Aspects of the Biology of Bull Trout (*Salvelinus confluentus*) in the Salmo River Watershed as Identified Through Radio Telemetry (2000/2001 data) and a Watershed Management Plan for the Species

Report Prepared For:

Columbia-Kootenay Fisheries Renewal Partnership and Columbia Basin Trust
c/o S.S. #3, Site 15, C-14, Mission Road
Cranbrook, B.C. V1C 6H3

BC Hydro
Power Supply Environment
6911 Southpoint Drive
Burnaby, B.C. V3N 4X8

BC Hydro
Kootenay Generation Area
601 18th Street
Castlegar, B.C. V1N 4A2

Report Prepared By:

James Baxter
Baxter Environmental
209 Second Street
Nelson, B.C. V1L 2K9

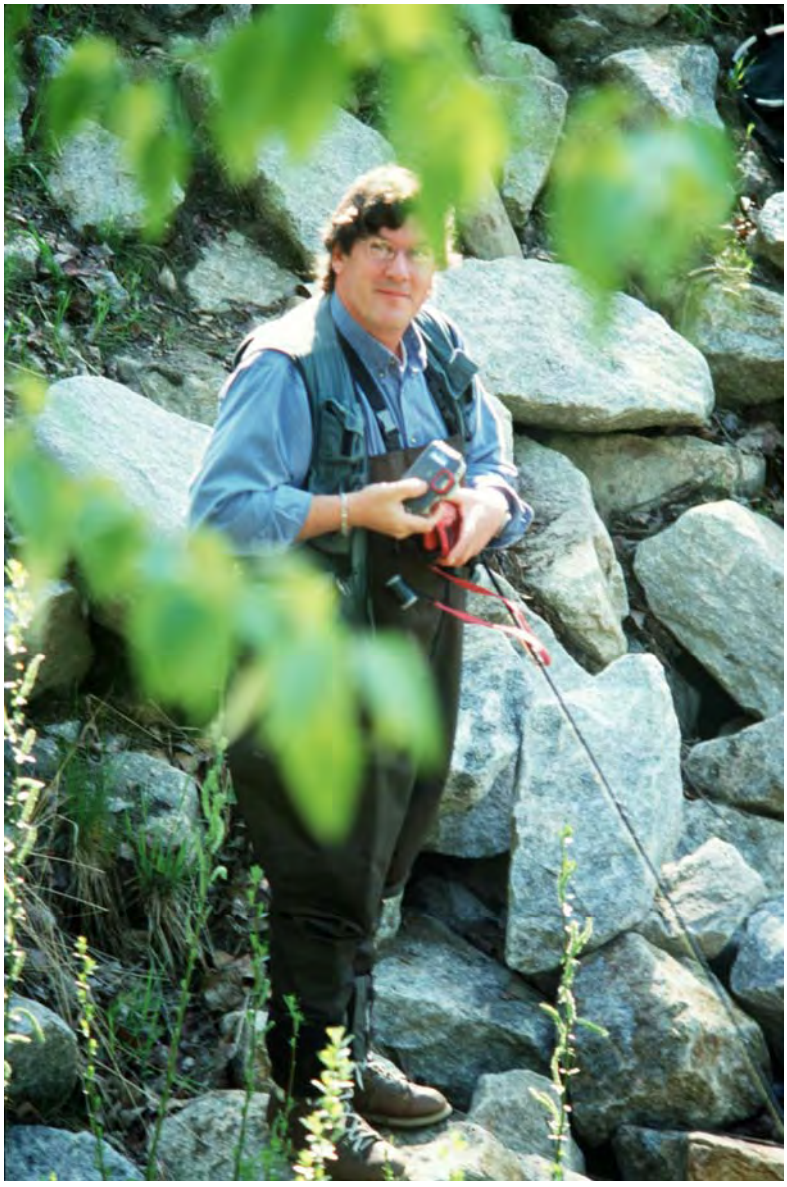
December 2001

EXECUTIVE SUMMARY

Over two years (1999-2001) a total of twenty bull trout were implanted with radio tags in the Salmo River watershed to determine the life-history and habitat use of the population. The specific objectives of the project were to identify major spawning, summering and overwintering areas, as well as to provide data on migration and spawning timing. A secondary objective was to determine if there was a migration to, or from, Seven Mile Reservoir by radio tagged bull trout. This report also summarizes the current status of the Salmo River bull trout population, and makes recommendations as to future management requirements.

A total of five spawning areas were identified in the Salmo River watershed and included Clearwater Creek, the upper Salmo River, Sheep Creek, Stagleap Creek and the South Salmo River. Some of the fish that migrated into the South Salmo River spawned in the United States of America. In 1999, bull trout entered spawning areas as early as the first week of August, while in 2000 entry into spawning areas had begun as early as the first week of July. The difference in timing was likely due to reduced discharge in the summer of 2000. All tagged bull trout that migrated to spawning areas made downstream migrations suggesting that post-spawning mortality was 0%. The project also identified major overwintering areas in the mainstem Salmo River between 0 and 47.00 km. All overwintering areas were associated with deep pool, large woody debris, or boulder. Of the twenty tagged bull trout, one made a downstream migration to the mouth of the Salmo River. However this fish was not tracked in the reservoir proper, and this further suggests that the population is a fluvial population.

DEDICATION



This work is dedicated to the memory of my friend and colleague Ric Olmsted. As a biologist fresh out of grad school, my first big project was a bull trout study in the Salmo River watershed that was funded by B.C. Hydro. Ric was largely responsible for me getting that project, and it has become a springboard for the road I have travelled as a fisheries biologist and the strong fisheries presence in the watershed today. I thank him for that. Ric was a friend of the Salmo River, and although we didn't always agree about fisheries issues in the watershed, I will miss his company along its banks.

ACKNOWLEDGEMENTS

Funding for the project was provided by BC Hydro (Seven Mile Unit 4), BC Hydro (Castlegar), the Columbia-Kootenay Fisheries Renewal Partnership and the Columbia Basin Trust. The successful completion was made possible only as a result of the co-operation of a large number of organizations and individuals within the following organizations.

Columbia-Kootenay Fisheries Renewal Partnership and Columbia Basin Trust

Bill Green and Kenton Andreashuk provided comments on the project, while Jaime Christales provided administrative assistance.

BC Hydro

BC Hydro supplied the radio tags that were utilized for the study and provided equipment, personnel, and monies for tracking flights. Specifically Ric Olmsted, Gary Birch and Dave Wilson were instrumental in providing funds and expertise for the project, with Ric providing assistance with fish capture. Dean den Biesen also assisted in the field. Without the commitment of funds from BC Hydro over the past several years, much of the recent fisheries work would not have been undertaken in the watershed. These projects have not only benefited BC Hydro, but the community and government managers as well. I thank the company for their continued interest in the bull trout population.

BC Ministry of Water, Land and Air Protection

The Ministry of Water, Land and Air Protection provided tracking equipment and personnel to aid in the completion of the project. Specifically John Bell assisted with fish capture and tracking. Colin Spence provided equipment for the fixed station. Albert Chirico ensured collection permits were put in place to allow fish capture. Jay Hammond and Bob Lindsay provided insight into project requirements and management issues.

Salmo Watershed Streamkeepers Society

Community volunteers that are members of the Salmo Watershed Streamkeepers Society assisted with various components of the project. Peter Neil, Art Field, Alice Nellestijn, Alice Kuzma, Doug Ellis, Brian Henderson, Mike van Wijk, Darcy Torrans, the Maloney family, the Spilker family, and Bill and June Stockdale have all been instrumental in aspects of this work over the past two years. The dedication of my friend Gerry Nellestijn to the watershed and its bull trout population has also been a key factor in ensuring the success of this project. His contributions go well beyond those usually given by a volunteer organization. I praise him for his commitment.

Frank Communications Inc.

Alice Nellestijn produced maps and data sheets that were utilized for the study and ensured that collected data was safely stored and entered into the tracking database. She also produced a poster display that was shown at Fisheries Renewal meetings and open houses within the community. She's an all around great gal.

Baxter Environmental

Jeremy Baxter provided technical assistance with all aspects of this project, and also managed not to scream at me too much when he should have. John Hagen also assisted with some of this work, and provided useful commentary on management and conservation concerns regarding this population.

Seattle City Power and Light

Seattle City Power and Light provided an additional ten radio tags for use in the study if they were required.

Columbia Basin Fish and Wildlife Compensation Program

Equipment was provided by the Columbia Basin Fish and Wildlife Compensation Program.

Geosense Consulting Ltd.

Graham Smith provided mapping logistics.

Canadian Helicopters

Duncan Wassick ensured aerial tracking could be undertaken.

Water Survey of Canada

Gordon Corcoran provided discharge data for the study period.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

Bull trout (*Salvelinus confluentus*) are a regionally significant species in the Kootenay area, and provide the basis for major fisheries in many watersheds. Some of these fisheries are harvest oriented, while others are catch and release situations that allow for angling opportunities to exist where populations can not sustain a high level of harvest. Developing the foundation for an understanding of the biology and population dynamics of bull trout on a population by population basis can be an important component of enabling proper fisheries management and addressing conservation concerns. It is also important in enabling appropriate protection measures to be put in place to sustain habitats critical for the maintenance of a population.

In the West Kootenay area, river resident populations of large bull trout are typically not common, especially in the areas associated with the lower Pend d'Orielle River. The Salmo River watershed however does have a population of bull trout that utilize the system for a significant portion, if not all, of their life-history. The population that utilizes the Salmo River watershed can attain sizes approaching 75 cm, and it appears that they are a fluvial population that utilizes the Salmo River mainstem for feeding and growth (Baxter 1999, 2001a; Baxter and Nellestijn 2000).

This project marks the second year of radio telemetry work conducted on the bull trout population of the Salmo River watershed. Initial studies in 1999/2000 involved tagging ten bull trout in the mainstem Salmo River and tracking the fish to their spawning and overwintering locations (Baxter and Nellestijn 2000). In addition migration and spawning timing were identified during the study. The results of the first year of study suggested that there was no use of Seven Mile Reservoir by the radio tagged bull trout. Spawning locations were identified in Clearwater Creek, Sheep Creek, the South Salmo River, Stagleap Creek, and the upper Salmo River.

In the summer of 2000 a second year of telemetry work was initiated, primarily in an attempt to tag bull trout in the mainstem Salmo River below the South Salmo River confluence or in the South Salmo River. This was the main focus of the tagging effort as

it was felt that bull trout radio tagged below the confluence or in the South Salmo River had the highest probability of possibly having migrated from Seven Mile Reservoir. In short, it was felt by a number of biologists that a second year of tagging effort was warranted to collect more data from the bull trout that were already radio tagged, and to further address the potential for reservoir use.

For this continuing project, radio telemetry was used as a methodology to identify the spawning locations of, and determine the overwintering and spawning habitat preferences of, the Salmo River bull trout population. The main objectives of the study were to:

1. identify new spawning areas (mainstem and tributary) within the watershed;
2. expand knowledge about the biology (migration timing, spawning timing, repeat spawning, spawning site fidelity) and habitat use (summering, spawning, and overwintering);
3. determine whether individuals within the Salmo River bull trout population utilize Seven Mile Reservoir for overwintering, or any other part of their life-history;
4. collect data that could be used in future conservation and enhancement opportunities;
5. promote community stewardship for the fisheries resources of the watershed; and
6. provide data that could be utilized in a management plan for the species in the watershed.

2.0 METHODS

2.1 Study Site

The Salmo River rises from the Selkirk Mountains 12 km southeast of Nelson, B.C. (Figure 1). The river progresses in a southerly direction for approximately 60 km from its origin to the confluence with the Pend d'Oreille River (Seven Mile Reservoir). Geographic information is summarized in Table 1. The system is a 5^{th} order stream, and has a total drainage basin area of roughly 123,000 ha.

Elevation in the basin ranges from 564 meters at its confluence to 2,343 meters at the height of land. Within this elevation range, the system comprises two biogeoclimatic zones (Braumandl and Curran 1992). At lower elevations, the valley lies within the Interior Cedar-Hemlock (ICH) zone, while areas in the higher elevations are found within the Englemann Spruce-Subalpine Fire (ESSF) zone. The Salmo River has a total of eight 2^{nd} and 3^{rd} order tributaries (including Apex Creek, Clearwater Creek, Hall Creek, Barrett Creek, Ymir Creek, Porcupine Creek, Erie Creek, and Hidden Creek) and two 4^{th} order tributaries (Sheep Creek and the South Salmo River) (Figure 1). The Water Survey of Canada maintains a gauging station on the Salmo River near the town of Salmo (Anonymous 1977). Mean annual discharge in the Salmo River (1949-1976) was 32.5 $m^3 \cdot sec^{-1}$, with mean monthly minimum and maximum values of 7.5 and 128.5 $m^3 \cdot sec^{-1}$, respectively. Runoff reaches a peak in May, with the highest flows between April and July each year.

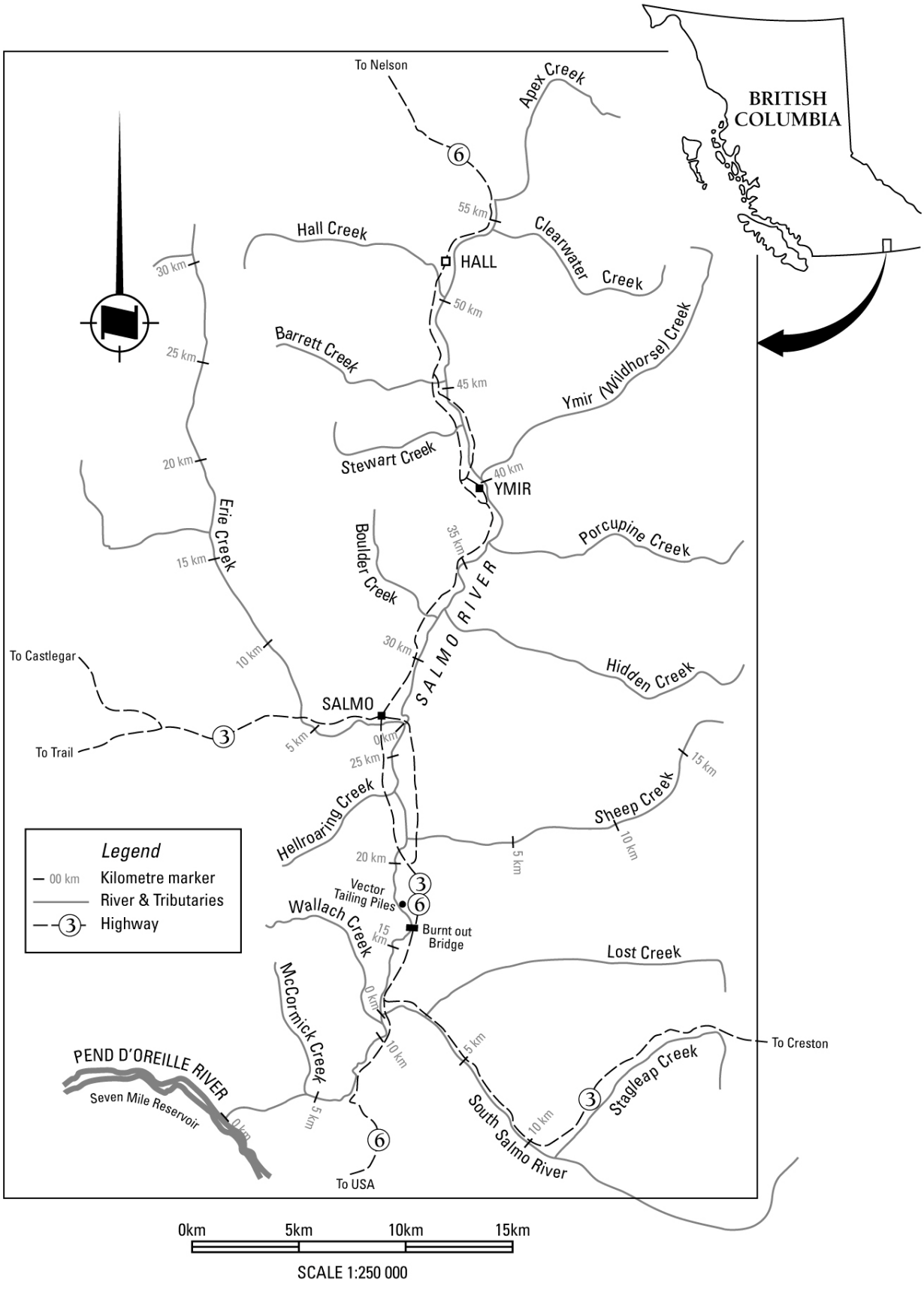


Figure 1. The Salmo River watershed study area.

Table 1. Summary of geographic information for the Salmo River study area.

Gazetted Name	Stream Length (km)	Area (ha)
Salmo River	60	123,000
Geographic Information		
Approximate distance and direction to the nearest town, city or landmark	12 km southeast of Nelson, B.C.	
MWALP Region	4	
MWALP Management Unit	4-8	
DFO District	Interior South East (#30)	
Ministry of Forests Region	Nelson	
Ministry of Forests District	Kootenay Lake	
NTS Base Map Reference	82 F/3 and 82 F/6	

2.2 Fish Capture and Tagging

2.2.1 Bull Trout Tagged in 1999

In 1999, bull trout in the Salmo River watershed were captured by angling. Capture primarily occurred in the mainstem Salmo River from early-July to the end of July, and continued again on August 31 with one fish being captured in a tributary (Clearwater Creek). The mainstem Salmo River was sampled from the town of Ymir to the South Salmo River confluence (roughly 60% of the available mainstem river habitat). Capture effort was focussed primarily on the mainstem Salmo River above the South Salmo River confluence, and not in Seven Mile Reservoir, for a number of reasons.

The primary reason was that it was felt that the timing of sampling effort would coincide with the upstream spawning migration of bull trout, and it would be a effective use of time and effort to sample above the South Salmo River confluence. The secondary reason was that fisheries work on Seven Mile Reservoir in 1994 and 1995 had failed to sample a large number of bull trout (R.L.&L. 1995) suggesting that the population was possibly a fluvial (mainstem overwintering) population and not an adfluvial (reservoir overwintering) population. The report also suggested that sampling efficiency would by higher in the Salmo River than in the reservoir. Effort was also limited to the areas above

the South Salmo River confluence due to access restrictions and the limited mainstem fish habitat (large pools) available below this point.

In total ten bull trout were tagged, and the methodology for radio tagging is presented in Baxter and Nellestijn (2000). Radio tags used during the first year of study were manufactured by Lotek Engineering in Newmarket Ontario. The tags used were model MCFT-3A (16 mm diameter, 50 mm length, 6.2 g weight in water, operation life >680 days), and were digitally coded tags transmitting on frequency 149.520.

2.2.2 Bull Trout Tagged in 2000

In 2000, bull trout in the Salmo River watershed were captured by two methods; angling and the use of fish fence operated on the South Salmo River (Baxter 2001b). All bull trout were radio tagged using the methodology outlined in Baxter and Nellestijn (2000). Radio tags used in this second year of study were also manufactured by Lotek Engineering. The tags used were model MCFT-3A (16 mm diameter, 50 mm length, 6.2 g weight in water, operation life >680 days; n=9) and model MCFT-3EM (11 mm diameter, 49 mm length, 4.3 g weight in water, operation life >399 days; n=1). The tags were digitally coded transmitting on frequencies 149.700 and 149.620.

In the mainstem, capture occurred between the mouth and the town of Ymir. In total five bull trout were tagged in the mainstem Salmo River from mid-June to mid-July. Two and three bull trout were tagged below and above the South Salmo River confluence, respectively. An additional five bull trout were tagged as outmigrating kelts from the South Salmo River between September 21 and October 17 2000 (see Baxter 2001b).

2.3 Discharge

Discharge data for the Salmo River is collected annually, and is obtained by the Water Survey of Canada from a recording station located at the Black Bluffs (downstream of the South Salmo River confluence). I requested this data to determine if bull trout

spawning movements were correlated with a certain discharge level or trend during the summer of 2000.

2.4 Tracking

Tracking was carried out by ground checks (boat and vehicle), and through the use of aerial monitoring in a helicopter (A-STAR). I used a Lotek SRX-400 receiver in conjunction with a single two or three element Yagi antennae for all ground and aerial tracking, and during tracking the location of each fish was noted as a description (river location) and UTM co-ordinate.

A fixed data-logging tracking station was also established at the migration barrier on the Salmo River in the summer of 1999 and 2000 to determine if any bull trout migrated into Seven Mile Reservoir (see Baxter 2001c, Baxter and Nellestijn 2000). The fixed station consisted of a battery powered receiver (Lotek SRX-400 with data logging software) within a weatherproof housing and connected to an upstream and downstream antennae (four element Yagi antennae) to resolve movement direction. The battery was replaced every two weeks, at which time the recorded data was downloaded to a portable computer.

3.0 RESULTS

3.1 Fish Capture and Tagging

3.1.1 Bull Trout Tagged in 1999

In 1999, A total of ten bull trout were implanted with radio tags of which nine fish were captured in the mainstem Salmo River between km 15 and km 30 (from the mouth), and one fish was sampled in a spawning tributary (Clearwater Creek). The capture location, sex, radio tag code, spawning location and overwintering location for each fish are summarized in Table 2 (for specific data regarding bull trout radio tagged in 1999 see Baxter and Nellestijn 2000). The average length of bull trout sampled was 57.0 cm, and catch per unit effort averaged 0.44 bull trout per angler day. Spawning sites were identified in Sheep Creek, Clearwater Creek, the South Salmo River, Stagleap Creek, and the upper Salmo River. These fish all survived spawning and were tracked in the second year of study.

Table 2. Summary data of bull trout captured in the Salmo River watershed and implanted with radio tags in 1999.

Capture Location (km)	Sex	Code	Spawning Location (km)	Overwintering Location (km)
Salmo R (18.45)	F	51	Sheep Ck (6.15)	Salmo R (18.45)
Salmo R (17.25)	F	54	South Salmo R (11.05)	Salmo R (17.75)
Salmo R (23.05)	M	56	South Salmo R (16.75)	Salmo R (21.05)
Salmo R (25.25)	F	58	Stagleap Ck (0.10)	Salmo R (24.00)
Salmo R (21.05)	F	60	Salmo R (53.80)	Salmo R (13.15)
Salmo R (25.25)	F	61	Sheep Ck (7.55)	Salmo R (20.00)
Clearwater Ck (3.80)	F	65	Clearwater Ck (3.80)	Salmo R (36.35)
Salmo R (17.85)	F	67	Stagleap Ck (0.85)	Salmo R (16.85)
Salmo R (18.45)	F	68	Clearwater Ck (3.80)	Salmo R (18.45)
Salmo R (23.05)	M	70	Salmo River (54.70)	Salmo R (23.05)

3.1.2 Bull Trout Tagged in 2000

In 2000, an additional ten bull trout were implanted with radio tags of which five fish were captured in the mainstem Salmo River, and five fish were sampled as outmigrating kelts from the South Salmo River (see Baxter 2001b). The date, capture location, sex, length, radio tag code, and Floy tag number for each fish is summarized in Table 3. Of the tagged fish, six fish were identified as females and four fish were classified as males. The average length of bull trout sampled was 56.0 cm. Catch per unit effort averaged 0.53 bull trout per day, and 55 angler days were expended using various methods.

Table 3. Summary data of bull trout captured in the Salmo River watershed and implanted with radio tags in 2000.

Date	Capture Location (km)	Sex	Length (cm)	Code	Floy Tag #
06/27/00	Salmo R (7.30)	M	40.0	9	G-0499, G-0500
06/28/00	Salmo R (11.80)	F	51.0	80	G-0906, G-0907
07/16/00	Salmo R (32.25)	F	45.0	84	G-0001, G-0002
07/18/00	Salmo R (39.90)	F	65.0	76	G-0004, G-0005
07/18/00	Salmo R (24.40)	F	56.5	77	G-0903, G-0904
09/21/00	South Salmo R (0.85)	F	57.5	78	B-0424, B-0423
09/28/00	South Salmo R (0.85)	F	63.0	83	B-0401, B-0402
10/10/00	South Salmo R (0.85)	M	59.5	82	B-0407, B-0408
10/11/00	South Salmo R (0.85)	M	65.5	79	B-0409, B-0410
10/17/00	South Salmo R (0.85)	M	59.5	85	B-0411, B-0412

3.2 Discharge

Discharge in the Salmo River in the summer of 2000 followed typical hydrograph patterns observed in the Salmo River in past years, with a decrease in runoff occurring through this period (Figure 2). The peak of freshet (June) occurred approximately a month earlier in 2000 than in 1999.

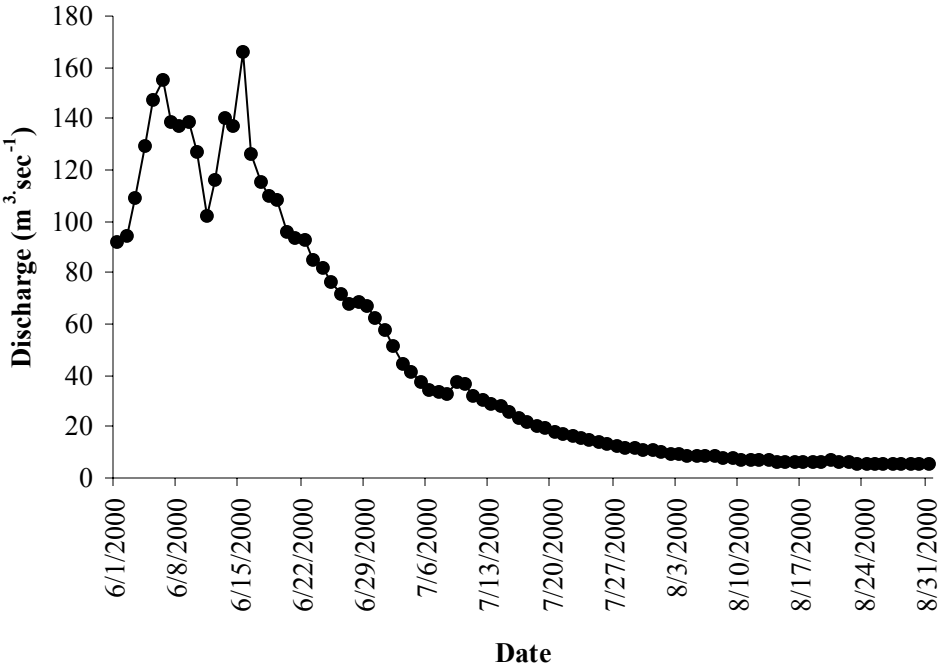


Figure 2. Discharge of the Salmo River during June, July and August of 2000.

3.3 Tracking

For this study I utilized both ground (road and boat) and aerial (helicopter) tracking. Fish were tracked on a biweekly basis from the end of July to the end of October (spawning period), and once during the overwintering period. Ground tracking did not locate all of the fish on all occasions. However, aerial tracking did locate the fish on all occasions that this survey method was used. In total nine ground tracking surveys and eight aerial tracking surveys were conducted during this study. Locations of individual radio tagged bull trout found during tracking events are summarized in Appendix I.

In 2000, the fixed station was set up on June 22 and removed on November 15. In total, the fixed station was downloaded eight times during the above period.

3.3.1 Upstream Migration, Spawning Locations, and Spawning Timing (Fish Tagged in 1999)

3.3.1.1 General Patterns

3.3.1.1.1 Migration Patterns (1999/2000)

Although all the bull trout that were radio tagged in 1999 were all sampled within a relatively small area of the mainstem (8 km distance; less than 13% of available mainstem habitat), extensive migrations occurred and bull trout spawning locations were found throughout the watershed. Two general migration patterns emerged for the nine original bull trout that were tagged in the mainstem in the first year of the study. The first pattern was an upstream movement within the Salmo River to a spawning area or tributary, while the second pattern was a downstream migration within the Salmo River to a major tributary. Four of the nine tagged bull trout made upstream migrations of 5 to 30 km in the Salmo River, typically in the first week of August. The locations that these fish spawned included the mainstem Salmo River above Hall Creek, Clearwater Creek, and Sheep Creek. Five of the nine tagged bull trout made downstream migrations of 5 to 10 km in the Salmo River to spawning tributaries, also in the first week of August. The locations that these fish spawned included the South Salmo River (both in Canada and the United States of America), and Stagleap Creek (tributary to the South Salmo River).

The spawning period in 1999 (timing while fish were in their spawning areas) for bull trout in the watershed was between the beginning of August and end of September, with spawning likely peaking around the middle of September. Fish remained in their spawning areas generally until the first or second week of October.

None of the bull trout radio tagged in 1999 were tracked by the fixed station at the mouth of the Salmo River in 1999/2000.

3.3.1.1.2 Migration Patterns (2000/2001)

Of the ten bull trout tagged in 1999, all successfully spawned and moved downstream to overwintering areas in the mainstem Salmo River during the winter of 1999/2000. All fish were assumed to be alive at the beginning of tracking in the early summer of 2000. In general these tagged bull trout remained in proximity to their overwintering area until mid-July. At that time similar migration patterns were observed as in 1999 (i.e., upstream and downstream migrations to spawning areas and tributaries). Again, extensive migrations occurred, and spawning locations were found throughout the watershed.

Three of the nine tagged bull trout made upstream migrations of 10 to 30 km in the Salmo River, typically starting in the second week of July. The locations that these fish spawned included the mainstem Salmo River above Hall Creek, Sheep Creek, and Clearwater Creek. Five of the nine tagged bull trout made downstream migrations of 5 to 15 km in the Salmo River to spawning tributaries, also beginning in mid-July. The locations that these fish spawned included the South Salmo River (both in Canada and the United States of America), and Stagleap Creek (tributary to the South Salmo River). Two of the tagged fish did not make spawning migrations in 2000, but were observed to be alive during snorkel surveys. In general the migration to spawning areas for the original radio tagged bull trout began earlier in the summer of 2000 than in the summer of 1999. The spawning period in 2000 for the original tagged bull trout was similar to 1999 (between the beginning of August and end of September, with spawning likely peaking around the middle of September). Fish remained in their spawning areas generally until the first week of October.

The second year of data from the ten bull trout in 1999 identified that 80% were repeat spawners, and that of the eight repeat spawners a total of seven (87.5%) spawned in the same general area. Site fidelity was therefore quite high.

None of the bull trout radio tagged in 1999 were tracked by the fixed station at the mouth of the Salmo River in 2000/2001.

3.3.1.2 Individual Patterns

A summary of the locations of individual fish is found in Appendix I, and includes UTM co-ordinates and km locations of fish by date.

3.3.1.2.1 Code 51

Code 51, a 58 cm female tagged in the Salmo River at km 18.45 on July 15 1999, ovewintered in the mainstem Salmo River at km 18.45 for the winter of 1999/2000 after spawning in Sheep Creek (Figures 3 and 4). It remained in this area for the summer of 2000 (i.e., did not spawn in the fall of 2000), and then made a short upstream migration in the mainstem river to km 19.35 to overwinter for winter of 2000/2001 (Figures 3 and 4).

3.3.1.2.2 Code 54

Code 54, a 60 cm female tagged in the Salmo River at km 18.25 on July 7 1999, spawned in the South Salmo River at km 11.05 in 1999 and then overwintered in the mainstem Salmo River at km 17.75 for the winter of 1999/2000 (Figures 5 and 6). The fish remained at km 17.75 until mid-July of 2000, at which time it made a rapid downstream migration into the South Salmo River. The fish then migrated down the South Salmo River, entered the Salmo River and moved upstream to the town of Ymir (Wildhorse Creek) over a period of two weeks. The fish then moved downstream in the Salmo River to km 37.10 where it presumably spawned and overwintered (Figures 5 and 6).

3.3.1.2.3 Code 56

Code 56, a 60 cm male tagged in the Salmo River at km 23.05 on July 15 1999, spawned in the South Salmo River in 1999 and overwintered in the mainstem Salmo River at km 21.05 during the winter of 1999/2000 (Figures 7 and 8). The fish remained in the Salmo River until mid-July 2000 at which time it migrated into the South Salmo watershed (Lost Creek and the South Salmo River) to spawn in the fall of 2000 (Figures 7 and 8). The fish then overwintered for the winter of 2000/2001 in the same location (km 21.05 of the Salmo River) as the previous year.

3.3.1.2.4 Code 58

Code 58, a 61 cm female tagged in the Salmo River at km 25.25 on July 11 1999, spawned in the South Salmo River watershed in 1999 (Stagleap Creek). It overwintered in the mainstem Salmo River at km 24.00 during the 1999/2000 winter (Figures 9 and 10). The fish remained in the Salmo River until mid-July 2000 at which time it migrated into the South Salmo River (to the US border) to spawn in the fall of 2000 (Figures 9 and 10). The fish then overwintered during 2000/2001 at km 25.25 of the Salmo River.

3.3.1.2.5 Code 60

Code 60, a 56 cm female tagged in the Salmo River at km 21.05 on July 17 1999, spawned in the mainstem Salmo River at km 53.80 in the fall of 1999, and overwintered in the Salmo River at km 13.15 (Figures 11 and 12). The fish gradually migrated upstream in the Salmo River until mid-July 2000 at which time it migrated rapidly upstream to km 53.85 where it remained to spawn in the fall of 2000 (Figures 11 and 12). The fish then moved downstream to overwinter at km 16.85 of the Salmo River during the winter of 2000/2001.

3.3.1.2.6 Code 61

Code 61, a 53 cm female tagged in the Salmo River at km 25.25 on July 7 1999, spawned in Sheep Creek during the fall of 1999, and then overwintered in the mainstem Salmo River at km 20.00 during the 1999/2000 winter (Figure 13 and 14). The fish then moved again into Sheep Creek in mid-July 2000, where it spawned in the fall of 2000 (Figures 13 and 14). After moving downstream, the fish overwintered in the mainstem Salmo River just upstream of the Sheep Creek confluence.

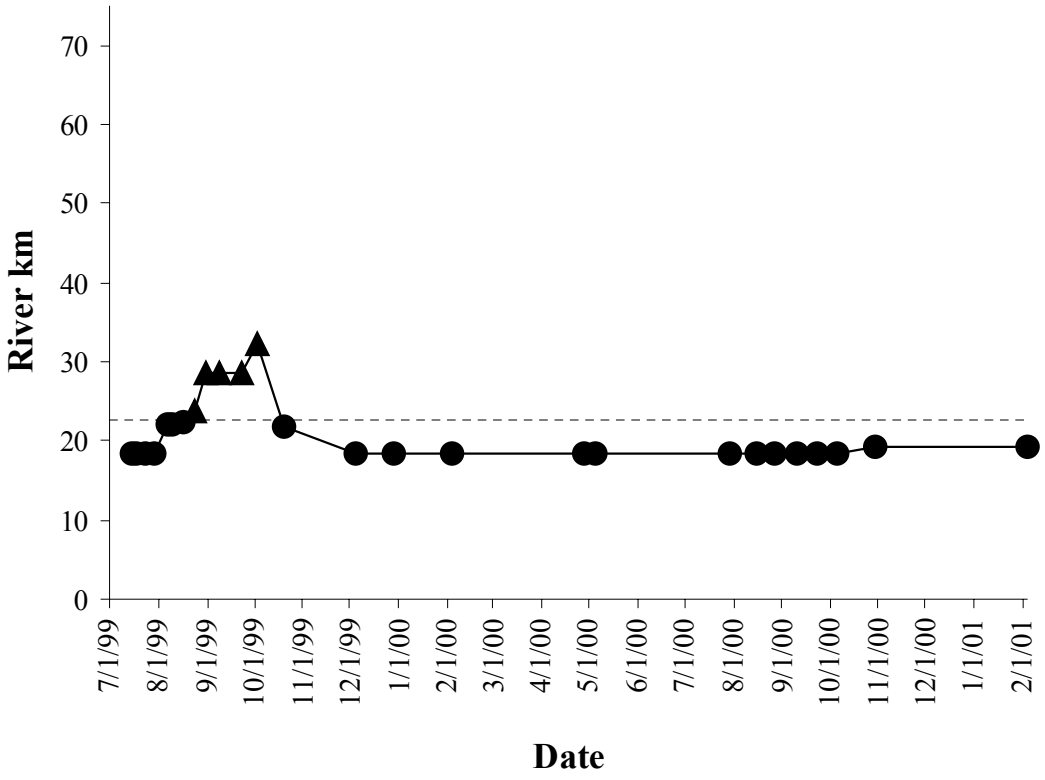


Figure 3. Migratory pattern of a 58 cm female bull trout (Code 51) in the Salmo River watershed from July 1999 to February 2001. Triangle points above the dotted gridline represent movement within the Sheep Creek watershed (spawning location 1999), and circle points represent locations within the Salmo River mainstem.

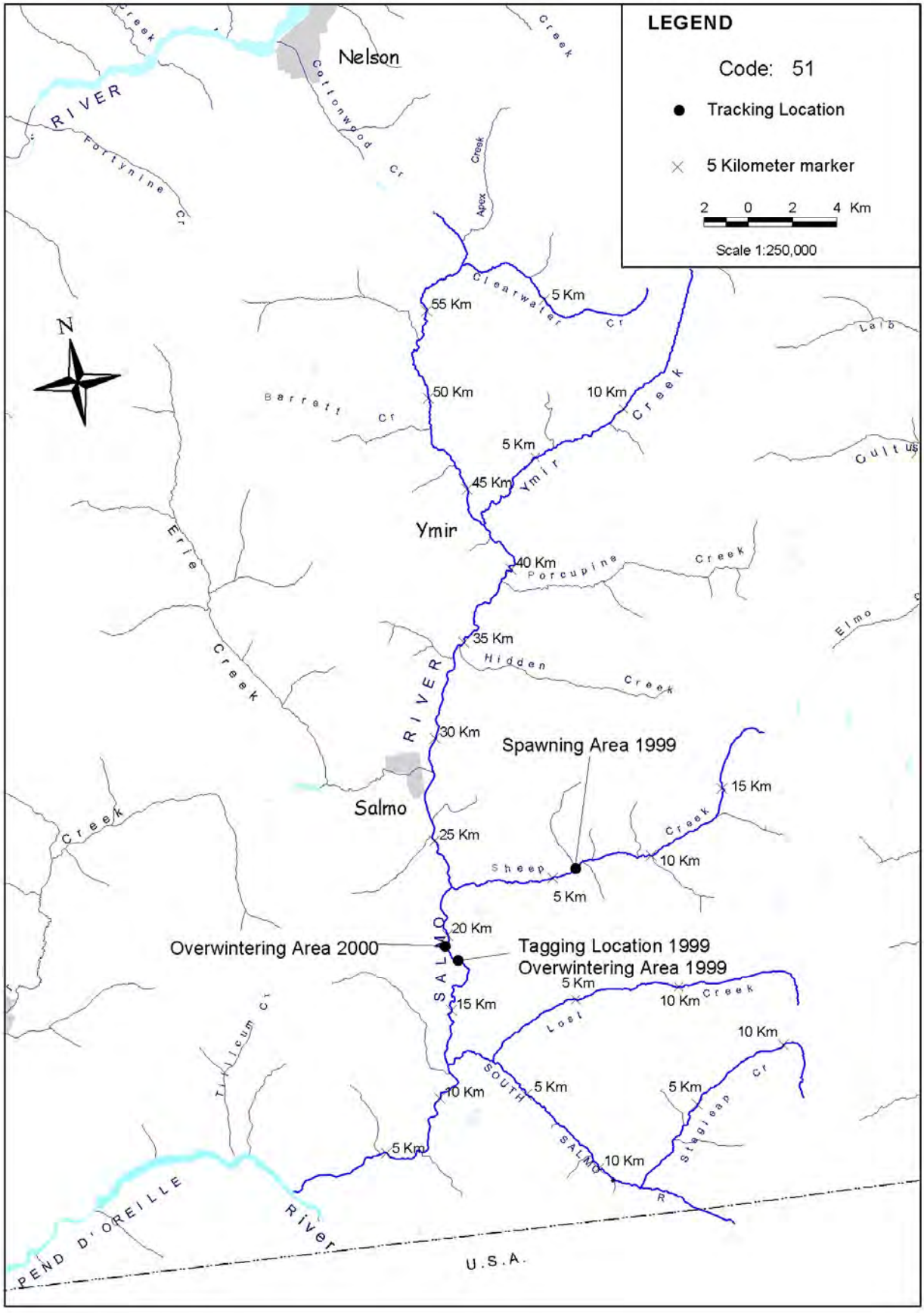


Figure 4. **Tracking locations of a 58 cm female bull trout (Code 51) within the Salmo River watershed from July 1999 to February 2001.**

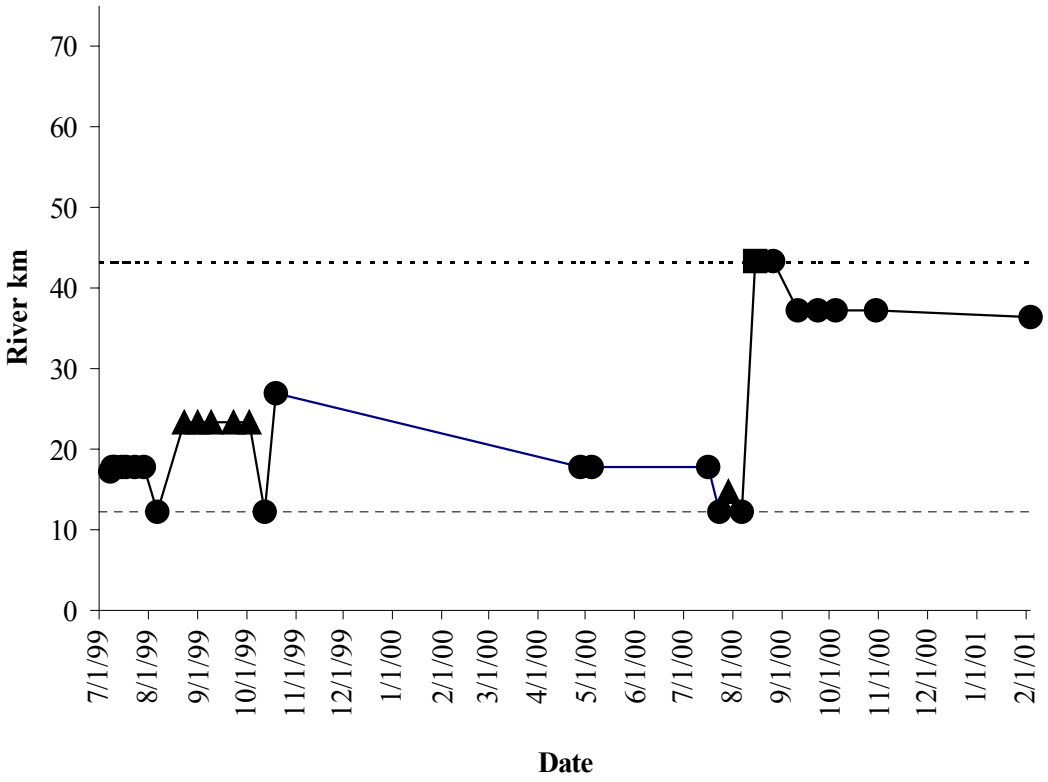


Figure 5. **Migratory pattern of a 60 cm female bull trout (Code 54) in the Salmo River watershed from July 1999 to February 2001. Triangle points above the dotted gridline represent movement within the South Salmo River watershed (spawning location), square points represent locations within Wildhorse Creek, and circle points represent locations within the Salmo River mainstem.**

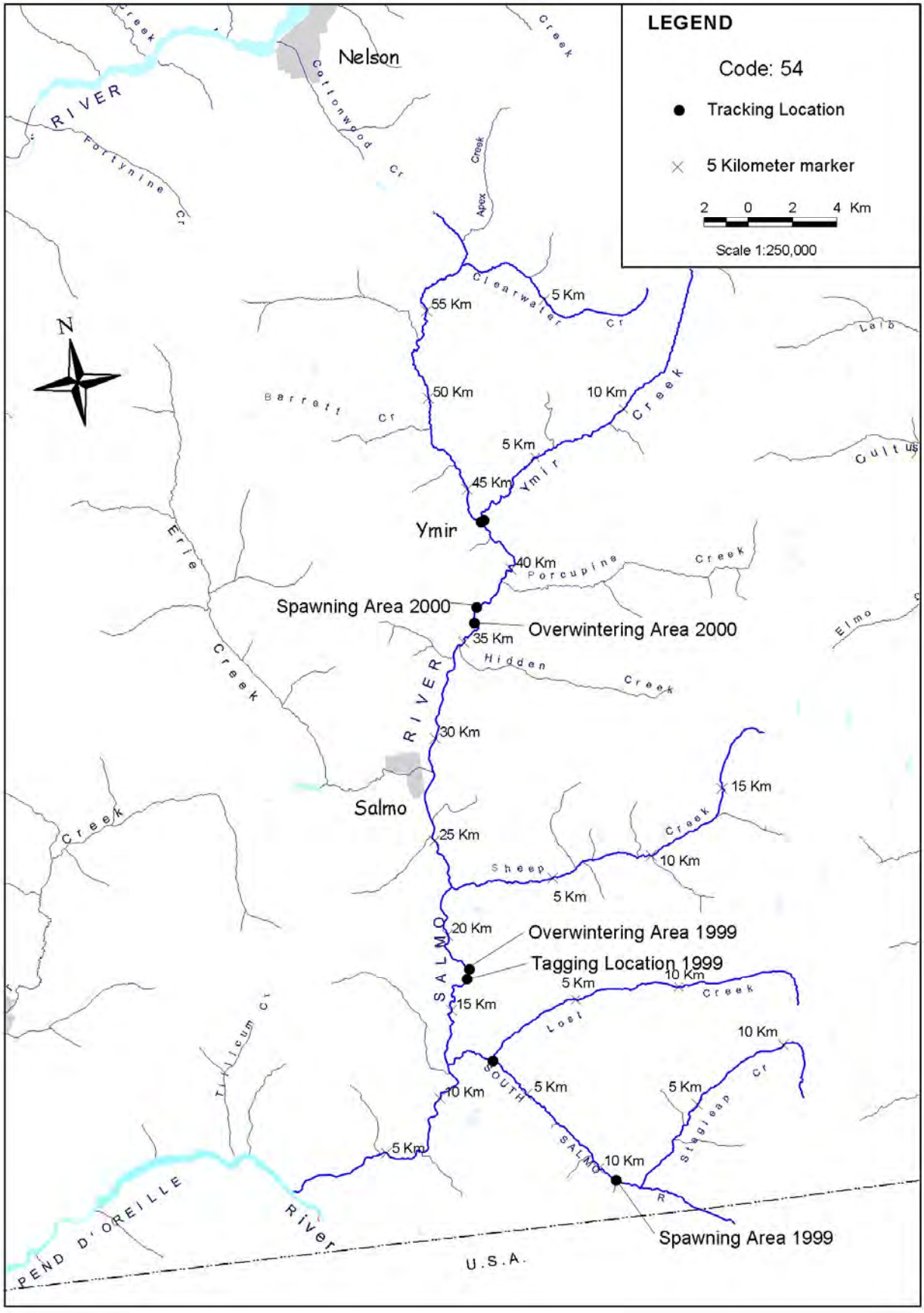


Figure 6. **Tracking locations of a 60 cm female bull trout (Code 54) within the Salmo River watershed from July 1999 to February 2001.**

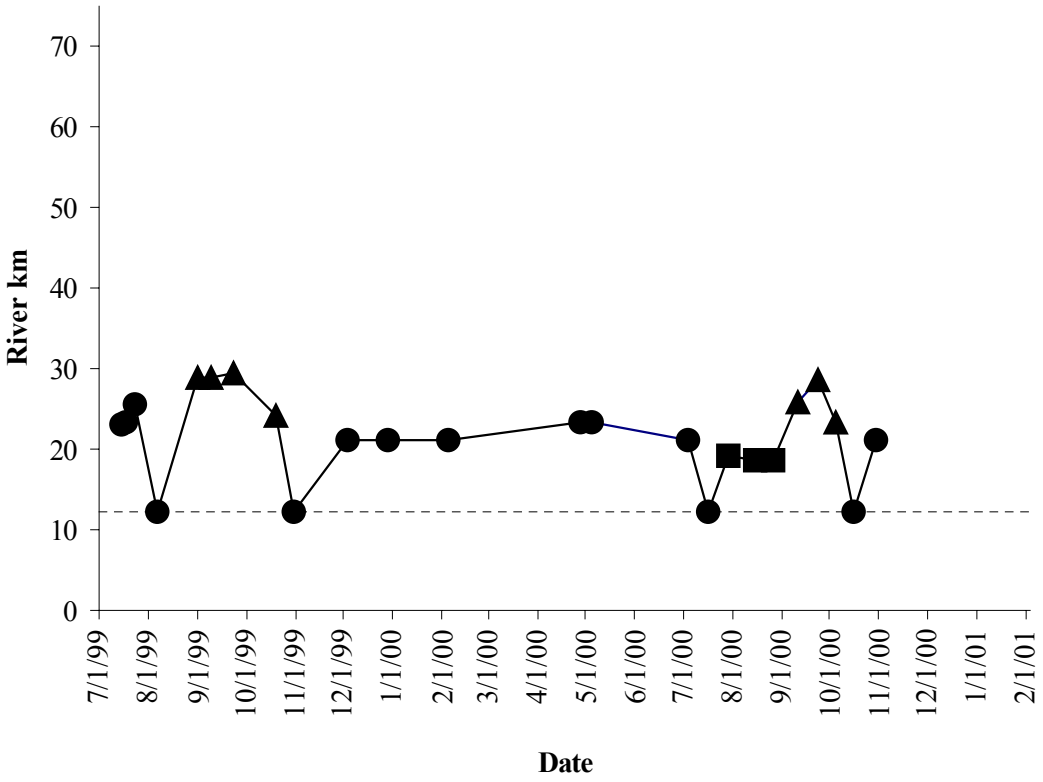


Figure 7. **Migratory pattern of a 60 cm male bull trout (Code 56) in the Salmo River watershed from July 1999 to February 2001. Square points (Lost Creek) and triangle points (South Salmo River) above the dotted gridline represent movement within the South Salmo River watershed (spawning location), and circle points represent locations within the Salmo River mainstem.**

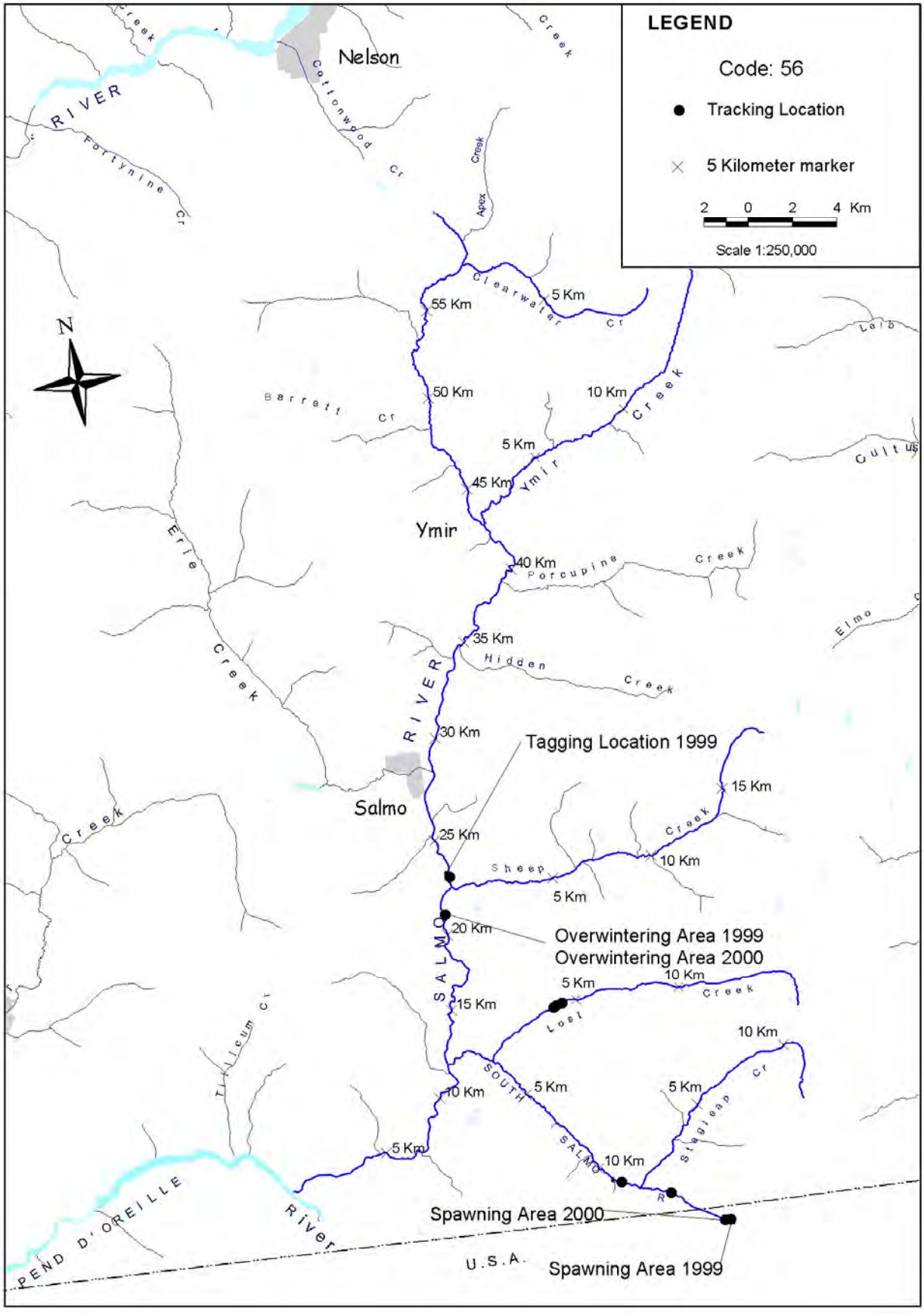


Figure 8. **Tracking locations of a 60 cm male bull trout (Code 56) within the Salmo River watershed from July 1999 to February 2001.**

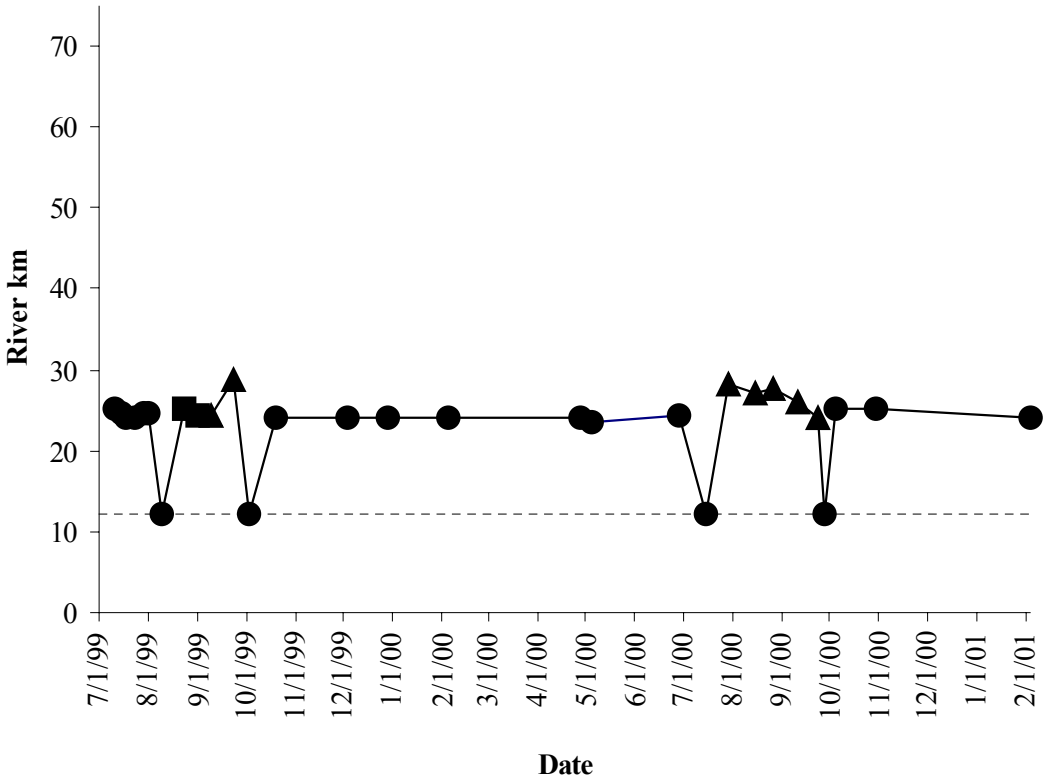


Figure 9. **Migratory pattern of a 61 cm female bull trout (Code 58) in the Salmo River watershed from July 1999 to February 2001. Square points (Stagleap Creek) and triangle points (South Salmo River) above the dotted gridline represent movement within the South Salmo River watershed (spawning location), and circle points represent locations within the Salmo River mainstem.**

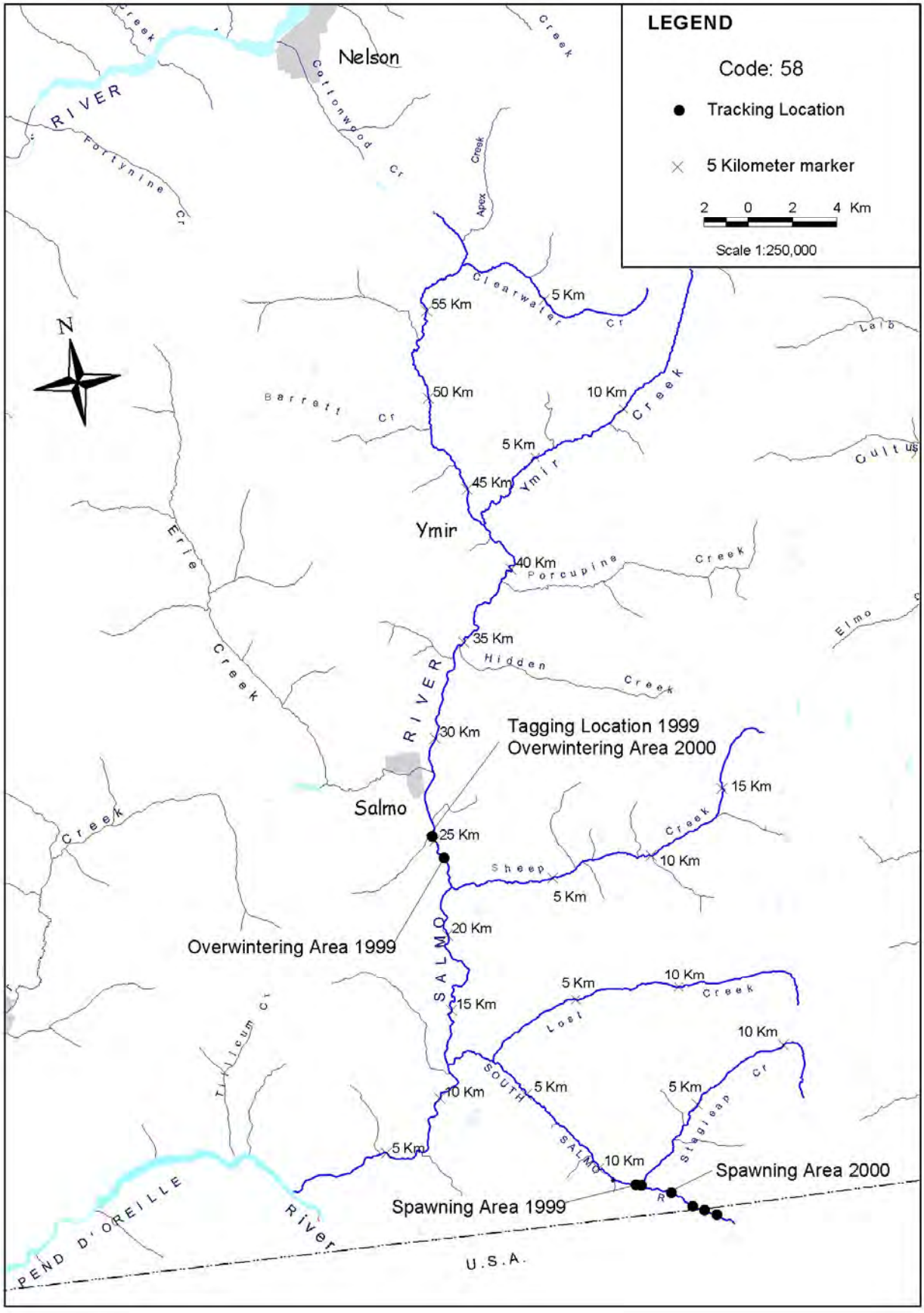


Figure 10. Tracking locations of a 61 cm female bull trout (Code 58) within the Salmo River watershed from July 1999 to February 2001.

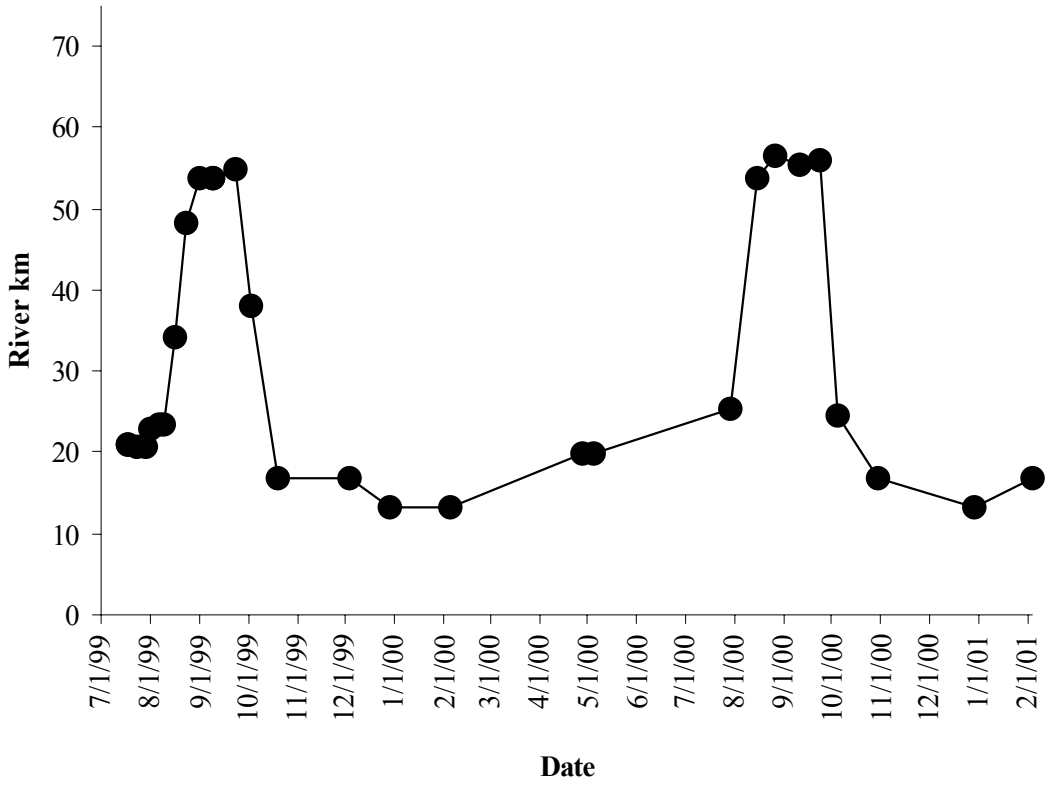


Figure 11. Migratory pattern of a 56 cm female bull trout (Code 60) in the Salmo River watershed from July 1999 to February 2001. Circle points represent locations within the Salmo River mainstem (spawning area).

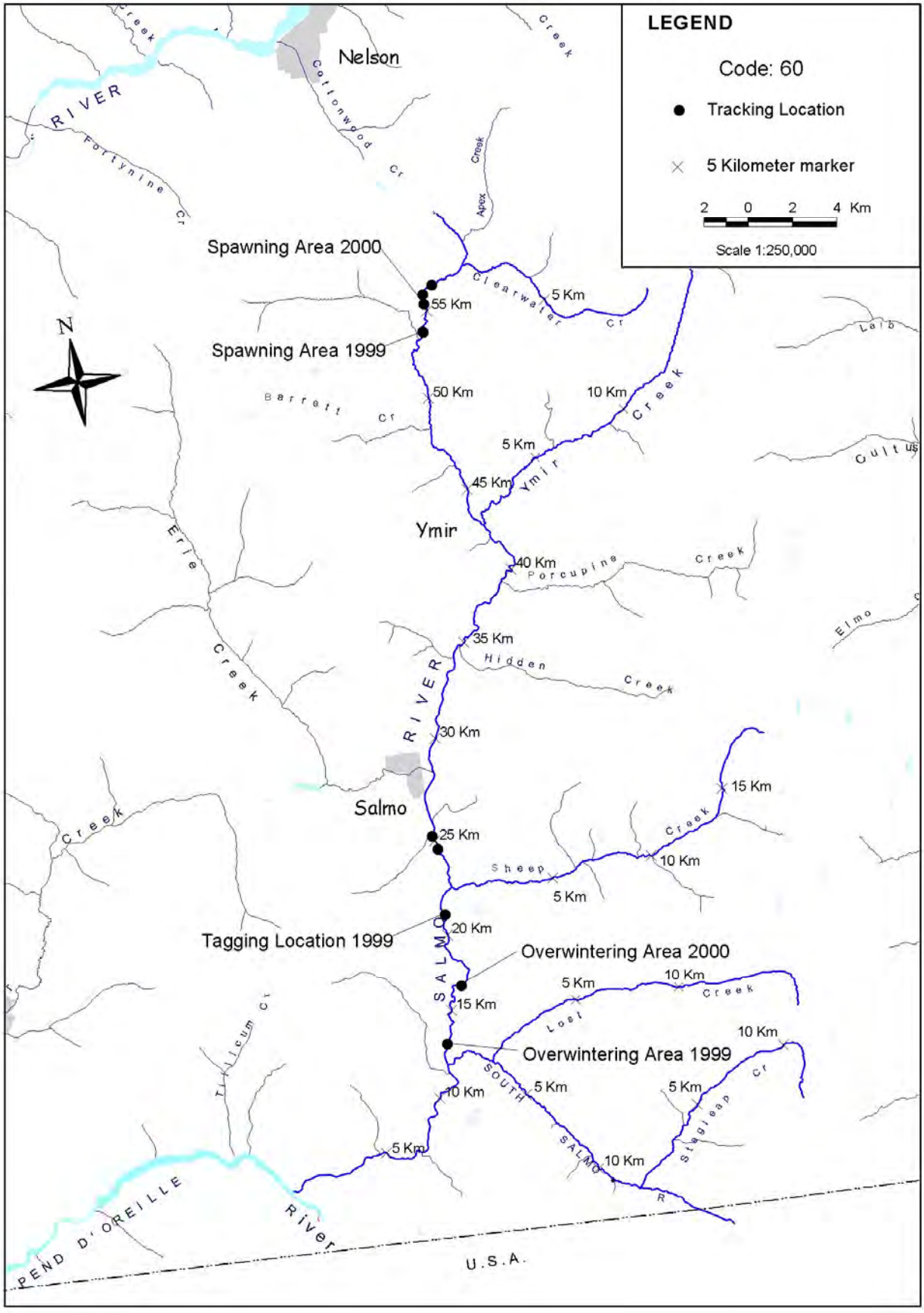


Figure 12. Tracking locations of a 56 cm female bull trout (Code 60) within the Salmo River watershed from July 1999 to February 2001.

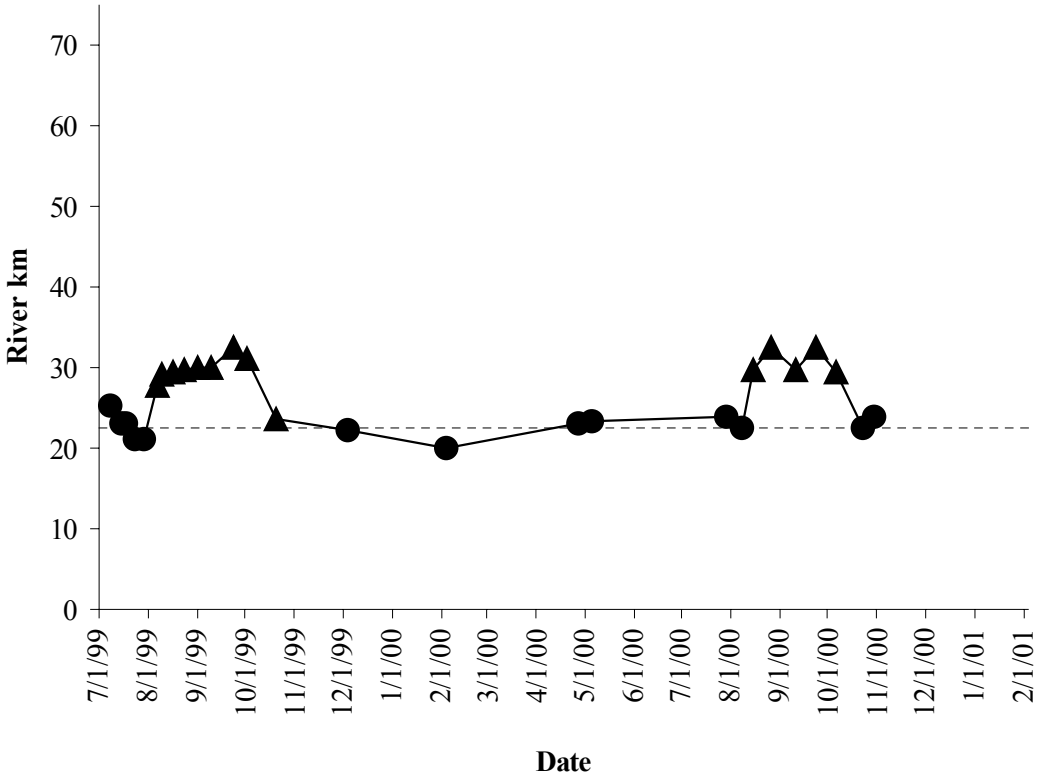


Figure 13. Migratory pattern of a 53 cm female bull trout (Code 61) in the Salmo River watershed from July 1999 to February 2001. Triangle points above the dotted gridline represent movement within the Sheep Creek watershed (spawning location), and circle points represent locations within the Salmo River mainstem.

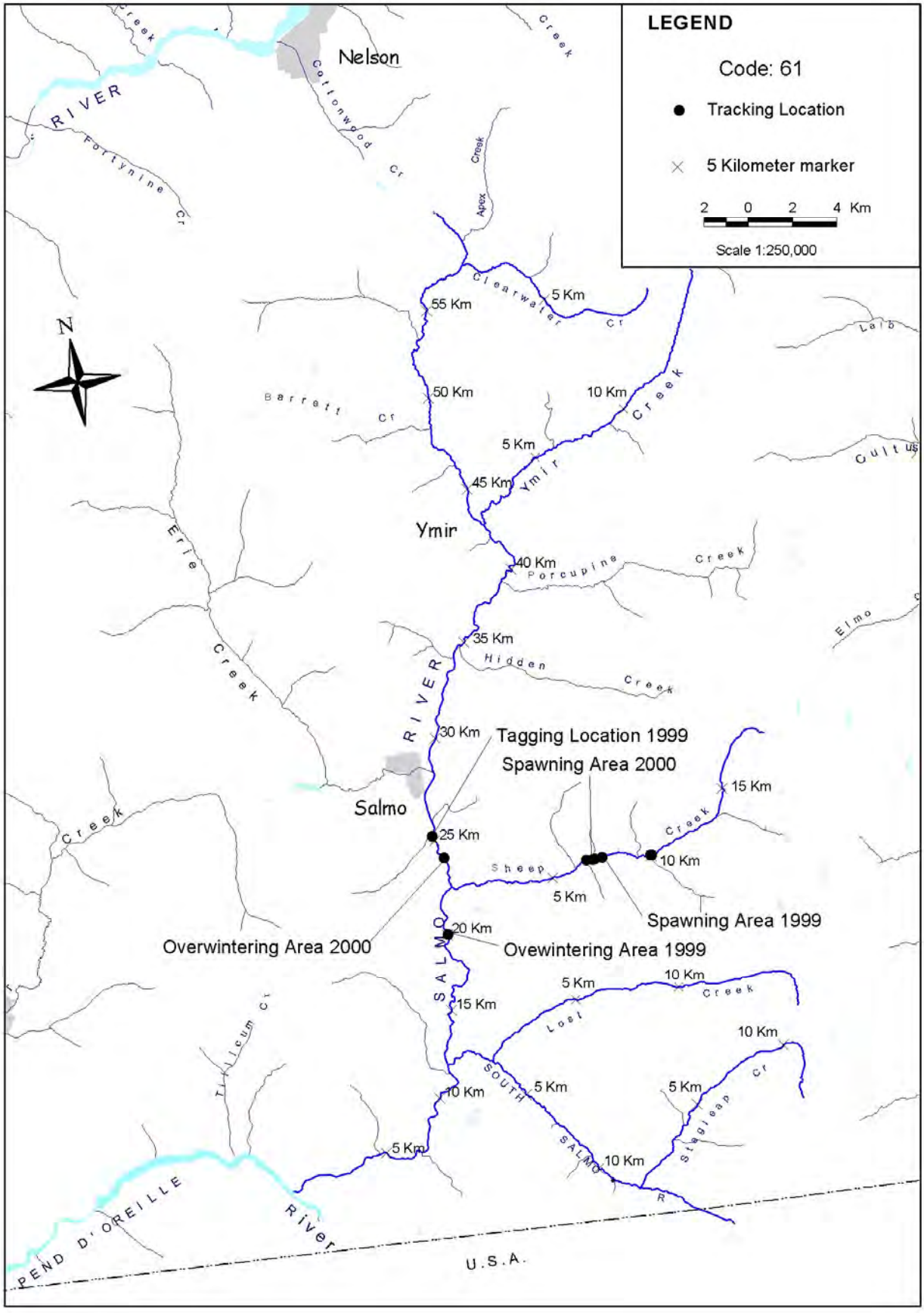


Figure 14. Tracking locations of a 53 cm female bull trout (Code 61) within the Salmo River watershed from July 1999 to February 2001.

3.3.1.2.7 Code 65

Code 65, a 54 cm female was tagged in Clearwater Creek at km 3.80 on August 31 1999, where it spawned in the fall of 1999 (Figures 15 and 16). The fish overwintered in the Salmo River at km 36.35 in the winter of 1999/2000. The fish then moved upstream again into Clearwater Creek in late-July 2000, where it spawned in the fall of 2000 at km 0.95 (Figures 15 and 16). The fish then overwintered at the same location as the previous winter.

3.3.1.2.8 Code 67

Code 67, a 52 cm female tagged in the Salmo River at km 17.85 on July 11 1999, spawned in Stagleap Creek in mid-September 1999, and overwintered in the mainstem Salmo River at km 18.45 in the winter of 1999/2000 (Figures 17 and 18). The fish then moved again into the South Salmo River in late-July 2000, where it migrated into Stagleap Creek and spawned in the fall of 2000 at km 0.85 (Figures 17 and 18). The fish then overwintered in the mainstem Salmo River below the South Salmo River confluence for the winter of 2000/2001.

3.3.1.2.9 Code 68

Code 68, a 50 cm female tagged in the Salmo River at km 18.45 on July 15 1999, spawned in Clearwater Creek in the fall of 1999, and overwintered in the mainstem Salmo River at km 18.45 for the winter of 1999/2000 (Figures 19 and 20). The fish has then remained in the area over the past seven months (Figures 19 and 20).

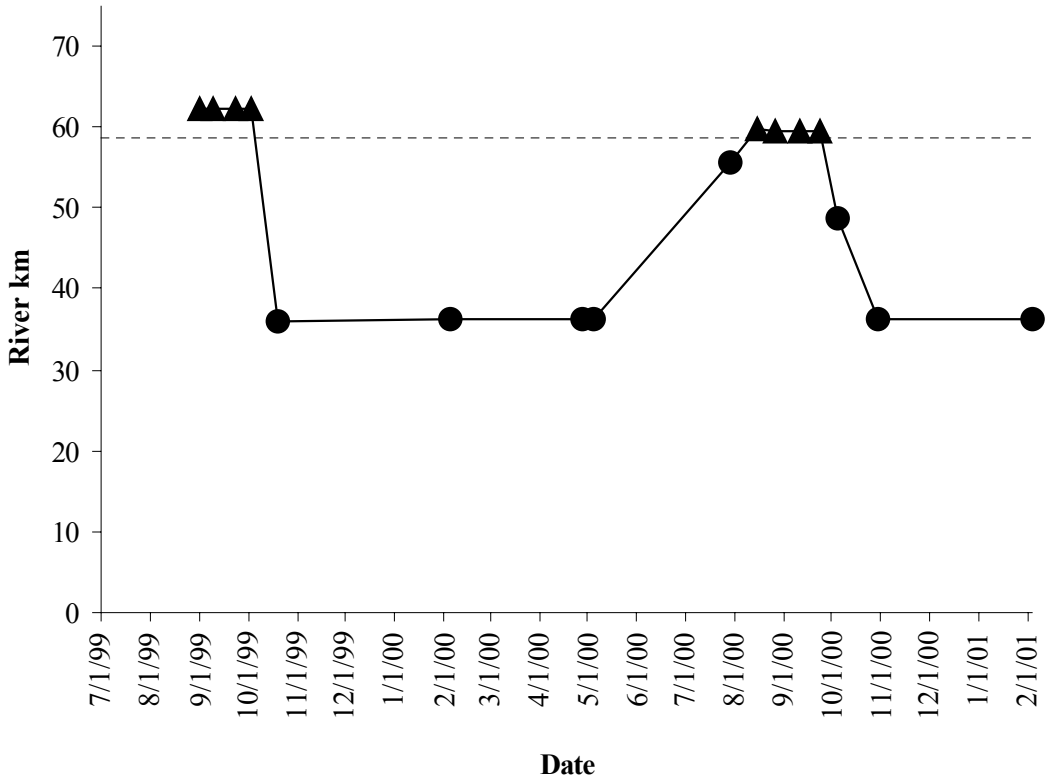


Figure 15. Migratory pattern of a 54 cm female bull trout (Code 65) in the Salmo River watershed from July 1999 to February 2001. Triangle points above the dotted gridline represent movement within the Clearwater Creek watershed (spawning location), and circle points represent locations within the Salmo River mainstem.

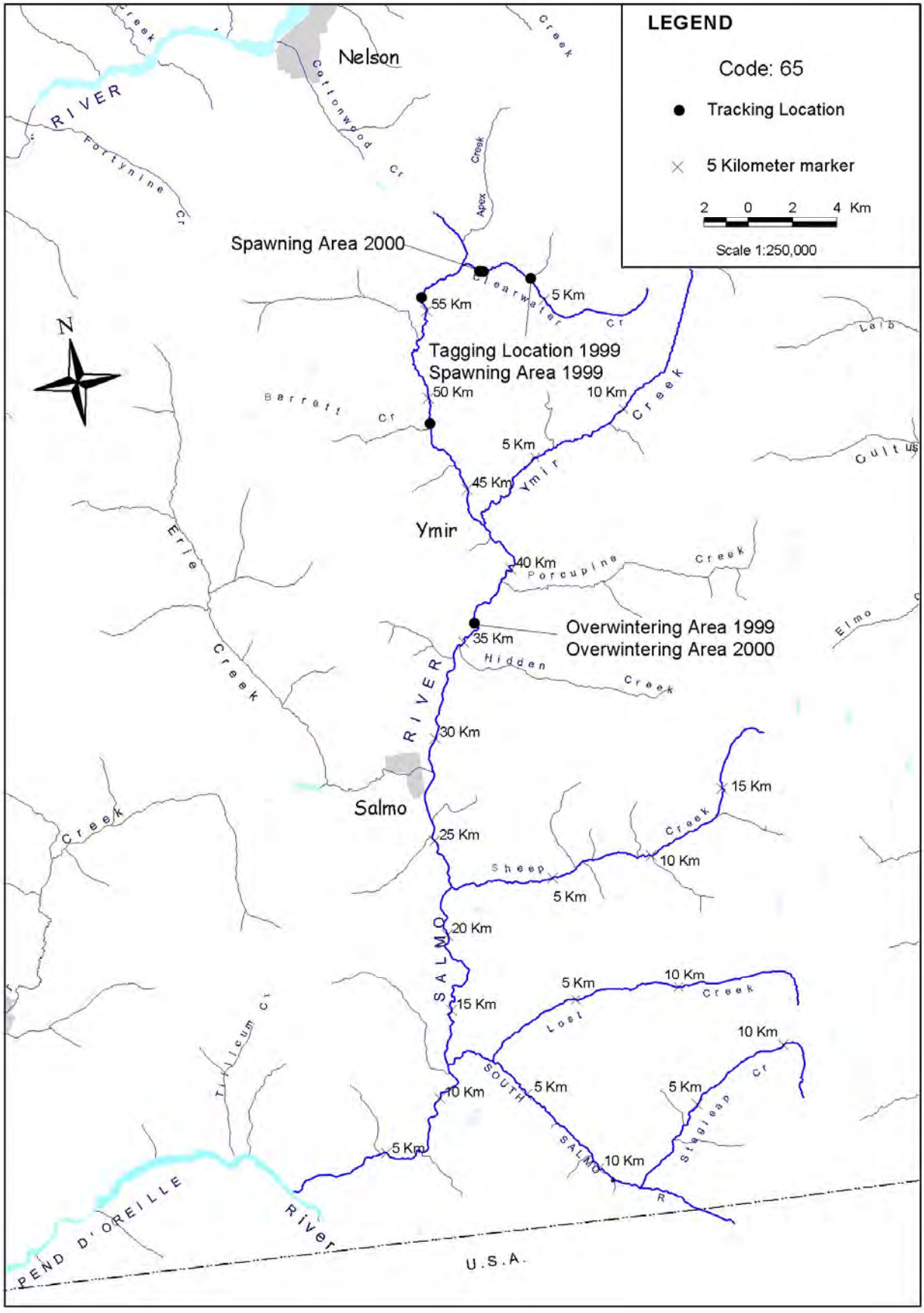


Figure 16. Tracking locations of a 54 cm female bull trout (Code 65) within the Salmo River watershed from July 1999 to February 2001.

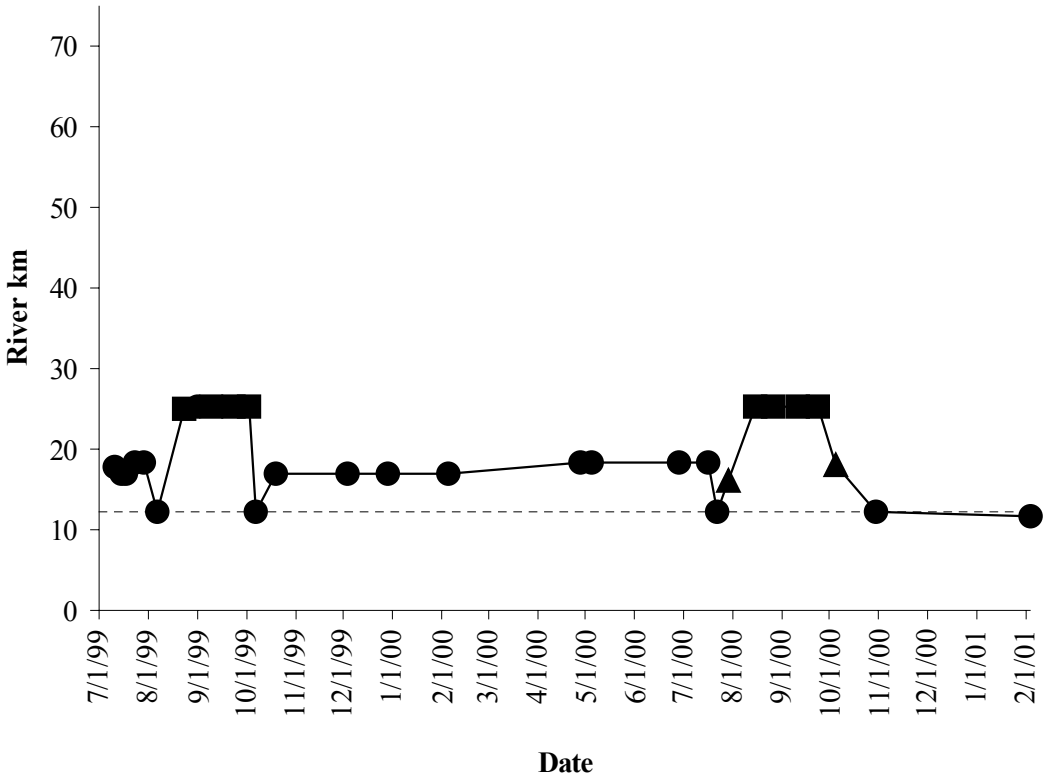


Figure 17. Migratory pattern of a 52 cm female bull trout (Code 67) in the Salmo River watershed from July 1999 to February 2001. Square points (Stagleap Creek) and triangle point (South Salmo River) above the dotted gridline represent movement within the South Salmo River watershed (spawning location), and circle points represent locations within the Salmo River mainstem.

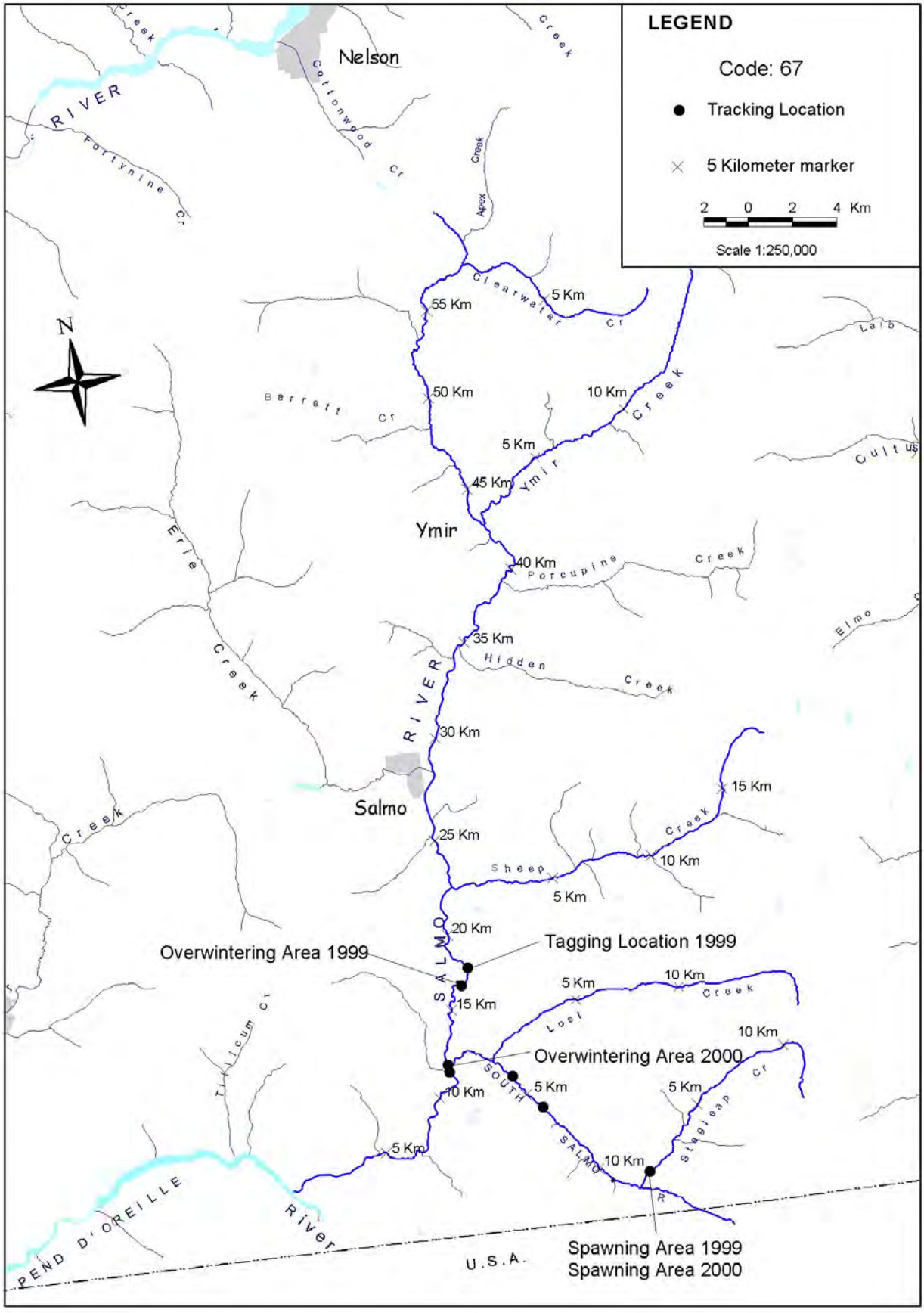


Figure 18. Tracking locations of a 52 cm female bull trout (Code 67) within the Salmo River watershed from July 1999 to February 2001.

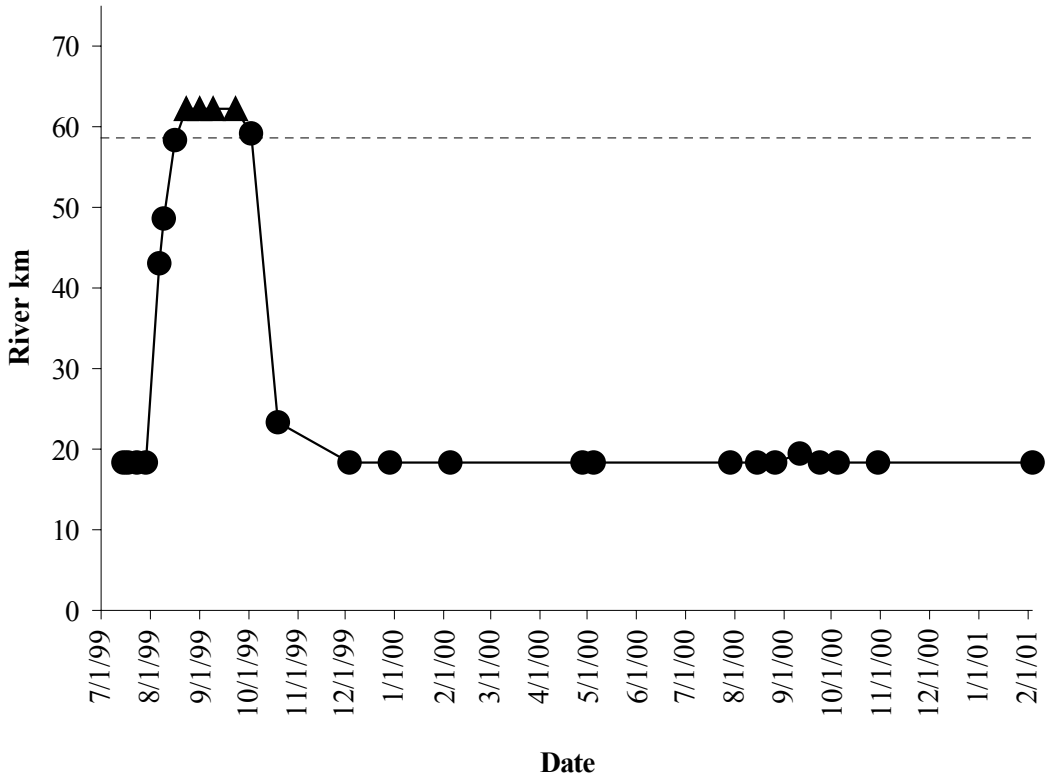


Figure 19. Migratory pattern of a 50 cm female bull trout (Code 68) in the Salmo River watershed from July 1999 to February 2001. Triangle points above the dotted gridline represent movement within the Clearwater Creek watershed (spawning location), and circle points represent locations within the Salmo River mainstem.

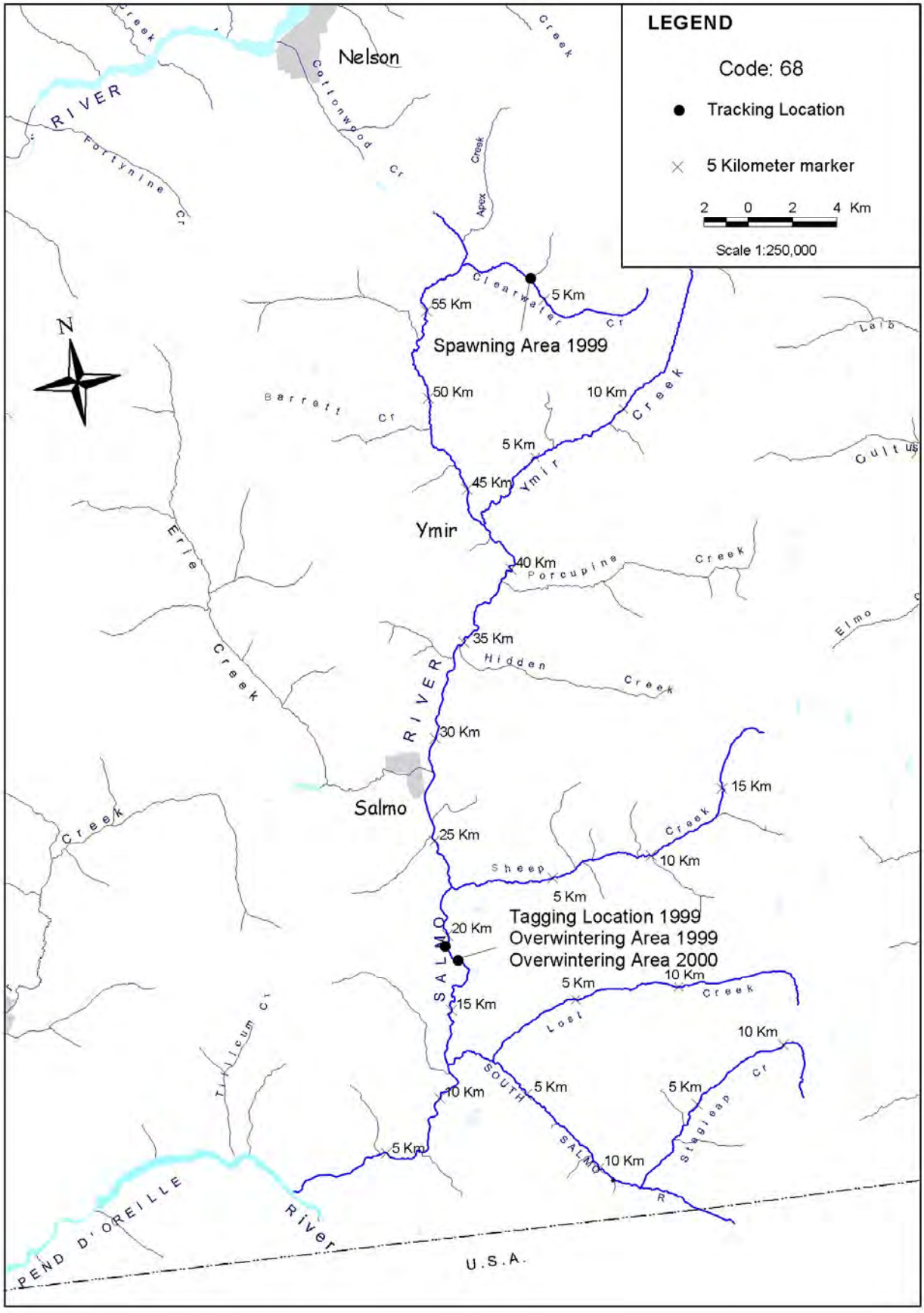


Figure 20. Tracking locations of a 50 cm female bull trout (Code 68) within the Salmo River watershed from July 1999 to February 2001.

3.3.1.2.10 Code 70

Code 70, a 67 cm male tagged in the Salmo River at km 23.05 on July 9 1999, spawned in the upper Salmo River if the fall of 1999 at km 54.70 (Figures 21 and 22). It then moved downstream to km 23.05 to overwinter in 1999/2000. In the following summer the fish then moved upstream again into the upper Salmo River in mid-July 2000, where it spawned in the fall of 2000 (Figures 21 and 22). The fish then overwintered in the in the mainstem Salmo River at km 24.00.

3.3.2 Upstream Migration, Spawning Locations, and Spawning Timing (Fish Tagged in 2000)

3.3.2.1 General Patterns

Of the five additional bull trout that were tagged in first 40 km of the mainstem Salmo River in 2000, two were tagged below the South Salmo River confluence, and three were tagged upstream of the Sheep Creek confluence. The other five bull trout tagged in the year 2000 were sampled at the South Salmo River fence during post-spawning migrations (Baxter 2001b). Of the five bull trout that were tagged prior to spawning, two did not undertake spawning migrations, while three made upstream migrations within the Salmo River to their spawning area or tributary. Initial migrations after tagging occurred in mid- to late-July. These three fish spawned in Clearwater Creek, the upper Salmo River, and the South Salmo River. The other two bull trout that were tagged remained in close proximity to the original tagging sites, but were confirmed alive during snorkel surveys. The spawning period for bull trout in the watershed in 2000 ranged between the beginning of August and end of September, with spawning likely peaking around the mid- to late-September. Fish remained in their spawning areas generally until the first or second week of October, after which time they migrated to overwintering areas.

One bull trout (code 80) was tracked moving downstream of the fixed station on September 14 2000.

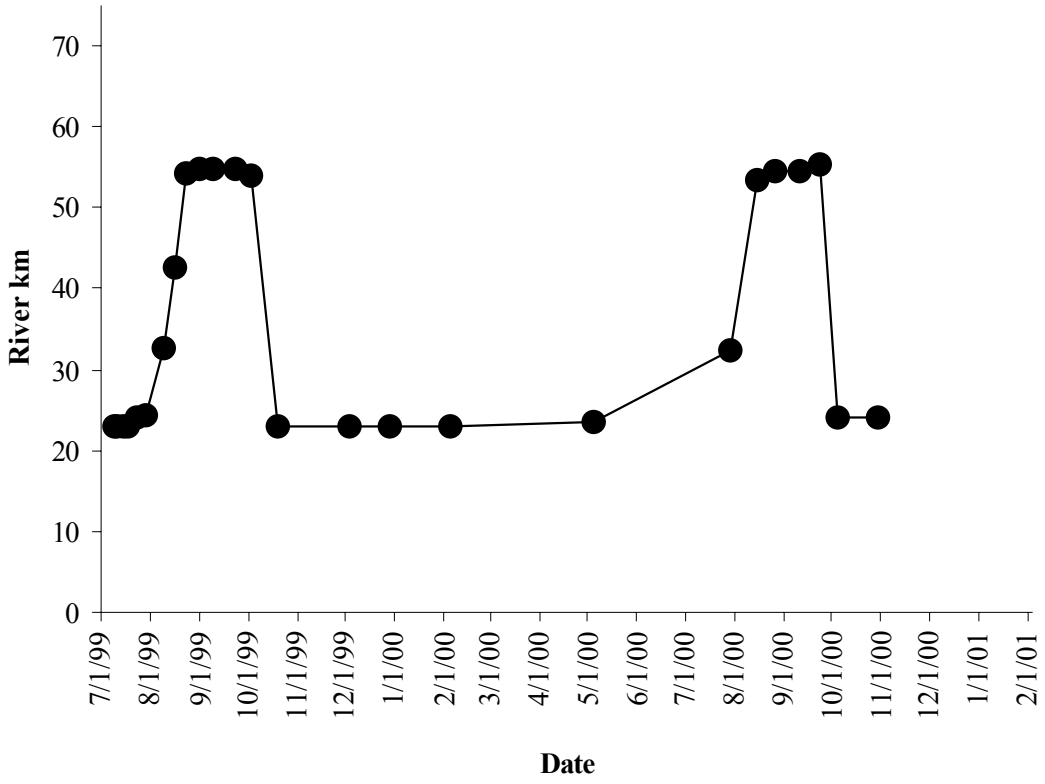


Figure 21. Migratory pattern of a 67 cm male bull trout (Code 70) in the Salmo River watershed from July 1999 to February 2001. Circle points represent locations within the Salmo River mainstem (spawning area).

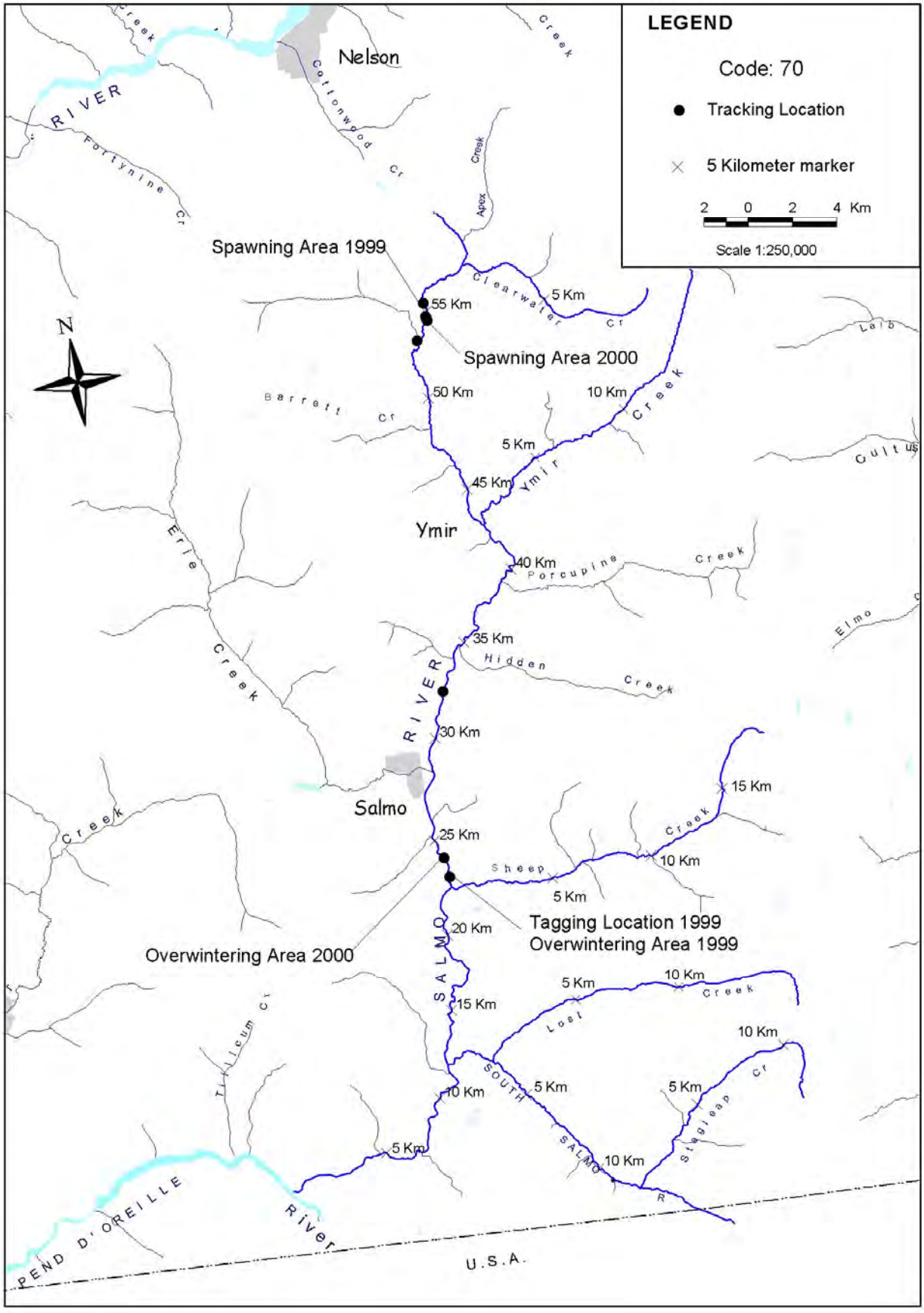


Figure 22. Tracking locations of a 67 cm male bull trout (Code 70) within the Salmo River watershed from July 1999 to February 2001.

3.3.2.2 Individual Patterns

A summary of the locations of individual fish is found in Appendix I, and includes UTM co-ordinates and km locations of fish by date.

3.3.2.2.1 Code 9

Code 9, a 40 cm male, was tagged in the Salmo River at km 7.30 on June 27 2000. It remained in this area for the summer of 2000 (i.e., did not spawn in the fall of 2000), and then made a short downstream migration in the mainstem river to km 5.70 to overwinter for winter of 2000/2001 (Figures 23 and 24).

3.3.2.2.2 Code 76

Code 76, a 65 cm female, was tagged in the Salmo River at km 39.90 on July 18 2000. The fish then began an immediate upstream migration in the mainstem Salmo River after it was tagged to its spawning location in the upper Salmo River at km 57.00 (Figures 25 and 26). The fish spawned in this area from mid- to late-September, after which time it made a rapid downstream migration to its overwintering location (Figures 25 and 26).

3.3.2.2.3 Code 77

Code 77, a 56.5 cm female, was tagged in the Salmo River at km 24.40 on July 18 2000. After it was tagged the fish began an immediate upstream migration to Clearwater Creek. (Figures 27 and 28). The fish then spawned in Clearwater Creek in late-September, after which time it made a rapid downstream migration to its overwintering location in the lower Salmo River (Figures 27 and 28).

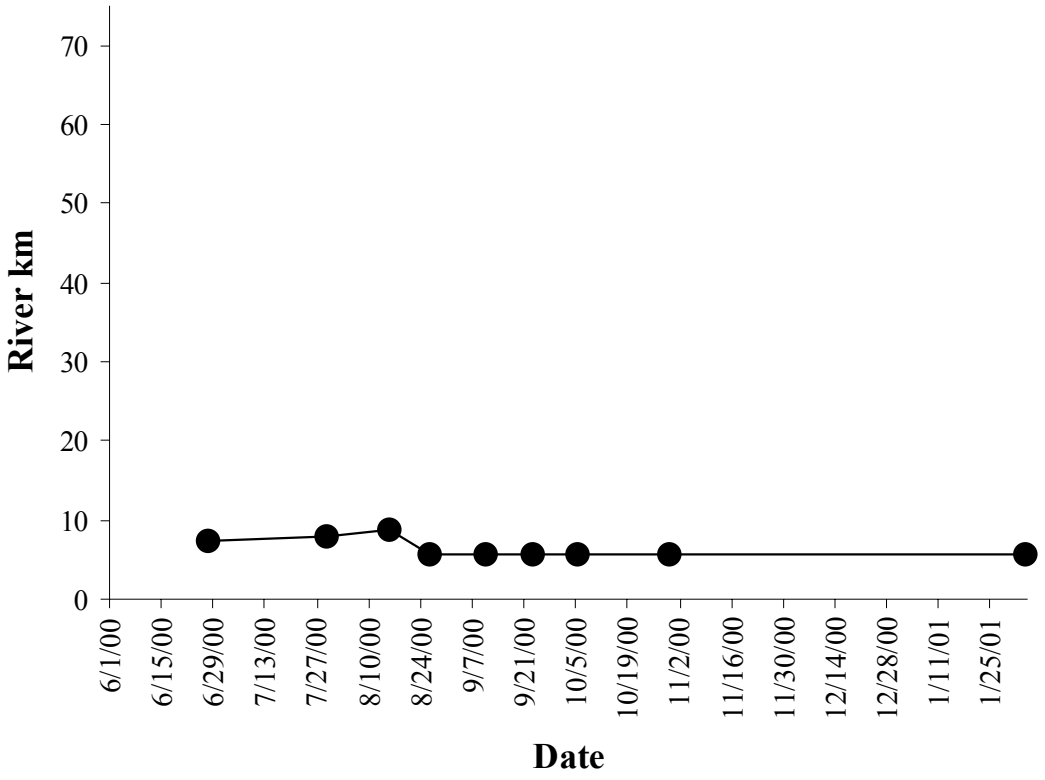


Figure 23. Migratory pattern of a 40 cm male bull trout (Code 9) in the Salmo River watershed from June 2000 to February 2001. Circle points represent locations within the Salmo River mainstem.

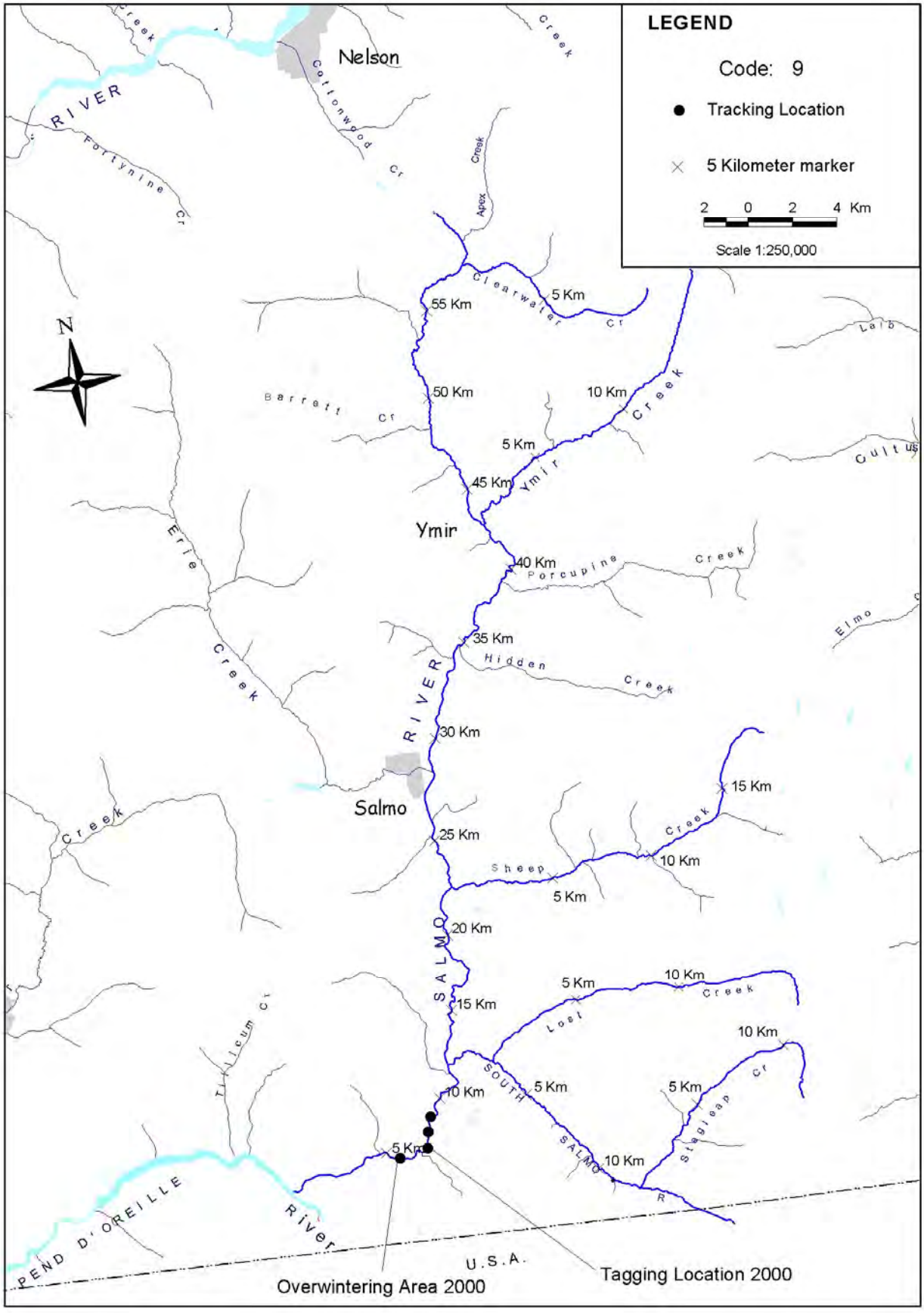


Figure 24. Tracking locations of a 40 cm male bull trout (Code 9) within the Salmo River watershed from June 2000 to February 2001.

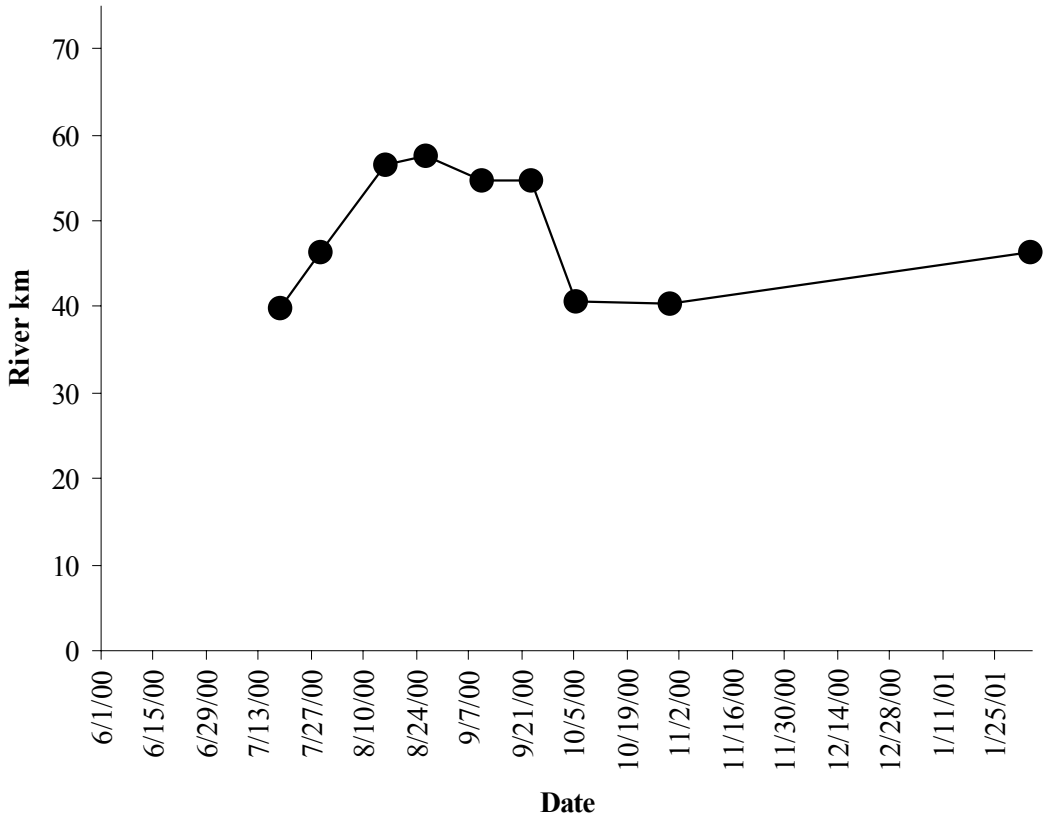


Figure 25. Migratory pattern of a 65 cm female bull trout (Code 76) in the Salmo River watershed from July 2000 to February 2001. Circle points represent locations within the Salmo River mainstem.

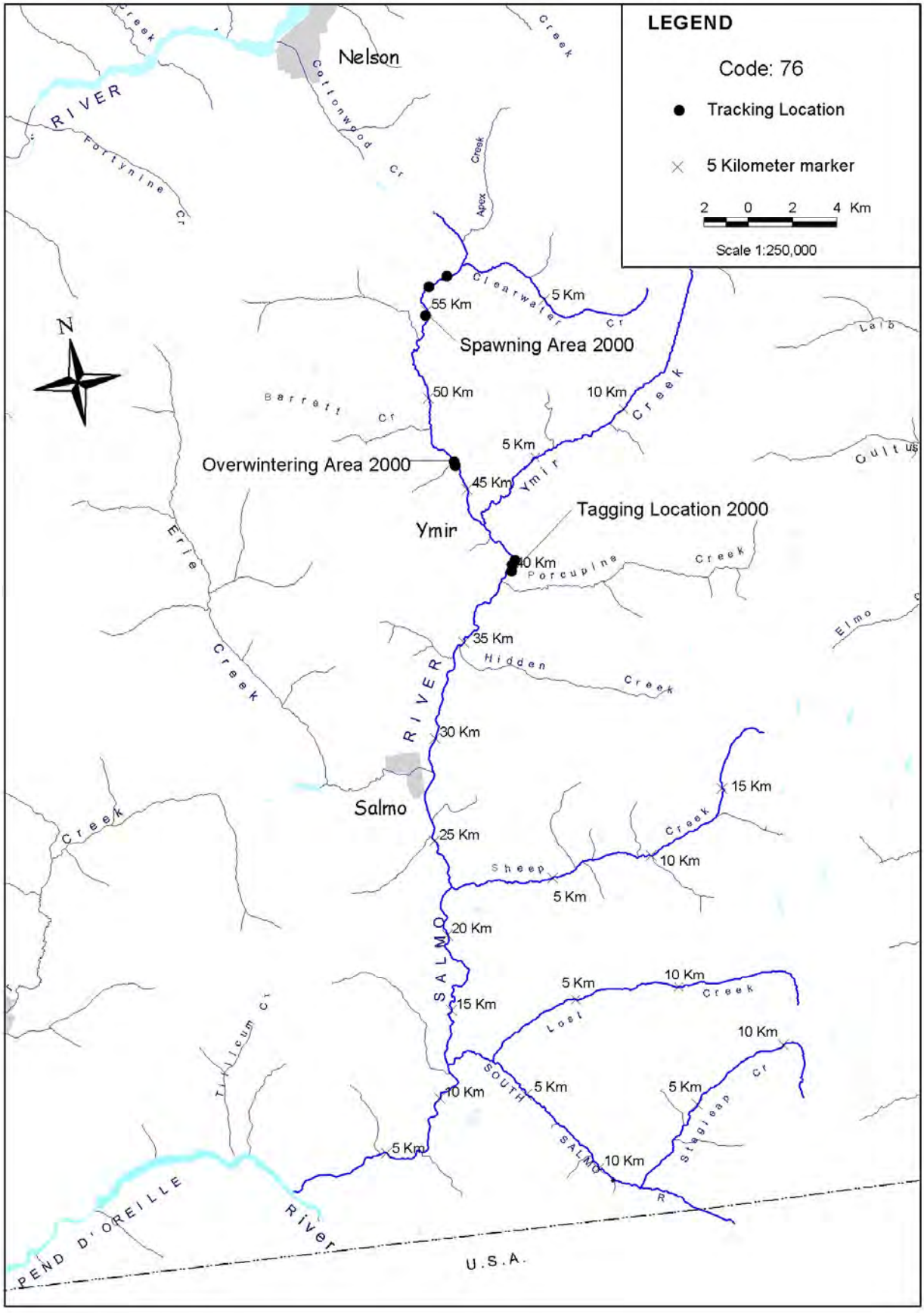


Figure 26. Tracking locations of a 65 cm female bull trout (Code 76) within the Salmo River watershed from July 2000 to February 2001.

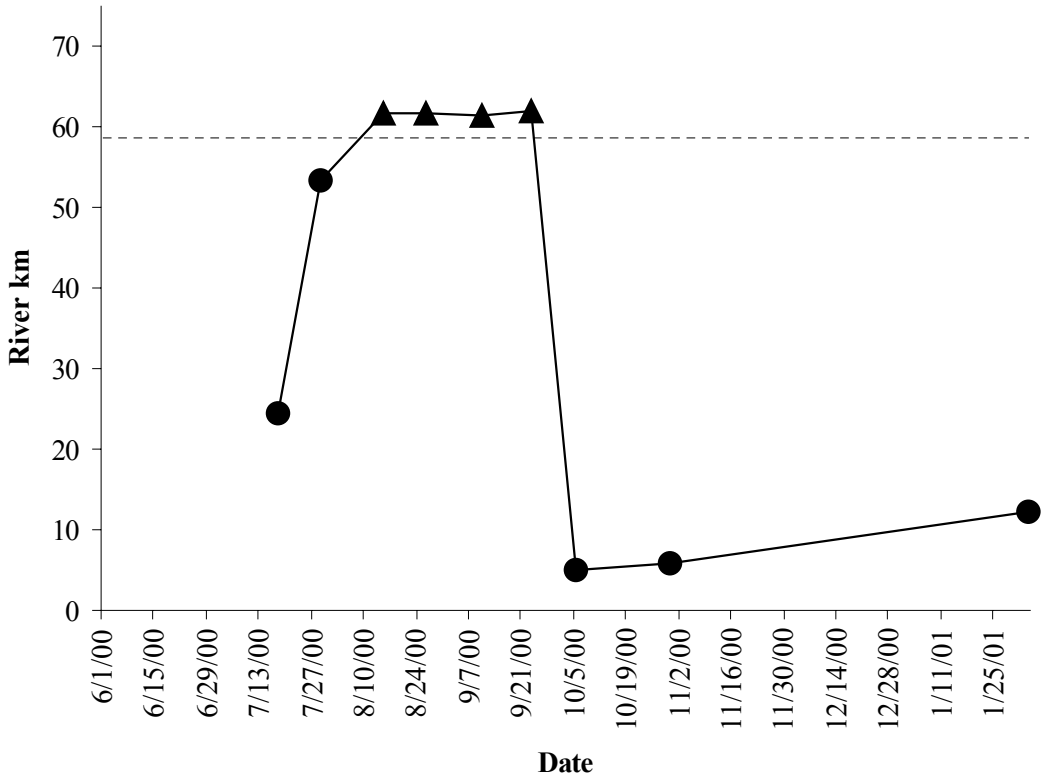


Figure 27. Migratory pattern of a 56.5 cm female bull trout (Code 77) in the Salmo River watershed from July 2000 to February 2001. Triangle points above the dotted gridline represent movement within Clearwater Creek (spawning location), and circle points represent locations within the Salmo River mainstem.

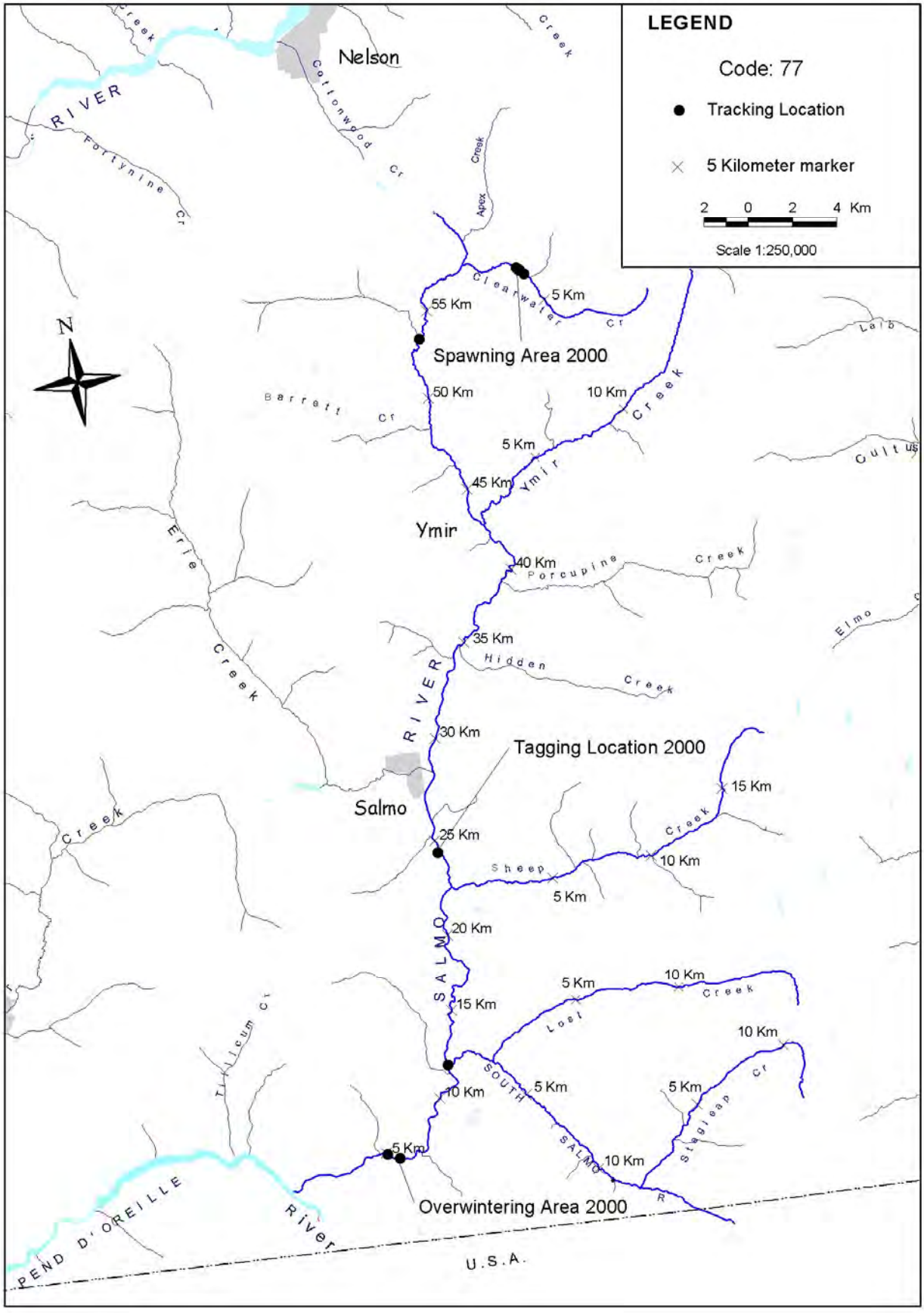


Figure 28. Tracking locations of a 56.5 cm female bull trout (Code 77) within the Salmo River watershed from July 2000 to February 2001.

3.3.2.2.4 Code 78

Code 78, a 57.5 cm female was tagged at the South Salmo River fence at 0.85 km on September 21 2000 during its post-spawning migration. The fish then made a migration into the mainstem of the Salmo River and moved upstream to its overwintering location at km 25.25 (Figures 29 and 30).

3.3.2.2.5 Code 79

Code 79, a 65.5 cm male, was tagged at the South Salmo River fence at 0.85 km on October 11 2000 after spawning in the system. Once tagged the fish moved into the mainstem Salmo River where it overwintered at km 16.85 (Figures 31 and 32).

3.3.2.2.6 Code 80

Code 80, a 51 cm female, was tagged in the Salmo River at km 11.80 on June 28 2000 After holding for a period of 2 weeks the fish moved into the South Salmo River where it spawned in early September 2000. The fish then migrated downstream to the mouth of the Salmo River where it overwintered (Figures 33 and 34). This fish was tracked moving downstream past the fixed station on September 14 in the evening.

3.3.2.2.7 Code 82

Code 82, a 59.5 cm male, was tagged at the South Salmo River fence at 0.85 km on October 10 2000 during its post-spawning migration. Once tagged the fish moved downstream into the mainstem Salmo River where it overwintered at km 16.85 (Figures 35 and 36).

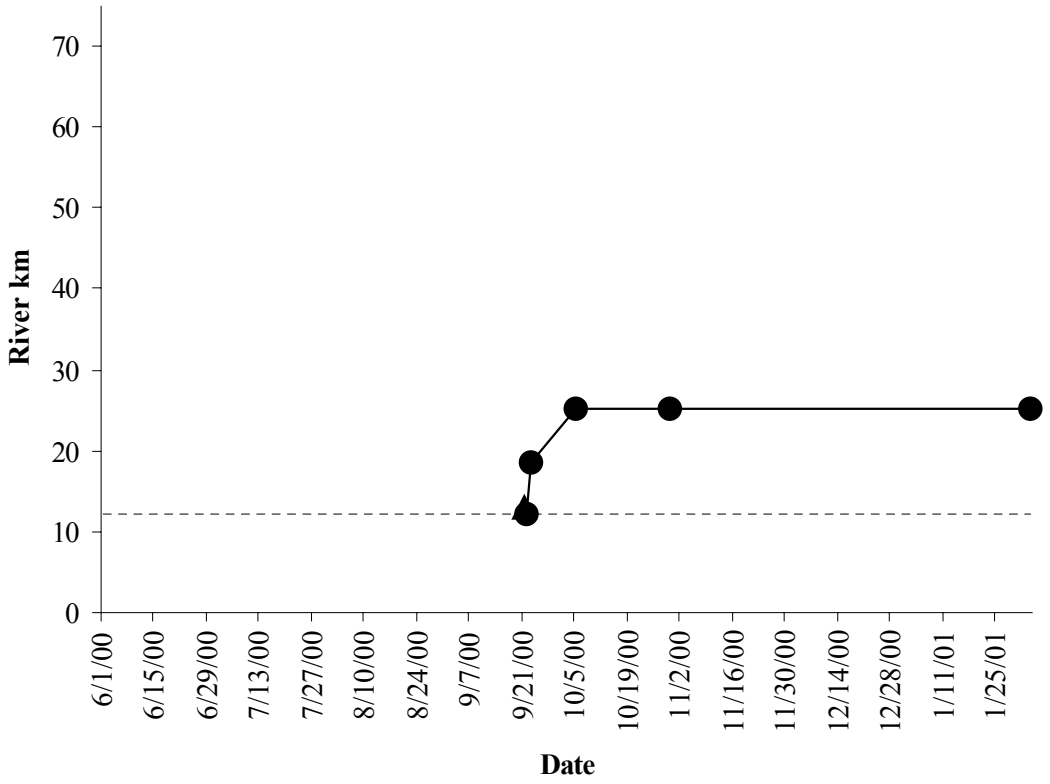


Figure 29. Migratory pattern of a 57.5 cm female bull trout (Code 78) in the Salmo River watershed from September 2000 to February 2001. Triangle points above the dotted gridline represent movement within the South Salmo River (spawning location), and circle points represent locations within the Salmo River mainstem.

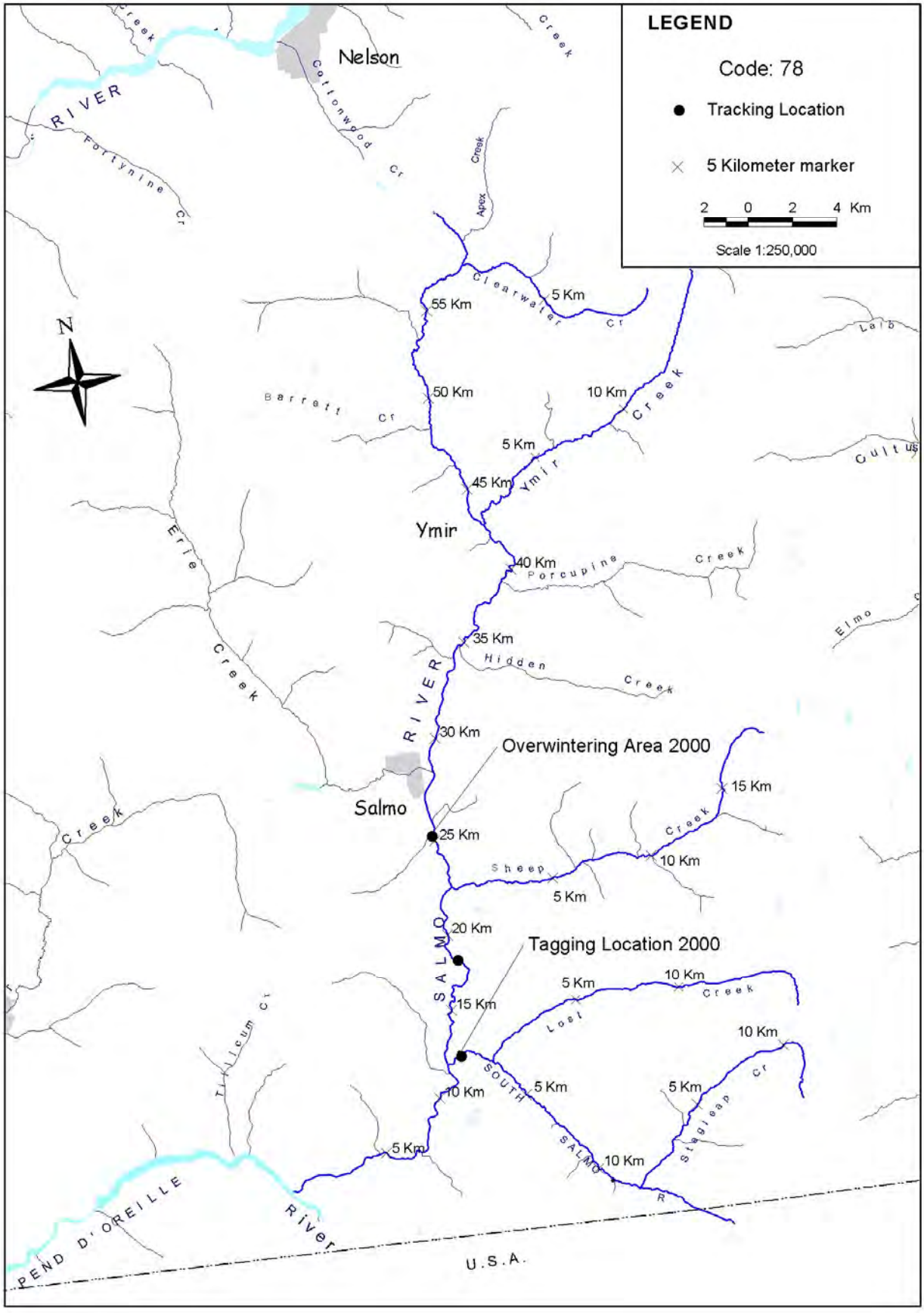


Figure 30. Tracking locations of a 57.5 cm female bull trout (Code 78) within the Salmo River watershed from September 2000 to February 2001.

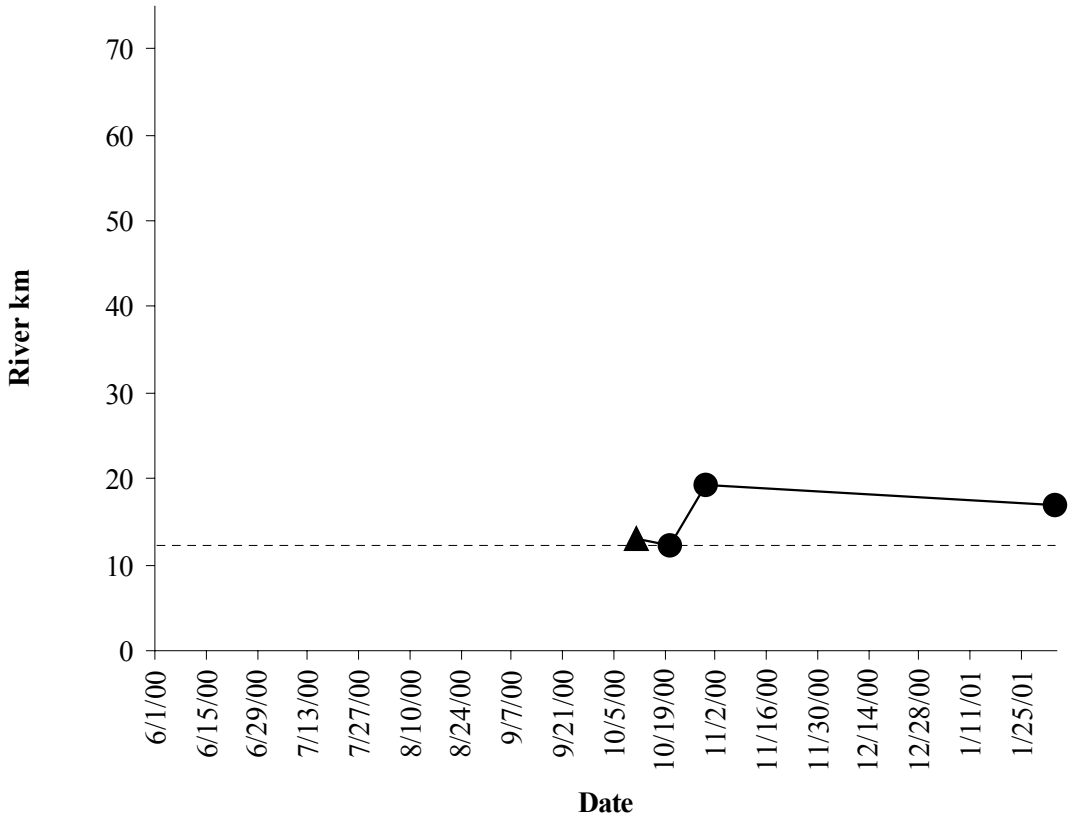


Figure 31. Migratory pattern of a 65.5 cm male bull trout (Code 79) in the Salmo River watershed from October 2000 to February 2001. Triangle points above the dotted gridline represent movement within the South Salmo River watershed (spawning location), and circle points represent locations within the Salmo River mainstem.

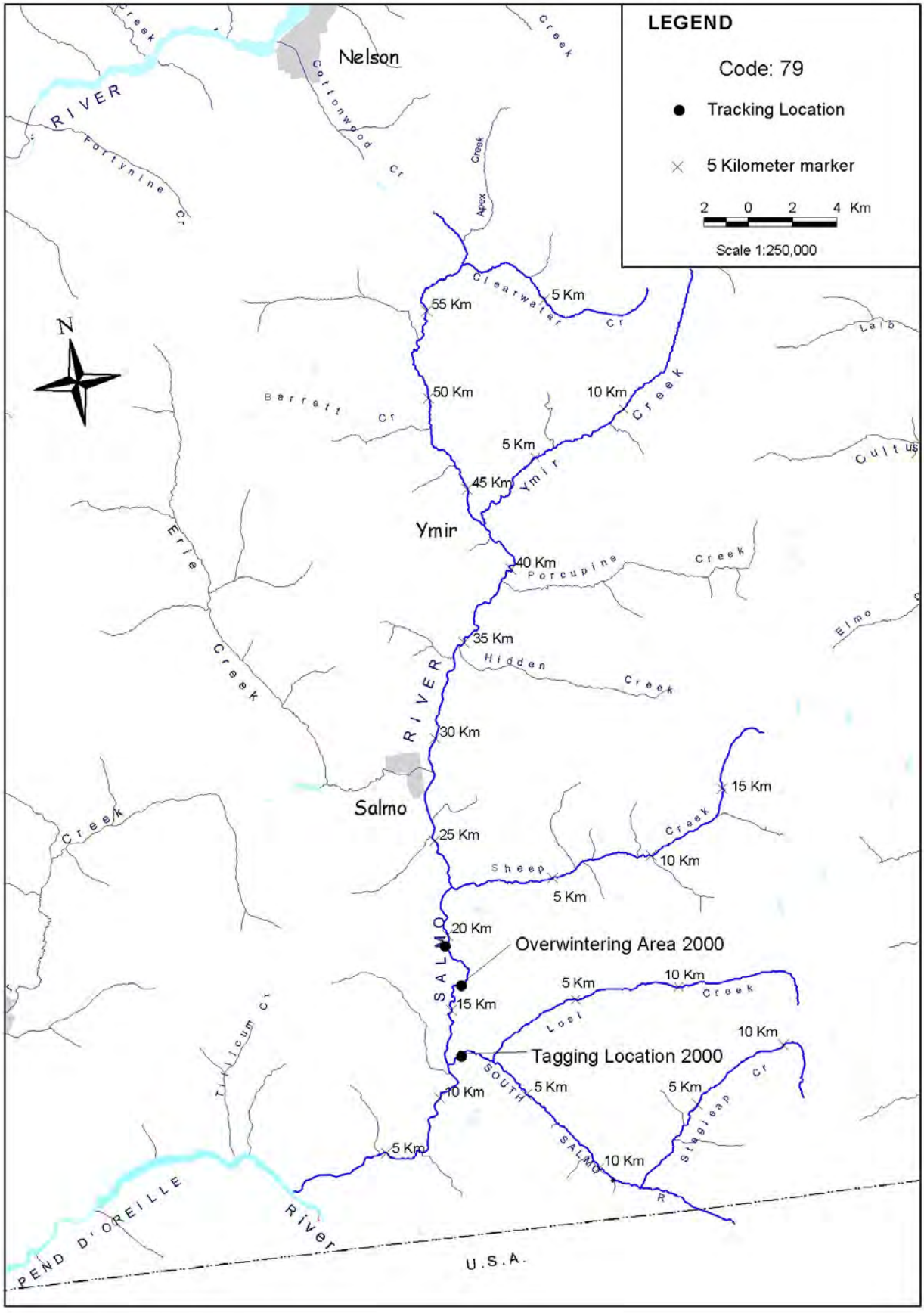


Figure 32. Tracking locations of a 65.5 cm male bull trout (Code 79) within the Salmo River watershed from October 2000 to February 2001.

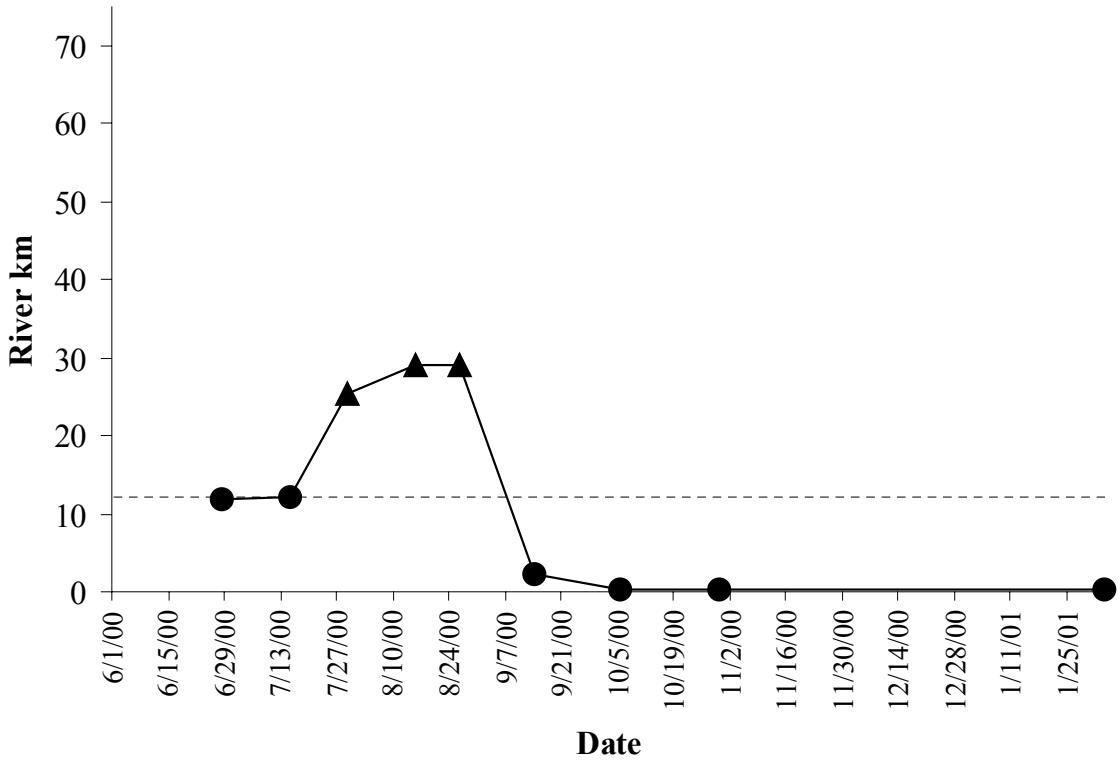


Figure 33. Migratory pattern of a 51 cm female bull trout (Code 80) in the Salmo River watershed from June 2000 to February 2001. Triangle points above the dotted gridline represent movement within the South Salmo River watershed (spawning location), and circle points represent locations within the Salmo River mainstem.

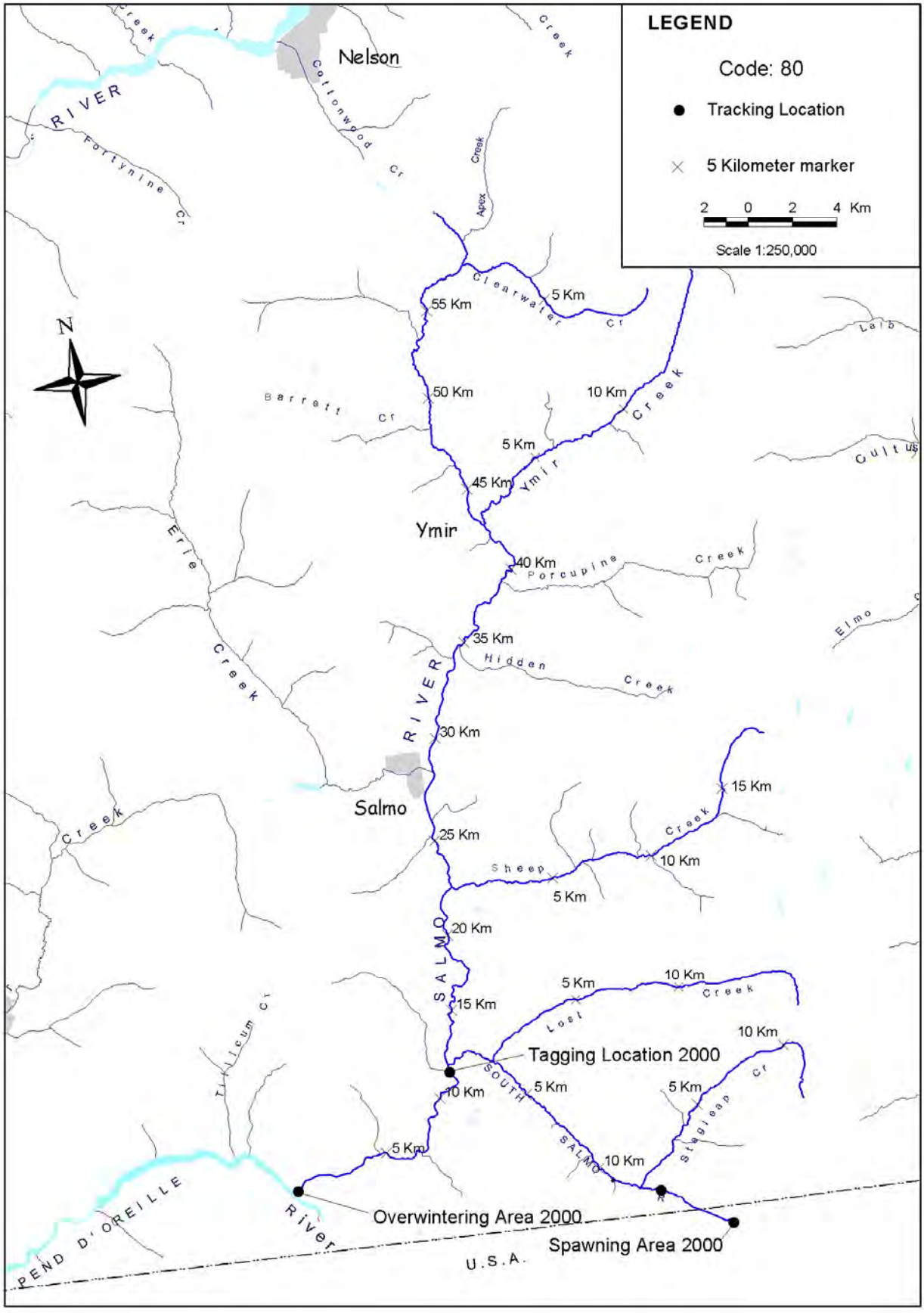


Figure 34. Tracking locations of a 51 cm female bull trout (Code 80) within the Salmo River watershed from June 2000 to February 2001.

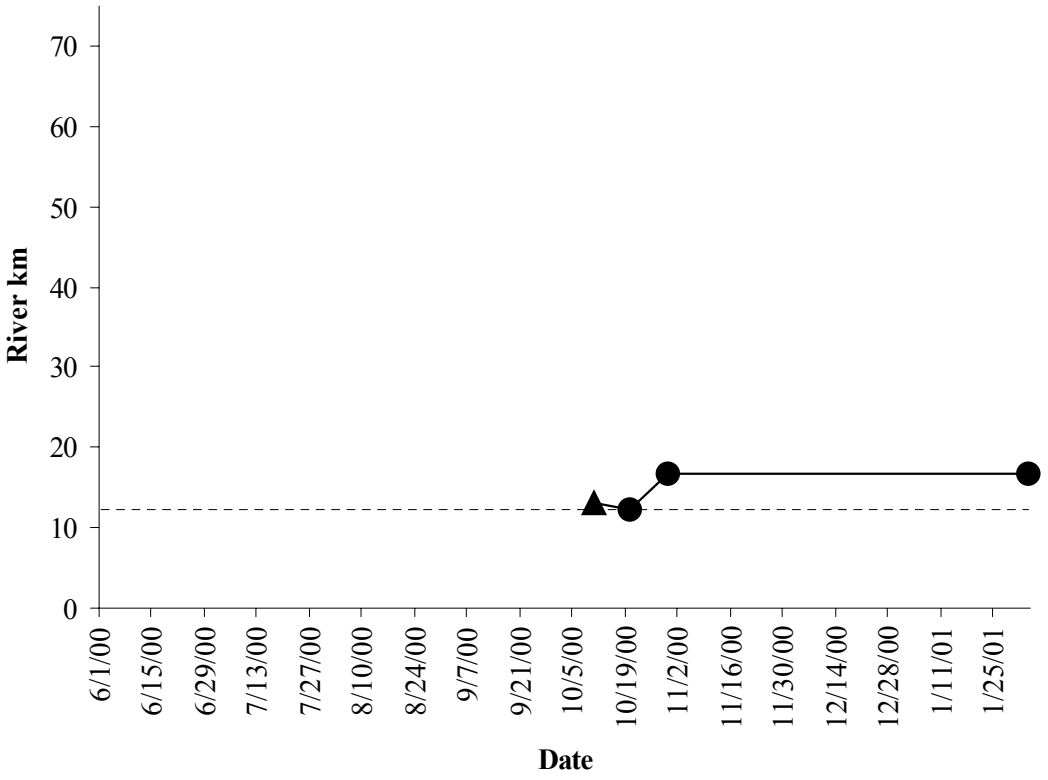


Figure 35. Migratory pattern of a 59.5 cm male bull trout (Code 82) in the Salmo River watershed from October 2000 to February 2001. Triangle points above the dotted gridline represent movement within the South Salmo River (spawning location), and circle points represent locations within the Salmo River mainstem.

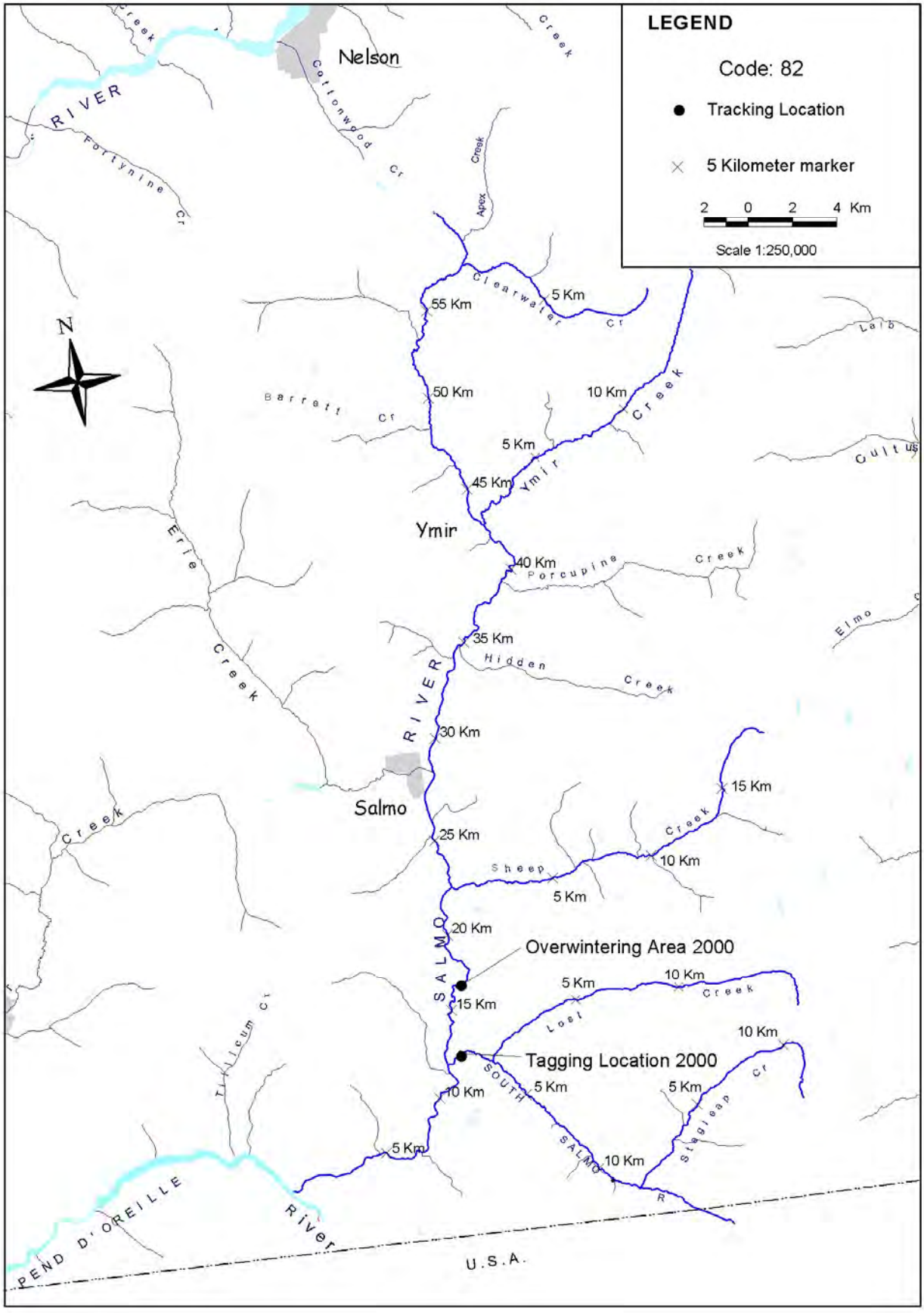


Figure 36. Tracking locations of a 59.5 cm male bull trout (Code 82) within the Salmo River watershed from October 2000 to February 2001.

3.3.2.2.8 Code 83

Code 83, a 63 cm female, was tagged at the South Salmo River fence at 0.85 km on September 9 2000 as it moved downstream after spawning. After it was tagged, the fish moved into the mainstem Salmo River where it overwintered at km 11.80 (Figures 37 and 38).

3.3.2.2.9 Code 84

Code 84, a 45 cm female was tagged in the Salmo River at km 32.25 on July 16 2000. This fish stayed in the same location from July 2000 to February 2001 (Figures 39 and 40), but has been confirmed alive during snorkel surveys.

3.3.2.2.10 Code 85

Code 85, a 59.5 cm male, was tagged at the South Salmo River fence at 0.85 km on October 17 2000. This fish spawned in the system prior to being tagged. Once tagged the fish moved into the mainstem Salmo River where it overwintered at km 9.35 (Figures 41 and 42).

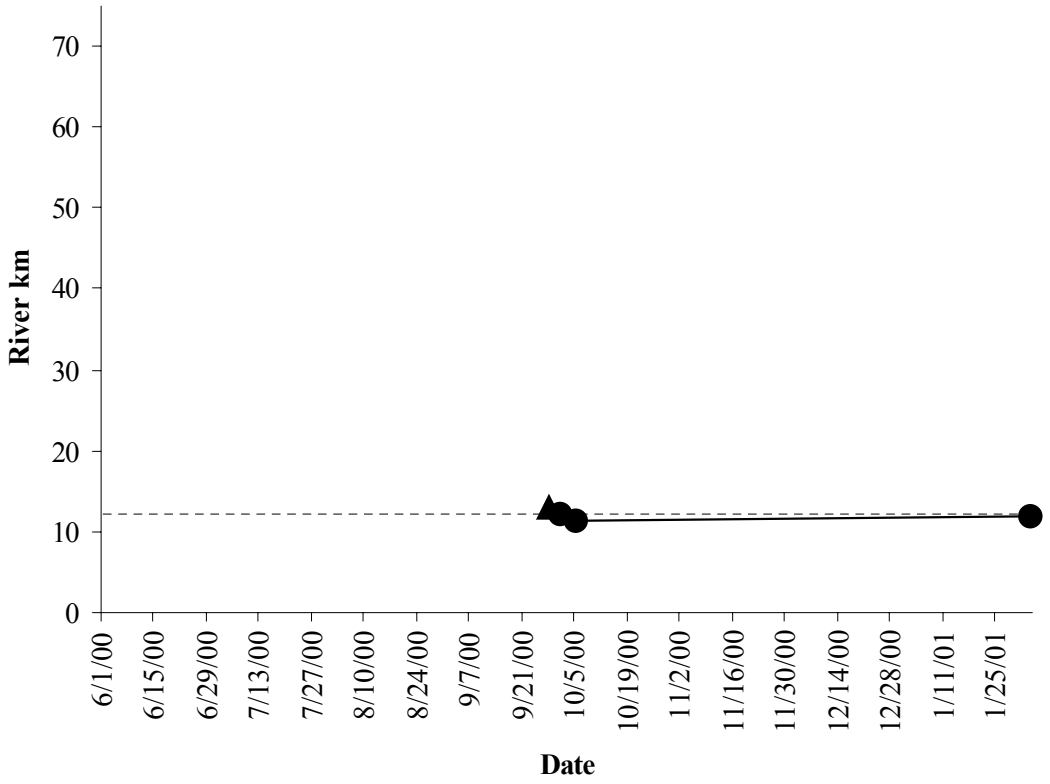


Figure 37. Migratory pattern of a 63 cm female bull trout (Code 83) in the Salmo River watershed from September 2000 to February 2001. Triangle points above the dotted gridline represent movement within the South Salmo River watershed (spawning location), and circle points represent locations within the Salmo River mainstem.

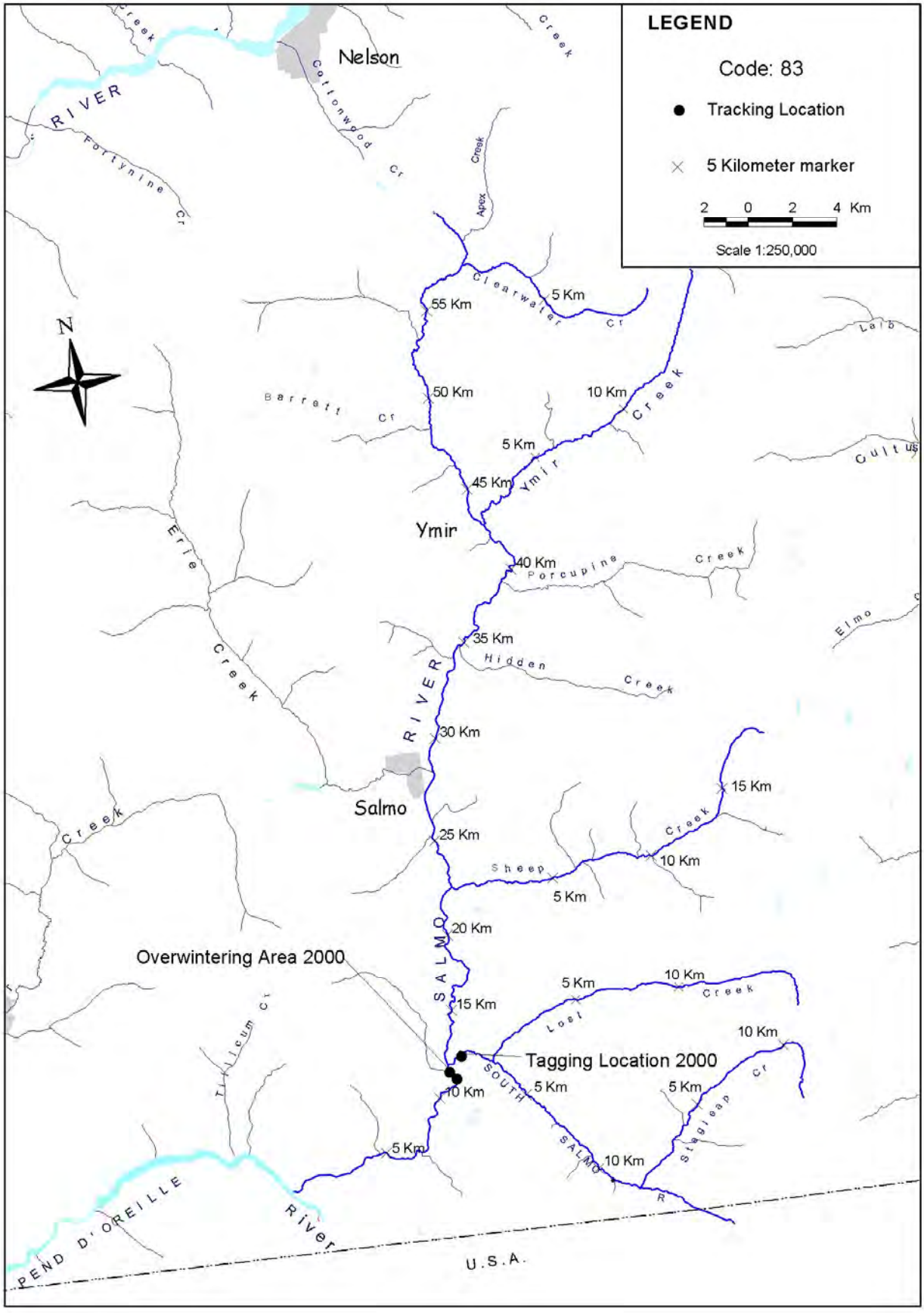


Figure 38. Tracking locations of a 63 cm female bull trout (Code 83) within the Salmo River watershed from September 2000 to February 2001.

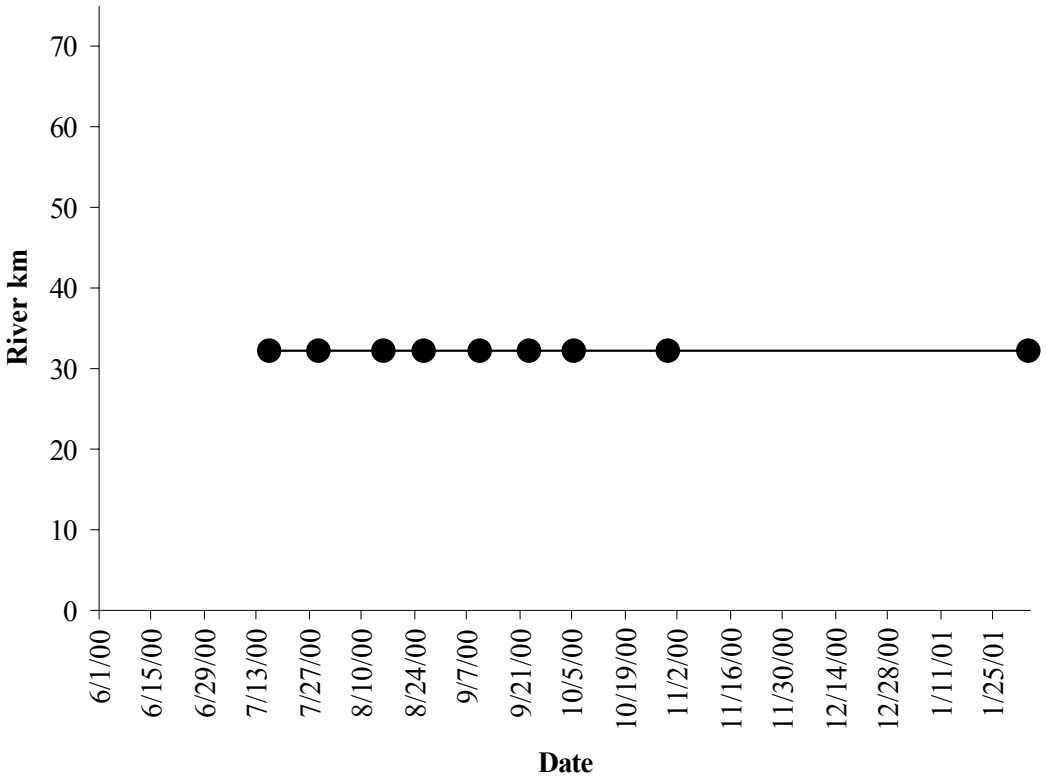


Figure 39. Migratory pattern of a 45 cm female bull trout (Code 84) in the Salmo River watershed from July 2000 to February 2001. Circle points represent locations within the Salmo River mainstem.

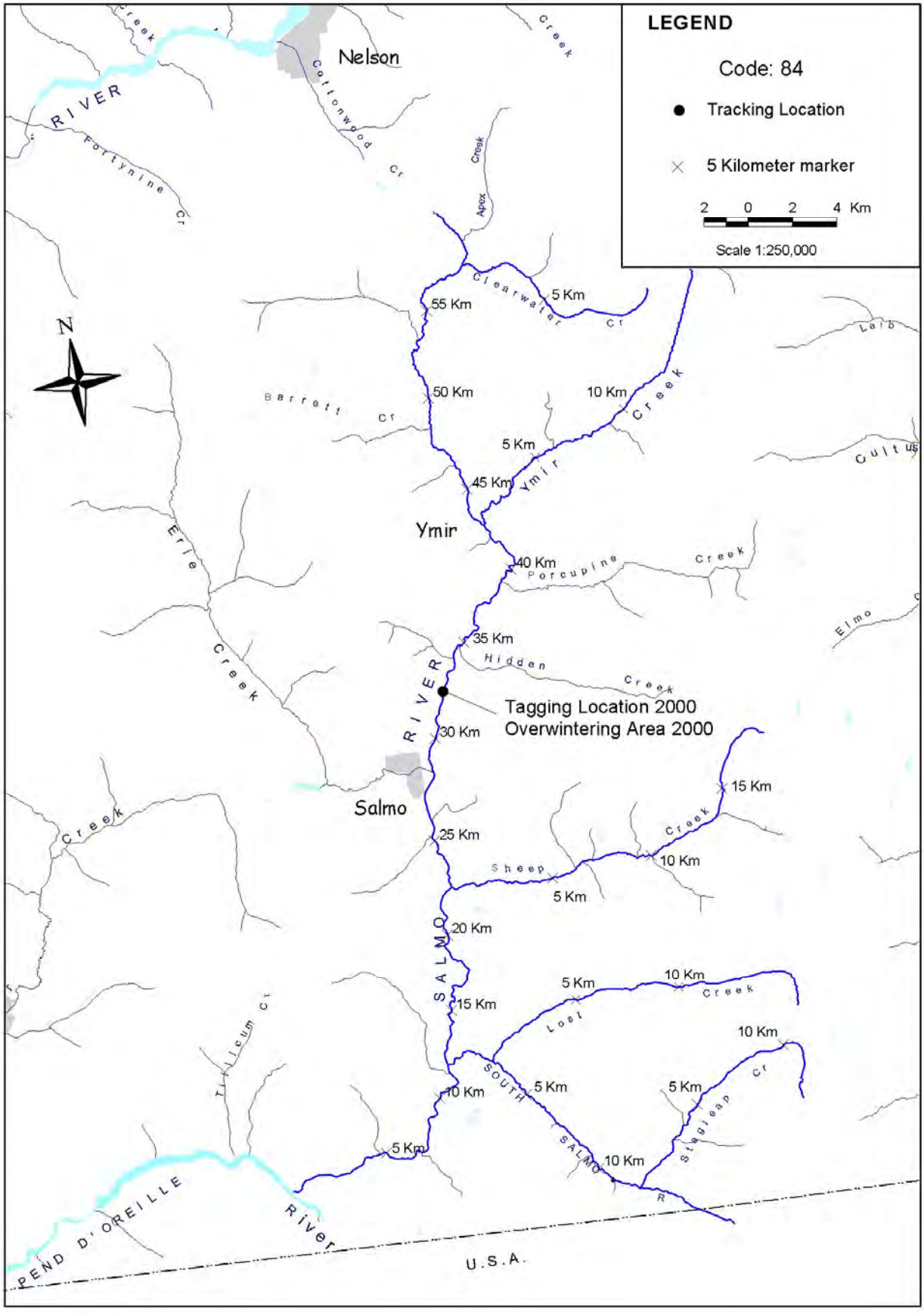


Figure 40. Tracking locations of a 45 cm female bull trout (Code 84) within the Salmo River watershed from July 2000 to February 2001.

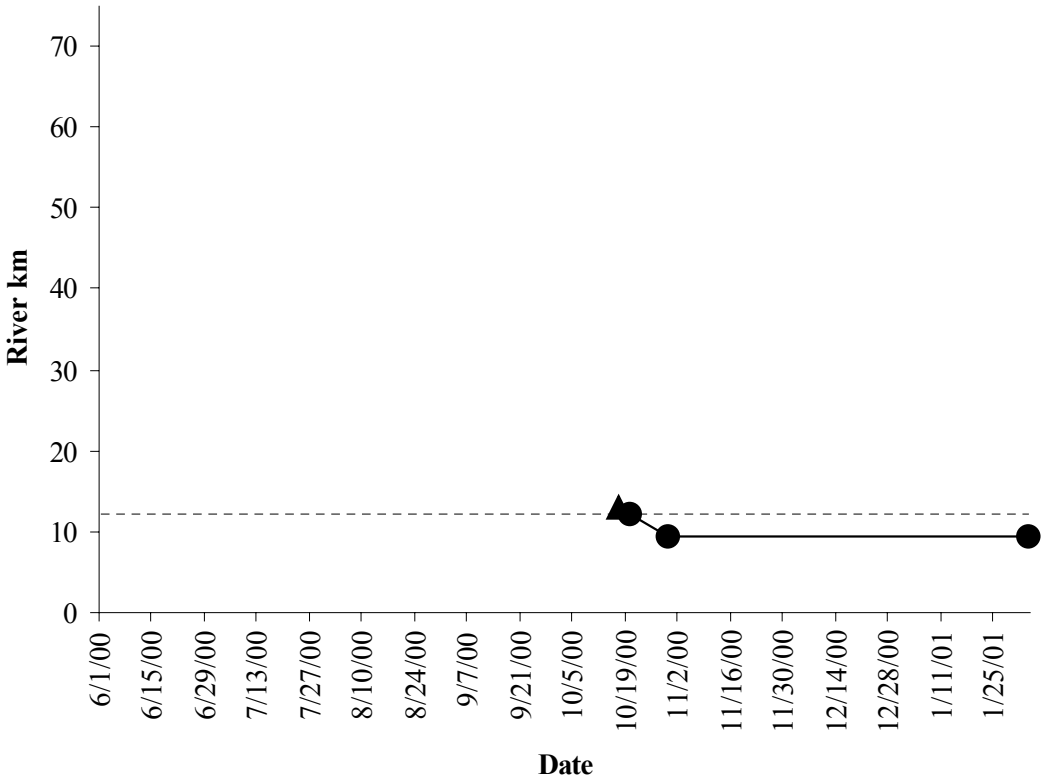


Figure 41. Migratory pattern of a 59.5 cm male bull trout (Code 85) in the Salmo River watershed from October 2000 to February 2001. Triangle points above the dotted gridline represent movement within the South Salmo River watershed (spawning location), and circle points represent locations within the Salmo River mainstem.

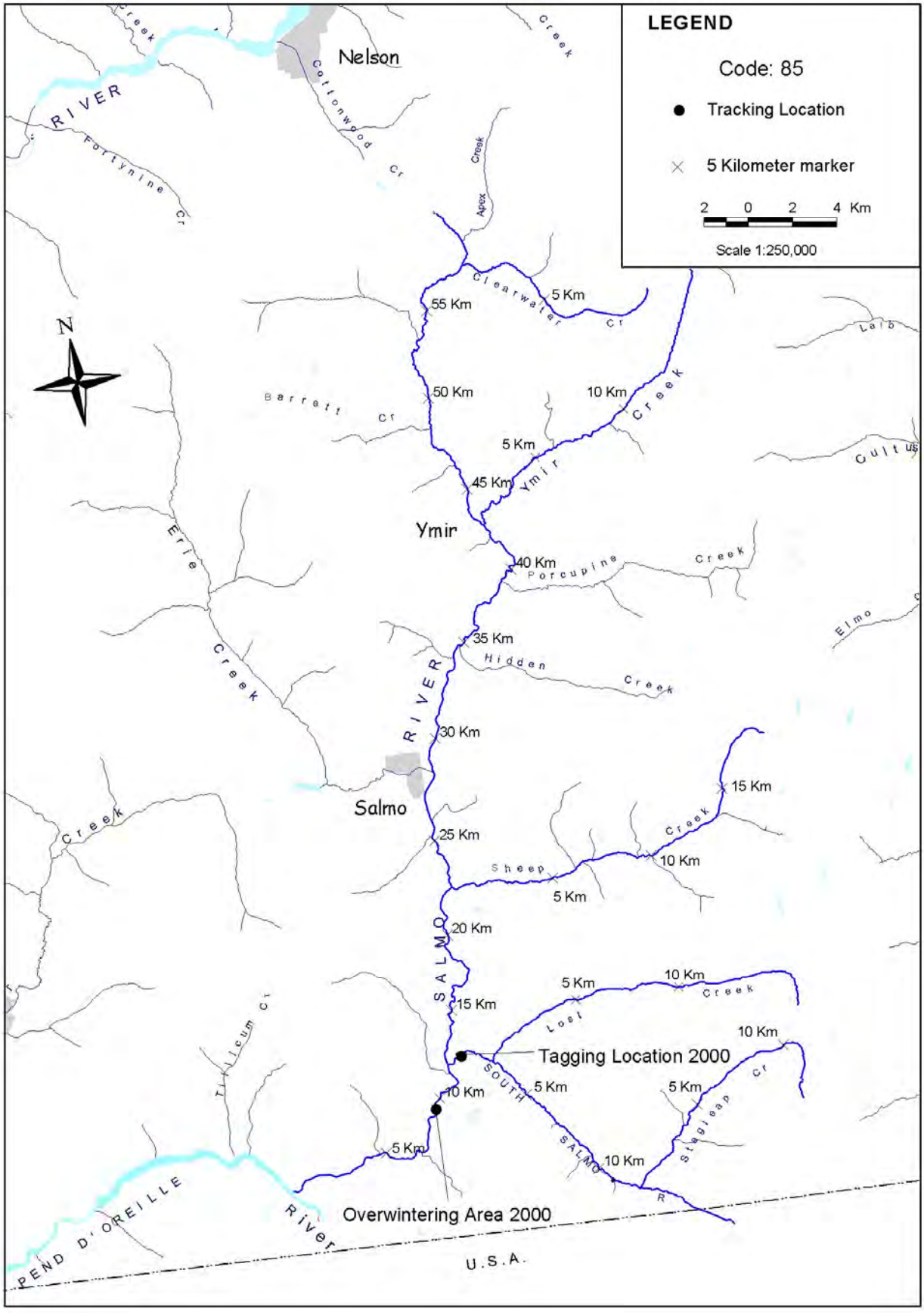


Figure 42. Tracking locations of a 59.5 cm male bull trout (Code 85) within the Salmo River watershed from October 2000 to February 2001.

3.3.3 Movement of Fish in Relation to Discharge

Snowpack levels were significantly lower in the winter of 1999/2000 than the previous winter, and as such, peak runoff occurred earlier in the spring of 2000 (Figure 43). Based on this discharge pattern, one could assume that bull trout would begin their spawning migrations earlier in the summer of 2000 if water levels around peak discharge are a cue to upstream spawning migrations of bull trout. I considered that movements less than 2 km between tracking events were not indicative of true spawning migration events (Swanberg 1997), and were within the limits of movement that may be explained by home range behaviour. Figure 44 shows the first and last date when bull trout had begun making a spawning migration in relation to river discharge. Spawning migrations began as early as the end of June and were mostly complete by mid-August.

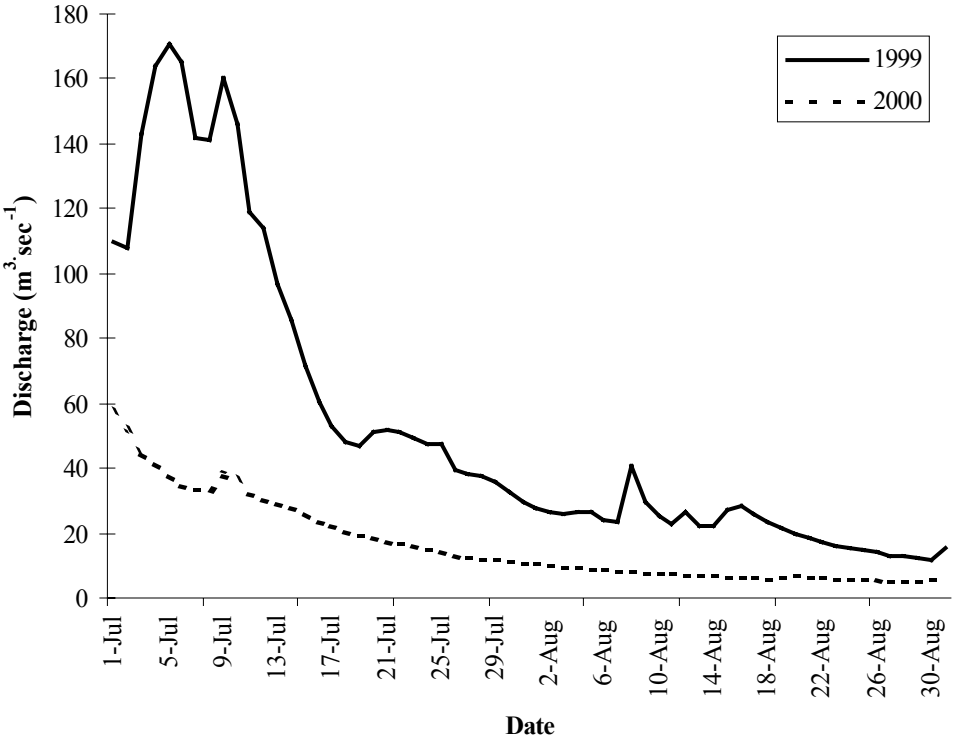


Figure 43. Water discharge in the Salmo River during July and August of 1999 and 2000.

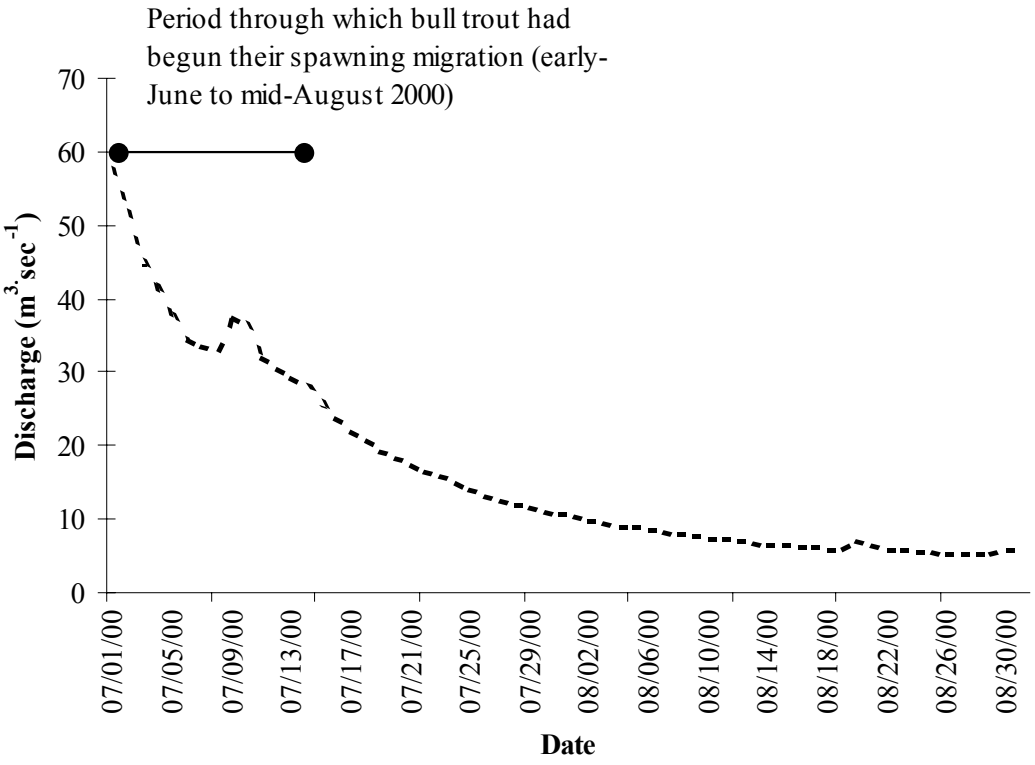


Figure 44. The relationship of the timing that bull trout had begun spawning migrations of distances 2 km or greater with regard to changes in water discharge in the Salmo River during July and August 2000.

3.3.4 Overwintering Habitat Locations

3.3.4.1 Fish Tagged in 1999

Of the eight bull trout that repeat spawned in 2000, all made post- spawning migrations to overwintering areas. This suggested that spawning mortality for these fish was 0%. The other two bull trout that did not make spawning migrations were also observed alive in the summer of 2000, and assumed not be dead at the end of the fall of 2000. As a result, a second year of overwintering data was available for all fish tagged in 1999. Locations of fish during the overwintering period in the winter of 2000/2001 are

summarized in Appendix I and Figures 3 to 22. The tracking identified that there were a number of locations that were utilized (Table 4). In some cases, an area was used by individual bull trout in both winters. The locations were distributed in the mainstem Salmo River between 12 km and 36 km, which extends the overwintering range from the previous year. In several cases fish moved to within 1 km of the area that they were originally tagged. Overwintering habitat was generally in deep pools where the depth, velocity, and cover in the form of large woody debris (LWD) conditions were suitable for holding during the winter period.

Table 4. 1999 and 2000 overwintering locations of bull trout radio tagged in 1999.

Code	Tagging Location (km)	1999 Overwintering Location (km)	2000 Overwintering Location (km)
51	Salmo R (18.45)	Salmo R (18.45)	Salmo R (19.35)
54	Salmo R (17.25)	Salmo R (17.75)	Salmo R (36.35)
56	Salmo R (23.05)	Salmo R (21.05)	Salmo R (21.05)
58	Salmo R (25.25)	Salmo R (24.00)	Salmo R (25.25)
60	Salmo R (21.05)	Salmo R (13.15)	Salmo R (16.85)
61	Salmo R (25.25)	Salmo R (20.00)	Salmo R (24.00)
65	Clearwater Ck (3.80)	Salmo R (36.35)	Salmo R (36.35)
67	Salmo R (17.85)	Salmo R (16.85)	Salmo R (12.15)
68	Salmo R (18.45)	Salmo R (18.45)	Salmo R (18.45)
70	Salmo R (23.05)	Salmo R (23.05)	Salmo R (24.00)

3.3.4.2 Fish Tagged in 2000

Of the ten bull trout radio tagged in 2000, all made post-spawning migrations to overwintering areas in the mainstem Salmo River. This suggested that spawning mortality for these fish was 0%. Locations of fish during the overwintering period in the winter of 2000/2001 are summarized in Appendix I and Figures 23 to 42. The tracking identified that there were a number of locations that were utilized (Table 5), and extended the mainstem overwintering range between 0 and 47 km of the Salmo River. Again overwintering habitat was found in association with deep pools and LWD.

Although one radio tagged bull trout was confirmed to have migrated to the mouth of the Salmo River through the use of the fixed telemetry station, on each occasion the fish was tracked it was found in association with the influence of the Salmo River (i.e., not present

in the reservoir proper). As such, it appears that the reservoir is not used as overwintering habitat by adult bull trout.

Table 5. 2000 overwintering locations of bull trout radio tagged in 2000.

Code	Tagging Location (km)	2000 Overwintering Location (km)	Habitat
9	Salmo R (7.30)	Salmo R (5.70)	Deep Pool
76	Salmo R (39.90)	Salmo R (46.45)	Deep Pool
77	Salmo R (24.40)	Salmo R (5.70)	Deep Pool
78	South Salmo R (0.85)	Salmo R (25.25)	Deep Pool
79	South Salmo R (0.85)	Salmo R (16.85)	Deep Pool/LWD
80	Salmo R (11.80)	Salmo R (0.20)	Deep Pool
82	South Salmo R (0.85)	Salmo R (16.85)	Deep Pool/LWD
83	South Salmo R (0.85)	Salmo R (11.80)	Deep Pool
84	Salmo R (32.25)	Salmo R (32.25)	Deep Pool
85	South Salmo R (0.85)	Salmo R (9.35)	Deep Pool

3.4 Summary of Results

1. A total of ten bull trout were implanted with radio tags in the Salmo River watershed in 1999 (nine in the mainstem Salmo River and one in Clearwater Creek), and an additional ten bull trout were tagged in 2000 (five in the mainstem and five in the South Salmo River).

2. The average fork length of tagged fish was 57.0 cm in 1999 and 56.0 cm in 2000.

3. Catch per unit effort averaged 0.44 and 0.53 bull trout per angler day in 1999 and 2000, respectively. Post-surgery mortality was estimated at 0% in both years as all bull trout underwent extensive upstream migrations to spawning areas, were observed alive during snorkel surveys, or underwent post-spawning migrations after tagging.

4. In 1999 bull trout began migrations to their spawning areas from July 15 to August 10 during a period of reduced decline in Salmo River discharge. In 2000 migrations began likely as early as mid-June due to lower river levels, and fish were tracked in tributaries in the first week of July.

5. Bull trout were tracked to a total of five spawning locations in 1999 (the upper Salmo River, Clearwater Creek, Sheep Creek, the South Salmo River, and Stagleap Creek (tributary to the South Salmo River)), with one fish spawning in the United States of America (South Salmo River). During tracking four of the ten tagged fish entered the South Salmo watershed, with two fish utilizing the South Salmo River in the United States of America.

6. No new spawning locations were identified in 2000, but eight of the ten bull trout tagged in 1999 repeat spawned in 2000. Seven of the eight repeat spawners (87.5%) also spawned in the same general area as the previous year, indicating a high degree of spawning fidelity between years.

7. There was significantly more use of tributary habitat than mainstem habitat by radio tagged bull trout for spawning in both 1999 and 2000.

8. Post-spawning migrations to overwintering habitat had generally occurred by the end of November, and it appeared that post-spawning mortality was 0% as all fish had moved significant distances downstream to overwintering areas in both years.

9. After two years of telemetry data on overwintering habitat, the entire mainstem of the Salmo River can be classified as potential bull trout overwintering areas where there is suitable cover in the form of deep pool in association with large woody debris or boulder.

10. Over the two years of study, only one of the radio tagged bull trout migrated past the fixed telemetry station at the mouth of the Salmo River. However, on every occasion

of tracking (both aerial and ground) the fish was found in the influence of the Salmo River. As such, it is unclear if Seven Mile Reservoir is utilized by bull trout for the adult stage of their life-history, but the data suggests the population is likely fluvial.

4.0 DISCUSSION

For small populations of any animal, anthropogenic agents that limit or cause negative population growth are a primary concern for the long term persistence of these populations. Over harvest and habitat destruction are two of these agents that can have such impacts on salmonid populations, and addressing these two issues in site-specific situations is the primary way that population declines can be stopped. Along these lines this discussion will focus on the life-history, habitat use and population status of the Salmo River bull trout population, as it is recommended that studying the natural history of a population is the first step in identifying the agents of population decline (Caughley 1994). Where appropriate, comments on the management of habitat or the population will be offered.

4.1 Life-History and Habitat Use

The second year of the bull trout radio telemetry study in the Salmo River watershed has provided additional life-history and habitat use data that strengthens our current understanding of bull trout population dynamics in the watershed. Given that habitat destruction has been identified as one of the most important agents that can lead to salmonid population decline (McElhaney et al. 2000), this project has been critical in identifying key reproductive habitats that may be necessary for the maintenance of the population. After the two years of radio telemetry data, it is likely that all major spawning areas in the watershed have been identified. These include the upper Salmo River, Clearwater Creek, Sheep Creek, and the South Salmo River watershed. Although juvenile bull trout have been found in other tributaries (see Baxter et al. 1998), the fact that no radio tagged bull trout were tracked (or spawners observed during redd surveys in 2000) in these systems suggests that the presence of juveniles in these systems is likely due to upstream migrations and not spawning events (Baxter 2001a). This type of pattern has previously been observed in other bull trout systems (McPhail and Taylor 1995). It is also likely that if the number of bull trout spawners in the watershed increased substantially, other tributaries within the Salmo River watershed would not be used immediately for spawning as there is an abundance of suitable spawning habitat that

could be expanded into within the currently used areas. In general, there seems to be an abundance of spawning habitat that is unused, particularly in the upper Salmo River and the South Salmo River.

The work has also documented the importance of the South Salmo River watershed as a critical spawning area for the bull trout population, and that the management and protection of this habitat has transboundary implications. As a result of the cross border movements that were observed during this study, there may be additional conservation and habitat protection opportunities due to the listing of the species in the United States of America. Thus, a more detailed discussion of the importance of the South Salmo River watershed to the bull trout population is warranted.

For the most part the upper South Salmo River in inaccessible, and as such has remained relatively pristine due to limited industrial activity. This has resulted in restricted access for angling opportunities and potential poaching, and likely is related to the large number of spawners tracked to this area. Within the South Salmo River, the area upstream of the Stagleap Creek confluence was identified by the telemetry work as a key spawning area over the past two years, with a large number of fish migrating into the United States of America to spawn. In the first year of the study, 44% of the bull trout tagged in the mainstem Salmo River used the river for spawning, followed by 40% of the mainstem tagged bull trout in second year. This data is consistent between years and shows the importance of the watershed as habitat for maintaining the population. Given that redd counts were not carried out in the South Salmo watershed due limited success in the past (Baxter 1999; Baxter et al. 1998), the completion of this project, and the South Salmo River fence project (see Baxter 2001b), has been key in increasing our knowledge and management abilities for the population. As the area in the United States of America where the bull trout spawn is within the Colville National Forest, habitat protection is likely afforded. However, it is possible that British Columbia should consider making the area from the Stagleap Creek confluence to the border protected in some way, to ensure that there is a key spawning refuge that is protected. This could take the form of a park or wilderness area.

Although a number of spawning areas were identified during the study, and are widely distributed throughout the Salmo River watershed, bull trout that spawn in these different areas intermix in the mainstem Salmo River during other phases of their life-history. The results suggest that where there is suitable rearing or overwintering habitat in the form of deep pools, large woody debris and large substrate, bull trout will use these areas. It also appears that for the most part bull trout are likely repeat spawners in this population as 80% of the fish tagged in 1999, spawned again in 2000. Spawning site fidelity was also high between years (87.5%). As the general pattern among bull trout populations is multiple spawnings by individuals over their life time, the results of this study suggest that each spawner in the Salmo River population can be critical, especially when the population is at apparent low levels.

The final point of this section of the discussion that requires some consideration, and has caused some considerable debate, is whether or not the population utilizes Seven Mile Reservoir for a portion of its life-history. It should be pointed out that this study has focussed on the adult stage of the life-history, and as such the results may be only relevant to that phase. Of the twenty bull trout that were radio tagged for this study, only one made a movement into the lower Salmo River towards Seven Mile Reservoir. This fish moved past the fixed station at the constructed barrier, but on each subsequent tracking was found upstream of the bridge on the lower Salmo River where it enters Seven Mile Reservoir. At no time was the fish tracked within the reservoir proper. All other tagged bull trout remained within the mainstem Salmo River, generally above km 5.00. Based on these results, and the fact that no large adfluvial type fish have been sampled or observed in the watershed (the largest fish that I have heard caught was 7 pounds), my opinion is that the population utilizes the mainstem Salmo River for the majority of its life-history. That is not to say that there is no potential for juvenile use of the reservoir, and the potential impact of entrainment through Seven Mile Dam on this juvenile phase.

4.2 Population Status

Given that the conservation of wild fish populations is a top priority for management of fish in the province of British Columbia, the Salmo River bull trout population fits this criteria as it is a native population that is at low levels. It is also likely the only remaining major bull trout population in the lower Pend d'Orielle River system, and thus has importance to both Canada and the United States of America. In conjunction with other work, this study has provided data that is extremely relevant to the management of this population. Redd counts conducted over the past four years in the watershed suggest that the spawning population of bull trout is likely less than 200 individuals (Baxter 1999, 2001a), and it is unknown how many of these spawners are successful. Given the conservation concerns that can arise when population levels are below the 200 individual level (see Boyce 1992; Nunney and Campbell 1993), and the potential for extinction of small salmonid populations that spawn in streams with limited habitat and have chance variation in recruitment (Routledge and Irvine 1999), management of the bull trout population to maintain a minimum viable population (MVP) size is desirable.

In basic terms, populations that are of small sizes are at greater risk to decline and extinction due to random environmental events (catastrophes), demographic stochasticity and genetic inbreeding and fixation of deleterious alleles (Simberloff 1988; Nunney and Campbell 1993). In shorter time frames, demographic and environmental considerations are of more importance in ensuring the survival of small populations (Nunney and Campbell 1993), as well as anthropogenic agents that can cause negative population growth (Caughley 1994). As such I will focus on discussing these processes and the potential impact on the Salmo River bull trout population.

Within the population of bull trout (N), there are a number of bull trout that will migrate to spawning areas to reproduce and a number of individuals within this spawning population that will contribute their genes to the next generation. This component is called the effective size of the population (Ne). Some authors have suggested that an effective population size of 50 or 500 would be considered as 'critical' or 'endangered' respectively (Mace and Lande 1991), and that populations within these thresholds may be

subject to genetic constraints. As a general rule the MVP size should be five to ten times Ne (see Nunney and Campbell 1993), or 250 to 500 individuals as a minimum. Assuming that the spawning component of the Salmo River bull trout population is near 200 individuals (and this is likely a conservatively high estimate), this would place the population within the limits of a conservation concern and there are a number of potential impacts that could directly affect this population.

The direct harvest of individuals within the population that could contribute to the spawning component is an anthropogenic agent that causes negative population growth on a yearly basis. Initial studies in 1997 (Baxter et al. 1998) suggested that the population size of bull trout was low, and as a result the Ministry of Water, Land and Air Protection (MWALP) initiated a catch and release fishery in 1999 (prior to 1999 the allowed harvest of bull trout was two per day over 30 cm). Assuming that habitat destruction was not a factor causing negative population growth, the implementation of these regulations should have resulted in a direct increase in the number of bull trout were making it to spawning grounds to reproduce. Our annual monitoring program as to the status of the bull trout population in the Salmo River watershed has been a program of enumerating redds in areas that are used for spawning. Although this program is not a method that produces a direct population estimate, it is an index that effectively monitors the status of the population, and can be carried out in a timely and cost-effective manner. Annual redd counts in the watershed suggest that the implementation of catch and release regulations has resulted in more bull trout spawning activity (Figure 45), and that the population appears to be growing. For now, this regulation appears to be satisfactory in at least stabilizing and possibly increasing the population size.

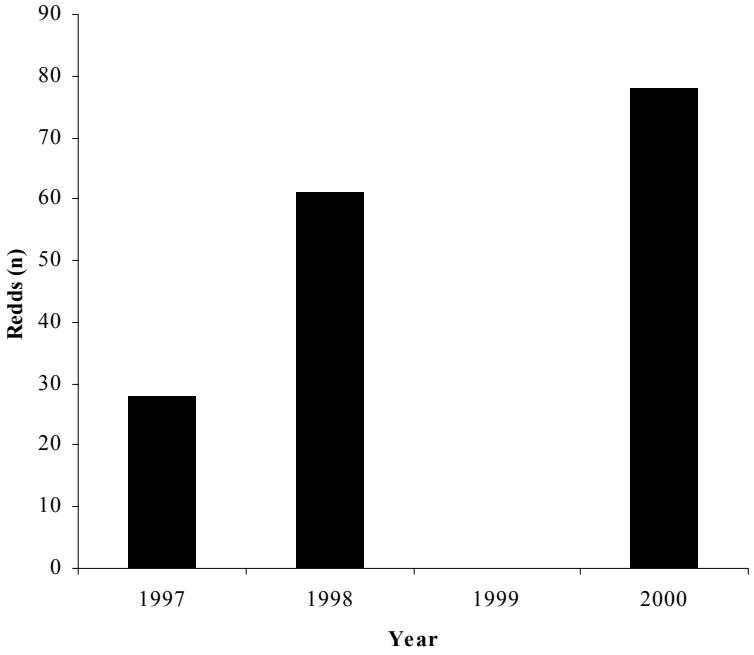


Figure 45. The number of bull trout redds constructed at three sites within the Salmo River watershed over the past four years.

Another impact that could directly limit the Salmo River bull trout population is some sort of environmental event that could affect spawning or recruitment during a year. Given that mother nature and environmental stochasticity are unpredictable, perhaps the best opportunity for limiting the potential impacts of environmental events is to ensure that a diversity of habitats and spawning areas are available to the population. As bull trout are known to be highly specific in the areas in which they select to spawn (Baxter and McPhail 1996; McPhail and Baxter 1996), this may require the protection of areas in the Salmo River watershed that are currently used for spawning by this small population. At the very least protection of major spawning areas as a refuge (i.e., the upper South Salmo River) may require consideration.

In conclusion the bull trout telemetry project in the Salmo River has contributed significantly to our understanding of the life-history and population dynamics of the population, and in conjunction with other work should provide the basis for effective management of the population in the future. It appears that for the time being the population size is increasing slightly, and that managing the population to a level where there is not a conservation concern may be achievable. It is recommended that all interested parties work together to ensure the persistence of this population in the future.

5.0 MANAGEMENT PLAN AND RECOMMENDATIONS

For the purposes of this rough management plan I have adopted a point form outline for major issues that in my opinion need to be addressed for continued management of the bull trout population.

1. Within the Salmo River watershed bull trout can enter spawning areas as early as the first week of July. As such, extra care should be taken with instream works in this watershed during the July15-August 15 work window.

2. The study identified five key spawning areas within the watershed, and these locations should be protected to the full extent of current legislation from habitat degradation. In particular the South Salmo River should be managed as critical habitat as it has transboundary issues and roughly 50% of the population appears to spawn in the watershed.

3. As the life of the radio tags is in excess of 680 days, the tagged fish should be tracked again in 2001/2002.

4. From the results of the telemetry work, and other projects, it is recommended that all tributaries to the Salmo River be closed to angling. My reasons for this suggestion are that there are very few rainbow trout in tributaries that are of legal size for harvest, and that there is the potential for mortality and poaching by allowing a legal catch and release fishery on bull trout while they are in spawning tributaries. Similar regulations are already in place within the region for tributaries to Kootenay Lake, and given that the Salmo River bull trout population is at levels where there may be a conservation concern the regulation seems warranted.

5. The program of redd counts should be continued in the watershed in order to monitor the status of the population, and the possible expansion of the population into new spawning areas. This program would also allow for a monitoring of the spawning areas to ensure there are no habitat concerns.

6. It is likely that in the near future there will need to be the consideration of whether or not to reinstate a harvest fishery. It is recommended that the fishery remain as a catch and release opportunity only, as the population is at levels where a possible conservation concern exists. Also given the fact that this is the only major population of bull trout remaining in the lower Pend d'Orielle River, a harvest fishery should be approached with extreme caution.

6.0 REFERENCES

Anonymous. 1977. Historical streamflow summary, British Columbia. Inland Waters Directorate, Water Survey of Canada, Ottawa, Canada, 758 p.

Baxter, J.S. 1999. Bull trout studies in the Salmo River watershed: 1998 and 1999. Report to BC Hydro, Environmental Department, Castlegar, B.C. Report by Baxter Environmental, Nelson, B.C.

Baxter, J.S. 2001a. Bull trout studies in the Salmo River watershed: 2000. Report to BC Hydro, Environmental Department, Castlegar, B.C. Report by Baxter Environmental, Nelson, B.C.

Baxter, J.S. 2001b. Summary of the South Salmo River bull trout enumeration project (2000). Report to Columbia-Kootenay Fisheries Renewal Partnership, Cranbrook, B.C. Report by Baxter Environmental, Nelson, B.C.

Baxter, J.S. 2001c. Assessment of a constructed non-sportfish migration barrier on the Salmo River using radio telemetry and Floy tagging. Report to BC Hydro, Burnaby, B.C. Report by Baxter Environmental, Nelson, B.C.

Baxter, J.S., and J.D. McPhail. 1996. Bull trout spawning and rearing habitat requirements: summary of the literature. B.C. Fisheries Technical Circular No. 98.

Baxter, J.S., and G. Nellestijn. 2000. Aspects of the biology of bull trout (*Salvelinus confluentus*) in the Salmo River watershed as identified through radio telemetry. Report to Columbia-Kootenay Fisheries Renewal Partnership and Columbia Basin Trust, Cranbrook, B.C. Report by Salmo Watershed Streamkeepers Society, Salmo, B.C. and Baxter Environmental, Nelson, B.C

Baxter, J.S., Coughlin, W.D., Pennington, B.M., and G.G. Oliver. 1998. Synoptic bioreconnaissance of bull trout distribution and abundance in the Salmo River watershed. Report to BC Hydro, Environmental Department, Castlegar, B.C. Report by Interior Reforestation Co. Ltd., Cranbrook, B.C.

Boyce, M.S. 1992. Population viability analysis. Annu. Rev. Ecol. Syst. 23: 481-506.

Braumandl, T.F. and M.P. Curran [*eds.*]. 1992. A field guide for site identification and interpretation for the Nelson Forest Region. British Columbia, Ministry of Forests, Land Management handbook No. 20.

Caughley, G. 1994. Directions in conservation biology. Journal of Animal Ecology 63: 215-244.

Mace, G.A., and R. Lande. 1991. Conservation Biology 5: 148-157.

McElhany, P., M.H. Ruckelhaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-42, 156 p.

McPhail, J.D., and E.B. Taylor. 1995. The Skagit char project. Report prepared for the Skagit Environmental Endowment Commission.

McPhail, J.D., and J.S. Baxter. 1996. A review of bull trout (*Salvelinus confluentus*) life history and habitat use in relation to compensation and improvement opportunities. B.C. Fisheries Management Report No. 104.

Nunney, L., and K.A. Campbell. 1993. Assessing minimum viable population size: demography meets population genetics. Trends Ecol. Evol. 8: 234-239.

R.L.&L. Environmental Services Ltd. 1995. Seven Mile Unit 4 Study: fish and aquatic investigations, September 1994 to June 1995 - study results and impact discussion. R.L.&L. Report No. 434-95D: 161p. Unpublished report prepared for BC Hydro.

Routledge, R.D., and J.R. Irvine. 1999. Chance fluctuations and the survival of small salmon stocks. Canadian Journal of Fisheries and Aquatic Sciences 56: 1512-1519.

Simberloff, D.S. 1988. The contribution of population and community biology to conservation science. Ann. Rev. Ecol. Syst. 19: 473-511.

Swanberg, T.R., 1997. Movements of and habitat use by fluvial bull trout in the Blackfoot River, Montana. Transactions of the American Fisheries Society 126: 735-746.

Appendix I. Locations of bull trout in the Salmo River watershed during radio tracking conducted in 1999, 2000, and 2001.

Sex	Female
Length (mm)	58
Weight (g)	2177
Floy Tag	P-24025
Channel	149.520
Code	51

Date	River	River km	Location Name	Location UTM Easting	Location UTM Northing	Comments	Tracking
15-Jul-99	Salmo	18.45	Ric's Pool	5439897	480701	Tagging Location 1999	B
17-Jul-99	Salmo	18.45	Ric's Pool	5439897	480701		B
23-Jul-99	Salmo	18.45	Ric's Pool	5439897	480701		B
29-Jul-99	Salmo	18.45	Ric's Pool	5439897	480701		B
1-Aug-99						NOT FOUND	R
6-Aug-99	Salmo	21.95	500 m d/s Sheep Creek Highway Bridge	5442859	480386		R
9-Aug-99	Salmo	21.95	500 m d/s Sheep Creek Highway Bridge	5439897	480701		R
16-Aug-99	Salmo	22.25	200 m d/s Sheep Creek Highway Bridge	5443077	480596		R
23-Aug-99	Sheep Creek	1.20	1.2 km u/s mouth	5443248	481920		R
31-Aug-99	Sheep Creek	6.15	Aspen Creek confluence	5443339	486507	Spawning Area 1999	A
9-Sep-99	Sheep Creek	6.15	Aspen Creek confluence	5443339	486507		A
23-Sep-99	Sheep Creek	6.15	Aspen Creek confluence	5443339	486507		A
2-Oct-99	Sheep Creek	9.85	200m d/s Waldie Creek confluence	5443541	489812		R
20-Oct-99	Salmo	21.85	600m d/s Sheep Creek Highway Bridge	5442770	480342		A
4-Dec-99	Salmo	18.45	Ric's Pool	5439899	480699	Overwintering Area 1999	R
29-Dec-99	Salmo	18.45	Ric's Pool	5439899	480699		R
4-Feb-00	Salmo	18.45	Ric's Pool	5439899	480699		A
27-Apr-00	Salmo	18.45	Ric's Pool	5439899	480699		A
5-May-00	Salmo	18.45	Ric's Pool	5439899	480699		B
29-Jul-00	Salmo	18.45	Ric's Pool	480701	5439900		A
15-Aug-00	Salmo	18.45	Ric's Pool	480701	5439900		A
26-Aug-00	Salmo	18.45	Ric's Pool	480701	5439900		A

Date	River	River km	Location Name	Location UTM Easting	Location UTM Northing	Comments	Tracking
10-Sep-00	Salmo	18.45	Ric's Pool	480701	5439900		A
23-Sep-00	Salmo	18.45	Ric's Pool	480701	5439900		A
05-Oct-00	Salmo	18.45	Ric's Pool	480701	5439900		A
30-Oct-00	Salmo	19.35	Carbody Run	480218	5440611	Overwintering Area 2000	A
03-Feb-01	Salmo	19.35	Carbody Run	480218	5440611		A

Sex	Female
Length (mm)	59.5
Weight (g)	1860
Floy Tag	P-24004
Channel	149.520
Code	54

Date	River	River km	Location Name	Location UTM Easting	Location UTM Northing	Comments	Tracking
7-Jul-99	Salmo	17.25	Burned Out Bridge	5438979	480985	Tagging Location 1999	B
9-Jul-99	Salmo	17.75	Vector Pool	5439445	481156		B
11-Jul-99	Salmo	17.75	Vector Pool	5439445	481156		B
15-Jul-99	Salmo	17.65	100m below Vector Pool	5439352	481111		B
17-Jul-99	Salmo	17.65	100m below Vector Pool	5439352	481111		B
23-Jul-99	Salmo	17.65	100m below Vector Pool	5439352	481111		B
29-Jul-99	Salmo	17.65	100m below Vector Pool	5439352	481111		B
1-Aug-99						NOT FOUND	B
6-Aug-99						NOT FOUND	R
9-Aug-99						NOT FOUND	R
16-Aug-99						NOT FOUND	R
23-Aug-99	South Salmo	11.05	500m d/s Atco Forestry Bridge	5429102	486555	Spawning Area 1999	R
31-Aug-99	South Salmo	11.05	500m d/s Atco Forestry Bridge	5429102	486555		A
9-Sep-99	South Salmo	11.05	500m d/s Atco Forestry Bridge	5429102	486555		A
23-Sep-99	South Salmo	11.05	500m d/s Atco Forestry Bridge	5429102	486555		A
2-Oct-99	South Salmo	11.05	500m d/s Atco Forestry Bridge	5429102	486555		R
20-Oct-99	Salmo	26.95	Pool d/s Lagoon Launch	5447248	480144		A
4-Dec-99						NOT FOUND	R
29-Dec-99						NOT FOUND	R
4-Feb-00						NOT FOUND	A
27-Apr-00	Salmo	17.75	Vector Pool	5439445	481156	Overwintering Area 1999	A
5-May-00	Salmo	17.75	Vector Pool	5439445	481156		B
16-Jul-00	Salmo	17.75	Vector Pool	5439445	481156		B
29-Jul-00	South Salmo	2.60	Mouth of Lost Creek	481681	5435167		A

Date	River	River km	Location Name	Location UTM Easting	Location UTM Northing	Comments	Tracking
15-Aug-00	Wildhorse Creek	0.25		484380	5459471		A
26-Aug-00	Salmo	43.20	Mouth of Widhorse Creek	484229	5459415		A
10-Sep-00	Salmo	37.10		483544	5455592		A
23-Sep-00	Salmo	37.10		483544	5455592	Spawning Area 2000	A
05-Oct-00	Salmo	37.10		483544	5455592		A
30-Oct-00	Salmo	37.10		483544	5455592		A
03-Feb-01	Salmo	36.35	Overwintering location 99 Code 65	483353	5454887	Overwintering Area 2000	A

Sex	Male
Length (mm)	60
Weight (g)	2358
Floy Tag	P-24007
Channel	149.520
Code	56

Date	River	River km	Location Name	Location UTM Easting	Location UTM Northing	Comments	Tracking
15-Jul-99	Salmo	23.05	Glide above Pool above Sheep Creek	5443705	480807	Tagging Location 1999	B
17-Jul-99	Salmo	23.45	Pool above Glide above Pool above Sheep Creek	5444072	480813		B
23-Jul-99	Salmo	25.45	200m above Hellroaring Creek Confluence	5445781	480347		B
29-Jul-99						NOT FOUND	B
1-Aug-99						NOT FOUND	R
6-Aug-99						NOT FOUND	R
9-Aug-99						NOT FOUND	R
16-Aug-99						NOT FOUND	R
23-Aug-99						NOT FOUND	R
31-Aug-99	South Salmo	16.75	In USA	5426708	491424	Spawning Area 1999	A
9-Sep-99	South Salmo	16.75	In USA	5426708	491424		A
23-Sep-99	South Salmo	17.30	In USA	5426415	491855		A
2-Oct-99						NOT FOUND	R
20-Oct-99	South Salmo	11.90	Slump u/s Atco Bridge	5428816	487278		A
4-Dec-99	Salmo	21.05	200m d/s Liness Road	5442019	480391	Overwintering Area 1999	R
29-Dec-99	Salmo	21.05	200m d/s Liness Road	5442019	480391		R
4-Feb-00	Salmo	21.05	200m d/s Liness Road	5442019	480391		A
27-Apr-00	Salmo	23.45	Pool above Glide above Pool above Sheep Creek	5444072	480813		A
5-May-00	Salmo	23.45	Pool above Glide above Pool above Sheep Creek	5444072	480813		B
04-Jul-00	Salmo	21.50	200m d/s Liness Road	5442019	480391		B
29-Jul-00	Lost Creek	4.30	4 km up Lost Creek	485120	5437358		A
15-Aug-00	Lost Creek	3.85		484700	5437210		A
26-Aug-00	Lost Creek	4.00		484835	5437275		A
10-Sep-00	South Salmo	13.75	D/S Border	488912	5428225		A

Date	River	River km	Location Name	Location UTM Easting	Location UTM Northing	Comments	Tracking
23-Sep-00	South Salmo	16.55	U/S Border	491188	5426713	Spawning Area 2000	A
05-Oct-00	South Salmo	11.30		486751	5428998		A
30-Oct-00	Salmo	21.05	200 m D/S Liness Rd	480397	5442013	Overwintering Area 2000	A

Sex	Female
Length (mm)	60.5
Weight (g)	2359
Floy Tag	P-24005
Channel	149.520
Code	58

Date	River	River km	Location Name	Location UTM Easting	Location UTM Northing	Comments	Tracking
11-Jul-99	Salmo	25.25	Hellroaring Creek confluence	5445610	480247	Tagging Location 1999	B
15-Jul-99	Salmo	24.60	Pool above rest stop	5445015	480452		B
17-Jul-99	Salmo	24.00	Pool below rest stop	5444550	480669		B
23-Jul-99	Salmo	24.00	Pool below rest stop	5444550	480669		B
29-Jul-99	Salmo	24.60	Pool above rest stop	5445015	480452		B
1-Aug-99	Salmo	24.60	Pool above rest stop	5445015	480452		R
6-Aug-99						NOT FOUND	R
9-Aug-99						NOT FOUND	R
16-Aug-99						NOT FOUND	R
23-Aug-99	Stagleap Creek	0.85	Stagleap Creek under powerlines	5429316	488076		R
31-Aug-99	Stagleap Creek	0.10	Stagleap Creek upstream confluence	5428734	487628	Spawning Area 1999	A
9-Sep-99	South Salmo	12.20	Stagleap Creek confluence	5428654	487540		A
23-Sep-99	South Salmo	16.55	In USA	5426691	491188		A
2-Oct-99						NOT FOUND	R
20-Oct-99	Salmo	24.00	Pool below rest stop	5444550	480669	Overwintering Area 1999	A
4-Dec-99	Salmo	24.00	Pool below rest stop	5444550	480669		R
29-Dec-99	Salmo	24.00	Pool below rest stop	5444550	480669		R
4-Feb-00	Salmo	24.00	Pool below rest stop	5444550	480669		A
27-Apr-00	Salmo	24.00	Pool below rest stop	5444550	480669		A
5-May-00	Salmo	23.45	Pool above Glide above Pool above Sheep Creek	5444072	480813		B
28-Jun-00	Salmo	24.40	Rest Stop	5444832	480403		B
29-Jul-00	South Salmo	16.10	1 km below border	490825	5426976		A
15-Aug-00	South Salmo	14.95	Border	489805	5427505		A
26-Aug-00	South Salmo	15.50	Border	490294	5427255		A

Date	River	River km	Location Name	Location UTM Easting	Location UTM Northing	Comments	Tracking
10-Sep-00	South Salmo	13.75	D/S Border	488912	5428225	Spawning Area 2000	A
23-Sep-00	South Salmo	12.00	D/S Stagleap	487384	5428797		A
05-Oct-00	Salmo	25.25	Hellroaring Creek	480249	5445609		A
30-Oct-00	Salmo	25.25	Hellroaring Creek	480249	5445609	Overwintering Area 2000	A
03-Feb-01	Salmo	24.00	Run below Rest Stop	480670	5444563		A

Sex	Female
Length (mm)	56
Weight (g)	1860
Floy Tag	P-24022
Channel	149.520
Code	60

Date	River	River km	Location Name	Location UTM Easting	Location UTM Northing	Comments	Tracking
17-Jul-99	Salmo	21.05	200m d/s Liness Road	5442021	480392	Tagging Location 1999	B
23-Jul-99	Salmo	20.75	500m d/s Liness Road	5441795	480388		B
29-Jul-99	Salmo	20.75	500m d/s Liness Road	5441795	480388		B
1-Aug-99	Salmo	22.75	200m d/s Sheep Creek confluence	5443423	480812		R
6-Aug-99	Salmo	23.40	Pool above Glide above Pool above Sheep Creek	5443987	480774		R
9-Aug-99	Salmo	23.40	Pool above Glide above Pool above Sheep Creek	5443987	480774		R
16-Aug-99	Salmo	34.15	Boulder Creek confluence	5453597	482237		R
23-Aug-99	Salmo	48.35	200m d/s Barrett Creek confluence	5463719	482511		R
31-Aug-99	Salmo	53.80	300m d/s Hall Creek confluence	5468221	482737	Spawning Area 1999	A
9-Sep-99	Salmo	53.80	300m d/s Hall Creek confluence	5468221	482737		A
23-Sep-99	Salmo	55.00	900m u/s Hall Creek confluence	5469205	483031		A
2-Oct-99	Salmo	38.05	Labyrinth Saw Mill	5455923	484267		R
20-Oct-99	Salmo	16.85	Run 400 m below Burned Out Bridge	5438725	480709		A
4-Dec-99	Salmo	16.85	Run 400 m below Burned Out Bridge	5438725	480709		R
29-Dec-99	Salmo	13.15	1 km u/s South Salmo River confluence	5436189	479735	Overwintering Area 1999	R
4-Feb-00	Salmo	13.15	1 km u/s South Salmo River confluence	5436189	479735		A
27-Apr-00	Salmo	19.75	Pool below Hippe Run	5440888	480391		A
5-May-00	Salmo	19.75	Pool below Hippe Run	5440888	480391		B
29-Jul-00	Salmo	25.25	Hellroaring Creek	480249	5445609		A
15-Aug-00	Salmo	53.85	D/S Hall Creek	482709	5468279		A
26-Aug-00	Salmo	56.55	U/S Hall Creek	483378	5470313		A
10-Sep-00	Salmo	55.35		482907	5469516	Spawning Area 2000	A
23-Sep-00	Salmo	55.85	Hall Creek	482916	5469943		A
05-Oct-00	Salmo	24.55	Run above Rest Stop	480439	5444975		A

Date	River	River km	Location Name	Location UTM Easting	Location UTM Northing	Comments	Tracking
30-Oct-00	Salmo	16.85	400 m d/s BO Bridge	480699	5438715	Overwintering Area 2000	A
03-Feb-01	Salmo	16.85	400 m d/s BO Bridge	480699	5438715		A

Sex	Female
Length (mm)	53
Weight (g)	1320
Floy Tag	P-24003
Channel	149.520
Code	61

Date	River	River km	Location Name	Location UTM Easting	Location UTM Northing	Comments	Tracking
7-Jul-99	Salmo	25.25	Hellroaring Creek confluence	5445610	480247	Tagging Location 1999	B
9-Jul-99						NOT FOUND	B
11-Jul-99						NOT FOUND	B
15-Jul-99	Salmo	23.05	Glide above Pool above Sheep Creek	5443705	480807		B
17-Jul-99	Salmo	23.05	Glide above Pool above Sheep Creek	5443705	480807		B
23-Jul-99	Salmo	21.05	200m d/s Liness Road	5442019	480391		B
29-Jul-99	Salmo	21.05	200m d/s Liness Road	5442019	480391		B
1-Aug-99						NOT FOUND	B
6-Aug-99	Sheep Creek	5.15	Site 1	5443084	485586		R
9-Aug-99	Sheep Creek	6.60	500m d/s Hedgehog Creek confluence	5443619	486816		R
16-Aug-99	Sheep Creek	6.90	200m d/s Hedgehog Creek confluence	5443670	487104		R
23-Aug-99	Sheep Creek	7.25	200m u/s Hedgehog Creek confluence	5443656	487450		R
31-Aug-99	Sheep Creek	7.55	500m u/s Hedgehog Creek confluence	5443706	487746	Spawning Area 1999	A
9-Sep-99	Sheep Creek	7.55	500m u/s Hedgehog Creek confluence	5443706	487746		A
23-Sep-99	Sheep Creek	10.05	Waldie Creek confluence	5443476	490005		A
2-Oct-99	Sheep Creek	8.50	900m d/s Nugget Creek confluence	5443799	488638		R
20-Oct-99	Sheep Creek	1.00	1000m u/s of mouth	5443298	481743		A
4-Dec-99	Salmo	22.10	500m d/s Sheep Creek confluence	5442953	480480		R
29-Dec-99						NOT FOUND	R
4-Feb-00	Salmo	20.00	below Liness Road	5441153	480388	Overwintering Area 1999	A
27-Apr-00	Salmo	23.05	Glide above Pool above Sheep Creek	5443705	480807		A
5-May-00	Salmo	23.45	Pool above Glide above Pool above Sheep Creek	5444072	480813		B
29-Jul-00	Salmo	24.00	Run below Rest Stop	480670	5444563		A
15-Aug-00	Sheep Creek	7.10		487305	5443658		A

Date	River	River km	Location Name	Location UTM Easting	Location UTM Northing	Comments	Tracking
26-Aug-00	Sheep Creek	10.00		489957	5443509		A
10-Sep-00	Sheep Creek	7.20		487405	5443658	Spawning Area 2000	A
23-Sep-00	Sheep Creek	9.95	At Waldie	489911	5443528		A
05-Oct-00	Sheep Creek	6.80	At Aspen	487008	5443657		A
30-Oct-00	Salmo	24.00	Run below Rest Stop	480670	5444563	Overwintering Area 2000	A

Sex	Female
Length (mm)	54
Weight (g)	1750
Floy Tag	C-000148
Channel	149.520
Code	65

Date	River	River km	Location Name	Location UTM Easting	Location UTM Northing	Comments	Tracking
31-Aug-99	Clearwater Creek	3.80	Falls	5470071	487864	Tagging Location 1999	R
9-Sep-99	Clearwater Creek	3.80	Falls	5470071	487864	Spawning Area 1999	A
23-Sep-99	Clearwater Creek	3.80	Falls	5470071	487864		A
2-Oct-99	Clearwater Creek	3.80	Falls	5470071	487864		R
20-Oct-99	Salmo	36.05	Pool 1 km above Gerry's Bridge	5454663	483527		A
4-Dec-99						NOT FOUND	R
29-Dec-99						NOT FOUND	R
4-Feb-00	Salmo	36.35	Pool above Gerry's Bridge	5454911	483420	Overwintering Area 1999	A
27-Apr-00	Salmo	36.35	Pool above Gerry's Bridge	5454911	483420		A
5-May-00	Salmo	36.35	Pool above Gerry's Bridge	5454911	483420		B
29-Jul-00	Salmo River	55.70	700 m u/s Spilkers	482849	5469814		A
15-Aug-00	Clearwater Creek	1.10		485776	5470632		A
26-Aug-00	Clearwater Creek	0.90		485592	5470684		A
10-Sep-00	Clearwater Creek	0.95	400 m U/S mouth	485632	5470654	Spawning Area 2000	A
23-Sep-00	Clearwater Creek	0.95	400 m U/S mouth	485632	5470654		A
05-Oct-00	Salmo	48.80		482521	5464137		A
30-Oct-00	Salmo	36.35	Overwintering location 99	483353	5454887	Overwintering Area 2000	A
03-Feb-01	Salmo	36.35	Overwintering location 99	483353	5454887		A

Sex	Female
Length (mm)	52
Weight (g)	1134
Floy Tag	P-24006
Channel	149.520
Code	67

Date	River	River km	Location Name	Location UTM Easting	Location UTM Northing	Comments	Tracking
11-Jul-99	Salmo	17.85	100m above Vector Pool	5439513	481094	Tagging Location 1999	B
15-Jul-99	Salmo	16.85	Run 400 m below Burned Out Bridge	5438719	480706		B
17-Jul-99	Salmo	16.85	Run 400 m below Burned Out Bridge	5438719	480706		B
23-Jul-99	Salmo	18.45	Ric's Pool (large LJ pool below car body run)	5439897	480701		B
29-Jul-99	Salmo	18.45	Ric's Pool (large LJ pool below car body run)	5439897	480701		B
1-Aug-99						NOT FOUND	R
6-Aug-99						NOT FOUND	R
9-Aug-99						NOT FOUND	R
16-Aug-99						NOT FOUND	R
23-Aug-99	Stagleap Creek	0.85	Stagleap Creek under powerlines	5429316	488076	Spawning Area 1999	R
31-Aug-99	Stagleap Creek	0.85	Stagleap Creek under powerlines	5429316	488076		A
9-Sep-99	Stagleap Creek	0.85	Stagleap Creek under powerlines	5429316	488076		A
23-Sep-99	Stagleap Creek	0.85	Stagleap Creek under powerlines	5429316	488076		A
2-Oct-99	Stagleap Creek	0.85	Stagleap Creek under powerlines	5429316	488076		R
20-Oct-99	Salmo	16.85	Run 400 m below Burned Out Bridge	5438719	480706	Overwintering Area 1999	A
4-Dec-99	Salmo	16.85	Run 400 m below Burned Out Bridge	5438719	480706		R
29-Dec-99	Salmo	16.85	Run 400 m below Burned Out Bridge	5438719	480706		R
4-Feb-00	Salmo	16.85	Run 400 m below Burned Out Bridge	5438719	480706		A
27-Apr-00	Salmo	18.45	Ric's Pool (large LJ pool below car body run)	5439897	480701		A
5-May-00	Salmo	18.45	Ric's Pool (large LJ pool below car body run)	5439897	480701		B
28-Jun-00	Salmo	18.45	Ric's Pool (large LJ pool below car body run)	5439897	480701		B
16-Jul-00	Salmo	18.45	Ric's Pool (large LJ pool below car body run)	5439897	480701		B
29-Jul-00	South Salmo	3.85	Section along Highway	482480	5434375		A
15-Aug-00	Stagleap Creek	0.85	Powerlines	488080	5429317		A

Date	River	River km	Location Name	Location UTM Easting	Location UTM Northing	Comments	Tracking
26-Aug-00	Stagleap Creek	0.85	Powerlines	488080	5429317		A
10-Sep-00	Stagleap Creek	0.85	Powerlines	488080	5429317	Spawning Area 2000	A
23-Sep-00	Stagleap Creek	0.85	Powerlines	488080	5429317		A
05-Oct-00	South Salmo	6.00		483673	5432813		A
30-Oct-00	Salmo	12.15	Mouth of South Salmo	479644	5435253	Overwintering Area 2000	A
03-Feb-01	Salmo	11.80	Mouth of Swift Creek	479692	5434910		A

Sex	Female
Length (mm)	50
Weight (g)	1814
Floy Tag	P-24024
Channel	149.520
Code	68

Date	River	River km	Location Name	Location UTM Easting	Location UTM Northing	Comments	Tracking
15-Jul-99	Salmo	18.45	Ric's Pool (large LJ pool below car body run)	5439898	480701	Tagging Location 1999	B
17-Jul-99	Salmo	18.45	Ric's Pool (large LJ pool below car body run)	5439898	480701		B
23-Jul-99	Salmo	18.45	Ric's Pool (large LJ pool below car body run)	5439898	480701		B
29-Jul-99	Salmo	18.45	Ric's Pool (large LJ pool below car body run)	5439898	480701		B
1-Aug-99	Salmo					NOT FOUND	R
6-Aug-99	Salmo	43.00	Ymir	5459268	484355		R
9-Aug-99	Salmo	48.75	200m u/s Barrett Creek confluence	5464099	482542		R
16-Aug-99	Salmo	58.35	200 m d/s Clearwater Creek confluence	5470930	484773		R
23-Aug-99	Clearwater Creek	3.80	Falls	5470063	487859	Spawning Area 1999	R
31-Aug-99	Clearwater Creek	3.80	Falls	5470063	487859		A
9-Sep-99	Clearwater Creek	3.80	Falls	5470063	487859		A
23-Sep-99	Clearwater Creek	3.80	Falls	5470063	487859		A
2-Oct-99	Clearwater Creek	0.50	500m u/s mouth	5470954	485310		R
20-Oct-99	Salmo	23.40	800m u/s Sheep Creek confluence	5443994	480776		A
4-Dec-99	Salmo	18.45	Ric's Pool (large LJ pool below car body run)	5439899	480700	Overwintering Area 1999	R
29-Dec-99	Salmo	18.45	Ric's Pool (large LJ pool below car body run)	5439899	480700		R
4-Feb-00	Salmo	18.45	Ric's Pool (large LJ pool below car body run)	5439899	480700		A
27-Apr-00	Salmo	18.45	Ric's Pool (large LJ pool below car body run)	5439899	480700		A
5-May-00	Salmo	18.45	Ric's Pool (large LJ pool below car body run)	5439899	480700		B
29-Jul-00	Salmo	18.45	Ric's Pool	480701	5439900		A
15-Aug-00	Salmo	18.45	Ric's Pool	480701	5439900		A
26-Aug-00	Salmo	18.45	Ric's Pool	480701	5439900		A
10-Sep-00	Salmo	19.35	Carbody Run	480218	5440611		A
23-Sep-00	Salmo	18.45	Ric's Pool	480701	5439900		A

Date	River	River km	Location Name	Location UTM Easting	Location UTM Northing	Comments	Tracking
05-Oct-00	Salmo	18.45	Ric's Pool	480701	5439900		A
30-Oct-00	Salmo	18.45	Ric's Pool	480701	5439900	Overwintering Area 2000	A
03-Feb-01	Salmo	18.45	Ric's Pool	480701	5439900		A

Sex	Male
Length (mm)	67
Weight (g)	3084
Floy Tag	P-24002
Channel	149.520
Code	70

Date	River	River km	Location Name	Location UTM Easting	Location UTM Northing	Comments	Tracking
9-Jul-99	Salmo	23.05	Glide above Pool above Sheep Creek	5443705	480807	Tagging Location 1999	B
11-Jul-99	Salmo	22.90	Pool above Sheep Creek	5443557	480750		B
15-Jul-99	Salmo	23.05	Glide above Pool above Sheep Creek	5443705	480807		B
17-Jul-99	Salmo	23.05	Glide above Pool above Sheep Creek	5443705	480807		B
23-Jul-99	Salmo	24.00	Pool below rest stop	5444550	480669		B
29-Jul-99	Salmo	24.40	Rest stop	5444832	480403		B
1-Aug-99						NOT FOUND	R
6-Aug-99						NOT FOUND	R
9-Aug-99	Salmo	32.70	2 km d/s Hidden Creek confluence	5452404	481780		R
16-Aug-99	Salmo	42.50	500m d/s Ymir	5458857	484558		R
23-Aug-99	Salmo	54.30	200m u/s Hall Creek confluence	5468640	482867		R
31-Aug-99	Salmo	54.70	600m u/s Hall Creek confluence	5468937	482910	Spawning Area	A
9-Sep-99	Salmo	54.70	600m u/s Hall Creek confluence	5468937	482910		A
23-Sep-99	Salmo	54.70	600m u/s Hall Creek confluence	5468937	482910		A
2-Oct-99	Salmo	53.90	200m d/s Hall Creek confluence	5468313	482700		R
20-Oct-99	Salmo	23.05	Glide above Pool above Sheep Creek	5443705	480807	Overwintering Area	A
4-Dec-99	Salmo	23.05	Glide above Pool above Sheep Creek	5443705	480807		R
29-Dec-99	Salmo	22.90	Pool above Sheep Creek	5443557	480750		R
4-Feb-00	Salmo	22.90	Pool above Sheep Creek	5443557	480750		A
27-Apr-00						NOT FOUND	A
5-May-00	Salmo	23.45	Pool above Glide above Pool above Sheep Creek	5444072	480813		B
29-Jul-00	Salmo	32.25	Bill Stockdale's	481564	5452033		A
15-Aug-00	Salmo	53.30	D/S Hall Creek	482416	5467920		A
26-Aug-00	Salmo	54.45	U/S Hall Creek	482966	5468766		A

Date	River	River km	Location Name	Location UTM Easting	Location UTM Northing	Comments	Tracking
10-Sep-00	Salmo	54.50	Near Hall	482952	5468812	Spawning Area 2000	A
23-Sep-00	Salmo	55.40	Near Hall	482894	5469564		A
05-Oct-00	Salmo	24.00	Run below Rest Stop	480670	5444563	Overwintering Area 2000	A
30-Oct-00	Salmo	24.00	Run below Rest Stop	480670	5444563		A

Sex	Male
Length (mm)	400
Weight (g)	
Floy Tag	G-0499, G-0500
Channel	149.620
Code	9

Date	River	River km	Location Name	Location UTM Easting	Location UTM Northing	Comments	Tracking
27-Jun-00	Salmo	7.30	Black Bluffs	478282	5431621	Tagging Location 2000	B
29-Jul-00	Salmo	8.05	200 m d/s Water Survey	478401	5432353		A
15-Aug-00	Salmo	8.80	U/S Water Survey	478575	5433009		A
26-Aug-00	Salmo	5.70	Rollie's Pool	476984	5431337	Overwintering Area 2000	A
10-Sep-00	Salmo	5.70	Rollie's Pool	476984	5431337		A
23-Sep-00	Salmo	5.70	Rollie's Pool	476984	5431337		A
05-Oct-00	Salmo	5.70	Rollie's Pool	476984	5431337		A
30-Oct-00	Salmo	5.70	Rollie's Pool	476984	5431337		A
03-Feb-01	Salmo	5.70	Rollie's Pool	476984	5431337		A

Sex	Female
Length (mm)	650
Weight (g)	
Floy Tag	G-004, G-005
Channel	149.700
Code	76

Date	River	River km	Location Name	Location UTM Easting	Location UTM Northing	Comments	Tracking
18-Jul-00	Salmo	39.90	Wesco Swimming Hole	485329	5457057	Tagging Location 2000	B
29-Jul-00	Salmo	46.25	Mouth of Stewart Creek	483414	5462091		A
15-Aug-00	Salmo	56.40	U/S Hall Creek	483246	5470262		A
26-Aug-00	Salmo	57.55	D/S Clearwater Creek	484112	5470641		A
10-Sep-00	Salmo	54.75		482930	5468989	Spawning Area 2000	A
23-Sep-00	Salmo	54.75	Near Hall	482930	5468989		A
05-Oct-00	Salmo	40.65		485521	5457506		A
30-Oct-00	Salmo	40.35	Seri's Pool	485386	5457326		A
03-Feb-01	Salmo	46.45	200 m U/S Stewart Creek	483380	5462286	Overwintering Area 2000	A

Sex	Female
Length (mm)	565
Weight (g)	
Floy Tag	G-0903, G-0904
Channel	149.700
Code	77

Date	River	River km	Location Name	Location UTM Easting	Location UTM Northing	Comments	Tracking
18-Jul-00	Salmo	24.40	Rest Stop	480414	5444835	Tagging Location 2000	B
29-Jul-00	Salmo	53.40	Mouth of Hall Creek	482505	5467961		A
15-Aug-00	Clearwater Creek	3.05		487346	5470512		A
26-Aug-00	Clearwater Creek	3.10		487390	5470493		A
10-Sep-00	Clearwater Creek	2.90		487258	5470625	Spawning Area 2000	A
23-Sep-00	Clearwater Creek	3.40	D/S Qua Creek	487577	5470290		A
05-Oct-00	Salmo	5.10	below Rollie's Pool	476461	5431579		A
30-Oct-00	Salmo	5.70	Rollie's Pool	476984	5431337	Overwintering Area 2000	A
03-Feb-01	Salmo	12.15	Mouth of South Salmo	479644	5435253		A

Sex	Female
Length (mm)	575
Weight (g)	
Floy Tag	B-0424, B-0423
Channel	149.700
Code	78

Date	River	River km	Location Name	Location UTM Easting	Location UTM Northing	Comments	Tracking
21-Sep-00	South Salmo	0.85	South Salmo Fence	480307	5435548	Tagging Location 2000	R
23-Sep-00	Salmo	18.45	Ric's Pool	480701	5439900		A
05-Oct-00	Salmo	25.25	Hellroaring Creek	480249	5445609		A
30-Oct-00	Salmo	25.25	Hellroaring Creek	480249	5445609	Overwintering Area 2000	A
03-Feb-01	Salmo	25.25	Hellroaring Creek	480249	5445609		A

Sex	Male
Length (mm)	655
Weight (g)	
Floy Tag	B-0409, B-410
Channel	149.700
Code	79

Date	River	River km	Location Name	Location UTM Easting	Location UTM Northing	Comments	Tracking
11-Oct-00	South Salmo	0.85	South Salmo Fence	480307	5435548	Tagging Location 2000	R
30-Oct-00	Salmo	19.35	Carbody Run	480218	5440611		A
03-Feb-01	Salmo	16.85	400 m d/s BO Bridge	480699	5438715	Overwintering Area 2000	A

Sex	Female
Length (mm)	510
Weight (g)	
Floy Tag	G-906, G-907
Channel	149.700
Code	80

Date	River	River km	Location Name	Location UTM Easting	Location UTM Northing	Comments	Tracking
28-Jun-00	Salmo	11.80	Mouth of Swift Creek	479692	5434910	Tagging Location 2000	A
29-Jul-00	South Salmo	13.25	1 km u/s Stagleap Creek	488485	5428399		A
15-Aug-00	South Salmo	17.00	U/S Border	491551	5426543		A
26-Aug-00	South Salmo	17.00	U/S Border	491551	5426543	Spawning Area 2000	A
05-Oct-00	Salmo	0.20	Mouth @ Pend	472225	5430428	Overwintering Area 2000	A
30-Oct-00	Salmo	0.20	Mouth @ Pend	472225	5430428		A
03-Feb-01	Salmo	0.20	Mouth @ Pend	472225	5430428		A

Sex	Male
Length (mm)	595
Weight (g)	
Floy Tag	B-0407, B-0408
Channel	149.700
Code	82

Date	River	River km	Location Name	Location UTM Easting	Location UTM Northing	Comments	Tracking
10-Oct-00	South Salmo	0.85	South Salmo Fence	480307	5435548	Tagging Location 2000	R
30-Oct-00	Salmo	16.85	400 m d/s BO Bridge	480699	5438715	Overwintering Area 2000	A
03-Feb-01	Salmo	16.85	400 m d/s BO Bridge	480699	5438715		A

Sex	Female
Length (mm)	630
Weight (g)	
Floy Tag	B-0401, B-0402
Channel	149.700
Code	83

Date	River	River km	Location Name	Location UTM Easting	Location UTM Northing	Comments	Tracking
28-Sep-00	South Salmo	0.85	South Salmo Fence	480307	5435548	Tagging Location 2000	R
05-Oct-00	Salmo	11.35	400 m D/S Swift Creek	479976	5434564		A
03-Feb-01	Salmo	11.80	Mouth of Swift Creek	479692	5434910	Overwintering Area 2000	A

Sex	Female
Length (mm)	450
Weight (g)	
Floy Tag	G-001, G-002
Channel	149.700
Code	84

Date	River	River km	Location Name	Location UTM Easting	Location UTM Northing	Comments	Tracking
16-Jul-00	Salmo	32.25	Bill Stockdale's	481564	5452033	Tagging Location 2000	B
29-Jul-00	Salmo	32.25	Bill Stockdale's	481564	5452033		A
15-Aug-00	Salmo	32.25	Bill Stockdale's	481564	5452033		A
26-Aug-00	Salmo	32.25	Bill Stockdale's	481564	5452033		A
10-Sep-00	Salmo	32.25	Bill Stockdale's	481564	5452033		A
23-Sep-00	Salmo	32.25	Bill Stockdale's	481564	5452033		A
05-Oct-00	Salmo	32.25	Bill Stockdale's	481564	5452033	Overwintering Area 2000	A
30-Oct-00	Salmo	32.25	Bill Stockdale's	481564	5452033		A
03-Feb-01	Salmo	32.25	Bill Stockdale's	481564	5452033		A

Sex	Male
Length (mm)	595
Weight (g)	
Floy Tag	B-0411, B-0412
Channel	149.700
Code	85

Date	River	River km	Location Name	Location UTM Easting	Location UTM Northing	Comments	Tracking
17-Oct-00	South Salmo	0.85	South Salmo Fence	480307	5435548	Tagging Location 2000	R
30-Oct-00	Salmo	9.35	U/S Water Survey	478859	5433306		A
03-Feb-01	Salmo	9.35	U/S Water Survey	478859	5433306	Overwintering Area 2000	A