

UPPER YUKON DRAINAGE FALL CHUM SALMON STUDIES
1973

(From Yukon River Anadromous Fish Investigations)
Completion Report for July 1, 1973 to June 30, 1974

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Introduction

Fall chum salmon are a unique race of chum salmon which are distinguished from summer chum salmon by: (1) later entrance into spawning streams, (2) later spawning period, (3) larger size, and (4) greater fecundity (Bakkala, 1970).

In 1973 over 300,000 fall chums were taken in the Yukon River drainage by commercial and subsistence fishermen. Although fall chums have composed an increasingly important portion of the total Yukon River salmon catch, very little information regarding their life history, abundance, and distribution was available before 1972. In 1972 several important spawning areas were located and the number of spawning fall chums estimated.

The objectives of the 1973 fall chum studies were:

1. Determine the distribution, abundance, and timing of fall chum salmon spawning populations.
2. Determine the magnitude of the Delta River fall chum salmon spawning population.
3. Determine the stream residence (lifespan) of tagged chum salmon in the Delta River.
4. Determine the age, sex, and size composition of the Delta River fall chum salmon population.

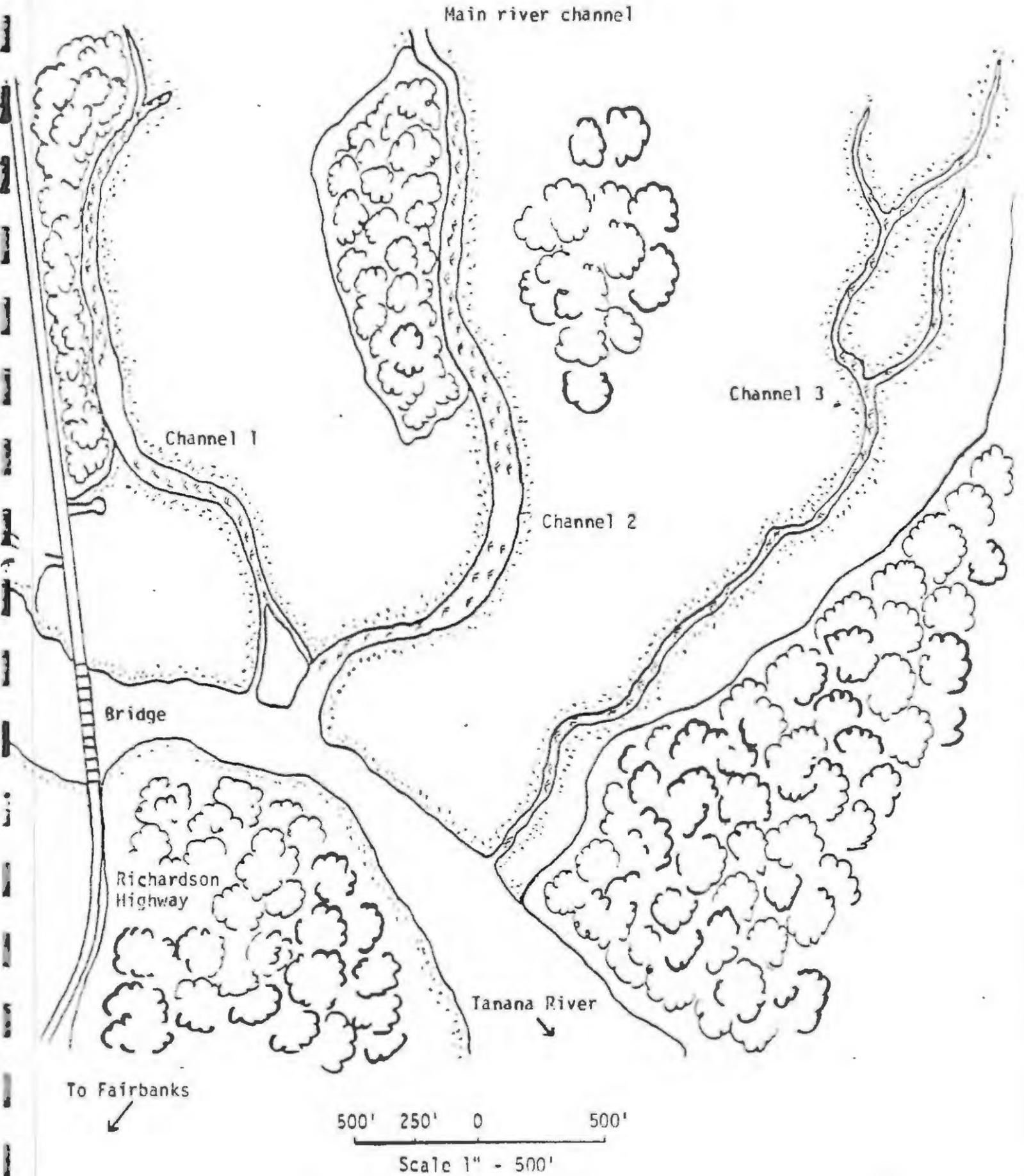
To accomplish these objectives, the aerial survey coverage was extended and an intensive study was initiated on the fall chum population which spawns in the lower Delta River, a tributary of the Tanana River. This area is accessible by road and is located adjacent to the Richardson Highway 1 mile west of the town of Big Delta. The spawning area consists of the three largest channels of the Delta River of which the first and third are not connected to the main river from October 1 to April 1 (Figure 21). The entire flow to all three channels during spawning (October 1 - December 15) is supplied by spring water. The second channel, which is the main river channel, is not utilized by spawning fall chums until mid-October when the main river freezes to the bottom above the spawning area and the flow of cold silty surface water stops. During spawning the channels are composed of a series of large, clear, shallow pools separated by very shallow riffles. These characteristics make it very easy to capture and observe spawning salmon. The riffles keep dead and dying salmon from drifting out of the study area.

Methods and Materials

Fall chum salmon were captured approximately 200 feet inside the mouth of the Delta River with a 150' x 4" x 2" beach seine. The fish were held in the seine while the length from mideye to fork of tail was measured, sex determined, and tags applied. Only silvery, healthy fish which were just entering the river were tagged. Each salmon was tagged with a numbered red Peterson disc tag in the muscular portion of the back anterior to the insertion of the dorsal fin. A scale smear was taken from a sample of the tagged salmon to determine age composition. Tagged salmon were held for a few minutes after tagging to insure they had not been injured before being released. No tag rewards were paid and the Delta River was closed to all sport fishing on October 13 to prevent harassment and removal of the spawning salmon.

Tag recoveries were made on a daily intensive carcass survey of the three channels comprising the Delta River spawning grounds. A record of the

Figure 21. Delta River fall chum salmon spawning area, 1973.



F - Spawning fall chums

total number of carcasses by sex and location of recovery was kept each day. A log of all tag recoveries was kept by tag number, date, and location of recovery. A portion of the carcasses was sampled for age, sex, and size composition. Spawning success was gauged by examining the gonads of carcasses. To avoid resampling, all carcasses were removed from the water and thrown up on the bank.

Stream life was defined as that period of time from the date of tagging at the mouth of the river to the date the salmon was recovered on the carcass survey.

Unspawned salmon were killed and frozen for laboratory examination at a later time. They provided data on fecundity, average weight, and age composition. Scales and otoliths were used in age determination for these salmon. Eggs were boiled until hard and fecundity was determined volumetrically.

Two aerial surveys were made of the lower Delta River; the first on October 22 with a Heliocourier STOL aircraft, and the second on October 26 with a Bell Jet Ranger helicopter. Aerial surveys were made of all the known and suspected fall chum spawning areas in the Tanana, Porcupine, and Chandalar River drainages (Figure 22). A Heliocourier was used to fly all these surveys with the exception that a Bell Jet Ranger was used to fly a second survey of the upper Tanana River. Escapement counts from the Canadian portion of the Yukon drainage were received from the Fisheries Division of Environment Canada.

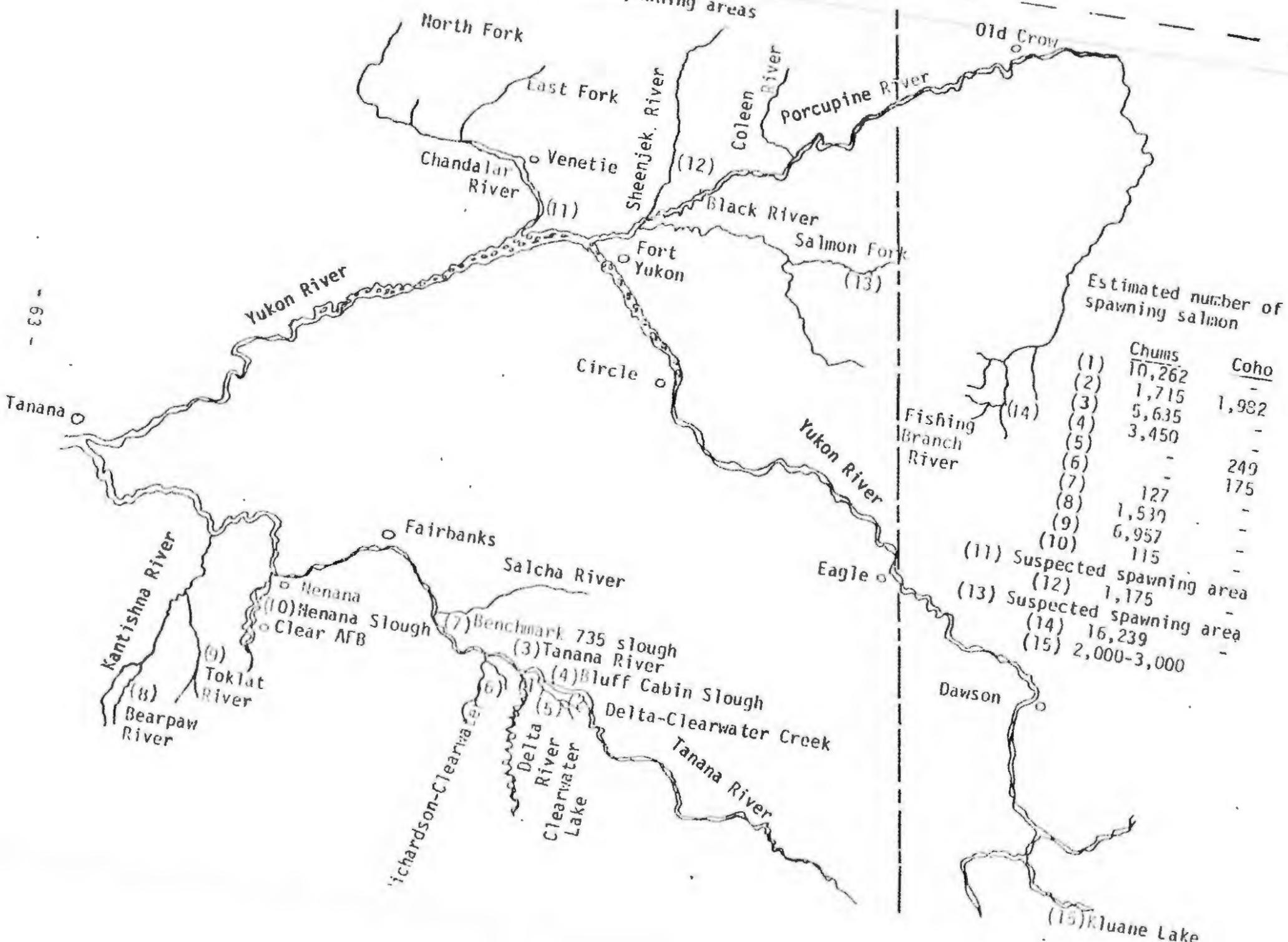
During tag and recovery operations on the Delta River, water temperatures and climatological data were recorded daily and limnological data periodically.

Results

The first chum salmon were observed in the Delta River on October 5. Between October 10 and October 20, a total of 303 fall chum salmon were tagged (Table 18).

A total of 3,999 carcasses was recovered on the spawning grounds and examined for tags (Table 19). A total of 113 tags was recovered by the survey crew (Table 20). Eight carcasses were also recovered which showed positive evidence of tag removal. During the study five of these tags were recovered from fishermen and two others were known to be in the possession of local residents. One tag remains unaccounted for.

Yukon fall chum and coho salmon spawning areas surveyed in 1973.



Estimated number of spawning salmon

| | Chums | Coho |
|------------------------------|-------------|-------|
| (1) | 10,262 | - |
| (2) | 1,715 | 1,982 |
| (3) | 5,635 | - |
| (4) | 3,450 | - |
| (5) | - | 249 |
| (6) | - | 175 |
| (7) | 127 | - |
| (8) | 1,537 | - |
| (9) | 6,957 | - |
| (10) | 115 | - |
| (11) Suspected spawning area | - | - |
| (12) | 1,175 | - |
| (13) Suspected spawning area | - | - |
| (14) | 16,239 | - |
| (15) | 2,000-3,000 | - |

Table 18. Fall chum salmon tagged in the Delta River, by channel and date, 1973

| Date | Channel 1 No. Tagged | Channel 2 No. Tagged | Channel 3 No. Tagged | Total Tagged |
|-------|-------------------------|-------------------------|-------------------------|-----------------|
| 10/10 | 101 | - | - | 101 |
| 11 | - | - | 71 | 71 |
| 12 | - | - | - | - |
| 13 | - | - | 15 | 15 |
| 14 | - | - | 33 | 33 |
| 15 | 11 | 11 | - | 22 |
| 16 | - | - | - | - |
| 17 | - | - | - | - |
| 18 | - | 20 | - | 20 |
| 19 | - | - | - | - |
| 20 | - | 41 | - | 41 |
| | <u>112</u> | <u>72</u> | <u>119</u> | <u>303</u> |

Table 19 Summary of Delta River daily fall chum salmon carcass surveys, 1973.

| Date | Channel 1 | | Channel 2 | | Channel 3 | | Total for Three Channels | |
|-------|----------------------------------|---------------------------------|----------------------------------|---------------------------------|----------------------------------|---------------------------------|----------------------------------|---------------------------------|
| | Total no. of carcasses recovered | Number of tagged fish recovered | Total no. of carcasses recovered | Number of tagged fish recovered | Total no. of carcasses recovered | Number of tagged fish recovered | Total no. of carcasses recovered | Number of tagged fish recovered |
| 10/15 | 127 | 0 | 0 | 0 | 0 | 0 | 127 | 0 |
| 16 | - 1/ | - | - | - | - | - | - | - |
| 17 | 79 | 0 | 4 | 0 | 0 | 0 | 83 | - |
| 18 | 48 | 0 | 1 | 0 | 8 | 0 | 57 | - |
| 19 | 39 | 1 | 2 | 0 | 1 | 0 | 42 | 1 |
| 20 | 57 | 1 | - | - | - | - | 57 | 1 |
| 21 | 53 | 0 | 8 | 0 | 11 | 0 | 72 | - |
| 22 | 73 | 2 | 4 | 0 | 5 | 0 | 82 | 2 |
| 23 | 63 | 2 | 1 | 0 | - | - | 64 | 2 |
| 24 | 46 | 1 | 3 | 0 | 9 | 2 | 58 | 3 |
| 25 | 65 | 2 | 4 | 1 | 7 | 0 | 76 | 3 |
| 26 | 60 | 4 | 37 | 1 | 4 | 2 | 101 | 7 |
| 27 | 67 | 5 | 15 | 1 | 12 | 1 | 94 | 7 |
| 28 | 101 | 4 | 26 | 1 | 19 | 6 | 146 | 11 |
| 29 | - | - | - | - | - | - | - | - |
| 30 | 182 | 6 | 92 | 3 | 6 | 3 | 280 | 12 |
| 31 | 114 | 7 | 51 | 4 | 17 | 1 | 182 | 12 |
| 11/ 1 | 80 | 4 | 40 | 3 | 5 | 1 | 125 | 8 |
| 2 | 77 | 3 | 73 | 1 | 9 | 0 | 159 | 4 |
| 3 | 101 | 2 | 85 | 2 | 10 | 1 | 196 | 5 |
| 4 | 89 | 4 | 132 | 4 | 7 | 0 | 228 | 8 |
| 5 | 51 | 1 | 98 | 1 | 6 | 0 | 155 | 2 |
| 6 | 59 | 3 | 101 | 2 | 9 | 1 | 169 | 6 |
| 7 | 70 | 3 | 217 | 6 | 15 | 1 | 302 | 10 |
| 8 | 66 | 1 | 182 | 2 | 20 | 0 | 268 | 3 |
| 9 | 116 | 1 | 191 | 2 | 28 | 4 | 335 | 7 |
| 10 | 53 | 1 | 217 | 1 | 18 | 1 | 288 | 3 |
| 11 | 37 | 0 | 206 | 4 | 10 | 0 | 253 | 4 |
| | 1,973 | 58 | 1,790 | 39 | 236 | 24 | 3,999 ^{3/} | 121 ^{2/} |

2/ Includes eight fish recovered with V cut in back where tag was removed.

1/ - indicates that no survey was made on that day.

3/ 2,079 (52%) males and 1,920 (48%) females.

Table 20. Percentage of fall chums tagged and recovered in each Delta River channel, 1973.

| Tags Applied | Recoveries | | | | | | | | | |
|--------------|------------|-----------|---------|-----------|---------|-----------|---------|-----------------|---------|--|
| | No. | Channel 1 | | Channel 2 | | Channel 3 | | Total Recovered | | |
| | No. | No. | Percent | No. | Percent | No. | Percent | No. | Percent | |
| Channel 1 | 112 | 45 | 76.2 | 12 | 20.4 | 2 | 3.4 | 59 | 100.0 | |
| Channel 2 | 72 | 3 | 15.8 | 16 | 84.2 | 0 | - | 19 | 100.0 | |
| Channel 3 | 119 | 6 | 17.1 | 10 | 28.6 | 19 | 54.3 | 35 | 100.0 | |
| Totals | 303 | 54 | 48.0 | 38 | 34.0 | 21 | 18.0 | 113 | 100.0 | |

A simple Peterson population estimate of 10,014 fall chums was made for the entire spawning area using the available data. The eight carcasses which showed evidence of tag loss were included as marked fish recovered in the estimate (Appendix Table 17).

Of the 303 chums tagged, 112 were tagged in channel 1, 72 in channel 2, and 119 in channel 3 (Table 20). A significant portion of these chums were not recovered as carcasses in the channel where they were tagged. The percentage recovered in the other two channels was 23.8, 15.8, and 45.7 for channels 1, 2 and 3 respectively.

Based on daily tag recoveries from carcasses, the average stream life was 20.7 days in channel 1, 16.8 days in channel 2, and 21.9 days in channel 3. The average stream life for all three channels was 20.4 days (Appendix Table 18).

The age, sex, and size sample was composed of 493 fall chums. Age classes 3₁ to 6₁ were represented with age class 4₁, comprising 77 percent of the sample (Table 21). Males composed 56.7 percent of the sample, but male chums comprised just 52 percent of the 3,999 carcasses examined on the carcass survey (Table 19). The average length was 607 mm for males and 589 mm for female chum salmon.

Based on an examination of the gonads of 202 carcasses, 87 percent of the male and 97 percent of the female chums were partially or completely spent (Table 22). An average of 103 eggs was retained per female.

A sample of unspawned chum salmon consisted of four males and 14 females. The males were composed of one 5₁ and three 4₁ age class fish with a mean length of 622 mm and a mean weight of 4.0 Kg. The females were composed of one 5₁ and 13 4₁ age class fish with a mean length of 589 and a mean weight of 2.9 Kg. The mean fecundity was 2,634 eggs per female. The age determination was the same using otoliths and scales (Table 23).

The October 22 and 26 surveys of the Delta River enumerated 6,500 and 7,971 fall chums respectively. The results of all the aerial surveys are presented in Table 24. Few fish were seen on either the Porcupine or Chandalar River drainages with the exception of 1,175 chums which Ken Alt, a sport fish biologist, observed in the Sheenjek River on September 19.

Climatological and limnological data for the Delta River is presented in Appendix Tables 19 and 20.

Table 21. Age, sex, and size composition of Delta River fall chum salmon, 1973.

| | 3 ₁ | 4 ₁ | 5 ₁ | 6 ₁ | Totals |
|--------------------------------|----------------|----------------|----------------|----------------|--------|
| Males | | | | | |
| Number | 41 | 196 | 20 | - | 257 |
| Percent | 9.0 | 43.3 | 4.4 | - | 56.7 |
| Mean Length $\frac{1}{2}$ (mm) | 559 | 614 | 637 | - | 607 |
| Females | | | | | |
| Number | 22 | 153 | 20 | 1 | 196 |
| Percent | 4.9 | 33.8 | 4.4 | .2 | 43.3 |
| Mean Length (mm) | 553 | 590 | 613 | 655 | 589 |
| Combined | | | | | |
| Number | 63 | 349 | 40 | 1 | 453 |
| Percent | 13.9 | 77.1 | 8.8 | .2 | 100 |
| Mean Length (mm) | 556 | 603 | 625 | 655 | 599 |

$\frac{1}{2}$ mideye to fork of tail

Table 22. Post-spawning condition of Delta River fall chum salmon carcasses, 1973.

| Males | | | | Females | | | | |
|-------------|-----------------|---------------|------------|-------------|-----------------|---------------|-----------------------------------|-----------|
| Spawned out | Partially spent | Did not spawn | Total | Spawned out | Partially spent | Did not spawn | Ave. no. of eggs retained females | Total |
| 27 (23%) | 76 (64%) | 15 (13%) | 118 (100%) | 62 (74%) | 19 (23%) | 3 (4%) | 103 | 84 (100%) |

Table 23. Age, sex, and size of unspawned Delta River fall chums, 1973.

| Males | | Females | |
|--------------------|---|---------------------|--|
| Sample size | - 4 | Sample size | - 14 |
| Average length | - 622 | Average length | - 589 mm |
| Average weight | - 4.0 kg | Average weight | - 2.9 kg |
| Age composition | - 1 (5 ₁) 3 (4 ₁) fish | Age composition | - 1 (5 ₁) 13 (4 ₁) fish |
| Ave. wt. of gonads | - 145 grams | Ave. wt. of ovaries | - 528 grams |

Table 24. Comparison of fall chum and coho aerial survey counts, 1972-1973.

| | 1972 | | | 1973 | | |
|---------------------------------|----------------------|------|---------------|----------------------|-------|---------------|
| | Chums | Coho | Survey Rating | Chums | Coho | Survey Rating |
| Tanana River Drainage | | | | | | |
| Bear Paw River | <u>3/</u> | - | - | 1,530 | - | fair |
| Toklat River | 1,000 | - | poor | 6,957 | - | good |
| Nenana River | <u>3/</u> | - | - | 115 | - | fair |
| Benchmark 735 Slough | 5,255 | - | fair | 127 ^{1/} | - | fair |
| Richardson Clearwater | - | 349 | poor | - | 175 | fair |
| Delta River | 3,650 | - | good | 7,971 | - | fair |
| Tanana River ^{2/} | 8,350 | - | fair | 5,635 | - | fair |
| Bluff Cabin Slough | 6,040 | - | fair | 3,450 | - | fair |
| Clearwater Creek and Lake | - | 417 | fair | - | 249 | poor |
| Delta Clearwater and Slough | - | 434 | poor | 1,715 | 1,982 | poor-good |
| Chandalar River Drainage | | | | | | |
| Chandalar River | <u>3/</u> | - | - | <u>4/</u> | - | poor |
| East Fork Chandalar | <u>3/</u> | - | - | <u>4/</u> | - | poor |
| Porcupine River Drainage | | | | | | |
| Black River | <u>3/</u> | - | - | <u>4/</u> | - | poor |
| Salmon Fork Black River | <u>3/</u> | - | - | <u>4/</u> | - | poor |
| Sheejek River | <u>3/</u> | - | - | 1,175 | - | poor |
| Salmon Trout River | <u>3/</u> | - | - | <u>4/</u> | - | poor |
| Yukon Territory Streams | | | | | | |
| Fishing Branch River | 35,000 ^{5/} | - | - | 16,239 ^{5/} | - | - |
| Kluane River | - | - | - | 3,000 | - | - |
| Glacier Creek | 150 | - | very poor | <u>3/</u> | - | 0 |

- ^{1/} survey made too early
- ^{2/} Richardson Highway Bridge to point four miles upstream
- ^{3/} not surveyed
- ^{4/} surveyed too late in season
- ^{5/} weir count

Discussion

Based on Robson and Regiers 1964 statistical analysis of sample size in Peterson mark and recapture experiments, the 1973 population estimate has a 95 percent chance of being within 25 percent of the actual population size. This means that, based on the data available, between 7,510 and 12,518 fall chums spawned in the Delta River in 1973.

The population estimate generally satisfied Rickers (1958) requirements for a valid Peterson estimate. One factor, however, could have caused the population to be too high. Three or four of the tagged salmon were seen in a Tanana River spawning area about 1/4 mile above the mouth of the Delta River. There is no way of determining how many tagged fish may have migrated out of the Delta River but no tag recoveries were made outside the Delta. It is probable that most of the chums entering the Delta River spawned there and although some migration did occur, it was not significant.

There are two factors which indicate the population estimate was reasonably accurate: (1) the peak aerial survey estimate of 7,971 chums was within the 95 percent confidence limits of the population estimate, and (2) when the project was terminated on November 15 over 1/2 of the spawning chums were still alive (based on observations of spawning density). This indicates that at least 8,000 chums spawned there since 3,999 carcasses had been recovered before November 15.

A significant number of salmon emigrated from the channel where they were tagged into one of the other two channels. The reason for this is unknown but could have been due to tagging shock, overcrowding or homing behavior. It is interesting to note that there was a relationship between the area of the spawning channel and the percentage of tagged salmon which emigrated. The third channel which had the smallest area available for spawning had the most emigration and the second channel which had the largest spawning area, the least emigration.

The average stream life in the Delta River (20.4 days) was similar to the 21.2 days found in the Fishing Branch River in 1973 (Elson, 1973). The Fishing Branch sample was composed of only 7 salmon but exhibited a range of stream life similar to the Delta River sample of 113 chums (Appendix Table 18).

Channel 2 chum salmon exhibited a significantly shorter average stream life (16.8 days) than either channel 1 or 3 chums. This was probably the result of delayed spawning since the chums did not enter channel 2 until October 17, 12 days after they entered the other two channels. The reason for this delay

appeared to be the near freezing water temperatures in channel 2 before that date. When channel 2 froze to the bottom above the spawning area on October 16, the flow of 0° C surface water stopped. The water temperature in the remaining portion of channel 2 rose to 3.5° C and on October 17, the chums moved in and began spawning (Appendix Table 19). This behavior indicates that Delta River chums will not spawn until water temperatures approach 2-4°C.

The average fecundity of 2,634 eggs per Delta River female chum was similar to the 2,513 egg average for Fishing Branch River females (Elson, 1973). The fecundity for Delta River chums was significantly higher than the 2,323 egg average for Yukon River summer chums (Regnart, Fridgen, and Geiger, 1965) but was significantly lower than the 3,649 egg average for Amur River chums (Lovetskaya, 1948).

The mean length of Delta River 4₁ (599 mm) and 5₁ (625 mm) age group fall chums was slightly larger than the mean length for Salcha River 4₁ (590 mm) and 5₁ (600 mm) age group summer chums (Table 15). However, the mean length of Delta River chums was significantly larger than the mean length of 4₁ (550 mm) and 5₁ (570 mm) Anvik River summer chums (Table 6). Larger size is a characteristic of fall chum salmon but this may not be entirely genetic. Fall chums enter the Yukon River about a month after the summer chums and the additional month of ocean growth could account for the size difference.

The Delta River spawning population was composed of a greater percentage of 3₁ and 4₁ age group chums than either the Anvik or Salcha River summer chum samples (Tables 6 and 15). This is in direct disagreement with Russian studies which found that Amur River fall chums had a greater percentage of 4₁ and 5₁ age group fish than Amur River summer chums (Lovetskaya, 1948).

The timing of the upper Tanana fall chum migration, September 15 to November 15, was much later than the summer chum salmon which reach this area in July and August. Upper Tanana fall chums exhibited essentially the same run timing as fall chums which spawn in the Amur River in Russia. They did show significantly different timing, however, from the 1973 Fishing Branch run which peaked in mid-September.

The Delta River spawning area is fed by spring water which apparently flows at a relatively constant rate and temperature throughout the year. Extensive research indicates that Siberian fall chums spawn exclusively in spring water areas (Grigo, 1953). The constant flow and warmer temperatures inherent in springs insure high survival but severely limit distribution of stocks adapted to these conditions. Temperature data from the Delta River spawning grounds indicate that the springs flow at temperatures ranging from 3.3 to 4.4° C. This is unusually warm for an area where extensive permafrost zones exist and the

source of this water should be investigated.

Four new fall chum salmon spawning areas were documented in the upper Yukon drainage in 1973 (Figure 22). The Bear Paw River, Nenana River slough, and Delta Clearwater slough were located in the Tanana River drainage. The Sheenjek River was located in the Porcupine River drainage. Aerial surveys in the Porcupine and Chandalar River drainages during November failed to locate any spawning salmon. This does not mean that large numbers of fall chums do not spawn there, however. A report from Ken Alt of the Sport Fish Division of the Alaska Department of Fish and Game, and interviews with local residents indicated that chum salmon spawned in the Sheenjek, Salmon Fork and Salmon Trout Rivers in September and October of 1973. This is earlier than fall chum salmon spawned in the Tanana but is approximately the same time they spawned in the Fishing Branch in 1973 (Elson, 1973).

It is recommended that all aerial surveys in the Porcupine and Chandalar rivers be flown during September in 1974.

Summary

1. Fall chums spaned in the Delta River between October 5 and December 15 in 1973.
2. Between October 10 and October 20, 303 fall chum salmon were tagged at the mouth of the Delta River. A total of 3,999 chum carcasses was examined for marks and 121 marked carcasses were recovered.
3. A simple Peterson population estimate of 10,014 chums was made for the Delta River in 1973.
4. A significant number of chums emigrated from the channel where they were tagged and recovered as carcasses in one of the other two channels.
5. The average stream life for fall chums in the Delta River spawning area was 20.4 days.
6. The Delta River carcass sample was made up of 77 percent age 4₁ fish. Males dominated in the sample comprising 56.7 percent of the total.
7. Eighty-seven percent of the males and 90 percent of the female chum salmon carcasses sampled were completely spent. An

average of 103 eggs was retained per female (carcass sample).

8. The average length of fall chum males sampled was 607 mm and 589 mm for females.
9. The mean number of eggs per female fall chum was 2,637.
10. The ages of the fall chum salmon in the fecundity sample from the Delta River as determined from otoliths were the same as the ages determined from scale samples.
11. The first aerial survey of the Delta River on October 22 enumerated 6,500 fall chums and the second on October 27, 7,971 fish.
12. Four new fall chum salmon spawning areas were located in 1973. They were the Bear Paw River, Nenana River slough, Delta-Clearwater Creek slough and the Sheenjek River.