



DRAFT ADULT ANADROMOUS FISH
INVESTIGATIONS MAY - OCTOBER
1984 SUMMARY

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Attention: Mr. William J. Wilson
Principal Investigator

Subject: Susitna Hydroelectric Project
Review of ADF&G report on Adult
Anadromous Fish Investigation - 1984

Dear Mr. Wilson:

Enclosed for your review and comment is a draft copy of the summary of
the Adult Anadromous Fish Investigations report inadvertently omitted
from the previous transmittal.

Please return your comments to me by March 15, 1985.

Very truly yours,



Larry Gilbertson
Aquatic Group Leader

sdw

Enc: as noted

*Sinda - as you can see, this is
a part of an earlier report
WJD
to Sus*

ARLIS

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DRAFT
ADULT ANADROMOUS FISH INVESTIGATIONS

MAY - OCTOBER 1984

SUMMARY

by

Bruce M. Barrett

Frederick M. Thompson

Susan N. Wick

1985

ALASKA DEPARTMENT OF FISH AND GAME

SUSITNA HYDRO AQUATIC STUDIES

REPORT NO. 1

620 East 10th Avenue, Third Floor

Anchorage, Alaska 99501

for

Alaska Power Authority

334 W 5th Avenue, Second Floor

Anchorage, Alaska 99501

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SUMMARY

The annual combined escapements of sockeye, pink, chum and coho salmon to Yentna and Sunshine stations has ranged between 0.6 and 2.6 million fish from 1981 to 1983 (Figure 66). Most of the between year variation has been due to pink escapements which have averaged 15 times higher in the even years (1982-84) than in the odd (1981-83) years. An influence

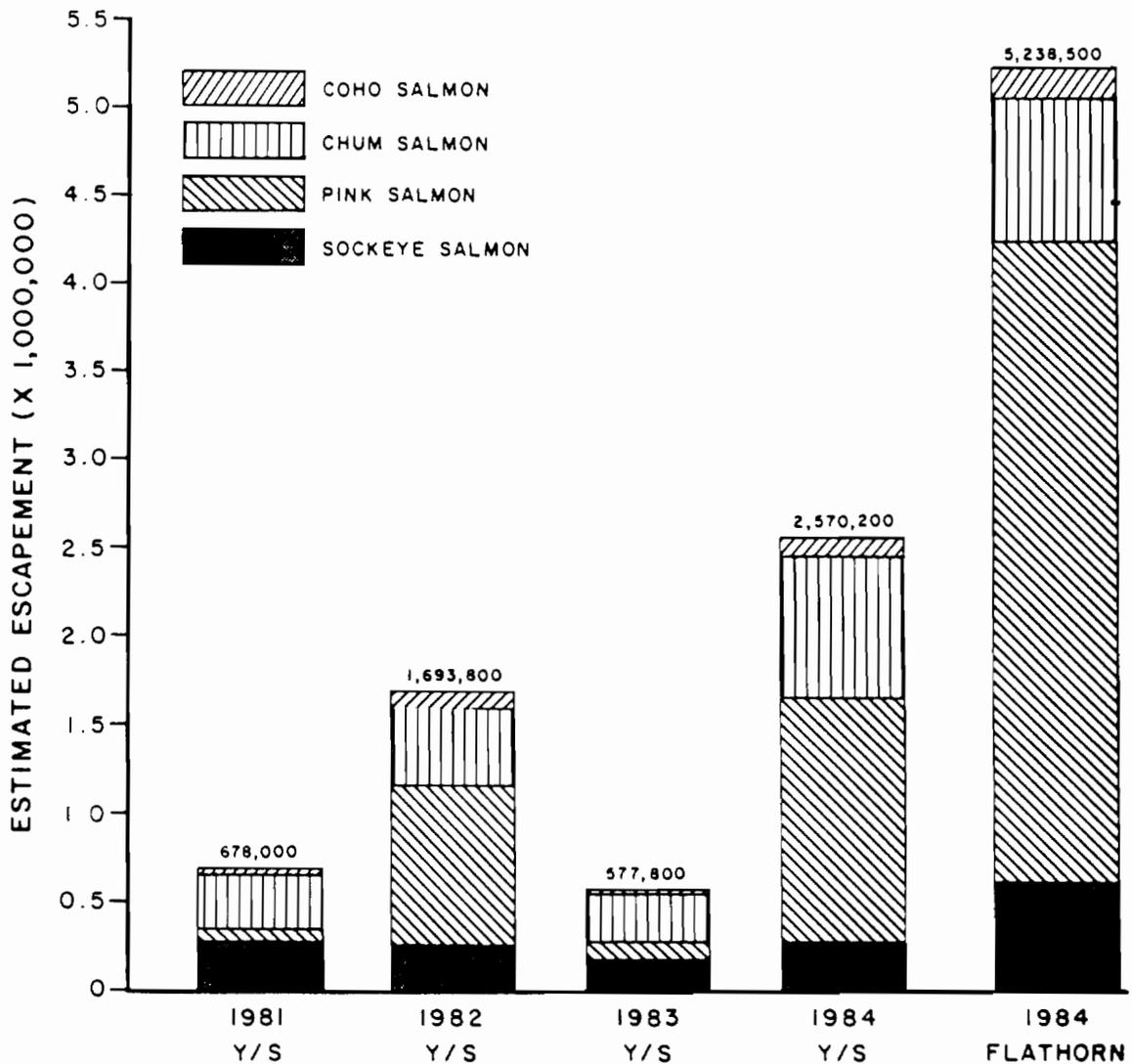


Figure 66. Susitna River sockeye, pink, chum and coho salmon escapements to the Yentna and Sunshine stations combined (Y/S) in 1981-84 and to Flathorn Station in 1984.

has also been an increase in chum escapements, particularly evident in 1984.

Monitoring of sockeye, pink, chum and coho salmon at Yentna and Sunshine stations, has provided a measure of the minimum or partial Susitna River escapement of these species (Figure 66). A better indication of total river escapement has been provided in 1984 by escapement monitoring at Flathorn Station located below all but two major spawning tributaries (Alexander and Fish creeks). The escapement for the four species at Flathorn Station in 1984 was approximately 5.2 million fish or about twice the combined same year escapement to Yentna and Sunshine stations. A comparison of the 1984 individual species escapements quantified at Flathorn, Yentna and Sunshine stations, indicate major spawning by sockeye, pink and coho occurred below Yentna and Sunshine stations, but only minor chum spawning.

Unlike the other four species, chinook have not been monitored at Yentna or Flathorn stations. The only monitoring in the lower reach has been at Sunshine Station with escapements being first quantified there in 1982. For this reason no estimate of the Susitna River chinook escapement is available. Based on drainage wide surveys since 1981, most of the chinook escapement is produced below Sunshine Station.

The balance of this section will cover, by species, 1981 through 1984 salmon investigations contracted to the ADF&G Su Hydro study team by the APA. Unless otherwise noted all references to 1981 through 1983 salmon data originate from the ADF&G, Phase I (1981), ADF&G, Phase II (1983) and Barrett et al. (1984) adult anadromous fish reports.

Chinook Salmon

Lower reach escapements at Sunshine Station have fluctuated between 52,900 and 121,700 fish and averaged 88,200 fish for the last three years (Figure 67 and Table 52). The escapement increases since 1982 may

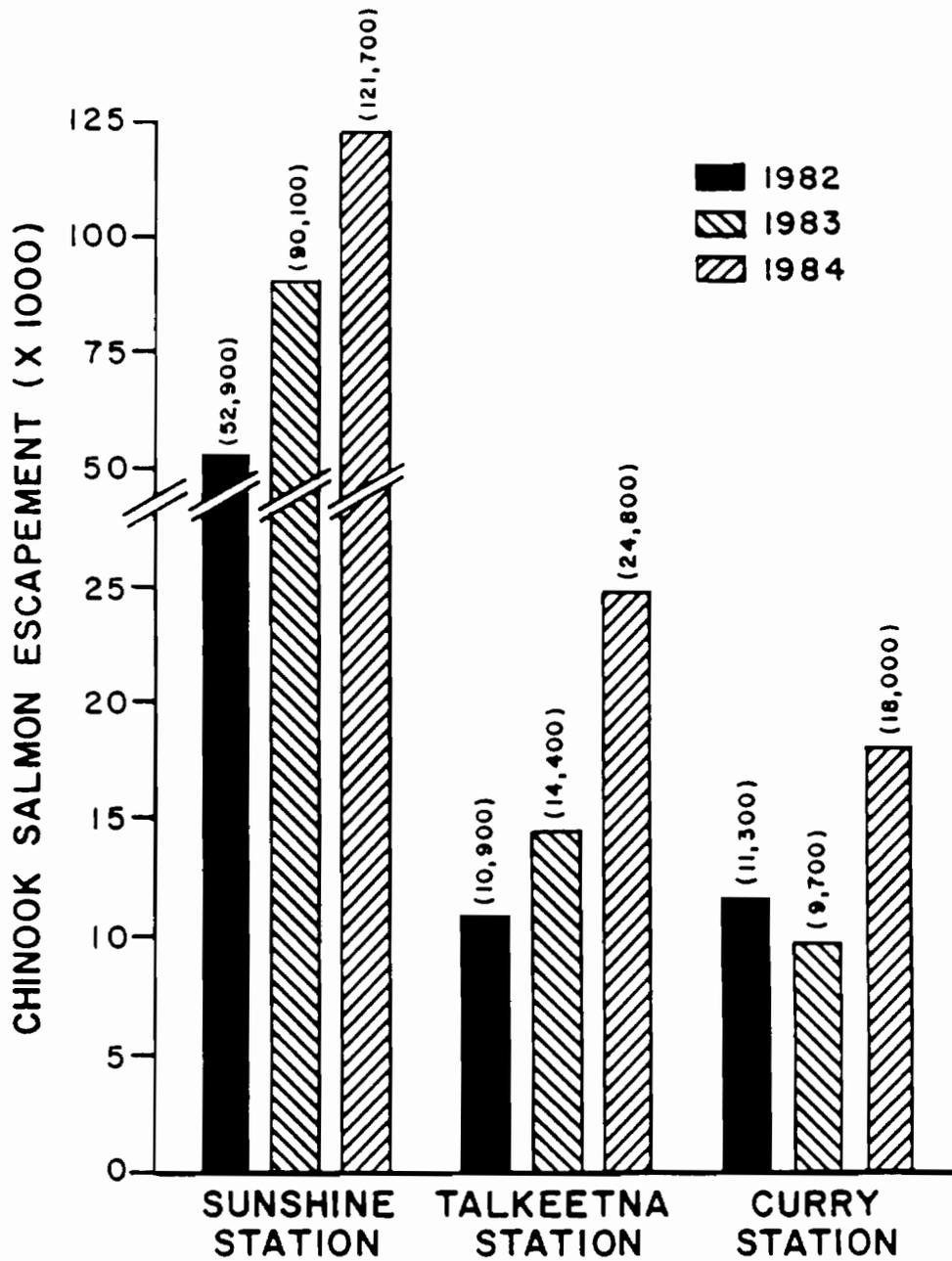


Figure 67. Minimum Susitna River chinook salmon escapements by station for 1982-84.

Table 52. Escapements by species and sampling locations for 1981-84.

Sampling Location	Year	Escapement ^{1/}					TOTAL	
		Chinook	Sockeye ^{2/}	Pink	Chum	Coho		
Flathorn Station	1984	<u>3/</u>	605,800	3,629,900	812,700	190,100	5,238,500	
Yentna Station	1981	<u>4/</u>	139,400	36,100	19,800	17,000	212,300	
	1982		113,800	447,300	27,800	34,100	623,000	
	1983		104,400	60,700	10,800	8,900	184,800	
	1984		149,400	369,300	26,500	18,200	563,400	
Sunshine Station	1981	<u>3/</u>	133,500	49,500	262,900	19,800	465,700	
	1982		52,900	151,500	443,200	45,700	1,123,700	
	1983		90,100	71,500	40,500	15,200	483,100	
	1984		121,700	130,100	1,017,000	765,000	94,700	2,128,500
Talkeetna Station	1981	<u>3/</u>	4,800	2,300	20,800	3,300	31,200	
	1982		10,900	3,100	73,000	49,100	5,100	141,200
	1983		14,400	4,200	9,500	50,400	2,400	80,900
	1984		24,800	13,100	177,900	98,200	11,800	325,800
Curry Station	1981	<u>3/</u>	2,800	1,000	13,100	1,100	18,000	
	1982		11,300	1,300	58,800	29,400	2,400	103,200
	1983		9,700	1,900	5,500	21,100	800	39,000
	1984		18,000	3,600	116,900	49,300	2,200	190,000

^{1/} Escapement estimates were derived from tag/recapture population estimates except Yentna Station escapements which were obtained using side scan sonar.

^{2/} Second run sockeye salmon escapements only.

^{3/} Chinook salmon were not monitored for escapement.

^{4/} Yentna Station side scan sonar equipment was not operational on the dates required to estimate the total Yentna River chinook salmon escapements for 1981-84.

be partly due to reduced foreign fishing in the Gulf of Alaska (pers. comm. K. Middleton, Middleton and Associates).

Middle reach escapements have also improved over the last three years (Figure 67). At Talkeetna Station the escapement has ranged from 10,900 to 24,800 fish and averaged 16,700 fish since 1982. At Curry Station escapement has ranged from 9,700 to 18,000 fish and averaged 13,000 fish. The 1984 escapements to these stations were about twice that of 1982 and 1983.

Some of the middle reach escapements in the last three years have included stray fish. For example, in 1984 about 45 and 24 percent of the respective Talkeetna and Curry stations escapements returned downstream and spawned in the lower reach, mainly in the Talkeetna and Chulitna river drainages. In the other years, there has also been less stray fish at Curry Station than at Talkeetna Station.

Chinook salmon have been abundant in the lower reach at Sunshine Station from the second week of June through the second week of July for the last three years (Figure 68). Peak abundance has normally occurred in the last two weeks of June. In the middle reach, fish have been abundant from the third week of June to the third week of July. The peak has usually occurred between the third and fourth weeks of June.

In 1984, chinook salmon migrating along the east and west banks at Sunshine Station were segregated with Chulitna River fish migrating almost entirely along the west bank, while Talkeetna River fish migrated mainly along the east bank. Middle reach fish were not segregated by bank, migrating past Sunshine Station nearly evenly off both banks.

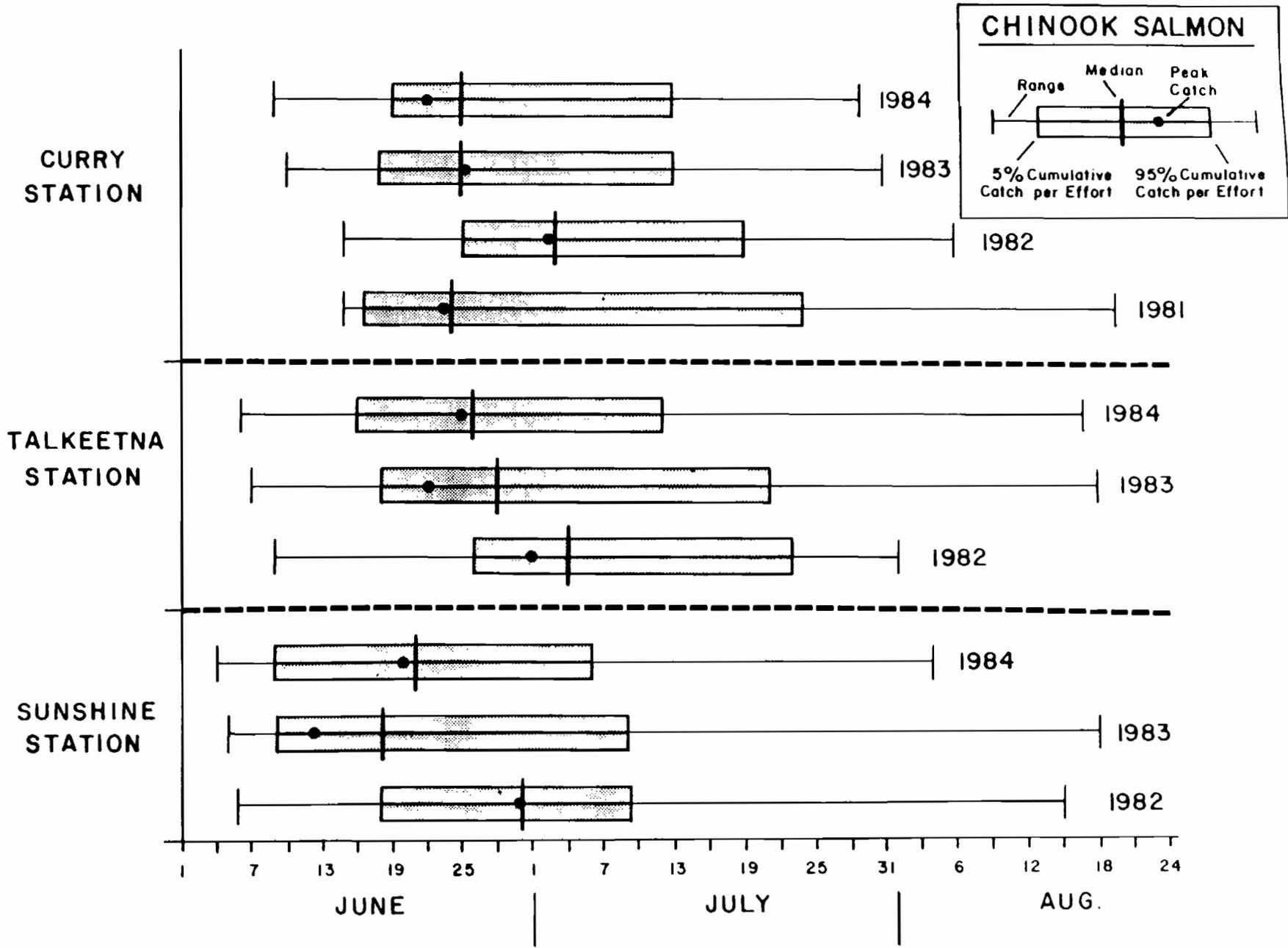


Figure 68. Migrational timing of chinook salmon based on fishwheel catch per unit effort at Sunshine, Talkeetna and Curry stations in 1981-84.

There was indication of a similar pattern in 1983. In the two previous years the sampling work at Sunshine Station did not differentiate specific populations.

In the lower and middle reach, chinook responded to high flows by slowing upstream migration. In 1984, a peak high water discharge of 93,000 cfs, measured by USGS at the Parks Highway Bridge (RM 83), resulted in a sharp catch reduction in the Sunshine Station fishwheels. The same flow event coincided with similar catch reductions at Talkeetna and Curry stations. In 1981 and 1982, radio tagged fish delayed migration at high flows.

...

Chinook migrated slower in the lower reach above Sunshine Station than in the middle reach between Talkeetna and Curry stations for the last three years (Table 53). The slower migration may be associated with

Table 53. Migration rates of chinook salmon between sampling stations, based on fishwheel tag recoveries.

Tagging Station Year	Recapture Station			
	Talkeetna		Curry	
	Days <u>1/</u>	Mpd <u>2/</u>	Days	Mpd
Sunshine				
1982	10.0	2.3	12.0	3.3
1983	13.0	1.8	12.0	3.3
1984	7.0	3.3	11.0	3.6
Talkeetna				
1982			6.0	2.8
1983			6.0	3.8
1984			4.0	4.3

1/ Days = number of days between captures.

2/ Mpd = miles per day. This value is based on the median number of days between captures.

milling in the confluence area of the Talkeetna and Chulitna rivers.

For the last four years, lower and middle reach chinook escapements have included fish ranging in age from three to seven years old (Table 54). Six year old fish routinely have been dominant with males more abundant than females (Table 55). The higher proportion of males has been partially due to an abundance of three year old male fish. Fish lengths have averaged from 602 to 816 mm (Table 55). The longest lengths were in 1984, attributable to more older fish than in the three previous years.

There has been no evidence of chinook spawning in the lower or middle reaches of the Susitna River mainstem or associated sloughs from 1981 through 1984. All spawning has occurred in streams. The stream mouths in the lower reach are used for passage only, while in the middle reach, many are both spawning and passage areas. In 1984 there was spawning at the mouths of Whiskers Creek, Fourth of July Creek, Indian River, Portage Creek, Cheechako Creek and Chinook Creek.

In the middle reach there has been about a 70 percent annual increase in stream escapements over the last four years (Table 56). Most of the increase has been in Indian River and Portage Creek. These streams support 95 percent of the spawning.

Table 54. Analysis of chinook salmon age data by percent from escapement samples collected at Sunshine, Talkeetna and Curry stations in 1981-84.

LOCATION	YEAR	AGE GROUP					BROOD YEAR								
		3	4	5	6	7	74	75	76	77	78	79	80	81	
SUNSHINE STATION	1981	27.6	31.9	23.1	16.9	0.5	0.5	16.9	23.1	31.9	27.6	-	-	-	
	1982	15.1	27.4	20.9	36.2	0.4	-	0.4	36.2	20.9	27.4	15.1	-	-	
	1983	1.5	3.9	39.0	45.0	10.6	-	-	10.6	45.0	39.0	3.9	1.5	-	
	1984	7.1	5.2	18.2	44.8	24.7	-	-	-	24.7	44.8	18.2	5.2	7.1	
TALKEETNA STATION	1981	15.8	29.8	21.4	30.1	2.9	2.9	30.1	21.4	29.8	15.8	-	-	-	
	1982	20.7	35.8	20.6	22.3	0.6	-	0.6	22.3	20.6	35.8	20.7	-	-	
	1983	22.5	9.4	34.0	27.9	6.2	-	-	6.2	27.9	34.0	9.4	22.5	-	
	1984	1.1	4.9	17.8	47.7	28.5	-	-	-	28.5	47.7	17.8	4.9	1.1	
CURRY STATION	1981	18.5	34.3	27.8	19.4	0	0	19.4	27.8	34.3	18.5	-	-	-	
	1982	17.0	29.3	22.4	30.8	0.5	-	0.5	30.8	22.4	29.3	17.0	-	-	
	1983	9.4	3.9	24.4	43.5	18.8	-	-	18.8	43.5	24.4	3.9	9.4	-	
	1984	10.7	6.0	13.3	40.6	29.4	-	-	-	29.4	40.6	13.3	6.0	10.7	

Table 55. Male to female chinook salmon ratios and average mean lengths from Sunshine, Talkeetna and Curry stations for 1981-84.

LOCATION	YEAR							
	1981		1982		1983		1984	
	Sex Ratio (M:F)	Average Mean Length (mm)	Sex Ratio (M:F)	Average Mean Length (mm)	Sex Ratio (M:F)	Average Mean Length (mm)	Sex Ratio (M:F)	Average Mean Length (mm)
SUNSHINE STATION	3.5:1	602	1.2:1	707	1.2:1	761	1.1:1	765
TALKEETNA STATION	2.7:1	711	2.3:1	642	2.4:1	626	1.0:1	816
CURRY STATION	1.9:1	668	1.5:1	725	1.4:1	743	1.3:1	801

Table 56. Peak survey counts and percent distribution of chinook salmon in streams above RM 98.6 in 1981-84.

Stream	River Mile	1981		1982		1983		1984		Average % Distribution
		Peak Count 1/	% Distri- bution							
Whiskers Creek	101.4	-	-	0	0	3	0.1	67	0.9	0.6
Chase Creek	106.9	-	-	15	0.6	15	0.3	3	*	0.4
Lane Creek	113.6	40	3.6	47	1.9	12	0.3	23	0.3	0.8
5th of July Cr.	123.7	-	-	3	0.1	0	0	17	0.2	0.2
Sherman Creek	130.8	-	-	3	0.1	0	0	0	0	*
4th of July Cr.	131.1	-	-	56	2.3	6	0.1	92	1.3	1.3
Gold Creek	136.7	-	-	21	0.9	23	0.5	23	0.3	0.6
Indian River	138.6	422	37.6	1,053	42.6	1,193	26.9	1,456	20.3	26.8
Jack Long Creek	144.5	-	-	2	0.1	6	0.1	7	0.1	0.1
Portage Creek	148.9	659	58.8	1,253	50.7	3,140	70.9	5,446	75.9	68.3
Cheechako Creek	152.5	-	-	16	0.7	25	0.6	29	0.4	0.6
Chinook Creek	156.8	-	-	5	0.2	8	0.2	15	0.2	0.2
Devil Creek	161.0	-	-	0	0	1	*	0	0	*
Fog Creek	176.1	-	-	0	0	0	0	2	*	*
TOTALS ^{2/}		1,121	100.0%	2,474	100.2%	4,432	100.0%	7,180	99.9%	99.9%

1/ Peak count includes live plus dead fish.

2/ Percent distribution totals may not equal 100 due to rounding errors.

* Trace

Sockeye Salmon

First run

First run sockeye salmon escapements at Sunshine Station have been approximately 5,800 fish in 1982, 3,300 fish in 1983 and 4,800 fish in 1984. These are estimates of spawners in the inlet stream of Papa Bear Lake, the only known spawning area above Sunshine Station.

First run fish have been abundant in the lower river at Sunshine Station from the first through the third weeks of June for the last three years (Figure 69). Most of the migration has been along the east bank. First run fish stray into the middle river as far as Talkeetna Station but return to the inlet stream of Papa Bear Lake to spawn.

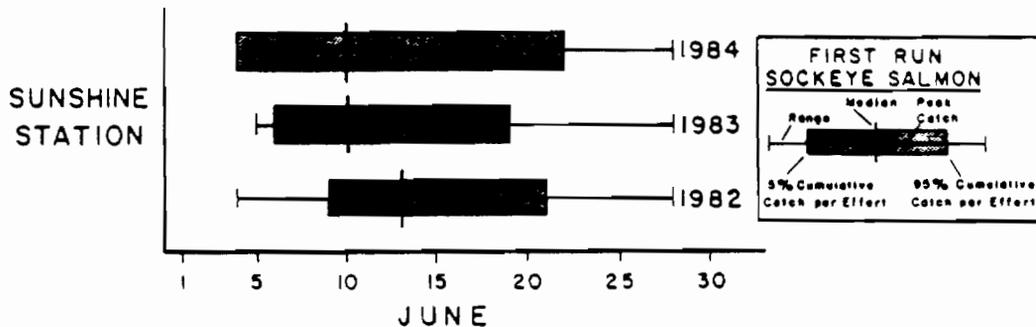


Figure 69. Migrational timing of first run sockeye salmon based on fishwheel catch per unit effort at Sunshine Station in 1982-84.

First run fish have ranged in age from four to six years old with the highest percentage being five year olds (Table 57). Nearly all the returning fish had spent a year in freshwater prior to going to sea. The average fish lengths have been 535 mm in 1982, 515 mm in 1983 and 531 mm in 1984 and the respective male to female ratios: 0.6:1, 1.3:1 and 0.5:1 (Table 58).

Table 57. Analysis of sockeye salmon age data by percent from escapement samples collected at Flathorn, Yentna, Sunshine, Talkeetna and Curry stations in 1981-84.

Location	Year	AGE GROUP					BROOD YEAR								
		3	4	5	6	7	74	75	76	77	78	79	80	81	
Flathorn Station	1984	6.8	46.0	45.7	1.5	0					0	1.5	45.7	46.0	6.8
Yentna Station	1981	0.8	8.6	86.2	4.4	0	0	4.4	86.2	8.6	0.8				
	1982	3.9	28.5	56.7	10.9	0		0	10.9	56.7	28.5	3.9			
	1983	5.1	68.1	24.9	1.9	0			0	1.9	24.9	68.1	5.1		
	1984	1.5	25.6	66.1	6.8	0				0	6.8	66.1	25.6	1.5	
Sunshine Station	1981 ^{1/}	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1982	0	6.4	89.5	4.1	0		0	4.1	89.5	6.4	0			
	1st run 1983	0	26.9	72.1	1.0	0			0	1.0	72.1	26.9	0		
	1984	0	3.3	96.4	0.3	0				0	0.3	96.4	3.3	0	
2nd run	1981	1.1	22.2	72.8	3.9	0	0	3.9	72.8	22.2	1.1				
	1982	3.1	23.8	70.6	2.3	0.2		0.2	2.3	70.6	23.8	3.1			
	1983	0.1	64.0	35.5	0.4	0			0	0.4	35.5	64.0	0.1		
	1984	4.2	62.5	32.6	0.7	0				0	0.7	32.6	62.5	4.2	
Talkeetna Station	1981	0	24.5	71.9	3.6	0	0	3.6	71.9	24.5	0				
	1982	4.3	23.3	71.6	0.8	0		0	0.8	71.6	23.3	4.3			
	1983	4.4	55.8	39.8	0	0			0	0	39.8	55.8	4.4		
	1984	1.1	83.9	14.6	0.4	0				0	0.4	14.6	83.9	1.1	
Curry Station	1981	0.7	28.5	69.3	1.5	0	0	1.5	69.3	28.5	0.7				
	1982	22.9	39.9	37.2	0	0		0	0	37.2	39.9	22.9			
	1983	6.7	72.1	21.2	0	0			0	0	21.2	72.1	6.7		
	1984	3.8	72.6	22.6	1.0	0				0	1.0	22.6	72.6	3.8	

^{1/} Sunshine Station was not operational until after passage of first run sockeye.

Table 58. Male to female sockeye salmon ratios and average mean lengths from Flathorn, Yentna, Sunshine, Talkeetna and Curry stations in 1981-84.

Location	YEAR							
	1981		1982		1983		1984	
	Sex Ratio (M:F)	Average Mean Length (mm)	Sex Ratio (M:F)	Average Mean Length (mm)	Sex Ratio (M:F)	Average Mean Length (mm)	Sex Ratio (M:F)	Average Mean Length (mm)
Flathorn Station	-	-	-	-	-	-	1.5:1	519
Yentna Station	1.2:1	580	2.1:1	532	1.5:1	494	0.9:1	535
Sunshine Station								
Run 1	1/	1/	0.6:1	535	1.3:1	515	0.5:1	531
Run 2	1.0:1	554	0.9:1	550	0.9:1	506	0.7:1	512
Talkeetna Station	0.6:1	548	1.3:1	548	1.6:1	509	0.7:1	513
Curry Station	0.8:1	549	2.1:1	466	1.6:1	484	1.4:1	495

1/ Sunshine Station was not operational until after the first run had passed RM 80.

Second Run

Second run sockeye salmon escapements in the lower river have averaged 126,800 fish to Yentna Station and 121,700 fish to Sunshine Station for the last four years (Figure 70 and Table 52). Combined escapements to these stations have ranged from 175,900 to 279,500 fish and averaged 248,400 fish (Figure 71). The 1984 combined escapement was the highest on record at 279,500 fish. The escapement at Flathorn Station in 1984 was over twice this at 605,800 fish. This indicates a major segment of the Susitna River escapement spawned below Yentna and Sunshine stations in 1984. Known spawning areas downstream of Sunshine Station include the Fish Creek, Alexander Creek, Whitso1 Lake and Deshka River drainages. It is possible that a portion of the Flathorn Station

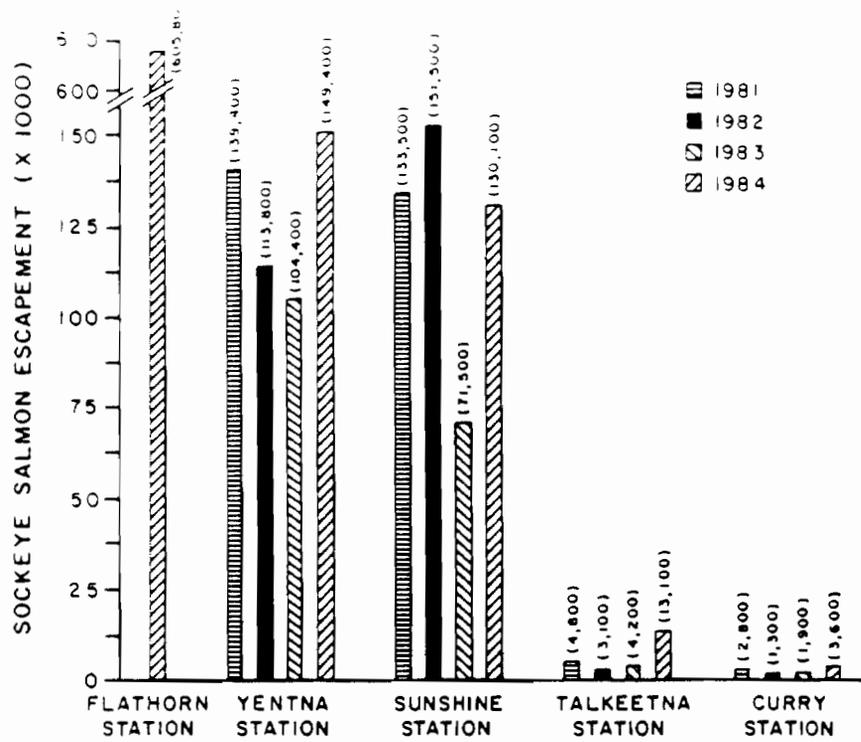


Figure 70. Minimum Susitna River sockeye salmon escapements by station for 1981-84.

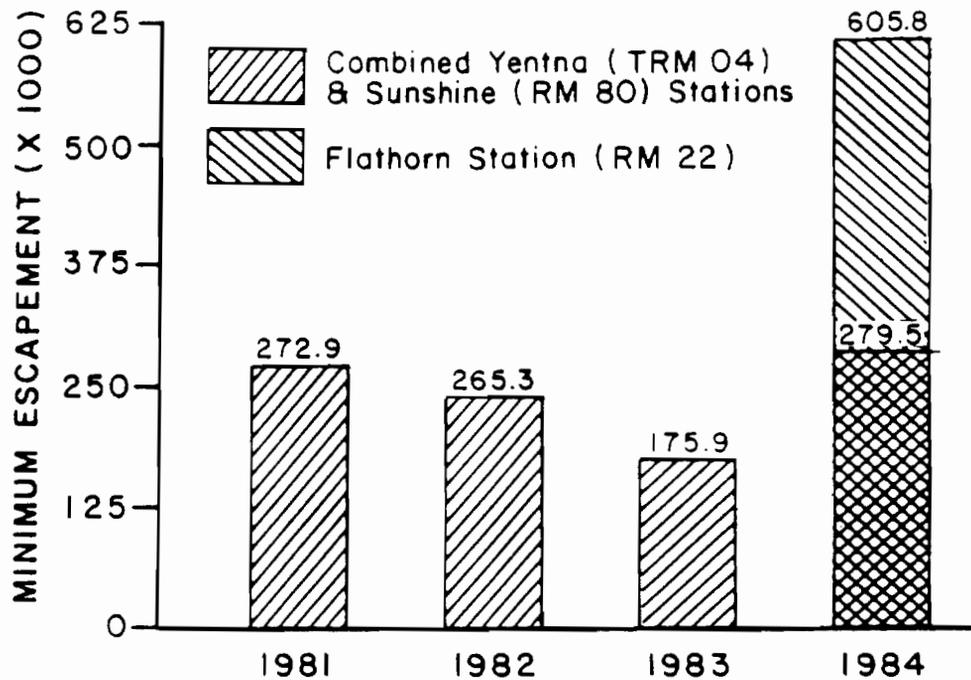


Figure 71. Minimum 1981-84 Susitna River sockeye salmon escapements based on population estimates at Flathorn, Yentna and Sunshine stations.

escapement spawned below this station based on the straying that occurs at other stations. The major spawning area below Yentna and Sunshine stations is in the Fish Creek drainage which enters the Susitna River about 14 miles downstream of Flathorn Station.

Middle river sockeye escapements measured at Talkeetna Station the last four years have ranged from 3,100 to 13,100 fish with a 6,300 fish average (Figure 70). At Curry Station, the range has been 1,300 to 3,200 fish with a 2,400 fish average. The escapements to these stations in 1984 were the highest on record.

Most of the fish that reached Talkeetna Station for the last four years have been strays that spawned downstream, primarily in the Talkeetna and Chulitna river drainages. About 46 percent in 1981, 48 percent in 1982, 38 percent in 1983 and 17 percent in 1984 of the Talkeetna Station escapement spawned in the middle reach. Less straying occurred at Curry Station. Approximately 79 percent in 1981, 100 percent in 1982, 84 percent in 1983 and 62 percent in 1984 of the Curry Station escapement were fish that spawned in the middle reach. The balance were stray fish.

Sockeye have been abundant in the lower reach annually between the second week of July and the second week of August the last four years (Figure 72). The peak has normally occurred around the fourth week of July. In the middle river, fish have been abundant from the third week of July to the fourth week of August. The peak has been between the last week of July and the first week of August.

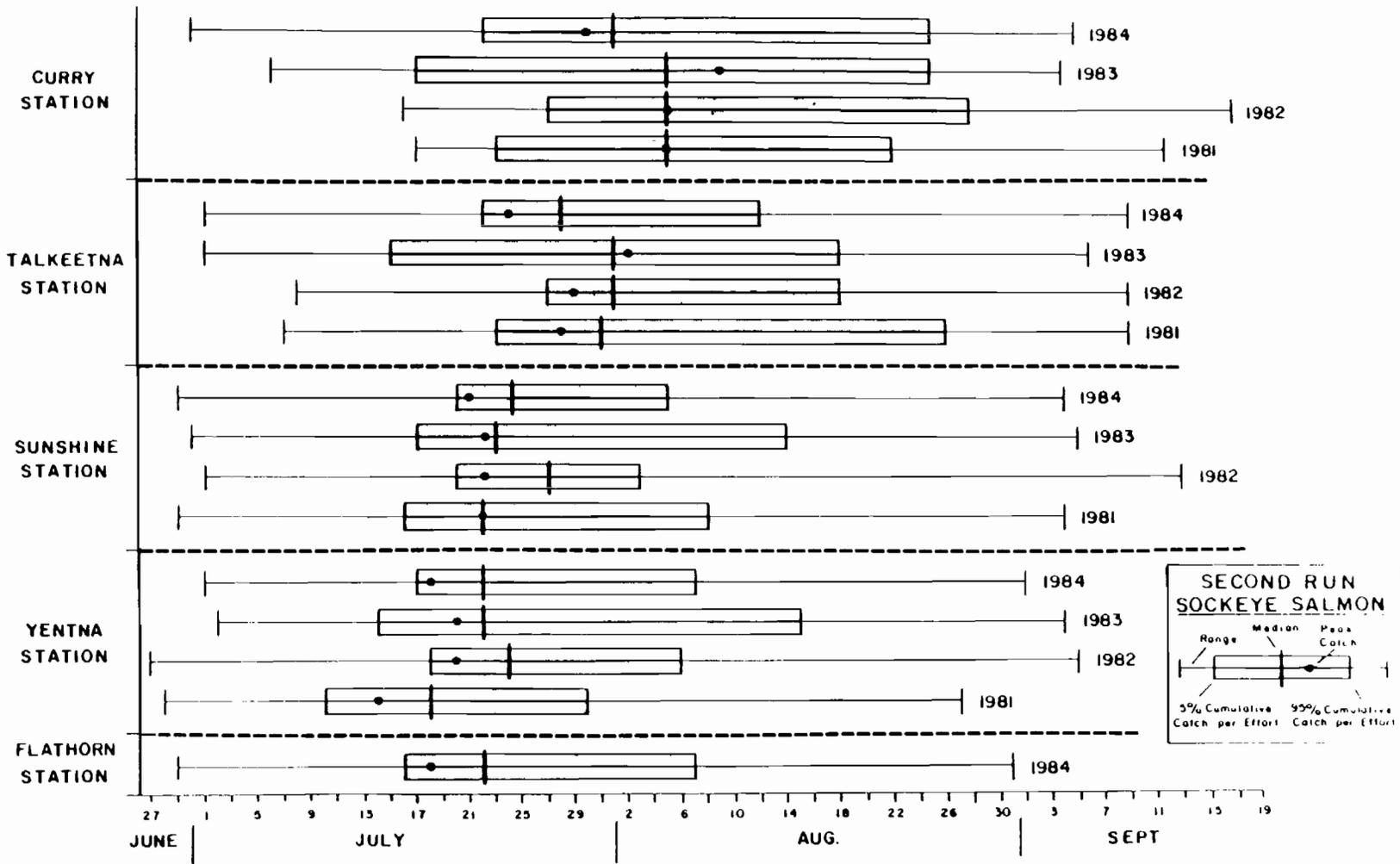


Figure 72. Migrational timing of second run sockeye salmon based on fishwheel catch per unit effort at selected stations in 1981-84.

In 1984, the majority of the escapement destined to Yentna and Sunshine stations passed Flathorn Station through the east channel. During all four years at Yentna and Sunshine stations, most of the migrating fish have passed along the south and east banks. In the middle river at Talkeetna Station the fish have been about evenly split between the east and west banks, while at Curry Station most of the fish have been along the east bank.

Migration speeds have been generally slower in the lower reach than in the middle reach for the last four years (Table 59). Presumably most of the slower travel speeds have been associated with straying and or

Table 59. Migration rates of sockeye salmon between sampling stations, based on fishwheel tag recoveries.

Tagging Station Year	Recapture Station <u>1/</u>								
	Yentna		Sunshine		Talkeetna		Curry		
	Days <u>2/</u>	Mpd <u>3/</u>	Days	Mpd	Days	Mpd	Days	Mpd	
Flathorn									
1984	3	3.3	8	7.3	11	7.4	14	7.0	
Sunshine									
1981					9.0	2.6	14.0	2.9	
1982					9.0	2.6	11.0	3.6	
1983					9.0	2.6	9.0	4.4	
1984					4.0	5.8	7.0	5.7	
Talkeetna									
1981							7.0	2.4	
1982							2.0	8.5	
1983							6.0	2.8	
1984							2.0	8.5	

1/ Dash denotes insufficient sample size to determine migration rates.

2/ Days = number of days between captures.

3/ Mpd = miles per day. This value is based on the median number of days between captures.

milling particularly at the Yentna and Susitna rivers confluence and the Talkeetna, Susitna and Chulitna rivers confluence.

Lower and middle river sockeye escapements for the last four years have included fish ranging in age from three to seven years old (Table 57). Most of the fish have been four and five years old. Nearly all sockeye in both reaches had smolted in their second year of life. Fish lengths have averaged between 466 and 580 mm (Table 58). Generally, males have been more abundant than females in both reaches (Table 58).

Sockeye fecundity was estimated at 3,350 eggs/female based on a 1983 study. This represents about 350 eggs less than the mean fecundity of North American stocks reported by Hart (1973).

There has been no evidence of spawning in the Susitna River lower mainstem including side channels in the last four years. In addition, stream mouths and sloughs which were surveyed only in 1984, were not spawning areas.

In the middle reach mainstem for two of the last four years there has been minor spawning. Eleven fish were observed spawning at one site in 1983 and 33 fish at seven other sites in 1984. The total number of mainstem spawners in 1983 and 1984 was probably in the range of 35 and 100 fish, respectively, assuming about one-third of the spawners were present at the time the highest counts were recorded. Streams in the middle reach also had little or no spawning habitat value in the last four years. Only one pair of spawning fish was observed in 1984, and that was at the mouth of Portage Creek.

Essentially all spawning in the middle reach has occurred in sloughs (Table 60). Since 1981, three sloughs have supported approximately 90 percent of the spawning. These have been sloughs 11, 8A and 21. Peak spawning in sloughs has normally occurred around the second week of September.

Table 60. Peak survey counts and percent distribution of second run sockeye salmon in sloughs above RM 98.6 in 1981-84.

Slough	River Mile	1981		1982		1983		1984		Average % Distribution
		Peak Count <u>1/</u>	% Distribution							
1	99.6	0	0	0	0	0	0	10	1.1	0.3
2	100.2	0	0	0	0	0	0	7	0.8	0.2
3B	101.4	1	0.1	0	0	5	0.9	20	2.2	0.8
3A	101.9	7	0.5	0	0	0	0	11	1.2	0.5
5	107.6	0	0	0	0	0	0	1	0.1	*
6A	112.3	1	0.1	0	0	0	0	0	0	*
8	113.7	0	0	0	0	0	0	2	0.2	0.1
8C	121.9	0	0	2	0.3	0	0	0	0	0.1
8B	122.2	0	0	5	0.8	0	0	1	0.1	0.2
Moose	123.5	0	0	8	1.3	22	4.0	8	0.9	1.1
8A	125.4	177	14.3	68	11.2	66	11.9	128	13.8	13.2
8	126.3	-	-	8	1.3	2	0.3	9	1.0	0.8
9	128.3	10	0.8	5	0.8	2	0.3	6	0.6	0.7
9B	129.2	81	6.5	1	0.2	0	0	7	0.8	2.7
9A	133.8	2	0.1	1	0.2	1	0.2	0	0	0.1
10	133.8	0	0	0	0	1	0.2	0	0	*
11	135.3	893	72.0	456	75.2	248	44.7	564	61.0	64.8
15	137.2	0	0	0	0	0	0	1	0.1	*
17	138.9	6	0.5	0	0	6	1.1	16	1.7	0.8
19	139.7	23	1.9	0	0	5	0.9	11	1.2	1.2
20	140.0	2	0.1	0	0	0	0	0	0	0.1
21	141.1	38	3.1	53	8.7	197	35.5	122	13.2	12.3
22	144.5	-	-	-	-	0	0	2	0.2	0.1
Totals <u>2/</u>		1,241	100%	607	100%	555	100%	926	100.2%	100.1%

1/ Peak count includes live plus dead fish.

2/ Percent distribution totals may not equal 100 due to rounding errors.

* Trace

In 1983 and 1984, sockeye salmon were monitored at several middle reach sloughs for observation life. The average time from slough entry to mortality or departure was 11.8 days/fish in 1983 and 8.4 days/fish in 1984.

Sockeye escapements to middle reach sloughs have been about 2,100 fish in 1981, 1,500 fish in 1982, 1,600 fish in 1983 and 2,200 fish in 1984. These numbers were calculated using two years of observation life data and four years of live fish counts.

In 1983 and 1984, female fish were examined for egg retention at several middle reach sloughs. The average was 249 eggs/female in 1983 and 64 eggs/female in 1984. Barrett in 1974 reported a positive correlation between egg retention and spawner density. This was not apparent in the last two years. Slough escapement was about 40 percent higher in 1984 than in 1983, but egg retention was about three times lower in 1984 than in 1983.

Pink Salmon

The 1984 pink salmon escapement to Flathorn Station was about 3,629,900 fish, which was 60 percent higher than the combined, same year escapement to Yentna and Sunshine stations. Since 1981, combined Yentna and Sunshine stations escapements have averaged 93,400 fish in the odd years and 1,138,400 fish in the even years (Figure 73). The escapement to Yentna and Sunshine stations have been generally within 30 percent of each other except in 1984 due to a higher than average escapement to Sunshine Station.

In the middle river at Talkeetna Station odd year pink salmon escapements have averaged 5,900 fish, while even year escapements have averaged 125,500 over the last four years (Table 52 and Figure 74). Average odd and even year escapements at Curry Station have been 3,300

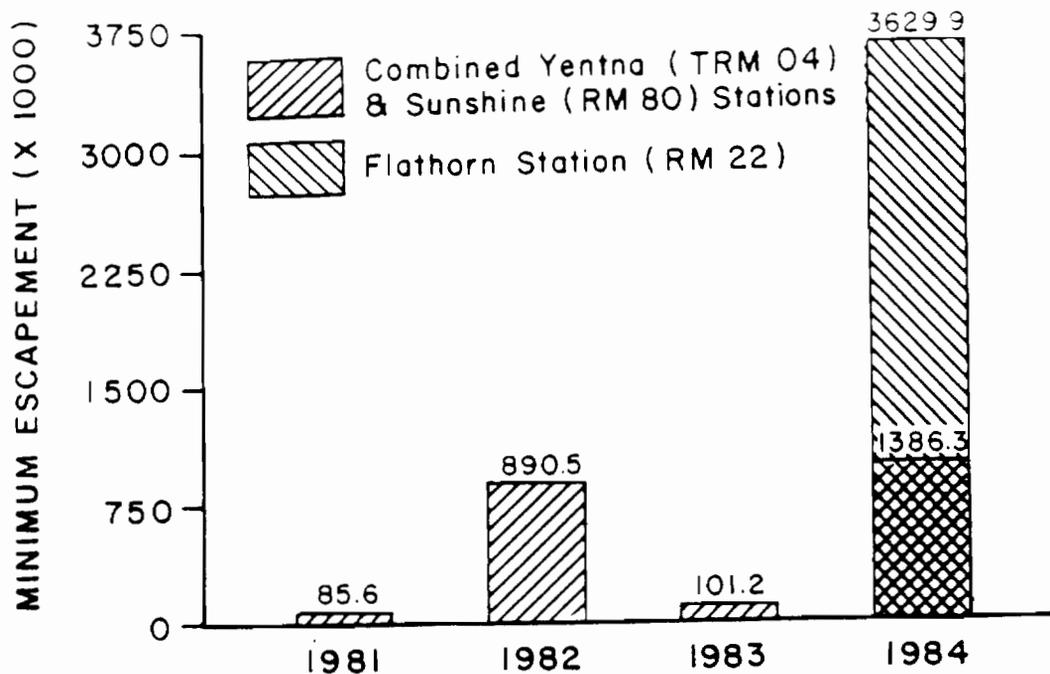


Figure 73. Minimum 1981-84 Susitna River pink salmon escapements based on population estimates at Flathorn, Yentna and Sunshine stations.

and 87,900 fish. At both stations, the 1984 escapement was about twice the previous even year escapement.

Most of the pink salmon entering the middle river reach have been stray fish at least in 1984. Based on spawning ground surveys about 85 and 80 percent of the fish reaching Talkeetna and Curry stations, respectively were strays.

The lower reach below Sunshine Station produces most of the pink salmon escapement. In 1984 about 10 percent of the escapement reaching Flathorn Station spawned in the Yentna River drainage, 60 percent in the lower reach between the Yentna River and Sunshine Station and 30 percent

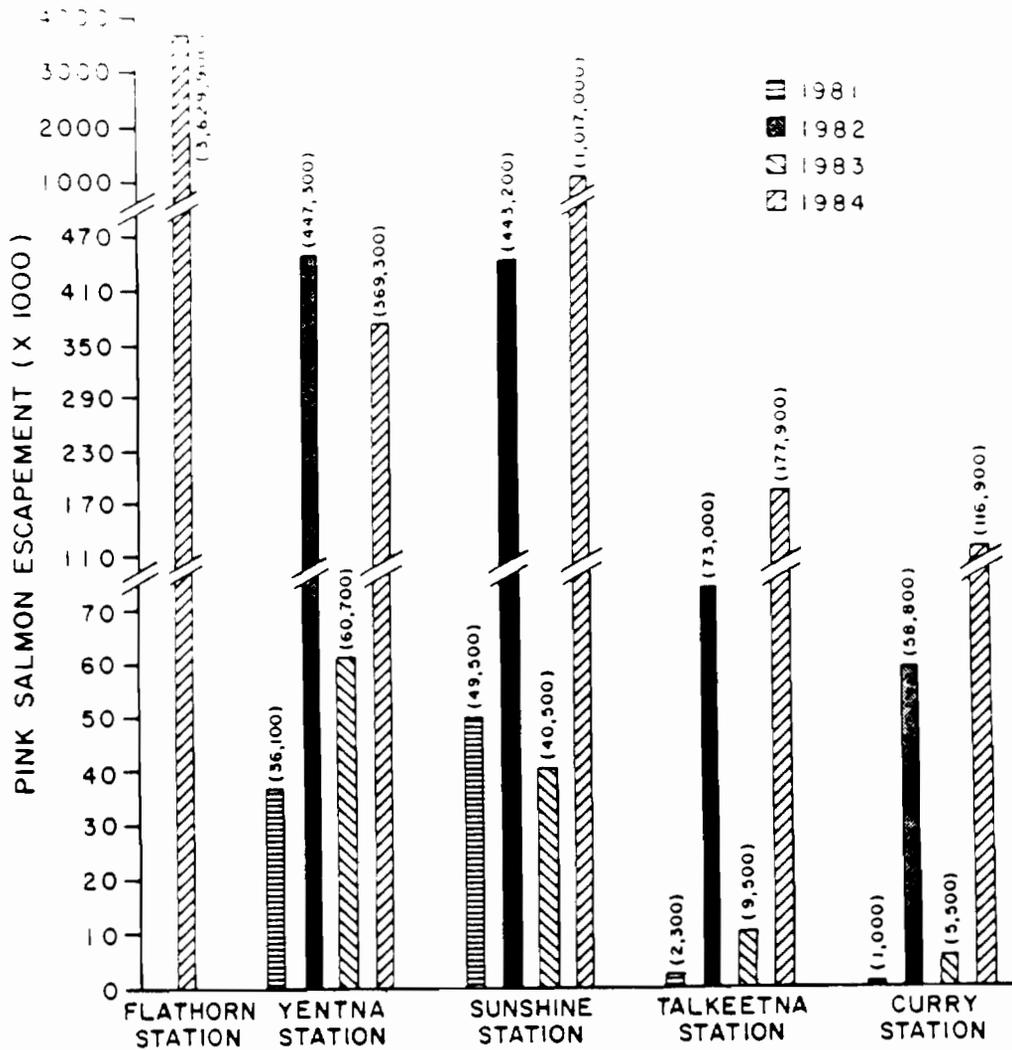


Figure 74. Minimum Susitna River pink salmon escapements by station for 1981-84.

above Sunshine Station. These are approximate values because a portion of the escapement reaching Flathorn Station probably spawned below this site, primarily in Alexander Creek.

Pink salmon have been abundant in the lower river from the second week of July to the third week of August in odd years and from the fourth week of July to the second week of August in even years (Figure 75). In the middle river fish have been abundant from the last week of July to the third week of August in odd years and from the last week of July to the second week of August in even years.

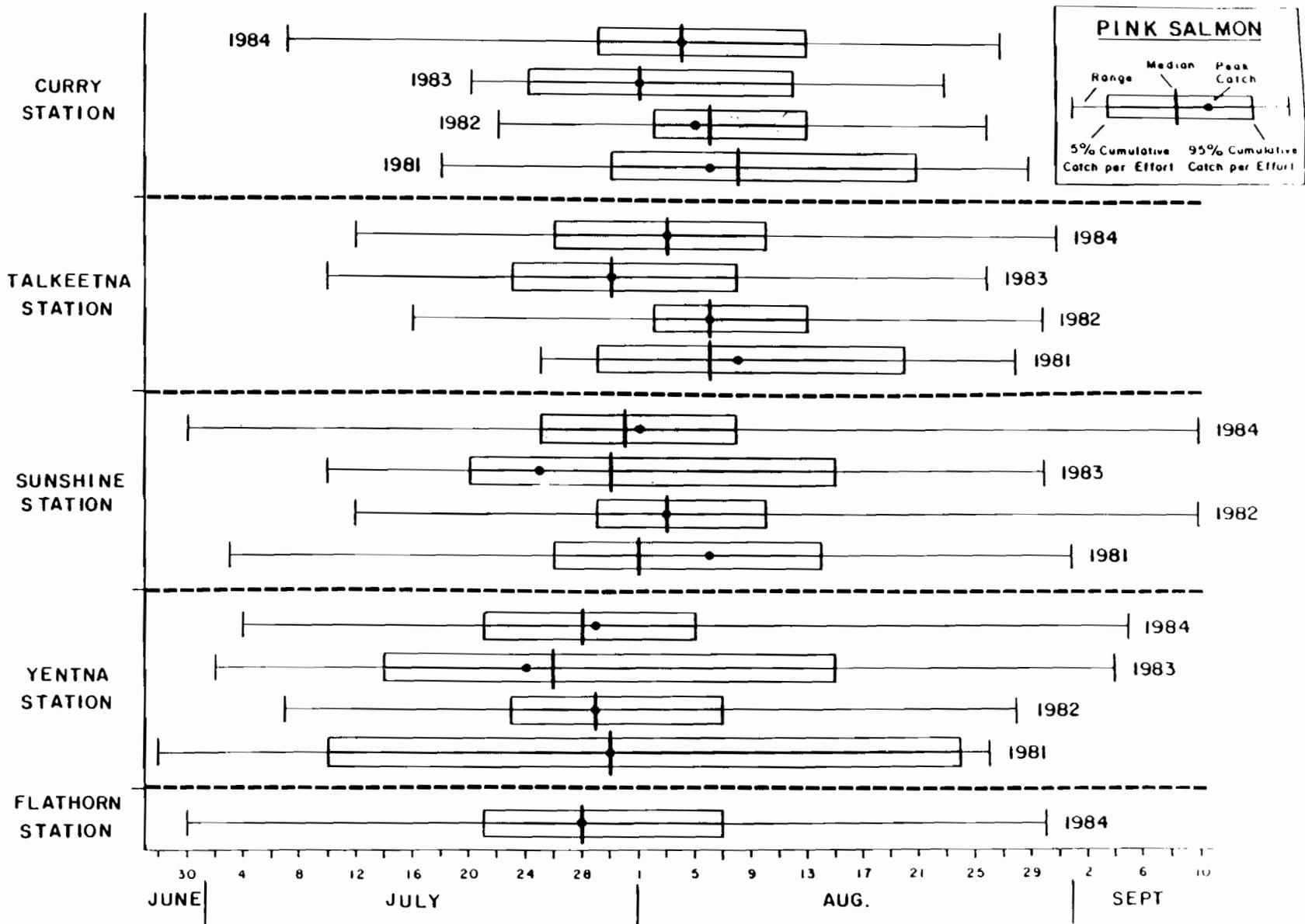


Figure 75. Migrational timing of pink salmon based on fishwheel catch per unit effort at selected stations in 1981-84.

In the lower river at Flathorn Station most of the fish migrated in the east channel in 1984. In the last four years at Yentna and Sunshine stations, most of the fish have traveled mainly off the south and east banks. In the middle river the fish have traveled predominantly off the east bank at both Talkeetna and Curry stations.

Recovery of pink salmon tagged at Flathorn Station in 1984 indicate Yentna River fish were evenly distributed in the east and west channels at Flathorn Station, whereas the fish destined to Sunshine Station migrated mainly in the east channel.

Pinks traveled at a slower rate between Flathorn and Yentna stations than between Flathorn and Sunshine stations (Table 61). This was probably due to straying and or milling in the Susitna and Yentna rivers confluence. In the middle river pink salmon have migrated slower between Sunshine and Talkeetna stations than between Talkeetna and Curry stations during the last four years. This was probably due to more milling or straying in the confluence areas of the Talkeetna, Susitna and Chulitna rivers. For the last four years, in even years pink salmon have migrated slower than in odd years.

No age information has been collected for the past four years on pink salmon because pinks are almost exclusively two year old fish. Fish lengths in both the lower and middle reaches have averaged from 419 to 474 mm with no major differences occurring between odd and even years (Table 62). Between and within year length variation may be due to ocean growth as pinks have essentially no freshwater rearing.

Generally, males have been slightly more abundant than females in both reaches with no major distinction between odd and even years (Table 62).

Susitna River pink salmon fecundities were calculated by regression analysis from a sample collected at Sunshine Station in 1983. The mean fecundity was 1,350 eggs/female which is within the range (900-2,000) reported by Morrow (1980).

Since 1981, there has been no confirmed spawning in the middle or lower reach mainstem. However, possible spawning may have occurred in 1984 at RM 119.1 based on a report from E. Woody Trihey and Associates.

Sloughs in the lower reach, above the Yentna River confluence, do not support spawning based on 1984 surveys. In the middle reach, minor spawning has occurred in sloughs for the last four years except in 1983 when there was no slough spawning. The primary spawning has been at sloughs 11, 8A and 20 (Table 63). Total spawning escapement has been 38 fish in 1981, 297 fish in 1982 and 647 fish in 1984.

In the lower reach, above the Yentna River confluence, pink salmon spawned in the mouths of 10 streams, based on 1984 surveys. Nearly all the spawning occurred at the mouths of Willow, Birch and Sunshine creeks.

Several thousand fish spawn in stream mouths above the Yentna River confluence in the relatively high even year escapements. In the middle river, pink salmon spawned in nine of the 22 stream mouths surveyed in

Table 61. Migration rates of pink salmon between sampling stations, based on fishwheel tag recoveries.

Tagging Station Year	Recapture Station ^{1/}							
	Yentna		Sunshine		Talkeetna		Curry	
	Days ^{2/}	Mpd ^{3/}	Days	Mpd	Days	Mpd	Days	Mpd
Flathorn 1984	2.0	5.0	6.0	9.7	10.0	8.1	11.0	8.9
Sunshine 1981					9.0	2.6	-	-
1982					3.0	7.7	4.0	10.0
1983					4.0	5.8	4.0	10.0
1984					3.0	7.7	4.0	10.0
Talkeetna 1981							3.0	5.7
1982							2.0	8.5
1983							2.0	8.5
1984							1.0	17.0

^{1/} Dash denotes insufficient sample size to determine migration rates.

^{2/} Days = number of days between captures.

^{3/} Mpd = miles per day. This value is based on the median number of days between captures.

Table 62. Male to female pink salmon ratios and average mean lengths from Flathorn, Yentna, Sunshine, Talkeetna and Curry station in 1981-84.

Location	YEAR							
	1981		1982		1983		1984	
	Sex Ratio (M:F)	Average Mean Length (mm)	Sex Ratio (M:F)	Average Mean Length (mm)	Sex Ratio (M:F)	Average Mean Length (mm)	Sex Ratio (M:F)	Average Mean Length (mm)
Flathorn Station	-	-	-	-	-	-	1.3:1	443
Yentna Station	0.8:1	474	1.0:1	428	0.9:1	426	1.2:1	445
Sunshine Station	0.8:1	447	1.8:1	435	1.0:1	429	1.1:1	441
Talkeetna Station	1.2:1	434	1.6:1	426	0.8:1	427	1.1:1	447
Curry Station	0.8:1	432	1.5:1	419	1.0:1	425	1.6:1	442

Table 63. Peak survey counts and percent distribution of pink salmon in sloughs above RM 98.6 in 1981-84.

Slough	River Mile	1981		1982		1983		1984		Average % Distribution
		Peak Count ^{1/}	% Distribution							
2	100.2	0	0	0	0	0	0	2	0.2	0.1
3B	101.4	0	0	0	0	0	0	28	2.6	1.7
3A	101.9	1	3.6	0	0	0	0	56	5.2	3.4
5	107.6	0	0	0	0	0	0	4	0.4	0.2
6A	112.3	0	0	35	6.9	0	0	0	0	2.1
8	113.7	25	89.3	0	0	0	0	1	0.1	1.6
Bushrod	117.8	-	-	-	-	-	-	10	0.9	2.4
8C	121.9	0	0	0	0	0	0	1	0.1	0.1
8B	122.2	0	0	0	0	0	0	68	6.4	4.1
Moose	123.5	0	0	8	1.6	0	0	25	2.3	2.0
A'	124.6	0	0	0	0	0	0	24	2.2	1.4
A	124.7	2	7.1	0	0	1	4.8	0	0	0.2
8A	125.4	0	0	28	5.5	3	14.2	134	12.5	10.0
B	126.3	-	-	32	6.3	0	0	0	0	2.6
9	128.3	0	0	12	2.4	0	0	1	0.1	0.8
11	135.3	0	0	131	25.8	7	33.3	121	11.3	15.5
15	137.2	0	0	132	26.0	1	4.8	500	46.8	38.0
17	138.9	0	0	0	0	0	0	1	0.1	0.1
19	139.7	0	0	1	0.2	1	4.8	0	0	0.1
20	140.0	0	0	64	12.6	7	33.3	85	8.0	9.4
21	141.1	0	0	64	12.6	1	4.8	8	0.7	4.4
TOTALS ^{2/}		28	100%	507	99.9%	21	100%	1,069	99.9%	100.2%

^{1/} Peak count includes live plus dead fish.

^{2/} Percent distribution totals do not equal 100 due to rounding errors.

1984. Based on peak index survey counts over the last four years Indian River, Fourth of July Creek and Lane Creek were the primary spawning streams (Table 64). Peak spawning occurred between the second and fourth weeks of August.

In 1983 and 1984, Indian River and Portage Creek surveys were of each streams entire spawning reach (Table 65). These surveys show that index counts of Portage Creek were not indicative of this streams spawning importance. For example, in 1984 the peak index count was 302 fish while a survey of the entire spawning reach revealed a peak count of

Table 64. Peak survey counts and percent distribution of pink salmon in stream index reaches above RM 98.6 in 1981-84.

Stream	River Mile	1981		1982		1983		1984		Average
		Peak Count <u>1/</u>	% Distribution	% Distribution						
Whiskers Creek	101.4	1	0.3	138	4.8	0	0	293	2.6	2.5
Chase Creek	106.9	38	10.1	107	3.8	6	0.5	438	3.9	3.4
Slash Creek	111.2	-	-	-	-	0	0	3	*	*
Gash Creek	111.6	-	-	-	-	0	0	6	*	*
Lane Creek	113.6	291	77.0	640	22.4	28	2.1	1,184	10.5	12.2
Clyde Creek	113.8	-	-	-	-	-	-	34	0.3	0.8
Maggot Creek	115.6	-	-	-	-	-	-	107	1.0	2.4
Lower McKenzie Creek	116.2	0	0	23	0.8	17	1.3	585	5.2	3.6
McKenzie Creek	116.7	0	0	17	0.6	0	0	11	0.1	0.2
Little Portage Creek	117.7	-	-	140	4.9	7	0.5	162	1.4	2.3
Fromunda Creek	119.3	-	-	-	-	-	-	40	0.4	0.9
Downunda Creek	119.4	-	-	-	-	-	-	6	*	0.1
Deadhorse Creek	120.8	-	-	-	-	-	-	337	3.0	7.7
Tulip Creek	120.9	-	-	-	-	-	-	8	0.1	0.2
5th of July Cr.	123.7	2	0.5	113	4.0	9	0.7	411	3.6	3.1
Skull Creek	124.7	8	2.1	12	0.4	1	0.1	121	1.1	0.8
Sherman Creek	130.8	6	1.6	24	0.8	0	0	48	0.4	0.5
4th of July Cr.	131.1	29	7.7	702	24.6	78	5.9	1,842	16.3	15.1
Gold Creek	136.7	0	0	11	0.4	7	0.5	82	0.7	0.5
Indian River	138.6	2	0.5	738	25.9	886	66.7	5,282	46.7	39.3
Jack Long Creek	144.5	1	0.3	21	0.7	5	0.4	14	0.1	0.2
Portage Creek	148.9	0	0	169	5.9	285	21.4	302	2.7	4.3
TOTALS ^{2/}		378	100.1%	2,855	100.0%	1,329	100.1%	11,316	100.1%	100.1%

1/ Peak count includes live plus dead fish.

2/ Percent distribution totals do not equal 100 due to rounding errors.

* Trace

2,707 fish. In Indian River about 58 percent of the 9,066 fish counted were within the index reach signifying this areas importance as spawning habitat. Based on peak counts, the estimated escapement to middle reach streams was about 26,700 fish in 1984.

Table 65. Peak survey counts and percent distribution of pink salmon in streams above RM 98.6 in 1983 and 1984.

Stream	River Mile	1983		1984		Average
		Peak Count <u>1/</u>	% Distribution	Peak Count <u>1/</u>	% Distribution	% Distribution
Whiskers Creek	101.4	0	0	293	1.7	1.5
Chase Creek	106.9	6	0.5	438	2.5	2.3
Slash Creek	111.2	0	0	3	*	*
Gash Creek	111.6	0	0	6	*	*
Lane Creek	113.6	28	2.1	1,184	6.8	6.3
Clyde Creek	113.8	-	-	34	0.2	0.4
Maggot Creek	115.6	-	-	107	0.6	1.1
L. McKenzie Cr.	116.2	17	1.3	585	3.3	3.1
McKenzie Creek	116.7	0	0	11	0.1	0.1
Ltl. Portage Cr.	117.7	7	0.5	162	0.9	0.9
Fromunda Creek	119.3	-	-	40	0.2	0.4
Downunda Creek	119.4	-	-	6	*	0.1
Deadhorse Creek	120.8	-	-	337	1.9	3.5
Tulip Creek	120.9	-	-	8	0.1	0.1
5th of July Cr.	123.7	9	0.7	411	2.4	2.2
Skull Creek	124.7	1	0.1	121	0.7	0.6
Sherman Creek	130.8	0	0	48	0.3	0.2
4th of July Cr.	131.1	78	5.9	1,842	10.5	9.9
Gold Creek	136.7	7	0.5	82	0.5	0.5
Indian River	138.6	886	66.7	9,066	51.8	51.4
Jack Long Creek	144.5	5	0.4	14	0.1	0.1
Portage Creek	148.9	285	21.4	2,707	15.5	15.4
TOTALS ^{2/}		1,329	100.1%	17,505	100.1%	100.1%

1/ Peak count includes live plus dead fish.

2/ Percent distribution totals do not equal 100 due to rounding errors.

* Trace

Chum Salmon

Lower river chum salmon escapements for the last four years at Yentna Station have averaged 21,200 fish and at Sunshine Station, 431,000 fish (Table 52). The 1984 escapement to both stations combined was 75 percent above the four year average. Most of this increase was at Sunshine Station. The Flathorn escapement in 1984 was about 812,700 fish, three percent above combined Yentna and Sunshine stations escapement for the same year (Figure 76). Essentially all of the Susitna River escapement reaches Flathorn Station because less than 500 chums probably spawn below this station annually.

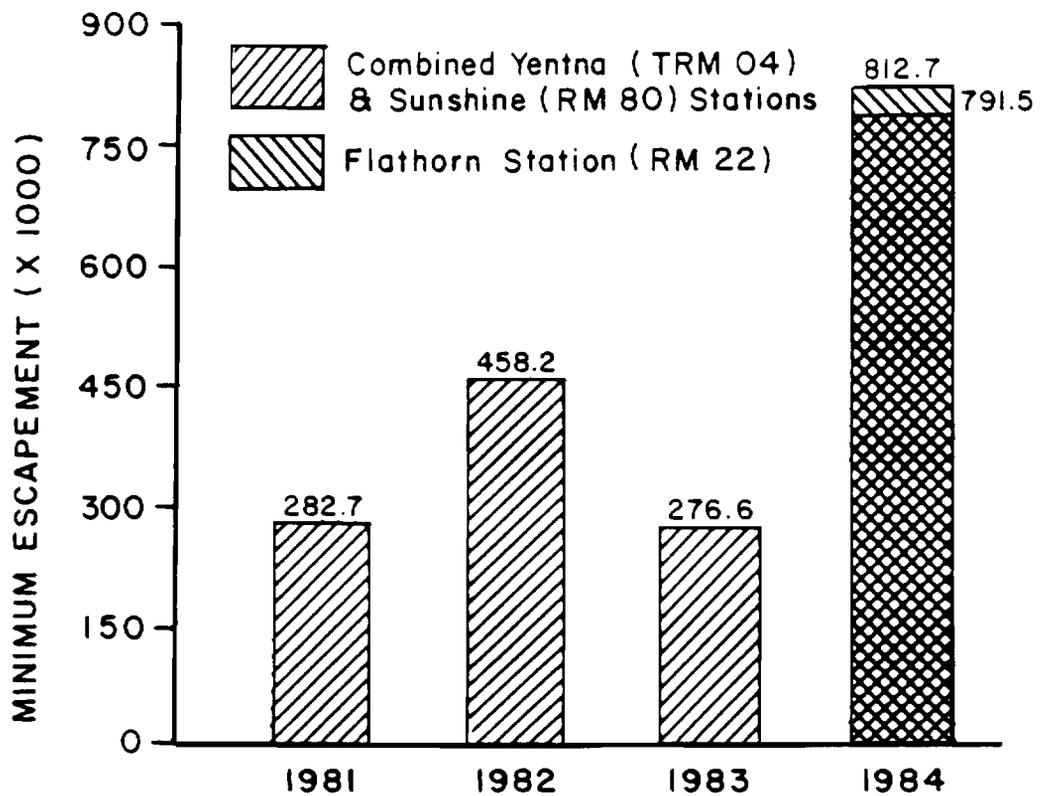


Figure 76. Minimum 1981-84 Susitna River chum salmon escapements based on population estimates at Flathorn, Yentna and Sunshine stations.

For the last four years in the middle reach, escapements to Talkeetna Station have ranged between 20,800 to 98,200 fish and averaged 54,600 fish (Figure 77). At Curry Station the escapements have ranged from 13,100 to 49,300 fish and averaged 28,200 fish. The 1984 escapement to both stations was about 1.8 times higher than average.

During all four years, a high proportion of the middle river escapement were fish which spawned in the lower reach, mainly in the Talkeetna River drainage. For example, in 1981 and 1982 several radio tagged fish

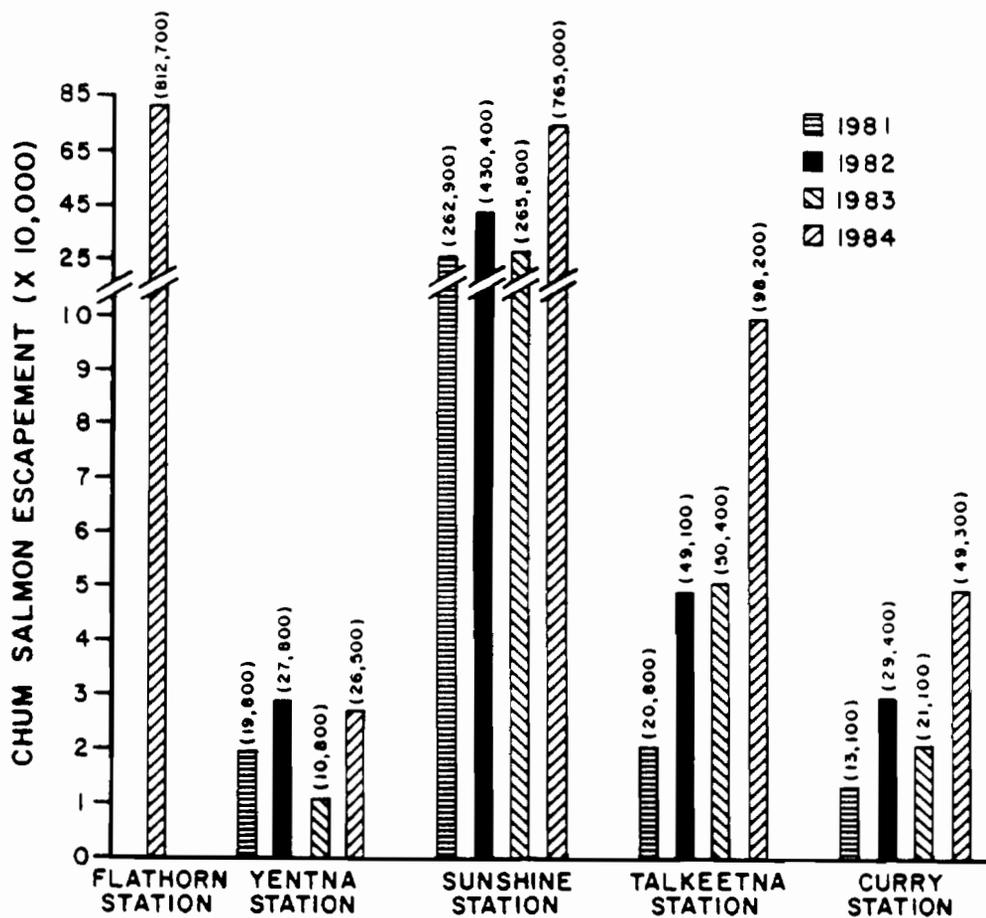


Figure 77. Minimum Susitna River chum salmon escapements by station for 1981-84.

released at Talkeetna and Curry stations spawned in the lower reach. In 1984 about 75 and 45 percent of the escapements to these stations were stray fish that spawned elsewhere.

In the lower river chum salmon have been abundant from the second week of July to the last week of August in each of the last four years with the peak occurring in the last week of July or the first week of August (Figure 78). In the middle reach, fish have been abundant from the third week of July to the last week of August. In general, peak abundance has occurred in the first week of August.

In 1984 nearly all the chum destined to Yentna and Sunshine stations traveled in the east channel past Flathorn Station. Apparently most of the Yentna Station fish crossed to the west side of the Susitna River in the six miles before the Yentna River confluence.

Migration speeds were slower in the lower than in the middle river in each of the last four years (Table 66). The slower migration speeds in the lower river may be associated with fish milling or straying in areas of the Yentna and Susitna rivers confluence.

In the lower and middle river, returning fish ranged in age from three to six years old in each of the last four years (Table 67). Most of the fish were four years old except in 1983 when the majority were five year olds. Fish lengths averaged from 584 to 608 mm for all four years (Table 68). Generally males were more plentiful than females in all four years (Table 68).

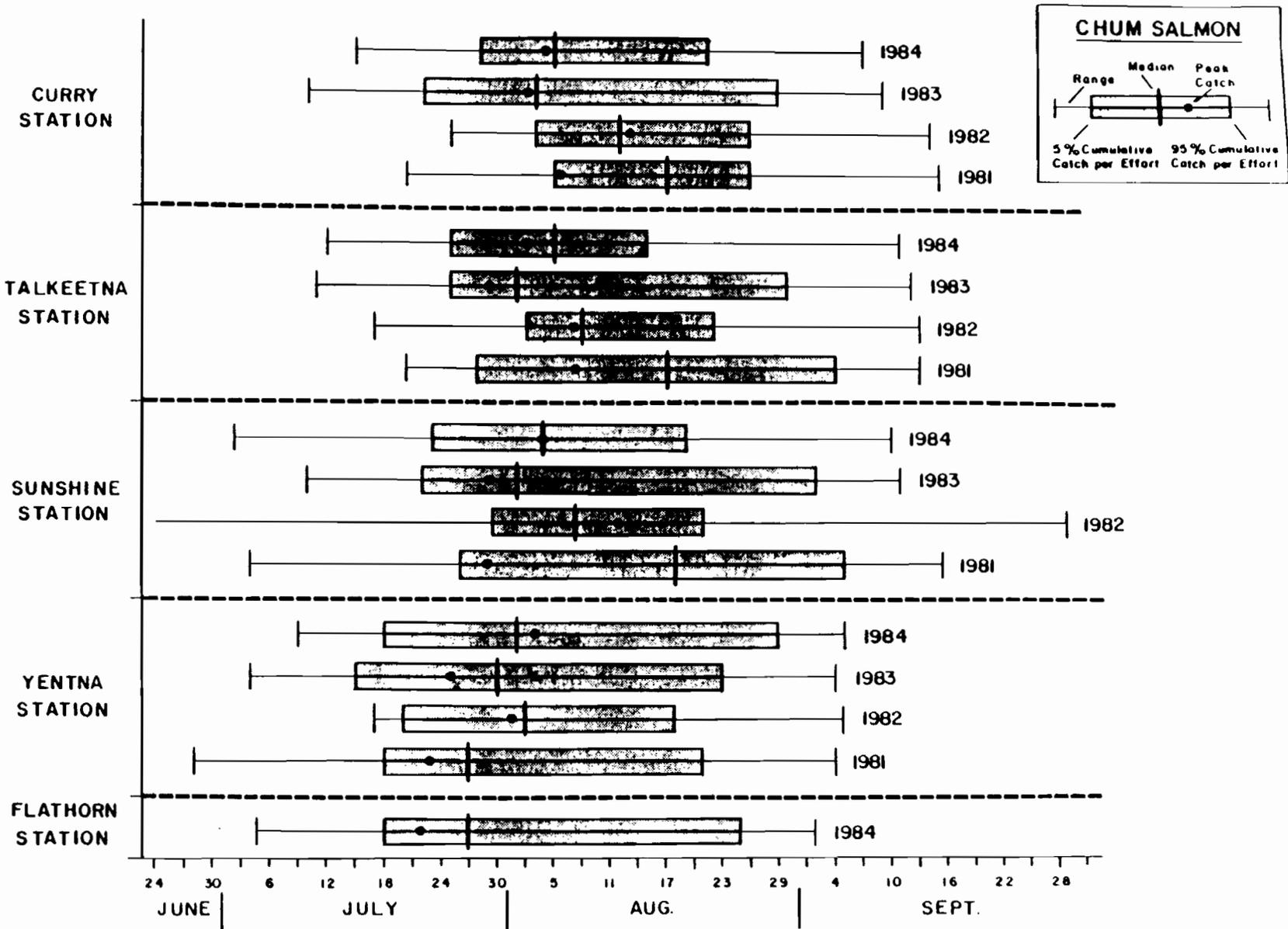


Figure 78. Migrational timing of chum salmon based on fishheel catch per unit effort at selected stations in 1981-84.

Table 66. Migration rates of chum salmon between sampling stations, based on fishwheel tag recoveries.

Tagging Station Year	Recapture Station ^{1/}							
	Yentna		Sunshine		Talkeetna		Curry	
	Days ^{2/}	Mpd ^{3/}	Days	Mpd	Days	Mpd	Days	Mpd
Flathorn 1984	4.0	2.5	13.0	4.5	15.0	5.4	16.0	6.1
Sunshine 1981					7.0	3.3	-	-
1982					5.0	4.6	5.0	8.0
1983					5.0	4.6	8.0	5.0
1984					4.0	5.8	6.0	6.7
Talkeetna 1981							4.0	4.2
1982							2.0	8.5
1983							4.0	4.2
1984							2.0	8.5

^{1/} Dash denotes insufficient sample size to determine migration rates.

^{2/} Days = number of days between captures.

^{3/} Mpd = miles per day. This value is based on the median number of days between captures.

Table 68. Male to female chum salmon ratios and average mean lengths from Flathorn, Yentna, Sunshine, Talkeetna and Curry stations in 1981-84.

Location	YEAR							
	1981		1982		1983		1984	
	Sex Ratio (M:F)	Average Mean Length (mm)	Sex Ratio (M:F)	Average Mean Length (mm)	Sex Ratio (M:F)	Average Mean Length (mm)	Sex Ratio (M:F)	Average Mean Length (mm)
Flathorn Station	-	-	-	-	-	-	1.1:1	586
Yentna Station	1.0:1	592	1.3:1	598	1.3:1	593	0.7:1	584
Sunshine Station	0.8:1	603	1.0:1	606	1.0:1	594	1.1:1	593
Talkeetna Station	1.3:1	584	1.9:1	609	1.5:1	606	1.4:1	605
Curry Station	1.1:1	602	1.1:1	603	1.9:1	614	2.0:1	597

Table 67. Analysis of chum salmon age data by percent from escapement samples collected at Flathorn, Yentna, Sunshine, Talkeetna and Curry stations in 1981-84.

Location	Year	AGE GROUP					BROOD YEAR							
		2	3	4	5	6	75	76	77	78	79	80	81	82
Flathorn Station	1984	0	15.5	73.9	10.2	0.4				0.4	10.2	73.9	15.5	0
Yentna Station	1981	0	6.6	84.1	9.3	0	0	9.3	84.1	6.6	0			
	1982	0	3.3	90.4	6.3	0		0	6.3	90.4	3.3	0		
	1983	0	2.2	46.1	51.3	0.4			0.4	51.3	46.1	2.2	0	
	1984	0.1	19.7	69.3	10.2	0.7				0.7	10.2	69.3	19.7	0.1
Sunshine Station	1981	0	4.1	88.7	7.2	0	0	7.2	88.7	4.1	0			
	1982	0	5.5	91.1	3.4	0		0	3.4	91.1	5.5	0		
	1983	0	0.3	40.1	68.4	1.2			1.2	58.4	40.1	0.3	0	
	1984	0	12.0	75.7	12.2	0.1				0.1	12.2	75.7	12.0	0
Talkeetna Station	1981	0	4.1	85.2	10.7	0	0	10.7	85.2	4.1	0			
	1982	0	4.9	87.1	8.0	0		0	8.0	87.1	4.9	0		
	1983	0	0.8	30.3	68.7	0.2			0.2	68.7	30.3	0.8	0	
	1984	0	6.5	69.2	22.9	1.4				1.4	22.9	69.2	6.5	0
Curry Station	1981	0	1.9	84.0	14.1	0	0	14.1	84.0	1.9	0			
	1982	0	2.1	85.8	12.1	0		0	12.1	85.8	2.1	0		
	1983	0	0	27.9	72.1	0			0	72.1	27.9	0	0	
	1984	0	10.4	71.0	16.7	1.9				1.9	16.7	71.0	10.4	0

Chum salmon were sampled for fecundity in 1983 at Sunshine Station. The average was 2,800 eggs/female which is within the range for North American stocks (Bakkala 1970).

Spawning in the lower reach has been documented in the mainstem, sloughs and stream mouths above the Yentna River confluence. In 1981, six mainstem sites were identified between RM 68.3 and 97.0. In the range of 180 chum salmon spawned at these areas determined by expanding the highest survey count (60 live fish) by a factor of three. This estimate is considered conservative because a peak count represents about 50 percent of a spawning escapement and the highest fish count for the mainstem was probably not made at the peak spawning period due to survey conditions.

In 1982 no spawning was observed. In 1983 the lower river mainstem was not surveyed. However, in 1984 surveys resumed and 12 spawning areas were identified between RM 62.1 and 98.0. An estimated 2,700 fish spawned at these sites as determined by the method previously outlined. None of the 12 areas located in 1984 were identified spawning areas in 1981.

In the last four years visibility in the mainstem has been generally poor in early September due to high flows and turbidity. In late September to freeze up (mid October) visibility has generally been better, and this was when most of the spawning in 1981 and 1984 was documented. It is likely that the peak spawning in 1981 and 1984 occurred sometime around mid September before visibility was good. In both years spawning was essentially over by the second week of October.

Six

In the middle reach above the Yentna River confluence, at least ~~five~~ sloughs are used for spawning based on 1984 surveys with approximately 900 fish spawning in these sloughs. Spawning extended from mid September to mid October and probably peaked about the last week of September in 1984.

Nearly all the stream mouths in the lower reach above the Yentna River confluence are used for passage and to a lesser extent for spawning based on 1984 surveys. The major spawning area found in 1984 was the Willow Creek mouth where there were about 350 spawners. Spawning occurred between the first and third weeks of August.

Chum spawning occurs in the middle reach in the mainstem, sloughs and streams. Most of the mainstem spawning areas were found in 1984 of the last four years (Table 69). However during 1981-83 surveys, visibility was poor in the mainstem due to higher flows and turbidity which probably caused some spawning areas to be missed. In addition more spawning in the mainstem probably occurred in 1984 than other years due to the record high escapement in 1984. In the last four years almost all spawning areas were above Curry Station. The spawning occurred in September and early October with the peak probably occurring between the second and third weeks of September.

In 1984 about 3,800 chums spawned in the mainstem middle river based on the assumptions that all spawning areas were identified and the highest fish count of these areas represented about one-third of the population. No estimates of the three previous spawning escapements are available because of inefficient sampling associated with poor visibility due to higher water and turbidity.

Table 69. Number of mainstem chum salmon spawning areas identified in the Susitna River middle reach in 1981-84 and the corresponding, highest fish counts.

Year	Number of Middle Reach Mainstem Spawning Sites	Highest Fish Count (Catch)
1981	4	14
1982	9	550
1983	6	219
1984	36	1,266

Twelve streams in the middle reach have been used for spawning by chum salmon during the last four years. The 1984 escapement to streams was the highest on record as were the escapements almost everywhere else. Most of the spawning since 1981 has been in Indian River and Portage Creek. The spawning in middle reach streams has normally occurred from the fourth week of July to the second week of September and has generally peaked in the last two weeks of August.

Spawning survey in 1983 and 1984 for Indian River and Portage Creek, were expanded beyond the the index areas to the full length of the streams. This was not done at other streams because elsewhere essentially all spawning occurs in the index areas. In both years at Indian River the majority of the spawning occurred in the index area whereas at Portage Creek most of the spawning occurred above the index area (Table 70 and 71). Together these creeks have had an average 92 percent of the total, middle river stream escapement for the last two years which was about 3,000 fish in 1983 and 7,650 fish in 1984.

Table 70. Peak survey counts and percent distribution of chum salmon in stream index reaches above RM 98.6 in 1981-84.

Stream	River Mile	1981		1982		1983		1984		Average % Distribution
		Peak Count ^{1/}	% Distribution							
Whiskers Creek	101.4	1	0.4	0	0	0	0	0	0	*
Chase Creek	106.9	1	0.4	0	0	0	0	1	0.1	*
Lane Creek	113.6	76	31.5	11	0.6	6	0.5	31	1.7	2.5
L. McKenzie Cr.	116.2	14	5.8	0	0	1	0.1	23	1.3	0.8
Ltl. Portage Cr.	117.7	0	0	31	1.8	0	0	18	1.0	1.0
5th of July Cr.	123.7	0	0	1	0.1	6	0.5	2	0.1	0.2
Skull Creek	124.7	10	4.2	1	0.1	0	0	4	0.2	0.3
Sherman Creek	130.8	9	3.7	0	0	0	0	6	0.3	0.3
4th of July Cr.	131.1	90	37.3	191	11.0	148	12.0	193	10.6	12.4
Indian River	138.6	40	16.6	1,346	77.5	811	65.6	1,272	70.0	69.0 ^{1/}
Jack Long Creek	144.5	0	0	3	0.2	2	0.2	4	0.2	0.2
Portage Creek	148.9	0	0	153	8.8	262	21.2	262	14.4	13.5
TOTALS ^{2/}		241	99.9%	1,737	100.1%	1,236	100.1%	1,816	99.9%	100.2%

^{1/} Peak count includes live plus dead fish.

^{2/} Percent distribution totals may not equal 100 due to rounding errors.

* Trace

Thirty-two sloughs in the middle reach have been used by chum salmon in the last four years (Table 72). Most of the spawning has been at sloughs 9, 8A, 11 and 21, ranked in order of importance. Slough escapements totaled 5,200 fish in 1981, 4,500 fish in 1982, 2,950 fish in 1983 and 14,650 fish in 1984. The four year average escapement of 6,800 fish was 50 percent below the 1984 escapement. All slough escapements were calculated using 1983 and 1984 observation life data and respective year survey counts. The average observation life of a chum in a slough was 6.9 days in 1983 and 6.8 days in 1984. Observation life studies were not conducted prior to 1983.

Table 71. Peak survey counts and percent distribution of chum salmon in streams above RM 98.6 in 1983 and 1984.

Stream	River Mile	1983		1984		Average
		Peak Count <u>1/</u>	% Distri- bution	Peak Count <u>1/</u>	% Distri- bution	% Distri- bution
Chase Creek	106.9	0	0	1	*	*
Lane Creek	113.6	6	0.4	31	0.8	0.7
L. McKenzie Cr.	116.2	1	0.1	23	0.6	0.5
Ltl. Portage Cr.	117.7	0	0	18	0.5	0.3
5th of July Cr.	123.7	6	0.4	2	0.1	0.2
Skull Creek	124.7	0	0	4	0.1	0.1
Sherman Creek	130.8	0	0	6	0.2	0.1
4th of July Cr.	131.1	148	9.9	193	5.1	6.4
Indian River	138.6	811	54.1	2,247	59.0	57.5
Jack Long Creek	144.5	2	0.1	4	0.1	0.1
Portage Creek	148.9	526	35.1	1,285	33.7	34.1
TOTALS <u>2/</u>		1,500	100.1%	3,814	100.2%	100.0%

1/ Peak count includes live plus dead fish.

2/ Percent distribution totals may not equal 100 due to rounding errors.

* Trace

Spawning in middle reach sloughs extended from the second week of August to the last week of September in each of the last four years. The peak spawning normally occurred in the first week of September or about one to two weeks later than in the nearby streams.

Egg retention at sloughs in the middle river averaged 114 and 463 eggs/female in 1983 and 1984, respectively. Median retention was 5.0 and 1.0 eggs/female. The higher retention in 1984 may have been associated with the record high escapement. Bakkala in 1970 reported that egg retention normally increased with spawner density. Egg retention was not studied in 1981 or 1982.

Table 72. Peak survey counts and percent distribution of chum salmon in sloughs above RM 98.6 in 1981-84.

Slough	River Mile	1981		1982		1983		1984		Average % Distribution
		Peak Count 1/	% Distribution							
1	99.6	6	0.2	0	0	0	0	12	0.2	0.1
2	100.2	27	1.1	0	0	49	3.4	129	1.7	1.4
3B	101.4	0	0	0	0	3	0.2	56	0.7	0.4
3A	101.9	0	0	0	0	0	0	17	0.2	0.1
S	107.6	0	0	2	0.1	1	*	0	0	*
6A	112.3	11	0.4	2	0.1	6	0.4	0	0	0.1
8	113.7	302	11.6	0	0	0	0	65	0.9	2.5
Bushrod	117.8	-	-	-	-	-	-	90	1.2	2.5
8D	121.8	0	0	23	1.0	1	*	49	0.7	0.5
8C	121.9	0	0	48	2.1	4	0.3	121	1.6	1.2
8B	122.2	1	*	80	3.6	104	7.1	400	5.3	4.1
Moose	123.5	167	6.4	23	1.0	68	4.7	76	1.0	2.3
A'	124.6	140	5.4	0	0	77	5.3	111	1.5	2.3
A	124.7	34	1.3	0	0	2	0.1	2	*	0.3
8A	125.4	620	23.9	336	15.0	37	2.5	917	12.1	13.2
B	126.3	-	-	58	2.6	7	0.5	108	1.4	1.6
9	128.3	260	10.0	300	13.4	169	11.5	350	4.6	7.5
9B	129.2	90	3.5	5	0.2	0	0	73	1.0	1.2
9A	133.8	182	7.0	118	5.3	105	7.2	303	4.0	4.9
10	133.8	0	0	2	0.1	1	*	36	0.5	0.3
11	135.3	411	15.8	459	20.5	238	16.2	1,586	21.0	18.6
13	135.9	4	0.2	0	0	4	0.3	22	0.3	0.2
14	135.9	0	0	0	0	0	0	1	*	*
15	137.2	1	*	1	*	2	0.1	100	1.3	0.7
16	137.3	3	0.1	0	0	0	0	15	0.2	0.1
17	138.9	38	1.5	21	0.9	90	6.1	66	0.9	1.5
18	139.1	0	0	0	0	0	0	11	0.2	0.1
19	139.7	3	0.1	0	0	3	0.2	45	0.6	0.4
20	140.0	14	0.6	30	1.3	63	4.3	280	3.7	2.7
21	141.1	274	10.6	736	32.8	319	21.8	2,354	31.2	25.7
22	144.5	-	-	-	-	114	7.8	151	2.0	3.7
21A	145.3	8	0.3	0	0	0	0	10	0.1	0.1
TOTALS		2,596	100%	2,244	100%	1,467	100%	7,556	100.1%	100.3%

1/ Peak count includes live plus dead fish.

* Trace

Coho Salmon

The lower river coho salmon escapement at Flathorn Station in 1984 was about 190,100 fish or 40 percent greater than the same year combined escapement at Yentna and Sunshine stations (Figure 79). Yentna and Sunshine stations combined escapements have ranged from 24,100 to 112,900 fish while averaging 63,200 fish the last four years (Figure 80). The 1984 Sunshine Station escapement was more than double the 1982 escapement which indicates an excellent return to spawning areas above Sunshine Station. This was further substantiated by the escapement to the middle river at Talkeetna Station where the 1984 escapement was also more than double the 1982 escapement. At Curry Station the 1984 escapement was 200 fish less than in 1982, which suggests that the large escapements to areas above Sunshine Station were not inclusive of those stocks spawning above Curry Station.

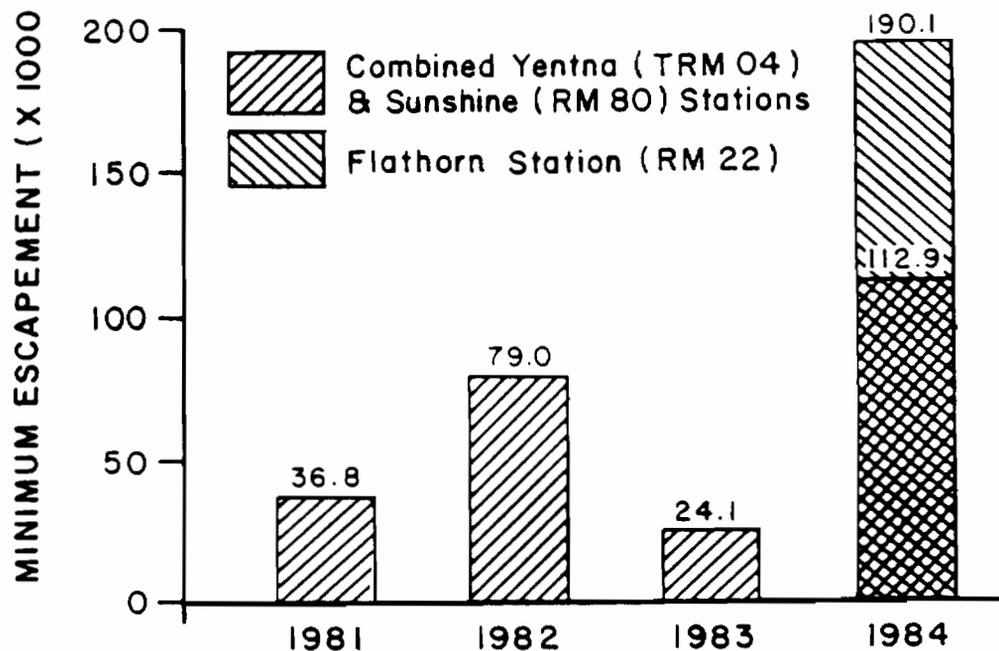


Figure 79. Minimum 1981-84 Susitna River coho salmon escapements based on population estimates at Flathorn, Yentna and Sunshine stations.

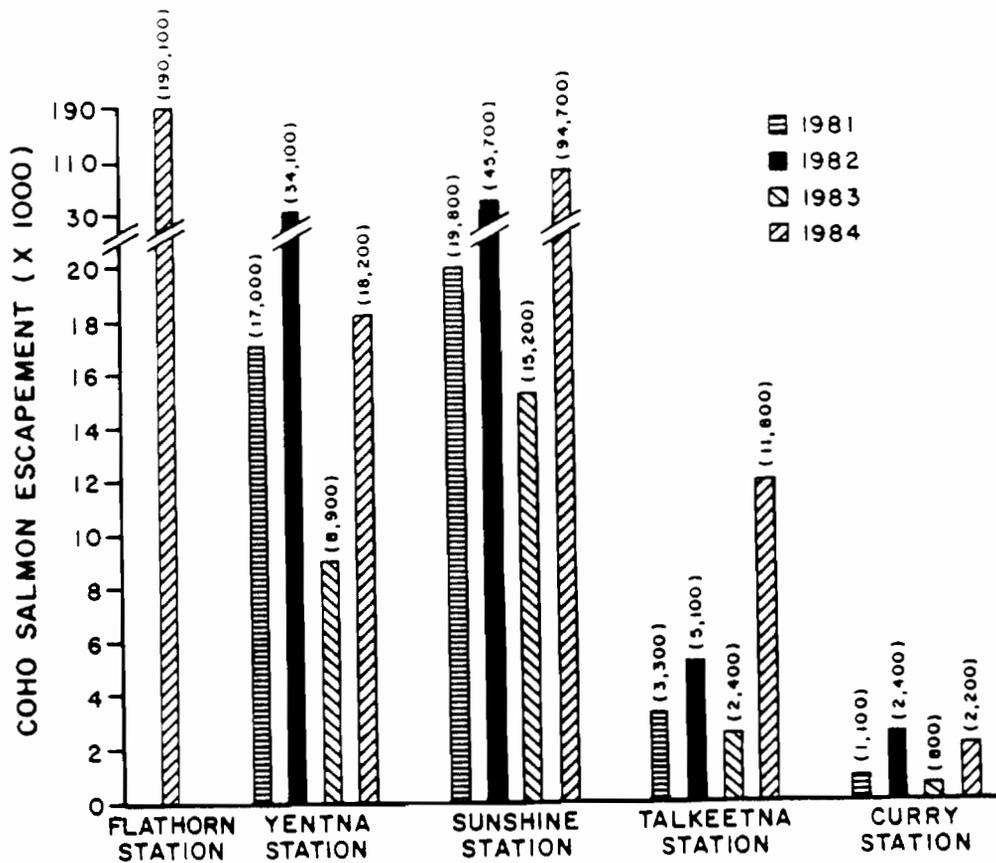


Figure 80. Minimum Susitna River coho salmon escapements by station for 1981-84.

A large portion of the escapement to the middle river are fish which stray and ultimately spawn in the lower river reach. In 1984 about 75 percent of the Talkeetna Station escapement and 45 percent of the Curry Station escapement were fish which strayed. The greater percentage of straying fish at Talkeetna Station was probably due to this stations proximity to the Talkeetna, Chulitna and Susitna rivers confluence. This premise is supported by 1982 radio telemetry studies. Ten of eleven coho salmon radio tagged at Talkeetna Station spawned below this site, while at Curry Station only one of five radio tagged fish spawned downstream of this site.

The lower and middle reach above Sunshine Station produces most of the escapement return. In 1984, 50 percent of the basin wide escapement returned to Sunshine Station and above, ten percent returned to spawning areas within the Yentna River drainage and 40 percent returned to spawning areas between the Yentna River and Sunshine Station. Specific spawning areas within the lower and middle reaches are discussed later in this section.

Cohos have been abundant in the lower river from the third week of July to the third week of August in the last four years (Figure 81). In the middle reach they have been abundant from the last week of July to the first week of September. In 1984 the escapement passed Flathorn Station primarily in the east channel. At Yentna and Sunshine stations, the migration has been mainly along the south and east banks during the last four years.

Tag recovery data in 1984 indicate that most coho salmon reaching Yentna and Sunshine stations migrated past Flathorn Station in the east channel. In the middle river at Talkeetna Station, the migration has been mainly along the west bank and at Curry Station evenly split between east and west banks during the last four years.

Coho salmon migration rates in the lower river were slower between Flathorn and Yentna stations than between Flathorn and Sunshine stations (Table 73). This was probably due to straying or milling in the confluence area of the Susitna and Yentna rivers. This pattern appears consistent with the middle river where the migration rates between Sunshine and Talkeetna stations was slower than between Talkeetna and

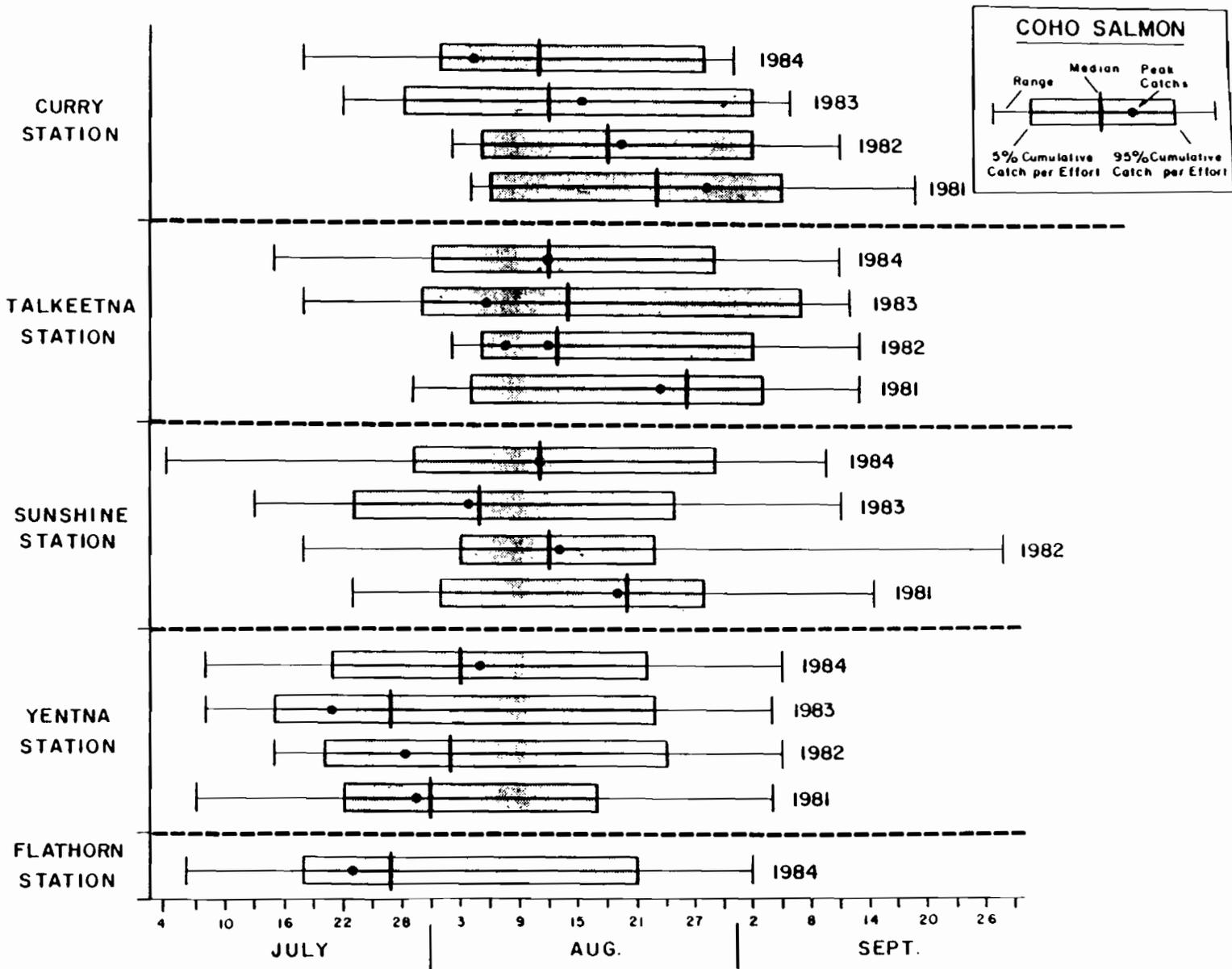


Figure 81. Migrational timing of coho salmon based on fishwheel catch per unit effort at selected stations in 1981-84.

Table 73. Migration rates of coho salmon between sampling stations, based on fishwheel tag recoveries.

Tagging Station Year	Recapture Station ^{1/}							
	Yentna		Sunshine		Talkeetna		Curry	
	Days ^{2/}	Mpd ^{3/}	Days	Mpd	Days	Mpd	Days	Mpd
Flathorn 1984	10.0	1.0	25	2.3	7	11.6	-	-
Sunshine 1981					-	-	-	-
1982					-	-	-	-
1983					15.0	1.5	20.0	2.0
1984					7.0	3.3	10.0	4.0
Talkeetna 1981							-	-
1982							-	-
1983							3.0	5.7
1984							3.0	5.7

^{1/} Dash denotes insufficient sample size to determine migration rates.

^{2/} Days = number of days between captures.

^{3/} Mpd = miles per day. This value is based on the median number of days between captures.

Curry stations due, presumably, to milling or straying during passage through the confluence area of the Talkeetna, Chulitna and Susitna rivers.

Coho salmon in the lower and middle river reach have ranged in age from three to five years old (Table 74). Four year olds were most abundant at all sites except in 1982 at Talkeetna and Curry stations when three year olds dominated the escapement. Coho salmon lengths in both river reaches have ranged from 517 to 559 mm (Table 75). Between and within year variability in lengths may be due to between year differences in age class composition or stock differences between sampling sites. Males were more abundant than females in both river reaches (Table 75).

Table 74. Analysis of coho salmon age data by percent from escapement samples collected at Flathorn, Yentna, Sunshine, Talkeetna and Curry stations in 1981-84.

Location	Year	AGE GROUP				BROOD YEAR						
		2	3	4	5	76	77	78	79	80	81	82
Flathorn Station	1984	0.4	33.9	64.2	1.5				1.5	64.2	33.9	0.4
Yentna Station	1981	0	16.1	82.9	1.0	1.0	82.9	16.1	0			
	1982	0	31.8	66.8	1.4		1.4	66.8	31.8	0		
	1983	0	16.1	80.4	3.5			3.5	80.4	16.1	0	
	1984	0	27.9	70.0	2.1				2.1	70.0	27.9	0
Sunshine Station	1981	0	31.8	65.1	3.1	3.1	65.1	31.8	0			
	1982	0	49.3	50.4	0.3		0.3	50.4	49.3	0		
	1983	0	35.9	63.3	0.8			0.8	63.3	35.9	0	
	1984	0	34.2	64.4	1.4				1.4	64.4	34.2	0
Talkeetna Station	1981	0	12.2	84.8	3.0	3.0	84.8	12.2	0			
	1982	0	59.0	41.0	0		0	41.0	59.0	0		
	1983	0	39.4	60.6	0			0	60.6	39.4	0	
	1984	0	31.7	67.3	1.0				1.0	67.3	31.7	0
Curry Station	1981	0	28.6	68.8	2.6	2.6	68.8	28.6	0			
	1982	0	54.0	46.0	0		0	46.0	54.0	0		
	1983	0	46.8	53.2	0			0	53.2	46.8	0	
	1984	0	46.4	52.4	1.2				1.2	52.4	46.4	0

Table 75. Male to female coho salmon ratios and average mean lengths from Flathorn, Yentna, Sunshine, Talkeetna and Curry stations in 1981-84.

Location	YEAR							
	1981		1982		1983		1984	
	Sex Ratio (M:F)	Average Mean Length (mm)	Sex Ratio (M:F)	Average Mean Length (mm)	Sex Ratio (M:F)	Average Mean Length (mm)	Sex Ratio (M:F)	Average Mean Length (mm)
Flathorn Station	-	-	-	-	-	-	1.4:1	542
Yentna Station	0.9:1	535	2.4:1	544	2.3:1	528	0.8:1	557
Sunshine Station	1.2:1	524	1.4:1	550	1.2:1	524	1.2:1	546
Talkeetna Station	1.5:1	531	1.5:1	550	1.7:1	528	1.1:1	559
Curry Station	2.0:1	517	1.3:1	531	2.0:1	524	1.1:1	531

Fecundity of Susitna River coho salmon was estimated to be 2,800 eggs/female based on a 1984 study. This was slightly higher (360, eggs/female higher) than reported by Hart (1973). Problems encountered with freezing and thawing immature eggs introduced an unknown error component into the analysis.

Spawning in lower and middle river main and side channel habitats has been limited. In 1984, two spawning sites were located in the lower river, one each at RM 87.5 and 94.5. In the middle river three spawning sites were located, one each in 1981, 1983 and 1984 at RM 129.2, 131.7 and 131.5, respectively.

Spawning in lower and middle river sloughs has been found to be virtually non-existent. One spawning site was identified in the lower river at RM 57.0 in 1984 the only year surveys were conducted. In the middle river spawning was confirmed only at RM 125.1 during the last four years.

Susitna River coho salmon spawn mainly in lower and middle river streams. In the lower river, fish were observed in eleven of the seventeen streams surveyed in 1984. Coho utilized the stream mouths of the eleven streams for either passage or milling as no fish were observed spawning in these areas.

In the middle river, fish spawned (in order of abundance) primarily in Gash Creek, Whiskers Creek, Chase Creek and Indian River based on peak index survey counts during the last four years (Table 76). In 1984, coho were observed spawning at the mouths of Whiskers, Slash, Fourth of July and Portage creeks. Spawning in the middle river has generally reached a peak during the month of September in the last four years.

In 1984 surveys of major coho salmon producing streams in the middle reach were inclusive of each streams entire spawning range (Table 77). Based on the peak counts of these surveys, stream escapements to Indian River and Whiskers Creek, the two most important coho producing streams, were 930 and 602 fish in 1984. The 1984 escapement to all middle reach streams was an estimated 2,900 fish.

Table 76. Peak survey counts and percent distribution of coho salmon in stream index reaches above RM 98.6 in 1981-84.

Stream	River Mile	1981		1982		1983		1984		Average
		Peak Count <u>1/</u>	% Distribution	% Distribution						
Whiskers Creek	101.4	70	15.3	176	27.8	55	42.3	117	16.3	21.5
Chase Creek	106.9	80	17.5	36	5.7	1	0.8	239	33.2	18.2
Slash Creek	111.2	-	-	6	1.0	2	1.5	5	0.7	0.8
Gash Creek	111.6	141	30.8	74	11.7	19	14.6	234	32.6	24.0
Lane Creek	113.6	3	0.7	5	0.8	2	1.5	8	1.1	1.0
L. McKenzie Cr.	116.2	56	12.2	133	21.0	18	13.9	24	3.3	11.9
Little Portage Creek	117.7	-	-	8	1.3	0	0	0	0	0.6
4th of July Cr.	131.1	1	0.2	4	0.6	3	2.3	1	0.1	0.4
Gold Creek	136.7	0	0	1	0.2	0	0	0	0	0
Indian River	138.6	85	18.6	101	16.0	27	20.8	70	9.7	14.6
Jack Long Cr.	144.5	0	0	1	0.2	1	0.8	0	0	0.2
Portage Creek	148.9	22	4.8	88	13.9	2	1.5	21	2.9	6.8
TOTALS ^{2/}		458	100.1%	633	100.2%	130	100.0%	719	99.9%	100.0%

1/ Peak count includes live plus dead fish.

2/ Percent distribution totals may not equal 100 due to rounding errors.

Table 77. Peak survey counts and percent distribution of coho salmon in streams above RM 98.6 in 1983 and 1984.

Stream	River Mile	1983		1984		Average
		Peak Count <u>1/</u>	% Distribution	Peak Count <u>1/</u>	% Distribution	% Distribution
Whiskers Creek	101.4	115	47.9	301	21.0	24.9
Chase Creek	106.9	12	5.0	239	16.7	15.0
Slash Creek	111.2	2	0.8	5	0.4	0.4
Gash Creek	111.6	19	7.9	234	16.3	15.1
Lane Creek	113.6	2	0.8	24	1.7	1.6
L. McKenzie Cr.	116.2	18	7.5	24	1.7	2.5
4th of July Cr.	131.1	3	1.3	8	0.6	0.7
Indian River	138.6	53	22.1	465	32.4	30.9
Jack Long Creek	144.5	1	0.4	6	0.4	0.4
Portage Creek	148.9	15	6.3	128	8.9	8.5
TOTALS ^{2/}		240	100.0%	1,434	100.1%	100.0%

1/ Peak count includes live plus dead fish.

2/ Percent distribution totals may not equal 100 due to rounding errors.

REFERENCES

- Alaska Department of Fish and Game. 1972. 1972 Tustumena Sockeye Salmon Research Report. Alaska Department of Fish and Game, Division of Commercial Fisheries, Soldotna, Alaska, USA.
- _____. 1981. Phase 1 final draft report. Subtask 7.10. Adult anadromous fisheries project (June-September 1981). Alaska Department of Fish and Game Susitna Hydro Aquatic Studies. Anchorage, Alaska, USA.
- _____. 1983. Susitna Hydro aquatic studies phase II final report. Volume 2. Adult anadromous fish studies, 1982. Alaska Department of Fish and Game Susitna Hydro Aquatic Studies. Anchorage, Alaska, USA.
- _____. 1984. Susitna Hydro aquatic studies (May 1983 - June 1984) procedures manual. Alaska Department of Fish and Game Susitna Hydro Aquatic Studies. Anchorage, Alaska, USA.
- Bakkala, R. G. 1970. Synopsis of biological data on the Chum Salmon, *Oncorhynchus keta* (Walbaum) 1972. FAO Species Synopsis No. 41, U.S., Fish and Wildlife Service Circular 315, Washington, D.C., USA.
- Barrett, B. M. 1974. An assessment of the anadromous fish populations in the upper Susitna River watershed between Devil Canyon and the Chulitna River. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage, Alaska, USA.
- _____. 1984. Summary of abundance and distribution of adult salmon in Susitna River sub-basins. Presented at: Aquatic Habitat Workshop No. 1, Susitna Hydroelectric Project, Northern Lights Inn, Anchorage, Alaska, February 15, 1984.
- Barrett, B. M., F.M. Thompson, and S.N. Wick, 1984. Adult anadromous fish investigations: May-October 1983. Alaska Department of Fish and Game Susitna Hydro Aquatic Studies. Report No. 1. Prepared for Alaska Power Authority. Anchorage, Alaska, USA.
- Bendix Corporation. 1980. Installation and operation manual side scan sonar counter (1980 Model). Report No. SP-78-017, North Hollywood, California, USA.
- BMDP. 1981. BMDP statistical software. University of California Press, Berkley, California, USA.
- Clutter, R. I. and L. E. Whitesel. 1956. Collection and interpretation of sockeye salmon scales. Bulletin of International Pacific Salmon Fisheries Commission, No. 9, Canada.
- Cousens, N. B. F., G. A. Thomas, C. G. Swann, and M. C. Healey. 1982. A review of salmon escapement estimation techniques. Canadian Technical Report of Fisheries and Aquatic Sciences, No. 1108, Nanaimo, British Columbia, Canada.

REFERENCES (cont)

- Delaney, K. 1984. Personal Communication. Alaska Department of Fish and Game, Division of Sport Fish, Anchorage, Alaska, USA.
- Hart, J. L. 1973. Pacific fishes of Canada. Fisheries Research Board of Canada, Bulletin 180, Ottawa, Canada.
- Lagler, K. F., J. E. Bardach and R. R. Miller. 1962. Ichthyology. John Wiley and Sons, Inc., New York, New York, USA.
- McPhail, J.D. and C. C. Lindsey. 1970. Freshwater fishes of northwestern Canada and Alaska. Fisheries Research Board of Canada, Bulletin 173, Ottawa, Canada.
- Meehan, W. R. 1961. Use of a fishwheel in salmon research management. Transactions of the American Fisheries Society Vol. 90: 490-494.
- Mills, M.J. 1983. Alaska Statewide Harvest Study. ADF&G Federal Aid in Fish Restoration. Volume 24. SW-I.
- Morrow, J. E. 1980. The freshwater fishes of Alaska. Alaska Northwest Publishing Company, Anchorage, Alaska, USA.
- Neilson, J. D., and G.H. Geen. 1981. Enumeration of spawning salmon from spawner residence time and aerial counts. Transactions of the American Fisheries Society 110: 554-556.
- Ricker, W. E. 1975. Computation and interpretations of biological statistics of fish populations. Bulletin 191. Information Canada, Ottawa, Canada.
- Schaefer, M. B. 1951. A study of the spawning populations of sockeye salmon in the Harrison River system, with special reference to the problem of enumeration by means of marked members. International Pacific Salmon Fisheries Commission, Bulletin IV, New Westminster, British Columbia, Canada.
- Seber, G. A. and R. Felton. 1981. Tag loss and the Petersen mark-recapture experiment. Biometrika 68 (1): 211-219.
- Thompson, F.M. and B. M. Barrett. 1983. Analysis of the species selectivity of fishwheels for the capture of adult salmon in the Susitna River In Synopsis of the 1982 aquatic studies and analysis of fish and habitat relationships. Alaska Department of Fish and Game, Su Hydro Aquatic Studies Program, Anchorage, Alaska, USA.
- Trihey, E. W. Memorandum to Andrew Hoffmann, 10 August 1984. Alaska Department of Fish and Game, 2207 Spenard Road, Anchorage, Alaska, USA.
- U.S. Geological Survey (USGS). 1984. Provisional summary of 1984 water resources data for Alaska.