FLATHEAD RIVER FISHERIES STUDY

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Prepared by

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EXECUTIVE SUMMARY

This report summarizes baseline fish information collected in the upper Flathead Basin during 1982. Information presented here initiates our recommended long-term monitoring program.

Fish abundance was estimated in selected tributaries to the North and Middle Forks of the Flathead River and in two sections of the Middle Fork using electrofishing and snorkel techniques. The number of fish (75 mm and longer) estimated using electrofishing methodologies were similar between years for most creeks sampled. Two-catch electrofishing estimators were found to be inefficient in streams larger than 20 cfs and we recommend mark-recapture electrofishing estimates be conducted in these larger streams. Snorkel counts in tributaries varied from year to year, possibly a result of observer bias. Pools in the Middle Fork of the Flathead River had lower densities of age I and older cutthroat trout in the Schafer Section and higher densities of age I and older cutthroat trout in the Gooseberry Section during 1982 than in either 1979 or 1980.

A basin-wide inventory of bull trout spawning sites identified 750 redds in the North Fork drainage and 388 redds in the Middle Fork drainage. Of the 750 redds seen in the North Fork drainage, 161 redds were found in Canadian waters. The number of redds seen in 1982 was higher than any previous year surveyed. We estimated that between 4,730 and 5,770 adult bull trout escaped into spawning tributaries. Redd distributions within tributaries were similar between years. Spawning activity was initiated at 9°C and two distinct pulses of spawning activity occurred in Coal Creek during September. We observed what appeared to be small (210 mm) early maturing male bull trout spawning with larger (500 to 600 mm) females.

Bull trout redds were located in slightly deeper water in 1982 than in 1981, probably a result of increased fall streamflows in 1982. Streambed composition of bull trout spawning areas were similar between 1982 and 1981, but Coal Creek's spawning areas had significantly higher percentages of material less than 2 mm than Big ($p<0.005$), Whale ($p<0.20$) or Trail ($p<0.005$) creeks. Predicted survival of bull trout embryos to fry emergence was between 40 to 60 percent for Coal Creek and 80 percent and higher for the other five streams sampled using survival estimates adapted from work by Tappel (1981) for chinook salmon.

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INTRODUCTION

This is the fifth annual progress report presenting information on the fish resources of the upper Flathead Basin. This study is part of a baseline environmental assessment funded by the EPA under the direction of the Flathead River Basin Steering Committee. This report summarizes data collected in the North and Middle Fork drainages of the Flathead River during 1982.

During 1982 we began implementing our recommended long-term monitoring program (Shepard and Graham 1983a). Data was not collected on the fish resource in Flathead Lake as part of this study during 1982. Other research is presently being conducted on Flathead Lake by the Montana Department of Fish, Wildlife and Parks (Decker-Hess and Graham 1982). We plan to repeat spring gill net sampling during 1983 following methods recommended by Shepard and Graham (1983a). Data summarized in this report differs somewhat from preceding annual reports, in that information presented here was collected from selected sites throughout the drainage and represents a blueprint for future monitoring reports. The data collected during 1982 are information which should be collected on a regular basis to monitor the condition of the fish resources of the upper Flathead basin. This information will aid fish and land managers in planning land and resource allocation in the future and as a barometer to indicate impacts of various land uses upon the fish resource.

Additional reports will soon be available which:

1) summarize fish and habitat information by stream reach for streams studied in the North and Middle Fork drainages during the course of this study (Montana Department Fish, Wildlife and Parks 1982a, Montana Department Fish, Wildlife and Parks 1982b);

2) recommend a program for monitoring westslope cutthroat and bull trout populations and their habitat within the upper Flathead Basin (Shepard and Graham 1983a);

3) recommend instream flows needed in the mainstem North, Middle and South forks of the Flathead River and the main Flathead River above Flathead Lake for maintaining the native cold-water fisheries in the upper Flathead system (Montana Department of Fish, Wildlife and Parks 1982c); and

4) document the present knowledge regarding the life history and habitat requirements of two important sport fish, westslope cutthroat and bull trout, in the upper Flathead basin including summaries of age-growth and movement information (Shepard et al. 1983).

Several other fishery investigations are presently being conducted to assess kokanee use of the Flathead River above Flathead Lake (McMullin and Graham 1981, Fraley and Graham 1982), kokanee spawning in Flathead Lake

(Decker-Hess and Graham 1982), and sport fish use of the Swan drainage above Swan Lake and potential impacts of micro-hydropower development on this fish resource (Leathe and Graham 1983). Shepard and Graham (1983b) presented preliminary information collected describing the potential impacts of forest management activities on the fish resource in Coal Creek, a tributary to the North Fork of the Flathead River.

DESCRIPTION OF STUDY AREA

A detailed description of the study area can be found in three previous progress reports prepared as part of this study (Graham et al. 1980, Fraley et al. 1981, Shepard et al. 1982). Locations of sites sampled in 1982 were described in detail by Shepard and Graham (1983a).

Water levels in eight westside North Fork tributaries were monitored during the summer and fall of 1982 (Appendix A). During the early summer period of 1982, water levels were similar or slightly higher in these tributaries than any of the other four previously gauged years. Late summer-early fall water levels were noticeably higher during 1982 in Coal, Hay, Teepee and Trail creeks.

METHODS

FISH ABUNDANCE

Electrofishing Estimates

Electrofishing was used to estimate the number of fish 75 mm and longer by species in Langford, Cyclone, Red Meadow, Whale and Coal creeks in the North Fork drainage, and Challenge, Ole and Morrison creeks in the Middle Fork drainage. Mark-recapture and two-catch electrofishing was done following methods described by Vincent (1971) and Seber and LeCren (1967) using modifications suggested by Shepard and Graham (1983a). Shepard and Graham believed that two-catch estimates were not reliable in streams in the upper Flathead basin which discharged 20.0 cfs or more at the time of sampling. Red Meadow, Whale and Trail creeks in the North Fork drainage all discharge significantly more water than 20.0 cfs (48.6, 51.8, and 51.9 cfs, respectively). Therefore, future attempts to estimate fish numbers in these creeks should rely on mark-recapture electrofishing methodologies.

Underwater Counts

Underwater counts were conducted to assess fish abundance in Akokala Creek, a tributary to the North Fork of the Flathead River flowing out of Glacier National Park, and Trail and Schafer creeks, tributaries to the Middle Fork of the Flathead River within the Bob Marshall and Great Bear wilderness areas. Underwater counts were also used to assess fish abundance in the mainstem Middle Fork in two 3.0 km sections located in the upper portion of the drainage. All underwater counts were done by divers following methods presented by Shepard et al. (1982).

INVENTORY OF BULL TROUT SPAWNING SITES

Distribution and Abundance

Twelve Middle Fork tributary drainages, nine North Fork tributary drainages and a portion of the North Fork of the Flathead River (referred to as the Flathead River on Canadian maps) in Canada from McLatchie Creek downriver to Pollock Creek were inventoried for bull trout spawning sites (redds) during September and October, 1982. Red Meadow Creek, a North Fork tributary, and Coal Creek, a Middle Fork tributary, were not surveyed in 1982. The upper portion of Coal Creek, a North Fork tributary, was surveyed more intensively in 1982 than in previous years. All surveys were conducted from the ground according to methods described by Shepard and Graham (1983a).

Spawning Activity

Spawning activity of adult bull trout was monitored in Coal Creek, a tributary to the North Fork of the Flathead River, as part of a study

contracted by the Montana Department of Fish, Wildlife and Parks for the USDA Forest Service, Flathead National Forest (Shepard and Graham 1983b). Recording weekly thermographs were installed at three sites in Coal Creek and ground surveys were conducted frequently during the early fall period when bull trout spawning activity is generally initiated.

Physical Characteristics of Spawning Sites

Substrate samples were collected from bull trout spawning areas in Big, Coal, Whale, Trail, Howell and Cabin creeks in the North Fork drainage, and Granite Creek in the Middle Fork drainage (Tables 1 and 2). Samples were collected and analyzed following methods presented by Shepard and Graham (1983a). Water depths over redds were measured (in cm) at the front edge of the depression.

Table 1. Locations of substrate coring transects sampled in the upper Flathead basin in 1982.

Creek	Transect numbers (four cores per transect)	Legal description
Big Creek	9, 10, 11	NE1/4,SE1/4,NE1/4 of Sec. 33, T33N, R22W
Coal Creek	4, 5, 6	SW1/4,NE1/4,SW1/4 of Sec. 28, T34N, R21W
	7, 8	SE1/4,NW1/4,NE1/4 of Sec. 34, T34N, R21W
Whale Creek	1, 2, 3	SE1/4,NW1/4,SE1/4 of Sec. 20, T36N, R22W
Trail Creek	12, 13, 14	NW1/4,NW1/4,SW1/4 of Sec. 29, T37N, R22W
	15, 16	SW1/4,SW1/4,NE1/4 of Sec. 30, T37N, R22W
Granite Creek	20, 21, 22	SW1/4,SW1/4,NE1/4 of Sec. 18, T28N, R13W
Howell Creek	20, 21	SE1/4,NW1/4,NW1/4 of Lot 8726, 114 32'W,49 5'N
	22	SW1/4,SW1/4,NW1/4 of Lot 8726, 114 32'W,49 5'N
Cabin Creek	23	SW1/4,SW1/4,NW1/4 of Lot 8727, 114 33'W,49 5'N

Table 2. Core sample site locations across each transect and distances between reference rebars at each transect for transects sampled in tributaries to the North and Middle forks of the upper Flathead River in 1982. Numbers are distances in meters from the left rebar looking downstream.

Creek	Transect Number	Core Number 1	2	3	4	Right rebar
Big Creek	9	9.2	10.2	11.2	12.1	18.9
	10	5.5	6.4	7.3	8.4	14.1
	11	4.2	6.3	8.5	10.5	21.4
Coal Creek	4	9.4	10.6	11.7	13.1	15.8
	5	9.0	10.9	12.4	13.3	15.3
	6	8.4	9.3	10.8	12.4	15.0
	7	6.2	8.2	10.8	12.6	20.4
	8	6.4	7.9	10.1	11.5	20.7
Whale Creek	1	4.8	5.8	8.1	11.1	18.9
	2	5.2	6.8	11.9	13.5	18.3
	3	3.7	6.3	7.7	8.8	22.5
Trail Creek	12	5.1	7.4	8.3	13.6	15.9
	13	5.8	7.1	9.8	12.1	18.4
	14	7.5	9.7	11.8	15.6	19.9
	15	2.3	3.4	8.9	10.7	18.9
	16	2.0	3.5	9.2	10.1	18.0
Granite Creek						
	17	10.5	11.3	12.0	13.6	20.6
	18	10.8	11.9	13.1	13.9	21.0
	19	11.1	12.0	13.1	14.1	21.2
Howell Creek	20	4.2	5.6	8.5	10.0	21.8
	21	5.0	6.1	7.4	9.0	19.7
	22	7.0	8.3	10.2	12.5	20.7
Cabin Creek	23	9.2	10.3	11.3	11.8	18.2

RESULTS AND DISCUSSION

FISH ABUNDANCE

Electrofishing Estimates

The number of fish 75 mm and longer estimated by species were similar between years in most of the creeks sampled (Table 3). The exceptions were juvenile bull trout in Whale and Red Meadow creeks and westslope cutthroat trout in Challenge Creek. Two-catch electrofishing estimators were used in Whale and Red Meadow creeks. The efficiency of electrofishing in these large creeks (discharging 51.8 and 48.6 cfs, respectively) limited the application of two-catch estimators as the low probabilities of capture (p-values) indicate. Estimated numbers of westslope cutthroat trout in Challenge Creek were higher in 1982 than in 1981; however, densities of cutthroat trout were similar between these two years (Table 3). The study section in Challenge Creek sampled during 1982 was begun approximately 50m below the section sampled in 1981. Surface area of the sample section in Challenge Creek was 990 m^2 in 1982 and 627 m^2 in 1981. While numbers of westslope cutthroat trout were similar between 1981 and 1982 in Cyclone Creek, densities of cutthroat trout were nearly twice as high in 1981. The surface area of the Cyclone Creek section was 720 m^2 in 1982 and 590 m^2 in 1981. We suggest numbers of fish within a sample section probably provide a more meaningful comparison than densities since discharges may fluctuate dramatically; however, if discharge is reduced to a level which reduces the ability of the stream to support fish, numbers may drop while densities remain the same.

Length frequency distributions were plotted for each species by creek where more than ten fish were captured (Appendix B). Age classes assigned to juvenile bull trout based on length frequencies alone showed that age 0, age I and age II+ bull trout were between 30 and 50 mm, 65 and 100 mm and longer than 110 mm, respectively, in Morrison and Whale creeks. Juvenile bull trout captured in Ole Creek during the late fall were larger for each age class. Length frequency data could not be used to assign ages of juvenile westslope cutthroat trout due to the size overlap among different aged fish.

The preliminary data suggest fish abundance in those tributaries selected for long-term monitoring can be reliably estimated using electrofishing estimators. We recommended using mark-recapture electrofishing estimators to sample fish populations in Reach I of Trail Creek, which we were unable to sample during 1982, as well as Red Meadow and Whale creeks (Shepard and Graham 1983a).

Additional fish abundance sampling was done in Coal Creek, a tributary to the North Fork of the Flathead River, as part of a U. S. Forest Service, Flathead National Forest contracted study (Shepard and Graham 1983b).

Table 3. Estimated numbers ($\hat{N}$) of westslope cutthroat and bull trout (≥75 mm) associated 95% confidence intervals, probability of capture ($\hat{p}$) (or mortalities for mark-recapture estimates), reach date, flow at time of estimate, area sampled and method of estimate (M-R = mark-recapture, 2-Catch - two catch) by electrofishing in selected tributaries to the upper Flathead River in 1980 to 1982.

					Cutthroat trout				Bull trout			
	Reach	Date	Flow (cfs)	Area (m^2)	Method	$\hat{N}$	95% CI	$\hat{p}$	Density No./100m^2	$\hat{N}$	95% CI	$\hat{p}$	Density No./100m^3
North Fork													
Langford	1	7/16/82	4.4	350	2-catch	88	± 9	.73	25.1	---	---	---	---
	1	8/8/81	---	297	2-catch	91	±16	.64	30.6	---	---	---	---
Cyclone	1	7/19/82	11.5	720	2-catch	131	± 3	.90	18.2	5	± 3	.67	0.7
	1	7/23/81	---	590	2-catch	177	±21	.65	30.0	---	---	---	---
Red Meadow	2	7/21/82	48.6	1,330	2-catch	129	±45	.48	9.7	61	±22	.18	4.6
	2	8/6/81	---	1,648	2-catch	172	±21	.65	10.4	15	± 2	.83	0.9
Whale	2	8/11/82	51.8	1,620	2-catch	2	± 0	1.0	0.1	NO ESTIMATE POSSIBLE			
	2	8/10/81	---	1,623	2-catch	17	±21	.43	1.0	76	±31	.50	4.7
Coal	2	8/5/82	58.8	1,740	M-R	12	± 9	(+2)[1/]	0.7	130	±36	(+2)[1/]	7.4
Middle Fork													
Challenge	1	7/15/82	4.9	990	2-catch	78	± 5	.83	7.9	1	± 0	1.0	0.1
	1	7/14/81	5.2	627	2-catch	47	± 1	.95	7.5	---	---	---	---
Ole	2	9/13/82	---	1,200	2-catch	25	±61	.29	2.1	25	±12	.57	2.1
Morrison	4	9/1/82	3.6	600	2-catch	---	---	---	---	93	± 5	.83	15.5
	4	9/23/80	---	673	M-R	---	---	---	---	91	±48	(-)[1/]	13.5

1/ These numbers are the number of mortalities between marking and recapture fishings.

Underwater Counts

Underwater counts of fish in Glacier National Park and designated wilderness area streams varied considerably between years (Table 4). We believe this variation may have been caused by observer bias. Work will continue during the 1983 field season to develop a better method for estimating fish abundance in areas where motorized equipment is prohibited.

Divers in the mainstem of the upper Middle Fork of the Flathead River saw very few fish in 1982, similar to results of censuses in previous years (Graham et al. 1980, Fraley et al. 1981). Densities of age I and older cutthroat trout in pools ranged from 0.46 to 1.30 fish per 100 m^2 in the Gooseberry section and from 0.51 to 1.13 in the Schafer section from 1979 to 1982 (Table 5). Juvenile bull trout densities were extremely low in all sections during all years, probably because divers could not observe them due to their habits (Fraley et al. 1981). One adult bull trout was observed in the Gooseberry section in the areas sampled in 1982.

There were an estimated 71 and 29 age II and older westslope cutthroat, 140 and 157 mountain whitefish less than 152 mm, and 151 and 253 mountain whitefish 152 mm and longer in the 3.0 km Gooseberry and Schafer Meadows sections of the Middle Fork of the Flathead River, respectively (Table 6). Fraley et al. (1981) estimated that a 16 km section of the Middle Fork of the Flathead River above Schafer Meadows contained 711 age II and older westslope cutthroat trout, 720 mountain whitefish less than 152 mm and 5,850 mountain whitefish 152 mm and longer, while a 16 km section below Schafer Meadows contained 402 age II and older westslope cutthroat trout, 220 mountain whitefish less than 152 mm and 10,620 mountain whitefish 152 mm and longer.

INVENTORY OF BULL TROUT SPAWNING SITES

Distribution and Abundance

There were 977 bull trout redds observed in the U.S. portion of the upper Flathead River basin during 1982, and 161 redds were seen in the Canadian portion of the basin. The North Fork drainage contained 750 redds and the Middle Fork drainage contained 388 redds (Tables 7 and 8). A total of 1138 redds were identified in surveyed areas of the upper Flathead basin. The number of redds seen in areas recommended for long-term monitoring (areas surveyed from 1979 to 1982) was higher in 1982 than in any previous year (Table 9).

Fraley et al. (1981) estimated that there were approximately 3.2 to 3.9 adult bull trout spawners per redd using trapping and redd count data. Using this ratio of adults per redd and estimating that 85 percent of the redds were identified in the U.S. portion of the North Fork drainage, 60 percent in the Canadian portion of the North Fork and 75 percent in the Middle Fork drainage, we estimated that between 4,730 and 5,770 adult bull trout entered spawning tributaries. Thirty-five percent of these fish entered Middle Fork tributaries, 47 percent entered North Fork tributaries in the U.S., and 18 percent spawned in the Canadian portion of the North Fork of the Flathead River (termed the Flathead River in Canada).

Table 4. Summary of fish densities observed in upper Flathead tributaries from snorkel counts in 1980, 1981 and 1982.

				Fish per 100m² surface area									
				Cutthroat trout					Bull trout				
	Reach	Date	Area	0	I	II	III+	Total	0	I	II	III+	Total
Akokala	001	9/2/82	1239.2	5.6	1.6	1.3	0.7	3.60	---	---	---	---	---
	001	8/19/81	1261.0	30.1	3.9	2.7	2.8	9.40	---	---	---	---	---
	001	8/19/80	1577.0	0.6	0.4	0.1	1.3	1.80	---	---	---	---	---
Schafer	003	7/13/80	357.6	---	---	0.8	3.1	3.90	---	---	---	---	---
Trail	001	8/24/82	1097.8	0.2	0.5	0.8	2.2	3.50	2.9	0.5	0.4	---	.90
	001	8/8/80	1126.9	---	---	---	0.3	0.30	0.7	0.4	0.7	0.5	1.60

Table 5. Summary of fish densities observed in the Middle Fork of the Flathead River from snorkel counts in 1979, 1980 and 1982.

			Fish per 100m² surface area									
			Cutthroat trout					Bull trout				
	Date	Area	0	I	II	III+	Total	0	I	II	III+	Total
Schafer Section (3 km)												
Riffle (3)	8/27/82	1836.8	--	--	---	---	---	---	--	--	---	---
Run (8)	&	5901.8	--	--	---	.05	.05	.01	--	--	---	---
Pool (6)	8/28/82	2937.7	--	--	.10	.41	.51	---	--	--	---	---
Pocketwater (2)		771.9	--	--	---	---	---	---	--	--	---	---
Combined (19)		11448.2	--	--	T[1]/	.13	.13	.01	--	--	---	---
Schafer Section												
Pools (8)	8/5/80	3295.0	--	--	.03	1.10	1.13	---	--	--	---	---
Schafer Section												
Pools (6)	7/29/80	1544.0	--	--	.45	.51	.96	---	--	--	.06	.06
Schafer Section												
Pools (3)	9/4/79	630.0	--	--	---	.63	.63	---	--	--	---	---
Gooseberry Section (3km)												
Riffle (3)	8/25/82	1879.5	--	--	.05	---	.05	---	--	--	---	---
Run (12)		7020.4	--	--	---	1.30	1.30	.01	--	--	---	---
Pool (7)		3272.9	--	--	---	1.30	1.30	---	--	--	---	---
Combined (22)		12172.8	--	--	.01	.43	.44	.01	--	--	---	---
Gooseberry Section												
Pool (4)	8/22/80	1960.0	--	.05	---	.41	.46	---	--	--	.05	.05

Table 5. (Cont.).

	Date	Area	Cutthroat trout					Bull trout				
			0	I	II	III+	Total	0	I	II	III+	Total
Gooseberry Section												
Pool (6)	7/24/80	4291.0	--	--	.47	.21	.68	---	--	--	---	---

1/ T = trace (less than .005).

Table 6. Estimates of the number of cutthroat trout, bull trout and mountain whitefish per 3 km in the Middle Fork of the Flathead River during 1982.

River section	Year	Cutthroat Age I	Cutthroat Age II	Cutthroat Age III+	Bull Trout Age I	Bull Trout Age II	Bull Trout Age III+	Mature[1/]	Mountain whitefish <152mm	Mountain whitefish >152mm
Schafer Meadows	1982	<1	4	25	<1	<1	<1	0	157	253
Gooseberry Park	1982	<1	8	63	<1	<1	<1	1	140	151

1/ Mature bull trout numbers were based on actual counts of bull trout in sampled areas and were not expanded over the entire section.

Table 7. Numbers and densities of bull trout redds by reach in North Fork tributaries surveyed in 1982.

Stream	Reach	Number of redds	Density in Reach(#/km)	Density in high use area(#/km)
Howell	I	4	2.0	---
	II	99	6.4	15.3
Cabin	I	0	---	---
Couldrey	I	9[1/]	0.9	---
	II	9	0.9	---
Kishenehn	I	23[1/]	1.6	---
Sage	I	4[1/]	0.2	---
Squaw	I	5[1/]	0.5	---
Flathead River (Pollock Cr.-McLatchie Cr.)		17	---	---
Trail	I	101[2/]	8.8	27.4
Whale	I	55	3.9	12.0
	II	181[2/]	15.7	21.4
Shorty	I	56	12.4	16.7
Coal	I	11	1.1	---
	II	64	7.6	14.7
	III	20	1.9	6.0
S.F. Coal	I	9	1.0	---
Mathias	I	17	11.3	11.3
Big	II	45	5.7	12.8
Hallowatt	I	31	7.6	15.3
TOTAL		750		

1/ Counts from Norecol Environmental Consulting Ltd., Vancouver, B.C.
2/ Trail Creek count includes one double redd and Whale Creek count includes 8 double redds.

Table 8. Numbers and densities of bull trout redds by reach in Middle Fork tributaries surveyed in 1982.

Stream	Reach	Number of redds	Density reach (#/km)	Density in high use area(#/km)
Nyack	2	23	11.5	11.5
Ole	2	51	12.8	14.6
Bear	2	23	3.0	11.5
Granite	1	34	6.2	11.5
Morrison	1	37	4.9	10.8
	2	14	3.7	10.0
	3	33	3.8	10.7
	4	2	.9	---
Lodgepole	1	23	3.5	7.1
Schafer	1	17	3.7	7.5
Dolly Varden	1	36	2.7	5.7
Clack	1	7	2.5	---
Bowl	1	8	3.1	4.6
	2	4	1.0	---
	3	7	4.4	---
Strawberry	1	11	2.2	---
	2	8	1.1	---
	3	2	0.4	---
	4	18	7.8	12.0
Trail	1	30	3.9	12.0
TOTAL		388		

Table 9. Number of redds observed within the sections recommended for redd survey monitoring on tributaries of the North and Middle Fork of the Flathead River.

Creek	1982	1981	1980	1979
North Fork				
Big	41	18	20[1/]	10[1/]
Coal	60	23	34	38[2/]
Whale	211	98	45	35
Trail	94	78	31[3/]	34[3/]
Middle Fork				
Ole	51	19	19	--
Morrison	86	32	75	--
Lodgepole	23	18	14	--
Granite	34	14[4/]	34	--
Schafer	17	12	10	--
Dolly Varden	36	31	21	--
Trail	30	26	31	--
Strawberry	39	21	17	--

1/ 1979 and 1980 counts may be high since redd surveys conducted during these two years began at Nicola Creek (located above Skookoleel Creek, our recommended beginning point).

2/ 1979 count may be high since this redd survey included an area below Road 909 (Cyclone Lake Cuttoff Road), our recommended lower boundary.

3/ 1979 and 1980 counts may be low since a portion of the creek we recommend surveying was not surveyed during these two years.

4/ 1981 count may be low since surface ice had formed on some portions of the creek making observation of redds difficult.

The increase in both the number of adults reaching spawning grounds and the number of redds may be attributed to two sources. Favorable conditions for spawning and juvenile rearing five to eight years ago probably strengthened year classes which spawned during 1982. In addition, the harvest of adult bull trout during 1982 was likely reduced by regulations which lowered the daily and possession limit allowed the angler to one fish from a previous limit of two fish daily and four in possession. This combination of strong year classes and reduced harvest allowed more adult bull trout to reach spawning grounds.

Redd frequency distributions were plotted for all surveyed streams by 0.5 km increments for 1980 to 1982 surveys of Middle Fork tributaries and 1981 and 1982 surveys of North Fork tributaries (Appendix C). Redds were observed further up tributary drainages in 1982, probably because increased fall streamflows permitted access to upper areas of tributaries by adult bull trout (Appendices A and C). Although more redds were seen during 1982 surveys, redds distributions were similar between years.

Spawning Activity

Spawning activity was monitored extensively in Coal Creek during 1982. Spawning appeared to peak at two distinctly different time periods in the fall and water temperature seemed to play an important role (Shepard and Graham 1983b). As maximum daily water temperatures dropped to 9 C spawning was initiated. Fraley et al. (1981) and Shepard et al. (1982) reported similar findings in earlier reports. During 1982, spawning activity declined for a two week period in mid-September when maximum daily water temperatures rose slightly, then increased sharply again as water temperatures fell to 7 C.

In Reach III of Coal Creek we observed a large (~ 550 mm) female bull trout actively digging a redd on 21 September. The female was in the process of covering the redd with gravels when we arrived. A small (~ 200 mm) bull trout was constantly beside her and his behavior was identical to that expected of a sexually mature adult male (Needham and Vaughan 1951, Leggett 1969, McPhail and Murray 1979). This small bull trout repeatedly moved up along side of the female and nudged her before moving back to hold in a position to the left and immediately posterior to her caudal fin. We believe this small juvenile-sized fish may have been actively spawning with the large migratory mature female. It appeared the fish had completed spawning immediately prior to the time we observed them as we were unable to observe the female or male actually extrude gametes.

The next day we returned with a backpack electrofishing unit consisting of a small gas powered generator-variable voltage pulsator combination. We collected several juvenile bull trout (size range: 130 to 160 mm) which had undeveloped gonads and two other male bull trout (215 mm and 316 mm in length), both which extruded milt when pressure was applied. The 316 mm male was found in the presence of a large (>500 mm) female bull trout, but she was not captured. All captured fish were preserved in a 10

percent formalin mixture after the body cavity was opened and a scale sample removed. The 316 mm male was spent and his stomach was full of trout eggs. The 215 mm male was ripe.

All the collected bull trout were two or three years of age (Table 10). The 316 mm male appeared to have grown rapidly during his third summer of life (the summer of 1982), based on the distance between the third annulus and the edge of the scale. This fast growth indicates he may have spent the summer of 1982 in the North Fork of the Flathead River and migrated upstream into Coal Creek in the fall.

Physical Characteristics of Spawning Sites

A plot of the frequency of redds against 0.05 m depth intervals revealed that adult bull trout spawned in areas of deeper water in North Fork tributaries than in Middle Fork tributaries (Figure 1). In 1982, more redds were seen at depths greater than 0.35 m when compared to 1981 (Shepard et al. 1982). The mode of the 1982 depth distribution of redds was between 0.20 and 0.30 m compared to a mode between 0.15 and 0.25 m for 1981 data, probably because of higher fall streamflows during 1982 (Appendix A).

Streambed composition by dry weight of material sampled from bull trout spawning areas varied between sites (Appendix D), but composite histograms of streambed composition by type of site within creeks were similar (Figure 2). A multiple comparison test found that the percent of material less than 2 mm in diameter was significantly higher in Coal Creek than in Big ($p < 0.005$), Whale ($p < 0.20$) or Trail ($p < 0.005$) creeks (Shepard and Graham 1983b). The relative abundance of fine material may affect bull trout embyro to emergent fry survival. We attempted to predict the various egg to fry survivals one would expect from sampled spawning areas in the upper Flathead tributaries by applying survival curves developed for chinook salmon by Tappel (1981). We realized the limitations of applying data from experiments with chinook salmon to bull trout, but feel the relationships will illustrate trends for bull trout emergence success between streams. Predicted survival of bull trout embryos to fry emergence was between 40 to 60 percent for Coal Creek and higher than 80 percent for the other streams sampled (Figure 3).

Composite substrate compositions for undisturbed areas of streambed in Big, Coal, Whale and Trail creeks were similar for fall, 1981 and fall, 1982 samples (Figures 4). Slight differences were seen in material larger than 50 mm, but these differences were probably not functionally significant. The percent of material larger than 50 mm may change dramatically from sample to sample depending upon whether the sample contains any large cobble material. Large cobble material can contribute a disproportionately high percent compared to the total sample. When evaluating spawning habitat, the material of interest is that material less than 50 mm.

We sampled Howell and Cabin creeks, tributaries to the Flathead River in Canada, and Granite Creek, a tributary to the Middle Fork of the Flathead River, for the first time in 1982 (Figure 5). The Canadian

Table 10. Length, state of maturity, sex and age of five bull trout captured in upper Coal Creek (Sec. 19, T34N, R22W) on 22 September, 1982.

Length (mm)	State of maturity	Sex	Age	Comments
132	Juvenile		2	
140	Juvenile		2	
155	Juvenile		3	
215	Mature	Male	3	was collected near a large female bull trout
315	Mature	Male	3	A large female bull trout was with this male at the time of collection.

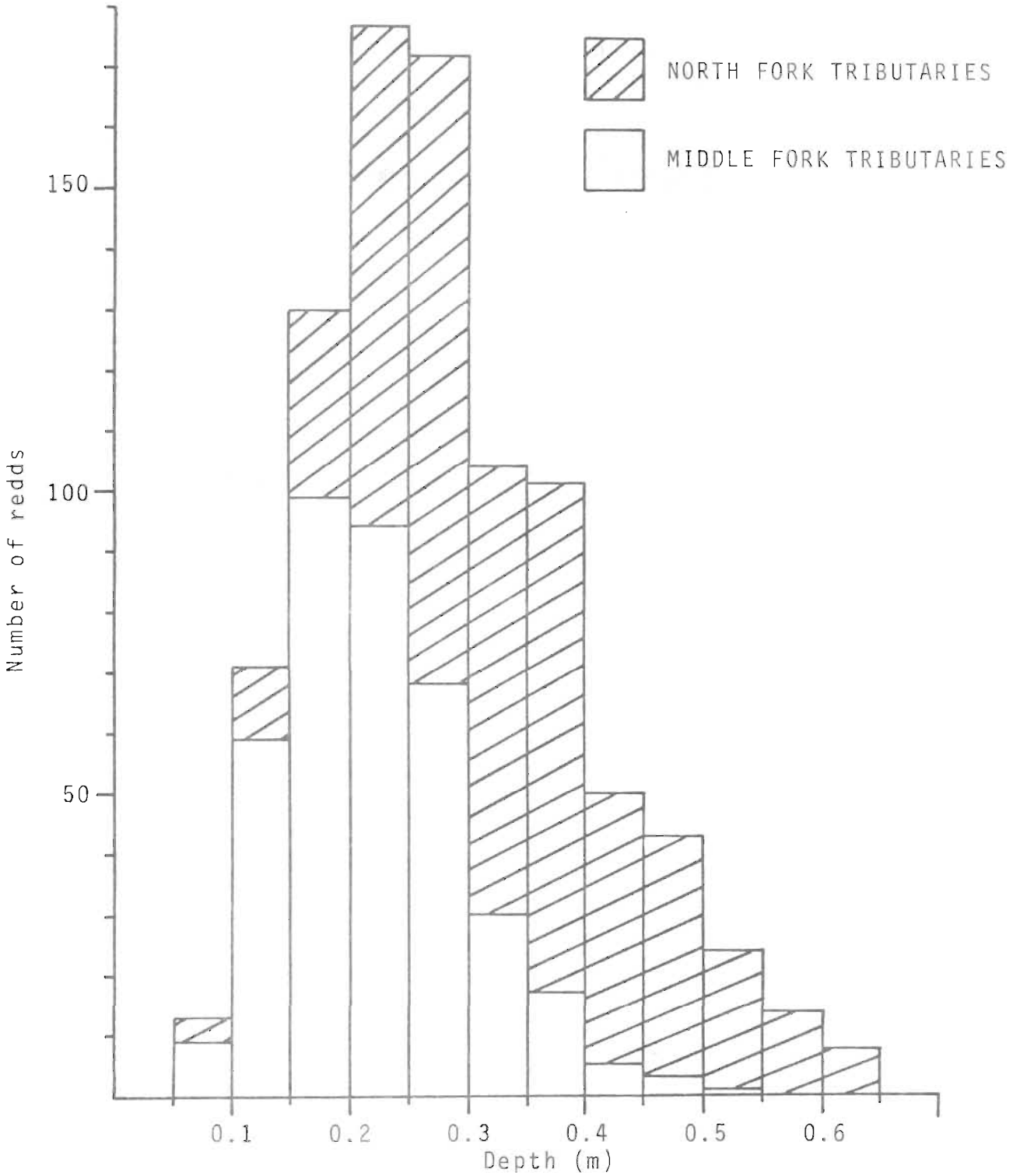

Figure 1. Depth distribution of bull trout redds enumerated during 1982 in North and Middle Fork tributaries.

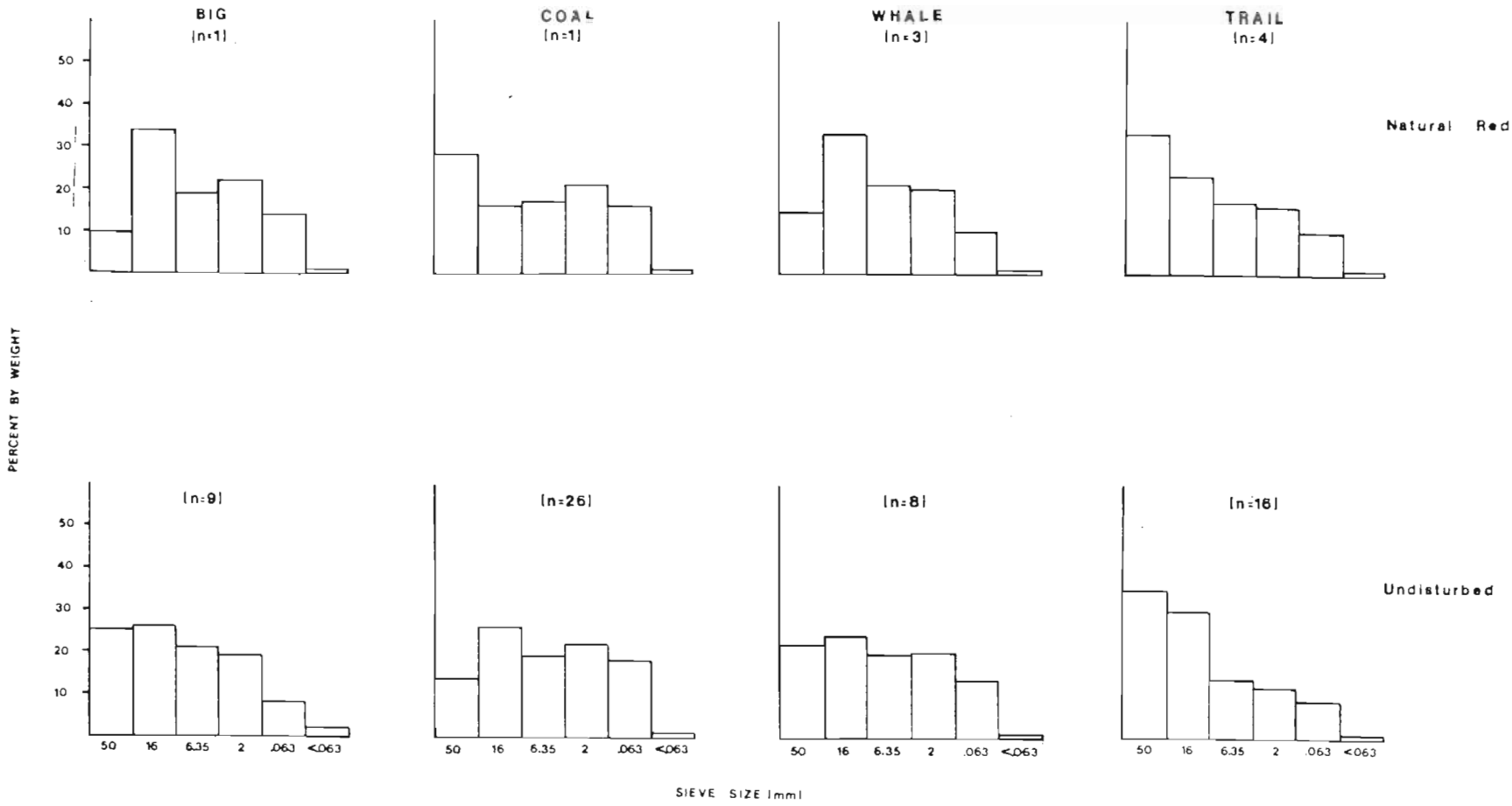

Figure 2. Composite streambed compositions of undisturbed areas and bull trout redds in Big, Coal, Whale and Trail creeks in the North Fork drainage of the Flathead River sampled during fall, 1982.

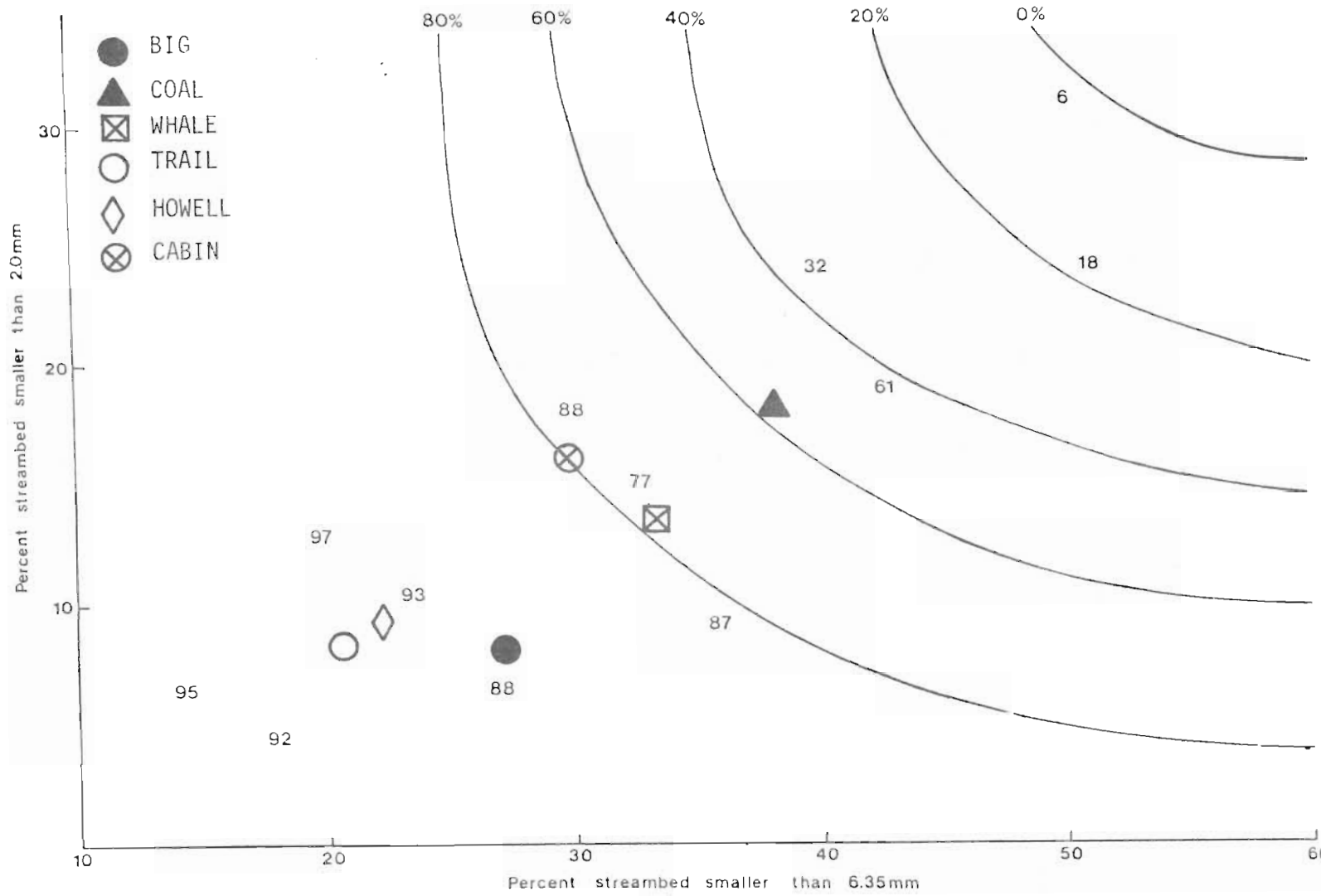

Figure 3. Predicted survival of bull trout embryos to emergence from spawning areas sampled in Big, Coal, Whale, Trail, Howell and Cabin creeks in the North Fork drainage of the Flathead River sampled during fall, 1982. Survival bands were adapted from research conducted by Tappel (1981) on chinook salmon.

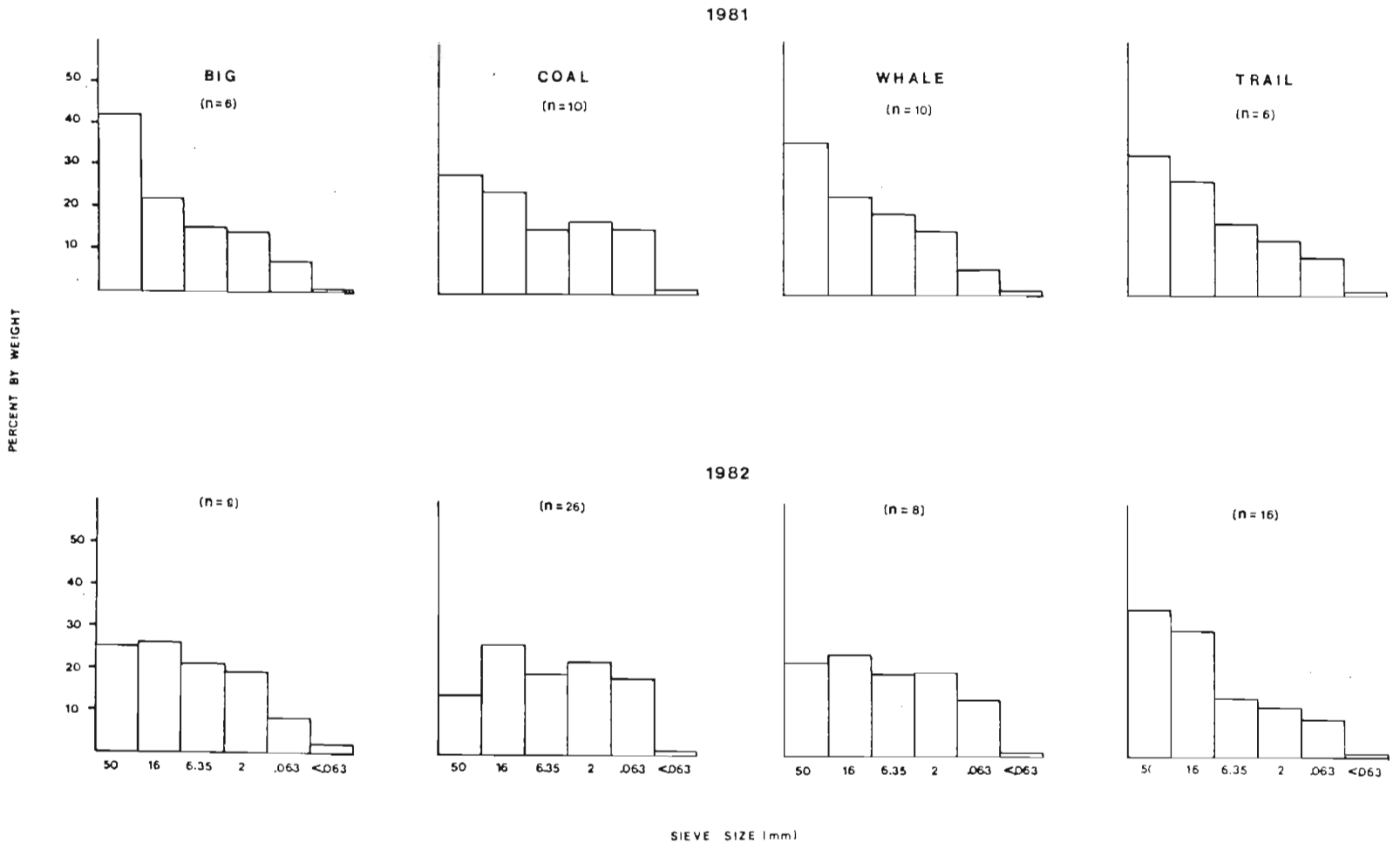

Figure 4. Composite streambed compositions of undisturbed areas in Big, Coal, Whale and Trail creeks in the North Fork drainage of the Flathead River sampled during fall, 1981 and fall, 1982.

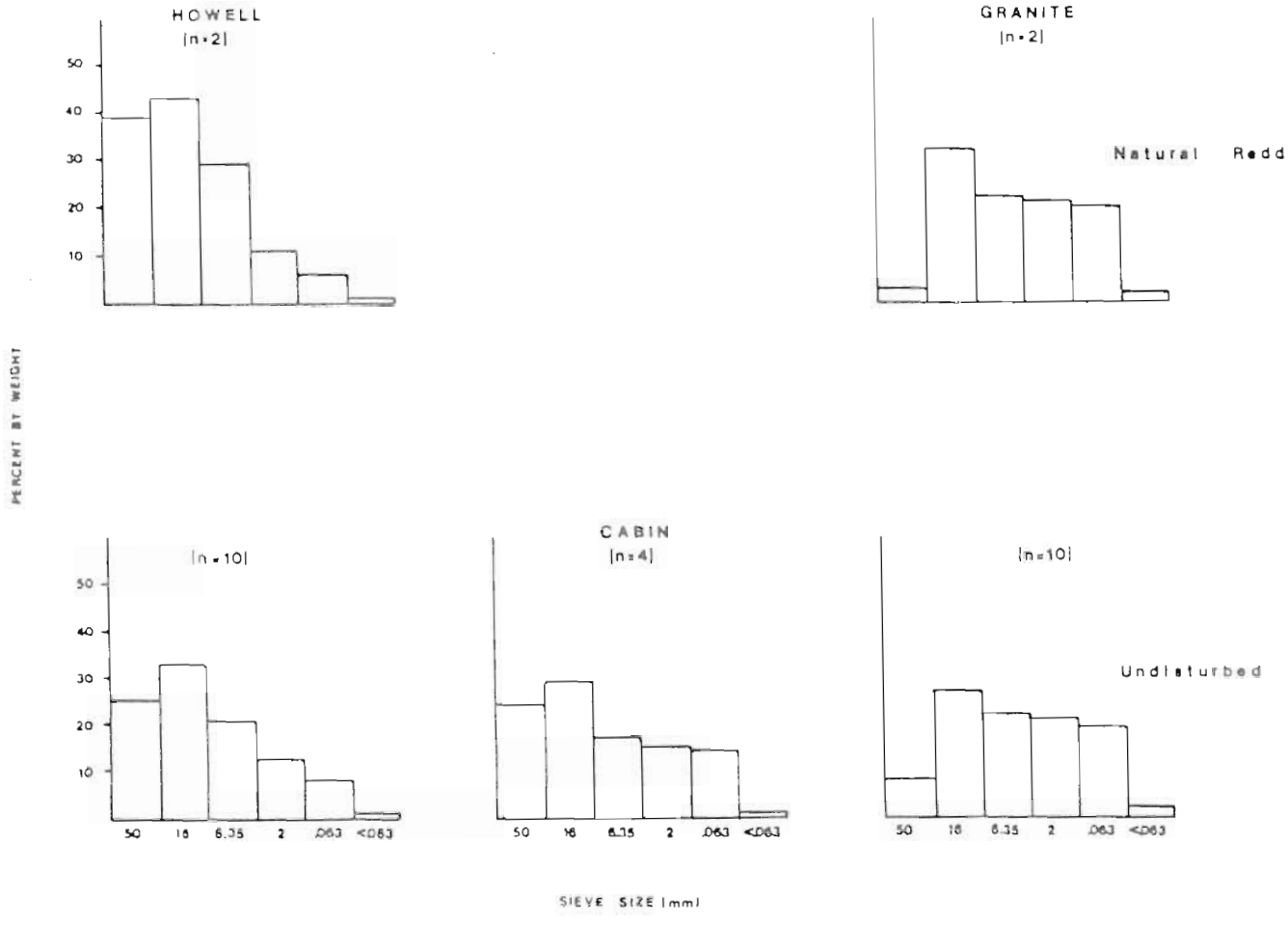

Figure 5. Composite streambed compositions of undisturbed areas and bull trout redds in Cabin and Howell creeks in the Canadian portion of the Flathead River drainage and Granite Creek in the Middle Fork drainage sampled during fall, 1982.

streams will not be sampled as part of the long-term monitoring effort (Shepard and Graham 1983a), but we felt it was important to collect a limited amount of baseline streambed composition data in these creeks in light of the proposed development. We recommended that streambed sampling continue in Granite Creek as part of the long-term monitoring program (Shepard and Graham 1983a). The transects sampled in Granite Creek were in a poor location because during sampling clay was encountered below the gravel streambed. This clay material caused the contribution of fine material to be inflated in several of the Granite Creek samples. The Granite Creek transects will be relocated during 1983 to avoid this problem.

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APPENDIX A

Water level measurements in westside North Fork tributaries during 1982.

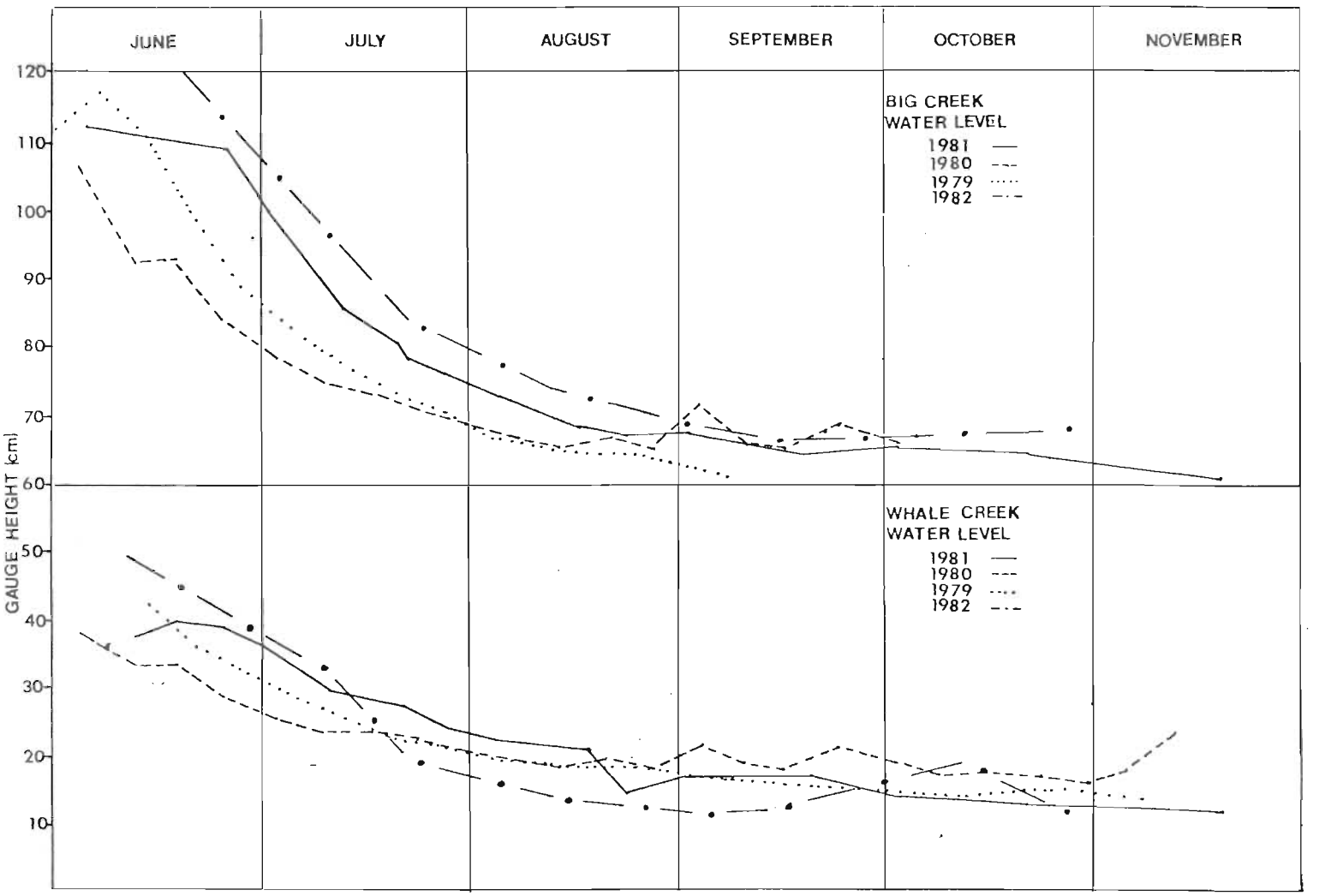


Figure 1. Seasonal water level fluctuation in Big Creek and Whale Creek during 1979, 1980, 1981 and 1982.

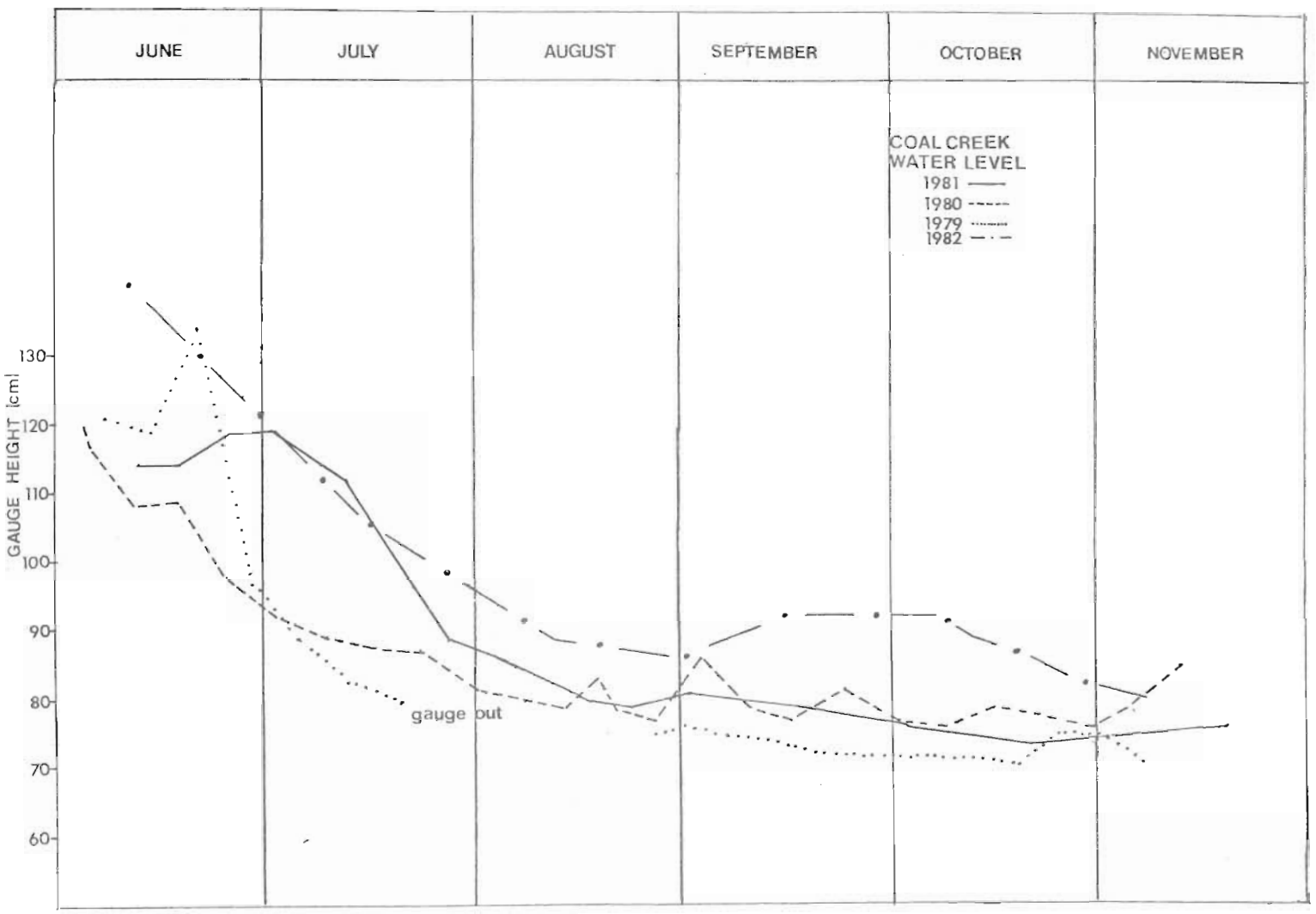


Figure 2. Seasonal water level fluctuations in Coal Creek during 1979, 1980, 1981 and 1982.

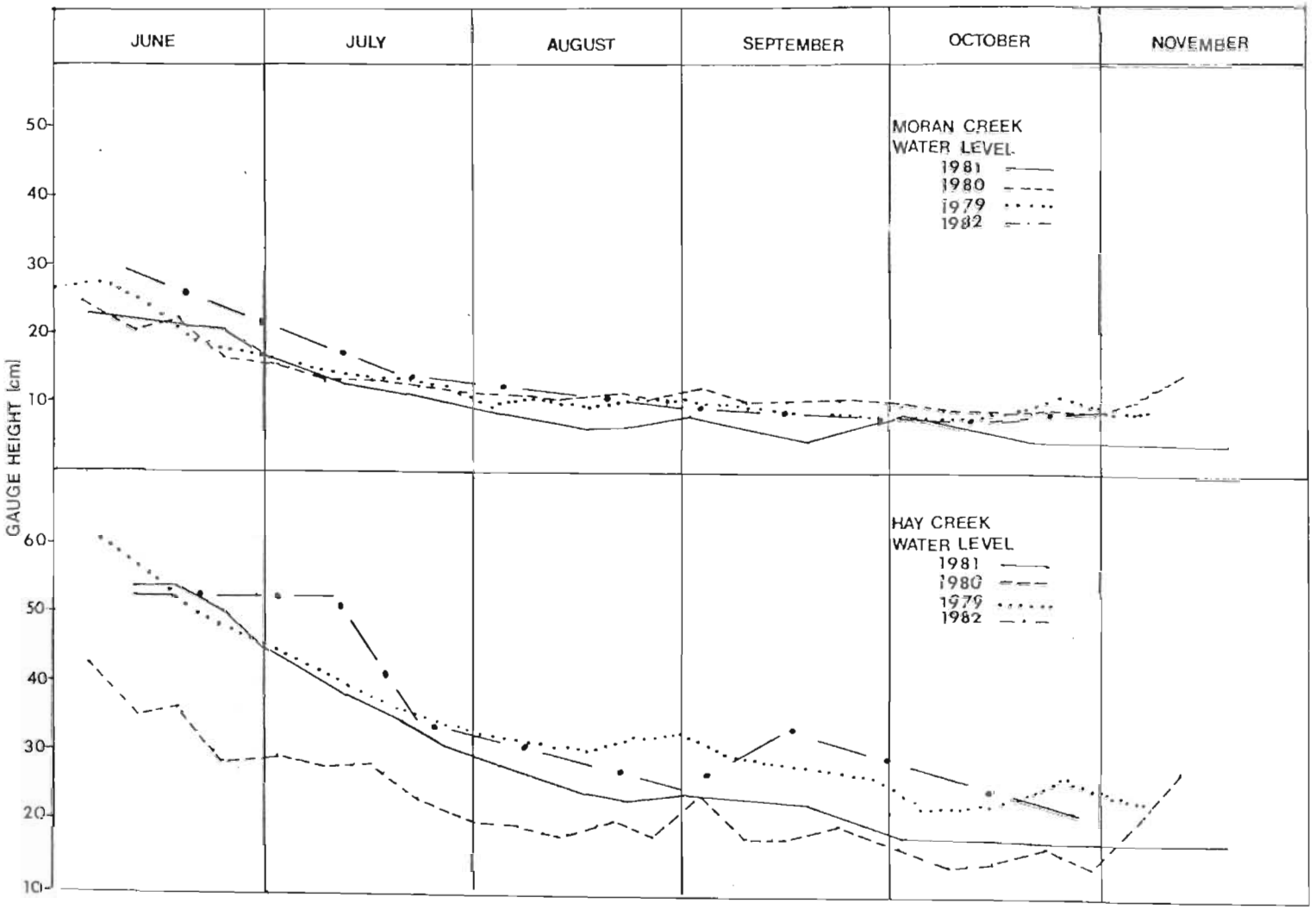


Figure 3. Seasonal water level fluctuation in Moran and Hay creeks during 1979, 1980, 1981 and 1982.

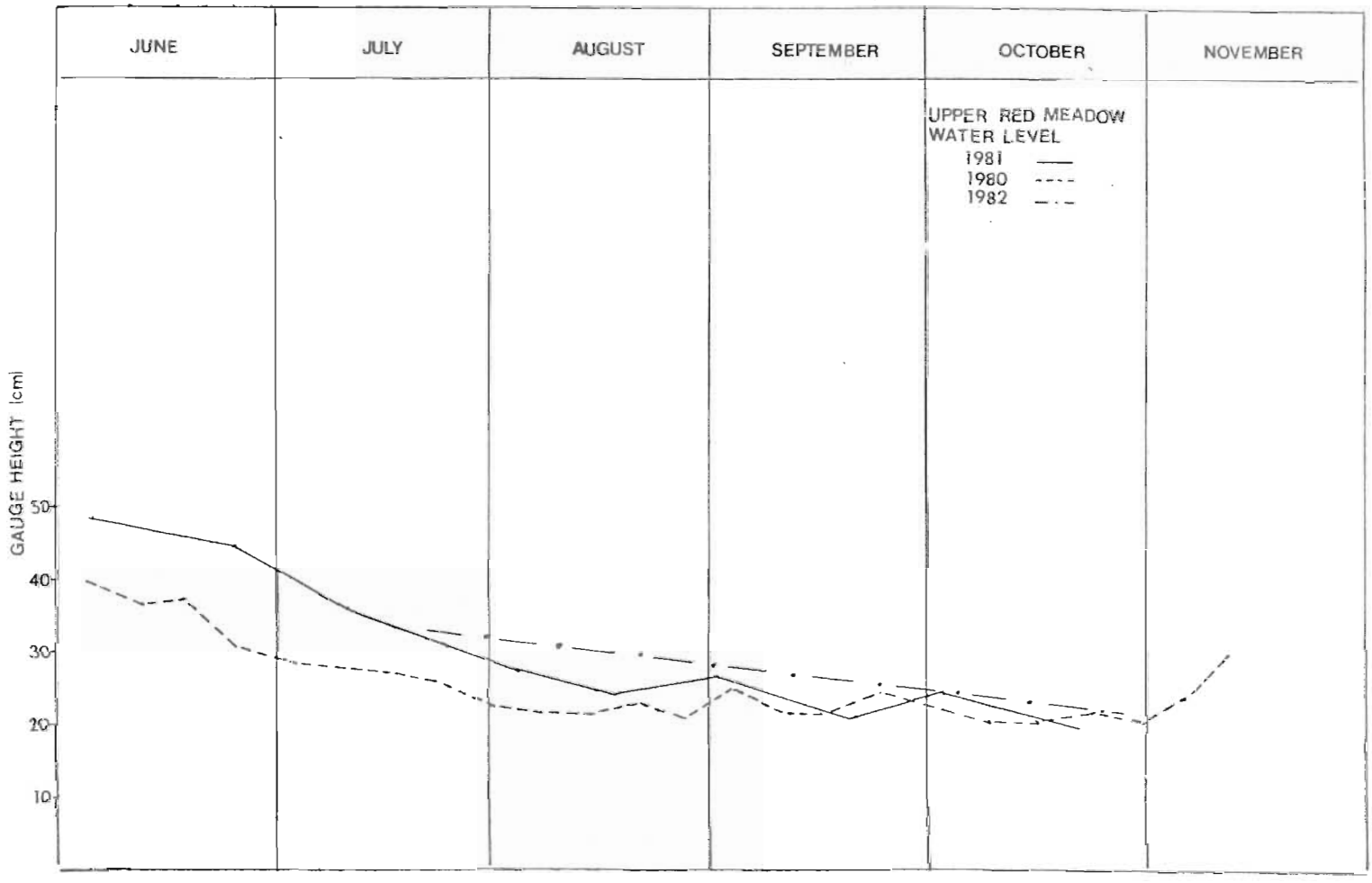


Figure 4. Seasonal water level fluctuations in Red Meadow Creek during 1980, 1981 and 1982.

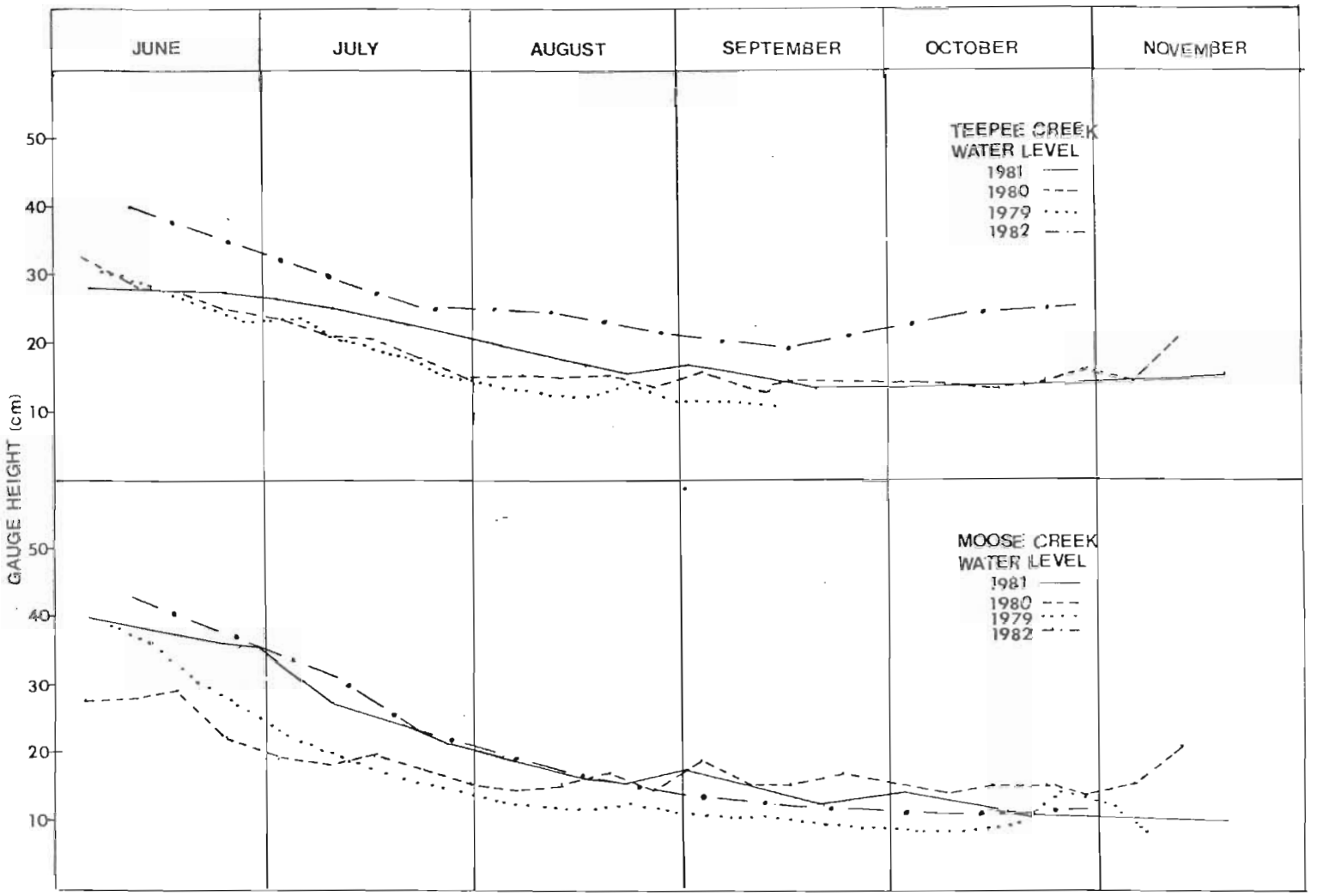


Figure 5. Seasonal water level fluctuations in Teepee Creek and Moose Creek during 1979, 1980, 1981 and 1982.

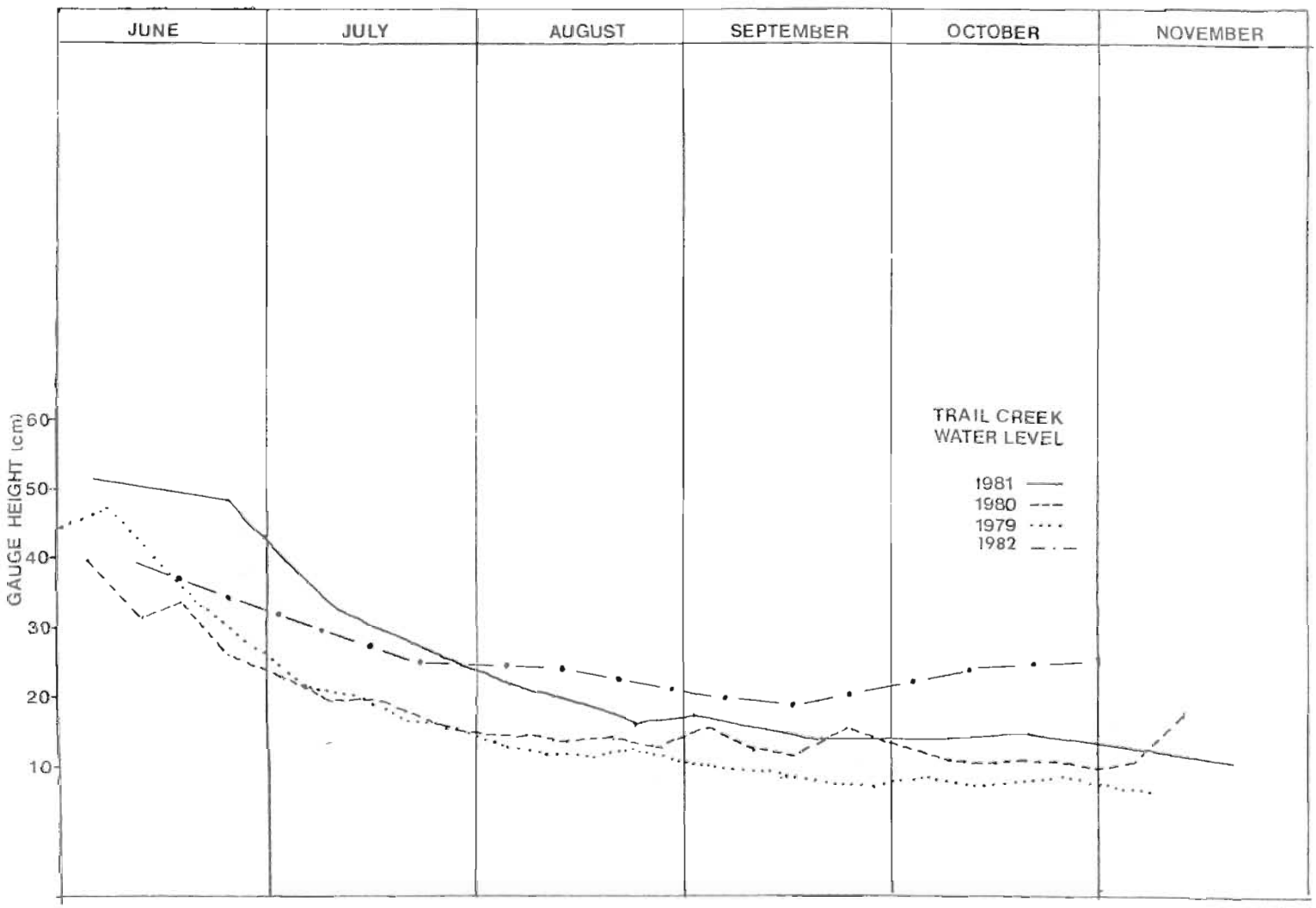
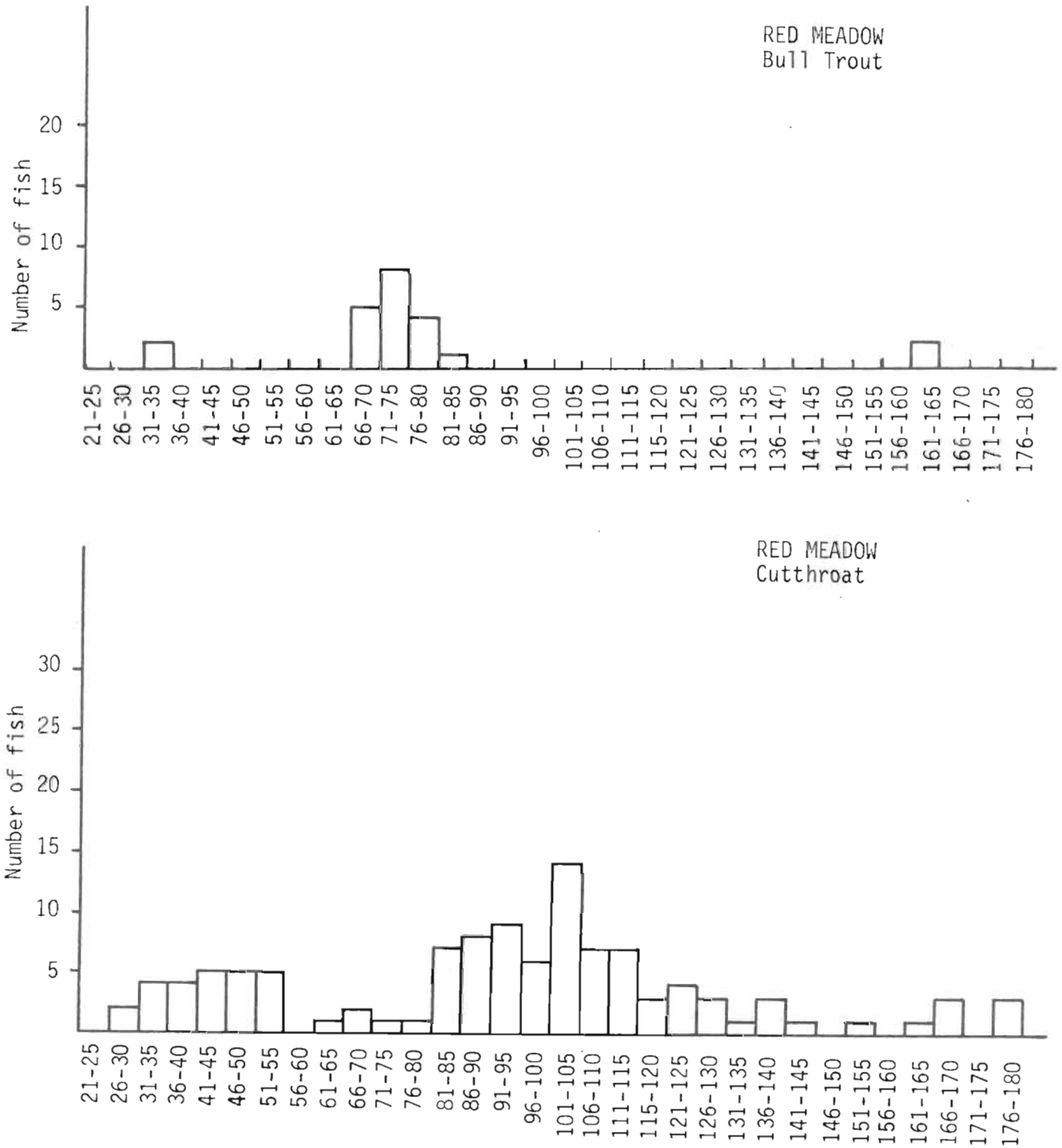


Figure 6. Seasonal water level fluctuations in Trail Creek during 1979, 1980, 1981 and 1982.

APPENDIX B

Length frequency distributions of westslope cutthroat and juvenile bull trout captured by electrofishing in upper Flathead River tributaries



Figures 1. Length frequencies of bull trout (upper) and cutthroat trout (lower) in Red Meadow Creek during summer 1982.

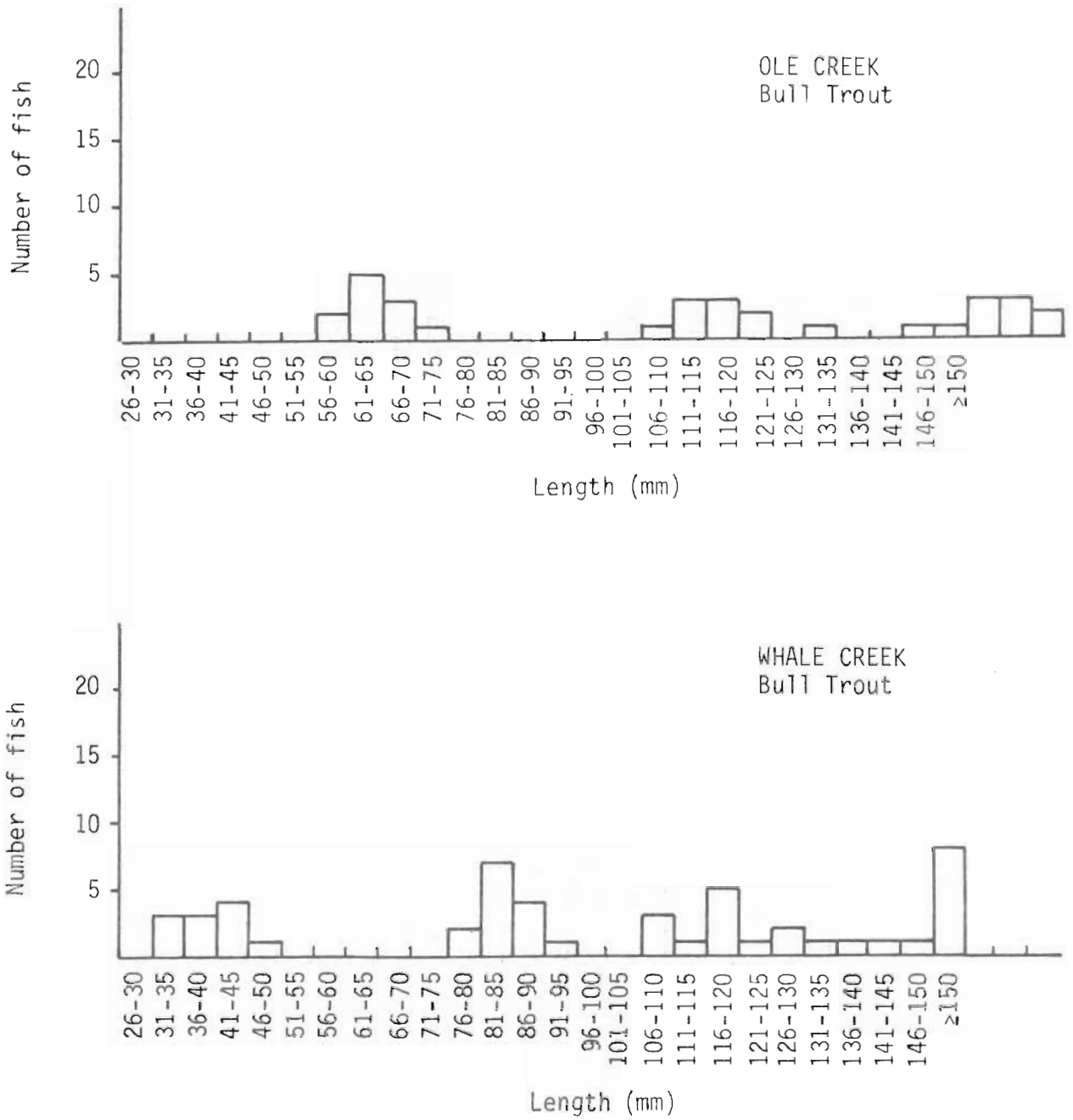


Figure 2. Length frequencies of bull trout in Ole Creek (upper) and Whale Creek (lower) during summer 1982.

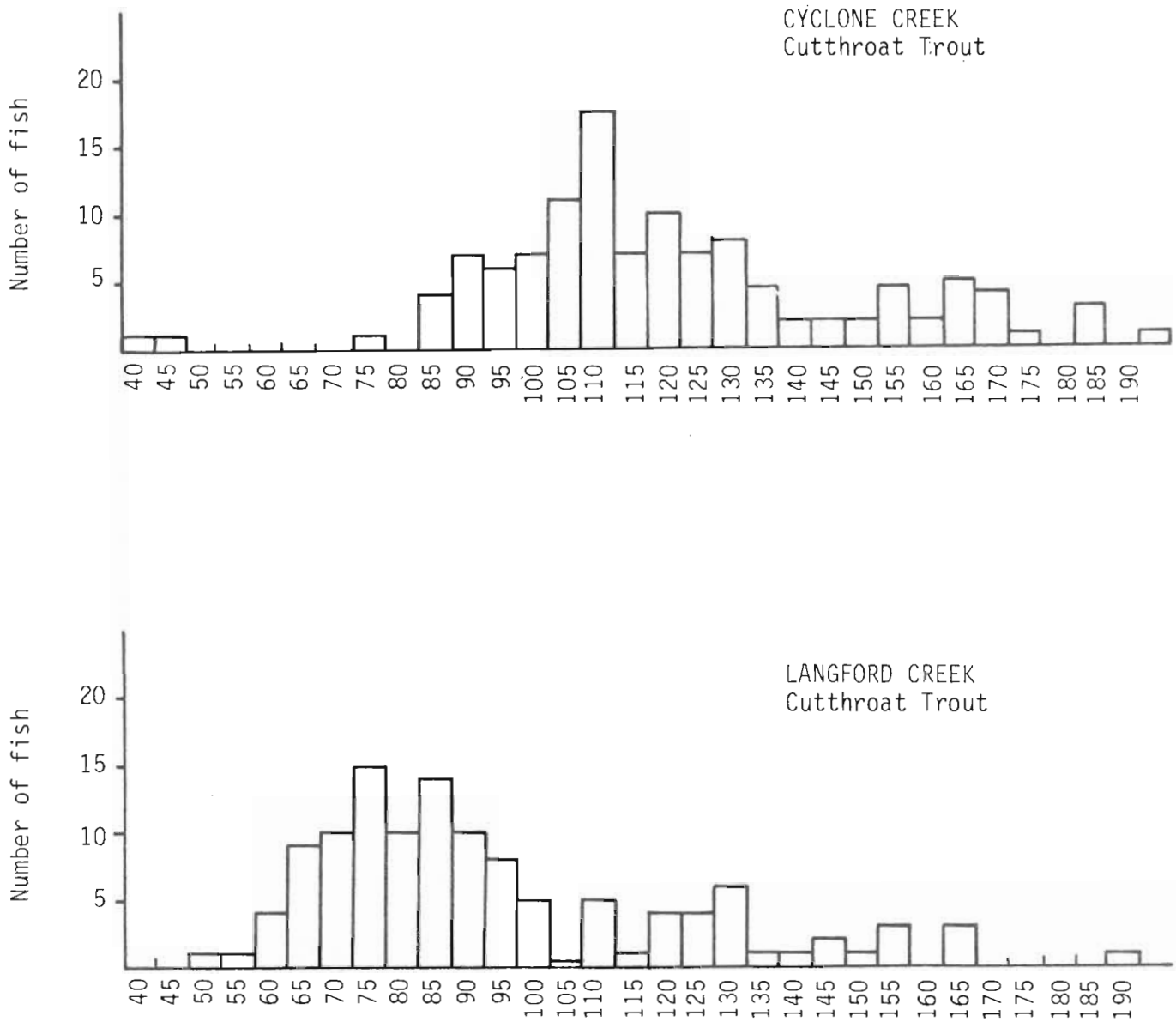


Figure 3. Length frequency of cutthroat trout in Cyclone Creek (upper) and Langford Creek (lower) during summer 1982.

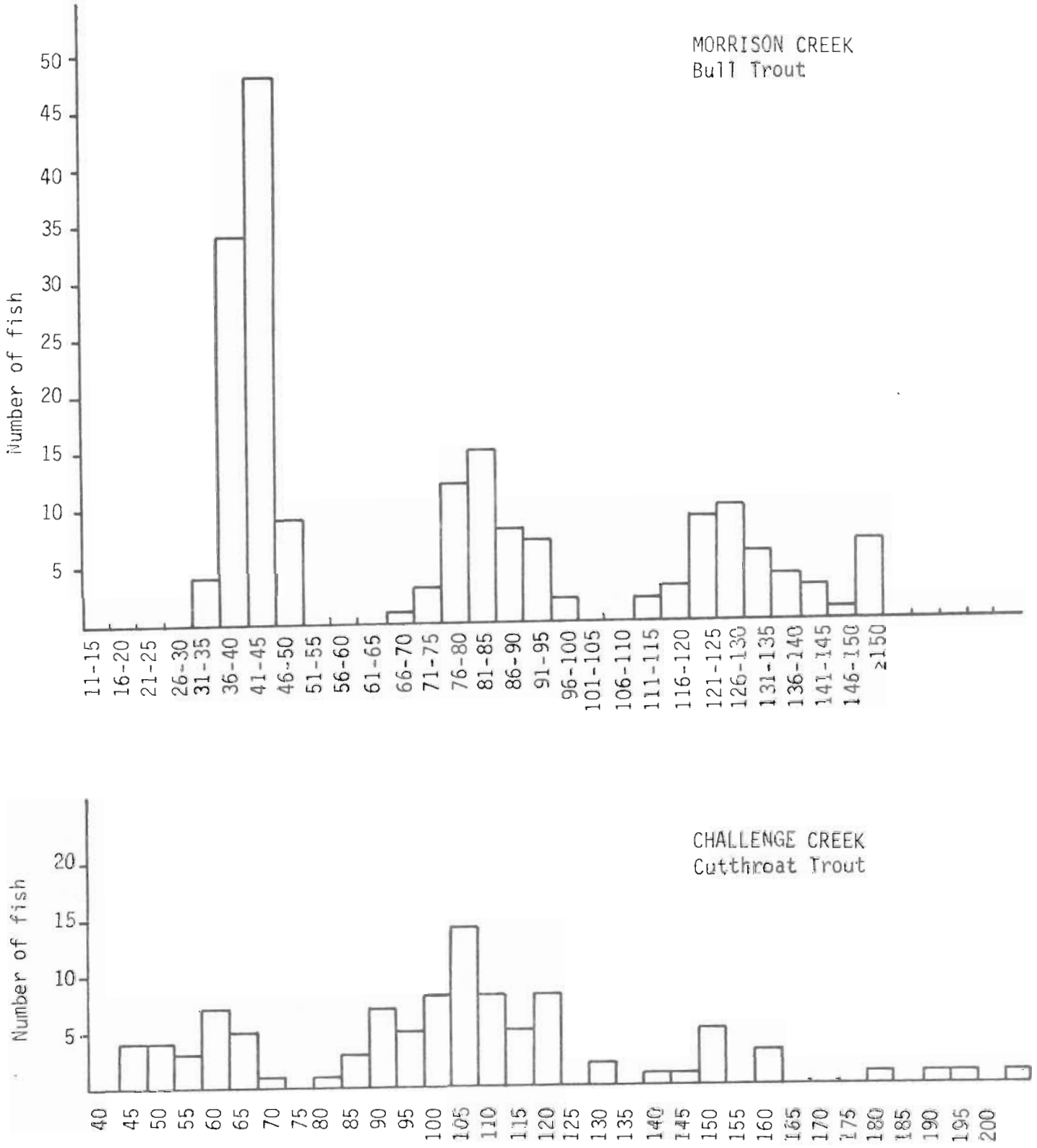


Figure 4. Length frequencies of bull trout in Morrison Creek (upper) and cutthroat trout in Challenge Creek (lower) in summer 1982.

APPENDIX C

Distributions of bull trout spawning sites by 0.5 km of stream length in upper Flathead River tributaries surveyed during fall, 1982

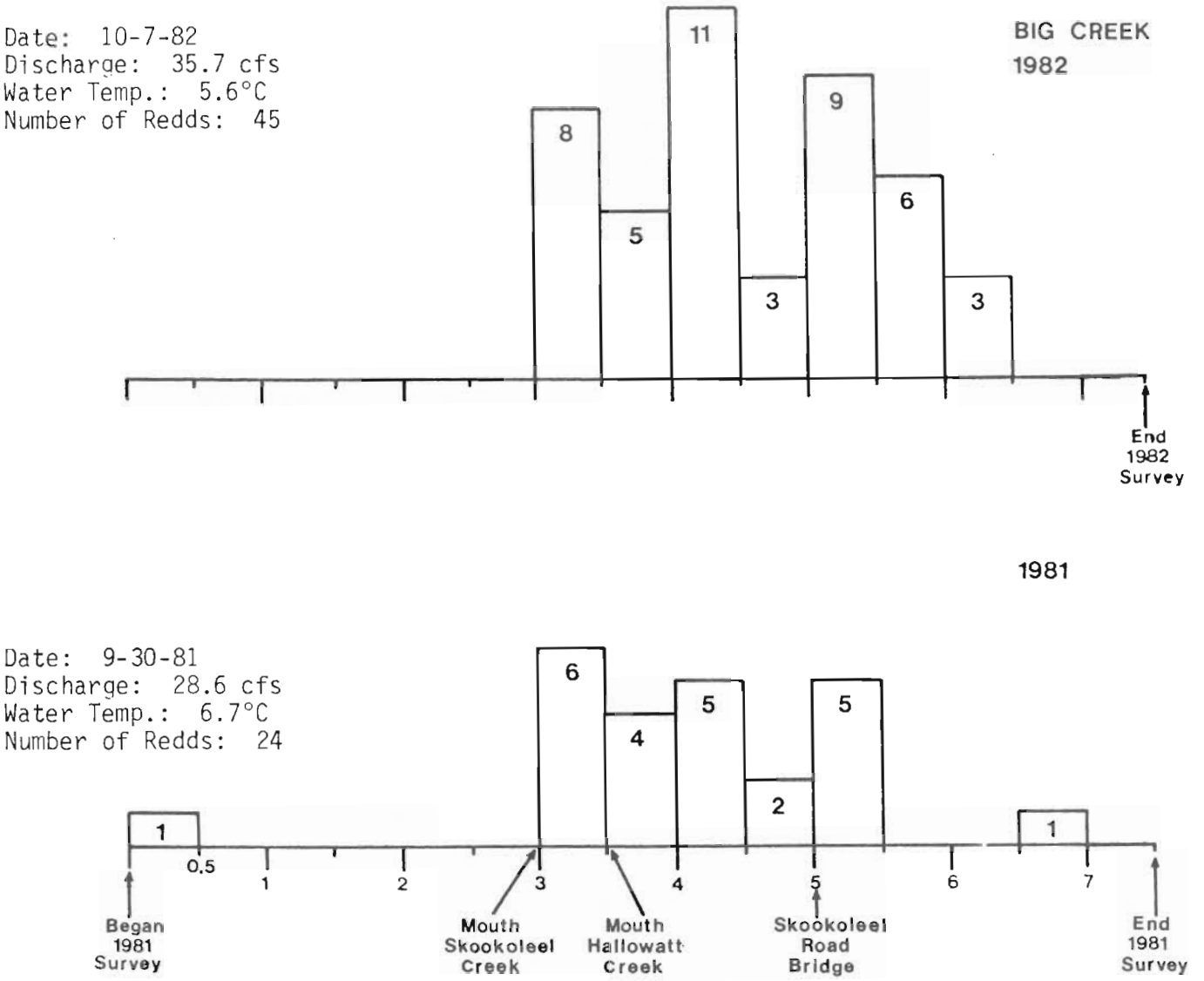


Figure 1. Bull trout redd distributions in Big Creek during 1981 and 1982.

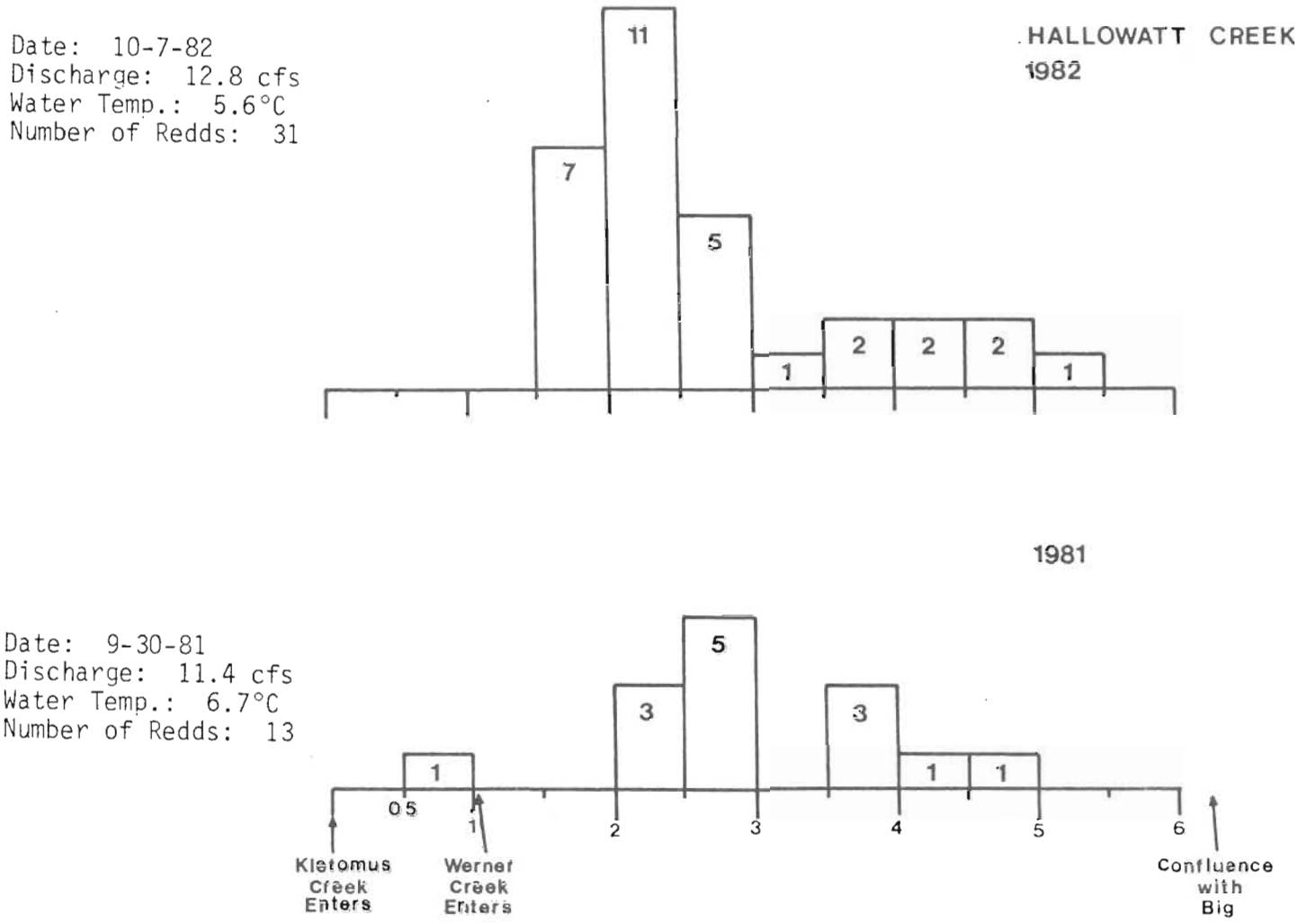


Figure 2. Bull trout redd distributions in Hallowatt Creek during 1981 and 1982.

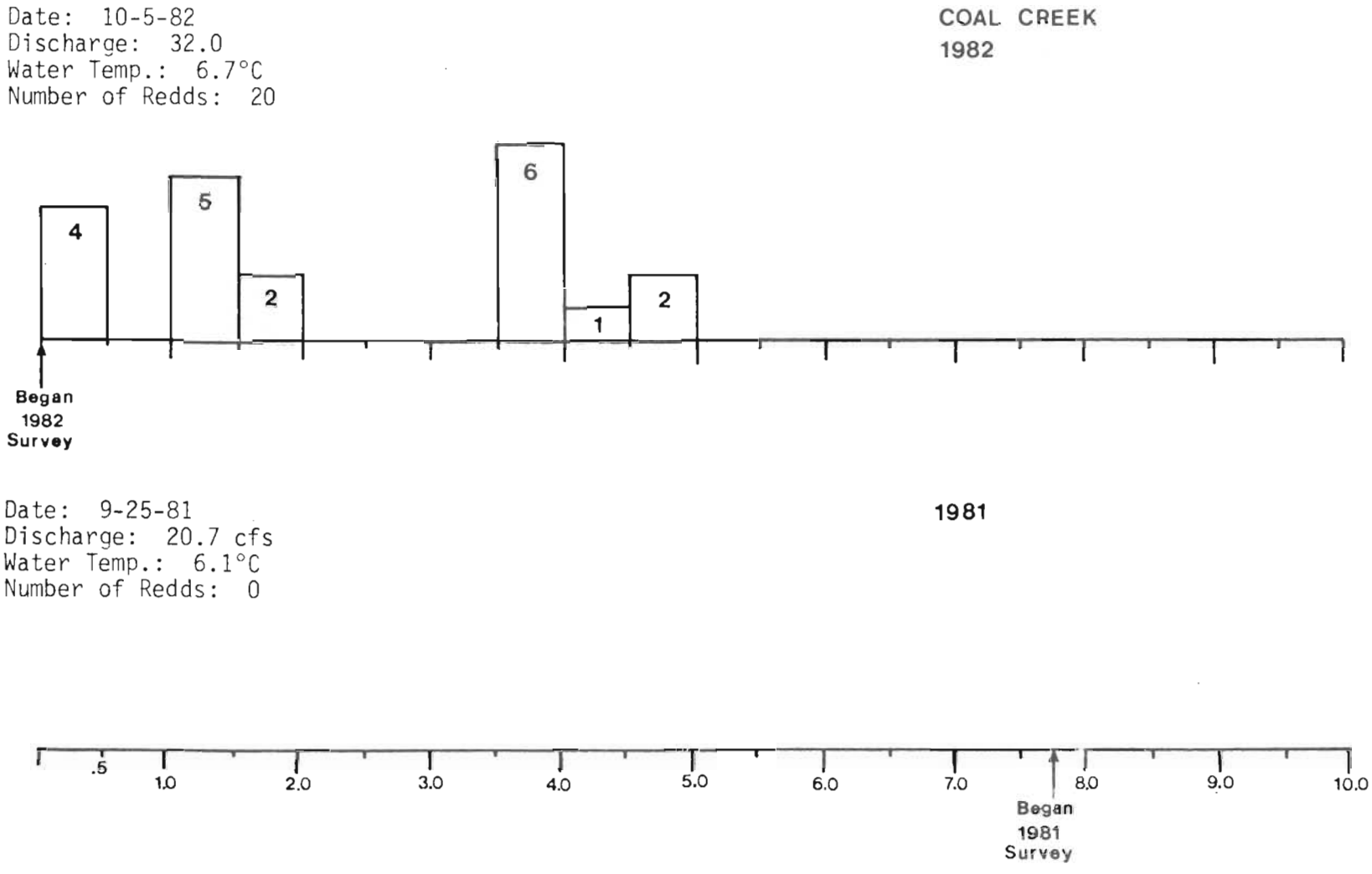


Figure 3. Bull trout redd distributions in the upper portion of Coal Creek during 1981 and 1982.

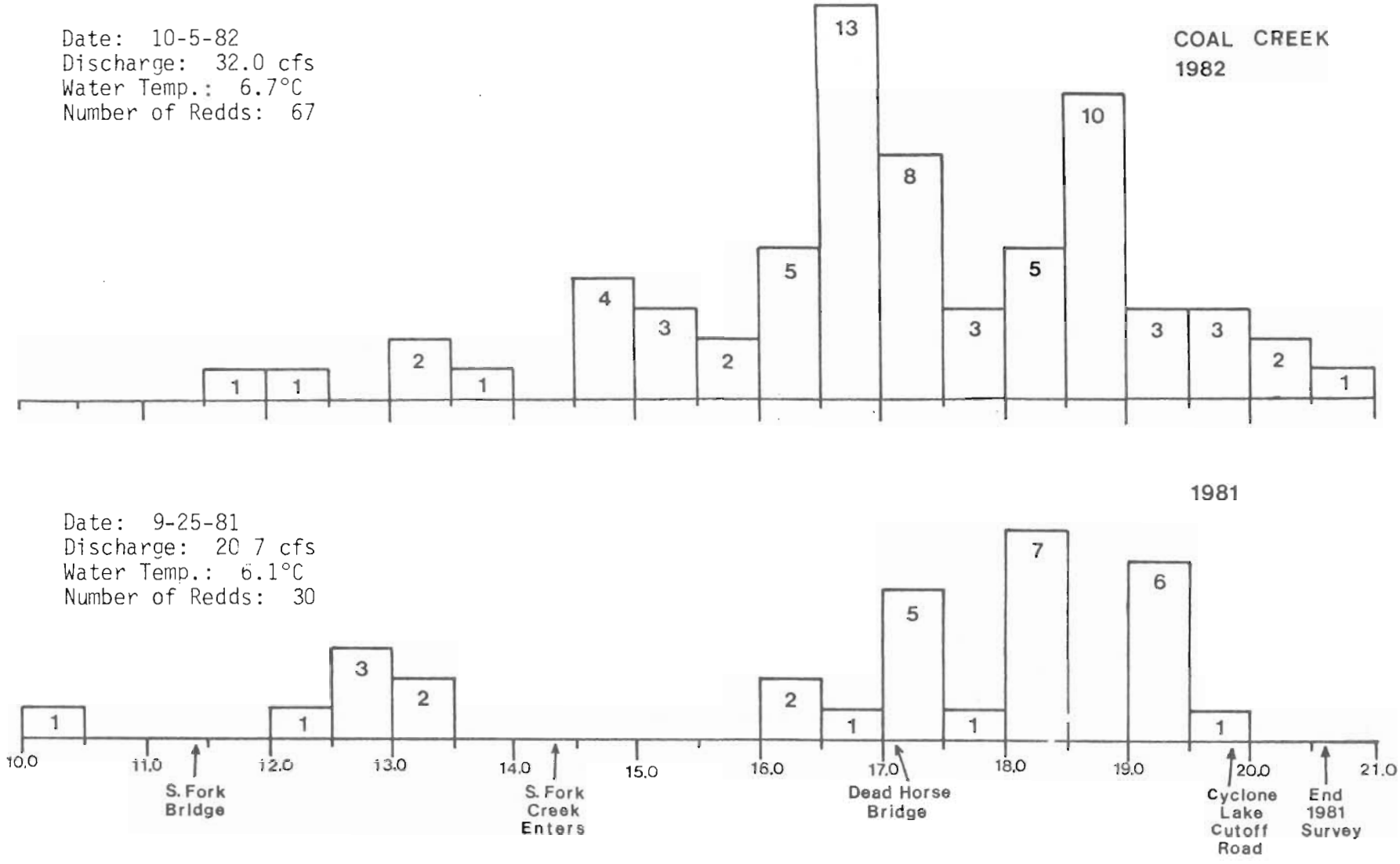
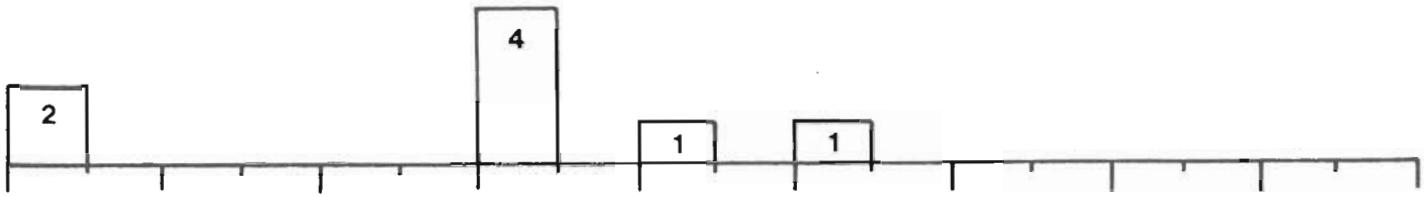


Figure 4. Bull trout redd distributions in the middle portion of Coal Creek during 1981 and 1982.

Date: 10-5-82
Discharge: 32.0 cfs
Water Temp.: 6.7°C
Number of Redds: 8

COAL CREEK
1982



Date: 9-25-81
Discharge: 20.7 cfs
Water Temp.: 6.1°C
Number of Redds: 0

1981

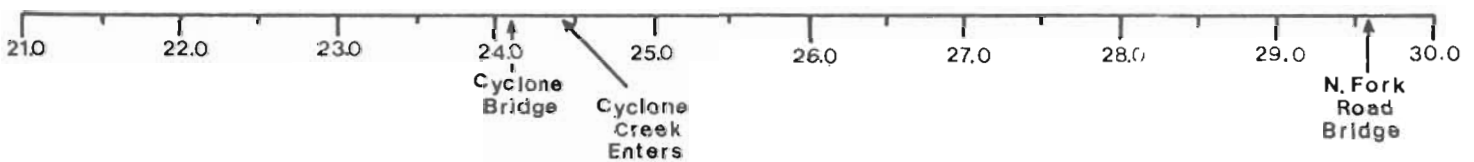


Figure 5. Bull trout redd distributions in the lower portion of Coal Creek during 1981 and 1982.

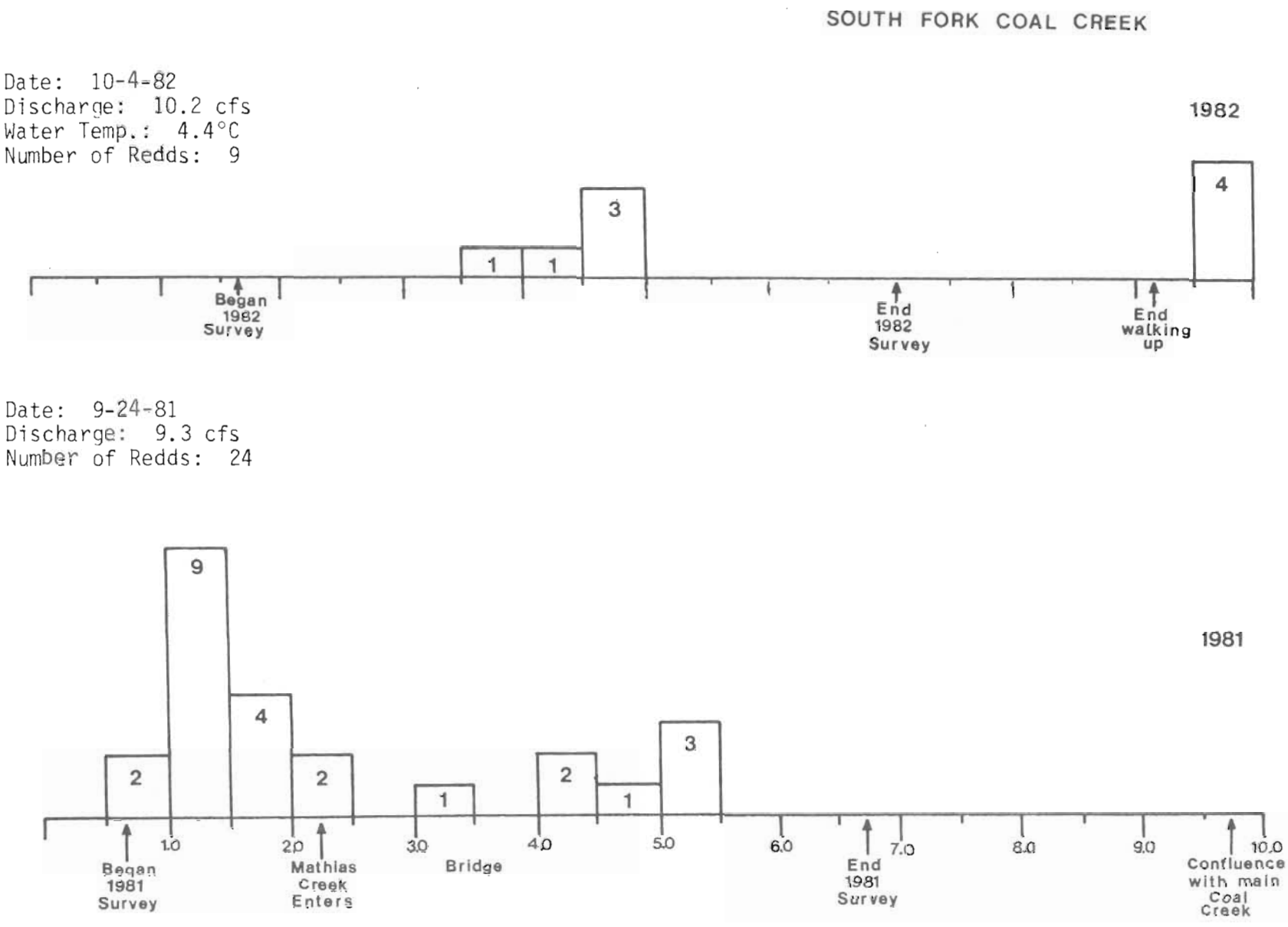
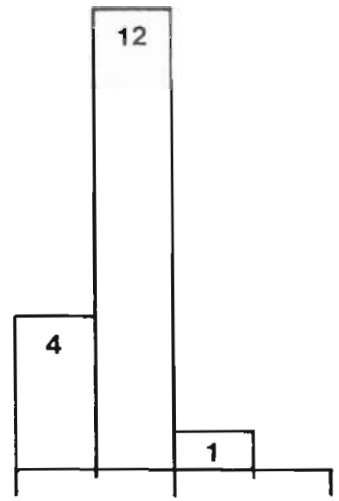


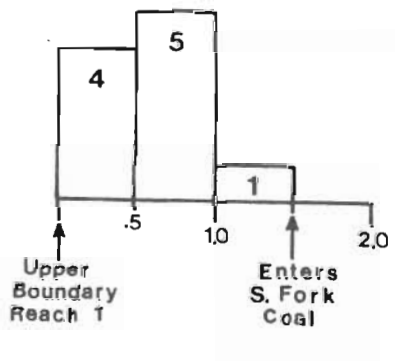
Figure 6. Bull trout redd distributions in the South Fork of Coal Creek during 1981 and 1982.

Date: 10-4-82
Discharge: 6.1 cfs
Water Temp.: 3.9°C
Number of Redds: 17



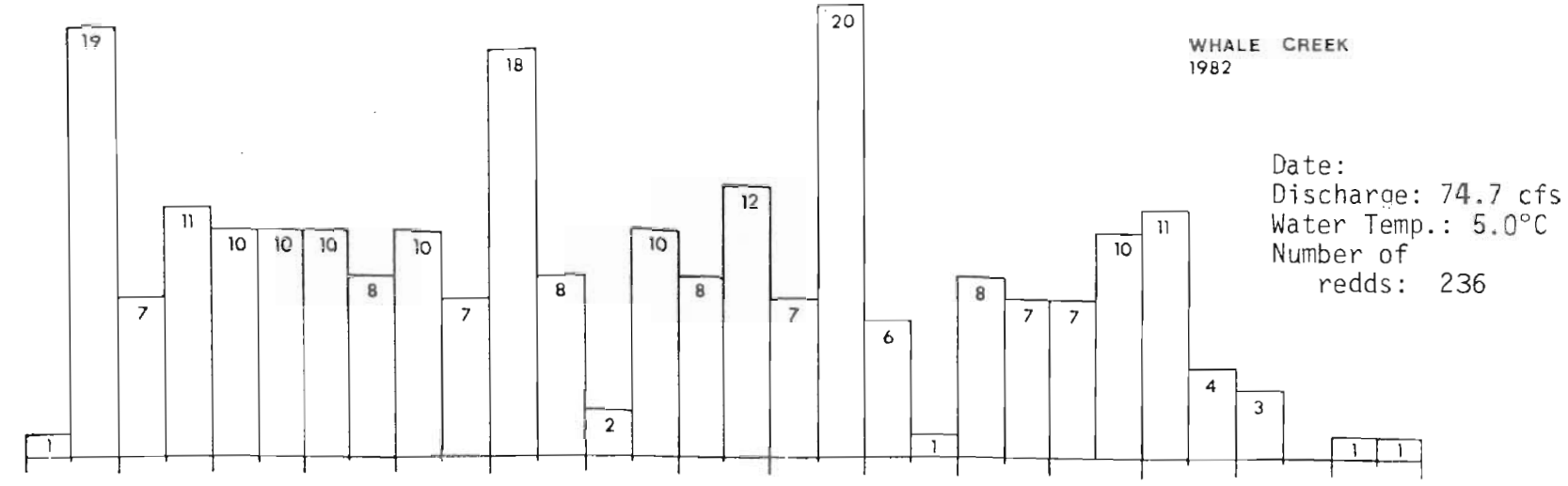
MATHIAS CREEK
1982

Date: 9-19-81
Discharge: 3.8 cfs
Number of Redds: 10



1981

Figure 7. Bull trout redd distributions in Mathias Creek during 1981 and 1982.



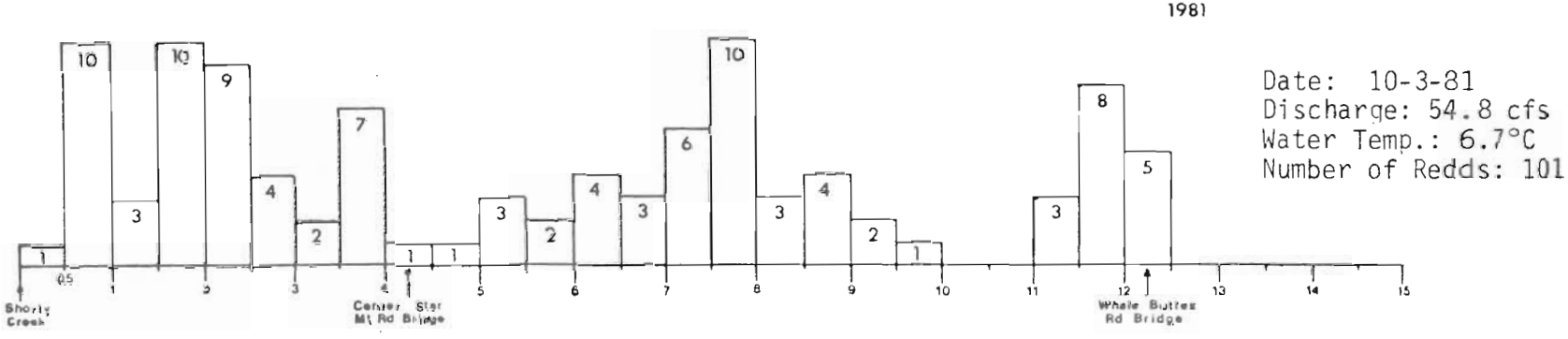


Figure 8. Bull trout redd distributions in Whale Creek during 1981 and 1982.

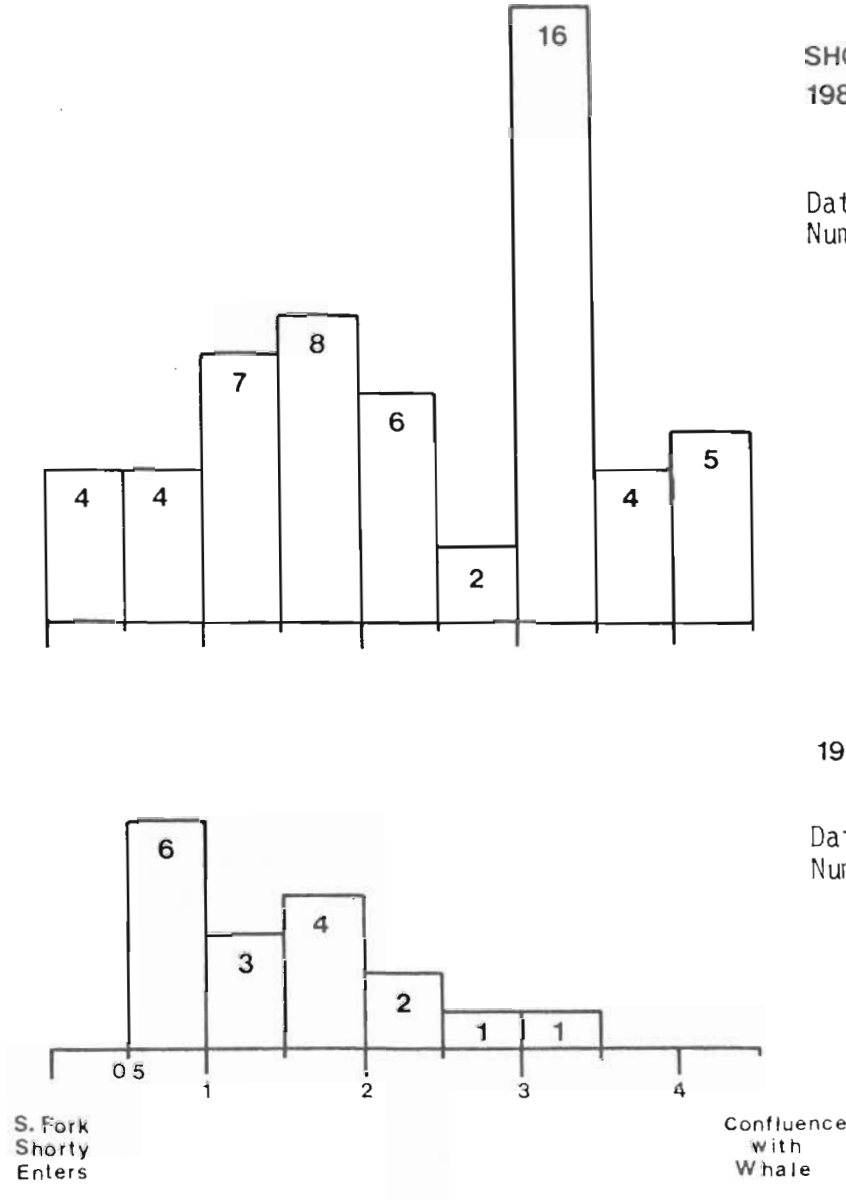


Figure 9. Bull trout redd distributions in Shorty Creek during 1981 and 1982.

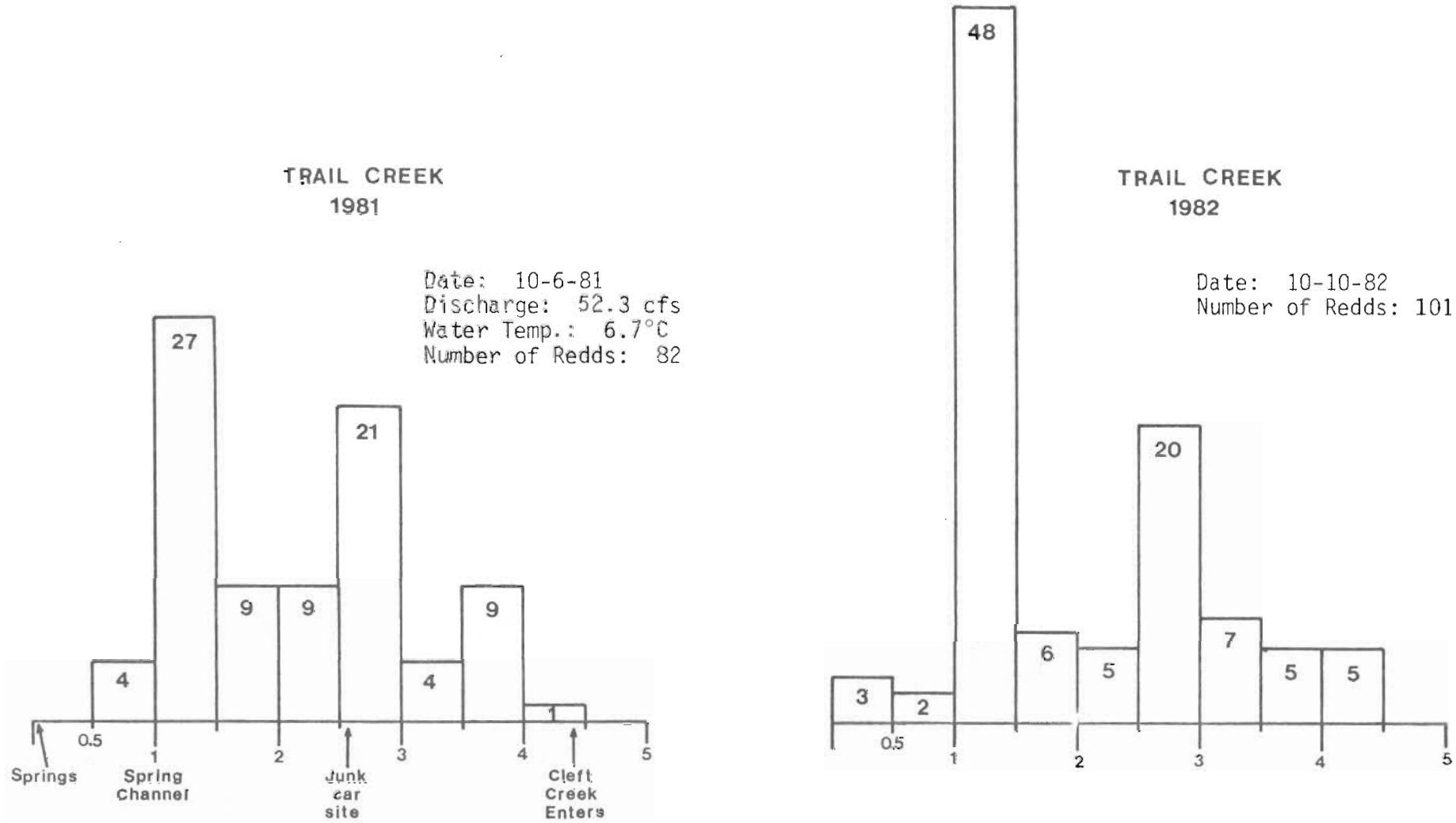


Figure 10. Bull trout redd distribution in Trail Creek during 1981 and 1982.

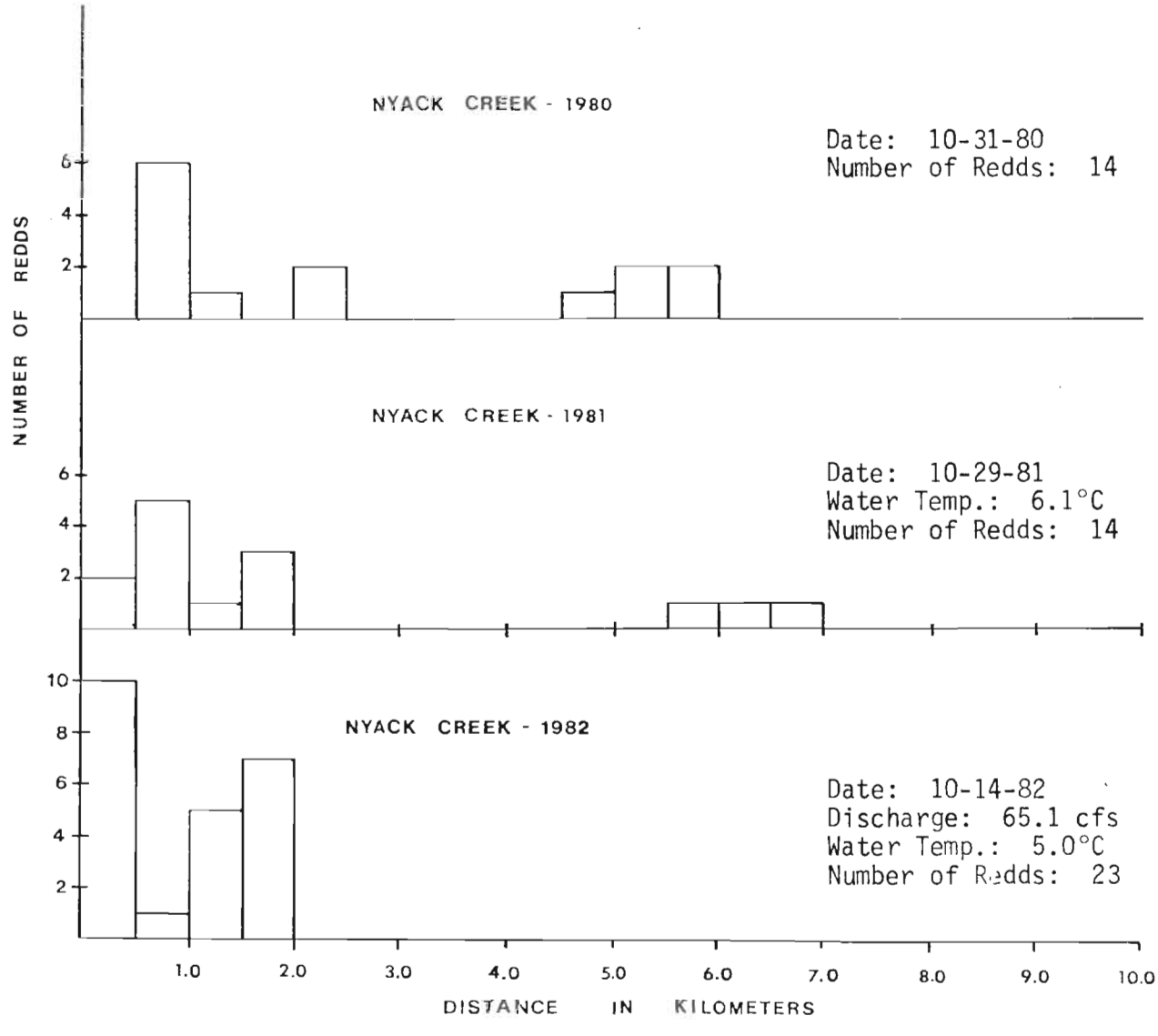


Figure 10. Bull trout redd densities in Nyack Creek surveyed in 1980, 1981 and 1982. Survey began at falls (kilometer 00 on figure) and ended at beginning of slough section (kilometer 10.0 on figure).

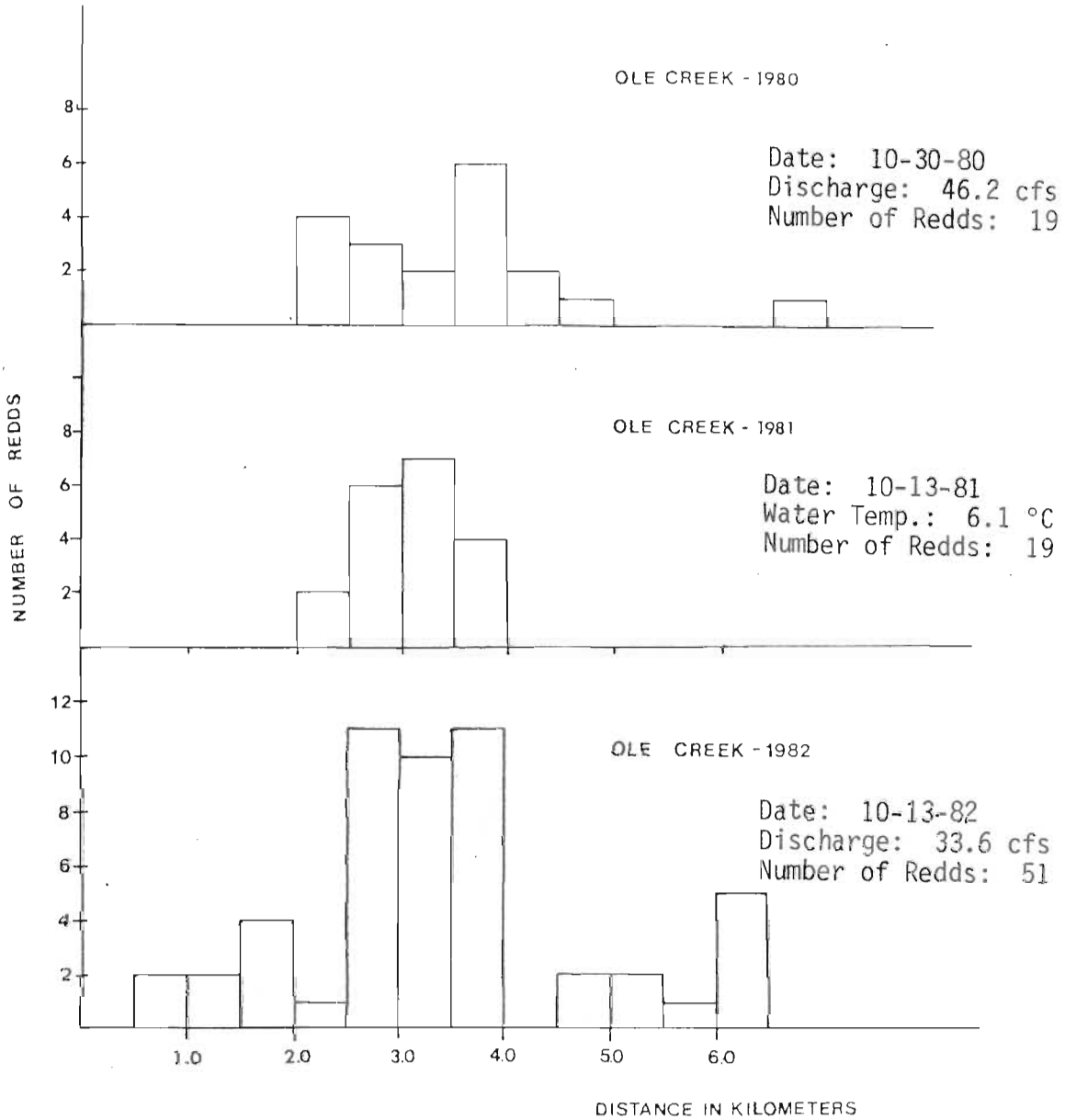


Figure 11. Bull trout redd distribution in Ole Creek surveyed in 1980, 1981 and 1982. Survey began at Fielding trail crossing (kilometer 0.0 on figure) and ended at upper end of canyon (kilometer 5.5 on figure).

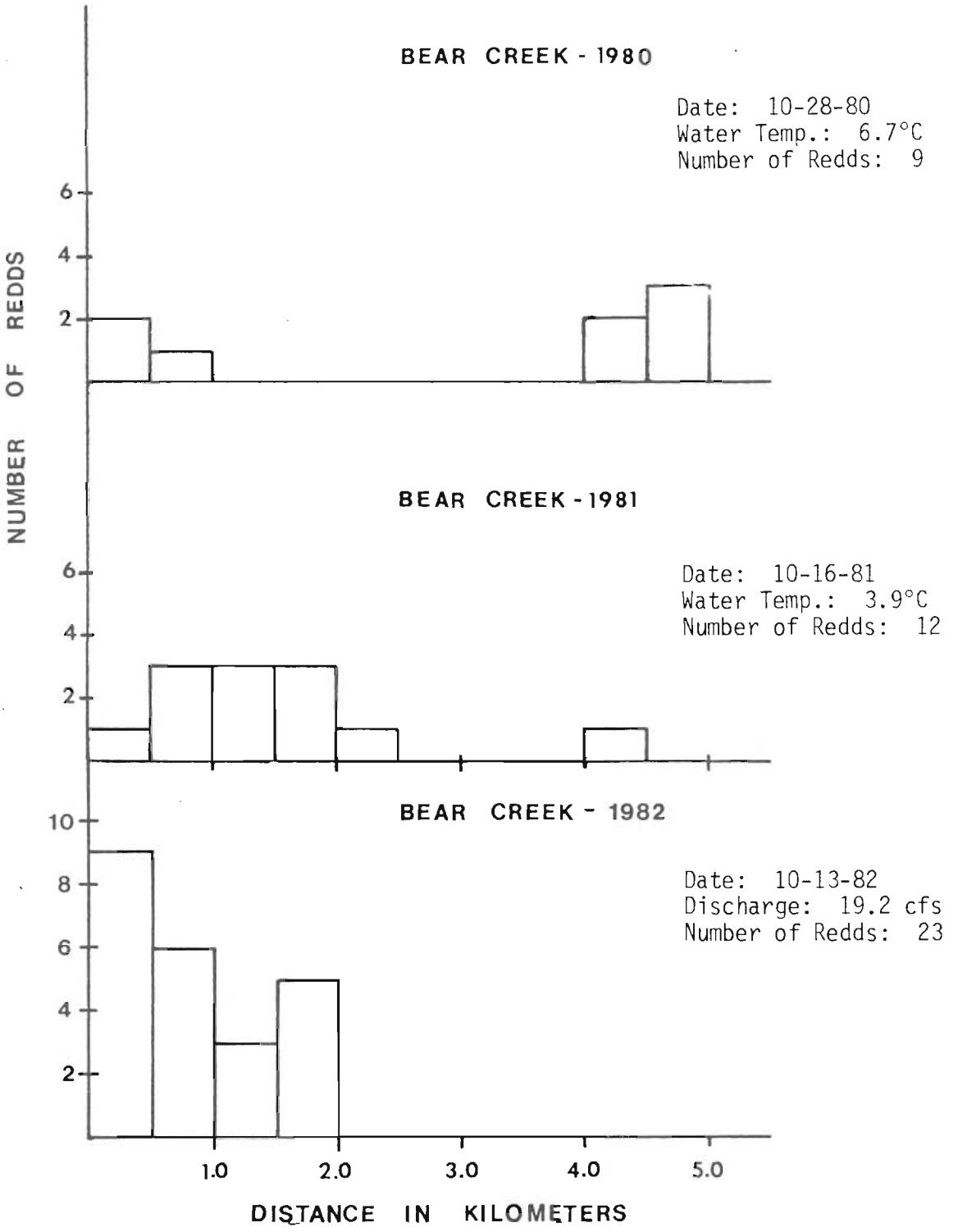


Figure 13. Bull trout redd distribution in Bear Creek surveyed in 1980, 1981 and 1982. Survey began at Highway 2 bridge (kilometer 0.0 on figure) and ended at upper end of canyon (kilometer 5.0 on figure).

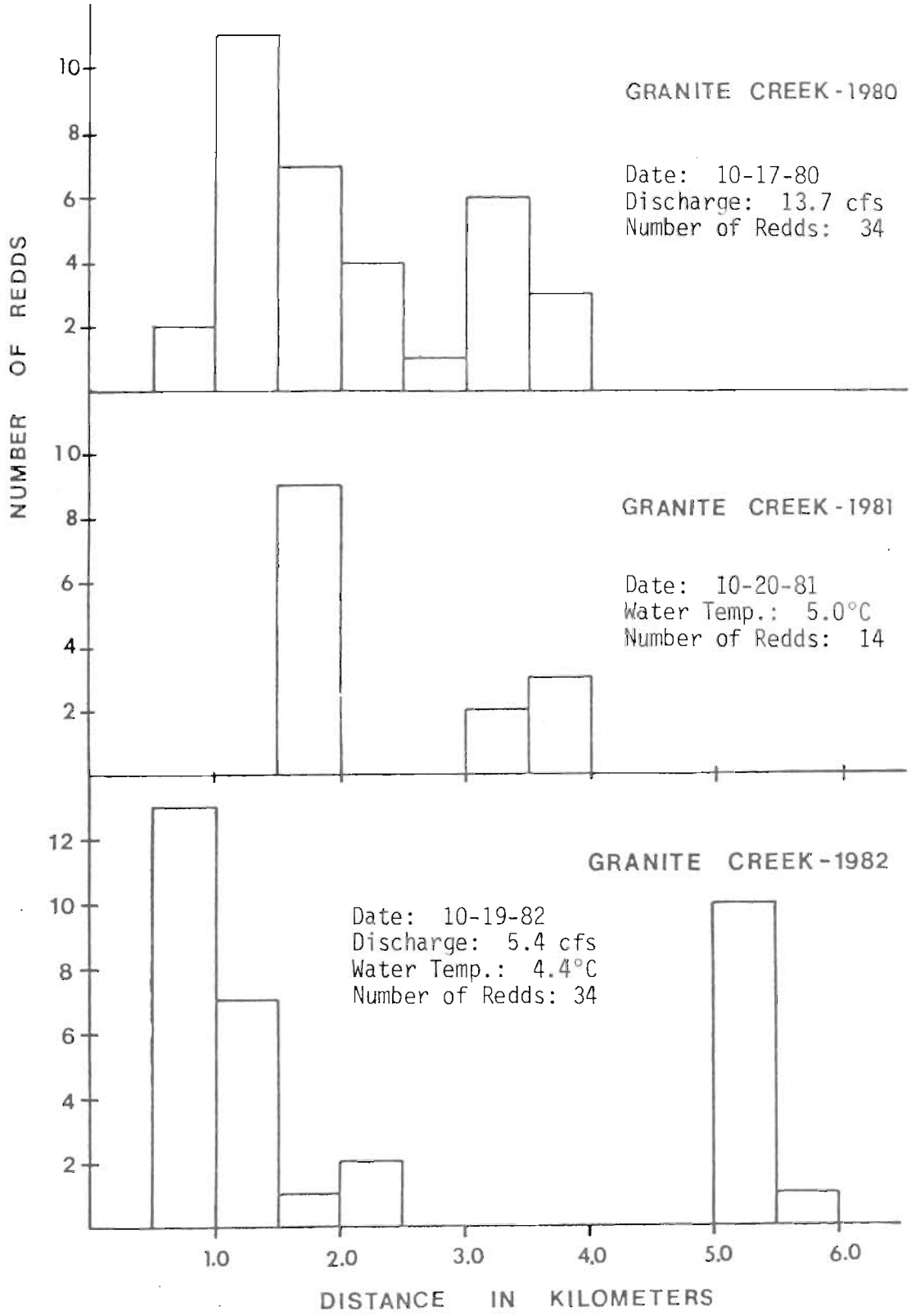


Figure 14. Bull trout redd distributions in Granite Creek surveyed in 1980, 1981 and 1982. Survey began at lower end of dry section in 1982 (kilometer 0.0 on figure) and ended at upper end of canyon (kilometer 6.5 on figure). Flow measurements were taken approximately 2 km below dry section.

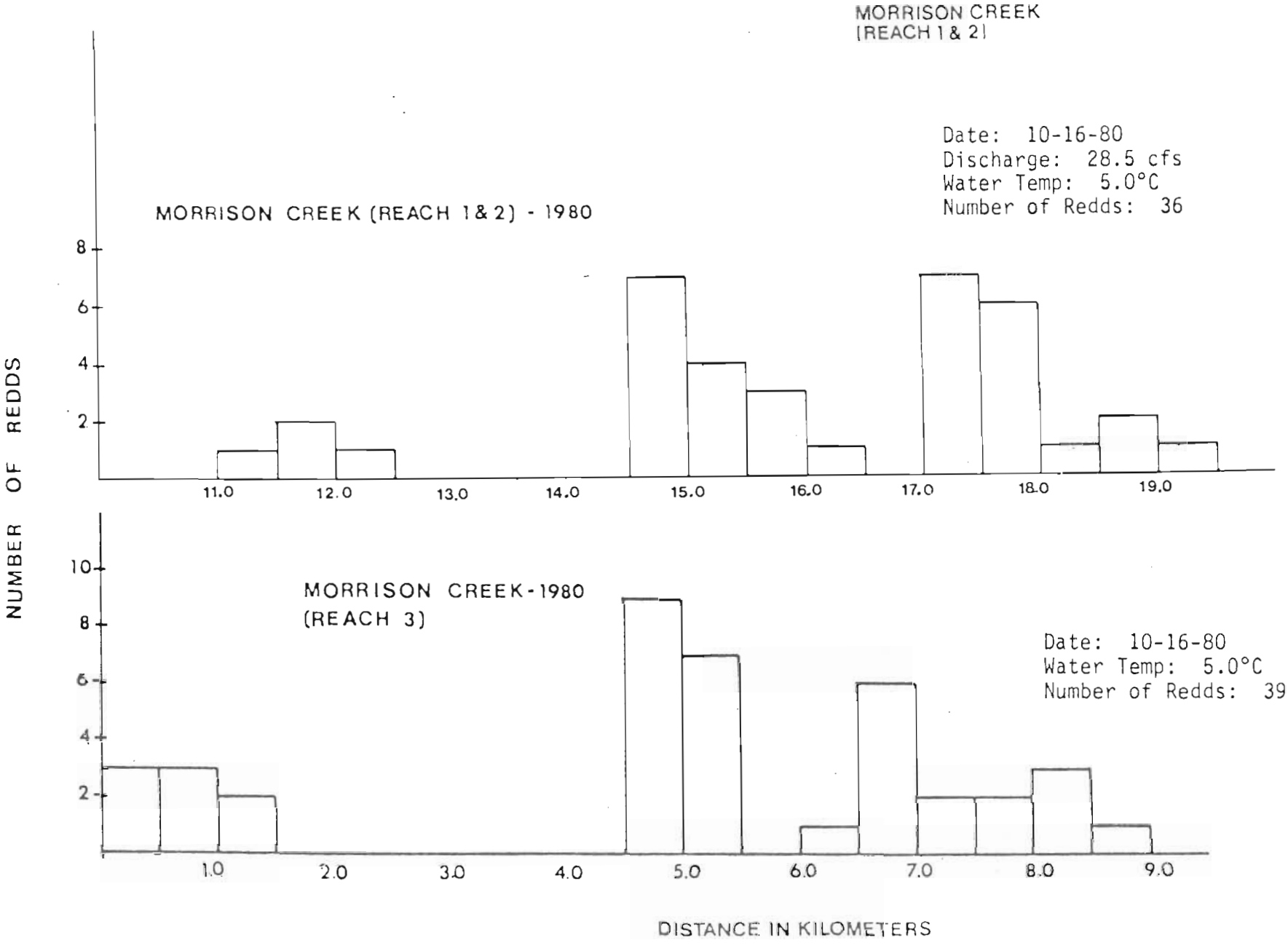


Figure 15. Bull trout redd distribution for Morrison Creek Reaches 1, 2 and 3, surveyed in 1980. Survey began at Puzzle Creek (kilometer 2.0 on figure) and ended at lower trail crossing (kilometer 18.8 on figure).

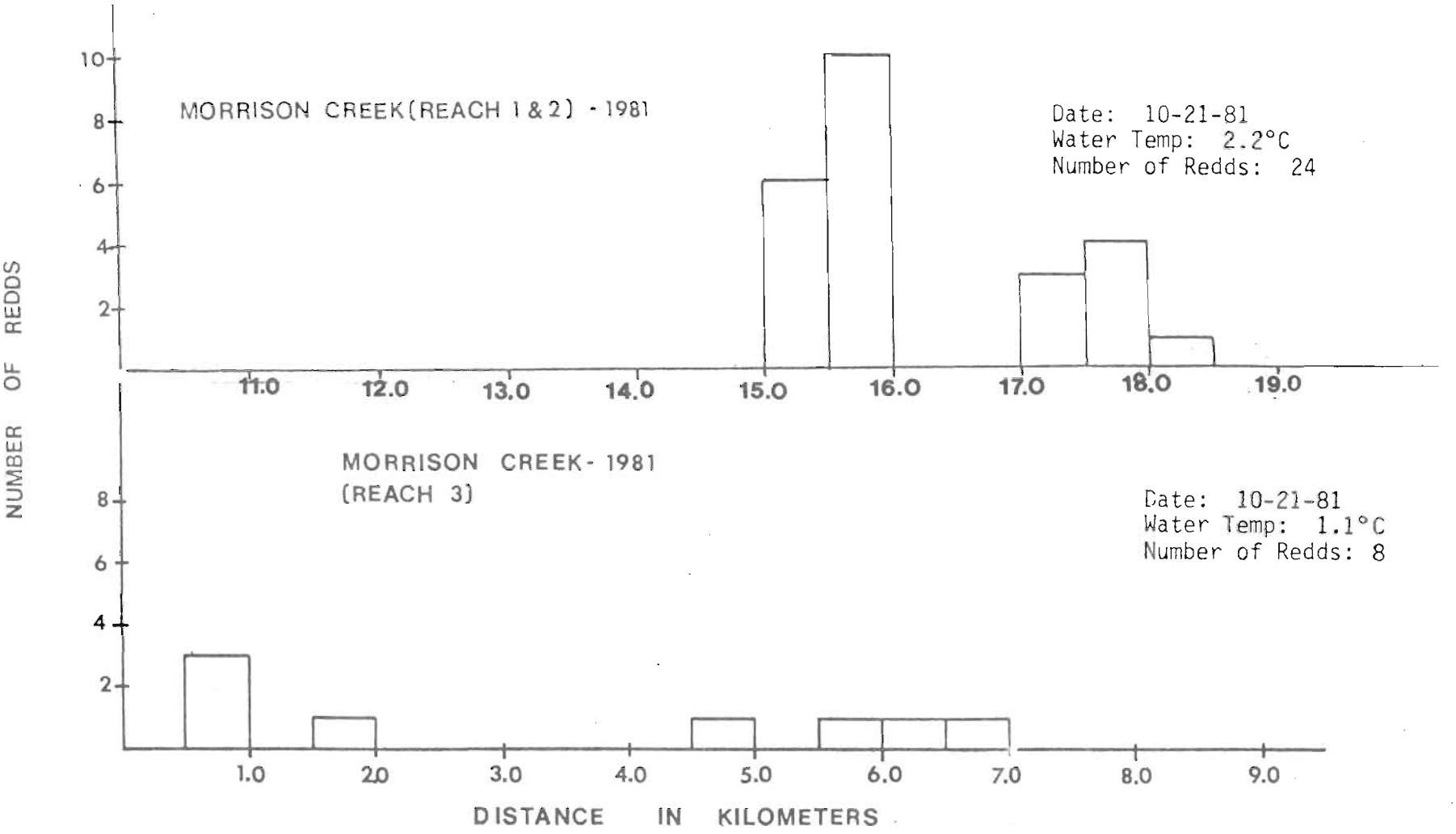


Figure 16. Bull trout redd distributions for Morrison Creek reaches 1, 2 and 3 surveyed in 1981. Survey began at Puzzle Creek (kilometer 2.0 on figure) and ended at lower trail crossing (kilometer 18.8 on figure).

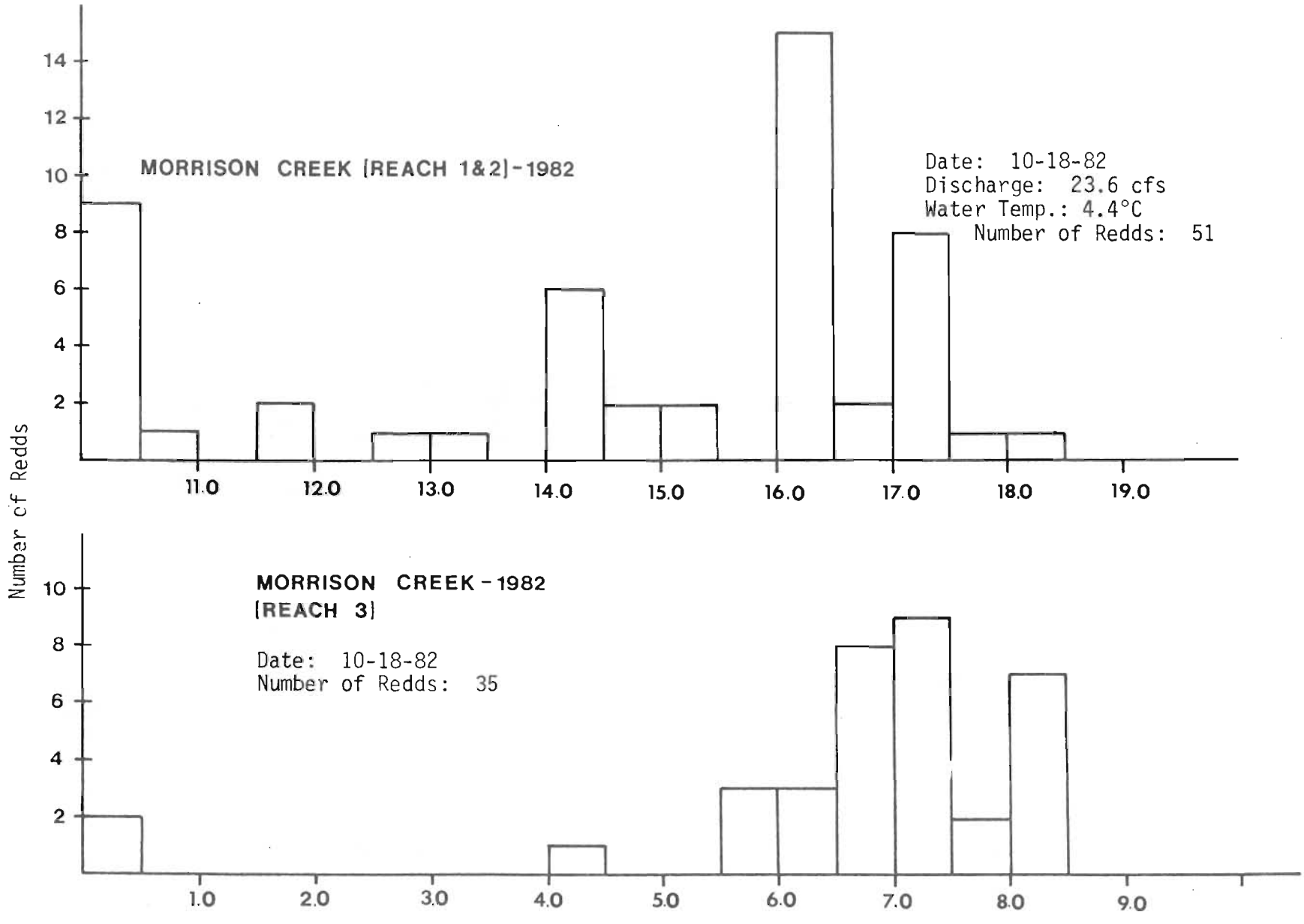


Figure 17. Bull trout redd distribution for Morrison Creek Reaches 1, 2 and 3 surveyed in 1981. Survey began at Puzzle Creek (kilometer 0.0 on figure) and ended at lower trail crossing (kilometer 18.8 on figure).

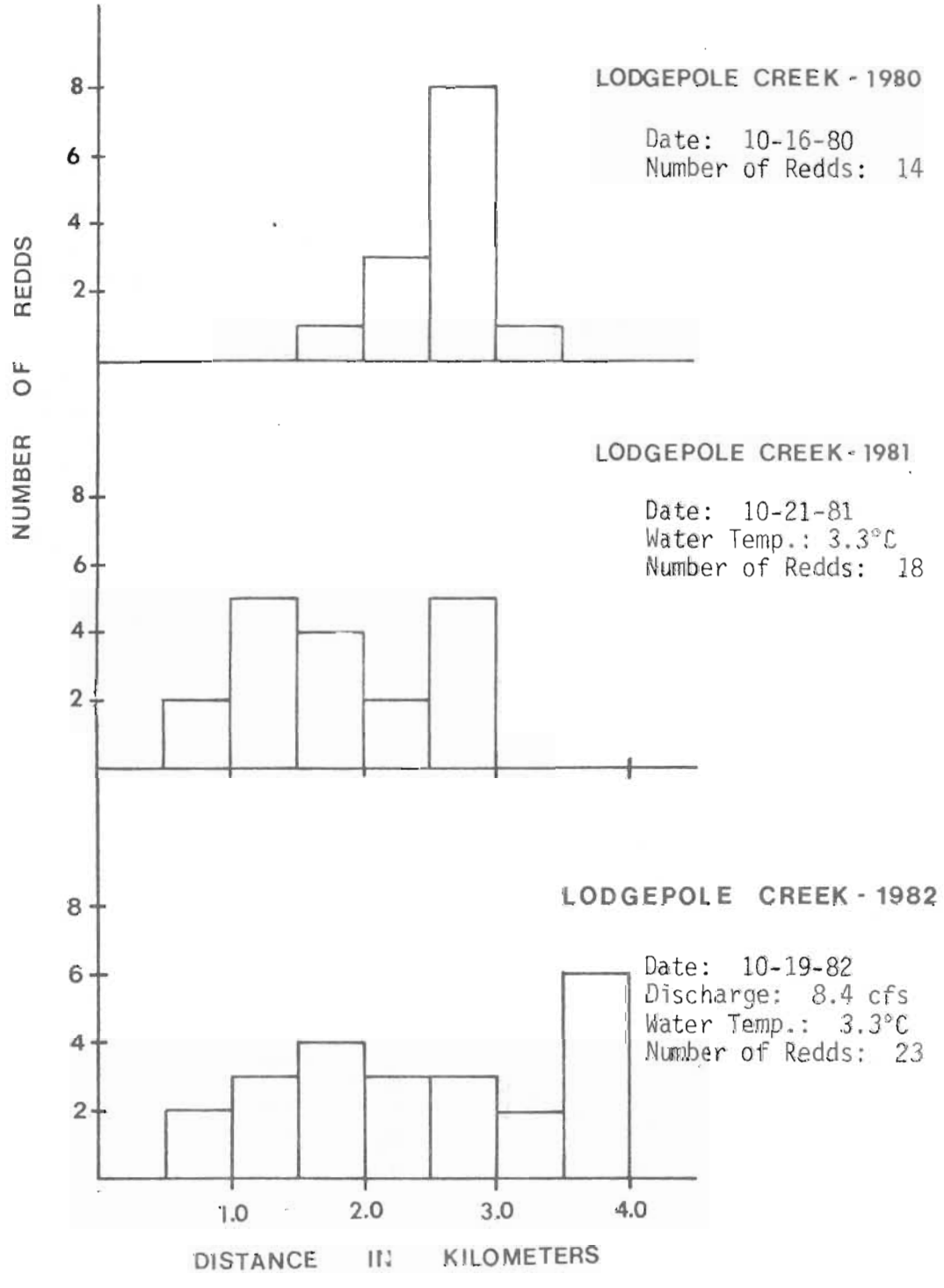


Figure 18. Bull trout redd distributions in Lodgepole Creek surveyed in 1980, 1981 and 1982. Survey began at mouth of Whistler Creek (kilometer 0.0 on figure) and ended at junction of Morrison Creek (kilometer 3.6 on figure).

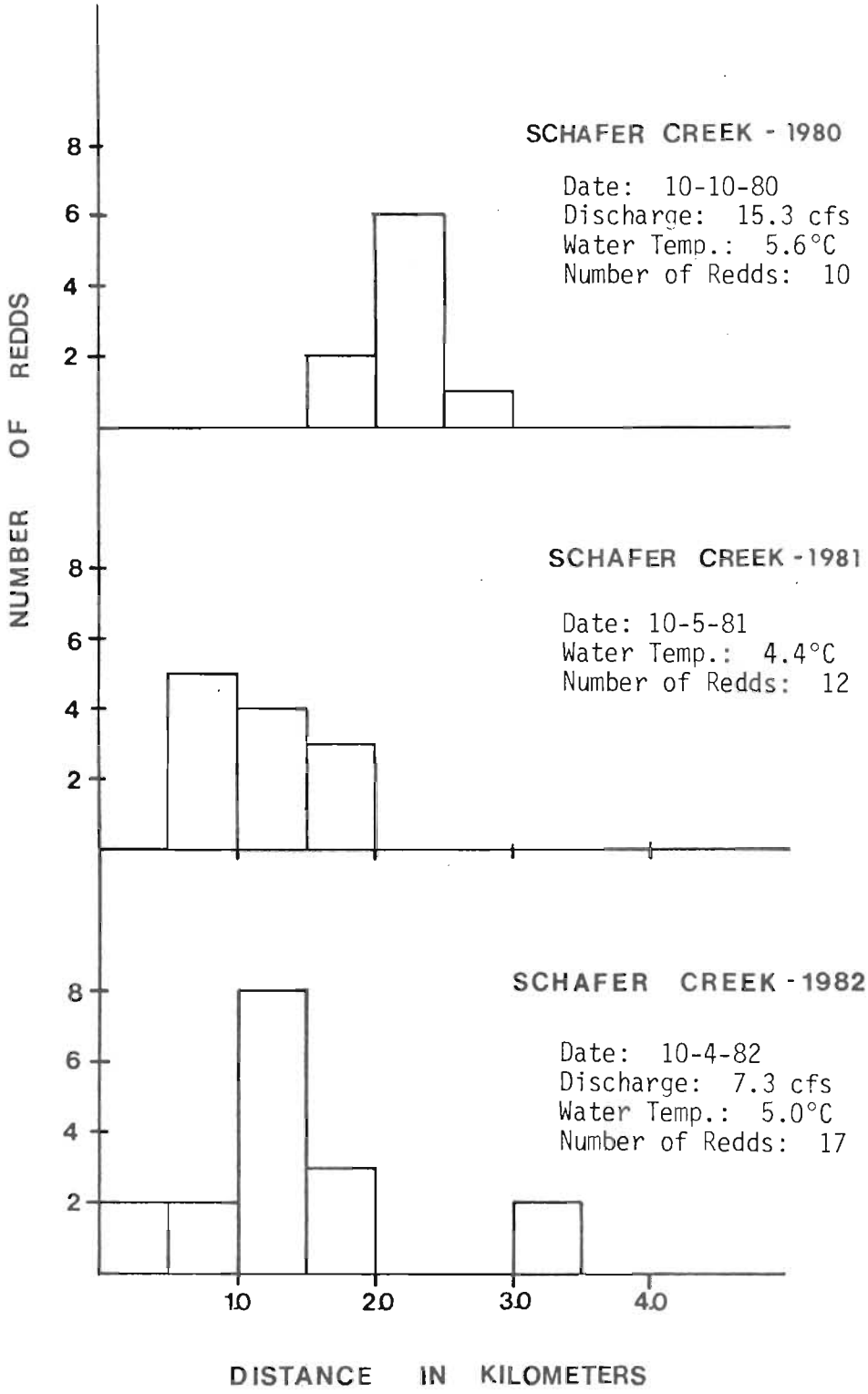


Figure 19. Bull trout redd distributions in Schafer Creek during 1980, 1981 and 1982. Surveys began at lower end of dry section (kilometer 0.0 on figure) and ended at the junction with Dolly Varden Creek (kilometer 4.2 on figure).

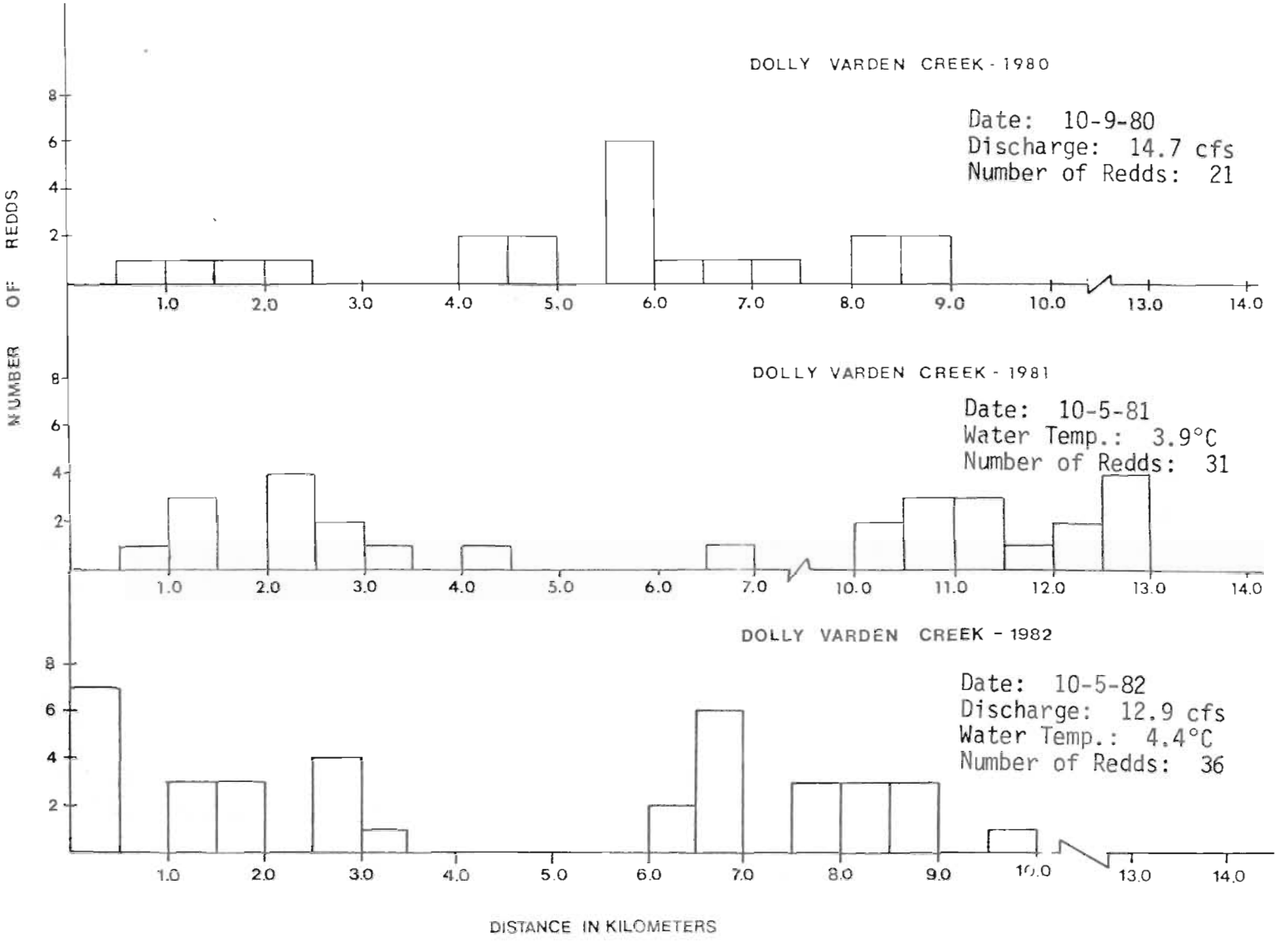


Figure 20. Bull trout redd distributions in Dolly Varden Creek during 1980, 1981 and 1982. Surveys began at the falls (kilometer 0.0 on figure) and ended at the junction with Schafer Creek (kilometer 14.2 on figure).

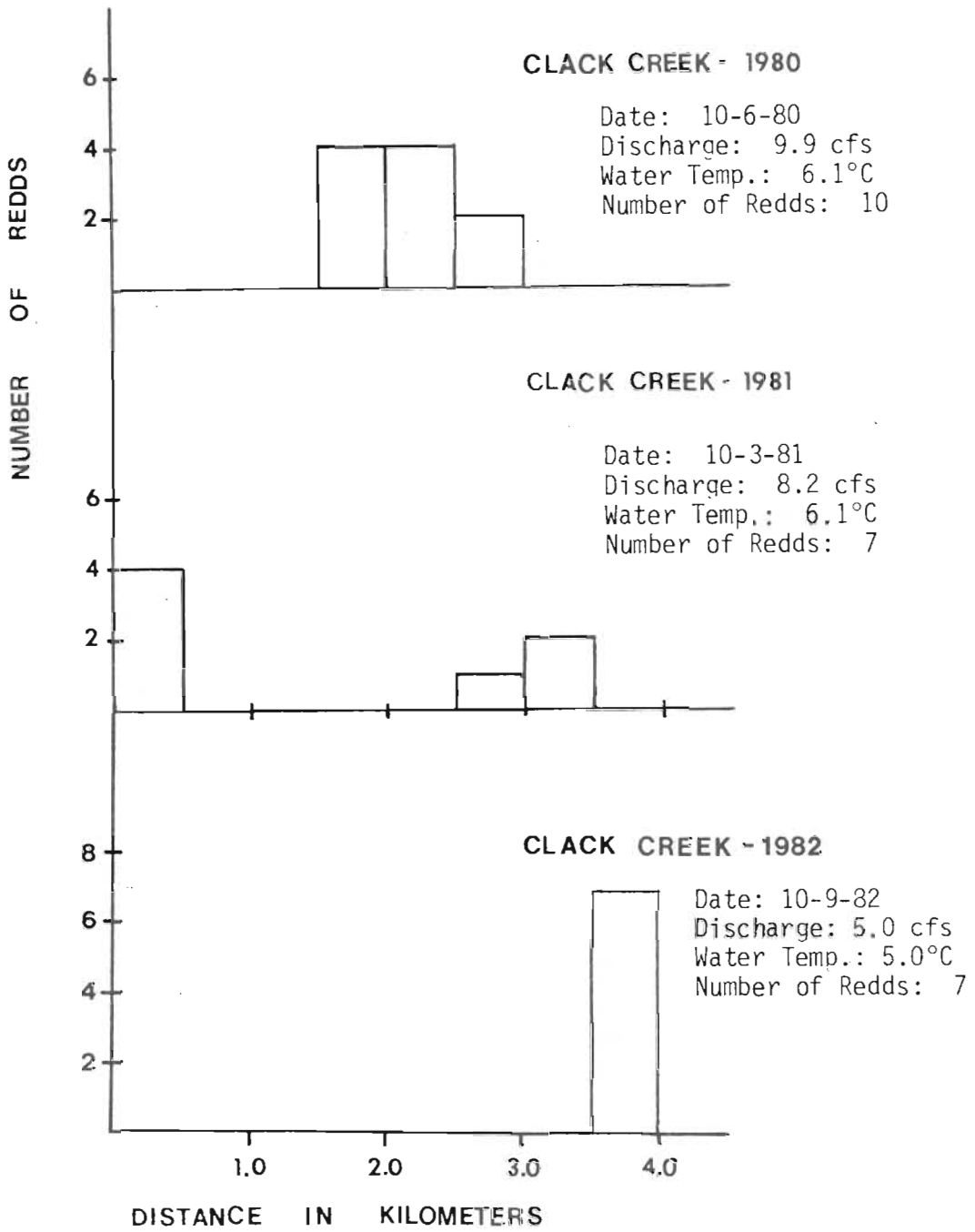


Figure 21. Bull trout redd distributions in Clack Creek surveyed in 1980, 1981 and 1982. Survey began at lower end of beaver dam section (kilometer 0.0 on figure) and ended at the junction with the Middle Fork (kilometer 4.1 on figure).

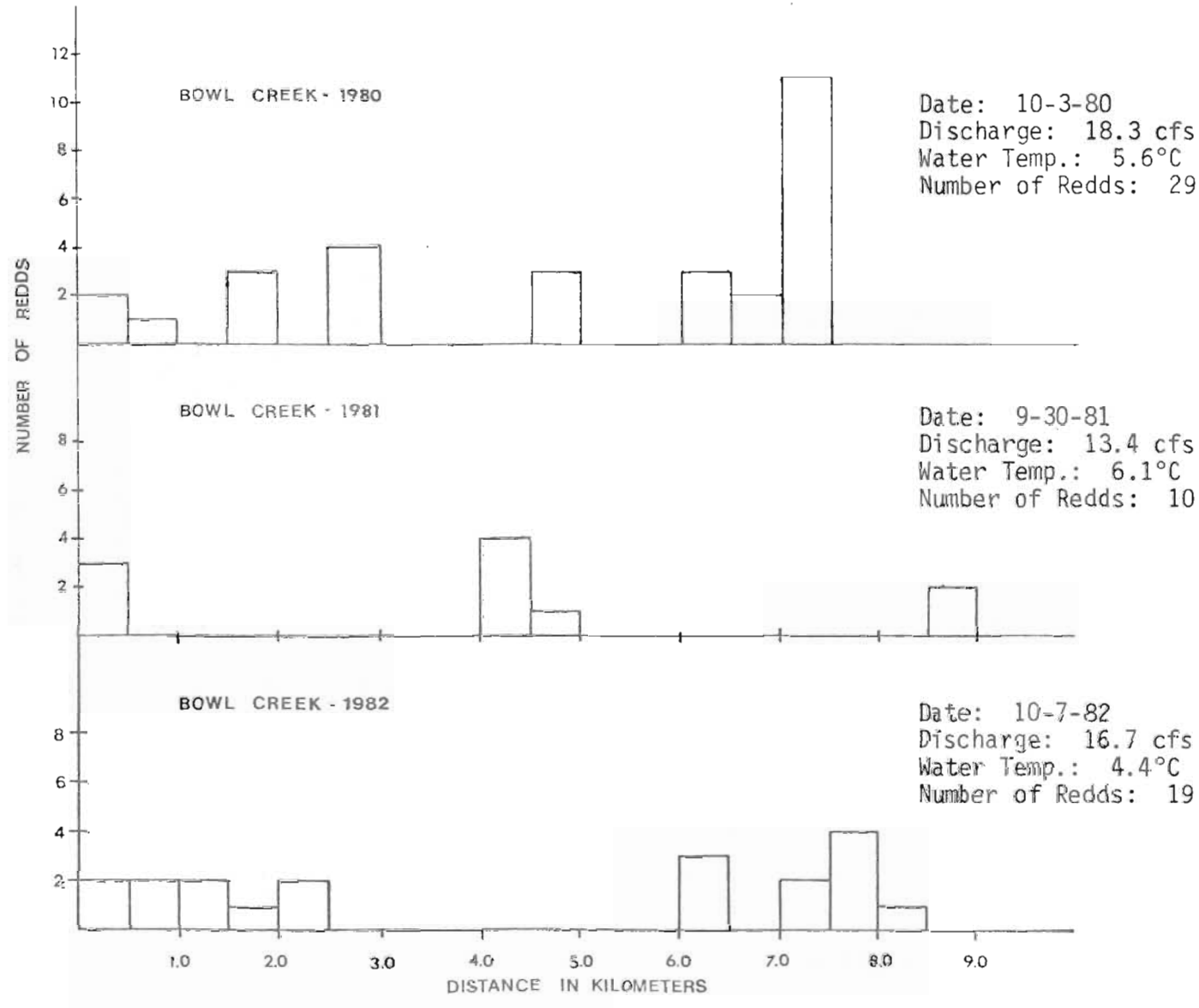


Figure 22. Bull trout redd distributions in Bowl Creek during 1980, 1981 and 1982. Surveys began above the mouth of Basin Creek (kilometer 0.0 on figure) and ended at the junction with Strawberry Creek (kilometer 9.1 on figure).

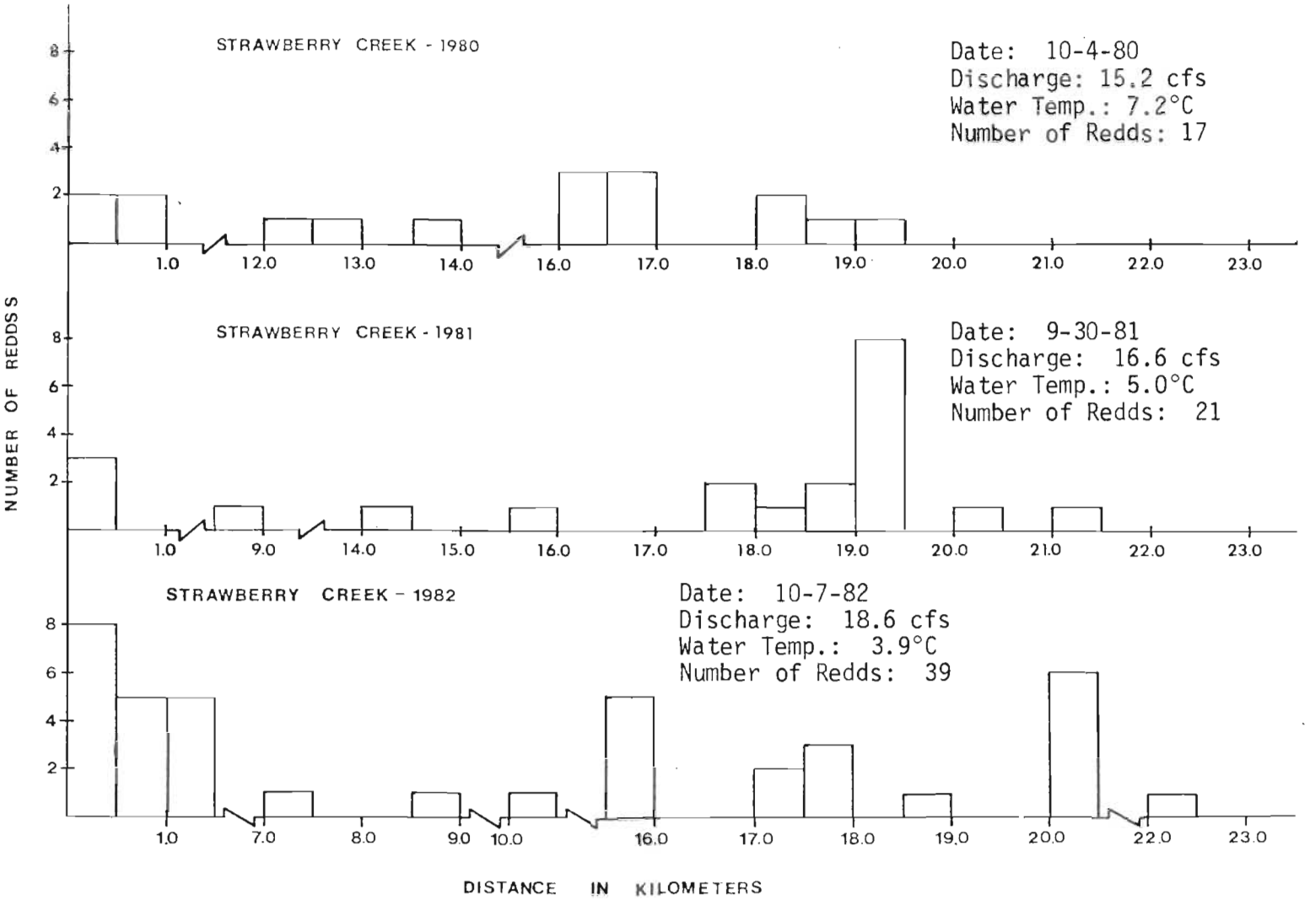


Figure 23. Bull trout redd distributions in Strawberry Creek surveyed in 1980, 1981 and 1982. Survey began at the upper forks (kilometer 0.0 on figure) and ended at the junction with Bowl Creek (kilometer 22.5 on figure).

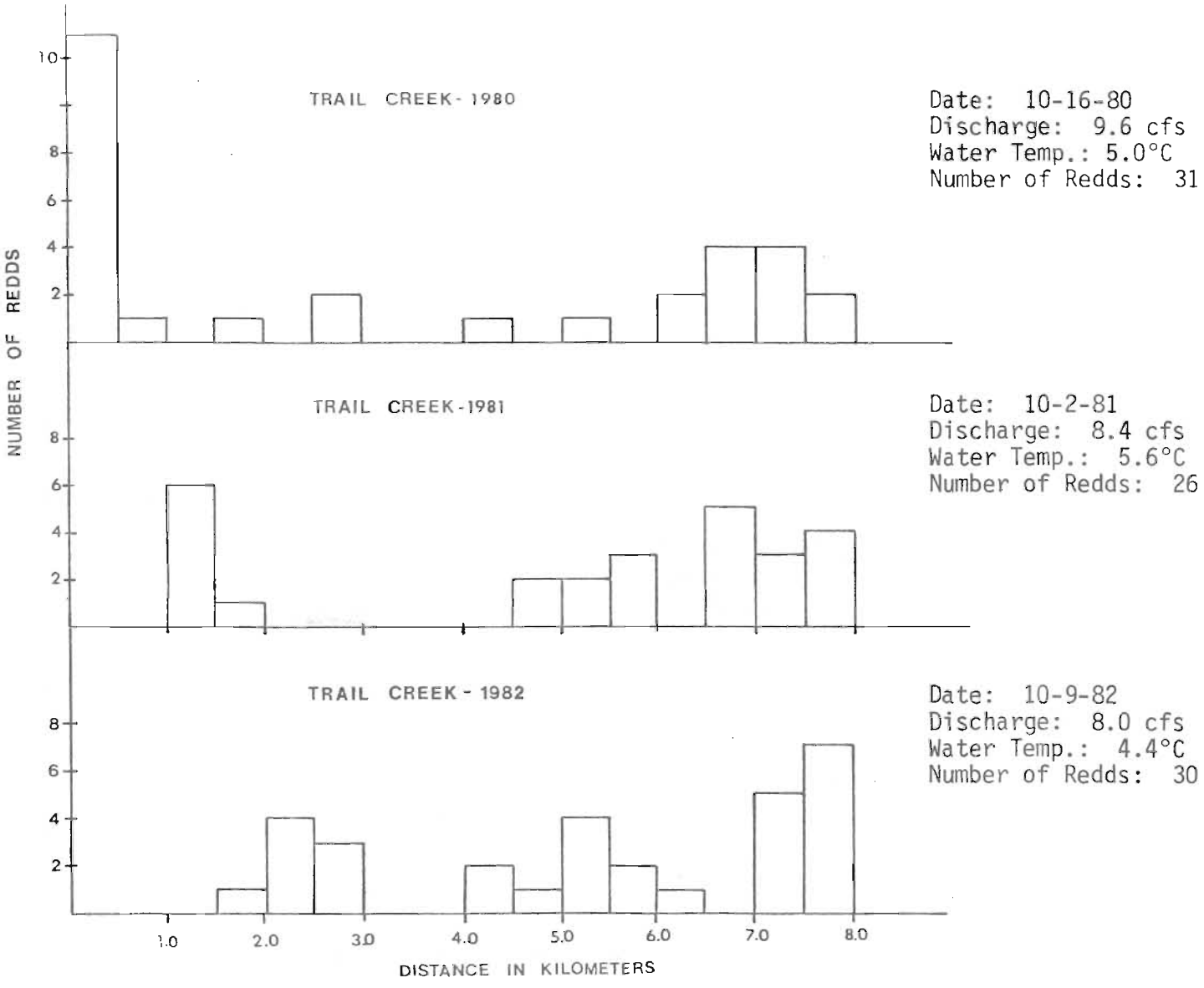


Figure 24. Bull trout redd distributions in Trail Creek during 1980, 1981 and 1982. Surveys began at Jeff Creek (kilometer 0.0 on figure) and ended at the junction of Strawberry Creek (kilometer 7.8 on figure).

APPENDIX D

Streambed composition (expressed as percent by dry weight over each size class) by sample of bull trout spawning areas in Big, Coal, Whale, Trail, Cabin and Howell creeks in the North Fork drainage of the Flathead River and Granite Creek in the Middle Fork drainage.

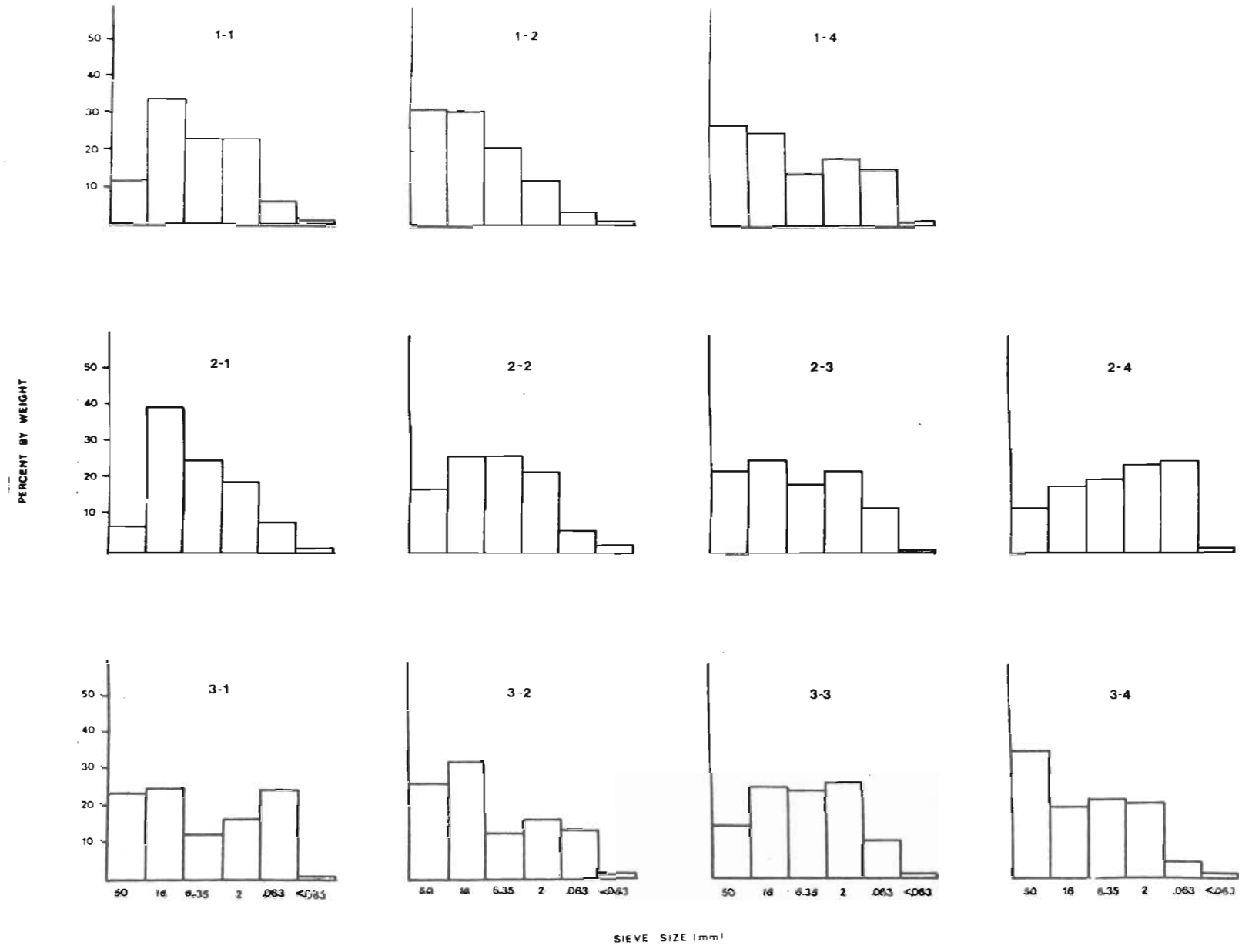


Figure 1. Substrate compositions by dry weight from transects #1, #2 and #3 in Whale Creek sampled during October, 1982.

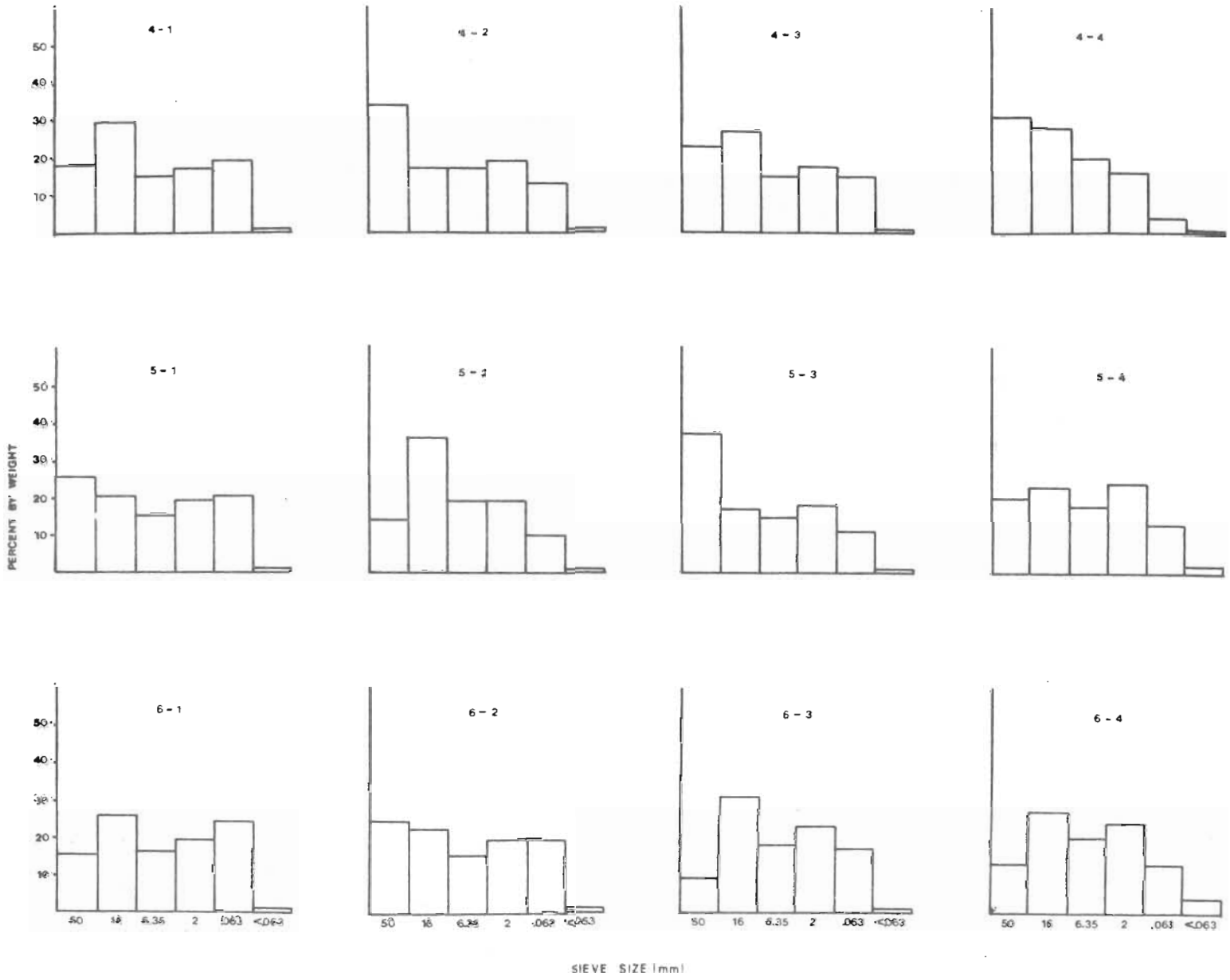


Figure 2. Substrate compositions by dry weight from transects #4, #5 and #6 in Coal Creek sampled during October, 1982.

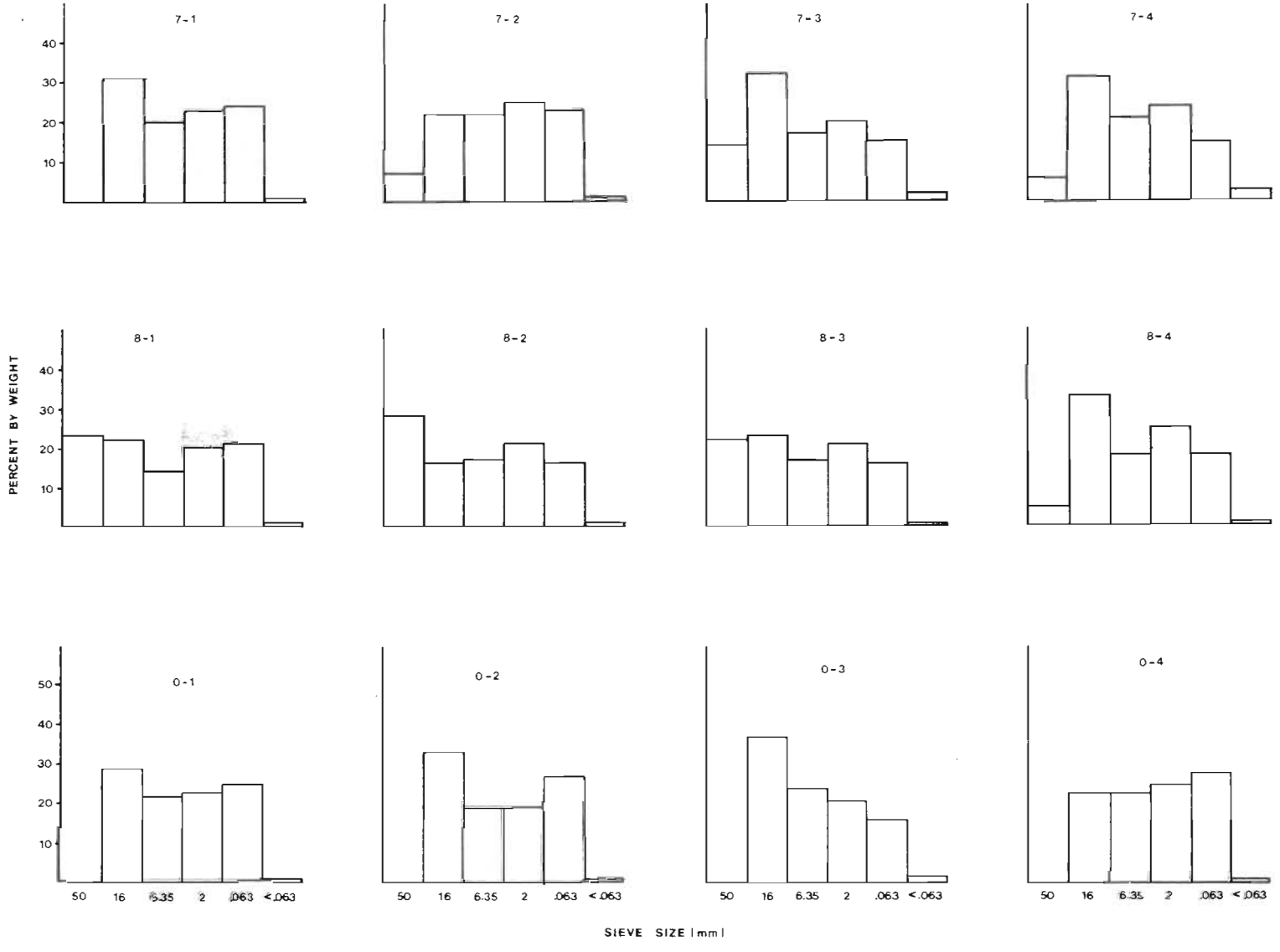


Figure 3. Substrate compositions by dry weight from transects #7, #8 and #0 in Coal Creek sampled during October, 1982.

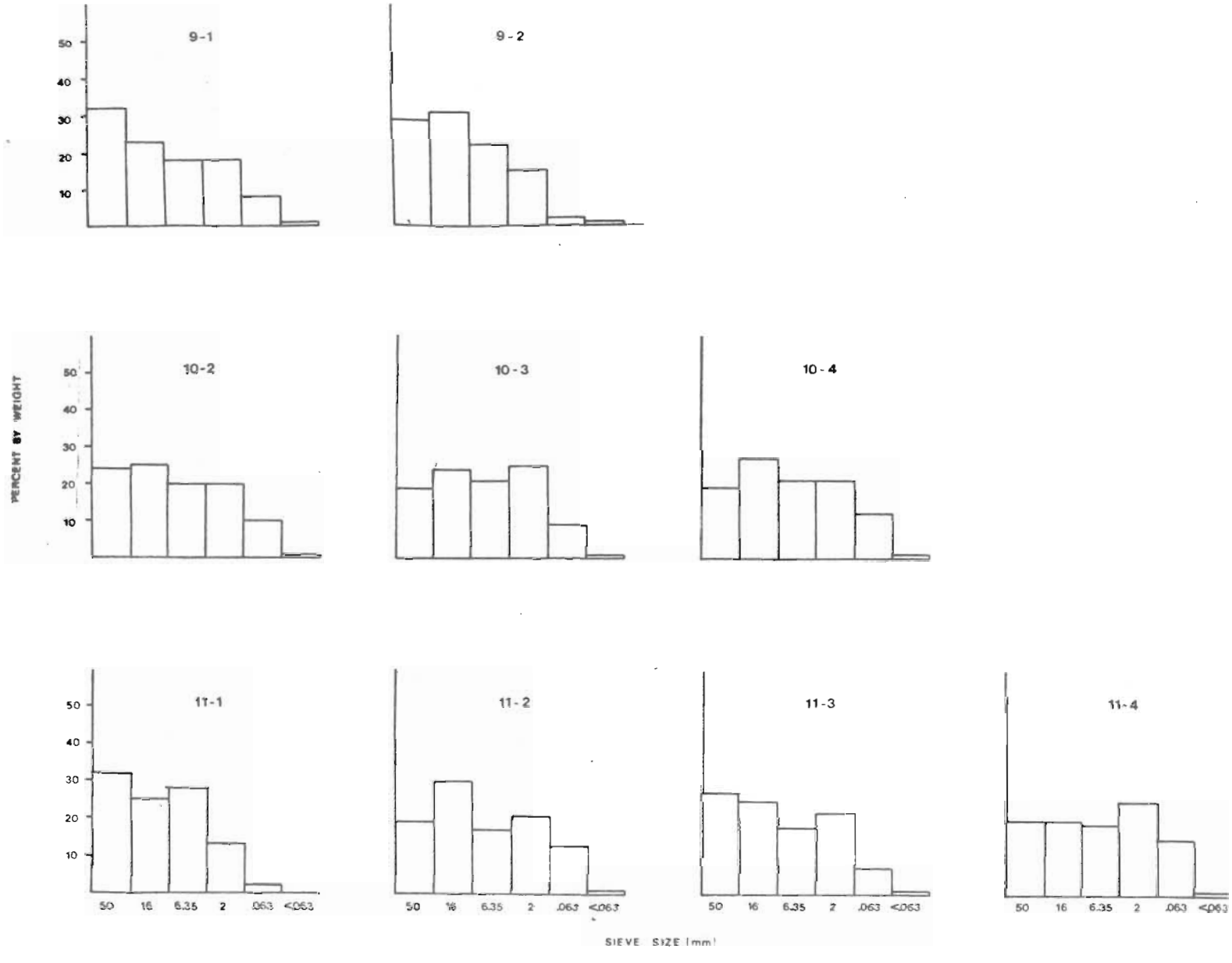


Figure 4. Substrate compositions by dry weights from transects #9, #10 and #11 in Big Creek sampled during October, 1982.

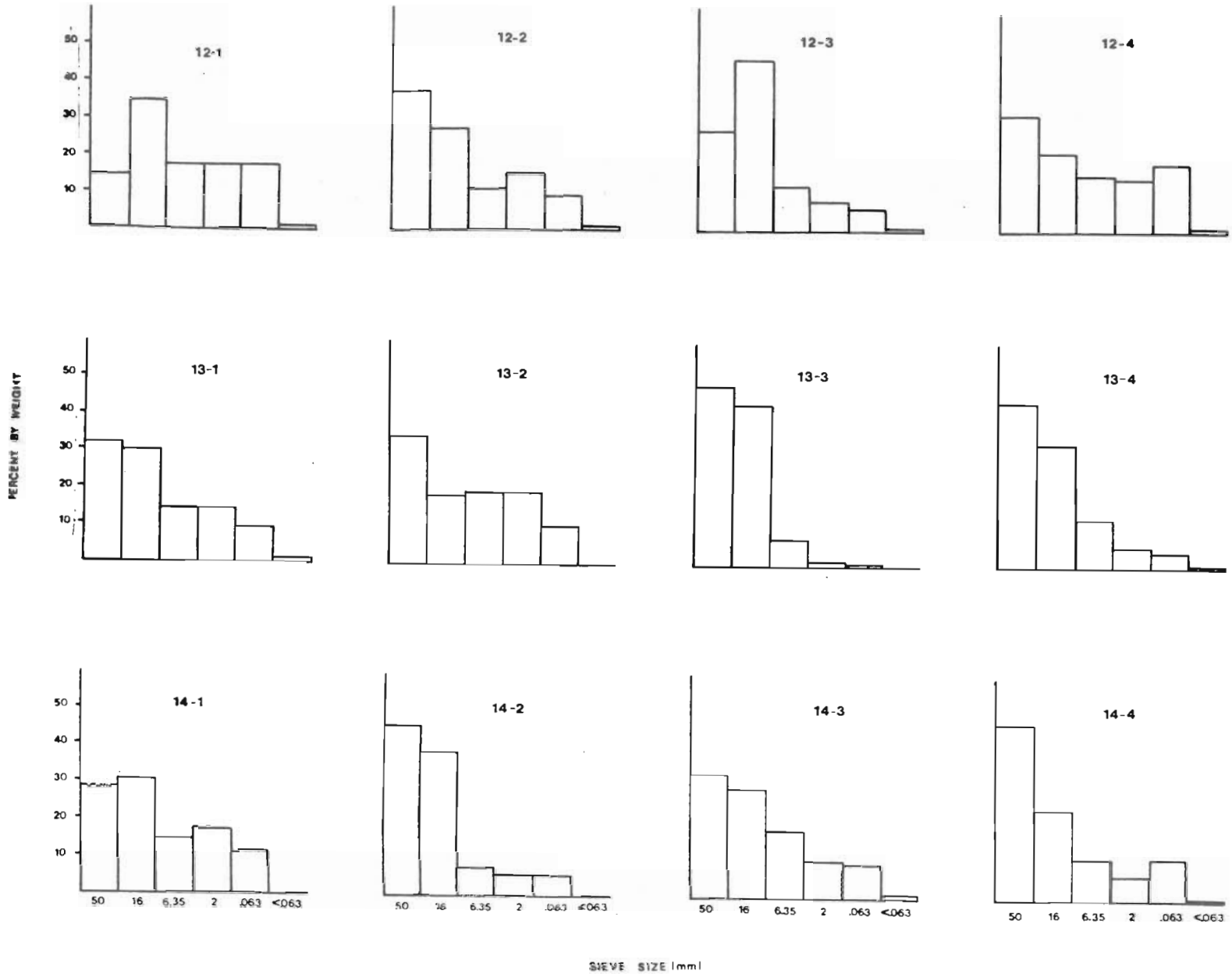


Figure 5. Substrate compositions by dry weight from transects #12, #13 and #14 in Trail Creek sampled during October, 1982.

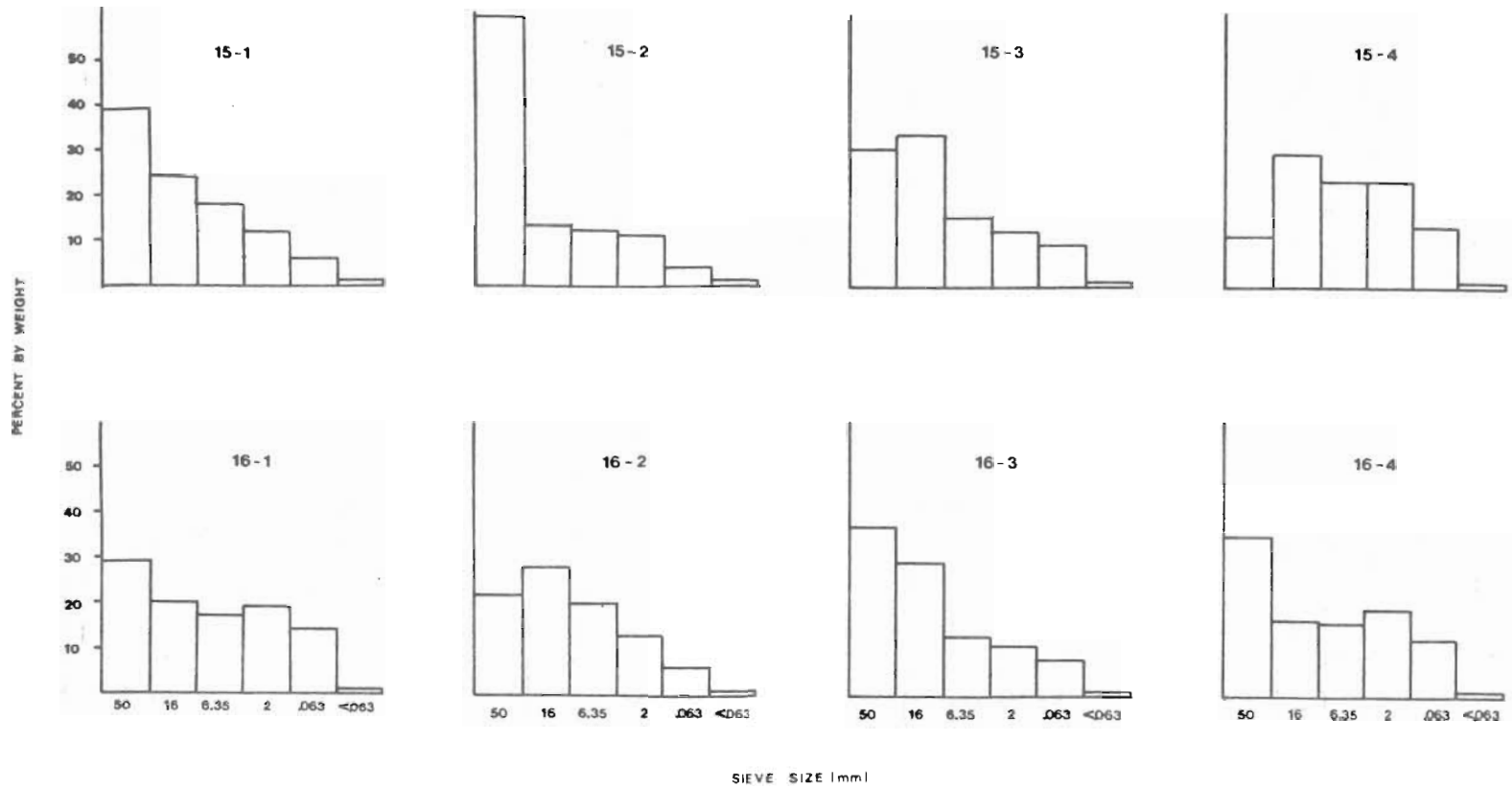


Figure 6. Substrate compositions by dry weight from transects #15 and #16 in Trail Creek sampled during October, 1982.

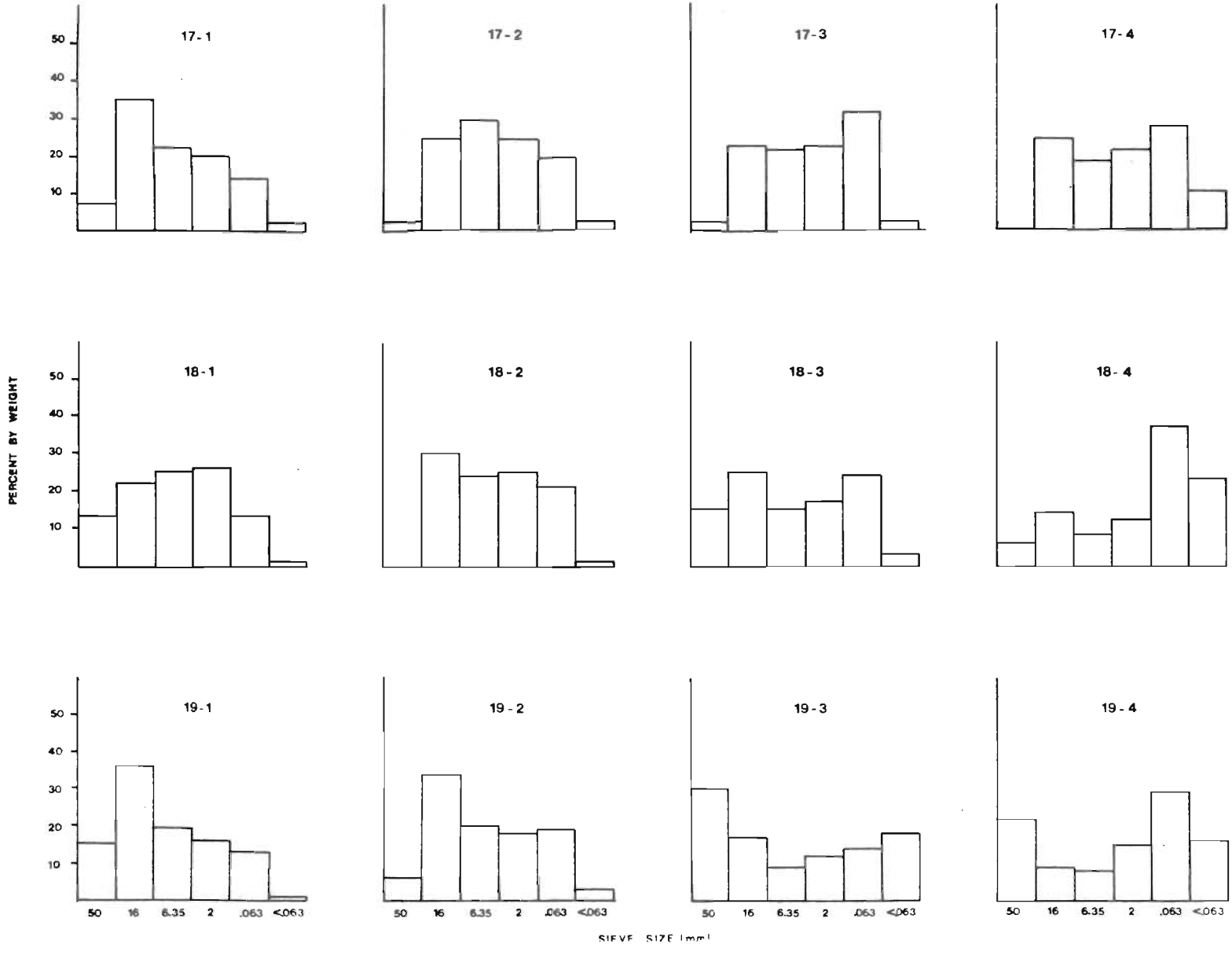


Figure 7. Substrate compositions by dry weight from transects #17, #18 and #19 in Granite Creek sampled during November, 1982.

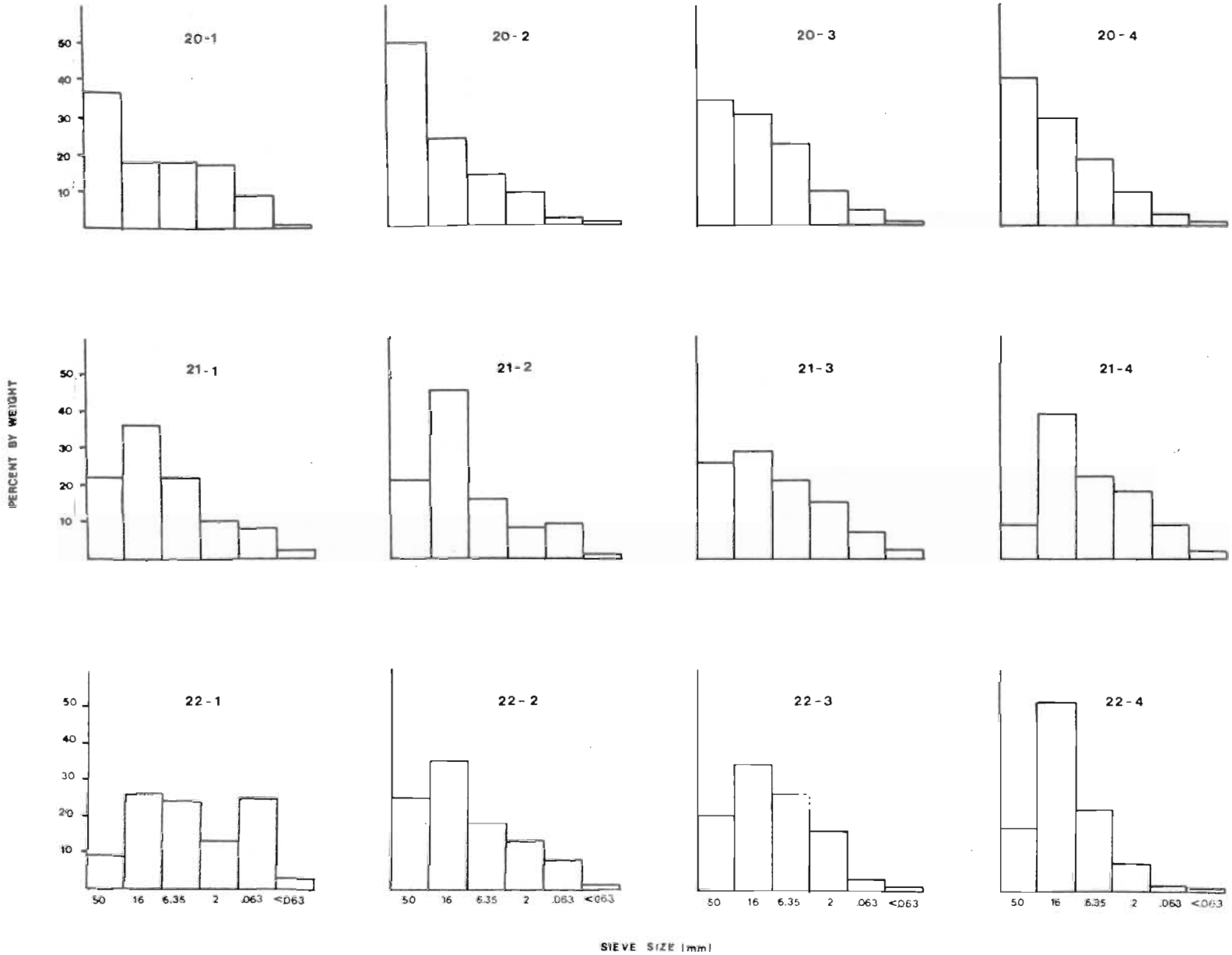


Figure 8. Substrate compositions by dry weight from transects #20, #21 and #22 in Howell Creek sampled during October, 1982.

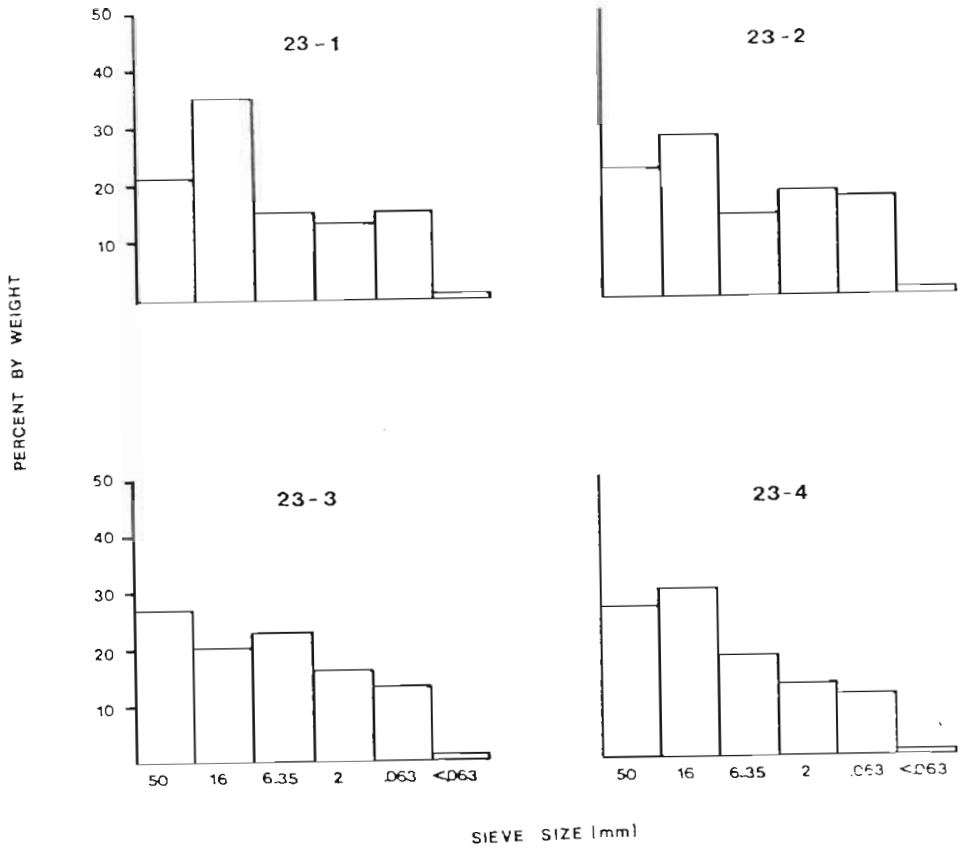


Figure 9. Substrate compositions by dry weight from transect #23 in Cabin Creek sampled during October, 1982.

STATE CODE NUMBERS BY CREEK

North Fork	Code	Middle Fork	Code
Big	08-0680	Nyack	08-5130
Whale	08-7700	Ole	08-5150
Coal	08-1620	Bear	08-0540
Moran	08-4920	Granite	08-3080
Hay	08-3340	Morrison	08-4940
Red Meadow	08-5760	Lodgepole	08-4240
Teepee	08-7200	Schafer	08-6160
Moose	08-4900	Dolly Varden	08-2280
Trail	08-7330	Clack	08-1080
Hallowatt	08-3240	Bowl	08-0820
S.F. Coal	08-6620	Strawberry	08-7020
Mathias	08-4580	Trail	08-7320
Shorty	08-6320	M.F. River	08-4740
Langford	08-4000	Challenge	08-1420
Cyclone	08-1840		
Akokala	08-0110		