Informational Leaflet 11

REHABILITATION OF BIG KITOI OUTLET STREAM, AFOGNAK ISLAND, ALASKA

By:

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April 3, 1962

STATE OF ALASKA
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DEPARTMENT OF
FISH AND GAME
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INTRODUCTION

In Alaska, both pink *(Oncorhynchus gorbuscha)* and chum *(Oncorhynchus keta)* salmon deposit their eggs in the gravel of coastal streams from July until October and fry migrate into saltwater the following spring. During the period of downstream migration both species of fry are from 26 to 36 millimeters long; being newly-emerged from the gravel, they are relatively helpless and are subject to extensive predation by larger fish.

One predator upon salmon fry is the freshwater sculpin (any one of a number of species of *Cottus*). Since studies of pink salmon were being conducted in Big Kitoi Outlet and since large numbers of sculpin *(Cottus aleuticus)* were found in this stream, a study was undertaken to determine the effect of treatment with toxaphene and rotenone upon the sculpin population.

One thousand lineal feet of Big Kitoi Outlet was used for this study; the stream was treated and studies were continued after treatment. Objectives were as follows:

1. To estimate number of *Cottus aleuticus* in a portion of Big Kitoi Outlet prior to treatment.

2. To determine extent of predation by sculpins on pink salmon fry during the spring downstream migration.

3. To determine types of invertebrate organisms living in the streambed and at the same time to find out food preferences of sculpins.

4. To evaluate the effect of administration of toxaphene on vertebrate and invertebrate organisms.

5. To determine rate of recruitment of vertebrate and invertebrate organisms after eradication of original populations.

This report is a brief summary of results of the rehabilitation of Big Kitoi Outlet. The length-weight relationship of sculpins, a starvation experiment, rate of recruitment of bottom organisms, rate of recruitment of sculpins from the lake and stream above the treated area, and observations on the life history of these fish will all be treated in more detail in later reports.

DESCRIPTION OF THE AREA

Big Kitoi Outlet (in the Chugach National Forest, Afognak Island) runs from Big Kitoi Lake (356 acres) for about 2,000 feet before it enters saltwater adjacent to Alaska Department of Fish and Game Kitoi Bay Research Station (Figure 1). The stream varies in width from 15 to 20 feet at the lake outlet to 60 feet in the extreme lower reaches. Average depth is about 11 inches. Since the stream is accessible to salmon for only half its total length (1000 feet) no physical characteristics were determined above the falls.

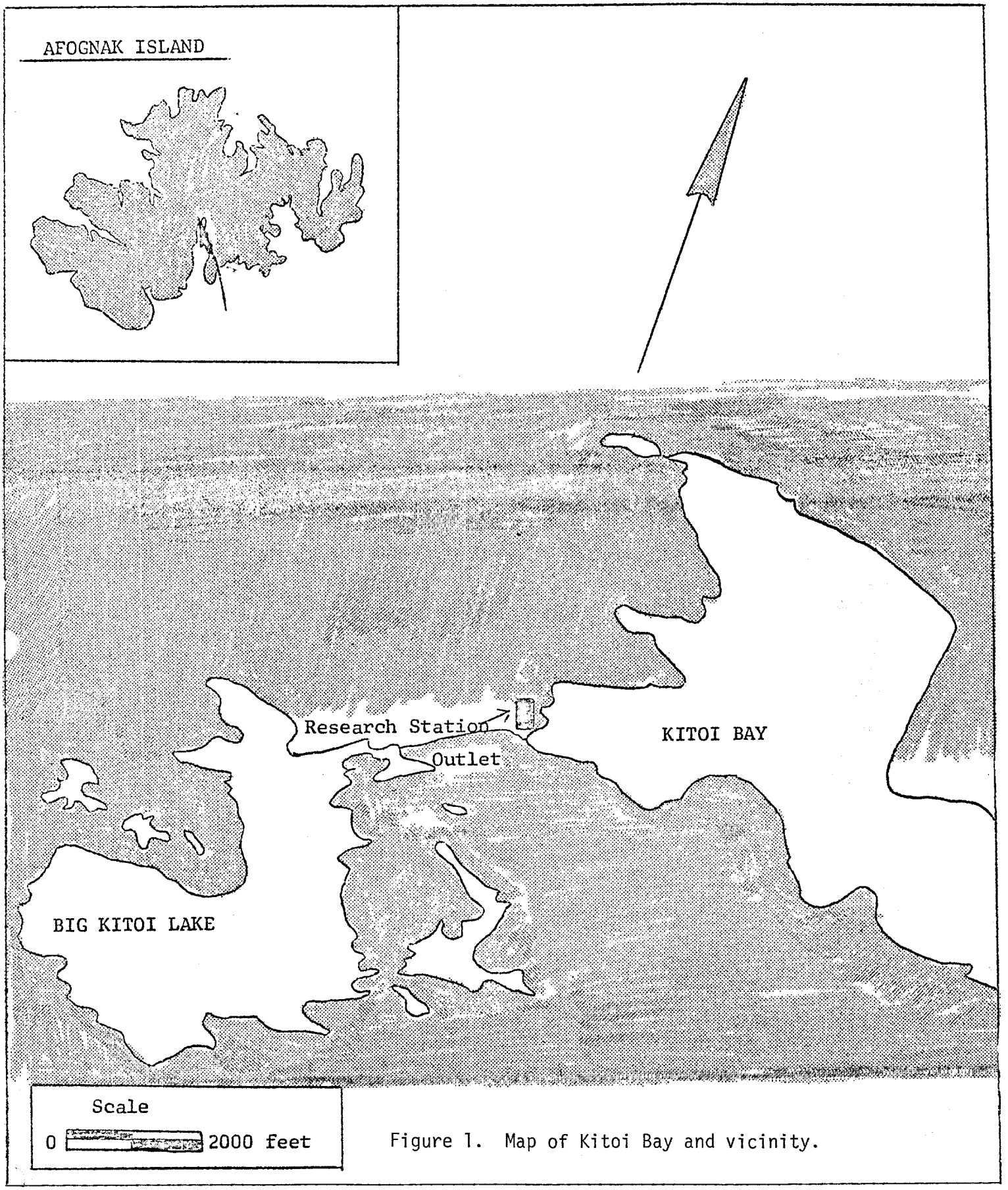

Figure 1. Map of Kitoi Bay and vicinity.

From falls to tidewater, the average gradient is 2.30 percent. The streambed is composed of rocks 6 to 18 inches in longest diameter with smaller materials in between. Analysis of samples of gravel show that at least 80 percent of the particles composing the streambed are larger than three millimeters.

No accurate statistics are available on spawning ground escapements to Big Kitoi Outlet prior to initiation of Department pink salmon studies. In 1960, there was an escapement of about 4,000 and in 1961, of about 5,000 pink salmon. Also present in the stream from time to time are coho salmon *(Oncorhynchus kisutch)*, dolly varden *(Salvelinus malma)* and rainbow trout *(Salmo gairdnerii)*, three-spined stickleback *(Gasterosteus aculeatus* - saltwater type*)*, a few smelt *(Osmerus* sp.*)*, and a few blennies *(*the crescent gunnel, *Pholis laeta)*.

THE REHABILITATION OPERATION

Big Kitoi Outlet stream was treated with toxaphene on July 5 and 6 and with rotenone on July 9, 1961.

Toxaphene was Agricultural Cooper Tox No. 6. Original five gallon cans were placed at the top of the 12 foot falls, and the emulsifiable concentrate was metered from the can by means of a simple siphon, rubber tube and adjustable clamp. Rate of flow was determined with a graduated cylinder and stopwatch. Thorough mixing was insured by the cascading water.

The first five gallons of toxaphene were metered over a period of 11.5 hours on July 5, and the second five gallons over a period of seven hours on July 6. Concentration of toxaphene was calculated on the basis of amount of liquid from the can mixed with known discharge of the stream (13.1 second feet).

Concentrations during the first day ranged from 0.225 to 3.000 ppm with an average concentration during the 11.5 hours of 1.232 ppm. On the second day, concentrations ranged from 1.438 to 2.696 ppm with an average concentration during the seven hours of 2.025 ppm.

On July 9, four 50 pound bags of rotenone were slit and placed at the same location as the toxaphene. Rotenone powder was allowed to leach from the bags for 5-1/2 hours; then the bags were dumped, creating a strong concentration of rotenone for a short period of time.

After treatment, all visible dead fish were counted. In addition, rocks were turned over and the streambed examined because most of the sculpins remained under rocks after they had died.

On one gravel bar in the intertidal zone, live sculpins were found (after the first day's treatment) under rocks after the tide receded. This bar was liberally sprinkled with powdered rotenone and the next day all sculpins were dead.

METHODS

Toxicity Tests

Toxicity of stream water was evaluated by placing live fish in small wire screen minnow traps up and down the stream and observing effects on fish at periodic intervals during and after treatment.

We determined the population of sculpins in Big Kitoi Outlet prior to poisoning by flushing random four square foot areas with a mixed air-water jet directed into the streambed (McNeil 1960). Sculpins are dislodged from the streambed and washed into a collecting net.

We determined the extent of predation by capturing sculpins with an electroshocker during the morning after a nightly outmigration of pink salmon fry had occurred. Specimens were preserved immediately and stomachs examined later.

Types of invertebrate organisms in the streambed were ascertained by periodic sampling with a Surber square foot bottom sampler. Each sample was sorted, organisms identified and the number in each group recorded. Weights were recorded to the nearest ten thousandth gram and data were transferred to IBM cards for tabulation.

RESULTS

Extent of Mixing

Heavier concentrations of both toxaphene and rotenone caused water in the stream to turn a milky color. Although it appeared that thorough mixing was achieved, a high concentration of fluorescein dye was inserted at the treatment point to make mixing easier to observe. Observations of dye showed complete mixing from the falls to tidewater, even in small pools and backwater eddies.

To determine the extent of penetration of toxicant into streambed gravels, plastic standpipes were placed (depth 7-8 inches) at six cross-sectional stations the length of the stream. A method of determining the concentration of toxaphene in water samples withdrawn from standpipes had previously been worked out in the Kitoi Research Station laboratory. However, when this method gave erratic results, the use of dye-marked water was resorted to. Vaux (in press) and Sheridan (in press) show a constant interchange between surface stream water and water in the gravel of the streambed. Based on these findings alone, we can assume penetration of toxicant into the gravel. In corroboration of the assumption, after dye was released upstream it was easily detectable in samples of water withdrawn from the standpipe.

Effects of Treatment

FISH

Treatment of Big Kitoi Outlet with 10 gallons of toxaphene dispensed over

a period of 18.5 hours at an average concentration of 1.232 to 2.025 ppm apparently achieved a complete kill of resident fish (numbers of fish of each species counted after treatment is given in Table 1).

Table 1. Number of dead fish of each species observed after treatment of Big Kitoi Outlet, July, 1961.

Species	Number Dead
Sculpins	2,000
Dolly Varden char	43
Rainbow trout	3
Coho fingerlings	74
Blennies	6
Total	2,126

Additional treatment with 200 pounds of rotenone was given three days later, merely as added insurance against sculpins remaining alive in either the stream or on gravel bars.

The use of coho and red salmon *(Oncorhynchus nerka)* smolts, three-spined stickleback and sculpins as bio-assay animals showed that the stream became definitely non-toxic after 21 days. In addition to bio-assay results, dolly varden char moved into the stream from saltwater and remained through duration of the salmon spawning run.

BOTTOM INVERTEBRATES

Nine 100 foot (lineal) sections in Big Kitoi Outlet were used in bottom fauna studies. However, major sampling effort was expended in section 3 to 9. Section 3 was flooded by salt water at each high tide and sections 4 and 5 were also influenced by extremely high tides. Section 9 was located immediately below a series of falls which prevent salmon and other fish from gaining entry into Big Kitoi Lake.

As a result of rehabilitating Big Kitoi Outlet effects on bottom organisms were as follows:

1. Insects succumbed more rapidly than other invertebrates such as clams and snails which were the last to disappear.

2. There was a complete kill of insects in the stream; however, molluscs were never completely eradicated although seriously depleted.

3. Amphipods and Isopods in intertidal sections were completely eradicated.

4. Upstream sections became barren of bottom fauna before lower and intertidal sections.

5. When recruitment started, later in the summer, upstream sections were first to show influx of bottom fauna. This is probably due at least partially to drift-in of organisms from the lake and stream above the rehabilitated area.

6. Partially-eradicated mollusc populations were first to show a marked increase.

7. Insects were very slow to appear in quantity and only now (more than six months later) are they again appearing in numbers.

A total of 116 sculpins were taken during the pre-rehabilitation period in March and May. Stomachs of 30 of these fish were empty; contents of the remaining 86 are shown in Table 2 as percent of sculpins taking each group of bottom fauna.

In general, it appears that food organisms were consumed because of availability rather than preference. However, midge larvae (Tendipedidae) seemed to be the most heavily utilized groups in all sections. In the most important intertidal section (Section 3) amphipods were taken to a large extent, and in this section, the midge larvae were less utilized, but also less prevalent.

Sculpins taken during this particular phase of the study did not show a heavy predation on pink salmon fry, but many cottids were captured after the major pink salmon fry migration had ended.

Bottom fauna data are summarized in Tables 3, 4, and 5. Table 3 shows the species composition and number of organisms per square foot in section 3 through 6 prior to rehabilitation in early July. These are combined results of March and May sampling. Results of post-rehabilitation sampling (July, August, and September) are shown in Table 4. Table 5 represents number and weight of organisms per square foot from the combined pre-rehabilitation and post-rehabilitation sampling.

DISCUSSION

A primary objective in treating Big Kitoi Outlet with toxicants was to eradicate the sculpin population because the fish prey upon pink salmon fry. We first established that, generally, sculpins prey upon salmon fry, and secondly we determined that this fish was a predator in Big Kitoi Outlet stream.

Instances of predation by sculpins on salmon fry are mentioned in various reports. There is some conflict on the extent of predation which makes us think that this may depend somewhat on the species of sculpin we are dealing with. Baily (1952) states that food studies on *Cottus bairdi* by Ricker (1934), Koster (1937), and Dineen (1951) indicate that this species is not a serious game fish predator. Bailey's (1952) study agreed with these findings.

Table 2. Number and percent of sculpins utilizing each group of bottom fauna (number of stomachs sampled is 86).

Group	No. and Percent of Sculpins Taking Each Group *						
	Sec. 3 (N=32)	Sec. 4 (N=6)	Sec. 5 (N=17)	Sec. 6 (N=10)	Sec. 7 (N=13)	Sec. 8 (N=8)	Total (N=86)
Tendipedidae	21-66	6-100	13-76	10-100	11-85	6-75	67-78
Simuliidae	0-0	0-0	3-18	1-10	2-15	2-25	8-9
Trichoptera	1-3	0-0	0-0	1-10	1-8	0-0	3-3
Ephemeroptera	0-0	0-0	1-6	0-0	0-0	0-0	1-1
Amphipoda	9-28	0-0	1-6	0-0	1-8	0-0	11-13
Isopoda	2-6	0-0	0-0	0-0	1-8	0-0	3-3
Misc.	7-22	3-50	8-47	5-50	2-15	4-50	29-34
Pink salmon fry	2-6	0-0	0-0	0-0	0-0	2-25	2-2

* Number before dash indicates number of sculpins taking each group. Number after dash indicates percent of sculpins taking each group.

Table 3. Number and percent of organisms per square foot before (March, May) rehabilitation.

Group	No. of organisms/sq. ft. (% organisms/sq. ft.) Sec. 3	Sec. 4	Sec. 5	Sec. 6	Total
Tendipedidae	46.4 (13.8)	24.5 (21.2)	82.3 (61.1)	43.3 (60.6)	49.1 (29.9)
Simuliidae	0 (0.0)	3.3 (2.9)	10.4 (7.7)	12.9 (18.0)	6.6 (4.0)
Misc. Diptera	1.0 (0.3)	3.9 (3.4)	2.0 (1.5)	3.0 (4.2)	2.5 (1.5)
Trichoptera	0 (0.0)	0.6 (0.5)	0.6 (0.4)	0.5 (0.7)	0.4 (0.2)
Ephemeroptera	0.1 (0.0)	0.8 (0.7)	5.3 (3.9)	5.3 (7.4)	2.8 (1.7)
Misc. Insecta	0.1 (0.0)	0 (0.0)	0.1 (0.1)	0 (0.0)	0.1 (0.1)
Annelida	5.0 (1.5)	11.8 (10.2)	0.9 (0.7)	4.3 (6.0)	5.5 (3.3)
Amphipoda	153.6 (45.7)	18.1 (15.7)	0.1 (0.1)	0 (0.0)	43.0 (26.1)
Isopoda	129.8 (38.6)	50.8 (44.0)	0.4 (0.3)	0 (0.0)	45.2 (27.5)
Gastropoda	0 (0.0)	0.3 (0.3)	5.4 (4.0)	0.9 (1.3)	1.6 (1.0)
Pelecypoda	0 (0.0)	1.6 (1.4)	27.3 (20.3)	1.5 (2.1)	7.6 (4.6)
TOTAL	336.0 (99.9)	115.5 (100.3)	134.6 (100.1)	71.5 (100.3)	164.4 (99.9)

Table 4. Number and percent of organisms per square foot after (July-Sept.) rehabilitation.

Group	No. organisms/sq. ft. (% organisms/sq. ft.)						
	Sec. 3	Sec. 4	Sec. 5	Sec. 6	Sec. 7	Sec. 9	Total
Tendipedidae	23.8 (25.1)	10.3 (20.6)	73.0 (93.8)	25.2 (55.3)	14.3 (43.3)	1.4 (17.9)	21.7 (42.8)
Simuliidae	0.2 (0.2)	0 (0.0)	0 (0.0)	0.1 (0.2)	0 (0.0)	0 (0.0)	0.1 (0.2)
Misc. Diptera	0 (0.0)	0 (0.0)	1.5 (1.9)	0 (0.0)	0.7 (2.1)	0.2 (2.6)	0.2 (0.4)
Trichoptera	0 (0.0)	0.1 (0.2)	0.3 (0.4)	0.1 (0.2)	0.3 (0.9)	1.0 (12.8)	0.2 (0.4)
Ephemeroptera	0.2 (0.2)	0 (0.0)	0.5 (0.6)	0.4 (0.9)	0 (0.0)	0.8 (10.3)	0.3 (0.6)
Misc. Insecta	0 (0.0)	0 (0.0)	0 (0.0)	0.2 (0.4)	1.0 (3.0)	0 (0.0)	0.1 (0.2)
Annelida	2.4 (2.5)	3.3 (6.6)	2.0 (2.6)	0 (0.0)	0 (0.0)	0 (0.0)	1.5 (3.0)
Amphipoda	20.6 (21.8)	3.5 (7.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3.7 (7.3)
Isopoda	47.4 (50.1)	19.3 (38.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	11.8 (23.2)
Gastropoda	0 (0.0)	0.5 (1.0)	0.3 (0.4)	5.0 (11.0)	1.0 (3.0)	2.0 (25.6)	1.8 (3.6)
Pelecypoda	0 (0.0)	13.1 (26.2)	0.3 (0.4)	14.6 (32.0)	15.7 (47.6)	2.4 (30.8)	9.2 (18.1)
TOTAL	94.6 (99.9)	50.0 (100.2)	77.8 (100.1)	45.6 (100.0)	33.0 (99.9)	7.8 (100.0)	50.7 (99.8)

Table 5. Number and weight of organisms per square foot before and after rehabilitation.

	Pre-rehabilitation		Post-rehabilitation	
Section	No. per sq. ft.	Wt. per sq. ft. (gms.)	No. per sq. ft.	Wt. per sq. ft. (gms.)
3	336.0	1.3832	94.6	0.4144
4	115.5	0.3097	50.0	0.0692
5	134.6	0.1420	77.8	0.2873
6	71.5	0.1671	45.6	0.0449
7	----	----	33.0	0.1208
9	----	----	7.8	0.0163
TOTAL ALL SECTIONS	164.4	0.5005	50.7	0.1356

On the other hand, Robertson (1949) reported that sculpins (species not mentioned) exacted the greatest toll on sockeye salmon fry migrating from tributary streams into Port John Lake (British Columbia). One sculpin, 4-1/2" long, contained 38 fry and the general average was 13 fry per sculpin. Pritchard (1936) determined that the average consumption of salmon fry by sculpins in McClinton Creek, B.C., for 1931 and 1933 was 0.8 and 1.5 fry per sculpin. Hunter (1959) stated that in Hooknose Creek, Port John, British Columbia, *Cottus aleuticus* and *Cottus asper* were in a ratio of 1:17. Stomach contents indicated they fed almost exclusively on pink and chum fry during the period of downstream migration. Hunter calculated that numbers of pink and chum fry consumed by sculpins alone (1948 to 1957) ranged from 73,868 in 1950 to 276,833 in 1948 (based on 1.5 fry per sculpin X number of sculpins X 35 days, period of 100% effectiveness of predators). Hikata and Nagasawa (1960) reported that of 442 *Cottus nozawae* stomachs examined in Memu Stream, Tokachi River system, 5.42 percent contained salmon fry.

Hence, it is clear that where freshwater sculpins have access to salmon fry, more than one species is a serious predator.

To evaluate the seriousness of predation in Big Kitoi Outlet, numbers of sculpins *(Cottus aleuticus)* were estimated, rate of digestion was studied and stomachs from captured specimens were examined. Population estimates are shown in Table 6.

Table 6. Population estimate of *Cottus aleuticus* in Big Kitoi Outlet stream.

Date	Type of Enumeration	Range of Estimate
November, 1961	Hydraulic excavator	24,026 ± 9,394
March, 1961	Hydraulic excavator	37,957 ± 9,265
July, 1961	Tag and recovery	40,040

A standing crop of 25,000 *C. aleuticus* in Big Kitoi Outlet is used as a basis for calculations in this report.

Rate of digestion studies showed that seven hours after consumption, pink salmon fry were readily detectable as such. After 20 hours, fry were mostly a digested mass, almost unrecognizable as fish. This means that pink fry (recognizable as such) found in sculpin stomachs in the morning were most likely eaten the previous night.

Along with the digestion experiment, a starvation experiment was conducted to determine how long sculpins could go without food. Thirty-five sculpins (5.0 to 9.4 cm long) were held without food from April 11 to July 14, 1961 in a 25-gallon aquarium with running water. The experiment was discontinued on July 14 when the first sculpins died and all were emaciated and in very poor condition. Decrease in weight and 95 percent confidence limits for mean weights over a period of 94 days are shown in Figures 2 and 3. Average weight loss of biomass was 0.92 grams with an average of 0.00979 gram weight decrease per day.

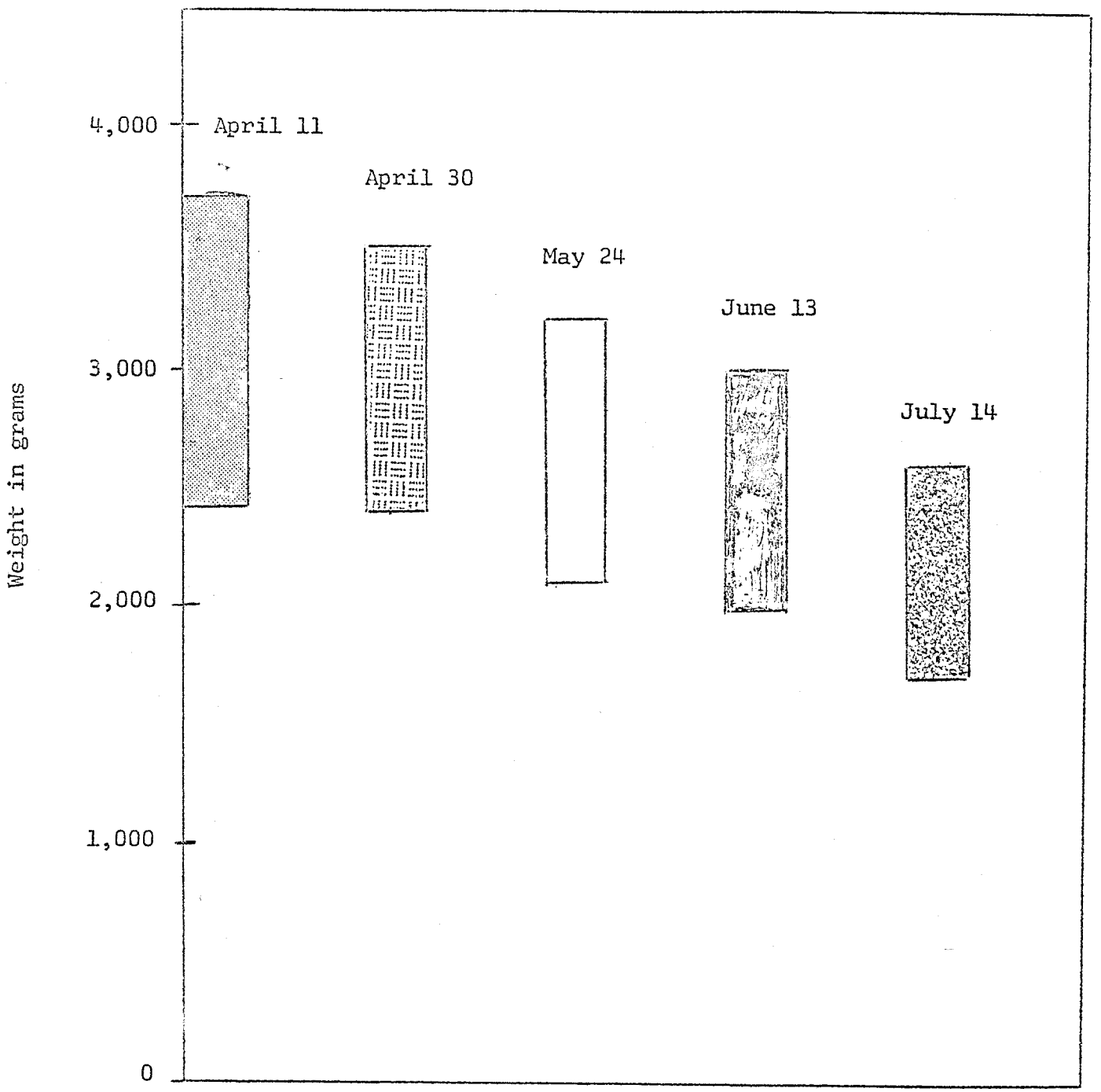

Figure 2. Ninety-five percent confidence limits for mean weights of 35 cottids given no food for a period of 94 days. Big Kitoi Outlet stream, 1961.

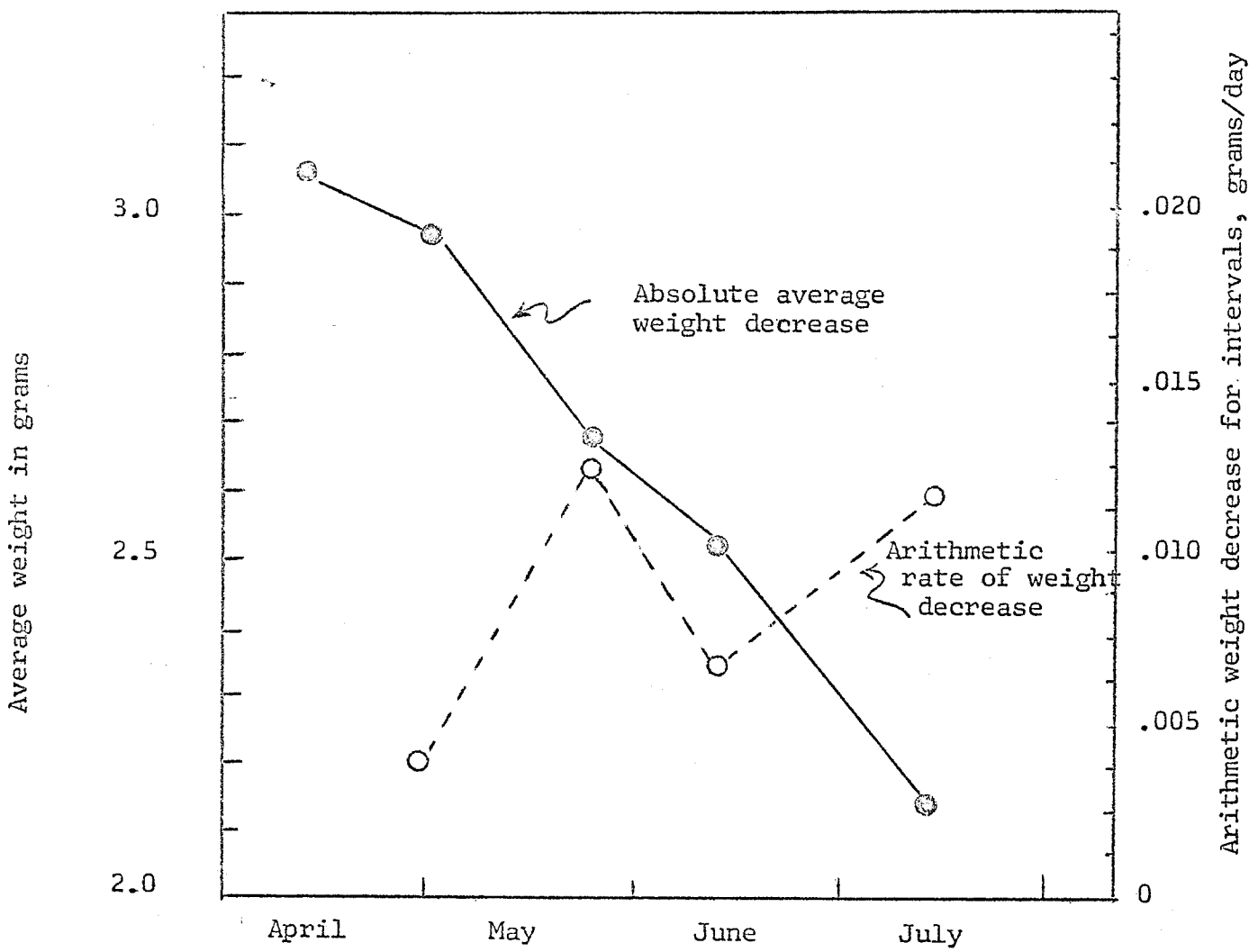

Figure 3. Decrease in weight of 35 cottids held without food for a period of 94 days. Big Kitoi Outlet - 1961.

It does not appear likely that *Cottus aleuticus* is an obligate predator on salmon eggs and fry. This freshwater sculpin usually has many bottom invertebrates available and we know that it feeds on these. It is more likely that salmon eggs in the fall and fry in the spring constitute a major portion of the diet at the time eggs and fry are available, and that invertebrate organisms are eaten during the remainder of the year.

To determine the extent of predation by sculpins in Big Kitoi Outlet, 180 were collected with an electro shocker on May 10, 11, and 12, 1961, while the downstream pink salmon fry outmigration was still going strong. Of the 180 sculpins, 25 contained an average of 2.1 fry, or an overall average of 0.139 fry per sculpin. The smallest sculpin found with fry was 2.7 cm, the largest 8.3 cm long. Of the 25,000 sculpins estimated in Big Kitoi Outlet, 97.8 percent (based on sample of 597 sculpins collected and measured after treatment, or 24,500, fall within the size range of sculpins preying upon pink salmon. Multiplying 30 days (duration of most intense pink salmon fry migration) X number of sculpins (24,500) capable of consuming fry X rate of predation by sculpins (0.139) we find that approximately 102,165 pink salmon fry were probably consumed by sculpins during the spring of 1961. Previously, we estimated 847,500 ± 418,600 fry in the gravel in March; hence 12 percent of the mean estimated number of pink salmon fry were eaten by sculpins.

The effect of predation of this type is density dependent (Neave, 1953). A constant number of sculpins can eat just so many pink salmon fry and no more, regardless of the number of fry available. Therefore, in years when few pink salmon fry are produced, a much larger proportion would be eaten, perhaps enough to keep a depressed spawning run depressed beyond the point of natural rehabilitation.

Big Kitoi Outlet was treated with rotenone in June, 1958. At that time, several hundred dead sculpins were collected and sent to the University of British Columbia. We have no information on the amount of rotenone used, duration of treatment or an evaluation of the extent of kill.

We do know, however, that either a complete kill was not achieved in 1958, or since that time, there has been recruitment into the lower from the upper section of the stream. Actually, both might have occurred. A comparison of the length frequency distribution of dead *Cottus* in 1958 with the length frequency distribution in 1961 indicates that the size as a whole was smaller in 1961 than in 1958 (mean length in 1958, 7.1 cm; in 1961, 5.8 cm). On the other hand, after treatment in 1961, four, five, and six year old sculpins were collected (Table 7). If a complete kill had been achieved in 1958 with no recruitment since that time, these age classes would not have been present in 1961.

Table 7. Age, average length at each age and range of lengths at each age for 111 *Cottus aleuticus* from Big Kitoi Outlet, March and April 1961.

Age	No. in sample in each age group	Average length (cm)	Range (cm)
1	6	2.9	2.4 - 3.6
2	5	3.9	3.2 - 5.0
3	41	5.8	4.4 - 7.2
4	37	6.8	5.8 - 8.0

-Continued-

Table 7. Age, average length at each age and range of lengths at each age for 111 *Cottus aleuticus* from Big Kitoi Outlet, March and April 1961 (continued).

Age	No in sample in each age group	Average length (cm)	Range (cm)
5	20	7.8	6.2 - 9.1
6	1	8.5	8.5
7*	1	13.1	13.1

* Otolith from largest sculpin was very difficult to read; therefore the 7 may be in error.

MANAGEMENT IMPLICATIONS

The results of treating Big Kitoi Outlet with toxaphene clearly show that this is a practical, economical, and effective way to control predators of salmon fry in streams. The amount of toxaphene needed will, of course, depend upon the volume of streamflow. The total amount of toxaphene needed to maintain a concentration of 1 ppm for 16 hours at various streamflows is given in Table 8.

Table 8. Total amount, milliliters per hour, and cost of toxaphene required to maintain a concentration of 1 ppm for 16 hours at various streamflows.

Streamflow in s.f.	Total amount toxaphene (gal)	Milliliters per hour	Gallons per hour	Cost (@ $2.80/gal)
25	10.8	2,549	0.67	$ 30.24
50	21.6	5,097	1.35	60.48
100	43.1	10,194	2.69	120.68
200	86.2	20,388	5.39	241.36
400	172.5	40,776	10.77	483.00
800	344.9	81,552	21.54	965.72
1600	689.8	163,104	43.09	1,931.44

Metering the toxicant into Big Kitoi Outlet was accomplished with a siphon arrangement and adjustable clamp. With this arrangement, it was difficult to maintain a constant flow. To properly meter small amounts of toxaphene (up to 6,000 ml/hour) we suggest first mixing toxaphene with water, ratio 1:1; then, meter from a 50 gallon plastic drum. A method of metering large amounts of toxaphene (3 to 50 gallons per hour) must be developed.

There was no noticeable decrease in toxicity in 1000 lineal feet of Big Kitoi Outlet. However, there might be a decrease in distances over one-half mile because of (1) aeration and (2) adsorption of toxin by streambed particles. This must be determined and will be investigated during the summer of 1962.

Although the method described in this report lends itself to eradication of undesirable fish in streams, it cannot be used where there are resident trout or salmon which should be preserved. Streams where only pink and chum salmon spawn are ideal for treatment. There are a number of these in each area of the state. For instance, Noerenberg (1961) reported that in Prince William Sound, pink and chum salmon comprise 90 percent of the run, sockeye 10 percent. Coho salmon are of little importance and no known spawning runs of king salmon *(Oncorhynchus tshawytscha)* or stellhead trout *(Salmo gairdnerii)* exist.

Conclusive evidence that Big Kitoi Outlet became free from toxicants in a short time is the success of pink salmon spawning in the stream after treatment. Pinks deposited eggs from August 25 until early October; hence spawning first occurred 50 days after treatment. Sampling of eggs in the streambed in November, 1961 revealed a very high survival and subsequent sampling of pre-emergent fry in March, 1962 gave a mean estimate of 1,123,974 fry, or 44 percent survival, eggs to fry.

ACKNOWLEDGMENTS

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We were assisted in fieldwork and collection of data by Leonard Revet and Clayton Copsey of the Kitoi Bay research staff. Miss Sandi Marconi prepared the figures and typed the manuscript.

Dr. Robert R. Parker, now with the Fisheries Research Board of Canada, first suggested the need for a study of sculpins in Big Kitoi Outlet stream.

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