RESULTS

ATTRIBUTES OF FISH POPULATIONS

Species Composition

A total of 26 species of fish (kokanee and sockeye salmon counted separately) were taken during the 1971 sampling program on the Okanagan basin lakes (Table 1). Several other species are known to occur in the system, but were not found in our survey. These include the bridgelip sucker (*Catostomus columbianus*) which is recorded from Osoyoos Lake (and may have been confounded with the longnose sucker in our records), tench (*Tinca tinca*) also from Osoyoos Lake, and lake chub (*Couesius plumbeus*) from Okanagan Lake. Other species possibly present but without definite record of occurrence include the white sturgeon (*Acipenser transroontanus*), brook trout (*Salvelinus fontinalis*) and coho salmon (*Oncorhynchus kisutch*).

At least 9 of the 26 species were caught in all of the lakes sampled

(Table 1), namely mountain whitefish, rainbow trout, kokanee, largescale sucker, carp, squawfish, peamouth chub, chiselmouth and prickly sculpin. Lake whitefish, which were introduced to the system in 1894, were not taken during 1971 in Wood or Kalamalka lakes, nor were any caught there by netting in 1929 or 1935 (Clemens et al. 1939). Only two pygmy whitefish were taken, one from Skaha and one from Osoyoos Lake. This species had not been recorded previously from the Okanagan system. Lake trout caught in Kalamalka came from 1500 hatchery reared stock (Riding Mountain Park, Manitoba via Jasper Hatchery). They were nearly 3 years of age when introduced to the lake in October, 1970. Three juvenile chinook salmon were caught in Osoyoos Lake, as well as four adult sockeye salmon. Representatives of the catfish, perch, bass and sunfish families were confined to the lower two lakes in the system except for pumpkinseed which were found in Skaha as well. Pumpkinseed were not taken in Skaha during extensive summer collections in 1948. Smallmouth bass have not been recorded before from the system. Burbot were frequently caught in Okanagan and Skaha but never in the other lakes. The slimy sculpin, seined from Kalamalka and Okanagan lakes, had not been recorded previously in the drainage.

Relative Abundance

1. Within-lake comparisons, 1971

Comparisons of relative abundance are possible between the two stations in Kalamalka and in Skaha as well as between the eight Okanagan Lake stations (Table 2). At Kalamalka, the south station consistently showed larger catches than did the north for each of the seasons and for most of the species, especially peamouth chub. Chi-square analyses showed

Table 1. Species[1] of fish taken from Okanagan basin lakes at designated stations[2] during the 1971 survey

FAMILY	COMMON NAME	SCIENTIFIC NAME	WOOD I	KALAMALKA S	KALAMALKA N	KALAMALKA Σ	OKANAGAN N	OKANAGAN W	OKANAGAN C	OKANAGAN K	OKANAGAN M	OKANAGAN P	OKANAGAN H	OKANAGAN S	OKANAGAN Σ	SKAHA N	SKAHA S	SKAHA Σ	VASEUX	OSOYOOS
Whitefishes (Coregonidae)	**Mountain Whitefish**	Prosopium williamsoni	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Pygmy Whitefish	Prosopium coulteri															✓	✓		✓
	Lake Whitefish	Coregonus clupeaformis					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Trout and Salmon (Salmonidae)	**Lake Trout**	Salvelinus namaycush		✓	✓	✓														
	Rainbow Trout	Salmo gairdneri	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Chinook Salmon	Oncorhynchus tshawytscha																		✓
	Sockeye Salmon	Oncorhynchus nerka																		✓
	Kokanee	Oncorhynchus nerka	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Suckers (Catostomidae)	**Largescale Sucker**	Catostomus macrocheilus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Longnose Sucker	Catostomus catostomus			✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Minnows (Cyprinidae)	**Carp**	Cyprinus carpio	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Redside Shiner	Richardsonius balteatus	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	
	Northern Squawfish	Ptychocheilus oregonensis	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Peamouth Chub	Mylocheilus caurinus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Chiselmouth	Acrocheilus alutaceus	✓	✓		✓	✓	✓	✓						✓	✓	✓	✓	✓	✓
	Leopard Dace	Rhinichthys falcatus							✓						✓					
	Longnose Dace	Rhinichthys cataractae			✓	✓														
Catfishes (Ictaluridae)	**Black Bullhead**	Ictalurus melas																	✓	✓
Codfishes (Gadidae)	**Burbot**	Lota lota					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Perches (Percidae)	**Yellow Perch**	Perca fluviatilis																	✓	✓
Basses and Sunfishes (Centrarchidae)	**Smallmouth Bass**	Micropterus dolomieui																		✓
	Largemouth Bass	Micropterus salmoides																		✓
	Pumpkinseed	Lepomis gibbosus														✓		✓	✓	✓
	Black Crappie	Pomoxis nigromaculatus																		✓
Sculpins (Cottidae)	**Prickly Sculpin**	Cottus asper	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
	Slimy Sculpin	Cottus cognatus		✓	✓	✓		✓	✓			✓			✓					
TOTAL	**26**	**26**	10	12	13	14	12	14	15	12	10	12	11	12	15	14	14	15	15	20

[1] listed as given in Carl et al. (1967) except for kokanee which herein is recognized as a distinct form.

[2] see Figure 1 for name and location

Table 2. Number of fish taken in combined spring, summer and autumn (standard) net sets at designated stations in Kalamalka, Okanagan and Skaha lakes.

	KALAMALKA		OKANAGAN								SKAHA	
SPECIES	N	S	N	W	C	K	M	P	H	S	N	S
Kokanee	173	130	429	276	241	189	303	430	184	104	247	126
Rainbow Trout	16	51	16	6	4	12	19	10	61	35	15	8
Lake Trout	30	61										
Mountain Whitefish	3	2	17	7	9	26	53	27	120	69	28	50
Lake Whitefish			119	54	55	86	84	29	105	95	197	275
Largescale Sucker	20	37	81	57	34	45	45	45	73	49	169	137
Longnose Sucker	2			9	7	6	12	6	2	3	4	8
Peamouth Chub	98	219	175	235	95	134	195	80	267	304	338	653
Squawfish	44	52	115	128	86	94	51	59	72	105	211	167
Carp	3	16	13	15	1	5	6	1	8	5	30	19
Chiselmouth		1	38	1	1						97	1
Burbot			27	12	20	6	5	20	13	7	2	2
Prickly Sculpin						2		2	9		1	
Pumpkinseed											2	
TOTAL	389	569	1030	800	553	605	773	709	914	776	1341	1446
Spring	106	212	329	346	165	179	157	100	269	381	438	320
Summer	93	139	212	181	89	190	131	73	401	271	213	485
Autumn	190	218	489	273	299	236	485	536	244	124	690	641

that the differences in relative abundance of species were highly significant ($p < 0.001$).

Although the north Okanagan station had the highest total catch, this was chiefly a result of large kokanee catches in the autumn and of lake whitefish throughout the netting period. Centre, Kelowna and Peachland stations were among the lowest in total catch. Indeed had not the latter station shown an especially large kokanee catch in the autumn (probably a result of its location near the mouth of a kokanee spawning stream), it would have exhibited the lowest total catch. After excluding kokanee and peamouth chub (schooling species probably not caught in gill nets as independent individuals), a series of chi-square and F tests (by chi-square rations; $p = 0.05$) were run on the Okanagan Lake stations to determine appropriate within-lake groupings. Relative abundance of species in catches at Whiteman and Centre were not significantly different but together were so when compared with North or Peachland. Catches combined for Kelowna and Mission did not differ significantly in relative abundance from those at Peachland, whereas those at Hatchery and South did when compared either to Peachland or to Kelowna. Catches of rainbow trout, mountain whitefish and lake whitefish were generally higher in the southern stations than those in central or northern regions of Okanagan Lake. Thus combinations of northern (N, W, C), central (K, M, P) and southern (H, S) stations would seem reasonable.

Although there were not large differences in total catch between north and south Skaha Lake stations, those for rainbow trout, largescale suckers and squawfish were higher in the north while the reverse was evident for mountain whitefish and lake whitefish. Relative abundance of species (with or without kokanee and peamouth chub) was significantly different ($p < 0.001$) between the two stations.

2. Between-lake comparisons, 1971

There were marked differences between the lakes in the total number of fish caught in the standard net sets (Fig. 2). The lowest total catch was from Wood Lake, followed by that at the south Kalamalka station. Those at Kalamalka north as well as Okanagan C and K were only slightly higher, while the highest catches in Okanagan itself came from the northern and southern ends. Catches at both Skaha stations, the highest in the system except for Vaseux, were nearly double those for most Okanagan stations. Those at Osoyoos were lower than Skaha or Vaseux but higher than most from Okanagan Lake. Summer catches in general were much lower than those in spring or autumn. In some cases, notably some central Okanagan stations (M, P) autumn catches (dominated by mature kokanee) far exceeded those in spring and summer combined.

An independent measure of total fish abundance may be inferred from echo sounder tracings (Fig. 3). These tracings show numerous inverted V marks, most of which probably represent individual fish (Northcote et al., 1964). Counts of such marks (Fig. 4) again show the Wood Lake station to be the lowest, followed by those on Kalamalka. As previously indicated by netting, the highest abundance of "fish" (marks) on Okanagan Lake occur near its north and south ends. Surprisingly, the echo soundings did not

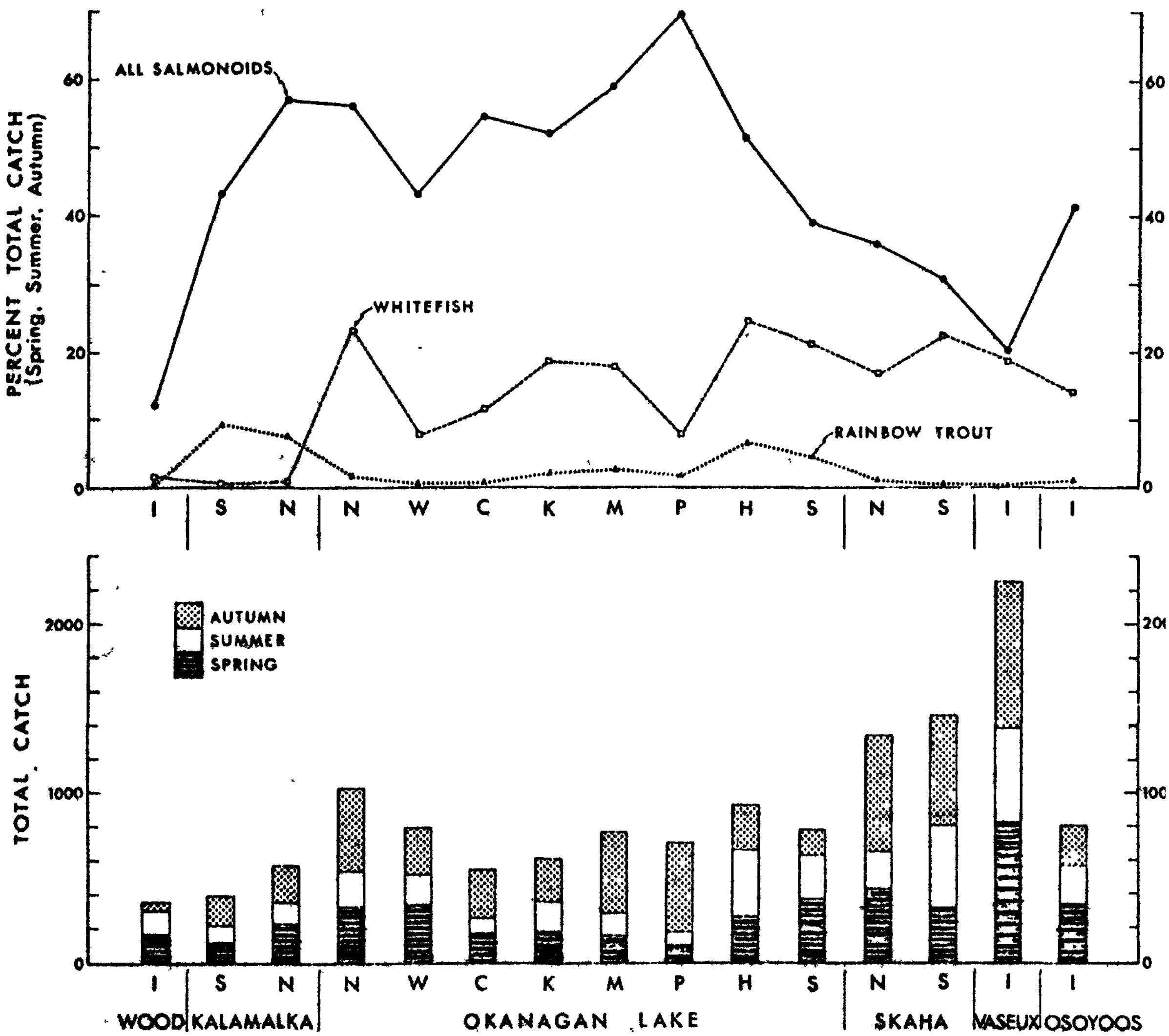


Fig. 2. Catch of fish in standard net sets at designated stations in Okanagan basin lakes, 1971. The histogram shows total and seasonal catch of all species; upper graph shows percent catch of selected groups (salmonoids = Salmonidae + Coregonidae; whitefish = mountain + lake + pygmy).

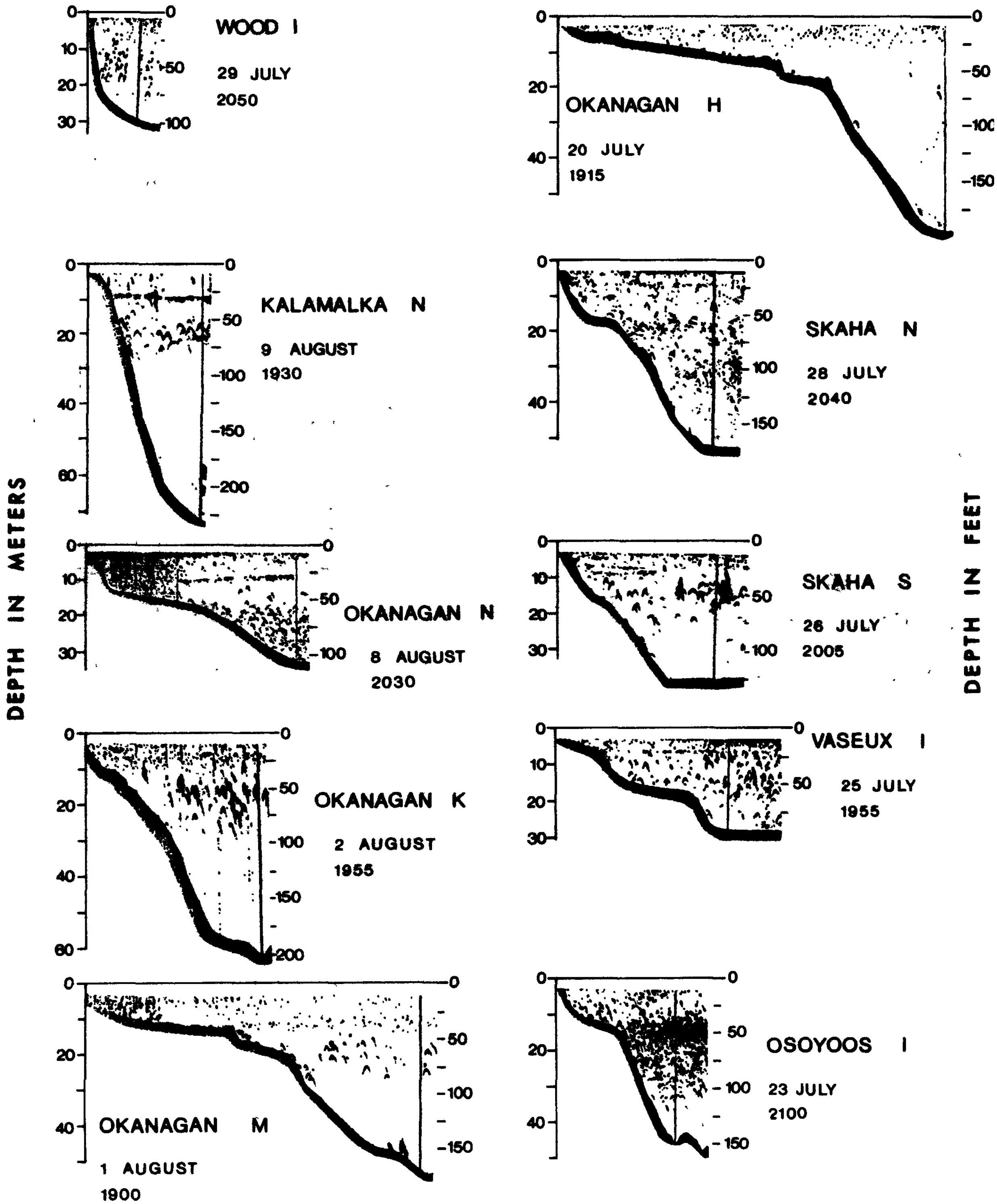


Fig. 3. Evening echo sounder traces at designated stations in the Okanagan basin lakes in summer, 1971. Time (Pacific Standard) tracing started shown below date; vertical line near offshore end indicates outer limit of netting station, depths in feet given at right of tracing; upper 3 meters not recorded by sounder.

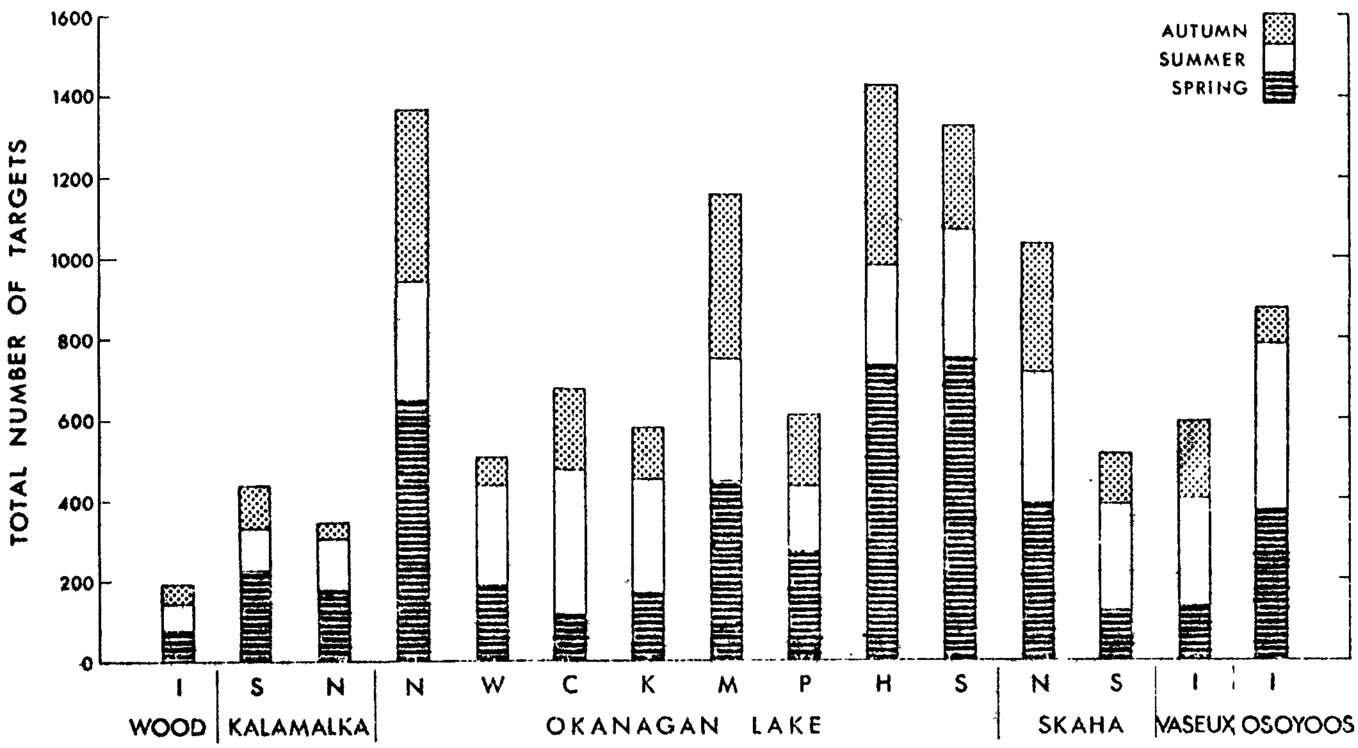


Fig. 4. Number of "targets" (fish marks) counted on evening echo sounder profiles at designated stations in Okanagan basin lakes, 1971.

record particularly large numbers of fish in either Skaha or Vaseux lakes. Peamouth chub, which are especially numerous in the latter lake and which migrate into near-surface layers in the evening (Northcote et al., 1964) in some lakes, may not have been recorded by the sounder.

The relative abundance of salmonoids (as opposed to "coarse fish" - largely catostomids and cyprinids) taken by netting in the basin lakes is given in Fig. 2. Lowest percentages of salmonoids were taken in Wood and Vaseux lakes (about 12 and 19 percent, respectively). In Kalamalka and in all Okanagan stations except at the south end, salmonoids made up well over 40 percent of the total catch and usually over half of it. Their contribution dropped to about a third in Skaha, but rose again to 40 percent in Osoyoos, largely a result of sizable kokanee catches there.

Whitefish were scarce in catches from Wood or Kalamalka lakes (Fig. 2) but in the other lakes ranged between 8 and 25 percent of the total. Rainbow trout contributed significantly to the catch at both Kalamalka stations and as well to stations H and S at the southern end of Okanagan; elsewhere they usually made up less than 2 percent of the total.

Three species of salmonoids (rainbow trout, kokanee, mountain whitefish) and four of "coarse fish" were common to gill net catches from the major basin lakes (Fig. 5). Highest and second highest total catches of salmonoids invariably were taken in either Okanagan or Kalamalka lakes whereas those for coarse fish always came from Skaha, Vaseux or Osoyoos lakes. This trend generally applied to catches from each of the three seasons considered separately (Fig. 5).

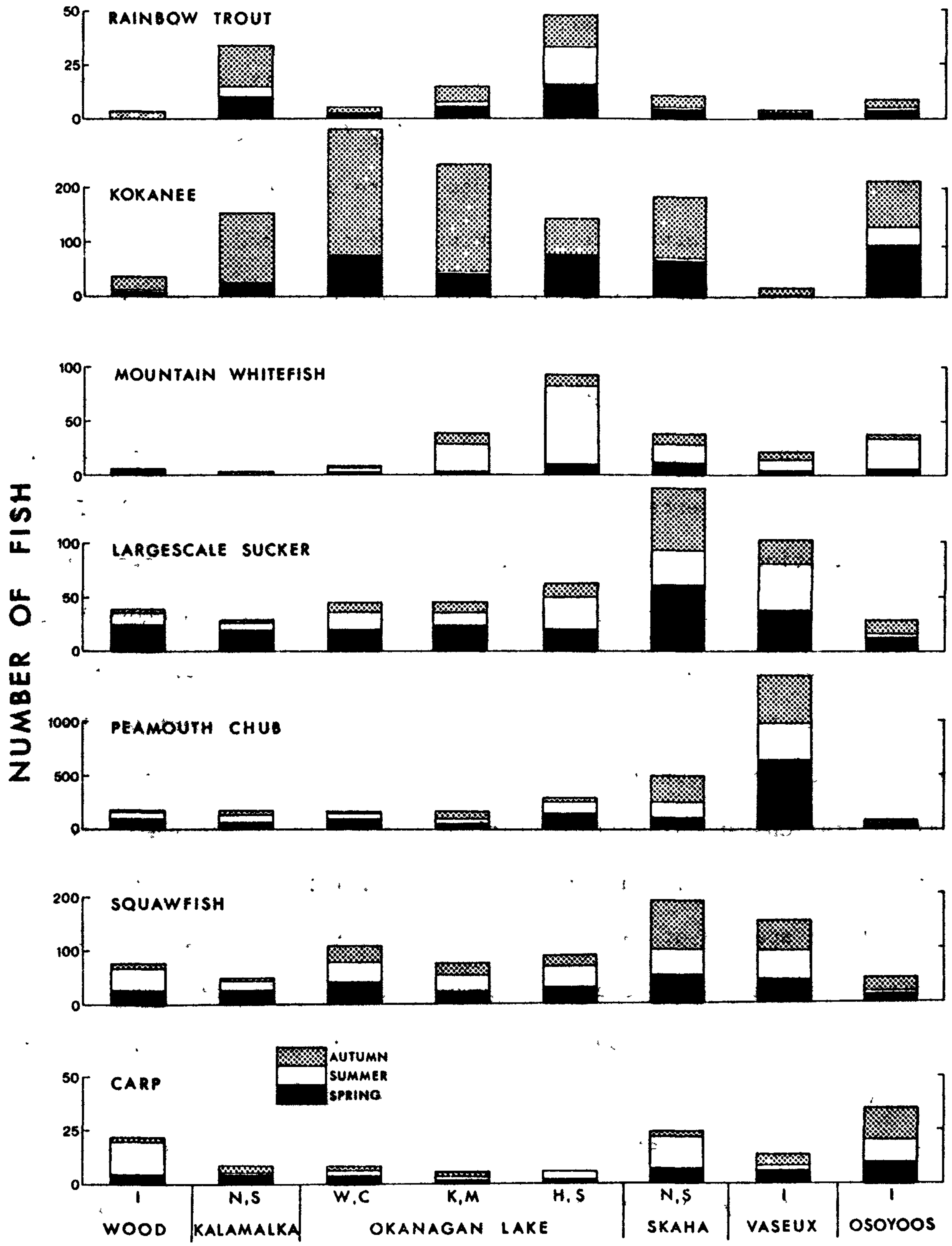


Fig. 5. Catch in standard gill net sets at designated stations (averaged for combinations shown) of seven species of fish common to the Okanagan basin lakes, 1971.

Lack of replication restricted opportunities to statistically compare differences in relative abundance of species between the basin lakes. An appropriate test was determination of F from the ratio of chi-square values calculated between lakes and within lakes (Table 3). Differences in relative abundance of species within the two stations for Kalamalka and Skaha were large so that rarely could a statistically significant difference be demonstrated between these stations and those for other lakes. Okanagan Lake northern (W, C), central (K, M) and southern (H, S) stations all showed significant differences in relative abundance when compared with Skaha, Vaseux and Osoyoos stations. Inspection of the contingency tables showed that larger catches of coarse fish species relative to salmonoids in the latter lakes probably accounted for most of the differences.

3. 1948 to 1971 comparisons

(a) Skaha Lake

Comparisons of species relative abundance between the 1971 netting program and data collected by Ferguson (MS 1949) from Skaha Lake in the summer of 1948 can be made, but not without considerable adjustment for differences in amount of net used, in depth distribution of the sets, and in type of net webbing (cotton in 1948; monofilament nylon in 1971). Approximately the same sequence of mesh sizes were fished in 1948 and 1971 but different depths and lengths of net were used. The catch data from 1948 was appropriately weighted to allow for differences in area of net fished. Then for comparison with 1948 data, the most similar combination of depth intervals from 1971 were selected and only catches from those sets

Table 3. Differences[1] in relative abundance of species caught in standard net sets in Okanagan basin lakes, 1971

LAKE & STATION		KL N-S	OK W-C	OK K-M	OK H-S	SK N-S
Wood	I	N.S.	N.S.	N.S.	N.S.	N.S.
Kalamalka	S	-	N.S.	N.S.	N.S.	N.S.
	N	-	N.S.	N.S.	N.S.	N.S.
Okanagan	N	N.S.	N.S.	N.S.	**	N.S.
	W	N.S.	-	N.S.	*	N.S.
	C	N.S.	-	N.S.	*	N.S.
	K	N.S.	N.S.	-	N.S.	N.S.
	M	N.S.	N.S.	-	N.S.	N.S.
	P	N.S.	N.S.	*	*	*
	H	N.S.	*	N.S.	-	N.S.
	S	N.S.	*	*	-	N.S.
Skaha	N	N.S.	N.S.	N.S.	*	-
	S	N.S.	**	**	*	-
Vaseux	I	*	**	**	**	N.S.
Osoyoos	I	N.S.	**	**	**	N.S.

[1]N.S. = not significant, $p > 0.05$; * = significant @ $p < 0.05$; ** = significant @ $p < 0.01$.

considered. Finally to adjust for differences in efficiency between monofilament nylon and cotton webbing, the 1948 catches were quadrupled. Molin (1953) gives data comparing catches in monofilament nylon nets similar to those used in the 1971 Okanagan study with cotton nets. For several Swedish lakes he showed that monofilament nylon nets usually took more than 7 times the total catch of cotton nets, and 3.7 times more for the three lakes roughly similar to Okanagan basin lakes in species composition and other characteristics.

From the series of netting data available for 1948 (Ferguson, MS 1949) the two sets were selected which most nearly approximated those made at the north and south stations in summer, 1971. Then the 1948 catches were appropriately adjusted for differences in net area and efficiency as outlined above, and compared with the 1971 data (Table 4). Chi-square tests show the difference between years (1948 > 1971) to be highly significant ($p < 0.001$), although the data are sparse. Numbers of mountain whitefish appear much lower in 1971 than 1948 at both stations. Also, no carp were taken in any of the lake net sets (8 different series in all) during the summer of 1948, although one was netted from the Okanagan River nearby. Several were caught by lake netting in 1971. The combined catch for both stations was somewhat lower in 1971 than in 1948 (adjusted catches). Furthermore the contribution of salmonoids was considerably lower in 1971 compared to 1948 (4.6% vs. 14.8%, respectively).

4. 1935 to 1971 comparisons

(a) Wood and Okanagan lakes

Adjustments similar to those described above for 1948 netting

Table 4. Number of fish taken in standard summer net sets near designated stations in Skaha Lake, 1948 and 1971

SPECIES	NORTH 1948[1] 20 July	NORTH 1971 29 July	SOUTH 1948[2] 22 July	SOUTH 1971 27 July	LAKE (N & S) 1948	LAKE (N & S) 1971
Rainbow Trout		2				2
Mountain Whitefish	36	2	24	3	60	5
Lake Whitefish		1		7		8
Largescale Sucker	72	33	56	29	128	62
Longnose Sucker				3		3
Peamouth Chub	96	59	80	128	176	187
Squawfish	24	33	16	24	40	57
Carp		12		5		17
Chiselmouth		1				1
TOTAL	228	144	176	199	404	343

[1] actual catch x 3 (net area adjustment) x 4 (webbing type adjustment).

[2] actual catch x 2 (net area adjustment) x 4 (webbing type adjustment).

data from Skaha Lake were required for the 1935 data of Clemens et al., (1939) from Wood and Okanagan lakes (Table 5). There apparently were marked differences in relative abundance at Wood Lake between years (pooled chi-square significant @ $p < 0.001$), and even if adjustment factors are only approximately correct, the 1935 catch would still far exceed that in 1971. No carp were netted in the summer 1935 sets (although they were certainly in the lake then) but 12 were caught in 1971. However, comparisons are based on single sets with large adjustments required for 1935 data, so again the changes apparent cannot be taken as any more than suggestive. The contribution of salmonoids to total catch on each year was about the same (2.3 and 2.4% for 1935 and 1971 respectively.

Somewhat more reliable comparisons of relative abundance can be made between 1935 and 1971 for Okanagan Lake because more netting data are available for the former year. There is little difference in total catch (combined stations) between the two years (Table 5), although a pooled chi-square test showed relative abundance by species to be significantly different ($p < 0.001$). No carp were netted at any of the stations shown for 1935 (only one was caught in nets all that summer) whereas single summer sets in 1971 took carp at three of the four 1971 stations shown (Table 5). Otherwise little consistent difference is apparent in relative abundance between each of the stations for 1935 and 1971.

Length-Frequency Distribution

1. Within-lake comparisons, 1971

There was no significant differences ($p < 0.05$) between the two Kalamalka stations in average lengths of netted rainbow trout, mountain

Table 5. Number of fish taken in standard summer net sets near designated stations in Wood and Okanagan lakes, 1935 and 1971

	WOOD		OKANAGAN									
	I		N		K		M		H		Σ Okanagan	
	1935[1]	1971	1935[2]	1971	1935[3]	1971	1935[4]	1971	1935[5]	1971	1935	1971
Rainbow Trout						2		2		1		5
Kokanee		2		1	16	1		1		1	16	4
Mountain Whitefish	40		12	7	20	17	12	35		44	44	103
Lake Whitefish					94	16	36	58	24	29	154	103
Largescale Sucker	136	11	12	27	4	21	12	4		12	28	64
Longnose Sucker					18	3		3			18	6
Peamouth Chub	1240	27	40	23	112	70	44	8	12	4	208	105
Squawfish	312	28	12	45		32		16			12	93
Carp		12		2				3		1		6
Chiselmouth		4		3								3
Burbot					10	2				6	10	8
Prickly Sculpin	20					1						1
TOTAL	1748	84	76	108	274	165	104	130	36	98	490	501

[1] actual catch x 4.9 (net area adjustment) x 4 (webbing type adjustment)
[2] actual catch x 3.4 (net area adjustment) x 4 (webbing type adjustment)
[3] actual catch for [23 July (x 1.9 net area adjustment) + 24 July (x 1.5 net area adjustment) averaged with 20 August (x 1.9 net area adjustment) + 21 August (x 4.5 net area adjustment)] x 4 (webbing type adjustment)
[4] actual catch for [11 August (x 0.4 net area adjustment) + 24 August (x 3.0 net area adjustment) + 26 August (x 1.9 net area adjustment)] x 4 (webbing type adjustment)
[5] actual catch x 3.0 (net area adjustment) x 4 (webbing type adjustment)

whitefish, largescale suckers, carp, peamouth chub or squawfish. Kokanee and lake trout were the only species showing significant differences, those from the southern station being larger.

For the Okanagan Lake stations where numbers were adequate to permit comparisons (Fig. 6), there were no significant differences in average length of rainbow trout caught. Kokanee from southern stations (H, S) were significantly smaller than those from all other stations, whereas for mountain and lake whitefish, largescale suckers, peamouth chub and squawfish those from southern stations were significantly larger than those from most other localities sampled in Okanagan Lake.

For the two Skaha Lake stations no consistent pattern of differences in size emerged, some species (kokanee mountain whitefish, peamouth chub and squawfish) being significantly larger in the north, some (lake whitefish and carp) being significantly larger in the south, and others (rainbow trout and largescale sucker) showing no significant differences.

2. Between-lake comparisons, 1971

Differences in average length of 8 species captured by netting in the basin lakes (Fig. 6) were compared statistically; only some of these will be noted specifically. Rainbow trout caught in Kalamalka were significantly smaller than those from Okanagan stations (W, C, N, K, M, P, H, S) but not Skaha or Osoyoos. Kokanee from Wood and Kalamalka were significantly smaller than those from any of the other lakes in the system except Osoyoos. Those from Skaha were the largest in the system. The average length of mountain whitefish from Okanagan increased towards the south; those from

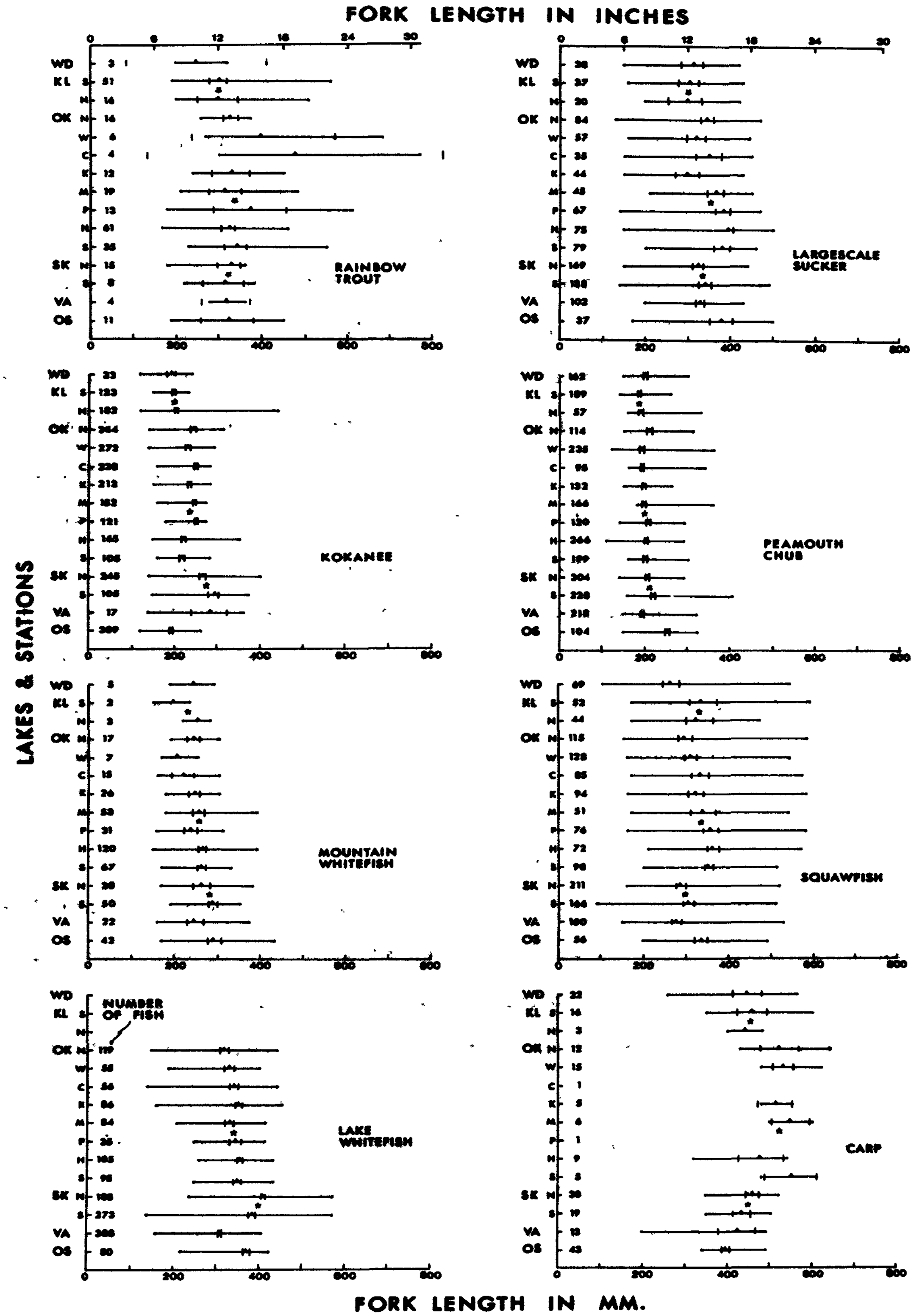


Fig. 6. Length characteristics (based on 10 mm class intervals) of fish taken at standard net sets from Okanagan basin lakes at designated stations (arranged from uppermost to lowermost in the drainage system), 1971. Symbols: •—• = range; • = average; || = 95% confidence intervals, where sample size (given at left) > 10; * = average length for lakes with 2 or more stations.

northern and central stations (N, W, C, K, P) were significantly smaller than southern Okanagan (H, S), Skaha or Osoyoos. Except for Vaseux, a distinct trend for increasing average length towards the south was evident in lake whitefish. Those from Skaha (N, S) were significantly larger than any other station, followed by Osoyoos.

The largest average lengths of largescale suckers were those from central - southern Okanagan (M, P, H, S) and Osoyoos, while the smallest were found in Okanagan (K), Kalamalka and Wood. Peamouth chub averaged the largest in Osoyoos Lake, followed by Skaha (S); the smallest came from Kalamalka (S). Changes in average lengths of squawfish within the system paralleled those for largescale sucker (Fig. 6); those from central - southern Okanagan and Osoyoos being the largest and those from Wood and Skaha the smallest. The largest carp (average length) were taken from Okanagan and the smallest from Osoyoos Lake.

3. Between-year comparisons

Both the average and maximum length of several species, netted from Skaha Lake increased between 1948 and 1971 (Fig. 7). Although very few kokanee were netted in 1948, many were taken by dynamiting. Even the largest of these did not attain the average length of the netted sample in 1971. Lake whitefish were much larger in 1971 as were large-scale suckers. Although other species (mountain whitefish, peamouth chub and squawfish) averaged slightly larger in 1971 compared to 1948, the differences were not significant ($p > 0.05$).

Small sample sizes (1935) prevented comparison of average

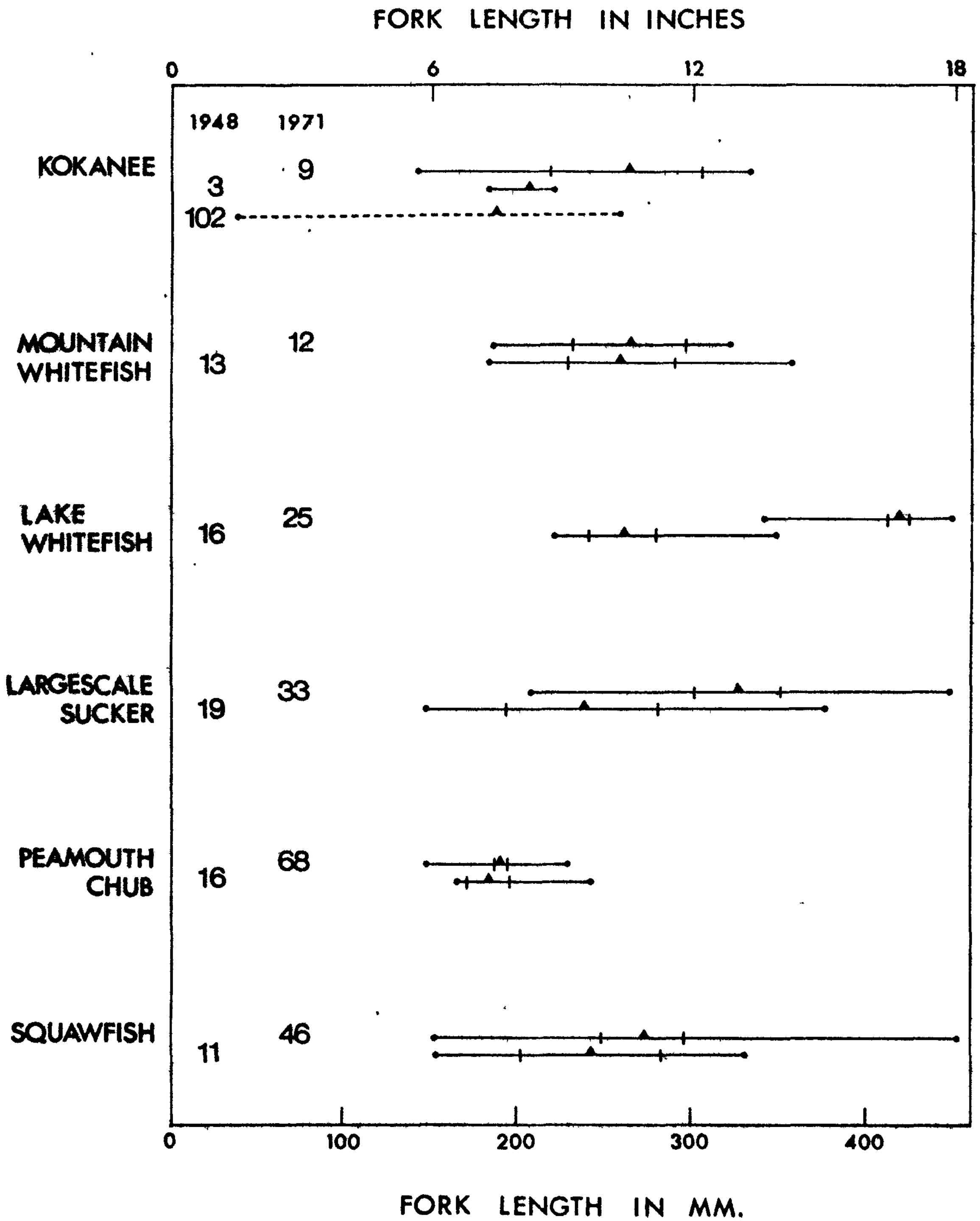


Fig. 7. Average (•) and range (•—•) in length of fish caught by standard net sets in Skaha Lake (Station N) in summer 1971 (upper) and 1948 (lower). Vertical marks on range line show 95% fiducial limits; sample size given at left; broken range line show statistics for 102 kokanee taken by dynamite blasting, summer 1948.

length of most species netted in standard sets from Wood or Okanagan lakesin 1935 and 1971. For peamouth chub (Fig. 8), a slight increase was indicated in the 1971 Okanagan sample.

Weight-Length Relationships

1. Within-lake comparisons, 1971

Weight-length regressions (log_{10} data) were compared for the salmonoids (kokanee, rainbow trout, mountain whitefish, lake whitefish) and coarse fish (largescale suckers, peamouth chub, squawfish, carp) at north and south stations in Kalamalka and Skaha lakes as well as for the 8 Okanagan Lake stations. Statistically significant differences ($p < 0.05$) in slope of the weight-length regressions were found only for rainbow trout (N > S) and peamouth chub (S > N) in Kalamalka Lake and for lake whitefish (S > N) and largescale suckers (S > N) in Skaha Lake. Within Okanagan the species showing the largest difference between stations was kokanee. Those from stations K and M, while themselves not significantly different were lighter in weight at the same length compared to the other 6 stations (i.e., they had a lower regression slope). Although two other species, mountain whitefish and squawfish, exhibited some significant differences in slope of weight-length regressions, these were often a result of comparing groups with widely disparate individuals.

2. Between-lake comparisons, 1971

Only 3 of the 4 salmonoids common to the lakes could be used for comparisons with Wood Lake because of the small number of rainbow trout taken there. In many (17 out of 27) of the comparisons with other lakes

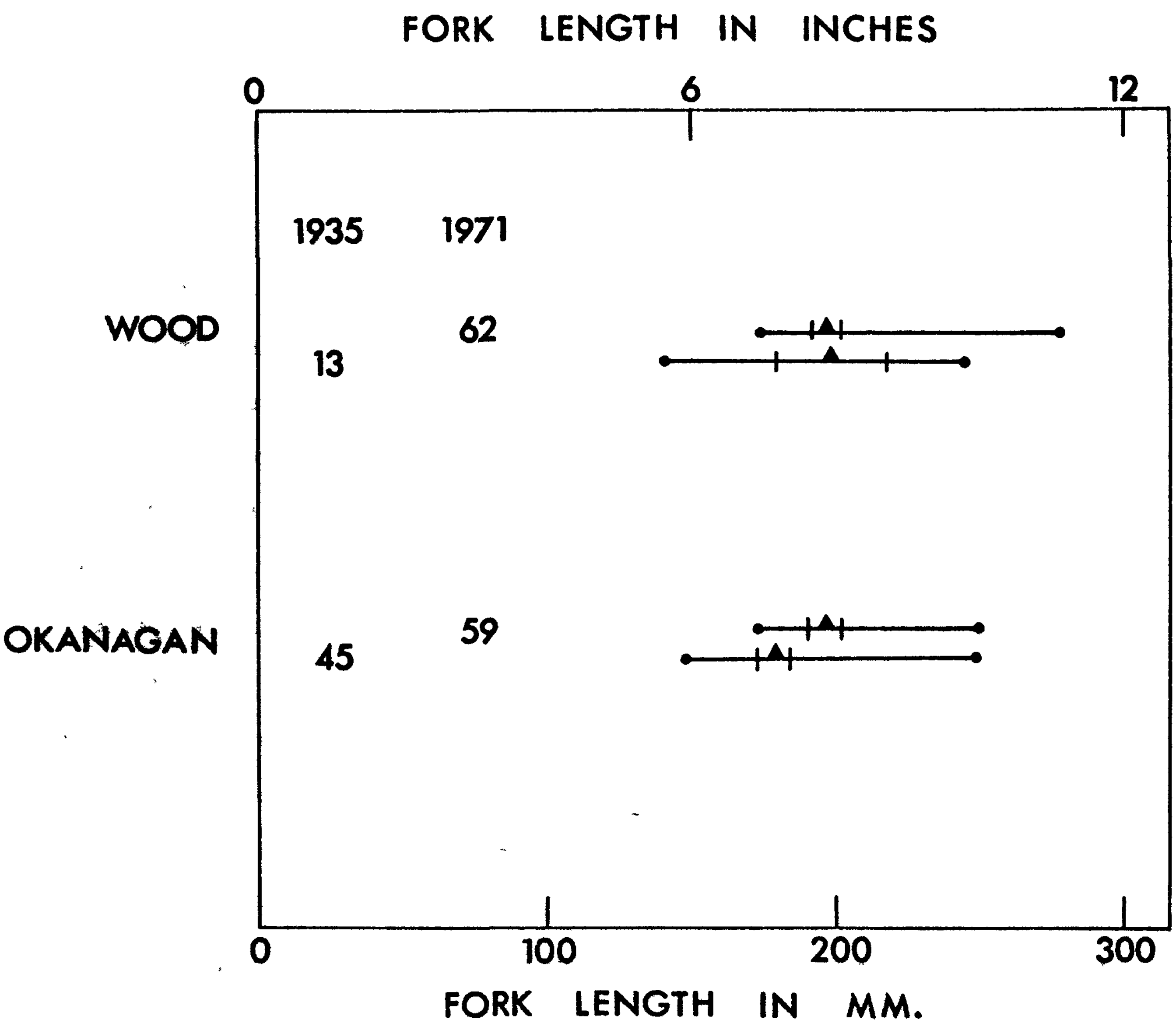


Fig. 8. Average (•) and range (•—•) in length of peamouth chub caught by standard gill net sets in Wood Lake and Okanagan Lake (Stations K, M) in summer, 1971 (upper) and 1935 (lower). Vertical marks on range line show 95% fiducial limits; sample size given at left.

where sample size was adequate, Wood Lake salmonoids and coarse fish either had a lower weight-length regression slope or were distinctly lighter in weight over most of the length range considered (i.e., showed negative displacement). In no case did Wood Lake fish show higher regression slopes or positive displacement compared with other lakes. Figure 9 shows a typical example of a lower regression slope for Wood Lake kokanee compared to those from Osoyoos Lake and of a negative displacement of the weight-length regression for Wood compared to Skaha Lake carp (1971). Weight-length regressions for Kalamalka fish were either lower than those in other lakes (by slope or displacement) or showed no significant difference as in that for squawfish in Figure 9. The only exception was shown in comparison between Kalamalka and Wood lake regressions where in 4 of the 6 cases Kalamalka had higher slope than Wood, and not significantly different in the remaining 2. Weight-length regression lines for Okanagan species were the same or higher than those for all lakes except Skaha. In most cases fish from Skaha had the highest weight-length regression slope or positive displacement; lake whitefish showed this most clearly (Fig. 9). Regressions for Vaseux fish tended to fall below those for Okanagan, Skaha and Osoyoos but were usually higher than Wood or Kalamalka. Those for Osoyoos followed the same trend as Okanagan but with more cases of little or no difference in slope or displacement.

3. Between-year comparisons

Weight-length regressions for Skaha kokanee, lake whitefish, (Fig. 9) peamouth chub and squawfish in 1971 showed significantly higher

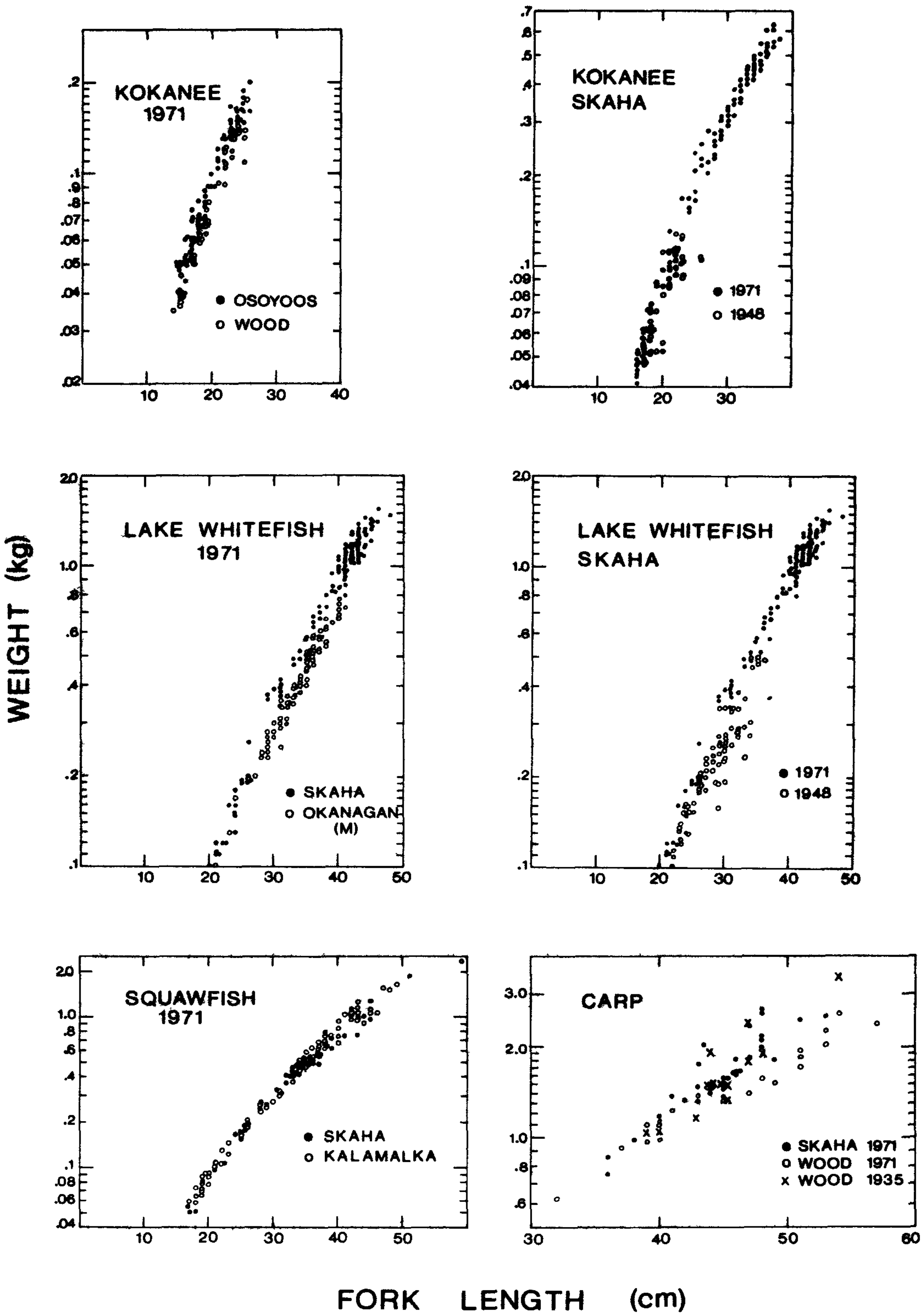


Fig. 9. Typical weight-length regressions for selected species of fish from the Okanagan basin lakes.

slopes or displacement than those in 1948. There was either no significant difference in other species or data were inadequate for comparisons (carp).

The weight-length data for Wood Lake carp in 1935 suggest that they then had a regression slope similar to that for Skaha in 1971 and not nearly as low as that shown by present day Wood Lake carp (Fig. 9). There has been no significant change in the weight-length regression for Okanagan rainbow trout between 1935 and 1971 (Fig. 10).

Age-Length Relationships

1. Within-lake comparisons, 1971

For Kalamalka Lake there were no significant differences between stations N and S in length for age groups where numbers were large enough to permit comparison (age 4, 4 rainbow trout; age 3, 4 kokanee). Okanagan data were grouped into 3 regions - north (stations N, W, C), central (stations K, M, P) and south (stations H, S). For several age groups of rainbow trout and mountain whitefish there was a trend towards increasing size from north to south in Okanagan Lake (Fig. 11). Differences in average size of age groups were significant for some of the trout comparisons (ages 2 and 5 between central and south areas) and most of those for mountain whitefish (ages 3 and 4 between north, central and south areas), In contrast, 3 year old kokanee were largest in the north area, especially those from stations N and C; central and south areas kokanee were not significantly different in size at age 3. There were no significant differences in size of various age groups of lake whitefish between the three regions of Okanagan Lake. Because of insufficient data no comparisons could be made between Skaha Lake stations N and S except for 2 year old

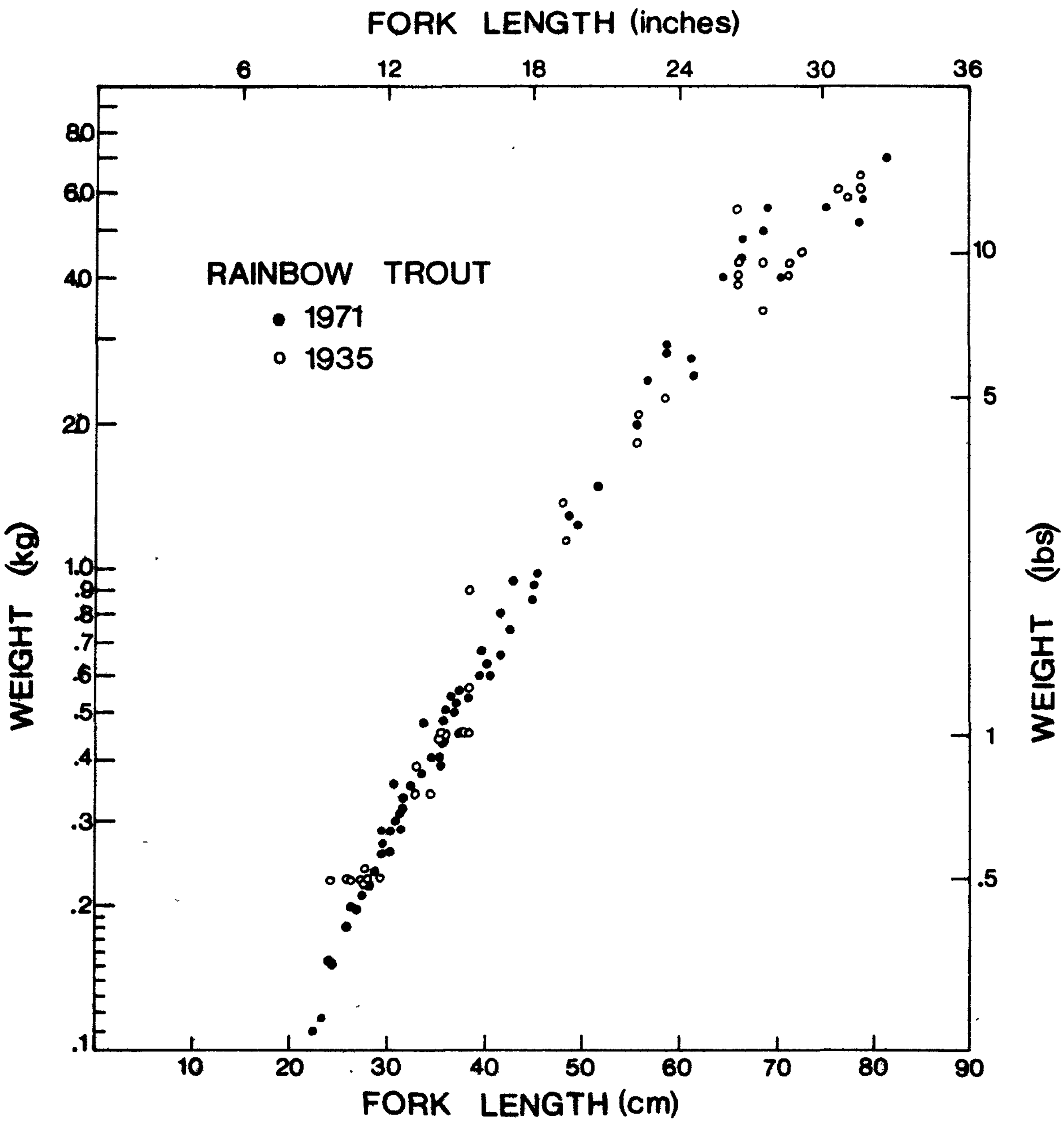


Fig. 10. Weight-length regression of Okanagan Lake rainbow trout.

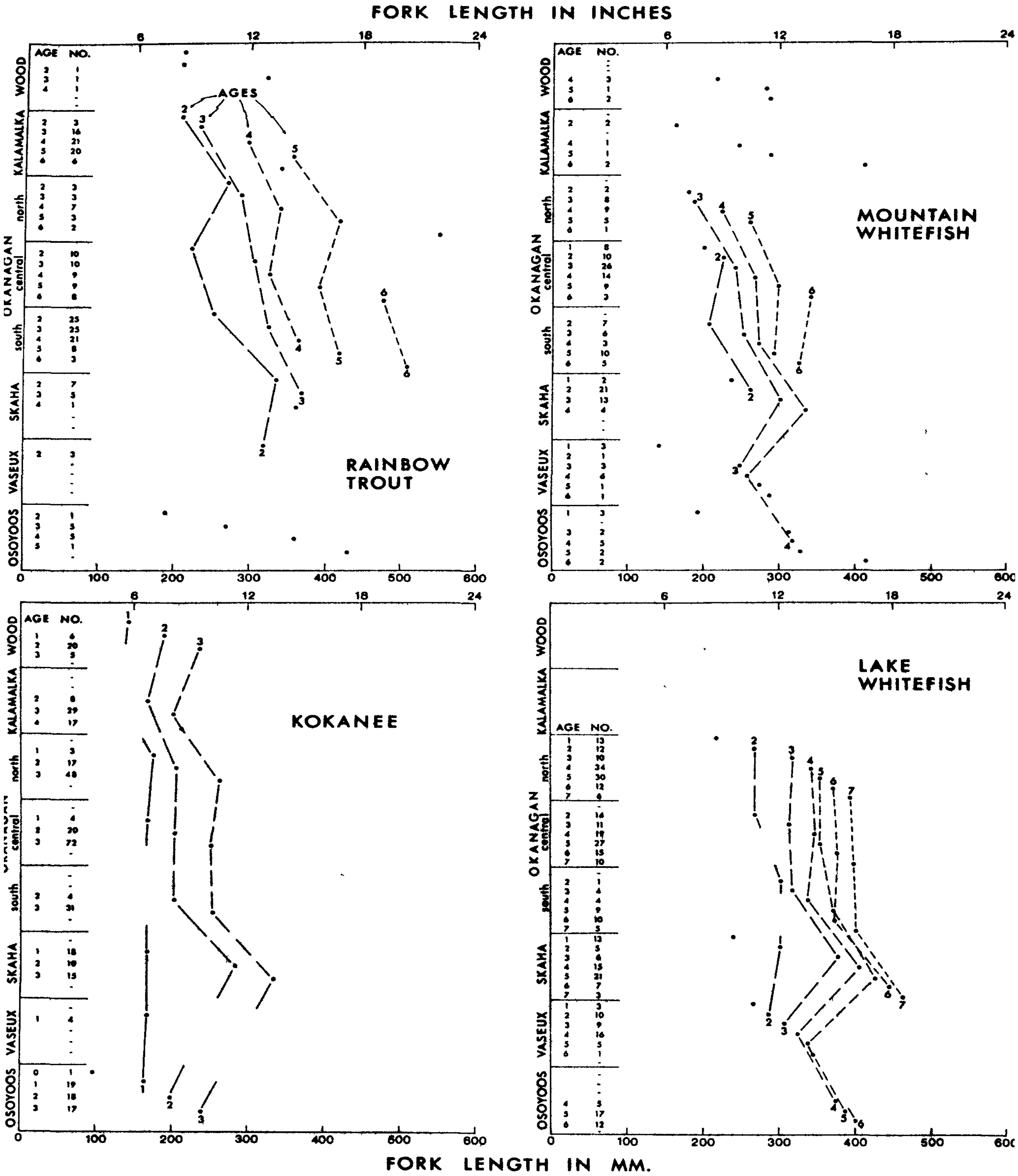


Fig. 11. Average size of different age groups of four Okanagan basin lake salmonoids in 1971. Sample size for age groups given at left; Okanagan north = Stations N + W + C; central = Stations K + M + P; south = Stations H + S.

kokanee; they showed no significant difference in average size.

2. Between-lake comparisons, 1971

Wherever sample size permitted, the average length of the various age groups shown for the species in Figure 11 were compared statistically between lakes or major lake areas (Okanagan). Most age groups of trout and whitefish showed an obvious trend for increasing size from north to south. Kalamalka trout (ages 3, 4, 5) were significantly smaller than those from north and central Okanagan combined or from south Okanagan. Age 2 and 3 mountain whitefish from Skaha were significantly larger than those from Okanagan Lake, as were all age groups of lake whitefish tested (ages 2-6). The average size of whitefish, especially lake whitefish, sharply decreased in Vaseux, compared to Skaha or Osoyoos lakes. Kokanee had the smallest average size in Kalamalka and the largest in Skaha for all age groups (1-3) where comparisons could be tested.

3. Between-year comparisons

All four Skaha Lake salmonoids showed significant increases in average length especially in older age groups between 1948 and 1971 (Fig. 12), despite small sample sizes on both years. Two year old mountain and lake whitefish in 1971 averaged nearly as large as their respective 4 year olds in 1948. No 3 or 4 year old kokanee caught in 1948 exceeded 240 mm in length whereas in 1971 none was less than 290 mm, and many were over 350 mm (some even at 2 years of age).

There has apparently been little change in the average length attained by the various age classes of Okanagan mountain whitefish, lake

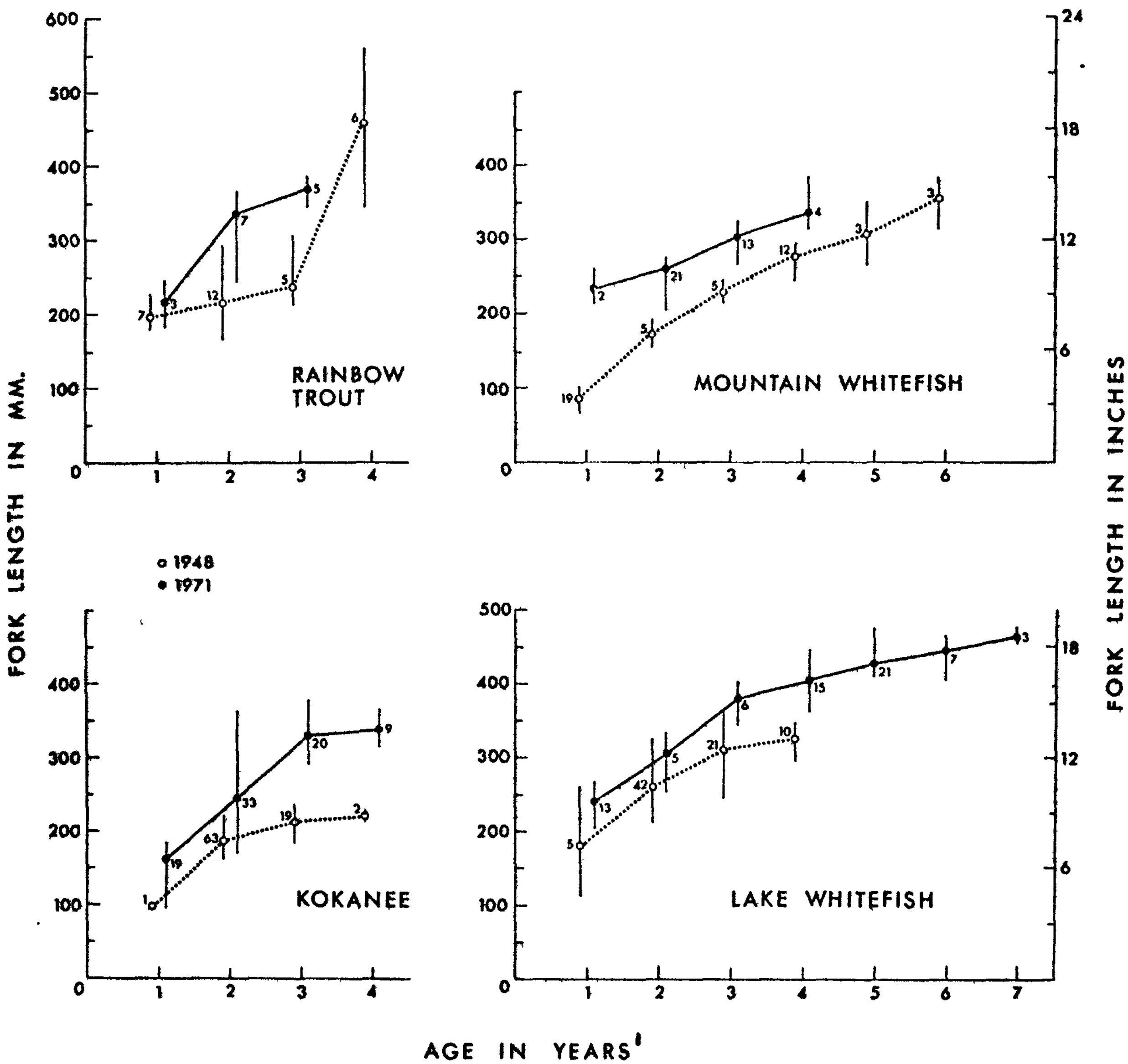


Fig. 12. Average and range (vertical lines) in length for designated age groups of Skaha Lake fish in 1948 (o) and 1971 (•). Sample size given near respective average. [1] refers to full years completed.

whitefish or even rainbow trout up to 3 years between 1935 and 1971 (Fig. 13). Older rainbow trout however are considerably smaller in 1971,and the sharp increase in length evident between 3 and 4 year olds in 1935, now appears to have been delayed at least 2-3 years. By lumping data from several years, slightly larger sample sizes are obtained for the early period and an intervening time period is obtained (Fig. 14). Again the same trend noted above between 1935 and 1971 data is shown. Interestingly, the sharp length increase for the 1946-55 period occurs between age 4 and 5, rather than a year earlier as in the 1935-45 period or a year later, as in 1971.

The average age of rainbow trout, kokanee and mountain whitefish caught in the netting program is highest in Kalamalka Lake (Table 6). For rainbow trout at least, this is in part related to the longer stream residence of Kalamalka fish, compared to others in the system such as Skaha (Table 7). Low average ages of the salmonoids are characteristic of Vaseux, Wood and to some extent, Skaha Lake.

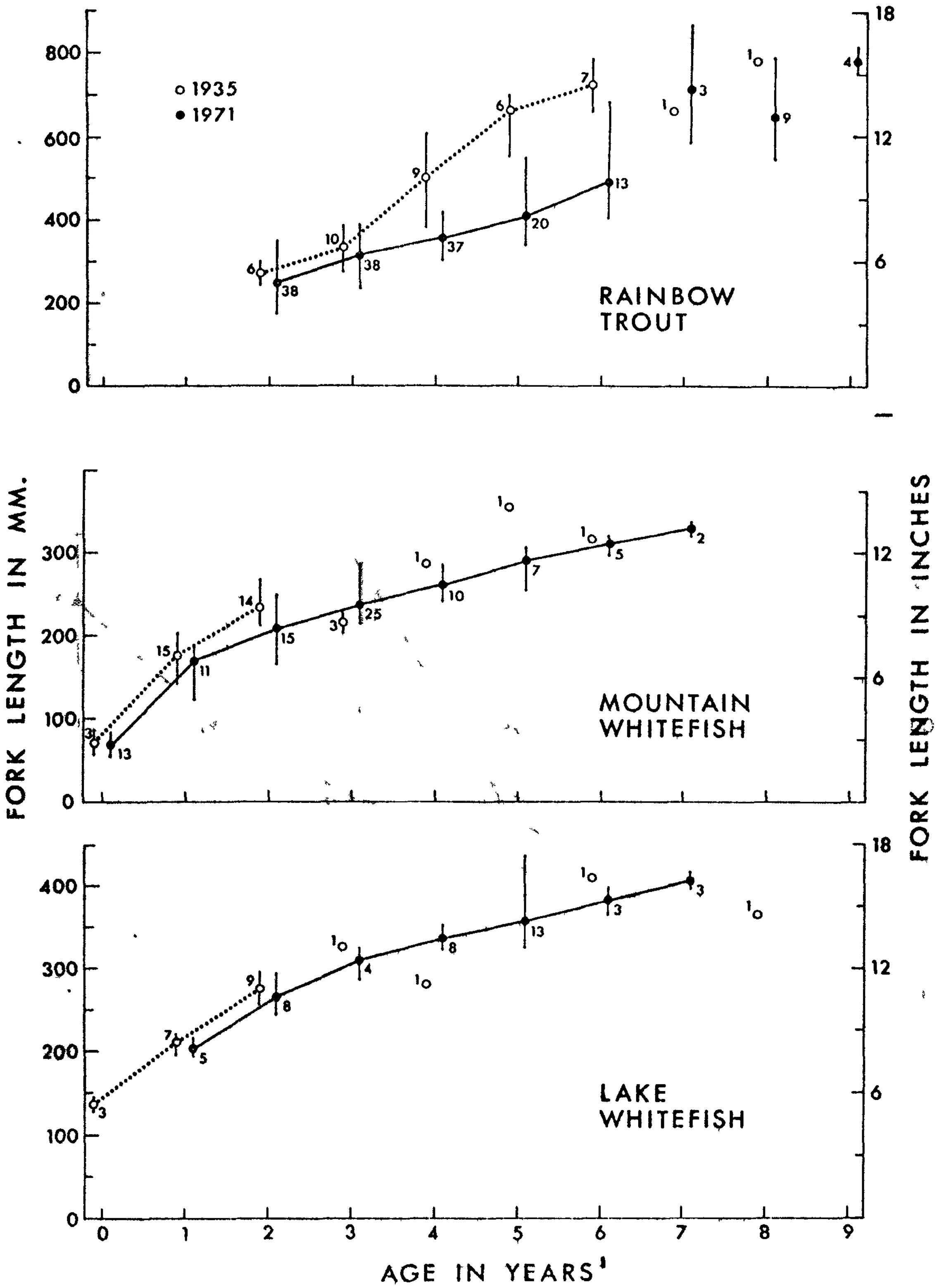


Fig. 13. Average and range (vertical lines) in length for designated age groups of Okanagan Lake fish in 1935 (o) and 1971 (•}. Sample size given near respective average. [1] refers to full years completed.

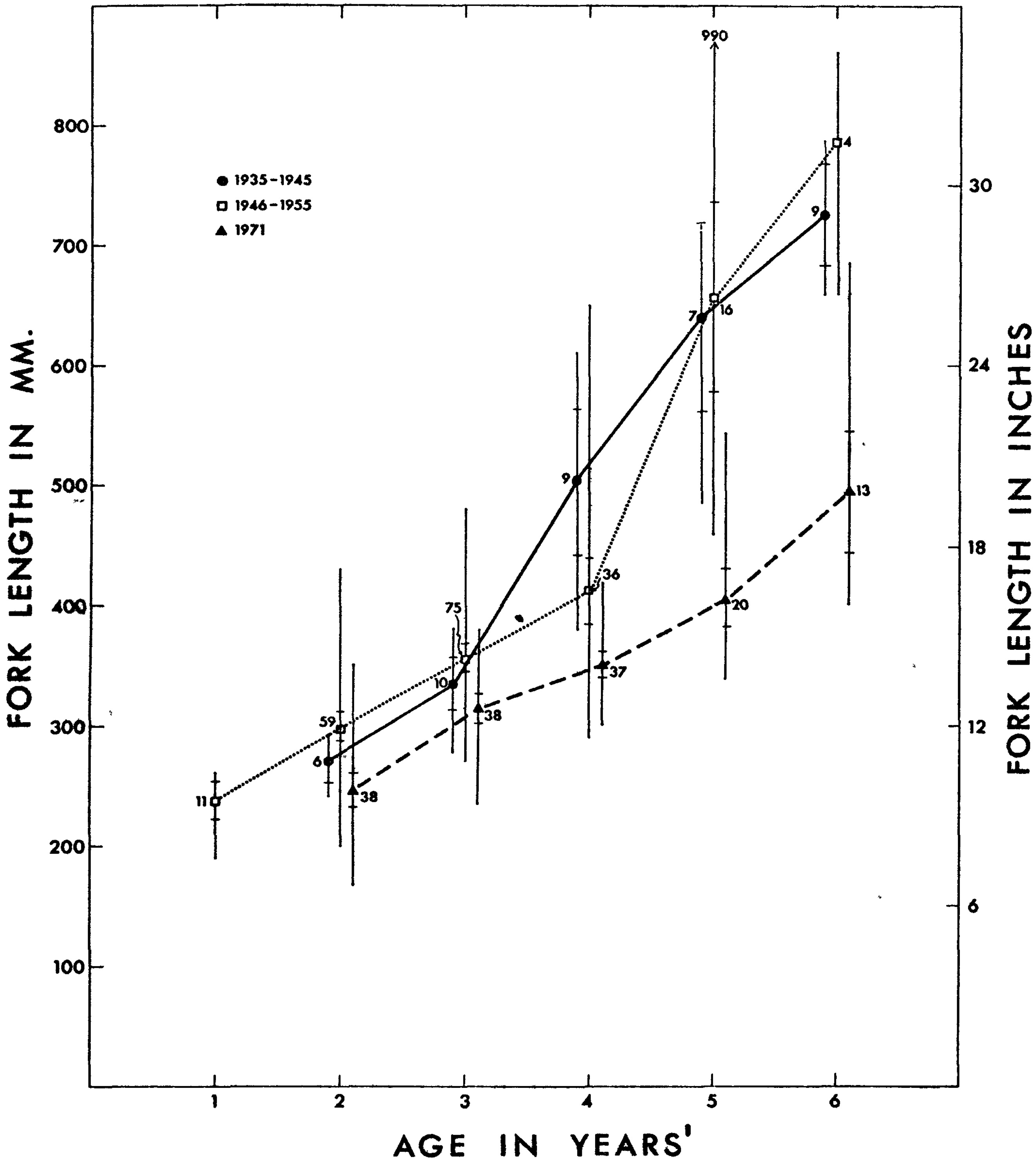


Fig. 14. Average and range (vertical lines) in length for the first six age groups of Okanagan Lake rainbow trout for three time periods. Sample size given near respective averages; 95% fiducial limits indicated on range lines. [1] refers to full years completed.

Table 6. Average age of four salmonoids caught in standard gill net sets in Okanagan basin lakes, spring autumn, 1971

LAKE	RAINBOW TROUT n[1]	$\bar{x}$[2]	r[3]	KOKANEE n	$\bar{x}$	r	MOUNTAIN WHITEFISH n	$\bar{x}$	r	LAKE WHITEFISH n	$\bar{x}$	r
Wood	3	2.0	1-3	41	2.2	1-4	3	3.3	1-5			
Kalamalka	67	4.3	2-8	73	3.2	2-4	5	4.6	1-6			
Okanagan	140	3.7	2-8	281	2.8	1-4	126	3.4	1-8	235	4.3	1-8
Skaha	15	2.2	1-4	74	2.2	1-4	22	2.7	2-4	73	3.8	1-7
Vaseux	4	1.7	1-2	5	1.0	1	13	3.8	2-6	48	3.3	1-6
Osoyoos	12	3.8	2-6	64	1.8	1-4	12	4.1	1-6	34	5.2	4-6

[1] number of fish

[2] average

[3] range

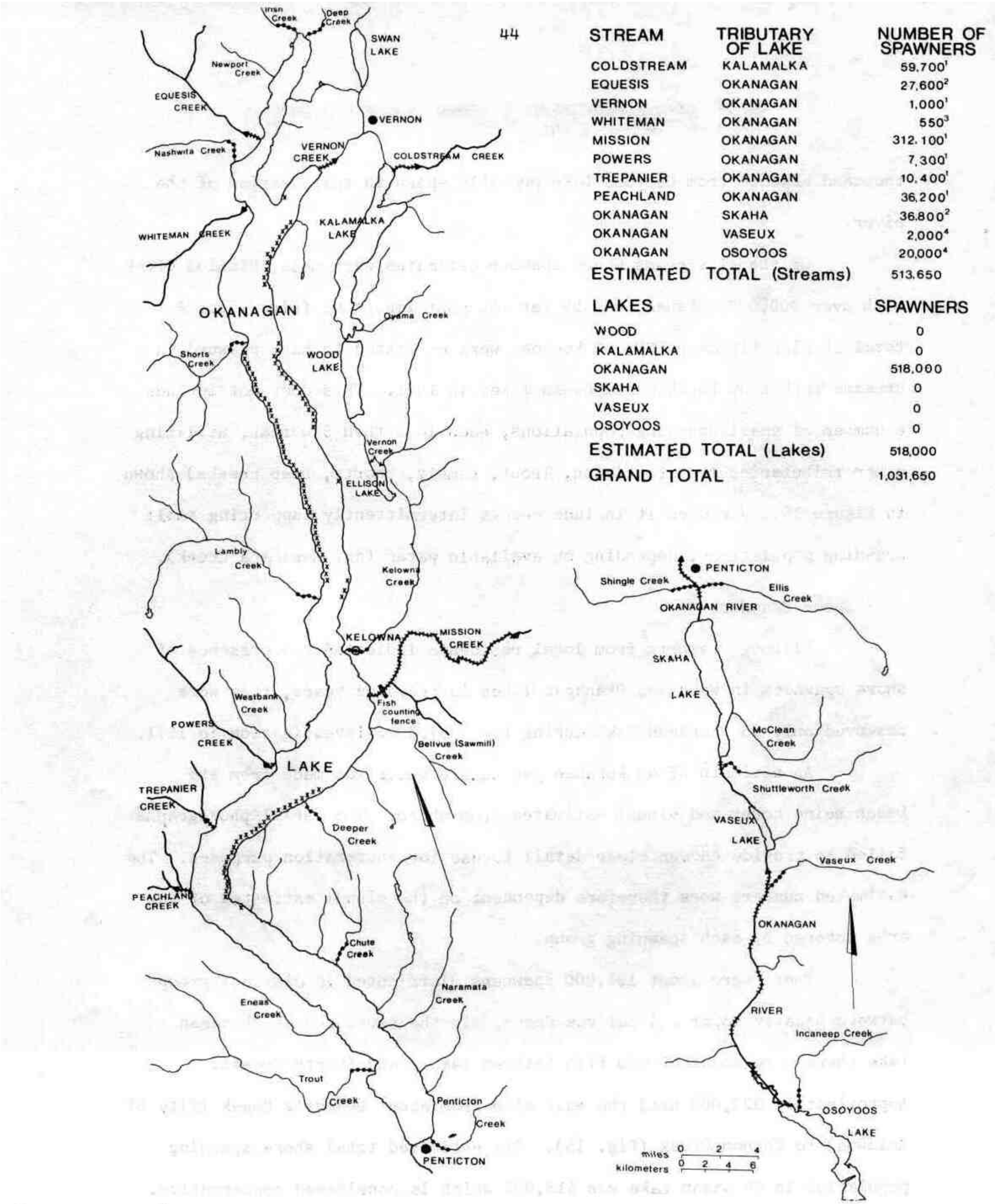
Table 7. Differences in minimum number of years which Okanagan basin rainbow trout reside in streams before lake entry (based on scale reading evidence).

LAKE	SAMPLE SIZE	MINIMUM YEARS OF STREAM RESIDENCE (%) 0+	1+	2+
Wood	2	100		
Kalamalka	67	6	88	6
Okanagan (N, W, C, K, M, P)	58	43	55	2
Okanagan (H, S)	81	32	68	
Skaha	17	53	47	
Vaseux	4	100		
Osoyoos	13	23	77	

KOKANEE SPAWNING ENUMERATION

Stream Spawners

Kokanee in spawning condition were observed in relatively few numbers (less than 2000) in the Okanagan River between Okanagan Falls and Vaseux Lake (Fig. 15). Spawning kokanee also were observed in the Okanagan River downstream from Maclntyre Dam, the upstream limit for fish coming from Osoyoos Lake. Because they were mixed with sockeye salmon spawning at the same time, it was impossible to obtain a good estimate but several



STREAM	TRIBUTARY OF LAKE	NUMBER OF SPAWNERS
COLDSTREAM	KALAMALKA	59,700[1]
EQUESIS	OKANAGAN	27,600[2]
VERNON	OKANAGAN	1,000[1]
WHITEMAN	OKANAGAN	550[3]
MISSION	OKANAGAN	312,100[1]
POWERS	OKANAGAN	7,300[1]
TREPANIER	OKANAGAN	10,400[1]
PEACHLAND	OKANAGAN	36,200[1]
OKANAGAN	SKAHA	36,800[2]
OKANAGAN	VASEUX	2,000[4]
OKANAGAN	OSOYOOS	20,000[4]
ESTIMATED TOTAL (Streams)		513,650

LAKES	SPAWNERS
WOOD	0
KALAMALKA	0
OKANAGAN	518,000
SKAHA	0
VASEUX	0
OSOYOOS	0
ESTIMATED TOTAL (Lakes)	518,000
GRAND TOTAL	1,031,650

Fig. 15. Spawning habitat and estimated populations of spawning kokanee in the Okanagan basin lakes and streams in 1971. [1] Estimation Method 1. [2] Estimation Method 2. [3] Count in one day only. [4] Very approximate estimates. (+++++) streams with > 500 spawning kokanee; (•) limit of accessable spawning habitat in those streams. (•—•) streams with < 500 spawning kokanee; (XXXX) shore spawning areas.

thousand kokanee from Osoyoos Lake probably spawn in that section of the river.

Of the 11 streams where spawner estimates were made, Mission Creek with over 300,000 kokanee, was by far the most important (Fig. 15). A total of slightly over 500,000 kokanee were estimated to have spawned in streams tributary to Okanagan basin lakes in 1971. This does not include a number of small spawning populations, each less than 500 fish, utilizing other tributaries (eg. Penticton, Trout, Lambly, Shorts, Deep creeks) shown in Figure 15. Nor does it include creeks intermittently supporting small spawning populations, depending on available water (eg. Naramata Creek).

Shore Spawners

Although reports from local residents indicated the presence of shore spawners in Wood and Okanagan lakes in previous years, they were observed only in Okanagan Lake during the period of investigation in 1971.

An estimate of 40 kokanee per square meter was made from the beach seine count and visual estimates from shore. The aerial photographs failed to provide enough clear detail to use for enumeration purposes. The estimated numbers were therefore dependent on the visual estimates of the area covered by each spawning group.

There were about 135,000 spawners distributed in distinct groups between Squally Point and Bellevue Creek. In the north end of Okanagan Lake there were about 60,000 fish between Lambly and Shorts creeks. Approximately 323,000 used the east side from about Brandt's Creek (City of Kelowna) to Vernon Creek (Fig. 15). The estimated total shore spawning population in Okanagan Lake was 518,000 which is considered conservative.

Because the estimate of total numbers of shore spawners is based on only one observation from the air, it is probably a minimum number. The estimate was probably made prior to the peak of the spawning period because only about 6-10 dead kokanee were observed in one area, just prior to making the estimates. If shore spawning kokanee follow the same pattern as stream spawning fish, one would see comparatively more dead spawners near the peak of spawning. It is therefore likely that maximum numbers were present after the count was made.

The tagged fish were observed 13 days after being tagged and the majority of them were over the same spawning site.

The substrate utilized by shore spawning kokanee differs dramatically from that used by stream spawners. The stones on the beaches appeared to be fractured material and had jagged, rough edges. The stones were loosely stacked without smaller gravels in the interstices. Several areas investigated with SCUBA gear, were composed of stones approximately 5 - 13 cm in diameter while other sites were composed of small boulders from about 20 to 40 cm in size. In both kinds of areas, live eggs were found down to a depth of about 30 cm. There was no evidence of redd construction such as one observes in stream spawning; eggs appeared to have trickled down into the interstices.

No spawners were observed in deep areas (10 m) bordering shore spawning sites; all those observed were in 0.5 to 2.5 meters and over 80 percent of all groups used areas 0.6 to 1.5 meters deep.

PESTICIDE AND HEAVY METAL ANALYSES

In 1970 fish samples were analyzed for chlorinated hydrocarbons by the B. C. Fish and Wildlife Branch and the B. C. Department of Health at the same laboratory. Some species from the 6 basin lakes were analyzed but not all species from all lakes. A number of analyses of individual fish from 3 of the lakes made it possible to calculate mean concentration and ranges (Table 8). Out of 75 analyses which included 10 species of fish, including those in Table 8, only one, a rainbow trout from Osoyoos Lake, exceeded the maximum allowable concentration (5.0 ppm) of total DDT. Concentrations of total DDT in these samples ranged from 0.03 ppm (a mountain whitefish from Okanagan Lake) to 6.85 ppm (a rainbow trout from Osoyoos Lake). Analyses of musculature collected from Okanagan Lake kokanee in 1966 (16 individuals and 11 analyses) indicated a range of total DDT from 1.99 to 5.00 ppm.

Analyses conducted in 1971 showed total residues of the DDT group to be extremely high in samples of the three principal sports fishes in Kalamalka Lake; samples of rainbow trout and squawfish in Okanagan Lake exceeded limits for total DDT residues as did lake whitefish in Skaha Lake (Table 9). Limits for mercury were exceeded in samples of rainbow trout from Okanagan Lake and in squawfish from Okanagan, Skaha and Osoyoos lakes. Of all analyses conducted on samples of main basin lakes in 1971, 22 percent (24 out of 107) showed concentrations of one of the heavy metals or total DDT or a combination of both in excess of set limits (Table 9). Organophosphates, herbicides, fungicides and P.C.B.'s were not detected.

Comparisons of analyses of fish collected 14 to 24 years ago with similar-sized fish collected in 1971 are probably too few in number to indicate any meaningful trend in time. Although a rainbow trout caught

Table 8. Mean concentration and range of total DDT in muscle tissue of mountain whitefish (Wood Lake), rainbow trout (Okanagan Lake) and kokanee (Skaha Lake) collected in 1970

SPECIES OF FISH	NUMBER OF ANALYSES	WEIGHT RANGE OF INDIVIDUALS (gm)	MEAN CONCENTRATION OF TOTAL DDT (ppm)	RANGE OF DDT CONCENTRATION (ppm)
		WOOD LAKE		
Mountain Whitefish	3	900 - 1135	0.65	0.31 - 1.09
		OKANAGAN LAKE		
Rainbow Trout	5	341 - 2497	0.99	0.21 - 2.27
		SKAHA LAKE		
Kokanee	4	227 - 341	0.79	0.62 - 1.06

Table 9. Concentration (parts per million wet tissue weight) of heavy metals and chlorinated hydrocarbons in samples of fish musculature, including skin and adipose tissue, in fish from Okanagan Basin lakes. NA = not analyzed; ND = not detected; *Cadmium - undetermined error in analysis; *Copper - error in analysis; *Zinc - values probably overestimated by about 30%. Enclosed (▭) numbers exceed limits (given in bold face at head of table) for marine and fresh water animal products set by Canada Food and Drug Directorate.[a,b]

SPECIES OF FISH	NUMBER OF INDIVIDUALS IN SAMPLE ANALYZED	MEAN FORK LENGTH (mm)	MEAN WEIGHT (gm)	AGE RANGE IN YEARS	CADMIUM	COPPER	LEAD	MERCURY	ZINC	TOTAL DDT (DDD + DDE + DDT + op DDT)
					Under Review	**100**	**10**	**0.5**	**100**	**5.0**
				WOOD LAKE						
Rainbow Trout	1	215	83	2	ND	2.00	ND	0.07	43.60	0.01
Kokanee	10	201	82	2 - 3	ND	1.10	ND	0.06	25.20	0.98
	8	221	118	2 - 4	*1.21	*ND	*ND	0.08	[*117.00]	0.94
				KALAMALKA LAKE						
Rainbow Trout	1	711	6512	9	NA	NA	NA	NA	NA	[19.18]
	1	-	6000	-	NA	NA	NA	NA	NA	[17.85]
	1	-	6000	-	ND	3.30	ND	0.05	0.64	[17.43]
	2	538	2019	5 - 7	ND	0.60	ND	0.06	6.00	[7.61]
	1	510	1415	8	*0.96	*ND	*ND	0.02	*100.00	[56.57]
	9	380	557	4 - 6	ND	0.60	ND	0.04	8.70	0.91
	2	350	495	5 - 6	*0.20	*ND	*ND	0.05	*ND	[6.32]
	5	310	297	3 - 5	ND	0.50	ND	0.04	19.30	1.08
	10	308	295	4 - 6	*2.15	*ND	*ND	0.01	*100.00	2.22
	10	300	259	3 - 5	ND	1.40	ND	0.04	11.00	0.23
Kokanee	1	445	849	3	ND	1.90	ND	0.11	13.80	[68.72]
	10	209	94	3 - 4	ND	1.70	ND	0.04	42.50	1.12
	10	191	76	3 - 4	*2.10	*ND	*ND	0.02	*20.00	3.88
	10	188	73	3 - 4	*1.06	*ND	*ND	0.01	*69.10	4.59
Mountain Whitefish	2	414	1033	6	ND	1.00	ND	0.05	24.90	[15.81]
	1	284	251	5	*ND	*ND	*ND	0.01	*ND	[12.25]
Carp	10	476	1746		*ND	*ND	*ND	0.07	[*120.00]	2.73
	4	386	1702		ND	1.60	ND	0.09	5.20	4.18
Largescale Sucker	6	359	489		ND	0.90	ND	0.12	15.00	0.14
Peamouth Chub	2	248	171		ND	2.60	ND	0.22	8.70	2.07
Lake Trout	5	506	1704	5	ND	0.90	ND	0.06	3.20	4.61
	10	411	748	5	*1.50	*ND	*ND	0.02	*100.00	[5.28]

Table 9 (cont'd)

OKANAGAN LAKE

Rainbow Trout	1	889	8674	6	ND	3.60	ND	0.13	15.00	1.34
	1	813	7021	9	ND	3.60	ND	0.62	6.70	11.60
	1	787	5216	9	NA	NA	NA	NA	NA	4.48
	1	ca 787	ca 5216	-	ND	16.00	ND	0.89	2.50	2.20
	1	ca 787	ca 5216	-	ND	13.00	ND	0.62	3.60	1.38
	10	675	4459	6 - 9	ND	0.50	ND	0.09	5.30	5.43
	6	493	3287	6 - 9	*0.49	*ND	*ND	0.15	*64.50	5.91
	1	505	1150	6	ND	8.10	ND	0.22	16.00	0.76
	8	401	720	4 - 7	ND	0.90	ND	0.06	8.90	1.58
	10	383	547	4 - 7	*ND	*ND	*ND	0.17	*57.70	2.92
	7	371	526	4 - 7	ND	0.30	ND	0.07	8.90	0.42
	7	376	479	5 - 7	ND	1.30	ND	0.25	10.00	1.13
	8	242	291	2 - 3	ND	0.80	ND	0.06	19.60	0.21
	10	291	285	2 - 7	ND	0.80	ND	0.06	10.60	0.54
	10	301	284	3 - 4	*0.96	*ND	*ND	0.06	*30.70	3.11
Kokanee	10	285	283	2 - 3	ND	1.40	ND	0.08	15.10	0.32
	9	288	220	3	ND	1.10	ND	0.05	13.70	0.64
	10	270	218	3	ND	1.10	ND	0.08	19.80	0.31
	10	261	190	3	*2.10	*ND	*ND	0.06	*ND	0.88
	11	126	130	3	*3.35	*ND	*ND	0.07	*45.80	2.86
	10	217	114	2 - 4	*ND	*ND	*ND	0.06	*18.70	1.60
	10	212	108	2 - 3	*0.88	*ND	*ND	0.11	*104.00	2.99
	10	274	102	2 - 3	ND	1.00	ND	0.15	13.00	0.41
	10	181	60	1 - 3	ND	1.00	ND	0.06	15.60	0.29
Mountain Whitefish	2	360	616	2 - 6	ND	1.20	ND	0.15	18.10	1.82
	9	269	267	3 - 8	*0.86	*ND	*ND	0.06	*44.50	2.05
	6	274	229	3 - 5	ND	0.90	ND	0.02	8.50	1.39
	1	273	202	5	*ND	*ND	*ND	0.07	*ND	0.92
	7	ca 270	ca 200	-	ND	1.60	ND	0.09	17.00	0.08
	4	265	182	2 - 4	ND	2.60	ND	0.06	26.00	0.86
Lake Whitefish	10	378	613	5 - 7	*0.86	*ND	*ND	0.07	*ND	1.88
	10	365	515	1 - 6	ND	0.20	ND	0.05	6.70	0.57
	10	363	480	4 - 6	*ND	*ND	*ND	0.14	*ND	0.90
	10	355	476	4 - 6	ND	0.80	ND	0.07	11.20	4.16
Carp	9	523	2366		*1.90	*ND	*ND	0.11	*8.70	1.00
Burbot	5	741	3748	7 - 8	ND	0.40	ND	0.28	4.90	0.39
	8	632	1929	4 - 10	ND	0.60	ND	0.11	5.70	0.14
Largescale Sucker	2	421	835		ND	1.50	ND	0.27	26.80	0.20
	10	406	798		ND	0.70	ND	0.16	12.30	0.99
Peamouth Chub	5	232	147		ND	1.50	ND	0.21	33.70	0.27
Squawfish	1	530	1817		ND	0.50	ND	1.79	64.60	5.50
	3	471	1458		ND	1.00	ND	0.59	5.90	3.61
	5	447	1268		ND	1.60	ND	0.13	14.00	0.45
	3	376	607		ND	1.60	ND	0.45	12.00	2.25
	3	358	544		ND	1.50	ND	0.24	29.00	1.60

Table 9 (cont'd)

					VASEUX LAKE					
Kokanee	10	332	417		ND	0.50	ND	0.06	9.60	0.79
Lake Whitefish	10	335	427		ND	0.40	ND	0.10	8.10	2.00
Perch	10	267	279		*7.63	*ND	*ND	0.14	*ND	0.24
Largescale Sucker	6	404	750		ND	1.90	ND	0.14	16.60	0.28
Squawfish	2	223	120		ND	3.70	ND	0.15	66.20	0.12
					OSOYOOS LAKE					
Rainbow Trout	5	385	612	4 - 5	*ND	*ND	*ND	0.05	*3.00	2.56
	2	372	547	4	ND	0.70	ND	0.09	11.10	0.28
	2	289	287	3	*0.41	*ND	*ND	0.01	*33.90	0.37
	2	274	240	3	ND	0.60	ND	0.06	27.00	0.11
Kokanee	10	221	135	2 - 3	*0.94	*ND	*ND	0.04	*ND	2.32
	6	209	117	2 - 3	*2.11	*ND	*ND	0.03	*65.20	2.26
Mountain Whitefish	5	337	448	3 - 6	ND	2.00	ND	0.10	13.70	1.89
Lake Whitefish	10	386	805	5 - 6	ND	0.40	ND	0.05	5.00	0.58
Carp	2	424	1161		ND	0.84	ND	0.09	20.00	0.56
Smallmouth Bass	3	260	289		ND	2.30	ND	0.39	10.20	0.11
	2	87	6.5		ND	18.00	ND	0.20	25.00	0.14
Perch	4	199	109		ND	2.60	ND	0.50	12.10	ND
	3	114	12.3		ND	ND	ND	0.09	29.00	0.27
Largescale Sucker	10	454	1180		ND	1.10	ND	0.10	12.20	0.33
Squawfish	1	389	669		ND	2.10	ND	0.57	6.90	2.62
Chiselmouth	10	252	207		ND	0.60	ND	0.08	27.50	0.44
	1	219	133		ND	7.20	ND	0.13	20.00	0.08

[a] Some samples of most species from Kalamalka and Okanagan lakes and some species from Wood, Skaha, Vaseux and Osoyoos were analyzed for organo-phosphates (Parathion, Malathion, Diazinon, ethion, dimethoate; Guthion, Sevin, captan) and herbicides (2-4-D, 2, 4, 5-T, Atrazine, tordon). None of these compounds were detected. Results of chlorinated hydrocarbon analyses were inspected for the presence of PCB's; none were detected.

[b] Practical limits of detection (parts per million);

Cadmium	0.003	DDE	0.01	Dieldrin	0.01	Diazinon	0.05	Guthion	1.00	Tordon	0.10
Copper	0.005	DDD	0.01	Heptachlor	0.01	Parathion	0.05	Sevin	1.00	Atrazine	0.10
Lead	0.04	DDT	0.01	Thiodan	0.01	Malathion	0.05	Captan	0.05		
Mercury	0.001	opDDT	0.01	Kelthane	0.05	Dimethoate	0.05	2, 4-D	0.05		
Zinc	0.01	Aldrin	0.01	Perthane	0.05	Ethion	0.05	2, 4, 5-T	0.05		

in Kalamalka in 1956 was smaller than the average of comparable rainbow trout analyzed in 1971, it had higher concentrations of total DDT, zinc, mercury and copper (Table 10). A single carp, caught in Osoyoos Lake 16 years ago, had a higher concentration of total DDT than the average of 2 carp caught in 1971; there was little difference in the concentrations of heavy metals. Three smallmouth bass collected in Osoyoos Lake in 1951 and 1956 had somewhat higher concentrations of total DDT than the average of 2 collected in 1971, however the 1971 fish were considerably smaller. Similarly, perch from Osoyoos showed higher concentrations of total DDT in 1951 than in 1971. There was little difference in concentration of heavy metals between years (Table 10).

Rainbow trout from some headwater lakes were compared with similar sized trout from Wood and Okanagan lakes into which they drain (Table 11). Concentrations of copper and zinc were higher in fish from Wood than the 2 tributary lakes; there was little difference in mercury but, surprisingly, total DDT levels found in Wood Lake fish were lower than concentrations in headwater fish. Levels of copper and mercury in trout from tributary headwater lakes were higher than those of the respective basin lakes but zinc and total DDT residues were lower.

Table 10. Concentration (parts per million wet tissue weight) of heavy metals and chlorinated hydrocarbons in samples of fish musculature in fish from Okanagan Basin lakes. These fish were collected from 1948 to 1956 and were stored in the Museum of Fishes at the University of British Columbia; 1971 data added for comparison. See Table 9 for limits set by Canada Food and Drug Directorate and details regarding analysis.

SPECIES OF FISH	DATE COLLECTED	NUMBER OF INDIVIDUALS IN SAMPLE ANALYZED	MEAN FORK LENGTH (mm)	MEAN WEIGHT (gm)	AGE RANGE IN YEARS	CADMIUM	COPPER	LEAD	MERCURY	ZINC	TOTAL DDT (DDD + DDE + DDT + op DDT)
				KALAMALKA							
Rainbow Trout	1951	1	226	150		ND	5.50	ND	0.10	22.00	2.81
	1971	10	300	259	3 - 5	ND	1.40	ND	0.04	11.00	0.23
				SKAHA							
Chiselmouth	1948	1	223	160		ND	7.60	ND	0.65	12.00	0.43
	1971	10	300	343		ND	0.60	ND	0.08	18.60	0.39
				OKANAGAN RIVER (between Vaseux and Osoyoos lakes)							
Chiselmouth	1951	10	152	36.7		ND	1.70	ND	0.08	22.00	0.47
				OSOYOOS							
Carp	1956	1	380	1065		ND	0.74	ND	0.06	24.00	2.96
	1971	2	424	1161		ND	0.84	ND	0.09	20.00	0.56
Smallmouth Bass	1951	2	139	37		ND	7.50	ND	0.26	25.00	0.80
	1956	1	100	13		NA	NA	NA	NA	NA	0.61
	1971	2	87	6.5		ND	18.00	ND	0.20	25.00	0.14
Perch	1951	2	113	17		NA	NA	NA	NA	NA	0.46
	1971	3	114	12.3		ND	ND	ND	0.09	29.00	0.27
Squawfish	1951	1	146	34		NA	NA	NA	NA	NA	0.92
	1956	3	293	316		ND	0.84	ND	0.21	9.60	4.88

Table 11. A comparison of ranges of heavy metal and total DDT concentrations in rainbow trout from some headwater and main-basin Okanagan lakes, Trout from each system range from about 200 to 400 mm in length. Concentrations in ppm wet tissue weight.

	LAKES		CADMIUM		COPPER		LEAD		MERCURY		ZINC		TOTAL DDT RESIDUE	
	Alex Mountain + Swalwell	Wood	Alex Mountain + Swalwell	Wood	Alex Mountain + Swalwell	Wood	Alex Mountain + Swalwell	Wood	Alex Mountain + Swalwell	Wood	Alex Mountain + Swalwell	Wood	Alex Mountain + Swalwell	Wood
Number of Individuals	26	1	NA	NA	0.30-0.80	2.0	ND	ND	0.05-0.07	0.07	5.0-7.0	43.6	0.06-0.10	0.01
Number of Samples	3	1												
	Jack Pine + Hydraulic + Fish Hawk	Okanagan	Jack Pine + Hydraulic + Fish Hawk	Okanagan	Jack Pine + Hydraulic + Fish Hawk	Okanagan	Jack Pine + Hydraulic + Fish Hawk	Okanagan	Jack Pine + Hydraulic + Fish Hawk	Okanagan	Jack Pine + Hydraulic + Fish Hawk	Okanagan	Jack Pine + Hydraulic + Fish Hawk	Okanagan
Number of Individuals	24	35	NA	ND-0.49	0.70-1.00	0.30-1.30	ND	ND	0.05-0.11	0.06-0.25	6.0-13.7	8.9-30.7	0.02-0.18	0.21-3.11
Number of Samples	5	4												