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LAKE AND STREAM INVESTIGATIONS

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DISTRIBUTION, ABUNDANCE, AND NATURAL HISTORY OF THE ARCTIC GRAYLING IN THE TANANA DRAINAGE

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TABLE OF CONTENTS

Study: G-III LAKE & STREAM INVESTIGATIONS Page

Job: G-III-G The Life History and Population Dynamics of Exploited Stocks of Arctic Grayling Associated with the Delta and Richardson Clearwater Rivers
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Abstract. 1
Key Words 2
Background. 2
Recommendations 5
Management 5
Research 6
Objectives. 6
Techniques. 6
Findings. 7
Population Monitoring of Clearwater Streams. 7
Indexing of Relative Abundance 7
Delta Clearwater River creel census. 16
Population Structure: Age, Length, and Weight. 19
Monitoring of Spawning Streams 25
Grayling Population Enhancement. 45
Literature Cited. 57
Acknowledgements. 58

LIST OF TABLES AND FIGURES

Figure 1. Tanana-Clearwater study area. 3
Table 1. List of common names, scientific names, and abbreviations of fishes. 4
Table 2. Summary of fish captured and catch rate (CPUE) for grayling, Mile One Slough, Delta Clearwater River, 1976-82, 1984 8
Table 3. Length frequencies and related Age Classes of Arctic Grayling captured in Mile One Slough, Delta Clearwater River, Spring 1978-82 and 1984. Numbers in parentheses are age compositions derived from scale and mark analysis 9
Figure 2. Relation of the CPUE of grayling captured in the spring at Mile One Slough to the CPUE of grayling captured during July electrofishing 2 years later. Spring data from 1976-82; July data from 1978-84. . . . 10
Table 4. Capture rates for Arctic grayling during index sampling, Delta Clearwater River, 1973, 1975-84 12
Table 5. Capture rates for Arctic grayling and round whitefish during index sampling, Richardson Clearwater River, 1977-84 13
Figure 3. Relation of the index of relative abundance of miles 4-13 Delta Clearwater River to angler CPUE (grayling harvested per hour). A: 1976-84. B: 1976-80, 1982, 1984. 14

TABLE OF CONTENTS (CONT'D) Page

Table 6. Arctic grayling abundance estimates, fish per mile, and related statistics from a 2-mile section of the Richardson Clearwater River, July 1982-84 15
Table 7. Creel census summary, boat and shore anglers combined, Delta Clearwater River, May 20-September 3, 1984. Numbers in parentheses are for completed trips only . . 17
Table 8. Comparison of censused grayling catch from the Delta Clearwater River, 1953-84. Numbers in parentheses denote completed angler trips 18
Table 9. Summary of statistics from creel censusing the Delta Clearwater River Arctic grayling fishery, 1978-84 Numbers in parentheses are data from completed trip interviews. 20
Table 10. Age frequency and length of Arctic grayling captured during index sampling, Delta Clearwater River, July 9-10, 1984 21
Table 11. Age frequency and length of Arctic grayling captured during index sampling, Richardson Clearwater River, July 11, 1984 22
Table 12. Age frequency and length of Arctic grayling harvested by anglers, Delta Clearwater River, 1984. 23
Table 13. Percent age composition of Arctic grayling electrofished in the Delta Clearwater River, 1975-84 24
Table 14. Percent length frequency of Arctic grayling electrofished in the Delta Clearwater River, 1973, 1975-84 26
Table 15. Percent age composition of Arctic grayling caught by anglers, Delta Clearwater River, 1977-84 27
Table 16. Percent length frequency of Arctic grayling caught by anglers, Clearwater River, 1973, 1977-84. 28
Table 17. Percent age composition of Arctic grayling electrofished in the Richardson Clearwater River, 1980-84. . . 29
Table 18. Percent length frequency of Arctic grayling electrofished in the Richardson Clearwater River, 1980-84. . . 30
Table 19. Summary of catch statistics and estimates from the Shaw Creek Spring Grayling Fishery, 1974-75, 1981-84 31
Figure 4. Caribou Creek Water levels at weir, 1981-84 34
Table 20. Length frequencies, related age classes and catch rates of Arctic grayling, post-spawning out-migration, Caribou Creek, June 1980-84 35
Table 21. Age frequency and length of post-spawning adult Arctic grayling captured in Caribou Creek, June 5-7, 1984. . . 36
Table 22. Number of Arctic grayling in 20-mm length groups sampled at Shaw and Caribou Creeks, 1984. 38
Table 23. Percentage of Arctic grayling exhibiting mouth damage in catches from Caribou Creek weir and electrofishing the Delta and Richardson Clearwater Rivers, 1980-84. Sample sizes are in parentheses 39
Table 24. Percentage of tagged Arctic grayling in samples collected from Shaw Creek, Caribou Creek, and Richardson Clearwater River, 1980-84. 41

TABLE OF CONTENTS (CONT'D) Page

Table 25. Population estimates for Arctic grayling greater than 150 mm in two sections of the Goodpaster River, June 27-29, 1984. 43
Table 26. Comparison of population estimates for Arctic grayling (greater than 150 mm) in the lower Goodpaster River, 1973-84. 44
Table 27. Age frequency and length of Arctic grayling captured in sections 2 and 6 of the Goodpaster River, June 27-28, 1984. 46
Table 28. Length frequencies and related age classes of Arctic grayling captured in the lower Goodpaster River, June 1975-84. 47
Table 29. Summary of Arctic grayling stocked into the Delta Clearwater, 1984. 49
Table 30. Length, weight, condition factor, and survival of pond-and hatchery-reared Arctic grayling stocked as 4-7-day-old fry on June 11, 1984 and sampled in late September 1984. 50
Table 31. Number, length, and composition of Arctic grayling stocked into the Delta Clearwater River as fingerlings in 1983 and recaptured at Mile One Slough, Spring 1984 53
Table 32. Percent composition in successive age classes of four-year classes of Arctic grayling stocked into the Delta Clearwater River, 1976-84. In parentheses are sample sizes for each age class 55
Table 33. Composition of four year-classes, 1975-78, of pond-reared Arctic grayling stocked into the Delta Clearwater River as percentage of subsamples of the four year-classes and as percentage of total samples, 1979-83 56

Volume 26 Study G-III-G

STATE OF ALASKA

Bill Sheffield, Governor

Annual Performance Report for

THE LIFE HISTORY AND POPULATION DYNAMICS OF EXPLOITED STOCKS OF ARCTIC GRAYLING ASSOCIATED WITH THE DELTA AND RICHARDSON CLEARWATER RIVERS

by

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Job Title: The Life History and Population Dynamics of Exploited Stocks of Arctic Grayling Associated with the Delta and Richardson Clearwater Rivers

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ABSTRACT

This project monitors Arctic grayling, *Thymallus arcticus* (Pallas), populations in two spring-fed tributaries of the mid-Tanana River drainage of interior Alaska. It includes the assessment of a grayling stocking program and the monitoring of two grayling spawning streams and associated life history of the above populations.

In 1984, the monitoring of the Delta Clearwater River indicated a population abundance similar to the previous 2 years and continuing the decline from the highs of 1979-81. Age and length compositions obtained from electrofishing and creel censusing indicated continued poor recruitment of younger age classes, but the catch rate from sampling the spring in-migration showed a large increase over sampling in 1982. The percentage of Age Class I was the highest yet found. In 1984, the sport fishery had a catch rate of 0.33 grayling per hour, the lowest in 10 years.

The 1984 electrofishing index for the Richardson Clearwater River showed a continuing decline in population abundance from the high recorded in 1982.

Harvest and pressure estimates for the Shaw Creek spring fishery were 913 grayling harvested and 2,292 angler-hours, the lowest in 6 years. Length compositions showed poor recruitment to the fishery.

Weir capture data from the postspawning migration of grayling from Caribou Creek include age and length compositions, sex ratios, tag loss and recapture rates, hooking damage rates and population estimates. Poor recruitment of prespawners was indicated. The catch rate of adult spawners was similar to 1983. The 1984 Petersen population estimate for the lower Goodpaster River was 510 ± 165 grayling per mile, and 82% greater than the 1982 estimate. Length compositions indicate a strong 1983 year class. Electrofishing catch rates and observations on an aborted egg take in the Goodpaster River in 1984 are also presented.

Four year classes (1975-78) of pond-reared Arctic grayling stocked into the Delta Clearwater River composed 8% of the 1984 electrofishing and creel samples. Numbers, lengths, and composition of grayling stocked in the Delta Clearwater River in 1983 and recovered in 1984 are presented.

The growth and survival rate of grayling fingerlings in five rearing ponds and Clear Hatchery in 1984 are presented. A total of 18,531 grayling was stocked into the Delta Clearwater River in 1984.

KEY WORDS

Arctic grayling, relative abundance, creel census, bog-fed systems, interior Alaska, migrations, age and length compositions, river stocking, tag loss, spring-fed systems, survival.

BACKGROUND

The Delta and Richardson Clearwater Rivers are two of the better-known spring-fed tributaries of the Tanana River of interior Alaska. They are located near Delta Junction, 100 mi southeast of Fairbanks, near the middle of the drainage (Fig. 1). They are characterized not only by their pristine water quality and nearly constant temperature and discharge profiles, but also by the unique mixed-stock nature of their Arctic grayling, *Thymallus arcticus* (Pallas), fisheries. With no significant spawning or overwintering of grayling, the streams afford only summer feeding areas for predominantly adult and subadult populations (≥ Age IV) that are unique to each stream. These populations represent stocks that spawned or reared in a number of the area's rivers and creeks. The Goodpaster and Volkmar Rivers and Caribou and Rapids Creeks (Fig.1) are known spawning and recruitment sources. In respect to the Delta Clearwater River and in general to other spring-fed systems, juvenile (Age I-III) and some subadult (Age IV-VI) grayling in-migrate in mid-April directly from overwintering areas in the Tanana River and represent the first recruitment (imprinting) to the river. Adults and subadults begin arriving from spawning areas in mid-May and continue into June. This group represents both old and new recruits. Out-migration begins in mid-August and is essentially complete by late November. Due to the migration and recruitment schedules, these populations contribute not only to the Delta and Richardson Clearwater Rivers fisheries, but to others as well.

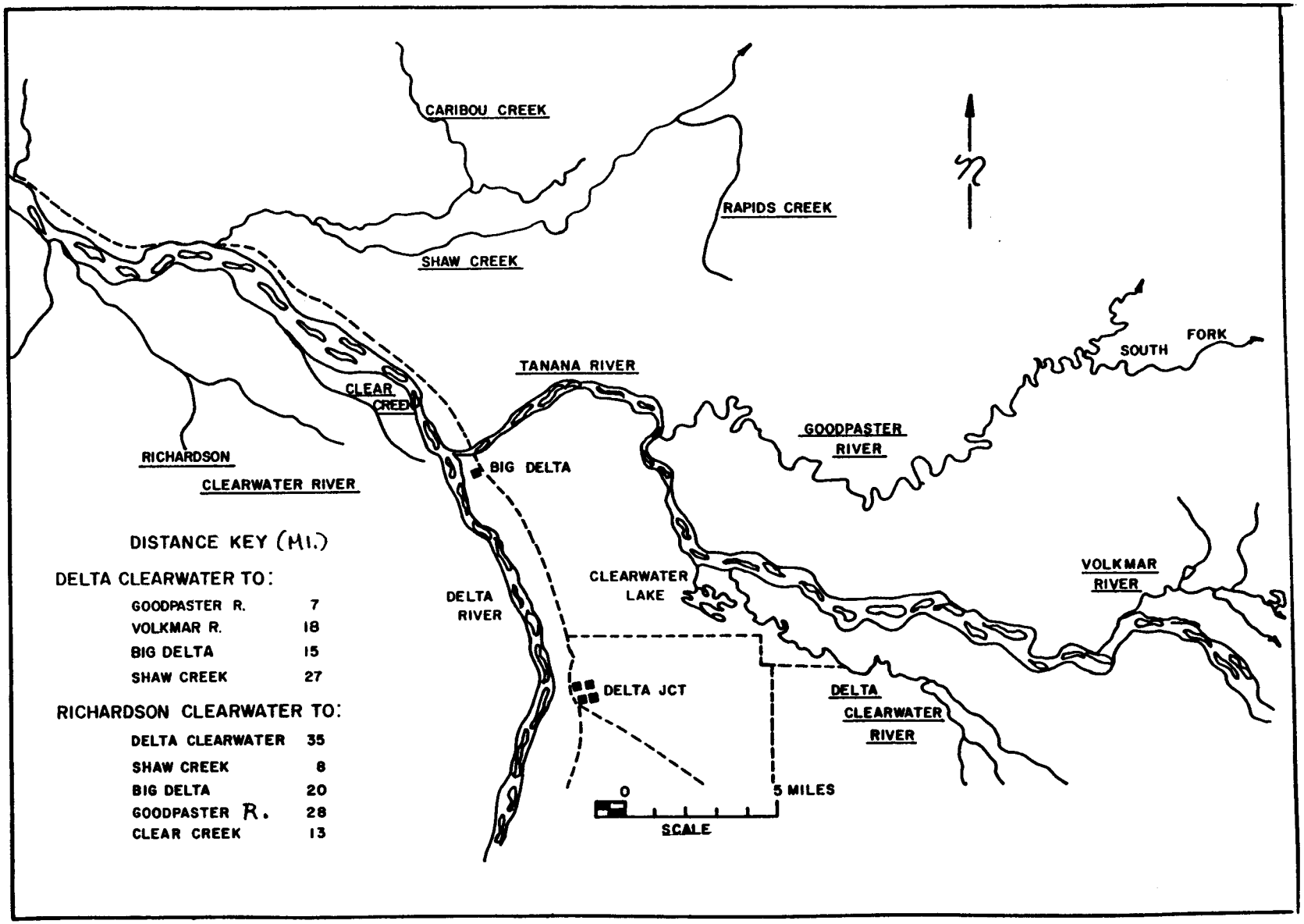

Fig. 1. Tanana-Clearwater Study Area

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

Common Name	Scientific Name and Author	Abbreviation
Arctic grayling	*Thymallus arcticus* (Pallas)	GR
Burbot	*Lota lota* (Linnaeus)	BB
Chinook salmon	*Oncorhynchus tshawytscha* (Walbaum)	KS
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

The Delta Clearwater River is the largest of the spring-fed systems, with a length of 20 mi for its main channel and 6 mi for its north fork. It is the most popular with fishermen and other recreationalists due to its road access, state campground and good grayling fishing. The mean length of its grayling (300 mm) is the largest of road-accessed summer fisheries in the Interior. As such, it is one of the largest grayling fisheries in the state, with a 7-year annual average of 5,929 person-days (14,823 hours) of angling pressure and a harvest of 6,376 grayling (Mills, 1984). It is also the first, and until 1984, the only indigenous grayling fishery in the state to be enhanced by stocking. In response to low population estimates, 400,000 fry, 34,438 pond-reared fingerlings and 1,022 pond-reared catchables were stocked from 1974 to 1979 in an experimental program. Assessment of the fingerling plants showed an average annual contribution to the sport harvest of 25% and a rise in catch rate from 0.54 grayling per hour to 0.79 for the years 1978 to 1981.

Of all the Interior spring-fed systems, the Delta Clearwater's drainage is the most highly impacted by human development. Agriculture in the form of large-scale grain production lies along its entire southern flank and surrounds its headwaters, residential development occurs along 4 mi of its southern bank and summer cabins extend along its lower 8 mi. Specific impacts of this development occurred in 1982 (Ridder, 1983) and 1984 when heavy runoff and newly cleared land combined to impair water quality and, possibly, fish numbers.

The Richardson Clearwater River is a Tanana River tributary entering 35 mi downstream of the Delta Clearwater River. It is among the largest of the clearwater streams, with a main channel 14 mi long. Largely inaccessible to the general public since access is limited to boat or floatplane, the river's human impact stems predominantly from its 19 recreational cabins. The river's grayling fishery offers superb angling. Average pressure and harvest estimates for 3 years are 1,210 person-days and 2,038 grayling. Agricultural and homestead development is proposed for its adjacent lands via state land lotteries.

Additional background information on past studies dating to 1952 may be found in Ridder (1982). Table 1 lists the fish species mentioned in this report.

RECOMMENDATIONS

Management

1. Monitoring of Arctic grayling populations in the Delta and Richardson Clearwater Rivers should be continued by various methods derived from indexing relative abundance and by creel censusing.

2. Transplants of grayling fingerlings into the Delta Clearwater River should continue.

3. Creel censusing the spring grayling fishery at Shaw Creek should continue.

Research

1. A study on the dynamics and early life history of Arctic grayling in a bog-fed spawning stream (Caribou Creek) should be initiated.

2. Refinement of the scale analysis method for stock identification should be initiated using fall collections of Age 0 fish from spawning streams and spring collection of Age I fish from spring-fed streams.

3. The evaluation of various methods of stocking grayling for optimum return to the Delta Clearwater River should be continued.

4. Weir operations during the postspawning migration out of Caribou Creek should be continued for population sampling.

5. Tagging studies should be initiated on postspawning grayling populations in all spawning streams within 40 mi of the Delta and Richardson Clearwater Rivers not previously covered in job reports. The Healy River and Kiana Creek should be first priorities.

6. Radio-tracking of grayling during and after their fall out-migration from the Delta and Richardson Clearwater Rivers should be initiated for determination of overwintering areas.

OBJECTIVES

1. To continue the annual monitoring of the Arctic grayling populations in the Delta and Richardson Clearwater Rivers for the assessment of trends and management programs.

2. To identify, assess and selectively monitor the spawning streams that provide recruitment to the Delta and Richardson Clearwater Rivers' grayling populations.

3. To evaluate various stocking methods and genetic strains of Arctic grayling for optimum return to the fishery of the Delta Clearwater River.

TECHNIQUES

Unless noted in the text, all capturing, sampling and aging techniques and formulae are the same as in previous years (Ridder, 1982, 1983), except that length and age samples were collected from every second fish during the Richardson Clearwater River indexing.

FINDINGS

Population Monitoring of Clearwater Streams

Monitoring of the early in-migration of juvenile grayling to the Delta Clearwater River took place, as in past years, at Mile One Slough, a side slough of the Tanana River entering the Clearwater at Mile 1 (Ridder, 1983). In 1984, the fyke trap was affixed to a stationary, covered holding pen and was fished continuously from April 16 to May 11 (25 days). It was emptied every 48 hours with the exception of weekends. The fishing time was the longest to date due to delayed silting and water level rise of the Tanana River, which has typically ended the trapping. A summary of numbers, species captured and grayling catches per trap day (CPUE) for 1984 and 1976-82 are given in Table 2. The length frequencies and related age classes of the grayling catches for the same years are shown in Table 3.

This monitoring has been used principally to evaluate the grayling stocking program, which is discussed later in this report. The grayling statistics in Tables 2 and 3 include the five year classes of these stocked fish (1975-78, 1983). The CPUE has been computed for both the total catch and the estimated catch of wild fish. The latter rate was found by subtracting numbers corresponding to the percentages of stocked fish of all year classes found by scale and mark analysis mentioned in this and earlier reports (Peckham and Ridder, 1979; Ridder, 1980-83).

The 1984 catch rates showed a large increase over those found in the last monitoring in 1982. Depending upon the specific rate, they either approached (total catch) or exceeded ("wild" catch) the average values found in all past years (Table 2). In an ideal population, the abundance of immature or sub-catchable fish would be a reliable indicator of the abundance of older, catchable fish in future years. Due to complex migrations and recruitment strategies, the Delta Clearwater River does not have such a population. Past studies (Reed, 1961; Pearse, 1974; Ridder, 1983) have suggested Age Classes III-V make up the first and largest recruitment to its fishery. If the spring catch rates from 1976-82 are indicative of the first three age classes, and the July indexing catch rates 2 years later (1978-84) are representative of Age Classes III-V, there is a slightly significant correlation ($r = 0.791$, $p < 0.05$) between the two (Fig. 2).

The composition of the catch in 1984 (Table 3) showed the highest percentage of Age Class I yet found, even when the proportion of stocked fish (18%, this report) is subtracted. Since the catch of this age class represents the first recruitment of any year class to the river's population, its apparent strength should help reverse the poor recruitment trend found in the younger year classes in 1983 and again in 1984.

Indexing of Relative Abundance

The 1984 indexing of relative abundance of grayling was conducted on July 9 and 10 in the Delta Clearwater River, and on July 11 in the Richardson Clearwater River. The sampling method and gear were the same

Table 2. Summary of fish captured and catch rate for Arctic grayling, Mile One Slough, Delta Clearwater River, 1976-82, 1984.

		1976	1977	1978	1979	1980	1981	1982	1984
GR:	FL < 200 mm	242	757	763	1,016	480	1,179	258	1,560
	FL ≧ 200 mm	159	436	869	140	65	71	33	6
	Total	401	1,193	1,632	1,156	545	1,250	291	1,566
RWF:	FL < 200 mm	8	52	43	279	161	63	36	142
	FL ≧ 200 mm	380	486	953	322	89	48	21	37
	Total	388	538	996	601	250	111	57	179
SS:		318	681	692	1,744	612	2,808	353	3,563
HWF:		6	3	60	74	68	11	5	4
LCI:		442	6	5	12	30	26	11	3
BB:		15	11	8	22	13	35	1	0
NP:		0	0	1	1	1	2	0	0
SSC:		6	8	2	5	1	8	5	9
LNS:		0	2	0	3	15	1	1	8
	Total	1,576	2,442	3,396	3,618	1,535	4,252	724	5,333
Interval		4/20-5/4	4/21-5/5	4/17-5/5	4/16-5/3	4/11-5/2	4/15-5/1	4/21-5/7	4/17-5/11
Days fished		8	8	12	12	21	16	16	25
CPUE[1]: GR		50.1	149.1	136.0	96.3	26.0	78.1	18.2	62.6
CPUE: GR adjusted[2]		NA	NA	87.0	66.5	17.9	73.5	18.2	53.6

[1] Catch per trap day.

[2] CPUE adjusted to exclude fish stocked as fingerlings.

Table 3. Length frequencies and related Age Classes of Arctic grayling captured in Mile One Slough, Delta Clearwater River, Spring 1978-82 and 1984. Number in parentheses are age compositions derived from scale and mark analysis.

Length (mm)	Related Age Class	Percent						
		1978	1979	1980	1981	1982	1984	Mean
70-109	I [1]	11	36 (50)	35 (37)	9 (7)	53	77 (84)	36.8
110-169	II	23	41 (33)	41 (34)	77 (76)	28	21 (14)	38.5
170-229	III	36	16 (10)	18 (19)	12 (14)	12	2 (2)	16.0
230-269	IV	21	5 (5)	5 (8)	2 (2)	6	(<1) (<1)	6.5
270-309	V	8	2 (2)	1 (2)	(<1) (1)	1		2.0
≧310	VI	1	(<1) (<1)			(<1)		0.2
Sample size		1,632	1,156	545	1,250	291	1,566	

[1] Length frequencies for 1978 and 1984 Age Class I exclude most stocked grayling of the 1977, 1978, and 1983 year classes due to their greater average length (Ridder, 1982, 1984).

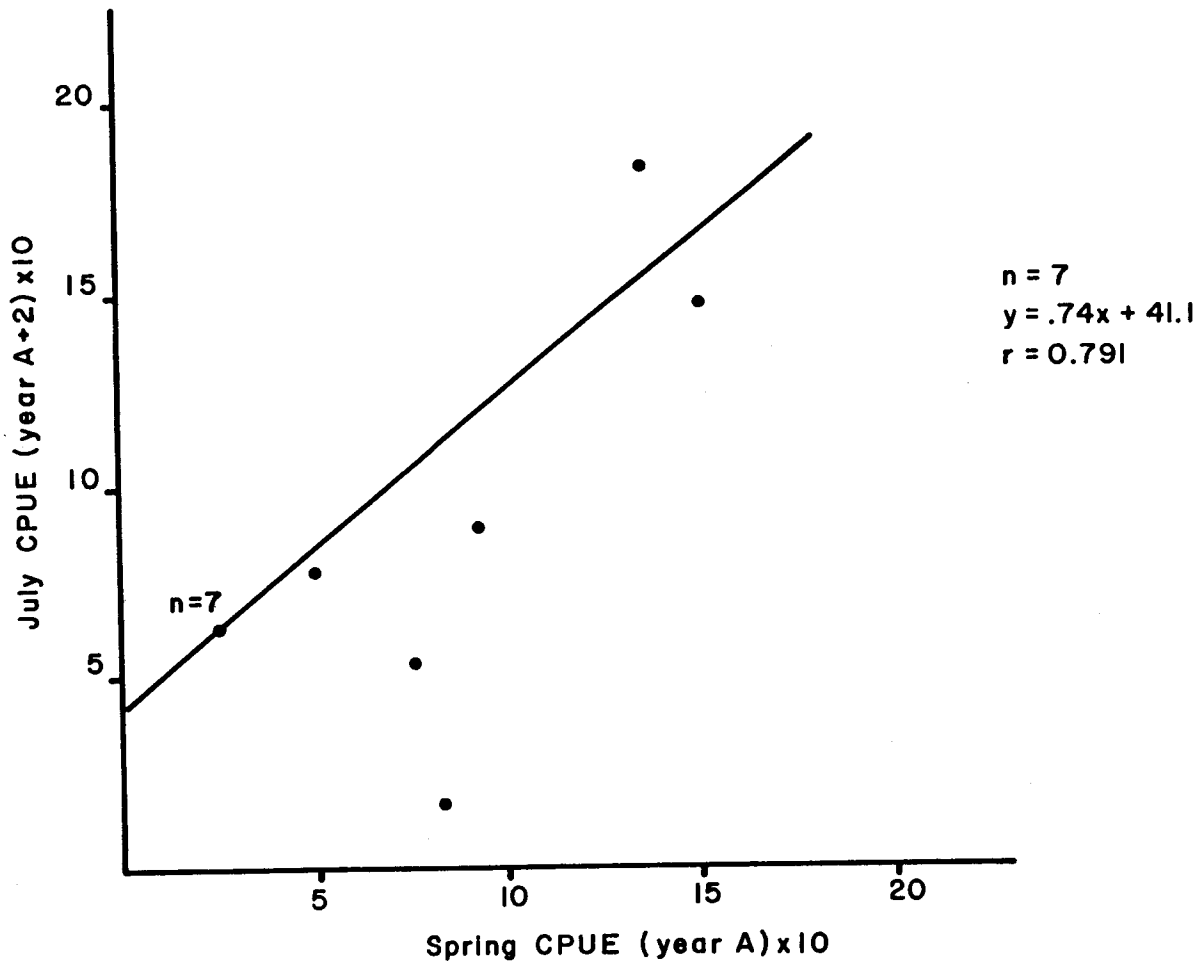

Fig. 2. Relation of the CPUE of grayling captured in the spring at Mile One Slough to the CPUE of grayling captured during July electrofishing 2 years later Spring data from 1982; July data 1978-84.

as in the past 7 years (Ridder, 1983). Weather conditions, which affect electrofishing efficiency, were good over the 2 days of the Delta Clearwater sampling, with the sky totally overcast and no wind. Conditions on the Richardson Clearwater were less than optimal with bright, sunny skies and no wind. A summary of 11 years of indices (electrofishing catch rates) from the Delta Clearwater is given in Table 4; a summary of the 9 years of indices from the Richardson Clearwater is given in Table 5. Both tables divide the rivers into sections which are described by Ridder (1980, 1981).

The Delta Clearwater River's 1984 index, while representing an increase over those found in the previous 2 years, is still similar to the low abundance levels of 1982 and 1983. The 1984 index is predominantly the result of a higher than average catch rate in the river's upper section. It is not considered significant, since repetitive indexing of 3 of the 4 mi of this section in 1983 gave a wide range of rates (29-76, $\bar{x}$ = 46) that appeared to parallel variable weather conditions (Ridder, 1984). The combined catch rate of the two lower sections, 13 fish, was very similar to the decreased rate of 8 fish found in 1983 (11 yr $\bar{x}$ = 43). Repetitive indexing of 3 of the 4 mi of the lowest section in 1983 showed no significant differences in catch rates (3-10, $\bar{x}$ = 6.7; Ridder, 1984). It is within these sections that the majority of angling occurs, and it is significant that angler catch rates, which have fallen in recent years, correlate with these sections' indices over the past 9 years ($r = 0.709$, $p < 0.05$; Fig. 3). The correlation coefficient increases dramatically when 1981 and 1983 data are excluded ($r = 0.937$; Fig. 3).

The 1984 index for the Richardson Clearwater River was the lowest of the past 5 years. As in the Delta Clearwater, an increase in catch rate came in the upper section, while the lower river gave a rate much lower than in the previous 2 years. The wide difference in these latter rates, approximately 100 fish, cannot be attributed to weather conditions, catchability or operating procedures, but is simply due to lower abundance. The same cannot be said for the increase of 17 fish in the catch rate of the upper section, which implies an abundance similar to 1983.

Two additional estimates were conducted for the third year in 1984 on the upper 2 mi of the Richardson Clearwater River (river miles 6.5 to 8.5, from the "lake" to the second tributary) to evaluate the accuracy of the electrofishing index in representing population abundance. A modified Petersen estimate was conducted over a 2-day period, July 11 and 12. A visual estimate was made on July 12, prior to the Petersen recapture run, by two observers standing on the deck of the electrofishing boat. Weather conditions--sunny and calm--were ideal for the visual estimate.

As in the previous years, the visual counts are considered a minimum, as fish in riffle areas went unseen. The 3 years of estimates and related statistics are shown in Table 6.

The electrofishing index, or catch rate, from one pass through this section of the river accurately reflects the abundance of grayling from

Table 4. Capture rates for Arctic grayling during index sampling, Delta Clearwater River, 1973, 1975-84.

Date	Mile Sections 4-7	8-13	14-17	Total Captured	Percent Catch[1] Composition
6/27/73	7	20	66	93	16.5
1974	...	...	...	...	...
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[2]	21	26	40	87	18.3
7/15/82	27	18	18	63	15.7
7/12/83	3	5	45	53	17.0
7/10/84	4	9	71	84	24.3
Mean	22	21	50	94	20.3

[1] Percentage of grayling in total grayling and round whitefish catch.

[2] Adjusted index for abnormal water levels on 7/7/81 (Ridder, 1982).

Table 5. Capture rates for Arctic grayling and round whitefish during index sampling, Richardson Clearwater River, 1977-84.

Date	Miles 1-7		Miles 7-8.5		Total Captured		GR Composition (%)
	GR	RWF	GR	RWF	GR	RWF	
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
7/19/83	156	61	64	10	220	71	76
7/11/84	57	56	81	4	138	60	70
Mean	99	76	102	6	163	80	66

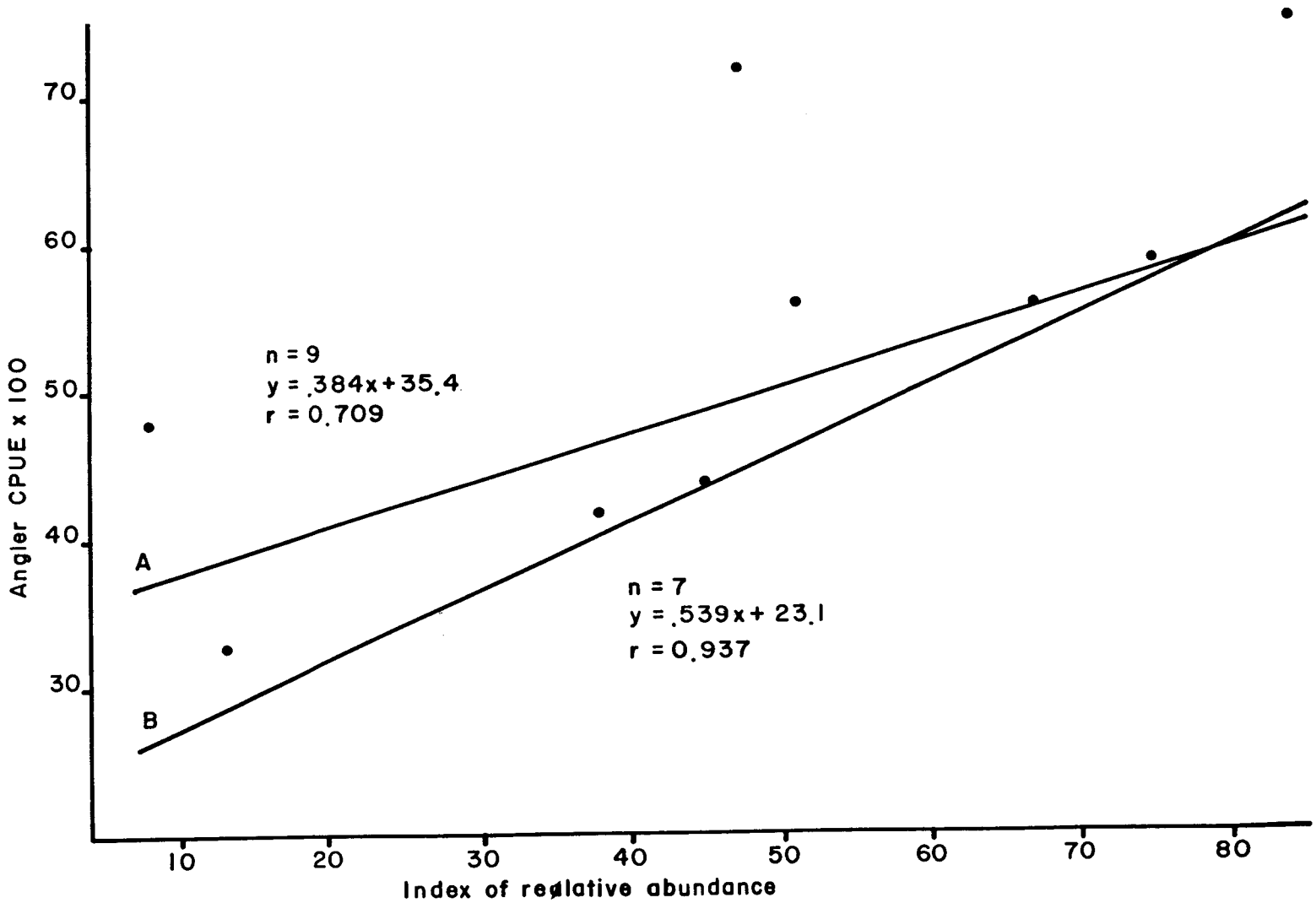

Fig. 3. Relation of the Index of Relative Abundance of Miles 4-13 Delta Clearwater River to Angler CPUE (grayling harvested per hour), Delta Clearwater River. A: 1976-1984. B: 1976-1980, 1982, 1984.

Table 6. Arctic grayling abundance estimates, fish per mile, and related statistics from a 2-mile section of the Richardson Clearwater River, July 1982-84.

	Mark/Recapture[1]							
Year	M	C	R	U[2]	estimate	0.95 CI	Visual	Index
1982	356	164	10	.028	2,670	1,514-5,340	1,175	102
1983	212	92	10	.047	896	508-1,730	539	52
1984	179	115	9	.050	1,038	574-2,076	497	51

[1] Modified Petersen, N = M(C+1)/R+1, from Ricker (1975). Statistics are totals; estimates and C.I.'s from equations were divided by 2.

[2] Recovery Rate U = R/M.

one year to the next. The visual counts and the Petersen estimates both show a high correlation to the index rates (r = 0.999 and 0.996, respectively) and depict a 1984 population abundance similar to 1983, but approximately half that of 1982. Both correlations are significant at the 90% confidence level, but only the visual count is significant at the 95% confidence level. While the data fulfill expectations, they define only the index of the upper Richardson Clearwater. As has been shown for the Delta Clearwater River, repetitive indices can vary significantly. The accuracy of any index and its use in evaluating population trends depend as much on location as on defining and accounting for the variables that can affect it.

Delta Clearwater River Creel Census

With the decision to rely on angler harvest and pressure estimates generated by the Statewide Harvest Survey (Mills, 1984), creel census effort for the past 2 years has been directed solely toward catch sampling and determination of catch rates (number of grayling kept per angler-hour). The censusing schedule was nonrandom and targeted to the high-use period between 1100 and 1700 hours. It was predominantly conducted on weekends and holidays that Ridder (1980) found accounted for over 60% of the total harvest and pressure. The census was conducted from May 20 through September 3, 1984, and sampled 17 days or 14.5% of the season. A typical census day involved 26 mi of river travel: from Mile 8, the location of the only public boat ramp and campground, to Mile 14, then back to Mile 8, down to Mile 1 and back to Mile 8. Interviews were conducted only during the return legs unless anglers were observed to be completing their trips. Shore-bound anglers are almost totally restricted to ¼ mi on either side of the campground and were censused between the upstream and downstream legs. A monthly summary of the 1984 season is given in Table 7.

The 1984 catch rates, both the 0.33 fish per hour from all trip types and the 0.40 fish per hour from completed trips, were the lowest rates found for the 10 years of censusing since 1973 and the fourth lowest for the 16 years of available data (Table 8). One obvious reason is the low abundance of fish found in the indexing of the main fishing locations, Miles 4-13, in July. Completed trip data from shore anglers further underscore the indexing. Comprising 37% of all completed trips, which is similar to previous years' data, shore anglers had a catch rate of zero in 1984 (0.46 fish per hour in 1983, 0.89 in 1982 and 0.85 in 1981). A less obvious cause for the extremely low catch rate of anglers during June (0.16 fish per hour) may be water conditions. Local fishermen interviewed during the month attributed their poor success to abnormally high and stained water that persisted from approximately June 11 to June 29.

While precipitation during this period was abundant, its influence on the spring-fed river was exacerbated by soil erosion and runoff channeling above and within the Delta Barley Project, much like the water quality impact in 1982 (Ridder, 1983; Roger Boyer, United States Department of Agriculture, Soil Conservation Service, pers. comm., 1984).

Table 7. Creel census summary, boat and shore anglers combined, Delta Clearwater River, May 20-September 3, 1984. Numbers in parenthesis are for completed trips only.

Month	Anglers Contacted	Angler Hours	Grayling Harvested	Hours Per Angler	Fish Per Angler	Fish Per Angler Hour
May	71	116	45	1.6	0.63	0.39
June	48	69	11	1.4	0.23	0.16
July	56	92	24	1.6	0.43	0.27
August/Sept.	31	40	20	1.3	0.65	0.50
Totals	206(43)	317(97)	100(39)	1.5(2.3)	0.49(0.91)	0.33(0.40)

Table 8. Comparison of censused grayling catch from the Delta Clearwater River, 1953-84. Numbers in parenthesis denote completed angler trips.

Year	Anglers	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)
1983	155 (24)	306 (62)	146 (44)	0.48 (0.71)
1984	206 (43)	317 (97)	100 (39)	0.33 (0.40)

* 12-inch size limit in effect.

Table 9 summarizes statistics from creel censusing the Delta Clearwater River from 1978 to 1984. A general decline in fishing success is seen to begin in 1982. A decline is not apparent until 1984 based only on completed trip data, and possibly 1983 if the completed trip data for the year are biased, as Ridder (1984) suggests.

The composition of anglers interviewed in 1984 is as follows: residents, 84%; military and dependents, 6%; nonresidents, 3%; unknown, 7%.

Population Structure: Age, Length, and Weight

The age frequency and length of grayling sampled in 1984 during the indexing of the Delta and Richardson Clearwater Rivers are given in Tables 10 and 11. Similar data from sampling anglers' creels on the Delta Clearwater River are given in Table 12.

The aging data from grayling captured during the 1984 Delta Clearwater River indexing gave approximately the same compositions as the 1983 data. Age Classes I through IV, 6% of the sample, continued to be poorly represented and were 79% below the 10-year mean sample composition of 29%. These age classes also represented 6% in 1983. Conversely, the composition of Age Classes VII and older, 41% (also 41% in 1983), was 89% above their 10-year mean of 21.7%. These compositions parallel the indexing catch rates that gave high rates in the upper river where the older grayling reside and below average rates in the lower sections where the immatures are found. The data imply very poor recruitment to the river over the past 2 years. Using Age Class IV as representative of the first recruitment relative to sampling gear, the year classes of 1979 and 1980 appear particularly weak. Age compositions found during the 10 years of indexing, 1975 to 1984, are listed in Table 13.

The length frequency data from 11 years of electrofishing are given in Table 14. In 1984, the sample ranged in length from 167 to 421 mm, with a mean of 325 mm; the same as found in 1983. The 10-year mean is 296 mm. These data show the same composition of small and large fish that is implied in the age compositions, but without the inaccuracies of the aging method.

Weights were obtained from the first 16 grayling captured during the 1984 indexing. Their lengths ranged from 269 to 410 mm, with a mean of 339 mm; and their weights from 216 to 855 g, with a mean of 536 g. Their standard condition factor was 1.37. In 1983 and 1982, condition factors were 1.29 and 1.27, respectively.

The age and length composition data found from sampling anglers' creels in 1984 show the same situation as the indexing samples, but not as extreme. In general, and because of the predominant fishing locations

Table 9. Summary of statistics from creel censusing the Delta Clearwater River Arctic grayling fishery, 1978-84. Numbers in parentheses are data from completed trip interviews.

	1978	1979	1980	1981	1982	1983	1984
Anglers contacted	453(274)	390(191)	189(59)	163(56)	140(46)	155(24)	206(43)
Hr/angler	2.3(2.6)	2.2(2.5)	1.6(2.3	1.8(2.4)	1.8(2.7)	2.0(2.6)	1.5(2.3)
Fish kept/angler	1.3(1.4)	1.3(1.5)	1.2(1.6)	1.3(1.9)	0.8(1.5)	0.9(1.8)	0.5(0.9)
Fish kept/hr	0.57(0.54)	0.59(0.60)	0.75(0.70)	0.72(0.79)	0.42(0.54)	0.48(0.71)	0.33(0.40)
Fish caught/hr	...	0.68(0.68)	0.81(0.78)	0.78(0.83)	0.55(0.60)	0.54(0.88)	0.43(0.53)

Table 10. Age frequency and length of Arctic grayling captured during index sampling, Delta Clearwater River, July 9-10, 1984.

Age Class	Age Frequency		Length (mm)	
	Number	Percent	Range	Mean
I	1	1	167	167
II	0	...	...	...
III	1	1	212	212
IV	3	4	269-302	282
V	18	22	270-339	303
VI	25	31	274-345	312
VII	12	15	311-382	336
VIII	13	16	330-410	365
IX	6	7	355-421	396
X	2	3	360-379	376
	81	100	167-421	325

Table 11. Age frequency and length of Arctic grayling captured during index sampling, Richardson Clearwater River, July 11, 1984.

Age Class	Age Frequency		Length (mm)	
	Number	Percent	Range	Mean
IV	5	7	233-284	264
V	7	10	235-302	275
VI	19	27	257-360	306
VII	13	18	312-369	341
VIII	14	20	335-398	359
IX	9	12	336-391	365
X	2	3	398-406	402
XI	2	3	391-392	392
	71	100	233-392	332

Table 12. Age frequency and length of Arctic grayling harvested by anglers, Delta Clearwater River, 1984.

Age Class	Age Frequency		Length (mm)	
	Number	Percent	Range	Mean
III	1	1	222	222
IV	15	20	228-29	258
V	23	30	248-350	302
VI	23	30	270-378	319
VII	6	8	330-374	348
VIII	6	8	322-387	350
IX	1	1	385	385
X	1	1	404	404
	76	99	222-404	307

Table 13. Percent age composition of Arctic grayling electrofished in the Delta Clearwater River, 1975-84.

Age Class	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	Mean
I	0	0	0	2	2	0	0	0	0	1	0.5
II	0	1	6	16	9	6	5	0	0	0	4.3
III	0	6	15	20	15	10	11	2	0	1	8.0
IV	11	13	20	24	10	26	14	34	6	4	16.2
V	33	28	13	18	32	27	24	32	31	22	26.0
VI	33	42	27	6	12	25	17	18	22.5	31	23.4
VII	14	9	16	14	11	3	19	6	22.5	15	13.0
VIII	5	1	1	0	8	1	6	2	16	16	5.6
IX	4	0	1	0	1	2	4	2	0	7	2.1
X	0	0	1	0	0	0	0	2	2	3	0.8
XI	0	0	0	0	0	0	0	2	0	0	0.2
Mean age	5.8	5.3	5.0	4.1	4.9	4.8	5.4	5.3	6.2	6.3	5.3
Sample size	63	76	98	80	152	166	80	61	49	81	

from Miles 5 to 10, creel samples have younger fish than indexing samples. The composition of Age Classes I-IV in the 1984 creel, 21%, is similar to the 24% found in 1983 and to its 8-year mean of 38.5%. For Age Classes VII and older, the composition was 18% in 1984, 15% in 1983, and 12.9% for the 8-year mean. The age compositions found in creel sampling from 1977 to 1984 are shown in Table 15.

The 80 grayling in the 1984 creel sample ranged in length from 222 to 404 mm, with a mean of 306 mm. As in the indexing samples, mean lengths have gradually increased since the late 1970's and are the result of three strong year classes, 1974-76 (Ridder, 1983). Length frequency data (50-mm groups) from 9 years of creel samples from the Delta Clearwater River are listed in Table 16.

The age compositions found from every second grayling captured during the 1984 Richardson Clearwater River indexing parallel those found in the Delta indexing. The composition of the first four age classes, 7%, was below the 5-year mean of 12.5%, while those of Age Class VII and older, 56% of the sample, were higher than their corresponding 5-year mean of 34.4%. Unlike the Delta Clearwater, these compositional changes in the youngest and oldest fish were not a repeat of 1983 data (Table 17). In regard to the younger fish, the compositional change was quite sudden.

The comparison of length frequency data of the total captures from 5 years of indexing the Richardson Clearwater (Table 18) gives a clearer picture of the above changes, especially in the younger fish, and specifically those in the 215-264-mm group that represent Age Classes III and IV. Despite the variations in the indexing catch rates of the lower 7 mi over the past 5 years (Table 5), the frequency of this group was quite constant until this year.

The condition factor from the first 10 grayling captured in the river was 1.21. In 1983 and 1982, the factors were 1.35 and 1.29, respectively. These fish ranged in length from 300 to 398 mm ($\bar{x}$ = 362 mm) and in weight from 365 to 702 g ($\bar{x}$ = 576 g).

Monitoring of Spawning Streams

Shaw Creek Spring Fishery:

The spring fishery at the mouth of Shaw Creek (Fig.1) was censused from April 8 to April 25, 1984, following a stratifed random schedule that sampled 56% of the total fishing hours, interviewed 469 anglers, and tabulated 401 harvested grayling, of which 359 were sampled. The fishery is focused on prespawning grayling that concentrate at the mouth of the creek while awaiting breakup and access to upstream spawning areas. The drainage is a major spawning stream. Its largest tributary, Caribou Creek, contributes recruitment to six other fisheries in the Delta area. A summary of the 1984 census (catch compositions and harvest and pressure estimates) is given in Table 19, along with similar data for the years 1974, 1975, and 1981-83.

Table 14. Percent length frequency of Arctic grayling electrofished in the Delta Clearwater River, 1973, 1975-84.

Length (mm)	1973	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	Mean[1]
115-164	0	0	1	1	4	3	1	1	0	(<1)	0	1.2
165-214	7	0	4	12	17	13	5	11	2	0	2	6.6
215-264	22	6	11	26	38	14	24	13	20	6	0	15.8
265-314	20	40	39	36	24	38	32	27	44	32	41	35.3
315-364	33	41	34	15	14	24	32	36	24	47	38	30.5
365-414	16	11	11	9	3	8	6	11	8	14	18	9.9
415-464	2	2	0	1	0	0	0	1	2	(<1)	1	0.7
Mean (mm)	...	...	307	277	252	285	294	299	299	325	325	296
Sample size	413	63	76	100	87	157	182	85	63	168	84	

[1] 10-year mean, 1975-84.

Table 15. Percent age composition of Arctic grayling caught by anglers, Delta Clearwater River, 1977-84.

Age Class	1977	1978[1]	1979	1980	1981	1982	1983	1984	Mean
I	0	0	0	0	0	0	0	0	0
II	3	2	2	5	1	1	0	0	1.8
III	11	8	17	13	20	11	6	1	10.9
IV	24	28	19	41	28	28	18	2	25.8
V	33	19	45	24	31	26	47	30	31.9
VI	19	14	11	12	12	22	14	30	16.7
VII	9	22	6	3	6	7	13	8	9.2
VIII	1	7	<1	2	1	1	2	8	3.1
IX	0	0	0	0	1	2	<1	1	0.5
X	0	0	0	0	0	0	0	1	0.1
Sample size	139	97	225	147	153	92	125	76	

[1] Possibly biased toward larger fish (Peckham and Ridder, 1979).

Table 16. Percent length frequency of Arctic grayling caught by anglers, Delta Clearwater River, 1973, 1977-84.

Length (mm)	1973	1977	1978	1979	1980	1981	1982	1983	1984	Mean[1]
115-165	0	0	0	0	0	0	0	0	0	0
165-214	3	10	3	3	3	2	2	1	0	3.0
215-264	19	19	18	36	34	37	18	20	14	24.5
265-314	39	46	37	46	47	40	56	50	42	45.5
315-364	24	21	29	14	14	14	20	27	36	21.8
365-414	13	4	11	1	2	6	4	2	8	4.7
415-464	2	0	3	0	0	1	0	0	0	0.5
Mean (mm)	304	284	299	273	277	281	290	293	306	288
Sample size	120	142	202	227	147	164	100	125	80	

[1] For years 1977-84.

Table 17. Percent age composition of Arctic grayling electrofished in the Richardson Clearwater River, 1980-84.

Age Class	1980	1981	1982	1983	1984	Mean
I	0	0	2	0	0	0.4
II	3	0	0	1	0	0.8
III	2	1	1	6	0	2.0
IV	16	8	12	17	7	12.0
V	32	37	16	25	10	24.0
VI	33	27	31	14	27	26.4
VII	11	22	27	25	18	20.6
VIII	3	3	10	8	20	8.8
IX	0	1	1	1	12	3.0
X	0	1	0	2	3	1.2
XI	0	0	0	0.1	3	0.8
Mean age	5.4	5.8	6.0	5.8	7.0	6.0
Sample size	152	158	128	143	71	

Table 18. Percent length frequency of Arctic grayling electrofished in the Richardson Clearwater River, 1980-84.

Length (mm)	1980	1981	1982	1983	1984	Mean
115-164	1	0	2	0	0	0.6
165-214	1	1	1	2	1	1.2
215-264	16	14	13	16	5	12.8
265-314	43	43	28	26	24	32.8
315-364	31	36	44	42	48	40.2
365-414	8	6	11	13	22	12.0
415-464	0	0	1	1	0	0.4
Mean (mm)	301	307	317	301	332	312
Sample size	170	167	325	220	138	

Table 19. Summary of catch statistics and estimates from the Shaw Creek Spring Grayling Fishery, 1974-75[1], 1981-84.

Length (mm)	Related Age Class	1974 (4/17-20) (%)	1975 (4/18-29) (%)	1981 (4/5-22) (%)	1982 (4/24-5/2) (%)	1983 (4/17-24) (%)	1984 (4/8-25) (%)
180-229	III	1	0	2	2	<1	<1
230-269	IV	26	13	24	16	8	4
270-309	V-VI	41	35	44	39	22	30
≧310	≧VI	32	52	30	43	70	66
Length range (mm)		180-411	231-390	184-379	215-405	228-415	226-440
Mean length (mm)		294	311	292	302	325	327
Male:female ratio		0.73:1	...	0.9:1	1.19:1	1.41:1	1.62:1
Sample size		187	54	271	377	304	359
CPUE[2]		2.40	1.60	2.14	0.87	0.89	0.41
Harvest		500	1,150	4,343	979	1,864	913
Angler hours		...	...	2,029	1,172	2,005	2,292
Person-Days		85	200	966	555	874	1,095
Duration (days)		4	11	18[3]	9	8	18

1 From Peckham (1975, 1976).

2 Grayling harvested per angler hour.

3 Closed by Emergency Order.

In 1984, 913 grayling were harvested and total angler-hours were 2,292 (1,095 person-days). This harvest was approximately half that of 1983, while the pressure was slightly higher. Estimates were based upon dividing the fishery into two strata: the first 10 days and the last 7 days. The strata were chosen on the basis of large differences in fish per angler and fish per angler-hour which were, respectively, 1.20 versus 0.46 fish per angler and 0.56 versus 0.22 fish per hour. Extrapolations of mean angler counts were made for each stratum and multiplied by the census statistics to obtain harvest and pressure estimates.

The harvest rate was 0.41 fish per hour, while the catch rate (harvest plus fish released) was 0.48 fish per hour. Both rates were down by more than half from those of 1983. The daily harvest rates ranged widely from zero to 1.65 fish per hour, but were the most consistent ($\bar{x}$ = 0.57 fish/hr) for the first 8 days. The remaining fishery experienced large daily fluctuations (0 to 0.61 fish/hr, $\bar{x}$ = 0.25 fish/hr) that had not been seen before. The pattern was not consistent with changing weather patterns, which ranged from a near blizzard to balmy, calm, and sunny. These rate swings could be interpreted as "waves" of fish moving up Shaw Creek and out of the fishery, although ice conditions, past history, and changes in catch compositions and census statistics could suggest other interpretations.

The length frequency of the creel sample ($\bar{x}$ = 327 mm, Table 19) was similar to that of 1983 ($\bar{x}$ = 325 mm) when the composition of adults (100% of fish ≧310 mm) increased 75% over the average composition of the 4 previous years. With a large mean length and skewed male-to-female sex ratio, the sample is heavy with large, old fish. This may be indicative of poor recruitment of younger age classes or it may also be a result of exceptionally strong year classes in the older fish. Past reports (Ridder, 1983, 1984) have identified 1974 to 1976 as such years. In 1984 these year classes were Age Classes VIII to X.

During the 1984 fishery, 36 recoveries were made of grayling that had been tagged in the Shaw Creek drainage from 1979 to 1983. Censusing produced 27 tags or 6.7% of the censused catch, while anglers returned 9 tags. Multiplying the estimated harvest (913 fish) by the tag percentage in the censused catch gives an expected return of 61 tags. The total recovered, 36, gives a recovery rate of 59% of expected returns, which is biased due to the census. Subtracting the censused catch (n = 401) from the harvest gives 512 fish and an expected 34 tags. Dividing angler returned tags (9) by expected tags (34) gives a tag reporting rate of 26.5%. Reporting rates found in 1982 and 1983 were, respectively, 9.7 and 14.6%.

The compositions of 436 anglers showed 61.0% were residents (18.4% from Delta, 45.5% from Fairbanks, and 36.1% unknown), 38.1% were military personnel or dependents, and 0.9% were nonresidents. From a subsample of 191 anglers, 22 (11.5%) had caught their limit of five grayling.

Caribou Creek Postspawning Out-Migration:

The migration of grayling out of Caribou Creek (Fig.1) was sampled from June 5 to June 15, 1984, using a weir described by Ridder (1982). As in

1983, the two traps of the weir were set to capture only out-migrating fish. A total of 1,786 fish of 10 species was captured: 1,163 grayling, 308 longnose suckers, 208 lake chubs, 81 round whitefish, 16 humpback whitefish, 4 least cisco, 3 northern pike, and one each of slimy sculpin, coho salmon and chinook salmon (both salmon were juveniles). The weir was manned by Fish and Game personnel for the first 6 days, while graduate students from the Alaska Cooperative Fishery Research Unit (ACFRU), University of Alaska, operated it for the last 5 days.

Water levels during the first 6 days ranged from 19 to 30 in, as measured from the weir floor. For the remaining period, levels fluctuated at around 48 in--the limit of the weir. The weir was kept functional at slightly greater depths by adding sand bags and stop logs, but on June 15 water levels exceeding 60 in were reached and the operation was shut down. While some fish undoubtedly evaded capture during the period, their numbers were not felt to be significant (Bob Clark, ACFRU, pers. comm). A graph of June water levels at the weir for the years 1981 through 1984 is shown in Fig. 4. Water temperatures over the 11-day period ranged from 8 to 11°C, the lowest recorded of all sampling years.

The statistics from sampling the entire catch of out-migrating grayling for the years 1980 through 1984 are shown in Table 20. The table includes the frequencies (percentage) of five length groups that are related to specific age classes (Ridder, 1982), numbers of total catch and of spawners, the length range and means of the catch, the CPUE (average number caught per day) of the total catch and of spawners, and the dates and time interval of the effort. The age frequency from scale analysis and lengths of 78 mature grayling sampled during June 5-7 are shown in Table 21.

The length and maturity compositions in the catch show a decline in recruitment to the spawning population, as was also seen in the earlier sampling of the Shaw Creek fishery (Table 22). The percentage of Age Class IV, prespawners, has declined approximately 87% since 1981, with the greatest declines in 1983 (61.1%) and 1984 (50.6%). These rapid drops suggest generally poor year classes of 1979 and 1980, which was also found in the Delta Clearwater River. Numbers of spawners caught have also declined yearly from their highs in 1982. While CPUE of the adults showed an increase from 1983, it is still below those found in the other years.

The strength of later year classes, 1982 and 1983 (Age I and II fish in 1984), appears to be strong when considering the compositions found in 1983 and 1984. Yet the catch of these younger fish is probably not entirely representative of their composition in the population, due to the nature of this migration and the unknowns regarding their movements between rearing and overwintering areas. As such, any statement regarding their future recruitment to the spawning population would be premature. The 1980 year class gave a high composition in 1981, yet almost disappeared in the catch in 1984.

In the grayling catch, 710 fish had lengths greater than 200 mm, which in past years was the cut-off size in applying tags. In 1984, only 178 fish in this length range were tagged.

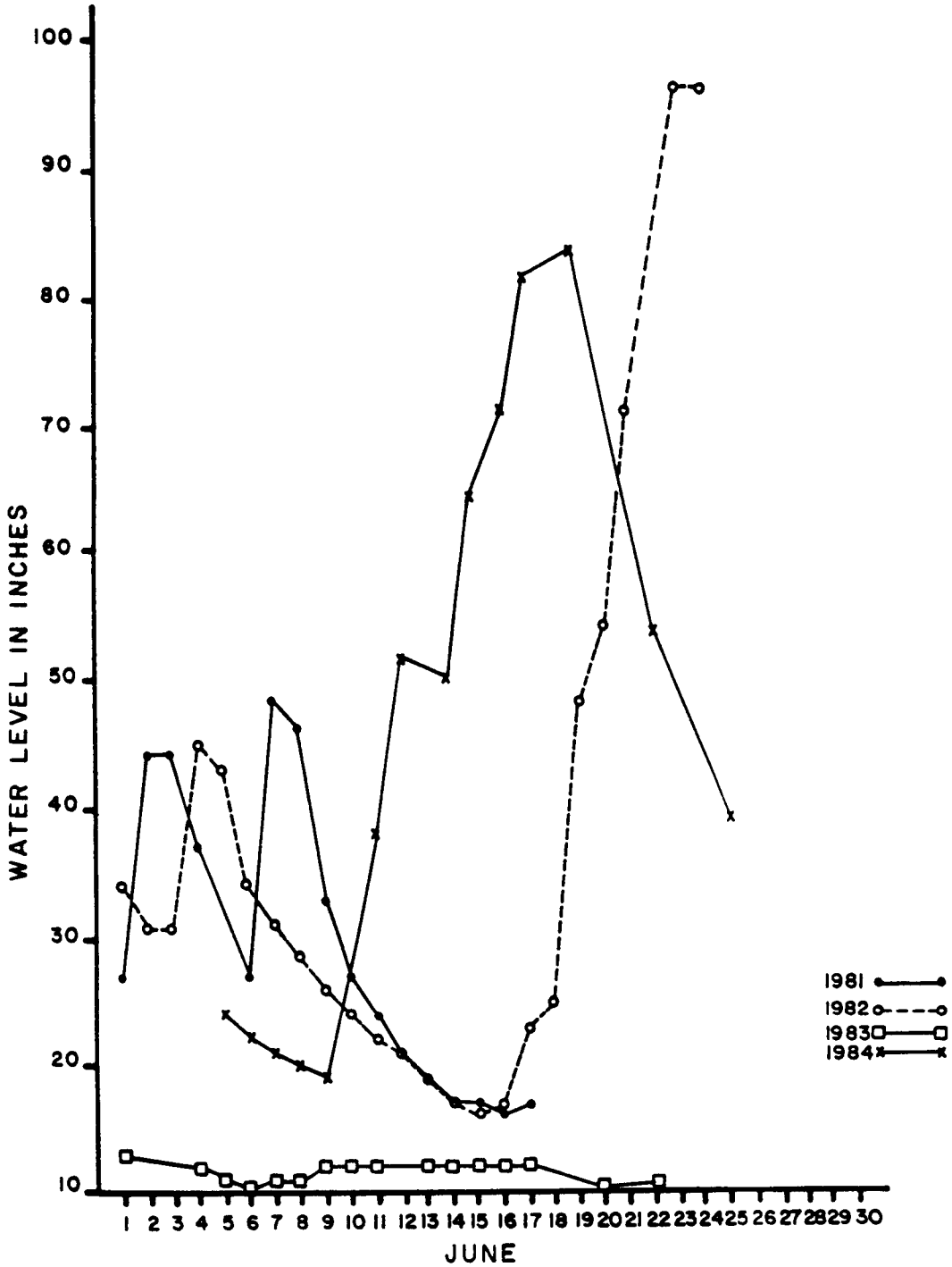

Fig. 4. Caribou Creek water levels at Weir, 1981-84.

Table 20. Length frequencies, related age classes and catch rates of Arctic grayling, post-spawning out-migration, Caribou Creek, June 1980-84.

Length (mm)	Related Age Class	1980[1] (6/2-12) (%)	1981[2] (6/7-19) (%)	1982 (6/2-20) (%)	1983 (6/2-20) (%)	1984 (6/5-15) (%)
70-109	I	2.1	24.6	2.8	40.8	15.2
110-169	II	11.5	1.8	6.3	3.0	20.8
170-229	III	5.1	7.4	4.9	1.6	6.3
230-269	IV	20.9	30.4	21.1	8.1	4.0
270-309	V-VI	27.9	28.1	38.2	24.5	18.3
≧310	≧VI	32.5	7.7	26.7	22.0	35.4
n (sampled)		1,482	1,755	2,062	1,676	1163
n (adults)		691[4]	847	1,447	708	571
Range (mm)		84-405	70-400	72-408	75-420	69-444
Mean (mm)		N/A	223	275	211	242
CPUE[3]: Total		134.7	135.0	108.5	98.6	105.7
Adults		62.8	65.2	76.2	41.6	51.9

[1] Fyke trap.

[2] Weir, 1981-84.

[3] Weir captures per day

[4] Estimate; 100% of n ≧290 mm

Table 21. Age frequency and length of post-spawning adult Arctic grayling captured in Caribou Creek, June 5-7, 1984.

Age Class	Age Frequency		Length (mm)		
	Number	Percent	Range	Mean	Std. Dev.
IV	1	1	247	247	0
V	7	9	264-304	281	18.0
VI	18	23	272-348	299	22.0
VII	28	36	302-367	340	18.8
VIII	18	23	308-387	348	21.6
IX	3	4	359-398	372	22.5
X	1	1	420	420	0
XI	2	3	359-400	380	29.0
	78	100	247-400	329	

Sex Ratios. The adult male to female ratio in 1984 was even (285:286). Together, these adults represented 49.1% of the catch, which is similar to 3 of the 4 years of sampling, which ranged from 42.2 to 48.3%. These percentages are much below the 70.2% of the fourth year, 1982.

The 1984 sex ratio is opposite that expected in an adult population heavy with large fish (Table 19). Ridder (1984) found males to predominate in the larger length ranges and noted that the increasing male-female ratio found in weir captures and in the Shaw Creek fishery corresponded to increasing mean lengths of the samples. Also, unlike previous years, the 1984 ratio was not at all similar to that found in the earlier fishery of 1.62:1. It also ended the 3-year trend of increasing ratios found at the weir. In the earlier sampling of the fishery at Shaw Creek's mouth, the trend continued.

These inconsistencies suggest that some bias may be present in either the sexing or the sampling. Sexing error can be ruled out since the error rate found this year, 6.1% (based on 66 tag recaptures, 4 were assigned a sex different than at tagging), is not much greater than the 5.2% found in 1983 and 4.4% in 1982. The same cannot be said for the sampling, where females were predominant in the adult catch of the first 4 days (0.56:1, n = 260) and males in the last 7 days (1.61:1, n = 311). Perhaps if the sampling were extended to its average of 15 days, the increasing prevalence of males in the catch would have produced the expected sex ratio. This temporal change in composition is important to consider in future monitoring and data analysis.

Mouth Damage. The presence of mouth damage noted on grayling sampled at Caribou Creek and during the indexing of the Clearwater streams has been routinely observed since 1980. It is assumed that the major cause is hooking, and includes fish not only released by anglers, but also those hooked and lost. Rates of mouth damage (percentage of sample) found in the three waters in 1984 and previous years are shown in Table 23. Rates found in Caribou Creek and the Richardson Clearwater River rose for the third consecutive year, while those in the Delta Clearwater River fell. In the former waters the rates are consistent with declining population levels and poor recruitment.

Tag Recaptures. The catch at the weir included 174 recaptures of grayling tagged either in Caribou Creek or mainstream Shaw Creek from 1979 to 1982 (n = 4,857). They composed 20.7% of the catch over 200 mm in length. The rate represented a small decline (16.2%) from the recapture rate in 1983 (24.7%) when compared to the rates of tag returns from the same tagging years in the samples from Shaw Creek's spring fishery and the Richardson Clearwater River's abundance estimates. The tag recapture rates in Shaw Creek and Richardson Clearwater fell 58.6% and 61.7%, respectively, in 1984. As noted in previous reports, the recapture rates of Caribou Creek tags in these waters do not consistently correspond to expectations relating to mortality and recruitment effects; neither do they in this comparison where the rate of decline would be expected to be similar. Although many interpretations can be made, the inconsistencies in the data suggest an unknown migratory behavior.

Table 22. Number of Arctic grayling in 20-mm length groups sampled at Shaw and Caribou Creeks, 1984.

Length (mm)	Shaw Creek (4/18-26/84) (n)	Caribou Creek (6/5-15/84) (n)
70-89	0	86[1]
90-109	0	92
110-129	0	30
130-149	0	133
150-169	0	76
170-189	0	21
190-209	0	27
210-229	1	27
230-249	1	16
250-269	12	31
270-289	42	96
290-309	67	116
310-329	98	124
330-349	61	124
350-369	38	97
370-389	28	43
390-409	9	17
410-429	1	5
430-449	1	2
TOTAL	359	1,163
Range (mm)	226-440	69-444
Mean (mm)	327	242

[1] 2 fish of 69 mm included.

Table 23. Percentage of Arctic grayling exhibiting mouth damage in catches from Caribou Creek weir and electrofishing the Delta and Richardson Clearwater Rivers, 1980-84. Sample sizes are in parentheses.

Location	Length (mm)	Year				
		1980	1981	1982	1983	1984
Delta Clearwater	≧200	26.9	34.1	28.6	37.5	31.3
		(182)	(85)	(63)	(168)	(83)
Richardson Clearwater	≧200	22.4	19.2	21.9	22.3	36.5
		(170)	(167)	(324)	(220)	(137)
Caribou Creek	200-249	...	6.1	2.1	5.8	0
	250-299	...	12.2	10.9	8.7	12.1
	300-349	...	19.9	16.6	19.9	21.1
	≧350	...	28.6	21.4	20.8	22.6
	≧200	...	11.7	10.9	16.3	17.6
			(1,393)	(2,390)	(978)	(710)

The catch also included 92 recaptures of grayling fin clipped at the weir in 1983. All grayling captured in 1983, including tag recaptures, were marked with a double fin clip. Thus, these recaptures included 27 tagged fish, or 29.3%, which is similar to the 24.7% tag composition in the 1983 catch (fish ≧200 mm). These similar ratios imply that differential effects on tagged and untagged fish are minimal.

The recaptures mentioned above are presented in Table 24 as percentages of samples collected from the three waters mentioned for the years 1980 to 1984. They are divided by year and location at tagging and fin clipping. Totals are included on number tagged and fin clipped, recaptures and sample sizes.

Thirty-five of the tagged grayling recaptured in 1984 were multiple recaptures. Thirty-two were recaptured three times (nine consecutively), and three were recaptured four times (one consecutively). These multiple recaptures represented 20.1% of all tags captured, which is similar to the 19.7% found in 1983. In both years, these recaptures represented 4.9% of all captured grayling greater than 200 mm in length. While these figures are indicative of grayling homing to specific spawning areas, the extent and frequency of the behavior are difficult to ascertain. For one example: In 1984, 28.6% of the multiple recaptures represented captures in consecutive years, while in 1983 they represented 75.6%. Again, one would expect the percentages to be similar in a population that annually homes to an area.

All grayling greater than 200 mm handled at the weir in 1982 received an adipose fin clip in addition to a tag. The 1983 estimate on tag loss over 12 months was 8.3%. In 1984, recaptures of these fin-clipped fish totaled 116, of which 21, or 18.1%, had lost their tags over the 2-year interval. The 2+ year (26 months) tag loss estimate found in the early July 1984 indexing of the Richardson Clearwater River was 24.0%, based on recaptures of 25 fin-clipped fish, of which six were without tags. In 1983, the Richardson sampling gave an estimate of 17.6% (n = 34) for a 13-month tag loss rate.

The recapture rates in Table 24 suggest that the fish found at the mouth of Shaw Creek in April and in the Richardson Clearwater River in July are of the same population. If the rates are considered as catch rates (number of tags found per 100 grayling), Caribou Creek's composition in the fisheries of the above waters can be quantified. The mean yearly catch rate calculated for each tagging year from Table 24 gives the following:

		Percent With Tags		
	Tag Year	Shaw	Caribou	Richardson
	1980	3.2	3.7	3.7
	1981	3.5	8.2	2.9
	1982	4.7	10.8	4.3
	1983	3.2	13.0	4.5
Total	$\bar{x}$	3.7	8.9	4.0

Table 24. Percentage of tagged Arctic grayling[1] in samples collected from Shaw Creek, Caribou Creek, and Richardson Clearwater River, 1980-84.

Year of tagging	Location of tagging	Number tagged	Recaptures (%) Shaw/April 1981	1982	1983	1984	Caribou/June 1980	1981	1982	1983	1984	Richardson/July 1980	1981	1982	1983	1984	Total Recaptures
1979	Shaw	156	0.3	0.5	0.3	0	0.2	0.3	0.1	0.1	0	0	0.5	0.2	0.2	0	19
1980	Shaw	94	0.5	0	0.3	0	...	0.4	0.1	0.2	0.1	0.6	0.5	0.4	0.2	0	20
	Richardson	30	0	0.3	0.3	0	...	0	0.2	0	0	0.6	0.5	0.4	0.5	0	12
	Caribou	1,283	3.7	4.6	3.6	1.0	...	3.3	3.8	3.4	4.2	8.8	4.8	4.4	3.2	2.3	326
1981	Caribou	1,323	...	4.8	3.6	2.0	...	...	9.3	9.1	6.2	...	3.2	3.9	4.1	0.8	435
1982	Caribou	2,001	...	...	6.3	3.0	...	...	...	11.5	10.1	...	...	5.0	4.3	4.2	273
1983	Caribou	923[2]	...	...	...	3.2	...	...	...	...	13.0	...	...	...	6.8	4.5	151
1984	Caribou	178	...	...	...	...	...	...	...	...	...	...	...	...	...	2.5	9
Totals: %			4.5	10.2	14.5	9.2	0.2	5.2	15.6	24.7	33.7	10.0	9.5	14.0	19.3	14.3	12.3
	Tags	5,988	27	40	44	37	3	55	323	228	239	17	18	76	85	51	1245
	Sample size		600	392	304	401	1294	1395	2390	923	710	170	189	542	441	355	10,106

[1] All sampling by ADF&G and represents fish ≧200 mm.

[2] In 1983 all grayling at Caribou weir received fin clips including tag recaptures. Number tagged and Caribou's recapture percentage represent all clipped fish ≧200 mm. Those fish with clips but no tags, n = 65, or 9.2% of sample.

The ratio of the overall means gives an estimate of Caribou Creek's composition: 42% to Shaw Creek and 45% to Richardson. If the 1980 rates are deleted from the computation because of their dissimilarity to the other years, the composition is decreased to 36% for each of the other populations.

Recaptures of immature grayling (Age I-III) that were fin clipped at the weir in 1981 and 1982 at lengths less than 200 mm (n = 2,606) totaled 6 in 1984. They ranged in length from 200 to 324 mm, averaged 245 mm, and represented 2.1% of the catch within this range (n = 288). In comparison, their compositions in the appropriate length ranges in 1982 and 1983 were 0.9 and 0.6%, respectively.

The tag recaptures made in Caribou Creek of fish tagged a year previously can be used in a mark/recapture population estimate for the year at tagging (Ricker, 1975) assuming that homing is complete, recruitment negligible or accountable, no differential rates of mortality and vulnerability exist, and tag loss is known. From 1984 recaptures of fish fin clipped at Caribou in 1983, the population at marking was estimated at 7,056 ± 1,439 (p = 0.95) or approximately half the estimates of 1982 and 1981, 15,555 and 13,877, respectively. The data for these modified Petersen estimates are taken from Table 24. The number marked in the formula for the latter 2 years was adjusted to compensate for a tag loss rate of 8.3%. The estimates are high because recruitment has not been accounted for and the assumption of complete homing is premature. As such, they should be regarded as more of an index than an estimate. They compare favorably to the abundance data from the Richardson Clearwater River which also showed population levels in 1983 to be approximately half of that found in 1982. The Caribou estimates will be refined by accounting for growth and then weighting recapture samples to specific length ranges that preclude recruitment.

Goodpaster River:

Population estimates of Arctic grayling greater than 150 mm fork length in two sections of the lower Goodpaster River were made from June 27 to June 29, 1984. These are shown in Table 25. The sections are each 3 mi long and located in the lower river at Miles 3-6 and Miles 15-18. The fish were captured for marking using electrofishing gear with two passes through each section on the first day. Fish were marked with an upper caudal fin clip. All grayling were measured, and scale samples were taken from the first 50 captured in each section. Recapture runs were made in the following days and consisted of one pass through each area. The method was similar and the sections were the same as in previous estimates made since 1975 and reported on by Peckham (1983). Tack (1975) estimated grayling per mi in each of three sections encompassing the entire 115 miles of the mainstem river in 1973 and 1974. His lower section was Miles 1-33. A listing of all population estimates in the lower Goodpaster River in grayling per miles is given in Table 26.

The combined estimate of both river sections in 1984, 510 ± 165 grayling/mi (p = 0.95), was 82% greater than the last and the lowest estimate made in 1982. It is near the yearly mean of 598 grayling/mi from all 9 years of estimates. The greater abundance of grayling in the lower river is also

Table 25. Population estimates for Arctic grayling greater than 150 mm in two sections of the Goodpaster River, June 27-29, 1984.

Section	Marked (M)	Catch (C)	Recaptures (R)	Estimate (N)[1] Section	Estimate (N)[1] Mile
2 (miles 3-6)	265	91	12	1,875±1,140	625±380
6 (miles 15-18)	216	169	28	1,266±492	422±164
Combined	481	260	40	1,688±495	510±165

[1] $N = \frac{M\ (C + 1)}{R + 1}$ and 0.95 confidence interval, (Ricker, 1975).

Table 26. Comparison of population estimates for Arctic grayling (greater than 150 mm) in the lower Goodpaster River, 1973-84.

Year	Method of Estimate	Length of Area (mi)	Population Estimate (GR/mi)
1973	Schnabel	33	770
1974	Petersen	33	323
1975	Petersen	6*	760
1976	Petersen	6	563
1977	Petersen	6	604
1978	Petersen	6	749
1980	Petersen	6	819
1982	Petersen	6	281
1984	Petersen	6	510
Mean			598

* The 6 miles for which the estimates were made in 1975 through 1982 include two index areas of 3 miles each (miles 3-6 and miles 15-18). No estimate was made in 1979, 1981, or 1983.

reflected in their catch rate of 122/hour of electrofishing versus the 83/hr found in 1982. The former rate is near the mean of the 6-year period, 1973-80 (Peckham, 1983).

The age frequency and lengths of a subsample of grayling (n = 100) captured in both sections in 1984 is shown in Table 27. The predominant age class, IV, is the same as in 1982. The mean age of the sample was 3.8 years.

The length frequencies and related age classes of all grayling (n = 592) captured in the marking runs in 1984, as well as in previous years since 1975, are shown in Table 28. The high percentage of grayling in the 70-109-mm range is remarkable, as these are the most difficult to capture with the electrofishing boat. Their numbers suggest an exceptionally strong 1983 year class. With the Goodpaster River being an important source of recruitment to the Delta Clearwater River (Reed, 1961; Ridder, 1983), this year class should help alleviate the poor recruitment to the Delta Clearwater of the past few years. The sampling at Mile One Slough is also indicative of this year-class strength.

Grayling Population Enhancement

Goodpaster River Egg Take:

The first attempt at an egg take in a large, rapid run off river met with both success in capturing sufficient numbers of adults and failure in securing eggs. The river was monitored closely for breakup, which occurred on May 11, 1984. Between May 14 and 18, 3.4 hours of boat-mounted electrofishing captured 650 grayling between river miles 5 and 6. Of these, 410 were adults: 297 males and 113 females, a 2.63:1 ratio. Sixteen of the females ranged in length from 249 to 398 mm and averaged 315 mm. Despite water temperatures during that period that ranged from 4.5 to 8.5°C, the classification of 97 females showed only 22% to be ripe, 29% spent, and 49% still green. It was decided to hold off the egg take until percentages increased.

Water level in the river was moderate and only slightly turbid until May 17. Over the next 36 hr, rain squalls caused the river to rise approximately 2 ft which disrupted the holding pens and allowed all but 10 fish to escape. The associated increase in turbidity and fish dispersion severely depressed the electrofishing catch rate and effectively ended the project. Future attempts will need better holding facilities and on-site monitoring.

Delta Clearwater River Stocking:

In the fall of 1983, 4,197 fingerling grayling were transplanted from the winter-kill rearing ponds on Fort Greely to two deeper lakes nearby. "J" Lake received 3,417 fish and Sheefish Lake 780. Assuming an approximate 50% yearly mortality (Ridder, 1984; Holmes, 1984), spring and fall plants of 1,000 Age I fish each were planned for the Delta Clearwater River.

In late May and early June of 1984, 192 hours of fyke trapping in "J" Lake caught 1,008 Age I grayling. Ninety-six hours of fyke trapping in

Table 27. Age frequency and length of Arctic grayling captured in Sections 2 and 6 of the Goodpaster River, June 27-28, 1984.

Age class	Number	Length (mm)	
		Range	Mean
I	7	78-112	92
II	7	144-169	161
III	17	180-228	204
IV	48	190-263	219
V	11	229-282	259
VI	7	286-295	258
VII	3	284-293	289
	100	78-295	213

Table 28. Length frequencies and related age classes of Arctic grayling captured in the lower Goodpaster River, June 1975-84[1].

Length (mm)	Related Age Class	Percentage of Fish Captured						
		1975	1976	1977	1978	1980	1982	1984
70-109	I	2	36[2]	41[2]	1	1	1	17
110-169	II	20			29	32	13	9
170-229	III-IV	60	42	50	62	51	56	43
230-269	IV-V	16	18	7	6	14	27	21
270-309	V-VI	1	3	2	2	2	3	10
≧310	≧VI	1	1	<1	0	<1	<1	<1
Sample size		702	491	799	789	713	374	592
Mean length (mm)		193	214[3]	186[3]	187	195	206	213

[1] 1975-1982 data from ADF&G files and Peckham (1983).

[2] Combined percentage of Ages I and II.

[3] Of grayling ≧150 mm.

Bolio Lake (a 1983 rearing pond whose fish were transplanted into "J" Lake) captured 21 fish, indicating overwintering capabilities and less than total success in 1983's fall removal. A sample (n = 20) from the total catch from both ponds ranged from 151 to 192 mm and averaged 170 mm. They all received yellow Floy tags and were stocked into the Delta Clearwater River at the state campground at Mile 8. There were no mortalities during transport, and the fish were in excellent condition. They exhibited some frenzy at stocking but settled down quickly and headed slowly downstream to a backwater where some feeding activity began.

The fall fyke trapping in the same lakes produced poor catches of the Age I fish. Seventy-two hours were spent in "J" Lake for 23 fish; 96 hours at Bolio Lake for 35 fish. One hundred and forty-four hours at Sheefish Lake netted 39 fish. Traps fished for 144 net-hours in Big Lake, which offers marginal overwintering, yielded 25 fish. The total 122 Age I grayling ranged in length from 170 to 260 mm and averaged 232 mm. All received tags and were stocked into the Delta Clearwater River.

The poor fall catches in "J" Lake are probably more a result of weather than high summer mortality. The heavy rains of June contributed to a rise in the level of the lake and provided access to a number of successive ponds leading to the Delta River. Wishbone Lake, used as a fingerling-rearing pond in 1984 and the first pond below "J" Lake, produced 17 Age I fish from 144 fyke trap hours. Although grayling were sighted in the next lake down, no attempt at trapping was made due to lack of accessibility and poor prospects. The other overwintering area, Sheefish Lake, also experienced a rise in water level over the summer. Although the rise in water level produced an almost complete lack of suitable fyke trap area, it is not believed to be the sole cause of the poor catches.

Fingerling plants (Age 0) totaled 17,380 and were made in the Delta Clearwater River on September 26, 1984, at the campground. They originated from Jack Lake stock and were all hatched and reared at Clear Hatchery. Their lengths (n = 49) ranged from 36 to 76 mm and averaged 62 mm (Table 29). Their condition at stocking was the poorest for any plant to date. Due to river current, an accurate estimate of mortality was difficult, but totaled at least 500. Many fish, estimated at 10-20%, exhibited stress behavior at stocking: erratic swimming at the surface, followed by rolling over and sinking. Some of these were seen to recover. In a survey of 3 river mile below the campground the next day approximately 600 live and 100 dead fingerlings were observed in the first mile and none thereafter. The live fish were sighted almost exclusively under cutbanks.

To ascertain the fingerlings' recruitment to the river's population, 8,038 (46.3%) of the stocked fish had their left pelvic fin clipped close to the base prior to transport. Most likely due to their small size, the fin-clipping was inaccurate or incomplete. After planting, 91 dead fish were collected, of which 61.5% (n = 56) were fin-clipped. Of these fin-clipped fish, 14.3% (n = 8) were minus a right pelvic clip, 8.9% (n = 5) had only a partial left pelvic clip, and 1.8% (n = 1) had both pelvic fins clipped. These clipping errors total 25% and will complicate

Table 29. Summary of Arctic grayling stocked into the Delta Clearwater, 1984.

Egg Source	Rearing Location	Date Stocked	Number Stocked	Length (mm) Range	Length (mm) Mean	Mark/ Fin clip	Fish/ lb
1983 Moose Lake	Ft. Greely[1]	5/25	616	157-184	167	Floy tag	...
1983 Moose Lake	Ft. Greely[1]	6/8	413	151-192	173	Floy tag	...
1983 Moose Lake	Ft. Greely[1]	9/21	122	170-260	232	Floy tag	2.3
1984 Jack Lake	Clear Hatchery	9/26	17,380	36-76	62	L. pelvic[2]	209

[1] Fish reared in various ponds but transplanted into "J" Lake for overwintering.

[2] 8,038 fish received fin clips.

Table 30. Length, weight, condition factor, and survival of pond-and hatchery-reared Arctic grayling stocked as 4-7-day old fry on June 11, 1984 and sampled in late September 1984.

Location	Number Stocked	Sample Date	Length (mm)		Weight (g)		Condition Factor[1]	Total Catch	Population Estimate	Survived (%)
			Range	Mean	Range	Mean				
West Pond	15,000	9/21	110-123	118	12.1-17.0	14.9	0.91	2,304	2,627[2]	17.5
Big Lake	25,000	9/21	122-141	130	18.8-28.4	23.9	1.09	1,834	...	...
Bolio Lake	50,000	9/11	115-138	131	17.5-30.6	26.7	1.19	...	5,747±1,640[3]	11.5±3.3
Left OP	15,000	9/21	118-136	127	16.4-26.4	21.8	1.06	1,941	2,082[2]	13.9
Wishbone Lake	15,000	9/21	97-121	112	...	...	...	22	...	...
Clear Hatchery	32,000	9/26	36-76	62	...	2.2	0.92	17,380	17,380	54.3

[1] $K = W/L^3 \times 10^5$

[2] Leslie method as outlined in Ricker, 1975.

[3] Modified Petersen estimate and 0.95 confidence interval from Ricker, 1975.

assessment of the 1984 plant in future years due to fin regeneration and confusion with the right pelvic clips given to a portion of the 1983 plant.

Although 100 fingerlings which were clipped and held at the hatchery for 72 hours experienced no mortalities (Dave Parks, Clear Hatchery, pers. comm.), the higher percentage of marked fish in the mortality sample than in the total stocked, 61.5% versus 46.3%, suggests either a differential mortality due to transport and fin-clipping, or inaccuracies in estimating numbers stocked from total weights. Other studies assessing mortality from fin-clipping found the procedure to be almost completely benign (Ridder, 1982, 1983).

A summary of grayling stocked into the Delta Clearwater River in 1984 is given in Table 29.

Pond Rearing:

On June 11, 1984, five shallow ponds on the Ft. Greely Military Reservation were stocked with a total of 120,000 grayling fry of Moose Lake origin. Between September 18 and 26, fyke traps (1,704 trap-hours) were used in four ponds to capture 6,101 fingerlings which were transplanted into Bolio Lake for overwintering and eventual stocking into the Delta Clearwater River at Age I in 1985. A summary of the ponds, number stocked, lengths, weights, condition factors, total catches, population estimates and estimated survival rates is given in Table 30.

Bolio Lake, as well as the other rearing ponds, experienced a large rise in water level in 1984 of approximately 2.5 ft. This resulted in water levels that were the highest of the past 9 years. Because of its past stocking history and overwintering capabilities, Bolio Lake was chosen as the sole overwintering lake. A modified Petersen estimate gave a fingerling population in the lake of 5,747 with a 0.95 confidence interval of ± 1,640 (M = 774, C = 348, R = 46). The marking and recapture efforts each involved 48 hours of fyke trapping.

Recoveries of Stocked Grayling:

<u>1983 Year Class</u> Spring sampling at Mile One Slough has been the best method of recapturing the younger age classes of grayling stocked as fingerlings. The captures at the slough are of fish in-migrating to the river from overwintering areas (Peckham and Ridder, 1979; Ridder, 1980, 1981) and offer a suitable index in assessing the success of the stocking program and its contribution to year-class strengths. In 1984, a total of 1,566 grayling was captured (Table 2). Based on recaptures of fish stocked in 1983 (Age 0), 95.6% of which received fin clips, and on the assumption that 109 mm was the upper limit of length of stream-reared Age Class I grayling (of 100 fish sampled in 1984, lengths ranged from 60 to 113 mm with $\bar{x}$ = 88.6 mm), 1,310 of these fish were Age Class I. Of these, 223 were recaptures of the four distinctively fin-clipped groups of stocked fingerlings (Ridder, 1984). Adjusted for the incomplete fin-clipping of one group, the total estimated recaptures were 236. Numbers, lengths, and compositions of these fish at time of stocking and at recapture are summarized in Table 31.

The contribution of these stocked fish to the 1983 year class at Mile One Slough, 18.2%, is considerably lower than the same age class contributions found from previous plants (1975-78 year classes) that range from 41 to 76% (Table 32). In itself, these percentages are not a good index of a plant's success, since a number of considerations must be made. Varying recruitment of wild fish can directly affect the percentage. The 1983 year class appears to be particularly strong by its showing at Mile One Slough, Caribou Creek, and the Goodpaster River. Similarly, the 1975 and 1976 year classes were found to have been recruited heavily (Ridder, 1983, 1984), yet plants of these year classes gave the highest contribution percentages of any stocking (Table 33), although sample sizes for the latter were small (n = 10 and 46, respectively; Ridder, 1981). Also, the method of identifying the two early plants was based solely on circuli counts rather than fin clips or a combination of counts and other marks. Ridder (1982) tentatively identified an overlap of 5% between the counts of the pond-reared fish and wild fish of older year classes. Being environmentally influenced, the circuli counts of wild fish in the same year classes could reasonably be higher, allowing a greater overlap and inflating the stocked fish contributions.

The overall recapture rate at Mile One Slough of the 1983 stocking was 2.2%, with a range in individual groups from 1.0 to 2.7%. These rates agree favorably with those of the 1977 and 1978 year classes. For the 1977 year class (n = 307), 1.6 to 2.4% of those stocked were recaptured the following spring; and similarly for the 1978 year class (n = 581), 2.1 to 3.3% (Peckham and Ridder, 1979; Ridder, 1980).

Past studies (cited above) indicated that some straying of the stocked fish does occur and that the majority of the fish overwinter either out of the river, in its lower reaches, or both. Provided numbers of out-migrating fish were proportional to stocking densities, the recaptures at Mile One Slough show that the September plants were more successful at imprinting to the river than the August plants. At stocking, numbers favored the September plants by a ratio of 1.33 to 1. At recapture, their ratio increased to 2.18 to 1 (Table 31). This shift is mostly attributable to the August plant of pond-reared fish which composed 20.0% of the total stocked for the year but only 8.9% of their recaptures. When the plants are segregated by rearing area rather than time, hatchery fish show better results overall than the pond-reared fish when comparing compositional changes.

From Table 31, length at stocking does not appear to affect stocking success. The hatchery fish were nearly half the size of the pond-reared fish, yet, as stated above, were better represented in the recapture sample.

Other sampling also recaptured some of the stocked fish and, although samples were small, gave different compositions of the four plants than at Mile One Slough. Sixteen grayling, all less than 157 mm, were captured by backpack shocker on May 1 in Spring #1, which is at Mile 5 of the river and had been used as a stocking location for the early year-class plants (Ridder, 1980). Eleven of these fish were recaptures and consisted of 10 pond-reared fish (7 September and 3 August plants) and 1 hatchery fish (September plant). Electrofishing Miles 7 and 6 and

Table 31. Number, length, and composition of Arctic grayling stocked into the Delta Clearwater River as fingerlings in 1983 and recaptured at Mile One Slough, Spring 1984.

Rearing Location	Month Stocked	At Stocking[1]			At Recapture				
		Number	Composition (% of total)	Mean Length (mm)	Number	Composition (% of total)	Length (mm) Range	Length (mm) Mean	Percent of Number Stocked
Ponds	August	2,189	20.0	108	21	8.9	109–126	120	1.0
Hatchery	August	2,503	22.8	60	49	20.8	67–97	78	2.0
Ponds	Sept.	3,292	30.0	150	87	36.9	117–176	151	2.6
Hatchery	Sept.	2,983	27.2	86	79[2]	33.4	77–112	89	2.7[2]
Totals		10,937			236				2.2

[1] From Ridder, (1984).

[2] Adjusted for partial fin clipping at stocking; N = 2,500 or 83.8% of total. Actual number recaptured at Mile One Slough was 66. Other plants were all completely fin-clipped.

seining the river adjacent to Spring #1 on August 20 and 24 captured 22 grayling (146-326 mm in length) that included 7 fin-clipped fish, which were again predominantly pond-reared fish (n = 6) from the September plant (n = 4). The one hatchery fish was from the September stocking. In summary, from samples totalling 38 grayling, 18 (47.4%) were recaptures of the fingerling plants. Of these, 16 (88.9%) were pond-reared fish, including 11 (61.1%) from the September plants and 5 (27.8%) from the August plants.

Recoveries and sightings of the Age I pond-reared fish stocked in late May (n = 1,029) were not made until July 1. On July 4, 12 of the yellow-tagged fish were seen in a school of approximately 60 grayling in a large pool at Mile 6. Indexing the lower river on July 10 captured one tagged fish (167 mm) at Mile 5. Anglers reported capturing seven tags: Two fish were caught on July 16, one in the outlet stream of Clearwater Lake (see Fig. 1) and the other at Mile 1; five fish were caught on August 29 at Mile 8. The electro-fishing and seining samples mentioned above included six tags or 27.2% of the total grayling captured (including the fingerling plants, stocked fish composed 59.1% of these samples). Lengths ranged from 177 to 203 mm, averaged 186 mm, and represented a 16-mm increase (5.3 mm per month) from the average length at the time of stocking.

1975-78 Year Classes In 1984 the four year classes of pond-reared grayling stocked into the Delta Clearwater River as fingerlings were represented by age classes VI-IX. Their representation in the population was based on analysis of scale characteristics in samples from electrofishing (n = 81) and creel sampling (n = 76) (technique described in Ridder, 1983). These age classes made up 58.6% of the two combined samples. The pond-reared fish made up 13% of these age classes and 8% of the total sample. Table 33 shows these and other year-class and sample compositions for the years 1979 -84. Table 32 shows the compositions of each year class of the plants in successive age classes from 1976 to 1984.

The percentages of these early plants are similar to those found in 1983, but are roughly half of those in 1981 and 1982 in both year-class and total samples. The reasons behind the declines are difficult to pinpoint. The identifying criteria to distinguish the plants from wild fish have been circuli counts to and including the first annulus; fish with 11 or more circuli are considered pond reared--any less are wild fish. The complete disappearance of the 1975 plant from the last 2 years, a major cause in the decline, could in part be attributable to the 40% of the plant originating from West Pond, which had the smallest range and mean of circuli counts of any of the plants (10-13, $\bar{x}$ = 11.4; Peckham and Ridder, 1979), allowing a greater overlap into those of wild fish and, hence, less recognition. The inaccuracies in aging older fish and small sample sizes must also be taken into consideration. The increase in the 1976 year-class sample composition over the last year, as well as the 1975-class disappearance, may be a result of this difficulty. Still adding to the considerations is the complex recruitment to the river which appears variable--not only in year-class strengths, but also age class at recruitment (Reed, 1961; Pearse, 1974; Ridder, 1980-1984).

Table 32. Percent composition in successive age classes of Four year classes of Arctic grayling stocked into the Delta Clearwater River, 1976-84. Number in parenthesis are sample sizes for each age class.

	Year Class			
	1975	1976	1977	1978
	Number Stocked			
Age Class	9,100	12,467	6,684	7,209
I	60	76	53	41
II	31	46	28	56
III	52	41	60	35
IV	29	39	32	35
V	21	25	16	22(90)
VI	25	35	9(34)	17(48)
VII	20	8(39)	6(18)	
VIII	0(11)	16(19)		
IX	0(7)			

Table 33. Composition of four year classes, 1975-78, of pond-reared Arctic grayling stocked into the Delta Clearwater River as percentage of sub samples of the four year classes and as percentage of total samples, 1979-83.

Year	Sample Size*	% of Four year classes in sample	Respective Age Class	Pond-reared GR (%)	
				In year 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
1983	216	81	V-VIII	14	12
1984	157	59	VI-IX	13	8

* Samples in each year from indexing and creel censusing.

LITERATURE CITED

Holmes, R. H. 1984. Population structure and dynamics of the Arctic grayling with emphasis on heavily fished stocks. Alaska Dept. Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1983-1984, Project F-9-16, 24(R-I):1-38.

Mills, M. J. 1984. Alaska Statewide Sport Fish Harvest Studies. Alaska Dept. Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1983-1984, Project F-9-16, 25 (SW-I-A). 118 pp.

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

Peckham, R. D. 1975. Evaluation of interior Alaska waters and sport fish with emphasis on stocked lakes. Alaska Dept. Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1974-1975, Project F-9-7, 16 (G-III-E):52-77.

_____. 1976. Evaluation of interior Alaska waters and sport fish with emphasis on managed waters, Delta District. Alaska Dept. Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1975-1976, Project F-9-8, 17(G-III-I):31-50.

_____. 1983. Evaluation of interior Alaska waters and sport fish with emphasis on managed waters, Delta District. Alaska Dept. Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1982-1983, Project F-9-15, 24(G-III-I):1-38.

_____ and W. P. Ridder. 1979. A study of a typical spring-fed stream of interior Alaska. Alaska Dept. Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1978-1979, Project F-9-11, 20(G-III-G).

Reed, Richard J. 1961. Investigation of the Tanana River grayling fisheries. Alaska Dept. Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1960-1961, Project F-F-R-1, 2(3-B): 195-213.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Department of the Environment, Fisheries and Marine Service. Ottawa, Canada. Bulletin 191.

Ridder, W. P. 1980. A study of a typical spring-fed stream of interior Alaska. Alaska Dept. Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1979-1980, Project F-9-12, 21(G-III-G): 43-93.

_____. 1981. A study of a typical spring-fed stream of interior Alaska. Alaska Dept. Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1980-1981, Project F-9-13, 22(G-III-G): 1-58.

_____. 1982. A study of a typical spring-fed stream of interior Alaska. Alaska Dept. Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1981-1982, Project F-9-14, 23(G-III-G): 1-61.

_____. 1983. A study of a typical spring-fed stream of Interior Alaska. Alaska Dept. Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1982-1983, Project F-9-15, 24(G-III-G): 1-54.

_____. 1984. The life history and population dynamics of exploited stocks of Arctic grayling associated with the Delta and Richardson Clearwater Rivers. Alaska Dept. Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1983-1984, Project F-9-16, 25(G-III-G):1-49.

Tack, S. L. 1975. Distribution, abundance and natural history of the Arctic grayling in the Tanana River drainage. Alaska Dept. Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1974-1975, Project F-9-7, 16(R-I). 35 pp.

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