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BEERE, M.C.

Movement of summer run
steelhead trout tagged

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Movements of Summer Run Steelhead Trout
Tagged with Radio Transmitters in the
Babine River during Spring, 1994.

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Abstract

Radio telemetry was used to determine the proportion of wild adult summer run steelhead migrating through the Department of Fisheries and Oceans' Babine River enumeration weir near the outlet of Nilkitkwa Lake. Spawning locations were determined, where possible, for all radio tagged fish. Conventional angling methods were used to capture steelhead in the upper 50 kilometers of the river during the spring, prior to spawning. Radio transmitters were inserted orally into the stomachs of twenty five fish. Steelhead movements were monitored with a stationary telemetry receiver and by helicopter. It was determined by stationary telemetry tracking that twelve (48%) steelhead migrated upstream of the Babine River enumeration weir; ten (83%) of these twelve fish were located upstream of the weir during tracking flights. The mainstem Babine River between the Nilkitkwa Lake outlet and the enumeration weir was identified as the major steelhead spawning area in the watershed. Steelhead also spawned in Boucher, Nichyeskwa and Secret creeks and in the Nilkitkwa and Shelagyote rivers.

Introduction

Estimating summer run steelhead (*Oncorhynchus mykiss*) spawning escapements for Skeena River stocks has been difficult to date in the absence of more detailed information than has traditionally been available. Most Skeena River tributaries are too large and volatile to maintain enumeration weirs on and water visibility is rarely sufficiently clear to conduct visual counts by snorkel surveys. As the Babine River commences at British Columbia's largest natural lake, which stabilizes water flows, it is one of the only Skeena tributaries on which it is possible to maintain an enumeration weir in the spring. The weir was constructed in 1946, 1.5 kilometers downstream of Nilkitkwa Lake, by the Department of Fisheries and Oceans (DFO) to enumerate sockeye salmon adults.

Available data suggests that the majority of summer run Babine River steelhead spawn at the outlet of Nilkitkwa Lake (Beere, 1991). If these fish are indeed representative of the entire population of Babine steelhead it would be possible to estimate the size of the Babine River stock by counting steelhead migrating through the DFO weir. This study was initiated to estimate the proportion of the Babine River summer run steelhead population that spawn upstream of the fence.

Study Area

General Description

The 99 km long Babine River flows from Nilkitkwa Lake, at a point approximately 78 km northeast of Smithers, northwest to its confluence with the Skeena River, approximately 49 km northeast of Hazelton (Figure 1). Twenty seven km (28%) of the Babine consists of a relatively high gradient canyon section in the lower one third of the river. The Babine River watershed drainage area upstream of the DFO weir is 6 790 km², and at that point the monthly mean discharge ranges from a low in March of 21.1 m³/s to a high in June of 126 m³/s (Water Survey of Canada, 1989). The majority of the watershed is found within the Sub-Boreal Spruce (SBS) biogeoclimatic zone; downstream of Gail Creek the river flows through Interior Cedar Hemlock (ICH).

Fish Populations

In addition to summer run steelhead, sockeye salmon (*O. nerka*), coho salmon (*O. kisutch*), chinook salmon (*O. tshawytscha*), pink salmon (*O. gorbuscha*), chum salmon (*O. keta*), resident rainbow trout (*O. mykiss*), cutthroat trout (*O. clarki*), Rocky

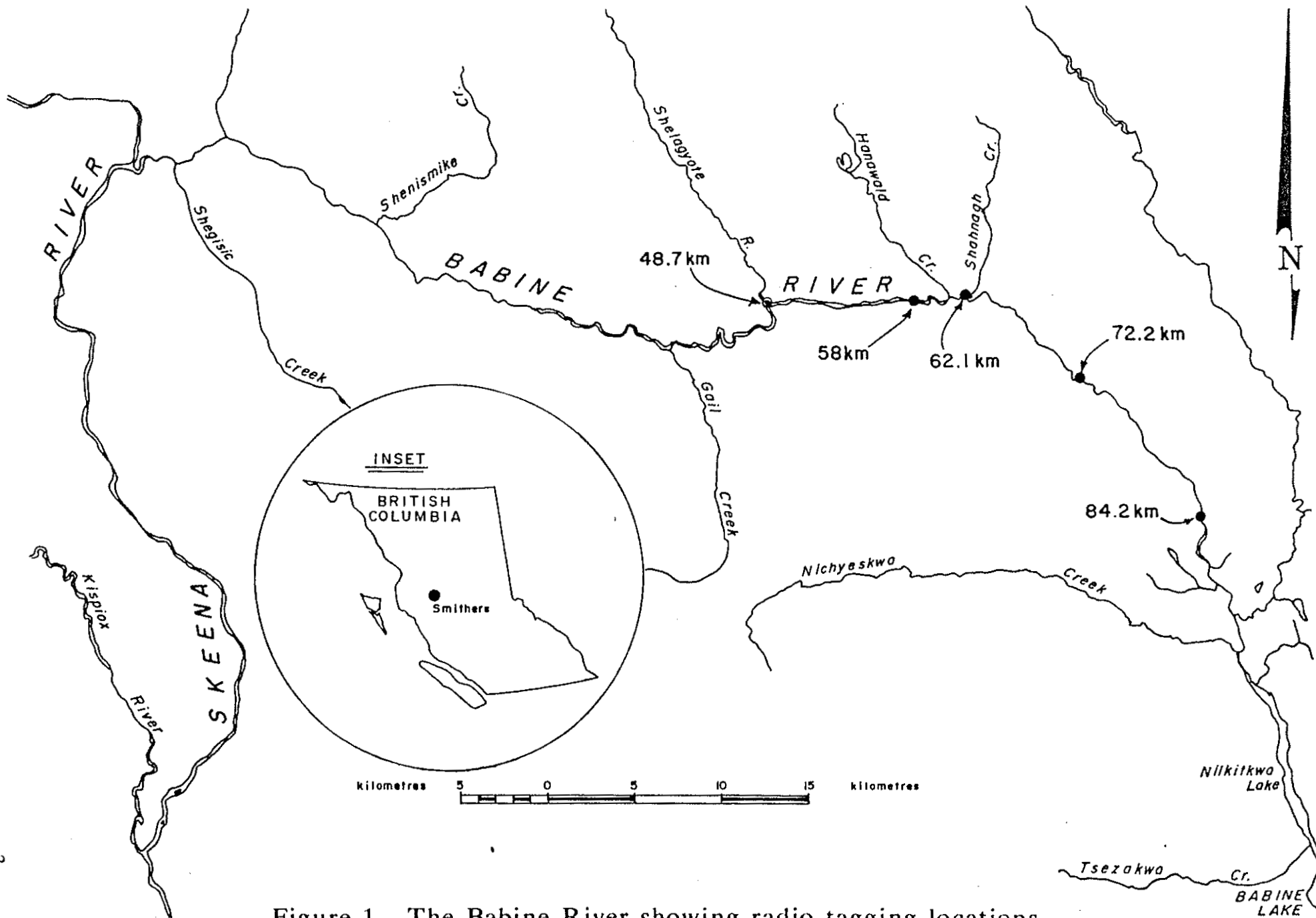


Figure 1. The Babine River showing radio tagging locations.

Mountain whitefish (*Prosopium williamsoni*), Dolly Varden char (*Salvelinus malma*) and/or bull char (*S. confluentus*) are all found in the Babine River.

The Department of Fisheries and Oceans has estimated average escapement of sockeye, coho, pink, chum and chinook salmon escapement over a ten year period (1980 to 1989) to be 464542, 2960, 60000, 2, and 863 respectively (Anonymous, 1991).

Escapement estimates are not available for the other species listed present. Steelhead, salmon (with the exception of chum, which are rare), rainbow trout, cutthroat trout, Dolly Varden and/or bull char and Rocky Mountain whitefish are widely distributed throughout the watershed.

Fisheries

Both Native and recreational fisheries exist on the Babine River; Natives fish for both commercial and sustenance purposes. Over the past ten year period, an average of 474 anglers have fished for steelhead in the Babine each year, accounting for an average yearly catch of 3678 steelhead (Figure 2; Anonymous, 1995). Other species listed are also captured in sport fisheries although no catch data is available. Current freshwater fishing regulations prohibit the retention of steelhead, sockeye, chum and pink salmon in the Babine; coho and chinook salmon, trout, char and whitefish may be retained. The retention of coho, chinook and sockeye salmon has been permitted in the past (Anonymous, 1994).

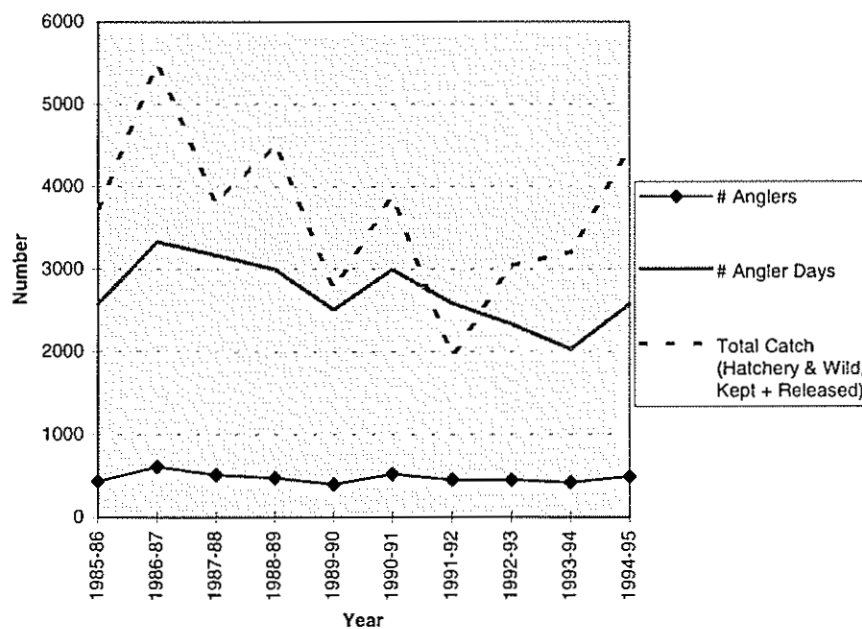


Figure 2: Number of anglers, angler days and total steelhead catch in the Babine River, 1985 to 1995 inclusive, as estimated by the British Columbia Steelhead Harvest Questionnaire.

Methods

Fish Capture and Tagging

Wild adult summer run steelhead were captured between kilometer 48 and 84 on the mainstem Babine River using conventional angling methods on April 14, 1994. Steelhead that were less than 65 cm or that appeared to be in less than optimum condition were marked at the base of the left side of the dorsal fin with a single coloured, numbered anchor tag (Floy Tags, Washington, U.S.A.) and released (Figure 3). All fish greater than 65 cm (fork length) that were in good condition were radio tagged. While the fish was held at the surface of the water, the radio transmitter was inserted orally into the stomach with a hollow, flexible plastic tube (Figure 4). Anaesthetic was not used as the possible effect on behavior was not known. Radio tagged fish were also marked with two anchor tags at the base of the left side of the dorsal fin. Sex, fork length, anchor tag number and colour, scars or hook marks, fish condition and radio tag number (if radio tagged) were noted for each fish captured. All tagging locations were described using Canadian Helicopter's global positioning satellite (G.P.S.) equipment (Trimble, model 19437-60, USA).

Radio Telemetry

Radio telemetry equipment used in this study was obtained from Lotek Engineering (Newmarket, Ontario). Radio transmitters used (model CFRT-3B) were cylindrical, 14.5 mm in diameter, 43 mm in length and had a 440 mm long antenna leading from the anterior end of the transmitter which protruded from the fishes mouth. Transmitters weighed 10.7 g in air, 4.2 g in water and were powered by a 3 volt Lithium battery which had a 260 day life. All transmitters emitted a digitally encoded radio signal at a frequency of either 151.010 or 151.030 MHz.

Radio tagged steelhead were tracked by helicopter on six separate flights beginning on April 27, 1994 and concluding on June 9, 1994. Individual radio tag signals were detected and decoded by telemetry receiver (model SRX_400 with software version 3.47 W16D). The receiver was used in combination with a 6 m length of RG-58 A/U double shielded coaxial cable and a three element Yagi antenna for aerial tracking flights. The Yagi antenna was mounted to the helicopter's high frequency antenna (Figure 3) with elements orientated perpendicular to the surface of the water to minimize radio signal attenuation (Lotimer, *et al.*, 1994). The receiver logged the time, transmitter code and relative signal strength in an internal memory that was later transferred to a computer file.



Figure 3. Photograph illustrating the insertion of an anchor tag.



Figure 4. Photograph illustrating the insertion of a radio transmitter.



Figure 5. Photograph of helicopter used for tracking flights showing location of telemetry antenna.

A stationary receiver station was installed immediately downstream of the DFO weir and operated from April 15 to June 9, 1994, to detect and record radio transmitters in the vicinity (Figure 6). Receiver stations consisted of a telemetry receiver stored on the riverbank in a camouflaged, weather proof box with a three element Yagi antenna mounted approximately 3 m up an adjacent tree. The receiver was externally powered by a deep cycle 12 volt lead acid battery (195 cold crank amps) and operated for ten days between battery changes. Data was logged by the receiver in the same fashion as for the mobile tracks and data was downloaded with a laptop computer in the field during battery changes.

Tagged fish locations were recorded on a 1:50 000 scale map to the nearest 500 m.

Weir Operations

The DFO enumeration weir was monitored by B.C. Environment staff from April 28 to May 16, 1994 to assess the feasibility of manually counting steelhead migrating through the weir. During this period fence panels were installed to direct migrating steelhead through seven adult sockeye funnel traps. Traps were opened for discrete periods of time during which steelhead passing upstream or downstream through the weir were enumerated. The results of this investigation are found elsewhere (Saimoto, 1995).

Data Interpretation

As steelhead may have exhibited an interrupted migration pattern and tracking flights were conducted at specific points in time, it was assumed that the calculated migration rates were the minimum possible migration rates. Migration rates were calculated by dividing the number of kilometers that an individual fish had migrated since last detection, by the number of days since last detection.

Determination of spawning locations was subjective. Radio tagged fish that were located at known or suspected spawning locations, that were repeatedly tracked to areas that had spawning potential or that migrated into Babine River tributaries were considered to have spawned at those locations. Individual radio tagged fish were not observed spawning.

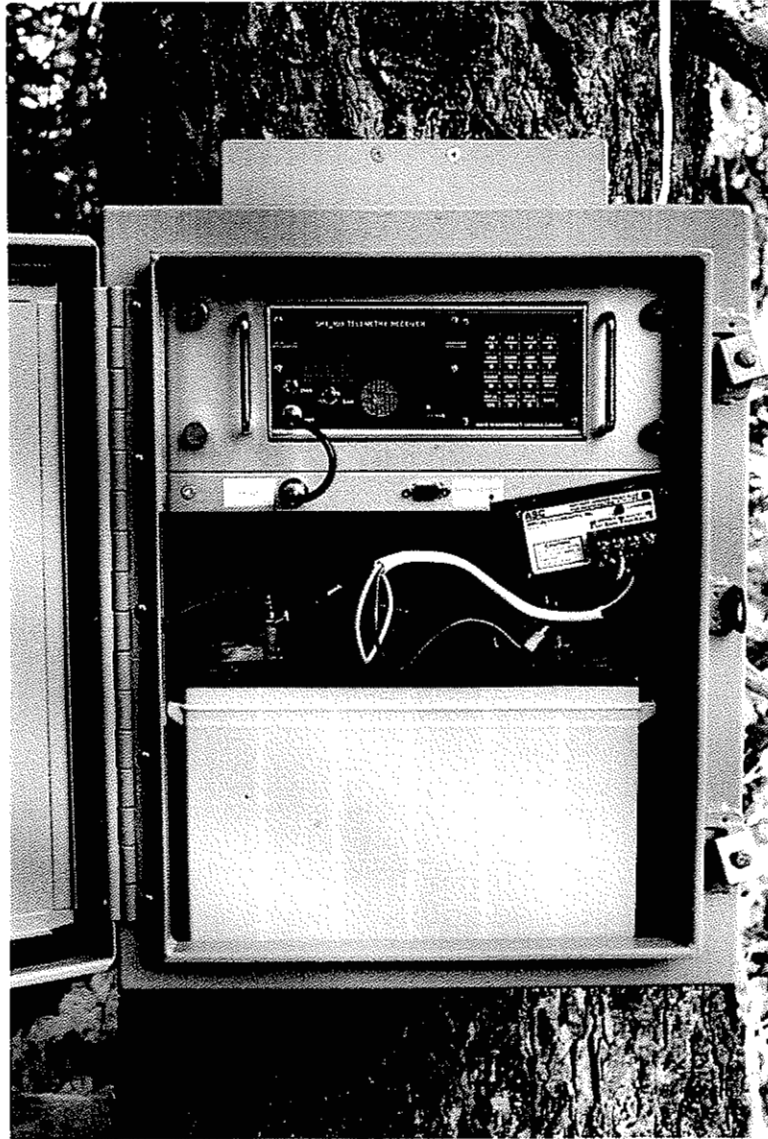


Figure 6: Photograph of stationary radio telemetry tracking station. Note receiver above and 12 volt deep cycle RV battery below. A three element Yagi antenna was fixed to the tree some 2 to 3 m above the receiver.

Results

Thirty five adult summer run steelhead were captured between kilometer 48 and 84 on the mainstem Babine River on April 14, 1994. Fish ranged in fork length from 71 to 96 cm and the sex ratio was 0.47 ♂ to 1 ♀. Twenty five fish were radio tagged; ten were anchor tagged only.

A minimum of three (8.6%) of the thirty five fish were scarred from having encountered either a tidal commercial or in-river Native gillnet.

Radio tagged steelhead were tracked by helicopter on six separate flights beginning on April 27, 1994 and concluding on June 9, 1994.

It was determined from fixed receiver station data that 12 (48%) radio tagged steelhead migrated upstream of the DFO weir (Table 1 and 2; Appendices 1-25). Only 10 (83%) of the 12 were located upstream of the weir during helicopter tracks. One of these fish migrated upstream of the weir after having spent a minimum of fifteen days in Secret Creek. Fish spent as little as 14 hours and as long as 22 days, 16 hours in the vicinity of the fixed station (Table 2).

Six (50%) of these 12 migrated through the weir during the period that it was fished (April 28 to May 16); only 2 (17%) emigrated downstream through the fence during this period. Six (50%) of the 12 fish that migrated upstream through the weir did so between 8:00 pm and midnight. All emigrants passed through the weir between 11:00 am and 10:00 pm (Table 2).

Seven (28%) were tracked only to areas of the mainstem Babine River and may have either spawned in the mainstem or entered a tributary stream to spawn without detection. Four (16%) of the seven are suspected to have died or regurgitated their transmitter, as the transmitter was repeatedly located in the same location or downstream of the original tagging site.

Seven steelhead (28%) were found in tributary streams and are assumed to have spawned there. Three (12%) were located in Nichyeskwa Creek; one female was located 20 kilometers up the Nichyeskwa. Two (8%) radios were found in Secret Creek; one 91 cm male was located approximately 3 km up the 5 km long creek and is believed to have remained in the creek for a minimum of 15 days. Single (4% respectively) radio tagged steelhead were found in the Nilkitkwa and Shelagyote rivers. The Nilkitkwa fish migrated a minimum of 29 km up the Nilkitkwa and spent a minimum of 6 days in the river. The Shelagyote fish was located 20 km upstream of the Babine-Shelagyote confluence and is believed to have spent a minimum of 24 days in the Shelagyote.

Table 1. Tagging information and subsequent locations on aerial tracks (river kilometers in brackets) of radio tagged Babine River summer steelhead, 1994.

Code	Sex	Length (FL in cm)	Tagging Location 14 April, 1994	Helicopter 27 April, '94	Helicopter 12 May, '94	Helicopter 16 May, '94	Helicopter 18 May, '94	Helicopter 27 May, '94	Helicopter 9 June, '94
Ch. 2	1	M	75	Beaver Flats(72)	u/s Beaver Flats(73)	Nilkitkwa(91+8)	Nilkitkwa(91+29)	Nilkitkwa(91+10)	
	2	F	73		Moose Run(83)	d/s Silver Hillton(48)	u/s Shelagyote(52)	Shelagyote(49)	u/s Gail Cr.(39)
	3	M	91		u/s Beaver Flats(73)	Nilkitkwa L.(97)	u/s weir(96)	Boucher Cr.(96)	
	4	F	71		u/s clearcut(77)		Nichyeskwa(93+20)	Nichyeskwa(93+18)	
	5	F	80		u/s clearcut(77)		Nichyeskwa(93+13)	Lobo(85)	
	6	F	79	Bonanza(62)	Coffee Pot(64)	Coffee Pot(64)	clearcut(75)	u/s weir(95)	u/s weir(96)
	7	F	84		Hanawald confl.(61)	u/s Hanawald(61)		Coffee Pot(64)	d/s Home Run(83)
	8	F	73		Coffee Pot(64)	Coffee Pot(64)	d/s Beaver Flats(71)	Home Run(84)	Nichyeskwa(93+2)
	9	F	80		u/s Coffee Pot(66)	u/s weir(95)	u/s weir(96)	u/s Coffee Pot(65)	
	10	F	82		Triple Header(58)	d/s T. Header(56)	d/s Hanawald(56)		u/s Thomlinson(35)
	11	M	96		Triple Header(58)	u/s weir(95)	u/s weir(96)		u/s weir(96)
	12	F	78		Triple Header(58)	clearcut(75)	d/s clearcut(74)	d/s clearcut(74)	u/s weir(96)
	13	M	88		Triple Header(58)	Secret Cr.(84+1)	Silver Hillton(48)		u/s Gail Cr.(39)
	14	M	91		d/s Triple Header(57)	Secret Cr.(84+1)	Secret Cr.(84+3)	Secret Cr.(84+1)	Secret Cr.(84+1)
	15	M	85		Triple Header(58)	u/s weir(95)	u/s weir(96)	u/s weir(96)	
	16	F	73	Silver Hillton(48)	Shelagyote confl.(49)				
	17	F	76		Shelagyote confl.(49)		u/s weir(95)	u/s weir(96)	
	18	F	74		Silver Hillton(49)	d/s Coffee Pot(63)			
	19	M	74		d/s Triple Header(57)	d/s Silver Hillton(48)	Silver Hillton(48)		
	20	M	71		Silver Hillton(48)		Shelagyote(49+16)	Shelagyote(49+20)	Shelagyote(49+16)
Ch. 1	16	F	85	Home Run(84)	Hot Shot(88)	d/s Laura's(80)	u/s clearcut(76)	u/s clearcut(76)	clearcut(75)
	17	F	84		u/s weir(97)	d/s weir(94)	u/s weir(95)		d/s clearcut(70)
	18	F	81		u/s clearcut(76)	d/s Coffee Pot(63)	u/s Shahnagh(63)	Coffee Pot(64)	Coffee Pot(64)
	19	F	84		Moose Run(83)	d/s Home Run(83)	d/s Norlakes(89)	u/s weir(95)	u/s Home Run(85)
	20	F	79		u/s weir(97)				d/s Hotshot(87)

Table 2. Dates and times of first and last detection of radio tagged Babine River steelhead at the telemetry receiver station located immediately downstream of the enumeration fence, kilometer 94 of the Babine River, April 15 through June 9, 1994.

Ch. 1	Code	Sex	Length	Tagging Date 14 April, 1994	Receiver Station Detection Date		Total Time Elapsed		
					First	Last	Days	Hours	Mins.
	16	F	85	Home Run	May 6 - 2320 hrs	May 7 - 1332 hrs		14	12
	17	F	84		April 22 - 2154 hrs	May 16 - 1530 hrs	22	16	36
	18	F	81						
	19	F	84		May 17 - 2058 hrs	May 20 - 1749 hrs	2	20	51
	20	F	79		April 22 - 1556 hrs	May 6 - 1907 hrs	14	3	11
Ch. 2	1	M	75	Beaver Flats					
	2	F	73						
	3	M	91		May 7 - 2303 hrs	May 21 - 1119 hrs	13	12	16
	4	F	71						
	5	F	80						
	6	F	79	u/s Shahnagh Cr.	May 18 - 1124 hrs	May 27 - 1344 hrs	9	2	20
	7	F	84						
	8	F	73						
	9	F	80		May 11 - 0844 hrs	May 17 - 2138 hrs	7	12	54
	10	F	82						
	11	M	96	Triple Header	May 7 - 2211 hrs	May 27 - 1344 hrs	19	15	33
	12	F	78		May 25 - 2251 hrs	June 1 - 1140 hrs	6	12	49
	13	M	88						
	14	M	91		June 2 - 0600 hrs	June 3 - 1721 hrs	1	11	21
	15	M	85		May 9 - 1402 hrs	May 28 - 1133 hrs	18	21	31
	16	F	73	Silver Hilton					
	17	F	76		May 13 - 1048 hrs	May 23 - 1833 hrs	10	7	45
	18	F	74						
	19	M	74						
	20	M	71						

As the first tracking flight was conducted on April 27, 13 days after tagging took place, accurate assessment of fish drop back immediately after tagging could not be made. However, on that date, five radio tagged steelhead were located downstream of the original tagging location. Two of these steelhead were later suspected to have either died or regurgitated their transmitter. One continued its upstream migration a minimum of 15 days after tagging while the other two were found upstream of the tagging location 19 days after tagging.

Migration rates between tracking dates ranged from -1.0 km/day (downstream migration) to 10 km/day. Average individual fish migration rates for the entire study period ranged from 0.1 km/day to 2.6 km/day. Analysis of migration rates excluded fish that were believed to have regurgitated the radio transmitter or that were suspected mortalities.

Total daily discharge steadily increased from approximately 30 m³/s, on April 14, to approximately 130 m³/s on May 27, when it leveled for about three weeks before beginning to recede (Figure 7; Water Survey of Canada, 1989). Water temperatures recorded during the study period are found in Figure 8 (Water Survey of Canada, 1989). The water temperature of the Babine River at kilometer 84 at the beginning of tagging operations (0934 hours) was 0 degrees Celsius.

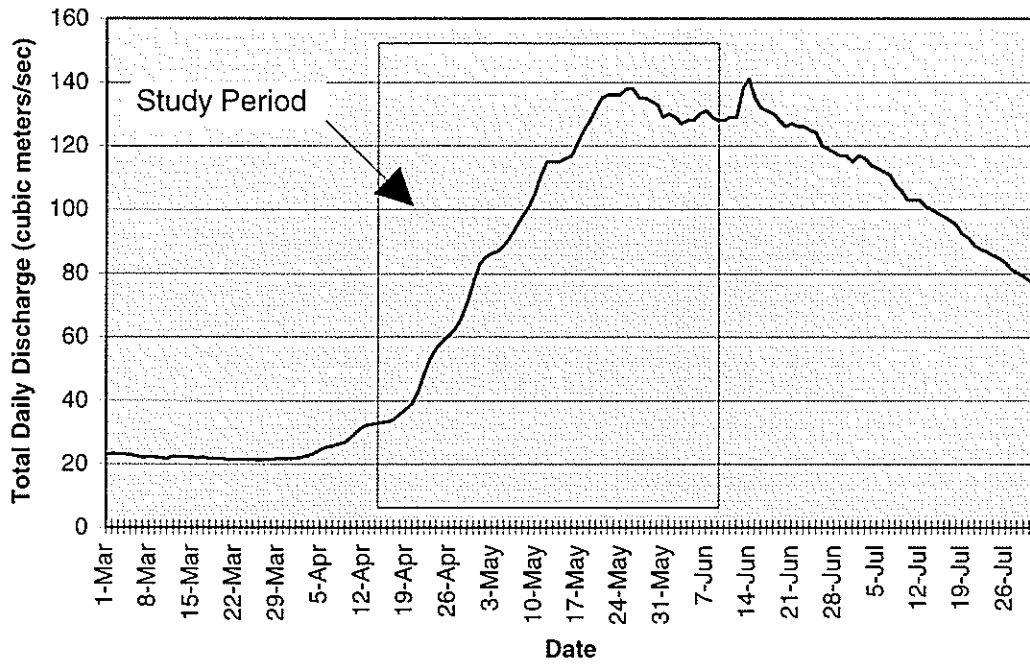


Figure 7 Total daily discharge of the Babine River at the outlet of Nilkitkwa Lake, March through July, 1994.

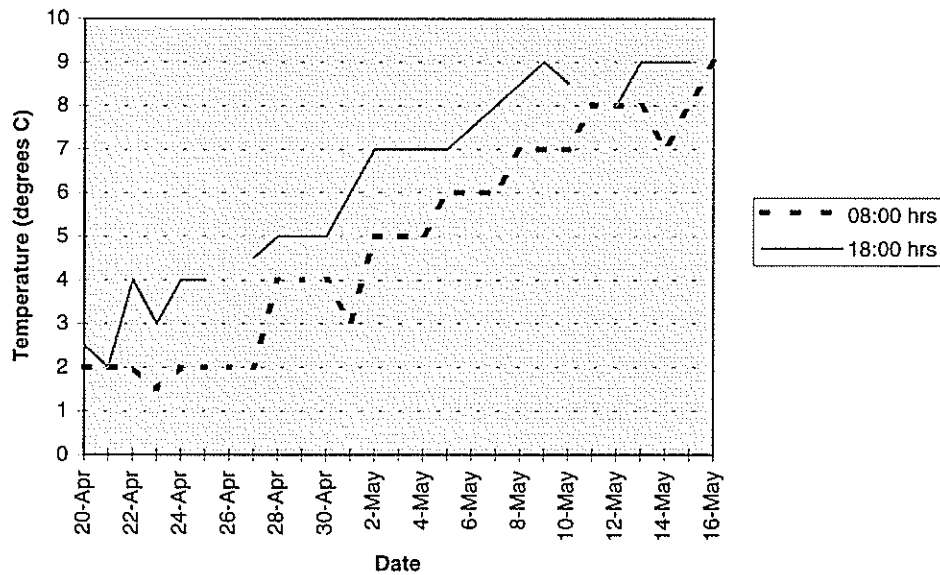


Figure 8: Daily water temperatures at the Babine River enumeration fence - April 20 through May 16, 1994.

Discussion

Annual variations in the number of radio tagged steelhead spawning upstream of the weir are expected given that the sample size was small (n=25). Twelve of 25 (48%) steelhead radio tagged in this study migrated upstream of the DFO weir. In a similar study, 15 steelhead were radio tagged between kilometer 52 and 83 on the Babine on April 11, 1990 (Beere, 1991). Eleven of the 15 (73%) radio tagged fish migrated upstream of the DFO weir. Excluding two suspected regurgitations or mortalities, 85% of the steelhead radio tagged in the 1990 study migrated upstream of the weir. In the current investigation, even after the exclusion of four suspected regurgitations or mortalities, only 57% of the radios migrated upstream of the weir.

The timing of spawning was not determined in this study. However, four radio tagged steelhead (3 ♀, 1 ♂) had moved downstream prior to the May 18 tracking flight (Table 1), indicating that they may have completed spawning by that time.

A single female that was located upstream of the weir on May 16 began her downstream emigration prior to a May 27 tracking flight indicating that she had completed spawning before that time. In the 1990 study, time of spawning was determined for only two fish and they were thought to have spawned between May 16 and May 24. It was difficult to ascertain time of spawning for other fish radio tagged because, as Lough (1983) noted in a study on the Zymoetz River, although spawning took place in mid-May to early June, some remained in the river until July 10. In the present and 1990 studies, time of spawning could only be estimated for fish exhibiting a post spawning emigration behavior.

Finding radio tagged steelhead in Secret Creek (km 84, Figure 1) was significant as this stream was not previously identified as a system utilized by steelhead. This short (4 km), high gradient stream is thought to be ephemeral during some years but is lake headed. The importance of small and particularly lake headed streams to steelhead can not be over emphasized. Forest harvest operations often overlook small streams, rationalizing their lack of importance due to size.

Minimum average individual fish migration rates of between 0.1 and 2.6 km/day (range: 0.08 km/day to 10 km/day) were similar to those found by Lough (1979) for steelhead angled between July 30 and August 2, 1978, 96 km upstream of Tye (1.4 - 1.8 km/day), and Beere (1995) on the Zymoetz River in April, 1994 (0.5 - 2.1 km/day). Conversely, Spence (1989), who was studying the migrations of steelhead seined in tidal waters in the fall of 1988, and for the most part, in the mainstem Skeena River, found that the average rate of travel for radio tagged steelhead less than 10 km upstream of the mouth of the Skeena was 7.5 km/day; up to kilometer 54 he found an average rate of 8.3 km/day; 10.4 km/day downstream of the Zymoetz River, 20.2 km/day between the Zymoetz and Bulkley rivers (individuals as high as 26.2 km/day), as high as 32 km/day upstream of Bulkley River and as low as 1.5 km/day. Spence documented that migration rates were reduced once steelhead had entered their natal stream in the fall, and that the final migration from an overwintering location to the spawning destination in the spring was slower than most fall migrations.

Only 6 (50%) of 12 radio tagged steelhead that migrated upstream of the DFO weir did so during the period that the weir was actively fished (April 28 to May 16); only 2 (17%) of those 12 migrated downstream through the weir during that period. One possible explanation for this is that the fish avoided the weir as long as possible when there was human activity on the weir, that the funnel traps used (reducing the width of the migration corridor) and the hours of operation disrupted normal migration behaviour. In a similar study conducted on the Babine in 1990 (Beere, 1991), when the weir was not actively monitored, 11 radio tagged steelhead migrated upstream of the weir. Nine (82%) of the 11 migrated upstream during the April 28 to May 16 period but only 2 (18%) of 11 had emigrated prior to May 16. This limited data suggests that steelhead migration through the weir may have been delayed in the current study as a result of actively fishing the weir. However further information must be gathered to eliminate the possibility that migration behaviour differences were due to between year differences in migration timing of Babine River steelhead.

Recommendations

1. Population estimates conducted solely at the DFO enumeration weir would not be sufficient in estimating the escapement of the entire Babine River summer run steelhead population. As tributaries such as Nichyeskwa and Secret creeks and the Nilkitkwa and Shelagyote rivers appear to be utilized as spawning areas, and possibly areas of the mainstem Babine River, an accurate estimate of steelhead escapement to the Babine River would have to take these populations into consideration. However, an annual estimate could be obtained if radio telemetry techniques were used in conjunction with weir counts.
2. A second telemetry fixed station at the Babine-Skeena confluence is recommended in order to determine the number of radio tagged steelhead that emigrate from the Babine after spawning. In addition to emigration timing data, an estimate of post spawning mortality could be made.
3. The importance of small and particularly lake headed streams to steelhead can not be over emphasized. Forest harvest operations often overlook small streams, rationalizing their lack of importance due to size. The utmost of care must be taken to inventory and protect these steelhead spawning/juvenile rearing streams when preparing forest harvest plans.
4. Although it was not conclusively demonstrated that actively fishing the DFO weir disrupted steelhead migrations, any further enumeration attempts at the weir should be carefully monitored to ensure that this does not occur.

Acknowledgments

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References

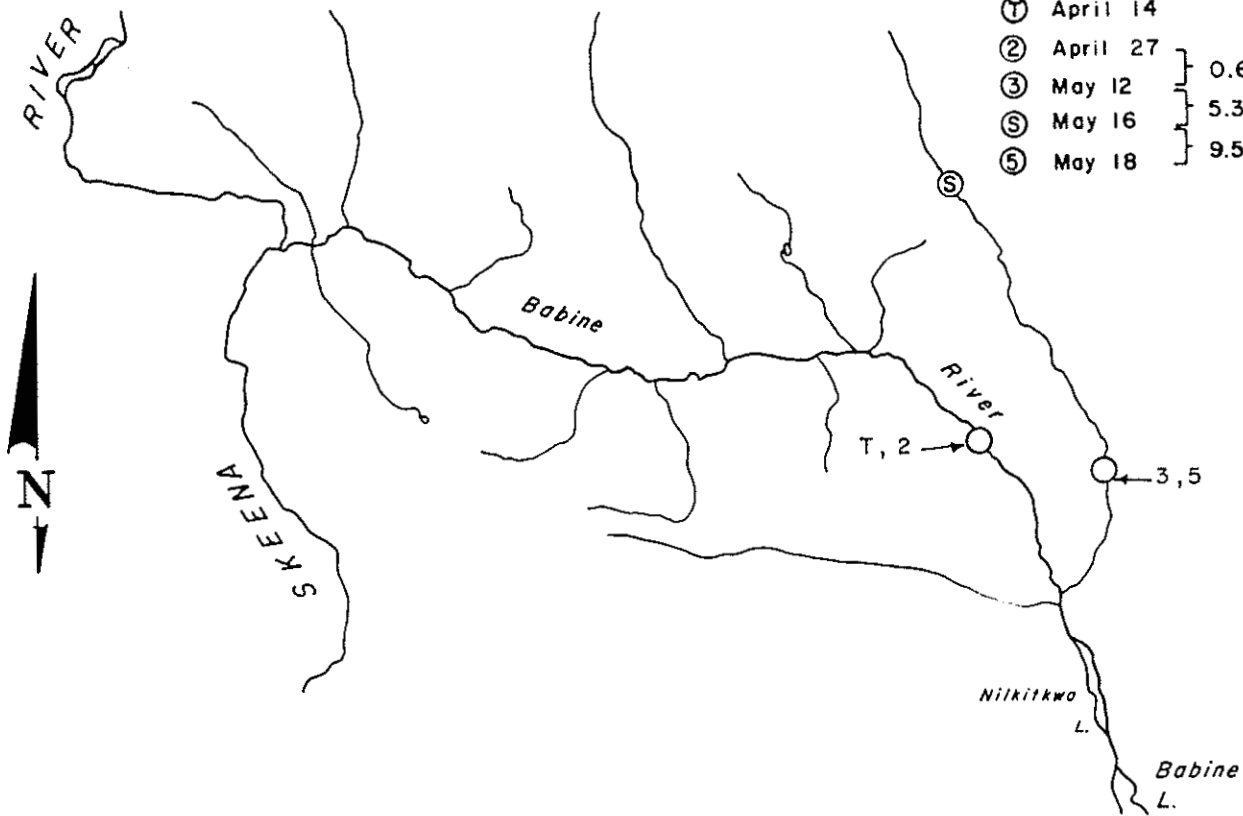
- Anonymous. 1991. Fish habitat inventory and information program. Stream summary catalogue. Subdistrict 4D Smithers Volume 1. Department of Fisheries and Oceans, Vancouver, B.C..
- Anonymous. 1994. British Columbia freshwater fishing regulations synopsis, 1994-1996. Fisheries Branch. B.C. Ministry of Environment, Lands and Parks, 2-780 Blanshard Street, Victoria, B.C., V8V 1X4..
- Anonymous. 1995. British Columbia steelhead harvest questionnaire 1984-1994. Fisheries Branch. B.C. Ministry of Environment, Lands and Parks, Data Warehouse. 2-780 Blanshard Street, Victoria, B.C., V8V 1X4..
- Beere, M.C. 1991. Radio telemetry investigations of Babine River steelhead, Spring 1990. Unpublished M.S. Skeena Fisheries Report # SK 71, 17 pp. B.C. Ministry of Environment, Lands and Parks, Smithers, B.C..
- Beere, M.C. 1995. Movements of summer run steelhead trout tagged with radio transmitters in the Zymoetz River during Spring, 1994. Unpublished M.S. Skeena Fisheries Report #93, 22 pp. B.C. Ministry of Environment, Lands and Parks, Smithers, B.C..
- Lotimer, J., C. Grant and B. Taylor. 1994. Advanced radio telemetry techniques for fisheries and wildlife applications. Unpublished. Literature provided at a biotelemetry workshop, February 7-9, 1994, Fairbanks, Alaska. Lotek Engineering, Newmarket, Ontario.
- Lough, M.J. 1979. Radio-telemetry studies of summer run steelhead trout in the Skeena River, 1978, with particular reference to equipment and capture methods. Unpublished M.S. Skeena Fisheries Report #78-10 (S.E.P.), 17 pp. B.C. Ministry of Environment, Lands and Parks, Smithers, B.C..
- Lough, M.J. 1983. Radio telemetry studies of summer steelhead trout in the Cranberry, Kispiox, Kitwanga and Zymoetz rivers and Toboggan Creek, 1980. Unpublished M.S. Skeena Fisheries Report #80-04 (S.E.P.), 73 pp. B.C. Ministry of Environment, Lands and Parks, Smithers, B.C..
- Saimoto, R.S. 1995. Babine River steelhead, 1993/94: population estimate and weir assessment. Unpublished M.S. Skeena Fisheries Report # SK 92, 22pp. B.C. Ministry of Environment, Lands and Parks, Smithers, B.C..
- Spence, C. R. 1989. Rates of movement and timing of migrations of steelhead trout to and within the Skeena River, 1988. Unpublished M.S. Skeena Fisheries Report # SK 62, 24 pp. B.C. Ministry of Environment, Lands and Parks, Smithers, B.C..

Water Survey of Canada. 1989. Historical streamflow summary - British Columbia.
1058 pp. Inland Waters Directorate, Water Resources Branch, Ottawa,
Canada..

Appendices

Appendices 1-25: Movements of individual radio tagged steelhead and maximum rates of travel between tracking dates. →T designates tagging location while S designates spawning location.

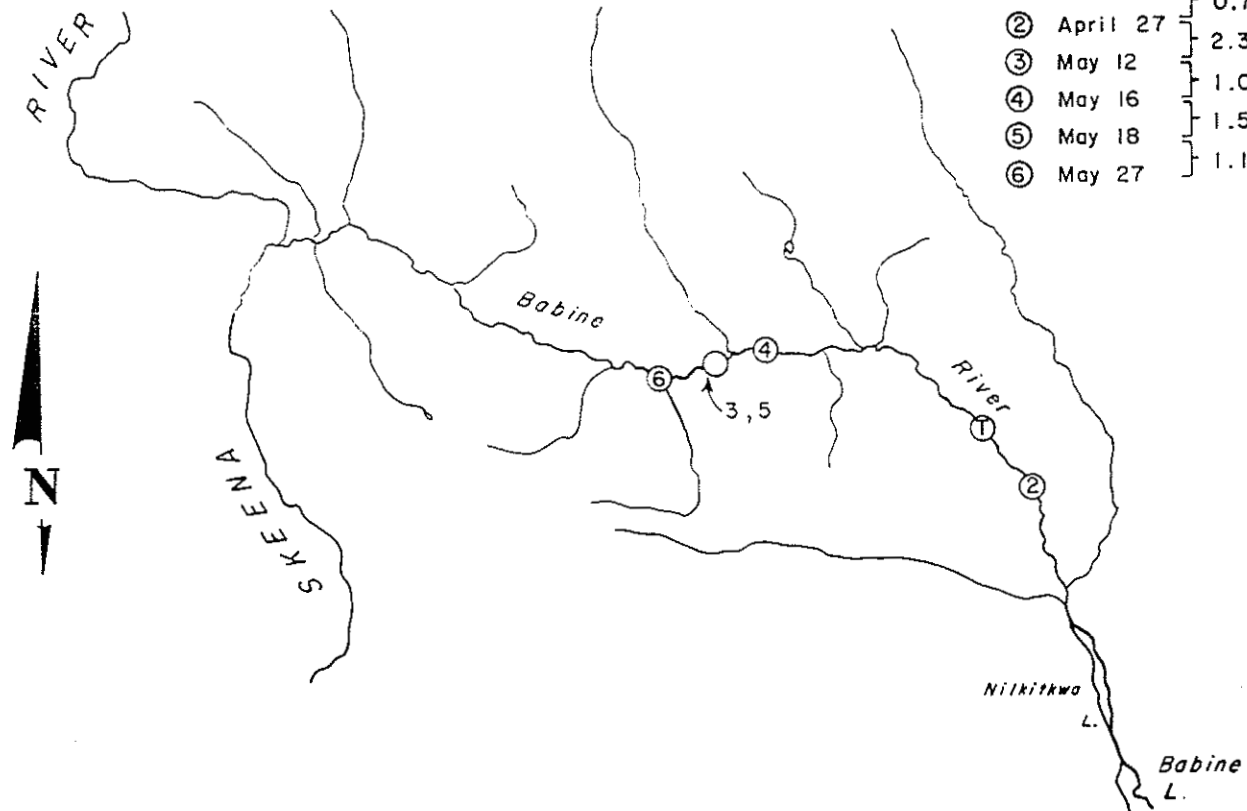
Steelhead #1 Aerial Tracks



- ① April 14
 - ② April 27
 - ③ May 12
 - ④ May 16
 - ⑤ May 18
- } 0.6 km/day
 } 5.3 km/day
 } 9.5 km/day d/s

Appendix 1. Movements of Radio Tagged Steelhead, Fish #1

Steelhead #2 Aerial Tracks

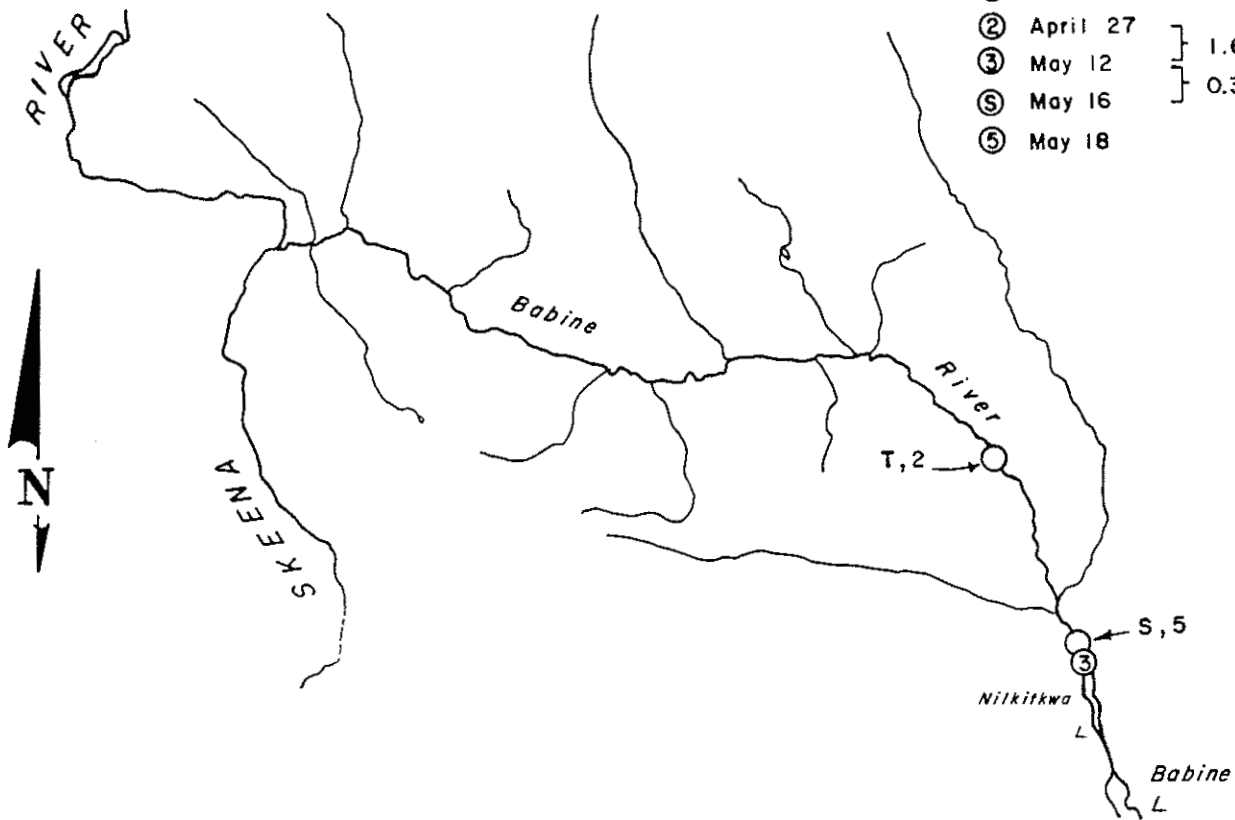


- ① April 14
 - ② April 27
 - ③ May 12
 - ④ May 16
 - ⑤ May 18
 - ⑥ May 27
- } 0.7 km/day
 } 2.3 km/day d/s
 } 1.0 km/day
 } 1.5 km/day d/s
 } 1.1 km/day d/s

Appendix 2. Movements of Radio Tanned Steelhead Fish #2

Steelhead #3 Aerial Tracks

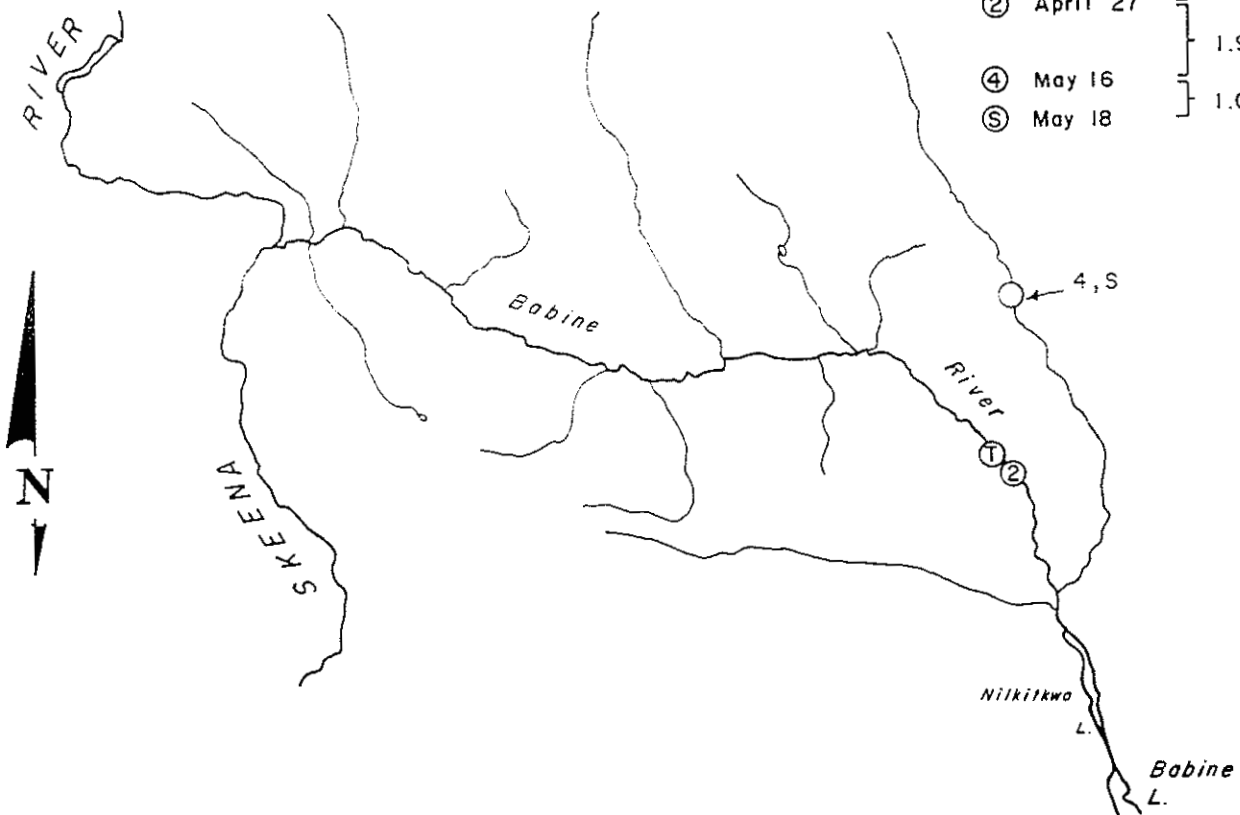
- ① April 14
 - ② April 27
 - ③ May 12
 - ④ May 16
 - ⑤ May 18
- } 1.6 km/day
} 0.3 km/day



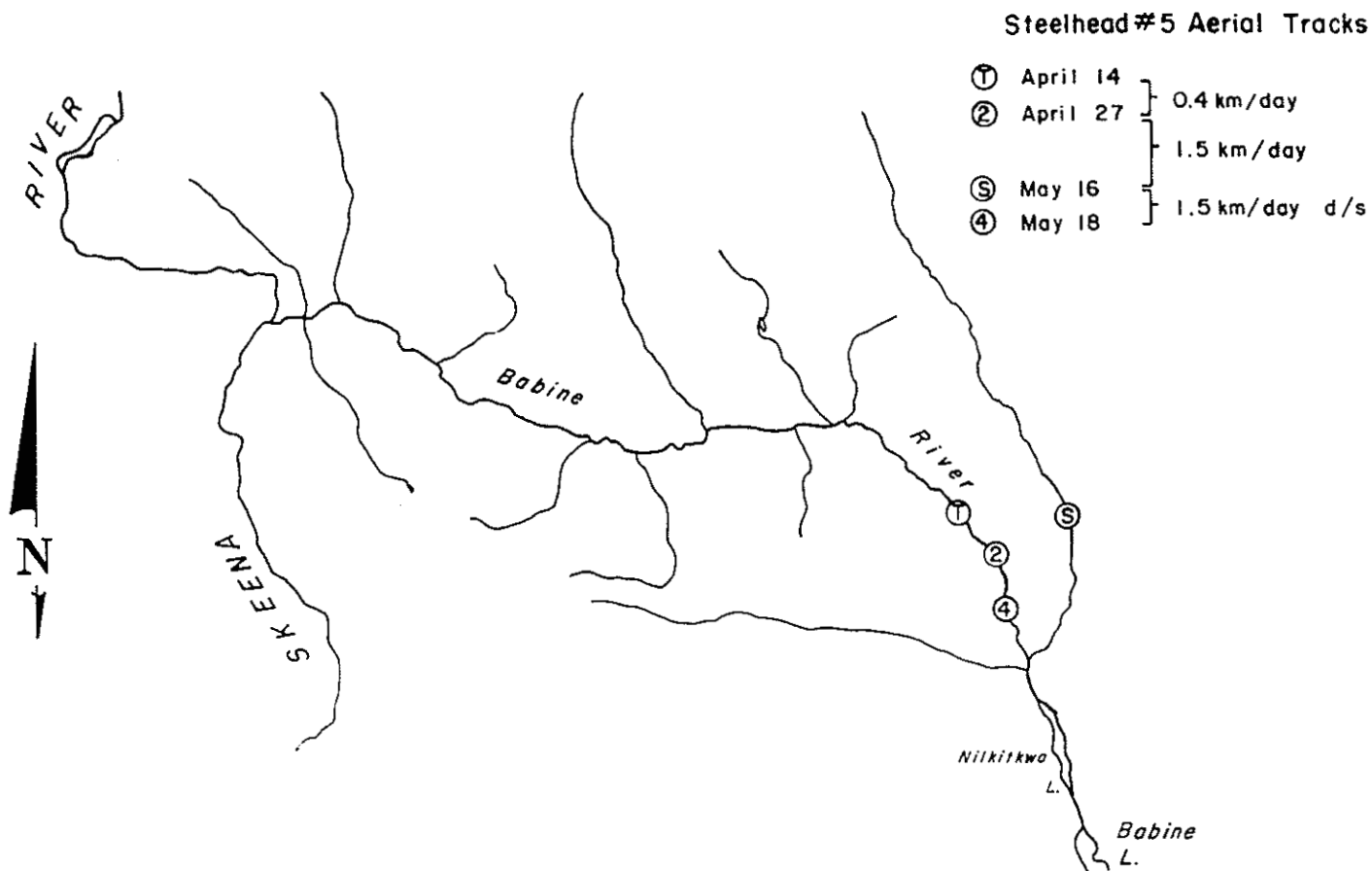
Appendix 3. Movements of Radio Tagged Steelhead, Fish #3

Steelhead #4 Aerial Tracks

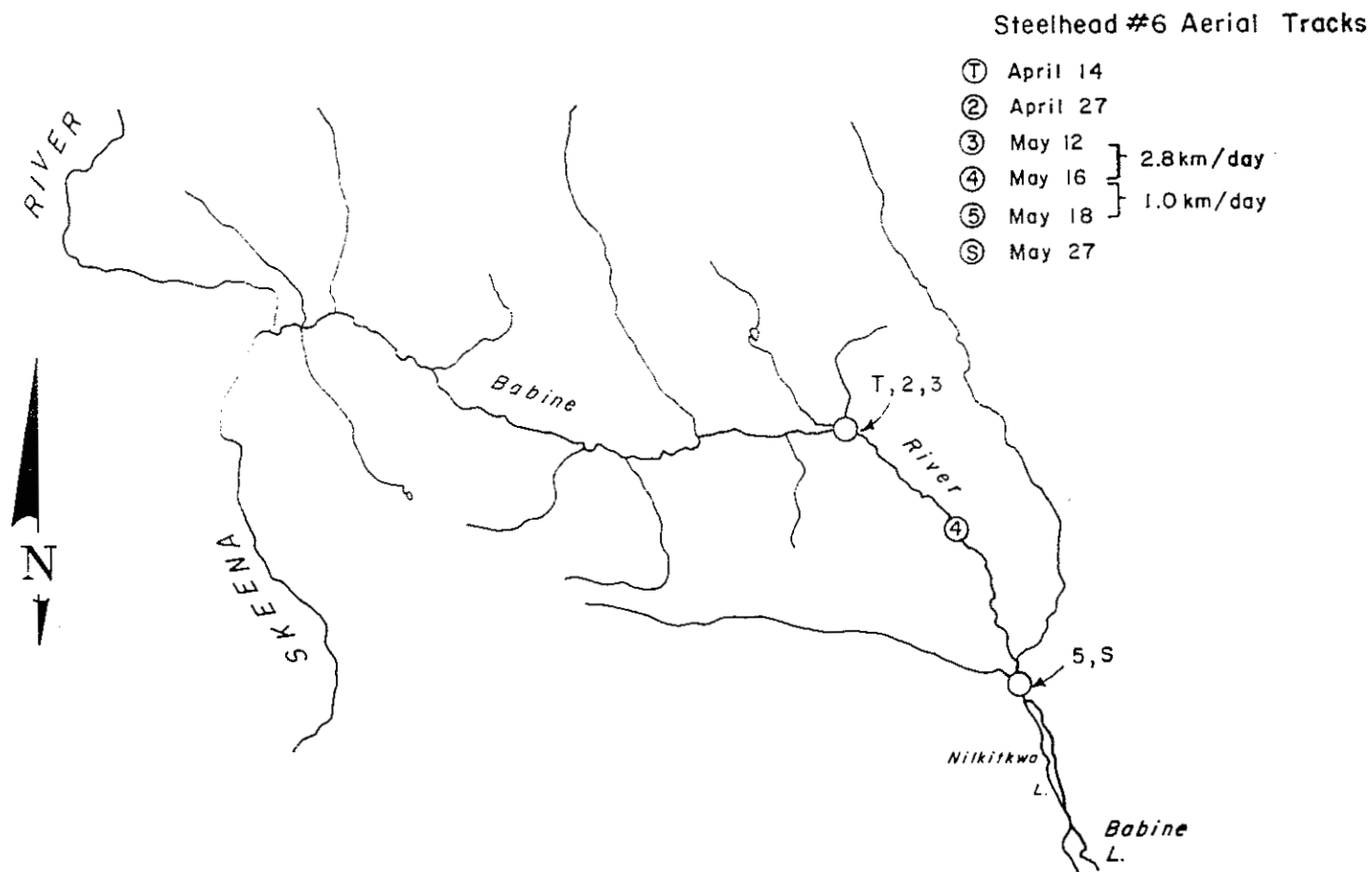
- ① April 14
 - ② April 27
 - ④ May 16
 - ⑤ May 18
- } 0.4 km/day
} 1.9 km/day
} 1.0 km/day



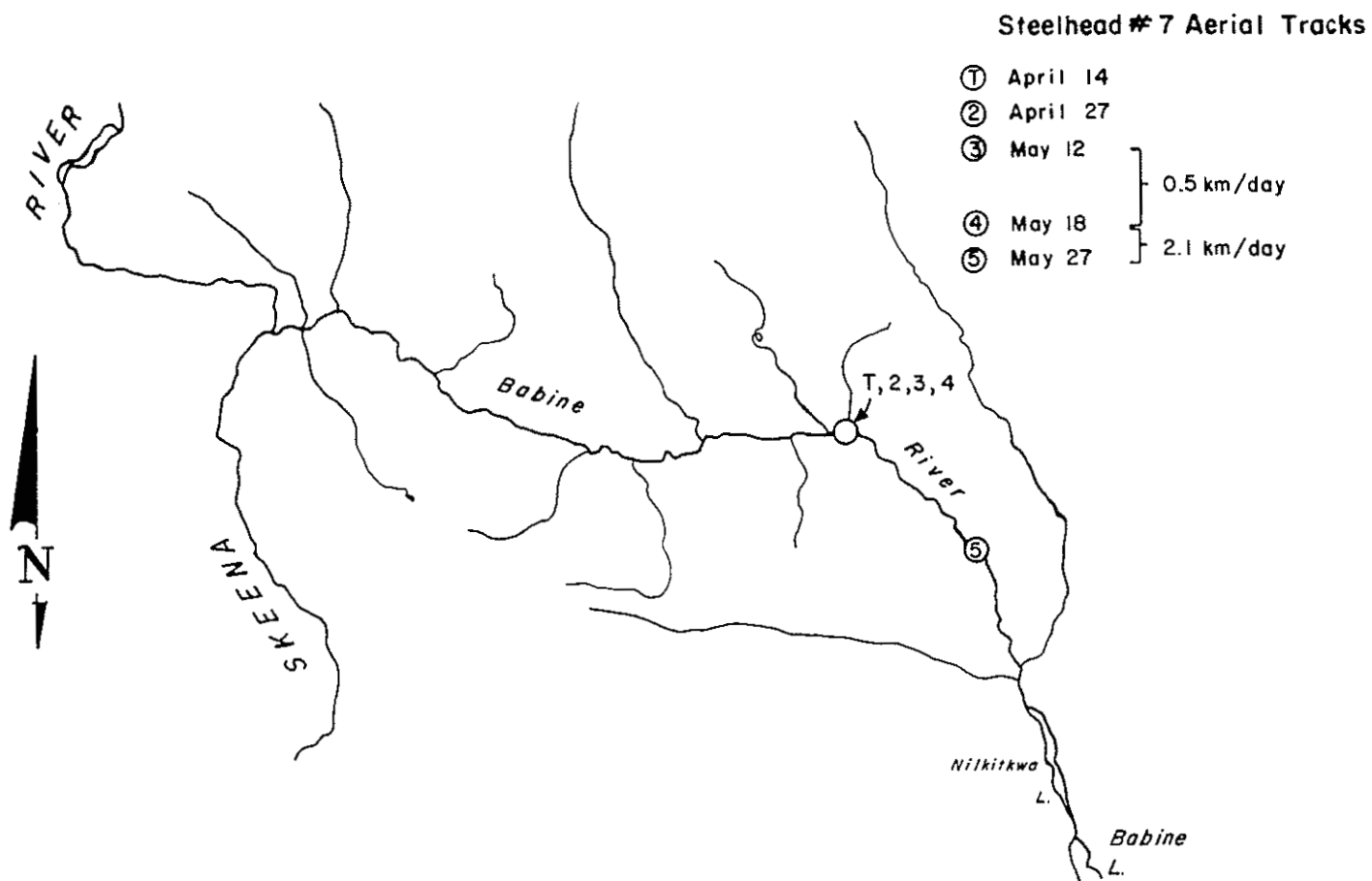
Appendix 4. Movements of Radio Tagged Steelhead, Fish #4



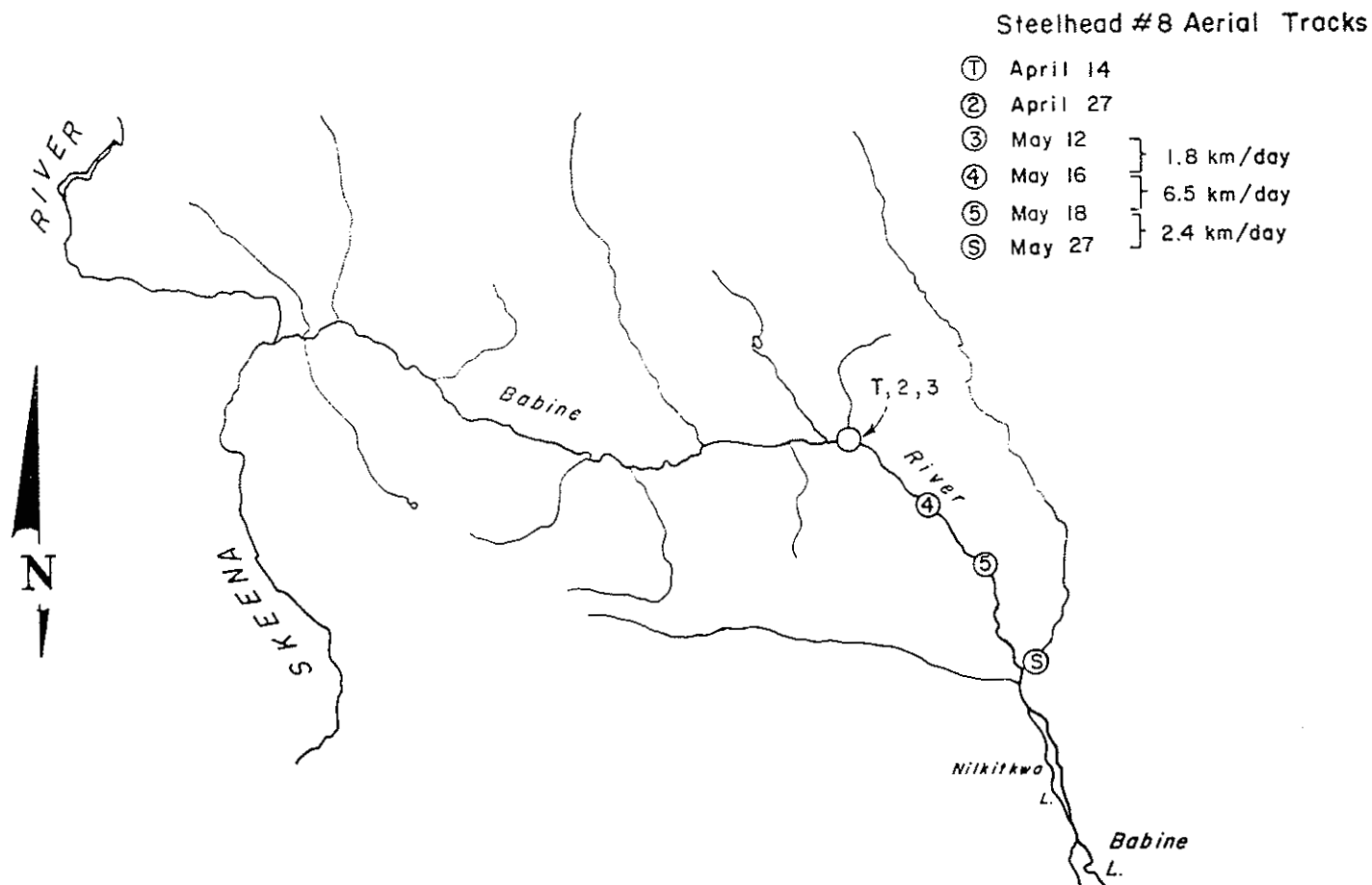
Appendix 5. Movements of Radio Tagged Steelhead, Fish #5



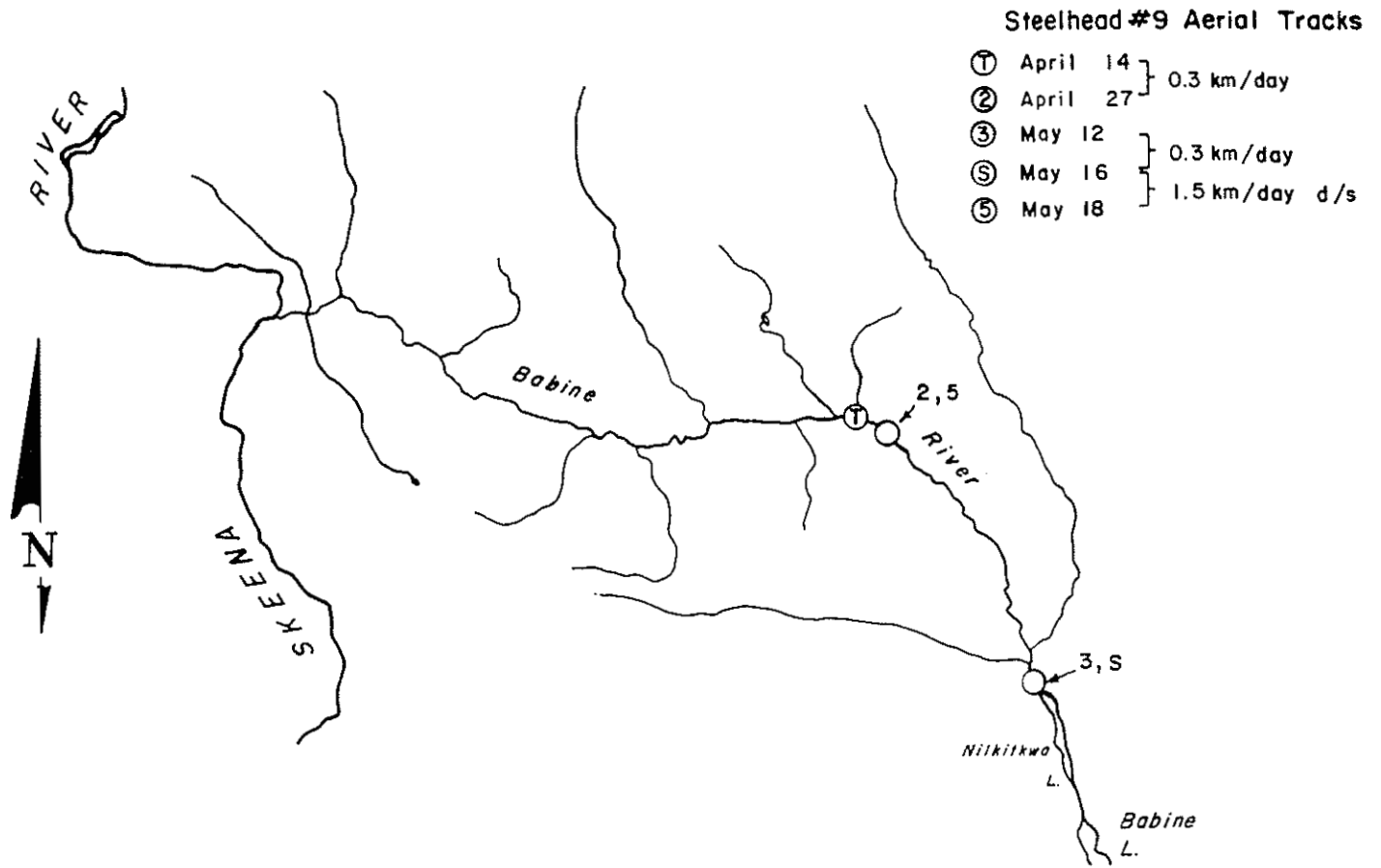
Appendix 6. Movements of Radio Tagged Steelhead, Fish #6



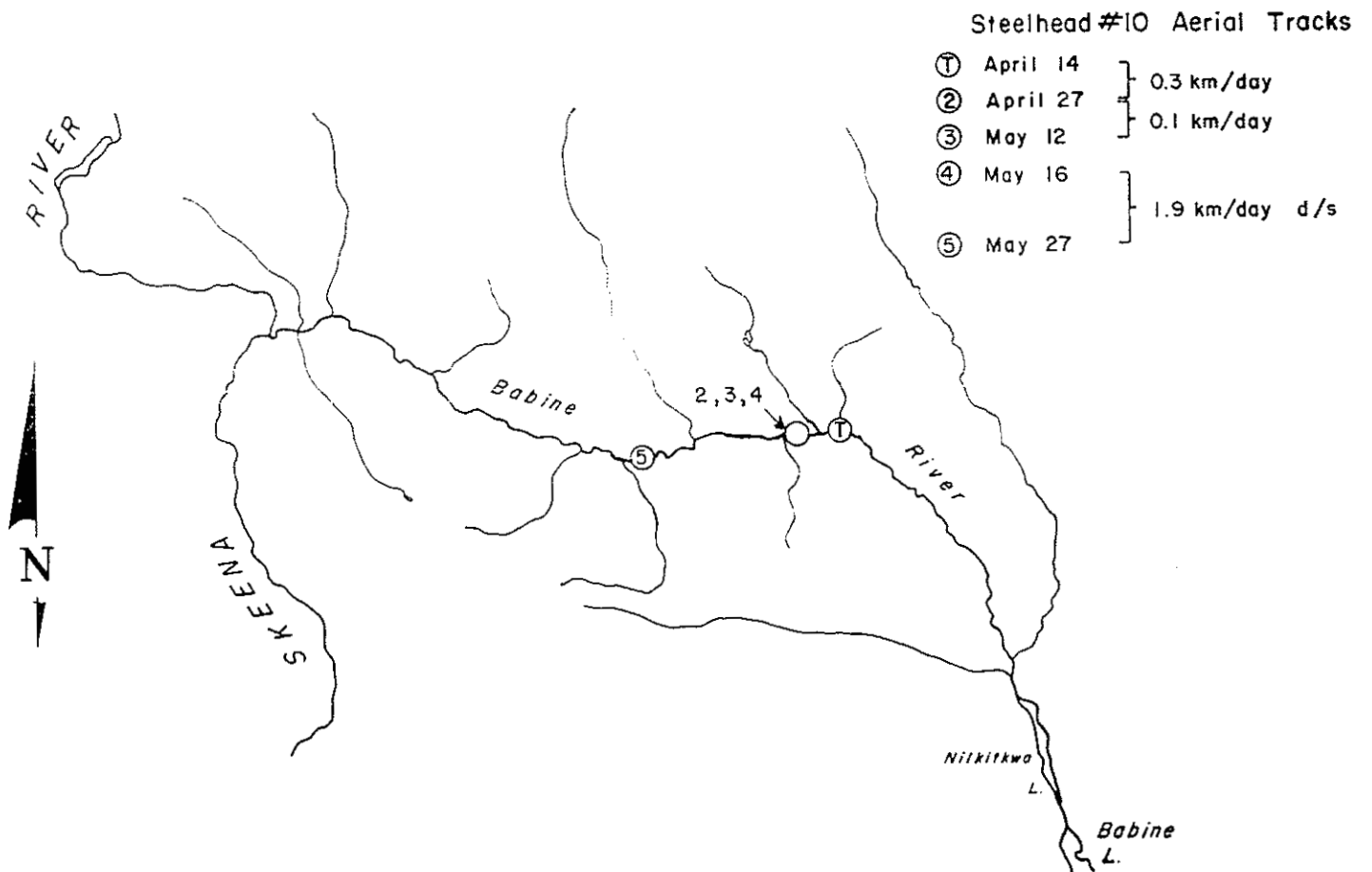
Appendix 7. Movements of Radio Tagged Steelhead, Fish #7



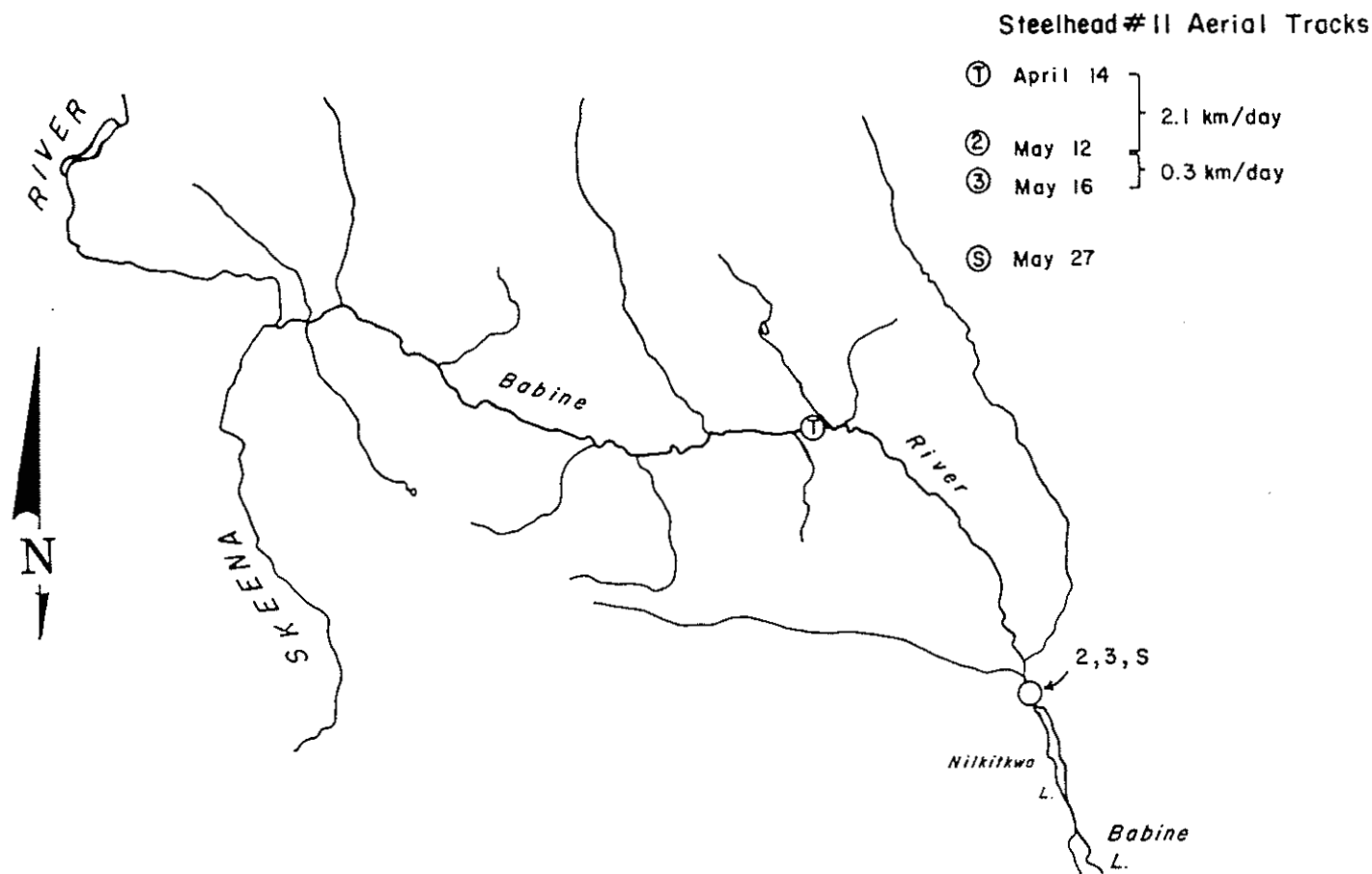
Appendix 8. Movements of Radio Tagged Steelhead, Fish #8



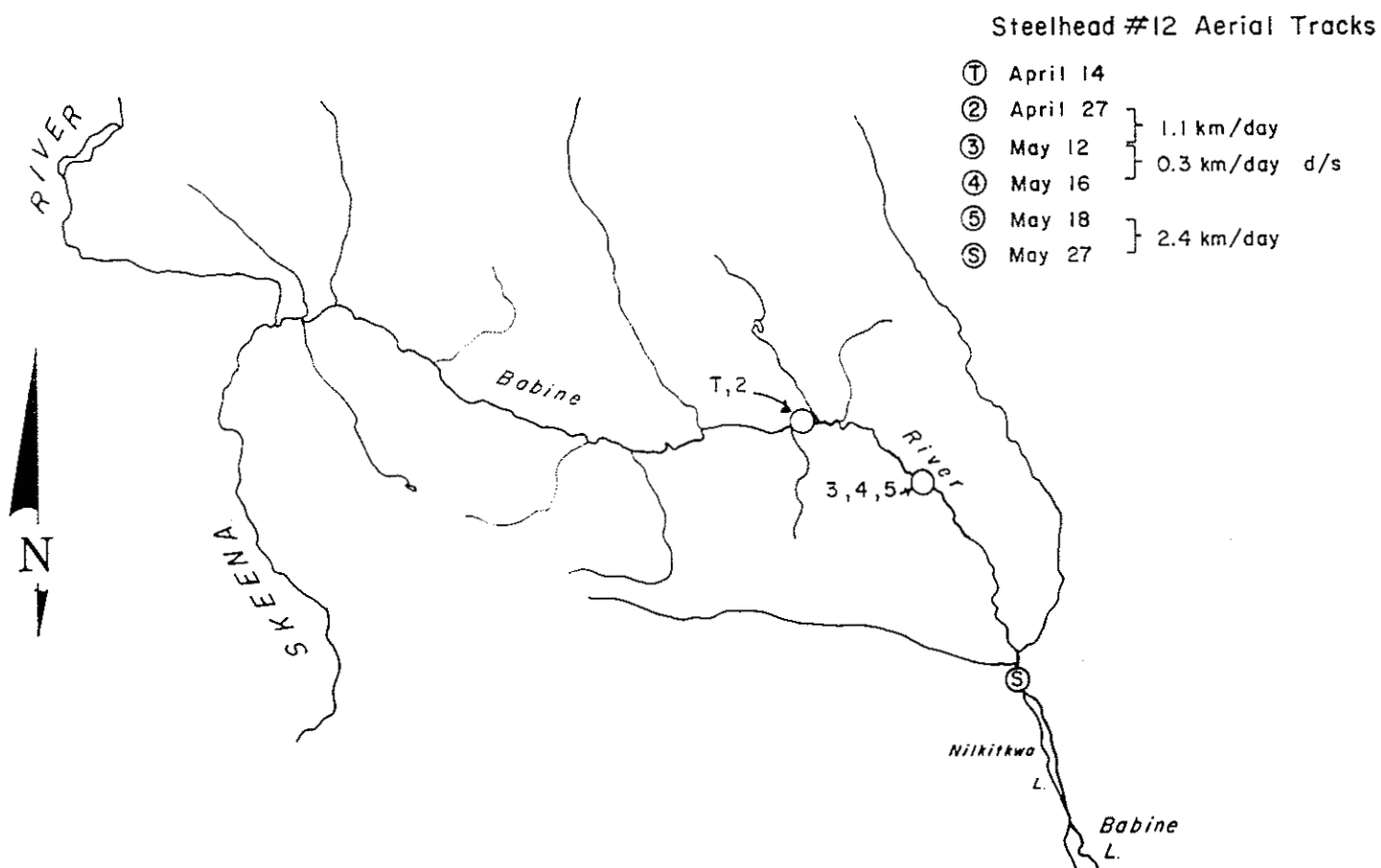
Appendix 9. Movements of Radio Tagged Steelhead, Fish #9



Appendix 10. Movements of Radio Tagged Steelhead, Fish #10



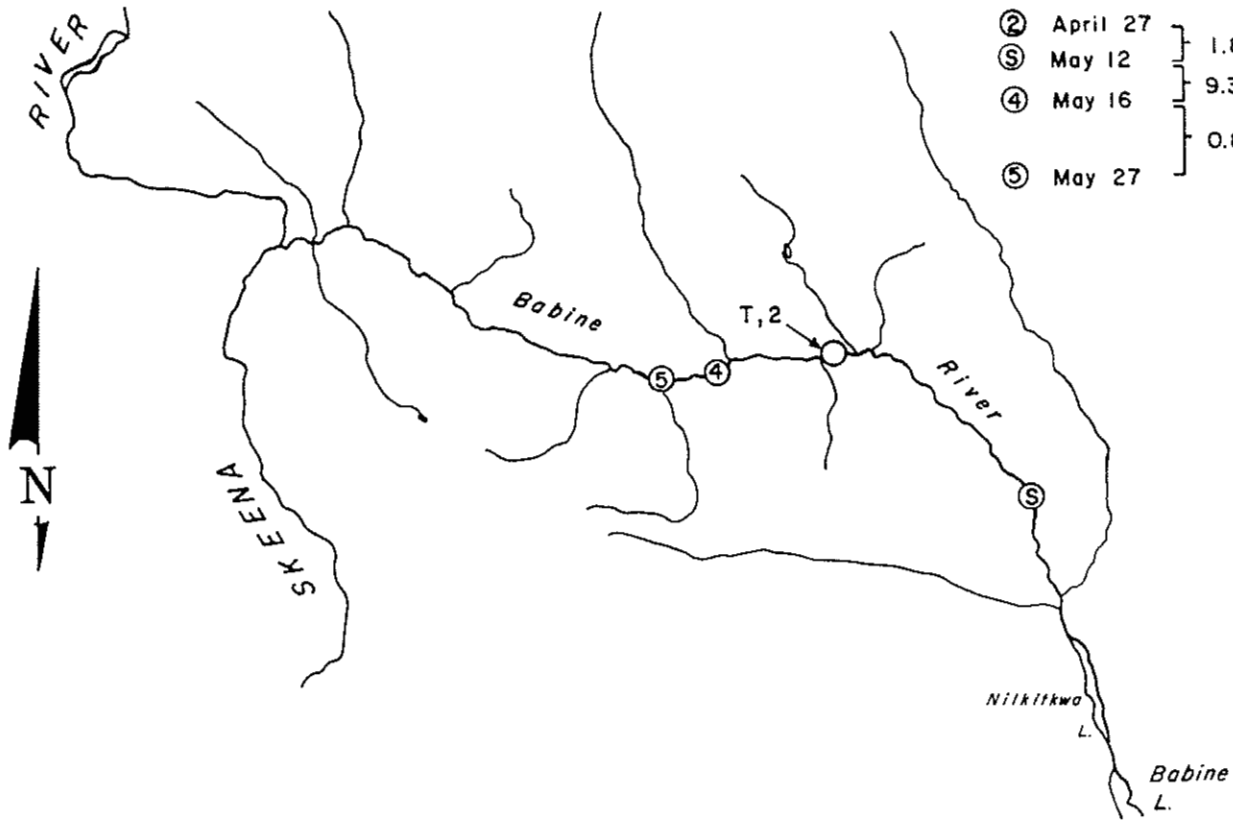
Appendix 11. Movements of Radio Tagged Steelhead, Fish #11



Appendix 12. Movements of Radio Tagged Steelhead, Fish #12

Steelhead # 13 Aerial Tracks

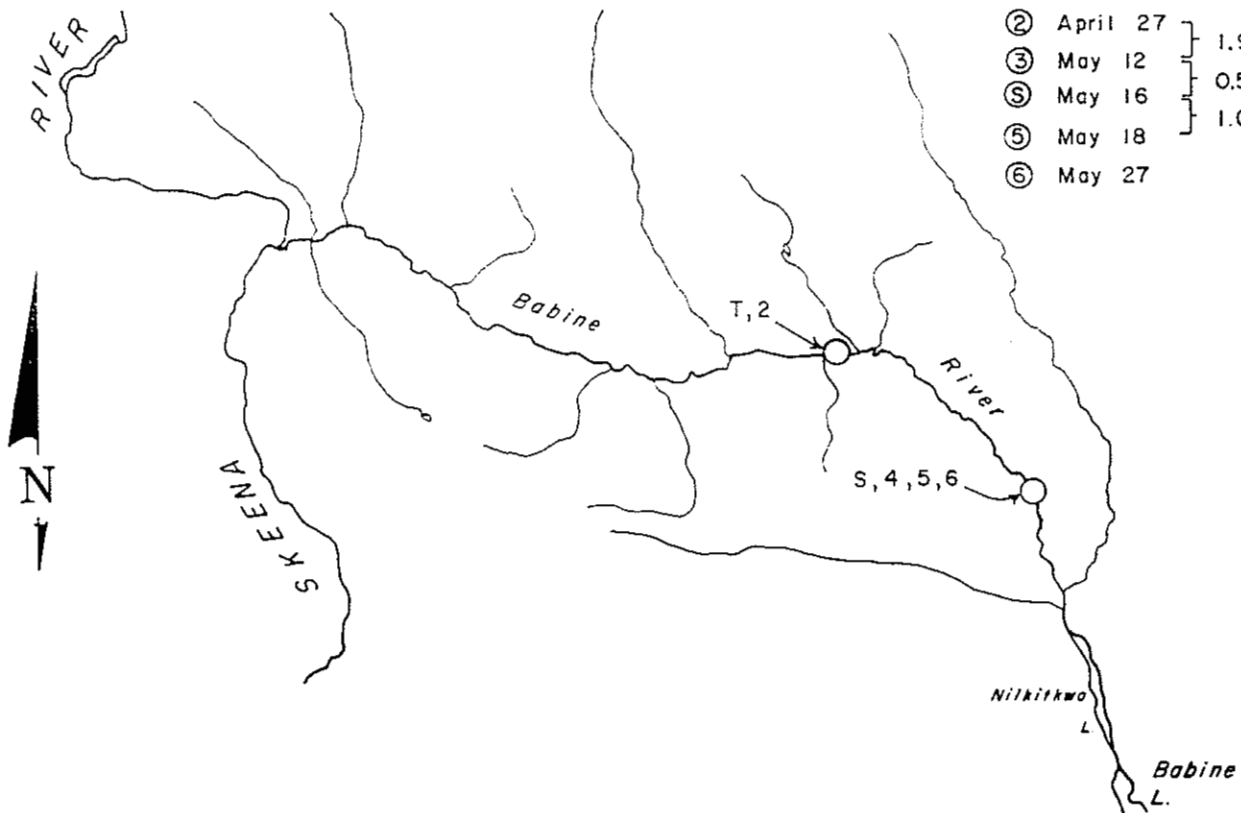
- ① April 14
 - ② April 27
 - ③ May 12
 - ④ May 16
 - ⑤ May 27
- 1.8 km/day
 9.3 km/day d/s
 0.8 km/day d/s



Appendix 13. Movements of Radio Tagged Steelhead, Fish #13

Steelhead # 14 Aerial Tracks

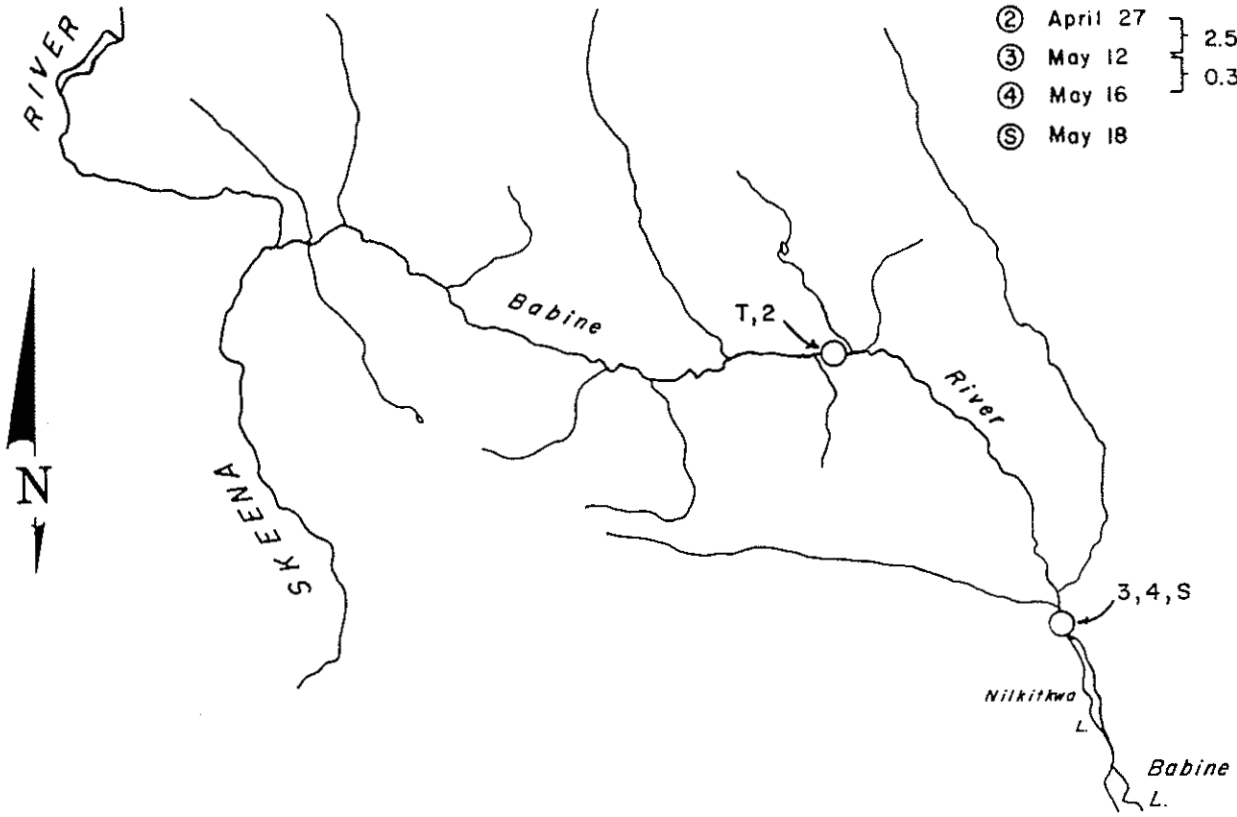
- ① April 14
 - ② April 27
 - ③ May 12
 - ④ May 16
 - ⑤ May 18
 - ⑥ May 27
- 1.9 km/day
 0.5 km/day
 1.0 km/day



Appendix 14. Movements of Radio Tagged Steelhead, Fish #14

Steelhead #15 Aerial Tracks

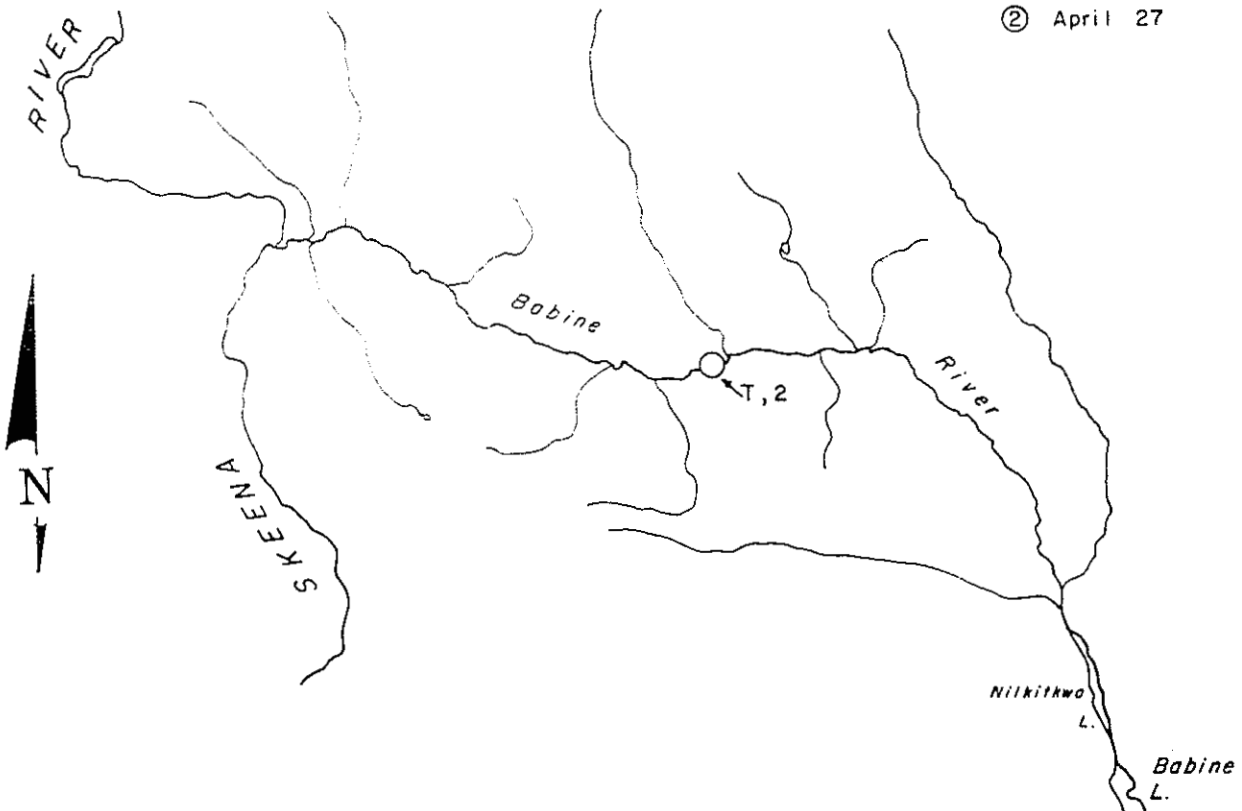
- ① April 14
 - ② April 27
 - ③ May 12
 - ④ May 16
 - ⑤ May 18
- } 2.5 km/day
} 0.3 km/day



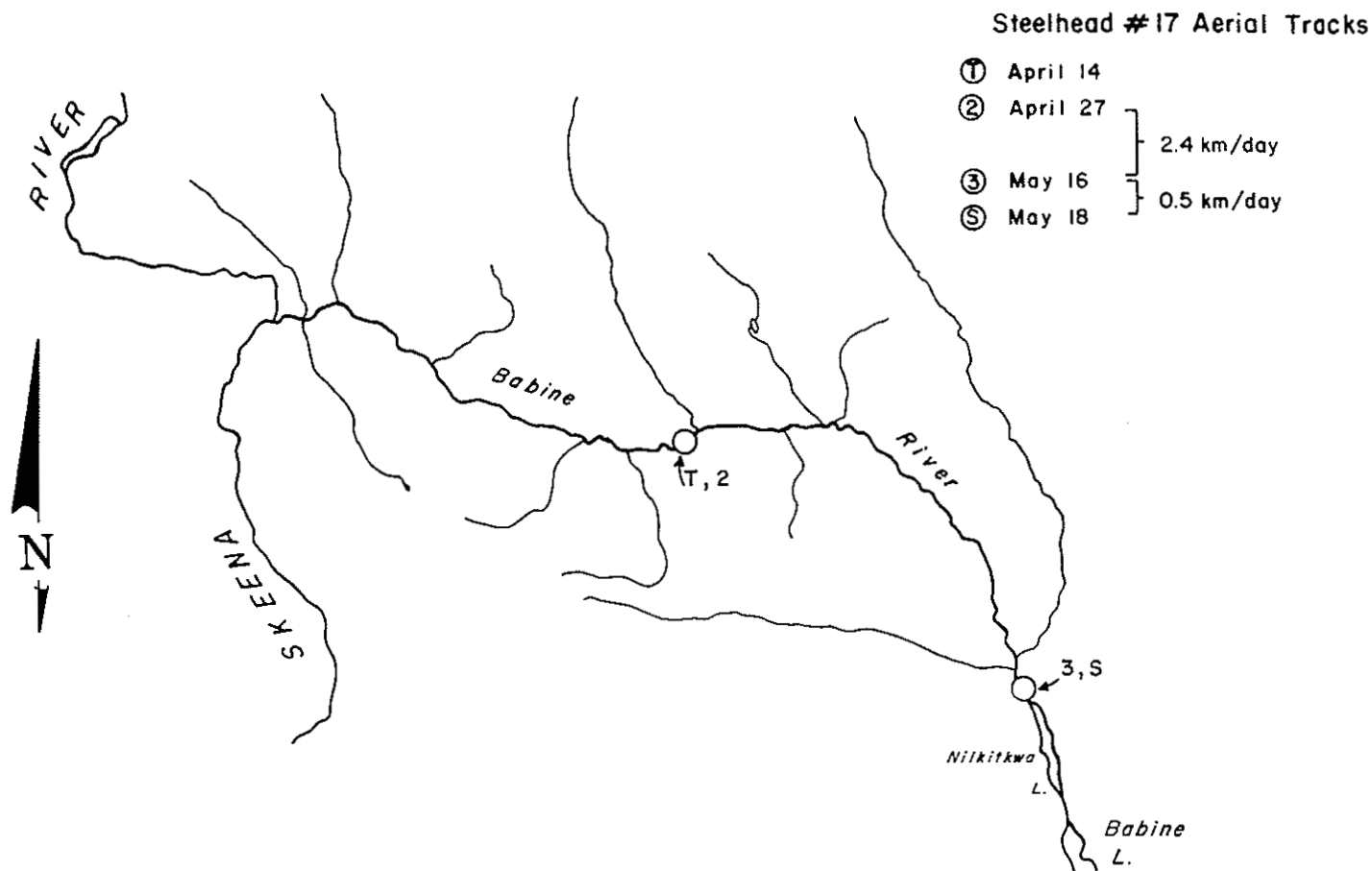
Appendix 15. Movements of Radio Tagged Steelhead, Fish #15

Steelhead # 16 Aerial Tracks

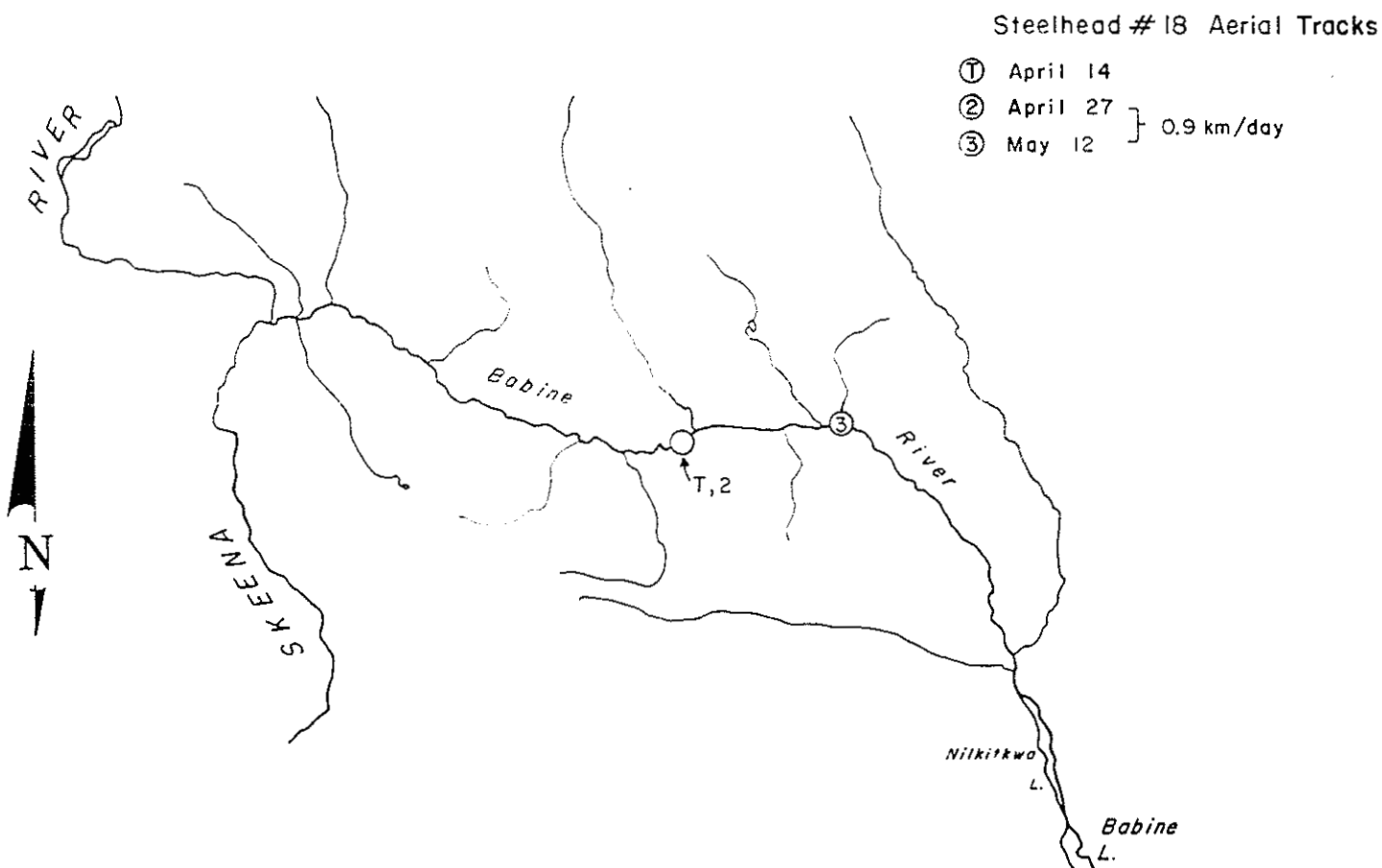
- ① April 14
- ② April 27



Appendix 16. Movements of Radio Tagged Steelhead, Fish #16



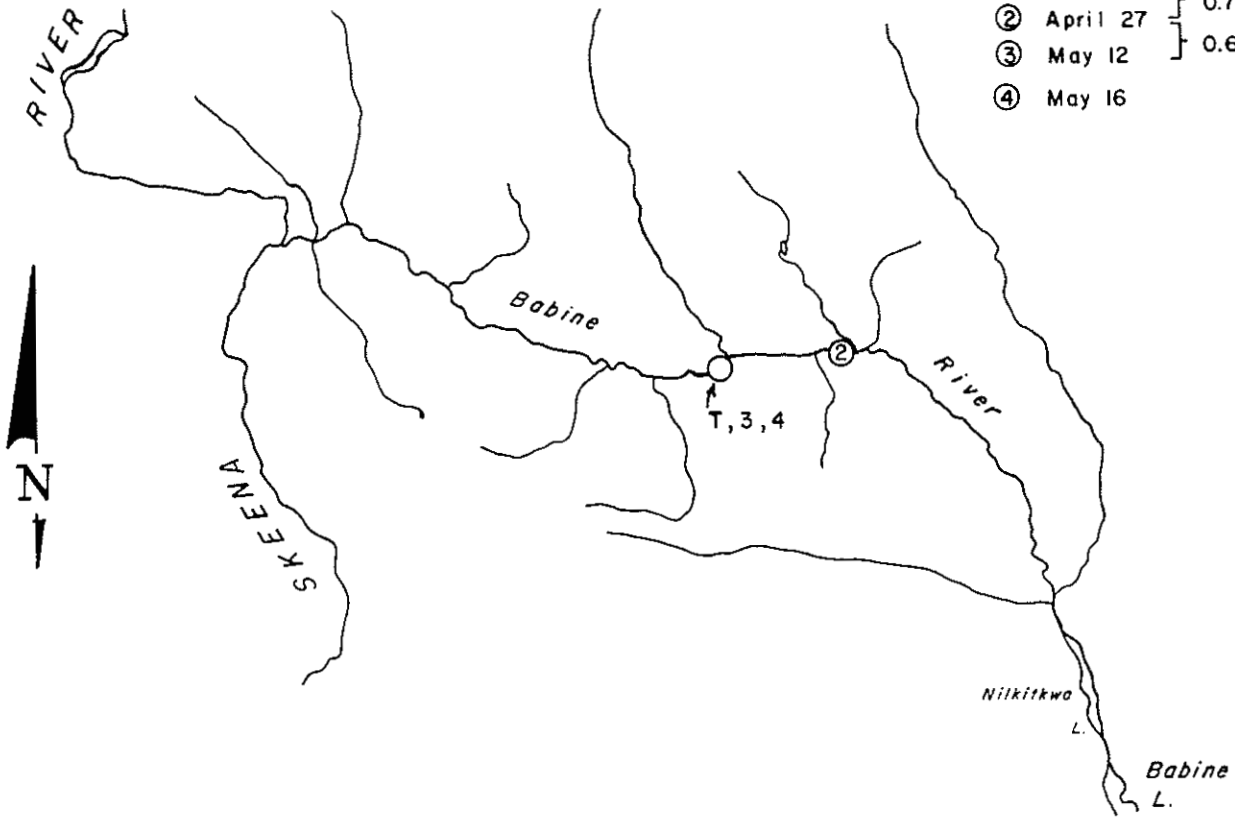
Appendix 17. Movements of Radio Tagged Steelhead, Fish #17



Appendix 18. Movements of Radio Tagged Steelhead, Fish #18

Steelhead # 19 Aerial Tracks

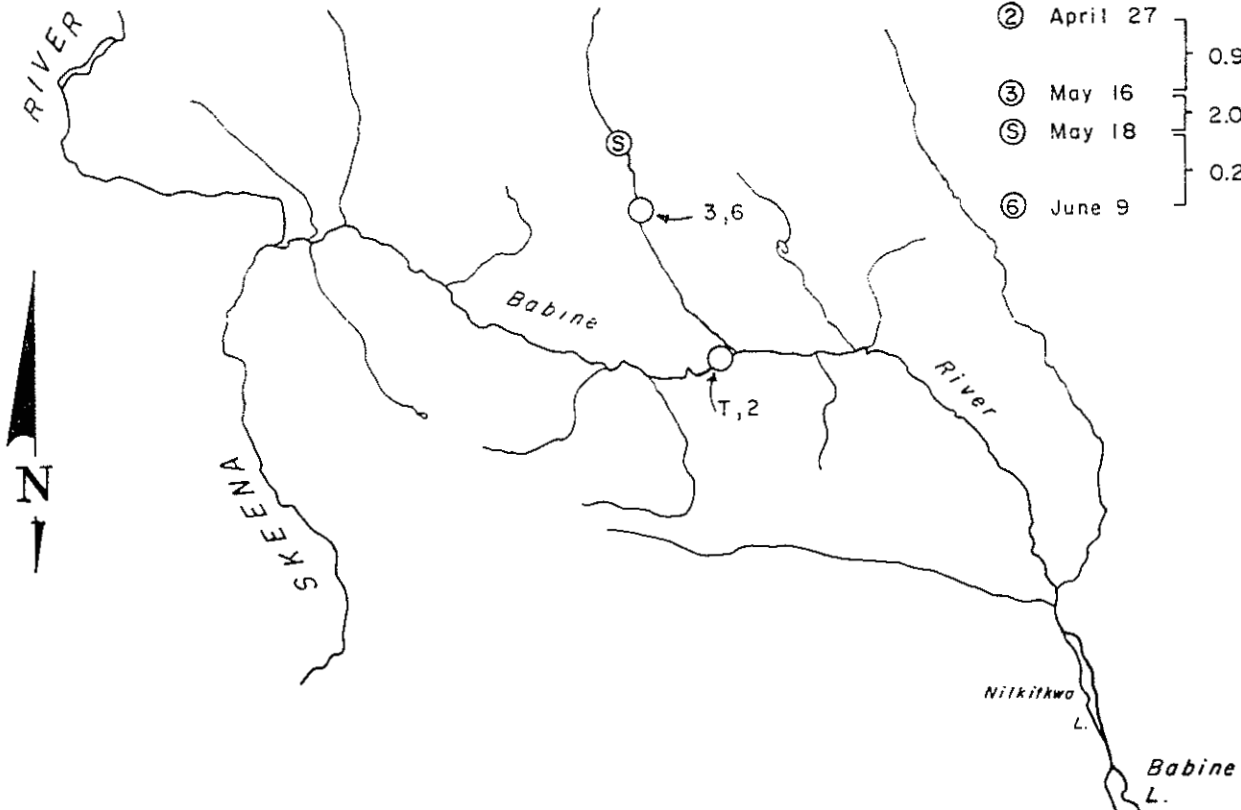
- ① April 14
 - ② April 27
 - ③ May 12
 - ④ May 16
- } 0.7 km/day
} 0.6 km/day d/s



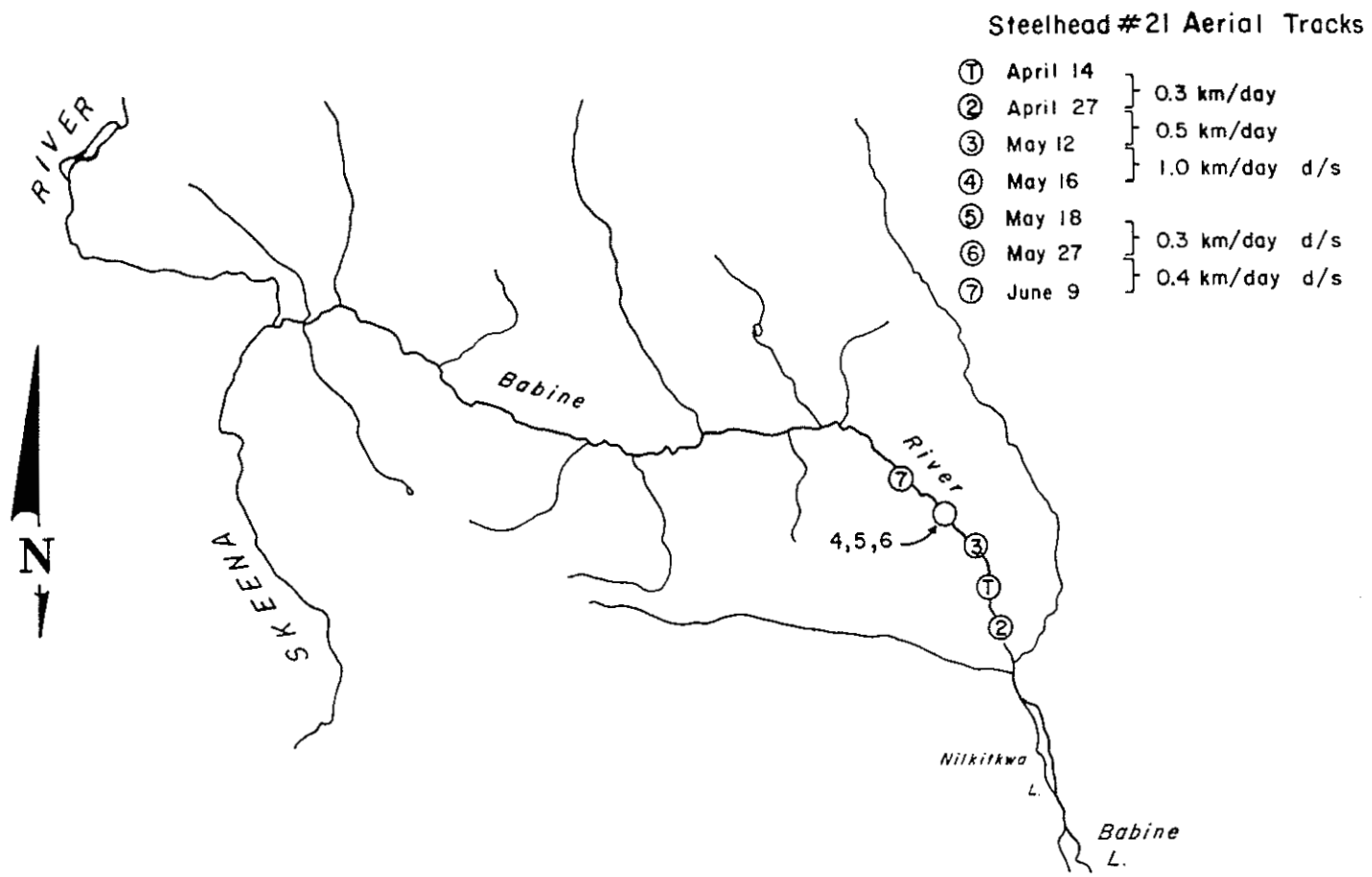
Appendix 19. Movements of Radio Tagged Steelhead, Fish #19

Steelhead # 20 Aerial Tracks

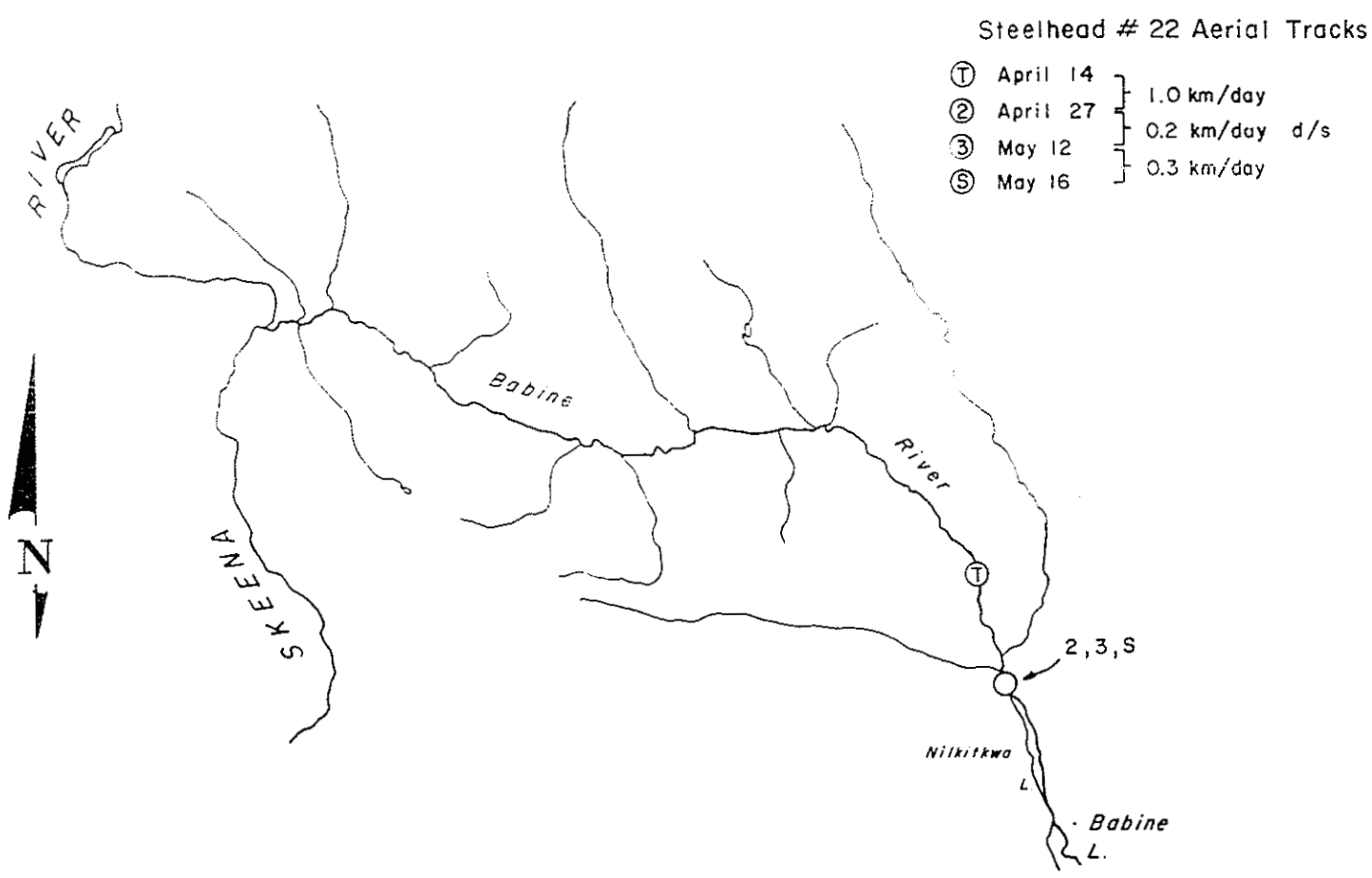
- ① April 14
 - ② April 27
 - ③ May 16
 - ⑤ May 18
 - ⑥ June 9
- } 0.9 km/day
} 2.0 km/day
} 0.2 km/day



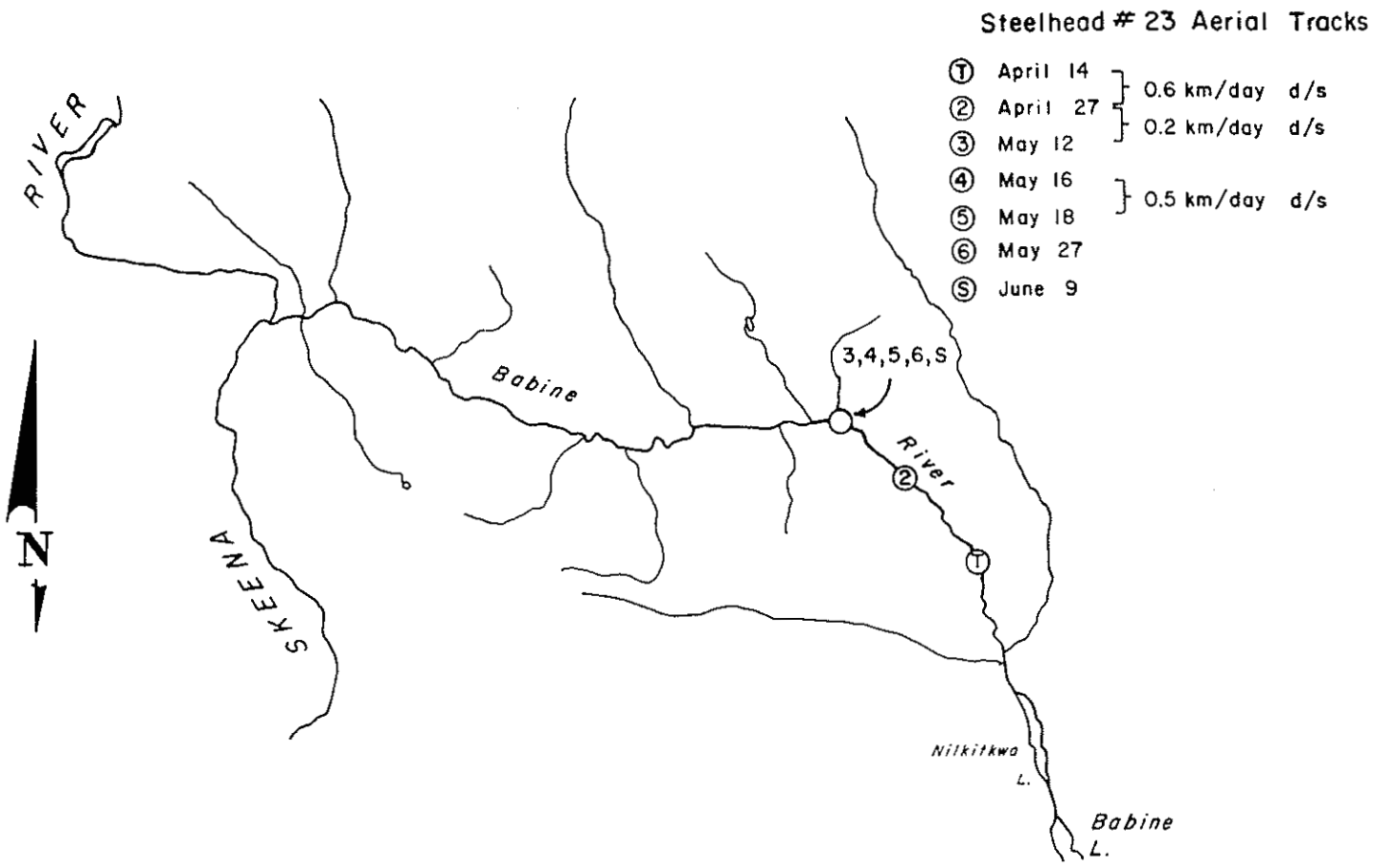
Appendix 20. Movements of Radio Tagged Steelhead, Fish #20



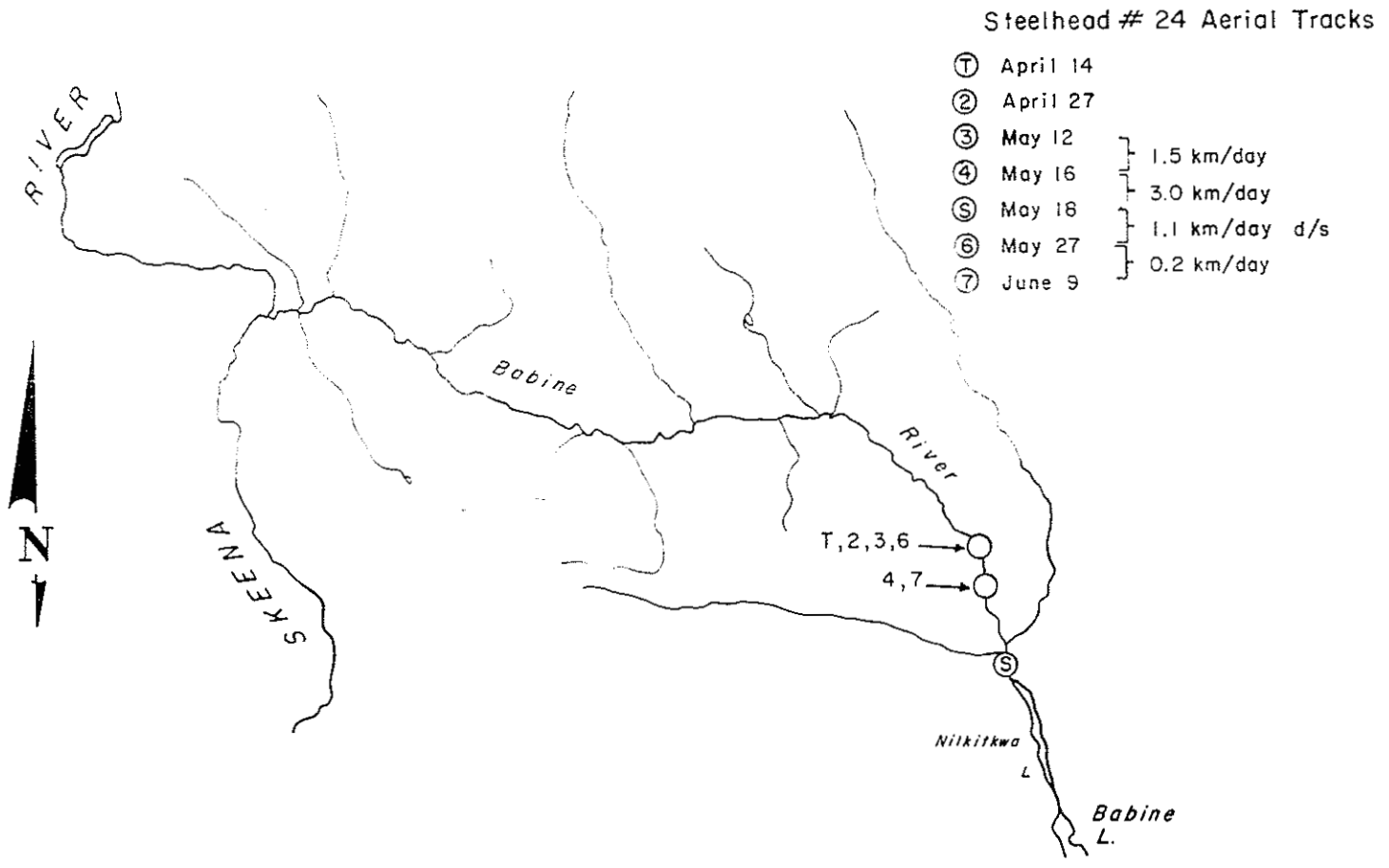
Appendix 21. Movements of Radio Tagged Steelhead, Fish #21



Appendix 22. Movements of Radio Tagged Steelhead, Fish #22



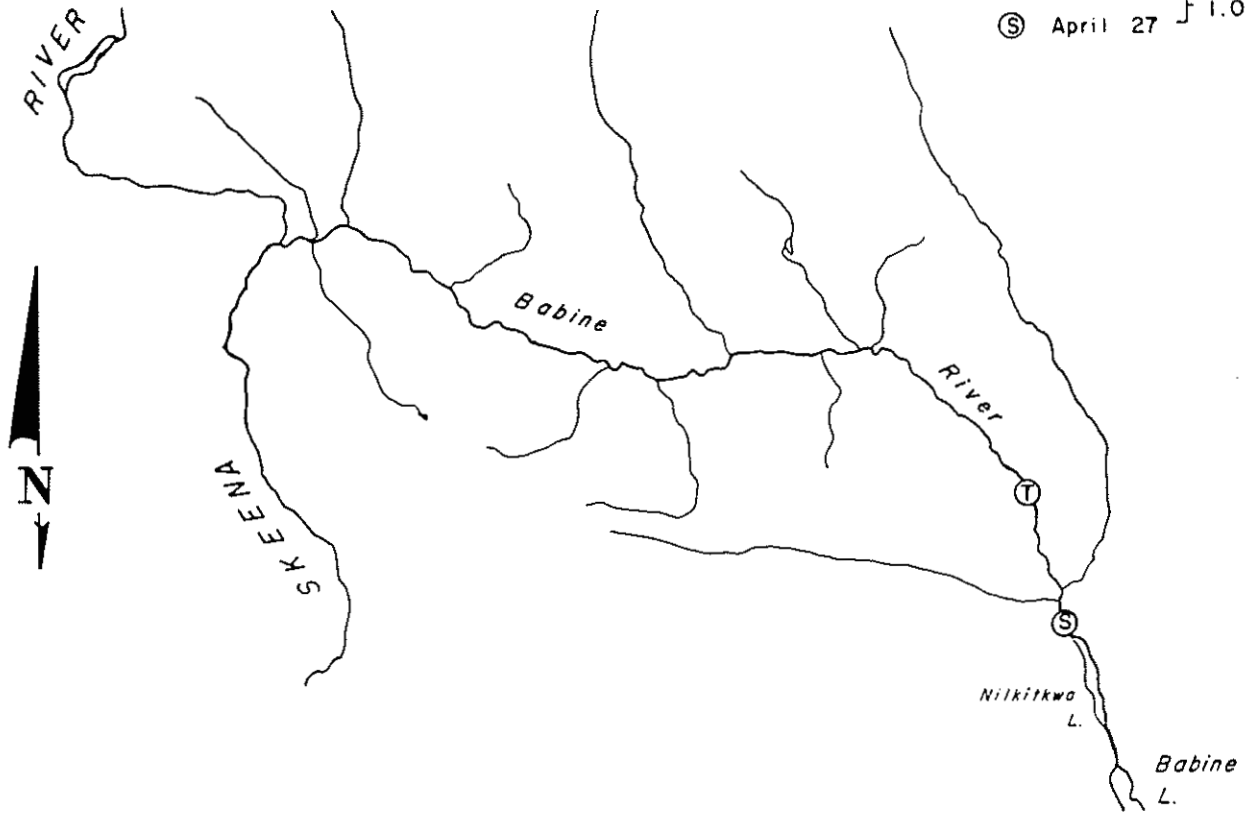
Appendix 23. Movements of Radio Tagged Steelhead, Fish #23



Appendix 24. Movements of Radio Tagged Steelhead, Fish #24

Steelhead #25 Aerial Tracks

- Ⓟ April 14
 - Ⓢ April 27
- } 1.0 km/day



Appendix 25. Movements of Radio Tagged Steelhead, Fish #25

Appendix 26: Information regarding summer steelhead radio tagged in the Babine River, April 14, 1994.

Appendix 26. Information regarding summer steelhead radio tagged in the Babine River, April 14, 1994.

Tagging Location (river km)	Fish Number	Sex	Fork Length (cm)	Radio Tag chan. code	Floy Tag No's. (yellow)	Comments	
Beaver Flats(72)	1	M	75	2	1	6508, 6509	clean tagging
	2	F	73	2	2	6510, 6511	transmitter in too far?
	3	M	91	2	3	6512, 6513	clean tagging
	4	F	71	2	4	6514, 6515	clean tagging
	5	F	80	2	5	6516, 6517	clean tagging
Bonanza(62)	6	F	79	2	6	6520, 6521	clean tagging
	7	F	84	2	7	6522, 6523	clean tagging
	8	F	73	2	8	6524, 6525	clean tagging
	9	F	80	2	9	6551, 6552	clean tagging
	10	F	82	2	10	6554, 6555	some resistance when inserting transmitter
Triple Header(58)	11	M	96	2	11	6559, 6560	transmitter inserted in far enough?
	12	F	78	2	12	6561, 6562	clean tagging
	13	M	88	2	13	6563, 6564	clean tagging
	14	M	91	2	14	6565, 6566	clean tagging
	15	M	85	2	15	6567, 6568	clean tagging
Silver Hilton(48)	16	F	73	2	16	6574, 6575	much resistance when inserting transmitter
	17	F	76	2	17	6576, 6577	clean tagging
	18	F	74	2	18	6578, 6579	clean tagging
	19	M	74	2	19	6580, 6581	clean tagging
	20	M	71	2	20	6582, 6583	clean tagging
Home Run(84)	21	F	85	1	16	6692, 6501	clean tagging
	22	F	84	1	17	6502, 6503	clean tagging
	23	F	81	1	18	6504, 6505	some resistance when inserting transmitter
	24	F	84	1	19	6696, 6506	clean tagging, sluggish on release
	25	F	79	1	20	orS4959, 6507	transmitter inserted too far in?