Volume 24 Study No. G-III

STATE OF ALASKA

Bill Sheffield, Governor

Annual Performance Report for

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

by

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Volume 24 Study No. G-III

RESEARCH PROJECT SEGMENT

State: Alaska Name: Sport Fish Investigations of Alaska

Project: F-9-15

Study No: G-III Study Title: LAKE & STREAM INVESTIGATIONS

Job No: G-III-G* Job Title: A Study of A Typical Spring-fed Stream of Interior Alaska

Cooperator: William P. Ridder

Period Covered: July 1, 1982 to June 30, 1983

ABSTRACT

Since 1975, this project has been directed at yearly monitoring of the population of Arctic grayling, Thymallus arcticus (Pallas), in the Delta Clearwater River to detect population trends and management needs. In 1981, this river was the second largest grayling fishery in Alaska. The project has included a yearly assessment of a grayling enhancement program begun in 1975. In 1979, it began investigations of local spawning streams to determine the population's recruitment sources and strategies.

In 1982, the seventh year of monitoring the spring in-migration of grayling and round whitefish, Prosopium cylindraceum (Pallas), the lowest catch per unit effort (fyke trap day) and the latest date of in-migration since the program's inception were noted. The 1980 year-class of grayling continued to show poor recruitment to the system at Age Class II, while the first year recruitment of the 1981 year-class was similar to Age Class I levels found in 1979 and 1980. The first possible impact on water quality by spring runoff from surrounding agricultural development was also noted during and after monitoring. Descriptions and results of water sampling are presented.

Spring runoff impacts on the water quality of the Richardson Clearwater River, a relatively undisturbed watershed, were also observed.

* "This research report has been numbered in a manner consistent with past projects which were partially funded with Federal dollars. Though no Federal dollars were available this year, the consistent project numbering will enable future researchers to locate this data."

Numbers and age compositions from 9 years of indexing the relative abundance of Arctic grayling and round whitefish by electrofishing in the Delta Clearwater River are presented and compared to 7 years of like data from indexing the Richardson Clearwater River. For the first time, differences in grayling abundance, age compositions, and year-class strength were apparent between the two systems. Indexing in the Delta Clearwater showed the lowest value to date, while the Richardson Clearwater River index gave the highest.

Four years of grayling age compositions are presented for Clear Creek, a smaller, relatively unknown spring system. Comparison of the data to that of the larger systems indicates that recruitment to Clear Creek does not come in yearly age-specific increments as in the others.

A creel census conducted on the Delta Clearwater River estimated a harvest of 4,352 grayling and 2,847 man-days of pressure in 1982. A catch rate of 0.54 fish per hour was found, which was a reversal of a 4 year trend of increasing rates that reached 0.79 in 1981. Age compositions from 6 years of harvest samples are also presented and show a small increase in mean age and length in 1982.

A voluntary creel census for summer residents of the Richardson Clearwater River was conducted for the third year. Based on the census and tag returns, an estimated 1,843 grayling were harvested in 1982.

A creel census was conducted during the 9 day spring fishery at Shaw Creek, a major spawning stream and one recruitment source for the Delta and Richardson Clearwater Rivers. An estimated 979 pre-spawning grayling were harvested at a rate of 0.87 fish per hour. The length composition of the catch was similar to that found in the previous year's harvest of 4,300. Returns of grayling tagged in the system during the fishery generated an estimated tag reporting rate of 0.456, which is comparable to that found in 1981 and in other studies.

Data on age and length composition, sex ratios and tag recoveries from 3 years of tagging studies conducted on post-spawning grayling populations from 3 major spawning streams in the study area are presented. No agreement was found in determining recruitment levels from each of these streams to the Delta Clearwater River by exploitation rates and by discriminate analysis of scale variables. Percentages of tags in respective samples are presented to describe the grayling populations of Shaw and Caribou Creeks and the Richardson Clearwater River. Observations on the pre-and post-spawning migrations in Caribou Creek are also given.

Two estimates of population size in the upper Richardson Clearwater River were made in July. A modified Petersen estimate gave 1,582 grayling per mile, with a 0.95 confidence interval of 935-2,857. A visual estimate gave 1,175 grayling per mile over the same section.

The 4 year-classes of pond-reared grayling stocked in the Delta Clearwater River between 1975 and 1978 represented 25 percent of the combined index and creel sample in 1982. Total return to the fishery to date is estimated at 16 percent of those stocked. Comparison between harvests of fingerling and catchable plants are presented and discussed.

KEY WORDS

Interior Alaska, Arctic grayling, spring-and bog-fed streams, post-spawning migrations, population indexing and estimates, stocking, creel census, stock separation, weir.

BACKGROUND

The present job was begun in 1973 in a study that brought to date information of fish species present in the Delta and Richardson Clearwater Rivers. Pearse (1974) presented life history information regarding population dynamics and intrastream movements of Arctic grayling and round whitefish. On the basis of this study's findings of low grayling abundance in the Delta Clearwater, annual work since 1975 has centered on this river with the monitoring of its fish populations through in-migration sampling, relative indexing of population abundance and creel censusing. It has included the initiation and assessment of an experimental program for enhancing the grayling population by transplanting four year-classes of pond-reared fingerlings and catchables. Comparative population monitoring has been conducted on the Richardson Clearwater since 1977 and on Clear Creek since 1979. Investigation of local spawning streams and the post-spawning migration of their grayling populations were begun in 1979 to determine the methodology and extent of their recruitment to the fisheries of the Delta and Richardson Clearwater Rivers.

Past studies of the Delta and Richardson Clearwater Rivers date back to 1952 when they were included in the U.S. Fish and Wildlife Service's (USF&WS) Arctic grayling life history study in the Tanana River drainage. After statehood in 1959, this study was continued to 1966 under the Alaska Department of Fish and Game (ADF&G). In relation to spring-fed streams, these studies emphasized inter-and intrastream migrations, determination of stocks, and creel censusing. The results of these studies were published by the USF&WS in their Quarterly Progress Reports of the Federal Aid in Fish Restoration Program, F-1-R-1 to F-1-R-8 and by ADF&G in their Annual Reports of Progress under the same program, Volumes 1 through 7.

Additional information on the Delta Clearwater River is contained in baseline studies conducted between 1978 and 1980 in response to large-scale agricultural development in the area. Individual reports on water quality and benthic investigations, chlorinated organics, and geohydrology of the area are on file with the Alaska Department of Natural Resources, North Central District, Division of Forest, Land and Water Management and with ADF&G, Delta Junction field office.

The Delta and Richardson Clearwater Rivers are two of the better known of the many spring-fed tributaries to the Tanana River of Interior Alaska. They are located near the town of Delta Junction, 100 miles southeast of Fairbanks, approximately near the middle of the drainage (Fig. 1). The Delta Clearwater is the largest of these systems with a length of 20 miles for its main channel and 6 miles for its north fork. It is also the most popular with fishermen and other recreationists due to its road access, state campground, aesthetics, and good Arctic grayling fishing. It is the second largest grayling fishery in the state with a 5 year average of

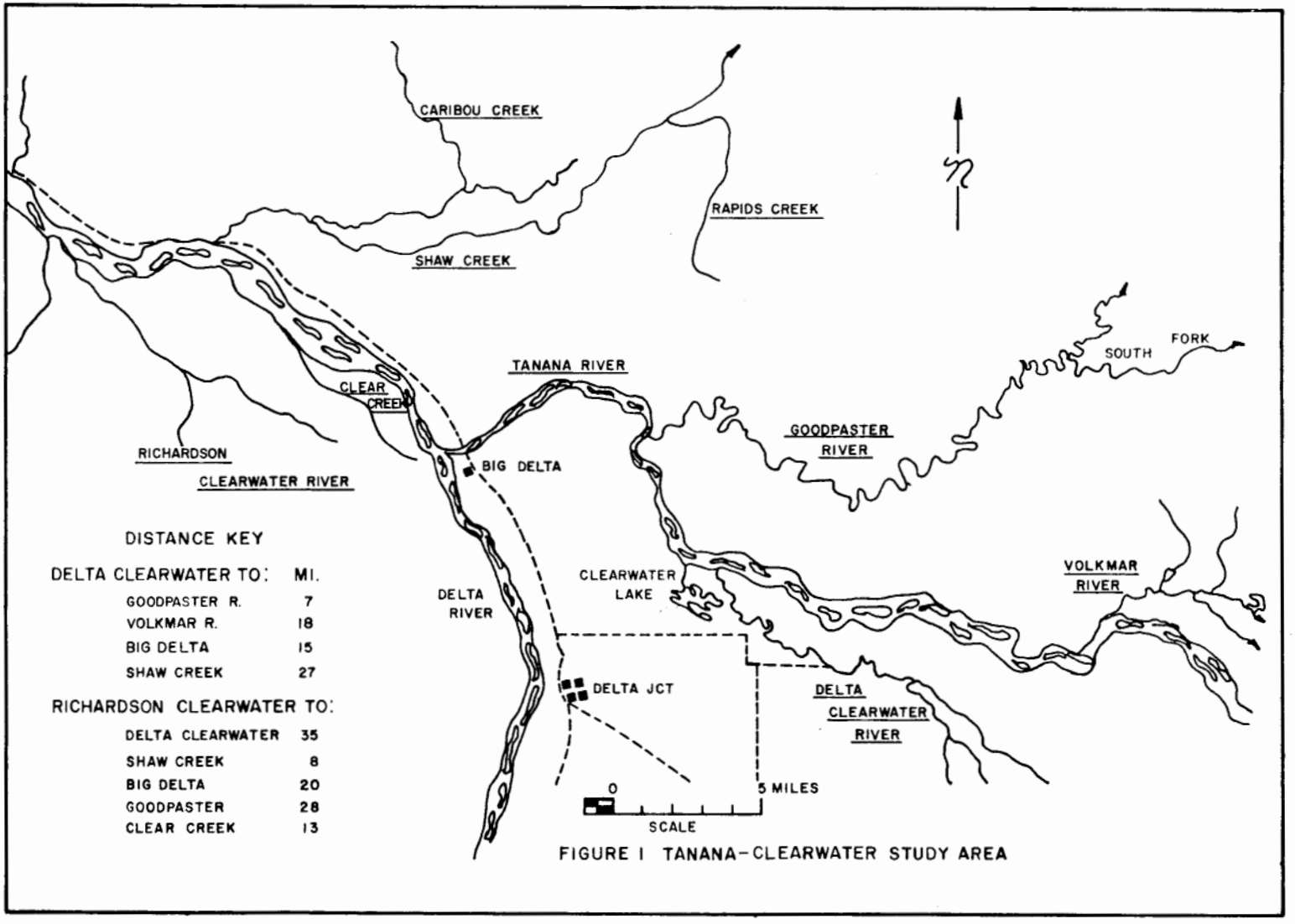

FIGURE I TANANA-CLEARWATER STUDY AREA

16,956 angler hours and a grayling harvest of 6,662 (Ridder, 1982). Of all the spring-fed systems, its drainage is the most impacted by human development. Agricultural development lies along its entire southern flank and also its headwaters; residential development occurs along 4 miles of its southern bank. The Richardson Clearwater River is located 35 mi downstream of the Delta Clearwater River. It is among the largest with its main channel 14 miles long. Largely inaccessible to the general public since access is limited to boat or float plane, the river's human impact stems predominantly from its 19 recreational cabins. The river's grayling fishery is lightly utilized and offers superb angling. In 1981 the grayling harvest was estimated at 1,500 (Mills, 1982). Agricultural development is proposed for its adjacent lands. Clear Creek, located approximately 23 miles below the Delta Clearwater River, is a small creek 7 miles long and typical of the majority of the spring systems in the drainage. Its fishery is unknown to the general public, inaccessible by road and is utilized by a few anglers who reside in a small, remote, homestead/farm area near its headwaters. Its grayling population is estimated to be less than 1,000.

These spring-fed systems are characterized by fairly constant temperatures, discharges and crystal clarity due to their ground water sources. Predominant fish species are grayling, round whitefish, coho salmon, and longnose suckers in the two larger systems and only grayling in Clear Creek. Of these species, only cohos spawn and overwinter in the systems, the others utilize them strictly as summer feeding areas. Grayling and round whitefish begin arriving in April with the migration of grayling lasting into June. In general, juvenile grayling and some sub-adults arrive directly from overwintering areas in the Tanana River and precede the adults and sub-adults who arrive from various spawning streams in the area. The known spawning streams include the Volkmar and Goodpaster Rivers, and in the Shaw Creek drainage, Caribou and Rapids Creeks. Outmigration begins in late August or early September, runs through the late fall spawning of cohos, and is essentially complete by late November. Table 1 lists the fish species mentioned in this report.

RECOMMENDATIONS

Management

1. Indexing of relative abundance of Arctic grayling by electrofishing in the Delta and Richardson Clearwater Rivers should be continued.

2. Monitoring of the Arctic grayling fishery in the Delta Clearwater River and the spring fishery at Shaw Creek should continue.

Research

1. The assessment of the stocking of four year-classes of pond-reared fingerling grayling into the Delta Clearwater River should continue.

2. The evaluation of various methods of stocking pond-reared grayling for optimum return to the fishery should be initiated.

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
Lake chub	Couesius plumbeus (Agassiz)	LC
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
Sockeye salmon	Oncorhynchus nerka (Walbaum)	RS

3. Weir operations during the post-spawning migration out of Caribou Creek should be continued for collection of tag-recoveries and population data.

4. Tagging studies should be initiated on post-spawning grayling populations in all spawning streams within 40 miles of the Delta and Richardson Clearwater Rivers not previously covered in job reports.

5. A study on the dynamics and life history of the grayling population in Caribou Creek should be initiated.

6. A statistical evaluation of the effectiveness and reliability of using electrofishing catch rates as an index of relative abundance for management decisions should be conducted.

7. Refinement of the scale analysis method for stock identification of spring-fed stream grayling populations should be continued utilizing Age 0 fish collected in the fall from spawning/rearing streams.

OBJECTIVES

1. To continue annual monitoring of existing stocks of Arctic grayling and whitefish in the Delta Clearwater River to determine changes in population structure, and to 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. To investigate the mechanism and levels of recruitment various spawning streams provide to the grayling populations of spring-fed systems in the Delta Junction area.

3. To assess transplanting of pond-reared grayling into the Delta Clearwater River to determine contribution to year class strength and angler harvest.

TECHNIQUES USED

All fork length and weight measurements, scale collections and tagging (Floy FD 68 anchor tags) were performed on fish anesthetized with MS-222. All weights were recorded using a Chattilon 51b dietary scale and were converted to grams.

Population sampling in the Goodpaster, Delta Clearwater and Richardson Clearwater Rivers was conducted using an alternating current boat-mounted shocker described by Van Hulle (1968). In the indexing of relative abundance in the Delta and Richardson Clearwater Rivers, grayling and round whitefish were captured in a single downstream pass. At the end of each 1 mile section in the Delta Clearwater River, and each 20 minute run in the

Richardson Clearwater River, lengths, weights and scale samples were taken and all captured fish were released above each mile or section ending point.

Sampling at Mile One Slough utilized a New Hampshire style fyke net with a 50 ft lead attached to one end to block the slough. All fish species captured were measured and all grayling ≥ 200 mm were tagged. Water temperatures were recorded to the nearest 1/2 degree Celsius as close to mid-day as possible. Delta Clearwater River temperatures were recorded above Mile One Slough.

Sampling at Caribou Creek used an experimental two-way weir described by Ridder (1982). Seine hauls were made to drive holding fish into the weir during periods of low water levels. All grayling ≥ 200 mm that bore or received tags were also given an adipose fin clip; all grayling ≤ 200 mm received a right ventral fin clip. Information gathered was put on Biological Data Processing forms and stored in the ADF&G, Sport Fish Division B.D.P. data storage system at Boeing Computer Services.

Sampling in Clear Creek used hook and line (fly fishing gear) and a 6 ft x 100 ft bag seine of 3/8 inch sq mesh. All grayling ≥ 200 mm were tagged and had scale samples taken.

All grayling scales used for age determination and scale variable analysis (circuli numbers and annuli distances) were taken from the fifth row above the lateral line and in line with the posterior of the dorsal fin. They were cleaned and those from fish <200 mm were mounted between glass slides and read using a Bausch and Lomb micro-projector at 46x magnification. For fish ≥ 200 mm, the cleaned scales were impressed on 20 mil acetate using a Carver press at 20,000 psi and heated to 200°F. They were aged along their dorsal radius using a 3 M model 114 microfiche reader.

Determinations of stream and pond-reared grayling were made from counting circuli to and including the first annulus along the anterior dorsal fold. All circuli counts of 11 or greater were considered to be pond-reared fish, as described by Peckham and Ridder (1979). Scale impressions selected for discriminate analysis of variables were projected at 100X magnification using equipment described by Cross et al (1981) and all circuli and annuli bisecting a line originating in the center of the focus and extending on a radius 10° anterior to the dorso-ventral axis were encoded with a digitizer at the Alaska Department of Fish and Game Stock Separation Laboratory. Circuli that bisected the line but were less than 10 mm in magnified length were excluded.

Population estimates and confidence intervals followed those described in Ricker (1975) using a modified Petersen formula of $N = M(C+1)/R+1$.

Condition factors (K) were determined by the formula K = weight divided by fork length^3 x 10^5.

FINDINGS

Monitoring of Arctic Grayling and Round Whitefish Stocks

Spring monitoring:

Yearly since 1976, monitoring of the spring in-migration to the Delta Clearwater River has been conducted beginning the first week of April with visual surveys of the lower 8 miles of river by riverboat. After the first observations of round whitefish, a fyke trap is set at the mouth of Mile One Slough which is located at Mile One of the river. A spring-influenced slough of the Tanana River, Mile One Slough is typically 1.3°C warmer than the Delta Clearwater River during the fyke trapping period. The slough typically runs clear until the first week of May when the rising, silt-laden Tanana River also causes the slough's water to rise and become silty. At this time fyke trapping ends.

Spring monitoring in 1982 recorded the latest and smallest in-migration since its inception. Initial sightings of whitefish were made on April 21, 3 days after the previous late date of April 18. River temperatures of 5°C, which past reports (Ridder, 1981; 1982) indicate affect the size of in-migration as evidenced by fyke trap catches, were not recorded till May 5. This warming was considerably later than in the previous 6 years. Fyke trap catch rates for grayling and round whitefish were also the lowest recorded, 18 and 4 per day, respectively. A summary of this 1982 spring monitoring and those of previous years is given in Table 2 and a summary of this and previous years' catch statistics for all species captured at Mile One Slough is given in Table 3.

The length-derived age frequencies of grayling captured at Mile One Slough in 1982 and for the 4 previous years are shown in Table 4. While the data show a good recruitment to the system of the 1981 year class, Age Class I, its percentage (53%) was undoubtedly influenced by the continuing poor recruitment of the 1980 year class which comprised 9% of the sample at Age I in 1981 and 28% at Age II in 1982. Considering that these first two age classes have comprised 76 to 83% of the catch since 1979, the actual level of recruitment of Age Class I in 1982 is very similar to that found in 1979 and 1980. With no appreciable reproduction occurring within the system, Age Class I represents the initial recruitment of any year class to the Delta Clearwater River from local spawning streams.

The first observable impact on water quality and possibly fishery resources by adjacent agricultural land development and production occurred during the 1982 spring in-migration. On May 3, the river's normally pristine clarity had changed to a deep humic-stained color that obscured the bottoms of pools. The deep stain lasted until May 7, at which time it began to slowly dissipate. Based upon subjective observations, the normal clarity did not return until well into June. The cause of the stain was due to a high volume of spring runoff from the cleared fields of the Delta Agricultural Project that was channeled by a firebreak to within ½ mi of the river's north fork. Water samples were collected on May 7 and 14 for herbicide analysis by the Alaska Department of Environmental Conservation (ADEC). Due to improper storage only the May 14 samples were analyzed and no gross concentration of herbicides were found, with ortho-phosphates less

Table 2. Summary of spring in-migration monitoring, Delta Clearwater River, 1976-1982.

Year	First in-migration Of whitefish	Fyke trapping		River temperatures	Grayling		Round whitefish	
		interval	days fished	first 5°C reading	total catch	CPUE**	total catch	CPUE
1976	April 14	4/20-5/4*	8	4/23	401	50	388	49
1977	April 11	4/21-5/5*	8	4/21	1,193	148	538	67
1978	April 14	4/17-5/5*	12	4/20	1,622	136	996	83
1979	April 18	4/16-5/3*	12	4/23	1,156	96	601	50
1980	April 7	4/11-5/2	21	4/23	545	26	250	12
1981	April 13	4/15-5/1	16	4/20	1,250	78	111	7
1982	April 21	4/21-5/7	16	5/5	291	18	57	4

* Trap pulled over weekends

** Catch per unit effort (trap day)

Table 3. Summary of fish captured by fyke trap at Mile One Slough, Delta Clearwater River, 1976-1982.

		1976	1977	1978	1979	1980	1981	1982
GR:	FL < 200 mm	242	757	763	1,016	480	1,179	258
	FL ≥ 200 mm	159	436	869	140	65	71	33
	Total	401	1,193	1,632	1,156	545	1,250	291
RWF:	FL < 200 mm	8	52	43	279	161	63	36
	FL ≥ 200 mm	380	486	953	322	89	48	21
	Total	388	538	996	601	250	111	57
SS:		318	681	692	1,744	612	2,808	353
HWF:		6	3	60	74	68	11	5
LCI:		442	6	5	12	30	26	11
BB:		15	11	8	22	13	35	1
NP:		0	0	1	1	1	2	0
SSC:		6	8	2	5	1	8	5
LNS:		0	2	0	3	15	1	1
	Total	1,576	2,442	3,396	3,618	1,535	4,252	724

Table 4. Length frequencies related to Age Classes of Arctic grayling captured in Mile One Slough, Delta Clearwater River, 1978 to 1982. In parentheses are age compositions derived from scale analysis.

Length Range (mm)	Related Age Class	Percent				
		1978	1979	1980	1981	1982
70-109	I	11*	36*(50)	35 (37)	9 (7)	53
110-169	II	23	41 (33)	41 (34)	77 (76)	28
170-229	III	36	16 (10)	18 (19)	12 (14)	12
230-269	IV	21	5 (5)	5 (8)	2 (2)	6
270-309	V	8	2 (2)	1 (2)	(<1) (1)	1
≧310	VI	1	(<1) (<1)			(<1)
Sample Size (n)		1,632	1,156	545	1,250	291

* In 1978 and 1979, length frequencies for Age Class I excludes fish from the 1977 and 1978 year class of stocked grayling due to their greater average length (Ridder, 1982). These frequencies thus represents only fish of wild origin.

than 0.05 mg/l and 2.4.D undetected. Penta chloropenol (PCP), a wood preservative, was found in concentrations from 0.03 to 0.94 µg/l (Joyce Beelman, ADEC, pers. comm.).

The high volume of spring run-off in 1982 also affected the water quality of the Richardson Clearwater River, although no significant land development has occurred within its drainage area. A May 14 visit to the river found it also to be humic stained, but less so than the Delta Clearwater River. The source of the stain was entirely due to the influence of a swollen tributary located near Mile 5 of the river (Sec. 28, T8S, R8E, Big Delta Quad, A-5). No water samples were collected.

Indexing of relative abundance:

The yearly indexing of the relative abundance of Arctic grayling and round whitefish stocks was conducted on July 15 and 16, 1982 on the Delta Clearwater River and on July 20, 1982 on the Richardson Clearwater River. The sampling method and crew were the same for both rivers in 1982, as well as for all indexing (electrofishing catch rates) since 1977. Weather conditions were cloudy with some wind and light rain on the Delta Clearwater River and sunny and calm on the Richardson Clearwater River. A summary of 9 years of catch rates for each of three sections of the Delta Clearwater River (described Ridder, 1980) is shown in Table 5 for grayling and Table 6 for round whitefish. A summary of the 7 years of indexing the Richardson Clearwater River is shown in Table 7. Since the lower 3 miles of the Delta Clearwater River were dropped from the index in 1982, the previous year's data presented in Tables 5 and 6 have been revised accordingly from that presented in earlier reports.

In the Delta Clearwater River, the 7 years of indexing since 1975 have shown two 3 year cycles of low to high grayling population indices, with the low 1981 index beginning the third cycle. This apparent cycle was broken in 1982 with the lowest index found to date. Since there are a number of variables that can affect sampling efficiency and thus the index, this pattern may be coincidence. Yet it is felt rates can be regarded as most accurate when depicting the extremes of population abundance such as found in 1982.

The efficiency of the capture gear is greatest in the upper section of the river and decreases in increments downstream due to river width. The river sections delineated in Table 5 are roughly analagous to this changing river morphology and to the electrofishing efficiency. The index rates of the upper section are felt to be the most indicative of grayling abundance of the three sections. The index rates of this section have also shown the greatest swings of values. The 1982 rate of this section, 18, is the second lowest recorded and compares to the 8 year mean of 53.

The low grayling populations indicated by the 1982 index is supported by the sharp drop in the catch rate of anglers which fell from 0.79 grayling per hour in 1981 to 0.54 grayling per hour in 1982. With the 1982 index rate primarily affected by the low rate of the upper section of river, it is interesting that a similar catch rate (0.54) was found from intensive censusing in 1978, the same year the record low index of the upper section was found.

Table 5. Capture rates for Arctic grayling during index sampling, Delta Clearwater River, 1973, 1975-1982.

Date	Mile Sections 4-7	8-13	14-17.5	Total Captured	Percent Catch Composition
6/27/73	7	20	66	93	16.5
7/02/75	13	8	43	64	14.0
6/30/76	11	27	41	79	17.6
7/06/77	26	25	49	100	22.9
7/10/78	39	28	9	76	15.8
7/17/79	51	24	74	149	23.1
7/15/80	39	45	98	182	38.6
7/07/81	6 (21)	27 (26)	40	73 (87)*	18.3
7/15/82	27	18	18	63	15.7
8 Yr $\bar{x}$ 1973-1981	24	26	53	103	21.1

* In parentheses: Adjusted index for abnormal water conditions on 7/7. See Ridder (1982).

Table 6. Capture rates for round whitefish during index sampling, Delta Clearwater River, 1973-1982.

Date	Mile Sections 4-7	8-13	14-17	Total Captured	Percent Composition
6/27/73	148	159	163	470	83.5
7/02/75	37	117	239	393	86.0
6/30/76	79	163	128	370	82.4
7/06/77	78	107	151	336	77.1
7/10/78	115	237	54	406	84.2
7/17/79	128	174	194	496	76.9
7/15/80	81	118	91	290	61.4
7/07/81	24	168	135	327	81.7
7/15/82	125	138	76	339	84.3
8 Yr $\bar{x}$ 1973-1981	86	155	144	385	78.9

Table 7. Capture rates for Arctic grayling and round whitefish during index sampling, Richardson Clearwater River, 1973, 1977-1982.

Date	Mile 1-7		Mile 7-8.5		Total Captured		GR Composition
	GR	RWF	GR	RWF	GR	RWF	%
8/01/73*	75	...	...		75	...	...
8/30/77	104	123	...		104	123	46
8/31/78	117	53	...		117	53	69
7/17/79	63	105	...		63	105	38
7/17/80	73	33	97	0	170	33	84
7/09/81	58	44	109	0	167	44	79
7/20/82	165	133	159	16	324	149	68
Mean (Pre-1982)	82	72	103	0	116	72	62

* Only lower 4 miles indexed (Pearse 1974).

Contrary to the low population levels in the Delta Clearwater River, an exceptionally high level was found in the indexing of the Richardson Clearwater River (Table 7). The 1982 index was 179% greater than the mean of all previous indices and over 90% greater than the previous record high. The rate was due primarily to the 184% increase over 1981 in the capture rate found in the lower 7 miles. If one disregards the indices found in the late August sampling of 1977 and 1978, when grayling are dropping down and out of the stream (Pearse, 1974; Tack, 1980) and allowing higher captures, this section had previously shown relatively consistent indices.

No similarities between the two spring-fed streams can be found in comparing index rates. Generally prior to 1982 the Richardson Clearwater River has shown a relatively constant level of grayling abundance while the Delta Clearwater River's level fluctuated. Yet age data taken from previous index samplings have shown the population structure of the two rivers to be very similar in age compositions, mean lengths and ages, and population trends (Tables 8 and 9).

In 1982 both rivers showed compositions of Age Classes I-III that were below their respective mean compositions. Age Classes IV and V were appreciably above their means in the Delta Clearwater, while in the Richardson Clearwater they were below their means. In the compositions of Age Classes VI and older, the Delta's indexing showed compositions similar to the previous year's means (32% vs. 40%) while the Richardson's compositions were much higher than average (69% vs. 35%). The mean age of the Delta sample was 5.28 in 1982, while its 7 year average was 5.08. In the Richardson, the 1982 mean age, 5.97, compares to its 6 year average of 5.07.

Another example of the two rivers' divergent population characteristics in 1982 are the composition of three year-classes, 1974 through 1976, which have shown excellent recruitment to both rivers in previous years (Table 10). As Age Classes II-IV, they precipitated the drop in mean sample length and age found in 1978 and then the subsequent yearly increases. In 1982, these year-classes, Age Classes VI-VIII, were again predominant in the Richardson's index sample (68%) where the mean length (317 mm) represented an increase for the fourth year. The 6-year-mean composition for these Age Classes is 35% in the Richardson. In the Delta Clearwater River, the three year-classes represented 26% of the sample, which is below the 7 year mean of 38% for the represented age-classes (Table 10B). In the Delta, the mean length of the 1982 sample (299 mm) was unchanged from 1981.

The age frequency, length and weights of 61 of the Arctic grayling captured during the 1982 indexing in the Delta Clearwater River are shown in Table 11. The length and weights are similar to those found in previous years. The average condition factor (K) found for the sample was 1.27. Pearse (1974) found a condition factor of 1.12 based on samples collected between May and October of 1973.

A sample of 72 round whitefish captured during the 1982 Delta Clearwater River indexing gave lengths from 227 to 422 mm, with a mean of 338 mm. The sample had weights ranging from 113 to 945g, with a mean of 446g. The

Table 8. Percent yearly age composition of Arctic grayling electrofished in the Delta Clearwater River, 1975-1982.

Age Class	1975	1976	1977	1978	1979	1980	1981	1982	Mean 1975-1981
I	0	0	0	2	2	0	0	0	1
II	0	1	6	16	9	6	5	0	6
III	0	6	15	20	15	10	11	2	11
IV	11	13	20	24	10	26	14	34	17
V	33	28	13	18	32	27	24	32	25
VI	33	42	27	6	12	25	17	18	23
VII	14	9	16	14	11	3	19	6	12
VIII	5	1	1	0	8	1	6	2	3
IX	4	0	1	0	1	2	4	2	2
X	0	0	1	0	0	0	0	2	(Π1)
XI	0	0	0	0	0	0	0	2	0
Mean Age	5.81	5.25	5.03	4.14	4.91	4.78	5.38	5.28	5.08
Mean Length (mm)	...	...	277	252	285	294	299	299	281
Sample Size	63	76	98	80	152	166	80	61	

Table 9. Yearly age frequencies of Arctic grayling electrofished in the Richardson Clearwater River, 1973, 1977-1982.

Age Class	1973	1977	1978	1979	1980	1981	1982	6 Year Mean 1973, 1977-1981
I	4	0	1	0	0	0	2	(<1)
II	0	2	3	2	3	0	0	2
III	17	15	17	11	2	1	1	11
IV	29	10	46	26	16	8	12	22
V	35	21	15	39	32	37	16	30
VI	11	33	11	11	33	27	31	21
VII	3	15	7	6	11	22	27	11
VIII	0	4	0	5	3	3	10	3
IX	0	0	0	0	0	1	1	(<1)
X	0	0	0	0	0	1	0	(<1)
Mean Age	4.33	5.29	4.32	4.84	5.35	5.79	5.97	5.07
Mean Length (mm)	...	291	252	280	301	307	317	286
Sample Size	75	100	74	62	152	158	128	

Table 10. A) Percent composition of three year-classes, 1974, 1975, and 1976, found in the total sample from index sampling, Delta and Richardson Clearwater Rivers, 1978-1982.

B) Mean compositions (percent) of three age class successions found during index sampling the Delta and Richardson Clearwater Rivers, 1973-1981.

A) Year	1978	1979	1980	1981	1982	1978-1981
Respective age classes	II-IV %	III-V %	IV-VI %	V-VII %	VI-VIII %	$\bar{X}$ %
Delta	60	57	78	60	26	64
Richardson	66	76	81	86	68	77

B) Age Classes	II-IV %	III-V %	IV-VI %	V-VII %	VI-VIII %	Data Years
Delta	34	53	65	60	38	7
Richardson	35	63	73	62	35	6

Table 11. Age frequency, length and weight of Arctic grayling captured in the Delta Clearwater River, July 15, 1982.

Age Class	Number	Percent	Length (mm)		Weight (g)	
			Range	Mean	Range	Mean
I	0	...	...	...	...	...
II	0	...	...	...	...	...
III	1	2	226	226	140	140
IV	21	34	198-300	261	113-360	225
V	20	32	250-334	294	212-450	333
VI	11	18	275-378	329	261-608	432
VII	4	6	328-397	360	419-630	500
VIII	1	2	312	312	414	414
IV	1	2	403	403	801	801
X	1	2	388	388	630	630
XI	1	2	435	435	900	900
Totals	61		198-435	299	113-900	342

condition factor (K) for the sample was 1.15. Pearse (1974) reported a condition factor of 1.10 for whitefish between the lengths of 330-349 mm collected during the first week in July 1973.

The age frequency and length of 128 of the grayling captured in the 1982 Richardson Clearwater River index sample are shown in Table 12. As in the Delta Clearwater sample, the length data are similar to previous years. A subsample of 21 grayling ranged in length from 260 to 368 mm ($\bar{x}$ = 330 mm) and in weight from 225 to 675g ($\bar{x}$ = 465 g, 1.03 lbs) and produced a condition factor (K) of 1.29.

Two estimates of population size in the upper Richardson Clearwater River were obtained over a 3-day-period, July 20-22, 1982. A Petersen estimate was conducted from Mile 8 to a point 4.75 miles downstream, just above the majority of the river's recreational cabins, using electrofishing gear. The population estimate for the section was 7,516 grayling, with a 0.95 confidence interval of 4,441-13,571. Grayling per mile were calculated to be 1,582 with a 0.95 CI of 935-2,857. Extrapolating to cover the 8 miles of river which the majority of grayling inhabit gives an estimate of 12,656 grayling, with a 0.95 CI of 7,480-25,713.

A visual estimate was obtained in the narrow section of river between Mile 8 and 6 by two observers standing on the deck of the electrofishing boat. A total of 2,350 grayling was counted, giving an estimate of 1,175 grayling per mile or 74.3% of the Petersen estimate. Although the visual estimate was conducted over water predominantly characterized by pools and placid runs, allowing excellent visibility, the count is felt to be a minimum. Some fish were herded into riffles and turbulent runs, which made enumeration impossible.

Clear Creek was sampled on July 28, 1982, as in previous years, by hook and line and seine. As in the previous July samplings, grayling were observed or captured only up to the creek's mid point, approximately Mile 4. No other fish species were observed. There appeared to be no stratification as to the size of fish among the sampling locations and no concentrations near the mouth as in August of 1979. Visual estimates by the sampling crew of the numbers of grayling present ranged from 300 to 400.

The age frequency and length of the 61 of 66 grayling sampled in 1982 (Table 13) continued the trend toward older and larger fish as in the large spring-fed systems, but based here solely on the recruitment strength of the 1976 year class (Table 14). This year class has been the predominant class in each sampling year beginning with Age Class III in 1979. As in the large spring streams, the percentages of juvenile grayling found in 1982 (3%) was low.

The comparison of grayling population data from Clear Creek shows a recruitment history that is at odds with that of the larger systems. New recruitment to the system does not appear to come in the yearly age-specific increments as in the larger systems, which generally lead to predominant age classes of V or VI (Tables 8 and 9). The Clear Creek population been nearly static for the past 4 years. Three of the five year-classes that made up 74% of the sample in 1979 as Age Classes II-IV, still comprised 79% of the 1982 sample as Age Classes V-VII (See Table 10B for comparisons). This situation may be a combination of the creek's

Table 12. Age frequency and length of Arctic grayling captured in the Richardson Clearwater River, July 20, 1982.

Age Class	Number	Percent	Length (mm)	
			Range	Mean
I	3	2	120-135	130
II	0	...	...	...
III	1	1	156	156
IV	15	12	235-272	251
V	20	16	270-318	293
VI	40	31	269-367	325
VII	35	27	316-390	350
VIII	13	10	354-400	373
IX	1	1	356	356
	128		120-400	317

Table 13. Age frequency and length of Arctic grayling captured by hook and line and seine in Clear Creek, July 28, 1982.

Age Class	Number	Percent	Length (mm)	
			Range	Mean
I	0	...	...	...
II	0	...	...	...
III	2	3	238-245	242
IV	11	18	220-270	253
V	14	23	277-315	293
VI	32	53	280-349	313
VII	2	3	347-360	354
≥ VIII	0	...	...	...
Total	61		220-360	296

Table 14. Percent age composition of Arctic grayling captured in Clear Creek, 1979-1982.

Age Class	8/29/79	7/7/80	7/17/81	7/28/82
I	0	0	2	0
II	5	4	2	0
III	43	17	11	3
IV	26	58	23	18
V	23	19	51	23
VI	3	2	5	53
VII	0	0	5	3
	n=39	n=52	n=43	n=61
Mean Length (mm)	250	256	270	296

limited amount of habitat and grayling's known territoriality towards feeding stations (Vascotto and Morrow, 1973) that could limit population size and possibly recruitment of subsequent year-classes.

Angler Harvest:

Delta Clearwater River. Creel census was conducted on the Delta Clearwater River from May 16 to September 6, 1982 using a random stratified sampling schedule and technique nearly identical to the two previous years of censusing. In 1982, sampling days covered 19.5% of the 113 day season (41% of weekends and holidays and 10% of weekdays). Angler interviews and counts were conducted over a 4 hour time period on each sampling day from Mile 1 to Mile 14 of the river. A total of 140 anglers was interviewed, representing 46 completed trips (Table 15). Boat anglers represented 72% of the completed trips, which is similar to previous years. They had a catch rate of 0.42 grayling kept per hour which compares to the 0.70 catch rate found in the previous 2 years. In 1979 and 1978, boat anglers had catch rates of 0.68 and 0.51, respectively. Shore anglers comprised the remainder of the completed trips and had a catch rate of 0.89 grayling kept per hour, which compares to their 0.85 catch rate found in 1981. In 1978 and 1979, shore anglers had catch rates of 0.34 and 0.30 respectively. For boat and shore anglers combined, the catch rate derived from completed trips was 0.54 grayling kept per hour.

A comparison of catch rates from 1953 to 1982 is shown in Table 16.

Pressure and harvest estimates for 1982 were derived from mean angler counts and from the separate catch data derived from the completed trip interviews of boat and shore anglers. The estimated 2,847 man-days of effort (7,706 angler hours) and 4,352 grayling harvested represents the fourth year of a decline from the estimates made in 1978 (Table 17), which was also the peak year of population impacts from the trans-Alaska oil pipeline construction. The low harvest estimate is not surprising considering the apparent low grayling population indicated by index sampling (Table 5) and the 32% decline in catch rate from that found in 1981 (Table 16). A shift in angler use patterns noted in 1982 is also considered a factor in the decline. In 1978 and 1979, weekend and holiday pressure estimates accounted for 63% and 72%, respectively, of the season's total estimate (Peckham and Ridder, 1979; Ridder, 1980). In 1980 and 1981, this use pattern was similar, with 76% and 70%, respectively (Ridder, unpubl.). In 1982 with the sampling ratio of weekends and holidays to weekdays unchanged from the previous 4 years, the use pattern was reversed; 36% of the total pressure was found during weekends and holidays, 64% during weekdays.

While catch success and harvest declined in 1982, the age structure of the harvest obtained from creel samples (Table 18) was somewhat different from the mean compositions found in creel samples over the previous 5 years (Table 19). The composition of grayling of Age Classes VI and greater (32%), showed an increase over both the 1981 sample (20%) and the 5 year mean (25%). This increase was largely due to the 1976 year-class (Age VI). It was accompanied by a slight decrease in the composition of fish Age III

Table 15. Creel census summary, boat and shore anglers combined, Delta Clearwater River, May 16 through Sept. 6, 1982. Numbers in parentheses are for completed trips only.

Month	Anglers Contacted	Angler Hours	Grayling Caught	Fish Per Angler	Hours Per Angler	Fish Per Angler Hour
May	52	102.2	40	0.77	1.97	0.39
June	33	55.5	24	0.72	1.68	0.43
July	31	57.5	14	0.45	1.85	0.24
August	24	39.6	30	1.25	1.65	0.76
Totals	140(46)	254.8(125.3)	108(68)	0.77(1.48)	1.82(2.72)	0.42(0.54)

Table 16. Comparison of censused grayling catch from the Delta Clearwater River, 1953-1982. Numbers in parentheses denote completed angler trips.

Year	Contacted	Hours	Catch	GR/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
1960	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)
1980	189 (59)	301 (136)	222 (92)	0.75 (0.70)
1981	163 (56)	295 (136)	217 (104)	0.72 (0.79)
1982	140 (46)	255 (125)	108 (68)	0.42 (0.54)

* 12-inch size limit in effect from 1955-1958.

Table 17. Comparison of Statewide Postal harvest surveys* and Delta Clearwater River creel census estimates 1977-1982.

Year	Harvest Survey		Creel Census	
	Man-days	Harvest	Man-days	Harvest
1977	6,881	6,118	5,923	6,397
1978	7,210	7,657	6,206	7,638
1979	8,398	6,492	5,379	6,968
1980	4,240	5,680	3,586	5,878
1981	4,673	7,362	3,143	5,706
1982	N.A.	N.A.	2,847	4,352
$\bar{x}$	6,280	6,662	4,514	6,157

* From Mills, 1979, 1980, 1981a and 1981b, 1982.

Table 18. Age frequency and length of sport caught Arctic grayling, Delta Clearwater River, May 15-Sept. 6, 1982.

Age Class	Number	Percent	Length (mm)	
			Range	Mean
II	1	1	242	242
III	10	11	220-268	248
IV	28	30	202-310	271
V	24	26	242-321	287
VI	20	22	269-355	314
VII	6	7	312-376	353
VIII	1	1	356	356
IX	2	2	380-390	385
	92		202-390	290

Table 19. Percent age composition and mean length of Arctic grayling caught by anglers, Delta Clearwater River, 1977-1982.

Age Class	Percent						1977-1981 Mean
	1977	1978*	1979	1980	1981	1982	
I	0	0	0	0	0	0	...
II	3	2	2	5	1	1	3
III	11	8	17	13	20	11	14
IV	24	28	19	41	28	28	28
V	33	19	45	24	31	26	30
VI	19	14	11	12	12	22	14
VII	9	22	6	3	6	7	9
VIII	1	7	(<1)	2	1	1	2
IX	0	0	0	0	1	2	(<1)
n=	139	97	225	147	153	92	

* Possibly biased towards larger fish (Ridder, 1979).

and younger (12%) compared to both 1981 (21%) and the 5 year mean composition (17%). The decrease of these younger fish was also apparent in the indexing sample. The increase of the older fish was not.

The mean age of the creel sample in 1982, 4.84, compares to the 5 year mean of 4.76 and the 1981 mean of 4.64.

The length frequencies (50 mm groups) of the 1982 creel sample are compared to 7 previous years in Table 20. They show the same trends as the aging data, but not the increase of the older, larger fish over the historical mean. This is probably a result of the inaccuracies inherent in the aging of scales of older grayling (Armstrong, 1982). The mean length of the 1982 sample, 290 mm, is greater than the 281 mm found in 1981, continuing the trend begun in 1979.

Richardson Clearwater River. A voluntary creel census program was conducted on the Richardson Clearwater River for the third year in 1982, mainly as an aid in monitoring recaptures of post-spawning grayling tagged in the Shaw Creek drainage. In previous years, all 17 summer residences on the river were contacted and their assistance requested. Based upon the 2 years of responses, contacts were made with only nine households in 1982, of which five responded with usable information. A total of 29 trips was recorded, representing 100 anglers (man-days), 72.5 hours, and a total catch of 602 grayling, of which 413 were harvested. This yields a harvest rate of 5.66 grayling per hour and a total catch rate of 8.25 per hour. The previous 2 years yielded harvest rates of 1.91 and 1.47 per hour.

While catch rates were much higher than previous years, and, like the river's indexing, reflected the large numbers of grayling present, use estimates were similar to previous years. Expanding the census data in a simple ratio to include all households would give minimum estimates of 1,404 grayling harvested and 340 man-days of effort. In 1980 and 1981, estimates of effort were, respectively, 334 and 346 man-days, while harvests were 995 in 1980 and 1,522 in 1981. A man-day was decidedly shorter in 1982.

While angling is predominantly by the residents of the river because of the river's relative inaccessibility, "outside" utilization of the fishery appears to have increased substantially in 1982. In 1981, tag recaptures in the river mailed in from "outside" anglers totaled eight tags, while residents returned 47. In 1982, residents returned 83 tags (20.1% of their reported harvest) while "outsiders" returned 40. A minimum estimate of their harvest can be found by using the tag reporting rate calculated for the Shaw Creek fishery discussed below. Dividing their reported tags (40) by the reporting rate (0.456) would give an estimate of 88 tags recaptured. Dividing 88 by the proportion of tags to harvest found in the voluntary census, (0.201) would give a harvest of 438 grayling for "outside" anglers. The total estimated harvest in the Richardson Clearwater River would then be 1,843 grayling.

Shaw Creek. A creel census was conducted at Shaw Creek from April 24 to May 2, 1982 using a random, stratified sampling schedule. This fishery is focused on prespawning grayling that concentrate at the mouth of the creek prior to its spring breakup. This bog-fed creek is a major spawning area

Table 20. Percent length frequency of sport harvested Arctic grayling, Delta Clearwater River, 1973-1982.

Length Class (mm)	1973	1976	1977	1978	1979	1980	1981	1982	Mean 1973-1981
115-165	0	0	0	0	0	0	0	0	0
165-214	3	0	10	3	3	3	2	2	3
215-264	19	9	19	18	36	34	37	18	25
265-314	39	52	46	37	46	47	40	56	44
315-364	24	36	21	29	14	14	14	20	22
365-414	13	3	4	11	1	2	6	4	6
415-464	2	0	0	3	0	0	1	0	(<1)
Mean Length (mm)	304	305	284	299	273	277	281	290	289
Mean Length (in)	11.9	12	11.2	11.7	10.7	10.9	11.1	11.4	11.4
Number in sample	120	33	142	202	227	147	164	100	1135

for grayling utilizing the Richardson Clearwater River. Caribou Creek, the largest tributary to Shaw Creek, is also the focus of postspawning migrations mentioned later in this report, and thus censusing provides accurate monitoring of grayling tagged there since 1980.

A summary of the creel census is given in Table 21. The overall catch or harvest rate found in 1982, (0.87 fish per hour) is down considerably from the rate found in 1981, (2.14). This is due to the breakup conditions experienced in 1982, which consisted of treacherous ice conditions and limited access. The conditions also limited the duration of the fishery to 9 days in 1982 (18 days in 1981) which approximates the interval between breakup of the Tanana River and breakup of Shaw Creek (April 30, 1982). Reflecting these conditions is the decrease in estimated harvest in 1982, 979 grayling versus the 4,343 grayling harvested in 1981. Pressure estimates were roughly half of what they were the previous year, 1,172 anglers hours (555 man-days) versus the 2,029 angler hours (966 man-days) in 1981.

The catch composition from a creel sample of 377 grayling was similar to that found in 1981. In 1982 grayling ranged in length from 215 to 405 mm, with a mean of 302 mm. In 1981 the lengths of 271 grayling ranged from 184 to 379 mm, with a mean of 292 mm.

Eighty-nine percent of the 1982 sample had lengths of 260 mm or greater, which represents predominantly mature fish. In 1981, 86% of the grayling were of this range. The male to female sex ratio found in 1982 was 1.19 to 1 (0.9 to 1 in 1981).

Tag returns generated by the fishery totaled 47. Forty-one were received during creel censusing, or 10.5% of the censused catch of 392 grayling. Multiplying the estimated harvest, 979, by this tag recapture rate gives an estimate of 103 total tag recaptures. The 47 tags returned from the fishery would then represent an estimated reporting rate (number of tagged fish reported per number of tagged fish caught) of 45.6%. Matlock (1981) found a reporting rate of 28% for internal tags in a saltwater fishery in Texas and cited rates of 60% by fresh water anglers in California and a 40% rate by Atlantic coast anglers. The reporting rate at Shaw Creek is, of course, high because of the censusing activities. Disregarding the tags found during censusing would leave 6 tags returned by anglers of their own volition out of an expected 62 tags, or a reporting rate of 9.7%. This same arithmetic was applied to data on the 1981 fishery (Ridder, 1982) and a reporting rate of 41% was calculated (including "censused" tags the rate was 49%). The large discrepancy may be in part due to tag educated and "tag weary" anglers in 1982.

Of the 47 tags returned, 45 represented grayling tagged in the Shaw Creek drainage. Of the remaining two, one was from 1980 tagging in the Richardson Clearwater River and one was from 1979 spring tagging at Mile One Slough, Delta Clearwater River.

Post-Spawning Migration Investigation

Past studies of the Delta and Richardson Clearwater Rivers have centered on Caribou Creek where a portion of its outmigrating postspawning grayling have been tagged yearly since 1980. Tagging has also been done on the Volkmar and Goodpaster Rivers, and Shaw and Rapids Creeks (Fig. 1).

Table 21. Summary of Shaw Creek spring creel census, April 24-May 2, 1982.

Censused Catch:

Period	Number Anglers	Total Hours	Grayling Harvest	Hours/ Angler	Fish/ Angler	Fish/ Hour
April 24 & 25	102	245	231	2.4	2.26	0.94
April 26 - 30	80	167	149	2.1	1.86	0.89
May 1 & 2	23	37	12	1.6	0.52	0.33
Total	205	449	392	2.2	1.91	0.87

Harvest and Pressure Estimates:

Total Angler Hours	1,172
Total GR Harvest	979
Total Man-Days	555

Angler Composition %

Resident:	55
Military:	42
Non-resident	1
Unknown:	2

Surveys of Banner and Tenderfoot Creeks, tributaries to the Tanana River, located downstream of Shaw Creek, showed no spawning concentrations of grayling (Ridder, 1980).

Post-Spawning Migration and Tagging

Caribou Creek, approximately 16 miles long, is the largest of nine named tributaries of Shaw Creek and is located 6 miles above its mouth. At the weir site, 300 yards from Shaw Creek, the creek is 20 feet wide with an average depth of 18 inches. The creek has an average flow of 17 cfs, but is subject to rapid fluctuation. In 1982, water levels remained high during most of the weir operation, with heavy rains finally causing water levels to crest the 4 foot weir and ending operations. The runoff peaked on June 24 with water levels 5 feet over the weir and with a volume of approximately 300 cfs, which is the greatest flow seen in the last 3 years.

The weir was operational from June 1 to June 20, 1982, a total of 19 days. A total of 6,789 fish of 10 species was captured in both the up and downstream traps. Arctic grayling totaled 3,876, or 57% of the catch, and 2,001 grayling were tagged. On June 18, prior to rising water levels, there were an estimated 1,000+ grayling holding within 300 yds upstream of the weir, which was similar to previous years' situations when operation ended. This and observations made during the trapping indicate a reluctance of grayling to enter the downstream trap, especially during low water conditions.

The total grayling catch in the upstream (in-migrant) trap was 1,814 and their length frequencies and related age classes are shown in Table 22 along with 1981 data. The catch structure cannot be regarded as indicative of the total population in-migrating to the creek since this in-migration had begun as early as April 30 when Shaw Creek broke up. On May 6, with 14 inches of water at 0°C flowing over a like amount of bottom-fast ice at the weir site, one grayling approximately 320 mm in length, was observed traveling upstream.

Of the total upstream catch, 534 grayling had lengths greater than 200 mm, and of these, 507 were tagged and 15 (2.8%) represented tag recaptures from previous years' efforts. Also, four fish were recaptured that had been tagged 1 to 6 days ($\bar{x}$ = 3 days) previously in the downstream trap. One hundred and twenty-seven of these grayling were considered mature and were sexed either by secondary sexual characteristics or reproductive products. Seventy-two females ranged in length from 241 to 331 mm, with a mean length of 271 mm. Fifty-five males ranged from 246 to 355 mm and averaged 290 mm.

The total catch of out-migrating grayling was 2,062 in 1982; 1,861 grayling were greater than 200 mm and 1,494 were tagged, 308 (16.6%) were recaptures from previous years tagging, 47 were recaptures of grayling tagged 1 to 17 days previously in the upstream trap and 10 were autopsied. The time interval between captures of these latter fish ranged from 3 to 16 days ($\bar{x}$ = 10.5) for 20 adults and from 1 to 17 days ($\bar{x}$ = 9.7) for 32 immatures.

Table 22. Length frequency and related age classes of Arctic grayling, in-migration, Caribou Creek, June, 1981, 1982.

Length Range (mm)	Related Age Class	6/7-6/19/81 n	6/7-6/19/81 %	6/1-6/20/82 n	6/1-6/20/82 %
70-109	I	84	22.8	712	39.3
110-169	II	61	16.6	426	23.5
170-229	III	156	42.6	354	19.5
230-269	IV-V	49	13.4	226	12.5
270-309	V-VI	16	4.3	75	4.1
310-409	≥VI	1	0.3	21	1.1
Total Catch		367		1,814	
Length Range		73-317 mm		64-355 mm	
Mean		175 mm		153 mm	

The sex ratio of 1,447 of these out-migrating grayling was 1.16 males to 1 female and was similar to the ratio found in the spring fishery at the mouth of Shaw Creek (1.19 to 1). As in the upstream catch, males averaged larger than the females, although both sexes of the out-migrants had greater average lengths. Males totaled 777 and ranged in length from 232 to 408 mm, averaging 315 mm. Females totaled 670 and ranged in length from 205 to 389 mm, averaging 290 mm. In 1981 average lengths were smaller; 291 mm for males, 276 mm for females.

Sexing the fish by sexual characteristics became more difficult toward the end of June as time after spawning increased. Thus some accuracy was lost. From comparing the sex of tag recaptures (n = 317) collected during weir operations to their ascribed sex at tagging a year earlier, an error percentage was calculated from mismatches and was found to be 4.4% (n=14). The second sexing favored males (57%) over females (29%).

As indicated by 3 years of age and length determinations of out-migrants captured at the weir site (Table 23), the migration consists mainly of adults and subadults (Age Class IV and older), especially in the years 1980 and 1982. These years show a population structure strikingly similar, while in 1981, the population contained roughly 20% more yearling grayling and 20% fewer of the largest adults. As pointed out by Ridder (1982), this structure may have been affected by the large harvest of prespawning adults at the mouth of Shaw Creek and the late breakup and other environmental conditions of 1981.

The principal destination of this postspawning out-migration from Caribou Creek is the Richardson Clearwater River (Ridder, 1981, 1982), and its population structure generally supports what other authors have concluded about recruitment to the similar spring-fed stream, the Delta Clearwater River. Schallock and Roguski (1967), considering the length frequencies of 6,000 grayling captured on hook and line in the Delta Clearwater River, showed that the greatest in-migration to the system occurs in the length range of 215-264 mm. Pearse (1974) stated that the initial recruitment to the Delta Clearwater River occurs at Ages III and IV, based on electrofishing captures. Ridder (1982), in describing the percentage of stocked grayling in four year-classes in the Delta Clearwater River, noted a decline in their percentages when each year-class reached Age Class IV and attributed it to added recruitment of wild grayling to the system at this age class.

This recruitment behavior to spring-fed streams is contingent upon imprinting which occurs after the fish first finds the stream. The observed habit of immatures and subadults accompanying adults on their migration provides one mechanism for this imprinting to occur. It can partially explain the situation in the Delta Clearwater River, where spring-monitoring shows a large immigration of immatures occurring before the adults. Of 721 grayling smaller than 200 mm fin clipped at Caribou Creek in 1981, only 8 (132-237 mm, $\bar{x}$ = 178 mm) were recaptured at the weir in 1982 out of a total of 911 captured in this size range (130-239 mm). It is possible that these marked fish bypassed the pre-and-post spawning migration and migrated directly to a summer feeding area from overwintering areas. Yet this imprinting of immatures does not explain the early April in-migration to the Delta Clearwater River of Age Class I fish.

Table 23. Length frequencies and related age classes of Arctic grayling, post-spawning out-migration, Caribou Creek, June 1980, 1981, 1982.

Length Range (mm)	Related Age Class	6/2-6/12/80* %	6/7-6/19/81** %	6/2-6/20/82** %
70-109	I	2.1	24.6	2.8
110-169	II	11.5	1.8	6.3
170-229	III	5.1	7.4	4.9
230-269	IV-V	20.9	30.4	21.1
270-309	V-VI	27.9	28.1	38.2
310-409	≧VI	32.5	7.7	26.7
Total Catch		1,482	1,755	2,062
Length Range		...	70-400 mm	72-408 mm
Mean		...	223 mm	275 mm

* Fyke trap
** Weir

The Goodpaster River, a large, rapid runoff river (Fig. 1) has long been known to be a source of recruitment to the Delta and Richardson Clearwater Rivers, based on tagging studies conducted in the late 1950's and early 1960's. These studies showed that grayling tagged in the Goodpaster in any one year were most likely to be recaptured in the spring-fed streams in following years (Schallock and Roguski, 1967). Reed (1961) noticed that tagging in 1958 was predominantly (45%) on Age Class II fish, while later recaptures in the Delta Clearwater River were predominantly Age Class V fish, and proposed an age-size concept to explain migration. Later studies showed that the lower Goodpaster, where most of the earlier tagging occurred, is populated predominantly by immature fish of Ages I to IV. (Tack, 1980). Unlike Shaw Creek, a bog-fed stream, Pearse (ADF&G, pers. comm.) found no discernible, prespawning migration into the Goodpaster River from the Tanana River during spring breakup, indicating that adults overwintered in the river. Tack (1980), in studies of intra-stream migration in the Goodpaster in the early 1970's, noted a preference in adults and subadults for upstream migration in May and early June. The question is whether recruitment from the Goodpaster River to spring-fed streams occurs in the same manner as from Caribou Creek, with younger fish following adults in a postspawning migration, or in some other method based on Reed's hypothesis that suggests a genetic determinator and randomness.

On May 19, 1982, 146 grayling were electrofished in the lower Goodpaster River between River Miles 3 and 5. The age frequency of 119 of these fish (Table 24) showed 56% to be Age Class V and older. Electrofishing the same section of river during the last week of June showed only 14% of a sample of 50 to be Age Class V and older (Peckham, ADF&G, pers. comm.). One hundred sixteen of the fish were greater than 200 mm and were tagged. Thirty-six fish could be sexed and the ratio of males to females was 0.44 to 1. Fourteen fish (8 males, 6 females) were classified as ripe, and 19 (3 males, 16 females) were spent. All fish of Age Class VII and older, 81% of Age Class VI, and 30% of Age Class V, were mature. All younger fish were immature.

Recruitment and Tag Recaptures

Recaptures in 1982 of Goodpaster River-tagged grayling totaled nine fish, or 7.8% of those tagged (Table 25) The age and length of these recaptures show mostly adult fish (3 of 4) migrating to the spring-fed streams, and immatures remaining in the river. The recapture sample is small, yet it can be assumed that some subadults followed the adults to the spring-fed streams. Four recaptures were by ADF&G during population estimates in the lower Goodpaster River in late June. Three of these fish (lengths of 226-264 mm, Ages III and IV) showed upstream movement, as they were part (1.4%) of a total catch of 214 grayling made between Miles 15-18. The remaining fish (214 mm, Age II) showed no movement as it was part (1.3%) of 79 fish caught between Miles 3-6. The other five recaptures were reported by anglers: one (240 mm, Age IV) in the Goodpaster River in August; one (318 mm, Age VI) in the Richardson Clearwater River; and three (303 mm, Age VI; 250 mm Age V; 346 mm Age VIII) in the Delta Clearwater River in late June.

Table 24. Age frequency and length of Arctic grayling captured by electrofishing gear, Goodpaster River, May 19, 1982.

Age Class	Number	Percent	Length (mm) Range	Mean
I	2	2	85-106	96
II	3	3	118-132	125
III	27	23	172-213	194
IV	31	26	206-246	217
V	23	19	217-287	257
VI	21	17	240-320	286
VII	6	5	322-358	335
VIII	5	4	316-358	337
IV	1	1	394	394
Total	119		85-394	240

Table 25. Summary of Arctic grayling tagged and recaptured from all sources in the mid Tanana River drainage, 1977 to 1982.

Tagging Location	Year	Number Tagged	Number Recoveries	Recovery Areas: Spring-fed Streams DCR N	RCR N	Clear N	5-Mile N	Shaw Cr. Drainage: Main Stem N	Caribou N	Salcha N	Tanana N	GP N	Other N
Shaw Creek:													
Main Stem:	1979	156	22	2	7	0	0	2	10	0	1	0	
(0-7 mi):	1980	94	20	0	8	1	0	0	8	1	2	0	
Rapids Cr:	1979	22	3	0	1	0	0	2	0	0	0	0	
Caribou Cr:	1980	1,283	467	4	162	5	3	109	179	4	1	0	
	1981	1,323	392	0	109	1	3	35	239	2	2	0	1**
	1982	2,001	175	0	98	3	1	15	51	5	0	2	
	Total	4,879	1,078	6	385	10	7	163	487	12	6	2	1
Delta Clearwater R.	1977-1982	2,422	340	327	3	0	0		0	0	4	0	2*
Richardson Clearwater R.	1980	30	15	0	8	1	0	2	4	0	0	0	
Volkmar R.	1980	112	12	12	0	0	0	0	0	0	0	0	
	1981	199	4	4	0	0	0	0	0	0	0	0	
Goodpaster R.	1982	116	9	3	1	0	0	0	0	0	0	5	
		7,759	1,456	348	397	11	7	169	491	12	10	7	3

* 1 Volkmar R., 1 Dry Creek

** Little Salcha River

The recapture locations of these Goodpaster grayling (Table 25) are the same as those found in the earlier studies (Table 26), predominantly in the Goodpaster River, followed by the Delta Clearwater River.

Those recaptures in one location, the Delta Clearwater River, when used as an exploitation rate (recaptures divided by total tagged) can be used as a general indicator of the level or extent of recruitment and compared to those from Caribou Creek and the Volkmar River. Since all Delta Clearwater recaptures (Table 25) were by anglers, the exploitation rates of all three streams can be compared. The tag reporting rate by anglers would have to be assumed constant, not only in each year, but also for the different colored tags used (red, yellow, and white). Also, angler pressure would need to be relatively constant as it was for the years 1980-1982 (Table 17).

Based on exploitation rates, Caribou Creek offers the least recruitment of the three streams to the Delta Clearwater River, and Volkmar River the most. Of the 4,607 grayling tagged in Caribou Creek since 1980 only four tags, 0.09% of the total, have been recaptured in the Delta Clearwater River over the past 3 years; one each in 1981 and 1982, and two in 1980 (Table 25). The Volkmar River, a bog-fed stream like Caribou Creek, had 5.1% (n=16) of its 311 tags recaptured in the Delta over a 2-year period. Roughly 50% (n=149) of these Volkmar tags were placed on fish out-migrating from the river in the fall of 1981, and thus, are not directly comparable to the spring tagging efforts in the other two systems. Of the 112 fish tagged in the Volkmar in the spring out-migration in 1980, 8% were recaptured in the Delta Clearwater River in the same year. This percentage compares to the 2.6% of the Goodpaster tags recaptured in the Delta Clearwater River in 1982. In two earlier studies (Table 26) where Goodpaster tagging was conducted over the entire summer, Delta Clearwater recapture percentages were 1.2 and 0.7%.

These exploitation rates and other percentages based on recaptures in other streams are inherently small and their differences appear minimal. This is misleading since recaptures of tagged grayling in the study area have been historically low. Of 14,661 grayling tagged over a 7 year period, 1960-1966, only 10.4% were recaptured by the end of the study (Table 26). Of 2,288 fish tagged between 1952 and 1958, the rate was 9.7% (Table 26). In the present study, recaptures by ADF&G have totaled 12.9% of all Shaw Creek tags (Table 27).

The recapture percentages of this study have to be viewed within an order of magnitude. The difference in first year recaptures between the Goodpaster and Volkmar River tags was 5.4%. The number of reported Delta Clearwater recaptures of Goodpaster tags would have to increase by 7 or 233% to have a rate equal to the Volkmar River.

Grayling tagged in Caribou and Shaw Creeks since 1979 have totaled 4,879, and 667 (13.7%) were recaptured both by anglers and ADF&G in 1982. The majority of the recaptures (n=442) came from the drainage itself: 68 from anglers in lower Shaw Creek and 374 from the Caribou weir. The Richardson Clearwater River had recaptures totaling 208: 76 from ADF&G population monitoring, 83 from the voluntary resident creel census and 49 from angler mail returns. Other locations (all recaptures were by anglers) included

Table 26. Grayling tagged and recovered mid-Tanana River drainage; A) 1952-1958, B) 1960-1966.

Tagging Areas	Number Tagged	Recovered No.	Recovered %	Area of Recapture: Goodpaster No.	Goodpaster %	Delta Clearwater No.	Delta Clearwater %	Richardson Clearwater No.	Richardson Clearwater %	Shaw Creek No.	Shaw Creek %	Other No.	Other %
A)													
Goodpaster R.	1,858	187	10.1	156	83.4	22	11.8	6	3.2	0	0	3[1]	1.6
Delta Clearwater R.	213	20	9.4	0	0	16	80.0	1	5.0	1	5.0	2[2]	10.0
Richardson Clearwater R.													
Shaw Creek	74	7		0	0	2	28.6	1	14.3	4	57.1		
Tanana at Big Delta	143	9		4	44.4	3	33.3	1	11.1	0	0	1[3]	11.1
Totals	2,288	223	9.7%	160	71.7	43	19.3	9	4.0	5	2.2	6	4.2
B)													
Goodpaster R.	6,097	320	5.2	237	75.0	45	14.1	38	11.9	0	0		
Delta Clearwater R.	6,539	836	12.8	3	0.5	831	99.2	2	0.3	0	0		
Richardson Clearwater R.	1,812	356	19.6	1	0.3	8	2.2	343	96.4	4	1.1		
Shaw Creek	213	12	5.6	0	0	5	41.7	5	41.7	2	16.6		
Totals	14,661	1,524	10.4	241	15.8	889	58.3	388	25.5	6	0.4		

1) Tanana River at Big Delta n=2, 5 Mile Clearwater River, n=1
2) Sam Creek and Clearwater Lake, one each
3) Unknown

Table 27. Number of Arctic grayling recaptured* and tagged in Shaw Creek, Caribou Creek and Richardson Clearwater River, 1979-1982. In parentheses is percentage of tags in respective samples.

Year of Tagging	Location of tagging	Number Tagged	Location Recaptured and Number								
			Shaw, April			Caribou, June			Richardson Clearwater, July		
			1980	1981	1982	1980	1981	1982	1980	1981	1982
1979	Shaw	156	...	2(0.3)	2(0.5)	3(0.2)	4(0.3)	3(0.1)	0	1(0.5)	1(0.2)
1980	Shaw	94	...	3(0.5)	0(0)	...	5(0.4)	3(0.1)	1(0.6)	1(0.5)	2(0.4)
	Richardson	30	...	0(0)	1(0.3)	...	0(0)	4(0.2)	1(0.6)	1(0.5)	2(0.4)
	Caribou	1,283	...	22(3.7)	18(4.6)	...	46(3.3)	91(3.8)	15(8.8)	9(4.8)	24(4.4)
1981	Caribou	1,323	...	...	19(4.8)	...	17(1.2)**	222(9.3)	...	6(3.2)	20(3.9)
1982	Caribou	2,001	...	...	...	...	...	51(2.1)**	...	...	27(5.0)
Totals				27(4.5)	40(10.2)	3(0.2)	72(5.2)	374(15.6)	17(10.0)	18(9.5)	76(14.0)
Sample Size				600	392	1,294	1,395	2,390	170	189	542

* Recaptures represent only those recorded during population sampling by ADF&G (Richardson Clearwater River electrofishing, Shaw Creek spring creel census, and Caribou weir (only fish >200 mm in sample size).

** Recaptured shortly after tagging.

the Delta Clearwater River (1), Clear Creek (6), Five Mile Clearwater River (1), Salcha River (5), Tanana River at Big Delta (1), Goodpaster River (2) and the Little Salcha River (1). With the exception of the last two locations, which are new, all locations were the same as previous years (Ridder 1982) and in roughly the same percentages. A summary of all recaptures since 1979 (n=1,078) is included in Table 25. Of interest in this table is that all Delta Clearwater River recaptures came from the same tagging year.

Not all grayling migrating out of Caribou Creek in 1982 left the drainage. During a June 23 trip to Gilles Creek, the second major tributary to Shaw Creek located at approximately Mile 44, a total of 33 grayling were captured by hook and line, including 3 tags (9.1%) which were all spent adult males. Two of these recaptures had been caught previously on June 6 at Caribou Creek, representing 1980 and 1982 tagging. The other recapture was also tagged in 1980. Twenty-three of the fish were autopsied and all 20 adults had spawned. Three males were still running milt. The male to female ratio was 0.92 to 1. On a June 4 trip to Gilles Creek no fish were found during visual and hook and line surveys in three locations; at the mouth, and at the drainage's mid and upper levels. These surveys indicate the creek was not a preferred spawning area in the Shaw Creek drainage.

While recaptures as exploitation rates are useful in describing various streams' recruitment to the Delta Clearwater River, recaptures taken as a percentage of a sample are more suited in describing Caribou Creek's recruitment to the Richardson Clearwater River and Shaw Creek populations. Table 27 presents a 3-year summary of numbers and sample percentages of fish tagged in the Shaw Creek drainage and recaptured there and in the Richardson Clearwater during sampling by ADF&G from 1980-1982. The tag compositions of the three samples are considered comparable, even though the samples are geographically and temporally distinct. The biases of the capture methods in Shaw Creek and the Richardson Clearwater River produced samples with similar length compositions that agree with those of the population tagged at Caribou Creek.

Considering the number of fish tagged in each year and location, the second and third years of recapture percentages of each year of tagging are remarkably similar among all three locations, especially those of Caribou fish tagged in 1980. While strongly indicating all three locations shared the same population, there are some interesting inconsistencies in the data. The sample percentages of 1980 and 1981 Caribou tags, 3.3 and 9.3% respectively, recaptured one year later at their tagging site, are distinctly different. Unlike the percentages of 1980 tags, in all samples the 1981 percentage is approximately twice as great as those found in the Shaw Creek sample (4.8%) and the Richardson sample (3.9%). If grayling home to spawning areas as strongly as they do to summer feeding areas, a greater recapture percentage would be expected in Caribou sampling than in the other locations.

Another inconsistency in the data that relates to migrations and behavior, and hence recruitment of grayling, again involves the recapture percentages of 1980 Caribou tags. If tags are evenly distributed in a population, their percentage in samples should decline in succeeding year due to recruitment of new individuals and mortality. The percentage of 1980 tags

from all three locations are remarkably similar in samples drawn in the second (3.3 to 4.8%) and third years (3.8 to 4.6%) after tagging. If more individuals of the marked segment were present in the populations in the third year than the second, the data could infer a cyclical pattern in spawning frequency and homing to feeding areas.

These inconsistencies do not necessarily detract from the impression given by these tag recoveries that the populations in these samples are closely connected, but they do make it difficult to quantify.

While the recoveries of 1981 tags conform to expectations, those of the 1980 tags do not and complicate determination of recruitment levels. Future tag recoveries form the 3 years of tagging may clarify the situation.

Scale Analysis:

The Commercial Fish Division, Alaska Dept. of Fish and Game, has successfully employed discriminant function analysis of scale patterns in the separation of Alaska salmon stocks in mixed-stocked fisheries (Krasnowski and Bethe, 1978). Ridder (1982) described the technique and presented findings and discussion on the analysis of six scale variables from Age Class III Arctic grayling collected from the Goodpaster and Volkmar Rivers and Caribou Creek (Fig. 1). These waters are all known spawning areas for grayling utilizing the Delta Clearwater River.

The application of the discriminating functions developed from the three spawning streams to a sample (n=98) of Age Class III grayling collected from the Delta Clearwater River in 1981 gave classifications that were opposite, in the case of Caribou Creek, to those indicated by recent tagging studies (Table 25). As seen in Table 28A, the three-way classification of the unknown (Delta Clearwater) sample gave Caribou Creek as the origin of 63.3% of the unknown, with the Volkmar River comprising 29.6% and the Goodpaster River 7.1%. In the tagging studies, recaptures by Delta Clearwater anglers of grayling tagged in Caribou Creek amounted to only 0.09% of the number tagged (n = 4,607); of Volkmar River tags, recaptures in the Delta clearwater amounted to 4.8% of the total tagged (n = 311); of Goodpaster River tags, anglers returned 2.6% of the total (n = 116).

Excluding Caribou Creek from the formation of the discriminating function because of its low contribution to the Delta Clearwater grayling stocks as indicated by tagging and its low test classification accuracy (55.3%), gives the two-way classification matrix shown in Table 28 B. This two-way discriminating function gave an overall accuracy in classification of 84.5%, which is greater that that of the three-way (67.5%). In the function's analysis of the unknown sample, the Goodpaster River represented 51% of the sample and the Volkmar River 49%.

The discrepancy between the findings from scale analysis and tagging is difficult to explain. As stated by Ridder (1982) classification accuracies could be improved by multiple procedures requiring larger sample sizes, additional statistical programs, and a larger set of variables, including distances between circuli, as well as annuli and fish lengths. These refinements in technique could improve the classification accuracy of the

Table 28. Test and unknown (Delta Clearwater River) classification matrices from discriminant analyses of Age III Arctic grayling (1981) using A; three-way test and B; Two-way test (from Ridder, 1982).

Actual Group of Origin	Sample Size	Classified Group of Origin			Overall Test Accuracy
		Goodpaster	Volkmar	Caribou	
A)					
Goodpaster	43	0.744	0.070	0.186	0.675
Volkmar	67	0.104	0.716	0.179	
Caribou	47	0.255	0.192	0.553	
Unknown	98	0.071	0.296	0.633	
B)					
Goodpaster	43	0.907	0.093		0.845
Volkmar	67	0.194	0.806		
Unknown	98	0.510	0.490		
Caribou	47	0.681	0.319		

Underlined proportions represent proportion of original sample correctly classified by the discriminating function.

Caribou Creek sample and then, possibly, that of the unknown sample. Yet the problem may not be in statistical technique as much as in the behavioral biology and in the sampling of the local grayling populations. In the above classification matrices, Caribou Creek may have simply functioned in the role of an impersonator. There are other grayling spawning systems upstream of the Delta Clearwater River, such as the Healy and George Lake systems, that could provide recruitment to the Delta's population. Additionally, there is the unknown behavior of the Age Class III grayling used in the analysis. The lack of recaptures of fin-clipped, immature grayling in Caribou Creek may also point to a randomness in selecting yearly feeding areas which would put fish of the selected age class in systems other than their natal ones. For scale analysis to work, the origin of the samples used in formulating the discriminating function must be known. Perhaps the best way to accomplish this would be to sample Age 0 fish from spawning streams in late fall and the unknown sample the following spring. While the present analysis is inconclusive, the applicability of the technique is still considered to have promise.

Grayling Stock Enhancement

In 1982, the four year-classes (1975-1978) of pond-reared grayling stocked into the Delta Clearwater as fingerlings were represented by Age Classes IV-VII. Their representation in the population was based on scale samples from the index and creel census sampling and is shown in Table 29. These age classes made up 88% of the two combined samples. Pond-reared fish comprised 27% of these age classes and 25% of the total combined samples. In 1981, the sampling showed a 24% contribution. These percentages may be high due to the increasing difficulty of accurately aging older grayling from scales. The mean lengths of some pond-reared fish in Age Classes VI and VII shown in the table are less than those of stream-reared fish. At stocking and in previous reports (Peckham and Ridder, 1980, 1981 and 1982) pond-reared fish were consistently larger than their wild cohorts.

The composition of these pond-reared grayling in the total sample and in their respective year-classes from 1979 to 1982 is shown in Table 30. The similarity of their compositions in the yearly samples contradicts their compositions in their four year-classes, which are seen to decrease in succeeding years. Though possibly due to straying or higher mortality rates, this contradiction is felt due to the manner of grayling recruitment to the river. Schallock and Roguski (1967) and Pearse (1974) have reported that grayling of Age Classes III and IV represent a large recruitment "boost" to the population in the Delta Clearwater River, and thus could affect the decline in pond-reared compositions in older age classes. This decline, coupled with the increasing percentage of the four year-classes in the sampling, has resulted in similar impositions in the total samples.

Another interpretation of the decline of pond-reared fish in older age classes, or simply an added effect, is a higher fishing mortality at younger ages. Table 31 is a summary of the estimated harvest of pond-reared grayling for the years 1977 to 1982 and follows the method used by Ridder (1982). While these fish first enter the fishery at Age Class II, the largest harvests of each plant occur at Age Classes III and IV. The predominant age classes found in creel sampling are Age Classes IV and V (Table 19).

Table 29. 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, 1982.

Year Class	Age	No. Circuli	Sample						Totals	
			Index			Creel				
			n	%	Mean Length	n	%	Mean Length	n	%
1978	IV	<10	13	62	260	19	68	269	32	65
		≥11	8	38	271	9	32	276	17	35
		Total	21		261	28		271	49	
1977	V	<10	17	85	292	20	83	285	37	84
		≥11	3	15	305	4	17	295	7	16
		Total	20		294	24		287	44	
1976	VI	<10	8	73	334	12	60	317	20	65
		≥11	3	27	316	8	40	308	11	35
		Total	11		329	28		314	31	
1975	VII	<10	3	75	348	5	83	353	8	80
		≥11	1	25	397	1	17	352	2	20
		Total	4		360	6		353	10	
	I-XI	≥11	15	27		22	24		37	25
		Total*	56			92			148	

* All totals and corresponding percentages include other age classes.

Table 30. Composition of 4 year-classes of pond-reared Arctic grayling, 1975-1978, stocked into the Delta Clearwater River as percentage of sub-samples of the 4 year classes and as percentage of total samples * 1979-1982.

Year	Sample Size	% of 4 yr-classes in sample	Respective age class	Pond-reared GR (%)	
				in yr classes	in total sample
1979	377	37	I-IV	62	23
1980	313	75	II-V	40	31
1981	233	83	III-VI	29	24
1982	148	88	IV-VII	27	25

* Samples in each year from indexing and creel censusing.

Table 31. Estimated harvests of year classes of pond-reared Arctic grayling transplanted into the Delta Clearwater River, 1977 to 1982.

Harvest Year	Year Class 1975	1976	1977	1978	Big Lake*	Totals
1977	182					
1978	275	145				
1979	503	841	132			
1980	141	868	443	112	59	
1981	82	318	256	388	9	
1982	37	335	136	399	2	
Totals	1,220	2,507	967	899	70	5,663
No. Stocked	9,100	12,467	6,684	6,558	651	35,460
Harvest as % of no. Stocked	13.4	20.1	14.5	13.7	10.8	16.0

* Big Lake was the source of 1978 year-class of grayling reared for 15 months before transplanting. All fish were tagged and estimates are based on tag recaptures and a tag reporting rate by anglers of 0.456.

The cumulative estimated harvest of pond-reared grayling by 1982 was 16% of those originally transplanted into the Delta Clearwater River (Table 31). This return to the fishery can be compared to the return of stocked rainbow and coho salmon from Quartz Lake located 10 miles northwest of Delta Junction. Of 33,000 rainbows of the Swanson River (Alaska) strain stocked in 1979 as fingerlings, 12.3% have been harvested by anglers as of 1982; of 150,000 coho salmon stocked as fingerlings in 1979, 33% have been harvested. (Richard Peckham, ADF&G pers. comm.)

In 1979, 651 Age I grayling pond-reared for 15 months in Big Lake (average length of 247 mm) were stocked into the Delta Clearwater River at Mile 8 in late September and all were tagged. Although first year recaptures of these fish in the Delta Clearwater by anglers were similar to returns of stream-reared grayling tagged one year previously, recaptures in the second year were much below those of the wild fish (Ridder, 1982). In 1982, no third year recaptures of Big Lake fish were reported by anglers or sampled by ADF&G in the Delta Clearwater. Again, this was below the recapture rate (percent of total tagged) for wild grayling tagged 3 winters previously at Mile One Slough (Ridder, 1982). By 1982, 3 years of recaptures of Big Lake grayling by anglers have totaled 30 or 4.6% of those originally stocked. This rate compares to the those found from recaptures of wild grayling that ranged from 9.5 to 17.2% and averaged 13.5% during a similar time interval (Ridder, 1982).

The total estimated 3 year harvest of Big Lake grayling was 10.8% of those stocked (Table 31). This harvest rate compares to those of the fingerling plants over the same interval that range from 10.5% for the 1975 plant to 14.9% for the 1976 plant, with an average of 12.9%. Although these 3 year rates are similar, the majority (84%) of the harvest of Big Lake fish came in the first year after stocking, while those of the fingerling plants came during the third and fourth years.

One Big Lake grayling was recaptured in 1982 during index sampling of the Richardson Clearwater River. Its fork length was 370 mm and it was the first to be recaptured outside the Delta Clearwater River.

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