

Objective 3: Determine the population size and distribution of eastern brook in Salmon Creek Reservoir.

ABSTRACT

The population size and distribution of brook trout, Salvelinus fontinalis (Mitchill), was determined in Salmon Creek Reservoir near Juneau. Mark/recapture techniques estimated the population to be 1,250 fish. This estimate ranges from 1,042 to 1,562 at the 95% confidence level. Fish were concentrated in the shallow areas of the lake. Catch per unit effort (CPUE) of 218 traps set in water shallower than 6 m was 1.40 fish/trap, while CPUE of 122 traps set deeper than 6 m was 0.82 fish/trap. Of the shallow trap sets those set in areas of rockslides or rocky substrate produced the highest catches. The average condition factor of fish sampled was 1.06, indicating no sign of stunting or overpopulation. The length-weight relationship of these brook trout was computed to be $\ln W = -11.29 + 2.97 \ln L$ where W = total weight in grams and L = fork length in millimeters. The coefficient of determination (r^2) for this curve was 0.98.

BACKGROUND

Salmon Creek Dam and Reservoir are located 3 miles (4.8 km) upstream from the mouth of Salmon Creek. The dam, located at $58^{\circ}20'30''$ N latitude, $134^{\circ}24'20''$ W longitude, is a concrete arch structure which was completed in 1915 for the Gastineau Mining Company. Salmon Creek Reservoir is about

1.2 miles (1.9 km) long and at the widest point about 0.3 miles (0.5 km) wide. Drainage area behind the dam is 4.3 miles² (11.2 km²). The present total capacity of the reservoir is 17,585 acre feet (21.7 hm³) with surface area of 192 acres (0.87 km²) (Balding, 1974).

Brook trout, Salvelinus fontinalis (Mitchell), fingerlings were originally planted in Salmon Creek Reservoir in 1926 by Joe Sprague of Juneau. The original stock was obtained as eyed eggs from a hatchery in Leadville, Colorado. In 1927 the reservoir was again stocked with 13,150 brook trout. The later plant was very successful and produced excellent fishing during the 1930's. The fishery has declined and fluctuated since that time. Possible causes include excessive winter drawdown of the reservoir and a change in type and abundance of food organisms.

The reservoir receives moderate fishing pressure during the summer months and has provided good ice fishing during the winter. Results from a voluntary report box located on the Salmon Creek trail during the period May 22 through August 30, 1960, revealed a catch rate of 1.6 fish per hour (Baade, 1961).

The daily bag and possession limit for Salmon Creek Reservoir was 30 fish prior to March 1975, while the normal daily limit was 15 fish. After March 1976 the normal daily limit was reduced from 15 to 10 fish, and the double daily limit for Salmon Creek Reservoir was eliminated. This reduction caused considerable public and political pressure to again increase the Salmon Creek Reservoir daily bag limit. On January 9, 1976,

an emergency regulation went into effect for a 120-day period. This temporary regulation again allowed a double daily limit (20 fish) in Salmon Creek Reservoir.

After the adverse reaction to the reduced bag limit the Sport Fish Division initiated a research program to evaluate the size and distribution of brook trout in Salmon Creek Reservoir. This report serves as a summary of that research.

RECOMMENDATIONS

Management

It is recommended that the daily bag and possession limits for brook trout in Salmon Creek Reservoir not be increased. The daily bag limit should be no higher than 10 fish and the possession limit no greater than two daily bag limits.

TECHNIQUES USED

Spacial Abundance and Distribution of Brook Trout

Spacial distribution and abundance of brook trout was determined by capturing fish in minnow traps baited with salmon roe and employing mark/recapture ratios.

Fish samples were taken using standard commercial minnow traps and modified minnow traps. Modified minnow traps were 36 inches (91.4 mm) long and 16 inches (40.6 cm) diameter with entrance funnels having aperture of 2 inches (5.1 mm) on either end. Minnow traps were fished systematically throughout the lake so all areas were sampled.

During the period June 15 through July 16 all fish captured in the large minnow traps were marked with an upper lobe caudal clip. During this initial marking period a multiple census (Schnabel type) was conducted. No fish were removed from the population.

After marked fish had distributed themselves throughout the lake for 7 weeks another sampling and marking effort was expended from September 8 through September 25. Fish were marked with a lower lobe caudal clip. Upon completion of trap sampling a sample was taken with gill nets to assure that sampling with traps was not missing a segment of the population. Population estimates and ranges were calculated by the Schnabel and Schumacher methods.

An attempt was made to capture and mark small rearing fish in the inlets and around the shoreline with commercial minnow traps. Commercial minnow traps were fished in strings from long lines in shallow water near the shoreline. All fish so captured were marked with an adipose clip in an attempt to enumerate this segment of the population.

Length Frequency, Growth, Condition Factor, and Food Habits

The length of fish captured in all traps was recorded as fork length after fish were anesthetized with MS-222. Length measurements were taken throughout the study period.

Growth rate of fish was determined from fish sampled at the end of the study period. Otoliths were taken from gill-net caught fish and preserved for later analyses.

Condition factor of fish was determined from total length and weight of fish captured in gill nets.

Food habits of brook trout were determined from trap and net caught fish. Traps used to catch fish for stomach samples had the bait eggs in containers so fish could not eat the bait. Stomach contents were preserved in 70% ETOH for laboratory identification. Laboratory analysis consisted of identifying and counting organisms.

Zooplankton

Zooplankton were collected by making duplicate vertical tows from 100 m with each of two nets. Nets used were 0.5 m diameter and 3 m long. Straining cloth of the No. 10 Nitex net had aperture of 153 microns and 45% open area, while the No. 20 Nitex net had aperture of 80 microns and 35% open area. Plankton were identified and counted. Dry and ash weight of plankton were determined gravimetrically. Efficiency of nets was not accounted for in calculations.

RESULTS

Abundance and Spacial Distribuion of Brook Trout

Brook trout were captured and marked during the periods June 17 through July 16 and September 8 through September 25. A Schumacher-Eschmeyer (1943) population estimate and associated data are presented in Table 1. The population estimate of brook trout captured by traps was 1,250. This population estimate at the 95% confidence level falls within the range of 1,042 to 1,562 individuals. The Schnabel population estimate calculated from trap data was very comparable at 1,149 fish (Table 2).

Another Schumacher-Eschmeyer population estimate was calculated using both trap and gill-net data (Table 1).

This estimate of 1,476 is higher because one of the gill nets did not capture any marked fish. The range of this population estimate at the 95% confidence level varies from 1,200 to 1,916.

A population estimate of small rearing fish (50 to 90 mm) was not possible. No fish were captured in the inlet streams. Recaptures of adipose-clipped fish marked from the commercial minnow traps set around the shoreline were insignificant.

The population of brook trout in Salmon Creek Reservoir is distributed throughout the benthic area but is more concentrated above 6 m. Traps were not fished in the pelagial area of the lake because of the difficulty in anchoring suspended traps.

Table 1. Estimation of brook trout population by Schumacher method, Salmon Creek Reservoir, 1976,

Date	Ct	Capture Method	Rt	R	M	Mt	MtRt	$\Sigma(MtRt)$	$C_t M_t^2$	$\Sigma(C_t M_t^2)$	$\hat{N} = \frac{\Sigma(MtRt)}{N} = \frac{\Sigma(C_t M_t^2)}{(C_t M_t^2)}$
June 17	5	MT*	0	0	5	0	0	0	0	0	0
18	8	MT	0	0	8	5	0	0	200	200	0
22	2	MT	0	0	2	13	0	0	338	538	0
24	4	MT	0	0	4	15	0	0	900	1,438	0
25	13	MT	0	0	13	19	0	0	4,693	6,131	0
July 8	13	MT	3	3	10	32	96	96	13,312	19,443	203
9	17	MT	1	4	16	42	42	138	29,988	49,431	358
12	18	MT	3	7	15	58	174	312	60,552	109,983	353
13	6	MT	0	7	6	73	0	312	31,974	141,957	455
14	2	MT	0	7	2	79	0	312	12,482	154,439	495
15	17	MT	2	9	15	81	162	474	111,537	265,976	561
16	19	MT	1	10	18	96	96	570	175,104	441,080	774
September 8	49	MT	8	18	41	114	912	1,482	636,804	1,077,884	727
9	33	MT	2	20	31	155	310	1,792	792,825	1,870,709	1,044
10	30	MT	6	26	24	186	1,116	2,908	1,037,880	2,908,589	1,000
13	19	MT	1	27	18	210	210	3,118	617,400	3,525,989	1,131
14	14	MT	4	31	10	228	912	4,030	727,776	4,253,765	1,056
15	19	MT	4	35	15	238	952	4,982	1,076,236	5,330,001	1,070
16	40	MT	9	44	31	253	2,277	7,259	2,560,360	7,890,361	1,087
17	25	MT	5	49	20	284	1,265	8,524	1,600,225	9,490,586	1,113
21	18	MT	3	52	15	304	912	9,436	1,663,488	11,154,074	1,182
22	16	MT	4	56	0	319	1,276	10,712	1,628,176	12,782,250	1,193
16	16	GN**	0	52	0	319					
32	32	MT + GN	4	56	0	319	1,276	10,712	3,256,352	14,410,426	1,345***
23	18	MT	3	59	0	315	945	11,657	1,786,050	14,568,300	1,250****
25	32	GN	5	64	0	315	945	11,657	1,786,050	16,354,350	1,403****
							1,575	13,232	3,175,200	17,743,500	1,341*****
							1,575	13,232	3,175,200	19,529,550	1,476*****

Ct The total sample taken on day t.
Rt The number of recaptures in the sample Ct.
M The number of fish marked from the sample Ct.
Mt The number of marked fish in the lake when the tth sample is drawn.
R ΣRt , the total of recaptures in the experiment.
N The population present throughout the experiment.

*Minnow trap.
**Gill net.
***Estimate includes gill-net catch of September 22.
****Final estimate based on minnow trap catches.
*****Estimate includes gill-net catch of September 25.
*****Estimate includes gill-net catches of September 22 and 25.

Table 2. Estimation of brook trout population by Schnabel method, Salmon Creek Reservoir, 1976.

Date	C_t	R_t	M	M_t	R	$C_t M_t$	$\sum(C_t M_t)$	$\frac{\sum(C_t M_t)}{N = R + 1}$
June 17	5	0	5	0	0	0	0	0
18	8	0	8	5	0	40	40	0
22	2	0	2	13	0	26	66	0
24	4	0	4	15	0	60	126	0
25	13	0	13	19	0	247	373	0
July 8	13	3	10	32	3	416	789	263
9	17	1	16	42	4	714	1,503	376
12	18	3	15	58	7	1,044	2,547	364
13	6	0	6	73	7	438	2,985	426
14	2	0	2	79	7	158	3,143	449
15	17	2	15	81	9	1,377	4,520	502
16	19	1	18	96	10	1,824	6,344	634
September 8	49	8	41	114	18	5,586	11,930	663
9	33	2	31	155	20	5,115	17,045	852
10	30	6	24	186	26	5,580	22,625	870
13	19	1	18	210	27	3,990	26,615	986
14	14	4	10	228	31	3,192	29,807	962
15	19	4	15	238	35	4,522	34,329	981
16	40	9	31	253	44	10,120	44,449	1,010
17	25	5	20	284	49	7,100	51,549	1,052
21	18	3	15	304	52	5,472	57,021	1,097
22	16	4	0	319	56	5,104	62,125	1,109
23	18	3	0	315	59	5,670	67,795	1,149

- C_t The total sample taken on day t.
 R_t The number of recaptures in the sample C_t .
M The number of fish marked from the sample C_t .
 M_t The number of marked fish in the lake when the tth sample is drawn.
R $\sum R_t$, the total of recaptures in the experiment.
N The population present throughout the experiment.

Comparison of the map showing bottom contours of Salmon Creek Reservoir (Figure 1) and the map showing location of trap locations during the spring (Figure 2) shows that most spring sets were in deep water. Most sets made during the fall sampling period (Figure 3) were in shallow water less than 6 m deep. Catch per unit effort of 218 traps set in water less than 6 m was 1.40 fish/trap. Catch per unit effort of 122 traps set deeper than 6 m was 0.82 fish/trap.

Shallow shoreline sets differed considerably in catch success. Traps set in areas of rockslides or on rocky substrate produced higher catches than those set along a sandy shoreline.

Length Frequency, Growth, Condition Factor, and Food Habits

The length frequency of brook trout captured in Salmon Creek Reservoir is shown in Figure 4. The most abundant size class captured were 230 to 239 mm. Over 10% of all fish captured were in this size group. This corresponds with an estimated age of 5.5 to 6 years old (Table 3). The longest fish captured was 301 mm and was 9 years old.

The length-weight relationship of brook trout in Salmon Creek Reservoir is represented by the exponential curve $\ln W = -11.29 + 2.97 \ln L$ where W = total weight in grams and L = fork length in millimeters. The coefficient of determination (r^2) for this curve was computed to be 0.98. This length-weight relationship with ages of brook trout are portrayed graphically in Figure 5.

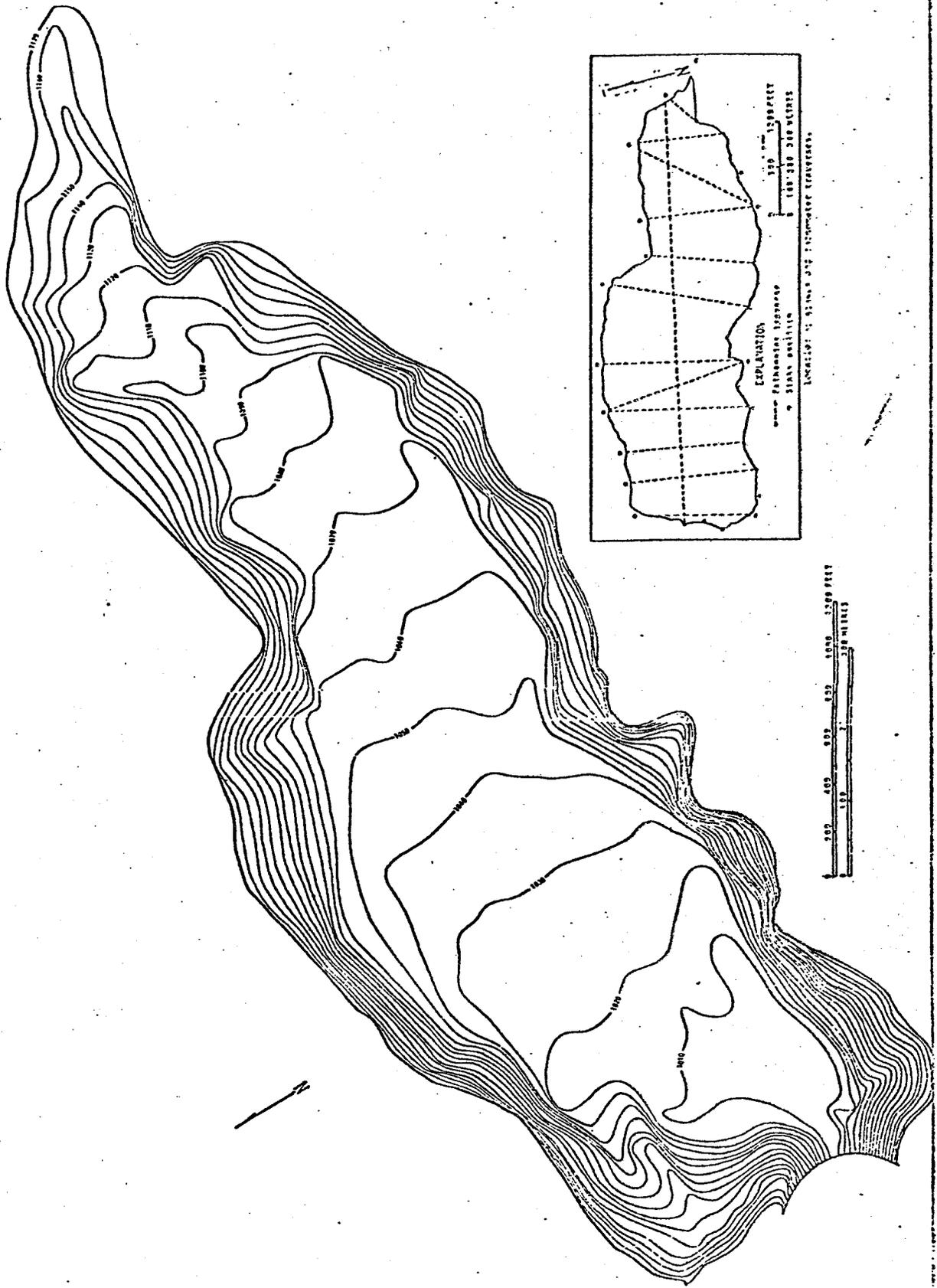


Figure 1. Bottom contour map of Salmon Creek Reservoir (from Balding, 1974).

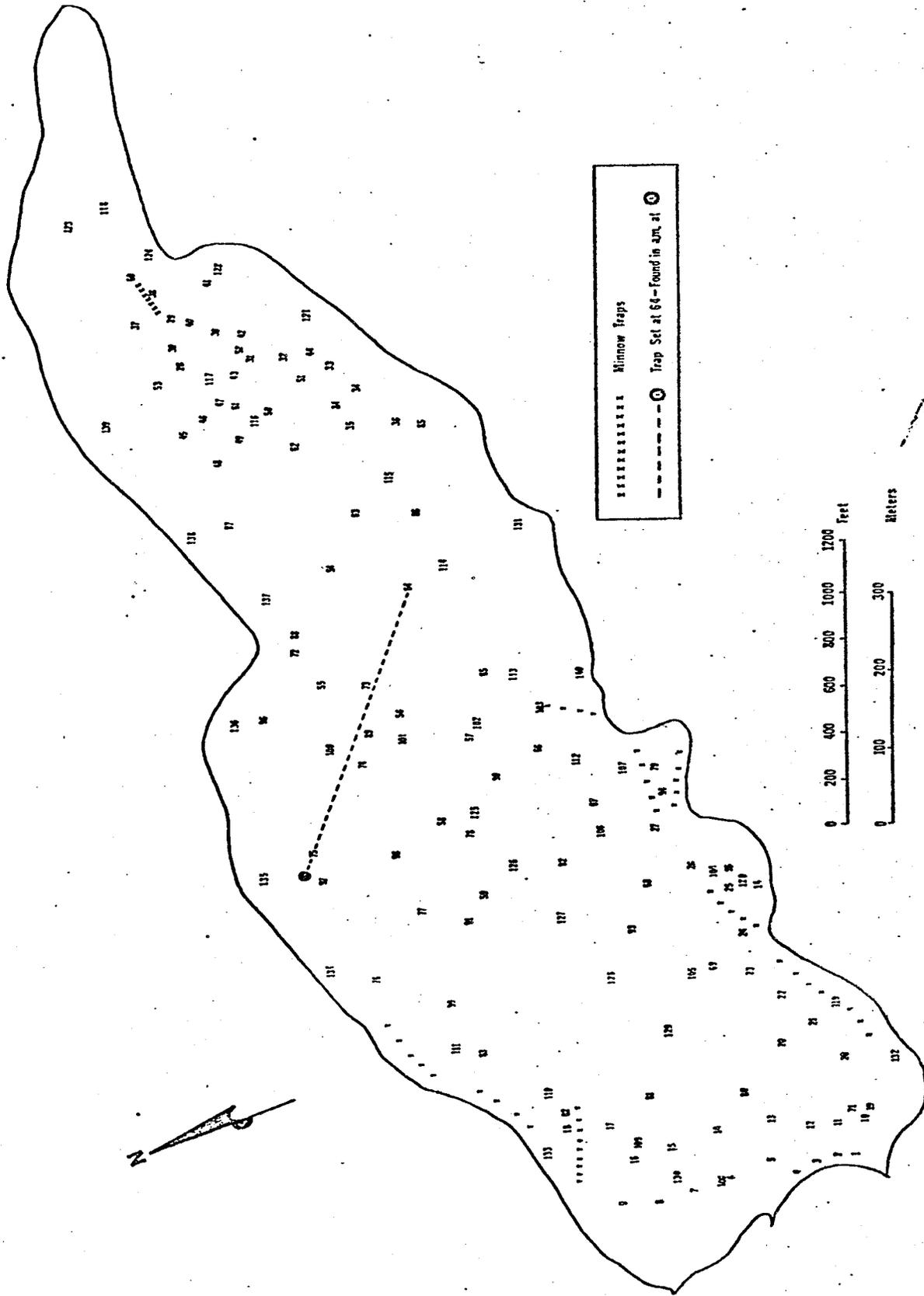


Figure 2. Trap set locations numbered consecutively, Salmon Creek Reservoir, June 17 - July 16, 1976.

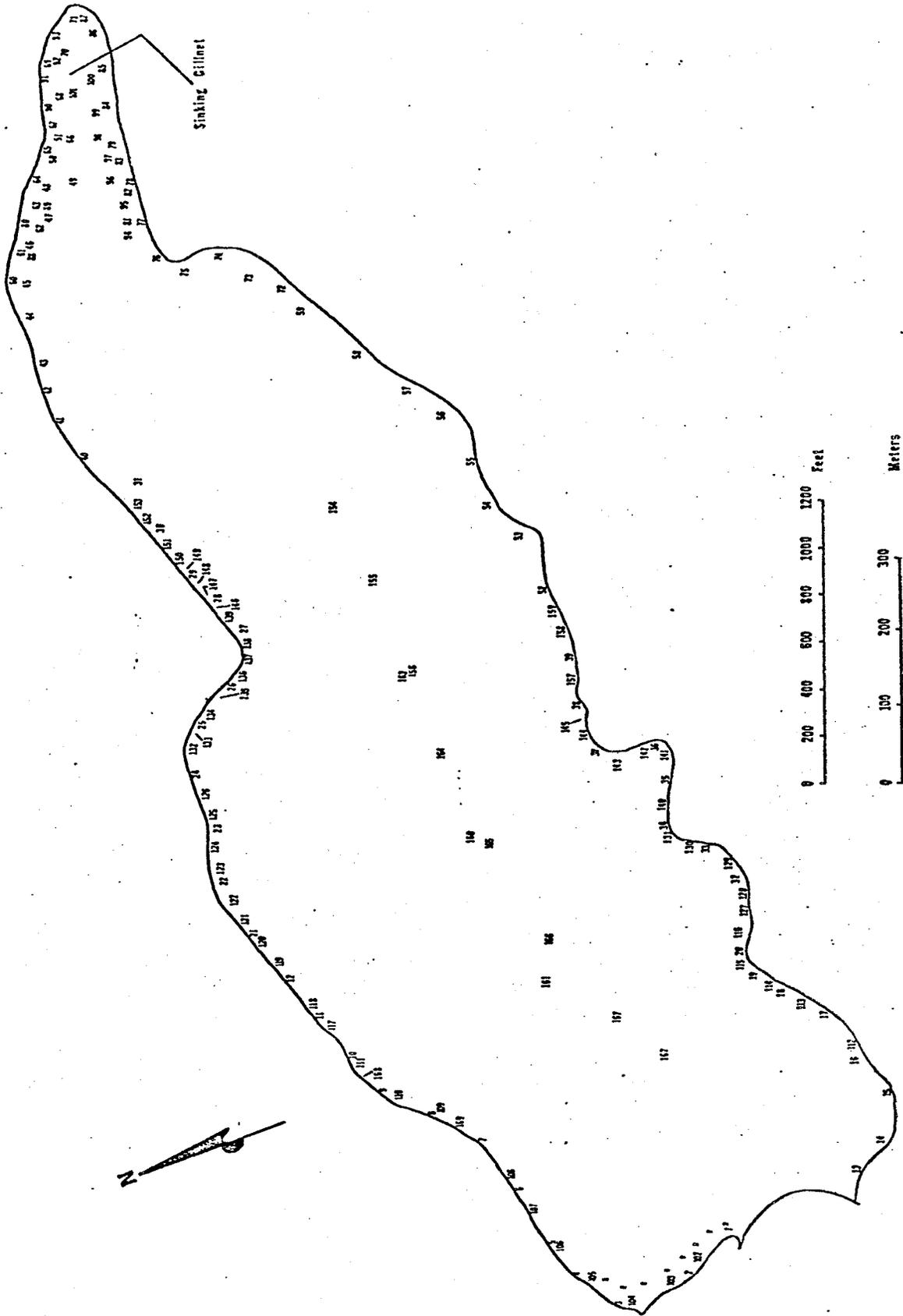


Figure 3. Trap set locations numbered consecutively, Salmon Creek Reservoir, September 8-25, 1976.

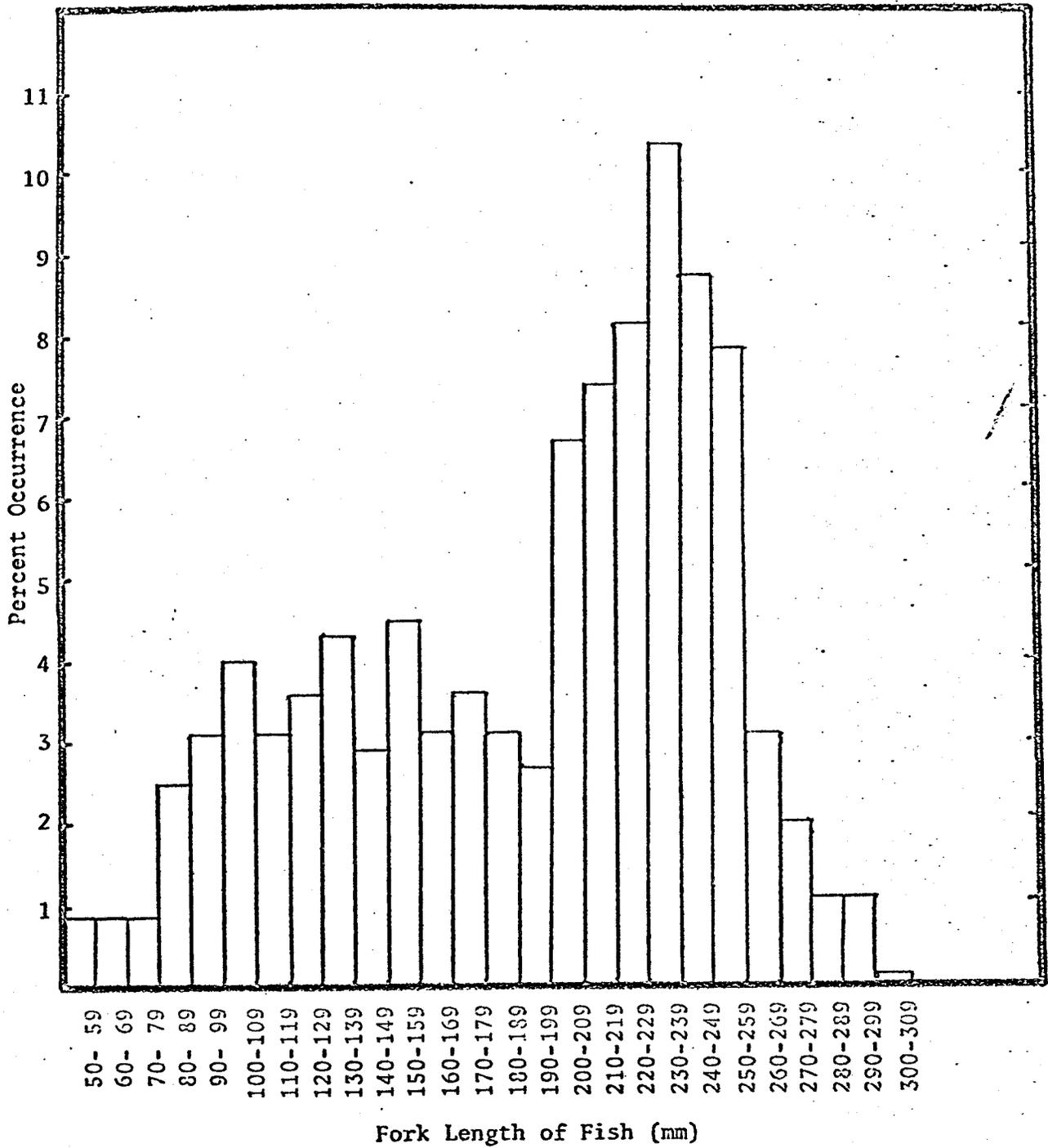


Figure 4. Percent occurrence of brook trout captured by 10 mm increment, Salmon Creek Reservoir, 1976.

Table 3. Total length* of brook trout by age class, Salmon Creek Reservoir, 1976.

<u>Age</u>	<u>Number</u>	<u>x Length (mm)</u>	<u>Range (mm)</u>	<u>Standard Deviation (min)</u>
1	1	59		
2	1	117		
3	8	168	160-182	8
4	12	191	151-228	29
5	11	226	202-289	24
6	15	240	214-263	12
7	9	253	229-283	16
8	3	263	245-278	16
9	1	301		

*Total length = 1.03 x fork length.

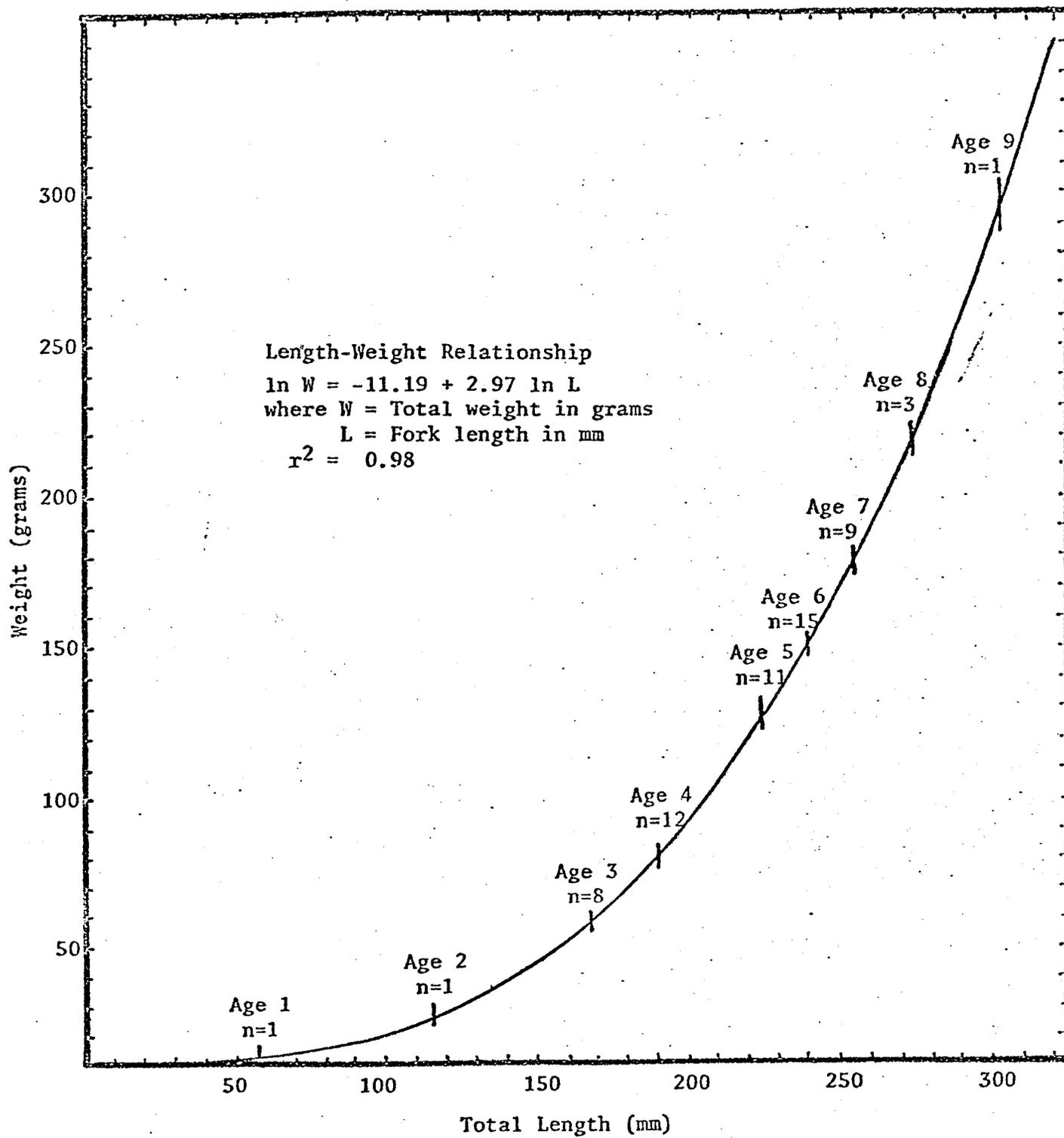


Figure 5. Length-weight-age relationship of brook trout in Salmon Creek reservoir, 1976.

The mean condition factor of 67 fish from throughout the length range of fish sampled was 1.06, the range of condition factors was 0.61 to 1.26, and the standard deviation was 0.11.

The condition factor of brook trout by age class is presented in Table 4. These condition factors ranged from 0.97 to 1.13.

Food habits of brook trout varied widely by individual and probably reflect availability (Table 5).

Zooplankton

Zooplankton analyses from Salmon Creek Reservoir are presented in Table 6. The most abundant organisms were rotifers. Daphnia sp. were by far the most abundant of the larger crustaceans.

DISCUSSION

Abundance and Distribution of Brook Trout

The population of catchable brook trout in Salmon Creek Reservoir is much lower than originally suspected. The population was estimated to be 1,042 to 1,562 at the 95% confidence level. No population estimate of rearing fish (50 to 90 mm) was possible, as few marked fish were recaptured. A population of this size does not justify a relaxed bag limit. If any adjustment to the limit were warranted, it would be a reduction. I do not

Table 4. Condition factor (K)* of brook trout by age class, Salmon Creek Reservoir, September 22-25, 1976.

Age	Number	Mean Total Length (mm)	Mean Total Weight (g)	Condition Factor	
				Mean	Range
1	1	59	2		
2	1	117	18	1.12	
3	8	168	50	1.04	0.61-1.20
4	12	191	81	1.11	0.95-1.27
5	11	226	135	1.13	0.97-1.23
6	15	240	143	1.00	0.91-1.17
7	9	253	170	1.03	0.87-1.23
8	3	263	189	1.04	0.97-1.11
9	1	301	309	1.13	

$$*K = \frac{100 \times \text{weight (g)}}{\text{Total length (cm)}^3}$$

Table 6. Plankton composition, density (organisms per square meter) and weight (milligrams per square meter) as collected with No. 10 and No. 20 Nitex plankton nets, Salmon Creek Reservoir, 1976.

<u>Date</u>	<u>July 30</u>		<u>September 14</u>	
	<u>45</u>	<u>45</u>	<u>41</u>	<u>40</u>
<u>Depth of Tow</u>				
<u>Mesh Size</u>	<u>10</u>	<u>20</u>	<u>10</u>	<u>20</u>
<u>Copepoda</u>				
<u>Calanoida</u>				
<u>Diaptomus sp.</u>	254	10	0	0
<u>Cyclopoida</u>	764	35	0	0
<u>Nauplii</u>	1,019	0	0	255
<u>Cladocera</u>				
<u>Daphnia sp.</u>	764	173	24,446	8,658
<u>Bosmia sp.</u>	0	25	0	0
<u>Chyclorus sp.</u>	509	15	1,273	0
<u>Rotatoria</u>				
<u>Keratella sp.</u>	10,440	198,623	1,528	829,124
<u>Asplancha sp.</u>	7,130	15,278	6,111	2,801
<u>Kellicottia sp.</u>	2,801	61,115	1,018	22,816
<u>Miscellaneous</u>	6,875	319,579	509	140,564
<u>Dry Weight</u>	16.3	91.7	155.8	155.8
<u>Organic Weight</u>	10.2	76.4	130.9	134.5
<u>Ash Weight</u>	6.1	15.3	21.4	25.0

feel this is necessary at this time; but if fishing pressure becomes too great, a reduction should be considered.

The brook trout are distributed throughout the benthic area of the lake but are much more abundant in the upper 6 m of the water column. They are often seen feeding on terrestrial drift at the lake's surface. Fish of all sizes (50 to 300 mm) congregate in shallow rocky areas.

Length Frequency, Growth, Condition Factors, and Food Habits

The largest fish captured was 301 mm (11.8 inches), but the most abundant size group is about 235 mm (9.4 inches). These fish are 5 to 7 years old. Growth in this reservoir is probably retarded partially because of cold-water temperature and short ice-free periods.

All fish captured were in healthy condition and had normal condition factors. The mean condition factor was 1.06. This condition factor compares favorably with other wild populations, as cited in Carlander (1969). This population shows no sign of overpopulation or stunting. Condition factor did not change significantly with age or length. Reproduction and spawning areas in the reservoir may be limited because of water level fluctuations.

Food habits of these brook trout are diversified. Stomach contents analyses indicate they eat anything that is available.

LITERATURE CITED

Baade, R. T. 1961. Creel census and population sampling of the sport fishes in southeast Alaska. Alaska Dept. of Fish and Game. Fed. Aid in Fish Restoration, Annu. Rep. of Prog., 1961-1962.

Balding, G. O. 1974. Hydrologic investigations of Salmon Creek Reservoir and drainage basin near Juneau, Alaska. U.S. Dept. of Inter., Geologic Surv. Adm. Rep.

Carlander, Kenneth D. 1969. Handbook of freshwater fishery biology. Iowa State Univ. Press, Ames, Iowa. 752 pp.

Schumacher, F. X. and Eschmeyer, R. W. 1943. The estimate of fish population in lakes or ponds. J. Tenn. Acad. Sci. 18:228-249.

Prepared by:

Artwin Schmidt

Fishery Biologist

Approved by:

s/W. Michael Kaill, Chief

Sport Fish Research

s/Rupert E. Andrews, Director

Sport Fish Division