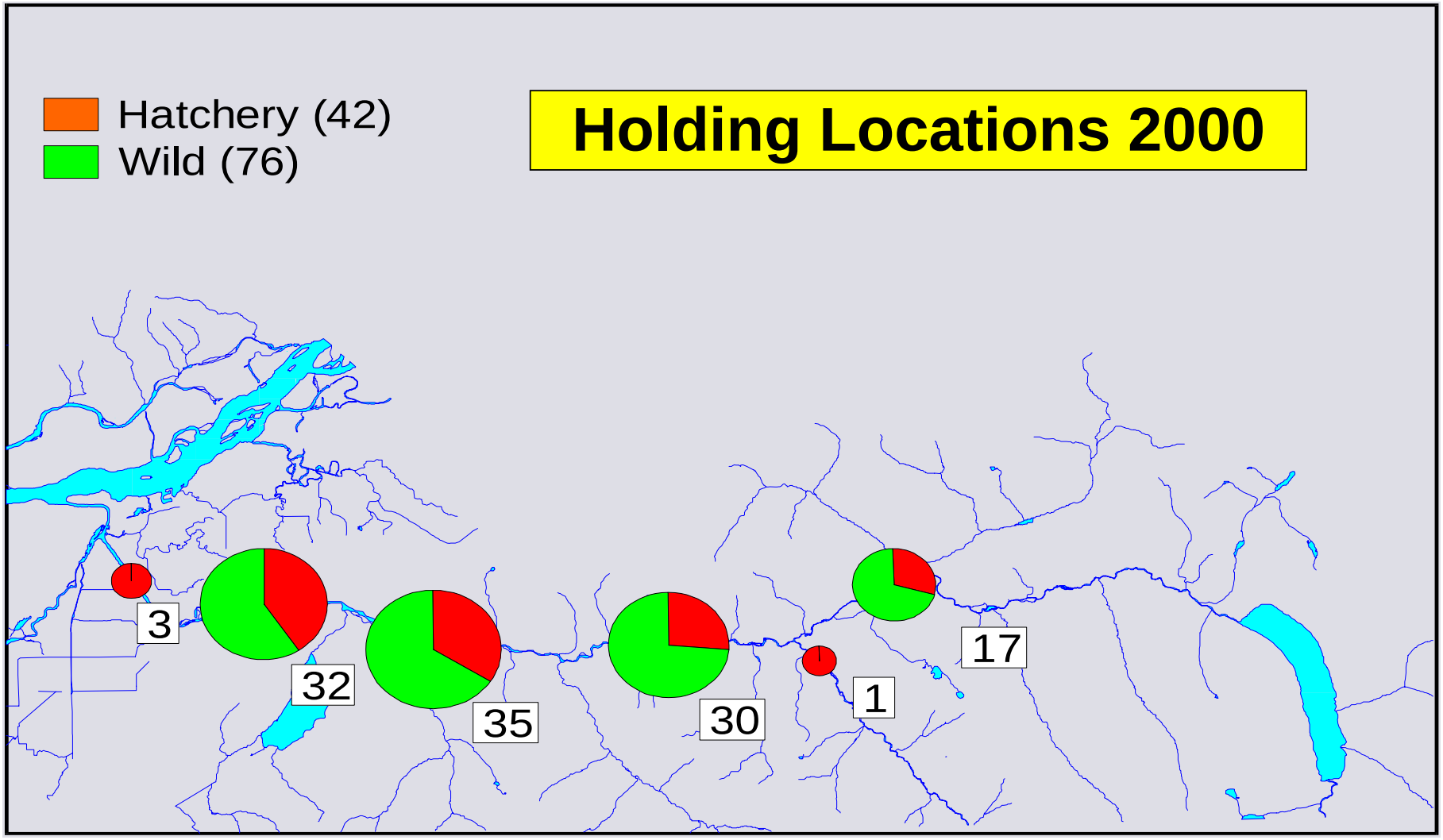


Figure 8. Holding locations prior to spawning, by survey zone, of radio-tagged hatchery and wild steelhead, in the Chilliwack River watershed, 2000. The numbers of radio-tagged steelhead that were observed holding in each zone are presented in boxes. See Figure 3 for an illustration of survey zone boundaries.

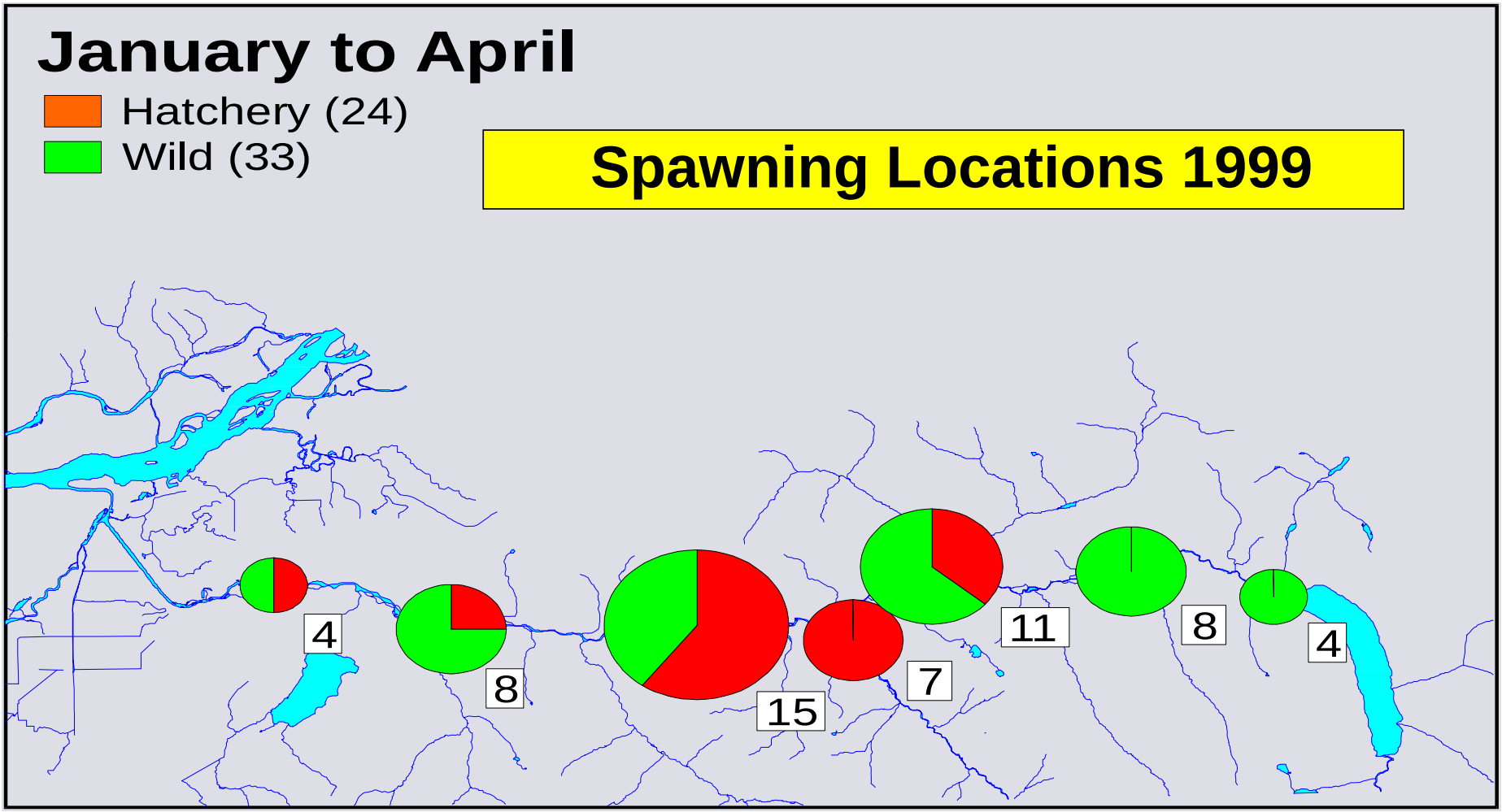


Figure 9. Spawning locations, by survey zone, of all radio-tagged hatchery and wild steelhead (from all run-timing release groups, January-April) that survived to spawn in the Chilliwack River watershed in 1999. The total number of radio-tagged steelhead in each zone is presented in boxes. See Figure 3 for an illustration of survey zone boundaries.

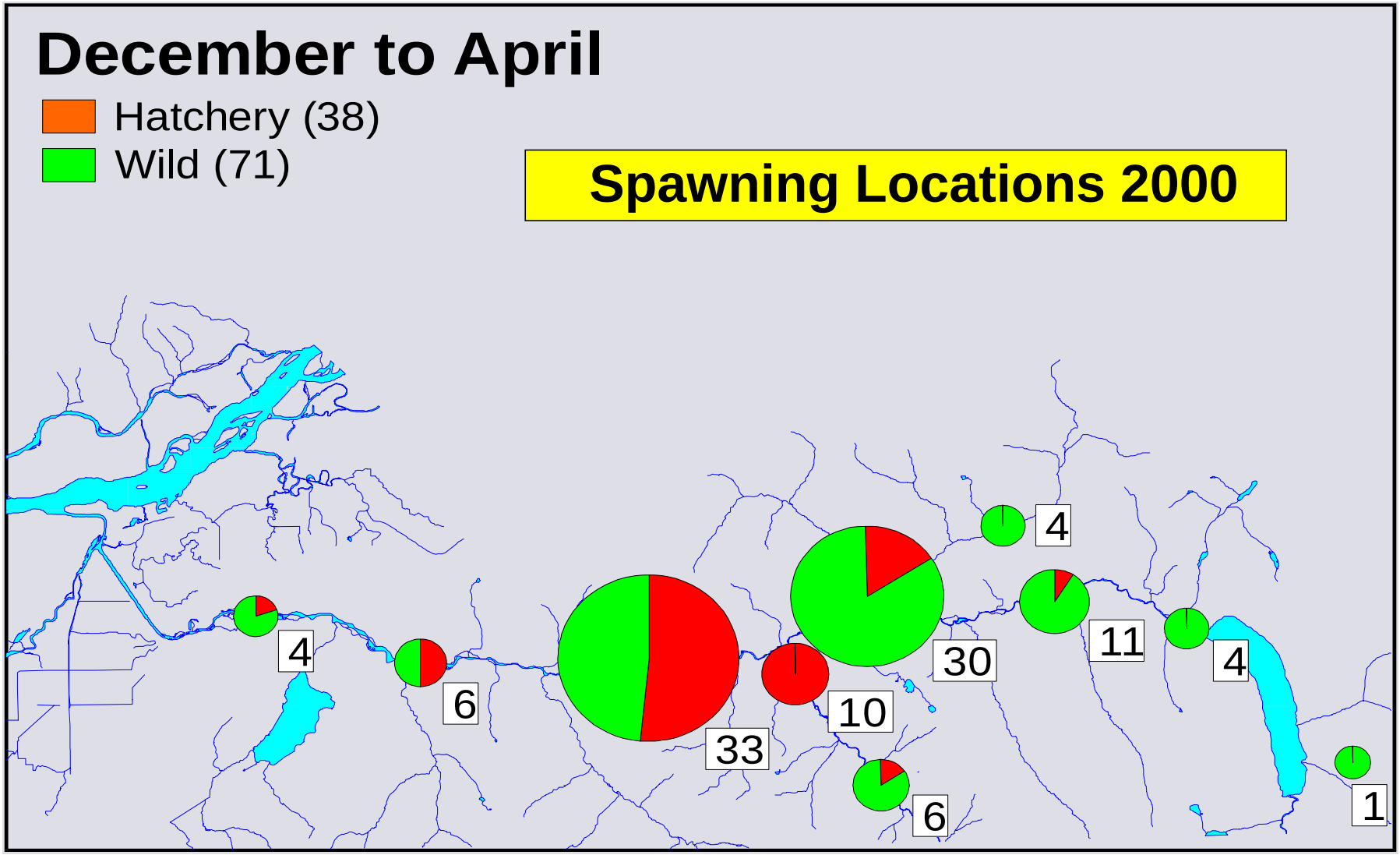
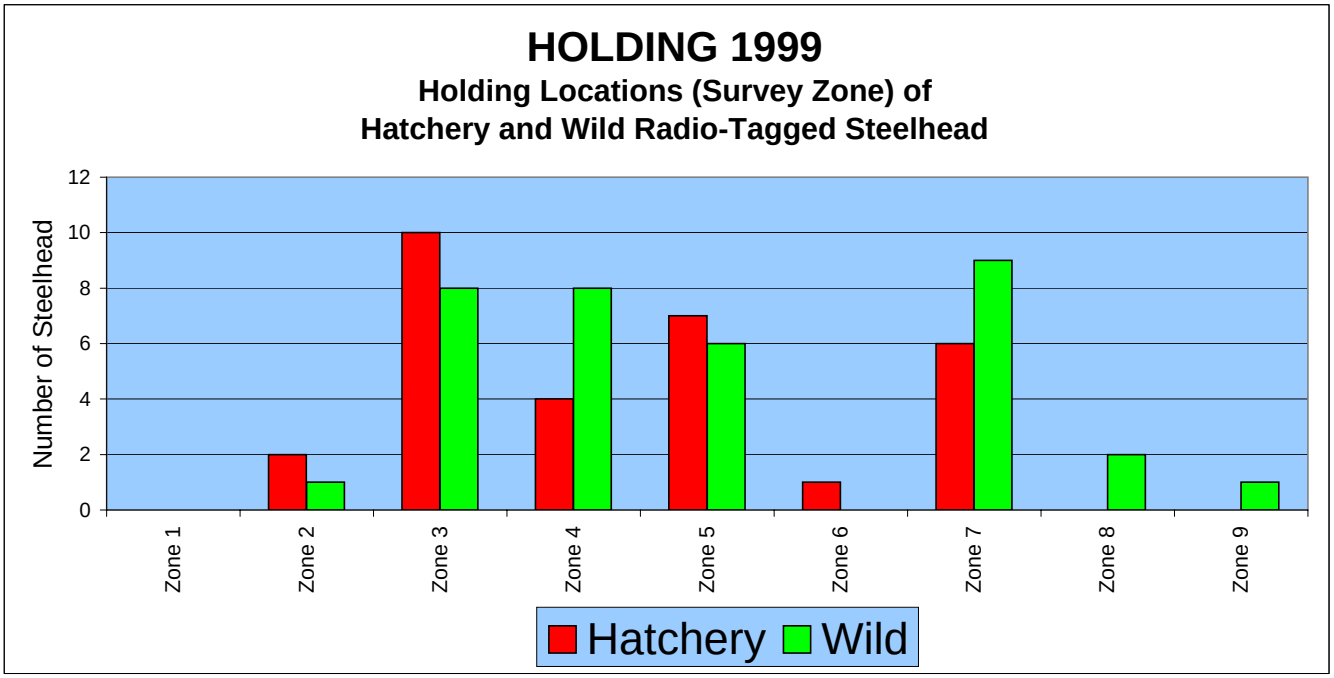


Figure 10. Spawning locations, by survey zone, of all radio-tagged hatchery and wild steelhead (from all run-timing release groups; fish tagged from December 1999 through April 2000) that survived to spawn in the Chilliwack River watershed in 2000. The total number of radio-tagged steelhead in each zone is presented in boxes. See Figure 3 for an illustration of. survey zone boundaries. See Appendix E for illustrations of the spawning distributions of hatchery and wild steelhead by release month (December 1999 through April 2000).



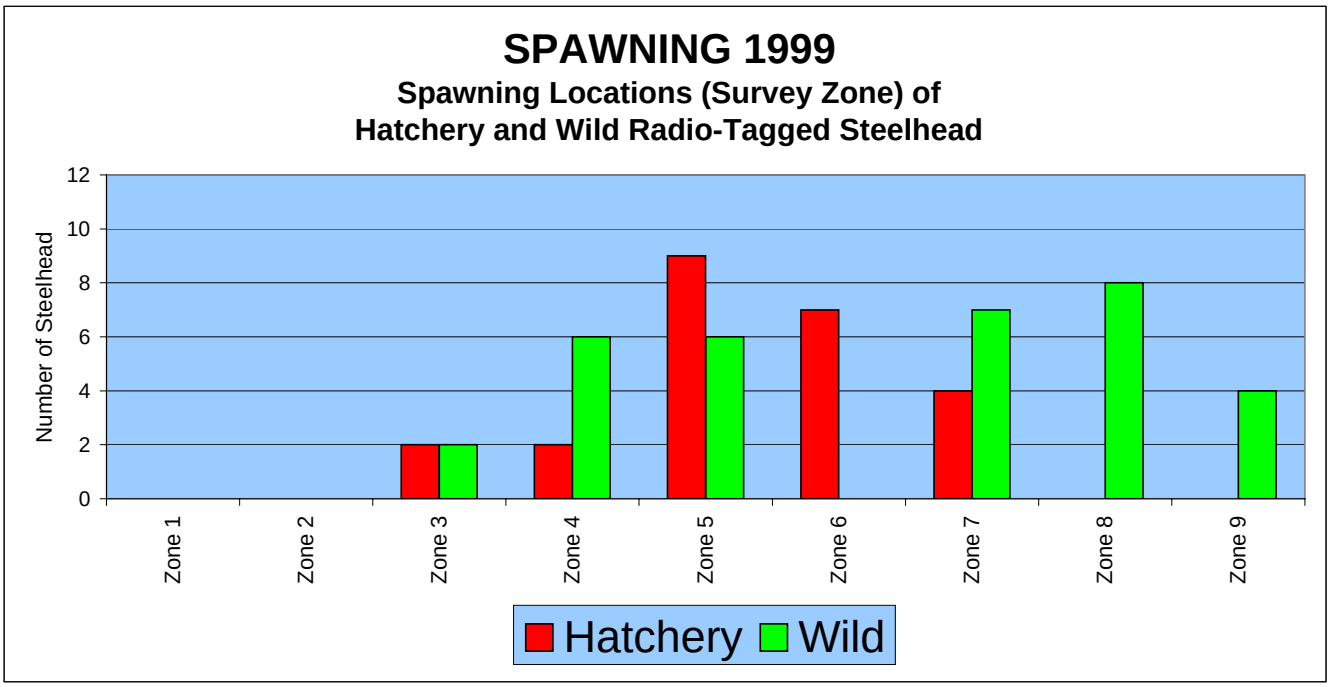
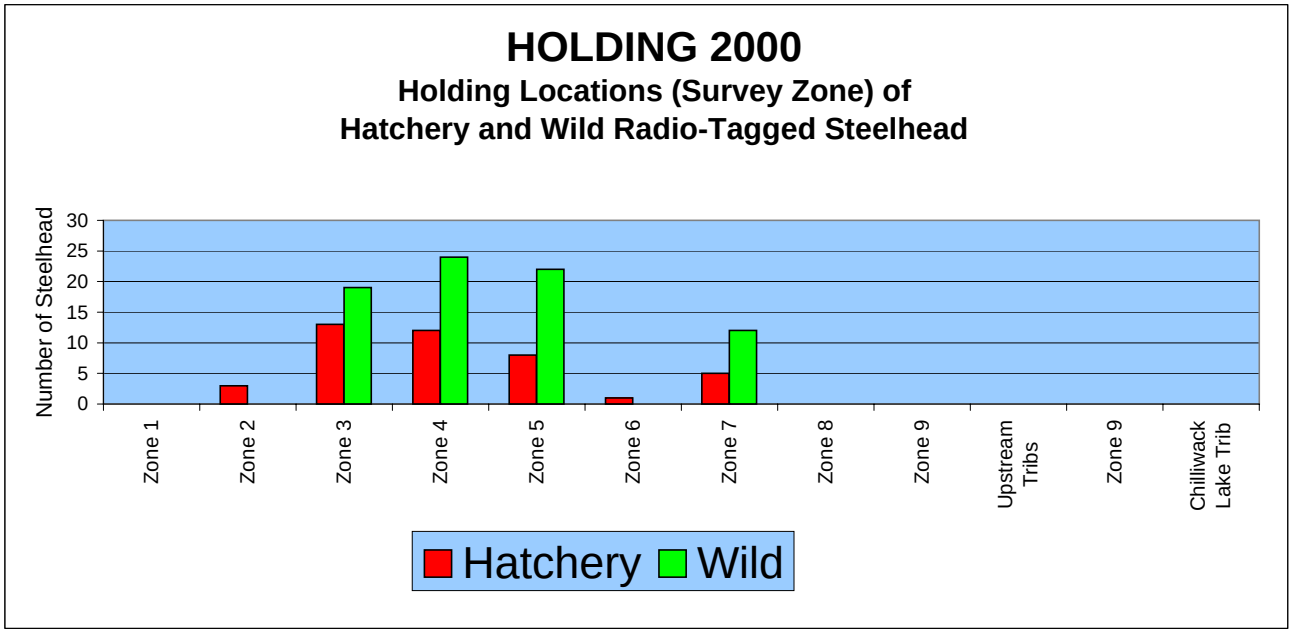


Figure11. Holding and spawning distribution of radio-tagged hatchery and wild steelhead in the Vedder/Chilliwack River watershed, by survey zone, 1999. Samples used in these analyses are subsets of the total number of radio-tagged steelhead released, composed of those fish with positive holding and spawning locations. See Figure 3 for an illustration of survey zone locations.



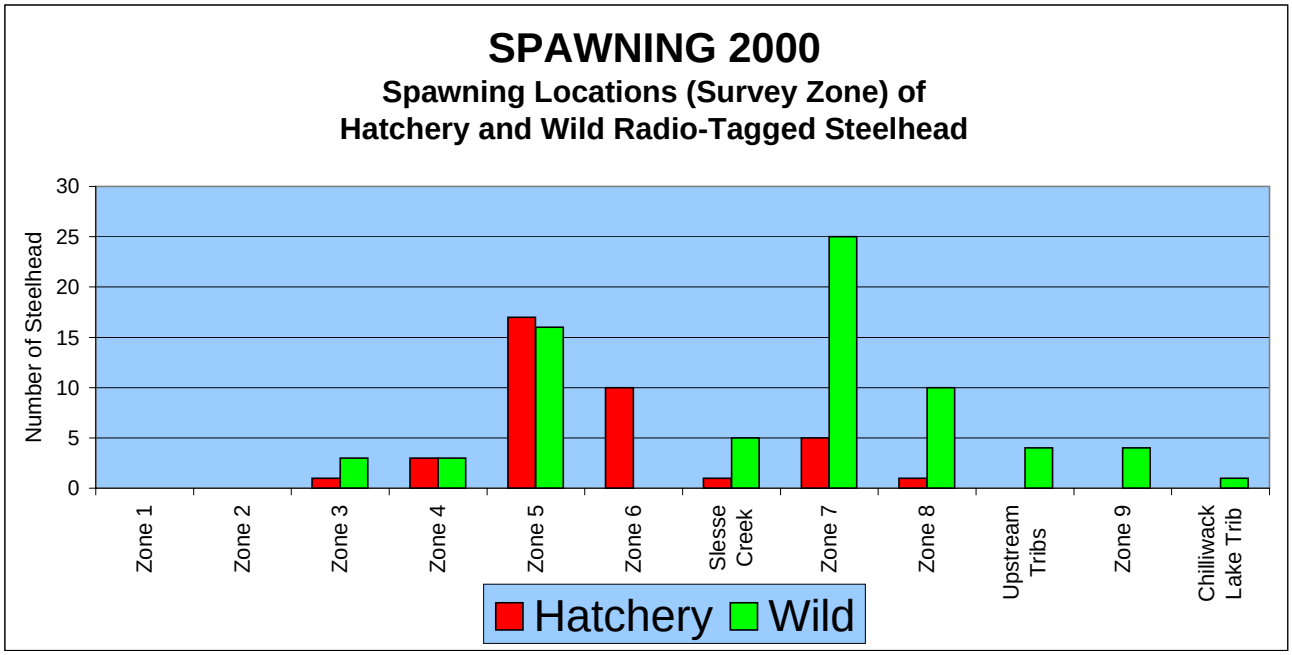
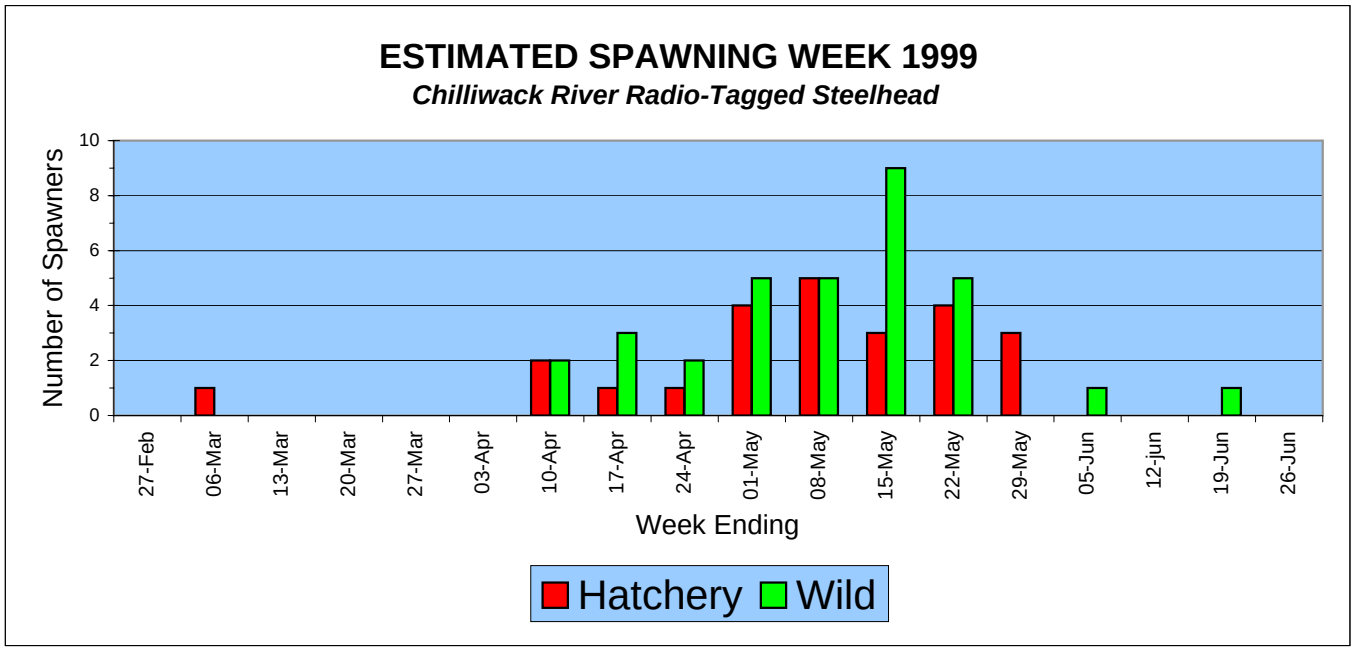


Figure12. Holding and spawning distribution of radio-tagged hatchery and wild steelhead in the Vedder/Chilliwack River watershed, by survey zone, 2000. Samples used in these analyses are subsets of the total number of radio-tagged steelhead released, composed of those fish with positive holding and spawning locations.



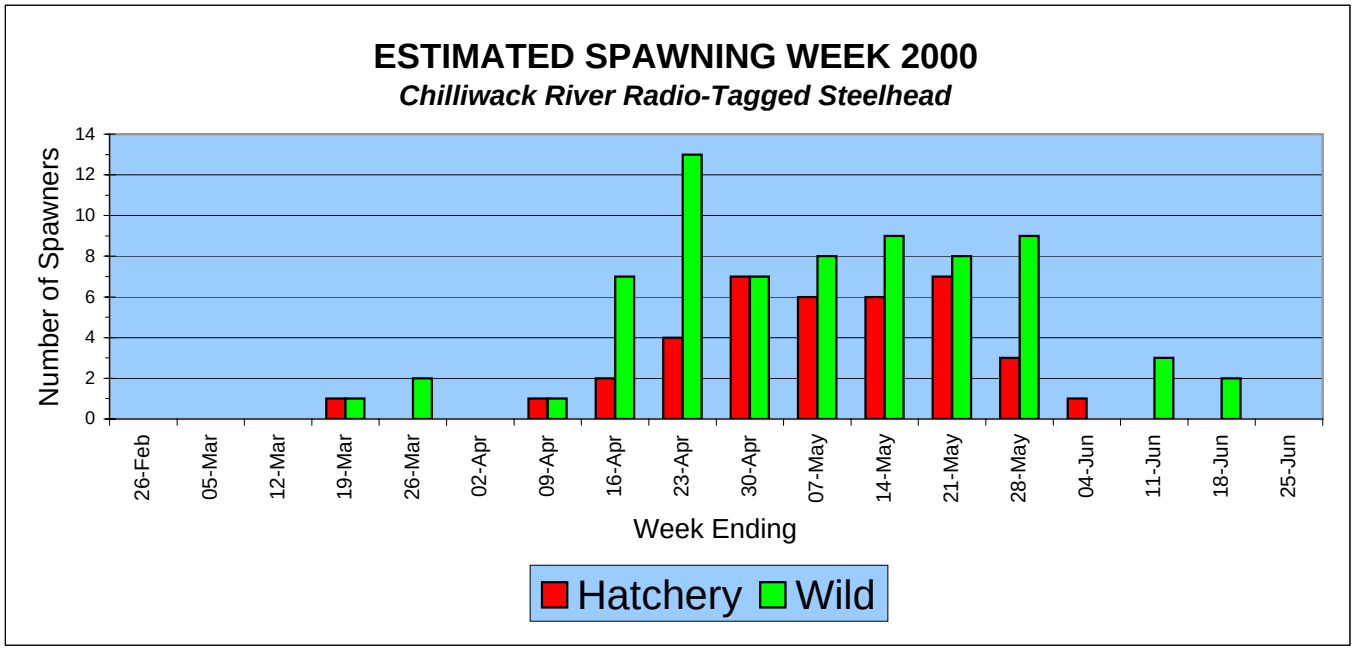
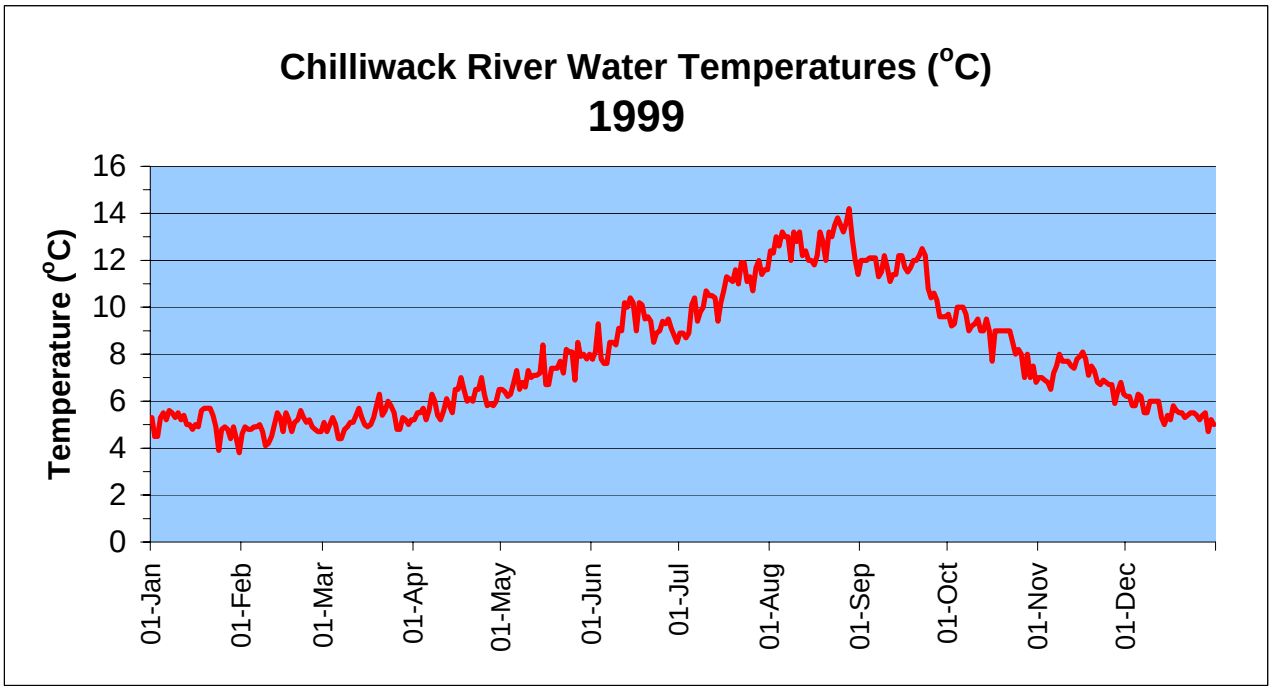


Figure 13. Estimated timing of spawning events of radio-tagged hatchery and wild steelhead in the Chilliwack River watershed in 1999 and 2000. Data presented are for all hatchery and wild radio-tagged steelhead that spawned in 1999 and 2000, for which an estimated spawning week could be positively assigned (1999: hatchery = 24, wild = 33; 2000: hatchery = 38, wild = 70).



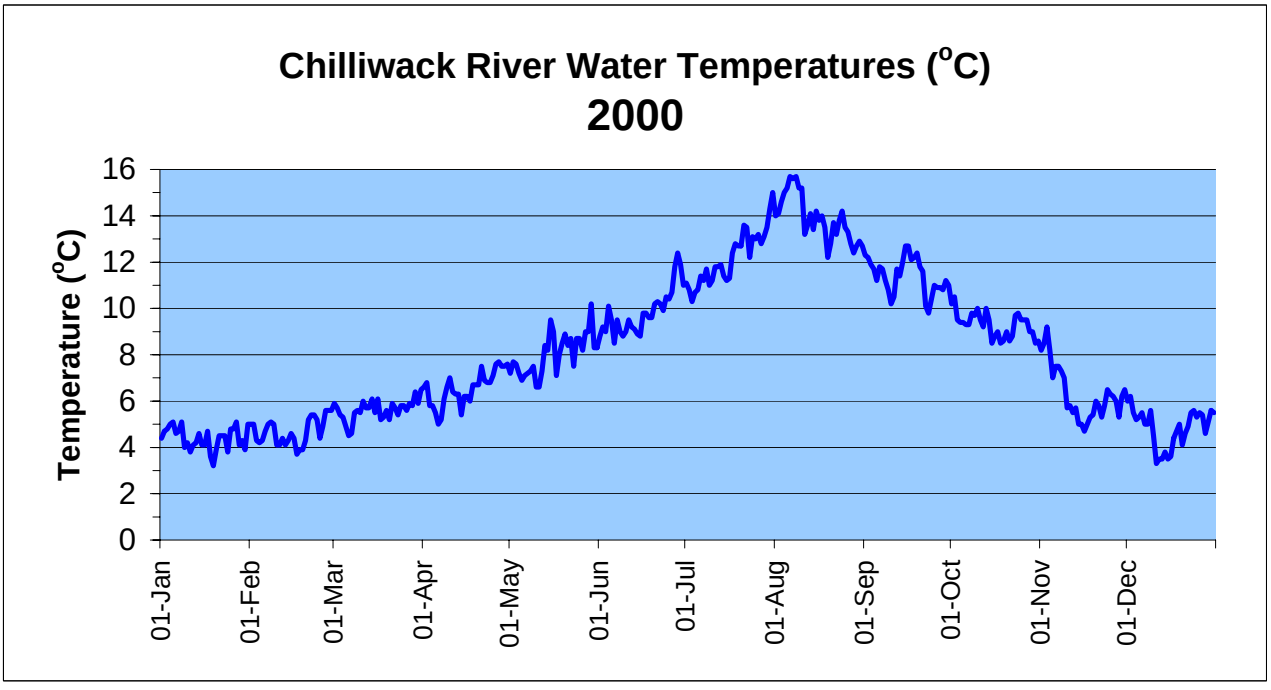


Figure 14. Daily average water temperatures in the Chilliwack River in 1999 and 2000. Temperatures were taken in the mainstem Chilliwack River near Slesse Creek (38 km upstream from the Fraser River). Data from Water Survey Canada.

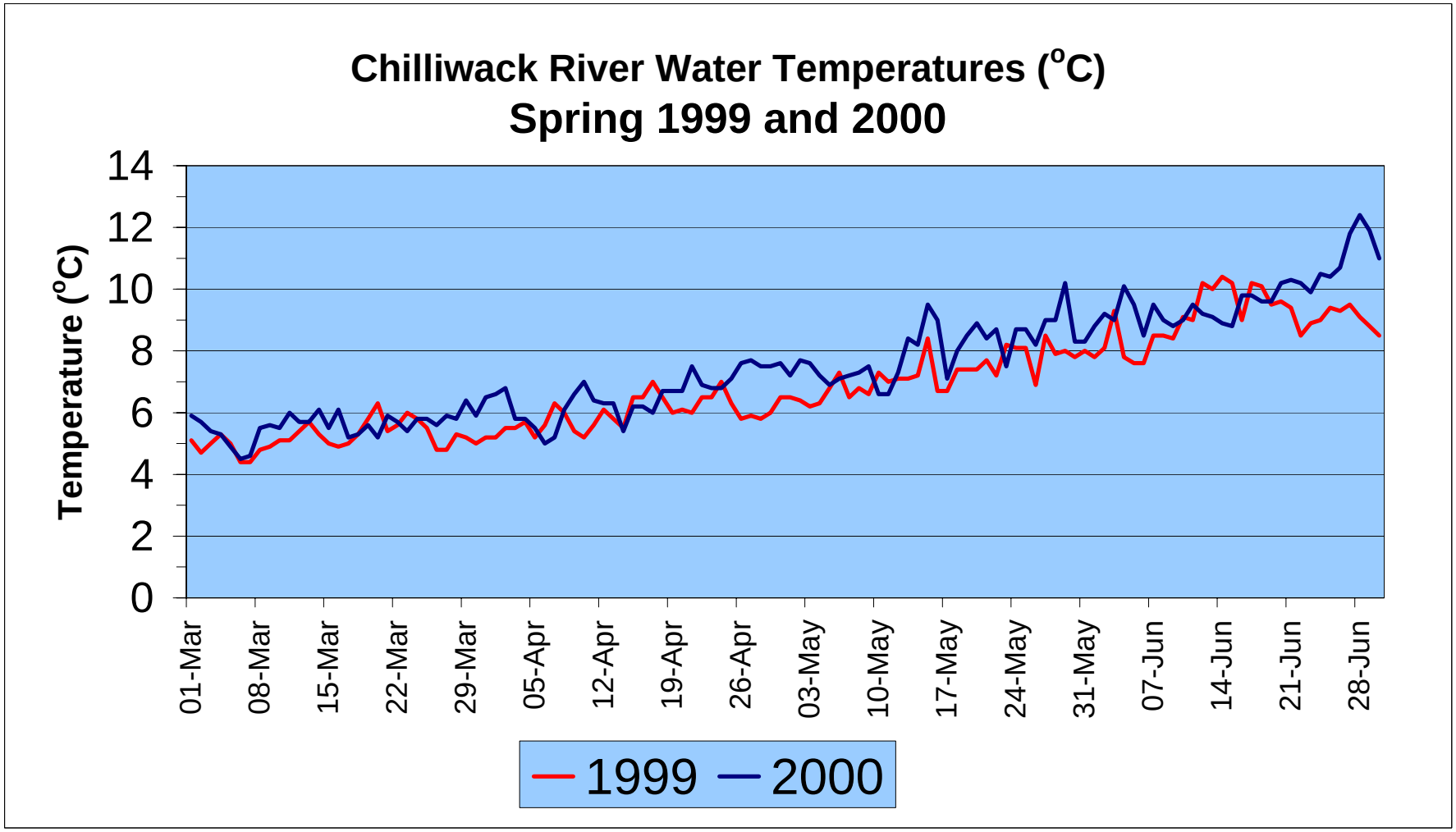


Figure 15. Comparison of daily average water temperatures in the Chilliwack River during March through June, 1999 and 2000. Temperatures were taken in the mainstem Chilliwack River near Slesse Creek (38 km upstream from the Fraser River). Data from Water Survey Canada.

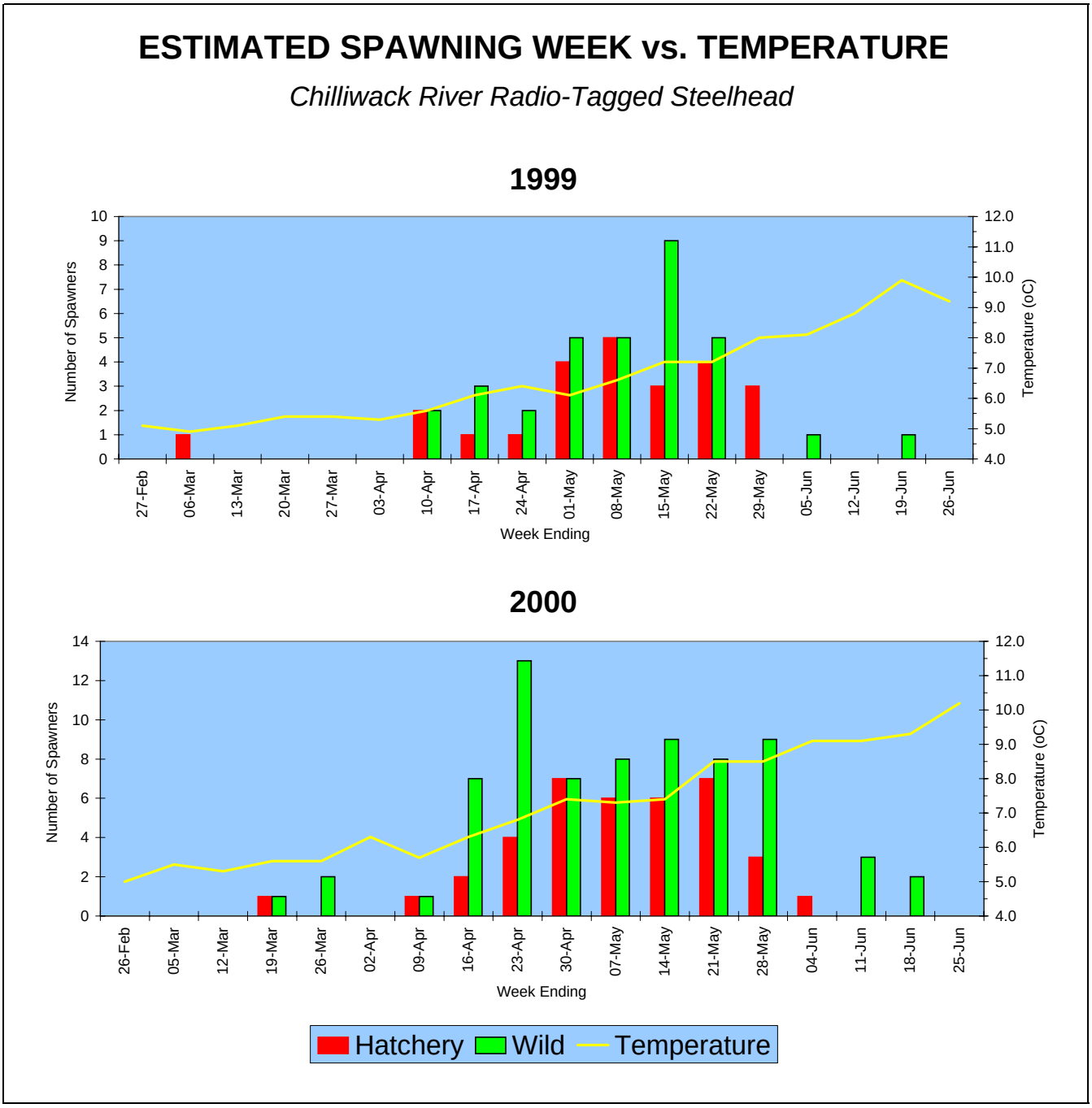
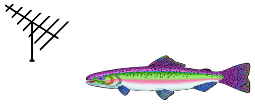


Figure 16. Illustrations of the estimated timing of spawning events of radio-tagged hatchery and wild steelhead, and average weekly water temperatures, in the Chilliwack River watershed in 1999 and 2000. Data presented are for all hatchery and wild radio-tagged steelhead that spawned in 1999 and 2000, for which an estimated spawning week could be positively assigned (1999: hatchery = 24, wild = 33; 2000: hatchery = 38, wild = 70).

APPENDICES



Appendix A

Tag and release information for all steelhead radio-tagged in the Vedder/Chilliwack River, 1999.

Appendix A. Tag and release information for all steelhead radio-tagged in the Vedder/Chilliwack River, 1999. [1]

Fish No.	Tag Date (dd/mmm/yy)	Type (H/W)	Sex (M/F)	Fork Length (cm)	Tagging Location	River Km	Survey Zone	Radio Tag Channel	Radio Tag Code	Spaghetti Tag No.	Angler Name	Tagger Name	Condition at Release
1	05-Jan-99	W	F	68.5	Lickman Road	12.5	3	8	65	306 B	Ernie Schepanowski	Troy Nelson	Excellent
2	08-Jan-99	H	M	66.0	Hatchery Hole	38.5	7	8	51	513 B	Peter Buck	Ray St. Pierre	Excellent
3	08-Jan-99	W	F	73.5	Hatchery Hole	38.5	7	8	56	387 B	Peter Buck	Ray St. Pierre	Excellent
4	11-Jan-99	W	M	81.5	Hatchery Hole	38.5	7	8	54	49 B	Jim Rissling	Jim Rissling	Excellent
5	11-Jan-99	H	M	79.5	Hatchery Hole	38.5	7	8	59	326 B	CEJ Mussell	CEJ Mussell	Excellent
6	11-Jan-99	W	M	74.0	Box Canyon Pool	42.5	7	8	60	218 B	Gordon Preseau	Jim Rissling	Excellent
7	12-Jan-99	H	F	78.0	Hatchery Hole	38.5	7	8	68	65 B	Jim Donaldson	CEJ Mussell	Excellent
8	12-Jan-99	W	M	81.5	Hatchery Hole	38.5	7	8	67	60 B	Clay Thornton	CEJ Mussell	Excellent
9	27-Jan-99	W	M	94.0	Hoogies	11.5	3	8	66	2	Steve Tan	Jim Rissling	Excellent
10	27-Jan-99	H	F	78.5	Hoogies	11.5	3	8	64	3	Jim Rissling	Jim Rissling	Excellent
11	27-Jan-99	H	F	70.5	Hoogies	11.5	3	8	53	7	Christina Dodd	Jim Rissling	Excellent
12	27-Jan-99	W	M	87.5	Hoogies	11.5	3	8	71	6	Rodolfo M. Tecson	CEJ Mussell	Excellent
13	03-Feb-99	W	F	69.0	Hoogies	11.5	3	8	76	14	Steve Tan	CEJ Mussell	Excellent
14	04-Feb-99	W	M	87.5	Hoogies	11.5	3	8	77	8	Steve Wright	Jim Rissling	Excellent
15	05-Feb-99	W	M	80.0	Teskey Rock	16.0	4	8	59	11	Nick Basok	CEJ Mussell	Excellent
16	05-Feb-99	W	F	78.0	Hoogies	11.5	3	8	74	12	Steve Tan	CEJ Mussell	Excellent
17	05-Feb-99	H	F	77.5	Hoogies	11.5	3	8	75	10	Jim Rissling	Jim Rissling	Excellent
18	06-Feb-99	H	F	67.0	Teskey Rock	16.0	4	8	62	5	Nick Basok	Nick Basok	Excellent
19	06-Feb-99	H	M	72.5	Teskey Rock	16.0	4	8	63	4	Nick Basok	Nick Basok	Excellent
20	11-Feb-99	W	F	73.0	Hoogies	11.5	3	8	73	1	Steve Tan	CEJ Mussell	Excellent
21	11-Feb-99	W	M	83.0	Hoogies	11.5	3	8	69	13	Steve Tan	CEJ Mussell	Excellent
22	12-Feb-99	W	F	74.0	Hoogies	11.5	3	9	53	18	Gord Pilling	CEJ Mussell	Excellent
23	12-Feb-99	W	F	79.0	Hoogies	11.5	3	9	52	21	Terry Leong	CEJ Mussell	Excellent
24	18-Feb-99	H	M	75.5	Lickman Rd	12.5	3	8	72	23	Ernie Schepanowski	Jim Rissling	Excellent
25	21-Feb-99	H	F	76.0	Vedder Canal	7.5	2	9	63	9	Nick Basok	Jim Rissling	Excellent
26	26-Feb-99	H	M	73.0	Hoogies	11.5	3	9	73	24	Jim Rissling	Jim Rissling	Excellent
27	26-Feb-99	H	F	79.0	Hatchery Hole	38.5	7	9	64	25	CEJ Mussell	CEJ Mussell	Excellent
28	26-Feb-99	H	F	77.5	Hatchery Hole	38.5	7	9	68	17	CEJ Mussell	CEJ Mussell	Excellent
29	26-Feb-99	H	M	78.5	Teskey Rock	16.0	4	9	76	30	Chris Gadsden	CEJ Mussell	Excellent

Appendix A. Tag and release information for all steelhead radio-tagged in the Vedder/Chilliwack River, 1999. [1]

Fish No.	Tag Date (dd/mmm/yy)	Type (H/W)	Sex (M/F)	Fork Length (cm)	Tagging Location	River Km	Survey Zone	Radio Tag Channel	Radio Tag Code	Spaghetti Tag No.	Angler Name	Tagger Name	Condition at Release
30	02-Mar-99	H	F	69.0	Hoogies	11.5	3	9	66	22	Jim Rissling	Jim Rissling	Excellent
31	02-Mar-99	W	M	84.5	Hoogies	11.5	3	9	56	32	George Wersta	CEJ Mussell	Excellent
32	02-Mar-99	H	M	83.5	Hoogies	11.5	3	25	78	27	Tom Milburn	CEJ Mussell	Excellent
33	02-Mar-99	W	F	81.5	Teskey Rock	17.0	4	9	71	42	Stan Kriznic	CEJ Mussell	Excellent
34	04-Mar-99	W	M	99.0	Hoogies	11.5	3	9	69	39	Gary Chan	Jim Rissling	Excellent
35	04-Mar-99	W	F	69.5	Hoogies	11.5	3	25	68	29	Jim Rissling	Jim Rissling	Excellent
36	05-Mar-99	W	M	72.5	Hoogies	11.5	3	25	60	33	Robert Hsu	CEJ Mussell	Excellent
37	05-Mar-99	W	F	77.0	Hoogies	11.5	3	25	54	37	Ray Rigolo	CEJ Mussell	Excellent
38	05-Mar-99	W	F	78.0	Hoogies	11.5	3	25	66	28	Emmanuel Lanuza	CEJ Mussell	Excellent
39	06-Mar-99	W	F	72.5	Hoogies	11.5	3	25	64	43	Ben Tham	CEJ Mussell	Excellent
40	06-Mar-99	W	F	83.5	Below Hoogies	11.0	3	25	57	47	Scott Thompson	CEJ Mussell	Excellent
41	06-Mar-99	W	F	79.0	Hoogies	11.5	3	25	61	45	Pascual Domingo	CEJ Mussell	Excellent
42	06-Mar-99	W	F	66.5	Hoogies	11.5	3	14	52	38	Cory Bannister	CEJ Mussell	Excellent
43	07-Mar-99	H	F	76.5	Hoogies	11.5	3	25	63	36	CEJ Mussell	CEJ Mussell	Excellent
44	07-Mar-99	W	F	77.5	Lickman Rd	12.5	3	14	53	46	Ernie Schepanowski	CEJ Mussell	Excellent
45	08-Mar-99	W	M	72.5	Hoogies	11.5	3	14	62	41	John Beaty	CEJ Mussell	Excellent
46	08-Mar-99	H	M	66.5	Hydro Bridge	10.0	2	25	71	34	Chris Gadsden	CEJ Mussell	Excellent
47	10-Mar-99	H	M	70.0	Hoogies	11.5	3	14	64	63	Kevin Albert	CEJ Mussell	Excellent
48	11-Mar-99	H	M	69.5	Hoogies	11.5	3	14	56	64	Steve Tan	CEJ Mussell	Excellent
49	01-Apr-99	W	M	83.5	Bergman Tailout	11.0	4	9	51	16	Nick Basok	Nick Basok	Excellent
50	01-Apr-99	H	M	77.0	Hoogies	11.5	3	14	55	125	Steve Tan	CEJ Mussell	Excellent
51	05-Apr-99	H	M	80.0	Vedder Canal	8.0	2	14	59	58	Chris Gadsden	Jim Rissling	Excellent
52	10-Apr-99	W	F	72.5	Vedder Canal	9.0	2	14	65	105	Gord Gadsden	CEJ Mussell	Excellent
53	10-Apr-99	W	F	72.5	Vedder Canal	9.0	2	14	63	77	Gord Gadsden	CEJ Mussell	Excellent
54	13-Apr-99	H	F	82.5	Hoogies	11.5	3	14	61	90	CEJ Mussell	CEJ Mussell	Excellent
55	13-Apr-99	H	M	73.0	Above Pilings	9.5	2	14	68	92	Daryl Imanse	CEJ Mussell	Excellent
56	13-Apr-99	H	M	88.5	Pilings	9.0	2	25	78	84	Chris Gadsden	Jim Rissling	Excellent
57	14-Apr-99	H	F	57.0	Hoogies	11.5	3	14	66	91	Greg Temple	CEJ Mussell	Excellent
58	15-Apr-99	H	M	70.0	Hoogies	11.5	3	14	71	96	Greg Temple	CEJ Mussell	Excellent

Appendix A. Tag and release information for all steelhead radio-tagged in the Vedder/Chilliwack River, 1999. [1]

Fish No.	Tag Date (dd/mmm/yy)	Type (H/W)	Sex (M/F)	Fork Length (cm)	Tagging Location	River Km	Survey Zone	Radio Tag Channel	Radio Tag Code	Spaghetti Tag No.	Angler Name	Tagger Name	Condition at Release
59	21-Apr-99	W	F	81.0	Hoogies	11.5	3	14	74	100	CEJ Mussell	CEJ Mussell	Excellent
60	21-Apr-99	W	F	76.0	Hoogies	11.5	3	14	60	89	Jim Rissling	Jim Rissling	Excellent
61	23-Apr-99	W	F	70.5	Stella's Rock	17.0	4	9	54	20	Bob St. Germaine	Marvin Rosenau	Excellent
62	23-Apr-99	W	F	73.0	Stella's Rock	17.0	4	9	55	59	Marvin Rosenau	Marvin Rosenau	Excellent
63	29-Apr-99	W	F	87.0	Hatchery Hole	38.5	7	9	57	70	Jim Rissling	Jim Rissling	Excellent
64	30-Apr-99	W	M	66.5	Hatchery Hole	38.5	7	14	71	114	Jim Rissling	Jim Rissling	Excellent
65	04-May-99	W	F	71.0	Ranger Run	37.0	5	14	72	95	CEJ Mussell	CEJ Mussell	Excellent
66	04-May-99	W	F	77.0	Ranger Run	37.0	5	14	73	86	CEJ Mussell	Jim Rissling	Excellent
67	05-May-99	H	F	72.0	Hatchery Hole	38.5	7	9	51	82	Chris Gadsden	CEJ Mussell	Excellent
68	05-May-99	H	F	76.0	Hatchery Hole	38.5	7	14	70	116	CEJ Mussell	Jim Rissling	Excellent
69	07-May-99	H	F	78.0	Stella's Rock	17.0	4	14	67	117	CEJ Mussell	Jim Rissling	Excellent
70	07-May-99	H	M	83.0	Hatchery Hole	38.5	7	14	58	119	Jim Rissling	Jim Rissling	Excellent
71	11-May-99	W	F	72.5	Hatchery Hole	38.5	7	14	61	87	CEJ Mussell	Jim Rissling	Excellent
72	11-May-99	W	F	76.0	Hatchery Hole	38.5	7	14	75	52	CEJ Mussell	Jim Rissling	Excellent

[1] Abbreviations are as follows: H/W = Hatchery/Wild; M/F = Male/Female

Appendix B

Tag and release information for all steelhead radio-tagged in the Vedder/Chilliwack River, 2000.

Appendix B. Tag and release information for all steelhead radio-tagged in the Vedder/Chilliwack River, 2000.[1]

Fish No.	Tag Date (dd/mmm/yy)	Type (H/W)	Sex (M/F)	Fork Length (cm)	Tagging Location	River Km	Survey Zone	Radio Tag Channel	Radio Tag Code	Spaghetti Tag No. / Color	Angler Name	Tagger Name	Condition at Release
1	23-Dec-99	H	F	71.5	Hatchery Hole	38.5	7	3	14	592 Yellow	Jim Donaldson	CEJ Mussell	Excellent
2	24-Dec-99	H	M	66.0	Above Lickman	12.5	3	3	15	590 Yellow	Chris Gadsden	CEJ Mussell	Excellent
3	25-Dec-99	W	F	77.0	Boulder Hole	26.0	4	3	16	507 White	John Beaty	CEJ Mussell	Excellent
4	26-Dec-99	H	M	68.5	Hatchery Hole	38.5	7	3	17	588 Yellow	CEJ Mussell	CEJ Mussell	Excellent
5	28-Dec-99	W	M	82.0	Above Lickman	12.5	3	3	28	508 White	Martin Fraser	CEJ Mussell	Excellent
6	29-Dec-99	H	F	76.0	Above Peach	14.5	3	3	29	619 Yellow	Chris Gadsden	CEJ Mussell	Excellent
7	31-Dec-99	W	M	66.0	Above Lickman	12.5	3	3	10	501 White	Ernie Schepanowski	Jim Rissling	Excellent
8	31-Dec-99	W	M	67.0	Below Vedder Crossing	15.0	3	3	11	500 White	Wayne Ridley	Jim Rissling	Excellent
9	31-Dec-99	H	F	76.0	Below Peach Rd	13.5	3	3	12	584 Yellow	Jack Worrall	Jim Rissling	Excellent
10	01-Jan-00	W	M	65.0	Twin Cedars	20.5	4	3	13	531 White	Gord Presseau	Jim Rissling	Excellent
11	02-Jan-00	H	F	76.5	Above Vedder Crossing	15.5	4	3	31	600 Yellow	Martin Fraser	CEJ Mussell	Excellent
12	03-Jan-00	H	F	76.0	Hatchery Hole	38.5	7	3	32	586 Yellow	Chris Gadsden	CEJ Mussell	Excellent
13	06-Jan-00	H	F	77.5	Brown Rd	12.0	3	3	33	612 Yellow	John Beaty	CEJ Mussell	Excellent
14	07-Jan-00	H	F	59.0	Lickman Rd	12.5	3	3	34	587 Yellow	Mel Lavery	CEJ Mussell	Excellent
15	07-Jan-00	H	F	79.0	Above Teskey Rock	16.0	4	3	30	604 Yellow	Jack Worrall	CEJ Mussell	Excellent
16	07-Jan-00	W	F	73.0	Above Vedder Crossing	15.5	4	3	35	527 White	Sandor Kmetyko Sr.	Jim Rissling	Excellent
17	07-Jan-00	H	F	76.0	Above Vedder Crossing	15.5	4	3	36	583 Yellow	Brian Summers	Jim Rissling	Excellent
18	08-Jan-00	H	F	69.0	Hatchery Hole	38.5	7	3	41	580 Yellow	Jim Rissling	Jim Rissling	Excellent
19	10-Jan-00	W	F	84.5	Above Vedder Crossing	15.5	4	3	48	523 White	Jim Rissling	Jim Rissling	Excellent
20	10-Jan-00	W	F	76.0	Brown Rd	12.0	3	3	42	506 White	Gordy Herron	Jim Rissling	Excellent
21	11-Jan-00	H	F	74.5	Above Brown Rd	12.0	3	3	37	615 Yellow	Chris Gadsden	CEJ Mussell	Excellent
22	11-Jan-00	W	M	78.0	Above Brown Rd	12.0	3	3	39	532 White	John Beaty	Jim Rissling	Excellent
23	12-Jan-00	H	F	72.0	Above Brown Rd	12.0	3	3	38	614 Yellow	Chris Gadsden	CEJ Mussell	Excellent
24	12-Jan-00	W	F	79.0	Above Brown Rd	12.0	3	3	40	526 White	Tom Milburn	CEJ Mussell	Excellent
25	12-Jan-00	H	F	75.0	Below Bergman Tailout	10.5	3	3	43	606 Yellow	John Beaty	CEJ Mussell	Excellent
26	13-Jan-00	W	F	77.0	Brown Rd	12.0	3	3	31	535 White	Don Fleming	CEJ Mussell	Excellent
27	13-Jan-00	H	F	79.0	Above Hydro Bridge	10.5	3	3	53	581 Yellow	Dusty Waite	Jim Rissling	Excellent
28	13-Jan-00	H	F	72.0	Top of Canal	8.0	2	3	45	618 Yellow	Jack Worrall	Jim Rissling	Excellent
29	13-Jan-00	W	F	93.0	Brown Rd	12.0	3	3	49	539 White	Cory Bannister	CEJ Mussell	Excellent
30	14-Jan-00	W	F	65.5	Below Pilings	9.0	2	3	47	530 White	Tony Mazzucco	Jim Rissling	Excellent
31	14-Jan-00	W	F	79.0	Hatchery Hole	38.5	7	3	45	524 White	Jim Donaldson	Jim Rissling	Excellent
32	16-Jan-00	W	F	74.0	Brown Rd	12.0	3	3	24	521 White	Stu Kemle	CEJ Mussell	Excellent

Appendix B. Tag and release information for all steelhead radio-tagged in the Vedder/Chilliwack River, 2000.[1]

Fish No.	Tag Date (dd/mmm/yy)	Type (H/W)	Sex (M/F)	Fork Length (cm)	Tagging Location	River Km	Survey Zone	Radio Tag Channel	Radio Tag Code	Spaghetti Tag No. / Color	Angler Name	Tagger Name	Condition at Release
33	16-Jan-00	H	F	69.0	Brown Rd	12.0	3	3	25	594 Yellow	Gord Gadsden	CEJ Mussell	Excellent
34	16-Jan-00	H	M	73.5	Brown Rd	12.0	3	3	23	608 Yellow	Ted Hansen	CEJ Mussell	Excellent
35	17-Jan-00	H	F	62.5	Brown Rd	12.0	3	3	44	601 Yellow	Greg Temple	Jim Rissling	Excellent
36	17-Jan-00	W	M	71.0	Brown Rd	12.0	3	3	52	503 White	Greg Temple	Jim Rissling	Excellent
37	17-Jan-00	W	F	70.0	Brown Rd	12.0	3	3	55	537 White	Rick Hogness	Jim Rissling	Excellent
38	18-Jan-00	W	M	59.5	Brown Rd	12.0	3	3	46	509 White	Rick Hogness	CEJ Mussell	Excellent
39	18-Jan-00	W	F	70.0	Brown Rd	12.0	3	3	57	502 White	Glen Van Breugel	Jim Rissling	Excellent
40	19-Jan-00	W	F	71.5	Brown Rd	12.0	3	3	60	505 White	Drago Tisic	Jim Rissling	Excellent
41	19-Jan-00	H	F	66.0	Above Lickman	12.5	3	3	27	605 Yellow	Ernie Schepanowski	Jim Rissling	Excellent
42	19-Jan-00	W	F	74.0	Below Vedder Crossing	15.0	3	3	50	522 White	Marc Audette	CEJ Mussell	Excellent
43	20-Jan-00	W	M	70.0	Brown Rd	12.0	3	3	63	536 White	Cecil Salmon	Jim Rissling	Excellent
44	20-Jan-00	H	F	59.0	Below Hydro Bridge	9.0	2	3	64	613 Yellow	Tom Milburn	Jim Rissling	Excellent
45	21-Jan-00	H	M	64.5	Brown Rd	12.0	3	3	51	610 Yellow	CEJ Mussell	CEJ Mussell	Excellent
46	21-Jan-00	W	M	69.5	Below Wilson Rd	8.5	2	3	26	504 White	Max Lang	Jim Rissling	Excellent
47	22-Jan-00	W	F	65.5	Brown Rd	12.0	3	3	56	529 White	Joe Tay	CEJ Mussell	Excellent
48	22-Jan-00	W	F	76.0	Brown Rd	12.0	3	3	58	511 White	Frank Flora	CEJ Mussell	Excellent
49	22-Jan-00	H	F	61.0	Top of Canal	8.0	2	3	59	589 Yellow	Ernie Schepanowski	CEJ Mussell	Excellent
50	23-Jan-00	W	F	78.5	Hydro Bridge	10.0	3	3	54	520 White	Mike Baker	CEJ Mussell	Excellent
51	23-Jan-00	W	M	71.0	Above Hydro Bridge	10.0	3	3	62	512 White	Mike Baker	CEJ Mussell	Excellent
52	23-Jan-00	H	M	71.0	Top of Canal	8.0	2	3	61	617 Yellow	Mike Baker	CEJ Mussell	Excellent
53	25-Jan-00	H	F	64.5	Teskey Rock	16.0	4	3	68	585 Yellow	Terry Duck	Jim Rissling	Excellent
54	27-Jan-00	W	M	67.5	Brown Rd	12.0	3	3	11	538 White	Keith Laxton	CEJ Mussell	Excellent
55	27-Jan-00	H	F	71.0	Brown Rd	12.0	3	3	65	607 Yellow	Mike Baker	CEJ Mussell	Excellent
56	27-Jan-00	H	F	63.0	Pilings	9.0	2	3	69	618 Yellow	Steve Roseboom	Jim Rissling	Excellent
57	27-Jan-00	H	F	80.0	Top of Canal	8.0	2	3	70	602 Yellow	Jack Worrall	Jim Rissling	Excellent
58	27-Jan-00	W	M	62.0	Below Hydro Bridge	9.5	2	3	66	510 White	Chris Gadsden	CEJ Mussell	Excellent
59	28-Jan-00	H	F	81.0	Hatchery Hole	38.5	7	3	67	603 Yellow	Jim Donaldson	CEJ Mussell	Excellent
60	31-Jan-00	H	F	71.5	Above Peach Rd	14.5	3	3	76	618 Yellow	Tom Milburn	Jim Rissling	Excellent
61	04-Feb-00	H	F	68.0	Hydro Bridge	10.0	2	3	73	556 Pink	John Beaty	CEJ Mussell	Excellent
62	04-Feb-00	H	F	62.0	Hoogies	11.5	3	3	74	546 Pink	Daryl Imanse	CEJ Mussell	Excellent
63	04-Feb-00	H	F	70.5	Brown Rd	12.0	3	3	41	576 Pink	Glen Van Breugel	Jim Rissling	Excellent
64	04-Feb-00	W	M	79.0	Brown Rd	12.0	3	3	72	661 Blue	Thomas Rutchman	Jim Rissling	Excellent

Appendix B. Tag and release information for all steelhead radio-tagged in the Vedder/Chilliwack River, 2000.[1]

Fish No.	Tag Date (dd/mmm/yy)	Type (H/W)	Sex (M/F)	Fork Length (cm)	Tagging Location	River Km	Survey Zone	Radio Tag Channel	Radio Tag Code	Spaghetti Tag No. / Color	Angler Name	Tagger Name	Condition at Release
65	05-Feb-00	W	M	67.0	Brown Rd	12.0	3	3	77	675 Blue	Rod Farquharson	Jim Rissling	Excellent
66	05-Feb-00	W	M	72.5	Hoogies	11.5	3	3	104	664 Blue	c/o Daryl Imanse	Jim Rissling	Excellent
67	05-Feb-00	W	M	65.5	Above Lickman	13.0	3	3	44	665 Blue	Tom Milburn	Jim Rissling	Excellent
68	06-Feb-00	W	M	87.5	Brown Rd	12.0	3	3	101	699 Blue	Glen Van Breugel	CEJ Mussell	Excellent
69	06-Feb-00	W	F	77.0	Brown Rd	12.0	3	3	102	697 Blue	Jerry Lavender	CEJ Mussell	Excellent
70	07-Feb-00	H	F	73.5	Brown Rd	12.0	3	3	79	575 Pink	Gwyn Joiner	Jim Rissling	Excellent
71	09-Feb-00	W	M	81.5	Brown Rd	12.0	3	3	69	670 Blue	Jim Rissling	Jim Rissling	Excellent
72	11-Feb-00	W	M	66.5	1st Washout	32.0	5	3	73	678 Blue	George Pavan	Jim Rissling	Excellent
73	11-Feb-00	H	F	72.0	Pilings	9.0	2	3	78	569 Pink	Chris Gadsden	Gord Gadsden	Excellent
74	12-Feb-00	W	M	68.0	Below Station 3	25.0	4	3	75	690 Blue	Martin Fraser	CEJ Mussell	Excellent
75	15-Feb-00	W	M	66.0	Brown Rd	12.0	3	3	71	676 Blue	Hilten Oliver	Gord Gadsden	Excellent
76	15-Feb-00	W	F	81.0	Brown Rd	12.0	3	3	70	662 Blue	Gord Gadsden	Gord Gadsden	Excellent
77	18-Feb-00	W	M	71.0	Below Pilings	9.0	2	3	82	679 Blue	Bryon McConnell	Gord Gadsden	Excellent
78	24-Feb-00	W	M	96.0	Tom's Tailout	11.0	3	3	105	669 Blue	Ernie McDuff	Jim Rissling	Excellent
79	25-Feb-00	W	F	71.0	Teskey Rock	16.0	4	3	106	677 Blue	Martin Fraser	Jim Rissling	Excellent
80	26-Feb-00	H	M	72.0	Below Vedder Crossing	15.0	3	3	27	555 Pink	Mike Baker	Jim Rissling	Excellent
81	28-Feb-00	H	M	70.0	Brown Rd	12.0	3	3	44	551 Pink	Jim Rissling	Jim Rissling	Excellent
82	29-Feb-00	H	M	70.0	Below Vedder Crossing	15.0	3	3	25	552 Pink	Mike Baker	Gord Gadsden	Excellent
83	01-Mar-00	H	M	75.0	Peach Hammer Hole	14.5	3	3	80	560 Pink	CEJ Mussell	CEJ Mussell	Excellent
84	03-Mar-00	W	F	73.0	Tom's Tailout	11.0	3	3	107	686 Blue	Gibran White	Jim Rissling	Excellent
85	06-Mar-00	H	M	72.0	Above Peach Rd	14.5	3	3	30	543 Pink	Chris Gadsden	Jim Rissling	Excellent
86	11-Mar-00	W	F	81.5	Below Xing	15.0	3	3	114	680 Blue	Vic Carrao	Jim Rissling	Excellent
87	14-Mar-00	W	F	78.0	Brown Rd	12.0	3	3	116	689 Blue	Thomas Rutchman	CEJ Mussell	Excellent
88	15-Mar-00	W	M	85.0	Brown Rd	12.0	3	3	104	688 Blue	Steve Tan	CEJ Mussell	Excellent
89	16-Mar-00	H	F	66.0	Tom's Tailout	11.0	3	3	14	573 Pink	Tom Milburn	CEJ Mussell	Excellent
90	16-Mar-00	H	F	65.5	Below Tom's Tailout	10.5	3	3	81	568 Pink	CEJ Mussell	CEJ Mussell	Excellent
91	19-Mar-00	W	F	72.0	Swoolie Log Jam	16.5	4	3	86	No S.T.	Mike Baker	Gord Gadsden	Excellent
92	19-Mar-00	W	M	67.0	Swoolie Log Jam	16.5	4	3	83	683 Blue	Daryl Imanse	Gord Gadsden	Excellent
93	20-Mar-00	W	M	76.5	Hoogies	11.5	3	3	101	692 Blue	Charlene Brown	Gord Gadsden	Excellent
94	20-Mar-00	W	M	79.0	Hoogies	11.5	3	3	112	663 Blue	Lee Pettyjohn	Gord Gadsden	Excellent
95	21-Mar-00	W	M	86.5	Swoolie Log Jam	16.5	4	3	119	681 Blue	Daryl Imanse	Gord Gadsden	Excellent
96	22-Mar-00	W	M	75.0	Hoogies	11.5	3	3	110	698 Blue	Bob Mitchell	CEJ Mussell	Excellent

Appendix B. Tag and release information for all steelhead radio-tagged in the Vedder/Chilliwack River, 2000.[1]

Fish No.	Tag Date (dd/mmm/yy)	Type (H/W)	Sex (M/F)	Fork Length (cm)	Tagging Location	River Km	Survey Zone	Radio Tag Channel	Radio Tag Code	Spaghetti Tag No. / Color	Angler Name	Tagger Name	Condition at Release
97	22-Mar-00	W	F	79.0	Peach Hammer Hole	14.5	3	3	103	684 Blue	CEJ Mussell	CEJ Mussell	Excellent
98	25-Mar-00	W	F	80.0	Swoolie Log Jam	16.5	4	3	113	693 Blue	Mike Baker	Gord Gadsden	Excellent
99	25-Mar-00	W	F	78.0	Hoogies	11.5	3	3	134	696 Blue	Stefan Hostancy	Gord Gadsden	Excellent
100	26-Mar-00	W	F	78.5	Vedder Xing	15.5	3	3	84	695 Blue	Terry Duck	Gord Gadsden	Excellent
101	27-Mar-00	W	F	67.0	Brown Rd	12.0	3	3	13	685 Blue	Greg Temple	CEJ Mussell	Excellent
102	27-Mar-00	W	F	65.0	Brown Rd	12.0	3	3	34	687 Blue	Lawrence Walker	Jim Rissling	Excellent
103	27-Mar-00	W	F	66.5	Hoogies	11.5	3	3	36	667 Blue	Cecil Salmon	CEJ Mussell	Excellent
104	27-Mar-00	H	M	66.0	Above Peach Rd	14.5	3	3	76	691 Blue*	Chris Gadsden	Jim Rissling	Excellent
105	28-Mar-00	W	M	83.0	Brown Rd	12.0	3	3	138	666 Blue	Scheryl King	Jim Rissling	Excellent
106	28-Mar-00	H	F	66.0	Hydro Bridge	10.0	3	3	61	563 Pink	Chris Gadsden	Jim Rissling	Excellent
107	28-Mar-00	H	F	74.0	Pilings	9.0	2	3	125	557 Pink	Tom Milburn	Jim Rissling	Excellent
108	29-Mar-00	H	F	86.0	Brown Rd	12.0	3	3	124	541 Pink	Bill Hellofs	CEJ Mussell	Excellent
109	29-Mar-00	W	M	72.0	Brown Rd	12.0	3	3	115	682 Blue	Daryl Imanse	CEJ Mussell	Excellent
110	29-Mar-00	W	F	75.0	Pilings	9.0	2	2	101	250 Orange	Tom Milburn	CEJ Mussell	Excellent
111	30-Mar-00	H	M	56.0	Above Stella's Rock	16.5	4	3	85	549 Pink	Ernie McDuff	Jim Rissling	Excellent
112	31-Mar-00	W	F	80.0	Brown Rd	12.0	3	3	117	674 Blue	Joe Nishida	Jim Rissling	Excellent
113	31-Mar-00	W	F	67.5	Hydro Bridge	10.0	3	2	105	672 Blue	Ernie Schepanowski	Jim Rissling	Excellent
114	01-Apr-00	H	F	61.0	Brown Rd	12.0	3	3	66	540 Pink	Todd Wampler	Jim Rissling	Excellent
115	01-Apr-00	W	F	73.5	Brown Rd	12.0	3	2	102	694 Blue	Glen Van Breugel	Jim Rissling	Excellent
116	01-Apr-00	W	F	66.5	Swoolie Log Jam	16.5	3	3	41	230 Orange	Mike Baker	Gord Gadsden	Excellent
117	01-Apr-00	W	F	72.0	Brown Rd	12.0	3	2	106	238 Orange	Young Ryu	Jim Rissling	Excellent
118	01-Apr-00	W	M	72.0	Hydro Bridge	10.0	3	2	103	232 Orange	Chris Gadsden	Jim Rissling	Excellent
119	01-Apr-00	H	F	78.0	Hydro Bridge	10.0	3	2	104	570 Pink	Chad Pickering	Jim Rissling	Excellent
120	01-Apr-00	H	M	64.5	Hydro Bridge	10.0	3	3	21	561 Pink	Chris Gadsden	Jim Rissling	Excellent
121	02-Apr-00	W	F	63.0	Brown Rd	12.0	3	3	78	245 Orange	Young Ryu	CEJ Mussell	Excellent
122	02-Apr-00	H	M	66.0	Brown Rd	12.0	3	3	43	565 Pink	Glen Van Breugel	Troy Nelson	Excellent
123	03-Apr-00	H	F	64.0	Brown Rd	12.0	3	3	22	547 Pink	Marc Audette	Jim Rissling	Excellent
124	05-Apr-00	W	M	67.0	Above Lickman	13.0	3	2	116	236 Orange	Chris Gadsden	CEJ Mussell	Excellent
125	05-Apr-00	W	F	71.5	Above Lickman	13.0	3	2	117	237 Orange	CEJ Mussell	CEJ Mussell	Excellent
126	05-Apr-00	H	F	66.0	Above Lickman	13.0	3	3	65	554 Pink	Daryl Imanse	CEJ Mussell	Excellent
127	05-Apr-00	H	F	65.0	Above Lickman	13.0	3	3	19	548 Pink	Daryl Imanse	CEJ Mussell	Excellent
128	05-Apr-00	H	F	69.0	Above Lickman	13.0	3	2	119	566 Pink	CEJ Mussell	CEJ Mussell	Excellent

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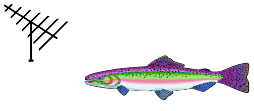
Fish No.	Tag Date (dd/mmm/yy)	Type (H/W)	Sex (M/F)	Fork Length (cm)	Tagging Location	River Km	Survey Zone	Radio Tag Channel	Radio Tag Code	Spaghetti Tag No. / Color	Angler Name	Tagger Name	Condition at Release
129	06-Apr-00	H	F	61.5	Above Lickman	13.0	3	3	20	542 Pink	Chris Gadsden	CEJ Mussell	Excellent
130	06-Apr-00	H	F	65.5	Below Peach Rd	14.0	3	3	17	578 Pink	Chris Gadsden	CEJ Mussell	Excellent
131	06-Apr-00	H	F	64.5	Peach Rd	14.0	3	2	118	550 Pink	Chris Gadsden	CEJ Mussell	Excellent
132	06-Apr-00	W	F	71.0	Peach Rd	14.0	3	2	121	227 Orange	Rick Nicholson	CEJ Mussell	Excellent
133	06-Apr-00	W	F	72.5	Peach Rd	14.0	3	2	125	243 Orange	Chris Gadsden	CEJ Mussell	Excellent
134	06-Apr-00	H	F	76.0	Above Lickman	13.0	3	2	138	553 Pink	Chris Gadsden	CEJ Mussell	Excellent
135	06-Apr-00	W	M	75.0	Above Lickman	13.0	3	2	114	247 Orange	Daryl Imanse	CEJ Mussell	Excellent
136	06-Apr-00	W	F	70.0	Above Lickman	13.0	3	2	113	235 Orange	Richard Poirier	CEJ Mussell	Excellent
137	06-Apr-00	H	F	78.0	Above Peach Rd	14.0	3	2	108	576 Pink	Jim Rissling	Jim Rissling	Excellent
138	07-Apr-00	H	F	59.5	Below Hydro Bridge	9.5	3	3	18	242 Orange	Tom Milburn	Jim Rissling	Excellent
139	07-Apr-00	H	F	80.0	Above Teskey Rock	16.0	4	2	139	579 Pink	Daryl Imanse	CEJ Mussell	Excellent
140	10-Apr-00	H	F	66.5	Above Lickman	13.0	3	2	118	248 Orange	CEJ Mussell	CEJ Mussell	Excellent
141	12-Apr-00	H	F	68.5	Above Peach Rd	14.0	3	2	140	228 Orange	Pete Schmyr	Jim Rissling	Excellent
142	13-Apr-00	W	M	77.0	Above Lickman	13.0	3	2	123	246 Orange	Chris Gadsden	CEJ Mussell	Excellent
143	17-Apr-00	H	F	65.0	Above Lickman	13.0	3	3	76	244 Orange	Chris Gadsden	CEJ Mussell	Excellent
144	17-Apr-00	H	F	66.5	Below Peach Rd	14.0	3	2	115	231 Orange	Chris Gadsden	CEJ Mussell	Excellent
145	19-Apr-00	W	F	65.0	Above Lickman	13.0	3	3	109	239 Orange	Jim Rissling	Jim Rissling	Excellent
146	19-Apr-00	W	M	82.5	Below Peach Rd	14.0	3	2	129	226 Orange	CEJ Mussell	CEJ Mussell	Excellent
147	20-Apr-00	H	F	66.0	Teskey Rock	16.0	4	3	111	268 Orange	Gwyn Joiner	Jim Rissling	Excellent
148	20-Apr-00	W	F	63.5	Above Lickman	13.0	3	2	126	249 Orange	Tyler Buck	Jim Rissling	Excellent
149	23-Apr-00	H	F	71.5	Below Peach Rd	14.0	3	2	111	233 Orange	Tom Milburn	Jim Rissling	Excellent
150	23-Apr-00	H	F	66.5	Below Peach Rd	14.0	3	2	107	241 Orange	Tom Milburn	Jim Rissling	Excellent
151	24-Apr-00	W	M	78.0	Below Peach Rd	14.0	3	3	108	240 Orange	Tom Milburn	Jim Rissling	Excellent
152	24-Apr-00	W	F	72.5	Above On The Way Store	17.5	4	2	122	412 Orange	Tom Milburn	Jim Rissling	Excellent
153	26-Apr-00	W	F	70.0	Lickman Rd	12.5	3	2	132	498 Orange	Steve Olson	Jim Rissling	Excellent
154	30-Apr-00	W	M	66.5	Above On The Way Store	18.0	4	2	124	234 Orange	Glen Sheppard	Jim Rissling	Excellent

[1] Abbreviations are as follows: H/W = Hatchery/Wild; M/F = Male/Female

Appendix C

Summary of tagging, holding, spawning, survival-to-kelt data, and fates, for all steelhead radio-tagged in the Vedder/Chilliwack River, 1999.



Appendix C. Summary of tagging, holding, spawning, survival-to-kelt data, and fates, for all steelhead radio-tagged in the Vedder/Chilliwack River, 1999.[A]

Fish No.	Type (H/W)	Sex (M/F)	Tag Date (dd/mmm/yy)	Location: Tagging Zone	Tagging Rkm	Holding Zone	Holding Rkm	Spawning Zone	Spawning Rkm	Fate	Spawning Week Ending	No. Days on Spawning Ground	No. of Reported Recaptures	Survived to Kelt?	Kelt (Station 1) Date
1	W	F	05-Jan-99	3	12.5	7	42.5	9	58.5	Spawned, Died	01-May	Unk	0	No	N/A
2	H	M	08-Jan-99	7	38.5	7	41.0	6	38.5	Spawned, Kelted? [1]	15-May	41	1	Unk	N/A
3	W	F	08-Jan-99	7	38.5	7	38.5	7	42.5	Spawned, Kelted	17-Apr	13	2	Yes	12-May
4	W	M	11-Jan-99	7	38.5	9	61.0	9	61.0	Spawned, Died	10-Apr	52	0	No	N/A
5	H	M	11-Jan-99	7	38.5	5	34.0	N/A	N/A	Killed by Angler	N/A	N/A	1	N/A	N/A
6	W	M	11-Jan-99	7	42.5	8	52.0	8	53.0	Spawned, Kelted	08-May	16	0	Yes	14-May
7	H	F	12-Jan-99	7	38.5	7	39.0	5	30.5	Spawned, Died	Unk	Unk	0	No	N/A
8	W	M	12-Jan-99	7	38.5	8	47.0	8	48.5	Spawned, Kelted	15-May	20	0	Yes	22-May
9	W	M	27-Jan-99	3	11.5	7	42.5	9	61.0	Spawned, Died	17-Apr	20	1	No	N/A
10	H	F	27-Jan-99	3	11.5	4	22.5	4	22.5	Spawned, Kelted	06-Mar	12	0	Yes	05-Mar
11	H	F	27-Jan-99	3	11.5	5	34.0	5	34.0	Spawned, Kelted	10-Apr	51	1	Yes	16-Apr
12	W	M	27-Jan-99	3	11.5	4	22.5	5	36.0	Spawned, Died	01-May	8	0	No	N/A
13	W	F	03-Feb-99	3	11.5	4	17.0	3	14.5	Spawned, Kelted	01-May	21	0	Yes	24-May
14	W	M	04-Feb-99	3	11.5	5	34.0	8	49.5	Spawned, Died	15-May	26	0	No	N/A
15	W	M	05-Feb-99	4	16.0	4	15.5	4	15.5	Spawned, Kelted	17-Apr	51	0	Yes	25-Apr
16	W	F	05-Feb-99	3	11.5	7	38.5	7	38.5	Spawned, Died	22-May	66	0	No	N/A
17	H	F	05-Feb-99	3	11.5	5	26.5	5	38.0	Spawned, Kelted	24-Apr	20	1	Yes	16-May
18	H	F	06-Feb-99	4	16.0	3	14.5	6	38.5	Spawned, Kelted	08-May	13	1	Yes	20-May
19	H	M	06-Feb-99	4	16.0	5	36.5	N/A	N/A	Killed by Angler	N/A	N/A	2	N/A	N/A
20	W	F	11-Feb-99	3	11.5	7	38.5	8	56.0	Spawned, Kelted	08-May	20	1	Yes	24-May
21	W	M	11-Feb-99	3	11.5	5	32.0	9	58.5	Spawned, Died	24-Apr	4	1	No	N/A
22	W	F	12-Feb-99	3	11.5	4	24.0	4	25.0	Spawned, Died	22-May	38	0	No	N/A
23	W	F	12-Feb-99	3	11.5	5	36.5	5	36.0	Spawned, Kelted	08-May	19	0	Yes	22-May
24	H	M	18-Feb-99	3	12.5	4	18.0	6	38.0	Spawned, Kelted	08-May	23	0	Yes	24-May
25	H	F	21-Feb-99	2	7.5	4	20.0	6	38.0	Spawned, Kelted	08-May	17	1	Yes	18-May
26	H	M	26-Feb-99	3	11.5	3	11.5	N/A	N/A	Unk (Killed?) [2]	N/A	N/A	0	N/A	N/A
27	H	F	26-Feb-99	7	38.5	7	38.5	5	36.0	Spawned, Kelted	17-Apr	11	1	Yes	25-Apr
28	H	F	26-Feb-99	7	38.5	7	38.5	5	35.0	Spawned, Kelted	01-May	10	0	Yes	16-May
29	H	M	26-Feb-99	4	16.0	5	34.0	5	34.0	Spawned, Died	10-Apr	N/A	0	No	N/A

Appendix C. Summary of tagging, holding, spawning, survival-to-kelt data, and fates, for all steelhead radio-tagged in the Vedder/Chilliwack River, 1999.[A]

Fish No.	Type (H/W)	Sex (M/F)	Tag Date (dd/mmm/yy)	Location: Tagging Zone	Tagging Rkm	Holding Zone	Holding Rkm	Spawning Zone	Spawning Rkm	Fate	Spawning Week Ending	No. Days on Spawning Ground	No. of Reported Recaptures	Survived to Kelt?	Kelt (Station 1) Date
30	H	F	02-Mar-99	3	11.5	2	5.0	7	39.0	Spawned, Kelted	29-May	7	0	Yes	02-Jun
31	W	M	02-Mar-99	3	11.5	3	11.5	4	25.0	Spawned, Died	15-May	30	2	No	N/A
32	H	M	02-Mar-99	3	11.5	2	9.5	N/A	N/A	Killed by Angler	N/A	N/A	1	N/A	N/A
33	W	F	02-Mar-99	4	17.0	7	42.5	8	49.5	Spawned, Kelted	01-May	17	0	Yes	23-May
34	W	M	04-Mar-99	3	11.5	3	11.5	7	38.5	Spawned, Died	15-May	31	4	No	N/A
35	W	F	04-Mar-99	3	11.5	7	42.5	8	49.5	Spawned, Kelted	22-May	15	1	Yes	30-May
36	W	M	05-Mar-99	3	11.5	3	11.5	N/A	N/A	Unk (Killed?[2]	N/A	N/A	0	Unk	N/A
37	W	F	05-Mar-99	3	11.5	5	36.5	5	38.0	Spawned, Kelted	08-May	17	0	Yes	23-May
38	W	F	05-Mar-99	3	11.5	2	4.0	Unk	Unk	Spawned, Kelted	10-Apr	19	0	Yes	13-Apr
39	W	F	06-Mar-99	3	11.5	5	31.5	8	54.0	Spawned, Kelted	22-May	6	0	Yes	09-Jun
40	W	F	06-Mar-99	3	11.0	4	26.0	5	36.0	Spawned, Kelted	01-May	20	0	Yes	15-May
41	W	F	06-Mar-99	3	11.5	4	N/A	4	N/A	Spawned, Kelted	24-Apr	N/A	0	Yes	26-Apr
42	W	F	06-Mar-99	3	11.5	3	11.5	8	50.0	Spawned, Kelted	22-May	18	2	Yes	07-Jun
43	H	F	07-Mar-99	3	11.5	3	11.5	7	49.5	Spawned, Kelted	08-May	13	1	Yes	23-May
44	W	F	07-Mar-99	3	12.5	3	13.0	7	44.0	Spawned, Kelted	01-May	9	0	Yes	21-May
45	W	M	08-Mar-99	3	11.5	3	11.5	5	36.0	Spawned, Kelted	15-May	36	1	Yes	23-May
46	H	M	08-Mar-99	2	10.0	3	11.5	6	38.0	Spawned, Died	29-May	41	0	No	N/A
47	H	M	10-Mar-99	3	11.5	3	11.0	5	37.0	Spawned, Kelted	08-May	10	0	Yes	08-May
48	H	M	11-Mar-99	3	11.5	5	37.5	6	38.0	Spawned, Kelted	22-May	13	0	Yes	25-May
49	W	M	01-Apr-99	4	11.0	N/A	N/A	N/A	N/A	Tag Removed[3]	N/A	N/A	1	N/A	N/A
50	H	M	01-Apr-99	3	11.5	5	33.5	5	34.0	Spawned, Died	15-May	30	0	No	N/A
51	H	M	05-Apr-99	2	8.0	N/A	N/A	N/A	N/A	Unk (regurg., killed)[4]	N/A	N/A	0	N/A	N/A
52	W	F	10-Apr-99	2	9.0	N/A	N/A	N/A	N/A	Spawned? Kelted	N/A	7	0	Yes	17-Apr
53	W	F	10-Apr-99	2	9.0	7	38.5	7	44.0	Spawned, Kelted	05-Jun	16	1	Yes	13-Jun
54	H	F	13-Apr-99	3	11.5	3	11.5	N/A	N/A	Killed by Angler	N/A	N/A	1	N/A	N/A
55	H	M	13-Apr-99	2	9.5	6	38.0	6	38.0	Spawned, Kelted	22-May	34	0	Yes	03-Jun
56	H	M	13-Apr-99	2	9.0	3	14.0	3	14.0	Spawned, Kelted	01-May	12	0	Yes	01-May
57	H	F	14-Apr-99	3	11.5	3	11.5	5	30.5	Spawned, Kelted	02-May	10	0	Yes	03-May
58	H	M	15-Apr-99	3	11.5	3	11.5	N/A	N/A	Killed by Angler	N/A	N/A	1	N/A	N/A

Appendix C. Summary of tagging, holding, spawning, survival-to-kelt data, and fates, for all steelhead radio-tagged in the Vedder/Chilliwack River, 1999.[A]

Fish No.	Type (H/W)	Sex (M/F)	Tag Date (dd/mmm/yy)	Location: Tagging Zone	Tagging Rkm	Holding Zone	Holding Rkm	Spawning Zone	Spawning Rkm	Fate	Spawning Week Ending	No. Days on Spawning Ground	No. of Reported Recaptures	Survived to Kelt?	Kelt (Station 1) Date
59	W	F	21-Apr-99	3	11.5	3	11.0	3	12.5	Spawned, Kelted	08-May	8	0	Yes	09-May
60	W	F	21-Apr-99	3	11.5	3	10.5	7	44.0	Spawned, tag died Jun	19-Jun	10	0	Unk	N/A
61	W	F	23-Apr-99	4	17.0	4	26.0	4	26.0	Spawned, Kelted	15-May	7	0	Yes	18-May
62	W	F	23-Apr-99	4	17.0	5	30.5	5	30.5	Spawned, Kelted	15-May	20	0	Yes	11-Jun
63	W	F	29-Apr-99	7	38.5	7	39.0	7	39.5	Spawned, Kelted	15-May	17	0	Yes	23-May
64	W	M	30-Apr-99	7	38.5	4	22.5	4	22.5	Spawned, Kelted	15-May	16	0	Yes	23-May
65	W	F	04-May-99	5	37.0	N/A	N/A	N/A	N/A	Spawned, Kelted	N/A	N/A	0	Yes	17-May
66	W	F	04-May-99	5	37.0	N/A	N/A	N/A	N/A	Spawned, Kelted	N/A	N/A	0	Yes	23-May
67	H	F	05-May-99	7	38.5	7	38.5	7	45.0	Spawned, Kelted	22-May	4	0	Yes	01-Jun
68	H	F	05-May-99	7	38.5	3	14.0	3	14.5	Spawned, Died	29-May	8	0	No	N/A
69	H	F	07-May-99	4	17.0	4	17.0	4	17.0	Spawned, Kelted	15-May	Unk	0	Yes	15-May
70	H	M	07-May-99	7	38.5	7	38.5	7	38.5	Spawned, Kelted	22-May	Unk	0	Yes	23-May
71	W	F	11-May-99	7	38.5	N/A	N/A	Unk	Unk	Spawned, Kelted	Unk	Unk	0	Yes	21-May
72	W	F	11-May-99	7	38.5	N/A	N/A	Unk	Unk	Spawned, Kelted	Unk	Unk	0	Yes	20-May

[A] Abbreviations are: H/W = Hatchery/Wild; M/F = Male/Female; N/A = Not Applicable; Unk = Unknown; Regurg. = tag regurgitation; Rkm = River Kilometer

[1] Fish spawned, then moved downstream, but tag never again detected after 6 June (tag died or fish removed); may have kelted after 21 June

[2] After moving upstream and behaving normally, tag disappeared after several weeks in popular fishing area (it is likely that the fish was recaptured, tag removed and not reported or returned; possibility that these fish were killed by anglers)

[3] Fish recaptured, tag removed by angler, fish released alive by angler, tag returned

[4] Radio tag for Fish No. 51 tag was detected at point of release (stationary) following release at popular fishing location (the tag could have been regurgitated at the time of release, or was recaptured and killed by angler, tag removed and tag left in river); because there was no reporting of this fish as a recapture, this fish could be considered a mortality as a result of the initial capture/tagging event

Appendix D

Summary of tagging, holding, spawning, survival-to-kelt data, and fates, for all steelhead radio-tagged in the Vedder/Chilliwack River, 2000.

Appendix D. Summary of tagging, holding, spawning, survival-to-kelt data, and fates, for all steelhead radio-tagged in the Vedder/Chilliwack River, 2000.[A]

Fish No.	Type (H/W)	Sex (M/F)	Tag Date (dd/mmm/yy)	Location						Fate	Spawning Week Ending	No. Days on Spawning Ground	No. of Reported Recaptures	Survived to Kelt?	Kelt (Station 1) Date
				Tagging		Holding		Spawning							
				Zone	Rkm	Zone	Rkm	Zone	Rkm						
1	H	F	23-Dec-99	7.0	38.5	N/A	N/A	N/A	N/A	Killed by Angler	N/A	N/A	1	N/A	N/A
2	H	M	24-Dec-99	3.0	12.5	7	38.5	5	27.5	Spawned, kelted	23-Apr	16	1	Yes	01-May
3	W	F	25-Dec-99	4.0	26.0	7	44.2	8	56.0	Spawned, kelted	30-Apr	10	0	Yes	18-May
4	H	M	26-Dec-99	7.0	38.5	N/A	N/A	N/A	N/A	Killed by Angler	N/A	N/A	2	N/A	N/A
5	W	M	28-Dec-99	3.0	12.5	7	38.5	9	59.5	Spawned, died	23-Apr	12	1	No	N/A
6	H	F	29-Dec-99	3.0	14.5	4	25.5	6	38.5	Spawned, kelted	23-Apr	9	0	Yes	30-Apr
7	W	M	31-Dec-99	3.0	12.5	5	33.5	8	54.2	Spawned, died	01-May	14	0	No	N/A
8	W	M	31-Dec-99	3.0	15.0	N/A	N/A	N/A	N/A	Unk [3]	N/A	N/A	1	Unk	N/A
9	H	F	31-Dec-99	3.0	13.5	7	38.5	6	38.0	Spawned, kelted	16-Apr	9	0	Yes	27-Apr
10	W	M	01-Jan-00	4.0	20.5	N/A	N/A	N/A	N/A	Unk [3]	N/A	N/A	2	Unk	N/A
11	H	F	02-Jan-00	4.0	15.5	N/A	N/A	N/A	N/A	Killed by Angler	N/A	N/A	1	N/A	N/A
12	H	F	03-Jan-00	7.0	38.5	7	38.5	6	38.0	Spawned, kelted	09-Apr	9	0	Yes	21-Apr
13	H	F	06-Jan-00	3.0	12.0	4	25.0	4	25.0	Spawned, died	14-May	14	0	No	N/A
14	H	F	07-Jan-00	3.0	12.5	N/A	N/A	N/A	N/A	Killed by Angler	N/A	N/A	1	N/A	N/A
15	H	F	07-Jan-00	4.0	16.0	N/A	N/A	N/A	N/A	Killed by Angler	N/A	N/A	1	N/A	N/A
16	W	F	07-Jan-00	4.0	15.5	5	36.5	7	43.0	Spawned, kelted	16-Apr	7	0	Yes	06-May
17	H	F	07-Jan-00	4.0	15.5	N/A	N/A	N/A	N/A	Killed by Angler	N/A	N/A	3	N/A	N/A
18	H	F	08-Jan-00	7.0	38.5	N/A	N/A	N/A	N/A	Killed by Angler	N/A	N/A	1	N/A	N/A
19	W	F	10-Jan-00	4.0	15.5	5	37.0	7	39.5	Spawned, kelted	26-Mar	6	0	Yes	04-Apr
20	W	F	10-Jan-00	3.0	12.0	5	38.0	Sles	Unk	Spawned, kelted	07-May	35	0	Yes	10-May
21	H	F	11-Jan-00	3.0	12.0	5	33.5	Sles	Unk	Spawned, kelted	30-Apr	25	1	Yes	15-May
22	W	M	11-Jan-00	3.0	12.0	N/A	N/A	N/A	N/A	Unk [4]	N/A	N/A	2	N/A	N/A
23	H	F	12-Jan-00	3.0	12.0	5	31.5	6	38.0	Spawned, kelted	30-Apr	16	2	Yes	08-May
24	W	F	12-Jan-00	3.0	12.0	7	38.5	7	41.2	Spawned, kelted	23-Apr	12	0	Yes	04-May
25	H	F	12-Jan-00	3.0	10.5	N/A	N/A	N/A	N/A	Killed by Angler	N/A	N/A	1	N/A	N/A
26	W	F	13-Jan-00	3.0	12.0	3	12.0	5	31.5	Spawned, kelted	07-May	14	0	Yes	13-May
27	H	F	13-Jan-00	3.0	10.5	3	15.5	N/A	N/A	Unk [4]	N/A	N/A	0	N/A	N/A
28	H	F	13-Jan-00	2.0	8.0	N/A	N/A	N/A	N/A	Killed by Angler	N/A	N/A	1	N/A	N/A

Appendix D. Summary of tagging, holding, spawning, survival-to-kelt data, and fates, for all steelhead radio-tagged in the Vedder/Chilliwack River, 2000.[A]

Fish No.	Type (H/W)	Sex (M/F)	Tag Date (dd/mmm/yy)	Location: Tagging Zone	Tagging Rkm	Holding Zone	Holding Rkm	Spawning Zone	Spawning Rkm	Fate	Spawning Week Ending	No. Days on Spawning Ground	No. of Reported Recaptures	Survived to Kelt?	Kelt (Station 1) Date
29	W	F	13-Jan-00	3.0	12.0	7	38.5	Sles	Unk	Spawned, died	14-May	32	0	No	N/A
30	W	F	14-Jan-00	2.0	9.0	5	28.0	5	36.5	Spawned, died	23-Apr	13	0	No	N/A
31	W	F	14-Jan-00	7.0	38.5	5	37.5	8	52.4	Spawned, kelted	23-Apr	13	0	Yes	05-May
32	W	F	16-Jan-00	3.0	12.0	5	33.5	7	42.0	Spawned, kelted	16-Apr	14	3	Yes	16-May
33	H	F	16-Jan-00	3.0	12.0	N/A	N/A	N/A	N/A	Killed by Angler	N/A	N/A	1	N/A	N/A
34	H	M	16-Jan-00	3.0	12.0	N/A	N/A	N/A	N/A	Unk [2]	N/A	N/A	0	N/A	N/A
35	H	F	17-Jan-00	3.0	12.0	N/A	N/A	N/A	N/A	Killed by Angler	N/A	N/A	1	N/A	N/A
36	W	M	17-Jan-00	3.0	12.0	5	38.0	7	43.5	Spawned, kelted	28-May	5	0	Yes	05-Jun
37	W	F	17-Jan-00	3.0	12.0	7	38.5	7	40.5	Spawned, kelted	23-Apr	12	0	Yes	07-May
38	W	M	18-Jan-00	3.0	12.0	3	12.0	Sles	Sles	Spawned, kelted	28-May	19	0	Yes	09-Jun
39	W	F	18-Jan-00	3.0	12.0	7	38.5	Lk Trib	Unk	Spawned, kelted	23-Apr	20	0	Yes	18-May
40	W	F	19-Jan-00	3.0	12.0	4	22.0	Trib	Trib	Spawned, kelted	30-Apr	15	1	Yes	20-May
41	H	F	19-Jan-00	3.0	12.5	N/A	N/A	N/A	N/A	Killed by Angler	N/A	N/A	1	N/A	N/A
42	W	F	19-Jan-00	3.0	15.0	4	25.5	8	53.5	Spawned, died	28-May	13	1	No	N/A
43	W	M	20-Jan-00	3.0	12.0	7	38.5	8	52.5	Spawned, kelted	16-Apr	13	1	Yes	30-Apr
44	H	F	20-Jan-00	2.0	9.0	N/A	N/A	N/A	N/A	Unk [2]	N/A	N/A	0	Unk	N/A
45	H	M	21-Jan-00	3.0	12.0	5	29.5	5	28.0	Spawned, kelted	14-May	16	2	Yes	19-May
46	W	M	21-Jan-00	2.0	8.5	3	12.0	3	12.0	Spawned, kelted	19-Mar	Unk	0	Yes	18-Mar
47	W	F	22-Jan-00	3.0	12.0	3	12.0	5	28.0	Spawned, kelted	07-May	14	1	Yes	05-Jun
48	W	F	22-Jan-00	3.0	12.0	7	38.5	7	40.0	Spawned, kelted	23-Apr	7	0	Yes	Unk (tag died)
49	H	F	22-Jan-00	2.0	8.0	4	24.0	5	37.0	Spawned, died	01-May	5	0	No	N/A
50	W	F	23-Jan-00	3.0	10.0	4	20.0	7	43.0	Spawned, kelted	16-Apr	8	0	Yes	02-May
51	W	M	23-Jan-00	3.0	10.0	5	30.5	5	27.5	Spawned, kelted	23-Apr	23	0	Yes	05-May
52	H	M	23-Jan-00	2.0	8.0	N/A	N/A	N/A	N/A	Killed by Angler	N/A	N/A	1	N/A	N/A
53	H	F	25-Jan-00	4.0	16.0	5	32.0	7	39.0	Spawned, kelted	28-May	16	0	Yes	12-Jun
54	W	M	27-Jan-00	3.0	12.0	5	33.0	5	36.0	Spawned, kelted	23-Apr	10	0	Yes	17-May
55	H	F	27-Jan-00	3.0	12.0	N/A	N/A	N/A	N/A	Killed by Angler	N/A	N/A	2	N/A	N/A
56	H	F	27-Jan-00	2.0	9.0	N/A	N/A	N/A	N/A	Killed by Angler	N/A	N/A	1	N/A	N/A

Appendix D. Summary of tagging, holding, spawning, survival-to-kelt data, and fates, for all steelhead radio-tagged in the Vedder/Chilliwack River, 2000.[A]

Fish No.	Type (H/W)	Sex (M/F)	Tag Date (dd/mmm/yy)	Location: Tagging Zone	Tagging Rkm	Holding Zone	Holding Rkm	Spawning Zone	Spawning Rkm	Fate	Spawning Week Ending	No. Days on Spawning Ground	No. of Reported Recaptures	Survived to Kelt?	Kelt (Station 1) Date
57	H	F	27-Jan-00	2.0	8.0	N/A	N/A	N/A	N/A	Killed by Angler	N/A	N/A	1	N/A	N/A
58	W	M	27-Jan-00	2.0	9.5	N/A	N/A	N/A	N/A	Unk [3]	N/A	N/A	2	N/A	N/A
59	H	F	28-Jan-00	7.0	38.5	7	38.5	7	39.0	Spawned, kelted	19-Mar		0	Yes	22-Mar
60	H	F	31-Jan-00	3.0	14.5	N/A	N/A	N/A	N/A	Killed by Angler	N/A	N/A	1	N/A	N/A
61	H	F	04-Feb-00	2.0	10.0	N/A	N/A	N/A	N/A	Killed by Angler	N/A	N/A	1	N/A	N/A
62	H	F	04-Feb-00	3.0	11.5	3	12.0	5	30-35	Spawned, kelted	30-Apr	14	0	Yes	17-May
63	H	F	04-Feb-00	3.0	12.0	N/A	N/A	N/A	N/A	Killed by Angler	N/A	N/A	1	N/A	N/A
64	W	M	04-Feb-00	3.0	12.0	4	17.0	5	30.5	Spawned, died	23-Apr	26	0	No	N/A
65	W	M	05-Feb-00	3.0	12.0	7	Unk	8	58.0	Spawned, kelted	23-Apr	9	0	Yes	09-May
66	W	M	05-Feb-00	3.0	11.5	N/A	N/A	N/A	N/A	Unk [1]	N/A	N/A	2	N/A	N/A
67	W	M	05-Feb-00	3.0	13.0	N/A	N/A	N/A	N/A	Mort (recaptured?)[5]	N/A	N/A	0	N/A	N/A
68	W	M	06-Feb-00	3.0	12.0	N/A	N/A	N/A	N/A	Unk [3]	N/A	N/A	3	N/A	N/A
69	W	F	06-Feb-00	3.0	12.0	4	20.0	5	30.0	Spawned, kelted	16-Apr	4	1	Yes	29-Apr
70	H	F	07-Feb-00	3.0	12.0	3	10.0	N/A	N/A	Unk [2]	N/A	N/A	0	Unk	N/A
71	W	M	09-Feb-00	3.0	12.0	5	33.5	Sles	Unk	Spawned, kelted	28-May	39	1	Yes	31-May
72	W	M	11-Feb-00	5.0	32.0	7	39.5	9	59.0	Spawned, kelted	21-May	7	0	Yes	03-Jun
73	H	F	11-Feb-00	2.0	9.0	N/A	N/A	N/A	N/A	Killed by Angler	N/A	N/A	1	No	N/A
74	W	M	12-Feb-00	4.0	25.0	7	38.5	8	52.0	Spawned, kelted	21-May	24	0	Yes	25-May
75	W	M	15-Feb-00	3.0	12.0	3	12.0	5	34.5	Spawned, kelted	21-May	12	0	Yes	05-Jun
76	W	F	15-Feb-00	3.0	12.0	3	11.0	5	30.5	Spawned, kelted	16-Apr	18	0	Yes	22-Apr
77	W	M	18-Feb-00	2.0	9.0	4	25.5	7	43.0	Spawned, died	23-Apr	7	0	No	N/A
78	W	M	24-Feb-00	3.0	11.0	5	36.0	Trib	Unk	Spawned, died	09-Apr	Unk	1	No	N/A
79	W	F	25-Feb-00	4.0	16.0	5	31.5	5	31.5	Spawned, died	26-Mar	Unk	0	No	N/A
80	H	M	26-Feb-00	3.0	15.0	3	15.0	5	36.0	Spawned, kelted	07-May	14	0	Yes	17-May
81	H	M	28-Feb-00	3.0	12.0	N/A	N/A	N/A	N/A	Unk [2]	N/A	N/A	0	Unk	N/A
82	H	M	29-Feb-00	3.0	15.0	3	15.0	8	53.0	Spawned, died	22-May	16	0	No	N/A
83	H	M	01-Mar-00	3.0	14.5	7	38.5	6	38.0	Spawned, kelted	21-May	30	1	Yes	30-May
84	W	F	03-Mar-00	3.0	11.0	3	12.0	Trib	Trib	Spawned, kelted	14-May	13	0	Yes	20-May

Appendix D. Summary of tagging, holding, spawning, survival-to-kelt data, and fates, for all steelhead radio-tagged in the Vedder/Chilliwack River, 2000.[A]

Fish No.	Type (H/W)	Sex (M/F)	Tag Date (dd/mmm/yy)	Location: Tagging Zone	Tagging Rkm	Holding Zone	Holding Rkm	Spawning Zone	Spawning Rkm	Fate	Spawning Week Ending	No. Days on Spawning Ground	No. of Reported Recaptures	Survived to Kelt?	Kelt (Station 1) Date
85	H	M	06-Mar-00	3.0	14.5	4	16.0	5	27.0	Spawned, kelted	28-May	15	0	Yes	02-Jun
86	W	F	11-Mar-00	3.0	15.0	5	5.0	8	56.0	Spawned, kelted	14-May	8	0	Yes	21-May
87	W	F	14-Mar-00	3.0	12.0	3	12.0	7	43.2	Spawned, kelted	30-Apr	7	0	Yes	19-May
88	W	M	15-Mar-00	3.0	12.0	4	26.0	5	Unk	Spawned, died	N/A	Unk	0	No	N/A
89	H	F	16-Mar-00	3.0	11.0	3	11.0	3	12.0	Spawned, died	14-May	unk	1	No	N/A
90	H	F	16-Mar-00	3.0	10.5	2	10.0	6	38.0	Spawned, kelted	07-May	9	1	Yes	21-May
91	W	F	19-Mar-00	4.0	16.5	Unk	4.0	7	45.0	Spawned, kelted	16-Apr	9	0	Yes	02-May
92	W	M	19-Mar-00	4.0	16.5	4	25.5	7	41.0	Spawned, kelted	14-May	9	0	Yes	23-May
93	W	M	20-Mar-00	3.0	11.5	4	25.5	7	43.0	Spawned, died	07-May	22	0	No	N/A
94	W	M	20-Mar-00	3.0	11.5	3	12.5	N/A	N/A	Unk (mort/recap?)[6]	N/A	N/A	0	N/A	N/A
95	W	M	21-Mar-00	4.0	16.5	4	18.0	N/A	N/A	Unk (mort/recap?)[6]	N/A	N/A	0	N/A	N/A
96	W	M	22-Mar-00	3.0	11.5	7	Unk	7	2.0	Spawned, died	28-May	13	1	No	N/A
97	W	F	22-Mar-00	3.0	14.5	5	Unk	9	Unk	Spawned, kelted	07-May	9	0	Yes	21-May
98	W	F	25-Mar-00	4.0	16.5	5	28.0	5	28.0	Spawned, died	07-May	32	0	No	N/A
99	W	F	25-Mar-00	3.0	11.5	3	11.5	N/A	N/A	Unk[4]	N/A	N/A	0	Unk	N/A
100	W	F	26-Mar-00	3.0	15.5	4	unk	5	Unk	Spawned, kelted	07-May	11	0	Yes	19-May
101	W	F	27-Mar-00	3.0	12.0	5	Unk	8	Unk	Spawned, kelted	14-May	12	0	Yes	27-May
102	W	F	27-Mar-00	3.0	12.0	4	Unk	4	22.5	Spawned, kelted	30-Apr	11	0	Yes	16-May
103	W	F	27-Mar-00	3.0	11.5	4	16.0	7	unk	Spawned, kelted	18-Jun	12	0	Yes	28-Jun
104	H	M	27-Mar-00	3.0	14.5	N/A	N/A	N/A	N/A	Killed by Angler	N/A	N/A	1	No	N/A
105	W	M	28-Mar-00	3.0	12.0	5	Unk	9	unk	Spawned, kelted	14-May	5	0	Yes	21-May
106	H	F	28-Mar-00	3.0	10.0	3	14.0	5	30.5	Spawned, kelted	21-May	9	0	Yes	03-Jun
107	H	F	28-Mar-00	2.0	9.0	2	7.0	N/A	N/A	Unk[4]	N/A	N/A	0	Unk	N/A
108	H	F	29-Mar-00	3.0	12.0	5	Unk	5	36.0	Spawned, kelted	30-Apr	7	0	Yes	10-May
109	W	M	29-Mar-00	3.0	12.0	5	Unk	5	Unk	Spawned, kelted	18-Jun	7	0	Yes	21-Jun
110	W	F	29-Mar-00	2.0	9.0	5	Unk	7	44.5	Spawned, kelted	23-Apr	8	0	Yes	25-Apr
111	H	M	30-Mar-00	4.0	16.5	4	Unk	5	30.5	Spawned, kelted	14-May	9	0	Yes	16-May
112	W	F	31-Mar-00	3.0	12.0	3	12.0	N/A	N/A	Unk[4]	N/A	N/A	0	Unk	N/A

Appendix D. Summary of tagging, holding, spawning, survival-to-kelt data, and fates, for all steelhead radio-tagged in the Vedder/Chilliwack River, 2000.[A]

Fish No.	Type (H/W)	Sex (M/F)	Tag Date (dd/mmm/yy)	Location						Fate	Spawning Week Ending	No. Days on Spawning Ground	No. of Reported Recaptures	Survived to Kelt?	Kelt (Station 1) Date
				Tagging		Holding		Spawning							
				Zone	Rkm	Zone	Rkm	Zone	Rkm						
113	W	F	31-Mar-00	3.0	10.0	4	25.5	7	unk	Spawned, kelted	14-May	10	0	Yes	21-May
114	H	F	01-Apr-00	3.0	12.0	5	34.0	5	34.5	Spawned, died	30-Apr	9	0	No	N/A
115	W	F	01-Apr-00	3.0	12.0	3	12.0	N/A	N/A	Unk [4]	N/A	N/A	0	Unk	N/A
116	W	F	01-Apr-00	3.0	16.5	4	16.0	7	41.5	Spawned, kelted	11-Jun	9	0	Yes	18-Jun
117	W	F	01-Apr-00	3.0	12.0	4	Unk	7		Spawned, kelted	14-May	14	0	Yes	25-May
118	W	M	01-Apr-00	3.0	10.0	3		Foley	Foley	Spawned, kelted	11-Jun	24	0	Yes	15-Jun
119	H	F	01-Apr-00	3.0	10.0	4	Unk	5	31.0	Spawned, died	28-May	10	0	No	N/A
120	H	M	01-Apr-00	3.0	10.0	4	Unk	7	44.0	Spawned, kelted	07-May	7	0	Yes	16-May
121	W	F	02-Apr-00	3.0	12.0	4	Unk	7	44.0	Spawned, kelted	21-May	10	0	Yes	05-Jun
122	H	M	02-Apr-00	3.0	12.0	3	Unk	5	37.5	Spawned, kelted	14-May	20	0	Yes	25-May
123	H	F	03-Apr-00	3.0	12.0	6	Unk	6	38.0	Spawned, kelted	23-Apr	9	0	Yes	09-May
124	W	M	05-Apr-00	3.0	13.0	3	14.0	3	14.0	Spawned, died	30-Apr	15	0	no	N/A
125	W	F	05-Apr-00	3.0	13.0	3	Unk	5	29.5	Spawned, kelted	28-May	10	0	Yes	04-Jun
126	H	F	05-Apr-00	3.0	13.0	3	13.0	5	30.5	Spawned, kelted	07-May	5	0	Yes	20-May
127	H	F	05-Apr-00	3.0	13.0	4	Unk	6	38.0	Spawned, kelted	14-May	8	0	Yes	21-May
128	H	F	05-Apr-00	3.0	13.0	4	Unk	7	41.0	Spawned, kelted	07-May	6	0	Yes	19-May
129	H	F	06-Apr-00	3.0	13.0	N/A	N/A	N/A	N/A	Unk [3]	N/A	N/A	0	Unk	N/A
130	H	F	06-Apr-00	3.0	14.0	N/A	N/A	N/A	N/A	Killed by Angler	N/A	N/A	1	No	N/A
131	H	F	06-Apr-00	3.0	14.0	N/A	N/A	N/A	N/A	Killed by Angler	N/A	N/A	1	No	N/A
132	W	F	06-Apr-00	3.0	14.0	4	22.5	4	24.0	Spawned, died	21-May	10	0	No	N/A
133	W	F	06-Apr-00	3.0	14.0	4	Unk	7	39.5	Spawned, kelted	21-May	4	0	Yes	12-Jun
134	H	F	06-Apr-00	3.0	13.0	3	Unk	4	16.0	Spawned, kelted	23-Apr	4	0	Yes	21-Apr
135	W	M	06-Apr-00	3.0	13.0	3	14.0	3	14.0	Spawned, died	30-Apr	10	0	No	N/A
136	W	F	06-Apr-00	3.0	13.0	3	13.0	7	46.5	Spawned, kelted	07-May	8	0	Yes	23-May
137	H	F	06-Apr-00	3.0	14.0	4	Unk	5	29.0	Spawned, kelted	16-Apr	8	0	Yes	28-Apr
138	H	F	07-Apr-00	3.0	9.5	2	9.0	5	36.0	Spawned, kelted	21-May	6	0	Yes	31-May
139	H	F	07-Apr-00	4.0	16.0	3		7	39.0	Spawned, kelted	30-Apr	8	1	Yes	10-May
140	H	F	10-Apr-00	3.0	13.0	4	16.0	4	17.5	Spawned, died	04-Jun	unk	1	No	N/A

Appendix D. Summary of tagging, holding, spawning, survival-to-kelt data, and fates, for all steelhead radio-tagged in the Vedder/Chilliwack River, 2000.[A]

Fish No.	Type (H/W)	Sex (M/F)	Tag Date (dd/mmm/yy)	Location						Fate	Spawning Week Ending	No. Days on Spawning Ground	No. of Reported Recaptures	Survived to Kelt?	Kelt (Station 1) Date
				Tagging		Holding		Spawning							
				Zone	Rkm	Zone	Rkm	Zone	Rkm						
141	H	F	12-Apr-00	3.0	14.0	5	35.5	5	37.0	Spawned, died	21-May	8	0	No	N/A
142	W	M	13-Apr-00	3.0	13.0	5	Unk	Sles	Sles	Spawned, kelted	21-May	20	0	Yes	31-May
143	H	F	17-Apr-00	3.0	13.0	4	Unk	5	33.5	Spawned, kelted	07-May	6	0	Yes	15-May
144	H	F	17-Apr-00	3.0	14.0	3	15.0	6	38.0	Spawned, kelted	21-May	5	0	Yes	22-May
145	W	F	19-Apr-00	3.0	13.0	4	Unk	7	44.5	Spawned, kelted	21-May	8	0	Yes	26-May
146	W	M	19-Apr-00	3.0	14.0	4	Unk	8	48.0	Spawned, kelted	11-Jun	15	0	Yes	Unk (tag died)
147	H	F	20-Apr-00	4.0	16.0	5	34.0	6	38.0	Spawned, died	21-May	10	0	No	N/A
148	W	F	20-Apr-00	3.0	13.0	5	Unk	7	39.0	Spawned, kelted	28-May	10	0	Yes	04-Jun
149	H	F	23-Apr-00	3.0	14.0	N/A	N/A	N/A	N/A	Killed by Angler	N/A	N/A	1	No	N/A
150	H	F	23-Apr-00	3.0	14.0	3	14.0	N/A	N/A	Unk [4]	N/A	N/A	0	Unk	N/A
151	W	M	24-Apr-00	3.0	14.0	3	14.0	N/A	N/A	Unk [4]	N/A	N/A	0	Unk	N/A
152	W	F	24-Apr-00	4.0	17.5	4	Unk	7	Unk	Spawned, kelted	28-May	9	0	Yes	05-Jun
153	W	F	26-Apr-00	3.0	12.5	3	Unk	5	Unk	Spawned, kelted	28-May	5	0	Yes	04-Jun
154	W	M	30-Apr-00	4.0	18.0	4	Unk	4	18.0	Spawned, kelted	14-May	14	0	Yes	19-May

[A] Abbreviations: H/W = Hatchery/Wild; M/F = Male/Female; N/A = Not Applicable; Unk = Unknown; Rkm = River Kilometer; Sles = Slesse Cr.; Lk = Lake; Trib = Tributary

[1] Tag removed by angler, left at river, found and returned by another angler

[2] Tag disappeared in popular fishing area (likely removed and not returned)

[3] Tag removed, returned; unknown if fish released alive

[4] Tag stationary in popular fishing area (fish could have been recaptured and released, tag regurgitation, spawned/died, died following release) or recaptured by angler and tag removed and left in river; all fish released in good condition, normal movement detected following release; recapture likely

[5] Fish No. 67 was found dead and the radio tag antenna appeared to have been tampered with, which suggests a recapture following release; however, because there was no reporting of this fish as a recapture, this fish could be considered a mortality as a result of the initial capture/tagging event

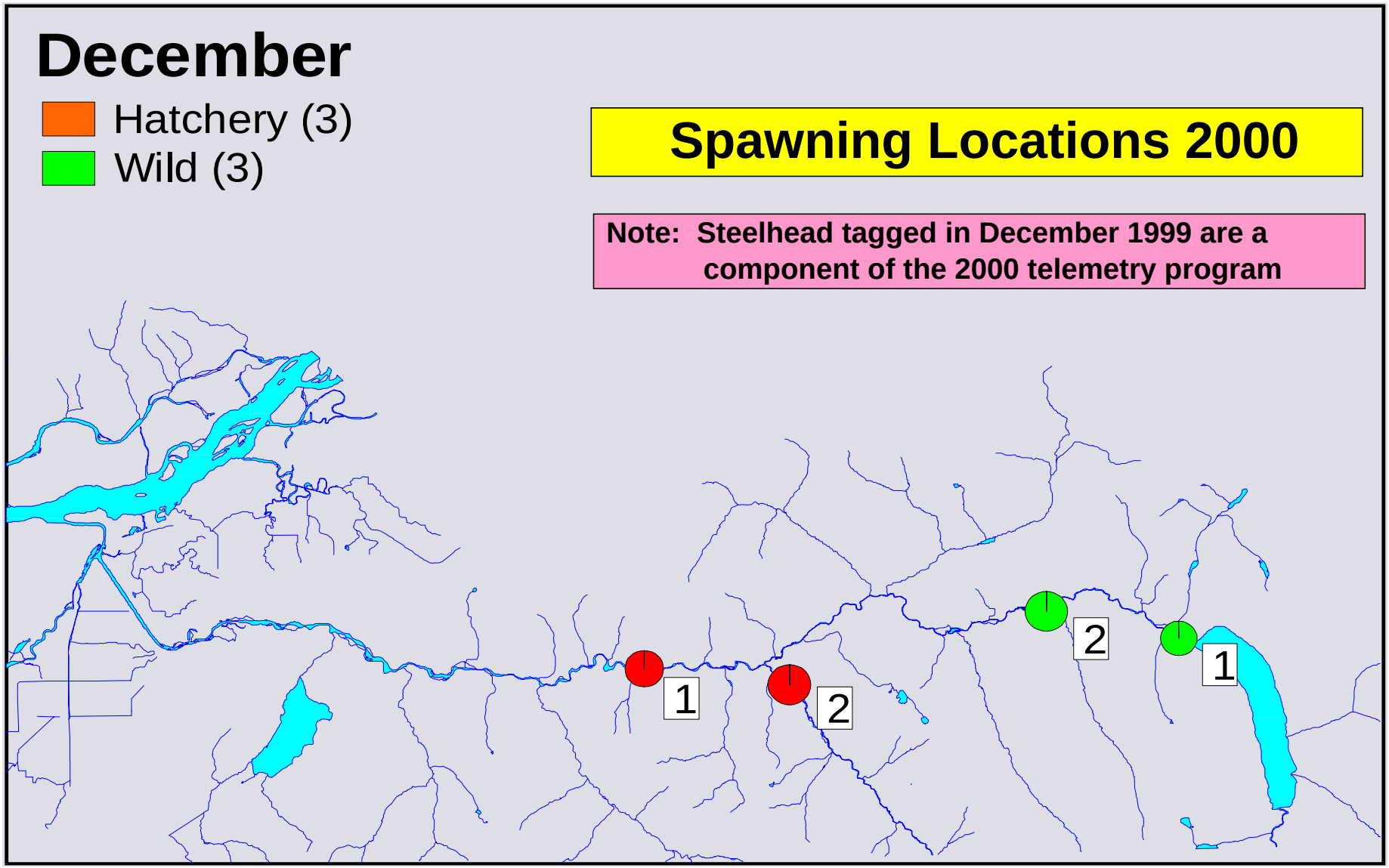
[6] The radio tags for Fish Nos. 94 and 95 became stationary in a popular fishing location about 2 km upstream from the tag release site 5-7 days following tagging (these fish could have spawned and died, or regurgitated the tag, or were recaptured and the tag removed and left in the river, or recaptured and died following release, or died with no recapture and thus could be considered a mortality as a result of the initial capture/tagging event).

Appendix E

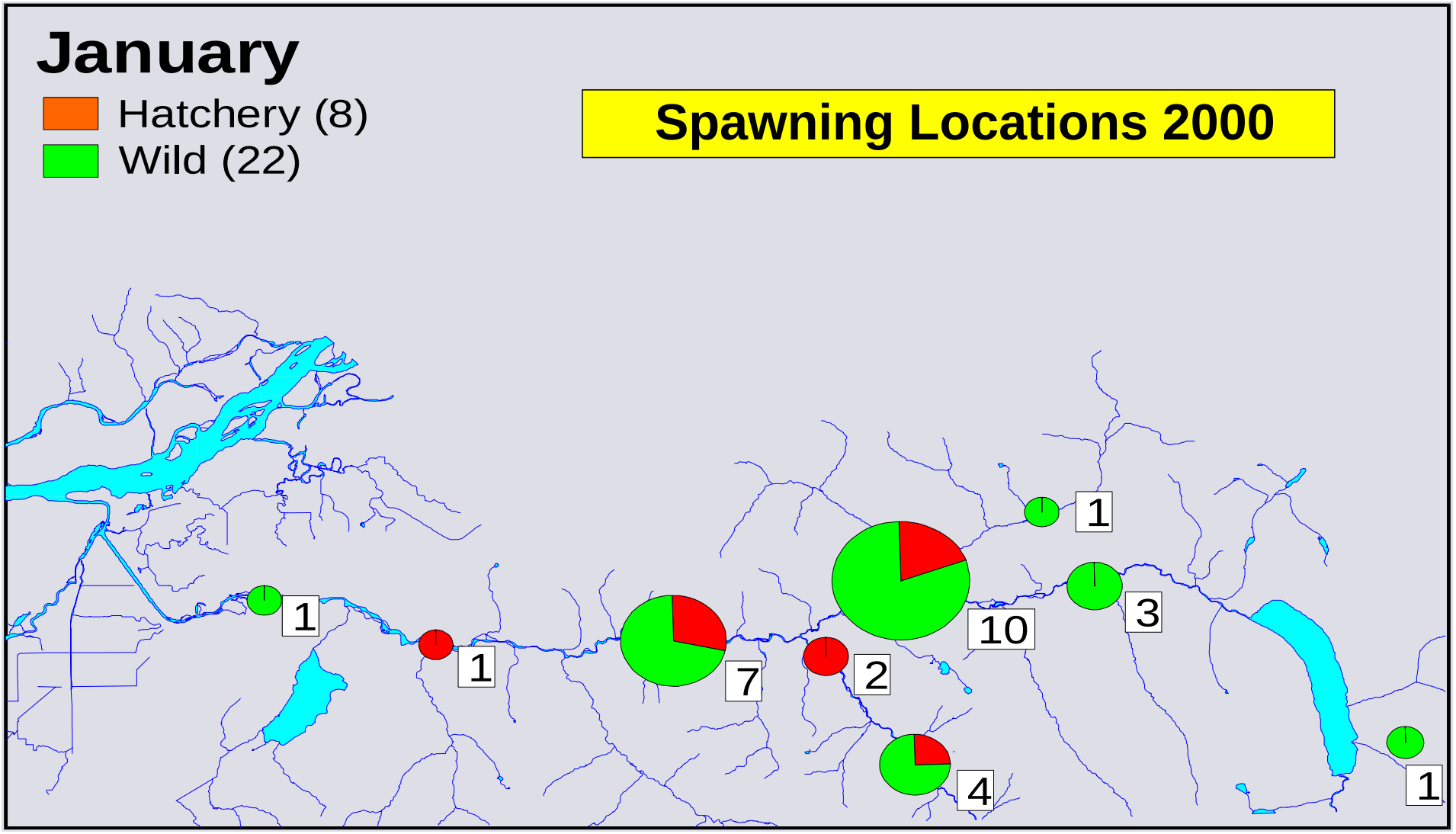
**Illustrations of spawning locations, by survey zone,
of radio-tagged hatchery and wild steelhead that survived to spawn in the
Chilliwack River watershed in 2000, stratified by tagging month:**

December 1999
January 2000
February 2000
March 2000
April 2000

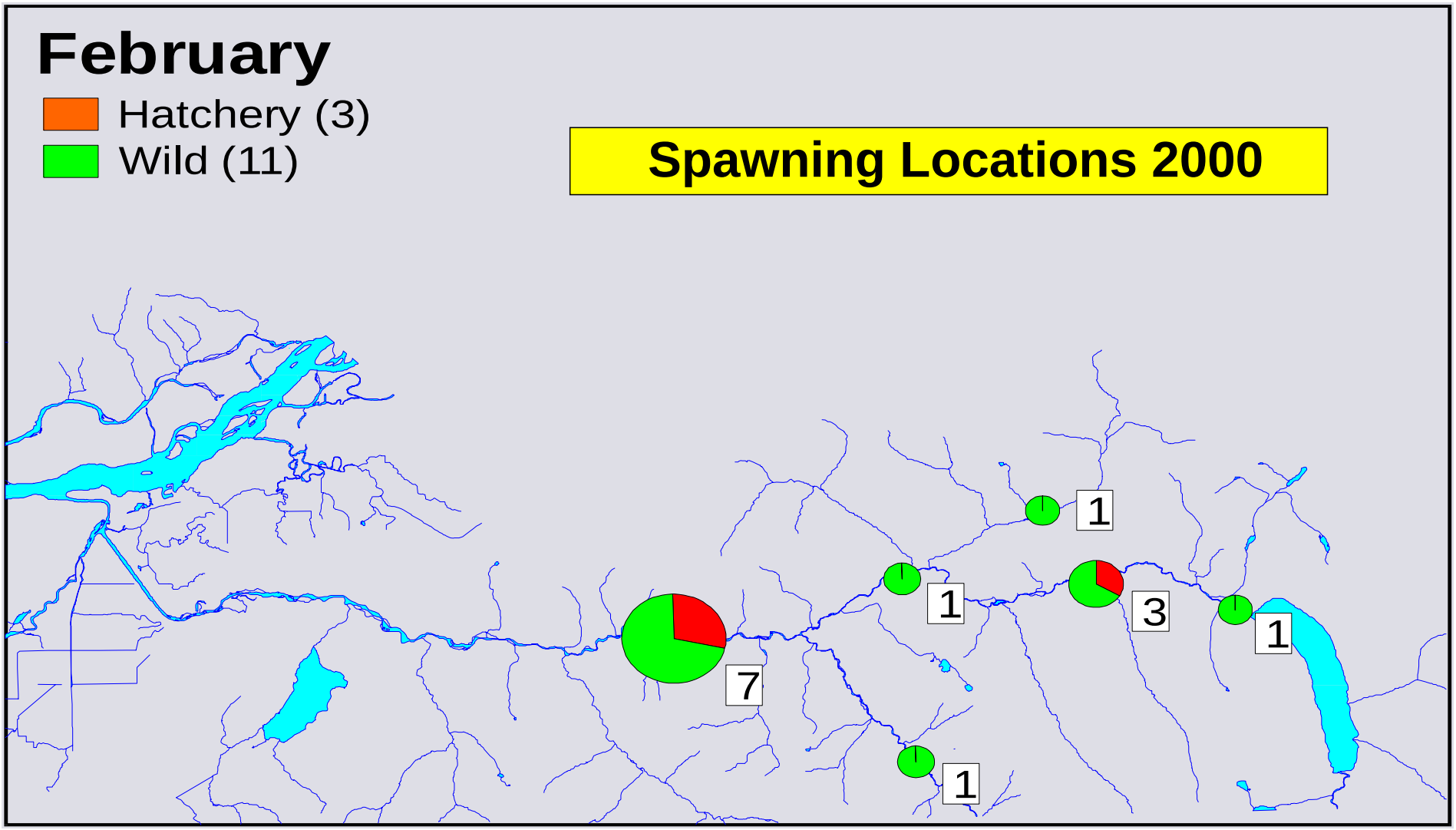
(5 illustrations)



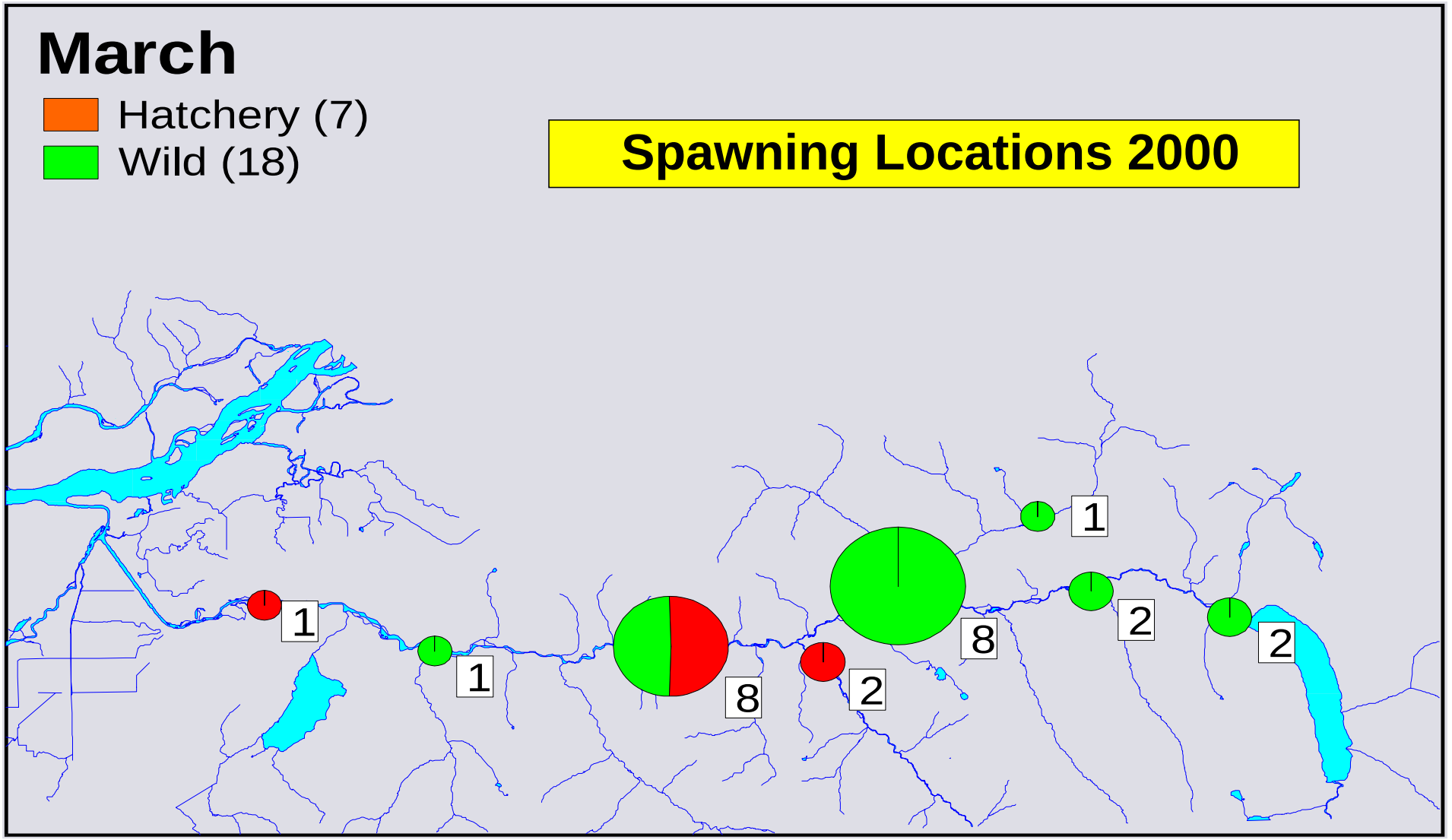
Appendix E-1. Spawning locations, by survey zone, of radio-tagged hatchery and wild steelhead **tagged in December 1999** that survived to spawn in the Chilliwack River watershed in 2000. The total number of radio-tagged steelhead in each zone is presented in boxes. See Figure 3 for an illustration of survey zone boundaries.



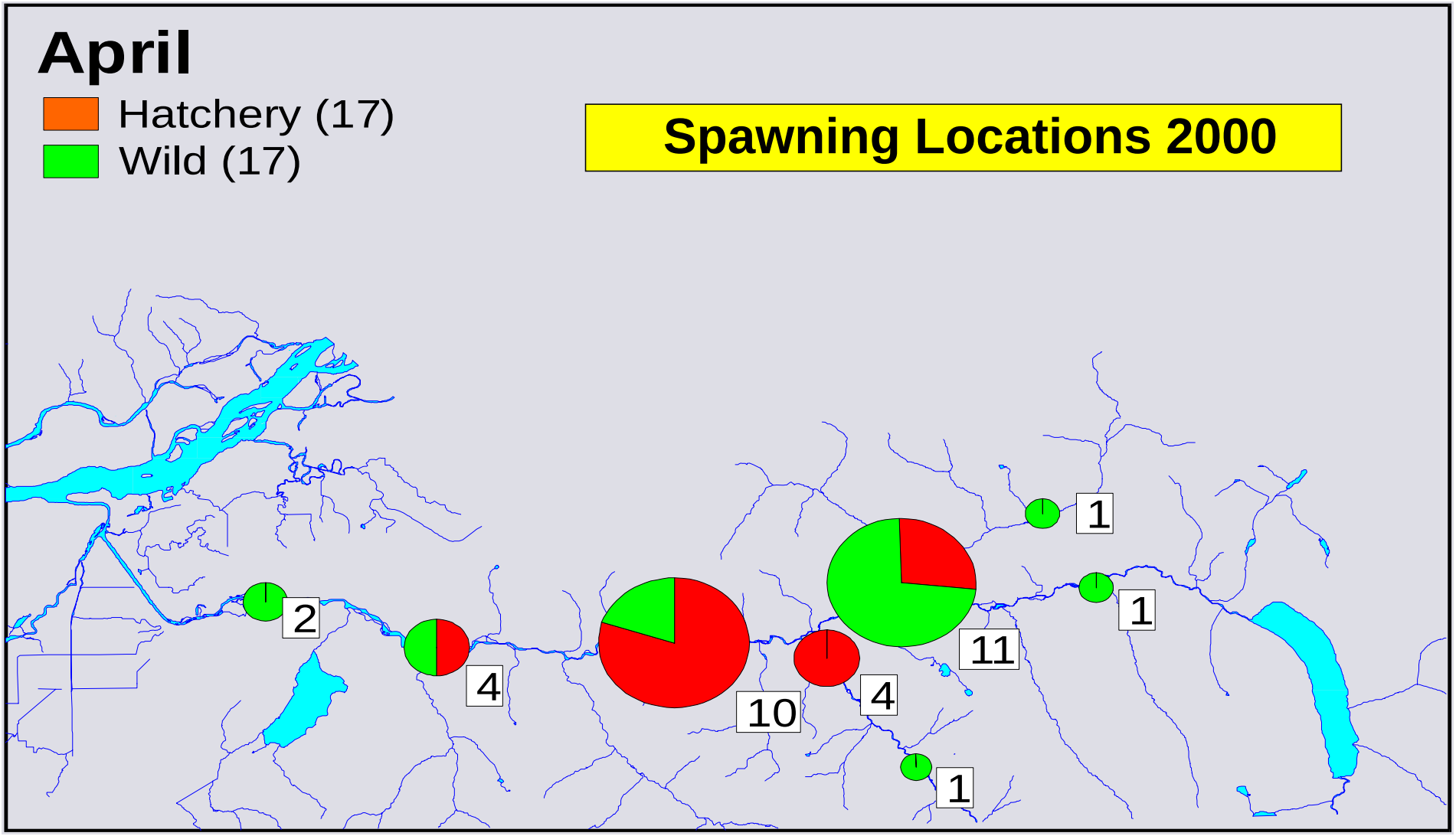
Appendix E-2. Spawning locations, by survey zone, of radio-tagged hatchery and wild steelhead **tagged in January 2000** that survived to spawn in the Chilliwack River watershed in 2000. The total number of radio-tagged steelhead in each zone is presented in boxes. See Figure 3 for an illustration of survey zone boundaries.



Appendix E-3. Spawning locations, by survey zone, of radio-tagged hatchery and wild steelhead **tagged in February 2000** that survived to spawn in the Chilliwack River watershed in 2000. The total number of radio-tagged steelhead in each zone is presented in boxes. See Figure 3 for an illustration of survey zone boundaries.



Appendix E-4. Spawning locations, by survey zone, of radio-tagged hatchery and wild steelhead **tagged in March 2000** that survived to spawn in the Chilliwack River watershed in 2000. The total number of radio-tagged steelhead in each zone is presented in boxes. See Figure 3 for an illustration of survey zone boundaries.



Appendix E-5. Spawning locations, by survey zone, of radio-tagged hatchery and wild steelhead **tagged in April 2000** that survived to spawn in the Chilliwack River watershed in 2000. The total number of radio-tagged steelhead in each zone is presented in boxes. See Figure 3 for an illustration of survey zone boundaries.