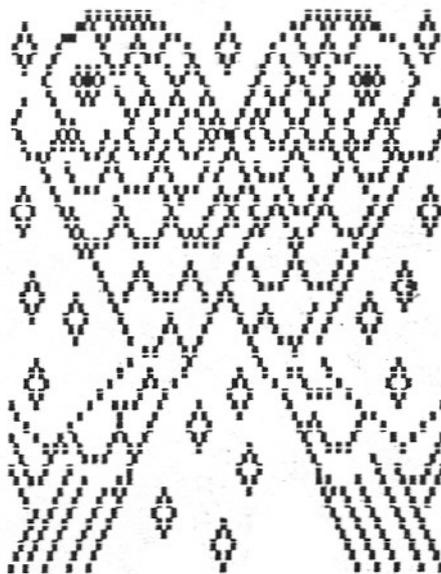
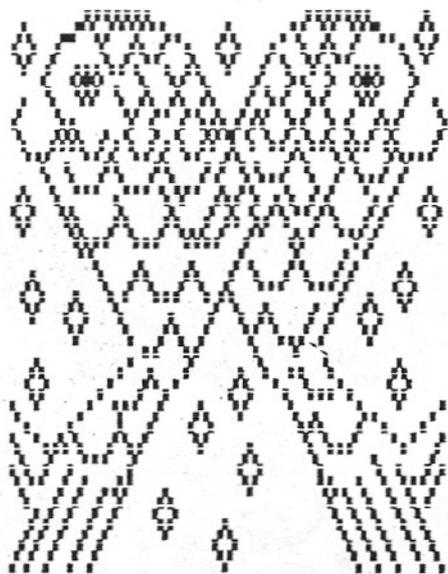




**REMOTE AND ROADSIDE
LAKE STUDY - 1984**

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INTRODUCTION

Personnel of the U.S. Fish and Wildlife Service, Kenai Fishery Resources Station, conducted fishery surveys on 20 lakes of the Kenai National Wildlife Refuge (NWR) from May 29 to September 7, 1984.

During formulation of the Kenai NWR Comprehensive Conservation Plan (USFWS 1985), a lack of refuge fish and wildlife information was identified as a major refuge problem. Subsequently, the Refuge Manager requested Fishery Resources Program personnel to undertake a study of specifically selected refuge lakes. The objective of the study was to evaluate lakes for their real and potential contribution to recreational fisheries. Data on fish, water quality, physical characteristics, vegetation, and wildlife were obtained to achieve this objective.

Eighteen lakes were surveyed in 1983 and results reported by Friedersdorff and Jakubas (1984) and Friedersdorff (1984). Results of the 20 lakes surveyed in 1984 are compended in this summary report.

METHODS

Each refuge lake was surveyed once for fish species composition and abundance plus water quality. Two lakes, used as controls, were surveyed three times - once early, mid, and late - in the field season.

Gill nets and minnow traps were used to sample fish. Gill nets were 100 feet long by 8 feet deep with five 20-foot panels of 1, 2, 2.5, 3, and 4-inch stretch measure monofilament. At each lake one floating net, set shallow, and one sinking net, set deep, were fished per 50 acres up to a maximum of six nets. Nets were set randomly with the intent of sampling different habitat types. Standard minnow traps, 16.5 x 9 inches covered with 1/8 inch bar wire mesh with 1 inch openings on ends, were painted green and brown and baited with salmon eggs. Five traps were fished for 15 acres, 10 traps for 50 acres, and two more traps for each additional 50 acres up to a maximum of 20 traps. Traps were fished around the shore in 3 to 15 feet of water. Gill nets and traps were normally fished for about 14 hour periods. A 6 foot deep by 30 foot long seine composed of 3/16-inch nylon webbing was fished along the shore of one lake to capture additional fish.

Fish were identified to species and counted. A range of fork lengths and weights were measured on up to 50 rainbow trout, char, salmon, and suckers at each lake. Large fish were measured to the closest 5 millimeters and 10 grams while smaller fish were weighed to the nearest 0.1 gram and length taken to the closest millimeter. Scales from rainbow trout were aged on a Bausch and Lomb projector. Back calculation of trout lengths was accomplished by direct proportion. Opercles of longnose sucker were aged with magnification under reflected and transmitted light.

Five broad categories of fish abundance were established from gill net and minnow trap catch per unit effort (CPUE). See Appendix A for CPUE formulae. For rainbow trout, Arctic char, Dolly Varden, salmon, and longnose sucker the categories were: (1) negligible abundance - 0.00, (2) low abundance 0.01 - 0.15, (3) moderate abundance 0.16 - 0.49, (4) moderately high abundance 0.50 - 1.00, and (5) high abundance ≥ 1.01 . Threespine stickleback CPUE from minnow traps was interpreted as: (1) negligible abundance 0.00, (2) low abundance 0.01 - 0.90, (3) moderate abundance 0.91 - 1.99, (4) moderately high abundance 2.00 - 2.99, and (5) high abundance ≥ 3.00 . Sculpin catches were too erratic for accurate abundance estimates.

Aquatic vegetation was mapped by charting areas of visible aquatic plants and sampling deep water areas, where vegetation could not be seen, with a modified rake. Aquatic plants were identified to species according to Hulthe'n (1974). The percent of aquatic vegetation coverage of the lake area was measured from field maps.

Water quality parameters were measured on all lakes during mid-July. Dissolved oxygen and temperature profiles were taken with a YSI 57 meter. Conductivity was measured with a YSI S-C-T 33 meter and pH with a Hach 17F Narrow Range pH kit. Total hardness and alkalinity were titrated with Hach HA-DT and AL-DT kits respectively. Total phosphorus, reactive phosphorus, Kjeldahl nitrogen, nitrate plus nitrite nitrogen, and total ammonia values were determined by the Alaska Department of Fish and Game Limnology Laboratory from chilled water samples. Water transparency was measured with a 20-centimeter Secchi disc and water color with a Forel-Ule color comparator.

Lake fertility levels were based on Moyle's work (MacKenthun and Ingram 1967) in which he used alkalinity concentrations to establish a four category lake productivity classification which we modified to a broader three class system: (1) low productivity 0 - 20 mg/l, (2) medium productivity 21 - 90 mg/l, and (3) high productivity >90 mg/l.

Lake maps were traced by pantograph from 1:15,840 scale, 1975, Kenai NWR aerial photos. Lake depths were measured with a Lowrance 1510 Trueline Recorder. Bathymetric maps, water volume, and mean depth were determined from field data. Lake drainage basins and stream drainages were verified from standard color and infrared aerial photos and U.S. Geological Survey 15 minute topographic maps. The Shoreline Development Factor and Morphoedaphic Index were calculated by mathematical formulae listed in Appendix A.

Statistical calculations were aided using Daisy Professional statistical software by Rainbow Company for the Apple II. Graphs were generated with Statpro statistical software by Wadsworth for the IBM.

Wildlife species identified at each lake were recorded. Technical terms used in this report are in Appendix B.

STUDY AREA

The Kenai National Wildlife Refuge is a majestic and diverse land encompassing nearly two million acres. It is located on the Kenai Peninsula with Refuge

headquarters, near the center of the refuge, about 55 air miles south of Anchorage. The Kenai Mountains, reaching an elevation of 6,600 feet, occupy the eastern third of the refuge. They are characterized by glaciers, snow, lichen tundra, and alder and willow shrubs. The remaining two-thirds of the refuge is part of the Kenai Lowlands composed of low hills and coastal plain. Boreal spruce-birch forests, coastal marshes, and numerous streams and lakes typify this area.

The refuge contains about 1,500 miles of cold water rivers and streams and 4,600 lakes. Approximately 83% of the lakes are 10 acres or less in surface area, 12% between 11-50 acres, 2% from 51-100 acres, 2% between 101-1,000 acres, and less than 1% over 1,001 acres. Of the total 165,000 acres of refuge lake water, 61% is accounted for by lakes larger than 1,001 acres, 13% 101-1,000 acres, 6% 51-100 acres, 9% 11-50 acres, and 11% of the lake area is 10 acres or smaller (Friedersdorff 1984). Large populations of salmon, trout, and char abound in refuge waters. These fish are important contributors to Alaska sport fishing and the Cook Inlet commercial fishery. The 20 lakes we surveyed in 1984 were located in the northern lowland portion of the refuge (Figure 1).

FISHERY RESOURCE SUMMARY

LAKE CLASSIFICATION

Sport fish classes were assigned to the 20 surveyed lakes. These classes were based on natural game fish abundance plus related factors such as fish species composition, lake fertility, dissolved oxygen and other chemical parameters, spawning habitat, and streams. Sport fish classes for each lake, as would be expected to occur under natural conditions, are listed in Table 1.

FISH DIVERSITY

Fish composition from all lakes totaled 12 species including rainbow trout, Dolly Varden, Arctic char, coho salmon, sockeye salmon, longnose sucker, round whitefish, threespine and ninespine stickleback, coastrange and slimy sculpin, and Arctic lamprey. Most of the sockeye were residuals or kokanee, and some of the coho were resident fish. Fish scientific names, use classes, and abbreviations used in report tables are in Table 2.

FISH DISTRIBUTION AND ABUNDANCE

Fish species distribution and abundance varied widely. The fish species captured from the 20 surveyed lakes which encompassed six watersheds are listed in Table 3. Fish abundance categories for each lake are summarized in Table 4. Individual lake species CPUE's for gill nets and minnow traps are in Tables 5 and 6.

RAINBOW TROUT - Rainbow trout were the most abundant game fish in this year's investigation and were present in all six watersheds and 16 lakes. The highest trout abundances were in Mull, Watson, and McLain lakes. The presence and

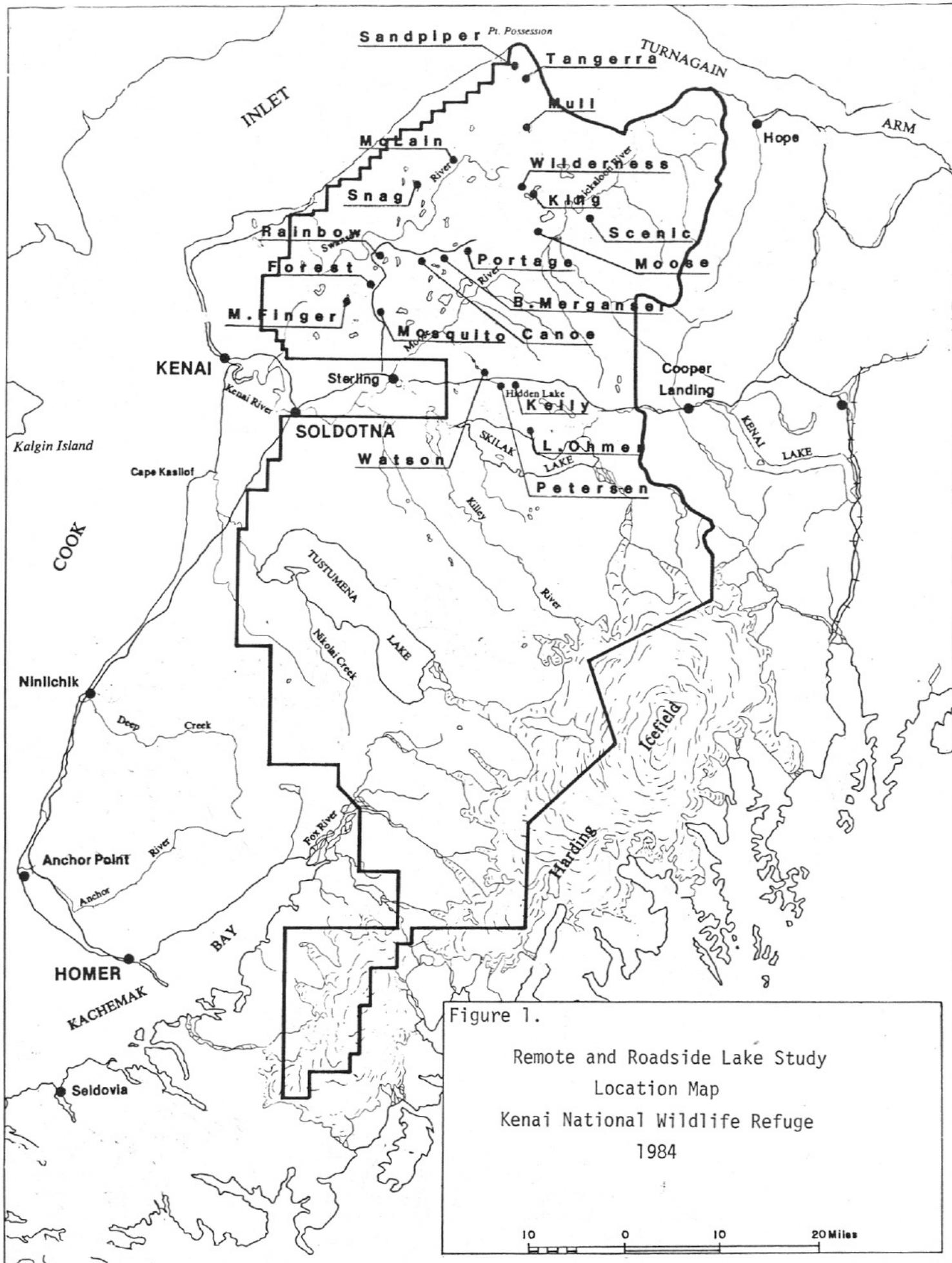


Table 1.

LAKE SPORT FISH VALUE CLASSIFICATION

Lake Name	Sport Fish Value ^{1/}
1. Canoe	Moderately high yield rainbow trout sport fishery, low yield char sport fishery, and coho salmon nursery area.
2. Middle Finger	Low yield Arctic char sport fishery.
3. Forest	Low yield rainbow trout sport fishery
4. Kelly	Moderate yield rainbow trout sport fishery and coho salmon nursery area.
5. King	Moderately high yield rainbow trout sport fishery, low yield Arctic char sport fishery, and low yield residual sockeye/kokanee sport fishery.
6. McLain	Moderately high yield rainbow trout sport fishery and coho salmon nursery area.
7. Big Merganser	Low yield rainbow trout sport fishery.
8. Moose	Negligible yield sport fishery and coho salmon nursery area.
9. Mosquito	Negligible yield sport fishery.
10. Mull	High yield rainbow trout sport fishery.
11. Lower Ohmer	Moderate yield rainbow trout sport fishery.
12. Petersen	Moderate yield rainbow trout sport fishery, coho salmon nursery area, and anadromous sockeye salmon spawning area.
13. Portage	Negligible yield sport fishery.
14. Rainbow	Moderate yield rainbow trout sport fishery.
15. Sandpiper	Moderately high yield rainbow trout sport fishery.
16. Scenic	Moderate yield rainbow trout sport fishery and coho salmon nursery area.
17. Snag	Low yield rainbow trout sport fishery and low yield Arctic char sport fishery.
18. Tangerra	Moderate yield rainbow trout sport fishery.
19. Watson	Moderately high yield rainbow trout sport fishery, low yield residual sockeye/kokanee sport fishery, and coho salmon nursery area.
20. Wilderness	Moderately high yield rainbow trout sport fishery, low yield Arctic char sport fishery, and low yield residual sockeye/kokanee sport fishery.

^{1/} Expected fish abundance that would occur under natural conditions

Table 2.

FISH SCIENTIFIC NAMES

Fish Class	Scientific Name	Abbreviation
<u>Game Fish</u>		
1. Rainbow Trout	<u>Salmo gairdneri</u>	RB
2. Dolly Varden	<u>Salvelinus malma</u>	DV
3. Arctic Char	<u>Salvelinus alpinus</u>	AC
4. Coho Salmon	<u>Oncorhynchus kisutch</u>	SS
5. Sockeye Salmon	<u>Oncorhynchus nerka</u>	RS
Residual Sockeye	Same	
Kokanee Salmon	Same	
<u>Non-Game Fish</u>		
6. Longnose Sucker	<u>Catostomus catostomus</u>	LS
7. Round Whitefish	<u>Prosopium cylindraceum</u>	RW
<u>Forage Fish</u>		
8. Threespine Stickleback	<u>Gasterosteus aculeatus</u>	TS
9. Ninespine Stickleback	<u>Pongitius pongitius</u>	NS
10. Coastrange Sculpin	<u>Cottus aleuticus</u>	CR
11. Slimy Sculpin	<u>Cottus cognatus</u>	SL
<u>Other</u>		
12. Arctic Lamprey	<u>Lampetra japonica</u>	AL

Table 3.

FISH SPECIES CAPTURED IN SURVEYED LAKES
Kenai National Wildlife Refuge - 1984

Lake	Fish Species	Watershed
1. Canoe	RB, DV, AC, SS ^{2/} , RS ^{1/} , LS, TS, CR	Swanson
2. Middle Finger	AC, LS, TS, CR, AL	Swanson
3. Forest	RB, SS ^{3/} , CR, TS	Swanson
4. Kelly	RB, SS ^{2/} , LS, TS	Kenai
5. King	RB, AC, RS ^{1/} , LS, TS, NS, CR	Swanson
6. McLain	RB, SS ^{2/} , RS ^{1/} , LS, TS, CR	Swanson
7. Big Merganser	RB, LS, TS, CR	Swanson
8. Moose	DV, SS ^{3/} , TS	Chickaloon
9. Mosquito	TS	Kenai
10. Mull	RB, RS ^{1/} , TS	Bedlam
11. Lower Ohmer	RB, TS, CR	Kenai
12. Petersen	RB, SS ^{2/} , LS, RS, TS, NS	Kenai
13. Portage	SS ^{4/} , TS	Swanson
14. Rainbow	RB, TS	Swanson
15. Sandpiper	RB, TS	Miller
16. Scenic	RB, SS ^{2/} , LS, RW, TS, SL	Chickaloon
17. Snag	RB, AC, LS, TS, CR	Swanson
18. Tangerra	RB, TS, CR	Dipper
19. Watson	RB, SS ^{2/} , RS ^{1/} , LS, TS	Kenai
20. Wilderness	RB, AC, RS ^{1/} , LS, TS, NS, CR	Swanson

-
- 1/ Residual Sockeye or Kokanee
2/ Juvenile Fish
3/ Resident
4/ Stocked

Table 4.

ABUNDANCES OF FISH SPECIES IN 20 LAKES
Kenai National Wildlife Refuge - 1984

Species	Abundance				Unclass- ified	Total Lakes
	High	Moderately High	Moderate	Low		
1. Rainbow Trout	3	4	6	3	0	16
2. Arctic Char	0	0	2	3	0	5
3. Dolly Varden	0	0	1	1	0	2
4. Coho Salmon	1	1	1	6 ^{1/}	0	9
5. Sockeye Salmon	0	1	1	5	0	7
6. Longnose Sucker	1	4	3	3	0	11
7. Round Whitefish	0	0	0	1	0	1
8. Threespine Stickleback	9	3	4	4	0	20
9. Ninespine Stickleback	0	0	0	3	0	3
10. Coastrange Sculpin	0	0	0	0	10	10
11. Slimy Sculpin	0	0	0	0	1	1
12. Arctic Lamprey	0	0	0	0	1	1

^{1/} Includes one lake with stocked coho salmon

Table 5.

LAKE GILL NET CATCH-PER-UNIT-EFFORT^{1/}
Kenai National Wildlife Refuge - 1984

Lake	RB	DV	AC	SS	RS	LS	RW	Total CPUE
1. Canoe	0.27	0.02	0.04	0.02	0.02	0.18	0.00	0.55
2. Middle Finger	0.00	0.00	0.39	0.00	0.00	0.08	0.00	0.47
3. Forest	0.32	0.00	0.00	0.01	0.00	0.00	0.00	0.33
4. Kelly	0.55	0.00	0.00	0.06	0.00	0.77	0.00	1.38
5. King	0.96	0.00	0.39	0.00	0.10	0.62	0.00	2.07
6. McLain	1.10	0.00	0.00	0.05	0.01	0.73	0.00	1.89
7. Big Merganser	0.14	0.00	0.00	0.00	0.00	0.11	0.00	0.25
8. Moose	0.00	0.20	0.00	0.10	0.00	0.00	0.00	0.30
9. Mosquito	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10. Mull	2.27	0.00	0.00	0.00	0.04	0.00	0.00	2.31
11. Lower Ohmer	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.13
12. Petersen (5/29/84)	0.43	0.00	0.00	0.86	0.00	0.55	0.00	1.84
Petersen (7/24/84)	0.32	0.00	0.00	0.25	0.00	0.21	0.00	0.78
Petersen (9/6/84)	0.17	0.00	0.00	0.26	0.61	0.04	0.00	1.08
13. Portage	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.07
14. Rainbow (6/13/84)	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.45
Rainbow (7/26/84)	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.44
Rainbow (9/13/84)	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.35
15. Sandpiper	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.63
16. Scenic	0.11	0.00	0.00	0.23	0.00	0.34	0.02	0.70
17. Snag	0.42	0.00	0.06	0.00	0.00	0.45	0.00	0.93
18. Tangerra	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.27
19. Watson	1.20	0.00	0.00	1.20	0.20	1.90	0.00	4.50
20. Wilderness	0.91	0.00	0.06	0.00	0.10	0.09	0.00	1.16
<hr/>								
Number of Lakes	16	2	5	9	7	11	1	20
Number of Cases	20	2	5	11	7	13	1	23
Mean	0.57	0.02	0.19	0.28	0.15	0.47	0.02	1.00
Standard Deviation	0.51	0.00	0.19	0.39	0.21	0.50	0.00	1.01
Range	0.11- 2.27	0.02- 0.02	0.04- 0.39	0.01- 1.20	0.01- 0.61	0.04- 1.90	0.02- 0.02	0.07- 4.50

^{1/} Fish per net hour

Table 6.

 LAKE MINNOW TRAP CATCH-PER-UNIT-EFFORT^{1/}
 Kenai National Wildlife Refuge - 1984

Lake	RB	SS	LS	TS	NS	SL	CR	AL	Total CPUE
1. Canoe	0.00	0.00	0.00	5.68	0.00	0.00	0.15	0.00	5.83
2. Middle Finger	0.00	0.00	<0.01	1.49	0.00	0.00	0.19	<0.01	1.69
3. Forest	<0.01	0.00	0.00	0.90	0.00	0.00	0.19	0.00	1.10
4. Kelly	<0.01	0.33	0.00	4.94	0.00	0.00	0.00	0.00	5.28
5. King	0.00	0.00	0.00	0.94	0.03	0.00	1.68	0.00	2.65
6. McLain	<0.01	<0.01	0.00	0.27	0.00	0.00	0.23	0.00	0.51
7. Big Merganser	0.02	0.00	0.00	0.56	0.00	0.00	0.74	0.00	1.32
8. Moose	0.00	<0.01	0.00	9.99	0.00	0.00	0.00	0.00	9.99
9. Mosquito	0.00	0.00	0.00	5.51	0.00	0.00	0.00	0.00	5.51
10. Mulla	0.00	0.00	0.00	4.64	0.00	0.00	0.00	0.00	4.64
11. Lower Ohmer	0.03	0.00	0.00	0.92	0.00	0.00	0.61	0.00	1.56
12. Petersen (5/29/84)	0.00	0.18	0.00	5.09	0.00	0.00	0.00	0.00	5.27
Petersen (7/24/84)	0.00	0.04	0.00	6.01	0.00	0.00	0.00	0.00	6.05
Petersen (9/6/84)	<0.01	0.16	0.00	1.80	<0.01	0.00	0.00	0.00	1.97
13. Portage	0.00	0.00	0.00	3.19	0.00	0.00	0.00	0.00	3.19
14. Rainbow (6/13/84)	0.00	0.00	0.00	2.88	0.00	0.00	0.00	0.00	2.88
Rainbow (7/26/84)	0.00	0.00	0.00	1.32	0.00	0.00	0.00	0.00	1.32
Rainbow ((/13/84)	0.00	0.00	0.00	6.50	0.00	0.00	0.00	0.00	6.50
15. Sandpiper	0.00	0.00	0.00	2.82	0.00	0.00	0.00	0.00	2.82
16. Scenic	0.00	<0.01	0.00	2.38	0.00	<0.01	0.00	0.00	2.39
17. Snag	0.00	0.00	0.00	1.63	0.00	0.00	0.34	0.00	1.97
18. Tangerra	0.00	0.00	0.00	2.90	0.00	0.00	<0.01	0.00	2.91
19. Watson	0.00	0.16	0.00	3.98	0.00	0.00	0.00	0.00	4.14
20. Wilderness	0.00	0.00	0.00	0.26	0.01	0.00	0.24	0.00	0.51
Number of Lakes	6	6	1	20	3	1	10	1	20
Number of Cases	8	8	1	24	5	1	10	1	24
Mean	<0.01	0.11	<0.01	3.19	<0.01	<0.01	0.44	<0.01	3.42
Standard Deviation	0.01	0.12	-	2.44	0.01	-	0.49	-	2.31
Range	0.00- 0.03	<0.01- 0.33	<0.01- <0.01	0.26- 9.99	0.00- 0.03	<0.01- <0.01	<0.01- 1.68	<0.01- <0.01	0.51- 9.99

^{1/} Fish per trap hour

number of rainbow trout in refuge lakes appeared influenced by spawning streams. Larger abundances of rainbow trout were normally associated with higher quality spawning streams, the closeness of the stream spawning habitat to the lake, and the ease of fish access between the spawning habitat and the lake. Lake tributary streams were classified into five different quality categories of spawning habitat (See Appendix C) and compared to the lake rainbow trout CPUE. The regression in Figure 2 demonstrates the positive relationship between greater trout abundance and higher quality stream type (spawning habitat). Approximately 35% of the variation in rainbow trout CPUE was explained by the regression which was statistically significant at the 0.01 level ($F=11.9$, df 1,22). Data from all 20 lakes were incorporated in the model.

Growth rates of 310 rainbow trout from the 16 refuge lakes were analyzed from scale patterns enlarged on a Bausch and Lomb projector. The trout ranged in age from one to 11 years. The regression in Figure 3 shows fish fork length compared to age. Approximately 99% of the variation in fish length was explained by the regression. If a zero intercept is substituted in the regression equation the average trout growth rate is 1.8 inches (46 mm) per year. Actual fish size would have been about 1.2 inches longer since fish fork length basic data was uncorrected for fish length at the time of scale formation. Scale formation is estimated to have occurred at approximately 30 mm. Carlander (1969) sites scale formation of rainbows in Washington State at 32 mm. No data was found relative to trout size at scale formation for Alaska. If a 30 mm intercept is substituted in the regression the average growth rate is 1.7 inches (42 mm) per year. The regression was calculated using the mean fish length at each age class. Fish sexes were not separated. The regression was statistically significant at the 0.01 level ($r=0.99$, df 9). Rainbow trout annual growth rates at individual lakes varied from 1.6 inches to 1.9 inches (See detailed lake reports).

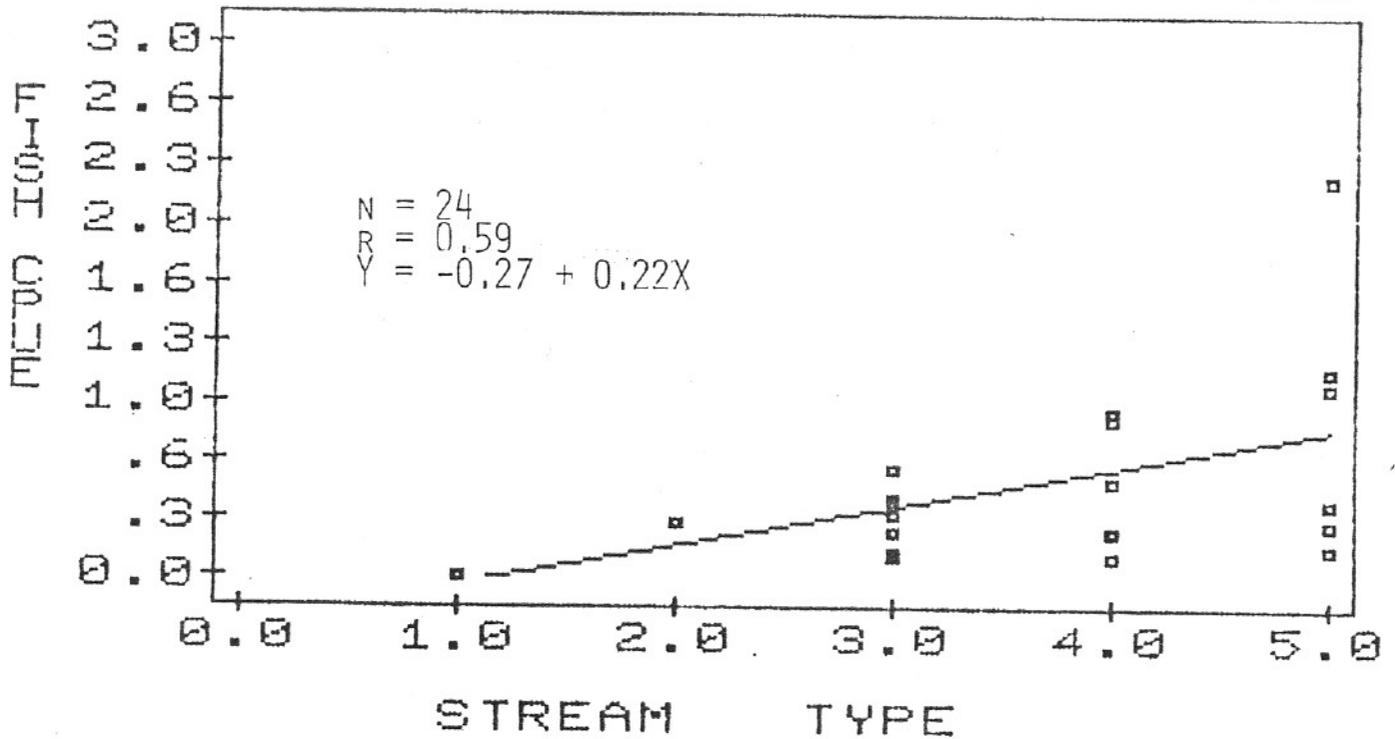
Length and weight relationships of rainbow trout from 16 lakes are shown in Figure 4. This curvilinear graph indicates trout weight gain in relation to fork length is low for the first 100 mm of size, changes geometrically between 100 mm and 300 mm, then becomes relatively linear beyond 300 mm. A total of 594 trout of both sexes constituted the data base. The model was computed using mean length and weights from 25 mm length groups. The regression was statistically significant at the 0.01 level ($r=0.96$, df 15).

A comparison of the 1983 and 1984 rainbow trout CPUE at Rainbow Lake, the only control lake fished both years, was made. The mean rainbow trout CPUE for 1983 was 0.35 and 1984 0.41 fish per net hour. The slightly higher 1984 CPUE is believed partly due to the shortened fishing period which also included peak catch hours as were covered in the 1983 survey. An Analysis of Variance indicated there was no significant difference in the rainbow trout population size between the two years at the .05 level of significance ($F=1.6$, df 1,4).

ARCTIC CHAR - Arctic char were the second most abundant game fish, being found in five lakes. They were captured only in the Swanson River Watershed. The highest abundances were in Middle Finger and King Lakes which possess the deep cold water habitat and rocky shoals this species appears to utilize. The negative relationship between Arctic char abundance and eutrophic waters (represented by MEI) in Figure 5 indicates that as the lake becomes deeper and less fertile (more oligotrophic) there is a tendency for larger populations of

FIGURE 2.

RAINBOW TROUT CATCH PER UNIT EFFORT COMPARED TO STREAM TYPE 1/



1/ SEE APPENDIX C FOR LAKE TRIBUTARY STREAM SPAWNING HABITAT CLASSIFICATION.

FIGURE 3.

RAINBOW TROUT AGE AND GROWTH
 16 LAKES KENAI NWR - 1984

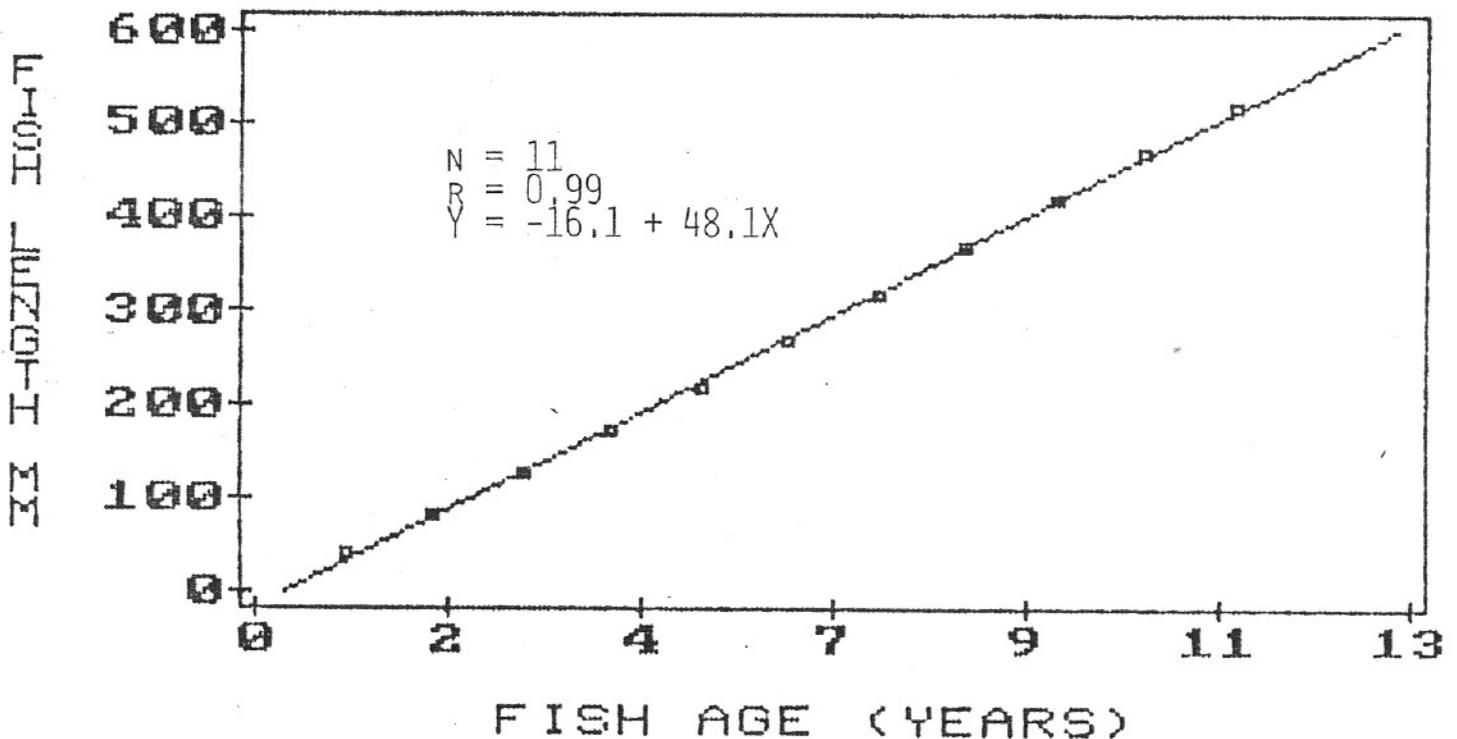


FIGURE 4.

RAINBOW TROUT LENGTH-WEIGHT
KENAI NWR - 1984

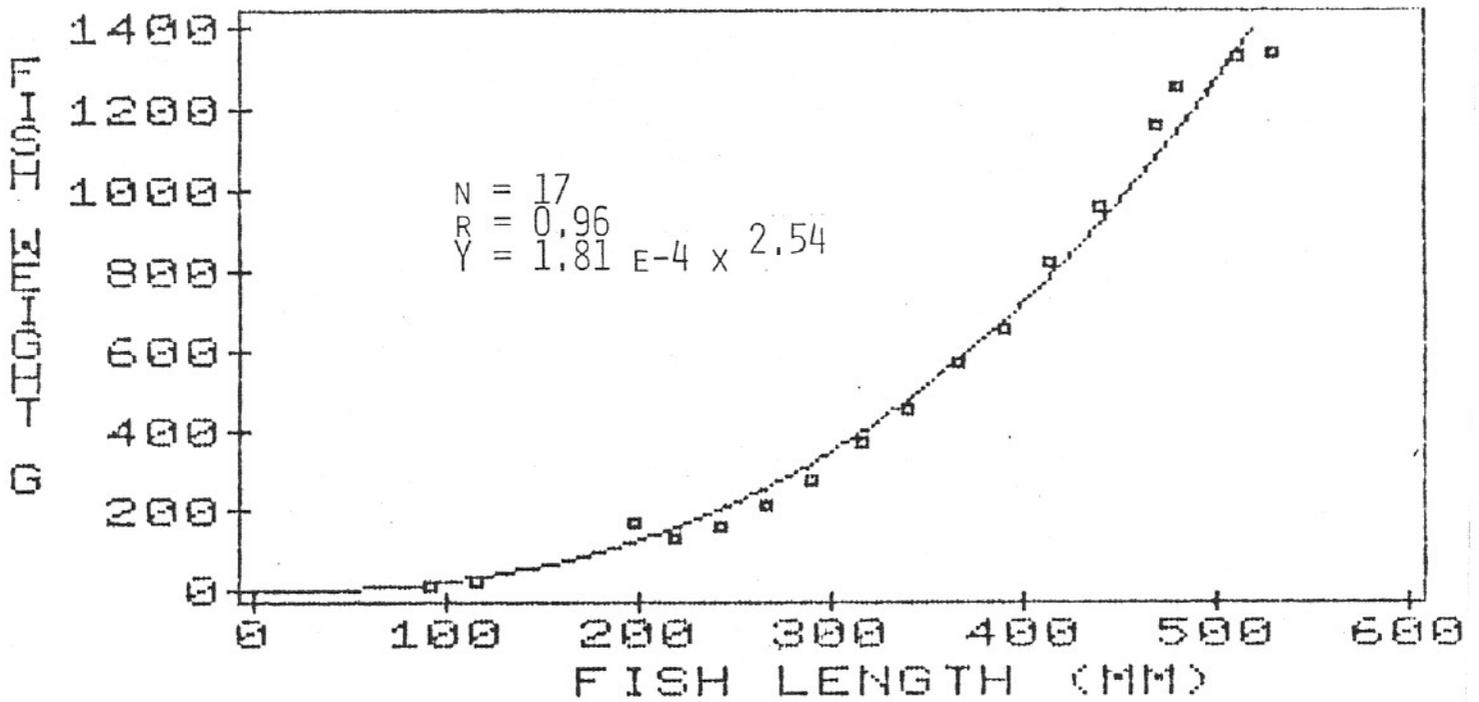
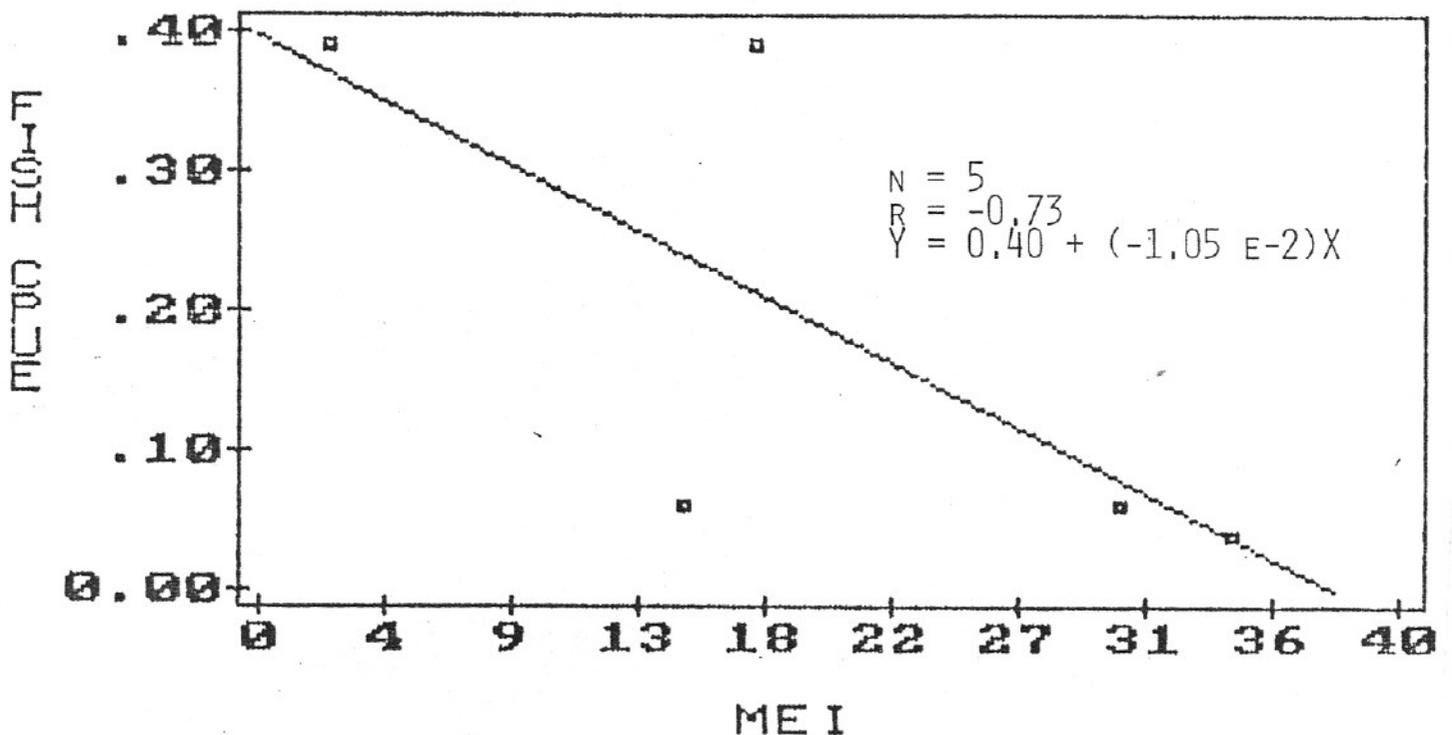


FIGURE 5.

ARCTIC CHAR CATCH PER UNIT EFFORT
COMPARED TO MEI, KENAI NWR-1984



Arctic char. Approximately 53% of the variation in Arctic char abundance was accounted for by the regression which was not statistically significant at the 0.05 level ($r = -0.73$, $df = 3$).

DOLLY VARDEN - Dolly Varden were found only in Canoe and Moose lakes which are in the Swanson River and Chickaloon River watersheds respectively. Canoe Lake had an adjoining anadromous stream required for spawning while the Moose Lake population is believed to have migrated from lower Mystery Creek during high flows.

COHO SALMON - Coho salmon were found in nine lakes which included the Kenai River, Swanson River, and Chickaloon River watersheds. They were stocked in Portage Lake by the Alaska Department of Fish and Game. Moose Lake appeared to have a seasonally landlocked population of coho; a large number of two year old coho in the lake had apparently lost their instinctive drive to outmigrate. These fish were believed to have been spawned in Mystery Creek or the Chickaloon River. Forest Lake had a limited residual coho population. The remaining six lakes including Canoe, Kelly, McLain, Petersen, Scenic, and Watson were nursery areas for juvenile anadromous coho populations.

SOCKEYE SALMON - Sockeye salmon were found in a total of seven lakes which included the Swanson River, Kenai River, and Bedlam Creek watersheds. Sockeye residuals and/or kokanee were in six lakes. In early September we found anadromous adult sockeye salmon in Petersen Lake. These sockeye were in the last stages of spawning. Adult anadromous sockeye may have been in a few other lakes, but they were not surveyed at the proper time to intercept the spawning run. Juvenile sockeye salmon were suspected of using some lakes for nursery purposes. No juveniles were taken during lake surveys as they were difficult to capture with our sampling gear.

LONGNOSE SUCKER - Longnose sucker were rather widely distributed being captured in 11 lakes which covered the Swanson River, Kenai River, and Chickaloon River watersheds. The sucker were usually associated with lakes having tributary streams; they were observed spawning in the Canoe Lake outlet stream. If no spawning stream was present then the lake normally had large rocky shoal areas.

Longnose sucker ranged from four to 19 years of age. Suckers in Middle Finger Lake were unusually small for their age classes and may represent a dwarf population. The longnose sucker age-growth regression in Figure 6 indicates longnose sucker growth is rapid for the first six years, then becomes relatively slow during the remaining years. The regression was computed from mean fork lengths of 81 fish. Middle Finger Lake data were excluded. Approximately 96% of the variation in sucker length was explained by the regression which was statistically significant at the 0.01 level ($r = 0.98$, $df = 12$).

Length-weight relationships of longnose sucker are shown in Figure 7. This regression indicates longnose sucker weight relative to length is initially low. After 250 mm fork length is attained, weight becomes high compared to length. Mean lengths and weights of 25 mm fork length groups based on 266 fish were used in computing the model. Approximately 98% of the variation in sucker weight was explained by the regression which was statistically significant at the 0.01 level ($r = 0.99$, $df = 11$).

FIGURE 6.

LONGNOSE SUCKER AGE AND GROWTH 10 LAKES KENAI NWR - 1984

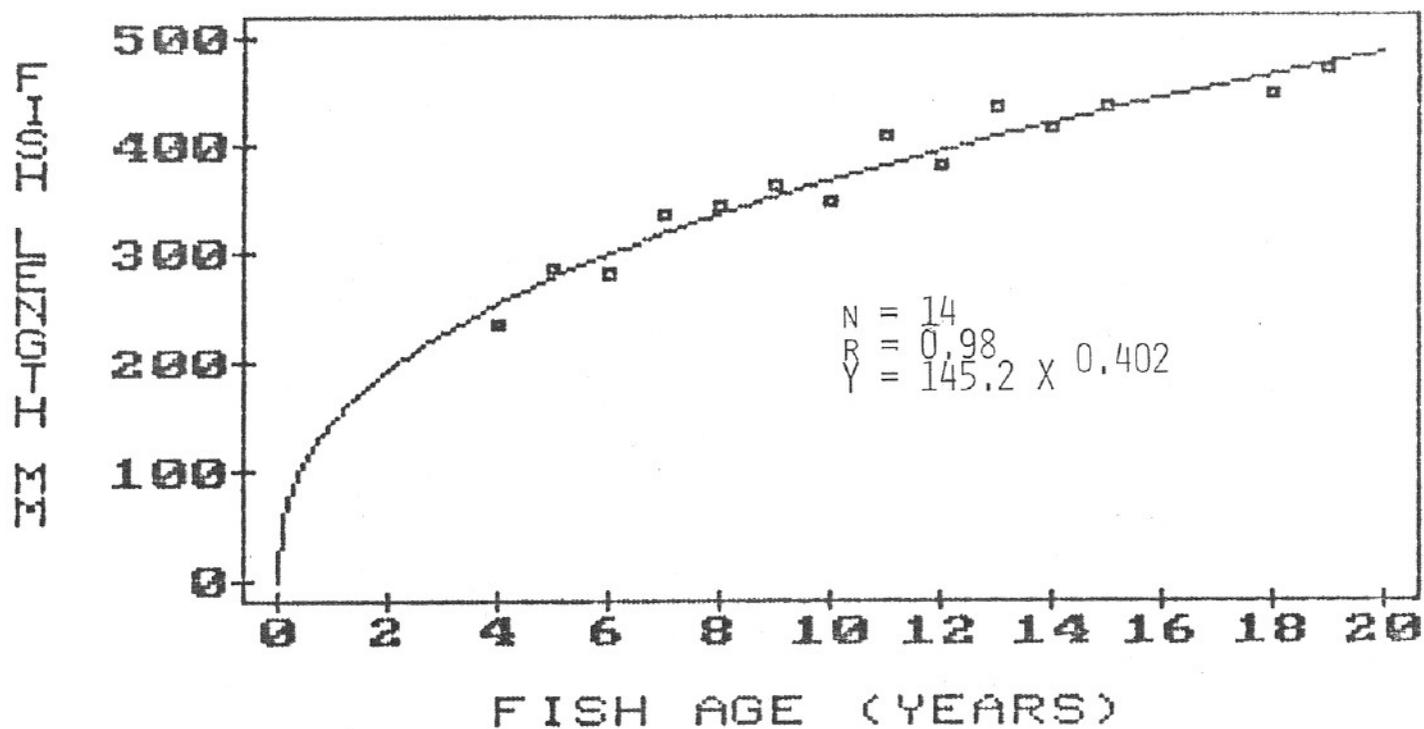
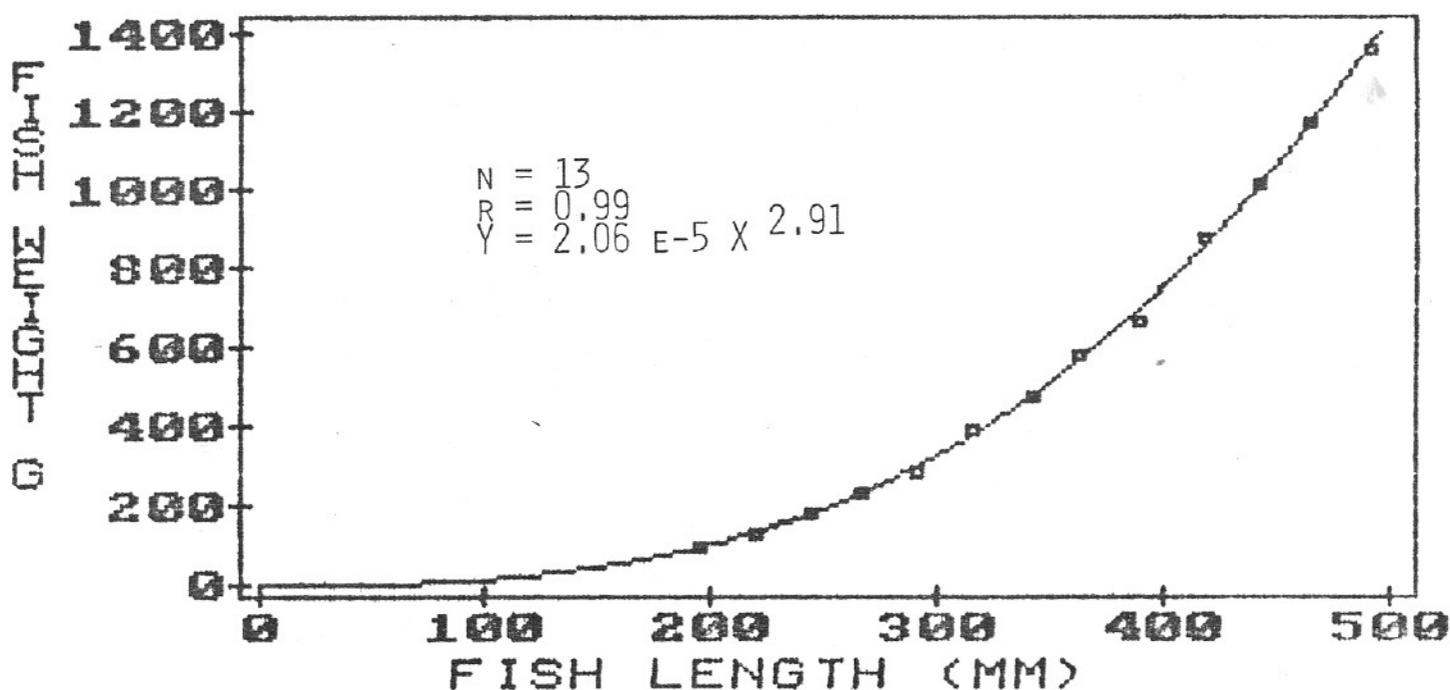


FIGURE 7.

LONGNOSE SUCKER LENGTH-WEIGHT KENAI NWR - 1984



OTHER SPECIES - Threespine stickleback were ubiquitous being found in all 20 surveyed lakes and six watersheds. Ninespine stickleback were much less numerous and only a few were found in King, Wilderness, and Petersen lakes which are in the Swanson River and Kenai River watersheds. Coastrange sculpin catches were somewhat erratic and did not always appear to be properly represented by our sampling. They were captured in 10 lakes situated in the Swanson River, Kenai River, and Dipper Creek watersheds, but may have been in a few more lakes. One slimy sculpin and one round whitefish were captured in Scenic Lake which is in the Chickaloon River watershed. The Arctic lamprey was taken in Middle Finger Lake.

CHEMICAL PROPERTIES

A comparison of the chemical parameters measured in the 20 Kenai NWR lakes studied during 1984 are in Table 7. Alkalinity, phosphorus, nitrogen, and conductivity are interrelated indicators of lake fertility. These parameters are important in controlling food production and related fish growth. Lack of one or more of these basic elements may be a fish limiting factor. The pH can affect spawning success and food production. Water temperature affects metabolic rates of lake organisms. Fish select desired water temperatures for growing, feeding, and reproduction. Dissolved oxygen levels greater than 6 mg/l are considered desirable for cold water game fish. We interpreted lake fertility using our three category modification of J.B. Moyle's productivity classification which is based on water alkalinity level. During the July water quality surveys, alkalinity ranged from 3 to 74 mg/l, phosphorus from 5.8 to 39.9 ug/l, Kjeldahl nitrogen from 0.19 to 0.49, pH from 6.7 to 7.8, dissolved oxygen from 0.1 to 12.6 mg/l, and water temperature from 4.0 to 18.8°C. Most of the lakes had high dissolved oxygen concentrations except in the deepest depths.

We also calculated lake Morphoedaphic Index (MEI) which is a fish yield model based on a combination of water conductivity (basic fertility) and mean depth (physical configuration). Figure 8 shows a clear positive relationship between total numbers of fish captured in gill nets and minnow traps for each lake and MEI. Approximately 49% of the variation in CPUE was explained by the regression which was statistically significant at the 0.01 level ($F=21.2$, df 1,23). Ryder et al. (1974), Jenkins (1982), Ryder (1965), and other authors have shown a definite positive relationship between MEI and fish yield in other parts of the United States, Canada, and the world. For the MEI to be most effective lakes should have a homogenous set of environmental conditions. Factors such as heavy fishing pressure, varying quality spawning areas, winter kill, excessive pollution, extreme inorganic turbidity, alternate year spawning, and epizotic mortality can reduce the effectiveness of the yield model.

Lake Morphoedaphic Indexes ranged from 2.4 to 137, the higher values reflecting shallower (greater euphotic zones) and more fertile (more elemental ions) lakes. The average MEI for the 20 lakes was 26.4 with a standard deviation of 32.6.

Table 7.

LAKE CHEMICAL CHARACTERISTICS
Kenai National Wildlife Refuge - July, 1984

Lake	D.O. Range (mg/l)	Temp. Range (°C)	pH	Specific Cond. @ 25°C	Alk. (mg/l)	Phos. (ug/l)	Kjeldahl Nitrogen (mg/l)	MEI
1. Canoe	11.5-0.4	16.3-6.2	7.5	138	57	16.1	0.31	34.2
2. Middle Finger	12.6-10.0	16.7-6.9	7.0	26	13	9.3	0.21	2.4
3. Forest	12.4-5.2	18.2-7.8	7.2	58	24	7.4	0.30	9.8
4. Kelly	9.9-0.2	16.3-10.7	7.8	122	59	9	0.19	22.7
5. King	11.8-0.5	17.0-5.7	7.8	133	63	12.6	0.28	17.5
6. McLain	9.8-3.2	17.8-11.0	7.4	87	46	10.9	0.32	16.7
7. Big Merganser	11.2-2.1	16.8-4.5	6.9	50	14	6.7	0.28	9.4
8. Moose	8.4-8.4	16.2-16.2	7.2	96	45	39.9	0.49	137
9. Mosquito	10.2-2.3	17.0-7.0	7.1	35	16	13.2	0.41	7.1
10. Mull	9.5-9.5	17.9-17.9	7.5	127	61	14.5	0.33	24.3
11. Lower Ohmer	12.2-0.2	15.6-5.0	7.7	105	48	9.3	0.30	9.0
12. Petersen	11.1-0.2	16.1-8.0	7.7	139	67	14.2	0.20	24.2
13. Portage	13.1-8.6	17.3-8.9	6.7	24	3	5.8	0.24	2.9
14. Rainbow	10.0-7.8	17.1-16.2	7.2	42	18	17.9	0.43	18.9
15. Sandpiper	10.9-0.4	17.8-7.0	7.2	104	38	9.9	0.42	18.7
16. Scenic	10.4-0.1	18.8-4.0	7.4	124	74	8.8	0.33	17.2
17. Snag	9.6-4.0	17.2-9.0	7.2	68	29	10.8	0.30	15.0
18. Tangerra	11.4-3.4	18.0-6.0	7.4	81	32	13.1	0.38	15.0
19. Watson	8.5-7.7	14.9-14.0	7.2	157	68	16.2	0.27	95.7
20. Wilderness	9.4-0.2	17.5-8.8	7.3	106	50	8.5	0.32	30.3
No. Lakes	20	20	20	20	20	20	20	20
Mean	-	-	-	91	41	12.7	0.32	26.4
Standard Deviation	-	-	-	41	22	7.2	0.08	32.6
Range	12.6-0.1	18.8-4.0	7.8-6.7	24-157	3-74	5.8-39.9	0.19-0.49	2.4-137

FIGURE 8. TOTAL FISH CATCH PER UNIT EFFORT COMPARED TO MORPHOEDAPHIC INDEX

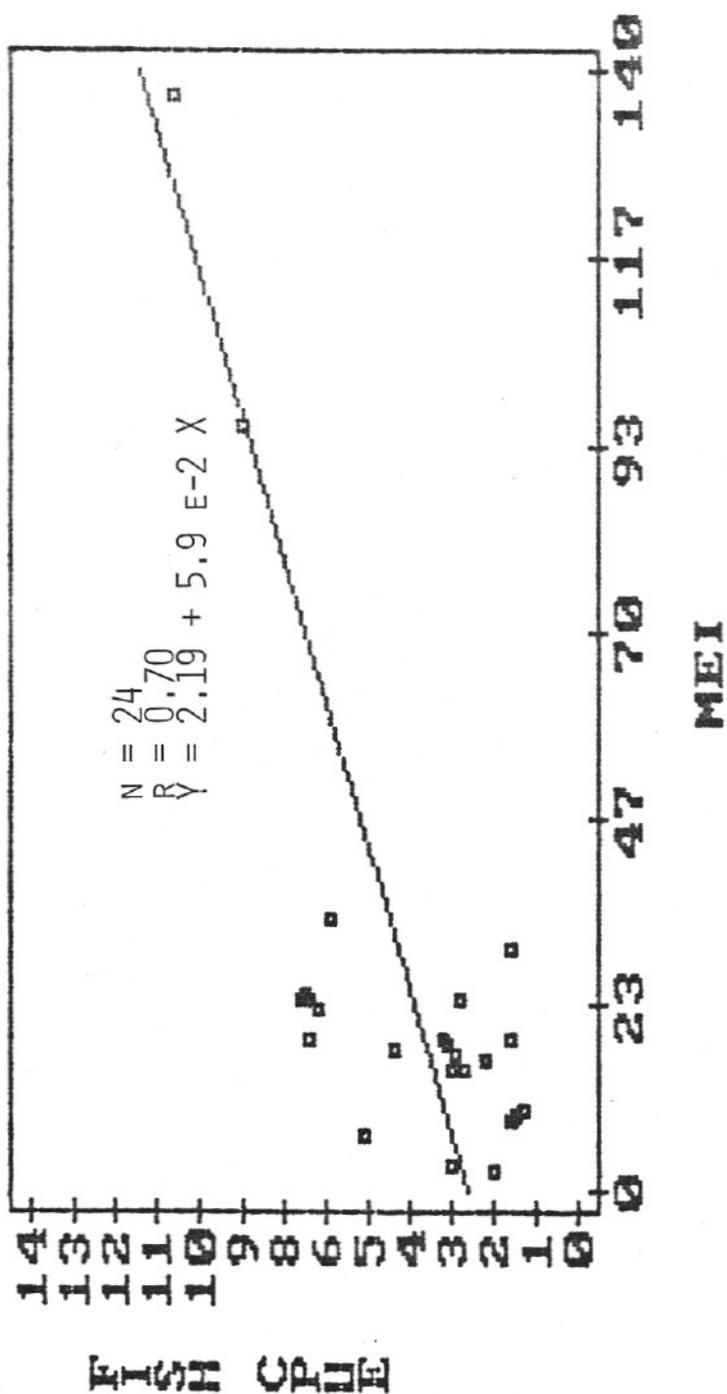


Table 9.

INFLOW STREAM NETWORK TYPE COMPARED
TO LAKE CONDUCTIVITY
Kenai National Wildlife Refuge - 1984

Inflow Stream Network Type							
Type 1 Conductivity		Type 2 Conductivity		Type 3 Conductivity		Type 4 Conductivity	
M. Finger	13	Forest	24	Kelly	59	Canoe	138
B. Merganser	14	Mull	61	King	63	Petersen	67
Mosquito	16	Rainbow	18	McLain	46	Watson	68
Portage	3	Snag	29	Moose	45		
		Tangerra	32	L. Ohmer	48		
				Sandpiper	38		
				Scenic	74		
				Wilderness	50		
Mean	11.5		32.8		52.9		91.0
SD	5.8		16.6		11.6		40.7

PHYSICAL PROPERTIES

A number of lake physical characteristics measured, which individually or in combination with other features influence fish diversity and abundance, are compared in Table 8. The 20 lakes surveyed varied in size from 28 to 472 acres, in maximum depth from 4.5 to 86 feet while mean depth was from 2.3 to 38.3 feet. Tributary streams were classified for each lake based on their value as spawning areas. Stream type descriptions of spawning value are in Appendix C.

An analysis was made to compare the fertility of lake waters (represented by conductivity) and the type of stream inflow network associated with the lake. Inflow streams were typed into four broad categories based on physical characteristics: (1) no inflow stream, (2) seasonal inflow from one or two small waterways, (3) one small permanent inflow stream or one or more medium to long seasonal inflow waterways, and (4) one or more medium to large permanent inflow streams. An Analysis of Variance indicated a significant relationship at the 0.01 level indicating higher quality inflow networks resulted in higher lake conductivities ($F=11.8$, $df\ 3,16$). The lake inflow stream ratings along with conductivity means and standard deviations are in Table 9.

VEGETATION AND WILDLIFE

Aquatic vegetation representing 12 families and 31 species were identified in 19 of the 20 lakes surveyed in 1984. Rainbow Lake was excluded from this summary since it was part of the 1983 survey. The principal families included lily, pondweed, and sedge.

Table 10 lists the number of aquatic plants identified at each lake along with the percent of aquatic coverage. Table 11 cross indexes aquatic plant families to common and scientific names. Over the field season, there was a noticeable difference in the variety and quantity of plant species in each lake. In early June much of the vegetation was dormant or just emerging and was not fully developed until late July. Therefore, the plant species present and percent of aquatic vegetation lake coverage would be lower for early surveys compared to those later in the year.

Wildlife identified by sight, sound, and sign, during the surveys consisted of mammals and birds. A total of 50 bird species were recognized during the 1984 lake study and are listed in Table 12. Mammals included beaver, muskrat, moose, black bear, red squirrel, and snowshoe hare. Beaver presence in lakes was considered important because of the potential effects their dams can have on fish habitat. Some of the potential habitat altering effects include increased lake water level, changed current patterns, altered water velocity, accelerated silt settlement rates, increased shoal areas, modified flushing rates, and blocked fish migration routes.

Table 8.

LAKE PHYSICAL FEATURES
Kenai National Wildlife Refuge

Lake	Surface Area (Ac.)	Maximum Depth (Ft.)	Mean Depth (Ft.)	Lake Volume (Ac.Ft.)	Water Trans. (Ft.)	Elevation (Ft/MSL)	Stream ^{2/} Type
1. Canoe	100	28	13.2	1320	13	190	4
2. Middle Finger	163	76	35.5	5700	33	235	1
3. Forest	101	41	19.4	1960	23	263	2
4. Kelly	141	41	17.6	2490	16	306	4
5. King	472	56	25	11800	30	215	4
6. McLain	248	35	17.2	4300	15	155	5
7. Big Merganser	43	65	17.4	750	18	220	3
8. Moose	302	4.5	2.3	680	4.5	238	1
9. Mosquito	69	41	16.1	1110	10	275	1
10. Mull	345	37	17.1	5900	15	178	5
11. Lower Ohmer	122	86	38.3	4700	18	420	3
12. Petersen	94	41	18.8	1800	15	295	5
13. Portage	28	52	27	745	26	255	1
14. Rainbow ^{1/}	150	17	7.3	1095	7	208	3
15. Sandpiper	72	35	18.2	1300	16	115	3
16. Scenic	110	44	23.6	2600	13	215	4
17. Snag	306	37	14.9	4500	13	195	3
18. Tangerra	173	45	17.5	3000	11	132	3
19. Watson	59	14	5.4	320	13	270	5
20. Wilderness	155	31	11.5	1800	16	210	4

^{1/} 1983 Data

^{2/} See Appendix C

Table 10.

AQUATIC VEGETATION AND WILDLIFE
Kenai National Wildlife Refuge - 1984

Lake	Aquatic Plant Species (No.)	Vegetation Lake Coverage (%)	Bird Species (No.)	Mammal Species (No.)	Beaver Present
1. Canoe	14	28	16	4	Yes
2. Middle Finger	9	6	23	3	Yes
3. Forest	14	12	9	4	Yes
4. Kelly	3	8	13	2	No
5. King	12	29	5	3	Yes
6. McLain	15	20	15	4	Yes
7. Big Merganser	7	67	6	2	No
8. Moose	9	85	9	3	Yes
9. Mosquito	11	11	13	3	No
10. Mull	11	10	7	3	Yes
11. Lower Ohmer	4	5	7	2	No
12. Petersen	7	6	27	5	Yes
13. Portage	8	3	5	3	No
14. Rainbow	-	21 ^{1/}	-	-	No
15. Sandpiper	14	28	21	4	Yes
16. Scenic	13	46	14	3	Yes
17. Snag	10	26	1	2	No
18. Tangerra	16	44	7	3	No
19. Watson	16	71	15	4	Yes
20. Wilderness	9	68	2	3	Yes

^{1/} 1983 Data

Table 11. AQUATIC PLANT FAMILIES AND SPECIES - 1984

Family	Common Name	Scientific Name
1. Buckwheat	water smartweed	<u>Polygonum amphibium</u>
2. Bur Reed	bur reed bur reed	<u>Sparganium angustifolium</u> <u>Sparganium minimum</u>
3. Crowfoot	crowfoot	<u>Ranunculus confervoides</u>
4. Duckweed	duckweed star duckweed	<u>Lemna minor</u> <u>Lemna trisulca</u>
5. Gentain	buck bean	<u>Menyanthes trifoliata</u>
6. Horsetail	horsetail horsetail	<u>Equisetum fluviatile</u> <u>Equisetum palustre</u>
7. Pondweed	pondweed pondweed pondweed pondweed pondweed pondweed pondweed pondweed pondweed pondweed pondweed pondweed pondweed pondweed pondweed	<u>Potamogeton alpinus</u> <u>Potamogeton epihydrus</u> <u>Potamogeton filiformis</u> <u>Potamogeton foliosus</u> <u>Potamogeton friesii</u> <u>Potamogeton gramineus</u> <u>Potamogeton natans</u> <u>Potamogeton perfoliatus</u> <u>Potamogeton praelongus</u> <u>Potamogeton robbinsii</u> <u>Potamogeton vaginatus</u> <u>Potamogeton zosterifolius</u>
8. Primrose	tufted loostrife	<u>Lysimachia thyrsiflora</u>
9. Quillwort	quillwort	<u>Isoetes muricata</u>
10. Sedge	sedge sedge spike rush bulrush	<u>Carex rhynchophysa</u> <u>Carex rostrata</u> <u>Eleocharis palustris</u> <u>Scirpus validus</u>
11. Water Lily	yellow pond lily dwarf water lily	<u>Nuphar polysepalum</u> <u>Nymphaea tetragona</u>
12. Water Milfoil	mare's tail water milfoil	<u>Hippuris vulgaris</u> <u>Myriophyllum spicatum</u>

Table 12.

LIST OF BIRD SPECIES

Remote and Roadside Lake Study, Kenai MWR - 1984

1. Alder Flycatcher	<u>Empidonax alnorum</u>
2. American Robin	<u>Turdus migratorius</u>
3. American Tree Sparrow	<u>Spizella arborea</u>
4. Arctic Tern	<u>Sterna paradisaea</u>
5. Bald Eagle	<u>Haliaeetus leucocephalus</u>
6. Barrow's Goldeneye	<u>Bucephala islandica</u>
7. Belted Kingfisher	<u>Ceryle alcyon</u>
8. Black-capped Chickadee	<u>Parus atricapillus</u>
9. Blackpoll Warbler	<u>Dendroica striata</u>
10. Black Scoter	<u>Melanitta nigra</u>
11. Bohemian waxwing	<u>Bombycilla garrulus</u>
12. Bonaparte's Gull	<u>Larus philadelphia</u>
13. Common Loon	<u>Gayia immer</u>
14. Common Merganser	<u>Mergus merganser</u>
15. Common Raven	<u>Corvus corax</u>
16. Common Redpoll	<u>Carduelis flammea</u>
17. Common Snipe	<u>Gallinago gallinago</u>
18. Dark-eyed Junco	<u>Junco hyemalis</u>
19. Glaucous Gull	<u>Larus hyperboreus</u>
20. Gray-cheeked Thrush	<u>Catharus minimus</u>
21. Gray Jay	<u>Perisoreus canadensis</u>
22. Greater Yellowlegs	<u>Tringa melanoleuca</u>
23. Great Horned Owl	<u>Bubo virginianus</u>
24. Lesser Scaup	<u>Aythya affinis</u>
25. Lesser Yellowlegs	<u>Tringa flavipes</u>
26. Mallard	<u>Anas platyrhynchos</u>
27. Mew Gull	<u>Larus canus</u>
28. Northern Harrier (Marsh Hawk)	<u>Circus cyaneus</u>
29. Northern Pintail	<u>Anas acuta</u>
30. Northern Waterthrush	<u>Seiurus noveboracensis</u>
31. Olive-sided Flycatcher	<u>Contopus borealis</u>
32. Orange-crowned Warbler	<u>Vermivora celata</u>
33. Pine Grosbeak	<u>Pinicola enucleator</u>
34. Red-necked Grebe	<u>Podiceps grisegena</u>
35. Red-tailed Hawk	<u>Buteo jamaicensis</u>
36. Ruby-crowned Kinglet	<u>Regulus calendula</u>
37. Rusty Blackbird	<u>Euphagus carolinus</u>
38. Sandhill Crane	<u>Grus canadensis</u>
39. Savannah Sparrow	<u>Passerculus sandwichensis</u>
40. Song Sparrow	<u>Melospiza melodia</u>
41. Surf Scoter	<u>Melanitta perspicillata</u>
42. Swanson's Thrush	<u>Catharus ustulatus</u>
43. Tree Swallow	<u>Tachycineta bicolor</u>
44. Trumpeter Swan	<u>Cygnus buccinator</u>
45. Varied Thrush	<u>Ixoreus naevius</u>
46. White-crowned Sparrow	<u>Zonotrichia leucophrys</u>
47. White-winged Crossbill	<u>Loxia leucoptera</u>
48. White-winged Scoter	<u>Melanitta fusca</u>
49. Wilson's Warbler	<u>Wilsonia pusilla</u>
50. Yellow-rumped Warbler	<u>Dendroica coronata</u>

FISH ABUNDANCE AND ENVIRONMENTAL PARAMETERS

A comparison of five fish CPUE's and 14 chemical, biological, and physical variables was made in Table 13 to pinpoint significant correlations. This correlation matrix suggests the most important parameters which might be used in construction of a predictive lake value fishery model.

One of the most significant correlation coefficients was the 0.70 between total fish CPUE and MEI. This factor shows that fish number normally increases proportionally with an increase in lake productivity. Rainbow trout and total gill net CPUE were highly correlated to stream type with coefficients of 0.59 and 0.66 respectively. These correlations indicate that the quality of stream spawning habitat is critical to the presence and abundance of larger stream spawners such as rainbow trout and longnose sucker. Char CPUE was negatively correlated with MEI (-0.17) indicating the preference of Arctic char for oligotrophic waters. This correlation is much lower than the correlation coefficient in Figure 5 (Arctic char vs. MEI) because it is diluted by Arctic char and MEI data from all 20 lakes as opposed to Figure 5's five cases. Char abundance was positively correlated with mean depth at 0.43 indicating the Arctic char's preference for cold deep lakes. The Shoreline Development Factor, often associated with high fish abundances in other parts of the United States, seemed to have no clear correlation with fish abundances in Kenai NWR lakes. Other chemical parameters were significantly correlated with the various fish CPUE's, however, they were also often highly correlated with conductivity which is part of the MEI equation.

Table 13.

CORRELATION MATRIX OF PHYSICAL, CHEMICAL, AND BIOLOGICAL FACTORS AFFECTING FISH ABUNDANCE IN TWENTY KENAI NATIONAL WILDLIFE REFUGE LAKES - 1984

	RB CPUE		Gill Minnow Net Trap CPUE		Total CPUE	A.C. CPUE	SDF	% Veg.	Mean Depth	Max. Depth	Water Trans.	Surface Water		pH	Cond. @ 25°C	Total Hard.	Total Alk.	Total Phos.	Kjel. N.	MEI	Stream Type
	CPUE	CPUE	CPUE	CPUE								Temp.	Temp.								
1. R. Trout CPUE	1.00	0.72	-0.09	0.21	0.01	0.01	0.05	-0.21	-0.23	<0.01	0.37	0.27	0.41	0.33	0.39	-0.04	<0.01	0.11	0.59		
2. Gill Net CPUE		1.00	0.01	0.40	0.09	-0.15	0.20	-0.22	-0.24	0.07	0.33	0.31	0.63	0.51	0.60	0.02	-0.29	0.38	0.66		
3. Minnow Trap CPUE			1.00	0.92	-0.20	-0.01	0.13	-0.41	-0.46	-0.43	-0.47	0.13	0.22	0.14	0.20	0.72	0.24	0.60	-0.10		
4. Total CPUE				1.00	-0.14	-0.07	0.20	-0.47	-0.52	-0.37	-0.30	0.24	0.45	0.33	0.42	0.67	0.10	0.70	0.17		
5. Arctic Char CPUE					1.00	0.45	-0.08	0.43	0.41	0.71	0.22	0.06	-0.07	-0.02	-0.04	-0.13	-0.24	-0.16	-0.17		
6. Shoreline Dev. Factor						1.00	-0.06	0.12	0.21	0.23	0.25	-0.14	-0.23	-0.27	-0.29	-0.11	-0.07	-0.22	-0.26		
7. % Aquatic Vegetation							1.00	-0.52	-0.39	-0.32	0.29	-0.26	0.15	0.19	0.11	0.40	0.37	0.67	-0.03		
8. Mean Depth								1.00	0.94	0.76	0.02	0.15	-0.05	0.03	-0.01	-0.62	-0.55	-0.59	-0.13		
9. Maximum Depth									1.00	0.73	0.05	0.09	-0.11	-0.07	-0.09	-0.65	-0.56	-0.61	-0.14		
10. Water Transparency										1.00	0.29	-0.03	-0.05	-0.08	-0.06	-0.60	-0.62	-0.42	-0.13		
11. Surface Water Temp.											1.00	-0.29	-0.04	0.03	-0.06	-0.37	-0.03	-0.10	0.06		
12. pH												1.00	0.77	0.70	0.80	0.05	-0.35	0.01	0.68		
13. Conductivity @ 25°C													1.00	0.88	0.97	0.12	-0.36	0.38	0.78		
14. Total Hardness														1.00	0.95	0.06	-0.24	0.30	0.67		
15. Total Alkalinity															1.00	0.12	-0.35	0.34	0.78		
16. Total Phosphorous																1.00	0.55	0.81	-0.13		
17. Kjeldahl Nitrogen																	1.00	0.31	-0.38		
18. MEI																		1.00	0.03		
19. Stream Type																			1.00		

Significance Level .05 - 0.40

Significance Level .01 - 0.52

INDIVIDUAL LAKE REPORTS

Detailed reports for 20 lakes follow. In alphabetical order they are: Canoe, Middle Finger, Forest, Kelly, King, McLain, Big Merganser, Moose, Mosquito, Mull, Lower Ohmer, Petersen, Portage, Rainbow, Sandpiper, Scenic, Snag, Tangerra, Watson, and Wilderness. Each individual lake report contains detailed information on lake biological, chemical, and physical parameters grouped in eight report sections entitled: (1) Physical Features, (2) Fish, (3) Aquatic Vegetation, (4) Water Quality, (5) Management History, (6) Wildlife, (7) Recreational Use, and (8) Fishery Resource Summary. Additionally, each report contains a summary data table plus a lake map.

CANOE LAKE

SURVEY PERIOD

Personnel of the U.S. Fish and Wildlife Service surveyed Canoe Lake twice during 1984. J.W. Friedersdorff and W.J. Jakubas conducted a fishery survey on June 11-12. Additional water quality data were gathered by G.A. Muhlberg and A.S. Firman on July 20. Table 1 summarizes Canoe Lake survey findings.

PHYSICAL FEATURES

Canoe Lake is located in the northeast section of the Kenai National Wildlife Refuge (NWR) and is part of the Swanson River watershed. Its latitude is north 60° 43' and longitude west 150° 41'. The lake and surrounding area were designated as wilderness by the Alaska National Interest Lands Conservation Act of 1980. The watershed area for the lake is estimated to be 8.7 square miles. Canoe Lake has a surface area of 100 acres, a volume of 1,320 acre feet, and is at an estimated elevation of 190 feet. The lake has a mean depth of 13.2 feet and maximum depth of 28 feet (Table 1 and Figure 1).

Low hill terrain characterizes watershed topography. Terrestrial vegetation is dominated by a white spruce - black spruce - paper birch forest with patches of alder along the lake's periphery. Two small bogs are located adjacent to the northern and southwestern sections of the lake.

Lake water level is maintained by three permanent flow streams, springs, and run-off. One inlet stream, located at the southern end of the lake, flows through a series of lakes including Contact, Martin, and two lakes designated by us as Canoe Lake 3 and Canoe Lake 2, before entering Canoe Lake. This stream is about 9 feet wide and slightly less than 1 foot deep. Flow was estimated to be about 7 cubic feet per second (cfs). The second inlet stream, flowing from Waterfowl Lake to the western side of Canoe Lake was 4 feet wide and 1 foot deep. Its flow was estimated slightly greater than 1 cfs. The outlet stream, on the lake's east side, varied from 10 to 18 feet wide and 1 to 3 feet deep. Flow was about 18 cfs.

The outlet stream courses about 0.25 miles connecting to Sucker Lake. From Sucker Lake it flows 1.5 miles northeast to Swan Creek which, in turn, flows 3 miles northwest to the Swanson River. Below Sucker Lake, the stream flows through a steel culvert under Swan Lake Road. The lower end of the culvert is elevated about 18 inches above the stream. This drop creates a falls which is believed to present a barrier to the upstream movement of small fish. Immigrating adult coho salmon were observed surmounting the falls during 1983 by Wally Jakubas of the Fishery Resources staff and Mike Hedrick, Assistant Refuge Manager of the Kenai NWR.

All three tributaries to Canoe Lake contain spawning gravel. Longnose sucker were observed spawning in the outlet stream; it also contained a large number of rainbow trout. The outlet stream was judged to be high quality trout and salmon spawning habitat and capable of providing anadromous fish passage to the lake. The other two streams appeared to be of moderate and low spawning value.

Table 1.

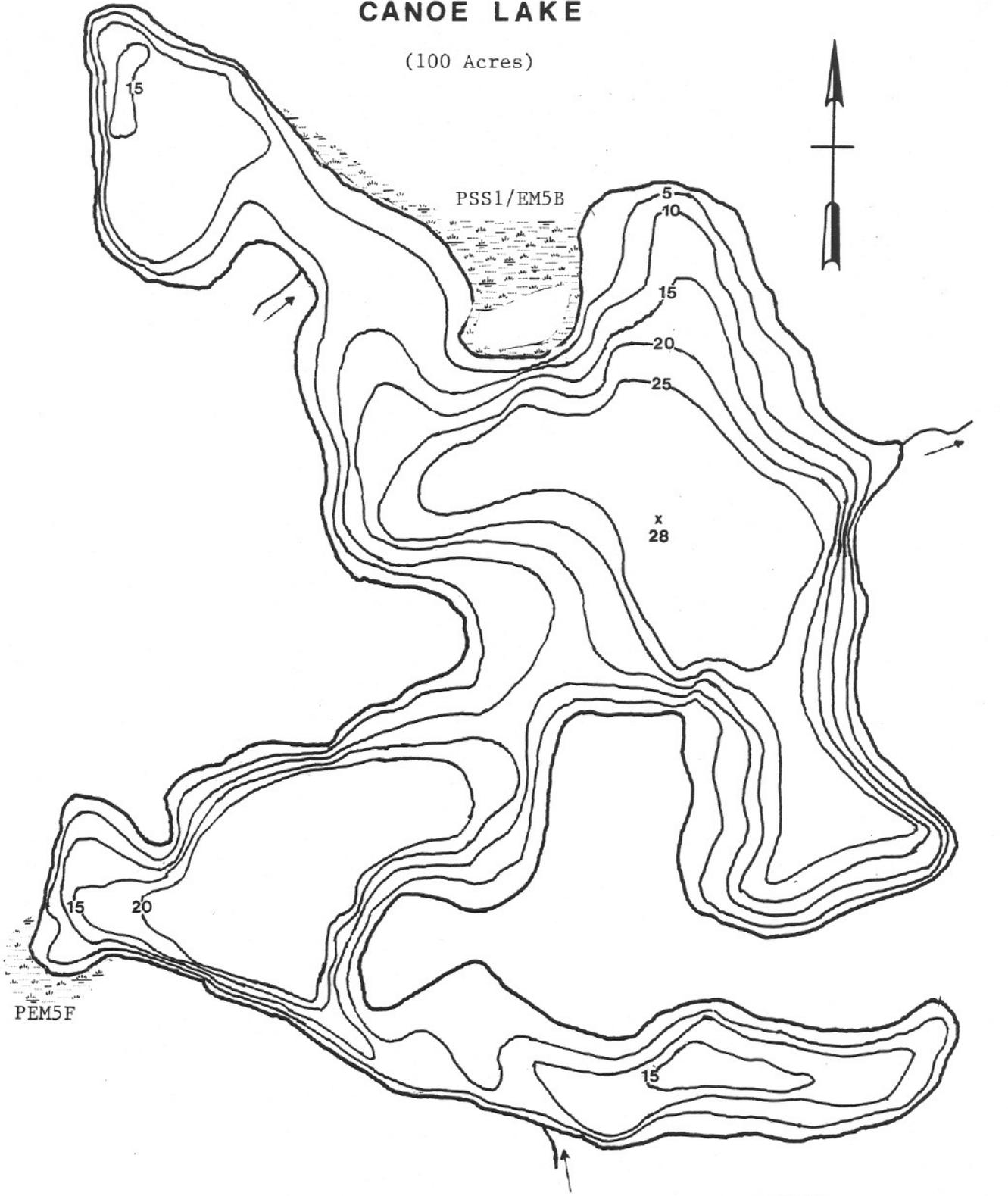
LAKE SURVEY SUMMARY
Canoe Lake

LOCATION				SPORT FISH VALUE	
				(Species)	(Yield)
Refuge	Kenai NWR	Map	Kenai (C-2)	Rainbow Trout	Moderately High
Lat.	N 60° 43'	Long.	W 150° 41'	Char	Low
T	7N R	8W	S 9	Coho Salmon	Nursery Area
Land Use Class	Wilderness				
PHYSICAL FEATURES				WATERSHED	
Surface Area (Ac.)	100			Swanson River	
Maximum Depth (Ft.)	28			FISH SPECIES	
Mean Depth (Ft.)	13.2			Rainbow Trout	
Volume (Ac.Ft.)	1320			Arctic Char	
Water Trans. (Ft.)	13			Dolly Varden	
Elevation (Ft.)	190			Coho Salmon	
TRIBUTARY STREAMS				WATER QUALITY	
Inlets (No.)	2 permanent flow			Temp. (°C)	16.3 - 6.2
Outlets (No.)	1 permanent flow			D.O. (mg/l)	11.5 - 0.4
Ocean Linkage	yes			pH	7.5
AQUATIC VEGETATION (Dominant Families)				Tot. Alk. (mg/l)	57
Pondweed, water lily, duckweed, quillwort, sedge				Tot. Hard. (mg/l)	54
Lake Coverage (%)				Tot. Phos. (ug/l)	16.1
				Tot. Kjell. N (mg/l)	0.31
				Cond. (umho)@ 25°C	138
				MEI	34.2 SDF 2.46
SURVEY DATES				RECREATION	
Fish 6/11-12/84				Types: Canoeing, fishing, wildlife viewing, camping, hunting. The lake is part of the Swan Lake Canoe Route--National Recreation Trail System.	
Water Quality 7-20-84				Public Facilities: Canoe trail. Nearby parking lot, pit toilet, canoe sign-in station, bulletin board.	
				Access: 100 yard path from Swan Lake Road. Aircraft landing and outboard motors prohibited on lake.	

Figure 1.

CANOE LAKE

(100 Acres)

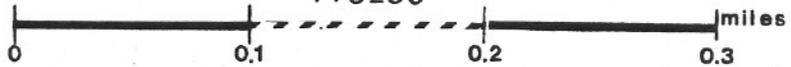


LEGEND

- Depth Contour (ft.) -
- Stream Flow -
- Bog -

SCALE

1 : 5280



Swan Lake Road provides automobile access to within 100 yards of the north end of Canoe Lake. Airplanes are currently restricted from landing on the lake and outboard motors are prohibited.

FISH

Rainbow trout was the most abundant game fish in Canoe Lake with a moderate catch per unit effort (CPUE) of 0.27 fish per net hour (Table 2). Arctic char and Dolly Varden were low in abundance with respective CPUE's of 0.04 and 0.02. Longnose sucker were moderately abundant (CPUE 0.18). About two weeks prior to our fish survey, Wally Jakubas of our staff saw a large number of small coho dimpling in the lake. Identification of the coho was verified by hook and line catch. The one sockeye salmon captured (CPUE 0.02) was a resident fish of intermediate size that had spent its entire life in fresh water; it was either a residual sockeye or a kokanee. Threespine stickleback, taken in minnow traps, were high in abundance (CPUE 5.68) while coastrange sculpin were found at a CPUE of 0.15. Four gill nets and 14 minnow traps were used to determine fish abundance.

Rainbow trout ranged in fork length from 9.8 inches (250 mm) to 15.4 inches (390 mm), in weight from 0.2 pound (100 g) to 1.5 pounds (660 g), and in condition from 0.54 to 1.25. Trout varied in age from five to eight years with an average growth rate of 1.9 inches per year (Table 3). The one sockeye salmon was three years old plus spring growth. Longnose sucker (Table 4) varied in age from six to 18 years with corresponding fork lengths from 12.2 inches (310 mm) to 17.3 inches (440 mm). Additional data on length, weight, and condition for rainbow trout, longnose sucker, Arctic char, sockeye salmon, coho salmon, and Dolly Varden are in Table 5.

AQUATIC VEGETATION

The most abundant species of aquatic vegetation were yellow pond lily; the pondweeds Potamogeton perfoliatus, P. praelongus, and P. gramineus; and star duckweed. Patches of horsetail, sweet gale, buck bean, wild calla, and marsh fivefinger were present along the shoreline. Approximately 28 percent of the lake was covered with aquatic vegetation.

Wetland areas sighted during our survey were in general agreement with those listed by the National Wetlands Inventory (USFWS 1978). One small emergent wetland (PEM5F) is situated along the lake's southwestern shore. A slightly larger scrub-shrub wetland (PSS1/EM5B) is located on the northern end of the lake. A complete list of vegetation identified is in Table 6.

WATER QUALITY

The lake's alkalinity level of 57 mg/l was above the average (39 mg/l) found in the 37 lakes surveyed during 1983-84. Lake waters are medium in productivity using our modification of J.B. Moyle's classification based on alkalinity level (MacKenthun and Ingram 1967). The pH of 7.5 was slightly alkaline. During July (Table 7), the lake was thermally stratified with the thermocline occurring near 16 feet. Dissolved oxygen levels were saturated to slightly supersaturated in the epilimnion. Low D.O. levels of 7 percent saturation (0.6 mg/l) occurred near the lake's deepest point, but represented only a small portion of the total lake volume.

Table 2.

FISH CATCH AND EFFORT SUMMARY
Canoe Lake 6/11-12/84

Gear	Average Fishing Time (hrs.)	Amount Gear (sq.ft.)	Fish Species	Total Fish Number	Sex M-F-U	Fish CPUE	
						Net Hour	Trap Hour
4 Gill Nets	14	3,200	Rainbow Trout	15	3-8-4	0.27	N/A
			Arctic Char	2	0-2-0	0.04	N/A
			Dolly Varden	1	0-1-0	0.02	N/A
			Coho Salmon	1	0-0-1	0.02	N/A
			Sockeye Salmon	1	1-0-0	0.02	N/A
			Longnose Sucker	10	0-0-10	0.18	N/A
			All Species	30	4-11-15	0.55	N/A
12 Minnow Traps	13		Threespine Stickleback	886	0-0-886	N/A	5.68
			Coastrange Sculpin	23	0-0-23	N/A	0.15
			All Species	909	0-0-909	N/A	5.83

1/ Sockeye residual or Kokanee salmon

Table 3.

BACK-CALCULATED FORK LENGTHS (MILLIMETERS) AT ANNULUS FORMATION*
of Rainbow Trout in Canoe Lake - 1984

Year Class	Number of Fish	Age of Fish												Capture FL	
		1	2	3	4	5	6	7	8	9	10	11	12		
1979	3	45	92	144	190	240									263
1978	8	44	86	135	181	231	284								300
1977	3	43	87	147	196	253	305	359							370
1976	1	44	98	137	171	229	293	341	375						390
Number of Fish	15	15	15	15	15	15	12	4	1						
Grand Mean (mm)		44	88	139	185	237	290	355	375						
Grand Mean (in)		1.7	3.5	5.5	7.3	9.3	11.4	14.0	14.8						
Annual Growth Increment (in)		1.7	1.8	2.0	1.8	2.0	2.1	2.6	0.8						

*Not corrected for length at scale formation

Table 4.

AGE-FORK LENGTH OF LONGNOSE SUCKER
Canoe Lake - 1984

Fish Age (years)	Sample Size (no.)	Fish Length		
		-----Mean----- (in)	(mm)	Range (mm)
6	1	12.2	310	-
7	2	13.0	330	315 - 345
9	2	13.8	350	340 - 360
10	2	14.5	368	350 - 385
18	1	17.3	440	-

Table 5.

FISH LENGTH, WEIGHT, AND CONDITION SUMMARY
Canoe Lake 6/11-13/84

Gear	Category	Species	Sample Size	Mean	Standard Deviation	Range
Gill Nets	Fork Length (mm)	Rainbow Trout	15	313	44.2	250 - 390
		Longnose Sucker	7	344	25.8	310 - 385
		Arctic Char	2	400	77.8	345 - 455
		Sockeye Salmon	1	220	-	-
		Coho Salmon	1	113	-	-
		Dolly Varden	1	435	-	-
	Weight (g)	Rainbow Trout	15	316	161	100 - 660
		Longnose Sucker	7	474	74.9	360 - 600
		Arctic Char	2	780	481	440 - 1120
		Sockeye Salmon	1	110	-	-
		Coho Salmon	1	15.9	-	-
		Dolly Varden	1	960	-	-
	Condition (K)	Rainbow Trout	15	0.96	0.16	0.54 - 1.25
		Longnose Sucker	7	1.17	0.15	1.05 - 1.49
		Arctic Char	2	1.13	0.09	1.07 - 1.19
		Sockeye Salmon	1	1.03	-	-
		Coho Salmon	1	1.10	-	-
		Dolly Varden	1	1.17	-	-

Table 6.

VEGETATION
Canoe Lake 6/11-12/84

AQUATIC VEGETATION

Class	Common Name	Scientific Name
Emergent	buck bean	<u>Menyanthes trifoliata</u>
	horsetail	<u>Equisetum fluviatile</u>
	sedge	<u>Carex sp.</u>
Floating	bur reed	<u>Sparganium angustifolium</u>
	dwarf water lily	<u>Nymphaea tetragona</u>
	pondweed	<u>Potamogeton gramineus</u>
	yellow pond lily	<u>Nuphar polysepalum</u>
Submergent	crowfoot	<u>Ranunculus confervoides</u>
	pondweed	<u>Potamogeton foliosus</u>
	pondweed	<u>Potamogeton friesii</u>
	pondweed	<u>Potamogeton praelongus</u>
	pondweed	<u>Potamogeton perfoliatus</u>
	pondweed	<u>Potamogeton zosterifolius</u>
	quillwort	<u>Isoetes sp.</u>
	star duckweed	<u>Lemna trisulca</u>
	water milfoil	<u>Myriophyllum spicatum</u>

WETLANDS VEGETATION*

Class	Symbol	Description
Emergent	PEM5F	palustrine, emergent, narrow leaved persistent, semipermanent
Scrub-shrub	PSS1/EM5B	palustrine, scrub-shrub, broad leaved deciduous, emergent, narrow leaved persistent, saturated

*National Wetlands Inventory (Kenai)

TERRESTRIAL VEGETATION

Class	Common Name	Scientific Name
Trees	alder	<u>Alnus sp.</u>
	black spruce	<u>Picea mariana</u>
	paper birch	<u>Betula papyrifera</u>
	quaking aspen	<u>Populus tremuloides</u>
	white spruce	<u>Picea glauca</u>
Shrub	sweet gale	<u>Myrica gale</u>
Below Shrub	marsh fivefinger	<u>Potentilla palustris</u>
	wild calla	<u>Calla palustris</u>

Water color was green brown, and Secchi disc transparency was 13 feet. The lake had a Morphoedaphic Index of 34.2 and Shoreline Development Factor of 2.46. Dissolved oxygen values at the time of the fishery survey are in Table 8.

MANAGEMENT HISTORY

The Alaska Department of Fish and Game (ADF&G) first surveyed Canoe Lake in October, 1964 (Engel and Johnson 1964). They reported capturing 37 rainbow trout, 6 coho salmon, 7 Dolly Varden, 1 sockeye salmon, and 4 longnose sucker in two experimental gill nets. Fishing time was not specified, but is believed to have been approximately 24 hours. State biologists reported lake sport fishing pressure to be moderate. During July, 1974, the Fish and Wildlife Service (FWS) resurveyed the lake (Nelson and Bailey 1974). A total of 47 rainbow trout and 21 longnose sucker were captured in 21 hours with two experimental gill nets for respective CPUE's of 1.12 and 0.50 fish per net hour. Creel census by the FWS during June and July, 1975, found angler sport catches of rainbow trout from the lake to be 0.46 and 0.14 fish per hour. No other survey work is known to have been accomplished on Canoe Lake.

WILDLIFE

One beaver was sighted near an active beaver lodge located on the southern shore of the lake. Two common loons were seen on the lake, and a bald eagle was spotted in flight. Muskrat presence was indicated by clam shell feeding areas. All wildlife species along with other pertinent data are in Table 9.

RECREATIONAL USE

Recreational uses of Canoe Lake include canoeing, fishing, wildlife viewing, camping, and hunting. The lake is one of the two launch points for the Swan Lake Canoe Route, part of the National Recreation Trail System. Rick Johnston, Outdoor Recreation Planner for the Kenai NWR, stated during the summer and fall over two thousand canoeists boat the lake. During our two day fishery survey, we observed 12 canoes on the lake, but this was not a complete count. Only a few boaters were observed fishing. There are no current records of fishing use. However, due to the relatively heavy canoeing, lake fishing pressure is believed moderate.

The canoe trail is the only public recreational facility on the lake. A sign-in box, bulletin board, parking lot, and pit toilet are located near the road. Several lake shore camping areas have been cleared by boaters.

FISHERY RESOURCE SUMMARY

Rainbow trout were the dominant game fish in Canoe Lake. They were found in moderate abundance (0.27). This catch, plus our observation of various age rainbow trout in the outlet stream, indicates successful spawning and recruitment of trout is occurring. Low abundances of Dolly Varden (CPUE 0.02) and Arctic char (CPUE 0.04) were present. One sockeye salmon was captured which was a residual sockeye or kokanee. The lake serves as a nursery area for juvenile coho salmon. Longnose sucker were found to be moderately abundant

Table 9.

WILDLIFE DATA
Canoe Lake 6/11-12/84

Animal Class	Common Name	Number	Sex M-F-U	Animal Assoc.	Verification	Habitat Type
Birds						
Waterfowl	common loon	2	1-1-0	Pair	Sight	Water
Passerines	American robin	-	-	-	Sight	-
	black-capped chickadee	-	-	-	Sight	-
	common redpoll	-	-	Flock	Sight	-
	dark-eyed junco	-	-	-	Sound	-
	gray jay	-	-	-	Sound	-
	northern waterthrush	-	-	-	Sight	-
	orange-crowned warbler	-	-	-	Sight	-
	pine grosbeak	-	-	-	Sight	-
	rusty blackbird	-	-	-	Sight	-
	Swanson's thrush	-	-	-	Sound	-
	tree swallow	-	-	-	Sight	-
	varied thrush	-	-	-	Sound	-
	yellow-rumped warbler	-	-	-	Sight	-
Shorebirds	common snipe	-	-	-	-	-
Raptors	bald eagle	1	-	Single	Sight	Flight
Mammals						
Big Game	moose	5 J+	0-2-3	Cow/Calf	Sight	-
Furbearers	beaver	1	0-0-1	Single	Sight	Water
	muskrat	-	-	-	clam shells	-
Others	red squirrel	1	0-0-1	Single	Sight	Trees

(CPUE 0.18) while threespine stickleback and coastrange sculpin constituted the main forage species.

Angler use in the lake is believed moderate due to the large number of canoeists. Lake water fertility is medium, and the MEI was 34.2. Dissolved oxygen concentrations were high for cold water game fish throughout most of the lake. A large amount of high, moderate, and low quality rainbow trout and salmon spawning habitat is adjacent to the lake in its three tributary streams. Although the culvert under Swan Lake Road appears to be a barrier to upstream movement of small fish, it does not prevent migration of adult coho salmon. Previous 1964 and 1974 surveys by the ADF&G and FWS confirmed our findings of fish species composition, however, their CPUE's of rainbow trout were significantly higher. Considering all information, we believe Canoe Lake can support a moderately high yield rainbow trout sport fishery, a low yield char sport fishery, and to be a coho salmon nursery area.

MIDDLE FINGER LAKE

SURVEY PERIOD

Personnel of the U.S. Fish and Wildlife Service surveyed Middle Finger Lake twice during 1984. W.J. Jakubas and A.S. Firman conducted a fishery survey on June 25-26. Detailed water quality data were gathered by J.W. Friedersdorff and W.J. Jakubas on July 17. Table 1 summarizes survey findings.

PHYSICAL FEATURES

Middle Finger Lake is located in the northcentral section of the Kenai National Wildlife Refuge (NWR). The lake is in the Swanson River Basin, but is landlocked from the ocean. Its latitude is north 60° 38' and longitude west 150° 53'. The lake and surrounding area were designated to be in the Moderate Land Management category by the Kenai NWR Comprehensive Conservation Plan (USFWS 1985). The watershed area for the lake is estimated to be 1.5 square miles. Middle Finger Lake has a surface area of 163 acres, a volume of 5,700 acre feet, and is at an elevation of 235 feet. The lake has a mean depth of 35.3 feet and maximum depth of 76 feet (Table 1 and Figure 1).

The watershed is composed of rolling hills rising to over 400 feet in elevation. An immature paper birch forest with scattered stands of mature birch and white spruce surrounds the lake. Alder is present along the shoreline. Most of the Finger Lakes area was burned in the 1969 refuge fire.

Lake water level is maintained by springs, streams, and run-off. An inlet channel was present at the south end of the lake, but had no flow. Aerial photos indicate a small lake about 0.1 mile south provides overflow to this stream. One outlet stream, located on the lake's northeast side, was about 1 foot wide and 0.5 foot deep. Flow was estimated at 0.2 cubic feet per second. This stream flows about 100 yards to East Finger Lake and appeared to be low to negligible quality rainbow trout spawning habitat. In turn, East Finger Lake is seasonally connected to South Finger Lake. Large quantities of clean gravel are present in shoal areas of Middle Finger Lake which could serve as Arctic char spawning habitat. The whole Finger Lakes system is landlocked. Middle Finger Lake is not connected to West Finger Lake as shown on USGS Topographic Map Kenai (C-3), 1951.

Access to Middle Finger Lake can be obtained via Finger Lakes Road and a short walk to the lake, however, this road is currently restricted from public use by a locked gate. Aircraft access is currently permitted. Outboard motors larger than 10 horsepower are prohibited by Refuge regulation.

FISH

Arctic char were the only game fish captured in the lake. They were found to be in moderate abundance at a catch per unit effort (CPUE) of 0.39 fish per net hour (Table 2). Longnose sucker were in low abundance (CPUE 0.08). Threespine stickleback were in moderate abundance (CPUE 1.49) while coastrange sculpin and one Arctic lamprey were also captured. A total of four gill nets and 14 minnow traps were used to determine fish abundance.

Table 1.

LAKE SURVEY SUMMARY
Middle Finger Lake

LOCATION				SPORT FISH VALUE	
				(Species)	(Yield)
Refuge	Kenai NWR	Map	Kenai (C-3)	Arctic Char	Low
Lat.	N 60° 38'	Long.	W 150° 53'		
T	6N	R	9W		
		S	5		
Land Use Class	Moderate Management				

PHYSICAL FEATURES

Surface Area (Ac.)	163
Maximum Depth (Ft.)	76
Mean Depth (Ft.)	35.3
Volume (Ac.Ft.)	5700
Water Trans. (Ft.)	33
Elevation (Ft.)	235

WATERSHED
Swanson River

FISH SPECIES

Arctic Char
Longnose Sucker
Threespine Stickleback
Coastrange Sculpin
Arctic Lamprey

WATER QUALITY

Temp. (°C)	16.7-6.9
D.O. (mg/l)	12.6-10.0
pH	7.0
Tot. Alk. (mg/l)	13
Tot. Hard. (mg/l)	12
Tot. Phos. (ug/l)	9.3
Tot. Kjehl. N (mg/l)	0.21
Cond. (umho)@ 25°C	26
MEI	2.4 SDF 2.28

TRIBUTARY STREAMS

Inlets (No.)	1 Intermittent
Outlets (No.)	1 Permanent
Ocean Linkage	None

RECREATION

Types: Fishing, hunting.

Public Facilities: None

AQUATIC VEGETATION
(Dominant Families)

Lily, pondweed, quillwort, sedge.

Lake Coverage (%) 6

Access: Aircraft, automobile access is possible within a short distance of the lake via Finger Lakes Road, however, this road is closed to public use by a locked gate. Outboard motors larger than 10 hp are prohibited by Refuge regulation.

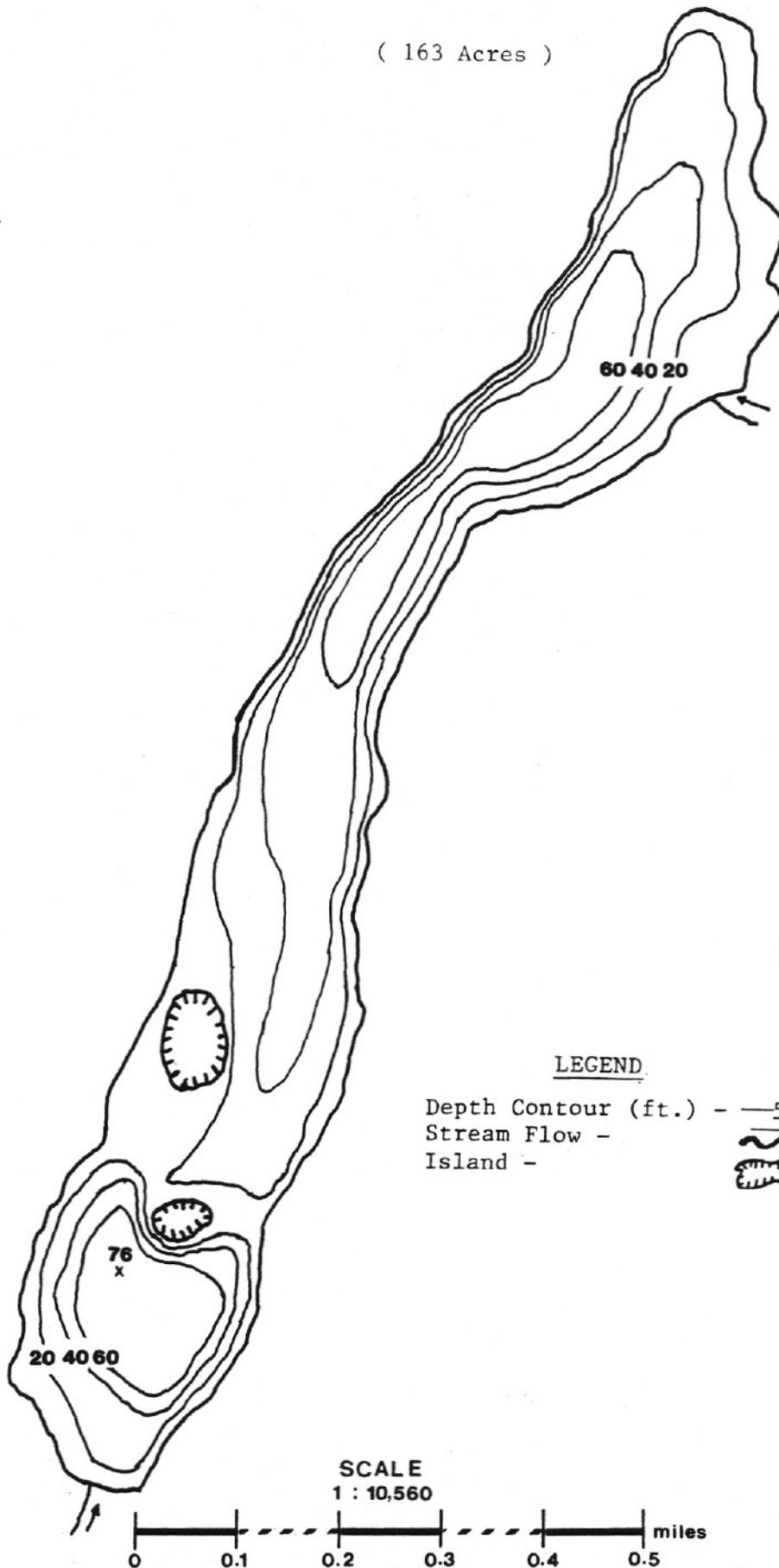
SURVEY DATES

Fish	6/25-26/84
Water Quality	7-17-84

Figure 1.

MIDDLE FINGER LAKE

(163 Acres)



LEGEND

- Depth Contour (ft.) - — 5 —
- Stream Flow - 
- Island - 

SCALE
1 : 10,560

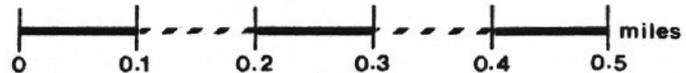


Table 2.

FISH CATCH AND EFFORT SUMMARY
Middle Finger Lake 6/25-26/84

Gear	Average Fishing Time (hrs.)	Amount Gear (sq.ft.)	Fish Species	Total Fish Number	Sex M-F-U	Fish CPUE	
						Net Hour	Trap Hour
4 Gill Nets	13	3,200	Arctic Char	20	7-8-5	0.39	N/A
			Longnose Sucker	4	1-3-0	0.08	N/A
			All Species	24	8-11-5	0.47	N/A
14 Minnow Traps	20		Arctic Lamprey	1	0-0-1	N/A	<0.01
			Longnose Sucker	1	0-0-1	N/A	<0.01
			Coastrange Sculpin	52	0-0-52	N/A	0.19
			Threespine Stickleback	418	0-0-418	N/A	1.49
			All Species	472	0-0-472	N/A	1.69

Arctic char ranged in fork length from 11.6 inches (295 mm) to 16.5 inches (420 mm), in weight from 0.6 pounds (250 g) to 1.7 pounds (750 g), and in condition from 0.76 to 1.25 (Table 3). Longnose sucker varied in fork length from 8.9 inches (225 mm) to 10.2 inches (260 mm). Their weight ranged from 0.2 pounds (110 g) to 0.3 pound (155 g), and condition from 0.88 to 0.97. Opercles from two longnose sucker indicated they were 7 and 8 years old.

The size of the longnose sucker from Middle Finger Lake was extremely small compared to the other 10 lakes sampled in 1984 containing longnose sucker. We suspect this lake may represent a dwarf population of sucker. Longnose sucker in Middle Finger Lake had a mean fork length of 9.4 inches (238 mm) which was only 65 percent of the average fork length of 14.4 inches (367 mm) found in the other 10 lakes. Their weight of 0.3 pound (125 g) was 20 percent of the average 1.4 pounds (632 g) and condition of 0.92 only 77 percent of the average 1.19. Previous collections of longnose sucker from Middle Finger Lake also showed them to be small fish (Table 6).

AQUATIC VEGETATION

Aquatic vegetation was sparse and largely confined to shallow areas around the shoreline and islands. Prominent aquatic species included yellow pond lily, several species of pondweed, quillwort, and sedge. No bogs were present. A complete list of vegetation is in Table 4.

WATER QUALITY

The lake's alkalinity level of 13 mg/l was only 33 percent of the average found in the 37 lakes surveyed during 1983-84. This value is equivalent to a low lake productivity level using our modification of Moyle's classification (Mackenthun and Ingram 1967). The pH of 7.0 was neutral. During July the lake was thermally stratified (Table 5). Surface water temperature was 16.7°C remaining in a narrow range down to the thermocline at 23 feet. Water temperature at 52 feet was 6.9°C. Dissolved oxygen concentrations were high throughout the water column. Dissolved oxygen levels were saturated to slightly supersaturated from the surface (10.0 mg/l) to 43 feet (12.0 mg/l) and about 90 percent saturated (11.2 mg/l) at 52 feet.

Water color was medium green and Secchi disc transparency 33 feet. The lake had a Morphoedaphic Index of 2.4 and Shoreline Development Factor, including islands, of 2.28. No dissolved oxygen profile was obtained during the fish survey due to equipment failure.

MANAGEMENT HISTORY

Middle Finger Lake was surveyed four times prior to our investigation by the Alaska Department of Fish and Game (ADF&G) and U.S. Fish and Wildlife Service (FWS). Only Arctic char and longnose sucker were captured. The CPUE for Arctic char ranged from 0.45 to 1.25 fish per net hour and for longnose sucker from 0.01 to 0.48. Individual survey CPUE's plus fish lengths and weights are summarized in Table 6.

Table 3.
FISH LENGTH, WEIGHT, AND CONDITION SUMMARY
Middle Finger Lake 6/25-26/84

Gear	Category	Species	Sample Size	Mean	Standard Deviation	Range
Gill Nets	Fork Length (mm)	Arctic Char	19	346	43.0	295 - 420
		Longnose Sucker	3	238	18.9	225 - 260
	Weight (g)	Arctic Char	19	417	159	250 - 750
		Longnose Sucker	3	125	26.0	110 - 155
	Condition (K)	Arctic Char	19	0.97	0.11	0.76 - 1.25
		Longnose Sucker	3	0.92	0.04	0.88 - 0.97

Table 4.

VEGETATION
Middle Finger Lake 6/25-26/84

AQUATIC VEGETATION

Class	Common Name	Scientific Name
Emergent	horsetail	<u>Equisetum fluviatile</u>
	sedge	<u>Carex rhynchophysa</u>
Floating	bur reed	<u>Sparganium angustifolium</u>
	pondweed	<u>Potamogeton gramineus</u>
	yellow pond lily	<u>Nuphar polysepalum</u>
Submergent	pondweed	<u>Potamogeton alpinus</u>
	pondweed	<u>Potamogeton praelongus</u>
	quillwort	<u>Isoetes muricata</u>
	water milfoil	<u>Myriophyllum spicatum</u>

TERRESTRIAL VEGETATION

Class	Common Name	Scientific Name
Trees	alder	<u>Alnus sp.</u>
	cottonwood	<u>Populus balsamifera</u>
	paper birch	<u>Betula papyrifera</u>
	white spruce	<u>Picea glauca</u>
	willow	<u>Salix sp.</u>
Below Shrub	marsh fivefinger	<u>Potentilla palustris</u>

Table 5.

WATER QUALITY DATA
Middle Finger Lake 7-17-84

Cloud Cover (%) 100 Air Temp (°C) 13.0 Wind (mph) 1-3 Chop (in) 0 Time 0845

Sample Depth (m)	Water Temp. (°C)	D.O. (mg/l)	pH	Specific Cond. @ 25°C (umho/cm)	Total Alk. as CaCO ₃ (mg/l)	Total Hard. as CaCO ₃ (mg/l)	Total Phos. P (ug/l)	React. Phos. P (ug/l)	Total Kjeldahl Nitrogen as N (mg/l)	Nitrate+ Nitrite as N (ug/l)	Total Ammonia N (ug/l)	Forel-Ule Color	Water Trans. (m)
0	16.7	10.0										VIII	10.0
1	16.7	10.0	7.0	26	13	12	9.3	1.4	0.21	<0.5	8.9		
2	16.7	10.0											
3	16.7	10.0											
4	16.5	10.0											
5	16.5	10.0											
6	16.5	10.0											
7	11.8	11.8											
8	11.5	12.4											
9	10.0	12.6											
10	8.8	12.6											
11	8.0	12.5											
12	7.5	12.3											
13	7.1	12.0					11.5	2.6	0.20	<0.5	<0.1		
14	7.0	11.5											
15	6.9	11.3											
16	6.9	11.2											

PREVIOUS FISHERY SURVEYS OF MIDDLE FINGER LAKE BY THE
ALASKA DEPARTMENT OF FISH AND GAME AND U.S. FISH AND WILDLIFE SERVICE

Table 6.

Date	Agency	Capture Method	Fish Species	Sample Size	CPUE ^{1/}	Length Mean (in) (mm)	Length Range (mm)	Weight Mean (lb) (g)	Weight Range (g)
7/64	ADF&G ^{2/}	Gill Net	Arctic Char	23	0.48	14.1 357	248-470	1.3 569	168-1162
			Longnose Sucker	23	0.48	- -	-	-	-
9/65	ADF&G	Gill Net	Arctic Char	83	0.56	10.7 271	198-385	0.5 204	73-622
			Longnose Sucker	52	0.35	8.1 206	155-297	0.2 82	41-282
6/66	ADF&G ^{3/}	Gill Net	Arctic Char	91	1.25	9.6 245	187-325	0.3 132	64-341
			Longnose Sucker	1	0.01	9.7 247	-	0.4 163	-
9/75	FWS ^{4/}	Gill Net	Arctic Char	22	0.45	9.2 234	195-285	0.3 132	70-240
			Longnose Sucker	2	0.04	5.9 150	-	0.1 55	50-60

- 1/ Fish per net hour
2/ Strickland and Bernhardson (1964)
3/ Watsjold and Goan (1966)
4/ Schuler and Crateau (1975)

WILDLIFE

Waterfowl observed on the lake included a brood of common loons plus a Barrow's goldeneye and common merganser. Arctic terns and a Bonaparte's gull were also seen. One bald eagle was in a burned tree near the lake while a red-tailed hawk was observed flying around the lake. A beaver was seen swimming in the lake. Four beaver lodges were located in the lake. Wildlife species along with pertinent data are in Table 7.

RECREATIONAL USE

Recreational uses of Middle Finger Lake include limited fishing and hunting. Fishing is believed to be low. There were no sport anglers present during our two day survey. No fishing pressure data are available for the lake. There are no public use facilities on the lake.

FISHERY RESOURCE SUMMARY

Our fishery survey found Arctic char to be the only game fish in the lake. They were found to be in moderate abundance (CPUE 0.39). The Arctic char have a self-sustaining population in this landlocked system. Longnose sucker were in low abundance (CPUE 0.08) while threespine stickleback and coastrange sculpin made up the forage species. Four previous surveys by ADF&G and FWS confirmed our survey results by finding Arctic char to be the only game fish in the lake plus capture of longnose sucker. Previous char abundances ranged from moderate (CPUE 0.45) to high (CPUE 1.25) while sucker varied from CPUE 0.01 to 0.48. During our 1983 survey of East Finger Lake (Friedersdorff and Jakubas 1984), we found only char and longnose sucker suggesting that the three connecting Finger Lakes - Middle, East, and South - have the same species composition.

Angler use of the lake is believed to be low. Lake water fertility is low and, the lake had a MEI of only 2.4. Dissolved oxygen levels were high for cold water game fish. In addition, large quantities of gravel are available in the lake for Arctic char spawning. It appears that a high proportion of the lake's fish production is accounted for by the char population since longnose sucker abundance is low and threespine stickleback moderate. Based on these data we believe Middle Finger Lake can support a low yield Arctic char sport fishery. Compared with other known char fisheries on the refuge, the number of char available to anglers would be moderate.

Table 7.

WILDLIFE DATA
Middle Finger Lake 6/25-26/84

Animal Class	Common Name	Number	Sex M-F-U	Animal Assoc.	Verification	Habitat Type
Birds						
Waterfowl	Barrow's goldeneye	1	0-1-0	Single	Sight	-
	common loon	4 J+	1-1-2	Brood	Sight	-
	common merganser	1	0-1-0	Single	Sight	Water
Passerines	alder flycatcher	M	-	-	Sound	-
	American robin	-	-	-	-	-
	American tree sparrow	-	-	-	-	-
	blackpoll warbler	1	-	-	Sound	-
	common raven	S	-	-	Sight	-
	dark-eyed junco	-	-	-	Sound	-
	gray jay	-	-	-	-	-
	orange-crowned warbler	1	-	-	Sound	-
	rusty blackbird	M	-	-	Sound	-
	song sparrow	1	-	-	Sound	-
	Swanson's thrush	-	-	-	-	-
yellow-rumped warbler	2	-	-	Sound	-	
Shorebirds	common snipe	-	-	-	-	-
	lesser yellowlegs	1	-	Single	Sight	birch/ willow
Gulls/Terns	Arctic tern	2	-	Single	Sight	Water
	Bonaparte's gull	1	-	Single	Sight	Water
Raptors	bald eagle	1	-	Single	Sight	burned tree
	great horned owl	-	-	-	Sound	Birch
	northern harrier	1	-	-	Sight	Birch
	red-tailed hawk	1	-	-	Sight	Flight
Mammals						
Big Game	black bear	-	-	-	Feces	-
	moose	-	-	-	Sight	-
Furbearers	beaver	-	-	-	Sight	Water

J=Juveniles; J+=Includes Juveniles; M=Many; S=Several

FOREST LAKE

SURVEY PERIOD

Personnel of the U.S. Fish and Wildlife Service surveyed Forest Lake once on July 10-11, 1984. J.W. Friedersdorff and W.J. Jakubas conducted both fishery and detailed water quality surveys during this period. Table 1 summarizes survey findings.

PHYSICAL FEATURES

Forest Lake is located in the northwest section of the Kenai National Wildlife Refuge (NWR) and is in the Swanson River Basin. Its latitude is north 60° 40' and longitude west 150° 50'. The lake and surrounding area were designated to be in both the Intensive and Moderate Land Management categories by the Kenai NWR Comprehensive Conservation Plan (USFWS 1985). Drainage for the watershed is estimated to be 1.4 square miles.

Forest Lake consists of three sub-lakes: a small lake draining to a middle size lake located to the east which, in turn, drains to a large lake located to the west (Figure 1). We surveyed only the large, most westerly water body which we will call West Forest Lake. This lake has a surface area of 101 acres, a volume of 1,960 acre feet, and is at an elevation of 263 feet (Table 1). The middle sized lake, which we will call East Forest Lake, adds an additional 21 surface acres and 245 acre feet; its maximum depth is approximately 24 feet. No physical measurements were made on the small third lake.

West Forest Lake is surrounded by low hills. Most terrestrial vegetation was burned in the 1969 refuge fire and now consists of regrowth alder, paper birch, black spruce, and white spruce. A large stand of mature spruce and birch is located on the lake's west side. Scattered mature spruce that survived the fire are also found around the lake. Two small bogs are situated at the southern end and along the eastern shore of the lake.

Lake water level is maintained by two streams, springs, and run-off. The inlet stream, on the east side, flows from East Forest Lake through a bog. This stream was 3 feet wide by 0.5 foot deep with aquatic vegetation covering most of the stream bed and banks. Water velocity was very low as both lakes are at nearly even elevations. Flow was estimated at 0.2 cubic feet per second (cfs). The outlet stream, on West Forest Lake's west side, was 2 feet wide and 0.25 foot deep. Its flow was estimated at 0.3 cfs. The lake outlet stream is blocked by an old beaver dam. Silt and gravel have settled behind the dam raising the lake bottom about 2 feet above the stream bed. At the time of our survey, the beaver dam constituted a barrier to upstream movement of fish to the lake. Aerial photos and aircraft over-flight indicated a stream floodway running west from West Forest Lake about 1.5 miles and connecting with the outflow from Mink Creek Lake to form a stream which runs 2.5 miles north to the Swanson River. The West Forest Lake outlet stream appeared to have negligible to low quality rainbow trout spawning characteristics while the other two lakes had no spawning habitat.

Table 1.

LAKE SURVEY SUMMARY
Forest Lake

LOCATION				SPORT FISH VALUE	
				(Species)	(Yield)
Refuge	Kenai NWR	Map	Kenai (C-3)	Rainbow Trout	Low
Lat.	N 60° 40'	Long.	W 150° 50"		
T	7N R 9W	S	27		
Land Use Class	Intensive & Moderate Mgmt.				

PHYSICAL FEATURES

Surface Area (Ac.)	101
Maximum Depth (Ft.)	41
Mean Depth (Ft.)	19.4
Volume (Ac.Ft.)	1960
Water Trans. (Ft.)	23
Elevation (Ft.)	263

WATERSHED
Swanson River

FISH SPECIES

Rainbow Trout
Coho Salmon
Threespine Stickleback
Coastrange Sculpin

WATER QUALITY

Temp. (°C)	18.2 - 7.8
D.O. (mg/l)	12.4 - 5.2
pH	7.2
Tot. Alk. (mg/l)	24
Tot. Hard. (mg/l)	20
Tot. Phos. (ug/l)	7.4
Tot. Kjehl. N (mg/l)	0.30
Cond. (umho)@ 25°C	58
MEI	9.8 SDF 1.48

1/ Resident fish

TRIBUTARY STREAMS

Inlets (No.)	1 Permanent
Outlets (No.)	1 Permanent
Ocean Linkage	Yes - Intermittent

RECREATION

Types: Fishing, camping, wildlife viewing, canoeing, hunting.

AQUATIC VEGETATION
(Dominant Families)

Lily, pondweed.	
Lake Coverage (%)	12

Public Facilities: None on the lake. A pull-over parking area is adjacent to Swanson River Road.

SURVEY DATES

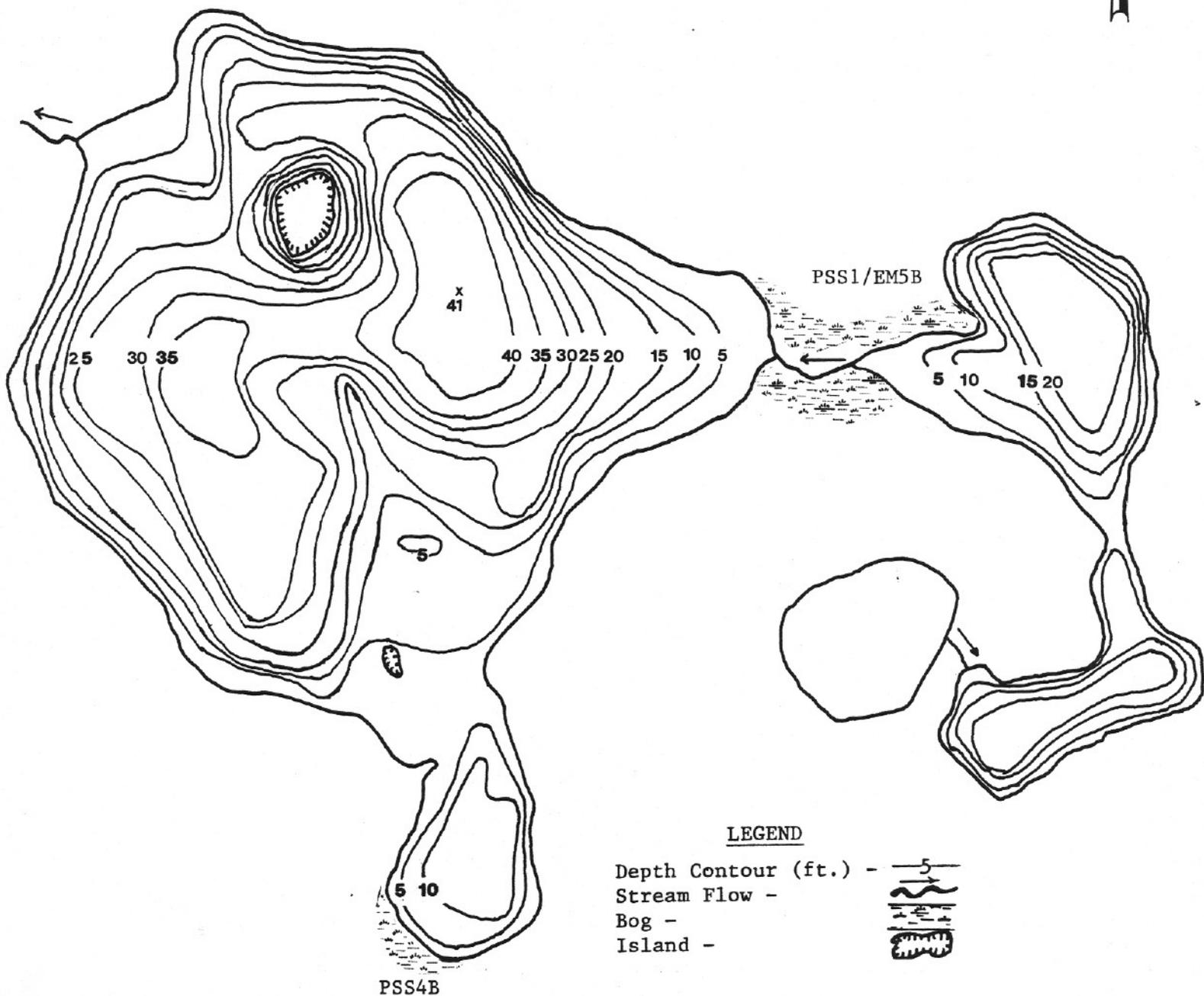
Fish	7/10-11/84
Water Quality	7-10-84

Access: Automobile access via Swanson River Road. A 0.2 mile long path from the road to the lake. Outboard motors greater than 10 hp are prohibited.

Figure 1.

FOREST LAKE

(101 Acres)



LEGEND

- Depth Contour (ft.) - 
- Stream Flow - 
- Bog - 
- Island - 

SCALE

1: 6 3 3 6



Access to the West Forest Lake is via Swanson River Road and a 0.2 mile long foot trail to East Forest Lake. Outboard motors in excess of 10 horsepower are prohibited by Refuge regulation.

FISH

Rainbow trout was the dominant game fish in the lake with a moderate catch per unit effort (CPUE) of 0.32 fish per net hour (Table 2). One resident coho salmon was captured (CPUE 0.01). Threespine stickleback, at a low abundance (CPUE 0.90), and coastrange sculpin constituted the forage species. A total of six gill nets and 14 minnow traps were used to measure fish abundance.

Rainbow trout ranged in fork length from 4.5 inches (115 mm) to 17.5 inches (445 mm). Corresponding weights were from 0.04 pounds (16.7 g) to 1.7 pounds (780 g). Trout condition factors were 0.86 to 1.32. The trout ranged in age two to nine years (Table 3) with an average annual growth rate of 1.8 inches. The single coho salmon captured was a medium size fish 11.2 inches (285 mm) in fork length and weighed 0.6 pounds (290 g). This fish was three years old and had spent its entire life in fresh water. Scale analysis indicated the coho grew at an average rate of 3.3 inches per year. Length, weight, and condition data for rainbow trout and the coho salmon are summarized in Table 4.

AQUATIC VEGETATION

Aquatic plants in West Forest Lake were concentrated along the shoreline and in the southern end of the lake. Yellow pond lily and the pondweeds, Potamogeton natans, P. gramineus, and P. praelongus, were the most prevalent aquatic plants. Two scrub shrub bogs, types PSS4B and PSS1/EM5B, identified in the National Wetlands Inventory (USFWS 1978), were verified during our field survey. Approximately 12 percent of the lake area was covered with aquatic plants. A complete list of vegetation is in Table 5.

WATER QUALITY

The lake's alkalinity level of 24 mg/l was lower than the 39 mg/l average found in the lakes surveyed during 1983-84. This value fits in the lower end of the medium fertility category using our modification of Moyle's lake fertility classification (MacKenthun and Ingram 1967). A pH of 7.2 was near neutral. The lake was thermally stratified with the thermocline occurring between 20 and 29 feet. Dissolved oxygen values (Table 6) were slightly supersaturated from the surface (10.2 mg/l) down through the thermocline to about 30 feet, then degrading gradually to 60 percent saturation (5.2 mg/l) at 39 feet near the bottom.

Water color was green yellow, and Secchi disc transparency was 23 feet. The lake had a Morphoedaphic Index of 9.8 and Shoreline Development Factor, including the island, of 1.48.

MANAGEMENT HISTORY

Alaska Department of Fish and Game (ADF&G) personnel surveyed East and West Forest Lakes in October, 1963. Their records (ADF&G 1963) indicated 24 rainbow trout were gill netted from West Forest Lake for a catch of 0.45 fish per hour. Fish fork lengths ranged from 6.1 inches (155 mm) to 17.5 inches (444

Table 2. FISH CATCH AND EFFORT SUMMARY
Forest Lake 7/10-11/84

Gear	Average Fishing Time (hrs.)	Amount Gear (sq.ft.)	Fish Species	Total Fish Number	Sex M-F-U	Fish CPUE	
						Net Hour	Trap Hour
6 Gill Nets	14	4,800	Rainbow Trout	27	5-11-11	0.32	N/A
			Coho Salmon	1	0-1-0	0.01	N/A
			All Species	28	5-12-11	0.33	N/A
14 Minnow Traps	18		Rainbow Trout	2	0-0-2	N/A	<0.01
			Threespine Stickleback	227	0-0-227	N/A	0.90
			Coastrange Sculpin	49	0-0-49	N/A	0.19
			All Species	278	0-0-278	N/A	1.10

1/ Resident fish

Table 3.

BACK-CALCULATED FORK LENGTHS (MILLIMETERS) AT ANNULUS FORMATION*
of Rainbow Trout in Forest Lake - 1984

Year Class	Number of Fish	Age of Fish												Capture FL		
		1	2	3	4	5	6	7	8	9	10	11	12			
1982	1	46	78													115
1981	1	63	110	178												220
1980	3	54	98	156	221											245
1979	3	44	88	135	180	244										277
1978	5	45	88	133	184	235	294									325
1977	6	40	71	112	160	213	269	325								359
1976	3	31	65	120	169	221	274	338	375							397
1975	1	51	89	136	182	246	305	348	390	428						445
Number of Fish	23	23	23	22	21	18	15	10	4	1						
Grand Mean (mm)		44	83	131	180	227	281	331	379	420						
Grand Mean (in)		1.7	3.3	5.2	7.1	9.0	11.0	13.0	14.9	16.9						
Annual Growth Increment (in)		1.7	1.5	1.9	1.9	1.9	2.1	2.0	1.9	2.0						

*Not corrected for length at scale formation

Table 4.

FISH LENGTH, WEIGHT, AND CONDITION SUMMARY
Forest Lake 7/10-11/84

Gear	Category	Species	Sample Size	Mean	Standard Deviation	Range
Gill Nets	Fork Length (mm)	Rainbow Trout	26	321	61.6	220 - 445
		Coho Salmon	1	285	-	-
	Weight (g)	Rainbow Trout	26	413	204	130 - 780
		Coho Salmon	1	290	-	-
	Condition (K)	Rainbow Trout	26	1.16	0.10	0.86 - 1.32
		Coho Salmon	1	1.25	-	-
Minnow Traps	Fork Length (mm)	Rainbow Trout	2	118	3.54	115 - 120
	Weight (g)	Rainbow Trout	2	17.4	0.92	16.7 - 18.0
	Condition (K)	Rainbow Trout	2	1.07	0.04	1.04 - 1.10

Table 5.

VEGETATION
Forest Lake 7/10-11/84

AQUATIC VEGETATION

Class	Common Name	Scientific Name
Emergent	horsetail	<u>Equisetum fluviatile</u>
	mare's tail	<u>Hippuris vulgaris</u>
	sedge	<u>Carex rhynchophysa</u>
	spike rush	<u>Eleocharis palustris</u>
	tufted loostrife	<u>Lysimachia thyrsoflora</u>
Floating	bur reed	<u>Sparganium angustifolium</u>
	dwarf water lily	<u>Nymphaea tetragona</u>
	pondweed	<u>Potamogeton gramineus</u>
	pondweed	<u>Potamogeton natans</u>
Submergent	yellow pond lily	<u>Nuphar polysepalum</u>
	bladderwort	<u>Utricularia sp.</u>
	pondweed	<u>Potamogeton praelongus</u>
	pondweed	<u>Potamogeton robbinsii</u>
	quillwort	<u>Isoetes muricata</u>
water milfoil	<u>Myriophyllum spicatum</u>	

WETLANDS VEGETATION*

Class	Symbol	Description
Scrub-shrub	PSS1/EM5B	palustrine, scrub-shrub, broad leaved deciduous, emergent, narrow leaved persistent, saturated
Scrub-shrub	PSS4B	palustrine, scrub-shrub, needle leaved, evergreen, saturated

*National Wetlands Inventory (Kenai)

TERRESTRIAL VEGETATION

Class	Common Name	Scientific Name
Trees	alder	<u>Alnus sp.</u>
	black spruce	<u>Picea mariana</u>
	cottonwood	<u>Populus balsamifera</u>
	paper birch	<u>Betula papyrifera</u>
	quaking aspen	<u>Populus tremuloides</u>
Shrub	sweet gale	<u>Myrica gale</u>
Below shrub	buck bean	<u>Menyanthes trifoliata</u>
	marsh fivefinger	<u>Potentilla palustris</u>
	wild flag	<u>Iris setosa</u>

mm). The beaver dam blocking the outlet stream was noted. The Fish and Wildlife Service (FWS) resurveyed West Forest Lake in July, 1975. Schuler (1975), using two experimental gill nets fished for 21 hours, reported capturing 19 rainbow trout for a CPUE of 0.45 fish per net hour. These fish ranged in fork length from 10.8 inches (275 mm) to 19.9 inches (505 mm) with ages reported from four to six years. Although Schuler found some of the trout scales to contain spawning checks, no small trout were captured during his survey. He concluded that the outlet beaver dam would prevent migrating trout from returning to the lake.

The smaller East Forest Lake was also surveyed by ADF&G in October, 1963 (ADF&G 1963) during which they captured 13 rainbow trout ranging in fork length from 8.0 inches (204 mm) to 18.4 inches (407 mm). These fish yielded a catch rate of 0.74 fish per hour. Schuler (1975) resurveyed East Forest Lake twice in July and August, 1975. In the first survey he fished two experimental gill nets for 23 hours capturing 4 rainbow trout for a CPUE of 0.09. Fish fork lengths ranged from 14.6 inches (370 mm) to 16.1 inches (410 mm). During the second survey he used an additional three quarter inch mesh net in an attempt to capture juvenile rainbow trout. No small trout were taken in the small mesh net, but three larger trout were captured in another experimental net. Schuler felt that the fishing situation in the East Forest Lake was only fair, and that migration of trout between the East and West Forest Lakes was infrequent or nonexistent as a result of stream blockage due to eutrophication. He recommended stocking East Forest Lake to improve angler sport fishing success. No further survey work was accomplished on Forest Lakes.

WILDLIFE

A pair of common loons and three Arctic terns were seen on the lake. An active beaver lodge, at the south end of the lake, verified the presence of beaver while freshwater clam shell feeding areas indicated the presence of muskrat. Wildlife species along with other pertinent data are in Table 7.

RECREATIONAL USE

Recreational uses of West Forest Lake include fishing, canoeing, wildlife viewing, camping, and hunting. During our two day survey we saw one canoe on East Forest Lake with two anglers. Conversations with several people who have recently fished the east lake during the summer indicated fishing was poor or they caught no fish. No definitive data is available on sport fishing use of West Forest Lake, but it is believed to be low.

A small pullover parking area on Swanson River Road is the only public use facility connected with the lake. A camping area has been cleared by recreationists on the island in the west lake. Access to West Forest Lake is by a narrow 0.2 mile long foot trail from the parking area, then a canoe trip through the narrow waterway connecting the east and west lakes. Outboard motors greater than 10 horsepower are currently prohibited by Refuge regulation.

FISHERY RESOURCE SUMMARY

Rainbow trout was the dominant game fish in West Forest Lake being found at a moderate abundance (CPUE 0.32). The variety of age classes captured indicates

Table 7.

WILDLIFE DATA
Forest Lake 7/10-11/84

Animal Class	Common Name	Number	Sex M-F-U	Animal Assoc.	Verifi- cation	Habitat Type
Birds						
Waterfowl	common loon	2	1-1-0	Pair	Sight	Water
Passerines	Alder flycatcher	1	-	-	Sound	-
	black-capped chickadee	1	-	-	Sound	-
	common redpoll	M	-	Flock	Sound	-
	common raven	M	-	Flock	Sound	-
	northern waterthrush	1	-	-	Sound	-
	tree swallow	2	-	Pair	Sight	-
	white-winged crossbill	1	-	-	Sound	-
Gulls/Terns	Arctic tern	3	-	Single	Sight	Water
Mammals						
Big Game	moose	-	-	-	Feces	-
Furbearers	beaver	-	-	-	Lodge	-
	muskrat	-	-	-	Clam Shells	-
Other	snowshoe hare	-	-	-	Cuttings	-

J=Juveniles; J+=Includes Juveniles; M=Many; S=Several

recruitment of young trout is taking place. We believe the trout are spawning somewhere in the outlet stream or Swanson River. The young trout and returning adults evidently immigrate and surmount the beaver dam to the lake during high water. The presence of the single three year old resident coho salmon suggests the lake is not always landlocked, and that occasional anadromous access from the Swanson River is available during high water periods. Coho salmon presence in the lake is not believed common since previous surveys by the ADF&G and FWS did not capture this species.

Fishing pressure in the lake is estimated to be low. The lake had a MEI of 9.8 and its fertility was in the low end of the medium range. Dissolved oxygen values were high for cold water game fish throughout most of the lake. The small outlet stream is probably in a low flow mode throughout much of the year. During dry years low stream flow plus the beaver dam at the lake outlet may reduce or block small trout from returning to the lake. Recruitment of young trout to the lake could possibly be improved by partial removal of the beaver dam blocking the outlet stream. West Forest Lake can normally support a low yield rainbow trout sport fishery. During periods when rainbow trout year classes are favorably affected by high water in the outlet stream, this classification could be higher. It is also unlikely the lake serves as a nursery area for coho salmon.

KELLY LAKE

SURVEY PERIOD

Personnel of the U.S. Fish and Wildlife Service surveyed Kelly Lake twice during 1984. J.W. Friedersdorff and G.A. Muhlberg conducted a fishery survey on June 4-5. Detailed water quality data were gathered by W.J. Jakubas and G.A. Muhlberg on July 18. Table 1 summarizes survey findings.

PHYSICAL FEATURES

Kelly Lake is located in the eastcentral section of the Kenai National Wildlife Refuge (NWR) and is part of the Kenai River Basin. It's latitude is north 60° 31' and longitude west 150° 22'. The lake and surrounding area were designated in the Moderate Land Management Category by the Kenai NWR Comprehensive Conservation Plan (USFWS 1985). The watershed area for the lake is estimated to be 6.3 square miles. Kelly Lake has a surface area of 141 acres, a volume of 2,490 acre feet, and is at an elevation of 306 feet. The lake has a mean depth of 17.6 feet and maximum depth of 41 feet (Table 1 and Figure 1).

Kelly Lake is bordered by low hills to the east and south with relatively flat terrain to the north and west. Terrestrial vegetation surrounding the lake consists primarily of young alder, aspen, spruce, and birch which are regrowth from the 1947 refuge fire. A mature stand of white spruce and paper birch lies between Kelly and Petersen Lakes with another small stand of mature trees on the lake's northeast side.

Kelly Lake forms the headwaters for the East Fork Moose River. It drains 0.1 mile west to Petersen Lake. Water supply to the lake consists primarily of seasonal run-off from Hikers Lake, and springs. A small inlet stream, at the east end of the lake, was dry at the time of survey; it had a 3 foot wide by 0.25 foot deep channel. The outlet stream, at the western end of the lake, was about 8 feet wide and 0.7 of a foot deep. Flow was estimated at 5 cubic feet per second (cfs). In September, this flow had dropped to around 3 cfs. The outlet stream was judged to be moderate quality rainbow trout spawning habitat and capable of providing seasonal anadromous fish passage. During dry periods, stream flow may be too low to permit fish movement.

A 0.7 mile long gravel road connects the lake to the Sterling Highway. Refuge regulations currently prohibit the use of outboard motors larger than 10 horsepower, and the landing of aircraft is not authorized.

FISH

Rainbow trout were the dominant game fish in the lake. They were moderately high in abundance with a catch per unit effort (CPUE) of 0.55 fish per net hour (Table 2) as were longnose sucker at a CPUE of 0.77. Juvenile coho salmon were moderately abundant at a CPUE of 0.33 fish per trap hour. Threespine stickleback were high in abundance (CPUE 4.94). A total of four gill nets and 14 minnow traps were used to measure fish abundance.

Table 1.

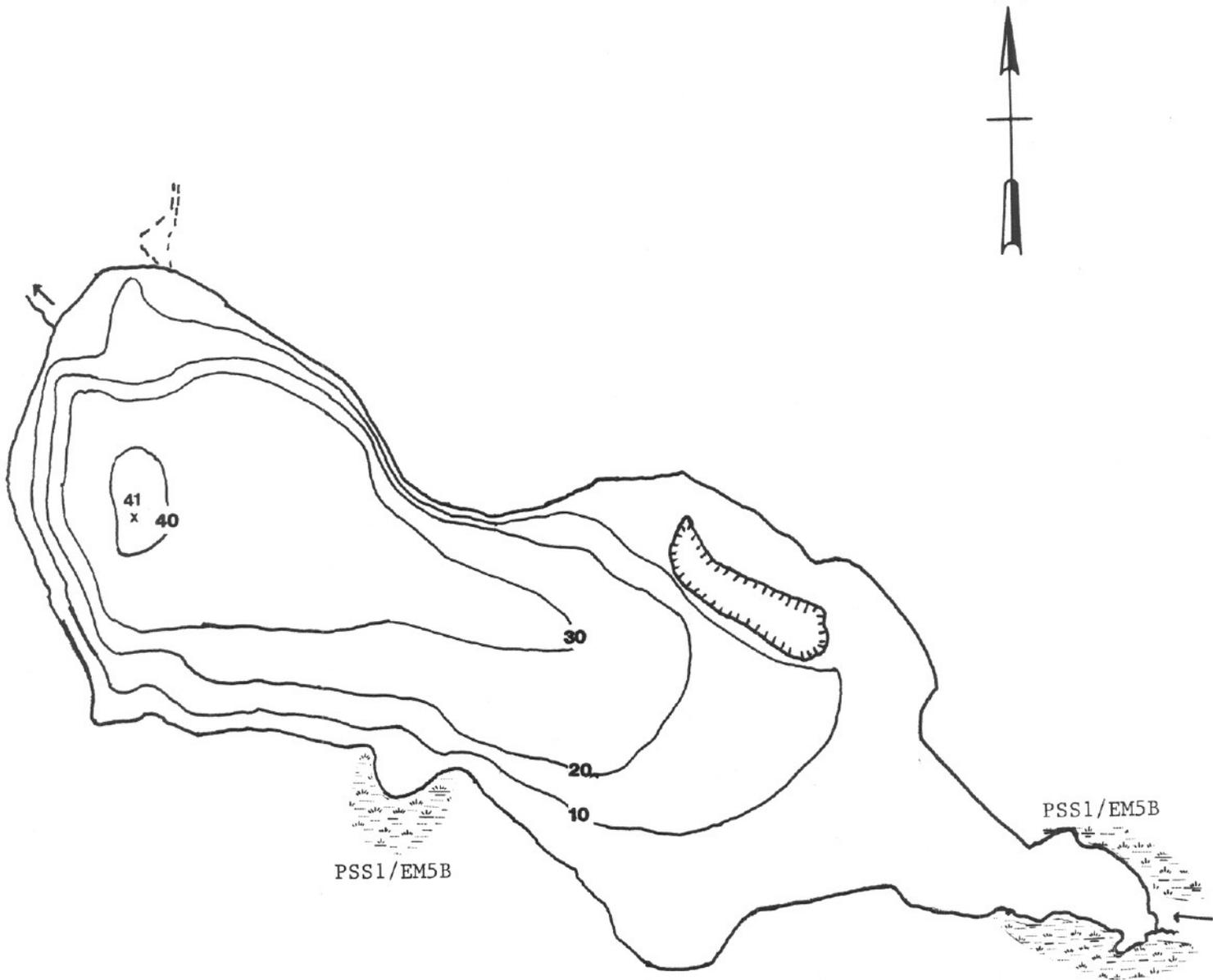
LAKE SURVEY SUMMARY
Kelly Lake

<u>LOCATION</u>		<u>SPORT FISH VALUE</u>	
Refuge <u>Kenai NWR</u>	Map <u>Kenai (C-1&2)</u>	(Species)	(Yield)
Lat. <u>N 60° 31'</u>	Long. <u>W 150° 22'</u>	<u>Rainbow Trout</u>	<u>Moderate</u>
T <u>5N</u> <u>R 6W</u>	S <u>20</u>	<u>Coho Salmon</u>	<u>Nursery Area</u>
Land Use Class <u>Moderate Management</u>		_____	_____
_____		_____	_____
<u>PHYSICAL FEATURES</u>		<u>WATERSHED</u>	<u>FISH SPECIES</u>
Surface Area (Ac.) <u>141</u>	_____	<u>Kenai River</u>	_____
Maximum Depth (Ft.) <u>41</u>	_____	<u>WATER QUALITY</u>	<u>Rainbow Trout</u>
Mean Depth (Ft.) <u>17.6</u>	_____	Temp. (°C) <u>16.3-10.7</u>	<u>Coho Salmon</u>
Volume (Ac.Ft.) <u>2490</u>	_____	D.O. (mg/l) <u>9.9-0.2</u>	<u>Longnose Sucker</u>
Water Trans. (Ft.) <u>16</u>	_____	pH <u>7.8</u>	<u>Threespine Stickleback</u>
Elevation (Ft.) <u>306</u>	_____	Tot. Alk. (mg/l) <u>59</u>	_____
<u>TRIBUTARY STREAMS</u>	_____	Tot. Hard. (mg/l) <u>68</u>	_____
Inlets (No.) <u>1 Intermittent</u>	_____	Tot. Phos. (ug/l) <u>9.0</u>	_____
Outlets (No.) <u>1 Permanent</u>	_____	Tot. Kjehl. N (mg/l) <u>0.19</u>	_____
Ocean Linkage <u>Yes - Seasonal</u>	_____	Cond. (umho)@ 25°C <u>122</u>	_____
_____	_____	MEI <u>22.7</u> SDF <u>1.70</u>	_____
_____	_____	<u>RECREATION</u>	_____
<u>AQUATIC VEGETATION</u>	_____	Types: <u>Fishing, camping, wildlife viewing,</u>	_____
(Dominant Families)	_____	<u>boating, hunting.</u>	_____
<u>Lily, pondweed</u>	_____	_____	_____
_____	_____	_____	_____
Lake Coverage (%) <u>8</u>	_____	Public Facilities: <u>Large parking lot, gravel</u>	_____
_____	_____	<u>boat access ramp, multiple firepits, picnic</u>	_____
_____	_____	<u>tables, water well, pit toilet, bulletin</u>	_____
<u>SURVEY DATES</u>	_____	<u>board.</u>	_____
Fish <u>6/4-5/84</u>	_____	_____	_____
Water Quality <u>7-18-84</u>	_____	Access: <u>Direct automobile access from the</u>	_____
_____	_____	<u>Sterling Highway via a 0.7 mile long gravel</u>	_____
_____	_____	<u>service road. Aircraft landing & outboard motor:</u>	_____
_____	_____	<u>larger than 10 hp prohibited.</u>	_____

Figure 1.

KELLY LAKE

(141 Acres)



LEGEND

- Depth Contour (ft.) -
- Stream Flow -
- Bog -
- Island -
- Access Road -

SCALE

1:7920

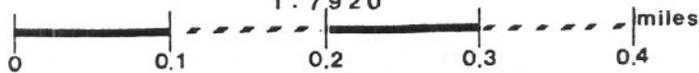


Table 2. FISH CATCH AND EFFORT SUMMARY
Kelly Lake 6/4-5/84

Gear	Average Fishing Time (hrs.)	Amount Gear (sq.ft.)	Fish Species	Total Fish Number	Sex M-F-U	Fish CPUE	
						Net Hour	Trap Hour
4 Gill Nets	16	3,200	Rainbow Trout	35	6-23-6	0.55	N/A
			Coho Salmon	4	0-0-4	0.06	N/A
			Longnose Sucker	49	1-0-48	0.77	N/A
			All Species	88	7-23-58	1.38	N/A
14 Minnow Traps	15		Coho Salmon	70	0-0-70	N/A	0.33
			Rainbow Trout	1	0-0-1	N/A	<0.01
			Threespine Stickleback	1038	0-0-1038	N/A	4.94
			All Species	1109	0-0-1109	N/A	5.28

Rainbow trout ranged in fork length from 3.3 inches (85 mm) to 16.5 inches (420 mm), in weight from 0.1 pounds (5 g) to 1.9 pounds (880 g), and in condition from 0.81 to 1.19. Aged trout (Table 3) were from one to nine years old and exhibited an average growth of 1.7 inches per year. The coho salmon were all one and two year old juveniles with fork lengths of 2.6 inches (65 mm) to 4.1 inches (105 mm) and weights from <0.01 pounds (2.8 g) to 0.03 pounds (11.3 g). Corresponding condition factors ranged from 0.60 to 1.09. Longnose sucker fork lengths ranged from 11.4 inches (290 mm) to 18.5 inches (470 mm), weights from 0.6 pounds (280 g) to 4.4 pounds (1995 g), and condition from 0.91 to 2.51. The suckers were from seven to 16 years old (Table 4). Additional data on length, weight, and condition for rainbow trout, coho salmon, and longnose sucker are in Table 5.

AQUATIC VEGETATION

Kelly Lake in early June was lightly vegetated with about eight percent of the lake area covered with aquatic plants. Yellow pond lily and the pondweed, Potamogeton praelongus, were the most abundant species; they were mostly present in scattered patches near the shore. Aquatic plants were in early stages of their yearly growth cycle. By mid-summer we expect additional species would have emerged and vegetation would have been more abundant. Only one of the three small scrub-shrub type PSS1/EM5B wetlands delineated by the National Wetlands Inventory (USFWS 1978) was prominent. This one wetland area is plotted in Figure 1. A complete list of vegetation is in Table 6.

WATER QUALITY

The alkalinity level of the lake at 59 mg/l was above the average 39 mg/l found in the 37 lakes surveyed during 1983-84. Lake water fertility was in the medium category based on our modification of J.B. Moyle's classification (MacKenthun and Ingram 1967). The pH of 7.8 was one of the most alkaline we found. In July, the temperature was uniform in the upper part of the lake declining only about 1°C from 16.3°C at the surface to 15.1°C at 26 feet (Table 7). Below this depth the temperature declined more rapidly to 10.7°C near bottom. Corresponding dissolved oxygen values were near saturation at the surface (9.6 mg/l) to 26 feet (9.4 mg/l); oxygen was extremely low in the bottom seven feet of the lake at 1% saturation (0.2 mg/l).

Water color was medium green with a Secchi disc transparency of 16 feet. The lake had a Morphoedaphic Index of 22.7 and Shoreline Development Factor, including islands, of 1.70. A dissolved oxygen profile at the time of the fishery survey is in Table 8.

MANAGEMENT HISTORY

The first fishery survey of Kelly Lake was made by the Alaska Department of Fish and Game (ADF&G) in July, 1960 (Kubik and Reynolds 1960). They captured 31 rainbow trout and 29 longnose sucker using two gill nets fished for about 24 hours. Respective fish CPUE's were 0.86 and 0.63. Length range for the trout was 7.9 inches (201 mm) to 17.1 inches (435 mm) and for longnose sucker 8.4 inches (213 mm) to 18.6 inches (473 mm). The Fish and Wildlife Service (FWS) surveyed the lake in 1974. A total of 54 rainbow trout and 21 longnose sucker were captured in two gill nets fished for 24 hours (Bailey 1974). Length range of these trout was 6.4 inches (162 mm) to 17.2 inches (436 mm) while weight

Table 3.

BACK-CALCULATED FORK LENGTHS (MILLIMETERS) AT ANNULUS FORMATION*
of Rainbow Trout in Kelly Lake - 1984

Year Class	Number of Fish	Age of Fish											Capture FL		
		1	2	3	4	5	6	7	8	9	10	11		12	
1983	1	71													85
1982	1	55	102												120
1980	1	48	72	119	177										215
1979	4	50	92	131	175	215									239
1978	8	46	82	126	169	208	250								275
1977	7	47	86	128	173	215	259	311							335
1976	2	38	71	115	162	211	257	305	352						383
1975	1	32	57	96	135	192	253	313	349	374					420
Number of Fish	25	25	24	23	23	22	18	10	3	1					
Grand Mean (mm)		47	83	125	169	211	254	310	351	374					
Grand Mean (in)		1.9	3.3	4.9	6.7	8.3	10.0	12.2	13.8	14.7					
Annual Growth Increment (in)		1.9	1.4	1.6	1.8	1.6	1.7	2.2	1.6	0.9					

*Not corrected for length at scale formation

Table 4.

AGE-FORK LENGTH OF LONGNOSE SUCKER
Kelly Lake - 1984

Fish Age (years)	Sample Size (no)	-----Mean-----		Fork Length Range (mm)
		(in)	(mm)	
7	2	12.6	320	290 - 350
8	4	13.0	331	320 - 360
9	3	13.9	352	345 - 360
10	2	13.3	338	310 - 365
11	3	15.0	382	365 - 395
12	2	14.2	360	340 - 380
15	1	16.9	430	-
16	1	16.5	420	-

Table 5.
FISH LENGTH, WEIGHT, AND CONDITION SUMMARY
Kelly Lake 6/4-5/84

Gear	Category	Species	Sample Size	Mean	Standard Deviation	Range
Gill Nets	Fork Length (mm)	Rainbow Trout	32	292	50.3	215 - 420
		Longnose Sucker	47	367	39.2	290 - 470
	Weight (g)	Rainbow Trout	32	285	177	110 - 880
		Longnose Sucker	47	623	270	280 - 1995
	Condition (K)	Rainbow Trout	32	1.03	0.08	0.86 - 1.19
		Longnose Sucker	47	1.22	0.22	0.91 - 2.51
Minnow Traps	Fork Length (mm)	Coho Salmon	26	82.7	10.2	65 - 105
		Rainbow Trout	1	85.0	-	-
	Weight (g)	Coho Salmon	26	5.75	2.30	2.8 - 11.3
		Rainbow Trout	1	5.00	-	-
	Condition (K)	Coho Salmon	26	0.98	0.10	0.60 - 1.09
		Rainbow Trout	1	0.81	-	-

Table 6.

VEGETATION
Kelly Lake 6/4-5/84

AQUATIC VEGETATION

Class	Common Name	Scientific Name
Emergent	horsetail	<u>Equisetum fluviatile</u>
	sedge	<u>Carex sp.</u>
Floating	yellow pond lily	<u>Nuphar polysepalum</u>
Submergent	pondweed	<u>Potamogeton praelongus</u>

WETLANDS VEGETATION*

Class	Symbol	Description
Scrub-shrub	PSS1/EM5B	palustrine, scrub-shrub, broad leaved deciduous, emergent, narrowleaved, saturated

*National Wetlands Inventory (Kenai)

TERRESTRIAL VEGETATION

Class	Common Name	Scientific Name
Trees	alder	<u>Alnus sp.</u>
	black spruce	<u>Picea mariana</u>
	paper birch	<u>Betula papyrifera</u>
	quaking aspen	<u>Populus tremuloides</u>
	white spruce	<u>Picea glauca</u>

varied from 0.12 pounds (57 g) to 2.2 pounds (997 g). Water quality measurements taken during the survey indicated the lake was suitable habitat for cold water game fish. In a letter to the Kenai NWR Refuge Manager, Bailey and Nelson (1974) stated the fishery was in excellent condition. No further surveys are known to have been conducted.

WILDLIFE

Pairs of northern pintail and common loon were present in addition to lesser scaup, common merganser, yellow legs, gulls, and one Arctic tern. One great horned owl was heard. All wildlife species identified along with other pertinent data are in Table 9.

RECREATIONAL USE

Kelly Lake is particularly popular as a camping site during the summer. Many visitors camp at the lake while enjoying other parts of the refuge. Fishing and wildlife viewing are also popular, as well as, small game hunting. During our survey we talked with several overnight campers. One angler, who frequently fishes the lake, indicated he could catch between three and five trout per hour during good fishing periods; at other times catch was low. No long term sport fishing data exists for this lake. However, due to the heavy visitor use, we believe fishing pressure to be at least moderate.

Public recreational facilities on the lake include multiple fire pits and picnic tables around the parking lot. A water well, gravel boat ramp, bulletin board, and pit toilet are also present. Outboard motors larger than 10 horsepower are prohibited by refuge regulation, and aircraft landing is not authorized.

FISHERY RESOURCE SUMMARY

Rainbow trout are the dominant game fish in the lake. They were found in moderately high abundance at a CPUE of 0.55. The variety of trout age classes present indicates successful spawning and recruitment is taking place for this species. The 1960 ADF&G and 1974 FWS surveys confirmed the long term existence of an abundant rainbow trout population. Additionally, a moderate number of juvenile coho salmon (CPUE 0.33) were captured indicating the lake is serving as a nursery area. Longnose sucker were moderately high in abundance (CPUE 0.77). Threespine stickleback at a high abundance (CPUE 4.94) were the primary forage species. This lake may, at times, harbor anadromous sockeye salmon. No juvenile sockeye were captured and adults were not present at the time of our survey as their spawning run occurs later in the year.

Angler use of the lake is judged to be moderate due to its popularity as a camping area. Lake water fertility was medium, and the lake had a MEI of 22.7. Dissolved oxygen concentrations were high throughout most of the lake's water column. The outlet stream was moderate quality rainbow trout spawning habitat as well as serving as a migratory route to areas of high quality spawning habitat and for anadromous fish. The fish passage character of the outlet stream and lower river spawning areas are believed key factors in maintaining the rainbow trout population. Kelly Lake is considered able to support a moderate yield rainbow trout sport fishery and to be a coho salmon

Table 9.

WILDLIFE DATA
Kelly Lake 6/4-5/84

Animal Class	Common Name	Number	Sex M-F-U	Animal Assoc.	Verification	Habitat Type
Birds						
Waterfowl	common loon	2	1-1-0	Pair	Sight	Water
	common merganser	2	0-0-2	-	Sight	Water
	lesser scaup	14	7-7-0	Pair	Sight	Water
	northern pintail	2	1-1-0	Pair	Sight	Water
Passerines	American robin	1	-	-	Sound	-
	Bohemian waxwing	1	-	-	Sight	-
	common raven	1	-	-	Sound	-
	gray jay	5	-	-	Sound	-
	tree swallow	3	-	-	Sound	-
Shorebirds	greater yellowlegs	1	-	Single	Sight	Water
Gulls/Terns	Arctic tern	1	-	-	Sight	Water
	Bonaparte's gull	3	-	-	Sight	Water
Raptors	great horned owl	1	-	-	Sound	-
Mammals						
Big Game	moose	2	0-1-0	Cow/Calf	Sight	-
Other	snowshoe hare	-	-	-	Cuttings	-

nursery area. In years when rainbow trout recruitment and survival is particularly successful, this classification would be higher.

KING LAKE

SURVEY PERIOD

Personnel of the U.S. Fish and Wildlife Service surveyed King Lake twice during 1984. J.W. Friedersdorff and A.S. Firman conducted a fishery survey on August 14-15. Additional water quality data were gathered by W.J. Jakubas and G.A. Muhlberg on July 18. Table 1 summarizes survey findings.

PHYSICAL FEATURES

King Lake is located in the northeast section of the Kenai National Wildlife Refuge (NWR) and is in the Swanson River Basin. Its latitude is north 60° 48' and longitude west 150° 19'. The lake and surrounding area were designated as wilderness by the Alaska National Interest Lands Conservation Act of 1980. The watershed area for the lake is estimated to be 9.1 square miles. King Lake has a surface area of 472 acres, a volume of 11,800 acre feet, and is at an elevation of 215 feet. The lake has a mean depth of 25 feet and maximum depth of 56 feet (Table 1 and Figure 1).

King Lake is surrounded by low hills reaching slightly over 400 feet in elevation. Terrestrial vegetation consists mostly of mature white spruce, black spruce, and paper birch with some alder along the shoreline. Four wetland areas are situated adjacent to the lake.

Lake water level is maintained by streams, springs, and run-off. Two small inlet streams, which may be intermittent, were found in close proximity to each other on the southwest shore. Both had flows of about 0.1 cubic feet per second. These streams were not shown on USGS Map Kenai (D-1), 1951, and could not be detected by aerial photo; they may be short spring feed flows. Another larger stream, indicated by USGS map, was shown connecting to the southern part of the lake. It was not detected during our shoreline reconnaissance and was probably not flowing at that time. Aerial photos indicate this stream originates about 2 miles south of the lake. A low divide at the headwaters of this stream may permit fish to pass between King Lake (Swanson River Basin) and Moose Lake (Chickaloon River Basin) during high water periods.

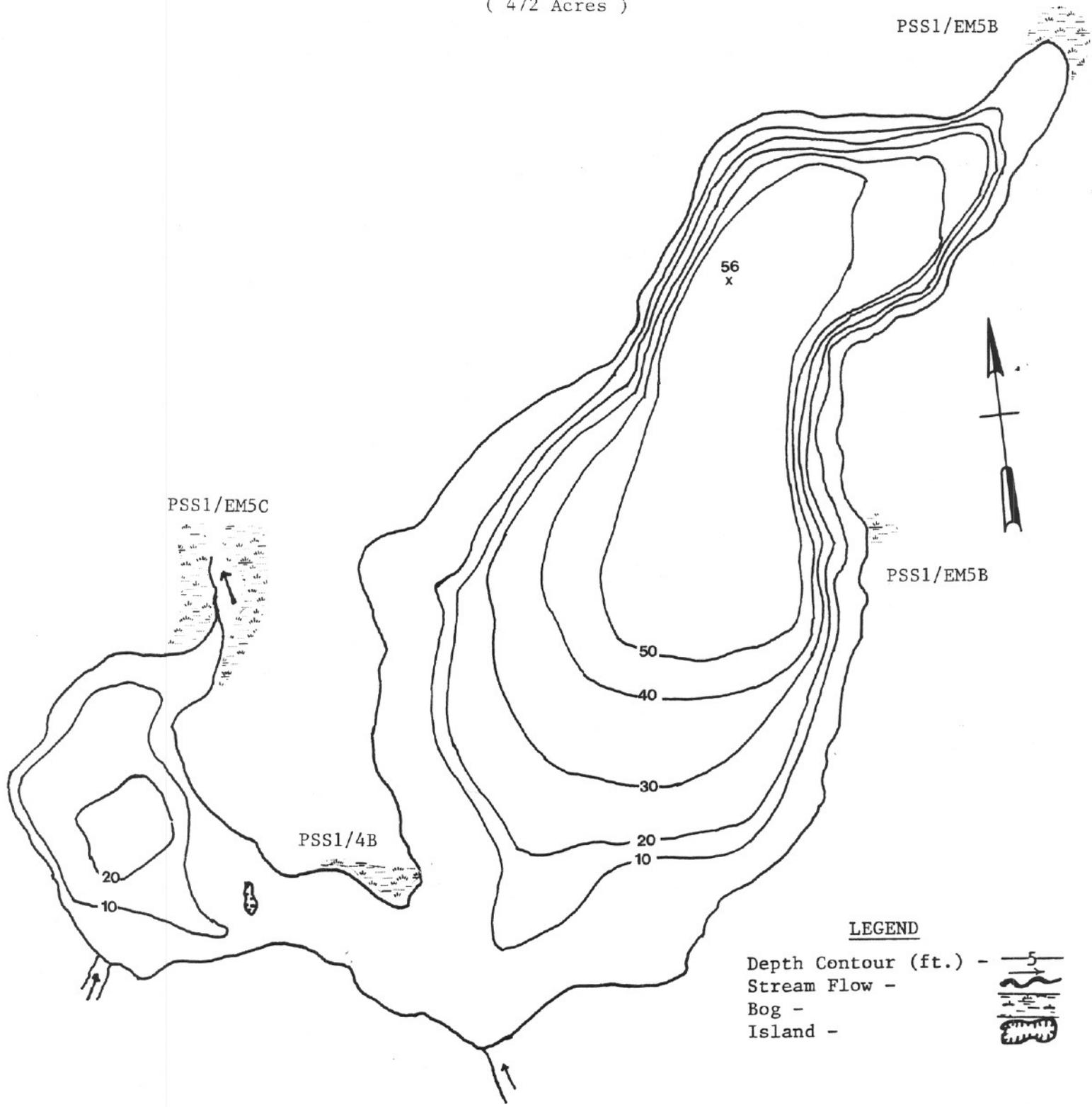
The outlet stream, at the southwest end of the lake, was between 6 and 12 feet wide and less than 1 foot deep. It was choked with aquatic vegetation and had no detectable current. Aerial photos indicate this stream connects over an approximate 10.5 mile route to the Swanson River. The stream flows from King Lake through Wilderness, Llerum, Lynx, and Pepper Lakes to Gene Lake. The outlet stream from Gene Lake forms a tributary to the Swanson River.

Large expanses of rocky shoal were present along the northeast and northwest shores of the lake which could serve as Arctic char spawning habitat. King Lake is remote. Aircraft landings are permitted, and the lake is part of one leg of the Swanson River Canoe Route.

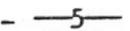
Figure 1.

KING LAKE

(472 Acres)

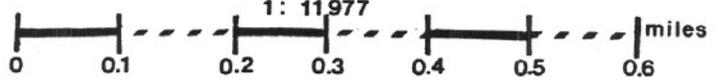


LEGEND

- Depth Contour (ft.) - 
- Stream Flow - 
- Bog - 
- Island - 

SCALE

1: 11977



FISH

Rainbow trout were the dominant game fish in King Lake. They were found to be moderately high in abundance with a catch per unit effort (CPUE) of 0.96 fish per net hour (Table 2). Arctic char were moderate at a CPUE of 0.39. A low abundance of resident sockeye salmon was found at a CPUE of 0.10. Threespine stickleback, ninespine stickleback, and coastrange sculpin constituted the forage species. Six gill nets and 20 minnow traps were used to determine fish abundance.

Rainbow trout ranged in fork length from 8.3 inches (210 mm) to 16.1 inches (410 mm), in weight from 0.3 pounds (120 g) to 1.7 pounds (770 g), and in condition from 0.97 to 1.52. Trout scales indicated the fish were from four to eight years old (Table 3). The trout were growing at an average rate of 1.8 inches per year. The sockeye salmon had a complete fresh water life history and were either sockeye residuals or kokanee. The sockeye ranged in fork length from 4.3 inches (110 mm) to 11.5 inches (295 mm). Their weights varied from 0.03 pound (15.5 g) to 0.7 pounds (305 g) with condition factors from 0.88 to 1.52. Arctic char varied in fork length from 10.6 inches (270 mm) to 17.5 inches (420 mm). Their weight ranged from 0.4 pounds (200 g) to 1.8 pounds (830 g). Char condition factors were from 0.89 to 1.17. The longnose sucker ranged in fork length from 8.7 inches (220 mm) to 18.1 inches (460 mm), in weight from 0.3 pounds (130 g) to 2.2 pounds (1010 g), and in condition from 1.03 to 1.41. Ages of the longnose suckers were from nine to 18 years (Table 4). A summary of fish length, weight, and condition factors for rainbow trout, Arctic char, sockeye salmon, and longnose sucker are in Table 5.

AQUATIC VEGETATION

Most of the aquatic vegetation in King Lake is along the east shore and in the shallow southern end. The pondweed Potamogeton robbinsi was the most abundant aquatic plant in the lake occupying as much as 40 percent of the shallow areas. Potamogeton praelongus was second in abundance being more prevalent in slightly deeper water. Yellow pond lily and bulrush were dense in specific areas. Four scrub shrub wetlands (types PSSI/EM5C, PSSI/EM5B, and PSSI/4B), plotted by the National Wetlands Inventory (USFWS 1978), were verified during the survey. Approximately 29 percent of the lake was covered with aquatic plants. A complete list of vegetation is in Table 6.

WATER QUALITY

The lake's alkalinity level of 63 mg/l was nearly double the 39 mg/l average found in the 37 lakes surveyed during 1983-84. This value corresponds to the medium lake water productivity category we modified from Moyle's classification (Mackenthun and Ingram 1967). A pH of 7.8 was among the highest found in the lake study. In July, the lake was thermally stratified with the thermocline occurring around 24 feet. Water temperature was 17.0°C on the surface declining to 5.7°C near the lake bottom (Table 7). Corresponding dissolved oxygen values were slightly supersaturated at the surface down to 26 feet, then degrading slowly to 62 percent saturation (7.5 mg/l) at 36 feet. From this point dissolved oxygen degraded rapidly and was very low near the lake bottom. Despite the low dissolved oxygen values in the deepest part of the lake, oxygen was adequate throughout most of the lake for cold water game fish.

Table 2. FISH CATCH AND EFFORT SUMMARY
King Lake 8/14-15/84

Gear	Average Fishing Time (hrs.)	Amount Gear (sq.ft.)	Fish Species	Total Fish Number	Sex M-F-U	Fish CPUE	
						Net Hour	Trap Hour
6 Gill Nets	13	4,800	Rainbow Trout	75	13-33-29	0.96	N/A
			Arctic Char	30	5-11-14	0.39	N/A
			Sockeye Salmon ^{1/}	8	3-2-3	0.10	N/A
			Longnose Sucker	48	0-0-48	0.62	N/A
			All Species	161	21-46-94	2.07	N/A
20 Minnow Traps	20		Ninespine Stickleback	12	0-0-12	N/A	0.03
			Coastrange Sculpin	672	0-0-672	N/A	1.68
			Threespine Stickleback	377	0-0-377	N/A	0.94
			All Species	1061	0-0-1061	N/A	2.65

^{1/} Residual Sockeye or Kokanee Salmon

Table 3.

BACK-CALCULATED FORK LENGTHS (MILLIMETERS) AT ANNULUS FORMATION*
of Rainbow Trout in King Lake - 1984

Year Class	Number of Fish	Age of Fish												Capture FL	
		1	2	3	4	5	6	7	8	9	10	11	12		
1980	2	49	100	148	199										235
1979	1	61	99	125	167	221									270
1978	7	40	77	124	172	221	271								304
1977	6	37	80	126	170	221	263	313							347
1976	5	46	85	131	176	223	273	320	363						394
Number of Fish	21	21	21	21	21	19	18	11	5						
Grand Mean (mm)		42	82	127	173	220	267	312	354						
Grand Mean (in)		1.6	3.2	5.0	6.8	8.7	10.5	12.3	13.9						
Annual Growth Increment (in)		1.6	1.6	1.8	1.8	1.8	1.8	1.8	1.7						

*Not corrected for length at scale formation

Table 4.

AGE-LENGTH OF LONGNOSE SUCKER
King Lake 1984

Fish Age (years)	Sample Size (no)	Fork Length		
		----Mean----		Range (mm)
		(in)	(mm)	
9	1	16.9	430	-
12	1	14.2	360	-
14	1	17.3	440	-
18	2	17.3	440	420 - 460

Table 5. FISH LENGTH, WEIGHT, AND CONDITION SUMMARY
King Lake 8/14-15/84

Gear	Category	Species	Sample Size	Mean	Standard Deviation	Range
Gill Nets	Fork Length (mm)	Rainbow Trout	60	308	45.9	210 - 410
		Arctic Char	29	333	33.3	270 - 420
		Sockeye Salmon	8	200	75.6	110 - 295
		Longnose Sucker	40	331	71.1	220 - 460
	Weight (g)	Rainbow Trout	60	374	152	120 - 770
		Arctic Char	29	393	136	200 - 830
		Sockeye Salmon	8	138	114	15.5 - 305
		Longnose Sucker	40	485	285	130 - 1010
	Condition (K)	Rainbow Trout	60	1.22	0.11	0.97 - 1.52
		Arctic Char	29	1.03	0.07	0.89 - 1.17
		Sockeye Salmon	8	1.24	0.22	0.88 - 1.52
		Longnose Sucker	40	1.20	0.08	1.03 - 1.41

Table 6.

VEGETATION
King Lake 8/14-15/84

AQUATIC VEGETATION

Class	Common Name	Scientific Name
Emergent	bulrush	<u>Scirpus validus</u>
	sedge	<u>Carex sp.</u>
	spike rush	<u>Eleocharis palustris</u>
Floating	bur reed	<u>Sparganium angustifolium</u>
	pondweed	<u>Potamogeton natans</u>
	water smartweed	<u>Polygonum amphibium</u>
	yellow pond lily	<u>Nuphar polysepalum</u>
Submergent	pondweed	<u>Potamogeton gramineus</u>
	pondweed	<u>Potamogeton praelongus</u>
	pondweed	<u>Potamogeton perfoliatus</u>
	pondweed	<u>Potamogeton robbinsii</u>
	pondweed	<u>Potamogeton zosterifolius</u>
	water milfoil	<u>Myriophyllum spicatum</u>

WETLAND VEGETATION*

Class	Symbol	Description
Scrub-Shrub	PSS1/EM5C	palustrine, scrub-shrub, persistent, emergent, narrow leaved persistent, seasonal
Scrub-Shrub	PSS1/EM5B	palustrine, scrub-shrub, persistent, emergent, narrow leaved, saturated
Scrub-Shrub	PSS1/4B	palustrine, scrub-shrub, persistent, broad leaved nonpersistent, saturated

*National Wetlands Inventory (Kenai)

TERRESTRIAL VEGETATION

Class	Common Name	Scientific Name
Trees	alder	<u>Alnus sp.</u>
	black spruce	<u>Picea mariana</u>
	paper birch	<u>Betula papyrifera</u>
	white spruce	<u>Picea glauca</u>
Shrub	sweet gale	<u>Myrica gale</u>
Below Shrub	buck bean	<u>Menyanthes trifoliata</u>
	marsh fivefinger	<u>Potentilla palustris</u>

Water color was medium green and Secchi disc transparency was 30 feet. The lake had a Morphoedaphic Index of 17.5 and Shoreline Development Factor of 1.80. Table 8 shows dissolved oxygen values present during the fishery survey.

MANAGEMENT HISTORY

Personnel of the Alaska Department of Fish and Game (ADF&G) surveyed King Lake in June, 1971 (Hollinshead and Johnson 1971). They reported catching rainbow trout, Arctic char, and longnose sucker for respective CPUE's of 0.03, 0.30, and 0.38 fish per net hour. The length of the single rainbow trout captured was 19.1 inches (485 mm), Arctic char 6.3 inches (160 mm) to 18.1 inches (460 mm), and longnose sucker 8.5 inches (216 mm) to 18.5 inches (470 mm). The type of length measurement they used was not specified. On April 8, 1971, the Fish and Wildlife Service took an under ice oxygen measurement. Dissolved oxygen was found to be 8 mg/l near the surface. No other survey work is known to have been accomplished on the lake.

WILDLIFE

Common loons, red-necked grebes, plus an unidentified duck in eclipse plumage were sighted on the lake. A single bald eagle and two great horned owls were seen perched in trees near the shore. Three active and one inactive beaver lodges indicated the presence of beaver, and muskrat presence was determined by clam shell feeding areas. Wildlife species along with other pertinent data are in Table 9.

RECREATIONAL USE

Recreational uses of King Lake include fishing, wildlife viewing, canoeing, and hunting. King Lake is a dead end leg of the Swanson River Canoe Route, part of the National Recreational Trail System. It reportedly receives only limited canoe use. The Kenai NWR issued a Special Use Permit to Alaska Air Guides allowing them to fly in clients to fish and use tent camp facilities built by the air carrier. Alaska Air Guides reported they flew in 117 clients in 1983 for two to three day fishing trips. Their clients have the most success for rainbow trout. Up to 10 percent of their catch could be Arctic char. Rick Johnston, Outdoor Recreation Planner for the refuge, indicated King Lake is one of the most popular fly-in winter ice sport fisheries on the refuge.

FISHERY RESOURCE SUMMARY

King Lake is a remote lake that is primarily used for sport fishing. Our fishery survey found rainbow trout to be the dominant game fish at a moderately high abundance of 0.96. The presence of various trout age and sized classes indicates that trout spawning and recruitment is occurring. Arctic char were moderately abundant (CPUE 0.39) while resident sockeye salmon were low in abundance (CPUE 0.10). The sockeye had a complete fresh water life history and were either residual sockeye or kokanee. Longnose sucker were moderately high in abundance (CPUE 0.62). An earlier ADF&G survey confirmed the same species we captured except that we found a much higher abundance of rainbow trout and the presence of the additional species, sockeye salmon. Threespine stickleback, ninespine stickleback, and coastrange sculpin constituted the forage species.

Table 9.

WILDLIFE DATA
King Lake 8/14-15/84

Animal Class	Common Name	Number	Sex M-F-U	Animal Assoc.	Verification	Habitat Type
Birds						
Waterfowl	common loon	5	-	Single	Sight	Water
	red-necked grebe	4	-	-	-	Water
	unid. duck	1	-	-	-	Water
Passerines	gray jay	-	-	-	Sight	-
Raptors	bald eagle	1	-	Single	Sight	Birch
	great horned owl	2	-	-	Sight	Forest
Mammals						
Big Game	moose	2	0-1-0	Cow/Calf	Sight	Shore
Furbearers	beaver	-	-	-	Lodge	-
	muskrat	-	-	-	Clam Shells	-

Sport fishing pressure in the lake is judged to be low at an estimated use of around 1.2 angler days per acre. The lake is considered a good rainbow trout fishing lake. Lake fertility is medium, and the MEI was 17.5. Dissolved oxygen values are high throughout most of the water column for cold water game fish. None of the tributaries adjacent to the lake appeared to contain rainbow trout spawning habitat. The most likely spawning area for rainbows is the outlet stream between King Lake and/or the Swanson River. Trout spawning habitat is believed to be of sufficient quality and quantity to allow rainbow trout to maintain game fish dominance. Adequate rocky shoals are present to support Arctic char spawning. King Lake can support a moderately high yield rainbow trout sport fishery, a low yield Arctic char sport fishery, and a low yield residual sockeye or kokanee salmon sport fishery.

McLAIN LAKE

SURVEY PERIOD

Personnel of the U.S. Fish and Wildlife Service surveyed McLain Lake twice during 1984. W.J. Jakubas and A.S. Firman conducted a fishery survey August 7-9. Detailed water quality data were gathered by J.W. Friedersdorff and W.J. Jakubas on July 17. Table 1 summarizes survey findings.

PHYSICAL FEATURES

McLain Lake is located in the northcentral section of the Kenai National Wildlife Refuge (NWR) and is part of the Swanson River Basin. Its latitude is north 60° 51' and longitude west 150° 34'. The lake and surrounding area were designated in the Traditional Land Management Category by the Kenai NWR Comprehensive Conservation Plan (USFWS 1985). The watershed area for the lake is estimated to be 2.1 square miles. McLain Lake has a surface area of 248 acres, a volume of 4,300 acre feet, and is at an elevation of 155 feet. The lake has a mean depth of 17.2 feet and maximum depth of 35 feet (Table 1 and Figure 1).

McLain Lake is circled by low hills to the south, west, and north reaching slightly over 250 feet in elevation. Relatively flat terrain lies to the east which gradually slopes to the Swanson River. Small stands of mature white spruce, paper birch, and black spruce intermixed with seasonal wetlands surround most of the lake. Scattered alder was present near the shore in the northern and southern sections of the lake. A large wet bog is located on the northern end of the lake and a smaller one along the eastcentral shore.

Lake water level is maintained by streams, springs, and run-off. Aerial photos indicate an inlet stream, originating from three small lakes about a mile north, empties into McLain Lake through the northern bog. This stream was about 6 feet wide and extremely shallow. A beaver dam was built across its mouth. The stream had no flow and was not considered rainbow trout spawning habitat. The outlet stream, at the southeast end of the lake, appeared to have permanent flow. It was about 6 feet wide and 0.5 feet deep. Water velocity was very slow and flow was estimated at 0.3 cubic feet per second. The outlet stream flows about 0.3 miles directly to the Swanson River and was judged to be medium quality rainbow trout spawning habitat. The Swanson River is believed to contain large quantities of high quality rainbow trout spawning habitat. USGS Topographic Map Keni (D-2), 1951, does not show the lake's outlet or inlet streams.

McLain Lake is remote. The most convenient means of access is aircraft, although, the lake can also be reached by canoe and a short hike from the Swanson River. The section of the river immediately adjacent to the lake is part of the Swanson River Canoe Route. Outboard motors larger than 10 horsepower are prohibited on the lake by Refuge regulation.

FISH

Rainbow trout were the dominant game fish in the lake. They were found to be high in abundance at a catch per unit effort (CPUE) of 1.10 fish per net hour

Table 1.

LAKE SURVEY SUMMARY
McLain Lake

LOCATION			SPORT FISH VALUE		
			(Species)	(Yield)	
Refuge	Kenai NWR	Map	Kenai (D-2)		
Lat.	N 60° 51'	Long.	W 150° 34'	Rainbow Trout	Moderately High
T	9N	R	7W	Coho Salmon	Nursery Area
Land Use Class	Traditional Management				

PHYSICAL FEATURES

Surface Area (Ac.)	248
Maximum Depth (Ft.)	35
Mean Depth (Ft.)	17.2
Volume (Ac.Ft.)	4300
Water Trans. (Ft.)	15
Elevation (Ft.)	155

TRIBUTARY STREAMS

Inlets (No.)	1 Intermittent
Outlets (No.)	1 Permanent
Ocean Linkage	Yes

AQUATIC VEGETATION
(Dominant Families)

Pondweed, lily, sedge	
Lake Coverage (%)	20

SURVEY DATES

Fish	8/7-9/84
Water Quality	7-17-84

WATERSHED
Swanson River

FISH SPECIES
Rainbow Trout
Coho Salmon
Sockeye Salmon 1/
Longnose Sucker
Threespine Stickleback
Coastrange Sculpin

WATER QUALITY

Temp. (°C)	17.8-11.0
D.O. (mg/l)	9.8-3.2
pH	7.4
Tot. Alk. (mg/l)	46
Tot. Hard. (mg/l)	40
Tot. Phos. (ug/l)	10.9
Tot. Kjehl. N (mg/l)	0.32
Cond. (umho)@ 25°C	87
MEI	16.7 SDF 1.14

1/ Sockeye residual or Kokanee

RECREATION

Types: Fishing, wildlife viewing, camping, boating. Ketchum Air Service has a Refuge Special Use Permit for a fly-in tent camp.

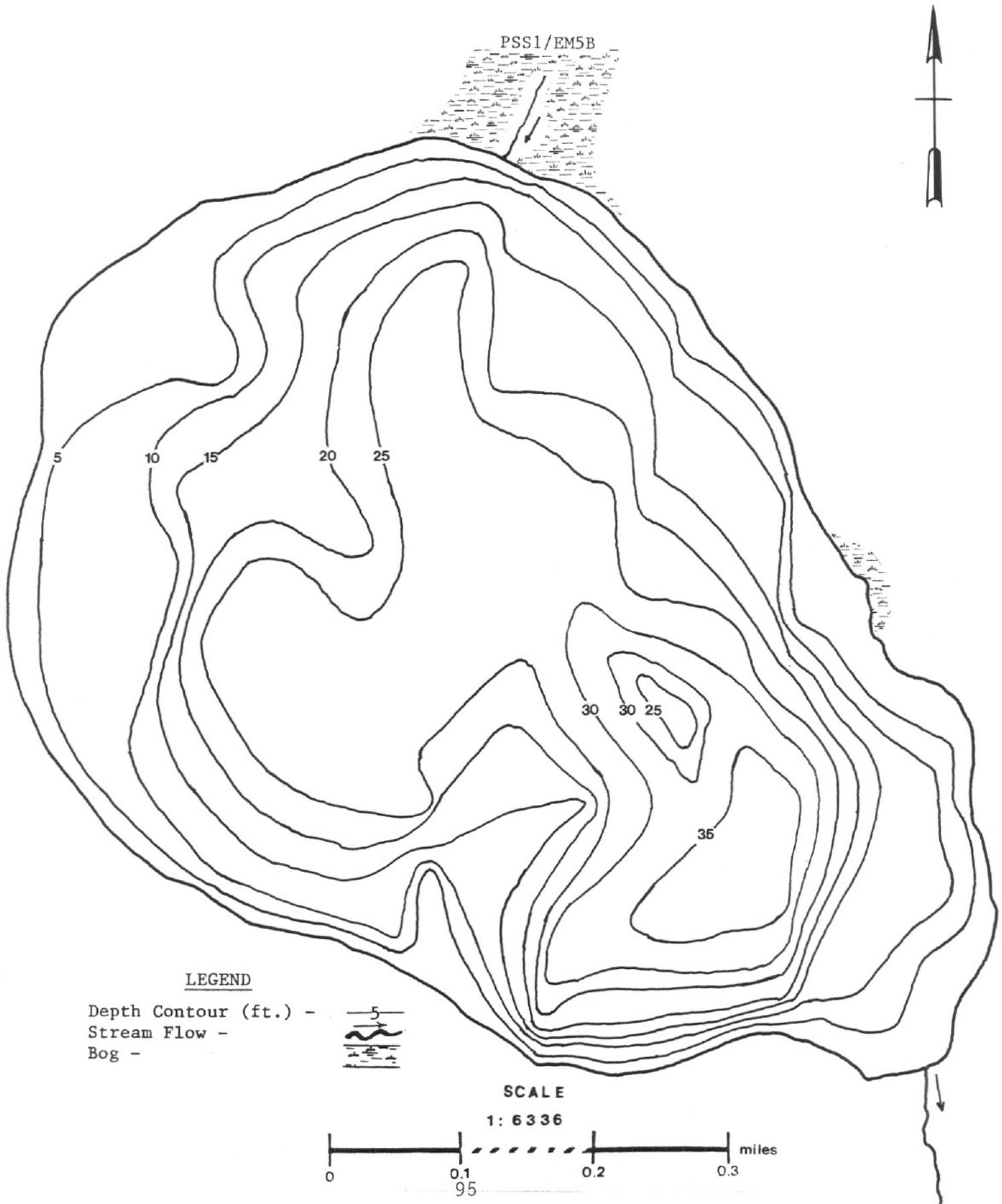
Public Facilities: None other than the tent camp facilities owned by Ketchum Air Service.

Access: Aircraft, canoe.

Figure 1.

McLAIN LAKE

(248 Acres)



(Table 2). Juvenile coho salmon were in low abundance (CPUE 0.05), and one resident sockeye salmon was captured. Longnose sucker were moderately high (CPUE 0.73). Threespine stickleback, at a low abundance (CPUE 0.27), and coastrange sculpin constituted the forage species. A total of six gill nets and 16 minnow traps were used to determine fish abundance.

Rainbow trout ranged in fork length from 4.7 inches (118 mm) to 13.8 inches (350 mm), in weight from 0.04 pounds (17.8 g) to 1.1 pounds (480 g), and in condition from 0.72 to 1.43. Scale analysis indicated the rainbow trout varied in age from two to seven years (Table 3) and had a growth rate of 1.6 inches per year. The coho salmon fork length went from 4.4 inches (112 mm) to 8.9 inches (225 mm). Their weight was from 0.03 pounds (13.7 g) to 0.2 pounds (110 g). Condition factors varied from 0.97 to 1.13. A sample of three coho were all two years old, and the fish were growing at an average rate of 1.8 inches per year. The single sockeye salmon captured had a complete freshwater life history. It was 14.2 inches (360 mm) fork length, weighed 1.3 pounds (570 g), and had a condition factor of 1.22. This fish was three years old and growing at 4.1 inches per year. It was either a sockeye residual or a kokanee. Longnose sucker ranged in fork length from 9.5 inches (240 mm) to 18.1 inches (460 mm). Their weights were from 0.3 pounds (150 g) to 2.8 pounds (1290 g). Condition factors varied from 0.95 to 1.43. Analysis of opercles indicated the sucker varied from four to 18 years old (Table 4). Length, weight, and condition for rainbow trout, coho salmon, sockeye salmon, and longnose sucker are summarized in Table 5.

AQUATIC VEGETATION

Aquatic vegetation was primarily located along shore areas of the lake. Yellow pond lily; the pondweeds, Potamogeton zosterifolius, P. perfoliatus, and P. praelongus; and bulrush were the most prevalent species. About 20 percent of the lake area contained aquatic vegetation. One scrub-shrub wetland (Type PSSI/EM5B), plotted in the National Wetlands Inventory (USFWS 1978), was sighted at the north end of the lake. Another small bog on the eastcentral shore was not identified in the wetlands inventory. A complete list of vegetation is in Table 6.

WATER QUALITY

The lake's alkalinity level of 46 mg/l was higher than the average 39 mg/l found in the 37 lakes tested during 1983-84. This value corresponds to the medium category in our modification of Moyle's classification (MacKenthun and Ingram 1967). The pH of 7.4 was slightly alkaline. In July, most of the lake water volume constituted the warmer epilimnion. Surface water temperature was 17.8°C and remained relatively stable to a depth of 16 feet where the temperature was 16.2°C (Table 7). A thermocline was present at 20 feet. Water was around 11°C in the deepest part of the lake. Corresponding dissolved oxygen concentrations were fully saturated (9.7 mg/l) at the surface down to 16 feet, then gradually declined to 30 percent saturation (3.2 mg/l) near the bottom. Most of the lake had high dissolved oxygen levels capable of supporting cold water game fish.

Water color was yellow green, and Secchi disc transparency 15 feet. The lake had a Morphoedaphic Index of 16.7 and a Shoreline Development Factor of 1.14. Table 8 shows dissolved oxygen values at the time of the fish survey.

FISH CATCH AND EFFORT SUMMARY
 McLain Lake 8/7-9/84

Table 2.

Gear	Average Fishing Time (hrs.)	Amount Gear (sq.ft.)	Fish Species	Total Fish Number	Sex M-F-U	Fish CPUE	
						Net Hour	Trap Hour
6 Gill Nets	14	4,800	Rainbow Trout	92	12-31-49	1.10	N/A
			Coho Salmon	4	0-0-4	0.05	N/A
			Sockeye Salmon ^{1/}	1	0-1-0	0.01	N/A
			Longnose Sucker	61	3-23-35	0.73	N/A
			All Species	158	15-55-88	1.89	N/A
16 Minnow Traps	26		Coastrange Sculpin	95	0-0-95	N/A	0.23
			Threespine Stickleback	114	0-0-114	N/A	0.27
			Rainbow Trout	2	0-0-2	N/A	<0.01
			Coho Salmon	3	0-0-3	N/A	<0.01
			All Species	214	0-0-214	N/A	0.51

^{1/} Sockeye residual or Kokanee salmon.

Table 3.

BACK-CALCULATED FORK LENGTHS (MILLIMETERS) AT ANNULUS FORMATION*
of Rainbow Trout in McLain Lake - 1984

Year Class	Number of Fish	Age of Fish												Capture FL	
		1	2	3	4	5	6	7	8	9	10	11	12		
1982	1	64	98												118
1979	4	47	78	124	171	214									246
1978	10	41	76	117	157	201	245								280
1977	8	40	76	120	160	203	245	286							313
Number of Fish	23	23	23	22	22	18	8	8							
Grand Mean (mm)		43	77	119	160	204	245	286							
Grand Mean (in)		1.7	3.0	4.7	6.3	8.0	9.6	11.3							
Annual Growth Increment (in)		1.7	1.4	1.7	1.6	1.7	1.6	1.6							

*Not corrected for length at scale formation

Table 4.

AGE-LENGTH OF LONGNOSE SUCKER
McLain Lake - 1984

Fish Age (years)	Sample Size (no)	Fork Length		
		-----Mean----- (in)	Range (mm)	
4	3	9.7	245	240 - 250
5	1	10.8	275	-
6	1	13.0	330	-
8	2	13.5	343	330 - 355
14	1	16.5	420	-
18	1	16.9	430	-

Table 5. FISH LENGTH, WEIGHT, AND CONDITION SUMMARY
McLain Lake - 8/7-9/84

Gear	Category	Species	Sample Size	Mean	Standard Deviation	Range
Gill Nets	Fork Length (mm)	Rainbow Trout	50	273	35.8	118 - 350
		Coho Salmon	3	150	64.7	112 - 225
		Sockeye Salmon	1	360	-	-
		Longnose Sucker	49	370	57.6	240 - 460
	Weight (g)	Rainbow Trout	50	230	89.8	17.8 - 480
		Coho Salmon	3	46.8	54.7	13.7 - 110
		Sockeye Salmon	1	570	-	-
		Longnose Sucker	49	641	275	150 - 1290
	Condition (K)	Rainbow Trout	50	1.07	0.17	0.72 - 1.43
		Coho Salmon	3	1.03	0.10	0.97 - 1.13
		Sockeye Salmon	1	1.22	-	-
		Longnose Sucker	49	1.18	0.10	0.95 - 1.43

Table 6.

VEGETATION
McLain Lake 8/7-9/84

AQUATIC VEGETATION

Class	Common Name	Scientific Name
Emergent	bulrush	<u>Scirpus validus</u>
	mare's tail	<u>Hippuris vulgaris</u>
	spike rush	<u>Eleocharis palustris</u>
	tufted loostrife	<u>Lysimachia thyrsiflora</u>
Floating	bur reed	<u>Sparganium angustifolium</u>
	pondweed	<u>Potamogeton natans</u>
	yellow pond lily	<u>Nuphar polysepalum</u>
Submergent	pondweed	<u>Potamogeton filiformis</u>
	pondweed	<u>Potamogeton friesii</u>
	pondweed	<u>Potamogeton gramineus</u>
	pondweed	<u>Potamogeton praelongus</u>
	pondweed	<u>Potamogeton perfoliatus</u>
	pondweed	<u>Potamogeton zosterifolius</u>
	quillwort	<u>Isoetes muricata</u>
water milfoil	<u>Myriophyllum spicatum</u>	

WETLAND VEGETATION*

Class	Symbol	Description
Scrub-shrub	PSS1/EM5B	palustrine, scrub-shrub, emergent narrow leaved persistent, saturated

*National Wetlands Inventory (Kenai)

TERRESTRIAL VEGETATION

Class	Common Name	Scientific Name
Trees	alder	<u>Alnus sp.</u>
	black spruce	<u>Picea mariana</u>
	paper birch	<u>Betula papyrifera</u>
	white spruce	<u>Picea glauca</u>
Below Shrub	grass	<u>Gramineae</u>
	marsh fivefinger	<u>Potentilla palustris</u>

MANAGEMENT HISTORY

On April 14, 1976, the Fish and Wildlife Service made a lake water quality check. They found, under four inches of snow and 30 inches of ice, the dissolved oxygen concentration at five feet to be 9.0 mg/l. Water temperature was 1°C and pH was 7.0. No previous fishery surveys have been conducted on the lake.

WILDLIFE

Waterfowl on the lake included pairs of common loon, red-necked grebes, and a flock of sandhill cranes. Arctic terns and Bonaparte's gulls were also present. A great horned owl was heard and a bald eagle was sighted flying around the lake. An active beaver lodge was located at the north end, and two beaver were sighted swimming. Wildlife species along with pertinent data are in Table 9.

RECREATIONAL USE

Recreational uses of McLain Lake include fishing, wildlife viewing, camping, and boating. Ketchum Air Service has been issued a Refuge Special Use Permit allowing them to establish a tent camp and fly in clients for sport fishing and camping. Records indicated Ketchum fishing clients utilized about 1700 visitor days during 1983. Ketchum Air Service personnel indicated the lake was good for rainbow trout fishing and always had lots of trout in the 8 to 15 inch range. In over 10 years they had never experienced a poor trout fishing year. There are no public use facilities on the lake other than those owned by the air carrier.

FISHERY RESOURCE SUMMARY

Rainbow trout are the dominant game fish in McLain Lake and were found at a high abundance of 1.10 fish per net hour. The variety of trout sizes and ages indicates spawning and recruitment are occurring. Longnose sucker abundance was moderately high (CPUE 0.73) while juvenile coho salmon (CPUE 0.05) were low. The lake is serving as a nursery area for coho juveniles. A single resident sockeye salmon was captured that had a complete fresh water life history. It was either a residual sockeye or a kokanee. A low abundance of threespine stickleback (CPUE 0.27) and coastrange sculpin constituted the forage species.

Angler use of the lake is believed low and almost entirely due to Ketchum Air Service fly-in clients. Sport fishing pressure is estimated to be around 6.7 days per acre annually. Air carrier personnel indicated the lake has furnished good rainbow trout fishing for over ten years. The lake was medium in fertility with a MEI of 16.7. Dissolved oxygen values were high for cold water game fish in the upper half of the lake. Moderate to high quality rainbow trout spawning habitat is immediately adjacent the lake in the outlet stream and Swanson River, and this is believed to be an important factor in maintaining a sizeable and stable rainbow trout population. Based on our findings we believe that McLain Lake can support a moderately high yield rainbow trout sport fishery and serve as a coho salmon nursery area.

Table 9.

WILDLIFE DATA
McLain Lake 8/7-9/84

Animal Class	Common Name	Number	Sex M-F-U	Animal Assoc.	Verification	Habitat Type
Birds	Waterfowl					
	common loon	4	-	Pairs	Sight	Water
	red-necked grebe	5	-	Single/Pair	Sight	Water
	sandhill crane	M	-	Flock	Sight	-
Passerines	alder flycatcher	-	-	-	Sound	-
	black-capped chickadee	-	-	-	Sound	-
	common redpoll	-	-	-	Sound	-
	dark-eyed junco	-	-	-	Sound	-
	gray jay	-	-	-	Sight	-
	olive-sided flycatcher	-	-	-	Sound	-
	ruby-crowned kinglet	-	-	-	Sound	-
	white-winged crossbill	-	-	-	Sound	-
Gulls/Terns	Arctic tern	2	-	Pair	Sight	-
	Bonaparte's gull	4	-	Flock	Sight	-
Raptors	bald eagle	1	-	Single	Sight	Flight
	great horned owl	1	-	-	Sound	Birch
Mammals	Big Game					
	moose	-	-	-	Cuttings	-
	black bear	-	-	-	Feces	-
Furbearers	beaver	2	-	Single	Sight	Water
Other	red squirrel	1	-	Single	Sight	-

BIG MERGANSER LAKE

SURVEY PERIOD

Personnel of the U.S. Fish and Wildlife Service surveyed Big Merganser Lake twice during 1984. J.W. Friedersdorff and G.A. Muhlberg conducted a fishery survey on June 19-20. Detailed water quality data were gathered by A.S. Firman and G.A. Muhlberg on July 19. Table 1 summarizes survey findings.

PHYSICAL FEATURES

Big Merganser Lake is in the northcentral section of the Kenai National Wildlife Refuge (NWR) and is part of the Swanson River Basin. Its latitude is north 60° 43' and longitude west 150° 38'. USGS Topographic Map Kenai (C-2), 1975 revision, misidentifies the correct location of the lake. It is actually located about one mile northwest and next to Swan Lake Road (Figure 1).

The lake and area south of Swan Lake Road were designated as wilderness by the Alaska National Interest Lands Conservation Act of 1980. The watershed for the lake is estimated to be 1.4 square miles in area. Big Merganser Lake has a surface area of 43 acres, a volume of 750 acre feet, and is at an estimated elevation of 220 feet. The lake has a mean depth of 17.4 feet and maximum depth of 65 feet.

Relatively flat terrain with a gentle northward slope surrounds Big Merganser Lake. Terrestrial vegetation consists mostly of black spruce, white spruce, alder, and paper birch which are regrowth of the 1947 refuge fire.

Lake water level is maintained by an outlet stream, springs, and run-off. Aerial photos indicate two lakes to the south, known as Alva and Arctic Loon Lakes, contribute run-off to Big Merganser Lake through a floodway which enters at the southeast end of the lake. In this area we found a bog, but could not find a defined stream channel. An outlet slough, at the northeast end of the lake, flows east about 90 yards through a wetland to Little Merganser Lake. The slough had an open water area about 6 feet wide and 1 foot deep. Water velocity was almost imperceptible. Flow was estimated at 0.4 cubic feet per second (cfs). From Little Merganser Lake there is a small outlet stream flowing north through a steel culvert under Swan Lake Road and about 0.4 mile to Swanson River. This outlet stream was about 1 foot wide and 0.25 foot deep. Its flow was also estimated at 0.4 cfs. There was a hole in the down stream end of the culvert that was allowing about 95 percent of the water to run under the pipe. The only rainbow trout spawning habitat we found was the small outlet stream from Little Merganser Lake; it appeared to be of marginal to low quality.

Access to Big Merganser Lake is normally via a natural dirt boat access on Little Merganser Lake and then through the connecting slough. Outboard motors larger than 10 horsepower are prohibited by Refuge regulation.

Table 1.

LAKE SURVEY SUMMARY
Big Merganser Lake

LOCATION				SPORT FISH VALUE	
				(Species)	(Yield)
Refuge	Kenai NWR	Map	Kenai (C-2)	Rainbow Trout	Low
Lat.	N 60° 43'	Long.	150° 38'		
T	7N	R	8W		
		S	2		
Land Use Class	Wilderness				

PHYSICAL FEATURES

Surface Area (Ac.)	43
Maximum Depth (Ft.)	65
Mean Depth (Ft.)	17.4
Volume (Ac.Ft.)	750
Water Trans. (Ft.)	18
Elevation (Ft.)	220

WATERSHED

Swanson River

FISH SPECIES

Rainbow Trout
Longnose Sucker
Threespine Stickleback
Coastrange Sculpin

WATER QUALITY

Temp. (°C)	16.8-4.5
D.O. (mg/l)	11.2 - 2.1
pH	6.9
Tot. Alk. (mg/l)	14
Tot. Hard. (mg/l)	11
Tot. Phos. (ug/l)	6.7
Tot. Kjehl. N (mg/l)	0.28
Cond. (umho)@ 25°C	50
MEI	9.4
SDF	1.71

TRIBUTARY STREAMS

Inlets (No.)	None
Outlets (No.)	1 - Intermittent
Ocean Linkage	Yes - Seasonal

RECREATION

Types: Fishing, wildlife viewing, hunting.

AQUATIC VEGETATION
(Dominant Families)

Lily, pondweed	

Lake Coverage (%)	67

Public Facilities: None. There is a small gravel parking pad, camping site, fire pit, picnic table, bulletin board, and dirt boat access ramp at Little Merganser Lake.

SURVEY DATES

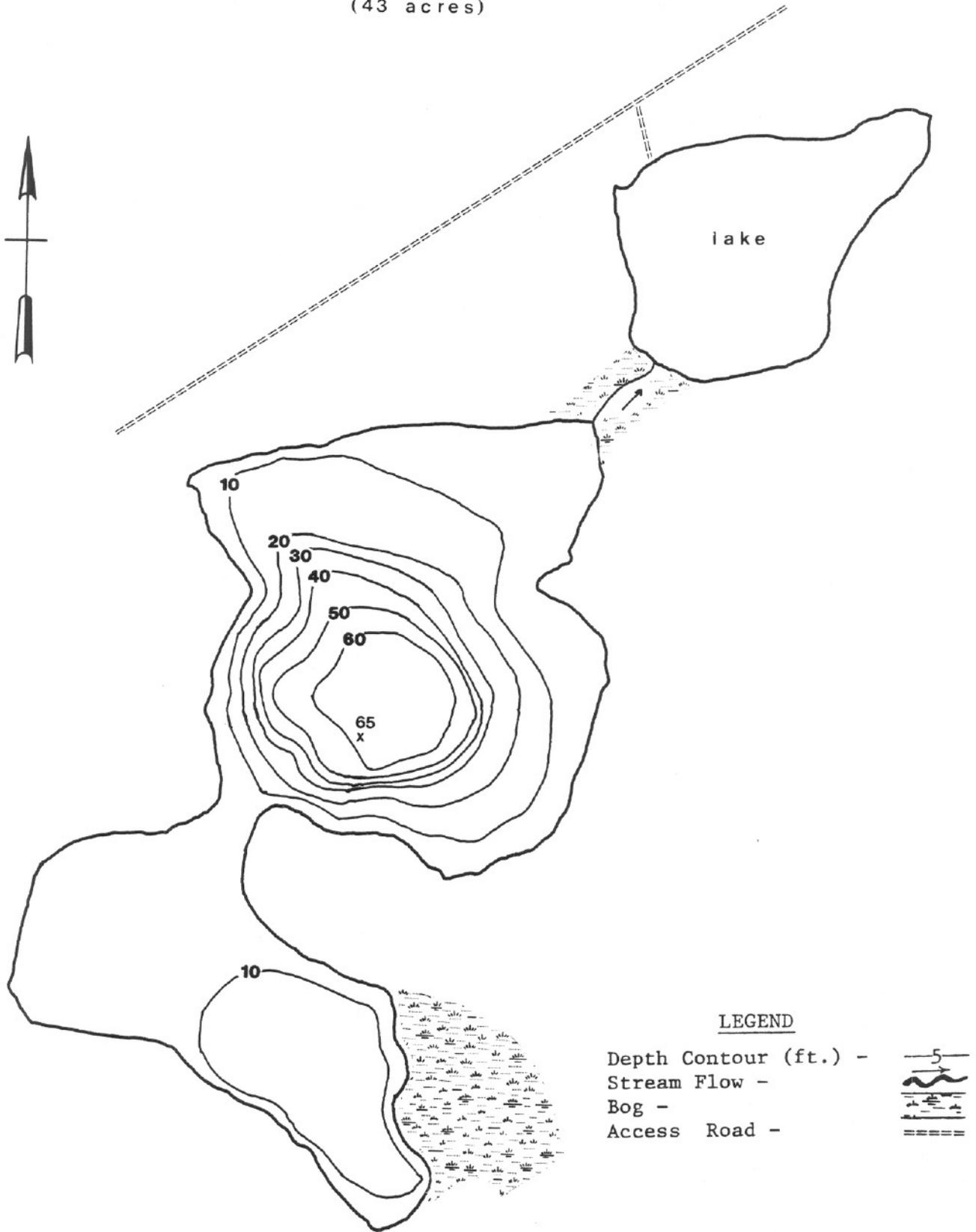
Fish	6/19-20/84
Water Quality	7-19-84
_____	_____
_____	_____

Access: Boat access through Little Merganser Lake. Outboard motors larger than 10 hp are prohibited by refuge regulation.

Figure 1.

BIG MERGANSER LAKE

(43 acres)

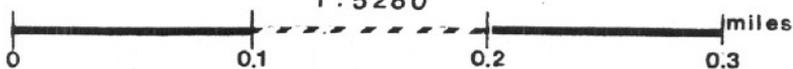


LEGEND

- Depth Contour (ft.) - 
- Stream Flow - 
- Bog - 
- Access Road - 

SCALE

1 : 5280



108

FISH

Rainbow trout were the only game fish present in the lake. They were in low abundance at a catch per unit effort (CPUE) of 0.14 fish per net hour (Table 2). Longnose sucker were also low in abundance (CPUE 0.11). Threespine stickleback (CPUE 0.56) and coastrange sculpin constituted the forage species. A total of two gill nets and 10 minnow traps were used to measure fish abundance.

Rainbow trout captured in gill nets and minnow traps ranged in fork length from 3.5 inches (90 mm) to 12.2 inches (310 mm), in weight from 0.1 pounds (6.0 g) to 0.7 pounds (320 g), and in condition from 0.80 to 1.16. The rainbow trout ranged in age from two to seven years (Table 3) and had an average annual growth rate of 1.7 inches. Two longnose sucker measured were 16.9 inches (430 mm) and 17.7 inches (450 mm) in fork length. Their weights were 2.0 pounds (900 g) and 2.4 pounds (1100 g). The suckers were 12 and 13 years old. Length, weight, and condition data for rainbow trout and longnose sucker are summarized in Table 4.

AQUATIC VEGETATION

Aquatic plants were abundant in Big Merganser Lake. They were most dense near the shore and in the shallow southern half of the lake. Yellow pond lily and the pondweeds, Potamogeton natans and P. gramineus, were the most prevalent species. Approximately 67 percent of the lake area was covered with aquatic vegetation. We found three small wetland areas on the lake - one between the two lakes, one at the southwest end, and one at the southeast end. None of these wetlands were identified by the National Wetlands Inventory. A complete list of vegetation is in Table 5.

WATER QUALITY

The lake's alkalinity level of 14 mg/l was only 36 percent of the average alkalinity found in the 37 lakes surveyed during 1983-84. The value translates to a low productivity level using our modification of Moyle's productivity classification (MacKenthun and Ingram 1967). The pH of 6.9 was slightly acidic. During July, the lake was thermally stratified. Surface temperature was 16.8°C, a thermocline occurred around 16 feet, and the bottom temperature was 4.5°C (Table 6). Associated dissolved oxygen values were 94 percent saturated at the surface (9.3 mg/l), supersaturated at 16 feet (11.2 mg/l), then slowly degrading to 17 percent saturation (2.1 mg/l) near the bottom. Most of the lake had adequate dissolved oxygen for cold water game fish.

Water color was dark yellow green, and Secchi disc transparency was 18 feet. The lake had a Morphoedaphic Index of 9.4 and Shoreline Development Factor of 1.71. Table 7 gives dissolved oxygen values found during the fish survey.

MANAGEMENT HISTORY

The Alaska Department of Fish and Game (ADF&G) surveyed Big Merganser Lake in August, 1961 (Kubik and Nagata 1961), and again in 1963. They captured low to moderate numbers of rainbow trout at CPUE's of 0.11 and 0.27 plus longnose sucker. The Fish and Wildlife Service (FWS) surveyed the lake in August, 1975,

Table 2. FISH CATCH AND EFFORT SUMMARY
Big Merganser Lake 6/19-20/84

Gear	Average Fishing Time (hrs.)	Amount Gear (sq. ft.)	Fish Species	Total Fish Number	Sex M-F-U	Fish CPUE	
						Net Hour	Trap Hour
2 Gill Nets	14	1,600	Rainbow Trout	4	0-0-4	0.14	N/A
			Longnose Sucker	3	0-2-1	0.11	N/A
			ALL Species	7	0-2-5	0.25	N/A
10 Minnow Traps	17	N/A	Rainbow Trout	4	0-0-4	N/A	0.02
			Coastrange Sculpin	126	0-0-126	N/A	0.74
			Threespine Stickleback	95	0-0-95	N/A	0.56
			ALL Species	225	0-0-225	N/A	1.32

Table 3.

BACK-CALCULATED FORK LENGTHS (MILLIMETERS) AT ANNULUS FORMATION*
of Rainbow Trout in Big Merganser Lake - 1984

Year Class	Number of Fish	Age of Fish												Capture FL	
		1	2	3	4	5	6	7	8	9	10	11	12		
1982	3	54	90												102
1979	1	51	92	138	185	222									240
1978	2	38	76	126	184	226	275								290
1977	1	34	73	116	163	202	245	292							305
Number of Fish	7	7	7	4	4	4	3	1							
Grand Mean (mm)		46	84	126	179	219	264	292							
Grand Mean (in)		1.8	3.3	5.0	7.0	8.6	10.4	11.5							
Annual Growth Increment (in)		1.8	1.5	1.7	2.1	1.6	1.8	1.1							

*Not corrected for length at scale formation

Table 4.
FISH LENGTH, WEIGHT, AND CONDITION SUMMARY
Big Merganser Lake 6/19-20/84

Gear	Category	Species	Sample Size	Mean	Standard Deviation	Range
Gill Nets	Fork Length (mm)	Rainbow Trout	4	281	32.8	240 - 310
		Longnose Sucker	2	440	14.1	430 - 450
	Weight (g)	Rainbow Trout	4	248	75.4	160 - 320
		Longnose Sucker	2	1000	141.4	900 - 1100
	Condition (K)	Rainbow Trout	4	1.09	0.05	1.06 - 1.16
		Longnose Sucker	2	1.17	0.06	1.13 - 1.21
Minnow Traps	Fork Length (mm)	Rainbow Trout	3	102	10.7	90 - 111
	Weight (g)	Rainbow Trout	3	9.1	3.10	6.0 - 12.2
	Condition (K)	Rainbow Trout	3	0.84	0.05	0.80 - 0.89

Table 5.

VEGETATION
Big Merganser Lake 6/19-20/84

AQUATIC VEGETATION

Class	Common Name	Scientific Name
Emergent	horsetail	<u>Equisetum fluviatile</u>
	sedge	<u>Carex sp.</u>
	spike rush	<u>Eleocharis palustris</u>
Floating	bur reed	<u>Sparganium minimum</u>
	dwarf water lily	<u>Nymphaea tetragona</u>
	pondweed	<u>Potamogeton natans</u>
	yellow pond lily	<u>Nuphar polysepalum</u>
Submergent	chara	<u>Chara sp.</u>
	milfoil	<u>Myriophyllum sp.</u>
	pondweed	<u>Potamogeton gramineus</u>

TERRESTRIAL VEGETATION

Class	Common Name	Scientific Name
Trees	alder	<u>Alnus sp.</u>
	black spruce	<u>Picea mariana</u>
	paper birch	<u>Betula papyrifera</u>
	white spruce	<u>Picea glauca</u>
Shrub	sweet gale	<u>Myrica gale</u>
Below Shrub	buck bean	<u>Menyanthes trifoliata</u>
	cotton grass	<u>Eriophorum sp.</u>
	grass	<u>Gramineae</u>
	marsh fivefinger	<u>Potentilla palustris</u>
	wild calla	<u>Calla palustris</u>

Table 6.

WATER QUALITY DATA
Big Merganser Lake 7-19-84

Cloud Cover (%) 100 Air Temp (°C) 14.5 Wind (mph) 5 Chop (in) 1 Time 1300

Sample Depth (m)	Water Temp. (°C)	D.O. (mg/l)	pH	Specific Cond. @ 25°C (umho/cm)	Total Alk. as CaCO ₃ (mg/l)	Total Hard. as CaCO ₃ (mg/l)	Total Phos. P (ug/l)	React. Phos. P (ug/l)	Total Kjeldahl Nitrogen as N (mg/l)	Nitrate+ Nitrite as N (ug/l)	Total Ammonia N (ug/l)	Forel-Ule Color	Water Trans. (m)
0	16.8	9.3										XVI	5.5
1	16.7	9.2	6.9	50	14	11	6.7	2.6	0.28	<0.5	<0.1		
2	16.7	9.2											
3	16.5	9.2											
4	15.5	11.0											
5	11.0	11.2											
6	8.2	11.1											
7	6.7	9.4											
8	6.0	8.4					7.6	2.4	0.25	<0.5	3.1		
9	5.5	7.4											
10	5.2	7.2											
11	5.0	7.1											
12	4.9	7.0											
13	4.9	6.6											
14	4.8	6.0											
15	4.6	5.3											
16	4.6	4.7											
17	4.5	2.1											

fishing one experimental gill net for 21 hours (Schuler 1975). Seven rainbow trout were captured for a CPUE of 0.33 fish per net hour. These trout ranged in fork length from 8.5 inches (215 mm) to 18.1 inches (460 mm) with reported ages ranging from one to six years. Schuler stated the variety of ages indicated trout reproduction was taking place and that the lake should sustain a good fishery.

WILDLIFE

A pair of common loons, a single Barrow's goldeneye, plus several Arctic terns were observed on the lake. Three species of passerine birds were also identified. Wildlife species along with other pertinent data are in Table 8.

RECREATIONAL USE

Recreational uses of Big Merganser Lake include fishing, wildlife viewing, and hunting. During our two day fish survey we spoke with one angler who indicated his family occasionally fished Little Merganser Lake for rainbow trout. Their fishing success was normally low, but they enjoyed the scenery, ease of access, and outdoors experience. We believe fishing pressure on Big Merganser Lake is low partially due to the more difficult access. No sport fishing data exists for the lake.

Big Merganser Lake has no public use recreational facilities. However, nearby Little Merganser Lake has a gravel parking pad, a natural dirt boat access, a fire pit, a picnic table, and a bulletin board.

FISHERY RESOURCE SUMMARY

Rainbow trout were the only game fish in Big Merganser Lake. They were low in abundance with a CPUE of 0.14. Similarly longnose sucker were low in abundance (CPUE 0.11). Previous ADF&G and FWS surveys corroborated our findings of species diversity and fish abundance. We found no evidence of juvenile coho salmon, although they may occasionally be present. A low abundance of threespine stickleback (CPUE 0.56) and coastrange sculpin constituted the forage species.

Fishing pressure on the lake is believed to be low. Lake water fertility was low, and the MEI was 9.4. Dissolved oxygen conditions were high throughout most of the lake. No rainbow trout spawning areas were present in Big Merganser Lake. Rainbow trout evidently spawn in the Little Merganser Lake outlet stream or Swanson River. This stream apparently permits fish passage, at least during high flow periods. If the hole in the road culvert becomes larger, it may retard or restrict fish passage. Big Merganser Lake can support a low yield rainbow trout sport fishery.

Table 8.

WILDLIFE DATA
Big Merganser Lake 6/19-20/84

Animal Class	Common Name	Number	Sex M-F-U	Animal Assoc.	Verifi- cation	Habitat Type
Birds						
Waterfowl	Barrow's goldeneye	1	1-0-0	Single	Sight	Water
	common loon	2	1-1-0	Pair	Sight	Water
Passerines	gray jay	M	-	-	Sight	Trees
	tree swallow	M	-	-	Sight	Trees
	white-crowned sparrow	M	-	-	Sight	Trees
Gulls/Terns	Arctic tern	3	0-0-3	Single	Sight	Water
Mammals						
Big Game	moose	6 J+	0-3-3	Cow/Calf	Sight	Shore
Other	red squirrel	1	0-0-1	Single	Sight	Trees

J=Juveniles; J+=Includes Juveniles; M=Many; S=Several

MOOSE LAKE

SURVEY PERIOD

Personnel of the U.S. Fish and Wildlife Service surveyed Moose Lake twice during 1984. J.W. Friedersdorff and A.S. Firman conducted a fishery survey on September 4-5. Additional water quality data were gathered by W.J. Jakubas and G.A. Muhlberg on July 18. Table 1 summarizes survey findings.

PHYSICAL FEATURES

Moose Lake is located in the northeast section of the Kenai National Wildlife Refuge (NWR) and is part of the Chickaloon River Basin. Its latitude is north 60° 44' and longitude west 150° 18'. The lake and surrounding area were designated as wilderness by the Alaska National Interest Lands Conservation Act of 1980. The watershed for the lake is estimated to be 3.3 square miles in area. Moose Lake has a surface area of 302 acres, a volume of 680 acre feet, and is at an elevation of 238 feet. The lake has a mean depth of 2.3 feet and maximum depth of 4.5 feet (Table 1 and Figure 1).

Moose Lake is situated in flat terrain with a gradual eastward slope toward Mystery Creek. Wetland bogs and muskeg surround most of the lake with a few small stands of black spruce and paper birch near the southwest and northern shores. Patches of dead spruce indicate the 1964 earthquake caused vertical land displacement which allowed water to saturate forested areas killing trees.

Lake water level is maintained by streams, springs, bog seepage, and run-off. Three seasonally intermittent inlet streams provide water to the lake. All had poorly defined channels, and none had detectable flow at the time of survey. A stream draining from Rabbit Foot Lake 1.5 miles to the southwest shore of Moose Lake had the most water; reflection of the water could be seen through dense vegetation the entire length between lakes. A second short inlet stream, originating from bog drainage, empties into the lake on the western side. Aerial photos indicate the third and longest inlet stream on the lake's northwest side has about a 2 mile drainage receiving water from two small lakes. It is possible the headwaters of this stream link with King Lake under high water conditions permitting temporary fish movement between the Chickaloon and Swanson River Basins.

The outlet stream, located on the south end of the lake, goes south then east about 1.5 miles before emptying into Mystery Creek. This stream was also swampy in character, had no well defined channel and no flow velocity. None of the streams, in the vicinity of the lake, exhibited visible rainbow trout or Dolly Varden spawning habitat.

Moose Lake is a remote lake. Overland hiking is the only means of access. Aircraft are restricted from landing on the lake by Refuge regulation.

FISH

Dolly Varden were found to be in moderate abundance with a catch per unit effort (CPUE) of 0.20 fish per net hour (Table 2). Intermediate size resident

Table 1.

LAKE SURVEY SUMMARY
Moose Lake

LOCATION				SPORT FISH VALUE	
				(Species)	(Yield)
Refuge	Kenai NWR	Map	Kenai (C-1&D-1)	Dolly Varden	Negligible
Lat.	N 60° 44'	Long.	W 150° 18'	Coho Salmon	Nursery Area
T	8N R 6W	S	34		
Land Use Class	Wilderness				

PHYSICAL FEATURES

Surface Area (Ac.)	302
Maximum Depth (Ft.)	4.5
Mean Depth (Ft.)	2.3
Volume (Ac.Ft.)	680
Water Trans. (Ft.)	4.5
Elevation (Ft.)	238

TRIBUTARY STREAMS

Inlets (No.)	3 Intermittent
Outlets (No.)	1 Intermittent
Ocean Linkage	Yes - Seasonal

AQUATIC VEGETATION
(Dominant Families)

Lily, pondweed, water milfoil

Lake Coverage (%) 85

SURVEY DATES

Fish 9/4-5/84
Water Quality 7-18-84

WATERSHED
Chickaloon River

FISH SPECIES
Dolly Varden 1/
Coho Salmon 1/
Threespine Stickleback

WATER QUALITY

Temp. (°C)	16.2-16.2
D.O. (mg/l)	8.4-8.4
pH	7.2
Tot. Alk. (mg/l)	45
Tot. Hard. (mg/l)	48
Tot. Phos. (ug/l)	39.9
Tot. Kjel. N (mg/l)	0.49
Cond. (umho)@ 25°C	96
MEI	137 SDF 1.29

1/ Resident and juvenile fish

RECREATION

Types: None

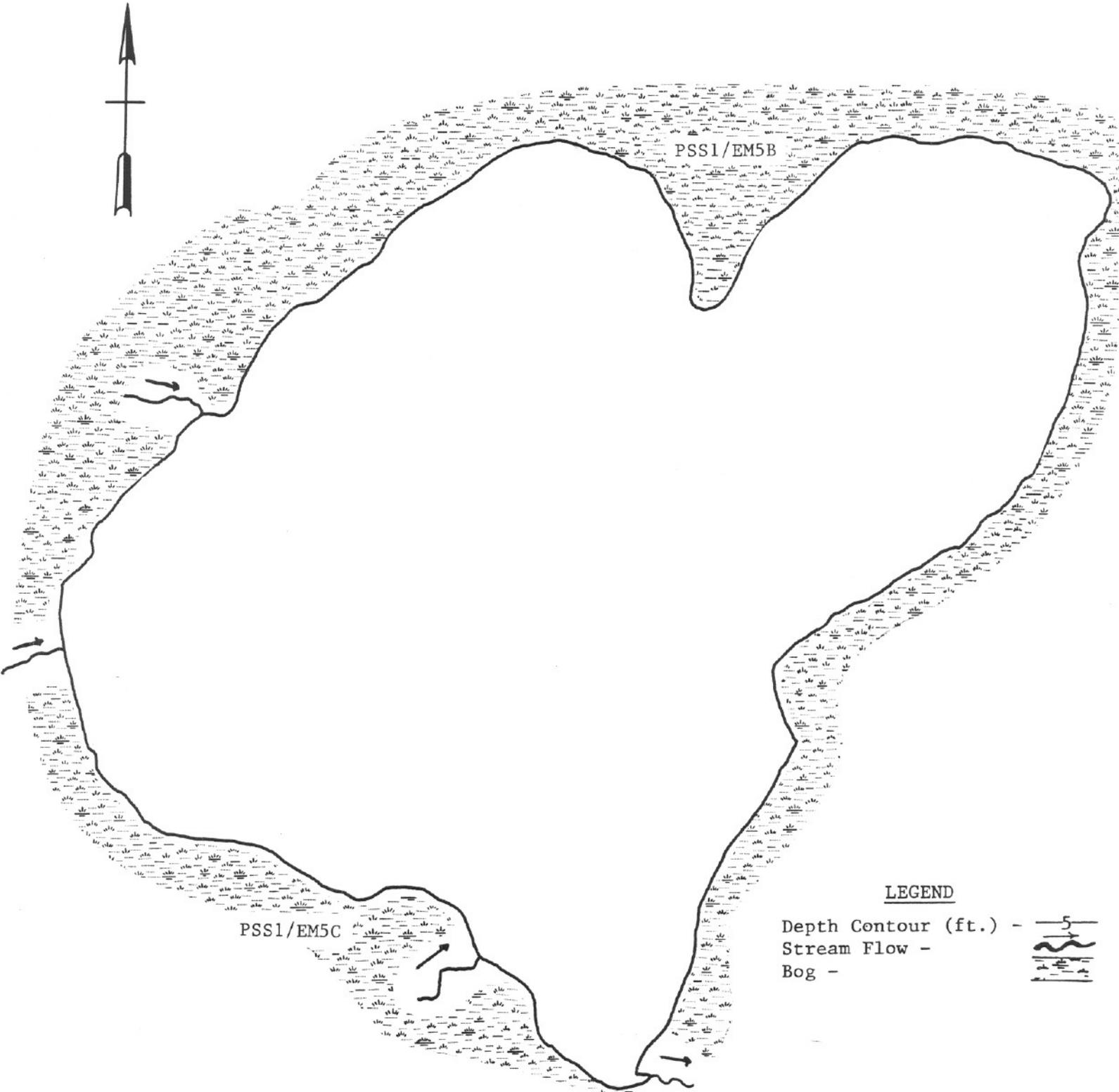
Public Facilities: None

Access: Remote hiking, snowmobiles.

Figure 1.

MOOSE LAKE

(302 Acres)



LEGEND

- Depth Contour (ft.) -
- Stream Flow -
- Bog -

SCALE

1:7920

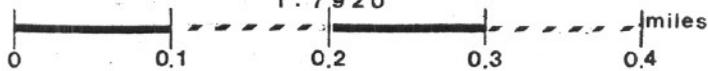


Table 2. FISH CATCH AND EFFORT SUMMARY
Moose Lake 9/4-5/84

Gear	Average Fishing Time (hrs.)	Amount Gear (sq.ft.)	Fish Species	Total Fish Number	Sex M-F-U	Fish CPUE	
						Net Hour	Trap Hour
6 Gill Nets	17	4,800	Dolly Varden	20	8-6-6	0.20	N/A
			Coho Salmon	10	0-0-10	0.10	N/A
			All Species	30	8-6-16	0.30	N/A
20 Minnow Traps	24		Threespine Stickleback	4794	0-0-4794	N/A	9.99
			Coho Salmon	1	0-0-1	N/A	<0.01
			All Species	4795	0-0-4795	N/A	9.99

coho salmon, captured in gill nets, were low in abundance (CPUE 0.10). One small juvenile coho salmon was taken in a minnow trap; a large number of similar size coho juveniles were seen dimpling in the lake. Threespine stickleback were in high abundance at a CPUE of 9.99. Six gill nets and 20 minnow traps were used to measure fish abundance.

The Dolly Varden were of intermediate size ranging in fork length from 8.3 inches (210 mm) to 14.6 inches (370 mm), in weight from 0.2 pounds (105 g) to 1.3 pounds (580 g), and in condition from 1.04 to 1.31. Coho salmon had a complete fresh water life history with fork lengths from 9.1 inches (230 mm) to 11.2 (285 mm). Their weights were from 0.4 pounds (190 g) to 0.8 pounds (360 g). Condition factors ranged from 0.99 to 1.64. Scale analysis indicated all the intermediate size coho were two years old. Their growth rate was 3.6 inches per year. Summaries of length, weight, and condition for Dolly Varden and coho salmon are in Table 3.

AQUATIC VEGETATION

Aquatic plants were abundant covering most of the lake. Dominant species included yellow pond lily, star duckweed; the pondweeds, Potamogeton robbinsii, P. zosterifolius, and P. perfoliatus; and water milfoil. Marsh vegetation surrounded most of the lake. Scrub shrub wetland areas (types PSSI/EM5B and PSSI/EM5C) were plotted by the National Wetlands Inventory (USFWS 1978). Approximately 85 percent of the lake was covered with aquatic plants. A complete list of vegetation is in Table 4.

WATER QUALITY

The lake's alkalinity level of 45 mg/l was slightly greater than the average 39 mg/l found in the 37 lakes surveyed during 1983-84. This value is equivalent to the medium productivity level using our modification of Moyle's lake fertility classification (MacKenthun and Ingram 1967). A pH of 7.2 was near neutral. The shallow lake was uniform in temperature at 16.2°C during the July survey (Table 5). Corresponding dissolved oxygen values of 8.4 mg/l were equivalent to 85 percent saturation.

Water color was green brown and Secchi disc transparency was clear to the lake bottom. The lake had a Morphoedaphic Index of 137 and a Shoreline Development Factor of 1.29. Dissolved oxygen values found at the time of the fish survey are in Table 6.

MANAGEMENT HISTORY

No previous fishery investigations have been conducted on Moose Lake.

WILDLIFE

Several waterfowl species including Barrow's goldeneye, mallard, red-necked grebe, scaup, and white-winged scoter appeared to be gathering in flocks prior to fall migration. Common loons were present as well as a nesting pair of trumpeter swans with one signet. Beaver presence was verified by four active beaver lodges on the lake, and we saw one muskrat. Wildlife species along with other pertinent data are in Table 7.

Table 3.

FISH LENGTH, WEIGHT, AND CONDITION SUMMARY
Moose Lake 9/4-5/84

Gear	Category	Species	Sample Size	Mean	Standard Deviation	Range
Gill Nets	Fork Length (mm)	Dolly Varden	16	307	44.7	210 - 370
		Coho Salmon	10	264	19.0	230 - 285
	Weight (g)	Dolly Varden	16	352	128	105 - 580
		Coho Salmon	10	266	55.4	190 - 360
	Condition (K)	Dolly Varden	16	1.17	0.10	1.04 - 1.31
		Coho Salmon	10	1.44	0.20	0.99 - 1.64

Table 4.

VEGETATION
Moose Lake 9/4-5/84

AQUATIC VEGETATION

Class	Common Name	Scientific Name
Floating	bur reed	<u>Sparganium angustifolium</u>
	dwarf water lily	<u>Nymphaea tetragona</u>
	yellow pond lily	<u>Nuphar polysepalum</u>
Submergent	pondweed	<u>Potamogeton robbinsii</u>
	pondweed	<u>Potamogeton praelongus</u>
	pondweed	<u>Potamogeton perfoliatus</u>
	pondweed	<u>Potamogeton zosterifolius</u>
	star duckweed	<u>Lemna trisulca</u>
	water milfoil	<u>Myriophyllum spicatum</u>

WETLANDS VEGETATION*

Class	Symbol	Description
Scrub-Shrub	PSS1/EM5B	palustrine, scrub-shrub, broad leaved persistent, emergent, narrow leaved
Scrub-Shrub	PSS1/EM5C	palustrine, scrub-shrub, broad leaved persistent, saturated persistent, seasonal

*National Wetlands Inventory (Kenai)

TERRESTRIAL VEGETATION

Class	Common Name	Scientific Name
Trees	black spruce	<u>Picea mariana</u>
	paper birch	<u>Betula papyrifera</u>
	white spruce	<u>Picea glauca</u>
Shrubs	sweet gale	<u>Myrica gale</u>
Below Shrub	buck bean	<u>Menyanthes trifoliata</u>
	cotton grass	<u>Eriophorum</u> sp.
	grass	<u>Gramineae</u>
	marsh fivefinger	<u>Potentilla palustris</u>

Table 7.

WILDLIFE DATA
Moose Lake 9/4-5/84

Animal Class	Common Name	Number	Sex M-F-U	Animal Assoc.	Verification	Habitat Type
Birds						
Waterfowl	Barrow's goldeneye	10	-	Flock	Sight	Water
	common loon	3	-	Flock	Sight	Water
	mallard	4	-	Flock	Sight	Water
	red-necked grebe	6	-	Single	Sight	Water
	scaup	10	-	Flock	Sight	Water
	trumpeter swan	3	1-1-1	Brood	Sight	Water
	white-winged scoter	4	-	-	Sight	Water
Shorebirds	belted kingfisher	1	-	-	Sight	-
	common snipe	2	-	Single	Sight	Wetland
Gulls/Terns	gulls	3	-	Single	Sight	Water
Mammals						
Big Game	moose	-	-	-	Tracks	-
Furbearers	beaver	-	-	-	Lodge	-
	muskrat	1	-	-	Sight	Wetland

RECREATIONAL USE

There are no recreational uses ascribed to the lake due to its remoteness. The lake has no recreational use facilities.

FISHERY RESOURCE SUMMARY

Dolly Varden are the dominant game fish in the lake with a moderate CPUE of 0.20. A population of two year old coho salmon was also present (CPUE 0.10). In addition to the population of two year old coho, we saw a large number of juvenile coho dimpling in the lake; their identification was verified by the capture of one small coho in a minnow trap. A high population of threespine stickleback (CPUE 9.99) was the only forage species captured.

We do not believe the lake receives any sport fishing pressure. Lake fertility was medium with a MEI of 137. At the time of our investigation, fish migration through tributary streams appeared impossible due to low flow and channels being choked with vegetation. We believe the coho salmon migrated from Mystery Creek during high water. Similarly, the Dolly Varden probably came from Mystery Creek or migrated down stream from Rabbit Foot Lake.

Winterkill of the coho salmon and Dolly Varden may occur in certain years owing to the lake's shallow depth and low oxygen levels that would be caused by vegetation decay coupled with lack of air-water oxygen interchange. The function of Moose Lake as a coho salmon nursery area is not clear. The number of coho that utilize the lake and subsequently migrate down river to the ocean is unknown. Our survey indicated a large number of coho had become landlocked and/or lost their drive to outmigrate. During higher water conditions migration may be possible. The high abundance of threespine stickleback indicates they dominate the lake. Based on our findings the lake is accorded a negligible yield sport fish value. Its coho salmon nursery value, although unclear, is probably low in most years.

in the stream, and
rainbow trout. The
which in turn, con-
Swanson River Road
leads from the road to

FISH

The only fish species
abundance at's catch
and 10 minnow traps

AQUATIC VEGETATION

Aquatic vegetation was
pond lily, the most
abundant species, along
shoreline. Three
listed as type P55/56

MOSQUITO LAKE

SURVEY PERIOD

Personnel of the U.S. Fish and Wildlife Service surveyed Mosquito Lake twice during 1984. W.J. Jakubas and A.S. Firman conducted a fishery survey on June 27-28. Additional water quality data were gathered by W.J. Jakubas and G.A. Muhlberg on July 18. Table 1 summarizes survey findings.

PHYSICAL FEATURES

Mosquito Lake is located in the northwestern section of the Kenai National Wildlife Refuge (NWR) in the Kenai River Basin. It's latitude is north 60° 38' and longitude west 150° 48'. The lake and surrounding area were designated to be in the Intensive Land Management category by the Kenai NWR Comprehensive Conservation Plan (USFWS 1985). The watershed area for the lake is estimated to be 0.7 square miles. Mosquito Lake has a surface area of 69 acres, a volume of 1,110 acre feet, and is at an estimated elevation of 275 feet. The lake has a mean depth of 16.1 feet and a maximum depth of 41 feet (Table 1 and Figure 1).

Relatively flat terrain with a gentle northward slope surrounds the lake. Terrestrial vegetation consists mostly of black spruce and immature paper birch which are regrowth from the 1969 refuge fire. A mature stand of spruce is on the lake's northeast side with four small bogs plus mature trees located on the lake's southern end.

Lake water level is maintained by springs, run-off, and one outlet stream. The outlet stream, at the northern end of the lake, averages 3 feet wide and 0.5 foot deep. Flow was estimated to be 0.25 cubic foot per second; the stream is probably intermittent during dry summer periods. No spawning gravel was seen in the stream, and it appears to have little or no spawning potential for rainbow trout. The stream drains north about 0.4 of a mile to Silver Lake, which in turn, connects to the West Fork Moose River and the Kenai River.

Swanson River Road passes near the south end of the lake. A 350 yard path leads from the road to the lake.

FISH

The only fish species captured was threespine stickleback. They were high in abundance at a catch per unit effort (CPUE) of 5.51 (Table 2). Four gill nets and 10 minnow traps were used to determine fish abundance.

AQUATIC VEGETATION

Aquatic vegetation was confined to shallow areas around the shoreline. Yellow pond lily, the pondweed Potamogeton gramineus, and horsetail were the most abundant species. Sweet gale shrubs were prevalent along most of the shoreline. Three scrub shrub wetland areas sighted during the survey were listed as type PSSI/EMB5 in the National Wetland Inventory (USFWS 1978). One

Table 1.

LAKE SURVEY SUMMARY
Mosquito Lake

LOCATION				SPORT FISH VALUE	
				(Species)	(Yield)
Refuge	Kenai NWR	Map	Kenai (C-3)	None	Negligible
Lat.	N 60° 38'	Long.	W 150° 48'		
T	6N R	9W	S 2		
Land Use Class	Intensive Management				

PHYSICAL FEATURES

Surface Area (Ac.)	69
Maximum Depth (Ft.)	41
Mean Depth (Ft.)	16.1
Volume (Ac.Ft.)	1110
Water Trans. (Ft.)	10
Elevation (Ft.)	275

TRIBUTARY STREAMS

Inlets (No.)	None
Outlets (No.)	1 Intermittent
Ocean Linkage	Intermittent

AQUATIC VEGETATION
(Dominant Families)

Lily, pondweed, horsetail.

Lake Coverage (%) 11

SURVEY DATES

Fish 6/27-28/84

Water Quality 7-18-84

WATERSHED
Kenai River

FISH SPECIES
Threespine Stickleback

WATER QUALITY

Temp. (°C)	17.0 - 7.0
D.O. (mg/l)	10.2 - 2.3
pH	7.1
Tot. Alk. (mg/l)	16
Tot. Hard. (mg/l)	15
Tot. Phos. (ug/l)	13.2
Tot. Kjehl. N (mg/l)	0.41
Cond. (umho)@ 25°C	35
MEI	7.1
SDF	1.66

RECREATION

Types: Wildlife viewing, hunting.

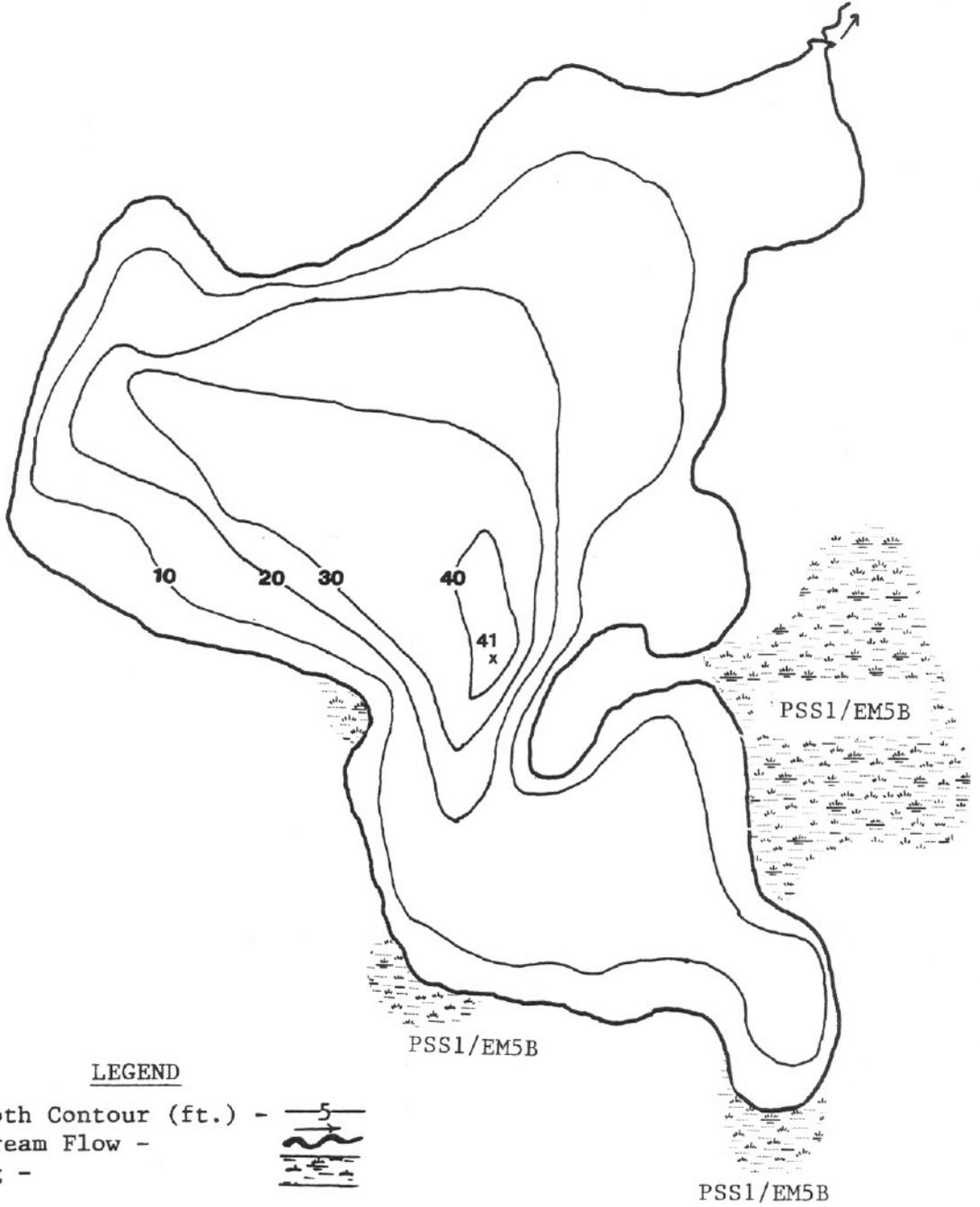
Public Facilities: Automobile pull over on Swanson River Road and Mosquito Lake sign.

Access: 350 yard trail from Swanson River Road.

Figure 1.

MOSQUITO LAKE

(69 Acres)



LEGEND

- Depth Contour (ft.) - 
- Stream Flow - 
- Bog - 

SCALE

1 : 5280

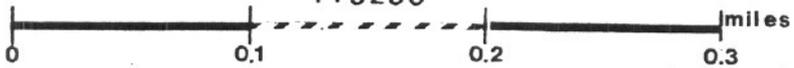


Table 2.

FISH CATCH AND EFFORT SUMMARY
Mosquito Lake 6/27-28/84

Gear	Average Fishing Time (hrs.)	Amount Gear (sq.ft.)	Fish Species	Total Fish Number	Sex M-F-U	Fish CPUE	
						Net Hour	Trap Hour
4 Gill Nets	15	3,200	-	-	-	0.00	-
10 Minnow Traps	17	N/A	Threespine Stickleback	936	0-0-936	N/A	5.51

additional small bog was on the southwest side of the lake. A complete list of vegetation is in Table 3.

WATER QUALITY

The lake's alkalinity level of 16 mg/l was less than half the average 39 mg/l found in the 37 lakes surveyed during 1983-84. Lake water fertility is low based on our modification of J.B. Moyle's classification (MacKenthun and Ingram 1967). The pH of 7.1 was near neutral. In July, the lake was thermally stratified (Table 4) with a thermocline beginning around 13 feet. Dissolved oxygen near the surface was 96 percent saturated (9.4 mg/l). Near the deepest point in the lake, oxygen was only 19 percent saturated (2.3 mg/l), however, a majority of the lake volume was above 7.0 mg/l.

Water color was dark yellow green, and Secchi disc transparency was 10 feet. The lake had a Morphoedaphic Index of 7.1 and a Shoreline Development Factor of 1.66. Dissolved oxygen levels at the time of the fish survey are in Table 5.

MANAGEMENT HISTORY

Mosquito Lake was initially surveyed by the Alaska Department of Fish and Game (ADF&G) in the fall of 1963 (Lawler and Lewis 1963). They captured 24 rainbow trout and 20 coho salmon in four gill nets fished over an approximate 24 hour period. Rainbow trout ranged in length from 6.0 inches (151 mm) to 16.0 inches (406 mm). The coho salmon ranged in length from 7.4 inches (187 mm) to 10.8 inches (274 mm). In 1974, the Fish and Wildlife Service (FWS) surveyed the lake (Crateau 1974). The FWS captured three large rainbow trout ranging in fork length from 18.5 inches (470 mm) to 20.7 inches (525 mm) using two gill nets fished about 24 hours. Two follow up fish surveys were accomplished in July 1974 and June 1975. No game fish were captured. During the same period summer and winter dissolved oxygen values were found adequate to support game fish. Crateau (1975) in a letter to the Kenai NWR manager, concluded that the 1974 rainbow trout catch represented the last of an old (eight years old +) remnant game fish population, and that by 1975, the lake was devoid of game fish. No further survey work is known to have been conducted.

WILDLIFE

A pair of common loons, Arctic terns, and one yellow legs was sighted on the lake. Several clam shell feeding areas were present indicating the presence of muskrat. All wildlife species identified along with other pertinent data are in Table 6.

RECREATIONAL USE

Recreational uses of Mosquito Lake consist mostly of wildlife viewing and hunting. Occasionally, a refuge visitor, unaware of the lake's lack of game fish, attempts to fish the lake. There are no public use facilities on the lake. A lake sign, pullover parking area, and trail aid visitors in finding the lake.

Table 3.

VEGETATION
Mosquito Lake 6/27-28/84

AQUATIC VEGETATION

Class	Common Name	Scientific Name
Emergent	horsetail	<u>Equisetum fluviatile</u>
	sedge	<u>Carex rostrata</u>
	spike rush	<u>Eleocharis palustris</u>
Floating	bur reed	<u>Sparganium angustifolium</u>
	dwarf water lily	<u>Nymphaea tetragona</u>
	yellow pond lily	<u>Nuphar polysepalum</u>
Submergent	crowfoot	<u>Ranunculus confervoides</u>
	pondweed	<u>Potamogeton epihydrus</u>
	pondweed	<u>Potamogeton gramineus</u>
	pondweed	<u>Potamogeton perfoliatus</u>
	water milfoil	<u>Myriophyllum spicatum</u>

WETLAND VEGETATION*

Class	Symbol	Description
Scrub-Shrub	PSS1/EM5B	palustrine, scrub-shrub, broad leaved deciduous, emergent narrow leaved persistent, saturated

*National Wetlands Inventory (Kenai)

TERRESTRIAL VEGETATION

Class	Common Name	Scientific Name
Trees	alder	<u>Alnus sp.</u>
	black spruce	<u>Picea mariana</u>
	paper birch	<u>Betula papyrifera</u>
	willow	<u>Salix sp.</u>
Shrubs	sweet gale	<u>Myrica gale</u>

Table 6.

WILDLIFE DATA
Mosquito Lake 6/27-28/84

Animal Class	Common Name	Number	Sex M-F-U	Animal Assoc.	Verification	Habitat Type
Birds						
Waterfowl	common loon	2	1-1-0	Pair	Sight	Water
Passerines	alder flycatcher	-	-	-	-	-
	American robin	1	-	-	Sound	-
	gray-cheeked thrush	-	-	-	-	-
	gray jay	1	-	-	Sight	-
	junco sp.	M	-	-	-	-
	orange-crowned warbler	1	-	-	Sound	-
	pine grosbeak	3	-	Flock	Sight	-
	rusty blackbird	1	-	-	-	-
	song sparrow	1	-	-	Sound	-
	tree swallow	M	-	-	Sight	-
white-crowned sparrow	M	-	-	Sight	-	
Shorebirds	yellowlegs	1	-	Single	Sight	Bog
Gulls/Terns	Arctic Tern	2	-	Pair	Sight	Water
Mammals						
Big Game	moose	1	-	-	Sight	-
Furbearers	muskrat	-	-	-	Clam Shells	-
Other	snowshoe hare	-	-	-	Cuttings	-

FISHERY RESOURCE SUMMARY

Threespine stickleback were the only fish captured during our survey. They had a high minnow trap CPUE of 5.51. Lake fertility was low, and its MEI was 7.1. Dissolved oxygen levels and other chemical parameters indicated lake water quality was adequate to support cold water game fish.

The 1963 ADF&G survey found a multi-aged population of rainbow trout and sub-adult population of coho salmon. The rainbow trout were progeny of outlet stream spawning or, like the coho, migrated through Silver Lake from the West Fork Moose River. Only a small, remnant population of rainbow was detected in the first 1974 FWS survey. Thereafter, no game fish were found. We believe the 1964 earthquake may have shifted land structure or created fissures altering water flow to and from the lake. Currently the outlet stream appears incapable of supporting rainbow trout spawning or allowing upstream migration of trout or coho salmon.

Mosquito Lake can currently support only threespine stickleback under natural conditions. This is equal to a negligible yield sport fish value. Under intensive management, such as stocking and/or stream rehabilitation, the lake appears to have the potential to support a low yield rainbow trout sport fishery.

MULL LAKE

SURVEY PERIOD

Personnel of the U.S. Fish and Wildlife Service surveyed Mull Lake twice during 1984. J.W. Friedersdorff and A.S. Firman conducted a fishery survey August 20-21. Detailed water quality data were gathered by J.W. Friedersdorff and W.J. Jakubas on July 17. Table 1 summarizes survey findings.

PHYSICAL FEATURES

Mull Lake is located in the northeast section of the Kenai National Wildlife Refuge (NWR) and is part of the Bedlam Creek Watershed. Its latitude is north 60° 54' and longitude west 150° 20'. The lake and surrounding area were designated wilderness by the Alaska National Interest Lands Conservation Act of 1980. The watershed area for the lake is estimated to be 9.1 square miles. Mull Lake has a surface area of 345 acres, a volume of 5,900 acre feet, and is at an estimated elevation of 178 feet. The lake has a mean depth of 17.1 feet and a maximum depth of 37 feet (Table 1 and Figure 1).

Mull Lake is surrounded by low hills slightly over 250 feet in elevation. They are forested with mature white spruce, paper birch, and in wetter areas, black spruce. An alder fringe rings most of the shoreline. Some of the area east of the lake was affected by the 1915-1920 refuge fire. Two moderate sized bogs, associated with streams, are located near the northeast and northwest ends of the lake. In addition, there are two other smaller bogs.

Lake water level is maintained by streams, springs, bog seepage, and run-off. The main inlet stream is fed from a small unnamed lake about 0.6 miles to the northwest. At its confluence with the lake, the inlet stream was approximately 10 feet wide and 4 feet deep. The stream became clogged with dense aquatic vegetation within 100 yards. There was no water flow, and the stream did not contain rainbow trout spawning habitat near the lake. The outlet stream is a slough about 18 feet wide and 3 feet deep passing 0.1 mile through a bog to Bedlam Lake. In turn, the outlet stream from Bedlam Lake, Bedlam Creek, flows about 5 miles to Turnagain Arm, an extension of Cook Inlet. The Mull Lake outlet stream bottom was covered with aquatic plants, organic debris, and silt. It did not constitute rainbow trout spawning habitat.

Mull Lake is remote. Aircraft landing is currently authorized. Flying is the only practical means of access. Outboard motors larger than 10 horsepower are prohibited by Refuge regulation.

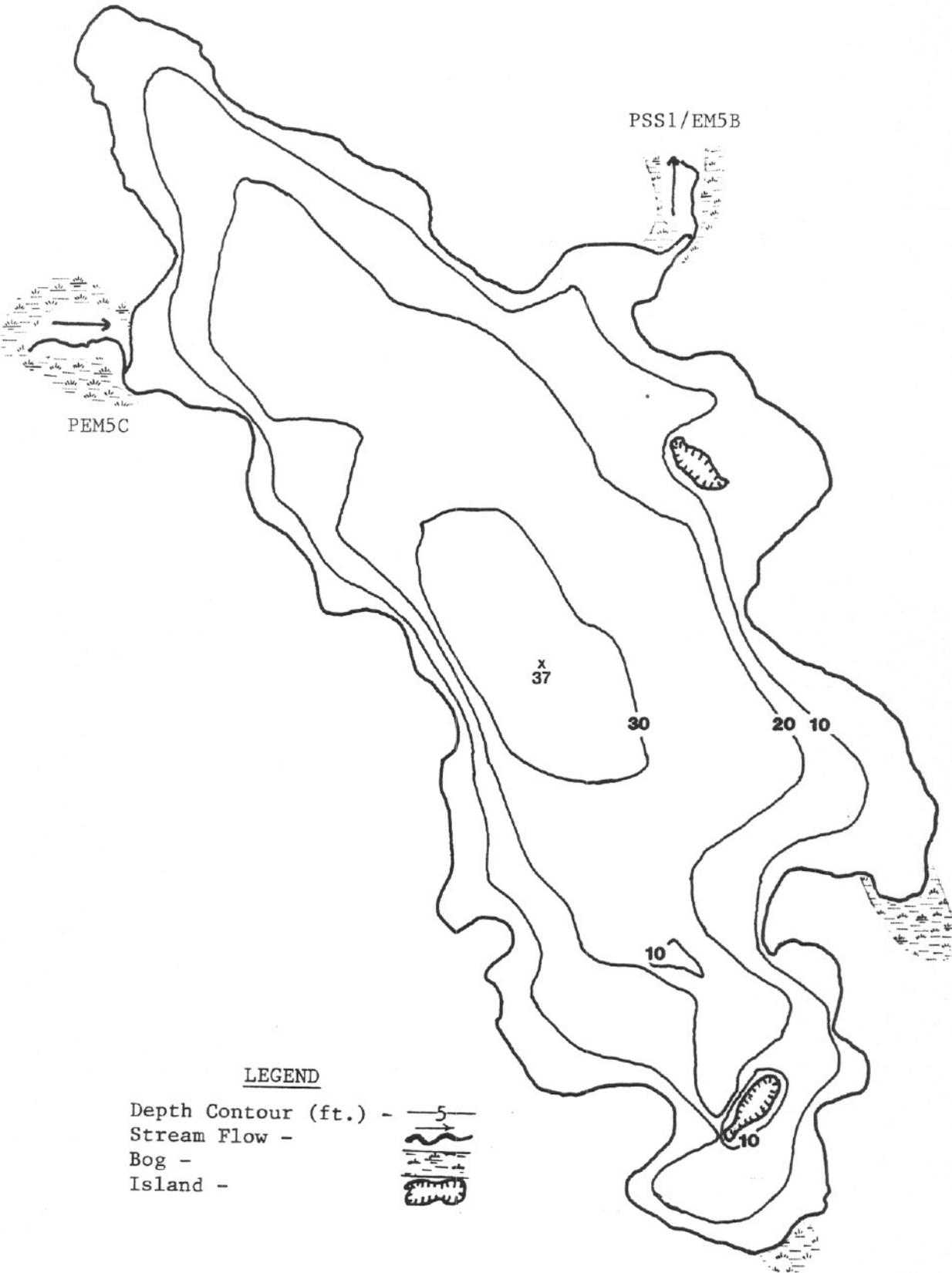
FISH

Rainbow trout were the dominant game fish in Mull Lake. They were found to be in high abundance at a catch per unit effort (CPUE) of 2.27 fish per net hour (Table 2). This was the highest abundance we found for rainbow trout in the 37 lakes surveyed during 1983-84. Verification of the high trout population was reinforced by the large number of "rainbow jumpers" observed during the survey. This is one of the few lakes where we saw this phenomenon. Two resident sockeye salmon were also captured (CPUE 0.04). Threespine stickleback at a high CPUE of 4.64 was the only forage species found. Dave Klosterman of

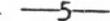
Figure 1.

MULL LAKE

(345 Acres)



LEGEND

- Depth Contour (ft.) - 
- Stream Flow - 
- Bog - 
- Island - 

SCALE
1 : 10,560

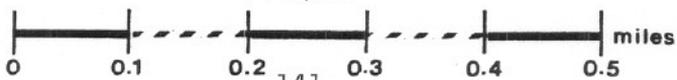


Table 2.

FISH CATCH AND EFFORT SUMMARY
Mull Lake 8/20-21/84

Gear	Average Fishing Time (hrs.)	Amount Gear (sq. ft.)	Fish Species	Total Fish Number	Sex M-F-U	Fish CPUE	
						Net Hour	Trap Hour
4 Gill Nets	13	3,200	Rainbow Trout ^{1/}	118	12-23-83	2.27	N/A
			Sockeye Salmon	2	1-0-1	0.04	N/A
			All Species	120	13-23-84	2.31	N/A
20 Minnow Traps	18	N/A	Threespine Stickleback	1671	0-0-1671	N/A	4.64

^{1/} Residual Sockeye or Kokanee Salmon

Alaska Bush Carriers, who has worked on the lake for over 10 years, indicated he had caught juvenile coho salmon in the past. A total of four gill nets and 20 minnow traps were used to measure fish abundance.

Rainbow trout ranged in fork length from 7.9 inches (200 mm) to 17.3 inches (440 mm), in weight from 0.2 pounds (110 g) to 2.0 pound (910 g), and in condition from 0.75 to 2.08. Scale analysis indicated the trout were from four to nine years old (Table 3). Their mean growth rate was 1.8 inches per year. The two sockeye salmon had a complete fresh water life history and were either sockeye residuals or kokanee salmon. The sockeye were 8.5 inches (215 mm) and 12.2 inches (310 mm) fork length, 0.3 pounds (120 g) and 0.9 pounds (410 g), with condition factors of 1.21 and 1.38. Scale analysis indicated the sockeye were two and three years old and were growing at an average rate of 3.3 inches per year. Length, weight, and condition data for the rainbow trout and sockeye salmon are summarized in Table 4.

AQUATIC VEGETATION

Aquatic vegetation in the lake was mostly confined to shoal waters near the shore. The pondweed, Potamogeton perfoliatus, was the dominant aquatic plant. There were also smaller growths of spike rush and bulrush. About 10 percent of the lake area contained aquatic vegetation. One scrub shrub wetland (type PSS1/EM5B), and one emergent wetland (type PEM5C) were plotted in the National Wetlands Inventory (USFWS 1978). The other bogs were not identified in the inventory. A complete list of vegetation is in Table 5.

WATER QUALITY

The lake's alkalinity level of 61 mg/l was almost twice as high as the average 39 mg/l found in the 37 lakes surveyed during 1983-84. This value corresponds to the medium category of lake productivity in our modification of Moyle's classification (MacKenthun and Ingram 1967). The pH of 7.5 was slightly alkaline. During the July water quality survey (Table 6), the deep area of the lake was not located, and only the epilimnion was sampled. In the August fish survey (Table 7), the deep part of the lake was sampled. Surface water temperature in this latter survey was 17.9°C and remained stable to 20 feet where water temperature was only slightly lower at 17.2°C. A thermocline occurred just below this depth at about 23 feet. At lower depths water temperature declined rapidly to 10.1°C near the bottom. Corresponding dissolved oxygen values were 86 percent saturated (8.3 mg/l) at the surface down to 16 feet, then degraded rapidly being less than 1 percent saturated (0.1 mg/l) between 23 and 33 feet, a value lethal to fish.

Water color was yellow green, and Secchi disc transparency was 15 feet. The lake had a Morphoedaphic Index of 24.3 and Shoreline Development Factor, including islands, of 1.90.

MANAGEMENT HISTORY

There have been no previous fishery surveys of Mull Lake.

WILDLIFE

Common loons, red-necked grebes, and one white-winged scoter were identified on

Table 3.

BACK-CALCULATED FORK LENGTHS (MILLIMETERS) AT ANNULUS FORMATION*
of Rainbow Trout in Mull Lake - 1984

Year Class	Number of Fish	Age of Fish												Capture FL	
		1	2	3	4	5	6	7	8	9	10	11	12		
1980	4	47	84	130	186										216
1979	5	45	85	129	189	251									280
1978	3	42	75	119	169	222	267								312
1977	10	36	72	110	156	210	266	312							351
1976	1	33	89	131	220	281	332	403	435						440
1975	1	39	79	131	180	223	267	320	386	438					460
Number of Fish	24	24	24	24	24	20	15	12	2	1					
Grand Mean (mm)		40	78	120	173	226	271	320	411	438					
Grand Mean (in)		1.6	3.1	4.7	6.8	8.9	10.7	12.6	16.2	17.2					
Annual Growth Increment (in)		1.6	1.5	1.7	2.1	2.1	1.8	1.9	3.6	1.1					

*Not corrected for length at scale formation

Table 4.

FISH LENGTH, WEIGHT, AND CONDITION SUMMARY
 Mull Lake 8/20-21/84

Gear	Category	Species	Sample Size	Mean	Standard Deviation	Range
Gill Nets	Fork Length (mm)	Rainbow Trout	63	306	58.3	200 - 440
		Sockeye Salmon	2	263	67.2	215 - 310
	Weight (g)	Rainbow Trout	63	369	187	110 - 910
		Sockeye Salmon	2	265	205	120 - 410
	Condition (K)	Rainbow Trout	63	1.22	0.21	0.75 - 2.08
		Sockeye Salmon	2	1.29	0.12	1.21 - 1.38

Table 5.

VEGETATION
Mull Lake 8/20-21/84

AQUATIC VEGETATION

Class	Common Name	Scientific Name
Emergent	bulrush horsetail spike rush	<u>Scirpus validus</u> <u>Equisetum fluviatile</u> <u>Eleocharis palustris</u>
Floating	bur reed duck weed yellow pond lily	<u>Sparganium angustifolium</u> <u>Lemna minor</u> <u>Nuphar polysepalum</u>
Submergent	crowfoot pondweed pondweed pondweed water milfoil	<u>Ranunculus confervoides</u> <u>Potamogeton gramineus</u> <u>Potamogeton perfoliatus</u> <u>Potamogeton zosterfolius</u> <u>Myriophyllum spicatum</u>

WETLANDS VEGETATION*

Class	Symbol	Description
Scrub-Shrub	PSS1/EM5B	palustrine, scrub-shrub, broad leaved deciduous, emergent, narrow leaved persistent, saturated
Emergent	PEM5C	palustrine, emergent, narrow leaved persistent, seasonal

*National Wetlands Inventory (Kenai)

TERRESTRIAL VEGETATION

Class	Common Name	Scientific Name
Trees	alder black spruce paper birch white spruce	<u>Alnus sp.</u> <u>Picea mariana</u> <u>Betula papyrifera</u> <u>Picea glauca</u>
Shrub	sweet gale	<u>Myrica gale</u>
Below Shrub	grass marsh fivefinger	<u>Gramineae</u> <u>Potentilla palustris</u>

Table 8.

WILDLIFE DATA
Mull Lake 8/20-21/84

Animal Class	Common Name	Number	Sex M-F-U	Animal Assoc.	Verification	Habitat Type
Birds						
Waterfowl	common loon	7	-	Single	Sight	Water
	red-necked grebe	3	-	Single	Sight	Water
	white-winged scoter	1	-	Single	Sight	Water
Passerines	gray jay	3	-	Single	Sight	Trees
Shorebirds	belted kingfisher	1	-	Single	Sight	-
Raptors	bald eagle	1	-	Single	Sight	Flight
	great horned owl	2	-	-	Sound	-
Mammals						
Big Game	moose	-	-	-	Cuttings	-
Furbearers	beaver	-	-	-	Lodge	-
	muskrat	-	-	-	Clam Shells	-

the lake. A bald eagle was sighted flying in the vicinity of the lake, and a great horned owl was heard at night. Two active beaver lodges, one on the south end and one on the north end of the lake, verified the presence of beaver. Muskrat presence was indicated by clam shell feeding areas. Wildlife species along with pertinent data are in Table 8.

RECREATIONAL USE

Recreational uses of Mull Lake include fishing, wildlife viewing, camping, and boating. Alaska Bush Carriers have a Refuge Special Use Permit allowing them to establish a tent camp and fly in clients for sport fishing. Refuge records indicate the air carrier flew in 130 people in 1983 for fishing and camping. During our survey a party of three anglers had just completed a three day fishing trip. They indicated they only caught eight trout, but had observed a lot of "jumpers". They said one of the trout was 20 inches long. There are no public use facilities on the lake other than those owned by Alaska Bush Carriers. Bob Richey, Assistant Refuge Manager, Kenai NWR, indicated Mull Lake was one of the best rainbow trout fishing lakes on the Kenai NWR.

FISHERY RESOURCE SUMMARY

Rainbow trout were the dominant game fish in Mull Lake. The relative abundance of rainbow (CPUE 2.27) was the highest found in any of the 37 lakes we surveyed during 1983-84. The variety of age and size classes indicates spawning and recruitment are occurring. Our 1983 survey of adjoining Bedlam Lake (Friedersdorff 1984) also found rainbow trout abundance to be high (CPUE 1.45). A low abundance of resident sockeye salmon was present in Mull Lake (CPUE 0.04). These fish were either residual sockeye or kokanee. Threespine stickleback at a high abundance (CPUE 4.64) were the only forage species taken.

Sport fishing pressure on Mull Lake is mostly attributed to air carrier clients. Anglers staying at the Bedlam Lake tent camps often cross through the connecting waterway to fish Mull Lake, plus additional fishing pressure comes from anglers transporting in private planes. We estimate the current fishing pressure on the lake is 2 angler days per acre. Bob Richey, Asst. Refuge Manager, stated that Mull Lake has been and continues to be one of the best rainbow trout fishing lakes on the refuge.

The Lake is medium in fertility and has a MEI of 24.3. Dissolved oxygen values were high for cold water game fish in the upper half of the lake. Inlet and outlet tributaries of Mull Lake do not constitute rainbow trout spawning habitat. However, nearby Bedlam Creek is high quality spawning habitat and a large number of juvenile rainbows were seen there in 1983. This nearby, high quality spawning area appears to play a key role in maintaining the Mull Lake trout population. Based on our findings, Mull Lake can support a high yield rainbow trout sport fishery.

LOWER OHMER LAKE

SURVEY PERIOD

Personnel of the U.S. Fish and Wildlife Service surveyed Lower Ohmer Lake twice during 1984. J.W. Friedersdorff and G.A. Muhlberg conducted a fishery survey on June 6-7. Detailed water quality data were gathered by W.J. Jakubas and G.A. Muhlberg on July 18. Table 1 summarizes survey findings.

PHYSICAL FEATURES

Lower Ohmer Lake is located in the central section of the Kenai National Wildlife Refuge (NWR) just north of Skilak Lake and is in the Kenai River Basin. Its latitude is north 60° 27' and longitude west 150° 18'. The lake and surrounding area were designated in the Intensive Land Mangement Category by the Kenai NWR Comprehensive Conservation Plan (USFWS 1985). The watershed area for the lake is estimated to be 2.0 square miles. Lower Ohmer Lake has a surface area of 122 acres, a volume of 4,700 acre feet, and is at an elevation of 420 feet. The lake has a mean depth of 38.3 feet and maximum depth of 86 feet (Table 1 and Figure 1).

Lower Ohmer Lake is bordered by low hills to the north and south, relatively flat topography to the west, and mountains over 1,000 feet in elevation to the east. Terrestrial vegetation consists of mature and immature white spruce, black spruce, and paper birch with heavy concentrations of alder plus light scatterings of quaking aspen around the lake periphery. Most of the immature trees are regrowth from the 1947 refuge fire which affected parts of the lake.

Lake water level is maintained by an inlet and outlet stream, springs, and run-off. The inlet flows about 0.4 miles from Upper Ohmer Lake entering Lower Ohmer Lake on the east shore. Just before reaching the lake it passes through a steel culvert running under the Skilak Campground Access Road. The inlet stream is a narrow, deep channeled waterway with numerous small pools and gravel riffles. Stream width is about 4 feet and depth 2 feet. Aerial photos indicate a small unnamed lake south of Upper Ohmer Lake contributes flow to the inlet stream. Inlet stream flow was estimated at 6 cubic feet per second (cfs). This flow is probably high compared to normal summer flows. The inlet stream appeared to be low quality rainbow trout spawning habitat.

The outlet stream is located at the southern tip of the lake. It flows about 0.9 miles to Skilak Lake with a drop in elevation of about 225 feet. This stream was approximately 6 feet wide and 1.5 feet deep. Flow was estimated at 13.5 cfs. A casual observation by Jack Dean of the Kenai Fishery Resources Station later in the summer showed this flow to be much lower. Substrate of the outlet stream was composed mostly of thick organic detritus and aquatic plants. The outlet appeared to be of negligible spawning quality in the vicinity of the lake. Large expanses of clean gravel were present in shoal areas around the lake.

Skilak Loop Road and a 0.1 mile gravel service road provide automobile access to a campground located on the lake's northeast side. The Upper Skilak Lake Campground Access Road skirts the eastern edge of the lake. Outboard motors larger than 10 horsepower are prohibited by Refuge regulation.

LAKE SURVEY SUMMARY
Lower Ohmer Lake

LOCATION

Refuge Kenai NWR Map Kenai (B-1)
 Lat. N 60° 27' Long. W 150° 18'
 T 4N R 6W S 9
 Land Use Class Intensive Management

SPORT FISH VALUE
(Species) (Yield)

Rainbow Trout Moderate

PHYSICAL FEATURES

Surface Area (Ac.) 122
 Maximum Depth (Ft.) 86
 Mean Depth (Ft.) 38.3
 Volume (Ac.Ft.) 4700
 Water Trans. (Ft.) 18
 Elevation (Ft.) 420

WATERSHED

Kenai River

FISH SPECIES

WATER QUALITY

Temp. (°C) 15.6-5.0
 D.O. (mg/l) 12.2-0.2
 pH 7.7
 Tot. Alk. (mg/l) 48
 Tot. Hard. (mg/l) 52
 Tot. Phos. (ug/l) 9.3
 Tot. Kjehl. N (mg/l) 0.30
 Cond. (umho)@ 25°C 105
 MEI 9.0 SDF 1.41

Rainbow Trout
Threespine Stickleback
Coastrange Sculpin

TRIBUTARY STREAMS

Inlets (No.) 1 Permanent

 Outlets (No.) 1 Permanent

 Ocean Linkage Yes

RECREATION

Types: Fishing, camping, boating, and wildlife viewing.

AQUATIC VEGETATION
(Dominant Families)

Lily, horsetail

Public Facilities: Multiple campsites, fire pits, picnic tables, pit toilet, water pump, bulletin board, and boat ramp.

Lake Coverage (%) 5

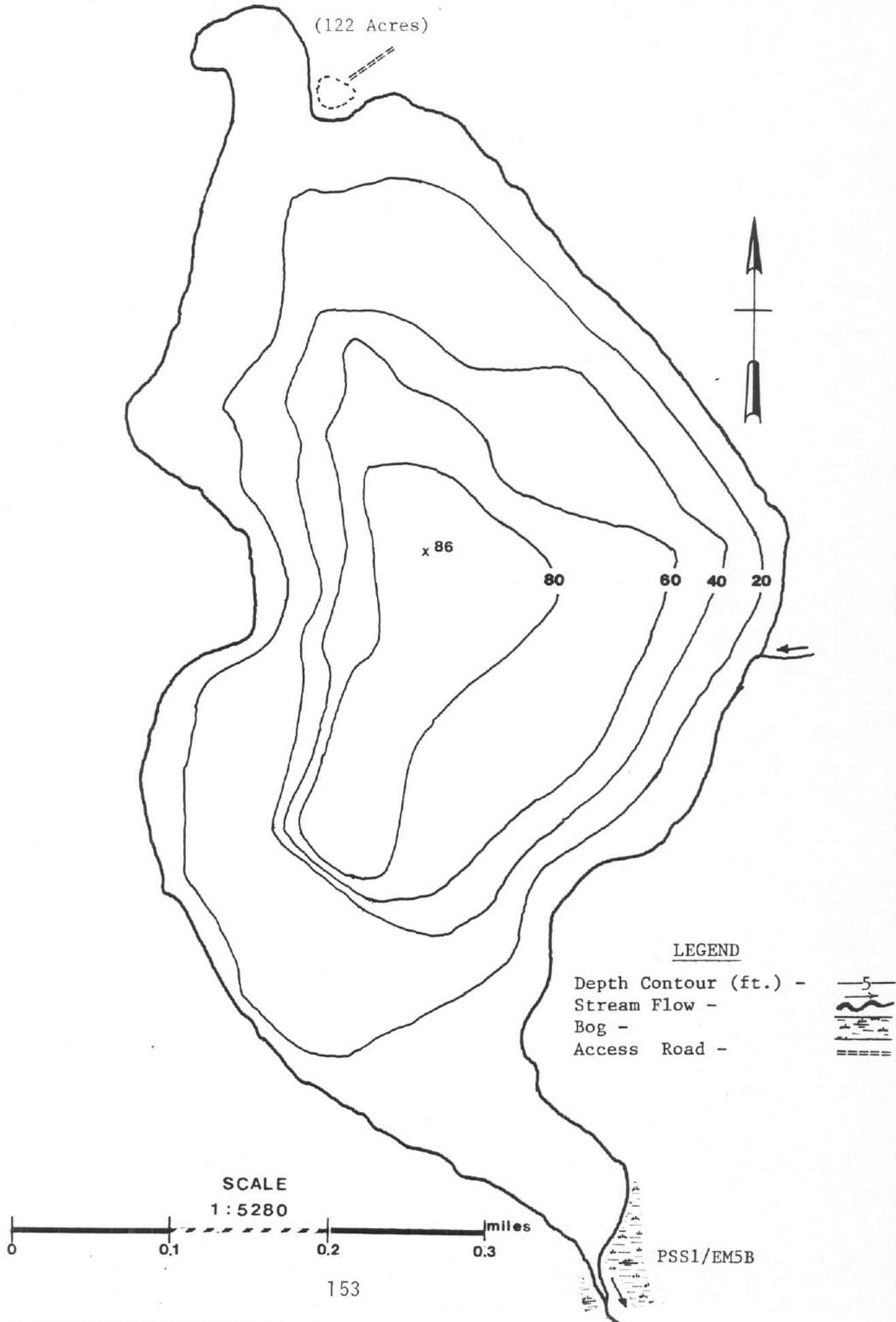
SURVEY DATES

Fish 6/6-7/84
 Water Quality 7-18-84

Access: Direct automobile access via Skilak Loop Road and a 0.1 mile long gravel service road. The Skilak Lake Upper Campground access road skirts the east side of the lake.

Figure 1.

LOWER OHMER LAKE



FISH

Rainbow trout were the only game fish captured in the lake (Table 2). They were found in low abundance at a catch per unit effort (CPUE) of 0.13 fish per net hour. Threespine stickleback, at a low abundance of 0.92 fish per trap hour, and coastrange sculpin constituted the forage species. A total of four gill nets and 14 minnow traps were used to determine fish abundance.

The rainbow trout ranged in fork length from 3.7 inches (95 mm) to 14.8 inches (375 mm) with corresponding weights from 0.02 pounds (9.2 g) to 1.2 pound (530 g). Their condition varied from 0.91 to 1.22. Length, weight, and condition factors for rainbow trout are summarized in Table 3. The trout were found to range in age from two to seven years (Table 4). Their average growth rate was 1.7 inches per year.

AQUATIC VEGETATION

Aquatic plant growth was sparse and found mostly in wind protected areas in the lake's northern and southern ends. Yellow pond lily was the most prevalent species and was in an early stage of emergence. Patches of dead bur reed and horsetail from the previous year's growth were found along the shoreline. About 5 percent of the lake was covered with aquatic vegetation. Plant growth would have increased by summer. One scrub shrub wetland (type PSS1/EM5B), plotted in the National Wetlands Inventory (USFWS 1978), was sighted at the southern end of the lake. A complete list of vegetation is in Table 5.

WATER QUALITY

The lake's alkalinity level of 48 mg/l was slightly higher than the average 39 mg/l found in the 37 lakes surveyed during 1983-84. This value corresponds to the medium range of lake productivity using our modification of Moyle's classification (MacKenthun and Ingram 1967). The pH of 7.7 was near the high end of the alkaline range we observed. The lake was thermally stratified in July (Table 6). Surface water temperature was 15.6°C declining to 14.3°C just above the thermocline at 20 feet, then progressively declining to 5.0°C at 82 feet. Dissolved oxygen was high throughout most of the lake's water column. From the surface to 26 feet oxygen was near atmospheric saturation levels, then gradually degraded to 50 percent saturation (6.4 mg/l) at 75 feet. At around 82 feet dissolved oxygen was almost completely absent (0.8 mg/l) presenting lethal conditions for fish.

Water color was yellow green, and Secchi disc transparency was 18 feet. The lake had a Morphoedaphic Index of 9.0 and Shoreline Development Factor of 1.41. Table 7 shows dissolved oxygen values present during the fishery survey.

MANAGEMENT HISTORY

The Alaska Department of Fish and Game (ADF&G) surveyed the lake in June, 1960. Dune (1960) reported capturing only rainbow trout for a CPUE of 0.20 fish per net hour. These trout ranged in length from 7.3 inches (185 mm) to 19.3 inches (490 mm). The Fish and Wildlife Service (FWS) surveyed the lake in June, 1974 and March, 1975 (Bailey 1974, Nelson and Crateau 1975). During the 1974 survey, 24 rainbow trout were captured for a CPUE of 1.00 fish per net

Table 2. FISH CATCH AND EFFORT SUMMARY
Lower Ohmer Lake 6/6-7/84

Gear	Average Fishing Time (hrs.)	Amount Gear (sq.ft.)	Fish Species	Total Fish Number	Sex M-F-U	Fish CPUE	
						Net Hour	Trap Hour
4 Gill Nets	16	3,200	Rainbow Trout	8	2-6-0	0.13	N/A
14 Minnow Traps	17		Rainbow Trout	8	0-0-8	N/A	0.03
			Coastrange Sculpin	146	0-0-146	N/A	0.61
			Threespine Stickleback	220	0-0-220	N/A	0.92
			All Species	374	0-0-374	N/A	1.56

Table 3.
FISH LENGTH, WEIGHT, AND CONDITION SUMMARY
Lower Ohmer Lake 6/6-7/84

Gear	Category	Species	Sample Size	Mean	Standard Deviation	Range
Gill Nets	Fork Length (mm)	Rainbow Trout	8	294	48.1	225 - 375
	Weight (g)	Rainbow Trout	8	288	142	110 - 530
	Condition (K)	Rainbow Trout	8	1.05	0.11	0.91 - 1.22
Minnow Traps	Fork Length (mm)	Rainbow Trout	8	115	10.4	95 - 125
	Weight (g)	Rainbow Trout	8	16.1	4.20	9.2 - 22.5
	Condition (K)	Rainbow Trout	8	1.04	0.09	0.92 - 1.15

Table 4.

BACK-CALCULATED FORK LENGTHS (MILLIMETERS) AT ANNULUS FORMATION*
of Rainbow Trout in Lower Ohmer Lake - 1984

Year Class	Number of Fish	Age of Fish												Capture FL	
		1	2	3	4	5	6	7	8	9	10	11	12		
1982	8	53	98												115
1979	2	33	67	107	154	207									240
1978	2	36	64	94	139	191	245								273
1977	4	43	83	128	170	214	264	311							333
Number of Fish	16	16	16	8	8	8	6	4							
Grand Mean (mm)		46	86	114	158	206	257	311							
Grand Mean (in)		1.8	3.4	4.5	6.2	8.1	10.1	12.2							
Annual Growth Increment (in)		1.8	1.6	1.1	1.7	1.9	2.0	2.1							

*Not corrected for length at scale formation

Table 5.

VEGETATION
Lower Ohmer Lake 6/6-7/84

AQUATIC VEGETATION

Class	Common Name	Scientific Name
Emergent	horsetail	<u>Equisetum fluviatile</u>
Floating	bur reed yellow pond lily	<u>Sparganium angustifolium</u> <u>Nuphar polysepalum</u>
Submergent	pondweed pondweed	<u>Potamogeton alpinus</u> <u>Potamogeton sp.</u>

WETLAND VEGETATION*

Class	Symbol	Description
Scrub-shrub	PSS1/EM5B	palustrine, scrub-shrub, broad leaved deciduous, emergent, narrow leaved persistent, saturated

*National Wetlands Inventory (Kenai)

TERRESTRIAL VEGETATION

Class	Common Name	Scientific Name
Trees	alder black spruce paper birch quaking aspen white spruce	<u>Alnus sp.</u> <u>Picea mariana</u> <u>Betula papyrifera</u> <u>Populus tremuloides</u> <u>Picea glauca</u>
Below Shrub	grass	<u>Gramineae</u>

Table 6.

WATER QUALITY DATA
Lower Ohmer Lake 7-18-84

Cloud Cover (%) 100 Air Temp (°C) 15.5 Wind (mph) 1-3 Chop (in) 1 Time 1545

Sample Depth (m)	Water Temp. (°C)	D.O. (mg/l)	pH	Specific Cond. @ 25°C (umho/cm)	Total Alk. as CaCO ₃ (mg/l)	Total Hard. as CaCO ₃ (mg/l)	Total Phos. as P (ug/l)	React. Phos. as P (ug/l)	Total Kjeldahl Nitrogen as N (mg/l)	Nitrate+ Nitrite as N (ug/l)	Total Ammonia as N (ug/l)	Forel-Ule Color	Water Trans. (m)
0	15.6	10.0										XIV	5.5
1	15.5	10.3	7.7	105	48	52	9.3	2.9	0.30	40.5	2.6		
2	15.4	10.3											
3	15.4	10.4											
4	15.4	10.4											
5	15.3	10.4											
6	14.3	10.4											
7	11.0	11.9											
8	8.8	12.2											
9	7.0	11.6											
10	6.5	11.4											
11	5.9	11.0											
12	5.7	9.6											
13	5.2	9.6											
14	5.2	9.5											
15	5.1	9.4											
16	5.1	9.2											
17	5.0	8.6											
18	5.0	8.3											
19	5.0	7.9											
20	5.0	7.6											
21	5.0	7.2											

Table 7.

WATER QUALITY DATA

Lower Ohmer Lake 6-6-84

Cloud Cover (%) 100 Air Temp (°C) 13.0 Wind (mph) 10 Chop (in) 3 Time 1500

Sample Depth (m)	Water Temp. (°C)	D.O. (mg/l)	pH	Specific Cond. @ 25°C (umho/cm)	Total Alk. as CaCO ₃ (mg/l)	Total Hard. as CaCO ₃ (mg/l)	Total Phos. as P (ug/l)	React. Phos. as P (ug/l)	Total Kjeldahl Nitrogen as N (mg/l)	Nitrate+ Nitrite as N (ug/l)	Total Ammonia as N (ug/l)	Forel-Ule Color	Water Trans. (m)
0	14.0	10.3											
1	14.0	10.5											
2	14.0	10.6											
3	14.0	10.6											
4	13.5	10.8											
5	12.5	11.4											
6	10.5	12.0											
7	8.0	12.0											
8	7.0	12.2											
9	6.5	12.2											
10	6.0	11.8											
11	5.5	11.7											
12	5.5	11.4											
13	5.0	11.3											
14	5.0	11.0											
15	5.0	11.0											
16	5.0	10.7											
17	5.0	10.5											
18	5.0	10.2											
19	5.0	10.0											
20	5.0	9.5											
21	5.0	9.4											

hour. The trout ranged in fork length from 6.2 inches (157 mm) to 14.5 inches (369 mm) with corresponding weights of 0.13 pounds (57 g) to 0.9 pounds (369 g). Three additional trout were taken in 1975 under the ice. They were slightly larger than in the previous summer survey and ranged in fork length from 13.2 inches (335 mm) to 16.9 inches (430 mm) and in weight from 1.0 pound (445 g) to 2.1 pounds (935 g). In a letter to the Kenai NWR Manager, Croteau (1975) indicated that the lake showed a stable population of rainbow trout with multi-year age classes, and that the lake could be considered an excellent fishery during both winter and summer months.

WILDLIFE

Wildlife sightings were relatively low. Four waterfowl species including black scoter, surf scoter, common loon, and common merganser were seen. Wildlife species along with other pertinent data are in Table 8.

RECREATIONAL USE

Recreational uses of Lower Ohmer Lake include fishing, camping, wildlife viewing, and boating. The campground is popular among tourists as a place to stay while visiting other parts of the refuge. Public use facilities consist of a large parking lot, multiple fire pits, picnic tables, water pump, dirt boat access, pit toilet, and a bulletin board. During our two day lake survey we saw several anglers fishing the lake from the Skilak Lake Access Road. They indicated they had average success for rainbow trout. No long term count of fishing pressure is available.

FISHERY RESOURCE SUMMARY

Rainbow trout were the only game fish in Lower Ohmer Lake being found at a low abundance (0.13). Previous surveys by the ADF&G and FWS substantiated our finding of rainbow trout as the single game fish species. In contrast, previous State and Federal surveys found higher trout abundances ranging from moderate to high. A low abundance of threespine stickleback (CPUE 0.92) and coastrange sculpin constitute the lake's forage species.

Angling pressure on the lake is probably low to moderate with a lot of the fishing occurring from the Skilak Lake Access Road. Water fertility was in the medium range, and the MEI was 9.0. Dissolved oxygen was high for cold water game fish throughout most of the lake. The inlet stream from Upper Ohmer Lake appeared to provide low quality rainbow trout spawning habitat. No fish passage problem was evident at the culvert under observed flows. The outlet stream, with an approximate 225 foot drop over 0.9 miles, may have an upstream fish blockage since juvenile coho salmon were not present in the lake. Our fish survey found a variety of trout age and size classes indicating that successful spawning and recruitment is occurring. Considering present lake conditions and the higher trout abundance found during earlier surveys, Lower Ohmer Lake is believed to be capable of supporting a moderate yield rainbow trout sport fishery.

Table 8.

WILDLIFE DATA
Lower Ohmer Lake 6/6-7-84

Animal Class	Common Name	Number	Sex M-F-U	Animal Assoc.	Verifi- cation	Habitat Type
Birds						
Waterfowl	black scoter	3	0-0-3	Single	Sight	Water
	common loon	2	1-1-0	Pair	Sight	Water
	common merganser	2	1-1-0	Pair	Sight	Water
	surf scoter	3	2-1-0	Pair/Single	Sight	Water
Passerines	gray jay	4	0-0-4	Single	Sight	-
	white-crowned sparrow	1	1-0-0	Single	Sight	-
Gulls/Terns	mew gull	2	0-0-2	Single	Sight	Water
Mammals						
Big Game	moose	-	-	-	Cuttings	-
Other	red squirrel	1	0-0-1	Single	Sight	-

PETERSEN LAKE

SURVEY PERIOD

Personnel of the U.S. Fish and Wildlife Service performed three fish surveys and one detailed water quality survey on Petersen Lake during 1984. The fish surveys were conducted on May 29-30 by W.J. Jakubas and G.A. Muhlberg, and on July 24-25 and September 6-7 by J.W. Friedersdorff and A.S. Firman. Detailed water quality data were gathered by J.W. Friedersdorff and A.S. Firman on July 24. Table 1 summarizes survey findings.

PHYSICAL FEATURES

Petersen Lake is located in the eastcentral section of the Kenai National Wildlife Refuge (NWR) and is part of the Kenai River Basin. Its latitude is north 60° 31' and longitude west 150° 23'. The lake name is misspelled on USGS Topographic Map Kenai (C-2), 1951 as "Peterson". It was named in the memory of James D. Petersen, Refuge Manager of the Kenai National Moose Range who drowned in a storm on Skilak Lake September 9, 1955, while on patrol duty. The lake and surrounding area were designated to be in the Moderate Land Management Category by the Kenai NWR Comprehensive Conservation Plan (USFWS 1985). The watershed area for the lake is estimated to be 8.7 square miles. Petersen Lake has a surface area of 94 acres, a volume of 1,800 acre feet, and is at an estimated elevation of 295 feet. The lake has a mean depth of 18.8 feet and maximum depth of 41 feet (Table 1 and Figure 1).

Petersen Lake is situated in relatively flat terrain with low hills to the south and a gentle slope to the west. Terrestrial vegetation around the lake consists of young paper birch and white spruce which are regrowth from the 1947 refuge fire. A mature stand of birch and spruce lies to the east between Petersen and Kelly lakes. Alder shrubs are common along most of the shoreline.

Lake water level is controlled by streams, springs, and run-off. The lake receives the flow from Kelly Lake located about 0.1 mile to the east. The larger inlet stream on the southeast shore was 9 feet wide and 0.3 feet deep. In July its flow was estimated at 4 cubic feet per second (cfs) and in September 5 cfs. This stream, with a series of small pools and riffles and moderate stretches of gravel substrate, was judged to be medium quality rainbow trout spawning habitat. The smaller inlet, located on the northeast shore, may be a split tributary from the larger inlet stream or spring fed. Its origin was not determined. It was 9 feet wide and 0.2 feet deep with an estimated flow of 1.4 cfs in July and 2.0 cfs in September. It had only small quantities of gravel in a few areas and was judged to be negligible to low quality rainbow trout spawning habitat. Although flow appeared to be permanent in both inlet streams, they may become too low during dry periods to permit fish passage.

The outlet stream, which is the East Fork Moose River, is located on the west end of the lake. It averaged 15 feet wide and 0.4 feet deep and consisted of a series of pools and riffles. July flow was estimated to be 6 cfs and September flow 14 cfs. About half the substrate was gravel and the stream appeared to be high quality rainbow trout spawning habitat. The outlet stream flows 10.8 miles northwest through Equemen, Watson, Imperi, and Afonasi lakes to the Moose

Table 1.

LAKE SURVEY SUMMARY
Petersen Lake

LOCATION				SPORT FISH VALUE	
				(Species)	(Yield)
Refuge	Kenai NWR	Map	Kenai (C-2)	Rainbow Trout	Moderate
Lat.	N 60° 31'	Long.	W 150° 23'	Coho Salmon	Nursery Area
T	5N	R	6W	S	18
Land Use Class	Moderate Management			Sockeye Salmon	Spawning

PHYSICAL FEATURES	
Surface Area (Ac.)	94
Maximum Depth (Ft.)	41
Mean Depth (Ft.)	18.8
Volume (Ac.Ft.)	1800
Water Trans. (Ft.)	15
Elevation (Ft.)	295

TRIBUTARY STREAMS	
Inlets (No.)	2 Permanent
Outlets (No.)	1 Permanent
Ocean Linkage	Yes

AQUATIC VEGETATION (Dominant Families)	
Lily, pondweed	
Lake Coverage (%)	6

SURVEY DATES	
Fish	5/29-30/84
Fish	7/24-25/84
Fish	9/6-7/84
Water Quality	7-24-84

WATERSHED		FISH SPECIES
Kenai River		
WATER QUALITY		
Temp. (°C)	16.1-8.0	Rainbow Trout ^{1/}
D.O. (mg/l)	11.1-0.2	Sockeye Salmon ^{1/}
pH	7.7	Coho Salmon
Tot. Alk. (mg/l)	67	Longnose Sucker
Tot. Hard. (mg/l)	60	Threespine Stickleback
Tot. Phos. (ug/l)	14.2	Ninespine Stickleback
Tot. Kjell. N (mg/l)	0.20	
Cond. (umho)@ 25°C	139	^{1/} Anadromous Fish
MEI	24.2 SDF 1.29	

RECREATION
Types: Camping, fishing, wildlife viewing, boating, hunting.

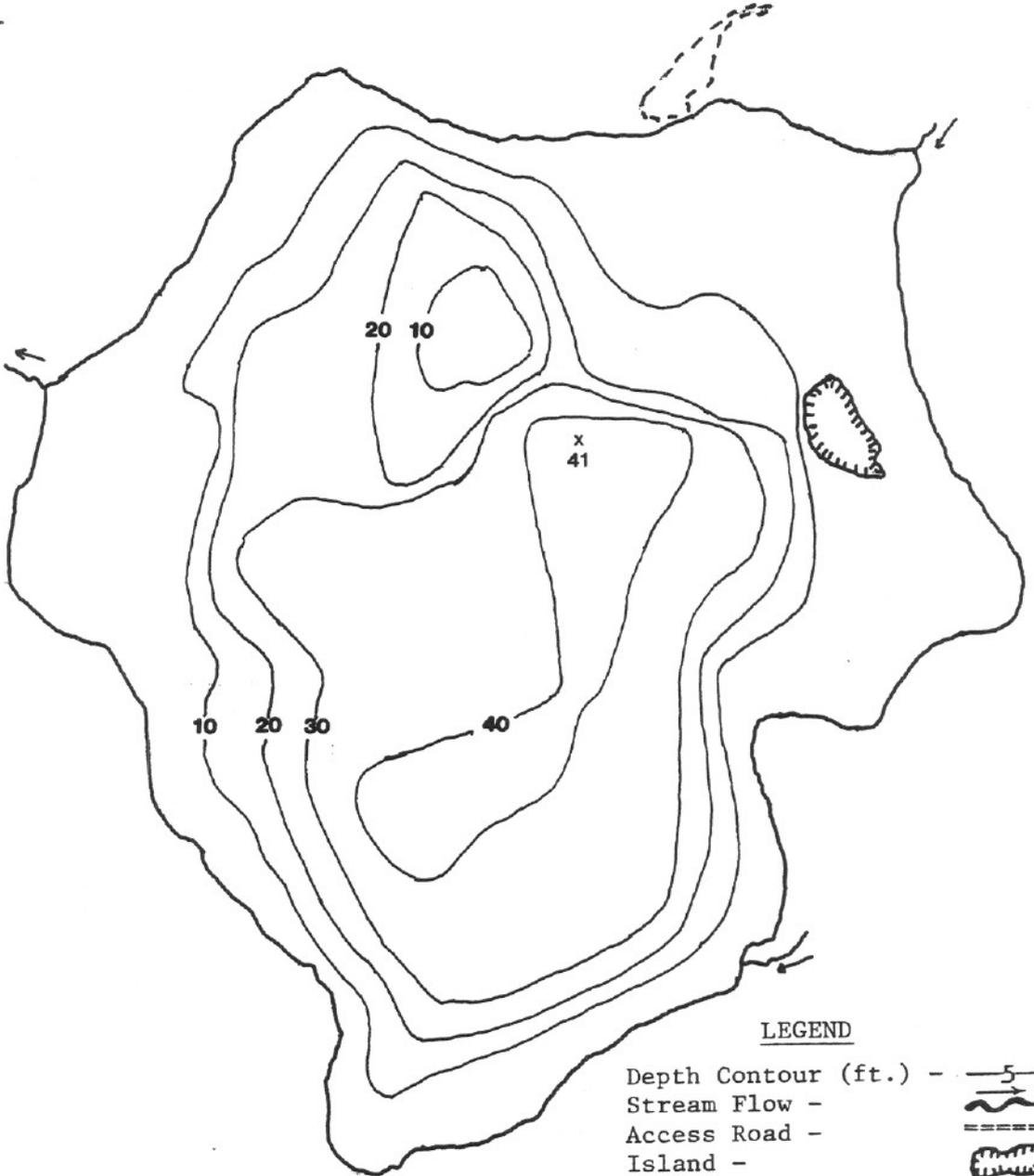
Public Facilities: Large parking lot, gravel boat access ramp, multiple fire pits, picnic tables, water well, pit toilet, and bulletin board.

Access: Direct automobile access from the Sterling Highway via a 0.6 mile gravel service road. Aircraft landing and outboard motors larger than 10 hp are prohibited by Refuge regulation.

Figure 1.

PETERSEN LAKE

(94 Acres)

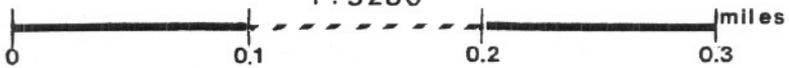


LEGEND

- Depth Contour (ft.) - 
- Stream Flow - 
- Access Road - 
- Island - 

SCALE

1 : 5280



River. It provides anadromous fish access to Petersen Lake as well as salmon spawning habitat. In turn the Moose River flows 9.2 miles southwest to a confluence with the Kenai River near Sterling. The lake bottom has large areas of 1 to 4-inch gravel with some cobble that appeared ideal habitat for sockeye salmon spawning.

Direct automobile access is provided to the lake by a 0.6 mile gravel road which connects to the Sterling Highway. Refuge regulations currently prohibit outboard motors larger than 10 horsepower and aircraft landing is not authorized.

FISH

Rainbow trout were the dominant game fish in the lake. They were found in moderate abundance in the May, July, and September surveys with respective catch per unit efforts (CPUE) of 0.43, 0.32, and 0.17 fish per net hour. Juvenile coho salmon ranged from a moderately high abundance (CPUE 0.86) in May to a moderate abundance (CPUE 0.25) in July. Longnose sucker ranged from moderately high abundance (CPUE 0.55) in May to a low abundance (CPUE 0.04) in September. In July, a seine was used to collect dimpling juvenile fish near the mouth of the outlet; 25 juvenile coho salmon were captured. During our September survey approximately 1,000 adult anadromous sockeye salmon were estimated to be in the lake resulting in a CPUE of 0.61 fish per net hour. About 10 percent of the sockeye observed were dead. All salmon were in full spawning color and examination of 55 specimens indicated they were mostly spawned out. A sockeye redd was located near the southeast inlet stream. During a later visit on October 26, only a few decomposed sockeye remnants remained. Threespine stickleback ranged from a high abundance of 6.01 fish per trap hour in July to a moderate abundance of 1.80 fish in September. One ninespine stickleback was trapped in our September survey. Species CPUE's for the three surveys are summarized in Tables 2, 3, and 4. A total of 4 gill nets and 12 minnow traps were used during each survey to measure fish abundance. A seine was used in July to capture additional juvenile salmon.

Rainbow trout ranged in fork length from 3.7 inches (95 mm) to 18.9 inches (480 mm) and in weight from 0.02 pound (9.6 g) to 2.9 pounds (1300 g) (Tables 5, 6, and 7). Their mean length was 12.6 inches (319 mm) and mean weight 1.0 pound (447 g). Their condition mean increased from 1.06 in May to 1.26 in July then decreased to 1.13 in September. Trout age varied from two to nine years (Table 8), and their average growth rate was 1.8 inches per year. Nearly all coho salmon were juvenile fish. Their fork length ranged from 1.5 inches (37 mm) to 9.7 inches (245 mm) and weight from 0.002 pound (0.7 g) to 0.4 pounds (160 g). Their mean fork length was 3.8 inches (96 mm) and mean weight 0.03 pounds (13 g). Condition means increased from 1.02 in May to 1.31 in July decreasing to 1.14 in September. A subsample of 11 coho showed them to be one and two years old and growing at an average rate of 1.9 inches per year. The longnose sucker ranged in fork length from 10.6 inches (270 mm) to 19.7 inches (500 mm) and in weight from 0.5 pounds (240 g) to 3.5 pounds (1575 g). Their mean fork length was 15.5 inches (394 mm) and mean weight 1.8 pounds (816 g). Mean condition varied little during the year being 1.27 in May, 1.23 in July, and 1.20 in September. Analysis of 10 sucker opercles indicated they ranged in age from five to 19 years (Table 9). The anadromous sockeye salmon ranged in fork length from 14.6 inches (370 mm) to 23.8 inches (605 mm). Sockeye scales were

FISH CATCH AND EFFORT SUMMARY
Petersen Lake 5/29-30/84

Table 2.

Gear	Average Fishing Time (hrs.)	Amount Gear (sq.ft.)	Fish Species	Total Fish Number	Sex M-F-U	Fish CPUE	
						Net Hour	Trap Hour
4 Gill Nets	14	3,200	Rainbow Trout	24	7-13-4	0.43	N/A
			Coho Salmon	48	0-0-48	0.86	N/A
			Longnose Sucker	31	14-8-9	0.55	N/A
			ALL Species	103	21-21-61	1.85	N/A
12 Minnow Traps	22	N/A	Coho Salmon	47	0-0-47	N/A	0.18
			Threespine Stickleback	1343	0-0-1343	N/A	5.09
			ALL Species	1390	0-0-1390	N/A	5.27

Table 3. FISH CATCH AND EFFORT SUMMARY
Petersen Lake 7/24-25/84

Gear	Average Fishing Time (hrs.)	Amount Gear (sq.ft.)	Fish Species	Total Fish Number	Sex M-F-U	Fish CPUE	
						Net Hour	Trap Hour
6 Gill Nets	14	4,800	Rainbow Trout	18	1-14-3	0.32	N/A
			Coho Salmon	14	0-0-14	0.25	N/A
			Longnose Sucker	12	1-1-10	0.21	N/A
			All Species	44	2-15-27	0.78	N/A
12 Minnow Traps	18	N/A	Threespine Stickleback	1298	0-0-1298	N/A	6.01
			Coho Salmon	8	0-0-8	N/A	0.04
			All Species	1306	0-0-1306	N/A	6.05

Table 4. FISH CATCH AND EFFORT SUMMARY
Petersen Lake 9/6-7/84

Gear	Average Fishing Time (hrs.)	Amount Gear (sq.ft.)	Fish Species	Total Fish Number	Sex M-F-U	Fish CPUE	
						Net Hour	Trap Hour
6 Gill Nets	15	4,800	Sockeye Salmon	55	16-7-32	0.61	N/A
			Rainbow Trout	15	4-6-5	0.17	N/A
			Coho Salmon	23	1-0-22	0.26	N/A
			Longnose Sucker	4	1-3-0	0.04	N/A
			All Species	97	22-16-59	1.08	N/A
12 Minnow Traps	20		Threespine Stickleback	432	0-0-432	N/A	1.80
			Ninespine Stickleback	1	0-0-1	N/A	<0.01
			Coho Salmon	39	0-0-39	N/A	0.16
			Rainbow Trout	1	0-0-1	N/A	<0.01
			All Species	473	0-0-473	N/A	1.97

Table 5.

FISH LENGTH, WEIGHT, AND CONDITION SUMMARY
Petersen Lake, 5/29-30/84

Gear	Category	Species	Sample Size	Mean	Standard Deviation	Range
Gill Nets	Fork Length (mm)	Rainbow Trout	21	311	55.2	225 - 395
		Coho Salmon	28	115	7.06	95 - 125
		Longnose Sucker	26	395	60.2	285 - 490
	Weight (g)	Rainbow Trout	21	351	186	110 - 660
		Coho Salmon	28	15.3	1.84	11.3 - 18.3
		Longnose Sucker	26	827	346	250 - 1575
	Condition (K)	Rainbow Trout	21	1.06	0.33	0.66 - 2.38
		Coho Salmon	28	1.02	0.31	0.71 - 1.34
		Longnose Sucker	26	1.27	0.15	1.08 - 1.88

Table 6.
FISH LENGTH, WEIGHT, AND CONDITION SUMMARY
Petersen Lake 7/24-25/85

Gear	Category	Species	Sample Size	Mean	Standard Deviation	Range
Gill Nets	Fork Length (mm)	Rainbow Trout	17	350	57.6	255 - 475
		Longnose Sucker	11	375	86.6	270 - 500
	Weight (g)	Rainbow Trout	17	582	290	210 - 1300
		Longnose Sucker	11	716	441	240 - 1540
	Condition (K)	Rainbow Trout	17	1.26	0.14	1.11 - 1.68
		Longnose Sucker	11	1.23	0.12	1.07 - 1.42
Seine	Fork Length (mm)	Coho Salmon	25	59.7	12.5	37 - 92
	Weight (g)	Coho Salmon	25	3.10	1.98	0.7 - 10.1
	Condition (K)	Coho Salmon	25	1.31	0.07	1.18 - 1.44

Table 7.
FISH LENGTH, WEIGHT, AND CONDITION SUMMARY
Petersen Lake 9/6-7/84

Gear	Category	Species	Sample Size	Mean	Standard Deviation	Range
Gill Nets	Fork Length (mm)	Rainbow Trout	13	292	121	95 - 480
		Coho Salmon	18	117	32.5	95 - 245
		Longnose Sucker	4	440	21.2	420 - 465
	Weight (g)	Rainbow Trout	13	425	420	9.60 - 1260
		Coho Salmon	18	23.0	34.3	8.10 - 160
		Longnose Sucker	4	1020	110	900 - 1140
	Condition (K)	Rainbow Trout	13	1.13	0.11	0.91 - 1.37
		Coho Salmon	18	1.14	0.17	0.93 - 1.65
		Longnose Sucker	4	1.20	0.05	1.13 - 1.25

Table 8.

BACK-CALCULATED FORK LENGTHS (MILLIMETERS) AT ANNULUS FORMATION*
of Rainbow Trout in Petersen Lake - 1984

Year Class	Number of Fish	Age of Fish											Capture FL			
		1	2	3	4	5	6	7	8	9	10	11		12		
1982	1	44	91													120
1980	4	50	93	147	197											238
1979	3	41	84	136	190	242										268
1978	4	39	72	118	167	217	259									296
1977	6	32	73	118	165	217	270	331								366
1976	6	30	64	104	153	207	269	328	379							423
1975	1	25	50	83	124	186	248	310	372	434						475
Number of Fish	25	25	25	24	24	20	17	13	7	1						
Grand Mean (mm)		36	75	120	169	216	266	328	378	434						
Grand Mean (in)		1.4	3.0	4.7	6.7	8.5	10.5	12.9	14.9	17.1						
Annual Growth Increment (in)		1.4	1.5	1.8	1.9	1.9	2.0	2.5	2.0	2.2						

*Not corrected for length at scale formation

Table 9.

AGE-LENGTH OF LONGNOSE SUCKER
Petersen Lake - 1984

Fish Age (years)	Sample Size (no)	Fork Length		Range (mm)
		-----Mean----- (in)	(mm)	
5	1	12.8	325	-
7	1	14.6	370	-
8	1	12.2	310	-
13	1	17.7	450	-
14	1	16.5	420	-
15	1	17.7	450	-
16	1	17.7	450	-
18	1	19.3	490	-
19	2	19.5	495	490 - 500

reabsorbed to a point accurate age determination was impossible, except that we were able to see one and two freshwater annuli and up to two ocean annuli.

AQUATIC VEGETATION

Aquatic vegetation in the lake was sparse and largely confined to areas near the eastern shore. Yellow pond lily and the pondweed, Potamogeton friesli were the dominant aquatic plants. No wetlands or bogs were present. Approximately 6 percent of the lake area was covered with aquatic vegetation. A complete list of vegetation is in Table 10.

WATER QUALITY

The lake's alkalinity level of 67 mg/l was almost twice as high as the average found in the 37 lakes surveyed during 1983-84. This value fits a medium productivity level using our modification of Moyle's lake productivity classification (MacKenthun and Ingram 1967). The pH of 7.7 was among the more alkaline found in the study. During July, the lake was thermally stratified (Table 11). Surface water temperature was 16.1°C and remained fairly constant down to 20 feet at 15°C. A thermocline was present at about 26 feet. Water temperature stabilized in a shallow hypolimnion at 8.0°C. Corresponding dissolved oxygen concentrations were supersaturated on the surface (10.8 mg/l) down to 20 feet (10.9 mg/l) and 97 percent saturated at 26 feet (10.3 mg/l). In the lower 12 feet of the lake dissolved oxygen was less than 1 percent saturated (0.2 mg/l), a condition lethal to fish. Most of the lake had high dissolved oxygen values for cold water game species. Temperature and dissolved oxygen profiles for June and September are shown in Tables 12 and 13.

Water color was medium green and Secchi disc transparency 15 feet. The lake had a Morphoedaphic Index of 24.2 and a Shoreline Development Factor, including the lake island, of 1.29.

MANAGEMENT HISTORY

Personnel of the Alaska Department of Fish and Game (ADF&G) first surveyed the lake in July, 1960. A total of 27 rainbow trout and 9 longnose sucker were captured in two days of gill netting for respective CPUE's of 0.19 and 0.06 fish per net hour (Kubik and Reynolds 1960). The length range of the rainbow trout was 7.0 inches (178 mm) to 18.3 inches (465 mm) and weight from 0.1 pound (45 g) to 2.5 pounds (1135 g). They also indicated the presence of stickleback. Their method of length measurement was not indicated. The Fish and Wildlife Service (FWS) surveyed the lake in July, 1974 (Bailey 1974). A total of 35 rainbow trout were captured (CPUE 0.73) and 33 longnose sucker (CPUE 0.69). The fork length range for the trout was 6.9 inches (175 mm) to 18.3 inches (465 mm) and weight from 0.1 pound (57 g) to 2.6 pounds (1162 g). Their mean length was 11.0 inches (280 mm) and mean weight 0.7 pound (305 g). Longnose sucker ranged in fork length from 8.7 inches (220 mm) to 18.3 inches (465 mm) and weight from 0.3 pound (113 g) to 2.6 pounds (1191 g). Their mean fork length was 15.8 inches (401 mm) and mean weight 1.8 pounds (813 g). Bailey and Nelson (1974), in an October 8 memo to the Kenai NMR Manager, stated the Petersen Lake fishery was in excellent condition and that the size range of trout indicated spawning was taking place in the lake and/or associated streams.

Table 10.

VEGETATION
Petersen Lake 9/6-7/84

AQUATIC VEGETATION

Class	Common Name	Scientific Name
Emergent	horsetail	<u>Equisetum fluviatile</u>
	mare's tail	<u>Hippuris vulgaris</u>
Floating	bur reed	<u>Sparganium angustifolium</u>
	yellow pond lily	<u>Nuphar polysepalum</u>
Submergent	pondweed	<u>Potamogeton friesii</u>
	pondweed	<u>Potamogeton praelongus</u>
	water milfoil	<u>Myriophyllum spicatum</u>

TERRESTRIAL VEGETATION

Class	Common Name	Scientific Name
Trees	alder	<u>Alnus sp.</u>
	black spruce	<u>Picea mariana</u>
	paper birch	<u>Betula papyrifera</u>
	white spruce	<u>Picea glauca</u>
Below Shrub	grass	<u>Gramineae</u>

WILDLIFE

During the three survey periods a variety of wildlife species were seen or heard (Table 14). Waterfowl included common loons, common mergansers, a northern pintail, and white-winged scoters. There were also 17 species of passerines, 4 species of shorebirds, and 4 species of gulls and terns. Bald eagles were seen flying around the lake on two occasions. No beaver lodge was present on the lake, but vegetative cuttings indicated beaver in nearby streams or lakes had visited the lake. The presence of muskrat was indicated by clam shell feeding areas.

RECREATIONAL USE

Petersen Lake is a popular camping area during the summer. Many visitors camp at the lake while enjoying other parts of the refuge. Fishing, wildlife viewing, and boating are also popular. During the July and September surveys there were from three to five campers in the parking area every day. Conversations with anglers indicated they could harvest up to one trout per hour during good fishing. They also indicated that they caught more medium sized trout than large ones.

Public recreation facilities on the lake include multiple fire pits and picnic tables around a large common parking lot. A water well, gravel boat ramp, bulletin board, and pit toilet are also present.

FISHERY RESOURCE SUMMARY

Rainbow trout were the dominant game fish in Petersen Lake. During our three surveys we found moderate trout CPUE's of 0.43, 0.32, and 0.17 fish per net hour. The variety of trout sizes and age classes indicates successful spawning and recruitment is occurring. The 1960 ADF&G and 1974 FWS surveys found moderate to moderately high trout abundances suggesting the long term presence of a healthy rainbow trout population.

Juvenile coho salmon ranged from a high abundance (CPUE 0.86) to a moderate abundance (CPUE 0.25) confirming the lake as a coho nursery area. The lake also affords spawning habitat for anadromous sockeye salmon and is suspected of serving as a nursery area for the juveniles, even though we failed to capture any young sockeye. Longnose sucker populations ranged from moderately high (CPUE 0.55) to low (CPUE 0.04). Threespine stickleback and ninespine stickleback constitute the forage species.

Fishing pressure on the lake is believed to be moderate, partly as a result of its popularity as a camping area. The lake is medium in fertility and had a MEI of 24.2. Dissolved oxygen values were high for cold water game fish except in the deepest parts of the lake. The inlet streams provide medium to low quality rainbow trout spawning habitat plus access to Kelly Lake. The outlet stream provides a migration route for anadromous fish and is high quality rainbow trout spawning habitat. The outlet stream plays a key role in maintaining the rainbow trout population. Based on our findings we believe Petersen Lake can support a moderate yield rainbow trout sport fishery. It also serves as a spawning area and possibly a nursery area for sockeye salmon,

Table 14.

WILDLIFE DATA
Petersen Lake
5/29-30/84, 7/24-25/84, 9/6-7/84

Animal Class	Common Name	Number	Sex M-F-U	Animal Assoc.	Verification	Habitat Type
Birds						
Waterfowl	common loon	12	2-2-8	Pair/Flock	Sight	Water
	common merganser	12	-	Brood	Sight	Water
	northern pintail	1	0-1-0	Nest	Sight	-
	white-winged scoter	3	-	Flock	Sight	Water
Passerines	American robin	S	-	-	-	-
	blackpoll warbler	1	-	-	Sound	-
	Bohemian waxwing	5	-	Flock	Sight	Trees
	common raven	1	-	-	Sound	-
	common redpoll	M	-	Flock	Sight	-
	gray jay	6	-	Single	Sight	Trees
	gray-cheeked thrush	2	-	-	Sound	-
	junco	M	-	-	Sight	-
	olive-sided flycatcher	1	-	Single	Sound	-
	orange-crowned warbler	2	-	-	Sound	-
	pine grosbeak	3	1-2-0	Single	Sight	-
	ruby-crowned kinglet	M	-	-	Sound	-
	rusty blackbird	S	-	-	Sound	-
	tree swallow	M	-	-	Sight	-
	white-crowned sparrow	M	-	-	Sight	-
Wilson's warbler	2	-	-	Sight	-	
yellow-rumped warbler	1	-	-	Sound	-	
Shorebirds	common snipe	1	-	-	-	-
	lesser yellowlegs	11	-	Single	Sight	Shore
	sandpiper	2	-	Single	Sight	Shore
	yellowlegs	6	-	-	Sight	Shore
Gulls/Terns	Arctic tern	4	-	Pair	Sight	Shore
	Bonaparte's gull	2	1-1-0	Pair	Sight	Island
	gull	3	-	Single	Sight	Water
	mew gull	2	1-1-0	Pair	Sight	-
Raptors	bald eagle	2	-	Single	Sight	Shore
Mammals						
Big Game	black bear	-	-	-	Feces	-
	moose	-	-	-	Feces	-
Furbearers	beaver	-	-	-	Cuttings	-
	muskrat	-	-	-	Clam Shells	-
Other	snowshoe hare	-	-	-	Sight	-

J=Juveniles; J+=Includes Juveniles; M=Many; S=Several

and as a nursery area for coho salmon. In years when rainbow trout recruitment and survival is particularly successful, the trout classification would be higher.

PORTAGE LAKE

SURVEY PERIOD

Personnel of the U.S. Fish and Wildlife Service surveyed Portage Lake twice during 1984. J.W. Friedersdorff and A.S. Firman conducted a fishery survey on June 21-22. Additional water quality data were gathered by G.A. Muhlberg and A.S. Firman on July 19. Table 1 summarizes survey findings.

PHYSICAL FEATURES

Portage Lake is located in the northcentral section of the Kenai National Wildlife Refuge (NWR) and is in the Swanson River Basin. It's latitude is north 60° 43' and longitude west 150° 32'. The lake and surrounding area were designated as wilderness by the Alaska National Interest Lands Conservation Act of 1980. The watershed for the lake is estimated to be 0.2 square miles in area. Portage Lake has a surface area of 28 acres, a volume of 754 acre feet, and is at an elevation of 255 feet. The lake has a mean depth of 27 feet and maximum depth of 52 feet (Table 1 and Figure 1).

Lake topography is characterized by low rolling hills and a ridge along the lake's west side composed of hills and the Swan Lake Road berm. Terrestrial vegetation surrounding the lake consists mostly of regrowth immature paper birch and white spruce resulting from the 1947 refuge fire. A small stand of mature white spruce and birch are located centrally along the lake's west bank. Two small bogs are located adjacent to the northern and southwestern parts of the lake.

Lake water level is maintained by springs and run-off. No tributary streams are present and the lake is landlocked. Our findings contradict those of Strickland and Bernhardson (1964) who reported a small intermittent outlet stream at the lake's southwest end. Bob Richey, Assistant Refuge Manager of the Kenai NWR, stated Swan Lake Road was constructed in 1960-61 and confirmed that no culvert is currently present to allow Portage Lake to drain west under the road. There may have been a small culvert in 1964 to allow drainage which has since been covered up. A large portion of the lake substrate is covered with silt; a few areas of clean gravel to rubble were present in shoal areas.

Swan Lake Road, located adjacent to the lake's southwest end, and a short gravel drive provide direct access to the lake. Airplanes are currently restricted from landing on the lake and outboard motors are prohibited.

FISH

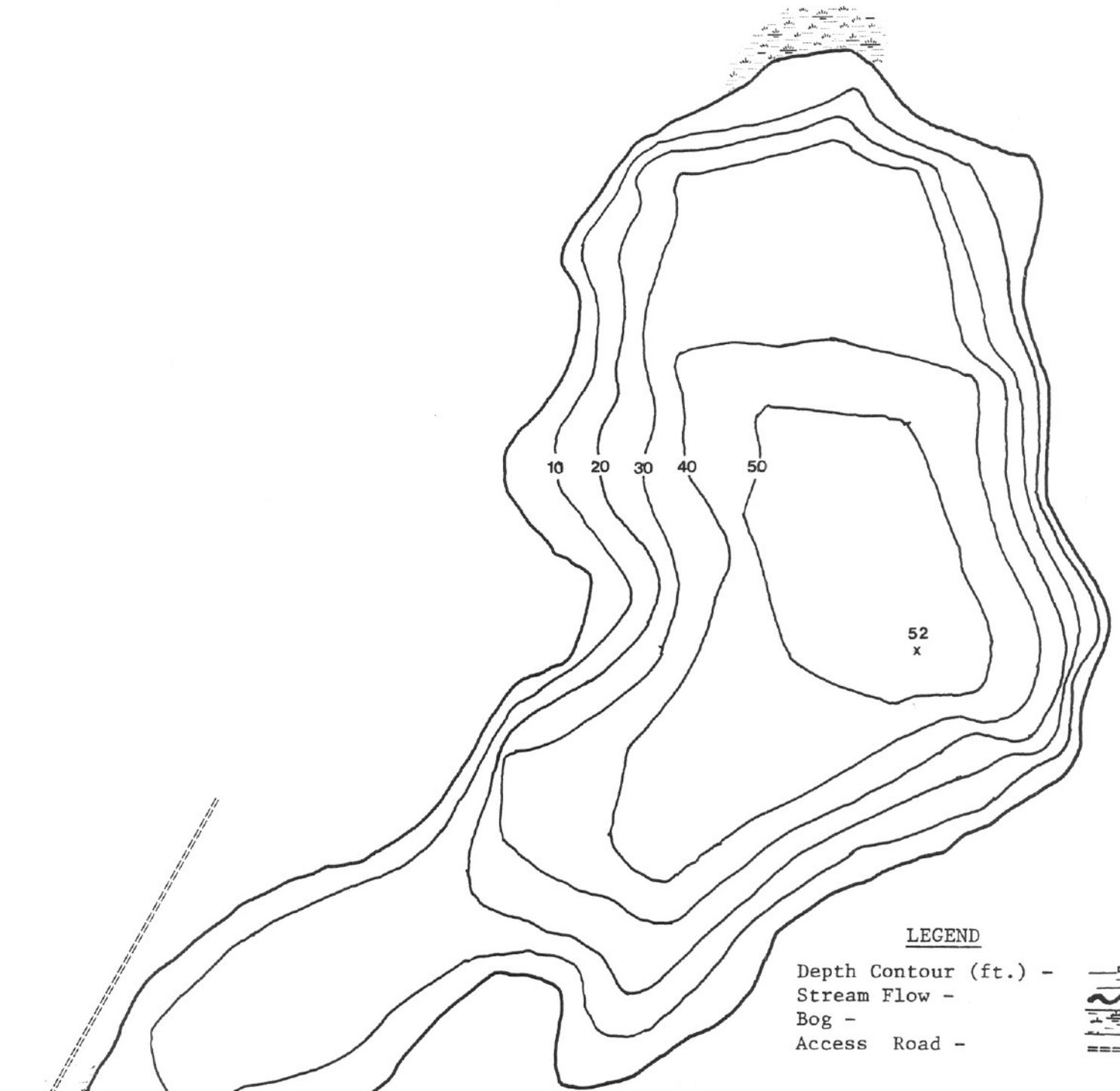
Only two coho salmon, stocked by the Alaska Department of Fish and Game (ADF&G), were captured in the lake. Their abundance was low at a catch per unit effort (CPUE) of 0.07 fish per net hour (Table 2). Threespine stickleback were high in abundance (CPUE 3.19). Two gill nets and 10 minnow traps were used to determine fish abundance.

The two coho salmon were 9.3 inches (235 mm) and 9.7 inches (245 mm) fork length with respective weights of 0.3 pounds (130 g) and 0.4 pounds (160 g).

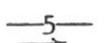
Figure 1.

PORTAGE LAKE

(28 acres)



LEGEND

- Depth Contour (ft.) - 
- Stream Flow - 
- Bog - 
- Access Road - 

SCALE
1 : 2640

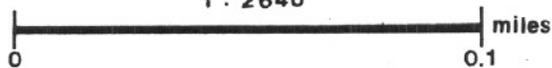


Table 2. FISH CATCH AND EFFORT SUMMARY
Portage Lake 6/21-22/84

Gear	Average Fishing Time (hrs.)	Amount Gear (sq. ft.)	Fish Species	Total Fish Number	Sex M-F-U	Fish CPUE	
						Net Hour	Trap Hour
2 Gill Nets	15	1,600	Coho Salmon ^{1/}	2	0-0-2	0.07	N/A
10 Minnow Traps	16	N/A	Threespine Stickleback	511	0-0-511	N/A	3.19

^{1/} Stocked by ADF&G

Condition factors were 0.92 and 1.09. Both fish were two years old. Their average annual growth rate was 3.9 inches per year.

AQUATIC VEGETATION

Aquatic plants were extremely spotty in the lake with only three percent of the water area covered with vegetation. Yellow pond lily and horsetail were the most abundant species. Sweet gale shrubs were present along most of the shoreline. Two small wetland areas adjacent to the lake identified during the survey were not plotted by the National Wetlands Inventory. A complete list of vegetation identified is in Table 3.

WATER QUALITY

The alkalinity level of Portage Lake was 3 mg/l which is the lowest for the 37 lakes surveyed during 1983-84. Productivity of the lake is low according to our modification of Moyle's classification based on alkalinity level (MacKenthun and Ingram 1967). The pH of 6.7 was slightly acidic. During July, the lake was thermally stratified with the thermocline occurring around 20 feet. Dissolved oxygen concentrations (Table 5) ranged from slight supersaturation in the epilimnion to 76 percent saturation (8.9 mg/l) near the lake bottom.

Water color was blue green, and Secchi disc transparency was 26 feet. The lake had a Morphoedaphic Index of 2.9 and Shoreline Development Factor of 1.48. Additional water quality data are in Table 4.

MANAGEMENT HISTORY

Portage Lake was first surveyed by the ADF&G in June, 1964 (Strickland and Bernhardson 1964). Threespine stickleback were the only fish they reported in the lake. In 1966, the State began a fish stocking program. Fry numbers and species stocked to date are: 1966 sockeye salmon (18,670); 1967 sockeye salmon (10,950); 1973 coho salmon (8,300); 1975 coho salmon (6,900); 1977 coho salmon (5,600); 1979 coho salmon (5,000); 1982 coho salmon (5,000); and 1984 chinook salmon (6,000). Fry in 1982 were stocked at a size of 284/pound and 1984 230/pound. Dave Nelson, Fishery Biologist with the ADF&G, said the latest coho salmon fish plant was of Seward origin while the chinook salmon plant was of Crooked Creek origin. Yearly test netting since 1977 by State personnel has yielded moderately high to high catches of salmon with CPUE's ranging from 0.74 to 2.64 stocked fish per hour.

WILDLIFE

A pair of common loons were observed on the lake along with one glaucous gull (this bird may have been a glaucous-winged gull). Wildlife species identified along with other pertinent data are in Table 6.

RECREATIONAL USE

Recreational uses of Portage Lake include canoeing, fishing, wildlife viewing, camping, and hunting. The lake is one of two launch points for the Swan Lake

Table 3.

VEGETATION
Portage Lake 6/21-22/84

AQUATIC VEGETATION

Class	Common Name	Scientific Name
Emergent	horsetail	<u>Equisetum fluviatile</u>
	mare's tail	<u>Hippuris vulgaris</u>
Floating	bur reed	<u>Sparganium minimum</u>
	dwarf water lily	<u>Nymphaea tetragona</u>
	yellow pond lily	<u>Nuphar polysepalum</u>
Submergent	crowfoot	<u>Ranunculus confervoides</u>
	pondweed	<u>Potamogeton gramineus</u>
	quillwort	<u>Isoetes muricata</u>

TERRESTRIAL VEGETATION

Class	Common Name	Scientific Name
Trees	alder	<u>Alnus sp.</u>
	black spruce	<u>Picea mariana</u>
	paper birch	<u>Betula papyrifera</u>
	white spruce	<u>Picea glauca</u>
Shrub	sweet gale	<u>Myrica gale</u>
Below Shrub	buck bean	<u>Menyanthes trifoliata</u>
	grass	<u>Gramineae</u>
	marsh fivefinger	<u>Potentilla palustris</u>

Table 6.

WILDLIFE DATA
Portage Lake 6/21-22/84

Animal Class	Common Name	Number	Sex M-F-U	Animal Assoc.	Verification	Habitat Type
Birds						
Waterfowl	common loon	2	1-1-0	Pair	Sight	Water
Passerines	gray jay	1	-	Single	Sight	Trees
	tree swallow	3	-	Single	Sight	Trees
	white-crowned sparrow	1	-	Single	Sight	Trees
Gulls/Terns	glaucous gull	1	-	Single	Sight	Trees
Mammals						
Big Game	moose	-	-	-	Feces	-
Other	red squirrel	-	-	-	Cuttings	-
	snowshoe hare	-	-	-	Cuttings	-

Canoe Route, part of the National Recreation Trail System. Mike Boylan, Outdoor Recreation Planner, Kenai NWR, stated that during the summer and fall over 2,000 boaters are estimated to use the lake. During our two day mid-June fishery survey we saw only two canoes crossing the lake and none of the canoeists were fishing. No current data is available on sport fishing use.

A short gravel access drive, boat ramp, sign-in box, bulletin board, limited parking, and the canoe trail constitute the public use recreational facilities for the lake.

FISHERY RESOURCE SUMMARY

Portage Lake contained no game fish prior to the ADF&G stocking program in 1966. A salmon sport fishery was developed as a result of the State's management effort. The lake is landlocked and has no tributary streams to support rainbow trout spawning. Water fertility was extremely low while dissolved oxygen levels were optimum for cold water fish species. Portage Lake has potential to provide a low yield stocked salmon fishery if the current management practices are continued. If management is discontinued, the lake will revert to a threespine stickleback population having a negligible yield sport fish value.

RAINBOW LAKE

SURVEY PERIOD

Personnel of the U.S. Fish and Wildlife Service conducted three fish surveys and one detailed water quality survey on Rainbow Lake during 1984. Fish surveys were on June 13-14 by J.W. Friedersdorff and W.J. Jakubas, on July 26-27 by W.J. Jakubas and A.S. Firman, and on September 13-14 by A.S. Firman and G.A. Muhlberg. Detailed water quality data were gathered by W.J. Jakubas and A.S. Firman on July 26. Table 1 summarizes survey findings.

PREVIOUS STUDIES

Rainbow Lake was a control lake during the Remote and Roadside Lake Study and was surveyed three times in 1983. The lake's fish abundance, water quality, physical features, aquatic vegetation, management history, and recreational uses for the 1983 field season were described by Friedersdorff and Jakubas (1984).

PHYSICAL FEATURES

Both the intermittent inlet stream on the southeast side of the lake and the permanent flow outlet stream on the lake's west side were observed for flow in the June survey. The inlet stream flow was estimated to be 0.1 cubic feet per second (cfs) and the outlet stream 0.5 cfs.

FISH

Rainbow trout were the only game fish in Rainbow Lake during 1984. Their relative abundance was moderate during all three fish surveys. Catch per unit effort (CPUE) was 0.45 fish per net hour in June, CPUE 0.44 in July, and CPUE 0.35 in September (Tables 2, 3, and 4). Threespine stickleback were the only forage fish taken at CPUE's of 2.88, 1.32, and 6.50 fish per trap hour for June, July, and September respectively. A total of six gill nets and 14 minnow traps were used during each survey to measure fish abundance.

Rainbow trout ranged in fork length from 8.5 inches (215 mm) to 20.9 inches (530 mm) and in weight from 0.2 pounds (110 g) to 3.0 pounds (1340 g). Their mean length was 12.2 inches (310 mm) and mean weight 0.9 pounds (409 g). Trout condition factors gradually increased through the sampling season from 1.15 in June to 1.16 in July and 1.38 in September (Table 5). Scale analysis showed trout age to vary from four to 11 years (Table 6). Their average growth rate was 1.9 inches per year.

WATER QUALITY

The lake's alkalinity level of 18 mg/l was less than half the average found in the 37 lakes surveyed during 1983-84. This value fits the low productivity category using our modification of Moyle's lake productivity classification (MacKenthun and Ingram 1967). The pH of 7.2 was slightly alkaline. In July the lake was not thermally stratified, however, it showed a gradual decline in water temperature from 17.1°C at the surface to 16.2°C near the bottom (Table

Table 2.

FISH CATCH AND EFFORT SUMMARY
Rainbow Lake 6/13-14/84

Gear	Average Fishing Time (hrs.)	Amount Gear (sq. ft.)	Fish Species	Total Fish Number	Sex M-F-U	Fish CPUE	
						Net Hour	Trap Hour
6 Gill Nets	14	4,800	Rainbow Trout	38	8-19-11	0.45	N/A
14 Minnow Traps	16	N/A	Threespine Stickleback	645	0-0-645	N/A	2.88

Table 3.

FISH CATCH AND EFFORT SUMMARY
Rainbow Lake 7/26-27/84

Gear	Average Fishing Time (hrs.)	Amount Gear (sq.ft.)	Fish Species	Total Fish Number	Sex M-F-U	Fish CPUE	
						Net Hour	Trap Hour
6 Gill Nets	13	4,800	Rainbow Trout	34	10-19-5	0.44	N/A
14 Minnow Traps	16		Threespine Stickleback	295	0-0-295	N/A	1.32

Table 4. FISH CATCH AND EFFORT SUMMARY
Rainbow Lake 9/13-14/84

Gear	Average Fishing Time (hrs.)	Amount Gear (sq.ft.)	Fish Species	Total Fish Number	Sex M-F-U	Fish CPUE	
						Net Hour	Trap Hour
6 Gill Nets	16	4,800	Rainbow Trout	34	18-9-7	0.35	N/A
14 Minnow Traps	20	N/A	Threespine Stickleback	1819	0-0-1819	N/A	6.50

Table 5.
FISH LENGTH, WEIGHT, AND CONDITION SUMMARY
Rainbow Lake

Gear	Category	Species	Sample Size	Mean	Standard Deviation	Range
Gill Nets	<u>6/13-14/84</u>					
	Fork Length (mm)	Rainbow Trout	33	313	66.0	230 - 455
	Weight (g)	Rainbow Trout	33	396	266	130 - 1110
	Condition (K)	Rainbow Trout	33	1.15	0.12	0.86 - 1.54
Gill Nets	<u>7/26-27/84</u>					
	Fork Length (mm)	Rainbow Trout	31	304	68.2	220 - 530
	Weight (g)	Rainbow Trout	31	372	300	110 - 1340
	Condition (K)	Rainbow Trout	31	1.16	0.10	0.90 - 1.34
Gill Nets	<u>9/13-14/84</u>					
	Fork Length (mm)	Rainbow Trout	26	313	67.6	215 - 510
	Weight (g)	Rainbow Trout	26	471	318	140 - 1325
	Condition (K)	Rainbow Trout	26	1.38	0.13	1.00 - 1.64

Table 6.

BACK-CALCULATED FORK LENGTHS (MILLIMETERS) AT ANNULUS FORMATION*
of Rainbow Trout in Rainbow Lake - 1984

Year Class	Number of Fish	Age of Fish												Capture FL	
		1	2	3	4	5	6	7	8	9	10	11	12		
1980	4	30	83	133	187										225
1979	5	32	73	116	169	229									265
1978	7	36	78	129	179	236	289								319
1977	3	38	76	126	183	233	290	343							377
1976	1	46	87	133	189	235	291	358	409						450
1975	4	42	82	118	160	208	256	312	374	426					463
1973	1	37	70	102	149	191	237	284	349	414	470	516			530
Number of Fish	25	25	25	25	25	21	16	9	6	5	1	1			
Grand Mean (mm)		36	78	124	175	226	260	324	376	424	470	516			
Grand Mean (in)		1.4	3.1	4.9	6.9	8.9	10.2	12.8	14.8	16.7	18.5	20.3			
Annual Growth Increment (in)		1.4	1.7	1.8	2.0	2.0	1.3	2.5	2.0	1.9	1.8	1.8			

*Not corrected for length at scale formation

7). Corresponding dissolved oxygen values were slightly supersaturated (10.0 mg/l) at the surface down to 10 feet, then slowly decreased to 79 percent saturation (7.8 mg/l) near the bottom. Overall dissolved oxygen concentrations were high for cold water game fish. Temperature and dissolved oxygen profiles for the June and September surveys are in Tables 8 and 9.

Water color was dark yellow green and Secchi disc transparency 7 feet. The lake had a Morphoedaphic Index of 18.9.

FISHERY RESOURCE SUMMARY

Rainbow trout are the dominant game fish in Rainbow Lake. During our three 1984 surveys the lake had a moderate population of trout with CPUE's of 0.45, 0.44, and 0.35 fish per net hour. The variety of trout sizes and ages indicates that successful spawning and recruitment is occurring. Fish surveys by the FWS in 1983 also found moderate rainbow trout abundances. Threespine stickleback with moderate to high abundances (CPUE 1.32-6.50) were the only forage species in the lake.

The lake is low in fertility and had an MEI of 18.9. Dissolved oxygen values were high throughout the lake. The outlet stream and Swanson River appear to be the spawning area for the lake's rainbow trout population. Access to these waters is believed a key factor in maintaining the lake's rainbow trout population. Based on our findings in 1983 and 1984, Rainbow Lake can support a moderate yield rainbow trout sport fishery.

SANDPIPER LAKE

SURVEY PERIOD

Personnel of the U.S. Fish and Wildlife Service surveyed Sandpiper Lake twice during 1984. W.J. Jakubas and A.S. Firman conducted a fishery survey on July 2-3. Detailed water quality data were gathered by J.W. Friedersdorff and W.J. Jakubas on July 17. Table 1 summarizes survey findings.

PHYSICAL FEATURES

Sandpiper Lake is located near the northern end of the Kenai National Wildlife Refuge (NWR) in the Miller Creek Watershed. Its latitude is north 61° 00' and longitude west 150° 24'. The northern tip of the lake is outside the refuge boundary while the remainder of the lake and surrounding area are within the refuge. The refuge area was designated as wilderness by the Alaska National Interest Lands Conservation Act of 1980. The watershed area for the lake is estimated to be 1.8 square miles. Sandpiper Lake has a surface area of 72 acres, a volume of 1,300 acre feet, and is at an estimated elevation of 115 feet.

The lake is situated in a low valley sloping gently to the south with low hills rising to over 150 feet on the east and west sides. A dense forest of mature white spruce and paper birch covers the hills down to the lake with scattered alder along the shoreline. A small bog is at the north end of the lake and a larger one at the southern end.

Lake water level is maintained by streams, springs, and run-off. A small inlet stream on the southeast side of the lake was about 3 feet wide and 0.3 feet deep, with an estimated flow of 0.1 cubic feet per second. Aerial photos indicate this stream is fed from Cook Lake about 1 mile to the east. The photos also indicate that a small lake about 0.2 miles to the west and one about 0.4 miles north have floodways that intersect the bog on the lake's north end. The inlet stream did not appear to be rainbow trout spawning habitat. The outlet stream, on the southwest side of the lake, was completely blocked with vegetation and had no perceptible flow. From the ground its stream channel was not well defined, however, aerial photos indicated a definite stream channel about 0.25 miles long through an unnamed lake to Vogel Lake. In turn, Vogel Lake forms the headwaters of Miller Creek which flows 3.8 miles to Cook Inlet. The outlet stream, in the vicinity of the lake, was not considered rainbow trout spawning habitat.

Sandpiper Lake is remote and difficult to reach. Aircraft is the most convenient means of access. Outboard motors larger than 10 horsepower are not permitted on the refuge portion of the lake by Refuge regulation.

FISH

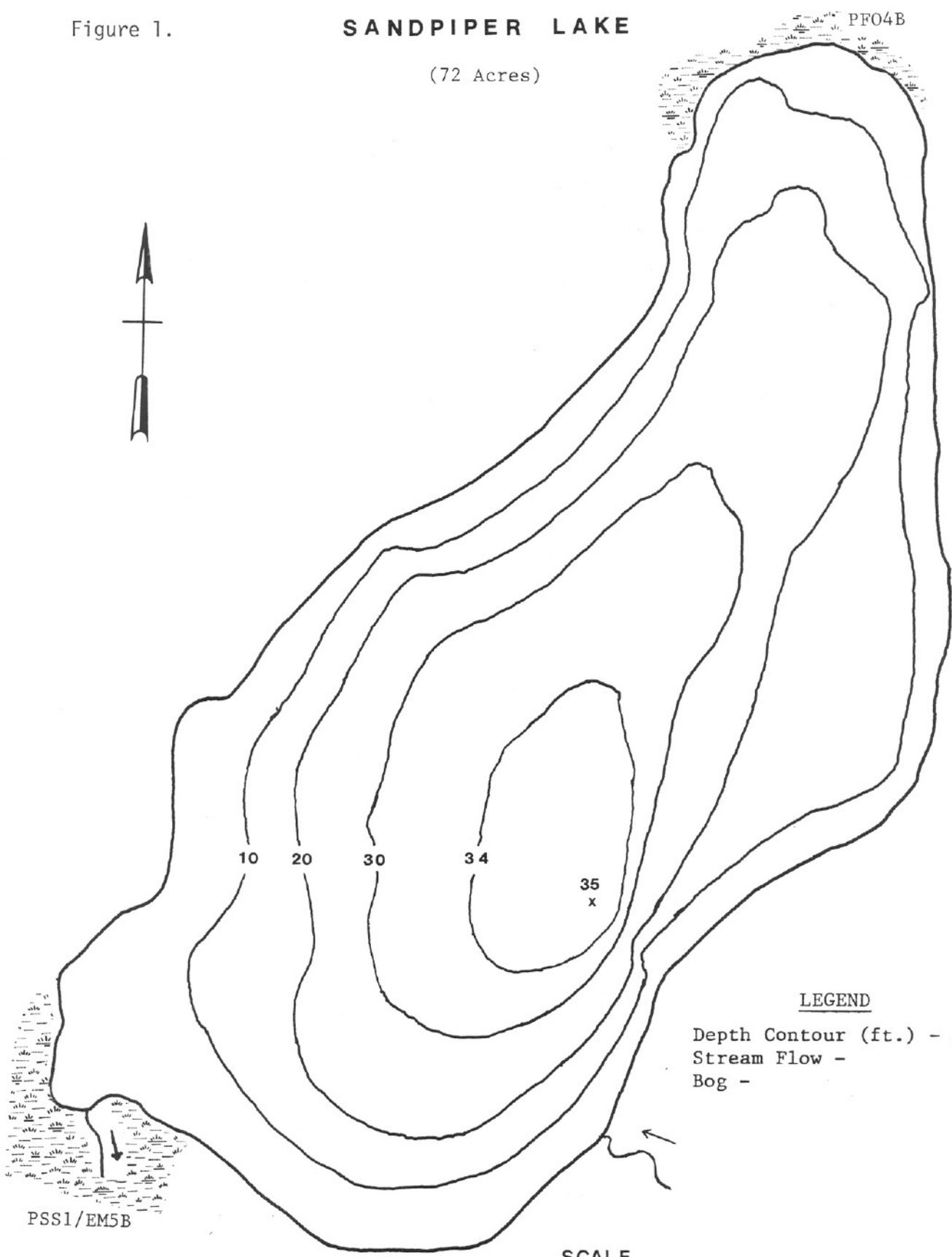
Rainbow trout were the only game fish in the lake. They were found to be in moderately high abundance at a catch per unit effort (CPUE) of 0.63 fish per net hour (Table 2). Threespine stickleback were in moderately high abundance

Figure 1.

SANDPIPER LAKE

(72 Acres)

PFO4B



PSS1/EMS B

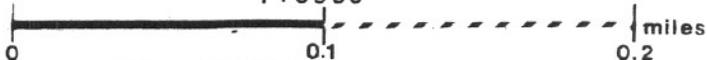
LEGEND

Depth Contour (ft.) -
Stream Flow -
Bog -



SCALE

1 : 3960



208

Table 2. FISH CATCH AND EFFORT SUMMARY
Sandpiper Lake 7/2-3/84

Gear	Average Fishing Time (hrs.)	Amount Gear (sq.ft.)	Fish Species	Total Fish Number	Sex M-F-U	Fish CPUE	
						Net Hour	Trap Hour
2 Gill Nets	15	1,600	Rainbow Trout	19	4-13-2	0.63	N/A
10 Minnow Traps	17	N/A	Threespine Stickleback	481	0-0-481	N/A	2.82

at a CPUE of 2.82 fish per trap hour. A total of two gill nets and 10 minnow traps were used to determine fish abundance.

Rainbow trout ranged in fork length from 8.7 inches (220 mm) to 15.8 inches (400 mm). Their weights were 0.3 pounds (130 g) to 1.7 pounds (770 g). Trout condition factors varied from 0.99 to 1.27 (Table 3). Analysis of scales indicated the rainbow trout ranged in age from five to nine years (Table 4). Their average growth rate was 1.7 inches per year.

AQUATIC VEGETATION

Aquatic vegetation was moderate in abundance and largely confined to shallow water areas near the lake's shoreline. Yellow pond lily; the pondweeds, Potamogeton natans, P. zosterifolius, and P. robbinsii; water milfoil, and bulrush were the dominant species. About 28 percent of the lake area was covered with aquatic plants. Three wetland bogs were present. Two of them (wetland types PF04B and PSS1/EM5B) were plotted by the National Wetlands Inventory (USFWS 1978). A complete list of vegetation is in Table 5.

WATER QUALITY

The lake's alkalinity level of 38 mg/l was nearly equal to the average 39 mg/l found in the 37 lakes we surveyed during 1983-84. Lake waters were medium in productivity using our modification of Moyle's classification (MacKenthun and Ingram 1967). The lake's pH of 7.2 was near neutral. During July, lake water was thermally stratified (Table 6). Surface water temperature was 17.8°C and remained near this value down to 16 feet where the thermocline began. A relatively shallow hypolimnion was present at about 30 feet having a temperature of approximately 7.3°C. Corresponding dissolved oxygen values were around 95 percent saturated (9.2 mg/l) from the surface to 16 feet. At 20 feet there was a band of fully saturated water (10.9 mg/l), then dissolved oxygen declined to 19 percent saturation (2.6 mg/l) near the bottom. Most of the lake had high dissolved oxygen values for cold water game fish. Dissolved oxygen values at the time of the fish survey are in Table 7.

Water color was yellow green and Secchi disc transparency 16 feet. The lake had a Morphoedaphic Index of 18.7 and Shoreline Development Factor of 1.28.

MANAGEMENT HISTORY

There are no previous fishery surveys of Sandpiper Lake.

WILDLIFE

Waterfowl sighted on the lake included common loon, lesser scaup, and mallard. Common snipe was the only shorebird seen. Three beaver lodges were on the lake, and one beaver was sighted swimming. Wildlife species along with pertinent data are in Table 8.

RECREATIONAL USE

Recreational uses of Sandpiper Lake include fishing, camping, and wildlife viewing. Rusts Flying Service has been issued a Refuge Special Use Permit allowing them to establish a tent camp and fly in clients for fishing and

Table 3.

FISH LENGTH, WEIGHT, AND CONDITION SUMMARY
 Sandpiper Lake 7/2-3/84

Gear	Category	Species	Sample Size	Mean	Standard Deviation	Range
Gill Nets	Fork Length (mm)	Rainbow Trout	18	309	57.0	220 - 400
	Weight (g)	Rainbow Trout	18	354	219	130 - 770
	Condition (K)	Rainbow Trout	18	1.12	0.06	0.99 - 1.27

Table 4.

BACK-CALCULATED FORK LENGTHS (MILLIMETERS) AT ANNULUS FORMATION*
of Rainbow Trout in Sandpiper Lake - 1984

Year Class	Number of Fish	Age of Fish											Capture FL		
		1	2	3	4	5	6	7	8	9	10	11		12	
1979	5	45	86	126	169	215									256
1978	4	40	77	121	171	217	263								303
1977	2	50	89	132	183	226	286	343							383
1976	1	35	86	129	192	254	301	352	364						395
1975	1	45	82	120	157	186	231	272	322	367					400
Number of Fish	13	13	13	13	13	13	8	4	2	1					
Grand Mean (mm)		43	83	125	173	218	269	327	343	367					
Grand Mean (in)		1.7	3.3	4.9	6.8	8.6	10.6	12.9	13.5	14.4					
Annual Growth Increment (in)		1.7	1.6	1.7	1.9	1.8	2.0	2.3	0.6	0.9					

*Not corrected for length at scale formation

Table 5.

VEGETATION
Sandpiper Lake 7/2-3/84

AQUATIC VEGETATION

Class	Common Name	Scientific Name
Emergent	bulrush	<u>Scirpus validus</u>
	horsetail	<u>Equisetum fluviatile</u>
	spike rush	<u>Eleocharis palustris</u>
Floating	bur reed	<u>Sparganium angustifolium</u>
	dwarf water lily	<u>Nymphaea tetragona</u>
	pondweed	<u>Potamogeton natans</u>
	yellow pond lily	<u>Nuphar polysepalum</u>
Submergent	crowfoot	<u>Ranunculus confervoides</u>
	pondweed	<u>Potamogeton alpinus</u>
	pondweed	<u>Potamogeton foliosus</u>
	pondweed	<u>Potamogeton gramineus</u>
	pondweed	<u>Potamogeton robbinsii</u>
	pondweed	<u>Potamogeton zosterifolius</u>
	water milfoil	<u>Myriophyllum spicatum</u>

WETLANDS VEGETATION*

Class	Symbol	Description
Scrub-Shrub	PSS1/EM5B	palustrine, scrub-shrub, broad leaved deciduous, emergent, narrow leaved persistent, saturated
Forested	PF04B	palustrine, forested, needle leaved evergreen, saturated

*National Wetlands Inventory (Tyonek)

TERRESTRIAL VEGETATION

Class	Common Name	Scientific Name
Trees	alder	<u>Alnus sp.</u>
	black spruce	<u>Picea mariana</u>
	paper birch	<u>Betula papyrifera</u>
	white spruce	<u>Picea glauca</u>
Shrub	sweet gale	<u>Myrica gale</u>
Below Shrub	wild flag	<u>Iris setosa</u>
	marsh fivefinger	<u>Potentilla palustris</u>

Table 8.

WILDLIFE DATA
Sandpiper Lake 7/2-3/84

Animal Class	Common Name	Number	Sex M-F-U	Animal Assoc.	Verification	Habitat Type
Birds						
Waterfowl	common loon	2	1-1-0	Pair	Sight	Water
	lesser scaup	6	3-3-0	Pair	Sight	Water
	mallard	9 J+	0-1-8	Brood	Sight	Water
	unid. duck	9 J+	0-1-8	Brood	Sight	Water
Passerines	alder flycatcher	-	-	-	Sound	-
	American robin	-	-	-	Sound	-
	blackpoll warbler	-	-	-	Sound	-
	Bohemian waxwing	-	-	-	Sound	-
	common redpoll	-	-	-	Sound	-
	gray jay	-	-	-	Sight	-
	northern waterthrush	-	-	-	Sound	-
	olive-sided flycatcher	-	-	-	Sound	-
	orange-crowned warbler	-	-	-	Sound	-
	ruby-crowned kinglet	-	-	-	Sound	-
	rusty blackbird	-	-	-	Sound	-
	Savannah sparrow	-	-	-	Sound	-
	Swanson's thrush	-	-	-	Sound	-
	tree swallow	M	-	-	Sight	-
	varied thrush	-	-	-	Sound	-
white-crowned sparrow	-	-	-	Sound	-	
white-winged crossbill	-	-	-	Sound	-	
Shorebirds	common snipe	1	0-0-1	Single	Sight	Marsh
Mammals						
Big Game	black bear	-	-	-	Feces	-
	moose	-	-	-	Feces	-
Furbearers	beaver	-	-	-	Sight	Water
Other	snowshoe hare	-	-	-	Sight	-

J=Juveniles; J+=Includes Juveniles; M=Many; S=Several

camping. The best fishing for rainbow trout is reportedly May to June and from August 15 into September. Air carrier records indicate 60 clients were flown to the lake during 1983 and spent an average of 2.5 days per trip. There are no public use facilities on the lake other than those owned by the air carrier.

FISHERY RESOURCE SUMMARY

Sandpiper Lake is a remote lake in a wilderness setting. Rainbow trout were the only game fish in the lake and were found to be moderately high in abundance (CPUE 0.63). The variety of trout age classes and sizes present indicates spawning and recruitment is occurring. Threespine stickleback, at a moderately high abundance (CPUE 2.82), were the only the forage species captured. The inlet and outlet tributaries, in the vicinity of the lake, did not constitute rainbow trout spawning habitat. Rainbow trout spawning is most likely occurring in downstream areas such as Miller Creek with the fish migrating when sufficient water flows are present. There could also be rainbow trout movement between Sandpiper Lake and Cook Lake. Sport fishing pressure on the lake is believed to be low at around 2.5 angler days per acre. The lake is medium in fertility and had a MEI of 18.7. Dissolved oxygen values were high in most of the lake for cold water game fish. Based on our findings we believe Sandpiper Lake can support a moderately high rainbow trout sport fishery.

SCENIC LAKE

SURVEY PERIOD

Personnel of the U.S. Fish and Wildlife Service surveyed Scenic Lake once during 1984. W.J. Jakubas and A.S. Firman conducted a fishery survey and detailed water quality survey on July 12-13. Table 1 summarizes survey findings.

PHYSICAL FEATURES

Scenic Lake is in the northeastern section of the Kenai National Wildlife Refuge (NWR) and is part of the Chickaloon River Basin. Its latitude is north $60^{\circ} 45'$ and longitude west $150^{\circ} 09'$. The lake and surrounding area were designated as wilderness by the Alaska National Lands Conservation Act of 1980. The watershed area for the lake is estimated to be 3 square miles. Scenic Lake has a surface area of 110 acres, a volume of 2,600 acre feet, and is at an elevation of 215 feet. The lake has a mean depth of 23.6 feet and maximum depth of 44 feet (Table 1 and Figure 1).

Scenic Lake is situated in relatively flat terrain in the Chickaloon River Basin. The lake is bordered by forested areas to the east and west and wetlands to the north and south. Terrestrial vegetation consists of black spruce, paper birch, and white spruce with scattered alder along the lake periphery. A large bog is on the southern end of the lake and a smaller one on the northern end.

Lake water level is maintained by streams, bog seepage, springs, and run-off. The main outlet stream flows west then north for about 1.5 miles connecting with Scenic Creek, a tributary of the Chickaloon River. This stream was about 30 feet wide and 4 feet deep; current was barely perceptible. The stream was blocked by a beaver dam and was heavily vegetated. Flow was estimated at 4.8 cubic feet per second. High water flows could pass around the side of the dam permitting fish passage. An inlet stream originating about two miles southeast passes through uplands and bogs entering at the southern end of the lake. It was about 15 feet wide and 1.5 feet deep. No flow was occurring at the time of survey. Several other small bog streams were present, but none had flow. They probably only functioned during high water periods and, therefore, are not shown in Figure 1. Only the outlet stream is shown on USGS Topographic Map Kenai (D-1), 1951. The inlet and outlet streams did not appear to contain rainbow trout spawning habitat.

Scenic Lake is remote and extremely difficult to reach. Aircraft is the most convenient means of access. Outboard motors greater than 10 horsepower are not permitted on the lake by Refuge regulation.

FISH

Rainbow trout were the dominant game fish in Scenic Lake. They were found in low abundance at a catch per unit effort (CPUE) of 0.11 fish per net hour (Table 2). Juvenile coho salmon and longnose sucker were also present at respective moderate abundances of CPUE 0.23 and CPUE 0.34. The only round

Table 1.

LAKE SURVEY SUMMARY
Scenic Lake

LOCATION				SPORT FISH VALUE	
				(Species)	(Yield)
Refuge	Kenai NWR	Map	Kenai (D-1)		
Lat.	N 60° 45'	Long.	W 150° 09'	Rainbow Trout	Moderate
T	8N	R	5W	Coho Salmon	Nursery Area
		S	28		
Land Use Class	Wilderness				

PHYSICAL FEATURES

Surface Area (Ac.)	110
Maximum Depth (Ft.)	44
Mean Depth (Ft.)	23.6
Volume (Ac.Ft.)	2600
Water Trans. (Ft.)	13
Elevation (Ft.)	215

WATERSHED

Chickaloon River

FISH SPECIES

	Rainbow Trout
	Coho Salmon
	Longnose Sucker
	Round Whitefish
	Threespine Stickleback
	Slimy Sculpin

WATER QUALITY

Temp. (°C)	18.8-4.0
D.O. (mg/l)	10.4-0.1
pH	7.4
Tot. Alk. (mg/l)	74
Tot. Hard. (mg/l)	110
Tot. Phos. (ug/l)	8.8
Tot. Kjel. N (mg/l)	0.33
Cond. (umho)@ 25°C	124
MEI	17.2
SDF	1.20

TRIBUTARY STREAMS

Inlets (No.)	1 Intermittent
Outlets (No.)	1 Permanent
Ocean Linkage	Yes - Seasonal

RECREATION

Types: Fishing, wildlife viewing, boating.
Ketchum Air Service holds a Refuge Special Use Permit for a fly-in tent camp.

Public Facilities: Tent camp facilities owned by Ketchum Air Service.

Access: Aircraft. Motors larger than 10 hp are prohibited by Refuge regulation.

AQUATIC VEGETATION
(Dominant Families)

Lily, pondweed.

Lake Coverage (%)	46
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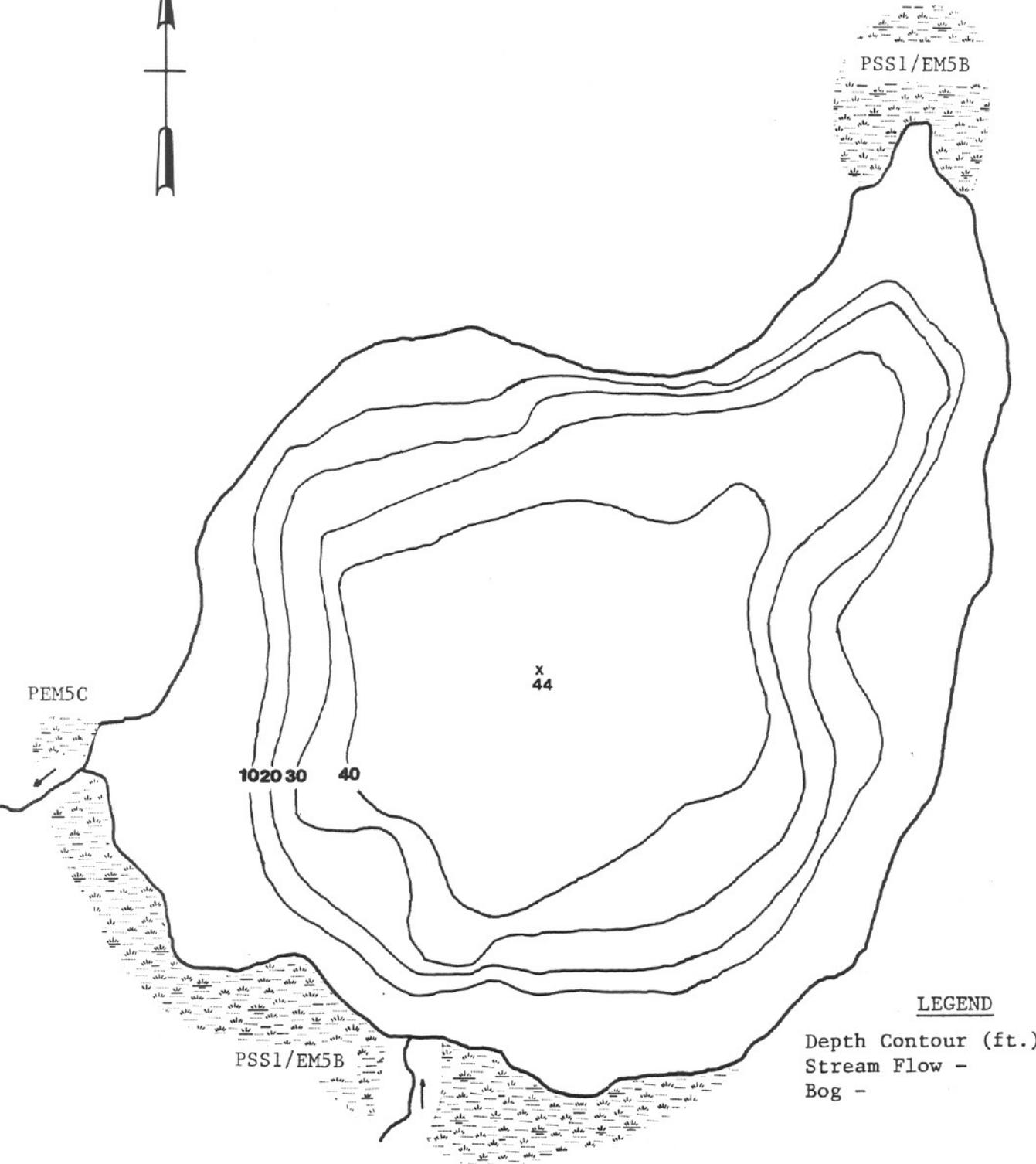
SURVEY DATES

Fish	7/12-13/84
Water Quality	7-12-84

Figure 1.

SCENIC LAKE

(110 Acres)



SCALE

1 : 5280



Table 2.

FISH CATCH AND EFFORT SUMMARY
Scenic Lake 7/12-13/84

Gear	Average Fishing Time (hrs.)	Amount Gear (sq.ft.)	Fish Species	Total Fish Number	Sex M-F-U	Fish CPUE	
						Net Hour	Trap Hour
4 Gill Nets	14	3200	Rainbow Trout	6	3-2-1	0.11	N/A
			Coho Salmon	13	0-0-13	0.23	N/A
			Longnose Sucker	19	5-3-11	0.34	N/A
			Round Whitefish	1	0-0-1	0.02	N/A
			All Species	39	7-6-26	0.70	N/A
12 Minnow Traps	17		Coho Salmon	1	0-0-1	N/A	<0.01
			Threespine Stickleback	485	0-0-485	N/A	2.38
			Slimy Sculpin	1	0-0-1	N/A	<0.01
	17		All Species	487	0-0-487	N/A	2.39

whitefish captured during our two year lake study was found in this lake. Threespine stickleback (CPUE 2.38) and slimy sculpin constituted the forage species. A total of four gill nets and 12 minnow traps were used to determine fish abundance.

The rainbow trout ranged in fork length from 8.3 inches (210 mm) to 13.8 inches (350 mm), in weight from 0.3 pounds (120 g) to 1.3 pounds (570 g), and in condition from 1.01 to 1.33. Ages of rainbow trout were from four to six years (Table 4). Their growth rate, as determined by scale analysis, was 1.9 inches per year. All the coho salmon captured were juveniles. Coho fork length ranged from 3.7 inches (95 mm) to 4.9 inches (125 mm) while their weight was from 0.03 pounds (12.3 g) to 0.04 pounds (18.8 g). Condition factors varied from 0.95 to 1.44. The Scenic Lake coho were determined to be one and two years old. Their average growth rate was 1.7 inches per year. Longnose sucker ranged in fork length from 7.7 inches (195 mm) to 16.0 inches (405 mm), in weight from 0.2 pounds (90 g) to 1.5 pounds (690 g), and in condition from 1.02 to 1.21. Their ages, determined from otoliths, ranged from four to 14 years (Table 5). The single round whitefish was 13.2 inches (335 mm) fork length and 1.0 pound (440 g) in weight. Length, weight, and condition data for rainbow trout, coho salmon, and longnose sucker are summarized in Table 3.

AQUATIC VEGETATION

Aquatic plants were dense in shallow areas around the lake periphery. The dominant species were yellow pond lily and the pondweeds, Potamogeton natans, P. perfoliatus, P. praelongus, and P. robbinsii. Patches of bur reed and horsetail were found along the shoreline. About 46 percent of the lake was covered with aquatic vegetation. Two scrub shrub wetlands (types PSS1/EM5B and PEM5C), plotted by the National Wetlands Inventory (USFWS 1978), were seen during our survey. A complete list of vegetation is in Table 6.

WATER QUALITY

The lake's alkalinity level of 74 mg/l was almost twice the average alkalinity found in the 37 lakes surveyed during 1983-84. This value corresponds to the medium range of lake productivity using our modification of Moyle's classification (Mackenthun and Ingram 1967). A pH of 7.4 was slightly alkaline. The lake was thermally stratified with a surface temperature of 18.8°C declining to 17.5°C at 10 feet just above the thermocline, then slowly declining to 4.0°C near the lake bottom (Table 7). Corresponding dissolved oxygen values ranged from supersaturation (10.3 mg/l) at the surface to saturated (10.2 mg/l) at 13 feet, and slowly degrading to 17 percent saturation (2.2 mg/l) at 33 feet. From this point dissolved oxygen was very low ranging from 0.2 mg/l to 0.1 mg/l.

Water color was dark yellow green, and Secchi disc transparency was 13 feet. The lake had a Morphoedaphic Index of 17.2 and Shoreline Development Factor of 1.20.

MANAGEMENT HISTORY

There were no previous fishery surveys for this lake.

Table 3.

FISH LENGTH, WEIGHT, AND CONDITION SUMMARY
Scenic Lake 7/12-13/84

Gear	Category	Species	Sample Size	Mean	Standard Deviation	Range
Gill Nets	Fork Length (mm)	Rainbow Trout	5	282	58.4	210 - 350
		Coho Salmon	9	111	8.20	95 - 125
		Longnose Sucker	16	277	71.3	195 - 405
	Weight (g)	Rainbow Trout	5	298	185	120 - 570
		Coho Salmon	9	15.7	1.84	12.3 - 18.8
		Longnose Sucker	16	277	207	90 - 690
	Condition (K)	Rainbow Trout	5	1.20	0.13	1.01 - 1.33
		Coho Salmon	9	1.17	0.15	0.95 - 1.44
		Longnose Sucker	16	1.10	0.06	1.02 - 1.21

Table 4.

BACK-CALCULATED FORK LENGTHS (MILLIMETERS) AT ANNULUS FORMATION*
of Rainbow Trout in Scenic Lake - 1984

Year Class	Number of Fish	Age of Fish												Capture FL	
		1	2	3	4	5	6	7	8	9	10	11	12		
1980	2	45	89	142	182										223
1979	1	33	70	110	167	217									240
1978	2	51	90	144	193	240	287								335
Number of Fish	5	5	5	5	5	3	2								
Grand Mean (mm)		45	86	136	183	232	287								
Grand Mean (in)		1.8	3.4	5.4	7.2	9.2	11.3								
Annual Growth Increment (in)		1.8	1.6	2.0	1.9	1.9	2.1								

*Not corrected for length at scale formation

Table 5.

AGE-LENGTH OF LONGNOSE SUCKER
Scenic Lake - 1984

Fish Age (years)	Sample Size (no)	Fork Length	
		----Mean---- (in)	Range (mm)
4	1	7.7	195
5	1	9.8	250
6	2	8.5	215
12	1	11.8	300
14	1	13.4	340

Table 6.

VEGETATION
Scenic Lake 7/12-13/84

AQUATIC VEGETATION

Class	Common Name	Scientific Name
Emergent	horsetail	<u>Equisetum fluviatile</u>
Floating	dwarf water lily	<u>Nymphaea tetragona</u>
	pondweed	<u>Potamogeton natans</u>
	sedge	<u>Carex sp.</u>
	yellow pond lily	<u>Nuphar polysepalum</u>
Submergent	bladderwort	<u>Utricularia sp.</u>
	bur reed	<u>Sparganium angustifolium</u>
	bur reed	<u>Sparganium minimum</u>
	chara	<u>Chara sp.</u>
	pondweed	<u>Potamogeton foliosus</u>
	pondweed	<u>Potamogeton gramineus</u>
	pondweed	<u>Potamogeton praelongus</u>
	pondweed	<u>Potamogeton perfoliatus</u>
	pondweed	<u>Potamogeton robbinsii</u>
	pondweed	<u>Potamogeton zosterifolius</u>
water milfoil	<u>Myriophyllum spicatum</u>	

WETLANDS VEGETATION*

Class	Symbol	Description
Scrub-shrub	PSS1/EM5B	palustrine, scrub-shrub, broad leaved deciduous, emergent, narrow leaved persistent, saturated
	PEM5C	palustrine, emergent, narrow leaved persistent, seasonal

*National Wetlands Inventory (Kenai)

TERRESTRIAL VEGETATION

Class	Common Name	Scientific Name
Trees	alder	<u>Alnus sp.</u>
	black spruce	<u>Picea mariana</u>
	paper birch	<u>Betula papyrifera</u>
	white spruce	<u>Picea glauca</u>
Below Shrub	buck bean	<u>Menyanthes trifoliata</u>
	marsh fivefinger	<u>Potentilla palustris</u>

WILDLIFE

Waterfowl sighted on the lake included a brood of Barrow's goldeneye, common loon, and lesser scaup. Sandhill cranes were heard, and a yellowlegs was sighted in a bog. Broods of Arctic terns were in lake bog areas and one red-tailed hawk was sighted. Two active and one inactive beaver lodges were in the southern end of the lake verifying the presence of beaver. Clam shell feeding areas indicated the presence of muskrat. Wildlife species along with pertinent data are in Table 8.

RECREATIONAL USE

Recreational uses of Scenic Lake consist mostly of sport fishing, wildlife viewing, camping, and boating. Ketchum Air Service, Inc. has been issued a Special Use Permit by the Kenai NWR allowing them to establish a tent camp and fly in clients for fishing and camping. Refuge records indicate the lake had 821 fishing days use in 1983 by air carrier clients.

Two fishing parties were flown to the lake during our survey. One party of three people caught three rainbow trout in two days. One of these trout was about 23 inches in length while the other two were around 14 inches. According to Ketchum personnel, sport fishing is best in the spring and fall for rainbows and poor during the summer. They indicated the lake tends to yield a lesser number of larger trout as opposed to a lot of small fish. There are no public use facilities on the lake other than those owned by the air carrier.

FISHERY RESOURCE SUMMARY

Scenic Lake is a remote lake in a wilderness setting. Our fishery survey found rainbow trout to be the dominant game fish at a low abundance of 0.11 fish per net hour. Warm water conditions are suspected to have reduced trout movement causing our relative abundance estimate to be lower than the actual fish population present. Trout age and size classes present indicated spawning and recruitment is occurring. Juvenile coho salmon are moderately abundant (CPUE 0.23) establishing the lake as a coho nursery area. Longnose sucker were also moderately abundant (CPUE 0.34). The only round whitefish captured during our two year lake survey was taken in this lake. A moderately high population of threespine stickleback (CPUE 2.38) and slimy sculpin constituted the forage species.

Sport fishing pressure on the lake comes almost totally from air carrier clients. It is believed to be low at around 7.5 fishing days per acre. Lake fertility is medium, and the MEI was 17.2. Dissolved oxygen values were high for cold water game fish in most of the lake. No rainbow trout spawning habitat was immediately adjacent in lake tributaries. The trout are believed to spawn in downstream reaches of Scenic Creek or the Chickaloon River which may also serve as spawning areas for the coho salmon. Taking into consideration that the fish abundance estimate was slightly low, Scenic Lake is considered to be able to support a moderate yield rainbow trout sport fishery and serve as a coho salmon nursery area.

Table 8.

WILDLIFE DATA
Scenic Lake 7/12-13/84

Animal Class	Common Name	Number	Sex M-F-U	Animal Assoc.	Verifi- cation	Habitat Type
Birds						
Waterfowl	Barrow's goldeneye	4 J+	0-2-2	Brood	Sight	Water
	common loon	3	1-1-1	Pair	Sight	Water
	lesser scaup	1	0-0-1	Single	Sight	Water
	unid. duck	2	-	Single	Sight	Water
Passerines	American robin	-	-	-	-	-
	blackpoll warbler	1	-	-	Sound	-
	common redpoll	-	-	-	Sound	-
	gray jay	1	-	-	Sight	-
	rusty blackbird	4	-	Pair	Sight	-
	Swanson's thrush	1	-	-	Sound	-
	white-winged crossbill	-	-	-	Sound	-
Shorebirds	sandhill crane	2	-	-	Sound	-
	yellowlegs	1	-	Single	Sight	Bog
Gulls/Terns	Arctic tern	10 J+	-	Brood	Sight	Bog
Raptors	red-tailed hawk	1	-	Single	Sight	Trees
Mammals						
Big Game	moose	-	-	-	Feces	-
Furbearers	beaver	-	-	-	Lodge	-
	muskrat	-	-	-	Clam Shells	-

SNAG LAKE

SURVEY PERIOD

Personnel of the U.S. Fish and Wildlife Service surveyed Snag Lake twice in 1984. J.W. Friedersdorff and G.A. Muhlberg conducted a fishery survey on August 6-7. Detailed water quality data were gathered by J.W. Friedersdorff and W.J. Jakubas on July 17. Table 1 summarizes survey findings.

PHYSICAL FEATURES

Snag Lake is located in the northcentral section of the Kenai National Wildlife Refuge (NWR) and is part of the Swanson River Basin. Its latitude is north 60° 49' and longitude west 150° 41'. The lake and surrounding area were designated to be in the Traditional Land Management category by the Kenai NWR Comprehensive Conservation Plan (USFWS 1985). The watershed area for the lake is estimated to be 1.9 square miles. Snag Lake has a surface area of 306 acres, a volume of 4,500 acre feet, and is at an estimated elevation of 195 feet. The lake has a mean depth of 14.9 feet and maximum depth of 37 feet (Table 1 and Figure 1).

Snag Lake is situated in relatively flat terrain surrounded by low hills. Terrestrial vegetation consists mostly of scattered stands of 20 to 40 year old paper birch and white spruce, and in wetter areas, black spruce. Scattered alder was adjacent to the shore. There were also large areas of open muskeg. The peninsula in the southeastern part of the lake is the only area containing mature trees, and is apparently the largest area to escape the ravages of the 1947 refuge fire. Three bogs were present adjacent to the northwestern, southeastern, and southern shores of the lake.

Lake water level is maintained by streams, springs, bog seepage, and run-off. A small inlet stream was on the southeast side of the lake, but a definite channel could not be distinguished from the ground, and there was no flow. Aerial photos verified the presence of this stream which is fed from a small lake about 0.1 mile to the east. Similarly, aerial photos indicated a floodway from Bufflehead Lake going about 0.2 mile through a bog to the northwest end of Snag Lake. This floodway was not apparent during our survey and is not shown on Figure 1.

The outlet stream, at the southern end of the lake, was about 6 feet wide and 3 feet deep with an estimated flow of 0.1 cubic feet per second. Within 300 yards the stream channel disappeared in dense aquatic vegetation. The stream bottom, in the vicinity of the lake, consisted of silt and detritus interspersed with aquatic plants; it would not support rainbow trout spawning. Aerial photos indicated the outlet stream flows south 3.5 miles to the Swanson River. The complete stream connection from Snag Lake to the Swanson River is not shown by USGS Topographic Map (Kenai D-2), 1951. Large areas of clean gravel were present along the northeastern lake shore which appeared capable of supporting Arctic char spawning.

Table 1.

LAKE SURVEY SUMMARY
Snag Lake

LOCATION				SPORT FISH VALUE	
				(Species)	(Yield)
Refuge	Kenai NWR	Map	Kenai (D-2)	Rainbow Trout	Low
Lat.	N 60° 49'	Long.	W 150° 41'	Arctic Char	Low
T	9N R 8W	S	33		
Land Use Class	Traditional Management				

PHYSICAL FEATURES

Surface Area (Ac.)	306
Maximum Depth (Ft.)	37
Mean Depth (Ft.)	14.9
Volume (Ac.Ft.)	4500
Water Trans. (Ft.)	13
Elevation (Ft.)	195

WATERSHED

Swanson River

FISH SPECIES

Rainbow Trout
Arctic Char
Longnose Sucker
Threespine Stickleback
Coastrange Sculpin

WATER QUALITY

Temp. (°C)	17.2-9.0
D.O. (mg/l)	9.6-4.0
pH	7.2
Tot. Alk. (mg/l)	29
Tot. Hard. (mg/l)	36
Tot. Phos. (ug/l)	10.8
Tot. Kjehl. N (mg/l)	0.30
Cond. (umho)@ 25°C	68
MEI	15.0 SDF 2.08

TRIBUTARY STREAMS

Inlets (No.)	1 Intermittent
Outlets (No.)	1 Intermittent
Ocean Linkage	Yes-Seasonal

AQUATIC VEGETATION
(Dominant Families)

Lily, pondweed, chara

Lake Coverage (%) : 26

SURVEY DATES

Fish	8/6-7/84
Water Quality	7-17-84

RECREATION

Types: Fishing, wildlife viewing, camping, boating. Ketchum Air Service holds a Refuge Special Use Permit for a fly in tent camp.

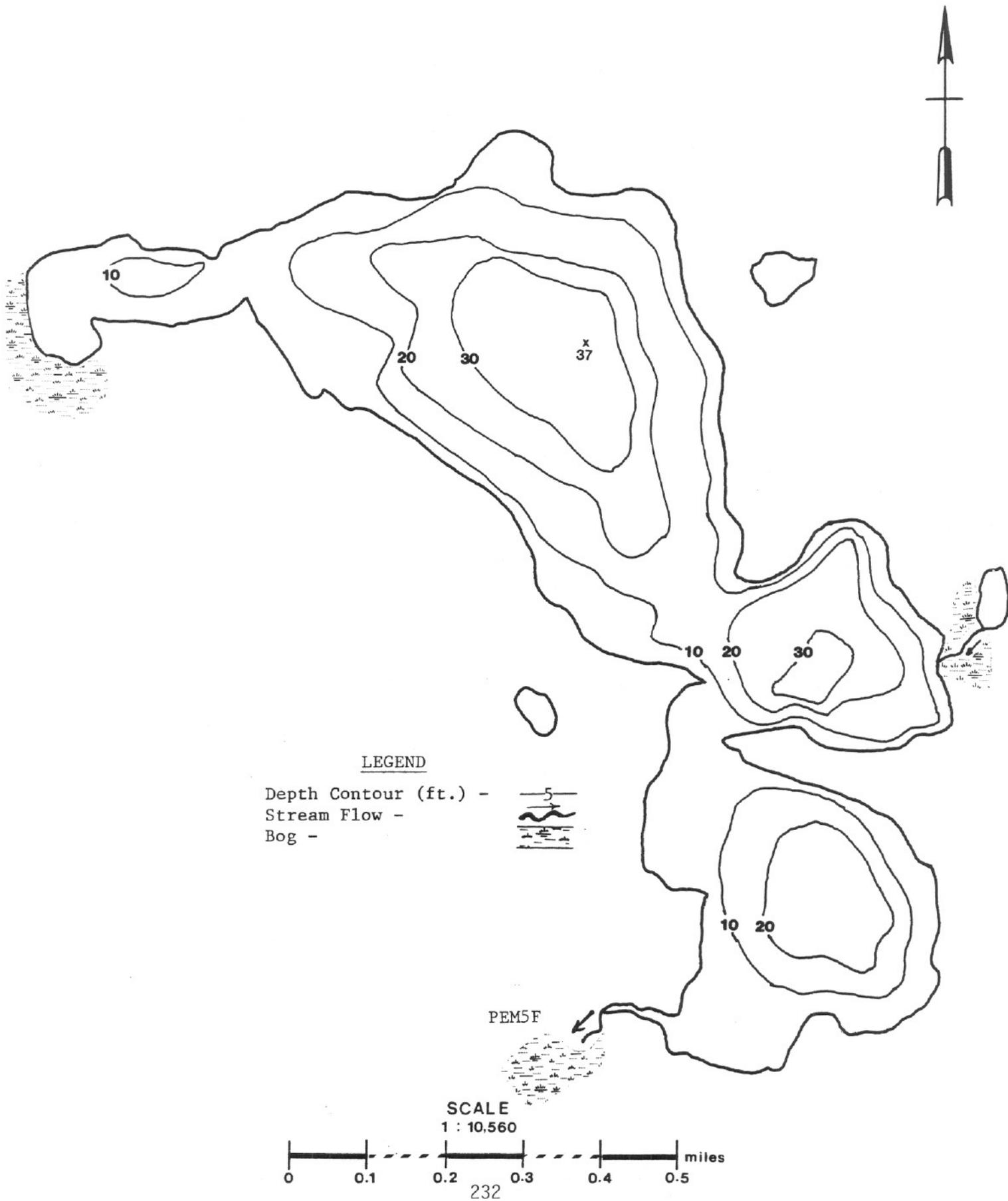
Public Facilities: None other than the tent camp facilities owned by Ketchum Air Service.

Access: Aircraft. Outboard motors larger than 10 hp are prohibited by Refuge regulation.

Figure 1.

SNAG LAKE

(306 Acres)



Snag Lake is remote. Aircraft landing is currently authorized and is the only practical means of access. Outboard motors larger than 10 horsepower are prohibited by Refuge regulation.

FISH

Rainbow trout were the dominant game fish in Snag Lake and were found in moderate abundance at a catch per unit effort (CPUE) of 0.42 fish per net hour (Table 2). Arctic char were in low abundance (CPUE 0.06) while longnose sucker were moderately abundant (CPUE 0.45). A moderate abundance of threespine stickleback (CPUE 1.63) and coastrange sculpin constituted the forage species. A total of six gill nets and 20 minnow traps were used to measure fish abundance.

Rainbow trout ranged in fork length from 8.7 inches (220 mm) to 17.3 inches (440 mm), in weight from 0.2 pounds (100 g) to 2.3 pounds (1050 g), and in condition from 0.61 to 1.39. Scale analysis indicated the rainbow trout varied from four to eight years old (Table 3) and had a average growth rate of 1.9 inches per year. Arctic char fork lengths ranged from 10.2 inches (260 mm) to 14.4 inches (365 mm). Their weights were from 0.3 pounds (140 g) to 1.0 pound (460 g), with condition factors from 0.80 to 1.07. The longnose sucker fork lengths ranged from 13.4 inches (340 mm) to 17.7 inches (450 mm), weights from 1.0 pounds (470 g) to 2.3 pounds (1020 g), and condition from 1.02 to 1.35. Opercle analysis indicated longnose sucker were from nine to 19 years old (Table 4). Length, weight, and condition for rainbow trout, Arctic char, and longnose sucker are summarized in Table 5.

AQUATIC VEGETATION

Aquatic vegetation most mostly confined to shoal waters near shore, in the lake's shallow north end, and adjacent the southeastern peninsula. Yellow pond lily; the pondweeds, Potamogeton natans, and P. gramineus; plus chara were the dominant aquatic plants. One emergent wetland (type PEM5F), at the south end of the lake, was plotted by the National Wetlands Inventory (1978); two other small bogs were not noted in the inventory. A complete list of vegetation is in Table 6.

WATER QUALITY

The lake's alkalinity level of 29 mg/l was 74 percent of the average alkalinity found in the 37 lakes surveyed during 1983-84. This value falls within the medium category of lake water productivity we modified from Moyle's classification (MacKenthun and Ingram 1967). The pH of 7.2 was slightly alkaline. During July, a layer of cooler water existed near the lake bottom, but did not fit the classic description of a thermocline (Table 7). Surface water temperature was 17.2°C. This temperature remained stable to 16 feet dropping to 9.0°C near the bottom. Corresponding dissolved oxygen levels were near saturation from the surface (9.4 mg/l) down to 16 feet, then slowly degraded to 34 percent saturation (4.0 mg/l) at 30 feet. The lake had high dissolved oxygen levels being above 7.0 mg/l down to 26 feet. Dissolved oxygen concentrations at the time of the fish survey are shown in Table 8.

Table 2.

FISH CATCH AND EFFORT SUMMARY
Snag Lake 8/6-7/84

Gear	Average Fishing Time (hrs.)	Amount Gear (sq.ft.)	Fish Species	Total Fish Number	Sex M-F-U	Fish CPUE	
						Net Hour	Trap Hour
6 Gill Nets	13	4,800	Rainbow Trout	33	12-14-7	0.42	N/A
			Arctic Char	5	3-0-2	0.06	N/A
			Longnose Sucker	35	1-3-31	0.45	N/A
			All Species	73	16-17-40	0.93	N/A
20 Minnow Traps	19	N/A	Threespine Stickleback	621	0-0-621	N/A	1.63
			Coastrange Sculpin	131	0-0-131	N/A	0.34
			All Species	752	0-0-752	N/A	1.97

Table 3.

BACK-CALCULATED FORK LENGTHS (MILLIMETERS) AT ANNULUS FORMATION*
of Rainbow Trout in Snag Lake - 1984

Year Class	Number of Fish	Age of Fish												Capture FL	
		1	2	3	4	5	6	7	8	9	10	11	12		
1980	5	50	89	144	194										225
1979	4	45	88	134	180	233									270
1978	8	44	83	132	186	241	295								331
1977	3	44	85	123	168	215	266	320							362
1976	5	40	76	120	164	215	270	327	388						429
Number of Fish	25	25	25	25	25	20	16	8	5						
Grand Mean (mm)		45	84	131	180	229	282	325	338						
Grand Mean (in)		1.8	3.3	5.2	7.1	9.0	11.1	12.8	15.3						
Annual Growth Increment (in)		1.8	1.5	1.9	1.9	1.9	2.1	1.7	2.5						

*Not corrected for length at scale formation

Table 4.

AGE-LENGTH OF LONGNOSE SUCKER
Snag Lake - 1984

Fish Age (years)	Sample Size (no)	Fork Length		Range (mm)
		-----Mean----- (in)	(mm)	
9	1	13.8	350	-
11	1	14.2	360	-
12	1	16.1	410	-
13	3	15.6	397	380-410
14	1	15.4	390	-
15	1	17.7	450	-
19	1	16.9	430	-

Table 5.

FISH LENGTH, WEIGHT, AND CONDITION SUMMARY
Snag Lake 8/6-7/84

Gear	Category	Species	Sample Size	Mean	Standard Deviation	Range
Gill Nets	Fork Length (mm)	Rainbow Trout	33	322	66.9	220 - 440
		Arctic Char	5	321	40.2	260 - 365
		Longnose Sucker	22	391	30.2	340 - 450
	Weight (g)	Rainbow Trout	33	445	268	100 - 1050
		Arctic Char	5	316	128	140 - 460
		Longnose Sucker	22	705	160	470 - 1020
	Condition (K)	Rainbow Trout	33	1.18	0.15	0.61 - 1.39
		Arctic Char	5	0.91	0.11	0.80 - 1.07
		Longnose Sucker	22	1.16	0.08	1.02 - 1.35

Table 6.

VEGETATION
Snag Lake 8/6-7/84

AQUATIC VEGETATION

Class	Common Name	Scientific Name
Emergent	horsetail	<u>Equisetum fluviatile</u>
	spike rush	<u>Eleocharis palustris</u>
Floating	bur reed	<u>Sparganium angustifolium</u>
	dwarf water lily	<u>Nymphaea tetragona</u>
	pondweed	<u>Potamogeton natans</u>
	yellow pond lily	<u>Nuphar polysepalum</u>
Submergent	chara	<u>Chara sp.</u>
	pondweed	<u>Potamogeton gramineus</u>
	pondweed	<u>Potamogeton perfoliatus</u>
	star duckweed	<u>Lemna trisulca</u>
	water milfoil	<u>Myriophyllum spicatum</u>

WETLANDS VEGETATION*

Class	Symbol	Description
Emergent	PEM5F	palustrine, emergent, narrow leaved persistent, semipermanent

*National Wetlands Inventory (Kenai)

TERRESTRIAL VEGETATION

Class	Common Name	Scientific Name
Trees	alder	<u>Alnus sp.</u>
	black spruce	<u>Picea mariana</u>
	paper birch	<u>Betula papyrifera</u>
	white spruce	<u>Picea glauca</u>
Shrub	sweet gale	<u>Myrica gale</u>
Below Shrub	buck bean	<u>Menyanthes trifoliata</u>
	cotton grass	<u>Eriophorum sp.</u>
	grass	<u>Gramineae</u>
	marsh fivefinger	<u>Potentilla palustris</u>

Water color was dark yellow green, and Secchi disc transparency was 13 feet. The lake had a Morphoedaphic Index of 15.0 and Shoreline Development Factor of 2.08.

MANAGEMENT HISTORY

There have been no previous fishery surveys of Snag Lake.

WILDLIFE

Bird sightings were sparse, partially due to high winds during the survey. A flock of common loons were seen on the lake, and muskrat presence was indicated by clam shell feeding areas. Wildlife species along with pertinent data are in Table 9.

RECREATIONAL USE

Recreational uses of Snag Lake include fishing, wildlife viewing, camping, and boating. Ketchum Air Service holds a Refuge Special Use Permit allowing them to establish tent camps and fly in clients for sport fishing. Refuge records indicate the lake had 808 recreation days use in 1983, clients of the air service. No people were fishing during our two day survey. Ketchum Air personnel indicated the lake produced low to moderate rainbow trout fishing and moderate to high char fishing in the spring. Fishing success falls off during July. There are no public use facilities on the lake other than those owned by the air carrier.

FISHERY RESOURCE SUMMARY

Rainbow trout were the dominant game fish in Snag Lake. The trout were in moderate abundance at a CPUE of 0.42. Arctic char were in low abundance (CPUE 0.06) and longnose sucker moderate abundance (CPUE 0.45). A moderate abundance of threespine stickleback (CPUE 1.63) and coastrange sculpin constituted the forage species.

Snag Lake is remote and primarily a fly-in sport fishery. Angler use is estimated at a minimum of 800 days per year or 2.6 angler days per surface acre. Lake water fertility is medium with a Morphoedaphic Index of 15.0. Fly-in tent camp operators indicated the lake has produced low to moderate rainbow trout sport fishing and moderate to high Arctic char fishing for a number of years. Dissolved oxygen was high for cold water game fish. Rainbow trout size and age classes indicate that successful spawning the recruitment is occurring, at least during most years. The rainbow trout spawn in the outlet stream or Swanson River which is accessible during periods of high flow. Adequate gravel is present in the lake for Arctic char spawning. Arctic char may be in higher abundance than our sampling indicated. Considering all data, we believe Snag Lake can support a low yield rainbow trout sport fishery and a low yield char sport fishery.

Table 9.

WILDLIFE DATA
Snag Lake 8/6-7/84

Animal Class	Common Name	Number	Sex M-F-U	Animal Assoc.	Verifi- cation	Habitat Type
Birds						
Waterfowl	common loon	8	-	Flock	Sight	Water
Mammals						
Big Game	moose	-	-	-	Cuttings	-
Furbearers	muskrat	-	-	-	Clam Shells	-

TANGERRA LAKE

SURVEY PERIOD

Personnel of the U.S. Fish and Wildlife Service surveyed Tangerra Lake twice during 1984. G.A. Muhlberg and A.S. Firman conducted a fishery survey on September 6-7. Detailed water quality data were gathered by J.W. Friedersdorff and W.J. Jakubas on July 17. Table 1 summarizes survey findings.

PHYSICAL FEATURES

Tangerra Lake is located in the northeast section of the Kenai National Wildlife Refuge (NWR) and is part of the Dipper Creek Watershed. Its latitude is north 60° 58' and longitude west 150° 22'. The lake and surrounding area were designated wilderness by the Alaska National Interest Lands Conservation Act of 1980. The watershed area for the lake is estimated to be 6.1 square miles. Tangerra Lake has a surface area of 173 acres, a volume of 3,000 acre feet, and is at an estimated elevation of 132 feet. The lake has a mean depth of 17.5 feet and maximum depth of 45 feet (Table 1 and Figure 1). During the survey our sounding gear broke down. An older depth contour map - origin unknown, but probably made by the Alaska Department of Fish and Game - was used to fill in missing data for the north end of the lake.

Low hills reaching over 175 feet in elevation border Tangerra Lake to the east and west with a mature forest of white spruce and paper birch surrounding the lake. Scattered alder is found along the shoreline. Four bogs are located on the south, southeast, and north shores of the lake.

Lake water level is maintained by streams, springs, bog seepage, and run-off. An inlet stream, on the southeast side of the lake, is fed by an unnamed lake located about 0.1 mile to the east. This stream was 1.5 feet wide by 0.8 feet deep. Flow was estimated at less than 0.05 cubic feet per second (cfs). The stream is probably intermittent during dry periods. This stream would not support rainbow trout spawning. Aerial photos indicated another inlet floodway at the south end of the lake entering through a bog. Since there was no physical sign of a stream channel, this floodway is not shown on Figure 1. The outlet stream, located at the northern end of the lake, had a width of 2 feet and depth of 0.5 feet. Its flow was estimated to be about 0.1 cfs. It is also probably intermittent during extended dry periods. This stream, in the immediate vicinity of the lake, did not constitute rainbow trout spawning habitat. Aerial photos show the outlet stream to flow east about 0.2 mile then turn north 0.2 mile connecting with another stream which flows east 1.7 miles through a series of three unnamed lakes to Turnagain Arm, an extension of Cook Inlet. The Tangerra Lake inlet and outlet streams are not shown on USGS Topographic Map Kenai (D-1), 1951.

Aircraft is the only practical means of reaching this lake.

FISH

Rainbow trout were the only game fish in the lake. They were found in moderate abundance at a catch per unit effort (CPUE) of 0.27 fish per net hour (Table

Table 1.

LAKE SURVEY SUMMARY
Tangerra Lake

LOCATION				SPORT FISH VALUE	
				(Species)	(Yield)
Refuge	Kenai NWR	Map	Kenai (D-1)		
Lat.	N 60° 58'	Long.	W 150° 22'	Rainbow Trout	Moderate
T	10N R 6W	S	8		
Land Use Class	Wilderness				

PHYSICAL FEATURES

Surface Area (Ac.)	173
Maximum Depth (Ft.)	45
Mean Depth (Ft.)	17.5
Volume (Ac.Ft.)	3,000
Water Trans. (Ft.)	11
Elevation (Ft.)	132

WATERSHED

Dipper Creek

FISH SPECIES

Rainbow Trout
Threespine Stickleback
Coastrange Sculpin

WATER QUALITY

Temp. (°C)	18.0-6.0
D.O. (mg/l)	11.4-3.4
pH	7.4
Tot. Alk. (mg/l)	32
Tot. Hard. (mg/l)	32
Tot. Phos. (ug/l)	13.1
Tot. Kjehl. N (mg/l)	0.38
Cond. (umho)@ 25°C	81
MEI	15.0 SDF 2.09

TRIBUTARY STREAMS

Inlets (No.)	1 Intermittent
Outlets (No.)	1 Intermittent
Ocean Linkage	Yes - Seasonal

RECREATION

Types: Fishing, wildlife viewing, boating, camping. Rusts Flying Service holds a Refuge Special Use Permit to have a tent camp and fly in clients for sport fishing.

Public Facilities: None other than those owned by Rusts Flying Service.

Access: Aircraft. Outboard motors larger than 10 hp are prohibited by Refuge regulation.

AQUATIC VEGETATION
(Dominant Families)

Pondweed, lily, sedge.	
Lake Coverage (%)	44

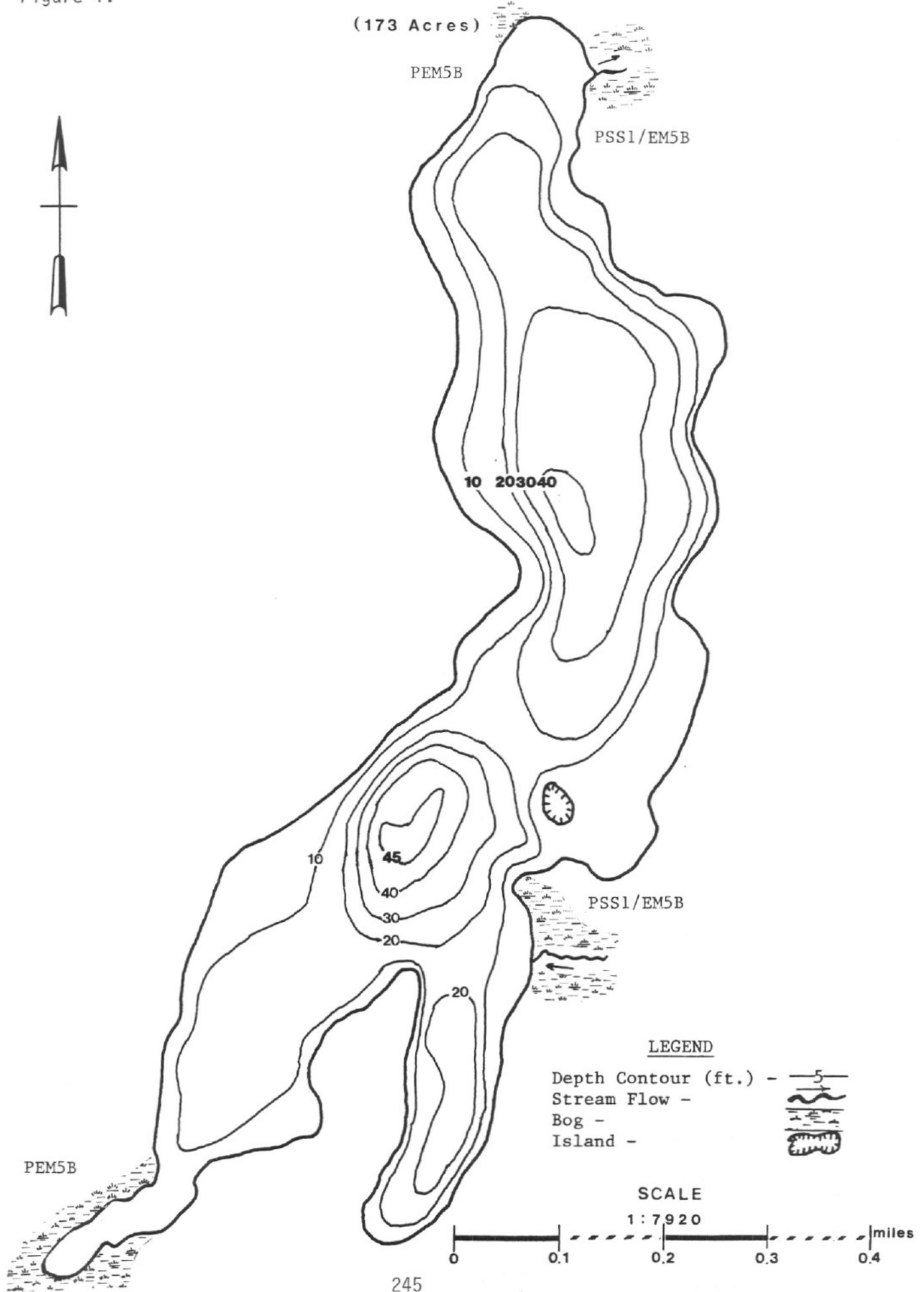
SURVEY DATES

Fish	9/6-7/84
Water Quality	7-17-84

Figure 1.

TANGERRA LAKE

(173 Acres)



PEM5B

PEM5B

PSS1/EM5B

10 203040

10

45

40

30

20

20

PSS1/EM5B

LEGEND

Depth Contour (ft.) - 

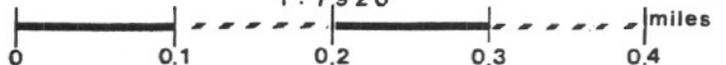
Stream Flow - 

Bog - 

Island - 

SCALE

1:7920



2). A moderately high population of threespine stickleback (CPUE 2.90) and one coastrange sculpin were the forage species. A total of six gill nets and 13 minnow traps were used to measure fish abundance.

Rainbow trout ranged in fork length from 9.1 inches (230 mm) to 18.7 inches (475 mm), in weight from 0.3 pounds (140 g) to 2.2 pounds (990 g), and in condition from 0.93 to 1.29 (Table 3). Scale analysis indicated the trout varied in age from four to 10 years old (Table 4). The trout were growing at an average rate of 1.8 inches per year.

AQUATIC VEGETATION

Aquatic vegetation was moderate in abundance and found mostly in the shallow areas of the lake adjacent the shoreline. The pondweeds, Potamogeton perfoliatus, P. alpinus, and P. natans, bulrush, and yellow pond lily were the most prominent aquatic plants. Two scrub shrub wetland areas (type PSSI/EM5B) and two emergent wetland areas (type PEM5B), identified in the National Wetlands Inventory (USFWS 1978), were seen during our survey. Approximately 44 percent of the lake area was covered with aquatic plants. A complete list of vegetation is in Table 5.

WATER QUALITY

The lake's alkalinity level of 32 mg/l was slightly below the average 39 mg/l found in the 37 lakes surveyed during 1983-84. This value fits the medium lake water productivity category we modified from Moyle's classification (MacKenthun and Ingram 1967). The pH of 7.4 was slightly alkaline. During July the lake was thermally stratified (Table 6). Surface water temperature was 18.0°C with a thermocline beginning around 16 feet at a water temperature of 16.9°C. Near the bottom, at 39 feet, water temperature was 6.0°C. Corresponding dissolved oxygen values were near maximum atmospheric saturation (9.5 mg/l) at the surface down to 23 feet (11.2 mg/l), then slowly degraded to 27 percent saturation (3.4 mg/l) at 39 feet. Dissolved oxygen was generally satisfactory for cold water game fish being above 6.0 mg/l from the surface to 36 feet.

Water color was dark yellow green and Secchi disc transparency was 11 feet. The lake had a Morphoedaphic Index of 15.0 and a Shoreline Development Factor, including the island, of 2.09. A dissolved oxygen profile was not taken at the time of the fish survey.

MANAGEMENT HISTORY

Personnel of the Alaska Department of Fish and Game (ADF&G) first surveyed Tangerra Lake in August, 1969. They captured 41 rainbow trout for a CPUE of 0.98 fish per net hour using two gill nets fished for 21 hours (Howe and Ashmore 1969). Captured trout ranged in length from 7.1 inches (180 mm) to 19.3 inches (490 mm) with a mean length of 11.7 inches (297 mm). Their method of length measurement was not specified. Trout weights varied from 0.1 pound (59 g) to 3.3 pounds (1498 g). State biologists further indicated that the inlet and outlet streams were intermittent. In 1975 the Fish and Wildlife Service (FWS) surveyed the lake (Schuler 1975). Six rainbow trout were captured in one gill net fished for 26 hours for a CPUE of 0.23 fish per net hour. The trout ranged in fork length from 12.2 inches (310 mm) to 17.7 inches (450 mm) and in weight from 0.7 pounds (300 g) to 2.5 pounds (1150 g). In a

Table 2.

FISH CATCH AND EFFORT SUMMARY
Tangerra Lake 7/30-31/84

Gear	Average Fishing Time (hrs.)	Amount Gear (sq.ft.)	Fish Species	Total Fish Number	Sex M-F-U	Fish CPUE	
						Net Hour	Trap Hour
6 Gill Nets	15	4,800	Rainbow Trout	24	10-13-1	0.27	N/A
13 Minnow Traps	18	N/A	Threespine Stickleback Coastrange Sculpin	679 1	0-0-679 0-0-1	N/A N/A	2.90 40.01
			All Species	680	0-0-680	N/A	2.91

Table 3.
 FISH LENGTH, WEIGHT, AND CONDITION SUMMARY
 Tangerra Lake 7/30-31/84

Gear	Category	Species	Sample Size	Mean	Standard Deviation	Range
Gill Nets	Fork Length (mm)	Rainbow Trout	24	371	54.8	230 - 475
	Weight (g)	Rainbow Trout	24	610	234	140 - 990
	Condition (K)	Rainbow Trout	24	1.14	0.11	0.93 - 1.29

Table 4.

BACK-CALCULATED FORK LENGTHS (MILLIMETERS) AT ANNULUS FORMATION*
of Rainbow Trout in Tangerra Lake - 1984

Year Class	Number of Fish	Age of Fish												Capture FL	
		1	2	3	4	5	6	7	8	9	10	11	12		
1980	1	51	87	138	189										230
1979	2	45	94	139	192	237									278
1978	2	42	79	126	174	229	293								330
1977	6	43	83	126	180	232	284	338							366
1976	10	37	73	118	166	216	266	313	362						397
1975	2	44	73	117	154	191	238	292	350	392					418
1974	1	34	76	113	147	181	219	265	319	404	458				475
Number of Fish	24	24	24	24	24	23	21	19	13	3	1				
Grand Mean (mm)		41	78	123	172	220	269	316	366	398	458				
Grand Mean (in)		1.6	3.1	4.8	6.8	8.7	10.6	12.4	14.0	15.7	18.0				
Annual Growth Increment (in)		1.6	1.5	1.8	1.9	1.9	1.9	1.9	1.6	1.6	2.4				

*Not corrected for length at scale formation

Table 5.

VEGETATION
Tangerra Lake 7/30-31/84

AQUATIC VEGETATION

Class	Common Name	Scientific Name
Emergent	bulrush	<u>Scirpus validus</u>
	horsetail	<u>Equisetum palustre</u>
	mare's tail	<u>Hippuris vulgaris</u>
	sedge	<u>Carex sp.</u>
	spike rush	<u>Eleocharis palustris</u>
Floating	bur reed	<u>Sparganium angustifolium</u>
	bur reed	<u>Sparganium minimum</u>
	dwarf water lily	<u>Nymphaea tetragona</u>
	pondweed	<u>Potamogeton natans</u>
	yellow pond lily	<u>Nuphar polysepalum</u>
Submergent	pondweed	<u>Potamogeton alpinus</u>
	pondweed	<u>Potamogeton filiformis</u>
	pondweed	<u>Potamogeton gramineus</u>
	pondweed	<u>Potamogeton praelongus</u>
	pondweed	<u>Potamogeton perfoliatus</u>
	pondweed	<u>Potamogeton zosterifolius</u>
	water milfoil	<u>Myriophyllum spicatum</u>

WETLANDS VEGETATION*

Class	Symbol	Description
Scrub-Shrub	PSS1/EM5B	palustrine, scrub-shrub, broad leaved deciduous, emergent, narrowleaved persistent, saturated
Emergent	PEM5B	palustrine, emergent, narrowleaved persistent, saturated

*National Wetlands Inventory (Kenai)

TERRESTRIAL VEGETATION

Class	Common Name	Scientific Name
Trees	alder	<u>Alnus sp.</u>
	cottonwood	<u>Populus tremuloides</u>
	paper birch	<u>Betula papyrifera</u>
	white spruce	<u>Picea glauca</u>
Shrub	sweet gale	<u>Myrica gale</u>
Below shrub	buck bean	<u>Menyanthes trifoliata</u>
	cotton grass	<u>Eriophorum sp.</u>
	marsh fivefinger	<u>Potentilla palustris</u>
	water hemlock	<u>Cicuta sp.</u>

June 9, 1975 memo to the Kenai NWR Manager, Schuler (1975) stated the lake fishery appeared to be doing well.

WILDLIFE

Two trumpeter swans were observed on the lake as well as a mallard, red-necked grebe, and white-winged scoter. Wildlife species along with other pertinent data are in Table 7.

RECREATIONAL USE

Recreational uses of Tangerra Lake include fishing, wildlife viewing, camping, and boating. Rusts Flying Service holds a Refuge Special Use Permit allowing them to establish a tent camp and fly in clients for sport fishing. Refuge records indicate that during 1983 the air service flew in 120 people. Rust's personnel describe the lake as a spotty rainbow trout lake. Some clients do well, but others often catch nothing. They indicate it is not a particularly productive lake for trout fishing. There appear to be fewer large trout caught as opposed to a lot of smaller fish. No people were at the lake during our fish survey. There are no public use facilities on the lake other than those owned by the air carrier.

FISHERY RESOURCE SUMMARY

Tangerra lake is a remote lake mostly used by fly-in anglers for sport fishing. Rainbow trout were the only game fish present and were found at a moderate abundance of 0.27 fish per net hour. The range of trout sizes and ages indicates spawning and recruitment is occurring. The presence of rainbow trout as the single game species was corroborated by previous FWS and ADF&G surveys, except the State found a much higher abundance of rainbow trout. Threespine stickleback at a moderately high abundance (CPUE 2.90) and coastrange sculpin constituted the forage species.

Fishing pressure on the lake is believed to be low at about 2.1 angler days per acre and mostly from fly-in clients. Lake fertility is medium, and the MEI was 15.0. Dissolved oxygen levels were high for cold water game fish in 80 percent of the water column. There was no rainbow trout spawning habitat evident in the immediate vicinity of the lake. Trout are believed to spawn in downstream reaches of the outlet stream migrating during high water periods. There may also be some fish interchange with the lake connected to the inlet stream. The absence of juvenile coho salmon suggests there is a downstream blockage preventing migration of anadromous fish. Tangerra Lake is believed capable of supporting a moderate yield rainbow trout sport fishery.

Table 7.

WILDLIFE DATA
Tangerra Lake 7/30-31/84

Animal Class	Common Name	Number	Sex M-F-U	Animal Assoc.	Verification	Habitat Type
Birds						
Waterfowl	mallard	1	0-1-0	Single	Sight	Water
	red-necked grebe	1	0-0-1	Single	Sight	Water
	trumpeter swan	2	1-1-0	Pair	Sight	Water
	unid. duck	6 J+	0-1-5	Brood	Sight	Water
	white-winged scoter	2	1-1-0	Pair	Sight	Water
Passerines	tree swallow	1	0-0-1	Single	Sight	Trees
	white-crowned sparrow	S	-	-	Sight	Trees
Gulls/Terns	mew gull	1	0-0-1	Single	Sight	Water
Mammals						
Big Game	black bear	-	-	-	Feces	-
	moose	1	0-1-0	Single	Sight	Alder
Other	red squirrel	1	0-0-1	Single	Sight	Spruce

WATSON LAKE

SURVEY PERIOD

Personnel of the U.S. Fish and Wildlife Service surveyed Watson Lake twice during 1984. W.J. Jakubas and G.A. Muhlberg conducted a fishery survey on July 5-6. Detailed water quality data were gathered by G.A. Muhlberg and A.S. Firman on July 20. Table 1 summarizes Watson Lake survey findings.

PHYSICAL FEATURES

Watson Lake is located in the eastcentral section of the Kenai National Wildlife Refuge (NWR) and is part of the Kenai River Basin. Its latitude is north 60° 32' and longitude west 150° 27'. The lake and surrounding area were designated in the Intensive Land Management Category by the Kenai NWR Comprehensive Conservation Plan (USFWS 1985). The watershed area for the lake is estimated to be 25.9 square miles. Watson Lake has a surface area of 59 acres, a volume of 320 acre feet, and is at an estimated elevation of 270 feet. The lake has a mean depth of 5.4 feet and maximum depth of 14 feet (Table 1 and Figure 1).

Low hills, situated on the east and west sides of the lake, form a shallow flood plain for the East Fork Moose River which passes through Watson Lake. Terrestrial vegetation around the lake consists of scattered black spruce, immature paper birch, quaking aspen, alder, and a limited quantity of willow which are regrowth from the 1947 refuge fire. No bog areas of significant size were noted.

Lake water level is maintained by three streams, springs, and run-off. The principal inlet and outlet streams are the East Fork Moose River. The East Fork Moose River drains Kelly, Petersen, and Equmen Lakes before entering Watson Lake at the south end. This permanent flow stream was about 7 feet wide and 1 foot deep. Flow was estimated to be 11 cubic feet per second (cfs). A smaller inlet stream, on the lake's southeast side, was 2 feet wide and 0.5 foot deep with an estimated flow slightly less than 1 cfs; it may become intermittent during dry periods. The outlet stream, at the north end of the lake, was 20 feet wide and 1 foot deep. Its flow was estimated at 15 cfs. The outlet stream flows 7.8 miles connecting with the Moose River which, in turn, flows 9.2 miles southwest to a confluence with the Kenai River.

The East Fork Moose River contains spawning gravel and flows which constitute high quality rainbow trout spawning habitat plus furnishing migratory fish passage. The smaller inlet stream appeared to be low quality trout spawning habitat. A 0.5 mile long gravel service road connects the lake to the Sterling Highway. Outboard motors over 10 horsepower are prohibited on the lake by Refuge regulation.

FISH

Rainbow trout were the most abundant game fish in the lake with a high catch per unit effort (CPUE) of 1.20 fish per net hour (Table 2). Juvenile coho salmon were also high in abundance (CPUE 1.20) as were longnose sucker (CPUE

Table 1.

LAKE SURVEY SUMMARY
Watson Lake

LOCATION				SPORT FISH VALUE	
				(Species)	(Yield)
Refuge	Kenai NWR	Map	Kenai (C-2)	Rainbow Trout	Moderately High
Lat.	N 60° 32'	Long.	W 150° 27'	Sockeye Salmon	Low
T	5N R 7W	S	11	Coho Salmon	Nursery Area
Land Use Class	Intensive Management				

PHYSICAL FEATURES

Surface Area (Ac.)	59
Maximum Depth (Ft.)	14
Mean Depth (Ft.)	5.4
Volume (Ac.Ft.)	320
Water Trans. (Ft.)	13
Elevation (Ft.)	270

WATERSHED
Kenai River

FISH SPECIES

Rainbow Trout
Coho Salmon 1/
Sockeye Salmon
Longnose Sucker
Threespine Stickleback

WATER QUALITY

Temp. (°C)	14.9-14.0
D.O. (mg/l)	8.5-7.7
pH	7.2
Tot. Alk. (mg/l)	68
Tot. Hard. (mg/l)	69
Tot. Phos. (ug/l)	16.2
Tot. Kjell. N (mg/l)	0.27
Cond. (umho)@ 25°C	157
MEI	95.7
SDF	1.37

1/ Residual Sockeye or Kokanee Salmon

TRIBUTARY STREAMS

Inlets (No.)	1 permanent flow
	1 intermittent flow
Outlets (No.)	1 permanent flow
Ocean Linkage	yes

RECREATION

Types: Fishing, camping, canoeing, wildlife viewing, hunting.

AQUATIC VEGETATION
(Dominant Families)

Lily, pondweed, sedge	
Lake Coverage (%)	71

Public Facilities: Multiple campsites, firepits, picnic tables, outhouse, water well, bulletin board, and boat ramp.

SURVEY DATES

Fish	7/5-6/84
Water Quality	7-20-84

Access: Direct access to the lake is over a 0.5 mile long gravel service road from the Sterling Highway. Outboard motors larger than 10 horse power prohibited.

Figure 1.

WATSON LAKE

(59 Acres)

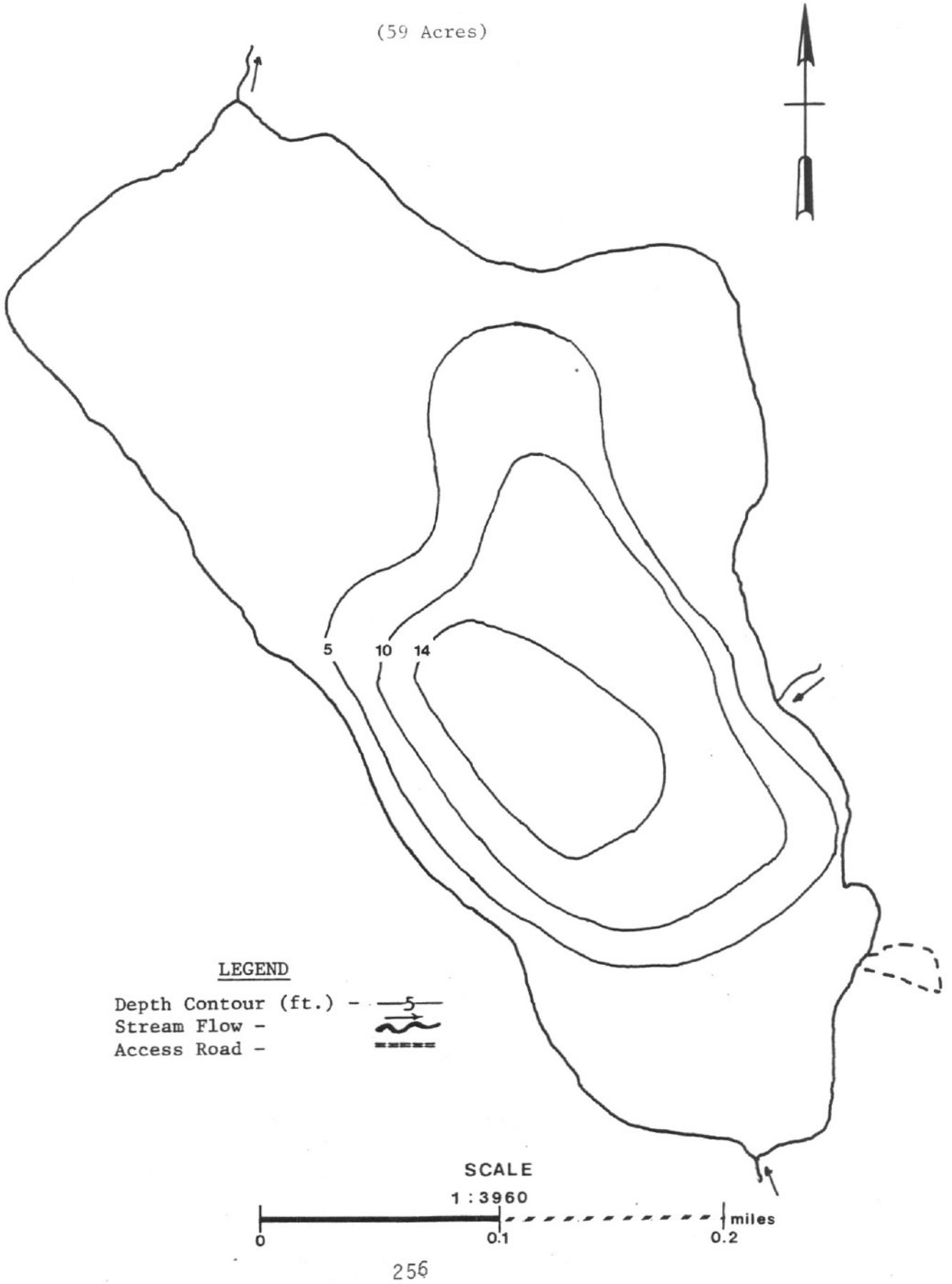


Table 2.

FISH CATCH AND EFFORT SUMMARY
Watson Lake 7/5-6/84

Gear	Average Fishing Time (hrs.)	Amount Gear (sq.ft.)	Fish Species	Total Fish Number	Sex M-F-U	Fish CPUE	
						Net Hour	Trap Hour
2 Gill Nets	15	1,600	Rainbow Trout	36	12-21-3	1.20	N/A
			Coho Salmon	36	0-0-36	1.20	N/A
			Sockeye Salmon ^{1/}	6	6-0-0	0.20	N/A
			Longnose Sucker	57	13-17-27	1.90	N/A
			All Species	135	31-38-66	4.50	N/A
10 Minnow Traps	21	N/A	Coho Salmon	33	0-0-33	N/A	0.16
			Threespine Stickleback	835	0-0-835	N/A	3.98
			All Species	868	0-0-868	N/A	4.14

1/ Residual Sockeye or Kokanee Salmon

1.90). Sockeye salmon were moderately abundant at a CPUE of 0.20. These sockeye were resident fish with a total freshwater life history and were either sockeye residuals or kokanee. Juvenile coho salmon were also captured in minnow traps (CPUE 0.16). Threespine stickleback with a high CPUE of 3.98 constituted the forage species. Two gill nets and 10 minnow traps were used to determine fish abundance.

A subsample of rainbow trout ranged in fork length from 8.5 inches (215 mm) to 16.0 inches (405 mm), in weight from 0.3 pounds (120 g) to 1.5 pounds (670 g), and in condition from 0.91 to 1.23. The coho salmon were juveniles varying in fork length from 3.9 inches (99 mm) to 4.6 inches (117 mm) and having weights from 0.02 pounds (11.3 g) to 0.04 pounds (19.7 g); condition factors were from 1.06 to 1.23. The sockeye salmon were of intermediate size varying in fork length from 8.2 inches (210 mm) to 9.3 inches (235 mm), in weight from 0.26 pounds (120 g) to 0.31 pounds (140 g), and in condition from 1.08 to 1.31. Longnose sucker varied in fork length from 11.6 inches (295 mm) to 17.9 inches (455 mm), in weight from 0.6 pounds (280 g) to 2.3 pounds (1060 g), and in condition from 0.86 to 1.30. Additional data on length, weight, and condition of rainbow trout, coho salmon, sockeye salmon, and longnose sucker are in Table 3.

The age of the rainbow trout ranged from four to eight years (Table 4). Average annual growth was 1.8 inches per year. Coho salmon were one and two years of age with an average annual growth of 1.6 inches per year. The sockeye salmon were all three years old; back calculation of scales indicated an average annual growth rate of 2.2 inches per year. Opercle analysis indicated the longnose sucker ranged in age from six to 18 years (Table 5).

AQUATIC VEGETATION

Watson Lake was heavily vegetated in shoal areas. Yellow pond lily; the pondweeds, Potamogeton natans, P. praelongus, P. perfoliatus, and P. zosterifolius; and bulrush were the most prevalent species. Two scrub shrub wetlands plotted in the National Wetlands Inventory (USFWS 1978) were not clearly evident during our survey and, therefore, are not shown in Figure 1. Approximately 71 percent of the lake was covered with aquatic plants. A complete list of vegetation is in Table 6.

WATER QUALITY

The lake's alkalinity of 68 mg/l was almost twice as high as the average 39 mg/l found in the 37 lakes surveyed during 1983-84. Lake water fertility is medium in productivity using our modification of J.B. Moyle's classification (MacKenthun and Ingram 1967). The pH of 7.2 was near neutral. The lake was not thermally stratified during July, however, water temperature declined slightly from 14.9°C at the surface to 14.0°C near the lake's deepest point (Table 7). Dissolved oxygen values were uniformly saturated at about 84 percent (8.5-8.4 mg/l) throughout most of the water column.

Water color was green brown with a Secchi disc transparency of 13 feet. The lake had a Morphoedaphic Index of 95.7 and a Shoreline Development Factor of 1.37. Dissolved oxygen levels at the time of the fish survey are in Table 8.

Table 3.
FISH LENGTH, WEIGHT, AND CONDITION SUMMARY
Watson Lake 7/5-6/84

Gear	Category	Species	Sample Size	Mean	Standard Deviation	Range
Gill Nets	Fork Length (mm)	Rainbow Trout	35	301	54.0	215 - 405
		Longnose Sucker	37	382	48.8	295 - 455
		Coho Salmon	10	106	6.50	99 - 117
		Sockeye Salmon	6	220	8.37	210 - 235
	Weight (g)	Rainbow Trout	35	316	162	120 - 670
		Longnose Sucker	37	651	234	280 - 1060
		Coho Salmon	10	13.8	2.50	11.3 - 19.7
		Sockeye Salmon	6	127	8.16	120 - 140
	Condition (K)	Rainbow Trout	35	1.07	0.07	0.91 - 1.23
		Longnose Sucker	37	1.13	0.11	0.86 - 1.30
		Coho Salmon	10	1.15	0.06	1.06 - 1.23
		Sockeye Salmon	6	1.19	0.10	1.08 - 1.31
Minnow Traps	Fork Length (mm)	Coho Salmon	1	67.0	-	-
	Weight (g)	Coho Salmon	1	3.00	-	-
	Condition (K)	Coho Salmon	1	1.00	-	-

Table 4.

BACK-CALCULATED FORK LENGTHS (MILLIMETERS) AT ANNULUS FORMATION*
of Rainbow Trout in Watson Lke - 1984

Year Class	Number of Fish	Age of Fish												Capture FL	
		1	2	3	4	5	6	7	8	9	10	11	12		
1980	2	46	92	151	203										223
1979	4	50	91	142	185	224									248
1978	4	37	73	118	165	215	263								279
1977	5	36	74	125	171	216	262	314							328
1976	4	40	73	114	156	208	262	317	369						384
Number of Fish	19	19	19	19	19	17	13	9	4						
Grand Mean (mm)		40	78	125	173	218	263	315	369						
Grand Mean (in)		1.6	3.1	5.0	6.8	8.6	10.4	12.4	14.6						
Annual Growth Increment (in)		1.6	1.5	1.9	1.9	1.8	1.8	2.1	2.1						

*Not corrected for length at scale formation

Table 5.

AGE-FORK LENGTH OF LONGNOSE SUCKER
Watson Lake - 1984

Fish Age (years)	Sample Size (no)	---Mean---		Fork Length	Range (mm)
		(in)	(mm)		
6	1	13.2	335		-
10	1	13.0	330		-
11	1	17.7	450		-
12	2	15.5	393		365 - 420
13	2	16.7	423		420 - 425
14	1	18.1	460		-
18	1	17.3	440		-

Table 6.

VEGETATION
Watson Lake 7/5-6/84

AQUATIC VEGETATION

Class	Common Name	Scientific Name
Emergent	bulrush	<u>Scirpus validus</u>
	horsetail	<u>Equisetum fluviatile</u>
	mare's tail	<u>Hippuris vulgaris</u>
	sedge	<u>Carex rhynchophysa</u>
	spike rush	<u>Eleocharis palustris</u>
	tufted loostrife	<u>Lysimachia tryrsiflora</u>
Floating	bur reed	<u>Sparganium angustifolium</u>
	dwarf water lily	<u>Nymphaea tetragona</u>
	pondweed	<u>Potamogeton natans</u>
	yellow pond lily	<u>Nuphar polysepalum</u>
Submergent	bladderwort	<u>Utricularia sp.</u>
	crowfoot	<u>Ranunculus confervoides</u>
	pondweed	<u>Potamogeton gramineus</u>
	pondweed	<u>Potamogeton praelongus</u>
	pondweed	<u>Potamogeton perfoliatus</u>
	pondweed	<u>Potamogeton vaginatus</u>
	pondweed	<u>Potamogeton zosterifolius</u>

TERRESTRIAL VEGETATION

Class	Common Name	Scientific Name
Trees	alder	<u>Alnus sp.</u>
	black spruce	<u>Picea mariana</u>
	paper birch	<u>Betula papyrifera</u>
	quaking aspen	<u>Populus tremuloides</u>
Below Shrub	marsh fivefinger	<u>Potentilla palustris</u>
	wild calla	<u>Calla palustris</u>

MANAGEMENT HISTORY

The first survey of Watson Lake (Kubik and Reynolds 1960) was conducted by the Alaska Department of Fish and Game (ADF&G) during July, 1960. Biologists reported capturing 16 rainbow trout and 16 longnose sucker in two gill nets fished for 24 hours. ADF&G made a series of fish surveys from 1967 through 1969 and reported capturing large numbers of rainbow trout, kokanee salmon, coho salmon, and longnose sucker (Engel 1967, 1968, and Engel and Watsjold 1969). The Fish and Wildlife Service (FWS) surveyed the lake in July, 1975 (Schuler 1975), capturing 21 rainbow trout, 31 longnose sucker, and one coho salmon for respective CPUE's of 0.28, 0.65, and 0.02. The trout ranged in fork length from 11.8 inches (300 mm) to 20.3 inches (515 mm). The single coho salmon had a fork length of 8.9 inches (225 mm). Shuler (1975), in a FWS letter to the Kenai NMR manager, stated that Watson Lake had an excellent rainbow trout population, and that the various trout size groups indicated reproduction was occurring. He further said that the coho salmon had established a landlocked population in the Watson - Peterson - Kelly Lake complex with most of these fish between two and three years old. We found no evidence of older, larger coho salmon in 1984.

WILDLIFE

A common loon, red-necked grebes, Arctic terns, and mew gulls were sighted on the lake. Common snipe and yellow legs were seen along the shore. A bald eagle and red-tailed hawk were observed. An active beaver lodge, at the north end of the lake, evidenced the presence of beaver while muskrat were indicated by clam shell feeding areas. Wildlife species identified along with other pertinent data are in Table 9.

RECREATIONAL USE

Recreational uses of Watson Lake include fishing, camping, wildlife viewing, boating, and hunting. During the summer the campground is believed to receive heavy public use. Our survey found an average of five campers constantly filling the parking area. Over the two day period we observed five boats fishing the lake. Winter ice fishing has also been noted. No long term count of fishing use is available. The lake serves as a launch point for the East Fork Canoe Route to the Sterling Highway Bridge.

FISHERY RESOURCE SUMMARY

Rainbow trout were the dominant game fish in Watson Lake being found in high abundance (CPUE 1.20). This catch included a good range of size and age classes indicating that successful spawning and recruitment was occurring. The presence of large numbers of juvenile coho salmon (CPUE 1.20) certifies the lake as a nursery area. A moderate abundance (CPUE 0.20) of intermediate size residual sockeye or kokanee was present. Adult anadromous sockeye salmon are also known to migrate through the lake; they were not present at the time of our survey. Although no juvenile sockeye were captured, they may also utilize the lake for nursery purposes. A high population of threespine stickleback constituted the forage species. Previous ADF&G and FWS surveys support our finding of species diversity and fish abundance.

Table 9.

WILDLIFE DATA
Watson Lake 7/5-6/84

Animal Class	Common Name	Number	Sex M-F-U	Animal Assoc.	Verification	Habitat Type
Birds	Waterfowl					
	common loon	1	0-0-1	Single	Sight	Water
	red-necked grebe	2	0-0-2	Single	Sight	Water
Passerines	American robin	-	-	-	Sound	Trees
	Bohemian waxwing	-	-	-	Sound	Trees
	dark-eyed junco	-	-	-	Sound	Trees
	gray-cheeked thrush	-	-	-	Sound	Trees
	rusty blackbird	-	-	-	Sound	Trees
	tree swallow	-	-	-	Sight	Trees
	white-crowned sparrow	-	-	-	Sound	Trees
Shorebirds	common snipe	1	0-0-1	Single	Sight	Bog
	greater yellowlegs	1	0-0-1	Single	Sight	Bog
Gulls/Terns	Arctic tern	2	0-0-2	Single	Sight	Water
	mew gull	2	0-0-2	Single	Sight	Water
Raptors	bald eagle	1	0-0-1	Single	Sight	Tree
	red-tailed hawk	1	0-0-1	Single	Sight	Tree
Mammals						
Big Game	moose	2 J+	0-1-1	Cow/Calf	Sight	Shore
Furbearers	beaver	-	-	-	Lodge	-
	muskrat	-	-	-	Clam Shells	-
Other	snowshoe hare	1	0-0-1	Single	Sight	Ground

Fishing pressure in the lake is believed to be moderate, partially due to its popularity as a camping site. The lake is medium in fertility and has a MEI of 95.7. Dissolved oxygen values were high for cold water game fish. High quality rainbow trout and salmon spawning habitat is provided by the East Fork Moose River which also serves as a migratory route for anadromous salmonids. Watson Lake can support a moderately high yield rainbow trout sport fishery, a low yield residual sockeye salmon sport fishery, and serve as a coho and possibly a sockeye salmon nursery area.

WILDERNESS LAKE

SURVEY PERIOD

Personnel of the U.S. Fish and Wildlife Service surveyed Wilderness Lake twice during 1984. G.A. Muhlberg and A.S. Firman conducted a fishery survey on August 1-2. Detailed water quality data were gathered by W.J. Jakubas and G.A. Muhlberg on July 18. Table 1 summarizes survey findings.

PHYSICAL FEATURES

Wilderness Lake is located in the northeast section of the Kenai National Wildlife Refuge (NWR) and is part of the Swanson River Basin. Its latitude is north 60° 49' and longitude west 150° 21'. The lake and surrounding area were designated wilderness by the Alaska National Interest Lands Conservation Act of 1980. The watershed area for the lake is estimated to be 15.7 square miles. Wilderness Lake has a surface area of 155 acres, a volume of 1,800 acre feet, and is at an elevation of 210 feet. The lake has a mean depth of 11.5 feet and maximum depth of 31 feet (Table 1 and Figure 1).

Wilderness Lake is surrounded by low hills reaching slightly over 350 feet in elevation. A dense forest consisting mostly of mature white spruce and paper birch with scattered alder along the shoreline surrounds the northern half of the lake. Two large wetland areas make up the southeast and southwest corners of the lake, while scattered black spruce and birch are present along the southcentral shore.

Lake water level is maintained by streams, springs, bog seepage, and run-off. The main inlet stream flows about 1.1 miles from King Lake. Its width was about 6 feet and depth 3.5 feet. Flow was estimated to be 0.5 cubic feet per second (cfs). The outlet stream, at the southwest corner of the lake, was approximately 10 feet wide by 2.5 feet deep. Its flow was estimated to be about 2 cfs. Aerial photos indicate the outlet stream continues approximately 9 miles to the north and west through Llerum, Lynx, Pepper, and Gene Lakes to a tributary of the Swanson River. The aerial photos further indicate a small unnamed lake drains to the northern tip of Wilderness Lake, and Wren Lake feeds to the southern shore. No flows were detected in these two floodways, and their confluences with the lake were not evident. Therefore, these streams are not shown on Figure 1.

Both the inlet and outlet streams contained dense aquatic vegetation, had mud bottoms, and their banks were floating bogs. They did not constitute rainbow trout spawning habitat.

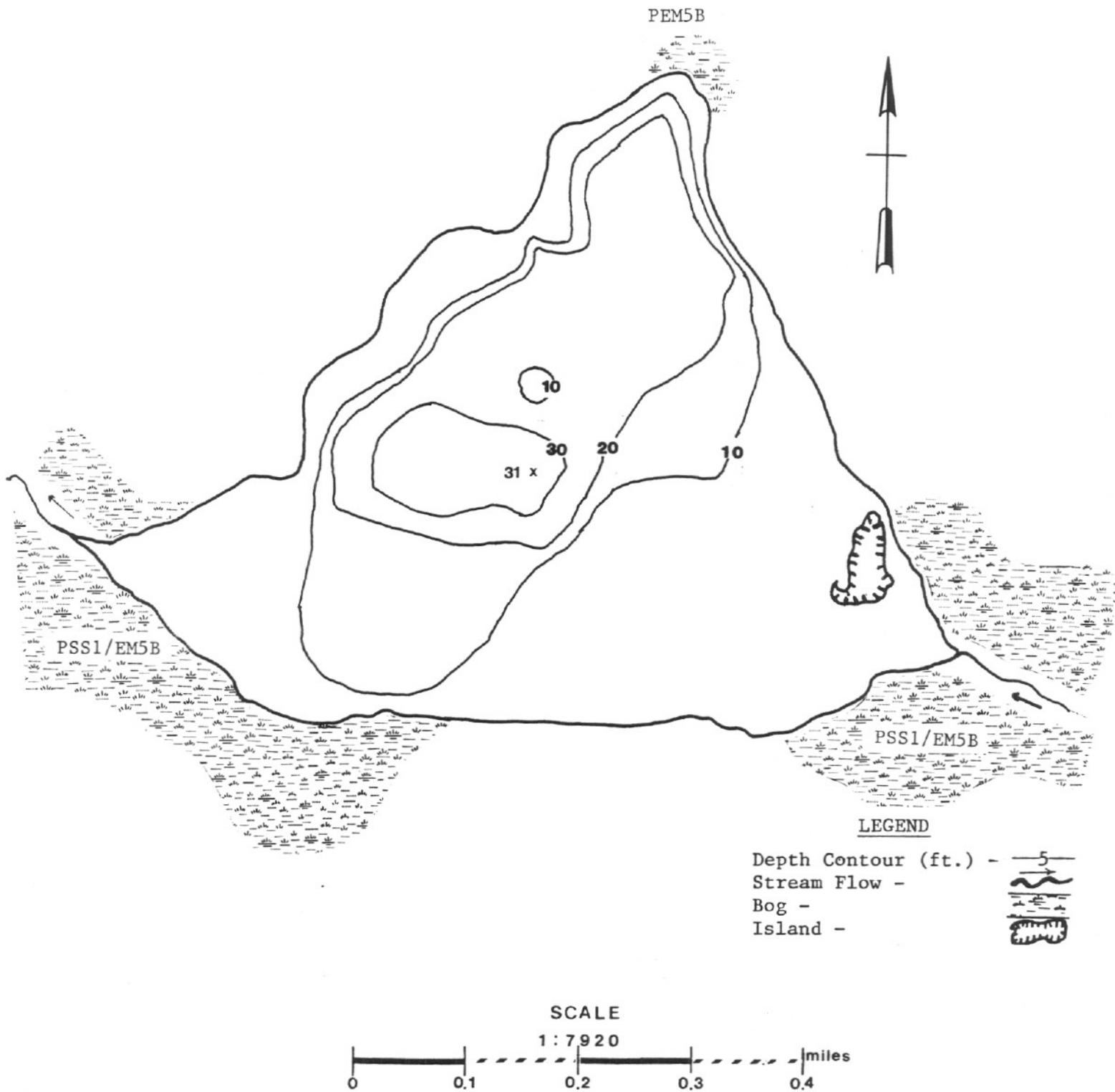
FISH

Rainbow trout were the dominant game fish in Wilderness Lake. They were in moderately high abundance with a catch per unit effort (CPUE) of 0.91 fish per net hour (Table 2). Resident sockeye salmon, Arctic char, and longnose sucker were all in low abundance with respective CPUE's of 0.10, 0.06, and 0.09. A low abundance of threespine stickleback (CPUE 0.26), ninespine stickleback, and coastrange sculpin constituted the forage species. A total of six gill nets and 14 minnow traps were used to measure fish abundance.

Figure 1.

WILDERNESS LAKE

(155 Acres)



LEGEND

- Depth Contour (ft.) -
- Stream Flow -
- Bog -
- Island -

SCALE

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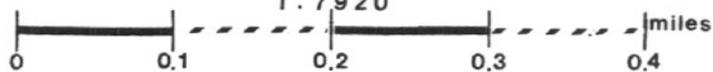


Table 2. FISH CATCH AND EFFORT SUMMARY
Wilderness Lake 8/1-2/84

Gear	Average Fishing Time (hrs.)	Amount Gear (sq.ft.)	Fish Species	Total Fish Number	Sex M-F-U	Fish CPUE	
						Net Hour	Trap Hour
6 Gill Nets	13	4,800	Rainbow Trout	71	5-17-49	0.91	N/A
			Arctic Char	5	1-0-4	0.06	N/A
			Sockeye Salmon ^{1/}	8	0-0-8	0.10	N/A
			Longnose Sucker	7	0-0-7	0.09	N/A
			All Species	91	6-17-68	1.16	N/A
14 Minnow Traps	21	N/A	Coastrange Sculpin	69	0-0-69	N/A	0.24
			Threespine Stickleback	75	0-0-75	N/A	0.26
			Ninespine Stickleback	3	0-0-3	N/A	0.01
			All Species	147	0-0-147	N/A	0.50

^{1/} Residual Sockeye or Kokanee Salmon

Rainbow trout ranged in fork length from 8.3 inches (210 mm) to 13.6 inches (345 mm), in weight from 0.2 pounds (100 g) to 1.1 pounds (490 g), and in condition from 0.82 to 1.29. Trout scales indicated the fish were from four to seven years old (Table 3), and the trout were growing at an average rate of 1.7 inches per year. The sockeye salmon had a complete freshwater life history and were either sockeye residuals or kokanee. They ranged in fork length from 9.8 inches (250 mm) to 12.2 inches (310 mm). Sockeye weights varied from 0.5 pounds (210 g) to 0.8 pounds (380 g) with condition factors from 1.13 to 1.47. All the sockeye were three years old and were growing at an average yearly rate of 3.0 inches. Arctic char varied in fork length from 14.0 inches (335 mm) to 19.7 inches (500 mm). Their weight ranged from 1.0 pounds (460 g) to 2.9 pounds (1310 g). Char condition factors were from 1.03 to 1.07. The longnose sucker ranged in fork length from 16.5 inches (420 mm) to 19.5 inches (495 mm), in weight from 2.0 pounds (890 g) to 2.9 pounds (1310 g), and in condition from 1.06 to 1.20. Longnose sucker ages, as determined from opercles, varied from eight to 13 years (Table 4). A summary of fish length, weight, and condition for rainbow trout, sockeye salmon, Arctic char, and longnose sucker are in Table 5.

AQUATIC VEGETATION

Aquatic vegetation was extensive and mostly confined to shallow areas near shore. Yellow pond lily; the pondweeds, Potamogeton robbinsii, P. natans, and P. alpinus were the most prevalent aquatic plants. Approximately 68 percent of the lake area was covered with aquatic vegetation. Three wetlands, scrub shrub (type PSS1/EM5B) and emergent (type PEM5B), plotted by the National Wetlands Inventory (USFWS 1978), were in general agreement with our wetland sightings. A complete list of vegetation is in Table 6.

WATER QUALITY

The lake's alkalinity level of 50 mg/l was higher than the 39 mg/l average found in the 37 lakes we surveyed in 1983-84. This value falls in the medium lake productivity category modified from Moyle's classification (MacKenthun and Ingram 1967). The pH of 7.3 was slightly above neutral. In July, the lake was thermally stratified with the thermocline occurring around 16 feet (Table 7). Water temperature was 17.5°C at the surface declining to 8.8°C near the bottom. Corresponding dissolved oxygen values were just below atmospheric saturation (9.4 mg/l) at the surface declining to 82 percent saturation (8.7 mg/l) at 20 feet. From this point dissolved oxygen became low being less than 1 percent saturated (0.2 mg/l) near the bottom. Despite the presence of low dissolved oxygen values near the bottom, overall oxygen conditions were adequate for cold water game fish. No water quality measurements were taken during the fish survey.

Water color was green yellow with a Secchi disc transparency of 16 feet. The lake had a Morphoedaphic Index of 30.3 and Shoreline Development Factor of 1.45.

MANAGEMENT HISTORY

Personnel of the Alaska Department of Fish and Game surveyed Wilderness Lake in June, 1971 (Hollingshead and Johnson 1971). They captured one rainbow trout,

Table 3.

BACK-CALCULATED FORK LENGTHS (MILLIMETERS) AT ANNULUS FORMATION*
of Rainbow Trout in Wilderness Lake - 1984

Year Class	Number of Fish	Age of Fish												Capture FL	
		1	2	3	4	5	6	7	8	9	10	11	12		
1980	2	41	88	131	183										220
1979	4	44	90	135	187	228									263
1978	9	44	85	132	177	223	262								296
1977	5	35	70	108	152	198	245	295							320
Number of Fish	20	20	20	20	20	18	14	5							
Grand Mean (mm)		41	82	127	174	217	256	295							
Grand Mean (in)		1.6	3.2	5.0	6.8	8.6	10.0	11.6							
Annual Growth Increment (in)		1.6	1.6	1.7	1.9	1.7	1.5	1.5							

*Not corrected for length at scale formation

Table 4.

AGE-LENGTH OF LONGNOSE SUCKER
Wilderness Lake - 1984

Fish Age (years)	Sample Size (no)	Fork Length		Range (mm)
		----Mean---- (in)	(mm)	
8	1	16.5	420	-
11	1	18.9	480	-
13	2	19.4	493	490-495

Table 5. FISH LENGTH, WEIGHT, AND CONDITION SUMMARY
Wilderness Lake 8/1-2/84

Gear	Category	Species	Sample Size	Mean	Standard Deviation	Range
Gill Nets	Fork Length (mm)	Rainbow Trout	65	288	29.1	210 - 345
		Arctic Char	4	401	67.0	355 - 500
		Sockeye Salmon	8	284	24.3	250 - 310
		Longnose Sucker	4	471	34.7	420 - 495
	Weight (g)	Rainbow Trout	65	269	84.0	100 - 490
		Arctic Char	4	723	397	460 - 1310
		Sockeye Salmon	8	306	61.9	210 - 380
		Longnose Sucker	4	1173	193	890 - 1310
	Condition (K)	Rainbow Trout	65	1.10	0.10	0.82 - 1.29
		Arctic Char	4	1.05	0.02	1.03 - 1.07
		Sockeye Salmon	8	1.31	0.15	1.13 - 1.47
		Longnose Sucker	4	1.12	0.06	1.06 - 1.20

Table 6.

VEGETATION
Wilderness Lake 8/1-2/84

AQUATIC VEGETATION

Class	Common Name	Scientific Name
Emergent	bulrush	<u>Scirpus validus</u>
	horsetail	<u>Equisetum palustre</u>
	mare's tail	<u>Hippuris vulgaris</u>
Floating	bur reed	<u>Sparganium minimum</u>
	pondweed	<u>Potamogeton natans</u>
	yellow pond lily	<u>Nuphar polysepalum</u>
Submergent	pondweed	<u>Potamogeton alpinus</u>
	pondweed	<u>Potamogeton praelongus</u>
	pondweed	<u>Potamogeton robbinsii</u>
	milfoil	<u>Myriophyllum sp.</u>

WETLANDS VEGETATION*

Class	Symbol	Description
Scrub-shrub	PSS1/EM5B	palustrine, scrub-shrub, broad leaved deciduous, emergent, narrow leaved persistent, saturated
Emergent	PEM5B	palustrine, emergent, narrow leaved persistent, saturated

*National Wetlands Inventory (Kenai)

TERRESTRIAL VEGETATION

Class	Common Name	Scientific Name
Trees	alder	<u>Alnus sp.</u>
	black spruce	<u>Picea mariana</u>
	paper birch	<u>Betula papyrifera</u>
	white spruce	<u>Picea glauca</u>
Shrub	sweet gale	<u>Myrica gale</u>
Below Shrub	buck bean	<u>Menyanthes trifoliata</u>
	marsh fivefinger	<u>Potentilla palustris</u>

one Arctic char, and four longnose suckers for respective CPUE's of 0.03, 0.03, and 0.12 fish per net hour in two gill nets fished for about 17 hours. The rainbow trout was 13.8 inches (351 mm) long, the char 16.9 inches (430 mm), and the suckers ranged in length from 17.5 inches (435 mm) to 20.1 inches (511 mm); the method used to measure fish was not indicated. On February 15, 1973, the Fish and Wildlife Service made an oxygen measurement through 18 inches of snow and 24 inches of ice; dissolved oxygen near the water surface was 3.0 mg/l. Another oxygen measurement was taken on April 6, 1976, through eight inches of snow and 37 inches of ice. The dissolved oxygen value during this latter survey was 8.0 mg/l. No other survey work is known to have been accomplished on the lake.

WILDLIFE

Common loons were on the lake, and a pair of sandhill cranes were in a bog. Three active beaver lodges in the southeast part of the lake verified the presence of beaver. Muskrat were indicated by the presence of clam shell feeding areas. Wildlife species and pertinent data are in Table 8.

RECREATIONAL USE

Recreational uses of Wilderness Lake include fishing, wildlife viewing, camping, canoeing, and hunting. Wilderness Lake is on a dead end leg of the Swanson River Canoe Route, part of the National Recreational Trail System. The lake reportedly receives only limited canoe use.

Ketchum Air Service, Inc. has been issued a Special Use Permit by the Kenai NWR allowing them to establish a tent camp and fly in clients to fish and camp. Refuge records indicate that about 1,400 visitor days were utilized by Ketchum clients in 1983. There are no public use facilities on the lake other than those owned by the air carrier.

FISHERY RESOURCE SUMMARY

Wilderness Lake is a remote lake in a wilderness setting that is primarily used for sport fishing. Rainbow trout are the dominant game fish being found in moderately high abundance (CPUE 0.91). The variety of trout ages and sizes indicates spawning and recruitment is occurring. Arctic char (CPUE 0.06), longnose sucker (CPUE 0.09), and resident sockeye salmon (CPUE 0.10) were in low abundance. The sockeye had a complete fresh water life history and were either sockeye residuals or kokanee. A low abundance of threespine stickleback (CPUE 0.26), ninespine stickleback, and coastrange sculpin constituted the forage species.

Fishing pressure on the lake is believed to be low at about 9 angler days per acre annually and almost totally from fly-in clients. Lake fertility is moderate, and the MEI was 30.3. Dissolved oxygen was high for cold water game fish in the upper half of the lake. Past water quality work indicates there may be some winter oxygen stress.

None of the tributaries adjacent to the lake appeared to contain rainbow trout spawning habitat. The most likely spawning area is somewhere in the outlet stream network or Swanson River. We believe there is fish interchange between Wilderness and King Lake. Arctic char and resident sockeye salmon probably

Table 8.

WILDLIFE DATA
Wilderness Lake 8/1-2/84

Animal Class	Common Name	Number	Sex M-F-U	Animal Assoc.	Verification	Habitat Type
Birds						
Waterfowl	common loon	4 J+	1-1-2	Brood	Sight	Water
	sandhill crane	4	2-2-0	Pair	Sight	Marsh
	unid. duck	6 J+	0-1-5	Brood	Sight	Water
Mammals						
Big Game	moose	3 J+	0-1-2	Cow/Calf	Sight	Marsh
Furbearers	beaver	-	-	-	Lodge	-
	muskrat	-	-	-	Clam Shells	-

migrate from there. Wilderness Lake can support a moderately high yield rainbow trout sport fishery, and low yield sockeye salmon and Arctic char sport fisheries.

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REFERENCES

- ADF&G. 1963. West Forest Lake survey data, 10-23-63 (Unpublished). Alaska Department of Fish and Game, Soldotna, AK.
- _____. 1963. East Forest Lake survey data, 10-24-63 (Unpublished). Alaska Department of Fish and Game, Soldotna, AK.
- Bailey, R.E. 1974. Kelly Lake survey data, 6-28-74 (Unpublished). U.S. Fish and Wildlife Service, Kenai Fishery Resources Station, Kenai, AK.
- _____. 1974. Lower Ohmer Lake survey data, 6-25-74 (Unpublished). U.S. Fish and Wildlife Service, Kenai Fishery Resources Station, Kenai, AK.
- _____. 1974. Peterson Lake survey data, 6-27-74 (Unpublished). U.S. Fish and Wildlife Service, Kenai Fishery Resources Station, Kenai, AK.
- Bailey, R.E., and J.M. Nelson. 1974. Management recommendations for Kelly Lake (Memo dated 10-8-74 to Kenai NMR Manager). U.S. Fish and Wildlife Service, Kenai Fishery Resources Station, Kenai, AK.
- _____. 1974. Management recommendations for Petersen Lake (Memo dated 10-8-74 to Kenai NMR Manager). U.S. Fish and Wildlife Service, Kenai Fishery Resources Station, Kenai, AK.
- Carlander, K.D. 1969. Handbook of freshwater fishery biology, Volume I. The Iowa State University Press, Ames, Iowa. 752 pp.
- Crateau, E.J. 1974. Mosquito Lake survey data, 6-24-74 and 7-2-74 (Unpublished). U.S. Fish and Wildlife Service, Kenai Fishery Resources Station, Kenai, AK.
- _____. 1975. Fishery management survey-Lower Ohmer Lake (Memo dated 3-14-75 to Kenai NMR Manager). U.S. Fish and Wildlife Service, Kenai Fishery Resources Station, Kenai, AK.
- _____. 1975. Mosquito Lake fishery management survey (Memo dated 8-13-75 to Kenai NMR Manager). U.S. Fish and Wildlife Service, Kenai Fishery Resources Station, Kenai, AK.
- Dune, J. 1960. Lower Ohmer Lake survey data, 6-17-60 (Unpublished). Alaska Department of Fish and Game, Soldotna, AK.
- Engel, L.J. 1967. Watson Lake survey data, 9-28-67 (Unpublished). Alaska Department of Fish and Game, Soldotna, AK.
- _____. 1968. Watson Lake survey data, 9-13-68 and 9-15-68 (Unpublished) Alaska Department of Fish and Game, Soldotna, Alaska.
- Engel, L.J., and D.A. Watsjold. 1969. Watson Lake survey data, 10-23-69 (Unpublished). Alaska Department of Fish and Game, Soldotna, AK.

- Engel, L.J., and W. Johnson. 1964. Canoe Lake survey data, 10-7-64 (Unpublished). Alaska Department of Fish and Game, Soldotna, AK.
- Friedersdorff, J.W. 1984. Remote and roadside lake study, Kenai National Wildlife Refuge, Vol. 2. U.S. Fish and Wildlife Service, Kenai Fishery Resources Station, Kenai, Alaska. 109 pp.
- _____. 1984. Technical supplement, aquatic habitats and fish species, Kenai comprehensive conservation plan, environmental impact statement and wilderness review (Unpublished data). U.S. Fish and Wildlife Service, Anchorage, Alaska. 47 pp.
- Friedersdorff, J.W., and W.J. Jakubas. 1984. Remote and roadside lake study, Kenai National Wildlife Refuge, Vol. 1. U.S. Fish and Wildlife Service, Kenai Fishery Resources Station, Kenai, AK. 150 pp.
- Hollingshead, L., and W. Johnson. 1971. King Lake survey data, 6-16-71 (Unpublished). Alaska Department of Fish and Game, Soldotna, AK.
- _____. 1971. Wilderness Lake survey data, 6-16-71 (Unpublished). Alaska Department of Fish and Game, Soldotna, AK.
- Howe, F., and J. Ashmore. 1969. Tangerra Lake survey data, 8-29-69 (Unpublished). Alaska Department of Fish and Game, Soldotna, AK.
- Hulten, E. 1974. Flora of Alaska and neighboring territories; a manual of the vascular plants. Stanford University Press, Stanford, CA. 1008 pp.
- Jenkins, R.M. 1976. Prediction of fish production in Oklahoma reservoirs on the basis of environmental variables. *Ann. Okla. Acad. Sc.* 5: 11-20.
- _____. 1982. The morphoedaphic index and reservoir fish production. *Trans. Am. Fish. Soc.* 111: 133-140.
- Kubik, S., and J. Reynolds. 1960. Kelly Lake survey data, 7-17-60 (Unpublished). Alaska Department of Fish and Game, Soldotna, AK.
- _____. 1960. Petersen Lake survey data, 7-9-60 (Unpublished). Alaska Department of Fish and Game, Soldotna, AK.
- _____. 1960. Watson Lake survey data, 7-7-60 (Unpublished). Alaska Department of Fish and Game, Soldotna, AK.
- Kubik, S., and T. Nagata. 1961. Big Merganser Lake survey data, 8-7-61 (Unpublished). Alaska Department of Fish and Game, Soldotna, AK.
- Lawler and Lewis. 1963. Mosquito Lake survey data, 9-5-63 (Unpublished). Alaska Department of Fish and Game, Soldotna, AK.
- Lind, O.T. 1974. Handbook of common methods in limnology. C.V. Mosby Company. 154 pp.

- Mackenthun, K.M., and W.M. Ingram. 1967. Biological associated problems in freshwater environments; their investigation and control. U.S. Dept. of Interior, Federal Water Pollution Control Administration. 287 pp.
- Nelson, J.M., and E.J. Crateau. 1975. Lower Ohmer Lake survey data, 3-5-75 (Unpublished). U.S. Fish and Wildlife Service, Kenai Fishery Resources Station, Kenai, AK.
- Nelson, J.M., and R.E. Bailey. 1974. Canoe Lake survey data, 7-16-74 (Unpublished). U.S. Fish and Wildlife Service, Kenai Fishery Resources Station, Kenai, AK.
- Ryder, R.A. 1965. A method of estimating the potential fish production from north-temperate lakes. *Trans. Am. Fish. Soc.* 94: 214-218.
- Ryder, R.A., S.R. Kerr, K.H. Loftus, and H.A. Regier. 1974. The morphoedaphic index, a fish yield estimator - review and evaluation. *J. Fish. Res. Board Can.* 31: 663-688.
- Schuler, J.A. 1975. Big Merganser Lake survey data, 8-21-75 (Unpublished) U.S. Fish and Wildlife Service, Kenai Fishery Resources Station, Kenai, AK.
- _____. 1975. East Forest Lake survey data, 7-7-75 and 8-1-75 (Unpublished). U.S. Fish and Wildlife Service, Kenai Fishery Resources Station, Kenai, AK.
- _____, 1975. Tangerra Lake fishery (Memo dated 6-9-75 to the Kenai NMR Manager). U.S. Fish and Wildlife Service, Kenai, Fishery Resources Station, Kenai, AK.
- _____. 1975. Tangerra Lake survey data, 5-22-75 (Unpublished). U.S. Fish and Wildlife Service, Kenai Fishery Resources Station, Kenai, AK.
- _____. 1975. Watson Lake chain (Memo dated 9-3-75 to Kenai NMR Manager). U.S. Fish and Wildlife Service, Kenai Fishery Resources Station, Kenai, AK.
- _____. 1975. Watson Lake survey data, 7-29-75 (Unpublished). U.S. Fish and Wildlife Service, Kenai Fishery Resources Station, Kenai, AK.
- _____. 1975. West Forest Lake survey data, 7-7-75 (Unpublished). U.S. Fish and Wildlife Service, Kenai Fishery Resources Station, Kenai, AK.
- Schuler, J.A., and E.J. Crateau. 1975. Middle Finger Lake survey data, 9-3-75, (Unpublished). U.S. Fish and Wildlife Service, Kenai Fishery Resources Station, Kenai, AK.
- Strickland and Bernhardson. 1964. Middle Finger Lake survey data, 7-8-64. (Unpublished). Alaska Department of Fish and Game, Soldotna, AK.
- _____. 1964. Portage Lake survey data, 6-22-64 (Unpublished). Alaska Department of Fish and Game, Soldotna, AK.

USFWS. 1978. National wetlands inventory maps, Kenai series. U.S. Fish and Wildlife Service, Anchorage, AK.

_____. 1985. Kenai National Wildlife Refuge, final comprehensive conservation plan, environmental impact statement, wilderness review. U.S. Fish and Wildlife Service, Anchorage, Alaska. 195 pp.

Watsjold, D.A., and Goan. 1966. Middle Finger Lake survey data, 7-31-66 (Unpublished). Alaska Department of Fish and Game, Soldotna, AK.

Zar, J.H. 1974. Biostatistical analysis. Prentice-Hall, Inc., Engelwoods, N.J. 620 pp.

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APPENDIX A
FISHERY MATHEMATICAL FORMULAE

1. Gill Net CPUE - Number of Fish per Net Hour: $CPUE = F/(N \times T)$, where F = number of fish (species), N = number of nets, and T = fishing time (average) in hours.
2. Fish Condition (K) - The Relative Plumpness of Fish: $K = W \times 10^5/L^3$, where W = individual fish weight in grams, and L = individual fish length (fork length, total length, etc.) in mm.
3. Minnow Trap CPUE - Number of Fish Per Trap Hour: $CPUE = F/(TN \times T)$, where F = number of fish (species), TN = number of traps, and T = fishing time (average) in hours.
4. Strata Volume SV - The Amount of Water in a Vertical Lake Strata: $SV = h/3(A_1+A_2+ \sqrt{A_1 \times A_2})$, where h = vertical depth of lake contour stratum, A_1 = surface area of upper lake contour, and A_2 = surface area of lower lake contour.
5. Lake Volume - Amount of Water in Lake: $LV = \Sigma SV$, where SV = strata volume.
6. Mean Depth - The Mean Depth of the Lake: $MD = LV/SA$, where LV = lake volume, and SA = lake surface area.
7. Morphoedaphic Index MEI - A relative Measure of Lake Productivity: $MEI = C/MD$, where C = lake conductivity in micromhos at 25°C, and MD = lake mean depth (meters).
8. Shoreline Development Factor SDF - The Degree the Lake Shoreline Deviates From a Perfect Circle: $SDF = S/2 \sqrt{a\pi}$, where S = length of shoreline (inches), and a = surface area of lake (square inches).

APPENDIX B
GLOSSARY OF TECHNICAL TERMS

Acre Foot - 43,560 cubic feet of water.

Alkalinity - The acid combining or buffering capacity of a solution.
Bicarbonate ions constitute almost all the alkalinity in local waters.

Anadromous Fish - A fish species that spawns in fresh water while attaining most of its growth as an ocean resident.

Annulus - A mark on a fish scale that is formed once a year. The mark is used to tell the fish's age.

Biomass - The total amount of living matter in a lake.

Boreal - Forest type consisting chiefly of conifers.

Catch-per-unit-effort (CPUE) - In fisheries, the number of fish captured per unit of time and amount of gear effort. See Relative Abundance.

Conductivity - Specific conductance is the measure of a water's capacity to conduct electrical current. It is normally expressed in micromhos per square centimeter.

Creel Census - A canvass of anglers to gather data on their fishing effort and catch.

Cover - A part of the environment, living or dead, utilized by fish for cover, resting, feeding, or spawning.

Detritus - Dead organic material.

Dissolved Oxygen (Do) - A commonly employed measure of water quality relating to the amount of elemental oxygen in solution. Ideal Do for cold water fish is above 6.0 mg/l, problems can occur between 6.0 and 3.0 mg/l, and below 3.0 mg/l conditions are stressful. Salmonids have been known to survive in Do levels as low as 1.5 mg/l under extreme cold water conditions.

Epilimnion - The upper, warmer portion of a lake thermally stratified from lower colder water layers.

Euphotic Zone - The upper, well-lighted zone of a lake where photosynthesis occurs.

Eutrophic - A body of water with high supplies of nutrients and hence rich organic production.

Fertility - In fisheries, a water body having nutrients in proper amounts to promote plant and animal growth when other factors are favorable.

Food Chain - A series of feeding relationships between organisms.

- Forage Fish - Usually smaller fish that are food for larger fish.
- Game Fish - Fish species that are highly prized by anglers for sport.
Examples include rainbow trout and salmon.
- Hardness - The total calcium and magnesium ion concentration in water normally expressed in mg/l calcium carbonate.
- Hypolimnion - The deeper colder part of a lake thermally stratified from the shallower and warmer upper layers.
- Kjeldahl Nitrogen - All organic nitrogen plus ammonia in water. Nitrogen is a key nutrient and sometimes a limiting factor.
- Kokanee Salmon - A sockeye salmon that has become genetically adapted to live its entire life and reproduce in a freshwater environment.
- Limnology - The study of freshwater lakes.
- Morphoedaphic Index - A relative measure of potential lake fish productivity based on morphological and chemical factors.
- Morphology - In geology, the study of land form.
- Non-game Fish - A fish species not sought after by anglers. A local example is longnose sucker.
- Nursery - In fisheries, that part of a stream, lake, or ocean where young fish congregate during early growth stages.
- Nutrient - A substance necessary for the normal growth and development of an organism.
- Oligotrophic - A cold deep body of water which lacks appreciable nutrients, minerals, or organisms.
- Parameter - A quantity that specifies a characteristic.
- pH - The negative logarithm of the hydrogen ion concentration expressed in gram equivalents. A pH 7 is approximately neutral, a lower pH means increasing acidity, a higher pH value increasing alkalinity.
- Phosphorous - A key element necessary for the growth of plant and animal tissue. It is often a limiting factor.
- Productivity - Yield in the general sense of fish harvest, or in more specialized usage, the annual production of food organisms.
- Recruitment - The younger fish that each year are added to the portion of the fishery population vulnerable to harvest.

Relative Abundance - In this study a term used to denote the comparative numbers of fish captured by gill nets or minnow traps over specific time periods.

Residual Sockeye Salmon - An anadromous sockeye salmon that has lost its drive to outmigrate from a freshwater lake nursery area to the ocean. The fish does not reproduce in freshwater.

Shoreline Development Factor - A mathematical term that describes lake shoreline irregularity.

Substrate - Materials making up the bottom of a stream or lake.

Thermal Stratification - Separation of lake waters due to density gradients caused by differences in water temperature.

Thermocline - A layer of water lying between upper warmer and lower colder water layers. It is characterized by temperature changes of at least one degree Centigrade per meter depth.

Winter Kill - Death of fish due to low dissolved oxygen levels. This occurs in lakes where oxygen cannot be replaced as rapidly as it is being used. The cause of low oxygen is due to ice and snow that blocks light preventing photosynthesis and sealing the water from atmospheric gas exchange.

LAKE TRIBUTARY STREAM SPawning HABITAT CLASSIFICATION

Appendix C.

Characteristic	Stream Type				
	1	2	3	4	5
Stream	May not be present. If present it is small and/or intermittent.	No spawning stream nearby, only transport stream to distant spawning habitat.	Spawning stream or transport stream present.	Spawning stream may or may not be nearby.	Spawning stream nearby.
Stream Size	If present, usually less than 6 ft. wide and 0.25 ft. deep.	Stream usually <10 ft. wide and 0.25 ft. deep.	Usually < than 15 ft. wide and 0.5 ft. deep.	Usually 15 to 20 ft. wide and 1.0 ft. deep.	Usually >20 ft. wide & 2.0 ft. deep.
Stream Flow	None to intermittent	Intermittent	Low flow, usually present, but may be impassible to fish during dry periods.	Perennial flow, may be low at times.	Perennial flow, moderate to high at all times.
Salmonid Spawning Habitat	Negligible	Negligible to low value.	Low to moderate value.	Moderate to high value.	Moderate to high value.
Fish Stream Transport	Fish migration could occur only under flood conditions.	Fish migration may not occur every year. High flows needed. Stream appears to be >1.0 mi. from low quality spawning habitat.	Fish migration would normally occur every year under seasonal high flow conditions.	Fish migration to spawning area usually >1.0 mi., but fish migration route usually good.	Fish migration to spawning area immediate to <1.0 mi. Fish migration route excellent.
Lake	Usually landlocked	Can be landlocked during dry years.	Usually not landlocked.	Not landlocked.	Not landlocked.
Indicator/ Species	No rainbow trout or anadromous salmon species in lake.	Rainbow trout present, usually in low abundance. Anadromous salmon usually not present.	Rainbow trout present, usually in low to moderate abundance. Anadromous salmon usually not present.	Rainbow trout present, usually in moderate to moderately high abundance. Anadromous salmon may be present.	Rainbow trout present, usually in moderately high to high abundance. Anadromous salmon usually present.

I/ Falls or beaver dams may prevent presence of anadromous species.