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MIGRATORY TIMING AND SPATIAL ENTRY PATTERNS OF CHUM SALMON (Oncorhynchus keta) IN KOTZEBUE SOUND

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ABSTRACT

Results from the 1981-82 Kotzebue Sound tagging project indicated that Kobuk River chum salmon entered the commercial fishing district earlier than Noatak chum salmon and migrated along the Baldwin Peninsula in Kotzebue Sound. Kobuk River chum salmon peaked in abundance in late July in both 1981 and 1982. The majority of fish tagged in the month of August were Noatak River chum salmon peaking in early August. Noatak River chum salmon tended to be widely distributed in the fishing district. Run timing differences between upper and lower Kobuk River chum salmon were found in 1982. Average time spent within the fishing district was 4.6 and 4.7 days in 1981 and 1982, respectively.

KEY WORDS: chum salmon, *Oncorhynchus keta*, Kotzebue tagging, migratory rate, stock separation.

INTRODUCTION

The Kotzebue Sound Commercial Fishing District includes all waters from Cape Prince of Wales north to Point Hope (Figure 1). The numerous small rivers within the district support five species of Pacific salmon, of which chum salmon (*Oncorhynchus keta*) are the most abundant. The annual migration of Kotzebue District chum salmon is primarily composed of stocks which spawn in the Noatak and Kobuk River drainages, the two largest rivers discharging into the eastern Chukchi Sea. Chum salmon are harvested by both commercial and subsistence fishermen. Commercial fishing for chum salmon in Kotzebue Sound takes place in a confined area within the district (Figure 1).

The commercial chum salmon fishery has steadily increased in economic importance since its modern inception in 1962. Commercial salmon harvests have fluctuated from a low of 29,400 in 1967, to a record catch of 677,200 in 1981 (Table 1). The ex-vessel value of the 1981 and 1982 harvests totaled 3.2 and 2.0 million dollars, respectively, and they were the most valuable harvests in district history.

Fishing activity typically begins on 10 July and continues through 31 August; peak catches usually occur between 4 and 10 August. Current management strategy is designed to minimize fishing effort in July to afford greater protection to Kobuk River stocks which were shown by Yanagawa (1968) to be most abundant in the commercial fishery at that time.

Escapement data demonstrate that the Noatak River supports a substantially larger spawning population of chum salmon than does the Kobuk River (Bigler 1983). Chum salmon spawn from mid August to mid October in the lower 100 miles (160 km) of the Noatak River. Kobuk River salmon spawn from late July to late August in the lower tributaries (Squirrel, Salmon, and Tutuksuk Rivers). Spawning activity continues into October in the upper Kobuk tributaries (Selby River slough, Ambler River, and the mouth of Beaver Creek).

The annual chum salmon subsistence harvest has been documented annually by the Department since 1962. Nearly all of the catch is consumed as dried fish.

Set gill nets are most commonly used by the residents of Kobuk River villages (Noorvik, Kiana, Ambler, Shungnak, and Kobuk) for subsistence fishing but some beach seining is done on spawning areas in late season. Beach seines are used almost exclusively by the residents of Noatak village on the Noatak River. A relatively small number of chum salmon are captured at fish camps on the lower Noatak River using gill nets. Subsistence fishing also occurs near Kotzebue, Sheshalik, and within Hotham Inlet (Figure 2).

A tagging study conducted in Kotzebue Sound from 1966 to 1968 provided evidence that Kobuk River chum salmon enter Kotzebue Sound earlier than Noatak River chums (Yanagawa 1968). A tendency for Kobuk River fish to travel adjacent to the Baldwin Peninsula was also shown by the Yanagawa study.

The primary objective of the 1981-82 tag and recapture study in Kotzebue Sound was to more clearly define Kobuk and Noatak River chum salmon stock migratory patterns and timing. The study was also intended to determine both the time

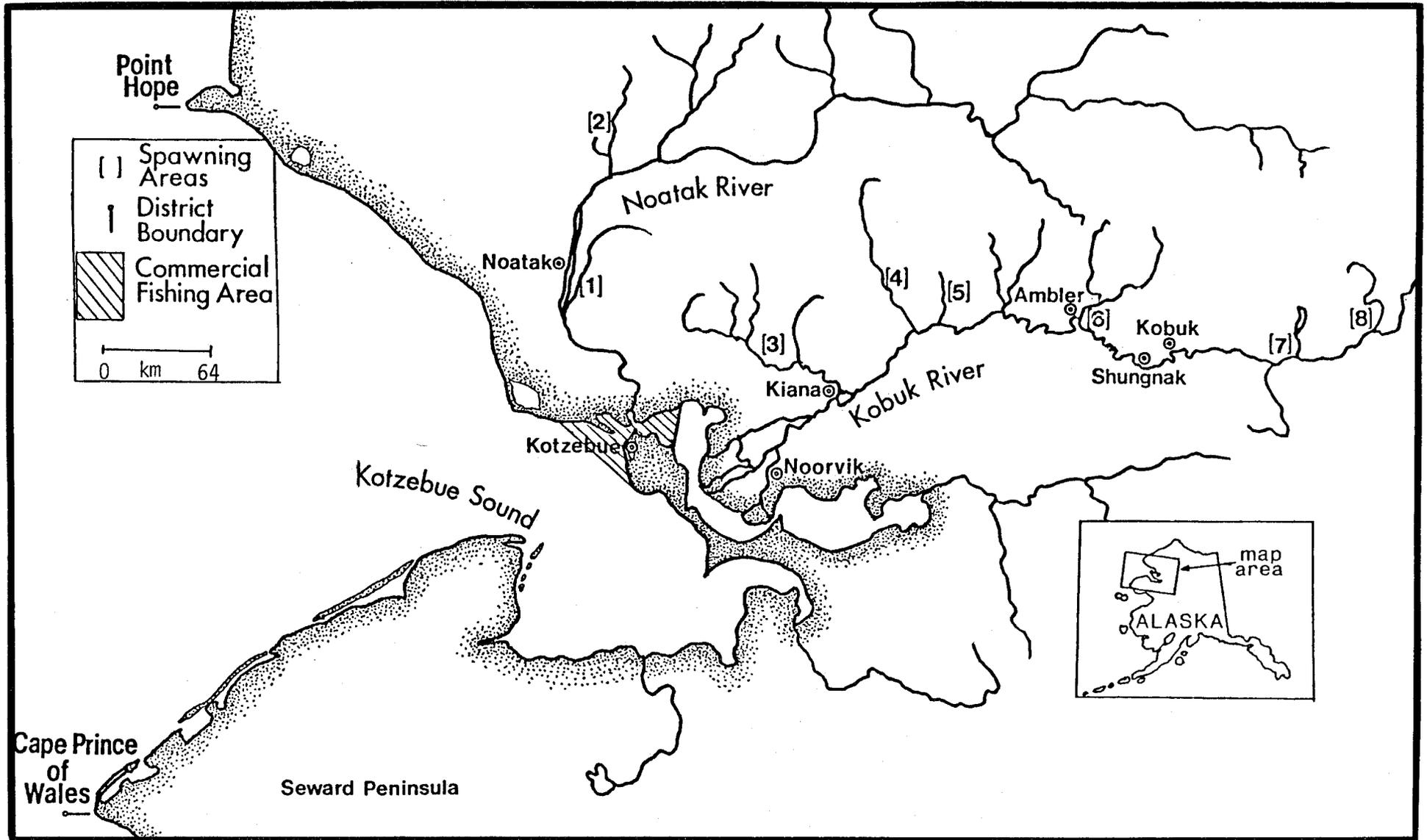


Figure 1. Kotzebue Sound commercial salmon fishing district and major chum salmon spawning areas in the Noatak and Kobuk River drainages; (1) Noatak River (lower 100 miles), (2) Kelly River and Creek, (3) Squirrel River, (4) Salmon River, (5) Tutuksuk River, (6) Ambler River, (7) Selby River and Slough, and (8) Beaver Creek.

Table 1. Catch, escapement, and total return of chum salmon (in thousands) to the Kotzebue District, 1962-1983.

Year	Escapement Index ¹	Commercial Catch	Subsistence Catch ²	Total Return Index
1962	180.5 ³	129.9	21.4	331.8
1963	88.6 ³	54.4	14.3	157.3
1964	117.8	74.5	17.0	209.3
1965	109.3 ³	40.0	19.6	168.9
1966	110.5	30.8	9.6	150.9
1967	61.0 ³	29.4	10.2	100.6
1968	53.1	30.4	12.3	95.8
1969	51.0	59.3	13.3	123.6
1970	161.5	159.7	22.7	343.9
1971	71.7	155.0	20.9	247.6
1972	91.2 ³	169.7	10.6	271.5
1973	186.5 ³	375.4	15.8	577.7
1974	251.4	627.4	19.7	898.5
1975	157.8	553.0	23.1	733.9
1976	57.6	159.8	9.9	227.3
1977	93.8 ³	195.9	4.1	293.8
1978	48.1 ³	111.5	11.3	170.9
1979	29.2	141.6	9.4	180.2
1980	216.7	367.3	8.5	592.5
1981	154.4	677.2	11.8	843.4
1982	148.5 ³	417.8	23.7	590.0
1983	139.1	175.7	12.9	327.7

¹ Peak aerial survey count in the year listed, unless footnoted otherwise.

² Estimated subsistence catches from Kobuk River villages and Kotzebue, excludes Noatak Village.

³ Escapement index estimated from the relationship between commercial fishery CPUE and total return noted in years where complete aerial surveys were conducted.

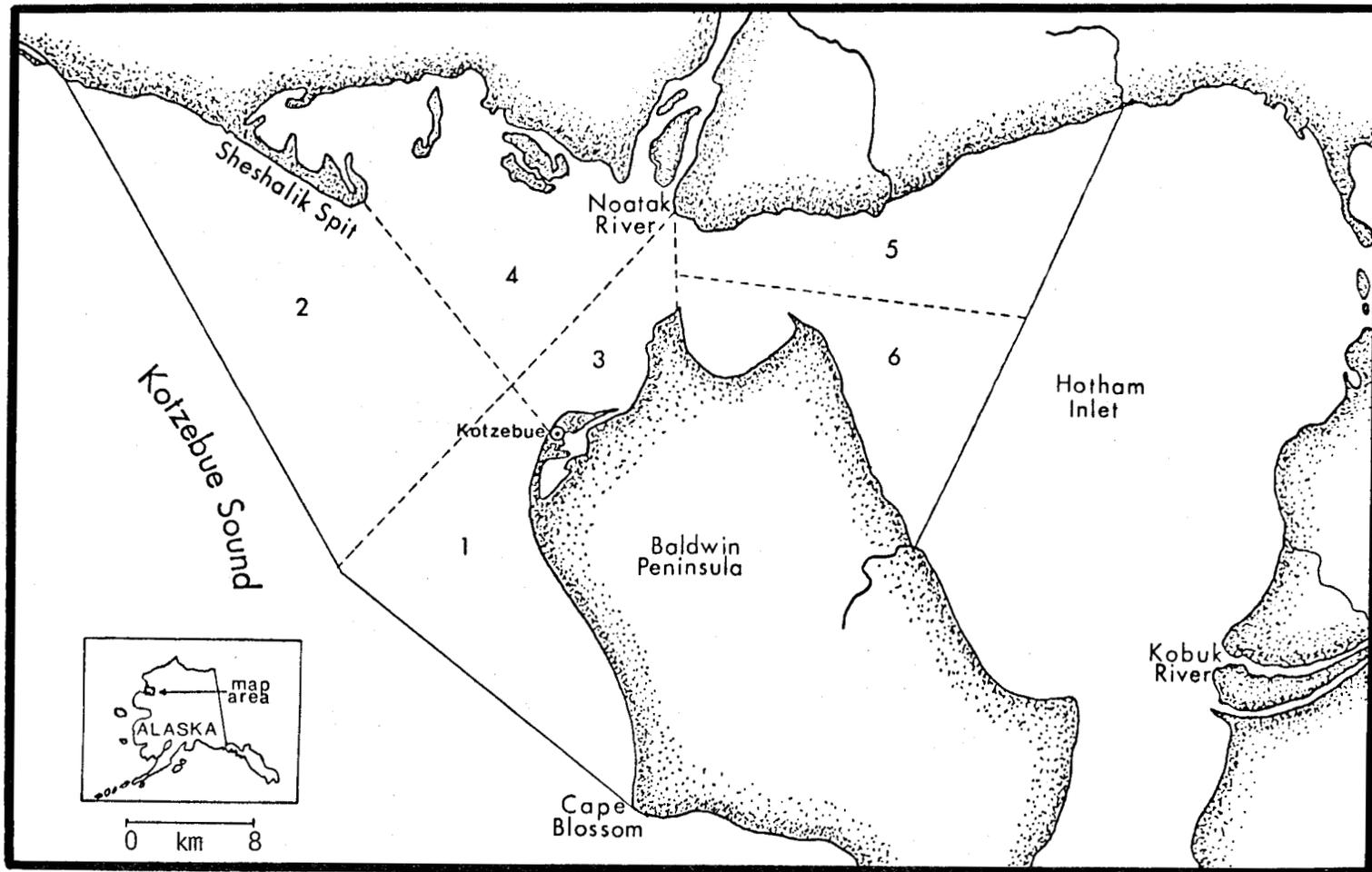


Figure 2. Chum salmon tagging areas used in 1981 and 1982 within the Kotzebue Sound commercial salmon fishing district.

spent within the commercial fishing district by chum salmon, as well as the travel time from tagging sites to recovery locations.

METHODS AND MATERIALS

Chum salmon were tagged throughout the Kotzebue Sound commercial fishing district. The district was partitioned into six tagging areas for spatial separation analysis (Figure 2).

Tagging was conducted from 14 July through 29 August in 1981 and from 1 July through 25 August in 1982 (Appendix 1). Three, two-person crews, operated 7.5 hours a day, six days a week throughout the season. Two local commercial fishermen tagged under contract in the northern portion of the district (areas 2 and 4; Figure 2). Two crews comprised of Alaska Department of Fish and Game (ADF&G) employees tagged in the south and east portion of the district (areas 1, 3, 5, and 6; Figure 2).

Salmon were captured using gill nets of similar configuration to those used in the commercial fishery (5-1/2 to 5-7/8 inch [14 to 15 cm] stretched mesh, up to 42 meshes deep and 50 fathoms [91 m] in length). Once captured, fish were tagged and released as quickly as possible. Fish were seldom out of the water for more than 40 seconds while an orange, 13 inch (33 cm), "spaghetti" type tag was applied.

Tags were inscribed with a sequential number and "ADF&G KOTZ \$2". A special stainless steel needle applicator was used to insert the tag immediately below and behind the dorsal fin. Once the needle was detached the free ends of the tag were tied in an overhand knot.

Tag number, species, sex, date, tag area, and general physical condition were recorded for each fish released. Physical condition upon release was subjectively assessed: Code 1 fish appeared vigorous and were considered in good condition; code 2 fish were questionable and code 3 fish were considered in poor condition.

The tagging study and its goals were announced to the public well before each season. A letter explaining the study was circulated to all limited entry permit holders immediately prior to the fishing season. Reward posters were placed in the Post Office and other conspicuous places in Kotzebue and all surrounding villages. Interviews and announcements were aired periodically over radio stations in Kotzebue and Barrow to develop and maintain community interest and to advertise tag rewards. Incentive for the public to return tags were boosted by periodic drawings for \$150.00 prizes and predesignating several tags to be worth \$100.00. The date, location, and method of recovery was recorded and a two dollar reward paid for each tag returned.

Commercial fish buyers cooperated by paying tag rewards to fishermen who turned over tags while selling fish. Buyers then attached the tags to the Department's copy of the fish ticket and were reimbursed at the end of each season.

ADF&G tagging crews conducted foot surveys of the Noatak and Kobuk River spawning areas to recover tags. These efforts were generally confined to areas of limited access to subsistence and sport fishermen. All major spawning grounds were sur-

veyed at least twice (Appendix 1, Table 3). The most effective tag recovery method from live fish proved to be snagging with sport tackle. ADF&G personnel conducting subsistence surveys of the Kotzebue region collected tags from village fishermen as well.

Statistical analysis was performed with the UCLA BMDP statistical package on the University of Alaska Honeywell computer system. All statistical tests were performed at the 95% confidence level.

RESULTS AND DISCUSSION

A total of 3,305 chum salmon was tagged from 14 July to 28 August, 1981 (Table 2), of which 831 (24.1%) tags were returned, including 710 (21.5%) with sufficient data for further analysis. Commercial catch recoveries totaled 550 (Table 3), while 96 were recovered from chum salmon spawning in the Kobuk River and 64 (Table 2) from Noatak River chum salmon spawning areas.

In 1982, 4,914 chum salmon were tagged from 1 July through 24 August (Table 2), and 1,197 (24.3%) tags were recovered from all sources. A total of 1,014 (20.6%) was returned with sufficient data for further analysis. Recoveries from the commercial fishery totaled 771 (Table 2), while 187 were recorded from the Kobuk River and 56 from the Noatak River (Table 2).

Only two tags were recovered from drainages other than the Noatak and Kobuk Rivers. A tag was recovered in 1981 from Fish Creek, a small stream draining into Hotham Inlet and, in 1982 a tag was returned from the Wulik River, which empties into Kotzebue Sound approximately 80 miles (130 km) north of Kotzebue.

Fluctuations in commercial fishing success were more or less mirrored by the total number of tags released during each fishing period (Figure 3). The resemblance in relative abundance between fishing success by the commercial fleet and the tagging crews suggests that results of this study represent the targeted population.

Migratory Timing of Noatak and Kobuk River Chum Salmon

Migratory timing conclusions are limited to the period of tagging operations; from 14 July through 29 August in 1981 and 1 July to 25 August in 1982. Most of the commercial fishery operations are included in these periods. Although chum salmon were still present upon project initiation and termination during both seasons, insufficient numbers were available to justify project continuance. Chum salmon have been reported within both the Kobuk and Noatak Rivers as late as December.

Only tags returned from the Noatak and Kobuk River drainages were included in the analysis of run timing. Direct comparison of the number of tags recovered from each river system was not possible because recovery effort was not proportionate to escapement abundance. All data (tagging and recovery) from each system were grouped by tagging week. That is, instead of grouping data by day of release, fish tagged from 1 July through 7 July were pooled to represent week one, data collected from 8-13 July, represent week two, and so on (Table 2). The proportions of data representing each weekly strata were then compared. Comparing proportions instead of actual tag numbers reduces statistical uncertainties introduced by unequal tagging and recovery effort.

Table 2. Number of chum salmon tagged in Kotzebue Sound and subsequently recovered in the Noatak and Kobuk Rivers, grouped by tagging week, 1981-1982.

<u>1981</u>	July				August				
	14-20	21-27	28-03	04-10	11-17	18-24	25-29		
Calender Week	14-20	21-27	28-03	04-10	11-17	18-24	25-29		
Tagging Week	1	2	3	4	5	6	7		
Tags Released Per Week	452	800	646	520	299	200	388	<u>Total</u> 3,305	
Percent	14	24	20	16	9	6	12		
Cum. Percent	14	38	57	73	82	88	100	100	
Kobuk River Recoveries	10	43	17	12	1	2	11	96	
Percent	10	45	18	13	1	2	12		
Cum. Percent	10	55	73	85	86	88	100	100	
Noatak River Recoveries	6	10	13	9	7	7	12	64	
Percent	9	16	20	14	11	11	19		
Cum. Percent	9	25	45	59	70	81	100	100	
<hr/>									
<u>1982</u>	July				August				
Calender Week	01-07	08-13	14-20	21-27	28-03	04-10	11-17	18-24	
Tagging Week	1	2	3	4	5	6	7	8	
Tags Released Per Week	120	269	754	880	1,011	895	832	153	<u>Total</u> 4,914
Percent	2	5	15	18	21	18	17	3	
Cum. Percent	2	7	23	41	62	80	97	100	100
Kobuk River Recoveries	9	12	31	41	33	36	26	6	187
Percent	5	6	17	21	17	18	13	3	
Cum. Percent	5	11	28	49	66	84	97	100	100
Noatak River Recoveries	0	1	2	7	14	14	16	4	56
Percent	0	2	4	12	23	23	29	7	
Cum. Percent	0	2	6	18	41	64	93	100	100

Table 3. Chum salmon tag recoveries in Kotzebue Sound by tagging area, 1981-1982.

Area ¹ Tagged	Area Recovered						Total Recovered	Percent Recovered	Total Released	Percent Released
	1	2	3	4	5	6				
<u>1981</u>										
1	23	20	6	41	9	0	99	18	729	22
2	47	186	3	71	5	0	312	57	1,546	47
3	7	11	5	17	3	0	43	8	359	11
4	3	41	2	15	2	0	63	11	192	6
5	1	2	0	0	4	0	7	1	200	6
6	3	5	3	11	3	1	26	5	279	8
Totals	84	265	19	155	26	1	550	100	3,305	100
<u>1982</u>										
1	219	58	44	97	13	0	431	56	2,537	52
2	62	40	11	32	6	0	151	20	986	20
3	53	18	29	38	13	0	151	20	1,233	25
4	1	6	1	26	0	0	34	4	115	2
5	0	0	0	0	0	0	0	0	0	0
6	0	0	4	0	0	0	4	0	43	1
Totals	335	122	89	193	32	0	771	100	4,914	100

¹ Tagging areas depicted in Figure 2.

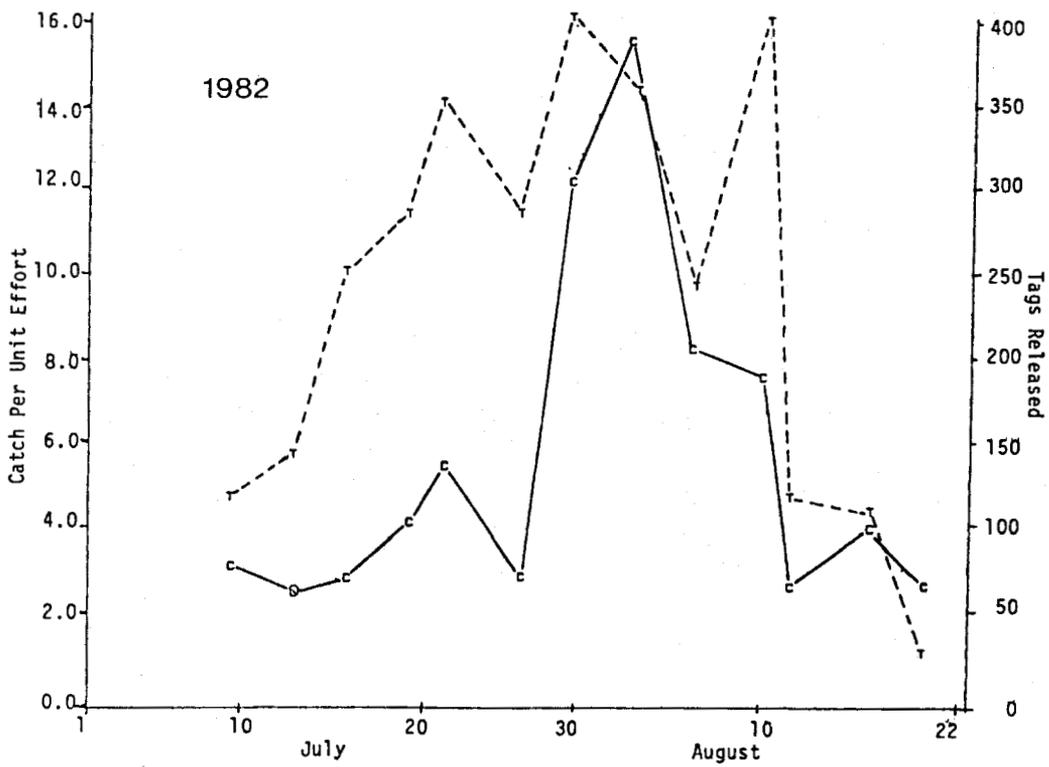
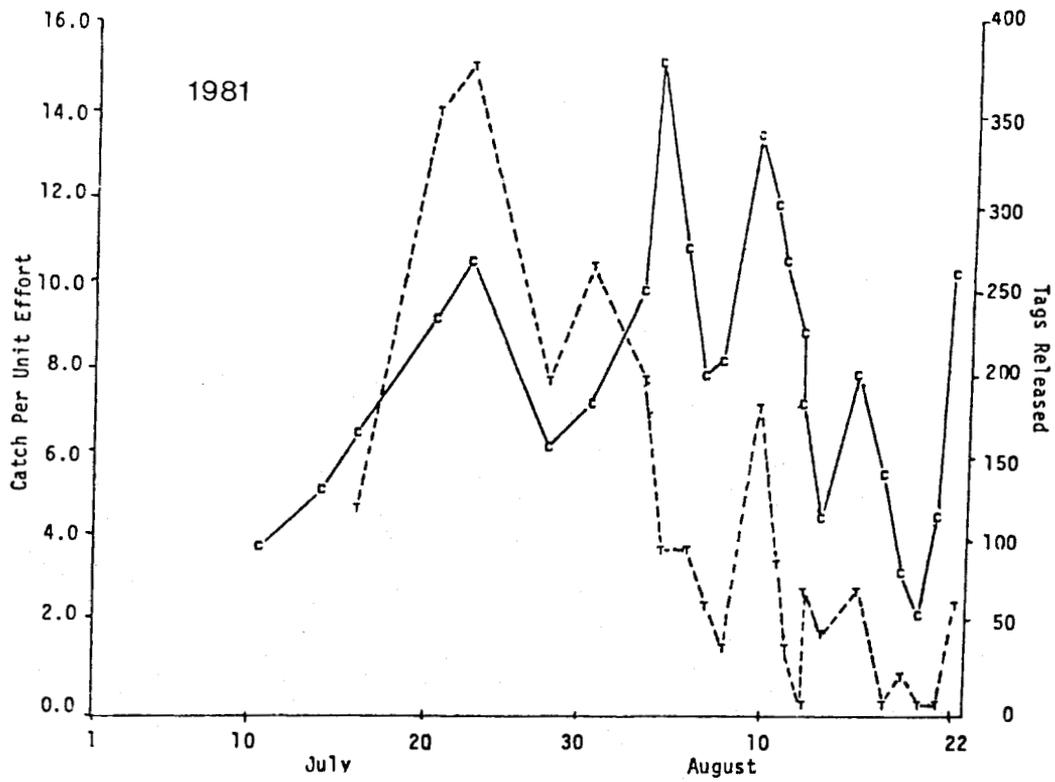


Figure 3. Commercial fishing period catch per unit effort (C) and total releases (T) per period for Kotzebue chum salmon in 1981 and 1982.

Tag recovery data obtained in 1981 indicated that 85% of all Kobuk River chum salmon passed through the commercial fishing district between 14 July and 10 August, and that Kobuk River salmon peaked in abundance between 21 and 27 July (Table 2). Noatak River chum salmon peaked in the commercial fishing district between 28 July and 3 August in 1981 (Figure 4).

Results obtained in 1982 indicated that by 10 August, 84% of all Kobuk River chum salmon had passed through the commercial fishery (Table 2). Kobuk River fish peaked in abundance between 21 and 27 July. Noatak River chum salmon peaked in mid-August (Table 2).

Mean dates of Kobuk and Noatak River chum salmon abundance in the Kotzebue Sound commercial fishing district (as indicated by tag returns) in 1981 were 31 July and 7 August, respectively. Comparable means for 1982 were 31 July and 4 August, respectively.

Migratory Timing of Upper and Lower Kobuk River Chum Salmon

The proportion of total recoveries per tagging week for both upper and lower Kobuk River recovery locations was compared. Tags recovered above the Tutuksuk River are considered upper Kobuk, tags recovered from spawning ground surveys of the Squirrel, Salmon, and Tutuksuk Rivers are considered lower Kobuk spawners (Figure 1). Tags returned from subsistence fishermen at Kiana and Noorvik are excluded since they represent fish of unknown origin.

Tag recovery data in 1981 indicated that, after 4 August, Kobuk chum salmon in Kotzebue Sound were primarily destined for upriver spawning areas. Both upper and lower Kobuk River stocks appeared to peak concurrently in the commercial fishery in 1981 (Figure 5).

In 1982, lower Kobuk chum salmon were most numerous in the commercial fishery from 1 July through early August, and peaked in abundance in late July. The abundance of upper Kobuk chum salmon increased substantially after early August (Figure 5).

Spatial Separation in Kotzebue Sound

More fish were tagged in areas 1 and 3 (Baldwin Peninsula) during both seasons because of unequal salmon abundance and disproportionate tagging effort. Sixty two percent of all fish in 1981 were tagged in areas 1 and 3; 75% in 1982. Subsequently, the majority of tags recovered on the Noatak and Kobuk Rivers originated in areas 1 and 3. In order to test for spatial separation the number of tags recovered on each river were compared with the number expected, given unequal sampling. Results from both seasons demonstrate that more Kobuk River tag returns than expected originated in areas 1 and 3, fewer than expected originated in areas 2 and 4 (Table 4). This strongly suggests that Kobuk River chum salmon migrate primarily along the Baldwin Peninsula. No spatial separation could be demonstrated for Noatak River fish.

Of fish tagged in Hotham Inlet (areas 5 and 6; Figure 2) in 1981, 88% were recovered from the Kobuk River, the remaining 12% were recovered from the Noatak River (Dinnocenzo 1981). There were no upriver recoveries of fish tagged in Hotham Inlet in 1982.

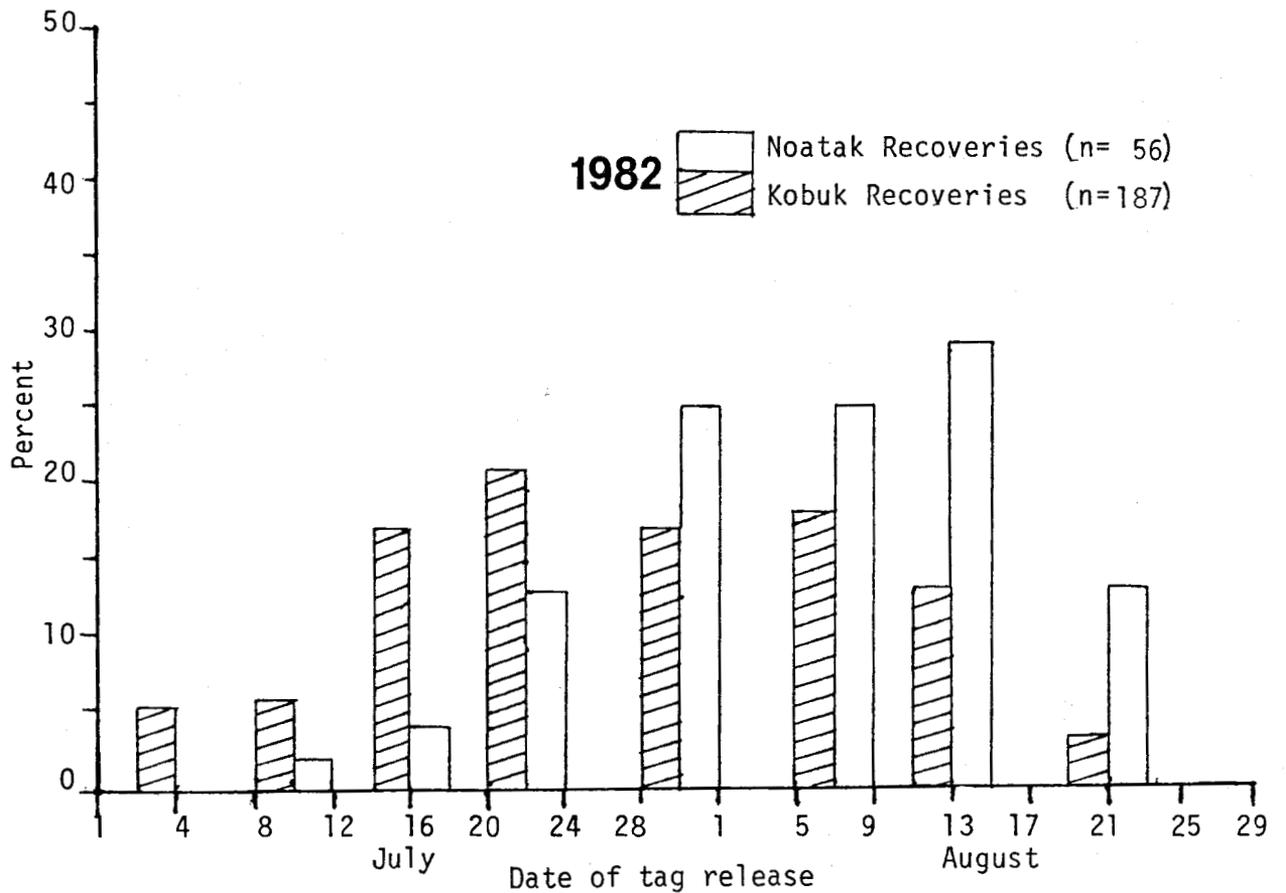
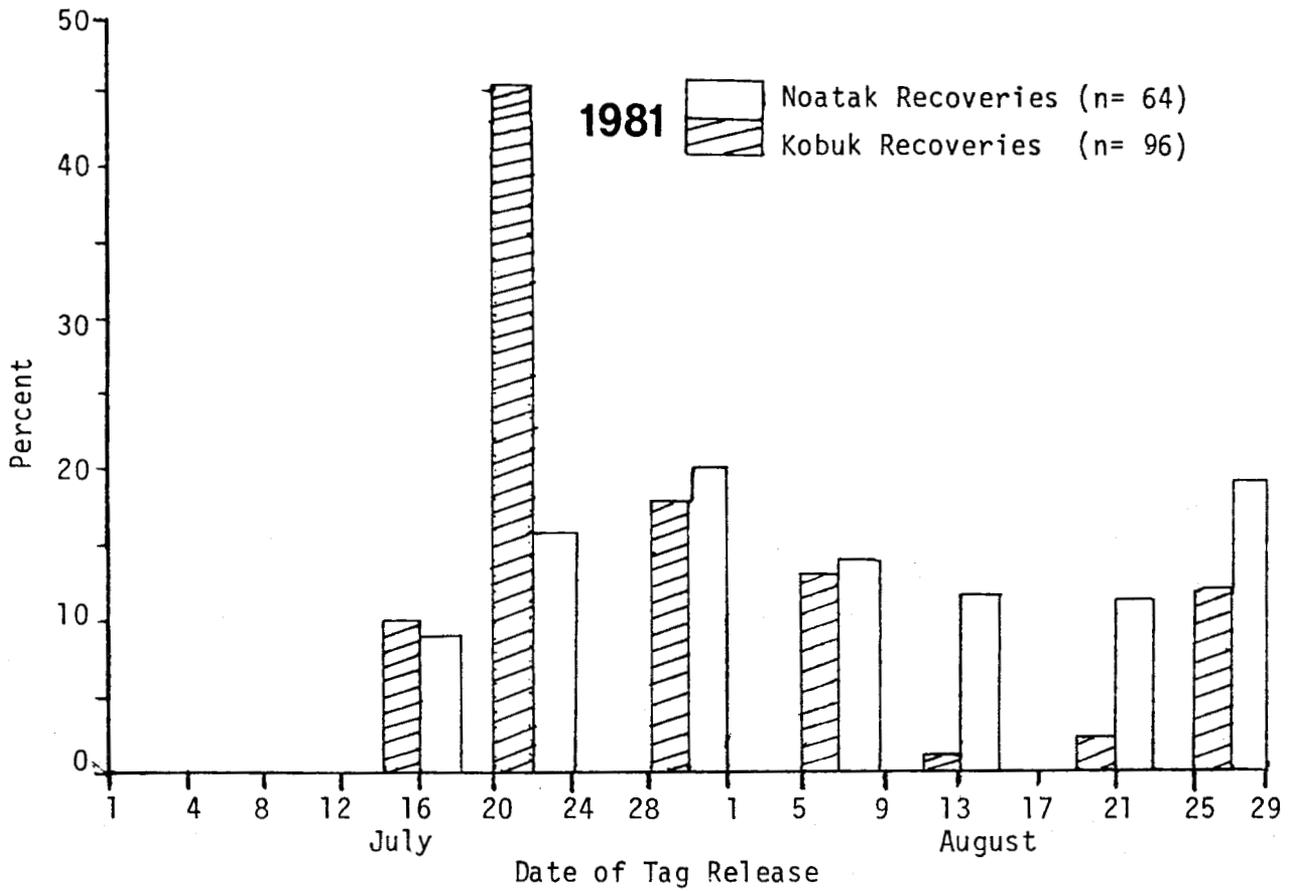


Figure 4. Relative proportions of Noatak and Kobuk River chum salmon in the Kotzebue Sound commercial fishing district as indicated by tag returns, 1981-1982.

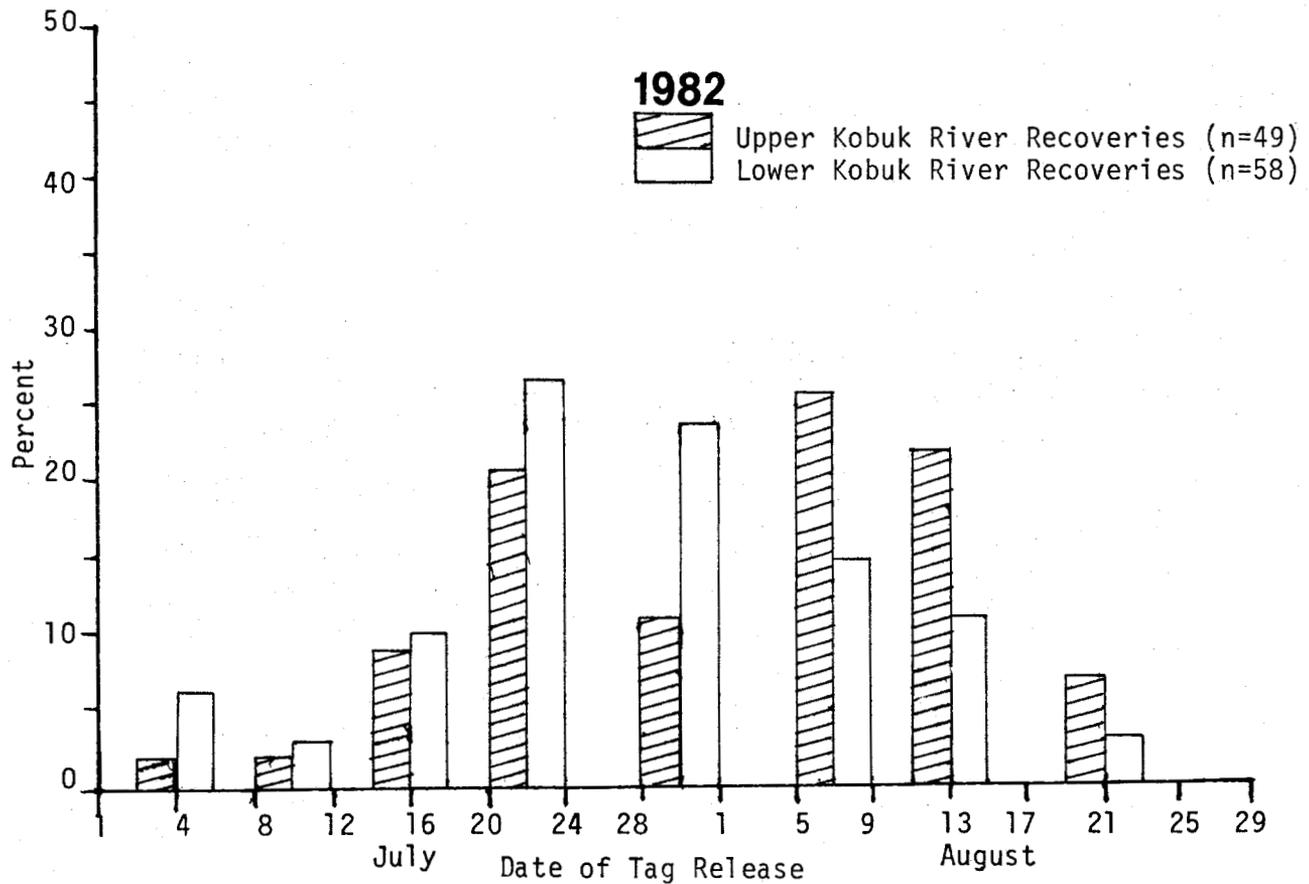
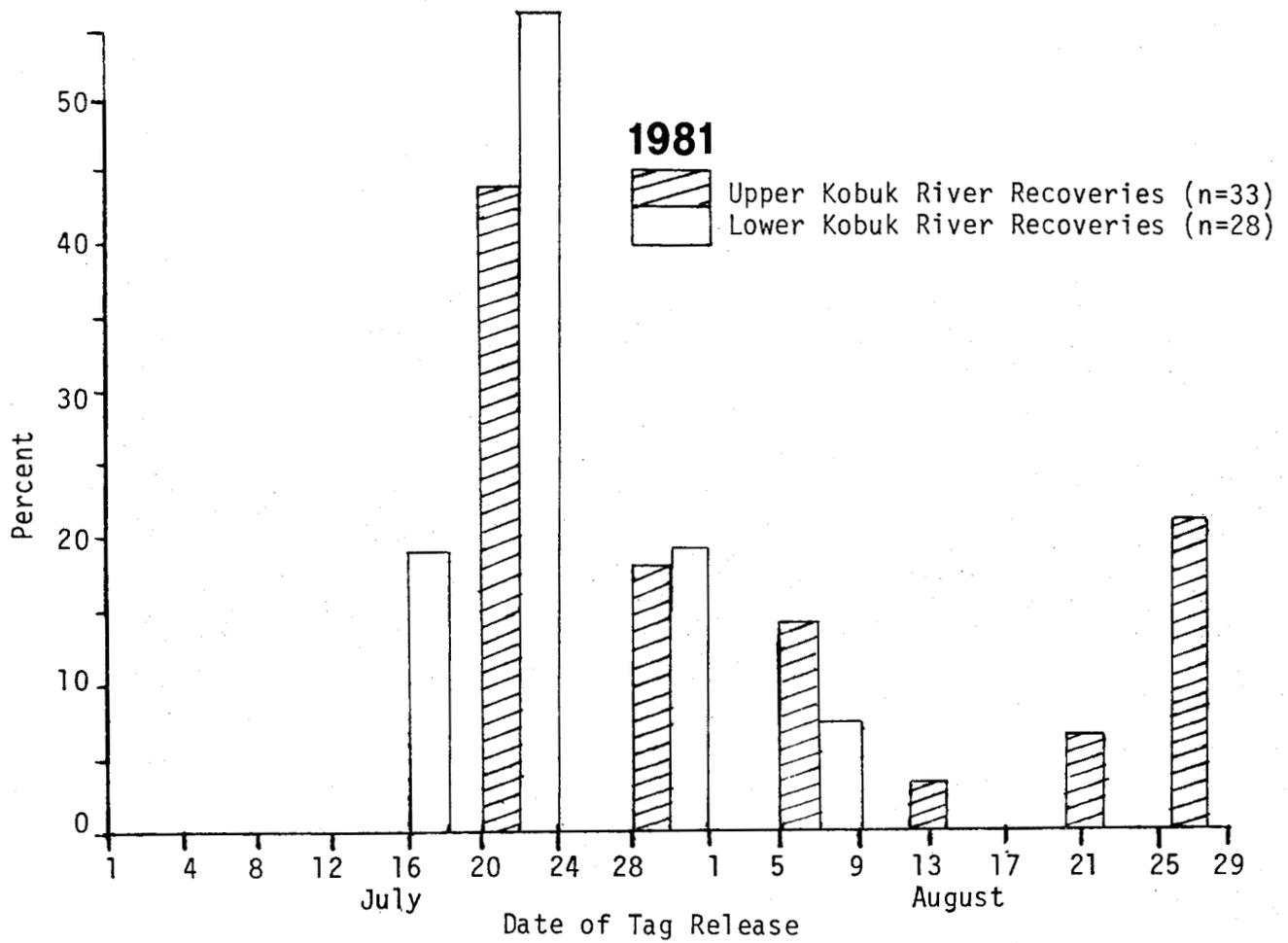


Figure 5. Relative proportions of upper and lower Kobuk River chum salmon in the Kotzebue Sound commercial fishing district, as indicated by tag returns, 1981-1982.

Table 4. Analysis of Noatak and Kobuk River spatial stock separation within Kotzebue Sound, 1981-1982.

Area of Release	Recapture Site	Expected ¹ Recoveries	Observed Recoveries	Z Test Results ²	Degrees of Freedom ³	Critical Value ⁴	Conclusion ⁵
1981							
1+3	Noatak R.	20	24	1.10	50	1.67	A
2+4	Noatak R.	31	27	1.19	50	1.67	A
1+3	Kobuk R.	25	49	6.17	63	1.67	B
2+4	Kobuk R.	39	15	12.50	63	1.67	B
1982							
1+3	Noatak R.	43	40	1.20	55	1.67	A
2+4	Noatak R.	13	16	0.89	55	1.67	A
1+3	Kobuk R.	142	160	3.33	183	1.65	B
2+4	Kobuk R.	42	24	3.03	183	1.65	B

¹ Number of tags expected to be recovered in a random sample of chum salmon from the respective rivers that have passed through Kotzebue Sound. That is, since 51 tags were recovered on the Noatak River in 1981, and 62 percent of all tags were released from areas 1 and 3, the expected number of Noatak recoveries from those areas is, (0.62)(51)=31; and so on.

² Expected/observed figures are compared using the "Z" Test, where:

$$Z = \frac{|P - \hat{P}|}{\frac{Pq}{n}}$$

P = Expected percentage recovered
 \hat{P} = Observed percentage recovered
 $q = 1 - P$
 n = Number of tags released in area

³ Degrees of freedom is: [(total number of tags recovered in each river) - 1].

⁴ The critical value for Z (appropriate degrees of freedom, 95 percent confidence).

⁵ A: Accept H_0 , the percentage of tags recovered upriver that originated in the given Kotzebue Sound tagging areas is a function of tagging effort. Spatial separation of migratory route is not suggested.

B: Reject H_0 , the percentage of tags recovered upriver that originated in the given Kotzebue Sound tagging areas does not reflect the percentage expected. Spatial separation is suggested.

Table 5. Migration rate and distance traveled of chum salmon tagged in Kotzebue Sound and recovered on the Noatak and Kobuk Rivers, 1981-1982.

Recovery Location	Sheshalik Releases ¹				Baldwin Peninsula Releases ²				
	Number Recovered ³	Mean Days-at-large	Distance Traveled in Miles	Miles/Day	Number Recovered ³	Mean Days-at-large	Distance Traveled in Miles	Miles/Day	Mean ⁴ Miles/Day
<u>1981</u>									
Noorvik	2	12.5	74	5.92	15	12.9	64	4.96	5.07
Kiana	1	23.0	99	4.30	7	30.0	89	2.97	3.14
Ambler	3	11.3	197	17.43	7	18.6	187	10.05	12.26
Shungnak	0	--	244	--	9	27.8	234	8.42	8.42
Kobuk	0	--	259	--	7	35.6	249	6.99	6.99
Noatak	12	32.6	90	2.76	4	31.8	80	2.52	2.70

<u>1982</u>									
Noorvik	7	11.4	74	6.49	33	17.8	64	3.60	4.10
Kiana	3	19.0	99	5.21	13	13.7	89	6.50	6.25
Ambler	1	17.0	197	11.59	10	16.0	187	11.69	11.68
Shungnak	1	36.0	244	6.78	9	19.4	234	12.06	11.53
Kobuk	3	29.7	259	8.72	11	29.5	249	8.44	8.50
Noatak	4	25.8	90	3.49	5	18.4	80	4.35	3.97
Noatak Sonar	1	25.0	40	1.67	3	28.7	36	1.25	1.36

¹ Chum salmon tagged in areas 2 and 4.
² Chum salmon tagged in areas 1, 3, 5, and 6.
³ Only includes data with known recovery dates.

⁴ Derived from the weighted formula:
 where, Xi is the number of recoveries
 from area i, and Yi is the average Miles/Day
 from area i.

$$\frac{\sum X_i(Y_i)}{\sum X_i}$$

Migration Rates and Milling Time

Several sources of error are possible in the calculation of time spent in Kotzebue Sound and migration rates to the rivers. The act of tagging can disrupt natural movements of chum salmon for several days (Chatwin 1953). No conscientious attempt was made in this study to detect alterations to natural movements caused by tagging.

Errors in the reported dates of recovery are thought to have occurred frequently in both seasons. Several tags were reported to have been recovered prior to the tagging date.

To simplify distance calculations, all salmon tagged in areas 2 and 4 were assumed to have traveled from Sheshalik Spit, fish tagged in areas 1, 3, 5, and 6 were assumed to have traveled from Kotzebue. Calculated mean migration rates were highly variable, ranging from 2.7 to 12.3 miles (4.3 to 19.8 km) per day (Table 5).

The lowest migration rate for both seasons was recorded for Noatak River fish. Noatak River salmon were primarily captured from spawning areas after an unknown period following their actual arrival. Therefore it is probable that true migration rates are higher than indicated. Four tagged fish were recaptured in 1982 approximately 50 miles (80 km) from the fishing district at the Noatak River sonar camp. Although captured during migration these fish exhibited the slowest average migration rate of any sampled (Table 5).

Salmon tags recovered in the lower Kobuk River indicate a slower migratory rate than those recovered in the upper Kobuk River (Table 5). These results are consistent with those of Yanagawa (1968).

A considerable amount of milling within Kotzebue Sound was indicated by tags returned from areas other than those of release (Table 3). The average time between tagging and recapture within the commercial fishing areas was 4.6 and 4.7 days for 1981 and 1982, respectively.

Physical Condition at Time of Release

A subjective assessment of the physical condition upon release was made for all fish in 1982. Each fish was assigned a single digit code for liveliness upon release. No significant difference can be demonstrated for each classification among tagged and recaptured fish. That is, the percentage of each code among tagged fish was close to those of all fish recaptured. These results suggest that post-tagging mortality either was not a factor, or was not predictable based upon subjective determinations of condition at release.

CONCLUSIONS

- 1) The majority of Kobuk River chum salmon migrate into the fishing district by traveling along the Baldwin Peninsula and reach peak abundance prior to 1 August.

- 2) Noatak River chum salmon migrate throughout Kotzebue Sound, no preferred migration corridors were indicated. These stocks reach peak abundance after 1 August.
- 3) Early migrating Kobuk River chum salmon are mostly destined for the spawning grounds of the lower Kobuk River (below Ambler). Late migrating Kobuk River stocks spawn above Ambler and are present in Kotzebue Sound during the peak of the Noatak River migration.

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APPENDIX 1

Appendix 1 - Table 1. Number of chum salmon tagged daily in Kotzebue Sound, 1981.

Date	Area Tagged						Daily Total	Cumulative Total
	1	2	3	4	5	6		
July								
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0
14	1	0	2	0	0	0	3	3
15	0	0	32	0	0	0	32	35
16	0	28	15	2	0	0	45	80
17	0	56	7	14	0	0	77	157
18	0	83	31	0	0	0	114	271
19	0	19	46	0	2	15	82	353
20	1	21	3	0	0	74	99	452
21	0	29	6	0	0	37	72	524
22	102	10	0	0	0	66	178	702
23	2	50	0	4	6	2	64	766
24	1	50	0	0	0	0	51	817
25	177	34	0	0	52	0	263	1,080
26	0	6	68	0	21	0	95	1,175
27	0	0	28	49	0	0	77	1,252
28	0	0	0	50	0	0	50	1,302
29	0	0	1	50	17	0	68	1,370
30	58	8	0	0	0	44	110	1,480
31	0	92	0	0	0	6	98	1,578

-Continued-

Appendix 1 - Table 1. Number of chum salmon tagged daily in Kotzebue Sound, 1981 (continued).

Date	Area Tagged						Daily Total	Cumulative Total
	1	2	3	4	5	6		
August								
1	0	50	0	0	1	0	51	1,629
2	141	0	0	0	3	0	144	1,773
3	74	50	0	0	0	1	125	1,898
4	0	50	0	0	12	9	71	1,969
5	0	50	0	0	17	23	90	2,059
6	0	51	0	0	38	0	89	2,140
7	5	50	0	0	5	0	60	2,208
8	8	25	0	0	2	0	35	2,243
9	12	75	0	0	3	0	90	2,333
10	18	50	0	0	17	0	85	2,418
11	30	49	0	0	2	0	81	2,499
12	9	30	0	0	0	0	39	2,538
13	0	4	0	0	0	0	4	2,542
14	0	0	65	0	0	0	65	2,607
15	15	27	1	0	2	0	45	2,652
16	0	0	0	0	0	0	0	2,652
17	15	2	48	0	0	0	65	2,717
18	0	0	0	0	0	0	0	2,717
19	0	11	2	0	0	2	15	2,732
20	0	0	0	0	0	0	0	2,732
21	0	0	0	0	0	0	0	2,732
22	8	50	4	0	0	0	62	2,794
23	6	0	0	0	0	0	6	2,800
24	0	96	0	21	0	0	117	2,917
25	39	101	0	2	0	0	142	3,059
26	4	69	0	0	0	0	73	3,132
27	3	40	0	0	0	0	43	3,175
28	0	65	0	0	0	0	65	3,240
29	0	65	0	0	0	0	65	3,305
Totals	729	1,546	359	192	200	279	3,305	
Percent	22	47	11	6	6	8		

Appendix 1 - Table 2. Number of chum salmon tagged daily in Kotzebue Sound, 1982.

Date	Area Tagged						Daily Total	Cumulative Total
	1	2	3	4	5	6		
July								
1	3	0	0	0	0	0	3	3
2	0	0	13	0	0	0	13	16
3	0	4	2	0	0	0	6	22
4	0	0	0	0	0	0	0	22
5	0	0	1	0	0	0	1	23
6	19	5	1	1	0	0	26	49
7	40	31	0	0	0	0	71	120
8	21	91	0	0	0	0	112	232
9	0	0	0	0	0	2	2	234
10	0	0	0	0	0	0	0	234
11	12	0	0	0	0	0	12	246
12	35	12	0	0	0	0	47	293
13	58	38	0	0	0	0	96	389
14	106	45	0	0	0	0	151	540
15	23	0	0	0	0	0	23	563
16	40	26	0	0	0	0	66	629
17	172	68	0	0	0	0	240	869
18	24	0	0	0	0	0	24	893
19	233	0	0	0	0	0	233	1,126
20	0	0	8	3	0	6	17	1,143
21	3	20	70	0	0	32	125	1,268
22	97	5	161	0	0	0	263	1,531
23	0	18	0	0	0	0	18	1,549
24	0	0	74	0	0	0	74	1,623
25	0	0	49	0	0	0	49	1,672
26	56	1	279	0	0	0	336	2,008
27	0	15	0	0	0	0	15	2,023
28	144	37	0	0	0	0	181	2,204
29	225	30	5	0	0	0	260	2,464
30	0	0	19	0	0	3	22	2,486
31	0	2	0	0	0	0	2	2,488

-Continued-

Appendix 1 - Table 2. Number of chum salmon tagged daily in Kotzebue Sound, 1982 (continued).

Date	Area Tagged						Daily Total	Cumulative Total
	1	2	3	4	5	6		
August								
1	361	0	2	0	0	0	363	2,851
2	116	6	0	0	0	0	122	2,973
3	0	61	0	0	0	0	61	3,034
4	193	22	0	0	0	0	215	3,249
5	206	25	0	0	0	0	231	3,480
6	0	32	0	0	0	0	32	3,512
7	0	94	0	0	0	0	94	3,606
8	166	0	0	0	0	0	166	3,772
9	76	47	0	0	0	0	123	3,895
10	0	8	0	26	0	0	34	3,929
11	0	82	0	0	0	0	82	4,011
12	111	0	200	32	0	0	343	4,354
13	0	0	0	31	0	0	31	4,385
14	0	0	0	22	0	0	22	4,407
15	0	0	240	0	0	0	240	4,647
16	0	15	13	0	0	0	28	4,675
17	0	86	0	0	0	0	86	4,761
18	0	5	0	0	0	0	5	4,766
19	0	1	96	0	0	0	97	4,863
20	2	8	1	0	0	0	11	4,874
21	0	2	0	0	0	0	2	4,876
22	0	0	0	0	0	0	0	4,876
23	0	1	0	0	0	0	1	4,877
24	0	27	0	0	0	0	27	4,904
25	0	10	0	0	0	0	10	4,914
Totals	2,542	980	1,234	115	0	43	4,914	
Percent	52	20	25	2	0	1		

Appendix 1 - Table 3. Number of chum salmon observed and tags recovered by ADF&G technicians on Noatak and Kobuk River spawning grounds, 1981-82 ¹

Location	Live	Carcass	Total	Tags ²	Ratio
<u>1981</u>					
<u>Noatak River Drainage</u>					
Noatak River	35,403	³	35,403	40	1:885
Kelly Lake and Creek	10,953	421	11,374	12	1:948
Kelly River	2,396	³	2,396	3	1:799
Drainage Total	48,752	421	49,173	55	1:894
<u>Kobuk River Drainage</u>					
Squirrel River	5,391	4,850	10,241	16	1:640
Salmon River	4,434	7,601	12,035	22	1:547
Drainage Total	9,825	12,451	22,276	38	1:586
Total	58,577	12,451	71,449	93	1:768
<u>1982</u>					
<u>Noatak River Drainage</u>					
Noatak River	32,099	10,309	42,408	45	1:942
Kelly Lake and Creek	4,344	³	4,344	12	1:362
Kelly River ⁴	186	312	498	1	1:498
Drainage Total	36,629	10,621	47,250	58	1:815
<u>Kobuk River Drainage</u>					
Squirrel River	7,087	773	7,860	21	1:374
Salmon River	1,604	5,659	7,263	29	1:250
Tutuksuk River	1,042	685	1,727	4	1:431
Drainage Total	9,733	7,117	16,850	54	1:312
Total	46,362	17,738	64,100	112	1:572

¹ Major spawning areas were surveyed at least twice between 21 August and 19 September 1981; 20 August and 15 September 1982.

² Includes tags seen but not recovered.

³ Carcasses included in live fish count.

⁴ Not a complete survey.

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