Volume 23 Project AFS 48-2

STATE OF ALASKA

Jay S. Hammond, Governor

Annual Performance Report for

ANCHOR RIVER STEELHEAD STUDY

by

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ALASKA DEPARTMENT OF FISH AND GAME

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RESEARCH PROJECT SEGMENT

State: Alaska Name: Sport Fish Investigations of Alaska

Project No.: AFS-48 Project Title: ANADROMOUS FISH STUDIES

Segment No.: AFS-48-2 Segment Title: Anchor River Steelhead Study

Cooperators: Joe Wallis and D. Thomas Balland

Period Covered: July 1, 1981 to June 30, 1982

ABSTRACT

An inclined plane downstream migrant trap, a fyke net and minnow traps were used to capture juvenile steelhead trout, Salmo gairdneri (Richardson), coho salmon, Oncorhynchus kisutch (Walbaum), chinook salmon, Oncorhynchus tshawytscha (Walbaum), and Dolly Varden, Salvelinus malma (Walbaum), in Anchor River during the period May 1 through October 14, 1981. Minnow traps were the most effective in capturing steelhead, but other species were captured effectively in the fyke net and inclined plane trap.

The majority of steelhead smolts migrated from mid-June to mid-July with the peak period in early July. Mean length of smolts was 161 millimeter (6.3 inches) and they averaged 38 grams in weight.
Eighteen steelhead trout were tagged with Floy anchor tags, but inadequate recoveries precluded making a population estimate.

Sixteen adult steelhead trout were tagged with radio transmitters in an attempt to monitor instream movements. Several fish were tracked throughout the winter, and most of the fish moved comparatively short distances during the period.

A creel census was conducted and an estimated 16,964 angler-days of effort were spent during the summer-fall fishery from July 13 through November 1. During this period, it was estimated that anglers harvested 571 steelhead trout; anglers kept 53.9 percent of the steelhead they caught.

The adult run was comprised of 12 separate age classes. First-spawning fish were of six age classes with the majority of both males and females of Age Class 3.2. Six separate age classes were represented in a sample of repeat spawners. Repeat spawners comprised 11.1 percent of the fish.

Analysis of scales from both juveniles and adults provided information on growth rates and size of steelhead trout smolts which survive to adults.

Age II smolts grow faster than Age III smolts, and Age III smolts grow faster than Age IV smolts. It was estimated that the adults had been produced by smolts which average about 170 millimeters in length with a range of approximately 130 to 210 millimeters.

KEY WORDS

Anchor River, Steelhead trout, Salmo gairdneri, salmon, Dolly Varden, creel census, scale analysis.

BACKGROUND

A vicinity map showing location of the study area is presented in Figure 1, and a list of species of fish is presented in Table 1.

In the Cook Inlet area, steelhead trout occur in only a few streams of the lower Kenai Peninsula, Anchor River, Ninilchik River, Stariski Creek, Deep Creek and a limited population in Crooked Creek, a Kasilof River tributary. We have very limited information regarding numbers of fish in these streams, but the total numbers are comparatively small.

The popularity and demand for steelhead fishing in the southcentral Alaska region is growing rapidly. The intensity of angling effort has increased dramatically on these few small streams during the last several years.

The Anchor River, the southern most steelhead trout stream on the Kenai peninsula, appears to have the largest run and is the site of the most intense fishery. About 15,000 to 20,000 man-days of angling effort are spent on Anchor River in the summer-fall fishery during the period steelhead are caught. Dolly Varden, coho salmon and steelhead trout are all caught during this period and it is not feasible to assign fishing effort to any one species. Total harvest of steelhead trout has ranged from about 600 to 1,500 annually from Anchor River during the past 5 years. This has accounted for about 26 to 40% of the total combined harvest of steelhead in the state.

Steelhead stocks in all streams on the Kenai Peninsula are similar to those termed "summer-run" throughout the Pacific Northwest. Adults enter the streams throughout the summer and fall, spend the winter in freshwater, then spawn the following spring and migrate back to sea.

Some aspects of Anchor River steelhead life history and population characteristics have been investigated periodically since the mid-1950's, but the studies have been intermittent and of limited scope. Total run size, adult migration and spawning characteristics, areas and timing of juvenile rearing and migration and the potential for supplemental production are a few important aspects which have not been adequately studied.

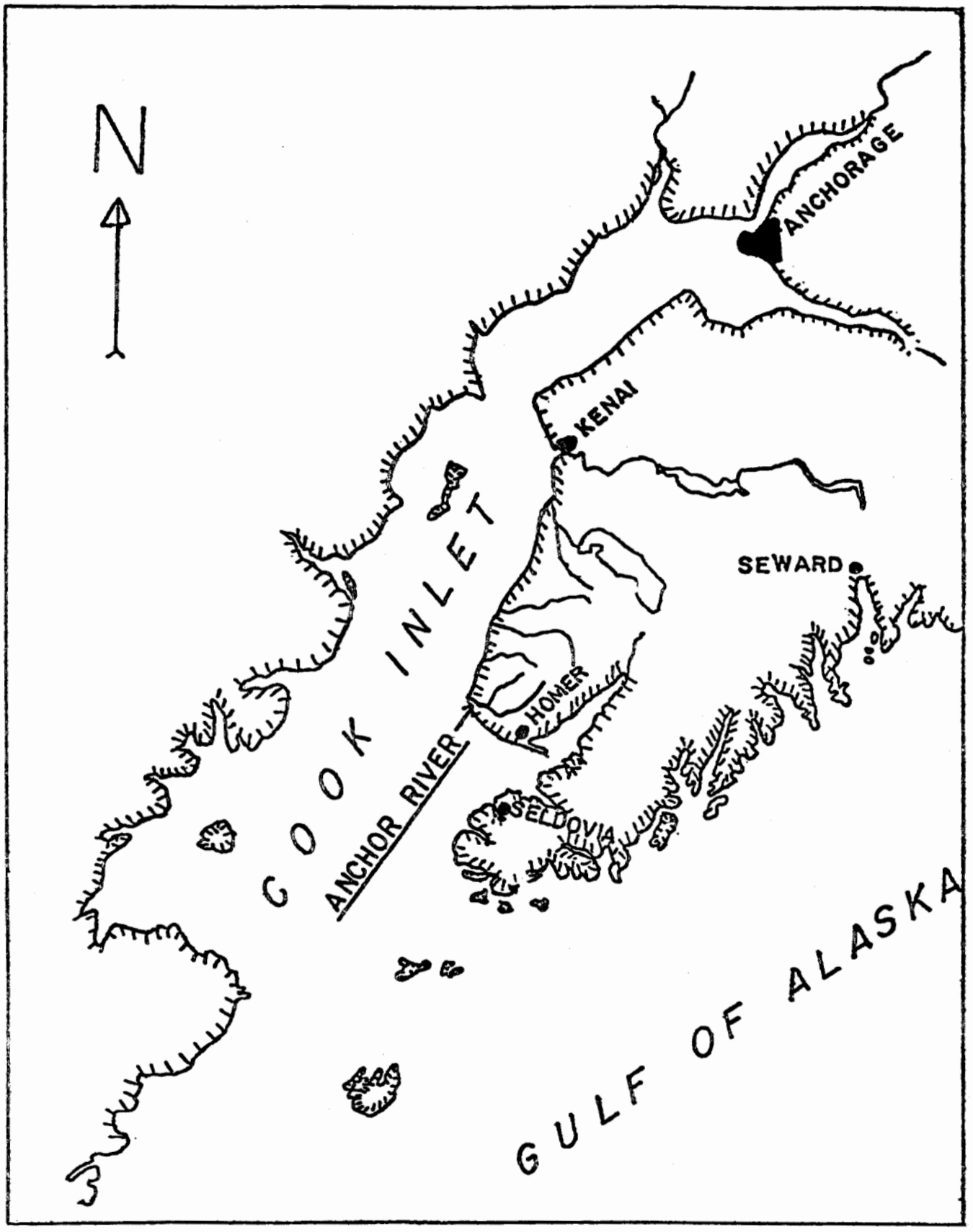

Figure 1. Vicinity map showing location of the study area.

Table 1. List of common names, scientific names and abbreviations.

Common Name	Scientific Name & Author	Abbreviation
Chinook salmon	Oncorhynchus tshawytscha (Walbaum)	KS
Coho salmon	Oncorhynchus kisutch (Walbaum)	SS
Dolly Varden	Salvelinus malma (Walbaum)	DV
Rainbow trout	Salmo gairdneri Richardson	RT
Steelhead trout	Salmo gairdneri Richardson	SH

The stocks of steelhead are entirely naturally produced at present and it is doubted that they can sustain future angler pressures without harm to the stocks, unless additional restrictions are imposed on the harvest or supplemental measures are undertaken.

The Department's goal is to provide continued recreational angling for steelhead on these streams. Its concern is the lack of biological information upon which to base management programs, formulate regulatory guidelines and evaluate need and potential for supplemental enhancement of these stocks.

This study was initiated to provide information for the Department of Fish and Game for use in refining its management program, and to provide direction to future enhancement of steelhead stocks.

RECOMMENDATIONS

1. The present objectives of this study should be retained and the study should be continued.

2. As soon as feasible, the scope of the study should be expanded to include definition of characteristics of the steelhead trout populations in other lower Kenai Peninsula streams.

OBJECTIVES

1. To determine size of steelhead trout stocks.

2. To determine instream behavior and intrasystem movement and migration.

3. To determine angler utilization and effects of current harvest levels.

4. To determine the need for supplementing steelhead trout stocks.

TECHNIQUES USED

Water temperatures were recorded with a Ryan-Peabody recording thermograph. Records were continuous from May 2 through October 31, except for a period when the thermograph malfunctioned.

An inclined plane downstream migrant trap described by Wallis and Balland (1981) was operated intermittently in the South Fork of Anchor River. A fyke net with a 2-foot opening and 25-foot wings was operated in the North Fork of Anchor River near the Sterling Highway culverts. Minnow traps were fished at various locations in the North and South Forks of Anchor River.

Adult steelhead trout were captured by hook and line and by drifting a small section of gill net through sections of the river to obtain fish for tagging both with serially numbered Floy tags and radio transmitters.

Radio transmitters were inserted into adult steelhead trout and movements were monitored with tracking receivers in an attempt to determine instream migration characteristics of adult steelhead trout. This was a cooperative project with the U.S. Fish and Wildlife Service who provided the tags, receivers and technical assistance. Fish were tracked by on-ground surveys and periodic aerial flights.

Five different types of radio transmitters were used:

1. Manufactured by Smith Root, Vancouver, WA; 3 in long; 5/8 inches diameter; 6½ in antenna; 4-6 months designed life; plastic body; 40 MHz frequency with individual frequency spaced one KHz apart (used in 1980).

2. Same as above except body covered with black neoprene.

3. "Miniature"; same as #2 except 2 in long.

4. "Chrome Dome"; same as #2 except no external antenna.

5. Weak's Radio; one only, approximately 3½ in long; irregular cigar-shaped, experimental radio from Bio Telemetry, Long Mount, Wyoming.

Nine of the tags were implanted in the stomach by use of a plastic tube, and antenna wires were fastened in the mouth with fish hooks. Seven tags were implanted in the body cavity by surgery.

A creel census was conducted during the period July 13-November 1, 1981. The method employed was a modification of that described by Neuhold and Lu (1957) and was described in detail by Wallis and Balland (1981).

Adult scales were mounted on gummed tape and pressed on acetate sheets, then examined on a microfiche viewer. Juvenile scales were mounted on microscope slides with the aid of a mucilage solution and covered with a cover slip.

Scale images were printed with a viewer/printer. Circuli counts in the freshwater portion of scales were made along a 20° ventral line using techniques described by Clutter and Whitesel (1956 for sockeye salmon).

FINDINGS

Daily maximum and minimum temperatures recorded in the South Fork of Anchor River are listed in Table 2.

Table 2. Minimum-Maximum Water Temperatures Recorded in Anchor River, 1981, °C.

Day	May	June	July	August	Sept.	Oct.
1	---	7-8	10-13	13-14	*	2-5
2	3-6	7-10	10-16	11-13	*	2-4
3	3-5	8-9	11-14	11-14	*	2-4
4	3-3	7-10	11-16	11-16	*	3-4
5	2-4	7-9	11-16	11-13	*	3-4
6	2-4	6-11	12-16	11-12	*	3-4
7	---	7-10	12-17	11-13	*	3-4
8	---	6-8	13-16	11-12	*	2-4
9	3-7	6-9	12-14	11-13	*	1-3
10	3-5	7-11	10-12	*	*	2-3
11	3-5	7-12	10-13	*	*	3-3
12	4-5	8-12	11-12	*	*	3-4
13	3-7	8-12	11-14	*	*	4-5
14	3-7	8-14	11-13	*	*	4-5
15	4-7	10-12	10-11	*	*	4-5
16	4-6	9-14	10-11	*	*	4-5
17	3-5	10-15	11-13	*	*	3-5
18	4-6	10-15	11-12	*	*	2-4
19	4-6	11-16	11-12	*	*	1-3
20	4-6	12-17	10-13	*	*	1-2
21	4-7	12-17	10-14	*	*	2-3
22	4-6	12-17	11-13	*	*	3-4
23	4-6	12-17	11-15	*	*	4-4
24	5-6	11-16	13-13	*	*	4-5
25	5-7	11-16	12-13	*	*	4-5
26	5-9	12-16	12-14	*	*	3-4
27	6-9	11-16	11-14	*	*	1-3
28	5-8	12-16	11-13	*	*	1-1
29	7-8	11-13	11-15	*	2-4	1-2
30	7-8	9-16	11-16	*	3-5	1-1
31	7-8	---	12-16	*	*	1-1

* Thermograph out of order

Juvenile Data

Juvenile salmonids were captured with traps and nets at various places throughout the drainage in an attempt to determine the distribution of rearing juveniles. Specific sampling site locations are noted on a map of Anchor River drainages in Figure 2, and the numbers of juvenile salmonids caught at each of these locations are listed in Table 3.

The greatest number of juvenile steelhead trout were captured in minnow traps in the North Fork of Anchor River near the Sterling Highway culverts, and this was the only site and method where substantial numbers of smolt size fish were captured. The size of juveniles captured at this site are listed in Table 4.

Smolts were considered to be those fish 135 mm and larger, based on peaks in length frequency of the juveniles. A length frequency distribution of steelhead trout smolts is shown in Figure 3. Mean length of smolts was 161 mm.

A length-weight relationship of juveniles of all sizes and from all locations is shown in Figure 4.

The numbers of minnow traps fished varied and traps were not fished continuously, therefore trap catches were adjusted to a standard catch per trap day to reflect the comparative abundance of smolts. The relative abundance of steelhead trout smolts captured in the minnow traps is illustrated in Figure 5. Trap catches increased about mid-June and reached a peak during the week ending July 12. Unfortunately, traps were not fished during the next week, but with the reduced catches during the week ending July 26, it is expected that catches during the week of July 19 would have been lower than the peak.

Adult Data

During the period September 15 to October 24, 18 steelhead trout were tagged with serially numbered Floy tags and released. Only one of these fish was recovered; it had been tagged in the intertidal area in Anchor River on September 15, and was captured by an angler in Stariski Creek on October 7.

One tag was recovered from a fish that had been tagged in 1979. It was a female and was 695 mm fork length when tagged September 13, 1979. At recovery on October 17, 1981 it was 800 mm in length. Scales had been taken from the fish at the time of tagging in 1979 and another was taken at recovery, thus providing a direct comparison of scale characteristics at the two times (Figure 6).

A total of 16 adult steelhead trout were tagged by insertion of radio transmitters in an attempt to monitor instream migration. Details of the tagging information, types of radios used and method of implanting are listed in Table 5. Most of the fish were tagged in the section of Anchor River downstream from the forks. Figure 7 is a map of the lower portion of

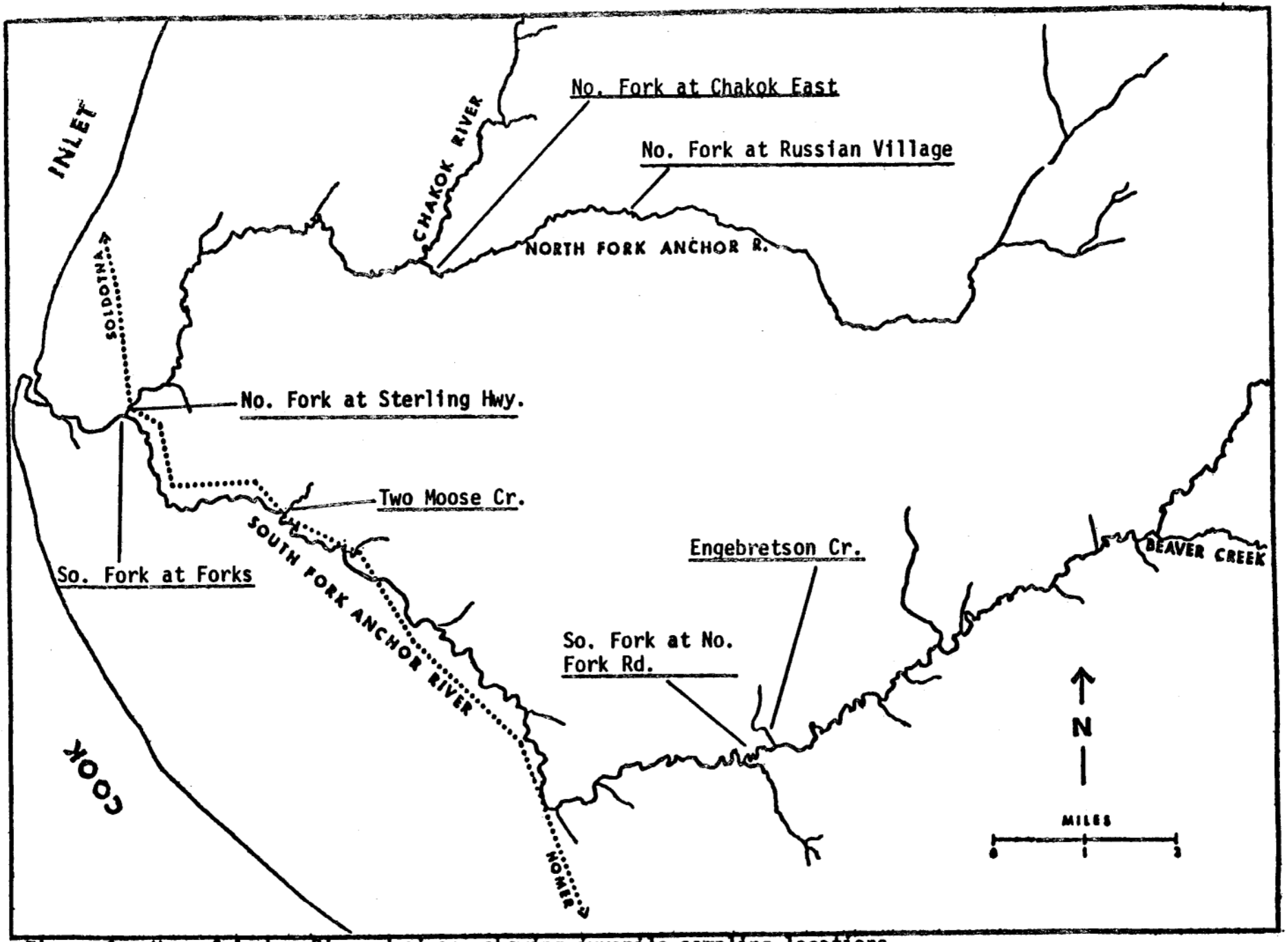

Figure 2. Map of Anchor River drainage showing juvenile sampling locations.

Table 3. Numbers of Juvenile Salmonids Captured in Anchor River, 1981.

Location	Method	Dates 1/	RT/SH	SS	KS	DV
So. Fk. at Forks	Inclined Plane Trap	5/8-9/11	17	510	458	320
So. Fk. at Forks	Minnow Traps	6/2-7/26	71	17	33	29
No. Fk. At Sterling Hwy.	Fyke Net	5/29-7/12	39	609	295	81
No. Fk. at Sterling Hwy.	Minnow Traps	5/509/15	261	229	359	126
So. Fk. at No. Fk. Road	Minnow Traps	4/29-6/1	16	3	5	24
Two Moose Creek	Minnow Traps	5/9-10/1	26	21	53	79
Engebretson Creek	Minnow Traps	5/9	0	0	3	3
Telephone Creek	Minnow Traps	5/14-5/20	0	3	0	0
No. Fk. at Chakok East	Minnow Traps	5/5-5/26	37	12	6	28
No. Fk. at Russ. Villiage	Minnow Traps	5/9-5/14	3	0	0	3
		Total	470	1,404	1,212	693

1/ All traps were operated intermittently.

Table 4. Lengths of juvenile steelhead trout captured in minnow traps in North Fork of Anchor River at Sterling Highway culvert, by weekly period, 1981.

Length Interval (mm)	Weekly Period																			
	5/10	5/17	5/24	5/31	6/7	6/14	6/21	6/28	7/5	7/12	7/19	7/26	8/2	8/9	8/16	8/23	8/30	9/6	9/13	9/20
40-44																	1			
45-49																	2			
50-54				1																
55-59																				
60-64							1									1				
65-69						1														
70-74																				
75-79										8										
80-84			1	1				1		7		1			3	1	1			
85-89				1		2				7		4			1	3		1		
90-94			1	2		1	1			2		1		1		4	1			
95-99			1					1	1	3		2				1		4		
100-104				2					1	5		1	1				2			
105-109								1		1						2				
110-114								1	1	2		1			1	1	1	1		
115-119				1		2		1	1	1		1					1			
120-124									3	1		1				1				
125-129			1					1	1	4		1			1	3	2			
130-134			1	1			1			4				1	1	2				
135-139						1				1							2			1
140-144					1				1	5						3				1
145-149						1	1			2										
150-154							3	1	1	3					1		1	1		
155-159	1	1			1		1	1	6	8		1				1	1			
160-164							1		4	3										1
165-169								4	6	6										
170-174								3	2	2										
175-179								3		2										
180-184						2	2	3												
185-189							1	2												
190-194							1	1												
195-199								1												

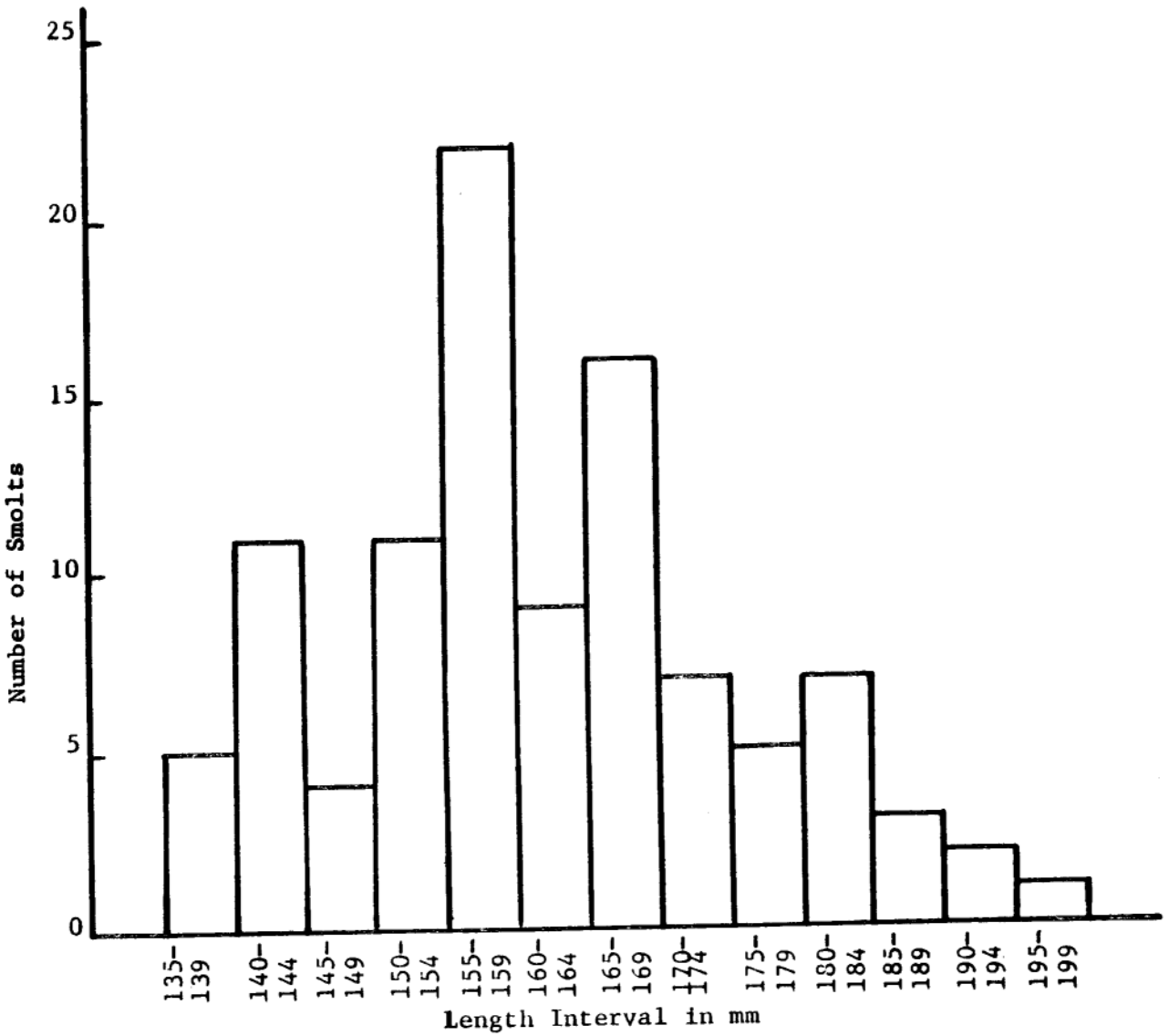

Figure 3. Length frequency of steelhead smolts caught in minnow traps in the North Fork of Anchor River, 1981.

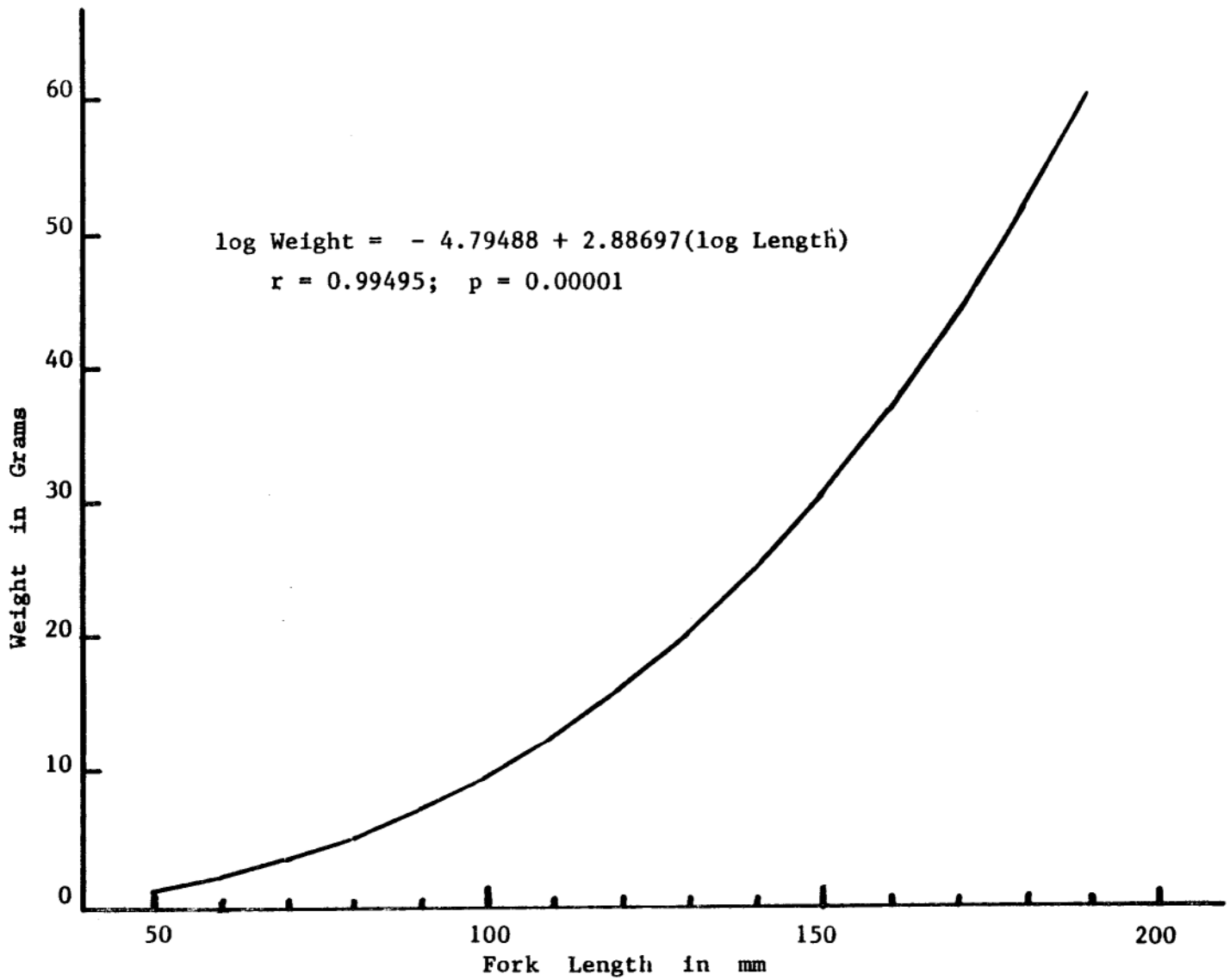

Figure 4. Length-weight relationship of juvenile steelhead in Anchor River, 1981.

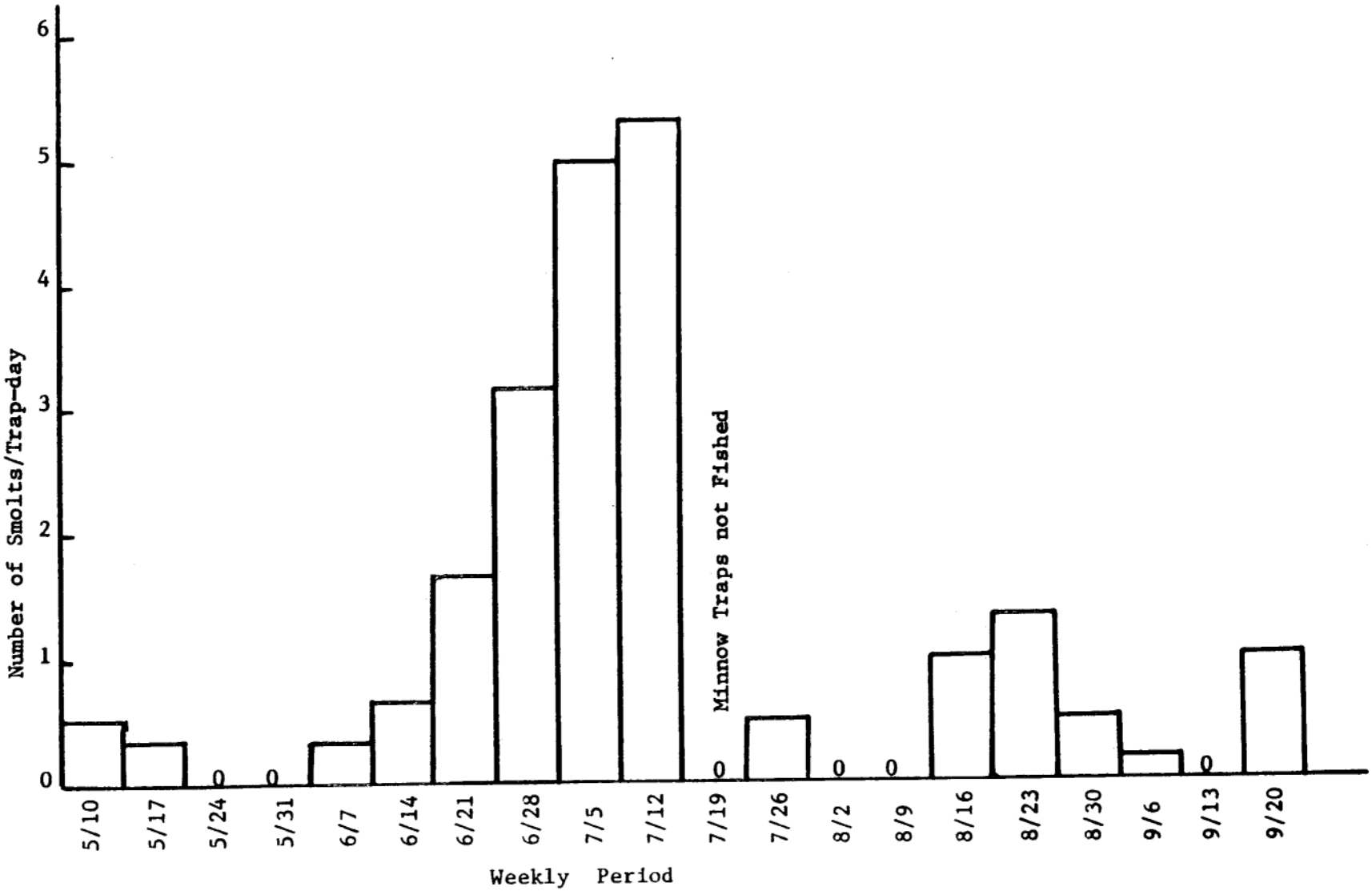

Figure 5. Relative abundance of steelhead smolts captured in minnow traps in North Fork of Anchor River, by weekly periods, 1981.

Figure 6. Photographs of scales from a steelhead at time of tagging in September 1979 (left) and at time of recovery in October 1981 (right), with saltwater annuli noted at arrows, and a spawning check which was formed during the winter - spring of 1979-80.

Table 5. Details of fish tagged with radio transmitters, Anchor River, 1981.

Fish No.	Date Tagged	Sex	Length (mm)	Location	Radio Frequency	Type of Radio	Method	Peterson Tag No.
1	9/30	F	700	Dudas	650-1	Reg. Type 2	Stomach	A445
2	9/30	M	720	Dudas	620-2	Miniature	Stomach	A446
3	9/30	-	670	Dudas	640-1	Miniature	Stomach	A447
4	9/30	M	720	Dudas	670-3	Reg. Type 2	Stomach	A648
5	10/1	F	550	Picnic	670-2	Miniature	Surgery	A449
6	10/1	M	670	Dudas	660-1	Reg. Type 2	Surgery	A450
7	10/1	F	795	Picnic	600-1	Reg. Type 2	Stomach	A451
8	10/1	M	710	Picnic	630-1	Reg. Type 2	Stomach	A452
9	10/1	M	760	Picnic	680-1	Reg. Type 2	Stomach	A453
10	10/1	M	745	Picnic	610-1	Reg. Type 2	Stomach	A454
11	10/1	F	705	Picnic	620-1	Reg. Type 2	Stomach	A455
12	10/7	M	780	Picnic	640-2	Old Model	Surgery	A456
13	10/16	F	640	Powerline	660-2	Chrome Dome	Surgery	A457
14	10/16	F	735	Powerline	630-2	Chrome Dome	Surgery	A458
15	10/16	F	680	Rock	600-1.5	Weaks Radio	Surgery	A459
16	10/16	F	---	Rock	720-1	Chome Dome	Surgery	A460

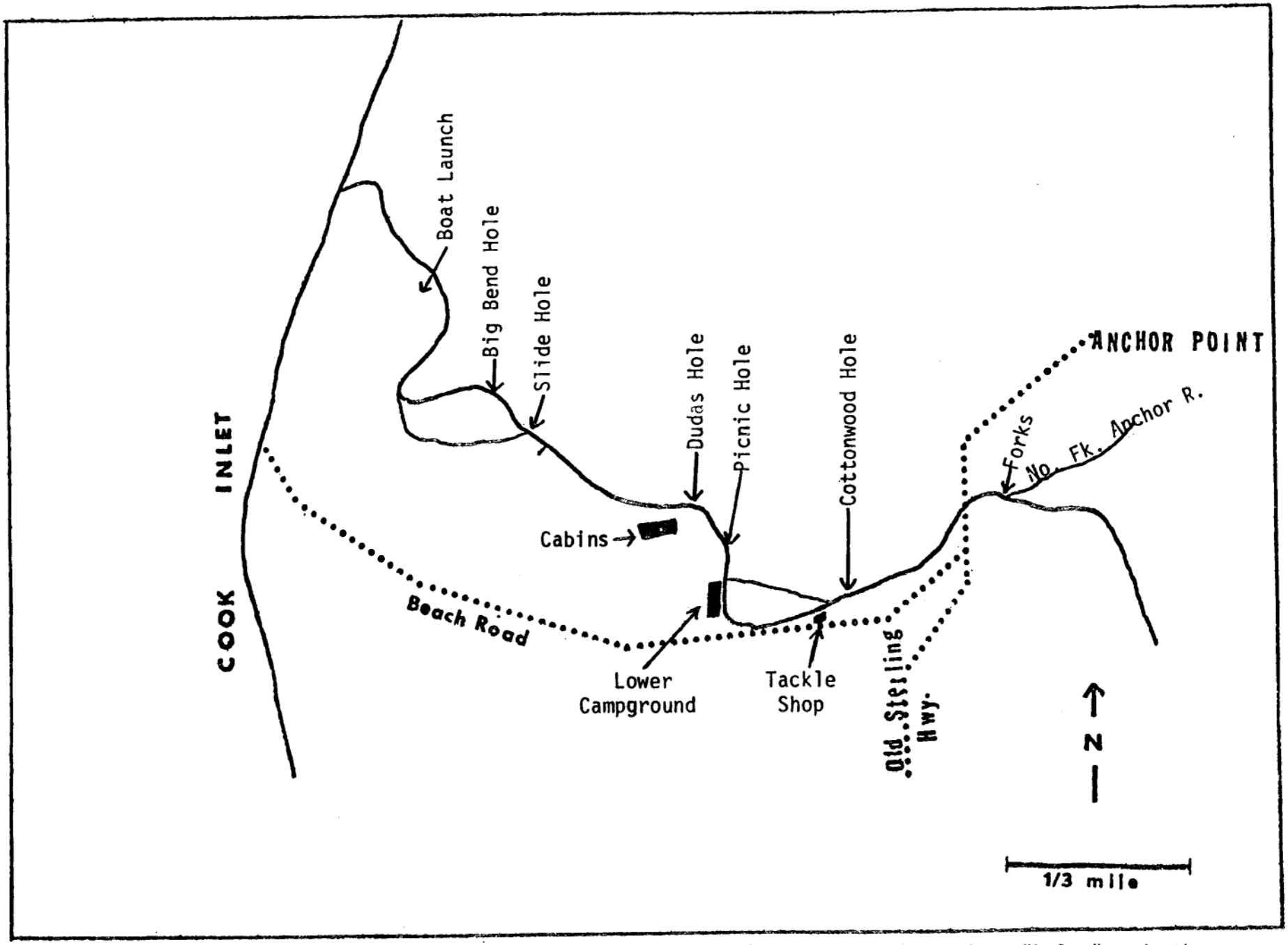

Figure 7. Vicinity map of lower portion of Anchor River showing location of various "holes" and other descriptive locations on the river.

Anchor River depicting various "holes" and other descriptive characteristics of the river.

Results of tracking most of the fish are illustrated in Figures 8 through 18, inclusive. Tagging sites are noted and the dates listed show the location of radio signals by time. A few of the radios transmitted signals for only a short time and were not heard again. A few transmitted for a month or two, then signals were lost. While we have no explanation, the possibilities are that: the radio malfunctioned; fish were caught by anglers and were not reported; or fish returned to saltwater where signals would not be detected.

Most of the fish were tagged in the section of Anchor River downstream of the forks. Following release, fish moved both upstream and downstream in a seemingly erratic manner. Movements ranged from the Big Bend Hole in the intertidal zone to a location approximately one-fourth mile upstream from the forks, an overall distance of about 1½ miles. All of the tagged fish which were still being tracked on February 1 were very close to the site at which they were tagged.

From October 12 until November 13, signals were not heard from Fish No. 11. Signals on October 12 were in the Big Bend Hole, in the intertidal area. It is speculated the fish may have returned to saltwater where signals could not be detected, then subsequently re-entered the stream.

Two fish were tagged at the Powerline Hole approximately 1.5 miles upstream of the forks. Signals from one (Fish No. 13) were recorded about 1 mile downstream from the tagging site and were lost after a few days. The other, Fish No. 14, moved upstream approximately 3 miles and, on February 1, had moved back downstream to a location approximately 1 mile above the tagging site.

On October 16, two fish were tagged at a point a few hundred yards upstream of the forks. Signals from one were recorded only one time after release, then were lost. The other (Fish No. 16) dropped downstream then was recorded in the North Fork near the Chakok River on November 13, the last time the signal was heard.

A creel census of the summer-fall fishery was started on July 13 and terminated on November 1. A total of 4,787 anglers were interviewed and completed anglers fished an average of 3.05 hours per day. Total angling effort during this period amounted to 16,964 man-days.

It was estimated that anglers harvested 571 steelhead trout from Anchor River; they are listed in Table 6 by area and weekly period. Information obtained during interviews showed that anglers kept 53.9% of the steelhead trout they caught.

A summary of creel census data since 1954 from the summer-fall fishery in Anchor River is presented in Table 7, with available population estimates and estimates of harvest of steelhead trout.

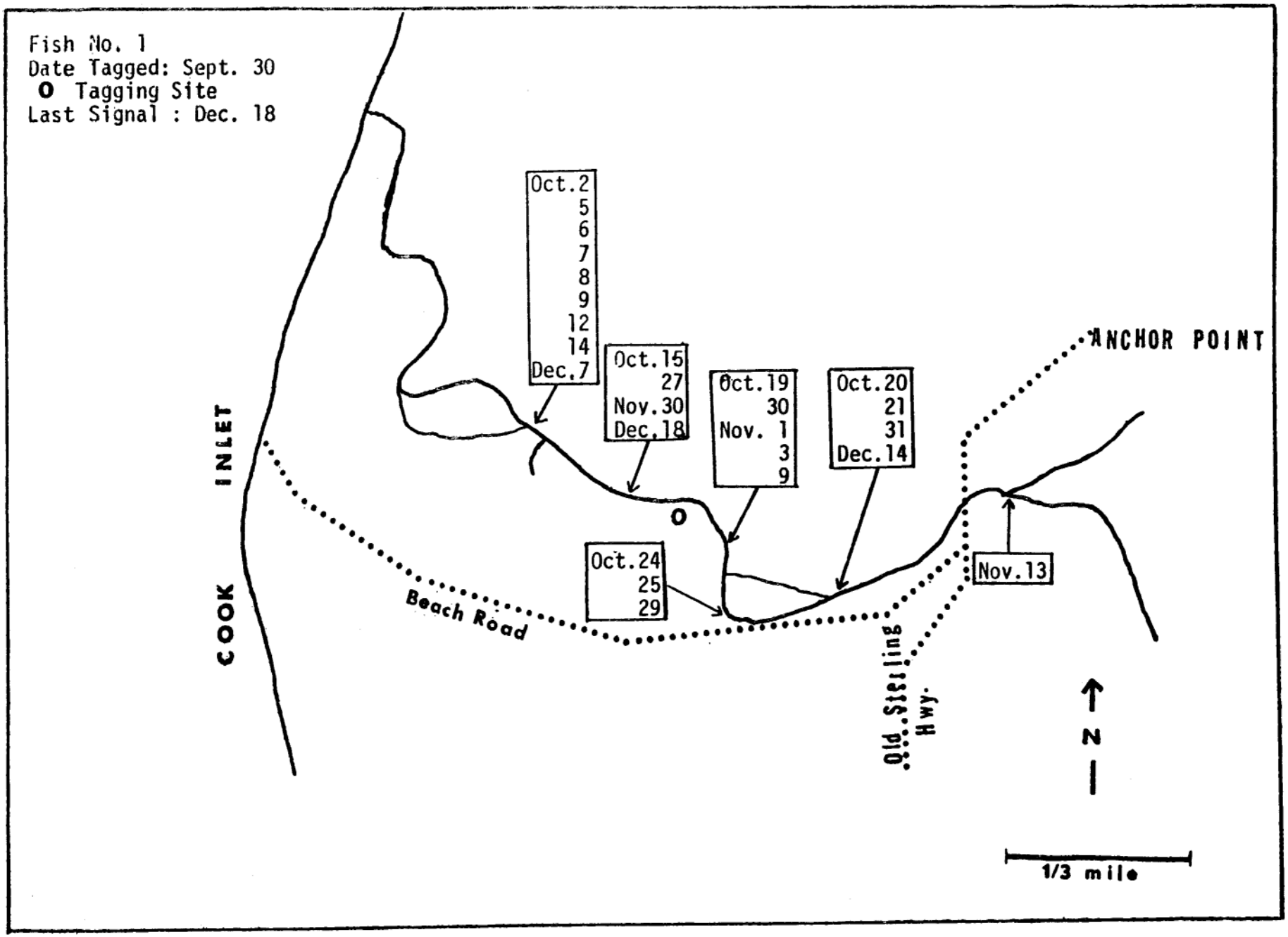

Figure 8. Location of radio signals from Fish Number 1, by date, Anchor River steelhead. 1981-82.

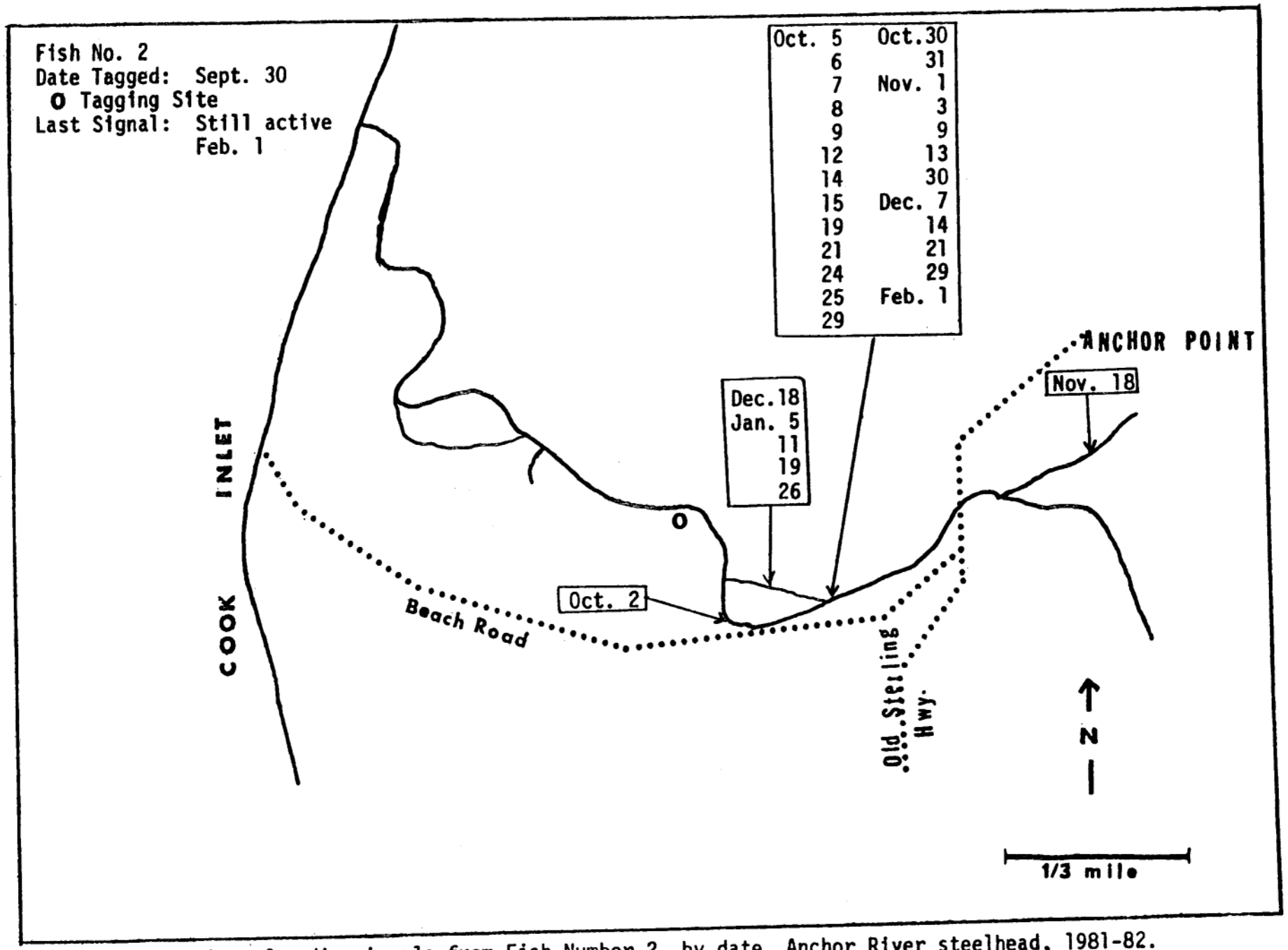

Figure 9. Location of radio signals from Fish Number 2, by date, Anchor River steelhead, 1981-82.

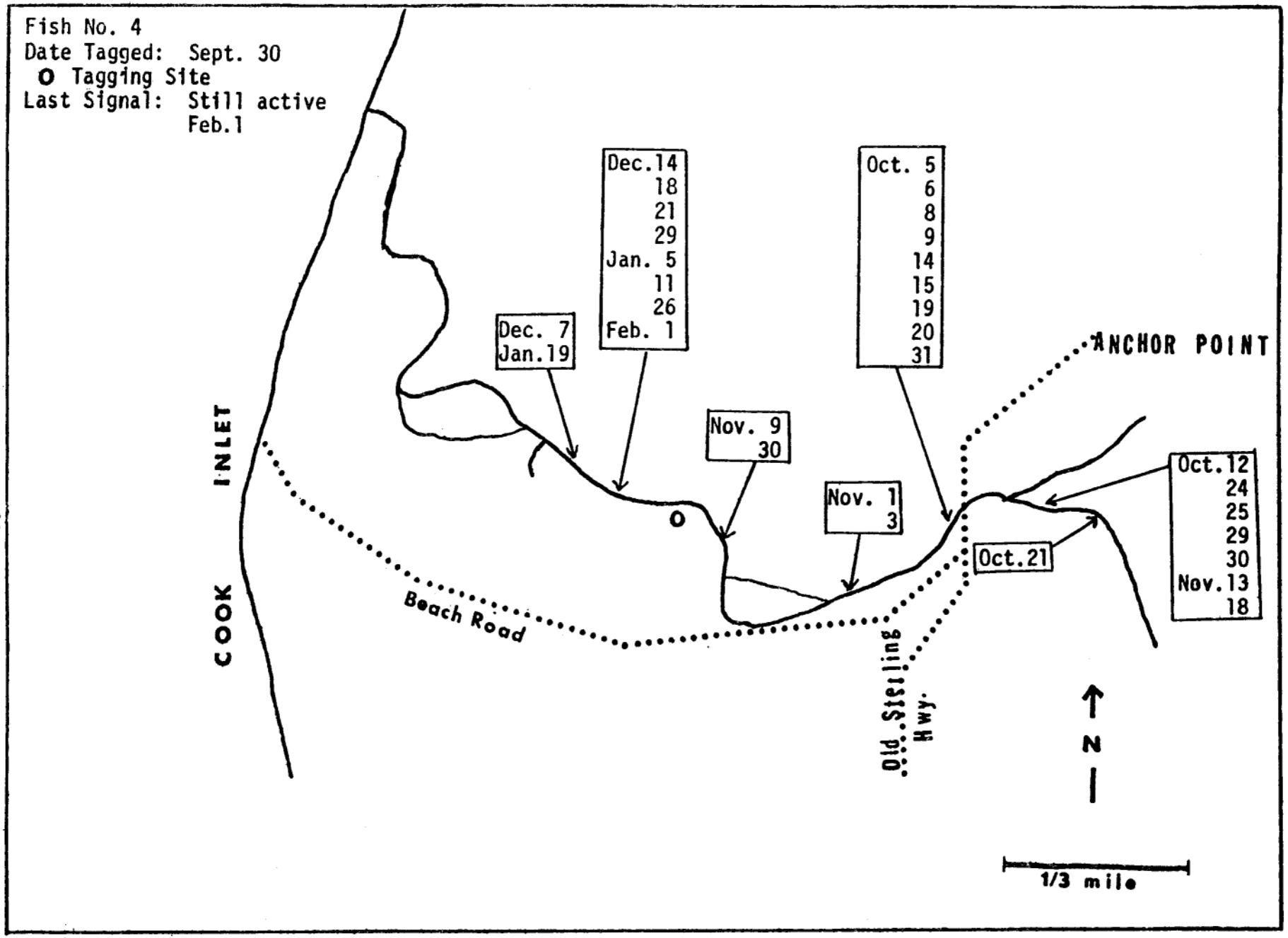

Figure 10. Location of radio signals from Fish Number 4, by date, Anchor River steelhead, 1981-82.

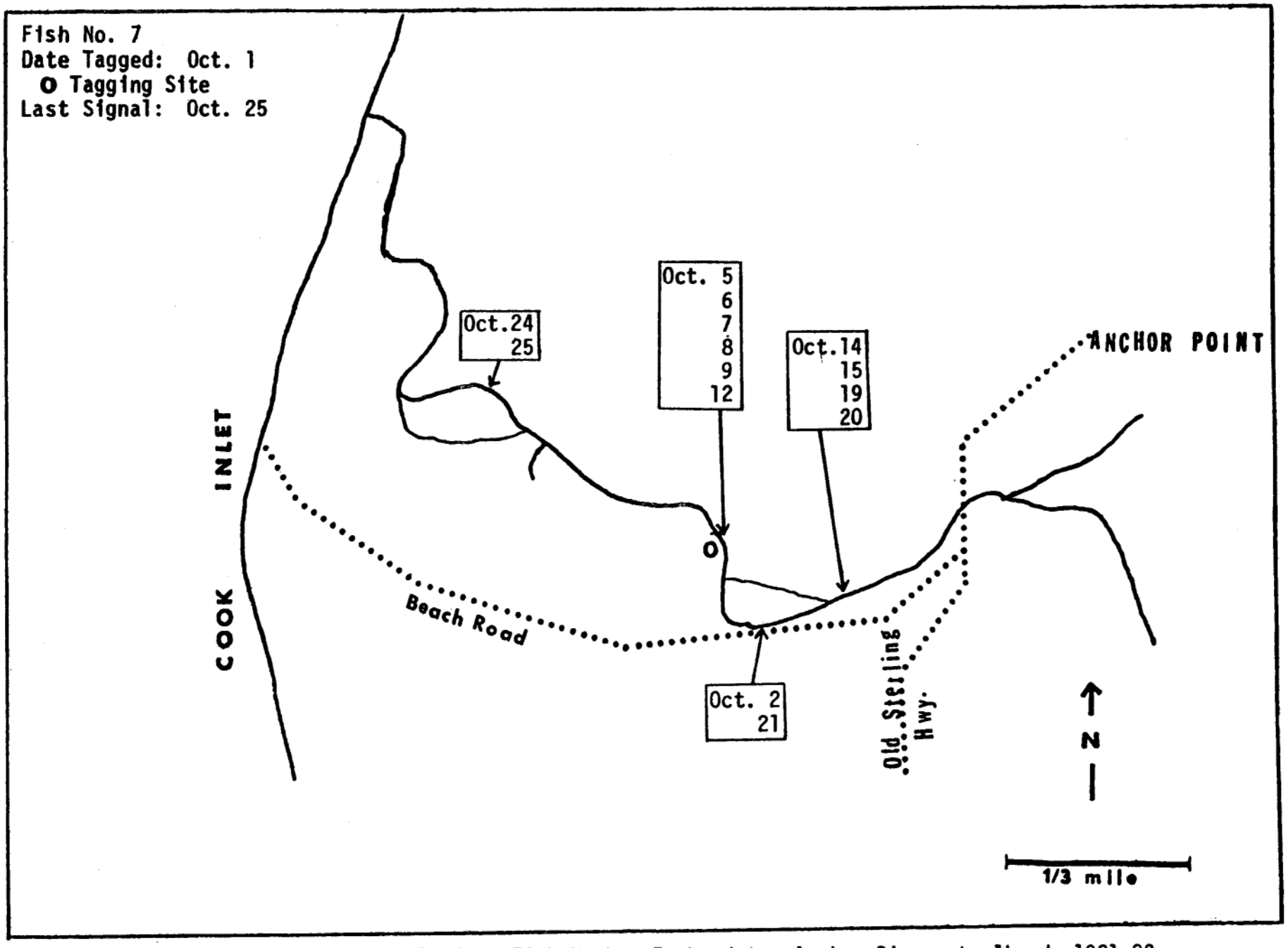

Figure 11. Location of radio signals from Fish Number 7, by date, Anchor River steelhead, 1981-82.

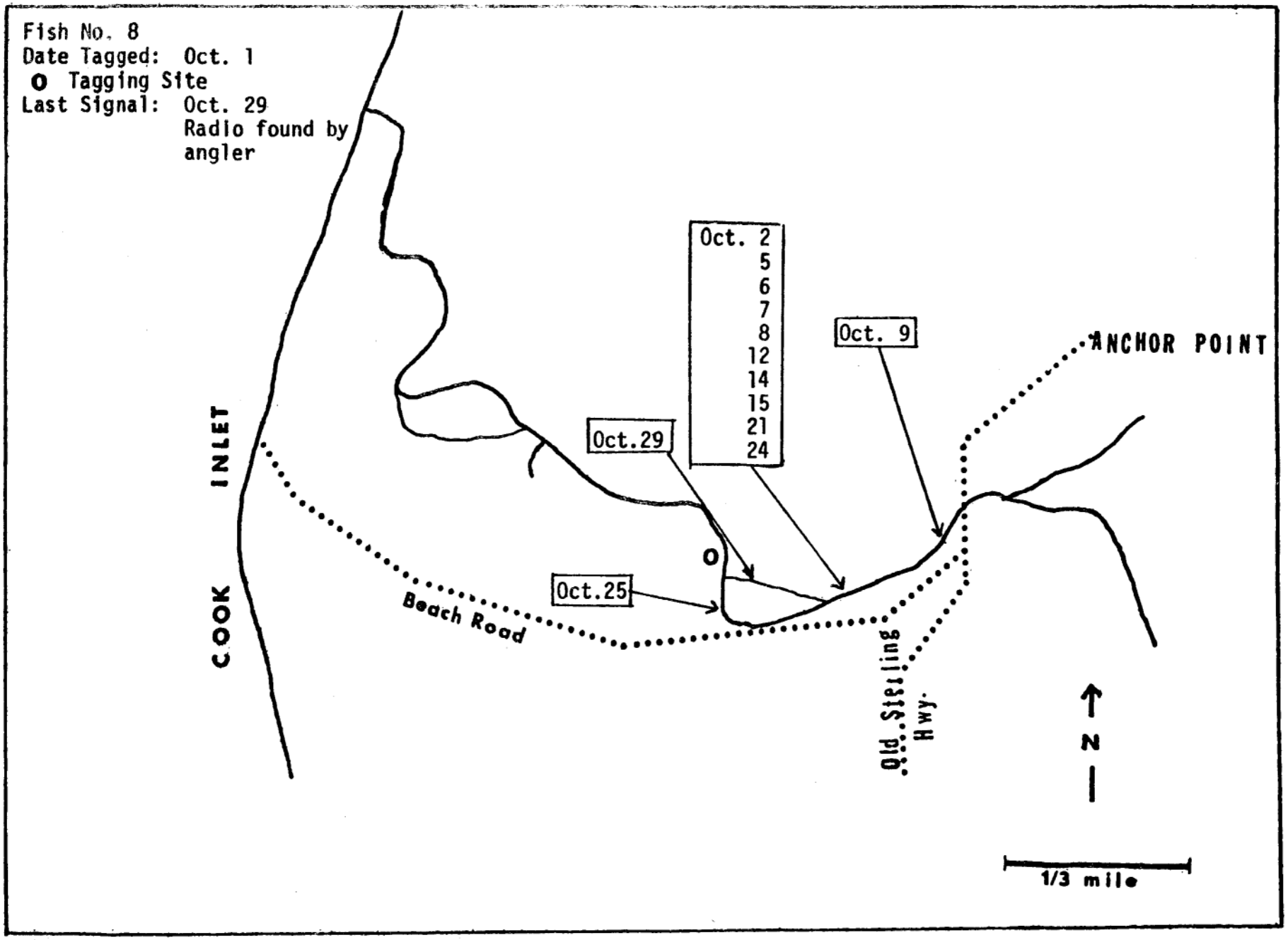

Figure 12. Location of radio signals from Fish Number 8, by date, Anchor River steelhead, 1981-82.

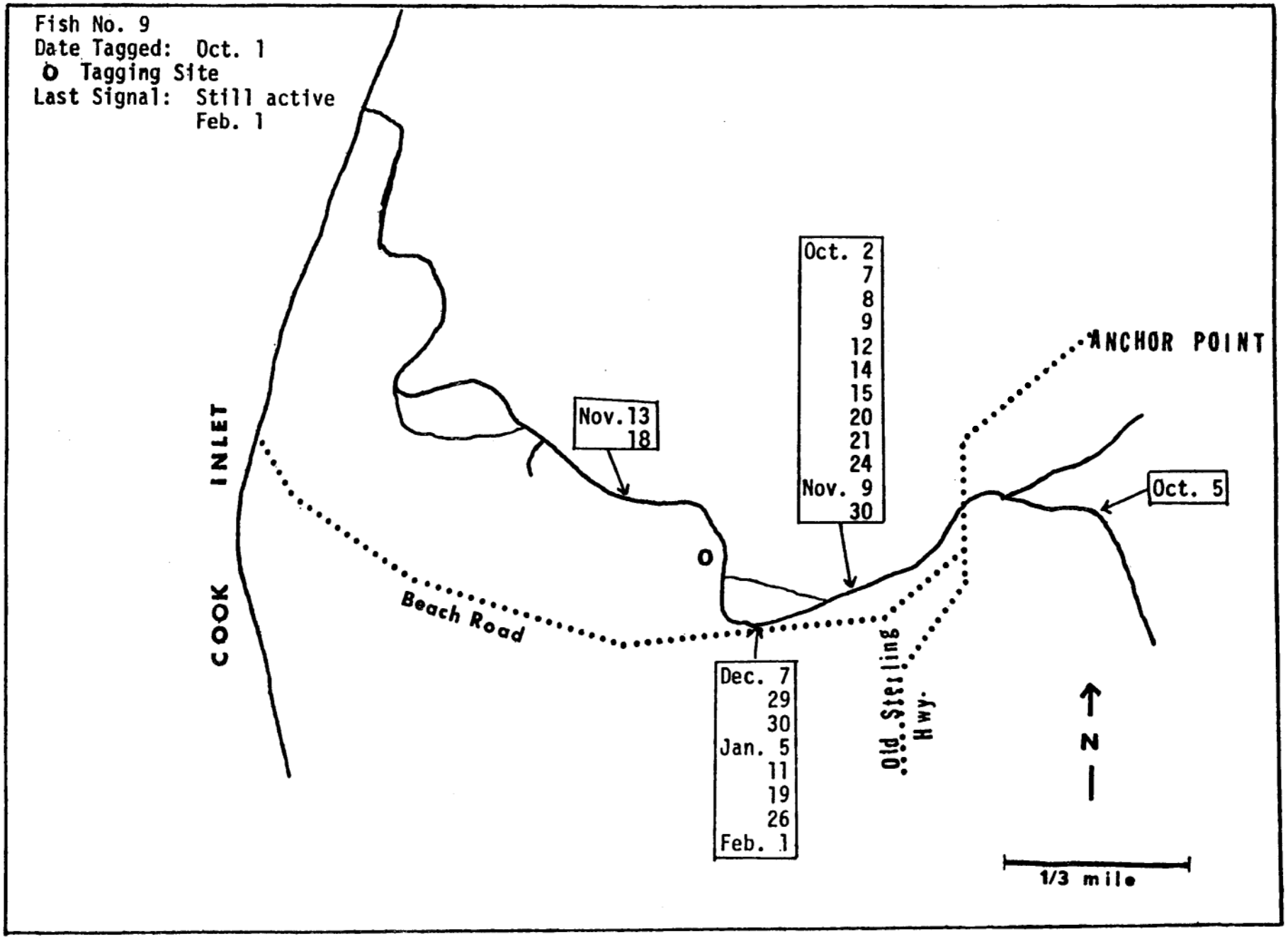

Figure 13. Location of radio signals from Fish Number 9, by date, Anchor River steelhead, 1981-82.

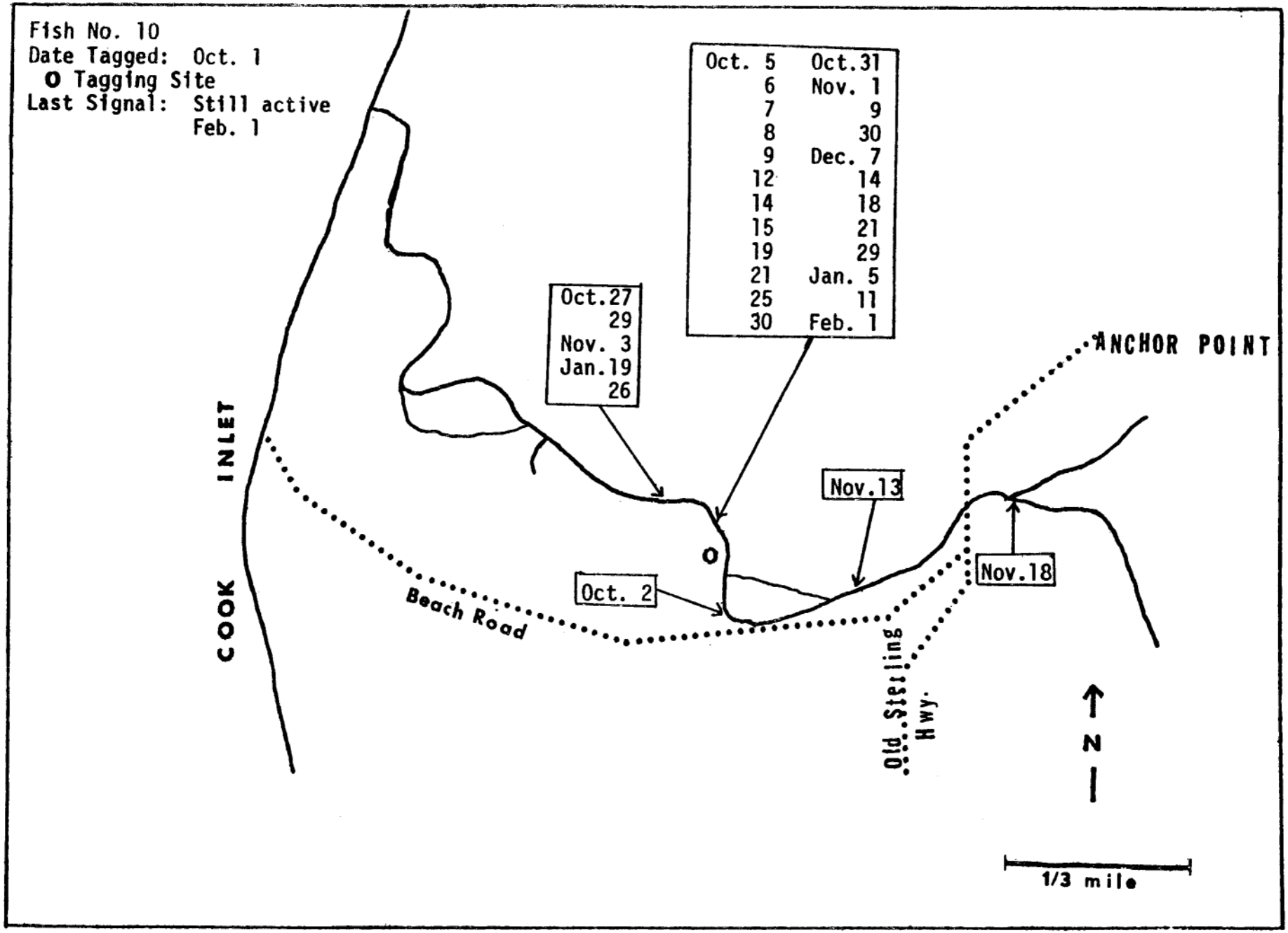

Figure 14. Location of radio signals from Fish Number 10, by date, Anchor River steelhead, 1981-82.

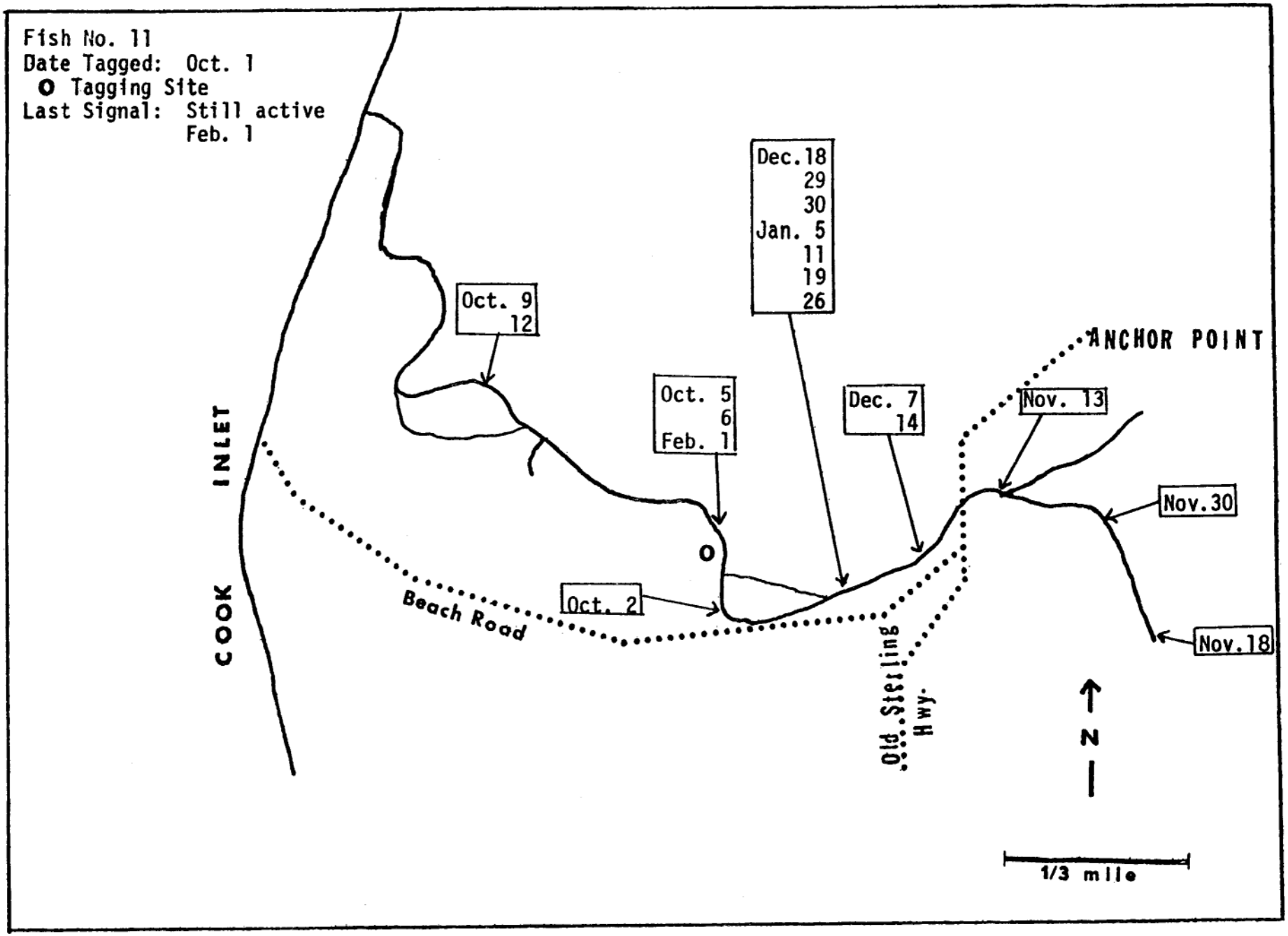

Figure 15. Location of radio signals from Fish Number 11, by date, Anchor River steelhead, 1981-82.

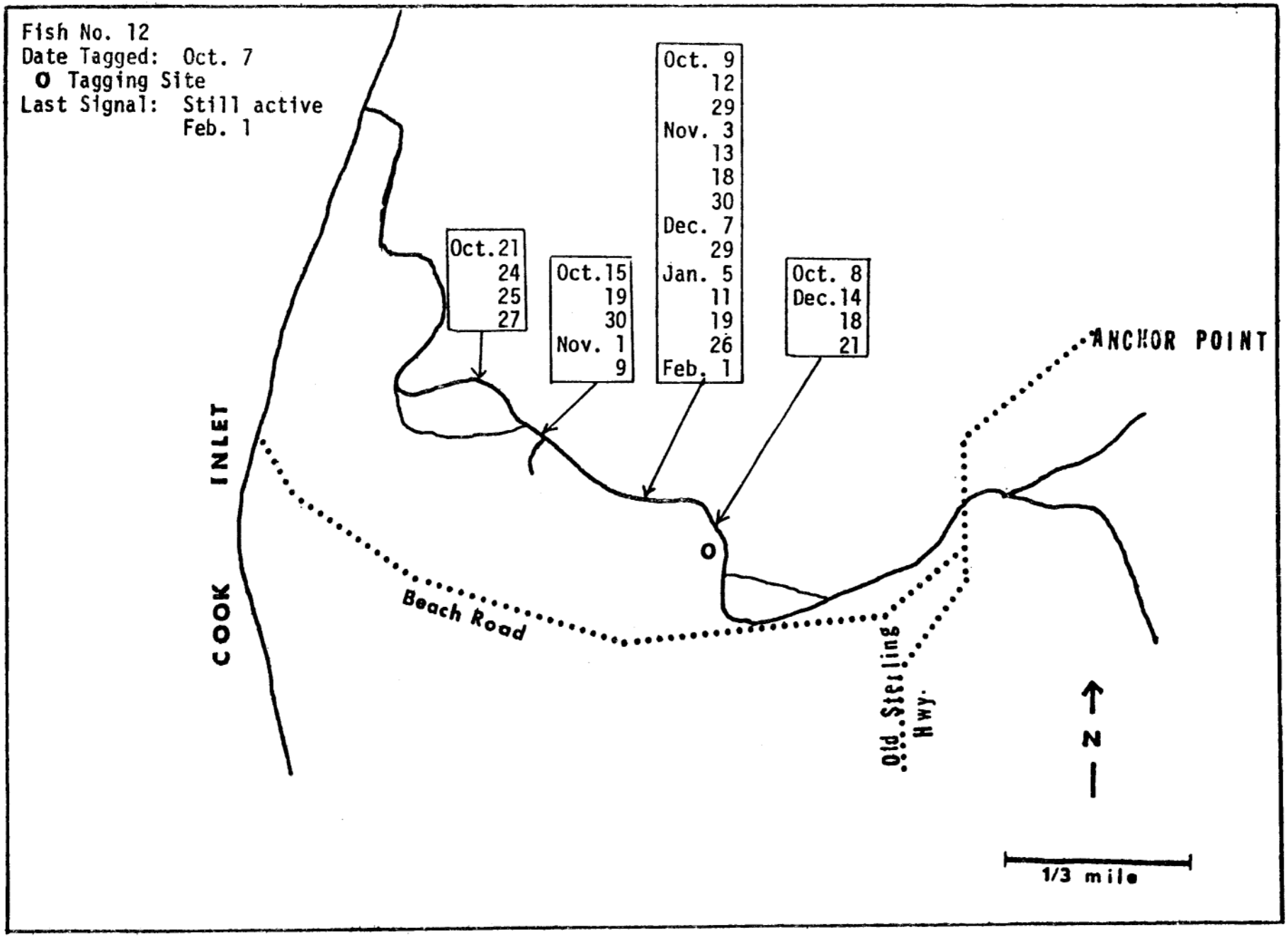

Figure 16. Location of radio signals from Fish Number 12, by date, Anchor River steelhead, 1981-82.

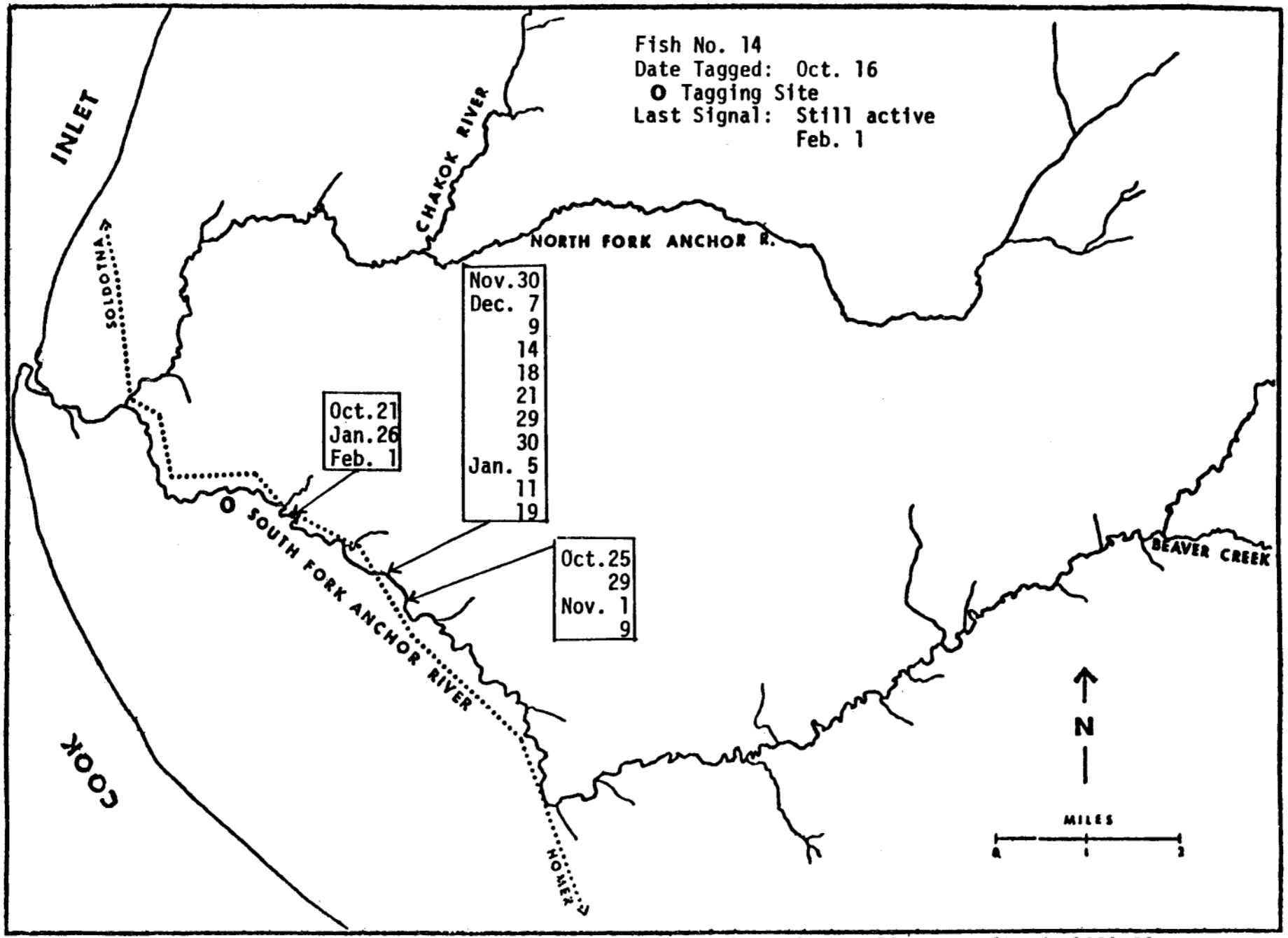

Figure 17. Location of radio signals from Fish Number 14, by date, Anchor River steelhead, 1981-82.

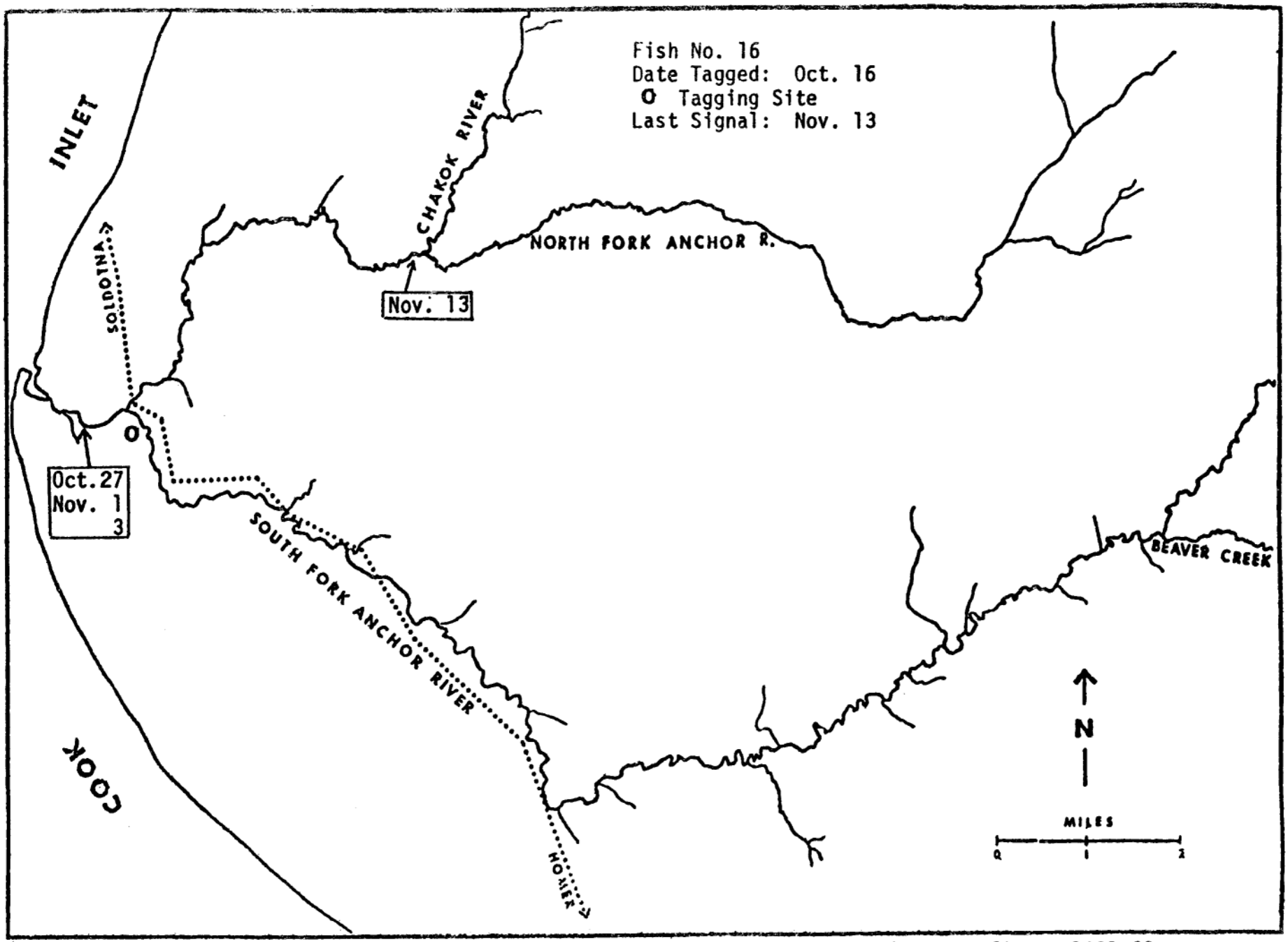

Figure 18. Location of radio signals from Fish Number 16, by date, Anchor River steelhead, 1981-82.

Table 6. Esitmated sport fish effort and harvest of steelhead from Anchor River by weekly intervals and area, July 13-November 1, 1981.

Week Ending	Effort Man-Hours	Area 1 1/	Area 2 2/	Total
7/19	2,822	0	0	0
7/26	3,354	0	0	0
8/2	3,078	0	0	0
8/9	6,148	0	0	0
8/16	4,800	11	0	11
8/23	6,115	6	0	6
8/30	4,163	43	0	43
9/6	3,270	26	15	41
9/13	2,513	62	0	62
9/20	1,627	19	0	19
9/27	2,330	72	2	74
10/4	2,516	68	8	76
10/11	2,684	81	7	88
10/18	3,586	81	5	86
10/25	1,764	46	0	46
11/1	969	19	0	19
Total	51,739	534	37	571

1/ Anchor River below forks
2/ South Fork Anchor River above confluence of North Fork

Table 7. Summary of angler effort, and estimates of harvest and total populations of steelhead on Anchor River.

Year	Period Covered in Census	Effort Man-Days	Steelhead Harvest	Estimates Total Runs	Source of Data
1954	5/29-10/23	3,000	247	511	
1957	5/1-10/15	5,800	50	600	
1960	5/7-10/2	5,300*	400	---	Dunn (1960)
1968	7/6-10/19	3,045	102	---	McHenry (1968)
1977	5/28-6/19	10,978	NC**	---	ADF&G (Unpubl. data)
	Bal. of Year	20,573	1,072	---	Mills (1979)
	Total	31,515			
1978	5/27-6/19	23,748	NC**	---	ADF&G (Unpubl. data)
	7/15-11/12	20,906	1,462	4,162	Wallis & Hammarstrom (1979)
1979	4/13-4/30	3,500	100	---	Wallis & Hammarstrom (1980)
	5/26-6/18	17,715	75	---	ADF&G (Unpubl. data)
	7/14-11/4	18,267	611	---	Wallis & Hammarstrom (1980)
	Total	39,482	786		
1980	5/24-6/16	10,109	15	---	ADF&G (Unpubl. data)
	7/1-11/15	15,157	847	2,388	Wallis & Balland (1981)
	Total	25,266	865		
1981	Feb-Mar 1981	2,000	100		ADF&G (Unpubl. data)
	5/30-6/22	12,570	25		
	7/13-11/1	16,964	571	---	
	Total	31,534	696		

* Effort incomplete - covers period 5/7-7/14 only.
** NC - Not covered in census.

Scales were collected from steelhead trout during creel census interviews. Total age determinations could be made from 90 fish and summaries of the age, sex composition and lengths of fish in the samples are presented in Table 8.

Ten of the 90 fish (11.1% of the sample) for which total age determinations could be interpreted had spawned previously. One fish was returning to spawn in its second consecutive year and all others had one ocean annulus following a spawning check. Two of the individual fish had spawned twice previously and had returned to spawn a third time. The percentage of repeat spawners is within the range of those reported earlier: Allin (1954) - 26%; Dunn (1960) - 3.5%; Redick (1968) -24.3%; McHenry (1969) - 16.2%; Wallis and Hammarstrom (1979) - 17.7%; Wallis and Hammarstrom (1980) - 17.5%; Wallis and Balland (1981) - 19.7%.

Viscera samples of 26 adult steelhead trout were sent to the ADF&G pathology laboratory in Anchorage for examination for pathogens. None of the major bacterial pathogens were detected.

Scale Analysis

Scales were collected from 328 juvenile steelhead to provide reference data on which to base an interpretation of adult scales.

A relationship between circuli counts and length of juveniles was established (Figure 19). There was close agreement between circuli counts and lengths of juveniles up to a size of about 140 mm, but large variation in circuli counts for fish of a given length greater than 140 mm. The reason for the greater variation in circuli counts of larger fish is related to what we term "plus" growth. "Plus" growth is defined as freshwater growth that occurs from time of completion of the final freshwater annulus until the first saltwater circulus begins to be formed. In general, spacing between circuli formed in this "plus" growth period is greater and more variable that during earlier periods.
The number of circuli formed after completion of the last freshwater annulus were counted to determine the approximate time of annulus formation and when the new growth begins. These counts were also used to determine the extent and timing of "plus" growth on smolts. The numbers of circuli formed after completion of the last freshwater annulus by time are illustrated in Figure 20. Very little new growth is exhibited until about mid-June, then there is a rapid increase in numbers of new circuli formed until about mid-September. In essence, circuli formation follows a normal growth pattern.

Smolts consist of 2-, 3- and 4-year-old fish. Circuli counts of each age group were compared to determine whether there were differences in their growth rates. This comparison is illustrated in Figure 21. Similar counts were made on the freshwater portion of adult scales to make the same comparison (Figure 22). It is apparent that 2-year-old smolts have the most rapid growth rate, and that 4-year-old smolts have the slowest. This confirms that growth rate is a factor in determining the age at which steelhead trout juveniles become smolts.

Table 8. Summary of age composition and lenghts of Anchor River steelhead trout; data from scales collected in creel census, fall 1981.

Age Class	Number	Length (mm) Mean	Length (mm) Range
First-time spawner			
Males			
2.1	2	595	560-630
2.2	3	707	675-710
3.1	14	590	545-630
3.2	15	741	640-800
4.1	1	---	555
4.2	2	730	710-750
Total	37		
Females			
2.2	5	699	635-741
3.1	4	571	550-595
3.2	34	706	645-770
Total	43		
Repeat spawners			
Males			
3.1s	1	---	645
3.1s1	2	715	700-730
3.1s1s1	1	---	850
Total	4		
Females			
2.2s1	1	---	775
3.1s1	1	---	790
3.2s1	3	810	800-825
3.2s1s1	1	---	860
Total	6		

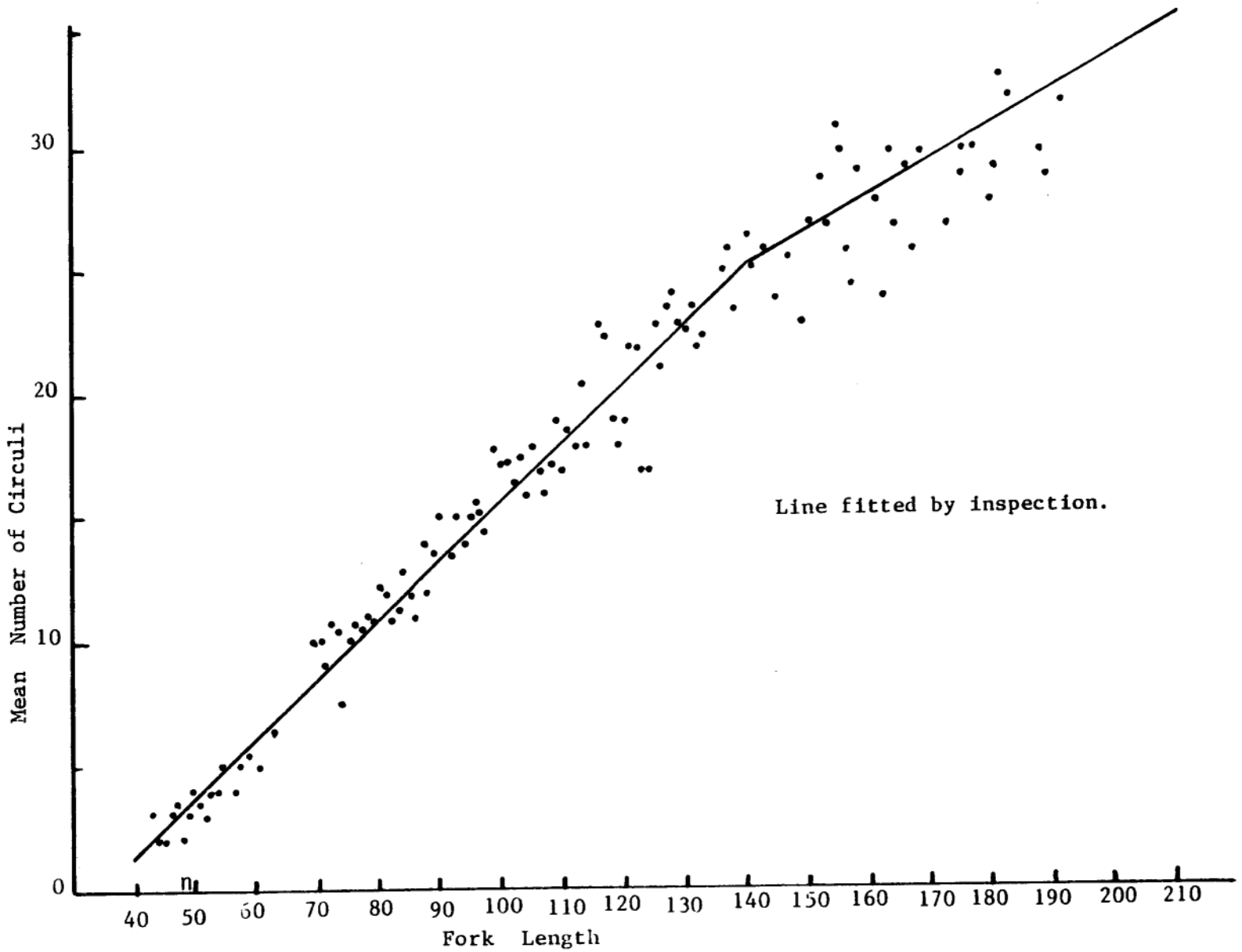

Figure 19. Relationship between fork length and mean number of circuli on juvenile steelhead in Anchor River, 1981.

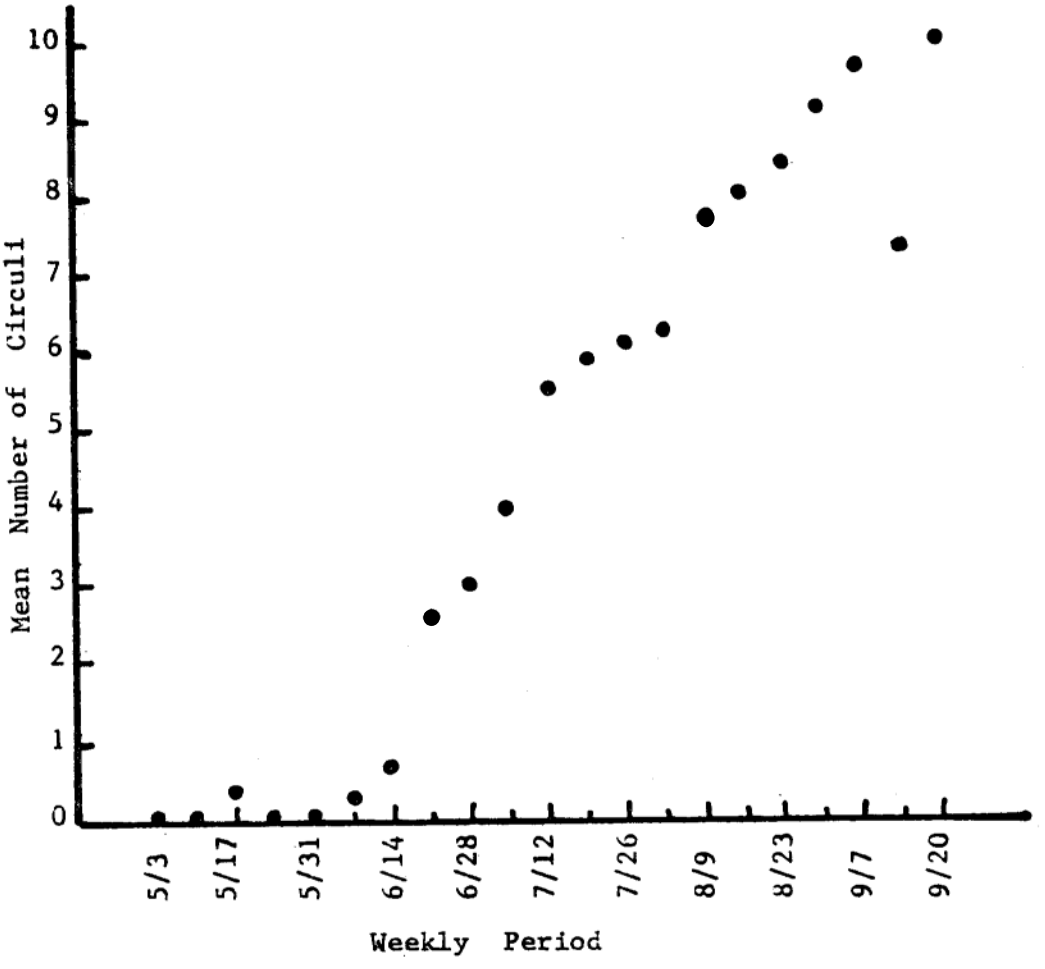

Figure 20. Mean numbers of circuli of new growth following completion of a freshwater annulus on juvenile steelhead trout scales from Anchor River, 1981.

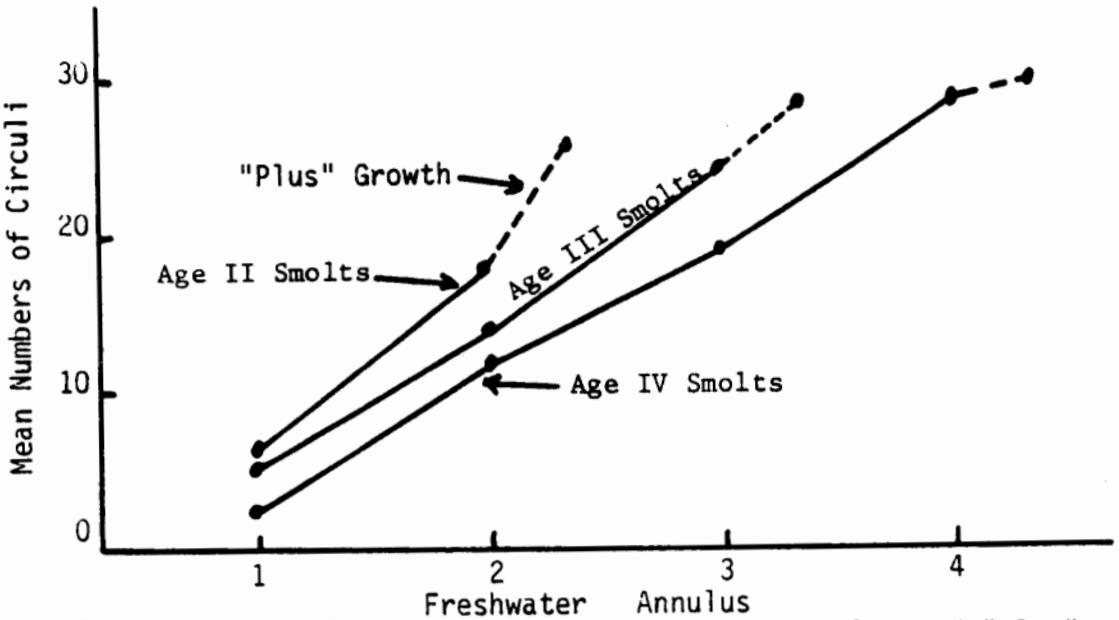

Figure 21. Mean circuli counts at each freshwater annulus and "plus" growth for Age II, III and IV steelhead smolts in Anchor River, 1981.

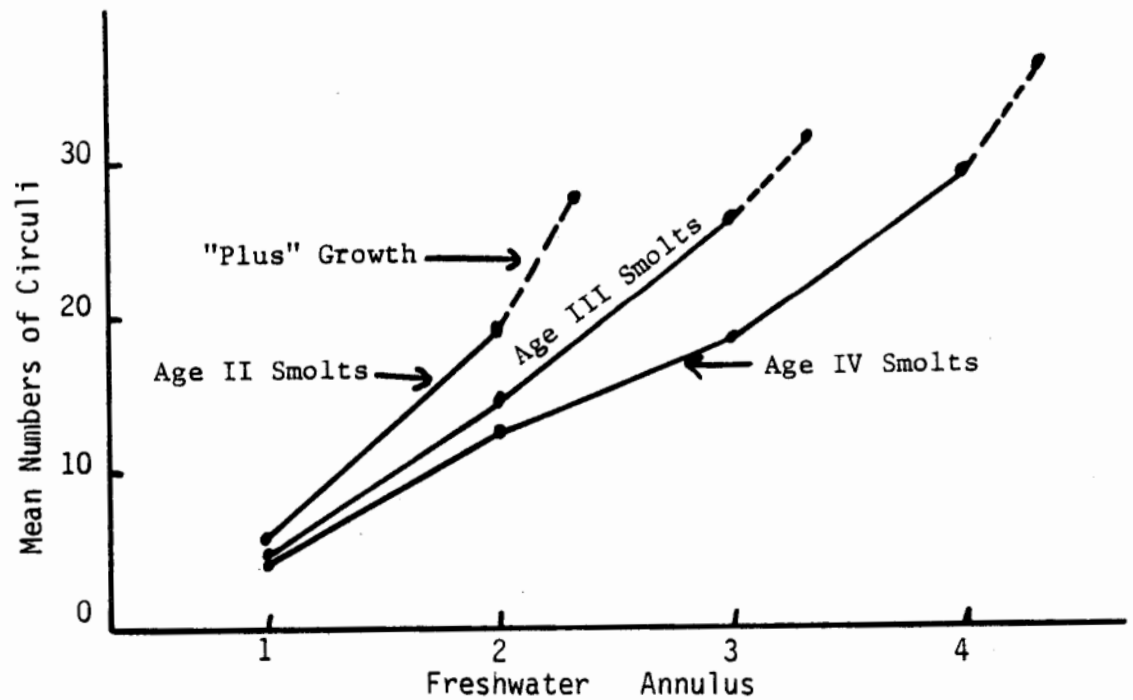

Figure 22. Mean circuli counts at each freshwater annulus and "plus" growth for Age II,III and IV steelhead smolts as determined from adult scales in Anchor River, 1981.

Circuli counts were made on the freshwater portion of adult scales in order to estimate their size at time of entry to sea. Results of these counts are listed in Table 9. Mean number of freshwater circuli was 31 with a standard deviation of 3.8. In referring to Figure 19, 31 circuli corresponds to fish approximately 170 mm, and fish 170 mm in length would weigh approximately 44 gm, or 10.3 fish per pound (see Figure 4).

"Plus" growth noted on adult scales average 5.5 circuli. This corresponds to the number of circuli which would be formed by early July (Figure 20).

DISCUSSION

The most successful technique of trapping juvenile steelhead of all sizes was the use of minnow traps. Traps which were most successful were homemade and 9 in in diameter. Steelhead trout smolts easily avoid being trapped in fyke nets and inclined plane traps, whereas other salmonids enter them readily. In the future we will concentrate on use of minnow traps for juvenile steelhead trout collections.

There was reasonably close agreement between the size of smolts trapped in minnow traps (161 mm mean length) and the estimated size based on adult scale analysis (170 mm mean length). Possible reasons for these differences are:

1. Different brood years were involved and it is very likely that there are differences in growth from year to year.

2. Smolts were trapped at least some period before they reached saltwater, whereas interpretation of adult scales was based upon growth up to the point where saltwater growth was evident on the scale. There is a time lag in information of scale characteristics which could explain the observed difference.

3. It has been recorded in other species and in other locations that larger smolts survive at a higher rate that smaller ones, and such differential in survival rates could explain the observed differences in trapping rates.

There was close agreement between the time smolts were trapped in Anchor River and the calculated time at which smolts had entered sea, as interpreted from adult scales. Adult scales showed a mean of 5.5 circuli formed as "plus" growth which corresponds to a period in early July; this was the same period when peak numbers of smolts were trapped in 1981.

Fish which were tagged with radio transmitters moved both upstream and downstream, but most remained in a same general area from the time of tagging in late September and early October until early February. This is of concern for those fish in the lower section of the river below the forks. That area receives the greatest fishing effort and the results show that the same fish are subjected to pressure for about a 1 to 2-month period in the fall. If the fish remain in the lower area until April and

Table 9. Frequencies of total number of freshwater circuli and number of freshwater circuli formed after the last freshwater annulus on scales from adult steelhead trout in Anchor River, 1981.

Total number of freshwater circuli		Number of freshwater circuli after last freshwater annulus	
Number of Circuli	Number of Fish	Number of Circuli	Number of Fish
21	1	0	8
22	1	1	2
23	0	2	1
24	2	3	12
25	4	4	11
26	5	5	14
27	2	6	7
28	5	7	7
29	9	8	13
30	5	9	10
31	11	10	2
32	13	11	0
33	9	12	3
34	8		
35	3	Total	90
36	5	Mean	5.5
37	5	Standard Deviation	3.0
38	0		
39	1		
40	1		
Total	90		
Mean	31.1		
Standard Deviation	3.8		

the river opens early enough to be fishable in the spring before the season is closed on April 15, the same fish are exposed to additional fishing effort. Vulnerability of the same individuals over such a prolonged period could easily lead to overfishing. This would be especially true in winters like 1976-77 when the river did not freeze over, or in 1980-81 when the river was "fishable" intermittently during January, February and March.

Up to now we have been unable to radio tag steelhead during the early segment of the run in August and early September. We speculate that fish which enter the river during that period move further upstream than the later segment of the run. During the coming year we will attempt to tag fish during the early part of the run to determine their instream migration patterns.

We also have been unable to have radio-tagged fish during the projected spawning period of May. Attempts will be made to obtain radios of a longer life and to track fish throughout their holding and spawning period.

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