Informational Leaflet 5

PRELIMINARY SURVEY OF AFOGNAK LAKE

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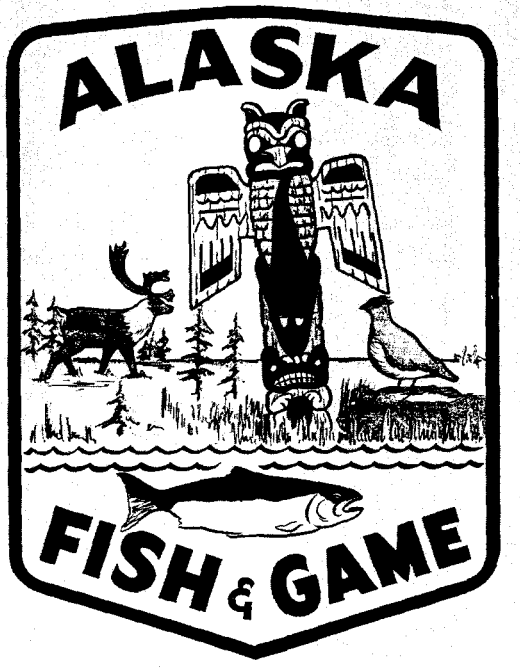

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SUBPORT BUILDING, JUNEAU

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Preliminary Survey of Afognak Lake

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INTRODUCTION

Afognak (also called Litnik) Lake is located on Afognak Island, lat. 58°07' N and long. 152°55'W. Since this lake system has a varied history of sockeye salmon production and apparently high productive potential, we conducted a preliminary survey starting in late July, 1961 and continuing through the spawning season. Stream studies were conducted by Bill Sheridan, lake studies by Bill Meehan and Bud Revet.

The general objective of this survey was to find out if we could discover factors limiting sockeye salmon production in the area and, using preliminary findings, to cooperate with Commercial Fisheries in recommending directions future work should take.

In this report, we present historical material and the results of a preliminary survey of inlet streams and the lake.

BACKGROUND

Afognak Lake contains about 1,200 surface acres, is long and narrow (Figure 1). There are two major inlets (Hatchery and Egg Take Creeks), several minor ones and an outlet of considerable size. Silver, sockeye, and pink salmon spawn in the system as do Dolly Varden and steelhead trout. The lake also contains three-spined stickleback and perhaps other species of fish as yet unobserved.

The whole of Afognak Island lies within the boundaries of the Chugach National Forest. Hence, the Navy rest camp located on Afognak Lake is leased from the U.S. Forest Service. A usable road runs from the rest camp (Figure 1) down to the beach adjacent to the lake outlet. The large old hatchery building is almost beyond repair, but there are other buildings not being used which are in better state of repair. It should not be difficult to lease one or two of these from the Forest Service and fix them up for use as a department field station.

A fish hatchery operated on Hatchery Creek, a major spawning tributary, from 1908 to 1932. To get water for the hatchery a 25-foot dam was built on Hatchery Creek a short distance above the stream-mouth. Thus, for a period of 24 years, sockeye salmon could not reach spawning areas in the stream. Hatchery records show that in 1910, 25,000 sockeye were spawned, from 1912-1915 less than 5,000 a year, in 1919, 26,000 and from 1925 to 1932 1,500 to 7,000 a year. Apparently during some years fish for spawning were captured at a weir at the lake outlet and during other years from Hatchery Creek.

Catch figures for the statistical area (in 1960, designated as 252-44, in 1961 designated as 252-34) in which most salmon bound for Afognak Lake would be caught, show that in 1960 7,725 sockeye, 358 cohoes, and 11,784 pinks and in 1961, 22,348 sockeye were captured. Three types of gear now in use are purse seines, beach seines, and set nets. In both 1960 and 1961, purse seines accounted for over 50 percent of the total catch of sockeye in the statistical area.

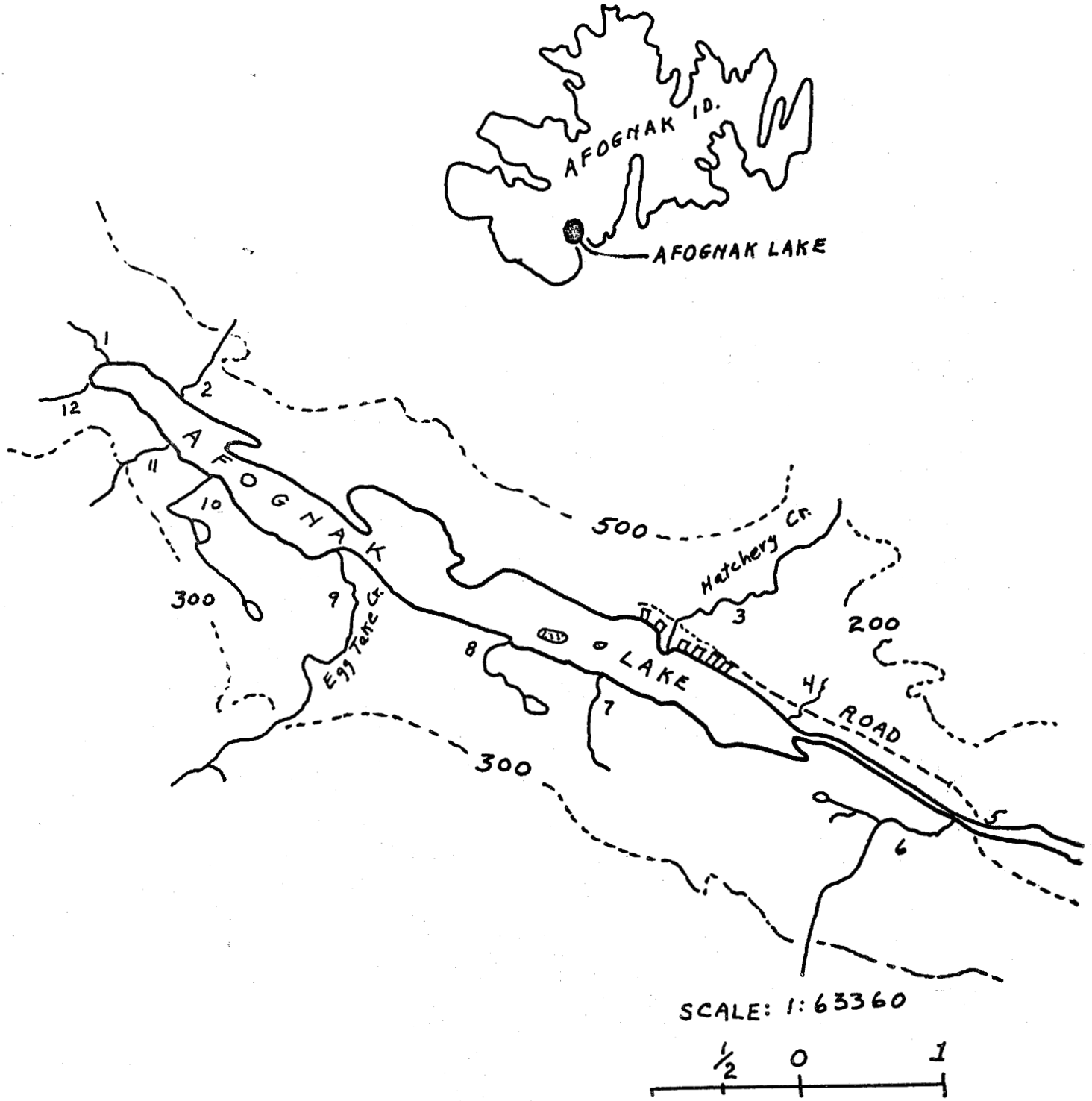

Figure 1. Afognak Lake system.

Catch and escapement statistics for past years are somewhat elusive. Apparently a weir was operated at the head of the outlet to Afognak Lake from 1926 to 1933. Weir count totals are as follows (Table 1):

Table 1. Weir counts, Afognak Lake, 1926-1933.

Year	Sockeye	Silvers	Pinks
1926	22,250	---	---
1927	7,491	4,216	1,075
1928	20,862	833	144
1929	25,428	435	227
1930	2,467	136	6,015
1931	30,515	3,318	234
1932	23,574	654	5,648
1933	36,144	---	---

Figures for sockeye probably represent close to the total run (with the exception of those fish taken by the commercial fishery before they reached Litnik Bay) for the season was closed in Litnik Bay from 1929 to 1933 (and possibly thereafter). Figures for pink and silver salmon do not mean too much for two reasons: (1) the main pink salmon spawning area is probably in the outlet below the weir site and (2) in 1926, 1927, 1928, and 1929 racks in the weir were closed "to prevent silver salmon from entering the lake and compelling silvers and pinks to spawn below the racks."[1]

From 1926 to 1933 the peak of sockeye passage through the weir ranged from early June to early July.

Actually, although we suspect that the Afognak Lake system once produced more sockeye than it produces today, data are not at hand to show either a cyclic trend or a general decline.

STREAM STUDIES

Objectives

Specific objectives of stream studies were:

1. To obtain an idea of the extent and type of available spawning area.

2. To measure streambed composition in the two major tributaries.

3. To measure dissolved oxygen content of intragravel water in the two major tributaries.

[1] Quote from Bureau of Fisheries Hatchery Superintendent's report (on file ADF&G Commercial Fisheries office, Kodiak).

4. To obtain water samples from various inlets for analysis of phosphate, nitrogen content, etc.

5. To determine abundance of spawning sockeye and their distribution in the streams.

Findings

Available spawning area

There is more than one mile of spawning area in Hatchery Creek. Since this stream averages about 10-15 feet wide at the low water levels, this gives a total of about 80,000 square feet or 8,888 square yards.

The length of available spawning area in Egg Take Creek is also at least one mile, and, with the same average width, would give the same area.

Other tributaries also contain spawning gravel, but the extent of utilization by various species of salmon must yet be determined. We also wish to determine precisely available spawning areas in Hatchery and Egg Take Creeks, in the outlet and on the lake beaches.

Streambed composition

Streambed composition is a good criterion of quality of spawning gravels, because it is now a well-known fact that large amount of silt and fine sand are factors limiting the freshwater survival of salmon. The streambed composition of Hatchery and Egg Take Creeks is given in Table 2, and a comparison of mean values from these streams and others (Big Kitoi on Afognak Island, Anan, Twelvemile, and Indian Creeks in Southeastern Alaska) are given in Figure 2 and Table 3.

Dissolved oxygen

Another criterion for determining the quality of salmon spawning beds is dissolved oxygen concentration of intragravel water. Dissolved oxygen levels (7-8 inches down in the gravel) for Hatchery and Egg Take Creeks are given in Table 4. Ninety-five percent confidence limits for means of four groups of samples are shown in Figure 3.

Chemical analyses of inlet streams

Water samples were obtained from inlet streams, frozen, and are now being analyzed.

Abundance and distribution of salmon in the system

In late July, there were a few (not over 2000) sockeye salmon spawning in Egg Take and Hatchery Creeks. On August 23, a complete foot survey was made of these streams which were then at spawning peak. In Egg Take Creek, 3,400 live and 2,000 dead sockeye were counted for a total of 5,400. In Hatchery Creek, 5,000 live and 1,580 dead sockeye were counted for a total of 6,580.

Table 2. Streambed composition of Hatchery and Egg Take Creeks, values expressed as percent by volume. July 27, 1961.

Mesh size in mm.	Hatchery Creek					Egg Take Creek					
	1	2	3	4	Average	1	2	3	4	5	Average
13.3	16.6	22.1	20.0	24.4	20.9	22.7	30.6	26.6	29.6	17.9	24.3
6.7	19.6	26.5	21.6	20.3	22.1	22.7	25.6	22.2	24.6	22.0	23.0
3.3	21.2	20.7	18.0	17.7	19.4	25.3	24.2	22.5	17.3	24.2	23.3
1.7	14.7	13.8	15.2	14.5	14.5	11.7	9.9	11.8	7.4	13.8	11.4
0.8	12.4	9.1	13.9	10.4	11.4	6.2	4.5	7.1	6.2	13.7	7.9
0.4	10.4	4.6	6.4	7.3	7.0	5.8	2.0	4.3	6.2	4.1	4.7
0.2	3.9	1.9	3.4	3.8	3.3	3.8	2.0	3.1	5.1	2.8	3.4
0.1	1.0	0.9	1.3	1.0	1.0	1.4	1.0	1.8	2.5	1.0	1.5
0.1	0.3	0.5	0.2	0.6	0.4	0.4	0.3	0.5	1.1	0.5	0.5

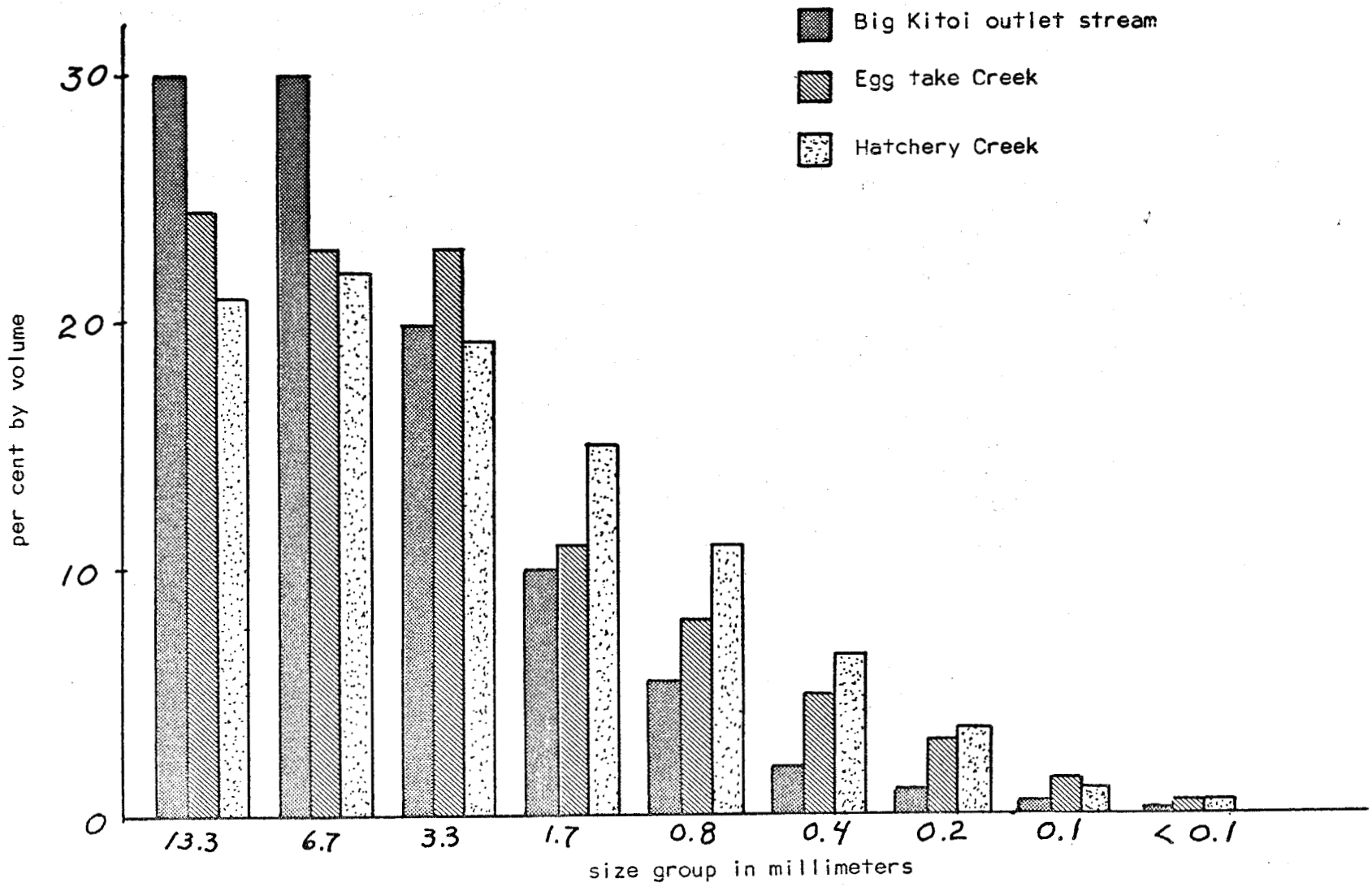

Figure 2. Percent volume of particles retained in each millimeter size group. Streambed samples from Big Kitoi outlet and two tributaries to Litnik Lake, Afognak Island, Alaska.

Table 3. Mean values, streambed composition, Hatchery and Egg Take Creeks compared with other streams[2].

Mesh size in mm.	Values and percent by volume. Big Kitoi	Hatchery	Egg Take	Anan	Twelvemile	Indian
13.3	30.6	20.9	24.3	10.4	13.9	14.9
6.7	31.0	22.1	23.0	10.3	13.0	12.5
3.3	19.6	19.4	23.3	10.1	12.9	10.9
1.7	9.6	14.5	11.4	9.6	9.6	7.0
0.8	6.3	11.4	7.9	10.6	11.6	8.3
0.4	1.6	7.0	4.7	3.9	9.5	4.8
0.2	0.8	3.3	3.4	1.3	3.6	1.2
0.1	0.5	1.0	1.5	0.3	1.2	0.4
0.1	0.2	0.4	0.5	0.2	5.0	2.6

[2] Values for Anan, Twelvemile, and Indian Creeks in Southeastern Alaska, taken from McNeil and Ahnell (1960).

Table 4. Dissolved oxygen values 7-8 inches in the gravel of Hatchery and Egg Take Creeks. (Values expressed in milligrams per liter). July 27, 1961.

N	Hatchery Creek above falls	Hatchery Creek below falls	Egg Take Creek
1	9.8	9.1	9.7
2	9.0	8.6	6.3
3	9.4	5.2	8.5
4	9.3	7.4	8.4
5	10.0	9.2	5.0
6	8.6	3.7	8.0
7	9.4	5.1	9.2
8	8.6	10.2	8.2
9	9.5	6.2	8.2
10	9.4	7.8	8.6
11	10.4	4.8	11.7
12	10.2		9.4
13	7.3		9.9
14	10.2		9.4
15	10.2		9.7
16	8.6		6.6
17	7.1		7.6
18	8.7		9.6
19	9.1		7.8
20	10.6		9.4
21	7.8		8.8
22	8.4		7.4
23	8.9		8.8
24	9.0		9.9
25	10.0		9.1
26	9.3		
27	9.0		
Average	9.1	7.0	8.6

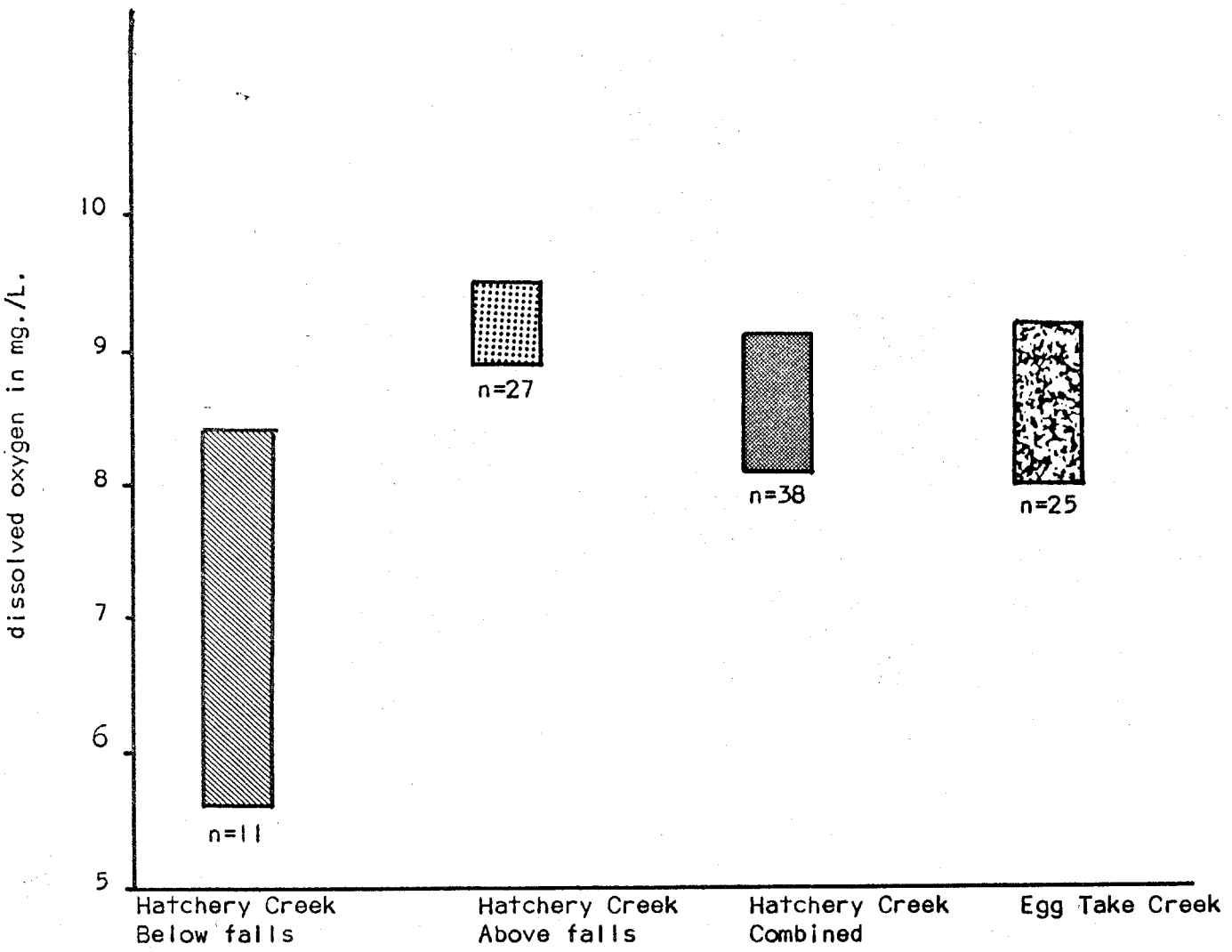

Figure 3. Ninety-five percent confidence limits for means of four groups of water samples taken for dissolved oxygen determination, Litnik Lake, Afognak Island, 7/27/61.

In both streams the ratio of jacks to normal fish was roughly 1:7. On September 8, there were but few sockeye left in each stream. The spawning peak probably ranged from August 15 to September 1.

The first beach spawning was noted on September 8. Scattered groups of lakeshore spawners were observed from the Navy recreation camp on around the periphery of the lake (an estimated 3,000 sockeye). We intend to make a detailed mapping survey of abundance and distribution of lakeshore spawners before the season is over.

So far, the estimated total run of sockeye is a catch of 24,000 plus an estimated escapement in Hatchery and Egg Take Creeks of 11,980 plus 3,000 beach spawners, or 38,980. The catch was approximately 61 percent of the total run.

Based on this year's examination, pink salmon apparently spawn mainly in the outlet stream between the covered bridge and the first rapids upstream. This is a good production area in which to conduct survival studies.

On September 8, an estimated 4,000 silver salmon were in the lake. On September 24, many silvers were observed milling around in the mouths of the inlet streams. Since silvers spawn later (October, November) we will keep track of their progress.

In the inlet spawning streams of Afognak Lake, all species of salmon are extremely vulnerable to bears of which there are many. The bear take over a season could easily account for 500 to 2,000 or more spawning salmon.

Survival of sockeye eggs in Hatchery Creek

A two hundred foot (lineal, up and down stream) section was sampled in Hatchery Creek on October 11, 1961. This section starts at the outlet of a beaver pond and continues for 200 feet upstream. This section was chosen because, at the peak of spawning on August 23, we observed that it was well utilized and appeared to be typical of the rest of the stream. Actually, the entire stream should have been sampled, but lack of time and inclement weather prevented this.

Fourteen random points were sampled. The stream was about 20 feet wide with a total area of 4,000 square feet, or about 444 square yards. A unit grid sampler encompassed 4 square feet. The stream temperature was 1.5° C. All eggs were eyed and well-developed.

Analyses of sampling data show:

1. Point estimate of mean number of eggs (both live and dead) in the sampling area was 262,000.

2. 95% confidence limits for the mean, range from 120,000 to 404,000 eggs.

3. Mean number of eggs per square yard is 589. Range is 270 to 909 eggs per square yard.

4. With regards to survival, point estimate is 76% with a range (95% confidence limits) of 57% to 95%.

5. Estimate of total number of eggs deposited in Hatchery Creek is 5 to 6 million.

There is more than one mile of available (and well used) spawning area in Hatchery Creek. According to the number of eggs, 114 female salmon spawned in the 200 foot sample section. If the sample section was representative of the stream, this gives a total of 2,964 females spawning in the stream. If we assume a 1:1 sex ratio, this gives a total escapement of 2 x 2964 = 5,928 sockeye. This figure agrees rather well with the peak count (made on August 23) of 6,580 fish.

Distribution and abundance of lakeshore spawners

The first estimate of numbers of beach spawners was made September 8. At that time, an estimated 3,000 sockeye were on the beaches. However, few of these fish were spawning.

On October 12, most of the shoreline was scouted for spawning sockeye. Visibility was very poor due to turbulence created by strong northwest winds; hence, the count of 500 spawning sockeye was conservative at best.

The highest concentration of beach spawners were observed 1/4 mile S.E. of the mouth of Egg Take Creek, at the N.W. end of the lake, off the tributary across from Batchelor's camp, 500 yards S.E. of the Recreation camp, on the same side of the lake. No beach spawning was observed from 500 yards S.E. of the Recreation camp to the outlet of Afognak Lake. The only area not examined extended from the outlet of Afognak Lake to a point opposite the Recreation camp.

There is a marked difference in the time of spawning of lakeshore and stream populations. While the peak of spawning in the tributary streams occurred in August, the peak of spawning of lakeshore spawners appeared to occur in late September and early October. The time of spawning of lakeshore spawners is similar to that of beach spawners in Little Kitoi Lake.

LAKE STUDIES

At the time of sampling (July 28-29, 1961) Afognak Lake did not exhibit a definite thermal stratification (Figure 4). Unless another series of temperature readings can be obtained earlier in the summer next year, it cannot be determined whether this is truly a non-stratifying lake or whether it was sampled during or shortly after a rather early fall overturn. Some Alaskan lakes have been recorded as having a definite thermocline for only a very short period, sometimes merely for a few weeks during early summer.

At the time the lake was sampled, there was an abundant supply of dissolved oxygen from the surface to the bottom of the lake, with slightly less than 9 p.p.m. at the bottom.

Another important series of measurements was made on the lake to determine photosynthetic activity at various levels. This was done by means of Carbon ^{14} uptake.

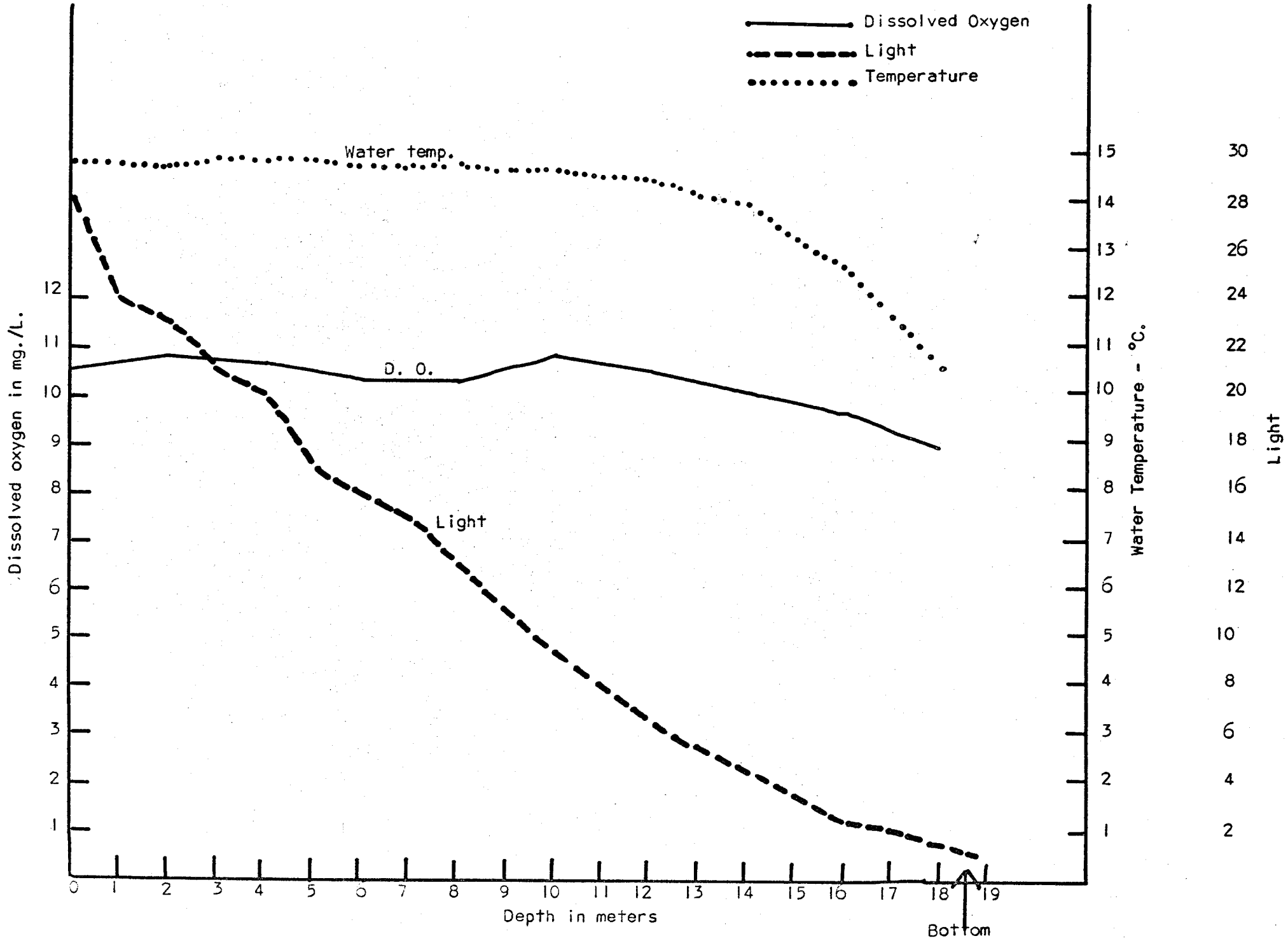

Figure 4. Temperature, dissolved oxygen, and light stratification - Afognak Lake.

Table 5 shows a peak of productivity at the surface, decreasing within the first few meters and then increasing again with increased depth. Earlier in the summer, a nitrogen-fixing alga *(Anabaena* sp.) was found floating in the surface of this lake.

The figures used in Table 6 are relative, since it is necessary to determine the total amount of carbon in the calcium carbonate alkalinity of the lake before the absolute productivity can be ascertained.

Table 5. Counts per minute of C_{14} using temporary algae standard.

Depth in meters	Dark Bottle	Light Bottle	LB - DB
0	367	1,099	732
2	43	44	0
4	59	249	190
6	40	845	805
8	190	294	104
10	66	3,448	3,382
12	107	3,079	2,972
14	104	3,618	3,514
16	133	2,416	2,283

Food Chain

Bottom samples taken at two different locations in the lake show that the most important fish-food organisms present at the time of sampling were midge larvae (Tendipedidae) and miscellaneous non-insect invertebrates such as annelid worms (Table 6). Plankton tows (Table 7) indicate the Cladocerans and Copepods are by far the most abundant zooplankters in the lake, and that at the time of sampling there was an increase in abundance from the surface to approximately 5 meters, after which a gradual decrease with increase in depth was indicated. However, even to approximately 15 meters, the deepest tow made, abundance compared very favorably with the richest lake in the Kitoi Bay area (Ruth Lake).

Four inlet streams were sampled for available fish food (Table 5); black flies (Simuliidae), midges (Tendipedidae), stoneflies (Plecoptera), May flies (Ephemeroptera) and caddis flies (Trichoptera) were all represented. These groups are generally considered to be the most important sources of fish-food for salmonids.

Table 6. Bottom organisms, Afognak Lake - July 28, 1961.

Bottom Organisms Present - Number - Followed by Percent of Each Group in Total Sample

	Insects																						
	Diptera		Plecoptera		Ephemeroptera			Trichoptera					Miscellaneous Invertebrate										
	Simuliidae	Tendipedidae	Chloroperlidae	Perlodidae	Heptageniidae	Baetidae	Limnephilidae	Brachycentridae	Psychomyiidae	Rhyacophilidae	Unidentified family	Oligochaeta	Nematoda	Hydra	Turbellaria	Hirudinea	Pelecypods (Sphaeriidae)	Total Numbers & % of Organisms in Sample		Wet Weight of Sample in Grams	
Lake-deep sample			20										3		1					24	0.0435
			83.33										12.50		4.17					100.00	
Lake-shallow sample			11										26	3			3	2		45	0.3715
			24.44										57.78	6.67			6.67	4.44		100.00	
Inlet #2		10							1				28			2				41	0.0715
		24.39							2.44				68.29			4.88				100.00	
Inlet #3		5	7	3	1		4	5	8	3				1						37	0.1200
		13.51	18.92	8.11	2.70		10.81	13.51	21.62	8.11				2.70						99.99	
Eaton Cr.			7	1			6	2	5		1	20	1	6			8			57	0.0680
			12.28	1.75			10.53	3.51	8.77		1.75	35.09	1.75	10.53			14.04			100.00	
Egg Lake Creek		2	5	2			6								1					16	0.0480
		12.50	31.25	12.50			37.50								6.25					100.00	

A sample of 50 fingerling silver salmon was obtained for determination of condition factor. The average condition factor of this sample of Afognak Lake cohoes was 1.31. Within a short period, two more samples of fingerling cohoes were obtained from lakes in the Kitoi Bay area for purpose of comparison. A sample from Little Kitoi Lake showed an average condition factor of 1.18, and a sample from Silver Lake showed a condition factor of 1.07.

In general, then, from the limited study undertaken, the system appears to have a good potential as a producer of sockeye salmon far above the population which it presently maintains.

Table 7. Plankton organisms, Afognak Lake - July 28, 1961.

		Counts					
		Copepoda		Cladocera			
	Vol. of bio mass	Calanoida	Cyclopoida	Bosmina	Daphnia	Misc. crus.	Total
(15 M) Deep	0.4 ml	1,463	104	6,380	---	303	8,251
(5 M) Mid	0.5 ml	2,035	248	4,675	55	55	7,068
(1 M) Surface	0.3 ml	504	220	7,068	---	165	7,957

RECOMMENDATIONS

1. That the Alaska Department of Fish and Game obtain a permit for one of the unused houses on Afognak Lake, repair and use it for a field station.

2. Install a weir at the lake outlet. This is a better location than downstream, for the width is less at the outlet, tides are not influential, and the location is easily accessible by skiff from the lake. The weir should be of a type to enable us to take scales and measurements of adult salmon entering the lake and smolts migrating seaward.

3. Adult salmon program.

    a. Tag fish in Afognak Bay to determine portion of sockeye entering the Afognak system, and to determine time of spawning and distribution of different races throughout the lake system.

    b. Check adults through weir, enumerate spawners, estimate fecundity, estimate ratio of jacks, obtain scales and measurements for age analysis.

4. Survival studies. Estimate abundance and percent survival of eggs and fry in November and just prior to emergence. Egg Take and Hatchery Creeks should be sampled thoroughly in March to determine survival and abundance of pre-emergent fry. Since there is very little known of survival of beach spawning populations, lakeshore spawning areas should be sampled if a method is developed by then.

5. Physical characteristics of spawning areas. Routine determination of dissolved oxygen levels in spawning gravels. Determine extent of gravel shift in inlet streams. Discover and evaluate other mortality factors.

6. Lake productivity. Carbon ^{14}, nitrogen, phosphorous, plankton, Ekman dredge samples; actually an extension of lake rehabilitation studies at Kitoi.

7. Smolts. Enumerate, age, and determine length-weight relationship of outgoing smolts. Mark by fin clipping to determine saltwater survival (total return run; catch plus escapement).

8. Predator control. It may be difficult in the face of public opinion to use toxicants in Afognak Lake. However, this may not be necessary. The huge Dolly Varden population in this system can now be decimated by taking advantage of this species' pattern of in-migration in the fall and outmigration in the spring. All Dolly Varden's coming through the weir will be killed. The stickleback population can be decimated by selective poisoning with emulsifiable rotenone.

9. Allow a larger percent of total run of sockeye salmon to enter Afognak Lake. Insure adequate protection of runs of all species against illegal fishing.

10. Keep a close check on, and do creel census of sport fish take of salmon. Our observations indicate the sport fish and personal use take is of considerable magnitude and largely uncontrolled.

11. The Afognak Lake system would provide an excellent opportunity to obtain life history information on the Dolly Varden. This work has already been initiated in the Kitoi Bay area, and comparative data would be quite useful.