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ALASKA DEPARTMENT OF FISH AND GAME

SUSITNA RIVER AQUATIC STUDIES PROGRAM

Report No. 11

WINTER STUDIES OF RESIDENT AND JUVENILE ANADROMOUS FISH (OCTOBER 1984 - MAY 1985)

PARTS 1 AND 2

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PART 1

Winter Studies of Juvenile Chinook and Coho Salmon in the Middle Susitna River, 1984-85

by Michael E. Stratton

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1.0 INTRODUCTION

Studies of juvenile salmon in the Susitna River have been a major part of the investigations being conducted by the Susitna River Aquatic Studies Program. The scope of these studies has been to describe the periods of freshwater residence, growth, timing of outmigration, distribution and relative abundance. Only one major winter study was conducted in the middle reach, during the winter of 1980-81. The objectives of this study were to determine the distribution and relative abundance of overwintering juvenile salmon and describe the habitat characteristics at rearing sites. This report presents the results of the juvenile salmon cold-branding study conducted on the Susitna River during the winter 1984-85. Two Pacific salmon species are addressed in this report: chinook salmon (*Oncorhynchus tshawytscha*) and coho salmon (*Oncorhynchus kisutch*).

Previous studies of juvenile salmon during 1982 and 1983 were focused on the reach of the Susitna River above the Chulitna confluence to Devil Canyon, the middle river (ADF&G 1983a, 1983b; Schmidt et al. 1984). These studies consisted primarily of stationary outmigrant traps at Talkeetna Station (RM 103.0) and sampling at mainstem, slough and tributary sites by beach seines and electroshocking. During the 1984 open-water season, an additional study, the summer cold branding study, was added in the middle reach to further describe juvenile chinook and coho salmon growth, migration timing and response to changing habitat conditions (Roth and Stratton 1985).

Investigations of the migration of juvenile salmon in the middle reach of the Susitna River from 1982-84 have indicated that a major outmigration occurs of smolt and pre-smolt juveniles of all species to areas below this reach. Previous winter studies have not provided information on the size of the overwintering populations of chinook and coho in the middle reach or their distribution. Towards the end of the summer 1984 cold branding studies, large numbers of juvenile salmon were observed both remaining in Indian River and entering selected sloughs and side channels. Catches, recaptures and outmigrant trap data all indicated that a large number of fish were remaining in the middle reach, and it appeared they would overwinter in these areas.

As the adult chinook escapement in the middle reach has continued to rise over the last five years (1,121 in 1981 to 7,180 in 1984) (Barrett et al. 1985), and there is no reason why they should not continue to rise (as this stock is not subjected to commercial fishing and very little sport fishing takes place), knowledge of the distribution and the responses of juvenile chinook and coho salmon to mainstem and rearing habitat changes is necessary to properly plan and manage this resource.

2.0 METHODS

2.1 Study Locations

Juvenile salmon studies were conducted in the middle Susitna River during the 1984-1985 winter season. Surveys were conducted in mid-October, after water levels had lowered and stabilized, to locate four sampling sites which contained sufficient numbers of juvenile chinook salmon to insure catches throughout the winter. The sites selected were Slough 9A (RM 133.6), Slough 10 (RM 133.8), Slough 22 (RM 144.3), and Indian River (RM 138.6) (Figure 1).

2.2 Field Data Collection and Recording

Mark-recapture studies of juvenile salmon using cold branding were conducted in the middle river from October 15, 1984 through May 15, 1985. Studies were conducted by a two or three man crew based at the Gold Creek cabin using helicopters and snowmachines for transportation.

Each of the four winter study sites was divided into "partitions." Partitioning was based on several habitat parameters including water depths and cover types. Each site contained from three to five partitions (Figures 2, 3, 4, and 5).

Baited minnow traps were used to capture juvenile salmon. Sites were sampled two to three times per month and fish were captured, branded,

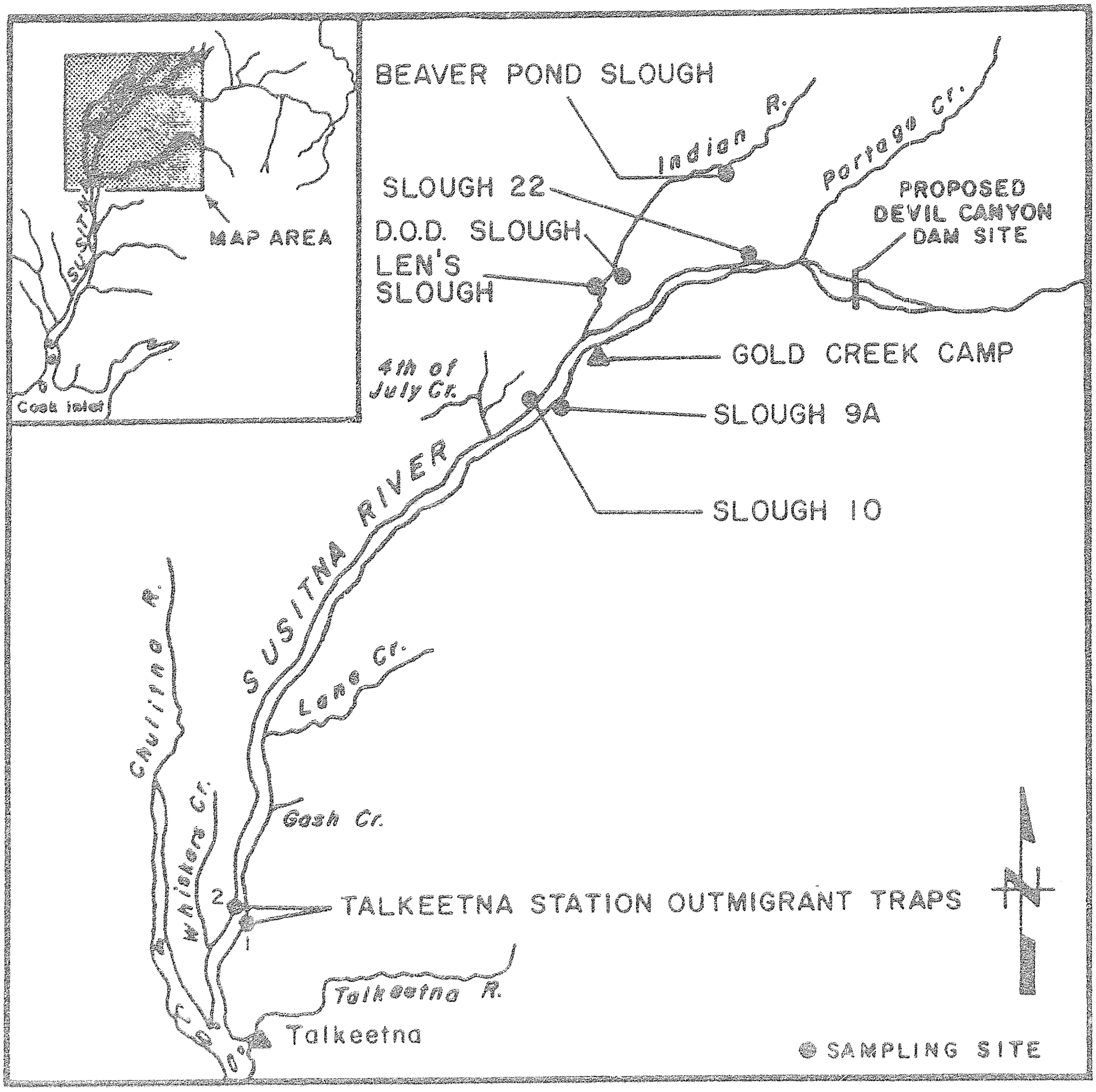

Figure 1. Map of cold branding sites in the middle reach of the Susitna River, winter 1984-85.

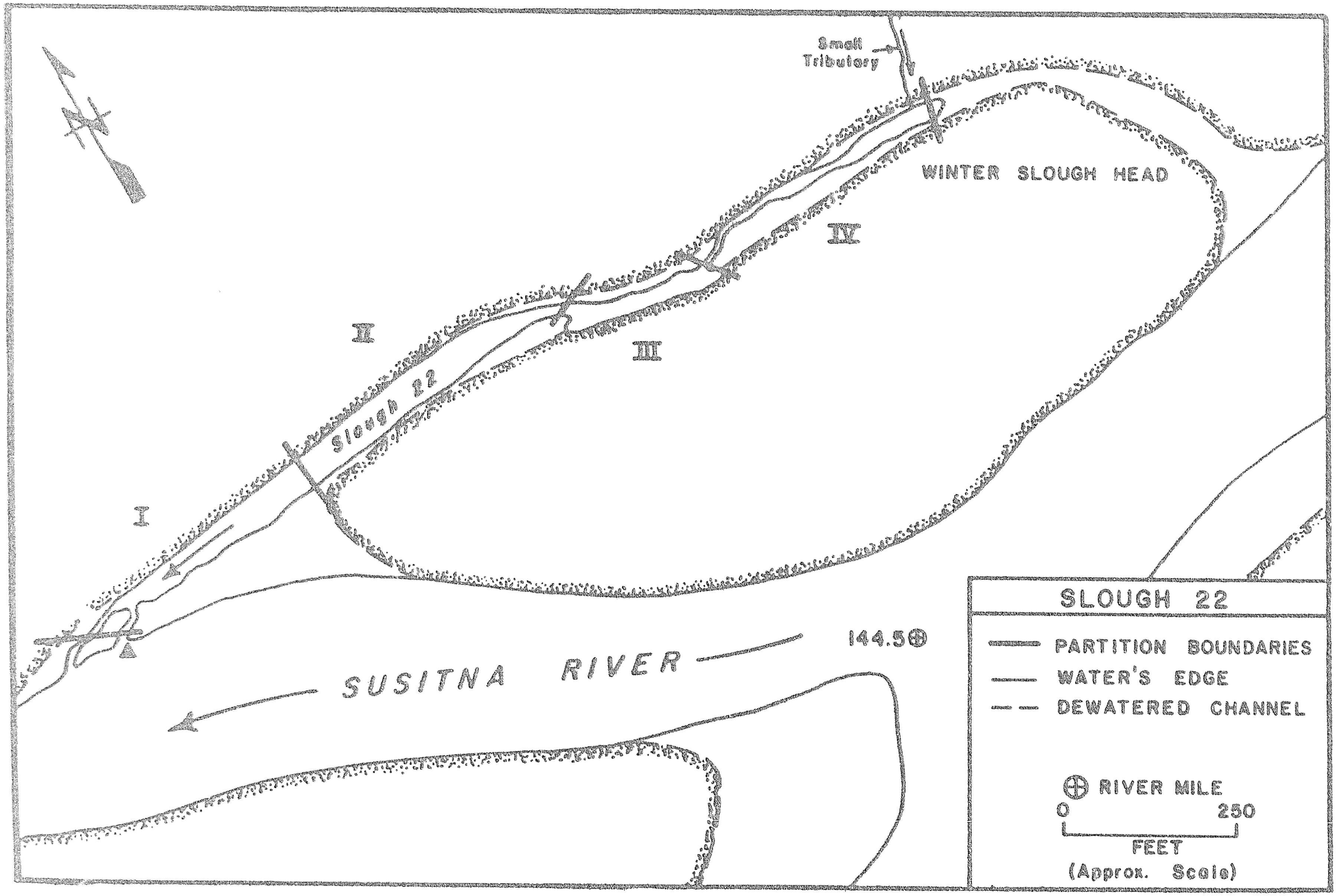

Figure 2. Map showing the partitioning of Slough 22, winter 1984-85.

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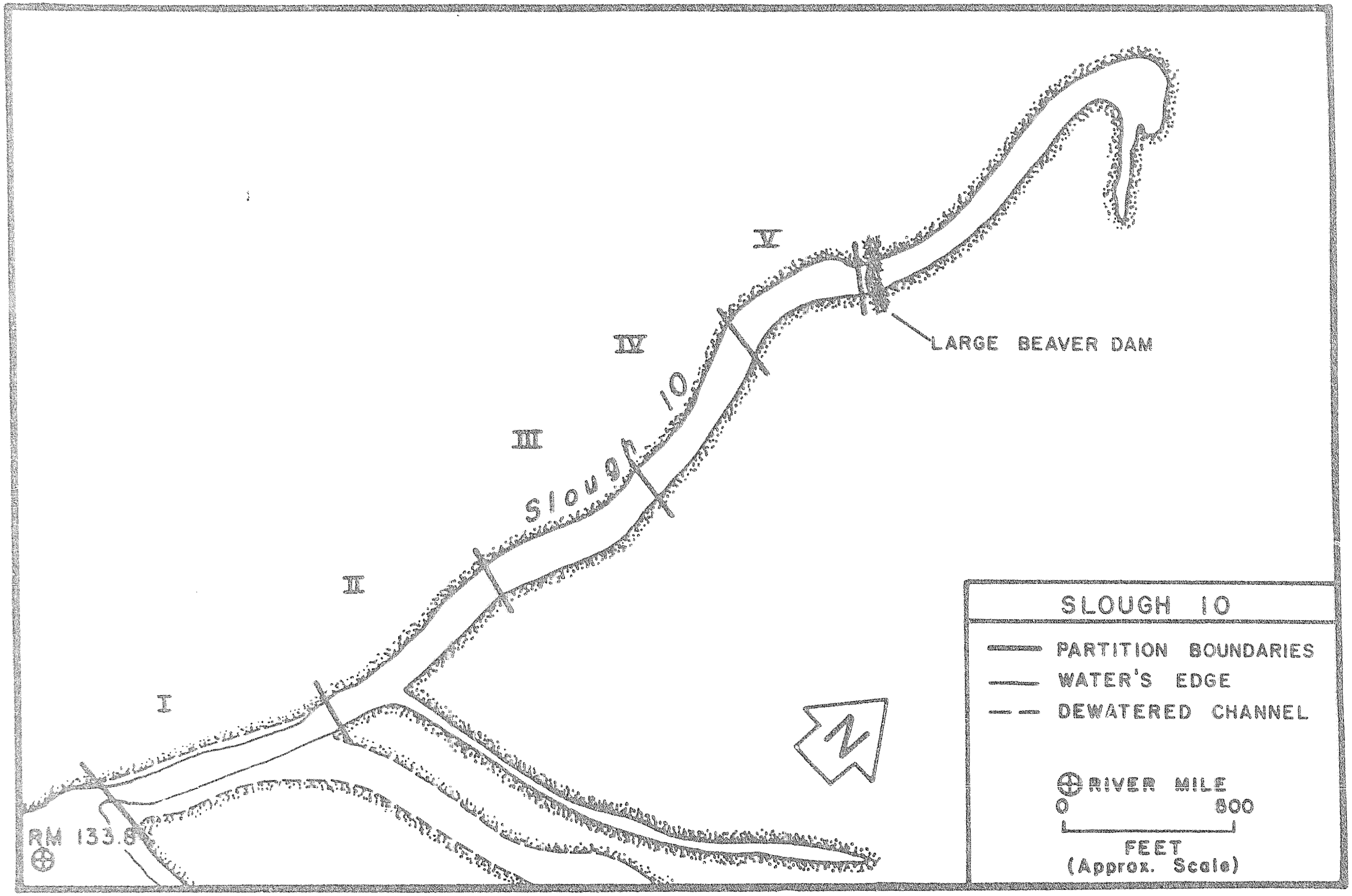

Figure 3. Map showing the partitioning of Slough 10, winter 1984-85.

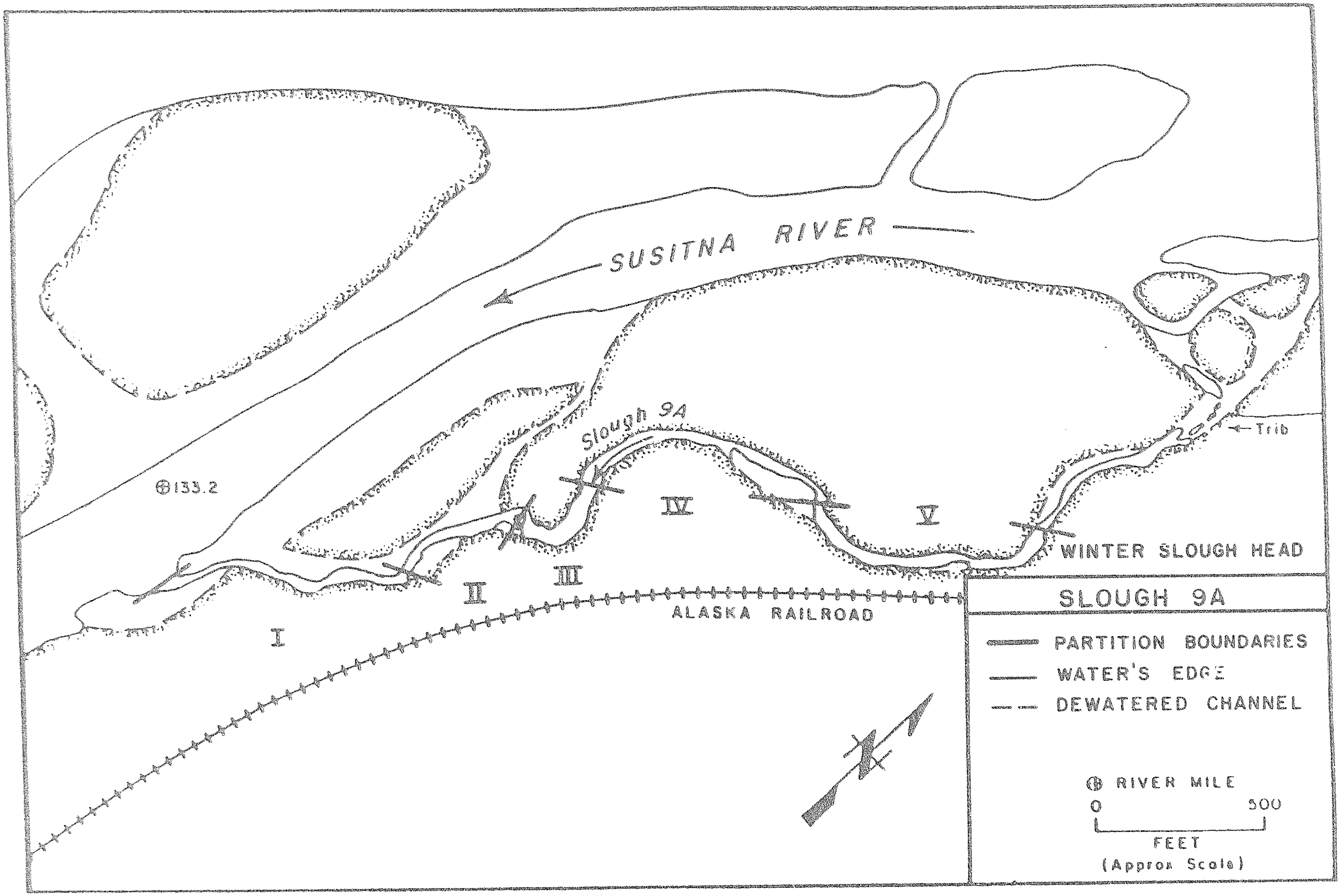

Figure 4. Map showing the partitioning of Slough 9A, winter 1984-85.

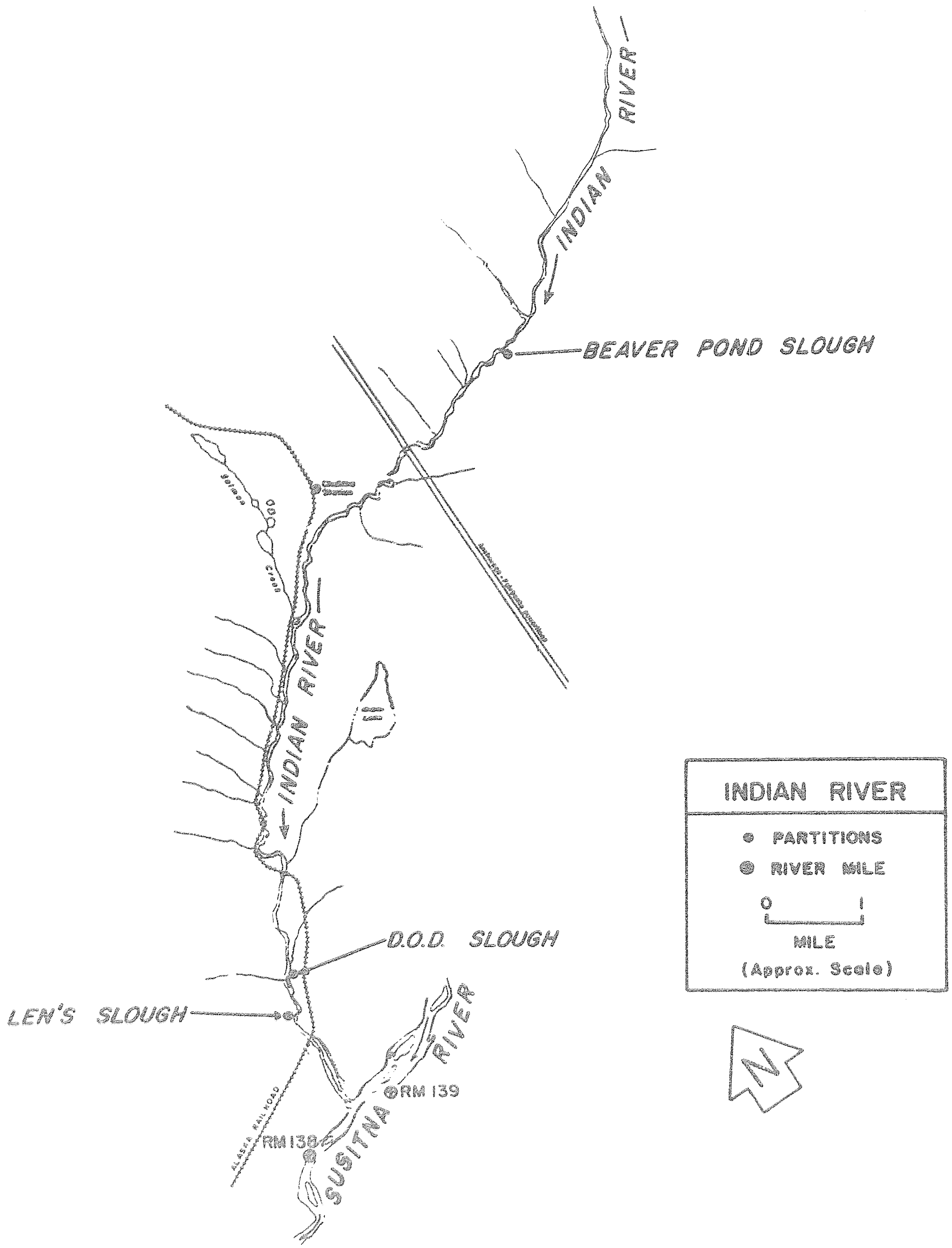

Figure 5. Map showing the partitions in Indian River, winter 1984-85.

and released during each sampling trip. Five traps were set in each partition in the same general area each trip. Changing ice conditions during the winter meant traps were set in a variety of conditions ranging from open water leads to under 40 inches of ice. All fish were marked and held overnight at the Gold Creek cabin, and then released in the partition where they were collected.

The brands consisted of single brass letters or symbols measuring three millimeters in height which were soldered onto threaded brass caps. Liquid nitrogen was used as the cooling agent and the branding procedures were similar to those outlined by Mighell (1969) and Raleigh et al. (1973). The cold branding equipment is described in ADF&G (1985a).

Juvenile chinook and coho salmon were marked with a distinctive brand to signify when and where they were captured. Fish were marked at one of three target branding sites on either side of their body (Figure 6), and a branding time of two seconds was used. Recaptures were rebranded if they did not already have a brand at the branding location for that time period.

Date, location, branding symbol, fishing effort, and collectors were recorded for each sampling site. Species, number of fish captured and branded, and numbers and symbols of recaptures were recorded for each partition. Total lengths of 50 juvenile chinook and coho salmon were recorded once a month at each sampling site.

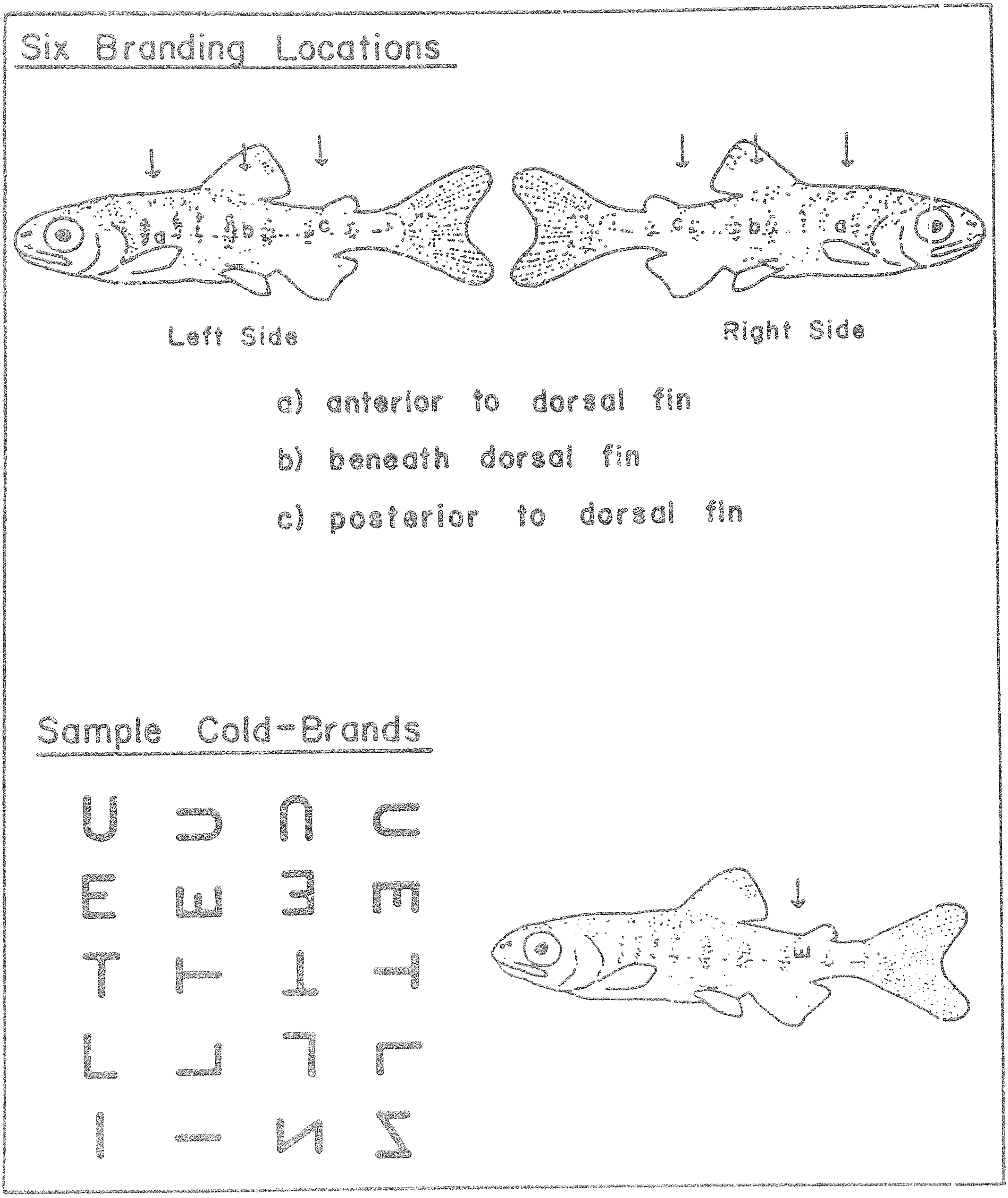

Figure 6. Branding ..cations and sample brands used for cold branding juvenile salmon, winter 1984-85.

Habitat data including cover type, percent cover, and average depth within each partition were visually assessed once towards the end of the field season. This was deemed sufficient as these parameters did not change much over the course of the field season.

Surface and intragravel water temperatures and percent ice cover and thickness data were collected at each partition, each trip. At the beginning of the study, water temperatures were taken with a Digisense thermometer, but continuing malfunctions forced us to finally use hand-held mercury thermometers. Temperature data from datapods in Indian River and Slough 10 were used in comparing selected habitat variables, as the hand-held thermometer temperatures varied greatly, depending on the exact sampling location.

2.3 Data Analysis

The catch per unit effort (CPUE) data is calculated as catch per minnow trap day. All sets were approximately 24 hours which was calculated as one minnow trap day.

Population estimates for each of the winter study sites are calculated by the Schaefer method (Ricker 1975), given in Appendix B. Population estimates for the entire 1983 brood year juvenile chinook salmon and that portion of it overwintering in the middle river above Talkeetna Station are calculated by the Petersen method (Ricker 1975), given in Appendix B.

3.0 RESULTS

3.1 Biological Data

3.1.1 Chinook Salmon

An estimated escapement of 9,120 adult chinook salmon (95% Confidence Interval 6,148 - 14,212) passed Curry Station (RM 120) during the summer of 1983. Based on peak escapement counts on the spawning grounds, 99.8% of these fish spawned at or above the 1984-85 winter studies sampling sites, with the majority going to Portage Creek (70.8%) and Indian River (26.9%) (Barrett et al. 1984).

The mean length of adult females past Curry Station in 1983 was 855 mm (Barrett et al. 1984). The average fecundities of Susitna River fish of this length as determined in the 1985 fecundity study at Sunshine station is 7,824 eggs (ADF&G 1985 unpublished data). This provides a total deposited egg estimate of 7.82 million for Indian River (escapement x male:female ratio x proportion in Indian River x mean fecundity).

3.1.1.1 Catch

A total of 11,543 juvenile chinook salmon were captured during the winter 1984-85 studies beginning in mid-October and ending in mid-May. Juvenile chinook were most abundant at Slough 22, where 59% of the total catch occurred (Table 1). Catches were high in early winter, peaking in December then rapidly declining to a low in May (Table 2).

3.1.1.2 Catch Per Unit Effort

Catch rates at the winter study sites varied greatly. Overall site catch rates (Figures 7, 8, 9, and 10) reflect the differences in juvenile chinook abundance between the sites. Slough 22 had, by far, the highest catch rates, while catch rates were generally lowest at Indian River and Slough 10. Catch rates were higher early in the season until January, when they dropped dramatically.

Catch rates at each site, within each partition, also varied greatly. At Slough 22 and Slough 9A, catch rates were higher in the upper partitions, while Slough 10 catch rates were generally higher at the mouth. Indian River catch rates were highest at Len's Slough, the lowest site. Catch rates by partition are shown in Appendix Figures A-1, A-2, A-3, and A-4.

3.1.1.3 Lengths

Chinook salmon juveniles exhibited little growth during the winter study (Figure 11). The mean length in the middle river at the end of the open water field season was 63 mm. Throughout the winter studies (October - May) the mean lengths at the study sites showed an increase of approximately 1 mm per month, by mid-May the mean lengths were around 70

Table 1. Juvenile chinook salmon catches by site and partition, 1984-85 winter studies.

Location	Partition		Catch	(%)	% Total
Indian River					
	Len's Slough		619	(51)	
	D.O.D. Slough		211	(17)	
	Beaver Pond Sl.		378	(32)	
		Total	1,208		(10%)
Slough 10					
	I		282	(27)	
	II		192	(18)	
	III		169	(16)	
	IV		296	(28)	
	V		109	(11)	
		Total	1,048		(9%)
Slough 9A					
	I		64	(3)	
	II		340	(14)	
	III		960	(38)	
	IV		451	(18)	
	V		686	(27)	
		Total	2,501		(22%)
Slough 22					
	I		1,670	(25)	
	II		1,425	(21)	
	III		1,196	(18)	
	IV		2,495	(36)	
		Total	6,786		(59%)

Table 2. Juvenile chinook salmon catch by site and date, 1984-85 winter studies.

Location	Date								Total
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	
Slough 22	940	1,074	1,883	1,442	445	622	327	53	6,786
Slough 10	237	237	143	252	28	124	17	10	1,048
Slough 9A	265	514	792	416	159	146	137	72	2,501
Indian River	236	190	392	207	70	40	51	22	1,208
TOTALS	1,678	2,015	3,210	2,317	702	932	532	157	11,543

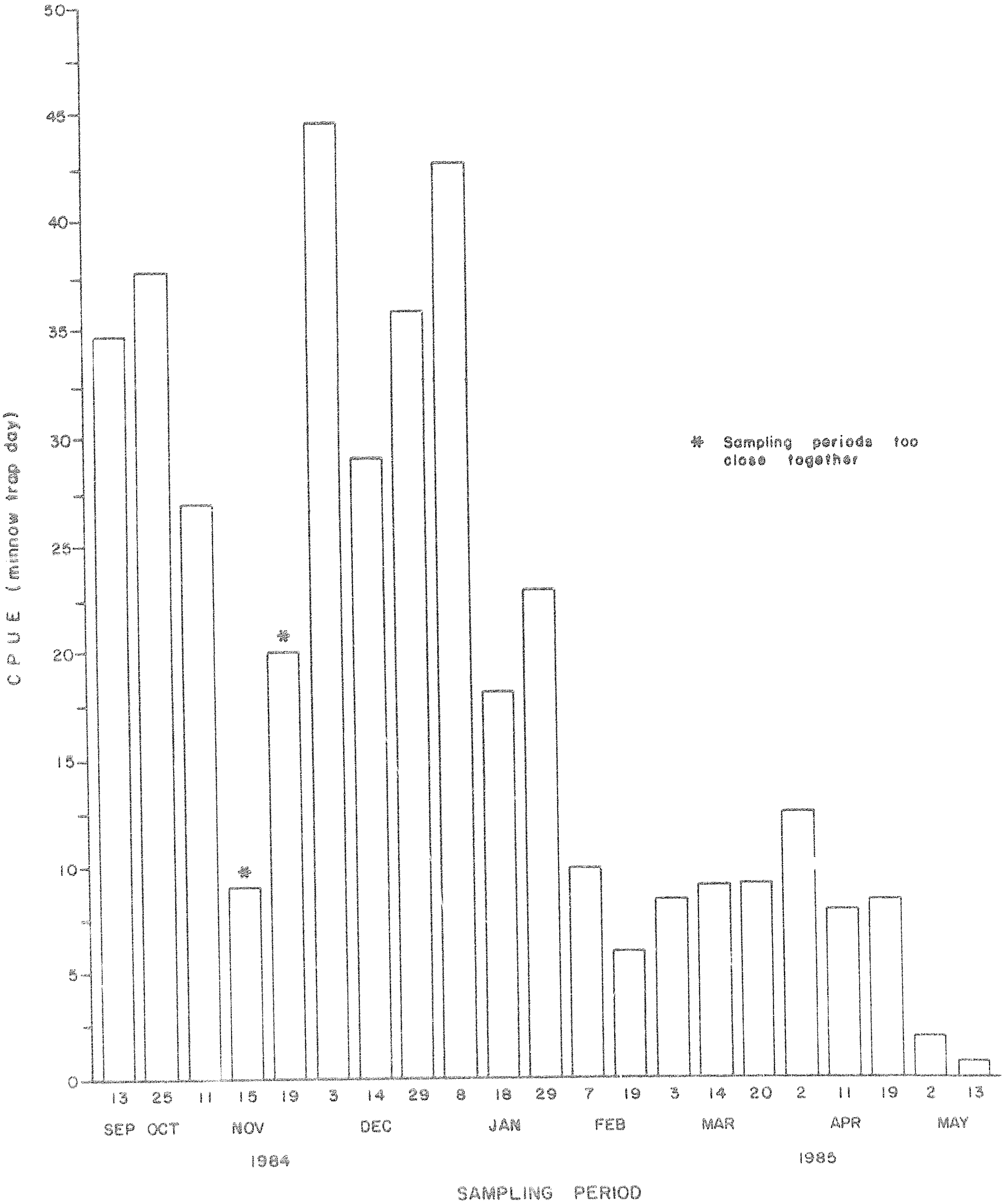

Figure 7. Overall site chinook catch rates at Slough 22, winter 1984-85.

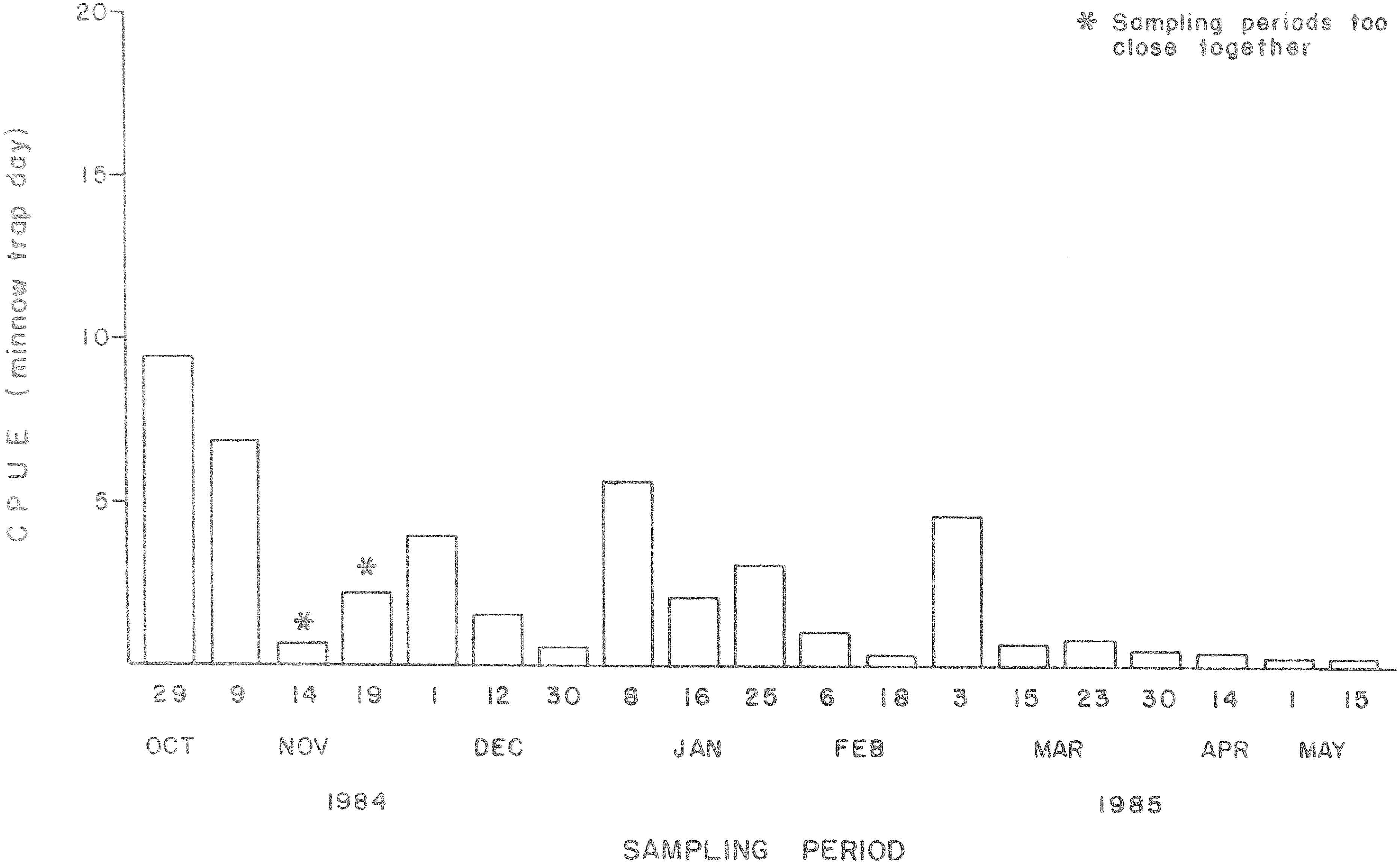

Figure 8. Overall site chinook catch rates at Slough 10, winter 1984-85.

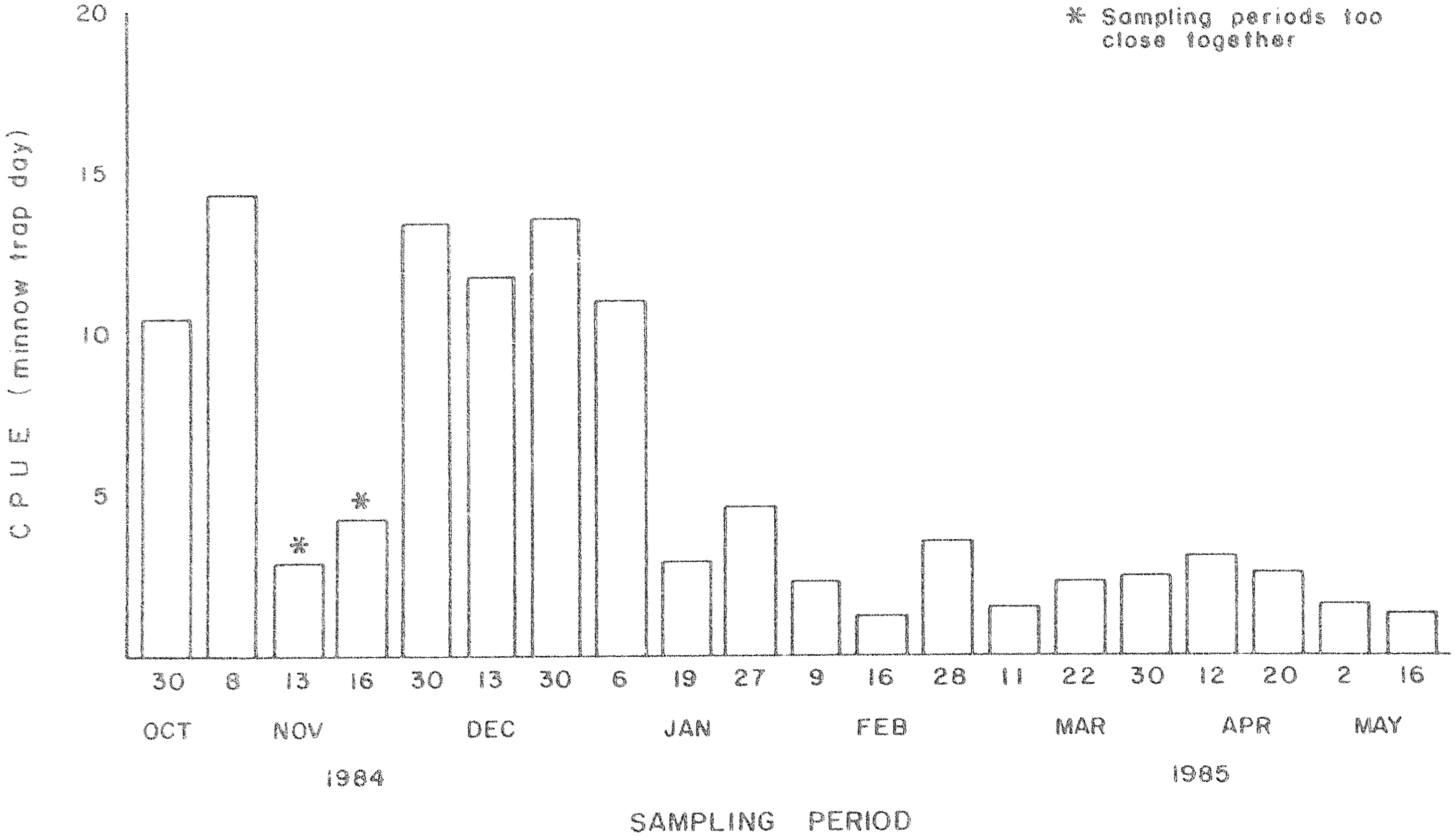

Figure 9. Overall site chinook catch rates at Slough 9A, winter 1984-85.

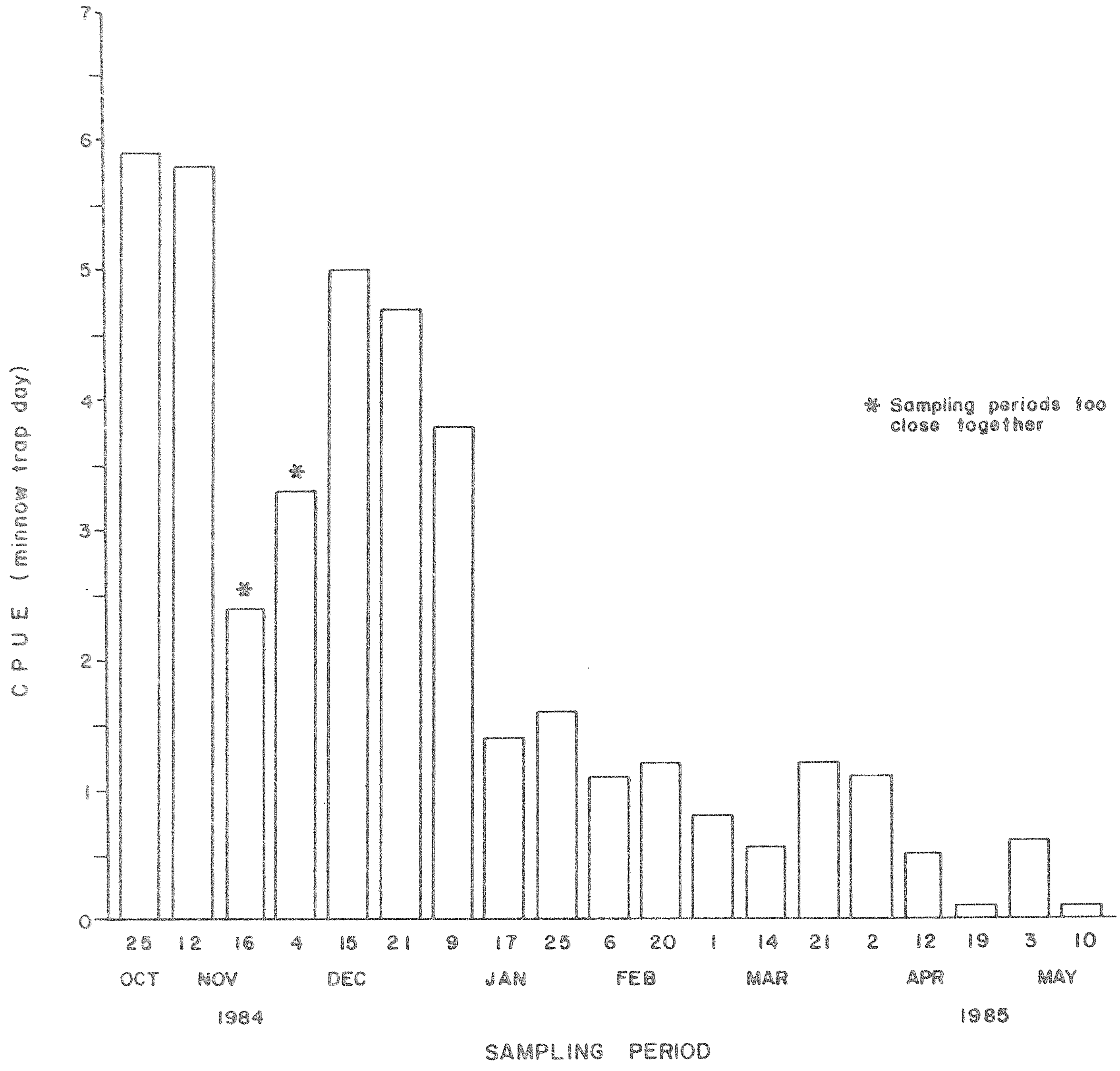

Figure 10. Overall site chinook catch rates at Indian River, winter 1984-85.

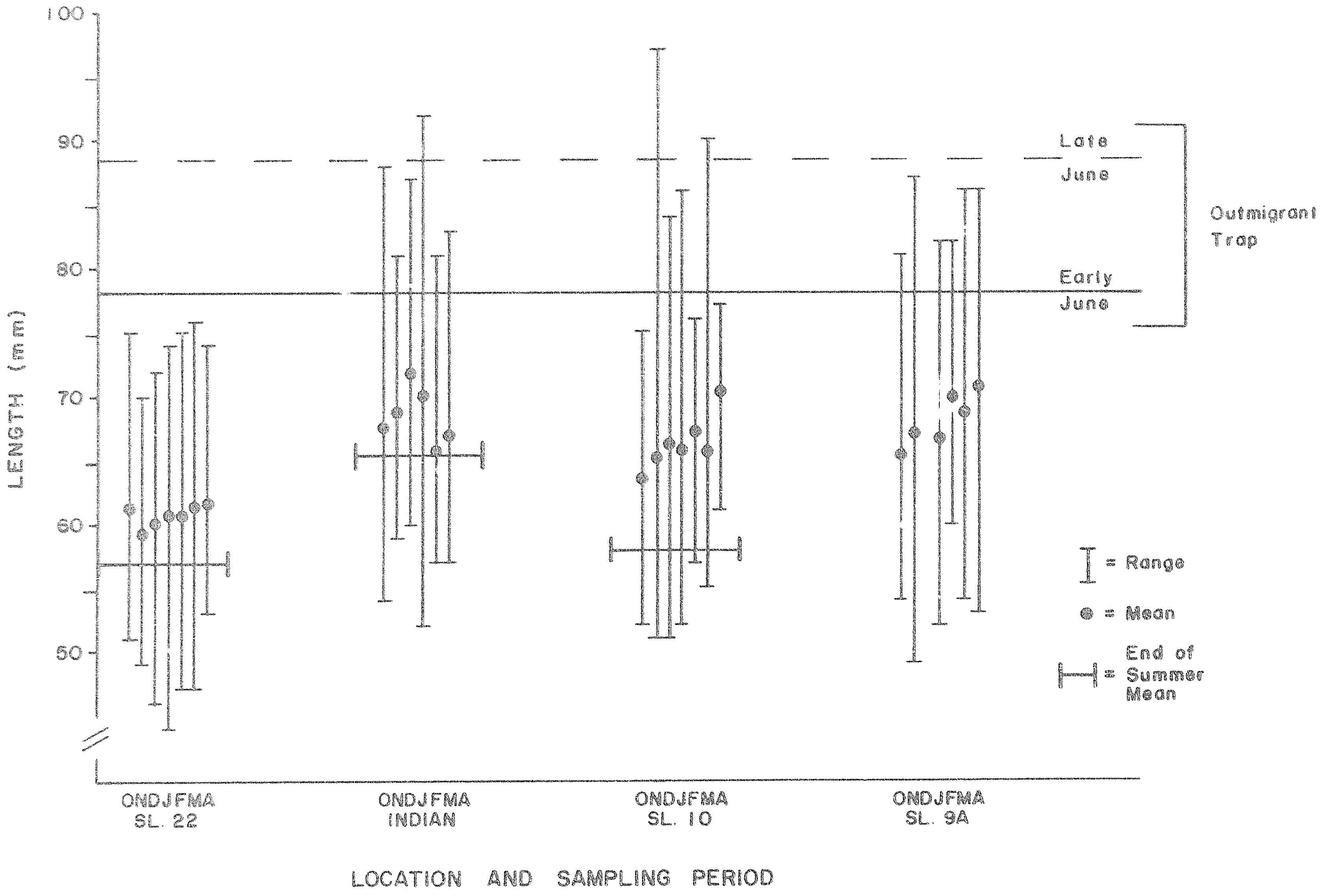

Figure 11. Juvenile chinook salmon mean lengths and range of lengths by site and sampling period, winter 1984-85.

mm. Preliminary 1985 outmigrant trap data shows a mean length of 78 mm by early June and 89 mm by late June (ADF&G 1985 unpublished data).

Figure 11 also shows a slight difference in lengths between Portage Creek and Indian River stocks. Indian River fish averaged approximately 8 mm larger than their Portage Creek counterparts (Portage Creek itself was not sampled. However, fish at Slough 22, almost 6 miles above Indian River, are all believed to be Portage Creek fish). Juvenile chinook lengths from Slough 9A and Slough 10, a mixture of both Indian and Portage fish, fell in between the Portage and Indian means.

3.1.1.4 Branding and recovery

A total of 9,744 juvenile chinook salmon were cold branded between October 15, 1984 and April 30, 1985 (Table 3). Of these, 3,265 were later recaptured (Table 4). All but two of the recaptures were made at the same site where the fish were originally branded and released. One fish was branded and released in Slough 22 on November 15 and recaptured at the mouth of Slough 10 on March 30. The other fish was branded November 16 in Indian River and recaptured at the mouth of Slough 10 on February 6. Recapture rates were highest in the recapture period immediately following the tagging period then slowly declined to almost nothing in May.

Many fish were captured and branded more than once. One individual fish in Slough 22 was captured on six occasions (Sept., Oct., Nov., Dec.,

Table 3. Juvenile chinook salmon tagging data by site and date, 1984-85 winter studies.

Location	Date							Total
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	
Slough 22	938	1,022	1,533	1,266	292	411	271	5,733
Slough 10	237	235	141	115	108	25	7	868
Slough 9A	265	499	707	401	111	89	128	2,200
Indian River	236	184	377	79	28	7	32	943
TOTALS	1,676	1,940	2,758	1,861	539	532	438	9,744

Table 4. Juvenile chinook salmon recaptures by site and date, 1984-85 winter studies.

Location	Date							Total
	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	
Slough 22	165	621	627	315	456	270	27	2,481
Slough 10	7	20	24	14	7	4	4	80
Slough 9A	27	86	90	50	38	21	15	327
Indian River	68	113	84	34	34	29	15	377
TOTALS	267	840	825	413	535	324	61	3,265

March and April) and received five brands. Actual tagging and recapture data are presented in Appendix B.

A total of 38 branded chinook were recaptured at the outmigrant traps at Talkeetna Station by August 6, 1985 (1985 preliminary data). Of these fish, 25 were from the summer 1984 cold branding study and 13 were from the winter study. The majority of these recaptures were from the summer cold branding study at Indian River. The actual data including branding and recapture date and branding and recapture location are presented in Appendix Table B-1.

3.1.1.5 Population Estimates

Population estimates were calculated for the winter study sites using the Schaefer method. The total estimates plus a monthly breakdown by site are given in Table 5. The largest populations were present at most sites during early winter, October - December, then fell sharply for the remainder of the winter. Slough 9A had the largest population for the winter with an estimated 14,216 fish. Slough 10 had the lowest population with an estimated 8,577 fish. Population estimates were calculated separately for two of the three Indian River partitions as the third, D.O.D. Slough, had too few recaptures. No confidence intervals are provided with the Schaefer estimate. The Schaefer tables are given in Appendix B.

The juvenile chinook population estimates calculated for the middle river above Talkeetna Station are 8.87 million (C.I. 6.67-12.08 million)

Table 5. Population estimates calculated by site and month for chinook salmon using the Schaefer method, 1984-85 winter studies.

Location	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Total
Slough 22	3,466	2,775	2,842	1,817	419	548	578	12,442
Slough 10	4,258	1,971	1,098	719	475	56	N/E	8,577
Slough 9A	3,525	3,787	3,360	1,681	660	512	691	14,216
Indian River								
Beaver Pond	306	223	179	74	22	N/E	N/E	804
Len's Slough	280	170	283	59	28	28	N/E	848

for the entire 1983 brood year and 1.98 million fish (C.I. 1.16 - 3.74 million) for that portion of the total which overwinter in the middle reach. The estimated percent of 1983 brood year juvenile chinook overwintering above Talkeetna Station during the 1984-85 winter is 22.4%. Since the Petersen estimater gives the maximum likely estimate, the estimated percent overwintering should be a minimum value. Data used in these Petersen estimates are given in Appendix Table B.

3.1.2 Coho Salmon

An estimated escapement of 761 adult coho salmon (95% C.I. 425-1,551) passed Curry Station during the summer of 1983. Based on peak escapement counts on the spawning grounds, 90.9% of these fish spawned at or above the 1984-85 winter studies sampling sites, with the majority going to Indian River (82%) (Barrett et al. 1984).

A coho fecundity study was conducted in 1984 at Sunshine Station. The fecundity for an average length female coho at Curry Station (542 mm) was determined to be 2,800 eggs (Barrett et al. 1985). This produces a total deposited egg estimate above Curry of 1.01 million.

3.1.2.1 Catch

A total of 472 juvenile coho salmon were captured during the 1984-85 winter studies. Juvenile coho were most abundant in Indian River and Slough 10, where 47 and 44% of the catch occurred, respectively. Very few coho were captured in Sloughs 9A and 22 (Table 6). Catches were highest in early winter, October-January, then rapidly decreased to a low of only 8 in May (Table 7).

3.1.2.2 Catch Per Unit Effort

Catch rates at the winter study sites were relatively constant. The catch rates at sites which contained cohos ranged between 0 and 3.4 fish per minnow trap day (Figures 12 and 13). Cohos were present during every sampling period at Slough 10, the only site where this occurred.

3.1.2.3 Lengths

Coho salmon juveniles exhibited little or no increase in length over the course of the winter study (Figure 14). The mean length in the middle river at the end of the open water season was 56 mm (Roth and Stratton, 1985). During the winter, mean lengths at the study sites showed an increase of approximately 1 mm per month. By mid-May, the mean length was around 62 mm. Preliminary outmigrant trap data from Talkeetna Station show mean lengths of approximately 69 mm in early June and 79 mm in late June.

3.1.2.4 Branding and Recovery

A total of 393 juvenile coho salmon were cold branded between October 15 and April 30 (Table 8). Thirty of these fish were later recaptured, all but one were recaptured in the same site where they were branded and

Table 6. Juvenile coho salmon catches by site and partition, 1984-85 winter studies.

Location	Partition		Catch	(%)	% Total
Indian River					
	Len's Slough (TRM ___)		54	(24)	
	D.O.D. Slough (TRM ___)		115	(51)	
	Beaver Pond Sl. (TRM ___)		55	(25)	
		Total	224		(47%)
Slough 10					
	I		7	(3)	
	II		8	(4)	
	III		6	(3)	
	IV		125	(60)	
	V		63	(30)	
		Total	209		(44%)
Slough 9A					
	I		-	(0)	
	II		4	(14)	
	III		12	(43)	
	IV		7	(25)	
	V		5	(18)	
		Total	28		(6%)
Slough 22					
	I		2	(18)	
	II		2	(18)	
	III		4	(36)	
	IV		3	(28)	
		Total	11		(3%)

Table 7. Juvenile coho salmon catch by site and date, 1984-85 winter studies.

Location	Date								Total
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	
Slough 22	2	3	2	3	-	-	-	1	11
Slough 10	47	51	34	24	33	10	5	5	209
Slough 9A	5	7	11	-	1	1	2	1	28
Indian River	55	25	37	75	16	12	3	1	224
TOTALS	109	86	84	102	50	23	10	8	472

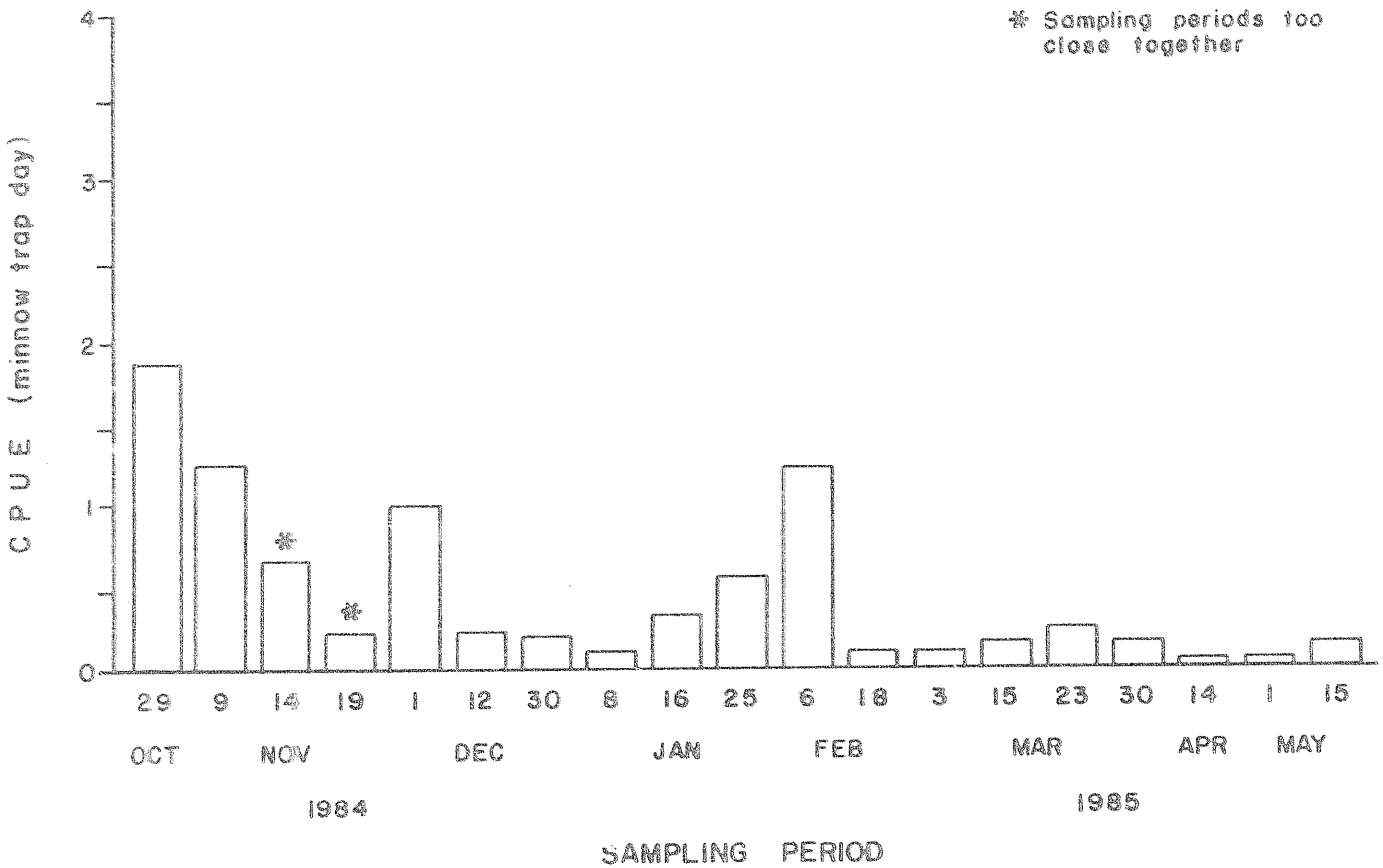

Figure 12. Overall site coho catch rates at Slough 10, winter 1984-85.

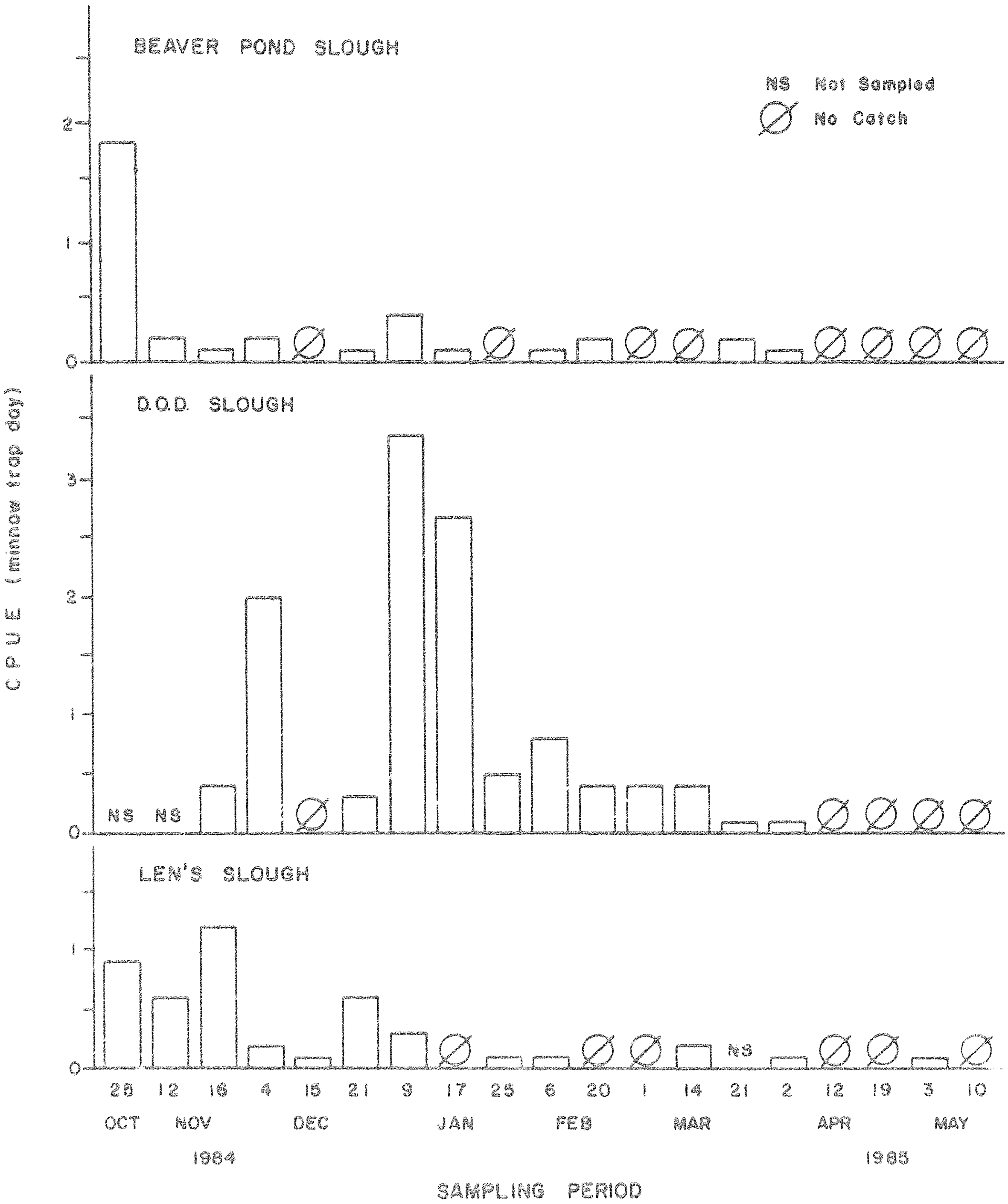

Figure 13. Juvenile coho catch rates at Indian River, winter 1984-85.

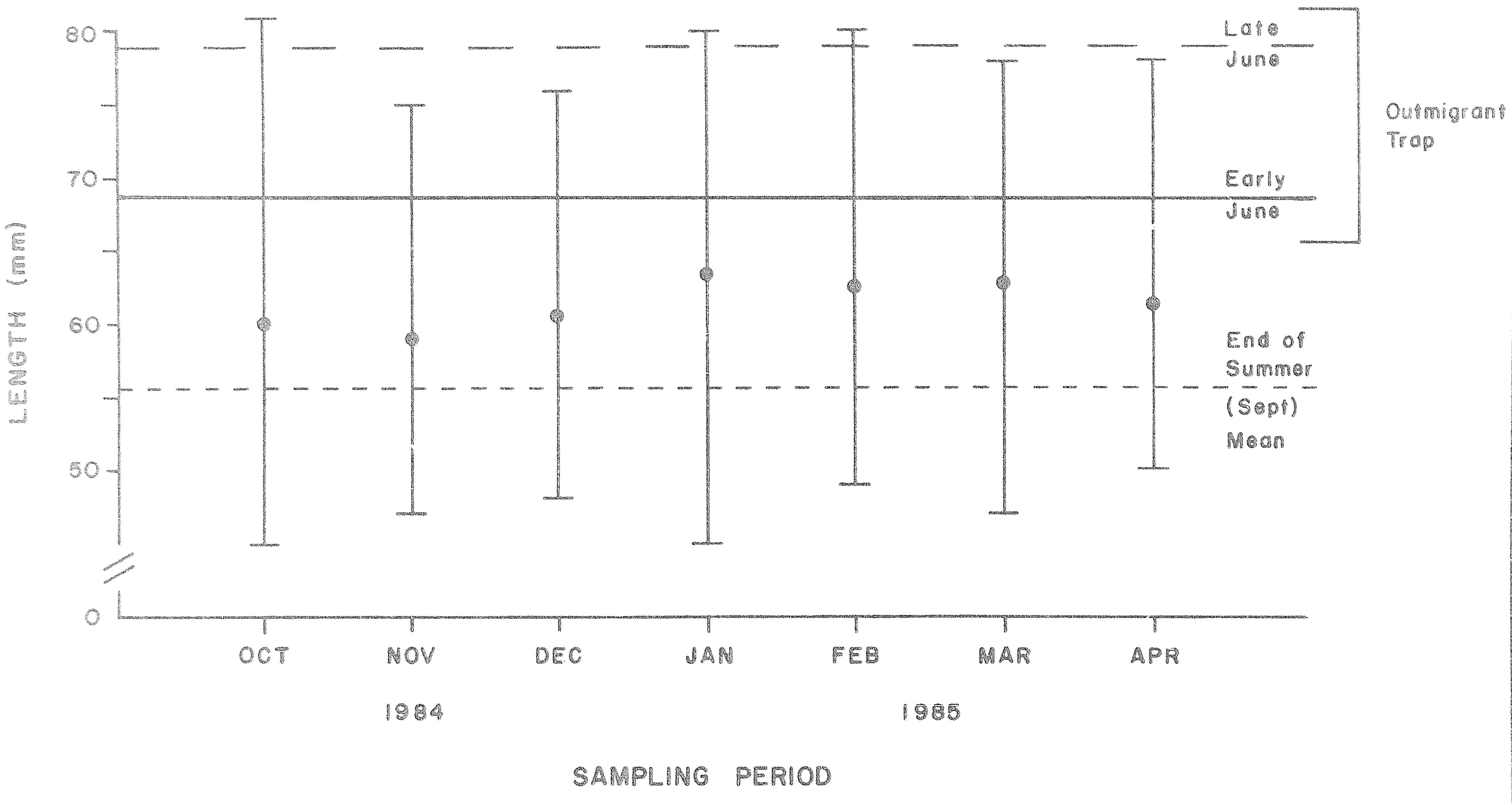

Figure 14. Juvenile coho salmon mean lengths and range of lengths by sampling period, winter 1984-85.

Table 8. Juvenile coho salmon tagging data by site and date, 1984-85 winter studies.

Location	Date							Total
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	
Slough 22	2	3	2	3	-	-	-	10
Slough 10	47	49	34	22	31	8	1	192
Slough 9A	5	16	1	1	-	1	2	26
Indian River	55	25	36	34	10	2	3	165
TOTALS	109	93	73	60	41	11	6	393

released (Table 9). The one exception was branded and released in Indian River on November 15 and recaptured in Slough 10 on February 6. The majority of the recaptures, like the catch, occurred prior to December.

Two branded coho were recaptured at the outmigrant traps at Talkeetna Station by July 16, 1985. Both of these fish had been branded in Indian River during the winter study, one on October 26 and one on March 14, and were recaptured on July 9 and 13, respectively.

3.2 Habitat Data

Discharge in the middle Susitna River average approximately 2,100 cubic feet per second (cfs) during the winter study, ranging from a high of 5,600 in mid-October to a low of 1,600 in April (USGS Provisional Data, 1985) (Figure 15). After the discharge has reduced to below 4,000 cfs (usually occurring in early-November), our observations suggest that Susitna River surface waters had little effect on the slough and side channel habitat conditions. The slough levels, water temperatures and physiochemical parameters are governed primarily by their groundwater sources and air temperatures, the exception being when local ice damming and staging occurs, overflowing slough mouth areas and, during excessive periods, actually overtopping the slough (this occurred in Slough 8A during the winter of 1982-1983).

Slough habitat and morphology for the open water season have been recorded for these study sites in previous ADF&G reports (ADF&G 198 a,

Table 9. Juvenile coho salmon recaptures by site and date, 1984-85 winter studies.

Location	Date							Total
	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	
Slough 22	-	2	-	-	-	-	-	2
Slough 10	2	8	2	1	1	-	3	17
Slough 9A	-	-	-	-	-	-	1	1
Indian River	3	1	4	-	1	-	1	10
TOTALS	5	11	6	1	2	-	5	30

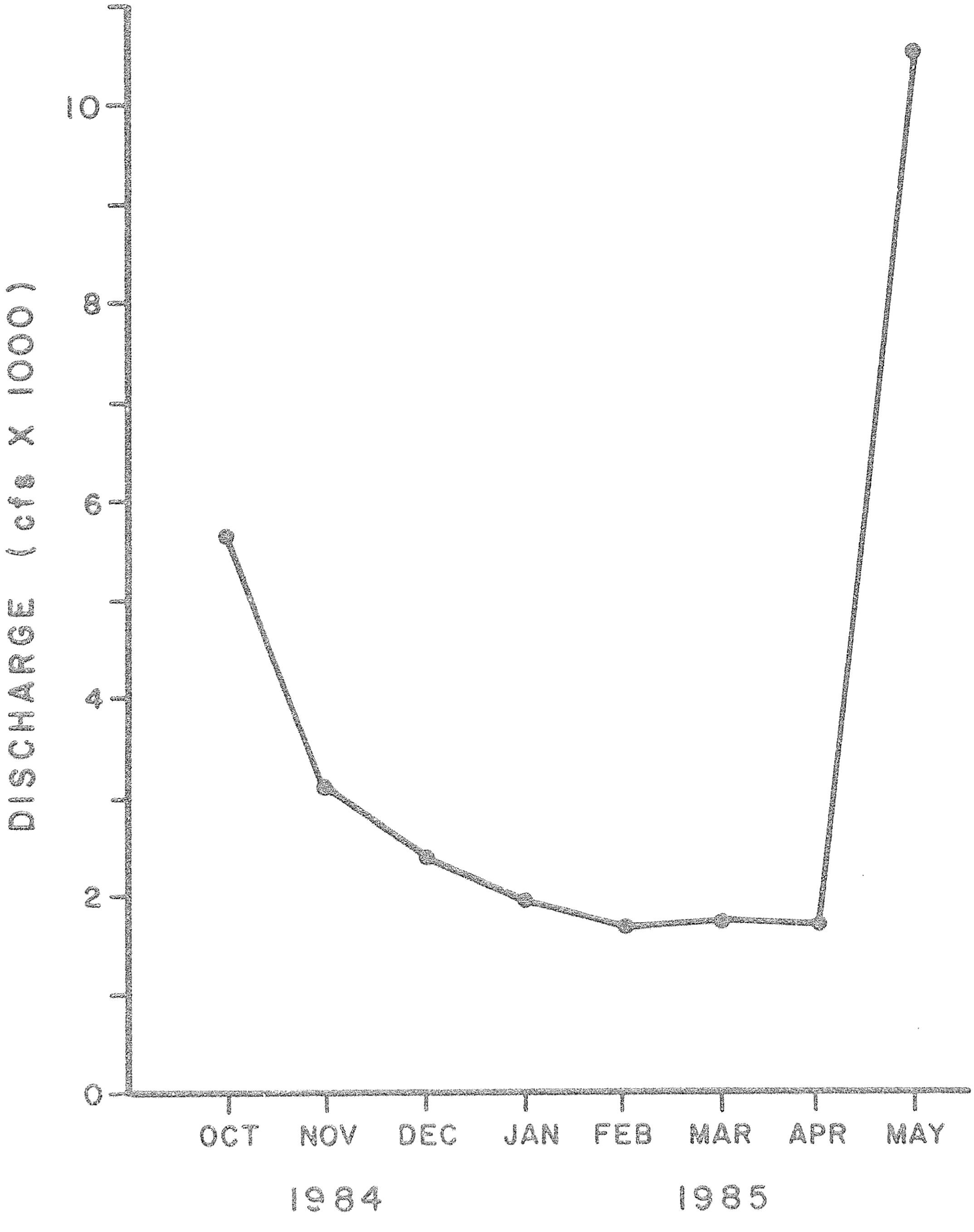

Figure 15. Mean Susitna River discharge by month, winter 1984-85.

1983c; Marshall 1983; Estes et al. 1984). The following section will provide an overall view of the basic habitat characteristics which occurred at the study sites during the 1984-85 winter study.

Basic habitat characteristics which changed little or not at all over the course of the winter study are summarized in Table 10. These characteristics include cover, water depth, and velocity. Cover ranged from none to boulders and included debris and aquatic vegetation. Average water depths ranged from 0.3 to 5.0 feet in the various partitions with velocities ranging from 0 to 0.6 feet per second (fps).

Cover suitability for chinook and coho salmon was calculated for each partition using the criteria outlined in Suchanek et al. 1984. These criteria do not take into account winter variables including water quality parameters, temperatures, and ice cover or fish behavior variables including reduced feeding and activity during the winter. Calculated cover suitabilities ranged from poor to excellent at Slough 22, poor to good at Slough 10, fair to excellent at Slough 9A, and fair to excellent at Indian River (Table 10).

Ice cover was a highly variable habitat characteristic during the winter study at most of the partitions. Percent ice cover is closely related to ambient air temperatures, water velocity, and water depth. Partitions with higher velocities had less ice cover, deeper partitions had more ice cover, and rising and lowering air temperatures decreased and increased ice cover, respectively. Figures 16, 17, 18, and 19 show

Table 10 . Basic habitat characteristics present at the winter study sites by partition, 1984-85 winter study.

Site	Section	Primary Cover	% Cover	Cover Suitability[1] Chinook	Cover Suitability[1] Coho	Secondary Cover	Average (ft) Depth	Average (fps) Velocity
Slough 10 (Upland Slough)	1	5"+	0 - 5	0.09	0.02	None	0.3	0.6
	2	Aq. Veg.	6 - 25	0.22	0.22	5"+	0.5	0.4
	3	Aq. Veg.	6 - 25	0.22	0.22	Debris	0.7	0.2
	4	Aq. Veg.	26 - 50	0.37	0.36	5"+	1.0	0.1
	5	3" - 5"	6 - 25	0.27	0.06	5"+	2.0	0.0
Slough 9A (Side Slough)	1	1" - 3"	6 - 25	0.21	0.08	3" - 5"	0.5	0.4
	2	3" - 5"	6 - 25	0.21	0.06	1" - 3"	1.5	0.2
	3	Debris	26 - 50	0.33	0.31	5"+	5.0	0.0
	4	5"+	6 - 25	0.29	0.06	3" - 5"	1.5	0.1
	5	3" - 5"	26 - 50	0.45	0.10	5"+	1.5	0.1
Slough 22 (Side Slough)	1	5"+	26 - 50	0.49	0.10	Debris	1.5	0.1
	2	5"+	0 - 5	0.09	0.02	None	3.0	0.0
	3	5"+	6 - 25	0.29	0.06	3" - 5"	2.0	0.1
	4	5"+	26 - 50	0.49	0.10	3" - 5"	0.7	0.0
Indian River (Tributary)	Len's	3" - 5"	6 - 25	0.27	0.06	5"+	0.5	0.3
	DOD							
	Lower	3" - 5"	6 - 25	0.27	0.06	Debris	1.5	0.1
	Upper	5"+	26 - 50	0.49	0.10	3" - 5"	0.7	0.4
	B.P.	3" - 5"	6 - 25	0.27	0.06	5"+	0.5	0.3

[1] Poor: 0.20

Fair: 0.21 - 0.30

Good: 0.31 - 0.40

Excellent: 0.40

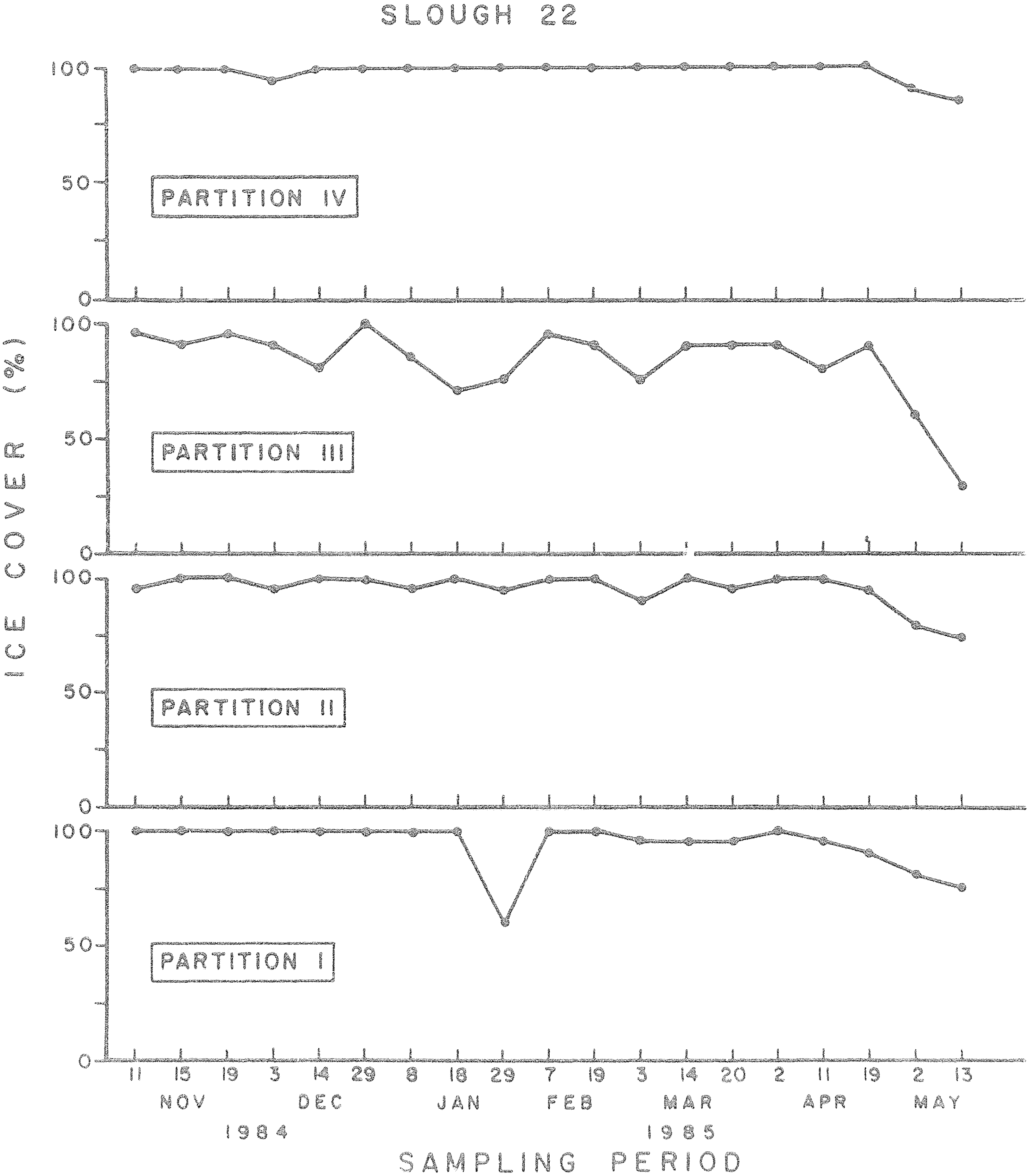

Figure 16. Ice cover present at Slough 22 by partition and sampling period, winter 1984-85.

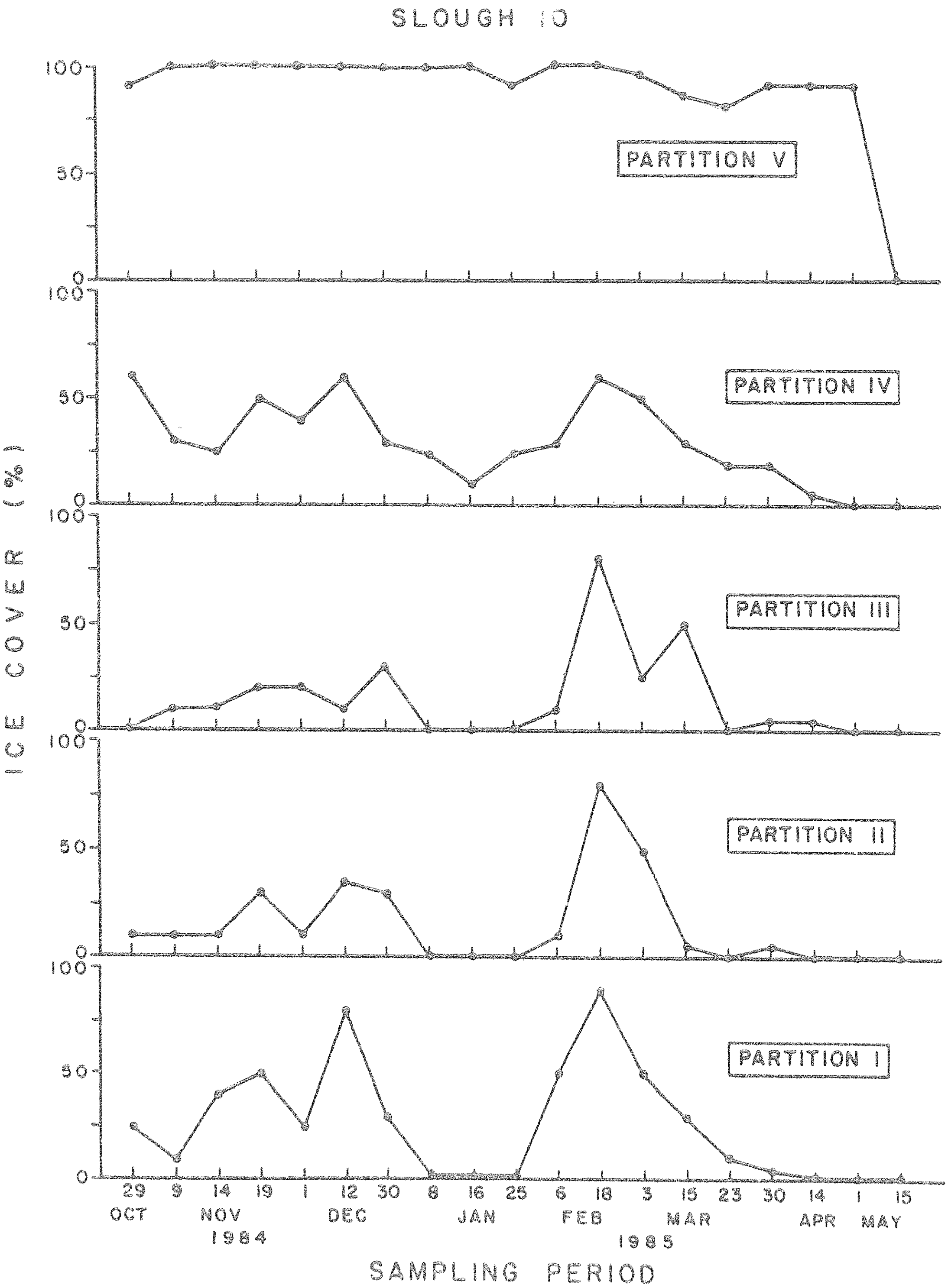

Figure 17. Ice cover present at Slough 10 by partition and sampling period, winter 1984-85.

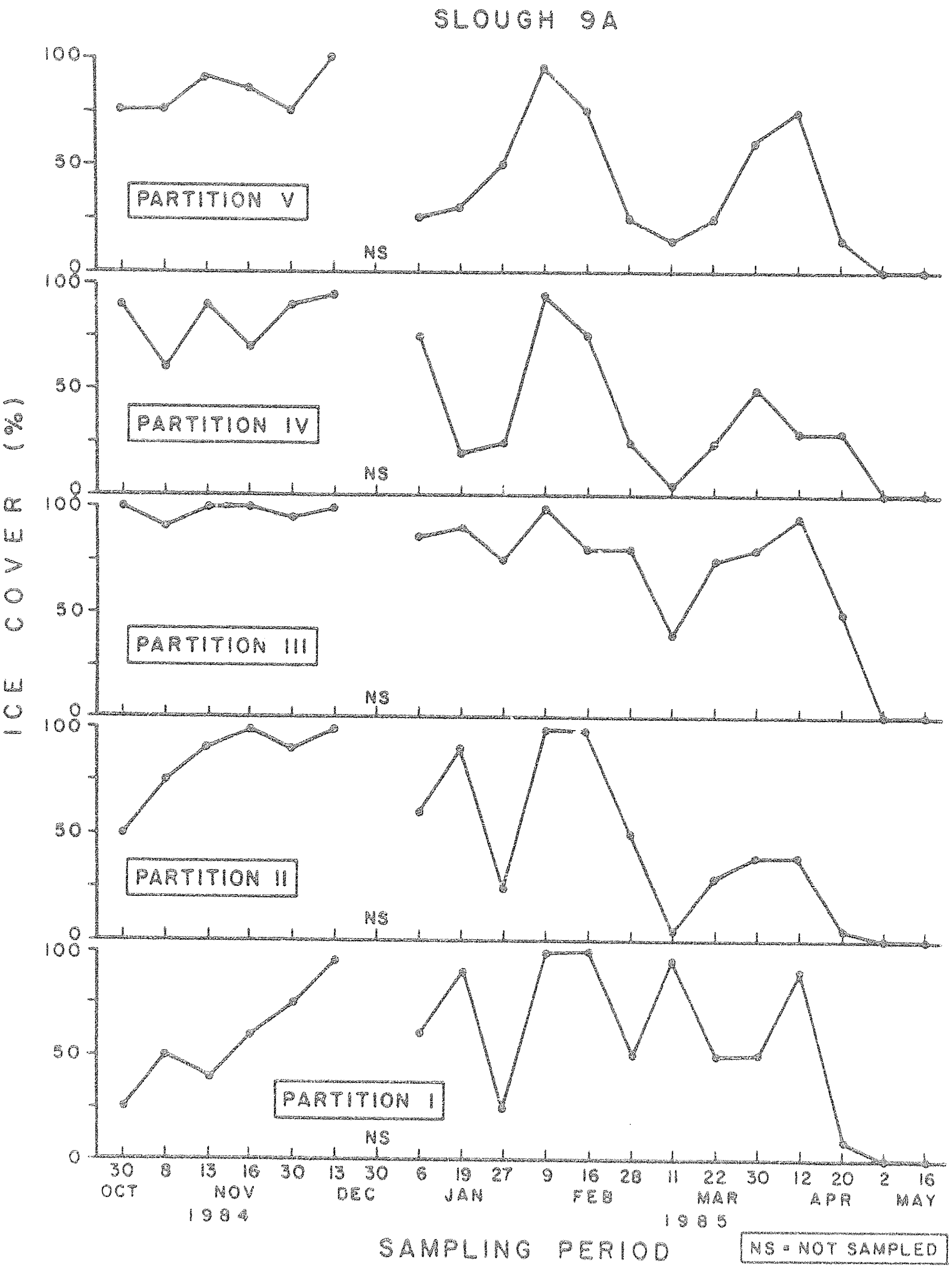

Figure 18. Ice cover present at Slough 9A by partition and sampling period, winter 1984-85.

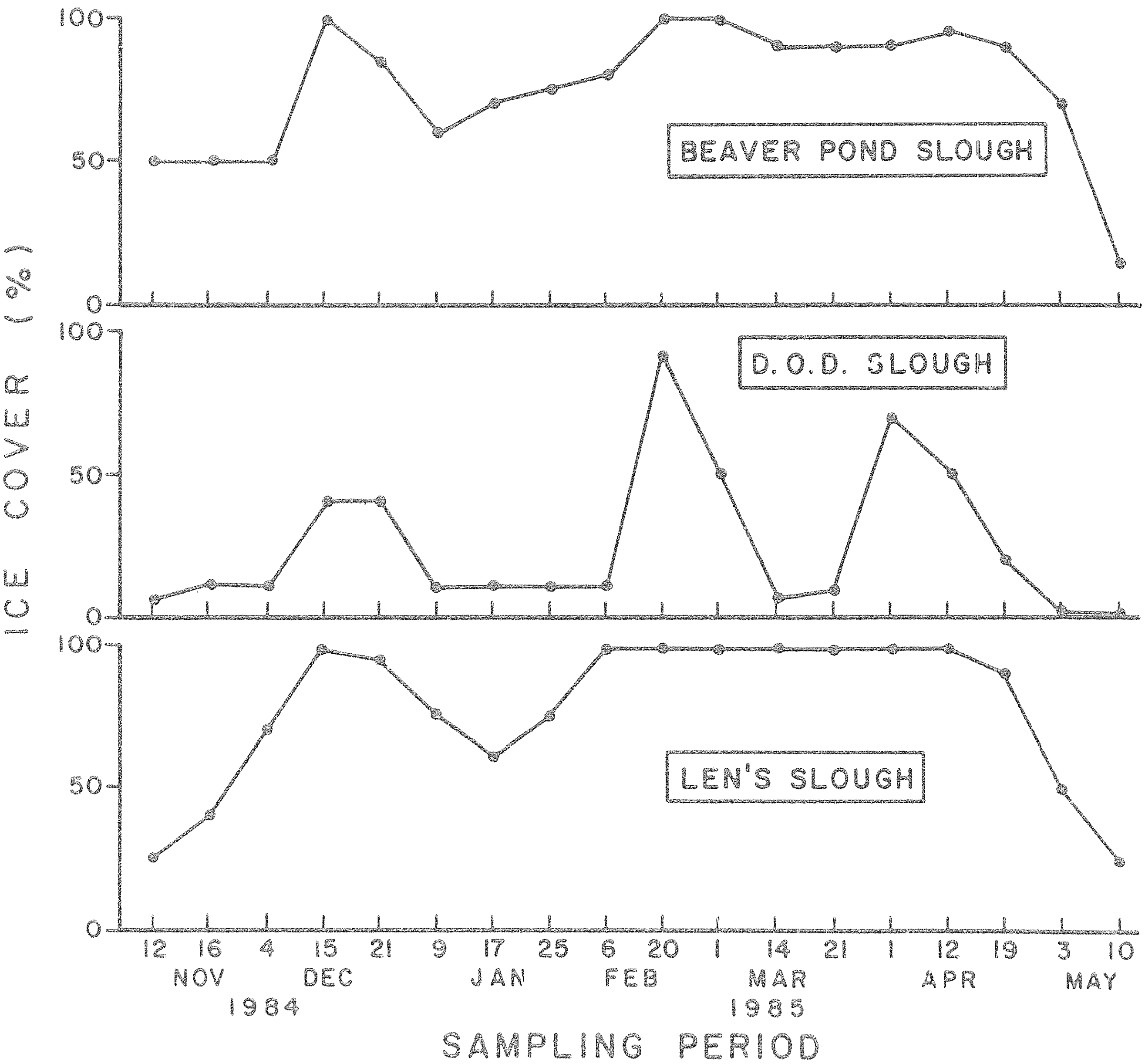

Figure 19. Ice cover present at Indian River by partition and sampling period, winter 1984-85.

the percent ice cover present at the four winter study sites by partition and Figure 20 shows the average mean air temperatures as recorded at the Sherman Weather Station at RM 129.2 (R&M Consultants Preliminary Data, 1985). Except in the partitions with near to continual ice cover, peaks and troughs in percent ice cover closely followed low and high air temperature peaks and troughs. Valid surface water temperatures were obtained only at Partition IV in Slough 10, from a continuous temperature recorder. Surface water temperatures for this partition are plotted for the sampling periods in Figure 20 and closely correlate with the mean air temperatures observed at these times.

Ice thickness at the four sites was highly variable, ranging from 0 to 48 inches. Most partitions had thick shelf ice along their perimeters with a strip of ice ranging from open water to six inches thick out towards the center or main channel. Ice thicknesses are reported in Appendix Table C.

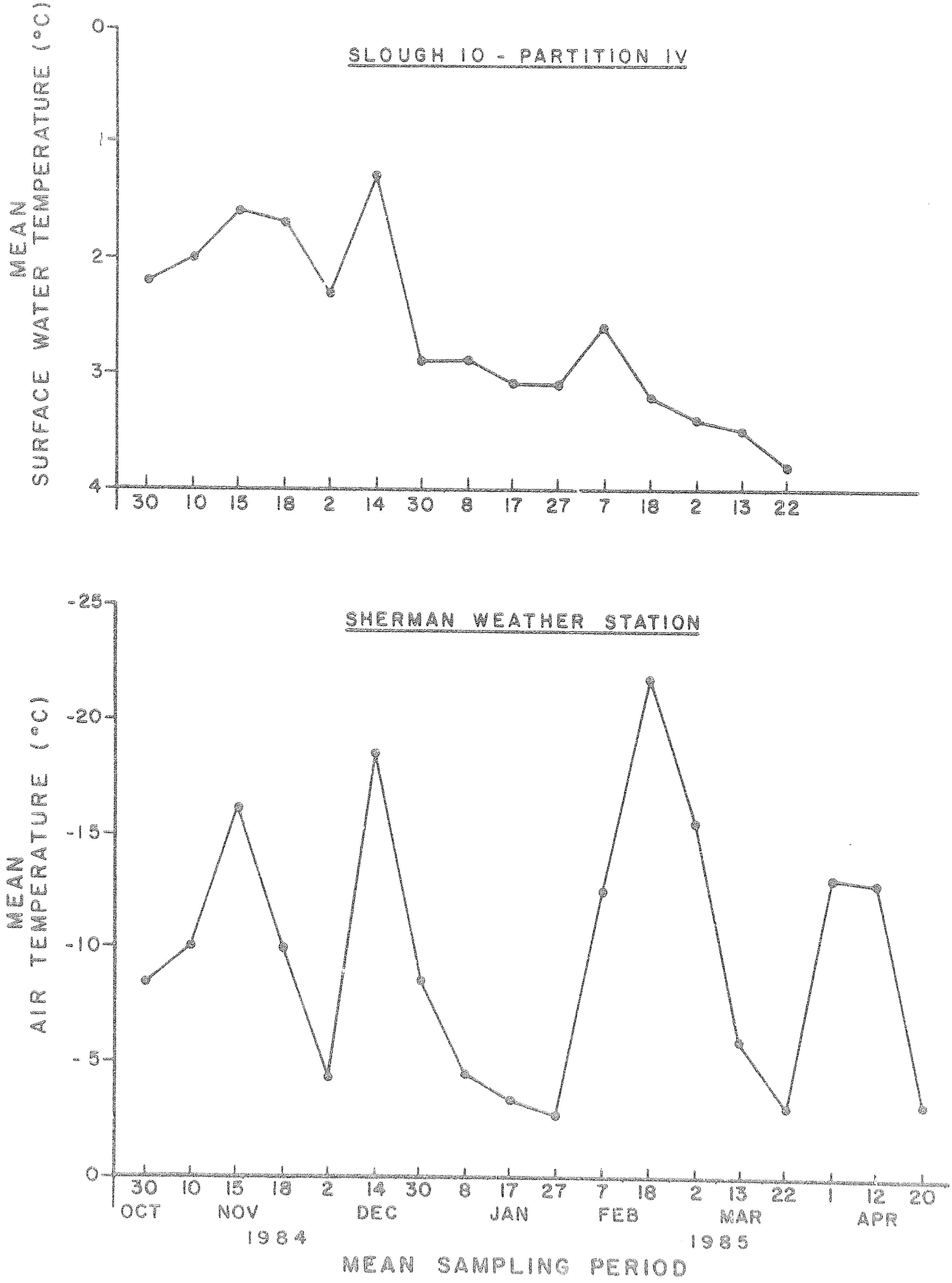

Figure 20. Plot of the correlation between air temperature and surface water temperature at Partition IV of Slough 10, winter 1984-85.

4.0 DISCUSSION

Previous winter studies of juvenile salmon in the middle reach of the Susitna River were basically designed to gather information describing their presence, relative abundance, and distribution. Data were collected on these variables and on many site associated habitat characteristics including cover, water depth, velocity, and water quality (ADF&G 1981a, 1981c).

During the 1980-81 winter study, with the majority of the sampling (minnow trapping) occurred between January 15 - April 30, 1981. This study found that juvenile chinook salmon were the most abundant species overwintering in the middle reach of the Susitna River and juvenile coho salmon were second.

4.1 Chinook Salmon

Adult chinook salmon spawning in the middle Susitna River has been documented only in tributary streams. Spawning in this reach occurs from July to September and the alevins emerge in March and April. Chinook salmon juveniles remain in freshwater for up to two years, but scale analysis of chinook returning to the Susitna River has concluded that the overwhelming majority of these fish remained in fresh water for one year (ADF&G 1981c, 1983a, 1983b; Barrett et al. 1984, 1985). Also, no Age 2+ chinook have been observed in the Susitna River during previous studies. This supports the idea that the vast majority of juvenile chinook remain one year in freshwater, but is not conclusive, as the hypothesis outlined by Roth and Stratton (1985) concerning a large number of juveniles outmigrating as 0+ fish with a very high mortality rate may still occur.

Previous studies of different aspects of the life history of juvenile chinook salmon in Upper Cook Inlet tributary streams have been reported by Delaney and Wadman (1979), Delaney et al. (1981), ADF&G (1981c, 1983a, 1983b), Hale (1983), Suchanek and Hale (1983), Roth et al. (1984), Dugan et al. (1984), Suchanek et al. (1984), Marshall et al. (1984), Roth and Stratton (1985), Suchanek et al. (1985), Anderson et al. (1985) and Hansen and Richards (1985).

4.1.1 Life History

Distribution

Chinook salmon juveniles in the middle reach appear to belong to one of two basic groups: (1) those that spend a portion of their first summer in the middle reach, then migrate out of this reach before winter; and (2) those which spend their entire first year within the middle reach. The first group was reported on in Roth and Stratton 1985, and the second group is the subject of this report. Which of these two groups is the most important in respect to returning adults is not known at this time. Knowledge of the importance of middle river reared juveniles to the maintenance of Susitna River stocks is needed to assess possible future impacts.

Within this second group are two sub-groups: (a) those which remain an entire year within their natal tributaries before beginning their smolting migration, and (b) those which leave their natal tributaries but overwinter in slough and side channel habitats in the middle reach. Previous winter studies and spot sampling during this winter study have indicated that little overwintering takes place in the mainstem Susitna River (ADF&G 1981c, 1983a, 1983b).

During the end of the summer 1984 cold branding study, large numbers of juvenile chinook were still present in Indian River and some sloughs in the middle reach and outmigrant trap catches had fallen to zero (Roth and Stratton 1985). Indian River catches were high but slowly declined until mid-December. Then, catches in the uppermost site (TRM 11.5) fell sharply and catches in the two lower sites (TRM 2.4 and 1.9) rose sharply. By the middle of January, catch rates at all three sites dropped to a very low level (1.5 - 3.0 fish per trap day) and remained at this level or lower for the rest of the season (Figure 21).

During this same period, catches in the two sloughs downstream from Indian River rose (Figures 8 and 9). This data, combined with the fact that a chinook and a coho branded in November in Indian River were recaptured in January and February in Slough 10, indicates that many juvenile chinook migrated out of Indian River between mid-December and mid-January. Catches at all sampling sites dropped dramatically after mid-January, possibly indicating that this outmigration of juveniles was not confined to Indian River, but occurred throughout the middle river.

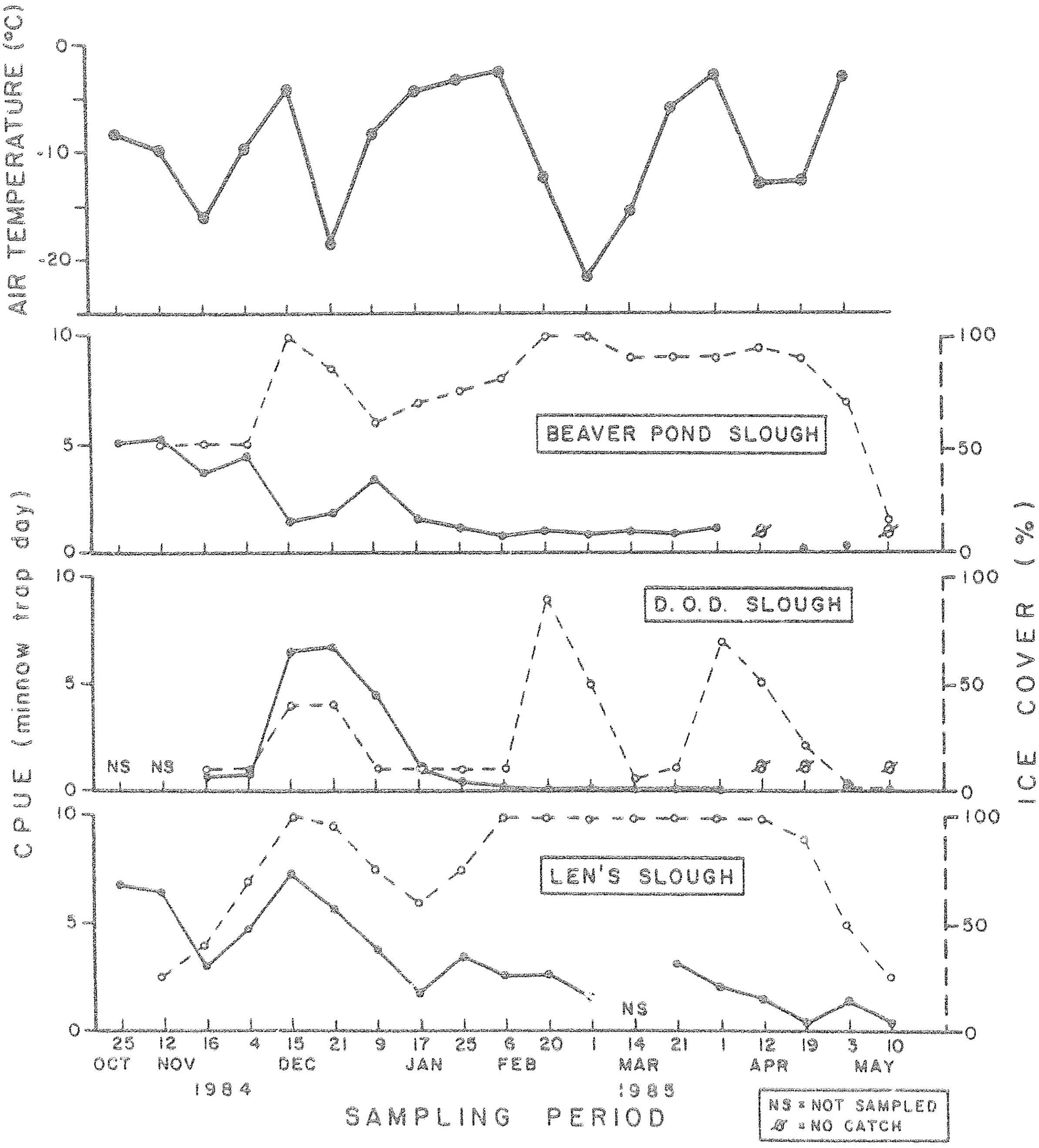

Figure 21. Plot of the catch rates at Indian River versus ice cover and air temperature by site and sampling period, winter 1984-85.

The recapture of a Slough 22, November branded fish at Slough 10 in March also lends support to this hypothesis.

The reason or reasons for this movement out of Indian are not known but several possibilities are graphically presented in Figure 21. As has been shown in Results Section 3.2, percent ice cover and air temperature are closely related. When both are compared to the catch rates at most sites, the catch can be seen to closely follow the peaks and troughs of these two parameters. This is especially true in Indian River where water temperatures quickly reach the freezing point in early winter and the 0.1 - 0.4°C water temperature changes which can be caused by air temperature changes are relatively much larger than would be expected. During this period when the large juvenile movement occurred in Upper Indian River, air temperatures had just risen from their first extreme low of the season (-10 to -24°C in late November and early December), the most ice cover to date was in place, the season's first heavy snowfall was occurring and the photoperiod was at its lowest point. As temperatures approached the second extreme low trough of the season in late December and ice cover remained high, the juveniles were in the process of leaving the lower areas of Indian River. The temperatures then rose and remained high until mid February, when the coldest weather of the season occurred and virtually all of the sites were ice covered. During this warming period in January, it would be expected that catches at all sites would increase due to increased activity by the fish, but this was not the case. Only slough site catches increased and Indian River catches continued to fall. Another interesting point of data from the sloughs below Indian is the fact that during this and subsequent sampling trips the recapture rates decreased. This could be caused by either or both of the following: a large number of new fish moved into the sampling site or a large number of fish moved out of the sampling site. Either case, combined with the aforementioned data, all tend to support the idea of a large midwinter juvenile movement out of Indian River and within the middle river itself. The extent of this movement downstream cannot be assessed at this time, but future winter studies using more sites and sites further downstream should help clear up these questions.

Another movement which is believed to have taken place at the slough sites over the course of the season was movement between partitions. In September, large numbers of juveniles were observed at the mouths of clearwater sloughs and side channels. By mid-October the juveniles had slowly dispersed within these sites and the major concentrations were in areas with more cover and groundwater sources (Roth and Stratton 1985). The data presented in Appendix Figures A-1, A-2, A-3 and A-4 indicate there was movement within the sloughs (i.e., at Slough 8A, fish that were concentrated in Partitions II and V during late November moved into Partition III during December). Although the data are not conclusive, this observation could easily be proved or disproved by branding fish from each partition with unique brands. Once again, the reasons for this movement are not known but could include: temperature, ice cover, ice thickness, photoperiod, and/or food supply.

In early May, as the days became longer, water and air temperatures increased, ice cover receded, and fish became more active prior to smolting it was expected that catches would increase, especially at partitions in the lower sections of the sites. As can be seen in Appendix Figures A-1, A-2, A-3, and A-4, this did occur, only not in the magnitude we had expected. The majority of juvenile chinook had left the sites prior to this time. Peak catch rates at the outmigrant traps occurred soon after the traps were installed, and very few juvenile chinook were captured during the coded wire tagging program in June (ADF&G 1985 unpublished data), again indicating that the majority of fish, due to some unexplained biological or physical factor, had left before breakup.

Perhaps this is a survival response with respect to the severe conditions which prevail in the upper middle reach and its tributaries during breakup, where the majority of the sloughs and side channels are breached and scoured by ice, debris, and high flows to the point where any fish not in the substrate would most likely be killed. Whatever the reason, all data indicates that the majority of the 1+ chinook outmigration from the middle river took place before breakup.

Growth

As is the case with the majority of cold water fishes, winter growth is quite slow relative to that achieved during the summer. Juvenile chinook in the middle reach of the Susitna River exhibited little or no growth during the winter of 1984-85. With the exception of Partition IV at Slough 22, an abundant food supply was available at all sites throughout the winter. At DOD Slough in Indian River, the rocks were literally covered with larval and pupal stages of aquatic insects. (Partition IV shrank to a single pool approximately 20 feet in diameter, completely cut off from the rest of the slough.) Fish stomachs examined occasionally throughout the season were always found to contain insects. From mid-April on, large hatches of aquatic insects were present at all sites and still little increase in lengths were recorded. In mid-May, when the winter sampling was concluded, growth of juvenile chinook salmon was still extremely slow.

After mid-May, some factor or factors occurred which triggered a tremendous spurt of growth by juvenile chinook. By early June, fish from the middle river which averaged approximately 64 mm in early October 1984 and 70 mm in mid-May 1985, were passing the Talkeetna outmigrant traps averaging 78 mm and by the end of June were averaging 89 mm. This is a growth of 6 mm during the seven month winter study and then a growth of 19 mm in just a little over one month in the spring. This implies a huge increase in the amount of available preferred food supplies coupled with the increased activity of these fish brought on by increased water temperatures and photoperiod.

Predation

Winter predation on juvenile salmon was found to be much more extensive than was originally thought. As winter progresses the amount of area available to the juvenile salmon shrinks, thereby concentrating the fish and making them more susceptable to predators. Although ice and snow cover do replace turbidity as a source of cover from terrestrial predators, juvenile fish are still vulnerable to these predators through open leads. The most active and successful terrestrial predator observed during this study was the dipper (Cinclus mexicanus). Dippers were observed throughout the winter at almost all open water areas of the Susitna River. Concentrations of dippers were observed at partitions containing large numbers of fish and were frequently observed capturing juvenile fish.

A species of shrew was also found to prey upon juvenile salmon. On at least three occasions, shrews were found in minnow traps which had been set with a portion above the water surface. The only remains of the fish were pieces of heads and tails. Although no shrew predation on juvenile salmon outside of minnow traps was observed, it is believed to occur.

Other terrestrial predators known to prey upon fish also occur within this area, including mink, marten and otter. However, no evidence of juvenile salmon predation was documented for these species.

The most abundant and probably the most successful predator we observed is an aquatic one, the slimy sculpin (Cottus cognatus). Slimy sculpin are found throughout the Susitna River, with highest concentrations occurring in the sloughs and tributaries containing high numbers of fish (ADF&G 1981c). Sculpin were captured incidentally at all sampling sites throughout the winter. Sculpin were also observed, both in minnow traps and lying on the substrate, dead with juvenile salmon protruding from their mouths. The fish had apparently choked or strangled on a juvenile salmon that was too large for it to handle. Sculpin predation could be an important factor in winter survival of juvenile salmon, especially the smaller fish.

Other resident fish species are present in the middle reach of the Susitna River, but few have been documented in the sloughs and tributaries during the winter (Sundet and Wenger, 1984; Sundet and Pechek, 1985). Although these fish do not appear to be a threat to juvenile salmon in the shallower sloughs and side channels, species such as burbot and rainbow trout would present a large threat to any population of juveniles overwintering in the mainstem.

4.1.2 Population Estimates

The population estimates calculated for the winter sampling sites also show a movement of juvenile fish during December and January. The population at Beaver Pond Slough (TRM 11.5) gradually declined during November and December then dropped sharply and continued to decline for the rest of the study. Meanwhile, the population at Len's Slough (TRM 1.9) was also declining during November, but made a sharp increase in December at the same time of the sharp decrease at Beaver Pond Slough. Then, during January, the populations at all the sites dropped sharply and continued to decline as the majority of fish moved out of Indian River.

Populations in the sloughs were generally stable during November and December. In January, when Indian River fish were outmigrating, catch rates rose at the slough sites but population estimates didn't (Table 5). Then in late January, the catch rates and population estimates fell sharply, indicating that "new" fish had moved in or the "old" fish had moved out. Catch rates and population estimates continued to decline until a small increase was observed in April. All indications are that the majority of the fish in the middle reach redistributed themselves downstream during December and January, and that the majority of these fish moved below our study area. The addition of more sampling sites between Curry and Talkeetna in the 1985-86 winter study will help pinpoint the extent of this winter redistribution.

4.1.3 Effects of Mainstem Conditions

Althoug mainstem discharage has little direct effect on slough and tributary rearing areas during the majority of the winter, major effects occur at times which can be placed in several categories: pre freeze-up, freeze-up, winter, and breakup.

Pre freeze-up flows are instrumental in determining when slough mouths are closed and fish access is possible. High flows just prior to freeze-up allow fish a longer access period to certain sloughs (i.e., Slough 22) while low flows shorten this period.

During freeze-up, mainstem flows are continually changing within specific areas due to local ice damming and staging. Some sloughs and side channels are overflowed, making these areas uninhabitable. During November at Slough 22, the side channel it connects to overflowed at least of three times, forming over 20 inches of overflow ice over the entire mouth and 400 feet up the slough.

During the winter of 1984-85, flows were basically stable with a limited amount of staging related to anchor ice formation, ice damming, and snow load occurring. A more detailed description of winter ice processes is given in the R&M 1985 Summary Ice Report (unpublished). Staging occurred during February in the Slough 10 area due to a heavy snowfall. Water backed up over 2,000 feet into Slough 10 raising the average depth in most partitions by approximately two feet. Although this provided a larger wetted habitable area, water temperatures were much colder than that normally found in the slough and no large influx of fish occurred. Ice damming, staging, and slough overtopping did not occur at any of the sampling sites this winter, but this action would probably flush any fish at the site downstream into the mainstem, as the prime reason for the fishes presence in the slough (warmer water) would now be absent.

The severe conditions occurring during breakup and the fish's response have been discussed in a previous section.

4.2 Coho Salmon

Adult coho salmon spawning in the middle Susitna River have been documented almost exclusively in tributary streams. Very small numbers have also been observed in sloughs and at mainstem spawning sites used by other species of salmon. Spawning occurs from August to October and the alevins emerge in March and April. Coho salmon juveniles remain in freshwater for up to three years, but scale analysis of returning adults has concluded that approximately half of the returning adults remained in freshwater for one year and the other half for two years (ADF&G 1981b, 1983d, 1983e; Barrett et al. 1984, 1985).

Only 472 juvenile coho salmon were captured during the 1984-85 winter studies and less than 20 were age 2+, indicating that the majority of these older fish overwinter in habitats below the middle reach.

Life History

Coho salmon juveniles exhibit habits quite similar to juvenile chinook salmon. So few juvenile coho were captured compared to chinook (472 coho versus 11,543 chinook) that little was learned about them. Coho were found to exhibit the same movements and responses to mainstem changes and habitat characteristics as chinook.

The only major difference found between chinook and coho was habitat preference. Coho preferred areas with greater depth and cover consisting of debris, vegetation, and undercut banks, while chinook like shallower, slightly more velocity and cover consisting of rocks and bolders. Beaver dams and ponds were found to be excellent coho cover. (Partition V of Slough 10 and Beaver Pond and DOD Slough in Indian River are prime examples.) This corresponds with the findings of Suchanek et al. (1984) for summer coho habitat preference.

Other habitats and characteristics of coho salmon during the winter study closely followed those outlined for chinook in Section 4.1.1. Since so few fish were captured and subsequently recaptured, no population estimates were calculated.

5.0 CONTRIBUTORS

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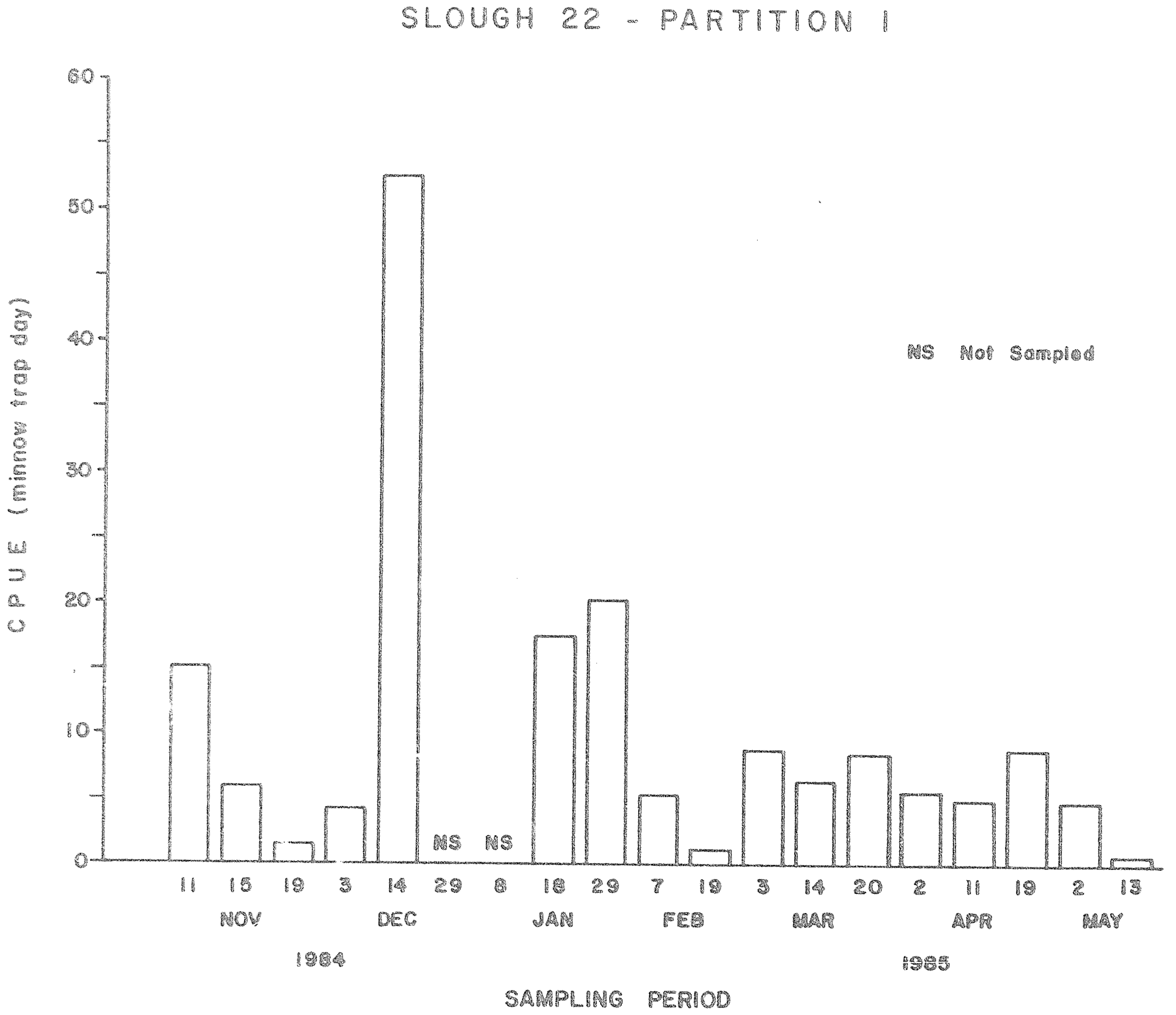
______, and S.D. Pechek. 1985. Resident fish distribution and life history in the Susitna River below Devil Canyon. Part 3 In: D.C. Schmidt, S.S. Hale, and D.L. Crawford, editors. Resident and juvenile anadromous fish investigations (May - October 1984). Susitna Aquatic Studies Program. Report No. 7. Alaska Department of Fish and Game, Anchorage, Alaska.

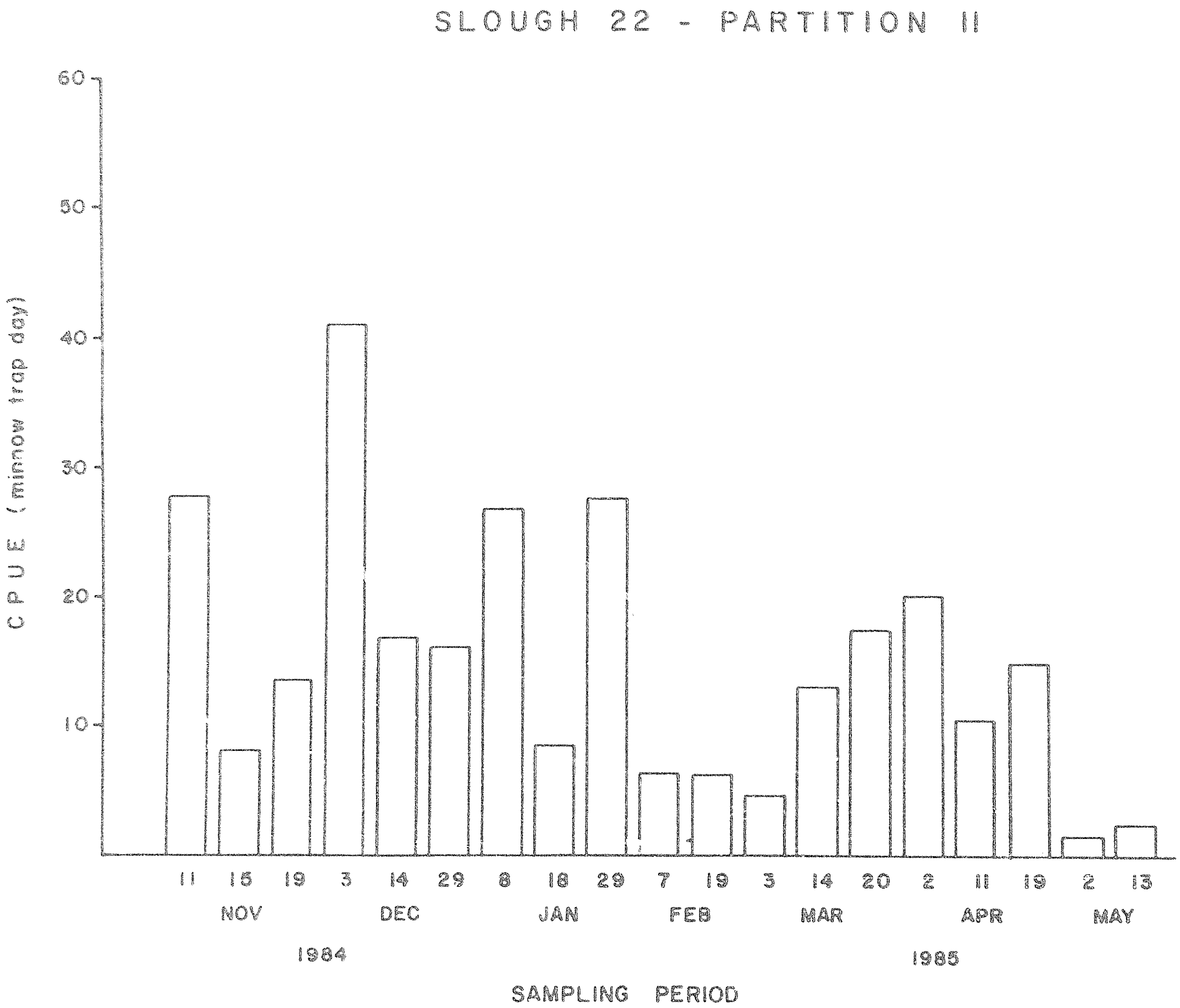
APPENDIX A

JUVENILE CHINOOK SALMON CATCH DATA

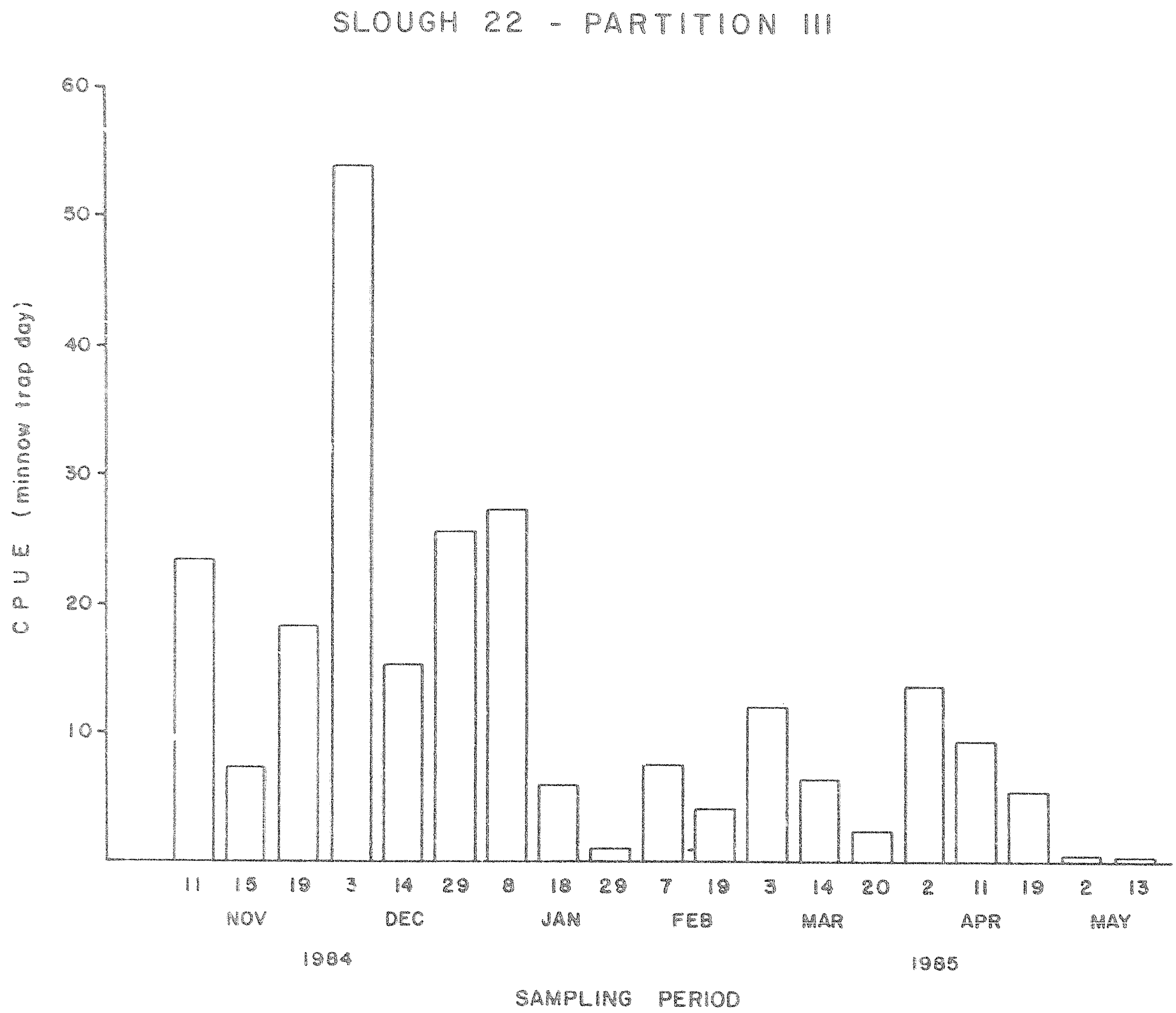
WINTER 1984-85



Appendix Figure A-1. Juvenile chinook salmon catch rates at Slough 22 by partition and sampling period, winter 1984-85.

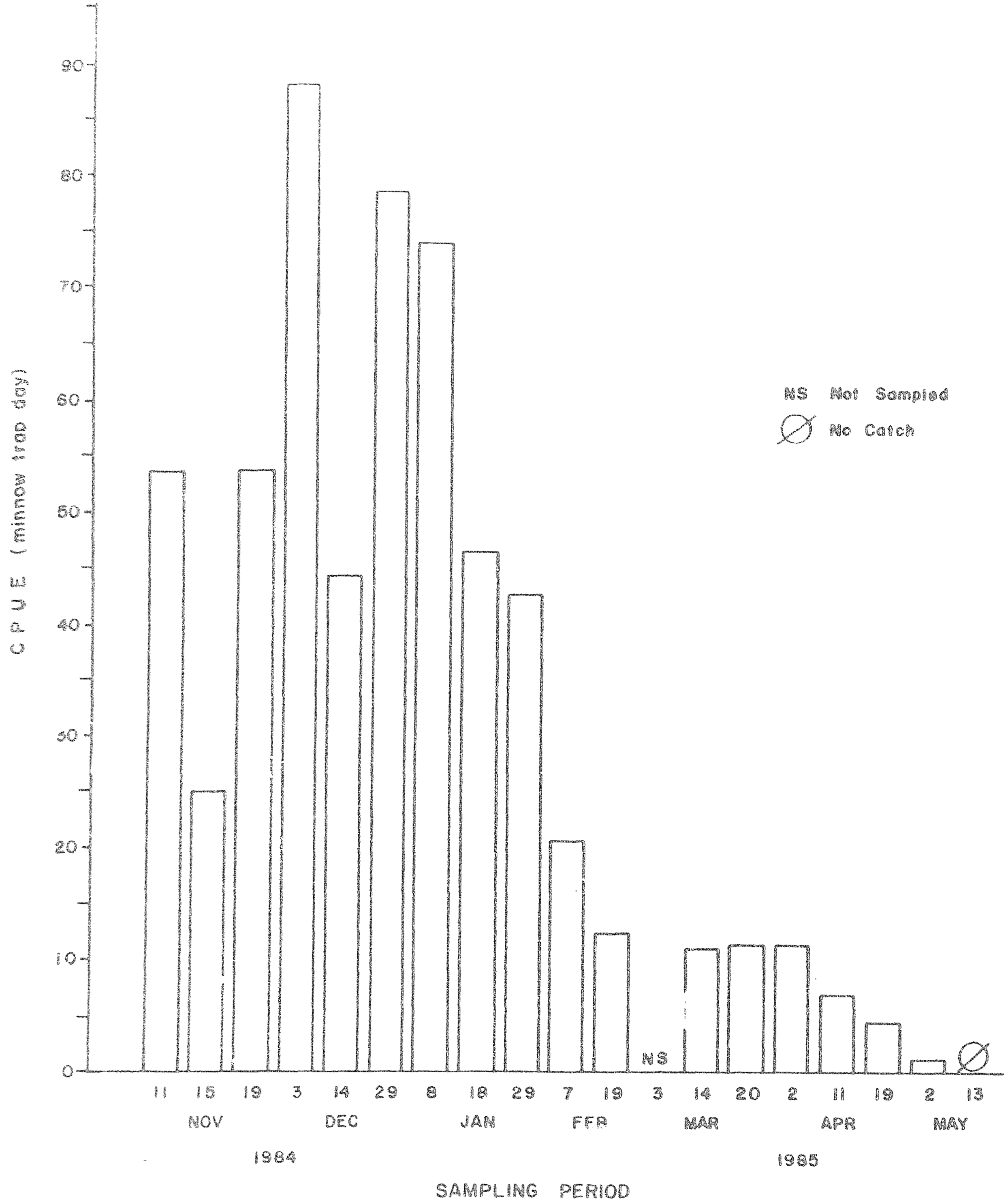


Appendix Figure A-1. (Continued).



Appendix Figure A-1. (Continued).

SLOUGH 22 - PARTITION IV



Appendix Figure A-1. (Continued).

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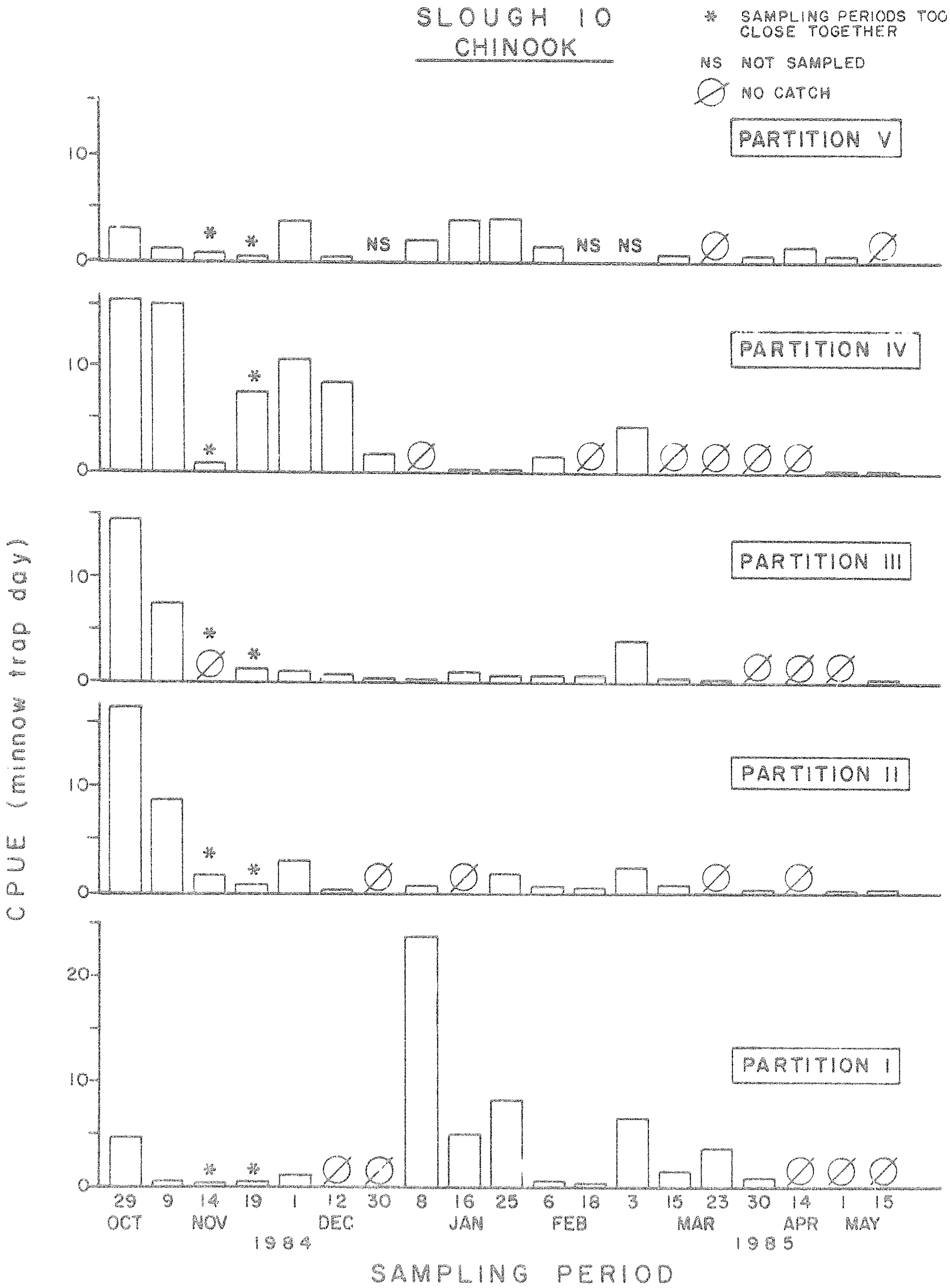
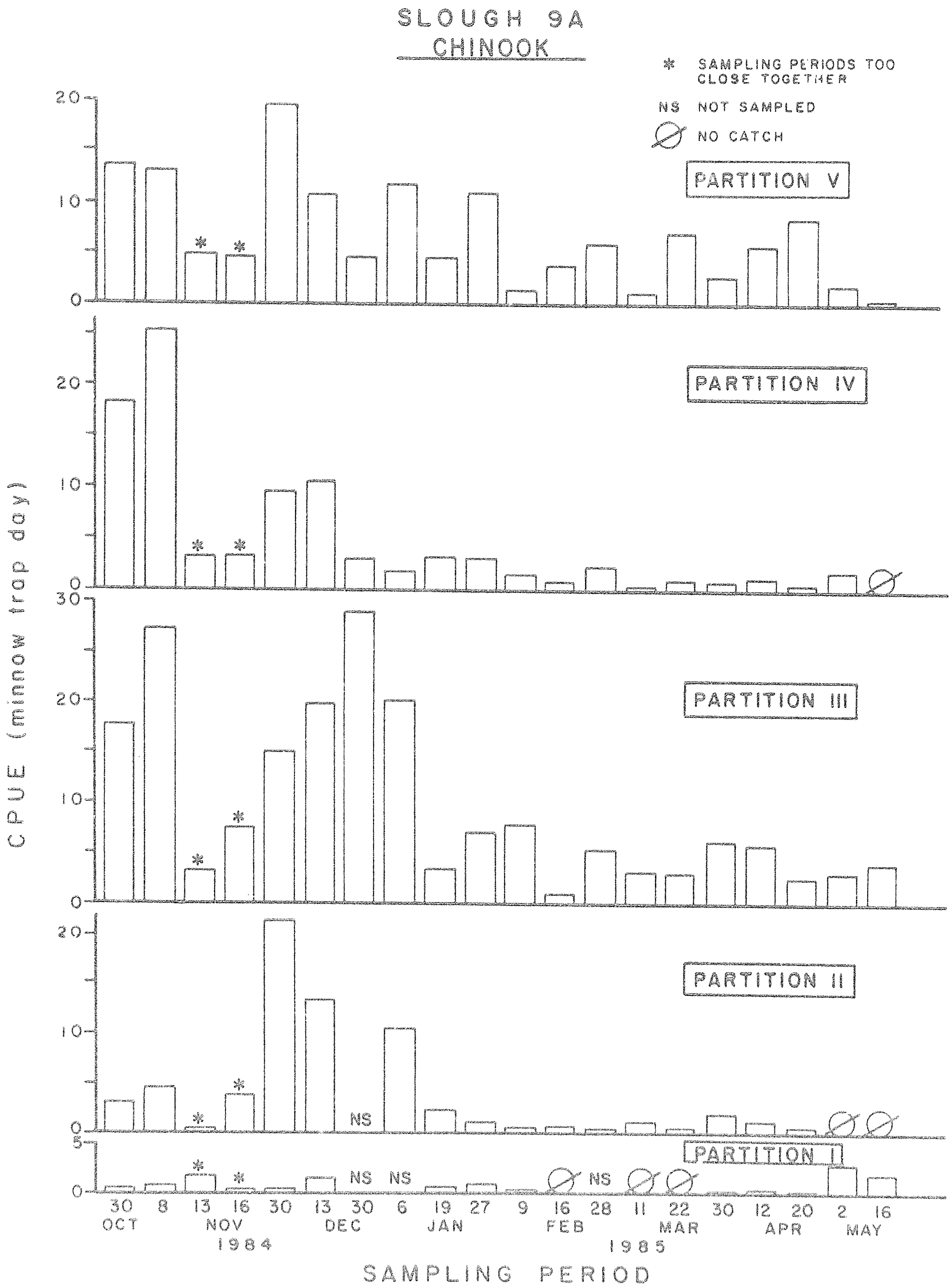
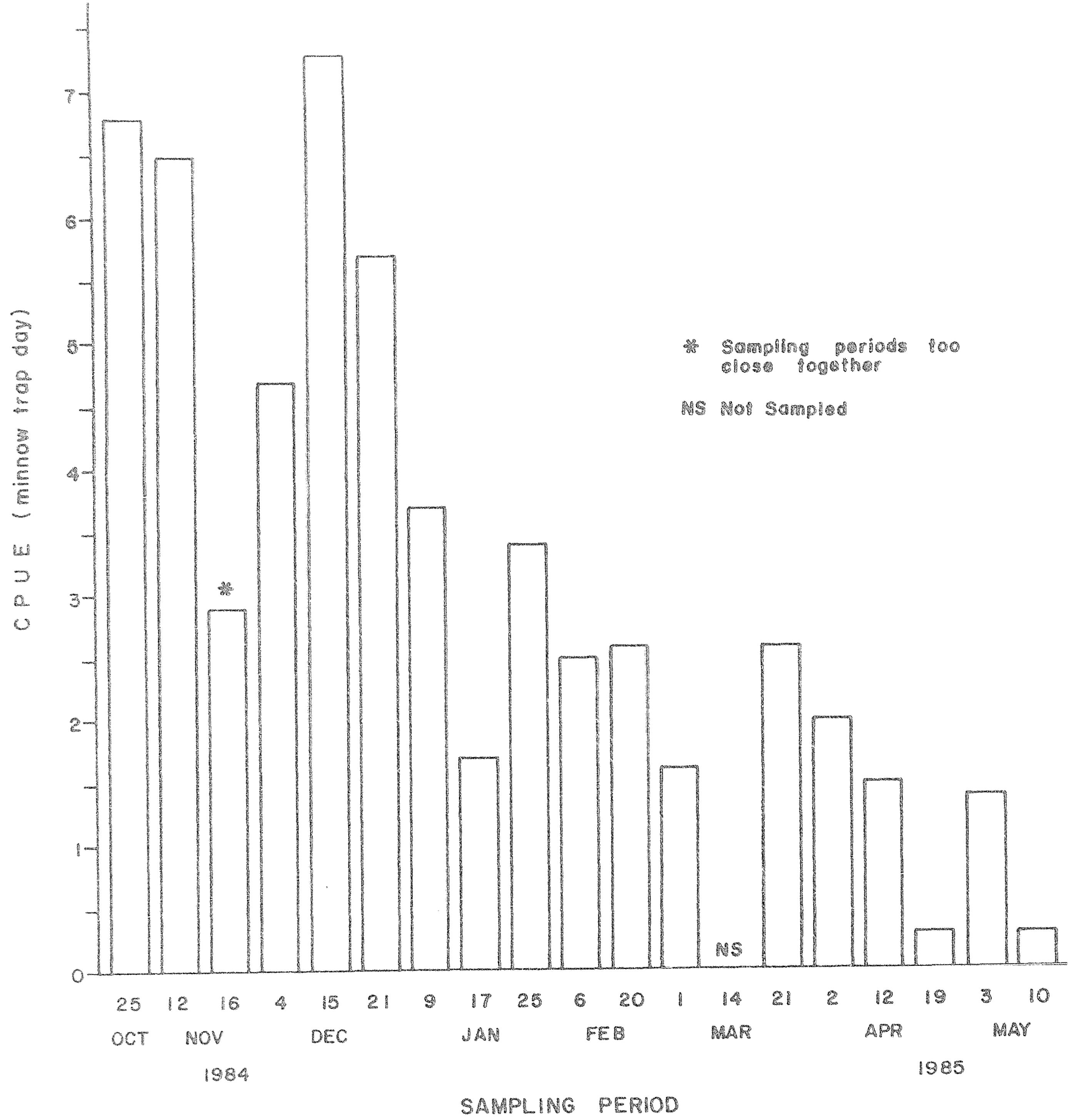


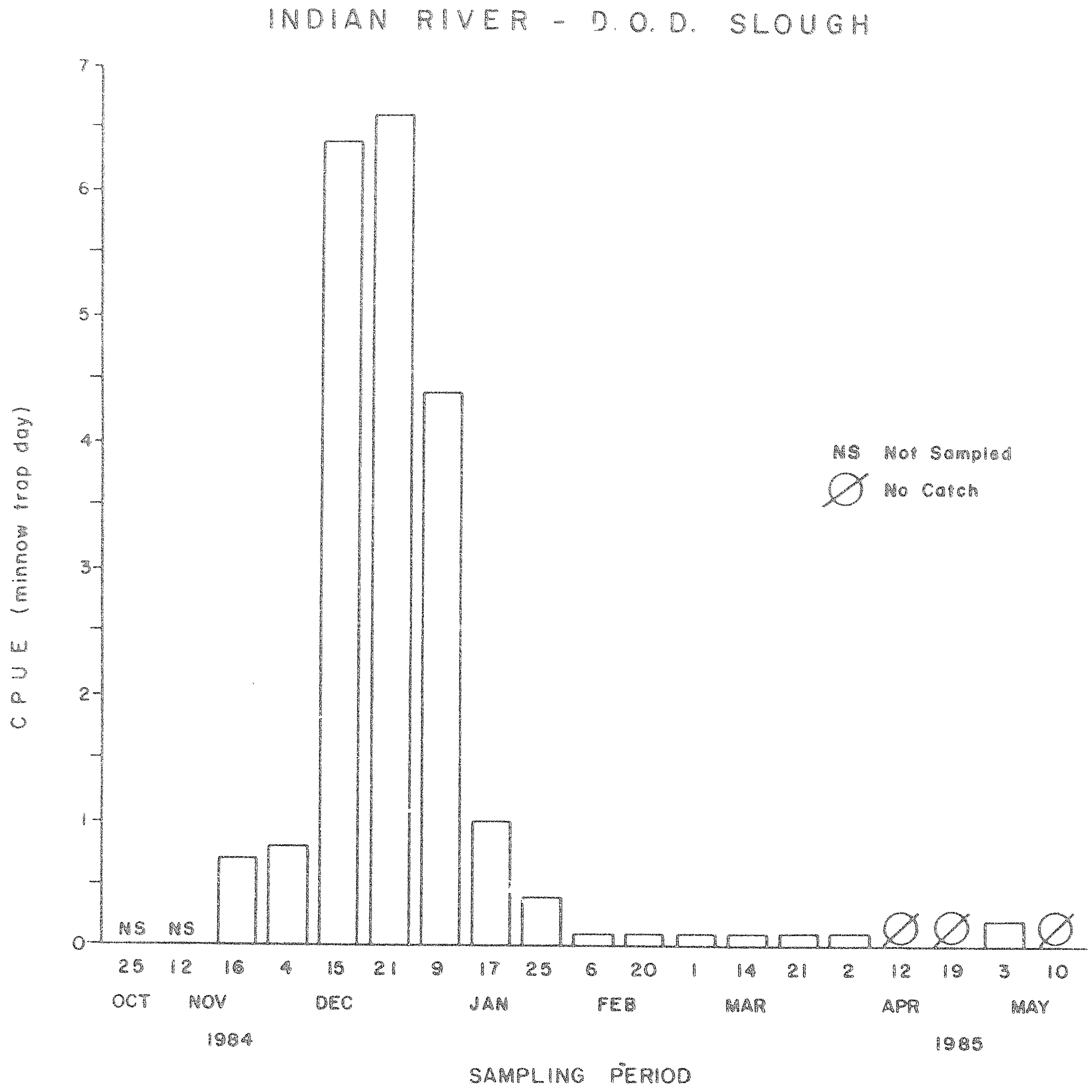
Appendix Figure A-2. Juvenile chinook salmon catch rates at Slough 10 by partition and sampling period, winter 1984-85.



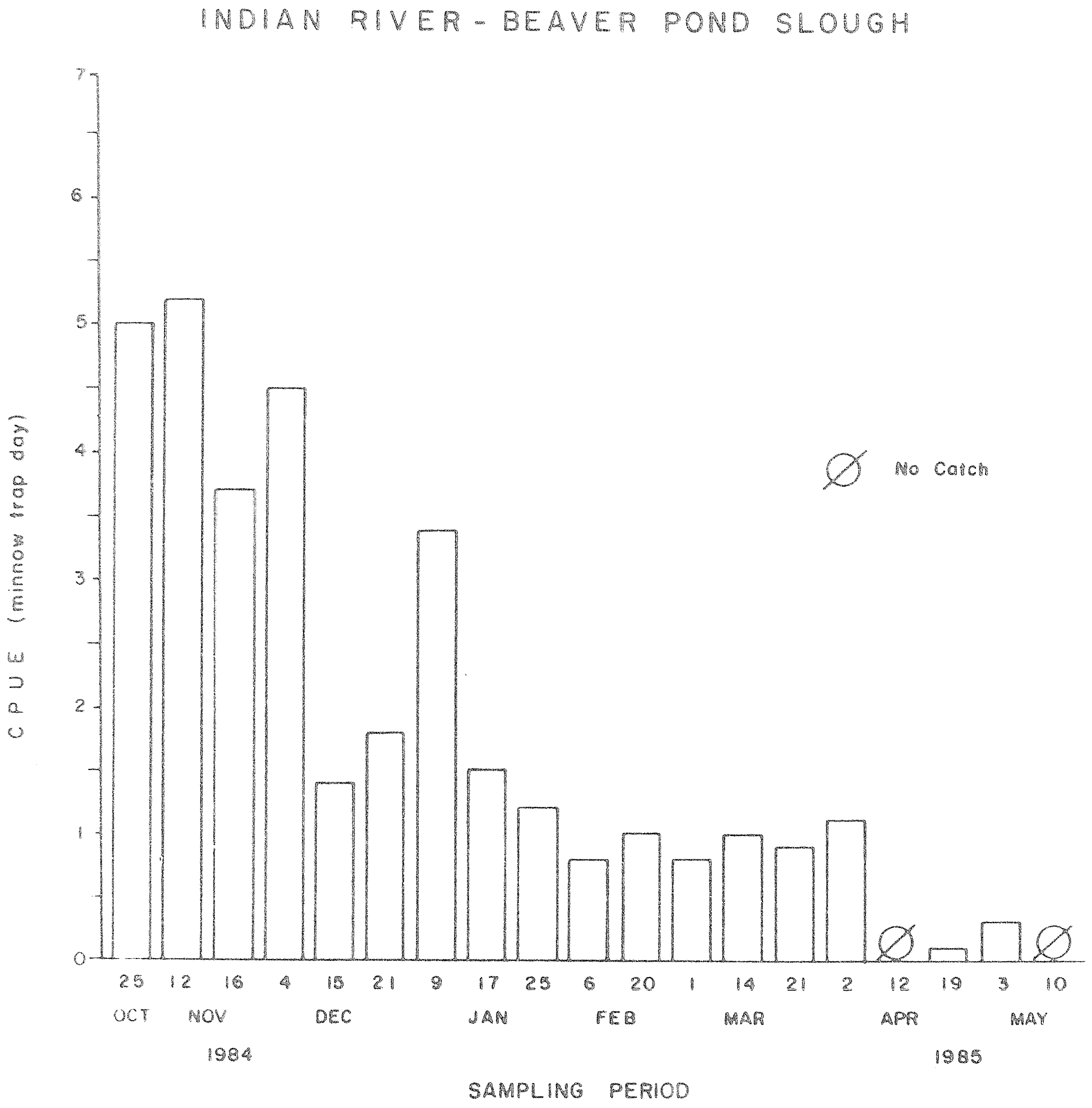
Appendix Figure A-3. Juvenile chinook salmon catch rates at Slough 9A by partition and sampling period, winter 1984-85.



Appendix Figure A-4. Juvenile chinook salmon catch rates at Indian River by partition and sampling period, winter 1984-85.



Appendix Figure A-4. (Continued).



Appendix Figure A-4. (Continued).

APPENDIX B

JUVENILE CHINOOK SALMON TAGGING,

RECAPTURE AND POPULATION ESTIMATE DATA,

WINTER 1984-85

Appendix Table B-1. Branding and recapture data for the cold-branded juvenile salmon recaptured at the Talkeetna outmigrant traps, 1985.

Talkeetna Trap 1985 Recapture Data				Cold Branding Data		Talkeetna Trap 1985 Recapture Data				Cold Branding Data	
#	Date	Species	Length	Date	Location	#	Date	Species	Length	Date	Location
1	5/28	411	65	8-29-84	Slough 19	26	6/20	411	86	9-11-84	Indian
2	5/31	411	81	11-15-84	Slough 22	27	7/3	411	75	8-27-74	Indian
3	5/31	411	86	9-25-84	Indian	28	7/3	411	70	9-11-84	Indian
4	5/31	411	77	9-24-84	Indian	29	7/3	411	70	8-27-84	Indian
5	5/31	411	77	9-13-84	Slough 22	30	7/4	411	85	8-11-84	Indian
6	6/1	411	74	12-15-84	Slough 9A	31	7/4	411	90	8-11-84	Indian
7	6/1	411	73	9-11-84	Indian	32	7/4	411	93	8-10-84	Indian
8	6/1	411	70	9-11-84	Indian	33	7/5	411	83	1-24-85	Slough 22
9	6/1	411	65	10-11-84	Slough 20	34	7/5	411	82	3-14-85	Indian
10	6/1	411	80	12-18-84	Indian	35	7/6	411	82	1-24-85	Slough 22
11	6/2	411	78	10-9-84	Indian	36	7/7	411	74	12-16-84	Slough 22
12	6/2	411	91	10-9-84	Indian	37	7/9	431	73	10-26-84	Indian
13	6/2	411	73	10-10-84	Indian	38	7/13	431	77	3-14-85	Indian
14	6/4	411	84	12-16-84	Slough 22	39	7/14	411	80	4-15-85	Slough 22
15	6/6	411	80	9-13-84	Slough 22	40	7/15	411	79	9-11-84	Indian
16	6/7	411	66	9-13-84	Slough 22						
17	6/7	411	88	10-10-84	Indian						
18	6/8	411	76	9-11-84	Indian						
19	6/8	411	79	8-10-84	Indian						
20	6/8	411	82	9-11-84	Indian						
21	6/10	411	95	4-16-85	Slough 9A						
22	6/13	411	62	1-8-85	Slough 22						
23	6/13	411	62	2-20-85	Slough 22						
24	6/13	411	67	2-20-85	Slough 22						
25	6/13	411	72	9-11-84	Indian						

The Schaefer method of estimating population size is given by Ricker (1975) as:

$$N = N_{ij} = R_{ij} \cdot \frac{M_i}{R_i} \cdot \frac{C_j}{R_j}$$

where: R_{ij} = number of fish which were marked during a tagging period (i) and subsequently recaptured during a recovery period (j).

M_i = number of fish marked during a single tagging period.

R_i = total recaptures of fish tagged in the ith period.

C_j = number of fish captured and examined for marks during a recovery period.

R_j = number of marked fish which were recaptured during a recovery period.

N_{ij} = estimate of the number of fish available for marking during a period (i) and the number available for recovery in a period (j).

The data collected for the estimate of the population of chinook salmon are tabulated by the Schaefer method in Appendix Tables __________. The computation of the population estimates are presented in Appendix Tables __________.

Appendix Table B-2. Petersen estimator data for 1983 brood year chinook juveniles in the middle reach above Talkeetna Station.

Total Estimate	Overwintering Estimate
M = 42952	M = 9744
C = 9702	C = 2647
R = 47	R = 13

8,866,889 = N = $\frac{M.C}{P}$ = n = 1,984,028
(6667524 - 12,078,849) (1,156,608 - 3,738,024)

where:

M = Number of 1983 brood year chinook marked (1984 summer + 1984-85 winter).

C = Catch of 0+ chinook after July 20, 1984 + catch of 1+ chinook during 1985 at Talkeetna traps.

R = Total number of 0+ chinook recaptured in 1984 + recaptures of 1+ chinook in 1985 at Talkeetna traps.

M = Number of chinook marked during 1984-85 winter study.

C = Catch of 1+ chinook during 1985 at Talkeetna trap.

R = Number of recaptures of 1984-85 winter study branded chinook.

Appendix Table B-3. Data collected at Slough 22 for juvenile chinook salmon to provide a Schaefer population estimate, 1984-85 winter study.

Period of Recovery (j)	Period of Tagging (i)							Total Recovered (Rj)	Total Observed (Cj)	Cj/Rj
	Oct	Nov	Dec	Jan	Feb	Mar	Apr			
November	134	-	-	-	-	-	-	134	1,074	8.01
December	212	787	-	-	-	-	-	499	1,883	3.77
January	136	161	384	-	-	-	-	681	1,442	2.12
February	51	54	104	92	-	-	-	301	445	1.48
March	70	71	94	135	57	-	-	427	622	1.46
April	45	32	46	64	24	44	-	255	327	1.28
May	5	2	5	4	3	3	3	25	53	2.12
Total Recovered (Ri)	653	607	633	295	84	47	3			
Total Marked (Mi)	938	1,022	1533	1,266	292	411	271			
Mi/Ri	1.44	1.68	2.42	4.29	3.48	8.74	90.33			

Appendix Table B-4. Computation of the juvenile chinook salmon population at Slough 22, 1984-85 winter study.

Period of Recovery (j)	Period of Tagging (i)							
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Total
November	1,546	-	-	-	-	-	-	1,546
December	1,151	1,818	-	-	-	-	-	2,969
January	415	573	1,970	-	-	-	-	2,958
February	109	134	372	584	-	-	-	1,199
March	147	174	332	846	290	-	-	1,789
April	83	69	142	351	107	492	-	1,244
May	15	7	26	36	22	56	575	737
TOTAL	3,466	2,775	2,842	1,817	419	548	575	12,442

Appendix Table B-5. Data collected at Slough 10 for juvenile chinook salmon to provide a Schaefer population estimate, 1984-85 winter study.

Period of Recovery (j)	Period of Tagging (i)							Total Recovered (Rj)	Total Observed (Cj)	Cj/Rj
	Oct	Nov	Dec	Jan	Feb	Mar	Apr			
November	4	-	-	-	-	-	-	4	237	59.25
December	3	16	-	-	-	-	-	19	141	7.42
January	9	12	2	-	-	-	-	23	252	10.96
February	6	4	1	3	-	-	-	14	115	8.21
March	1	1	1	3	1	-	-	7	44	6.29
April	0	1	0	2	0	1	-	4	8	2.00
May	0	1	1	0	1	1	0	4	10	2.50
Total Recovered (Ri)	23	35	5	8	2	2	0			
Total marked (Mi)	237	235	141	115	108	25	7			
Mi/Ri	10.30	6.71	28.20	14.38	54.00	12.50	0.00			

Appendix Table B-6. Computation of the juvenile chinook salmon population at Slough 10, 1984-85 winter study.

Period of Recovery (j)	Period of Tagging (i)							
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Total
November	2,441	-	-	-	-	-	-	2,441
December	229	797	-	-	-	-	-	1,026
January	1,016	882	618	-	-	-	-	2,516
February	507	220	232	354	-	-	-	1,313
March	65	42	177	271	340	-	-	895
April	0	13	0	58	0	25	-	96
May	0	17	71	36	135	31	0	290
TOTAL	4,258	1,971	1,098	719	475	56	0	8,577

Appendix Table B-7. Data collected at Slough 9A for juvenile chinook salmon to provide a Schaefer population estimate, 1984-85 winter study.

Period of Recovery (j)	Period of Tagging (i) Oct	Nov	Dec	Jan	Feb	Mar	Apr	Total Recovered (Rj)	Total Observed (Cj)	Cj/Rj
November	14	-	-	-	-	-	-	14	512	36.57
December	23	51	-	-	-	-	-	74	786	10.62
January	15	29	30	-	-	-	-	74	416	5.62
February	9	13	16	11	-	-	-	49	159	3.24
March	4	7	14	13	0	-	-	38	146	3.84
April	2	6	6	5	1	1	-	21	136	6.48
May	1	4	1	3	1	2	3	15	81	5.40
Total Recovered (Ri)	68	110	67	32	2	3	3			
Total Marked (Mi)	265	499	707	401	111	89	128			
Mi/Ri	3.90	4.54	10.55	12.53	55.50	29.67	42.67			

Appendix Table B-8. Computation of the juvenile chinook salmon population at Slough 9A, 1984-85 winter study.

Period of Recovery (j)	Period of Tagging (i)							
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Total
November	1,997	-	-	-	-	-	-	1,997
December	953	2,459	-	-	-	-	-	3,412
January	329	740	1,779	-	-	-	-	2,848
February	114	191	547	447	-	-	-	1,299
March	60	122	567	625	0	-	-	1,374
April	51	177	410	406	360	192	-	1,596
May	21	98	57	203	300	320	691	1,690
TOTAL	3,525	3,797	3,360	1,681	660	512	691	14,216

Appendix Table B-9. Data collected at Beaver Pond Slough (TRM 11.5 Indian River) for juvenile chinook salmon to provide a Schaefer population estimate, 1984-85 winter study.

Period of Recovery (j)	Period of Tagging (i) Oct	Nov	Dec	Jan	Feb	Mar	Total Recovered (Rj)	Total Observed (Cj)	Cj/Rj
November	21	-	-	-	-	-	21	89	4.24
December	17	14	-	-	-	-	31	77	2.48
January	13	10	7	-	-	-	30	61	2.03
February	2	1	3	1	-	-	7	21	3.00
March	0	4	1	1	1	-	7	26	3.71
April	0	1	2	0	0	0	3	12	4.00
May	1	1	0	0	0	0	2	3	1.50
Total Recovered (Ri)	54	31	13	2	1	0			
Total Marked (Mi)	100	88	67	22	6	17			
Mi/Ri	1.85	2.84	5.15	11.0	6.0	0			

Appendix Table B-10. Computation of the juvenile chinook salmon population at Beaver Pond Slough (TRM 11.5, Indian River) 1984-85 winter study.

Period of Recovery (j)	Period of Tagging (i)							
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Total
November	165	-	-	-	-	-		165
December	78	99	-	-	-	-		177
January	49	58	73	-	-	-		180
February	11	9	46	33	-	-		99
March	0	42	19	41	22	-		124
April	0	11	41	0	0	0		52
May	3	4	0	0	0	0		7
TOTAL	306	223	179	74	22	0		804

Appendix Table B-11. Data collected at Len's Slough (TRM 1.9 Indian River) for juvenile chinook salmon to provide a Schaefer population estimate, 1984-85 winter study.

Period of Recovery (j)	Period of Tagging (i) Oct	Nov	Dec	Jan	Feb	Mar	Total Recovered (Rj)	Total Observed (Cj)	Cj/Rj
November	42	-	-	-	-	-	42	94	2.24
December	50	27	-	-	-	-	77	177	2.30
January	14	10	25	-	-	-	49	88	1.30
February	11	5	5	1	-	-	21	46	2.19
March	9	9	8	3	1	-	30	33	1.10
April	3	4	8	1	3	8	27	38	1.41
May	5	2	2	1	2	1	13	17	1.31
Total Recovered (Ri)	134	57	48	6	6	9			
Total Marked (Mi)	136	89	173	43	21	20			
Mi/Ri	1.01	1.56	3.60	7.17	3.50	2.22			

Appendix Table B-12. Computation of the juvenile chinook salmon population at Len's Slough (TRM 1.9, Indian River) 1984-85 winter study.

Period of Recovery (j)	Period of Tagging (i)						
	Oct	Nov	Dec	Jan	Feb	Mar	Total
November	95	-	-	-	-	-	95
December	115	97	-	-	-	-	212
January	25	28	162	-	-	-	215
February	24	17	39	16	-	-	96
March	10	15	32	24	4	-	85
May	7	4	9	9	9	3	41
TOTAL	280	170	283	59	28	28	848

APPENDIX C

ICE THICKNESS DATA, WINTER 1984-85

endix Table C-1. Ice thicknesses (in inches) observed at the winter study sites by partition and sampling period, winter 1984-85.

		Mean Sampling Period Date																
ation	Partition	11-10	11-15	11-18	12-1	12-14	12-30	1-8	1-17	1-27	2-7	2-18	3-2	3-13	3-22	4-1	4-12	4-20
ugh 22																		
	I	1-3	2-16	6-16	6-16	2-18	4-18	4-18	6-24	0-24	2-24	0-20	0-18	0-14	0-12	2-12	0-14	0-10
	II	0-5	4-18	2-18	0-18	2-18	2-22	0-24	1-24	0-24	1-24	0-24	0-18	1-16	0-16	1-16	6-18	0-10
	III	0-5	0-10	0-10	0-16	0-16	2-24	0-24	0-24	0-20	0-18	0-18	0-16	1-16	0-16	0-16	0-16	0-10
	IV	2-10	10-16	10-20	10-24	13-26	10-36	10-36	16-36	10-36	10-36	10-36	10-36	10-36	10-36	10-40	10-48	8-48
ugh 10																		
											0							
	I	0-1	0-4	0-3	0-1	0-2	0-6	0	0	0	0-2	0-6	0-3	0-1	0-2	0-1	0	0
	II	0-1	0-1	0-2	0-1	0-1	0-6	0	0	0	0-2	0-4	0-3	0-1	0	0-1	0	0
	III	0-1	0-1	0-2	0-1	0-1	0-6	0	0	0	0-2	0-4	0-3	0-1	0	0-1	0	0
	IV	0-1	0-3	0-2	0-2	0-1	0-6	0	0-3	0-2	0-2	0-4	0-3	0-2	0-3	0-1	0	0
	V	2-4	6-12	8-16	10-16	6-16	6-20	3-20	4-20	0-12	1-15	1-12	0-18	0-12	0-12	0-12	0-6	0-6
ugh 9A																		
	I	0-1	0-2	0-3	0-2	0-2	N/S	0-2	0-12	0-6	1-6	1-6	0-6	0-2	0-4	0-6	0-2	0-2
	II	0-3	0-8	0-8	0-6	1-6	N/S	0-18	0-24	0-6	1-6	1-12	0-3	0-6	0-4	0-1	0-2	0-1
	III	0-4	6-14	6-14	0-18	6-18	N/S	0-18	0-24	0-24	1-20	0-20	0-18	0-18	0-12	0-14	0-14	0-12
	IV	0--2	0-10	0-2	0-16	0-12	N/S	0-8	0-4	0-3	0-4	0-8	0-8	0-4	0-3	0-3	0-2	0-1
	V	0-3	0-10	0-3	0-16	2-12	N/S	0-6	0-6	0-3	0-4	0-8	0-8	0-6	0-6	0-6	0-2	0-2
ian River																		
	Len's	0-2	0-3	0-4	0-2	1-12	N/S	0-12	0-12	0-12	1-12	1-12	1-12	0-12	1-12	1-12	1-6	0-6
	DOD Slough	N/S	0-2	0-2	0-1	0-3	N/S	0-1	0-2	0-3	0-2	0-8	0-6	0-4	0-2	0-2	0-1	0
	Beaver Pond	0-2	0-3	0-4	0-2	1-6	N/S	0-6	0-6	0-6	0-4	1-8	1-6	0-4	0-6	0-3	0-2	0-1

PART 2

Winter Resident Fish Distribution and Habitat Studies Conducted in the Susitna River Below Devil Canyon, 1984-85

by Richard L. Sundet

ABSTRACT

Studies of selected resident fish species were conducted in both the lower (below the Chulitna River confluence) and middle (between the Chulitna River confluence and Devil Canyon) Susitna River during the winter of 1984-85. These studies primarily collected movement and habitat data from resident fish which were radio tagged in the spring or fall of 1984. These studies showed that middle river rainbow trout overwintered in the mainstem Susitna River, while lower river rainbow trout usually overwintered in side channels. Most rainbow trout overwintered from 0.0 to 4.0 miles below the mouth of the tributary they were tagged at. Rainbow trout in both reaches of river overwintered in areas of low to moderate water velocities (0.0-2.5 fps) and in areas of surface ice. No rainbow trout overwintered in areas that had anchor ice. Middle river rainbow trout were found in slightly deeper waters than lower river rainbow trout. Several middle river rainbow trout overwintered close to each other suggesting that this species congregate during the winter. Two pronounced winter movements were recorded for rainbow trout in both reaches of river: one between mid-September and mid-October and one between mid-December and mid-January. Most rainbow trout begin to migrate from the mainstem to tributaries during breakup in May. Lower river burbot spawned between late January and early February. Four spawning sites at the Deshka River were documented. Several radio tagged burbot probably spawned in the mainstem Susitna River between RM 13.0 and RM 92.0. Burbot showed both a pre- and post-spawning migration of up to 20 miles. Monitoring data suggest some middle river Arctic grayling overwinter in the mainstem at RM 147.0, [near Portage Creek (RM 148.8)], while other stocks migrate 40.0 miles downriver to overwinter near Talkeetna.

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1.0 INTRODUCTION

The lower and middle Susitna River Resident Fish Studies were initiated in the fall of 1980 to determine the relative abundance and distribution of resident fish in those reaches of river. Between 1980 and 1984, sampling effort was primarily done during the open-water periods, mid-May to mid-October. However, studies were also conducted during the winters of 1980-81 and 1982-83 (ADF&G 1981b, 1983c). These studies primarily documented burbot (Lota lota Linnaeus) distribution, relative abundance, and suspected spawning areas with the use of baited hooks or trotlines. It was difficult to sample resident fish, other than burbot, effectively with standard methods because of winter conditions such as ice cover and frazil ice (slush ice). To better understand the winter distribution of important sportfishing species of resident fish, a radio tagging program was initiated in the fall of 1981. Since that time, radio tagged rainbow trout (Salmo gairdneri Richardson) and burbot have been successfully monitored over the winters of 1981-82, 1982-83, and 1983-84 (ADF&G 1983b, 1983c; Sundet and Pechek 1985). In addition, several Arctic grayling (Thymallus arcticus Pallus) were monitored over the winter of 1982-83 (ADF&G 1983c). Several sampling trips conducted during those winters at radio tagged fish relocations, however, yielded limited habitat data on their winter rearing areas. Because winter rearing habitat data were limited, many more resident fish were radio tagged in the fall of 1984 and surveyed more frequently in the winter of 1984-85 compared to other years to better document their winter habitat.

To better answer questions concerning the overwintering distribution and habitat of resident fish, the 1984-85 winter study had the following objectives: (1) to describe the distribution and habitat associated with overwintering rainbow trout in the lower Susitna River (between Cook Inlet and the Chulitna River confluence), (2) estimate the response of rainbow trout overwintering habitat at selected sites (radio tagged fish relocation sites) to hydraulic changes during the winter period. Although the primary intent of this study was to monitor the responses of radio tagged rainbow trout over the winter in the lower Susitna River, biologists were unable to capture many rainbow trout large enough to accommodate radio tags during the fall of 1984 in that reach of river. Therefore, some rainbow trout were radio tagged during the fall of 1984 in the middle Susitna River (between the Chulitna River confluence and Devil Canyon) to increase the sample size. In addition, several rainbow trout which were radio tagged in the spring of 1984 were monitored through the winter until the batteries of their radio tags expired. Several middle river Arctic grayling and lower river burbot were also radio tagged in the fall of 1984 using radio tags left over from previous years of radio tagging efforts. These fish were also monitored through the winter of 1984-85. Relative abundance studies were also done at radio tagged burbot relocations to determine locations and timing of spawning of burbot.

This report primarily addresses winter resident fish studies which were conducted from November 1, 1984 to April 1, 1985. However, radio telemetry monitoring data from fish tagged in September and October 1984 are presented from the time of tagging to the end of May 1985. These data are presented to the end of May because breakup was late in 1985, having occurred on May 24 (R&M 1985). In addition, winter monitoring data are presented from several middle river rainbow trout radio tagged during May and June 1984.

2.0 METHODS

2.1 Study Locations

2.1.1 Relative abundance

Sampling sites were chosen in conjunction with the radio telemetry study. During the winter of 1984-85, radio tagged fish were located in the mainstem Susitna River between RM 6.0 to RM 150.1. In addition, sampling was done in the Deshka River[1] [river mile (RM) 40.6, tributary river miles (TRM's) 0.0 - 29.5] where several radio tagged burbot were found. Figure 1 shows a map of the Susitna River between Cook Inlet and Devil Canyon and its principal tributaries therein.

2.1.2 Radio telemetry

Selection of radio tagging sites in the lower Susitna River during the fall of 1984 were based on resident fish data collected in 1981 and 1982 (ADF&G 1981b, 1983b). Primary efforts to capture rainbow trout in the mainstem Susitna were focused at the mouths of the Deshka River, Willow Creek (RM 49.1), Little Willow Creek (RM 50.5), Kashwitna River (RM 61.0), Sheep Creek Slough (RM 66.1), Montana Creek (RM 77.0), and Talkeetna River (RM 97.0). The upper reaches of Sheep Creek (RM 68.0),

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1 This tributary is identified on USGS topographic maps (1958) as Kroto Creek. However, the more common name for this tributary is the Deshka River and that is the name which has been utilized in this and past reports.

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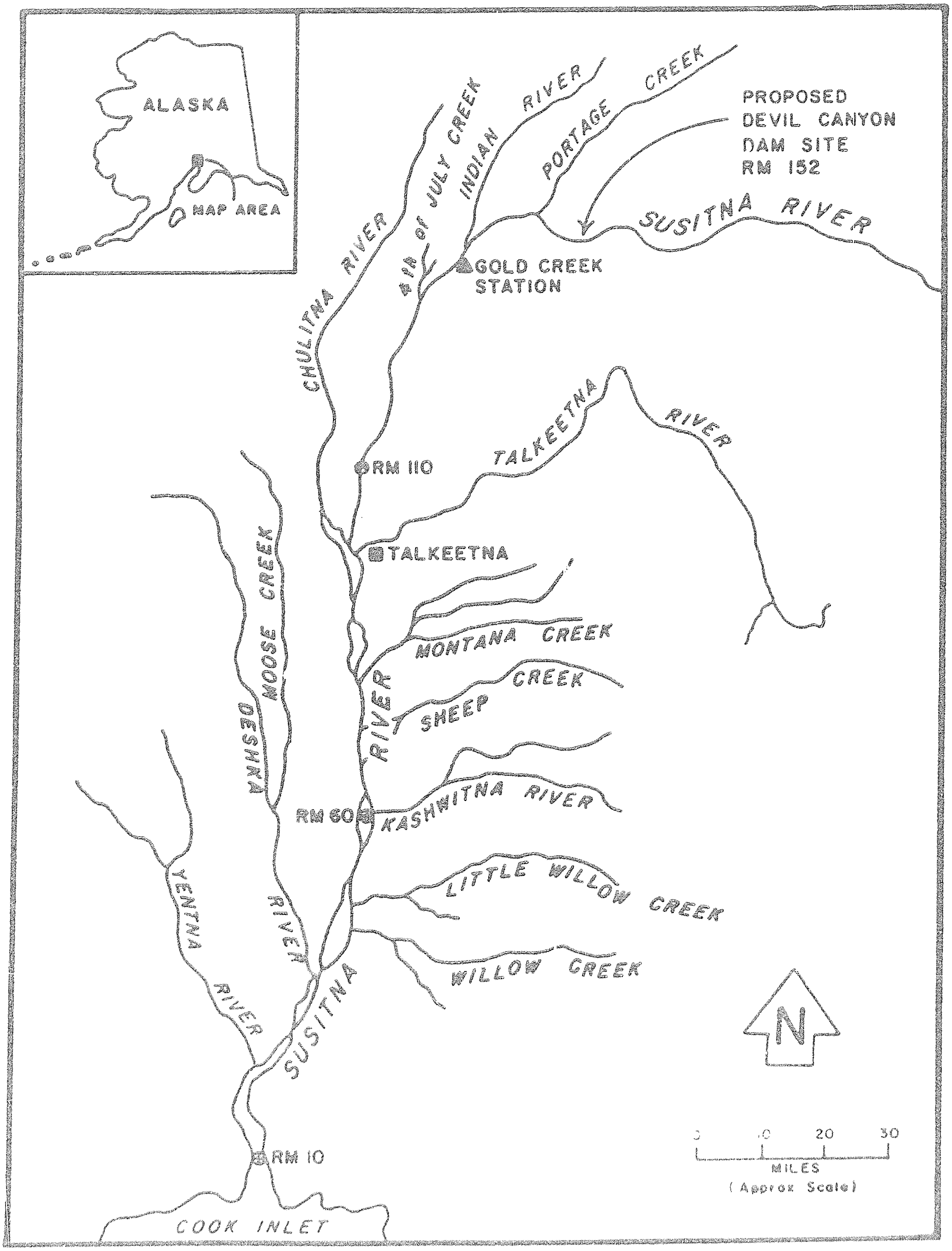

Figure 1. Map of the Susitna River and its main tributaries between Cook Inlet and Devil Canyon.

Goose Creek (RM 72.0), and Montana Creek were also sampled for rearing rainbow trout. Efforts to capture burbot for radio tagging were focused at the mouth of the Deshka River although backwater areas in the mainstem were also sampled.

Selection of radio tagging sites in the middle Susitna River during the spring and fall of 1984 were based on resident fish distribution data collected during the 1981, 1982, and 1983 open-water field seasons (ADF&G 1981b, 1983b; Sundet and Wenger 1984). Primary efforts to capture and radio tag rainbow trout and Arctic grayling in the mainstem Susitna were focused at the mouths of Whiskers Creek (RM 101.4), Lane Creek (RM 113.6), Fourth of July Creek (RM 131.1), Indian River (RM 138.6), and Portage Creek (RM 148.8). Some rainbow trout were also caught and radio tagged in the upper reaches of Fourth of July Creek, Indian River, and Portage Creek during May and June 1984.

2.2 Data Collection

2.2.1 Relative abundance

Resident fish were captured during the winter of 1984-85 by trotlines, burbot sets, and angling. Gill nets were also set in several areas, however, no fish were captured. Catch and biological data were also taken from sportfishermen fishing for burbot on the Deshka River during the winter.

Biological data (age, length, sex, and sexual maturity) were collected as outlined in ADF&G (1983a). Otoliths for age determination were taken from burbot sampling mortalities.

Habitat parameters were measured at suspected burbot spawning areas. These parameters included mean column water velocity, water depths, ice thickness, the presence or absence of slush ice, substrate type, and general water quality. Specific habitat data collection methodology is summarized in ADF&G (1983a).

2.2.2 Radio telemetry

Most rainbow trout and Arctic grayling which were radio tagged in 1984 were captured by boat electrofishing or by hook and line (Appendix Tables A-1, A-2, and A-3). Burbot which were radio tagged were captured by boat electrofishing or hoop net (Appendix Table A-4). Scales were taken from rainbow trout and Arctic grayling for aging purposes.

Habitat parameters were measured at radio tagged fish relocation sites during the winter of 1984-85. During ground surveys in December, January, and February, radio tagged fish were located to within a four-foot-radius and habitat measurements were made as close to the signal as possible. Habitat parameters measured were the same as those taken at burbot spawning sites. During the ground surveys, the fate of each located radio tagged fish was also determined.

Equipment

Radio telemetry receiving equipment used in this study was developed by Smith-Root Incorporated in Vancouver, Washington. Receiving equipment consisted of a low frequency (40 MHz) radio tracking receiver (Model RF-40) and scanner (Model SR-40), and a loop antenna (Model LA-40).

Radio transmitters manufactured by Smith-Root Incorporated and Advanced Telemetry Systems (ATS of Bethel, Minnesota) were used in the 1984-85 study. Two types of radio tags were used: internal and external. Internal radio tags were provided by both Smith-Root and ATS while external radio tags were provided by ATS. Smith-Root radio tags with a six or a nine month life expectancy were implanted in burbot. Advanced Telemetry Systems' radio tags with 6-11 month life expectancies were implanted in rainbow trout and also several burbot when the supply of Smith-Root tags was exhausted. Since past efforts to internally radio tag Arctic grayling have failed (ADF&G 1983c), ATS' external radio tags were attached to this species.

Smith-Root transmitters (Model P40-500L 3v) were identical to those used in previous resident fish telemetry studies (ADF&G 1983b, 1983c). Smith-Root transmitters used in the 1984-85 studies had pulse rates of 0.5, 1.0, or 3.0 pulses per second (pps) with the 0.5 pps radio tags having a life expectancy of nine months while the others had a life expectancy of six months. Advanced Telemetry Systems' internal transmitters (Model 10-35) were identical to those used in 1983 and 1984 summer telemetry studies with pulse rates between 1.0 and 2.4 pps (Sundet and Wenger 1984; Sundet and Pechek 1985).

The Advanced Telemetry Systems' external radio tags (Model RM625) that were used were the same as those used in 1984 summer studies (Sundet and Pechek 1985). The power source for the transmitters was a 1.4 volt mercury battery providing life expectancies of 90 days. The pulse rates for these tags were 2.4 pps.

Transmitter frequencies used (40.600-40.770 MHz) were the same range as used in 1983 and 1984 summer studies (Sundet and Wenger 1984; Sundet and Pechek 1985). All radio tags were immersed in cold water (1.5°C) for 48 hours to ensure they were transmitting properly before they were implanted in fish.

Transmitter implantation

Based on personal communications with Carl Burger (USFWS) and experience gathered from the previous three years of radio telemetry studies, the minimum fork length of rainbow trout and Arctic grayling radio tagged in the summer and fall of 1984 was set at 380 mm (ADF&G 1983b, 1983c; Sundet and Wenger 1984). The minimum total length of burbot to be radio tagged was set at 525 mm.

Internal radio tags were implanted using the same procedures described in Ziebell (1973) and discussed in Sundet and Wenger (1984). External tags were attached in a similar manner as attaching Peterson discs (Sundet and Pechek 1985). Before surgery or attaching external tags, fish were anesthetized with MS-222 (tricaine methane sulfonate).

After radio tagging, the fish were placed into a live box and held upright until they regained their equilibrium. The fish were then held overnight whenever possible for observation. The following day the sutures were checked and the transmitter's signal was tested before releasing each radio tagged fish near their point of capture.

Tracking

Biologists radio tracked fish over the mainstem Susitna between RM's 0.0 and 154.0 primarily by fixed wing aircraft or helicopter during the winter of 1984-85. Aerial radio tracking was done using methods described in ADF&G (1981c). Radio tracking conducted between September and freeze-up (mid-October) 1984 was done by boat or fixed wing aircraft approximately every 10-14 days. Between freeze-up and late May 1985, radio tracking was done by fixed wing aircraft or helicopter every 20 days.

Additionally, tracking flights were regularly made over the Deshka River (TRM's 0.0 to 29.5). Fixed wing radio tracking was also done occasionally over various tributaries such as Yentna River (RM 28.5), Willow Creek, Little Willow Creek, Fourth of July Creek, and Portage Creek.

When helicopters were used for tracking, fish were pinpointed and habitat data were often collected after landing at their relocations. Occasionally, snowmobiles were also used during the winter to pinpoint radio tagged fish.

3.0 RESULTS

3.1 Lower Susitna River

3.1.1 Rainbow Trout

Ten rainbow trout were radio tagged in the lower river between September 6 and October 12, 1984. A summary of their capture, biological, and radio tagging data is presented in Appendix Table A-1. During intensive surveys to radio tag rainbow trout in the upper reaches of several east side tributaries such as Montana Creek during September 1984, only three rainbow trout large enough to accommodate a radio tag were captured and radio tagged. It was believed that most of the rainbow trout had outmigrated these tributaries to the mainstem Susitna because of a flood in late August before the tagging surveys commenced. It was hoped that a number of rainbow trout could have been radio tagged in their summer rearing east side tributaries so their fall outmigration would have been better documented. In their summer rearing areas, we believed rainbow trout could be more easily and readily captured then after they outmigrated and dispersed into the mainstem. Sundet and Pechek (1985) further discuss overall catches of these surveys.

The remaining seven lower river rainbow trout were captured and radio tagged between RM 49.5 and RM 96.0 with four fish being captured in the mainstem or side channels of the Susitna River and three fish being captured at tributary mouths.

Two of the ten radio tagged rainbow trout yielded little data. Rainbow trout 609-2.0 was found for only one week after and within 0.1 mile of where it was tagged and released. Because this fish was not found again, the battery of its radio tag was believed to have expired soon after the fish was released. Rainbow trout 739-2.3 was pinpointed on January 14 during a ground survey and was believed dead at that time. After it was tagged, it moved consistently downriver and was found at RM 9.6 in mid-January (Figure 2).

Figures 2 and 3 show the winter movements of the rainbow trout which provided good results. Two of the three rainbow trout (609-1.3 and 620-1.2) which were tagged in the upper reaches of east side tributaries remained in those tributaries for at least two weeks before outmigrating to the mainstem Susitna. The remaining rainbow trout tagged in a tributary (599-1.2) moved into the mainstem Susitna soon after tagging. By early October, all three of these rainbow trout were found in the mainstem Susitna.

After moving into the mainstem Susitna, the three rainbow trout which were radio tagged in tributaries, as well as the other five successfully radio tagged rainbow trout, showed variable movements. Six of the eight radio tagged rainbow trout showed a general downstream movement with three of these fish (599-1.2, 650-1.3, 660-1.0) eventually moving back upriver during the winter. Two fish (602-2.0 and 630-1.0) moved slightly downriver for the winter and another (640-1.4) moved rapidly downriver (28.0 miles) before holding. The remaining two fish (609-1.3

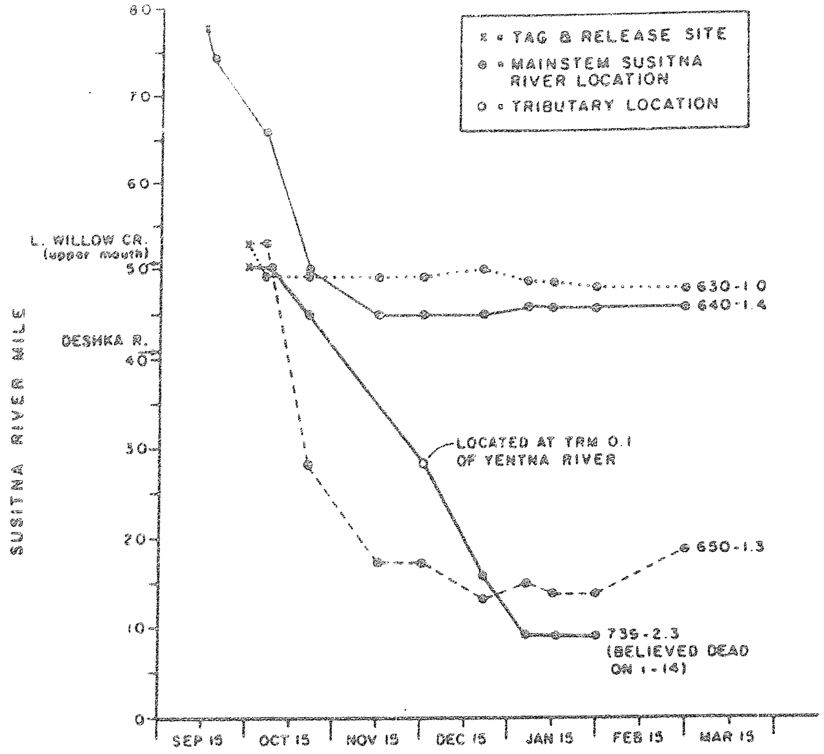

Figure 2. Movement of four radio tagged rainbow trout in the Susitna River, September 1984 to March 1985.

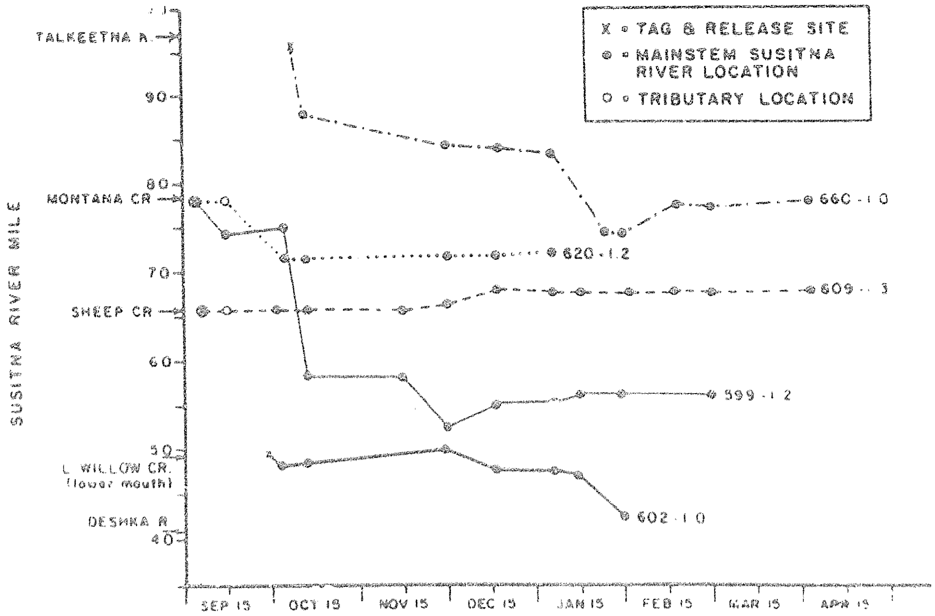

Figure 3. Movement of five radio tagged rainbow trout in the Susitna River, September 1984 to April 1985.

and 620-1.2) moved slightly upriver. The maximum upriver movement by the eight successfully radio tagged rainbow trout was shown by rainbow trout 650-1.3 which moved 5.5 miles. This fish also exhibited the maximum downriver movement (20 miles).

Eight of the ten radio tagged rainbow trout were ground surveyed during mid-January or February. At this time, rainbow trout 739-2.3 was pinpointed and believed dead. The remaining seven fish were believed alive when ground surveyed. Four of the fish (602-2.0, 609-1.3, 630-1.0, 640-1.4) were found in side channels approximately 200 feet wide and in water depths under four feet (Appendix Table A-5). The remaining three rainbow trout were found in the mainstem Susitna in waters between 1.5 to 10.0 feet deep. One of the seven fish believed alive (599-1.2) was found in open-water during a ground survey, as well as much of the winter. The remaining six fish believed alive when ground surveyed, were found under ice cover. In addition to the time when the ground surveys occurred, these six fish appeared to have remained under ice cover for much of the winter. A summary of the habitat data collected at the relocation sites of the seven rainbow trout believed alive is presented in Table 1. Specific measurements at each radio tagged fish relocation are presented in Appendix Table A-5.

During ice drilling over seven radio tagged fish, five fish moved between 30 and 200 feet while no movement was detected for two fish (660-1.0 and 739-2.3). Rainbow trout 739-2.3 was determined to be dead but rainbow trout 660-1.0 was believed alive since it had recently moved upriver 3.0 miles. Sampling gear was set overnight near five radio

Table 1. Summary of habitat data collected at Susitna River radio tagged rainbow trout relocations, January and February 1985. All rainbow trout were captured in the lower Susitna River in 1984.

	Depths (ft)					Water Quality			
	water	ice	slush	velocity (fps)	substrate	temp °C	DO mg/l	conductivity umhos/cm	pH
n	7	7	7	7	6	6	2	6	6
X	3.5	1.8	0.0	1.0	sand/gravel	-0.2	10.6	184	7.0
range	0.4-10.0	0.0-3.0	-	0.0-3.5	silt/cobble	-0.3-0.0	10.2-10.9	160-202	6.7-7.3

tagged rainbow trout. None of the radio tagged rainbow trout were captured, but seven non-spawning burbot were captured in mid-January near rainbow trout 640-1.5 at RM 46.0 (Appendix Table B-1).

3.1.2 Burbot

Fourteen river burbot were radio tagged in the lower river between September 14 and October 17, 1984. Most (8) of these fish were radio tagged at the Deshka River (RM 40.6). Another three burbot were radio tagged in the mainstem Susitna close to the Deshka River. Appendix Table A-4 lists the biological, capture, and radio tagging data of these fish. Little data were provided by four of the radio tagged burbot. Two fish (610-3.0 and 629-3.0) apparently died soon after tagging and their movement is not further discussed. For another (619-2.2), the radio tag's battery apparently expired soon after deployment (Figures 4 and 5). The remaining fish (770-2.4) which yielded limited data was recaptured by a sportfisherman 2.5 months after being radio tagged and released (Figure 4).

The remaining ten burbot showed variable movements. All ten radio tagged burbot showed an upstream movement between 0.4 miles and 30.2 miles (Figures 4 to 6). The maximum downstream movement was exhibited by burbot 659-1.0 which moved downriver 39.8 miles after ascending the Deshka River (Figures 4 and 5).

Five of the ten radio tagged burbot which yielded good results spent much of the winter in the Deshka River. Three of these fish (659-1.0,

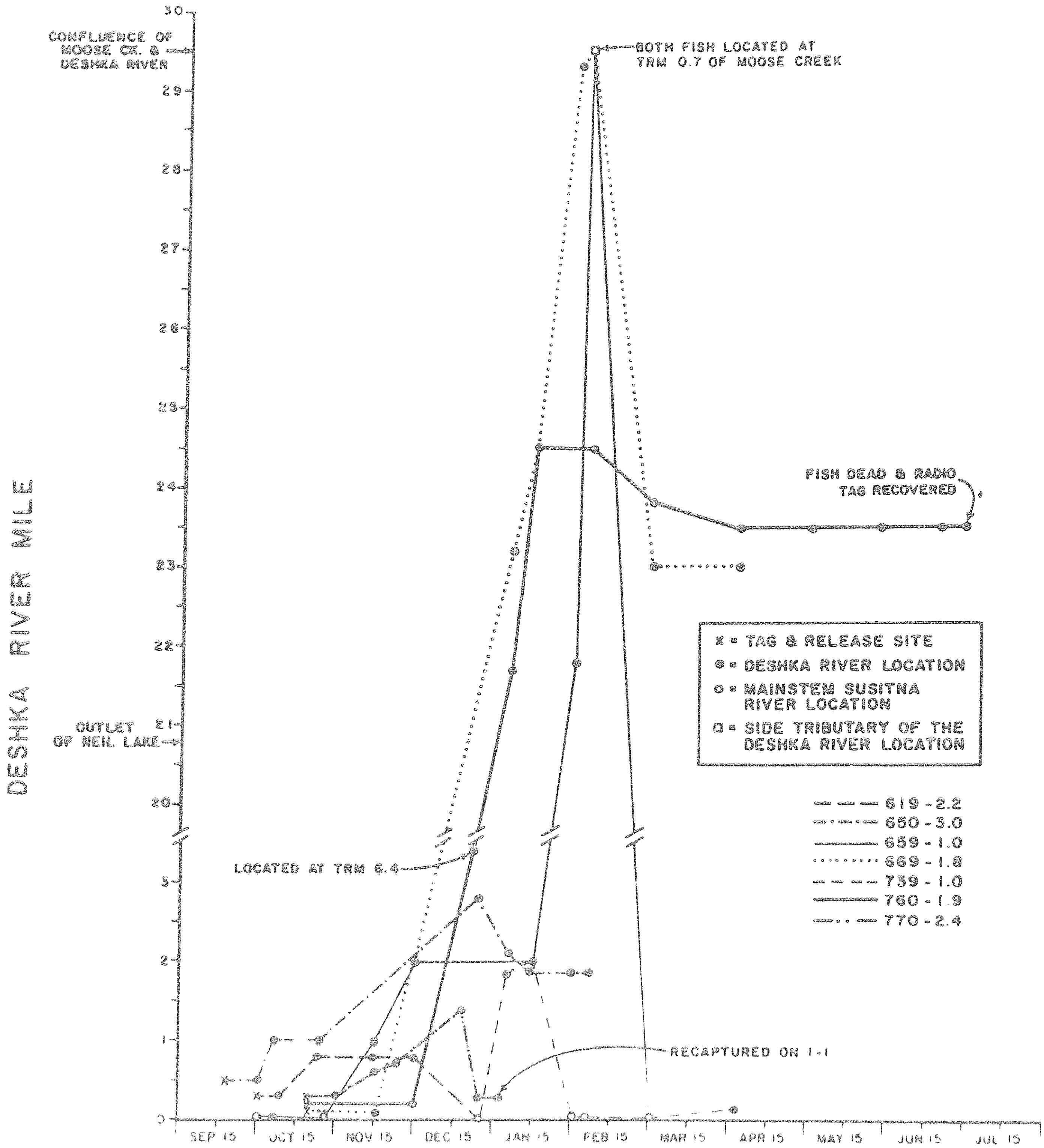

Figure 4. Movement of seven radio tagged burbot in the Deshka River (RM 40.6), September 1984 to July 1985.

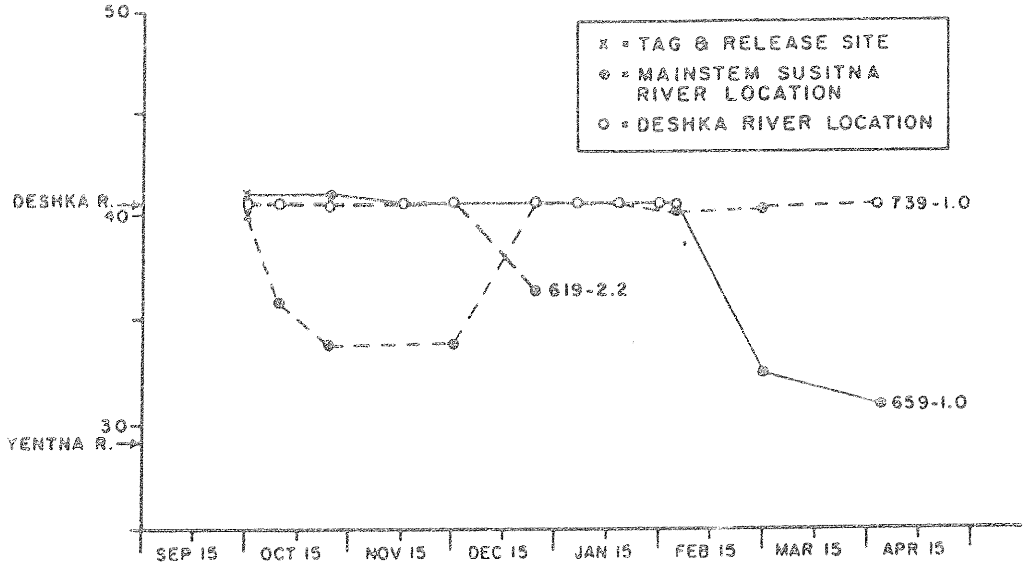

Figure 5. Movement of three radio tagged burbot in the Susitna River, September 1984 to April 1985.

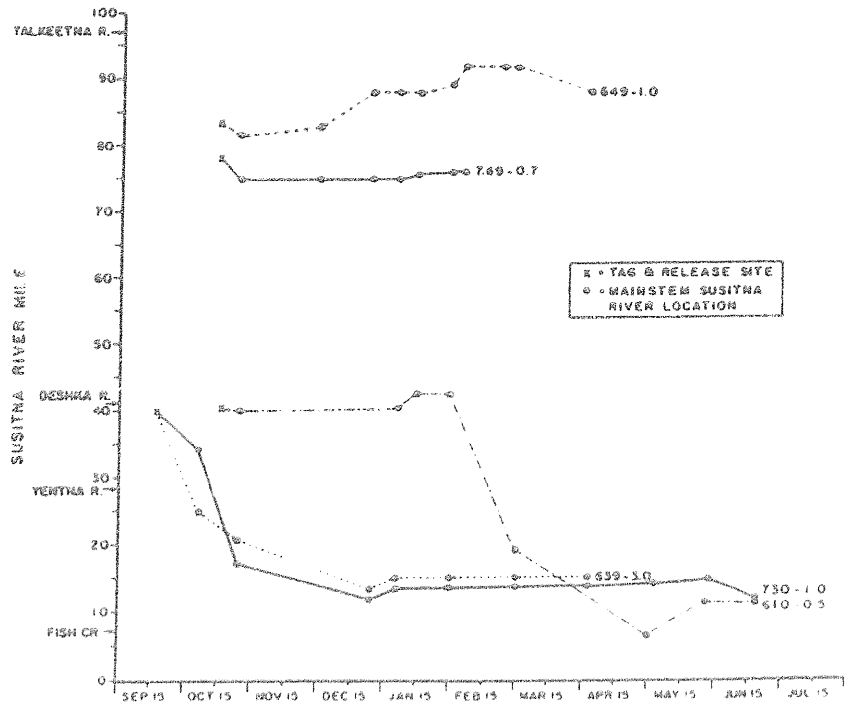

Figure 6. Movement of five radio tagged burbot in the Susitna River, September 1984 to June 1985.

669-1.8, 760-1.9) migrated to the upper reaches of the Deshka River with two of the fish being found at TRM 0.7 of Moose Creek on February 5. Moose Creek flows into the Deshka River at TRM 29.5 of the Deshka River. Two other radio tagged burbot (650-3.0 and 739-1.0) spent much of the winter near TRM 2.0 of the Deshka River. Burbot 659-1.0 also ascended the upper reaches of the Deshka River after spending 1.5 months at TRM 2.0.

Movement data were also collected on five radio tagged burbot which remained in the mainstem (Figure 6). Generally during the winter of 1984-85, one fish (649-1.0) moved upriver, another (749-0.7) remained relatively stationary, while the remaining three burbot (610-0.5, 639-3.0, 730-1.0) moved downriver to the lower reaches of the Susitna River.

Sampling trips conducted from mid-December through February showed most (9 of 10) of the radio tagged burbot that were ground surveyed were alive and habitat data were collected near each radio tagged fish. Burbot 629-3.0 was believed dead during a ground survey on January 16. Seven of the nine fish believed alive when ground surveyed moved after ice drilling over them. Meanwhile, the remaining two fish (649-1.0 and 650-3.0) surveyed were believed alive because they had recently or after sampling moved upriver.

Habitat measurements taken at 14 radio tagged burbot relocations showed they were generally found in low water velocities and depths in the Deshka River, and in low water velocities and variable depths in the mainstem. However, few areas in the Deshka River are believed to exceed 6.0 feet in water depth during the winter. By comparison, the lower mainstem Susitna River has many areas which have winter water depths greater than 6.0 feet. The radio tagged burbot were also generally found under solid ice cover. In three instances, radio tagged burbot were found near open leads but still under ice. In one instance, a radio tagged burbot was found under overflow. Table 2 presents a summary of habitat data collected at the radio tagged burbot relocation sites. Specific habitat measurements at each relocation site are presented in Appendix Table A-6.

During ground surveys, burbot sets and trotlines were set overnight near several radio tagged burbot. Although none of the radio tagged burbot were captured, 33 untagged burbot were captured in varying stages of sexual maturity (Appendix Table B-1).

By May, only one radio tagged burbot (760-1.9) was found in the upper reaches of the Deshka River. During a ground survey in late June, the radio tag of this fish was found along the shoals of the Deshka River at RRM 23.5. It appeared this fish died some time in late April.

Biological characteristics: sexual development, age, length, and sex composition

Non-spawning, pre- and post-spawning burbot were captured by biologists in the Susitna River and the Deshka River between December 17 and Febru-

Table 2. Summary of habitat data collected at Susitna River radio tagged burbot relocations, December 1984 and February 1985. All rainbow trout were captured in the lower Susitna River in 1984.

	Depths (ft)					Water Quality			
	water	ice	slush	velocity (fps)	substrate	temp °C	DO mg/l	conductivity umhos/cm	pH
At mainstem sites									
n	4	4	4	4	4	3	2	3	3
X	3.3	2.3	1.9	0.1	gravel/cobble	-0.1	12.2	144.7	7.2
range	0.2-7.8	1.5-3.0	0.0-4.3	0.0-0.1	sand/cobble	-0.2-0.0	11.5-12.9	74.0-188.0	7.1-7.3
At Deshka River sites									
n	10	10	10	10	10	9	5	9	9
X	1.1	2.3	0.0	0.3	gravel/sand	0.0	9.1	78.6	6.8
range	0.1-3.0	1.5-2.9	0.0-0.0	0.0-0.5	sand/cobble	-0.2-+0.2	8.4-10.4	58.0-101.0	6.4-7.2

ary 8. In addition, burbot catch and biological data were obtained from a sportfisherman at the Deshka River who recorded his catch data from late November to mid-December 1984.

Lower river pre-spawning burbot were captured from November 25 to January 16. Post-spawned burbot were first captured on February 5 at TRM 0.7 of Moose Creek. All burbot captured after February 5 were post- or non-spawners. Several non-spawners were also captured before February 5. Sampling locations and catch per unit effort (CPUE) of all burbot captured during the winter of 1984-85 are presented in Appendix Table B-1.

Between November 25 and February 8, 63 burbot were sexed by necropsy and their sexual maturities were recorded (Appendix Table B-2). Fifty-three of the 67 burbot were aged. Ages ranged from 5 to 12 with ages 7 (20.8%), 6 (15.1%), 8 (15.1%) and 9 (15.1%) comprising the majority of the sample. Lengths of aged fish ranged from 405 mm to 740 mm in total length (TL) (Appendix Table B-3). Figure 7 illustrates the average length and range of lengths for each age class of burbot sampled between December 1984 and February 1985.

Of the 53 burbot aged, 35 fish were pre- or post-spawners. Eight of the pre- or post-spawners were males ranging from 405 mm to 740 mm (TL) and encompassing age classes 6 to 11. The remaining 27 pre- or post-spawning aged females ranged from 360 mm to 780 mm (TL) and encompassed age classes 5 to 12. The remaining 18 burbot aged were non-spawners.

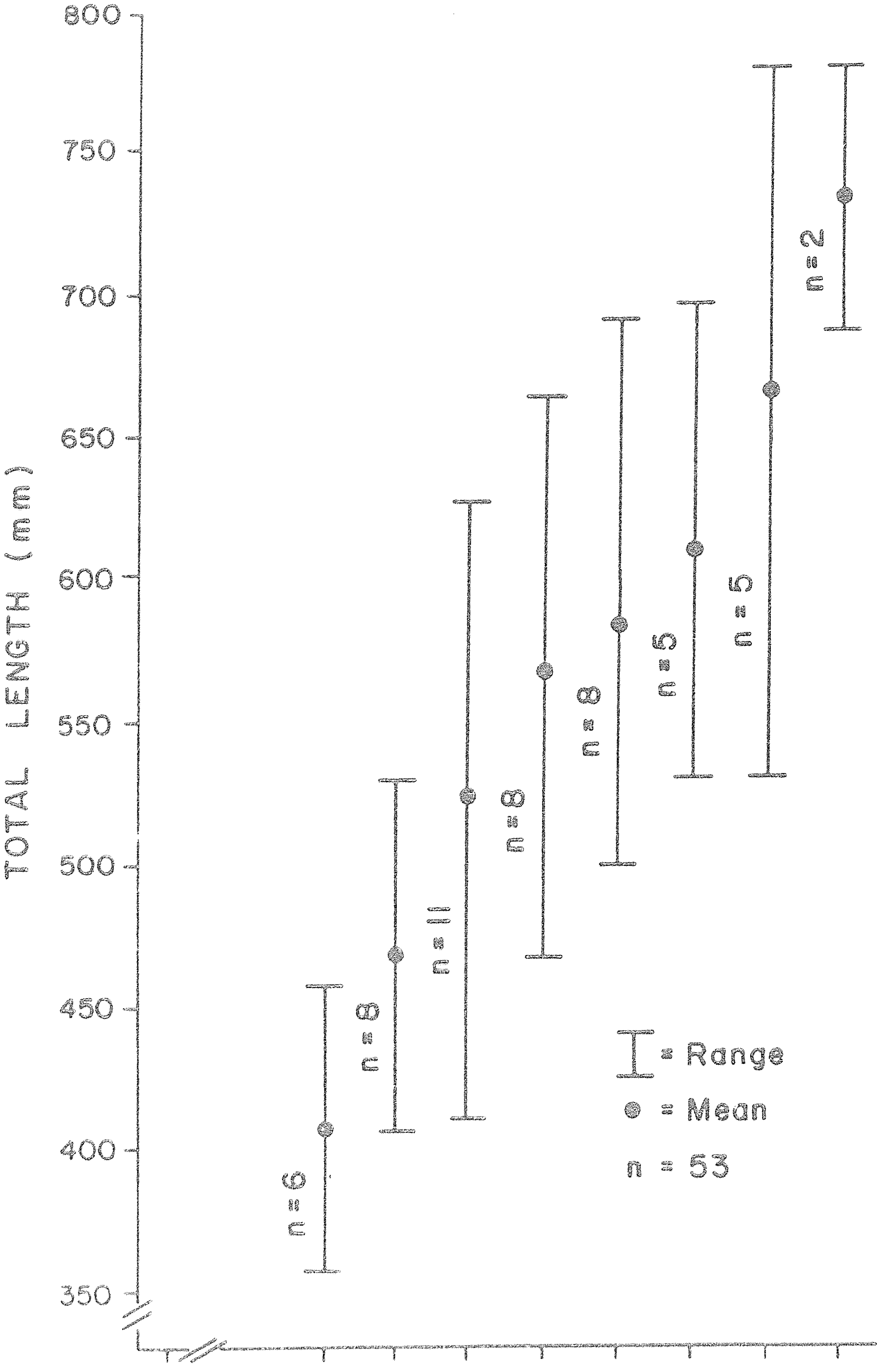

Figure 7. Age-length relationships for burbot captured in the Susitna River between Cook Inlet and Devil Canyon, December 1984 through February 1985.

Five non-spawners were males ranging in length from 410 mm to 665 mm and age from 5 to 8 years. The 13 non-spawning females ranged in length from 400 mm to 705 mm and age from 5 to 12 years.

3.2 Middle River

3.2.1 Rainbow Trout

Thirteen rainbow trout were radio tagged in the middle river during September and October 1984 and their movements were monitored over the winter of 1984-85. Another 15 rainbow trout which were radio tagged in May or June 1984 having functional radio tags at the beginning of the winter study (November 1, 1984), were also monitored over the winter. Capture, biological, and radio tagging data for the rainbow trout radio tagged in the fall of 1984 are provided in Appendix Table A-2. Capture data for the rainbow trout which were radio tagged during the spring of 1984 are reported in Sundet and Pechek (1985) along with monitoring data between May and November 1984.

Little useful data were collected from six radio tagged fish monitored over the winter because they were determined or believed dead during the fall of 1984 or the winter of 1984-85. Two of these fish (598-1.6 and 670-1.2) probably died before November 1984 and their fates are discussed in Sundet and Pechek (1985).

Two rainbow trout were determined dead (740-1.1 and 749-1.1) during ground surveys in late January or early February. Rainbow trout 618-2.1

was believed dead during a late January ground survey (Figure 8). The remaining rainbow trout (719-1.6) moved upriver during late September, but then slowly moved back downriver and was believed dead during an early February ground survey (Figure 9).

The other 22 rainbow trout were determined or believed to be alive during the winter. All of the 22 radio tagged rainbow trout had outmigrated from tributaries to the mainstem by early October. Overwintering movements of these 22 radio tagged rainbow trout can be placed into three categories based on the distance the fish overwinters in the Susitna River from their Susitna River tagging site or from the mouths of the tributaries in which they were tagged. These categories are: (1) near (within 4.0 miles), (2) medium (between 4.1 miles and 15.0 miles), and (3) far (over 15.0 miles).

Movements of the 22 rainbow trout which were determined or believed alive are provided in Figures 8 to 12. All of the 22 fish overwintered in the mainstem Susitna with 14 of 21 fish overwintering near their Susitna River tagging sites or the mouths of the tributaries where they were tagged.[2] Five of the radio tagged rainbow trout (608-1.9, 620-1.2, 629-1.0, 709-1.2, 770-1.1) overwintered between 4.1 and 15.0 miles from their Susitna River tagging location or the mouths

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[2] One rainbow trout (728-1.0) was not included in discussing the general overwintering movements because it was accidently moved after capture and displaced 10 miles downriver. Its overwintering movement data can only be interpreted as questionable.

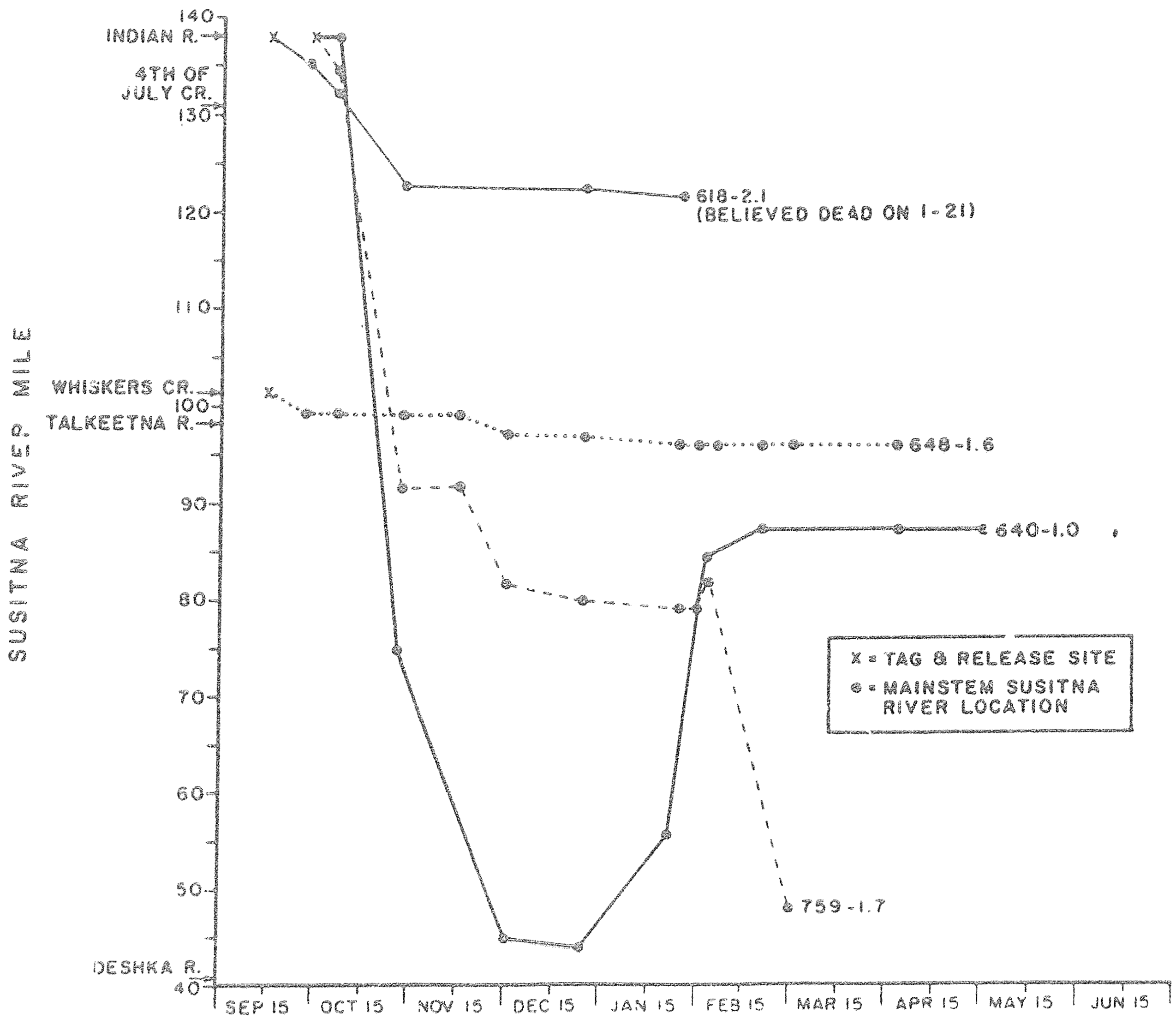

Figure 8. Movement of four radio tagged rainbow trout in the Susitna River, September 1984 to May 1985.

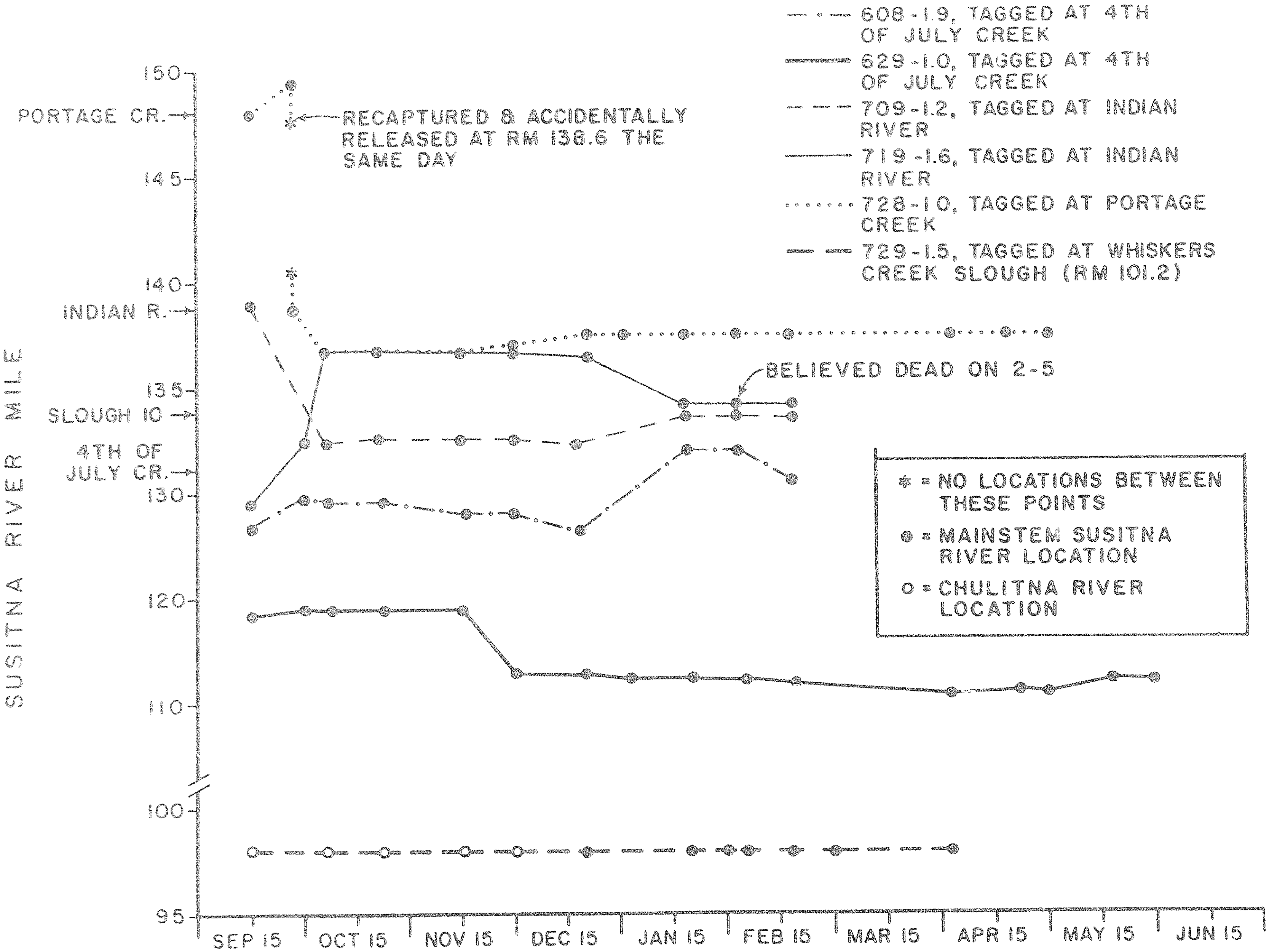

Figure 9. Winter movement of six radio tagged rainbow trout which were tagged during the spring of 1984, Septemb… 1984 to May 1985.

of the tributaries where they were tagged (Figures 9, 10, and 11). The remaining two radio tagged rainbow trout (640-1.0 and 759-1.7) were found up to 90 and 94 miles from where they were tagged at in late September (Figure 8). Because these two fish moved downriver so rapidly and far, it appears they were injured during capture or tagging. It also appears these two fish healed and attempted to move back upriver. Both fish appeared to have died in early or late February, however, because thereafter they either moved downriver or remained stationary.

Only two of the 21 radio tagged rainbow trout (659-1.8 and 749-1.8) overwintered for more than two months upstream of their mid-October locations.

While the 21 radio tagged rainbow trout were found between RM's 42.0 and 151.0 from September 1984 to May 1985, the majority of these fish were generally found in several specific sections of the mainstem. During this time period, eight of the 21 rainbows were found between RM's 146.0 and 151.0 (Figures 10 and 12). Four fish were found between RM's 135.0 and 140.0 (Figure 11), and two fish were found between RM's 97.0 and 100.0 (Figures 8 and 9).

Generally, most of the radio tagged rainbow trout monitored over the winter of 1984-1985 moved their maximum distance between mid-September and late November 1984. A number of radio tagged fish also appeared to move between late December and mid-January. In addition, the few rainbow trout with radio tags still functioning in the spring appeared move in early April.

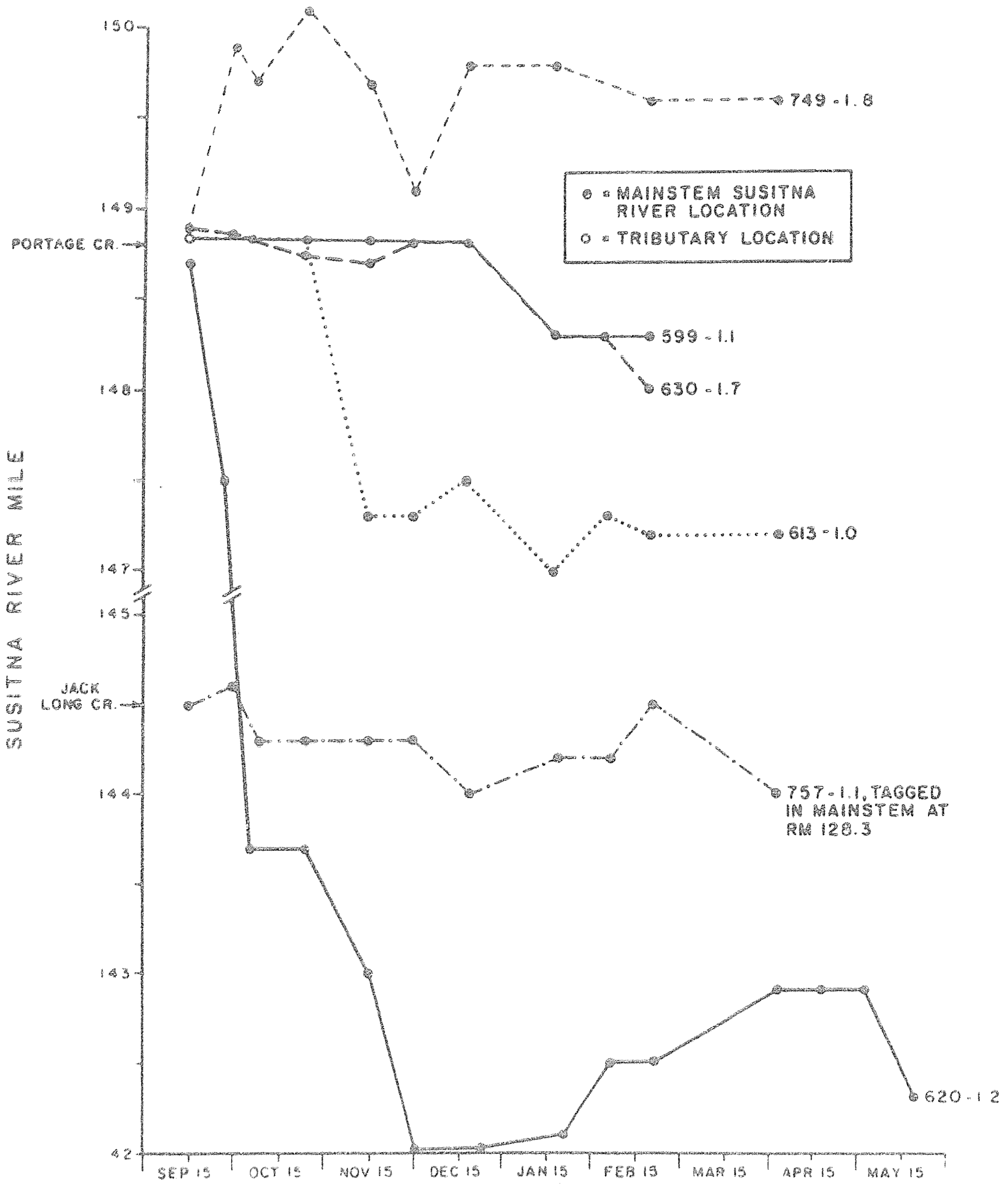

Figure 10. Winter movement of six radio tagged rainbow trout which were tagged during the spring of 1984 in the Susitna River, September 1984 to May 1985. All except one fish was tagged in Portage Creek.

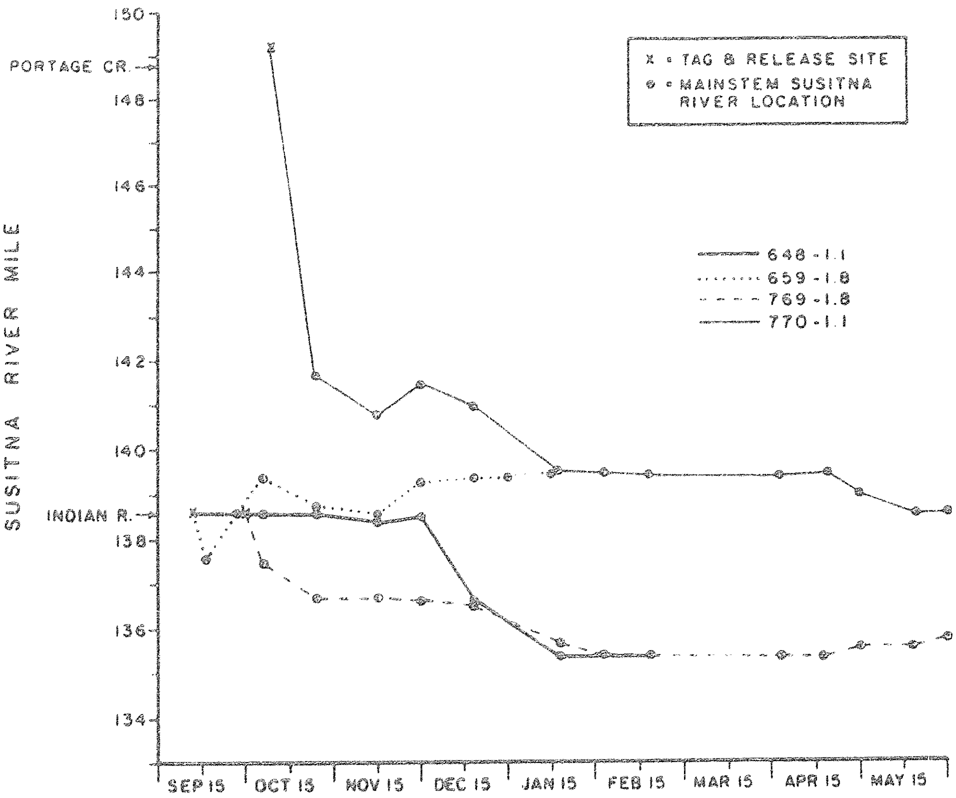

Figure 11. Movement of four radio tagged rainbow trout in the Susitna River, September 1984 to May 1985.

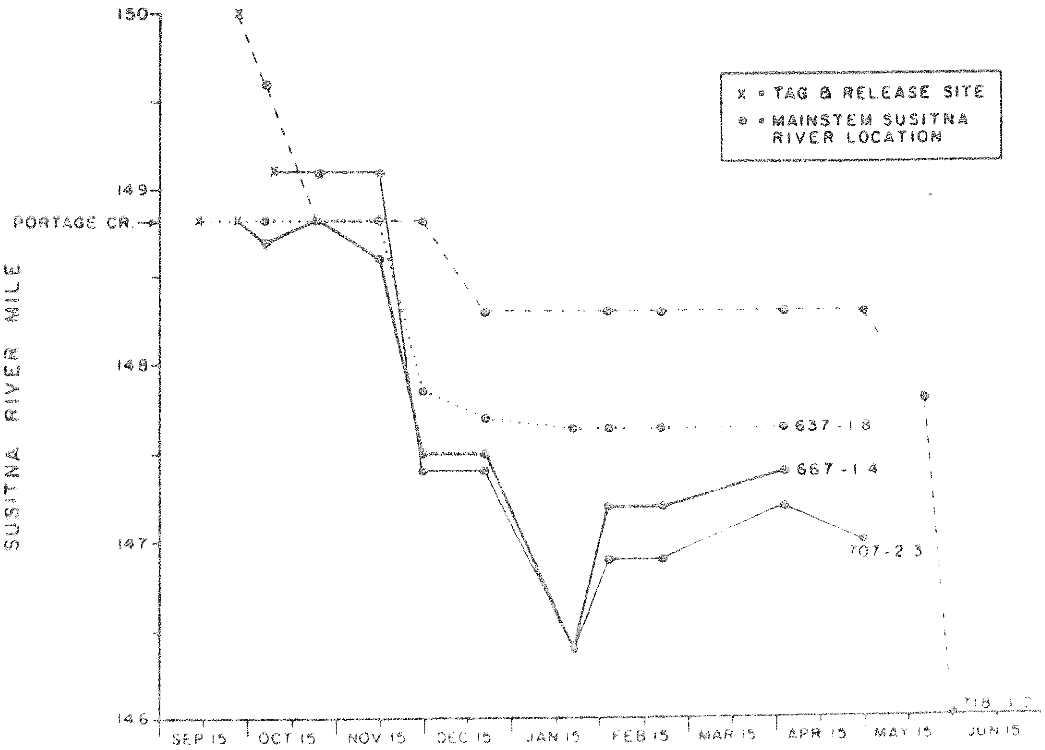

Figure 12. Movement of four radio tagged rainbow trout in the Susitna River, September 1984 to May 1985.

During ground surveys conducted in January and February, data were collected at 29 fish relocations from 23 different radio tagged rainbow trout which were determined or believed to be alive. During these relocation surveys, all of the radio tagged rainbow trout were found in the mainstem Susitna and generally in waters of low to moderate velocities and of moderate depths. Most (26 of 29) rainbow trout relocations were at areas of ice cover, however, ten relocations were within 200 feet of open leads. Table 3 summarizes the habitat data collected at the 29 fish relocations while specific measurements taken at each fish relocation site are presented in Appendix Table A-7.

Often two or more radio tagged rainbow trout were found within 100 feet of each other when ground surveyed. Sites where radio tagged fish were found together were: RM's 135.4, 139.5, 146.4, 147.0, and 148.3. Also, in one instance at RM 147.0, a radio tagged rainbow trout (613-1.0) was found 50 feet from a radio tagged Arctic grayling (740-2.3).

During ice augering at the radio tagged rainbow trout relocation sites, movement was detected at 19 of 25 sites. Sampling was done at several of the relocation sites. None of the radio tagged fish were captured, however, several non-tagged fish were captured. Three burbot were captured near rainbow trout 629-1.0 and one burbot was captured near a rainbow trout believed dead (598-1.6) (Appendix Table B-1). One rainbow trout was captured by hook and line at RM 146.4 and near rainbow trout 667-1.4 and 707-2.3 in early February.

Table 3. Summary of habitat data collected at Susitna River radio tagged burbot relocations, December 1984 and February 1985. All rainbow trout were captured in the middle Susitna River in 1984.

	Depths (ft)					Water Quality			
	water	ice	slush	velocity (fps)	substrate	temp °C	DO mg/l	conductivity umhos/cm	pH
n	28	28	28	28	28	27	24	27	25
X	4.4	2.3	0.4	0.9	cobble	0.0	12.9	235	7.2
range	0.9-10.0	0.0-4.3	0.0-3.7	0.0-2.5	silt/cobble	-0.2-+0.3	10.2-15.7	140-306	6.0-7.7

During ground surveys, habitat measurements were also taken at the relocations of six radio tagged rainbow trout which were determined or believed dead. These fish were found in little or no water (Appendix Table A-7).

3.2.2 Arctic Grayling

Five Arctic grayling were radio tagged in the middle river on September 11 or September 26, 1984. Appendix Table A-3 presents the capture, biological, and radio tagging data of these fish.

Winter movements of three of the radio tagged Arctic grayling (610-2.4, 629-2.2, 639-2.3) contrasted with the movements of the remaining two fish (600-2.4 and 740-2.3) (Figure 13). The three fish moved rapidly downriver (between 36.6 and 63.6 miles) in the mainstem Susitna River immediately after their tagging and release at the mouth of Indian River. The other two fish remained relatively stationary in the mainstem Susitna River, just downriver from their tagging site at the mouth of Portage Creek. One of the fish which moved rapidly downriver (610-2.4) also became relatively stationary after moving 36.6 miles in 20 days.

Two of the Arctic grayling which moved rapidly downriver (629-2.2 and 639-2.3) provided little data because the batteries of their radio tags were presumed to have prematurely expired. Biologists failed to discover these fish during intensified monitoring flights in the areas where the two fish were last found.

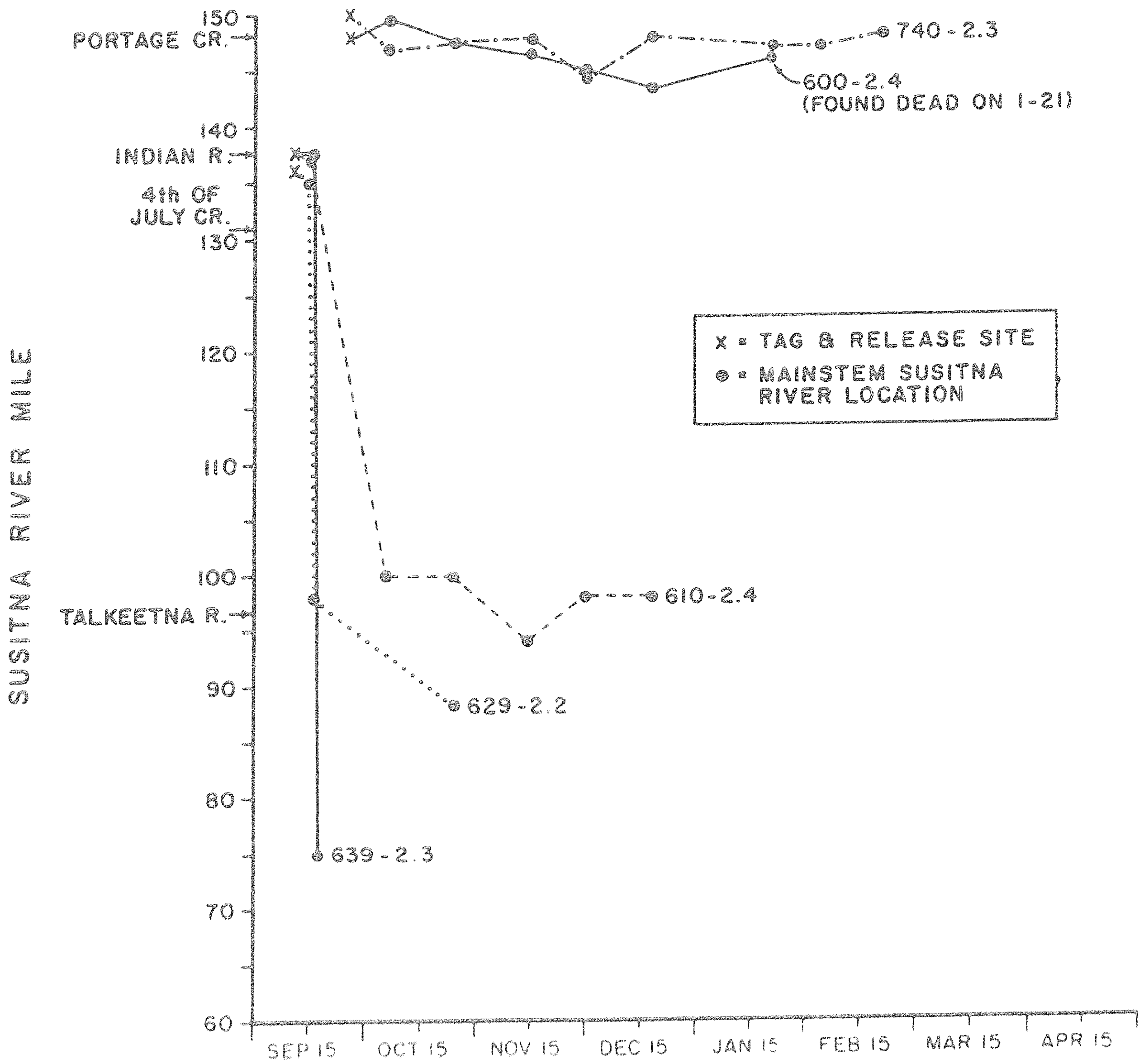

Figure 13. Movement of five radio tagged Arctic grayling in the Susitna River, September 1984 to February 1985.

During winter ground surveys beginning in mid-January, only two of the five Arctic grayling's radio tags were functioning. In mid-January, Arctic grayling 600-2.4 was found dead under solid ice, but Arctic grayling 740-2.3 was found alive at RM 147.0 and 50 feet from rainbow trout 613-1.0. During ice drilling, the Arctic grayling moved 35 feet. Habitat measurements taken near Arctic grayling 740-2.3 on January 21 included: water depth = 2.3 ft, ice = 3.0 ft, slush = 0.0 ft, velocity = 0.3 fps; substrate was 60% cobble and 40% gravel; water quality was pH = 7.4, DO = 14.5 mg/l, conductivity = 228 umhos/cm, water temperature = -0.2°C.

No habitat data were collected near Arctic grayling 740-2.3 during later ground surveys, but on February 5 this fish was pinpointed at the same location where it was in mid-January (along the east shore of an island). On February 28, it was found 0.4 miles upriver of the earlier locations in the east channel of the Susitna River in a deep back eddy and near open-water.

4.0 DISCUSSION

Few practical and efficient methods have been found to sample resident fish populations in the Susitna River during the winter. Baited trotlines have been found to be effective for capturing burbot but hoop nets were determined as too difficult to set and electrofishing is impossible. Winter studies in other areas of Alaska have found gill nets to be effective for sampling fish populations other than burbot (Bendock 1981, 1982, 1983; Hallberg 1984). Although gill nets were set in the Susitna River during the winter of 1984-85 to help determine the abundance of resident fish at specific sites (radio tagged fish relocations), these efforts failed. This failure can be attributed to several factors encountered in previous Susitna River winter studies (winter of 1980-81). These factors included: 1) water too shallow, 2) water velocity was too great, and 3) the presence of slush or frazil ice. Winter gill netting in other rivers has probably succeeded because those waters have deep pools without slush ice.

While winter resident fish abundance studies largely failed, winter movement patterns of select resident fish in the Susitna River have been better understood through the use of radio telemetry. By using radio telemetry, data have also been indirectly gathered on the abundance and habitat conditions of select overwintering Susitna River resident fish. While these data will be discussed later for each resident fish species studied during the winter of 1984-85, several general conclusions can be made after examining all the data collected during the falls and winters from 1980-85.

Overall resident fish boat electrofishing catches have decreased between late September and October in 1982, 1983, and 1984 although conductivities increased, thereby increasing the efficiency of boat electrofishing (ADF&G 1983b; Sundet and Wenger 1984; Sundet and Pechek 1985). Since more fish are moving out of tributaries into the mainstem in the fall, it is believed each year that catches would increase instead of decrease in October. However, water clarity increases substantially during this time and fish may move into deeper water for cover. Habitat suitability studies show that some species of mainstem Susitna River resident fish are found significantly more often in turbid water that provides cover than clear water areas (Suchanek et al. 1984). In 1984, turbidities appeared to be less during October than in other years (1981-83). In October of 1984, even boat electrofishing in waters six feet deep at normal productive areas such as the mouth of Portage Creek failed to catch many resident fish any species compared to September catches.

Other support for the assumption that fish move into deeper mainstem waters as turbidities decrease are provided by radio tagged fish and hook and line data. Radio tagged rainbow trout and Arctic grayling were pinpointed in October of 1983 and 1984 and in all cases, these fish were found in water greater than six feet deep. Angling in October at the mouths of productive middle river tributaries such as Portage Creek has shown that rainbow trout and Arctic grayling are captured more frequently in deep water during the day. Angling catches are also higher during dusk than during the day, indicating fish move out of deeper waters and into the shoals. This diurnal-nocturnal type of movement has been documented by other studies with fish using darkness as cover for feeding purposes (Campbell and Neuner 1985).

Previous ADF&G winter studies have indicated that radio tagged fish may seek specific overwintering areas. These areas are believed to have upwelling since high conductivities were recorded (ADF&G 1983b, 1983c, 1983d; Sundet and Wenger 1984; Sundet and Pechek 1985). During the winter of 1984-85, however, high conductivities were recorded at all the radio tagged fish relocation sites in the mainstem Susitna including those sites where fish were believed to be dead. In addition, control mainstem sites at Gold Creek (RM 136.7) and at RM 133.8 were monitored twice a month from December to February. All conductivities taken at these two sites were also high (in excess of 200 umhos/cm). Although the radio tagged fish may have been in areas of upwelling, we only sampled the upper layer of the water column. In future studies, a different sampling method should be incorporated to examine the waters immediately off or in the substrate. By sampling the upper water column, any upwelling was probably diffused into the main body of water thereby making it undetectable.

Although few resident fish other than burbot have been captured by winter sampling in the Susitna River from 1980-85, these capture data and especially radio tagged fish data suggest resident fish seek certain areas to overwinter (ADF&G 1983b, 1983c, 1983d). Often radio tagged fish of one species are found with fish of the same and other species. Winter work elsewhere in Alaska, especially on the North Slope, has found several fish species inhabiting the same wintering areas (Bendock 1981, 1982; Bendock and Burr 1984; Hallberg 1984). Bendock suggested this "cohabitation" may occur because few suitable overwintering areas exist and, therefore, fish are concentrated in certain areas. Hallberg (1984) has found several different species in the same area during the winter, however, he did not find any large concentrations of resident fish. These studies, however, identified several possible causes which limit areas where resident fish can overwinter. These are: 1) water depths, 2) deteriorated water quality - low DO, and 3) frazil (slush) ice. Anchor ice, cover, and water velocities are also believed to limit overwinter areas (Maciolek and Needham 1952; Needham and Jones 1959; Chapman and Bjornn 1969; Campbell and Neuner 1985). Principal factors which probably affect the overwintering of middle Susitna River resident fish are the presence of slush and anchor ice, high water velocities, available cover, and the dewatering of side channels. Since there is less anchor ice formation and a greater number of large side channels, available cover and high water velocities are probably the critical limiting factors for overwintering in the lower river. Turbidity is believed to be a less important factor in determining overwintering habitat for resident fish. Winter mainstem turbidities are generally under 5 nephelometric units (NTU's) and resident fish are believed to seek deeper areas or areas under ice for cover.

At times during the winters of 1983-84 and 1984-85, extensive formations of anchor ice and slush ice has been observed in the middle Susitna River, especially above RM 120.0. Slush ice has been reported to impair the functioning of fish gills (Tack 1938 in Armstrong 1982). Anchor ice disrupts and decreases the areas of overwintering, and is suspected to increase overwintering trout mortality (Cerven 1973; Needham and Jones 1959). Since anchor ice is not found under ice cover, in areas of groundwater, or in water depths over 6.0 feet (Karl Schoch, pers. comm), these are the types of areas where resident fish may prefer to overwinter.

Although there is little field data, Susitna River resident fish mortalities are probably higher during the winter than the summer. Maciolek and Needham (1952) found 50% of marked trout died during the 1950-51 winter at Convict Creek. They attributed most of these mortalities to dewatering of side channels where most of the trout overwintered. Needham and Jones (1959) also believed high winter mortalities of fish were due to physical catastrophies such as floods, entrapment under collapsed snow banks, and dewatering. Reimier (1957) found that physical catastrophies caused more trout mortalities than the lack of food availability.

4.1 Lower Susitna River

4.1.1 Rainbow Trout

Until 1984, the life history of lower Susitna River rainbow trout had been largely interpreted from 1981 and 1982 catch per unit effort (CPUE) data, and monitoring data from several rainbow trout which were radio tagged in the fall of 1981 and 1982. Although we planned were to radio tag a number of rainbow trout in 1984 to increase our knowledge of rainbow trout populations on the lower river, few large fish were captured. Eight rainbow trout were successfully radio tagged in the fall of 1984, however, and their movements were monitored over the winter. These data added considerably to our knowledge of lower river rainbow trout overwintering habitat.

Rainbow trout in the lower Susitna River are suspected of moving out of east side tributaries into the mainstem beginning in late August. This movement is believed to be triggered by typical late season floods coupled with rapidly decreasing tributary discharges beginning shortly after the flooding (Sundet and Pechek 1985). In 1984, a flood occurred between August 20 and 30. Sampling in early September in the upper reaches of several of the smaller east side tributaries such as Montana Creek failed to capture many rainbow trout. Since water levels rapidly decreased after the late August flood and a primary food source of salmon eggs was no longer available because few adult salmon were left in these tributaries after September 1, it is likely that a number of rainbow trout outmigrated these tributaries to the mainstem Susitna during late August to early September. It is probable this outmigration occurs, however, from mid-August to mid-October. This theory is supported by movement data of three radio tagged rainbow trout. These three fish were radio tagged in the upper reaches of east side tributaries in early September of 1984 and all three fish moved out of the tributaries by early October (Figure 3). One of these fish had outmigrated as early as mid-September.

During September, sport fishermen's rainbow trout catches generally increase at the mouths of east side tributaries. High catches of rainbow trout have been observed or reported at the mouths of Kashwitna River and Talkeetna River until mid-October when slush ice flows down those rivers (Roy Bloomfield and Earle Foster, pers. comm.). In 1984, fewer rainbow trout were captured at these tributary mouths than in past years (Earle Foster, pers. comm.). One reason for this difference may have been the extremely high water during the flood in late August of 1984 which flushed most of the fish out earlier than a normal fall flood.

Tag-and-recapture data also show some Talkeetna River rainbow trout outmigrate from that tributary (Sundet and Wenger 1984). It is unknown why these fish would move out of this tributary since several lakes such as Mama and Papa Bear lakes are available for overwintering.

Few large rainbow trout are suspected of outmigrating the larger west side tributaries such as the Deshka River in the fall (Sundet and Pechek 1985). Some smaller rainbow trout, however, are believed to outmigrate the Deshka River in the fall.

After reaching the mainstem Susitna River in the fall, movement data of radio tagged rainbow trout monitored over three winters show that two different migrational behaviors of overwintering occur for lower river rainbow trout. Approximately half of the radio tagged rainbow trout overwintered in the mainstem near the tributary where they were tagged (probably their summer rearing and natal tributary) (ADF&G 1983b, 1983c; Figures 2 and 3). The other half of the radio tagged fish generally overwintered between 10 and 20 miles downriver of their tagging sites.

Lower river rainbow trout appear to prefer to overwinter in side channels rather than the mainstem Susitna. During the winter of 1981-82, the two living radio tagged rainbow trout pinpointed were in side channels (ADF&G 1983b). In January and February of 1985, four of eight radio tagged rainbow trout were pinpointed in side channels. One of the eight fish in the mainstem pinpointed during winter of 1984-85 was believed dead. These side channels were 100-300 feet wide with waters probably no greater than four feet deep. Measurements taken at winter radio tagged fish relocations show rainbow trout are found mostly in areas of low to moderate water velocities and depths (ADF&G 1983d; Table 1). In two cases, however, radio tagged fish were pinpointed in areas of deep water (Appendix Table A-5). Only one of the nine radio tagged rainbow trout pinpointed and believed alive during the winter ground surveys has been in an area of open water (ADF&G 1983d; Appendix Table A-5).

Elsewhere, few studies have determined the overwintering requirements of rainbow trout. Studies have shown, however, that rainbow trout prefer to overwinter in areas of ice cover and suggest rainbow trout use surface ice as a protective cover (Maciolek and Needham 1952; Needham and Jones 1959). Chapman and Bjornn (1969) found winter cover was important in holding overwintering fish, especially substrate areas with large rocks. Since much of the substrate in the lower Susitna River is composed of sand and gravel, areas of surface ice with low water velocities are probably very important for the success of overwintering rainbow trout in that reach. Other salmonid studies have found the mean water velocity as the most critical parameter in the selection of an overwintering site (Wichers 1978).

Between September and April, lower Susitna River rainbow trout show two pronounced mainstem movements with one occurring near early October and another near late December. Other than these time periods, rainbow trout appear relatively sedentary in the winter. The early October movement is during freeze-up and probably occurs because fish are seeking an overwintering area. Studies conducted in the middle Susitna River show a similar movement (ADF&G 1983c; Sundet and Pechek 1985). Chapman and Bjornn (1969) also found that a downstream movement occurs during the fall for salmonids. Bjornn (1971) also indicated that a downstream movement during or preceding winter did not occur if sufficient winter cover was available. While it is unknown what extent freeze-up has on lower river Susitna River rainbow trout populations, it would appear that it has an effect from observing the fall movements of some of the radio tagged rainbow trout. During freeze-up on the lower Susitna River, slush ice usually begins to flow in early October, an ice bridge usually forms by late October and 90% of the lower river is frozen over by late November (R&M 1981, 1982, 1983, 1984, 1985).

The other pronounced winter movement, in late December, of lower river rainbow trout occurs when the river is nearly 100% frozen over and air temperatures usually drop below -25°C for the first time in the winter. Although it is unclear if air temperatures are responsible for this increase in activity, Logan (1963) found trout moved more in December, January, and February when temperatures were low and surface ice was present. Stratton (1985) found that juvenile chinook salmon are more active during warmer air temperatures (refer to part 1 of this report).

Beginning in early May, lower river rainbow trout begin to migrate from the mainstem Susitna River into tributaries for summer rearing (ADF&G 1981b, 1983b; Sundet and Pechek 1985). Unfortunately, it is unknown when the exact spring movement occurs from the mainstem since all of the radio tags dispensed in 1981, 1982, and 1984 in lower river rainbow trout ceased functioning before April of the following years. Tag-and-recapture data, however, shows that rainbow trout continue to migrate from the mainstem to tributaries through late May (ADF&G 1981b, 1982b). Some May and June tag recoveries have been made 30 miles upriver of their tagging sites suggesting that some lower river rainbow trout make extensive spring upriver migrations.

4.1.2 Burbot

Lower Susitna burbot have been commonly found during the summer in the turbid mainstem and its adjacent sloughs and side channels (ADF&G 1981b, 1983b; Sundet and Pechek 1985). Burbot are also known to reside in the turbid Yentna River (RM 28.5) during the summer. Past studies have shown that burbot are found in high numbers in clear-water tributaries such as Alexander Creek (RM 10.1) and Deshka River (RM 40.6) during the spring, fall, and winter. Few adult burbot have been captured in Alexander Creek or Deshka River in the summer and only then near their mouths. Past summer catch data show that a definite correlation exists between burbot numbers and turbidity in the Susitna River (Hale 1983; Suchanek and Hale 1983). Tag-and-recapture data and studies elsewhere show burbot are relatively sedentary during the summer (ADF&G 1983b; Sundet and Wenger 1984; Morrow 1980).

After rearing in the mainstem Susitna and its side channels during the summer, a pronounced migration of burbot occurs from these mainstem areas into Alexander Creek and Deshka River in the fall (ADF&G 1981b, 1983b; Sundet and Pechek 1985). Data collected in 1981 shows this movement begins at Alexander Creek in mid-August and at Deshka River in late August. During these times, adult burbot were found up to TRM 4.0 of the Alexander Creek and TRM 4.5 of the Deshka River. Since burbot spawn during the winter, this movement is probably associated with a pre-spawning migration.

Catch data from the Deshka River in 1984 suggests this movement began in early September or earlier during that year (sampling was not done in July or August of 1984) (Sundet and Pechek 1985). Sorokin (1971) found burbot moved into Lake Baikal tributaries in the fall as water temperatures approached 10 to 12°C.

In 1984, intensive effort was employed at the Deshka River (TRM's 0.0-6.0) during the spring and fall to capture burbot. Catch data from that year suggest that a number of sub-adults (between 200 and 390 mm TL) move to the spawning areas with adult burbot. The classification of sub-adults and adults was determined by their relative spawning maturity. Since 1982, approximately 85% of burbot greater than 390 mm TL have been found to be spawners (ADF&G 1983b, 1983c; Appendix Table B-2). Although burbot in the Susitna River have been found to be capable of spawning at 310 mm TL, a much lower percentage of fish under 390 mm TL spawn than those above 390 mm. From early September to mid-October of 1984, burbot catches at the Deshka River were composed of 57 to 64% sub-adults. During these time periods in 1984, burbot catches increased (50 in early September, 121 in late September, and 103 in early October) with approximately the same effort. The catch per unit effort (CPUE), however, was the highest in early October. A similar seasonal increase in catch and CPUE was found in 1981 (ADF&G 1981b). Other studies have found a similar seasonal increase in burbot catches during the open-water season. Hallberg (1984), sampling in the mainstem Tanana River near the mouth of the Chena River from mid-June to early October, captured 50% of his seasonal burbot catch during early October. He speculated his catches increased because of freeze-up, between late September and early October, which forced burbot to relocate from some Tanana River sloughs and side channels into the mainstem Tanana. Thereby, making them more concentrated and susceptible for trapping.

The overall burbot sex composition over the years has shown female burbot are more numerous than males in the Susitna River. Between 1981 and 1985, burbot sex ratios have fluctuated between 1:1 to 1:2.0 male to female (ADF&G 1981b, 1983b, 1983c; Appendix Figure B-2).

Since burbot spawn under the ice, no burbot have been observed spawning in the Susitna River. By systematically sampling th_ same area over time and observing radio tagged burbot, however, several spawning sites at the Deshka River have been documented. Spawning has occurred at TRM's 0.0, 1.9, 2.0, and 24.5 (ADF&G 1983c). Until the winter of 1984-1985, burbot were believed to only spawn in the lower reaches of the Deshka River. During the winter of 1984-1985, two radio tagged burbot ascended the Deshka River and apparently spawned at TRM 24.5. Trotlines set near the radio tagged burbot at TRM 24.5 in mid-January captured several non-tagged burbot which were close to spawning. Figure 14 show a map of the area at TRM 24.5 of the Deshka River. Maps of the other Deshka River sites where burbot have spawned are provided in ADF&G (1983c). While not documented, burbot spawning probably occurs at other areas on the Deshka River as well.

During the winter of 1982-1983 and 1984-1985, burbot were believed to have spawned at the four sites in the Deshka River between mid-January and early February. These sites are characterized by low to moderate water velocities (0.0-2.1 fps) and depths (0.2-9.0 ft) over a sand to cobble substrate. The higher velocities and depths were recorded at the interface of the Deshka River and the mainstem Susitna. Point specific data collected at radio tagged burbot relocations in mid-January 1985 suggest some burbot may spawn in upper reaches of the Deshka River in depths as low as 0.2 feet. While past conductivity readings have generally been disproven as documenting areas of upwelling (refer to Section 4.0), data collected in 1985 at TRM 24.5 of the Deshka River does suggest upwelling may occur at that location. Elsewhere in the

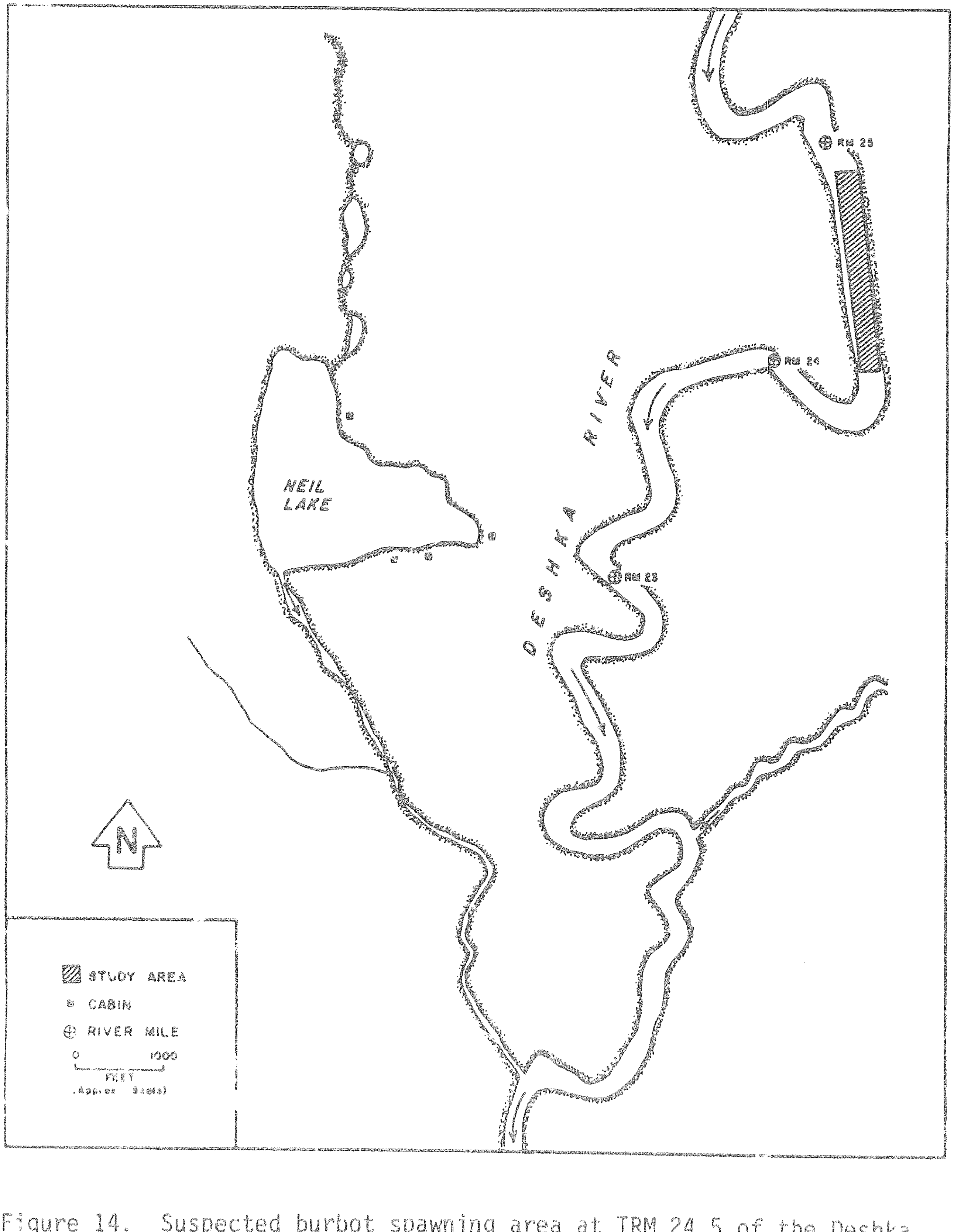

Figure 14. Suspected burbot spawning area at TRM 24.5 of the Deshka River (RM 40.6).

Deshka River, recorded winter conductivity readings have been lower (between 58-68 umhos/cm compared to 101 umhos/cm at TRM 24.5) (ADF&G 1983c; Appendix Table A-6). Some other winter Deshka River conductivities have been higher (83 umhos/cm), but those were taken (winter of 1982-83) at the interface of the Deshka River and the mainstem Susitna (ADF&G 1983c).

Burbot are also believed to spawn in the mainstem Susitna River. Support for this hypothesis is provided by radio tagged burbot. Since approximately 85% of burbot over 390 mm TL are spawners for a given year (ADF&G 1983c), and burbot radio tagged are all over 525 mm, it is likely that several of the radio tagged fish monitored over the winters of 1981-82, 1982-83, and 1984-85 spawned in the mainstem Susitna River (ADF&G 1983b, 1983c). Eleven successfully radio tagged burbot tagged in 1981 or 1982 remained in the mainstem between RM's 19.0 and 89.6 from January to February, while five successfully radio tagged burbot in 1984 remained in the mainstem between RM's 13.0 and 92.0 during this time period. Several of the fish monitored in the winter of 1984-85 may have migrated over 20 miles to the lower reaches of the Susitna River (RM 13.0) to spawn. One radio tagged burbot monitored over the winter of 1982-83 may have moved 113.0 miles to spawn at RM 26.0 (1983c). Comparison of radio tagged burbot monitoring data between years show that extensive mainstem spawning may occur between RM's 74.0 - 92.0. In all three winters of monitoring radio tagged burbot, some radio tagged burbot have remained in this area. This area is characterized by large bends in the river which provides many back eddies. Water depths are generally moderate to deep and water velocities ranging from 0.0 to an estimated 8.0 fps. In these areas, point specific measurements taken at radio tagged burbot relocations suggest spawning occurs in moderately deep waters with little water velocity (ADF&G 1983b, 1983c, 1983d). A number of burbot have also been found under slush ice where the amount of available water is under two feet.

Although burbot spawning has been observed to occur elsewhere at areas of open-water (Sorokin 1971), our observations suggest Susitna burbot use spawning areas with ice cover. In January and February, the lower Susitna River and its tributaries are over 95% ice covered.

After spawning, radio tagged Susitna River burbot show a definite dispersal. Data from the winters of 1981-82 and 1982-83 show a slight downstream movement (0.5-7.0 miles) (ADF&G 1983b, 1983c). Meanwhile, data from the winter of 1984-85 showed one burbot (659-1.0) ascended 20 miles and another (669-1.8) 6 miles of the Deshka River after apparently spawning. Another fish (739-1.0), moved 2.0 miles downriver and into the mainstem. Other studies have reported variable post-spawning movements. MacCrimmon (1959) observed an upriver post-spawning run while Sorokin (1971) observed a downriver post-spawning movement.

Burbot catches in the Deshka River are generally high from December to February then decrease substantially after February (ADF&G 1983b, 1983c). Some burbot still remain in the Deshka River in May after breakup occurs, however, burbot CPUE is low during May. Several burbot have been observed captured by sportfishermen at the mouth of the Deshka River in late May, but in most cases, these fishermen were fishing near the interface (Susitna and Deshka River waters). Since burbot are light and temperature sensitive (Scott and Grossman 1973), it is likely most burbot move out of clear water tributaries as ice cover decreases and water temperatures increase.

4.2 Middle Susitna River

4.2.1 Rainbow Trout

Most middle river rainbow trout rear during the summer in clear-water tributaries such as Fourth of July Creek (RM 131.1), Indian River (RM 138.6), and Portage Creek (RM 148.8) (Sundet and Wenger 1984; Sundet and Pechek 1985). Beginning in early September, rainbow trout start outmigrating tributaries to the mainstem Susitna River for overwintering. By October 6 of both 1983 and 1984, all of the radio tagged rainbow trout were found in the mainstem Susitna. The fall outmigration from the tributaries appears to be correlated to a decrease in tributary water discharge (Sundet and Pechek 1985). However, other factors such as photoperiodism, and declining water temperatures and food sources (few spawning salmon were found in middle river tributaries after September 1), may contribute to this outmigration. Studies done in 1984 suggest the fall outmigration from tributaries is complete before tributary water temperatures decline to 2°C (Sundet and Pechek 1985).

Monitoring data over three years show about half (24 of 46 successfully radio tagged rainbow trout) middle river rainbow trout overwinter in the mainstem Susitna River between 0.0 and 4.0 miles from their Susitna River tagging site or the mouth of the tributary where they were tagged (ADF&G 1983b; Sundet and Pechek 1985; Figures 8 to 12). Only eight of 46 radio tagged fish successfully monitored over three years migrated over 15.0 miles to an overwintering site.

Once rainbow trout outmigrate tributaries in the fall, the general movement is downriver. A small percentage of radio tagged rainbow trout from 1981-85 (10.8%), however, have overwintered above or at the tributary mouth where they were found in mid-September. Bjornn (1971) suggested that a downstream movement preceding winter did not occur if sufficient winter cover was locally available.

Most middle river rainbow trout overwinter in the mainstem, however, several radio tagged fish have been found to overwinter at the mouth of Indian River or in side channels such as Gash Creek Side Channel (ADF&G 1983c; Sundet and Pechek 1985). In contrast, lower river rainbow trout overwinter more often in side channels than the mainstem Susitna. However, in the lower river many more side channels are available for overwintering than in the middle river.

Until the winter of 1984-85, little data have been available on the specific areas and habitat conditions where overwintering middle river rainbow trout are found. The primary problem experienced during past winter ground surveys to pinpoint radio tagged fish and thereafter collect habitat data has been a lack of ice cover in the areas where the fish were located. Between November and mid-January most of the middle river has remained open water and that is where most of the radio tagged fish have overwintered. For example, in mid-January 1984, 14 of 17 radio tagged fish that were located were found in open-water areas, thereby preventing biologists from making precise habitat measurements. When fish were found in open-water areas, only estimates or general observations could be made on their overwintering habitat. These general observations, however, found that rainbow trout are found in areas with no anchor ice and in either pools or riffles. Also, during past winter studies, after mid-January batteries of radio tags began expiring from rainbow trout radio tagged during the previous open-water period. Therefore, fewer fish were available to collect point specific data during mid-winter ground surveys when most of the river is frozen.

Between slush ice (in early October) and freeze-up (mid-January), most middle river rainbow trout probably use water depth over a substrate with rock as their primary cover. Lewis (1967 cited in Chapman and Bjornn 1969) also found that with the onset of winter adult rainbow trout moved into deeper water.

During mid-winter when most of the river is frozen, data from Januarh and February of 1985 suggest middle river rainbow trout prefer to overwinter at areas under surface ice with low to moderate water velocities (0.0 to 2.5 fps) and moderate water depths (3.0 - 6.0 ft)

(ADF&G 1983c; Sundet and Pechek 1985; Table 3). In areas of higher water velocities (1.0 fps), rubble or cobble predominated the substrate indicating rainbow trout may use the larger substrate as a means of cover. Chapman and Bjornn (1969) found substrate areas with large rocks important for overwintering fish. Lewis (1969) reported that cover is important to trout in terms of security and photonegative response.

While substrate and water depths act as mid-winter cover for rainbow trout, it appears that surface ice is the most important. During the mid-winters of three years, most radio tagged middle river rainbow trout have been found under surface ice (ADF&G 1983c; Sundet and Pechek 1985). Other support for this hypothesis is provided by radio tagged fish monitored in January and February of 1985. During these time periods, it was found that often the radio tagged rainbow trout were located within 100 feet of an open lead, suggesting rainbow trout prefer to use surface ice if present as cover. Winter studies elsewhere report depth and substrate are important in selection of rainbow trout overwintering habitat, but only as they relate to cover and velocity (Campbell and Neuner 1985).

Although surface ice does appear to be an important factor in mid-winter cover, several radio tagged fish have shown there is suitable overwintering habitat in deep (6.0 ft) open-water areas of the middle Susitna River as well (ADF&G 1983c; Appendix Table A-7).

Over three winters, radio tagged rainbow trout have generally overwintered in certain sections of the middle river. These sections are: RMs 95-101, 110-115, 128-140, and 144-151. In all cases, a major tributary is located within these sections. The upper three sections are characterized by deep pools off bedrock banks, although some gently sloping shores are present in these areas. The lower section is composed of several miles of both the lower and middle river. Between RM 98.5 and RM 101.0, there are several channels between islands, and below RM 98.5 there are more channels but the water depth is greater than the area above RM 98.5. Since several Whiskers Creek rainbow trout have overwintered in the area just below the Chulitna River confluence (RM 98.5), this area would appear to be an overwintering area for rainbow trout stocks of that tributary.

During the winter of 1984-85, a number of radio tagged rainbow trout were found within 100 feet of each other. This suggests that middle river rainbow trout congregate (school) during the winter.

Although slush ice and anchor ice is common in the middle river in the winter, no radio tagged rainbow trout has been found over anchor ice and few under slush ice during winter surveys.

As with lower river rainbow trout, two pronounced winter movements occur for middle river trout. In addition, middle river radio telemetry data shows the spring migration from the mainstem to the tributaries.

Most middle river radio tagged rainbow trout show some movement between mid-September and mid- October and again between mid-December and mid-January. The former movement is during the beginning of freeze-up (usually early October, R&M 1985), and probably occurs because fish are moving to suitable overwintering habitat. While freeze-up begins in the middle river in early October when slush ice flows, the majority of the middle river is not frozen over with surface ice until late December (R&M 1981, 1982, 1983, 1984). During mid-December, air temperatures usually drop below -30°C for the first time in the winter. This decrease in temperature progresses ice formation and may be the cause of the increase in rainbow trout activity in December (refer to section 4.1.1 for further details).

Spring movements of radio tagged fish show most rainbow trout begin an upriver migration from the mainstem Susitna to clear-water tributaries in early May. This movement is during or just preceding breakup. However, some radio tagged rainbow trout appear to begin migrating as early as March (ADF&G 1983c; Sundet and Pechek 1985). Several fish monitored in May of 1984 moved 10 miles upriver in a few days (Sundet and Pechek 1985). This strong upriver movement in May is probably a spawning run. One of the fish which moved rapidly upriver in May of 1984 was recaptured and found to be a pre-spawning female (rainbow trout 670-1.4).

4.2.2 Arctic Grayling

Until the winter of 1984-85, little data had been collected on overwintering middle Susitna River Arctic grayling. Insights to the factors governing the overwintering distribution and habitat of these stocks of Arctic grayling were largely interpreted from catch per unit effort (CPUE) and tag-and-recapture data gathered during the 1981-84 open-water periods. These data suggested most middle river Arctic grayling overwinter near their summer rearing tributaries with the most important of these tributaries being Indian River (RM 138.6) and Portage Creek (RM 148.8) (ADF&G 1981b, 1983b; Sundet and Wenger 1984; Sundet and Pechek 1985). These data as well as data from one radio tagged Arctic grayling, also suggested Arctic grayling begin outmigrating from the upper reaches of tributaries to the mainstem Susitna in late August and all are in the mainstem by mid-October. Schallock (1966) speculated the outmigration of Arctic grayling in the Chatanika River slowly begins in mid-July. Meanwhile, Tack (1980) found the Arctic grayling outmigration from the upper to the lower reaches of the Chena River is later, and spread over a relatively large time period (September through December). Tack hypothesized that Arctic grayling moved out of bog streams because water depths greatly decrease and out of spring-fed streams because of frazil (slush) ice (Tack in Armstrong 1982). After reaching the mainstem Susitna, most Portage Creek fish were believed to overwinter between RM 147.0 and RM 151.0, and most Indian River fish were believed to overwinter near that tributary. However, some 1983-84 tag-and-recapture data suggested that a long downstream migration to overwintering areas may occur for some Indian River and Portage Creek fish (Sundet and Pechek 1985). Several of these fish were recaptured quite a distance downriver suggesting one overwintering area in the middle river may be near Slough 6A (RM 112.3).

The addition of data from five radio tagged fish monitored over the winter of 1984-85 provided support to both beliefs that some middle river Arctic grayling stocks overwinter near their summer rearing tributary while some stocks move far downstream to overwinter. Support for both theories are provided by past Arctic grayling studies (Armstrong 1982; Tack 1972, 1980; Rolland Holmes, pers. comm.).

Two of the 1984 radio tagged Arctic grayling overwintered near their tagging sites (Portage Creek) while the other three fish (tagged in Indian River) moved over 30 miles downriver to overwinter near or below Talkeetna. Although one of the fish tagged at Portage Creek was found dead during the winter, these two fish apparently selected to overwinter in the mainstem Susitna between RM 147.0 and RM 148.0. This area is characterized by having a large island (referred by locals as Fat Canoe Island) in the center of the streambed with shallow shorelines, steep bedrock banks along the east and west banks of the mainstem, and deep pools along the east and west banks in the mainstem. Because the shoals of the island are suspected of having upwelling and because of the deep pools in the mainstem, this area was previously thought to be capable of harboring a sizeable population of overwintering fish (Sundet and Wenger 1984; Sundet and Pechek 1985). Since a number of rainbow trout which were radio tagged in 1984 also overwintered in this area, this hypothesis appears to be true.

Although no Arctic grayling point specific data have been collected at other middle river areas during the winter, it is probable other Arctic grayling stocks overwinter in other sections of the middle river with habitat similar to that found between RM 147.0 and RM 148.0.

While it appears many middle river Arctic grayling overwinter near their summer rearing tributaries, several Susitna River recaptured and radio tagged Arctic grayling have been found far downriver of their tagging sites. Two hypotheses exist for this phenomenon. Either the fish were injured during capture or tagging, thereby causing them to drift downriver, or a natural fall outmigration over large distances occurs in a short time period during September or October. Unfortunately, it is difficult to prove if either or both of these hypotheses are true. In past studies, we have found that during radio tagging efforts in the spring, fish are naturally moving upriver and any sudden and long movement downriver of their tagging sites indicates these fish were injured. Injuries are most often detected within 14 days of tagging. It is unlikely, however, that all three of the fish radio tagged in the fall of 1984 were injured so there may be an extensive downstream migration occurring for middle river Arctic grayling in the fall. Other Alaska studies have shown Arctic grayling can move large distances relatively quickly to overwintering areas (West and Wiswar 1985; Rolland Holmes, pers. comm). Studies have shown these large movements typically occur from small muskeg streams (such as Whiskers Creek) or small gravel and mountain streams (such as Indian River) to suitable larger river overwintering areas (such as the Susitna River). Past studies (1981-84) may have failed to determine long distance movements of Arctic grayling because the fall downriver migration appears to occur very quickly, and the spring upriver migration occurs under the ice or during breakup before efficient open-water sampling occurs. It is unknown, however, why middle river stocks from Indian River or elsewhere would migrate so far downstream when "apparent" good overwintering habitat exists in areas near RM's 147.0, 136.0, 133.6, and 125.0. These areas are characterized by deep waters with areas of slow to moderate water velocity. Such areas provide middle river rainbow trout with apparent by suitable overwintering habitat (refer to Section 4.2.1).

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APPENDIX A

RADIO TAGGED FISH TAGGING AND HABITAT DATA

Appendix Table A-1. Summary of tagging data for radio tagged rainbow trout captured on the Susitna River between Cook Inlet and the Chulitna River confluence, September and October 1984.

Radio Frequency/ Fork Lengths (mm)	Floy Tag Number	Age	Method Captured	Location Captured and Released	River Mile	Date Captured	Date Released
599-1.2/398	5483	6	H.L.	Montana Creek	TRM 5.0	9/6	9/6
602-2.0/385	18929	6	E.F.	Little Willow Creek (lower mouth)	49.5	9/30	9/30
609-1.3/392	5488	6	H.L.	Sheep Creek	TRM 5.0	9/7	9/7
609-2.0/458	18953	6	E.F.	Mainstem - East Channel	53.0	9/30	9/30
620-1.2/436	5485	7	H.L.	Montana Creek	TRM 5.0	9/6	9/6
630-1.0/525	18952	9	E.F.	Mainstem - East Channel	53.0	9/30	9/30
640-1.4/395	18715	6	E.F.	Montana Creek	77.0	9/15	9/15
650-1.3/425	18954	7	E.F.	Mainstem - East Channel	53.0	9/30	9/30
660-1.0/423	19116	-	E.F.	Mainstem - East Channel	96.0	10/12	10/12
739-2.3/457	18969	7	E.F.	Little Willow Creek (upper mouth)	50.1	9/30	9/30
TOTAL = 10							

-- = Not Aged
EF = Electrofishing
HL = Hook and Line
TRM = Tributary River Mile

Appendix Table A-2. Summary of tagging data for radio tagged rainbow trout captured on the Susitna River between the Chulitna River confluence and Devil Canyon, September and October 1984.

Radio Frequency/ Fork Lengths (mm)	Floy Tag Number	Age/ Sex	Method Captured	Location Captured and Released	River Mile	Date Captured	Date Released
618-2.1/468	18321	7/-	EF	Indian River	138.6	9/12	9/13
640-6.0/420	18479	6/-	HL	Indian River	138.6	9/27	9/28
637-1.8/471	18146	8/-	EF	Portage Creek	148.8	9/13	9/13
648-6.1/400	17676	6/-	EF	Indian River	138.6	9/17	9/12
648-1.6/400	18346	-/-	EF	Whiskers Creek Slough	101.2	9/14	9/14
654-1.8/411	17675	7/-	EF	Indian River	138.6	9/17	9/12
667-1.4/455	17608	-/-	HL	Portage Creek	148.8	9/26	9/26
707-2.3/410	19208	6/-	EF	Mainstem	144.2	10/9	10/9
718-1.0/410	18445	6/-	EF	Mainstem	150.0	9/26	9/26
749-7.1-475	2823	8/-	EF	Slough 20	140.1	9/29	9/29
759-1.7/412	18480	5/-	HL	Indian River	138.6	9/27	9/29
770-1.1/436	19207	6/-	EF	Mainstem	144.2	10/9	10/9
769-1.8/457	18481	7/M	HL	Indian River	138.6	9/27	9/28
TOTAL = 13							

-- = not sexed or not aged
EF = Electorfishing
HL = Hook and line

Appendix Table A-3. Summary of tagging data for radio tagged Arctic grayling captured on the Susitna River between the Chulitna River confluence and Devil Canyon, September 1984.

Radio Frequency/ Fork Lengths (mm)	Floy Tag Number	Age	Method Captured	Location Captured and Released	River Mile	Date Captured	Date Released
600-2.4/390	14455 (recap)	9	H.L.	Portage Creek	148.8	9/26	9/26
610-2.4/390	--	8	E.F.	Indian River	138.6	9/11	9/12
629-2.2/390	17914	--	E.F.	Mainstem	137.7	9/11	9/12
639-2.3/408	17915	--	E.F.	Indian River	138.6	9/11	9/12
740-2.3/409	18448	9	E.F.	Mainstem	150.0	9/26	9/26
TOTAL = 5							

-- = Not Aged
EF = Electrofishing
HL = Hook and Line
HN = Hoop Net

Appendix Table A-4. Summary of tagging data for radio tagged burbot captured on the Susitna River between Cook Inlet and the Chulitna River confluence, September and October 1984.

Radio Frequency/ Total Lengths (mm)	Brand of Tag	Floy Tag Number	Method Captured	Location Captured and Released	River Mile	Date Captured	Date Released
610-0.5/685	Smith-Root	14740	H.N.	Deshka River	40.6	10/14	10/17
610-3.0/753	Smith-Root	18346	E.F.	Mainstem	93.2	9/15	9/15
619-2.2/570	Smith-Root	18991	H.N.	Deshka River	TRM 1.0	10/1	10/1
629-3.0/575	Smith-Root	14995	H.N.	Deshka River	TRM 1.0	9/14	9/17
639-3.0/567	Smith-Root	18833	E.F.	Mainstem	40.0	9/17	9/17
649-1.0/795	Smith-Root	19158	E.F.	Mainstem	83.9	10/15	10/15
650-3.0/535	Smith-Root	13934	H.N.	Deshka River	TRM 0.5	9/16	9/17
659-1.0/637	Smith-Root	18911	E.F.	Mainstem	40.8	9/29	9/29
669-1.8/635	ATS	14739	H.N.	Deshka River	40.6	10/14	10/17
730-1.0/578	Smith-Root	18401	H.N.	Mainstem	40.4	9/18	9/18
739-1.0/679	Smith-Root	13994	H.N.	Deshka River	TRM 1.0	9/28	9/29
749-0.7/568	Smith-Root	19152	E.F.	Mainstem	78.0	10/15	10/15
760-1.9/635	ATS	14992	H.N.	Deshka River	40.6	10/15	10/17
770-2.4/709	ATS	14749	H.N.	Deshka River	40.6	10/15	10/17

Total = 14

EF = Electrofishing
HN = Hoop Net
TRM = Tributary River Mile
ATS = Advanced Telemetry System

Appendix Table A-5. Radio tagged lower river rainbow trout habitat measurements taken at their relocations in January and February 1984. Fish were tagged in 1984. All but rainbow trout 739-2.3 were believed alive at the time habitat readings were taken.

Radio Frequency	Date	Site Description	RM/TRM	Ice Open (o) Covered (c)	Movement (in ft)	Depths (ft) Water	Ice	Slush	Velocity (fps)	Substrate	Water Quality Temp°C	DO mg/l	umhos/cm	pH	General Comments
599-1.2	1/15	Mainstem	56.5	o	-	10.0*	0.0	0.0	3.5*	-	-	-	-	-	in open water so no specific measurements could be taken. Fish fate was unknown.
602-2.0	1/15	Side Channel approximately 200' wide	46.8	c	±30.0	1.5	1.5	0.0	0.8*	sand	-0.3	-	160.0	6.8	
609-1.3	2/15	Side Channel approximately 200' wide	66.9	c	-50.0	0.4	2.0	0.0	0.0	silt/gravel	0.0	10.9	188.0	6.9	
630-1.0	1/16	Side Channel approximately 200' wide	49.0	c	+200.0	1.2	2.8	0.0	0.1*	silt	0.2	-	202.0	7.2	
640-1.4	1/15	Side Channel approximately 200' wide	46.0	c	-150.0	1.4	1.3	0.0	0.3*	sand/gravel	-0.3	-	171.0	6.8	
650-1.3	1/14	Mainstem	14.3	c	±100.0	8.5	2.1	0.0	1.9	sand	-0.2	-	195.0	6.7	200.0 ft from an open lead
660-1.0	2/21	Mainstem	77.4	c	0.0	1.5	3.0	0.0	0.4	gravel/cobble	-0.2	10.2	190.0	7.3	
739-2.3[a]	1/14	Mainstem	9.6	c	0.0	1.0	2.5	0.0	0.0	sand	0.0	-	278.0	7.2	believed dead

* = Estimated measurements because meter did not work.
\- = No movement or no measurements taken.
a = Fish believed dead.

Appendix Table A-6. Radio tagged burbot habitat measurements taken at their relocations from December 1984 to February 1985. Fish were tagged in the lower Susitna River in 1984 and all fish were believed alive at the time habitat readings were taken.

Radio Frequency	Date	Site Description	RM/TRM	Ice Open (o) Covered (c)	Movement (in ft)	Depths (ft) Water	Ice	Slush	Velocity (fps)	Substrate	Water Quality Temp°C	DO mg/l	umhos/cm	pH	General Comments
610-0.5	1/16	Mainstem	42.1	c	-150.0	7.8	3.0	3.3	0.1	gravel/cobble	0.0	-	172.0	7.1	
649-1.0	1/24	Mainstem	88.0	c	0.0	0.2	1.5	4.3	0.0	cobble	-	-	-	-	100.0' from an open lead
650-3.0	1/12	Deshka River	40.6/1.9	c	0.0	1.0	2.5	0.0	0.4	gravel/sand	-	-	-	-	
650-3.0	2/7	Deshka River	40.6/1.9	c	0.0	1.1	2.9	0.0	0.2	sand/gravel	0.0	10.4	74.0	6.9	
659-1.0	12/16	Deshka River	40.6/2.0	c	0.0	2.0	2.0	0.0	0.5	gravel/cobble	-0.2	8.4	73.0	6.4	
659-1.0	1/12	Deshka River	40.6/2.0	c	0.0	2.0	2.0	0.0	0.1	sand/gravel	-0.1	-	87.0	7.0	located on the opposite side of the river from 12/16
659-1.0	2/4	Moose Creek, a tributary of the Deshka River at TRM 29.5	40.6/0.7	c	-10.0	0.2	2.5	0.0	0.4	gravel/sand	0.1	9.0	58.0	6.9	75.0' from an open lead
669-1.8	1/15	Deshka River	40.6/24.5	c	+20.0	0.1	2.2	0.0	0.0	gravel	-0.2	-	97.0	6.8	on 1/16 found at TRM 25.5
669-1.8	2.4	Moose Creek, a tributary of Deshka River at TRM 29.5	40.6/0.7	c	-10.0	0.2	2.5	0.0	0.4	gravel/sand	0.1	9.0	58.0	6.9	located 100.0' from burbot 659-1.0 and 75.0' from an open lead
739-1.0	1/12	Deshka River	40.6/2.0	c	-300.0	1.6	2.7	0.0	0.3	sand/gravel	-0.1	-	92.0	7.0	located 100.0' below burbot 659-1.0
739-1.0	2/7	Mainstem	40.7	c	0.0	1.3	2.5	0.0	0.0	gravel/cobble	-0.2	11.5	74.0	7.3	
750-0.7	1/24	Mainstem	75.4	c	-200.0	4.0	2.0	0.1	0.1	gravel/sand	0.0	12.9	188.0	7.3	
760-1.9	1/15	Deshka River	40.6/24.5	c	+20.0	0.2	2.5	0.0	0.0	gravel	+0.2	-	101.0	7.2	
760-1.9	2/4	Deshka River	40.6/24.5	2.0' of overflow	-	-	-	-	-	-	-	-	-	-	located 200.0' below the 1/15 location
770-3.0	12/16	Deshka River	40.6/1.4	c	-600.0	3.0	1.5	0.0	0.6	sand/gravel	-0.2	8.6	67.0	6.4	captured on 1/1 at TRM 0.3

Appendix Table A-7. Radio tagged (RT) middle river rainbow trout habitat measurements taken at their relocations in January and February 1984. Fish were tagged in 1983.

Radio Frequency	Date	Site Description	RM/TRM	Ice Open (o) Covered (c)	Movement (in ft)	Depths (ft) Water	Ice	Slush	Velocity (fps)	Substrate	Water Quality Temp°C	DO mg/l	umhos/cm	pH	General Comments
599-1.1	1/22	Mainstem	148.3	c	-100.0	4.4	2.9	0.0	1.5	cobble/gravel	-0.2	15.5	250	7.6	100 ft. from RT rainbow 630-1.7 and 718-1.0
599-1.1	2/20	Mainstem	148.3	c	-100.0	4.7	3.0	0.0	1.4	rubble/cobble	-0.2	11.4	231	-	100 ft from RT rainbow 718-1.0
613-1.0	1/21	Mainstem	147.0	c	+25.0	1.5	3.1	0.0	0.3	cobble/gravel	-0.2	14.6	254	6.0	50 ft from RT grayling 740-2.3
613-1.0	2/21	Mainstem	147.2	c	-250.0	5.3	2.2	0.0	0.5	4ubble/cobble	-0.1	12.7	306	7.7	50 ft from RT rainbow 667-1.4 was 75 ft from an open lead
608-1.9	1/21	Mainstem	132.0	c	+50.0	0.9	2.7	2.3	0.0	cobble	-0.1	12.4	230	7.1	
620-1.2	1/23	Mainstem	142.1	c	+200.0	4.6	2.6	0.0	0.1	rubble/cobble	0.0	12.6	232	7.0	50 ft from an open lead
629-1.0	1/21	Mainstem	121.2	c	±25.0	3.5	1.5	0.0	0.3	sand/cobble	+0.3	12.0	187	7.0	50 ft from an open lead, 100 ft away on 1/22 from 1/21 location.
630-1.7	1/22	Mainstem	148.3	c	-50.0	3.9	2.8	0.0	1.8	rubble/cobble	-0.2	15.7	246	7.2	100 ft from RT rainbow 599-1.1 and 718-1.0
640-1.0	1/16	West Mainstem Channel	53.3	c	-150.0	4.5	3.3	0.2	0.1*	sand	0.0	-	183	7.0	
637-1.8	1/22	Mainstem	147.6	c	0.0	5.3	2.2	0.0	1.6	gravel	+0.1	13.1	244	7.4	probably alive, moved upriver 20 ft next day.
637-1.8	2/8	Mainstem	147.5	c	-50.0	-	-	-	-	-	-	-	-	-	
648-1.1	2/5	Mainstem	135.4	c	-100.0	3.5	2.5	0.0	1.0	rubble/cobble	-0.1	11.9	239	7.0	100 ft from RT rainbow 769-1.8
648-1.1	2/20	Mainstem	135.4	c	0.0	2.2	2.3	2.0	1.0	cobble/gravel	0.0	11.4	280	7.2	100 ft from RT rainbow 769-1.8 and 200 ft from an open lead
648-1.6	1/23	Mainstem	96.3	c	-400.0	3.0	3.4	0.0	0.5	cobble	+0.2	11.9	225	7.0	40 ft from an open lead
659-1.8	1/25	Mainstem	139.5	c	+200.0	7.0	1.6	0.0	0.1	rubble/cobble	0.0	13.6	258	7.2	100 ft from an open lead and 50 ft from RT rainbow 770-1.0

Appendix Table A-7 (Continued).

Radio Frequency	Date	Site Description	RM/TRM	Ice Open (o) Covered (c)	Movement (in ft)	Depths (ft) Water	Ice	Slush	Velocity (fps)	Substrate	Water Quality Temp°C	DO mg/l	umhos/cm	pH	General Comments
667-1.4	1/21	Mainstem	146.4	o	-	10.0*	0.0	0.0	2.5*	cobble	0.1	-	195	7.4	in an open lead and 50 ft from RT rainbow 707-2.3, probably alive.
667-1.4	2/21	Mainstem	147.2	c	-25.0	3.5	2.0	0.0	0.2	rubble/cobble	-0.1	12.8	293	7.7	50 ft from RT rainbow 613-1.0 and 125 ft from an open lead
709-1.2	1/21	Mainstem	133.6	o	-	6.0*	0.0	0.0	1.5*	gravel/cobble	-	-	-	-	below Slough 10 in open lead, probably alive.
707-2.3	1/21	Mainstem	146.4	O	-	10.0*	0.0	0.0	2.5*	cobble	-0.1	-	195	7.4	in an open lead and 50 ft fro RT rainbow 667-1.4, probably alive.
718-1.0	1/22	Mainstem	148.3	c	-100.0	3.9	2.8	0.0	1.8	rubble/cobble	-0.2	15.7	246	7.2	100 ft from RT rainbow 599-1. and 630-1.7.
718-1.0	2/20	Mainstem	148.3	c	-100.0	1.5	3.0	3.5	0.5	rubble/cobble	-0.2	11.4	231	-	100 ft from RT rainbow 599-1.
728-1.0	2/5	Mainstem	137.6	c	0.0	4.0	2.5	0.0	0.4	rubble/cobble	-0.1	14.8	270	7.0	fate was undetermined.
729-1.5	1/23	Mainstem	98.6	c	+100.0	4.2	2.6	0.0	0.2	silt	+0.2	13.5	228	7.4	75 ft from an open lead.
749-1.5[b]	1/22	Mainstem	149.8	c	-	6.7	4.3	0.0	1.8	rubble/cobble	-0.1	13.5	245	7.3	strange signal.
757-1.1	1/22	Mainstem	144.2	c	+20.0	4.0	1.8	0.0	0.3	cobble/rubble	-0.2	10.2	170.0	7.2	
759-1.7	1/24	Mainstem	79.7	c	0.0	1.0	2.8	3.7	0.2	rubble	0.0	13.4	140.0	6.6	believed dead on 1/24 but lat proved alive because it moved upriver.
770-1.1	1/25	Mainstem	139.5	c	-800.0	5.2	1.8	0.0	0.9	rubble/cobble	0.0	14.6	249	7.4	100 ft from an open lead and 50 ft from RT rainbow 659-1.5
769-1.8	2/5	Mainstem	135.4	c	0.0	3.5	2.5	0.0	1.0	rubble/cobble	-0.1	11.9	239	7.0	100 ft from RT rainbow 648-1.
769-1.8	2/20	Mainstem	135.4	c	0.0	4.3	2.2	0.0	1.3	cobble/gravel	+0.3	10.6	286	7.3	100 ft from RT rainbow 648-1. and 200 ft from an open lead.

Appendix Table A-7 (Continued).

Radio Frequency	Date	Site Description	RM/TRM	Ice Open (o) Covered (c)	Movement (in ft)	Depths (ft) Water	Depths (ft) Ice	Depths (ft) Slush	Velocity (fps)	Substrate	Water Quality Temp°C	Water Quality DO mg/l	Water Quality umhos/cm	Water Quality pH	General Comments
<u>Radio tagged rainbow trout believed dead</u>															
598-1.6	1/14	Side Channel	31.8	c	0.0	1.0	1.6	0.0	0.4	sand	-0.2	-	183	6.8	
618-2.1	1/21	Mainstem	123.8	c	0.0	1.9	3.4	0.0	0.4	cobble	0.0	14.1	236	6.6	on east bank pps. 3.0
719-1.6	2/5	Side Channel below Slough 11	134.1	c	0.0	0.0	2.0	0.0	0.0	cobble	-	-	-	-	
<u>Radio tagged rainbow trout determined dead</u>															
670-1.2	1/25	Mainstem	136.5	[illegible]		[illegible]									
[illegible]	[illegible]	Plume of Indian River	138.3	o		0.2	0.0								
749-1.1	1/23	Mainstem	139.9	c		0.0	3.0								

* = Estiamted measurements because meter did not work.

\- = No movement or measurements taken because of open water or meters were not working.

a = Strange signal, therefore was difficult to pinpoing. Measurements however were probably taken within 20 ft of the fish.

APPENDIX B

BURBOT BIOLOGICAL CHARACTERISTICS AND RESIDENT FISH CATCH DATA

Appendix Table 8-1. Resident fish catch per unit effort (CPUE)[1] at selected sites on the Susitna River and its tributaries between Cook Inlet and Devil Canyon, November 1984 to February 1985.

				BURBOT CATCH											
Location	RM/TRM	Date(s) Sampled	Method of Capture*	Numbers of Pre-Spawners Captured M	F	Nubmers of Post-Spawners Captured M	F	Numbers of Non-Spawners Captured M	F	Other Species Catch	Number of Gear	Total Number of Hours Fished	CPUE For All Burbot Capture	CPUE For Other Species Captured	Comments
Sampling gear set to primarily capture lower river burbot															
Mainstem	35.6	1/16-17	TL						1		3	72.0	0.3	0.0	near RT burbot 629-3.0
Mainstem	40.5	12/16-17	TL		1						1	20.0	1.0		
Deshka River	40.6/0.0	11/24-25	BS	4	4						10	160.0	0.8		
	/0.0	12/7-8	BS	3							5	80.0	0.6		
	/0.0	12/15-17	BS	5	5			3			18	420.0	0.7		
	/1.9	1/12-13	TL		1				1	8	2	48.0	0.5		near RT burbot 650-3.0
	/1.9	2/7-8	BS				1				1	24.0	1.0		near RT burbot 650-3.0
	/1.9	2/70=-8	TL				3		1		3	72.0	1.3		
	/2.0	1/12-13	BS		1						1	21.0	1.0		near RT burbot 659-1.0 and 739-1
	/2.0	1/12-13	TL		5				1		2	42.0	1.5		
	/2.0	2/7-8	TL				1		1		4	96.0	0.5		RT burbot 660-1.0 and 734-1.0 we located near here on 1/12
	/24.5	1/15-16	TL	4	4						3	72.0	2.7		near RT burbot 664-1.8 and 760-1
Moose Creek a trib. of Deshka River at TRM 29.5	40.6/0.7	2/4-5	BS								2	48.0	0.0		near RT burbot 659-1.0 and 669-1
		2/4-5	TL			1	3				3	72.0	1.3		
Mainstem	40.7	2/7-8	BS				1				3	63.0	0.3		near RT burbot 739-1.0
		2/7-8	TL								2	42.0	0.0		
Mainstem	42.1	1/16-17	TL								3	72.0	0.0		near RT burbot 610-0.5
Mainstem	75.4	1/23-24	TL					1	1		3	72.0	0.7		near RT burbot 740-0.7
Mainstem	88.0	1/23-24	BS								6	144.0	0.0		near RT burbot 649-1.0
Mainstem	92.0	2/21-22	BS								1	24.0	0.0		near RT burbot 649-1.0
	92.0	2/21-22	TL								1	24.0	0.0		
TOTAL CATCH =				16	21	1	9	4	6						

Appendix Table B-1(Continued).

Location	RM/TRM	Date(s) Sampled	Method of Capture*	BURBOT CATCH: Numbers of Pre-Spawners Captured M	F	Nubmers of Post-Spawners Captured M	F	Numbers of Non-Spawners Captured M	F	Other Species Catch	Number of Gear	Total Number of Hours Fished	CPUE For All Burbot Capture	CPUE For Other Species Captured	Comments
Sampling gear set to primarily capture lower river rainbow trout															
Mainstem	9.6	1/14-15	BS								2	48.0		0.0	near RT rainbow trout 739-2.3
Mainstem	14.3	1/14-15	GN								2	44.0		0.0	near RT rainbow trout 650-1.3
Side Channel	46.0	1/15-16	TL					2	5		2	48.0	3.6	0.0	near RT rainbow trout 640-1.5
Side Channel	46.8	1/15-16	TL								2	48.0		0.0	near RT rainbow trout 602-2.0
Mainstem	77.4	2/21-22	TL								2	48.0		0.0	near RT rainbow trout 660-1 0
TOTAL CATCH =								2	5						
Sampling gear set to primarily capture middle river rainbow trout															
Side Channel	31.8	1/14-15	TL						1		1	24.0	1.0	0.0	near RT rainbow trout 598-1.6 which was believed dead
Mainstem	86.8	2/21-22	GN								1	24.0		0.0	
	86.8	2/21-22	BS								1	24.0		0.0	near RT rainbow trout 640-1.0
	86.8	2/21-22	TL								1	24.0		0.0	
Mainstem	121.2	1/21-22	BS						1		1	24.0	1.0	0.0	near RT rainbow trout 629-1.0
	121.2	1/21-22	TL		2						1	24.0	2.0	0.0	
Mainstem	132.0	1/21-22	BS								1	24.0		0.0	near RT rainbow trout 608-1.9
	132.0	1/21-22	TL								1	24.0		0.0	
Mainstem	133.5	2/6	HL								2	0.5		0.0	
Mainstem	133.6	1/21-22	GN								1	24.0		0.0	near RT rainbow trout 709-1.2
		1/21-22	TL								1	24.0	0.0		
		2/6	HL								2	1.2	0.0		

Appendix Table 8-1 (Continued).

Location	RM/TRM	Date(s) Sampled	Method of Capture*	BURBOT CATCH: Numbers of Pre-Spawners Captured M	F	Nubmers of Post-Spawners Captured M	F	Numbers of Non-Spawners Captured M	F	Other Species Catch	Number of Gear	Total Number of Hours Fished	CPUE For All Burbot Capture	CPUE For Other Species Captured	Comments
Mainstem	135.4	2/20-21	BS								1	24.0		0.0	near RT rainbow trout 648-1.1
	135.4	2/20-21	TL								2	48.0		0.0	and 769-1.8
Mainstem	146.4	1/21-22	GN								1	24.0		0.0	near RT rainbow trout 667-1.4
		1/21-22	TL								1	24.0		0.0	and 707-2.3
		2/6	HL							1	2	0.8		1.2	
		2/20-21	BS								1	24.0		0.0	
		2/20-21	TL								1	24.0		0.0	
Mainstem	147.2	2/21-22	GN								1	24.0		0.0	near RT rainbow trout 613-1.0
		2/21-22	BS								1	24.0		0.0	and 667-1.4
		2/21-22	TL								1	24.0		0.0	
Mainstem	147.6	1/22-23	TL								2	48.0		0.0	near RT rainbow trout 637-1.8
Mainstem	148.3	2/20-21	BS								1	24.0		0.0	near RT rainbow trout 599-1.1
	148.3	2/20-21	TL								2	48.0		0.0	and 718-1.0
TOTAL CATCH =					1				2	1					

* GN = gill net
BS = burbot set
TL = trotline
HL = hook and line

Appendix Table B-2. Relative sexual maturity of burbot captured on the Susitna River between Cook Inlet and Devil Canyon, December 1984 to February 1985.

Condition of Gonads	Length[1]	Age	Date Captured	Area of Capture	River/Tributary Mile/River Mile
Sex - Male					
pre-spawn	405	6	1/16	Deshka River	40.6/24.5
non-spawn	410	5	1/16	Deshka River	40.6/0.0
pre-spawn	410	7	1/16	Deshka River	40.6/24.5
non-spawn	520	7	12/17	Deshka River	40.6/0.0
non-spawn	525	7	1/16	Mainstem	46.0
pre-spawn	533	8	12/16	Deshka River	40.6/0.0
pre-spawn	535	8	1/16	Deshka River	40.6/24.5
pre-spawn	565	7	12/16	Deshka River	40.6/0.0
pre-spawn	590	10	1/16	Deshka River	40.6/24.5
non-spawn	625	7	1/16	Mainstem	46.0
non-spawn	665	8	1/25	Mainstem	75.4
pre-spawn	740	11	12/16	Deshka River	40.6/0.0
post-spawn	430	6	2/5	Moose Creek off Deshka R.	29.5/0.5
Total Number of Males = 13					
Sex - Female					
non-spawn	400	5	1/22	Mainstem	121.2
non-spawn	405	5	1/14	Deshka River	40.6/1.8
non-spawn	460	5	1/16	Mainstem	46.0
pre-spawn	465	8	1/16	Deshka River	40.6/24.5
pre-spawn	485	8	1/14	Deshka River	40.6/1.9
non-spawn	490	6	1/16	Mainstem	46.0
pre-spawn	490	7	1/16	Deshka River	40.6/24.5
pre-spawn	510	7	12/17	Mainstem	40.5
pre-spawn	510	7	1/14	Deshka River	40.6/2.0
non-spawn	515	6	2/8	Deshka River	40.6/1.9
non-spawn	515	9	1/15	Mainstem	31.8
pre-spawn	520	7	1/16	Deshka River	40.6/24.5
pre-spawn	524	7	12/16	Deshka River	40.6/0.0
pre-spawn	530	6	12/17	Deshka River	40.6/0.0
pre-spawn	530	10	1/16	Deshka River	40.6/24.5
pre-spawn	530	11	1/14	Deshka River	40.6/2.0
non-spawn	540	7	2/8	Deshka River	40.6/2.0
non-spawn	565	8	1/14	Deshka River	40.6/2.0
pre-spawn	575	8	1/14	Deshka River	40.6/2.0
non-spawn	600	9	1/16	Mainstem	46.0
pre-spawn	605	10	1/14	Deshka River	40.6/2.0
pre-spawn	615	11	1/14	Deshka River	40.6/2.0
non-spawn	645	8	1/16	Mainstem	46.0
non-spawn	660	9	1/17	Mainstem	35.6
pre-spawn	665	10	12/17	Deshka River	40.6/0.0
non-spawn	690	12	1/16	Mainstem	46.0
pre-spawn	695	9	1/15	Deshka River	40.6/2.0
pre-spawn	700	10	12/17	Deshka River	40.6/0.0
non-spawn	705	11	1/25	Mainstem	75.4
pre-spawn	780	11	1/22	Mainstem	121.2
pre-spawn	780	12	1/22	Mainstem	121.2
post-spawn	360	5	2/5	Moose Creek off Deshka R.	29.5/0.5
post-spawn	385	5	2/8	Deshka River	40.6/1.9
post-spawn	445	6	2/5	Moose Creek off Deshka R.	29.5/0.5
post-spawn	450	6	2/5	Moose Creek off Deshka R.	29.5/0.5
post-spawn	470	5	2/8	Deshka River	40.6/1.9
post-spawn	500	9	2/8	Deshka River	40.6/1.9
post-spawn	515	9	2/8	Deshka River	40.6/1.9
post-spawn	535	9	2/8	Deshka River	40.6/2.0
post-spawn	620	9	2/8	Mainstem	40.7
Total number of females = 40					

[1] Total length in millimeters.

Appendix Table B-3. Burbot age-length[1] relationships by sex on the Susitna River between Cook Inlet and Devil Canyon, December 1984 to February 1985.

		Cook Inlet to Chulitna Confluence			Chulitna Confluence to Devil Canyon			Both Sexes: Cook Inlet to Devil Canyon			
Age (Years)	Sex	Total No. of fish Sampled	Mean length (mm)	Range of length (mm)	Total No. of fish Sampled	Mean length (mm)	Range of length (mm)	Total No. of fish Sampled	Percent Frequency	Mean length (mm)	Range of length (mm)
5	M	1	410	-	-	-	-	6	11.3	403	360-460
	F	4	403	360-460	1	400	-				
6	M	2	418	405-430	-	-	-	8	15.1	467	405-530
	R	6	483	445-530	-	-	-				
7	M	5	529	410-625	-	-	-	11	20.8	522	410-625
	F	6	516	490-540	-	-	-				
8	M	3	578	533-665	-	-	-	8	15.1	559	465-665
	F	5	547	465-645	-	-	-				
9	F	8	580	500-695	-	-	-	8	16.1	580	500-695
10	M	1	590	-	-	-	-	5	9.4	618	530-700
	F	4	625	530-700	-	-	-				
11	M	1	740	-	-	-	-	5	9.4	674	530-780
	F	3	617	530-705	1	780	-				
12	M	1	690	-	1	780	-	2	3.8	735	690-780
TOTAL		50	539	360-705	3	653	400-780	53	100.0	546	360-780

[1] Total length, nose-tail