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HOMING OF ARCTIC CHAR, Salvelinus alpinus (Linnaeus)
TO FEEDING AND SPAWNING SITES IN THE
WOOD RIVER LAKE SYSTEM, ALASKA

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ABSTRACT

Arctic char prey heavily on sockeye salmon, Oncorhynchus nerka (Walbaum), smolt during the smolts' summer emigration from the Wood River lake system, Bristol Bay, Alaska. Most Arctic char predation on sockeye salmon smolt occurs at the lake system's narrow river heads and mouths (feeding sites). Since 1975, the Alaska Department of Fish and Game has conducted research to quantitatively investigate Arctic char predation on sockeye salmon smolt in the Wood River lake system. As part of the research, a tagging study of Arctic char at feeding and spawning sites (pre-spawning concentrations) was conducted. The migratory study reported herein is mostly an analysis of the tagging experiments conducted at and in conjunction with the Agulowak River mouth feeding sites in Lake Aleknagik.

Approximately 10,000 to 15,000 Arctic char annually concentrate from June through August at the Agulowak River mouth to prey on emigrating sockeye salmon smolt. Most of the Arctic char that migrate to the Agulowak River mouth remain at that feeding site throughout the smolt emigration and, between 1975 and 1978, approximately 98% of the population that resided at the Agulowak River mouth returned (homed) to that same feeding site the following year. Little or no migration of Arctic char between the Agulowak River mouth and other feeding sites was documented during those years. Nine other feeding sites were documented in the Wood River lake system. For those feeding sites where annual migration could be documented, at least 75% of the Arctic char present at a given feeding site homed back to that same feeding site in future years.

Most of the Arctic char that summered at the Agulowak River mouth migrated to spawning sites at Youth or Sunshine Creeks of Lake Aleknagik during the fall. Approximately 50% of the Arctic char found at the Youth and Sunshine Creek spawning sites were fish that had resided at the Agulowak River mouth feeding site. Most of the Arctic char that resided at Youth and Sunshine Creek spawning sites homed back to one or the other of these sites the following year. Little or no migration of Arctic char between Youth and Sunshine Creek spawning sites and other spawning sites was documented.

The type of migratory patterns for Arctic char observed between the Agulowak River and the Youth and Sunshine Creek spawning site complex were also documented at several other feeding and spawning sites throughout the Wood River lake system. Analysis of approximately 80,000 tagging records conclusively demonstrates that Arctic char from different feeding sites represent discrete subpopulations or stocks.

INTRODUCTION

Arctic char prey on sockeye salmon smolt during the smolt's summer emigration from the Wood River lake system, Bristol Bay, Alaska. During this migration, the smolt are heavily concentrated at the lake system's narrow river heads and mouths (Figure 1) where they are particularly vulnerable to predation. Most Arctic char predation on sockeye salmon smolt occurs at these sites where Arctic char concentrate (Nelson 1966), hereby referred to as Arctic char feeding sites.

Since 1975, the Alaska Department of Fish and Game has conducted research to investigate Arctic char predation on sockeye salmon in the Wood River lake system. A predation suppression program was initiated at the Agulowak and Agulukpak River mouths where predation was excessive on migrating smolt. Arctic char were removed from these feeding sites and confined in large pens until most of the smolt emigration was completed (Meacham 1977). A tagging study of Arctic char at the Agulowak and Little Togiak River mouths was initiated in 1975. The tagging study was subsequently expanded to include: (1) other feeding sites throughout the lake system, and (2) pre-spawning concentrations of Arctic char spawning sites (Figure 1). The study reported here was conducted as part of the overall research program and is an indepth analysis of migratory behavior of Wood River Arctic char.

The migrational habits of both Arctic char and Dolly Varden, Salvelinus malma (Walbaum) have been the focus of several investigations (Delacy 1941; Grainger 1953; and Revet 1962). Homing to reproductive sites has been documented for both species (Armstrong 1974; Craig 1977; and McLeave et al 1977). Based on systematics, it has been hypothesized that two genetically distinct subpopulations of Arctic char exist within a single lake in Scandinavia (Nilson and Filipsson 1972) and the same was found in a single lake in England (LeCren and Kipling 1963) through analysis of tagging data. Study of Arctic char systematics by McPhail (1961) led to the conclusion that there was more than one stock or subpopulation of Arctic char in Lake Aleknagik of the Wood River lake system.

The objective of this research paper is to analyze some of the migratory habits, specifically homing behavior, of Arctic char in the Wood River lake system. Homing is hereby defined as the annual return of an animal to a place formerly occupied rather than to other equally probable places (Carlson and Haight 1972). This analysis will be confined to tagging experiments conducted at and in conjunction with the Agulowak River mouth between 1975 and 1978. The results of these tagging experiments will be used to answer the following questions:

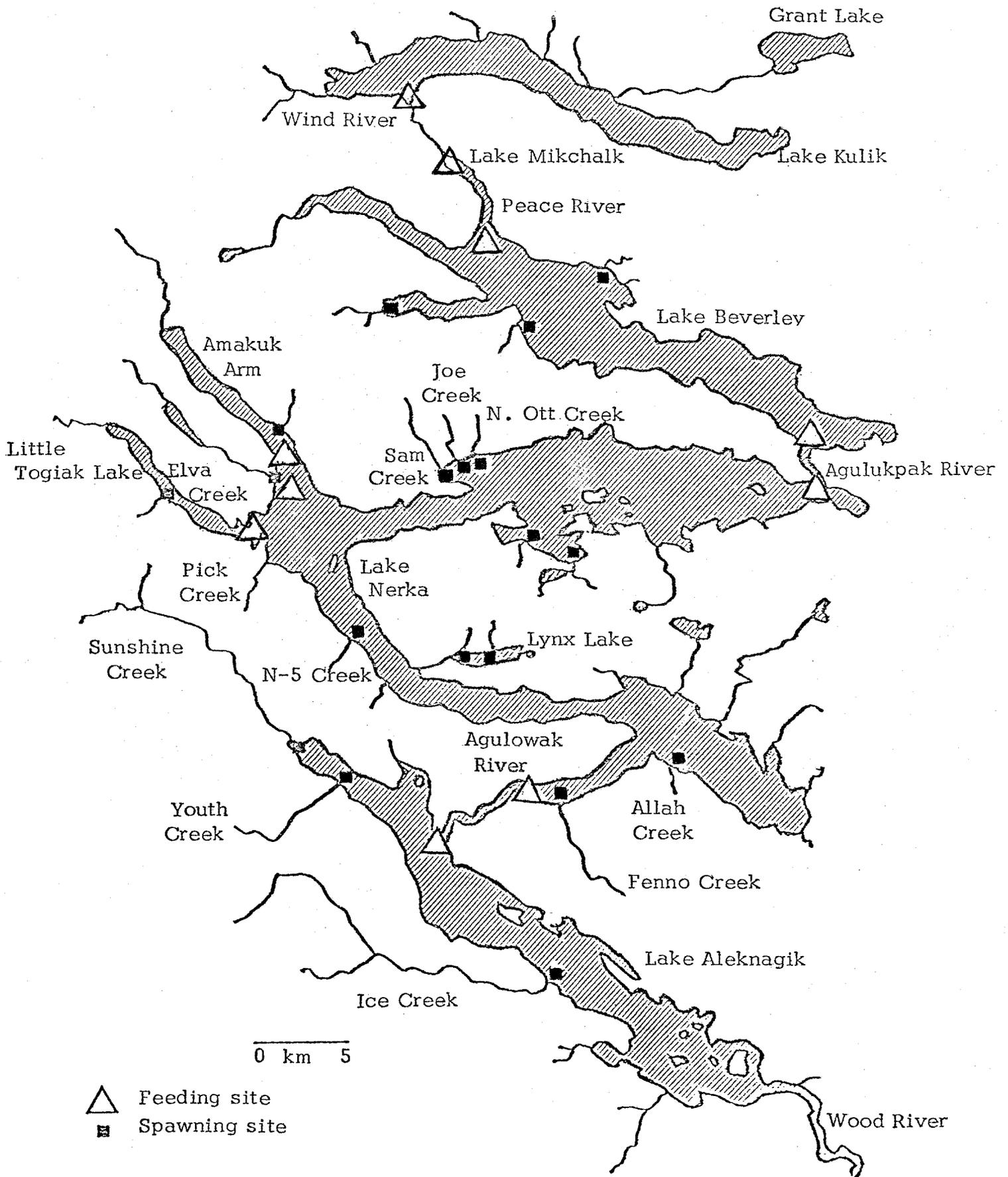


Figure 1. Documented Arctic char feeding and spawning sites in the Wood River lake system, Bristol Bay, Alaska.

- (1) To what extent do Arctic char migrate between feeding sites or do they home to and remain at specific feeding sites?
- (2) Where do Arctic char that reside at feeding sites during the summer migrate during the fall to spawn?
- (3) Where do Arctic char that reside at spawning sites during the fall migrate during the summer?
- (4) To what extent do Arctic char migrate between spawning sites or do they home to and remain at specific spawning sites?

METHODS

Capture Effort at Feeding Sites

System-wide: Arctic char were captured, tagged, and released throughout the Wood River lake system between May 15 and August 15 from 1975 to 1978 to document major feeding sites (Table 1). Capture methods included hand operated purse seines (53 and 69 meters long), variable mesh gill nets (30 meters long), beach seines (61 meters long), and hook and line gear with artificial lures. Captured Arctic char were anesthetized with tricaine methanesulfonate (M.S. 222), marked with an individually numbered Floy internal anchor tag, measured for fork length, and either released or confined in holding pens and then later released. The number of Arctic char residing at feeding sites was estimated with Petersen and Schnabel population estimates.

Only Arctic char greater than 300 mm are included in this analysis. The intent of this research is to examine the migratory habits of those Arctic char that are capable of being significant predators on sockeye salmon. It is felt that Arctic char less than 300 mm in length do not significantly prey on sockeye salmon smolt.

Agulowak River Mouth: Arctic char were sampled at the Agulowak River mouth each year between 1975 and 1978 (Table 2). Most of the fish were captured by purse seine. In 1977, approximately 5,600 Arctic char were confined whereas approximately 6,100 were confined in 1978.

Arctic char were also gillnetted in other areas of northern Lake Aleknagik during June and July of 1976 and 1977 to examine Arctic char population density and movement in areas of the lake system where Arctic char do not concentrate at feeding sites (Lake Aleknagik sampling areas). A total of 249

Table 1. Summary of the sampling effort for Arctic char at feeding sites throughout the Wood River lake system, 1975-1978.

Location	Years sampled	Number captured ^{1/}	Number tagged and released ^{2/}	Population estimate ^{3/}
<u>Lake Aleknagik</u>				
Agulowak River Mouth	1975-1978	20,188	18,635	11,200
<u>Lake Nerka</u>				
Agulowak River Head	1977	758	712	8,880
Little Togiak River Mouth	1975-1978	1,391	573	5,381
Elva Creek	1975-1977	451	278	2,255
Amakuk Arm	1975-1977	722	367	4,260
Agulukpak River Mouth	1975-1978	8,673	5,195	6,006
<u>Lake Beverley</u>				
Agulukpak River Head	1977	846	608	9,614
Peace River Mouth	1976-1977	1,229	987	5,248
<u>Mikchalk Lake</u>				
Wind River Mouth	1977	438	370	3,257
<u>Lake Kulik</u>				
Wind River Head	1977	468	375	8,627
TOTAL		35,164		64,728

^{1/} Total number of Arctic char captured during the period May 15 to August 15, 1975 through 1978.

^{2/} Total number of Arctic char tagged and released during the period May 15 to August 15, 1975 through 1978. Includes all multiple recaptures.

^{3/} Average of all population estimates calculated for that feeding site.

Arctic char were captured in 1976 and an additional 273 Arctic char were captured in 1977.

Table 2. Summary of sampling effort and population size of Arctic char at the Agulowak River mouth, 1975-1978.

Year	Number captured	Number tagged and released	Population estimate	95% confidence interval
1975	3,687	3,378	13,490	10,967 to 17,520
1976	4,075	3,469	11,062	10,188 to 12,099
1977	6,012	5,631	8,480	7,806 to 9,435
1978	6,414	6,188	11,822	9,769 to 15,745

Migration of Arctic char between the Agulowak River mouth and other feeding sites throughout the lake system was quantified through differential recapture to capture ratios. Annual migration was documented through the mark and release of Arctic char at feeding sites and their subsequent recapture at some feeding site during the following season. Within-season migration was documented in the same manner except that the recapture period was limited from May 16 to August 15 of the same year that the fish were initially marked.

In addition to documenting trends in annual Arctic char migration, recapture to capture estimates were further refined through analysis of single year migrations by calculating the percentage of fish that move from any location, A, to any other location, B, as follows:

$$\text{Percent of fish that migrate from A to B} = \left(\frac{R_B N_B}{C_B} / T \right) \times 100\%$$

where R_B = the number of recaptured fish at location B that were originally tagged at location A.

N_B = the population estimate at location B.

C_B = the total catch at location B.

and R_B/C_B is an estimate of the proportion of the catch at B which was tagged at A.

$\frac{R_B N_B}{C_B}$ is an estimate of the number of char tagged at A that are present at B.

$T = \sum \frac{R_B N_B}{C_B}$ where the sum is over all locations sampled (all potential location B's).

This calculation weights the number of recaptured fish caught in any location, B, by the sampling effort at B. Mortality and recruitment are not accounted for, therefore, only percentage estimates can be derived.

Capture Effort at Spawning Sites

Arctic char were captured, tagged, and released throughout the Wood River lake system from September 15 to October 15 between 1975 and 1978, in an effort to document major spawning sites (Table 3). All Arctic char were captured by beach seine at the mouths of small tributary streams. Captured Arctic char were measured, tagged, and released as previously described. Population estimates of the number of Arctic char residing at each spawning site were not calculated because assumptions regarding the estimates were not met.

Migration of Arctic char between spawning sites was also examined on both an annual and within-season basis. Documentation and analysis of these migratory patterns used the same methods as previously described for feeding site analysis.

RESULTS AND DISCUSSION

Migration of Arctic Char Between Feeding Sites

Annual Migration: Most of the Arctic char that resided at the Agulowak River mouth during the summer homed to that same feeding site the following year (Tables 4 and 5). The recapture rate of 0.3187 for the total return of Arctic char to the Agulowak River mouth is two orders of magnitude larger than the recapture rate of Arctic char that were tagged at the Agulowak River mouth and recaptured at any other feeding site. Based on the three year study of tag returns, 97 to 99% of the Arctic char present at the Agulowak River mouth homed back to the Agulowak River mouth the following year. The 1976 to 1977 homing estimate of 98% is probably the most valid point estimate because 1977 was the only year when all the major feeding sites throughout the lake system were sampled.

Annual migration between the Agulowak River mouth feeding site and other feeding sites was minimal and ranged from only 0.2 to 2.6%. The Agulukpak River mouth was the only feeding site where annual emigration was documented for each year. Some annual emigration was also documented for each year from the Agulowak River mouth to other Lake Aleknagik sampling areas, but the numbers were consistently small (a total of nine fish in three years). While the recapture rate for fish that were found in Lake Aleknagik

Table 3. Summary of the sampling effort for Arctic char at spawning sites throughout the Wood River lake system, 1976 through 1978. The numbers of Arctic char captured and released are the totals for all the years that each spawning site was sampled^{1/}.

Location	Years sampled	Number captured ^{2/}	Number tagged and released ^{3/}
<u>Lake Aleknagik</u>			
Ice Creek	1976-1978	814	814
Youth Creek	1977	153	102
	1978	<u>697</u>	<u>694</u>
	1977-1978	850	796
Sunshine Creek	1976	226	226
	1977	913	790
	1978	<u>868</u>	<u>865</u>
	1976-1978	2,007	1,881
<u>Lake Nerka</u>			
Fenno Creek	1976-1978	1,465	1,462
Allah Creek	1976-1978	173	173
Lynx Creek	1977	162	162
N-5 Creek	1976-1978	296	286
Pick Creek	1976-1978	1,574	1,390
Elva Creek	1976-1978	1,371	1,275
Amakuk Arm Creek	1976-1978	187	187
Sam Creek	1976-1978	1,759	1,740
Joe Creek	1977-1978	1,280	1,260
N. Ott Bay Creek	1977-1978	626	620
Hidden Lake Creek	1976-1978	475	468
Ivan Creek	1976-1978	222	214
<u>Lynx Lake</u>			
Dago Creek	1977-1978	2,807	2,752

Continued

Table 3. Summary of the sampling effort for Arctic char at spawning sites throughout the Wood River lake system, 1976 through 1978. The numbers of Arctic char captured and released are the totals for all the years that each spawning site was sampled^{1/} (continued).

Location	Years sampled	Number captured ^{2/}	Number tagged and released ^{3/}
'A' Creek	1977-1978	832	782
Lynx Creek Head	1977-1978	347	347
<u>Little Togiak Lake</u>			
'D' Creek	1977-1978	524	524
<u>Lake Beverley</u>			
B-6 Creek	1976-1977	42	41
B-12 Creek	1976-1977	20	20
Silverhorn Creek	1976-1977	58	58
TOTAL		17,729	

^{1/} Yearly totals for Youth and Sunshine Creeks are shown because of indepth treatment of these data.

^{2/} Total number of Arctic char captured during the period September 15 to October 15, 1976 through 1978.

^{3/} Total number of Arctic char tagged and released during the period September 15 to October 15, 1976 through 1978. Includes all multiple recaptures.

Table 4. Summary of recapture to capture ratios for Arctic char tagged at the Agulowak River mouth feeding site and subsequently found at all feeding sites and other summer locations at least one year later.

Location recaptured	Number recaptured R _B 1/	Number captured C _B 2/	Recapture ratio R _B /C _B
<u>Lake Aleknagik</u>			
Nushagak Bay	1	-	-
Wood River	1	-	-
L. Aleknagik Sampling Area	11	273	.0403
Agulowak River Mouth	5,259	16,501	.3187
<u>Lake Nevka</u>			
Agulowak River Head	1	758	.0013
Little Togiak River Mouth	2	1,077	.0018
Elva Creek	0	266	-
Amukuk Arm	1	591	.0017
L. Nerka Sampling Area	0	241	-
Agulukpak River Mouth	21	8,647	.0022
<u>Lake Beverley</u>			
Agulukpak River Head	2	841	.0024
Peace River Mouth	0	1,229	-
<u>Mikchalk Lake</u>			
Wind River Mouth	0	442	-
<u>Lake Kulik</u>			
Wind River Head	0	468	-
TOTAL	5,299	31,334	.1691

1/ The number of fish found at feeding sites between 1976 and 1978 that were originally tagged at the Agulowak River mouth between 1975 and 1977. These figures do not include within-season movement.

2/ The total catch of Arctic char at the recapture location between 1976 and 1978.

Table 5. Summary of all tag returns of Arctic char that were tagged at the Agulowak River mouth and subsequently found at feeding sites and other summer locations during the following year.

Location recaptured	Number recaptured R_B <u>1/</u>	Recapture ratio N_B/C_B <u>2/</u>	Expected number of recaptures $R_B(N_B/C_B)$ <u>3/</u>	Percent of $(R_B)(N_B/C_B)$ <u>4/</u>
----- 1975-1976 -----				
L. Aleknagik Sampling Areas <u>5/</u>	7	-	-	-
Agulowak River Mouth	497	2.70	1,341.90	99.4
Agulukpak River Mouth	4	2.18	8.72	0.6
----- 1976-1977 -----				
Nushagak Bay <u>5/</u>	1	-	-	-
L. Aleknagik Sampling Areas <u>5/</u>	1	-	-	-
Agulowak River Mouth	1,407	1.41	1,982.46	98.0
Agulowak River Head	1	11.72	11.72	0.6
Agulukpak River Mouth	8	1.91	15.28	0.8
Agulukpak River Head	1	11.36	11.36	0.6
----- 1977-1978 -----				
Wood River	1	-	-	-
L. Aleknagik Sampling Areas	-	-	-	-
Agulowak River Mouth	2,526	1.84	4,646.00	97.2
Little Togiak River Mouth	2	63.30	126.60	2.6
Amakuk Arm <u>5/</u>	1	-	-	-
Agulukpak River Mouth	5	2.18	10.36	0.2

1/ The number of fish found in any location, B, in year (X + 1) that were originally tagged at the Agulowak River mouth in year X.

2/ Ratio of: (1) the population estimate at the recapture location in year (X + 1), and (2) the total catch at the recapture location in year (X + 1).

3/ Weighted total.

4/ Percent of the total Arctic char population that were marked at the Agulowak River mouth in year X and found at a feeding site in year (X + 1).

5/ Number of Arctic char at this location was not estimated.

sampling areas is one order of magnitude greater than the recapture rate for any feeding site except the Agulowak River mouth, these fish may not represent annual emigration from the Agulowak River mouth, but, only reflect a sampling bias (i.e., these fish may have been intercepted while migrating to or from the Agulowak River mouth).

Little annual immigration to the Agulowak River mouth from other feeding sites was documented (Table 6) in that only 31 fish were found at the Agulowak River mouth that had been tagged at another feeding site. Most of the immigration was documented from the Agulukpak River mouth (22 of 31). While it is difficult to account for differential mark and release efforts at other feeding sites, the trends in the immigration data support the conclusions from the annual emigration data in that: (1) relatively little annual migration of Arctic char occurred between the Agulowak River mouth and other feeding sites throughout the lake system, and (2) such straying as did occur was between the Agulowak River mouth and the Agulukpak River mouth.

Within-season Migration: Little within-season migration occurred between the Agulowak River mouth and any other feeding sites (Table 7). A total of 17 Arctic char were found to have migrated between the Agulowak River mouth and other feeding sites during the same season that they were tagged. These data support the conclusions from the annual migration data that: (1) little migration occurred between the Agulowak River mouth and other feeding sites, (2) those locations where migration was documented on an annual basis were virtually the same as those locations where within-season migration was documented, and (3) most of the migration of Arctic char between the Agulowak River mouth and other feeding sites occurred specifically with the Agulukpak River mouth.

Migration of Arctic Char Between the Agulowak River Mouth and Spawning Sites

Most of the migration from the Agulowak River mouth was documented to spawning sites tributary to Lake Aleknagik (Table 8). Overall during the three year study, approximately 20% of the Arctic char captured at Youth Creek and 20% of the Arctic char captured at Sunshine Creek were tagged at the Agulowak River mouth. The next highest overall percentage of recaptures occurred at Ice Creek (approximately 6%) and Fenno Creek (approximately 4%). The recapture rates for Arctic char from the Agulowak River mouth that were found at any of the other many spawning sites was less than 3%. Since about 50% of the Agulowak River mouth Arctic char population was marked by the fall of 1978, all of the 1978 percentages can be roughly doubled to calculate an estimate of the actual percentages of Agulowak River mouth Arctic char that were present at any spawning site during the fall of 1978. It is concluded

Table 6. Numbers of Arctic char found at the Agulowak River mouth that were tagged at some other feeding site or summer location at least one year earlier.

Year recaptured at the Agulowak River mouth	Location and Year Tagged					Total	
	Lake Aleknagik sampling area 1977	Little Togiak River mouth 1975	Elva Creek 1975	Agulukpak River mouth 1976	Agulukpak River mouth 1977		Wind River mouth 1977
1976		1	1			2	
1977	1	1	1	2		5	
1978		3		4	16	1	24
TOTAL	1	5	2	6	16	1	31

Table 7. Numbers of Arctic char that migrated between the Agulowak River mouth and other feeding sites or other summer locations during the same year.

Emigration from the Agulowak River Mouth	
<u>Location and Year Recovered</u>	<u>Number</u>
Wood River, 1978	1
Lake Aleknagik Sampling Area, 1976	1
Lake Aleknagik Sampling Area, 1977	1
Lake Aleknagik Sampling Area, 1978	1
Agulukpak River Mouth, 1977	<u>2</u>
<hr/>	
TOTAL	6
Immigration to the Agulowak River Mouth	
<u>Location and Year Tagged</u>	<u>Number</u>
Lake Aleknagik Sampling Area, 1977	3
Mud Creek, 1977	1
Agulukpak River Mouth, 1978	<u>7</u>
<hr/>	
TOTAL	11

Table 8 . Summary of recapture to capture ratios for Arctic char that were tagged at the Agulowak River mouth and subsequently found at spawning sites during the same year.

Location recaptured	1976			1977			1978		
	Number recaptured R _B 1/	Number captured C _B 2/	Recapture ratio R _B /C _B	Number recaptured R _B 1/	Number captured C _B 2/	Recapture ratio R _B /C _B	Number recaptured R _B 1/	Number captured C _B 2/	Recapture ratio R _B /C _B
<u>Lake Aleknagik</u>									
Ice Creek	5	84	.0595	10	216	.0463	37	514	.0719
Youth Creek				41	153	.2418	126	697	.2023
Sunshine Creek	24	226	.1057	207	913	.2333	161	868	.1786
Other Lake Aleknagik	0	0	-	0	0	-	0	44	-
<u>Lake Nerka</u>									
Fenno Creek	3	199	.0151	3	252	.0119	49	1,015	.0483
Pick Creek				5	660	.0076	4	691	.0058
Elva Creek				5	538	.0093	3	718	.0042
Sam Creek				3	420	.0071	1	1,120	.0009
Joe Creek				2	249	.0080	2	1,031	.0019
N-5 Creek	1	279	.0229						
Other Lake Nerka	0	1,009	-	0	293	-	0	750	-
<u>Lake Beverley</u>	0	43	-	0	112	-			
<u>Little Togiak Lake</u>				0	197	-	1	380	.0026
<u>Lynx Lake</u>				0	873	-	1	2,888	.0003

1/ The number of fish found at spawning sites that were originally tagged at the Agulowak River mouth during the same year.

2/ The total catch of Arctic char at the recapture location.

that: (1) most of the Arctic char that reside at the Agulowak River mouth migrate to the Youth or Sunshine Creek spawning sites, (2) approximately 40% of the Arctic char population present at both Youth and Sunshine Creeks are composed of individual fish from the Agulowak River mouth, and (3) very few of the Arctic char that reside at the Agulowak River mouth migrate to spawning sites tributary to Lake Nerka, Lake Beverley, Little Togiak Lake, or Lynx Lake.

A large proportion of the Arctic char residing at Youth and Sunshine Creeks migrate to the Agulowak River mouth (Table 9). These figures are based on a total tag and release sample during 1977 of 102 Arctic char from Youth Creek and 790 Arctic char from Sunshine Creek. While the Agulowak and Agulukpak River mouths were the only feeding sites where substantial sampling occurred in 1978, it is clear that the number of Arctic char that migrate to the Agulowak River mouth from these spawning sites is one or two orders of magnitude larger than the number that migrate to the Agulukpak River mouth.

Table 9. Number of Arctic char tagged at Youth or Sunshine Creeks during 1977 and recovered at the Agulowak River mouth during 1978.

Location recaptured	Youth Creek		Sunshine Creek	
	Number recaptured	R/C	Number recaptured	R/C
Wood River	1	-	2	-
Lake Aleknagik sampling areas	1	-	1	-
Agulowak River Mouth	13	.0020	88	.0137
Agulukpak River Mouth	2	.0001	2	.0001

Migration of the Arctic Char Between Spawning Sites

Annual Migration: Most of the Arctic char that reside at the Youth and Sunshine Creek spawning sites annually return to one or the other of these sites (Table 10). Only three Arctic char were documented to have migrated to other spawning sites as opposed to 47 that were documented to have returned. The 1976 to 1977 analysis is only partially valid because in 1976, only 226 Arctic char were tagged and released from Sunshine Creek

Table 10. Summary of recapture to capture ratios for Arctic char that were tagged at either Youth Creek or Sunshine Creek and subsequently found at spawning sites the following year.

Location recaptured	Number captured C_B ^{3/}	Youth Creek ^{1/}		Sunshine Creek	
		Number recaptured R_B ^{2/}	Recapture ratio R_B / C_B	Number recaptured R_B ^{2/}	Recapture ratio R_B / C_B
<u>Lake Aleknagik</u>					
Sunshine Creek	913			12	.0131
Other L. Aleknagik	153			0	-
<u>Lake Nerka</u>	2,412			0	-
<u>Lake Beverley</u>	112			0	-
<u>Little Togiak Lake</u>	197			0	-
<u>Lynx Lake</u>	873			0	-
----- 1977-1978 -----					
<u>Lake Aleknagik</u>					
Youth Creek	868	3	.0043	28	.0100
Sunshine Creek	697	2	.0023	7	.0302
Ice Creek	514			1	.0020
Other L. Aleknagik	44	0	-	0	-
<u>Lake Nerka</u>					
Pick Creek	691	0	-	2	.0029
Other L. Nerka	4,935	0	-	0	-
<u>Lake Beverley</u> ^{4/}	0	0	-	0	-
<u>Little Togiak Lake</u>	380	0	-	0	-
<u>Lynx Lake</u>	2,908	0	-	0	-

^{1/} Youth Creek was not sampled in 1976.

^{2/} Recaptures of Arctic char initially tagged at Youth or Sunshine Creek during the previous year.

^{3/} The total catch of Arctic char at the recapture location.

^{4/} Lake Beverley was not sampled in 1978.

and no sampling occurred at Youth Creek. The number of recaptures of Arctic char marked at Youth Creek in 1977 and recaptured at spawning sites in 1978 is small as only 102 Arctic char were tagged and released from that site. However, the trends in the recapture data for both spawning sites are supportive in that the recapture rates for Arctic char that home to these spawning sites are an order of magnitude larger than the recapture rates for any other spawning site. No recoveries of fish that were tagged at Youth or Sunshine Creeks were recovered at Lake Beverley, Little Togiak Lake, or Lynx Lake spawning sites.

Immigration of Arctic char from spawning sites throughout the lake system to Youth and Sunshine Creeks is not substantial in that of 2,631 Arctic char examined at these two sites, only 10 or less than one percent had immigrated from other spawning sites (Table 11). Most of the immigration to Sunshine Creek was documented from Youth Creek and most of the immigration to Youth Creek was documented from Sunshine Creek. These data support the previous conclusion that most of the Arctic char that reside at Youth or Sunshine Creeks annually return to one of these sites and that there is a significant level of migration between these two sites.

Within-season Migration: Most of the within-season migration between spawning sites was documented between Youth Creek and Sunshine Creek (80%) (Table 12). Most of the remaining migration was documented within Lake Aleknagik (Ice Creek) while only two fish migrated to another lake basin (Fenno Creek in Lake Nerka). No within-season migration was documented with Lake Beverley, Little Togiak Lake, or Lynx Lake. It is concluded that Arctic char that reside at Youth and Sunshine Creeks migrate between these two streams within and between different years, but that they do not interact significantly in a migrational sense with Arctic char residing at other spawning sites during the fall.

Migratory Habits of Arctic Char in Feeding and Spawning Sites Throughout the Lake System

The migratory pattern of the Arctic char population that resided at the Agulowak River mouth are not unique when compared to other Arctic char in the Wood River lake system. Similar analyses conducted for other major feeding sites throughout the lake system determined that at least 75% of the Arctic char present at a given feeding site homed back to that same feeding site in future years (Table 13).

Table 11. Summary of Arctic char that were tagged at spawning sites and subsequently found at Youth Creek or Sunshine Creek at least one year later, 1976-1978 ^{1/}.

Location tagged	Number of fish marked, 1976-1977	Recaptures, 1977-1978	
		Youth Creek	Sunshine Creek
<u>Lake Aleknagik</u>			
Youth Creek	102	-	2
Sunshine Creek	1,016	11	-
Ice Creek	300	1	3
<u>Lake Nerka</u>			
Fenno Creek	449	0	1
Allah Creek	173	1	1
Joe Creek	234	1	0
Other L. Nerka	3,032	0	0
<u>Lake Beverley</u>	155	0	0
<u>Little Togiak Lake</u>			
'D' Creek	170	0	1
Other L. Togiak Lake	27	0	0
<u>Lynx Lake</u>			
'A' Creek	230	0	1
Other Lynx Lake	538	0	0
Total	-	14	9
Total discounting Youth and Sunshine interaction	-	3	7

^{1/} Analysis excludes fish that homed to either Youth or Sunshine creeks.

Table 12. Summary of Arctic char that were tagged at spawning sites tributary to Lake Aleknagik and subsequently found at another spawning site during the same year, 1977-1978.

Recovery site	Tagging Site			Total
	Sunshine Creek	Youth Creek	Ice Creek	
1977				
Sunshine Creek	-	3	0	3
Youth Creek	0	-	0	0
<u>Ice Creek</u>	<u>0</u>	<u>0</u>	<u>-</u>	<u>0</u>
Total	0	3	0	3
1978				
Youth Creek	6	-	0	6
Ice Creek	5	-	-	5
<u>Fenno Creek</u>	<u>0</u>	<u>2</u>	<u>-</u>	<u>2</u>
Total	11	37	0	48

Table 13. Summary of Arctic char feeding sites and homing percentages of each population throughout the Wood River lake system, 1975-1978.

Feeding site	Year	Percent of the population that homed to that site
<u>Lake Nerka</u>		
Little Togiak	1975-1976	97.0
River mouth	1976-1977	100.0
	1977-1978	99.3
Agulukpak River	1976-1977	93.6
mouth	1977-1978	76.2
<u>Lake Beverley</u>		
Peace River	1976-1977	83.7
mouth		

Migratory patterns for Arctic char from feeding sites in Lake Nerka and Lake Beverley to specific spawning sites was not as well documented as was migration between comparable sites in Lake Aleknagik mostly due to sample size problems. While Arctic char from any given feeding site tended to migrate to spawning sites within the same lake basin, no single spawning site demonstrated as high a percentage of Arctic char originating from a single feeding site as was documented for Youth and Sunshine Creeks.

The migratory patterns of Arctic char tagged and released at Youth and Sunshine Creeks are also not unique in the Wood River lake system. Arctic char found at spawning sites in a given year returned to the same site or complex of sites geographically close to that site (McBride 1978). Most of the Arctic char present at a given complex of spawning sites migrated between the spawning sites within that complex (both annually and within-season), but rarely migrated to spawning sites outside of the complex.

Subpopulation Identification

The tagging data examined to date shows that the overall Wood River lake system Arctic char population is composed of many (in excess of 20) discrete subpopulations or stocks. Arctic char present at feeding sites account for only 65,000 or 40% of the 160,000 (95% confidence interval 135,000 to 210,000) Arctic char estimated to be in the lake system (Meacham 1977). Arctic char present at feeding sites have little or no migratory interaction with either Arctic char in other feeding sites or the remaining 60% of the total Arctic char population at large in the lake system. This thesis is further supported by McPhail (1961) who concluded that Arctic char present at Hansen Creek in Lake Aleknagik probably represent a genetically distinct form of Salvelinus from other Lake Aleknagik Arctic char because of differences in gill raker and pyloric caecum counts. Tagging data also provides a basis for suggesting that there may be a genetic basis for this separation due to geographical segregation of the distribution of spawners.

CONCLUSIONS

1. Approximately 98% of the Arctic char that reside at the Agulowak River mouth during the summer home back to the Agulowak River mouth the following year, whereas, about 2% migrate to other feeding sites. Most of the Arctic char that migrate to the Agulowak River mouth stay at that feeding site throughout the smolt emigration period.
2. Approximately 50% of the Arctic char present at Youth and Sunshine Creeks in the fall are composed of fish that had migrated from the Agulowak River

mouth. No other spawning site had more than 10% Agulowak River mouth fish.

3. Most of the recaptured Arctic char found at the Agulowak River mouth that had originally been tagged at spawning sites were tagged at either Youth or Sunshine Creeks.
4. Most of the recaptured Arctic char found at Youth or Sunshine Creeks that had originally been tagged at any of the 21 documented spawning sites were originally tagged at Youth or Sunshine Creeks indicating homing to spawning sites.
5. The homing and migratory trends of Arctic char at the Agulowak River mouth feeding site and Youth and Sunshine Creek spawning sites have been confirmed by investigations in other Wood River lakes.
6. The Wood River Arctic char population is composed of many different sub-populations of which the Agulowak - Youth - Sunshine population complex is only one.

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