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YUKON AND TANANA RIVER FALL CHUM SALMON TAGGING STUDY,
1976 - 1980

By

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ABSTRACT

A fall chum salmon (*Oncorhynchus keta*) tagging study was conducted on the Yukon River in 1976, 1977, and 1978, and on the Tanana River in 1979 and 1980. A total of 1,217 fall chums was tagged in 1976, 5,359 in 1977, 9,668 in 1978, 7,259 in 1979, and 5,279 in 1980. Tag recoveries totaled 608 (50%), 1,951 (36%), 4,682 (48%), 1,346 (18%), and 1,234 (23%) for each of these years, respectively. Results indicate that upper Yukon River fall chums migrate mostly along the north bank of the Yukon River in the Galena-Ruby area, while Tanana River fall chums migrate mostly along the south bank. Run timing is earlier for the upper Yukon River stock. Fishwheel catches on the north bank of the Yukon River at Galena in 1977 peaked on 10 and 24 August, while peak catches on the south bank occurred on 24 August and 20 September. Attempts to separate upper Yukon River and Porcupine River stocks in 1978 were unsuccessful. Approximately 95% of the tag returns were recovered below the Yukon-Porcupine confluence. Attempts to separate upper Tanana and Toklat River fall chum stocks in 1979 and 1980 were likewise unsuccessful, as there does not appear to be a significant difference in bank orientation or run timing between these two stocks in the lower Tanana River near Manley Hot Springs. Petersen population estimates of the fall chum salmon run in the upper Yukon and Tanana Rivers in 1976 and 1977 were 197,017 and 412,285 fish for each year, respectively. The 1978 fall chum run in the upper Yukon River was estimated at 165,390 fish. The Tanana River fall chum salmon run was estimated to be 676,241 and 338,770 fish for 1979 and 1980, respectively. Each population estimate is substantially higher than the sum of harvest and observed escapement. Two causes are given for the disparity between documented and estimated population size: (1) Aerial surveys are minimum escapement estimates because of turbid water, poor weather conditions, and the immense size of the watershed and, in addition, peak counts do not include early and late spawners; and (2) tag and recovery population estimates are inflated by the failure of some fishermen to return tags.

INTRODUCTION

The Yukon River (Figure 1) is the largest river in Alaska, and fourth largest in North America, flowing over 2,000 miles from its source in British Columbia, Canada, to its mouth on the Bering Sea. It drains an area approximately 330,000 square miles. All five species of Pacific salmon are found in the drainage, with chum salmon (*Oncorhynchus keta*) being the most abundant. Chinook salmon (*O. tshawytscha*) are second in abundance followed by coho (*O. kisutch*), pink (*O. gorbuscha*) and sockeye (*O. nerka*) salmon. The latter two species are only found in token numbers in the lower portion of the river and are caught occasionally with the more abundant commercial species.

Fall and summer chum salmon occur as two distinct populations in the Yukon River drainage. Fall chum salmon can be distinguished from summer chum salmon by their later run timing (mid-July to late August entry into mouth of Yukon River), larger body size (7 to 9 lb), and bright silvery appearance. Summer chum salmon with their earlier run timing (early June to early July) spawn primarily in runoff streams in the lower 500 miles of the drainage. Major spawning areas have been identified in the Andreefsky, Anvik, and Nulato Rivers. Fall chum salmon spawn in the upper portion of the drainage in spring fed streams and sloughs. Major spawning areas have been identified in the Chandalar, Sheenek, and Fishing Branch Rivers in the upper Yukon drainage, and the Toklat, Delta, and main Tanana River near Delta Junction in the Tanana drainage.

Fall chum salmon abundance fluctuates greatly. In the 9-year period, 1972-1980, the sum of harvest and observed escapement ranged from a low of 247,000 to a high of 896,000 fish (Table 1). Effective management for optimum yield of the resource requires an adequate escapement of each spawning stock. This objective is difficult to achieve due to the fact that harvest occurs hundreds of miles and several weeks from the spawning grounds. In many cases, the effect of a management strategy can be assessed only after the fishing season is over and the individual stocks have reached the spawning grounds. Identification of discrete fall chum salmon stocks and development of appropriate management strategies in the Yukon River fishery would allow for optimum harvest of each stock according to abundance.

A similar fall chum salmon stock identification problem exists in the Tanana River (Figure 2), a major tributary of the Yukon River. The Toklat River has accounted for an average 70% of the observed Tanana River fall chum salmon spawning escapement in the years 1976-1980, as compared to only 30% for the entire Tanana drainage upstream of the Kantishna River confluence (Table 2). The Toklat stock could probably support greater harvest in some years. However, management regulations formulated to increase harvest of Toklat chum salmon must at the same time allow for continued escapement of upper Tanana stocks at present levels.

A tagging study was conducted on the Yukon River near Galena (Figure 1) in 1976 and 1977 to determine whether upper Yukon and Tanana River fall chum

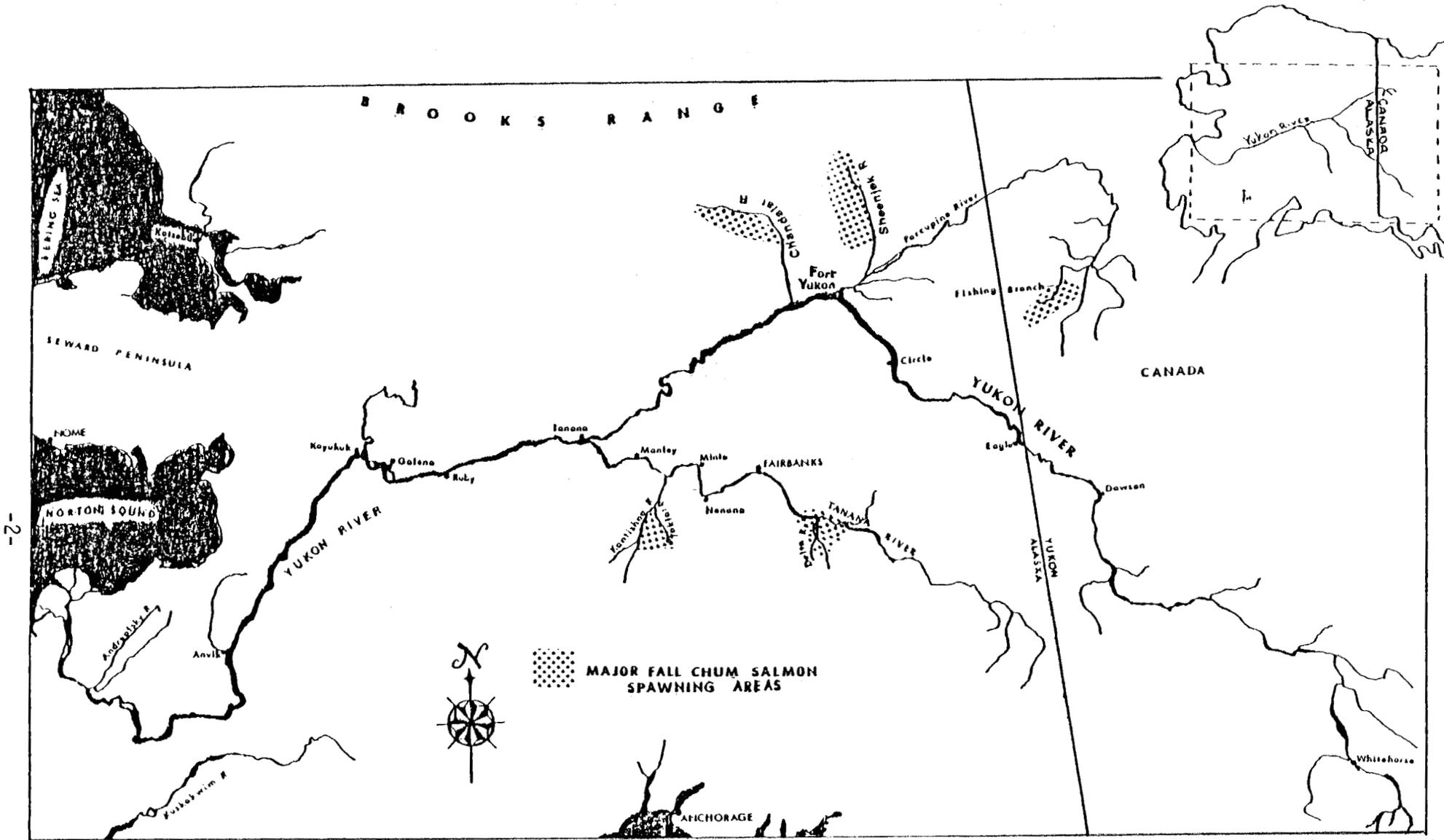


Figure 1. Map of the Yukon River showing major fall chum salmon spawning areas.

Table 1. Harvest and escapement of Yukon River fall chum salmon, 1972-1980, in thousands of fish.

Year	Harvest ¹	Observed Escapement ²	Documented Population ³
1972	188	59	247
1973	291	45	336
1974	354	144	498
1975	340	527	867
1976	228	78	306
1977	331	114	445
1978	332	88	420
1979	596	300	896
1980	469	75	544
1972-1980 Average	348	159	507

¹ Includes commercial and subsistence harvest in the Alaska portion of the drainage.

² Escapement counts are "peak" counts made by aerial survey of known spawning areas in the Yukon and Tanana drainage. Survey conditions not optimal for all streams in all years, and not all streams were surveyed in some years.

³ Sum of harvest and observed escapement.

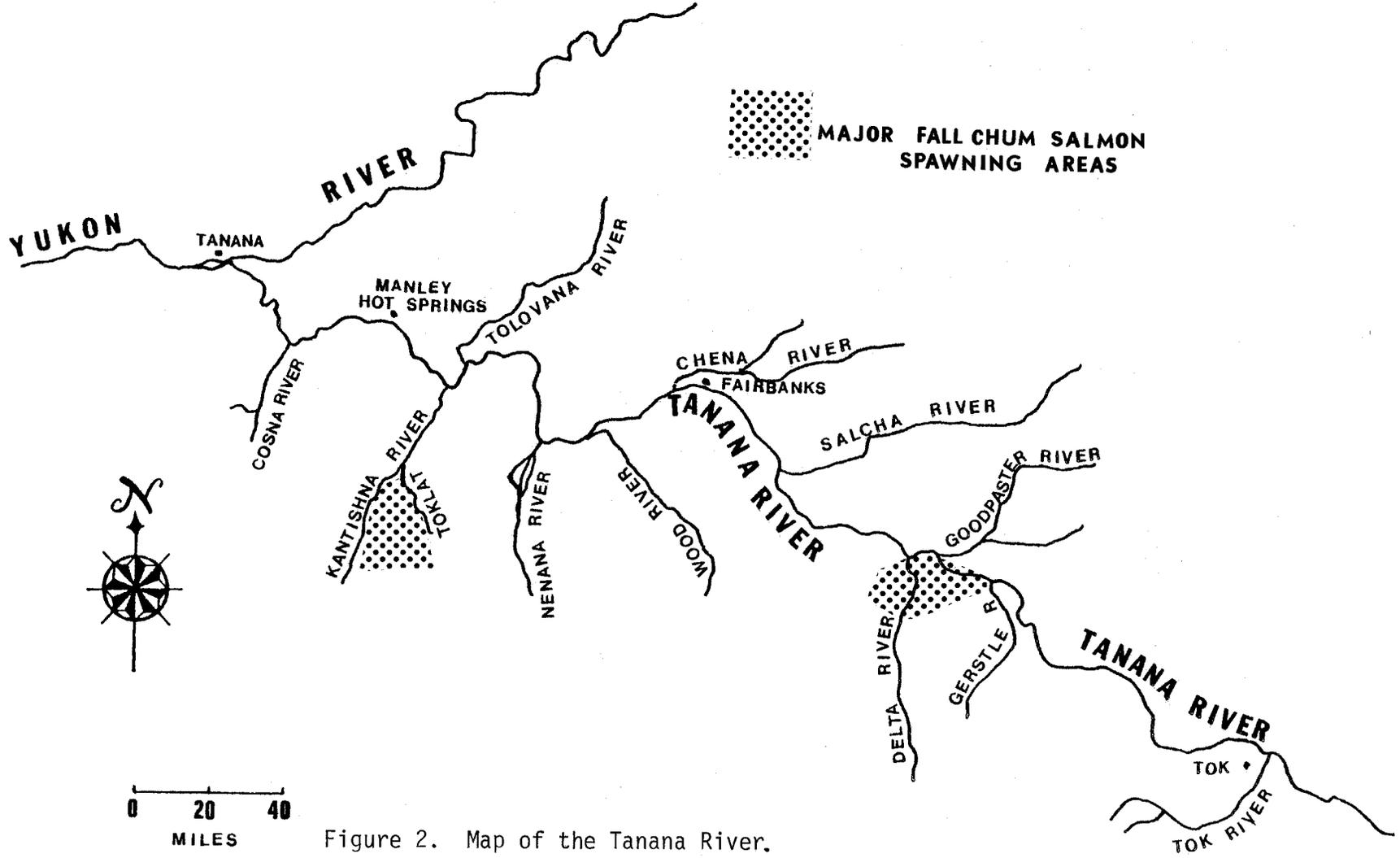


Figure 2. Map of the Tanana River.

Table 2. Tanana River fall chum salmon escapement, 1976-1980¹.

	1976	1977	1978	1979	1980	Average
<u>Upper Tanana River</u>						
Delta River	5.5	17.9	10.1	8.1	4.6	9.2
Tanana South Bank ²	5.0	3.7	5.7	20.8	3.4	7.7
Bluff Cabin Slough	3.2	6.5	5.3	6.9	3.2	5.0
Delta Clearwater Slough	1.6	1.9	0.5	3.8	0.9	1.7
Benchmark Slough	0.3	1.3	1.7	2.7	1.6	1.5
<hr/>						
Total Upper Tanana River	15.6 (30)	31.3 (56)	23.3 (40)	42.3 (20)	13.7 (35)	25.1 (30)
<hr/>						
<u>Toklat River</u>	37.2 (70)	25.0 (44)	35.0 (60)	172.1 (80)	25.2 (65)	58.9 (70)
<hr/>						
Total Tanana River Drainage	52.8	56.3	58.3	214.4	38.9	84.0
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¹ In thousands of fish. Estimated by aerial survey. Numbers in parenthesis are percent of total Tanana River escapement observed in the upper Tanana and Toklat River.

² Richardson Highway bridge to Blue Creek.

salmon could be distinguished by bank orientation or run timing. Tagging was expanded to the upper Yukon River above Tanana Village in 1978. The study was shifted to the Tanana River near Manley Hot Springs (Figure 2) in 1979 and 1980 to determine whether upper Tanana and Toklat River fall chum salmon could be separated.

Results were originally reported in a series of annual Federal Aid technical reports (Mauney and Geiger 1977; Mauney 1979, 1980; Mauney and Buklis 1980; Buklis 1981). The purpose of this report is to present the significant results of the 5-year tagging program in a single document. The presentation is divided into two parts: Part I covers the Yukon River study, 1976-1978; Part II covers the Tanana River study, 1979-1980.

PART I - YUKON RIVER STUDY, 1976 - 1978

Methods and Materials

Fishwheels were rented under contract from local fishermen and operated at the following locations in August and September of each year:

<u>Year</u>	<u>River Bank</u>	<u>Location</u>
1976	North	Galena
	South	Galena
1977	North	Galena
	South	Galena
	South	Ruby
1978	North	Tanana Village
	North	30 mi above Tanana
	South	29 mi above Tanana
	South	Ruby

Fishwheels were equipped with liveboxes to hold the fish until they could be tagged and released. Captured chum salmon in good condition were identified by sex and tagged with an individually numbered, 1 in diameter Petersen disc tag. A 2 dollar reward was paid for each tag returned by fishermen. The date, location, and method of recovery was reported with the tag returns. In addition, Department personnel conducted spawning ground surveys in October and November of each year to recover tagged fish.

Although the primary objective of the study was to identify fall chum salmon stocks in the Yukon River drainage, the data can also be used to generate Petersen population estimates. The formula is (Ricker 1975):

$$\hat{N} = \frac{(M + 1)(C + 1)}{(R + 1)}$$

where M = Number of fish tagged

C = Subsequent catch

R = Number of recaptures

\hat{N} = Population size estimate

The variance is:

$$V(\hat{N}) = \frac{(M + 1)^2 (C + 1)(C - R)}{(R + 1)^2 (R + 2)}$$

The 95% confidence interval (CI) is given by:

$$95\% \text{ CI} = \sqrt{V(\hat{N})} (\pm 1.96)$$

The exploitation rate is estimated by the ratio of recaptures to the number of fish marked, or

$$R/M$$

Results and Discussion

A total of 1,217 fall chum salmon was tagged in August and September of 1976 (Appendix Table 1), 5,359 in 1977 (Appendix Table 2), and 9,668 in 1978 (Appendix Table 3). Tag recoveries totaled 608 (50%) in 1976, 1,951 (36%) in 1977, and 4,682 (48%) in 1978. The majority of the chum salmon recovered each year were taken by fishwheels, with gillnets and spawning ground surveys providing most of the remainder (Table 3). Tag returns from commercial fishermen ranged from 30% of all recoveries in 1977 to 62% in 1976, while tag returns from subsistence fishermen ranged from 30% of all recoveries in 1976 to 56% in 1977 (Table 3). Only four tags were recovered by sport fishermen in the course of the 3-year study.

One of the objectives of the tagging conducted at Galena and Ruby in 1976 and 1977 was to determine whether upper Yukon and Tanana River fall chum salmon stocks could be distinguished by bank orientation. Tag recoveries were assigned to one of three areas for this analysis: below the Yukon-Tanana confluence, within the upper Yukon drainage, and within the Tanana River drainage.

Three hundred forty-five (57%) of the tag returns in 1976 and 610 (31%) of the tag returns in 1977 were recovered below the Yukon-Tanana confluence. These returns cannot be identified by stock, and are, therefore, excluded from the analysis. However, the distribution of the remainder of the recoveries indicates a significant difference in bank orientation between the two stocks. Seventy-nine percent of the chum salmon recovered in the upper Yukon in 1976 has been tagged on the north bank, 21% on the south bank. Conversely, 86% of the chum salmon recovered in the Tanana River had been tagged on the south bank of the Yukon River, only 14% on the north bank (Figure 3 and Appendix Table 4). Similar results were obtained in 1977. Eighty-eight percent of the chum salmon recovered in the upper Yukon River in 1977 had been tagged on the north bank, 12% on the south bank. Conversely, 96% of the chum salmon recovered in the Tanana River had been tagged on the south bank of the Yukon River, only 4% on the north bank (Figure 3 and Appendix Table 5). These results indicate that upper Yukon River fall chum salmon migrated mostly along the north bank, and Tanana River fall chum salmon migrated mostly along the south bank of the Yukon River in the Galena-Ruby area.

Daily fall chum salmon catches by fishwheels located on the north and south bank of the Yukon River at Galena in 1977 indicated a difference in run timing between the two stocks. Peak catches occurred on the north bank on 10 and 24 August, and somewhat later on the south bank with peaks on 24 August and 20 September (Figure 4). Fishwheel catches are greatly influenced by the water depth and current at the site, as well as the proximity of other fishing gear. Although fishwheels are not an ideal indicator of run strength, it does appear that the upper Yukon fall chum salmon stocks migrate past the Galena area earlier than do Tanana River stocks.

Objectives of the study are altered in 1978 in an attempt to identify individual fall chum salmon stocks within the upper Yukon River drainage. One fishwheel was located on the north bank of the Yukon River 30 mi above the Yukon-Tanana confluence, the second on the south bank 29 mi above the confluence near Tanana Village. A fourth fishwheel was located on the south bank near Ruby, the same site used in 1977.

Table 3. Yukon River fall chum salmon tag recoveries by fishery and gear, 1976-1978.

Fishery	1976		1977		1978	
	N	%	N	%	N	%
Commercial	376	62	594	30	2,229	48
Subsistence	185	30	1,100	56	1,704	36
Sport	0	0	3	-	1	-
Spawning Ground	31	5	108	6	97	2
Unknown	16	3	146	7	651	14
Total	608	100	1,951	100	4,682	100
Gear						
Fishwheel	400	66	1,352	69	2,347	50
Gillnet	153	25	432	22	1,918	41
Beach Seine	0	0	4	-	0	0
Handpicked	31	5	107	5	98	2
Unknown	24	4	56	3	319	7
Total	608	100	1,951	100	4,682	100

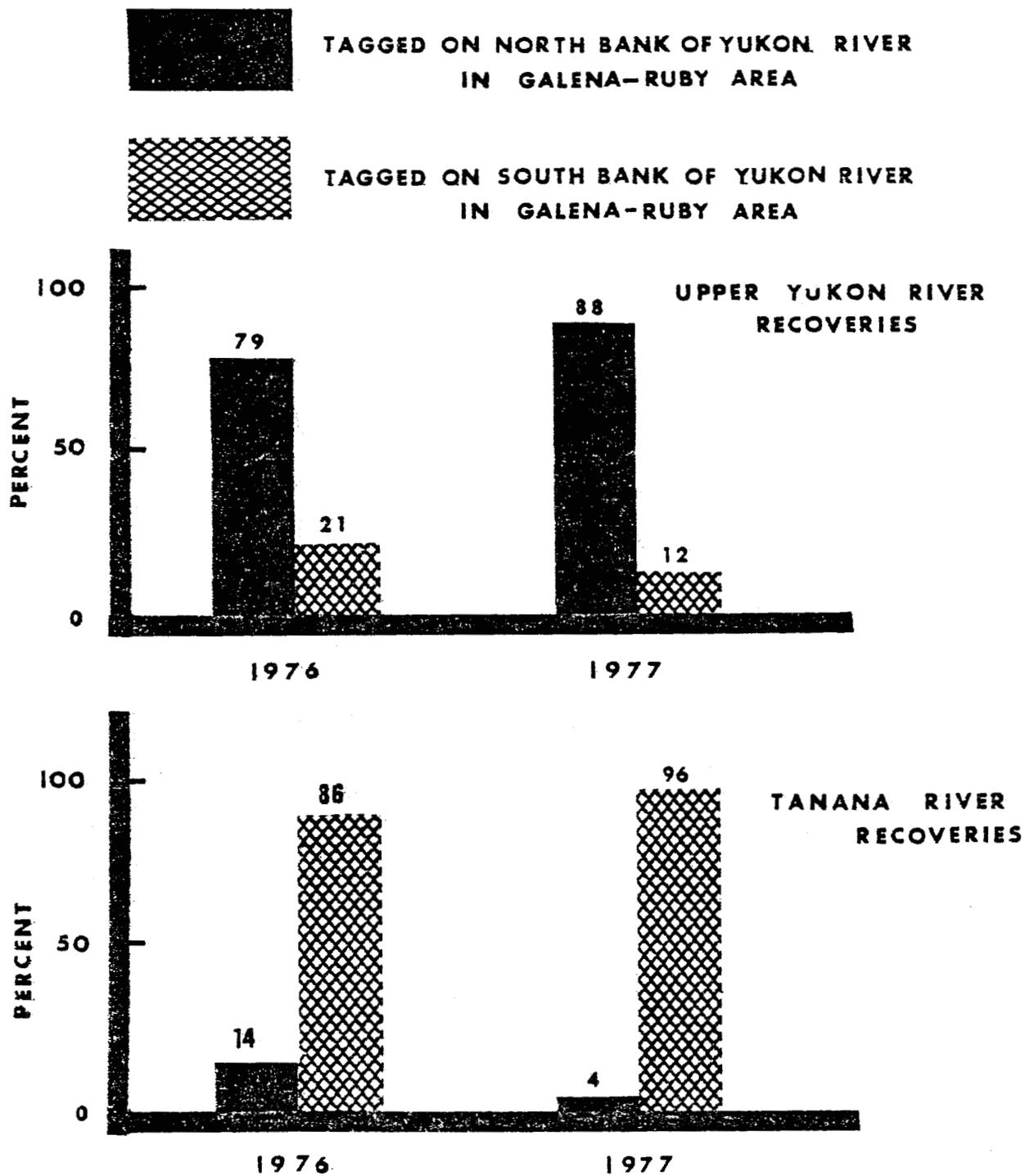


Figure 3. Recovery of fall chum salmon in the upper Yukon River (above) and in the Tanana River (below) that were originally tagged on the north and south bank of the Yukon River in the Galena-Ruby area, 1976 and 1977.

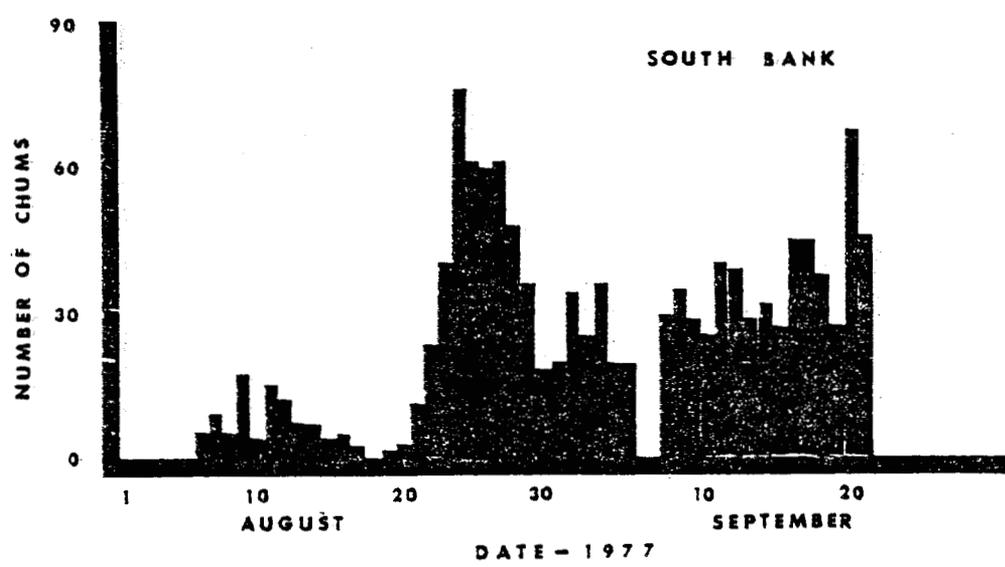
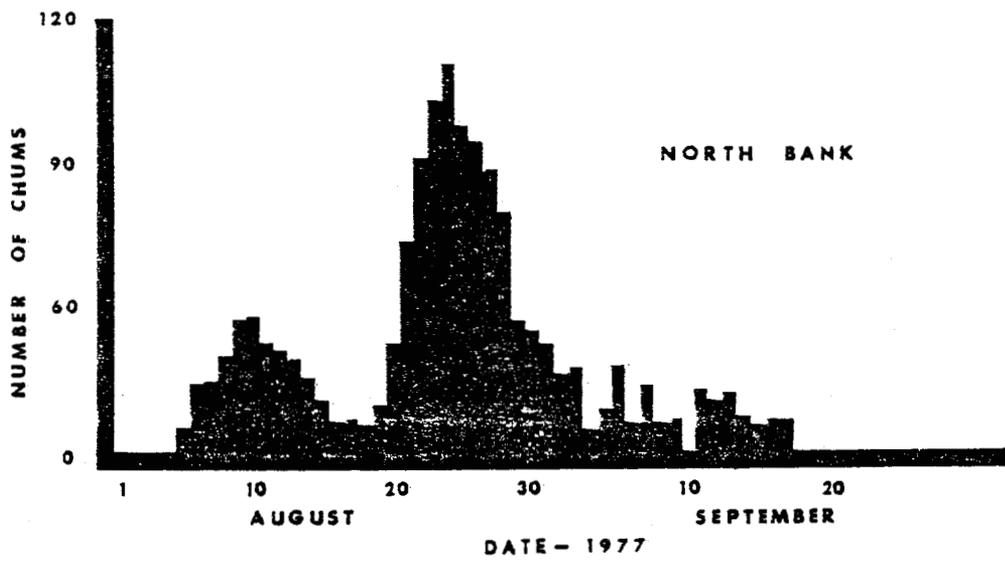


Figure 4. Fall chum salmon run timing as indicated by fishwheel catch on the north and south bank of the Yukon River near Galena, 1977.

Tag returns were assigned to one of five areas: below the Yukon-Tanana confluence, Yukon River between Tanana and Porcupine Rivers, Yukon River above the Porcupine River, within the Tanana drainage, and within the Porcupine River drainage (Table 4). Approximately 95% of the tag returns from the three fishwheels at or above Tanana Village were recovered below the Porcupine confluence, either below the Yukon-Tanana confluence (9%) or between the Tanana-Porcupine Rivers (86%). The remainder of the tag returns came from the Yukon River above the Porcupine confluence (2%), within the Porcupine drainage (1%), and in the Tanana drainage (less than 1%).

The high percentage of tagged fish recovered in the main Yukon River fishery below the Porcupine River confluence makes specific stock identification impossible. Spawning ground surveys conducted by Department personnel on the Sheenjek and Fishing Branch Rivers, tributaries of the Porcupine, produced only 2 tag recoveries in 1976, 4 in 1977, and 13 in 1978 (Table 5). An average of one tagged fish was recovered for every 2,647 fall chums examined during spawning ground surveys in the Porcupine drainage for the 3-year period.

The recovery of fall chum salmon tagged at Ruby in 1978 once again indicated that Tanana River stocks migrated along the south bank of the Yukon River in the Galena-Ruby area. Twenty-nine percent of the tag returns from the Ruby tagging site were recovered below the Yukon-Tanana confluence, 66% within the Tanana River drainage, and only 5% within the upper Yukon River drainage (Table 4). More time was spent surveying the Tanana River spawning grounds and more tags were recovered than from the Porcupine drainage. The Toklat and Delta Rivers, tributaries of the Tanana, produced 28 tag recoveries in 1976, 102 in 1977, and 86 in 1978 (Table 5). An average of one tagged fish was recovered for every 252 fall chum salmon examined during spawning ground surveys in the Tanana drainage for the 3-year period.

Petersen population estimates were calculated for the fall chum salmon run in the Yukon River above Tanana Village and in the Tanana River for 1976 and 1977, while the estimate was only for the Yukon River above Tanana Village in 1978. Data used for these calculations included the number of fish tagged each year minus the number of tagged fish recovered below the Yukon-Tanana confluence, the commercial and subsistence harvest in the Yukon above Tanana Village and in the Tanana River, and the number of tags returned by commercial and subsistence fishermen in these areas. Estimates of 197,017, 412,285 and 165,390 fall chum salmon were calculated for 1976, 1977, and 1978, respectively (Table 6). The exploitation rate was estimated to be 34%, 20%, and 53% for each of these years, respectively.

Each of the population estimates is higher than the documented population size. The sum of harvest and observed escapement was 144,967, 233,079, and 117,491 fall chum salmon in 1976, 1977, and 1978, respectively. The population estimates were 36%, 77%, and 41% higher than the documented population for each of these 3 years, respectively.

Fall chum escapements in the Yukon and Tanana Rivers are estimated by aerial survey counts of peak spawning concentrations. Turbid water, poor weather conditions, and the immense size of the watershed probably result in under-

Table 4. Yukon River fall chum salmon tag recoveries by recovery area, 1978.

Tagging Site	RECOVERY AREA												Total Recoveries	
	Below Yukon-Tanana Confluence		Yukon Between Tanana and Porcupine		Yukon Above Porcupine		Tanana Drainage		Porcupine Drainage		Unknown			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Upper Yukon North Bank ¹	92	8	1,015	88	12	1	3	-	19	2	15	1	1,156	100
Upper Yukon South Bank ²	59	5	990	89	22	2	4	-	12	1	20	2	1,107	100
Tanana Village North Bank	201	13	1,280	82	28	2	11	1	12	1	30	2	1,562	100
Subtotal Upper Yukon	352	9	3,285	86	62	2	18	-	43	1	65	2	3,825	100
Ruby-South Bank	248	29	42	5	0	0	565	66	0	0	2	-	857	100

¹ Thirty miles above Tanana Village.

² Twenty-nine miles above Tanana Village.

Table 5. Number of fall chum salmon observed and tags recovered by foot survey of upper Yukon and Tanana River spawning grounds, 1976-1978.

<u>Upper Yukon Drainage</u>	<u>1976</u>			<u>1977</u>			<u>1978</u>		
	<u>Chums</u>	<u>Tags</u>	<u>Ratio</u>	<u>Chums</u>	<u>Tags</u>	<u>Ratio</u>	<u>Chums</u>	<u>Tags</u>	<u>Ratio</u>
Sheenjek River	4,500	0	-	6,000	3	1: 2,000	12,000	10	1:1,200
Fishing Branch River	8,800	2	1:4,400	12,000	1	1:12,000	7,000	3	1:2,333
Total	13,300	2	1:6,650	18,000	4	1: 4,500	19,000	13	1:1,462
<hr/>									
<u>Tanana River Drainage</u>									
Toklat River	900	27	1:33	12,000	83	1:145	12,000	85	1:141
Delta River	600	1	1:600	17,000	19	1:895	12,000	1	1:12,000
Total	1,500	28	1:54	29,000	102	1:284	24,000	86	1:279

Table 6. Upper Yukon River drainage fall chum salmon Petersen population estimates, 1976-1978¹.

Year	Marked (m)	Catch (c)	Recapture (R)	Population Estimate (N)	95% Confidence Interval	Exploitation Rate (R/M)
1976	966 ²	66,622 ⁴	326 ⁶	197,017	175,748 - 218,286	0.34
1977	4,950 ²	119,579 ⁴	1,435 ⁶	412,285	391,097 - 433,473	0.29
1978	6,940 ³	87,281 ⁵	3,662 ⁷	165,390	160,148 - 170,632	0.53

¹ Population estimates are for both the Yukon River above Tanana Village and for the Tanana River in 1976 and 1977. The 1978 population estimate is only for the Yukon River above Tanana Village due to the location of the tagging sites.

² Total number of chums tagged minus the number of tagged fish recovered below the Yukon-Tanana confluence.

³ Total number of chums tagged from the three fishwheels located on the Yukon River at or above Tanana Village.

⁴ Commercial and subsistence harvest on the Yukon River above Tanana Village and on the Tanana River.

⁵ Commercial and subsistence harvest on the Yukon River above Tanana Village.

⁶ Tag returns from commercial and subsistence fishermen on the Yukon River above Tanana Village and on the Tanana River.

⁷ Tag returns from commercial and subsistence fishermen on the Yukon River above Tanana Village.

assessment of population abundance. In addition, peak counts fail to include early and late spawners. The documented population of fall chum salmon in the Yukon drainage is therefore a minimum estimate. Conversely, the tag and recovery population estimates are probably inflated by the failure of some fishermen to return tags. These two factors, underassessment of escapements and incomplete tag returns probably account for the disparity between the documented and estimated population size.

PART II. TANANA RIVER STUDY, 1979 - 1980

Methods and Materials

Two fishwheels were rented under contract from local fishermen and operated in the lower Tanana River near Manley Hot Springs (Figure 2) in August and September of 1979 and 1980. Each fishwheel was equipped with a livebox to hold the fish until they could be tagged and released. Captured chum salmon in good condition were identified by sex and tagged with an individually numbered orange (south bank wheel) or yellow (north bank wheel) "spaghetti" type plastic tag.

A 2 dollar reward was paid for each tag returned by fishermen. The date, location, and method of recovery was reported with the tag returns. In addition, Department personnel conducted spawning ground surveys in October and November of each year for tag recoveries.

Petersen population estimates were calculated as outlined in the previous section.

Results and Discussion

One fishwheel was located on the north bank of the Tanana River 8 mi below Manley Hot Springs, while the second wheel was on the south bank, 40 mi below the village, in 1979. To rigorously test for a difference in bank orientation between stocks, the two fishwheels should be located directly opposite each other. A second factor, besides bank orientation, is introduced when the tagging sites are located some 32 mi apart. It is unknown whether differences in tag recoveries in the upper Tanana and Toklat Rivers are then a function of the river bank of tagging or to the river mile of tagging. In an attempt to resolve this problem, the two fishwheels were located within 4 mi of each other in 1980. One wheel was again located on the north bank, 8 mi below Manley Hot Springs, while the other was on the south bank, 4 mi below the village. It is difficult to locate an adequate fishwheel site on the south bank of the Tanana River near Manley Hot Springs because of the shallow water and slack current, and a 4 mi separation between fishwheels was considered acceptable.

Chum salmon catches in 1980 were consistently lower in the south bank fishwheel than the north bank wheel. Dropping water levels forced the selection of a new south bank fishwheel site on 18 August and during the following 12-day period six new sites were fished with little success. Gillnets (5-7/8" mesh, 100 ft long) were fished on 29 August at two potential sites on the south bank to obtain an index of chum salmon abundance. One net caught one chum, while the other did not catch any during a 17-hour set. The north bank wheel had captured 771 chums by 29 August while the south bank wheel had captured only 172.

The few chum salmon captured for tagging and the difficulty in locating a suitable fishwheel site on the south bank near Manley Hot Springs forced a change in the design of the study. The south bank fishwheel was moved

on 2 September to the north bank, 10 mi below Manley Hot Springs and 2 mi below the original north bank fishwheel. The original north bank wheel will be referred to henceforth as fishwheel #1, and the wheel 2 mi downriver will be referred to as fishwheel #2.

A total of 7,259 fall chum was tagged in August and September of 1979 (Appendix Table 6) and 5,279 in 1980 (Appendix Table 7). Tag recoveries totaled 1,346 (18%) in 1979 and 1,234 (23%) in 1980. As in the Yukon River study, the majority of the chum salmon recovered each year were taken by fishwheels, will gillnets and spawning ground surveys providing the remainder (Table 7). Unlike the Yukon River study, the Tanana River subsistence fishery provided more tag returns than the commercial fishery. Tag returns from subsistence fishermen and from spawning ground surveys outnumbered returns from commercial fishermen in both 1979 and 1980 (Table 7). The commercial fishing season lasted only a few days on the Tanana River in 1979 and 1980, while the subsistence fishery operated for several weeks. Four tags were recovered by sport fishermen in 1979, none in 1980.

The recovery of tagged chum salmon in the upper Tanana and Toklat Rivers in 1979 indicated only a slight difference in bank orientation between the two stocks in the lower Tanana River. Fifty-nine percent of the chum salmon recovered in the upper Tanana had been tagged at the north bank fishwheel. Conversely, 65% of the chum salmon recovered in the Toklat had been tagged at the south bank fishwheel (Table 8). These recovery rates are not much greater than the 50% expected if no difference in bank orientation existed between the stocks, and may in fact be chance variations from the 50% figure. Since tagging was essentially conducted only on the north bank in 1980 (Table 9), further refinement of stock identification by bank orientation is not possible. It does not appear that the upper Tanana and Toklat River fall chum salmon stocks can be distinguished by bank orientation in the lower Tanana River near Manley Hot Springs.

Department personnel conducted spawning ground surveys of the Toklat and upper Tanana Rivers. A total of 25,310 fall chum salmon was observed in the Toklat River drainage by foot survey in 1980, and 242 tags were recovered, for a tagged:untagged chum ratio of 1:105 (Table 10). A total of 7,425 fall chums was observed in the upper Tanana River drainage by foot survey, and only 18 tags were recovered, for a tagged:untagged chum ratio of 1:412 (Table 11). The difference in tag recovery rates is probably due to the fact that the upper Tanana stocks pass through several fisheries upstream of the Kantishna River confluence, whereas the Toklat stock is virtually unintercepted between the Manley Hot Springs fishery and the spawning grounds. Addition of the Tanana River subsistence harvest (42,675 fish) and commercial harvest (12,526 fish) above the Kantishna River confluence, to the number of chum salmon observed on the upper Tanana spawning grounds (7,425 fish) yields a total of 62,626 chum salmon in the upper Tanana examined for tags. Addition of 743 tags returned by subsistence and commercial fishermen upstream of the Kantishna River confluence to the 18 tags recovered on the upper Tanana spawning grounds yields a total of 761 tag returns, for a tagged:untagged chum ratio of 1:82. This compares more favorably with the tagged:untagged chum ratio of 1:105 for the Toklat River.

Table 7. Tanana River fall chum salmon tag recoveries by fishery and gear, 1979 and 1980.

<u>Fishery</u>	1979		1980	
	<u>N</u>	<u>%</u>	<u>N</u>	<u>%</u>
Commercial	260	19	193	16
Subsistence	673	50	717	58
Sport	4	-	0	0
Spawning Ground	375	28	274	22
Unknown	34	3	50	4
Total	1,346	100	1,234	100
<hr/>				
<u>Gear</u>				
Fishwheel	593	44	569	46
Gillnet	307	23	347	28
Hook & Line	3	-	0	0
Handpicked	374	28	274	22
Unknown	69	5	44	4
Total	1,346	100	1,234	100

Table 8. Tanana River fall chum salmon tag recoveries by recovery area, 1979.

	Recovery Area							
	Tagged		Tanana Below Kantishna		Tanana Above Kantishna		Kantishna-Toklat	
	N	%	N	%	N	%	N	%
North Bank	3,278	51	164	37	317	59	130	35
South Bank	3,531	49	274	63	217	41	244	65
Total	7,259	100	438	100	534	100	374	100

Table 9. Tanana River fall chum salmon tag recoveries by recovery area, 1980.

	Recovery Area									
	Tagged		Tanana Below Kantishna		Tanana Above Kantishna		Kantishna-Toklat		Total	
	N	%	N	%	N	%	N	%	N	%
North Bank	5,113		215	18	719	61	254	21	1,188	100
South Bank	166		1	2	43	93	2	4	46	100

Table 10. Number of fall chum salmon observed and tags recovered by foot survey of Toklat River spawning grounds, 1980¹.

Location	Live	Carcass	Total	Tags	Ratio
Sushana River	8,750	4,100	12,850	85	1:151
Geiger Creek	1,900	1,400	3,300	42	1:80
Toklat River near Shushana	100	300	400	6	1:67
Unnamed Tributary Creek	2,200	3,560	5,760	45	1:125
Unnamed Tributary Creek	1,500	1,500	3,000	63	1:48
Total	14,450	10,860	25,310	242	1:105

¹ Streams were surveyed several times between 10/14 and 11/1. Initial population estimates were increased to account for the arrival of new fish on subsequent surveys. Ratios listed are the ratio of tagged to untagged fish. Includes only those tags recovered by Department personnel assigned to this project.

Table 11. Number of fall chum salmon observed and tags recovered by foot survey of upper Tanana River spawning grounds, 1980¹.

Location	Live	Carcass	Total	Tags	Ratio
Delta River	2,000	200	2,200	6	1:367
Bluff Cabin Slough	1,000	350	1,350	2	1:675
Delta Clearwater River	100	20	120	0	-
Clearwater Lake Outlet	5	0	5	0	-
South Bank Tanana	1,500	350	1,850	1	1:1,850
Benchmark Slough	1,750	150	1,900	9	1:211
Total	6,355	1,070	7,425	18	1:412

¹ Ratios listed are the ratio of tagged to untagged fish. Includes only those tags recovered by Department personnel assigned to this project.

Petersen population estimates of 676,241 and 383,770 fall chum salmon were calculated for the Tanana River drainage in 1979 and 1980, respectively (Table 12). The exploitation rate was estimated to be 13% and 18% for each of these years, respectively. Both population estimates are high since the sum of harvest and observed escapement was only 300,583 fall chums in 1979 and 108,817 in 1980. The population estimate was 125% higher than the documented population in 1979, and 253% higher in 1980. The difference between the documented population size and the population estimate is probably a result of the same factors cited in the Yukon River study, namely the under-assessment of escapements and the inflated population estimates because of the failure of some fishermen to return tags. It is not known why the disparity between the two methods is so much greater in the Tanana River than the Yukon River.

Examination of chum salmon tag returns in terms of tagging date indicates a slight difference in run timing between the upper Tanana and Toklat River stocks in the Manley Hot Springs area. The upper Tanana stocks demonstrate an early component that is not seen in the Toklat stock. At the south bank fishwheel in 1979, 50% run passage occurred on 3 September for the upper Tanana stock and on 17 September for the Toklat stock (Figure 5). At the north bank fishwheel in 1979, 50% run passage occurred on 7 September for the upper Tanana stock and on 12 September for the Toklat stock (Figure 6). At fishwheel #1 in 1980, 50% run passage occurred on 6 September for the upper Tanana stock, and on 13 September for the Toklat stock (Figure 7). Fishwheel #2 did not start fishing until 3 September, thus missing the early component of the upper Tanana run.

As a result, 50% run passage was 3 days earlier for the Toklat stock (12 September) than for the upper Tanana stock (Figure 8). Although 50% run passage was consistently earlier for the upper Tanana stock, there is great overlap in run timing with the Toklat stock. It does not appear that the run timing of upper Tanana and Toklat River fall chum salmon stocks is sufficiently discrete to allow for single stock harvest in the Manley Hot Springs area.

Table 12. Tanana River fall chum salmon Petersen population estimates, 1979 and 1980.

Year	Marked (m)	Catch (c) ¹	Recapture (R) ²	Population Estimate (N)	95% Confidence Interval	Exploitation Rate (R/M)
1979	7,259	86,066	923	676,241	632,896 - 719,586	0.13
1980	5,279	69,848	960	383,770	359,686 - 407,854	0.18

¹ Catch is the sum of commercial and subsistence harvest in the Tanana River drainage.

² Recaptures are the tags returned by commercial and subsistence fishermen in the Tanana River drainage.

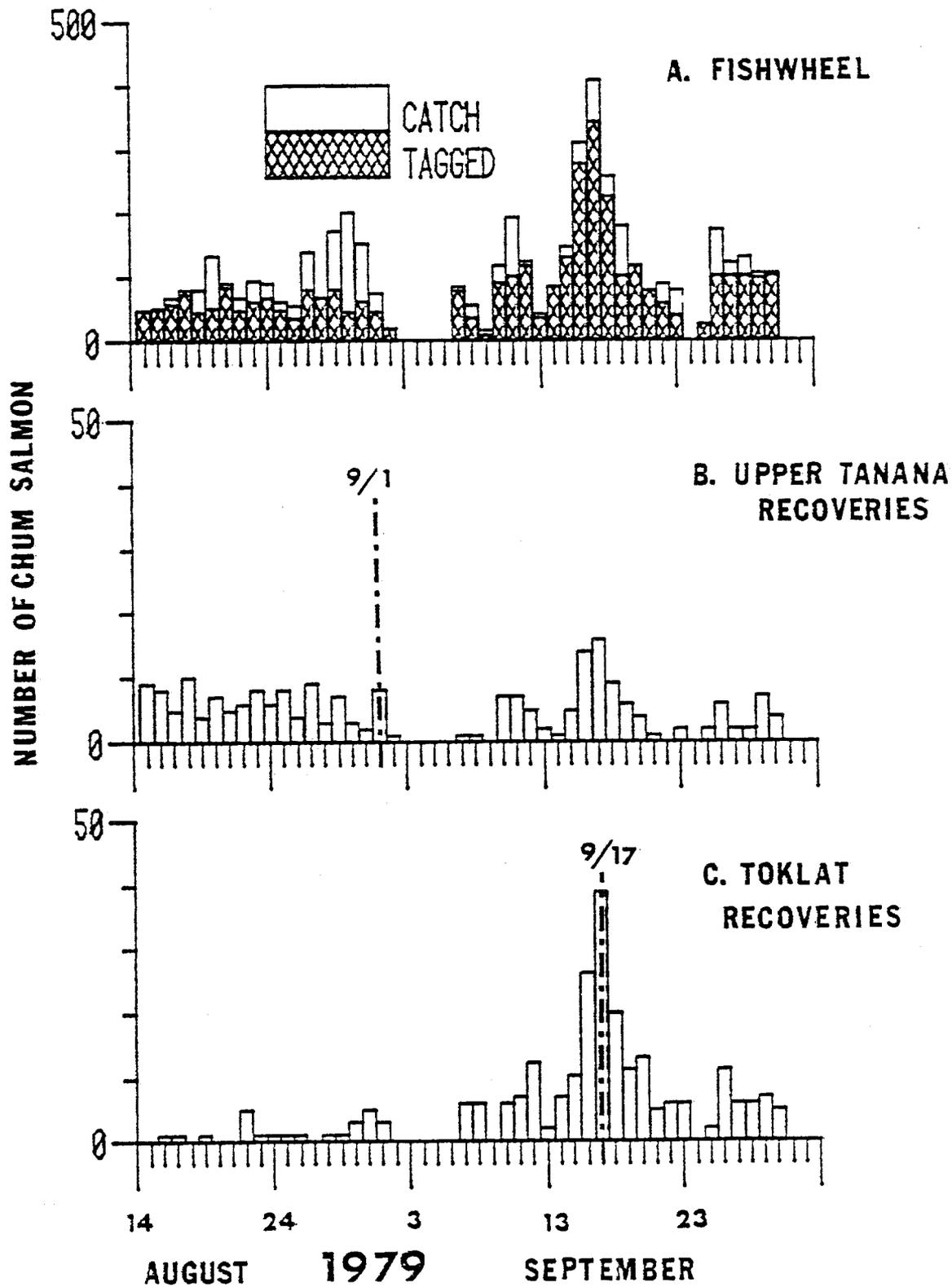


Figure 5. Run timing of fall chum salmon along the south bank of the Tanana River, 40 mi below Manley Hot Springs, in 1979, as indicated by (a) number of chums captured by fishwheel and tagged daily, (b) number of chums tagged and later recovered in the upper Tanana River, and (c) number of chums tagged and later recovered in the Toklat River. The date of 50% run passage for each stock is indicated with dotted line.

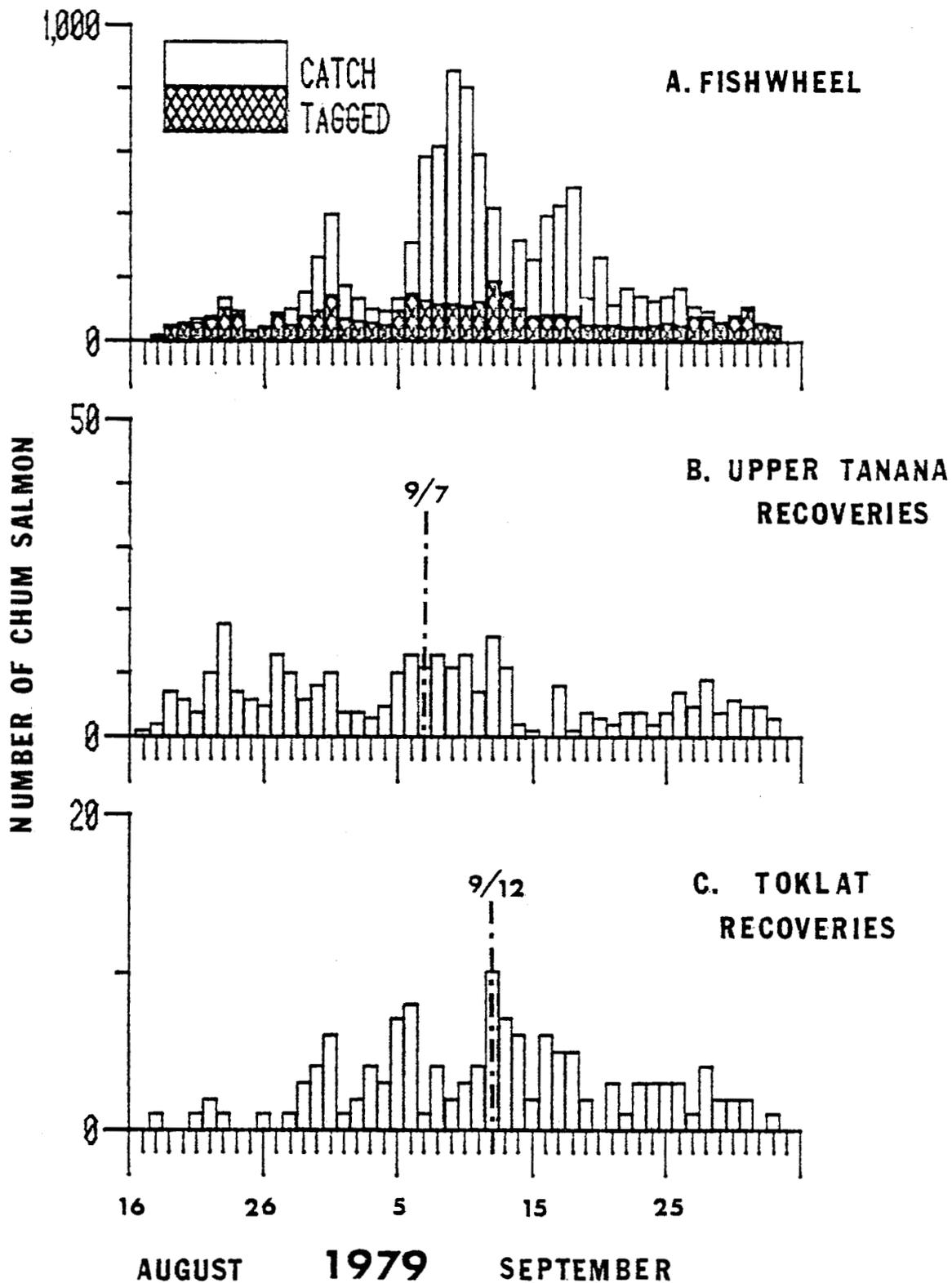


Figure 6. Run timing of fall chum salmon along the north bank of the Tanana River, 8 miles below Manley Hot Springs, in 1979, as demonstrated by (a) number of chums captured by fishwheel and tagged daily, (b) number of chums tagged and later recovered in the upper Tanana River, and (c) number of chums tagged and later recovered in the Toklat River. The date of 50% run passage for each stock is indicated with dotted line.

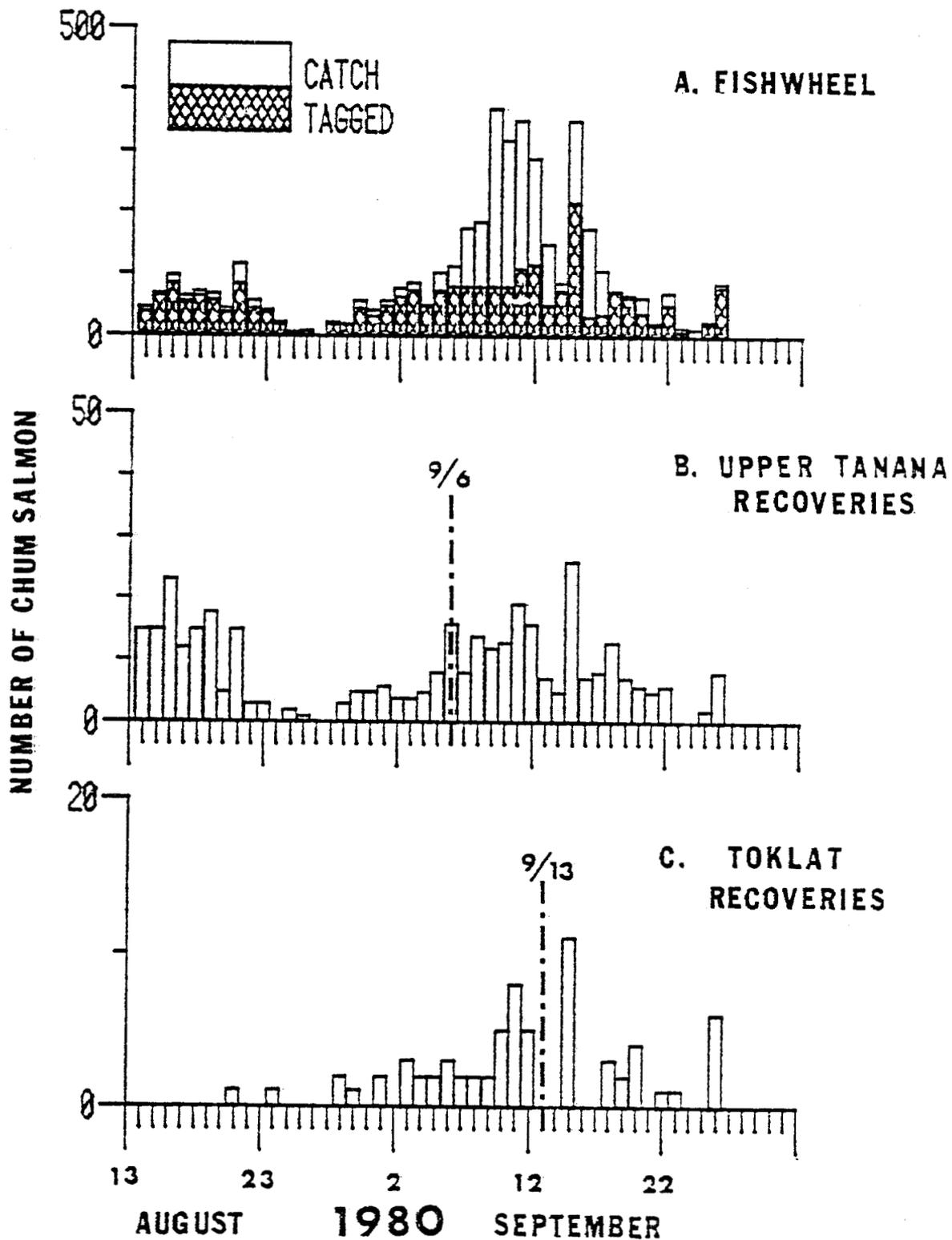


Figure 7. Run timing of fall chum salmon along the north bank of the Tanana River, 8 miles below Manley Hot Springs, in 1980, as demonstrated by (a) number of chums captured by fishwheel and tagged daily, (b) number of chums tagged and later recovered in the upper Tanana River, and (c) number of chums tagged and later recovered in the Toklat River. The date of 50% run passage for each stock is indicated with dotted line.

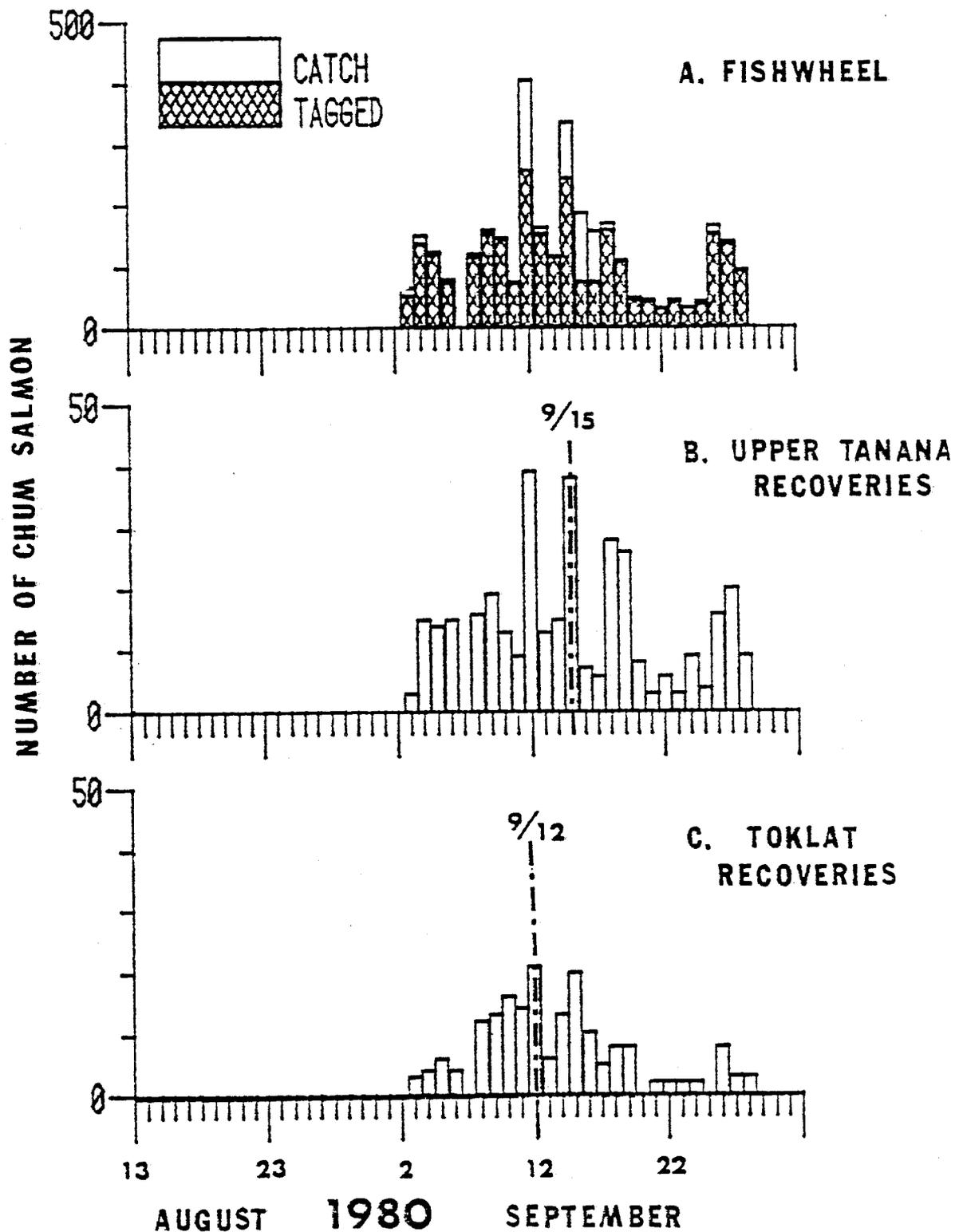


Figure 8. Run timing of fall chum salmon along the north bank of the Tanana River, 10 miles below Manley Hot Springs, in 1980, as demonstrated by (a) number of chums captured by fishwheel and tagged daily, (b) number of chums tagged and later recovered in the upper Tanana River, and (c) number of chums tagged and later recovered in the Toklat River. The date of 50% run passage for each stock is indicated with dotted line.

CONCLUSIONS AND DISCUSSION

Yukon River fall chum salmon stocks were identified by bank orientation in the Galena area as a result of tagging conducted in 1976, 1977, and 1978. Upper Yukon River stocks migrate mostly along the north bank of the Yukon River in the Galena area, while Tanana River stocks migrate later and mostly along the south bank. Attempts to refine separation of individual stocks within the upper Yukon River in 1978 and within the Tanana River in 1979 and 1980 were not successful.

Management regulations were adopted by the Board of Fisheries in December 1980 based on the results of the tagging study. Boundaries within District 4 were redefined such that subdistrict 334-42 encompasses the north bank of the Yukon River between Cone Point and Illinois Creek, while subdistrict 334-43 encompasses the south bank (Figure 9). The new subdistrict boundaries will allow management biologists to regulate harvest of stocks on the north and south bank proportional to run magnitude and spawning requirements for each stock.

The tagging studies were designed to identify stocks and were not intended to be used for abundance estimation. Fall chum salmon population estimates based on tag and recovery data were as much as $2\frac{1}{2}$ times greater than the sum of catch and observed escapement. Future tagging or sonar enumeration studies of Yukon and Tanana River fall chum salmon may help resolve the present disparity between aerial survey and Petersen population estimates.

ACKNOWLEDGMENTS

The author would like to credit James Mauney, who was Project Leader of the study from 1976 through 1979, and whose annual reports provided a basis for much of the material presented here. Thanks also go to Ron Regnart, Bill Arvey, Mike Geiger, and Fred Andersen for their assistance in the design and evaluation of the study, and for their critical review of this manuscript.

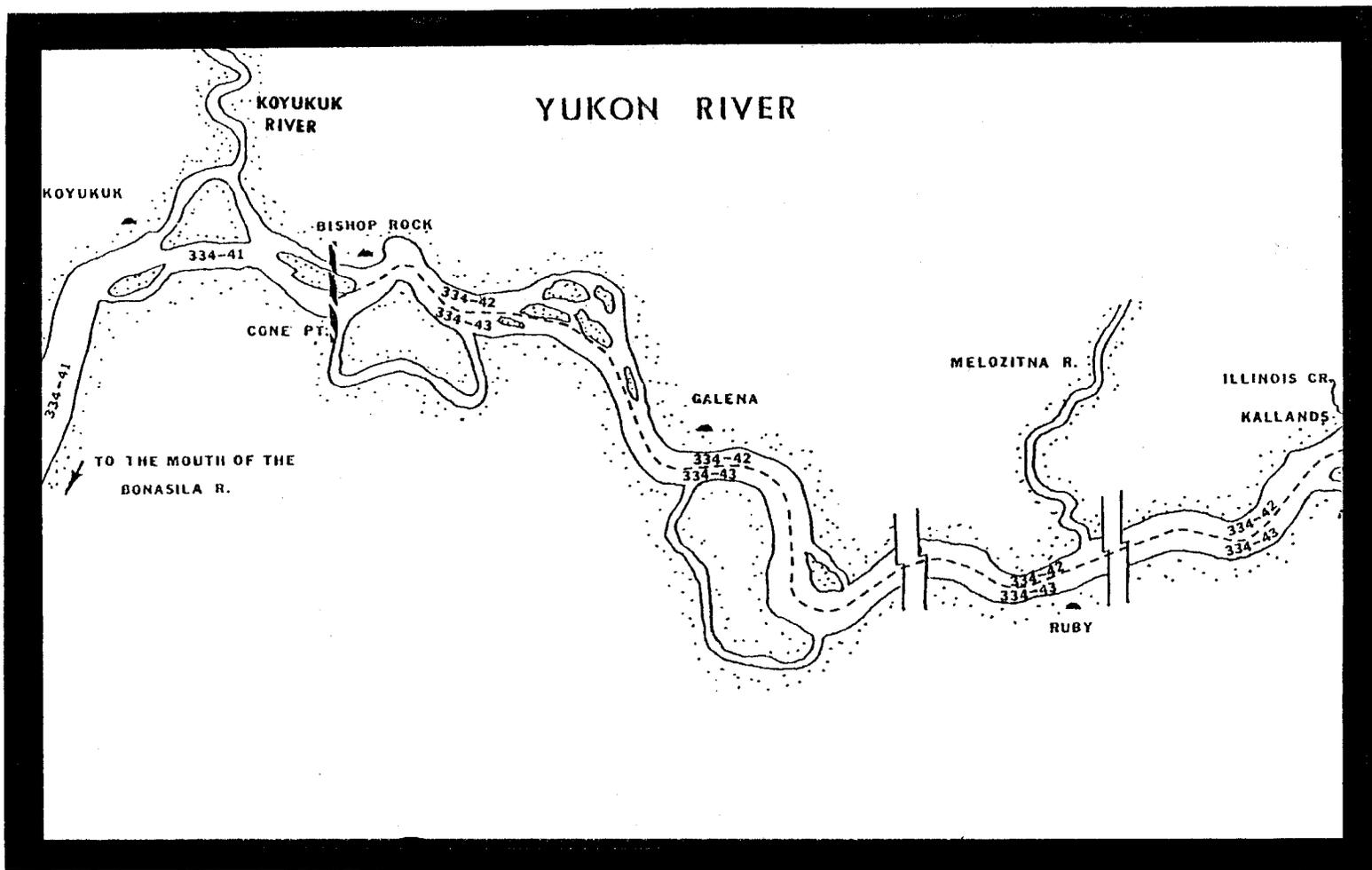


Figure 9. Map of the Yukon River in the Galena area, showing the new subdistrict boundaries dividing the north and south banks of the river.

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APPENDICES

Appendix Table 1. Number of fall chum salmon tagged daily on the north and south bank of the Yukon River near Galena, 1976.

Date	Galena North Bank		Galena South Bank	
	Daily	Cumulative	Daily	Cumulative
8/12	4	4	-	-
8/13	9	13	-	-
8/14	26	39	13	13
8/15	43	82	13	26
8/16	30	112	12	38
8/17	28	140	15	53
8/18	14	154	6	59
8/19	9	163	9	68
8/20	8	171	6	74
8/21	8	179	10	84
8/22	5	184	2	86
8/23	5	189	0	86
8/24	5	194	0	86
8/25	8	202	7	93
8/26	17	219	11	104
8/27	11	230	19	123
8/28	9	239	36	159
8/29	20	259	27	186
8/30	54	313	43	229
8/31	29	342	48	277
9/ 1	28	370	61	338
9/ 2	22	392	27	365
9/ 3	25	417	45	410
9/ 4	22	439	39	449
9/ 5	16	455	39	488
9/ 6	14	469	15	503
9/ 7	14	483	38	541
9/ 8	8	491	25	566
9/ 9	10	501	25	591
9/10	17	518	21	612
9/11	7	525	17	629
9/12	3	528	11	640
9/13	11	539	8	648
9/14	6	545	10	658
9/15	-	-	7	665
9/16	-	-	4	669
9/17	-	-	3	672

Appendix Table 2. Number of fall chum salmon tagged daily on the north and south bank of the Yukon River near Galena, and on the south bank near Ruby, 1977.

Date	Galena North Bank		Galena South Bank		Ruby South Bank	
	Daily	Cumulative	Daily	Cumulative	Daily	Cumulative
8/ 5	8	8	-	-	-	-
8/ 6	26	34	2	2	-	-
8/ 7	27	61	8	10	-	-
8/ 8	33	94	5	15	-	-
8/ 9	49	143	16	31	-	-
8/10	46	189	3	34	12	12
8/11	36	225	15	49	22	34
8/12	36	261	11	60	36	70
8/13	37	298	6	66	24	94
8/14	30	328	7	73	24	118
8/15	22	350	4	77	27	145
8/16	11	361	5	82	15	160
8/17	12	373	3	85	11	171
8/18	11	384	0	85	3	174
8/19	19	403	2	87	4	178
8/20	41	444	3	90	9	187
8/21	81	525	10	100	7	194
8/22	111	636	22	122	6	200
8/23	134	770	39	161	29	229
8/24	146	916	74	235	70	299
8/25	129	1,045	60	295	110	409
8/26	125	1,170	57	352	132	541
8/27	112	1,282	62	414	165	706
8/28	95	1,377	48	462	139	845
8/29	52	1,429	35	497	38	883
8/30	51	1,480	17	514	51	934
8/31	47	1,527	20	534	25	959
9/ 1	31	1,558	34	568	50	1,009
9/ 2	33	1,591	22	590	67	1,076
9/ 3	10	1,601	35	625	79	1,155
9/ 4	17	1,618	19	644	72	1,227
9/ 5	36	1,654	19	663	72	1,299
9/ 6	12	1,666	0	663	40	1,339
9/ 7	28	1,694	29	692	30	1,369
9/ 8	12	1,706	35	727	43	1,412
9/ 9	13	1,719	28	755	36	1,448
9/10	0	1,719	25	780	32	1,480
9/11	24	1,743	40	820	19	1,499
9/12	23	1,766	39	859	15	1,514
9/13	25	1,791	28	887	30	1,544
9/14	14	1,805	32	919	59	1,603
9/15	11	1,816	27	946	47	1,650
9/16	13	1,829	43	989	42	1,692
9/17	13	1,842	43	1,032	64	1,756
9/18	-	-	38	1,070	55	1,811
9/19	-	-	26	1,096	41	1,852

-continued-

Appendix Table 2. Number of fall chum salmon tagged daily on the north and south bank of the Yukon River near Galena, and on the south bank near Ruby, 1977 (continued).

Date	Galena North Bank		Galena South Bank		Ruby South Bank	
	Daily	Cumulative	Daily	Cumulative	Daily	Cumulative
9/20	-	-	66	1,162	92	1,944
9/21	-	-	48	1,210	62	2,006
9/22	-	-	-	-	68	2,074
9/23	-	-	-	-	53	2,127
9/24	-	-	-	-	47	2,174
9/25	-	-	-	-	51	2,225
9/26	-	-	-	-	43	2,268
9/27	-	-	-	-	16	2,284
9/28	-	-	-	-	6	2,290
9/29	-	-	-	-	9	2,299
9/30	-	-	-	-	8	2,307

Appendix Table 3. Number of fall chum salmon tagged daily on the north bank and south bank of the Yukon River thirty miles above Tanana Village, on the north bank of Tanana Village, and on the south bank at Ruby, 1978.

Date	Yukon North Bank		Yukon South Bank		Tanana Village North Bank		Ruby South Bank	
	Daily	Cumulative	Daily	Cumulative	Daily	Cumulative	Daily	Cumulative
8/ 1	-	-	-	-	38	38	9	9
8/ 2	-	-	-	-	36	74	24	33
8/ 3	29	29	-	-	41	115	16	49
8/ 4	60	89	43	43	43	158	26	75
8/ 5	33	122	33	76	43	201	28	103
8/ 6	49	171	27	103	28	229	23	126
8/ 7	7	178	15	118	13	242	16	142
8/ 8	58	236	24	142	18	260	16	158
8/ 9	33	269	17	159	24	284	14	172
8/10	28	297	21	180	21	305	9	181
8/11	41	338	7	187	13	318	9	190
8/12	25	363	14	201	19	337	18	208
8/13	41	404	12	213	23	360	20	228
8/14	30	434	13	226	42	402	31	259
8/15	52	486	30	256	42	444	23	282
8/16	44	530	33	289	55	499	17	299
8/17	55	585	43	332	44	543	36	335
8/18	50	635	44	376	62	605	43	378
8/19	60	695	48	424	65	670	45	423
8/20	82	777	66	490	62	732	44	467
8/21	42	819	61	551	59	791	41	508
8/22	41	860	48	599	42	833	21	529
8/23	40	900	36	635	25	858	20	549
8/24	40	940	22	657	19	877	23	572
8/25	26	966	20	677	26	903	32	604
8/26	19	985	11	688	29	932	38	642
8/27	35	1,020	19	707	31	963	32	674
8/28	58	1,078	36	743	35	998	19	693
8/29	56	1,134	31	774	26	1,024	20	713
8/30	48	1,182	17	791	16	1,040	13	726
8/31	20	1,202	13	804	16	1,056	18	744

-continued-

Appendix Table 3. Number of fall chum salmon tagged daily on the north bank and south bank of the Yukon River thirty miles above Tanana Village, on the north bank of Tanana Village, and on the south bank at Ruby, 1978 (continued).

Date	Yukon North Bank		Yukon South Bank		Tanana Village North Bank		Ruby South Bank	
	Daily	Cumulative	Daily	Cumulative	Daily	Cumulative	Daily	Cumulative
9/ 1	36	1,238	19	823	12	1,068	46	790
9/ 2	44	1,282	22	845	21	1,089	98	888
9/ 3	75	1,357	56	901	123	1,212	109	997
9/ 4	111	1,468	79	980	148	1,360	76	1,073
9/ 5	146	1,614	92	1,072	120	1,480	93	1,166
9/ 6	103	1,717	73	1,145	111	1,591	165	1,331
9/ 7	89	1,806	65	1,210	120	1,711	100	1,431
9/ 8	92	1,898	64	1,274	116	1,827	286	1,717
9/ 9	56	1,954	70	1,344	71	1,898	213	1,930
9/10	44	1,998	81	1,425	61	1,959	55	1,985
9/11	41	2,039	78	1,503	60	2,019	36	2,021
9/12	-	-	73	1,576	59	2,078	102	2,123
9/13	-	-	80	1,656	118	2,196	96	2,219
9/14	-	-	69	1,725	97	2,293	101	2,320
9/15	-	-	64	1,789	100	2,393	44	2,364
9/16	-	-	48	1,837	99	2,492	109	2,473
9/17	-	-	39	1,876	75	2,567	57	2,530
9/18	-	-	44	1,920	72	2,639	132	2,662
9/19	-	-	27	1,947	81	2,720	20	2,682
9/20	-	-	9	1,956	96	2,816	26	2,708
9/21	-	-	-	-	87	2,903	20	2,728
9/22	-	-	-	-	42	2,945	-	-

Appendix Table 4. Yukon River fall chum salmon tag recoveries by recovery area, 1976.

Tagging Site	Recovery Area						Total Recoveries
	Below Yukon-Tanana Confluence		Upper Yukon Drainage		Tanana River Drainage		
	N	%	N	%	N	%	
Galena North Bank	144	42	76	79	23	14	243
Galena South Bank	201	58	20	21	144	86	365
Total	345	100	96	100	167	100	608

Appendix Table 5. Yukon River fall chum salmon tag recoveries by recovery area, 1977.

Tagging Site	Recovery Area						Total Recoveries
	Below Yukon-Tanana Confluence		Upper Yukon Drainage		Tanana River Drainage		
	N	%	N	%	N	%	
Galena North Bank	247	40	514	88	30	4	791
Galena South Bank	170	28	33	6	218	29	421
Ruby South Bank	193	32	34	6	512	67	739
Total	610	100	581	100	760	100	1,951

Appendix Table 6. Number of fall chum salmon tagged daily on the north and south bank of the Tanana River near Manley Hot Springs, 1979.

Date	North Bank		Date	South Bank	
	Daily	Cumulative		Daily	Cumulative
8/15	0	0	8/15	49	49
8/16	0	0	8/16	52	101
8/17	7	7	8/17	58	159
8/18	19	26	8/18	76	235
8/19	43	69	8/19	47	282
8/20	49	118	8/20	51	333
8/21	58	176	8/21	85	418
8/22	69	245	8/22	45	466
8/23	107	352	8/23	63	529
8/24	87	439	8/24	67	596
8/25	32	471	8/25	48	644
8/26	45	516	8/26	36	680
8/27	83	599	8/27	82	762
8/28	55	654	8/28	67	829
8/29	77	731	8/29	81	910
8/30	98	829	8/30	47	957
8/31	141	970	8/31	62	1,019
9/ 1	71	1,041	9/ 1	47	1,066
9/ 2	67	1,108	9/ 2	18	1,084
9/ 3	60	1,168	9/ 3	3	1,087
9/ 4	49	1,217	9/ 4	0	1,087
9/ 5	100	1,317	9/ 5	0	1,087
9/ 6	147	1,464	9/ 6	0	1,087
9/ 7	129	1,593	9/ 7	78	1,165
9/ 8	115	1,708	9/ 8	35	1,200
9/ 9	115	1,823	9/ 9	11	1,211
9/10	113	1,936	9/10	92	1,303
9/11	123	2,059	9/11	100	1,403
9/12	186	2,245	9/12	116	1,519
9/13	147	2,392	9/13	36	1,555
9/14	103	2,495	9/14	86	1,641
9/15	78	2,573	9/15	130	1,771
9/16	87	2,660	9/16	277	2,048
9/17	84	2,744	9/17	341	2,389
9/18	76	2,820	9/18	223	2,612
9/19	49	2,869	9/19	100	2,712
9/20	50	2,919	9/20	117	2,829
9/21	50	2,969	9/21	78	2,907
9/22	46	3,015	9/22	60	2,967
9/23	46	3,061	9/23	39	3,006
9/24	50	3,111	9/24	0	3,006
9/25	59	3,170	9/25	25	3,031
9/26	50	3,220	9/26	100	3,131
9/27	79	3,299	9/27	100	3,231
9/28	80	3,379	9/28	100	3,331
9/29	59	3,438	9/29	98	3,429
9/30	76	3,514	9/30	102	3,531
10/1	104	3,618			
10/2	61	3,679			
10/3	49	3,728			

Appendix Table 7. Number of fall chum salmon tagged daily on the north and south bank of the Tanana River near Manley Hot Springs, 1980.

Date	North Bank #1		South Bank		North Bank #2	
	Daily	Cumulative	Daily	Cumulative	Daily	Cumulative
8/11	-	-	5	5	-	-
8/12	-	-	4	9	-	-
8/13	-	-	24	33	-	-
8/14	39	39	48	81	-	-
8/15	64	103	20	101	-	-
8/16	83	186	10	111	-	-
8/17	54	240	23	134	-	-
8/18	66	306	22	156	-	-
8/19	58	364	0	156	-	-
8/20	40	404	1	157	-	-
8/21	86	490	0	157	-	-
8/22	47	537	4	161	-	-
8/23	38	575	3	164	-	-
8/24	18	593	2	166	-	-
8/25	6	599	0	166	-	-
8/26	10	609	0	166	-	-
8/27	3	612	0	166	-	-
8/28	20	632	0	166	-	-
8/29	20	652	0	166	-	-
8/30	44	696	-	-	-	-
8/31	33	729	-	-	-	-
9/ 1	50	779	-	-	-	-
9/ 2	66	845	-	-	-	-
9/ 3	75	920	-	-	52	52
9/ 4	48	968	-	-	136	188
9/ 5	75	1,043	-	-	119	307
9/ 6	81	1,124	-	-	74	381
9/ 7	81	1,205	-	-	0	381
9/ 8	80	1,285	-	-	114	495
9/ 9	80	1,365	-	-	151	646
9/10	81	1,446	-	-	142	788
9/11	111	1,557	-	-	72	860
9/12	118	1,675	-	-	257	1,117
9/13	52	1,727	-	-	154	1,271
9/14	76	1,803	-	-	115	1,386
9/15	217	2,020	-	-	244	1,630
9/16	34	2,054	-	-	75	1,705
9/17	35	2,089	-	-	75	1,780
9/18	74	2,163	-	-	159	1,939
9/19	64	2,227	-	-	107	2,046
9/20	39	2,266	-	-	46	2,092
9/21	21	2,287	-	-	42	2,134
9/22	52	2,339	-	-	30	2,164
9/23	10	2,349	-	-	43	2,207
9/24	0	2,349	-	-	34	2,241
9/25	23	2,372	-	-	38	2,279
9/26	81	2,453	-	-	154	2,433
9/27	-	-	-	-	137	2,570
9/28	-	-	-	-	90	2,660

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