N.S.R.A.A.

Fisheries Sampling Report

Turner Lake Investigations

1985

DRAFT

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Introduction

During 1985 an extensive fisheries study was conducted at Turner Lake in Southeast Alaska. The research was prompted by the longtime interest of N.S.R.A.A. members in assessing the potential of Turner Lake to produce sockeye salmon (Oncorhychus nerka). The study was undertaken with the cooperation of the Alaska Department of Fish and Game (A.D.F.& G.) and the United States Forest Service (U.S.F.S.). The primary responsibility of the A.D.F.& G. was to conduct a complete limnological survey of the lake, while the U.S.F.S. was to provide logistical support.

Turner Lake is located 16 miles east of Juneau (Fig. 1). The lake outlet, which is barriered to anadromous fish migration, drains into Taku Inlet, which is the site of an established sockeye and coho salmon gillnet fishery. The lake covers over 3100 acres, measures nine miles in length, and has a maximum depth of 215 meters. Although lake elevation is only 73 feet, the lake basin is extremely steep sided, being surrounded by vertical rock faces and 4500 foot peaks. The shallow littoral area of the lake is extremely limited.

The lake supports a popular recreational fishery for coastal cutthroat trout (Salmo clarki). Trophy size cutthroat (4-6 lb) are present in the lake and are taken by anglers each year according to the U.S.F.S. cabin logs. Turner Lake is the site of two U.S.F.S recreational cabins, and is recognized as a high quality recreational fishery area in the Tongass Land Use Management Plan. An angler ?

Turner Lake also supports populations of Dolly Varden char (Salvelinus malma), kokanee (Oncorhynchus nerka) and prickly sculpin (Cottus asper). Kokanee and Dolly Varden are caught by anglers, however most of the fishing effort is directed toward cutthroat trout.

The primary goal of the research at Turner Lake was to assess the feasibility and impact of introducing sockeye salmon to the lake. The major objectives of the study were to; 1) Assess the rearing resources of the lake 2) Estimate the amount and quality of salmonid spawning habitat 3) Investigate species interaction in terms of spatial distribution, diet overlap, and predation.

Although there are obvious life history differences between anadromous sockeye salmon and kokanee, we studied kokanee as a predictor for the factors potentially limiting the production of juvenile sockeye. The kokanee in Turner Lake mature after three or four years in the lake and measure 185 to 220 mm at maturity. The fecundity of the kokanee in Turner Lake is approximately 350 eggs/female, which is roughly 15% of the fecundity of a mature sockeye.

Field Sampling

Fisheries sampling began at ice-out in mid-June and continued until late October. A temporary camp was established on th south side of the lake. The lake was divided into three sampling areas (Fig. 1) and sampling effort was directed equally towards each of these areas.

Both of the inlets seemed to be fed primarily by snowmelt and runoff, as the stream level fluctuated dramatically in response to the weather. Low winter water levels and freezing temperatures could make the inlets unsuitable for sockeye salmon incubation.

Fish Distribution

Cutthroat trout probably use both of the major inlets for spawning. Cutthroat spawn in the spring and incubate during the summer months. Water levels are high during this time due to snowmelt and runoff. Cutthroat have been observed (Dave Browning, U.S.F.S., Juneau) in mid-May using the lower portion of the east inlet. Since ice-out was in mid-June during 1985 and cutthroat spawning probably peaks in May, we observed no cutthroat spawning activity. However, we did capture a spawned-out female near the south inlet in June. The amount, if any, of cutthroat spawning in the lake is unknown. Juvenile cutthroat trout were observed throughout the field season in the rocky nearshore areas. Fish as small as 50 mm were observed, however the smallest cutthroat captured were in the 90-100 mm range. No juveniles were observed or captured in the inlet streams. This evidence indicates that the cutthroat are using the rocky nearshore as a rearing area. Cutthroat in all size ranges appear to be shore orientated, the only exception being the larger (300 mm +) piscivorous fish which were captured in the pelagic area, although even catches of these fish were always higher nearshore.

In late October, Dolly Varden in ripe condition were captured near the mouths of inlet streams. Dolly Varden fry and juveniles were captured in the south inlet as much as one mile from the lake. Therefore, we believe that the fish use the lake inlets for spawning. Larger juveniles and adult fish were found along the entire lakeshore, particularly in areas of sandy substrate and woody debris.

Kokanee appear to spawn exclusively along the lakeshore, particularly in the areas adjacent to the inlet streams. The inlet streams were closely monitored for spawning activity during September and October, but no kokanee were observed. However, large groups of ripe fish were seen near the east inlet and in the southeastern corner of the lake. Gillnet sampling in October revealed ripe and spawned-out kokanee in these areas. The fish were a drab olive-brown color and showed considerable fin erosion, likely due to redd making activity. The fish were spawning at a depth of 40-60 ft. There could be any number of such spawning areas thoughout the lake. Kokanee in other lake systems utilize large substrate, upwelling areas. (Hassemer and Reiman 1981.) Kokanee fry were observed and captured in the delta area of the south inlet during August. During the same sampling period, we also observed a school of 30-50 fry in the southeast corner of the lake which we suspect were kokanee. No fry were observed in the inlet streams. Kokanee fry generally move offshore after a limited stay in the littoral zone. We captured larger juveniles (100 mm+) and adults with open water gillnet sets, however townetting which targeted smaller fish, proved ineffective.

The prickly sculpin spawn in the spring in rocky stream or inshore ares. Adhesive eggs are usually attached to a rock. The young are planktonic and may be eaten by juvenile sockeye. Juvenile (20-50mm) and adult sculpin (60-200mm) were abundant along the entire lakeshore.

Length and Weight Relationships

The cutthroat trout captured ranged in size from 83 to 572 mm, and had an average

The kokanee which we sampled to determine diet composition ranged in size from 110 to 200 mm. Numerical composition data were not compiled due to the vast difference in size among prey items (e.g. zooplankton versus adult insects). Cyclopoid copepods dominated prey items in terms of frequency of occurrence (Table 5). Fish under 140 mm fed almost exclusively on zooplankton. However, large kokanee often contained adult insects. Dipteran, Coleopteran, Hymenopteran and Tricopteran adults all make up a significant portion of the kokanee diet (Fig. 15). Cladocerans were not nearly as common in stomach samples as were copepods. The high percentage cyclpoid copepods in the diet likely reflects their numerical abundance in the lake since cyclopoids may be selected against by juveniles sockeye (Eggers 1978). Schools of kokanee were frequently observed cruising the surface, particularly near inlet streams, while feeding on adult insects. It should be noted that the majority of kokanee sampled were captured in a floating gillnet, which may have biased the sample toward the insect dominated diet.

An extensive study of prickly sculpin diet was not undertaken, however several fish were examined and contained primarily Trichopteran and Chironomid larvae.

Discussion

Diet Comparison

The diets of Dolly Varden and cutthroat trout follow the pattern described by Andrusak and Northcote (1971) for sympatric populations of these species. Specifically, the Dolly Varden preyed most heavily on benthic insect larvae while cutthroat trout feeding was concentrated at the lake surface (Fig. 16). Diet shifts by cutthroat to benthic larvae during fall and spring were noted, while both Dolly Varden and cutthroat take advantage of the super-abundance of terrestrial insects available on the lake surface during the summer months. Schutz and Northcote (1972) present evidence which indicates that Dolly Varden are more efficient at capturing benthic prey and cutthroat trout are more adept at surface feeding. Larger Dolly Varden do not appear to adopt a piscivorous diet in Turner Lake, although they are major predators on young salmon in some systems (Foerster 1968).

Generally, smaller cutthroat and older kokanee exhibited a preference for adult insects, however, this preference was not exhibited by young kokanee or large cutthroat. Dolly Varden fed on adult insects throughout the field season, with the peak occurring in August. Because of the abundance of surface food during the summer months, it is unlikely that significant competition for food occurs then. Any interspecific competition for food would likely occur during times of low food abundance (i.e. winter and spring). It is reasonable to assume that kokanee would probably consume a large proportion of plankton at this time, and cutthroat would search out available benthic prey. It is important to note that juvenile sockeye would likely feed exclusively on zooplankton, so competition with cutthroat would be minimal.

The effect of cutthroat predation on sockeye is difficult to predict. However, since the kokanee with their limited fecundity maintain a healthy population, predation should not be pre-emptive to a sockeye enhancement program. Sculpin may also be a significant predator of sockeye, particularly on the eggs and fry (Foerster 1968).

References

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Table 1

CONDITION FACTOR (K)*

SPECIES	$\bar{X}$*	RANGE	STANDARD ERROR	n
Cutthroat Trout	1.03	0.50 - 2.88	0.027	151
Dolly Varden	0.90	.52 - 1.96	0.007	199
Kokanee	1.10	.94 - 1.24	0.004	166

Table 1 Condition factors (K) of Turner Lake resident fish species 1985.

Table 2

LAKE AND SPECIES	NUMBER	CONDITION FACTOR (K)* $\bar{X}$	RANGE	STANDARD DEVIATION
Ella,				
Cutthroat Trout	24	0.84	0.45-1.19	0.15
Dolly Varden	3	1.35	0.87-2.31	0.83
Kokanee	11	1.00	0.87-1.35	0.17
Manzanita,				
Cutthroat Trout	27	0.88	0.64-1.28	0.13
Dolly Varden	21	0.95	0.73-1.71	0.20
Turner,				
Cutthroat	25	1.02	0.74-1.32	0.10
Dolly Varden	27	0.94	0.82-1.06	0.07
Kokanee	18	1.03	0.89-1.15	0.08
Wilson,				
Cutthroat Trout	50	1.05	0.81-2.09	0.20
Dolly Varden	3	0.85	0.74-1.03	0.16
Kokanee	1	1.03		

* $K = \frac{\text{weight (gm)} \times 10^5}{\text{length (mm)}^3}$

Table 2 Condition factors (K)* of cutthroat trout, Dolly Varden and kokanee, O. nerka (Walbaum), from Ella, Manzanita and Wilson lakes, (from Schmidt 1977).

Table 4

Turner Lake 1985

Dolly Varden Diet Summary

	JUNE		JULY		AUG		OCT		OVERALL	
	Percent numerical composition	% Occ.	Percent num. comp.	% Occ.	Percent num. comp.	% Occ.	Percent num. comp.	% Occ.	Percent num. comp.	% Occ.
	n=7		n=19		n=7		n=8		n=41	
Insects:										
Trichoptera (larvae)	78.5	57.1	47.5	63.2	54.0	28.6	30.4	100.0	52.8	63.4
Trichoptera (adult)	–	–	0.6	5.2	4.4	42.9	2.8	37.5	1.7	17.1
Ephemeroptera (larvae)	0.5	14.3	1.3	5.2	–	–	–	–	0.4	4.9
Ephemeroptera (adult)	–	–	–	–	–	–	–	–	–	–
Plecoptera (larvae)	0.9	28.6	1.3	10.5	5.3	28.6	0.5	12.5	1.6	17.1
Plecoptera (adult)	–	–	–	–	–	–	–	–	–	–
Hymenoptera (adult)	–	–	1.9	10.5	0.9	14.3	0.9	12.5	0.8	9.8
Coleoptera (adult)	–	–	1.3	10.5	–	–	–	–	0.3	4.9
Hemiptera (adult)	0.5	14.3	–	–	–	–	–	–	0.1	2.4
Diptera (adult)	–	–	22.8	36.8	12.4	57.1	0.9	12.5	7.4	29.3
Chironomidae (larvae)	11.7	57.1	8.2	21.0	4.4	28.6	64.5	25.0	25.9	29.3
Chironomidae (adult)	2.3	28.6	–	–	–	–	–	–	–	–
Culicidae (adult)	–	–	–	–	–	–	–	–	–	–
Simulidae (adult)	0.5	14.3	–	–	–	–	–	–	0.1	2.4
Tipulide	2.3	28.6	–	–	–	–	–	–	0.7	4.9
Lepidoptera (larvae)	1.9	28.6	–	–	–	–	–	–	0.5	4.9
Mysid shrimp	0.5	14.3	13.9	10.5	18.6	28.6	–	–	6.3	12.2
Cyclopoid Copepods	–	–	–	–	–	–	–	–	–	–
Cladocerans	–	–	–	–	–	–	–	–	–	–
Arachnids	–	–	–	–	–	–	–	–	–	–
Fish	–	–	1.3	5.2	–	–		–	0.3	2.4

Table 6

Turner Lake 1985

Prey Item Count Summaries

Species Sample Size	Kokanee 71	Dolly Varden 41	Cutthroat 116
Insects:			
Trichoptera (larvae)	4	369	261
Trichoptera (adult)	34	12	266
Ephemeroptera (larvae)	-	3	10
Ephemeroptera (adult	1	-	2
Plecoptera (larvae)	-	11	5
Plecoptera (adult)	2	-	2
Hymenoptera (adult)	320	6	446
Coleoptera (adult)	179	2	205
Hemiptera (adult)	4	1	27
Diptera (adult)	1544	52	804
Chironomidae (larvae)	15	181	140
Chironomidae (adult)	13	5	25
Culicidae (adult)	7	-	-
Simulidae (adult)	-	1	2
Tipulide	-	5	-
Lepidoptera (larvae)	-	4	-
Mysid shrimp	-	45	15
Colembola		1	17
Cyclopoid Copepods	90,201	-	-
Cladocerans	10,375	-	-
Arachnids	1	-	6
Fish	-	2	19
Mouse			1

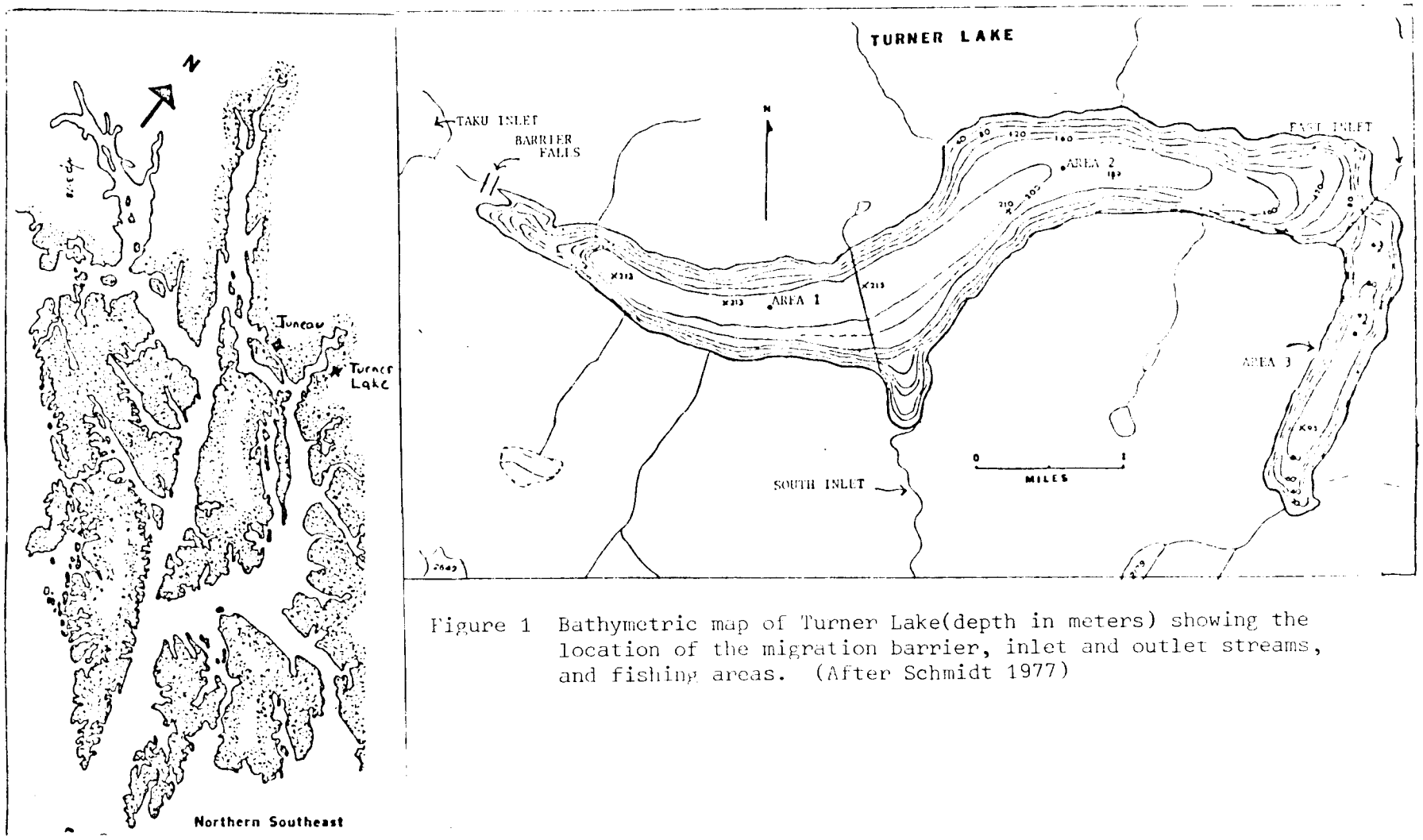

Figure 1 Bathymetric map of Turner Lake(depth in meters) showing the location of the migration barrier, inlet and outlet streams, and fishing areas. (After Schmidt 1977)

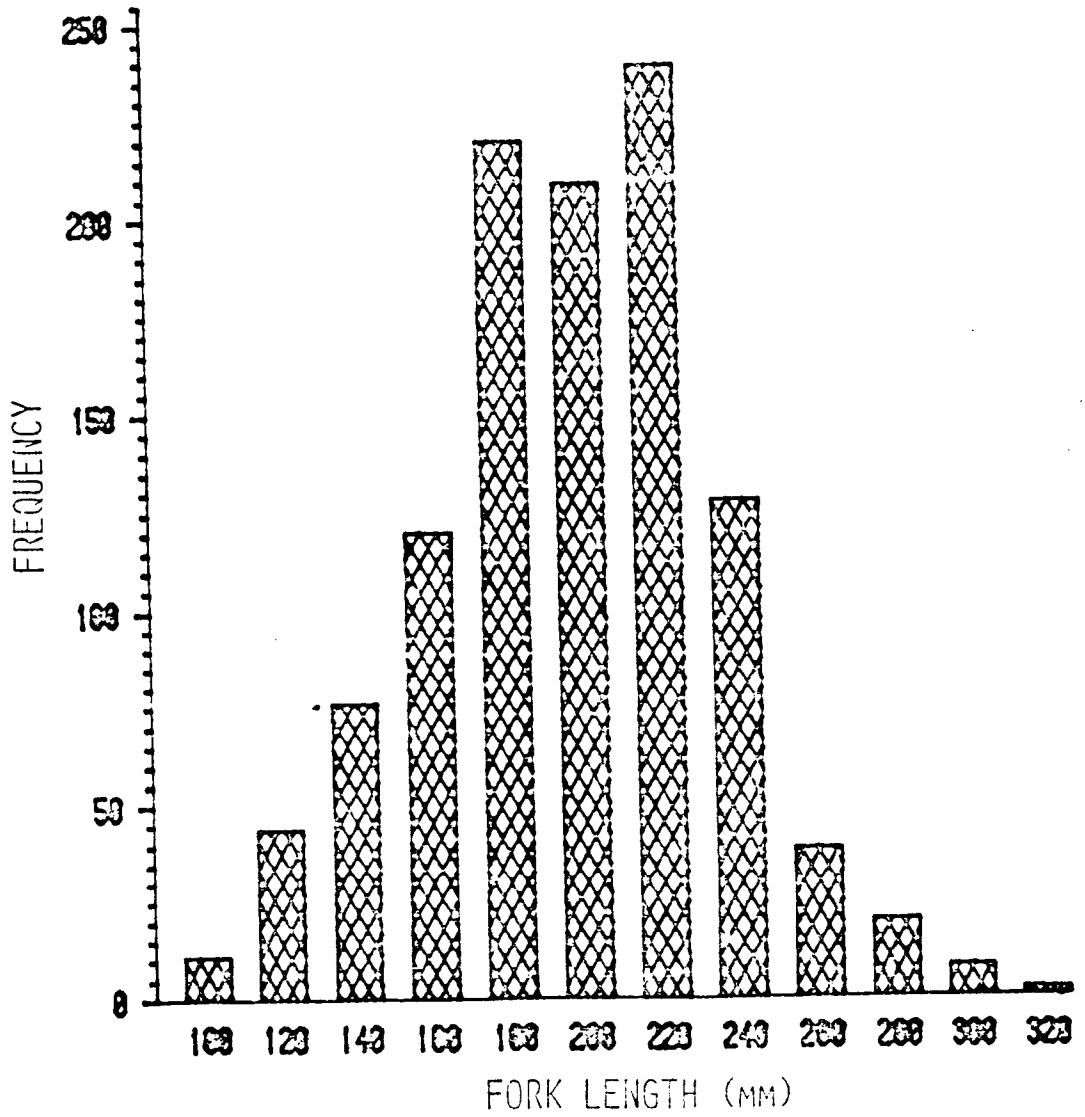

Figure #3 Length frequency plot for Turner Lake Dolly Varden. (fork length in mm, n=1116)

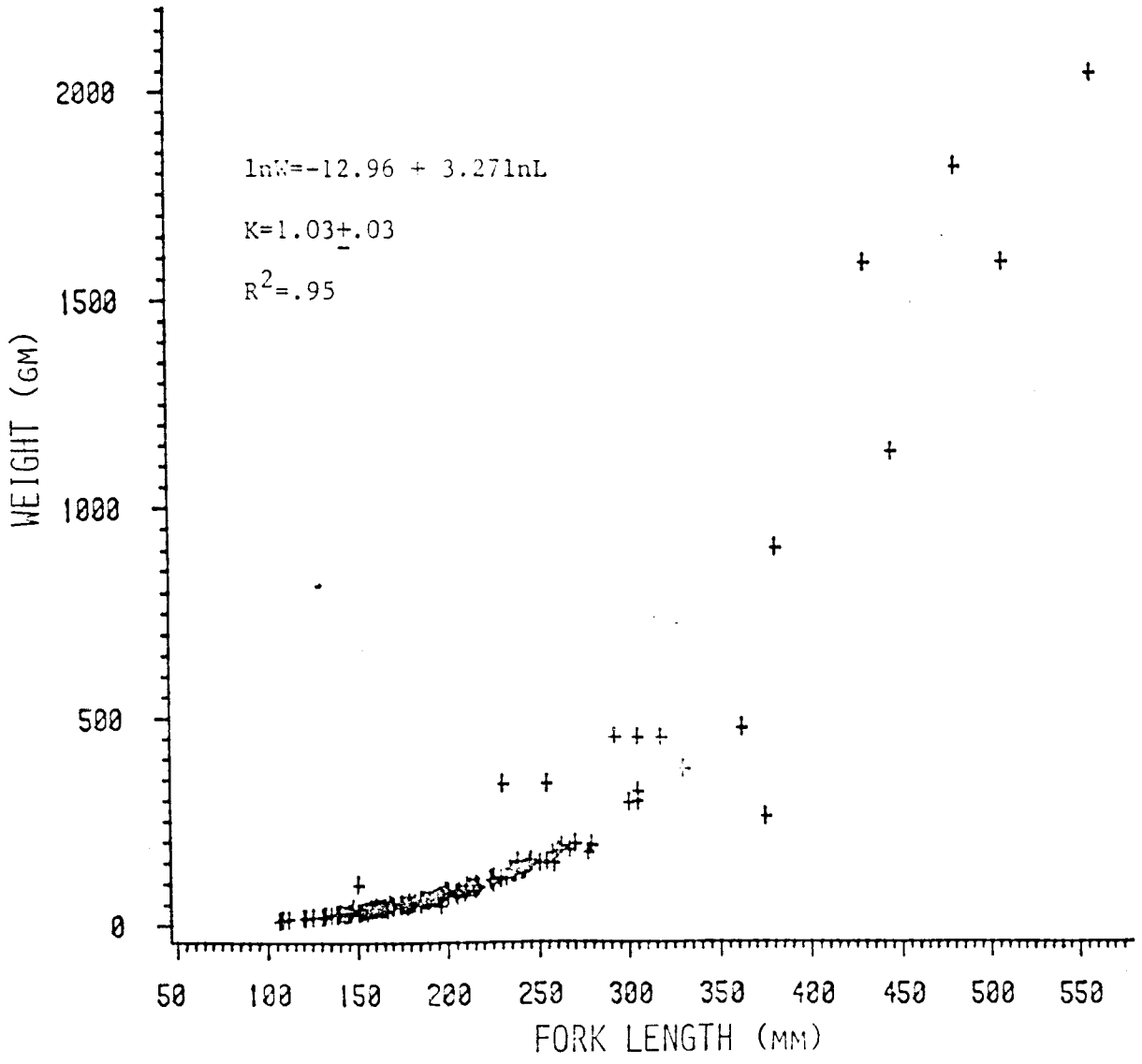

Figure #5 Regression of (ln) weight (gm) on (ln) fork length (mm) showing condition factor (K) for cutthroat trout.

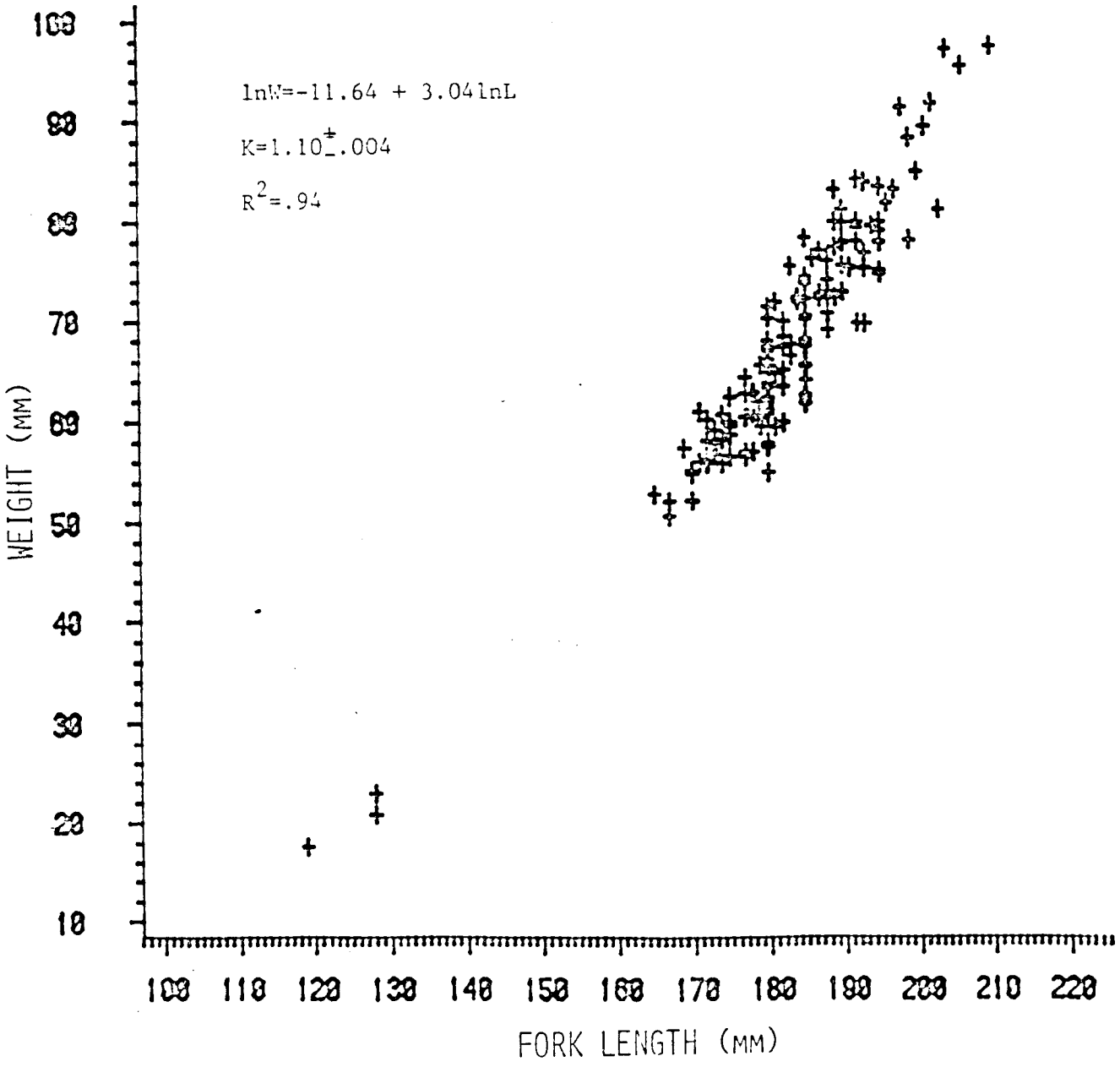

Figure #7 Regression of (ln) weight (gm) on (ln) length (mm) showing condition factor (K) for kokanee.

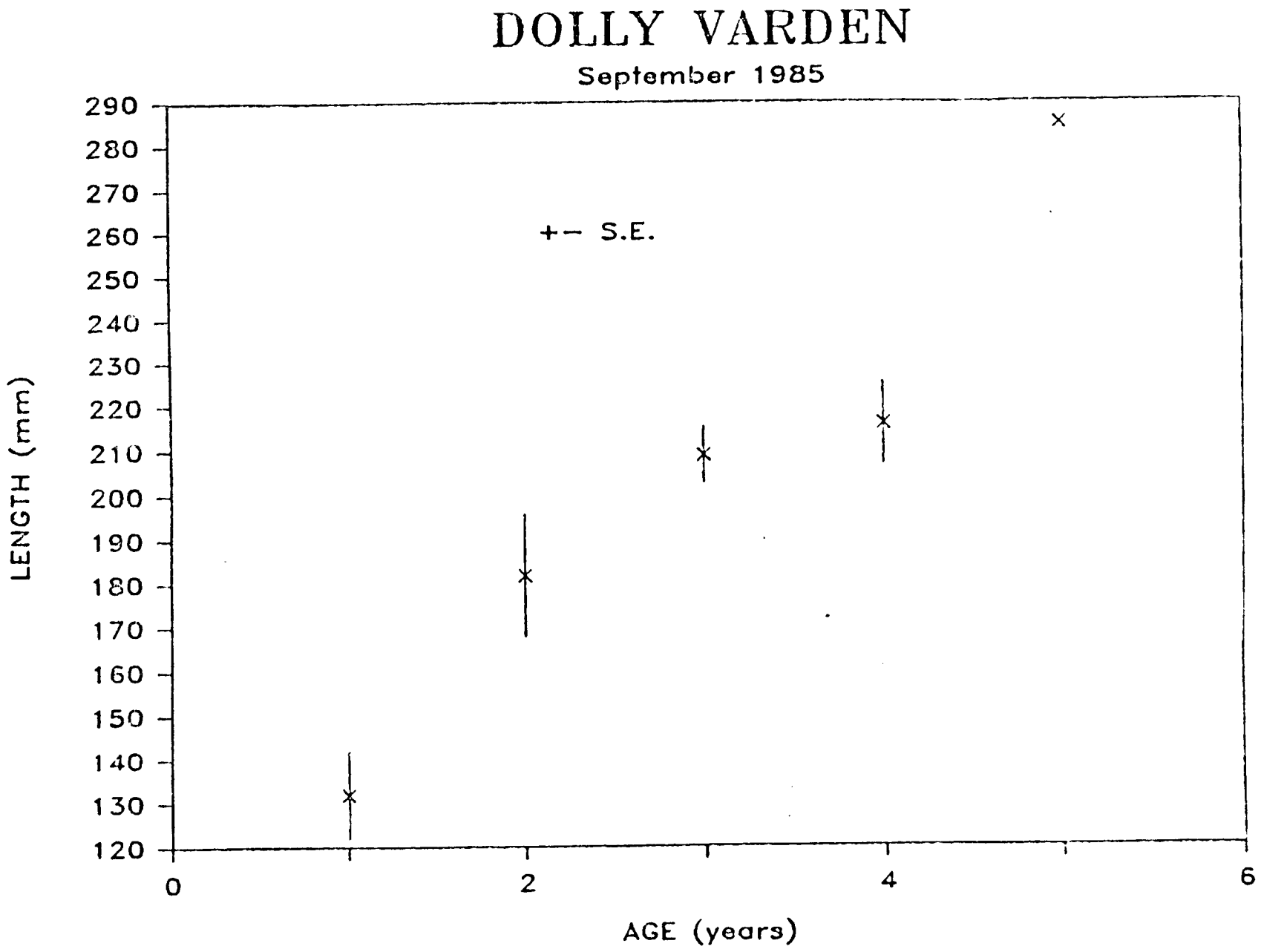

Figure #9 Age and length of Dolly Varden char from Turner Lake, September 1985 (+ - standard error)

% NUMERICAL COMPOSITION OF PREY

FOR TURNER LAKE CUTTHROAT

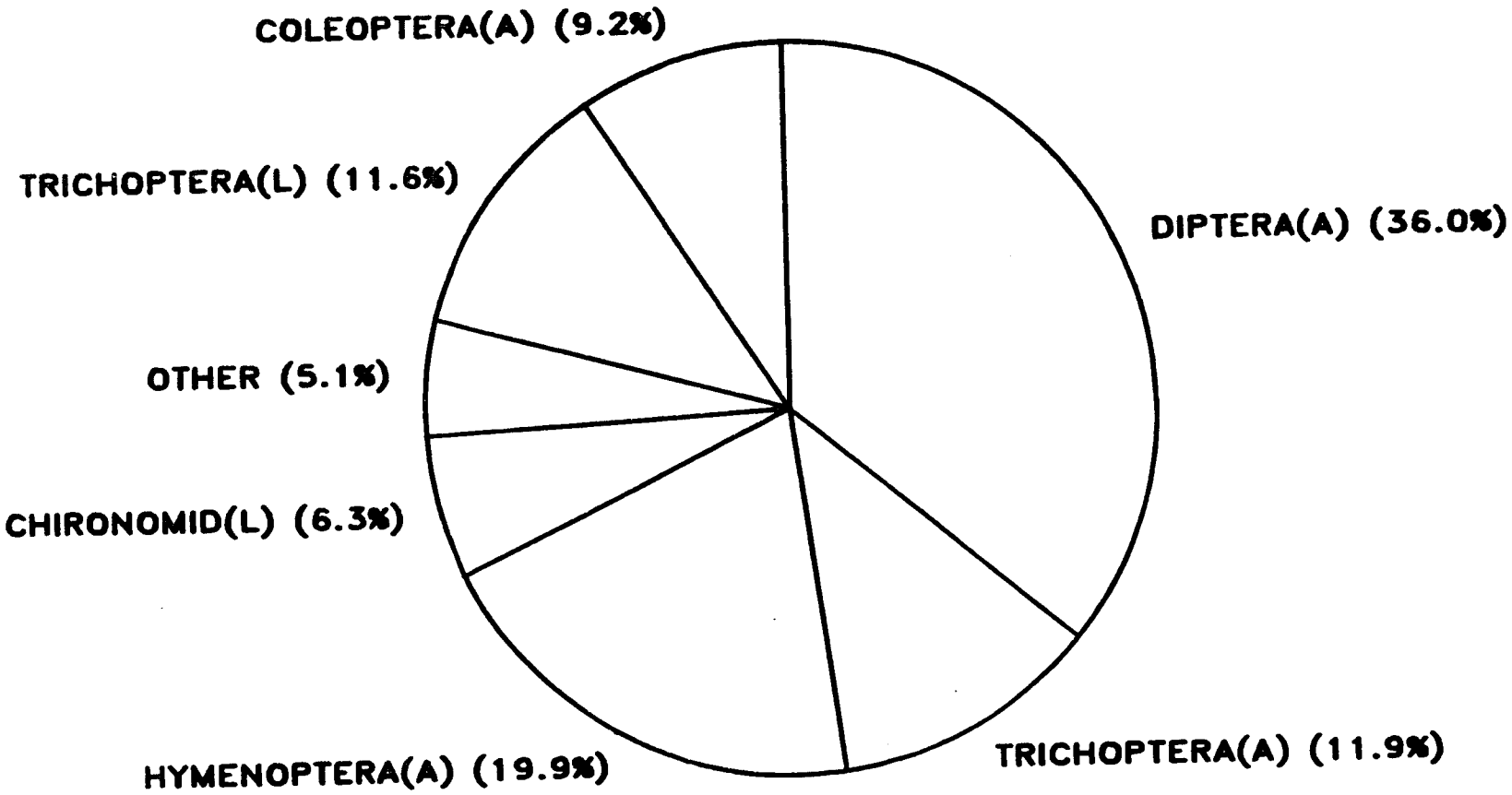

Figure #11 Percent numerical composition of major prey items for Turner Lake cutthroat trout. (June through October 1985)

% NUMERICAL COMPOSITION OF PREY

FOR TURNER LAKE DOLLY VARDEN

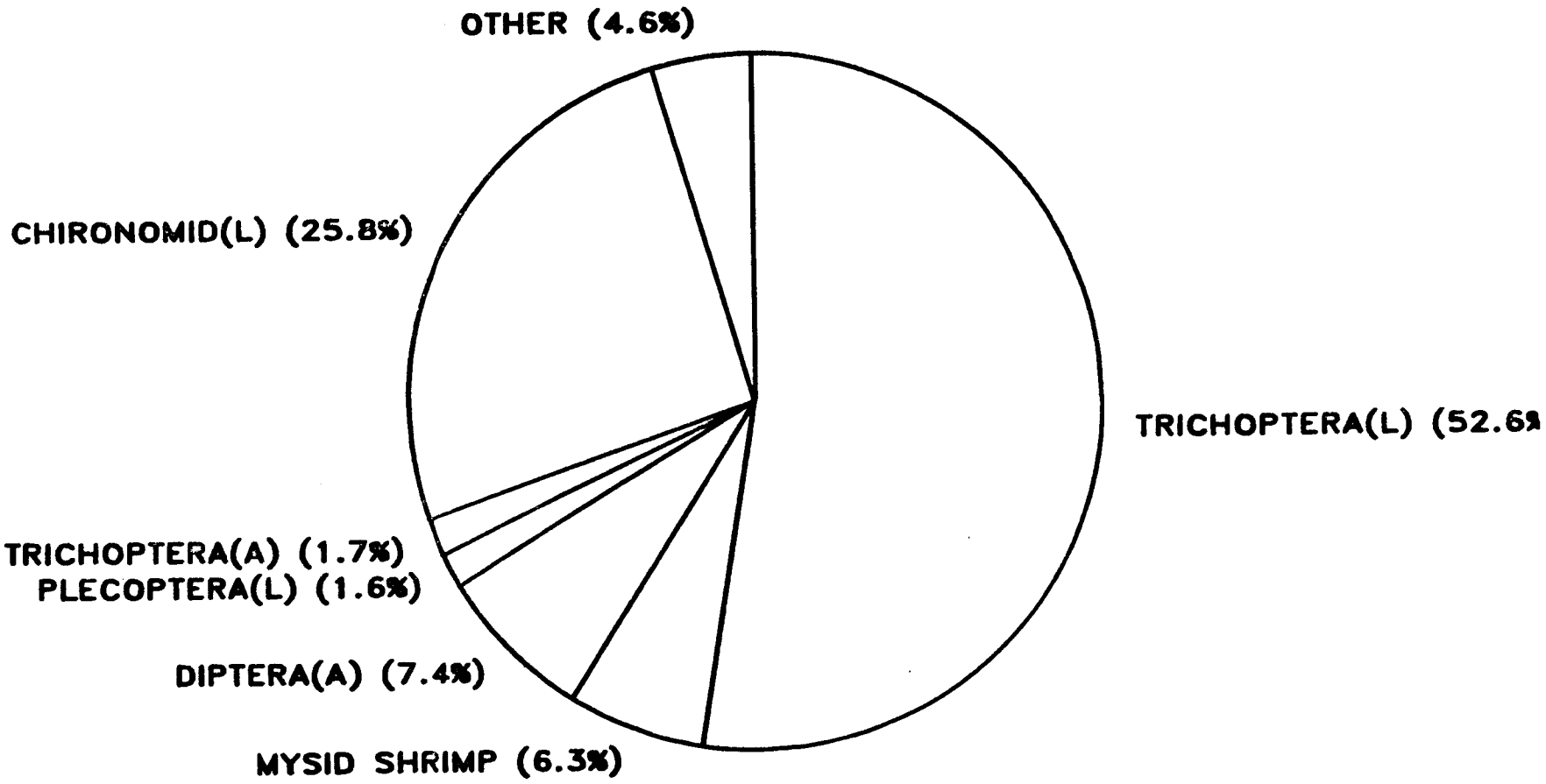

Figure #13 Percent numerical composition of major prey items for Turner Lake Dolly Varden. (June through October 1985)

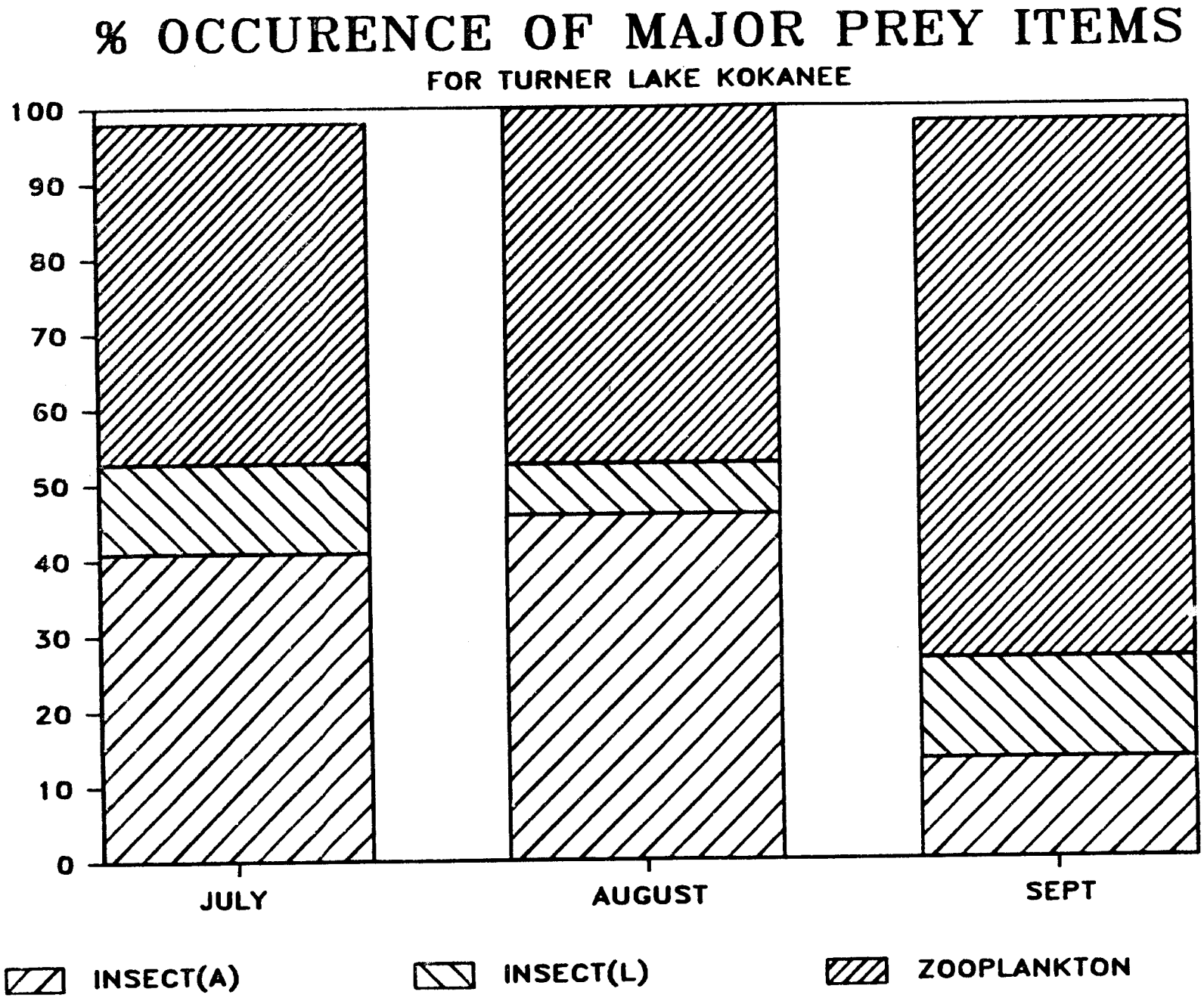

Figure #15 Percent occurence of major prey items for Turner Lake kokanee. (July through September 1985)

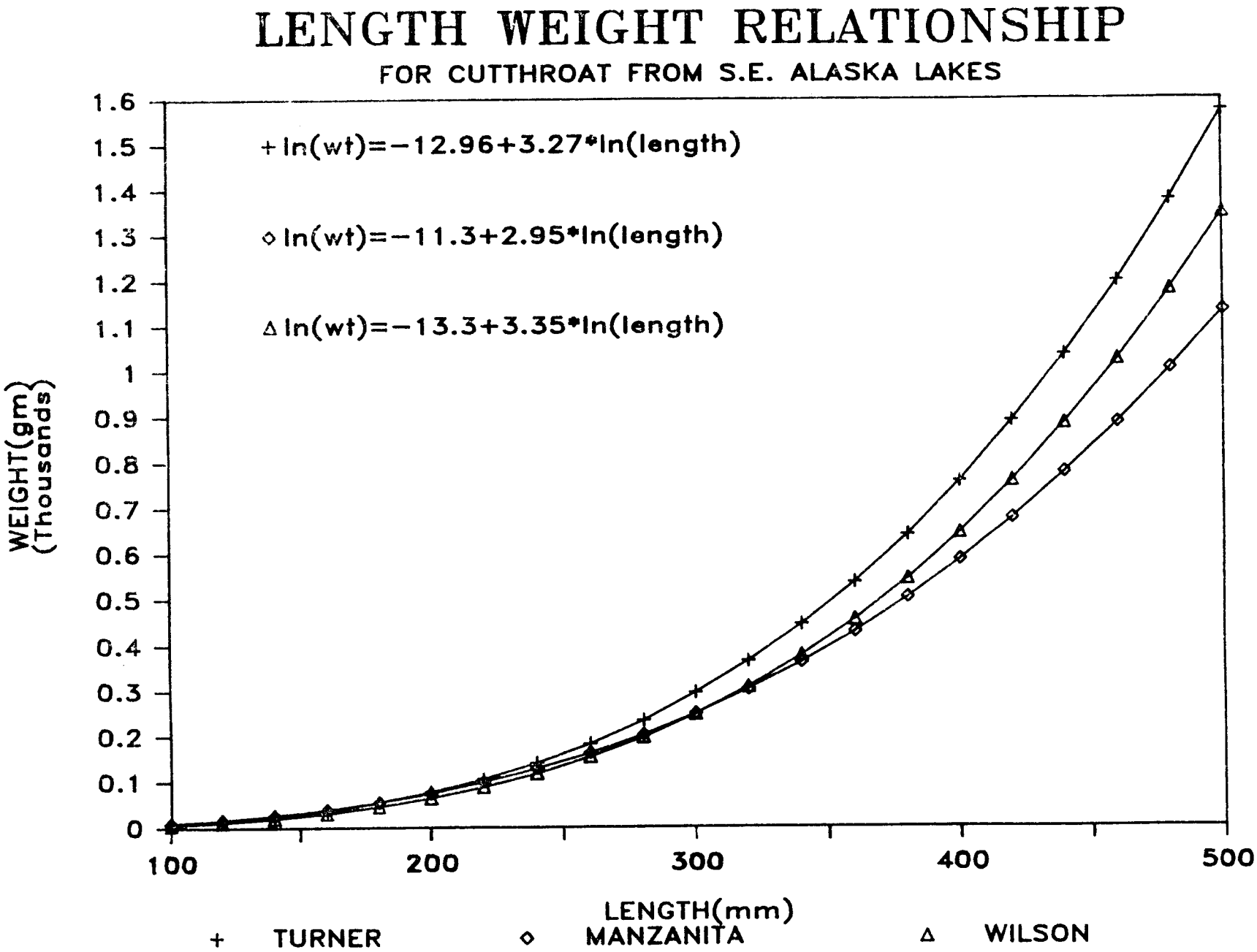

Figure #17 Fork length (mm) and weight (gm) for cutthroat trout from Southeast Alaska lakes. Data from Turner Lake 1985 (r^2 = .94) and from Schmidt (1977) for Manzanita (r^2 = .98) and Wilson (r^2 = .98) lakes.

Table 6

Turner Lake 1985

Prey Item Count Summaries

Species	Kokanee	Dolly Varden	Cutthroat
Sample Size	71	41	116
Insects:			
Trichoptera (larvae)	4	369	261
Trichoptera (adult)	34	12	266
Ephemeroptera (larvae)	-	3	10
Ephemeroptera (adult	1	-	2
Plecoptera (larvae)	-	11	5
Plecoptera (adult)	2	-	2
Hymenoptera (adult)	320	6	446
Coleoptera (adult)	179	2	205
Hemiptera (adult)	4	1	27
Diptera (adult)	1544	52	804
Chironomidae (larvae)	15	181	140
Chironomidae (adult)	13	5	25
Culicidae (adult)	7	-	-
Simulidae (adult)	-	1	2
Tipulide	-	5	-
Lepidoptera (larvae)	-	4	-
Mysid shrimp	-	45	15
Colembola		1	17
Cyclopoid Copepods	90,201	-	-
Cladocerans	10,375	-	-
Arachnids	1	-	6
Fish	-	2	19
Mouse			1