FEDERAL AID IN FISH RESTORATION
STUDY R-I

ARCTIC GRAYLING TANANA RIVER DRAINAGE

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ALASKA DEPARTMENT OF FISH AND GAME
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Volume 17 Study R-I

STATE OF ALASKA

Jay S. Hammond, Governor

Annual Performance Report for

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

by

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RESEARCH PROJECT SEGMENT

State: ALASKA

Name: Sport Fish Investigations of Alaska

Project No.: F-9-8

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Study Title: DISTRIBUTION, ABUNDANCE, AND NATURAL HISTORY OF THE ARCTIC GRAYLING IN THE TANANA RIVER DRAINAGE

Period Covered: July 1, 1975 to June 30, 1976

ABSTRACT

A population estimate in Chena River study Section 6 revealed 191 grayling, *Thymallus arcticus* (Pallas), per kilometer.

Recruitment of Age Class III grayling in the lower Chena River was low (24.7%) for the second year in succession. Though not as low as the 1974 recruitment of 12.1%, it was well below the 60.5% in 1973.

A spring study of Badger Slough revealed a strong migration of grayling into the stream beginning in early April and continuing through the remainder of April. All sizes of grayling were present but adults were more abundant early in the migration, whereas yearlings became more abundant later in April. Spawning grayling were observed in the stream above the Peede Road crossing on May 12.

The delayed effects of capturing grayling with a boat mounted electro-fishing unit were tested by holding captured grayling for 72 hours. After 72 hours grayling dead or near death ranged from 5% to 8% and those injured ranged from 12% to 42%.

A low intensity creel census covering most of the accessible areas of the Chena River gave an estimate of 40,000 man-hours of angling with a yield of 26,500 grayling from May through August.

RECOMMENDATIONS

It is recommended that:

1. Recruitment rates for grayling in the Chena River be determined with as much refinement as possible.

2. Studies be continued to evaluate the effectiveness and effects on dc and pulsed dc electrofishing on Arctic grayling.

3. Creel census programs be continued on the Chena River with emphasis on obtaining statistically based catch data.

TECHNIQUES

The Chena River sections referred to in this report are the same as in previous years and are repeated here for convenience (Table 1).

A boat mounted electrofishing unit described by Van Hulle (1968) and Roguski and Winslow (1969) was used to capture Arctic grayling for population estimates, age frequency studies, and in the shocker evaluation studies.

Population estimates were made using the techniques of Schumacher-Eschmeyer as described in Ricker (1958). Calculations of survival rates also follow those outlined in Ricker.

Grayling scales used for age determination were mounted on 20 mil acetate, using a heated press at 35,000 pounds pressure for 20 seconds. The scales were individually cleaned prior to mounting. The scales were read on a Bruning 200 Microfiche Reader.

Table 1. Chena River Study Sections.

Section Number	Section Name	River Miles*	Section Length km	Section Length mi
1	River Mouth to University Ave.	0-6 (0-9.7)	9.7	6
2a	University Ave. to Peger Road	6-8 (9.7-12.9)	3.2	2
2b	Peger Road to Wendell Street	8-11 (12.9-17.7)	4.8	3
3	Wendell St. to Wainwright RR Bridge	11-14.5 (17.7-23.3)	5.6	3.5
4	Wainwright RR Bridge to Badger Slough	14.5-21.5 (23.3-34.6)	11.3	7
5	Badger Slough		26.6	16.5
6	Badger Slough to Little Chena	21.5-25	5.6	3.5
7	Little Chena River		99.0	61.5
8	Little Chena to Nordale Slough	25-31.5 (40.3-50.7)	10.5	6.5
9a	Nordale Slough to Bluffs	31.5-55.5 (50.7-89.4)	38.6	24
9b	Bluffs to Bailey Bridge	55.5-63 (89.4-101.4)	21.1	7.5
10	Bailey Bridge to Hodgins Slough	63-79 (101.4-127.2)	25.8	16
11	Hodgins Slough to 90 Mi. Slough	79-90 (127.2-144.9)	17.7	11
12	90 Mi. Slough to First Bridge	90-92 (144.9-148.1)	3.2	2
13	First Bridge to Second Bridge	92-94.5 (148.1-152.1)	4.0	2.5
14	Second Bridge to North Fork	94.5-102 (152.1-164-2)	12.1	7.5
15	North Fork of Chena River		56.4	35
16	East Fork of Chena River		99.8	62

* km in parentheses

JOB R-I-A Population Structure, Migratory Patterns and Habitat Requirements of the Arctic Grayling.

OBJECTIVES

1. Determine Arctic grayling populations and age class Structure in index sections of the Chena River.

2. Determine the dynamics of the spring migration of Arctic grayling in Badger Slough.

3. Determine the effects of capturing and handling techniques on Arctic grayling using long and short term holding experiments.

FINDINGS

Population Estimates

Mark and recapture population estimates for Arctic grayling, *Thymallus arcticus* (Pallas), in the Chena River were held to a minimum during the 1975 field season because of concern that undue harm was being done to the population by the alternating current electrofishing unit used to capture the grayling. Of the four Chena River sections in which yearly population estimates (Roguski and Tack, 1970; Tack, 1971, 1972, 1973 1974, 1975) have been made, only Section 6 (the 5 km section of Chena River between the mouth of Badger Slough and the mouth of the Little Chena River) was used this year. During the time the estimate was conducted, the water was low but carried enough silt to limit visibility to about one meter. The silt was entering the Chena River from the Little Chena River as the result of a mining operation in the headwaters of the Little Chena River. Capture rate was very poor (13.2 grayling/hr). Results and details of the estimate were as follows:

			Grayling per kilometer	
Inclusive dates of marking	GR Marked	GR Recap	Schumacher-Eschmeyer Estimate	90% Confidence Limits
7/10 - 7/14	63	2	191	114 - 589

The number of grayling involved in the estimate was small so the results should be regarded with caution. The estimate is for grayling over 150 mm fork length. The estimate of 191 grayling/km represents an increase over the 1974 estimate of 100 grayling/km (Tack 1975).

Annual Survival Rate

In 1973 sampling was begun to yield age frequency data to facilitate monitoring the recruitment and survival rates of Arctic grayling in the lower Chena River. Since the calculations are based on the assumption that all age classes accessible to the capture equipment are represented in the sample proportionately to their presence in the population, some precautions were necessary. The sampling was done at approximately the same time each year to avoid variation due to seasonal migration of various age groups. In 1973 and 1974 large samples were taken and subsequently randomly sub-sampled. In 1975 so few grayling were captured that the entire initial sample of 89 fish was used.

The age frequency of the 1975 sample (Table 2) reveals one feature of overriding significance. Age Class III is depressed for the second year in succession. Though not as seriously as in 1974 (Tack, 1975) it is still far below the 60.5% in 1973 (Tack, 1974). The 1973 data for the Chena River and Goodpaster River (Tack, 1974) showed the electrofishing equipment used in all sampling to representatively sample Age Classes III and above. Thus the fact that Age Class V numerically exceeds Age Class III in the 1975 sample is further indication of the depression of Age Class III. It could also be argued that Age Class III in 1973 was exceptionally large and it probably was at a very good recruitment level. The average recruitment level for Chena River grayling probably falls somewhere between the low 12.1% in 1974 and the high 60.5% in 1973. Several more years of data will be needed to verify trends in recruitment.

The annual survival rates calculated from the 1975 data (Table 3) are confused by the strong 1970 year class (Age Class V) or the low 1971 and 1972 year classes (Age Classes III and IV). This variable recruitment makes survival rates calculated between year classes erratic. Survival of cohorts is also affected by variable recruitment. An attempt to smooth this effect was made by setting the 1974 and 1975 Age Class III equal to the 1973 Age Class III and recalculating subsequent age class values according to the formula:

$$C_{yi} = \frac{(0_{yi})\ (100\% - 0_{73}\ III)}{100\% - 0_{y}III}$$

where

C_{yi}=adjusted age frequency for year y and age class i

0_{yi}=observed age frequency for year y and age class i

$0_{73}III$= observed 1973 age frequency for Age Class III of 60.5%

$0_{y}III$=observed age frequency for year y and Age Class III

(12.2% in 1974) (24.7% in 1975)

The adjusted data produced somewhat more consistent survival rates for cohorts, but more years of data will be necessary before useful survival rates can be derived.

Table 2. Age and length frequency of grayling captured in section 6 and at the Chena River Dam Site, 1975.

Fork Length (mm)	I	II	III	IV	V	VI	VII	VIII	n	Length Freq.
130										
140										
150										
160		4							4	4.5
170		5	2						7	7.9
180		1	5						6	6.7
190		2	1						3	3.4
200			4						4	4.5
210			4	2	4				10	11.2
220			5	3	3	1			12	13.5
230			1	3	3	2			9	10.1
240				2	5	1			8	9.0
250				2	4	3			9	10.1
260					2	2			4	4.5
270						4	1		5	5.6
280					1	4	1		6	6.7
290					1				1	1.1
300										
310										
320								1	1	1.1
330										
n		12	22	12	23	17	2	1	89	
Age Freq %		13.5	24.7	13.5	25.8	19.1	2.2	1.2		
$\bar{x}$ Fork Length		171	200	229	238	258	275	...		

Table 3. Survival rates of grayling in lower 76 km of the Chena River based on age frequency data from 1973, 1974, and 1975.

	Percent Frequency					Annual Survival Rate						
Age Class	1973	1974	1974a*	1975	1975a*	1973	1974	1974a	1975	1975a	1973-74a Cohorts	1974a-75a Cohorts
III	60.5	12.1	60.5	24.7	60.5							
						0.298		0.327	0.546	0.117	0.327	0.117
IV	18.0	44.1	19.8	13.5	7.1							
						0.167	0.562	0.566			0.622	0.682
V	3.0	24.8	11.2	25.8	13.5							
							0.157	0.161	0.740	0.740	0.600	0.893
VI	0.0	3.9	1.8	19.1	10.0							
							0.077	0.056	0.115	0.120		0.667
VII	0.5	0.3	0.1	2.2	1.2							

*a - Data adjusted by setting the frequency for Age Class III equal to the 1973 Age Class III frequency and recalculating the frequency for subsequent age classes.

Badger Slough Study

Badger Slough enters the main Chena River 34.6 km above the latter's confluence with the Tanana River. Badger Slough (Chena Slough on most maps) was a slough of the Tanana River prior to 1941 when the Army Corps of Engineers built a levee along the northerly bank of the Tanana River as flood protection for Fairbanks and Fort Wainwright (then Ladd Air Force Base). The levee cut off the flow of heavily silt laden water into the slough and as a result the slough became a clear-flowing stream draining the lowlands behind the levee.

Badger Slough is fed by springs and seepage that are sufficiently warm to keep portions of the headwaters open throughout the winter. Also because of the slightly warmed water in the slough, ice in the lower stretches of the slough melts out before other rivers, including the Chena, break up There is usually enough open water by the first week of April to provide angling opportunities. A few grayling are usually present when the first open leads occur but success is not good until the latter half of April. The fishery becomes very active during late April and most of May, then drops to a fraction of the spring level for the remainder of the summer The drop in fishing effort is probably due to several factors including other streams becoming ice free, the appearance of a lush growth of macrophytes in the slough, and probably the movement of many grayling back into the Chena River. The fishery has been assessed for six of the last eight years (Table 4) showing fluctuations in effort and catch per unit of effort but no trends.

Other than creel census information, little was known about the grayling population. Though the fish appeared to run up the stream early in the spring this was not known positively, nor were the size of the run and the age classes involved. Gravid females were occasionally taken in the fishery but no spawning had been observed. Nor was it known if the grayling present in April and May remained in Badger Slough all summer or returned to the main Chena River. The following study was undertaken to answer some of these questions.

On April 8, 1975, a weir was placed across the mouth of Badger Slough by cutting through about 16 inches of ice and driving metal fence posts into the bottom. The weir and upstream trap were kept in operation until April 29 when rising water washed them out. During the period of operation the weir was not always a complete barrier due to washouts under the frozen part of the bank. It is assumed, however, that a representative cross section of the upstream migration of grayling was captured. All grayling captured were measured, scale sampled for age determination, fin clipped, and tagged if over 150 mm fork length.

Shortly after the weir was put in place on April 8, the upstream migration increased rapidly to peak on April 14 (Fig. 1). The peak consisted primarily of adult grayling and grayling between 125 mm and 270 mm fork length. Following the peak, the number of yearling grayling (less than 125 mm fork length) increased steadily until April 23, while the number of adult grayling decreased. After April 23 the run appeared to drop off;

Table 4. Summary of Creel Census results for Badger Slough 1968 to 1975.

Year	Inclusive Dates of Census	Days	Total Angler Hrs	Total GR Harvest	GR/day	GR per Angler Hr
1968*	4/17-5/31	45	8,970	7,355	163	.82
1969**	4/12-5/31	50	6,929	5,542	111	.80
1970***	5/01-5/31	31	6,206	2,669	86	.43
1971	No Census					
1972****	4/08-5/24	47	7,174	6,170	131	.86
1973*****	4/05-5/31	57	8,511	9,958	175	1.17
1974	No Census					
1975	4/09-5/31	53	5,947	5,639	106	.95

* Roguski and Winslow, 1969
** Roguski and Tack, 1970
*** Tack, 1971
**** Tack, 1973
***** Tack, 1974

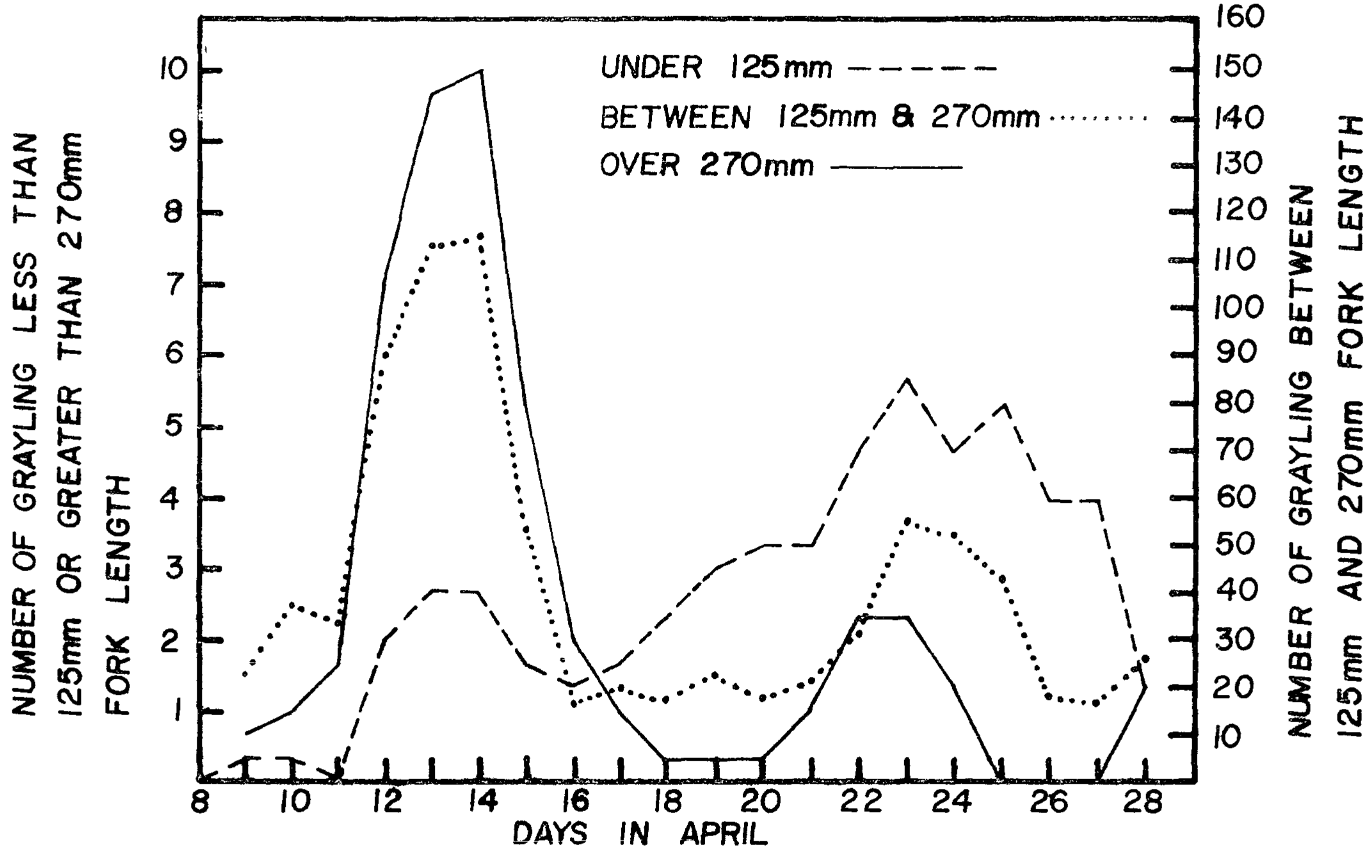

FIGURE 1

NUMBER OF YEARLING (UNDER 125mm), JUVENILE (BETWEEN 125mm AND 270mm), AND ADULT (OVER 270mm) GRAYLING PASSING THE BADGER SLOUGH WEIR FROM APRIL 8 TO APRIL 28, 1975 (DATA SMOOTHED BY MOVING AVERAGE OF 3).

however, a large hole under one bank was found April 28, which may account for the drop in numbers. The size of the run was not determined by this study as the temporary weir was not a total block to fish passage.

Of the approximately 1,000 grayling tagged at the weir in April, 75 tags were returned by anglers. Eleven tags were returned in April, all from Badger Slough. May recaptures totaled 51, of which 46 came from Badger Slough and 5 from the lower Chena River. Thirteen recaptures were made in June, of which 7 were from Badger Slough and 6 from the Chena River downstream from the mouth of Badger Slough. No recaptures were made in later months. These recapture results indicate that grayling begin moving back into the Chena River in May and continue this movement in June. The results, however, are only indications as it was observed that some grayling moved out of Badger Slough immediately after leaving the resting pool following tagging. They apparently went through holes in the weir and were later recaptured at the weir trying to reenter Badger Slough. It should also be noted that very little angling occurs in the Chena River in April and May, while in June angling pressure is greater in the Chena River than in Badger Slough.

A survey of Badger Slough was done in early May to determine the extent of grayling distribution and the presence or absence of spawning. Grayling were found throughout the main slough and well into its two main headwater branches. On May 12, grayling were observed spawning on riffles from Peede Road crossing upstream for 8 km to the eight mile turnout. Three days later spawned out grayling were found above eight mile turnout in both headwater branches and probably had spawned there.

The Badger Slough study provided several pieces of useful information toward the management of the fishery but did not yield a good estimate of the run size. Tag and recapture techniques for population estimation were unreliable because of the tendency of anglers not to report the recaptures and the impossibility of contacting anglers to retrieve the tags. A more durable weir set across Badger Slough above the winter ice bridge at the northeast end of Persinger Drive probably would provide means for enumerating the run.

Effects of Alternating Current Electrofishing Techniques on Arctic Grayling

Boat mounted ac electrofishing units have been used to capture fish in Interior Alaska since 1967 (Van Hulle, 1968). These units were initially used to capture Arctic grayling.

During this early work the alternating current system was more productive than direct current electrofishing in the river conditions where grayling were found. Early work by Webster et al. (1955) also found ac superior to dc of equal strength for capturing brown trout in a stream situation.

In early work, electrofished grayling were observed for periods of up to an hour in tubs or streamside eddies (Roguski, E.A., 1975, pers. comm.)*. It was concluded that grayling could withstand the stress of ac shock since, with rare exception, they recovered rapidly in the live pen and swam away upon release in quiet pools. On several occasions, grayling tagged after being captured by electrofishing were recaptured by anglers the same day. In 1972 a large number of grayling were captured by electrofishing and subsequently used by personnel of the Institute of Water Resources in experiments on thermal tolerances of these fish (LaPerriere and Carlson, 1973). Besides finding grayling tolerant of temperatures in excess of 20°C they had virtually no mortality attributable to the method used to capture the fish.

The problem of delayed mortality, however, needed clarification before the ac electrofishing unit could be used for accurate population dynamics work. Spencer (1967) reported the occurrence of dislocated vertebrae and ruptured dorsal arteries in bluegills, *Lepomis macrochirus* Rafinesque, and largemouth bass, *Micropterus salmoides* (Lacepede), in relation to various levels of ac and dc current. For bluegills, vertebral fractures and dislocations averaged 4.6% for 155 Volts ac at 2 Amperes and only 1.5% for 115 V dc at 1.9 A. Spencer points out that not all fish with obvious injuries died, and some fish that died appeared to have no injuries. Hauck (1949) observed a variety of harmful effects of 115 V ac shock on large rainbow trout, including the appearance of dark vertical bars on that area of the fish which touched an electrode. A mortality rate of 26% occurred among 503 trout averaging 3.7 lbs. Pratt (1955) compared the effects of alternating and direct current on three species of trout by holding them 1' from an electrode (the positive electrode for dc) for 15 seconds. There was no difference in mortality between the three species, but at the end of the 36-day experiment involving three shockings, 11.1% (15 fish) of the 135 fish exposed to alternating current died while only 2.0% (3 fish) exposed to direct current died.

The following experiments were undertaken to assess the mortality rate that could be expected when the alternating current electroshocker was used to capture grayling for mark and recapture population estimates. Time constraints prevented successful testing of the marking or tagging process so these findings are concerned only with the capture method.

Short term holding experiments were conducted in 1974 (Tack, 1975) and repeated in 1975 to verify the 1974 findings. (The 1974 experiments showed a substantially higher rate of mortality and injury among grayling captured by ac electrofishing than among grayling captured by seine.) The 1975 experiments sought further to determine cause of death or nature of injury and also observed how mortality occurred during the 72 hour holding period.

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*Roguski, E. A., Alaska Department of Fish and Game, Fairbanks Alaska.

Two sets of experiments were run in 1975. The first set began June 16 and involved 100 grayling captured with 150 V at 2.5 A. This level of electricity was the minimum that would effectively stun grayling under the conditions extant in the Chena River at this time and would therefore be the normal working level. One hundred grayling were tested at that level in 1974. The second set of experiments began June 23 and tested groups of 25 grayling captured at progressively higher voltage settings. The second set also included 50 grayling captured by seine. The time required to capture, transport and inspect each batch of grayling is shown in Table 5.

The condition of fish in each batch when entered into the pens, during the 72 hour holding period, and at the conclusion of the experiment is shown in Table 6. The results from pens 3 and 4 of Set I were affected by fish being caught in folds of the holding pens. In pen 3 only two fish were involved but both died. In pen 4 nearly all the fish were trapped for several hours and mortality was high. In subsequent discussion of the results of this study, the condition and results data from pens 3 and 4 of Set I are not included.

Another abnormality in the experimental procedure occurred when the amperage dropped at voltage settings above 200. This happened in both 1974 and 1975. The same Coffelt shocker control box was used both years and the same generator was used for all except the 225 V and 250 V captures in 1975.

There was not an obvious pattern to the mortality data occurring during the 72 hour holding period in 1975. Of the 10 deaths that occurred, one was dead upon reaching the holding pen, four died in the first 24 hours, three in the second 24 hours and two in the third 24 hours. Considering the large number of fish still in the injured catagory after 72 hours, it seems likely that more deaths would have occurred had the holding period been extended.

Autopsy of nine of the ten grayling that died during the holding period revealed the following: one had a broken spine, internal hemorrhage and hemorrhage of the caudal vessels; one had internal and caudal vessel hemorrhage; two had internal hemorrhage only; three had caudal vessel hemorrhage only; and two had no discernible injuries.

Fourteen of the 50 grayling classified as injured in the 1975 experiments (excluding pens 3 and 4 of Set I) were autopsied. The selection was not random, as the more severely injured were favored. Three fish had both internal and caudal vessel hemorrhages, one had internal hemorrhage only, five had caudal vessel hemorrhage only and two had both caudal hemorrhage and broken spines. One grayling had a large bruise on one side and swam poorly, another swam poorly and was very pale colored. Still another had developed an infection behind the eyes causing them to protrude. The two fish with broken spines and caudal hemorrhages were belly-up and both also had one or both eyes clouded. The other 36 grayling classified as injured were able to swim well and appeared healthy enough to have a good chance of survival, so were released.

Table 5. Capture and handling information for test groups used in short term holding experiment to test effect of ac electroshock on Arctic grayling, 1975.

Date of Capture	Pen No.	Treatment	Time to Capture	Time to Transport & Enter into Pens	Water Temp
6/16/75	1&2	150 V 2.5 A	37 min	30 min	13°C
	3&4	150 V 2.5 A	43 min	15 min	13°C
	5	175 V 3.0 A	15 min	10 min	13°C
6/23/75	3&4	seined	30 min	15 min	13°C
	1&2	200 V 4.4 A	15 min	20 min	13°C
	5	225 V 3.5 A	10 min	15 min	13°C
	6	250 V 3.0 A	25 min	20 min	13°C

Table 6. The condition of grayling at entry to the holding pens, during the 72 hour holding period and after the holding period, 1975.

Capture Treatment	Pen No.	Condition of Fish Entered: Healthy	Injured*	Dead	Black Marks	Belly-Up	Other Injury	Condition of Fish During Experiment: 0-12 Hrs D**	0-12 Hrs BU***	12-24 Hrs D	12-24 Hrs BU	24-48 Hrs D	24-48 Hrs BU	48-72 Hrs D	48-72 Hrs BU	Results After 72 Hours: Healthy	Near Dead	Dead	Injured	Black Marks	Necrotic Areas	Lacerations	Bent Spine	Remarks
SET I																								
150 V**** 2.5 A*****	1	16	9	0	8	4	1 w/bent spine	1	2	0	1	1	1	1	1	16	0	3	6	3	2	0	1	
150 V 2.5 A	2	15	10	0	9	0	1 w/broken spine	0	0	0	1	0	1	1	0	18	0	1	6	2	3	0	1	
150 V 2.5 A	3	12	13	0	13	2		1	1	3	0	0	0	0	0	10	0	4	11	8	7	0	0	2 fish died in fold of pen
150 V 2.5 A	4	18/61	7/39	0/0	6/36	1/7	0	0/2	2/5	6/9	1/3	3/4	2/4	2/4	1/2	10/54	1/1	11/19	4/27	3/16	1/13	0/0	0/2	many fish trapped in fold of holding pen for several hours
175 V 3 A	5	7	18	0	14	4	1 w/bent spine	1	0	0	1	1	0	0	0	16	0	2	7	6	4	0	1	
SET II																								
Seined	3	24	1	0	0	0	0	0	0	0	0	0	0	0	0	24	0	0	1	0	0	1	0	
Seined	4	25	0	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	
200 V 4.4 A	1	8	17	0	15	6	0	0	1	0	2	0	2	0	1	12	1	0	12	2	7	2	0	
200 V 4.4 A	2	6	19	0	19	3	1 eye w/ laceration	0	1	0	0	0	0	0	0	15	0	0	9	5	3	1	0	1 fish escaped
225 V 3.5 A******	5	6	19	0	18	2	3 w/blood spots under scales	1	0	0	0	0	0	0	0	14	0	1	9	7	2	0	0	1 fish escaped
250 V 3 A******	6	8	16	1	16	0	1 w/right eye popped out	0	2	1	1	1	0	0	0	19	0	3	3	1	1	1	0	

* Injured-includes total number of fish with injuries. Some fish had more than one type of injury.
** D-dead
*** BU-belly up
**** V-volts
***** A-amperes
****** The Amperes dropped when a new generator was used

The average condition of each group of grayling improved during the holding period in 1975. In all groups except the two disqualified there were as many (in one case) or more healthy fish after 72 hours than when entered. By far the most common injury at time of capture was the appearance of black marks on the fish's sides. Some of these were vertical bars no more than 3 mm wide but some involved one whole side or major part of one side of a fish or both sides of the caudal peduncle. After 72 hours some of the black marks disappeared; others turned white, swelled up and became devoid of slime. Autopsy revealed that black areas resulted when underlying blood vessels ruptured. When the caudal peduncle was black it usually indicated a rupture of the caudal vein or artery. The larger black areas resulting from the rupture of several vessels and cases of black caudal peduncle almost always turned white in color after a day or two. The small black marks remained black or disappeared altogether.

The ultimate fate of grayling with necrotic areas is not known at this time. After 72 hours fish with necrotic patches up to 6-8 cm^2 were swimming quite well and otherwise appeared healthy. In cases where the entire caudal region was affected, the fish swam poorly and often had trouble remaining upright.

A number of conclusions can be drawn from the results of the short term holding experiments. Table 7 summarizes the results in percentage form to aid in the evaluation. It is apparent that seine captured grayling were in excellent condition after 72 hours in comparison to shocker captured fish, leading to the conclusion that capture by the ac electroshocker used in this experiment was more damaging to grayling than seine capture. In the two years of testing, one grayling died and two were injured of 102 captured by seine. Shocker capture of 369 grayling resulted in 20 (5.4%) dead or near dead and 87 (23.6%) injured. Even the 144 grayling captured with the lowest voltage (150 V) had 6.2% dead or near dead and 17.4% injured.

The 14 injured grayling taken for autopsy after holding in the 1975 experiments would probably have died if released. Most swam poorly and the injuries found were of a debilitating nature. Even if only half of them died it would mean that 10% of the grayling handled in 1975 subsequently died.

The use of progressive voltage levels from 150 to 250 V did not produce a clear pattern of increased mortality and injury with increased voltage. The 1974 data indicated a pattern of increasing injury rate with voltage but the 1975 data showed the greatest injury rate at 200 V and the lowest rate at 250 V. These ambiguous results are probably the result of inherent variability in the shock received by any one fish depending on where it entered the electric field. The electric field created by the four 1/2" electrodes is "hottest" near the electrodes (Novotny and Priegel, 1974), a characteristic that is aggravated by use of small diameter electrodes.

It is probably manipulation of the electrode configuration and size that provides the best possibility of decreasing the harmful effects of ac electroshock capture techniques.

Table 7. The results of short term (43 to 65 hrs in 1974; 72 hrs in 1975) holding experiments to test the effect of capture by ac electroshocker on Arctic grayling.

Capture Voltage	Capture Amperage		No. of Grayling		Percent of Grayling							
					Healthy		Near Death		Dead		Injured	
	1974	1975	1974	1975	1974	1975	1974	1975	1974	1975	1974	1975
150 V	2.5	2.5	94	50	51	68	2	0	3	8	14	24
175 V	4.0	3	25	25	76	64	8	0	0	8	16	28
200 V	5.0	4.4	25	50	76	54	8	2	0	0	16	42
225 V	4.3	3.5	25	25	64	56	4	0	4	4	28	36
250 V	3.0	3.0	25	25	64	76	0	0	8	12	28	12
Seine capture			52	50	94	98	0	0	2	0	2	2