

Informational Leaflet 95

ILIAMNA LAKE WATERSHED FRESHWATER COMMERCIAL FISHERIES INVESTIGATION OF 1964

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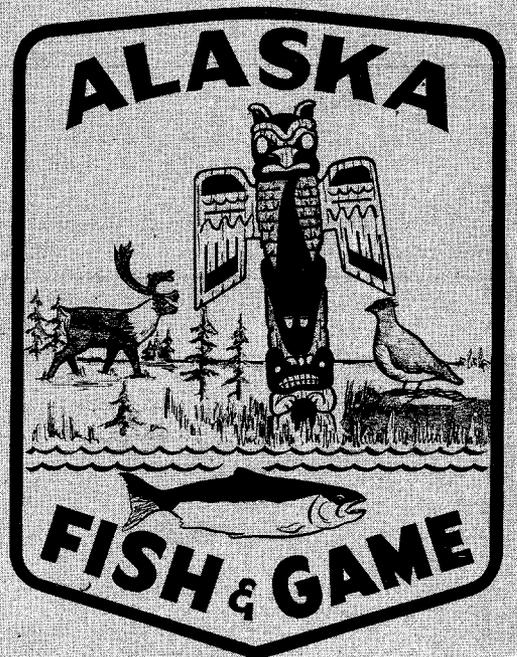


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INTRODUCTION

A commercial freshwater fisheries research program was initiated in 1964 for the purpose of sampling commercially caught freshwater fish from the Iliamna Lake watershed of Bristol Bay.

This program was prompted by the efforts of Alaska Fish, Inc. to begin a commercial fishery in 1964 after preliminary investigations in 1962-1963 convinced them that commercial quantities of fish were available in the Iliamna Lake drainage.

In conjunction with this fishery effort in 1964, a mutual agreement was arranged between the Alaska Department of Fish and Game and the Alaska Department of Economic Development^{1/} to enable biological assessment of this new industry possibility. In accord with this agreement a program was initiated to collect biological data to serve as a basis for future study. This report is a presentation of that data.

ILIAMNA LAKE SYSTEM

The Iliamna Lake drainage, 7,700 square miles (Munn, 1961 and 1962) abuts against the Aleutian Mountain range near its origin on the Alaska Peninsula and the Alaska Mountain range near its western terminus. Iliamna Lake, the largest lake in Alaska, is about 80 miles long by 20 miles wide and covers a surface area of 1,042 square miles (Munn, 1961 and 1962). The lake is approximately oval in shape being narrower at the head and wider near the outlet. The deepest areas are located near the east end, specifically in Pile Bay (Figure 1). A depth of 1,020 feet has been recorded (Munn 1961 and 1962) in this area. The lake is located approximately 50 feet above sea level and is

^{1/} Formerly Alaska Department of Economic Development and Planning.

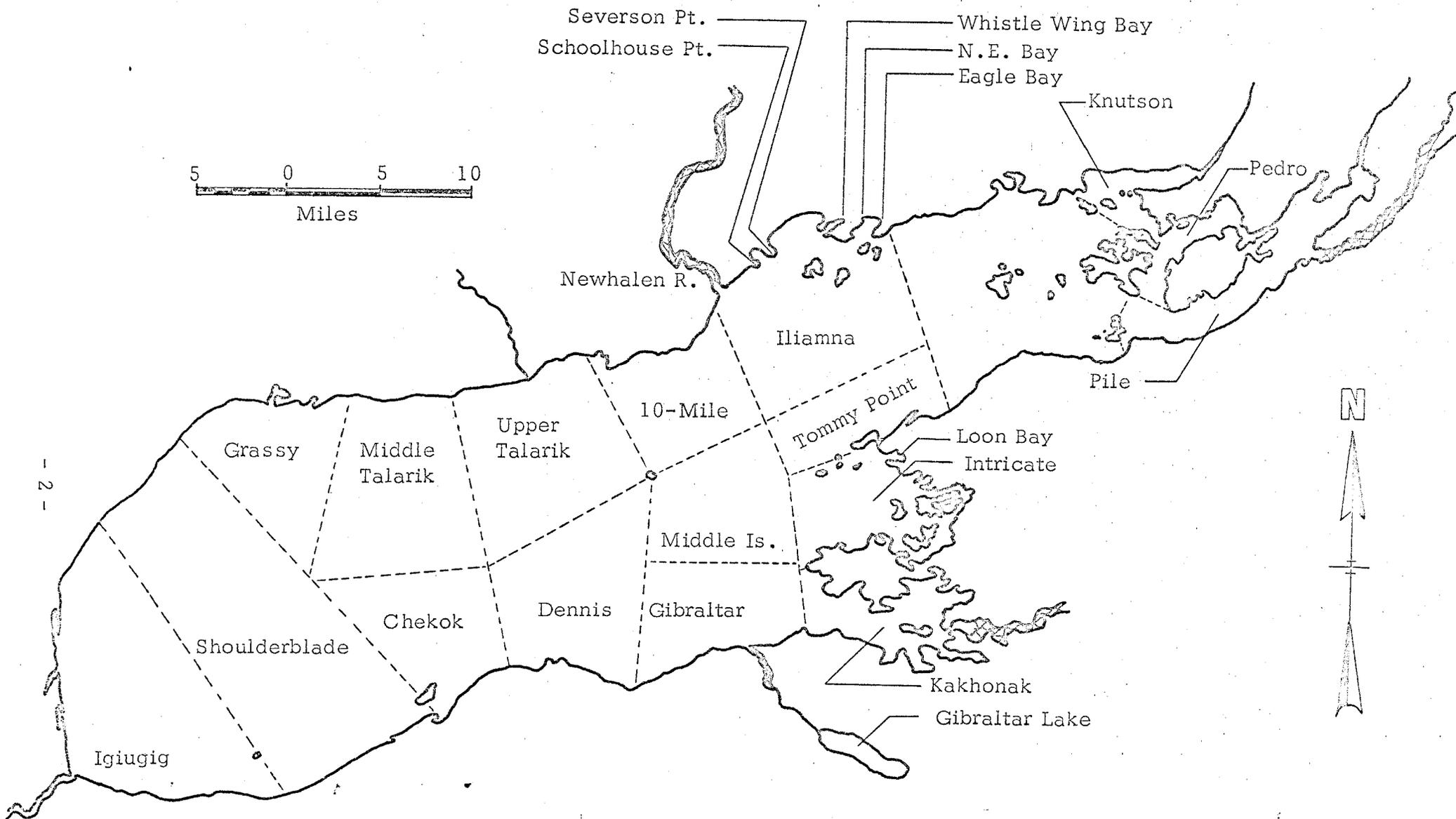


Figure 1. Iliamna Lake. The lake is subdivided into 18 fishing areas based on physical differences (John Munn, 1961 and 1962).

the source of the Kvichak River which empties into Bristol Bay, a portion of the Bering Sea.

The commercial fishing effort in Lake Clark was also sampled the first year. Lake Clark is about 50 miles long by 4 miles wide and contains approximately 143 square miles of surface area (Munn 1961 and 1962). Lake Clark joins Iliamna Lake via the Newhalen River. Six Mile Lake, a small bay located near the outlet of Lake Clark (Figure 2), was the area where most of the fishing effort was concentrated.

There are six villages in the Iliamna Lake - Lake Clark area: Igiugig, Newhalen, Iliamna, Pedro Bay, Kokhanok and Nondalton, with Nondalton being the only large village in the near vicinity of Lake Clark. Of the approximately 500 people living in the area, about half participate in the commercial salmon fishery and could be considered potential freshwater commercial fishermen (Bottenfield 1965).

FISHERIES ACCOUNT

The Iliamna Lake watershed is the world's largest lake producer of red salmon. The total commercial production in the system based on returns of adult salmon in the last ten years has been in excess of 22 million fish (10-year average 8,750,000). Though important as a rearing area for red salmon, the lake proper has contributed very little in the way of local economy into the area.

Sport Fishing

Sport fishing has, in the past few years, become increasingly important to the area's economy. Big 20-30 inch rainbow trout attract large numbers of sport fishermen into the area each year. The incidental take of large lake trout, Dolly Varden and arctic char are an added incentive to sport fishermen. Present sport fishing areas of importance are the Newhalen River, Copper River, Lower Talarik Creek, Kvichak River and Gibraltar Lake.

The importance of the area's sport fishing waters is of major concern to the Alaska Department of Fish and Game. It is the Department's belief that both the commercial and sport fishing interests are compatible by employing various management techniques.

Subsistence Fishing

Fish in the Iliamna Lake drainage are used for human consumption and

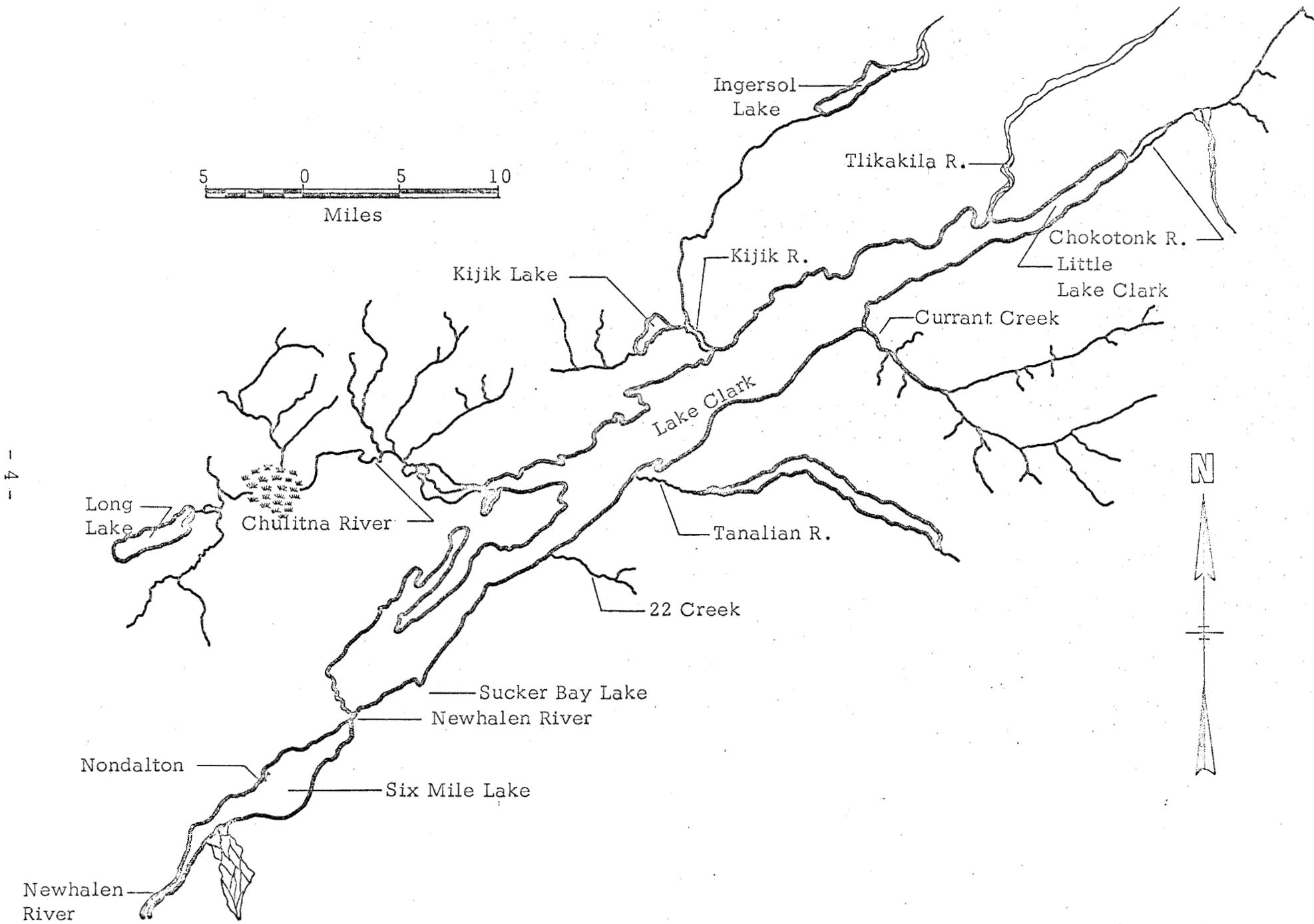


Figure 2. Lake Clark, showing the Six Mile Lake area where commercial freshwater fishing was conducted in 1964.

dog food. A great number of people, because of their remote village existence, live off the natural available food supply. The historical use of the resident and anadromous fish populations has been for subsistence purposes.

According to recent subsistence fish surveys on the number of salmon utilized in the Iliamna Lake drainage, it was found that the people take between 50,000 and 80,000 salmon each year (Kerns and Phinney, 1963). No assessment has been made on the numbers of freshwater fish taken for subsistence purposes.

TRANSPORTATION AND PROCESSING

Transportation in the local area and to and from the area of commercial fishing is a matter of major concern in the future development of the commercial freshwater fisheries. In the Iliamna Lake area, transportation is by boat until near "freeze up" or when floating free ice becomes hazardous to lake travel. After "freeze up" transportation is provided by dog team. A slow evolution is currently underway from the use of dogs to mobile snow machines. Aircraft is the primary means of travel in and out of the area.

The above statement depicts the situation for most of Alaska. There are few connecting road systems, consequently, aircraft are substituted to a large extent. A scheduled airlines provides twice a week passenger and freight service to an airstrip located near the village of Iliamna. A bush pilot in the near vicinity accomodates people with local air transportation.

In order for a fish product to be shipped and marketed outside Alaska, it is necessary for the fish to be processed. Processing in 1964 involved holding of cleaned fish in a "cold" box located in the village of Iliamna. Temperature in the cold box was held just below freezing (32° f.). The fish were packed in ice free cardboard styrofoam insulated cartons, 60 pounds of fish to the box. Shipments were made aboard the commercial airlines on an "available space only" basis.

FRESHWATER COMMERCIAL FISHERIES

Training Program

An educational training program in the use of freshwater fishing gear sponsored by the Federal Man Power Development and Training Act played a key role in developing interest among the local people of Iliamna Lake in 1964. Although the winter fishing methods taught are not new, having been used on the Great Lakes and Great Slave Lake, etc., the method is relatively new to Alaska.

The gear used consists of a "jigger", ice chisel and diver gill net (Figure 3). A round hole about 2 to 3 feet in diameter is cut through the ice. The "jigger", a board 2"x12"x8' (Figure 3), is activated by an iron bar hinged so that a portion extends above and below the board. The top portion of the bar contacts the underside of the ice. A running line is attached to the lower section. A series of jerks on the running line propels the board beneath the ice. A second hole is made over the jigger and the board and attached line are recovered. The gill net is attached to the running line at the place of origin (first hole). The net is then played into the hole by pulling from the jigger recovery hole. After the gill net has been stretched in place the attached anchors are secured to the lake bottom and ice surface. In order to recover the fishing net, the holes are reopened; a running line is attached to the surface anchor line and the net is lifted from the opposite end. The net is picked clean of fish and the net pulled back into fishing place from the opposite end by the running line (Figure 4). The gill nets were most often fished on the lake bottom.

Fish Composition

There are 22 known species of fish in the Iliamna Lake watershed (Bond and Becker, 1963). Of the 22 species, eight are in sufficient quantity to be harvested commercially. The following species were harvested for commercial purposes during 1964: Dolly Varden (Salvelinus malma), arctic char (Salvelinus alpinus), lake trout (Salvelinus namaycush), humpback whitefish (Coregonus pidschian), pike (Esox lucius), least cisco (Coregonus sardinella), arctic cisco (Coregonus autumnalis) and burbot (Lota lota). Other fish species of future possible commercial significance include: round whitefish (Prosopium cylindraceum) and arctic smelt (Osmerus dentex).

The Bristol Bay area marks the upper limit of the Dolly Varden range and the lower limit for arctic char. Due to physical similarities of the two species they are grouped as arctic char in this study. Separating the arctic char-Dolly Varden complex under winter field conditions was not considered practical.

The taxonomic status of the genus Coregonus is at present unclear. The species C. clupeaformis, C. lavaretus, C. pidschian, and C. nasus have at times been used synonymously in North America, Europe and Asia. Their characteristics are readily modified by the associated environment. In this report the species of humpback whitefish referred to will be C. pidschian.

Fishing Areas

Iliamna Lake is divided into 18 commercial fishing areas (Figure 1) for purposes of this report and its future management, based on different physical characteristics (John Munn, 1961 and 1962). Surface area, volume and depth



Figure 3. A "jigger" used in propelling a running line beneath the ice is shown leaning against the mobile snow machine. Note portable one-man net reel mounted on sled arms for easy transporting and laying out of net.



Figure 4. Retrieving gill net through ice.

are given in Appendix Table A. Fishing effort and sampling during the spring months of 1964 were limited to the Iliamna and Intricate fishing areas, the only exception being one sample obtained from the Knutson area (Figure 1). In the fall, commercial fishing effort was centered in Middle Talarik and Igiugig areas. The largest single commercial catches to date were obtained from these two areas.

Fishing in Lake Clark was restricted to one area - Six Mile Lake.

Effort

The fishing effort on Lake Iliamna during the winter of 1964 was sporadic; most of the commercial catches being made by three fishermen. Two of the men fished five shackles of "diver" gill net of 4 inch stretch mesh measure, for a total of 275 fathoms of gear in the vicinity of Iliamna village. The third person fished two 50 fathom shackles of "diver" gill net, 4-1/2 inch stretch mesh measure in the Intricate and Loon Bay area (Figure 1).

Twelve fishermen participated in the spring fisheries on Lake Clark. Gear used was 4 and 4-1/2 inch mesh "diver" gill nets, similar in type to those used in the Great Lake fisheries. A total of 385 fathoms of gill nets were used, 325 fathoms of 4-1/2 inch mesh and 60 fathoms of 4 inch mesh.

The Alaska Department of Fish and Game used two variable mesh gill nets for sampling smaller species of fish and juvenile populations in Iliamna Lake throughout the fishery. The gill nets mesh size used varied from 1-1/2 to 4 inches in a length of 125 feet (Appendix Table C).

Fishing Interval

The Iliamna Lake 1964 freshwater commercial fishery commenced in March although attempts in taking commercial numbers of fish were made earlier (January and February) in the year (Appendix Table B). The fishery was terminated in June due to the complete effort change to commercial salmon fishing season. The freshwater fishery was again activated on September 4, 1964.

Winter-Spring Catches, 1964

In Iliamna Lake the total commercial catch for the winter-spring period was 1,844 pounds of arctic char, 82 pounds of lake trout and 247 pounds of whitefish for 2,173 pounds of fish. Value to the fishermen was \$434.60 (Table 1). The fish taken by these fishermen during the four-month period does not represent

Table 1. Iliamna Lake commercial freshwater fisheries catch and value to the fishermen, 1964

Lake Iliamna	Month	Dressed Pounds of Arctic Char	Avg. Wt.	Dressed Pounds of Lake Trout	Avg. Wt.	Dressed Pounds of Whitefish	Avg. Wt.	Dressed Pounds of Pike	Avg. Wt.	Fisher- man Effort	Total Pounds	Total Value
	March	312	2.6	40	3.1					3	352	\$ 70.40
	April	377	2.9	--	---	20	1.2	--	---	4	397	79.40
	May	909	2.3	12	4.0	82	1.3	--	---	7	1,003	200.60
	June	246	1.1	30	3.0	145	1.5	--	---	9	421	84.20
Sub-total		1,844	2.1 <u>1/</u>	82	3.2 <u>1/</u>	247	1.4 <u>1/</u>	--	---	12 <u>2/</u>	2,173	\$ 434.60
	Sept.	1,041	2.1	--	---	--	---	--	---	8	1,041	208.20
	Oct.	1,921	1.5	296	3.3	8	1.0	32	2.1	10	2,257	448.20
	Nov.	1,690	1.1	---	---	562	2.5	--	---	13	2,252	450.40
	Dec.	57	1.1	---	---	--	---	--	---	2	57	11.40
Sub-total		4,709	1.4 <u>1/</u>	296	3.3 <u>1/</u>	570	2.4 <u>1/</u>	32	2.1 <u>1/</u>	14 <u>2/</u>	5,607	\$1,118.20
Grand total		6,553		378		817		32			7,780	\$1,552.80

1/ The period average weights are obtained by weighting the monthly average weight by the monthly catch (in numbers of fish). The number of fish caught per month is estimated by the ratio of the monthly total dressed pounds to the monthly average weight.

2/ Total number of individual fishermen involved in the fishery.

the total catch or effort. Because of the extremely poor 1963 salmon season a large number of freshwater fish were utilized locally for subsistence purposes. The numbers of fish entering into the commercial aspects of the fisheries were those fish in excess of personal needs. Contrary to normal fishing practices, each fisherman in the fisheries did not necessarily fish one net; oftentimes two or more fishermen would fish one net and this would vary on a day-to-day basis.

In Lake Clark, the fishing situation was similar to Iliamna Lake; however, the catches were larger. Fishing effort in Lake Clark was delayed until the month of April due to lack of gear and fishermen orientation by the training school. In three months of fishing, 1,823 pounds of lake trout and 7,855 pounds of whitefish were harvested for a total of 9,678 pounds of fish. Value to the fishermen was \$1,935.60 (Table 2). Lake trout is evidently the only species of char in Lake Clark.

The total pounds of commercially harvested fish in the drainage during the winter-spring operation was 11,851 pounds. The total value received by the fishermen was \$2,370.20. Fish taken for personal needs constituted approximately 40 percent of the catch. The resultant total pounds of fish caught considering all aspects of the fishery was about 16,591.

Fall-Winter Catch, 1964

The Iliamna Lake drainage again received a poor salmon escapement in 1964. The subsistence fish needs of the people in the area were provided largely by the commercial freshwater fishery. In the ensuing time between the spring fishery and fall, additional freshwater fishing gear was purchased. The total fathoms of gear used in Iliamna Lake in the fall-winter period was 3,300 fathoms or 12 times the amount used in the spring. The total pounds of fish in the commercial catch was approximately twice that taken in the spring (5,607) (Table 1). The fishermen received \$1,118.20 for their fishing effort.

The fathoms of freshwater gear used in Lake Clark were 5,400 or about 14 times the amount used in the spring fishery. The total pounds of fish caught in the four months, September-December was approximately 1,000 pounds more than taken in the spring period. The total pounds of fish taken in the fall was 10,870 pounds, valued at \$2,157.20.

1964 Catch

The total 1964 harvest was 28,328 pounds. The total value realized by the fishermen during the first year was \$5,645.60.

Table 2. Lake Clark commercial freshwater fisheries catch and value to the fishermen, 1964.

Lake Clark	Month	Dressed Pounds of Lake Trout	Avg. Wt.	Dressed Pounds of Whitefish	Avg. Wt.	Dressed Pounds of Pike	Avg. Wt.	Dressed Pounds of Burbot	Avg. Wt.	Fisher-men Effort	Total Pounds	Total Value
	April	273	2.7	386	1.5	--	--	--	--	8	1,659	\$ 331.80
	May	1,363	2.8	4,205	1.5	--	--	--	--	12	5,568	1,113.60
	June	187	2.5	2,264	1.5	--	--	--	--	10	2,451	490.20
Sub-total		1,823	2.8 ^{1/}	7,855	1.5 ^{1/}	--	--	--	--	12 ^{2/}	9,678	1,935.60
	Sept.	295	2.9	674	1.2	--	--	--	--	7	969	193.80
	Oct.	1,590	2.4	6,678	1.3	133	4.9	8	1.0	15	8,409	1,667.70
	Nov.	118	3.1	458	1.2	27	6.3	--	--	3	603	117.90
	Dec.	43	1.2	846	1.2	--	--	--	--	3	889	117.80
Sub-total		2,046	2.4 ^{1/}	8,656	1.3 ^{1/}	160	5.1 ^{1/}	8	1.0 ^{1/}	17 ^{2/}	10,870	\$2,157.20
Grand total		3,869		16,511		160		8			20,548	\$4,092.80

^{1/} The period average weights are obtained by weighting the monthly average weight by the monthly catch (in number of fish). The number of fish caught per month is estimated by the ratio of the monthly total dressed pounds to the monthly average weight.

^{2/} Total number of individual fishermen involved in the fishery.

The 1964 commercial catch was sold primarily in the vicinity of Anchorage, Alaska. Even with competitive pressures from other local fresh fish and shell fish species available to Alaskans, all fish put on the market were sold (Table 3).

Fishing effort was concentrated in locations close to shore. There is a reason to believe that the areas sampled or commercially fished in the fishery may not be truly representative of the numbers of fish available. Offshore fresh-water fisheries are known to produce good catches, especially in large bodies of water. There is no reason to believe the same would not be true in both Iliamna Lake and Lake Clark.

Fish success for all species of fish (Figure 5 and 6) appeared to improve for the most part with effort except during the months of June and December. This is partially due to only eleven days of fishing during these two months.

The commercial catches in the two areas (Iliamna-Intricate) of Iliamna Lake differed notably (Table 4 and Appendix Table B). Comparatively, the Intricate area produced more and larger fish. Char, rainbow trout and suckers were the species taken. Some suckers entered the catch during the latter part of April and May. Whitefish were absent from the Intricate area catch, although many were caught at several locations in Iliamna Lake. However, at no time did they constitute the bulk of the spring catch. Contrary to this, in the use of the small variable 1-1/2 - 4 inch experimental net (Appendix Table C), whitefish (cisco) made up a large portion of the catch.

In the few whitefish and arctic char samples obtained thus far, it appears that there may be definite racial groups of fish populations in the lake with possible overlap of these groups in some areas. The basis for this statement is the apparent morphological differences in fish entering the catch from various areas of the lake. It has been demonstrated in large well-established whitefish fisheries in Canada that discrete groups exist and that the catchability of each group can change erratically (L.D. Hewson, 1959).

Fishing success in Lake Clark (Six Mile Lake) in the spring of 1964 was higher than in Iliamna Lake (Figure 5, Appendix Table D). The population of concentrated whitefish taken in Six Mile Lake was apparently attracted there by the abundance of insect larvae. All fish stomachs examined were filled with insect larvae, Chironomidae.

Round-Dressed Weights

The differences between round and dressed weights (Figures 7, 8 and 9) of fish in Iliamna Lake and Lake Clark varied considerably, and would be of

Table 3. Total fish receipts on freshwater fish taken from the Lake Iliamna drainage freshwater fishery, 1964.

Species	Total Dressed Weight	Price per Pound	Value to Fishermen	First Wholesale Price-Alaska Market Price per Pound	Wholesale Value
Whitefish	17,328	\$0.20	\$3,465.60	\$0.45	\$ 7,686.45
Arctic char	6,553	0.20	1,310.60	0.60	3,931.80
Lake trout	4,247	0.20	849.90	0.55	2,335.80
Pike	192	0.10	19.20	0.35	67.20
Burbot	8	0.10	0.80	0.30	2.40
Totals	28,238		\$5,645.60		\$14,023.70

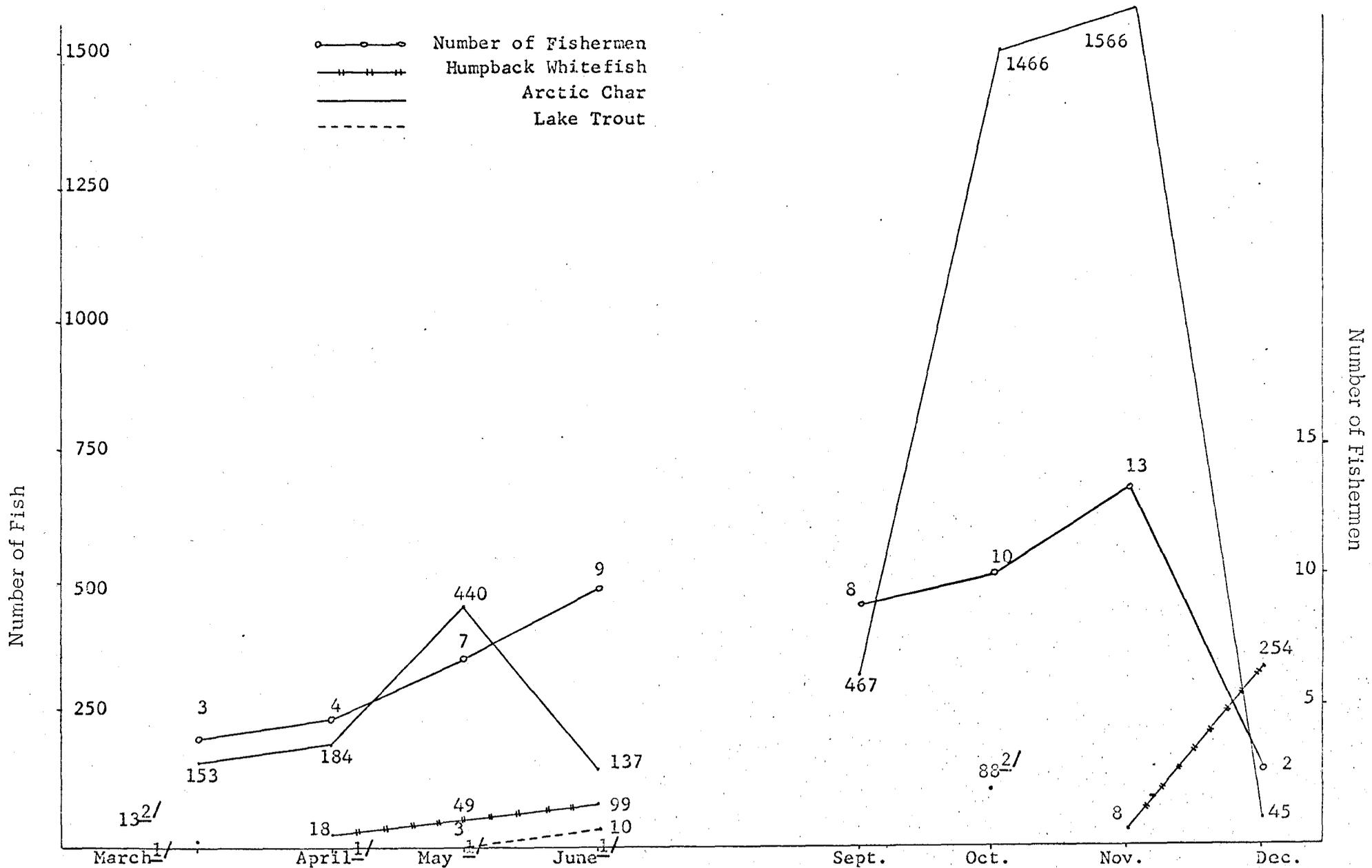


Figure 5.--Effort and catch by monthly periods for various species of fish entering the Lake Iliamna commercial freshwater fisheries, 1964.

- 1/ Numbers of fish caught during the months of March, April, May and June were obtained from sampler weighed by period catches to adjust for changes in the magnitude of the catch.
- 2/ Lake trout entered the Lake Iliamna fisheries during the two months March and October of 1964 in the amounts given.

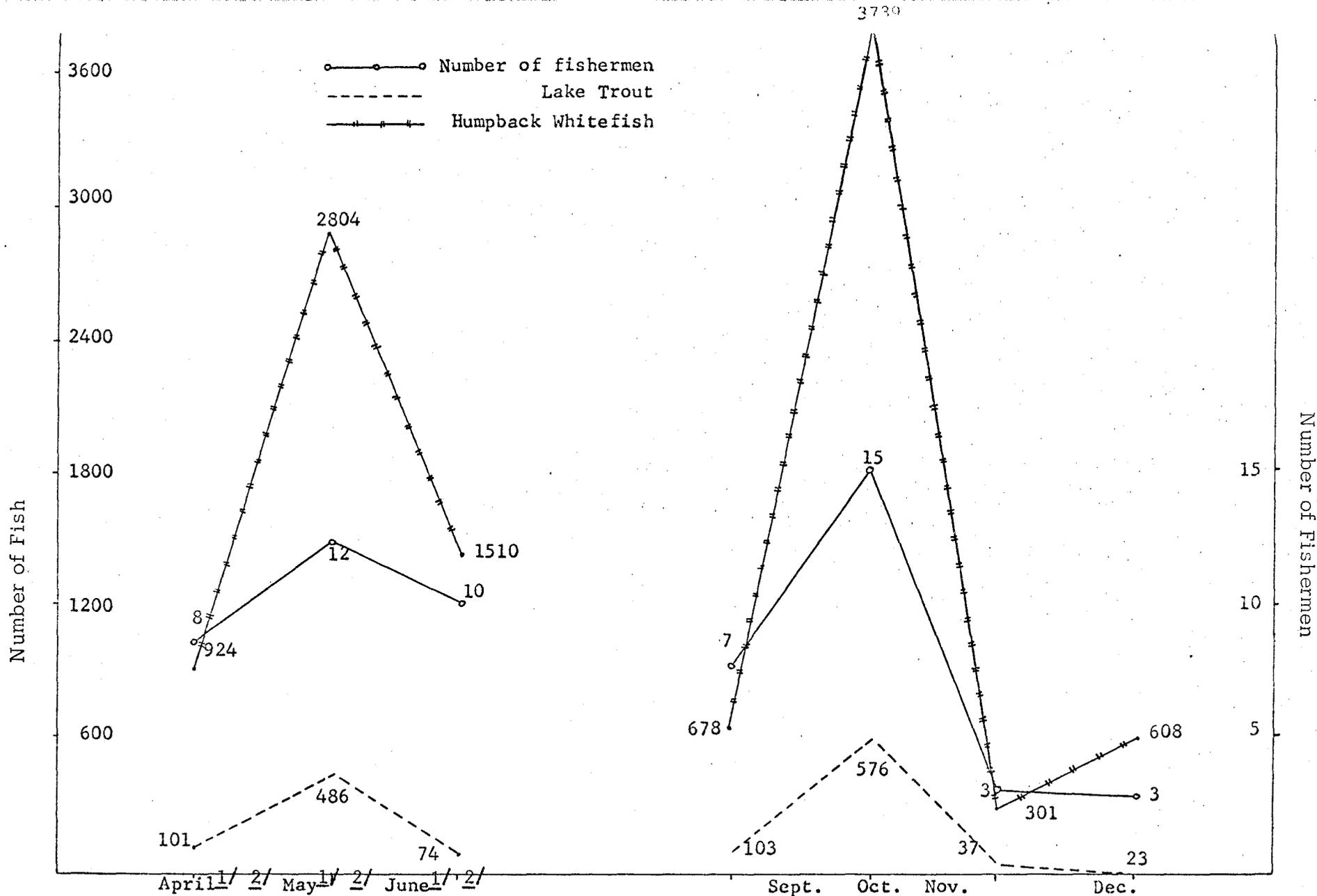


Figure 6.--Effort and catch by monthly periods for various species of fish entering at Lake Clark commercial freshwater fisheries, 1964.

- 1/ Numbers of fish given during the month of April, May and June are from sampler weighted by period catches to adjust for changes in the magnitude of the catch.
- 2/ During the month of October, 133 pike and 8 burbot were taken. In the month of November, 27 additional pike entered the fishery.

Table 4. Commercial freshwater fish catch samples by use of 4 and 4-1/2 inch mesh gill nets for the months March-June in Iliamna Lake, 1964.

Area ^{1/}	Information	Species ^{3/}						
		AC	WF	LT	RB	Cs	S	B
Iliamna	Number	119	19	25		1		2
	Length range in inches	8.7-24.5	16.7-19.0	8.5-26.0		9.5		21.2-23.0
	Mean length	17.9	18.0	19.3		9.5		22.0
	Round weight range	.2- 3.5	.2- 2.4	1.9- 4.0		.3		2.3- 2.6
	Mean weight	2.0	2.2	2.3		.3		2.5
	Frequency ^{2/}	.083	.013	1017		10007		.001
	Percent composition	72	12	15		trace		1
Intricate	Number	191	5	3	49		27	
	Length range in inches	9.0-27.0	12.2-17.7	19.7-25.0	15.7-29.5		15.0-17.5	
	Mean length	20.1	15.9	22.5	20.4		16.3	
	Round weight range	.3- 6.9	.2- 1.7	2.1- 2.4	1.2-12.1		1.0- 2.1	
	Mean weight	2.8	1.3	3.2	3.6		1.6	
	Frequency ^{2/}	.103	.002	.002	.026		.014	
	Percent composition	69	2	1	18		10	

^{1/} Commercial fishing areas are shown in Figure 1.

^{2/} Number of fish taken per hour of fishing with 50 fathoms of gill net.

^{3/} Arctic char - AC, Humpback whitefish - WF, Cisco - Cs, Lake trout - LT, Sucker - S, Burbot - B.

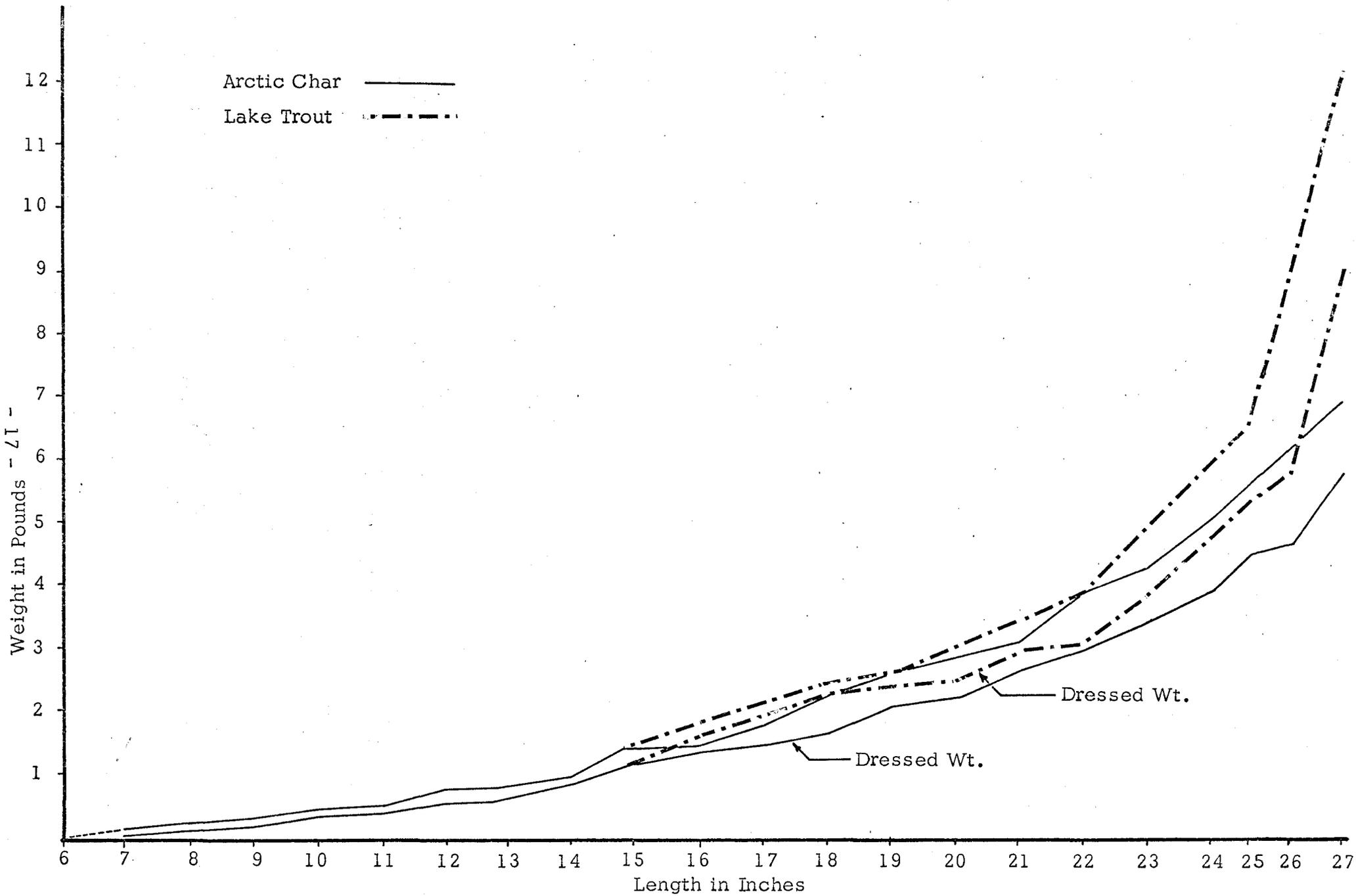


Figure 7. Relationship between mean length and round and dressed weights of arctic char and lake trout in Iliamna Lake, 1964. 1/

1/ Dressed weights are with head on.

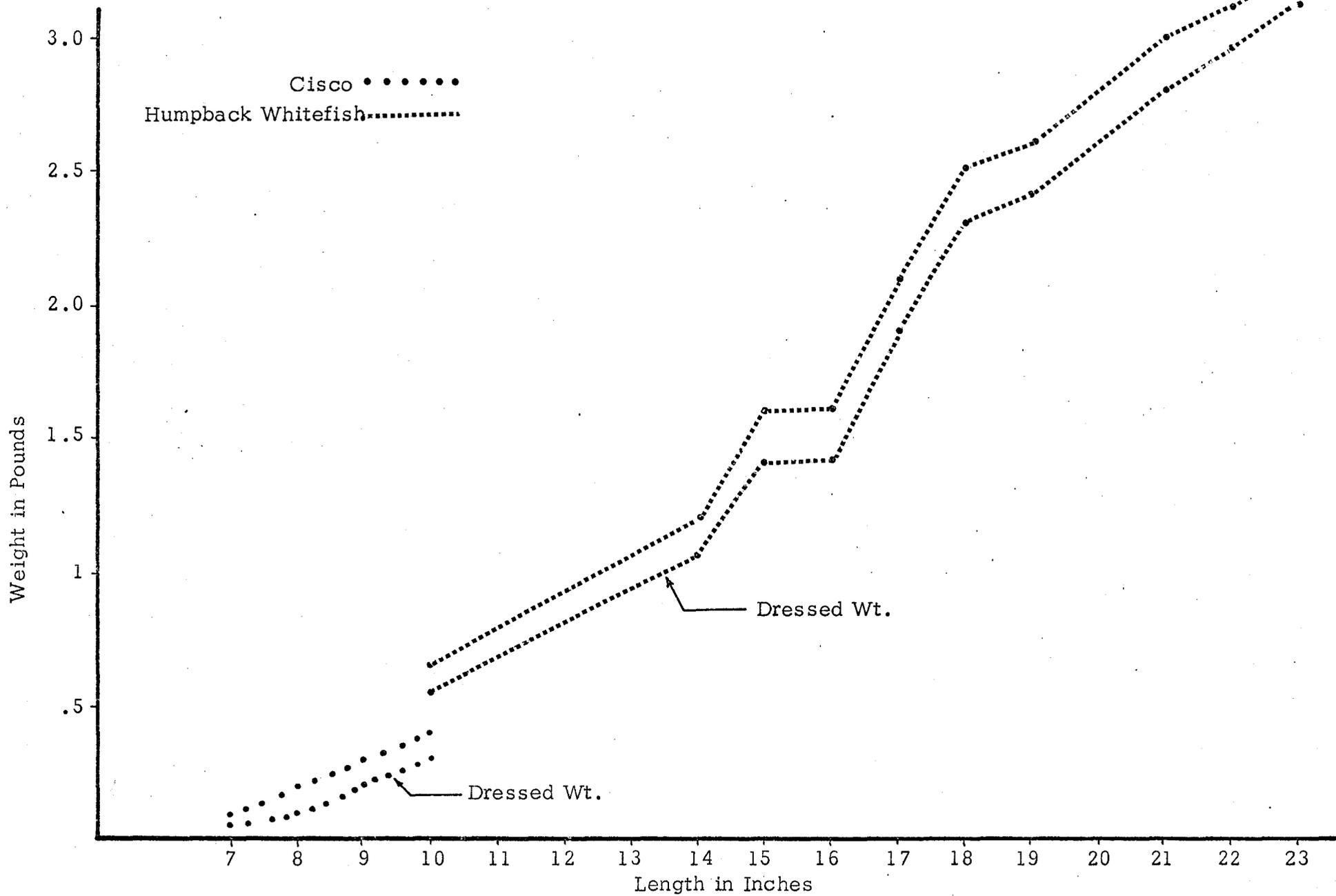


Figure 8. Relationship between mean length and round and dressed weights of humpback whitefish and Cisco whitefish in Iliamna Lake in 1964. $\frac{1}{2}$ Dressed weights are with head on.

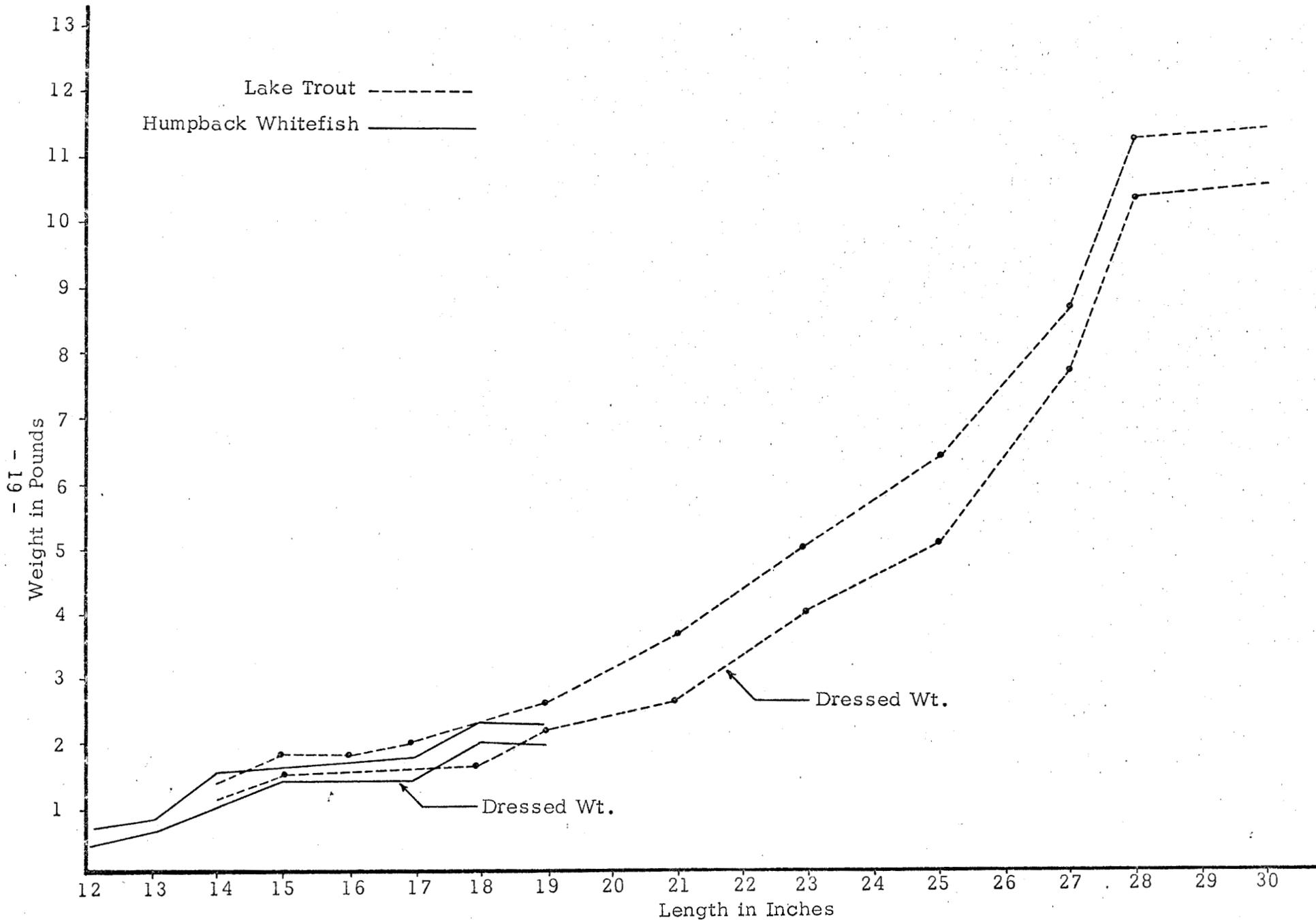


Figure 9. Relationship between mean length and round and dressed weights of lake trout and humpback whitefish in Lake Clark, 1964. ^{1/}

^{1/} Dressed weights are with head on.

economic significance in shipment cost and filling market demands. Notable differences in round and dressed weights of lake trout in Iliamna Lake occurred in lengths over 19 inches (Figure 7). The weight difference varied from .2 pounds for a 19 inch fish to 3 pounds for a 27 inch fish. In Lake Clark, large differences in round and dressed weights occurred in fish over 16 inches in length. The weight difference of a 16 inch fish was .2 pounds while weight differences in fish over this length approximated .7 pounds (Figure 9).

Arctic char in Iliamna Lake did not exhibit great round and dressed weight differences (Figure 7). An apparent difference in weights occurred in fish over 16 inches long, and poundage difference ranged from 15 to 1.2 pounds.

Humpback whitefish entering the Iliamna Lake commercial catch did not show drastic differences between dressed and round weights. The difference in weights varied from approximately .1 pound to .3 pound. Round and dressed weights of cisco in the same lake varied about .1 pound (Figure 8). In Lake Clark, weight differences of the round and dressed whitefish were approximately .2 pound (Figure 9).

Length-Weight Relationship

Lake trout growth in Iliamna Lake remained fairly constant up to 22 inches whereupon phenomenal weight gains were made (Figure 7). The growth pattern change is possibly due to several factors one of which would be a change in feeding habits. It would appear that lake trout possibly become piscivorous feeders after reaching 19 inches in this lake.

The arctic char growth pattern in Iliamna Lake (Figure 7) resembles that of lake trout until 25-26 inches whereupon the weight of lake trout exceeds arctic char as much as five pounds.

Lake trout were caught in Lake Clark up to 30 inches in length and in excess of 11 pounds (Figure 9).

The growth rate of humpback whitefish in Iliamna Lake is greater than in Lake Clark. A 23 inch dressed whitefish in this lake will weigh 3 pounds (Figure 8). In Lake Clark, the largest whitefish entering the catch were 19 inches in length and weighed two pounds dressed (Figure 9). The length distribution of fish entering the commercial fishery are shown in Figures 10 and 11.

Length and Age Composition

Scales and lengths were collected from 294 arctic char from Iliamna Lake

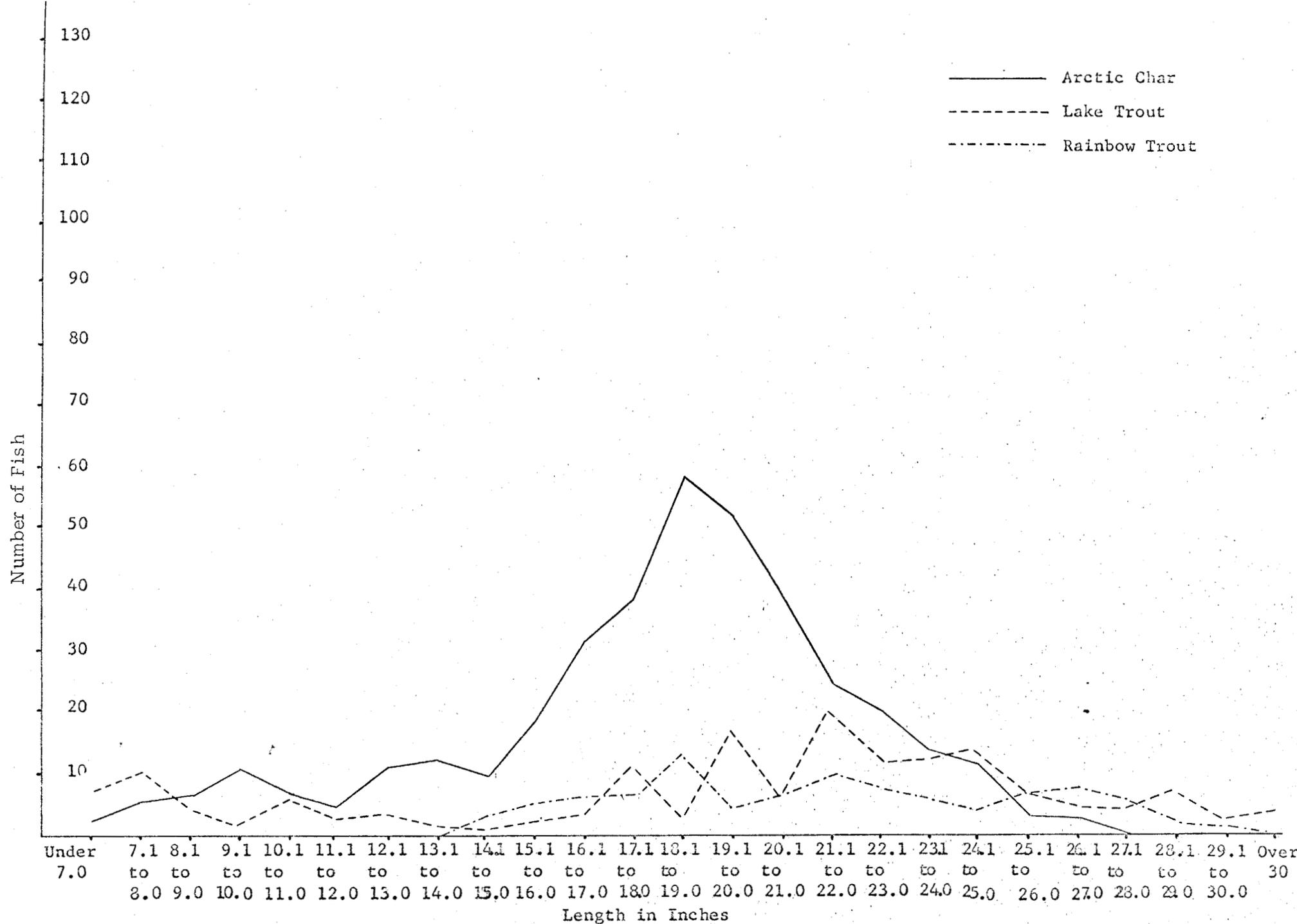


Figure 10.--Length distribution of fish entering the Iliamna Lake and Lake Clark commercial catch, 1964

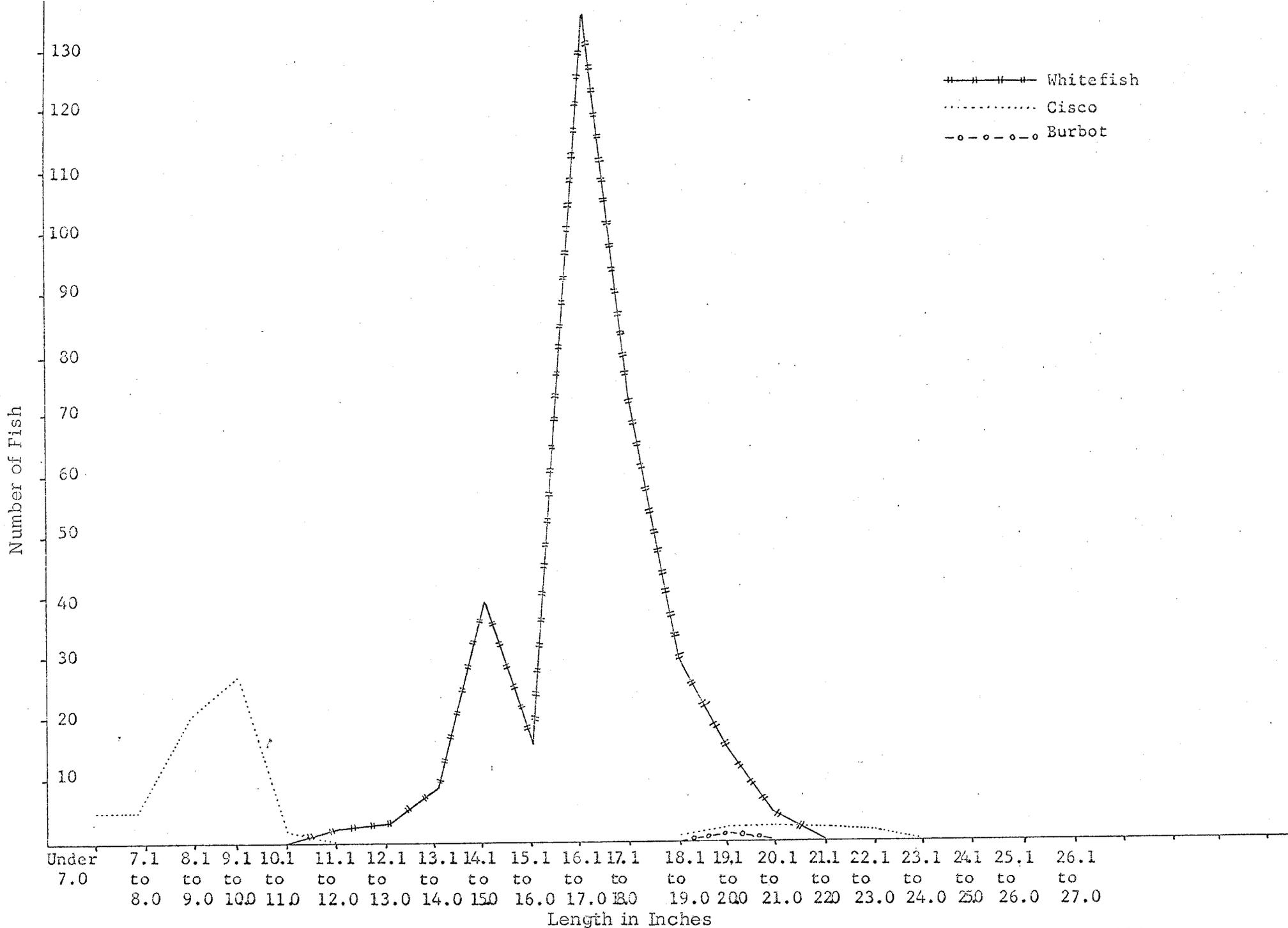


Figure 11 -- Length distribution of fish entering the Iliamna Lake and Lake Clark commercial catch, 1964

and 290 humpback whitefish from Lake Clark during sampling of the commercial catches. Samples of other species were small and not considered representative of the total population.

Lengths from tip of snout to fork of tail were taken to the nearest 0.1 inch. Weights were determined from a spring balance scale and read to the nearest 0.1 ounce. Scale samples were taken from the left side in the area between the base of the dorsal fin and the lateral line. Ages were assessed by counting the number of annuli and expressed in Roman numerals. A micro-projector was used in reading whitefish scales and a binocular dissecting scope for reading char scales. A few bronchiostegal rays were taken from Lake trout. It was concluded that accurate age readings could be made by this method.

In the Iliamna Lake fishery, arctic char 5 years and older, 16 inches through 20 inches in length, were the most susceptible to the fishery with the 4-4-1/2 inch mesh gill nets used (Table 5).

Humpback whitefish in age classes five through thirteen were taken in the Lake Clark fishery (Table 6). Five year old whitefish averaged 14.7 inches in length and thirteen year old whitefish averaged 17.8 inches in length. The majority of the whitefish taken were between 14 and 17 inches in length.

Maturation Information

The reproductive systems of commercially caught fish were examined for sexual development. Gonad development was classified into four groups using length as an added criteria; juveniles - eggs or testes visible but not fully developed; sub-adult - eggs or testes developed to pre-spawning stage; ripe adult - eggs or testes mature, loose or commencing to separate; spawned adult - few loose eggs in the cavity or distended testes.

Information on distribution and maturity of various species of fish in Iliamna Lake has been recorded by location of catch, Appendix Tables F, G and H. Sub-adults were taken in all areas sampled. Spawned adults were taken in a few locations. Most of the arctic char came from the Intricate Bay area. Using the number of spawned arctic char adults as a criteria, this area is evidently used extensively by spawning char populations. Few juveniles were sampled due to the limited use of variable mesh experimental gill nets.

From both gonad examination and scale readings of arctic char, it was concluded that arctic char reach sexual maturity at four years or upon reaching a length of 13 inches.

Gonad information collected on mature arctic char and lake trout indicates

Table 5. Frequency distribution by length and age group of arctic char in the Iliamna Lake commercial fishery, 1964.

Length interval (inches)	Age Group								Total
	II	III	IV	V	VI	VII	VIII	IX	
6.5- 7.4	3	-	-	-	-	-	-	-	3
7.5- 7.9	2	-	-	-	-	-	-	-	2
8.0- 8.4	1	-	-	-	-	-	-	-	1
8.5- 8.9	-	1	-	-	-	-	-	-	1
9.0- 9.4	-	1	1	-	-	-	-	-	2
9.5- 9.9	-	1	2	-	-	-	-	-	3
10.0-10.4	8	3	1	-	-	-	-	-	12
10.5-10.9	-	1	-	-	-	-	-	-	1
11.0-11.4	4	3	-	-	-	-	-	-	7
11.5-11.9	-	-	2	-	-	-	-	-	2
12.0-12.4	-	-	1	-	-	-	-	-	1
12.5-12.9	-	-	3	3	-	-	-	-	6
13.0-13.4	-	-	4	1	-	-	-	-	5
13.5-13.9	-	-	3	-	-	-	-	-	3
14.0-14.4	-	-	2	2	-	-	-	-	4
14.5-14.9	-	-	1	2	-	-	-	-	3
15.0-15.4	-	-	1	5	1	-	-	-	7
15.5-15.9	-	-	1	2	2	-	-	-	5
16.0-16.4	-	-	3	2	4	1	-	-	10
16.5-16.9	-	-	-	2	6	-	-	-	8
17.0-17.4	-	-	-	5	5	4	-	-	14
17.5-17.9	-	-	-	9	3	4	-	-	16
18.0-18.4	-	-	-	3	12	3	-	-	18
18.5-18.9	-	-	-	4	10	4	-	-	18
19.0-19.4	-	-	-	5	12	4	3	-	24
19.5-19.9	-	-	-	4	8	7	2	-	21
20.0-20.4	-	-	-	2	7	7	3	-	19
20.5-20.9	-	-	-	1	4	9	3	-	17
21.0-21.4	-	-	-	-	3	4	-	-	7
21.5-21.9	-	-	-	-	1	4	3	1	9
22.0-22.4	-	-	-	-	4	2	1	1	8
22.5-22.9	-	-	-	-	-	4	2	3	9
23.0-23.4	-	-	-	-	-	2	2	-	4
23.5-23.9	-	-	-	-	-	5	1	2	8
24.0-24.4	-	-	-	-	-	1	1	2	4
24.5-24.9	-	-	-	-	-	-	2	2	4
25.0-25.4	-	-	-	-	-	3	1	1	5
25.5-25.9	-	-	-	-	-	1	-	-	1
26.0-26.4	-	-	-	-	-	-	1	-	1
26.5-26.9	-	-	-	-	-	-	-	-	-
27.0-27.4	-	-	-	-	-	-	1	-	1
Total Number	18	10	26	51	82	69	26	12	294
Percentage of total	6.1	3.4	8.8	17.4	27.9	23.5	8.8	4.1	
Average length	9.4	9.7	13.0	17.1	18.6	20.5	21.9	23.4	

Table 6. Frequency distribution by length and age group of humpback whitefish in the Lake Clark commercial freshwater fishery, 1964.

Length interval (inches)	Age Group									Total
	V	VI	VII	VIII	IX	X	XI	XII	XIII	
14.5-14.9	4	4	2	-	-	-	-	-	-	10
15.0-15.4	1	9	5	3	9	4	-	-	-	31
15.5-15.9	-	10	6	7	5	4	6	2	3	43
16.0-16.4	-	1	15	12	9	10	5	7	2	61
16.5-16.9	-	-	14	12	8	8	5	3	2	52
17.0-17.4	-	-	4	6	5	6	6	4	6	37
17.5-17.9	-	-	-	8	1	5	7	1	5	27
18.0-18.4	-	-	1	-	4	4	2	3	1	15
18.5-18.9	-	-	-	-	-	-	3	-	1	4
19.0-19.4	-	-	-	1	1	2	1	1	-	6
19.5-19.9	-	-	-	1	0	1	0	1	0	3
20.0-20.4	-	-	-	-	-	1	-	-	-	1
Total number	5	24	47	50	42	45	35	22	20	290
Percentage of total	1.7	8.3	16.2	17.2	14.8	15.4	12.1	7.6	6.7	
Average length	14.7	15.2	15.9	16.4	16.8	17.0	17.2	17.5	17.8	

these fish spawn in alternate years. Some variation may occur between species, sexes and different ages. Additional information is required before the spawning pattern can be accurately determined.

The sex ratios of different species taken in the spring fishery are given in Appendix Table H. As spring advanced, the arctic char catch ratio changed from 50:50 to a catch of 33:67 with more females entering the catch. In lake trout, the tendency was just the opposite, more males being caught than females as the season advanced.

Condition and Flesh Color

The condition of arctic char was considered good throughout the winter-spring period. Fish of poor physical appearance were not common. Generally, fish of poor appearance (slender bodies) reflected heavy parasitism. Tape worm plerocercoid cysts of Trienophorus crassus were observed on the body organs of nearly all arctic char examined. Fish with heavy infestation were noted to have cysts embodied in the flesh. It is unlikely that marketing problems would develop if grading were employed. This parasite is not infectious to humans.

The humpback and cisco whitefish were considered of excellent quality and would not present any marketing problems.

Samples of fish with commercial potential were sent to the Department's parasitologist. As of this writing no additional information on other parasites is available.

Flesh color is an important criteria in marketing fresh fish (unless of course, food coloring is used). Flesh color of char and lake trout were separated into five standards (S.D. Rawson, 1961). The five color standards used were: creamy white, pale yellow, yellow orange, bright orange and orange red (Table 7). Color variation for arctic char occurred in the two areas sampled, Iliamna and Intricate. Arctic char in the Iliamna area of 17-23 inches in length exhibited orange flesh coloration. Flesh color variation was less pronounced in fish under and over these lengths. In the Intricate area, orange coloration occurred in fish 15-27 inches in length with most of the variation occurring in fish under 17 inches. Lake trout samples were inadequate for area comparison. In the samples observed, lake trout flesh color appeared to be much lighter than that of arctic char.

Feeding Habits

Stomach content examination of arctic char and lake trout revealed that smaller fish constitute the main winter-spring diet. The major food item for

Table 7. Incidence of flesh color variations in arctic char and lake trout in Lake Iliamna as determined from samples taken during the month of February-June, 1964.

Area ^{1/}	Species ^{2/}	Length range in increments of 2 inches	Flesh color in numbers and percent () ^{3/}				
			1	2	3	4	5
Iliamna	AC	7.0- 9.0	4(2.5)	4(2.5)	2(1.2)		
		9.0-11.0			9(5.6)		
		11.0-13.0		2(1.2)	2(1.2)	2(1.2)	
		13.0-15.0	1(.6)	2(1.2)	4(2.5)	2(1.2)	
		15.0-17.0			12(7.5)	5(3.1)	
		17.0-19.0	4(2.5)	10(6.2)	9(5.6)	21(13.0)	2(1.2)
		19.0-21.0	1(.6)	2(1.2)	16(10.0)	14(8.7)	1(.6)
		21.0-23.0		2(1.2)	8(5.0)	13(8.1)	1(.6)
		23.0-25.0		1(.6)	2(1.2)	1(.6)	
		25.0-27.0			2(1.2)		
	LT	7.0- 9.0	9(20.5)				
		9.0-11.0	1(2.3)	2(4.5)			
		11.0-13.0		1(2.3)	1(2.3)		
		13.0-15.0					
		15.0-17.0	1(2.3)				
		17.0-19.0	2(4.5)	5(11.3)	5(11.4)		
		19.0-21.0	1(2.3)	7(15.9)	1(2.3)		
		21.0-23.0		2(4.5)	2(4.5)		
		23.0-25.0			2(4.5)		
		25.0-27.0			1(2.3)		1(2.3)
Intricate	AC	7.0- 9.0					
		9.0-11.0		2(1.1)	1(.6)		
		11.0-13.0			6(3.3)	1(.6)	
		13.0-15.0		1(.6)	7(3.8)		
		15.0-17.0	2(1.1)	4(2.2)	5(2.7)	5(2.7)	1(.6)
		17.0-19.0	3(1.6)	5(5.7)	12(6.6)	12(6.6)	4(2.2)
		19.0-21.0	2(1.1)	5(2.7)	21(11.0)	26(14.3)	2(1.1)
		21.0-23.0		4(2.2)	13(7.1)	10(5.5)	
		23.0-25.0	2(1.1)	3(1.6)	6(3.3)	7(3.8)	1(.6)
		25.0-27.0		1(.6)	4(2.2)	4(2.2)	1(.6)
	LT	7.0- 9.0					
		9.0-11.0					
		11.0-13.0					
		13.0-15.0					
		19.0-21.0			2(50.0)	1(25.0)	

Table 7 (Continued)

Area ^{1/}	Species ^{2/}	Length range in increments of 2 inches	Flesh color in numbers and percent (%) ^{3/}				
			1	2	3	4	5
		21.0-23.0					
		23.0-25.0					
		25.0-27.0			1(25.0)		
Knutson	AC	7.0- 9.0	3(15.0)		2(10.0)		
		9.0-11.0		4(20.0)	2(10.0)		
		11.0-13.0		3(15.0)	3(15.0)		
		13.0-15.0				1(5.0)	
		15.0-17.0			1(5.0)		
		17.0-19.0					1(5.0)
		19.0-21.0					
		21.0-23.0					
		23.0-25.0					
		25.0-27.0					

^{1/} Iliamna Lake commercial freshwater fishing sub-division (areas) are shown in Figure 1.

^{2/} Arctic char - AC, lake trout - LT.

^{3/} Five standards of flesh color used are as follows: 1 - creamy white, 2 - pale yellow, 3 - yellow orange, 4 - bright orange, 5 - orange red.

arctic char appeared to be three-spine stickleback. Lake trout tended to feed more on ciscos. Other items included in the stomachs of arctic char and lake trout were sculpins, snails, freshwater clams and insect material. Insect content increased as the spring period progressed. A few red salmon smolt were observed in the stomachs of char during the late spring. It is the local belief that salmon smolt constitute the bulk of the char's diet. In the few char stomach samples collected in late spring, no conclusions could be reached on utilization of red salmon smolts.

Whitefish fed on insect larvae, snails and freshwater clams. Most often the stomachs were empty. Accelerated feeding commenced with the advancement of spring and ice breakup.

Temperature and Depth

Increased fishing success in the winter-spring fishery of 1964 was associated with bottom temperatures over 35° F. (Appendix Table E). Additional information on temperature regimes is necessary in the 18 areas of Iliamna Lake before any correlations with catch can be made.

The summer heat budget indicates that there are greater thermal variations between areas than between years (John Munn, 1961 and 1962). Stratification of the lake into distinct temperature layers during the summer seldom occurs due to constant mixing by wind action. The development of a thermocline in the lake varies from year to year and is dependent on wind turbulence (John Munn, 1961 and 1962).

DISCUSSION

Alaska contains one of the world's largest remaining relatively unexploited freshwater fisheries resources. This resource is in commercially harvestable quantities throughout most of the state, and with proper management could become one of the most valuable. Additionally, the labor force necessary to carry on the fishery would consist primarily of people in the low income groups presently living in remote villages.

The first attempts in harvesting freshwater species were considered superior to expectations. From this initial effort there appeared three major obstacles to overcome in the establishment of this fishery: (1) knowledge of the resource, (2) transportation and (3) the establishments of markets. Of equal significance in this first attempt was the valuable experience gained in the methods and techniques of winter fishing. The fact that Bristol Bay and Alaska has an extremely

valuable resource in her freshwater fish stocks has been made more evident than ever.

It is imperative that biological information be obtained on the freshwater species in order to assure the perpetuation of this future fishery.

Unfortunately, the fish yield information for the various bodies of water will differ, and obtaining reliable estimates of the sustainable yield will take considerably more effort than given to date. The quickest and surest way to obtain this knowledge is by having an active commercial fishery. Yield information, once obtained, will undoubtedly encourage new effort and assist in justifying new investments.

SUMMARY

Information on the 1964 Iliamna Lake watershed commercial freshwater fishing venture is presented. The investigation revealed there are suitable commercial stocks of char and whitefish in the Iliamna watershed. Other species of fish may be present in suitable commercial numbers but were not harvested by the small fishery.

Fish receipts in the first year of operation show that a catch of 17,328 pounds of whitefish, 6,553 pounds of arctic char, 4,247 pounds of lake trout, 192 pounds of pike and 8 pounds of burbot for a total of 28,328 pounds of fish were marketed for \$14,023.70. The fishermen received \$5,645.60 for their effort.

The catch per unit of effort was difficult to obtain because of the subsistence fish needs. The largest numbers of fish taken were from Lake Clark.

Arctic char in Iliamna Lake attain an average length of 17.1 inches in five years. The bulk of the catch using 4 and 4-1/2 inch mesh gill nets was between 16 inches and 20 inches in length.

The humpback whitefish in Lake Clark are slow-growing taking 13 years to attain a length of 17.8 inches. The length range of fish entering the commercial catch was between 14.7 and 17.8 inches. Samples of other fish were inadequate for obtaining additional information.

Arctic char in Iliamna Lake mature at four years of age. It is also evident from gonad examination that arctic char spawn in alternate years.

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APPENDIX

The following appendix shows in detail information on the Iliamna Lake watershed commercial fisheries. Appendix Table A presents volumetric information on 18 areas in Iliamna Lake. Appendix Tables B-D show the spring fishery catch at various locations. These datum may be of future value in determining catch per fishing effort and variation in species composition by season.

Distribution and catch during the winter is closely associated to the lake system temperature regime (Appendix Table E).

Additional information on the seasonal distribution of age groups is important in the future management of the Iliamna watershed commercial freshwater fishery. Appendix Tables F, G and H show stages of maturity collected in various areas of Iliamna Lake during the spring of 1964.

Appendix Table I lists sex ratio information on different species of fish taken in the commercial fisheries.

Appendix Table A. Surface, area, volume and depth of 18 areas in Iliamna Lake^{1/}

Area	Percent area of total lake	Area sq. miles	Acre feet	Ave. depth in feet	Area mean depth
Igiugig		107.08	4,630,837	67.6	
Shoulderblade		145.80	10,959,824	117.5	
Grassy		53.08	2,877,166	84.7	
Middle Talarik		80.36	6,184,003	120.2	
Chekok		56.28	6,629,076	184.0	
Upper Talarik		70.52	4,215,629	93.4	
Dennis		67.36	5,634,350	130.7	
10-Mile		44.88	2,839,064	98.9	
Middle Islands		55.48	4,855,269	136.7	
Gibraltar		<u>39.76</u>	<u>2,082,682</u>	81.9	
Sub-total	69.1%	720.60	50,917,900		111.5
Kakhonak		28.60	809,076	44.2	
Intricate		<u>33.36</u>	<u>1,327,112</u>	62.2	
Sub-total	6.0%	61.96	2,136,188		53.2
Tommy Point		31.20	4,121,588	206.4	
Iliamna		81.84	9,550,021	182.3	
Triangle Island		93.72	14,280,442		
North Triangle		(57.60)	(6,876,339)	186.7	
South Triangle		<u>(36.12)</u>	<u>(7,404,103)</u>	320.2	
Sub-total	19.8%	206.76	27,962,051		223.9
Knutson		12.12	1,384,671		
North Knutson		(6.84)	(894,199)	204.4	
South Knutson		(5.28)	(490,472)	145.0	
Pedro		12.36	826,911		
North Pedro		(10.64)	(793,673)	116.5	
South Pedro		(1.72)	(33,238)	30.1	
Pile		<u>29.08</u>	<u>9,751,074</u>	523.9	
Sub-total	5.1%	53.56	11,962,656		203.9
TOTAL		1,042.08	92,878,795	139.4	

^{1/} The information for this table was extracted freely from the report "Summer Thermal Conditions in Iliamna Lake, Bristol Bay, Alaska in 1961 and 1962" by John Munn, a University of Washington, College of Fisheries publication.

Appendix Table B. Catch samples of commercial freshwater fish species in Iliamna Lake taken by the use of 4 and 4-1/2 inch mesh gill nets during March-June, 1964.

Date	Location	Species ^{1/}	Catch	Length in inches		Weight in pounds			Total Weight	Frequency ^{2/}	Percent Comp.
				Range	Mean	Range		Mean			
						Round	Dressed				
2/8-3/2	Severson Pt.	AC	2	14.5-23.0	11.0	1.8-3.3		1.9	14.9	.073	63
		WF	4	17.0-17.5	17.1	2.1-2.4		2.1	5.8	.042	37
3/2-3/8	Rabbit Island	AC	14	12.3-20.5	16.1		0.5-2.0	1.5	19.4	.039	61
		WF	2	18.5	18.4		2.3-2.4	2.2	4.7	.006	9
		LT	7	15.5-26.0	21.6		1.0-3.3	2.8	19.8	.019	30
3/8-3/12	Whistle Wing Bay	AC	14	15.5-19.3	17.5	1.5-3.0		2.2	30.1	.029	70
		WF	1	17.8	17.8	2.4		2.4	2.4	.005	5
		LT	5	17.3-19.5	18.4	1.9-2.7		2.2	11.7	.010	25
3/13-3/19	Intricate Bay	AC	19	14.0-25.0	18.0		1.3-4.5	2.4	45.8	.132	95
		LT	1	25.0	25.0		4.2	4.2	4.2	.006	5
3/22-3/27	Intricate Bay	AC	10	16.2-24.5	19.5	1.7-5.3		2.9	29.5	.083	63
		RB	5	17.2-26.5	22.0	1.8-7.6		4.2	22.0	.041	31
		S	1	15.3	15.3	1.2		1.2	1.2	.008	6
3/22-3/30	Intricate Bay	AC	5	14.0-24.0	20.6	1.1-4.5		3.1	15.9	.023	24
		WF	1	16.2	16.2	1.5		1.5	1.5	.004	5
		RB	15	15.7-29.5	21.4	1.4-12.1		4.4	66.6	.070	71
3/30-4/4	Rabbit Island	AC	3	8.7-19.2	14.6	0.2-2.5		1.1	4.1	.026	30
		LT	4	8.5-22.0	16.8	0.2-3.0		1.9	7.7	.033	40
		CS	1	9.5	9.5	0.3		0.3	0.3	.008	10
		B	2	21.2-23.0	22.0	2.3-2.6		2.5	4.9	.016	20
3/25-4/2	Intricate Bay	AC	4	15.2-26.2	24.3	1.1-5.0		2.9	11.4	.024	66
		LT	2	19.7-20.5	20.1	2.1-2.4		2.3	4.5	.013	34

^{1/} Arctic Char - AC, Humpback Whitefish - WF, Cisco - CS, Lake Trout - LT, Suckers - S, Burbot - B, Rainbow Trout - RB.

^{2/} Number of fish taken per hour of fishing with 50 fathoms of gill net.

Appendix Table B. (Continued)

Date	Location	Species ^{1/}	Catch	Length in inches		Weight in pounds			Total Weight	Frequency ^{2/}	Percent Comp.
				Range	Mean	Range		Mean			
						Round	Dressed				
3/30-4/4	Intricate Bay	AC	7	17.0-24.0	18.2	1.6-6.4		3.4	24.2	.058	37
		RB	7	15.7-25.7	18.3	1.3-6.8		2.5	17.8	.058	37
		S	5	16.0-17.5	16.1	1.0-2.1		1.5	7.8	.042	26
4/12-4/15	Eagle Bay	AC	7	12.7-21.5	18.0		0.5-2.9	1.7	11.7	.042	64
		LT	4	17.5-19.5	18.1		1.5-2.0	1.7	6.9	.024	36
4/11-4/13	Intricate Bay	AC	4	16.0-19.0	18.1	1.2-3.3		2.1	8.6	.066	22
		RB	2	17.7-27.0	22.3	1.6-7.0		4.3	8.6	.033	11
		S	12	15.0-17.5	16.1	1.2-1.9		1.6	18.6	.200	67
4/13-4/16	N. E. Bay	AC	19	14.5-24.5	18.5	0.9-3.5		1.8	35.3	.198	95
		LT	1	18.7	18.7	2.1		2.1	2.1	.010	5
4/10-4/18	Loon Bay	AC	28	9.0-23.0	16.5	0.3-4.6		2.1	60.1	.146	100
4/13-4/23	Intricate Bay	AC	9	17.5-25.0	20.8	1.7-5.7		3.2	29.0	.027	64
		RB	3	17.5-23.0	19.6	1.6-5.0		3.1	9.3	.009	22
		S	2	16.0-16.5	16.2	1.6		1.6	3.2	.006	14
4/18-4/24	N. E. Bay	AC	25	12.0-22.2	18.3		0.5-2.8	1.7	42.9	.174	78
		LT	4	20.2-24.5	22.5		2.2-4.0	3.3	13.2	.028	13
		WF	3	16.7-19.0	18.5		2.1-2.7	2.3	7.1	.020	9
4/18-4/25	Loon Bay	AC	15	15.7-21.5	19.4		0.9-2.7	2.0	30.0	.089	100
4/23-4/28	Intricate Bay	AC	6	18.0-27.0	23.5	2.3-6.9		4.5	27.3	.063	100
4/25-4/28	Loon Bay	AC	9	9.0-22.0	20.8	0.2-3.2		2.5	22.5	.125	90
		WF	1	16.5	16.5	1.2		1.2	1.2	.014	10

^{1/} Arctic Char - AC, Humpback Whitefish - WF, Cisco - CS, Lake Trout - LT, Suckers - S, Burbot - B, Rainbow Trout - RB.

^{2/} Number of fish taken per hour of fishing with 50 fathoms of gill net.

Appendix Table B. (Continued)

Date	Location	Species ^{1/}	Catch	Length in inches		Weight in pounds			Total Weight	Frequency ^{2/}	Percent Comp.
				Range	Mean	Range	Dressed	Mean			
4/28-5/6	Intricate Bay	AC	22	10.5-24.5	19.2	0.4-5.5		2.8	62.8	.115	56
		RB	10	17.0-28.5	19.3	1.2-9.7		5.6	55.7	.052	26
		WF	1	12.2	12.2	0.6		0.6	0.6	.005	3
		S	6	16.0-17.5	17.2	1.6-2.4		1.9	11.3	.031	15
5/6-5/10	Loon Bay	AC	21	13.0-22.5	19.2		0.5-4.1	2.0	42.1	.219	100
5/11-5/14	Intricate Bay	AC	12	16.5-25.5	22.4	1.5-5.4		3.9	47.0	.166	80
		RB	2	19.0-20.5	19.7	2.1-2.6		2.3	4.7	.027	13
		S	1	16.7	16.7	1.7		1.7	1.7	.014	7
5/17-5/18	Newhalen	AC	1	21.0	21.0		2.4	2.4	2.4	.041	20
		WF	4	17.6-20.2	18.5		2.0-3.1	2.3	9.5	.166	80
5/23-5/25	Newhalen	WF	4	18.0-19.5	18.8		2.0-2.9	2.5	10.0	.083	100
5/24-5/25	Newhalen	AC	14	16.0-23.2	19.9		1.0-3.0	1.9	27.8	.583	100
5/25-5/27	Newhalen	AC	15	13.9-22.5	19.5		0.6-2.9	2.2	32.3	.312	100
5/30-5/31	Intricate Bay	AC	14	13.6-24.7	22.9	0.5-6.2		3.7	52.2	.583	100
6/1-6/2	Intricate Bay	AC	4	23.0-24.5	23.8	4.9-6.2		3.9	15.7	.222	50
		RB	3	18.4-21.7	20.0	2.0-3.5		2.8	8.5	.167	38
		WF	1	17.7	17.7	1.6		1.6	1.6	.055	12
6/3-6/4	Intricate Bay	AC	6	17.2-22.8	18.8	2.0-4.5		2.1	12.7	.250	67
		RB	2	20.2-21.0	20.6	2.8-3.4		3.1	6.2	.083	22
		WF	1	17.2	17.2	1.7		1.7	1.7	.042	11

^{1/} Arctic Char - AC, Humpback Whitefish - WF, Cisco - CS, Lake Trout - LT, Suckers - S, Burbot - B, Rainbow Trout - RB.

^{2/} Number of fish taken per hour of fishing with 50 fathoms of gill net.

Appendix Table C. Catch samples of commercial freshwater fish species in Iliamna Lake taken by use of experimental 1-1/2 - 4 inch mesh gill net, 125 feet in length during March-June, 1964.

Date	Location	Species ^{1/}	Catch	Length in inches		Weight in pounds			Total Weight	Frequency ^{2/}	Percent Comp.
				Range	Mean	Range		Mean			
						Round	Dressed				
3/7-3/11	Severson Pt.	AC	1	14.0	14.0	0.8		0.8	0.8	.010	20
		CS	1	9.2	9.2	0.2		0.2	0.2	.010	20
		LT	2	7.2-7.2	7.2	0.1-0.1		0.1	0.2	.012	40
		B	1	15.0	15.0	1.4		1.4	1.4	.010	20
3/14-3/18	Severson Pt.	WF	1	13.0	13.0	0.7		0.7	0.7	.010	14
		CS	6	8.7-10.2	9.3	0.2-0.4		0.3	1.8	.063	86
3/14-3/18	Knutson Bay	AC	15	7.0-13.5	9.4	0.1-1.2		0.3	5.7	.156	79
		LT	3	6.5-7.0	6.8	0.1-0.1		0.1	0.3	.031	16
		CS	1	7.2	7.2	0.1		0.1	0.1	.010	5
3/30-4/5	School House Pt.	AC	3	7.2-14.0	10.7	0.1-0.8		0.4	1.4	.018	15
		LT	5	7.1-23.0	10.4	0.1-4.9		1.3	6.6	.030	25
		CS	11	6.7-9.5	8.7	0.1-0.3		0.2	2.3	.065	55
		B	1	22.0	22.0	2.7		2.7	2.7	.006	5
4/5-4/6	School House Pt.	LT	1	8.0	8.0	0.2		0.2	0.2	.042	33
		CS	2	9.2-9.5	9.3	0.3-0.3		0.3	0.6	.083	67
4/6-4/8	School House Pt.	LT	2	7.0-25.5	16.2	0.1-7.0		3.5	7.1	.043	50
		CS	2	7.2-9.0	8.1	0.1-0.2		0.2	0.3	.043	50
4/8-4/15	School House Pt.	AC	1	12.5	12.5	0.6		0.6	0.6	.006	4
		LT	6	7.0-16.5	10.1	0.1-1.9		0.6	3.6	.036	25
		CS	17	8.0-9.7	9.0	0.1-0.3		0.3	4.1	.101	71
4/9-4/17	Knutson Bay	AC	4	6.5-18.7	11.9	0.1-2.1		0.8	3.5	.021	80
		LT	1	8.5	8.5	0.3		0.3	0.3	.005	20

^{1/} Arctic Char - AC, Humpback Whitefish - WF, Cisco - CS, Lake Trout - LT, Suckers - S, Burbot - B, Rainbow Trout - RB.

^{2/} Number of fish taken per hour of fishing with 50 fathoms of gill net.

Appendix Table D. Catch samples of commercial freshwater fish species in Lake Clark taken by the use of 4 and 4-1/2 inch mesh gill nets during 1964.

Date	Location	Species ^{1/}	Catch	Length in inches		Weight in pounds			Total Weight	Frequency ^{2/}	Percent Comp.
				Range	Mean	Round	Dressed	Mean			
4/19	Chulitna Bay	WF	8	15.5-19.0	16.9	1.4-2.6		1.9	15.4	.889	73
		LT	1	19.8	19.8	2.5		2.5	2.5	.111	9
		S	2	21.0-21.5	21.2	4.0-4.4		4.2	8.4	.222	18
4/18-4/20	Six Mile	WF	13	14.5-19.0	16.0	1.2-3.0		1.7	23.2	.270	65
		LT	7	18.2-27.5	21.4	2.1-8.7		4.2	29.7	.145	35
4/26-4/27	Six Mile	WF	14	14.5-17.5	14.5		1.3-1.7	1.6	23.5	.666	61
		LT	9	23.5-29.5	27.2		4.0-14.2	8.7	79.0	.375	39
5/16-5/17	Six Mile	LT	10	21.1-27.0	23.5		2.5-5.2	3.7	36.8	.416	100
5/22-5/24	Six Mile	WF	13	14.0-18.0	16.1	1.0-2.5		1.6	21.0	.271	93
		LT	1	19.0	19.0	2.7		2.7	2.7	.021	7
5/22-5/24	Six Mile	WF	1	16.7	16.7	1.8		1.8	1.8	.021	20
		LT	3	18.0-22.5	19.8	1.8-2.5		2.0	6.1	.063	60
		GR	1	15.0	15.0	1.0		1.0	1.0	.021	40
5/23-5/25	Six Mile	WF	28	12.0-16.7	15.1		0.7-1.7	1.1	32.7	.583	100
5/24-5/25	Six Mile	WF	24	15.0-18.2	16.5		1.2-2.2	1.7	39.2	.500	100
5/26-5/27	Six Mile	WF	24	14.1-17.7	15.8		1.0-1.9	1.3	33.0	1.000	75
		LT	8	16.7-19.0	17.8		1.5-1.9	1.6	12.8	.334	25
5/26-5/27	Six Mile	WF	32	13.8-18.2	15.9		0.9-2.0	1.3	43.4	1.133	100

^{1/} Arctic Char - AC, Humpback Whitefish - WF, Cisco - CS, Lake Trout - LT, Grayling - GR, Suckers - S, Burbot - B.

^{2/} Numbers of fish taken per hour of fishing with 50 fathoms of gill net.

Appendix Table E. Water temperature recordings taken at gill net locations in Iliamna Lake and Lake Clark, 1964.

Date	Location	Time	Air Temp. °F.	Ice thickness in inches	Water temp. range along net	Fishing depth in feet	Length of net ^{1/}	No. of Each Species ^{2/}	Total No. Fish
March 5	Severson Pt.	11:00 a.m.	28	36	35.9/36.2°	48/60	125'	--	--
5	Severson Pt.	11:00 a.m.	28	36	35.3/35.9	42/54	125'	--	--
5	Severson Pt.	11:00 a.m.	28	36	35.4/36.0	62/74	125'	--	--
5	Severson Pt.	11:00 a.m.	28	36	35.5/36.2	76/88	125'	--	--
8	Whistle Wing Bay	10:00 a.m.	30	28	36.0/36.2	42/54	50 fth.	2 WF 14 AC 7 LT	23
April 4	Eagle Bay	12:00 noon	38	28	34.5/35.5	48/60	150 fth.	4 LT	4
4	Eagle Bay	12:00 noon	38	28	34.2/34.8	16/28	150 fth.	2 B 1 CS 3 AC	6
4	Eagle Bay	3:15 p.m.	38	29	33.5/33.6	12/24	50 fth.	1 LT	1
4	Rabbit Island	3:15 p.m.	38	29	35.0/36.1	63/75	50 fth.	--	--
4	Eagle Bay	3:50 p.m.	38	29	37.0/35.0	46/58	50 fth.	1 AC 1 CS 1 LT	3
4	Rabbit Island	3:50 p.m.	38	29	35.4/33.9	20/42	125'	--	--
5	School House Pt.	5:10 p.m.		30	34.3/34.5	36/48	125'	4 LT	4
5	School House Pt.	5:10 p.m.		30	34.5/34.7	21/33	125'	1 B 3 AC 11 CS	15
6	School House Pt.	4:40 p.m.	36	31	34.2/34.5	25/37	125'	1 LT	1
6	School House Pt.	4:40 p.m.	31		34.2/34.5	24/36	125'	2 CS	2
6	School House Pt.	4:40 p.m.	36	31	34.2/34.2	25/37	125'	--	--
7	Eagle Bay	2:40 p.m.	36	30	34.0	0/ 6	125'	--	--
7	Eagle Bay	2:40 p.m.	36	30	35.0	16/28	125'	--	--
7	Eagle Bay	2:40 p.m.	36	30	35.0/35.0	23/29	125'	--	--

Appendix Table E. (Continued)

Date	Location	Time	Air Temp. °F.	Ice Thickness in inches	Water temp. range along net	Fishing depth in feet	Length of Net ^{1/}	No. of Each Species ^{2/}	Total No. Fish
April 8	School House Pt.	12:30 p.m.	36	30	34.5/33.5	45/31	125'	2 LT 2 CS	4
8	Newhalen	1:30 p.m.	36	40	36.4/36.5	34/90	125'	--	--
9	Knutson Bay	11:40 a.m.	44	20	36.2/39.2	105/117	125'	--	--
10	Loon Bay	11:00 a.m.	54	35	35.0/36.5	11/23	100 fth.	--	--
10	Loon Bay	11:00 a.m.	54	35	35.2/36.5	12/24	100 fth.	--	--
10	Loon Bay	1:00 p.m.	54	35	35.1/38.2	10/22	100 fth.	--	--
10	Loon Bay	1:00 p.m.	54	35	36.0/38.2	9/21	100 fth.	--	--
10	Loon Bay	1:30 p.m.	54	35	35.5/39.0	11/23	100 fth.	--	--
10	Tommy Pt.	1:30 p.m.	54	35	35.7/39.3	10/22	100 fth.	--	--
10	Intricate Bay	5:30 p.m.	42	34	37.0/37.6	20/27	100 fth.	5 S 7 RB 7 AC	19
12	Intricate Bay	9:45 a.m.	30	38	37.0/37.7	20/27	375 fth.	7 AC 4 LT	11
12	Intricate Bay	9:45 a.m.	30	38	35.0/35.5	5/12	375 fth.	--	--
12	Intricate Bay	10:30 a.m.	34	39	35.5	6/13	375 fth.	--	--
12	Intricate Bay	10:30 a.m.	34	42	39.9/41.5	35/42	375 fth.	--	--
12	Intricate Bay	10:30 a.m.	34	38	38.1/39.0	22/34	375 fth.	--	--
13	Intricate Bay	10:00 a.m.	25	38	35.1/35.5	5/12	100 fth.	2 RB	2
13	Intricate Bay	10:00 a.m.	25	38	37.3/37.7	20/27	100 fth.	4 AC	4
13	Intricate Bay	10:00 a.m.	25	38	39.5/41.5	30/42	100 fth.	12 S	12
15	School House Pt.	2:00 p.m.	49.5	28	35.8/36.0	40/52	125'	17 CS	17
15	School House Pt.	2:00 p.m.	49.5	28	36.5/37.0	101/107	125'	6 LT 1 AC	7
15	N. E. Bay	3:30 p.m.	35.5	29	36.5/37.0	24/30	125'	--	--
15	N. E. Bay	3:30 p.m.	35.5	29	35.8/37.1	17/23	125'	--	--

Appendix Table E. (Continued)

Date	Location	Time	Air Temp. °F.	Ice Thickness in inches	Water temp. range along net	Fishing depth in feet	Length of Net ^{1/}	No. of Each Species ^{2/}	Total No. Fish
April 16	Rabbit Island	2:30 p.m.	36	28	36.0	30/36	200 fth.	15 AC	15
16	Rabbit Island	4:00 p.m.	36	28	36.0/36.5	35/41	200 fth.	4 AC	4
16	Severson Pt.	5:30 p.m.	36	28	37.2	31/37	200 fth.	1 LT	1
17	Knutson Bay	5:45 p.m.	36	24	38.5/39.0	119/125	125'	4 AC 1 LT	5
18	Loon Bay	12:45 p.m.	37	34	37.7/39.5	17/23	50 fth.	27 AC	27
18	Loon Bay	12:45 p.m.	37	34	37.5/40.0	18/24	50 fth.	1 AC	1
18	Chulitna Bay	6:15 p.m.	37	19	26.5	1/ 6	50 fth.	--	--
18	Chulitna Bay	6:15 p.m.	37	19	37.0	14/20	50 fth.	--	--
20	Six Mile	11:15 a.m.	40	40	36.1	10/16	150 fth.	20 WF	20
20	Six Mile	11:30 a.m.	40	40	36.0/36.1	24/30	150 fth.	3 LT	3
20	Six Mile	10:30 a.m.	40	40	36.1/36.3	18/24	150 fth.	--	--
20	Six Mile	10:40 a.m.	40	40	36.1/37.0	30/36	150 fth.	--	--
23	Intricate Bay	12:00 noon	41	35	36.0/36.5	6/12	100 fth.	6 AC 3 AC	9
23	Intricate Bay	12:00 noon	41	35	40.0/41.9	30/42	100 fth.	3 RB 2 S	5
24	N. E. Bay	11:15 a.m.	36		36.7/37.2	17/23	150 fth.	25 AC	25
24	N. E. Bay	12:00 noon	36		38.1/38.4	25/31	150 fth.	4 LT 3 WF	7
25	Loon Bay	11:45 a.m.	32	36	38.0/40.8	17/23	50 fth.	15 AC	15
25	School House Pt.	5:45 a.m.	32	30	36.6/37.1	47/53	50 fth.	--	--
28	Loon Bay	1:00 a.m.	40	29	39.1/41.5	18/23	50 fth.	9 AC 1 WF	10

Appendix Table E. (Continued)

Date	Location	Time	Air Temp. °F.	Ice Thickness in inches	Water temp. range along net	Fishing depth in feet	Length of Net ^{1/}	No. of Each Species ^{2/}	Total No. Fish
April 28	Chulitna Bay	5:00 p.m.	34	28	37.0	15/21	50 fth.	--	--
28	Chulitna Bay	5:00 p.m.	34	28	36.5/37.0	9/15	50 fth.	--	--
29	Intricate Bay	1:30 p.m.	35	20	37.0	6/12	100 fth.	--	--
29	Intricate Bay	2:10 p.m.	35	20	37.5/38.5	24/30	100 fth.	--	--
29	Intricate Bay	2:10 p.m.	35	20	41.5/43.5	36/42	100 fth.	--	--
29	Knutson Bay	2:40 p.m.	37	20	38.5	116/122	100 fth.	--	--
29	Knutson Bay	3:00 p.m.	37	20	40.0	186/192	100 fth.	--	--
May 3	Pile Bay	12:00 noon	36		36.5	51/57	50 fth.	--	--
3	Pile Bay	12:00 noon	36		36.5	138/144	50 fth.	--	--
3	Pile Bay	12:00 noon	36		36.5	72/78	50 fth.	--	--
4	Six Mile	2:30 p.m.		45	37.0/37.1	20/26	50 fth.	12 LT	12
4	Six Mile	2:30 p.m.		45	36.5/37.0	17/23	50 fth.	3 WF	3
6	Intricate Bay	3:15 p.m.		30	40.5/42.0	36/42	50 fth.	1 RB 6 S 1 CS	8
6	Intricate Bay	6:00 p.m.		20	39.5/41.7	18/24	50 fth.	42 AC 2 WF 1 RB	45
7	N. E. Bay	8:00 p.m.			38.5	17/23	100 fth.	21 WF	21
7	N. E. Bay	8:00 p.m.			38.0/39.1	24/30	100 fth.	5 LT	5
10	Pile Bay	1:45 p.m.	25		36.1/36.2	77/83	50 fth.	27 AC	27
10	Loon Bay	6:08 p.m.	28	20	41.2/42.0	17/23	50 fth.	1 B	1
14	Intricate Bay	1:30 p.m.	35	30	37.6/38.0	6/12	50 fth.	12 AC	12
14	Intricate Bay	2:30 p.m.	35	30	39.2/39.3	22/28	50 fth.	2 RB	2
14	Intricate Bay	2:30 p.m.	35	30	40.4/42.0	36/42	50 fth.	1 S	1
26	N. E. Bay	12:00 noon			39.5/40.0	1/ 6	50 fth.	--	--

Appendix Table E. (Continued)

1/ The letters "fth" indicate fathoms.

2/ Arctic Char - AC, Humpback Whitefish - WF, Cisco - CS, Lake Trout - LT, Burbot - B,
Rainbow Trout - RB, Sucker - S.

Appendix Table F. Maturation of Arctic Char taken in samples during the investigation of Iliamna Lake freshwater commercial fishery, March-June, 1964.

Month	Location ^{1/}	Site	Range of length in inches ^{3/}	Juvenile Numbers ^{2/}		Sub-adult Numbers ^{2/}		Ripe Adult Numbers ^{2/}		Spawned Adult Numbers ^{2/}	
				Male	Female	Male	Female	Male	Female	Male	Female
March	Iliamna	Severson Pt.	8-9	1							
			12-13				1				
			14-15			1					
		Whistle Wing	15-16	2		1	1				
			16-17			1	1				
			17-18					1	2		
	18-19						1				
	19-20						2	2			
	Knutson	Knutson Bay	7-8	3	1						
			8-9	3							
			9-10	2	1						
			10-11	1	1						
			11-12	1							
			12-13	2							
	Intricate	Intricate Bay	10-11	2		1	1				
			11-12	1	1						
			14-15						1		
			16-17				1	1			
			17-18				1				
			18-19						1		
19-20							1	1			
20-21								1			
21-22									1		
24-25								1			
April	Iliamna	Rabbit Island	8-9	1							
			16-17								1
			19-20								1

Appendix Table F. (Continued)

Month	Location ^{1/}	Site	Range of length in inches ^{3/}	Juvenile Numbers ^{2/}		Sub-adult Numbers ^{2/}		Ripe Adult Numbers ^{2/}		Spawned Adult Numbers ^{2/}		
				Male	Female	Male	Female	Male	Female	Male	Female	
April	Iliamna	School House Pt.	7-8	1								
			11-12		1							
			14-15	1								
		Eagle Bay	14-15									1
			15-16									1
			18-19				1				1	2
			19-20					1				1
		N. E. Bay	9-10									
			11-12	1								
		Intricate	Intricate Bay	10-11								
	15-16				1							
	16-17						1	3				
	17-18						2	1				1
	18-19						1	2				
	19-20						2					
	20-21						1					1
	21-22							3				
	22-23											6
	23-24										2	4
	25-26									1		
Loon Bay	18-19				1	7				1		
	19-20					2				1		
	20-21				2					2		
	21-22					1			1	1		
	22-23								1	1		
May	Iliamna	N. E. Bay	9-10	1	1							
			12-13	1								
Intricate	Intricate Bay	15-16	1									
		16-17				2						

Appendix Table F. (Continued)

Month	Location ^{1/}	Site	Range of length in inches ^{3/}	Juvenile Numbers ^{2/}		Sub-adult Numbers ^{2/}		Ripe Adult Numbers ^{2/}		Spawned Adult Numbers ^{2/}	
				Male	Female	Male	Female	Male	Female	Male	Female
May	Intricate	Intricate Bay	19-20			1					
			20-21			1					
			21-22					2			
			23-24								2
			24-25			1	3				2
		Loon Bay	19-20			1	1				
			20-21					2			
			22-23			1					
			24-25			1					
June	Intricate	Intricate Bay	16-17				1				
			17-18			4					
			18-19			1	1				
			21-22					2			
			22-23			1	1				1
			23-24								3
TOTALS				24	9	37	47	--	--	5	37

^{1/} Iliamna Lake commercial freshwater fishing areas are shown in Figure 1.

^{2/} Juveniles - eggs or testes visible but not fully developed. Sub-adult - eggs or testes developed to pre-spawning stage, no indication of readiness to spawn. Ripe adult - eggs or testes material loose or commencing to separate (eggs or sperm freely extracted from fish). Spawned adult - few loose eggs in the cavity or distended testes.

^{3/} The ranges listed in this column correspond to the intervals used in a length frequency distribution.

Appendix Table G. Maturation of Lake Trout taken during investigations of Iliamna Lake freshwater commercial fisheries, March-June, 1964.

Month	Location ^{1/}	Site	Range of length in inches ^{3/}	Juvenile Numbers ^{2/}		Sub-adult Numbers ^{2/}		Ripe Adult Numbers ^{2/}		Spawned Adult Numbers ^{2/}			
				Male	Female	Male	Female	Male	Female	Male	Female		
March	Iliamna	Severson Pt.	7- 8	2									
			8- 9	1									
		Whistle Wing	17-18										
	19-20					1	2						
	Intricate	Intricate Bay	22-23									1	
			7- 8	1									
8- 9				2									
9-10			1										
April	Iliamna	Rabbit Island	10-11	1	3								
			12-13	3									
			19-20				1						
			School House Pt.	7- 8	4	1							
				10-11	1								
				11-12	2								
12-13		1											
16-17						1							
25-26				1									
TOTALS				16	7	3	5				1		

^{1/} Iliamna Lake commercial freshwater fishing areas are shown in Figure 1.

^{2/} Juveniles - eggs or testes visible but not fully developed. Sub-adult - eggs or testes developed to pre-spawning stage, no indication of readiness to spawn. Ripe adult - eggs or testes material loose or commencing to separate (eggs or sperm freely extracted from fish). Spawned adult - few loose eggs in the cavity or distended testes.

^{3/} The ranges listed in this column correspond to the intervals used in a length frequency distribution.

Appendix Table H. Maturation of Cisco taken during investigations of Iliamna Lake freshwater commercial fisheries, March-June, 1964.

Month	Location	Site	Range of length in inches ^{3/}	Juvenile Numbers ^{2/}		Sub-adult Numbers ^{2/}		Ripe Adult Numbers ^{2/}		Spawned Adult Numbers ^{2/}	
				Male	Female	Male	Female	Male	Female	Male	Female
March	Iliamna	Severson Pt.	4- 5				1				
			6- 7			1					
			7- 8					2			
			8- 9		1	1	2				
			9-10					3			
		School House Pt.	7- 8	1							
		9-10		1	1	2					
	Knutson	Knutson Bay	2- 8	1							
TOTALS					2	2	3	10			

- 1/ Iliamna Lake commercial freshwater fishing areas are shown in Figure 1.
- 2/ Juveniles - eggs or testes visible but not fully developed. Sub-adult - eggs or testes developed to pre-spawning stage, no indication of readiness to spawn. Ripe adult - eggs or testes material loose or commencing to separate (eggs or sperm freely extracted from fish). Spawned adult - few loose eggs in the cavity or distended testes.
- 3/ The ranges listed in this column correspond to the intervals used in a length frequency distribution.

Appendix Table I. Sex ratio of various fish taken in the commercial fisheries of Iliamna Lake and Lake Clark by the use of 4 and 4-1/2 inch mesh gill nets during the months of March-June, 1964.

Lake	Month	Location ^{1/}	Percent ratio between male and female ^{2/}				
			AC Male-Female	WF Male-Female	LT Male-Female	CS Male-Female	S Male-Female
Iliamna	March	Iliamna	50:50		40:60		
		Intricate	50:50		75:25		
	April	Iliamna	58:42		66:34	50:50	
		Intricate	57:43				47:53
	May	Intricate	34:66				
	June	Intricate	33:67				
Lake Clark	April	Six Mile		50:50	90:10		
	May	Six Mile		45:55	66:34		

^{1/} Locations of catch are given in Figure 1 of this report.

^{2/} Arctic Char - AC, Humpback Whitefish - WF, Lake Trout - LT, Cisco - CS, Suckers - S.

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