

AYK REGION
NS/K ESC. REPORT# 10

KWINIUK RIVER COUNTING TOWER PROJECT, 1973

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ABSTRACT

A salmon counting tower project on the Kwiniuk River, completed its ninth season of operation in 1973. The Kwiniuk River escapement for 1973 was 28,029; 37,070 and 57, for chum salmon (Oncorhynchus keta), pink salmon (O. gorbuscha) and king salmon (O. tshawytscha) respectively. Forecasts of chum salmon runs using pink salmon brood year escapements were made, yielding 1974 and 1975 estimates of 42,679 and 33,306 respectively. Aerial survey counts of salmon in 1973 were found to be 68 and 66 percent effective over tower counts for chum and pink salmon, respectively.

INTRODUCTION

A salmon counting tower project was initiated in 1965 on the Kwiniuk River, 110 miles east of Nome (Figure 1). The Kwiniuk River, similar to other major rivers in Norton Sound, receives moderate runs of chum and pink salmon which are harvested by subsistence and commercial fishermen. To effectively manage the Norton Sound fisheries, it is important that frequent estimates of escapements during the season be obtained by either tower counts or aerial survey counts. The tower count

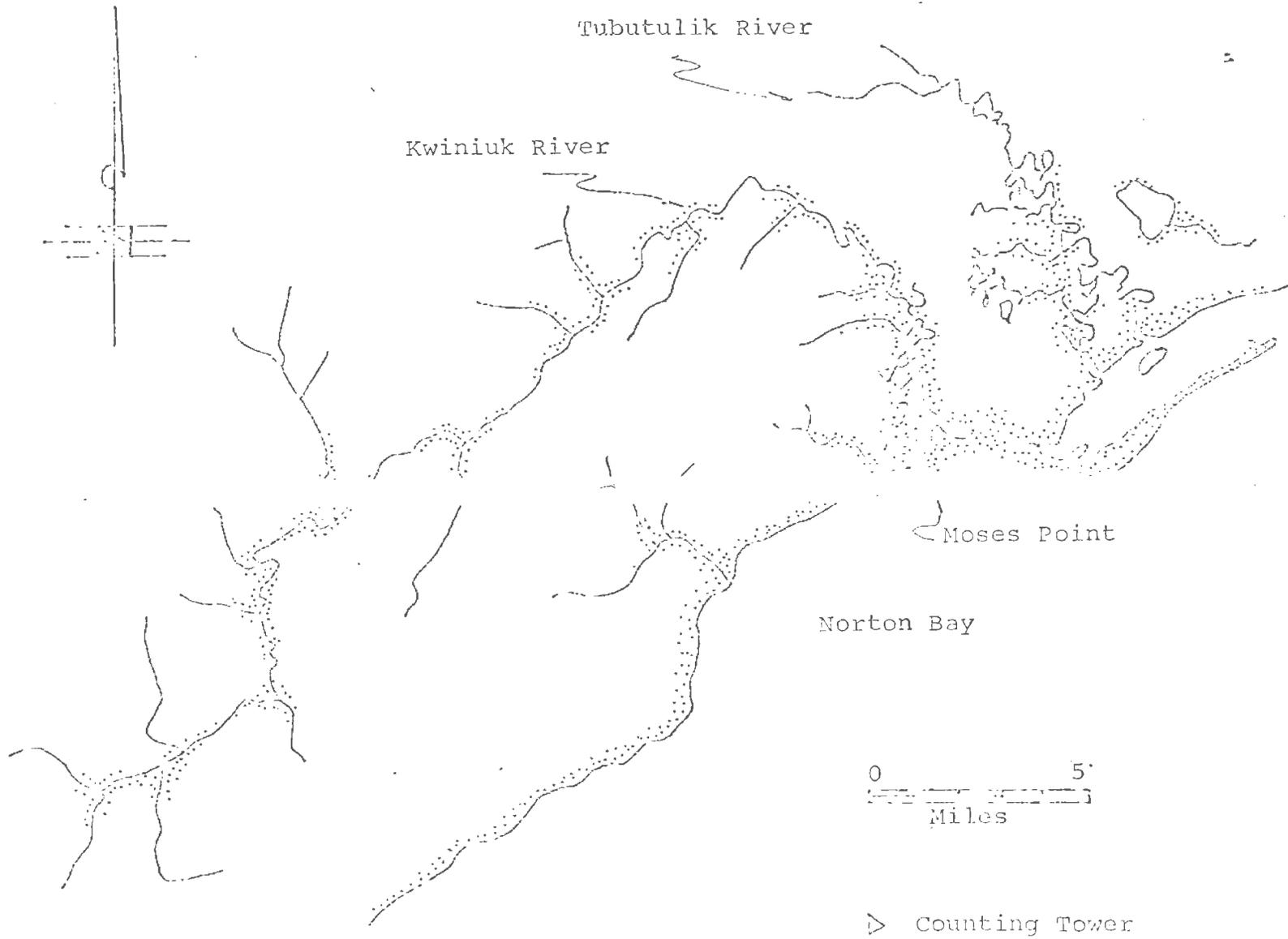


Figure 1. Salmon counting tower location. Kwiniuk River, 1973.

is the more accurate method and provides a check on the aerial surveys conducted.

OBJECTIVES

The 1973 project objectives were to:

1. Obtain daily and seasonal timing and magnitude of salmon escapements.
2. Periodically sample the Moses Point commercial salmon fishery and the escapement populations for age, sex and size information.
3. Conduct late season salmon carcass surveys of the Kwiniuk and Tubutulik Rivers to determine species composition and sex ratios.

METHODS AND MATERIALS

A portable 20-foot aluminum counting tower was erected adjacent to the river upon a 30-foot high bank at the same location used since 1965, approximately five miles above the river mouth.

A 75-foot weir of 3/8" mesh hardware cloth was constructed to block a secondary channel formed by a mid-river sand bar located across the main channel from the tower.

A power line with three 400-watt incandescent light bulbs housed in 18-inch diameter reflectors was strung

across the main channel to provide illumination during darkness. A 1250-watt generator provided electric current for the lights.

A three-man crew began 18 hour counting operations on June 25, and terminated counting operations on July 25, 1973. Each crew member counted salmon for two 3-hour shifts daily, from 1200 until 0600 the next day. Hourly counts were totaled. Salmon moving downstream were subtracted from the total count.

One aerial survey of the lower Kwiniuk River was conducted from a chartered Cessna 180 aircraft.

The commercial fishery catches were periodically sampled for age, sex and size information at the buying station near the river mouth. The escapement population was sampled near the tower site using a beach seine to capture the fish.

Forecasts of chum salmon escapement were made, based upon pink salmon escapement of the same parent year, (Mattson, 1966).

RESULTS

In 1973 a total of 28,029 chums and 37,070 pink salmon was counted past the tower. The main peaks of the chum run occurred during the period July 8-10, and

14-19, while the peak of the pink run passed the tower during the period July 10-21 (Figure 2). The daily chum run was heaviest from 1700 to 2400, with the largest counts occurring from 1800 to 2200. The pink migration was greatest during a similar period, 1700 to 0100, with the peak occurring from 1800 to 2400 (Table 1 Figure 3).

In 1973, a total of 57 king salmon was counted past the tower. The daily cumulative king salmon escapement is presented in Table 2.

An aerial survey of the lower Kwiniuk River was conducted on July 7, 1973 with a count of 6,045 chum and 3,180 pink salmon. The cumulative tower count on that date was 8,870 chum and 4,795 pink salmon for a percent effectiveness of 68 and 66 respectively.

A total of 360 chums was sampled from the Moses Point commercial fishery and 279 chums were collected by beach seine from the spawning population of the Kwiniuk River. Carcass surveys were conducted on the Kwiniuk and Tubutulik Rivers on August 4-7 and 10-13 respectively. A total of 4,628 chum and 5,759 pink salmon carcasses was enumerated on the Kwiniuk survey. The Tubutulik survey yielded a carcass count of 5,839 chums and 18,997 pink salmon. Ninety-one chum carcasses

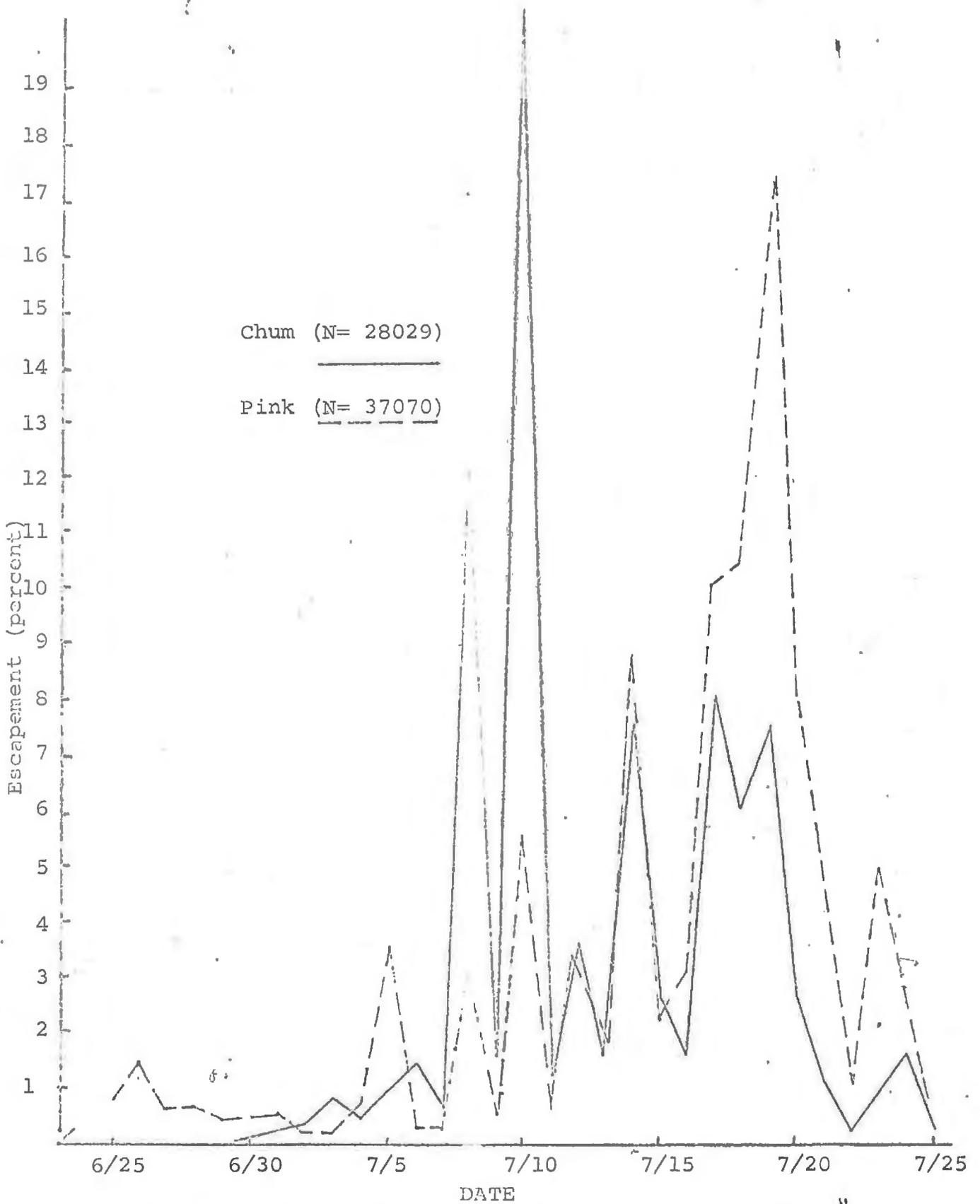


Figure 2. Daily escapement of chum and pink salmon, Kwiniuk River, 1973.

Table 1. Kwinik River daily hourly counts and percentages, 1973.

Species: Ch. l.

	Daily % of																						
	0	1	2	3	4	5	12	13	14	15	16	17	18	19	20	21	22	23	Total	Total			
25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	-	-	11				
26	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	2				
27	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4				
28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0				
29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0				
30	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9				
y 1	-	-	-	-	-	-	-	-	1	-	-	64	-	-	6	-	-	-	71	0.			
2	34	-	-	-	-	-	3	-	-	-	-	1	-	-	72	-	-	110	0.				
3	-	1	-	-	-	-	-	2	-	-	39	40	-	1	37	74	1	195	0.				
4	2	-	-	-	-	-	-	-	-	-	95	5	163	461	294	82	10	1112	4.				
5	4	-	-	-	-	-	-	5	592	252	109	305	1014	519	92	48	40	51	3031	10.			
6	51	12	-	-	-	-	1	15	54	125	46	15	-	-	-	34	-	35	388	1.			
7	-	-	-	-	-	-	-	3	-	2	-	-	-	6	-	37	45	49	142	0.			
8	-44	6	-34	2	10	3	15	20	-	-	245	766	421	131	274	308	504	793	3420	12.			
9	133	15	13	1	-	-	4	-	-	-	-	25	1	4	22	6	40	111	375	1.			
10	251	160	18	29	17	-	-	35	94	346	600	134	269	61	1151	1117	1202	668	6152	21.			
11	44	8	-	2	1	6	119	28	36	7	24	9	3	2	-	1	19	9	215	1.			
12	166	-	-	-1	-4	-5	-	-	-	3	-	24	81	68	40	139	216	239	966	3.			
13	102	98	77	27	-2	-	-	-	-	1	-	6	3	2	2	36	102	19	473	1.			
14	35	33	3	2	-	-	5	-	-	73	95	775	588	495	53	-	7	4	2168	7.			
15	-27	9	2	-1	1	-	-	-	1	55	28	251	59	8	5	2	32	297	722	2.			
16	16	2	3	-	1	-	9	21	47	20	-	19	13	135	23	111	51	1	472	1			
17	711	36	13	32	14	-	-	1	-	70	327	137	231	113	112	22	242	197	2258	8.			
18	16	9	2	5	24	13	-	-	9	4	8	236	713	285	209	51	46	49	1679	6.			
19	67	24	12	-	-	3	-	-	-1	52	108	283	390	232	580	190	194	18	2152	7.			
20	5	2	-	-	1	-	2	-	-1	1	4	15	20	109	243	210	92	65	768	2.			
21	36	6	18	7	-	-	-	-1	-	3	-	1	28	24	30	68	72	17	309	1.			
22	6	2	1	3	1	-	-	-	-	-1	2	14	2	1	5	-	-	2	37	0			
23	-	2	-	-	1	-	-	-	-	88	125	3	-	-	-	-	-	10	229	0.			
24	23	2	2	-	-	-	4	3	3	-	1	50	10	4	7	1	11	317	438	1.			
25	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21	0.			
daily	1665	427	130	108	64	20	162	132	834	1104	1722	3201	3956	2362	3310	2801	3070	2961	28029	100			
of	5.9	1.5	0.5	0.2	0.2	0.1	0.6	0.5	3.0	3.9	6.1	11.4	141	8.4	11.8	10.0	11.0	10.6	100.0				

Table 1. (continued) Kwiniuk River daily-hourly counts and percentages, 1973. Species: Pink

Date	0	1	2	3	4	5	12	13	14	15	16	17	18	19	20	21	22	23	Daily Total	% of Total
June 25	-	-	-	17	-	2	5	5	-	101	72	24	12	12	50	12	-	10	322	0.9
26	26	19	45	16	81	18	5	6	7	20	7	3	30	101	121	4	-	-	509	1.4
27	2	21	49	8	4	4	2	2	4	21	1	15	3	20	31	22	10	3	222	0.6
28	30	-	4	4	-	-	1	3	3	9	11	19	20	31	-	48	21	19	223	0.6
29	36	11	4	-	-	-	6	7	22	7	11	9	2	5	2	7	7	1	137	0.4
30	27	7	-	7	2	1	-	3	10	8	5	14	9	8	5	11	24	21	162	0.4
July 1	40	3	-	7	13	3	-	1	18	3	21	19	18	7	15	9	10	-	187	0.5
2	8	-	-	-	-	2	13	-	-	13	-	-	20	-	6	30	-	-	92	0.2
3	3	6	5	-	-	-	-	7	-	-	-	18	15	-	-	7	21	2	84	0.2
4	-	-	-	-	-	-	-	-	-	8	2	13	4	12	142	57	18	-4	252	0.7
5	3	-	-	-	-	-	1	-	101	54	10	44	375	502	87	67	31	26	1301	3.5
6	18	-	-	-	-	-	1	1	4	11	2	2	1	-	-1	18	-	8	65	0.2
7	4	-	-	-	-	-1	-	-	-	-	-	-	-	-	-	9	37	26	75	0.2
8	-26	-	-21	-10	12	-	2	-	-	-	47	142	192	60	219	152	150	245	1164	3.1
9	125	9	2	-	1	-	-	-	-	-	-	-	-	-	-	-	2	40	-	-
10	15	3	7	3	4	1	1	3	4	-	8	1	95	28	353	456	677	441	2100	5.7
11	3	-	-	3	2	10	81	22	36	3	9	-	11	14	6	-	6	42	248	0.7
12	112	-	-	-5	-2	-6	-	-	1	6	13	18	37	68	29	155	359	427	1212	3.3
13	172	39	46	62	-	-1	-	-	-	-	-	12	-	6	48	113	142	103	742	2.0
14	64	33	20	16	8	-	3	1	4	55	53	304	1484	1046	112	-	19	9	3231	8.7
15	-15	21	5	-	-	-	1	-	-	34	25	379	140	43	26	5	117	100	881	2.4
16	31	8	1	-	-	1	27	88	246	53	-	38	16	271	78	212	106	-	1176	3.2
17	1329	46	30	131	94	3	1	1	-	84	394	171	292	160	240	82	193	527	3778	10.2
18	59	20	6	38	142	20	2	-	36	5	8	312	1026	424	415	126	128	100	2867	7.7
19	109	48	25	-	-	7	2	-	-	202	404	1033	842	481	1735	643	959	44	6534	17.6
20	4	1	4	-	2	-1	-	-	6	5	11	33	42	346	697	996	582	313	3041	8.2
21	67	14	-	19	1	-	1	-	-	2	-	25	8	64	148	816	724	164	2053	5.5
22	10	3	6	8	-	-	-	-	-	2	35	58	25	23	71	36	89	41	407	1.1
23	10	4	-	-	2	-	3	4	11	539	675	58	19	-	4	10	13	511	1863	5.0
24	118	19	5	-	-	-	53	28	22	14	52	322	53	41	107	3	61	946	1844	5.0
25	114	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	114	0.3
Hourly Totals	2496	335	243	324	366	63	211	182	535	1259	1876	3086	4791	3773	4752	4106	4507	4165	37070	100.0
% of total run	6.7	0.9	0.6	0.9	1.0	0.2	0.6	0.5	1.4	3.4	5.1	8.3	12.9	10.2	12.8	11.1	12.2	11.2	100.0	

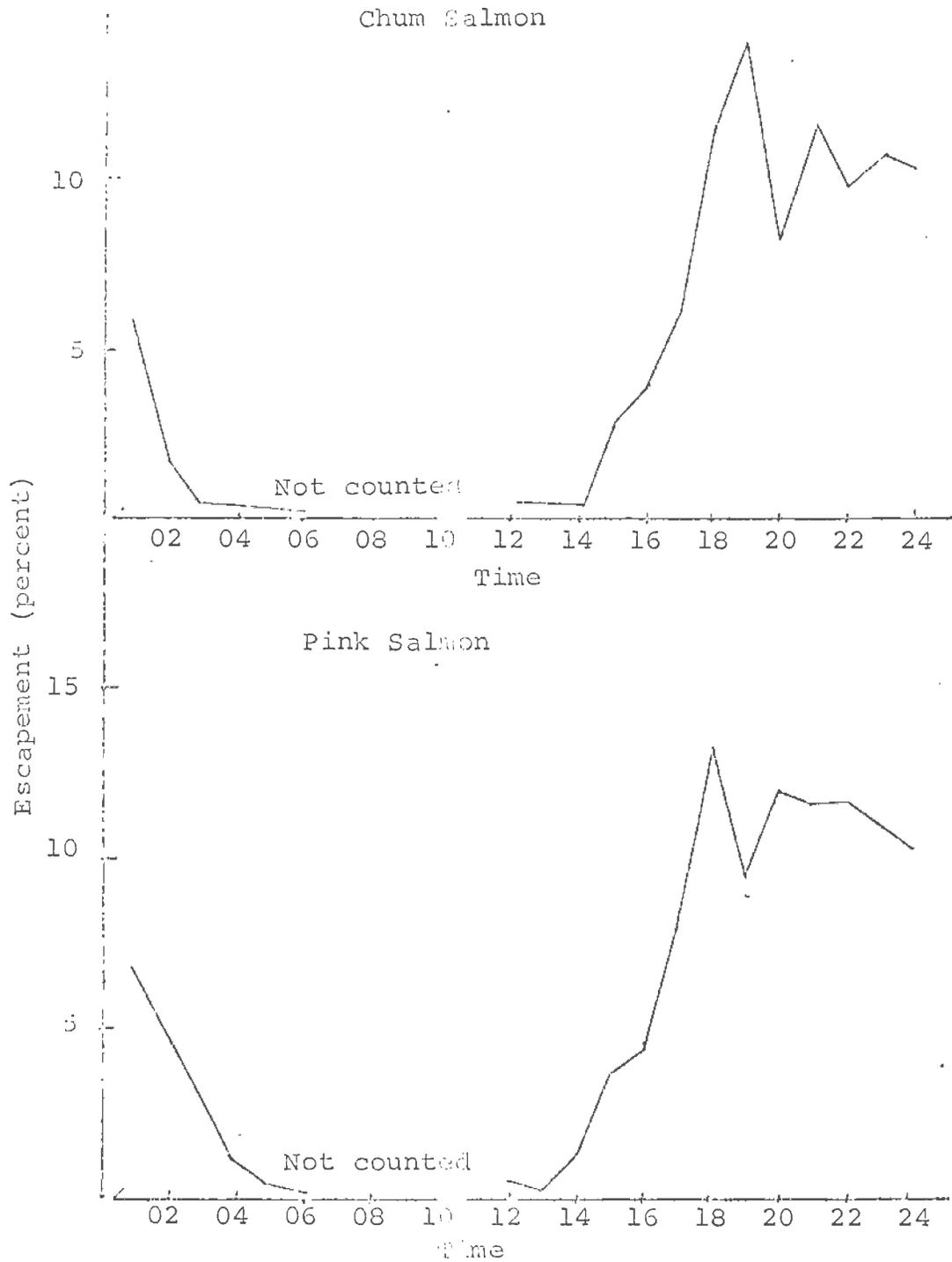


Figure 3. Hourly migration patterns of chum and pink salmon, Kaniuk Tower, 1973.

Table 2. Daily Cumulative King Salmon Escapement , past Kwiniuk Tower, Kwiniuk River, 1973.

Date	Daily Escapement	Cumulative Escapement
7/8	1	1
7/10	2	4
7/11	1	5
7/12	6	11
7/13	1	12
7/14	4	16
7/15	1	17
7/17	4	21
7/18	8	29
7/19	14	45
7/20	6	51
7/21	3	54
7/22	3	57

were sampled for scales, sex and length. Scales collected were aged and the data will be tabulated in the Northern region salmon age, sex and size data report, 1973.

DISCUSSION

Based upon research data from 1965-1969, the average chum salmon escapement during these hours was 3.66 percent (Hurd, 1972). Using these figures, the expanded total escapements were 28,617 chums and 38,426 pinks (Table 3).

The 1973 expanded chum salmon escapement of 28,617 chums was 18.1% below the previous 8-year average escapement of 32,466; the 1973 expanded pink salmon escapement of 38,426 pinks was 40.9% below the previous 8-year average escapement of 65,013 (Hurd, 1972).

The 1973 king salmon escapement of 57 was the second highest recorded. There is evidence that the king salmon run is developing as indicated by the increasing escapement trend (A.Y.K. Annual Management Report, 1972).

The correlation between commercial catch per unit effort for chum salmon and escapement past the tower four days later was 0.87 with a coefficient of determination of 0.75 (75%) (Table 4).

Table 3. Daily total cumulative salmon escapement, Kwiniuk River, 1973.

Date	Species	
	Chum	Pink
6/25	11	322
6/26	13	831
6/27	17	1,053
6/28	17	1,276
6/29	17	1,413
6/30	26	1,575
7/1	97	1,762
7/2	207	1,854
7/3	402	1,938
7/4	1,514	2,190
7/5	4,545	3,491
7/6	4,933	3,556
7/7	5,075	3,631
7/8	8,495	4,795
7/9	8,870	4,979
7/10	15,022	7,079
7/11	15,337	7,327
7/12	16,303	8,539
7/13	16,776	9,281
7/14	18,944	12,512
7/15	19,666	13,393
7/16	20,138	14,569
7/17	22,396	18,347
7/18	24,075	21,214
7/19	26,227	27,748
7/20	26,995	30,789
7/21	27,304	32,842
7/22	27,341	32,249
7/23	27,570	35,112
7/24	28,008	36,956
7/25	28,029	37,070
	<u>x 2.1%</u>	<u>x 3.66%</u>
	= 588	= 1,356
	+ 28,029	+37,070
	<u>28,617</u>	<u>38,426</u>

Table 4. Correlation between commercial catch per unit effort for three-day period and chum escapement past the Kwiniuk tower four days later, 1973

Period	Chum Escapement per 3-day period		Period	Commercial catch per unit effort per 3-day period		
	X	X ²		Y	Y ²	XY
7/2 - 4	1488	2214144	6/28 - 30	0.6	0.36	892.8
7/5 - 7	3561	12680721	7/2 - 4	2.9	8.41	10326.9
7/9 - 11	10262	105308644	7/5 - 7	6.1	37.21	62598.2
7/12 - 14	3607	13010449	7/9 - 11	3.4	11.56	12263.8
7/16 - 18	5131	26327161	7/12 - 14	1.7	2.89	8722.7
7/19 - 21	3229	10426441	7/16 - 18	1.7	2.89	4489.3
7/22 - 25	725	525625	7/19 - 21	0.9	0.81	652.5
	28003	170493185		17.3	64.13	99946.2

r =

$$\frac{\sum xy - \frac{\sum x \sum y}{n}}{\sqrt{\sum y^2 - \frac{(\sum y)^2}{n}}}$$

= 0.87

r² = .75 or 75%

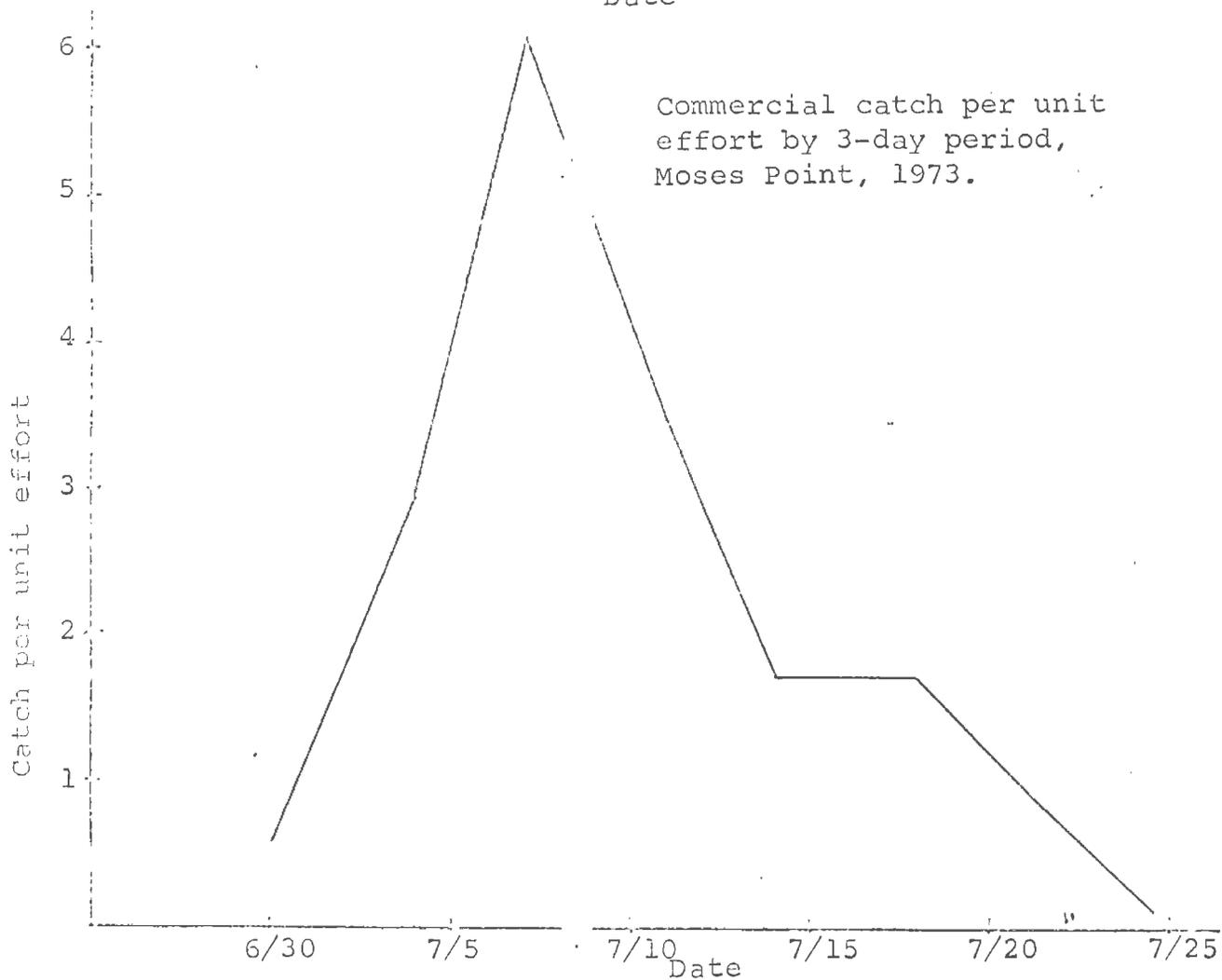
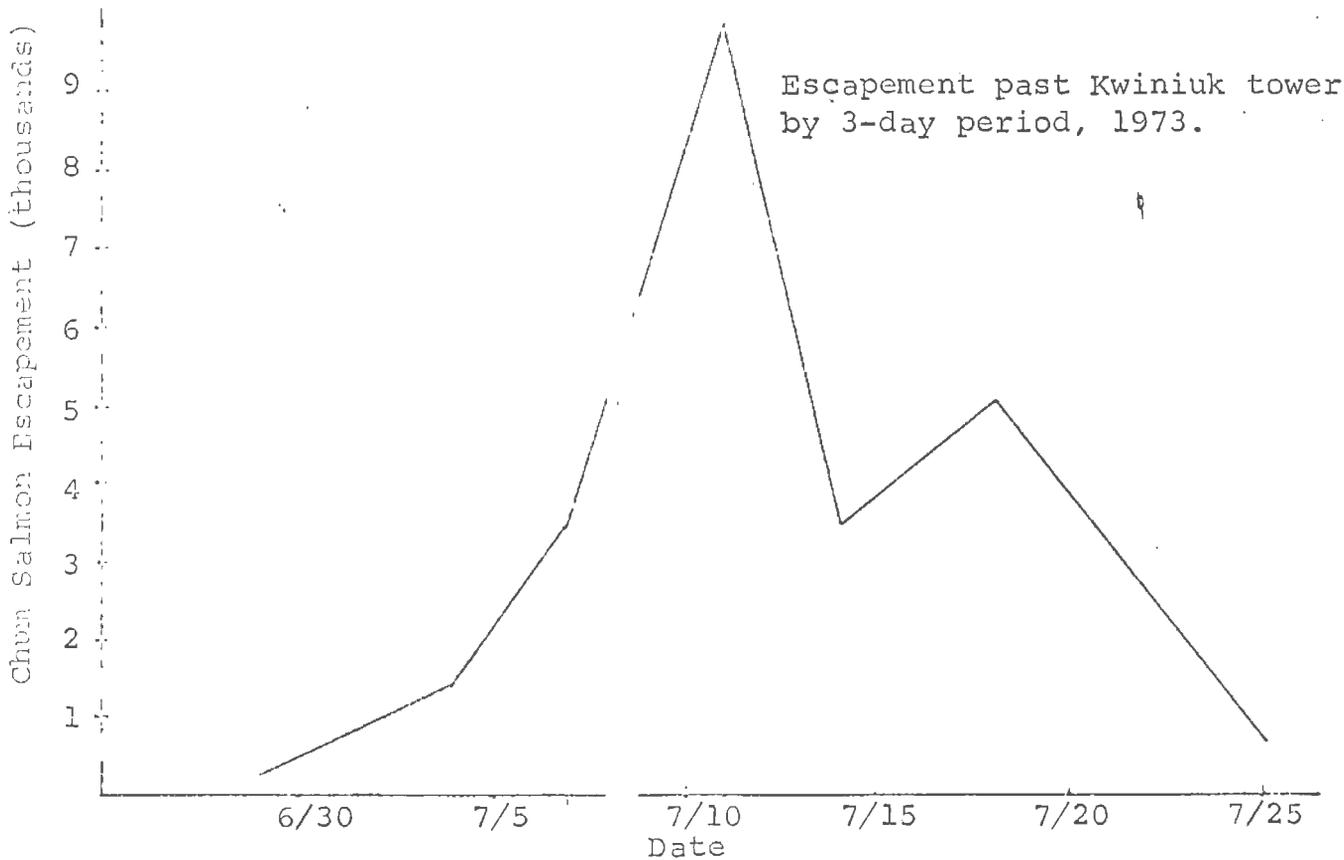


Figure 4. Chum salmon escapement and commercial catch by 3-day period, Kwiniuk River, Moses Pt., 1973.

In 1972 an estimate of the chum salmon escapement past the Kwiniuk Tower was made for 1973 and 1974 based on escapement of pink salmon of the same parent year (Hurd, 1972). The projected escapement for 1973 of 23,630 was 17.5 percent below the actual expanded escapement of 28,617 chum salmon. Previous chum salmon escapements have demonstrated close correlation with pink escapements of the same brood year, although this years' correlation coefficient (r) and coefficient of determination (r^2) indicated a poor r and r^2 value. The deviation may be attributed to the discrepancy between the 1972 projected chum escapement of 110,952 and the actual expanded escapement of 30,686 (Hurd, 1972).

If the 1972 expanded chum escapement and the 1970 expanded pink salmon escapement were removed from the data, the resulting r and r^2 values, 0.993 and 98.6 percent, respectively, demonstrate high correlation. The method and calculations are presented in Table 5.

This year, in an additional effort to derive a projected chum salmon run estimate, an analysis was conducted combining expanded Kwiniuk River escapements with commercial salmon harvest documented from the Moses Pt. area. The "outlier" years of 1972 and 1970 for chum and pink salmon, respectively, were removed from

Table 5. Forecasting chum salmon returns based upon pink salmon abundance of the same brood year (Mattson, 1966). Kwiniuk River - Moses Pt., 1973.

Year	Kwiniuk River Escapement Data		Year
	X Pink Escapement	Y Chum Escapement	
1965	15,834	2,444	1967
1966	10,629	18,813	1968
1967	3,508	19,687	1969
1968	126,764	68,004	1970
1969	56,683	38,679	1971
*1970	235,131	30,686	*1972
1971	16,634	28,617	1973
1972	62,461	** (42,679)	1974
1973	38,426	** (33,306)	1975

Correlation coefficient for first seven years = 0.452
 $r^2 = 0.204$ (20.4%)

*Correlation coefficient with 1970 pink and 1972 chum data removed..... = 0.933
 $r = 0.986$ (98.6%)

**Forecast of chum salmon returns with 1970 pink and 1972 chum data removed.

$$b = \frac{n \sum xy - \sum x \sum y}{n \sum x^2 - (\sum x)^2} = 0.39$$

for 1974:

$$\hat{Y} = 18,320 + (0.39) 62,461 = 42,679$$

$$a = \bar{Y} - b\bar{x} = 18,320$$

for 1975:

$$\hat{Y} = 18,320 + (0.39)X$$

$$\hat{Y} = 18,320 + (0.39) 38,426 = 33,306$$

the data, resulting in unusually high r (0.993) and r^2 (98.6%) values. Projected chum escapement and harvest combined for the Kwiniuk River, Moses Pt. area for 1974 and 1975 are 67,429 and 56,866 respectively. It is felt that these methods for determining chum escapements should be tested for several more years to determine their validity (Table 6).

The aerial survey of July 7 demonstrated a percent effectiveness of 68 and 66 for chum and pink salmon respectively. Past aerial surveys have ranged in overall effectiveness (both species) from 13 to 125 percent. The 9 year average for both species is 54 percent with a 9 year average for chum and pink salmon of 68 and 38 percent respectively. The comparison between aerial survey counts and tower counts since 1965 is presented in Table 7.

In 1973 the Moses Point commercial harvest of 31,389 chums was below the previous 9 year average of 33,091 chums. The peak of the catch occurred on July 7. The pink salmon harvest of 10,603 was above the previous 9 year average of 7,093 pinks and the peak occurred on June 30 (Table 8 and Table 9).

SUMMARY

1. For the ninth consecutive year a counting tower project on the Kwiniuk River, a typical Norton Sound salmon stream, was operated primarily for the purpose

of obtaining the daily and seasonal timing and magnitude of the salmon runs which can generally be applied toward management of the Norton Sound fisheries.

2. An expanded total of 28,617 chums and 38,426 pink salmon was recorded as passing the tower in 1973. The peak of the chum run occurred on July 5-10, while the pink run peaked during the period of July 10-21. The 1973 counts were the fifth highest for both chums and pinks.
3. Age, sex and size data was collected from the commercial fishery at Moses Point and the spawning escapement population of the Kwiniuk and Tubutulik Rivers.

LITERATURE CITED

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3. Mattson, Chester R. 1966. Forecasting chum salmon
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same brood year. USFWS Informational Leaflet
No. 87. pp. 84-92.

MEMORANDUM

State of Alaska

TO:

Paul Cunningham
Division of Commercial Fisheries
Nome

DATE : March 28, 1974

FROM:

Mel Seibel, Senior Biometrician
Division of Commercial Fisheries
Juneau

SUBJECT: Kwiniuk River counting tower
report

Paul - following are the comments which I have on your Kwiniuk River counting tower report.

1. You might change the title to say 'Kwiniuk River Salmon Enumeration' as this is more descriptive of the actual objective of the program.
2. There appears to be a discrepancy in the 1965 pink escapement shown in Tables 3, 6, 7. Table 3 shows 8,301 while Tables 6 and 7 show 15,834.
3. You make reference to collection of age composition data but I couldn't find any in the tables.
4. What percentage of the Moses Point commercial fishery is derived from Kwiniuk River stocks? Are Kwiniuk River stocks harvested in fisheries other than the Moses Point fishery?
5. Relative to the forecasting of chum returns from pink returns of the same brood year, I have several comments. First, the basic approach seems reasonable and worth investigating. I do have some questions regarding the analytic techniques used however.

The basic assumption made is that because pink and chum salmon have similar early life histories - both spawning in the same general areas and migrating seaward after emergence - the relative survival of pink salmon from a given year should give some indication of the survival of chum salmon from the same brood year. From the standpoint of forecasting chum salmon returns, this correlation - if it exists - can be used as the return of pink salmon from a given brood year is known two years later, while chum salmon from that same brood year do not return for 3-5 years.

Paul Cunningham

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We must answer several questions. First - what measure of pink salmon survival should we use? An obvious index of survival would be the ratio of adult return to parent spawners. If we use either the escapement or return from a given brood year this does not take into account the effect of brood year escapement of pinks and hence does not give a measure or index of relative survival which is needed to apply to chum escapements. (Note that the relative magnitude of pink and chum escapements in a given year vary substantially, from 13% to 87% and, therefore, the pink escapement is not a good measure of the relative chum escapement.) Thus, one would be surprised if the data in Table 6, i.e., pink escapement in year N and chum escapement in year N+2, would show a close correlation over a long period of time.

While the data in Table 7, i.e., total pink salmon return in year N and chum return in year N+2 might be better correlated than the data in Table 6, there is still the implicit assumption that pink and chum escapements in the same brood year are proportional. This assumption does not appear to be justified.

Another approach might circumvent the above problems. Lets assume that the relative survival of pink salmon, i.e., return per spawner, is correlated (or related in some consistent fashion) with the relative survival of chum salmon from the same brood year. The simplest approach which might be taken is shown in the attached Table 1 and Figure 1. In brief we try to detect a relationship between pink return per spawner and chum return per spawner from the same brood years.

The data in Table 1 and Figure 1 is pretty self-explanatory. Obviously we can't just ignore 1968 and 1969. The question is why we don't see a better fit? There are some obvious problems. (1) we are assuming that return is directly proportional to escapement for both pink and chum. While this might be true for a wide range of escapements, we know that the relationship is not proportional but rather is described by a Ricker-type curve. Are the escapements observed for either pink or chum close to or exceeding the available spawning area? If so we would have to make appropriate adjustments in the return-spawner ratios. (2) Is there competition for spawning areas between pink and chums for the spawning densities observed? (3) We've assumed that chum mature as 4-year fish (or an equivalent assumption). This may not be a good assumption. If you have chum age composition data you could use actual return per spawner for chums. If you have this data, this would be the first improvement I would look at.

Paul - I'll stop with the above comments. You apparently have some real good data in this report. I would suggest that you shoot for an Informational Leaflet report sometime in the near future. This should include any age-sex data that has been collected.

cc: Regnart

TABLE 1. KWINTUK RIVER PINK AND CHUM SALMON DATA

YEAR N	PINK DATA			CHUM DATA		
	PINK ESCAP	PINK RETURN IN YEAR (N+2)	RATIO OF R/E	CHUM ESCAP	CHUM RETURN IN YEAR (N+4)	RATIO OF R/E
1965	15.8	3.5	0.2	26.6	11.7	0.7
66	10.6	135.8	12.8	32.8	97.7	3.0
67	3.5	68.5	19.6	24.4	82.5	3.4
68	126.8	248.2	2.0	18.8	61.9	3.3
69	56.8	17.6	0.3	19.7	59.4	3.0
70	235.1	68.2	0.3	68.0	()	
71	16.6	49.0	3.0			

FIGURE 1. PLOT OF CHUM RETURN PER SPawner AGAINST PINK RETURN PER SPawner OF SAME BROOD YEAR

