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STATE OF ALASKA

Jay S. Hammond, Governor

Annual Performance Report for

A STUDY OF A TYPICAL SPRING-FED STREAM OF INTERIOR ALASKA

by

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TABLE OF CONTENTS

STUDY NO. G-III LAKE AND STREAM INVESTIGATIONS Page

Volume 19 Study No. G-III

RESEARCH PROJECT SEGMENT

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ABSTRACT

The Delta Clearwater River from Mile 17 to the mouth was sampled with an electro-fishing boat as part of an ongoing project to monitor existing stocks of Arctic grayling, *Thymallus arcticus* (Pallas), and round whitefish, *Prosopium cylindraceum* (Pallas). Comparisons of relative abundance with like sampling in 1973 and from 1975 through 1977 are presented. The percent composition of grayling was 16.7 in 1978 compared to 22.2 percent in 1977, and 15.7 percent in 1973.

Unlike the four previous years in which Age Class VI was predominant, Age Class IV was found to be predominant and comprised 24 percent of the total. Grayling in the smaller age and length classes represented the highest percentage of the total sample to date, indicating contribution from stocking of pond reared grayling.

Similar sampling was conducted on the Richardson Clearwater River. Age, length, and capture rates are discussed.

A creel census was conducted on the Delta Clearwater River from May 13 to September 5, 1978, providing 274 completed angler trip interviews with a catch success rate of 0.54 fish per hour. Pressure counts provided an estimate of 6,206 anglers and a harvest of 7,638 grayling.

Stock enhancement through the stocking of pond reared grayling into spring areas of the Delta Clearwater River was assessed. Juvenile grayling were absent from the spring areas in April, but were present by early May, suggesting that imprinting of some of their numbers does occur. Scale circuli analysis of grayling in the first three age classes captured during spring monitoring showed a 53 percent contribution of pond reared grayling to Age Class I, 46 percent to Age Class II, and 52 percent to Age Class III. Results of fluorescent pigment marking of 1977 transplanted grayling are discussed.

Results of pond rearing of grayling fry stocked in three lakes are presented. A total of 6,610 Age 0 grayling was captured by fyke nets and removed from two of the lakes in late September. Population estimates for both lakes provide percent survival and percent removal estimates.

An electrofishing boat and fyke net were utilized to sample fish entering Mile One Slough during late April and early May. The total catch of round whitefish greater than 150 mm during the three week period was 1,574.

July sampling of the Delta Clearwater River with an electrofishing boat showed that round whitefish comprised 83.3 percent of the sample, reversing a declining trend of the previous two years.

A total of 1,690 grayling was captured at Mile One Slough from April 18 to May 5. A total of 884 grayling larger than 200 mm was tagged. Length frequency and age composition of tagged grayling are presented and compared with data from 1977 tagging operations as well as locations of tag returns reported in 1978.

BACKGROUND

The Delta Clearwater River is a spring-fed system located approximately 13 km (8 mi) northeast of Delta Junction (Fig. 1). The main channel of the river is approximately 32 km (20 mi) in length and the north fork is about 10 km (6 mi) in length. The river drains an area of approximately 906 km^2 (350 mi^2) drawing heavily on groundwater as its source. Fairly constant water flows, and water temperatures characterize this and other Interior Alaskan spring-fed systems. The river provides an extremely popular sport fishery for Arctic grayling. Table 1 lists common and scientific names and abbreviations of fish referred to in this report. Public access is available at the State of Alaska Clearwater Campground near Mile 9 of the river. A boat launching ramp provides access to the rest of the river.

Past work, going back to the United States Fish and Wildlife Service studies initiated in 1952, is described by Pearse (1976). Recent studies by Pearse (1974, 1976) provided life history information regarding length frequencies and distribution, length-weight relationships, condition factors, age and sex composition, and maturity for Arctic grayling and round whitefish.

Annual work since 1975 and including the present study deals with monitoring existing fish stocks and determining the feasibility and effects of round whitefish removal. Enhancement of the grayling population by transplanting pond-reared grayling was begun in 1975 and has averaged 8,750 fingerlings a year.

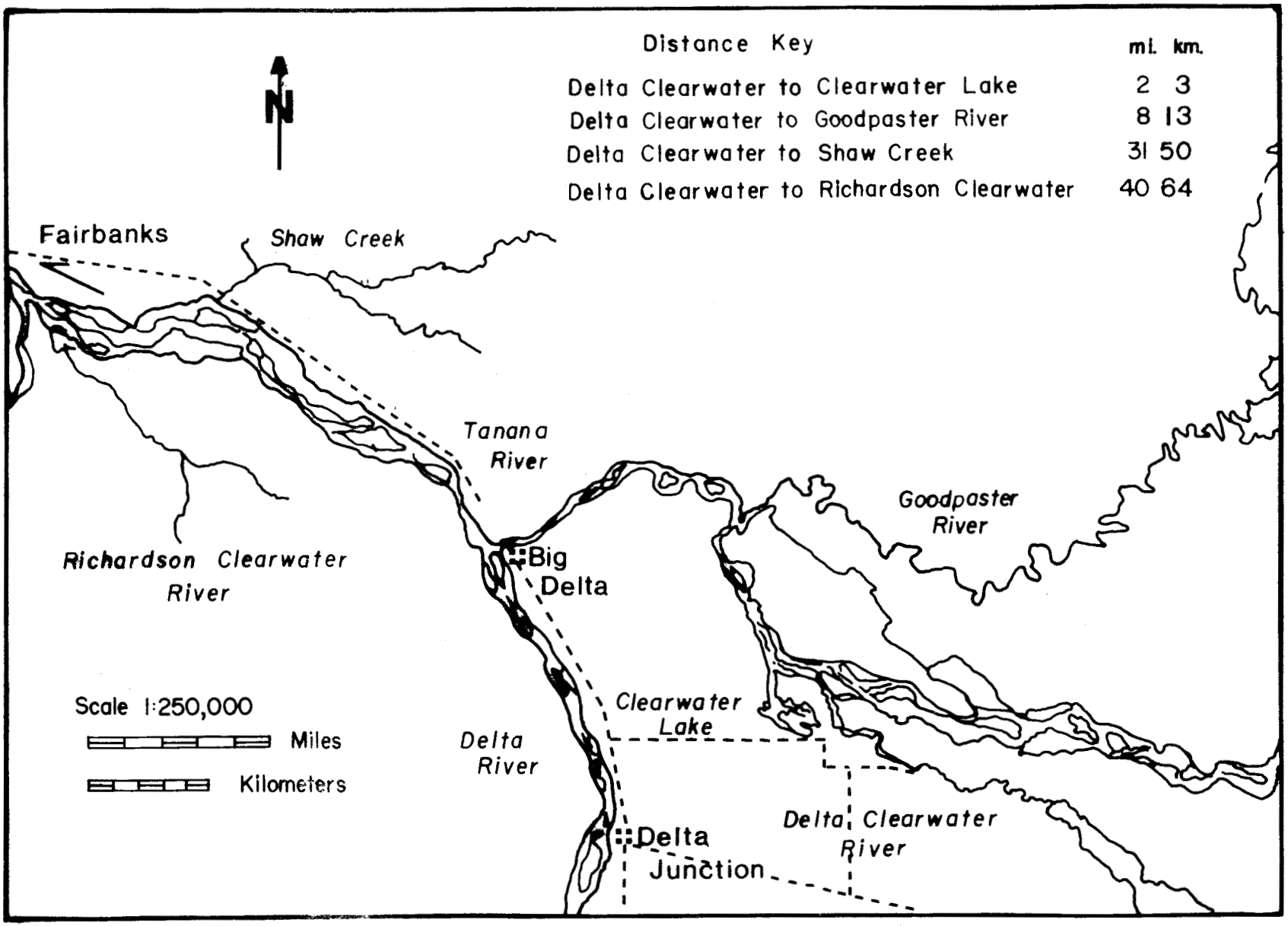

FIGURE 1. TANANA - CLEARWATER STUDY AREA

Table 1. List of common, scientific names, and abbreviations of fish species mentioned in this report.

Common Name	Scientific Name and Author	Abbreviation
Arctic grayling	*Thymallus arcticus* (Pallas)	GR
Burbot	*Lota lota* (Linnaeus)	BB
Humpback whitefish	*Coregonus pidschian* (Gmelin)	HWF
Least cisco	*Coregonus sardinella* Valenciennes	LCI
Northern pike	*Esox lucius* Linnaeus	NP
Round whitefish	*Prosopium cylindraceum* (Pallas)	RWF
Slimy sculpin	*Cottus cognatus* Richardson	SSC
Silver salmon	*Oncorhynchus kisutch* (Walbaum)	SS

RECOMMENDATIONS

1. Index sampling of Arctic grayling and round whitefish in the Delta Clearwater and Richardson Clearwater rivers should be continued.

2. Monitoring of sport fish harvest in the Delta Clearwater River and Clearwater Lake Outlet should continue.

3. The experimental program of pond rearing and transplanting of Arctic grayling to the Delta Clearwater River should be continued.

4. Assessment of results of the grayling transplants into spring areas of the Delta Clearwater should continue.

5. The suitability of grayling enhancement utilizing grayling pond reared for two summers versus one summer of pond rearing should be assessed.

6. Monitoring of early spring fish movement into the Delta Clearwater River should continue.

7. Investigations towards utilizing a local population of Arctic grayling as an egg source should be initiated.

8. A program of spawning surveys in conjunction with tagging operations for determination of the origin of Delta Clearwater River grayling stocks should be initiated.

OBJECTIVES

1. Continue annual monitoring of existing stocks of Arctic grayling and whitefish in the Delta Clearwater Rivers to determine changes in population structure.

2. Assess transplanting of pond reared grayling into the Delta Clearwater River to determine contribution to year class strength and angler harvest.

3. Determine the feasibility of reducing round whitefish numbers as a means of controlling competition between grayling and round whitefish.

TECHNIQUES USED

Fish population sampling to obtain estimates of relative abundance in the Delta Clearwater River was done by utilizing an alternating current boat-mounted shocker described by Van Hulle (1968). Grayling and whitefish were captured during a single downstream run. At the end of each one-mile section, lengths and scale samples were taken and all grayling and whitefish counted. Grayling were released within the section in which they were captured.

Spring areas previously stocked with pond reared grayling were sampled with a Coffelt backpack dc shocker. Fish were measured to fork length in millimeters and weight in grams and scale samples were taken. Fish were checked for dye marks in the laboratory.

Monthly samples of grayling in rearing ponds were collected using a 15.2 m (50 ft) bag seine; lengths, weights, and scale samples were taken the same day.

Sampling at Mile One Slough utilized a New Hampshire style fyke net with a 15.2 m (50 ft) lead attached to one wing to block the slough. Arctic grayling captured were anesthetized with MS-222 and fish $\leq$ 200 mm were checked for fluorescent dye marks with a battery operated UV lamp. Fish $\geq$ 200 mm were tagged with Floy FD 67 tags. All grayling were measured to fork length in millimeters and scale samples were taken from a representative sample.

Fall removal of grayling from rearing ponds was accomplished using fyke nets. The fish were transported in a pickup mounted tank. Condition factors were determined by the formula K= weight divided by fork length^3 x 10^5. Population estimates were made using the standard Petersen formula: N = number of fish marked and released, multiplied by the number of fish examined for marks, divided by the number of marked recaptures.

Pond reared grayling stocked in 1978 were spray marked with powdered fluorescent pigment applied with a sand blast gun at 80-100 psi pressure.

Fish scales used for age determination were cleaned and those from fish $\leq$ 200 mm were mounted between glass slides and then read using a Bausch and Lomb micro-projector. For fish $\geq$ 200 mm, the scales were mounted on 20 mil acetate using a Carver press at 20,000 psi heated to 200°F for 30 seconds and then read on a Bruning 200 Microfiche Reader.

FINDINGS

Monitoring of Arctic Grayling and Round Whitefish Stocks

Spring Monitoring:

As in previous years, spring monitoring in 1978 took place at Mile One Slough, a side channel of the Tanana River that enters the Delta Clearwater River at Mile 1. A fyke trap was fished totally blocking the slough. The slough is fed by spring upwelling during the months that the Tanana is non-glacial. In April, many of the fish entering the Delta Clearwater from the Tanana move into Mile One Slough prior to further upstream movement. This probably occurs because the slough is typically several degrees warmer than the Delta Clearwater. In 1978, the temperature difference ranged from 2°C on April 25 to 0.5°C on May 5.

Fish were first observed in the Delta Clearwater River on April 14, 1978 when 10 round whitefish were sighted at Mile 8. On April 18, when the fyke trap was set at Mile One Slough, approximately 200 round whitefish were counted in the lower 12.8 km (8 mi) of the river. Grayling were probably present with the whitefish, but positive identification was difficult as they were in mixed schools. These dates of the first immigration are comparable to previous years.

The fyke trap was fished for 12 days over a 3-week period that terminated on May 5 due to increasing water levels, turbidity, and a declining catch. A total of 1,617 round whitefish and 1,690 Arctic grayling was captured by both the trap and electrofishing in the slough. Daily catches of all species captured are presented in Table 2. A large increase in humpback whitefish was noted in 1978. Sixty-eight were captured, whereas in 1976 and 1977, six and three, respectively, were caught.

Table 3 presents a summary of the catch per unit effort (CPUE) of Arctic grayling and round whitefish as expressed by catch by fyke trap per day for 3 years, 1976-1978. The CPUE for round whitefish has continued to increase each year despite a removal program begun in 1975 and will be discussed later in this report. Also, the CPUE for grayling has increased dramatically from 50 in 1975 to 148 in 1977. The large increase can be attributed to the stocking of a total of 350,000 fry in 1974 and 1975 and to the transplanting of pond reared fingerlings yearly since 1975. The small drop in CPUE from 1977 to 1978 is most evident in the numbers of grayling less than 200 mm in length. This can be traced to the numbers of pond reared grayling stocked into the Delta Clearwater, with 12,000 planted in 1976 and 7,000 in 1977.

The length frequency of all grayling captured at Mile One Slough is presented in Figure 2. The effects of the enhancement program, discussed in depth later in this report, can be clearly seen, with the mean lengths of pond and stream reared grayling of the first three age classes agreeing closely with the peak frequencies shown. The dominant peak occurs between 200 and 250 mm (Age III and IV), and with little or no reproduction taking place in the Delta Clearwater River; this corresponds to the first large recruitment of young grayling into the river (Pearse 1974).

A higher percentage of younger fish is represented by this spring sampling than is found in the July index sampling that is discussed later. Fish less than 264 mm in length comprised 91% of this sample; whereas, they constituted 59% in the July sample. The larger, mature grayling do not enter the Delta Clearwater until mid-May to mid-June and thus this spring sample is composed predominately of young, immature fish.

Index Sampling:

Fish population index sampling was conducted on the Delta Clearwater River from Mile 17 to the mouth on July 10 and 11, 1978. Arctic grayling and round whitefish stunned with an electrofishing boat were dip netted during a single downstream run through each 1-mile section.

Table 2. Summary of fish captured at Mile One Slough, April 18 - May 5, 1978.

Date	RWF		GR		SS	HWF	Other Species
	<150 mm	>150 mm	<200 mm	>200 mm			
April 18		135	53	99	23	2	
April 19	3	35	25	46	153	1	
April 20		14	15	45	13	2	1 LCI, 1 BB, 1 SSC
April 21	15	100	195	132	20	2	4 LCI, 1 NP
April 25	12	181(112)*	119	130(11)	33	18	2 BB
April 26	4	263(41)	44	125(5)	41	18(2)	
April 27		33(273)	74(5)	110(37)	100	1(5)	1 BB
April 28	3	64(195)	36	94	20	4(1)	2 BB
May 2	1	41	54	35	84	6	
May 3	4	36	59	30	70	4	2 BB
May 4		37	68	15	74	2	
May 5	1	14	21	8	61		1 SSC
Totals	43	953(621)	763(5)	869(53)	692	60(8)	

* Numbers in parentheses indicate fish captured with electrofishing boat.

Table 3. Summary of Arctic grayling and round whitefish captured by fyke trap at Mile One Slough, Delta Clearwater River, 1976-1978.

Date	Number Trap Days	Grayling				Round Whitefish			
		<200 mm	>200 mm	Total	GR/day	<200 mm	>200 mm	Total	RWF/day
1976	8	242	159	401	50	8	380	388	49
1977	8	757	424	1,181	148	52	486	538	67
1978	12	763	869	1,632	136	43	953	996	83

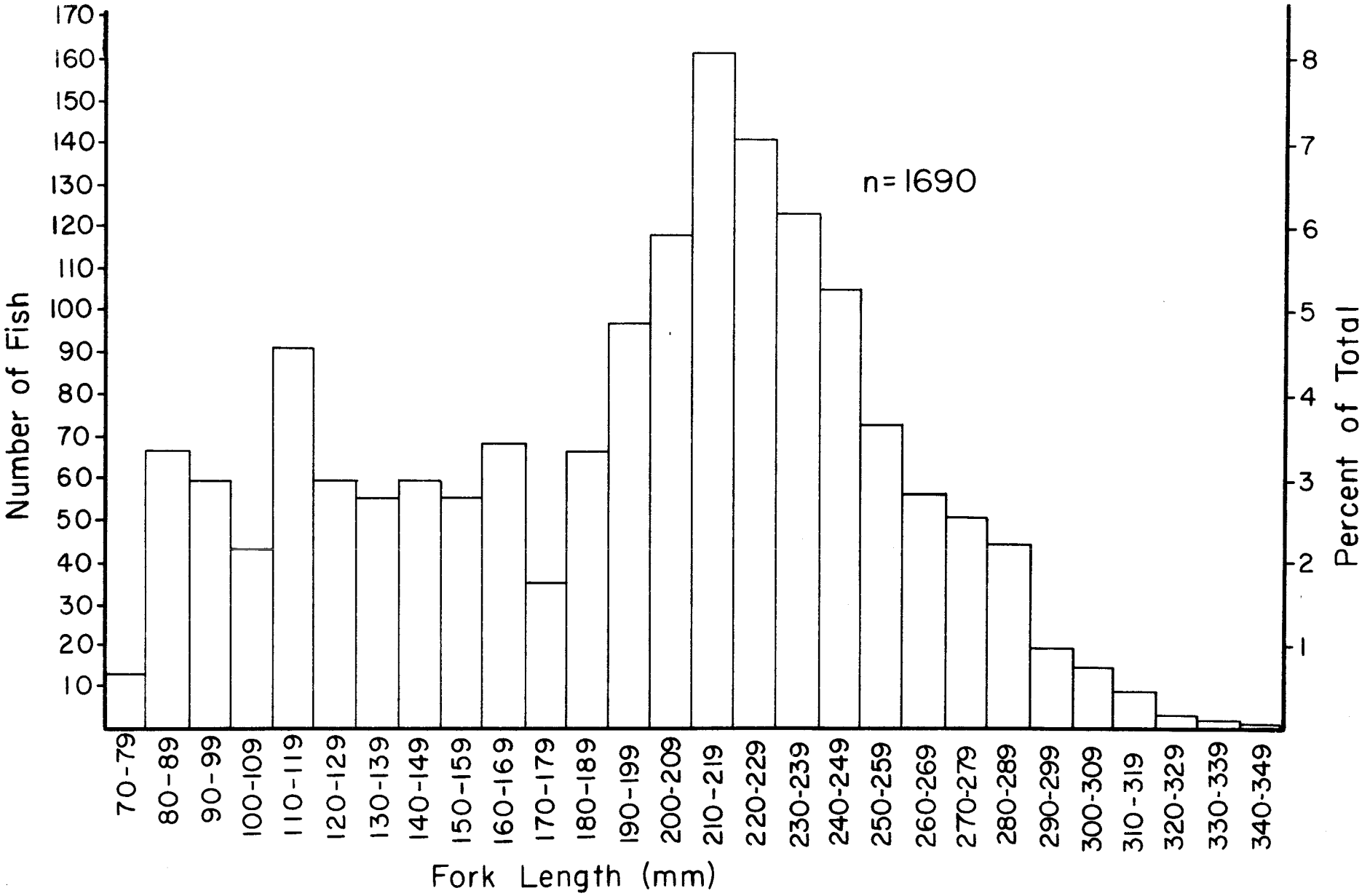

Fig. 2. Length frequency of Arctic grayling captured by fyke trap at Mile One Slough, Delta Clearwater River, April 18 - May 5, 1978.

Table 4 compares relative capture rates of grayling and whitefish in 1978 with rates from like sampling in 1973 and 1975 through 1977 (Pearse, 1974, 1976; Peckham, 1977, 1978). Despite the largest removal of round whitefish (1,617) in April at Mile One Slough since the program began in 1975, the combined capture rate of grayling and whitefish by electrofishing in 1978 (520) is the highest since 1973 when 606 were captured. The percent composition of grayling in 1978, 16.7%, was lower than the 22.2% found in 1977 and the 17.3% found in 1976, but still higher than the percentage found in 1973 and in 1975 when the grayling enhancement and whitefish removal programs were initiated. Conversely, the percent composition of round whitefish in the 1978 sampling, 83.3%, is higher than the 1977 and 1976 figures but still less than in 1973 and 1975.

The relative capture rates per section (Table 4) show a conspicuous declining trend in the upper 3 miles for both grayling and round whitefish. This area affords the best conditions for boat shocking on the Delta Clearwater River and offers the least variability for estimates of relative abundance. In addition, visual surveys in May and June and observations made throughout the season during angler boat counts failed to sight any fish above Mile 15. The absence of round whitefish may be attributable to the record 1,617 removed in April, since stratification within a river for some species correlates with migrational timing. Grayling stratify throughout a river according to size, the larger fish being found in the headwaters (Tack, 1974), and their absence in the upper 3 miles may in part be due to angler harvest on the lower reaches of the river. Twenty-nine percent of the angler harvest was comprised of Ages VII and VIII; whereas, in the index sampling, 14% were Age VII and no Age VIII grayling were captured.

Conversely, the relative capture rates in Section 5 through 9 show a slightly increasing trend for grayling. The low rates found in 1978 for Sections 5 and 8 are misleading since two schools of grayling in Section 8 and one in Section 5 were observed but avoided capture. These schools were comprised of grayling in the 200 mm range. This 5-mile section of the Delta Clearwater contains the four spring areas where grayling fingerling plants are made in the fall.

The age frequency and length of 80 grayling from a total of 87 captured during the index run is presented in Table 5, and comparison of age composition from 1973 and 1975 through 1977 is shown in Table 6. Unlike the four previous years in which the predominant Age Class was VI, in 1978 Age Class IV is predominant. This could be the result of the planting of 250,000 fry in 1974. The percentage of Age Class VI captured in 1978 (6%) is considerably below the norm of the four previous years. Such poor recruitment to an otherwise strong age class can be the result of a weak year class or increased angling mortality, or both. In 1977, 33% of the sampled angler harvest was Age V fish, while the 1977 index run showed only 13% for this age group.

A larger percentage of the younger age groups are represented in 1978 than in any of the previous years. Of the 31 grayling Aged I, II, and III, 23 or 29% of the aged sample had circuli counts of 11 or more to the

Table 4. Relative capture rates per section for Arctic grayling and round whitefish during a single downstream pass with an electroshocker, Delta Clearwater River, 1973 and 1975-1978.

River Section	Grayling					Round Whitefish				
	6/27/73	7/02/75	6/30/76	7/06/77	7/10/78	5/18/73	7/02/75	6/30/76	7/06/77	7/10/78
17	25	36	9	5	0	48	142	2*	13	0
16	10	1	14	8	0	28	21	24	36	7
15	22	5	12	18	3	22	76	60	59	18
14	9	1	6	18	6	65	0	42	43	29
13	8	3	5	1	6	14	65	48	16	33
12	0	0	3	1	1	34	0	14	16	35
11	2	3	3	5	1	16	21	13	24	53
10	3	0	2	2	3	52	16	27	11	38
9	2	0	5	1	13	14	0	50	14	48
8	5	2	9	15	4	29	15	11	26	30
7	4	4	6	3	14	48	0	9	14	34
6	1	2	1	5	10	34	0	23	19	36
5	2	6	3	18	8	33	27	29	45	30
4	0	1	1	0	7	33	10	18	2	15
3	2	0	0	0	2	29	0	10	2	8
2	0	0	1	1	0	12	0	17	14	2
1	0	0	5	0	9	0	0	10	0	17
Totals	95	64	85	101	87	511	393	407	354	433
% Comp 1973	15.7					84.3				
% Comp 1975		14.0					86.0			
% Comp 1976			17.3					82.7		
% Comp 1977				22.2					77.8	
% Comp 1978					16.7					83.3

* 296 round whitefish were captured by boat shocker and removed in sections 17 and 16 on May 6 and 7, 1976.

Table 5. Age frequency and length of Arctic grayling captured with electrofishing gear in the Delta Clearwater River, July, 1978.

Age Class	Number	Percent	Length mm	
			Range	Mean
I	2	2	146-164	155
II	13	16	154-217	186
III	16	20	196-262	230
IV	19	24	199-274	244
V	14	18	276-324	294
VI	5	6	274-330	309
VII	11	14	304-377	343
VIII		0		
	80			252

Table 6. Age composition of Arctic grayling electrofished in the Delta Clearwater River, 1973, 1975-1978.

Age Class	1973		1975		1976		1977		1978	
	no.	%	no.	%	no.	%	no.	%	no.	%
I	3	1		0		0		0	2	2
II	5	2		0	1	1	6	6	13	16
III	38	16		0	4	6	15	15	16	20
IV	53	22	7	11	10	13	19	20	19	24
V	38	17	21	33	21	28	13	13	14	18
VI	57	24	21	33	32	42	26	27	5	6
VII	31	13	9	14	7	9	16	16	11	14
VIII	10	4	3	5	1	1	1	1		0
IX		0	2	4		0	1	1		0
X	1	.5		0		0	1	1		0
XI	1	.5		0		0		0		0
	n=237		n=63		n=76		n=98		n=80	

first annulus, indicating a strong contribution from fingerling stocking of pond reared grayling. Stream reared grayling average 8.7 circuli (Pearse, 1976) to the first annulus. In comparison, in 1977, only 21 grayling were captured from Age Classes II and III, with no Age I grayling present; only five of these fish had circuli counts of 11 or more.

A 377 mm, seven-year-old grayling was the largest and oldest fish captured during the index run. The mean length from the index sampling was 252 mm. In 1977, the mean length was 277 mm.

Table 7 presents the length frequencies of Arctic grayling electrofished in the Delta Clearwater River for 5 years, 1973 and 1975 through 1978. Again in 1978, grayling in the smaller length ranges are representing a higher percentage of the total than in previous years. In 1978, 59% of the grayling fell between 115 and 265 mm, while in 1977, 39% fell within this range and 29% in 1973. Grayling within the range 315-464 mm comprised 17% of the total in 1978, 25% in 1977, and 52% in 1973.

Richardson Clearwater River

Index sampling was conducted on the Richardson Clearwater River on August 31, 1978. As in 1977, a single downstream pass was conducted with an electrofishing boat from the fork at Mile 7 to the mouth. A total of 117 Arctic grayling and 53 round whitefish was collected.

The age frequency and lengths of 74 Arctic grayling from the Richardson Clearwater is presented in Table 8. The grayling ranged in length from 152 to 368 mm and had a mean length of 252 mm. The mean lengths of Age Classes I to III were lower than those of the Delta Clearwater sample, while the older age classes of the Richardson Clearwater were slightly higher. The difference in the younger age classes is attributable to the higher percentage (77%) of grayling in these classes with circuli counts of 11 or more found in the Delta Clearwater sample. These pond reared grayling have greater growth in their first year than stream reared fish. The small differences in the older fish is a result of the month and a half lag in sampling the Richardson Clearwater.

Table 9 shows the age composition of Arctic grayling electrofished in the Richardson Clearwater from the years 1973, 1977, and 1978. Age Class IV was predominant at 46% of the total; whereas, in 1977 Age Class VI was most frequently captured. This is identical to the situation found in the Delta Clearwater in 1978 and 1977. In the Delta Clearwater this age group predominance might be accounted for by the stocking in 1974 of 250,000 fry. This could also be the case with the Richardson Clearwater since there does appear to be some straying of pond reared fish from the Delta Clearwater into the Richardson Clearwater. Of the 16 fish in the three younger age groups captured in 1978, 4 or 25% had circuli counts of 11 or more. The average circuli count to the first annulus of 48 Richardson Clearwater grayling Age IV and greater was 7.9 in 1978, and of 96 fish sampled in 1977, it was 8.0. The range of circuli counts for both years was 5 to 12. In addition, sampling of areas in the Delta Clearwater in 1975 where the fry were stocked (Pearse, 1976) failed to turn up any

Table 7. Length frequency of Arctic grayling electrofished in the Delta Clearwater River, 1973-1977.

Length Class (mm)	1973 %	1975 %	1976 %	1977 %	1978 %
115-164	0	0	1	1	4
165-214	7	0	4	12	17
215-264	22	6	11	26	38
265-314	19	40	39	36	24
315-364	33	41	34	15	14
364-414	16	11	11	9	3
415-464	3	2	0	1	0
No. Fish	413	63	76	100	87

Table 8. Age frequency and length of Arctic grayling captured in the Richardson Clearwater River, August 31, 1978.

Age Class	Number	Length (mm) Range	Mean
I	1	152	152
II	2	171-184	178
III	13	171-260	217
IV	34	216-298	260
V	11	260-324	288
VI	8	292-349	320
VII	5	305-368	348
	74	152-368	252

Table 9. Age composition of Arctic grayling captured in the Richardson Clearwater River in August, 1973, 1977, and 1978.

Age Class	*1973 Number	%	1977 Number	%	1978 Number	%
I	3	4	0	-	1	1
II	0	-	2	2	2	3
III	13	17	15	15	13	17
IV	22	29	10	10	34	46
V	26	35	21	21	11	15
VI	8	11	33	33	8	11
VII	2	3	15	15	5	7
VIII	0	-	4	4	0	-
IX	0	-	0	-	0	-
X	1	1	0	-	0	-
	75		100		74	

* Only lower 4 miles were sampled.

fingerling grayling, suggesting a mass downstream displacement of the fry. That the survivors of this plant could have redistributed themselves between the two major spring systems in the Delta area is conceivable.

The capture rate for grayling and round whitefish in the Richardson Clearwater was 47 grayling/hr and 21 round whitefish/hr. In 1977, it was 69 and 82 per hour, respectively. The capture rate for the Delta Clearwater was 12 grayling/hr and 62 round whitefish/hr. Part of the difference in capture rates lies in the physical differences of the two streams. Electrofishing is more effective in the Richardson Clearwater due to more confined channels and greater frequency of riffle areas. Sport harvest may account for some difference also as angling pressure is much greater on the Delta Clearwater. The Richardson Clearwater is fished predominantly by a few summer residents as it is almost unknown to the majority of the angling public and is largely inaccessible.

Grayling Stock Enhancement

Assessment of Grayling Transplanted from 1975 through 1977:

Five spring areas of the Delta Clearwater River stocked with pond reared fingerling grayling in September, 1977, were surveyed and sampled with a backpack shocker during April and May, 1978. Three spring areas, designated 1,2, and 3 have been utilized since 1975; Spring 1-A has been in use since 1976 and Spring 2-A was first stocked in 1977.

A survey of Springs 1, 2, and 3 conducted on April 18 and an additional survey of Springs 2 and 3 on April 24 failed to reveal grayling, although rearing silver salmon were sighted. In an April 5, 1977 survey grayling were collected in two of these areas.

On May 2 and 3, 1978, grayling were sighted and samples collected in all of the springs except Spring 2-A. Of the 45 grayling collected, 30 tested positive for fluorescent dye which was administered to all pond reared grayling prior to stocking in 1977. These marked fish were present in all four spring areas and had a mean length and weight of 112 mm and 14.2 g and an average circuli count of 13.7. The grayling stocked in 1977 had a mean length of 109 mm and a mean circuli count of 13.5. Of the 15 fish that bore no fluorscent pigment, six were of Age I, seven were Age II and two were Age III.

Three of the six Age I non-marked fish had circuli counts of 13 or greater and had a mean length of 120 mm, indicating they were from the transplants but had experienced mark loss. The other three fish had counts of 10 circuli and less, and a mean length of 87 mm, indicating they were stream reared or wild fish. Stream reared grayling average 8.7 circuli to the first annulus (Pearse, 1976), and have a mean length of 87 mm in the spring of their second year. Two of these Age I "wild" grayling were captured in Spring 1. Pearse, in extensive surveys of all spring areas of the Delta Clearwater prior to enhancement efforts in 1973, found young-of-the-year grayling only in Spring 1.

The seven Age II fish were collected in Springs 1,2, and 3. Four of these had high circuli counts ranging from 13 to 15. Grayling transplanted to these areas in 1976 averaged 12.5 circuli to the first annulus. Of the three fish with circuli counts of 10 or less, two were captured in Spring 1, the other in Spring 2.

Age III grayling were collected in only two areas, Springs 1 and 3. The two fish had circuli counts of 12 and 14 to the first annulus. The fish stocked in 1975 had an average count of 14 circuli at time of stocking. Large grayling possibly of Age Class III were observed in Spring 2, but their presence in deep water prevented capture by backpack shocker. A summary of all captures is presented in Table 10.

In addition to the 45 fish sampled, 175 grayling in the 100 mm range were observed in the four spring areas and approximately 50 fish in the 160-200 mm range were observed in three of the four areas, Spring 1-A being the exception.

Though grayling have been found in these spring areas as early as April 5 (Peckham, 1978), which would indicate overwintering use of the spring areas, it appears that such was not the case in 1978, since grayling were absent from the areas in April. Surveys of the Delta Clearwater River adjacent to and downstream from these springs on April 14, and 18, failed to reveal any schools of small grayling. The presence of pond reared grayling in the spring areas during May suggests that imprinting of some transplanted grayling does occur.

During spring monitoring at Mile One Slough a total of 763 grayling smaller than 200 mm was captured; in 1977, 710 and 1976, 242. Grayling of Age Classes I, II, and a small percentage of Age III are represented in the lengths below 200 mm. With the program of transplanting fingerling grayling into the Delta Clearwater beginning in 1975 an increase in numbers of the younger age classes is to be expected during inmigration.

As all 1977 fingerling plants received a fluorescent dye mark, an effort was made during 1978 spring monitoring to check for marks on all grayling of Age Class I. Since the lengths of the plants ranged from 101 to 125 mm from a small sample made at the time of stocking, a length of 139 mm was chosen as the cutoff point during the testing. A total of 324 grayling from a total of 387 captured between the range of 70-139 mm was tested for the presence of dye. A total of 106 was found marked and 218 unmarked . A summary of the testing for each 10 mm group is presented in Table 11.

To ascertain the degree of mark loss during the 7-month interval since transplanting and without the availability of a control group (which was lost to predators), three daily samples were selected during trapping at Mile One Slough. Care was taken in selecting fish within the range of those stocked and in reading the scales of this sample only those fish possessing a circuli count to the first annulus of 12 or more (pond reared). Those Age I fish collected from the spring areas in May were also used as a sample. In addition, captures totaling 15 of 371 Age I+ fish

Table 10. Summary of age, length, weight, scale circuli counts and dye marks from Arctic grayling sampled from spring areas of the Delta Clearwater River, May, 1978.

Location	No. Marked	No. Not Marked	Age	Length (mm) Range	Length (mm) Mean	Weight (g) Range	Weight (g) Mean	Circuli Counts Range	Circuli Counts Mean
Spring 1	7		I	108-121	115	11.5-16.3	14.3	13-15	13.4
		2	I	77-90	84	4.3- 6.8	5.6	9-10	9.5
		3	II	130-165	144	22.2-51.4	33.5	9-14	11.0
		1	III		180		37.5		14.0
Spring 1A	12	1	I	87-120	108	7.3-15.9	12.9	12-14	13.3
Spring 2	7		I	103-127	114	12.8-17.3	15.0	12-16	14.3
		2	I	91-118	105	6.5-17.0	11.8	10-15	12.5
		2	II	154-160	157	35.1-37.4	36.3	8-14	11.0
Spring 3	4		I	108-117	112	13.1-15.4	14.5	12-15	13.8
		2	I	119-124	122	17.7-21.0	19.4	13-14	13.5
		2	II	164-176	170	45.5-49.8	47.7	13-15	14.0
		1	III		197		71.5		12.0
Totals	30		I	187-127	112	7.3-17.3	14.2	12-16	13.7
		6*	I	77-124	104	4.3-21.0	12.3	8-15	11.8
		7**	II	130-176	157	22.2-51.4	39.1	8-15	12.0
		2	III	180-197	189	37.5-71.5	54.5	12-14	13.0

* 3 had $\leq$ 10 circuli, 3 $\geq$ 11 circuli
** 3 had $\leq$ 10 circuli, 4 $\geq$ 11 circuli

Table 11. Summary of fluorescent dye testing, Mile One Slough, Delta Clearwater River, April 18-May 5, 1978.

Length (mm) Range	Number Marked	Number Not Marked
70-79	0	11
80-89	0	61
90-99	0	48
100-109	16	26
110-119	65	19
120-129	22	43
130-139	3	10
	106	218

Table 12. Percent mark loss of fluorescent dye marked Arctic Grayling.

Date	Sample Location	n	Marked	Not Marked**	% Loss
April 19	Mile One Slough	10	9	1	10
April 20	Mile One Slough	11	10	1	9
April 21	Mile One Slough	20	12	8	40
April 18 - May 5*	Mile One Slough	15	14	1	7
May 2 - May 3	Spring Areas	33	30	3	9
Totals		89	75	14	16

* Sample consisted of pond reared fish stocked in 1977 at Age I all of which received an adipose clip in conjunction with spray marking.

** Non-marked fish all had circuli counts to first annulus of 12 or greater and were considered pond reared.

transplanted from the rearing ponds in 1977, which had received an adipose clip in conjunction with dye marking, were utilized. As summarized in Table 12, the mark loss was 16%, considerably higher than the 2% found in similarly marked juvenile coho held in ponds for a 6-month period (Phinney et. al, 1969). This mark loss for grayling is not unreasonable considering the time interval, the stream environment, and considerable handling during recapture and testing.

If figures in Table 11 are adjusted to compensate for this mark loss, which amounted to 20 grayling, 126 grayling would be considered marked, or 39% attributable to the enhancement program within the length range of 70-139 mm (Table 13). Since Age Class II grayling of stream origin overlap this range (Table 14), the contribution to the strength of the 1977 year class due to the enhancement program cannot be accurately estimated without including scale analysis.

In differentiating between pond and stream reared grayling, it is assumed that fish possessing circuli counts to the first annulus of 11 or more are pond reared fish and those with 10 or fewer are stream reared. Pond reared grayling from each of the three plants represented in this year's sampling have consistently shown high circuli counts, with the exception of the 1975 plant originating from West Pond, which ranged from 10-13 circuli and averaged 11.4. Overall, the pond reared grayling circuli counts ranged from 10-16 with a mean of 12.9. Stream reared fish have ranged from 5-14 circuli with a mean of 8.7 in 1975 (Pearse, 1976), 7-11 circuli averaging 8.8 in 1976 (Peckham, 1977) and 5-12 circuli with a mean of 8.5 in this study. For the purposes of this study, the overlap is considered minimal. Data concerning the amount of overlap and its effect on estimates of the enhancement program's contribution to age class strength will be assembled and presented in the completion report.

From the testing for dye marks (Table 11) and from the circuli counts from a sample of 12, all of the 138 grayling captured in the 70-99 mm size range at Mile One Slough are considered stream reared fish. In the 100-109 mm group, scale samples from 13 of the 43 fish captured indicate 2 (15%) were stream reared and this percentage is substracted from the total to give an adjustment of 37 pond reared grayling represented in this 10 mm group. In the 110-119 mm group a sample of 25 from the 91 captured all indicated pond reared fish. In the 120-129 mm group, 6 (54%) of 11 fish sampled out of a total of 60 grayling captured were Age II, with the remainder Age I grayling from the 1977 plant. Thus 28 of the total in this group are from the enhancement program. Also, in the 130-139 mm group, 85% of a sample of 13 indicated Age II while the rest were from the 1977 plant, and thus of the 55 captured only 7 are considered pond reared. Summarized in Table 13, 163 grayling, or 53%, of the 307 Age I fish in the 70-139 mm range captured during spring monitoring are found to be from the pond rearing program. A total of 144 or 47% of Age I grayling are considered to be stream reared.

In Table 14, age and circuli counts are presented for 144 grayling in the first 3 age classes sampled at Mile One Slough. Sample size in each 10 mm grouping of Age II and Age III fish was too small to warrant the

Table 13. Estimate of 1977 year class strength due to pond reared transplants from A, dye marking experiments, and B, circuli counts to first annulus.

A. Dye Marking:

Total Fish Tested Within a Range of 70-139 mm = 324

	Marked	Non-Marked
	106	218
16% Mark Loss	+20	-20
	126	198
	39% pond reared	61% stream reared

B. Circuli Counts:

Length Range (mm)	Total No. Capture	Pond Reared	Stream Reared	No. Age II
70-99	138	0	138	0
100-109	43	37	6	0
110-119	91	91	0	0
120-129	60	28	0	32
130-139	55	7	0	48
Totals	387	163	144	80
	-80 Age II			
	307 Age I	53%	47%	

Table 14. Summary of age, length and scale circuli counts to the first annulus of 144 Arctic grayling in the first three Age Classes sampled at Mile One Slough, Delta Clearwater River, April 18 - May 5, 1978.

Circuli Count 10 or fewer							Circuli Count 11 or more						
			Length (mm)		Circuli					Length (mm)		2 - Circuli	
No.	%	Age	Range	Mean	Range	Mean	No.	%	Age	Range	Mean	Range	Mean
12	(47)*	I	71-105	87	6-10	8.5	31	(53)*	I	103-131	111	11-15	13.5
32	54	II	120-168	139	7-10	8.7	27	46	II	135-187	160	11-15	13.0
20	48	III	176-230	207	6-10	8.3	22	52	III	187-243	215	11-15	12.4

* Scale samples not representative, percentage arrived at by means set forth in text.

method used above in assessing the contribution of the enhancement program to these age classes.

Of the 59 Age II grayling, 27 (46%) had circuli counts of 11 or more and averaged 13.0 and thus are considered to be from the 1976 plant of 12,000. Of 42 Age III fish, 22 (52%) had circuli counts greater than or equal to 11 ($\bar{x}$=12.4) and are from the 1975 plant of 9,100. Of the 20 (47%) Age III that had counts of 10 or less, a percentage may be from a plant of 100,000 fry made the same year.

It is too early in the enhancement program to accurately arrive at a figure for its contribution to angler harvest. The Age III grayling representing the first fingerling plant in 1975 are of a length that ranks on the lower end of angler preference. From a sample of 97 grayling from angler creels only 10 (10%) comprise Age II and Age III fish. Six (60%) of these ten fish (two Age II and four Age III fish) had circuli counts of 11 or greater. Since sizes of pond reared fish are greater than that of stream reared fish of the same age, angler preference for larger fish would favor those fish from the enhancement program.

Assessment of 1978 Pond Rearing:

Three small, natural lakes ranging in size from 1.5 to 3.6 surface hectares (3.7-8.9 acres) were stocked with grayling fry on June 21, 1978. Each of the lakes received 25,000 fry.

Coal Mine #3 (1.5 ha, 3.7 a) is the deepest of the lakes at 5.8 m (19 ft). Growth for the July and August samples is the lowest of the three lakes (Table 15). The lake has colder water temperatures than the others and also a large population of slimy sculpin. Fyke traps set for a total of 48 hours captured only 45 grayling on August 10, and seining the day before caught only 20, whereas over 200 sculpin were captured. Due to the apparent poor survival and inferior growth, no fall removal of fingerlings was attempted in Coal Mine 3.

West Pond (3.6 ha, 8.9 a) has been utilized as a rearing pond for four consecutive years. The size of the fish in the July and August samples (Table 15) was similar to that recorded in previous years (Peckham, 1977, 1978). Fish in the September sample were the largest, with a mean of 126 mm, from any rearing pond since the program began. A possible explanation for this increase in growth may have been the removal of 535 fingerlings in August.

For the second year condition factors of fish sampled in September have been lower than the previous year (Table 16), being 1.08 in 1976, 0.97 in 1977, and 0.89 in 1978. Also for the second consecutive year, percent survival from fry has been low at 5% while in 1976 it was 18%. In 1977, (Peckham, 1978) it was postulated that the decrease in condition and survival may have been caused by the presence of Age I fish and the ensuing predation and competition. In 1978, the lake completely winterkilled and the cause of the low productivity of the past two years most likely is a result of less food availability.

Table 15. Mean fork lengths, weights, and condition factors of pond reared Arctic Grayling*, 1978.

Pond	Sample Date	n	Mean Length (mm)	Mean Weight (g)	Condition Factor**	Water Temperature (C°)
Coalmine #3	July 17	10	39	0.8	1.34	17.5
	Aug. 9	10	72	3.9	1.04	17.5
Left O.P.	July 17	10	63	3.3	1.31	21.5
	Aug. 14	10	94	8.7	1.04	18.0
	Sept. 19	10	107	11.1	0.90	7.8
West Pond	July 17	10	56	2.4	1.36	19.0
	Aug. 10	11	93	8.4	1.04	19.0
	Sept. 19	10	126	18.0	0.89	8.0

* All ponds stocked with 25,000 fry on June 12, 1978.

** Condition factor = $K = \frac{\text{weight}}{\text{length}^3} \times 10^5$

Table 16. Summary of estimated stocking survival* of Arctic grayling from two rearing ponds, 1975-1978.

	Date	Age	Population Estimate	Estimated Percent Survival	Number Removed	Estimated Percent Removed	Fish Per Pound	Condition Factor
Left O.P.	Oct. 02, 1975	0	5,441	22	5,400	99	32	1.10
	Sept. 22, 1976	0	8,385	34	7,900	94	36	1.13
	Sept. 28, 1977	0	5,484	22	5,463	99	38	0.90
	Sept. 28, 1977	I	-	-	37	-	3.6	-
	Sept. 21, 1978	0	5,991	24	5,318	89	41	0.90
West Pond	Oct. 02, 1975	0	-	-	3,700	-	33	1.02
	Sept. 21, 1976	0	4,385	18	4,200	95	54	1.08
	Sept. 28, 1977	0	795	5	1,200	100	38	0.97
	Sept. 28, 1977	I	339	-	334	99	3.6	-
	Sept. 21, 1978	0	1,101	5	1,292	100	25	0.89

Prior to removal for transplanting into the Delta Clearwater River, 467 fingerlings from West Pond were captured with a fyke trap, fin clipped and returned to the lake. During removal over the next 4 days 320 fish were examined for clips and 137 were found to be marked. The Petersen population estimate of 1,101 is smaller than the actual removal of 1,292 (Table 16).

Left O.P. Pond (1.5 ha, 3.7 a) has also been utilized as a rearing pond for the past 4 years and of the three lakes is the most fertile. The mean length of grayling at each sampling was 3 to 4 mm less than the 1977 samples (Table 15), but the July and August sampling still showed the best growth of the three lakes stocked in 1978. The condition factor of the September sample was the same (0.90) as in 1977, but lower than the 1.10 found in 1976, and can be attributed to reduced habitat brought on by a falling water level which was 0.3 m lower than 1977 and 0.8 m lower than 1976. The estimated percent surviving from fry was not affected and at 24% was 2% greater than that estimated in 1977 (Table 16).

Prior to transplanting, 585 fingerlings were captured by fyke trap, fin clipped, and released. At the end of 4 days of trapping, 809 were examined and 79 were found to be marked. Using the Petersen method this gave a population estimate of 5,991 grayling of which 5,318 (89%) were captured.

Prior to stocking into four spring areas and the main channel of the Delta Clearwater River, all grayling were spray marked with fluorescent pigment and in addition some received an adipose clip. An attempt was made to differentiate between stocking areas; with two pigment colors available, four different marks were possible for the five locations. Two spring areas, Spring 2 and 3, being nearly identical in habitat, area, and river location shared the same mark. Numbers planted in each area were based on spring surveys and available habitat. The grayling withstood the handling extremely well and mortality was negligible.

Angler Harvest and Pressure

A creel census was conducted on the Delta Clearwater River from May 13 to September 5, 1978, following a randomly stratified schedule of 2-hour boat runs for angler counts and 2-hour interval periods for catch data. A day was divided into six 2-hour periods that ran from 9 a.m. to 9 p.m. May through July, and from 9 a.m. to 7:30 p.m. during August and September. A censused day consisted of two periods encompassing a boat run and an interview period. A boat run consisted of running the river from Mile 1 to Mile 17. Interviews were conducted at the public boat ramp and campground at Mile 8.5, and at the Clearwater Lodge landing Mile 8.75. These are the major access points for the majority of anglers utilizing the Delta Clearwater. Out of the 115 day season, 37 or 100% of weekend days and holidays, and 26 or 33% of weekdays were censused.

A total of 453 anglers was contacted, of which 274 represented completed trips, and these formed the basis of all computations. These completed trips represented 723 angler hours and 385 grayling harvested for a

catch rate of 0.54 fish per hour. Boat anglers, who represented 59% of all anglers, had a catch rate ranging from 0.51 fish per hour during May, June, and July with an average angler trip of 3.1 hours to 0.79 fish per hour and 2.4 hours per angler during August and September. Shore anglers, who were predominately limited to fishing within 1.6 km (1 mi) either side of the lodge's landing succeeded at a rate ranging from 0.34 to 0.65 fish per hour during the same monthly periods. Their average trip length for the two periods were 1.4 and 1.7 hours per angler. Combined, boat and shore anglers averaged 2.6 hours per angler with a catch rate of 0.54 fish per hour over the season. Censused catch data by month for completed trips only with boat and shore anglers combined are presented in Table 17.

An estimate of pressure was arrived at by averaging the boat run counts made during all the censused periods and then multiplying by the total numbers of periods available for each part of the season. The season was divided according to differing time periods. Also, since shore anglers and boat anglers experienced differing catch rates, both among themselves and between the two season periods, the expansion was broken down accordingly and is presented in Table 18. An estimated 6,206 anglers fished the Delta Clearwater in 1978 with 40% fishing weekdays and 60% utilizing weekends and holidays. This is a 5% increase over the 5,923 anglers reported in 1977, (Peckham, 1978). In 1978, a total of 14,404 hours was expended to harvest 7,638 grayling. This is an 860% increase in hours and a sixteen fold increase in harvest over the 1960 estimation of 1,500 hours and 465 grayling harvested, (Reed, 1961).

A comparison of censused catch and catch rates is presented in Table 19. Since 1973, taking into account sampling scheme differences and interview effort, the catch rate has been fairly constant.

Lengths were recorded for 202 Arctic grayling from angler creels and of these 97 were sampled for age determination. The age frequency and lengths of this sample are shown in Table 20. As in the index sample Age Class IV predominated with 28% of the total. The Age Class VI percentage was lower than would be expected in a normal curve as was the case in the index sample. Age Class VII was the second largest age group harvested with 22% of the total. Overall, the older age groups, V to VIII, constituted a larger percentage in the harvest sample (62%) than in the index sample (38%) while the reverse was true of the younger aged fish of Age Classes I to III, 10% and 39% respectively. Of the younger fish, two Age II and 4 of the 8 Age III fish in the harvest sample (60%) had circuli counts of 11 or more, indicating recruitment to the fishery from the pond rearing enhancement program.

Table 21 compares the 1978 length frequency of 202 harvested Arctic grayling with three previous years. The mean length, 299 mm, found this year compares closely with 302, 305, and 284 mm means found in 1973, 1976, and 1977. It should be noted that the higher percentages found in the larger length classes may not be indicative of the true population structure. Angler preference and efficiency in addition to interviewer bias may account for the greater number of large grayling found in this

Table 17. Creel census summary, completed trips only, boat and shore anglers combined, Delta Clearwater River, May 13 - September 5, 1978.

Month	Anglers Contacted	Angler Hours	Grayling Caught	Mean Length (mm)	Fish Per Angler	Hours Per Angler	Fish Per Hour
May	77	249.5	87	272	1.1	3.2	.34
June	72	213.3	122	310	1.7	3.0	.57
July	74	150	91	304	1.2	2.0	.60
August	47	93.5	73	295	1.6	2.0	.80
Sept.	4	16.5	12	-	3.0	4.1	.73
Totals	274	722.8	385	295	1.4	2.6	.54

Table 18. Estimate of use and Arctic grayling harvest from angler counts and interviews, Delta Clearwater River, May 13 - September 5, 1978.

Period	Weekdays		Weekends and Holidays	
	Boat Anglers	Shore Anglers	Boat Anglers	Shore Anglers
May, June, July:				
Anglers	765	940	1,950	1,026
Hours/Angler	3.1	1.4	3.1	1.4
Total Hours	2,372	1,316	6,045	1,435
Fish/Hour	0.51	0.34	0.51	0.34
Grayling Harvest	1,209	447	3,083	488
August, September:				
Anglers	403	389	515	218
Hours/Angler	2.4	1.7	2.4	1.7
Total Hours	967	661	1,236	371
Fish/Hour	0.79	0.65	0.79	0.65
Grayling Harvest	764	430	976	241

Totals:	Weekdays	Weekends and Holidays	Season
Anglers	2,497 (40%)	3,709 (60%)	6,206
Hours	5,316 (37%)	9,088 (63%)	14,404
Grayling Harvest	2,850 (37%)	4,788 (63%)	7,638

Table 19. Comparison of censused catch from the Delta Clearwater River, 1953-1978.

Year	Anglers Contacted	Angler Hours	Catch	Catch/Hour
1953	300	1,057	307	.29
1954	48	113	52	.46
1955*	52	172	126	.73
1956*	172	680	211	.31
1957*	102	514	211	.41
1958*	115	835	259	.31
1973	315	664	436	.65
1976	58	124	52	.42
1977	307	596	333	.56
1978	453 (274)**	1,049 (723)	592 (385)	.56 (.54)

* 12-inch size limit in effect from 1955-1958.
** Numbers in parenthesis are for completed trips only.

Table 20. Age frequency and length of sport harvested Arctic grayling, Delta Clearwater River, April 28 - September 5, 1978.

Age Class	Number	Percent	Length (mm) Range	Mean
II	2	2	204-250	227
III	8	8	198-277	239
IV	27	28	210-320	269
V	18	19	255-329	297
VI	14	14	269-370	318
VII	21	22	303-390	346
VIII	7	7	370-430	394
	97	100	204-430	299

Table 21. Length frequency of sport harvested Arctic grayling, Delta Clearwater River, 1973-1978.

Length Class (mm)	1973 %	1976 %	1977 %	1978 %
115-164	-	0	0	0
165-214	-	0	10	3
215-264	-	9	19	18
265-314	-	52	46	37
315-364	-	36	21	29
365-414	-	3	4	11
415-464	-	0	0	3
Mean length (mm)	302	305	284	299
Inches	11.9	12	11.2	11.7
Number in sample	435	33	142	202

sample and not in the index run. As in 1976 and 1977, the largest percentage of harvested grayling (37%) fell between 265 and 314 mm.

In addition to the scheduled creel census program, notebooks were distributed in early May to those local and summer residents of the Delta Clearwater River who agreed to record data on fishing trips originating from their households. Of the eleven notebooks given out, nine were returned at the end of the season, representing a total of 210 man-days of fishing effort and ranging from 0 to 68 man-days per household with a mean of 23. Total grayling caught was 1,112 of which 649 were kept. The catch rate of 1.29 grayling per hour (representing only fish kept) was over twice the .54 grayling per hour recorded by the creel census program as were the fish kept per angler, 3.1 grayling versus 1.4 grayling.

Round Whitefish Investigations

Since 1975 early spring movement into the Delta Clearwater River has been monitored with the primary purpose of investigating the feasibility of removing round whitefish. Estimates by Pearse (1974), indicated that round whitefish were six times more plentiful than grayling in the Delta Clearwater. It had been proposed that this species competes for food and space with Arctic grayling and that a reduction in whitefish numbers may be desirable and beneficial to the grayling.

During spring monitoring, as described previously, a total of 1,617 round whitefish, of which 43 were less than 150 mm in length, was captured by both fyke trap and electrofishing boat. A summary of daily catches by both methods is presented in Table 2. This was the largest number removed during spring monitoring since the program began. During 1975, 1976, and 1977 numbers of whitefish captured during this inmigration period were 1,200, 688, and 1,339, respectively.

With methods and timing of trap placement during spring monitoring being consistent from year to year, the catch per unit effort for round whitefish as stated previously in this report, has increased yearly since 1976 when it was 49, to 67 in 1977, and to 83 in 1978. This has occurred concurrently with the rise in catch per unit effort for Arctic grayling (Table 3).

Despite the record number of whitefish removed in April, the percentage of whitefish to total fish captured during the July index sampling, 83.3%, reversed a declining trend over the previous 2 years which reached 77.8% in 1977, and approached the 84.3% recorded in 1973 (Table 4).

In addition to those fish removed during the spring, whitefish captured while index sampling were also removed; and in 1978 with 433 being captured, brought the season total to 2,050. Season totals for the years 1975 through 1977 were 1,593, 1,091, and 1,641, respectively. Thus since 1975, 6,375 round whitefish have been removed from the Delta Clearwater River. Considering the greater relative abundance of round whitefish this number is relatively small when compared to the 1978 grayling sport harvest estimate of 7,638.

Arctic Grayling Tagging

During spring monitoring at Mile One Slough, 884 grayling greater than 200 mm were tagged with Floy FD 67 tags. During like monitoring in 1977, 582 grayling were tagged, with 180 mm instead of 200 mm being the minimum length.

Length frequency of the 884 grayling tagged, plus 162 grayling in the 180-199 mm range, is presented along with the 1977 data in Table 22. The percentages in each length class for 1978 do not differ significantly from the previous year's figures. The predominant length class in both years is 215-264 mm with 55% in 1977 and 50% in 1978.

Table 23 presents the age frequency of tagged grayling from 1977 and 1978. Seventeen grayling between the lengths of 180-199 which were not tagged are included in the 1978 figures in order to be comparable with the 1977 data. The percentage of Age II fish found in 1978, (7%) is greater than the 1% found in 1977, and may be either due to scale sampling bias or the result of the 1976 transplant of 12,100 fingerlings; whereas, a smaller plant of 9,100 in 1975 could have contributed to the Age II fish in 1977. The predominance of Age IV in 1978 (44%) as with the predominance of Age III in 1977 (61%) may be the result of the 250,000 fry stocked in the Delta Clearwater system in 1974. Also there is a possibility that 100,000 fry stocked in spring areas of the Delta Clearwater in 1975 may account for part of the 39% of Age III grayling. Age Class V represented 4% of the sample in 1978, while in 1977 it was 13% and although indicating poor recruitment, July sampling did not bear this out.

Tag returns from anglers totaled 135 for the 1978 season, with 32 from the 1977 tagging operation and 103 from 1978. The 103 returns represent 12% of 1978 effort while in 1977, 6% (34) of those tagged were returned. This increase may in part be due to increased creel census activities in 1978, allowing more anglers to return tags and not solely to a higher angler harvest.

From angler returns of 1978 tagged grayling, 14% were caught downstream of the tagging site at Mile One Slough, and 63% were caught upstream. A total of 23%, or 24 returns, were not specific as to location. In 1977, 18% of the returns were from downstream locations and 59% were caught upstream.

Three of the returns in 1978 came from other systems. One 1977 tagged grayling was caught during May in the Volkmar River, a distance of 26 km (16 mi) up the Tanana River from the tagging site. Another 1977 fish was caught in April downstream in the Tanana at Big Delta, a distance of 21 km (13 mi). A 1978 tagged fish was caught in July in the Richardson Clearwater River, a distance of 64 km (40 mi) downstream from the Delta Clearwater. A summary of all tag returns from the past two years is presented in Table 24.

Table 22. Length frequency of Arctic grayling greater than 180 mm in length captured at Mile One Slough and tagged with Floy FD 67 tags, spring, 1977 and 1978.

Length Class (mm)	1977		1978	
	n	%	n	%
180-214	190	33	363*	35
215-264	320	55	520	50
265-314	65	11	155	15
315-364	3	1	8	1
	578		1,046*	

* Actual number tagged was 884, 162 fish in 180-199 mm range were not tagged, but included in table for comparison to 1977 figures.

Table 23. Age frequency of Arctic grayling tagged with Floy FD 67 tags at Mile One Slough, Spring, 1977 and 1978.

Age	1977		1978	
	n	%	n	%
II	1	1	7	7
III	59	61	40	39
IV	18	19	45	44
V	13	13	4	4
VI	5	5	6	6
VII	1	1	1	1
	97		103	

Table 24. Summary of angler returns by locations of Arctic grayling tagged at Mile One Slough, Delta Clearwater River, Spring 1977 and 1978.

Location	Grayling tagged in 1977, n=582		Grayling tagged in 1978, n=884
	1977 returns	1978 returns	1978 returns
Delta Clearwater River:			
Unspecified	6	7	24
Mile 1-4	5	1	6
Mile 5-8	13	14	43
Mile 9-12	1	3	15
Mile 13-16	1	1	1
Clearwater Lake Outlet	6	4	13
Richardson Clearwater			1
Tanana River (at Big Delta)		1	
Shaw Creek	1		
Volkmar River		1	
Dry Creek	1		
Totals	34	32	103

From 10 grayling captured at Mile One Slough in 1978 and tagged in 1977, yearly growth was found to average 45 mm (1.8 in). These fish ranged from 200 to 242 mm at time of tagging.

Discussion

Population Analysis:

The primary purpose of the current study is to monitor population levels of Arctic grayling and round whitefish. Methods used towards this end involve an index sampling run with an electrofishing boat in July, creel census programs, and visual surveys. While variability due to river morphology, weather, and sampling crews doubtlessly influence the relative capture rates of fish by electrofishing gear per river section, the total capture does give useful information of population structure and in time these variabilities will tend to diminish in their significance to reveal trends. Creel census programs will complement the index sampling and also give information on pressure and total harvest.

During the past five annual studies index sampling has shown a continuous decline in numbers of the larger mature grayling concurrently with an increase in juvenile grayling and thus total captures, allowing for variables, have remained relatively constant. The predominant age class in the latest study (Age IV) has fallen from that of mature fish as found in previous studies (Age Classes V and VI) to an age class of immature fish. Similarly, the sport fishery, despite a 1978 harvest that was three times the 1973 population estimate for grayling, has maintained a catch rate comparable to previous years. Although the predominant age class in the fishery has also fallen to immature fish, the harvest continues to include large adult grayling in greater proportion than is found in the index sampling. These trends are the first effects of an impact the growing fishery is bringing to the Delta Clearwater grayling populations. With increasing fishing pressure due to the growing population of Delta Junction and Fairbanks further declines in older fish and more wide spread changes in catch rate and structure can be expected.

The grayling from the enhancement program, due to enter the fishery in 1979 and representing roughly half of the first three age classes present in the river, should alleviate some of the pressures against recruitment of stream reared fish into the older age classes. Yet there are no assurances that upon maturing and seeking suitable spawning areas in other systems, these pond reared grayling, will continue to inmigrate to the Delta Clearwater River and, if they do, whether numbers surviving into succeeding age classes will be sufficient to alleviate the angling pressures against the older stream reared fish. Thus in order to maintain the status of the Delta Clearwater as a quality fishing river, size and age composition need to be closely monitored to determine if the decline in older grayling continues. If it does, more restrictive size limitations may be required.

Grayling Stock Enhancements:

The practice of utilizing small, natural lakes for grayling rearing has provided 34,500 fingerlings over the past four years for stocking in the Delta Clearwater River. Yearly surveys of stocking locations have shown grayling from all previous plants to be present and indicate that imprinting of some of their numbers does occur. Approximately 50% of inmigrating fish in the first three age classes are found to be from the enhancement program.

The extent of the contribution of pond reared fish to the sport fishery will not be known until 1979 when Age IV fish from the 1975 plant enter the fishery. With little or no reproduction occurring in the Delta Clearwater, the first large recruitment of grayling typically occurs between 215 and 264 mm, predominantly Age IV fish, and the contribution of the enhancement program to older age classes is expected to be lower than that found in the younger age classes.

It is not yet known whether the grayling populations that utilize spring-fed systems constitute a single or a mixed stock, yet it appears that their use of the systems is not a random affair. In order to extend the usefulness of the enhancement program in addition to maintaining the genetic integrity of these populations it would be advantageous to investigate the possibilities of conducting a local egg take. It would be best undertaken in conjunction with a program of spawning surveys and tagging operations in regard to determining the origin of Delta Clearwater River grayling stocks. Thus the pond rearing program would not only enhance the sport fishing by adding numbers but also possibly the spawning capacity of these spring-fed system populations.

Round Whitefish Investigations:

Estimates of the populations of round whitefish and Arctic grayling in the Delta Clearwater River in 1973 showed that whitefish outnumbered a surprisingly low number of grayling by six to one. The program to reduce whitefish numbers was begun in 1975 with the idea of reducing competition between the two species and thus benefitting the grayling. The results of the program to date have been inconclusive with net catches of both species during spring inmigration increasing and with values of relative abundance of whitefish in July showing no definitive trends that could not be attributed to variabilities inherent in sampling techniques. The problem is that due to time and manpower constraints and no known method of consistently capturing large numbers of round whitefish the numbers of whitefish removed are not sufficient to drastically alter population levels and thus affect the competition, if any, between the two species in the Delta Clearwater. A study should be initiated to gain a better understanding of the size and distribution of the round whitefish population through a tagging program.

LITERATURE CITED

Pearse, G. A. 1974. A study of a typical spring-fed stream of Interior Alaska. Alaska Dept. of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1973-1974, Project F-9-6, 15(G-III-G): 1-29.

_____. 1976. A study of a typical spring-fed stream of Interior Alaska. Alaska Dept. of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1975-1976, Project F-9-8, 17(G-III-G): 1-17.

Peckham, R. D. 1977. A study of a typical spring-fed stream of Interior Alaska. Alska Dept. of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1976-1977, Project F-9-9, 18(G-III-G): 50-64.

_____. 1978. A study of a typical spring-fed stream of Interior Alaska. Alaska Dept. of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1977-1978, Project F-9-10, 19(G-III-G): 22-45.

Phinney, D. E., and S. B. Matthews. 1969. Field test of fluorescent pigment marking and finclipping of coho salmon. J. Fish. Res. Bd. Canada, 26: 1619-1624.

Reed, R. J. 1961. Investigations of the Tanana River grayling fisheries. Alaska Dept. of Fish and Game. Federal Aid in Fish Restoration Annual Report of Progress, 1960-1961, Project F-5-R-2, 2(3-C): 215-224.

Tack, S. L. 1974. Distribution, abundance, and natural history of the Arctic grayling in the Tanana River drainage. Alaska Dept. of Fish and Game. Fed. Aid in Fish Restoration, Annual Report of Progress, 1973-1974 Project F-9-6, 15(R-I): 52 pp

Van Hulle, F. D. 1968. Investigations of the fish populations in the Chena River. Alaska Dept. of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1967-1968, Project F-5-R-9, 9:(15-B) 287-304.

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