

Alaska Fisheries Technical Report Number 46

**MIGRATORY BEHAVIOR AND SEASONAL
DISTRIBUTION OF RADIO-TAGGED RAINBOW
TROUT IN THE KENAI RIVER, ALASKA**

May 1998

Region 7

U.S. Fish and Wildlife Service • Department of the Interior

ALASKA FISHERIES TECHNICAL REPORT NUMBER 46

MIGRATORY BEHAVIOR AND SEASONAL DISTRIBUTION OF
RADIO-TAGGED RAINBOW TROUT IN THE KENAI RIVER, ALASKA

by

Douglas E Palmer

U S Fish and Wildlife Service
Kenai Fishery Resource Office
P O. Box 1670
Kenai, Alaska 99611

May 1998

Disclaimer

The mention of trade names or commercial products in this report does not constitute endorsement or recommendation for use by the Federal government.

The U.S. Department of Interior prohibits discrimination in Departmental Federally Conducted Programs on the basis of race, color, national origin, sex, age, or handicap. If you believe that you have been discriminated against in any program, activity, or facility operated by the U.S. Fish and Wildlife Service or if you desire further information please write to

U.S. Department of Interior
Office for Equal Opportunity
1849 C Street, N.W.
Washington, D.C. 20240

The correct citation for this report is

Palmer, D.E. 1998. Migratory behavior and seasonal distribution of radio-tagged rainbow trout in the Kenai River, Alaska. U.S. Fish and Wildlife Service, Alaska Fisheries Technical Report Number 46, Kenai, Alaska

Table of Contents

	<i>Page</i>
List of Figures	ii
List of Appendices	ii
Abstract	1
Introduction	1
Study Area	3
Methods	5
<i>Implanting Transmitters</i>	5
<i>Locating Radio-Tagged Rainbow Trout</i>	6
Results	7
<i>Fish Survival and Transmitter Retention</i>	7
<i>Rainbow Trout Radio-Tagged Above Skilak Lake</i>	7
<i>Rainbow Trout Radio-Tagged Below Skilak Lake</i>	11
<i>Geographic Range</i>	14
Discussion	17
Management Considerations	18
Acknowledgments	19
References	20
Appendix A	22
Appendix B	25
Appendix C	66

List of Figures

<i>Figure</i>		<i>Page</i>
1	Map of the Kenai River watershed showing locations of fixed telemetry stations	2
2	Estimates of catch and harvest of rainbow trout in the upper and middle sections of the Kenai River from 1984 to 1995 (Mills 1985-1994, Nelson 1995, Howe et al 1995,1996)	4
3	Seasonal distribution of rainbow trout that were radio-tagged above Skilak Lake Transmitters were implanted from 27 July through 22 August 1995	8
4	Locations of radio-tagged rainbow trout in the upper Kenai River from 15 May through 15 June, 1996	10
5	Seasonal distribution of rainbow trout that were radio-tagged below Skilak Lake Transmitters were implanted from 28 August through 15 September 1995	12
6.	Locations of radio-tagged rainbow trout in the middle Kenai River from 15 May through 15 June, 1996	13
7	Tracking locations (black triangles) of all rainbow trout radio-tagged above and below Skilak Lake for the period 27 July 1995 through 22 November 1996	15
8	Home range of radio-tagged rainbow trout defined as the distance between the farthest upstream and downstream locations of individual fish in the Kenai River watershed Includes only fish that were tracked for more than one year Sample size is indicated above each bar	16

List of Appendices

<i>Appendix</i>		<i>Page</i>
A	Tracking history summaries of radio-tagged rainbow trout in the Kenai River during 1995 and 1996	22
B	Locations of individual rainbow trout radio-tagged above Skilak Lake	25
C.	Locations of individual rainbow trout radio-tagged below Skilak Lake	66

Migratory Behavior and Seasonal Distribution of Radio-Tagged Rainbow Trout in the Kenai River, Alaska

DOUGLAS E PALMER

U.S. Fish and Wildlife Service, Kenai Fishery Resource Office

P O Box 1670, Kenai, Alaska 99611, (907) 262-9863

Abstract — Radio telemetry was used to monitor the seasonal movements of large (>350 mm fork length) rainbow trout *Oncorhynchus mykiss* in the Kenai River from July 1995 through November 1996. Radio transmitters were surgically implanted in 40 fish above Skilak Lake and 39 fish below Skilak Lake. Movement of rainbow trout to overwintering areas began in late September and was complete by mid-December. Rainbow trout radio-tagged above Skilak Lake selected overwintering areas in Skilak Lake (64%), Kenai Lake (18%), and river locations between Skilak and Kenai lakes (18%). Rainbow trout radio-tagged below Skilak Lake selected overwintering areas in Skilak Lake (72%) and river locations below Skilak Lake (28%). Movement from overwintering areas to spawning and feeding locations occurred during May and early June. The Russian River was an important spawning area for rainbow trout radio-tagged above Skilak Lake. Spawning likely occurred in the Kenai River above and below Skilak Lake, but glacial turbidity hampered visual confirmation. Most radio-tagged rainbow trout demonstrated considerable site fidelity to feeding and overwintering habitats. The geographic ranges of rainbow trout radio-tagged above and below Skilak Lake strongly suggest the possibility of two or more semi-isolated stocks.

Introduction

The Kenai River (Figure 1) provides a variety of recreational fishing opportunities and receives more angler effort than any other river in Alaska (Howe et al 1996). Although most anglers participate in popular sport fisheries targeting chinook salmon *Oncorhynchus tshawytscha*, sockeye salmon *O. nerka*, and coho salmon *O. kisutch*, the Kenai River also supports a major fishery for rainbow trout *O. mykiss*. Catches of rainbow trout in the Kenai River have ranged from 8,720 to 62,152 fish annually since 1984 (Mills 1991-1994, Nelson 1995, Howe et al 1995, 1996).

Rainbow trout are caught throughout the Kenai River, but anglers targeting this species generally concentrate their efforts on the upper and middle sections of river. The upper Kenai River, defined here as the section of river between Skilak and Kenai lakes, was managed as a trophy fishery from 1989-1996 and as a catch and release fishery beginning in 1997. Regulations governing this fishery are very restrictive. Anglers may use only unbaited, artificial lures during the open season from 15 June through 14 April. Trophy regulations allowed anglers to harvest one rainbow trout over 30 inches per day with an annual limit of two fish; however, no harvest is allowed under more recent catch and release regulations. The middle Kenai River, defined here as the section of river between the Moose River and

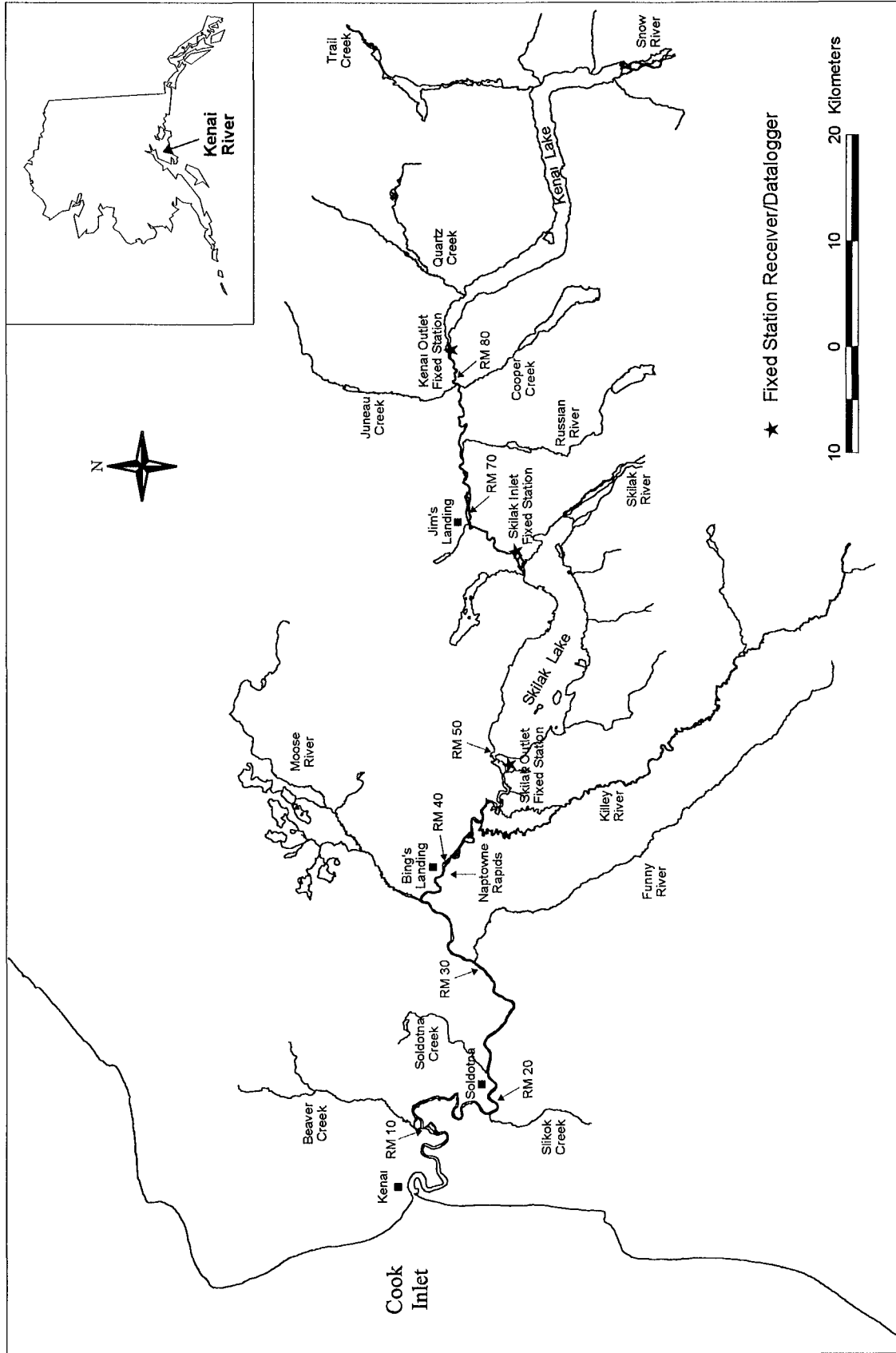


Figure 1.- Map of the Kenai River watershed showing locations of fixed telemetry stations.

Skilak Lake, is managed for sustained yield which allows for more liberal regulations governing the rainbow trout fishery. The open season is identical to the upper river, however, bait is permitted from 1 July through 30 September. Anglers are permitted to harvest one rainbow trout of any size per day with an annual limit of two fish over 20 inches.

The popularity of both fisheries has increased substantially in recent years and can be visualized through annual increases in the number of fish being caught (Figure 2). During 1995, anglers caught an estimated 33,476 rainbow trout in the upper Kenai River (Howe et al. 1996) compared to only 2,020 in 1986 (Nelson 1995). Similarly, anglers caught an estimated 13,072 rainbow trout in the middle Kenai River during 1995 compared to only 1,750 in 1986. Although catches have increased in recent years, harvests of rainbow trout in both sections of river have remained at low levels (Figure 2). Since 1992, anglers have harvested less than 1% of the rainbow trout caught in the upper river and about 5% of the rainbow trout caught in the middle river (Mills 1993,1994, Howe et al 1995,1996).

Increased sport fishing pressure in recent years coupled with a lack of current biological information on rainbow trout in the Kenai River generated concern about potential negative impacts to populations in the upper and middle sections of river. This concern prompted studies by the Alaska Department of Fish and Game (Department) and the U S Fish and Wildlife Service (Service). The Department conducted a stock assessment of the rainbow trout population in the upper Kenai River during 1995 (Hayes and Hasbrouck 1996). Our study was conducted concurrently and focused on movement patterns and seasonal distribution of rainbow trout in the Kenai River. Specific objectives were to

1. Describe the migratory behavior and seasonal distribution of radio-tagged rainbow trout in the Kenai River above Naptowne Rapids;
2. Identify spawning areas selected by radio-tagged rainbow trout, and,
3. Determine if discrete populations of rainbow trout exist above and below Skilak Lake

Findings from both studies will add considerably to our current knowledge of rainbow trout in the Kenai River and assist managers in developing future management strategies

Study Area

The Kenai River drainage encompasses approximately 5,500 km² on the Kenai Peninsula in Southcentral Alaska (Figure 1). The Kenai River is glacially fed and originates at the outlet of Kenai Lake. The upper reach of the Kenai River is about 27 km long and extends from Kenai Lake to the inlet of Skilak Lake. The river traverses Skilak Lake for about 24 km, then

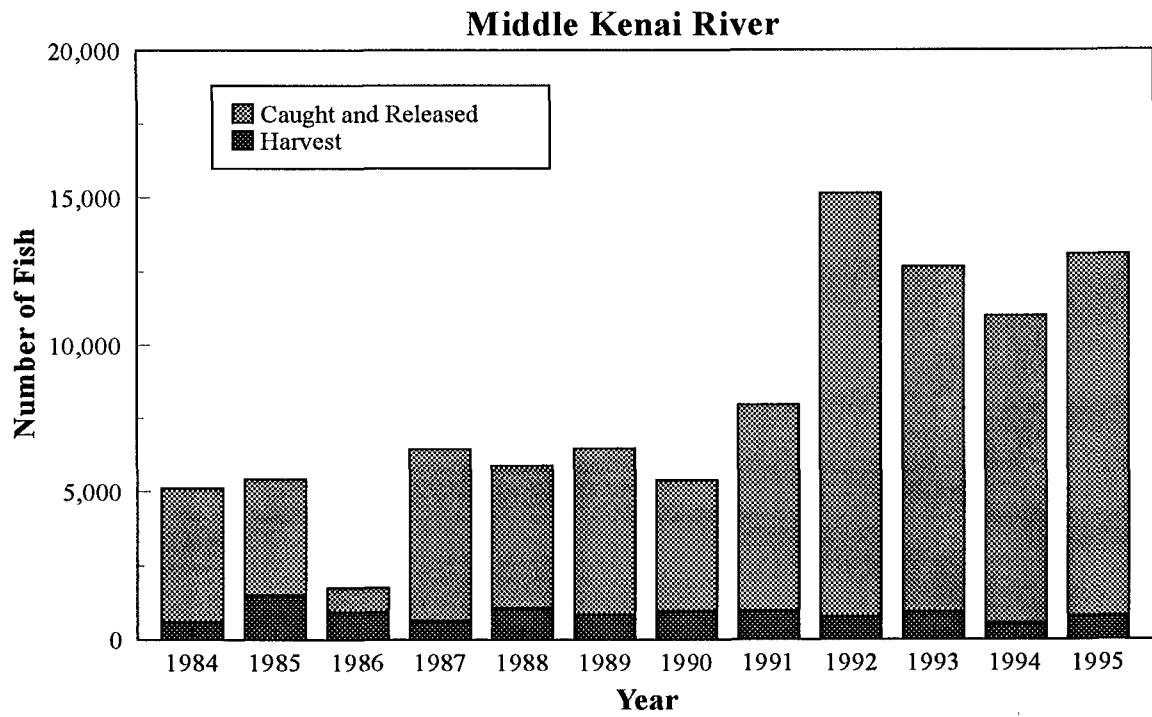
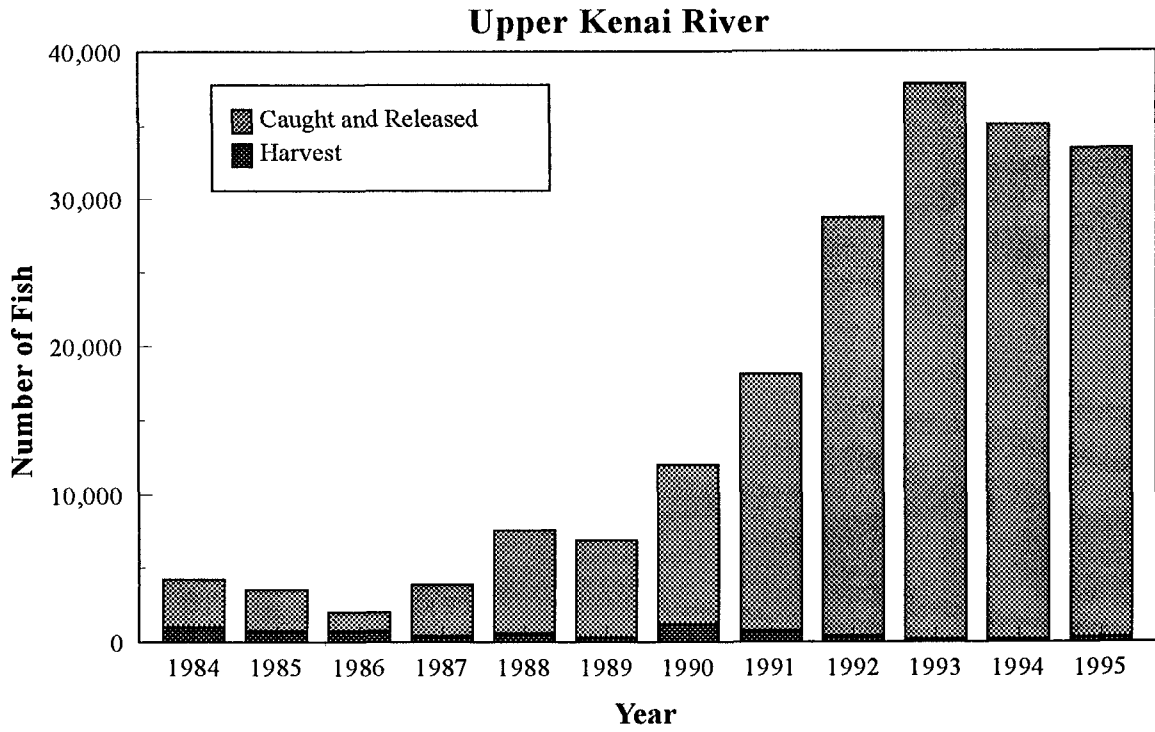


Figure 2 — Estimates of catch and harvest of rainbow trout in the upper and middle sections of the Kenai River from 1984 to 1995 (Mills 1985-1994; Nelson 1995, Howe et al 1995,1996)

flows another 17 km to Naptowne Rapids. Below Naptowne Rapids, the river flows another 63 km to Cook Inlet.

Discharge in the Kenai River depends on the outflow of Kenai and Skilak lakes and lacks the flow extremes characteristic of streams without headwater lakes. The mean annual discharge in the Kenai River at Soldotna is approximately 167 m³/s with summer flows ranging from 142 to 850 m³/s (Bigelow et al 1985). Glacial melt produces turbid conditions throughout the year, but water clarity improves during winter months when flows range from 23 to 142 m³/s.

Major tributaries that enter the Kenai River above Naptowne Rapids include the Killey River which empties into the Kenai River at river mile (RM) 44, the Skilak River which contributes melt water from Skilak Glacier at the east end of Skilak Lake, and the Russian River at RM 73.8

Methods

Radio telemetry was used to describe the migratory behavior and seasonal distribution of rainbow trout in the Kenai River. Seventy-nine rainbow trout (>350 mm fork length) were surgically implanted with radio transmitters during July-September 1995. Transmitters were implanted in 40 fish between Skilak and Kenai lakes and 39 fish between Naptowne Rapids and Skilak Lake (Figure 1). Hook-and-line gear was used to capture fish for radio transmitter implants.

Implanting Transmitters

Rainbow trout to receive radio transmitters were anesthetized in a 100 mg/L solution of tricaine methanesulfate (MS-222) and water. A fish was considered ready for surgery when a slight loss of equilibrium was reached (stage 3 anesthesia; Summerfelt and Smith 1990). The fish was then placed ventral side up in a neoprene-lined cradle and a 12-15 mm incision was made 2-3 cm anterior to the pelvic girdle, just large enough for the transmitter to be inserted into the peritoneal cavity. The external antenna was routed under the pelvic girdle and through the body wall slightly off the mid-ventral line and anterior to the vent. Oxytetracycline was administered intraperitoneally at a dosage of 0.5 mg/kg body weight to prevent infection. The incision was closed with three or four individual stitches of absorbable suture and Vetbond[®] adhesive. All surgical instruments and transmitters were soaked in a cold sterilant and rinsed in saline solution before use. Total surgery time averaged six minutes. Fish were swimming upright and respiring normally within 3-5 minutes of being returned to a freshwater holding tank. Fish were released near the capture site once they gained equilibrium. These surgical procedures were similar to those described by Hart and Summerfelt (1975) and Ross and Kleiner (1982).

Radio transmitters (Lotek[®] model CFRT-3EM) measured 48 mm in length and 10 mm in diameter and were equipped with a 30-cm plastic coated wire antenna. Transmitter weight (8.1 g in air) was less than 2% of the fish weight, as recommended by Winter (1983). Transmitters were equipped with 390-d batteries, and each operated with a unique digital code on one of four frequencies between 150 and 151 MHz.

Locating Radio-Tagged Rainbow Trout

Movements of radio-tagged rainbow trout were documented using a combination of fixed stations and aerial and ground-based surveys. Receivers used for tracking were the SRX 400 receiver/datalogger (Lotek Engineering Incorporated[®]).

Ground-based tracking was conducted from a boat and on foot. The Kenai River above Naptowne Rapids was surveyed by drift boat once a week from 18 August to 28 November 1995 and from 7 May to 20 November 1996. An additional 22 tracking surveys were conducted below Naptowne Rapids during the study period. A four-element Yagi antenna attached to a 2.4-m mast was used to locate radio-tagged rainbow trout. A portable global positioning system (GPS) was used to determine the latitude and longitude of each located fish. Observers estimated the river mile location (nearest 0.1 RM) of radio-tagged fish from a navigation map of the mainstem Kenai River. Ground-based tracking on foot occurred weekly on the lower Russian River from 22 May through 27 June 1996. A hand-held H-antenna and portable GPS were used to determine fish locations during foot surveys.

Aerial tracking was conducted at least once each month from August 1995 through November 1996. Surveys were conducted from a PA-18 fixed-wing aircraft equipped with two H-antennas, one mounted on each wing strut. The aerial survey was conducted at 200-300 m above ground-level along the Kenai River and shorelines of Skilak and Kenai lakes. Tributary watersheds also were surveyed periodically to document movement out of the mainstem Kenai River. The latitude and longitude of each fish was determined from the aircraft GPS.

Three fixed stations were installed at strategic locations to automatically monitor the timing and identities of fish moving into or out of Skilak and Kenai lakes (Figure 1). Each fixed station consisted of two Yagi antennas and a receiver/datalogger powered by a 12-V deep cycle battery. The use of two antennas allowed us to determine the direction of travel of fish near fixed-station-sites. Solar panels were installed at each station to charge the 12-V battery. Fixed stations were operated from 22 August through 28 November 1995 and from 7 May through 20 November 1996. Cold temperatures, reduced light, and poor access to sites prohibited operation of fixed stations during winter months. During operation, fixed stations were visited weekly to check operation of the station, check or replace the 12-V battery and download data from the receiver/datalogger.

Data Analysis

Information collected with various tracking methods was integrated into one database to archive the dates and locations of each radio-tagged rainbow trout. Locations were recorded as latitude and longitude coordinates and displayed on a geographic coverage of the Kenai River watershed using ArcView® software. The study period for each radio-tagged rainbow trout was defined as the number of days between transmitter implantation and the date of final radio contact or last observed movement. A radio-tagged rainbow trout was considered dead or to have expelled the transmitter when the transmitter was recovered during a ground survey, or the transmitter signal did not move from a specific location during a period when radio-tagged fish were seasonally migrating.

Distances between consecutive locations were used to describe movement of radio-tagged rainbow trout. Lake distances (Skilak and Kenai lakes) were calculated as shortest distance (nearest 0.1 km) between two consecutive locations. River distances (Kenai and Killey rivers) were calculated to the nearest 0.1 RM and then converted to metric units. The “home range” of individual rainbow trout which were tracked for one year or more was defined as the distance between the furthest upstream and downstream location.

Results

Fish Survival and Transmitter Retention

Nineteen (24%) of the 79 radio-tagged rainbow trout disappeared, died, or expelled their transmitters during 1995 (Appendix A). Of the remaining 60 fish, 58 survived and retained their transmitters through the winter. From May through August 1996, an additional 20 fish disappeared, died, or expelled their transmitters including five that were harvested by anglers below Skilak Lake. Nearly half ($N=38$) of the radio-tagged rainbow trout provided movement information for more than one year.

Rainbow Trout Radio-Tagged Above Skilak Lake

From 27 July through 22 August 1995, 40 rainbow trout were captured with hook-and-line in the Kenai River above Skilak Lake (upper river) and implanted with radio transmitters (Appendix A). Radio-tagged fish were captured between RM 65.7 and 80.9 and ranged from 355-662 mm fork length. Locations of individual rainbow trout radio-tagged above Skilak Lake are shown in Appendix B.

Movement of radio-tagged rainbow trout from upper river locations to overwintering areas began in late September and was completed by late November (Figure 3). The majority of

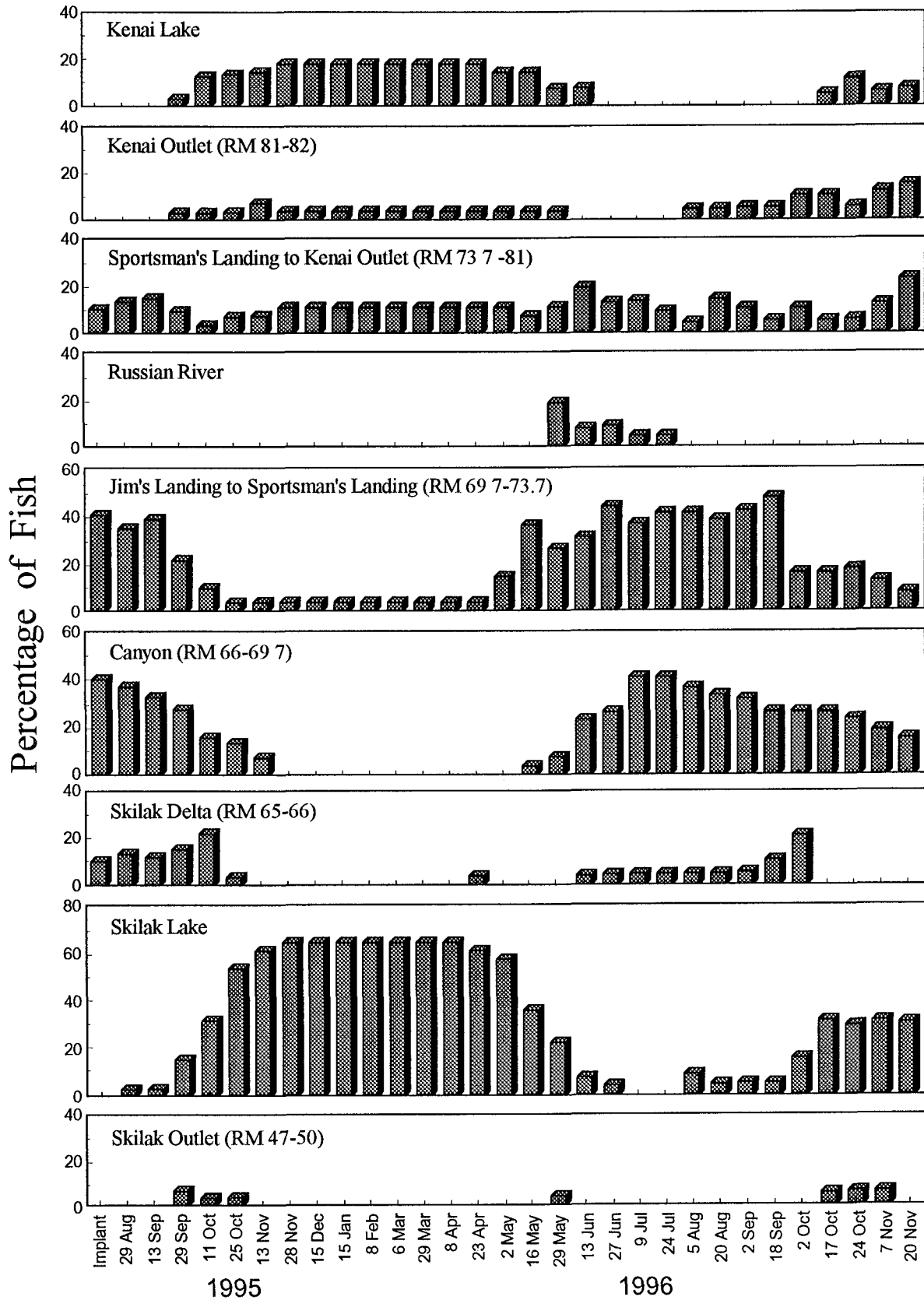


Figure 3 — Seasonal distribution of rainbow trout that were radio-tagged above Skilak Lake. Transmitters were implanted from 27 July through 22 August 1995.

fish selected overwintering areas in Skilak Lake (64%), while others overwintered in Kenai Lake (18%) and river locations between Skilak and Kenai lakes (18%) Rainbow trout overwintering in lakes traveled more extensively during the winter months than fish overwintering in the river (Appendix B). Rainbow trout in Skilak and Kenai lakes traveled an average distance of 49 km during the winter period Fish overwintering in the Kenai River generally remained within a 1-km section of river for the entire winter.

Movement of rainbow trout from overwintering areas in Skilak and Kenai lakes to spawning and feeding locations in the upper Kenai River occurred during May and June Five radio-tagged fish entered the Russian River during the spawning period in late May and early June (Figure 4) Most radio-tagged rainbow trout remained in the lower 500 m of the Russian River or confluence area during the spawning period, however, one fish (# 168) was located approximately 2 km upstream from the confluence with the Kenai River on two separate occasions (29 May and 4 June). Other than in the Russian River, radio-tagged rainbow trout did not concentrate in any specific area during spawning. Some radio-tagged fish were found in the numerous side channels between the Russian/Kenai River confluence and Jim's Landing during the spawning period, but it was difficult to determine if spawning fish were present because of glacial turbidity

From mid-June through late September, most radio-tagged rainbow trout were located at feeding areas between Skilak and Kenai lakes (Figure 3). The majority (70-82%) of rainbow trout selected feeding areas between Jim's Landing and Sportsman's Landing (RM 69 7-73 7) or in the Kenai River canyon (RM 66-69 7). The remaining fish were located above Sportsman's Landing, Skilak delta (RM 65-66), or in the Russian River Three radio-tagged rainbow trout entered Skilak Lake during the summer period, but each fish spent less than two weeks in the lake.

Upper river rainbow trout exhibited strong fidelity to summer feeding and overwintering areas. Of the 21 fish which were tracked for one year or more, 20 spent most of the summer in the same section of river where they were tagged the previous summer Similarly, all 12 fish that were tracked to overwintering areas in 1996-97 selected the same area as in 1995-96. All four rainbow trout that spent a second winter in the Kenai River generally selected sites within 200 m of overwintering sites chosen the previous year

Radio-tagged rainbow trout from the upper Kenai River occasionally were found in the outlet (RM 47-50) below Skilak Lake (Figure 3) Of the seven fish which traveled below Skilak Lake, five entered this section of river between late September and early November in either 1995 or 1996 Residence time in this section of river was less than a week for three

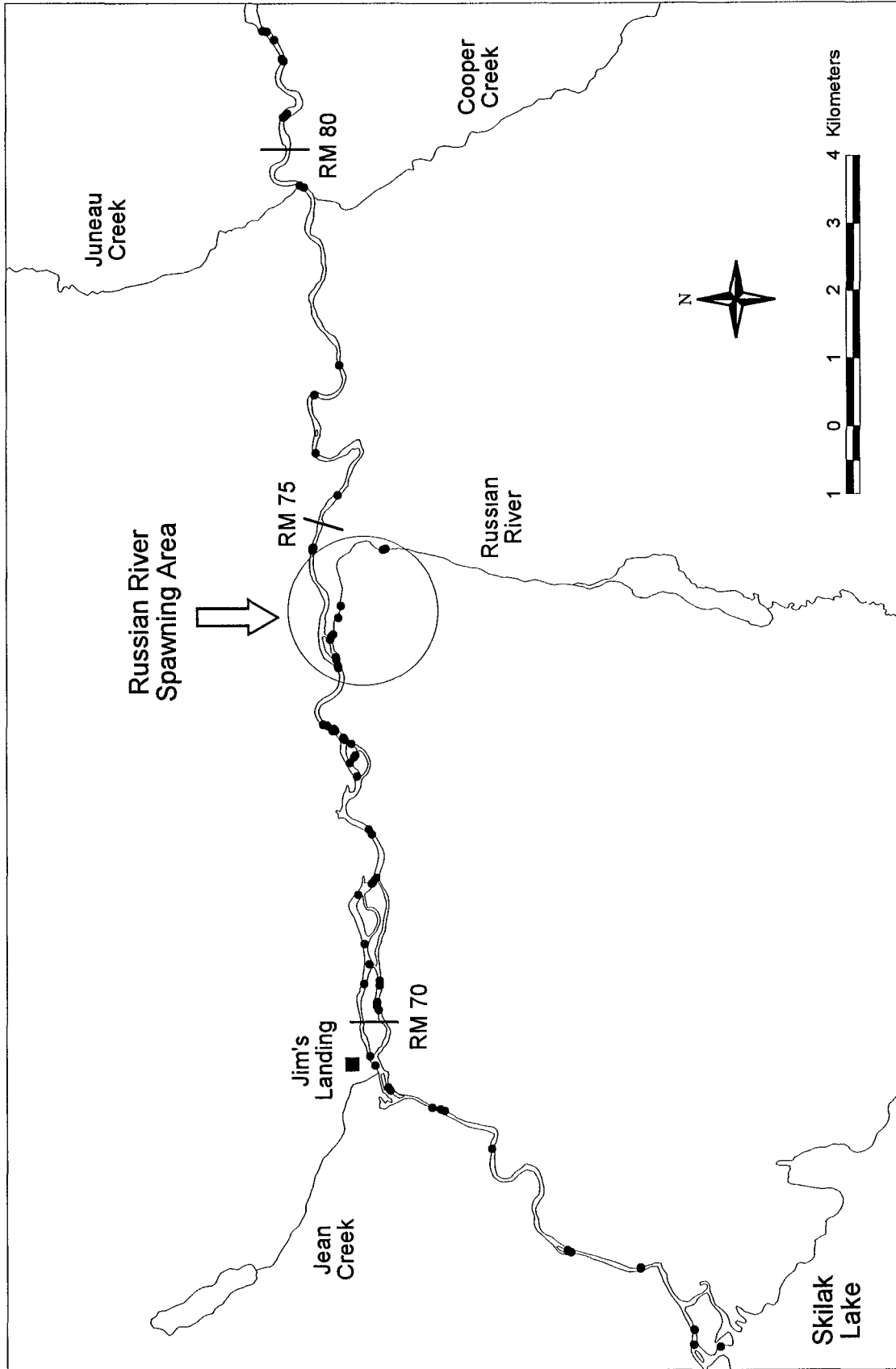


Figure 4.— Locations of radio-tagged rainbow trout in the upper Kenai River from 15 May through 15 June, 1996

of the fish, however, two fish remained here for about a month. Two other upper river fish entered the river below Skilak Lake during May 1996, but stayed less than five days.

Rainbow Trout Radio-Tagged Below Skilak Lake

From 28 August through 15 September 1995, 39 rainbow trout were captured with hook-and-line in Kenai River below Skilak Lake (middle river) and implanted with radio transmitters (Appendix A). Radio-tagged fish were captured between RM 40.0 and 47.9 and ranged from 353-617 mm fork length. Locations of individual rainbow trout radio-tagged below Skilak Lake are shown in Appendix C.

Movement of radio-tagged rainbow trout from middle river locations to overwintering areas began in late September and was completed by mid-December (Figure 5). The majority of rainbow trout selected overwintering areas in Skilak Lake (72%) and the outlet (RM 47-50) below Skilak Lake (19%). Two rainbow trout spent some of the winter period in the outlet below Skilak Lake and the remainder of the winter in the lake. One rainbow trout (# 163) overwintered in the river between RM 42 and 44. Like the winter movement patterns observed for upper river fish, rainbow trout from the middle river that overwintered in Skilak Lake traveled more extensively than fish overwintering in river locations (Appendix C). Rainbow trout in Skilak Lake traveled an average distance of 39 km during the winter period compared to fish overwintering below Skilak Lake which generally remained within a 1-km section of river for the entire winter.

Rainbow trout moved from overwintering areas to spawning and feeding locations in the middle Kenai River during May. During the suspected spawning period of 15 May - 15 June, radio-tagged fish were located between RM 35.5 and 49.8 (Figure 6). The largest concentration of radio-tagged rainbow trout observed during this period ($N=7$) occurred between RM 47 and 48. This section of river is characterized by extensive gravel bars which should provide excellent spawning habitat, but it was difficult to determine if spawning fish were present because of glacial turbidity.

From mid-June through late August, the majority of radio-tagged rainbow trout were located between RM 19.6 and 47.0 (Figure 5). About half of the radio-tagged fish selected feeding areas above Bing's Landing (RM 39.5). The remaining fish were located below Bing's Landing or in the Killey River. One rainbow trout (# 125) was located at RM 19.6 below the Soldotna bridge from late June through mid-September. Two rainbow trout (#'s 117 and 141) were located in the Killey River during June and July. Both fish remained in the Killey River for 5-6 weeks and were observed as many as 15 kilometers above the river mouth.

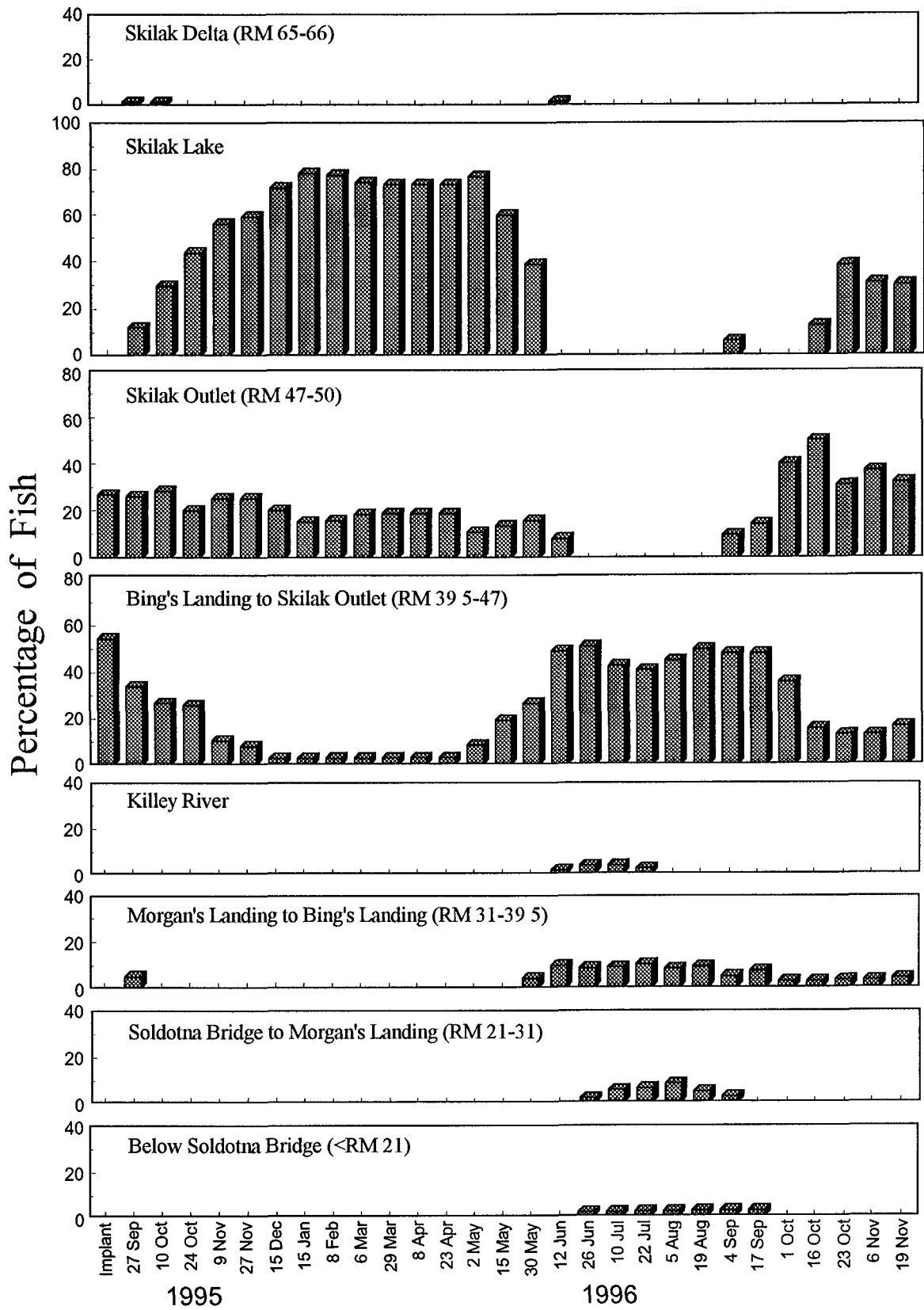


Figure 5 — Seasonal distribution of rainbow trout that were radio-tagged below Skilak Lake. Transmitters were implanted from 28 August through 15 September 1995.

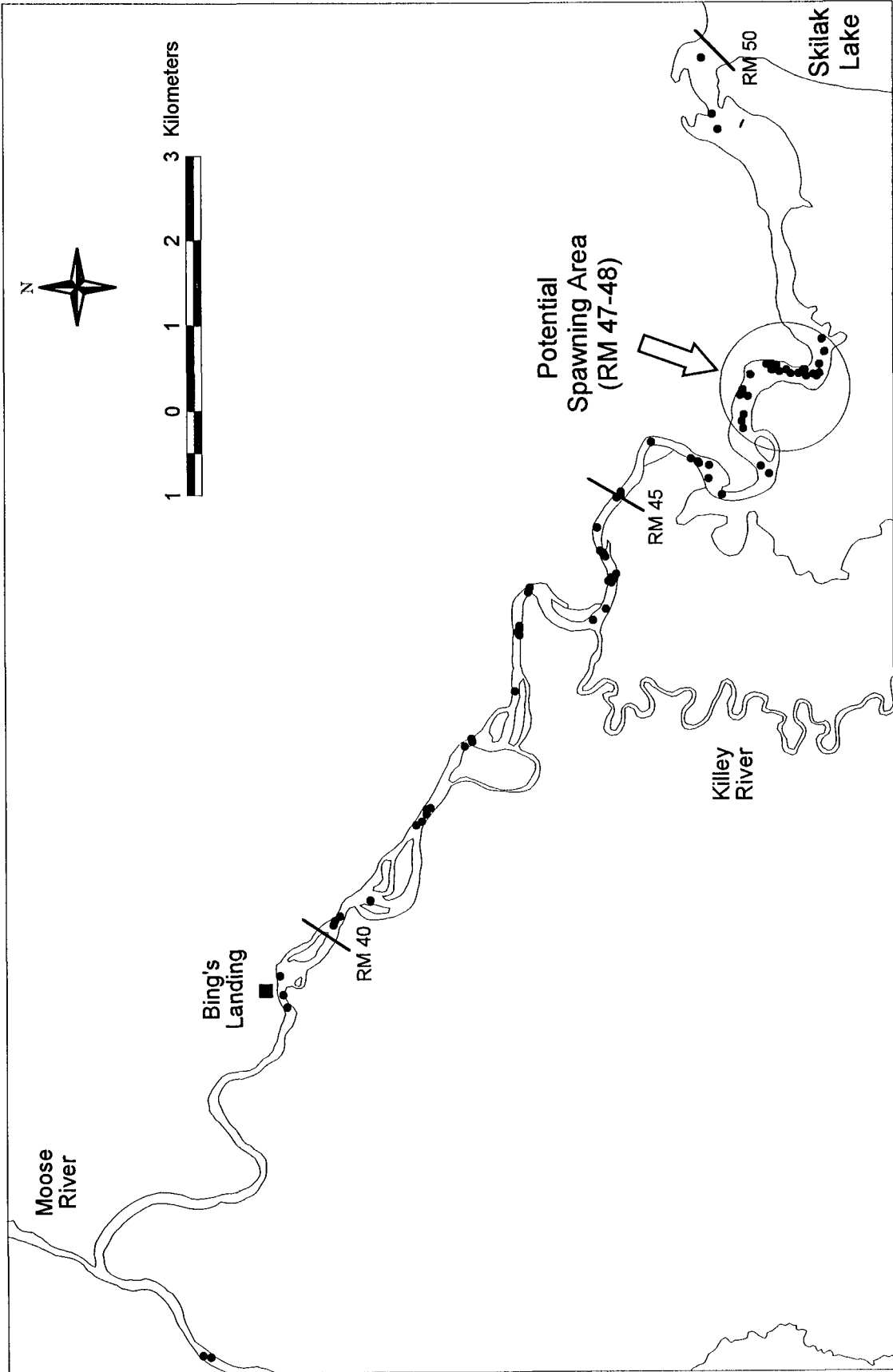


Figure 6 — Locations of radio-tagged rainbow trout in the middle Kenai River from 15 May through 15 June, 1996.

Beginning in September, many rainbow trout which spent the summer at feeding locations below RM 47.0 moved upriver toward Skilak Lake (Figure 5). By 16 October, 75% ($N=12$) of the radio-tagged fish had moved upriver into the outlet ($N=10$) or Skilak Lake ($N=2$). By late October, three of the outlet fish moved to overwintering locations in Skilak Lake.

Middle river rainbow trout exhibited strong fidelity to overwintering areas. Of the 14 fish that were tracked to overwintering areas in 1996-97, 11 had returned to the same area used for overwintering in 1995-96. Ten of the 11 fish selected overwintering locations in the outlet ($N=4$) or Skilak Lake ($N=6$). One rainbow trout (# 163) began the winter period at RM 42.6 within 100 m of where it spent most of the previous winter. The three rainbow trout that did not begin the winter at sites selected the previous winter, may have eventually moved to these locations, but most fish could not be tracked beyond late November because transmitter batteries had expired.

Rainbow trout radio-tagged in the middle Kenai River occasionally entered the delta (RM 65-66) above Skilak Lake (Figure 5). Of the three fish that traveled above Skilak Lake, two (#'s 137 and 169) were located in this section of river during late September and early October 1995 and the other fish (# 97) was observed here in early June 1996. Residence time in this section of river was less than a week for two of the fish, but fish # 169 remained here nearly a month.

Geographic Range

The geographic range of radio-tagged rainbow trout extended from RM 19.6 to the upper end of Kenai Lake, a distance of nearly 140 km (Figure 7). Rainbow trout radio-tagged above Skilak Lake were never located below RM 47 and rainbow trout radio-tagged below Skilak Lake were never located above RM 65.8. Both groups of fish used Skilak Lake as their primary overwintering area, but each group had a high level of fidelity to the section of river where radio transmitters were implanted.

Home ranges of radio-tagged rainbow trout ranged from 4-61 km for fish that were tracked for one year or more (Figure 8). Most rainbow trout (82%) had home ranges between 11 and 50 km. Five rainbow trout had a home range more than 50 km and two had home ranges less than 10 km. Rainbow trout radio-tagged above Skilak Lake had a mean home range of 28 km compared to 33 km for rainbow trout radio-tagged below Skilak Lake.

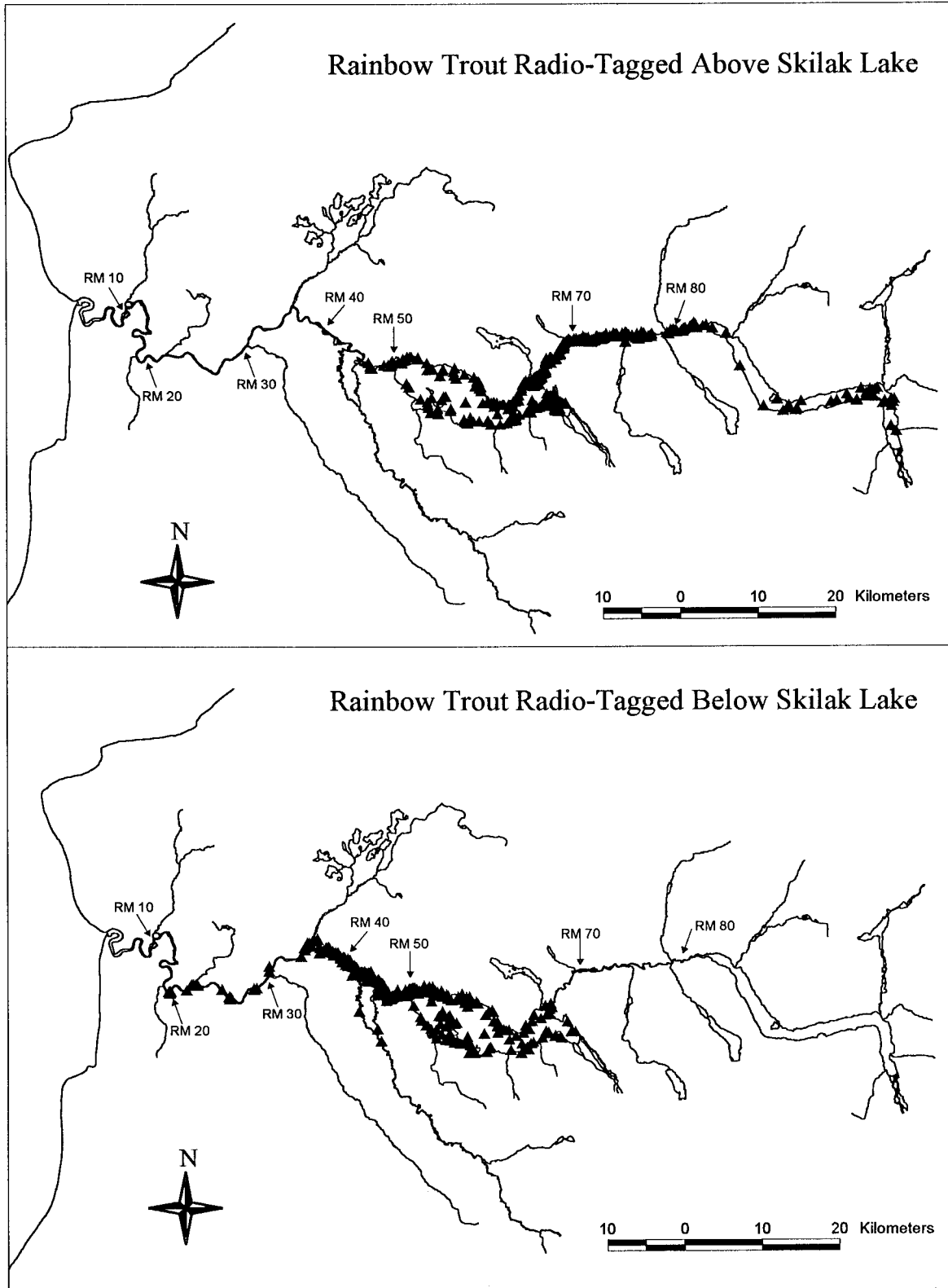


Figure 7.— Tracking locations (black triangles) of all rainbow trout radio-tagged above and below Skilak Lake for the period 27 July 1995 through 22 November 1996

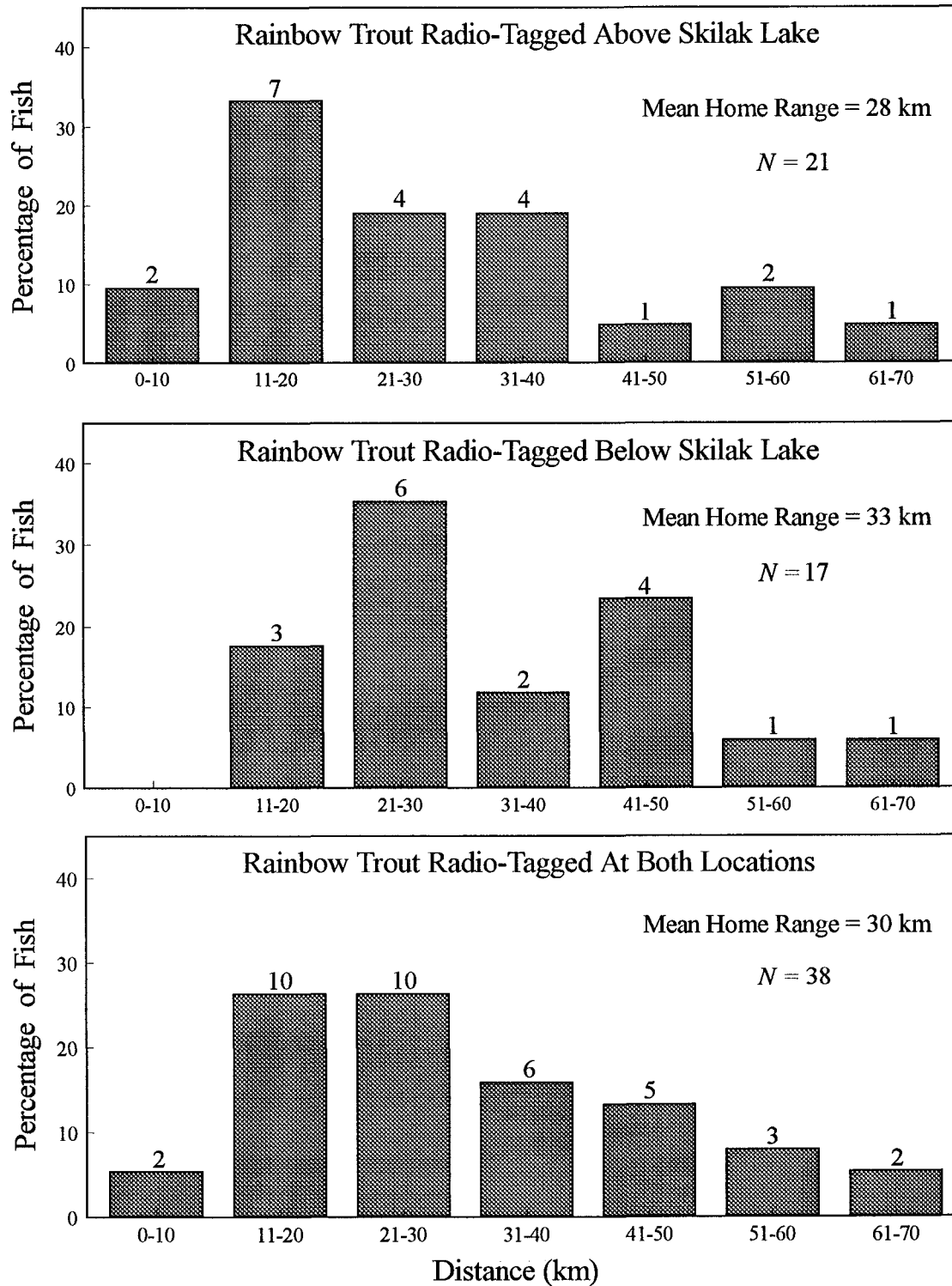


Figure 8 — Home range of radio-tagged rainbow trout defined as the distance between the farthest upstream and downstream locations of individual fish in the Kenai River watershed. Includes only fish that were tracked for more than one year. Sample size is indicated above each bar.

Discussion

When interpreting the results of this radio telemetry study, I assumed that the behavior of radio-tagged rainbow trout was similar to that of untagged rainbow trout. Anglers that caught or harvested rainbow trout with transmitters reported that these fish appeared in good condition. In most cases, the incision was completely healed and little or no abrasion resulted from the external antenna. Rainbow trout radio-tagged during this study ranged from 352-662 mm fork length, therefore, results can only be applied to rainbow trout in this size range.

Rainbow trout radio-tagged in the Kenai River selected overwintering areas in both lake and riverine habitats. Most (91%) rainbow trout overwintered in either Skilak or Kenai lakes or in outlet reaches below these lakes. These habitats provide the best refuge from severe conditions that can occur during winter months in northern systems (Northcote 1997). Using these overwintering habitats makes the most bioenergetic sense because energy costs associated with activity would typically be less in habitats with little or no flow (Adams and Breck 1990). Despite the possible drawbacks of overwintering in a riverine habitat, some radio-tagged rainbow trout (9%) did overwinter in the Kenai River. These fish may belong to fluvial subpopulations which remain in the mainstem Kenai River for the entire year.

Fidelity to summer feeding areas and overwintering areas was very strong. Fidelity to feeding areas could only be evaluated for rainbow trout radio-tagged above Skilak Lake that were tracked for one year or longer ($N=21$), however, nearly all (95%) of these fish spent most of their second summer in the same section of river where they were tagged the previous summer. Similarly, the level of fidelity to overwintering areas was strong for rainbow trout radio-tagged above and below Skilak Lake. Rainbow trout overwintering at river locations were typically found within 200 m of overwintering sites chosen the previous year, rainbow trout overwintering in lakes returned to the same lakes the following winter. Northcote (1997) reports that several salmonid species display considerable site fidelity to feeding and survival habitats, and, in many cases, fidelity to these habitats remains similar between successive generations.

The Russian River is an important spawning area for rainbow trout above Skilak Lake. Spawners begin entering the Russian River during early May with peak spawner abundance usually occurring in late May or early June. During 1996, spawner counts conducted by the Alaska Department of Fish and Game peaked at 519 fish on 29 May (D. Athons, Alaska Department of Fish and Game, Soldotna, personal communication). This timing correlates well with the occurrence of radio-tagged rainbow trout in the Russian River, when five fish were located on 29 May.

Although glacial turbidity made it difficult to determine if radio-tagged rainbow trout were spawning in the Kenai River above and below Skilak Lake, some spawning likely occurs

there. Several areas in the main channel and side channels are characterized by extensive gravel bars that should provide excellent spawning habitat for rainbow trout. The spawning period in the Kenai River may occur later than that observed in the Russian River because of differences in water temperature. Water temperatures in the Russian River ranged from 11-13°C between 29 May and 4 June 1996. During the same period, water temperatures in the Kenai River ranged from 6-8°C. If the thermal requirements of spawners in the Kenai River are similar to rainbow trout spawning in the Russian River, the peak spawning period in the Kenai River may occur closer to mid-June when main channel temperatures approach 10°C.

Results from this study suggest that discrete stocks of rainbow trout occur above and below Skilak Lake. Rainbow trout radio-tagged in the Kenai River above Skilak Lake had a high level of fidelity to that section of river. Similarly, rainbow trout radio-tagged in the Kenai River below Skilak Lake had a high level of fidelity to that section of river. Findings of other studies have drawn similar conclusions. Miller et al. (*In Preparation*) performed genetic analyses of mitochondrial DNA variation for rainbow trout tissue samples collected from above and below Skilak Lake. Two genotypes occurred in both collections, but in significantly different proportions. The most common genotype in rainbow trout collected below Skilak Lake (56%) was the least common in rainbow trout collected above Skilak Lake (4%). These genetic findings were concordant with the radio telemetry findings, indicating the possibility of two or more semi-isolated stocks. Evidence of population substructuring also was observed by Lafferty (1989) during a mark-recapture experiment conducted in 1986 and 1987. Lafferty (1989) observed some movement of Floy-tagged rainbow trout within the mainstem Kenai River and tributaries, but no movement was observed across Skilak Lake.

Management Considerations

Knowledge of the migrations and specific habitat requirements (spawning, feeding, and overwintering areas) of rainbow trout in the Kenai River is essential for formulating and improving management strategies. Findings from this study and others (Miller et al. *In Preparation*, Lafferty 1989) indicate that rainbow trout above and below Skilak Lake represent distinct stocks. Management strategies have been based on that assumption for several years. Other findings from this study indicate that while most rainbow trout overwinter in a lake or lake outlet, some overwinter in the Kenai River. Rainbow trout which spend the entire year in the Kenai River may belong to a fluvial subpopulation that is genetically distinct from fish that overwinter in a lake. Genetic differences between these groups of fish need to be examined.

Important spawning areas for rainbow trout in the Kenai River watershed are the mainstem river and Russian River. The Russian River has always been recognized as an important spawning area for rainbow trout above Skilak Lake and the spawning period has been well documented. Specific areas and timing of spawning in the Kenai River are less understood.

and have been difficult to assess because glacial turbidity interferes with visual observations. Locations of radio-tagged rainbow trout during the suspected spawning period have provided some insight into areas important for spawning, however, a more detailed assessment would assist managers in refining existing regulations.

Acknowledgments

Special appreciation is extended to Ted Otis, John Tobin, Brad Benter, Ken Gates, John Linderman, Lance Beckman, Jerry Sizemore, Sheri Faulkner and many others who assisted with field activities. There were a number of Kenai River fishing guides who assisted the crew during tagging, notably Andy Szczesny and Kurt Muse. Rip Shively provided invaluable instruction and insights in surgical techniques and radio tracking. Thanks to pilots Rick Ernst and Rick Johnston who assisted with aerial tracking surveys. Appreciation is also extended to Steve Klosiewski for biometrical assistance.

References

- Adams, S.M. and J.E. Breck. 1990 Bioenergetics Pages 389-415 *in* C.B. Schreck and P.B. Moyle, editors Methods for Fish Biology American Fisheries Society, Bethesda, Maryland
- Bigelow, B B , R D Lamke, P J Still, J L Van Maanen, and J.E Vaill 1985 Water resources data, Alaska, water year 1984 U S Geological Survey, Water Data Report AK-84-1, Anchorage
- Hart, L G. and R C Summerfelt 1975 Surgical procedures for implanting ultrasonic transmitters into flathead catfish *Pylodictis olivaris*. Transactions of the American Fisheries Society 1.56-59
- Hayes, S.R and J J Hasbrouck 1996 Stock assessment of rainbow trout in the upper Kenai River, Alaska, in 1995 Alaska Department of Fish and Game, Fishery Data Series Number 96-43, Anchorage
- Howe, A L , G Fidler, and M J Mills 1995 Harvest, catch, and participation in Alaska sport fisheries during 1994 Alaska Department of Fish and Game, Fishery Data Series Number 95-24, Anchorage
- Howe, A L., G Fidler, A E. Bingham, and M J Mills 1996 Harvest, catch, and participation in Alaska sport fisheries during 1995. Alaska Department of Fish and Game, Fishery Data Series Number 96-32, Anchorage
- Lafferty, R 1989 Population dynamics of rainbow trout, Kenai River, Alaska Masters Thesis, University of Alaska, Fairbanks
- Miller, S , M A Cronin, W J Spearman, and D E Palmer *In Preparation* Genetic differentiation of rainbow trout *Oncorhynchus mykiss* in the Kenai River, Alaska. U.S Fish and Wildlife Service, Alaska Fisheries Technical Report Number __, Anchorage, Alaska
- Mills, M J 1991 Harvest, catch, and participation in Alaska sport fisheries during 1990 Alaska Department of Fish and Game, Fishery Data Series Number 91-58, Anchorage
- Mills, M J 1992 Harvest, catch, and participation in Alaska sport fisheries during 1991 Alaska Department of Fish and Game, Fishery Data Series Number 92-40, Anchorage
- Mills, M J 1993 Harvest, catch, and participation in Alaska sport fisheries during 1992. Alaska Department of Fish and Game, Fishery Data Series Number 93-42, Anchorage
- Mills, M.J 1994 Harvest, catch, and participation in Alaska sport fisheries during 1993 Alaska Department of Fish and Game, Fishery Data Series Number 94-28, Anchorage

- Nelson, D. 1995 Area management report for the recreational fisheries of the Kenai Peninsula, 1994. Alaska Department of Fish and Game, Fishery Management Report Number 95-4, Anchorage.
- Ross, M J and C F. Kleiner. 1982 Shielded-needle technique for surgically implanting radio-frequency transmitters in fish *Progressive Fish Culturist* 44 41-43
- Summerfelt, R C and L S Smith 1990 Anesthesia, surgery, and related techniques Pages 213-272 *in* C B Schreck and P B Moyle, editors *Methods for Fish Biology*. American Fisheries Society, Bethesda, Maryland
- Winter, J.D. 1983 Underwater biotelemetry Pages 371-395 *in* L.A Nielsen and D.L. Johnson, editors *Fisheries Techniques*. American Fisheries Society, Bethesda, Maryland

Appendix A.— Tracking history summaries of radio-tagged rainbow trout in the Kenai River during 1995 and 1996.

Transmitter code number	Fork length (mm)	Implant location (river mile)	Study dates ^a	Study period (d)	Number of observations during study period ^b
Upper River RadioTransmitter Implants					
90	372	69.3	27 Jul 95 - 16 Sep 95	52 ^c	9
92	385	66.2	27 Jul 95 - 26 Aug 96	397 ^d	33
94	427	66.2	27 Jul 95 - 7 Nov 96	470	47
96	403	70.2	8 Aug 95 - 8 Nov 96	459	41
100	535	67.1	8 Aug 95 - 7 Nov 96	458	51
106	499	71.1	9 Aug 95 - 10 Oct 96	429	41
136	447	73.9	9 Aug 95 - 7 Nov 96	457	50
118	505	65.7	10 Aug 95 - 20 Nov 96	469	45
132	479	68.9	10 Aug 95 - 1 Nov 96	450	48
164	424	67.3	10 Aug 95 - 31 Oct 95	83 ^c	12
116	399	71.8	14 Aug 95 - 13 Jun 96	305 ^d	21
128	498	70.5	14 Aug 95 - 7 Nov 96	452	41
134	371	71.8	14 Aug 95 - 20 Oct 95	68 ^d	3
162	414	71.3	14 Aug 95 - 3 Aug 96	356	36
98	551	68.9	15 Aug 95 - 17 Oct 96	430	37
104	380	66.2	15 Aug 95 - 27 Jun 96	318 ^d	27
108	360	65.7	15 Aug 95 - 6 Sep 95	23 ^d	2
114	555	67.3	15 Aug 95 - 8 May 96	268 ^d	25
130	535	68.9	15 Aug 95 - 5 Oct 95	52 ^c	2
140	458	67.3	15 Aug 95 - 20 Aug 96	372 ^d	34
152	662	65.7	15 Aug 95 - 4 Jun 96	295 ^d	21
154	537	67.3	15 Aug 95 - 22 Nov 96	466	51
168	632	68.4	15 Aug 95 - 24 Oct 96	437	49
102	355	74.6	16 Aug 95 - 20 Nov 96	463	50
112	466	77.8	16 Aug 95 - 5 Oct 95	51 ^c	8
138	445	80.9	16 Aug 95 - 20 Nov 96	463	56
148	386	72.2	16 Aug 95 - 25 Oct 96	437	37
150	454	72.2	16 Aug 95 - 11 Oct 95	57 ^d	8
120	522	69.9	17 Aug 95 - 9 Nov 95	85 ^d	18
122	492	72.2	17 Aug 95 - 22 Nov 96	464	44
146	561	72.2	17 Aug 95 - 20 Nov 96	462	40
160	584	72.0	17 Aug 95 - 25 Aug 95	9 ^c	3
88	580	71.6	21 Aug 95 - 20 Nov 96	458	50
126	523	70.1	21 Aug 95 - 20 Nov 96	458	48
144	593	70.3	21 Aug 95 - 7 Jun 96	292 ^c	22

Appendix A.— (Continued)

Transmitter code number	Fork length (mm)	Implant location (river mile)	Study dates ^a	Study period (d)	Number of observations during study period ^b
156	514	70 1	21 Aug 95 - 27 Jun 96	312 ^c	24
110	464	67 3	22 Aug 95 - 13 Sep 95	23 ^d	6
124	452	68 9	22 Aug 95 - 17 Oct 96	423	33
142	498	67.3	22 Aug 95 - 7 Sep 95	17 ^d	3
166	446	65 7	22 Aug 95 - 30 Aug 95	9 ^c	5

Middle River RadioTransmitter Implants

91	384	46 3	28 Aug 95	0 ^c	0
93	505	40 0	28 Aug 95 - 16 Oct 96	416	37
115	441	41 5	28 Aug 95 - 10 Jul 96	318 ^d	20
121	387	46 3	28 Aug 95 - 21 Oct 96	421	40
133	405	46 3	28 Aug 95 - 6 Nov 96	437	46
145	442	41 5	28 Aug 95 - 19 Jun 96	297 ^d	22
159	467	46 7	28 Aug 95 - 10 Oct 95	44 ^d	8
161	380	43 0	28 Aug 95 - 6 Mar 96	192 ^c	12
95	367	44 6	29 Aug 95 - 19 Nov 96	449	45
157	353	46 8	29 Aug 95 - 1 Nov 96	431	44
113	508	43 0	30 Aug 95 - 7 Aug 96	344 ^e	28
125	452	47.5	30 Aug 95 - 6 Nov 96	435	42
131	418	48 2	30 Aug 95 - 19 Nov 96	448	47
143	388	41 5	30 Aug 95 - 20 Oct 95	52 ^d	1
169	474	47 5	30 Aug 95 - 16 Jun 96	292 ^c	19
97	532	47 9	31 Aug 95 - 19 Nov 96	447	41
105	505	45 0	31 Aug 95 - 30 May 96	274 ^c	15
119	477	46 4	31 Aug 95 - 15 Jan 96	138 ^d	11
123	549	46 4	31 Aug 95 - 21 Sep 95	22 ^c	2
139	585	47 9	31 Aug 95 - 4 Oct 95	35 ^d	6
141	457	41 2	31 Aug 95 - 19 Nov 96	447	44
155	431	46 4	31 Aug 95 - 6 Jul 96	311 ^c	25
167	420	41 5	31 Aug 95 - 5 Jun 96	280 ^d	15
99	501	40 0	06 Sep 95 - 21 Sep 95	16 ^d	1
101	472	42 9	06 Sep 95 - 19 Nov 96	441	47
103	378	47 4	06 Sep 95 - 26 Jun 96	295 ^d	17
127	553	40.0	06 Sep 95 - 4 Oct 95	29 ^d	4
129	453	46 4	06 Sep 95 - 1 Jul 96	300 ^c	25
137	489	45 0	06 Sep 95 - 22 Nov 96	444	37
163	436	46 4	06 Sep 95 - 19 Nov 96	441	43

Appendix A — (Continued)

Transmitter code number	Fork length (mm)	Implant location (river mile)	Study dates ^a	Study period (d)	Number of observations during study period ^b
109	478	47.5	08 Sep 95 - 28 Aug 96	356 ^c	23
135	612	47.7	08 Sep 95 - 16 Oct 96	405	37
147	525	47.2	08 Sep 95 - 16 Oct 96	405	31
165	431	47.7	08 Sep 95 - 15 Oct 96	404	25
89	453	47.5	11 Sep 95 - 4 Oct 96	390	37
117	482	41.5	11 Sep 95 - 31 Jul 96	325 ^d	22
151	458	47.5	11 Sep 95 - 15 Jul 96	309 ^c	28
107	617	47.5	15 Sep 95 - 25 Oct 96	407 ^d	41
153	444	40.0	15 Sep 95 - 10 Jul 96	300 ^d	19

^a From implantation of transmitter to final radio contact or last observed movement

^b Includes observations from ground, aerial, and fixed station tracking. Observations from fixed stations were included only if fish traveled upstream or downstream past the station

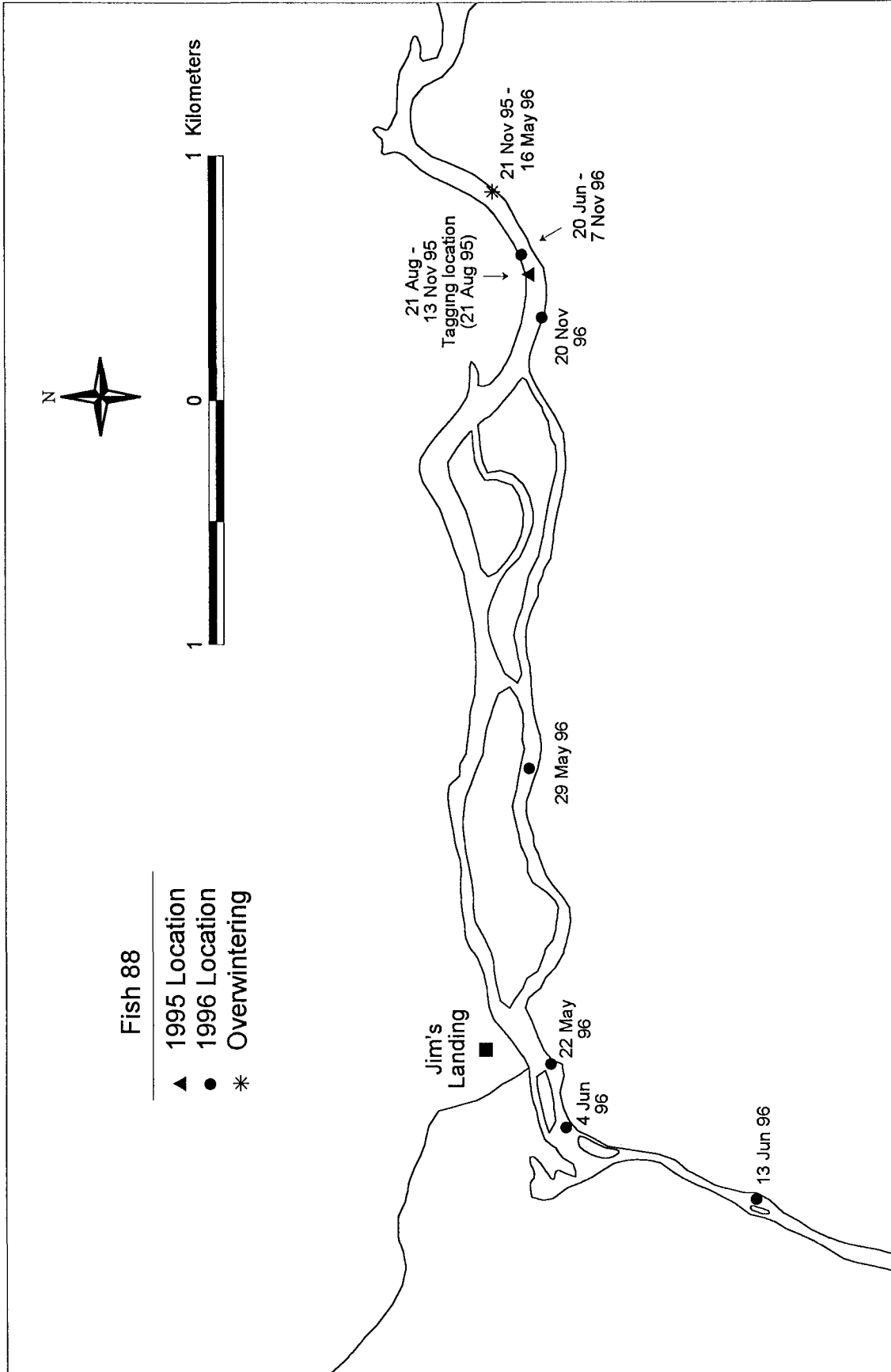
^c Fish disappeared within the study area

^d Fish died or expelled transmitter

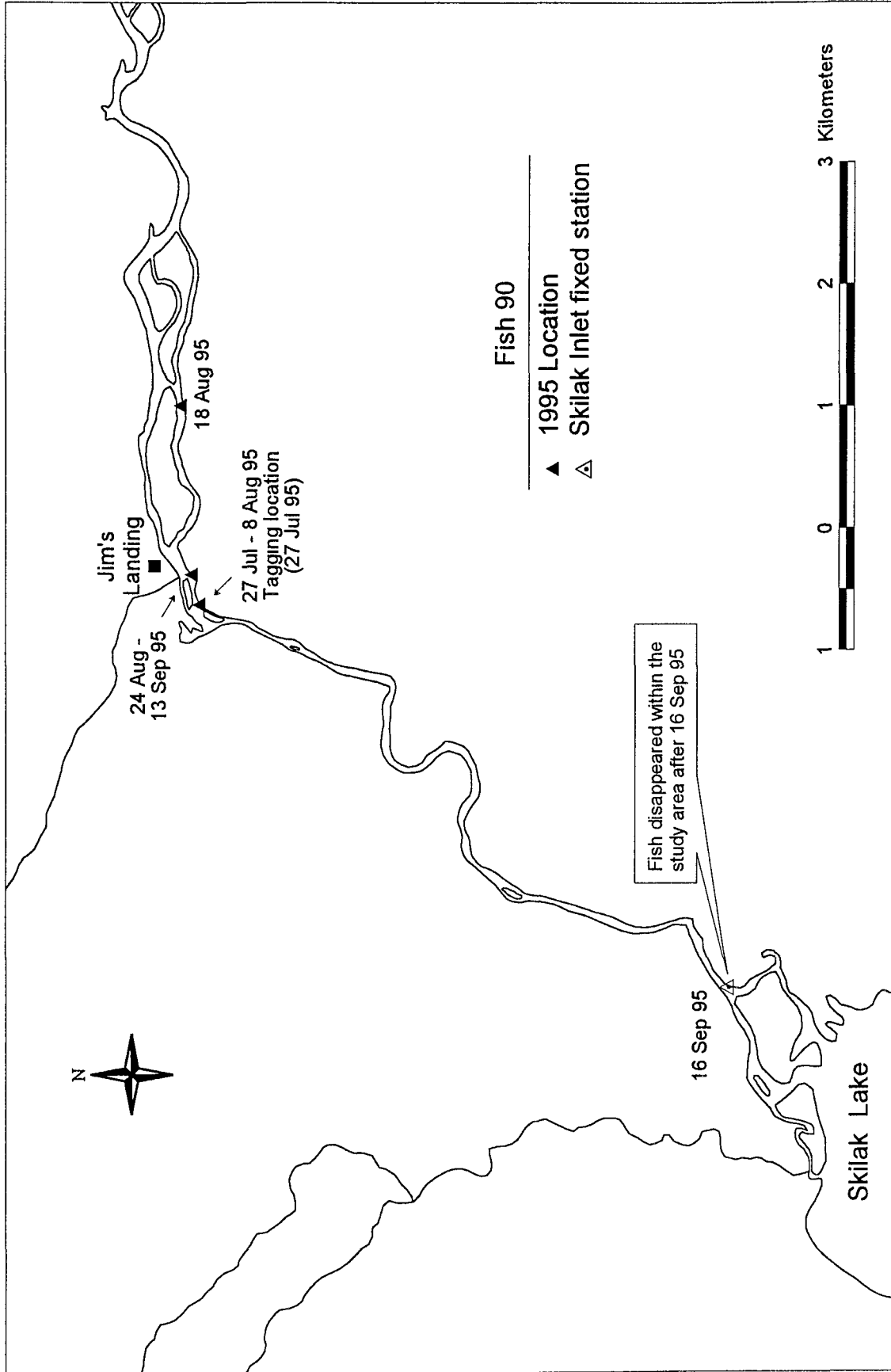
^e Fish harvested by angler

APPENDIX B

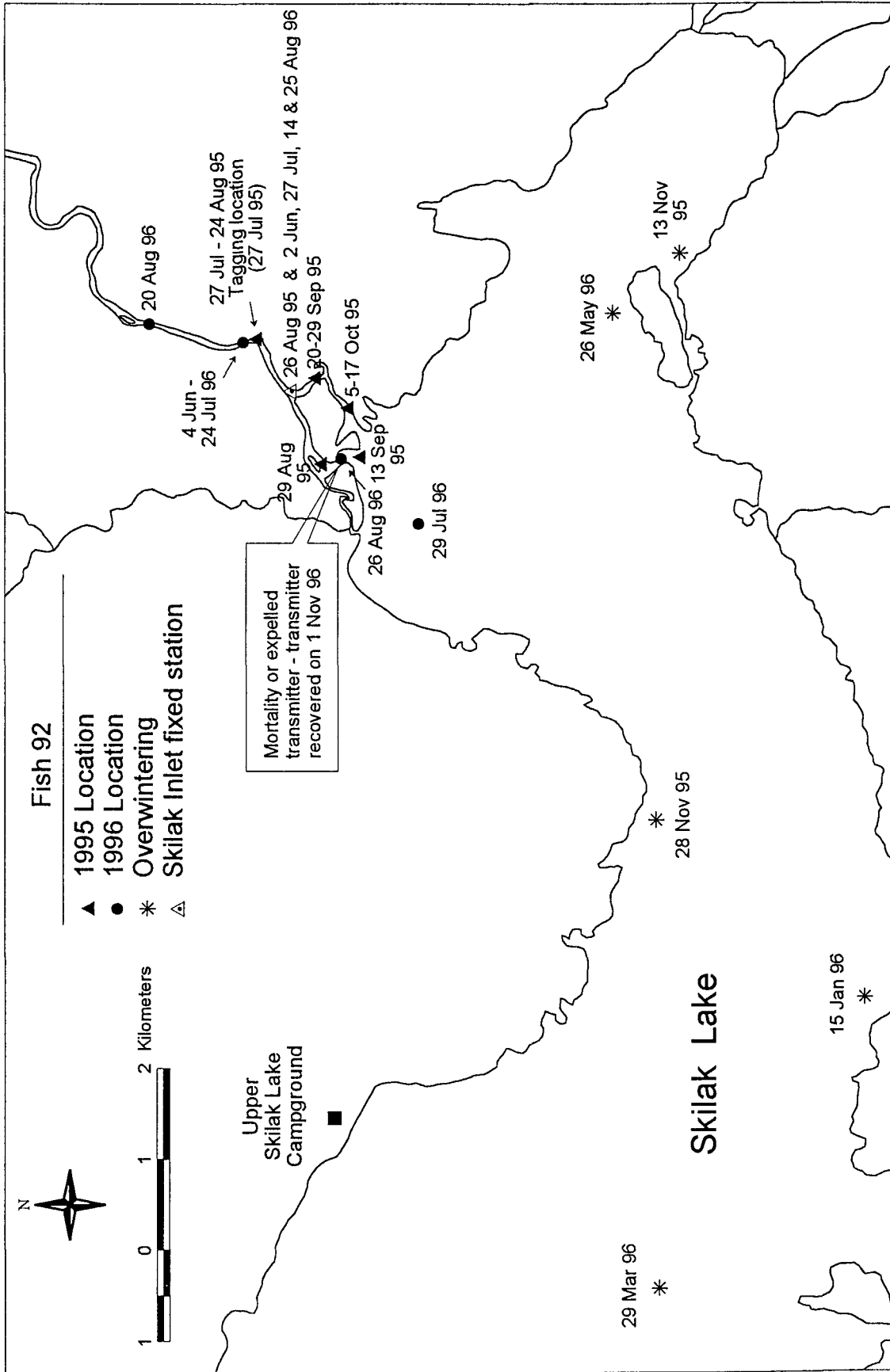
Locations of Individual Rainbow Trout Radio-Tagged Above Skilak Lake



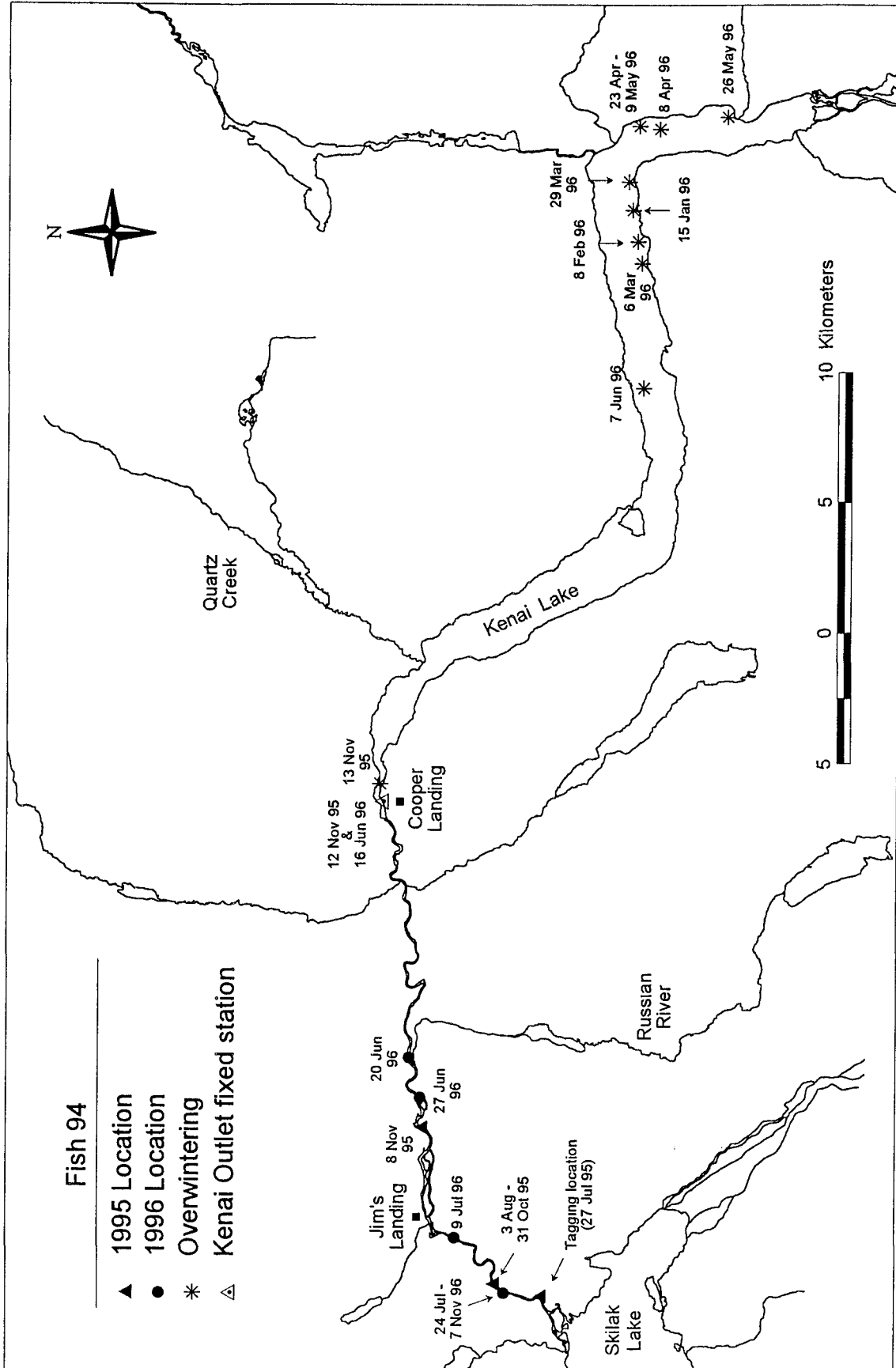
Appendix B1 — Locations of rainbow trout number 88 from 21 August, 1995 through 20 November, 1996



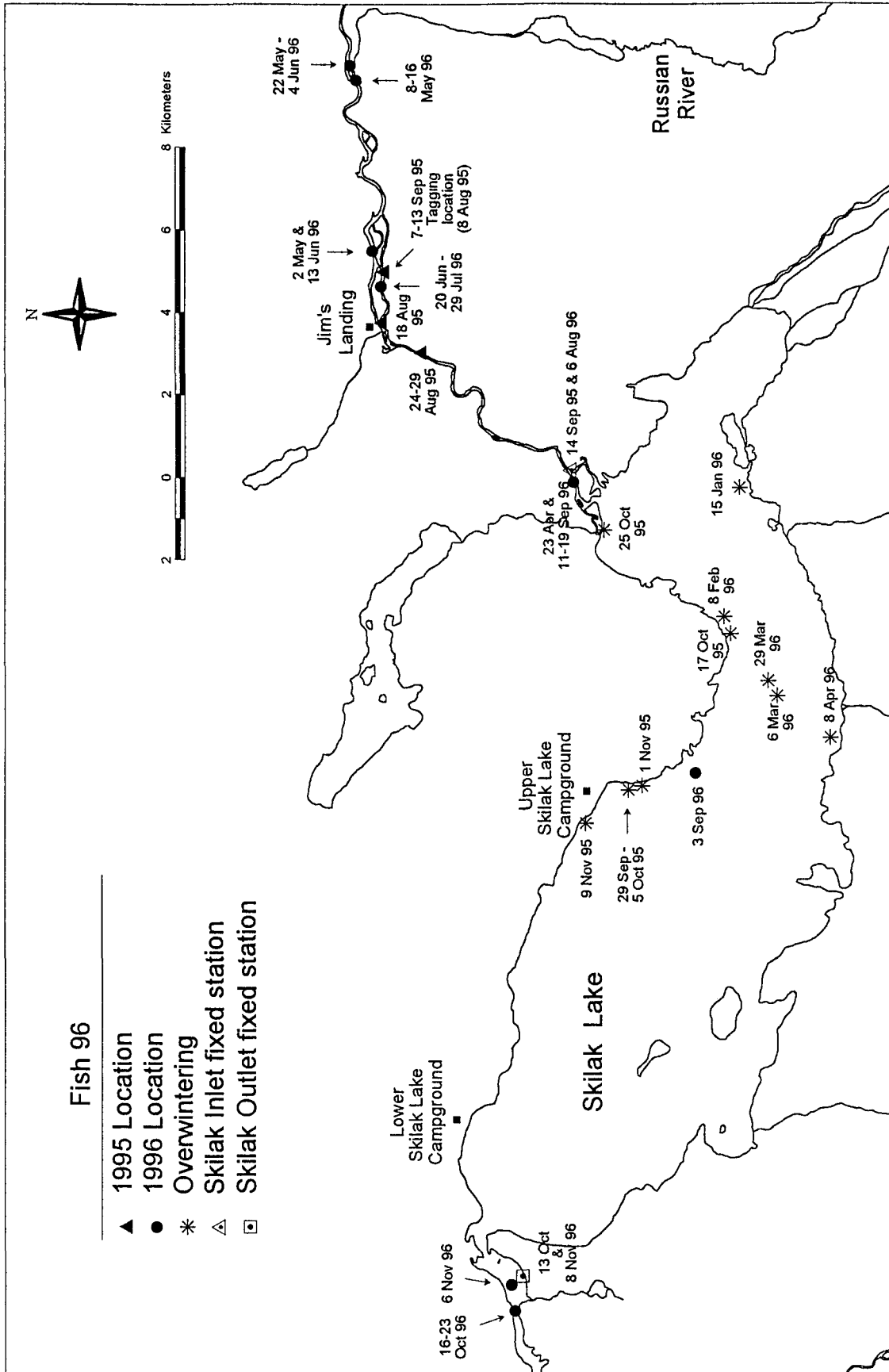
Appendix B2. — Locations of rainbow trout number 90 from 27 July through 16 September, 1995



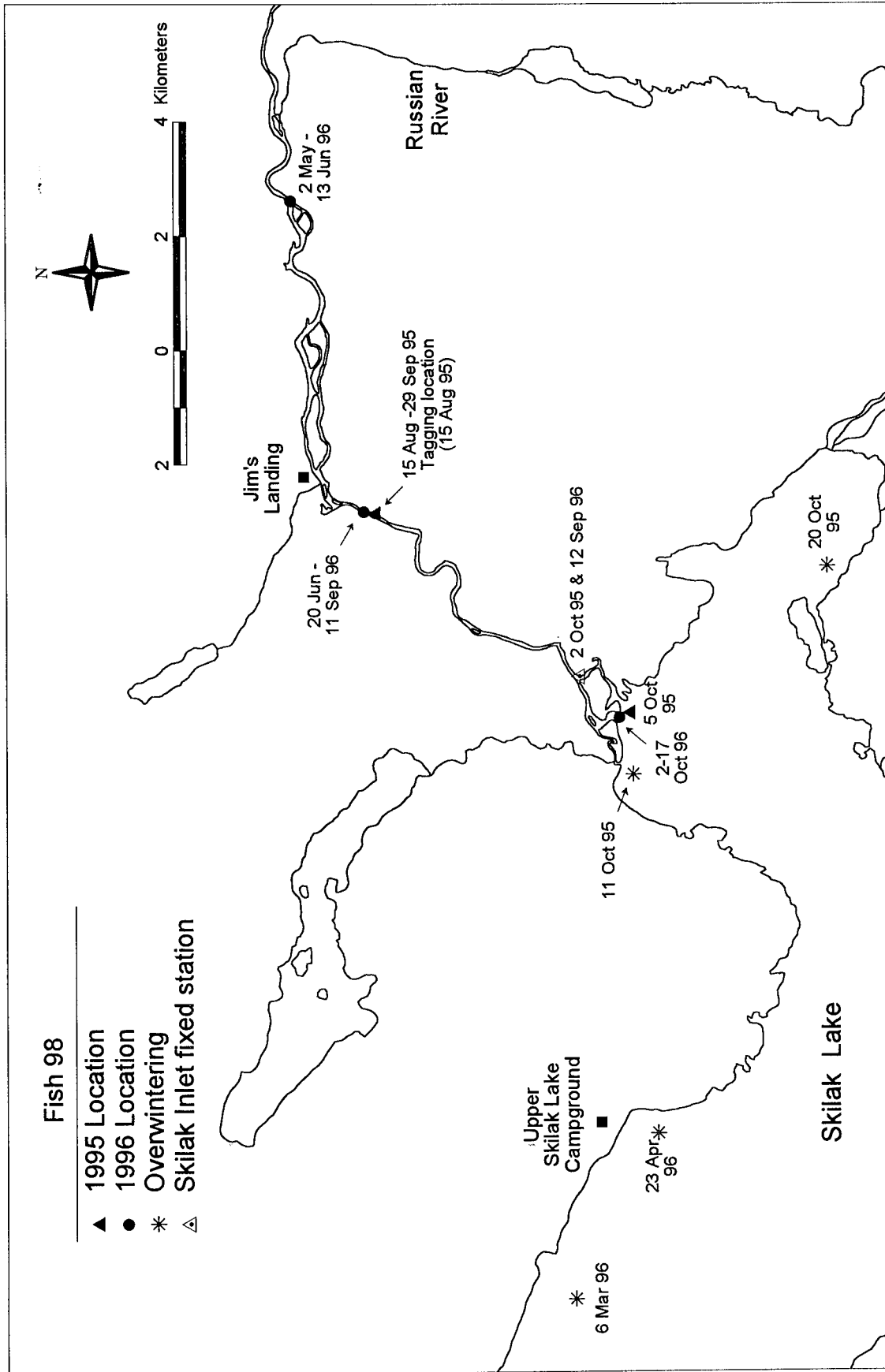
Appendix B3 — Locations of rainbow trout number 92 from 27 July, 1995 through 26 August, 1996.



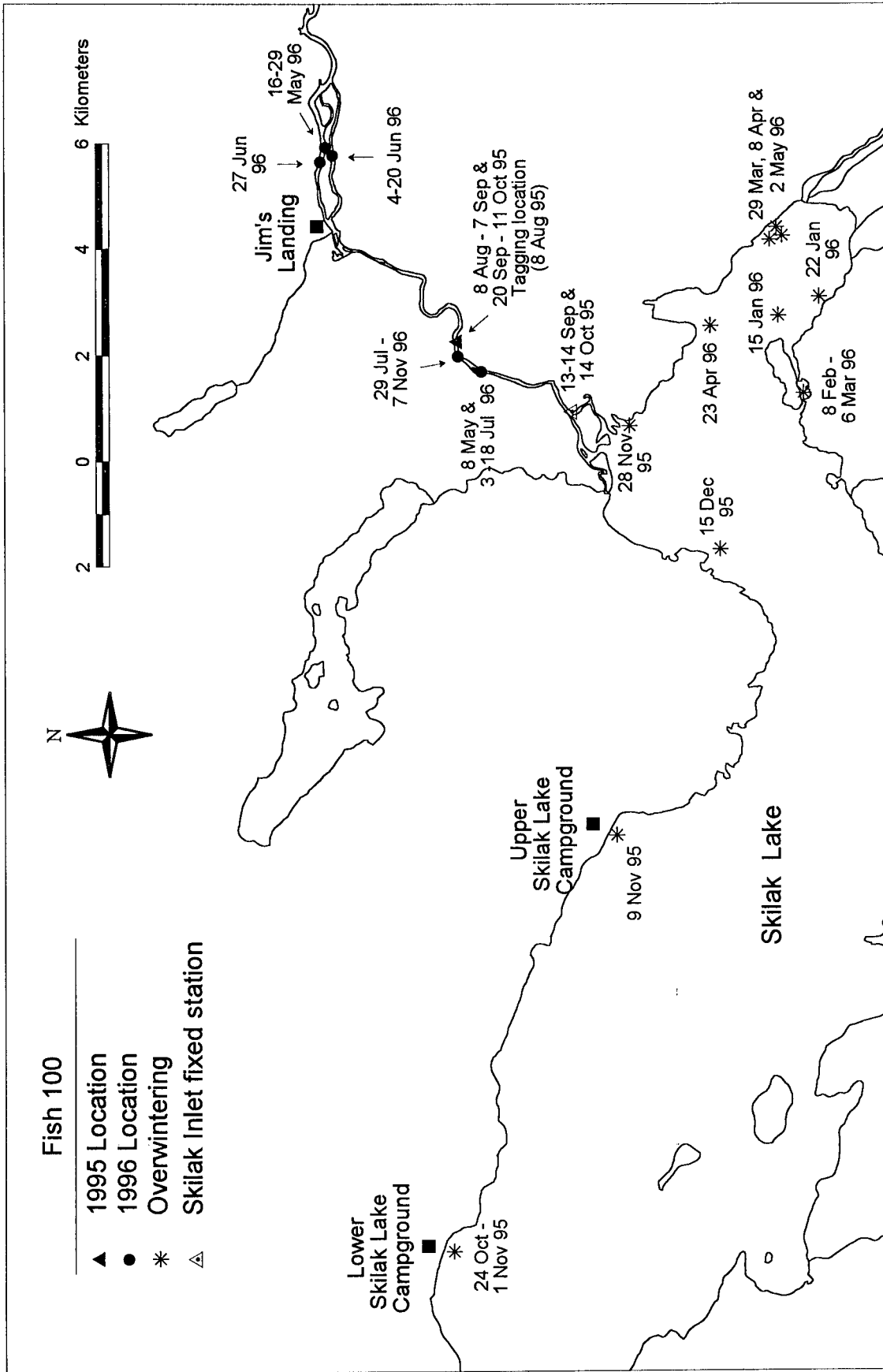
Appendix B4.— Locations of rainbow trout number 94 from 27 July, 1995 through 7 November, 1996.



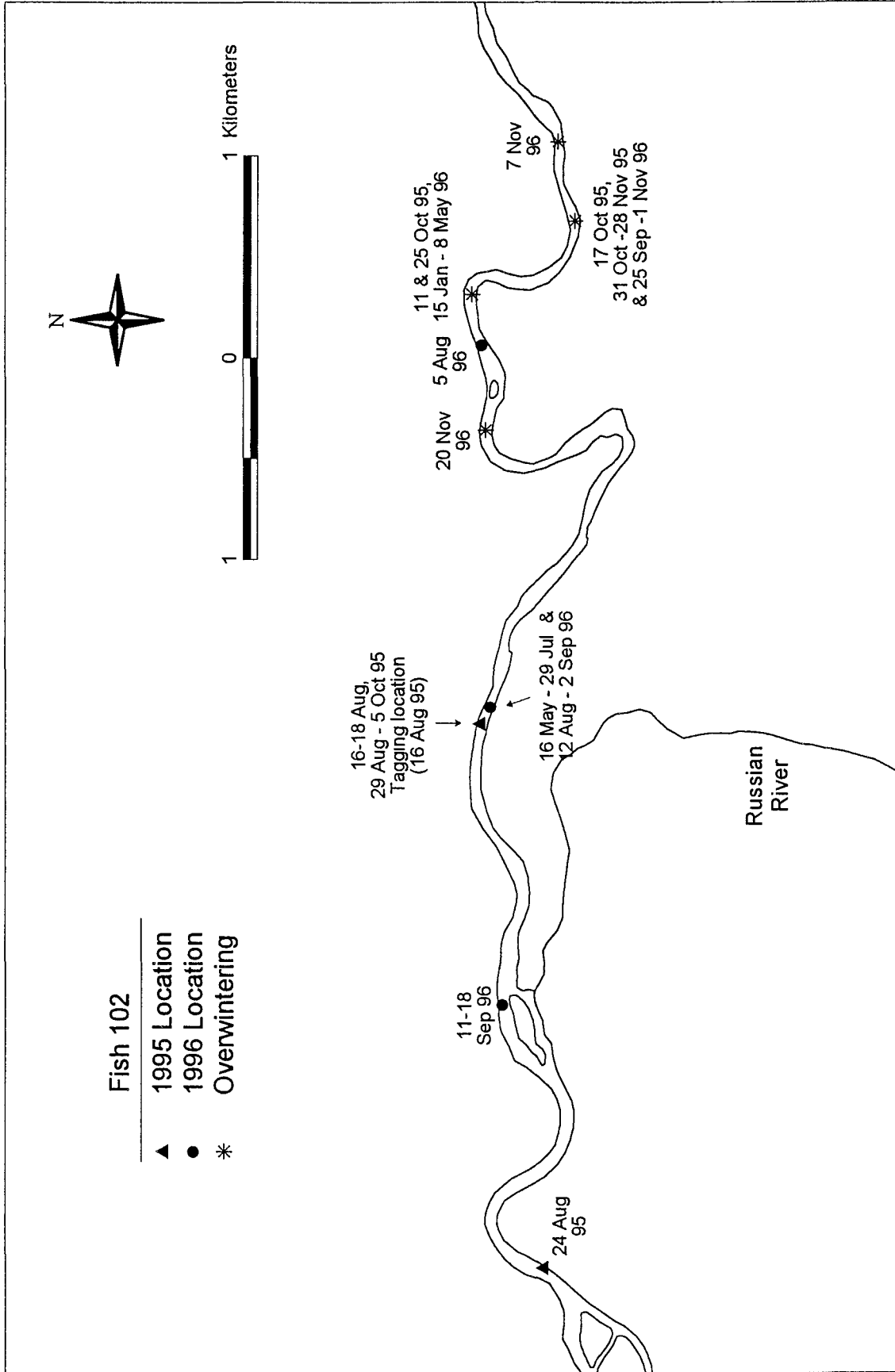
Appendix B5 — Locations of rainbow trout number 96 from 8 August, 1995 through 8 November, 1996.



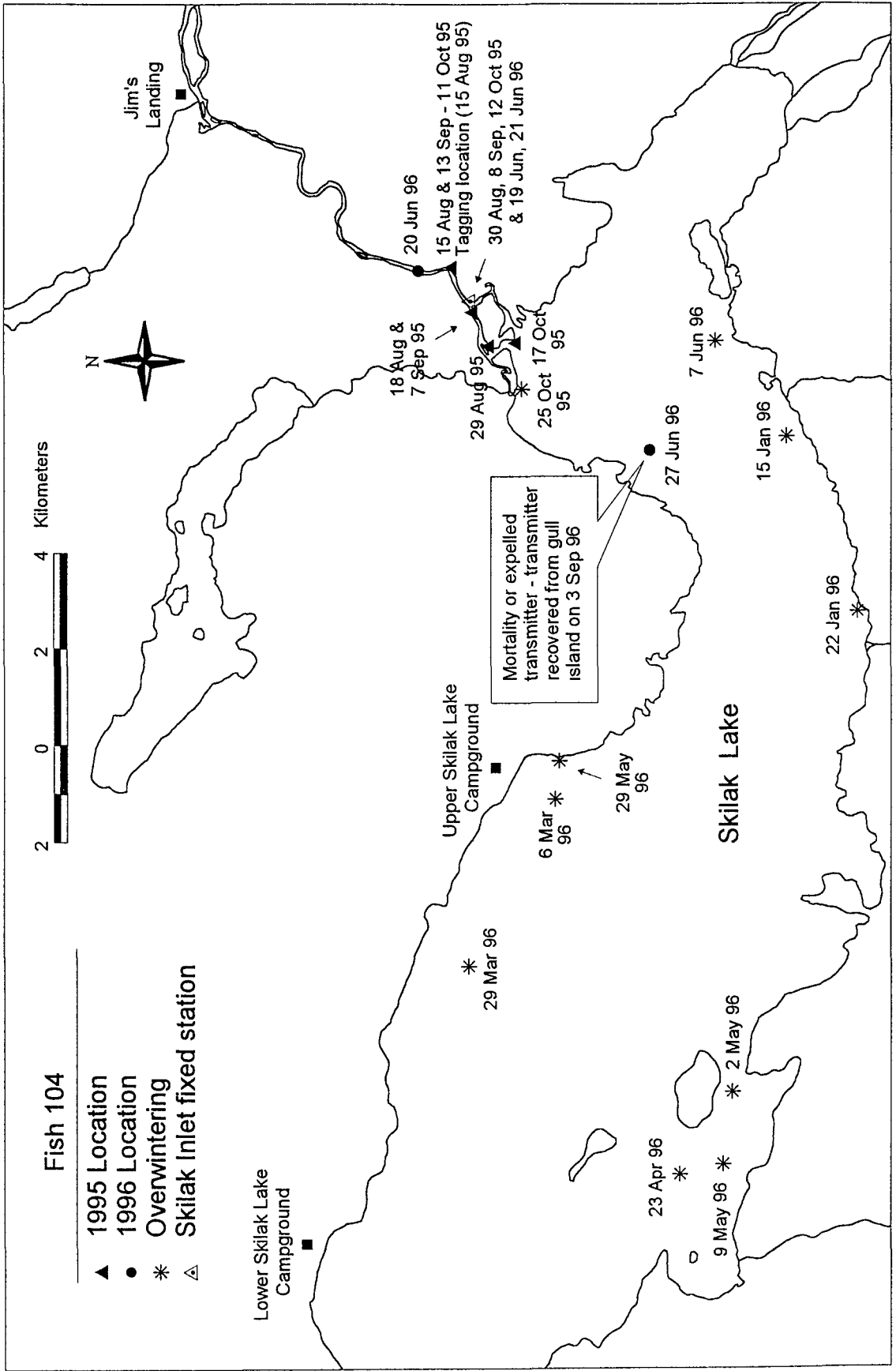
Appendix B6 — Locations of rainbow trout number 98 from 15 August, 1995 through 17 October, 1996.



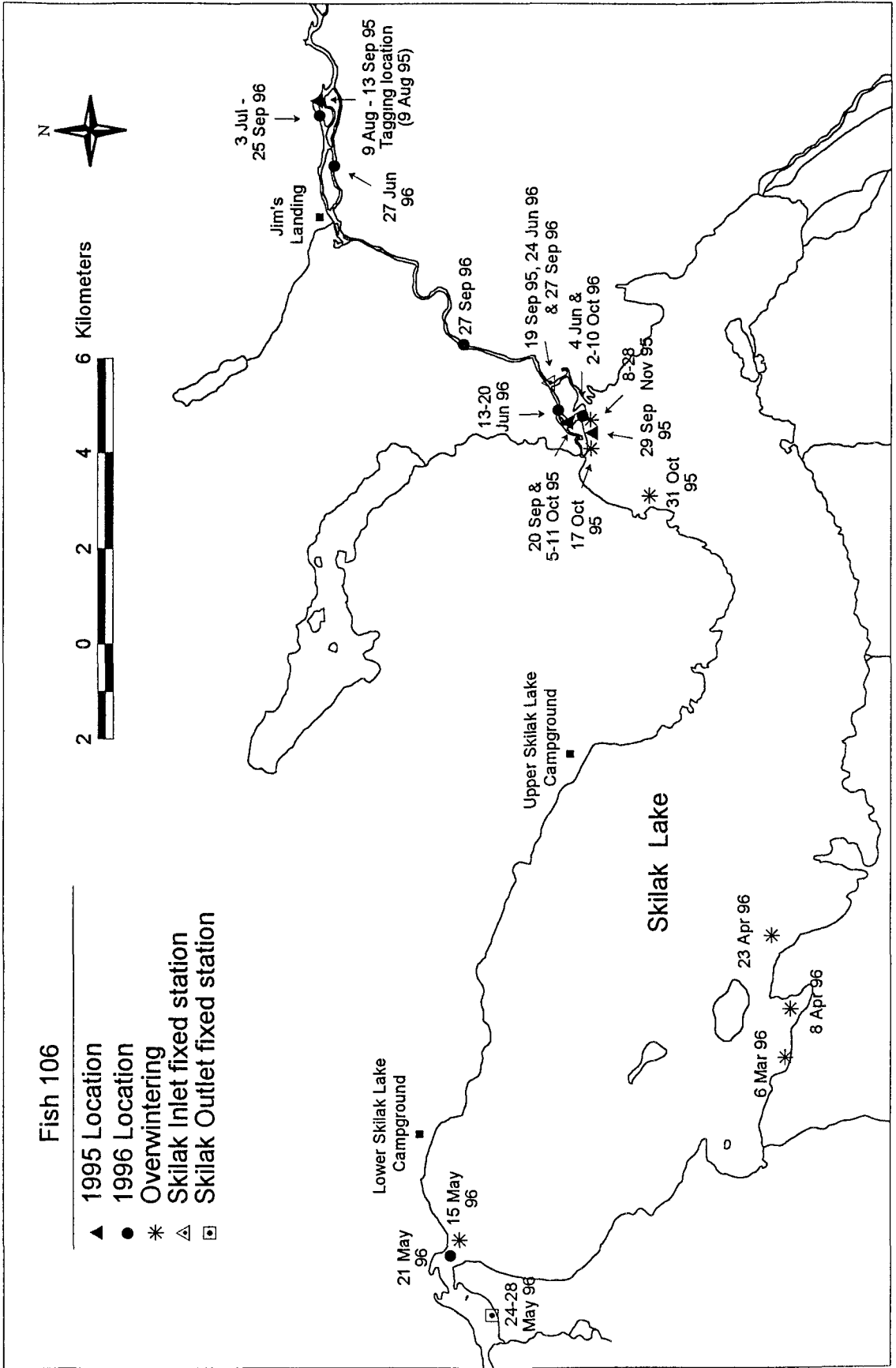
Appendix B7 — Locations of rainbow trout number 100 from 8 August, 1995 through 7 November, 1996.



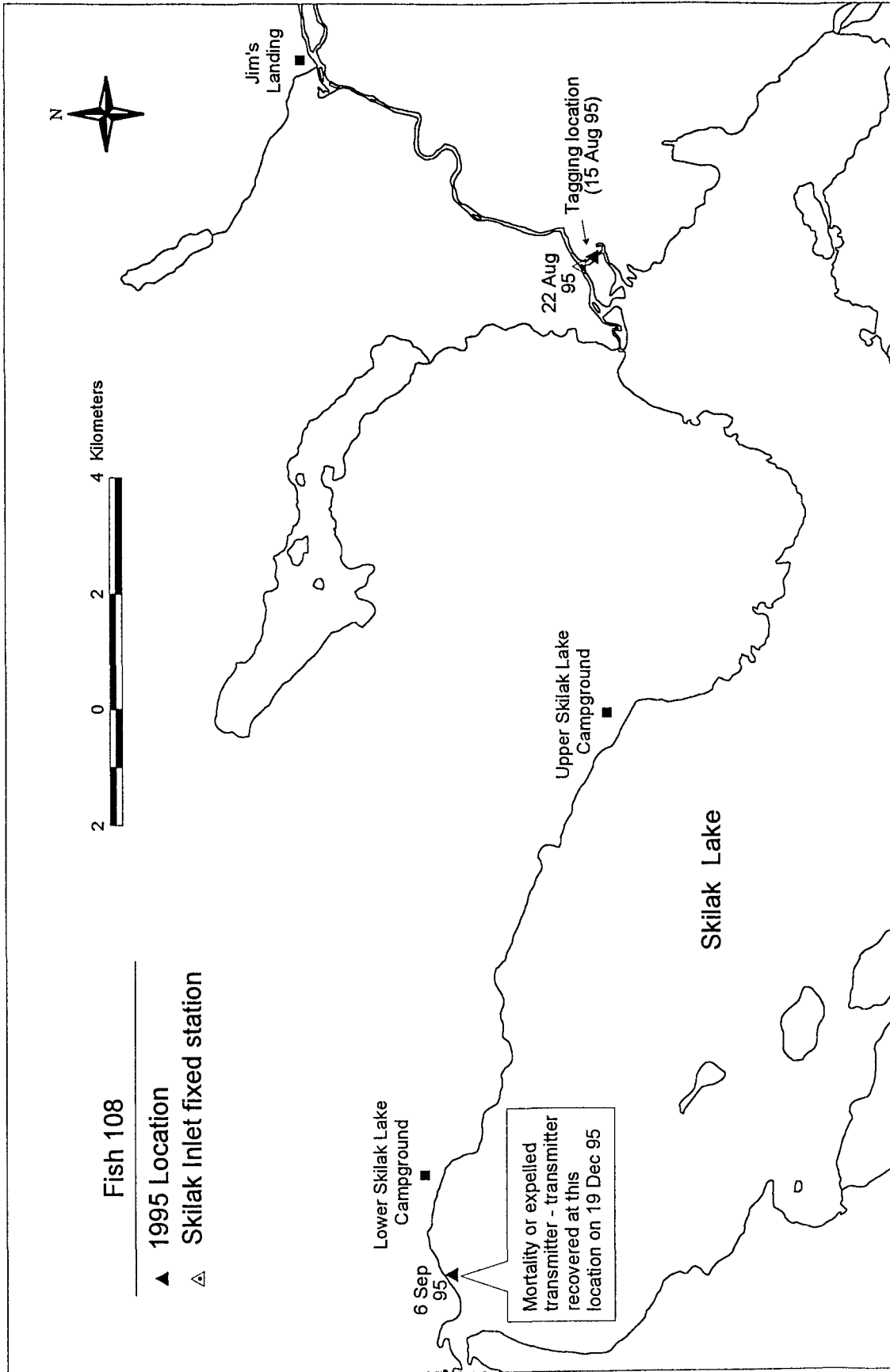
Appendix B8. --- Locations of rainbow trout number 102 from 16 August, 1995 through 20 November, 1996.



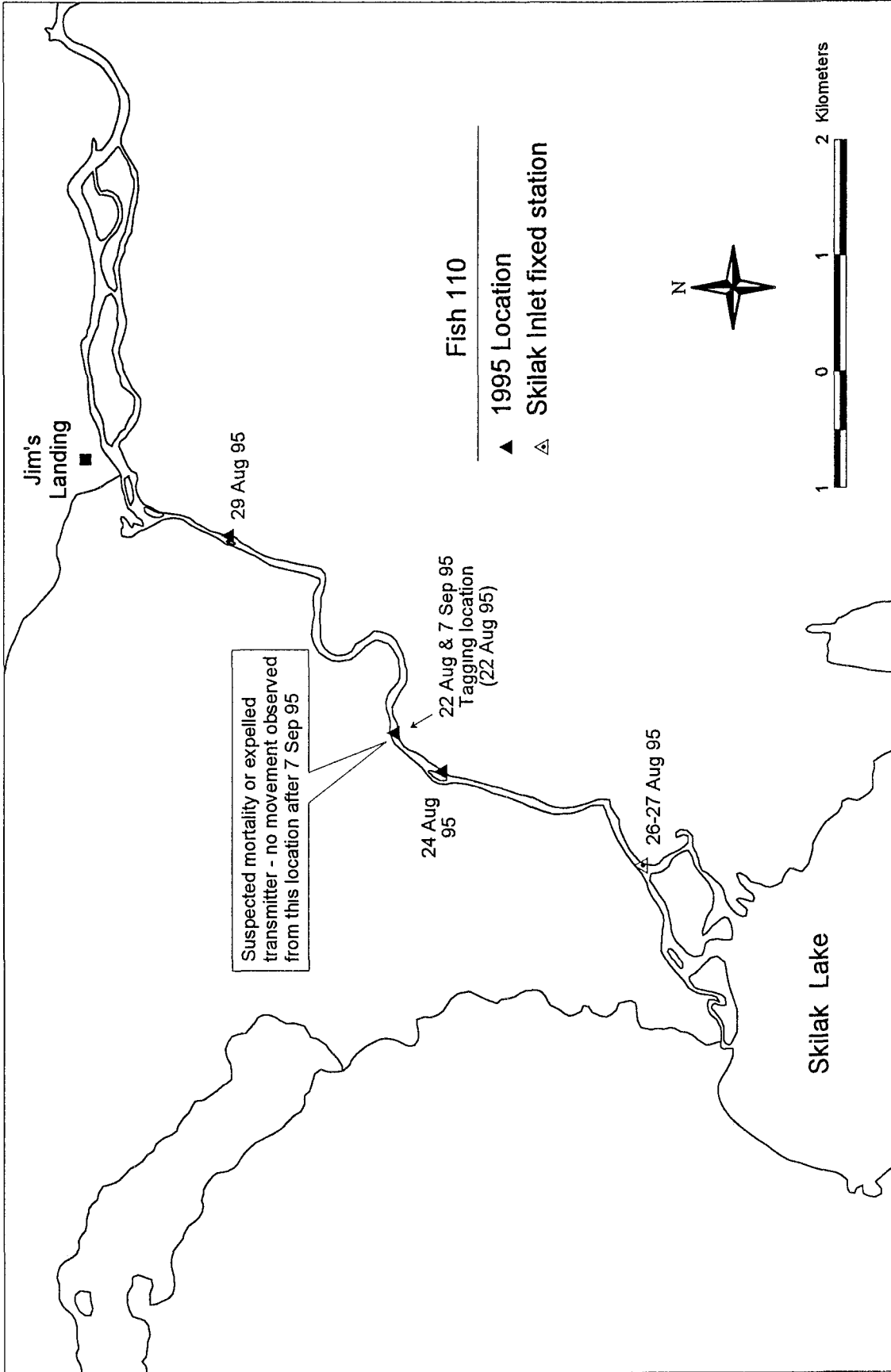
Appendix B9 — Locations of rainbow trout number 104 from 15 August, 1995 through 27 June, 1996.



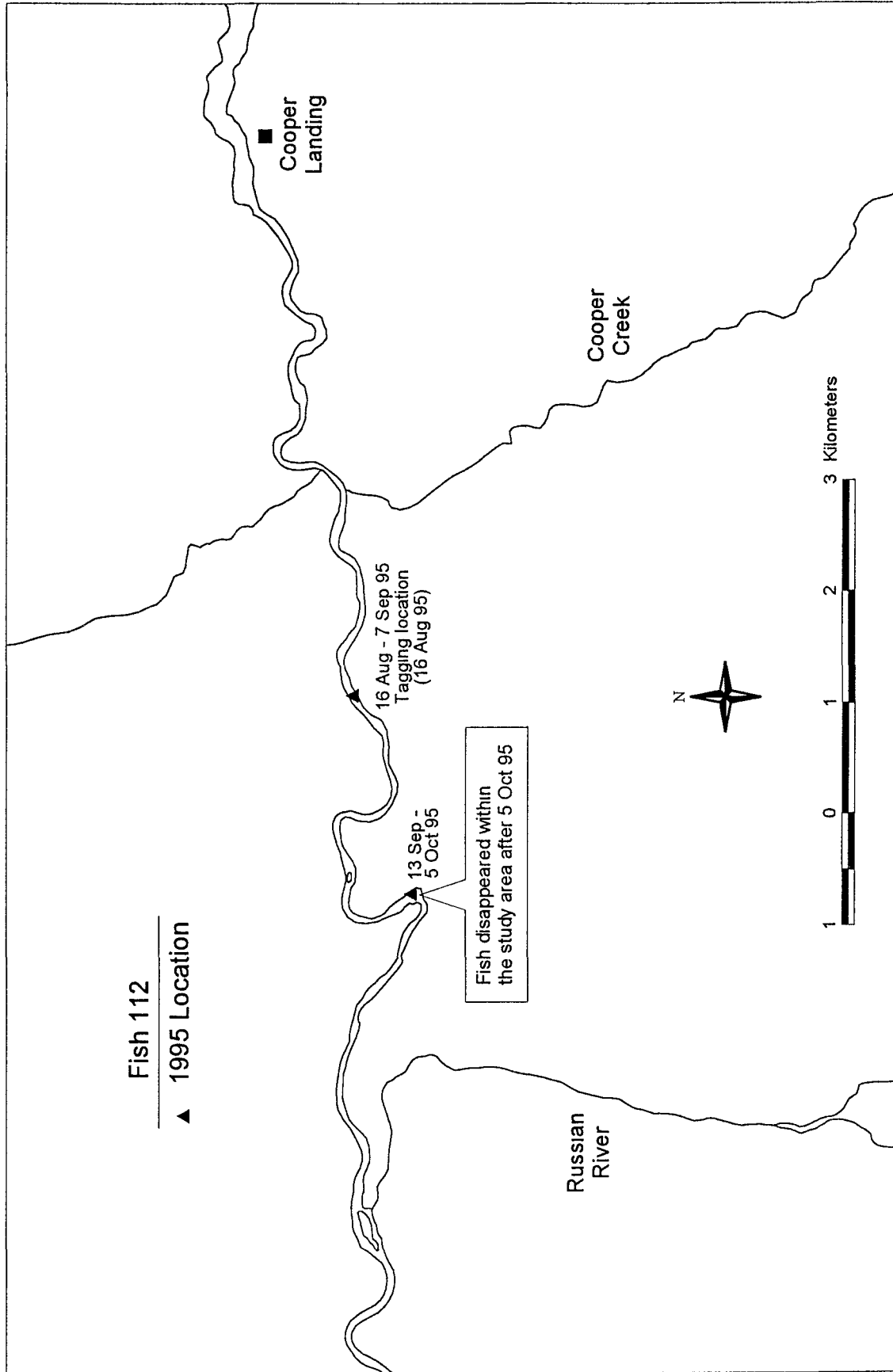
Appendix B10 — Locations of rainbow trout number 106 from 9 August, 1995 through 10 October, 1996.



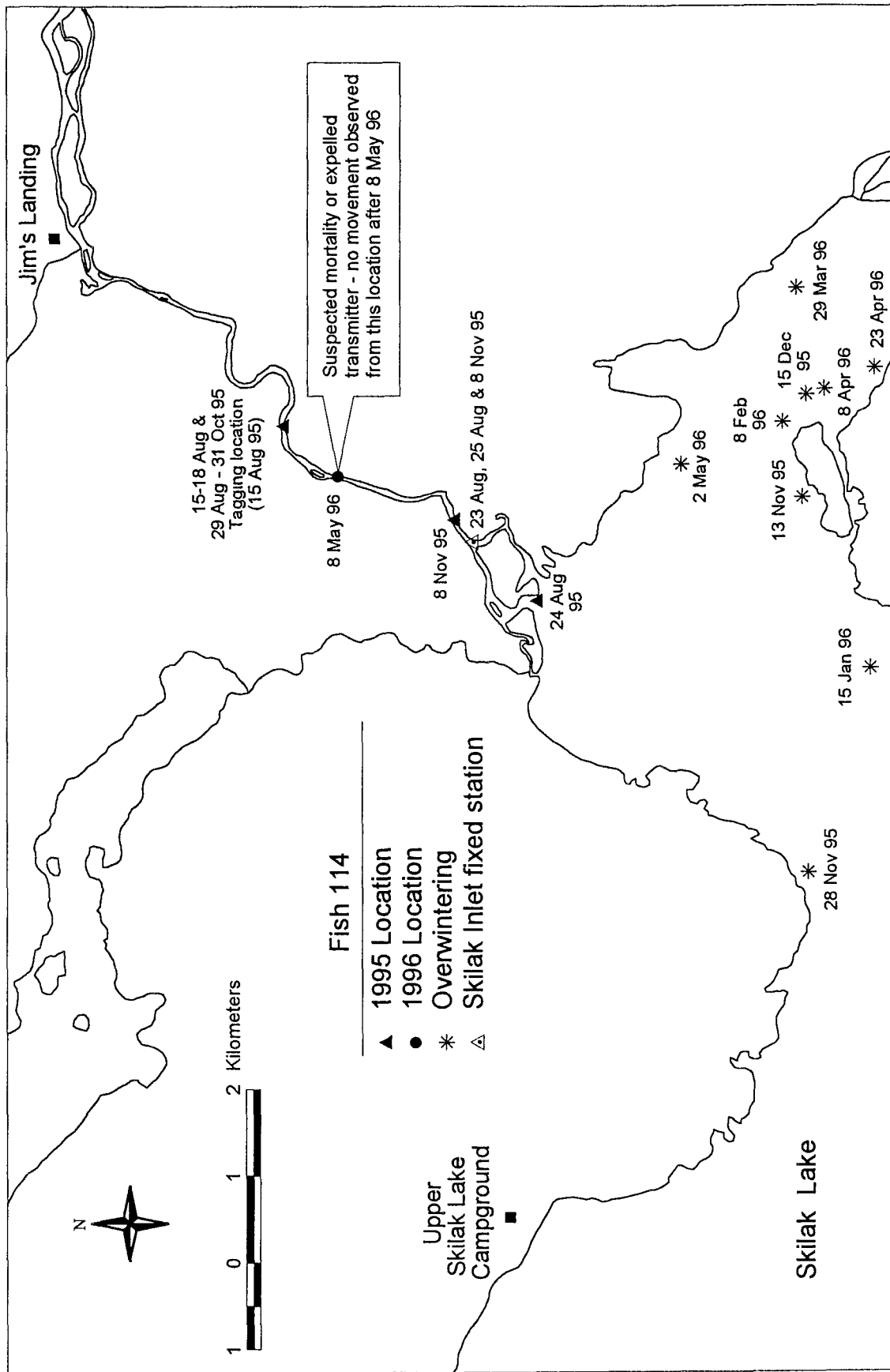
Appendix B11.— Locations of rainbow trout number 108 from 15 August through 6 September, 1995.



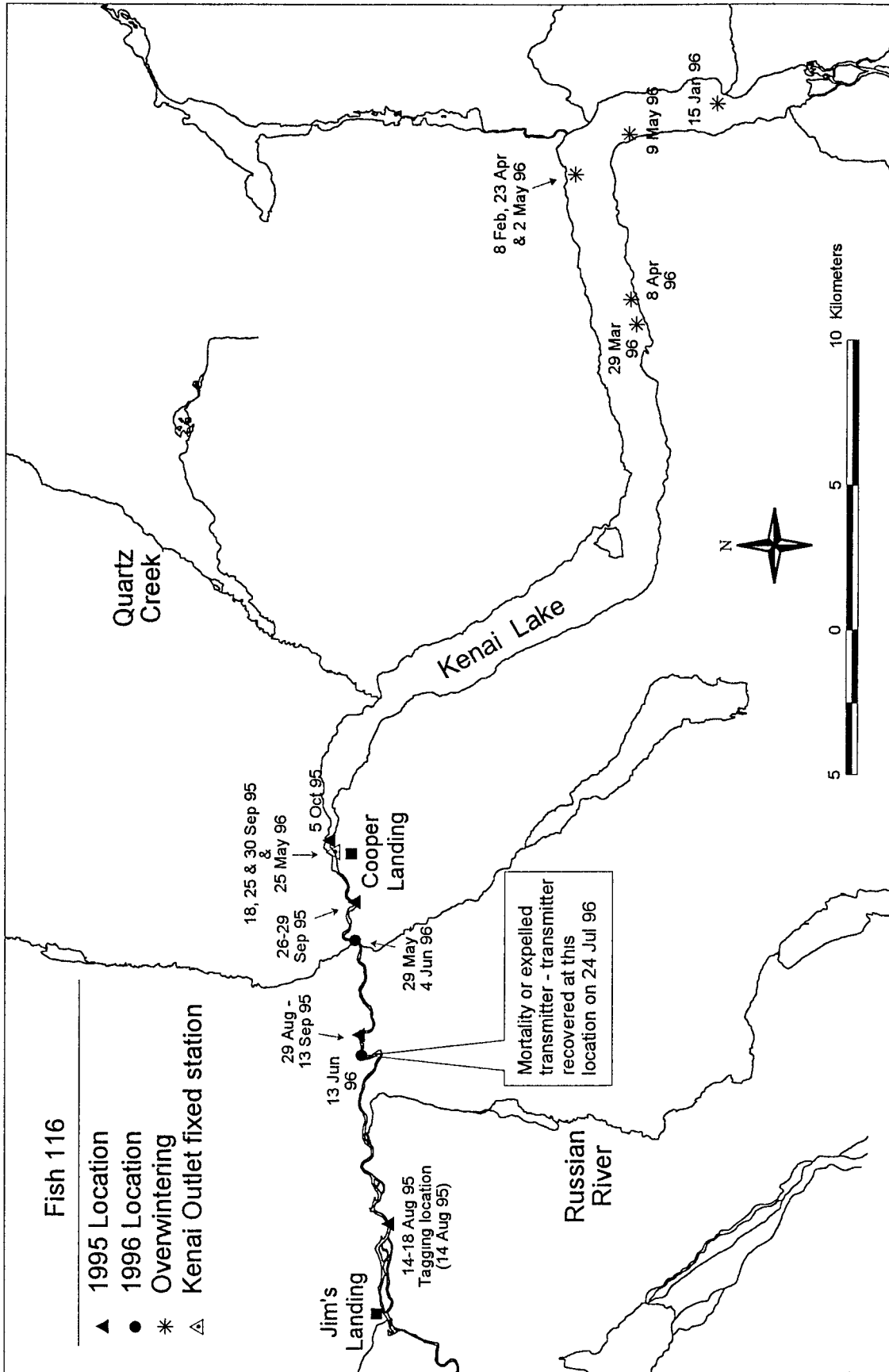
Appendix B12.— Locations of rainbow trout number 110 from 22 August through 13 September, 1995.



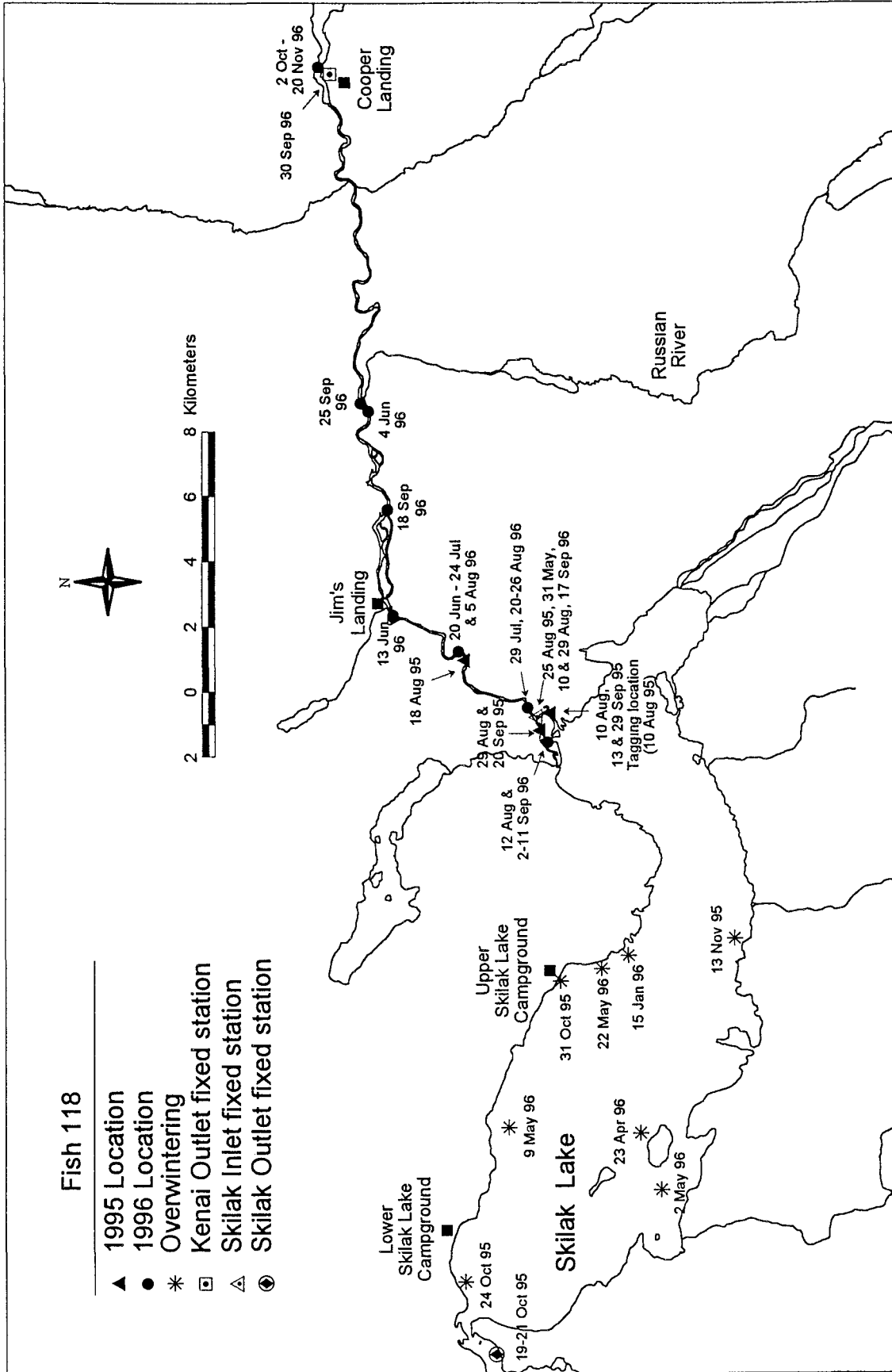
Appendix B13 — Locations of rainbow trout number 112 from 16 August through 5 October, 1995



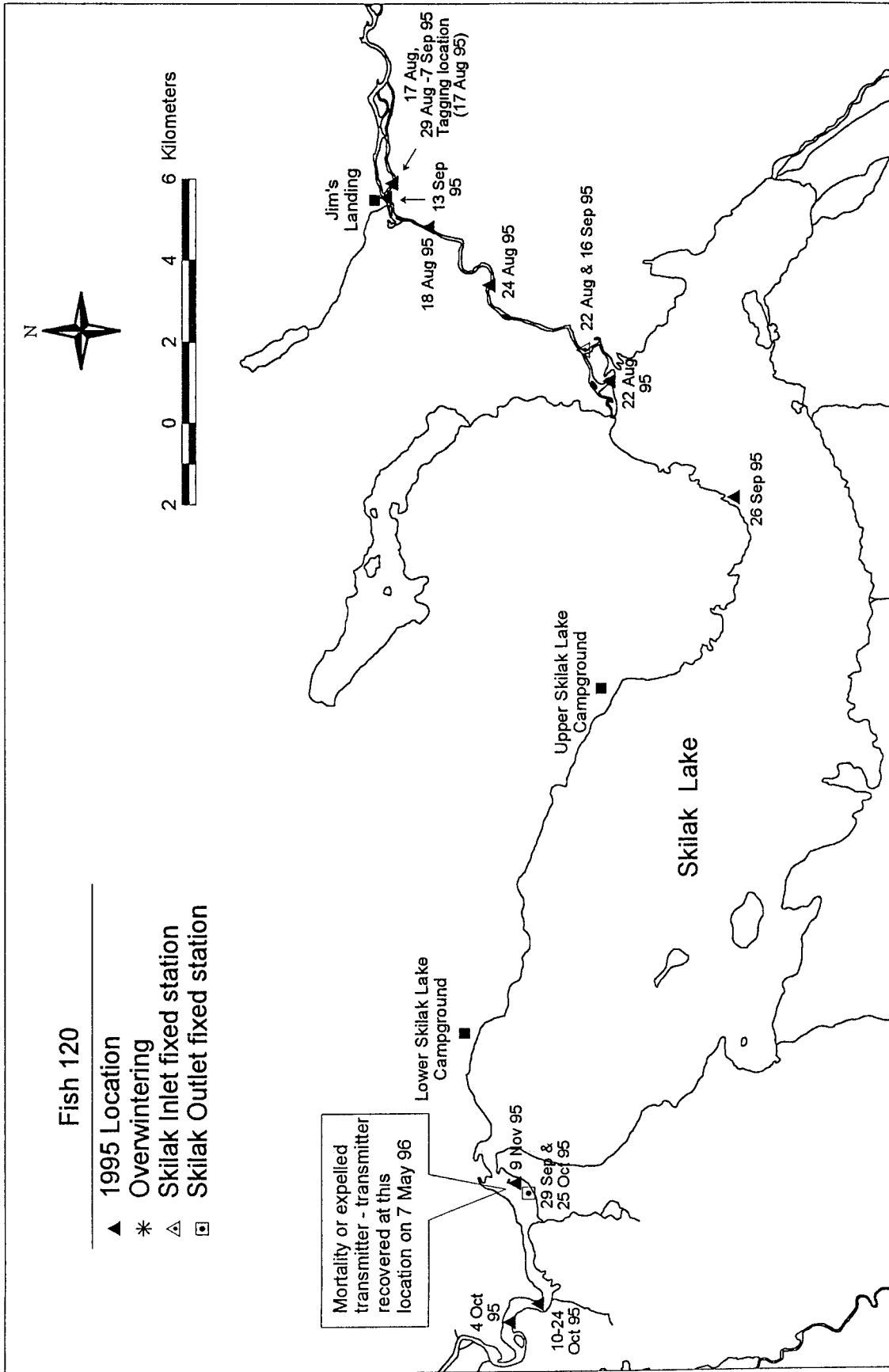
Appendix B14.— Locations of rainbow trout number 114 from 15 August, 1995 through 8 May, 1996.



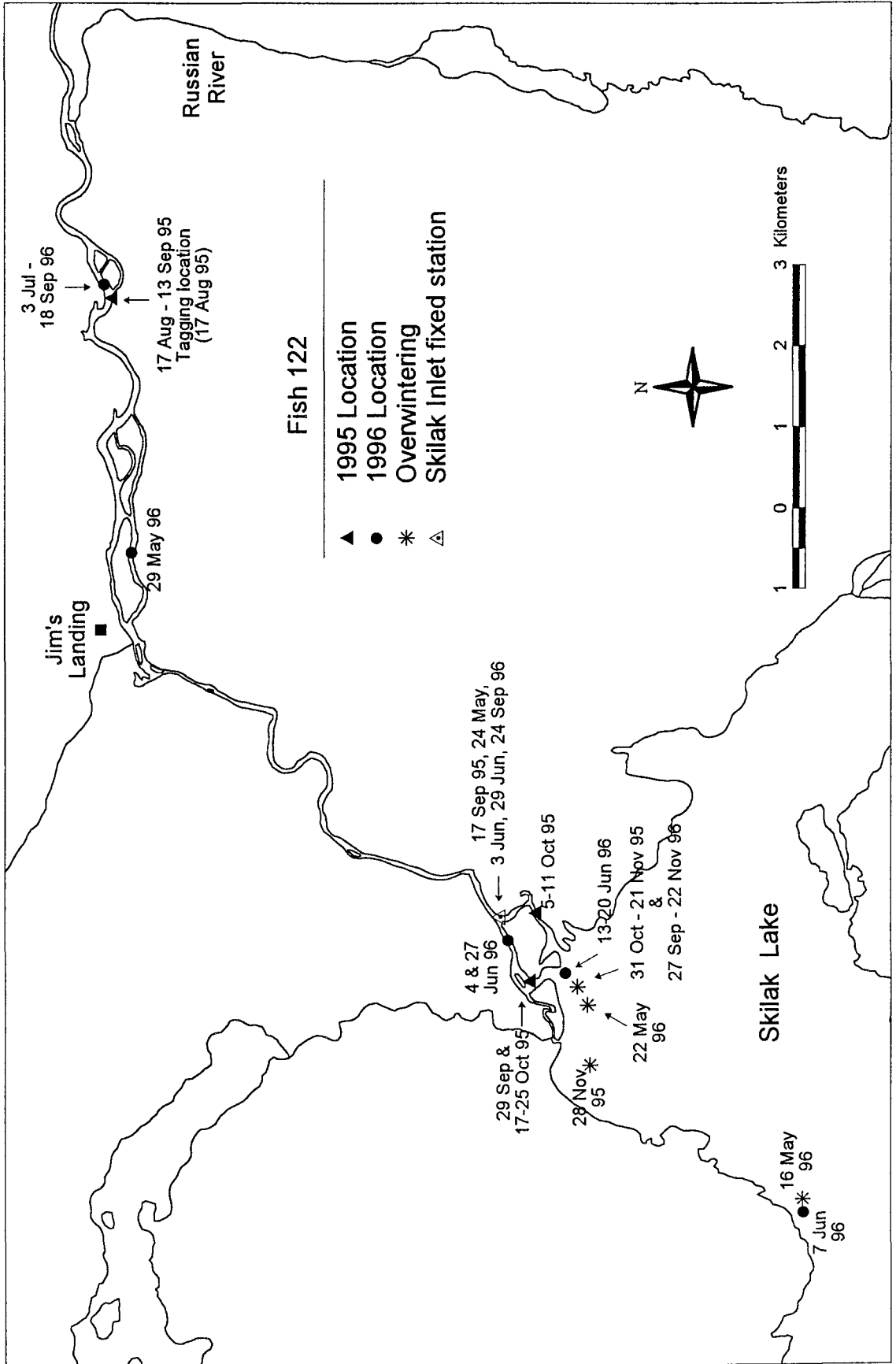
Appendix B15 — Locations of rainbow trout number 116 from 14 August, 1995 through 13 June, 1996



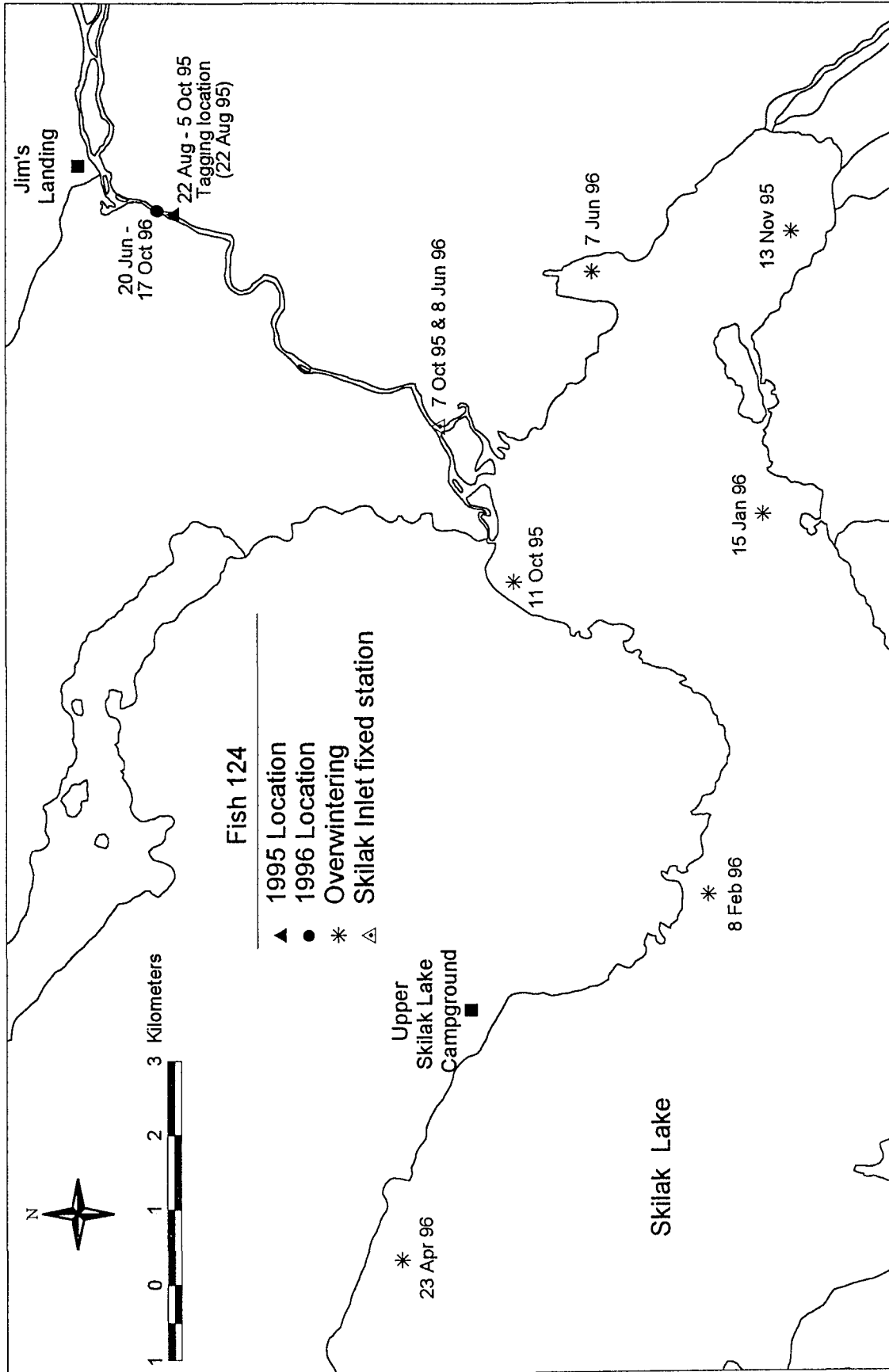
Appendix B16.— Locations of rainbow trout number 118 from 10 August, 1995 through 20 November, 1996.



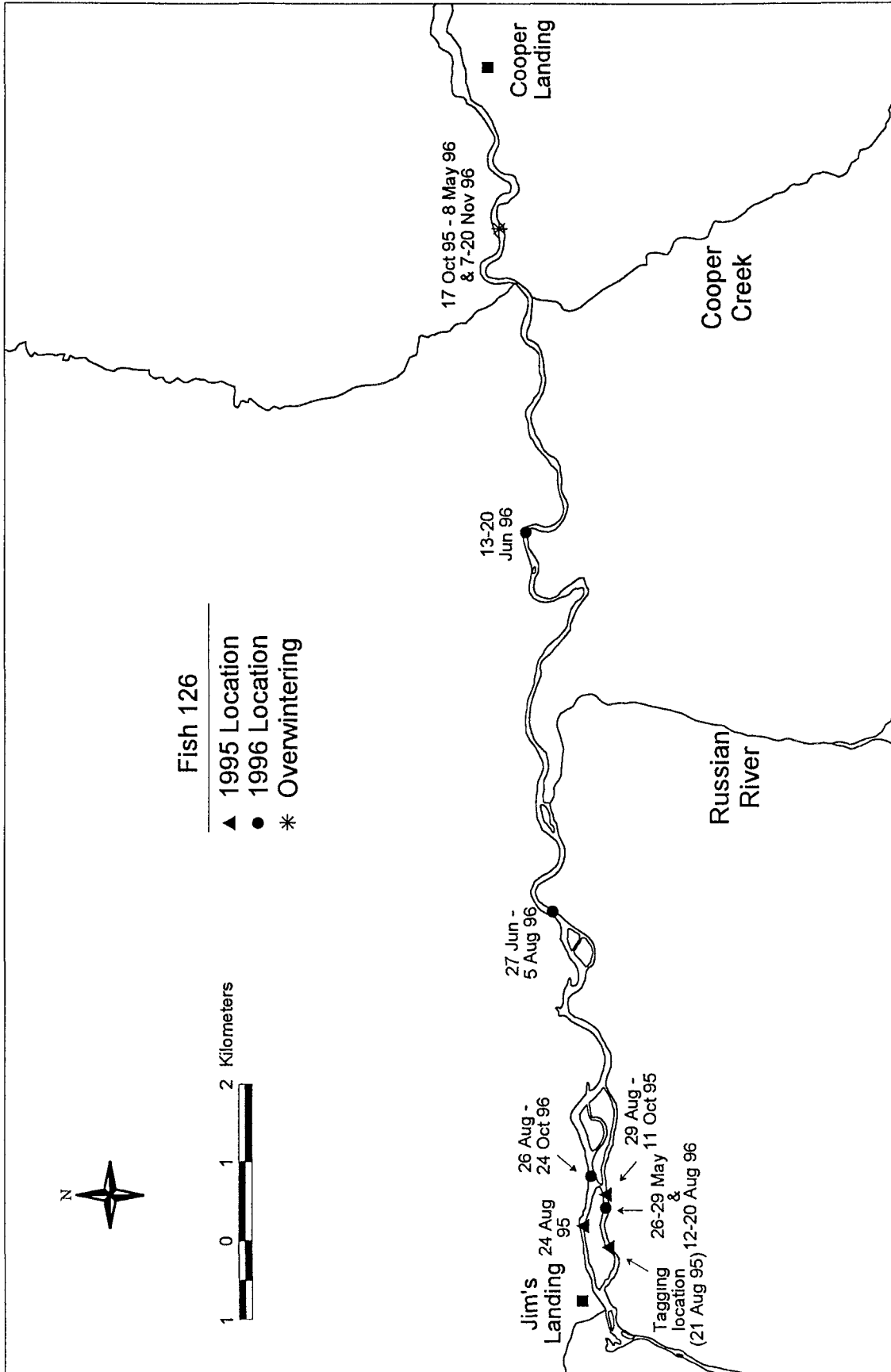
Appendix B17 — Locations of rainbow trout number 120 from 17 August through 9 November, 1995



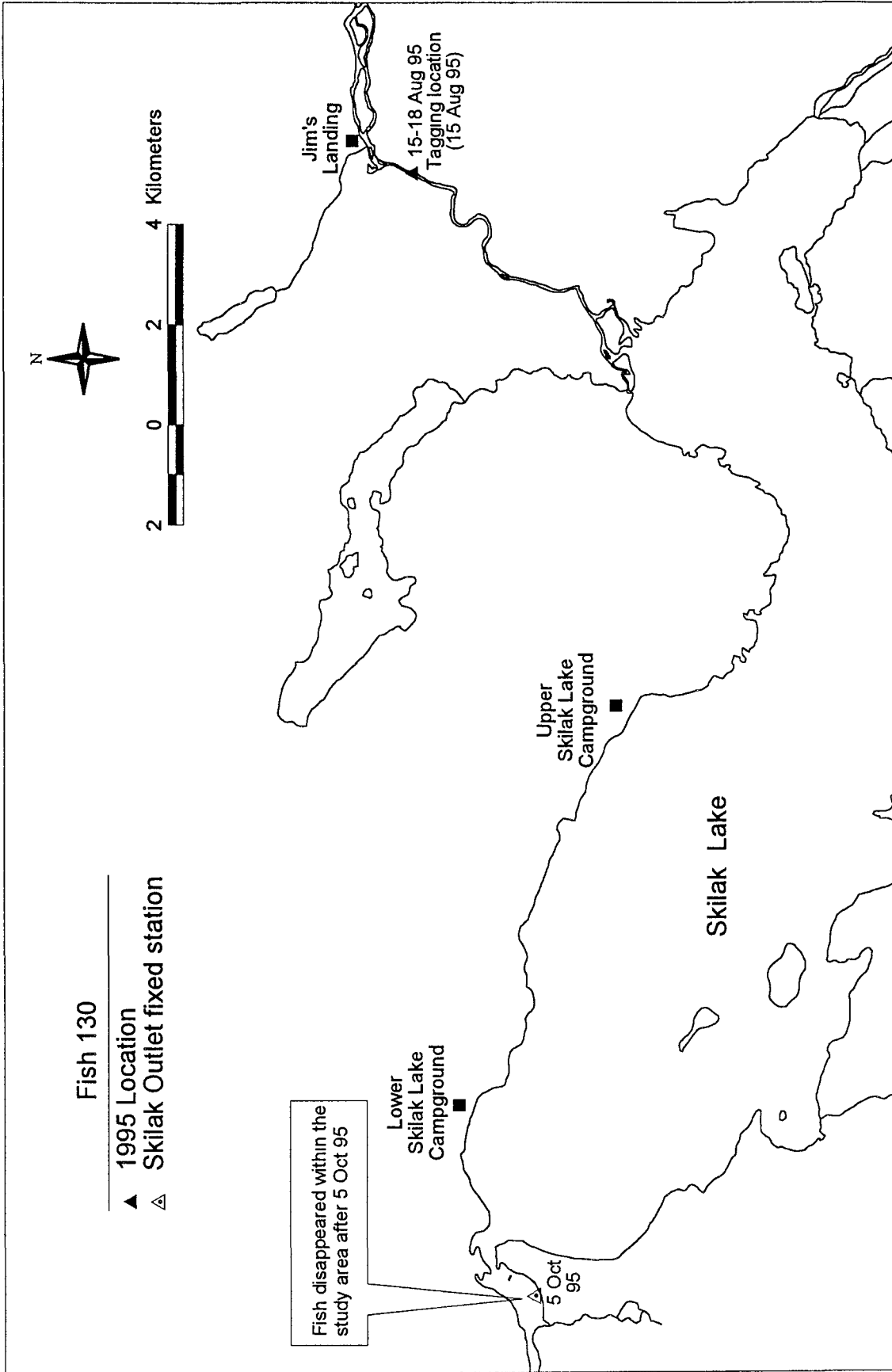
Appendix B18.— Locations of rainbow trout number 122 from 17 August, 1995 through 22 November, 1996



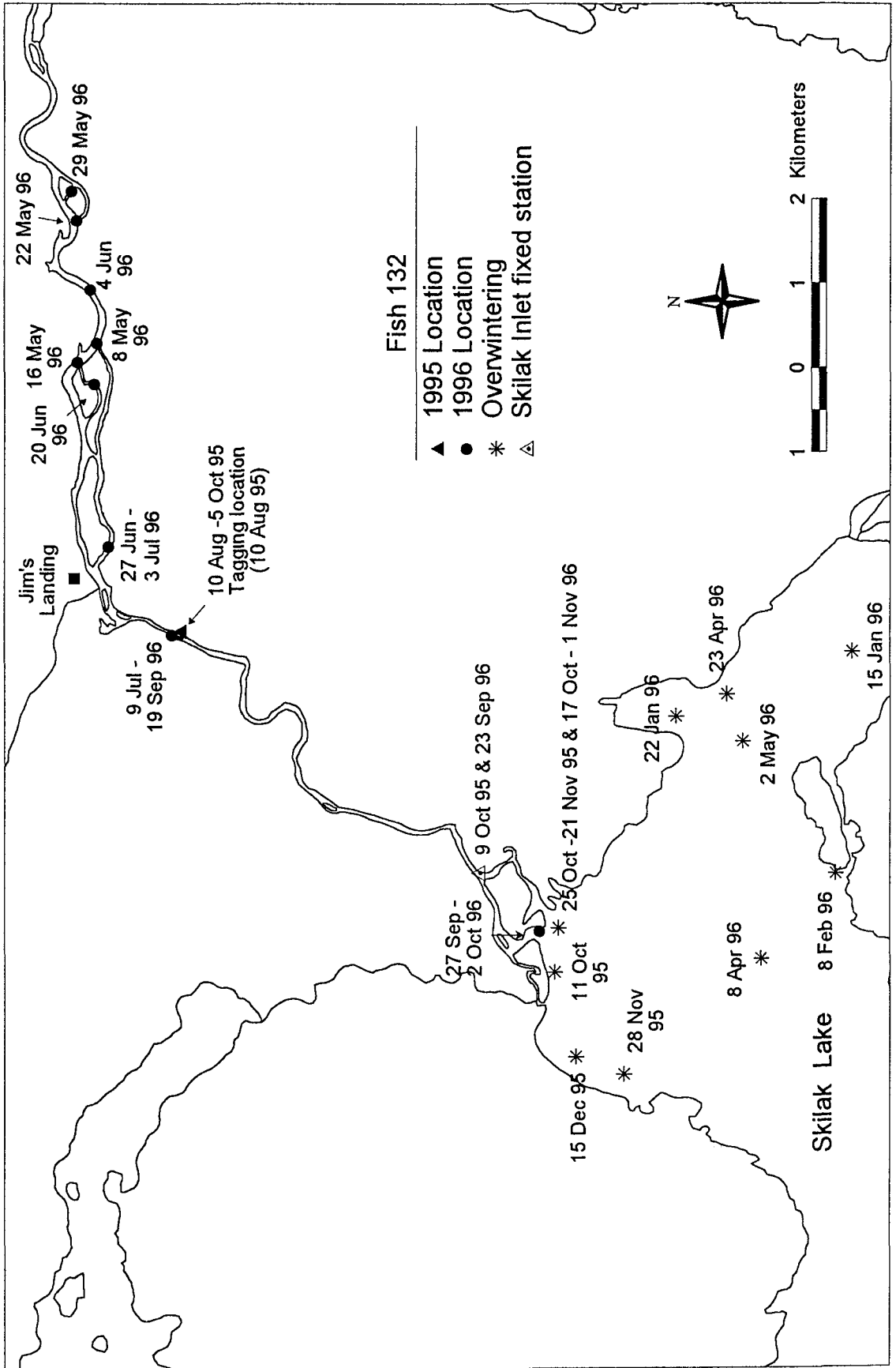
Appendix B19. — Locations of rainbow trout number 124 from 22 August, 1995 through 17 October, 1996.



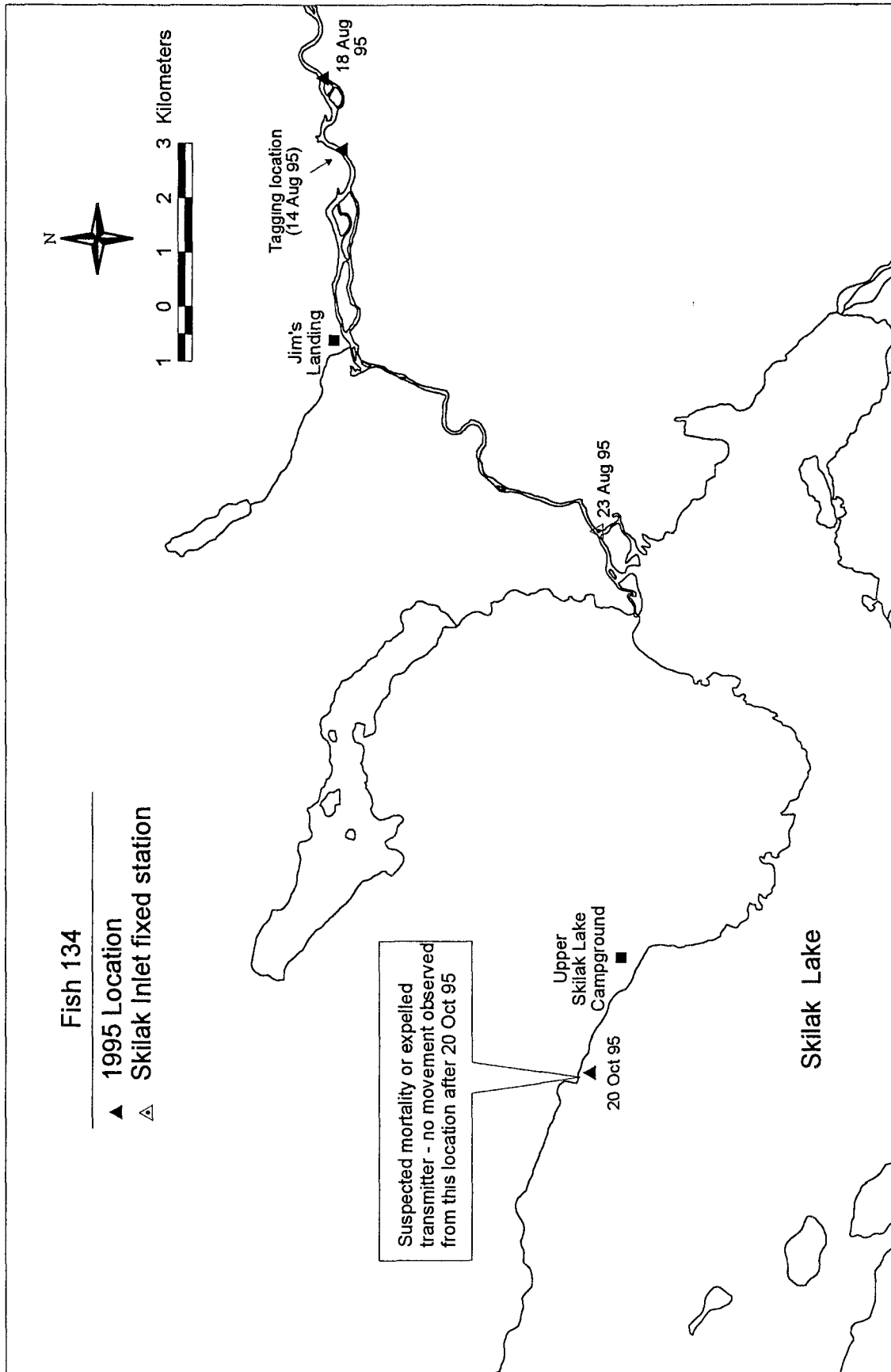
Appendix B20 — Locations of rainbow trout number 126 from 21 August, 1995 through 20 November, 1996.



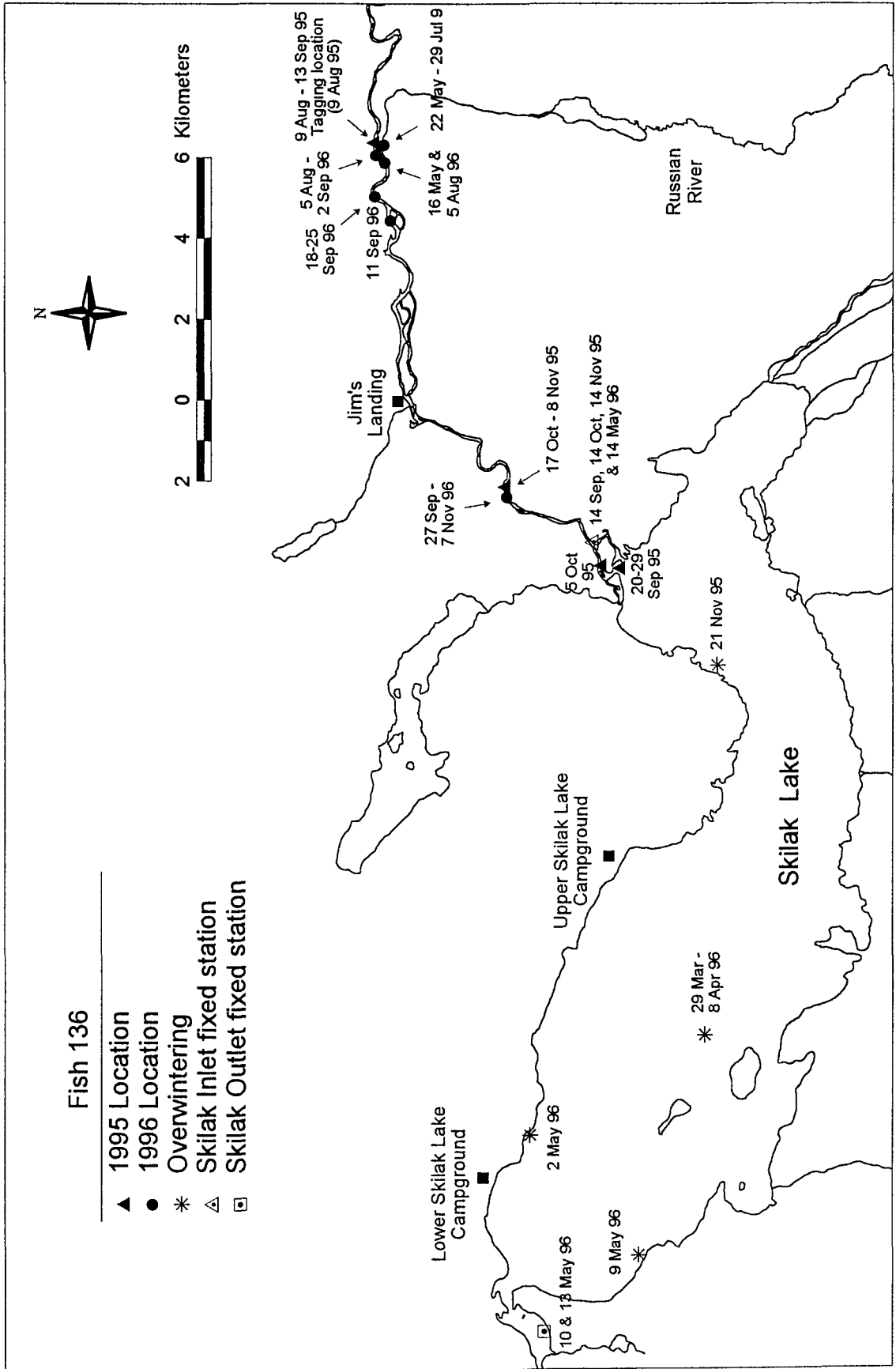
Appendix B22.— Locations of rainbow trout number 130 from 15 August through 5 October, 1995.



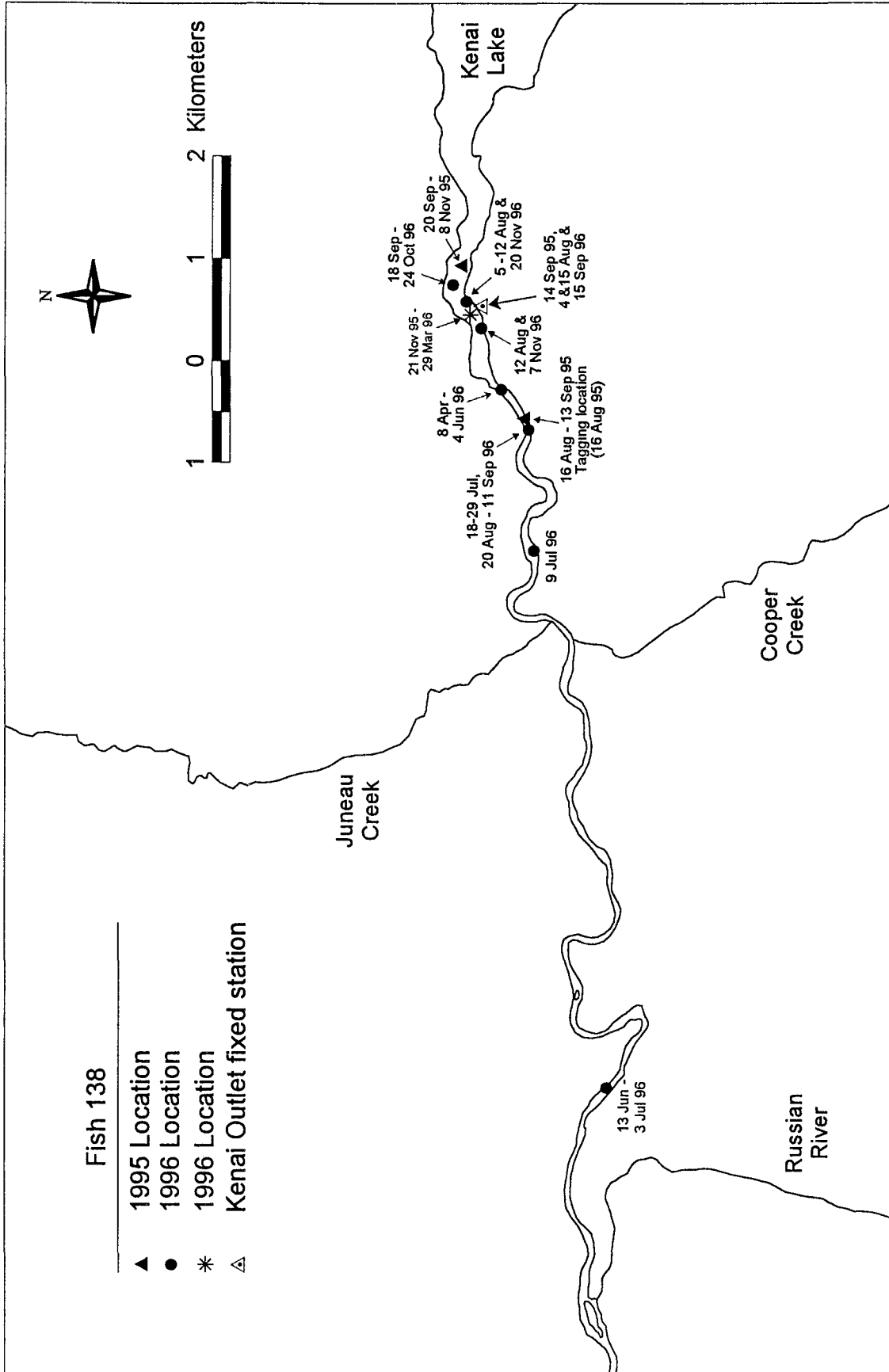
Appendix B23 — Locations of rainbow trout number 132 from 10 August, 1995 through 1 November, 1996.



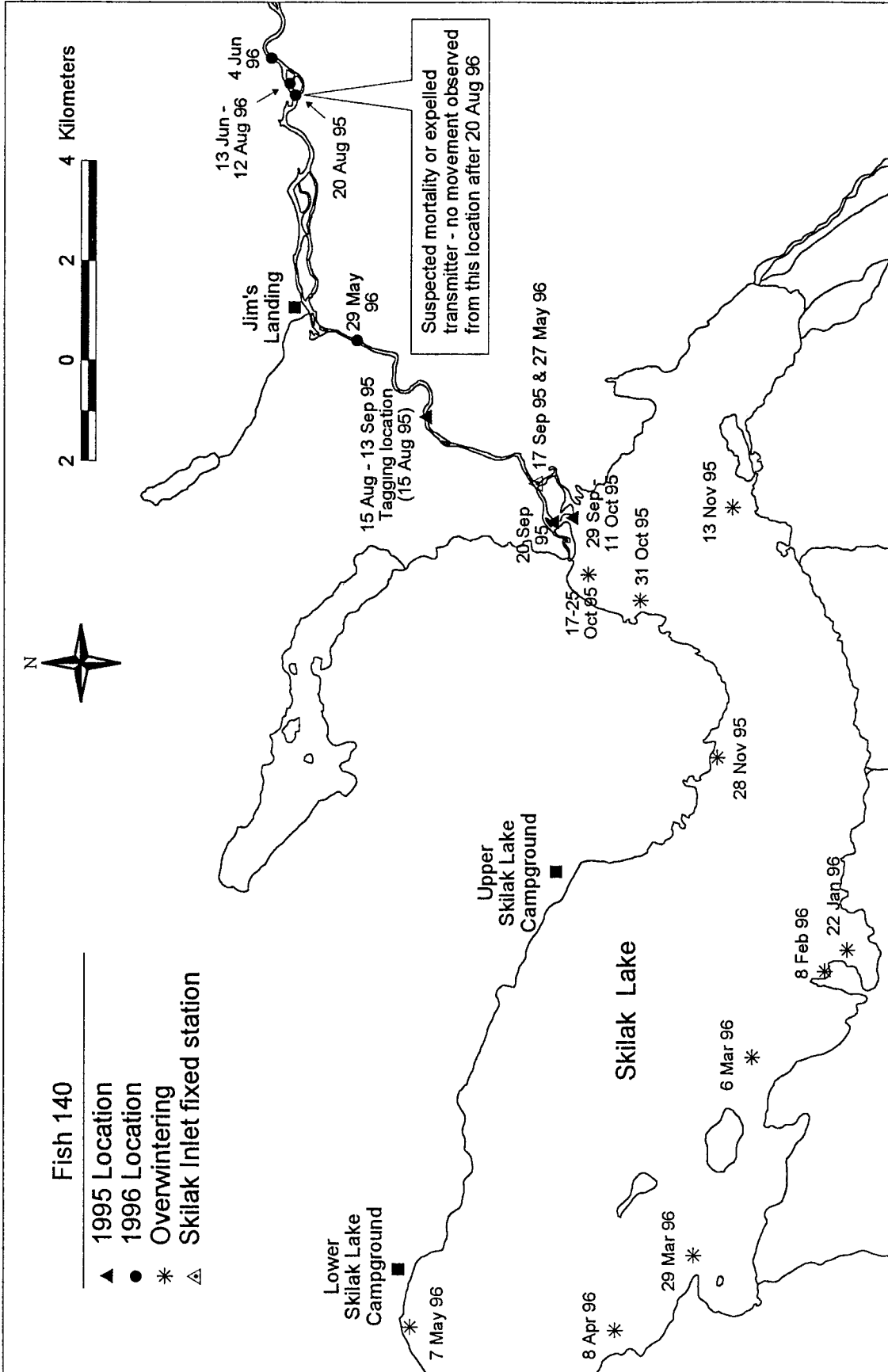
Appendix B24.— Locations of rainbow trout number 134 from 14 August through 20 October, 1995



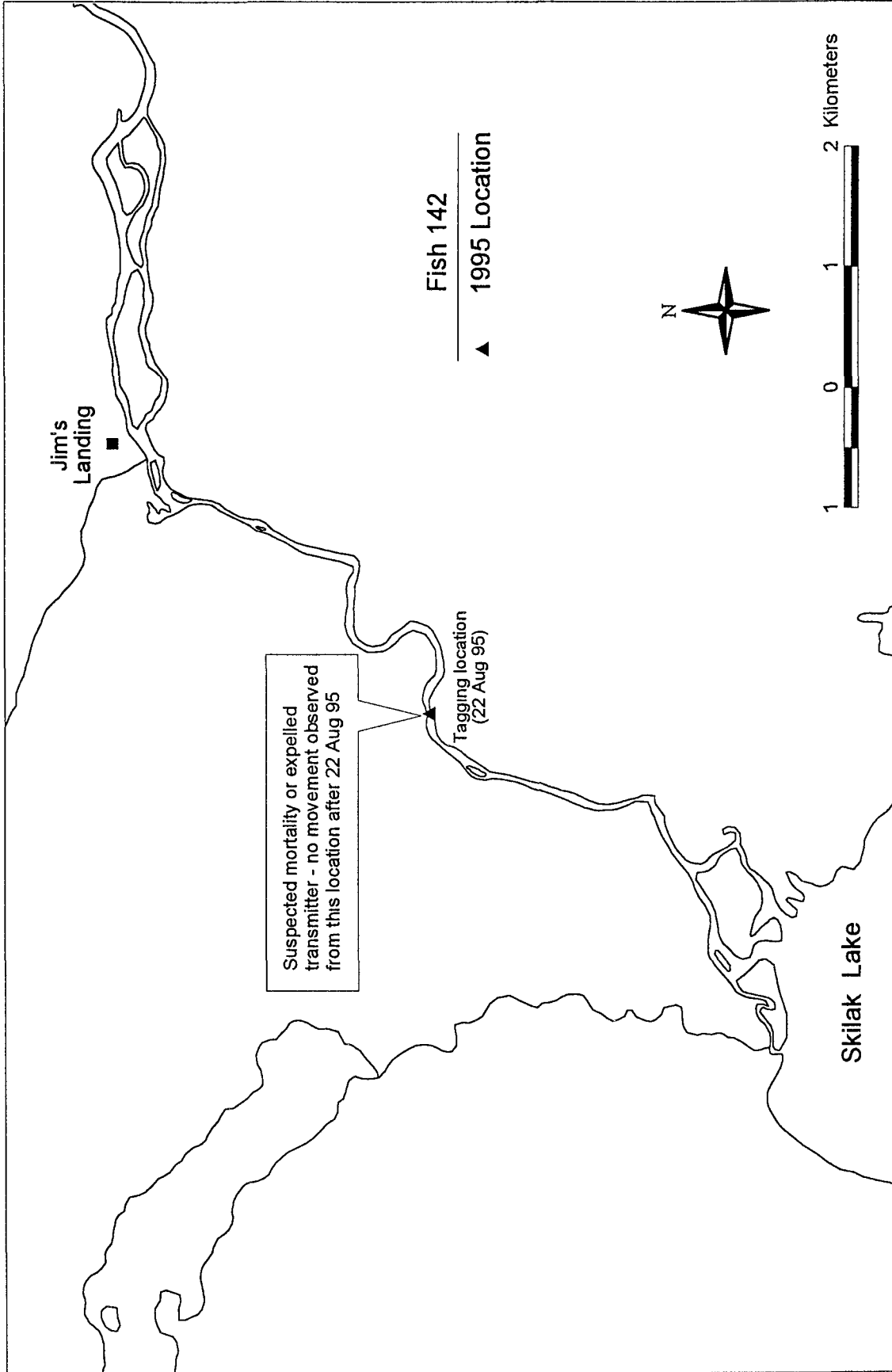
Appendix B25 — Locations of rainbow trout number 136 from 9 August, 1995 through 7 November, 1996.



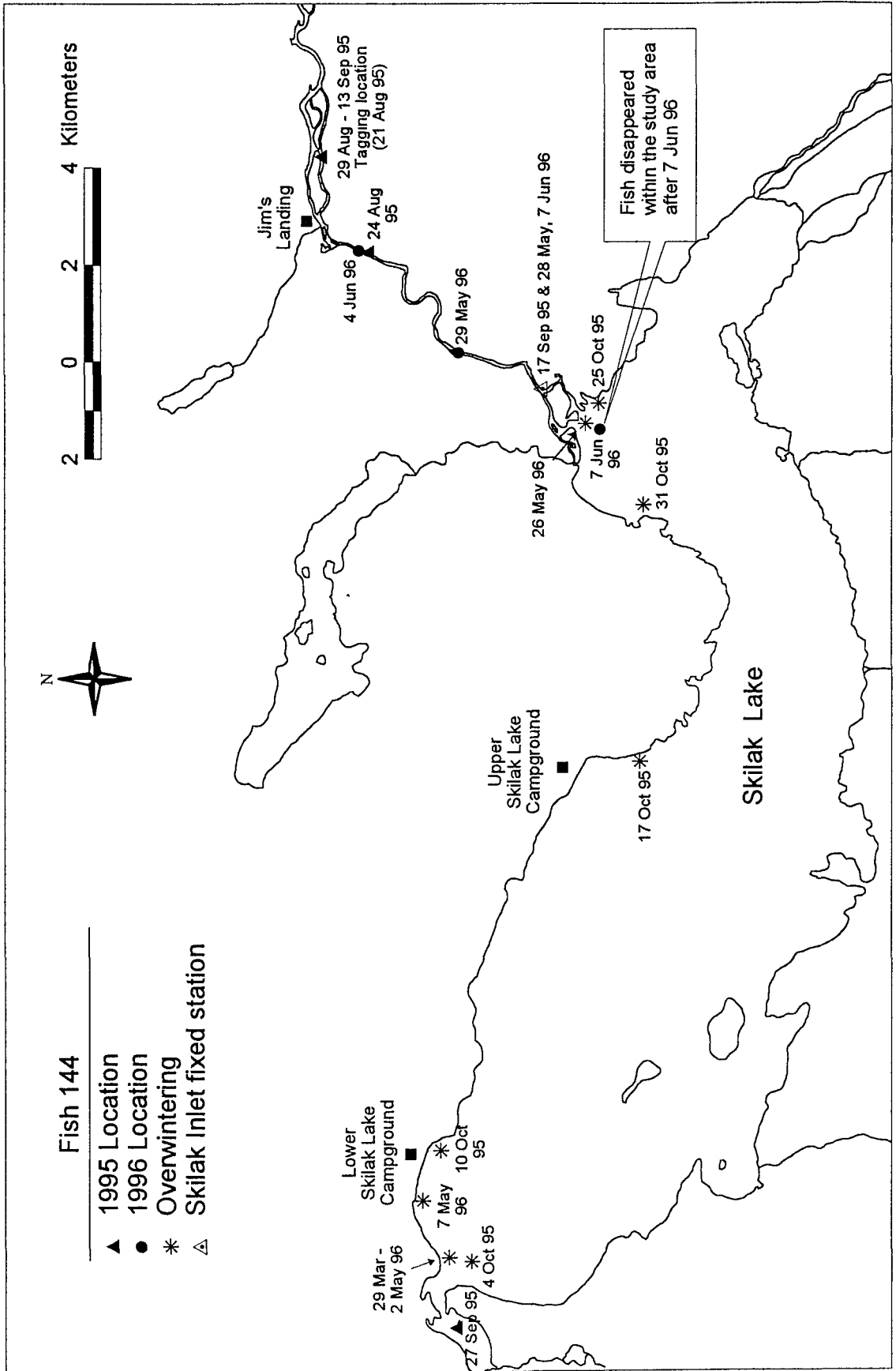
Appendix B26.— Locations of rainbow trout number 138 from 16 August, 1995 through 20 November, 1996.



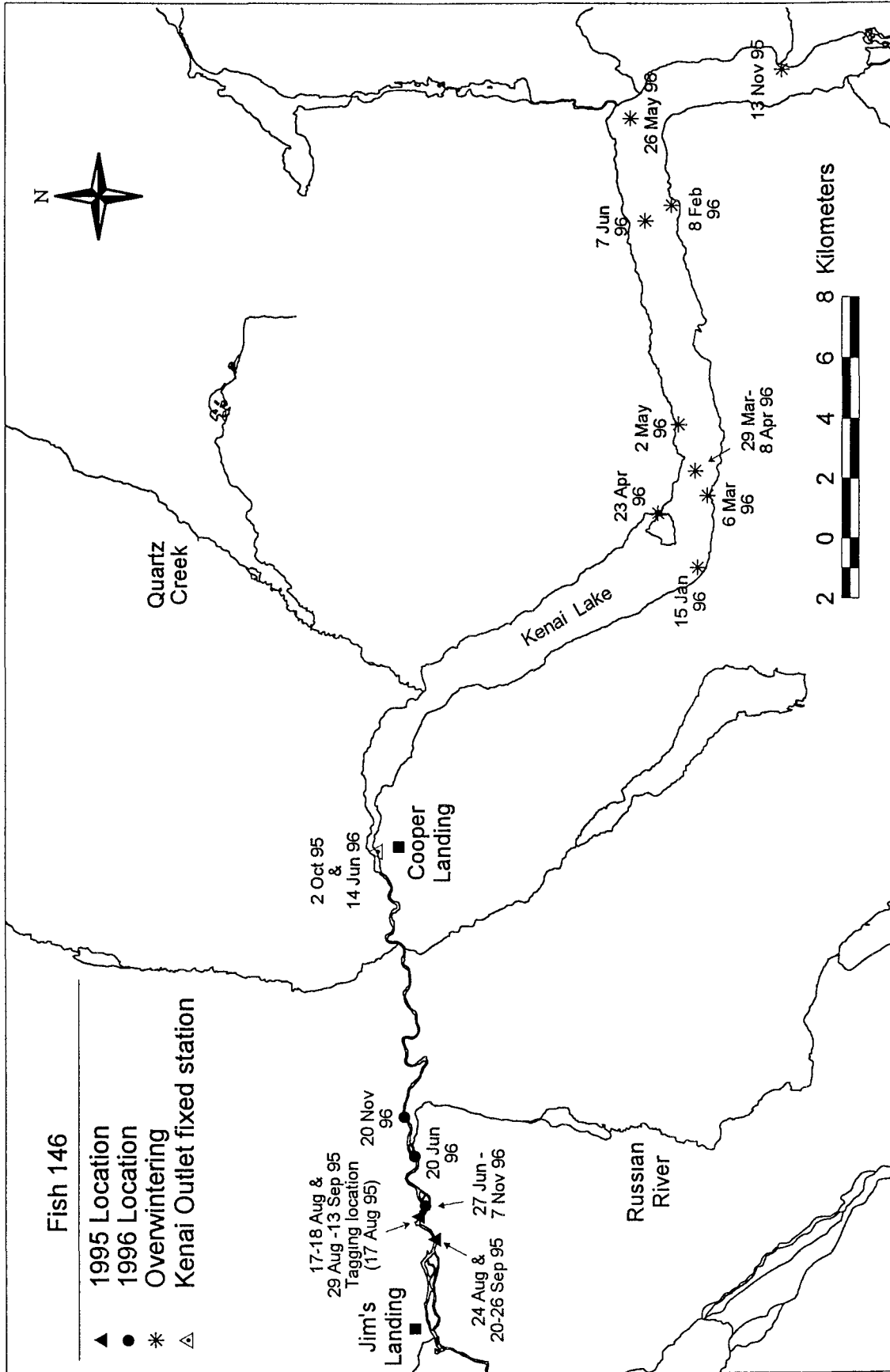
Appendix B27 — Locations of rainbow trout number 140 from 15 August, 1995 through 20 August, 1996.



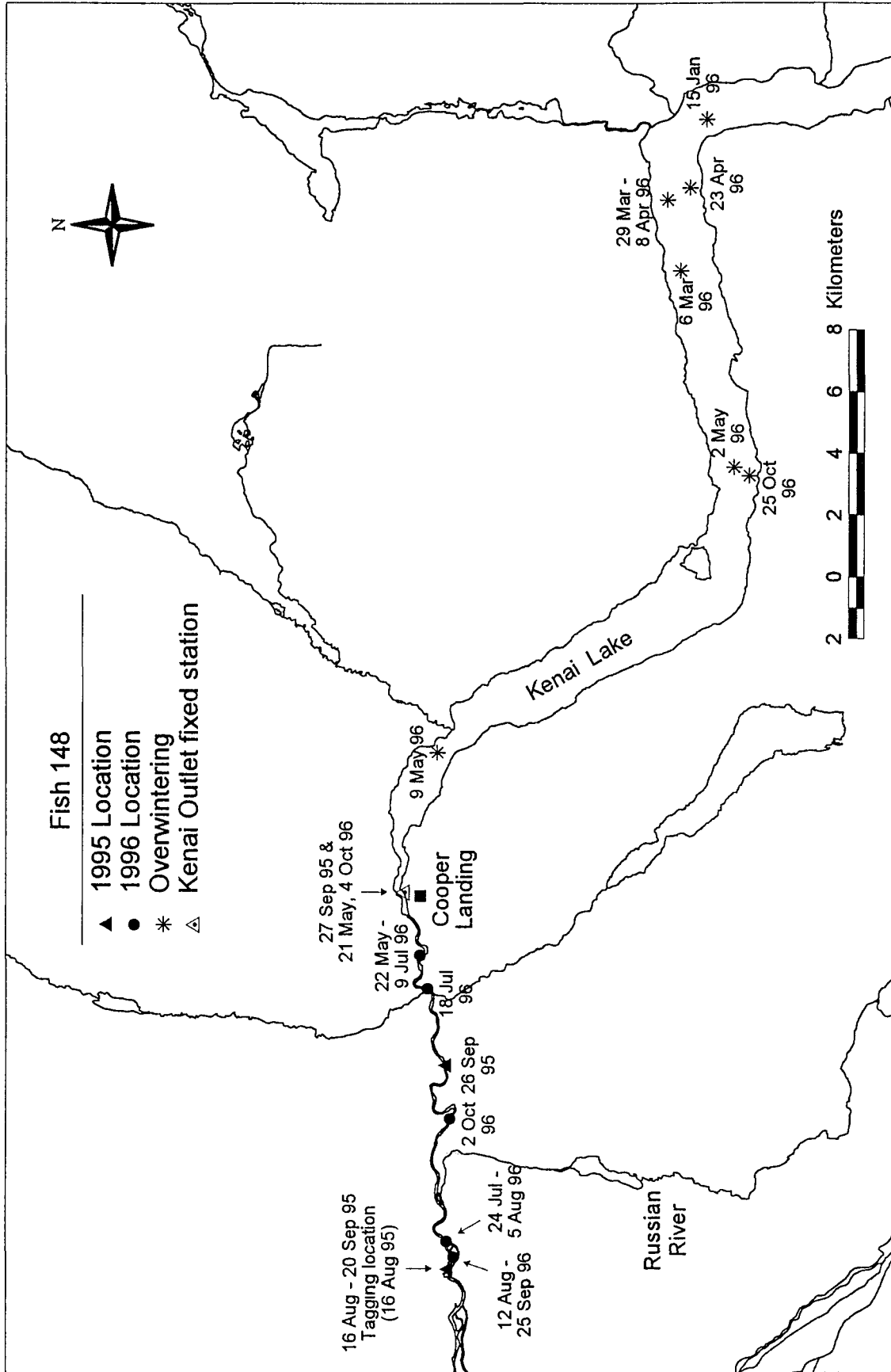
Appendix B28. — Locations of rainbow trout number 142 from 22 August through 7 September, 1995.



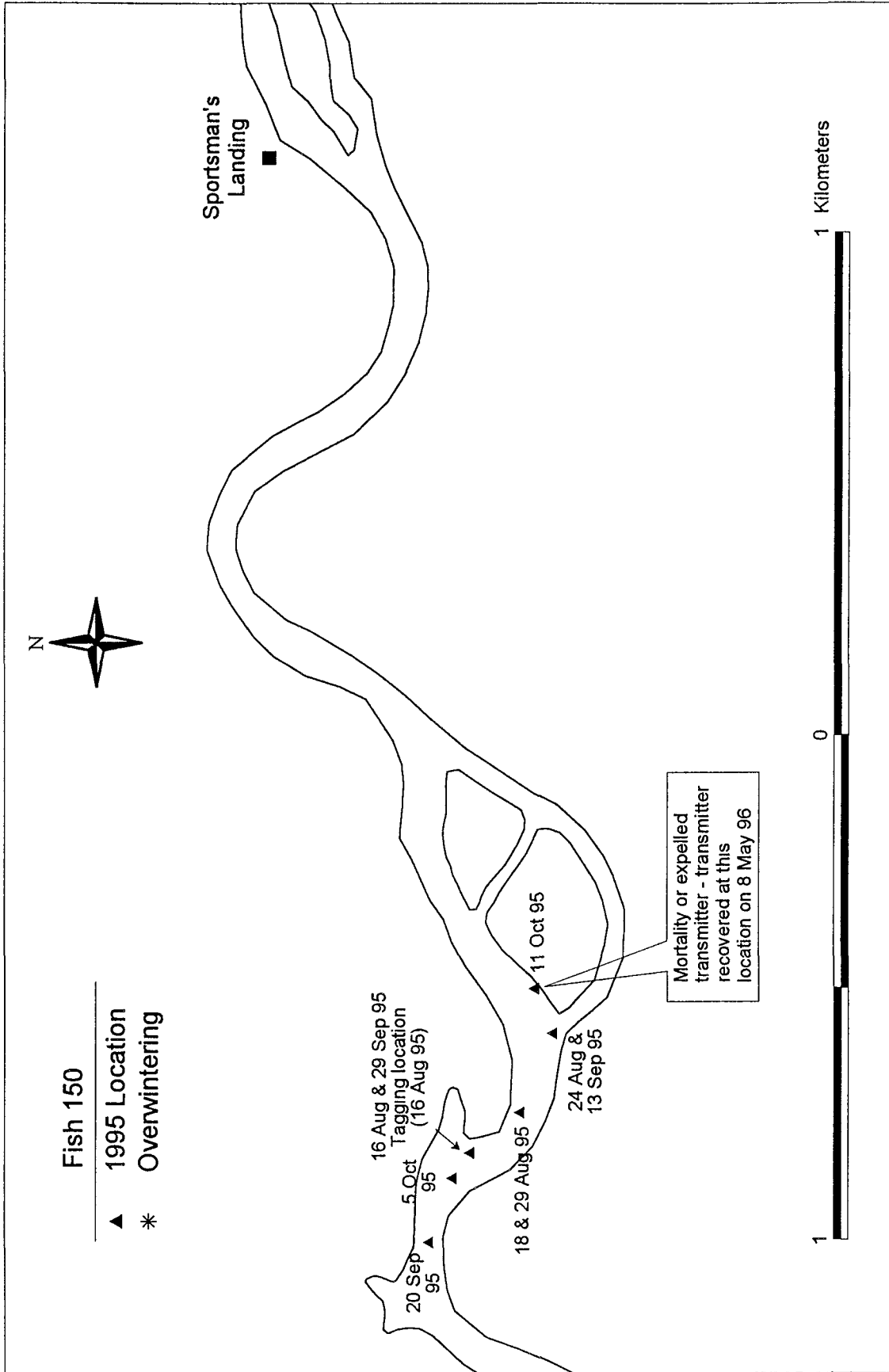
Appendix B29.— Locations of rainbow trout number 144 from 21 August, 1995 through 7 June, 1996.



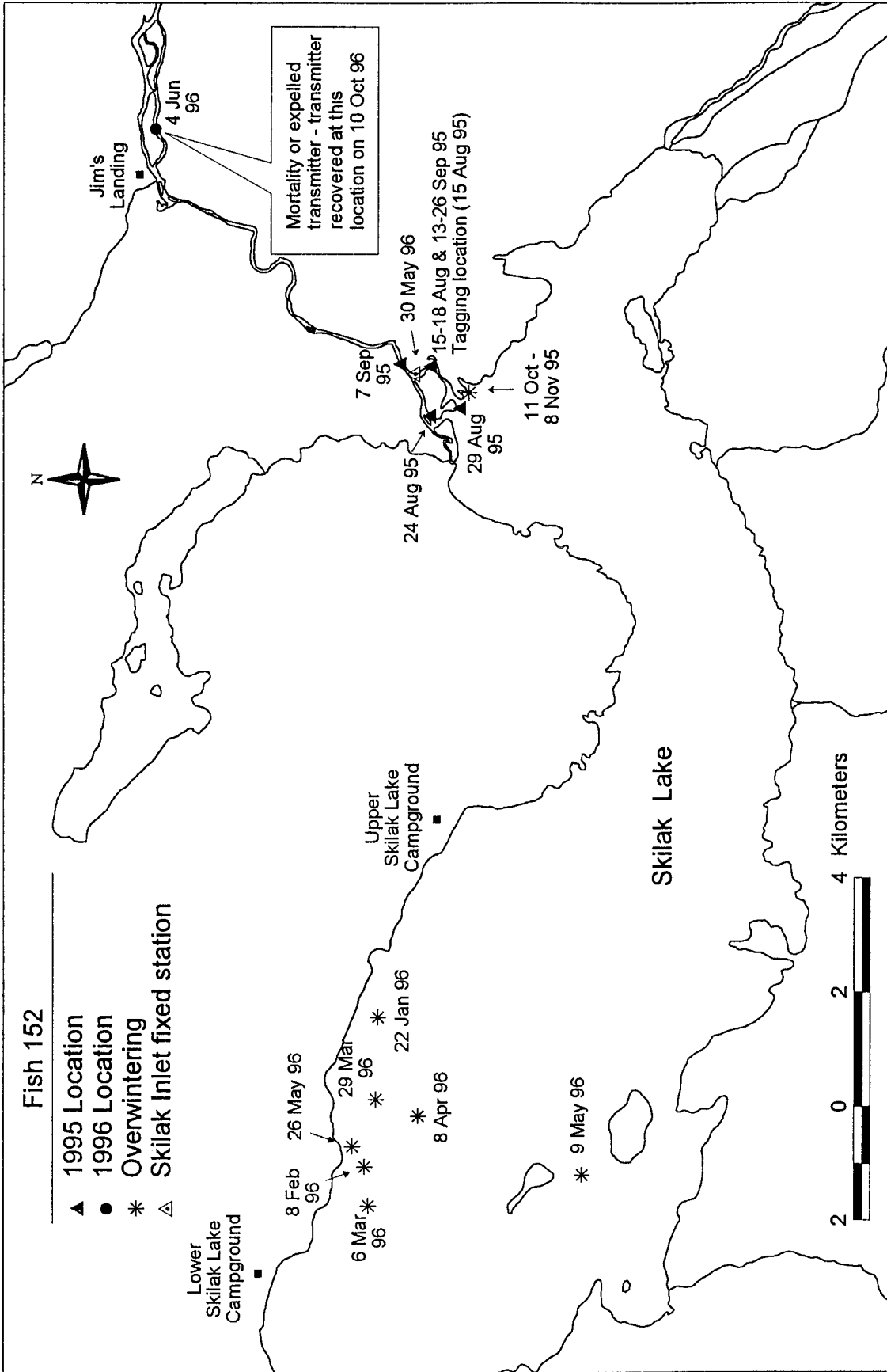
Appendix B30 — Locations of rainbow trout number 146 from 17 August, 1995 through 20 November, 1996.



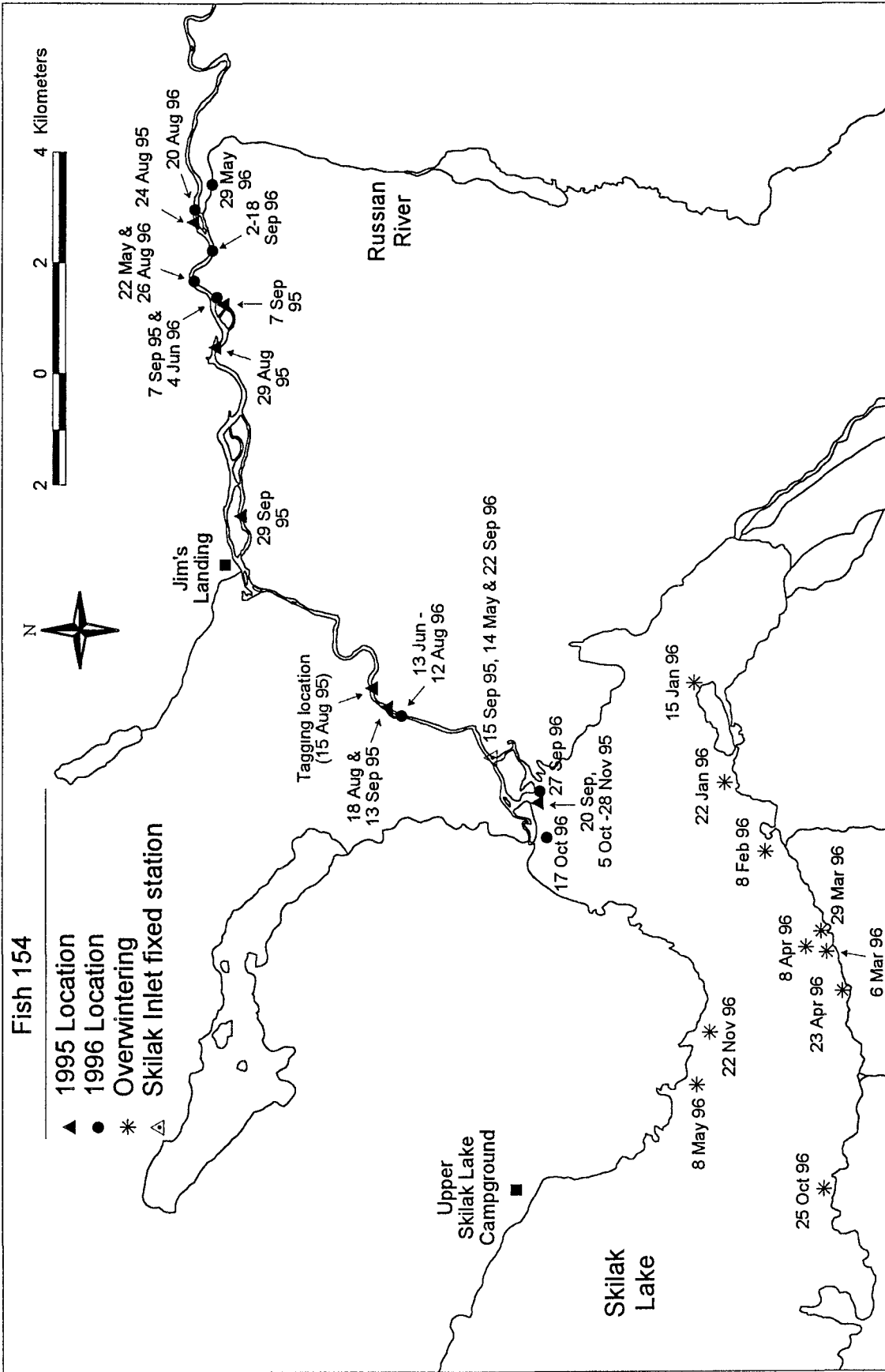
Appendix B31 — Locations of rainbow trout number 148 from 16 August, 1995 through 25 October, 1996.



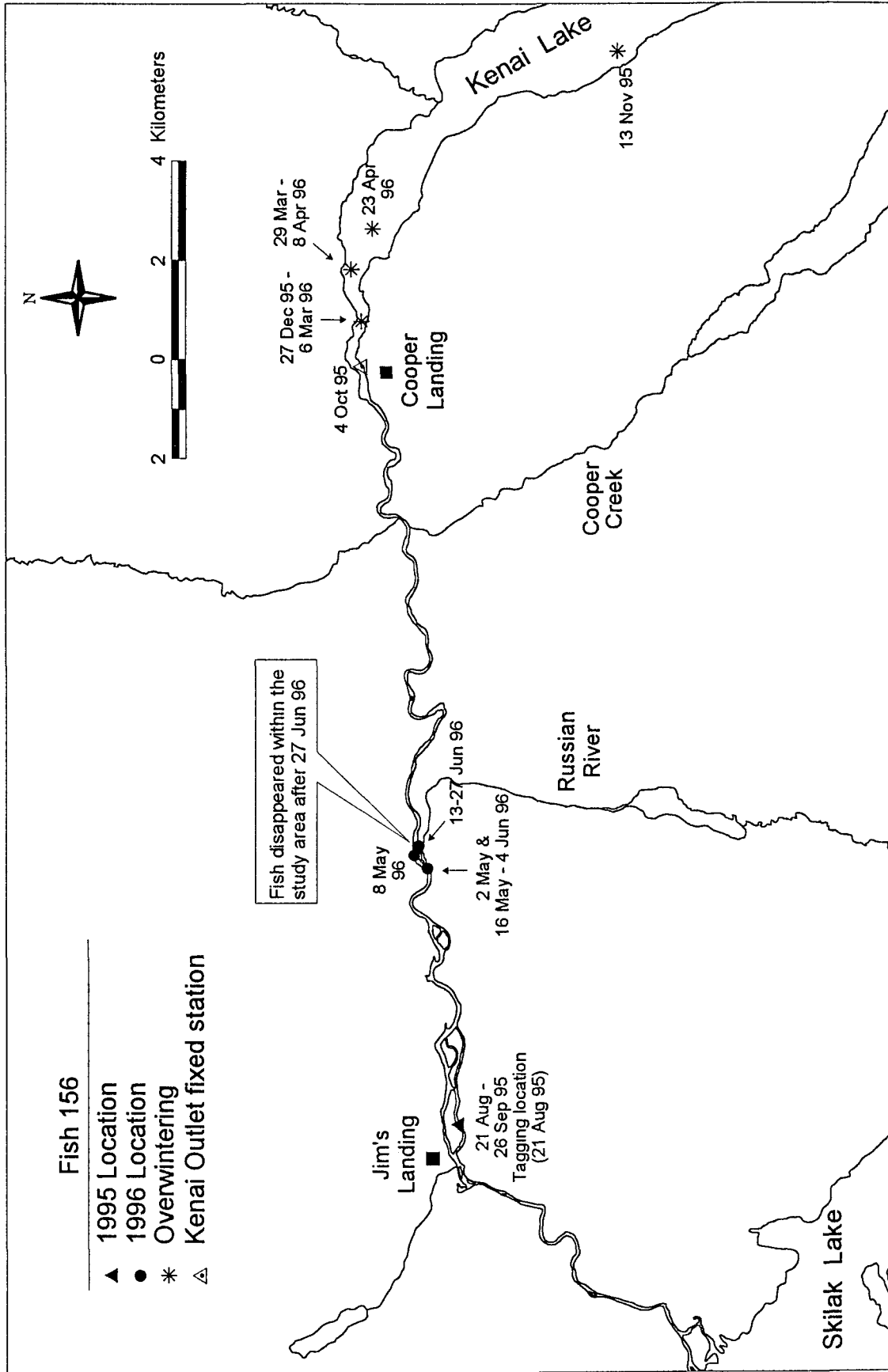
Appendix B32.— Locations of rainbow trout number 150 from 16 August through 11 October, 1995.



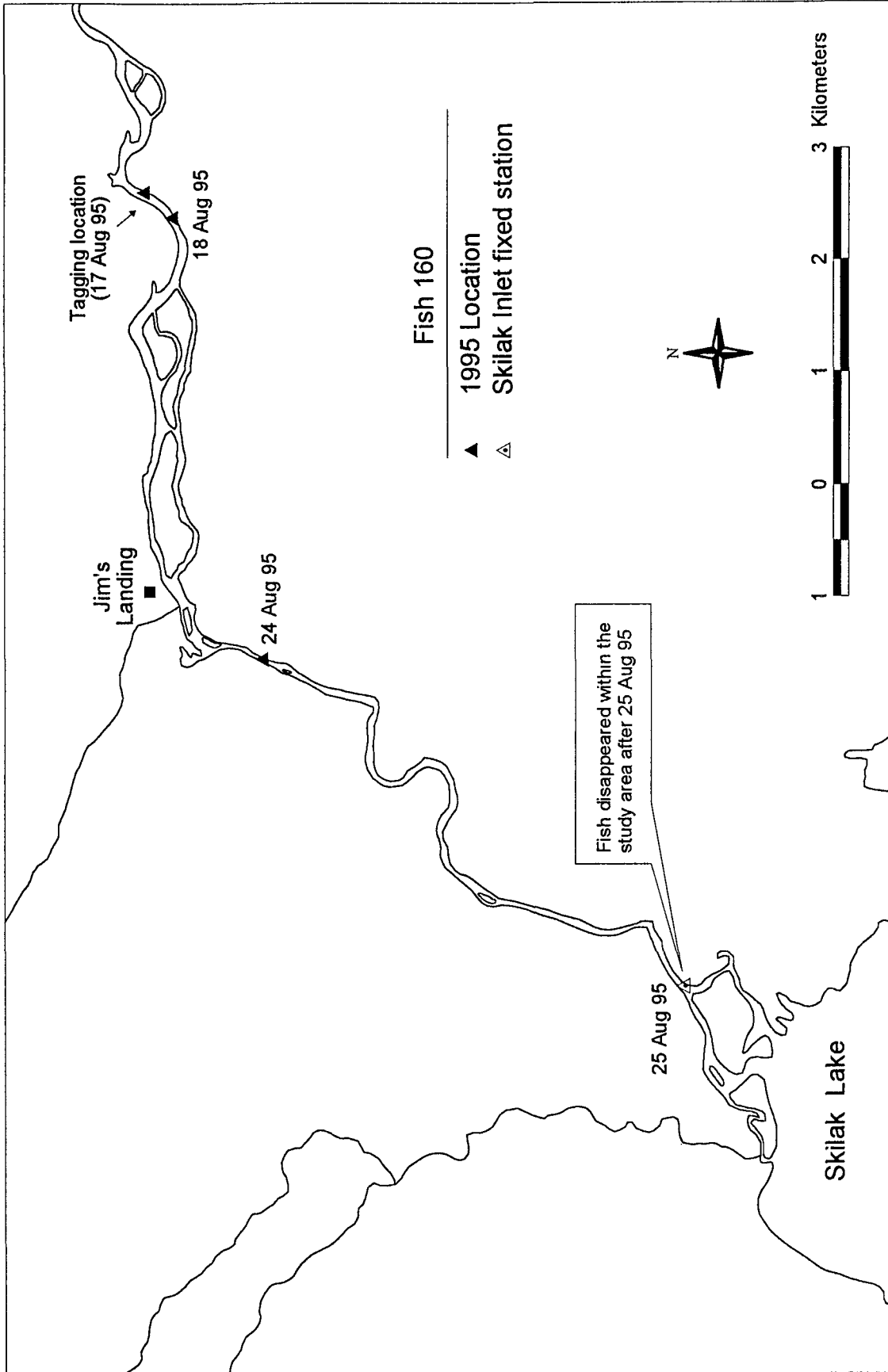
Appendix B33 — Locations of rainbow trout number 152 from 15 August, 1995 through 4 June, 1996.



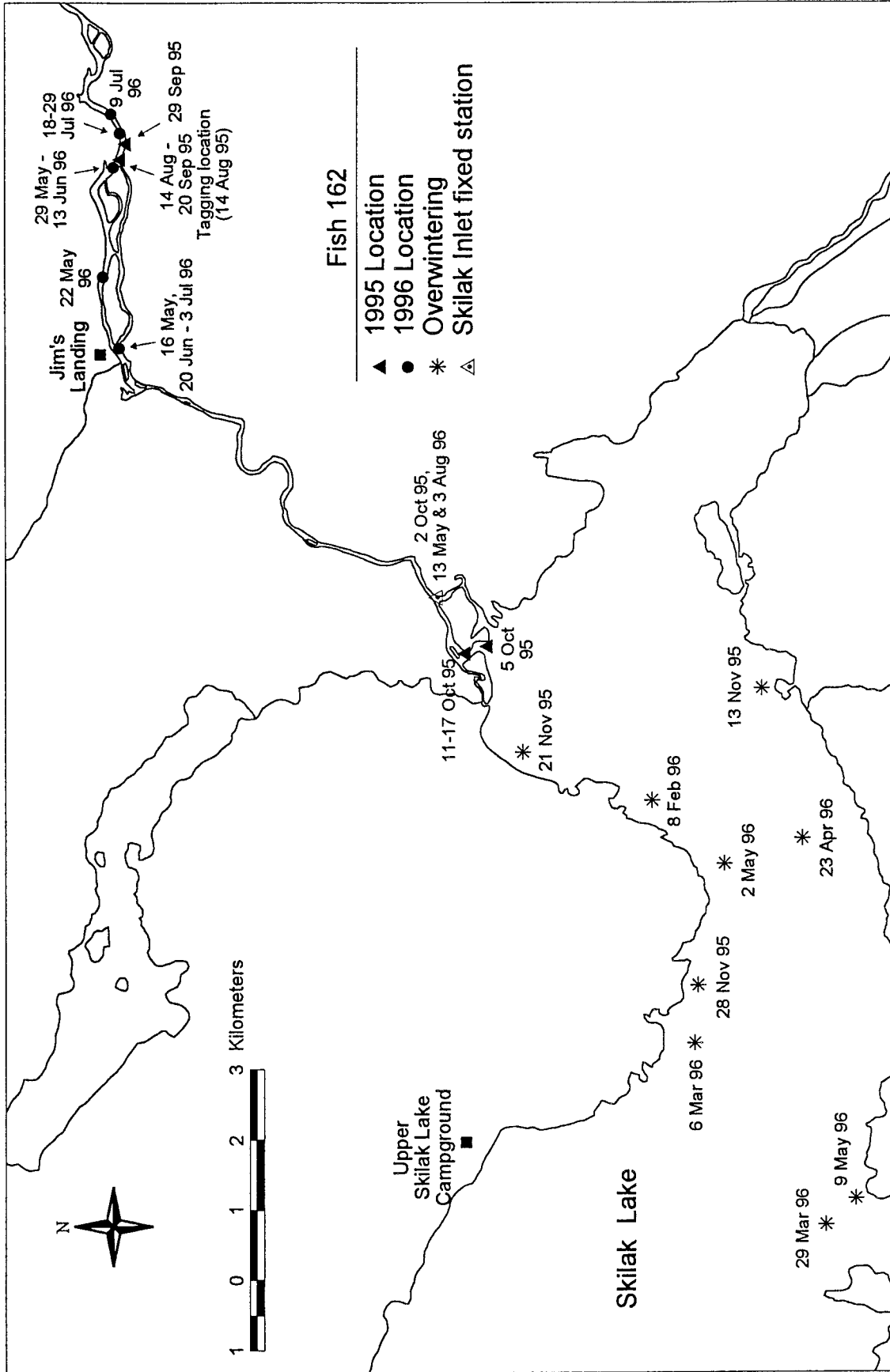
Appendix B34.— Locations of rainbow trout number 154 from 15 August, 1995 through 22 November, 1996.



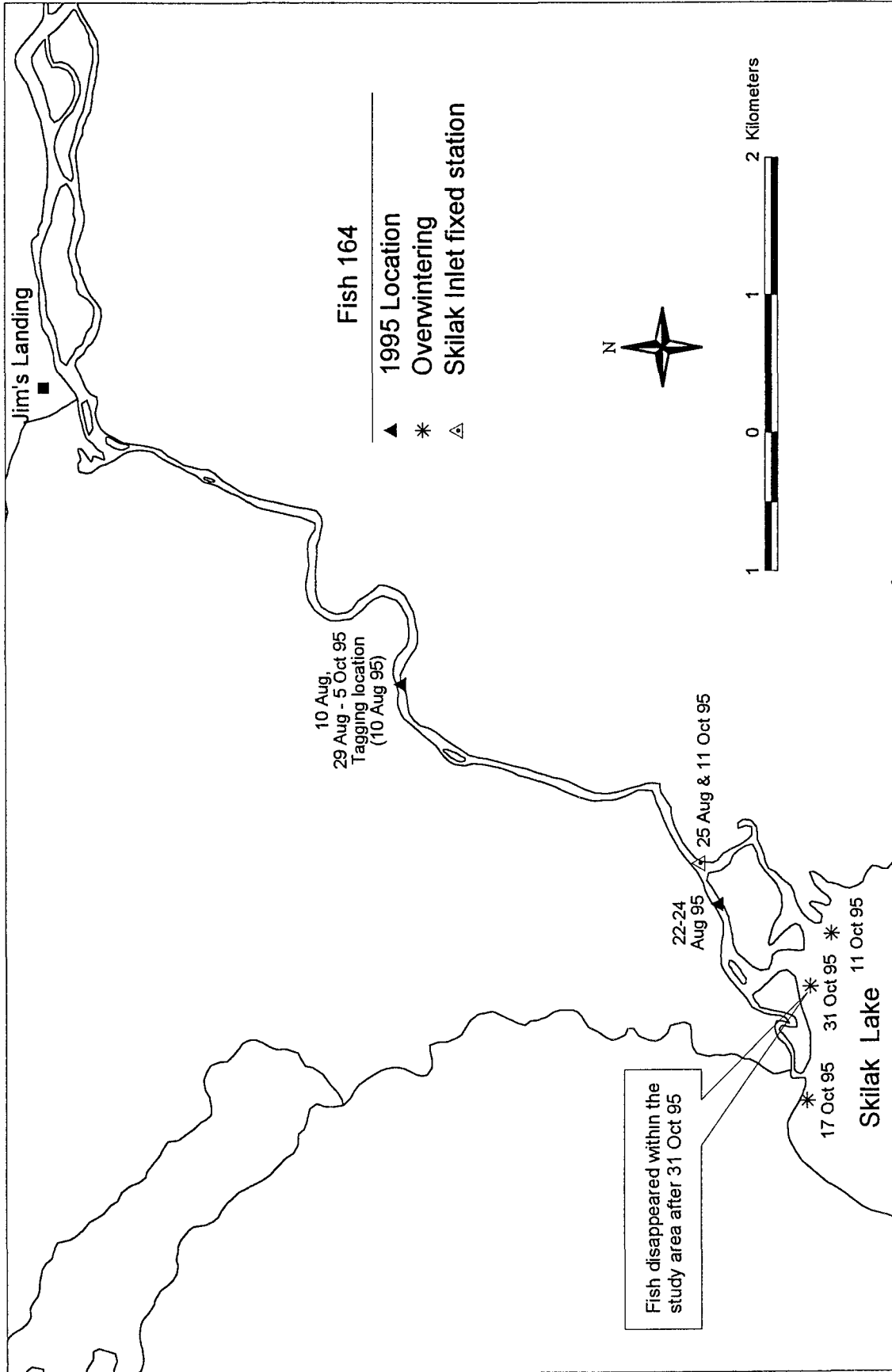
Appendix B35.— Locations of rainbow trout number 156 from 21 August, 1995 through 27 June, 1996.



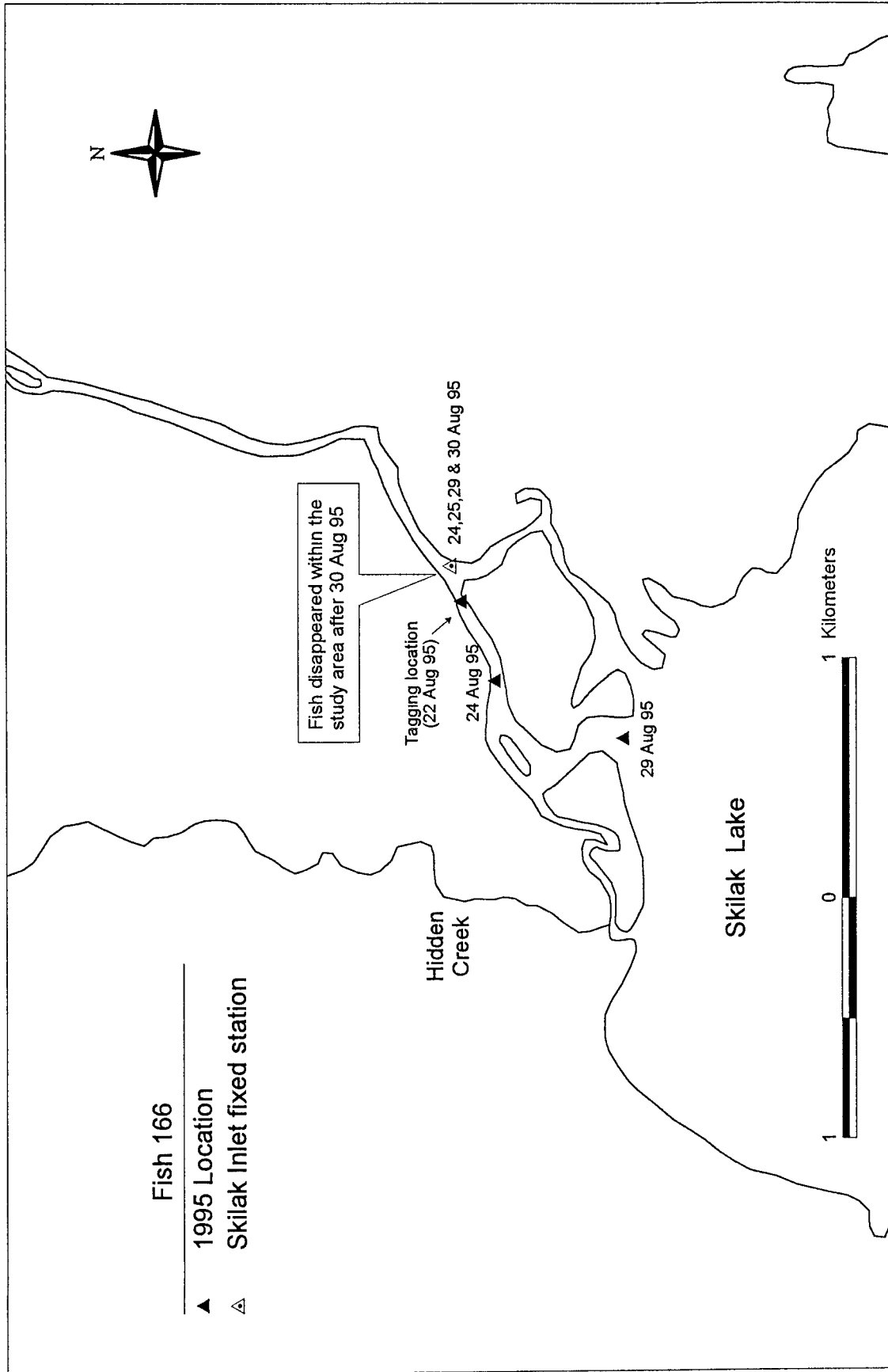
Appendix B36.— Locations of rainbow trout number 160 from 17-25 August, 1995.



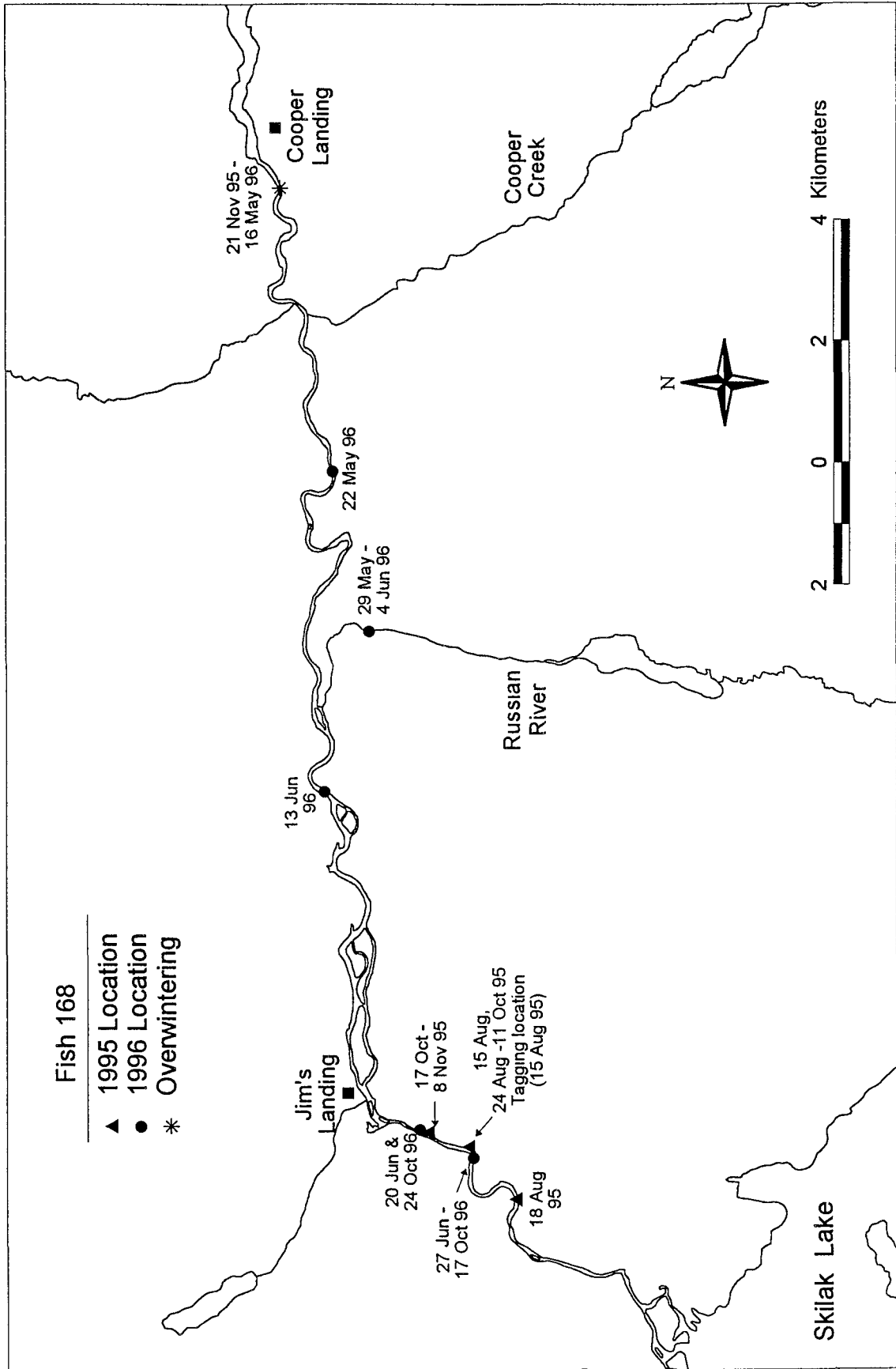
Appendix B37 — Locations of rainbow trout number 162 from 14 August, 1995 through 3 August, 1996.



Appendix B38.— Locations of rainbow trout number 164 from 10 August through 31 October, 1995.



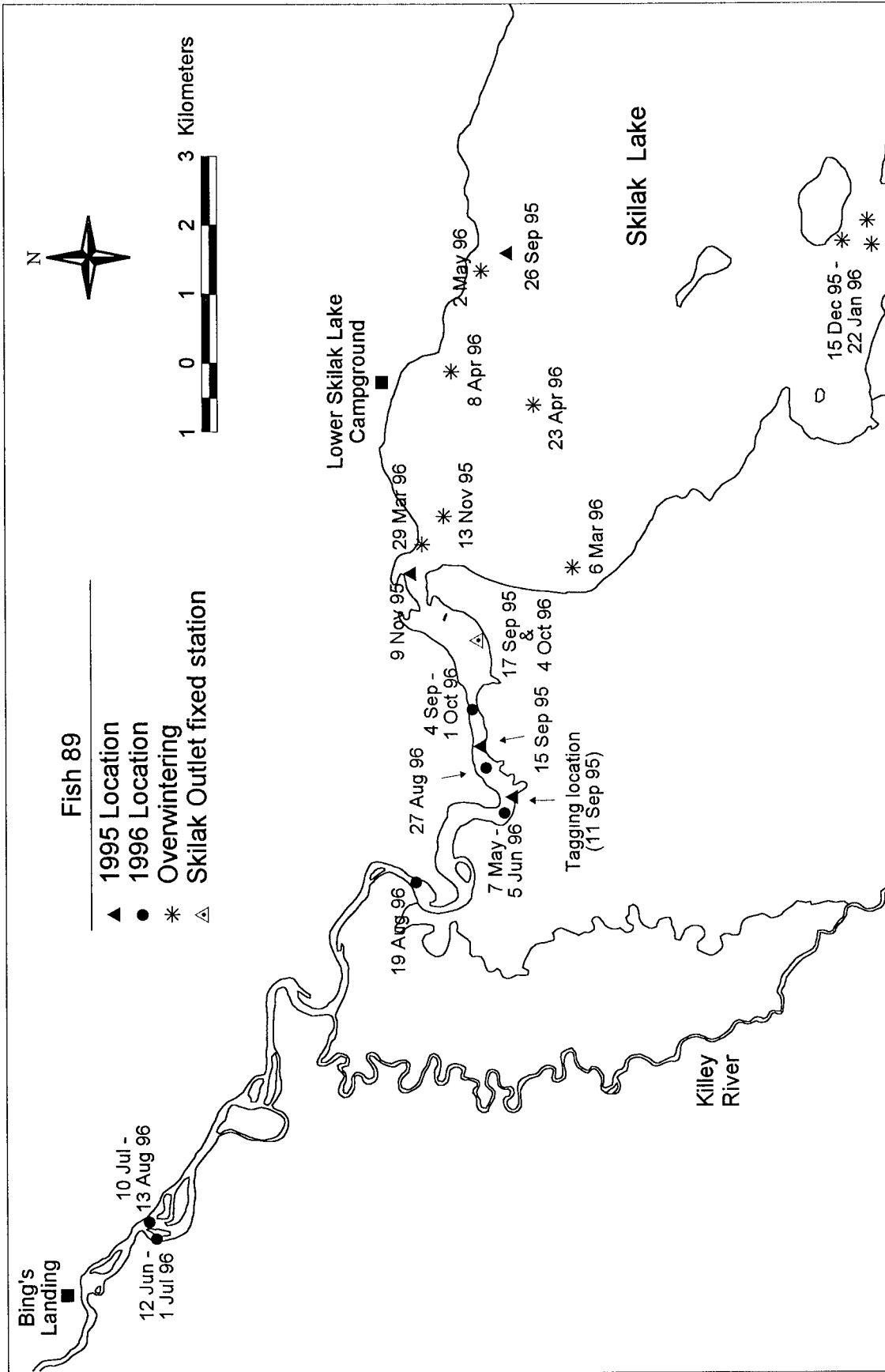
Appendix B39 — Locations of rainbow trout number 166 from 22-30 August, 1995.



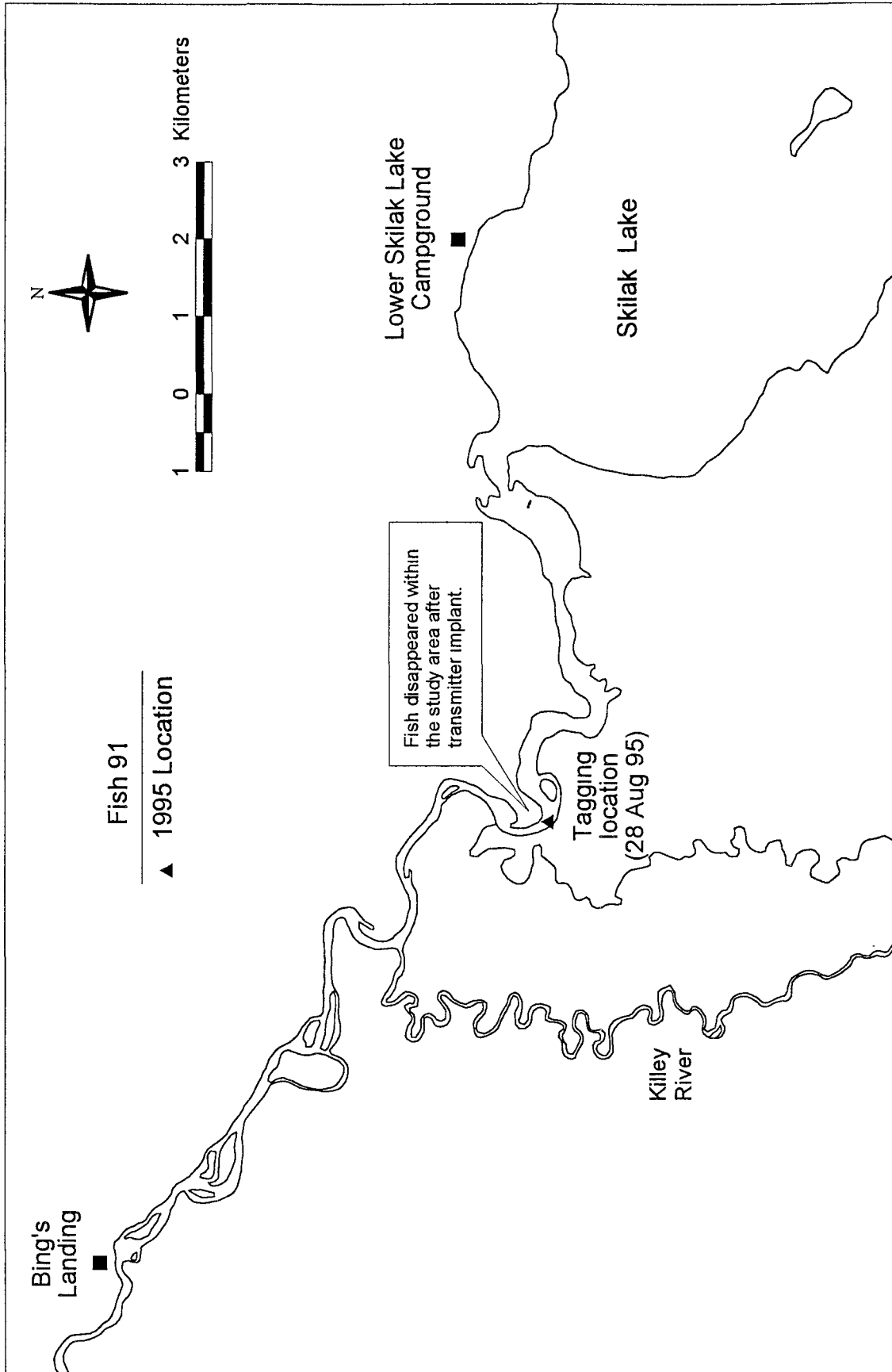
Appendix B40 — Locations of rainbow trout number 168 from 15 August, 1995 through 24 October, 1996.

APPENDIX C

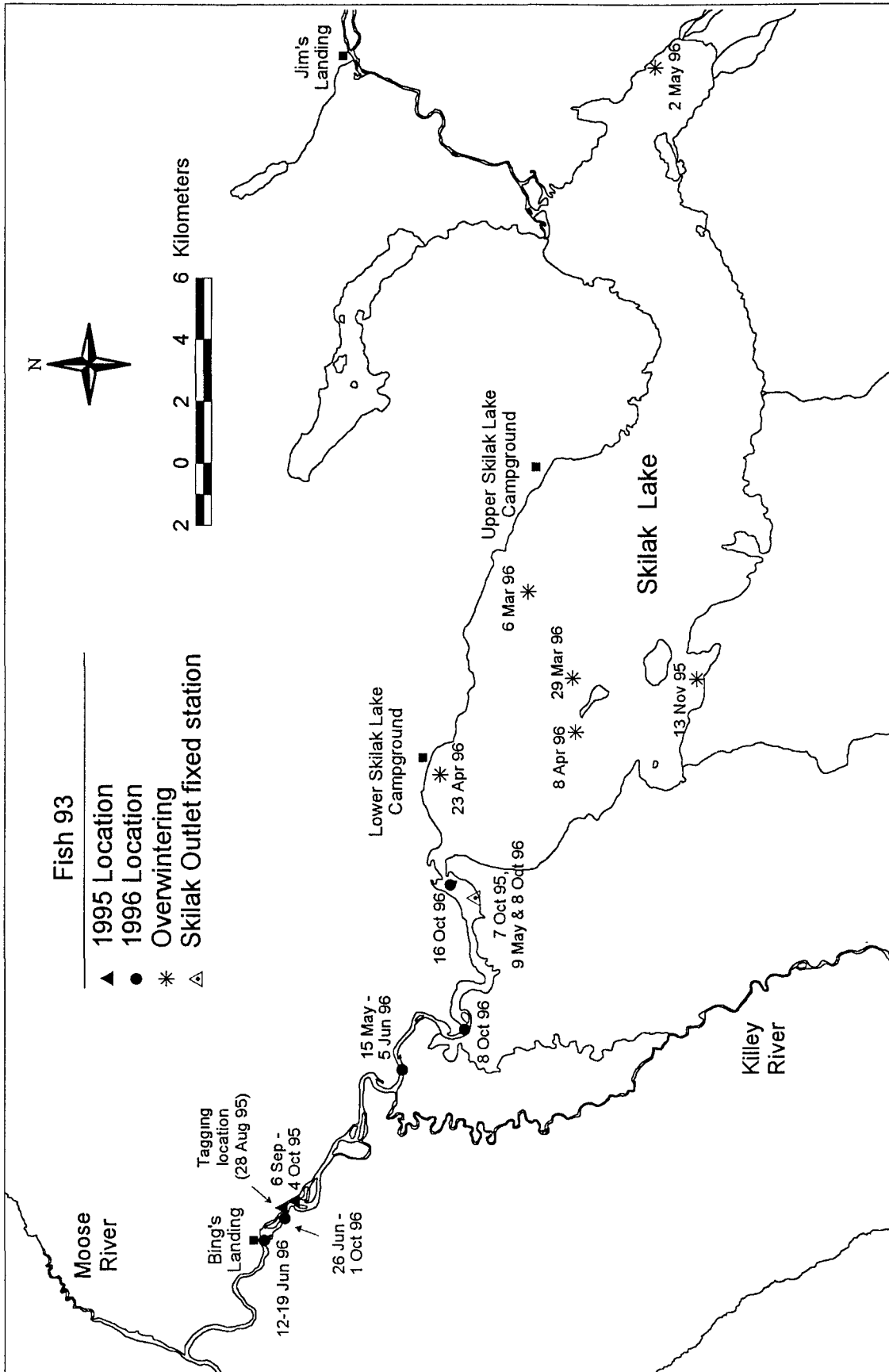
Locations of Individual Rainbow Trout Radio-Tagged Below Skilak Lake



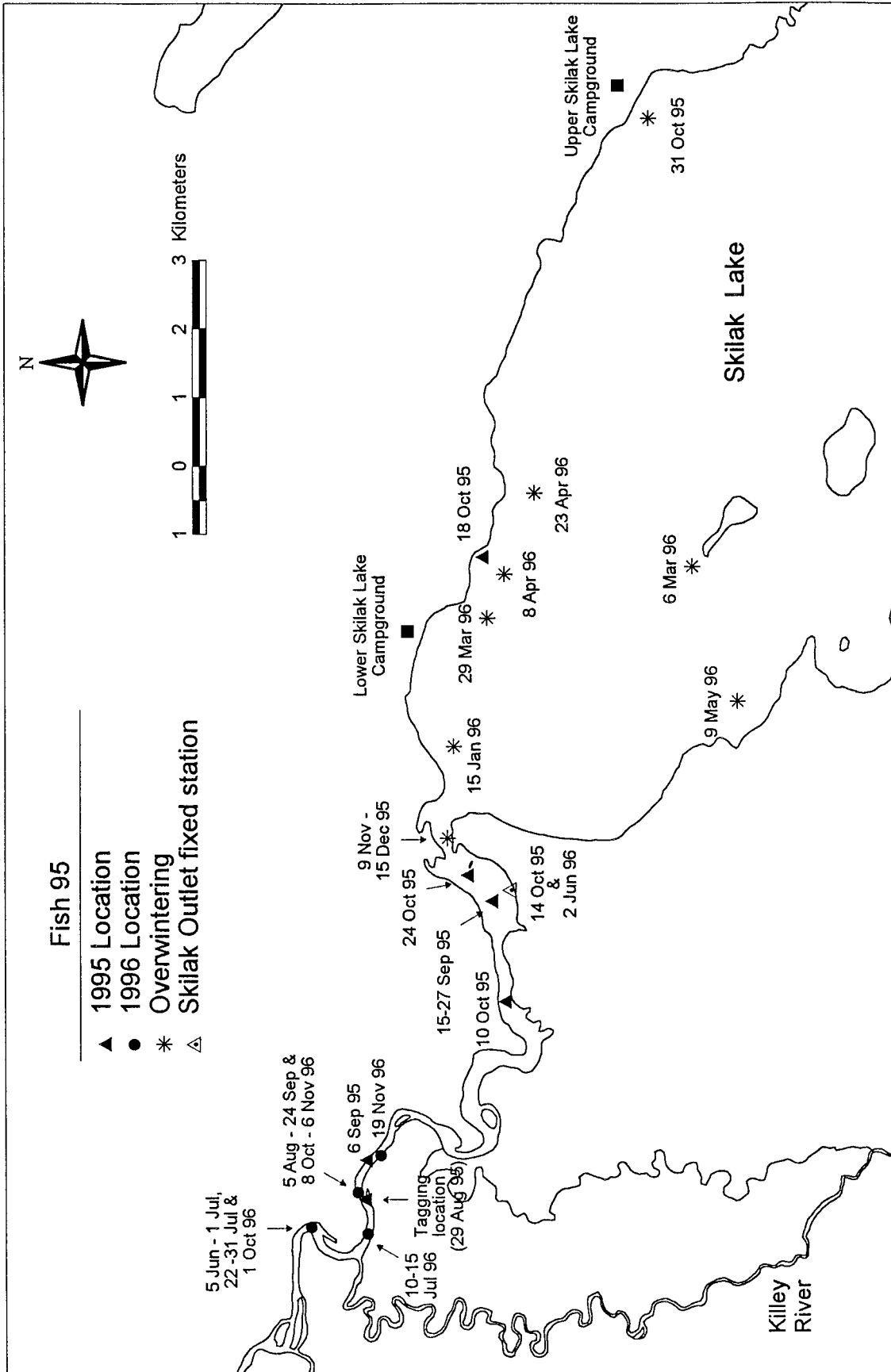
Appendix C1.— Locations of rainbow trout number 89 from 11 September, 1995 through 4 October, 1996



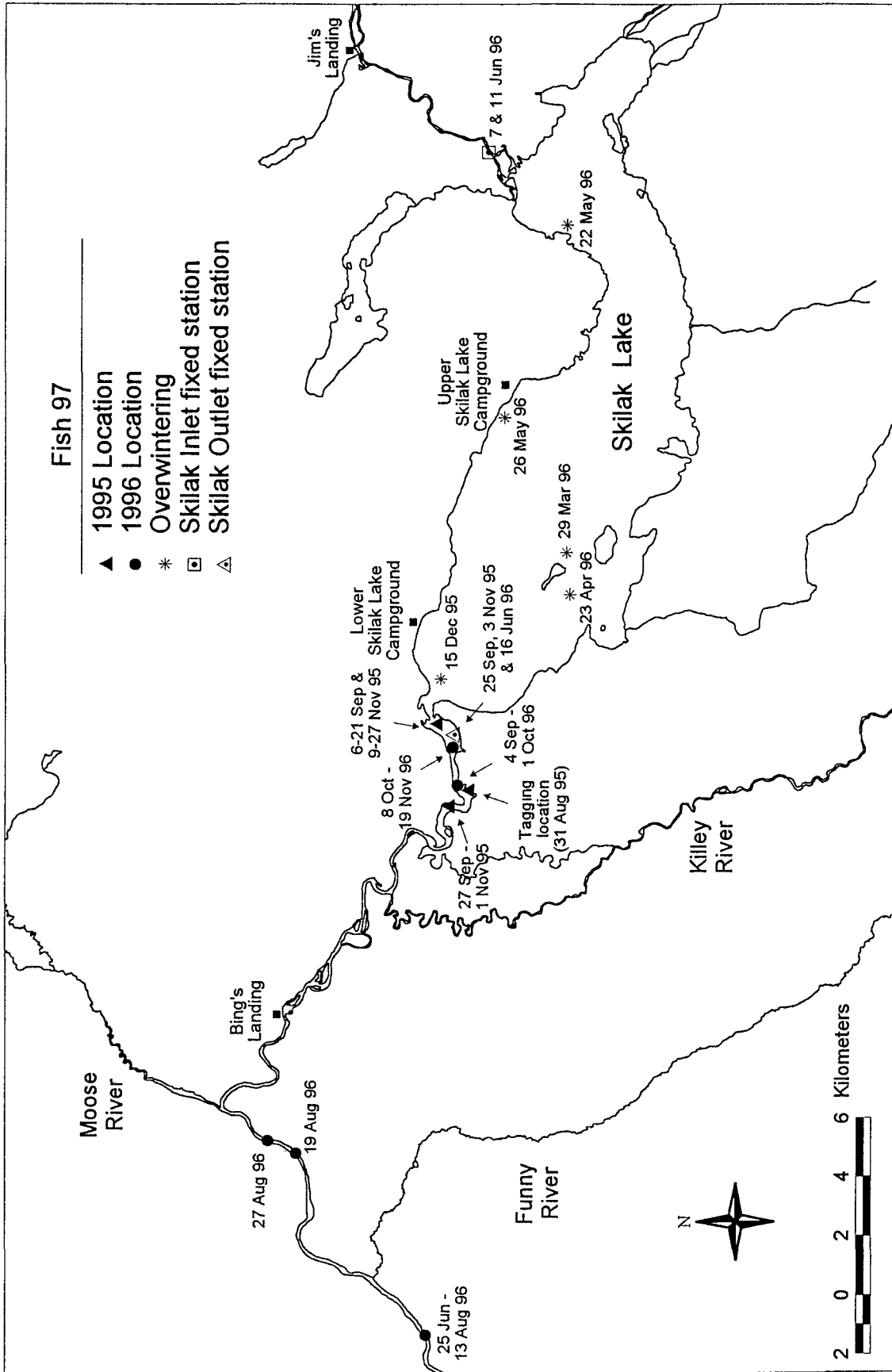
Appendix C2.— Location of rainbow trout number 91 on 28 August, 1995.



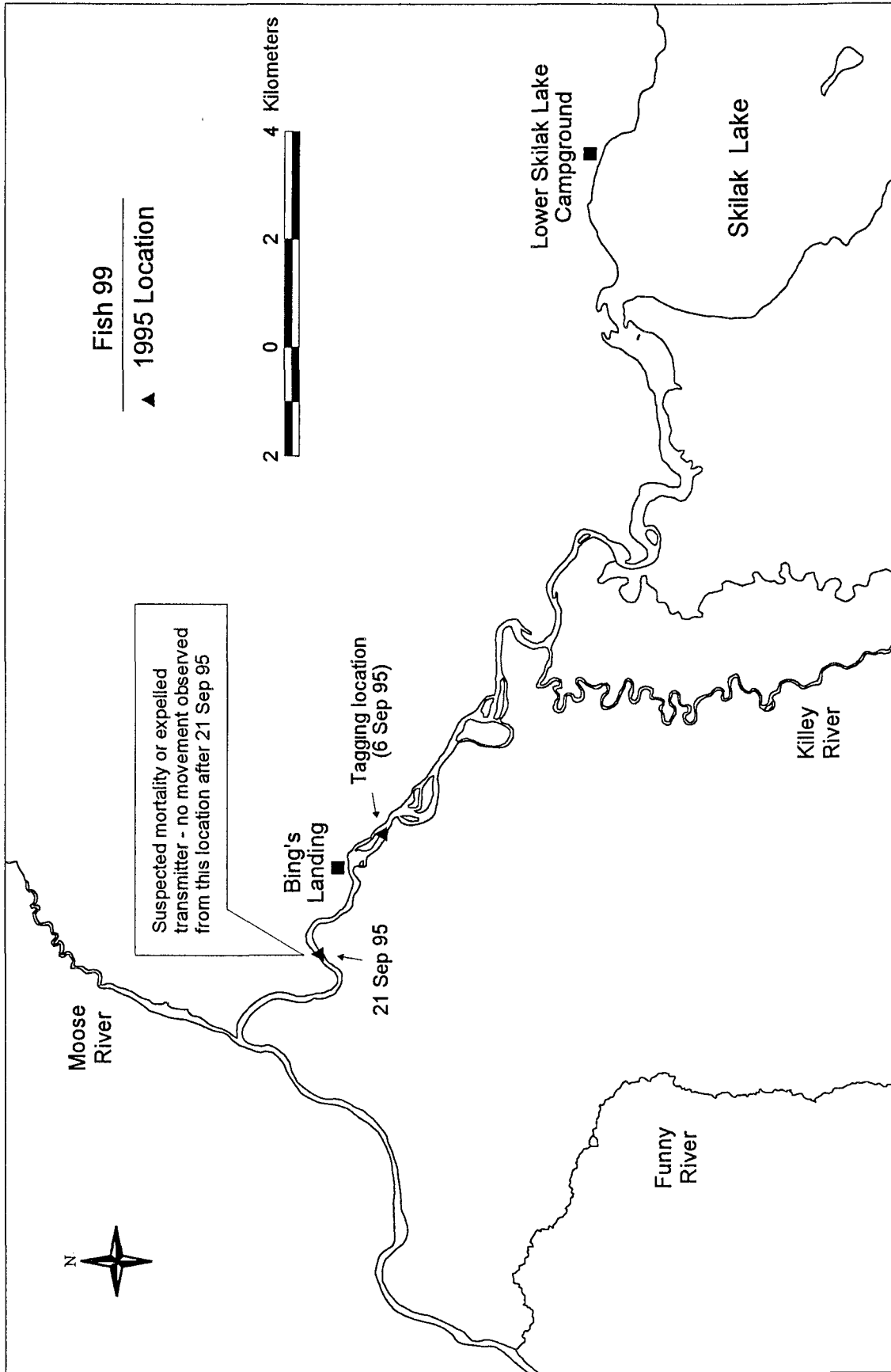
Appendix C3.— Locations of rainbow trout number 93 from 28 August, 1995 through 16 October, 1996.



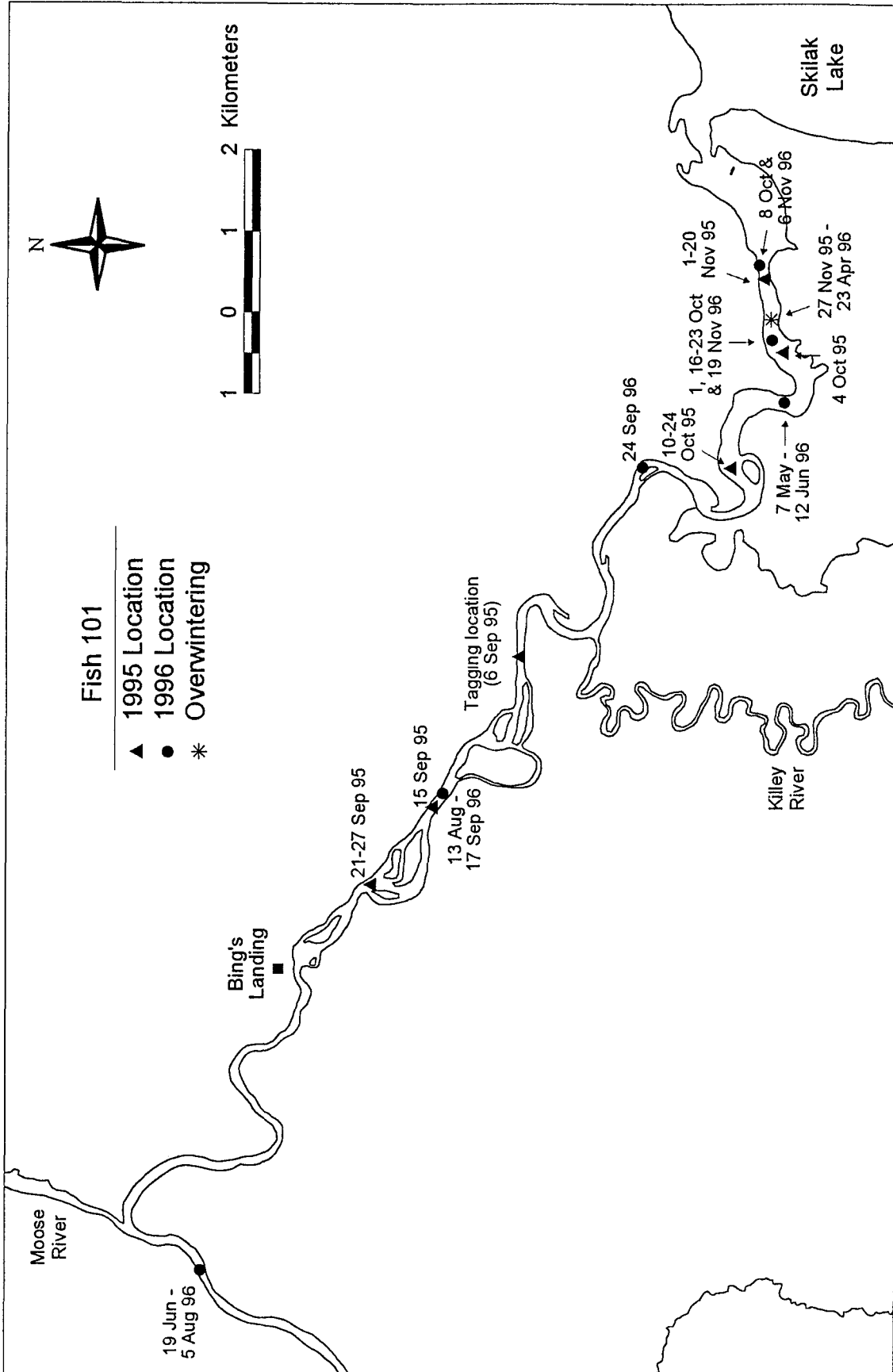
Appendix C4.— Locations of rainbow trout number 95 from 29 August, 1995 through 19 November, 1996.



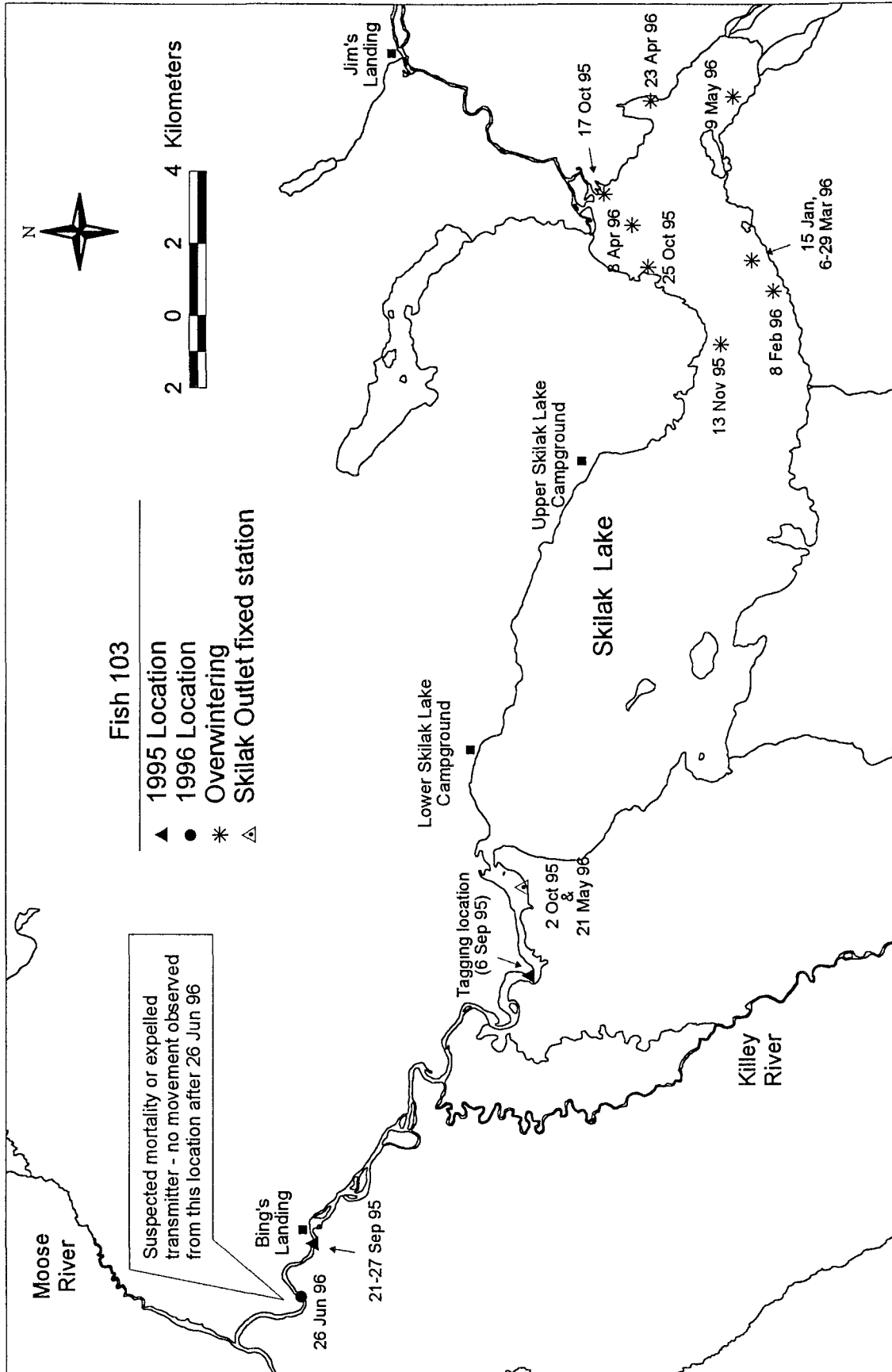
Appendix C5 — Locations of rainbow trout number 97 from 31 August, 1995 through 19 November, 1996.



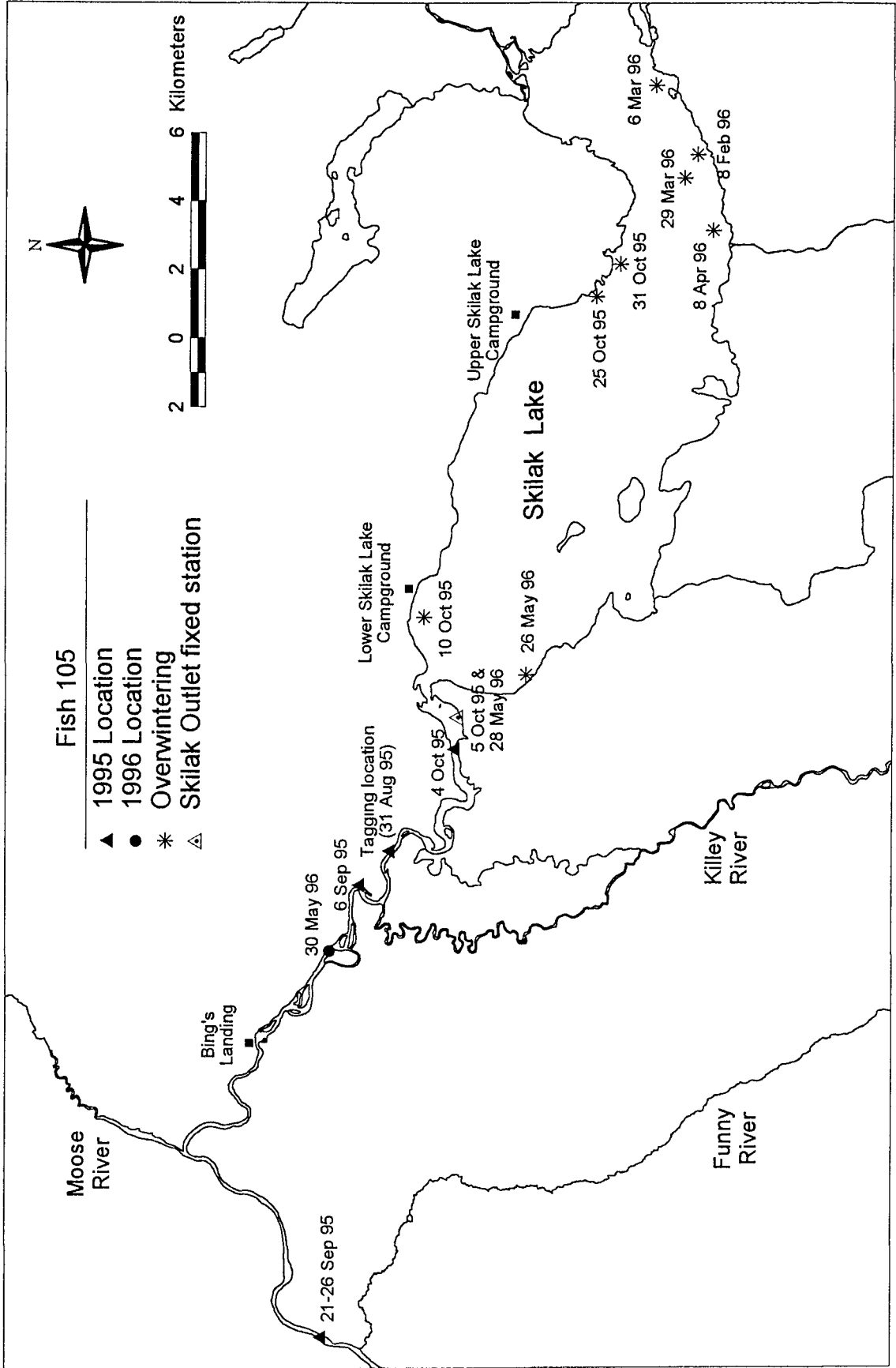
Appendix C6.— Locations of rainbow trout number 99 from 6-21 September, 1995.



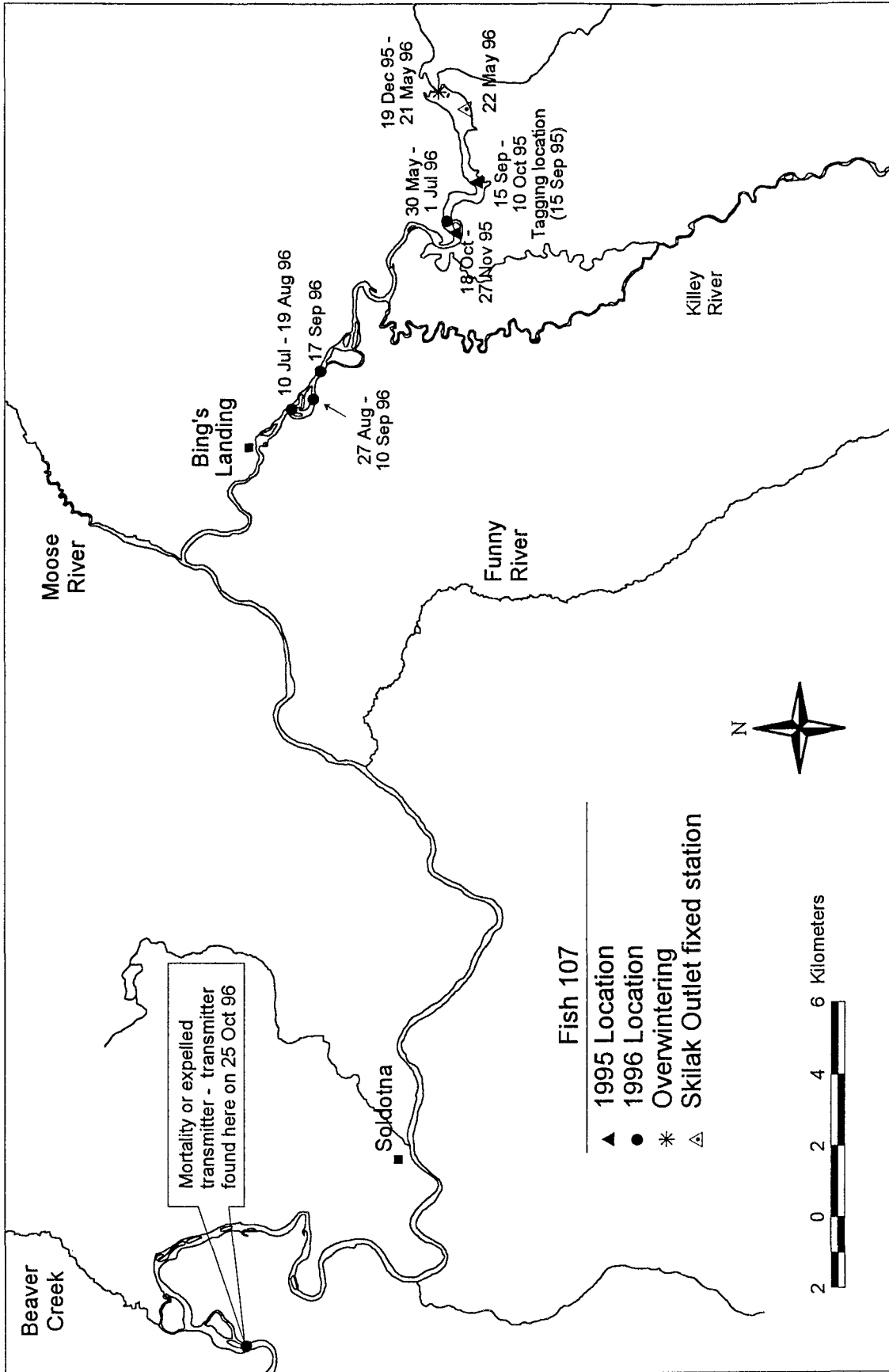
Appendix C7.— Locations of rainbow trout number 101 from 6 September, 1995 through 19 November, 1996.



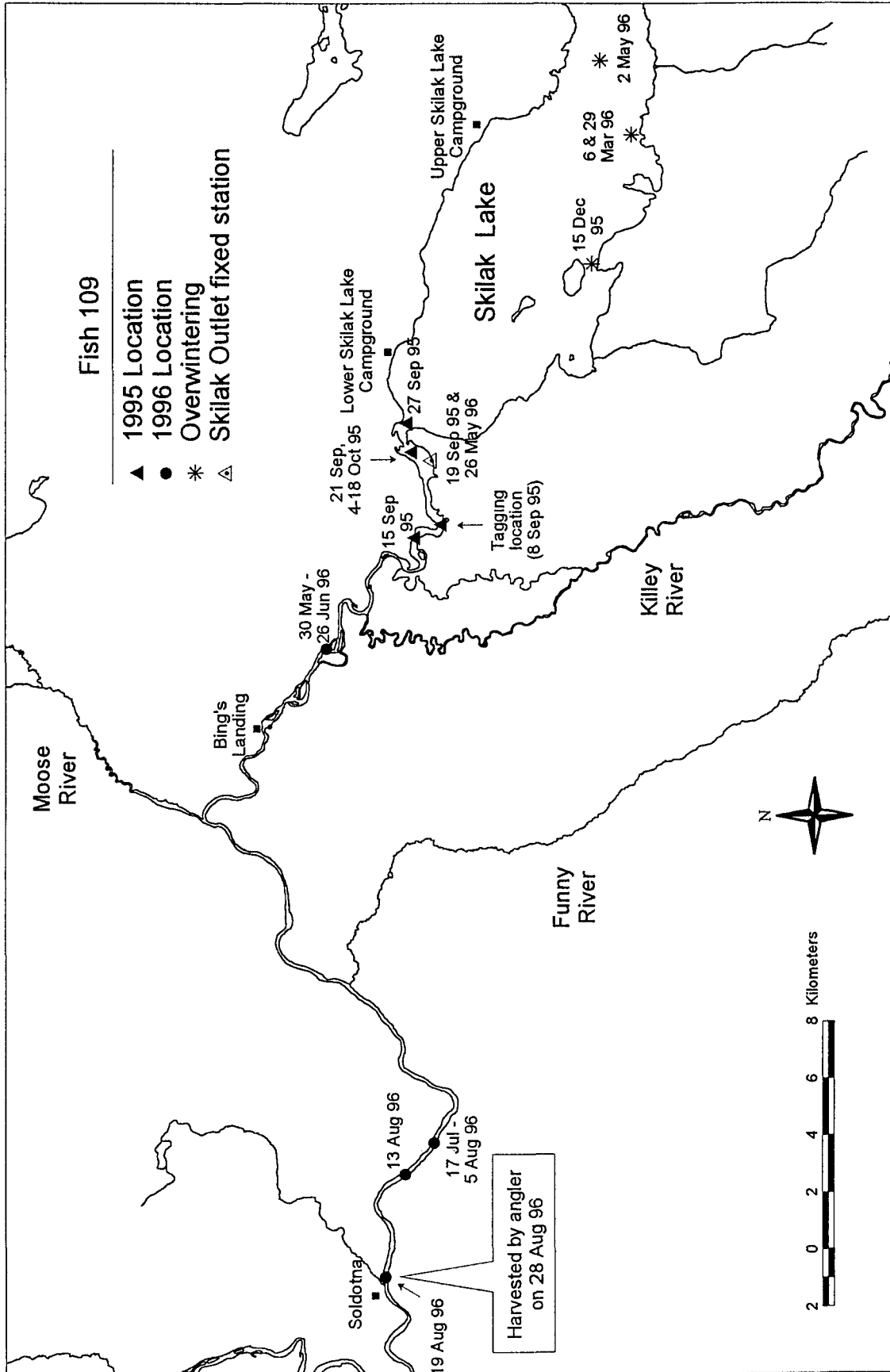
Appendix C8.— Locations of rainbow trout number 103 from 6 September, 1995 through 26 June, 1996.



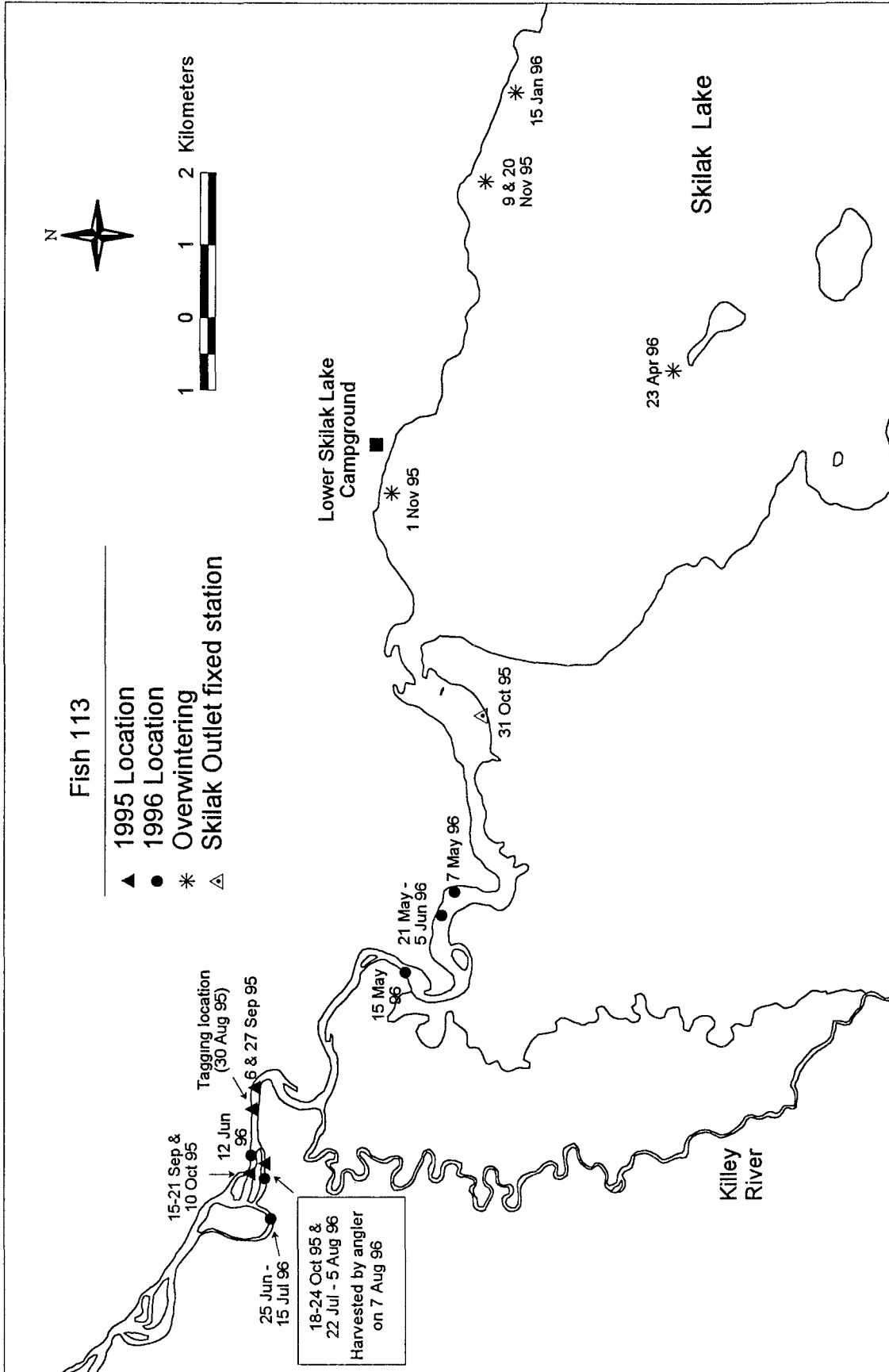
Appendix C9 — Locations of rainbow trout number 105 from 31 August, 1995 through 30 May, 1996.



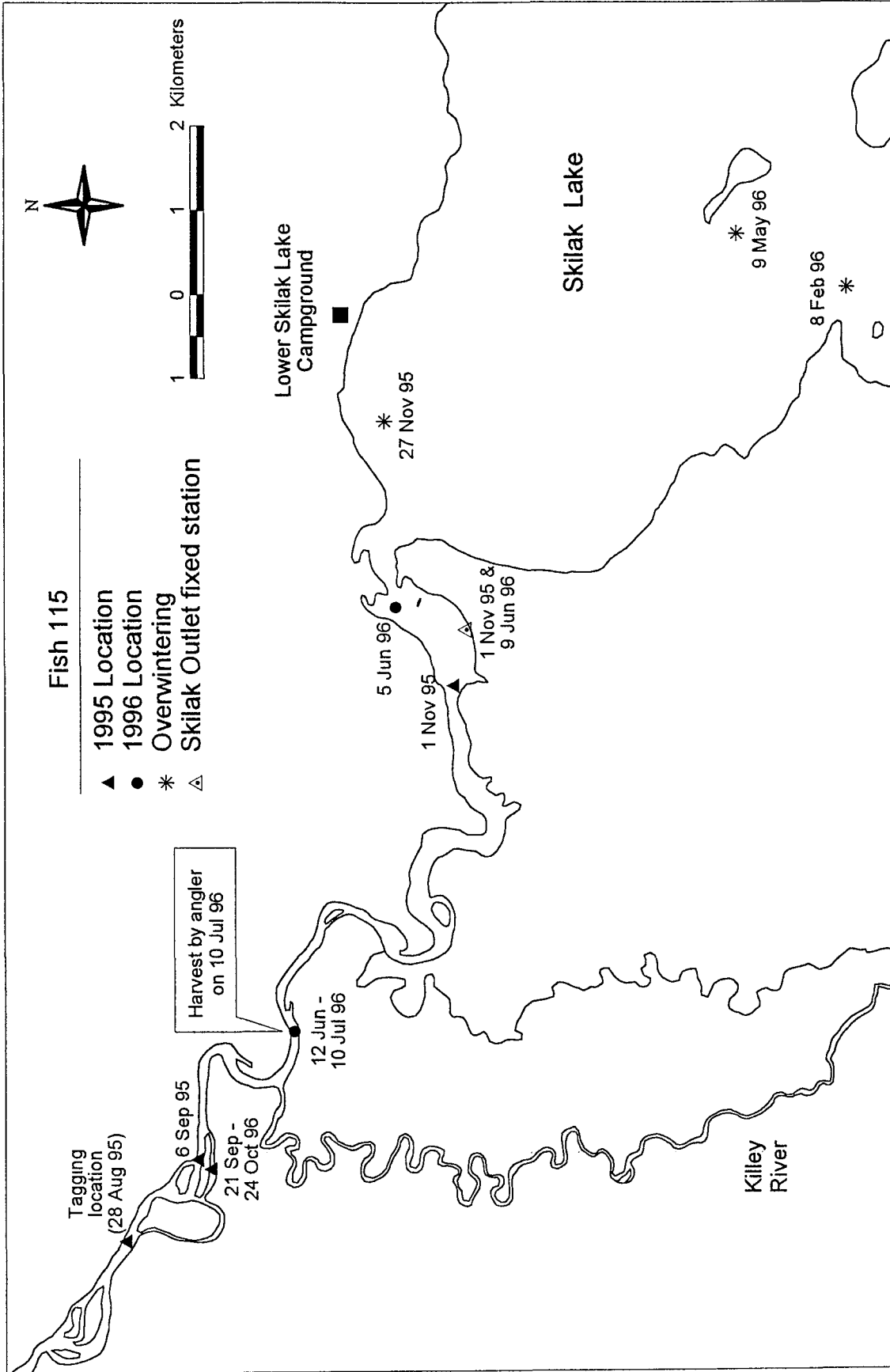
Appendix C10 — Locations of rainbow trout number 107 from 15 September, 1995 through 25 October, 1996.



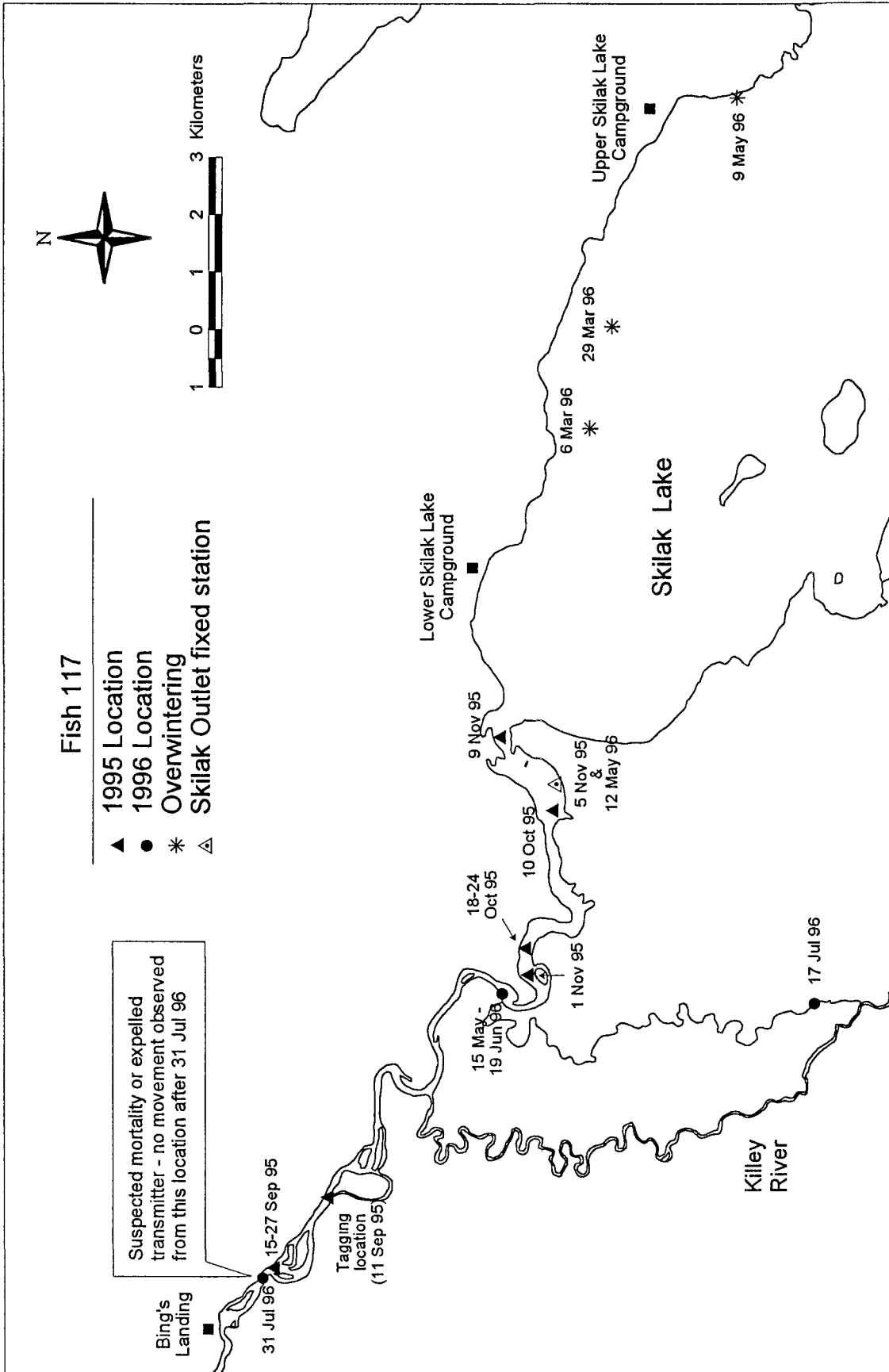
Appendix C11.— Locations of rainbow trout number 109 from 8 September, 1995 through 28 August, 1996.



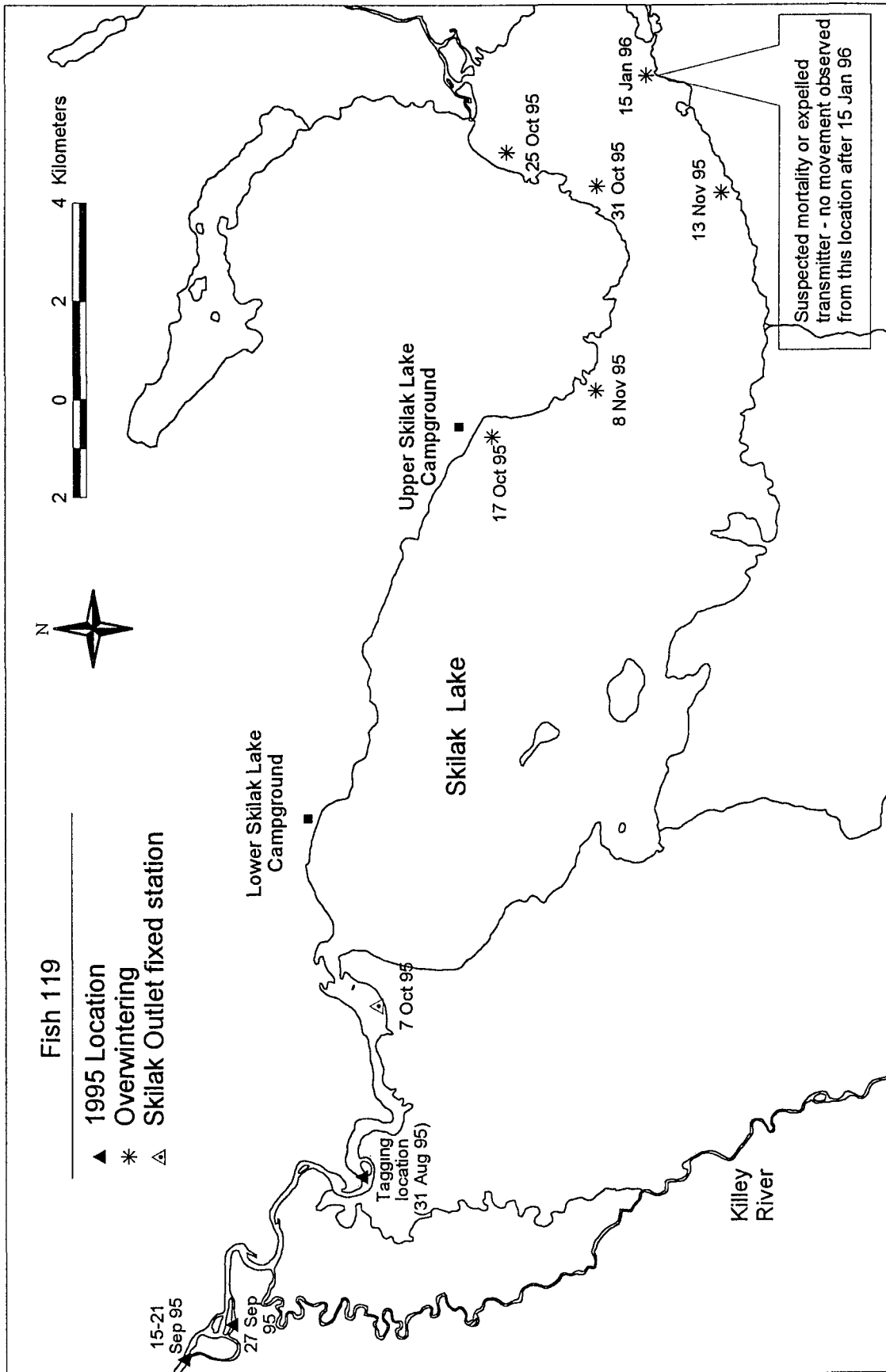
Appendix C12.— Locations of rainbow trout number 113 from 30 August, 1995 through 7 August, 1996.



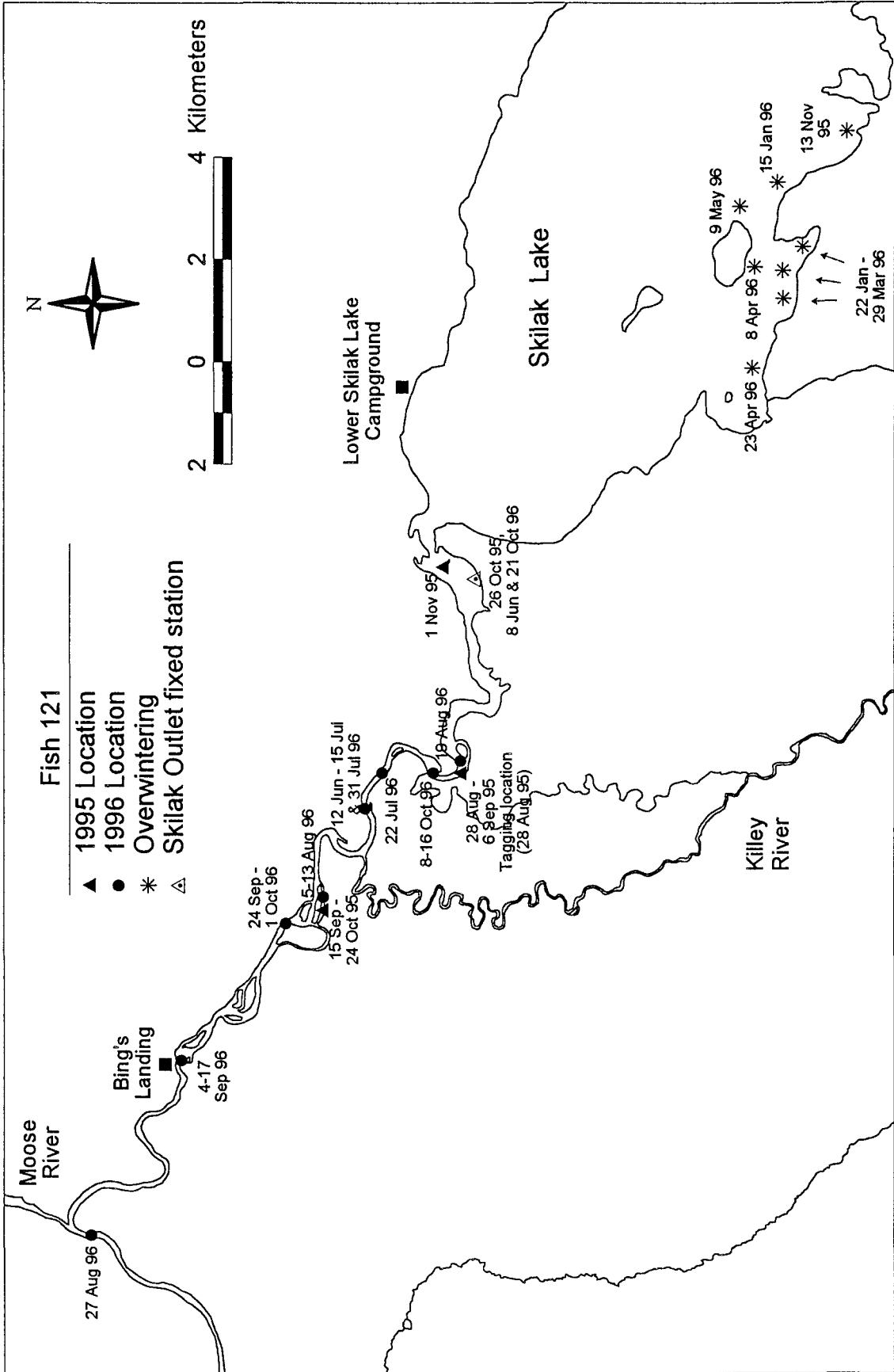
Appendix C13 — Locations of rainbow trout number 115 from 28 August, 1995 through 10 July, 1996.



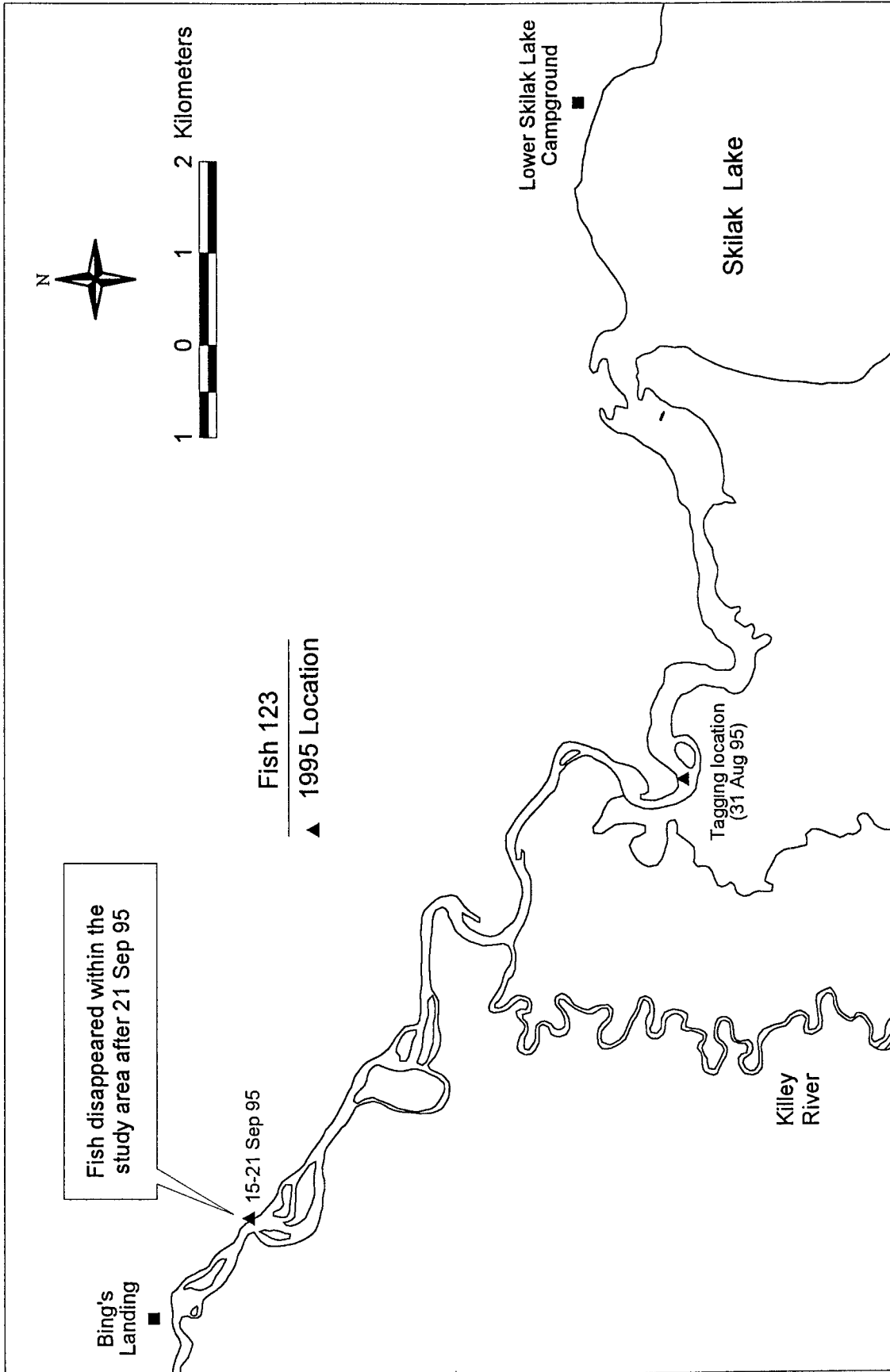
Appendix C14.— Locations of rainbow trout number 117 from 11 September, 1995 through 31 July, 1996.



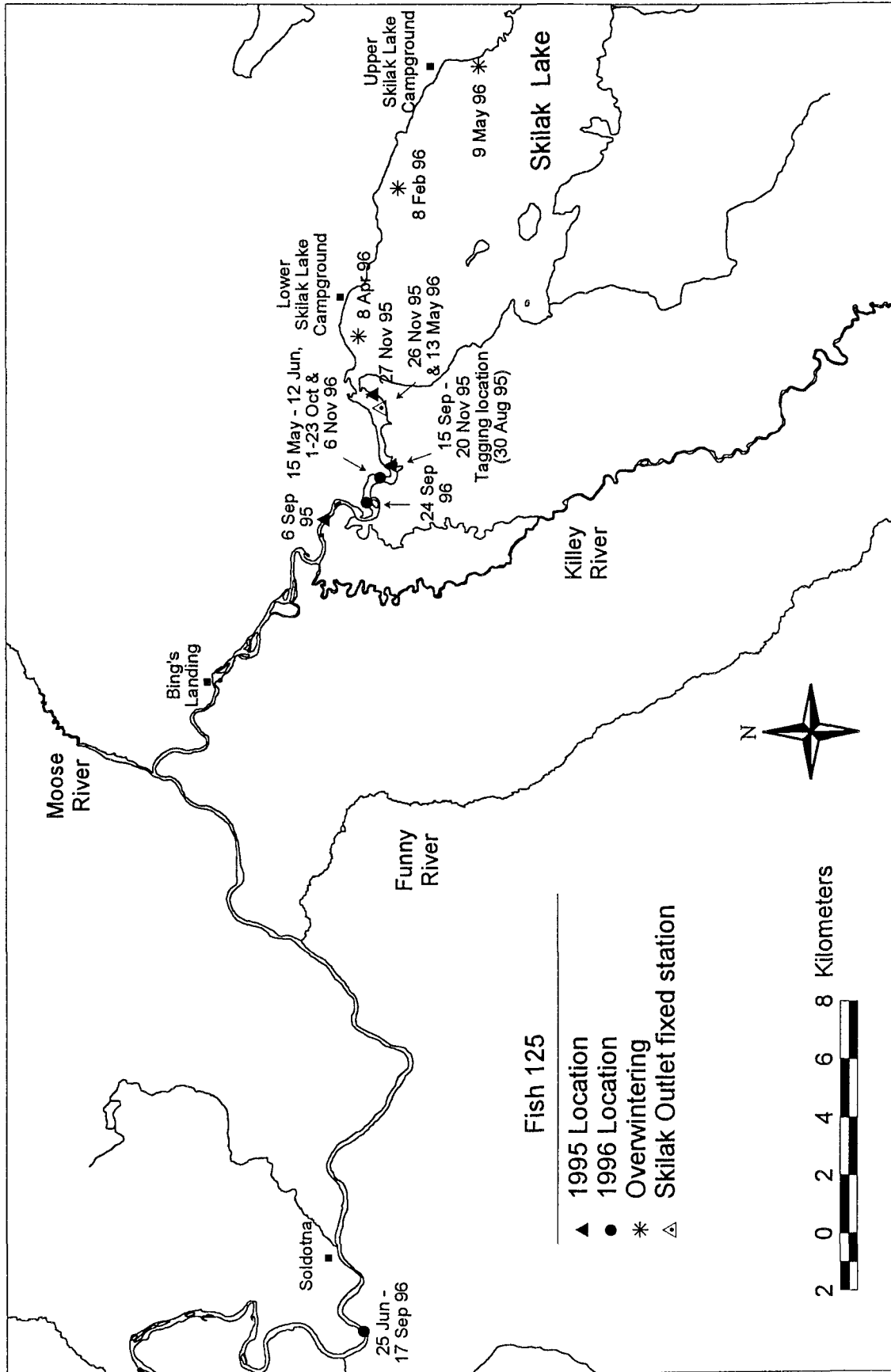
Appendix C15 — Locations of rainbow trout number 119 from 31 August, 1995 through 15 January, 1996.



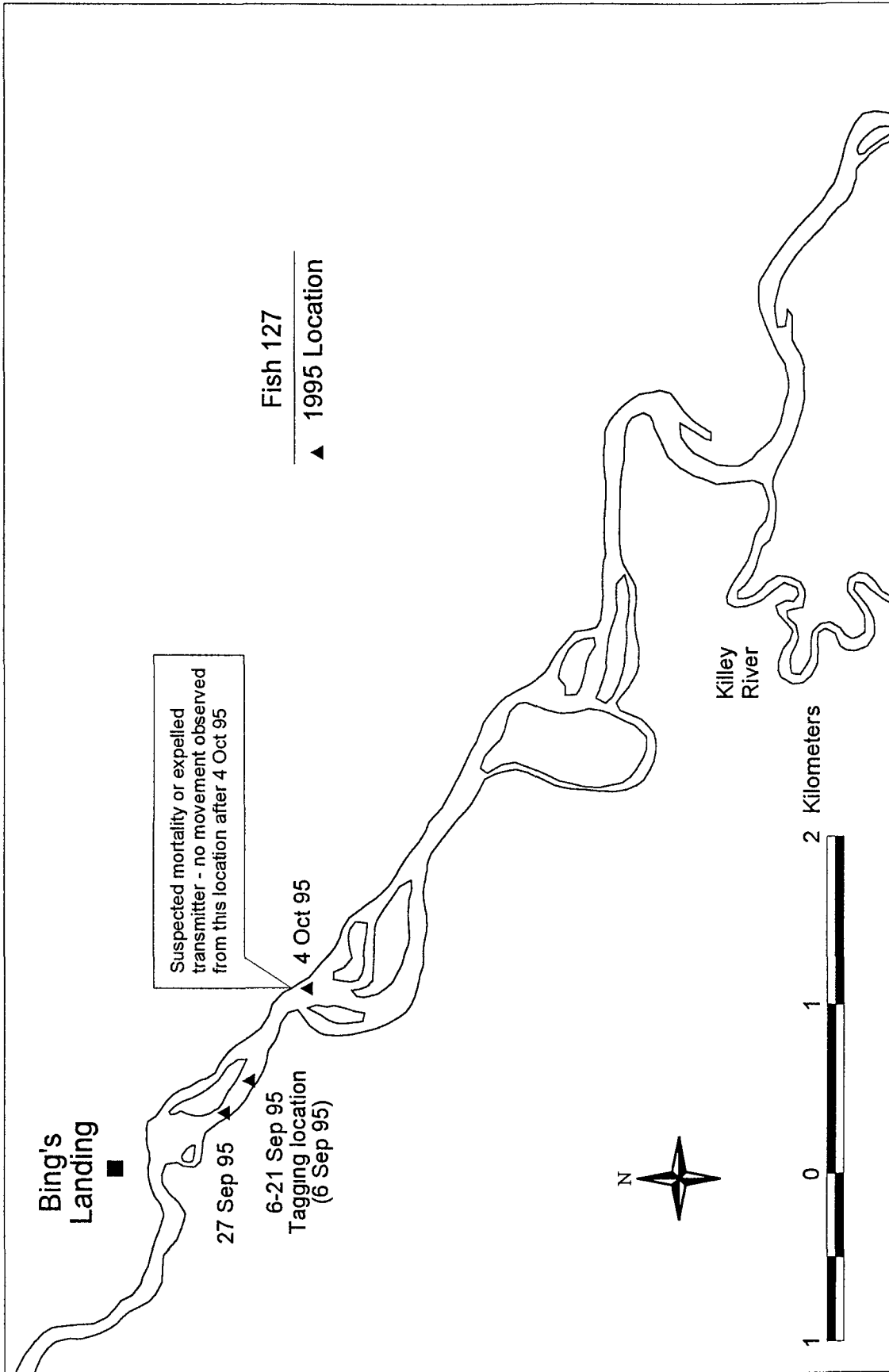
Appendix C16 — Locations of rainbow trout number 121 from 28 August, 1995 through 21 October, 1996.



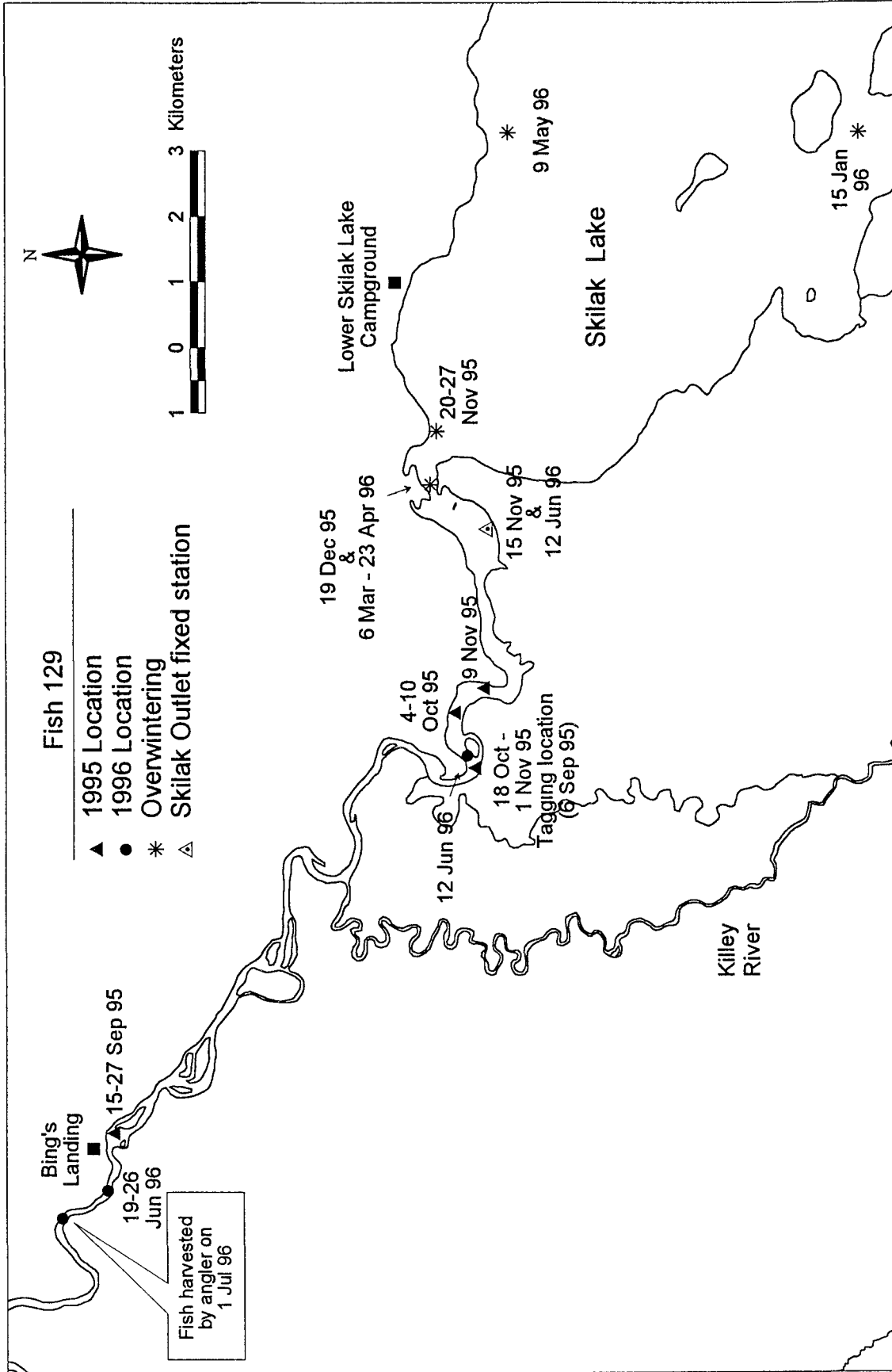
Appendix C17.— Locations of rainbow trout number 123 from 31 August through 21 September, 1995.



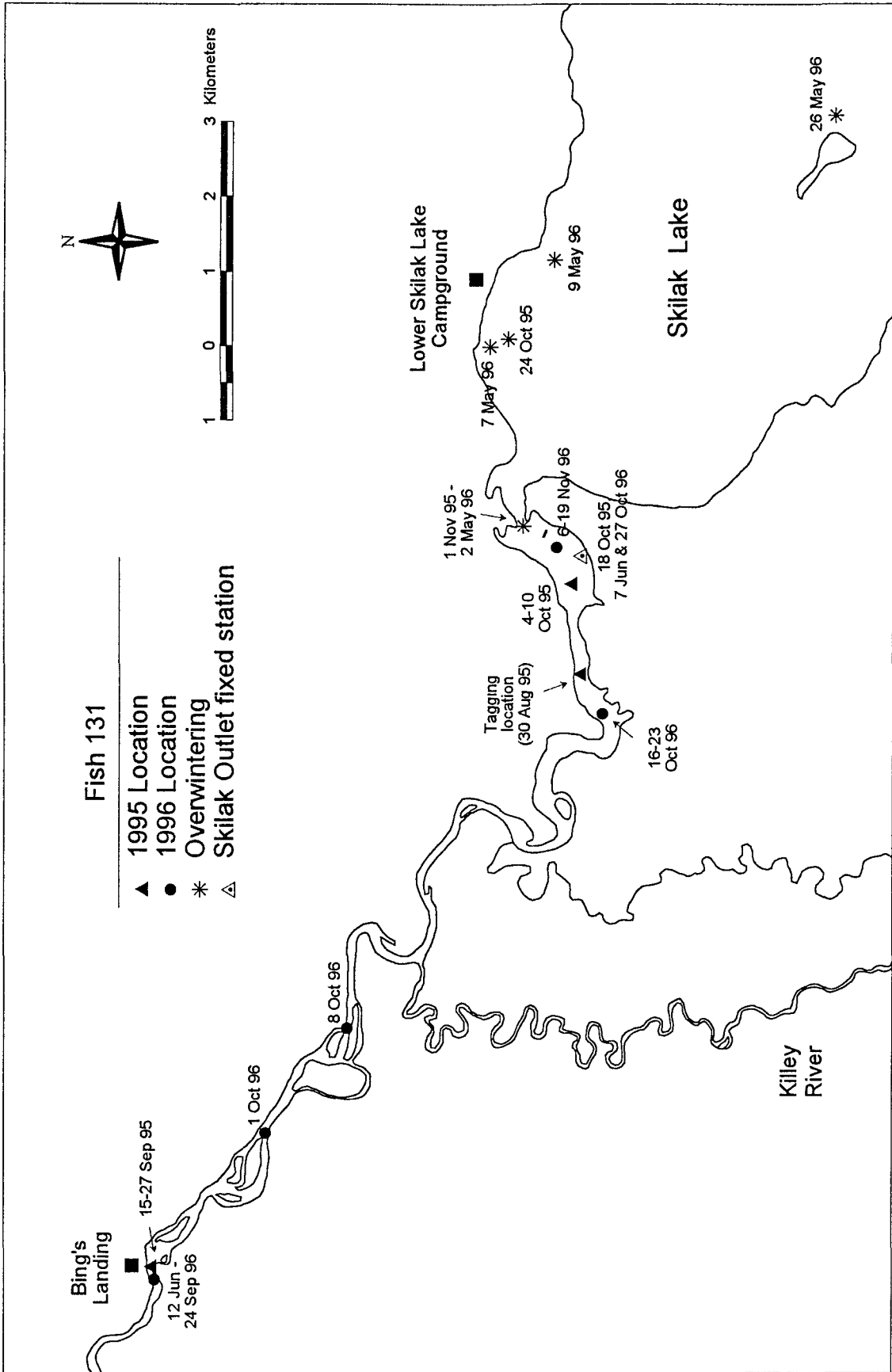
Appendix C18.— Locations of rainbow trout number 125 from 30 August, 1995 through 6 November, 1996.



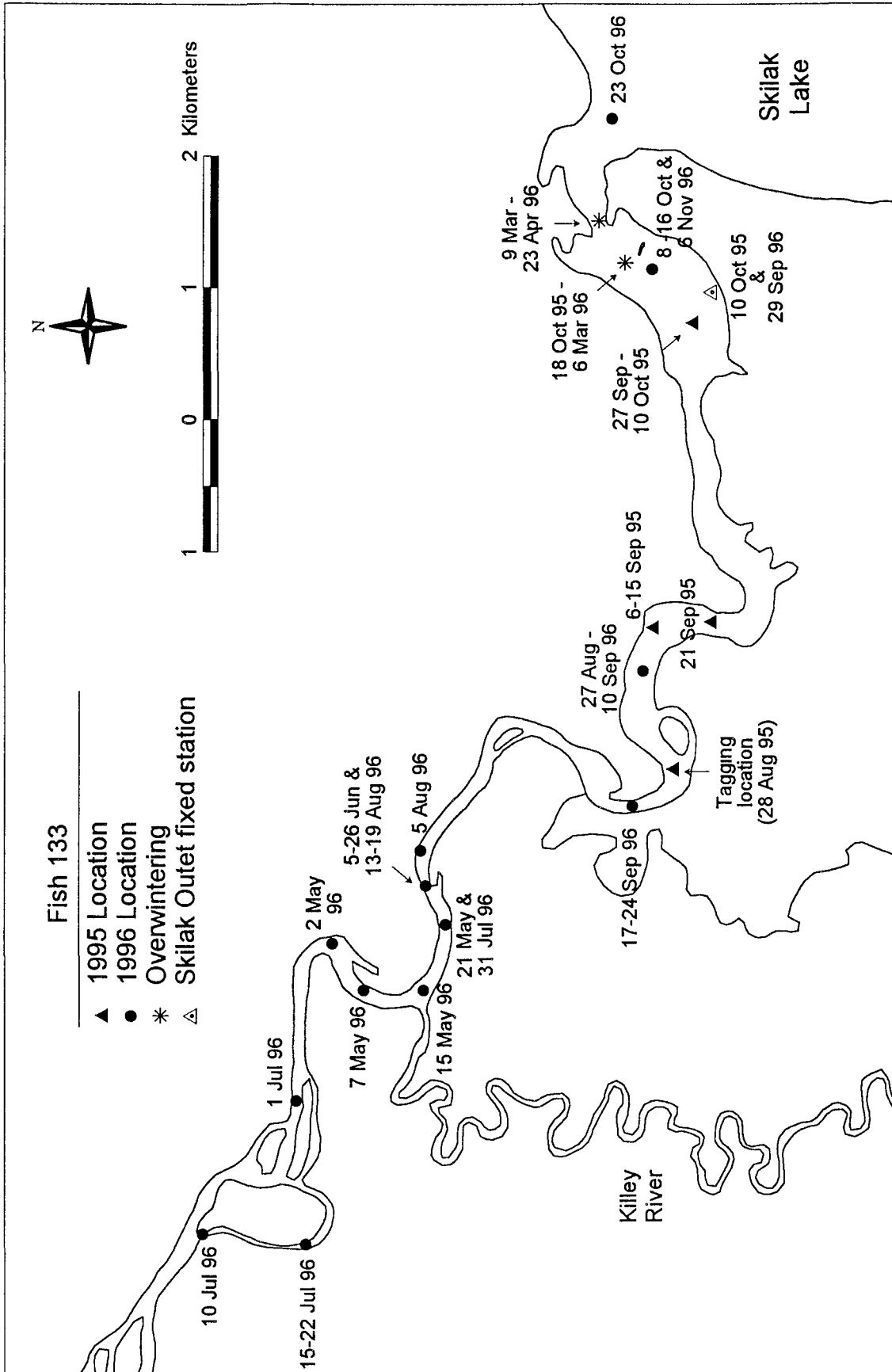
Appendix C19 — Locations of rainbow trout number 127 from 6 September through 4 October, 1995.



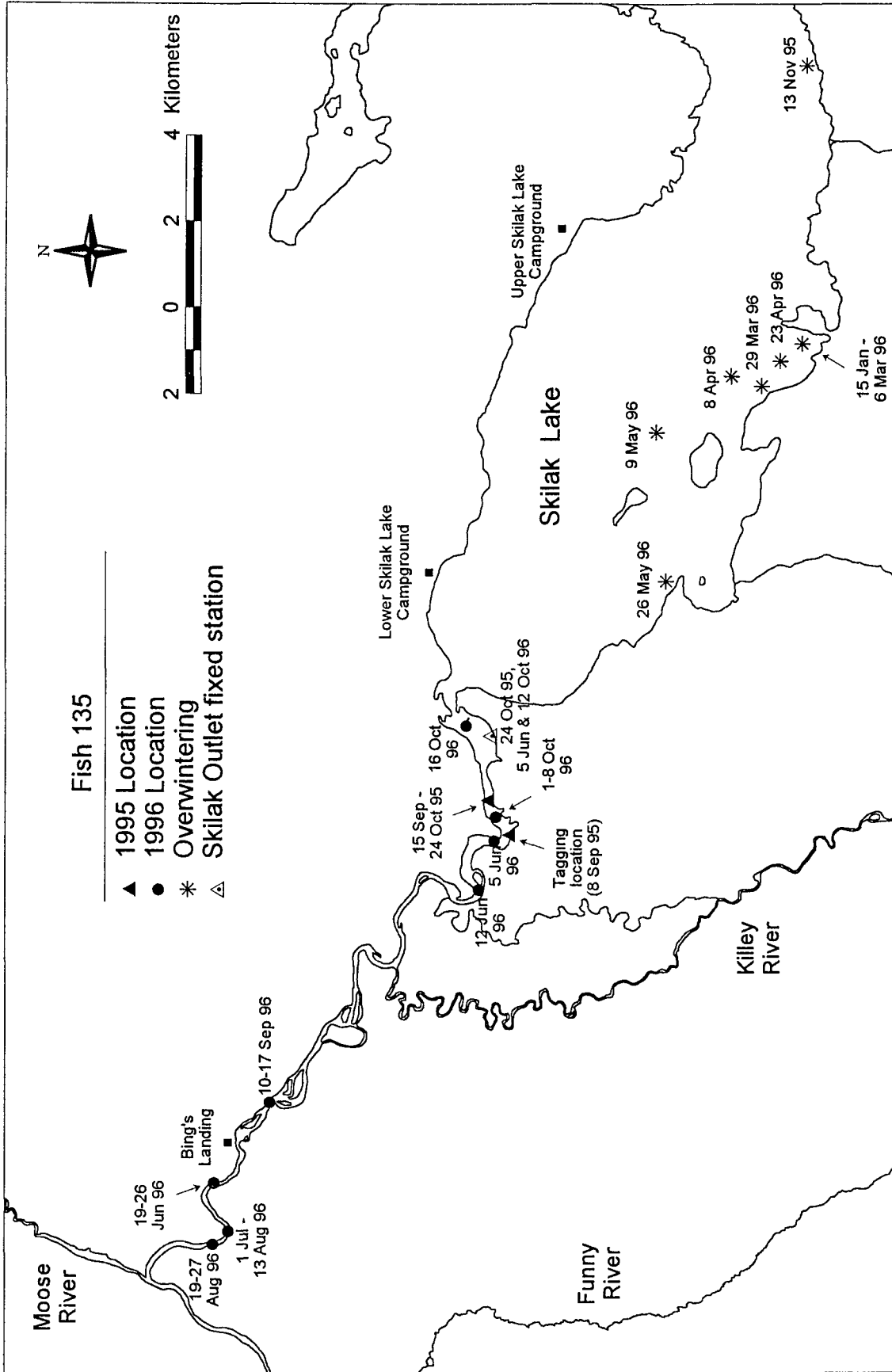
Appendix C20 — Locations of rainbow trout number 129 from 6 September, 1995 through 1 July, 1996.



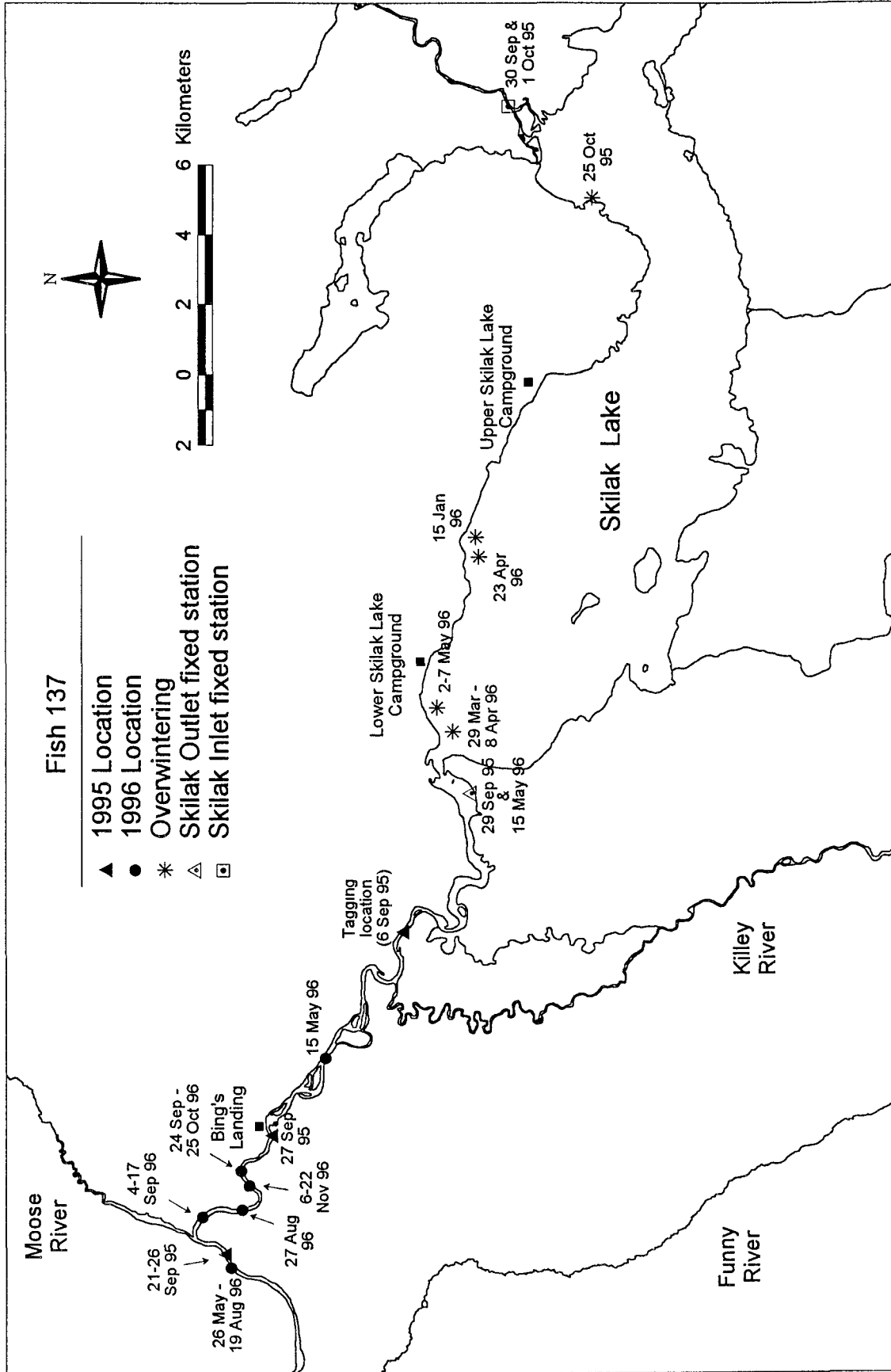
Appendix C21.— Locations of rainbow trout number 131 from 30 August, 1995 through 19 November, 1996.



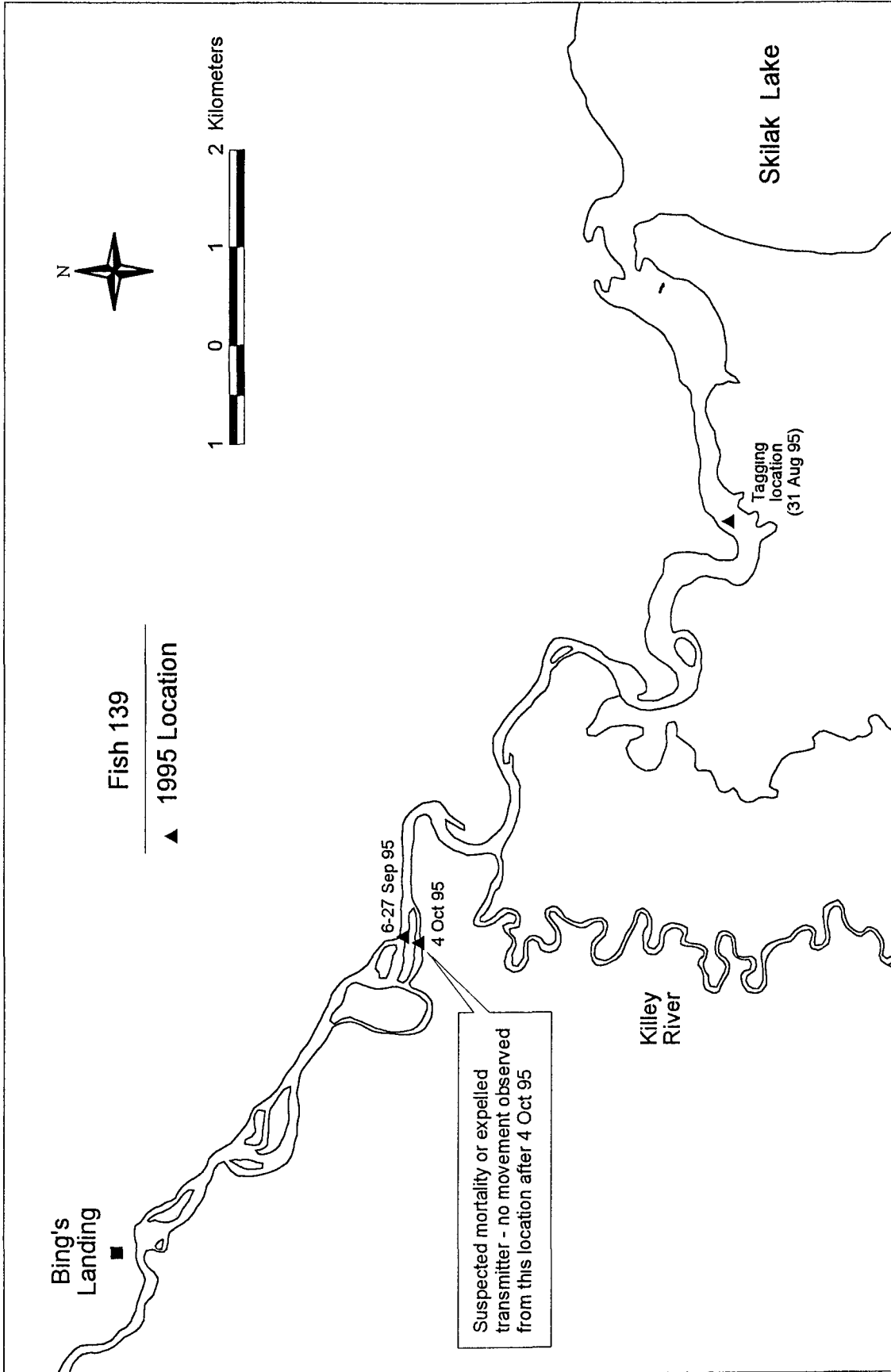
Appendix C22.— Locations of rainbow trout number 133 from 28 August, 1995 through 6 November, 1996.



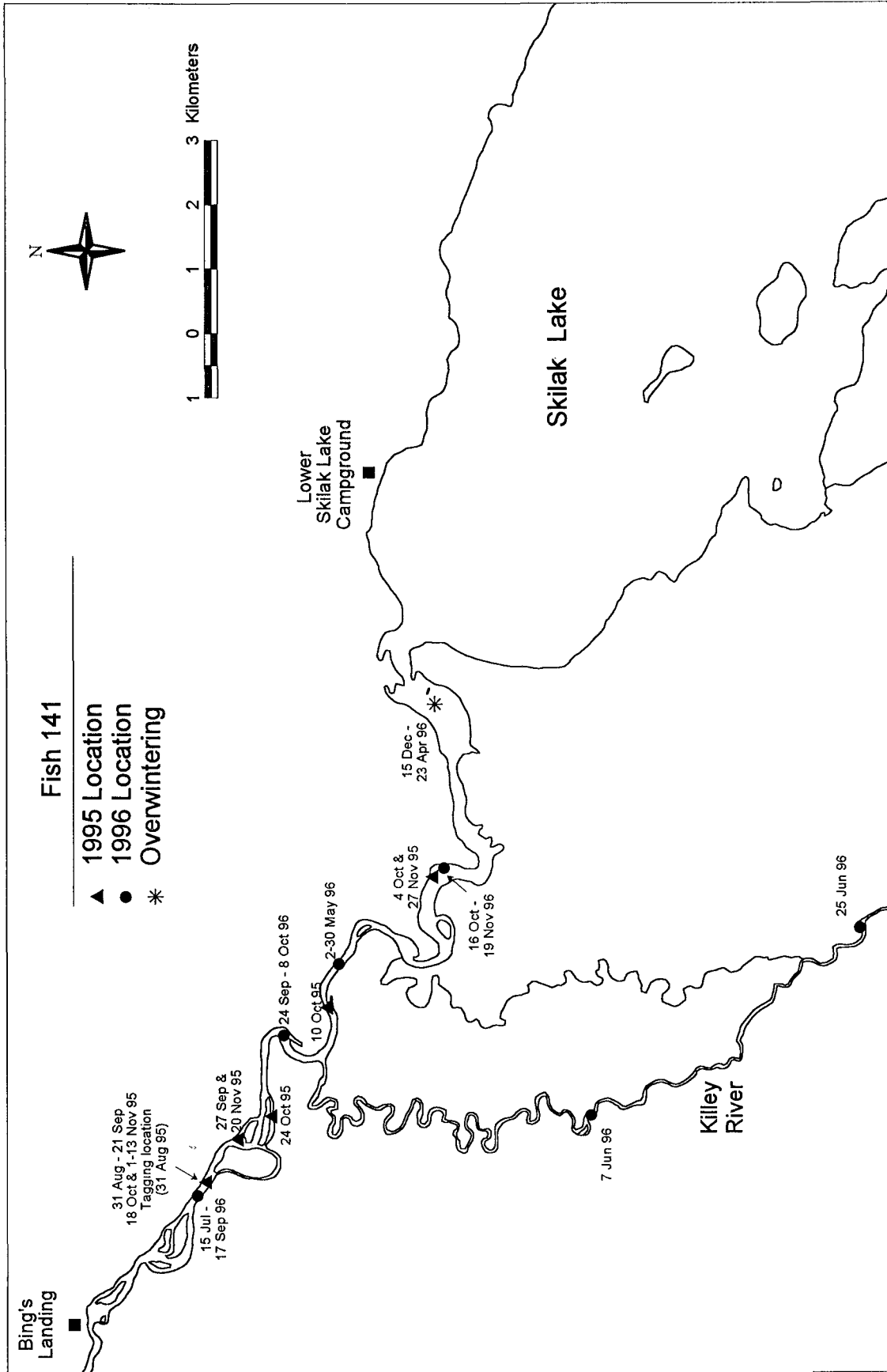
Appendix C23 — Locations of rainbow trout number 135 from 8 September, 1995 through 16 October, 1996.



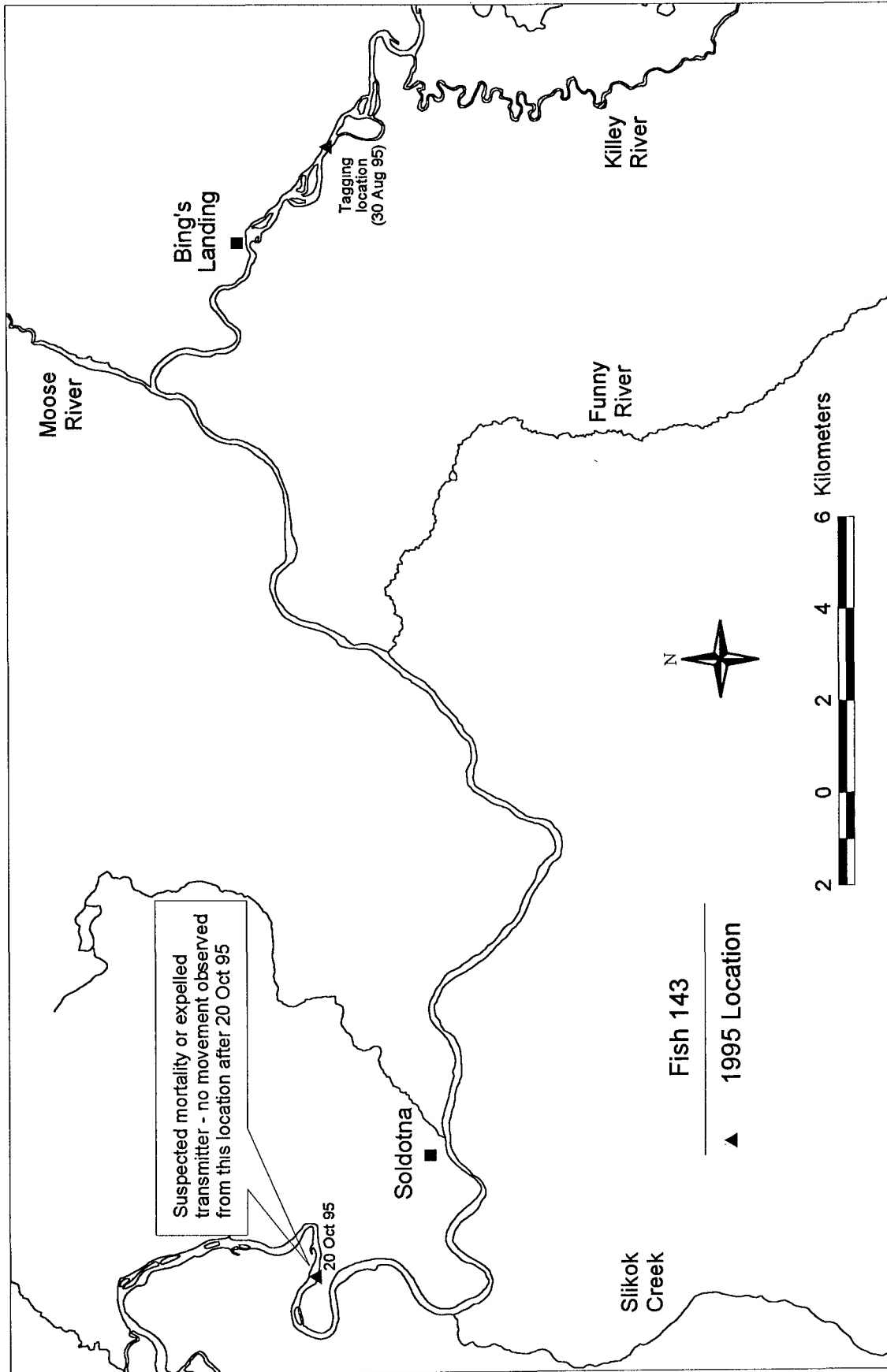
Appendix C24.— Locations of rainbow trout number 137 from 6 September, 1995 through 22 November, 1996.



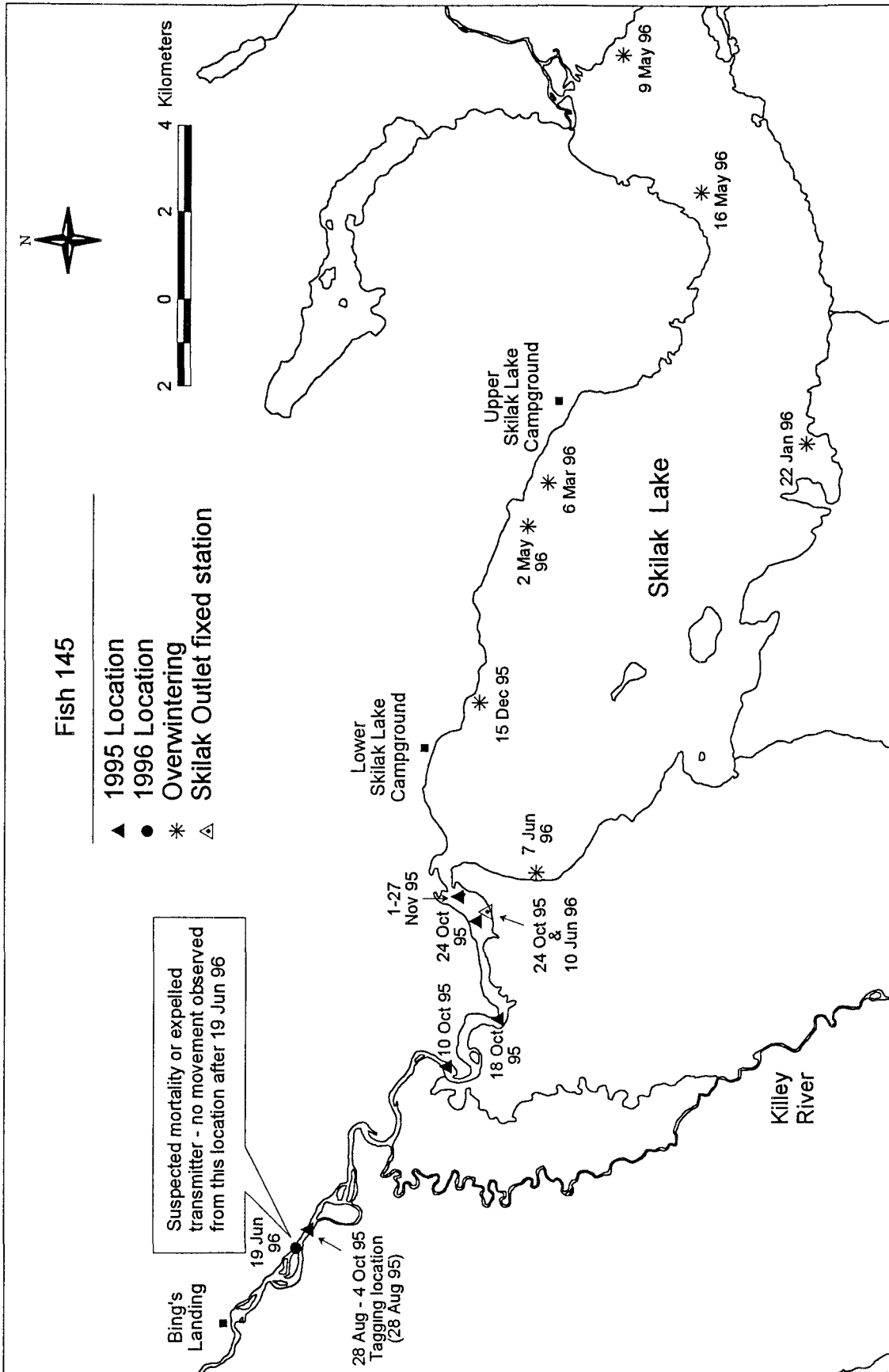
Appendix C25 — Locations of rainbow trout number 139 from 31 August through 4 October, 1995.



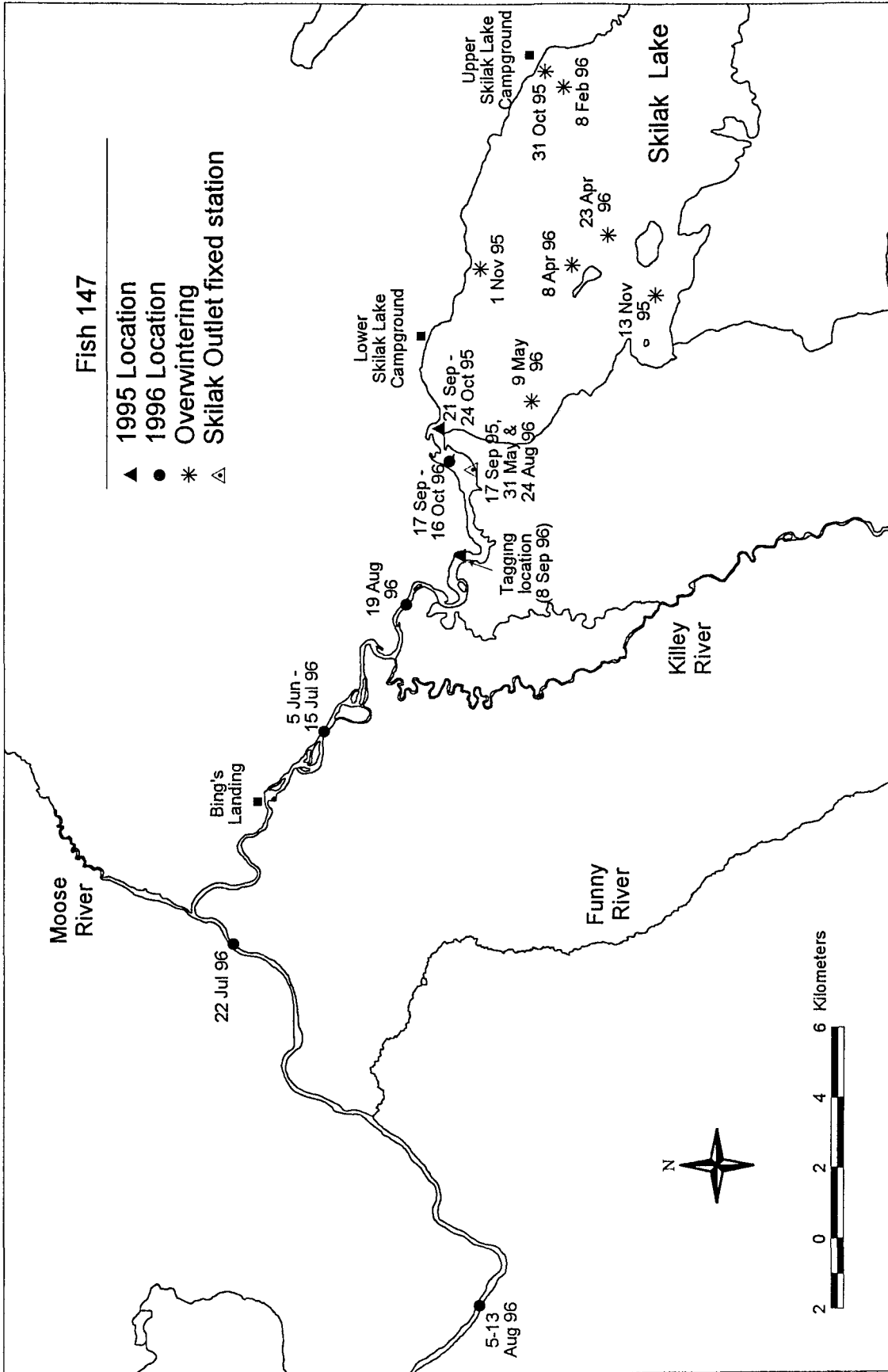
Appendix C26.— Locations of rainbow trout number 141 from 31 August, 1995 through 19 November, 1996.



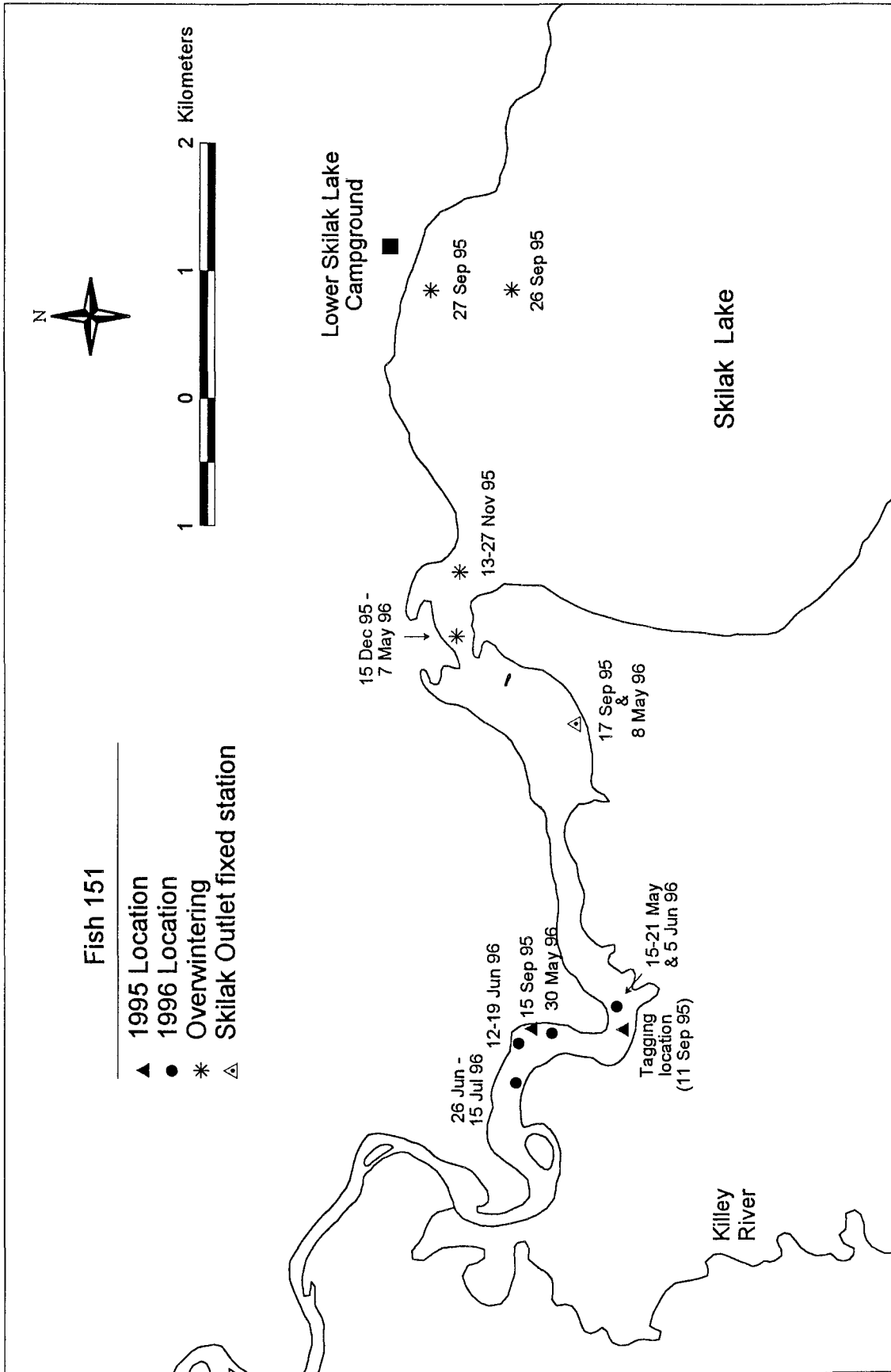
Appendix C27.— Locations of rainbow trout number 143 from 30 August through 20 October, 1995.



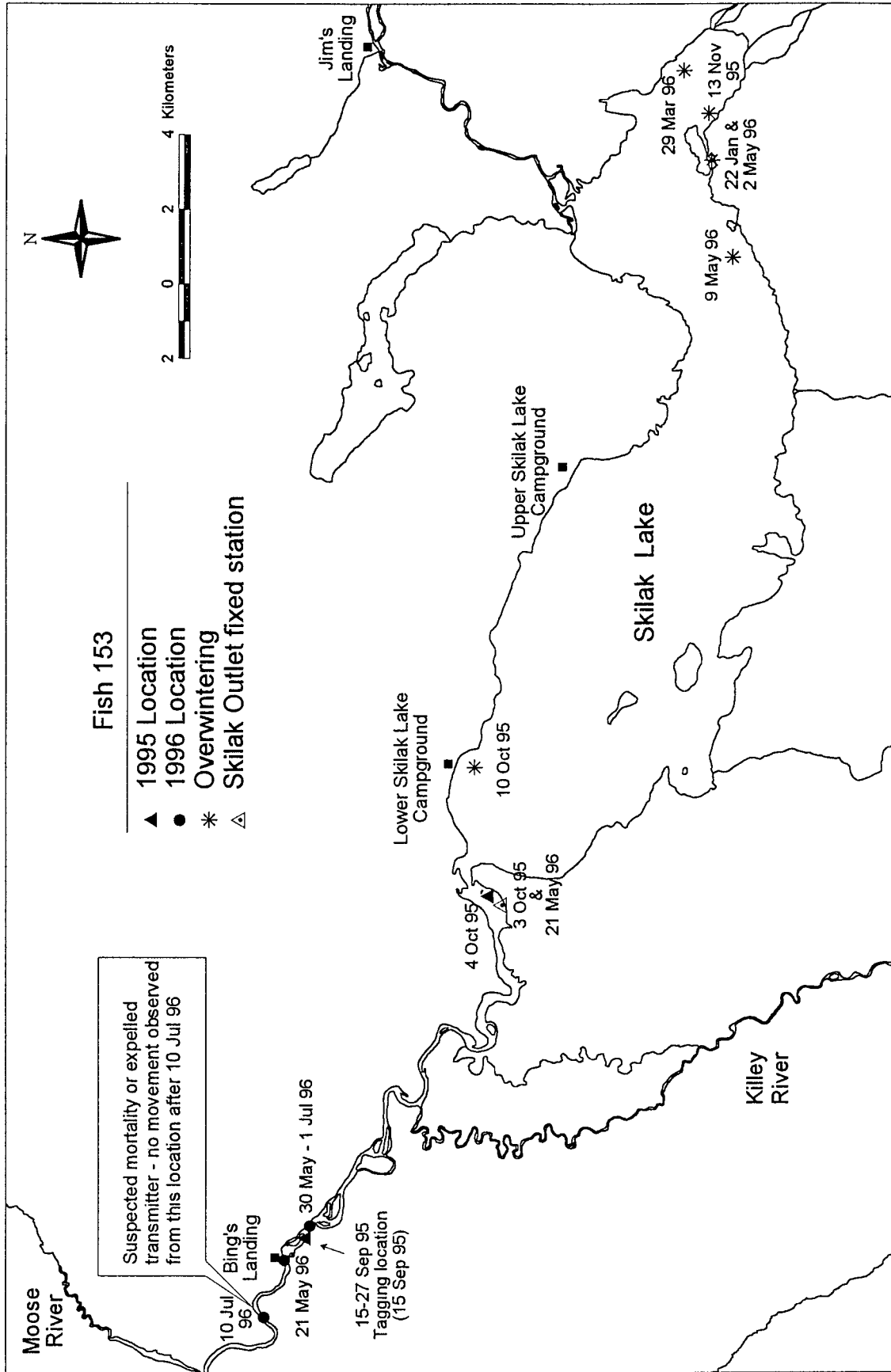
Appendix C28 — Locations of rainbow trout number 145 from 28 August, 1995 through 19 June, 1996.



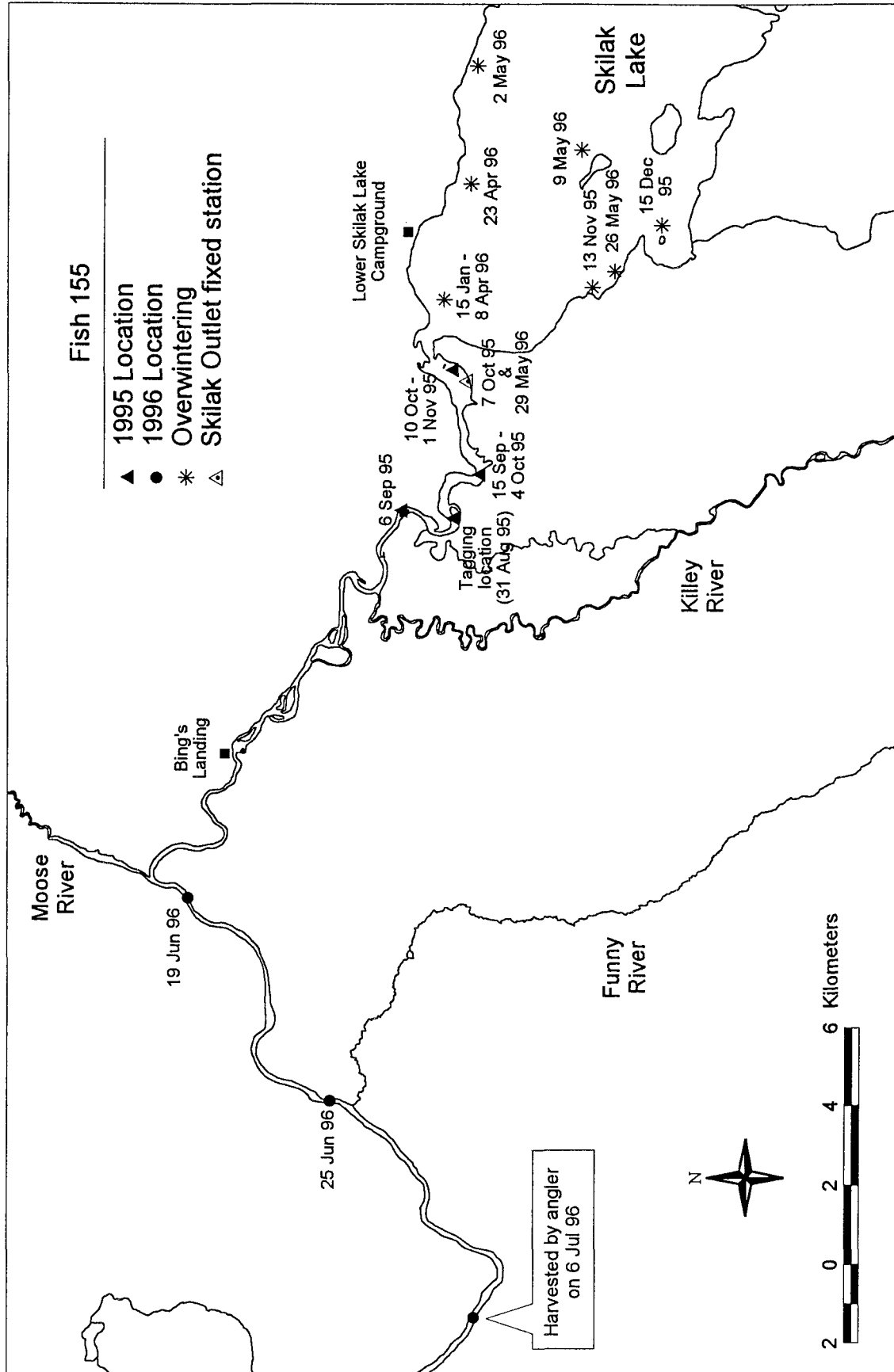
Appendix C29 — Locations of rainbow trout number 147 from 8 September, 1995 through 16 October, 1996.



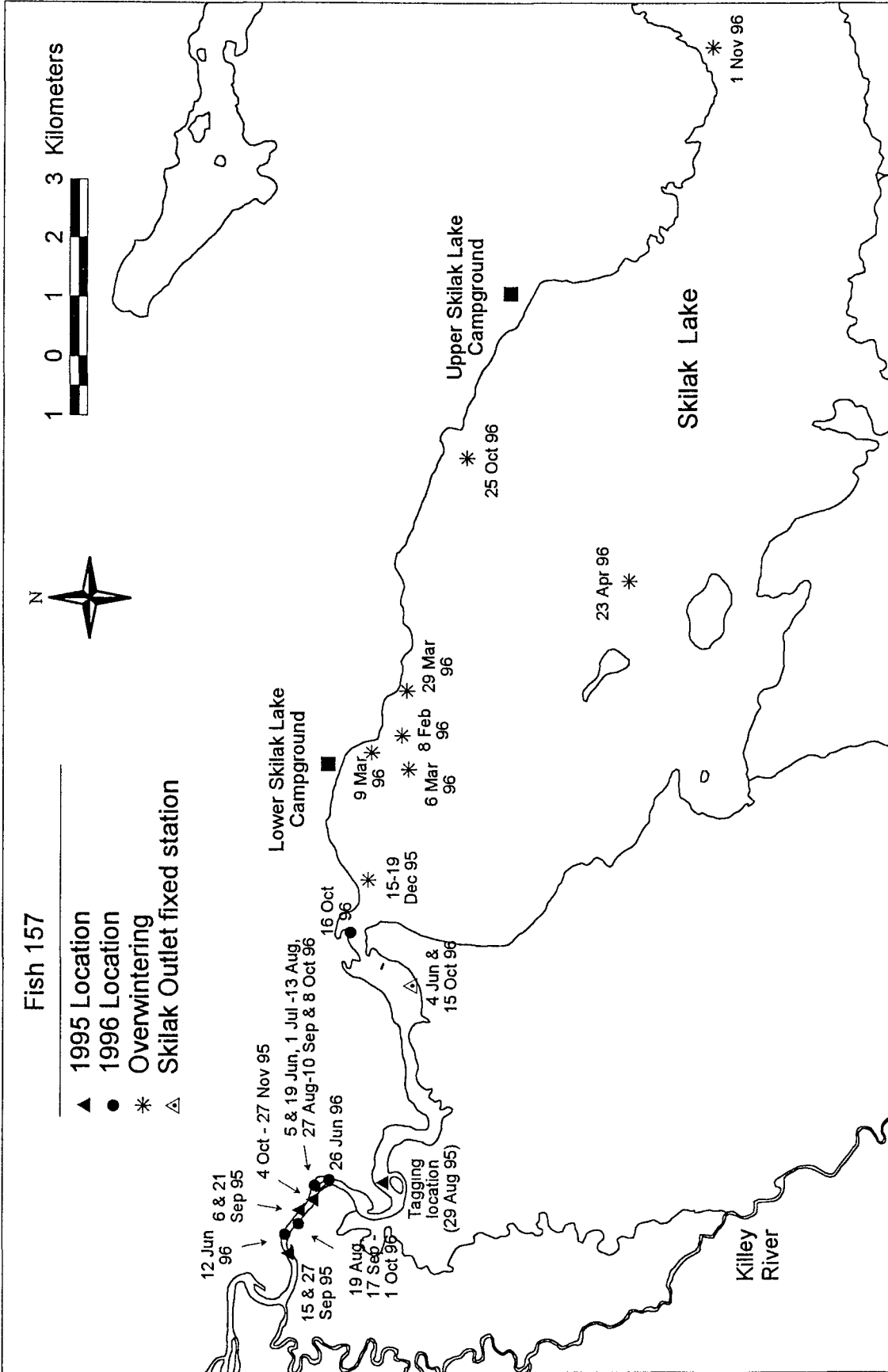
Appendix C30 — Locations of rainbow trout number 151 from 11 September, 1995 through 15 July, 1996.



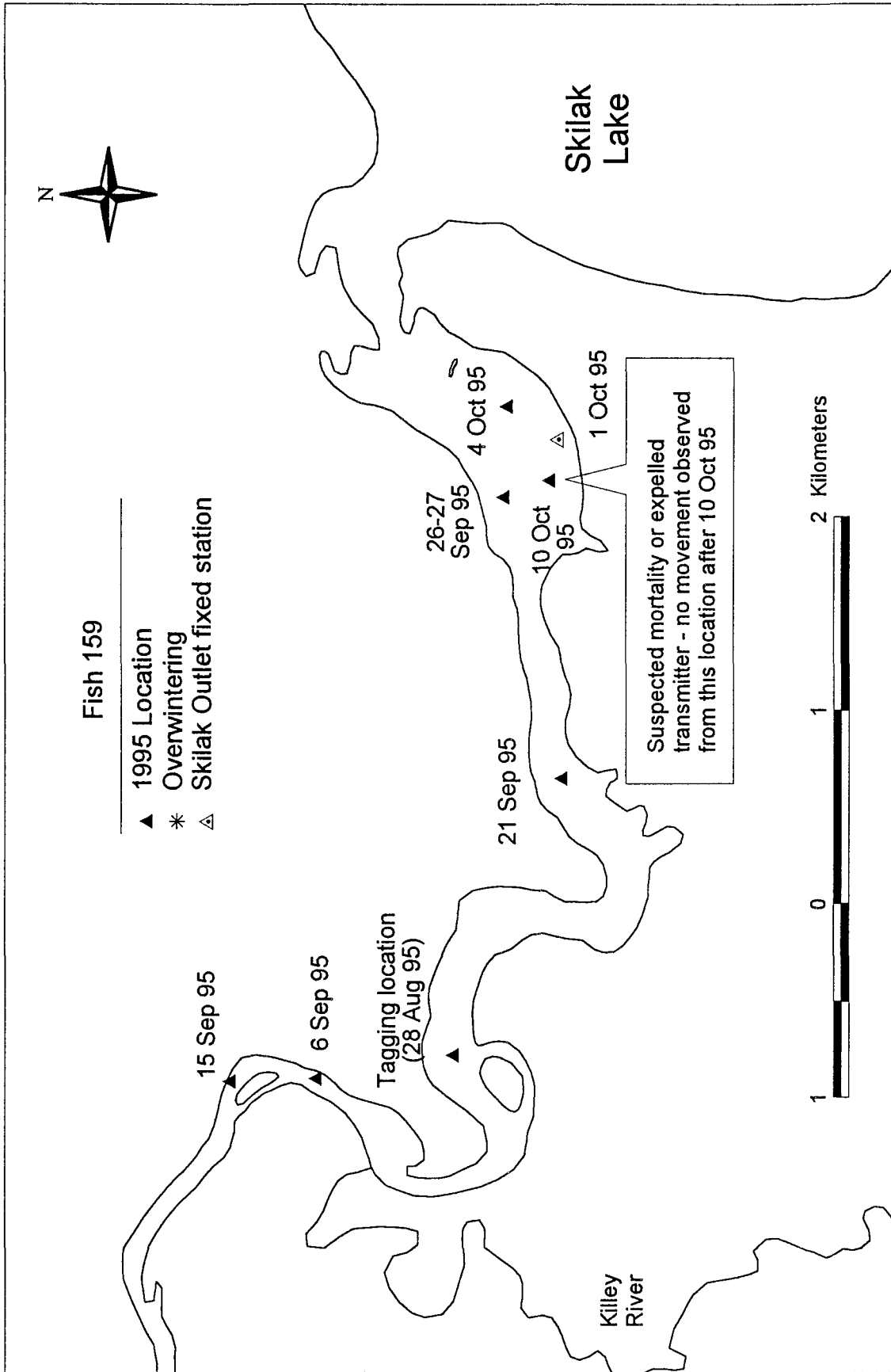
Appendix C31 — Locations of rainbow trout number 153 from 15 September, 1995 through 10 July, 1996.



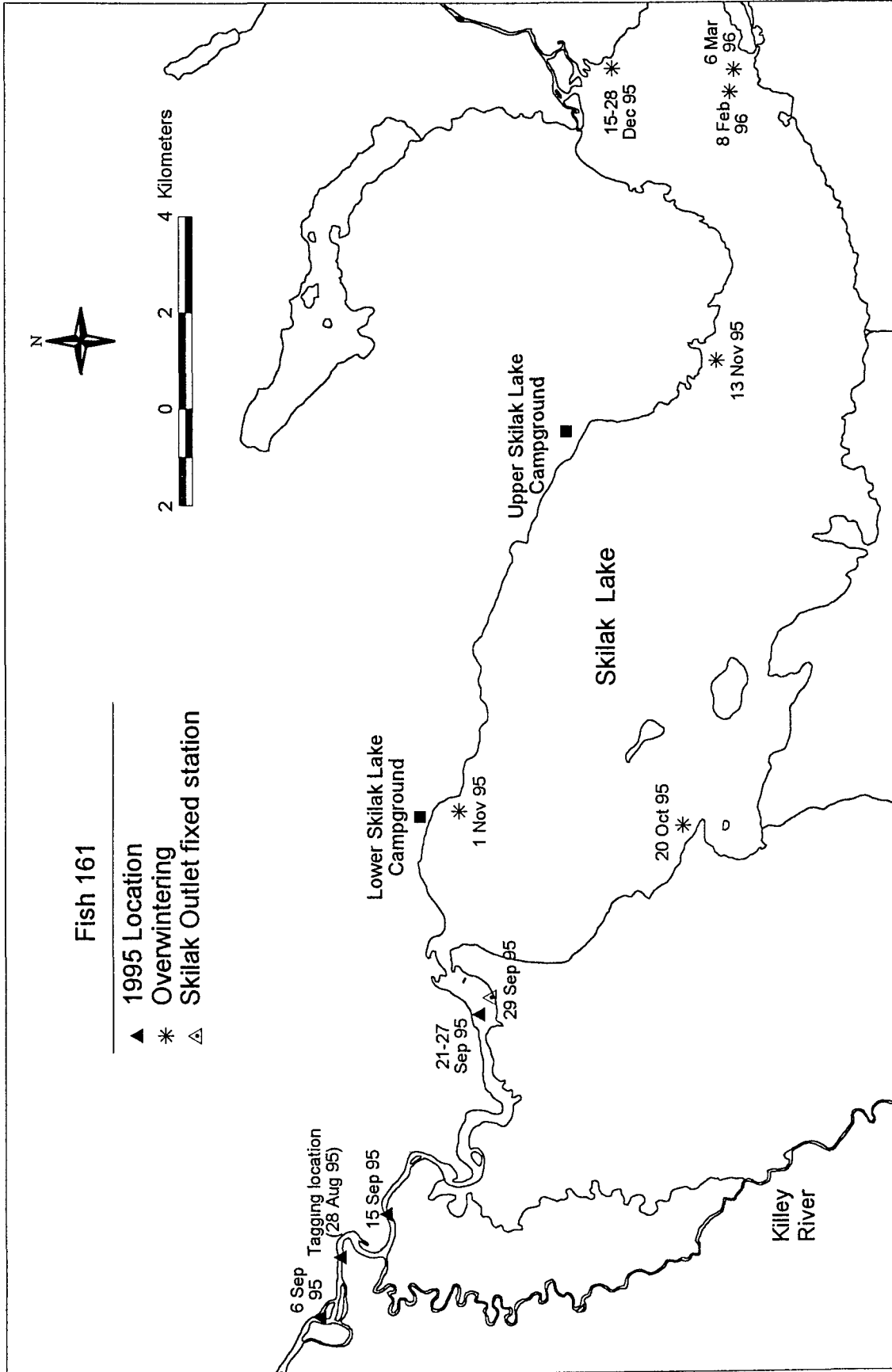
Appendix C32.— Locations of rainbow trout number 155 from 31 August, 1995 through 6 July, 1996



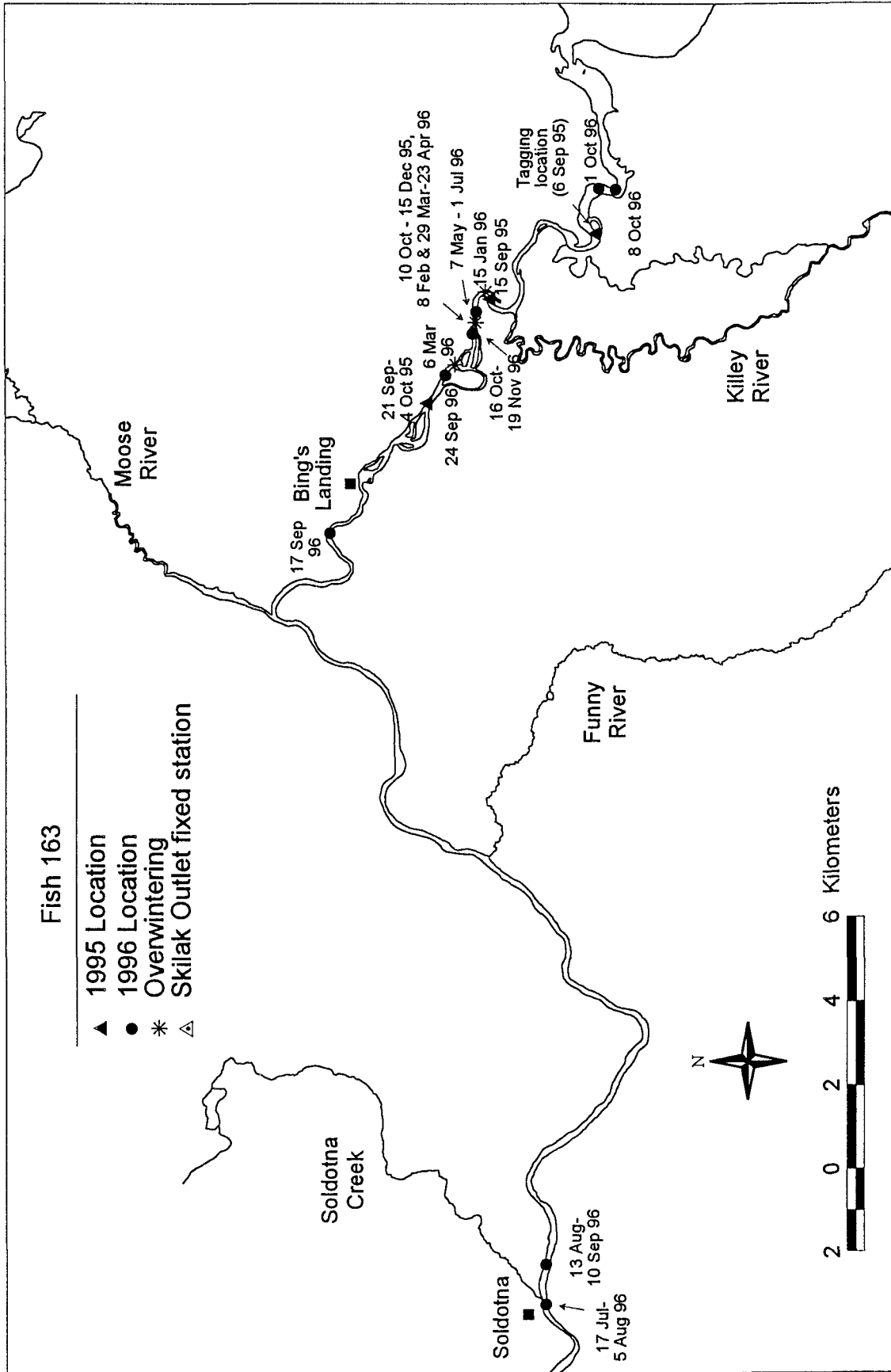
Appendix C33.— Locations of rainbow trout number 157 from 29 August, 1995 through 1 November, 1996.



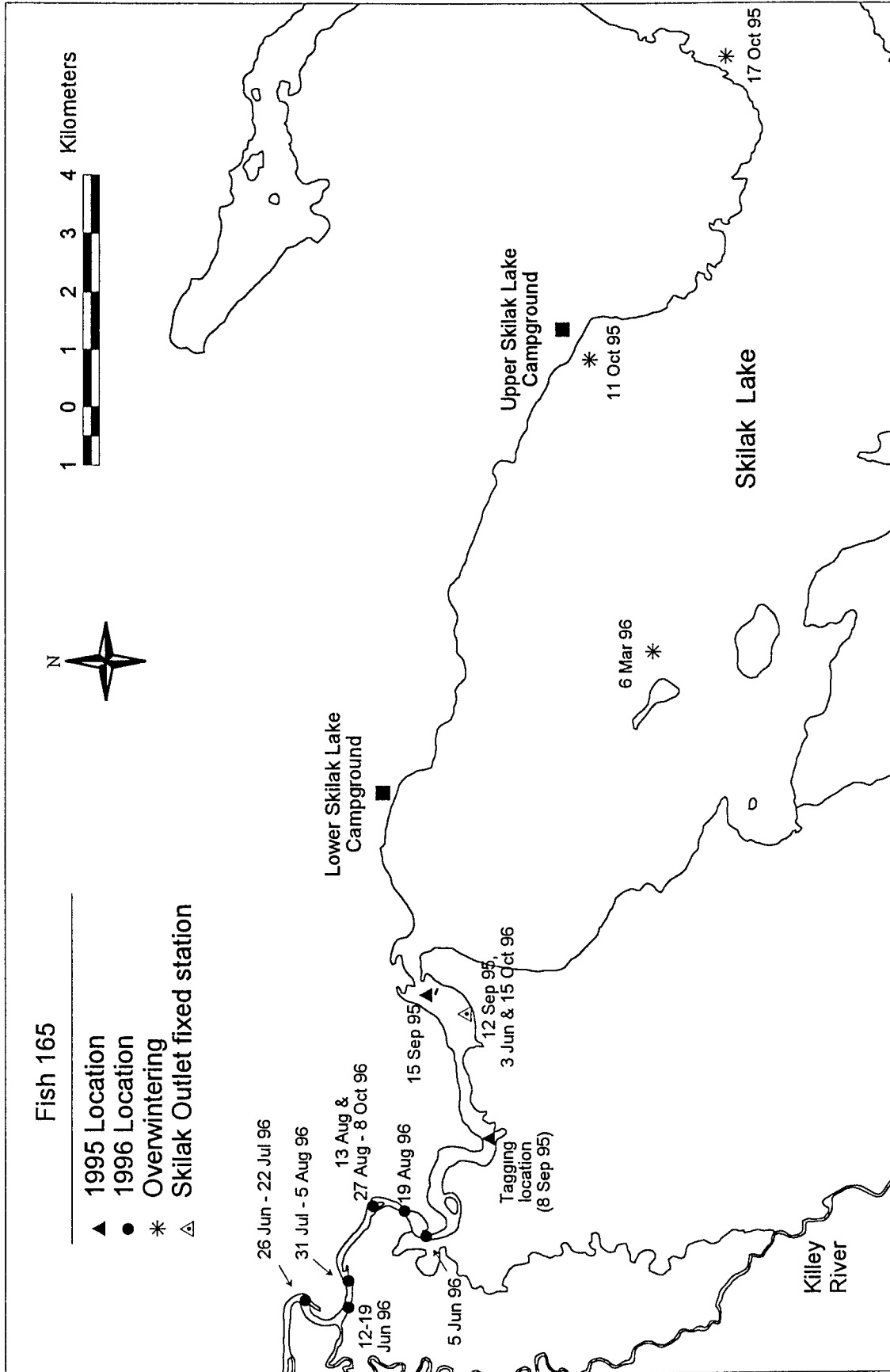
Appendix C34.— Locations of rainbow trout number 159 from 28 August through 10 October, 1995.



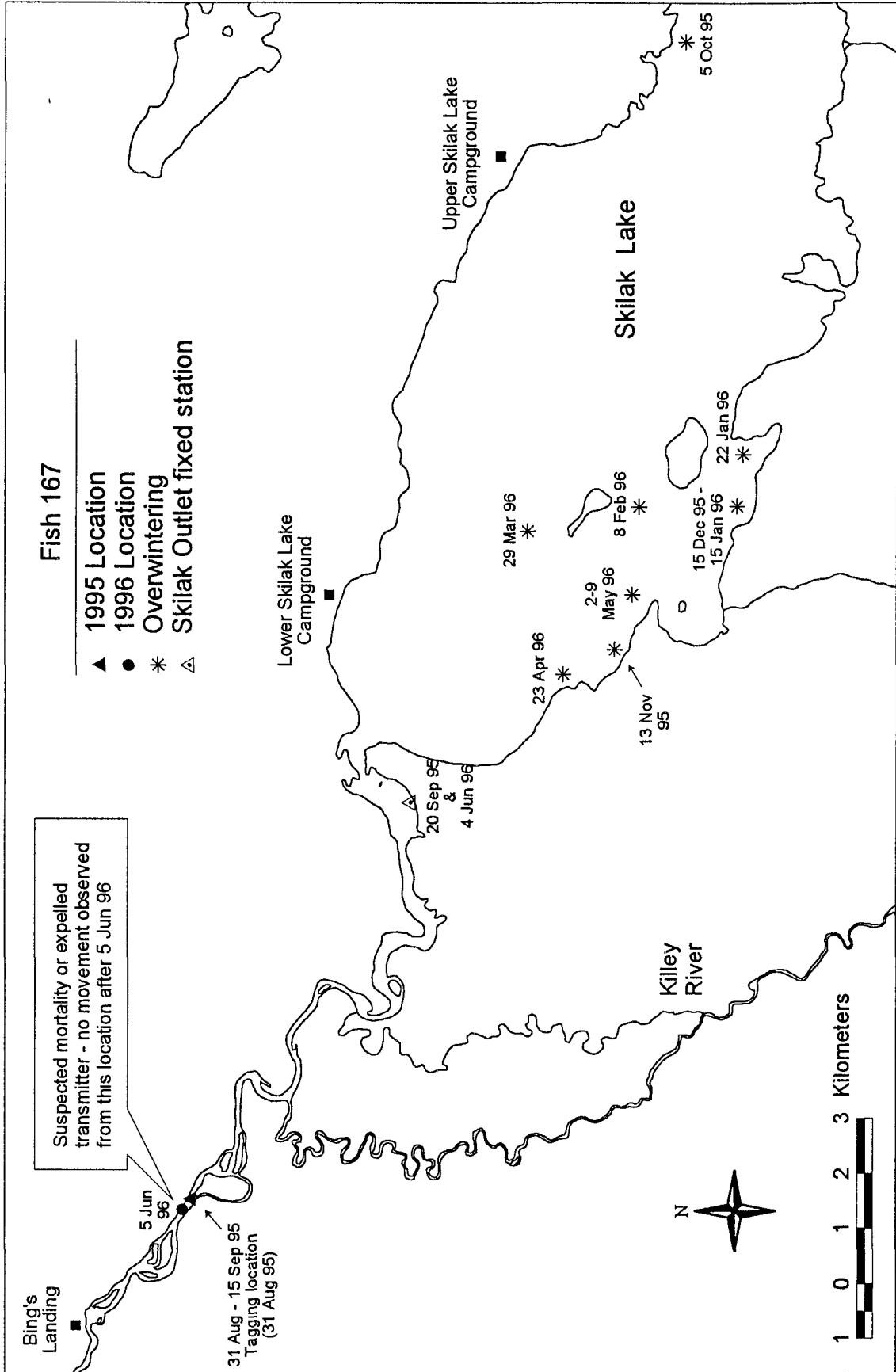
Appendix C35 — Locations of rainbow trout number 161 from 28 August, 1995 through 6 March, 1996.



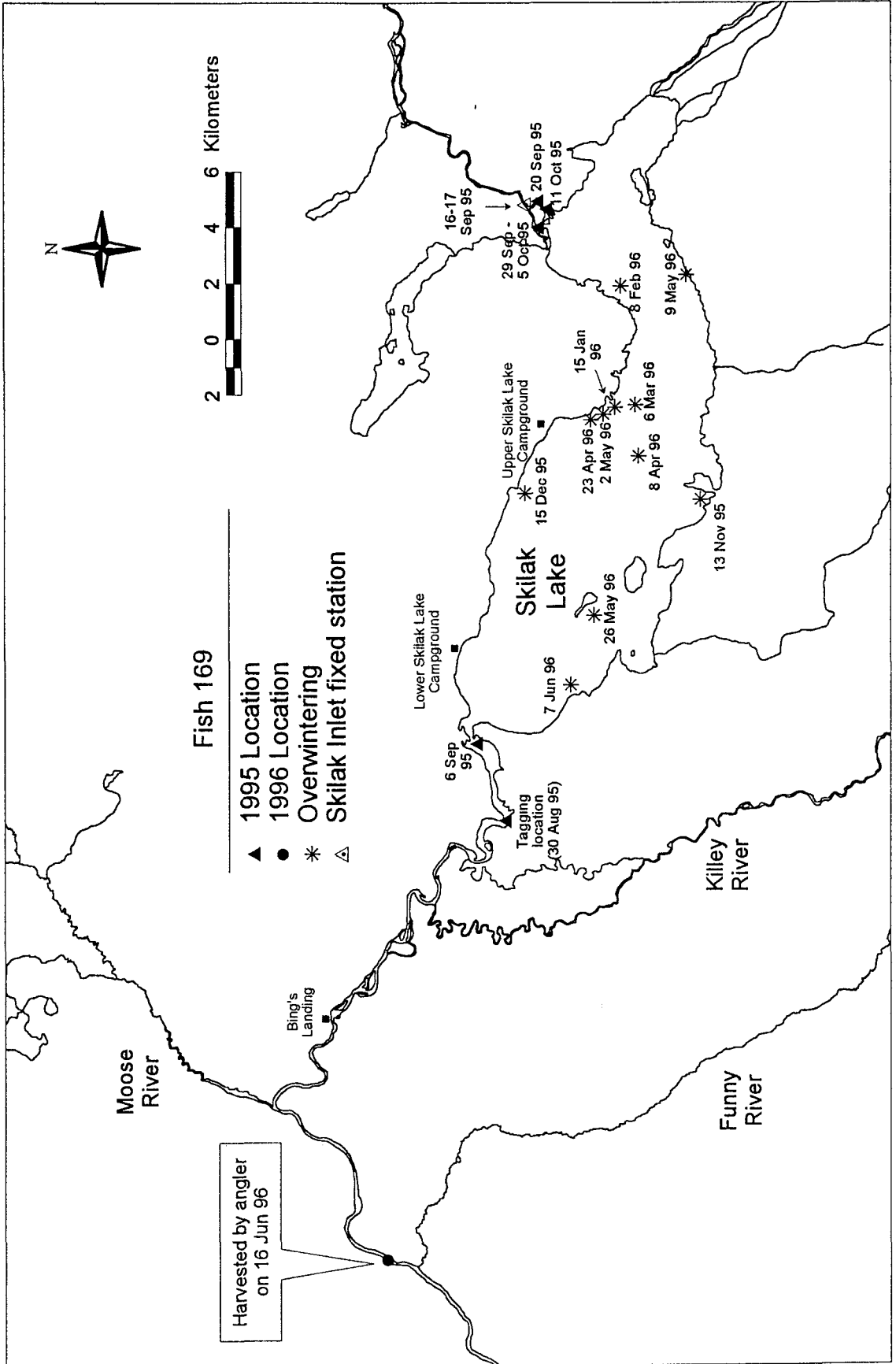
Appendix C36.— Locations of rainbow trout number 163 from 6 September, 1995 through 19 November, 1996.



Appendix C37 — Locations of rainbow trout number 165 from 8 September, 1995 through 15 October, 1996.



Appendix C38 — Locations of rainbow trout number 167 from 31 August, 1995 through 5 June, 1996.



Appendix C39.— Locations of rainbow trout number 169 from 30 August, 1995 through 16 June, 1996.