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YUKON RIVER KING SALMON TAGGING STUDIES

1963-1964

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INTRODUCTION

A tag and recovery study of Yukon River chum salmon was initiated during the 1961 season. This project was financed by federal funds and was part of a program of emergency salmon investigations carried on by the Department under contract to the U. S. Fish and Wildlife Service. Fishwheels were used to capture salmon for tagging purposes, and although considerable numbers of chum salmon were captured, relatively few king salmon were taken.

This federally sponsored program was discontinued after the 1962 season and the Department assumed full responsibility for salmon investigations of the Yukon River. In 1963, the Department operated two tagging sites. One site, at Pilot Station, was an attempt to continue the chum salmon investigations. Three Fish and Game aides operated a single fishwheel at this site from mid-June to mid-August. Considerable numbers of king salmon were tagged at this site and so this data is included in this section. The Pilot Station site was not operated after the 1963 season.

The other tagging site was located at Flat Island on the south mouth of the Yukon River, located approximately five miles northwest of Sheldons Point. One of the advantages of this site is that it is located below most of the fishing effort. Salmon were captured with approximately 25 fathoms of set gill net with a mesh size of 8 1/2 inches (stretched measure). The Flat Island site was operated during both the 1963 and 1964 seasons.

The main objectives of these tagging studies were to determine run timing, differentiation of races, population size, and percentage utilization

by the commercial fishery of the king salmon run. These studies are also contributing much life history information as tagging site personnel periodically sample the commercial catches for age, size, sex and fecundity information. The Flat Island site is also expected to yield day to day management information regarding the effectiveness of weekly openings and closings of the fishery. During 1963 and 1964, considerable effort was expended in experimentation with fishing methods.

METHODS AND MATERIALS

Captured salmon were tagged with "spaghetti tags", consisting of 13 inch lengths of 1/16 inch diameter yellow plastic tubing. The tags were inserted with a needle applicator approximately one inch below and slightly forward of the insertion of the dorsal fin. The legend of each tag included reward information and the mailing address of the Anchorage office of the Alaska Department of Fish and Game. A one dollar reward was offered for each tag recovery. The majority of the recovered tags were obtained and paid for by Department biologists and subsistence survey crews.

When possible, the sex and fork length was recorded for every salmon tagged. Fork lengths were not recorded for king salmon tagged during 1963 at the Flat Island site. Each tagged salmon was classified as to its condition upon release. Fish classified as to Category 1 were considered in good condition, Category 2 consisted of fish of questionable condition, and Category 3 fish were considered to have been released in poor condition. Salmon that were taken from the net in very poor condition, i.e. bleeding from the gills, were not tagged. These fish were sampled for age, sex, and size information and then were given to local processors.

FINDINGS

The daily and seasonal catches of both tagging sites are presented in Table 51.

The Pilot Station fishwheel was put into operation after the king salmon run in that area had been in progress for an estimated ten days. Although missing the early segment of the run, the site was in operation during the peak of the king run. The fishwheel was fished 24 hours a day, but storms occasionally halted operation.

The gill net fished at Flat Island during 1963 was operated 24 hours a day. Analysis of catches made that year show that a majority of kings were captured at or near times of high tides. Therefore, during 1964, it was decided to operate the gill net approximately five hours prior and two hours following each high tide. This resulted in an average of seven-eight hours fished each day during 1964. There were indications that the run behaved differently in 1964 with more fish entering the river during low or outgoing tides. However, the small catch by the tagging site gear during 1964 is thought to be due largely to the fact that the king run was smaller or was exposed to fishing effort for a shorter period of time.

Sex and Size Composition of Tagged King Salmon

Flat Island: King salmon tagged at Flat Island in 1963 were predominantly males (55 percent males:45 percent females), but during the following year, females were in the majority (42 percent males:58 percent females). Males tagged in 1964 averaged 83.1 cm in fork length while females averaged 88.4 cm. Because of the relatively small sample sizes, it does not seem practical to compare sex ratios for the two years. No obvious changes in sex composition as the season progressed could be determined for either year.

TABLE 51

KING SALMON CATCHES AT YUKON RIVER
TAGGING SITES, 1963-1964

Date	Flat Island						Pilot Station		
	1963			1964			1963		
	Number Tagged	Number Killed	Total Catch	Number Tagged	Number Killed	Total Catch	Number Tagged	Number Killed	Total Catch
June 8	10	1	11						
9	34	7	41						
10	6	0	6						
11	60	4	64						
12	87	8	95						
13	10	0	10						
14	2	0	2						
15	42	2	44						
16	55	6	61						
17	17	1	18						
18	6	1	7	1	1	2	11	2	13
19	59	9	68	9	2	11	7	15	22
20	11	5	16	38	7	45	19	2	21
21	2	0	2	45	13	58	5	2	7
22	4	0	4	18	6	24	Fishwheel did not operate		
23	14	95	109	1	2	3	Fishwheel did not operate		
24	23	2	25	0	0	0	Fishwheel did not operate		
25	2	1	3	7	0	7	4	0	4
26	18	33	51	9	3	12	49	3	52
27				11	5	16	3	0	3
28				6	13	19	6	0	6
29				0	0	0	12	0	12
30				1	0	1	4	0	4
July 1				1	0	1	8	0	8
2				1	17	18	5	0	5
3				5	0	5	3	0	3
4				9	4	13	1	0	1
5				3	0	3	1	0	1
6				3	0	3	0	0	0
7				0	0	0	0	0	0
8				3	0	3	1	0	1
9				2	0	2	1	0	1
10				1	0	1	0	0	0
11				0	0	0	1	0	1
12				1	0	1	0	0	0
13							0	0	0
14							0	0	0
15							1	0	1
TOTALS:	462	175	637	175	73	248	142	24	166

Pilot Station: Tagged king salmon were composed of 69.7 percent males and 30.3 percent females. During the period from June 18 to June 25, females were dominant (37 percent males:63 percent females), but males dominated thereafter. In fact, during the period from June 27 to July 15, not a single female was captured. The mean fork lengths were 48.4 cm and 67.8 cm for males and females respectively.

Flat Island Versus Pilot Station: Comparison of sex and size data from the two tagging sites is considered important although data from two different years are being compared. Table 52 presents comparative sex and size data for the two tagging sites. The data indicates that the Pilot Station fishwheel was selective to fish of a smaller size when compared to the gill net catches of Flat Island. This would result in sex ratios in favor of males for Pilot Station kings. Age studies of Yukon River kings indicate that all age 3_2 and a majority of age 4_2 and 5_2 fish are composed of males. The age, sex, and size composition of the Pilot Station fishwheel catch is no doubt affected somewhat by the removal of larger and older fish by the gill net fishery, located downriver.

Recoveries of Tagged King Salmon

Flat Island: Recovery rates were similar for both 1963 and 1964. Of the total tags out, 30.7 percent and 33.1 percent were recovered in the commercial and subsistence fisheries during 1963 and 1964 respectively (see Table 52).

Table 53 compares recovery of tagged salmon according to their condition upon release. There was a relatively low recovery rate for salmon classified as Condition 3 for both years. As previously explained, these were

TABLE 52

KING SALMON TAGGING AND RECOVERY DATA
FOR YUKON RIVER TAGGING SITES, 1963-1964

	Flat Island 1963	Flat Island 1964	Pilot Station 1963
Number Tagged	453	175	142
Sex Composition (Percentage Females)	45.4	58.0	30.3
Mean Fork Length (centimeters) - Males	-	83.1	48.4
Mean Fork Length (centimeters) - Females	-	88.4	67.8
Number of Recoveries	139	58	70
Percentage Recovery of Tags Out	30.7	33.1	49.3
Percentage Recovery by Gear:			
Gill Net (8 1/2" Mesh)	91.4	84.5	15.7
Gill Net (5 1/2" Mesh)	2.2	1.7	11.4
Gill Net (Mesh Unknown)	0.7	1.7	5.7
Fishwheel	0.7	10.3	55.7
Gear Unknown	5.0	1.7	11.4

TABLE 53

RECOVERY OF TAGGED KING SALMON CLASSIFIED
AS TO CONDITION, FLAT ISLAND, 1963-1964

	1963			1964		
	Number Tagged	Number Recovered	Percentage Recovered	Number Tagged	Number Recovered	Percentage Recovered
Condition 1	308	102	33.1	83	29	34.9
Condition 2	44	17	38.6	37	15	40.5
Condition 3	34	5	14.7	52	12	23.1
Unclassified	67	15	22.4	3	2	66.7
TOTAL:	453	139	30.7	175	58	33.1

RELATION BETWEEN TAG RECOVERIES TO COMMERCIAL KING SALMON CATCHES
FOR VARIOUS AREAS OF YUKON RIVER, 1963

Area	Number of Tag Recoveries	Commercial Catch	Ratio of Tag Recoveries To Commercial Catch
South Mouth: Flat Island to Sunshine Bay	104	30,998	1:298
Aproka Pass to Anuk River	13	22,284	1:1,714
Mountain Village to Holy Cross	18	31,187	1:1,732

tagged fish that were considered to have been in poor condition upon release. The low recovery rates of fish of this category, 14.7 percent in 1963 and 23.1 percent in 1964, indicates a high mortality after release. Removal of Condition 3 salmon from recovery rate computations yields the adjusted rates of 33.8 percent and 36.7 percent for 1963 and 1964 respectively.

Table 52 shows the recovery rates made by various types of gear. The greatest percentage of recoveries were taken by 8 1/2 inch gill nets, 91.4 percent in 1963 and 84.5 percent in 1964.

Table 54 shows the number of recoveries made in various areas of the river for 1963 and 1964. Note that only 2.9 percent and 8.6 percent of the total recoveries were made above Holy Cross during 1963 and 1964 respectively. The following factors should be considered in evaluation of the distribution of these tag recoveries:

1. Kings captured with 8 1/2 inch gill net are less susceptible to capture by smaller meshed nets and by fishwheels. These latter types of gear are commonly used above Holy Cross.

2. Tagged fish, especially on days open to commercial fishing, were released near commercial gear. Also, some tagged fish may have milled in the Flat Island area before resuming normal upstream migration. Recovery rates would be expected to increase in these cases.

3. King salmon entering the middle and north mouths were not tagged. Therefore, fewer recoveries in relation to catch would be expected in areas upstream of the confluence of the three mouths. Table 53 also shows the relation between tag recoveries and commercial catches of king salmon for areas below and above the juncture of the three mouths. The ratio between tag recoveries and commercial catches was 1:298 for the south mouth and approximately 1:1,700 for areas upstream from the juncture of the three mouths.

TABLE 54

RECOVERIES OF TAGGED KING SALMON BY AREA
1963-1964

Area of Recovery	Mileage from Flat Island	Flat Island Tagged Kings 1963	Flat Island Tagged Kings 1964	Pilot Station Tagged Kings 1963
Below Flat Island (South Mouth)	-	11	3	
Flat Island and Vicinity	0	14	10	
South Mouth	1-11	32	6	
Alakanuk	17	13	11	
Kwiguk-Emmonak	24	11	12	
Aproka-Kwikpak Passes	30-43	17		
Fish Village to Anuk River	52-63	11	2	
Mountain Village and Vicinity	87-97	4	2	
Mouth of Andreafsky River	104	2	1	
Pilot Station and Vicinity	109-138	8	3	10
Marshall and Vicinity	149-170	2		4
Ohagamut	185	1		3
Russian Mission and Vicinity	212-226	1		6
Holy Cross	279		1	
Anvik and Vicinity	317-366			10
Kaltag	449			1
Nulato	484			5
Koyukuk	502	1		1
Ruby and Vicinity	553-581	1	2	10
Tanana and Vicinity	695			5
Rampart	763		1	2
Manley Hot Springs, Tanana River	765			1
Nenana, Tanana River	860			3
Allakaket, Koyukuk River	956		1	
Fort Yukon	1,002		1	6
Circle	1,061			2
Eagle	1,213			1
Dawson (Canada)	1,319	1		
Fort Selkirk and Vicinity (Canada)	1,439	1		
Area Unknown	-	8	2	
TOTALS:		139	58	70

Pilot Station: A total of 49.3 percent of the tagged king salmon were recovered. The greatest percentage of recoveries were taken by fishwheels followed by 8 1/2 inch gill net and 5 1/2 inch gill net recoveries.

Because of the small numbers of king salmon tagged, the differences in recovery rates for the two sites are difficult to interpret. The different types of gear at each site were sampling various age, sex, and size segments of the population and may have an important bearing on the differences in recovery rates noted.

Determination of Races

Yukon River king salmon spawn in tributary streams located from 90 to over 2,000 miles upstream from the river mouth. There are spawning populations of king salmon within forty miles of Norton Sound (Bering Sea) and also within seventy-five miles of the Gulf of Alaska. It is possible, therefore, that the king salmon population is composed of different stocks or races that have developed in response to the diverse and widely separated environments of the Yukon drainage. Catch records show that there are generally two or more "peaks" in the run which may be an indication of the presence of these races. These races may differ from one another in their use of spawning grounds, time of migration, relative abundance, and productivity. Identification of these stocks would have important implications to fisheries management and especially in relation to determining the effects of the proposed Rampart Dam site.

A tag and recovery program is one possible way to identify and separate races of salmon. To date, there have been too few recoveries made in the upper reaches of the drainage to contribute much information relative to this study. With the exception of subsistence fisheries on the Tanana River,

Koyukuk River, and tributaries in Canada, there has been no practical way to recover tags on the other tributaries. During 1963, five (5) recoveries were made upstream of Mile 500 and all represent kings that were tagged during the period June 11-19 at Flat Island. There were two distinct peaks in the run that entered the south mouth, on June 12 and from June 22 to 24. This scant information suggests that the king salmon run that originates in the upper reaches of the drainage migrate during the first portion of the run.

There were thirty-one (31) recoveries of Pilot Station tagged kings made above Mile 500 in 1963. No pattern could be determined by comparing the area of recovery and tagging dates with the possible exception of Tanana River recoveries. Of the four recoveries made in the Tanana River, all were king salmon tagged at Pilot Station on June 26.

The 1964 run, as previously discussed, was late and of short duration. Since the run in 1964 was atypical and few kings were tagged, further discussion of this run will not be attempted in this analysis.

Migration Rates

Table 55 presents the migration rates (miles traveled per day) for recoveries in various areas of the river for king salmon tagged during 1963 and 1964. Average rates of travel for kings tagged at both sites and recovered above Mile 500 ranged between twenty-one to twenty-five miles a day. A few individual kings traveled an average of thirty or more miles a day.

Migration rates calculated from these upstream recoveries are thought to more nearly represent the actual rate of travel than rates calculated for recoveries made below Mile 500. Tagged fish may be released in a weakened or a disoriented condition, and in some cases, tagged salmon have been recovered considerable distances below the tagging site. Salmon in this

TABLE 55

MIGRATION RATES OF TAGGED KING SALMON, 1963-1964

Recovery Area	Flat Island (Mile 0)						Pilot Station (Mile 122)		
	1963			1964			1963		
	Number of Recoveries	Migration Rates 1/ Range	Migration Rates 1/ Average	Number of Recoveries	Migration Rates 1/ Range	Migration Rates 1/ Average	Number of Recoveries	Migration Rates 1/ Range	Migration Rates 1/ Average
Alakanuk to Anuk River	50	5-35	11	23	2-24	6	-	-	-
Mountain Village to Koyukuk	13	3-42	10	5	8-15	10	24	3-36	14
Upstream from Koyukuk	3	18-22	21	5	19-31	25	29	11-60	22
ALL AREAS	66	3-42	14	33	2-31	16	53	3-60	20

1/ Miles traveled per day.

condition would be expected to travel at slower rates of speed than normal. The percentage of error in calculations of normal rates of travel is, in most cases, greater over the smaller the distance traveled before recovery was made. It could not be determined if the rate of travel increases as the run progresses upriver. Migration rates calculated from tag and recovery studies should be considered minimum figures. The following section discusses another method of determining migration rates which are thought to be more realistic.

RUN TIMING - YUKON KING SALMON 1964

Figure 5 shows the daily catch per unit of effort for fishermen in various areas of the Yukon River drainage. The Flat Island (south mouth) catch was taken with gill nets operated by Department tagging crews. Catches from statistical area 334-18 were made by commercial fishermen in the area from Fish Village to the Anuk River. Catches from Paimiut, Ruby, Rampart, and Fort Yukon were obtained from catch calendars that were submitted by subsistence fishermen. Each village or fishing location is positioned according to its relative distance upstream from Flat Island (Mile 0). Peak catches are designated by arrows (↑). Finally, lines have been plotted from the x axes to connect the peak catches of each fishing location. These lines indicate the average migration rates for various segments of the king salmon run.

Subsistence fishing effort and efficiency may vary from day to day. Consequently, dates of peak catches were assigned on the basis of a general trend of increasing and then decreasing catches over a period of several

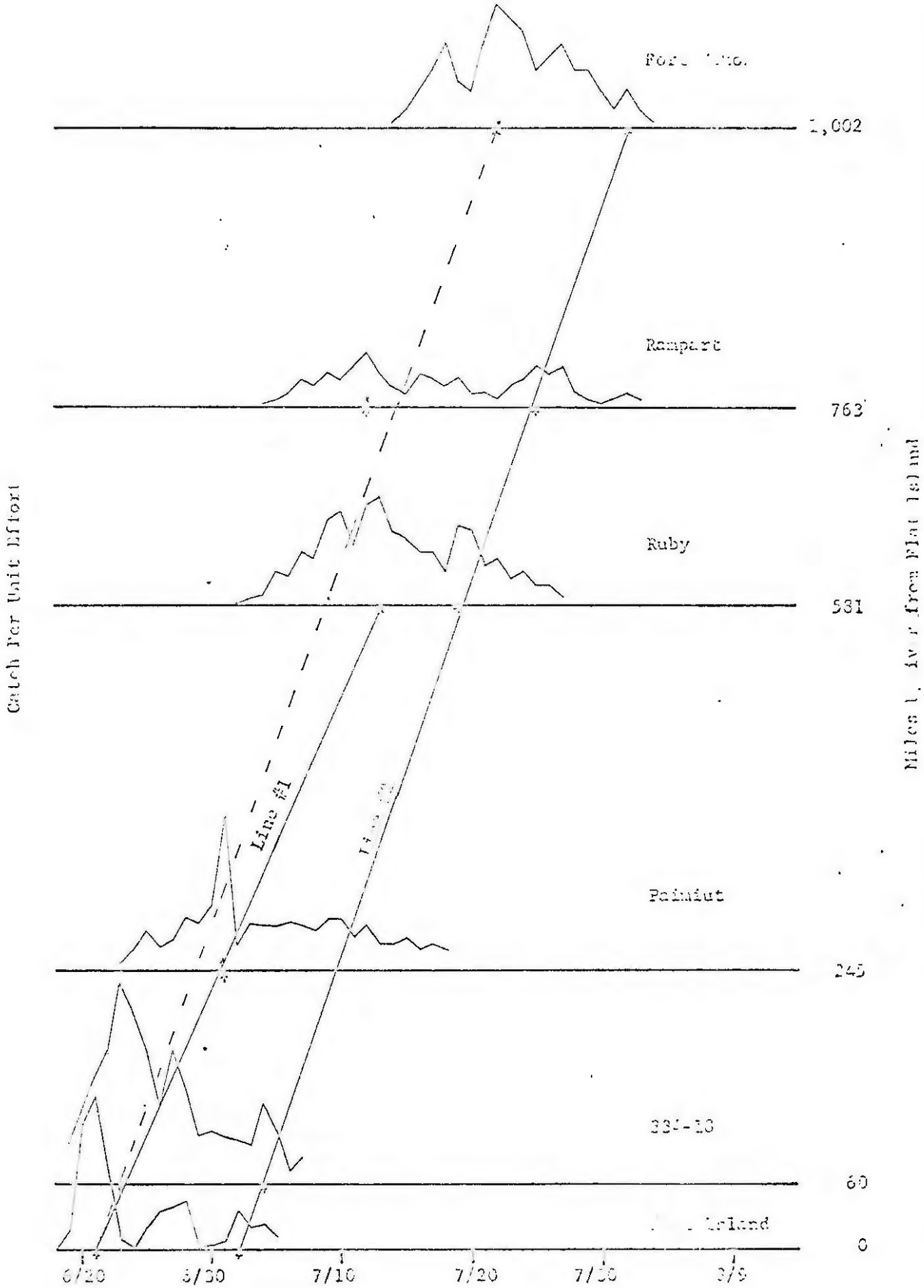

FIGURE 5 1964 KING SALMON CATCH

days. Rampart's subsistence catches do not show distinct peaks when compared to other villages probably because a large portion of the total catch was sold to commercial processors.

An approximate straight line can be fitted to the June 20 peak at Flat Island and peak catches as far upriver as Ruby (see Line number 1 in Figure 5). The slope of this line indicates the average migration rate for this segment of the run was twenty-five miles a day. Projection of this line does not fit the earlier peak catches made at Rampart and Fort Yukon. The dotted line, shown for comparative purposes, connects peak catches made at Fort Yukon, statistical area 334-18 and Flat Island. The slope of this line indicates a migration rate of approximately thirty miles a day. The much smaller peak in catches made at Flat Island on July 2 can be traced with a straight line as far upriver as Rampart or perhaps Fort Yukon. The slope of this line indicates an average migration rate of thirty-two miles a day for this segment of the run.

This study is very similar to the 1963 study in that the first or early peak at the mouth can be followed upstream only as far as Ruby or Tanara. Dates of peak catches in areas upstream from Ruby in 1964 were approximately six days earlier than that predicted by extending line number 1 in Figure 5.

There are at least three possible reasons why the run timing in areas upstream from the confluence of the Tanana and Yukon Rivers is different from that of downstream areas:

1. The rate of migration increases as the run progresses upriver. This trait has been noted in studies of salmon runs in other systems, but has not been fully studied in relation to Yukon River salmon. Only ten days separate the peak catches made at Ruby and Fort Yukon which indicates a migration rate of forty-two miles a day for this segment of the run.

2. Each village is fishing different stocks of king salmon. This may be a result of salmon entering spawning tributaries which are located between villages. For example, the peak catches made in Ruby on July 13 may have been mainly taken from king salmon stocks bound for the Tanana River and other tributaries located between Ruby and Rampart or Fort Yukon. The segment of the run that produced the peak catches at Fort Yukon may have passed through the village of Ruby prior to July 13 (see dotted line in the figure). It is also possible that each stock or segment of the run may differ in its rate of travel and accessibility to fishermen.

3. There is the remote possibility that an early segment of the run passed through the lower and middle Yukon areas prior to or during breakup when there was no fishing effort. This would account for the early catches made at Fort Yukon and Rampart. Apparently this has happened occasionally in the past, but there is no evidence to support this theory in regard to the 1964 run.

It is likely that an increase in migration rate and the fishing of different stocks both influence run timing to some extent.

The Canadian Department of Fisheries reported that king salmon were counted through the fish facility at Whitehorse Rapids Dam (Mile 1,754) from August 13 through August 29; the peak of the run occurred from August 19 through August 22. This peak occurred sixty-two days later than the June 20 peak at Flat Island which indicates that this segment of the run traveled approximately twenty-eight miles a day.

Based on dates of first arrival and peak catches, the 1964 run was seven to thirteen days late in arriving to various areas of the Yukon River drainage when compared to 1963. The above analysis indicates that king salmon travel an average of approximately thirty miles a day although their rate of travel is probably less in the lower Yukon and more in the upper Yukon areas.