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Jay S. Hammond, Governor

Annual Performance Report for

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

by

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RESEARCH PROJECT SEGMENT

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ABSTRACT

The Delta Clearwater River from Mile 17 to the mouth was sampled with an electrofishing boat as part of a 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 1978 are presented. The percent composition of grayling was 23.3 percent in 1979, the highest recorded to date.

Age class compositions from index sampling are compared with those from previous years' sampling efforts. Recruitment strengths are discussed for various year classes. The 1974 year class, which produced the strongest age class in 1978, Age Class IV, was again predominant in 1979 as Age Class V and comprised 32 percent of the total.

Similar sampling was conducted on the Richardson Clearwater River. Age, length, and capture rate are discussed and compared with like sampling in 1973 and from 1977 to 1978 and with the Delta Clearwater sample.

A creel census was conducted on the Delta Clearwater River from May 12 to September 3,1979, providing 191 completed angler trip interviews and revealed a catch rate of 0.60 fish per hour. Pressure counts provided estimates of 12,135 angler hours and a harvest of 6,968 grayling, which were 16 percent and 9 percent respectively below the estimates from a similar program conducted in 1978. Comparisons of estimates derived from on-site census programs and from the statewide harvest survey are made.

A total of 1,156 grayling and 701 round whitefish was captured at Mile One Slough during spring monitoring. The catch of fish greater than 200 millimeters, 140 grayling and 322 whitefish, was much below the 1978 catch, and indicates migration into the Delta Clearwater River was later than in past years. Comparisons with the catch-per-unit-effort found during like monitoring from 1976 to 1978 are presented.

Stock enhancement through the stocking of pond-reared grayling into spring areas and to the main channel of the Delta Clearwater was assessed. From recaptures of fluorescent pigment-marked and finclip-marked grayling coded to stocking locations, interstream movements of recent transplants are defined and locations rated for overwintering capabilities and habitat preferences. Scale analysis of Age I-IV grayling captured during spring monitoring showed a 31 percent contribution to total catch. Similar analysis of grayling scales collected during index and creel sampling showed a 23 percent contribution to each. Comparisons of the contributions to each of the four age classes from the samples are discussed. Results of pond-rearing grayling for two summers prior to transplanting are discussed. A total of 718 Age I grayling was captured by fyke traps from Big Lake. They had a mean length of 247 millimeters (9.7 inches) and mean weight of 176 grams.

Clear Creek, a small spring-fed stream, was sampled in August, and age frequencies and lengths of grayling are presented.

Escapement counts of coho salmon, Oncorhynchus kitsutch (Walbaum), were taken on October 22 and 23 from Mile 17 of the Delta Clearwater to its mouth and from the outlet to Clearwater Lake. A total of 9,985 salmon was counted, the largest escapement since the counts were initiated in 1971. Chum salmon, O. keta (Walbaum), were observed in the upper river for the first time.

BACKGROUND

The Delta Clearwater River is a spring-fed system located approximately 8 mi northeast of Delta Junction (Fig. 1). The main channel of the river is approximately 20 mi in length and the north fork is about 6 mi in length. The river drains an area of approximately 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. 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. Table 1 lists common and scientific names and abbreviations of fish referred to in this report.

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 on 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 in the present study includes 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 annually.

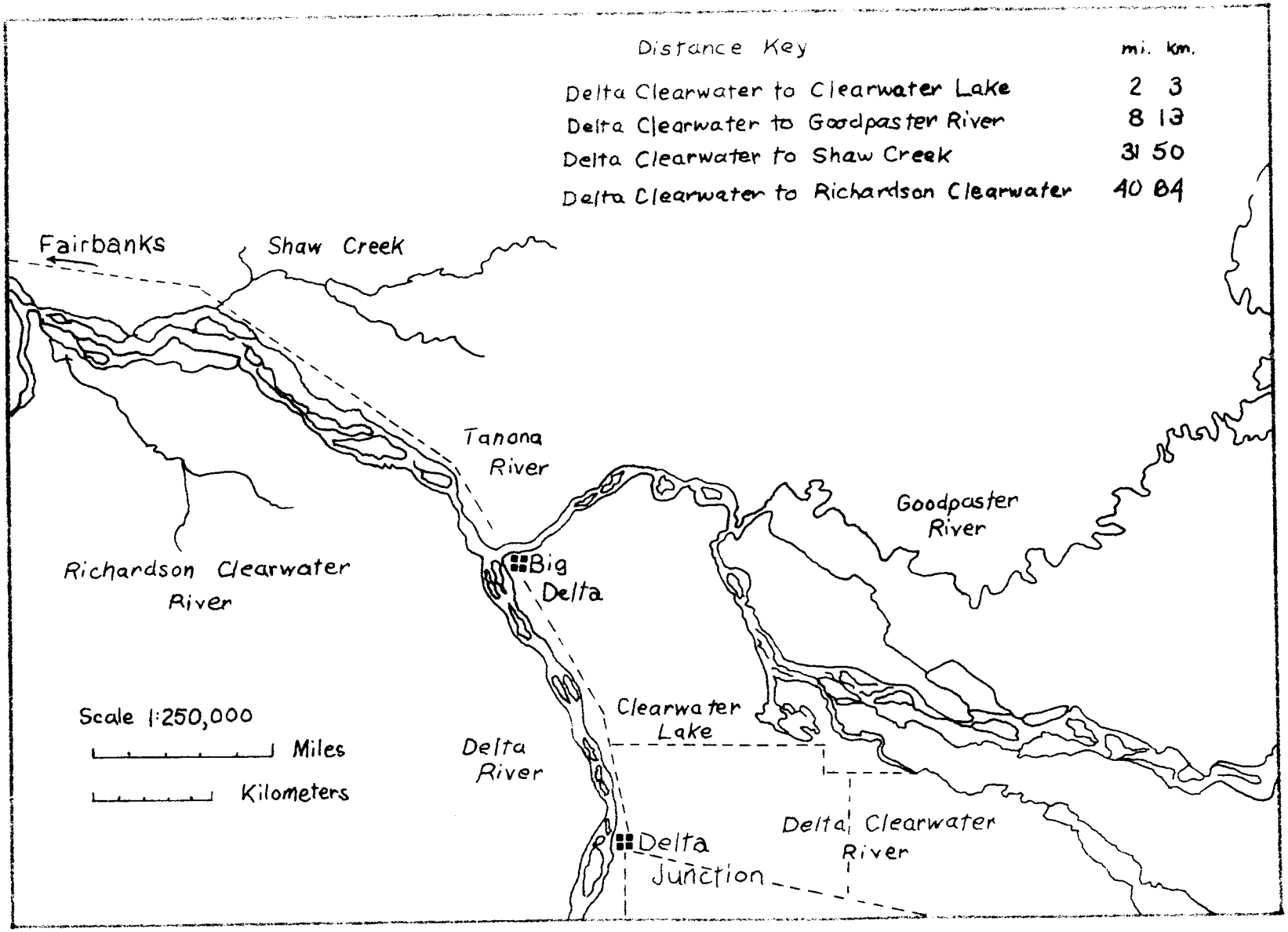

Figure 1. Delta Clearwater Distances.

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
Chum salmon	Oncorhynchus keta (Walbaum)	CS
Coho salmon	Oncorhynchus kisutch (Walbaum)	SS
Humpback whitefish	Coregonus pidschian (Gmelin)	HWF
Least cisco	Coregonus sardinella Valenciennes	LCI
Longnose Sucker	Catostomus catostomus (Forster)	LNS
Northern pike	Esox lucius Linnaeus	NP
Round whitefish	Prosopium cylindraceum (Pallas)	RWF
Slimy sculpin	Cottus cognatus Richardson	SSC

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 continued.

8. An evaluation of the use of scale analysis in separation of spring-fed systems grayling stocks should be initiated.

9. Investigations on the post-spawning migration of adult grayling from Shaw Creek to local spring-fed systems, with emphasis in the Richardson Clearwater River, should begin.

OBJECTIVES

1. Continue annual monitoring of existing stock of Arctic grayling and whitefish in the Delta Clearwater River to determine changes in population structure. Monitor existing stocks of Arctic grayling and whitefish in the Richardson Clearwater River to determine changes in population structure and similarity with trends in the Delta Clearwater River.

2. Assess transplanting of pond-reared grayling into the Delta Clearwater River to determine contribution to year class strength and angler harvest. Determine availability of local grayling egg sources for pond rearing program.

TECHNIQUES

Fish population sampling to obatain 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 1-mile section, lengths and scale samples were taken and all grayling and whitefish were 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 scale samples were taken. Fish were checked for dye marks in the field. Additional survey of spring areas were done visually.

Spring samples of grayling in rearing ponds were collected using a 125 x 6 ft monofilament gill net comprised of five graduated mesh panels ranging from 1/2 to 2 in bar measure.

Sampling at Mile One Slough utilized a New Hampshire style fyke net with a 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 pigment marks with a battery operated ultraviolet lamp. Fish $\geq$ 200 mm were tagged with Floy FD 67 tags. All grayling $\geq$ 200 mm were measured to fork length in millimeters and had scale samples taken. A random sample of grayling $\leq$ 100 mm and from each 10 mm group between 100 and 200 mm that tested negative for fluorescent pigment were measured to fork length and had scale samples taken.

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 $K=\text{weight divided by fork length}^3 \times 10^5$. 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. All fish were anesthetized with MS-222, tagged with Floy FD 67 anchor tags and received an adipose fin clip prior to transplanting.

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 impressed on 20 mil acetate using a Carver press at 20,000 psi heated to 200°F for 30 seconds and read along their dorsal radius on a Bruning 200 Microfiche Reader. Determinations of stream-reared and pond-reared grayling were made from counting circuli to and including the first annulus along the anterior dorsal fold. All circuli counts of eleven or greater were considered to be from pond-reared fish, as described by Peckham and Ridder (1979).

FINDINGS

Monitoring of Arctic Grayling and Round Whitefish Stocks

Spring Monitoring:

Since 1976 spring monitoring of Arctic grayling and round whitefish migrating into the Delta Clearwater River has taken place at Mile One Slough, a side channel of the Tanana River that enters the Delta Clearwater at Mile One. The slough is strongly influenced by springs during the months the Tanana is low and non-glacial. A fyke trap is fished totally blocking the slough at its mouth. A percentage of fish entering the Delta Clearwater from the Tanana in April move into Mile One Slough prior to further upstream movement, possibly due to its temperature typically being several degrees warmer than the Delta Clearwater.

On April 16, 1979, when the fyke trap was set, no fish were sighted on a survey of the Delta Clearwater from Mile 8 to its mouth. The first observation of fish in the lower river occurred on April 18 when approximately 30 round whitefish were seen at Mile 5 and five fish (two round whitefish and three grayling) were captured in the trap. Large numbers were not seen in the river until April 23 when 500 whitefish were counted in the lower 8 mi of the river. Similar surveys made in past years have observed fish as early as April 10 (Pearse, 1974) and as late as April 14 (Peckham, 1977) and indicate that the 1979 in-migration was late. The effect water temperature has on the timing of the in-migration is inconclusive, based on the available data. At the time of initial fish observations in the Clearwater, temperatures of the Tanana River taken just above the Clearwater's mouth have ranged from 33°F in 1976 to 35°F in 1979 and of the Delta Clearwater itself, 37°F in 1976 to 39°F in 1977.

The trap was fished for 12 days during a 3-week period that ended May 3 due to high and turbid water conditions in the slough. In 1978, the trap was also fished for 12 days and was removed on May 5 due to similar conditions. A total of 1,156 Arctic grayling and 601 round whitefish was captured, while in 1978 1,632 grayling and 996 whitefish were caught. The catch per unit effort (CPUE), as expressed by catch per fyke trap per day, was 96 for grayling and 50 for round whitefish, and was lower than in the previous 2 years. For grayling greater than 200 mm and for total whitefish, catches were similar to the CPUE's found in 1976. The lower values of 1979 reflect the late in-migration of fish greater than 200 mm and the fact that, unlike previous years when trap placement coincided with initial fish observations in the river, trap placement in 1979 was made 2 days prior to actual fish sightings. A summary of fish captured and CPUE's for grayling and round whitefish at Mile One Slough is presented in Table 2.

The catch of grayling less than 200 mm (1,016) made in 1979 is 33% greater than the 763 caught in 1978 and a 420% increase from the 242 captured in 1976 (Table 2). Part of this increase since 1976 can be attributed to the plantings of pond-reared fingerlings since 1975 and is discussed later in this report. The catch of round whitefish less than 200 mm (n=279) is also much greater than in 1978 (n=48). These large captures of fish less than 200 mm, predominately Age Classes I and II, indicate that in-migration of juveniles precedes the arrival of immatures, Age III to V, which in turn precedes the in-migration of larger, mature fish (Pearse 1974). The numbers also suggest that timing of trap placement to fish sightings (only the larger individuals are easily observed) may have precluded greater captures of smaller fish in the past.

The catch of grayling greater than 200 mm (140), was considerably less than the 869 caught in 1978 and the 436 caught in 1977, and was close to the number caught in 1976 (159). As in 1977 and 1978, these larger grayling, including those captured by electrofishing gear during the same time period, were tagged with Floy FD 67 tags, although in 1977, 180 mm was used as the minimum length. The length frequency of the 1979 tagged grayling, including 66 fish in the 180-199 mm range and six captured with electrofishing gear, is compared with the previous 2 years' length frequencies of tagged fish in Table 3. The predominant length class is 180-214 mm in 1979 unlike the 215-264 mm class found in 1977 and 1978 and is again indicative of the stratification of this year's in-migration.

Table 2. Summary of fish captured by fyke trap and CPUE for grayling and round whitefish at Mile One Slough, 1976-1979.

		1976	1977	1978	1979
GR:	<200	242	757	763	1,016
	>200	159	436	869	140
RWF:	<200	8	52	43	279
	>200	380	486	953	322
SS		318	681	692	1,744
HWF		6	3	60	74
SSC		6	8	2	5
BB		15	11	8	22
LCI		442	6	5	12
NP				1	1
LNS			2		3
#Trap Days		8	8	12	12
CPUE*	GR	50	148	136	96
	RWF	49	67	83	50

* Catch per day.

Table 3. 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, 1978 and 1979.

Length Class (mm)	1977		1978		1979	
	n	%	n	%	n	%
180-214	190	33	363*	35	101	48
215-264	320	55	520	50	89	42
265-314	65	11	155	15	21	10
315-364	3	1	8	1	1	(<1)
	578		1,046*		212**	

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

** Actual number tagged was 146, 66 fish in 180-199 mm range were added for comparison number.

The age frequency of Arctic grayling greater than 180 mm captured in 1979 is presented along with like data from 1977 and 1978 in Table 4. The predominant age class in 1979 is Age III, whereas Age IV was predominant in 1978 and Age III in 1977. As explained in last year's (Peckham and Ridder 1979), report the predominant age classes in 1977 and 1978, Ages III and IV, may have been due to the stocking of 250,000 fry into the Delta Clearwater system in 1974. Considering the predominant catch of juvenile fish this year, this explanation may also pertain to the relatively high percentage (16%) of Age V fish in 1979.

The catch of 322 round whitefish greater than 200 mm in 1979 was less than the 953 captured in 1978 and also less than the 486 and 380 captured in 1977 and 1976 respectively. The average length and weight derived from a sample of 101 fish in this length grouping was 252 mm and 144 grams. Pearse (1974), in spring tagging studies of round whitefish in the Tanana River below the Delta Clearwater, found a mean length of 350 mm. As in the timing of the grayling in-migration, it appears that the smaller juvenile and immature fish migrate into the river prior to the adults and suggests that either their choice of overwintering habitat lies closer to their summer rearing habitat or that they are more sensitive to environmental changes triggering their migrations.

The length frequency of all Arctic grayling and of all round whitefish over 200 mm in length captured during spring monitoring is presented in Figure 2. The peaks found at 90-99 mm and 110-119 mm represent the average lengths of Age I stream-reared and Age I pond-reared grayling, respectively. Less obvious are the peaks associated with the average lengths of Age II stream and pond-reared grayling, 140-149 and 170-179 mm, respectively. Analysis of the effects of stocking pond-reared fingerlings will be presented later in this report.

A large increase in the catch of humpback whitefish noted in 1978 over the small catches of 1976 and 1977 continued in 1979 with 74 captured (Table 2). Six of these were over 200 mm in length and averaged 304 mm and 338 grams. They are strictly spring visitors to the Delta Clearwater River, since summer monitoring and sampling since 1973 have failed to capture or observe any individuals. They are, however, summer residents of nearby Clearwater Lake.

Index Sampling:

Index sampling was conducted on the Delta Clearwater River from Mile 17 to the mouth on July 17 and 18, 1979. The river is divided into three sections based on gross morphology and fish habitat rather than on stream miles as in past reports. The upper section, miles 14-17 begins at the forks and encompasses the first 4 mi of the right fork. This section is the smallest of the three in length and width, averaging 18 feet wide. The middle section, miles 8-13, averages 27 ft in width and begins just below the state campground. Both the upper and middle sections offer prime feeding habitat for Arctic grayling and contain the highest percentage of large grayling (greater than 300 mm in fork length) (Pearse 1974). The lower 7-mi section, is on the average wider and slower than the upper sections and contains predominantly smaller grayling (less than 300 mm). Its lower 3 mi are also heavily influenced by back-up water when high

Table 4. Age frequency of Arctic grayling tagged with Floy FD 67 tags at Mile One Slough, Spring, 1977, 1978, and 1979.

Age	1977		1978*		1979*	
	n	%	n	%	n	%
II	1	1	7	7	10	6
III	59	61	40	39	80	45
IV	18	19	45	44	57	32
V	13	13	4	4	28	16
VI	5	5	6	6	1	1
VII	1	1	1	1	0	0
	97		103		176	

* Includes grayling 180-199 mm not tagged.

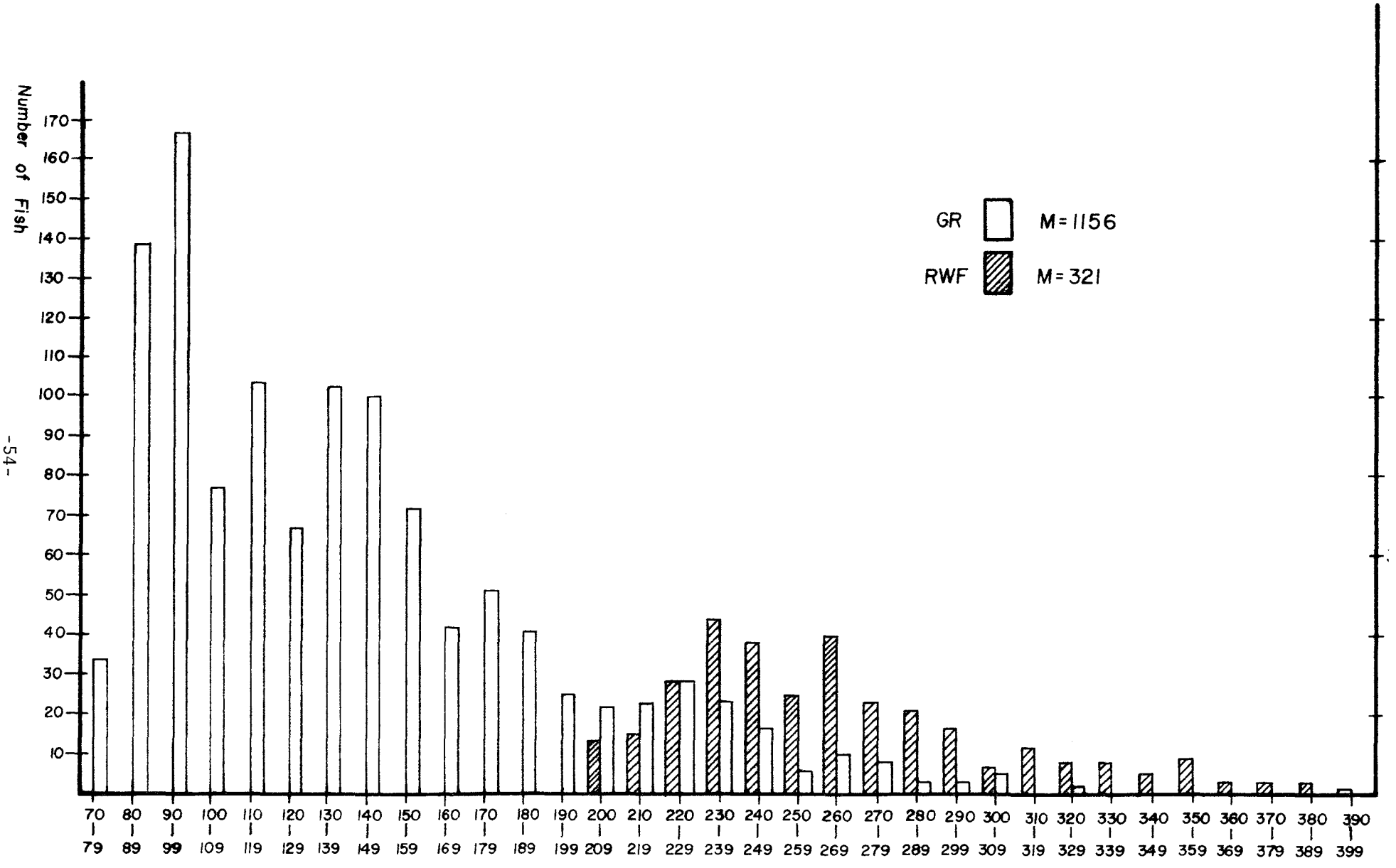

Figure 2. Length frequency of Arctic grayling and round whitefish captured by fyke trap at Mile One Slough, Delta Clearwater River, April 16 - May 3, 1979. (Does not include whitefish less than 200 mm in length.)

Tanana River water acts as a dam during the warmer months. The best electrofishing conditions are found in the upper section, due to frequency of riffle areas and narrow stream width, the poorest conditions are found in the lower section.

The relative capture rates per section for 1979 and for 5 previous years are shown in Table 5. Captures of grayling and whitefish, 157 and 518, were the largest since 1973. Total grayling captured was 80% above the 87 caught in 1978 and 55% above the previous high year in 1977. Total catch of whitefish in 1979 approximated the 511 caught in 1973. From 1975 through 1978, a program investigating whitefish competition with grayling attempted to reduce whitefish numbers as one approach, and the low catches (as compared to 1979 and 1973) for these years might reflect the effort. The 20% in catch this year over 1978 may be attributable to the cessation of the removal program. The capture rates of both species reflect their composition; with the percentage of grayling in the index, 23.3%, the highest in 6 years and the reciprocal composition of whitefish, 76.7%, the lowest in 6 years.

The increase in the capture rate for grayling in the lower section which is 550% greater than in 1973 and 353% over the 1975 rate can be traced to the enhancement program begun in 1975. In this program fingerling grayling were transplanted into four spring areas located within the lower section. Fifty-two percent of the grayling captured in this section in 1979 possessed the high circuli counts found in the pond-reared transplants. In 1976, when 17 grayling were captured, one age class from the stocking program would have been available but small size of these fish would have precluded their capture by electrofishing. From 1977 to the present, the increase is attributable to older age classes from the program becoming susceptible to capture. Twenty-three percent of 27 grayling captured in 1977 in this section had high circuli counts, and in 1978, 31% of the 50 captured exhibited them.

The middle section, with the exception of 1975, shows a consistent capture rate ranging from 20 in 1973 to 28 in 1978 and averaging 25. In 1978, 24 grayling were captured here. This section receives over 60% of the angling pressure, as the main access points, the state campground and Clearwater Lodge, are located in its lower mile. Angler catch rates recorded during the 1973 and 1977-1979 seasons have been nearly constant and corroborate the consistency of the index rates. The low index catch in 1975 of eight grayling can be the result of many variables, not the least of which is lack of fish. Data from creel census, visual observations and weather conditions during the index run that could substantiate whether the rate was truly indicative of abundance are not available to the author.

The capture rates in the upper section are consistent from 1975 to 1977, averaging 44. The lack of grayling, evidenced by the low capture rate in 1978 of eight, (80% below the average of the previous 3 years), was confirmed by visual observations and from angler interviews throughout the season (Peckham and Ridder, 1979). Similarily the high capture rate in 1979, when 74 grayling were caught, more than an 800% increase over the 1978 rate and 168% above the 1975-1977 average, paralleled visual observations and angler success. Grayling fry plants totaling 100,000 made in the left fork in 1974 and 1975 fry plants of approximatedly 15,000 made at Mile

Table 5. Capture rates per section for Arctic grayling and round whitefish during index sampling, Delta Clearwater River, 1973-1979.

Species	Date	Mile Sections 0-7	8-13	14-17	Total Captured	Percent Composition
GR	6/27/73 1974	9	20	66	95	15.7
	7/02/75	13	8	43	64	14.0
	6/30/76	17	27	41	85	17.3
	9/06/77	27	25	49	101	22.2
	7/10/78	50	28	9	87	16.7
	7/17/79	59	24	74	157	23.3
RWF	6/27/73 1974	189	159	163	511	84.3
	7/02/75	37	117	239	393	86.0
	6/30/76	116	163	128	407	82.7
	7/06/77	96	107	151	354	77.8
	7/10/78	142	237	54	433	83.3
	7/17/79	150	174	194	518	76.7

15 of this section may have contributed in part to the large increase in the 1979 rate over previous years. These plants would be of Ages IV and V in 1979, as shown in Table 6. They averaged 282 and 291 mm in fork length, respectively.

In 1973, 6% of the fish captured in the upper section were below 300 mm in length while in 1979, 35% were below this length. The effect environmental conditions in 1979 may have had on grayling migrations and thus use of this spring-fed system can only be guessed at, but exceptionally heavy runoff in the Tanana River and resulting high levels of backup water in the lower Delta Clearwater may have influenced density dependent factors and "pushed" these smaller grayling further up the river than in other years.

Age frequency and lengths of 152 Arctic grayling from the total 157 captured during the index run are also presented in Table 6 and a comparison of age composition from all years of index sampling is shown in Table 7. The 1974 year class, Age V in 1979, comprising 32% of the total, was the predominant age class in 1979--as it was in 1978 at Age IV. The strength of this class may be in part due to the planting of 250,000 fry into the system in 1974. The small percentage, 10%, of Age IV fish in the sample in 1979, (the 1975 year class) is remarkable in that it follows high percentages of this year class in 1978 and 1977. In 1975 the enhancement program first stocked pond-reared fingerlings into the system, and previous index samples of this 1975 year class showed 83% to be pond-reared in 1977 at Age II and 46% in 1978 at Age III (Peckham 1978, Peckham and Ridder 1979). Of the 15 Age IV fish in 1979, 53% had the high circuli counts of the pond-reared grayling. Also, according to Pearse (1974), Age III and IV grayling represent the first sizable recruitment to the Delta Clearwater, as evidenced by electrofishing captures. The percentage of the 1971 year class, (8% of the index sample were Age VIII in 1979), reversed a declining trend of this age class in previous years, and since it too was poorly represented at Age IV, (11% in 1975), it was above the average for successive age classes. Thus any prognosis regarding the 1975 year class in future age classes is uncertain.

Age VI, with 12% of the sample in 1979, is for the second consecutive year considerably below the percentages found in 1975 through 1977. This 1973 year class also showed poor recruitment in 1978 as Age Class V. The 1972 year class, which showed the poorest recruitment to Age Class VI in all index years, (6% in 1978), and also to Age Class V in 1977 (13%), showed relative improvement in 1979 as Age Class VII (11%). These figures point out the variable recruitment of specific year classes to successive age classes in the Delta Clearwater River and the difficulty in defining population trends.

The mean fork length of the 1979 index sample (Table 6) was 285 mm, with a range from 161 to 403 mm. In 1977 and 1978, the mean lengths of the index were 277 and 252 mm respectively. The larger mean in 1979 was undoubtably influenced by the increased rate of capture of older grayling in the upper section. The length frequency of this and past years index sampling is shown in Table 8. The cumulative frequency of the three length classes between 315 and 464 mm, 32% in 1979, was improved over the frequencies found in 1978 (17%) and in 1977 (25%), but still below the 45 and 54% found

Table 6. Age frequency and length of Arctic grayling captured with electrofishing gear in the Delta Clearwater River, July 1979.

Age Class	Number	Percent	Length (mm) Range	Length (mm) Mean
I	3	2	161-164	163
II	14	9	158-222	191
III	23	15	185-259	223
IV	15	10	249-305	282
V	49	32	249-341	291
VI	18	12	286-365	326
VII	17	11	320-377	341
VIII	11	8	325-396	370
IX	2	1	375-403	389
	152			285

Table 7. Percent age composition of Arctic grayling electrofished in the Delta Clearwater River, 1975-1979.

Age Class	1975	1976	1977	1978	1979	5 Year Average
I	0	0	0	2	2	1
II	0	1	6	16	9	6
III	0	6	15	20	15	11
IV	11	13	20	24	10	16
V	33	28	13	18	32	25
VI	33	42	27	6	12	24
VII	14	9	16	14	11	13
VIII	5	1	1	0	8	3
IX	4	0	1	0	1	1
X	0	0	1	0	0	(<1)
XI	0	0	0	0	0	0
	n=63	n=76	n=98	n=80	n=152	

Table 8. Length frequency of Arctic grayling electrofished in the Delta Clearwater River, 1975-1979.

Length Class (mm)	1975 %	1976 %	1977 %	1978 %	1979 %
115-164	0	1	1	4	3
165-214	0	4	12	17	13
215-264	6	11	26	38	14
265-314	40	39	36	24	38
315-364	41	34	15	14	24
364-414	11	11	9	3	8
415-464	2	0	1	0	0
No. Fish:	63	76	100	87	157

in 1976 and 1975. The cumulative frequency of the first two length classes, 115 to 214 mm continues to be above those found in the first 2 years of sampling; 16% in 1979 versus none at all in 1975 and only 5% in 1976. As in the increased compositions of the younger age classes since 1975, this reflects the contribution from the enhancement program, which amounted to 21% of the total index sample in 1979 and included fish in the four length classes between 115 and 314 mm. The apparent lack of recruitment to Age Class IV this year is seen in the impressive decline in the composition of the 215-264 mm class, 14% in 1979 compared to 38% in 1978 and 26% in 1977. However, this length class is better represented than in 1976; it was 11% then and in 1975 it was 6%.

Richardson Clearwater River

In past years index sampling was conducted on the Richardson Clearwater River during August. However, to be comparable to the Delta Clearwater in studying the grayling and whitefish seasonal use of such systems, the sampling in 1979 was conducted following the Delta Clearwater index sampling on July 19. As in previous years a single downstream pass was conducted with an electrofishing boat from the fork at Mile 7 to the mouth. A total of 63 Arctic grayling and 105 round whitefish was captured, an almost complete reversal of the catch in 1978 when 117 grayling and 53 whitefish were captured. In 1977, 104 grayling and 123 whitefish were captured. The change in the sampling dates this year may account for the large decline in grayling catch. Grayling and whitefish are down in the spring-fed systems in late August when the previous samples were taken and were concentrated in the lower stretches of the river, allowing for effective electroshocking capture. Compared to previous years, a large number of grayling were observed in the upper section of the Richardson Clearwater in 1979, but they avoided capture because this section is very wide. Thus the catch is not considered truly indicative of their abundance and not comparable to previous index sampling.

The age frequency and length of 62 Arctic grayling from the index sampling of the Richardson Clearwater are presented in Table 9 and are compared to previous year samples in Table 10. Age class V at 39% was predominant in the 1979 sample, while in 1978 Age Class IV at 46% was preponderant and, together with identical findings on the Delta Clearwater's index sampling, indicates the strength of the 1974 year class. In 1973 and 1977, Age Classes V and VI, respectively, were predominant. Age Classes I-III comprised the lowest percentages of the 4 years of sampling, a total of 13%, with no Age I fish present. This compares to 21% in both 1973 and 1978 and 17% in 1977. There was an increase in the percentages of older fish over that found in 1978 due to 5% of Age Class VIII present in the sample. No Age Class VIII fish were captured in 1978. Age VI and VII fish, 11% and 6% of the sample, were almost identically represented in 1978, when they comprised 11% and 7%. The cumulative percentages of the fish Ages VI and older, was 22% in 1979, 18% in 1978, 52% in 1977, and 15% in 1973.

In comparison to the Delta Clearwaters index sampling, the major differences found in the Richardson Clearwater sampling were in Age Classes I-IV percent compositions and mean lengths (Tables 6 and 9). Compositions of Age Classes I, II, and IV showed the greatest disparity in percentages between the two systems. For Ages I and II, the Richardson Clearwater

Table 9. Age frequency and length of Arctic grayling captured in the Richardson Clearwater River, July 17, 1979.

Age Class	Number	Percent	Length (mm) Range	Length (mm) Mean
I				
II	1	2	162	162
III	7	11	180-248	206
IV	16	26	224-277	253
V	23	39	244-326	293
VI	7	11	282-332	310
VII	5	6	312-368	343
VIII	3	5	356-377	363
	62		162-377	280

Table 10. Age composition of Arctic grayling captured in the Richardson Clearwater River in 1973 and 1977 through 1979.

Age Class	August 1973* No.	%	August 1977 No.	%	August 1978 No.	%	July 1979 No.	%
I	3	4	0		1	1	0	
II	0		2	2	2	3	1	2
III	13	17	15	15	13	17	7	11
IV	22	29	10	10	34	46	16	26
V	26	35	21	21	11	15	24	39
VI	8	11	33	33	8	11	7	11
VII	2	3	15	15	5	7	4	6
VIII	0		4	4	0		3	5
IX	0		0		0		0	
X	1	1	0		0		0	
	75		100		74		62	

* Only lower 4 miles were sampled.

showed a lower composition (none for Age I and 2% for Age II) than the Delta Clearwater sample, which gave 2% Age I and 9% Age II fish.

The difference in composition of Age IV grayling was the reverse, with 26% in the Richardson sample, as opposed to 10% in the Delta sample. Age III fish comprised 11% in the Richardson and 15% in the Delta. The mean lengths of these four Age Classes from the Richardson sample average 25 mm less than those found in the Delta Clearwater. This suggests that the discrepancies in 1979 are due to the enhancement program in the Delta Clearwater which transplant fingerling grayling that are in the average 20-25 mm larger than like-age "wild" fish, and which contributed 65% of these age classes in the Delta Clearwater index in 1979.

Of the older grayling, the Richardson Clearwater sample showed a 22% composition of Age VI-VIII fish, while the Delta Clearwater sample gave 32% and included 1% Age IX. Part of this difference may be attributable to the failure to capture the multitude of grayling observed in the upper Richardson Clearwater. Both Tack (1974) and Pearse (1974) mention the stratification of older grayling in the upper sections of rivers. While the percentages differed, the mean lengths of these age classes in the Richardson Clearwater averaged only 7 mm less than the same classes in the Delta Clearwater.

Although the mean lengths for each age classes showed some large differences between the two systems, the length ranges and mean lengths for each respective sample taken cumulatively are similar; the Richardson Clearwater sample ranged from 162 to 377 mm and averaged 280 mm while the Delta Clearwater sample ranged from 163 to 403 mm and averaged 285 mm.

Clear Creek:

Clear Creek, a small spring-fed system lying on the south side of the Tanana River, flows from its source near Big Delta (9 mi northwest of Delta Junction) 7 mi into a side slough of the Tanana River at a point approximately 6 mi above the mouth of the Richardson Clearwater River. It was sampled on August 29, and lengths and scales were collected from 39 grayling. Grayling and round whitefish were observed only within a half-mile of its mouth. The grayling sample was predominantly immature fish, with Age Class III being the predominant class (43% of the sample). The sample's lengths ranged from 194 to 356 mm and had a mean of 250 mm. The age frequency and length of these grayling are presented in Table 11.

Angler Harvest and Pressure

A creel census was conducted on the Delta Clearwater River from May 12 to September 3, 1979, following a stratified random schedule. Out of the 115-day season, 35, or 95% of weekend days and holidays, and 28, or 36% of weekdays, were censused. The sampling schedule and scheme are nearly identical to the one used in 1978, differing only in the length of boat-run periods in August and September (1.5 hours in 1978, 2 hours in 1979) and the extent of river censused (Mile 1 to 17 in 1978, Mile 1 to 14 in 1979) (Peckham and Ridder 1979).

Table 11. Age frequency and length of Arctic grayling captured by hook and line in Clear Creek, August 24, 1979.

Age Class	Number	Percent	Length (mm) Range	Length (mm) Mean
I				
II	2	5	194-197	196
III	17	43	209-260	227
IV	10	26	250-295	263
V	9	23	261-328	280
VI				
VII	1	3	356	356
	39	100	194-356	250

A total of 390 anglers was contacted, of which 190 represented completed trips and these formed the basis of all computations. The completed trips represented 469 angler hours and 286 Arctic grayling harvested for a catch rate of 0.60 fish per hour. In 1978 completed trips were recorded for 274 anglers, with a catch rate of 0.54 fish per hour.

Boat anglers represented 58% of all anglers (59% in 1978) and had a catch rate ranging from 0.88 fish per hour in June to 0.17 fish per hour in August, and averaged 0.68 fish per hour for the season. In 1978 boat anglers had a catch rate of 0.51 fish per hour. For shore anglers, success was much lower due to limited access to the river, which predominantly covered less than 1 mi on either side of the Clearwater Lodge landing. Their catch rate ranged from 0.47 fish per hour in May to 0.01 fish per hour in July and averaged 0.30 fish per hour for the season, which is similar to the 0.34 fish per hour recorded for the 1978 season. Table 12 presents censused catch data by month.

Catch rates in this report do not include fish caught and released. Including released fish, success by month ranged from 0.63 to 0.92 fish per hour for boat anglers, from 0.13 to 0.15 for shore anglers, and for both combined averaged 0.68 fish per hour for the season.

Angler success declined from a high catch rate in May and June to a very low catch rate in August and September. This progression is exactly the opposite found in 1978. Poor weather and lack of expertise of anglers contacted may have combined to produce these results in a part of the season which has traditionally afforded the best angling opportunities, or there may have simply been a lack of fish. Observations of large insect hatches during the latter part of August and through September, accompanied with little or no feeding activity, supports the theory that few fish were present. Sampling surveys by Department personnel on two other spring-fed systems in the Tanana drainage in late August found grayling present only near the mouths of the creeks and suggest an early outmigration (Peckham, Hallberg, pers. comm., 1979).

Because success rates for boat and shore anglers differ greatly, harvest estimates were made for each using their seasonal averages and are presented in Table 13. The pressure estimate for 1979 totaled 5,379 anglers, 66% fishing on weekends and holidays and 34% on weekdays. They spent 12,135 hours to harvest 6,968 grayling. This is a 16% reduction in pressure and 9% reduction in catch over the 1978 figures of 14,404 angler hours (6,206 anglers) and 7,638 grayling harvested.

Table 14 gives a comparison of estimates on man-days of effort and grayling harvest for the Delta Clearwater River for 1977-1979 derived from creel census programs and from results of a statewide harvest survey (Mills 1979 and pers. comm., 1980). Though the statewide survey has estimated approximately 1,000 man days above that found from creel census estimates for both 1977 and 1978, the estimates of grayling harvest from both programs for these years are remarkably close. The survey shows promise in alleviating the manpower and costs of on-site creel census programs, but the year lag in data presentation may be a problem in directing the management of some intensive and important fisheries.

Table 12. Creel census summary, completed trips only, boat and shore anglers combined, Delta Clearwater River, May 12 through September 3, 1979.

Month	Anglers Contacted	Angler Hours	Grayling Caught	Mean Length (mm)	Fish Per Angler	Hours Per Angler	Fish Per Hour
May	72	137.3	95	277	1.3	1.9	0.68
June	45	101.5	79	271	1.8	2.3	0.78
July	41	150.5	94	285	2.3	3.7	0.62
August	27	57.3	10	269	0.37	2.1	0.18
Sept.	6	22	8	307	1.3	3.7	0.35
Totals	191	468.6	286	278	1.5	2.5	0.60

Table 13. Estimate of use and Arctic grayling harvest from angler counts and interviews, Delta Clearwater River, May 12 through September 3, 1979.

	Weekdays		Weekends and Holidays	
	Boat Anglers	Shore Anglers	Boat Anglers	Shore Anglers
Anglers	796	1,031	2,331	1,221
Hours/Angler	2.8	1.5	2.8	1.5
Total Hours	2,229	1,547	6,527	1,832
Fish/Hour	0.68	0.30	0.68	0.30
Grayling Harvest	1,516	464	4,438	550

Totals:	Weekdays	Weekends and Holidays	Season
Anglers	1,827 (34%)	3,552 (66%)	5,379
Hours	3,776 (31%)	8,359 (69%)	12,135
Grayling Harvest	1,980 (28%)	4,988 (72%)	6,968

Table 14. Comparison of statewide harvest survey and Delta Clearwater Creel census estimate 1977-1979.

Year	Harvest Survey		Creel Census	
	Mandays	Harvest	Mandays	Harvest
1977	6,881	6,118	5,923	6,397
1978	7,210	7,657	6,206	7,638
1979			5,379	6,968

A comparison of censused catch and catch rates is presented in Table 15. The catch rates of the 5 years, 1973, and 1976-1979, have averaged 0.56 fish per hour while the average of the 6 years from 1953-1958 was 0.42 fish per hour (Reed 1961).

The age frequency and length of 225 grayling harvested by anglers in 1979 are presented in Table 16 and are compared with the age compositions found during the index sampling in Table 17. As in the index sample, Age V was predominant at 45% of the total, but accounted for a greater precentage than the index's 32%. Unlike last year, when a sampling bias was considered present (Peckham and Ridder 1979), the 1979 creel sample contained a smaller percentage of older fish (Age VI and above), 17%, than the index sample's 32%. The same situation was found in 1977, the creel showed 29% and the index 46%. An explanation may be that the great majority of anglers, whether they use a boat or go on foot, fish within 3 mi of the main access points on Mile 8 of the river, while the majority of large grayling are found between Miles 12 and 17. This may also explain the differences in mean lengths of Age Classes V-VIII found between the creel (Table 17) and index samples (Table 6).

Of the younger fish, Age Classes I-IV, the creel and index samples were similar with 38% and 36% respectively in 1979. For 1977 and 1978 these age classes also accounted for 38% of the angler harvest, while the index sample was similar only in 1977 (41%). No Age I fish were found in angler creels and only a small percentage of Age II fish were found compared to index samples. This simply reflects the anglers' preference for larger fish. The 19% of Age IV grayling in this year's creel sample, while higher than 10% found in the index, again reflects the unexpectedly poor recruitment to these age groups. Sixty percent of these younger fish in the 1979 creel possessed high circuli counts, indicating a strong contribution from the enhancement program. These latter fish accounted for 23% of the total creel sample. In comparison, the index sampling gave 65% of Age I-IV and 23% of the total sample due to the enhancement program.

The 1979 length frequency of 227 grayling harvested by anglers is presented along with frequencies from 4 previous years in Table 18. As in previous years, the largest percentage of the harvest sample (46%) in 1979 fell in the 265-314 mm length class. Noteworthy is the large increase in the 215-264 length class, 36% in 1979, as opposed to an average of 17% in the previous 4 years. Much of this increase, as mentioned previously, may be attributable to the enhancement program. Also of note is the decrease of the three larger length classes between 315-464 mm, which accounted for 15% of the 1979 harvest sample. In 1978, 43% of the sample consisted of these length classes, 25% in 1977 and 39% in 1973 and 1976.

The mean length in 1979 was 273 mm while the mean for the 4 previous years was 298 mm (Table 18). This drop in the mean length can also be attributed to the increase catch composition due to the enhancement program in 1979, 21%, over the 8% found in 1978.

Table 15. Comparison of censused catch from the Delta Clearwater River, 1953-1979.

Year	Anglers Contacted	Angler Hours	Catch	Catch/Hour
1953	300	1,057	307	0.29
1954	48	113	52	0.46
1955*	52	172	126	0.73
1956*	172	680	211	0.31
1957*	102	514	211	0.41
1958*	115	835	259	0.31
1973	315	664	436	0.65
1976	58	124	52	0.42
1977	307	596	333	0.56
1978	453 (274)**	1,049 (723)	592 (385)	0.56 (0.54)
1979	390 (191)	840 (469)	504 (286)	0.59 (0.60)

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

Table 16. Age frequency and length of sport harvested Arctic grayling, Delta Clearwater River, May 12 through September 3, 1979.

Age Class	Number	Percent	Length (mm) Range	Mean
II	4	2	172-224	214
III	38	17	190-276	235
IV	44	19	220-314	268
V	101	45	235-341	282
VI	24	11	279-385	319
VII	13	6	309-365	336
VIII	1	(<1)	330	330
	225		172-385	273

Table 17. Comprison of age composition (%) between creel (hook and line) and index sampling (electrofishing gear), Delta Clearwater River, 1977-1979.

Age Class	1977		1978		1979	
	Creel	Index	Creel	Index	Creel	Index
I	0	0	0	2	0	2
II	3	6	2	16	2	9
III	11	15	8	20	17	15
IV	24	20	28	24	19	10
V	33	13	19	18	45	32
VI	19	27	14	6	11	12
VII	9	16	22	14	6	11
VIII	1	1	7	0	(<1)	8
IX	0	1	0	0	0	1
X	0	1	0	0	0	0
	n=139	n=98	n=97	n=80	n=225	n=152

Table 18. Length frequency of sport harvested Arctic grayling, Delta Clearwater River, 1973-1979.

Length Class (mm)	1973 %	1976 %	1977 %	1978 %	1979 %
115-164	0	0	0	0	0
165-214	3	0	10	3	3
215-264	19	9	19	18	36
265-314	39	52	46	37	46
315-364	24	36	21	29	14
365-414	13	3	4	11	1
415-464	2	0	0	3	0
Mean Length (mm)	304	305	284	299	273
Mean (in)	11.9	12	11.2	11.7	10.7
Number in sample	120	33	142	202	227

Grayling Stock Enhancement

Spring Area Surveys:

Four spring areas of the Delta Clearwater River stocked with fluorescent pigment marked, pond-reared, Age 0 grayling in September 1978 were sampled with a backpack shocker during April and May 1979. Three areas, designated 1, 2, and 3, have been used as planting sites yearly since 1975. Spring 1A has been in use annually since 1976. Of the four, Spring 1A is the largest and offers the best rearing habitat (pools and abundant cover) but has the coldest and also the most uniform of temperatures, ranging from 35.6 to 39°F over an 8-month period. Spring 1 is the smallest and in a ranking of habitat follows Spring 1A. Its temperature range is the most extreme of the four, ranging from 32.5°F in November to 49°F in July. Springs 1 and 1A have single channels varying in width from 6 to 18 feet and both lie within a quarter mile of each other at Mile 5 of the Delta Clearwater River. Spring 2, at Mile 7.5 and Spring 3 at Mile 8.2 are similar in terms of habitat types and morphology. Temperatures ranged from 35.6 to 44.4°F in Spring 2 and from 37.4 to 47.3°F in Spring 3. Both are dominated by old beaver ponds which cover approximately 1 acre in Spring 2 and 1.5-2 acres in Spring 3.

Presampling surveys on April 12 of springs 1, 1A and 3 were successful only in 1A where 37 grayling in the 100-150 mm range were observed. Lingering shelf ice along the spring margins may have prevented grayling observations and capture in Spring 3. In 1977, Age I grayling were collected in Springs 1 and 3 on April 5 (Peckham 1978).

On April 24, sampling surveys were successful in all spring areas except Spring 1. Grayling were finally observed and collected in Spring 1 on May 2. A total of 121 grayling was captured in the four areas; 76 of these in Spring 2. Of the total captured, 89 were pigment marked, and of these 87 were Age I and two were Age II (1977 transplants also received dye marks prior to planting). Of the 32 unmarked fish, 27 were Age I, four were Age II, and one was Age III.

Of the 27 unmarked Age I grayling 13 exhibited high circuli counts (ranging from 11-15 with a mean of 13) indicating they were pond-reared fish that had experienced mark loss. These fish averaged 112 mm in length, while the grayling transplants in the fall of 1978 averaged 116 mm. The remaining 14 Age I grayling ranged from 62 to 92 mm in length with a mean of 83 mm, and past studies (Pearse 1976, Peckham 1977 and 1978, Peckham and Ridder 1979) indicate they were all stream-reared "wild" fish. The percentage of these wild grayling in this year's sample, 11.6%, was greater than the 6.6% wild Age I fish captured in 1978 (Peckham and Ridder, 1979). In 1978, 67% were captured in Spring 1 and 33% in Spring 2. In 1979 92% (12) of the wild Age I fish were taken in Spring 2 and 8% (1) in Spring 1. Pearse (1974), in pre-enhancement surveys of spring areas captured grayling (Age 0) only in Spring 1.

The capture of seven Age II and III grayling in 1979, 5.8% of the sample, was less than in 1978 when they comprised 20% of the 45 grayling captured. The 1979 percentage of pond-reared grayling in these age classes, 43%, was also down from the 67% in 1978. Of the four unmarked Age II grayling in

1979, three were wild fish captured in Spring 2 and one was a pond-reared fish captured in Spring 1A. The two pigment-marked Age IIs came from Springs 2 and 3. In 1978, the Age II fish were captured in springs 1, 2, and 3, and the wild fish were captured in Springs 1 and 2. The single Age III grayling captured in 1979 was a pond-reared fish taken in Spring 3. In 1978, two Age III fish, both pond-reared, were captured, one from Spring 1 and one from Spring 3. A summary of all captures is presented in Table 19.

In addition to those fish captured in the four spring areas, approximately 240 grayling were observed. Of these, approximately 40 were greater than 150 mm, most likely Age Classes II and III, and were seen in all areas except Spring 1. The majority of all grayling sighted (approximately 150) were in Spring 2 and the least were seen in Spring 1.

In addition to the sampling surveys of planting locations, surveys were conducted in seven other areas during May, and juvenile grayling were either captured or observed in four of these on May 10. Grayling were present in two areas within Mile 13; one grayling was observed in a small spring at Mile 13.5, but advoided capture. In a backwater area at Mile 13.9, eight grayling were captured, four of which bore fluorescent pigment, three were Age I and one was Age II. Three of the unmarked fish were Age I and one was Age II. Three unmarked fish were considered pond-reared. Both of the springs had temperatures of 42°F. Springs at Mile 11.3 and at Mile 15 (temperature 42°F) both contained only rearing coho salmon on May 10. In Spring 2A (temperature 41°F) at Mile 5.2, which had received one plant of fingerlings in 1977, two grayling were observed along with many rearing coho salmon on April 24. An April 25 survey of a spring at Mile 1.5 revealed no grayling, but juvenile round whitefish and coho salmon were observed. A May 30 survey of Remington Spring, Mile 8.9, gave the largest observation of grayling in a spring area to date, when over 340 grayling were estimated. Thirty-four were captured, of which 11 tested positive for fluorscent dye. Six of these were Age Class I and five were Age Class II. Of the 23 grayling that had no marks, two were Age I, 15 were Age II, and six were Age III and of these, one Age I, three Age II, and one Age III were pond-reared grayling.

Surveys were also conducted of the spring planting areas and Remington Spring in July, October, and twice in November to document grayling presence and temperature fluctuations. These are summarized, along with April and May observations, in Table 20. Springs 1 and 1A appear to have a different use pattern than Springs 2 and 3. While numbers of fish sighted from April 12 to May 24 are increasing in 1 and 1A, they are decreasing in 2 and 3, despite warming temperatures. In late fall almost the reverse is true. Numbers of fish fall rapidly in Springs 1 and 1A after the early fall in-migration, as does the temperature, while the drop of both is less drastic in Springs 2 and 3. Ice cover in the spring, and ice and poor light conditions in November affect the accuracy of the observed numbers. Ice affects Spring 1 least because of a confined channel and considerable water velocity, whereas the beaver ponds of Spring 2 and 3 are influenced readily by freezing temperatures. Whether or not overwintering of grayling occurs in these spring areas has not been documented, but considering spring movements and fall temperatures and fish observations, Springs 2 and 3 are more likely to be overwintering areas than Spring 1. The October sightings of grayling in springs 2 and 3 were made below the beaver ponds,

Table 19. Summary of age, length, scale circuli counts and dye marks from Arctic grayling sampled from spring areas of the Delta Clearwater River, 1979.

Location	Date	No. Marked	Number Not Marked	Age	Length (mm) Range	Length (mm) Mean	Circuli Counts Range	Circuli Counts Mean
Spring 1	5/2	10		I	104-117	111		
			3	I	80-110	99	8-13	11.3
Spring 1A	4/24	15		I	92-119	109		
			3	I	103-116	110	12-13	12.6
			1	II		170		14
Spring 2	4/24	53		I	104-140	114		
		1		II		161		12
			19	I	67-122	94	12-15*	13*
			3	II	120-137	128	7-9	8
Spring 3	4/24	9		I	104-122	112		
		1		II		156		
			2	I	92-117	105	11-13	12
			1	III		224		14
Spring 13.9	5/10	3		I	107-128	118		
		1		II		174		
			3	I	97-108	102	10-13	11.6
			1	II		169		13
Remington Spring	5/30	5		I	100-136	122		
		6		II	156-188	174		
		Λ	2	I	92-108	100	9-12	10.5
			15	II	132-186	152	7-13	9.5
			6	III	170-220	189	7-13	9.5

Table 19. Cont. Summary of age, length, scale circuli counts and dye marks from Arctic grayling sampled from spring areas of the Delta Clearwater River, 1979.

Location	Date	No. Marked	Number Not Marked	Age	Length (mm) Range	Length (mm) Mean	Circuli Counts Range	Circuli Counts Mean
Totals		95		I	92-140	113		
		9		II	156-188	171		
			32**	I	67-122	98	9-15	11.7
			20***	II	120-186	150	7-13	9.7
			7****	III	170-224	194	7-14	10.1
		104	59					

* Circuli counts from 7 grayling, 100-122, $\bar{x}$=112 mm.
** 18 grayling had $\geq$ 11 circuli, 14 had $\leq$ 10 circuli.
*** 5 grayling had $\geq$ 11 circuli, 15 had $\leq$ 10 circuli.
**** 2 grayling had $\geq$ 11 circuli, 5 had $\leq$ 10 circuli.

Table 20. Summary of Arctic grayling observations and water temperatures, spring areas, Delta Clearwater River, 1979.

	Springs										River
	1A		1		2		3		Remington		
	°F	n	°F	n	°F	n	°F	n	°F	n	°F
April 12		(37)	39.2	(0)				(0)*			
April 24	35.6	(20)	39.2	(0)	41.0	(150)	41.0	(30)			39.2
May 25	39.2	(70)	46.4	(18)	42.8	(2)	44.6	(2)	49.1	(340)	44.6
July 30	38.5	(0)	49.1	(0)	44.4	(0)	47.3	(2)	49.1	(1)	45.0
Oct. 5	35.6	(83)	38.5	(60)	40.1	(110)	40.1	(208)	38.1	(61)	36.5
Nov. 8			35.4		37.4	(35)	37.4	(150)			33.8
Nov. 14	35.6	(0)*	32.5	(10)	35.6		37.4				32.0

* Ice cover prevented positive identification of grayling.

while the November surveys observed them well up into the ponds and frequenting the iced- over portions. The April 12 observations of grayling in Spring 1A and the increase in numbers through May may indicate a small overwintering population followed by the in-migration of fish from downstream. During spring monitoring at Mile One Slough, juvenile grayling were not captured until April 18 and, on May 3, when monitoring ceased, a total of 1,016 had been captured, of which 151 were dye-marked Age I grayling.

Despite the warmest temperatures of the year, grayling do not use the springs in July. The three grayling observed in two spring areas were located at their mouths. Rearing coho salmon are still in the springs at this time, but their numbers are much reduced over previous surveys and largely limited to fry.

Prior to transplanting into the four spring areas, 1, 1A, 2, 3, and to the main river in September 1978, the pond-reared grayling were given different marks to monitor their movements between stocking locations and the river. Two colors of fluorescent dye were used in conjunction with an adipose clip to differentiate four of the five areas. Springs 2 and 3, because of their similarity and proximity, were given the same mark. A list of marks and stocking densities for each area is presented in Table 21, together with a summary of mark recaptures from the six springs sampled.

In Table 21, the capture locations for each mark show a stratification as to river location and spring type. All four marks were captured in Springs 2 and 3, whereas the captures in the two lower, cooler springs were limited to those grayling planted there 6 1/2 months previously. The captures in the furthest upstream areas, Remington Spring and Spring 13.9, were limited to grayling that had been stocked in the river and in Springs 2 and 3. Because grayling with all marks were captured at Mile One Slough, 4 miles downstream of the nearest spring, this stratification does not reject the occurrence of downstream movements, but rather, shows the disinclination of fish planted elsewhere to enter Springs 1 and 1A. The interchange between areas is not considered entirely due to a spring upstream migration as Table 21 would also indicate. The obvious outmigration immediately following stocking can go both ways; the October 5 survey found recently tagged and transplanted grayling in Springs 2 and 3 and in Remington Spring, both below and above their planting site, the main channel of the Delta Clearwater River at Mile 8.3.

A summary of marks recaptured in areas other than their stocking locations, obtained from samples captured in the spring areas and at Mile One Slough, is presented in Table 22. The cumulative captures from both areas represent a large downstream displacement after stocking; 15% of the sample was captured upstream of stocking locations, 20% showed no movement, and 65% showed downstream movement. The largest percentage of recaptures came from Springs 1 and 1A, the smallest from Springs 2 and 3.

The recapture percentage of grayling at Mile One Slough that were stocked directly into the river at Mile 8.3 was expected to be the highest of the different plants. The river offered the least desirable habitat to hold the young fish and would, in turn, cause the majority to disperse downstream. Because this plant was recaptured in the two surveyed springs

Table 21. Number and percent of dye marked pond-reared arctic grayling recaptured in spring areas, Delta Clearwater River, Spring, 1979.

Location (mark)*	Y	O	YAD	OAD**	Total
Spring 1A (Y)	14		1		15
Spring 1 (YAD)	3		7		10
Spring 2 (O)	15	22	9	7	53
Spring 3 (O)	1	5	1	2	9
Spring 13.9		2		1	3
Remington Springs		4		1	5
Totals	33	33	18	11	95
Percent of Individual Plants	1.7	1.3	2.0	.9	1.4

* Locations with marks denote planting sites:

Location	Mark	Number Grayling Planted
1A	Yellow	1,900
1	Yellow plus adipose clip	880
2	Orange	1,300
3	Orange	1,300
** Main River (Mile 8.3)	Orange plus adipose clip	1,178
		6,558

Table 22. Number and percent* of dye marked Arctic grayling recaptured in areas other than planting sites, Delta Clearwater River, Spring, 1979.

Location	Y**		O		YAD		OAD	
	n	%	n	%	n	%	n	%
Springs	19	1.0	6	.2	11	1.3	11	.9
Mile One Slough	49	2.6	46	1.8	31	3.5	25	2.1
Total	68	3.6	52	2.0	42	4.8	36	3.1

* Percent of plants for each mark.

**

Mark	Plant Location
Y: yellow pigment	Spring 1A
O: orange pigment	Springs 2 and 3
YAD: yellow pigment with adipose clip	Spring 1
OAD: orange pigment with adipose clip	River at mile 8.3

directly below its stocking site, the percentage actually found during spring monitoring, the third highest occurrence of the four marks, would suggest that some of the river plants located suitable areas in other small springs not surveyed, and in the river itself.

Assessment of Year Class Contribution:

To assess the contribution of the enhancement program to the 1979 population of Arctic grayling in the Delta Clearwater River, scale samples were collected from spring monitoring at Mile One Slough, from index sampling in July, and from angler creels throughout the season. In addition, grayling less than 200 mm in length captured at Mile One Slough were tested for the presence of fluorescent pigment that had been sprayed on all transplants in 1977 and 1978.

A total of 1,156 grayling was captured at Mile One Slough, of which 1,016 were less than 200 mm in length. Captures of like-sized grayling totaled 763 in 1978, 710 in 1977, and 242 in 1976. The increase in catch of these fish in the last few years is in part due to the enhancement program, but migration timing and recruitment levels also contribute. A late in-migration was noted in 1979. This led to increased capture of small grayling and afforded an excellent representation of this segment of the Delta Clearwater grayling population. In past studies, juvenile grayling had proven difficult to capture and their numbers were seen as indicative of a general lack of recruitment in the younger age classes.

All 1,016 grayling were tested for fluorescent pigment and 197 were found marked. The fish in the sample were from Age Classes I, II, and III. A summary of marked fish in each 10 mm group to 200 mm is given in Table 23.

An accurate representation of the enhancement program cannot be derived solely from the marking experiments, due to the overlap in size ranges of Age I pond-reared fish and Age II wild fish (Peckham and Ridder 1979). The marking does, however, make it easier to differentiate pond-reared from stream-reared grayling and, coupled with scale analysis, provides an accurate assessment of the enhancement program.

Scale samples were taken from all 829 grayling below 200 mm found not marked with the pigment. Samples were collected in each of the 10 mm groups between 100 and 200 mm to ascertain the percentages of pond-reared grayling in each group that suffered a loss of the pigment and to determine the overlap of age classes. The percentages so derived were used to adjust the unmarked sample to reflect the numbers of stream-reared amd pond-reared grayling in each 10 mm group and age class. The technique is summarized in Table 24. The table also includes 62 grayling greater than 200 mm that were not checked for marks but, together with those less than 200 mm, represent the entire catch of Age Class III at Mile One Slough.

To arrive at the percent contribution to each age class due to the enhancement program, the number of fish in each 10 mm length group that had 11 or more scale circuli in the adjusted unmarked sample (Table 24) were added to the number of marked pond-reared grayling found in the same length groups as shown in Table 23. For Age Class I, the 91 unmarked grayling estimated to be pond-reared Age I fish were added to the 144 marked fish found below

Table 23. Summary of fluorescent dye testing, Mile One Slough, Delta Clearwater River, April 16-May 3,1979.

Length (mm)	Number Marked	Number Not Marked
70-99	0	338
100-109	14	62
110-119	76	28
120-129	35	31
130-139	19	83
140-149	7	93
150-159	5	66
160-169	7	35
170-179	12	39
180-189	8	33
190-199	4	21
	187	829

n=1,016

Table 24. Percent composition of non-marked Arctic grayling, Ages I-III, with circuli counts to and including the first annulls of eleven or greater and adjusted values to total non-marked catch, Mile-One Slough, Delta Clearwater River, Spring 1979.

	Total Non-Marked	Sample Size n	% > 11			Adjusted Values					
						I		II		III	
			I	II	III	< 10	> 11	< 10	> 11	< 10	> 11
70-99	338	12	0			338	0				
100-109	62	25	92			5	57				
110-119	28	12	100			0	28				
120-129	31	20	20	0		0	6	25	0		
130-139	83	25	0	0		0	0	83	0		
140-149	93	25	0	4				89	4		
150-159	66	25		12				58	8		
160-169	35	25		40				21	14		
170-179	39	25		44	0			8	17	14	
180-189	33	18		27	12			0	9	20	4
190-199	21	19		0	29					15	6
200-209		22*			14					16	3
210-219		23			13					11	3
220-		17									
	829	293				343	91	284	52	82	27

* All fish captured over 200 mm were aged, adjusted value is thus true value.

the length of 140 mm, to give a total of 235 pond-reared grayling, or 41% due to the enhancement program out of a total Age Class I capture of 578. Similarily, the adjusted unmarked catch of Age Class II from the enhancement program (52) was added to the number of marks found between 140 and 200 mm, (43) to give a 25% contribution to the total capture of Age Class II, (379) at Mile One Slough. For Age Class III, an estimated 59 grayling fell below 200 mm, of which 10 had the high circuli counts of pond reared grayling. These were added to the 17 pond-reared grayling of Age III found in the aged sample of 140 grayling greater than 200 mm caught at Mile One Slough to give 27 grayling, or 25%, due to the program.

Age Class IV, which would include the first pond-reared grayling transplant made in 1975, was represented by 57 fish during spring monitoring. Of this number 7, or 12%, are considered to be from the transplant. A summary of the numbers and percentages of grayling from the enhancement program in the first four age classes captured at Mile One Slough is presented in Table 25 along with similar data gathered during index and creel sampling.

As shown in Table 25 the spring sample comprised a greater percentage of pond-reared grayling (31%) than either the index or creel sample, both of which showed a 23% contribution. As stated previously, spring monitoring captures predominantly immature fish of Age Class IV and younger, which in 1979 amounted to 97% of the catch. The index and creel samples, by nature of their capture methods, are biased towards larger fish and comprised only 36% and 38% respectively of these four age classes in 1979. The greater length of pond-reared grayling versus like-aged "wild" grayling would in turn bias their representation in the first two age classes found in these samples. One hundred percent of the Age I captures from index sampling, 100% of the Age II fish sampled from creels, and 79% of Age II fish from the index represented pond-reared grayling, while spring monitoring identified only 41% Age I and 25% Age II pond-reared grayling.

The percentages of pond-reared and stream-reared grayling in Age Classes III and IV found in these three samples also show differences that may stem from bias relating either to size selectivity or to grayling behavior. The percent of Age III pond-reared fish in the index and creel samples, 76% and 61% respectively, are much greater than the 25% found during spring monitoring. The similarity of the mean lengths between the two grayling types of Age Class III in the creel sample, a difference of only 2 mm, points to size bias towards the larger individuals, and hence to the pond-reared fish of this class, and is reflected in the highest percentage of the three samples. At transplanting, pond-reared grayling have averaged from 101 mm fork length in 1976 to 117 mm fork length in 1978, while similar-aged "wild" grayling average 88 mm fork length (Peckham 1978; Peckham and Ridder 1979) for a mean difference ranging from 13 to 29 mm. Although less so than the creel sample, the composition of Age III fish in the index sample due to the enhancement program, 61%, is still over twice that found in the spring sample. In this instance it may be related less to size bias and more to the stratification of grayling by age in the system. The young "wild" fish locate themselves in the lower sections of the river (Tack 1974) where the electrofishing conditions are poorer, while the pond-reared grayling remain in or "home" to the areas where they were stocked and where electrofishing conditions are more favorable.

Table 25. Mean length in mm and percent composition of Arctic grayling with circuli counts to and including first annulus of 11 or greater and 10 or less, Delta Clearwater River, 1979.

		Sample									Totals	
		Spring Monitoring*			Index			Creel				
Age	No. Circuli	n	%	Mean Length	n	%	Mean Length	n	%	Mean Length	n	%
Age I	≤ 10	343	59	88	0			0			343	59
	≥ 11	235	41	109	3	100	163	0			238	41
	Total	578		197	3		163	0			581	
Age II	≤ 10	284	75	145	3	21	164	0			287	72
	≥ 11	95	25	173	11	79	198	4	100	214	110	28
	Total	379		152	14		191	4		214	397	
Age III	≤ 10	82	75	198	9	39	208	9	24	233	100	59
	≥ 11	27	25	213	14	61	233	29	76	235	70	41
	Total	109		202	23		223	38		235	170	
Age IV	≤ 10	50	88	236	7	47	279	25	57	260	82	71
	≥ 11	7	12	255	8	53	284	19	43	278	34	29
	Total	57		238	15		282	44		268	116	
Total**		1,156			152			225			1,153	
	≥ 11	364	31%		36	23%		52	23%		452	29%

* Mile One Slough
** All totals and corresponding percentages include older age classes not shown.

Similarly, the lower percentage of pond-reared grayling in Age Class IV, (12%) in the spring sample, than in either the index (53%) or the creel sample (43%) indicates that some type of bias is present. Considering the natural recruitment to the Delta Clearwater River, predominantly Age III and IV grayling (Pearse 1974), and the negative effect mortality has on the numbers of successive age groups of a particular year class, the percentages of the 1975 pond-reared transplants, found in the index and creel samples appear abnormally high. Yet the composition of Age Class IV in the index sample and, to a lesser extent, in the creel sample indicated poor recruitment to this age class. This, in turn, would increase the percentage of pond-reared fish in the samples. In addition, the late in-migration noticed during spring monitoring could have negatively affected a representative sample of this age class, since in-migration is stratified by age and length; the younger fish precede the older fish. Thus, unlike the previous three age classes, the spring sample probably underestimates the contribution of pond-reared grayling to Age Class IV, and a more accurate estimate is to be found in the creel sample.

Table 26 presents a summary of the composition of grayling in successive age classes captured at Mile One Slough that possess 11 or more scale circuli to the first annulus, and of the number of pond-reared grayling transplanted in the years 1975-1979. The compositions in Age Class I for the 4 years follow closely the number of grayling stocked during the previous fall. The largest plant made, 12,096 grayling in 1976, is followed the next spring by the largest Age I composition, 76%, of pond-reared grayling recorded. The smallest plant, 6,610 in 1978, represents the lowest composition found, 41%. The declines in composition found in successive age classes might not be an actual representation of mortality. Since little or no natural reproduction has been found in the Delta Clearwater, the predominant source of recruitment is from other systems. Past studies have indicated that recruitment occurs differentially, with greatest recruitment at Ages III to IV (Pearse 1974).

Assessment of 1978 Pond Rearing:

Due to the unavailability of grayling fry in 1979, no ponds were stocked and thus no transplants of Age 0 grayling were made into the Delta Clearwater. Three ponds that were stocked in 1978, but were not used in that year's transplant program, were gill-netted in May to assess numbers of Age I grayling surviving and suitability of size and circuli counts to the enhancement program. Poor gill net catches in Coal Mine Pond #3 and the low catch rate of two age classes in East Pond negated their suitability. Catches of Age I grayling in Big Lake, located on Fort Greely Military Reservation, were considered sufficient to warrant fyke trapping and transplanting.

Big Lake is an 80 a lake located 16 mi south of Delta Junction. It was first stocked with grayling in 1967 and provided good angling success until 1974, when falling water levels produced anoxic conditions and the lake winterkilled. In 1978, when it again received a plant of 50,000 grayling fry for a proposed winter study of a lake aeration device, the lake had a maximum depth of 9 ft and averaged 4 feet. Prior to removal for transplanting into the Delta Clearwater River, 176 grayling were captured by

Table 26. Percent composition of Arctic grayling with circuli counts to and including the first annulus of 11 or greater, Mile-One Slough, Delta Clearwater River, 1976-1979.

Year	Number Stocked	Age I		Age II		Age III		Age IV	
		N**	%	N	%	N	%	N	%
1975	9,100								
1976	12,096	10	60						
1977	6,684+(371*)	46	76	70	31				
1978	6,610	200	47	59	46	42	52		
1979		587	41	397	25	109	27	57	12

* Age I at planting.
** Total sample size.

fyke trap, fin clipped, and returned to the lake. At the end of 4 days of fyke trapping, 537 grayling were examined for clips and 131 were found marked. Using the Petersen method, this gave a population estimate of 721. The total fyke trap catch was 718, and thus represented a 99% success in removal.

All captured fish were tagged with Floy FD 67 anchor tags and marked with an adipose fin clip before transplanting into the main channel of the Delta Clearwater at Mile 8.3. Lengths, weights and scales were taken from a sample of 20. Lengths ranged from 230 to 267 mm with a mean of 247 mm. Weights ranged from 153 to 212 g with a mean of 176 g. Circuli counts ranged from 14 to 18 to the first annulus and averaged 15.9.

The mean length of these Age I grayling compares favorably to the mean length of 238 mm of Age Class IV grayling captured during 1979 spring monitoring. Similar Age II stream-reared grayling captured in the spring of 1979 averaged 145 mm, while the pond-reared Age II from the Delta Clearwater averaged 173 mm.

The estimated survival from the original 1978 plant of 50,000 fry was 1.4%. The survival estimates of grayling reared for only one season in other rearing ponds on Fort Greely have ranged from 5% to 18% at West Pond and from 22% to 34% at Left O.P. Pond (Peckham and Ridder 1979).

The condition coefficient (K) for Big Lake grayling sampled on September 27 at transplanting was 1.16. In an August sample it was 1.08. The condition coefficients for grayling from East and Left O.P. ponds at the four previous transplants have ranged from 0.89 to 1.08 for the former and 0.90 to 1.13 for the latter.

Egg Source Investigations:

Three creeks were surveyed during May to determine their potential as grayling egg sources for the pond-rearing program. Surveys of Banner and Tenderfoot Creeks, 35 and 24 mi northwest of Delta Junction via the Richardson Highway, failed to reveal spawning concentrations of grayling. A gill net and minnow trap fished in Tenderfoot Creek caught only one adult least cisco and a few rearing coho salmon and longnose suckers. Conversations with the owner of a nearby roadhouse and local miners pointed to a lack of grayling in Banner Creek. A University of Alaska, Institute of Water Resources crew, collecting benthos and water samples from Banner Creek, reported seeing only one adult grayling during their work.

Rapids Creek, a bog fed tributary to Shaw Creek, was surveyed on May 17 and 18. Spawning activity was observed and 22 grayling were sampled, of which seven were classed as ripe. The number of spawners observed was considered sufficient to support an egg take, but the fact that the creek lies 16 mi from the nearest road might pose logistical problems.

Escapement Counts:

Escapement counts of coho salmon in the Delta Clearwater River and Clearwater Lake outlet were made on October 22 and 23, and are presented along with counts made since 1971 in Table 27. Escapement in 1979 of 8,970 in

Table 27. Coho salmon escapement counts for the Delta Clearwater River and Clearwater Lake Outlet, 1971-1979.

Date	Delta Clearwater River	Clearwater Lake Outlet
Oct. 15, 1971	3,000*	ND
Nov. 9, 1972	630**	ND
Oct. 17 & 24, 1973	3,322	551
1974	ND	ND
Oct. 22 & 24, 1975	5,100	1,500
Oct. 21 & 22, 1976	1,920	460
Oct. 24 & 25, 1977	4,793	730
Oct. 25 & 26, 1978	4,798	570
Oct. 22 & 23, 1979	8,970	1,015

* Estimate only. Counts from 1973 on were made utilizing an elevated platform.

** Count made late under poor conditions.

the river was the largest to date, and represents an increase of 86% over the 1978 escapement. The outlet escapement of 1,015 is the second largest recorded and is a 78% increase over 1978. The river escapement in 1979, as in previous years, is a minimum value since it did not include those spawners utilizing the many spring areas located along the 17 mi censused.

Chum salmon, which have been seen only in the first 2 mi of the Delta Clearwater since the counts were initiated, were also noted in small numbers at Mile 7 and Mile 12. The run of chum salmon into the Tanana River in 1979 was the largest documented in recent years, and this probably accounts for their presence in the upper Clearwater (Fred Andersen, Commercial Fish Div., Alaska Department of Fish and Game, pers. comm.).

LITERATURE CITED

Mills, M. J. 1979. Statewide harvest study. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1978-1979, Project F-9-11 20 (SW-I): 112 pp.

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 Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1975-1976, Project F-9-8, 18(G-III-G): 50-64

Peckham, R. D. 1977. 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, 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.

Peckham, R. D. and W. P. Ridder. 1979. 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, 1978-1979, Project F-9-11, 20(G-III-G): 25-64.

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. Federal Aid in Fish Restoration, Annual Report of Progress, 1973-1974, Project F-9-6, 15(R-I): 52pp.

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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