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Distribution and Abundance of Chinook (*Oncorhynchus tshawytscha*) and Chum (*O. keta*) Salmon in the Upper Yukon River System in 1974, as Determined by a Tagging Program

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Northern Operations Branch
Pacific Region

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ABSTRACT

During the 1974 Yukon River tagging program a total of 727 chinook salmon (Oncorhynchus tshawytscha) and 1,276 chum salmon (Oncorhynchus keta) were tagged with Petersen disc and spaghetti tags 48.3 km below Dawson City. The tag recovery program showed a greater catch incidence of Petersen disc-tagged salmon than spaghetti-tagged salmon. The program indicated that a large portion of the chinook and chum salmon populations are main-stem spawners. Population estimates for chinooks range from 11,100 to 36,700 and for chum salmon from 8,960 to 31,352. Information on length, sex, age composition, gear selectivity and migration rates for both salmon species is included in this report.

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1.0 INTRODUCTION

During the summer and fall of 1974 a chinook salmon (Oncorhynchus tshawytscha) and chum salmon (Oncorhynchus keta) tag and recovery program was carried out on the upper Yukon River. This program was a continuation of the 1973 tagging program which represented one part of an overall study on the Yukon River salmon populations passing Dawson City, Yukon Territory (Sweitzer, 1974).

The 1974 program was similar in nature to the 1973 program; the only difference being that investigations with spaghetti tags, as well as Petersen disc tags, were conducted in 1974 to determine the recovery rate of the two tag types in order to improve on estimates of abundance; whereas, in 1973 only disc tags were used. The 1973 tagging program established which of the major and minor tributaries were utilized by spawning chinook and chum salmon. The data from the 1973 program was used to establish relative distribution and to calculate an overall population estimate for both species.

The objectives of the 1974 tag and recovery program were:

a. to establish if there was a catch incidence difference between Petersen disc and spaghetti tags;
b. to collect comprehensive age-length data;
c. to locate new spawning areas;
d. to expand existing migration and distribution data;
e. to collect comprehensive catch data in order to establish a basis for proper management of stocks;
f. to provide an estimate of abundance of salmon populations passing Dawson City.

2.0 METHODS

In 1974 a fishwheel, as described by Sweitzer (1974), was used to capture migrating chinook and chum salmon (Figure 2). The fishwheel was located in the 1973 location, approximately 48.3 km downstream from Dawson City (Figure 1).

A base camp was set up on the N.E. shore of the Yukon River directly opposite the fishwheel to enable constant surveillance of the wheel during daylight hours thereby reducing the amount of down time caused by fluctuating water levels and floating debris.

The captured salmon were held in live boxes along each side of the fishwheel (Figure 3). These were checked twice daily and the salmon were sexed, measured for fork length and then were tagged and released. For aging purposes two scales were taken from each fish from the area two scale rows above the lateral line on a line from the posterior edge of the dorsal fin to the anterior end of the anal fin.

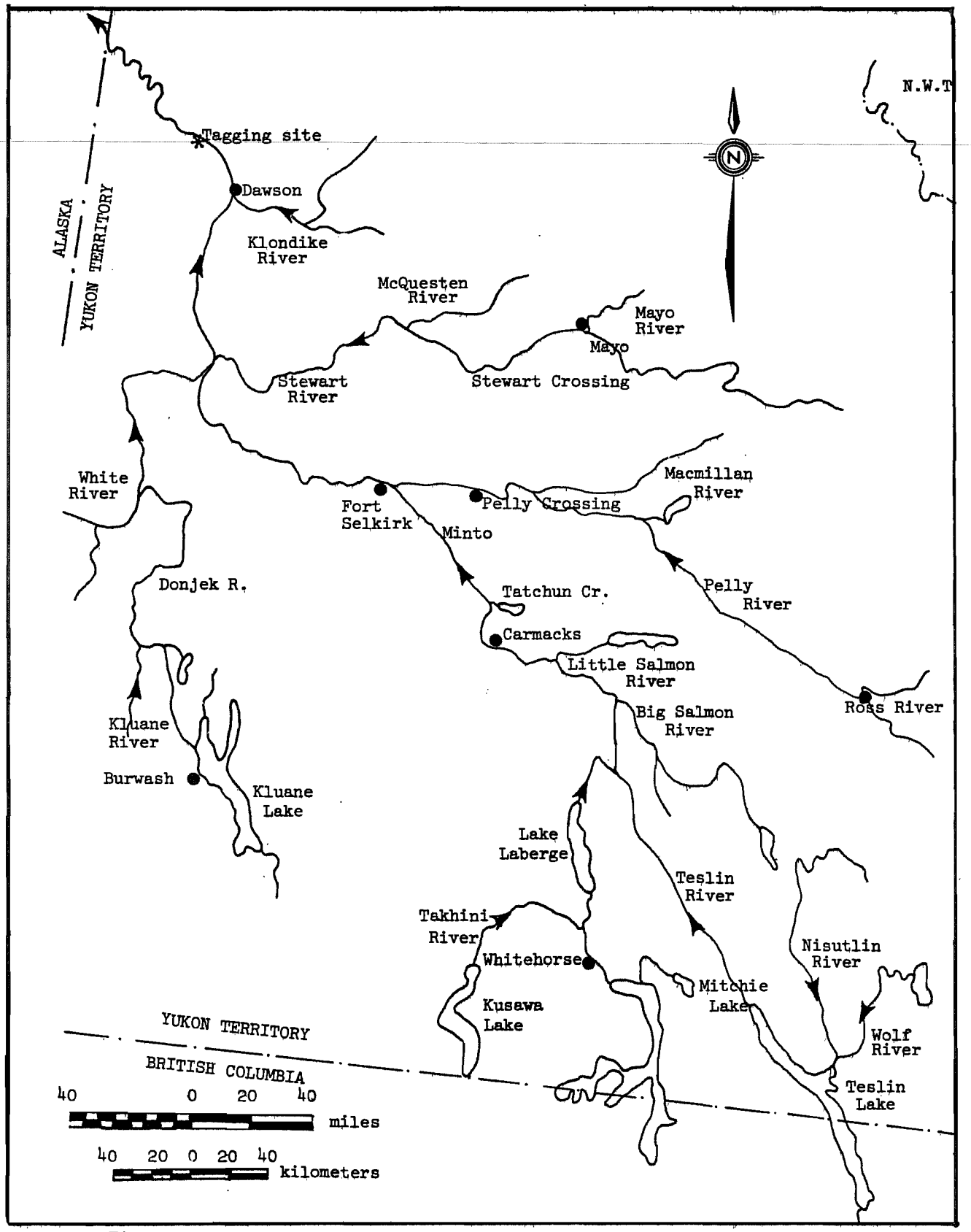

Figure 1. Map of study area showing the upper Yukon River system and tagging location

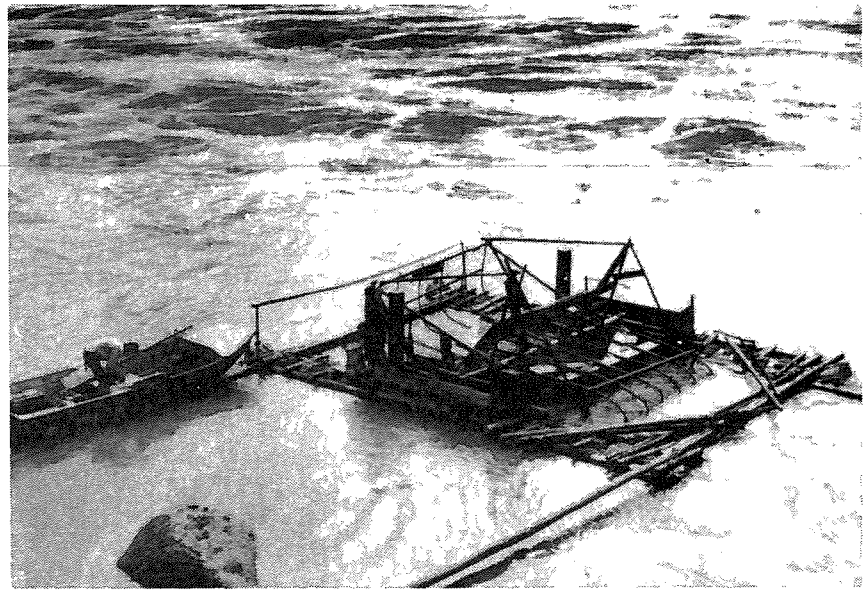

Figure 2. Fishwheel located 48.3 km downstream from Dawson City

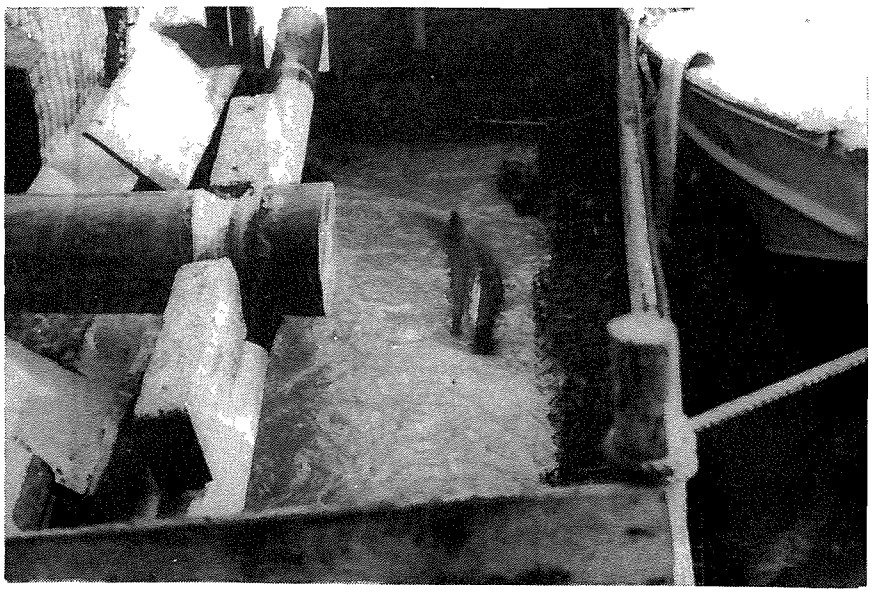

Figure 3. Live boxes located along each side of fishwheel

2.1 Tagging program

The tagging program commenced on July 7, 1974 and was concluded on October 2, 1974 when ice conditions made fishwheel operation impossible (Figure 6).

The two types of fish tags utilized were numbered Petersen disc tags 11 mm in diameter (Figure 4) and numbered spaghetti tags 4 mm in diameter and 15.24 cm in length (Figure 5). The Petersen disc tags were attached by passing a 10.16 cm nickel pin through the muscle tissue just anterior of the dorsal fin (Figure 4). Baffles were utilized to prevent tag breakage. The spaghetti tags were applied using a special needle-like applicator, which was inserted through the muscle tissue slightly posterior to the dorsal fin. The ends of the tag were then knotted together. A piece of surveyor's flagging ribbon was attached, lime green in color for the chum salmon and flourescent orange for the chinook salmon (Figure 5), to aid in aerial observations of salmon on their spawning grounds. The Petersen disc tags and spaghetti tags were applied to chinook and chum salmon in a 1:2.3 ratio throughout the period of tagging.

Test drift netting in late August using 16.51 cm mesh gillnets 15.25 m in length and 2.44 m in depth was conducted at the Ingersol Islands, a mainstem spawning ground. Four chinook were captured by this method and tagged with helium filled weather balloons attached through the muscles in the dorsal fin by a fine monofilament line. It was hoped that it would be possible to track these balloon-tagged chinook by boat in order to locate new mainstem spawning grounds.

2.2 Recovery program

A monthly fish catch calendar for July through October (Figure 7) was distributed by personal contact or by mail to all commercial, domestic and

Figure 4. Petersen disc-tagged chinook

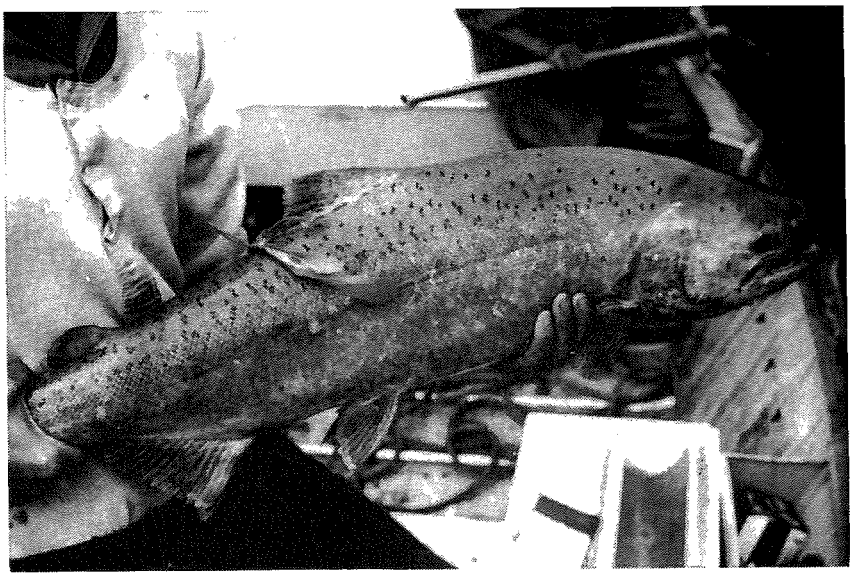

Figure 5. Spaghetti-tagged chinook

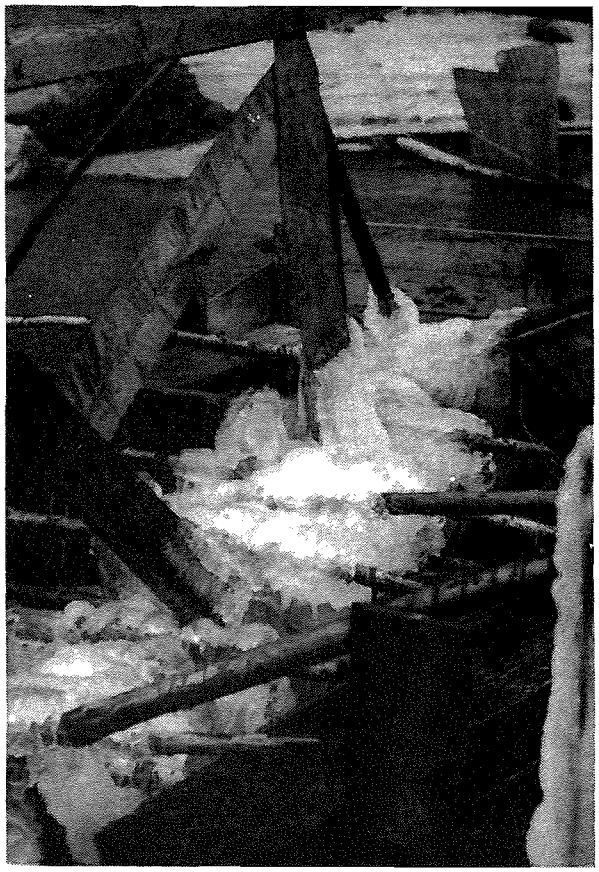

Figure 6. Icing conditions at fishwheel

Yukon Territory

Subsistence Fish Calendar

October, 1974

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
		1 kings____ dogs____ inconnu__	2 kings____ dogs ____ inconnu__	3 kings____ dogs____ inconnu__	4 kings____ dogs____ inconnu__	5 kings____ dogs____ inconnu__
6 kings____ dogs____ inconnu__	7 kings____ dogs____ inconnu__	8 kings____ dogs____ inconnu__	9 kings____ dogs____ inconnu__	10 kings____ dogs____ inconnu__	11 kings____ dogs____ inconnu__	12 kings____ dogs____ inconnu__
13 kings____ dogs____ inconnu__	14 kings____ dogs____ inconnu__	15 kings____ dogs____ inconnu__	16 kings____ dogs____ inconnu__	17 kings____ dogs ____ inconnu__	18 kings____ dogs____ inconnu__	19 kings____ dogs____ inconnu__
20 kings____ dogs____ inconnu__	21 kings____ dogs____ inconnu__	22 kings____ dogs____ inconnu__	23 kings____ dogs____ inconnu__	24 kings____ dogs____ inconnu__	25 kings____ dogs____ inconnu__	26 kings____ dogs____ inconnu__
27 kings____ dogs____ inconnu__	28 kings____ dogs____ inconnu__	29 kings____ dogs____ inconnu__	30 kings____ dogs____ inconnu__	31 kings____ dogs____ inconnu__		

NAME:_____

ADDRESS:_____

Fisheries Service
1100A 1st Ave.
Whitehorse, Y.T.

Figure 7. Monthly fish-catch calendar

subsistence fishermen. The calendar enabled fishermen to record their daily catches in an easy manner. Commencing July 1, 1974 two Fisheries Service personnel travelled weekly into the field to collect the catch data and pay a $2.00 reward for each tag recovered by the fishermen. They also examined the monthly calendars to insure the daily catches were being properly recorded and to getan indication of how the salmon run was progressing. A 8.24 m jet boat was used by field personnel to maintain contact with fishermen inaccessible by road.

The Whitehorse fishway was also monitored during 1974 (Figure 8). There, chinook salmon were counted and sampled on their upstream journey to compare size and age data with that gathered at the tagging site.

2.3 Population estimates

A modified Petersen formula (Ricker, 1958) was used for the calculation of both the 1973 and 1974 population estimates where:

$$N = \frac{mc}{r + 1}$$

N = estimate of population size

m = numbered tagged

c = total catch (ie. number of salmon caught, tagged and untagged)

r = number of recaptured tags

+1 = to reduce statistical bias

For the calculation of the 95% confidence limits of r, the following formula was applied:

$$r = x + 1.92 \pm 1.96 \quad x + 1.0$$

x = number of actual tags recovered

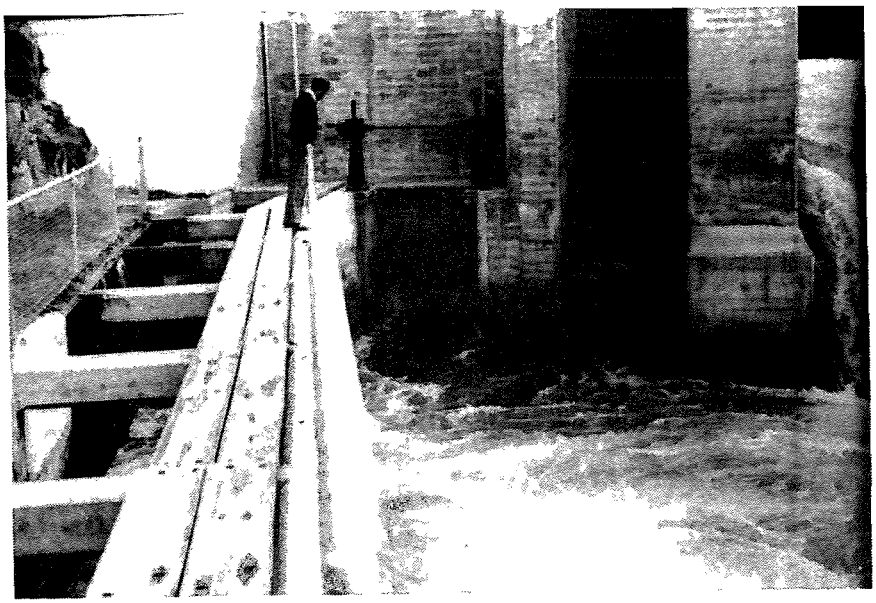

Figure 8. Whitehorse fishway

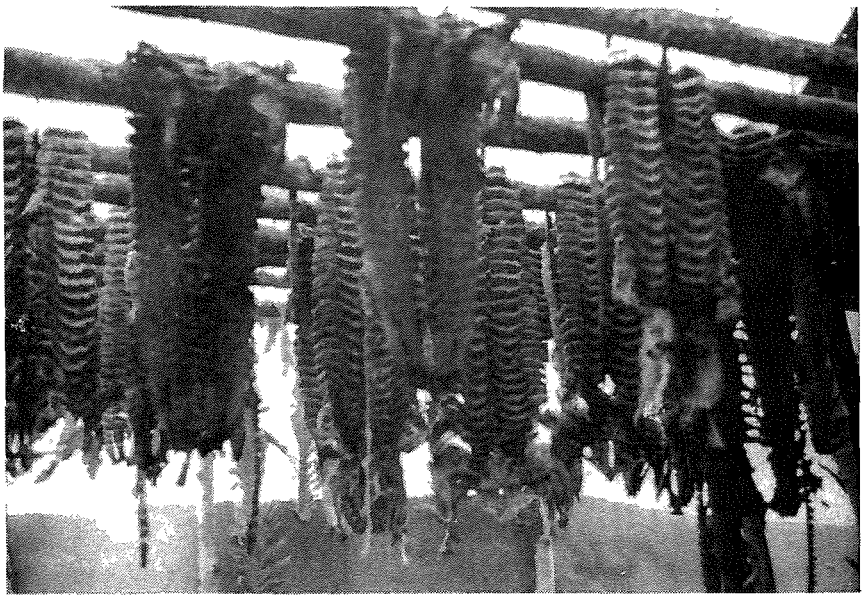

Figure 9. Native subsistence camp drying chinook salmon

3.0 RESULTS AND DISCUSSION

3.1 Gear selection and location

For sampling a fishwheel was selected over gillnet-capture methods since the latter methods subject the salmon to greater risks of physical damage and mortality as demonstrated in Alaskan studies conducted at the mouth of the Yukon River in 1963 (Alaska Dept. of Fish and Game Annual Report, 1963). Here, mortality reached 25%.

The location of the fishwheel was chosen to enable the capture of salmon prior to their entering fishing areas upstream. This would enable the tagged salmon to disperse prior to coming in contact with the fishery upstream.

3.2 Chinook salmon

A total of 727 chinook salmon were tagged in 1974, up 285 from the 442 tagged during the 1973 program. This increase may have been the results of greater wheel efficiency due to decreased amounts of debris in the river and/or an increased chinook salmon run. The latter view was supported by increases in the Canadian and Alaskan catches for 1974 (Appendices 1a-b-c).

Eight native subsistence camps (Figure 9), eight domestic and four commercial licensed fishermen were located on the Yukon River between Carmacks and Dawson City. On the Pelly River between Pelly Crossing and the confluence of the Pelly and Yukon Rivers there were five native subsistence camps, two domestic and one commercial licensed fishermen. However, the largest concentration of commercial fishermen was from Dawson City to the tagging wheel site where nine fishwheels and four gillnets were in operation.

In 1974 nineteen commercial and fourteen domestic licenses were issued. In addition forty-six subsistence fishermen were known to be fishing the Yukon River system.

The chinook salmon run commenced on July 7 and peaked between July 20 and August 6 during which time 442 chinook salmon were tagged and released. From Figure 10 it appears that two peaks of abundance occurred, one between July 20 and July 27 and the other between July 31 and August 4. Two peaks within the chinook salmon run were first recorded in 1963 Alaskan studies conducted at the mouth of the Yukon River (Alaska Department of Fish and Game Annual Report, 1963). These studies found that the two peaks were evident as far upstream as Ramparts. This may indicate that there are different races of chinooks comprising the Yukon River population. However, further studies are needed to confirm this.

When examining the male and female chinook populations at the fishwheel site it is interesting to note that both sexes peaked at approximately the same time (Figure 10). This was paralleled by the peaking of the male and female chinooks some three weeks later at the Whitehorse fishway (Figure 11). The male to female ratio at the tagging site was 2.4:1; whereas, it was 1.6:1 at the Whitehorse fishway.

There was a very high incidence of small male chinooks less than 71 cm in length and an absence of large males at the tagging site. A bias toward the capture of small male chinooks by fishwheels has been reported on the Yukon River (Trasky, 1973). This bias was also reflected in the catches of commercial, domestic and subsistence fishermen. (Pers. comm. 1974).[1]

The total chinook salmon catch in 1974 by all Yukon River fisheries was 5,503 (Table 1). This figure was up 26% from the 1973 catch of 4,076 (Sweitzer, 1974) despite the fact that there was no significant increase in effort.

[1] Personal discussion with commercial, domestic and subsistence fishermen during 1974 season.

Table 1. Total chinook salmon catch during 1974 broken down by general location and fishery type

Type of Fishery	No. of Chinook Pelly River	No. of Chinook Stewart River	No. of Chinook Yukon River	No. of Chinook Teslin River	Totals
COMMERCIAL	86		1709	13	1808
DOMESTIC	186	21	199		406
SUBSISTENCE	473	233	2563	20	3289
TOTALS	745	254	4471	33	5503*

* does not include 75 chinook salmon taken in subsistence fishery of Porcupine River at Old Crow

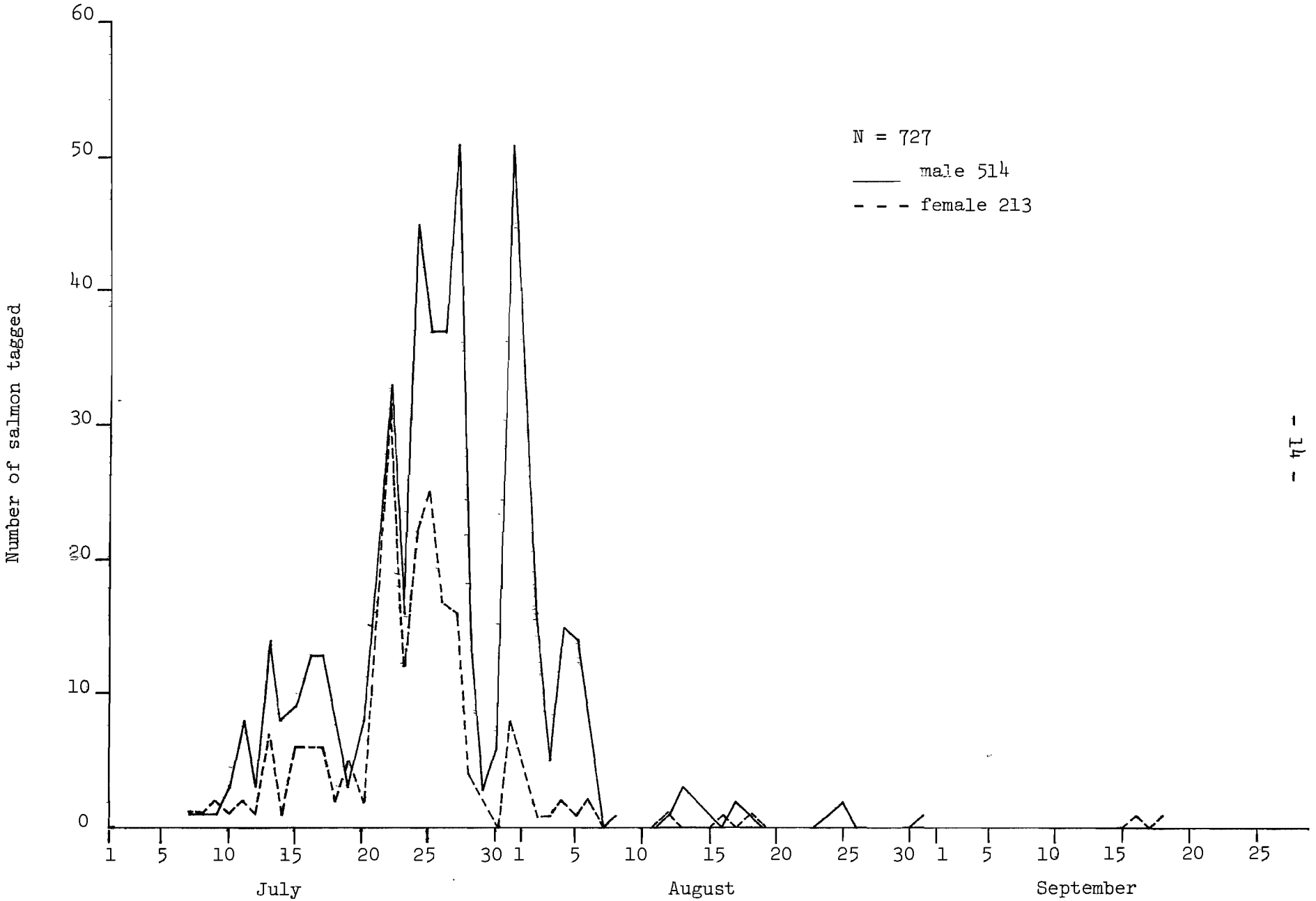

Figure 10. Daily number of male and female chinook salmon tagged at Dawson fishwheel 1974

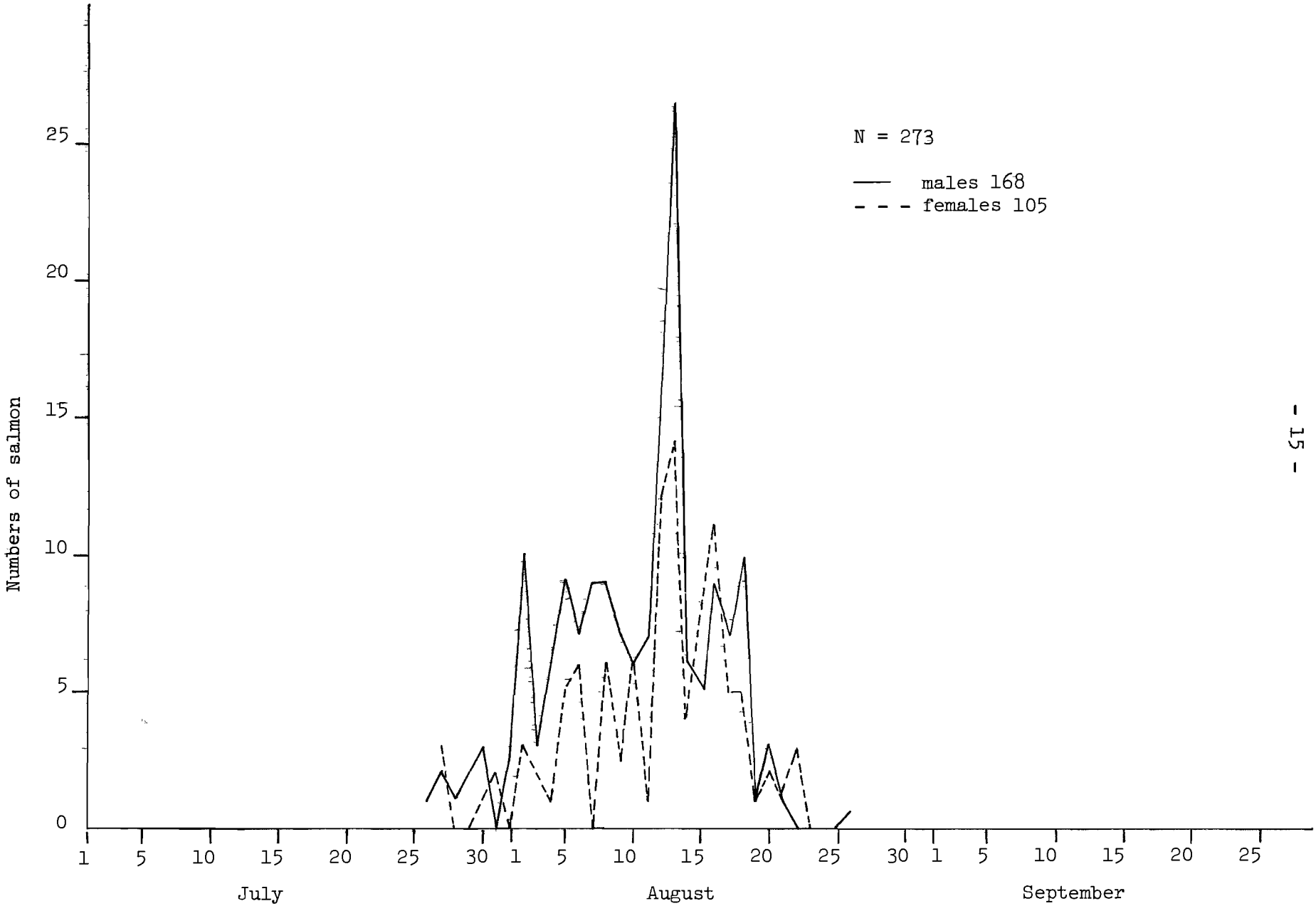

Figure 11. Daily number of male and female chinook salmon counted at the Whitehorse fishway in 1974.

3.2.1 Length and age composition

The chinook salmon sampled at the tagging site ranged in fork length from 36 to 120 cm for males and from 50 to 112 cm for females (Figure 12). The majority of the males were between 50 to 71 cm whereas, the bulk of the females were from 55 to 71 cm. The mean length for male chinook was 66 cm and the mode was 60 cm. The mean length for female chinook was 71 cm and the mode was 60 cm. These modal values for male and female chinooks were considerably lower than the 1973 figures of 76 and 77 cm and 82 and 89 cm respectively (Sweitzer, 1974).

The ages of a subsample of 490 chinook sampled at the tagging site varied from 3 to 6 years for both male and female (Table 2). Each scale used for aging had one freshwater annulus. The age composition for the 349 male chinooks sampled in 1974 was: 12.0% III; 71.4% IV; 14.3% V; and 2.3 % VI. The age composition of the 41 female chinooks sampled was: 1.4% III; 61.7% IV; 27.0%V; and 9.9%VI. The high incidence of age IV fish is probably due to selectivity of the fishwheel for smaller younger fish (Geiger et al. 1968).

The age composition of 52 male chinook sampled at the Whitehorse fishway was: 23.0% IV; 36.5% V; 36.5% VI; 4.0% VII; and for 34 females sampled was: 8.8% V; 82.4% VI; 8.8% VII.

The size and age composition of the run at Dawson however, has no doubt been modified through selection arising from gillnet fisheries in Alaska.

The fork lengths of the 90 chinook salmon sampled at the Whitehorse fishway ranged from 55 to 105 cm. Here, male chinook had a mean length of 78 cm and a mode of 84 cm. The mean length for female chinook was 79 cm with a mode of 84 cm (Figure 13). From Figure 13 it appears that chinook salmon passing through the Whitehorse fishway in 1974 were generally larger

Table 2. Length and age frequency of male and female chinook salmon at tagging site in 1974

Fork length in cm.	Females				Males				Totals
	III	IV	V	VI	III	IV	V	VI	
31 - 40		1			2				3
41 - 50		1			3	3			7
51 - 60	1	34		1	23	96	2		157
61 - 70	1	38	9		14	105	8		175
71 - 80		12	12			42	19		85
81 - 90		1	11	1		3	7	1	24
91 - 100			6	9			7	5	27
101 - 110				2			7	2	11
111 - 120				1					1
Totals	2	87	38	14	42	249	50	8	490

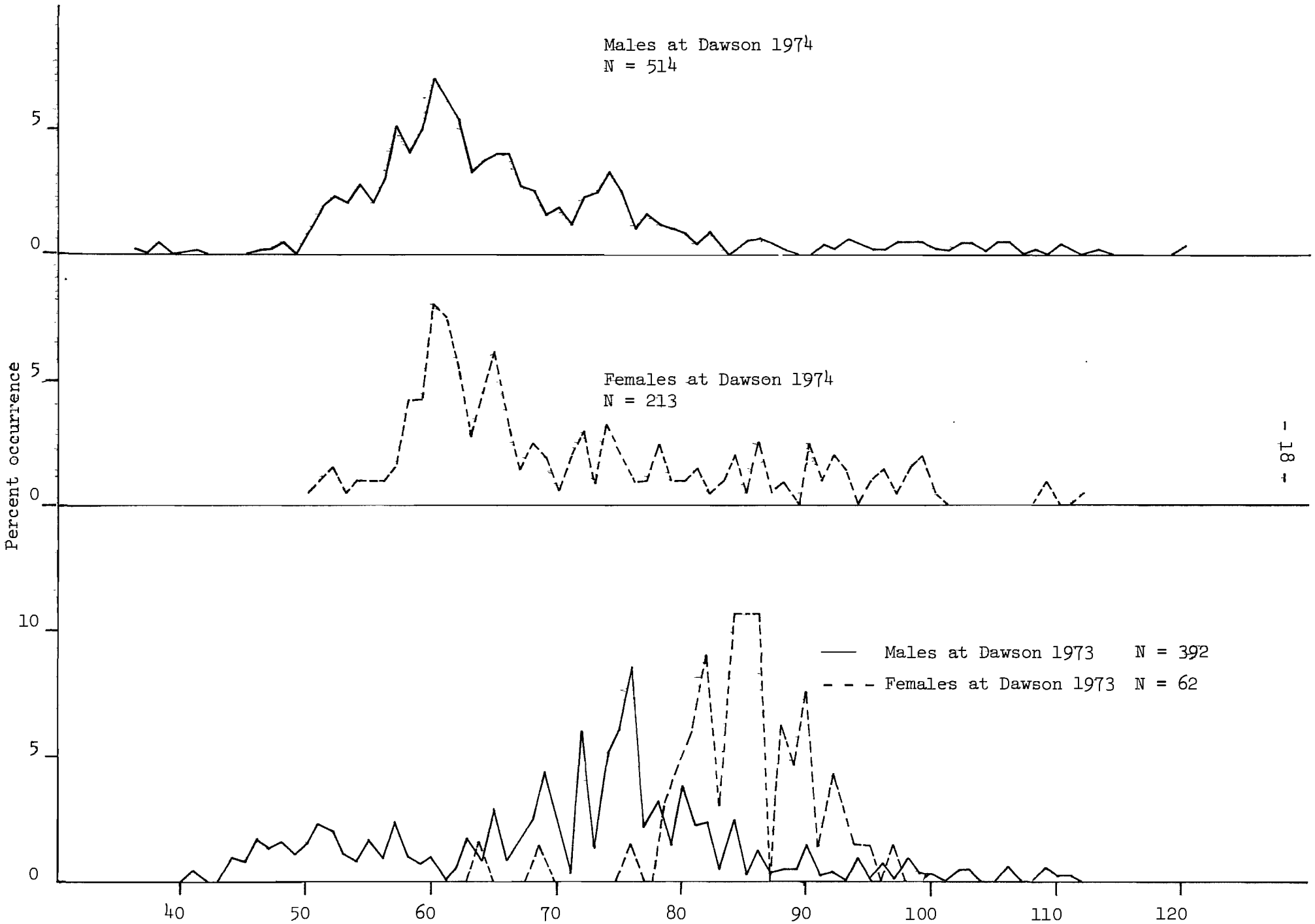

Figure 12. Fork lengths (cm) by percent occurrence of male and female chinook salmon at the Dawson fishwheel, 1973-74

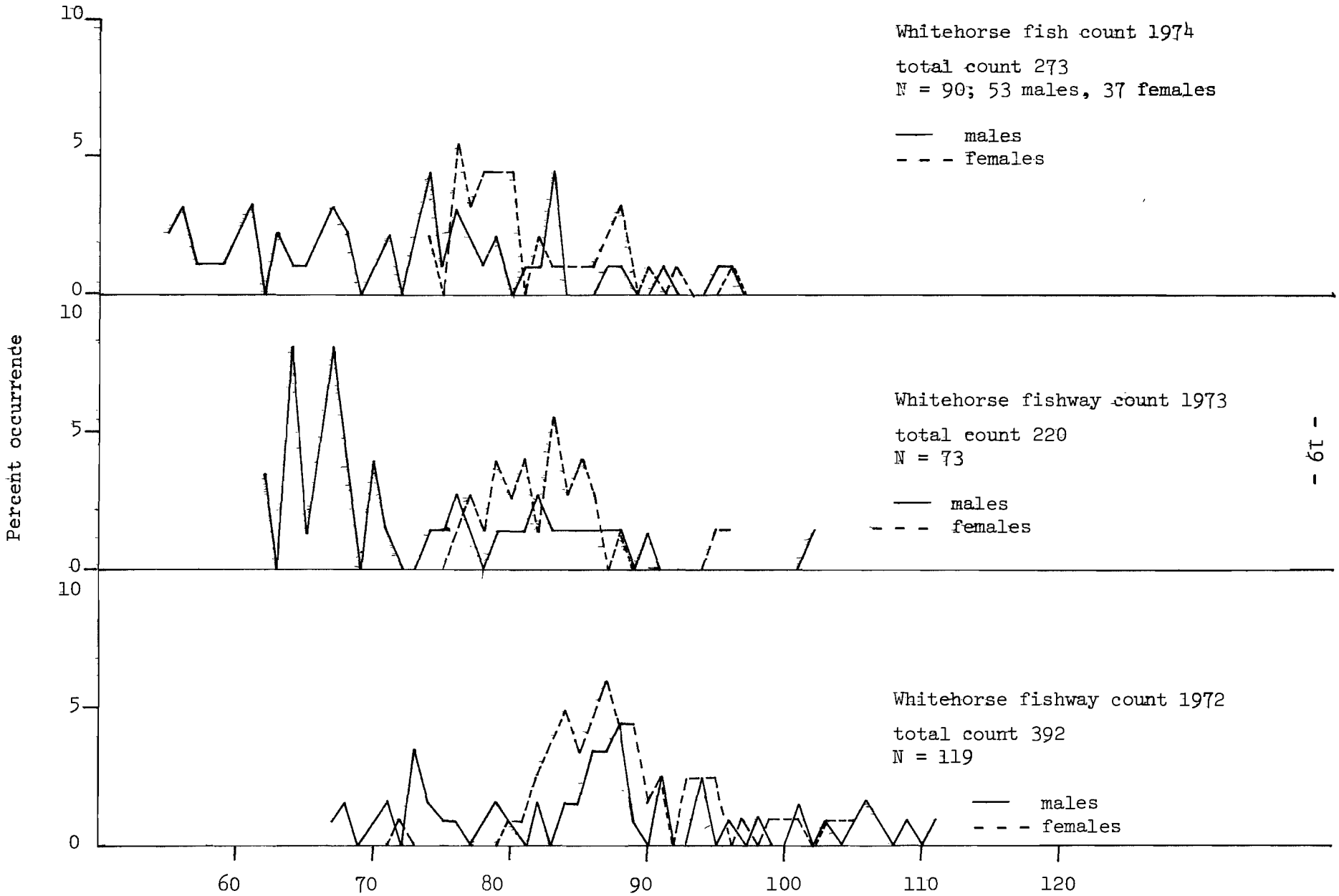

Figure 13. Fork lengths (cm) by percent occurrence of male and female chinook salmon at the Whitehorse fishway, 1972-1974

than those sampled elsewhere.

3.2.2 Rate of migration

The average rate of migration was calculated by dividing the distance travelled (km) by the time expired (days) between tagging and recovery sites (Appendix 2). Chinook salmon ranged an average rate of migration from 14.4 km to 49.9 km per day. The overall mean rate of travel was 30.9 km per day. This was lower than the 42.3 km per day reported by Trasky (1973) and the rates reported in the 1963 Annual Report on the Arctic-Yukon-Kuskokwin area of 48.3 to 77.4 km per day (Alaska Dept. of Fish and Game Annual Report 1963). Initially it would seem that the 1974 migration rate is conservative but considering that the chinook may be reducing their upstream speed as they near their respective spawning beds, the figure may in fact be fairly accurate. From Appendix 2 it does not appear that the sex, size or tag type applied affects the speed of upstream migration.

3.2.3 Catch incidence of Petersen disc tags versus spaghetti tags

To a sample of 727 chinook, 511 spaghetti tags and 216 Petersen disc tags were applied to maintain a planned ratio of 1:2.3. The recovery rate of spaghetti tags was 24.7% while that for Petersen disc tags was 49.1%. (Table 3). The total combined tag recovery rate was 31.9%. It is interesting to note that the 1973 recovery rate of Petersen disc tags was only 20.7% (Sweitzer, 1974), less than one half that of the 1974 value.

Table 3 gives a breakdown of the recovery rates of each type of tag by sex and gear. It is interesting to note that 38.9% of the recovered Petersen disc-tagged fish were taken by gillnets and only 10.2% by fish-wheels. This suggests that those fish tagged with Petersen discs were more susceptible to capture by gillnets. However, there may be some bias in the data presented in Table 3 since there were four times as many gillnets as

Table 3. Tag application and recovery by sex and gear for chinook salmon

Tags Applied	Petersen			Spaghetti			Grand Total
	M	F	Total	M	F	Total	
	149	67	216	362	149	511	727
Tags Recovered							
gillnet	55	29	84	63	15	78	162
fishwheel	16	6	22	36	12	48	70
total	71	35	106	99	27	126	232
% Tags Recovered							
gillnet	36.9	43.3	38.9	17.4	10.1	15.3	22.3
fishwheel	10.7	9.0	10.2	9.9	8.1	9.4	9.6
total	47.6	52.3	49.1	27.3	18.2	24.7	31.9

fishwheels in operation and the comparative efficiency of the two types of gear was not known. In the overall picture it would appear that either tag type would make the fish more susceptible to a gillnet fishery, thus introducing some bias in the population estimates. Further bias may result if tagged fish do not properly disperse into the migrating population (Geiger et al. 1967).

From Table 3 it appears that tagged male chinooks are more susceptible to capture than female tagged chinooks.

3.2.4 Incidence of catch based on size, sex and tag type

Due to the high recovery incidence of Petersen disc tags and male chinook salmon an examination of the size, sex and tag type applied was undertaken. From Table 4 it is evident that male chinook of all length-classes are more likely to be caught than females in both types of gear. The previously noted selectivity of fishwheels would probably explain the higher rate of males recovered by the fishwheels. The fact that a fishwheel was used as the method for capture for the tagging operation, the over abundance of males tagged probably attributes to this sex ratio imbalance. The higher rate of recovery of male chinooks by gillnets was probably due in part to secondary sexual characteristics of the male such as enlarged teeth and hooked snout, which would make them extremely more susceptible to entanglement in gillnets. Also the fact that of the 180 recovered male chinooks (Table 4), 39% bore Petersen tags which would make them even more susceptible to the gillnet fishery. Fishwheel selectivity explains the abundance of smaller males but the absence of large male and female chinook may indicate that these larger fish tend to travel in mid-channel. This segment of the chinook population would be less likely to be intercepted, since all salmon fishermen on the Canadian section of the Yukon River fish adjacent to the

Table 4. Length classes of tagged chinook salmon recovered by sex and gear

Fork length class	Tag Type	Gillnet		Fishwheel		Total	
		male	female	male	female	male	female
≤ 60 cm	Petersen	19	9	11	1	30	10
	Spaghetti	19	2	13	3	32	5
61 - 70 cm	Petersen	27	12	5	4	32	16
	Spaghetti	12	4	16	3	28	7
71 - 80 cm	Petersen	6	5			6	5
	Spaghetti	23	7	5	5	28	12
81 - 90 cm	Petersen	3	3			3	3
	Spaghetti	1	2		1	1	3
91 - 100 cm	Petersen				1		1
	Spaghetti	5		1		6	
≥ 100 cm	Petersen						
	Spaghetti	3		1		4	
Totals	Petersen	55	29	16	6	71	35
	Spaghetti	63	15	36	12	99	27
		118	44	52	18	170	62

river banks. This differs from the Alaskan drift net methods of fishing which would tend to sample a greater segment of the population (Alaska Department of Fish and Game Annual Report 1966).

The apparent lack of large male and female chinook may also be attributed to:

a. the large Alaskan gillnet fishery conducted on the Yukon River (Appendix 1a-b-c) utilizing 20.3 cm mesh gillnets prior to July 3. These nets would be selective for the larger males and females (Trasky, 1973);

b. the bulk of Canadian fishermen utilizing mesh sizes of 15.88 cm or less throughout the chinook season with a tendency toward the capture of smaller fish;

c. the Japanese catch in the Bering Sea which has increased 5 fold in recent years from 69,000 to 876,000 (Pennoyer & Regnart, 1973). With this increased pressure at sea the chance of survival of older fish at sea is reduced;

d. a strong year-class (1970) appearing in the 1974 adult return.

3.2.5 Spawning areas

Chinook salmon were sighted at the Ingersol Islands, slightly upstream from the mouth of the Pelly River, in 1974. This area was previously identified as a mainstem spawning ground in 1973 (Sweitzer, 1974). Numerous chinook carcasses were also noted in the Yukon Crossing area and finning chinooks were observed at the outlet of Lake Laberge. These observations seem to indicate that a considerable mainstem spawning population of chinooks may exist in the Yukon River. Carcasses sighted along the Yukon River in early September appeared to be those of large fish although none were measured or sexed. Table 5 gives a spawning ground summary for 1974. Due to the limited time for spawning ground enumeration in 1974, the escape-

Table 5. Numbers of chinook and chum salmon counted on spawning grounds in 1974

Location	Chinook	Chum	Methods of Survey
Big Salmon River*	70		aerial and ground
Klondike River*	44		aerial and ground
Kluane River		300 - 500	aerial and ground
McQuesten River	40		ground
Mayo River*	2		aerial and ground
Nisutlin River*	150		aerial (incl. redd count)
Tatchun Creek	192		ground
Yukon River	30	190	ground
Whitehorse fishway	276		ground

* note aerial surveys were probably done too late in season for accurate chinook counts

ment figures may not reflect true spawning ground figures.

The helium balloon tagging experiment proved unsuccessful as the water friction on the monofilament line caused the balloons to be forced to the surface of the river. This seriously affected the hydrostatic balance of the chinook and subsequently caused the loss of balloons due to line breakage. Perhaps sonic tags would be a satisfactory method of tracking mainstem spawners.

The decline in the run through the Whitehorse fishway (Figure 14) may be due in part to the turbine mortality of fry and smolts (Lister, 1960, Hryciuk, 1973). The run may also be affected by the selectivity of the fishing gear along this migration route.

3.2.6 Population estimate

The tagged to untagged ratio of captured fish varied from 1:8 for gillnets and 1:15 for fishwheels at Dawson City to 1:37 for gillnets at Carmacks and 1:273 at the Whitehorse fishway (Table 6). The tag recoveries made in the Dawson area in 1973 were disregarded because it was postulated that the fish caught immediately upstream of the tagging site were over represented by tagged fish recuperating from the tagging experience. In other words the tagged fish were not mixed throughout the population. This has been previously noted in Alaska (Geiger et al. 1967). The 1974 estimates were calculated in two parts, the first included the Dawson catch and recovery data, and the second part disregarding this data. To this end six population estimates were made based on various combinations of the 1974 data.

Part 1. Dawson catch and recovery data included:

a. using Petersen disc tags only:

$$N = \frac{216\ (5503)}{106 + 1} = 11{,}109$$

the 95% confidence limits are:

Table 6. Catch of chinook salmon tagged and untagged by location, sex, tag type and gear

Location	Tagged M	Tagged F	Tag Type Petersen	Tag Type Spaghetti	Total Tagged	Total Untagged	Ratio of Tagged to Untagged	Gear	Distance in km from tagging wheel
Yukon River									
Dawson area	51	18	21	48	69	1042	1:15	fishwheel	8.0-48.8
	28	13	18	23	41	327	1:8	gillnet	16.0-73.0
Stewart City	1	1	1	1	2	69	1:35	gillnet	145.0
Coffee Cr. area						10		gillnet	209.0
Balarat Cr. area						25		gillnet	217.0
Victoria Rock	6	2	5	3	8	134	1:17	gillnet	306.0
Ft. Selkirk	11	3	10	4	14	248	1:18	gillnet	312.0
Minto	6	6	10	2	12	158	1:13	gillnet	351.0
Carmacks	49	12	30	31	61	2240	1:37	gillnet	419.0-451.0
Whitehorse	1			1	1	272*	1:272	fishway	757.0
Fisheries' fishwheel	1	1	1	1	2			fishwheel	0
Pelly River									
Pelly Farms	2		1	1	2	95	1:48	gillnet	322.0
Pelly Crossing	9	4	6	7	13	599	1:46	gillnet	354.0-403.0
Ross River						30		gillnet	644.0
Stewart River									
Mayo area	1	1		2	2	243	1:122	gillnet	386.0
Teslin River									
Johnson's Crossing	2	1	1	2	3	51	1:17	gillnet	692.0
Alaskan fishermen	2		2		2			gillnet	Eagle, Alaska
Totals	170	62	106	126	232	5271	1:23		

* not included in total untagged figure

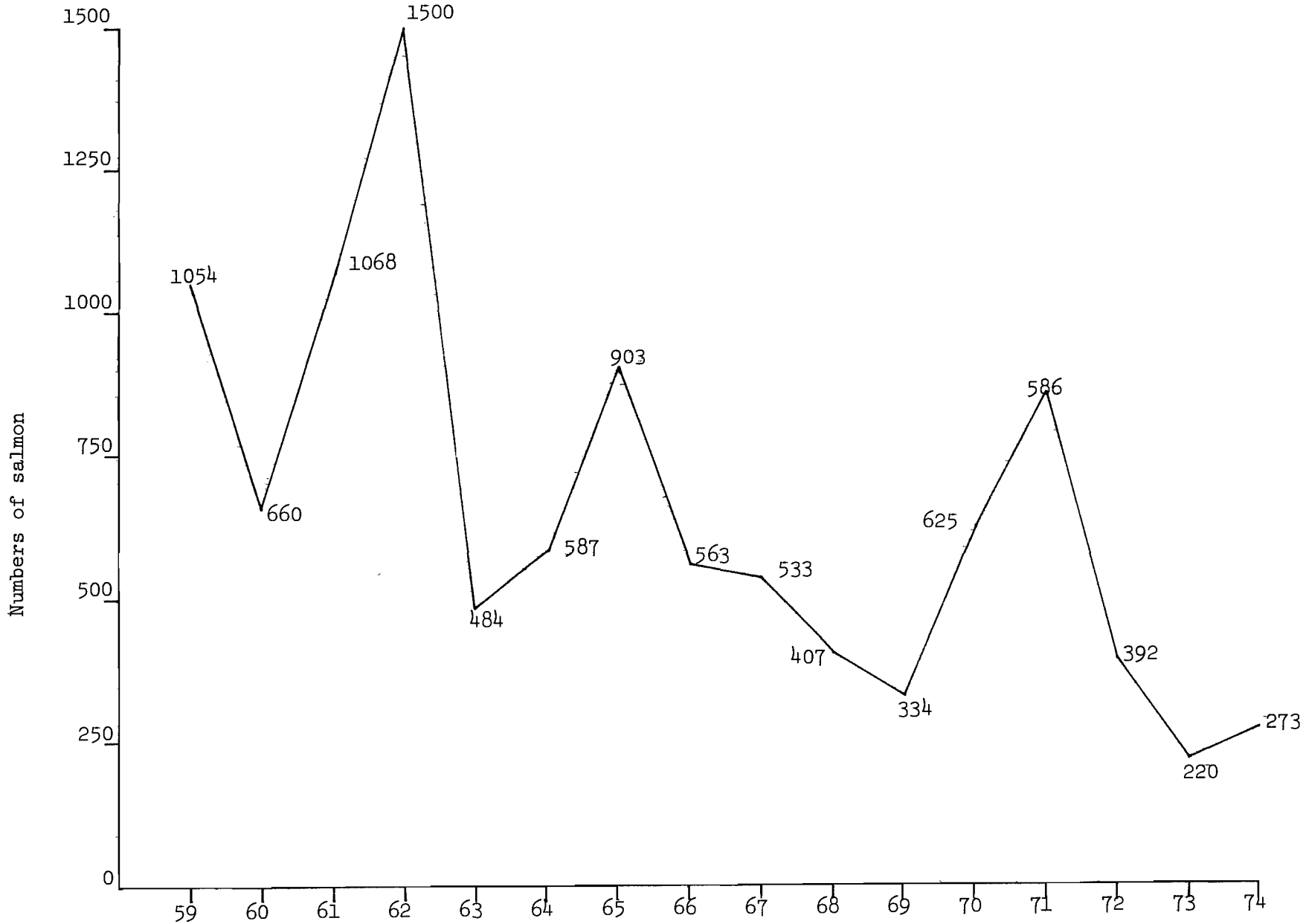

Figure 14. Whitehorse fishway chinook salmon counts 1959-74

lower limit = $\frac{216\ (5503)}{128 + 1}$ = 9,214

upper limit = $\frac{216\ (5503)}{88 + 1}$ = 13,355

b. using spaghetti tags only:

N = $\frac{511\ (5503)}{126 + 1}$ = 22,142

the 95% confidence limits are:

lower limit = $\frac{511\ (5503)}{150 + 1}$ = 18,623

upper limit = $\frac{511\ (5503)}{106 + 1}$ = 26,280

c. using spaghetti and Petersen discs combined:

N = $\frac{727\ (5503)}{232 + 1}$ = 17,170

the 95% confidence limits are:

lower limit = $\frac{727\ (5503)}{264 + 1}$ = 15,097

upper limit = $\frac{727\ (5503)}{204 + 1}$ = 19,515

Part II. Dawson catch and recovery data excluded:

a. using Petersen disc tags only:

N = $\frac{216\ (4024)}{67 + 1}$ = 12,782

the 95% confidence limits are:

lower limit = $\frac{216\ (4024)}{85 + 1}$ = 10,107

upper limit = $\frac{216\ (4024)}{54 + 1}$ = 15,803

b. using spaghetti tags only:

N = $\frac{511\ (4024)}{55 + 1}$ = 36,719

$$\text{lower limit} = \frac{511\ (4024)}{72 + 1} = 28{,}168$$

$$\text{upper limit} = \frac{511\ (4024)}{42 + 1} = 47{,}820$$

c. using spaghetti tags and Petersen tags combined:

$$N = \frac{727\ (4024)}{232 + 1} = 12{,}555$$

the 95% confidence limits are:

$$\text{lower limit} = \frac{727\ (4024)}{264 + 1} = 11{,}039$$

$$\text{upper limit} = \frac{727\ (4024)}{204 + 1} = 14{,}270$$

The estimates of abundance within 95% confidence limits ranged from 9,214 to 47,820 depending upon which data was used. As only Petersen disc tags were used in the 1973 program, and considering the high incidence of recapture of Petersen disc tags in the 1974 program, it would appear that the 1973 population estimates are conservative.

Therefore considering the bias towards the recapture of Petersen disc tags, and the probability that tagged chinook did not properly disperse in the spawning population prior to reaching Dawson the estimate of 36,700 using spaghetti tag recovery, excluding Dawson catch data, is probably the best estimate of the 1974 abundance.

3.3 Chum salmon

The total number of chum salmon tagged in 1974 was 1,276; an increase of 109 fish over 1973. The location of the base camp could have attributed to this slight increase but the 1974 overall catch was also greater. Therefore the run may have been slightly larger (Appendix 1a-b-c). The first chum salmon was tagged on the 13th of August and the run peaked between September 20 and 25, approximately one week later than in 1973 (Figure 15).

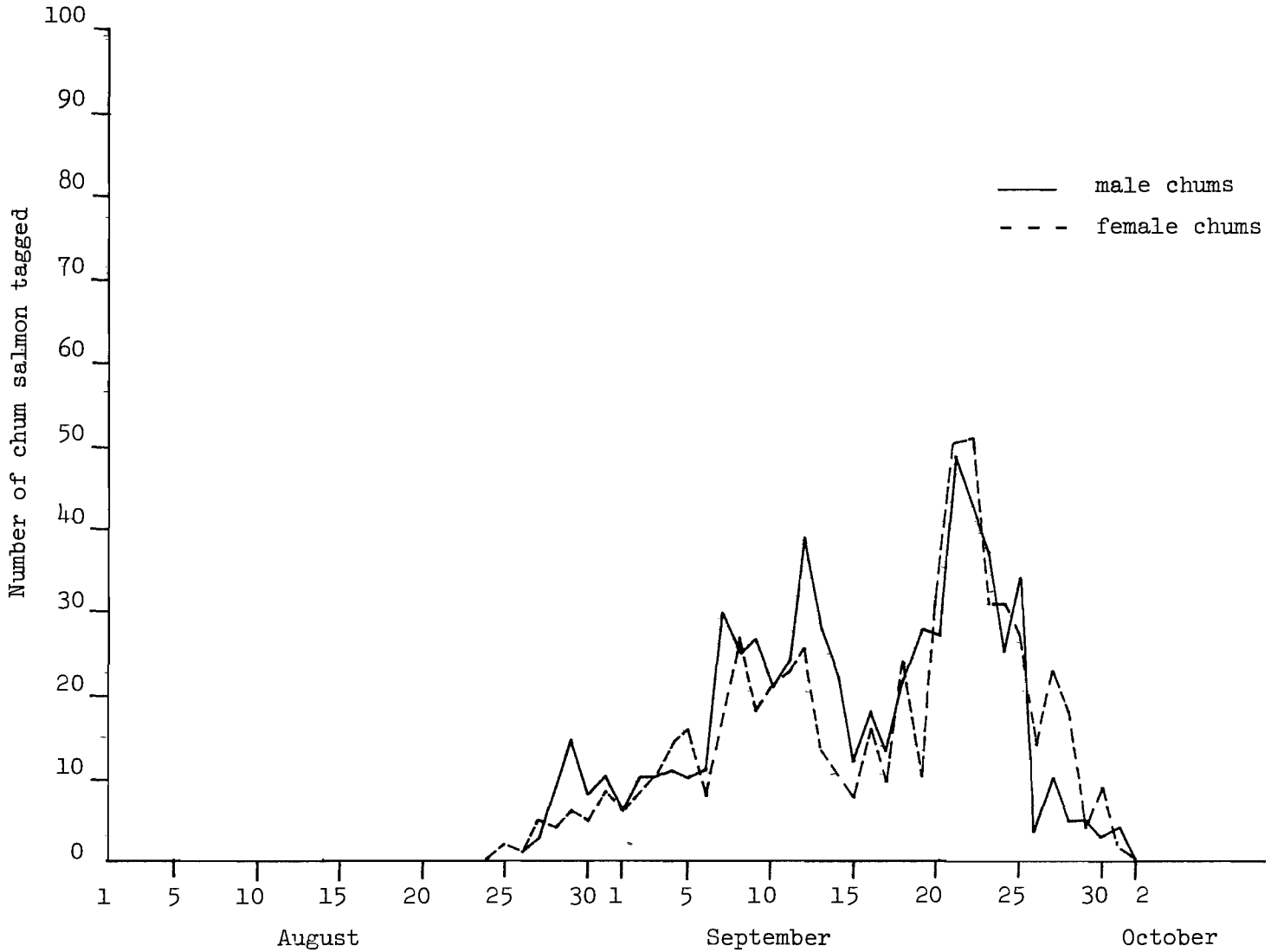

Figure 15. Daily counts of male and female chum salmon at the Dawson fishwheel

The tagging operation was terminated October 2, 1974 due to heavy icing conditions. This was unfortunate since chum salmon continued to pass the tagging site as was indicated by a test net. It would have been interesting to see if there was a second run of chum salmon following, which was indicated by increased catches during the first week of October at Eagle, Alaska (Pers. comm.).[2] Chum salmon were also reported passing Ramparts during the 1st week in October in 1962 (Sears, 1963) which also indicates that a late run of chum salmon can occur.

The sex composition of the chum salmon was approximately evenly divided with 661 (51.8%) males and 615 (48.2%) females. Both sexes peaked at the tagging site at approximately the same time indicating that they migrate upstream together (Figure 15). There also appeared to be two distinct peaks in the chum run (Figure 15) suggesting that more than one race of chum salmon frequents the upper Yukon River system.

3.3.1 Length and age composition

The chum salmon sampled at the tagging site ranged in fork length from 52 to 80 cm for males and from 52 to 79 cm for females (Figure 16). The majority of the males were between 64 and 70 cm, with a mean length of 66.6 cm and a mode of 67 cm. The bulk of the females were in the 59 and 66 cm range with a mean length of 61.8 cm and a mode of 64 cm.

Figure 16 shows that although more fish were tagged in 1974 they were generally smaller than those tagged in 1973. Sixteen chum carcasses measured on the Kluane River ranged in fork length from 52 to 63 cm for males and 52 to 58 cm for females. This probably is not indicative of the true size range of Kluane River chum salmon due to the small sample size.

[2] Personal communication with Alaska Department of Fish and Game personnel.

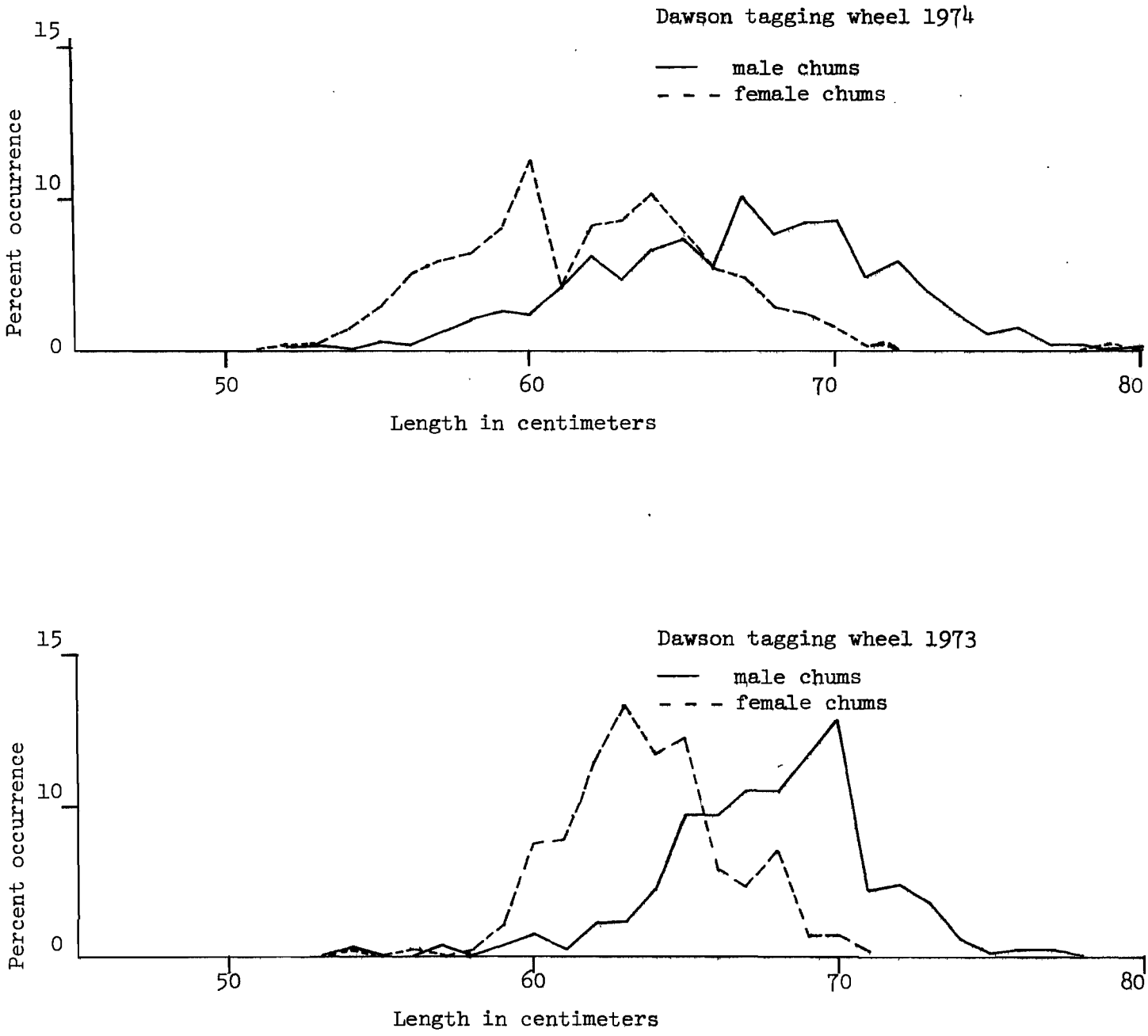

Figure 16. Fork lengths (cm) of male and female chum salmon at Dawson fishwheel 1973-74

Age varied from 3 to 5 years for both sexes. The age composition at the tagging site was 61.5% III, 37.2% IV, 1.3% V for males, and 62.0% III, 36.8% IV, and 1.2% V for females.

3.3.2 Rate of migration

The average rate of travel for chum salmon varied from 20.2 km per day to 33.8 km per day depending on the recovery point used (Appendix 3). The average for the six recovery points used was 28.4 km per day. This was significantly less than the 40.3 km per day found for Yukon River chum in 1964 (Alaska Department of Fish and Game Annual Report, 1964). From Appendix 3 it does not appear that the size, sex or tag type affect their upstream migration rates.

3.3.3 Catch incidence of Petersen disc tags versus spaghetti tags

Of the total 1,276 chum salmon tagged, 894 spaghetti tags and 382 Petersen disc tags were applied. The recovery rate for Petersen tags was 29.1% while for spaghetti tags it was 19.8% (Table 7). The overall recovery rate in 1974 was 22.6%. This was slightly higher than the 1973 recovery rate of 17.6% (Sweitzer, 1974). When comparing the Petersen disc tag recovery rates of 1974 and 1973 one finds that the 1974 rate is 11.5% higher. This increase may have been due to a more intensive effort by field personnel to recover tags from the fishermen. Although the higher catch incidence of Petersen disc tags for chum salmon is not as dramatic as that of chinook salmon, it is evident that Petersen disc-tagged fish are more susceptible to recapture than are spaghetti-tagged fish (Table 7). There may be some bias with regard to the catch incidence of the Petersen disc tag-type since 57.6% of the recovered Petersen discs were between Dawson City and the tagging site, indicating that the tagged fish may not

Table 7. Tag application and recovery by sex and gear for chum salmon

Tags Applied	Petersen			Spaghetti			Grand Total
	M	F	Total	M	F	Total	
	199	183	382	462	432	894	1276
Tags Recovered							
gillnet	35	23	58	54	27	81	139
fishwheel	32	21	53	58	38	96	149
% Tags Recovered							
gillnet	17.6	12.6	15.2	11.7	6.3	9.1	10.9
fishwheel	16.0	11.5	13.9	12.6	8.8	10.7	11.7
total	33.7	24.1	25.1	24.3	15.1	19.8	22.6

have adequately dispersed.

3.3.4 Catch incidence based on length, sex and tag type

As was illustrated by the tagged male chinook salmon the tagged male chum appear to be more susceptible to recovery than do the females (Table 8). From Table 7 there appeared to be a higher recovery rate of male than female Petersen disc-tagged chums. There also appeared to be a higher rate of recovery of spaghetti-tagged males than females. The recovery rate of males by gillnets is slightly higher than females and slightly lower by fishwheels. Although the sex ratio of male to female at the tagging site was almost 1:1 the recovery rate upstream was 1.6:1. The higher proportion of males recovered by both gear types could be attributed to:

a. the deformities of the male jaws and dentition which makes them extremely susceptible to entanglement in gillnets (Figure 17);
b. male chums may tend to travel closer to the river bank than females.

The last possibility may be somewhat contradicted by the sex ratio at the tagging site. Ideally, tagging operations should occur on both sides of the river to verify random tagging and distribution of fish (Lebida, 1972).

The dominant length-class recovered is between 61 and 70 cm (Table 8). Here, it does not appear that Petersen disc-tagged chum are more susceptible to capture by a particualr gear type than are spaghetti-tagged chum. There may be some bias here in that a proportionately higher number of spaghetti tags were applied.

3.3.5 Spawning areas

The spawning population of chum salmon in 1974 appeared to be very low when compared to previous years. For example only 300 to 500 chum were found in the Kluane River between kilometer 1787 and 1800 of the

Table 8. Length-classes of tagged chum salmon recovered by sex and gear

Fork length class	Tag Type	Gillnet		Fishwheel		Total	
		male	female	male	female	male	female
≤ 60 cm	Petersen	4	7	1	5	5	12
	Spaghetti	6	7	7	7	13	14
61 - 70 cm	Petersen	24	16	25	16	49	32
	Spaghetti	29	20	40	30	69	50
71 - 80 cm	Petersen	7		6		13	
	Spaghetti	19		11	1	30	1
Totals	Petersen	35	23	32	21	67	44
	Spaghetti	54	27	58	38	112	65

Figure 17. Chum salmon showing deformed jaws and teeth

Alaska Highway and 200 chums in the Yukon River at kilometer 212 of the Klondike Highway (Table 5). It is speculated however, that a large portion of the chum salmon population spawned in mainstem areas of the Yukon River drainage system. The Yukon, White and Kluane River systems were extensively covered by aerial surveys in 1974 but the only spawning observed was in the previously mentioned spawning areas. The reduction of the Alaskan gillnet mesh size to 15.2 cm effective July 3 for the first time in 1974 may have had some impact on the Canadian stocks. Appendix 1a-b-c shows that the Alaskan chum salmon catch was up considerably over previous years.

3.3.6 Population estimate

The total commercial, domestic and subsistence catch of chum salmon in 1974 by all gear types was 4,646 (Table 9), up slightly from the 1973 figure of 3,886 (Sweitzer, 1974). The tagged to untagged ratio (Table 10) varied from 1:18 for gillnets and 1:11 for fishwheels at Dawson to 1:32 for gillnets at Carmacks. Due to the close proximity of a large portion of the commercial fishery gear to the tagging wheel site, the catch and recovery data at Dawson was disregarded in the 1973 estimates (Sweitzer, 1974). As with chinook salmon, the 1974 estimates were calculated in two parts, the first including Dawson catch and recovery data and the second disregarding this data. To this end six population estimates are given.

Part I. Dawson catch and recovery data included:

a. using Petersen disc tags only:

$$N = \frac{382\ (4646)}{111 + 1} = 15,846$$

the 95% confidence limits are:

$$\text{lower limit} = \frac{382\ (4646)}{134 + 1} = 13,146$$

Table 9. Total chum salmon catch during 1974 broken down by general location and fishery type

Type of Fishery	No. of Chum Pelly River	No. of Chum Yukon River	No. of Chum Kluane River	Totals
COMMERCIAL		2544		2544
DOMESTIC		466		466
SUBSISTENCE	14*	1590	32	1636
Totals	14	4600	32	4646**

* indicates number of chum tags turned in - data sketchy as contact with natives after fishery completed was poor due to weather and their transient nature.

** does not include 5000-7000 chum salmon taken in subsistence fishery on Porcupine River at Old Crow.

Table 10. Catches of chum salmon tagged and untagged by location, sex, tag type and gear

Location	Tagged M	Tagged F	Tag Type Petersen/Spaghetti		Total Tagged	Total Untagged	Ratio of Tagged to Untagged	Gear	Distance in km from tagging wheel
Yukon River									
Dawson area	9	8	8	9	17	303	1:18	gillnet	
	89	60	51	98	149	1687	1:11	fishwheel	8.0-73.0
Stewart City	8	5	8	5	13	98	1:8	gillnet	145.0
Coffee Cr. area	10	6	5	11	16	261	1:16	gillnet	209.0
Balarat Cr. area	18	6	9	15	24	377	1:16	gillnet	217.0
Victoria Rock									306.0
Fort Selkirk	12	4	9	7	16	434	1:27	gillnet	312.0
Minto	5	2	2	5	7	178	1:25	gillnet	351.0
Carmacks area	19	12	14	17	31	998	1:32	gillnet	419.0-451.0
Pelly River									
Pelly Crossing Area	9	5	5	9	14	32	1:2	gillnet	354.0-403.0
Burwash									
Kluane River			5	9		32			316.0
Alaskan fishermen		1		1					Ruby, Alaska
Totals	179	109	111	177	228	4358	1:15		

upper limit = $\frac{382\ (4646)}{92 + 1}$ = 19,084

b. using spaghetti tags only:

$N = \frac{894\ (4646)}{177 + 1}$ = 23,334

the 95% confidence limits are:

lower limit = $\frac{1276\ (4646)}{323 + 1}$ = 18,297

upper limit = $\frac{1276\ (4646)}{257 + 1}$ = 22,977

Part II. Dawson catch and recovery data excluded:

a. using Petersen disc tags only:

$N = \frac{382\ (2490)}{52 + 1}$ = 17,946

the 95% confidence limits are:

lower limit = $\frac{382\ (2490)}{70 + 1}$ = 13,396

upper limit = $\frac{382\ (2490)}{37 + 1}$ = 25,031

b. using spaghetti tags only:

$N = \frac{894\ (2490)}{70 + 1}$ = 31,352

the 95% confidence limits are:

lower limit = $\frac{894\ (2490)}{88 + 1}$ = 25,012

upper limit = $\frac{894\ (2490)}{55 + 1}$ = 39,751

c. using Petersen disc and spaghetti tags combined:

$N = \frac{1276\ (2490)}{122 + 1}$ = 25,831

the 95% confidence limits are:

lower limit = $\frac{1276\ (2490)}{146 + 1}$ = 21,614

$$\text{upper limit} = \frac{1276\ (2490)}{102 + 1} = 30,847$$

The 1974 estimates of abundance ranged from a low of 15,846 to a high of 31,352 depending upon which catch and tag recovery data was utilized. If the 1974 estimate of 17,946 is compared to the 1973 estimate of 39,669 fish (Sweitzer, 1974), both calculated in a similar manner, one finds that it is 45% lower. This apparent decrease could be attributed to the fact that Petersen disc tag recoveries in 1974 were up 11.5% over the 1973 recovery of 17.6%. It would appear that the higher susceptibility of Petersen disc-tagged fish to capture by gillnets may be introducing a bias in the Petersen disc tag population estimates. If this is true the 1973 estimates for chums, based on Petersen disc tag recovery, may be conservative. Based on 1974 data the spaghetti tag estimate of 31,352 excluding Dawson catch and recovery data, is probably most representative of the 1974 spawning population.

3.4 Susceptibility of Petersen disc tags

It is evident from this study that a Petersen disc-tagged fish is more likely to be recaptured by gillnets than the other tag type. In 1974 several fishermen were observed in the process of removing salmon from their gillnets. It appeared that larger salmon were caught either by the head, jaws or both. This left the rest of its body to thrash up against the net. Through this action a disc-tagged fish would readily become entangled either by the discs of the tag or the protruding twisted end of the tagging pin. In addition Petersen disc-tagged salmon that were small enough to just pass through the webbing of the net were likely to become entangled at the discs or the twisted tagging pin. On the other hand, salmon that bore spaghetti tags did not seem to experience any of

the problems discussed above.

Other possibilities which may account for the higher return rate of Petersen disc tags are as follows:

a. loss of spaghetti tags (knot untied, broken plastic, although spaghetti tags left to soak in water at room temperature for up to two months still remained knotted and flexible);

b. Petersen tags affect the swimming ability of salmon more than spaghetti tags;

c. not all spaghetti tags were turned in.

4.0 SUMMARY

A total of 727 chinook and 1,276 chum salmon were tagged and released in the Yukon River during the 1974 program.

Chinook salmon ranged in fork length from 36 to 120 cm. Age IV was dominant for both males and females representing 71.4% and 61.7% respectively of the sample.

Chum salmon ranged in fork length from 52 to 80 cm. Age IV was dominant for both males and females representing 61.5% and 62.0% respectively of the sample.

Tagged chinook salmon travelled upstream at an average rate of 31.3 km per day while chums travelled at 28.4 km per day.

The catch incidence of Petersen disc tags for chinook salmon was 49.0% as compared to 24.7% for spaghetti tags. For chum salmon the catch incidence was 29.1% and 19.8% respectively.

The highest rate of recapture of tagged male chinook and chum salmon were in the 61 to 70 cm fork length range.

Mainstem chinook salmon were found spawning at the Ingersol Islands, Yukon Crossing, and the outlet of Lake Laberge while chum salmon were found spawning in a clear water side-channel of the Yukon River adjacent to kilometer 212 of the Klondike Highway.

The estimates of abundance ranged from 11,100 to 36,700 for chinook salmon while chum salmon estimates ranged from 15,846 to 31,352.

Petersen disc tags were extremely susceptible to recapture in a gillnet fishery and may have biased any population estimate based on their use.

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APPENDIX 1a Alaskan and Canadian commercial salmon catch data from 1963 - 1974

	Alaska				Yukon Territory			Total			
Year	King	Coho	Chum	Total	King	Chum	Total	King	Coho	Chum	Total
1963	117,048	5,575		122,632	2,283	2,192	4,475	119,331	5,575	2,192	127,098
1964	93,587	2,430	8,347	104,364	3,208	1,929	5,137	96,331	2,430	10,276	109,501
1965	118,014	661	23,211	141,886	2,265	2,071	4,336	120,279	661	25,282	146,222
1966	93,254	19,254	71,058	183,627	1,942	3,157	5,099	95,257	19,254	74,215	188,726
1967	129,430	11,047	49,412	189,889	2,187	3,343	5,530	131,617	11,047	52,755	195,419
1968	106,526	13,303	67,375	187,204	2,212	435	2,647	108,738	13,303	67,810	189,851
1969	90,720	15,076	192,582	298,378	1,640	2,279	3,919	92,360	15,076	194,861	302,297
1970	79,301	13,188	347,348	439,837	2,611	2,479	5,090	81,912	13,188	349,827	444,927
1971	110,507	12,203	289,685	412,395	3,178	1,761	4,939	113,685	12,203	291,446	417,334
1972	92,840	22,233	287,844	402,917	1,769	2,532	4,301	94,609	22,233	290,376	407,218
1973	75,353	36,641	517,434	629,928	1,871	2,228	4,099	77,224	36,641	519,662	634,027
1974	96,902	16,825	877,368	991,095	2,214	3,010	5,224	99,116	16,825	880,378	996,319

APPENDIX 1b Alaskan and Canadian subsistence salmon catch data 1963 - 1974

Year	Alaska			Yukon Territory			Total		
	King	Other Salmon	Total	King	Other Salmon	Total	King	Other Salmon	Total
1963	24,862	396,075	420,937	8,108	25,500	33,608	32,970	421,575	454,545
1964	16,171	481,449	497,620				16,171	481,449	497,620
1965	16,608	448,861	465,469	3,000	9,800	12,800	19,608	485,661	478,269
1966	11,572	213,186	224,758	2,700	8,600	11,300	14,272	221,786	236,058
1967	16,448	274,977	291,425	3,000	13,600	16,600	19,448	288,577	308,025
1968	12,106	181,024	193,130	2,900	11,100	14,000	15,006	192,124	207,130
1969	14,000	210,772	224,772	1,000	5,500	6,500	15,000	216,272	231,272
1970	14,310	225,528	239,838	2,100	1,200	3,300	16,410	226,728	243,138
1971	22,451	201,772	223,984	2,800	14,000	16,800	25,251	215,533	240,784
1972	17,931	133,102	151,033	1,657	8,000	9,657	19,588	141,102	160,690
1973	20,099	179,241	199,340	2,116	6,938	9,054	22,215	186,179	208,394
1974	17,186	282,466	299,652	3,379	8,636	12,015	20,565	291,102	311,667

APPENDIX 1c Alaskan and Canadian total utilization catch data 1963 - 1974

	Alaska			Yukon Territory			Total		
Year	King	Other Salmon	Total	King	Other Salmon	Total	King	Other Salmon	Total
1963	141,910	401,650	543,560	10,391	27,692	38,083	152,301	429,342	581,643
1964	109,758	492,226	601,984	3,208	1,929	5,137	112,066	494,155	607,121
1965	134,622	472,733	607,355	5,265	11,871	17,136	139,887	484,604	624,491
1966	104,887	303,498	408,385	4,642	11,757	16,399	109,529	315,255	424,784
1967	145,878	333,436	481,314	5,187	16,943	22,943	151,065	352,379	503,444
1968	118,632	261,702	380,334	5,112	11,535	16,647	123,744	273,237	396,981
1969	104,720	418,430	523,150	2,640	7,779	10,419	107,360	426,209	533,569
1970	93,611	586,064	679,675	4,711	3,679	8,390	98,322	589,743	688,065
1971	132,958	503,421	636,379	5,978	15,761	21,739	138,936	519,182	658,118
1972	110,771	443,179	553,950	3,426	10,532	13,958	114,197	453,711	567,908
1973	95,452	733,917	829,369	3,987	9,166	13,153	99,434	743,083	842,522
1974	114,088	1,176,659	1,290,747	5,593	11,646	17,239	119,681	1,188,305	1,307,986

APPENDIX 2 Chinook salmon migration rates

Distance from tagging site	Tag Type	Tag Number	Sex	Length (cm)	Date tagged	Date Recovered	No. of Days	Average km/day	Gear
41.4 km	P	34909	M	51	13 July	14 July	1	41.4	fw
"	P	34956	F	58	22 July	26 July	4	10.4	fw
"	S	18185	M	57	24 July	10 Aug.	22	1.9	fw
"	S	18211	M	58	24 July	25 July	1	41.4	fw
"	S	18225	M	59	24 July	27 July	3	13.8	fw
"	S	18234	F	91	25 July	29 July	4	10.4	fw
"	S	18237	M	65	25 July	29 July	4	10.4	fw
"	S	18249	M	56	25 July	30 July	5	8.3	fw
"	S	18342	F	65	27 July	29 July	2	20.7	fw
"	P	34744	F	63	27 July	30 July	3	13.8	fw
"	S	18352	M	61	27 July	29 July	2	20.7	fw
"	S	18357	M	60	27 July	30 July	3	13.8	fw
"	P	34768	M	58	31 July	27 Aug.	27	1.5	fw
"	S	18424	M	61	1 Aug.	3 Aug.	2	20.7	fw
Average km/day at this distance =								16.3	
146.0 km	P	34734	F	81	27 July	3 Aug.	7	20.8	gn
"	S	81378	M	61	30 July	9 Aug.	10	14.6	gn
Average km/day at this distance =								17.7	
312.2 km	S	18063	M	75	16 July	27 July	11	28.4	gn
"	P	34930	M	65	18 July	26 July	8	39.0	gn
"	P	34964	F	61	22 July	29 July	7	44.6	gn
"	S	81876	M	66	23 July	30 July	7	44.6	gn
"	P	34976	M	56	23 July	30 July	7	44.6	gn
"	P	34721	F	64	26 July	23 Aug.	28	11.1*	gn
"	P	34741	M	58	27 July	4 Aug.	8	39.0	gn
"	S	18358	M	59	27 July	22 Aug	26	12.0	gn
"	P	34755	M	57	28 July	16 Aug.	19	16.4	gn
"	P	34763	F	61	31 July	23 Aug.	23	13.6	gn
"	S	18399	M	65	31 July	6 Aug.	6	52.0	gn
"	P	34777	M	61	31 July	10 Aug.	10	31.2	gn

APPENDIX 2 continued

Distance from tagging site	Tag Type	Tag Number	Sex	Length (cm)	Date tagged	Date Recovered	No. of Days	Average km/day	Gear
312.2 km	P	34786	M	65	1 Aug.	21 Aug.	20	15.6	gn
"	P	34803	M	58	4 Aug.	17 Aug.	13	24.0	gn
Average km/day at this distance =								29.7	
431.6 km	P	34917	M	68	15 July	22 July	7	61.7	gn
"	S	18055	M	78	16 July	27 July	11	39.2	gn
"	S	18017	M	73	21 July	9 Aug.	19	16.4	gn
"	P	34967	M	57	22 July	6 Aug.	15	28.8	gn
"	S	18367	M	99	28 July	9 Aug.	12	36.0	gn
"	P	34753	M	51	28 July	9 Aug.	12	36.0	gn
"	S	18420	M	93	31 July	9 Aug.	9	47.9	gn
Average km/day at this distance =								38.9	
685.9 km	S	18186	M	66	24 July	26 Aug.	33	20.8	gn
Pelly River									
322.6 km	P	34957	M	70	22 July	29 July	7	46.1	gn
"	S	18227	M	77	24 July	30 July	6	53.8	gn
Average km/day at this distance =								49.9	
Pelly River									
367.0 km	P	34778	M	61	31 July	8 Aug.	8	45.9	gn

* indicates tagged fish that may have been injured during tagging operation

gn - gillnet

fw - fishwheel

APPENDIX 3 Chum salmon migration rates

Distance from tagging site	Tag Type	Tag Number	Sex	Length (cm)	Date Tagged	Date Recovered	No. of Days	Average km/day	Gear
41.4 km	S	19016	M	63	28 Aug.	30 Aug.	2	20.7	fw
"	P	45312	M	65	29 Aug.	31 Aug.	2	20.7	fw
"	S	19080	M	60	3 Sept.	5 Sept.	2	20.7	fw
"	S	19083	M	67	3 Sept.	6 Sept.	3	13.9	fw
"	S	19129	M	60	6 Sept.	8 Sept.	2	20.7	fw
"	S	19156	M	67	7 Sept.	9 Sept.	2	20.7	fw
"	S	19155	F	56	7 Sept.	14 Sept.	7	5.9	fw
"	S	19172	M	72	7 Sept.	9 Sept.	2	20.7	fw
"	S	19186	F	56	8 Sept.	12 Sept.	4	10.3	fw
"	S	19236	M	69	9 Sept.	12 Sept.	3	13.9	fw
"	P	45408	M	66	10 Sept.	12 Sept.	2	20.7	fw
"	S	19262	M	69	10 Sept.	12 Sept.	2	20.7	fw
"	P	45415	F	63	11 Sept.	13 Sept.	2	20.7	fw
"	P	45417	M	57	11 Sept.	12 Sept.	1	41.4	fw
"	S	19306	M	60	12 Sept.	13 Sept.	1	41.4	fw
"	S	19341	F	57	12 Sept.	14 Sept.	2	20.7	fw
"	S	19344	M	68	12 Sept.	14 Sept.	2	20.7	fw
"	S	19366	F	67	13 Sept.	19 Sept.	6	6.9	fw
"	P	45468	M	71	14 Sept.	16 Sept.	2	20.7	fw
"	P	45472	M	69	15 Sept.	16 Sept.	1	41.4	fw
"	S	19405	M	67	15 Sept.	17 Sept.	2	20.7	fw
"	P	45474	F	64	15 Sept.	17 Sept.	2	20.7	fw
"	S	19419	F	66	16 Sept.	19 Sept.	3	13.9	fw
"	P	45479	F	68	16 Sept.	19 Sept.	3	13.9	fw
"	S	19425	M	59	16 Sept.	19 Sept.	3	13.9	fw
"	P	45487	F	60	16 Sept.	19 Sept.	3	13.9	fw
"	S	19441	M	63	17 Sept.	19 Sept.	2	20.7	fw
"	P	45489	M	72	17 Sept.	19 Sept.	2	20.7	fw
"	S	19467	F	60	18 Sept.	19 Sept.	1	41.4	fw
"	S	19484	M	68	18 Sept.	20 Sept.	2	20.7	fw
"	S	19508	M	72	19 Sept.	21 Sept.	2	20.7	fw

APPENDIX 3 continued

Distance from tagging site	Tag Type	Tag Number	Sex	Length (cm)	Date Tagged	Date Recovered	No. of Days	Average km/day	Gear
41.4 km	S	19512	M	72	19 Sept.	22 Sept.	3	13.9	fw
"	P	45531	F	59	20 Sept.	22 Sept.	2	20.7	fw
"	S	19568	F	66	21 Sept.	25 Sept.	4	10.3	fw
Average km/day at this distance =								20.2	
146. km	S	19360	M	64	13 Sept.	27 Sept.	14	10.4	gn
"	S	19415	M	71	15 Sept.	21 Sept.	6	24.3	gn
"	S	19478	F	66	18 Sept.	25 Sept.	7	20.8	gn
"	S	19503	M	64	19 Sept.	25 Sept.	6	24.3	gn
"	P	45526	F	58	20 Sept.	24 Sept.	4	36.5	gn
"	P	45557	M	60	21 Sept.	25 Sept.	4	36.5	gn
"	P	45558	M	64	21 Sept.	26 Sept.	5	29.2	gn
"	P	45559	F	69	21 Sept.	25 Sept.	4	36.5	gn
"	P	45568	M	69	22 Sept.	26 Sept.	4	36.5	gn
"	S	19701	M	68	23 Sept.	26 Sept.	3	48.7	gn
"	P	45644	F	58	25 Sept.	30 Sept.	5	29.2	gn
"	P	45648	M	62	25 Sept.	30 Sept.	5	29.2	gn
"	P	45661	F	55	27 Sept.	1 Oct.	4	36.5	gn
Average km/day at this distance =								30.7	
216.5 km	S	19200	M	72	8 Sept.	15 Sept.	7	30.9	gn
"	S	19218	M	74	9 Sept.	16 Sept.	7	30.9	gn
"	P	45424	F	62	11 Sept.	20 Sept.	9	24.1	gn
"	P	45427	F	60	11 Sept.	18 Sept.	7	30.9	gn
"	S	19384	M	71	14 Sept.	21 Sept.	7	30.9	gn
"	P	45464	F	61	14 Sept.	20 Sept.	6	36.1	gn
"	P	45465	F	64	14 Sept.	21 Sept.	7	30.9	gn
"	P	45490	M	69	17 Sept.	23 Sept.	6	36.1	gn
"	S	19453	M	71	17 Sept.	9 Oct.	22	9.8	gn
"	S	19462	M	58	18 Sept.	24 Sept.	6	36.1	gn
"	S	19509	M	61	19 Sept.	27 Sept.	8	27.1	gn
"	S	19577	M	65	21 Sept.	9 Oct.	18	12.0	gn

APPENDIX 3 continued

Distance from tagging site	Tag Type	Tag Number	Sex	Length (cm)	Date Tagged	Date Recovered	No. of Days	Average km/day	Gear
216.5 km	P	45553	M	69	21 Sept.	27 Sept.	6	36.1	gn
"	S	19600	M	67	21 Sept.	27 Sept.	6	36.1	gn
"	S	19618	F	65	21 Sept.	27 Sept.	6	36.1	gn
"	S	19642	M	62	22 Sept.	28 Sept.	6	36.1	gn
"	S	19647	M	75	22 Sept.	28 Sept.	6	36.1	gn
"	P	45584	F	59	22 Sept.	29 Sept.	7	30.9	gn
"	P	45587	M	71	22 Sept.	28 Sept.	6	36.1	gn
"	S	19712	M	69	23 Sept.	30 Sept.	7	30.9	gn
"	S	19755	M	60	24 Sept.	9 Oct.	15	14.4	gn
"	S	19839	M	73	27 Sept.	8 Oct.	11	19.7	gn
"	S	19852	M	60	27 Sept.	7 Oct.	10	21.7	gn
"	P	45672	M	69	29 Sept.	11 Oct.	12	18.0	gn
Average km/day at this distance =								28.7	
312.2 km	S	19077	M	71	2 Sept.	13 Sept.	11	28.4	gn
"	P	45404	F	68	10 Sept.	20 Sept.	10	31.2	gn
"	S	19358	M	56	13 Sept.	26 Sept.	13	24.0	gn
"	P	45504	F	64	18 Sept.	27 Sept.	9	34.7	gn
"	S	19497	M	73	19 Sept.	28 Sept.	9	34.7	gn
"	P	45515	M	56	19 Sept.	27 Sept.	8	39.0	gn
"	S	19514	M	64	19 Sept.	28 Sept.	9	34.7	gn
"	S	19587	F	62	21 Sept.	29 Sept.	8	39.0	gn
"	P	45552	M	70	21 Sept.	15 Oct.	24	13.0	gn
"	P	45576	F	63	22 Sept.	1 Oct.	9	34.7	gn
"	S	19681	F	57	22 Sept.	30 Sept.	8	39.0	gn
"	P	45601	M	67	23 Sept.	11 Oct.	18	17.3	gn
"	P	45604	M	66	23 Sept.	1 Oct.	8	39.0	gn
"	P	45613	M	69	23 Sept.	10 Oct.	17	18.4	gn
"	S	19753	M	67	24 Sept.	11 Oct.	17	18.4	gn
"	P	45673	M	71	29 Sept.	15 Oct.	16	19.5	gn
Average km/day at this distance =								29.0	

APPENDIX 3 continued

Distance from tagging site	Tag Type	Tag Number	Sex	Length (cm)	Date Tagged	Date Recovered	No. of Days	Average km/day	Gear
349.7 km	P	45556	M	61	21 Sept.	5 Oct.	14	25.0	gn
"	P	45624	M	64	24 Sept.	5 Oct.	11	31.8	gn
Average km/day at this distance								28.4	
421.8 km	S	19502	M	65	19 Sept.	2 Oct.	13	32.4	gn
"	S	19529	F	69	20 Sept.	2 Oct.	12	35.1	gn
Average km/day at this distance =								33.8	

fw - fishwheel

gn - gillnet