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FISH COMMUNITY ASSESSMENT ON CABINET GORGE AND NOXON RAPIDS RESERVOIRS

MAY 1995

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FISH COMMUNITY ASSESSMENT ON CABINET GORGE AND NOXON RAPIDS RESERVOIRS

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Section 1
Summary

During 1993 and 1994, Washington Water Power Company (WWP) evaluated fish communities on Cabinet Gorge and Noxon Rapids Reservoir. This report presents the study methods and results of the 1994 evaluations, with a brief comparison to the 1993 efforts (ND&T 1994).

During 1994, over 54,300 fish representing 22 species were sampled in Cabinet Gorge and Noxon Rapids Reservoirs through gill netting, electrofishing, and beach seining. Relative abundances indicate the most abundant fish in Cabinet Gorge Reservoir were redside shiner *Richarsonius balteatus*, northern squawfish *Ptychocheilus oregonensis*, and yellow perch *Perca flavescens*. The most abundant fish sampled in Noxon Rapids Reservoir were pumpkinseed *Lepomis gibbosus*, yellow perch, and northern squawfish.

Cyprinids dominated (57 percent) the fish community in Cabinet Gorge Reservoir whereas centrarchids dominated (52 percent) the fish community in Noxon Rapids Reservoir. Dominance of these families was consistent with the morphology and habitat characteristics of each reservoir. Noxon Rapids Reservoir is wider, with lower velocities, higher temperatures, and extensive littoral areas; Cabinet Gorge Reservoir is narrow, with higher velocities and relatively few low-velocity littoral areas.

Fish habitat use was evaluated through chi-square analysis, comparison of relative abundances, principal component plots, and correlations with habitat variables. The most abundant fish sampled in Cabinet Gorge Reservoir (redside shiner and northern squawfish) showed preferences for larger substrates and low concentrations of vegetation. The most abundant fish sampled in Noxon Rapids Reservoir (pumpkinseed and yellow perch) preferred low velocities, high concentrations of vegetation, and small substrate sizes. Salmonids in both reservoirs were found to favor habitats with cold water inflows or more riverine conditions. Largemouth bass *Micropterus salmoides* tended to select for low velocities, dense vegetation, and

small substrates whereas smallmouth bass *M. dolomieui* selected for larger substrate sizes and limited vegetation regardless of velocity.

Cabinet Gorge and Noxon Rapids Reservoirs have fish communities typical of similar lakes and reservoirs in the Pacific Northwest. Subtle differences in the fish communities between the two reservoirs are related to variations in basic habitat characteristics and habitat availability. Available habitats in both reservoirs are best suited to cool- or warm-water, habitat generalist fish species. Relative abundance of salmonids is low, which is consistent with waters that have temperatures exceeding 19 to 20°C. In addition, Noxon Rapids Reservoir has developed an above-average bass fishery that continues to improve and is even now considered one of the best in Montana.

Section 2
Introduction

The Washington Water Power Company (WWP) owns and operates the Cabinet Gorge and Noxon Rapids Hydroelectric Developments (HED) on the lower Clark Fork River in northwest Montana and Idaho. Both projects are licensed by the Federal Energy Regulatory Commission (FERC). As part of seeking a renewal of the FERC licenses for these developments, WWP will be conducting a variety of resource surveys useful for understanding the project environment.

One area of interest is the characterization of the fish communities in both reservoirs. This includes determining what fish species exist in the reservoirs, and general information on relative abundance and overall status. A variety of fish surveys have been conducted on both reservoirs since their construction, providing data on species and population trends. These surveys show that the fish community has changed over the last 30 to 40 years (Huston 1985), and has been variably affected by fish stocking and other State of Montana management efforts.

The Cabinet Gorge and Noxon Rapids HEDs were constructed during 1952 and 1958, respectively. Following completion of the Noxon Rapids project, Montana Department of Fish Wildlife and Parks (MDFWP) rotenoned both reservoirs as well as Thompson Falls Reservoir (Montana Power Company project located immediately upstream) to remove the existing fish populations (Huston 1985). Repeated attempts were then made to establish a cold water fishery in these reservoirs. Substantial numbers of rainbow trout *Oncorhynchus mykis*, cutthroat trout *O. clarki*, kokanee *O. nerka*, coho *O. kisutch*, brown trout *Salmo trutta*, and burbot *Lota lota* were introduced in the '50s, '60s, and '70s but none have provided a strong fishery (Huston 1985). Smallmouth bass *Micropterus dolomieui* were introduced in 1982 and have been expanding in numbers and distribution ever since. Largemouth bass *M. salmoides,* which were present in the system before construction of the reservoirs, have also been stocked and have increased in numbers in the last 15 years (Huston, MDFWP, personal communication). Recently, walleye *Stizostedion vitreum,* northern pike *Esox lucius,* and lake trout *Salvelinus namaycush* have been found in Noxon Rapids Reservoir, although their numbers and status are unknown.

Because of continual shifts in the fish community, it will be useful to have recently collected baseline data on the fish communities in Cabinet Gorge and Noxon Rapids Reservoirs. In 1993 WWP initiated intensive fish sampling efforts, and over 9,100 fish were sampled (ND&T 1994). The 1994 fish community assessment was a continuation of the 1993 efforts and included the following objectives:

- determine fish species occurrence;
- assess the relative abundance of fish species; and
- evaluate fish habitat association.

2.1 Study Area

2.1.1 Area Description

Noxon Rapids and Cabinet Gorge Reservoirs are located in western Montana and northern Idaho on the lower Clark Fork River (Figure 1). The Clark Fork River basin drains an area of approximately 56,320 square km (22,000 square miles) and flows for more than 544 km (340 miles) from its origin at the confluence of the Silver Bow and Warm Springs Creeks to its mouth on Lake Pend Oreille, Idaho.

The lower 100 km (62 miles) of the watershed, which encompass Noxon Rapids and Cabinet Gorge Reservoirs, are predominately forest lands managed by the U.S. Forest Service (USFS), Idaho Panhandle, and Lolo and Kootenai National Forests. The valley in which the reservoirs are situated is relatively narrow, ranging between 1.6 km (1 mile) and 5.8 km (3.6 miles) wide. Most of the forest on the south side of the river has been intensively managed, while the forest on the north is less actively managed, with a portion designated as the Cabinet Wilderness Area. Other uses in the watershed include light industry, agriculture, mining, and recreation.

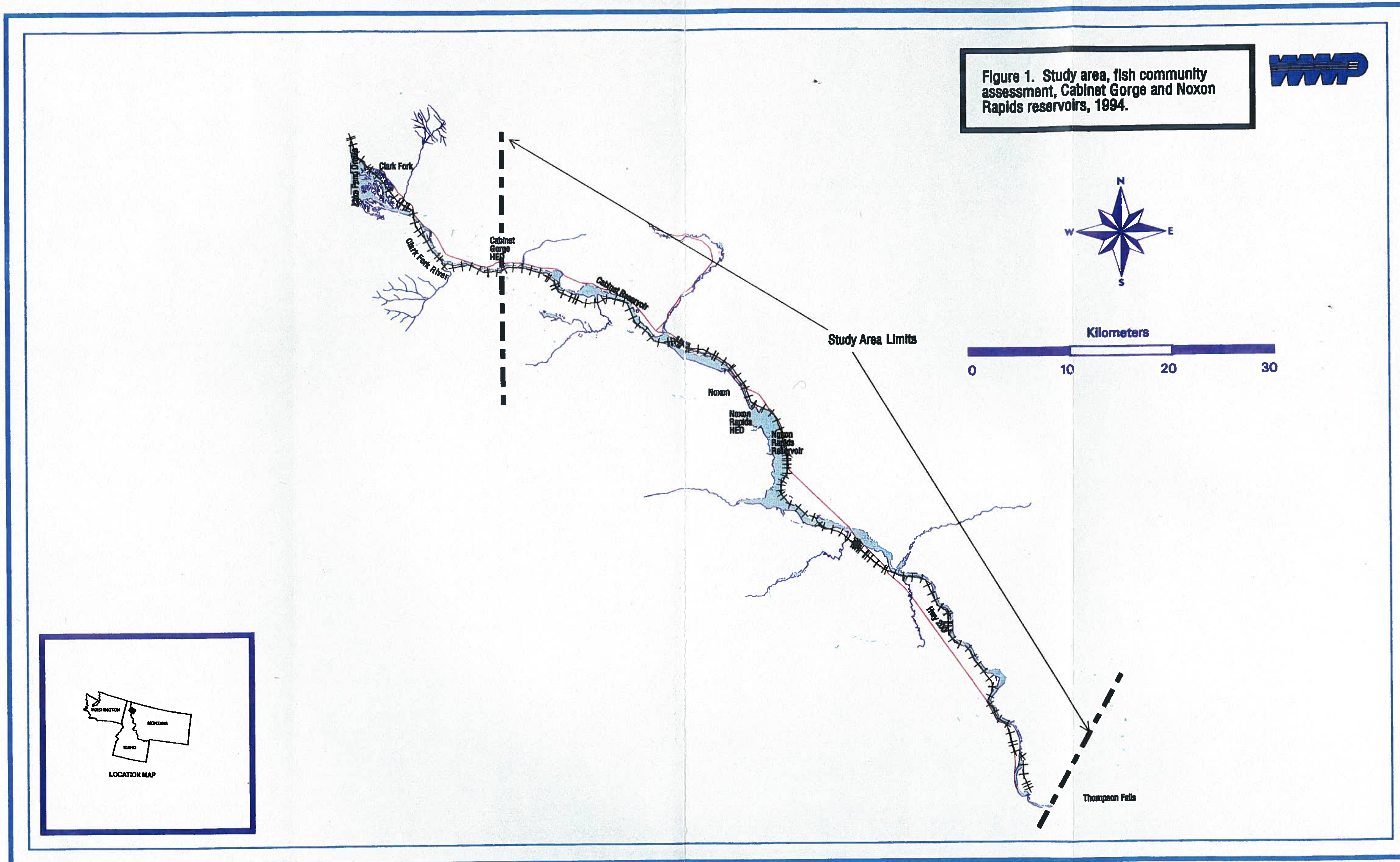


Figure 1. Study area, fish community assessment, Cabinet Gorge and Noxon Rapids reservoirs, 1994.

There are no large population centers along the projects. Thompson Falls, Montana, population 1,319, is the largest town and is located at the upper end of the Noxon Rapids Reservoir. The smaller communities of Trout Creek along Noxon Rapids Reservoir and Noxon along Cabinet Gorge Reservoir number fewer than 500 residents. State highway 200 and a railroad follow the entire length of the projects. Publicly accessible local and USFS roads provide additional access along both sides of the reservoirs.

2.1.2 Noxon Rapids Reservoir

The Noxon Rapids HED (FERC license No. 2075) is a limited storage facility constructed in 1958 and is located at approximately river mile 170 (USGS map) on the Clark Fork River. The reservoir is approximately 57 km (35.5 mi) long extending upstream to near the town of Thompson Falls, Montana. At full pool of 711 m (2,331 ft) mean sea level (MSL), the dam creates a 3,215 hectare (7,940 surface acres) reservoir, and the maximum known depth of the reservoir is 61 m (200 ft).

The Noxon Rapids HED is operated with seasonal and daily storage use. Generally the reservoir is operated within 3.1 m (10 ft) of full pool between October 1 and May 15. The reservoir is refilled to within 0.3 m (1 foot) of full pool no later than May 15 and operated within 1.2 m (4 ft) of full pool through September 30. Under special circumstances, the reservoir may be drawn down a maximum of 11 m (36 ft) below full pool. The last maximum draw was in 1985.

2.1.3 Cabinet Gorge Reservoir

The Cabinet Gorge HED (FERC license No. 2058) is a limited storage facility constructed in 1952 and is located at approximately river mile 150 (USGS map) on the Clark Fork River. The reservoir is approximately 32.2 km (20 mi) long. At full pool elevation of 663 m (2,175 feet) MSL, the dam creates a 1,292 hectares (3,200 surface acre) reservoir, and the maximum known depth of the reservoir is 37 m (121 ft).

Cabinet Gorge HED is operated using daily storage. Reservoir fluctuations from 0.5 to 1.2 m (1.5 to 4.0 ft) are typical with a maximum possible drawdown of 4.6 m (15 ft). However, drawdowns approaching the 4.6 m level are infrequent and associated with special circumstances.

Section 3
Methods

3.1 Habitat Characterization

Cabinet Gorge and Noxon Rapids Reservoirs were divided into general habitat types (Table 1, Figures 2 and 3) based on reservoir morphology, water velocity, substrate size, slope, and depth characteristics collected during 1993 (ND&T 1994). General habitat types were divided into 0.5 km (0.32 miles) littoral sampling sites. These sites were randomly selected for fish sampling in proportion to the total length of the habitat type in each reservoir. Additional open-water sites were also selected for sampling of deep water habitats.

TABLE 1
GENERAL HABITAT TYPES - CABINET GORGE AND NOXON RAPIDS RESERVOIRS

LITTORAL HABITAT			
Habitat Name	**Expected Substrate Size (mm)**	**Slope**	**Location**
Silt	.01 - 75 mm	<.45	Throughout reservoirs
Cobble	> 75 mm	<.45	Throughout reservoirs
Trib-Bays	variable	<.45	Throughout reservoirs
Steep	variable	>.45	Throughout reservoirs
Lower Canyon*	variable	variable	Beaver Creek Bay to Finley Flats
Upper Canyon*	variable	variable	Finley Flat to Flat Iron Boat Ramp
Riverine**	variable	variable	Most upper portion of each reservoir
OPEN-WATER HABITAT			
Habitat Name	**Depth**	**Distance from Shore**	**Location**
Open Water (Cabinet)	> 20 m	> 200 m	Bull River Bay to the west end of Heron Bay
Open Water (Noxon	10-20 m	> 200 m	Mouth of Beaver Creek Bay to Noxon Rapids Dam
Deep Open Water*	> 20 m	> 200 m	Beaver Creek Bay to Noxon Dam

* Habitat types are found only on Noxon Rapids Reservoir.
** The highest velocities occurred here (> 6 cm/sec).

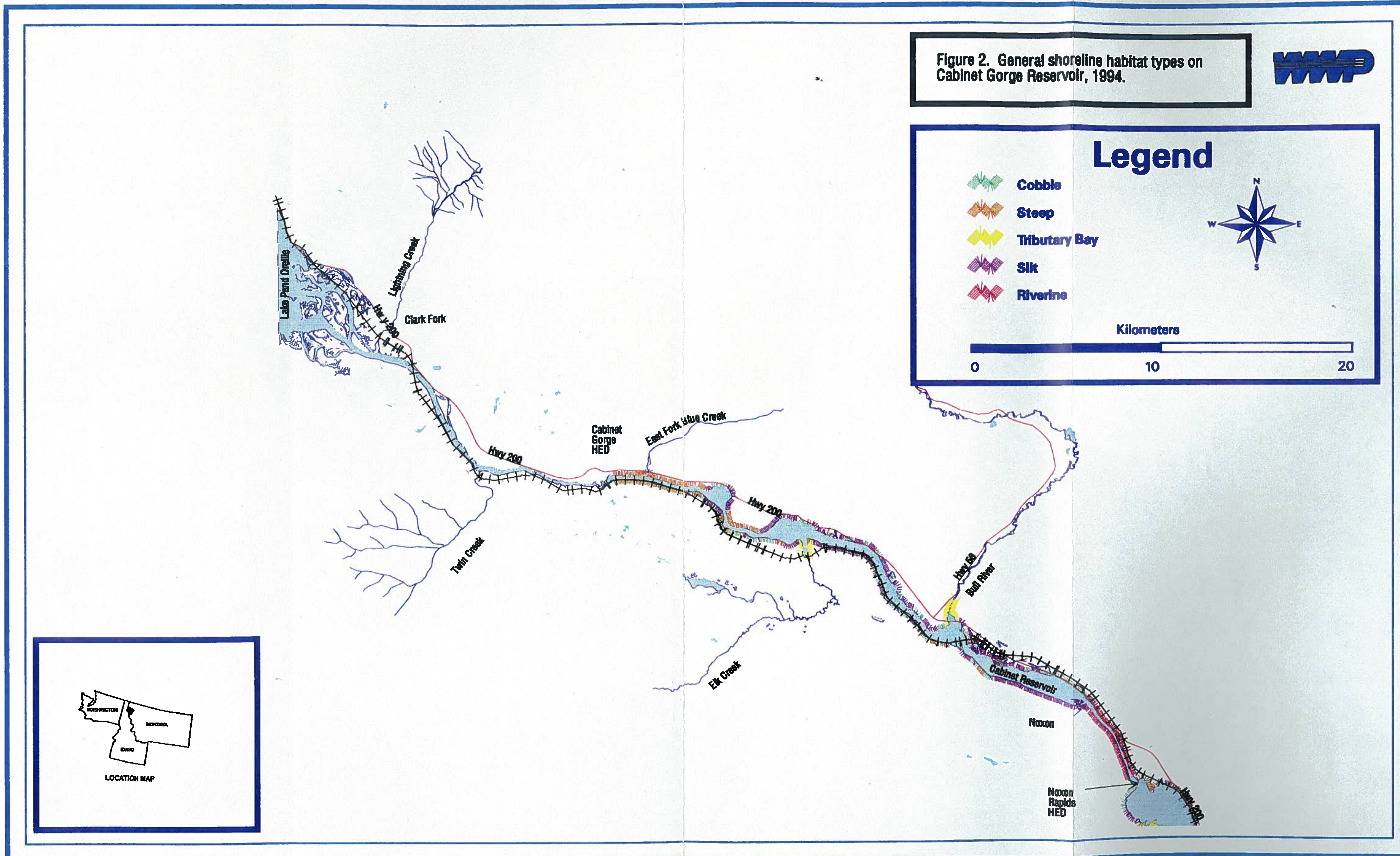


Figure 2. General shoreline habitat types on Cabinet Gorge Reservoir, 1994.

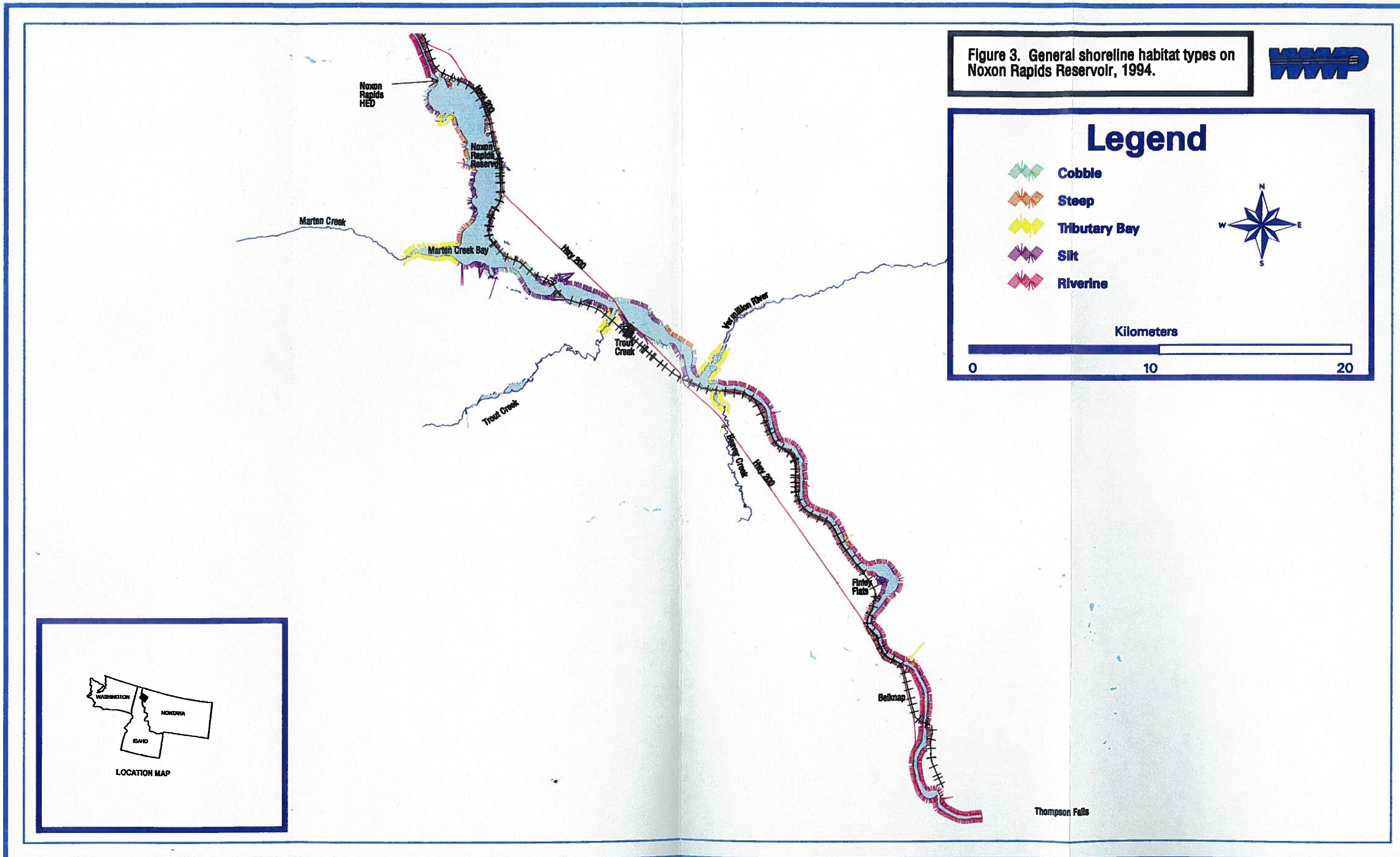


Figure 3. General shoreline habitat types on Noxon Rapids Reservoir, 1994.

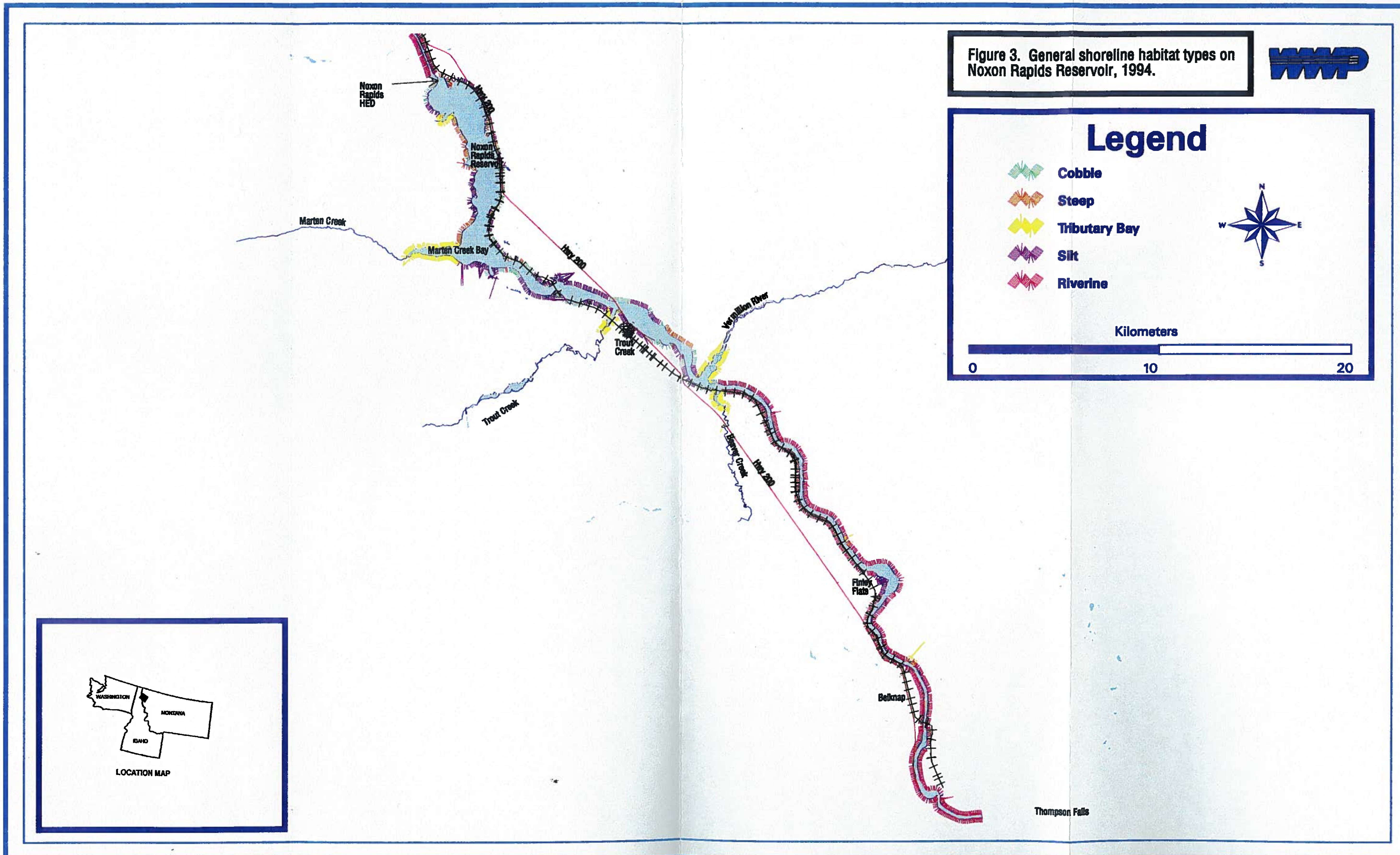


Figure 3. General shoreline habitat types on Noxon Rapids Reservoir, 1994.

In 1994, habitat was characterized at each littoral sampling site for:

- water velocity 1 meter below the surface;
- water velocity 1 meter above the bottom;
- slope;
- maximum and minimum depth;
- substrate composition;
- distance from shore;
- percent vegetation; and
- surface and bottom temperature.

We used discriminant analysis to confirm or reclassify the littoral sampling sites into more descriptive and discrete habitat types based on water velocity, slope, substrate, and vegetation coverage (Johnson and Wichern 1992). This analysis was not performed for the open-water sites (depth > 10 meters (33 feet), and > 200 meters (650 feet) from shore).

Principal component analysis was used to group the littoral habitat variables of substrate, slope, percent vegetation, and surface and bottom water velocities into two variables (principal components 1 and 2). Two principal component scores were calculated based on these five habitat attributes. These principal component scores were then graphed to describe littoral habitat types and depict littoral habitat use by fish (Meffe and Sheldon 1988; Lobb and Orth 1991; DuPont 1994). Open water habitats were not depicted through principal component analysis because greater depths made visual classification of substrate size and percent vegetation impossible.

3.2 Fish Sampling

Fish were sampled during summer (June 25 to September 29) and fall (October 15 to November 17) and were collected through electrofishing, beach seining, gill netting, bait trapping, and trap netting. Gear types were evaluated during the first month for sampling biases and efficiency. At the request of MDFWP, a Lake Merwin trap was evaluated in August.

Two experimental sinking gill nets were set at each sampling site for one overnight period lasting approximately 18 hours. Each gill net had six, 7.62 meters by 1.83 meters (25 feet by 6 feet) panels with mesh sizes (stretch) ranging from 25 to 150 mm (1 to 6 inches) at 25 mm (1 inch) increments. Nets were set perpendicular to shore with the panel mesh sizes for one net increasing away from shore, while for the other net they decreased. Gill netting was the only technique used to sample open-water sites, which are sites over 200 meters (650 feet) from shore with depths > 10 meters (33 feet).

Two nights of boat electrofishing were conducted at each littoral sampling site. Electrofishing occurred at night and generally consisted of 10 minutes of continuous shocking while paralleling the shoreline in depths < 1.3 meters (4 feet).

Three standardized beach seine hauls were made at each littoral sampling site and were repeated for two days. We used a 30.48 m by 3.05 m (100 feet by 10 feet) beach seine with 6 mm (1/4 inch) mesh.

Two trap nets were set overnight (approximately 18 hours) and fished for 2 nights at each site. Trap nets consisted of a frame approximately 1.83 m wide by 1.22 m high (6 feet by 4 feet), a 3.65 m (12 feet) long basket, and a 15.24 to 18.29 m (50 to 60 feet) long lead. Generally, two 91 by 61 by 30 cm (3 by 2 by 1 feet) hardware cloth bait traps with a 91 cm (36 inch) vertical slot entrance 3.8 cm (1.5 in) wide were fished concurrently with the trap nets. Bait traps were baited with approximately 1 to 2 cups of dry dog food.

Sampled fish were identified, counted, and measured for total length (mm). When large numbers (> 500) of one species were sampled, at least 20 were measured and the remainder were counted. Relative abundance (percent total catch) of each species was calculated for each reservoir. Scale samples were taken from a representative size range of selected fish species and provided to MDFWP.

3.3 Habitat Use

Total catch of fish by size class (< 100 mm, 100-200 mm, > 200 mm; < 4 inches, 4 to 8 inches, > 8 inches) was calculated for each of the habitat types in each reservoir.

Fish utilization of each littoral habitat type during summer and fall was evaluated by four methods:

- comparing catch rates among habitat type;
- chi-square goodness of fit tests (Ott 1988; Daniel 1990);
- principal component analysis (Johnson and Wichern 1992); and
- correlations between fish and habitat variables (Ott 1988).

Use of open-water sites by fish was evaluated by comparing gill net catch rates. To minimize influence of gear bias on habitat use elevation, catches were combined between gear types (Hinch et al. 1991). Before combining the data, catches were weighted by calculating relative abundances of fish for each gear type (Weaver et al. 1993).

Section 4
Results

4.1 Habitat Characteristics

We collected habitat variables from 85 littoral sites and 18 open water sites on Noxon Rapids Reservoir and 50 littoral and 10 open water sites on Cabinet Gorge Reservoir. Sampling sites were classified into 13 discrete littoral habitat types which were confirmed through discriminant analysis and two open-water habitat types. Habitat type characteristics of sampling sites are presented in Table 2, and locations and habitat type classification are shown on Figures 4 and 5.

Through principal component analysis, the littoral habitat variables were grouped into two principal components which explain about 83 percent of the variation in the habitat variables tested (Table 3, Figure 6).

TABLE 3
PRINCIPAL COMPONENT LOADINGS OF HABITAT VARIABLE AT LITTORAL SAMPLING LOCATIONS

	PC1	PC2
Slope	**0.855**	0.031
Percent vegetation	**-0.785**	-0.330
Average substrate size	**0.882**	0.006
Surface water velocity	0.122	**0.967**
Bottom water velocity	0.083	**0.976**
% of variance explained	42.9%	40.0%

On Cabinet Gorge Reservoir, the four littoral habitats were differentiated primarily by vegetation coverage, substrate type, and velocity. Silt habitat had the smallest substrate sizes, the highest coverage of vegetation, gradual slopes, and the lowest velocities. Gravel habitat had

TABLE 2
1994 HABITAT TYPE CHARACTERISTICS - CABINET GORGE AND NOXON RAPIDS RESERVOIRS

CABINET GORGE RESERVOIR					
Habitat Name	**Observed Habitat Characteristics**				
	Percent Vegetation	**Substrate size (mm)**	**Slope**	**Surface velocity (cm/sec)**	**Gill net depths (m)**
Silt	60-100	.01-8	.07-.36	0-1	0-8
Gravel	25-60	2.0-60	.07-.58	0-4	0-16
CoBo	0-20	60-400	.35-.78	2-5	0-27
Riverine	0-25	8-100	.20-.40	6-27	0-13
OW	0			0-20	10-20
NOXON RAPIDS RESERVOIR - ZONE 1					
Habitat Name	**Observed Habitat Characteristics**				
	Percent Vegetation	**Substrate size (mm)**	**Slope**	**Surface velocity (cm/sec)**	**Gill net depths (m)**
Silt	55-100	0.1-10	.04-.32	0	0-7
Gravel	23-50	2-62	.05-.39	0-2	0-23
Cobble	2-23	30-108	.11-.61	0-4	0-23
Boulder	0-20	125-425	.30-.70	0-4	0-17
OW				0-3	9-15
DOW				0-2	23-28
NOXON RAPIDS RESERVOIR - ZONE 2					
Habitat Name	**Observed Habitat Characteristics**				
	Percent Vegetation	**Substrate size (mm)**	**Slope**	**Surface velocity (cm/sec)**	**Gill net depths (m)**
Silt	65-100	0.1-8	.05-.17	0-2	0-5
Gravel	34-50	9-37	.23-.55	1-8	0-24
Cobble	0-23	18-100	.33-.55	1-8	0-27
Boulder	0-17	125-425	.39-.76	3-8	0-24
Riverine	2-20	21-88	.17-.36	10-34	0-12

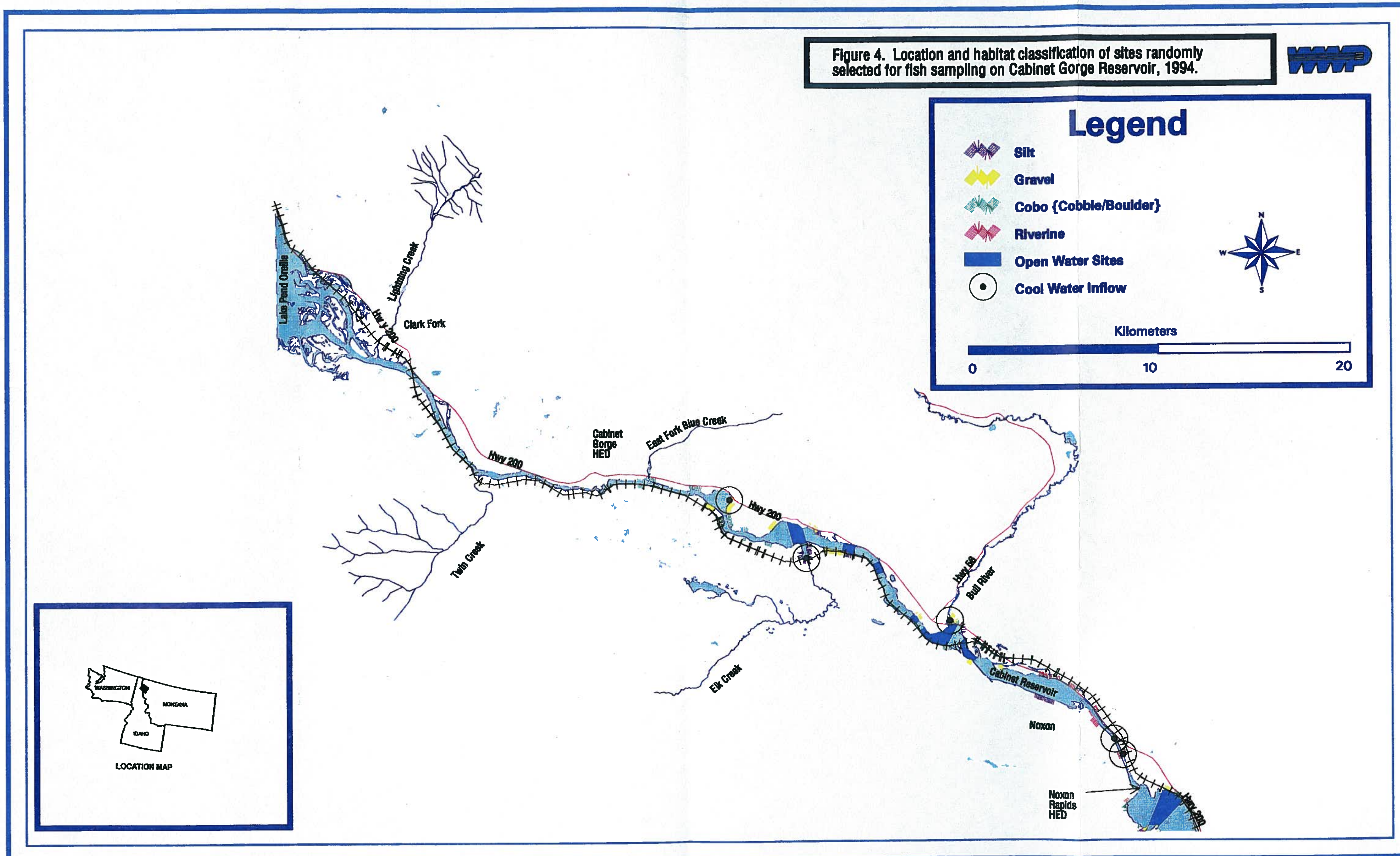


Figure 4. Location and habitat classification of sites randomly selected for fish sampling on Cabinet Gorge Reservoir, 1994.

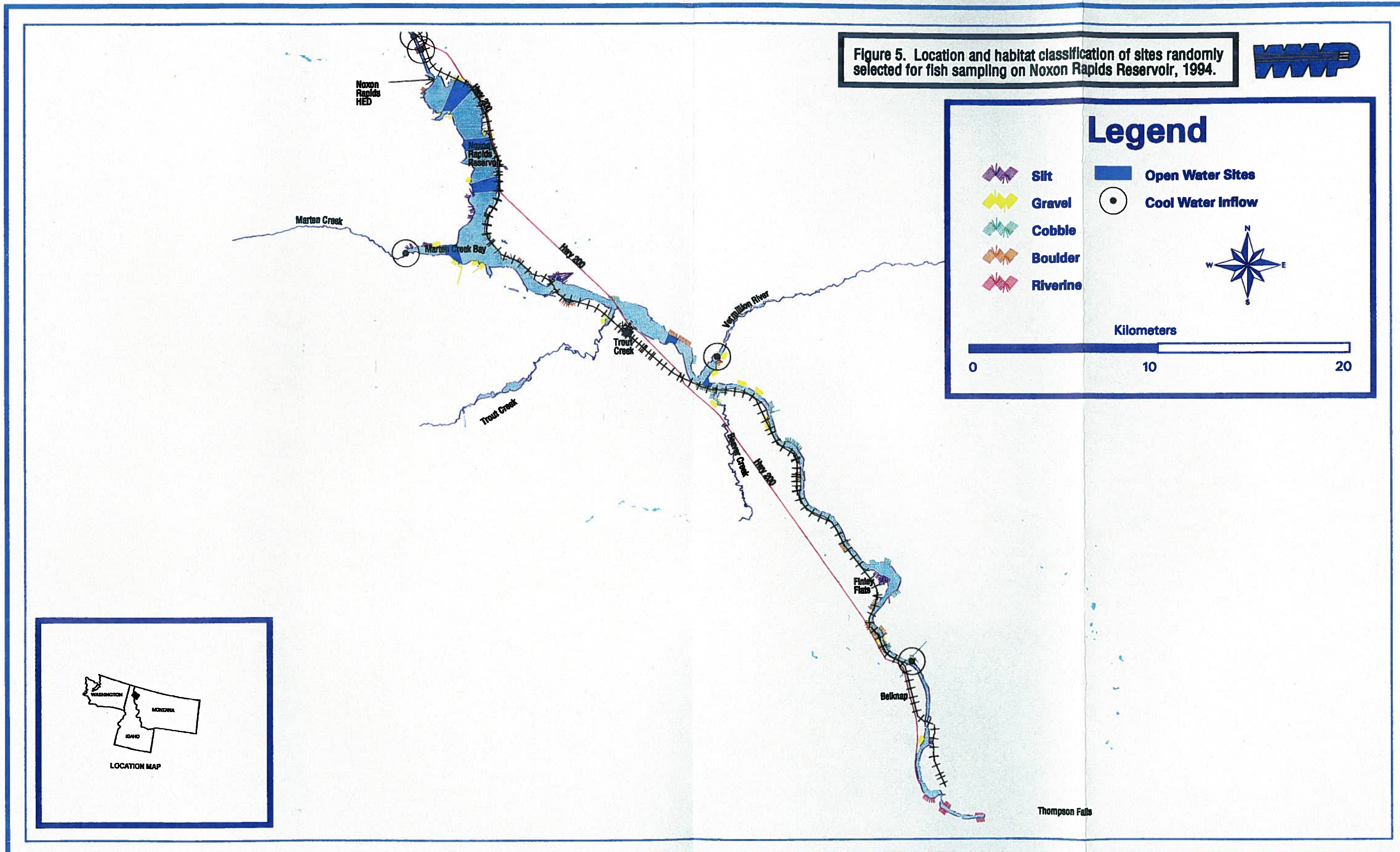


Figure 5. Location and habitat classification of sites randomly selected for fish sampling on Noxon Rapids Reservoir, 1994.

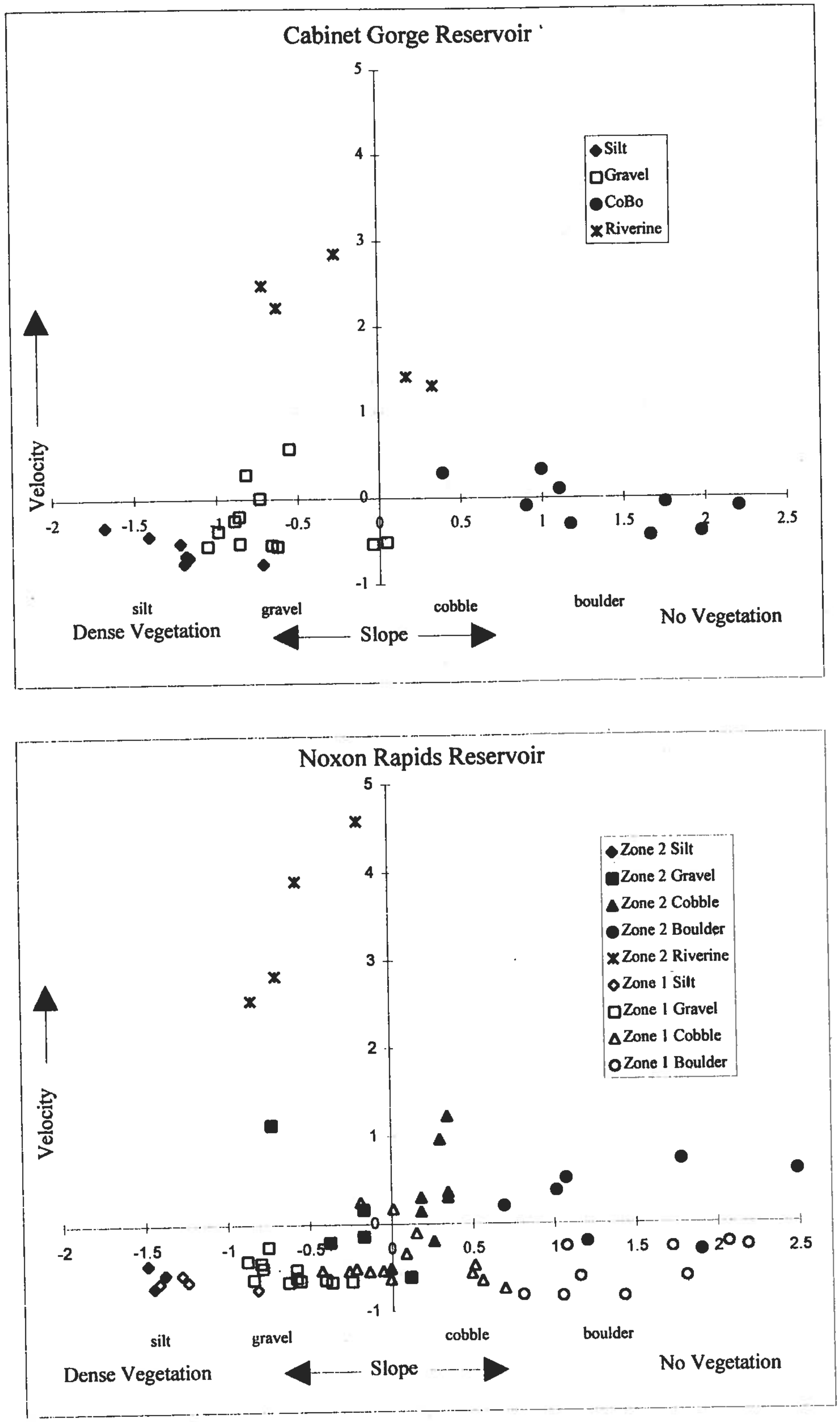


Figure 6. Principal Component Habitat Analysis: Plots of principal component scores depicting habitat conditions at sampling site on Cabinet Gorge and Noxon Rapids Reservoirs.

larger substrate sizes, less vegetation, steeper slopes, and slightly higher velocities than silt habitat. Based on the relatively low amount of these habitats and similarity in features other than substrate, the cobble and boulder habitats were combined, forming the CoBo habitat. CoBo habitat had the largest substrate sizes, the least vegetation, and the steepest slopes. Riverine habitat was distinguished as having the highest velocities and was located in the upriver portion of the reservoir, closest to Noxon Rapids Dam.

Open-water sites in Cabinet Gorge Reservoir were located > 200 meters (650 feet) from shore, and depths ranged from 10 to 20 meters (33 to 66 feet). These sites were located from Bull River Bay down to Heron Bay. Open water sampling did not occur in other portions of the reservoir because depths did not exceed 10 m or the nets could not be located > 200 m from shore.

We separated Noxon Rapids Reservoir into two zones. Zone 1 includes the wider portion of the reservoir with the lowest water velocities and largest littoral areas, and is located downstream of Beaver Creek Bay. Zone 2 is a more narrow, canyon-like portion of the reservoir which is located upriver from Beaver Creek Bay, and has higher water velocities. The upper portion of Zone 2 was classified as Riverine and had the highest water velocities. The rest of Zone 2 and all of Zone 1 were separated into the four habitat types: silt, gravel, cobble, and boulder with the same general characteristics as in Cabinet Gorge Reservoir.

Open-water sites sampled in Noxon Rapids Reservoir were located between Beaver Creek Bay and the Noxon Rapids Dam (zone 1) and included depths > 10 meters (33 feet). Because of the depths in Noxon Rapids Reservoir (> 61 meters; 200 feet), open-water sites were further divided into open-water sites (10 to 20 meters; 33 to 66 feet) and deep open-water sites (> 20 meters; 66 feet in depth).

Surface water temperatures during the summer (June 25 to September 29) averaged about 19.5 and 21.0°C in Cabinet Gorge and Noxon Rapids Reservoirs, respectively, whereas in the fall (October 15 to November 17) temperatures averaged about 9°C in both reservoirs. Because some sampling sites were found to have substantial (> 5°C) temperature differences between the surface and bottom waters, these sites were reclassified "cold water influence" for purposes of evaluating habitat use.

4.2 Gear Evaluation

Evaluation of gear types indicated that beach seining, electrofishing, and gill netting were the most appropriate fish sampling methods. These techniques sampled the greatest number of species, had the highest catch rates, and could sample multiple sites in one day (Table 4). Gill netting was effective in sampling larger fish (> 100 mm; 4 inches) and was the only technique that would effectively sample open water. Electrofishing sampled all size classes of fish and was time efficient, although it was limited to shallow water < 1.3 meters (4 feet) deep. Beach seining was time efficient and effective in sampling large numbers of fish, especially the smaller size classes. However, beach seining was also limited to shallow water (< 3 meters; 10 feet) and was most effective over smaller substrate sizes.

TABLE 4
EVALUATION OF GEAR TYPES

	Number of Fish Sampled				# of Species	# of Sample Attempts	Fish per Attempt	Attempt/ Day
Gear Types	**<100mm**	**100-200mm**	**200mm**	**Total**				
Bait Trap	45	153	112	310	5	45	6.89	5-10
Beach Seine	212	1,536	101	1,849	12	22	84.1	10
Electrofishing	27	452	124	603	13	27	82.2	5
Gill Netting	16	1,179	1,0251	2,220	17	27	82.2	5
Trap Netting	32	639	351	1,022	11	45	22.7	5
Merwin Trap	17	95	259	371	9	6	61.8	1-4

Based on the gear type evaluations, we felt we could adequately characterize the fish communities utilizing gill nets, electrofishing, and beach seines. In addition, by limiting our sampling effort to the use of three gear types, we were able to sample more sites in each reservoir allowing us to better evaluate the communities.

4.3 Fish Composition

Gill net, electrofishing, and beach seine data were used to evaluate the fish communities. During the summer and fall of 1994, a total of 54,392 fish representing 22 species (Table 5) was sampled from Noxon Rapids and Cabinet Gorge Reservoirs through 2,157 minutes of electrofishing, 489 beach seine hauls, and 5,992 gill net hours.

A total of 41,836 fish were sampled in Noxon Rapids Reservoir. The most abundant fish sampled were pumpkinseed (43 percent), followed by yellow perch (18 percent) and northern squawfish (18 percent) (Table 6). Centrarchids were the most abundant family sampled (52 percent) (Figure 7). Zone 1 had a higher percentage of centrarchids (58 vs. 46 percent) and percids (26 vs. 12 percent) and a lower percentage of cyprinids (12 vs. 37 percent) compared to Zone 2 (Figure 8).

A total of 12,556 fish were sampled in Cabinet Gorge Reservoir. The most abundant fish sampled were redside shiner (29 percent), northern squawfish (18 percent) and , yellow perch (16 percent) (Table 7). Cyprinids were the most abundant family sampled (57 percent) (Figure 9).

4.4 Habitat Use of Fish

Chi-square goodness of fit tests indicate fish species sampled in adequate numbers to allow for analysis are selecting certain habitat types (Appendix A, Table A-1). Results of comparing relative abundance to habitat type (Appendix A, Figures A-1 through A-6), habitat correlations (Appendix B, Tables B-1 through B-4), and principal component analysis (Appendix B, Figures B-1 and B-2) are also presented in the Appendices.

TABLE 5
SUMMARY OF 1994 FISH SAMPLING: CABINET GORGE AND NOXON RAPIDS RESERVOIRS

		Total # sampled
Family Salmonidae		
	Cutthroat trout *Oncorhynchus clarki*	8
	Rainbow trout *Oncorhynchus mykiss*	57
	Brown trout *Salmo trutta*	148
	Bull trout *Salvelinus confluentus*	13
	Lake trout *Salvelinus namaycush*	2
	Lake whitefish *Coregonus clupeaformis*	184
	Mountain whitefish *Prosopium williamsoni*	174
Family Esocidae		
	Northtern pike *Esox lucius*	26
Family Cyprinidae		
	Peamouth *Mylocheilus caurinus*	3,703
	Northern squawfish *Ptychocheilus oregonensis*	9,666
	Redside shiner *Richardsonius balteatus*	4,426
Family Catostomidae		
	Longnose sucker *Catostomus catostomus*	356
	Largescale sucker *Catostomus macrocheilus*	2,420
Family Ameiuridae		
	Bullhead species *Ameiurus sp.*	525
Family Gadidae		
	Burbot *Lota lota*	2
Family Centrarchidae		
	Smallmouth bass *Micropterus dolimieui*	1,621
	Largemouth bass *Micropterus salmoides*	2,045
	Pumpkinseed *Lepomis gibbosus*	19,211
	Black crappie *Pomoxis nigromaculatus*	2
Family Percidae		
	Yellow perch *Perca flavescens*	9,796
	Walleye *Stizostedion vitreum*	6
Family Cottidae		
	Slimy sculpin *Cottus cognatus*	1

Total catch during July - November, 1994 on Cabinet Gorge and Noxon Rapids Reservoirs. Fish were sampled by electrofishing (2,157 minutes), beach seining (489 hauls), and gill netting (5,992 hours).

TABLE 6
SUMMARY OF 1994 FISH SAMPLING: NOXON RAPIDS RESERVOIR

Species	size (mm)	ZONE 1 HABITATS silt (4)	gravel (13)	cobble (15)	bouler (13)	ow (8)	dow (10)	Zone 1 Total (63)
Pumpkinseed	<100	952	5894	815	358	0	0	8019
	100-200	238	475	180	56	3	0	952
Yellow perch	<100	11	40	8	10	9	0	78
	100-200	355	1820	919	517	301	113	4025
	>200	47	265	259	209	160	57	997
Northern squawfish	<100	2	271	27	12	0	1	313
	100-200	3	16	38	11	0	1	69
	>200	46	153	301	314	65	38	917
Peamouth	<100	0	17	5	0	0	0	22
	100-200	3	10	12	3	4	7	39
	>200	60	143	267	194	149	143	956
Largemouth bass	<100	423	744	72	149	0	0	1388
	100-200	14	18	8	0	0	0	40
	>200	11	25	15	17	0	0	68
Smallmouth bass	<100	5	126	193	327	0	0	651
	100-200	2	12	76	87	0	0	177
	>200	1	12	26	51	8	0	98
Largescale sucker	<100	0	0	0	0	0	0	0
	100-200	0	1	5	0	0	0	6
	>200	22	73	82	90	23	1	291
Redside shiner	<100	0	0	0	0	0	0	0
	100-200	0	3	11	0	0	0	14
	>200	0	0	0	0	0	0	0
Bullhead	<100	1	0	0	1	0	0	2
	100-200	5	35	26	34	4	1	105
	>200	12	42	24	36	12	1	127
Lake whitefish	<100	0	0	0	0	0	0	0
	>200	3	41	9	27	6	4	90
Brown trout	<100	0	4	4	2		0	10
	100-200	0	3	4	0	0	0	7
	>200	8	12	10	2	4	3	39
Longnose sucker	<100	0	3	0	0	0	0	3
	100-200	0	0	0	0	0	0	0
	>200	1	6	3	8	1	6	25
Mountain whitefish	<100	0	0	0	0	0	0	0
	100-200	0	4	0	0	0	0	4
	>200	0	4	0	1	0	0	5
Rainbow trout	<100	0	0	0	0	0	0	0
	100-200	0	0	1	0	0	0	1
	>200	0	1	0	1	0	0	2
Northern pike	>200	0	4	1	0	0	0	5
Bull trout	>200	0	2	0	1	0	0	3
Walleye	>200	0	0	0	3	0	0	3
Cutthroat trout	>200	0	0	1	0	0	0	1
Lake trout	>200	0	0	0	1	0	0	1
Black Crappie	all	0	0	0	0	0	0	0
Burbot	all	0	0	0	0	0	0	0
Total	all	2225	10279	3402	2522	749	376	19553

Total catch during July - November, 1994 at littoral, open water (ow), and deep open water (dow) habitat sites on Noxon Rapids Reservoir. Fish were sampled by electrofishing (1,345 minutes), beach seining (307 hauls), and gill netting (3,743 hours). Number of sites sampled are in parentheses.

Continued next page.

TABLE 6 (cont.)
SUMMARY OF 1994 FISH SAMPLING: NOXON RAPIDS RESERVOIR

		ZONE 2 HABITATS					Zone 2	Grand	
Species	size (mm)	silt (5)	gravel (9)	cobble (9)	boulder (8)	riverine (9)	Total (40)	total by species	% of catch
Pumpkinseed	<100	394	6822	1600	4	11	8831	17994	43.01
	100-200	156	30	6	0	0	192		
Yellow perch	<100	25	3	0	2	0	30	7726	18.47
	100-200	827	835	349	138	107	2256		
	>200	102	105	81	32	20	340		
Northern squawfish	<100	103	1435	1443	55	1692	4728	7446	17.80
	100-200	182	205	304	90	102	883		
	>200	11	117	149	151	108	536		
Peamouth	<100	6	23	33	2	644	708	2409	5.76
	100-200	18	59	51	11	0	139		
	>200	34	167	194	120	30	545		
Largemouth bass	<100	448	9	6	5	0	468	1983	4.74
	100-200	3	7	2	0	0	12		
	>200	2	1	4	0	0	7		
Smallmouth bass	<100	7	111	90	44	273	525	1602	3.83
	100-200	0	27	40	25	8	100		
	>200	2	9	15	14	11	51		
Largescale sucker	<100	1	2	181	3	328	515	1218	2.91
	100-200	0	2	6	0	2	10		
	>200	67	79	97	78	75	396		
Redside shiner	<100	6	204	12	3	517	742	807	1.93
	100-200	0	26	11	2	12	51		
	>200	0	0	0	0	0	0		
Bullhead	<100	1	0	2	0	0	3	251	0.60
	100-200	2	0	0	0	0	2		
	>200	9	0	2	0	1	12		
Lake whitefish	<100	0	1	0	0	0	1	151	0.36
	>200	0	6	11	15	28	60		
Brown trout	<100	0	0	1	0	1	2	66	0.16
	100-200	0	0	1	1	1	3		
	>200	0	0	3	0	2	5		
Longnose sucker	<100	2	3	8	0	0	13	61	0.15
	100-200	2	6	0	0	0	8		
	>200	5	1	2	4	0	12		
Mountain whitefish	<100	0	0	0	0	34	34	49	0.12
	100-200	0	0	1	0	1	2		
	>200	0	1	2	0	1	4		
Rainbow trout	<100	1	0	1	0	1	3	26	0.06
	100-200	1	0	0	0	6	7		
	>200	0	3	1	1	8	13		
Northern pike	>200	15	3	1	0	0	19	24	0.06
Bull trout	>200	0	2	3	1	1	7	10	0.02
Walleye	>200	0	0	0	3	0	3	6	0.01
Cutthroat trout	>200	0	3	0	1	0	4	5	0.01
Lake trout	all	0	0	1	0	0	1	2	0.00
Black Crappie	all	0	0	0	0	0	0	0	0.00
Burbot	all	0	0	0	0	0	0	0	0.00
Total	all	2432	10307	4714	805	4025	22283	41836	100.00

Total catch during July - November, 1994 at littoral, open water (ow), and deep open water (dow) habitat sites on Noxon Rapids Reservoir. Fish were sampled by electrofishing (1,345 minutes), beach seining (307 hauls), and gill netting (3,743 hours). Number of sites sampled are in parentheses.

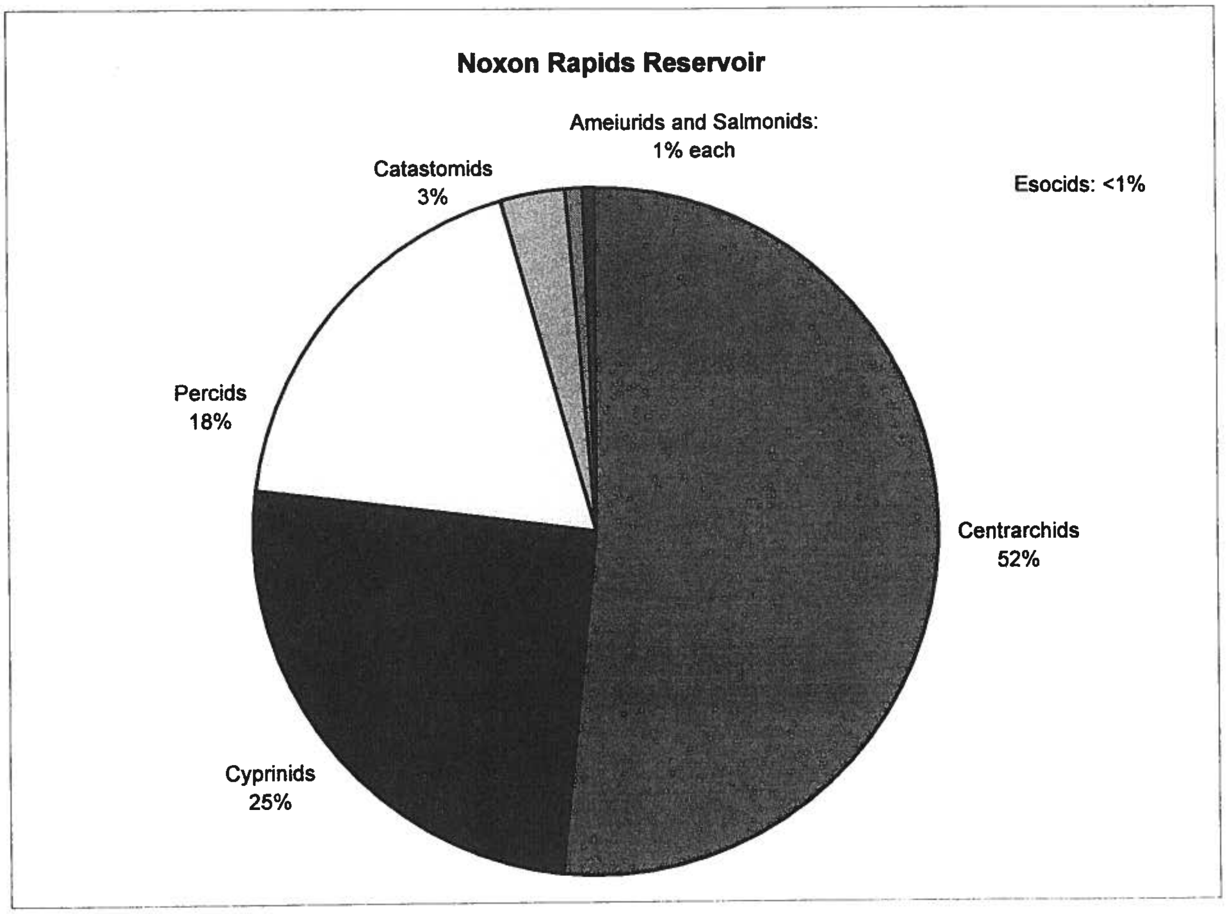
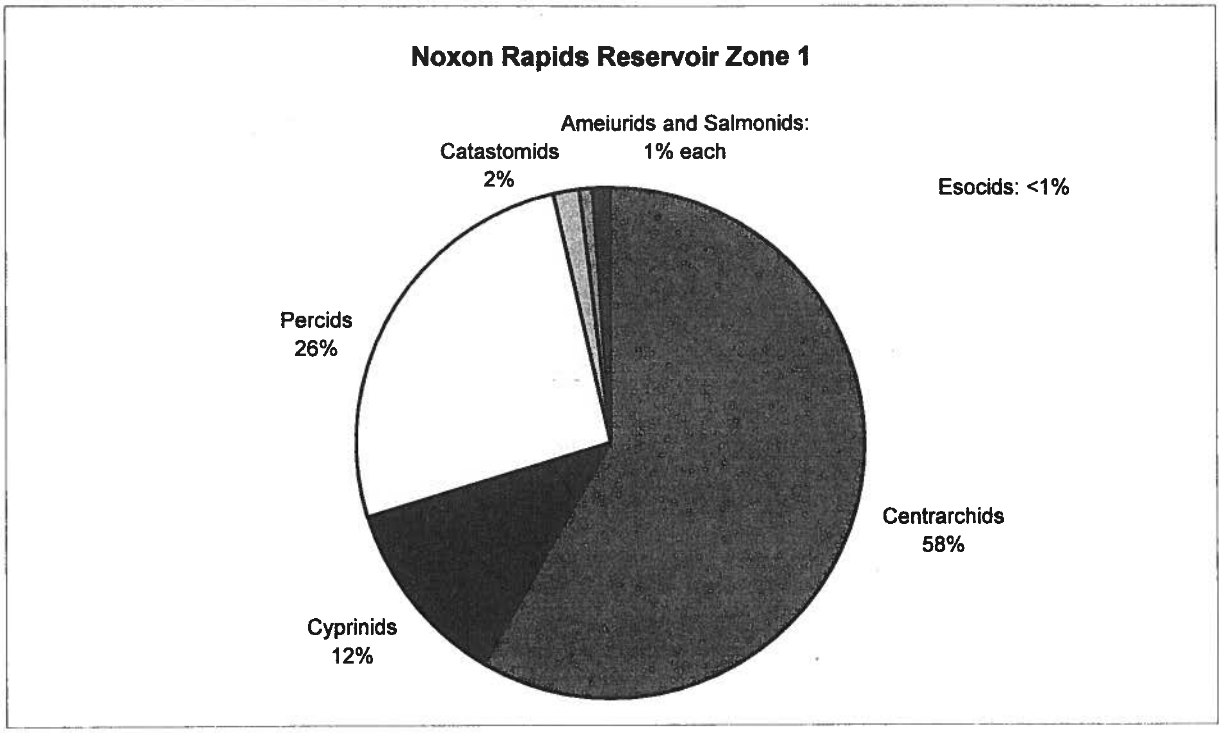


Figure 7. Family Abundance for Fish Sampled in 1994 - Noxon Rapids Reservoir.



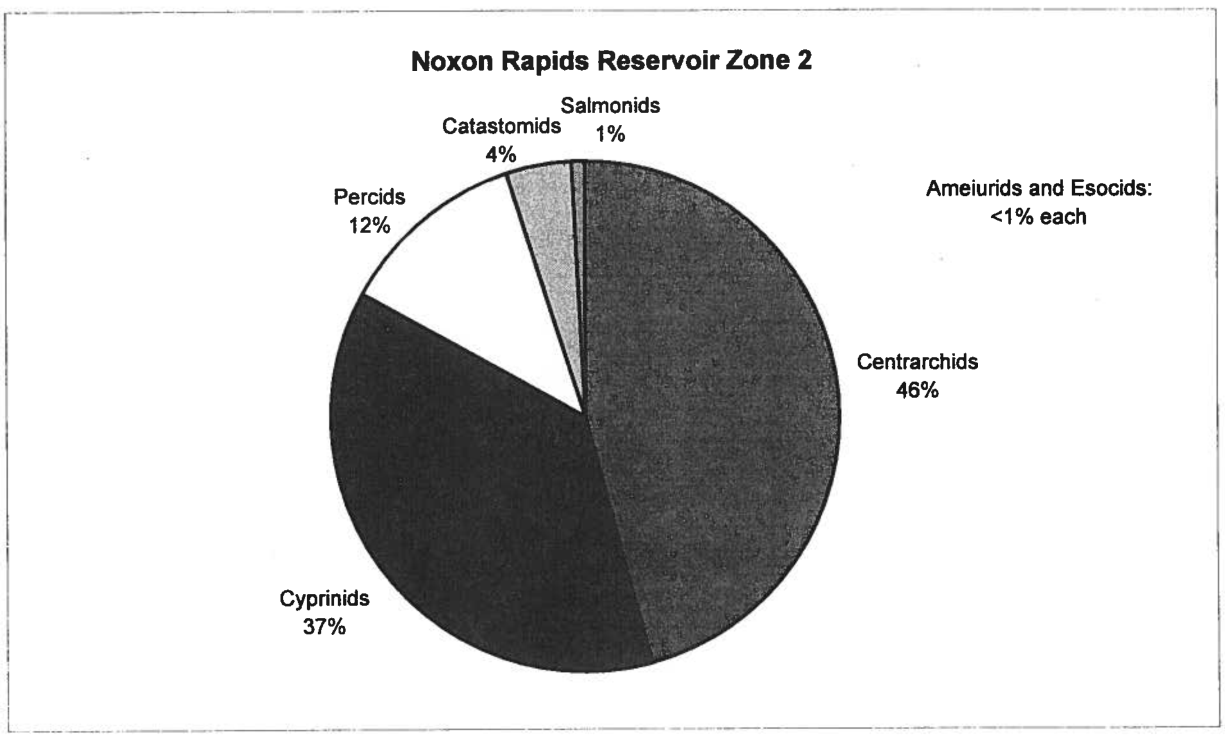


Figure 8. Family Abundance for Fish Sampled in 1994 - Noxon Rapids Reservoir, Zone 1 and Zone 2.

TABLE 7
SUMMARY OF 1994 FISH SAMPLING: CABINET GORGE RESERVOIR

Species	size (mm)	Habitat silt (13)	gravel (16)	cobo (13)	riverine (8)	ow (10)	Totals (60)	total by species	% of catch
Redside shiner	<100	290	1628	360	193	0	2471	3619	28.82
	100-200	116	294	528	208	2	1148		
Northern squawfish	<100	11	19	42	17	0	89	2220	17.68
	100-200	490	353	150	244	1	1238		
	>200	238	233	252	119	51	893		
Yellow perch	<100	28	22	0	1	0	51	2070	16.49
	100-200	907	612	47	167	12	1745		
	>200	96	89	35	43	11	274		
Peamouth	<100	120	102	28	53	0	303	1294	10.31
	100-200	52	64	19	10	11	156		
	>200	244	338	163	61	29	835		
Pumpkinseed	<100	588	290	16	35	0	929	1217	9.69
	100-200	208	68	1	11	0	288		
Largescale sucker	<100	92	449	95	8	0	644	1202	9.57
	100-200	14	15	7	5	0	41		
	>200	148	167	105	95	2	517		
Longnose sucker	<100	126	23	36	6	0	191	295	2.35
	100-200	1	5	1	1	0	8		
	>200	33	61	0	2	0	96		
Bullhead	<100	259	0	0	0	0	259	274	2.18
	100-200	1	1	0	0	0	2		
	>200	11	1	1	0	0	13		
Mountain whitefish	<100	18	17	0	9	0	44	125	1.00
	100-200	12	24	0	18	0	54		
	>200	0	19	2	5	1	27		
Brown trout	<100	0	0	0	1	0	1	82	0.65
	100-200	3	23	1	2	0	29		
	>200	4	23	14	8	3	52		
Largemouth bass	<100	41	4	0	1	0	46	62	0.49
	100-200	7	0	0	1	0	8		
	>200	8	0	0	0	0	8		
Lake whitefish	100-200	0	0	0	3	0	3	33	0.26
	>200	0	7	12	11	0	30		
Rainbow trout	100-200	3	1	0	7	0	11	31	0.25
	>200	6	3	2	9	0	20		
Smallmouth bass	<100	0	0	0	3	0	3	19	0.15
	100-200	1	1	1	3	0	6		
	>200	5	0	2	3	0	10		
Bull trout	>200	1	1	0	0	1	3	3	0.02
Cutthroat trout	100-200	0	0	0	1	0	1	3	0.02
	>200	0	1	0	1	0	2		
Black crappie	100-200	2	0	0	0	0	2	2	0.02
Burbot	>200	0	0	2	0	0	2	2	0.02
Northern pike	all	2	0	0	0	0	2	2	0.02
Slimy sculpin	all	0	0	1	0	0	1	1	0.01
Lake trout	all	0	0	0	0	0	0	0	0.00
Walleye	all	0	0	0	0	0	0	0	0.00
Total	all	4186	4958	1923	1365	124	12556	12556	100.00

Total catch during July -November, 1994 at littoral and open water (ow) habitat sites on Cabinet Gorge Reservoir. Fish were sampled by electrofishing (812 minutes), beach seining (182 hauls), and gill netting (2,249 hours). Number of sites sampled are in parentheses.

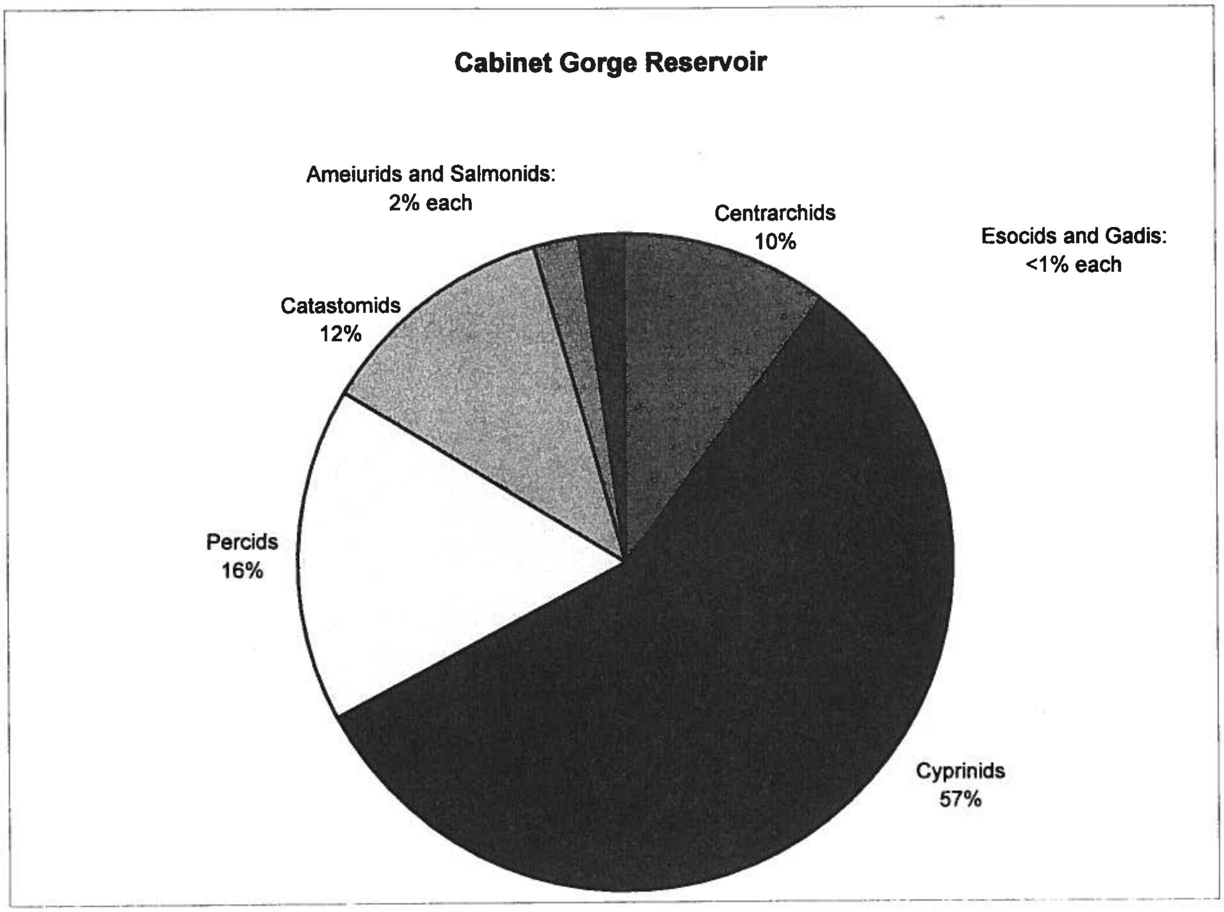


Figure 9. Family Abundance for Fish Sampled in 1994 - Cabinet Gorge Reservoir.

As part of our analysis of habitat use, we defined six habitat-use guilds in the two reservoirs, five littoral guilds, and one open water. The habitat-use guilds were:

- vegetated (> 50 percent), low velocity areas (< 0.03 m/sec; 0.10 f/s) with smaller substrates (silt- gravel), and gradual slopes (~ 0.15);
- moderately vegetated (25 to 50 percent), low velocity areas (< 0.04 m/sec; 1.13 f/s) with gravel substrates and moderate slopes (~0.25);
- cobble and boulder substrates (CoBo), limited vegetation, (< 25 percent) steeper gradients (~0.40) and low to moderate velocities (< 0.08 m/sec);
- high velocity areas (> .08 m/sec) located in the upper reaches of each reservoir;
- areas with cold water influences (streams and springs); and
- open-water areas over 200 m from shore and depths > 10 m.

There was some overlap in habitat use among guilds. Many species of fish also had size classes that belonged to different habitat guilds, and fish were not always found to use the same habitat between the reservoirs (Table 8).

4.5 Discussion

The composition of the fish communities sampled in the reservoirs reflects the characteristics of the available habitat. The most abundant fish sampled in Noxon Rapids Reservoir were pumpkinseed and yellow perch, which preferred smaller substrate sizes, low velocities, and high concentrations of vegetation. The most abundant fish sampled in Cabinet Gorge Reservoir were redside shiner and northern squawfish, which showed preferences for larger substrates and low concentrations of vegetation regardless of water velocities.

TABLE 8
HABITAT-USE GUILDS BY SPECIES AND SIZE CLASS

	Guild 1 Silt-Gravel		Guild 2 Gravel		Guild 3 CoBo		Guild 4 Riverine		Guild 5 Cold Inflow		Guild 6 Open Water	
Species	**CG**	**NR**	**CG**	**NR**	**CG**	**NR**	**CG**	**NR**	**CG**	**NR**	**CG**	**NR**
Bullhead	1,2,3	1,2,3										
Largemouth bass	1,2,3	1,2,3										
Pumpkinseed	1,2	1,2										
Northern pike		3										
Yellow perch	1,2	1,2,3	3									3
Peamouth			2,3	2			1	1				3
Longnose sucker			1	1,2					2,3	3		
Largescale sucker			3					1,2	1,2	3		
Northern squawfish			2	2	1,3	3		1				
Redside shiner					1,2			1,2				
Smallmouth bass						1,2,3	1,2,3					
Walleye						3						
Mountain whitefish			1					1	2,3	2,3		
Lake whitefish							1,2,3			1,2,3		
Rainbow trout							1,2,3	1,2,3				
Brown trout									1,2,3	1,2,3		
Bull trout										3		

Note: CG = Cabinet Gorge Reservoir, NR = Noxon Rapids Reservoir.
Size Classes: 1 = <100 mm, 2 = 100 to 200 mm, 3 = >200 mm.

Cabinet Gorge Reservoir is narrow, with higher velocities, an abundance of larger substrate areas, and limited low velocity littoral areas. Cyprinids (redside shiner, northern squawfish, and peamouth chub) were the most abundant (57 percent of catch) family of fish sampled in this reservoir. Bennett and DuPont (1992 and 1993) found cyprinids dominated the fish community in Pend Oreille River, Idaho where higher velocities and larger substrates were abundant. Scott and Crossman (1973) and Simpson and Wallace (1982) state that redside shiner, northern squawfish, and peamouth select larger substrates and higher velocities for spawning. The habitat conditions in Cabinet Gorge Reservoir (WWP 1995) provide suitable conditions for spawning and rearing of these cyprinids species, and young cyprinids were found in a wide variety of habitats.

Overall, Noxon Rapids Reservoir was dominated by centrarchids, which comprised 52 percent of the total catch. In addition to deeper water, the large littoral areas in Noxon Rapids Reservoir often support extensive aquatic macrophyte communities and provide warmer temperatures and large areas with little or no velocity. These conditions are well suited for centrarchids, especially during winter when they prefer areas of zero velocities and depths > 1.2 m (4 feet) (Sheehan et al. 1990, Ashe 1991; Carlson 1992; Pitlo 1992). Year-class strength for centrarchids in northern waters is generally based on over-winter survival of age 0 fish (Bowles 1985; Rieman 1987; Sheehan et al. 1990; Hatch 1991). Cooler water temperatures (2-3°C < Noxon) and few zero velocity areas with depths > 1.2 m (4 feet) explain why centrarchids are less abundant in Cabinet Gorge Reservoir.

Habitat conditions in Zone 2 of Noxon Rapids Reservoir are similar to those in Cabinet Gorge Reservoir. Zone 2 would have a similar fish community, dominated by cyprinids, if fish composition calculations are adjusted for the high catches of young pumpkinseed (Figure 10). It appears many of the cyprinids are using the higher velocity areas in Zone 2 of Noxon Rapids Reservoir for spawning and/or rearing, as this is where the most young fish were sampled.

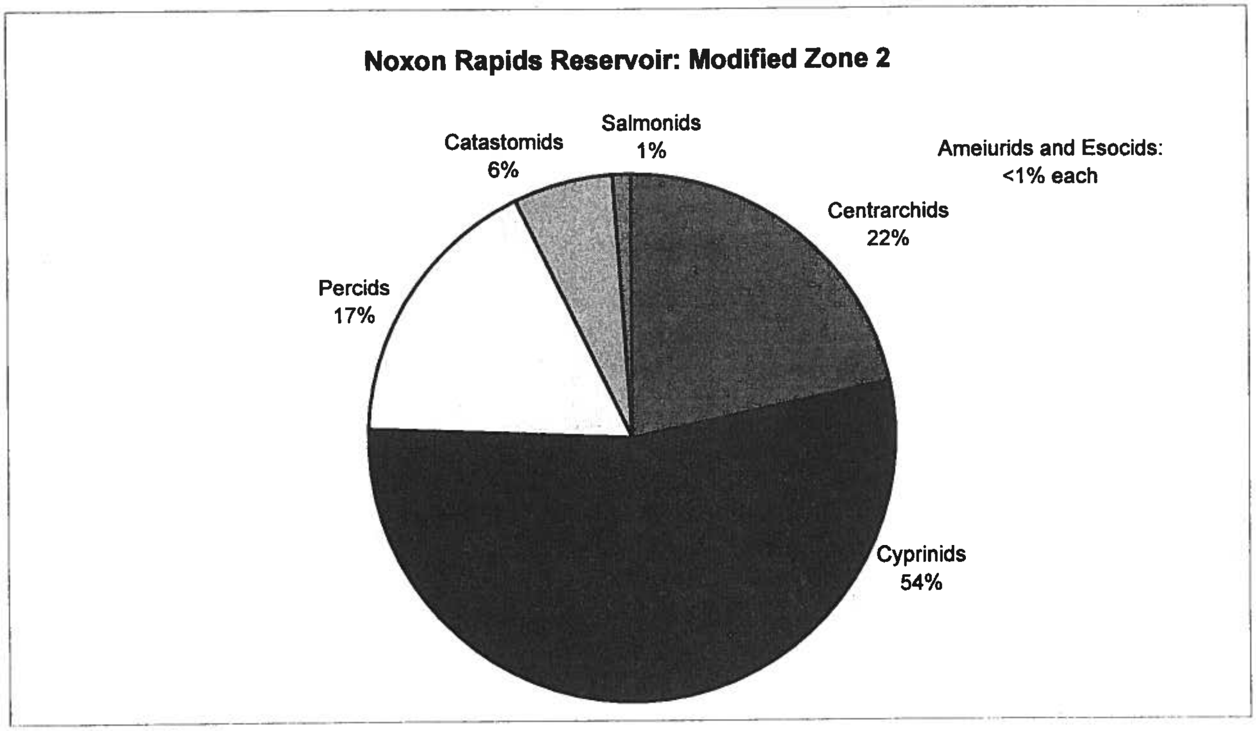
Pumpkinseed was the most abundant species in Noxon Rapids Reservoir, showing a strong preference for the smaller substrate, lower velocity areas. Although similar habitat preferences existed for pumpkinseed in Cabinet Gorge Reservoir, the species was of much lower relative abundance. This is consistent with the lesser amounts of low velocity habitat as well as less favorable temperature and winter conditions.

Redside shiner was the most abundant species in Cabinet Gorge Reservoir, and were common in all but the open water habitats. The species was of much lower abundance in Noxon Rapids Reservoir, although still occurring in a variety of habitats. Differences between the reservoirs is likely due to overall reservoir morphologies.

Yellow perch, northern squawfish, and peamouth were also among the most abundant fish species in both reservoirs. Although each showed some habitat preference, they were common in all habitat types. The abundance of yellow perch, squawfish, and peamouth in the reservoirs is due to their ability to occupy a variety of habitats and the suitability of reservoir temperatures (Scott and Crossman 1973).

Smallmouth bass were the sixth most abundant species sampled in Noxon Rapids Reservoir in 1994. Since introduction of smallmouth bass in 1982, the species has become well established. The ability of this species to become so widely distributed and well established in Noxon Rapids Reservoir in such a relatively short amount of time demonstrates high habitat suitability.

Smallmouth bass were sampled most frequently in the reservoirs from the riverine habitat. They showed preferences for higher velocities and coarser substrates. These habitat characteristics are common in the upper portion of Zone 1 and throughout Zone 2 of Noxon Rapids Reservoir and throughout Cabinet Gorge Reservoir. The low relative abundance of smallmouth bass in Cabinet Gorge Reservoir is likely due less to favorable temperature and winter habitat characteristics.



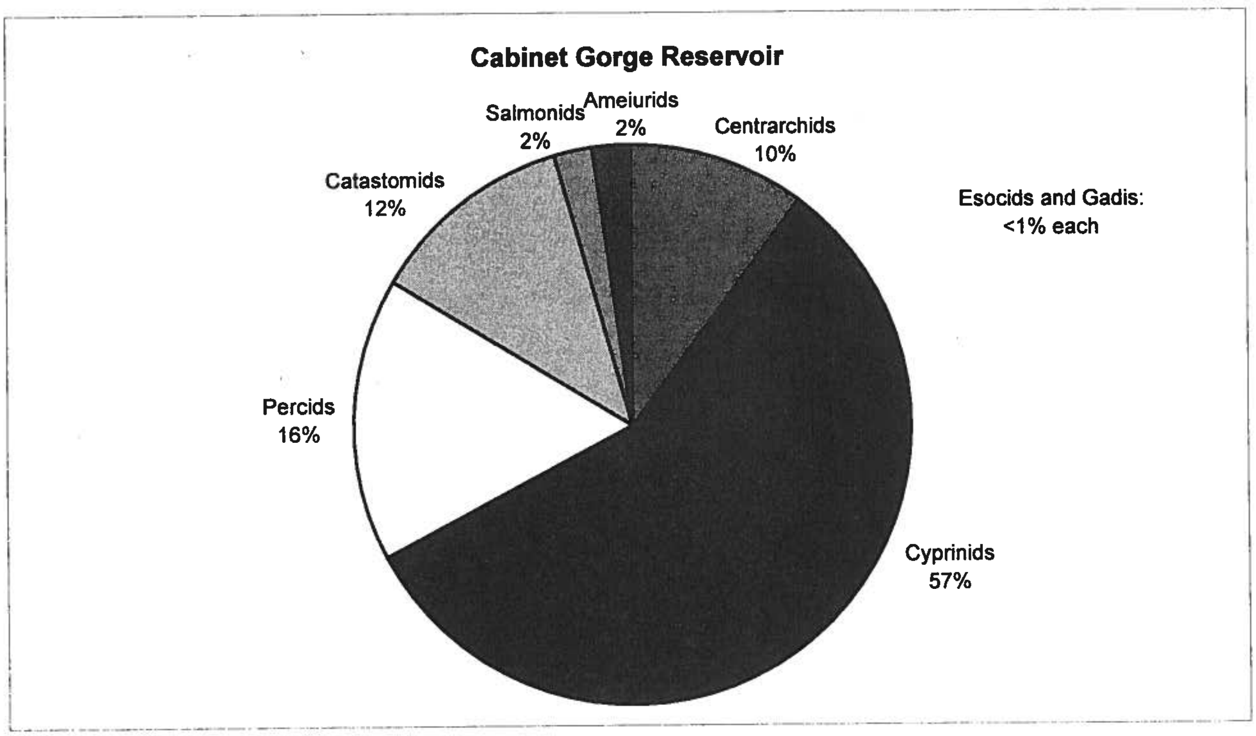


Figure 10. Comparison of Fish Composition in Noxon Rapids Reservoir Zone 2 to Cabinet Gorge Reservoir with Adjusted Pumpkinseed Catches.

Relative abundance of largemouth bass in Noxon Rapids Reservoir is comparable to similar lakes and reservoirs in this region with popular bass fisheries (Hatch 1991; Liter 1991). MDFWP considers Noxon Rapids Reservoir as one the best bass fisheries in Montana (Huston, MFWP, personal communications). As with smallmouth bass, the low relative abundance of largemouth bass in Cabinet Gorge Reservoir is likely due less to favorable temperature and winter habitat characteristics.

Fish that demonstrated preferences for cold water influences during the summer (salmonids and longnose sucker) only represented 0.9 percent and 4.6 percent of the catch in Noxon Rapids and Cabinet Gorge Reservoirs, respectively. During the summer, salmonids in Noxon Rapids Reservoir showed strong preferences for habitats with cold water influences. However, in Cabinet Gorge Reservoir rainbow trout, lake whitefish, and mountain whitefish were commonly sampled outside of known cold water refuges. The cooler temperatures in Cabinet Gorge Reservoir (2 to 3°C cooler than Noxon during the summer) may allow them to occupy other habitats. Cold water springs are known to exist in both reservoirs, many of which probably have not been identified. These springs could provide additional habitat for fish seeking cooler temperatures. Overall, however, summer temperatures in most areas of the reservoirs generally exceed 21°C and are not well suited for trout (Carlander 1969; Stevenson 1987; Bjornn and Reiser 1991). This explains why salmonids continue to occur only in relatively low numbers, despite many years of stocking.

Our sampling showed many of the fish in the reservoirs change habitat use from summer to fall. Largemouth bass, pumpkinseed, yellow perch, bullhead, peamouth, largescale sucker > 200 mm (8 inches) and northern squawfish > 200 mm selected lower velocities than they did during the summer. In Noxon Rapids Reservoir, smallmouth bass were sampled during the fall from areas with larger substrate sizes as compared to where they were sampled during the summer. No smallmouth were sampled in Cabinet Gorge Reservoir during the fall, which may indicate they moved to deeper waters. Also during the fall, salmonids were sampled more frequently outside of habitats with cold water influences. These seasonal shifts in habitat use are all consistent with the reported results and conclusions of other researchers (Munther 1970; Scott and Crossman 1973; Sheehan et al.; Pitlo 1992).

Timing of spawning also affects seasonal habitat use. Bull trout, brown trout, lake whitefish, and mountain whitefish all spawn during the fall or early winter (Scott and Crossman 1973). In the fall, these fish were sampled most often in tributary mouths or in the riverine habitat, areas which may provide spawning habitat or access to it.

Similar trends in fish distribution and habitat suitability are evident when comparing 1994 and 1993 (ND&T 1994) study results. Minor differences in relative abundance between years are explained by:

- 1994 had a warm dry summer; whereas 1993 had a cool wet summer;
- gear types varied; and
- sampling sites were randomly selected in 1994 but were selected for distribution throughout the reservoirs in 1993.

Yellow perch were the dominant fish sampled during 1993 in both reservoirs, comprising nearly 50 percent of the catch. Although yellow perch were also abundant during 1994, they did not exceed 19 percent of the catch in either reservoir. However, few age 0 yellow perch were sampled during 1994 indicating unsuccessful spawning or gear-type bias. In addition, relative abundances for pumpkinseed, redside shiner, largemouth bass, and smallmouth bass were higher in 1994 than in 1993. These differences are most likely a result of variations in gear types, as most of these fish were sampled through electrofishing and beach seining during 1994, gear types not used in the 1993 study. Additionally, flow and weather conditions during 1994 provided better spawning conditions for centrarchids and may also have contributed to the higher catches of age 0 fish. All of these factors would affect reported species relative abundance, although results from both years demonstrate the reservoirs to be best suited for cool- to warm-water species, particularly habitat generalists.

Section 5
Conclusions

Cabinet Gorge and Noxon Rapids Reservoirs have fish communities typical of similar lakes and reservoirs in the Pacific Northwest. Subtle differences in the fish communities between the two reservoirs are related to variations in basic habitat characteristics and habitat availability. Available habitats in both reservoirs are best suited to cool- or warm-water, habitat generalist fish species. Relative abundance of salmonids is low, which is consistent with waters that have temperatures exceeding 19 to 20°C. In addition, Noxon Rapids Reservoir has developed an above-average bass fishery that continues to improve and is even now considered one of the best in Montana.

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APPENDICES

APPENDIX A

CHI SQUARE HABITAT USE ANALYSIS TABLES

AND

SPECIES RELATIVE ABUNDANCE GRAPHS BY HABITAT TYPE

Table A-1. Chi-square analysis of habitat utilization for fishes sampled from Noxon Rapids Reservoir during the summer of 1994.

		Black Bullhead				Peamouth				Largescale Sucker				Largemouth Bass			
	Habitat	Observed	Expected	X2	p-value	Observed	Expected	X2	p-value	Observed	Expected	X2	p-value	Observed	Expected	X2	p-value
Zone 1	silt	44.16	19.71	30.32		54.43	115.99	32.66		19.69	113.53	77.55		673.56	183.44	1309.45	
	gravel	42.34	19.71	25.96		45.91	115.99	42.33		47.07	113.53	38.91		144.16	183.44	8.41	
	cobble	28.45	19.71	3.87		94.79	115.99	3.87		54.78	113.53	30.4		95.68	183.44	41.98	
	boulder	39.53	19.71	19.91		75.31	115.99	14.27		55.63	113.53	29.52		289.29	183.44	61.08	
Zone 2	silt	16.59	19.71	0.49		39.98	115.99	49.81		100.78	113.53	1.43		398.18	183.44	251.37	
	gravel	0.00	19.71	19.71		120.61	115.99	0.18		95.39	113.53	2.9		10.97	183.44	162.17	
	cobble	2.29	19.71	15.4		163.8	115.99	19.71		150.02	113.53	11.73		12.76	183.44	158.81	
	boulder	0.00	19.71	19.71		221.67	115.99	96.29		253.15	113.53	171.73		26.39	183.44	134.46	
	riverine	4.07	19.71	12.41		227.38	115.99	106.98		245.22	113.53	152.77		0.00	183.44	183.44	
	Totals	177.43		147.79	p < 0.001	1043.87		366.12	p < 0.001	1021.74		516.93	p < 0.001	1651		2311.17	p < 0.001

		Lake Whitefish				Mountain Whitefish				Northern Squawfish				Pumpkinseed			
	Habitat	Observed	Expected	X2	p-value	Observed	Expected	X2	p-value	Observed	Expected	X2	p-value	Observed	Expected	X2	p-value
Zone 1	silt	6.47	10.5	1.55		0.00	5.22	5.22		174.82	678.69	374.08		2078.09	1567.64	166.21	
	gravel	27.36	10.5	27.04		8.46	5.22	2.01		196.45	678.69	342.65		2726.49	1567.64	856.66	
	cobble	4.26	10.5	3.71		0.00	5.22	5.22		303.45	678.69	207.47		2164.68	1567.64	227.38	
	boulder	12.66	10.5	0.44		0.00	5.22	5.22		293.85	678.69	218.21		2067.75	1567.64	159.55	
Zone 2	silt	0.00	10.5	10.5		0.00	5.22	5.22		650.4	678.69	1.18		1393.76	1567.64	19.29	
	gravel	5.47	10.5	2.41		3.27	5.22	0.73		713.88	678.69	1.83		2208.91	1567.64	262.32	
	cobble	6.77	10.5	1.33		5.13	5.22	0.00		1155.53	678.69	335.03		1411.79	1567.64	15.49	
	boulder	24.42	10.5	18.45		0.00	5.22	5.22		1133.91	678.69	305.34		55.61	1567.64	1458.4	
	riverine	7.13	10.5	1.09		30.15	5.22	118.98		1485.9	678.69	960.08		1.68	1567.64	1564.28	
	Totals	94.54		66.53	p < 0.001	47		147.83	p < 0.001	6108.2		2745.87	p < 0.001	14108.8		4729.58	p < 0.001

		Redside Shiner				Smallmouth Bass				Yellow Perch			
	Habitat	Observed	Expected	X2	p-value	Observed	Expected	X2	p-value	Observed	Expected	X2	p-value
Zone 1	silt	0.00	85.44	85.44		19.36	168.69	132.19		633.55	479.4	49.57	
	gravel	12.56	85.44	62.17		75.13	168.69	51.89		714.65	479.4	115.44	
	cobble	10.26	85.44	66.16		257.04	168.69	46.27		640.18	479.4	53.92	
	boulder	0.00	85.44	85.44		506.93	168.69	678.19		347.46	479.4	36.31	
Zone 2	silt	10.26	85.44	66.16		11.02	168.69	147.37		666.65	479.4	73.14	
	gravel	93.67	85.44	0.79		75.79	168.69	51.16		525.51	479.4	4.43	
	cobble	43.63	85.44	20.46		119.82	168.69	14.16		327.35	479.4	48.22	
	boulder	11.84	85.44	63.4		297.64	168.69	98.57		331.69	479.4	45.51	
	riverine	586.78	85.44	2941.54		155.49	168.69	1.03		127.55	479.4	258.24	
	Totals	769		3391.57	p < 0.001	1518.24		1220.8	p < 0.001	4314.59		684.79	p < 0.001

*Black crappie, burbot, cutthroat trout, bull trout, longnose sucker, brown trout, lake trout, northern pike, rainbow trout, and walleye were present but not sampled in numbers sufficient to conduct chi-square tests.

Table A-2. Chi-square analysis of habitat utilization for fishes sampled from Noxon Reservoir during the fall of 1994.

		Peamouth				Largescale Sucker				Largemouth Bass				Northern Squawfish			
	Habitat	Observed	Expected	χ^2	p-value	Observed	Expected	χ^2	p-value	Observed	Expected	χ^2	p-value	Observed	Expected	χ^2	p-value
Zone 1	silt	30.99	26.00	0.96		30.56	13.54	21.39		41.10	36.89	0.48		15.20	71.19	44.04	
	gravel	15.46	26.00	4.27		7.35	13.54	2.83		92.70	36.89	84.45		32.66	71.19	20.85	
	cobble	27.83	26.00	0.13		6.79	13.54	3.36		31.26	36.89	0.86		46.20	71.19	8.77	
	boulder	19.03	26.00	1.87		11.97	13.54	0.18		145.75	36.89	321.27		61.12	71.19	1.42	
Zone 2	silt	16.79	26.00	3.26		14.47	13.54	0.06		20.22	36.89	7.53		3.36	71.19	64.62	
	gravel	36.93	26.00	4.60		9.99	13.54	0.93		0.97	36.89	34.98		35.07	71.19	18.33	
	cobble	43.08	26.00	11.23		17.09	13.54	0.93		0.00	36.89	36.89		118.88	71.19	31.95	
	boulder	42.49	26.00	10.47		10.79	13.54	0.56		0.00	36.89	36.89		153.13	71.19	94.33	
	riverine	1.36	26.00	23.34		12.85	13.54	0.04		0.00	36.89	36.89		175.07	71.19	151.59	
	Totals	233.96		60.13	$p < 0.001$	121.88		30.29	$p < 0.001$	332.00		560.24	$p < 0.001$	640.70		435.89	$p < 0.001$

		Pumpkinseed				Redside Shiner				Smallmouth Bass				Yellow Perch			
	Habitat	Observed	Expected	χ^2	p-value	Observed	Expected	χ^2	p-value	Observed	Expected	χ^2	p-value	Observed	Expected	χ^2	p-value
Zone 1	silt	630.86	427.33	96.94		0.00	4.22	4.22		0.00	6.21	6.21		125.25	107.64	2.88	
	gravel	573.38	427.33	49.92		0.00	4.22	4.22		4.51	6.21	0.46		144.44	107.64	12.58	
	cobble	930.74	427.33	593.03		2.37	4.22	0.81		7.56	6.21	0.30		74.33	107.64	10.31	
	boulder	454.71	427.33	1.75		0.00	4.22	4.22		25.41	6.21	59.39		81.63	107.64	6.29	
Zone 2	silt	265.47	427.33	61.31		0.00	4.22	4.22		0.00	6.21	6.21		249.57	107.64	187.14	
	gravel	750.62	427.33	244.57		0.03	4.22	4.15		4.99	6.21	0.24		115.72	107.64	0.61	
	cobble	203.48	427.33	117.26		8.46	4.22	4.25		0.00	6.21	6.21		73.28	107.64	10.97	
	boulder	0.00	427.33	427.33		10.15	4.22	8.32		7.48	6.21	0.26		67.25	107.64	15.16	
	riverine	36.73	427.33	357.04		16.99	4.22	38.60		5.91	6.21	0.01		37.31	107.64	45.95	
	Totals	3846.00		1949.16	$p < 0.001$	38.00		73.03	$p < 0.001$	55.86		79.29	$p < 0.001$	968.76		291.88	$p < 0.001$

[a]Black crappie, black bullhead, burbot, cutthroat trout, bull trout, longnose sucker, brown trout, lake trout, mountain whitefish, northern pike, rainbow trout, and walleye were present but not sampled in numbers sufficient to conduct chi-square tests.

Table A-3. Chi-square analysis of habitat utilization for fishes sampled from Cabinet Reservoir during the summer of 1994.

	Black Bullhead				Peamouth				Largescale Sucker				Longnose Sucker			
Habitat	Observed	Expected	χ^2	p-value	Observed	Expected	χ^2	p-value	Observed	Expected	χ^2	p-value	Observed	Expected	χ^2	p-value
silt	267.91	68.25	584.10		119.40	159.69	10.16		131.74	266.87	68.43		54.33	69.75	3.41	
gravel	2.19	68.25	63.95		128.76	159.69	5.99		241.47	266.87	2.42		28.89	69.75	23.93	
CoBo	2.90	68.25	62.57		250.12	159.69	51.21		534.70	266.87	268.78		181.58	69.75	179.29	
riverine	0.00	68.25	68.25		140.48	159.69	2.31		159.59	266.87	43.13		14.20	69.75	44.24	
Totals	273.00		778.87	$p < 0.001$	638.76		69.67	$p < 0.001$	1067.50		382.76	$p < 0.001$	279.00		250.86	$p < 0.001$

	Brown Trout				Largemouth Bass				Lake Whitefish				Mountain Whitefish			
Habitat	Observed	Expected	χ^2	p-value	Observed	Expected	χ^2	p-value	Observed	Expected	χ^2	p-value	Observed	Expected	χ^2	p-value
silt	1.50	9.73	6.96		45.01	12.75	81.65		0.00	6.50	6.50		2.43	11.50	7.16	
gravel	8.47	9.73	0.16		0.49	12.75	11.80		0.00	6.50	6.50		1.60	11.50	8.52	
CoBo	21.10	9.73	13.31		0.00	12.75	12.75		18.58	6.50	22.46		25.30	11.50	16.55	
riverine	7.84	9.73	0.37		5.50	12.75	4.12		7.42	6.50	0.13		16.67	11.50	2.33	
Totals	38.91		20.80	$p < 0.001$	51.00		110.32	$p < 0.001$	26.00		35.59	$p < 0.001$	46.00		34.55	$p < 0.001$

	Northern Squawfish				Pumpkinseed				Rainbow Trout				Redside Shiner			
Habitat	Observed	Expected	χ^2	p-value	Observed	Expected	χ^2	p-value	Observed	Expected	χ^2	p-value	Observed	Expected	χ^2	p-value
silt	244.97	348.21	30.61		602.21	272.00	400.88		4.21	6.00	0.53		212.45	749.81	385.11	
gravel	210.45	348.21	54.50		261.91	272.00	0.37		2.31	6.00	2.27		802.14	749.81	3.65	
CoBo	551.13	348.21	118.26		172.05	272.00	36.72		1.74	6.00	3.03		1429.61	749.81	616.32	
Riverine	386.28	348.21	4.16		51.82	272.00	178.23		15.74	6.00	15.82		555.05	749.81	50.59	
Totals	1392.82		207.53	$p < 0.001$	1088.00		616.20	$p < 0.001$	24.00		21.65	$p < 0.001$	2999.26		1055.67	$p < 0.001$

	Smallmouth Bass				Yellow Perch			
Habitat	Observed	Expected	χ^2	p-value	Observed	Expected	χ^2	p-value
silt	2.55	4.75	1.02		510.17	397.19	32.13	
gravel	0.51	4.75	3.78		352.71	397.19	4.98	
CoBo	1.75	4.75	1.90		359.98	397.19	3.49	
Riverine	14.19	4.75	18.77		365.92	397.19	2.46	
Totals	19.00		25.47	$p < 0.001$	1588.78		43.06	$p < 0.001$

'Black crappie, burbot, cutthroat trout, bull trout, lake trout, northern pike, and walleye were present but not sampled in numbers sufficient to conduct chi-square tests.

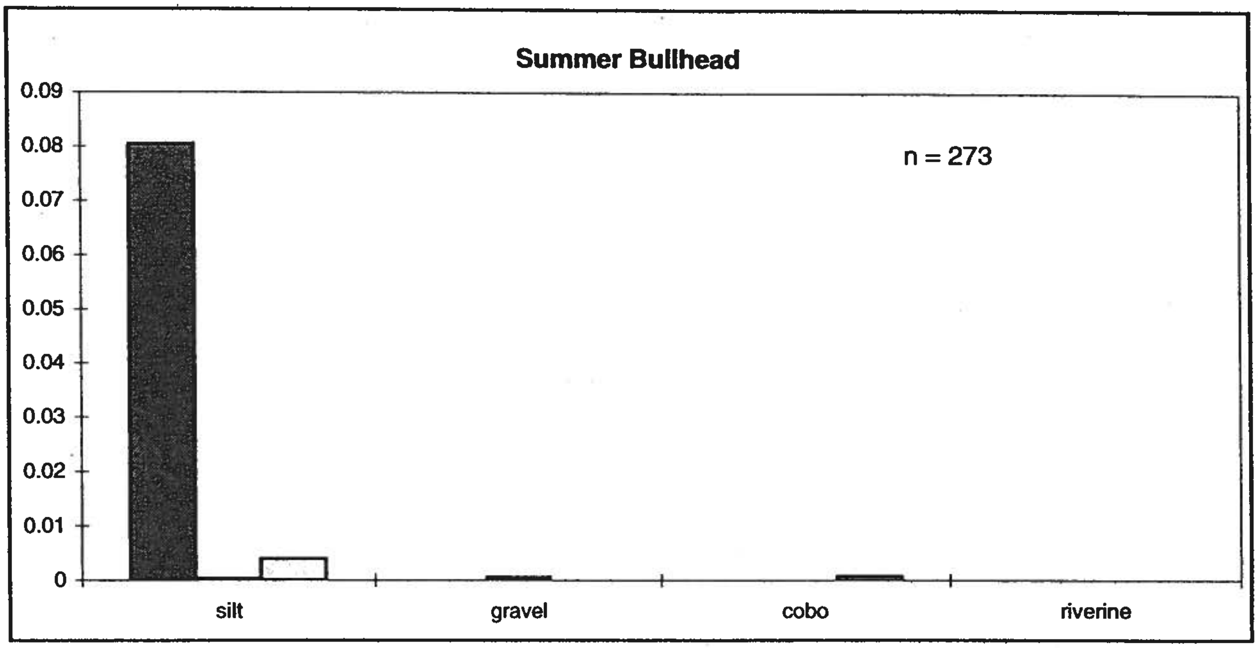
Table A-4. Chi-square analysis of habitat utilization for fishes sampled from Cabinet Reservoir during the fall of 1994.

	Peamouth				Largescale Sucker				Longnose Sucker				Brown Trout			
Habitat	Observed	Expected	χ^2	p-value	Observed	Expected	χ^2	p-value	Observed	Expected	χ^2	p-value	Observed	Expected	χ^2	p-value
silt	46.07	55.01	1.45		14.09	24.25	4.26		2.63	4.00	0.47		1.25	5.00	2.82	
gravel	59.56	55.01	0.38		25.27	24.25	0.04		2.32	4.00	0.70		1.56	5.00	2.37	
CoBo	104.91	55.01	45.27		36.75	24.25	6.44		10.78	4.00	11.50		15.69	5.00	22.83	
riverine	9.50	55.01	37.65		20.89	24.25	0.46		0.26	4.00	3.49		1.51	5.00	2.43	
Totals	220.03		84.75	$p < 0.001$	97.00		11.21	$p < 0.05$	16.00		16.15	$p < 0.01$	20.00		30.46	$p < 0.001$

	Mountain Whitefish				Northern Squawfish				Pumpkinseed				Redside Shiner			
Habitat	Observed	Expected	χ^2	p-value	Observed	Expected	χ^2	p-value	Observed	Expected	χ^2	p-value	Observed	Expected	χ^2	p-value
silt	23.91	15.87	4.07		49.59	55.37	0.60		51.53	32.25	11.53		16.33	143.25	112.45	
gravel	9.19	15.87	2.81		54.75	55.37	0.01		22.54	32.25	2.92		98.74	143.25	13.83	
CoBo	20.13	15.87	1.15		84.08	55.37	14.88		3.78	32.25	25.13		306.46	143.25	185.94	
riverine	10.23	15.87	2.00		33.08	55.37	8.97		51.14	32.25	11.07		151.47	143.25	0.47	
Totals	63.46		10.03	$p < 0.05$	221.49		24.46	$p < 0.001$	129.00		50.65	$p < 0.001$	573.00		312.69	$p < 0.001$

	Yellow Perch			
Habitat	Observed	Expected	χ^2	p-value
silt	36.25	25.48	4.55	
gravel	14.42	25.48	4.80	
CoBo	17.36	25.48	2.58	
riverine	33.88	25.48	2.77	
Totals	101.91		14.71	$p < 0.01$

[*]Black crappie, black bullhead, burbot, cutthroat trout, bull trout, largemouth bass, lake trout, lake whitefish, northern pike, rainbow trout, smallmouth bass, and walleye were present but not sampled in numbers sufficient to conduct chi-square tests.



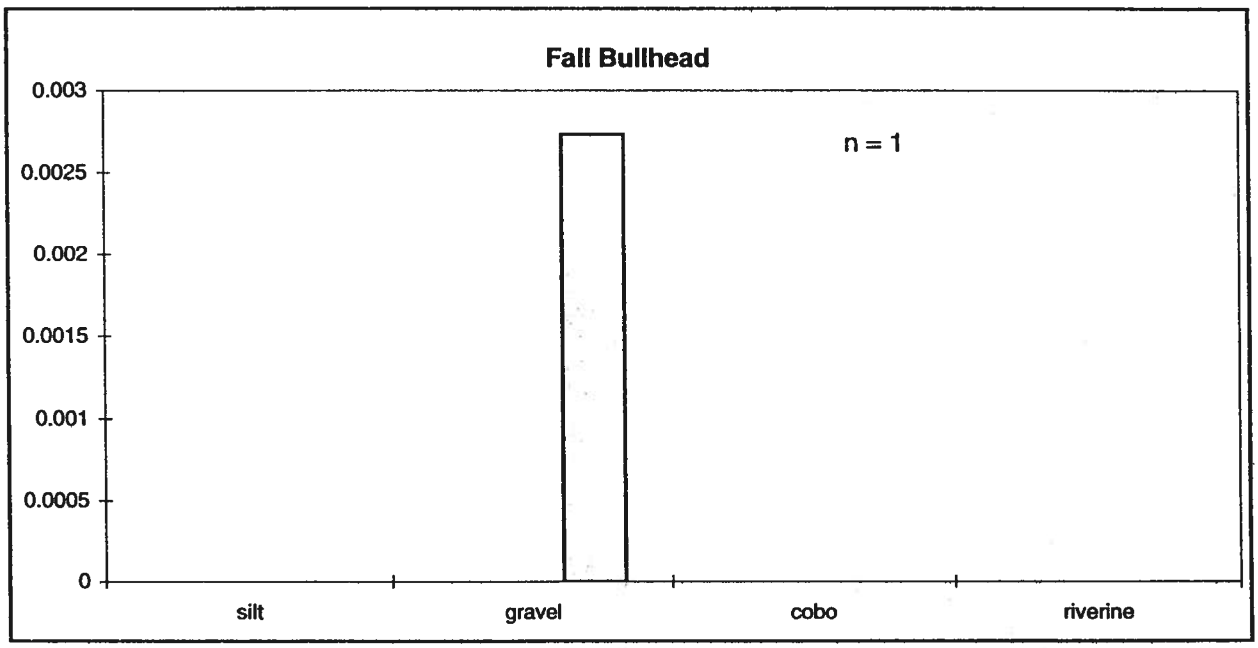
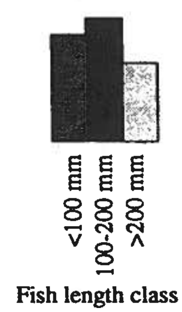
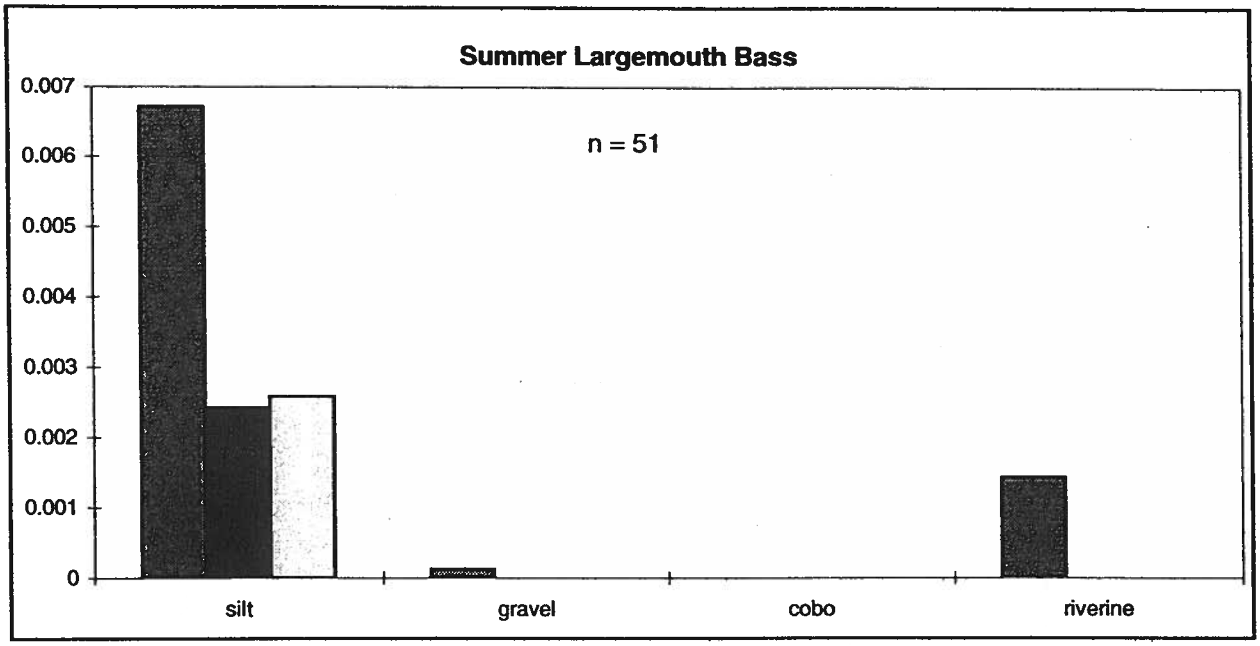


Figure A-1. Relative abundance (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Cabinet Gorge Reservoir.





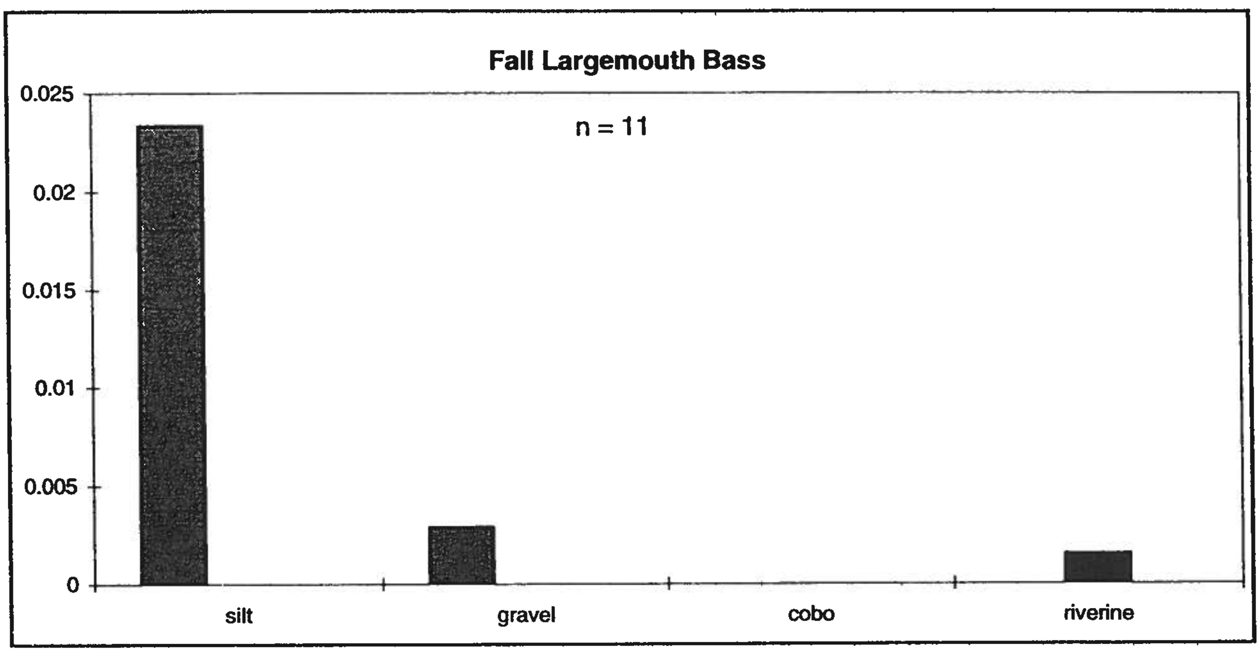
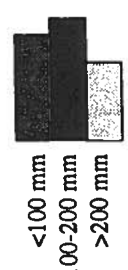
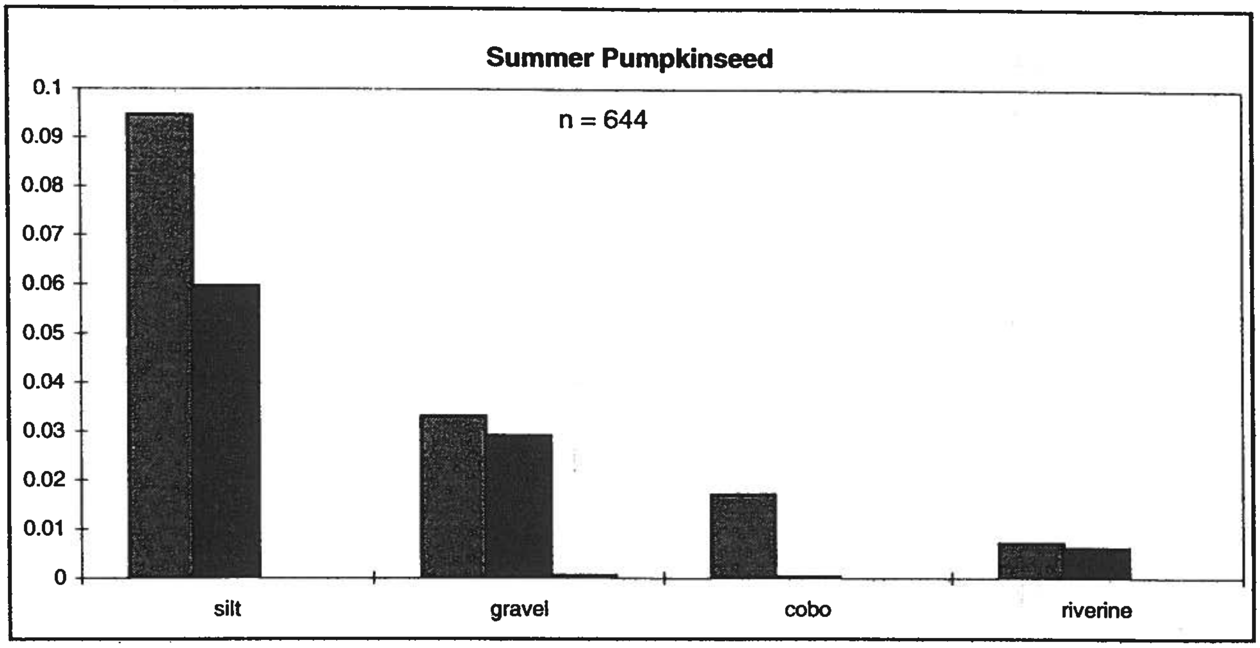


Figure A-1. Relative abundance (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Cabinet Gorge Reservoir.



Fish length class



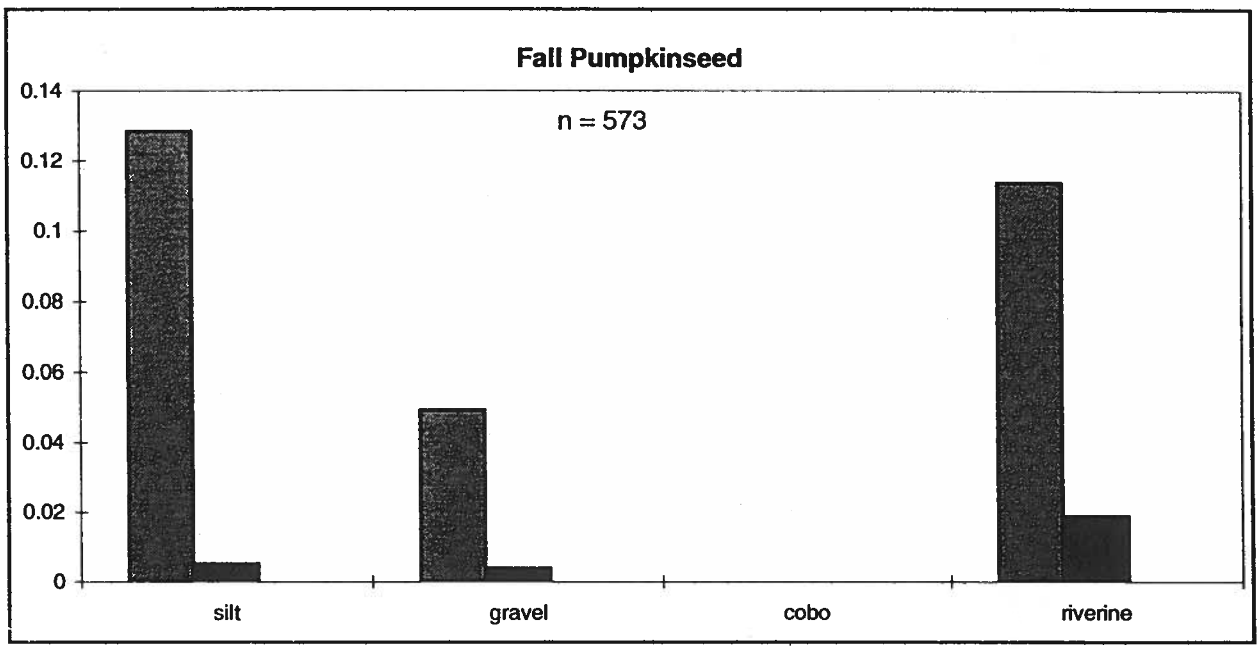
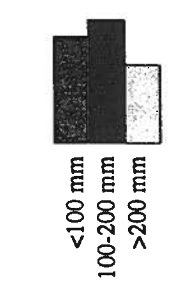


Figure A-1. Relative abundance (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Cabinet Gorge Reservoir.



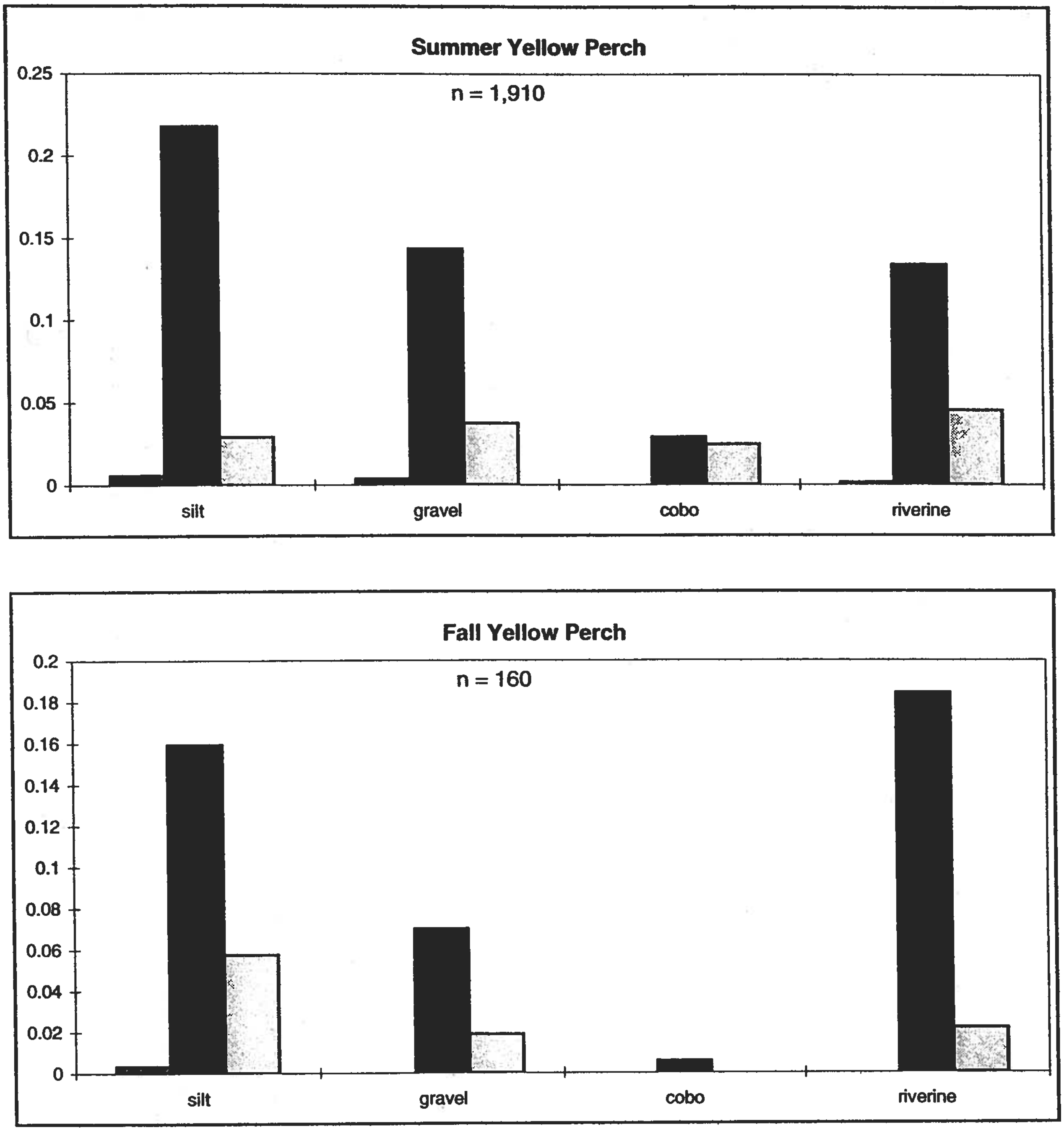
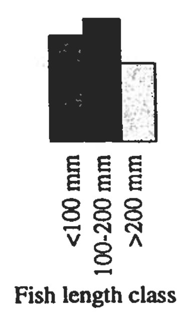


Figure A-1. Relative abundance (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Cabinet Gorge Reservoir.



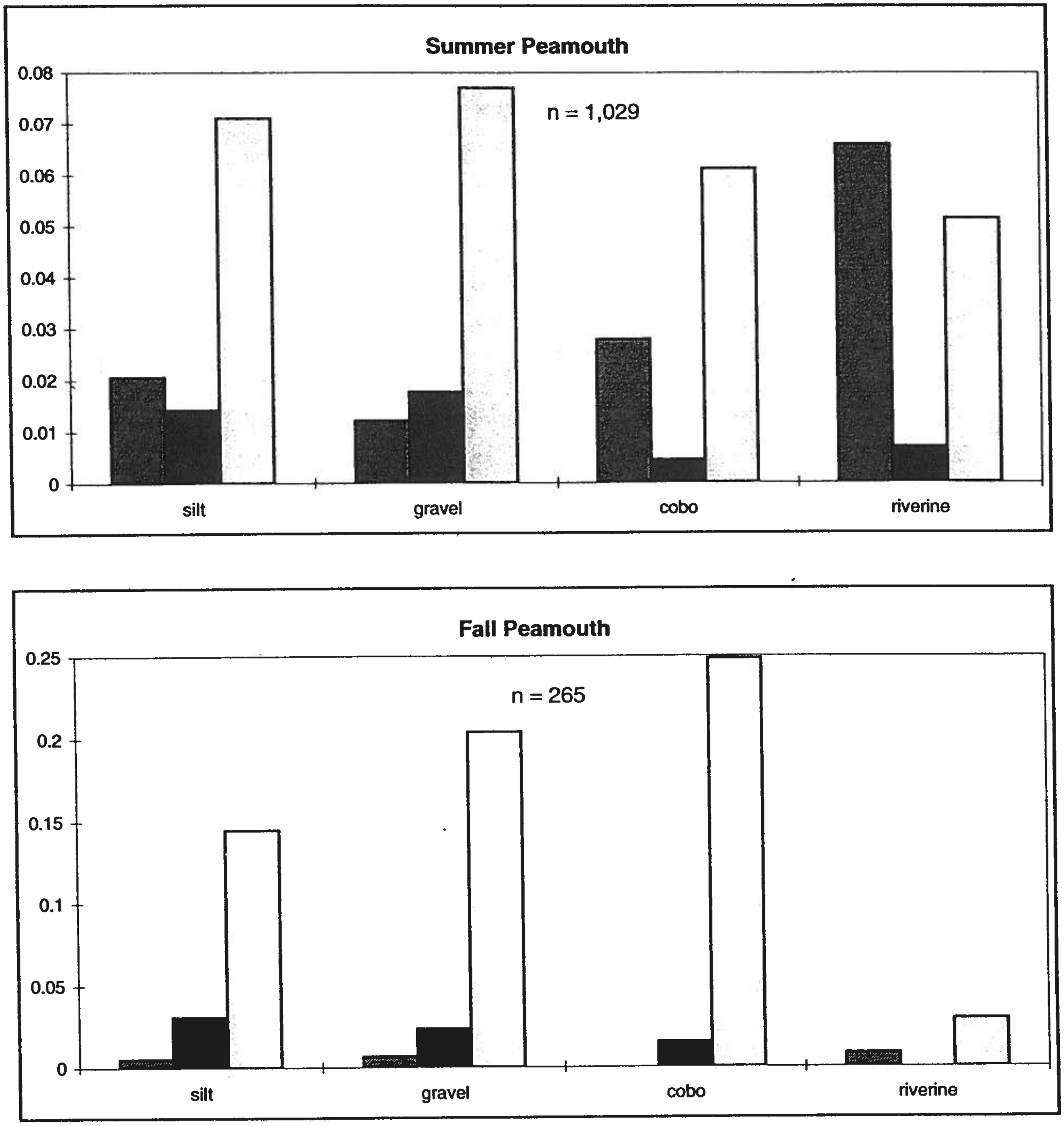
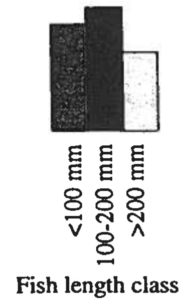


Figure A-1. Relative abundance (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Cabinet Gorge Reservoir.



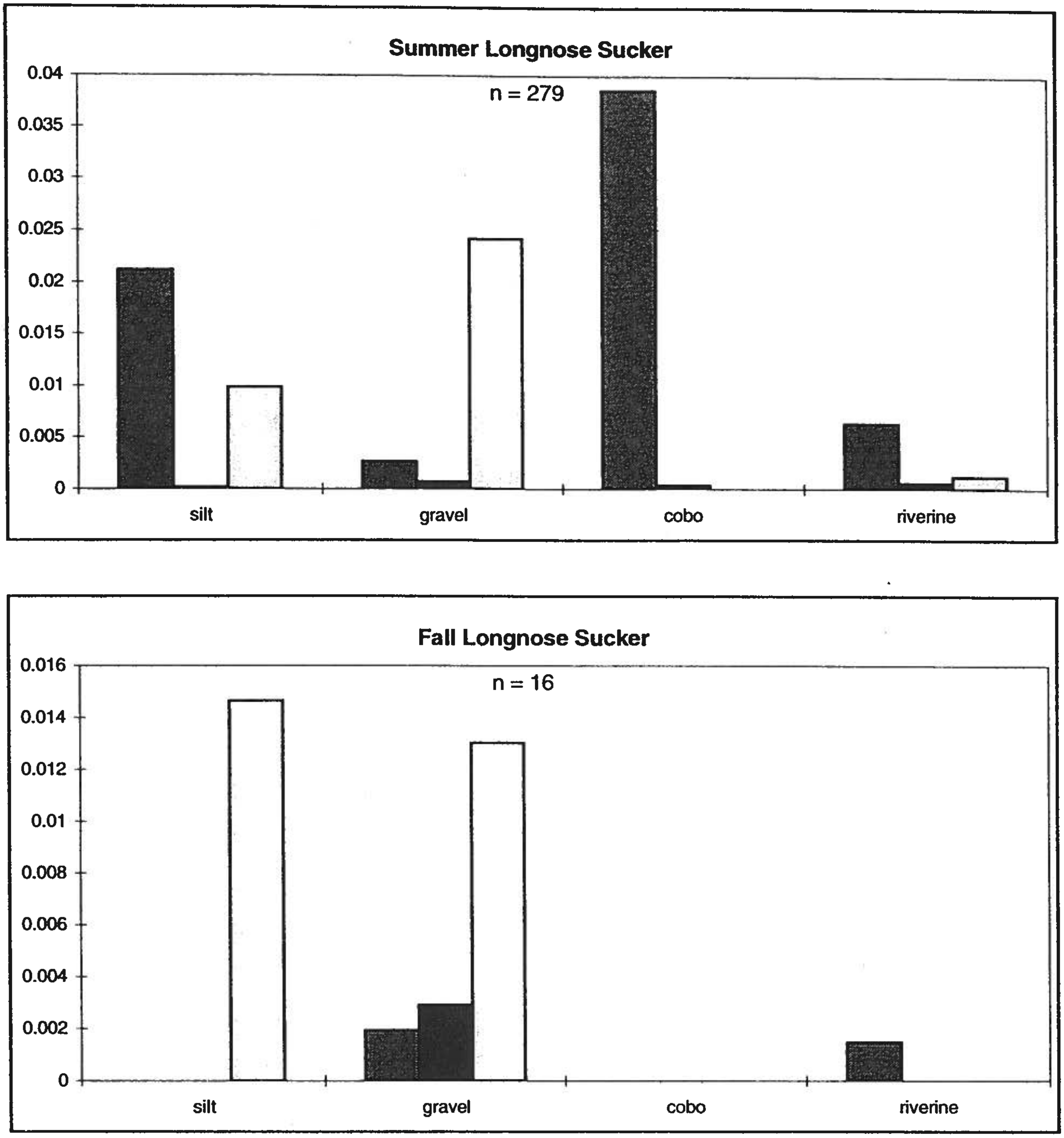
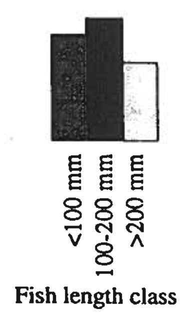
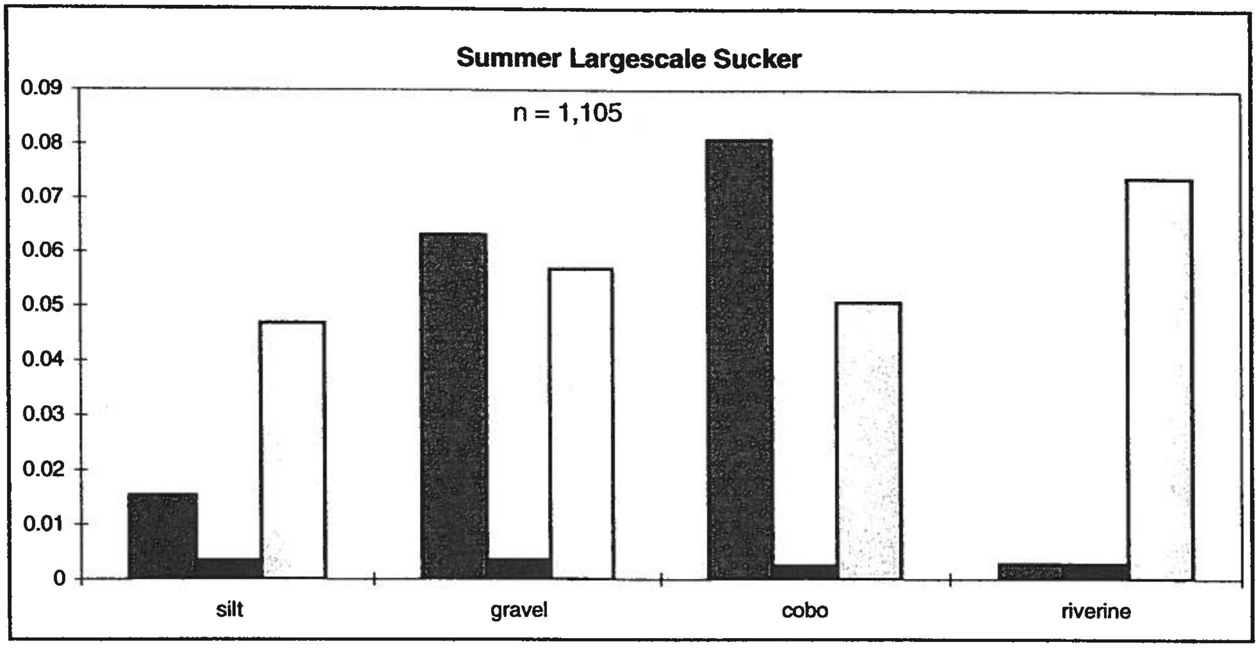


Figure A-1. Relative abundance (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Cabinet Gorge Reservoir.





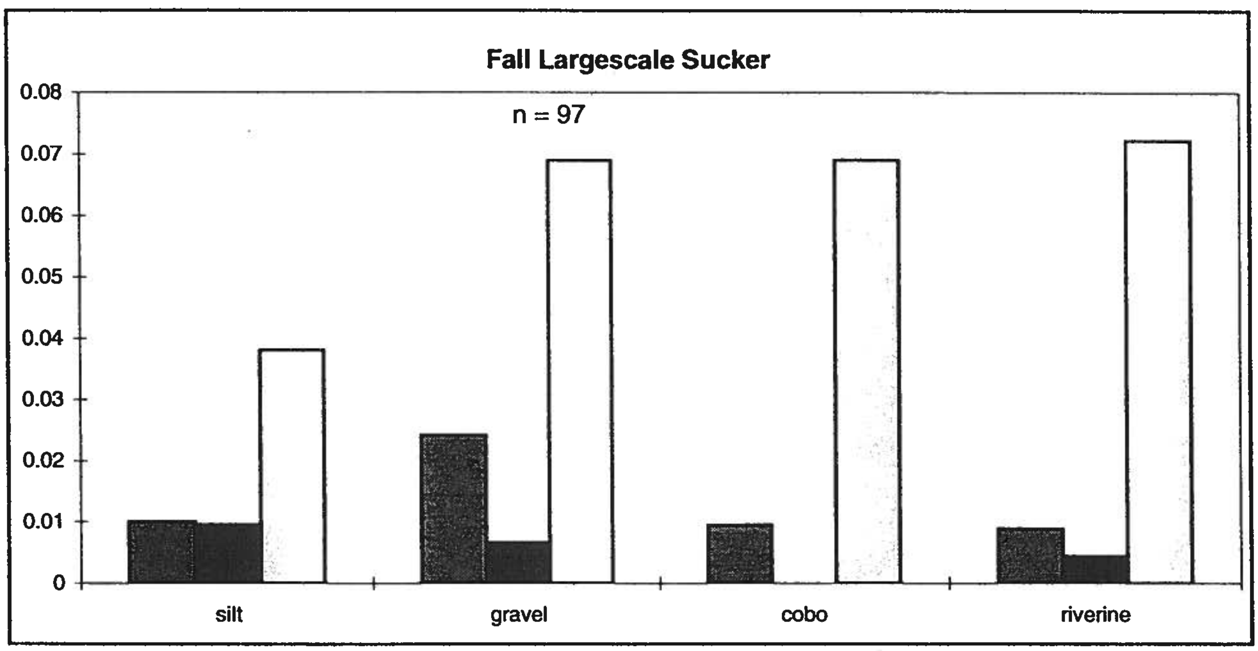
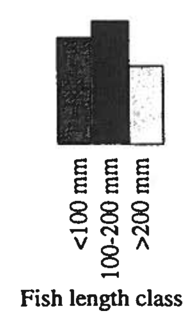
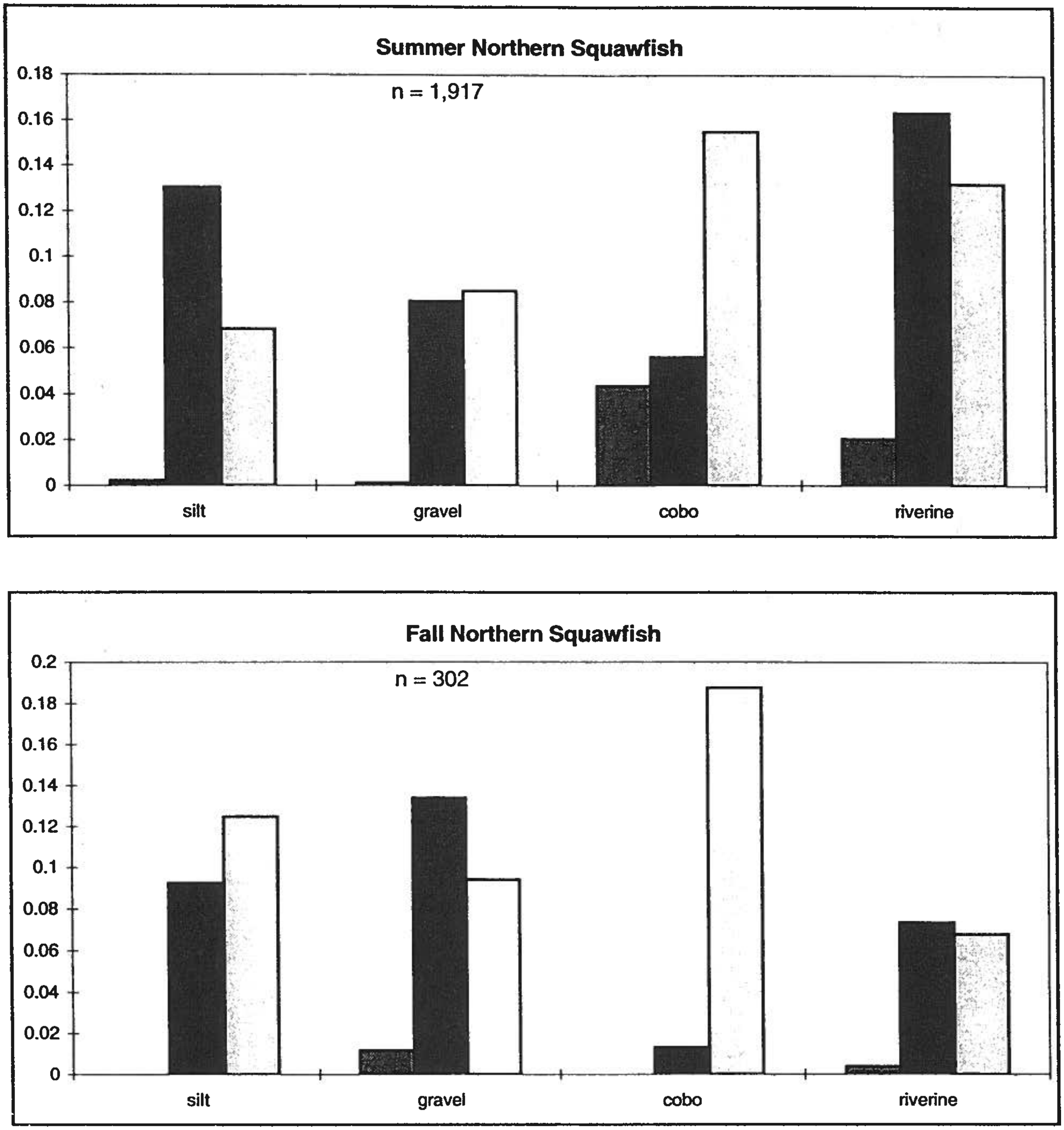


Figure A-1. Relative abundance (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Cabinet Gorge Reservoir.





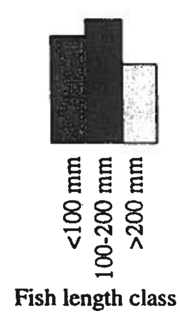
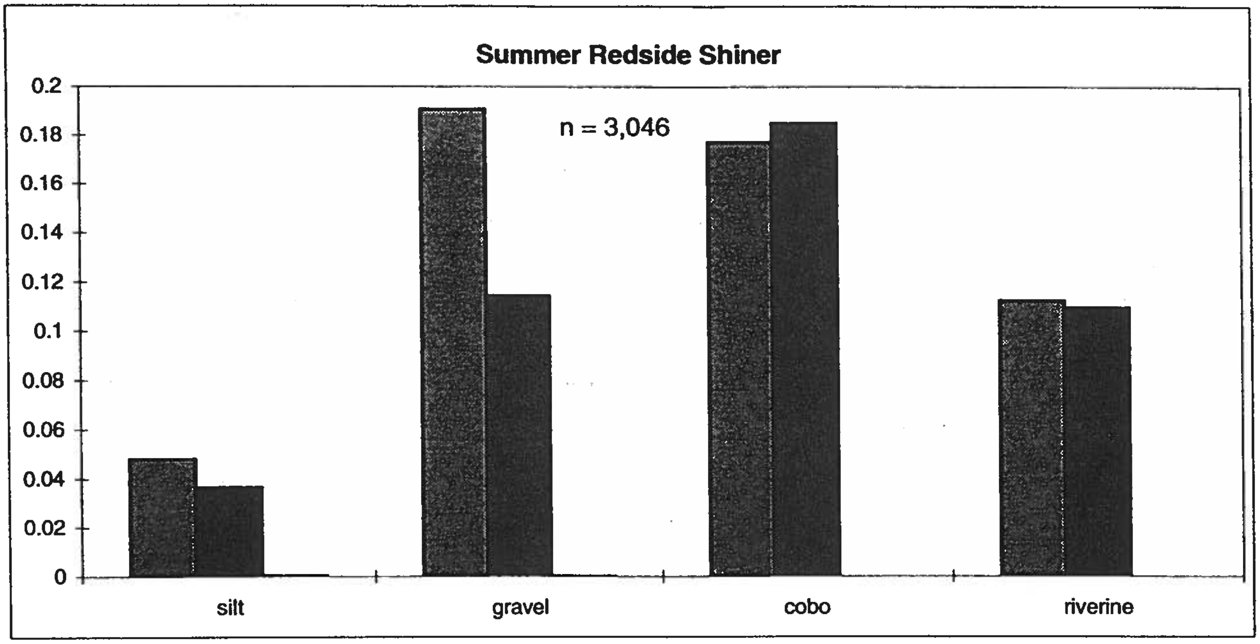


Figure A-1. Relative abundance (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Cabinet Gorge Reservoir.



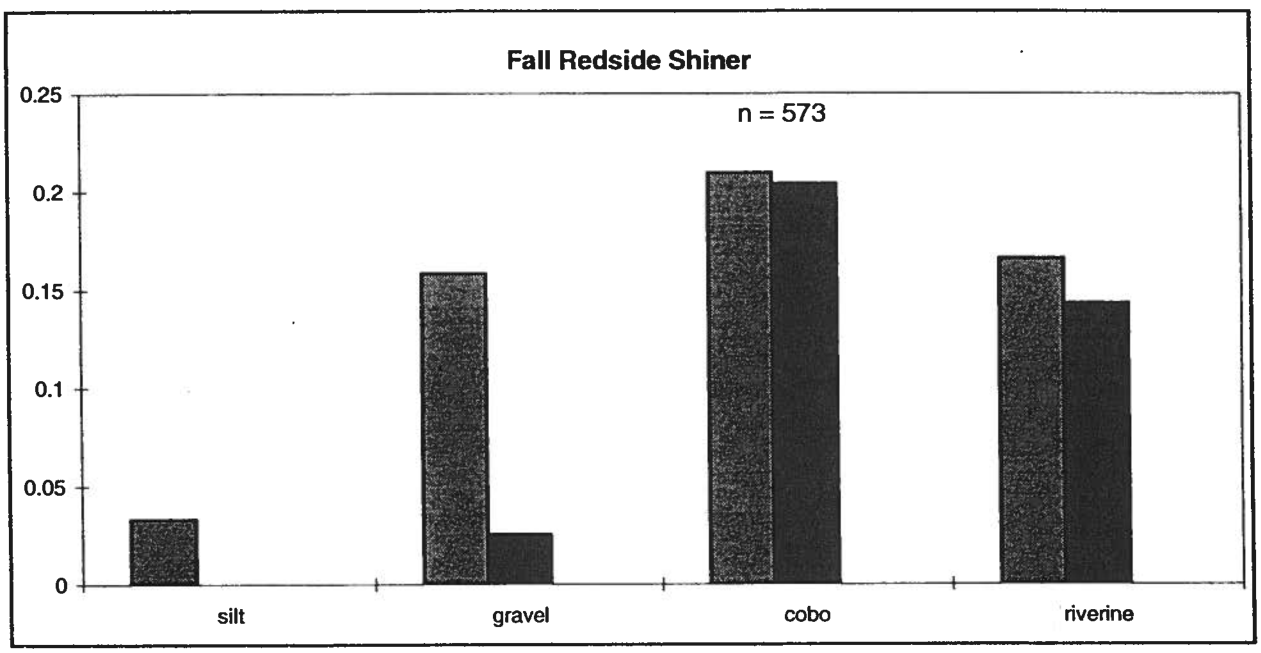
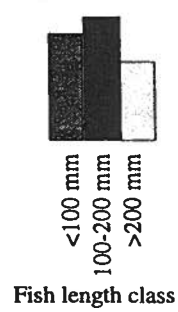
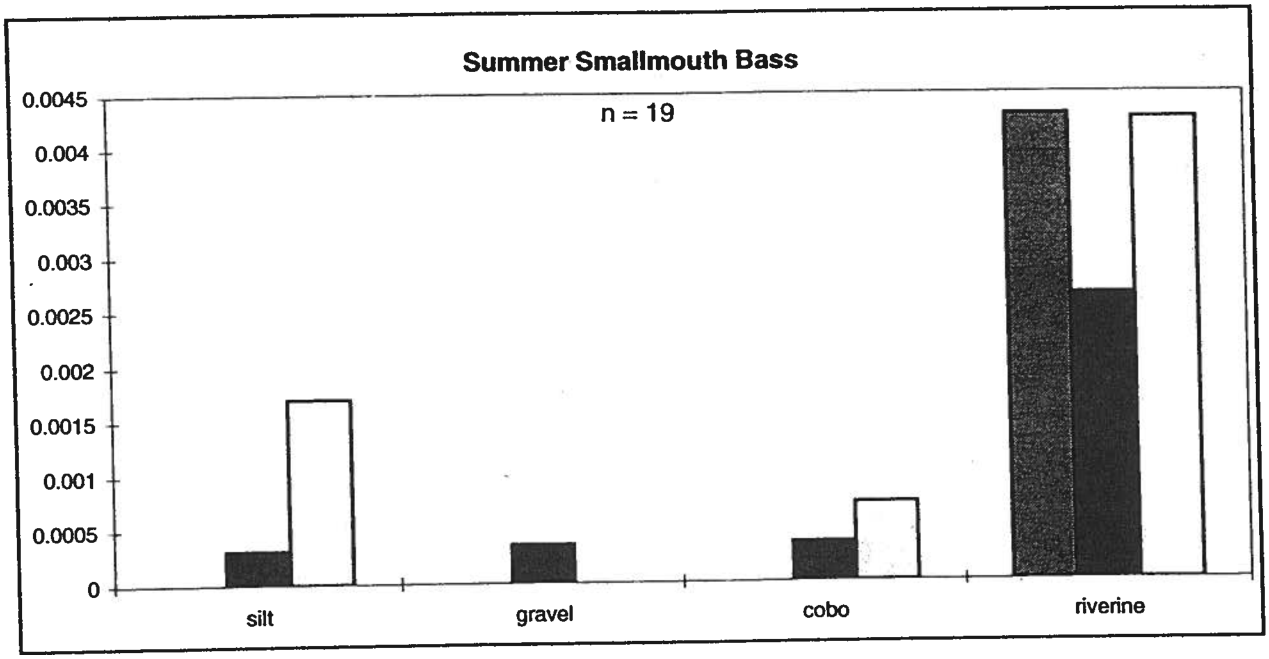


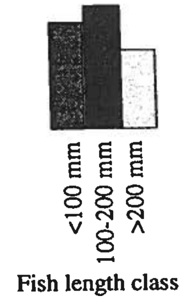
Figure A-1. Relative abundance (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Cabinet Gorge Reservoir.

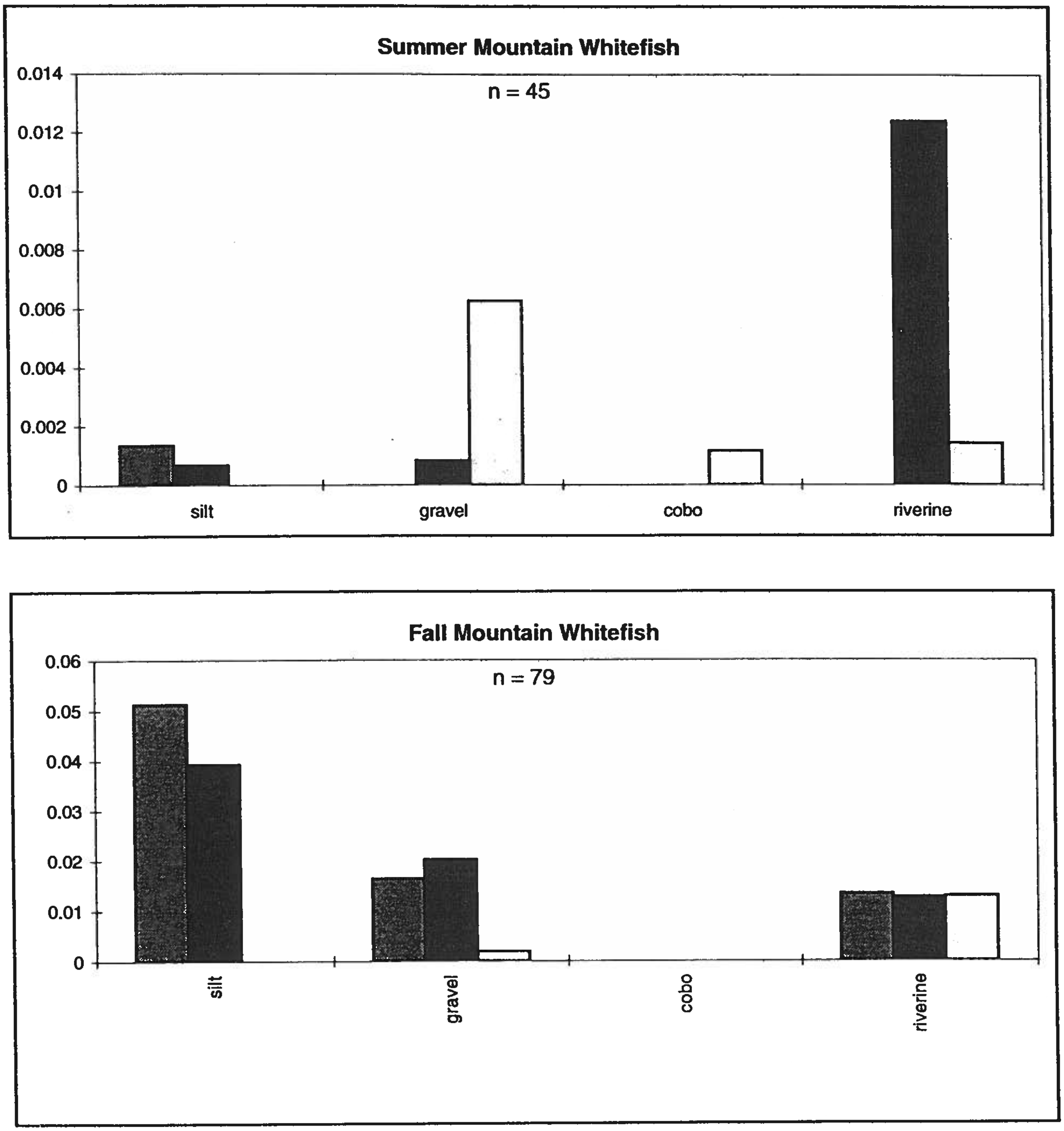




No smallmouth bass were sampled during the fall.

Figure A-1. Relative abundance (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Cabinet Gorge Reservoir.





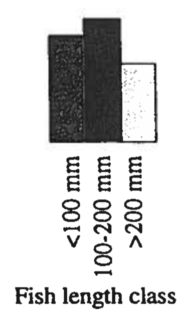
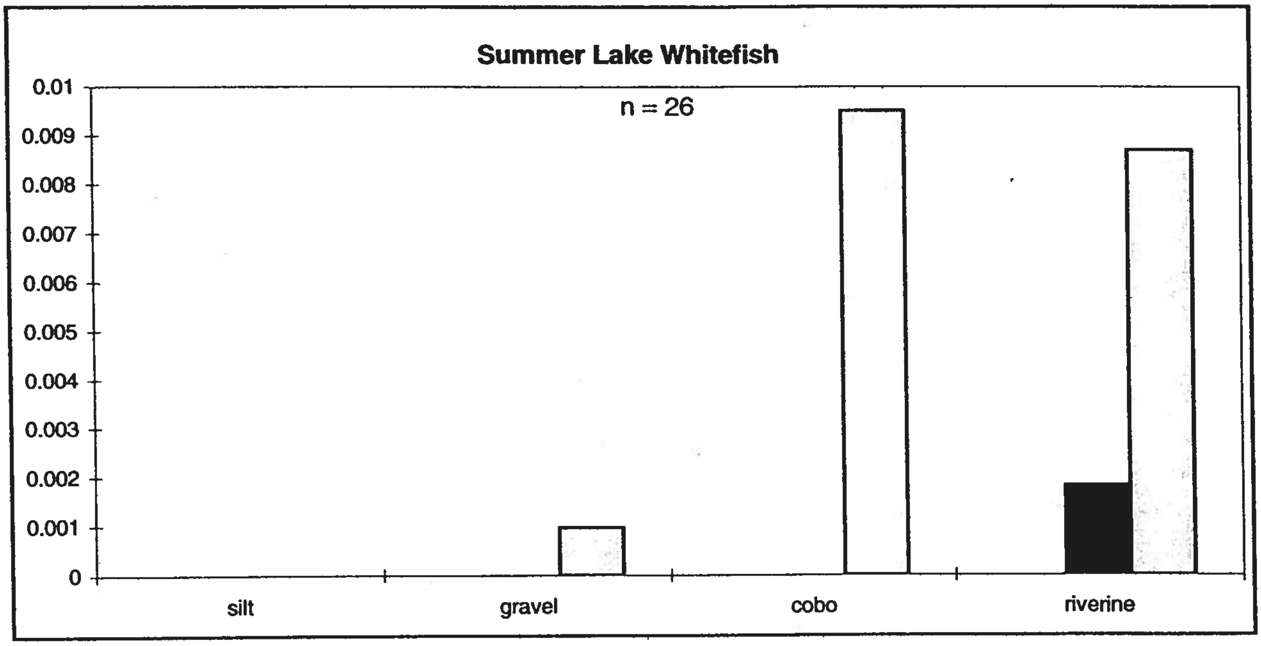


Figure A-1. Relative abundance (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Cabinet Gorge Reservoir.



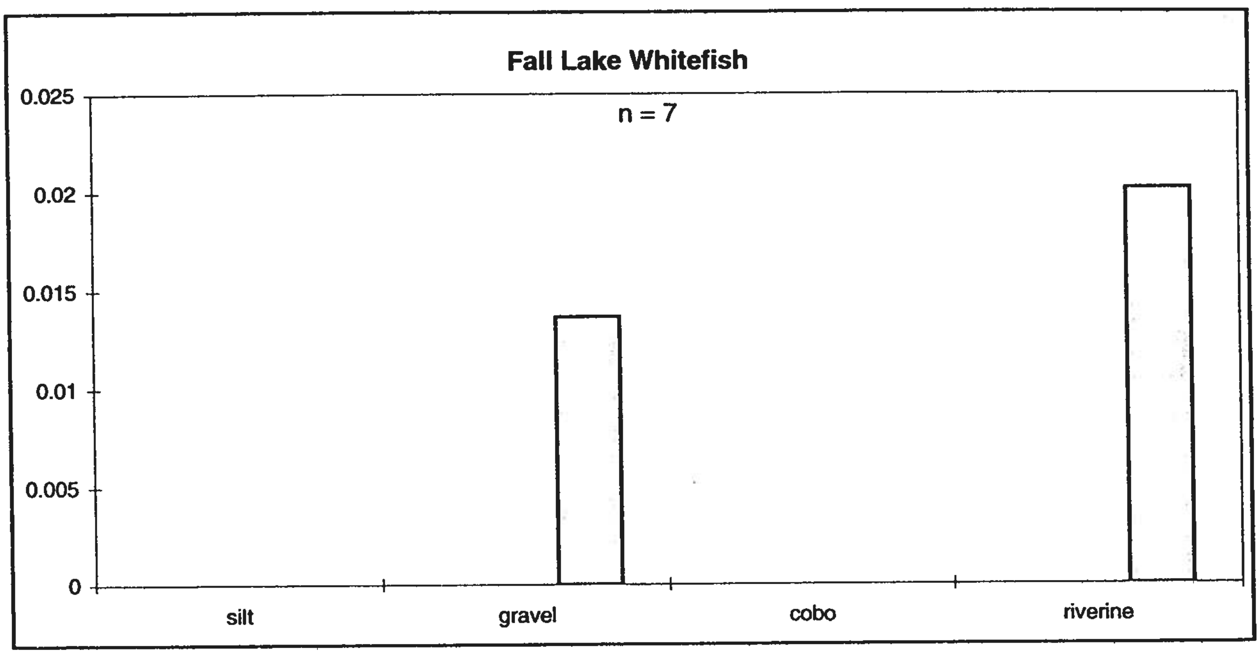
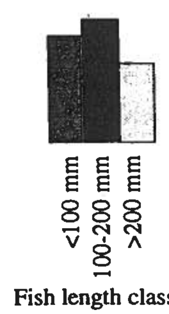
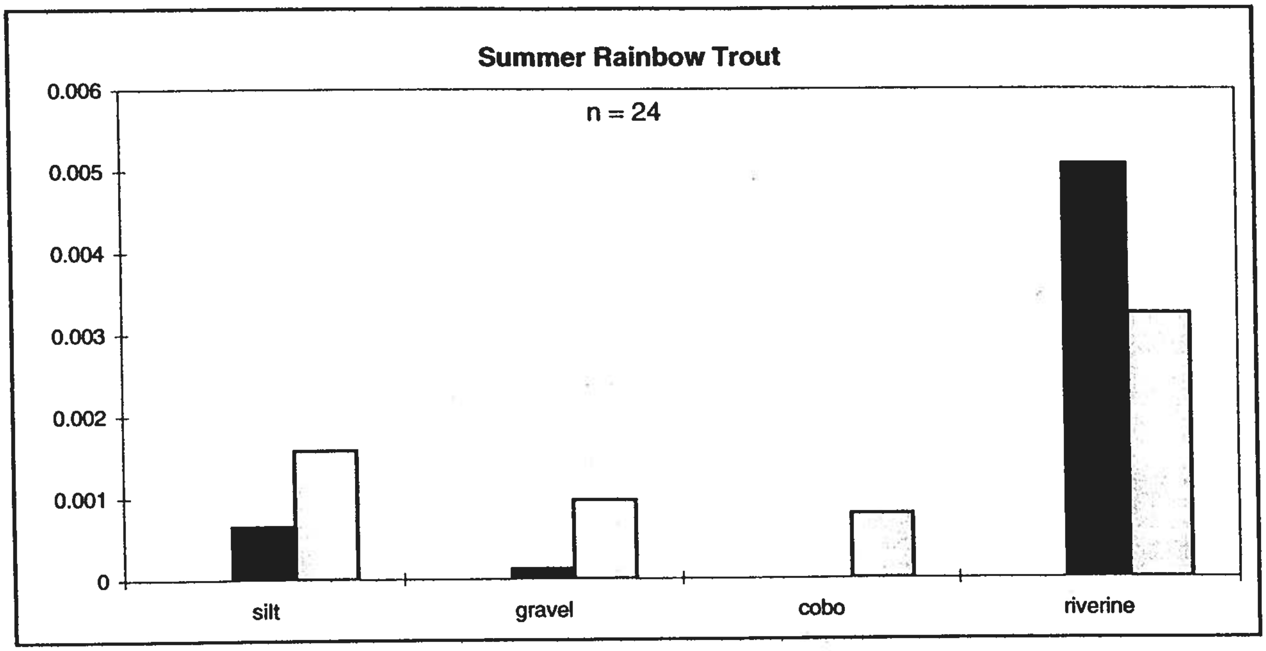


Figure A-1. Relative abundance (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Cabinet Gorge Reservoir.





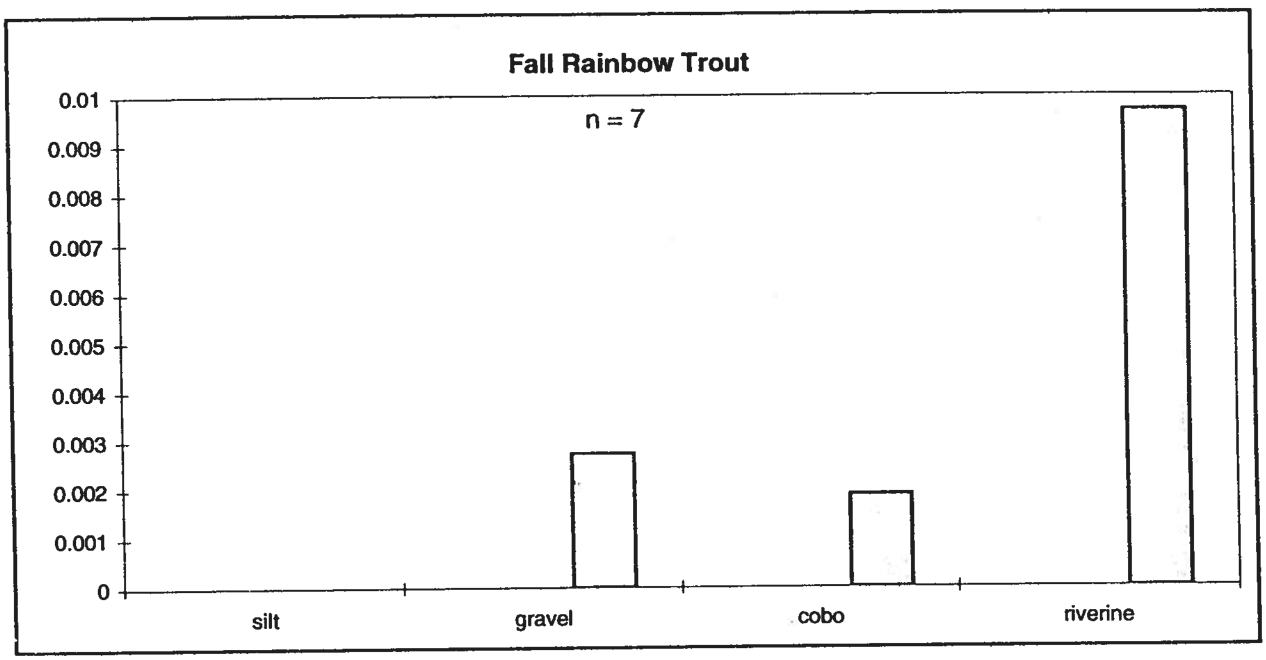
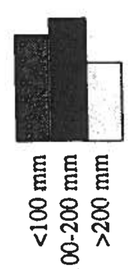
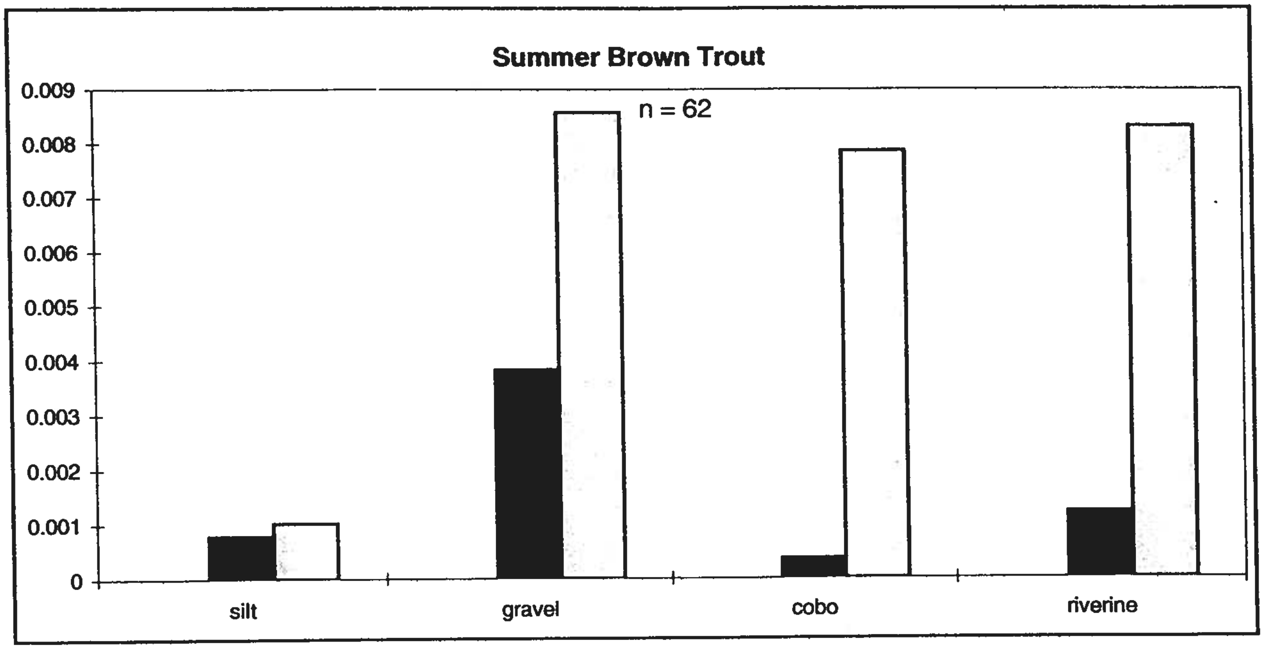


Figure A-1. Relative abundance (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Cabinet Gorge Reservoir.





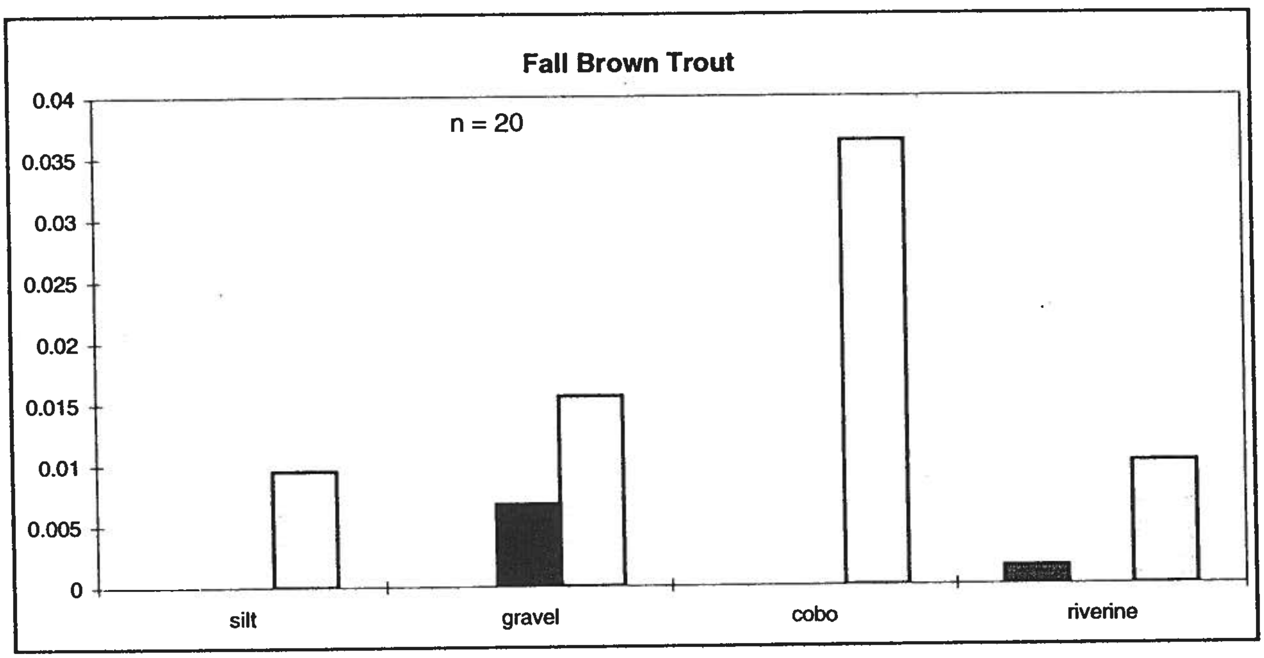
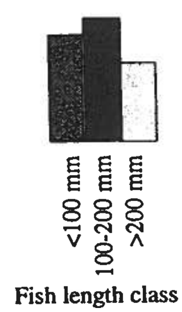
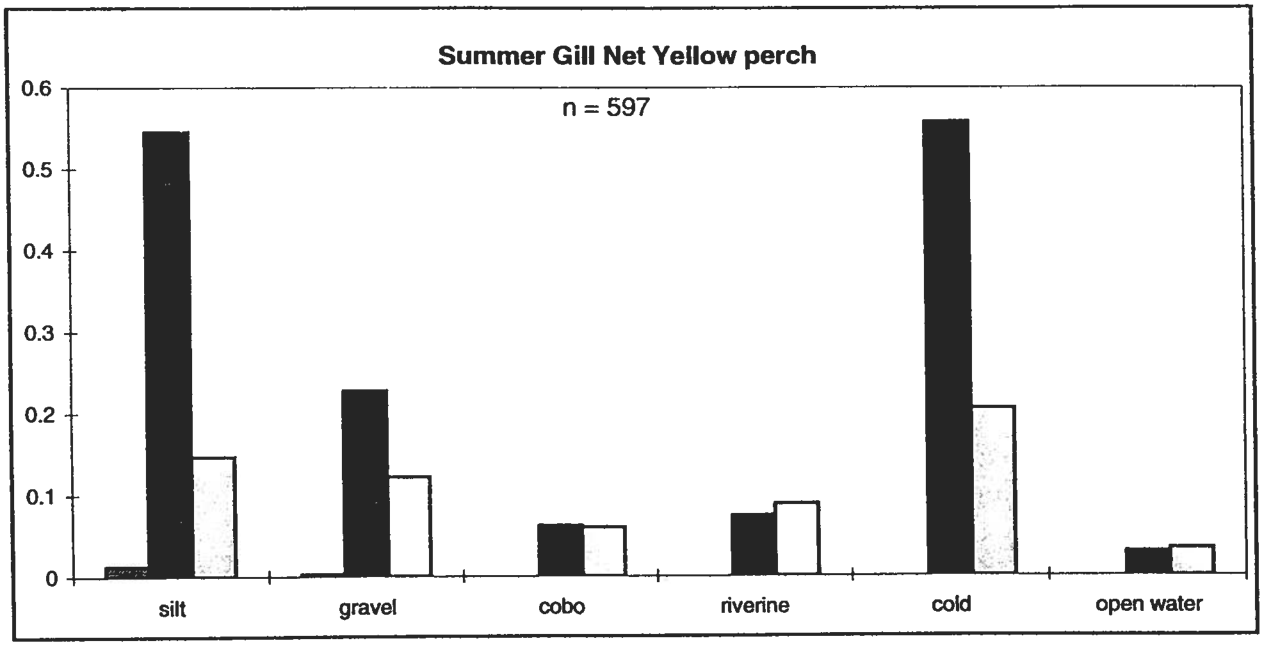
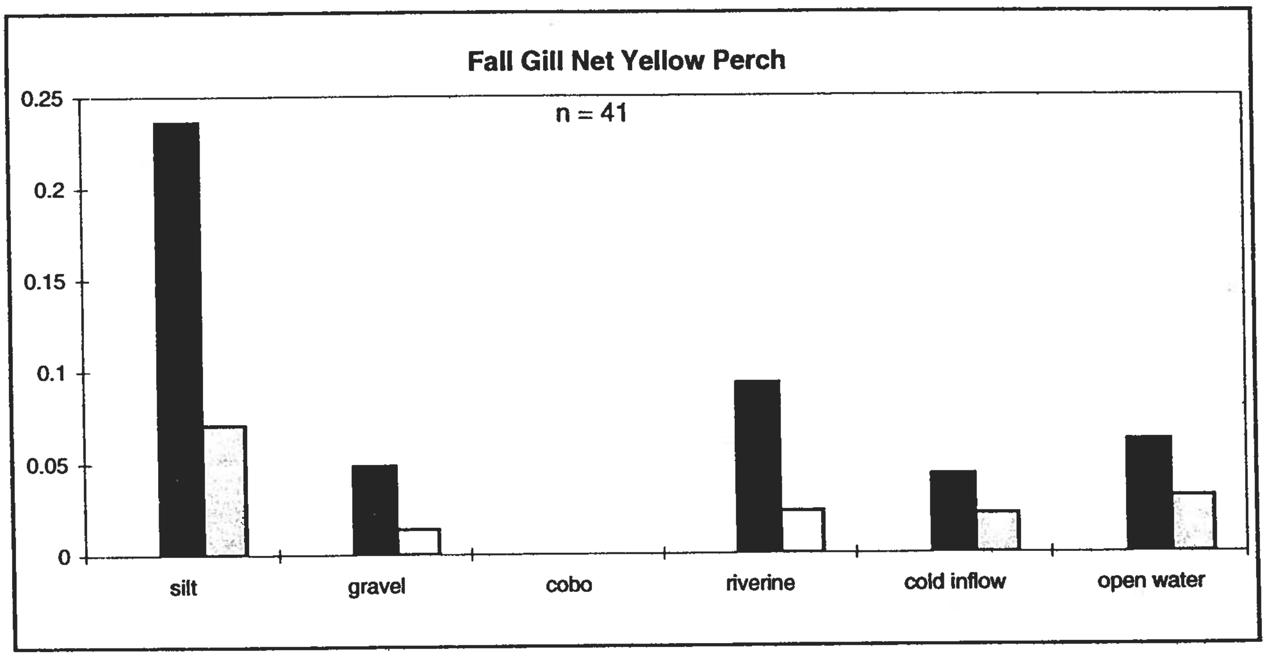


Figure A-1. Relative abundance (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Cabinet Gorge Reservoir.







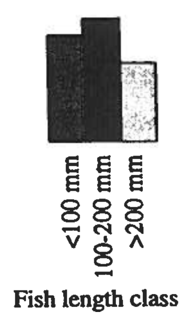
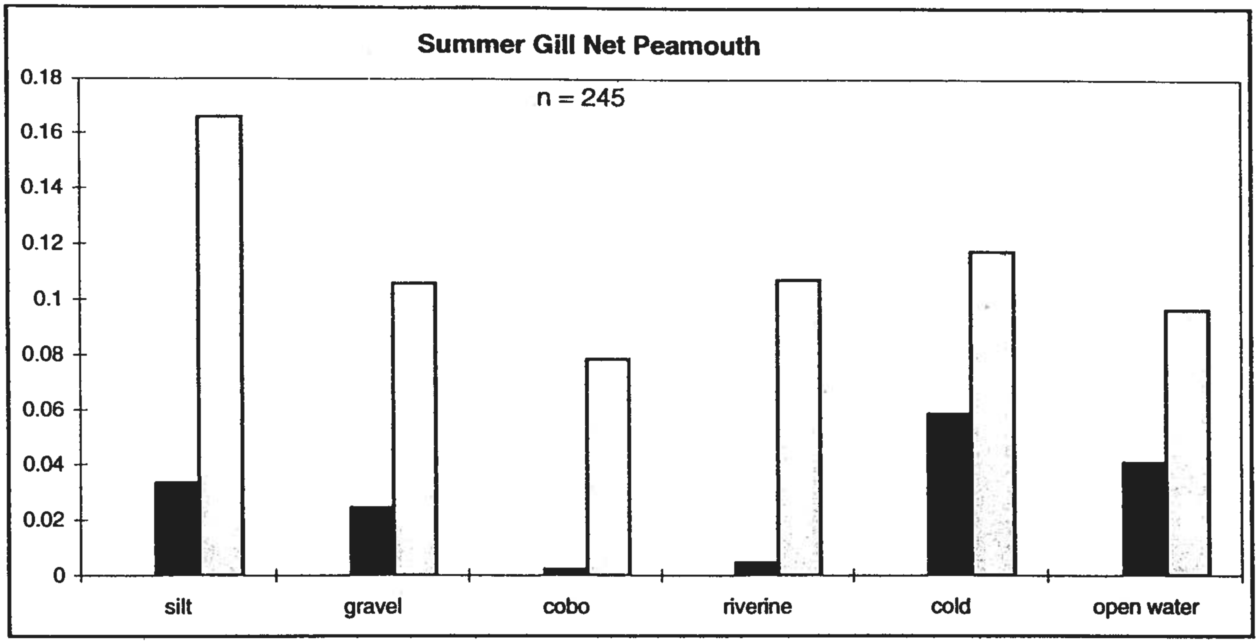
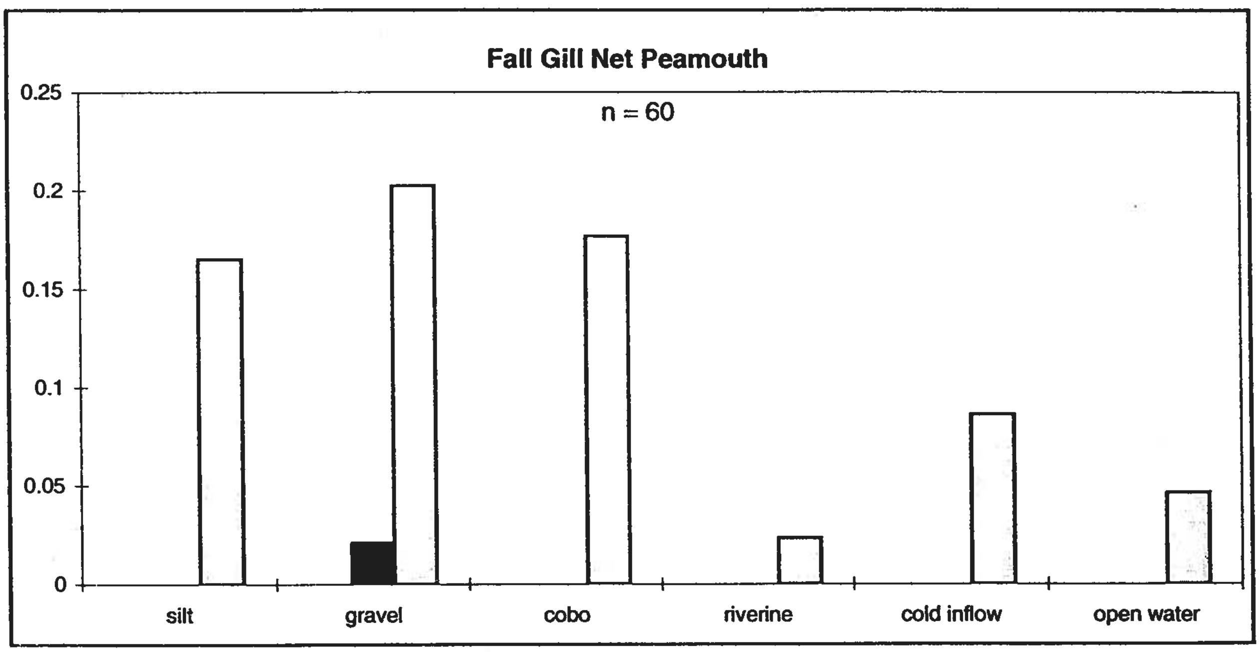
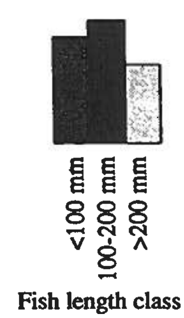


Figure A-2. Gill netting catch rates of fish size classes from each habitat type in Cabinet Gorge Reservoir.







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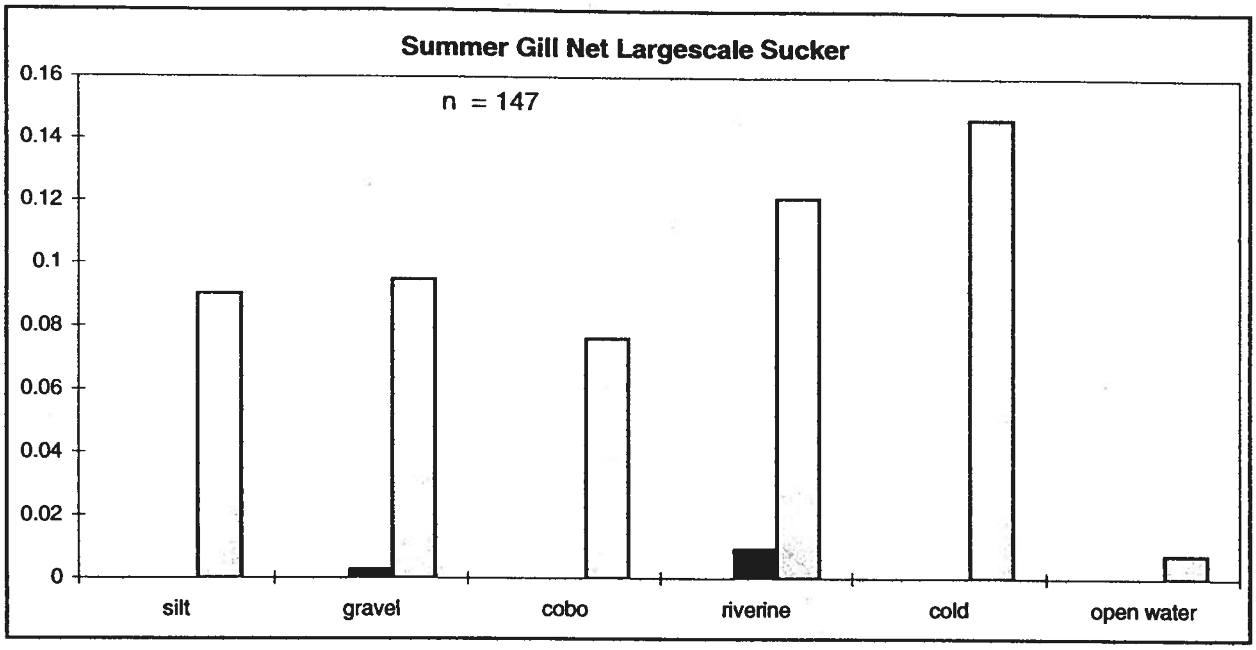


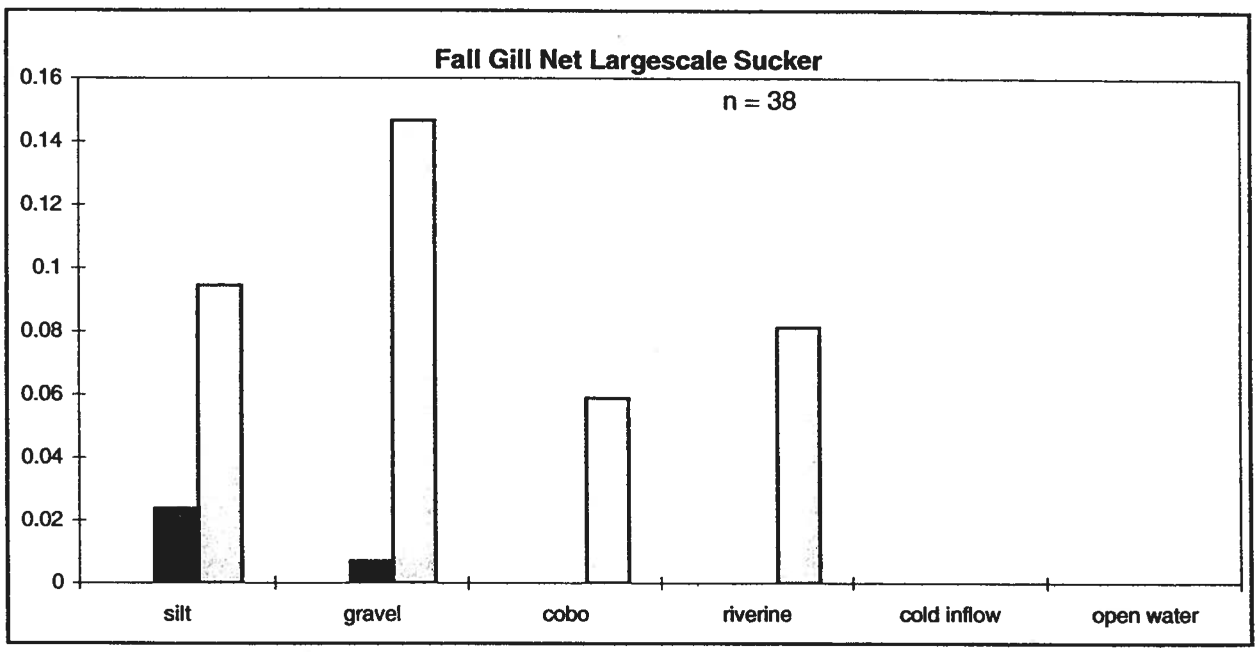
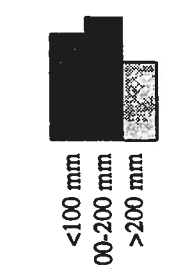


Figure A-2. Gill netting catch rates of fish size classes from each habitat type in Cabinet Gorge Reservoir.



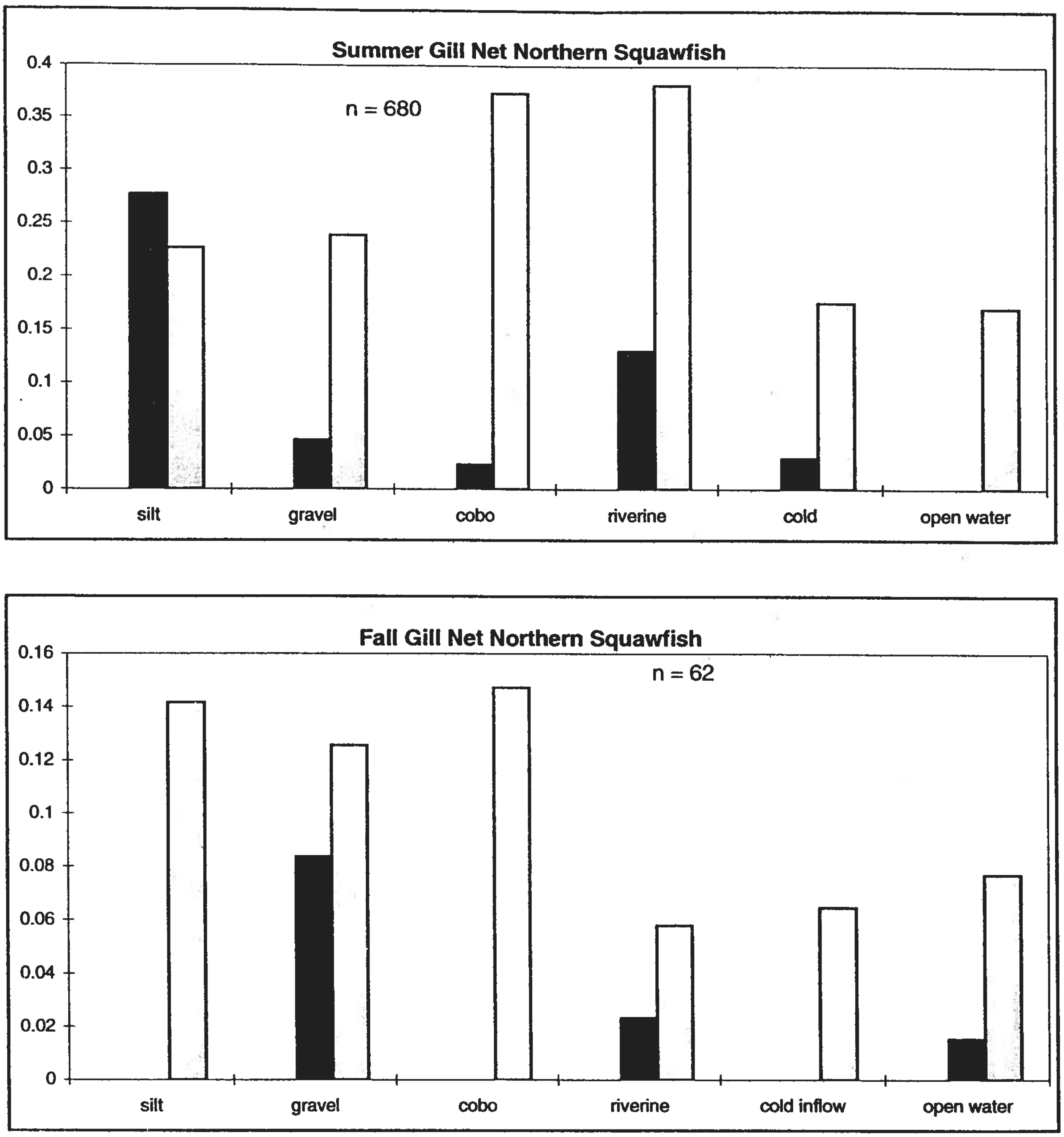
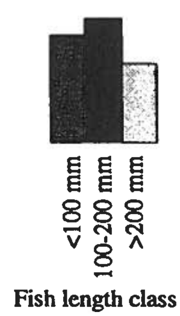
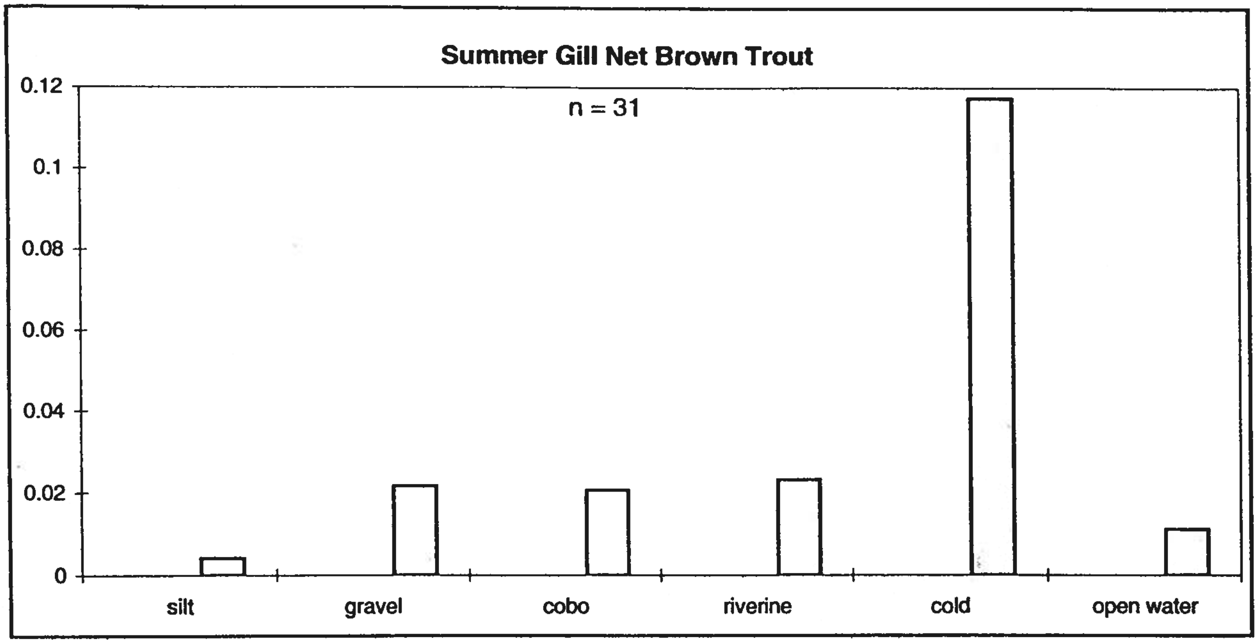


Figure A-2. Gill netting catch rates of fish size classes from each habitat type in Cabinet Gorge Reservoir.





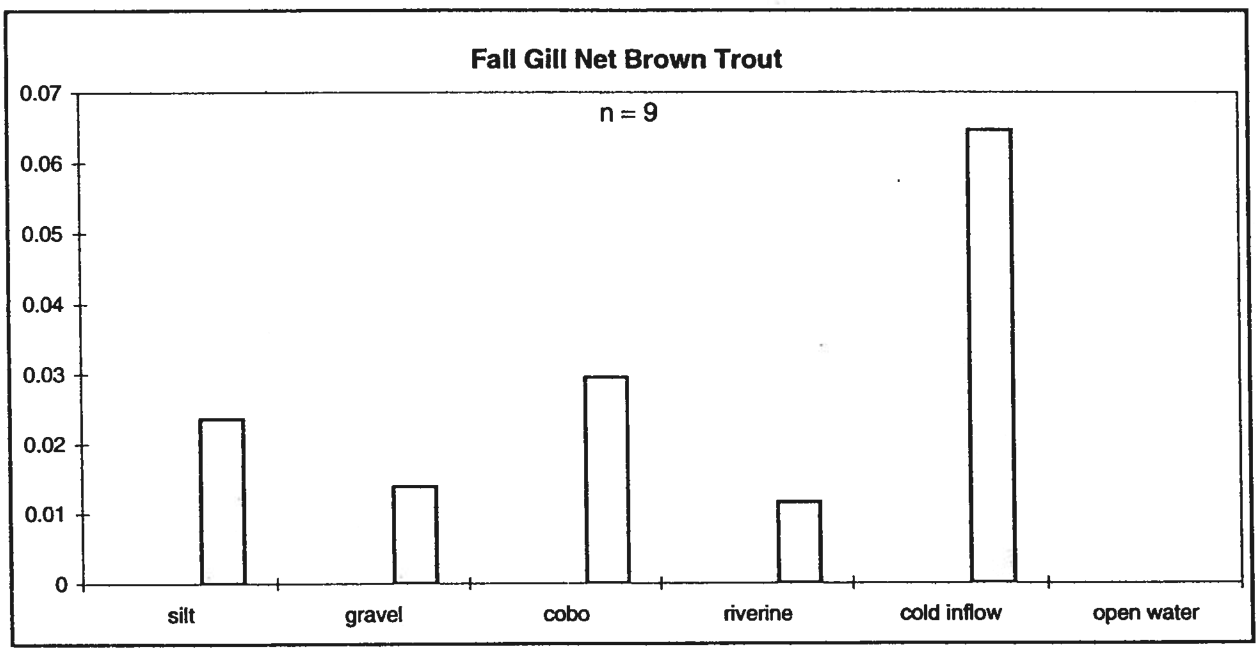
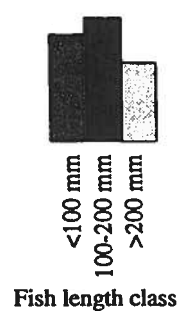
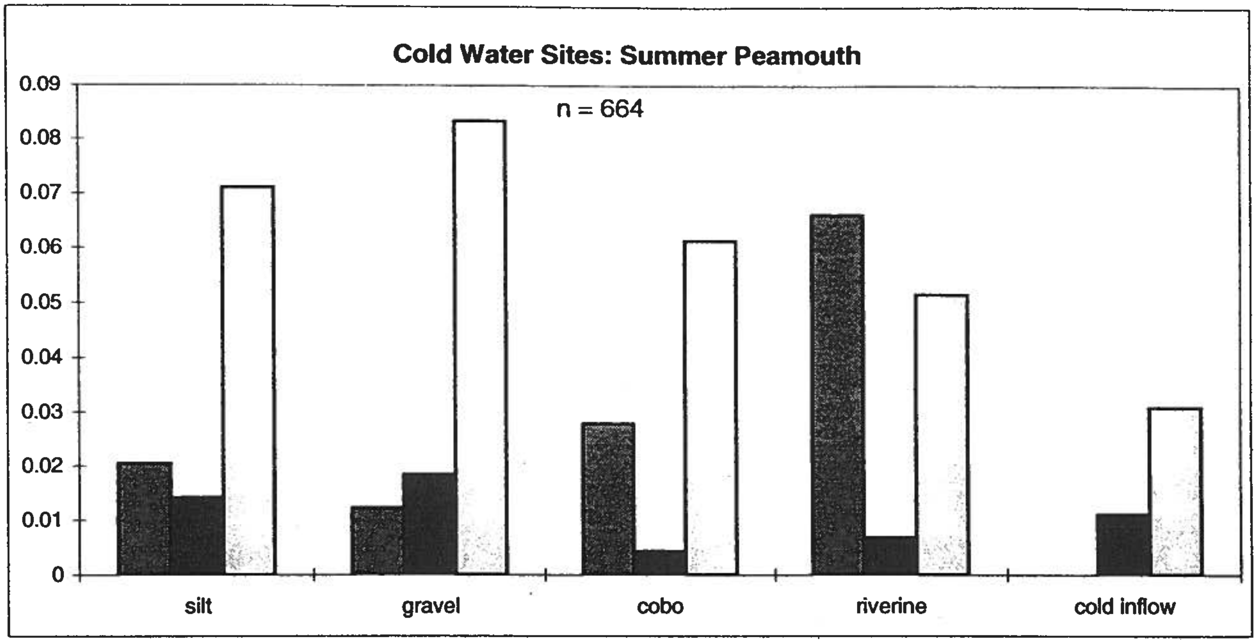


Figure A-2. Gill netting catch rates of fish size classes from each habitat type in Cabinet Gorge Reservoir.





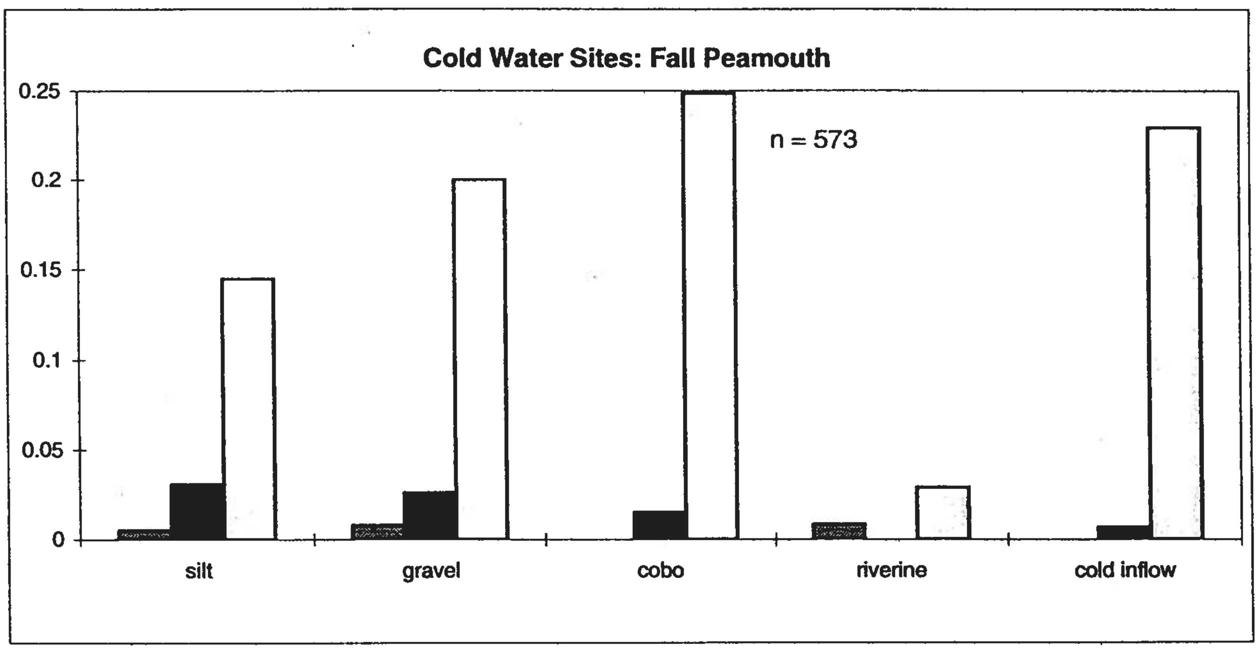
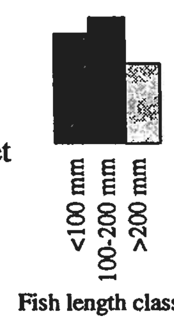
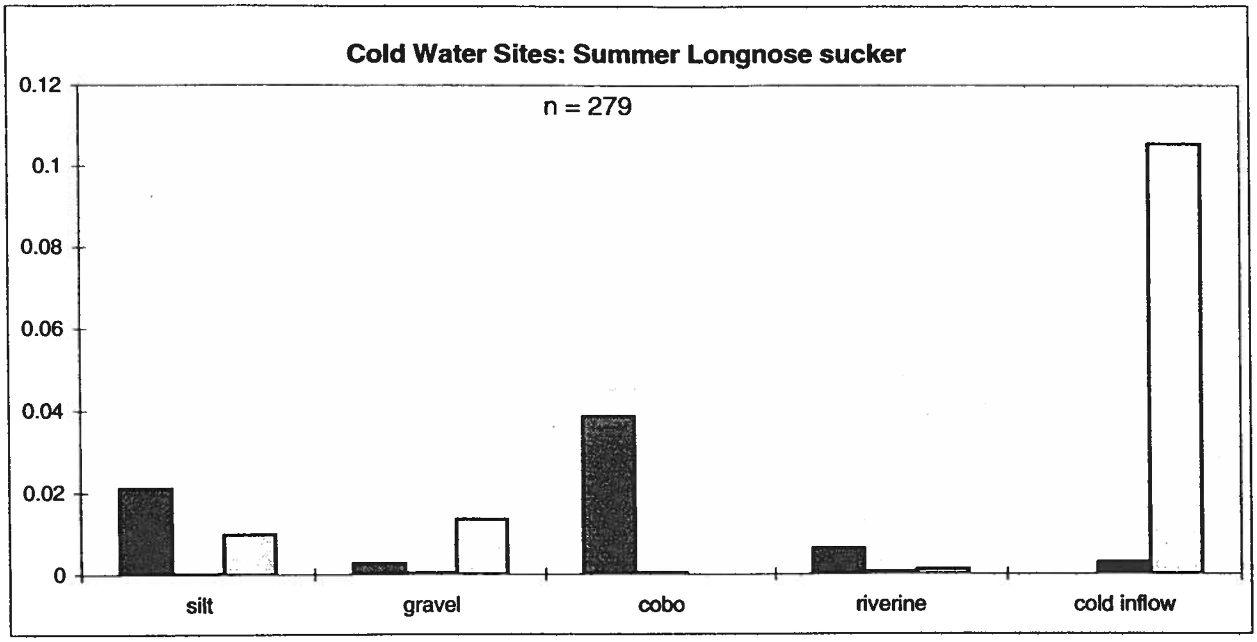


Figure A-3. Relative abundance at sites with cold water influences (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Cabinet Gorge Reservoir.





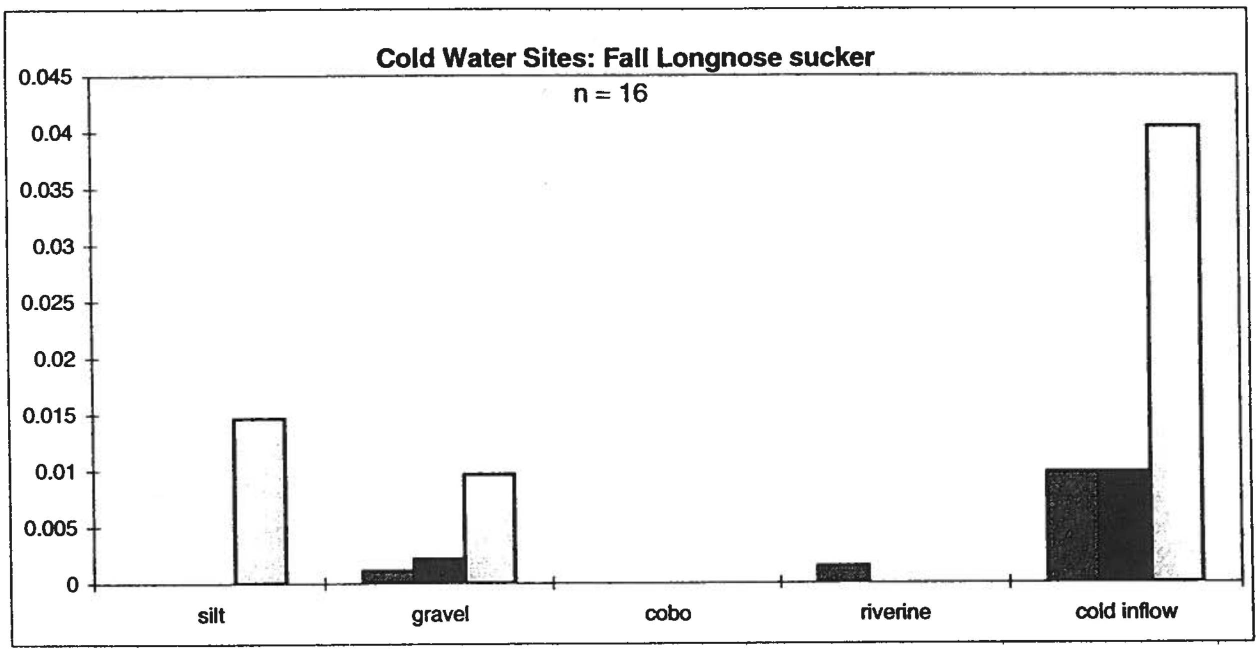
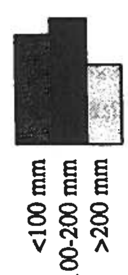


Figure A-3. Relative abundance at sites with cold water influences (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Cabinet Gorge Reservoir.



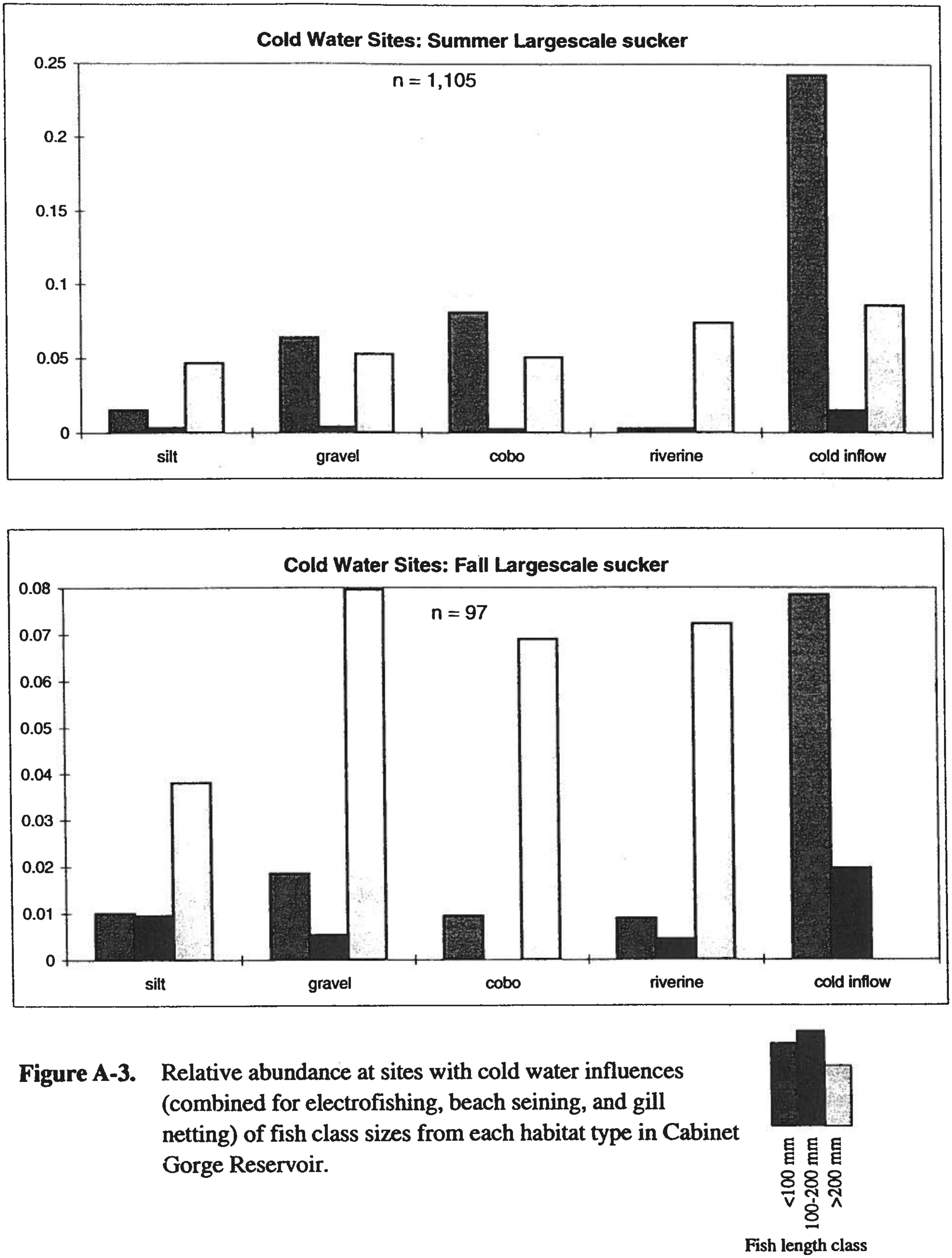
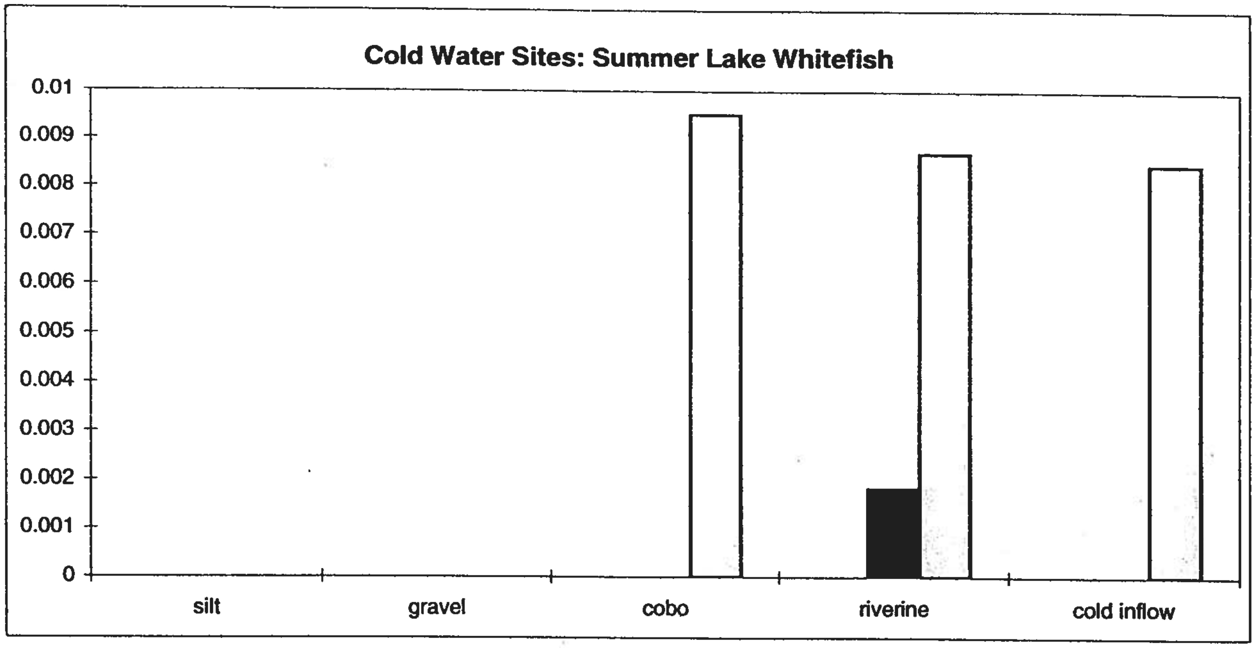
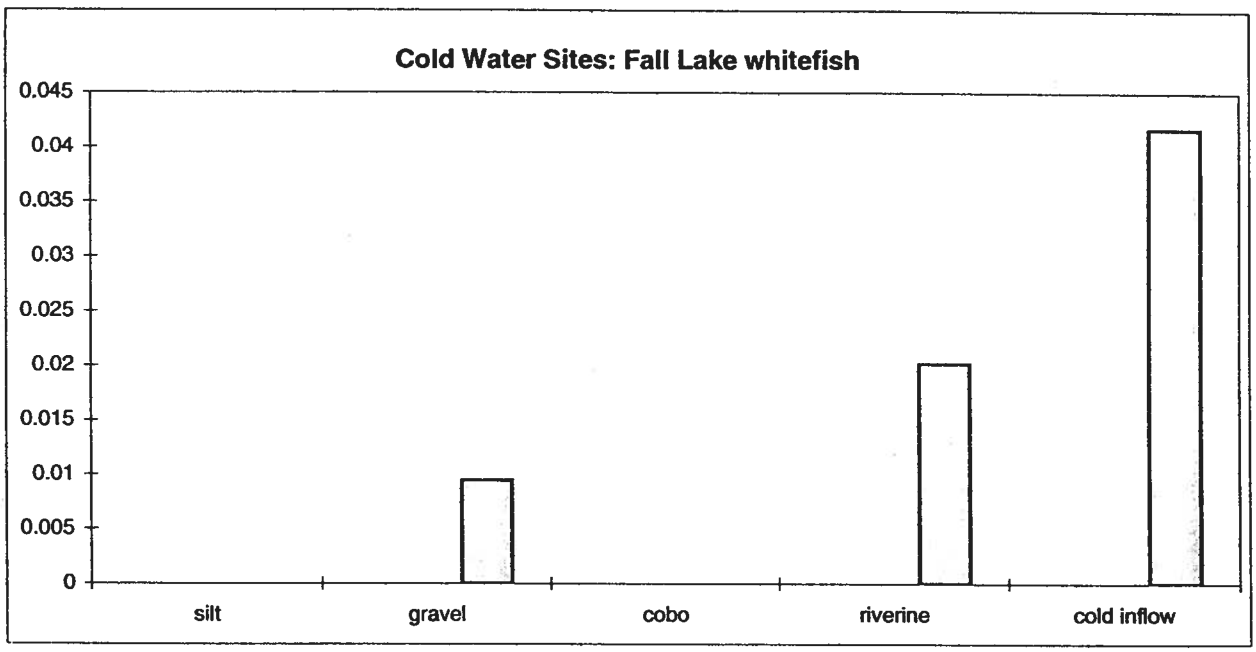


Figure A-3. Relative abundance at sites with cold water influences (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Cabinet Gorge Reservoir.





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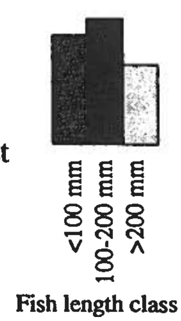
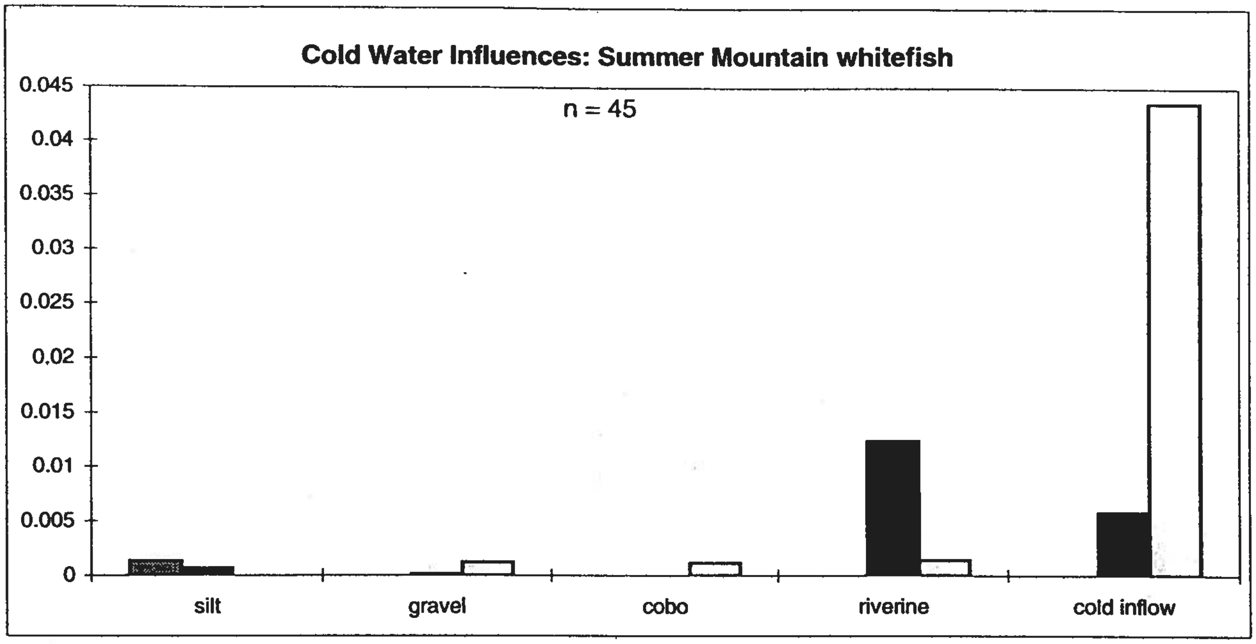




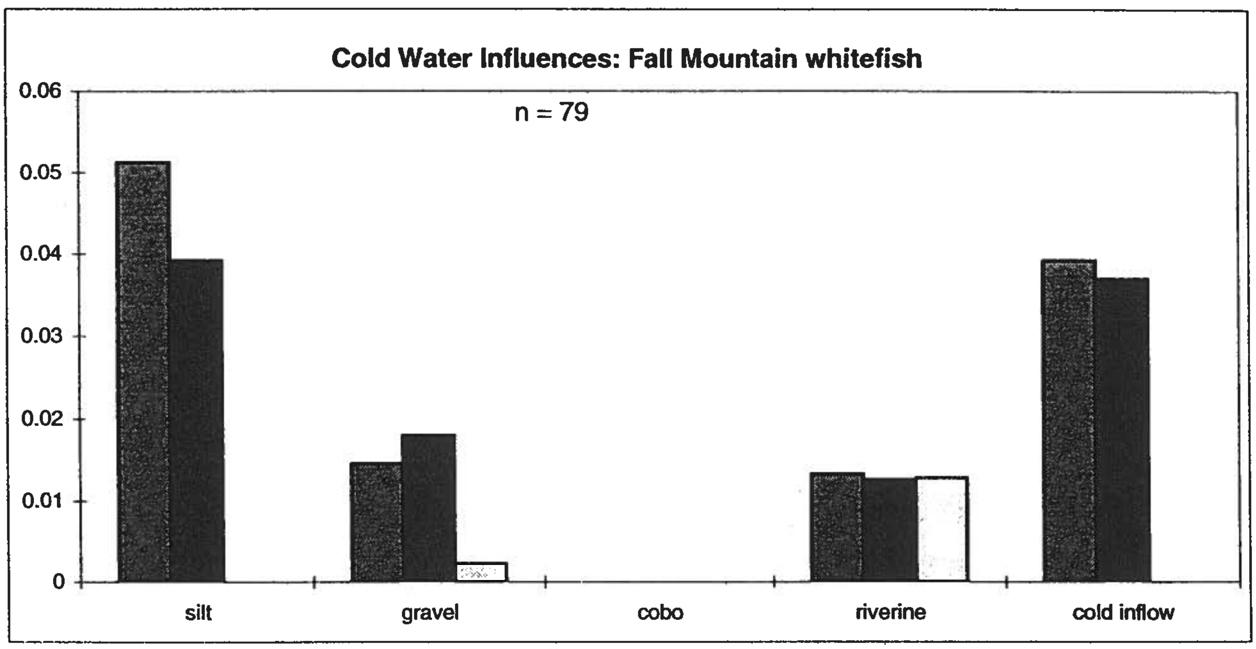
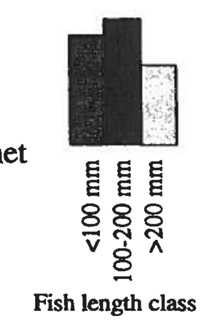
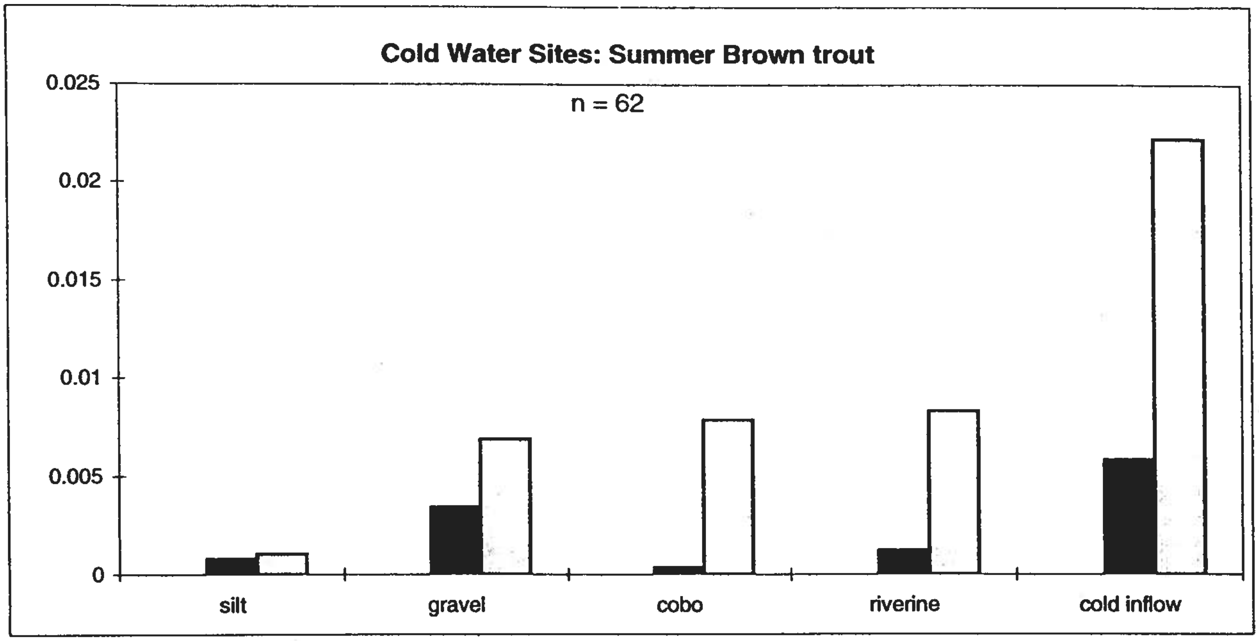


Figure A-3. Relative abundance at sites with cold water influences (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Cabinet Gorge Reservoir.





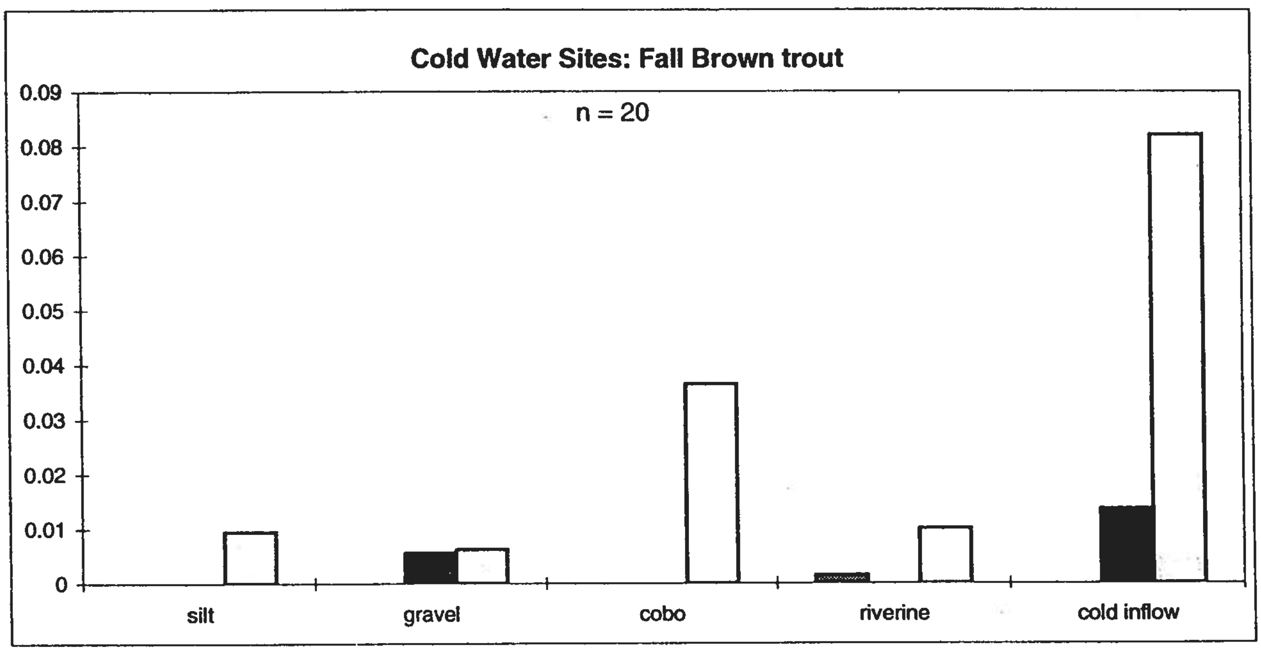
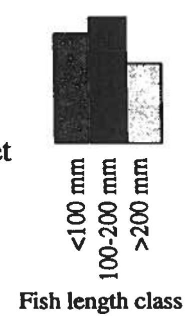


Figure A-3. Relative abundance at sites with cold water influences (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Cabinet Gorge Reservoir.



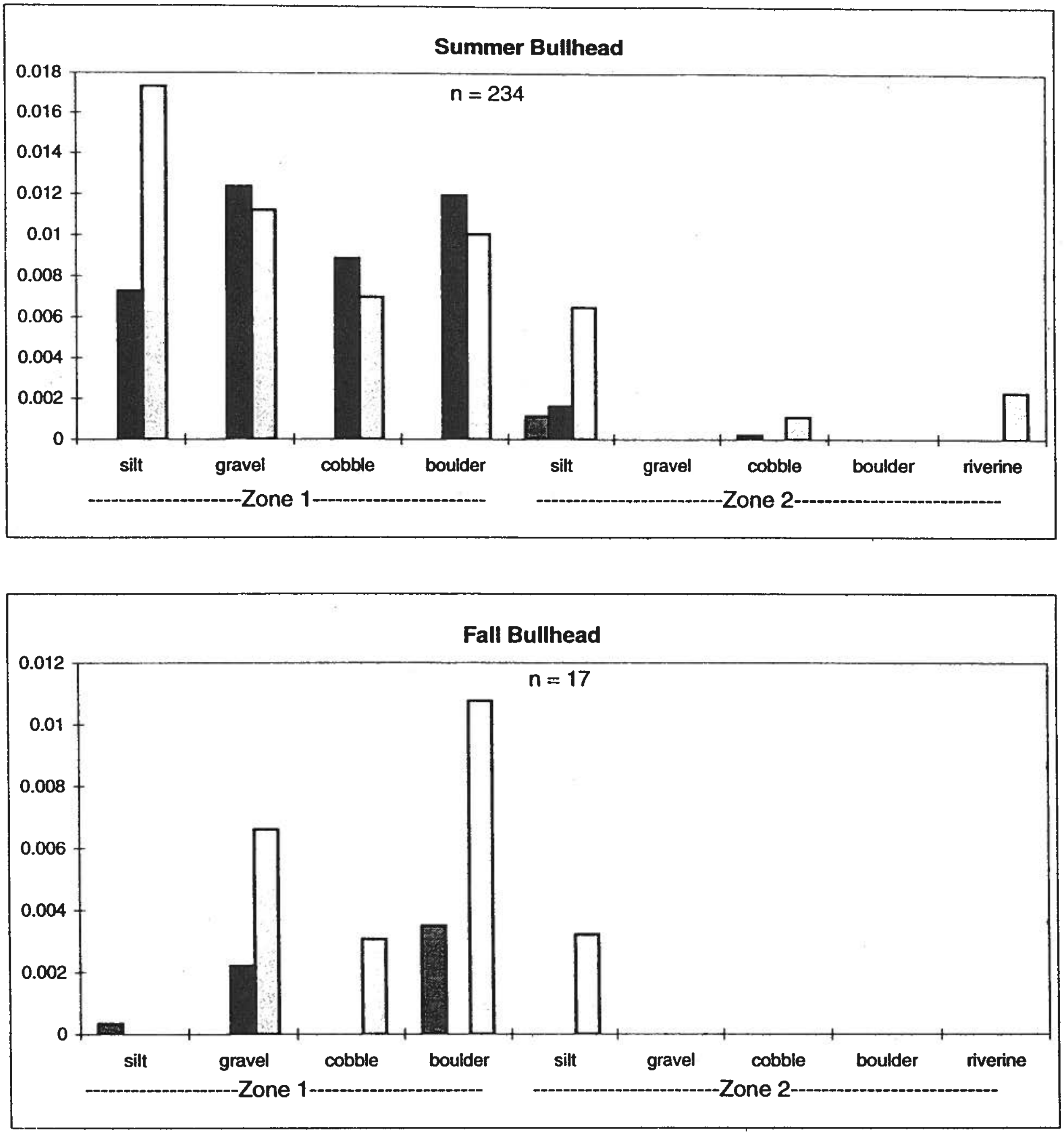
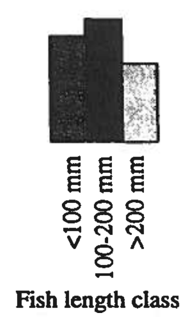
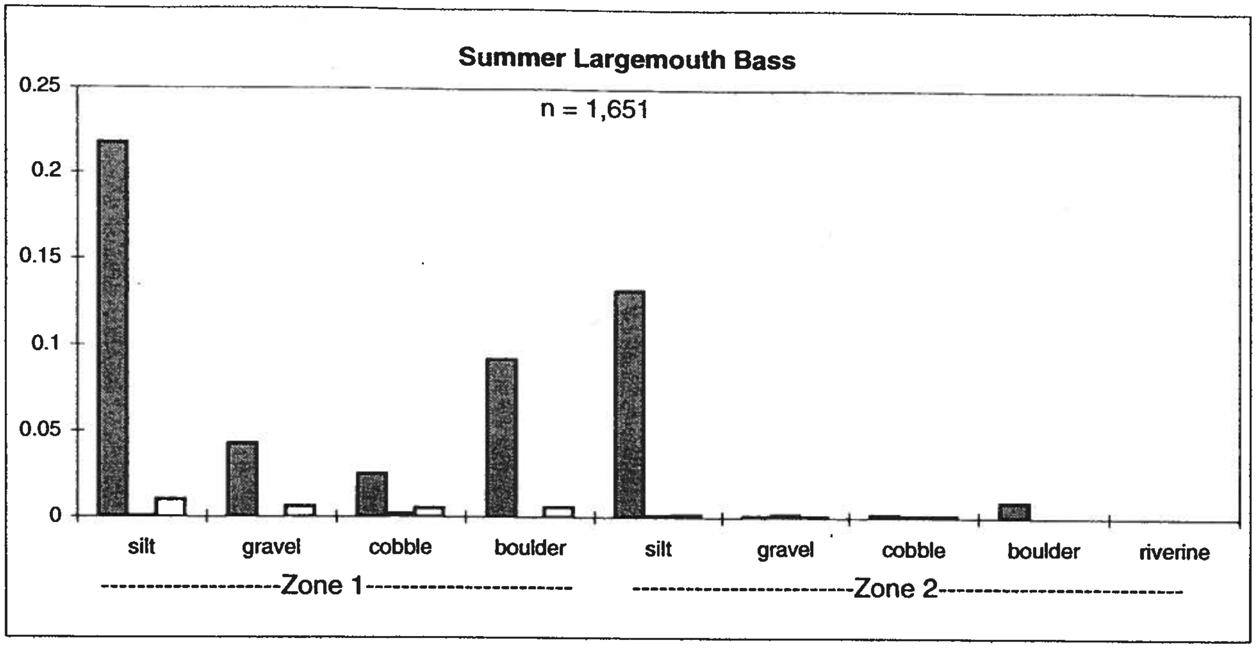


Figure A-4. Relative abundance (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Noxon Rapids Reservoir.





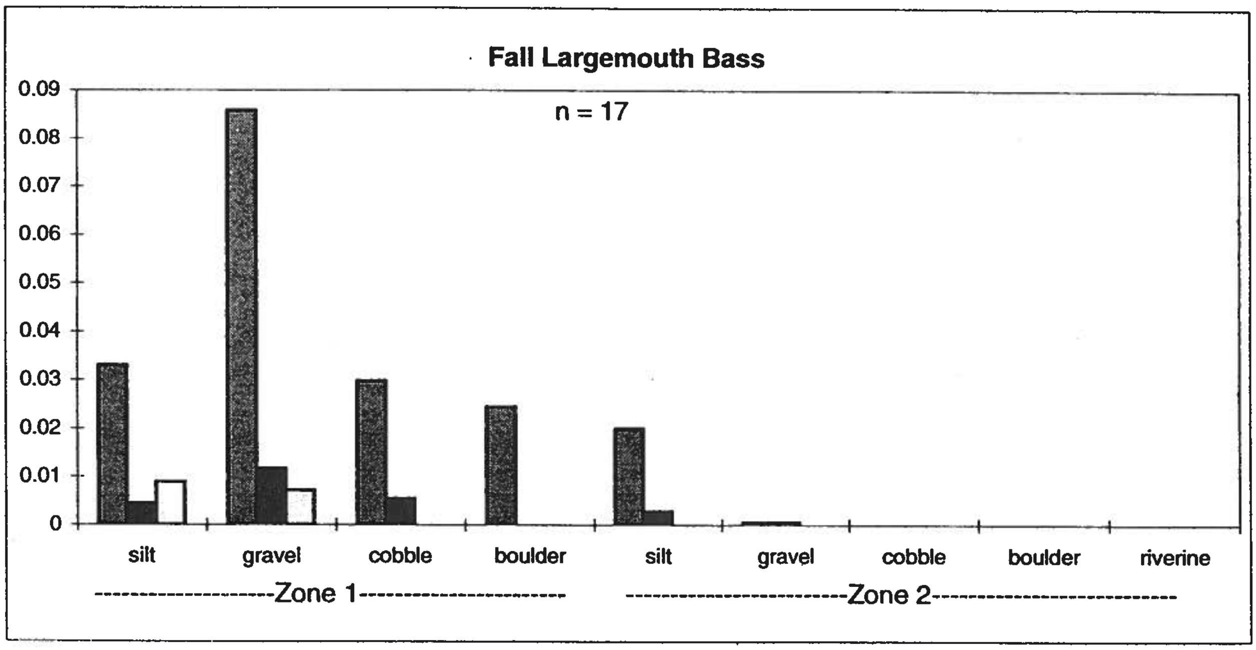
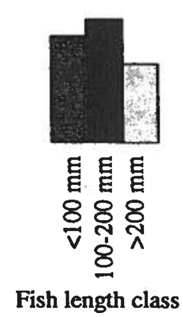
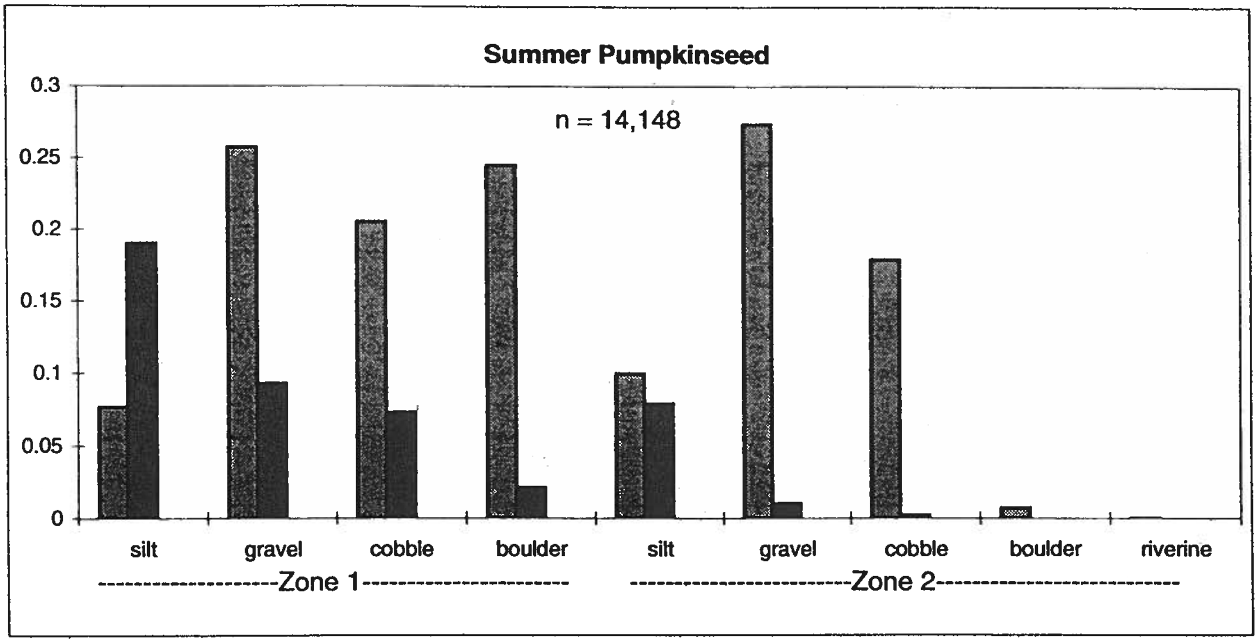


Figure A-4. Relative abundance (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Noxon Rapids Reservoir.





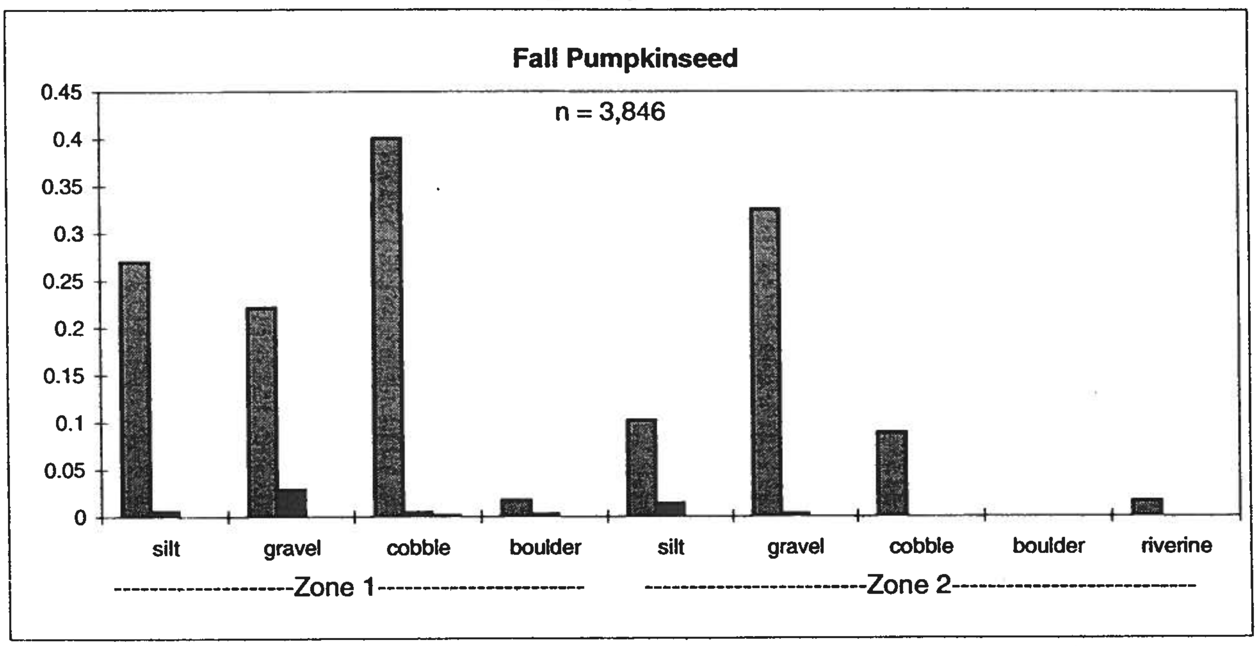
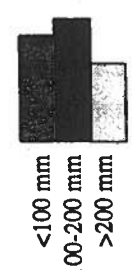
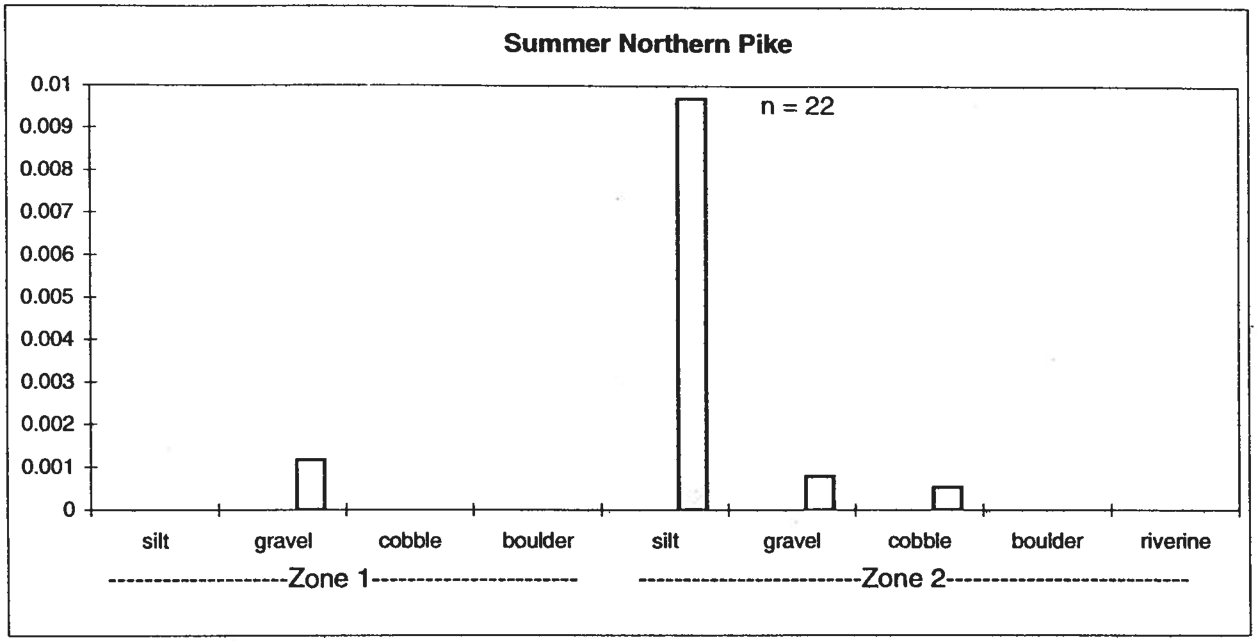


Figure A-4. Relative abundance (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Noxon Rapids Reservoir.





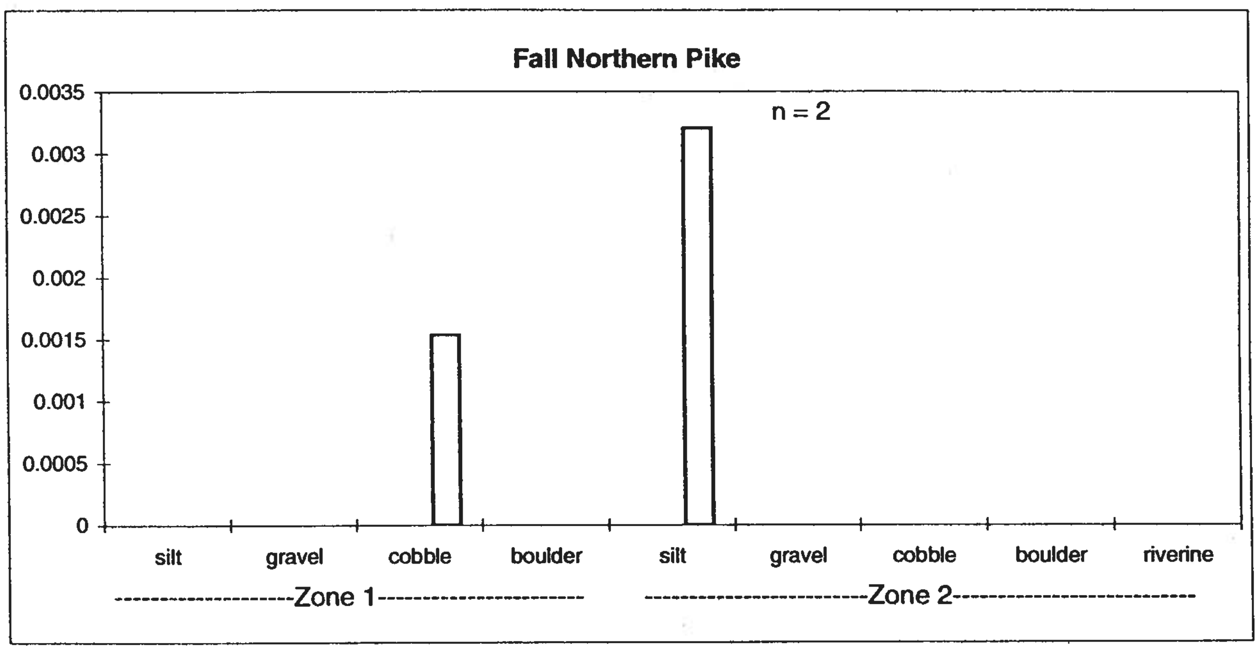
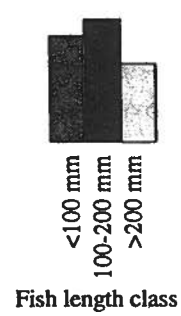


Figure A-4. Relative abundance (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Noxon Rapids Reservoir.



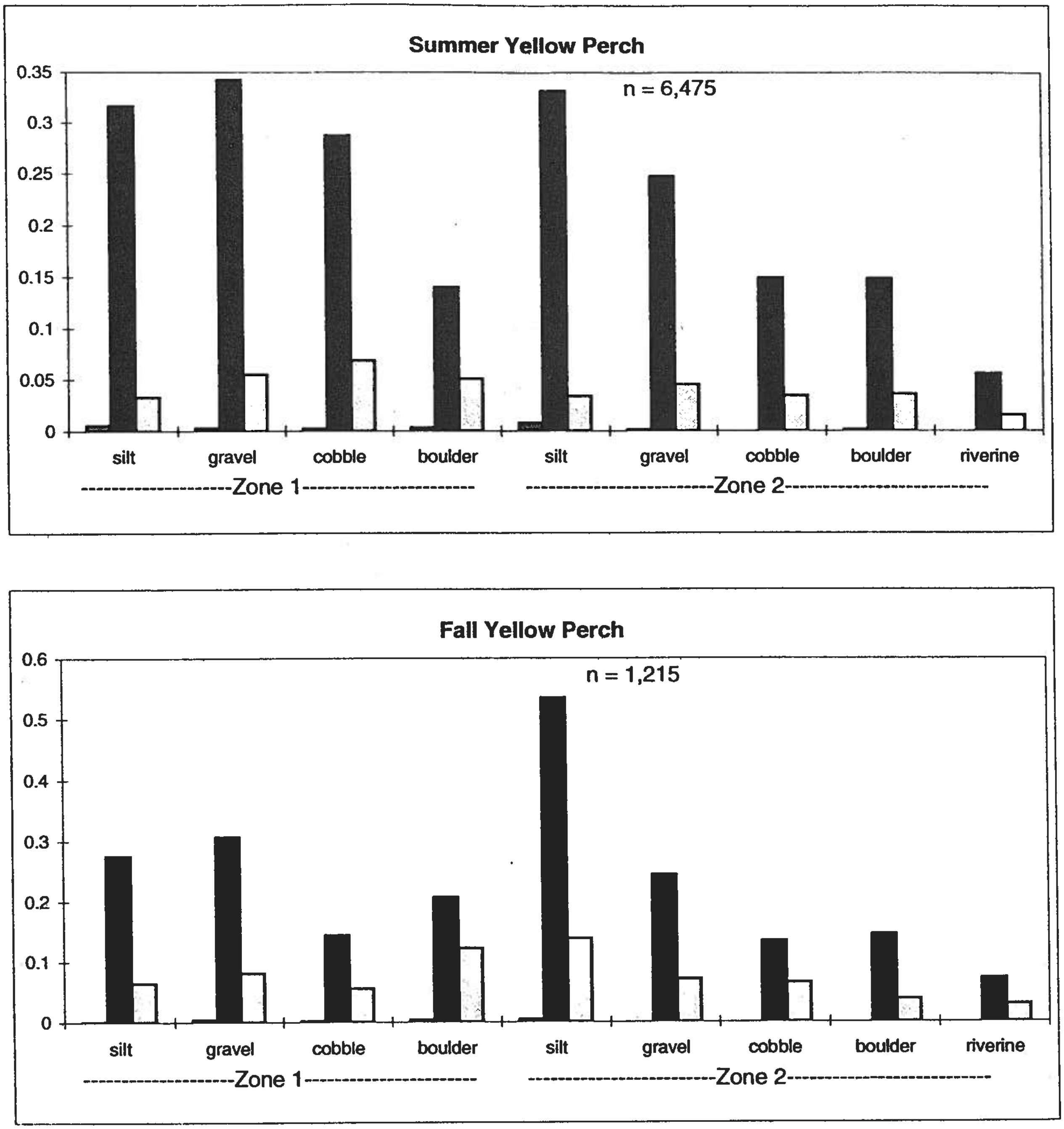
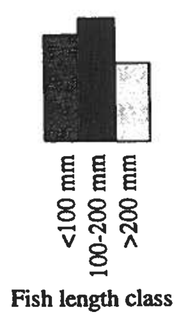
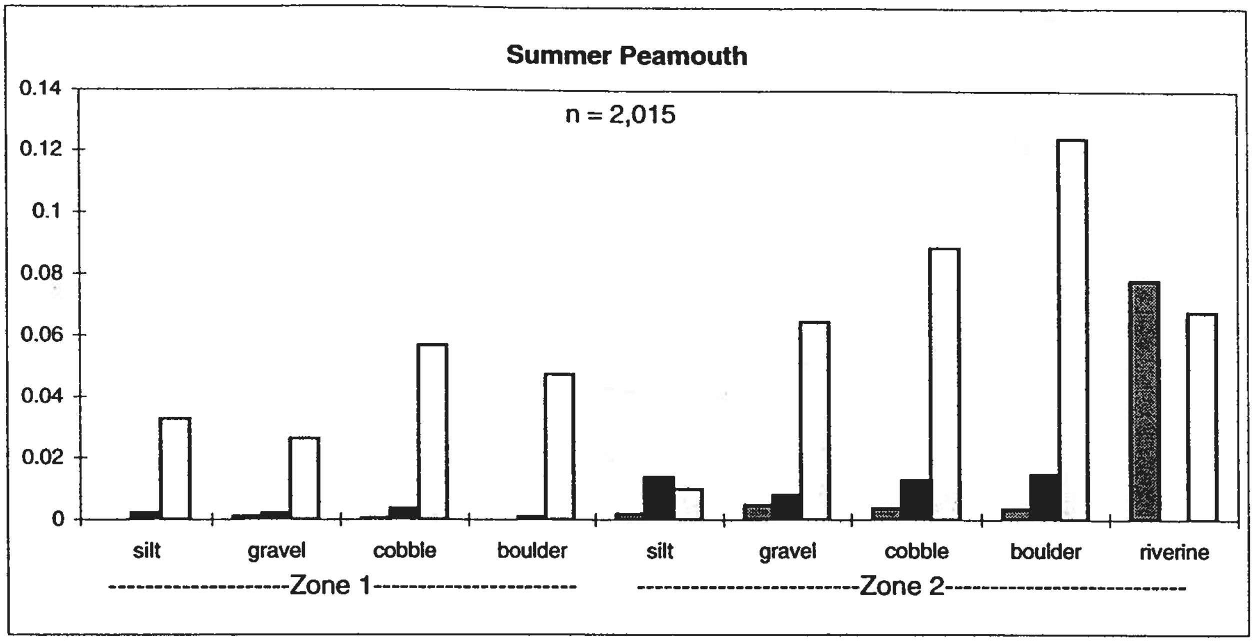


Figure A-4. Relative abundance (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Noxon Rapids Reservoir.





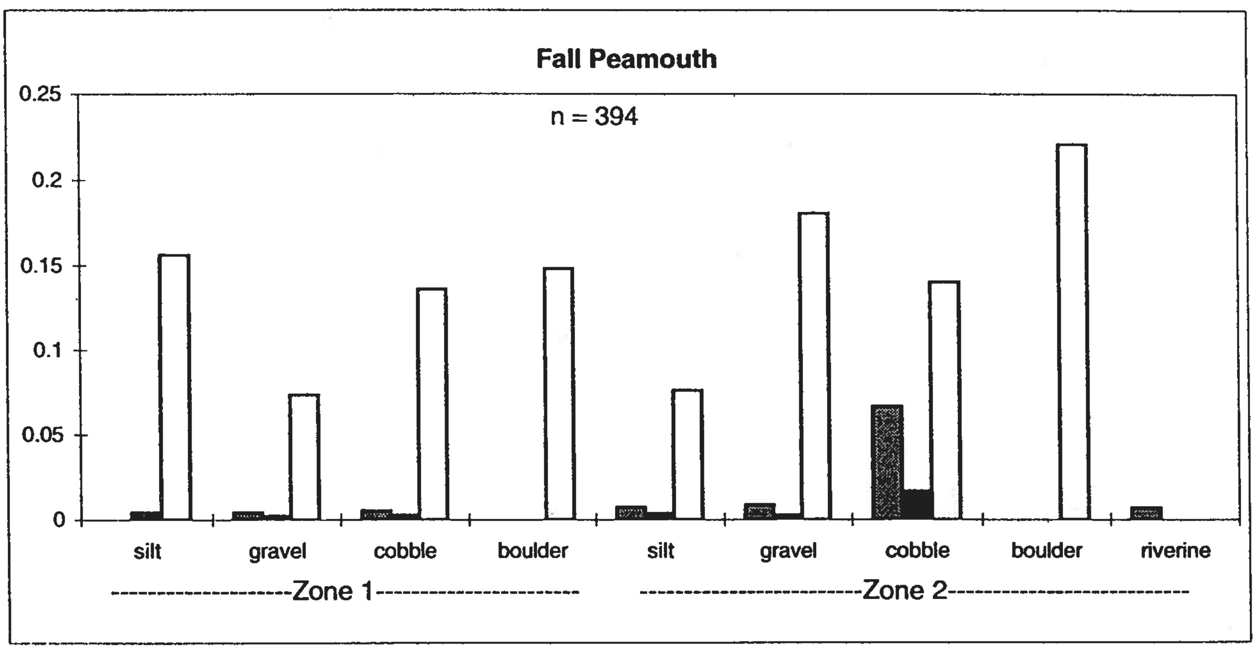
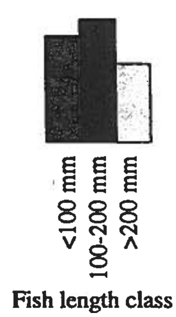
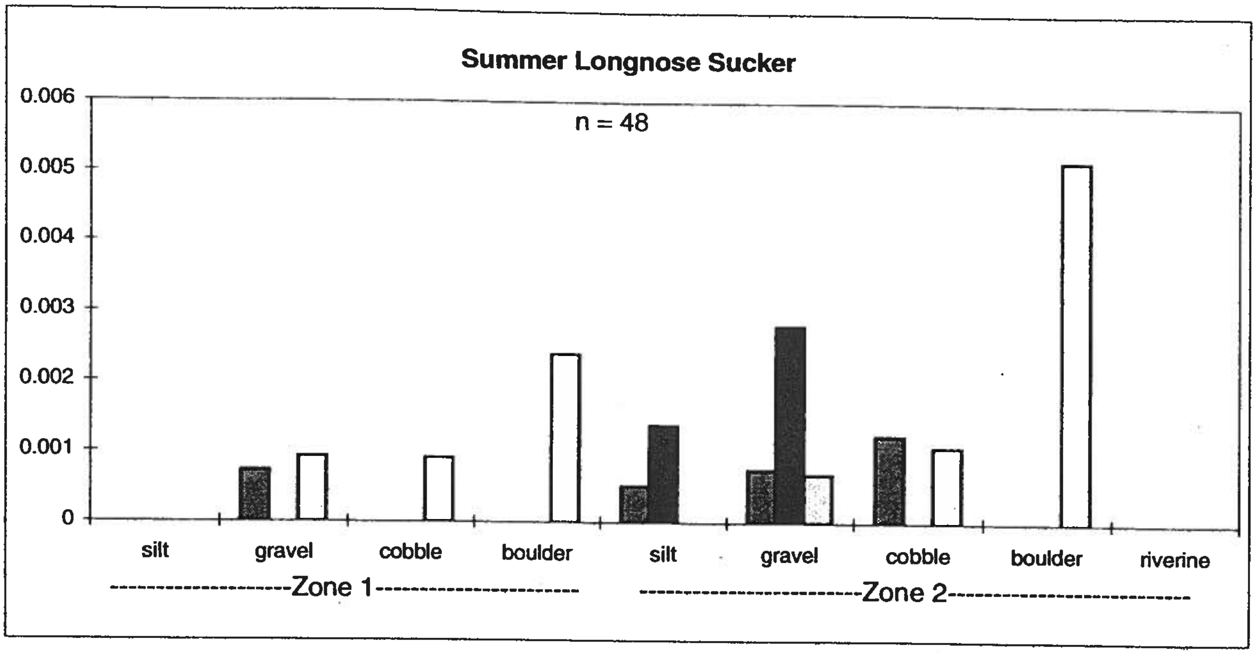
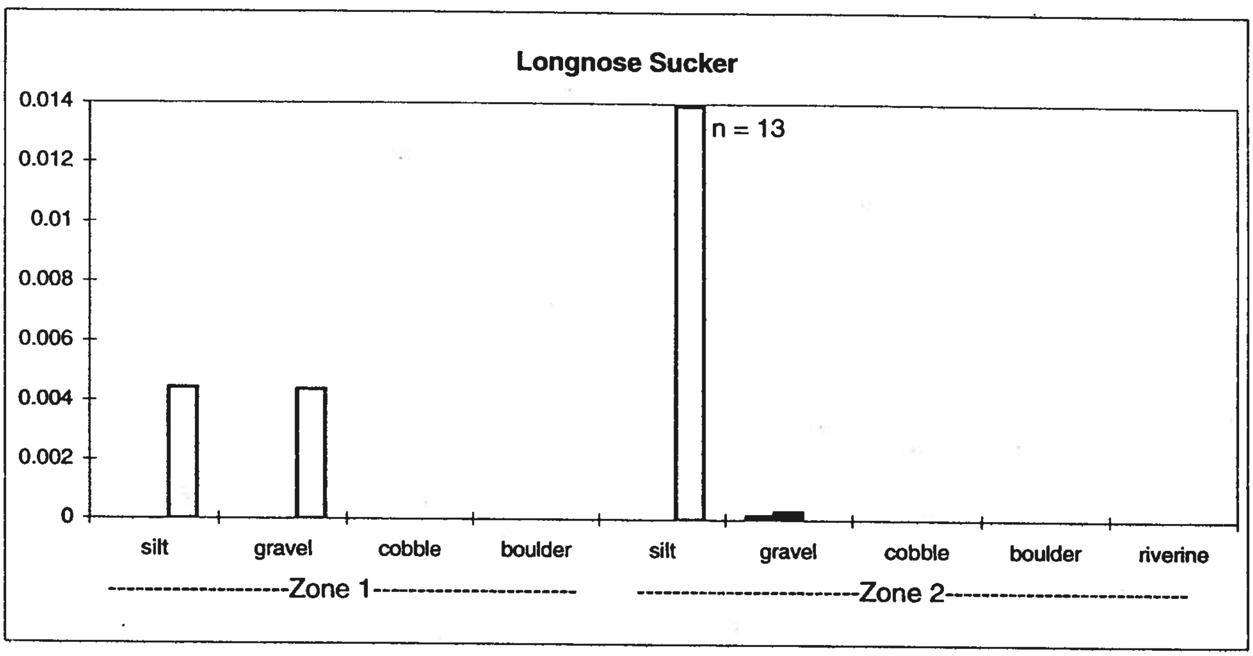


Figure A-4. Relative abundance (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Noxon Rapids Reservoir.







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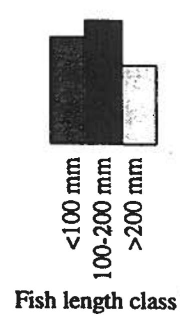

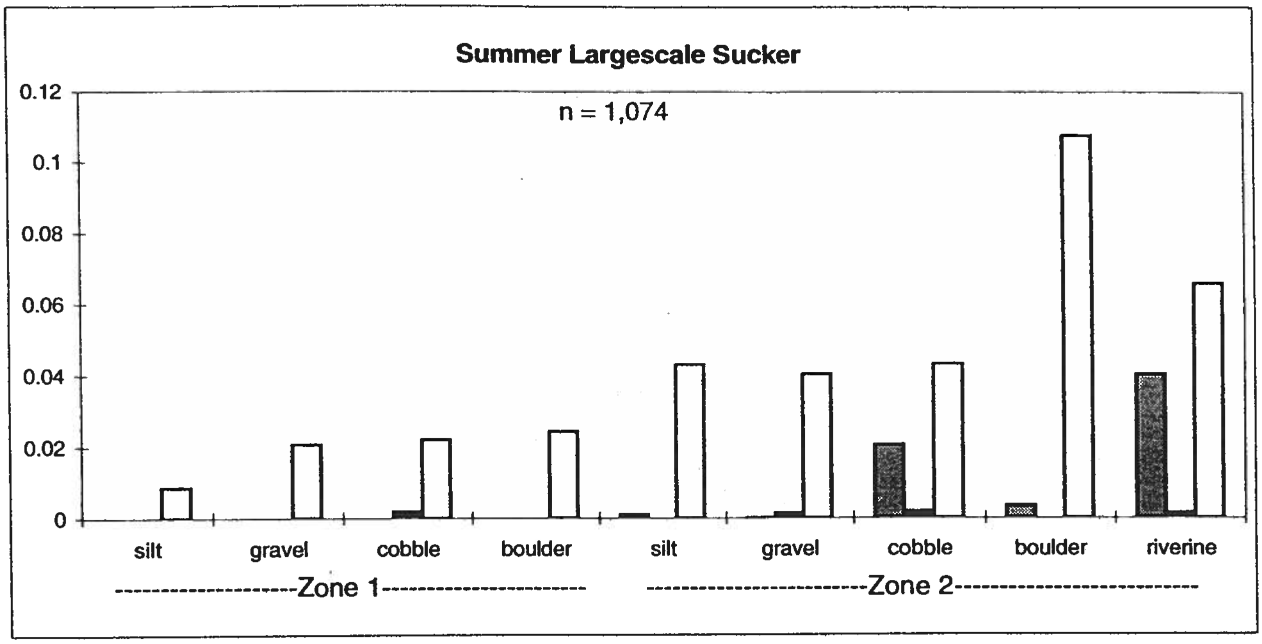

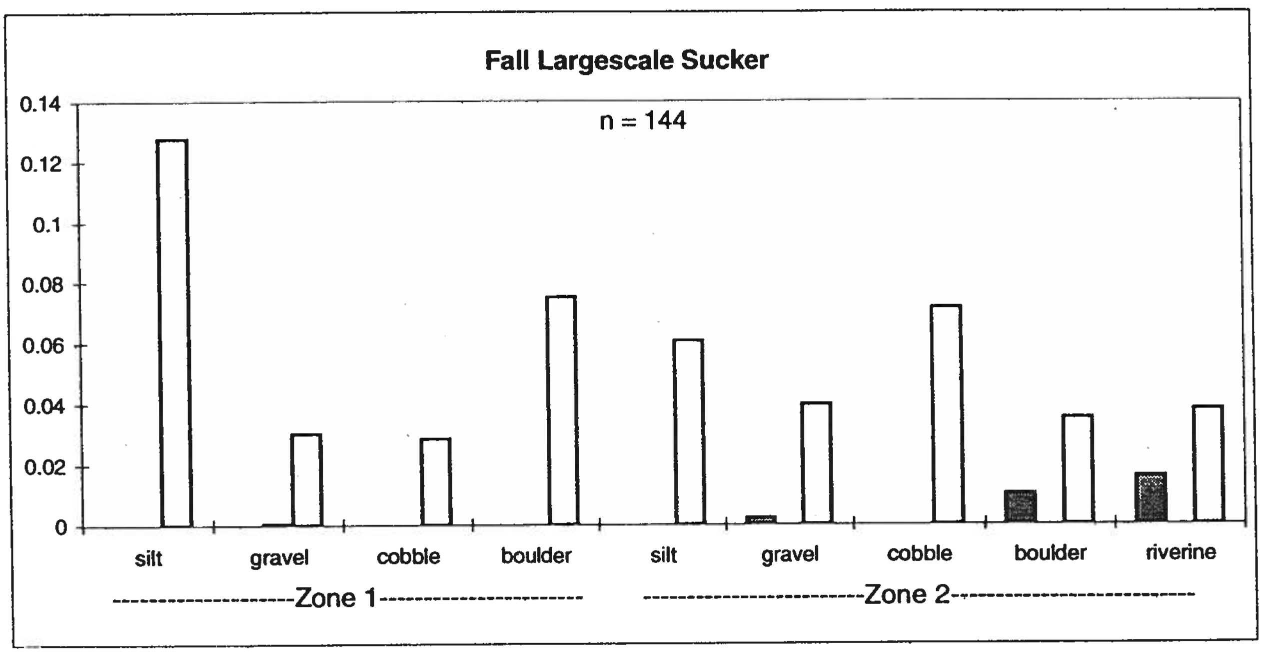

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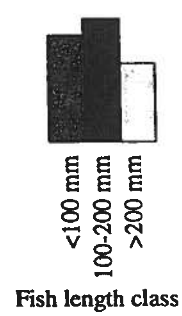

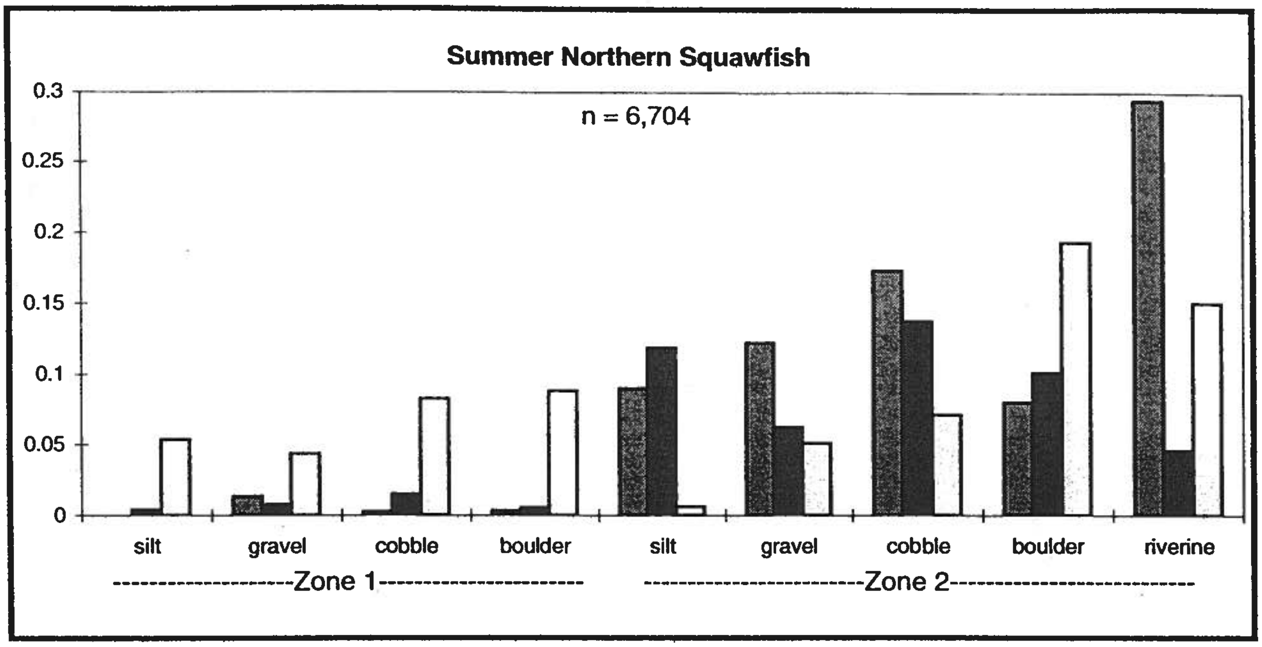

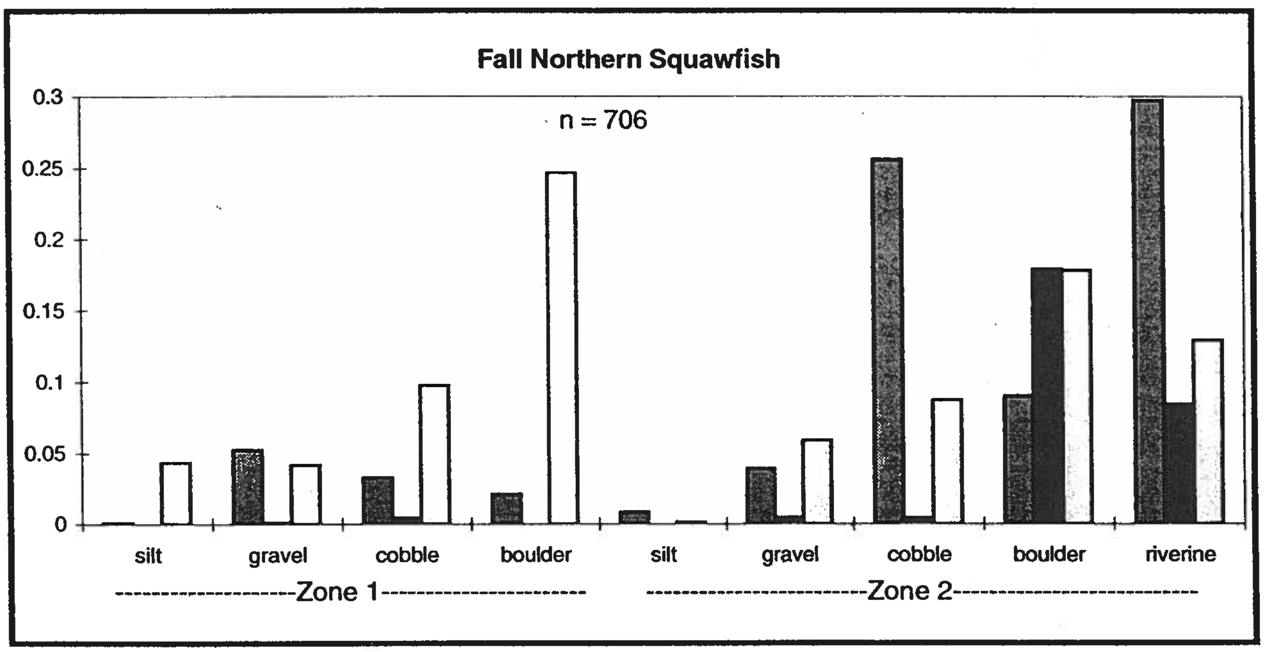

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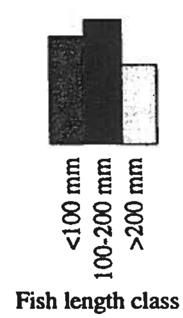

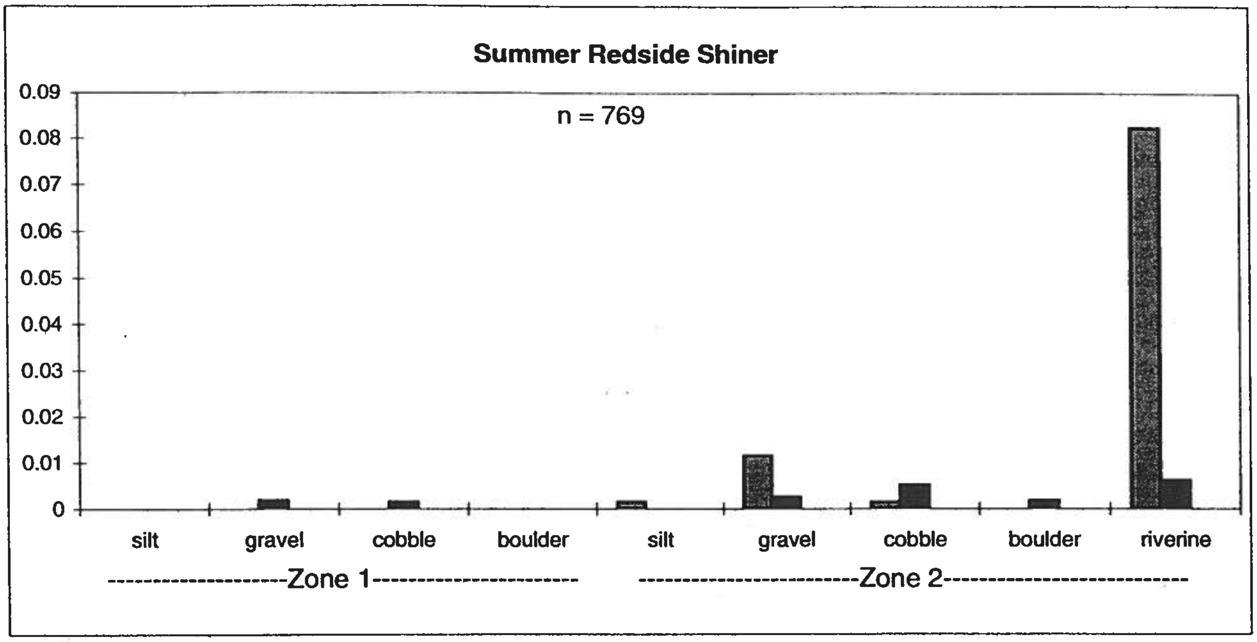

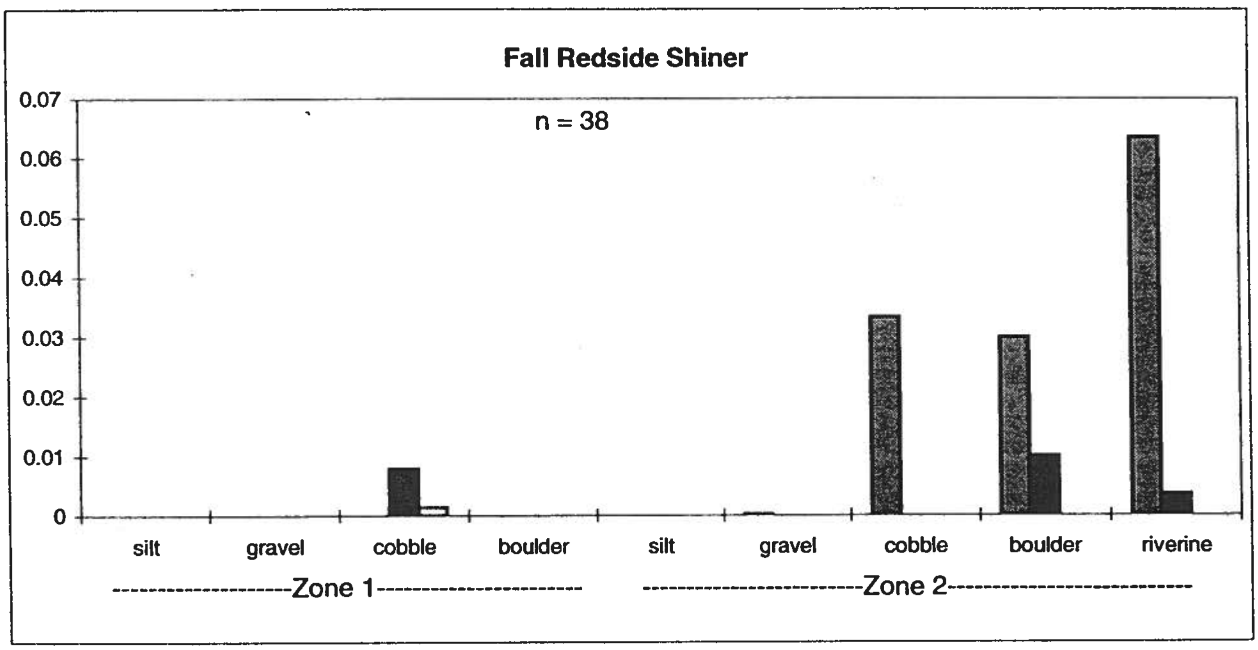

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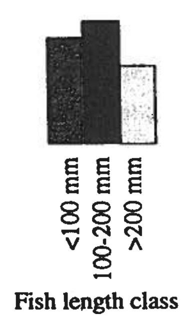

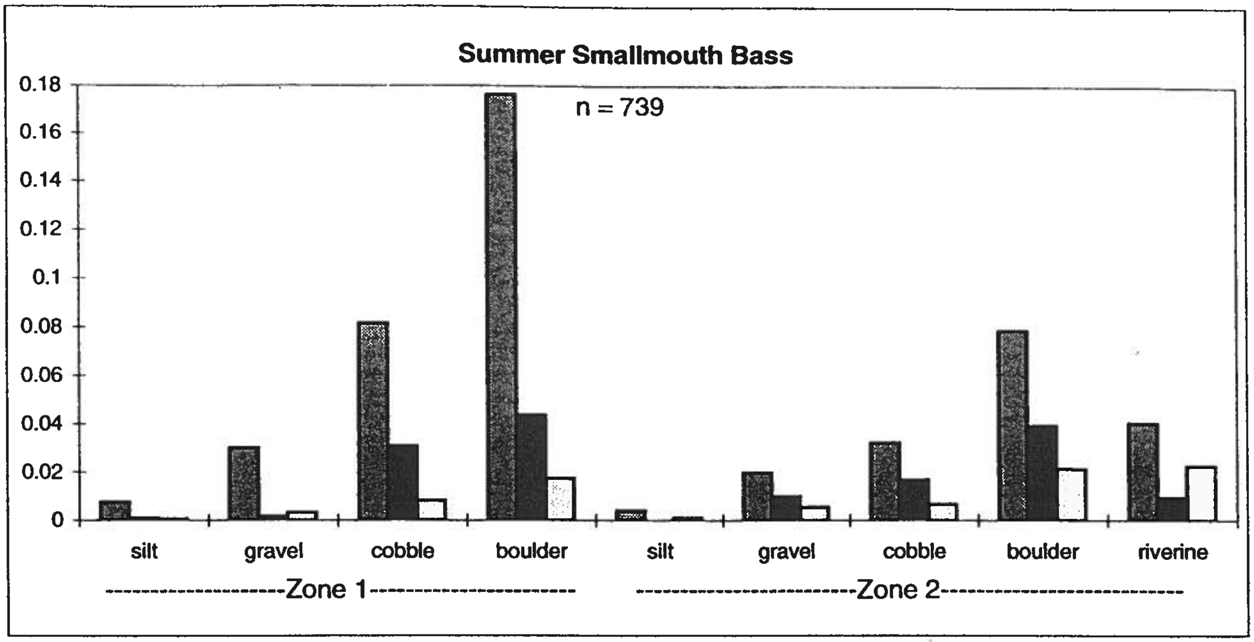

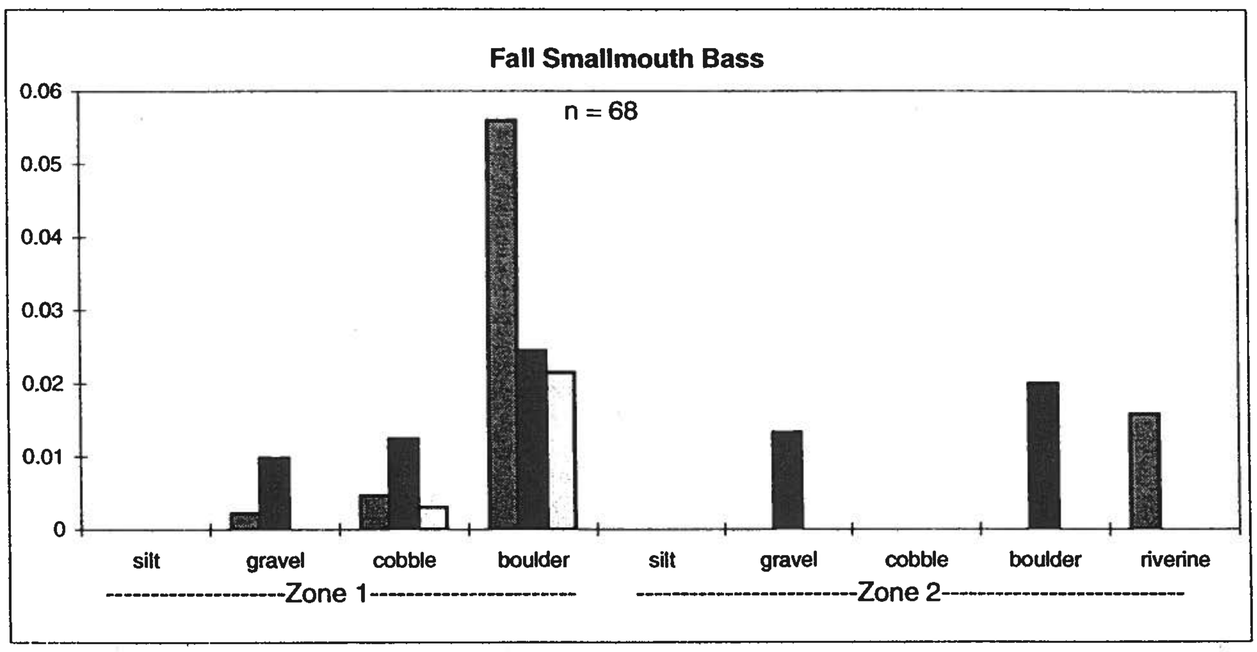

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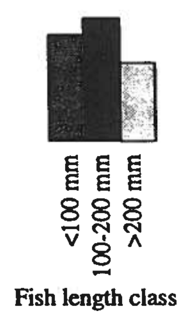

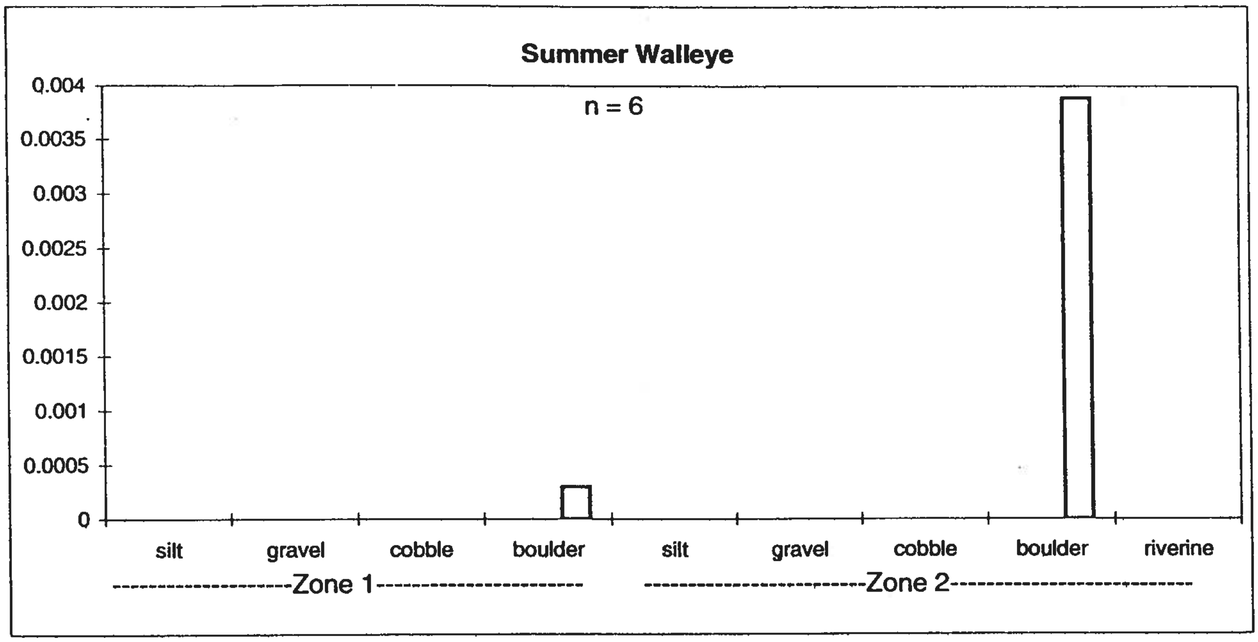

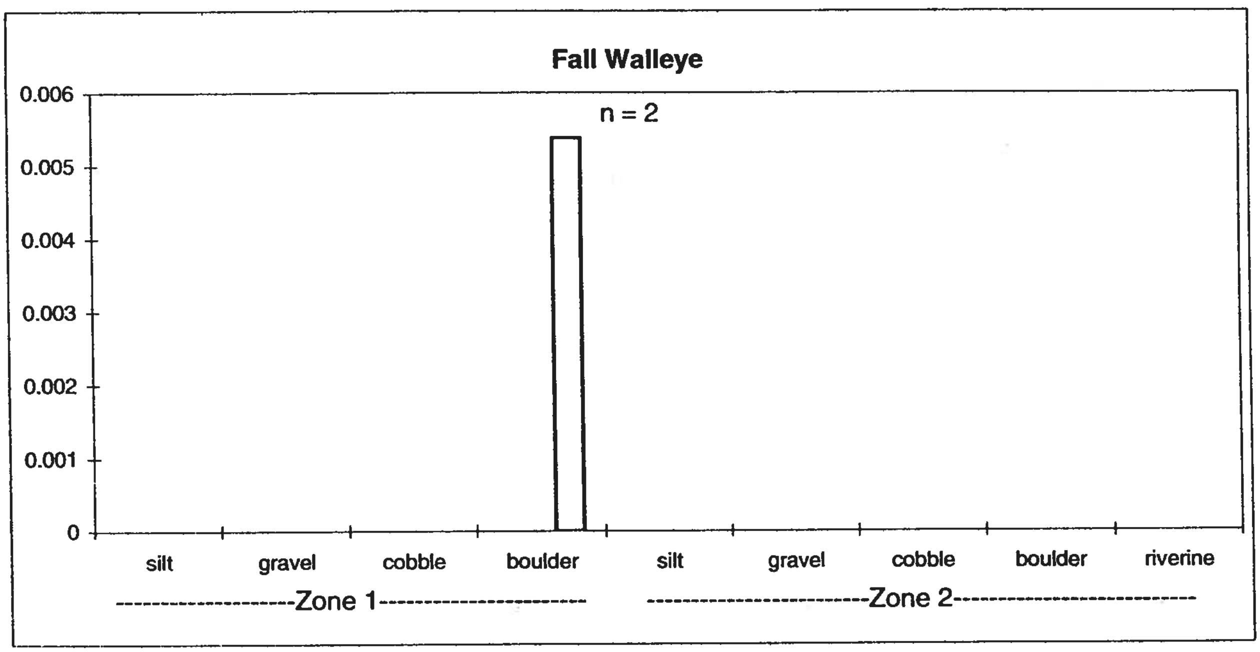

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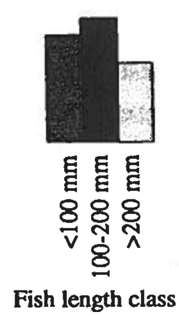

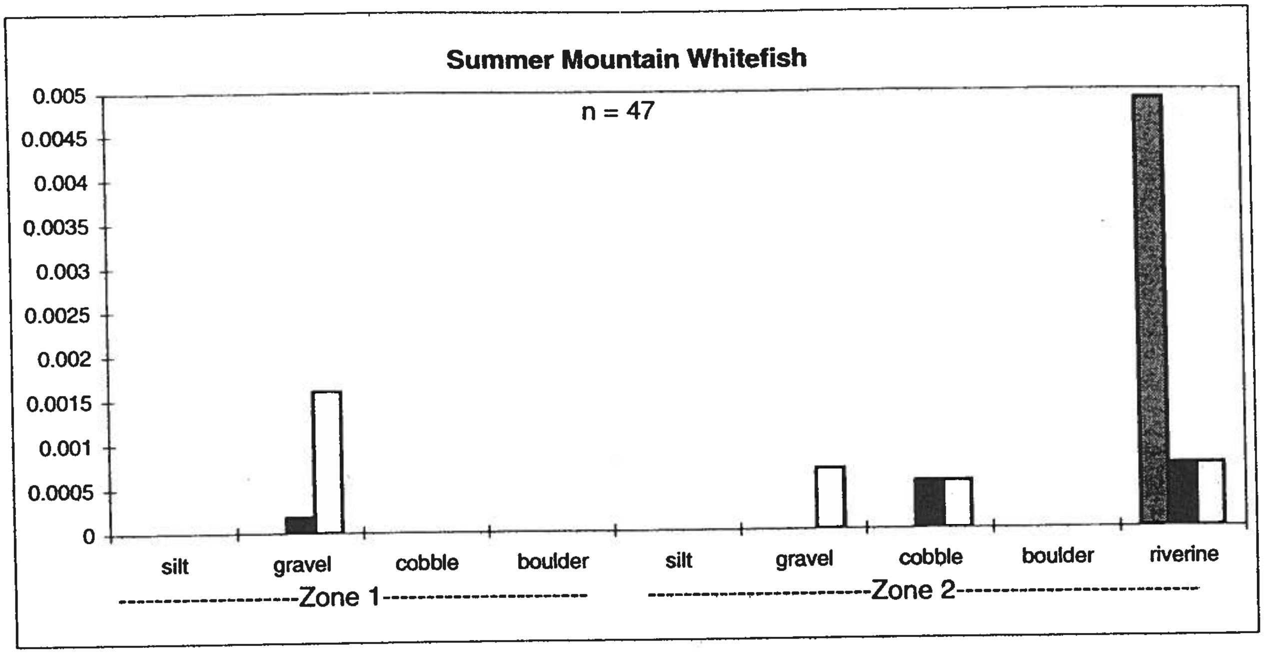

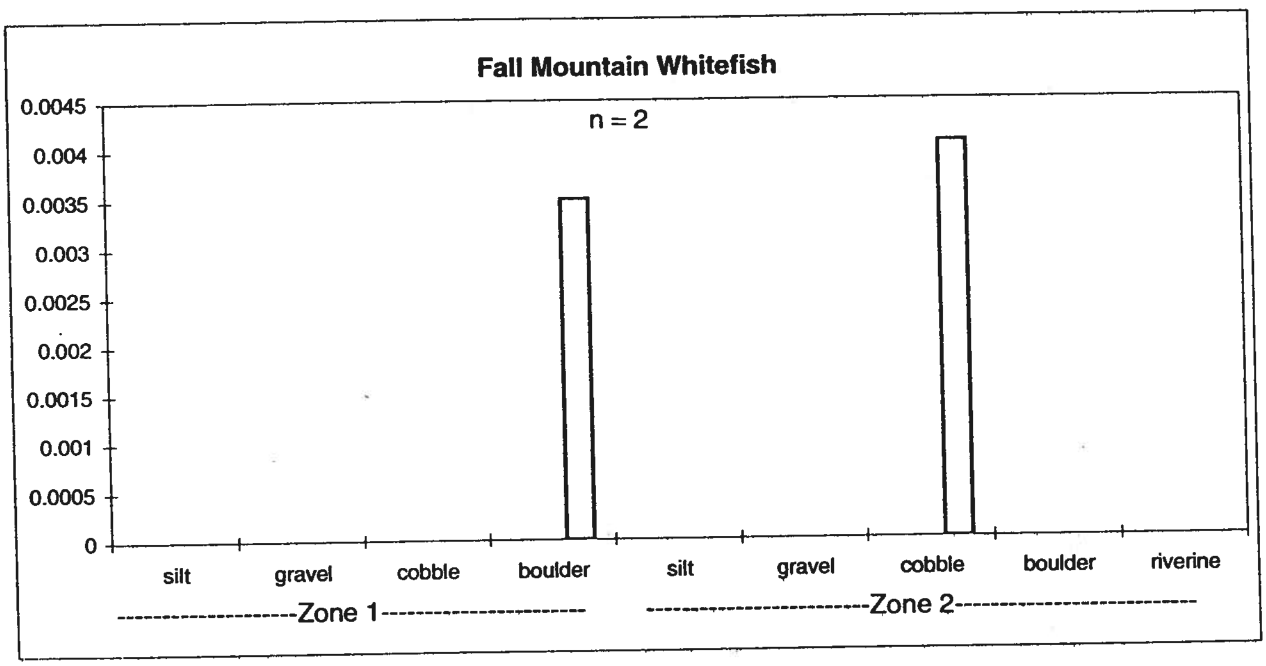

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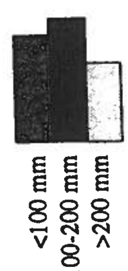

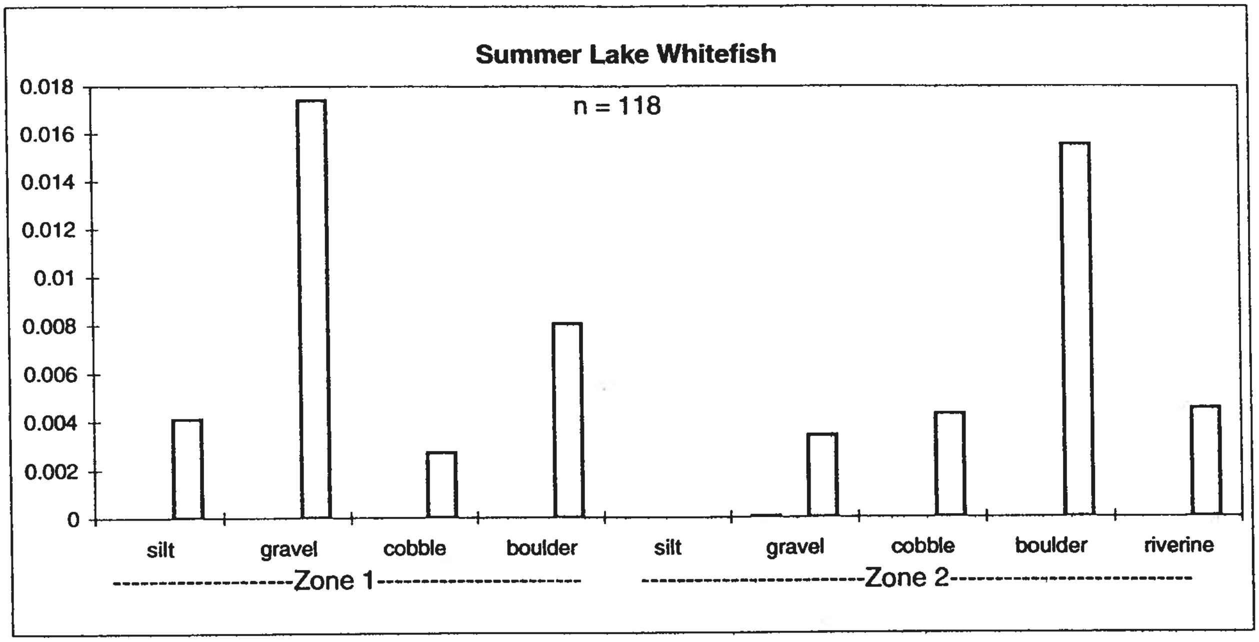

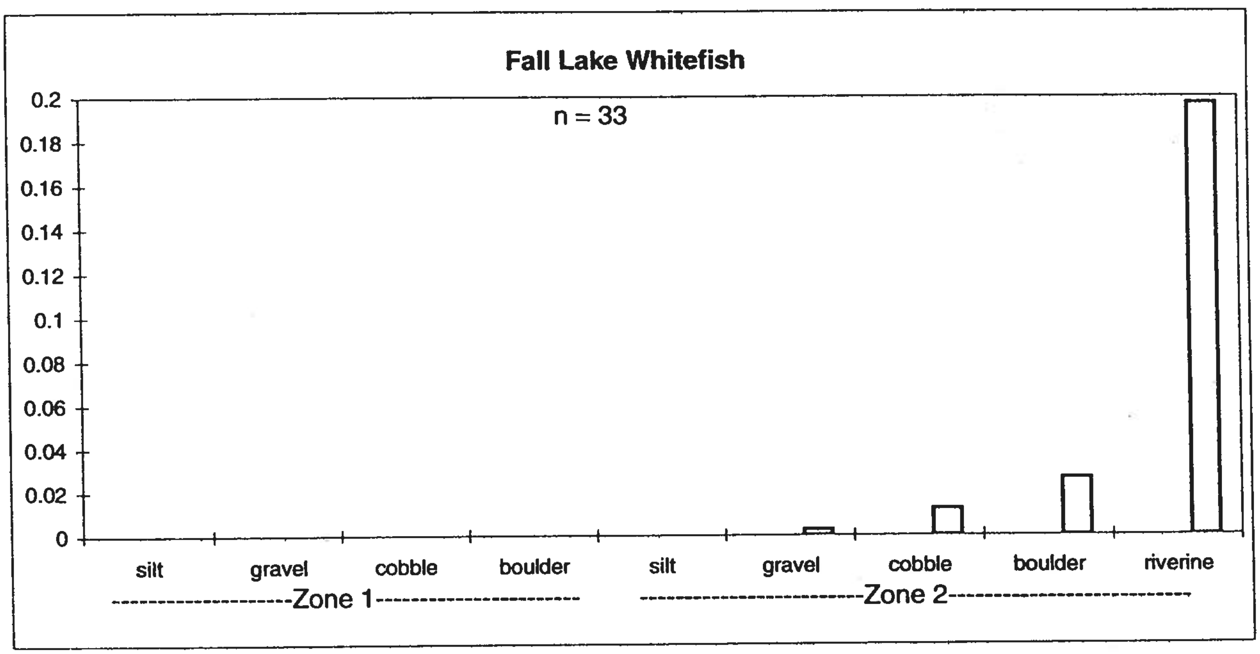

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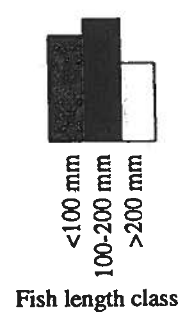

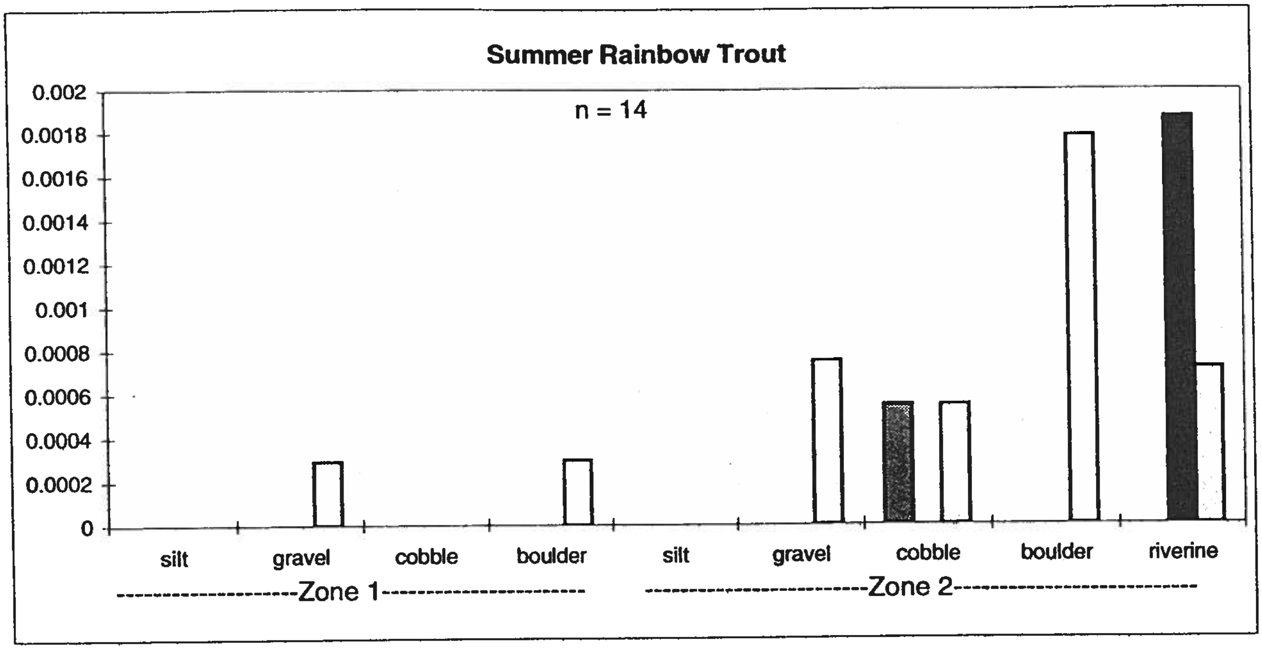

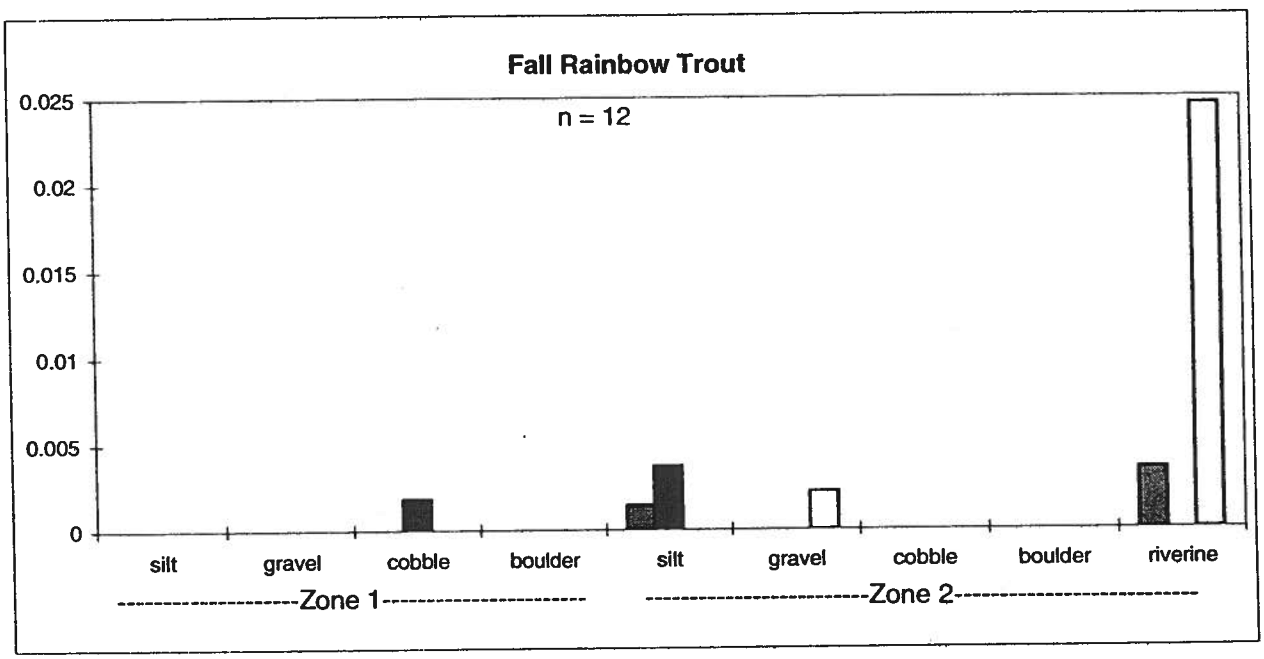

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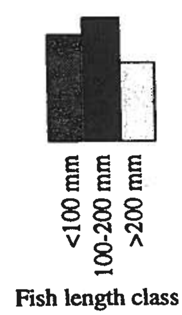

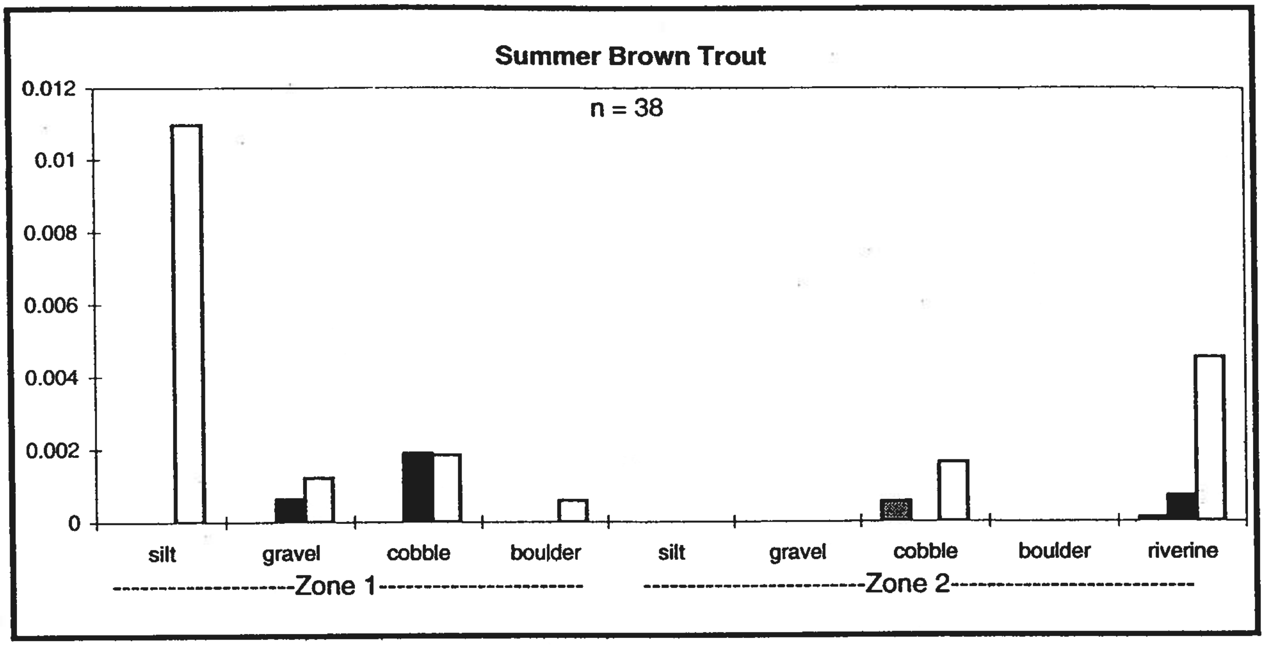

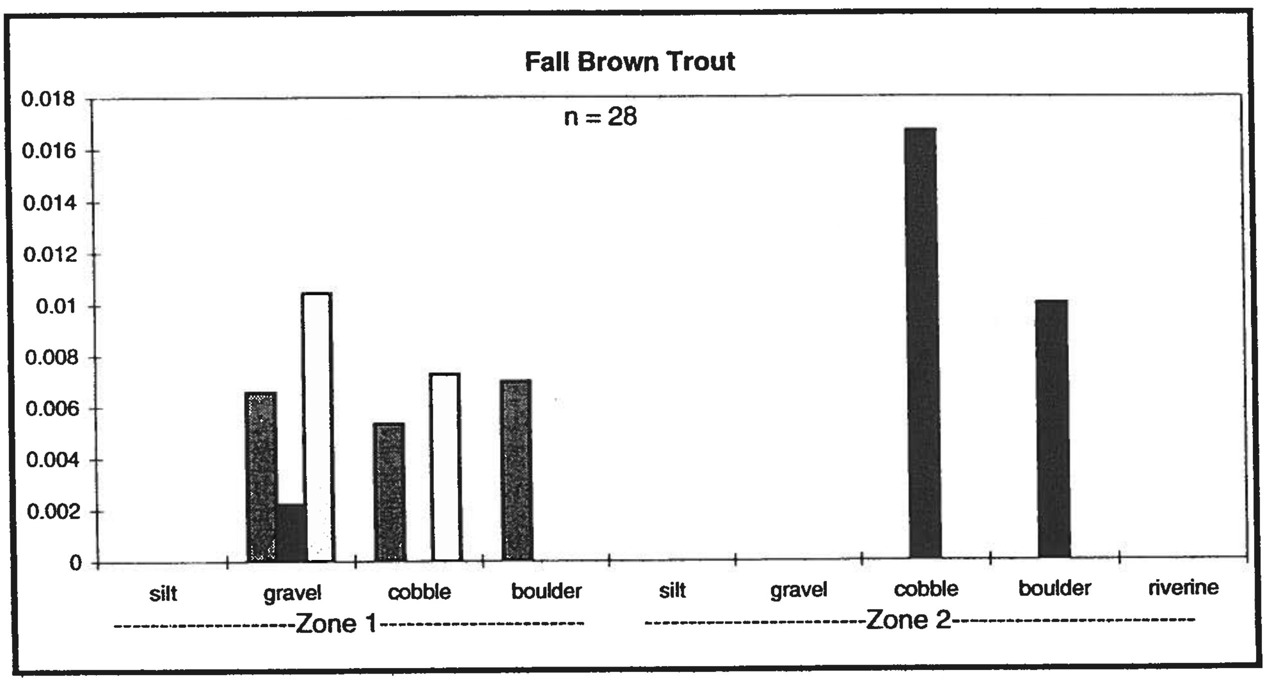

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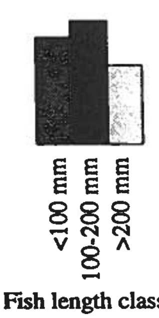

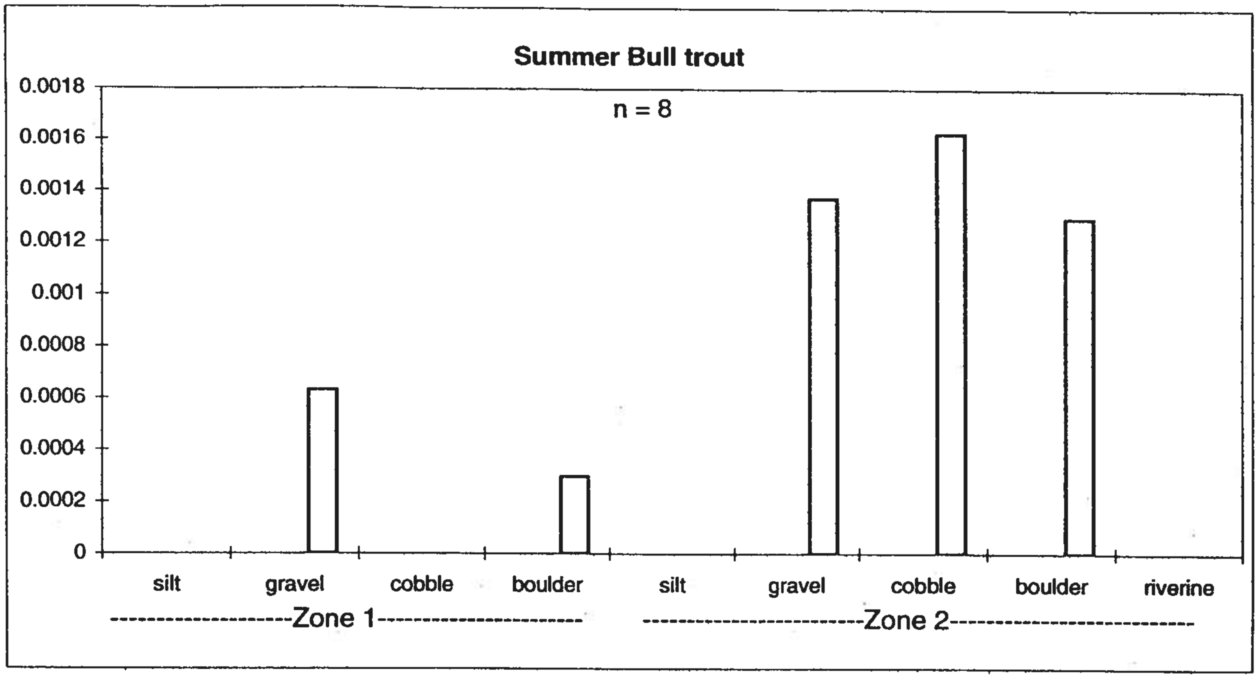

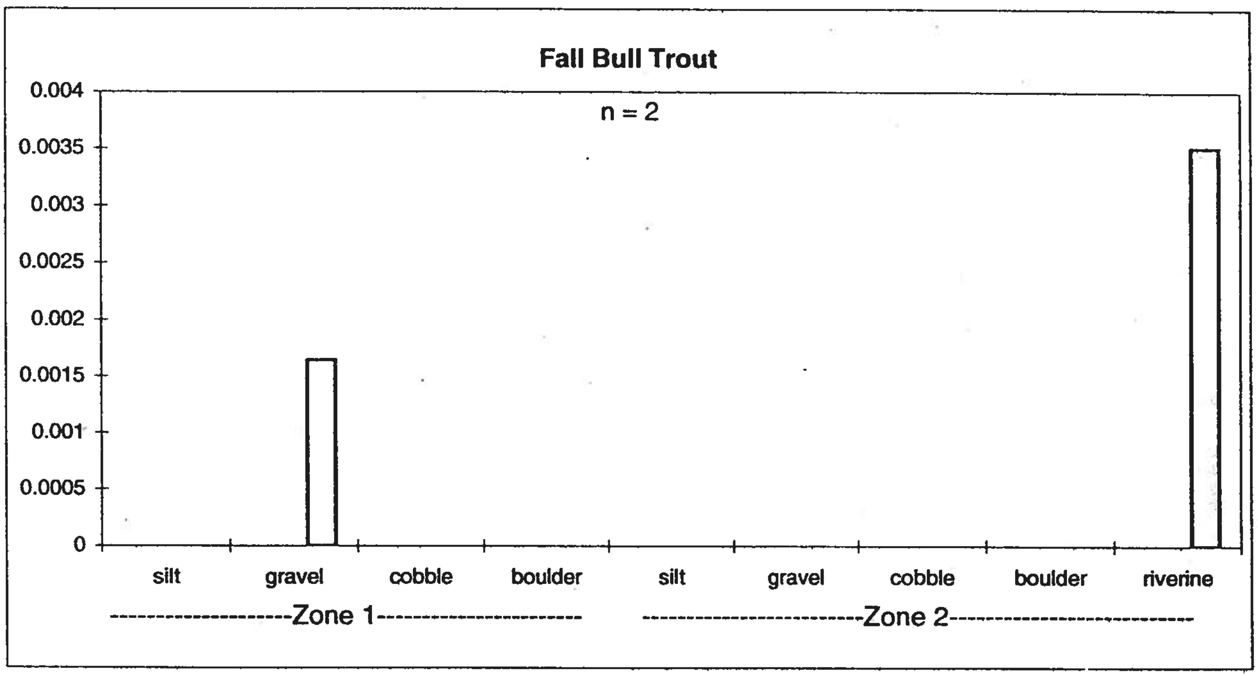

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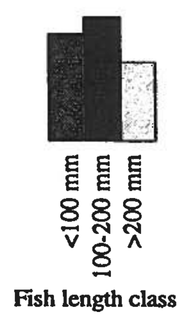
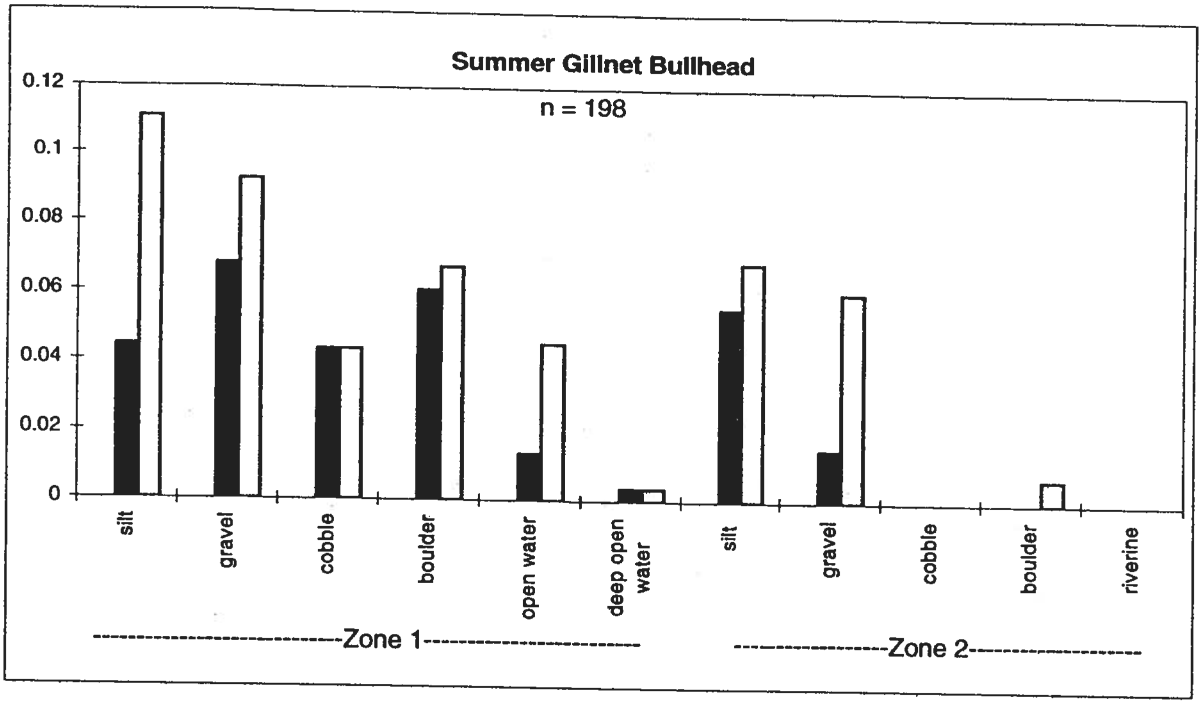




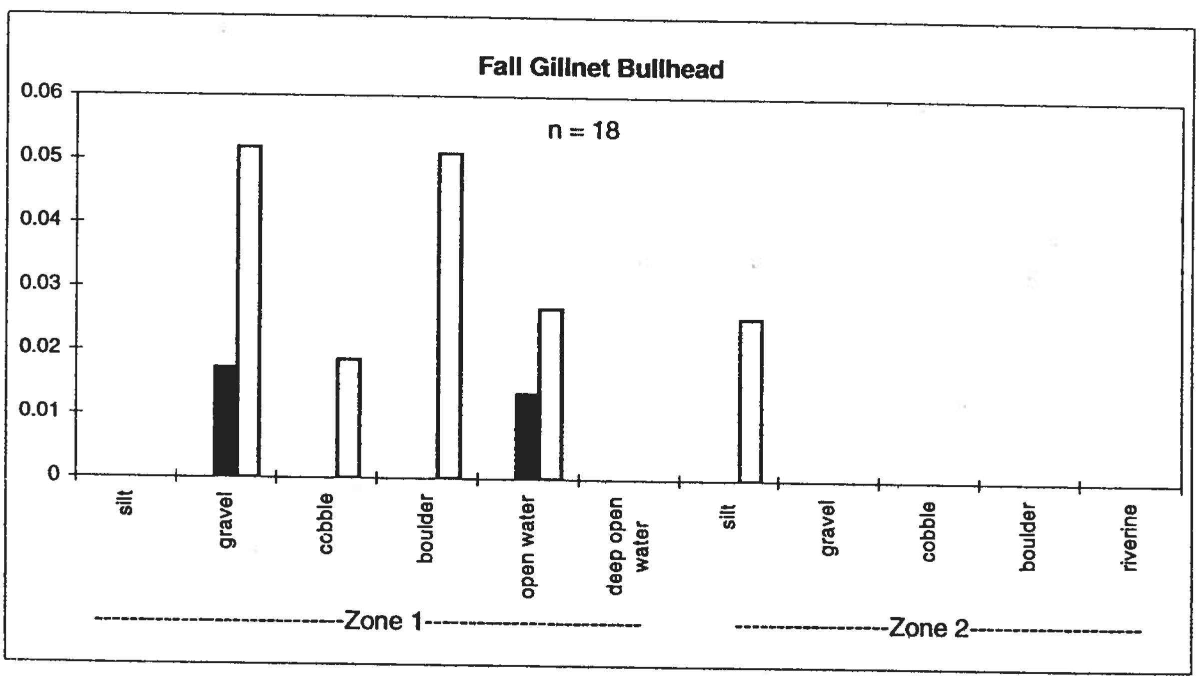
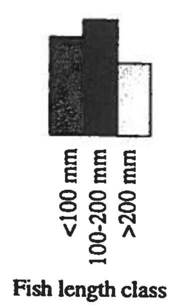
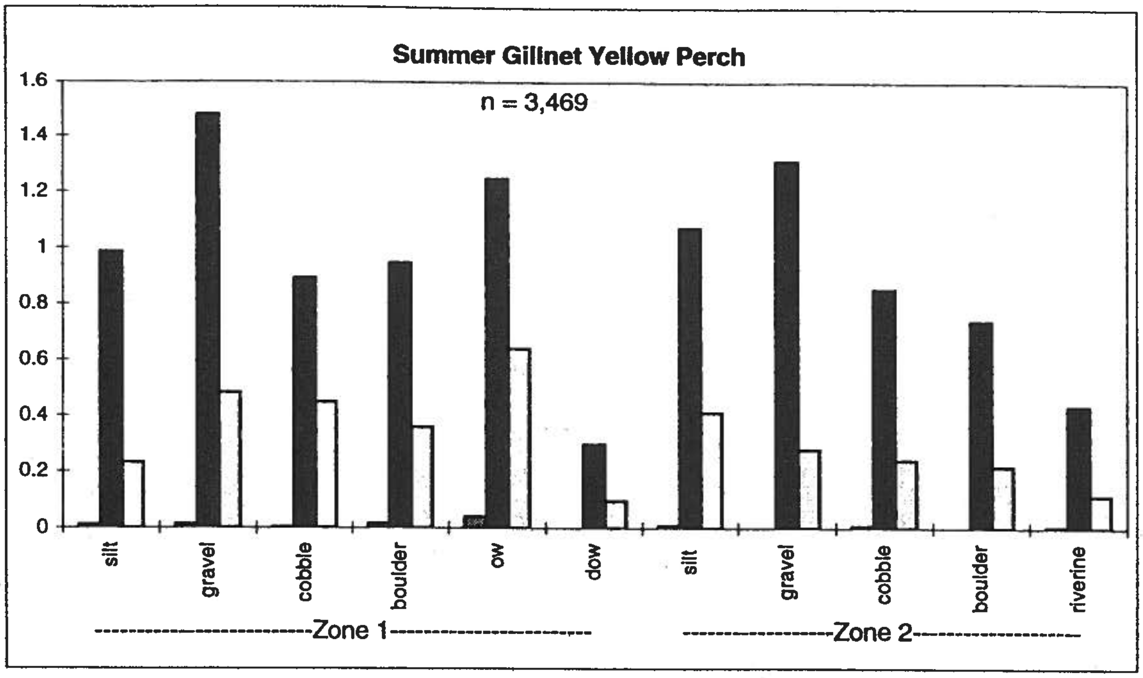
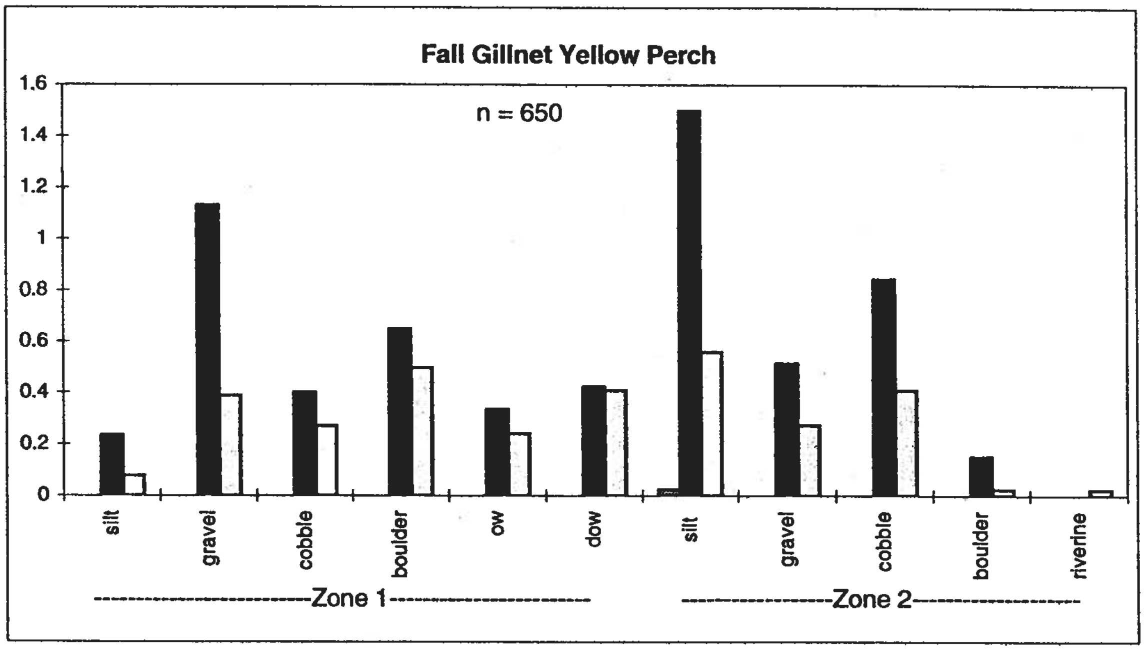
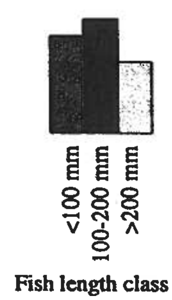


Figure A-5. Gill netting catch rates of fish size classes from each habitat type in Noxon Rapids Reservoir.









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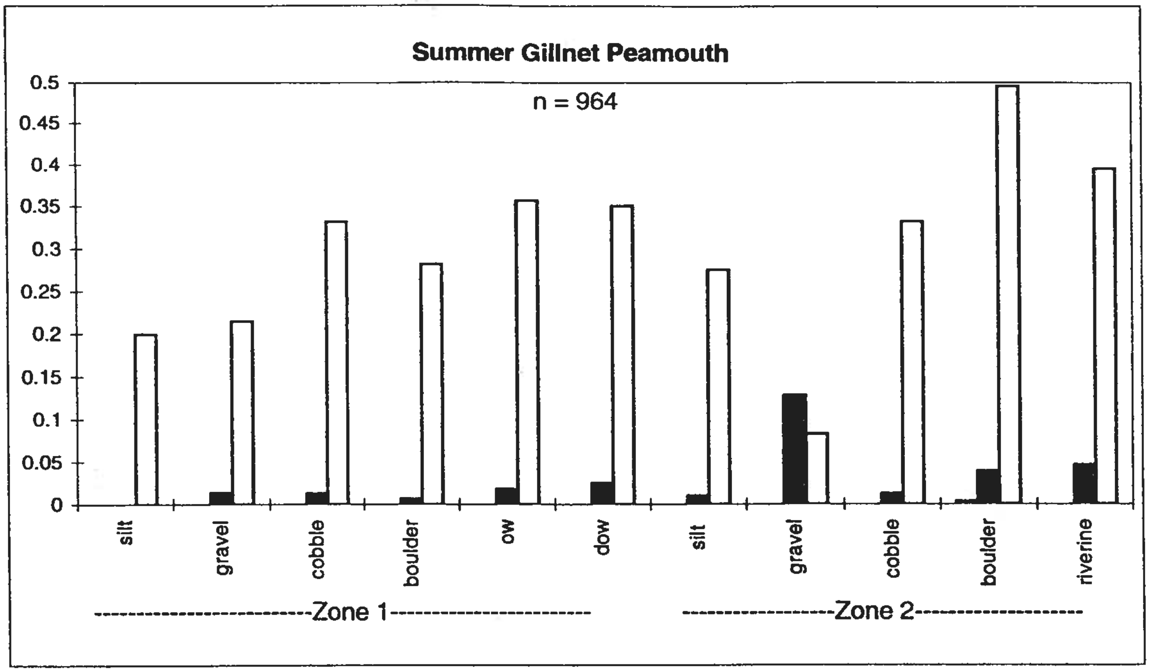

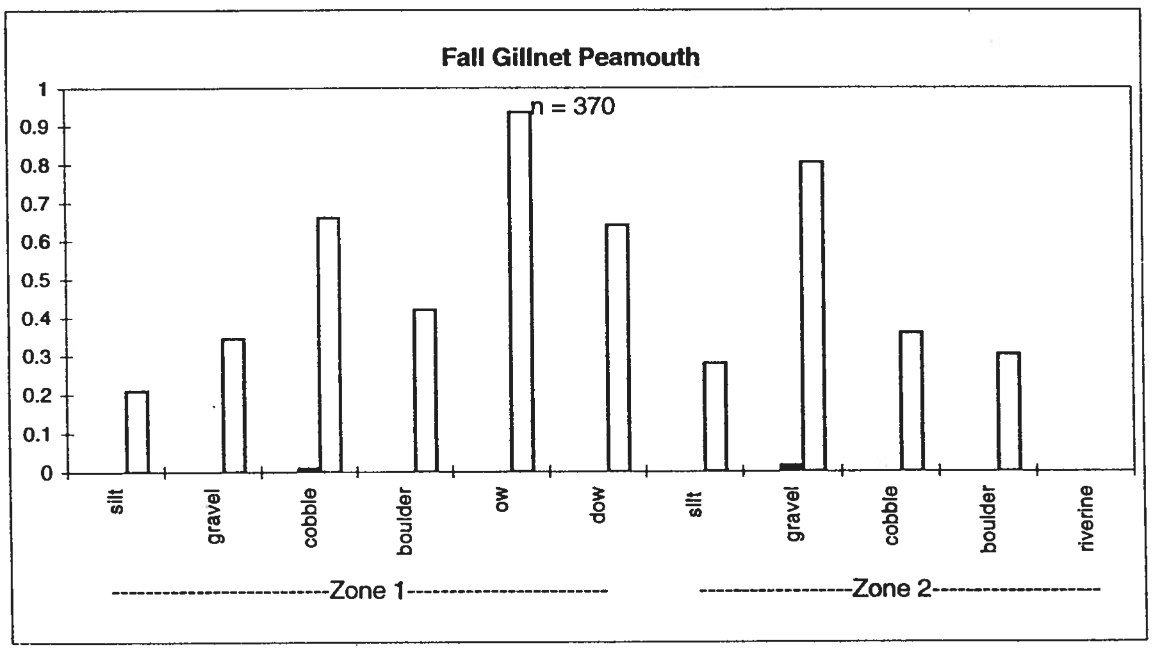

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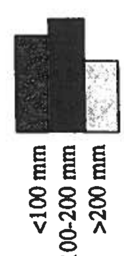

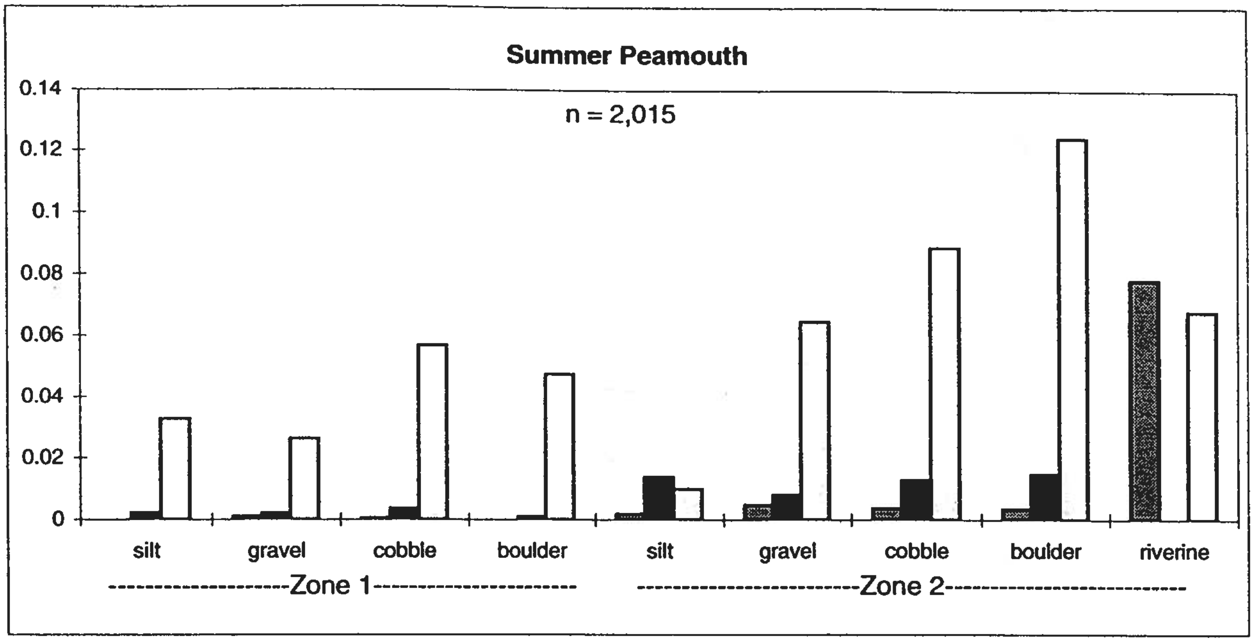

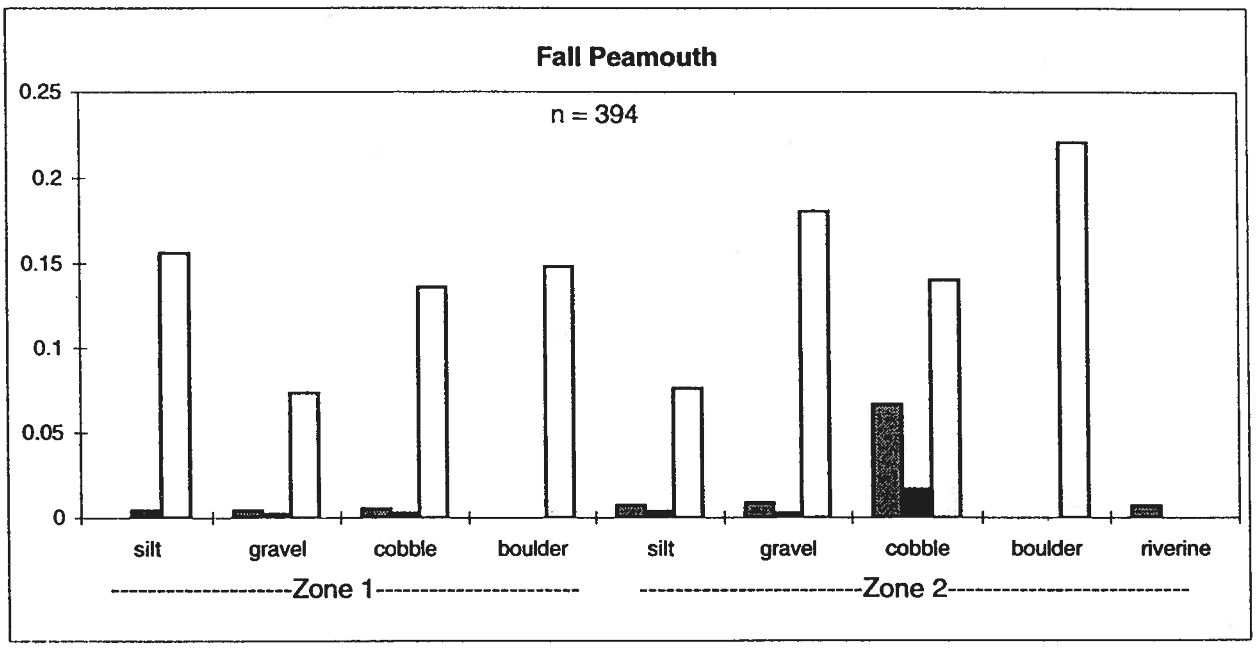

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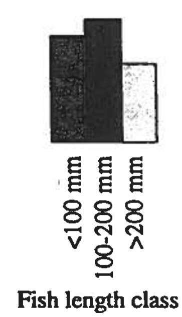

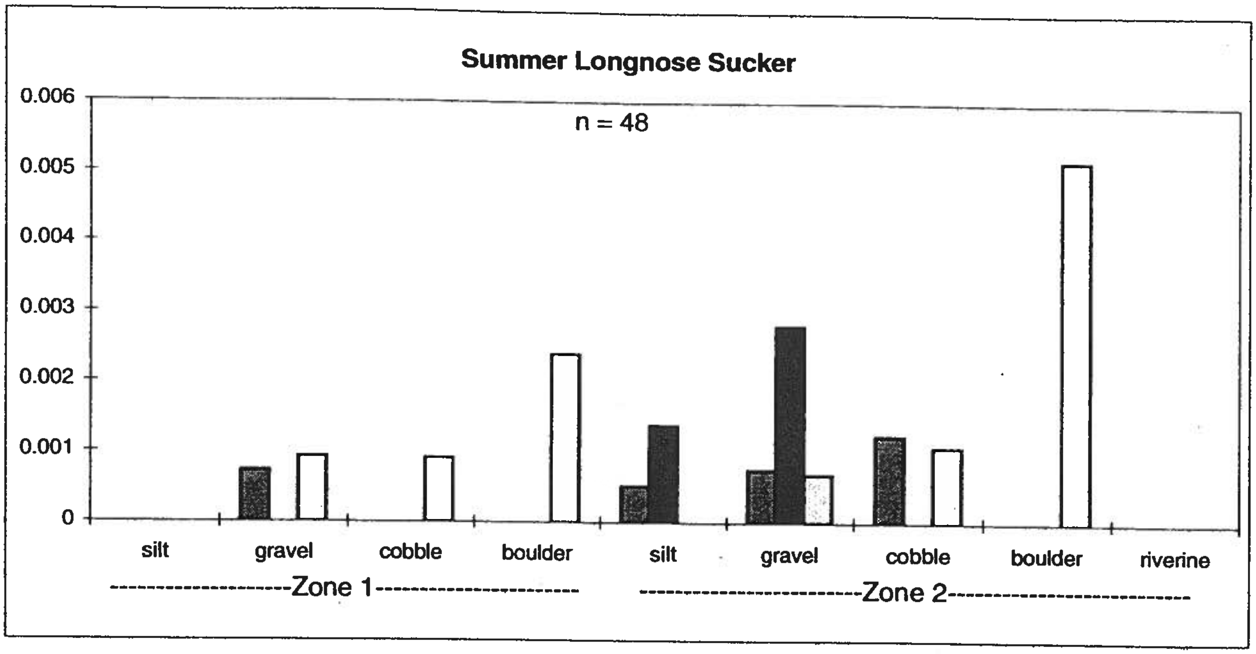

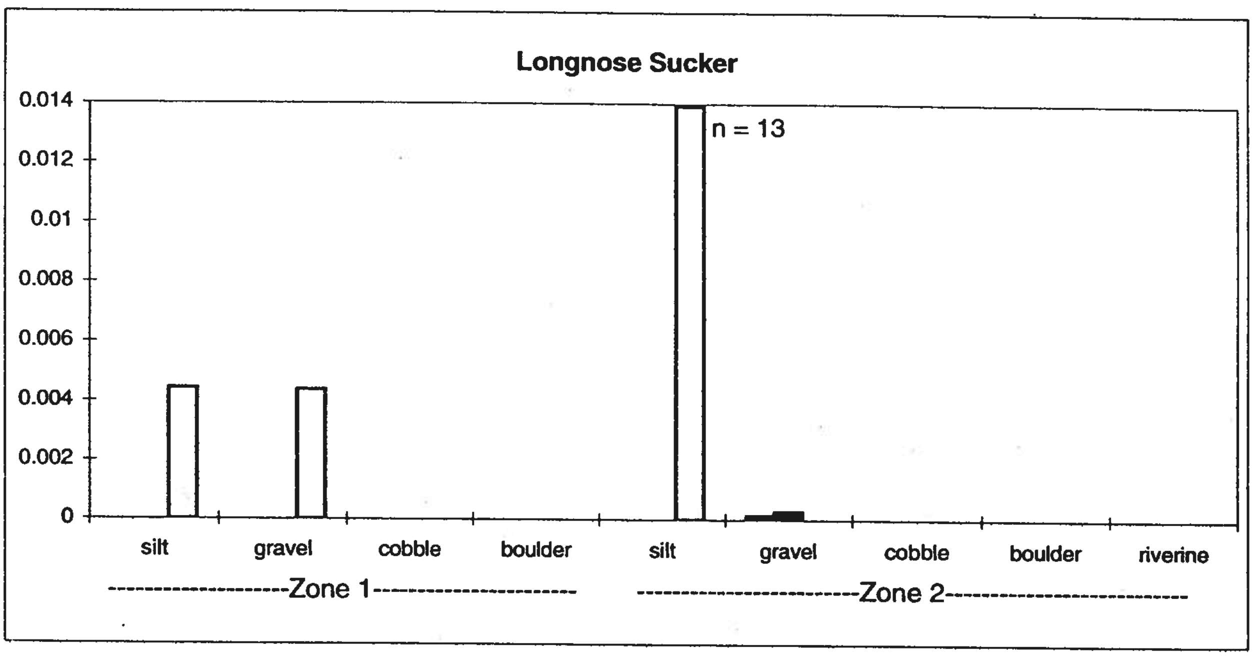

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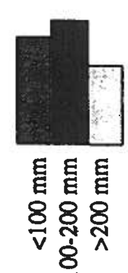

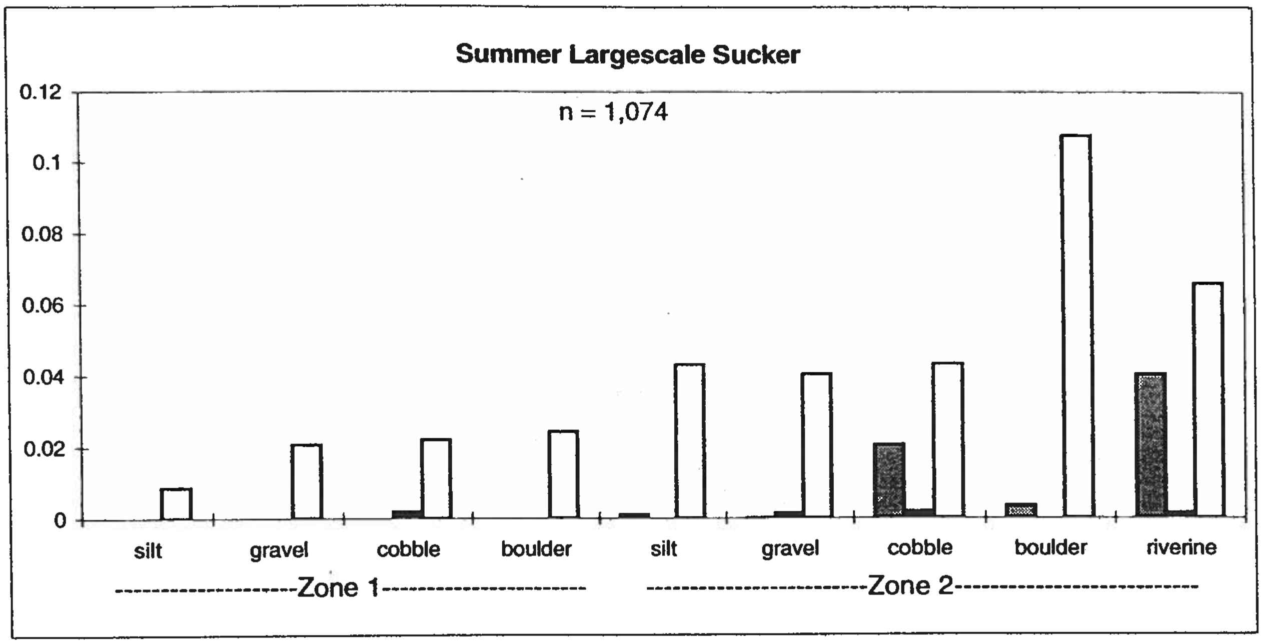

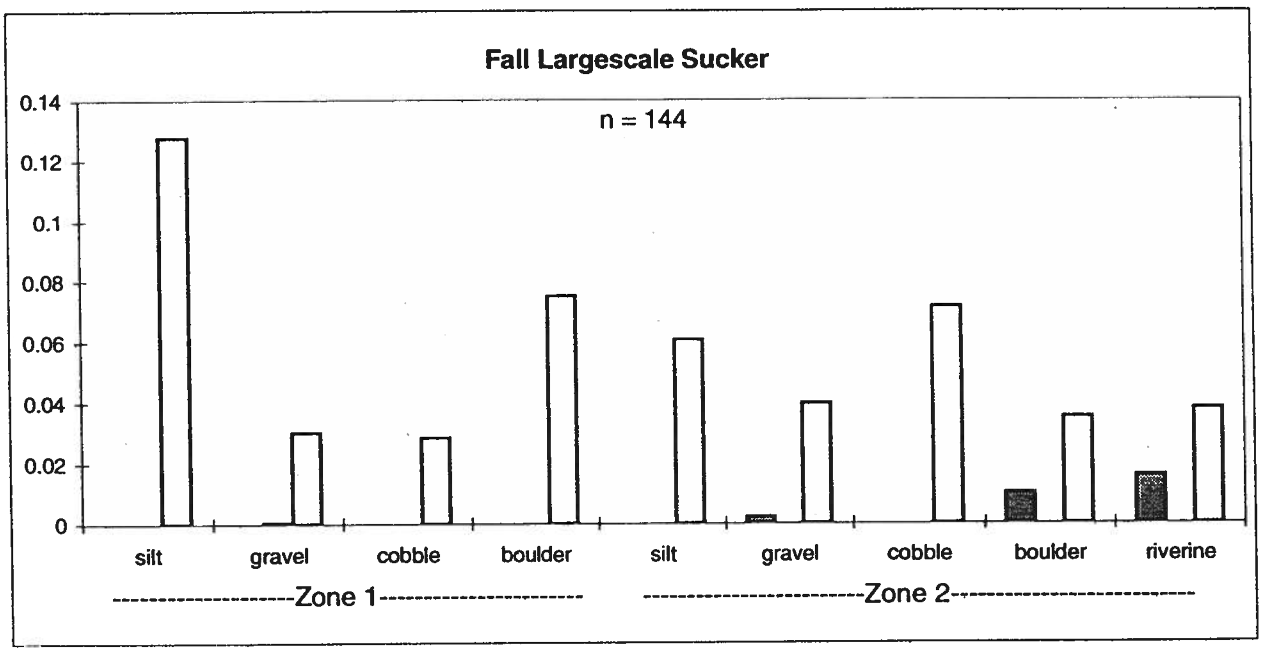

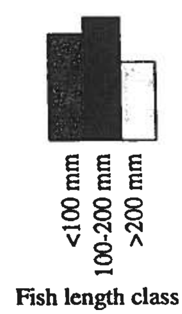

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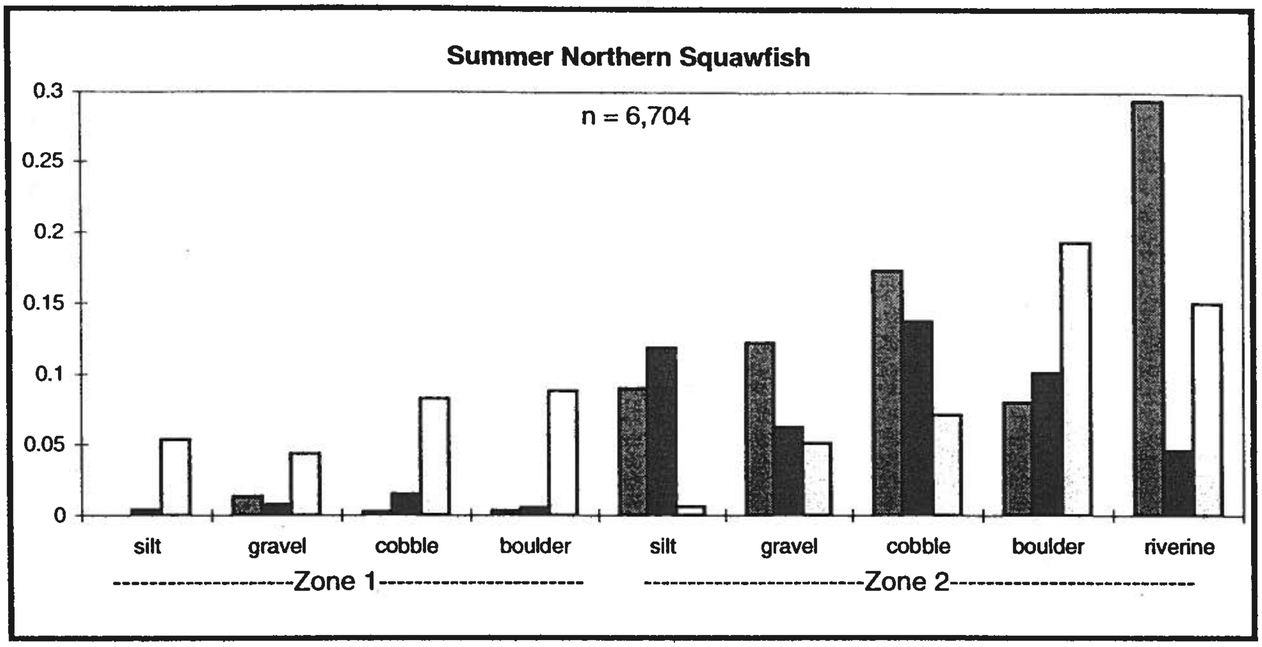

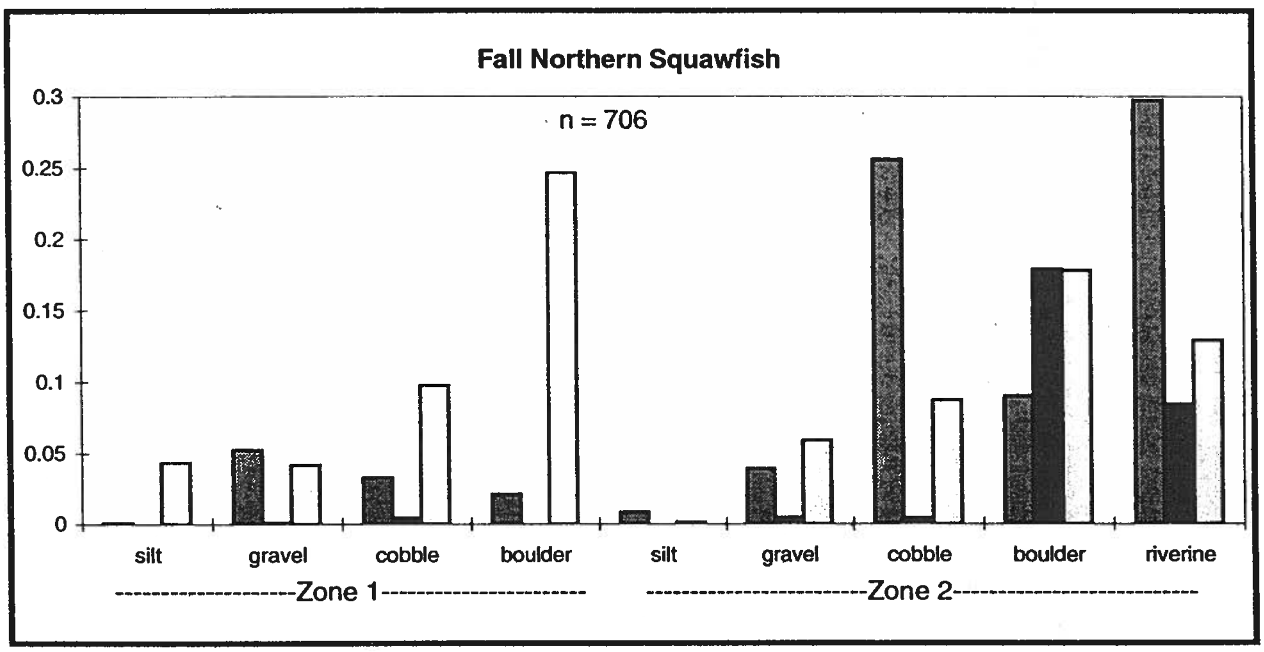

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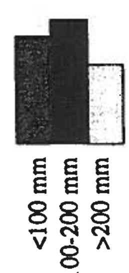

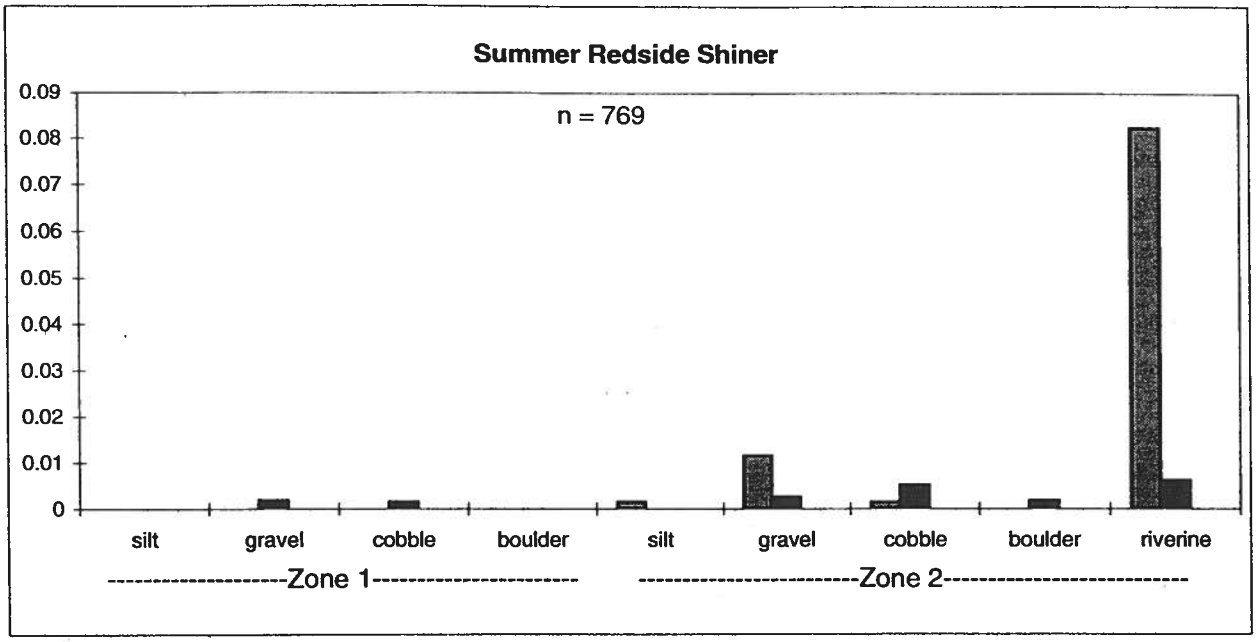

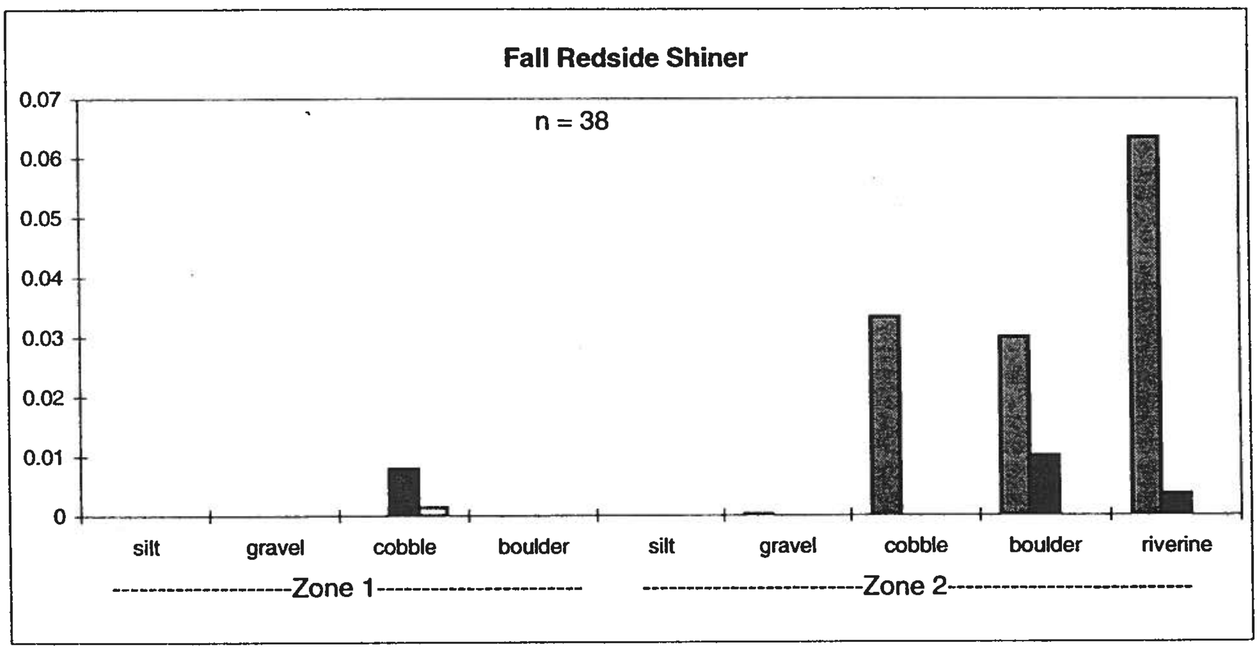

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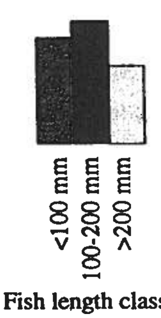

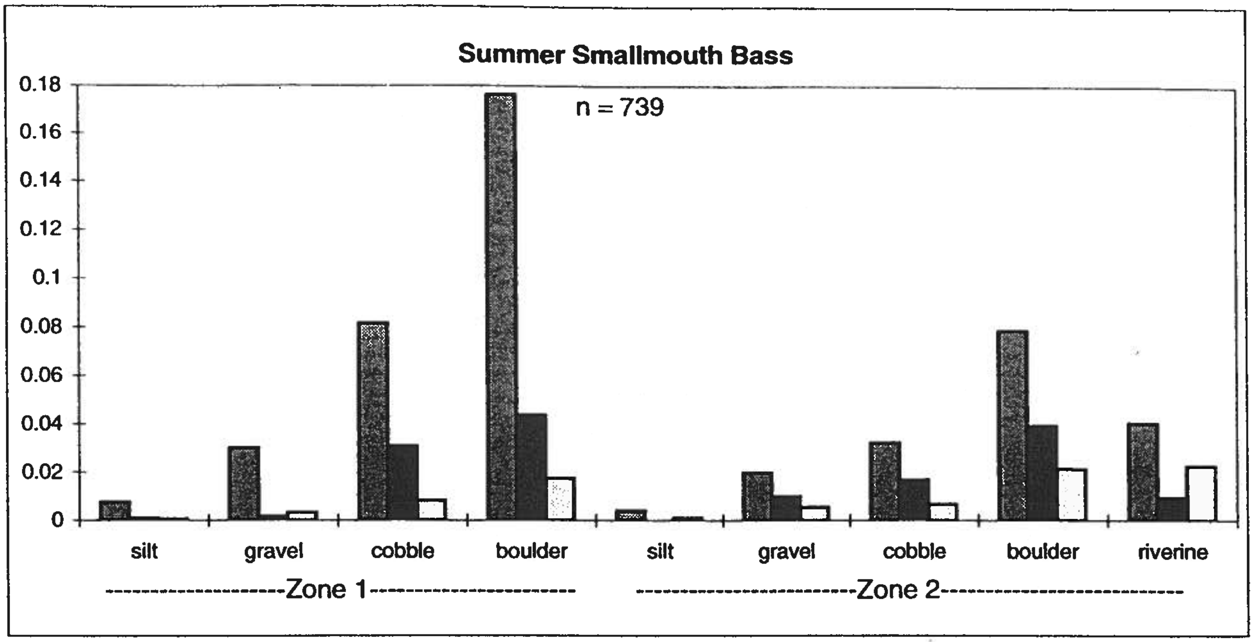

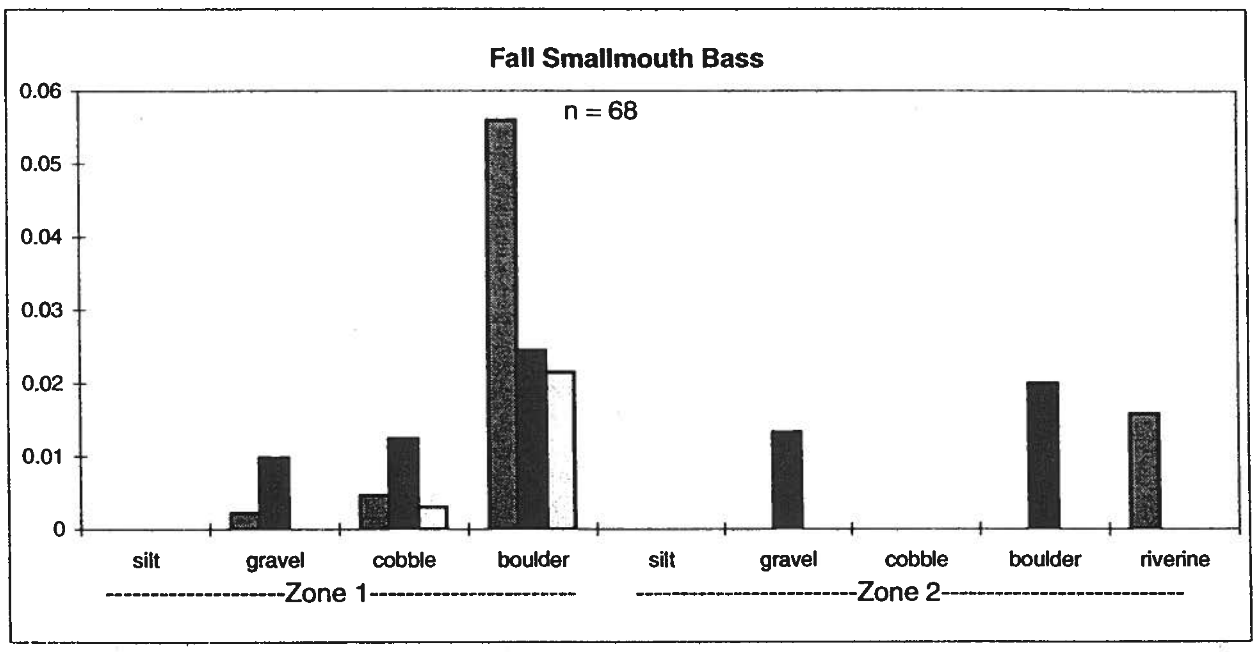

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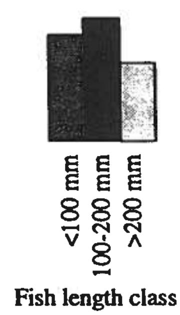

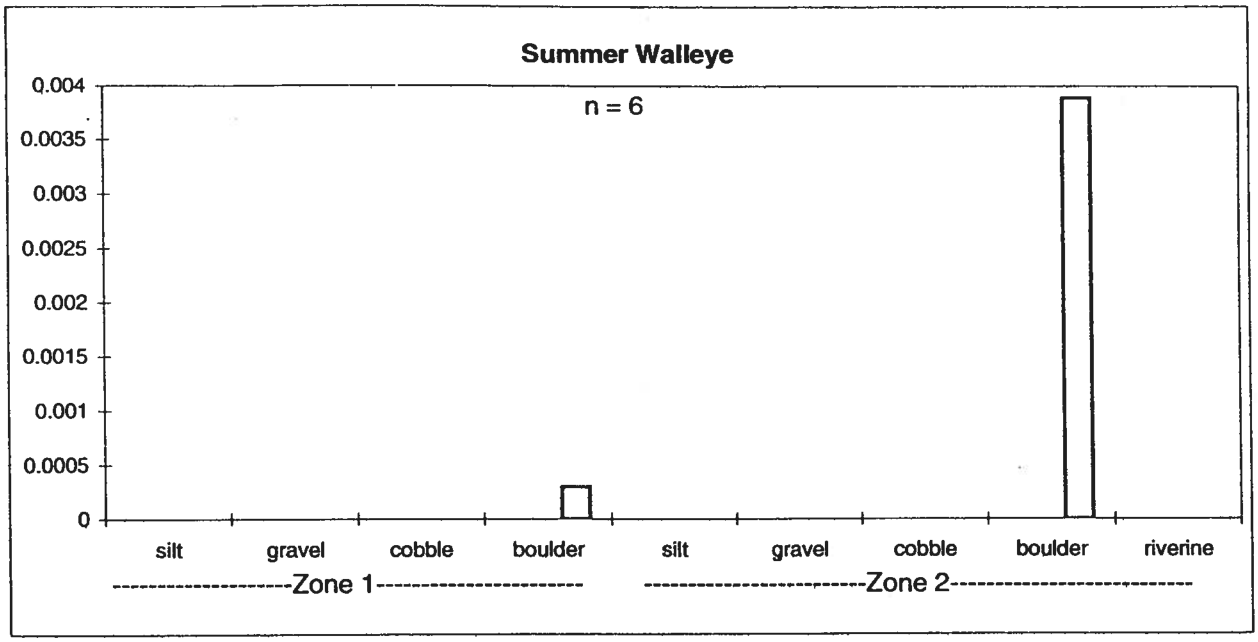

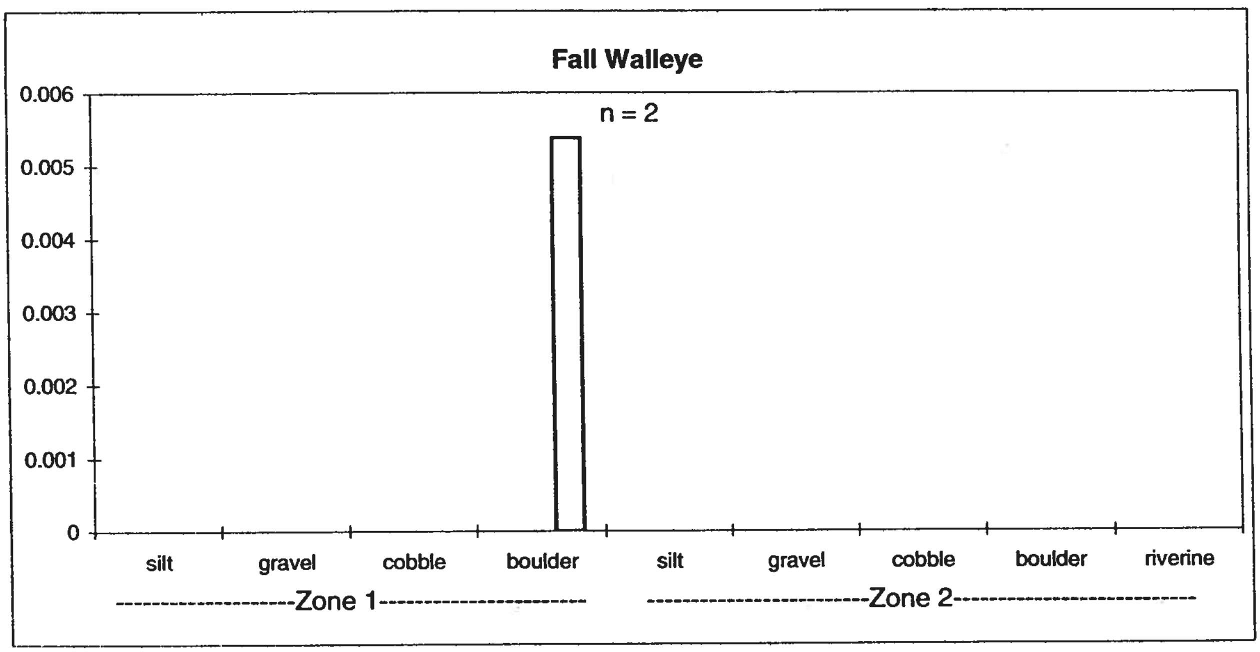

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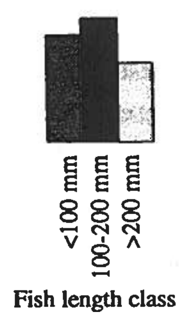

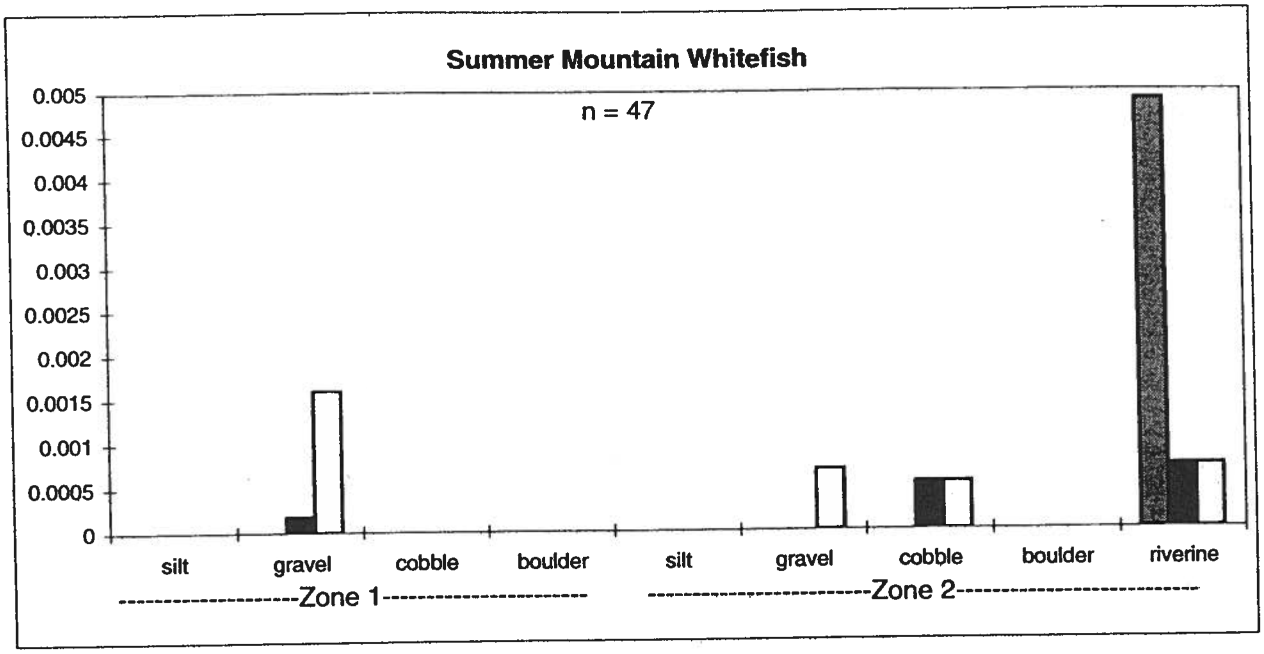

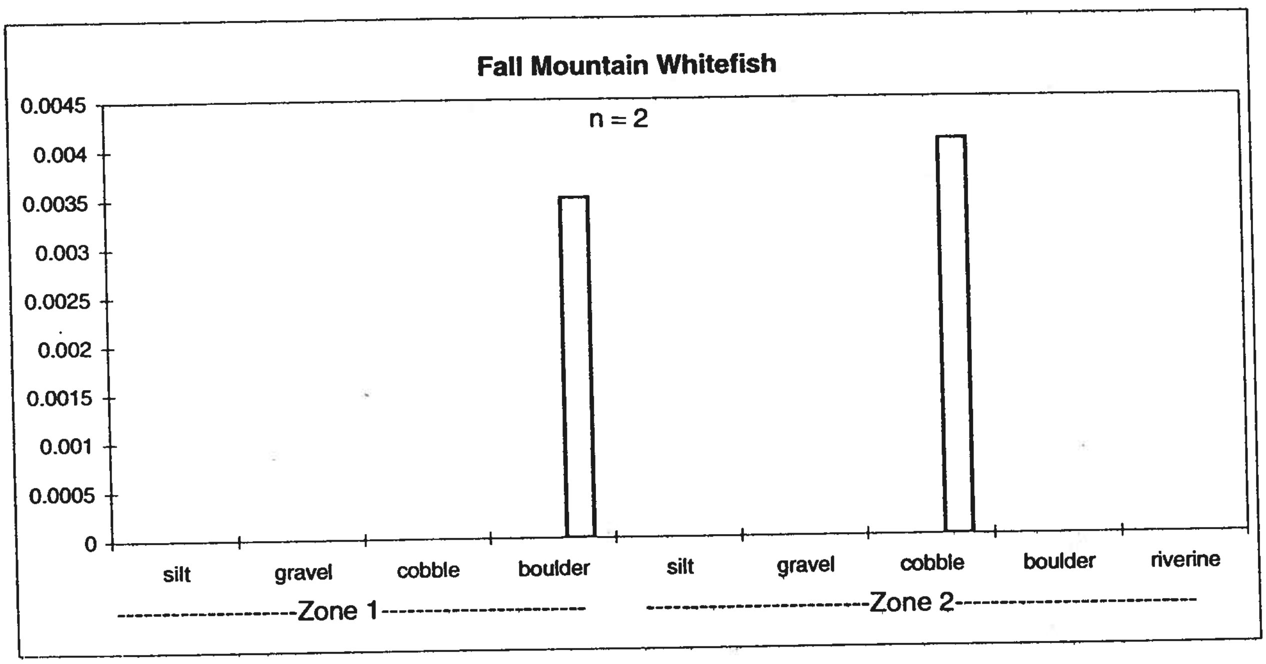

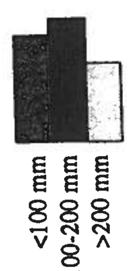

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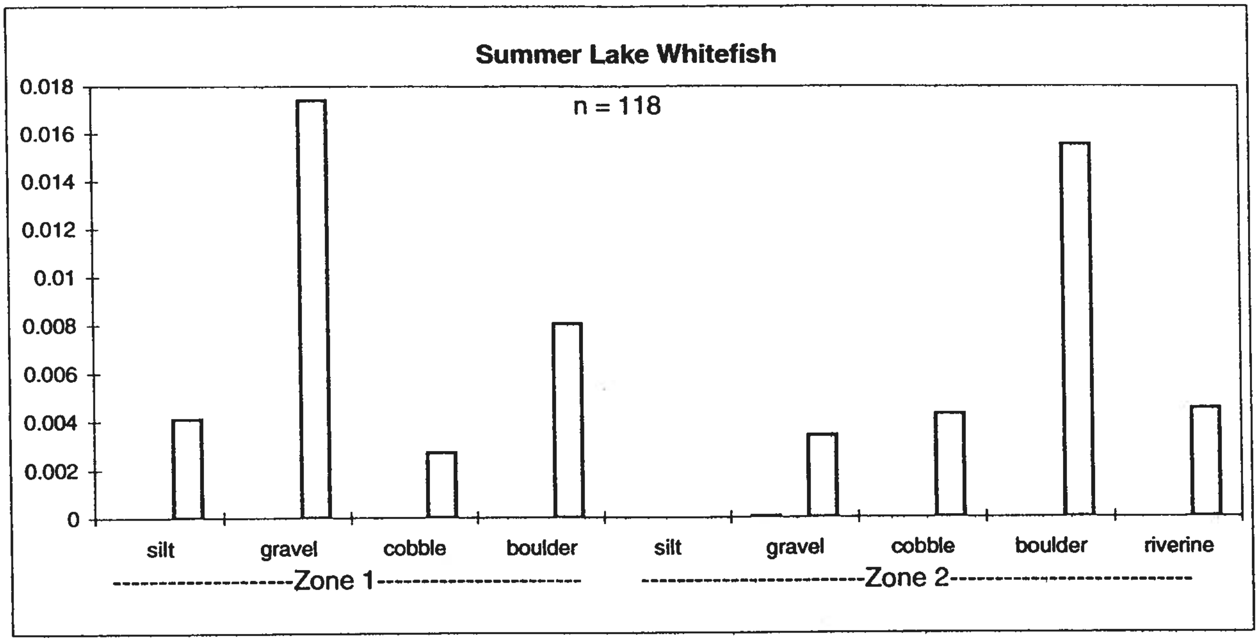


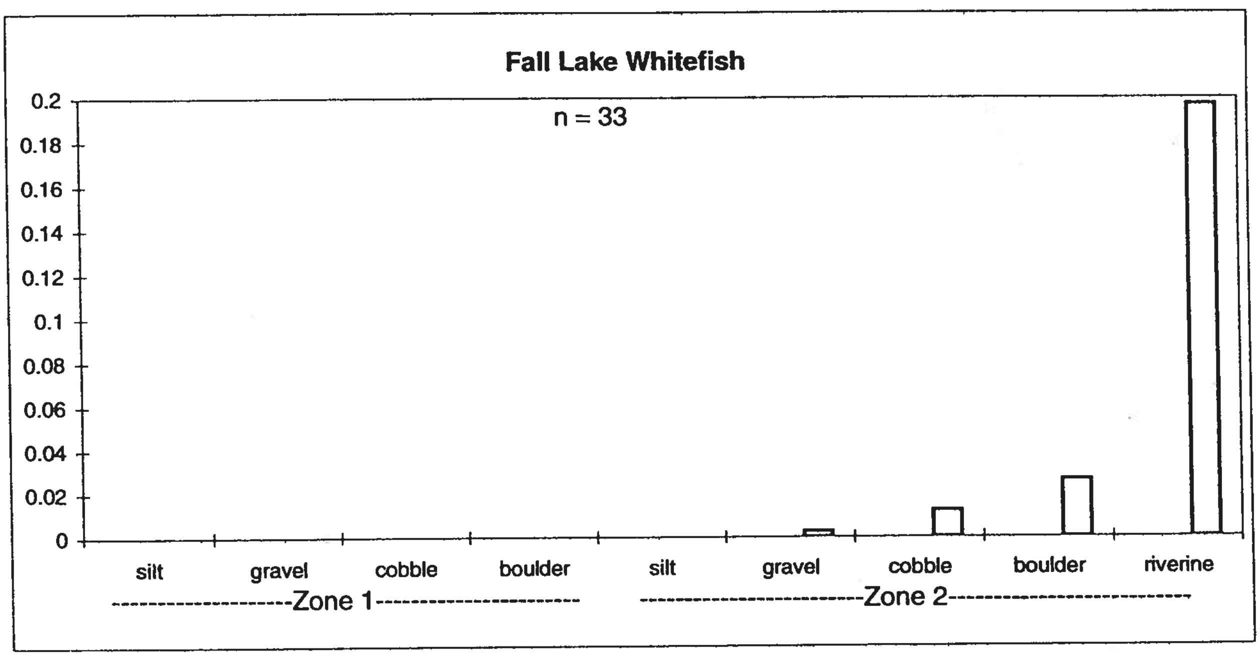
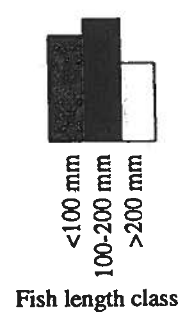
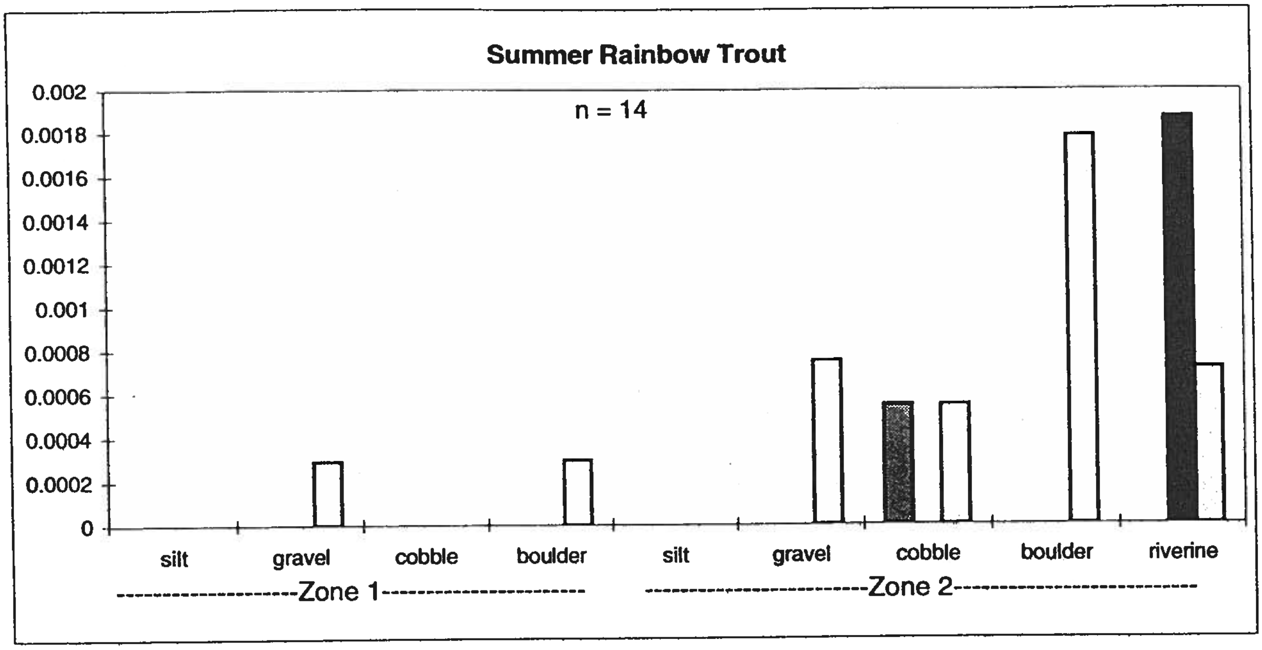


Figure A-4. Relative abundance (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Noxon Rapids Reservoir.





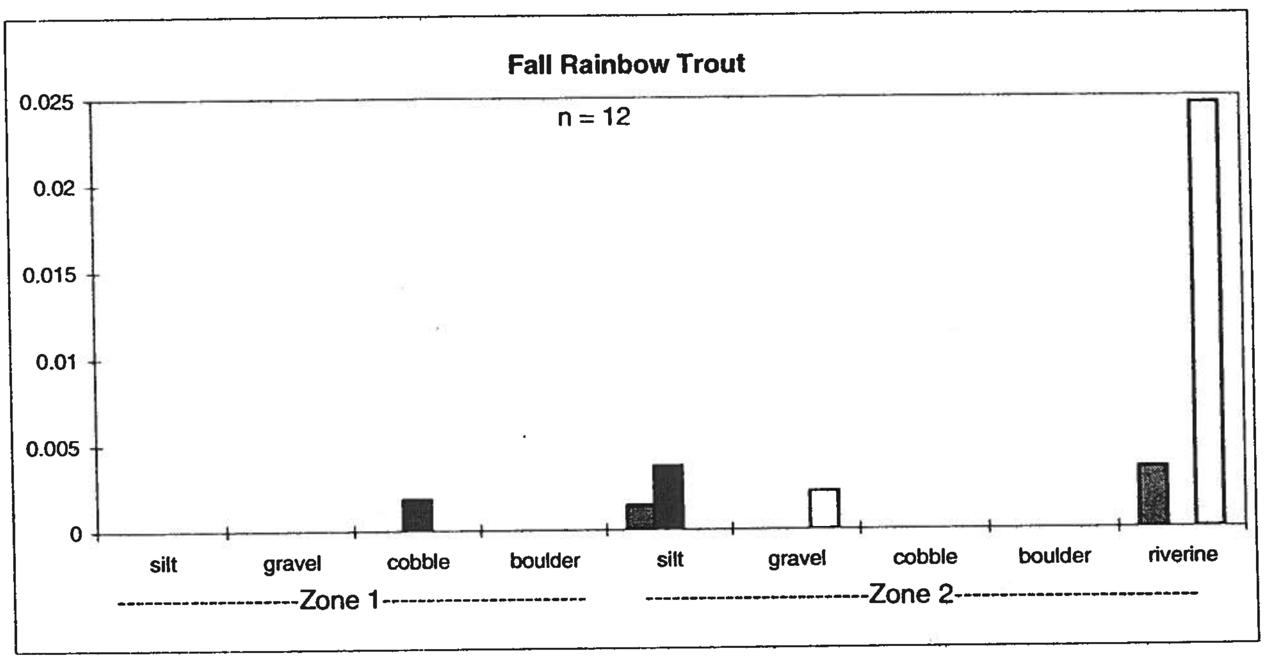
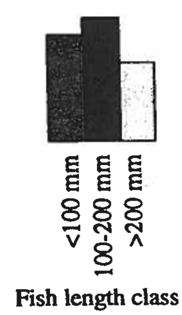
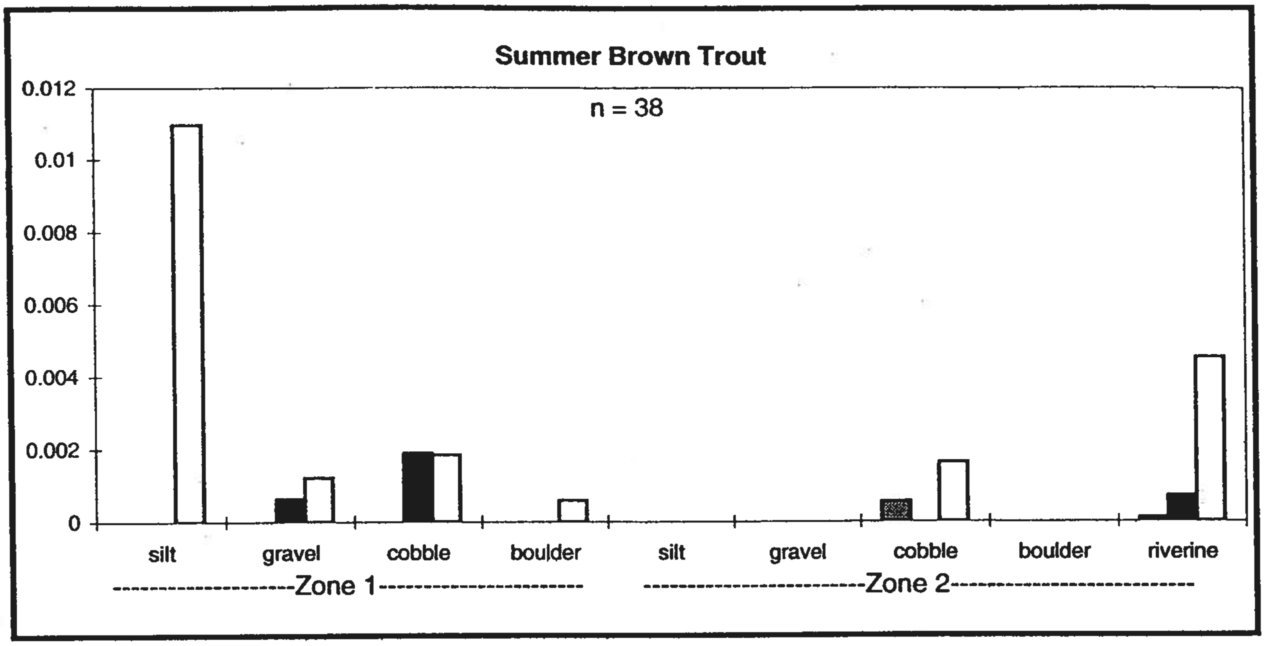


Figure A-4. Relative abundance (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Noxon Rapids Reservoir.





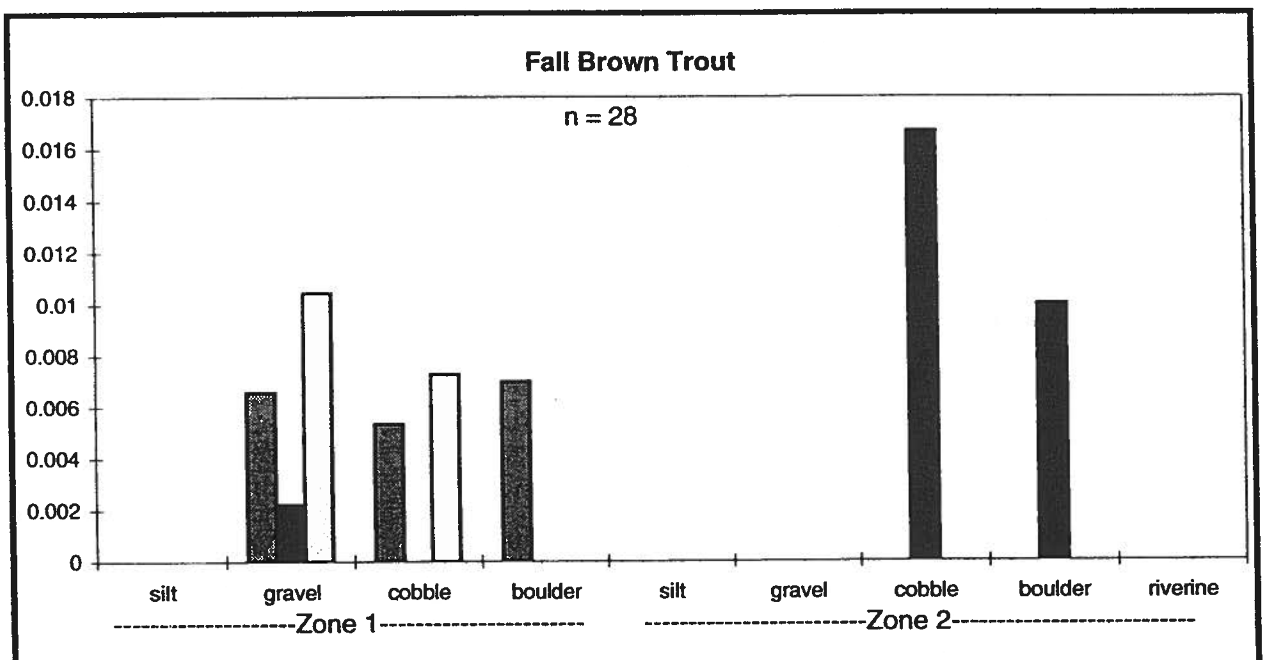
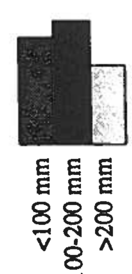
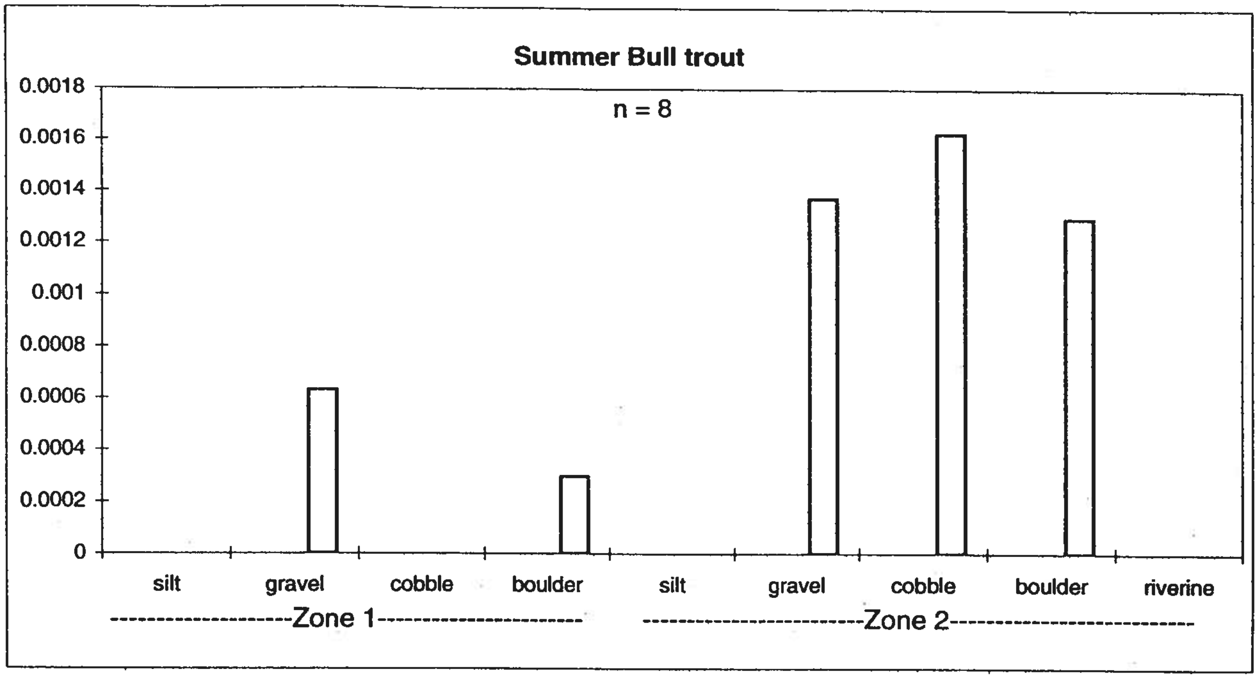


Figure A-4. Relative abundance (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Noxon Rapids Reservoir.





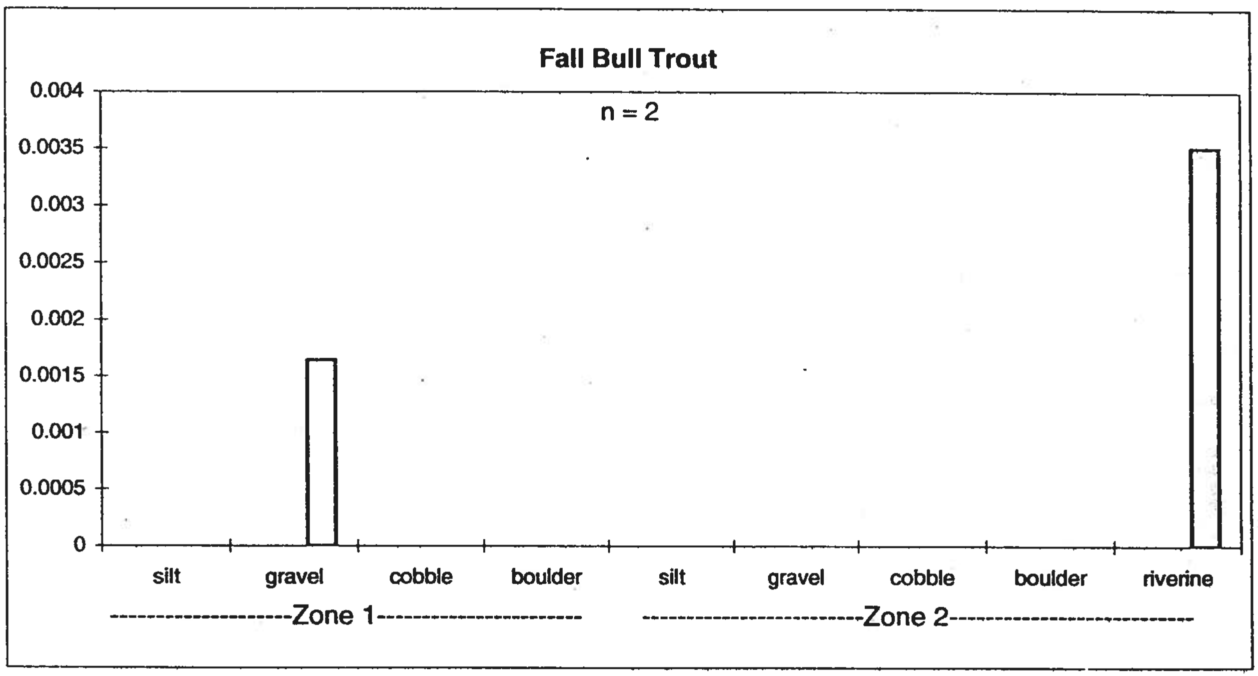
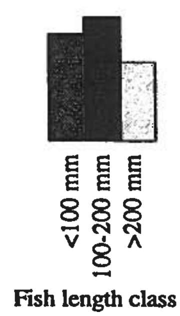
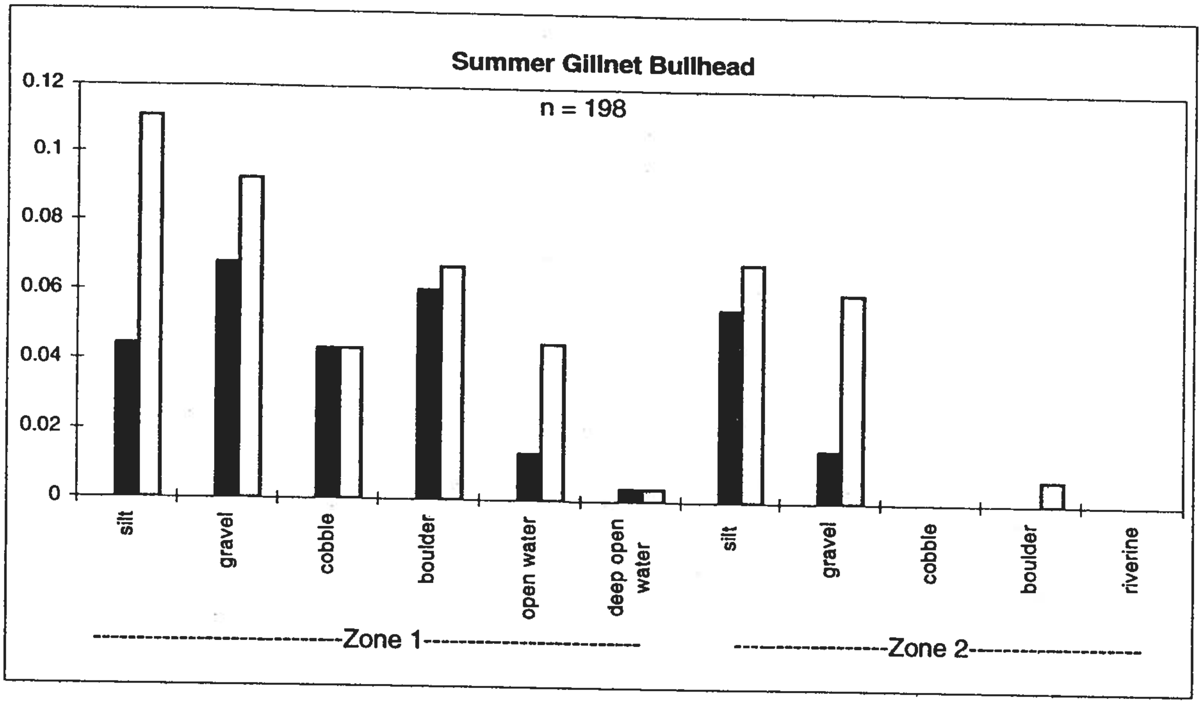


Figure A-4. Relative abundance (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Noxon Rapids Reservoir.





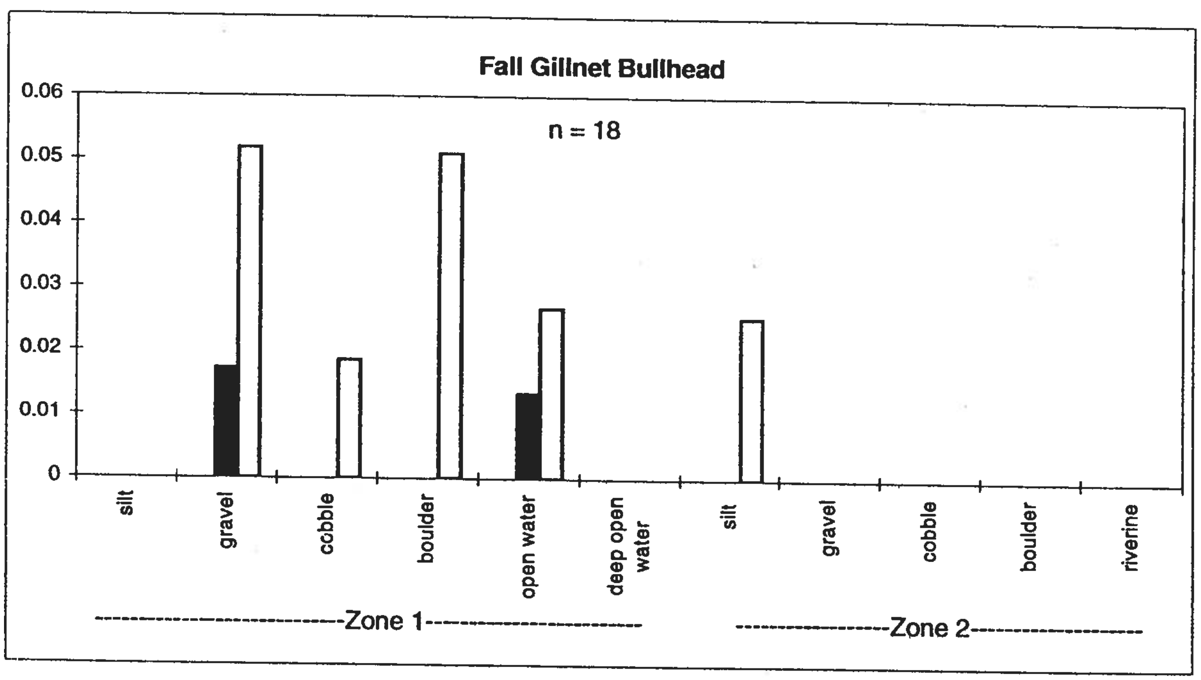
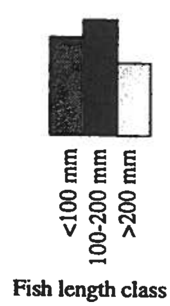
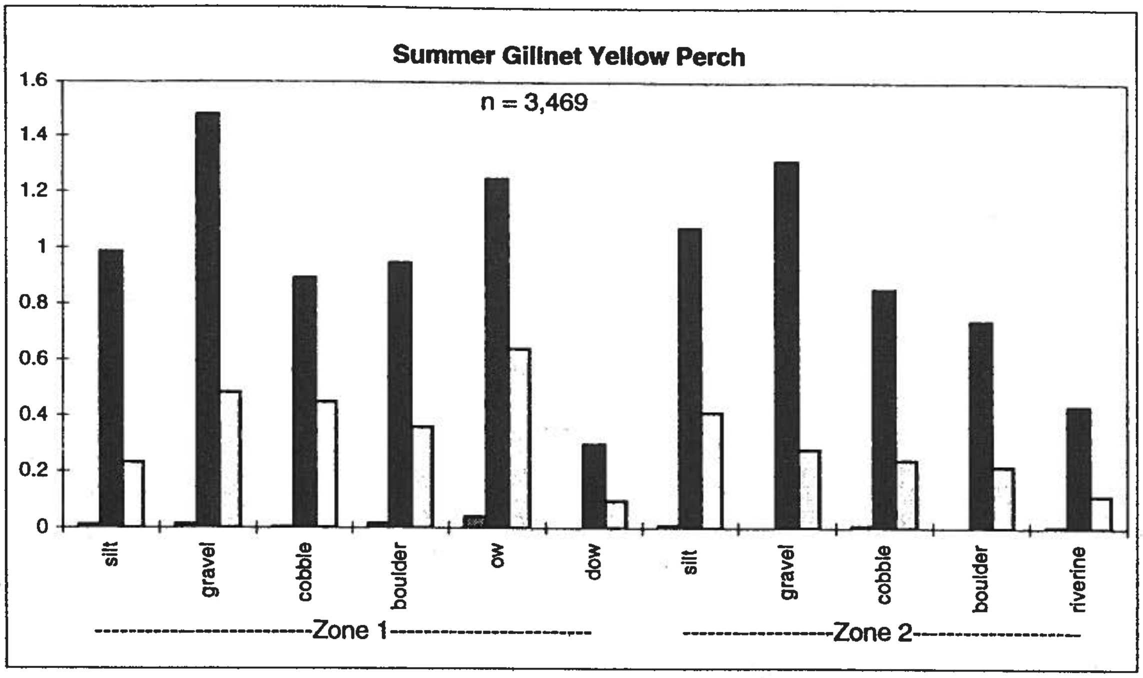


Figure A-5. Gill netting catch rates of fish size classes from each habitat type in Noxon Rapids Reservoir.





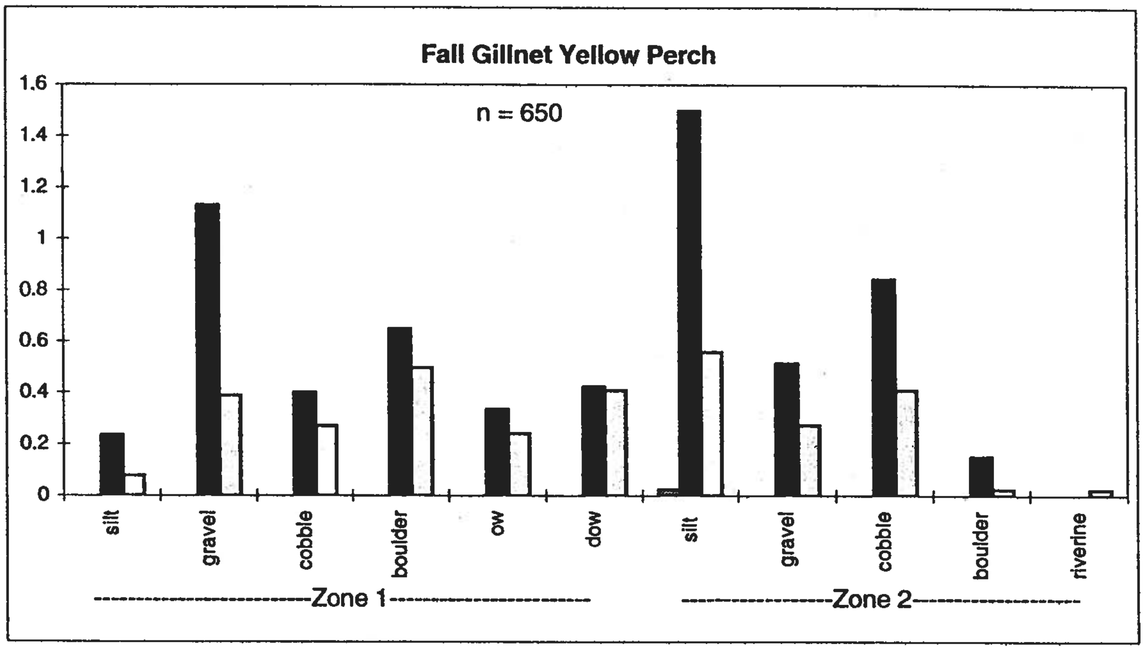
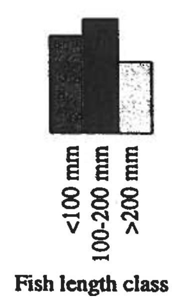
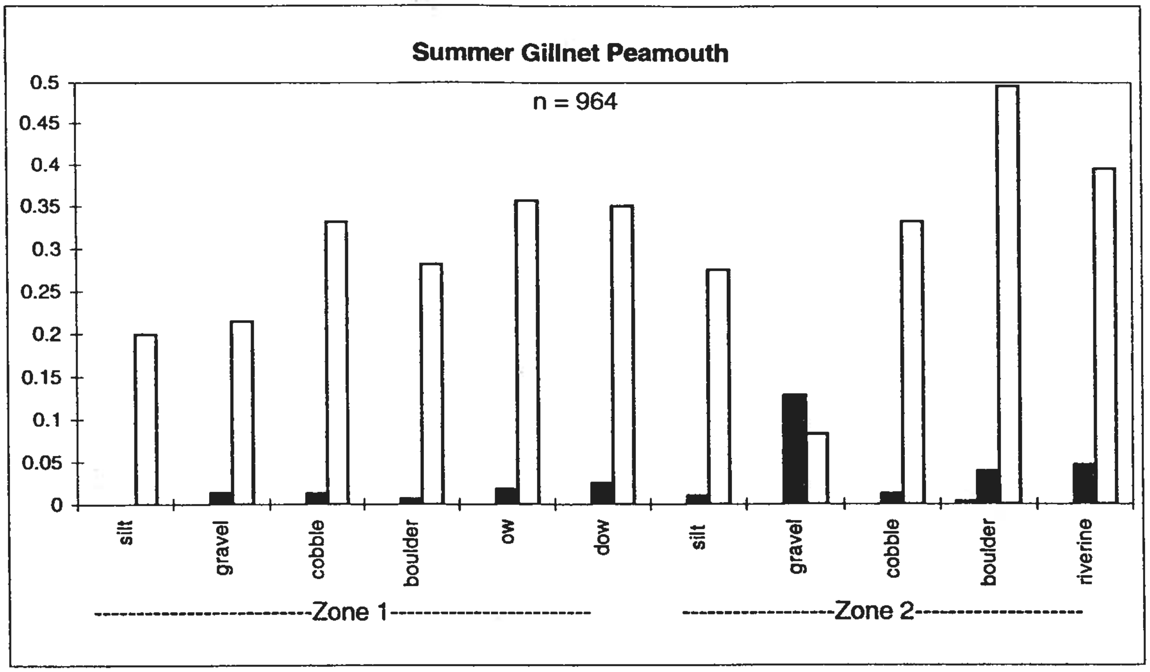


Figure A-5. Gill netting catch rates of fish size classes from each habitat type in Noxon Rapids Reservoir.





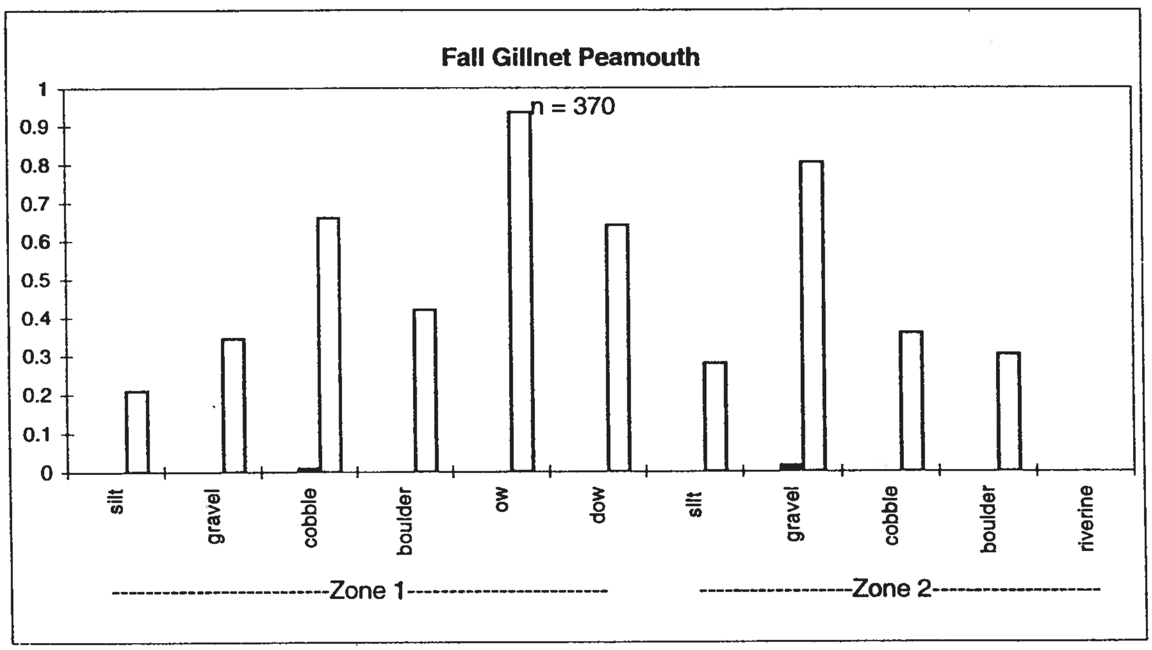
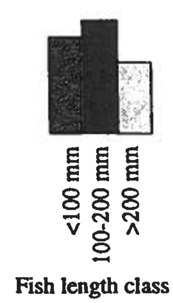
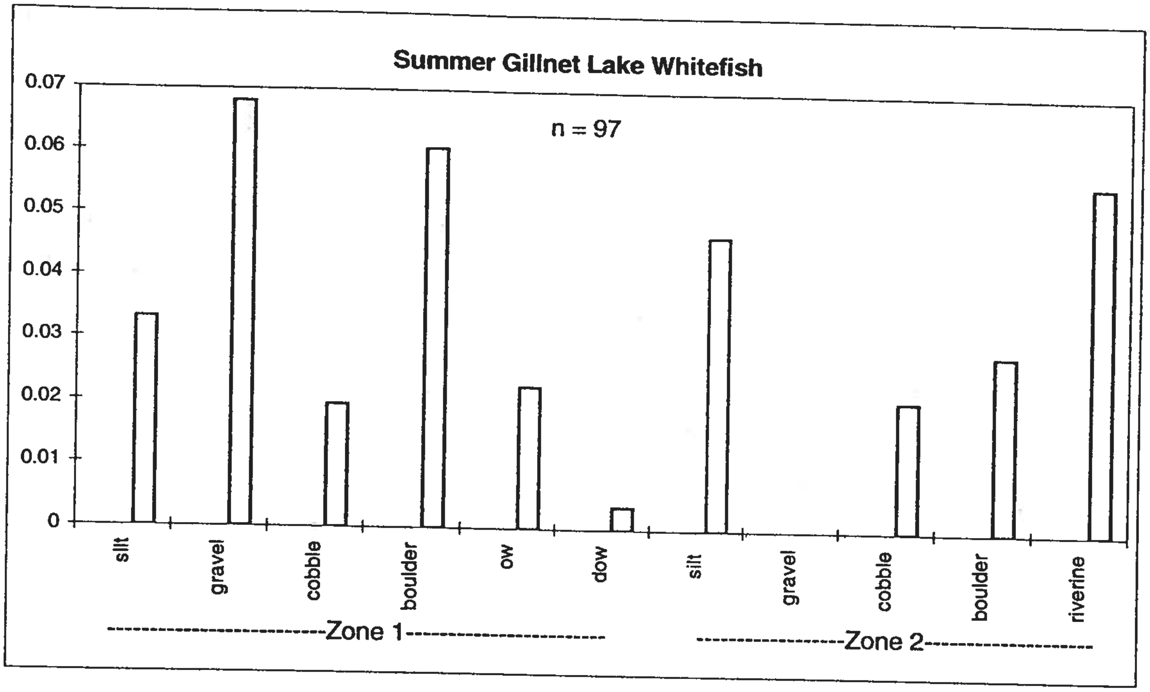


Figure A-5. Gill netting catch rates of fish size classes from each habitat type in Noxon Rapids Reservoir.





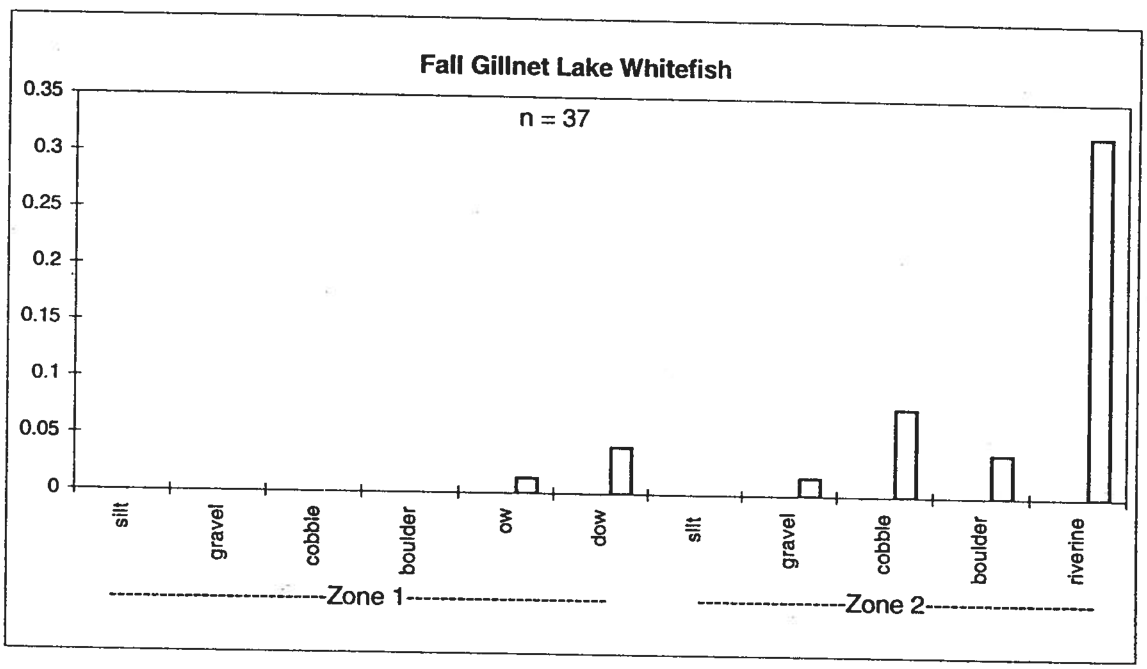
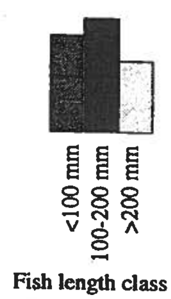
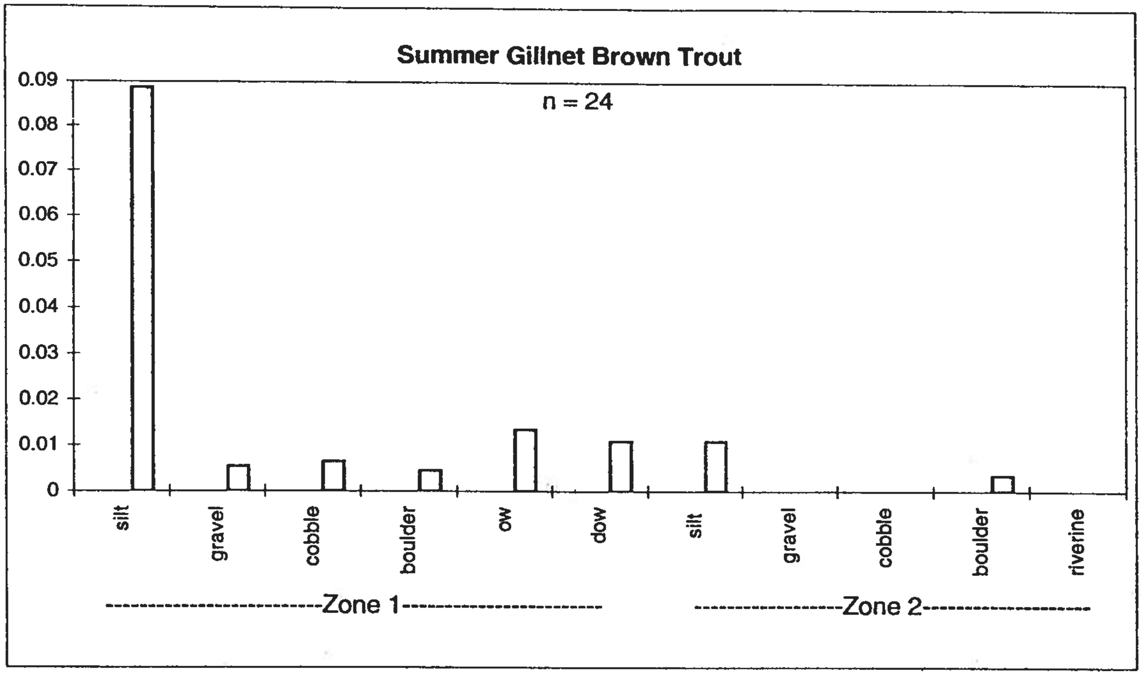


Figure A-5. Gill netting catch rates of fish size classes from each habitat type in Noxon Rapids Reservoir.





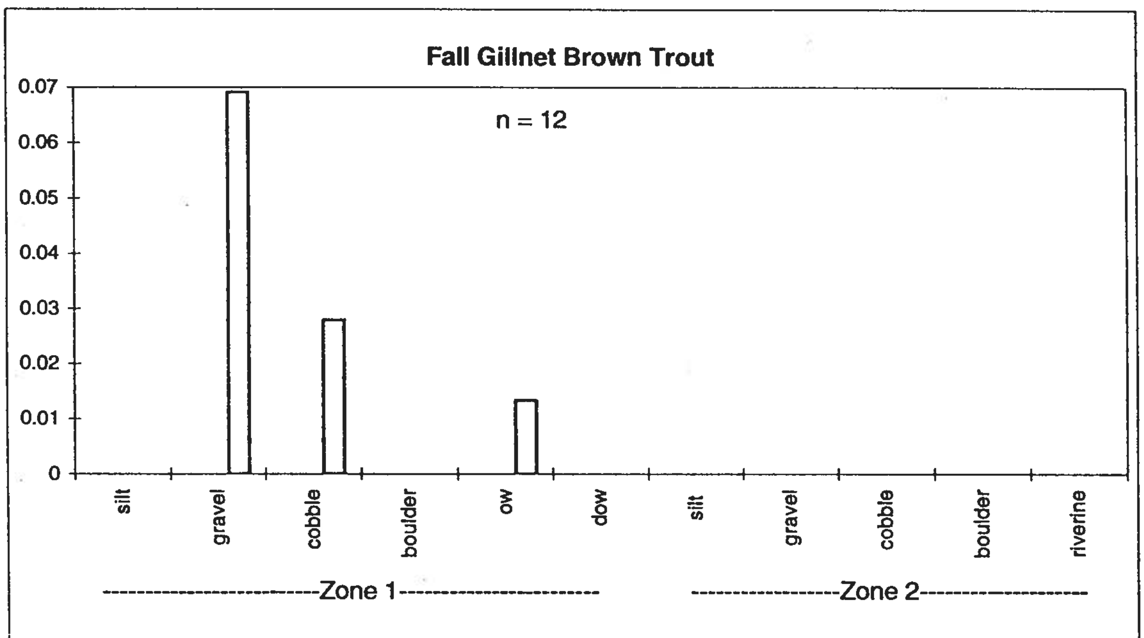
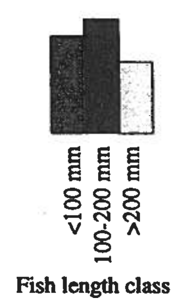
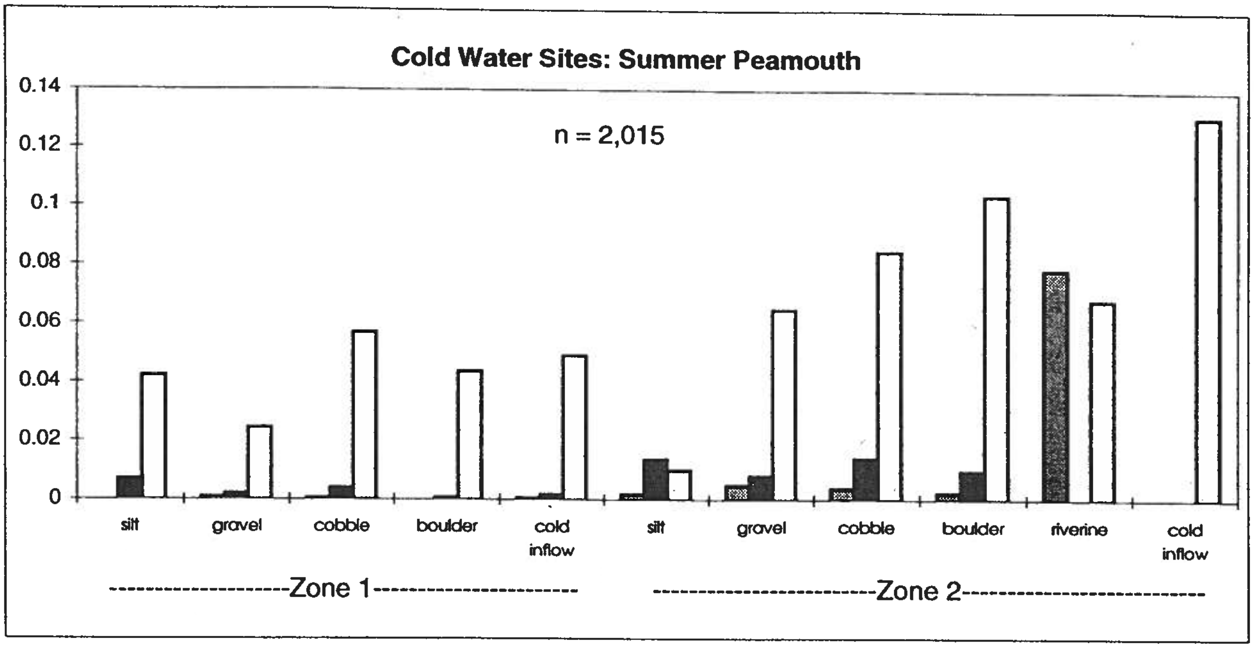


Figure A-5. Gill netting catch rates of fish size classes from each habitat type in Noxon Rapids Reservoir.





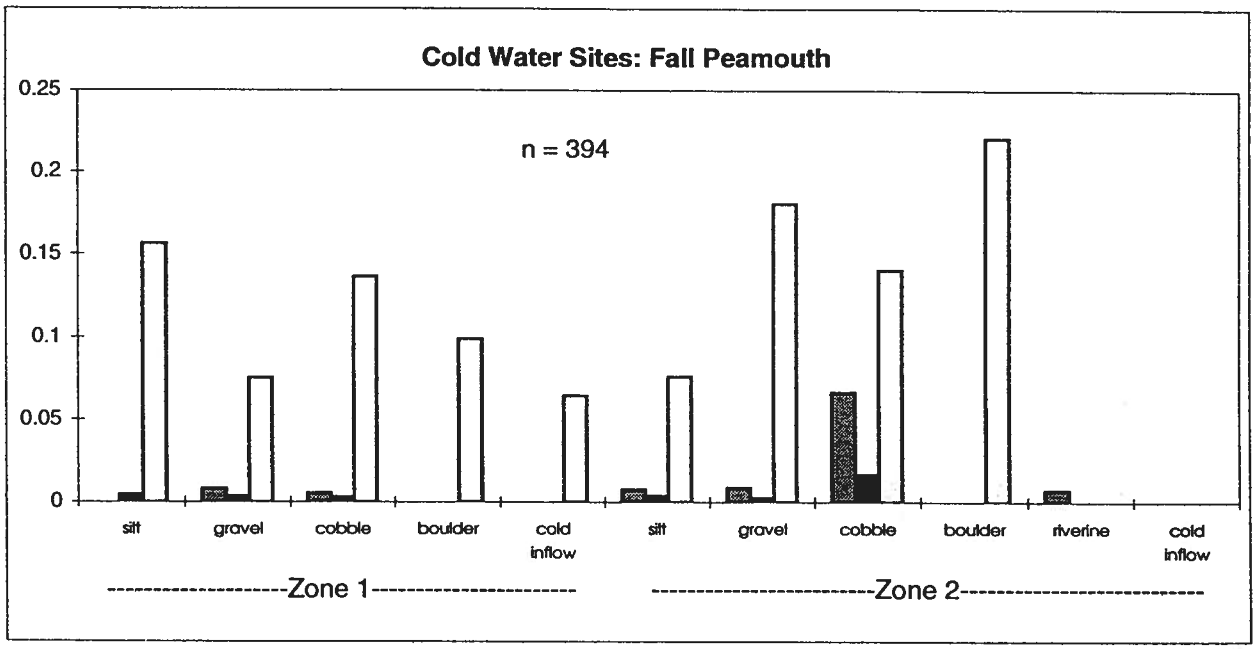
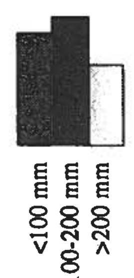
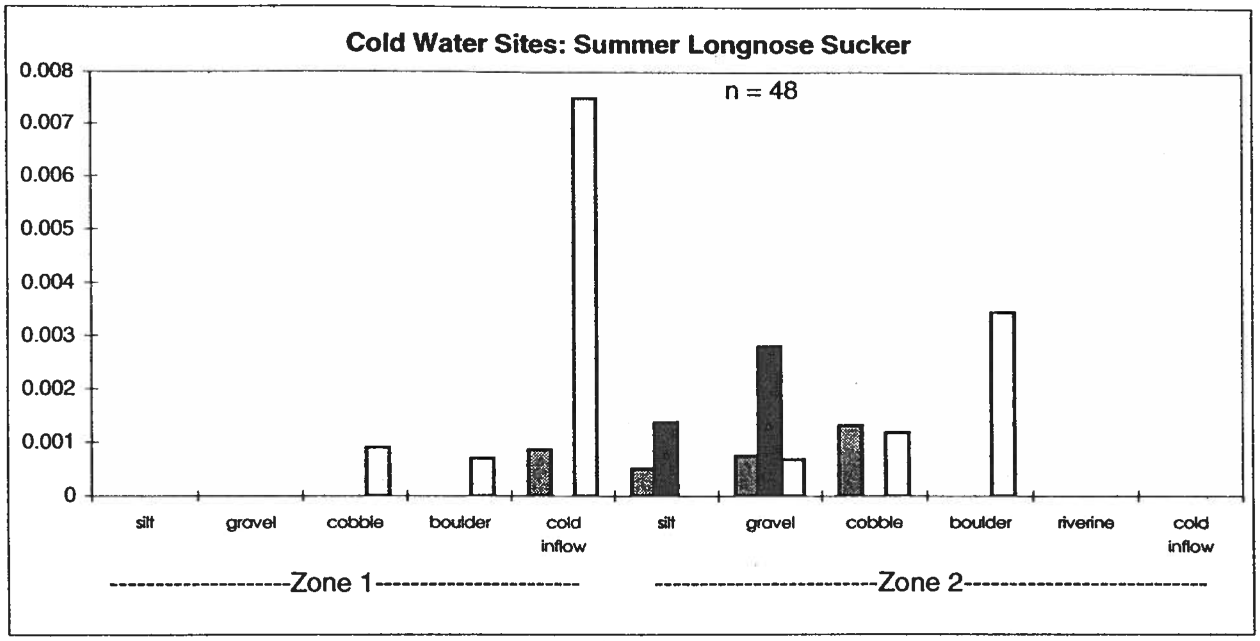


Figure A-6. Relative abundance at sites with cold water influences (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Noxon Rapids Reservoir.





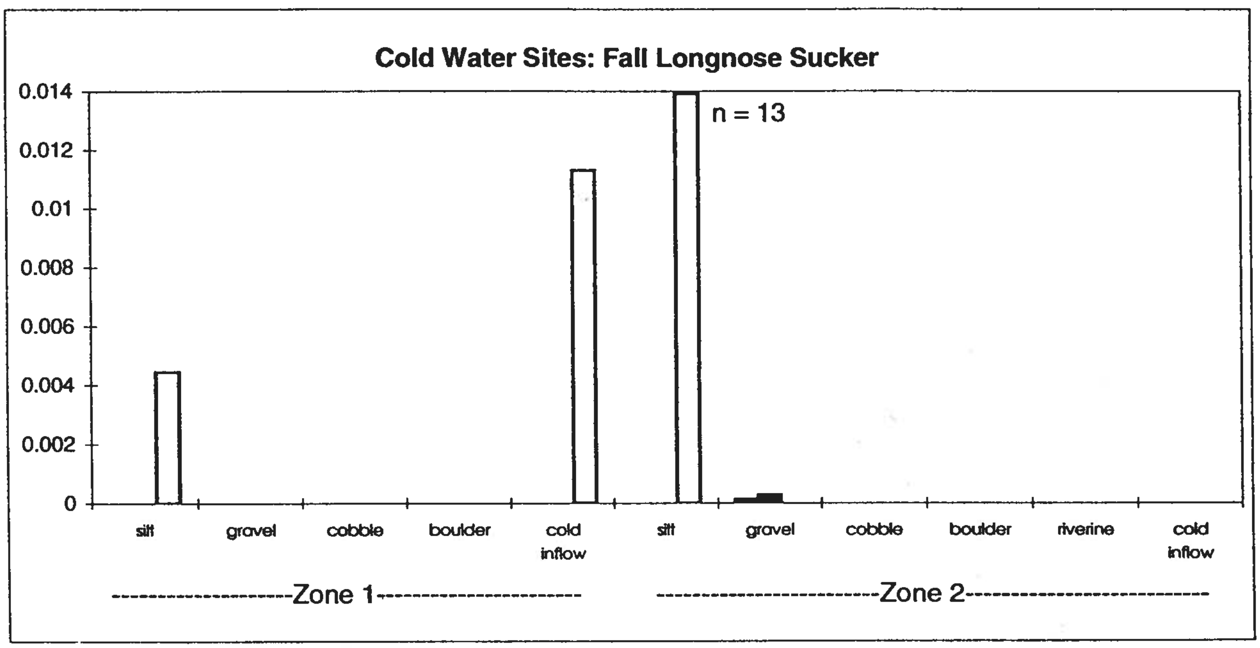
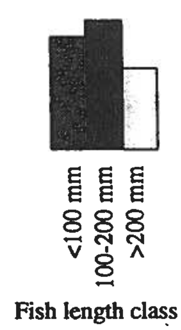
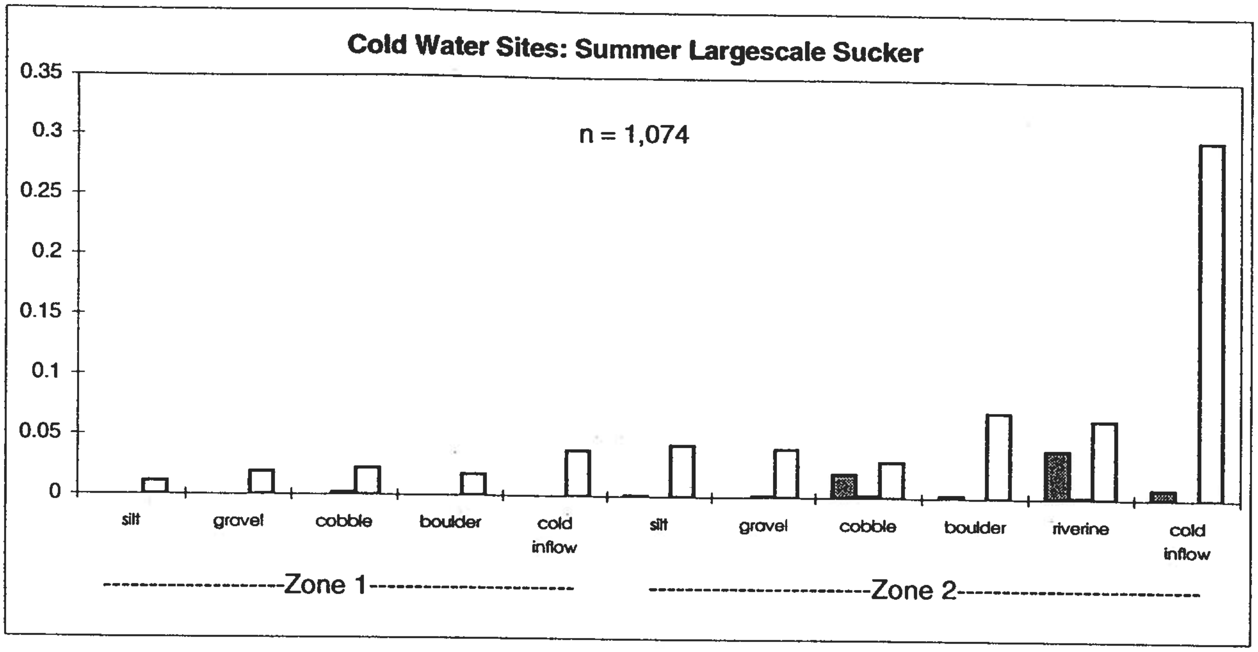


Figure A-6. Relative abundance at sites with cold water influences (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Noxon Rapids Reservoir.





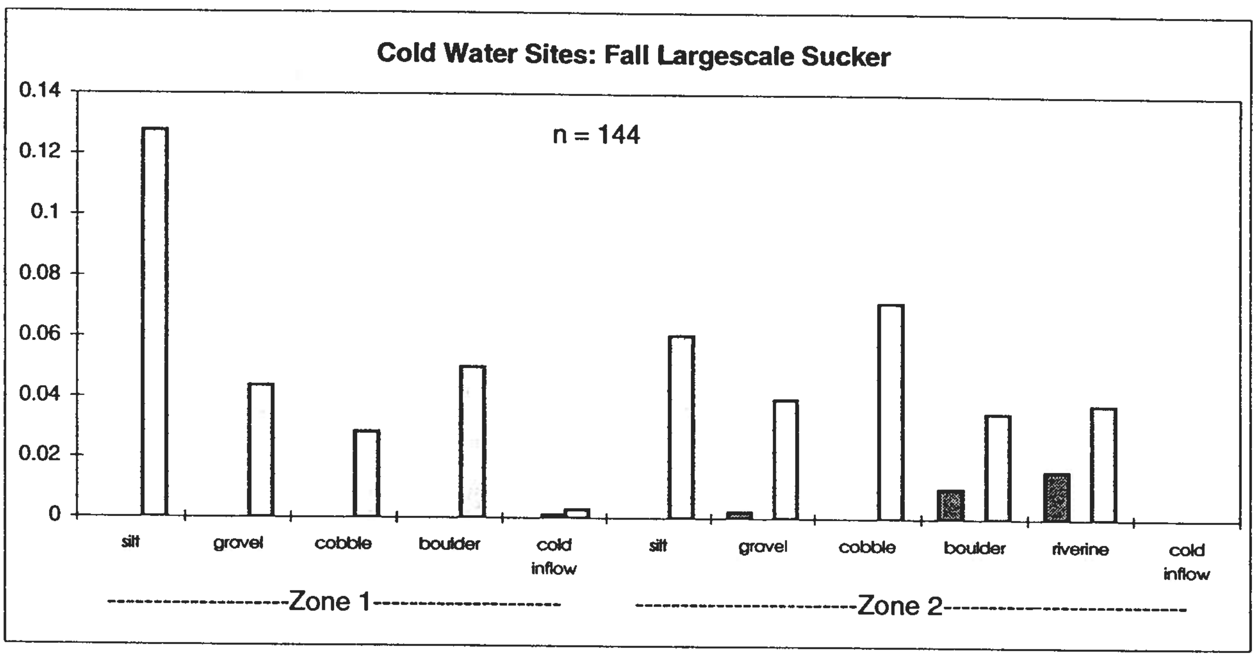
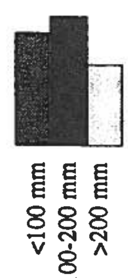


Figure A-6. Relative abundance at sites with cold water influences (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Noxon Rapids Reservoir.



Fish length class

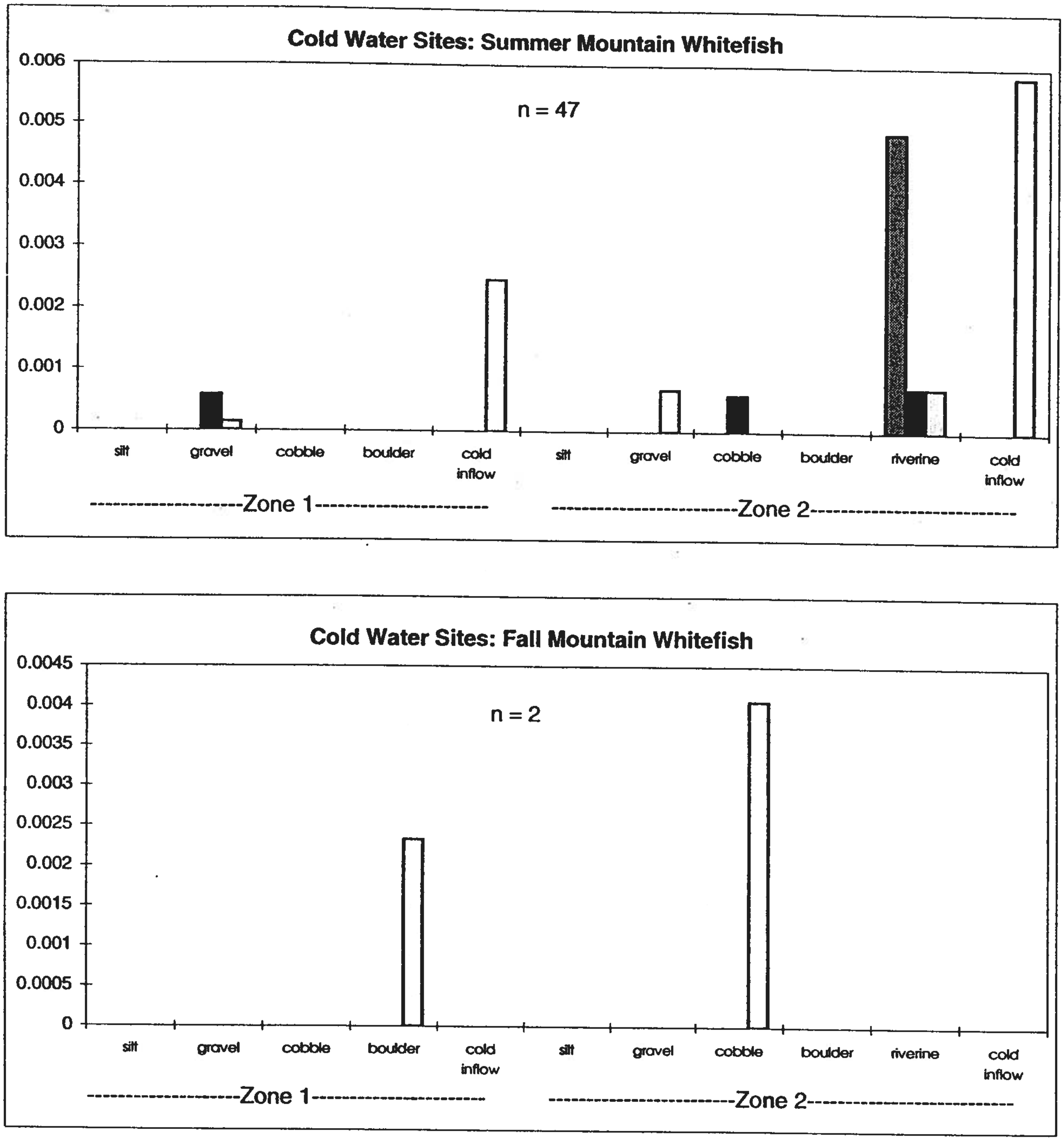
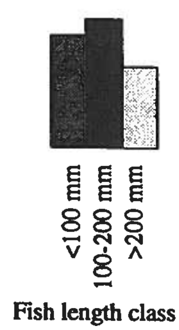
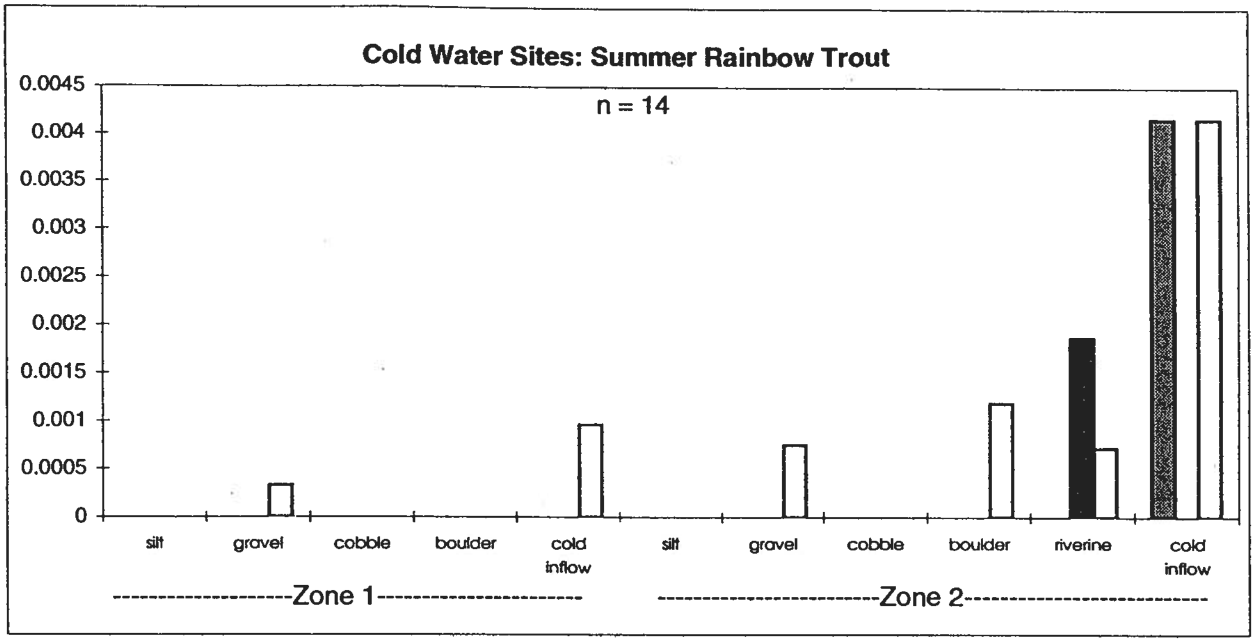


Figure A-6. Relative abundance at sites with cold water influences (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Noxon Rapids Reservoir.





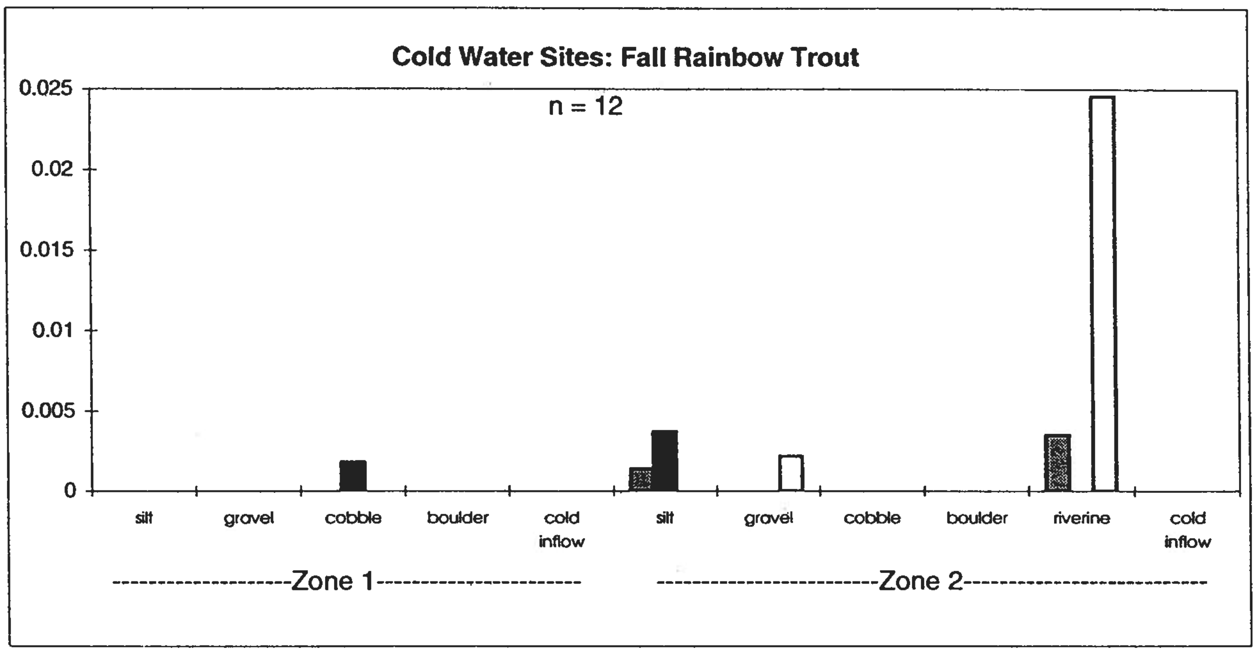
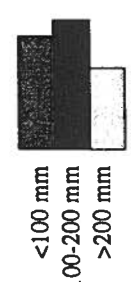
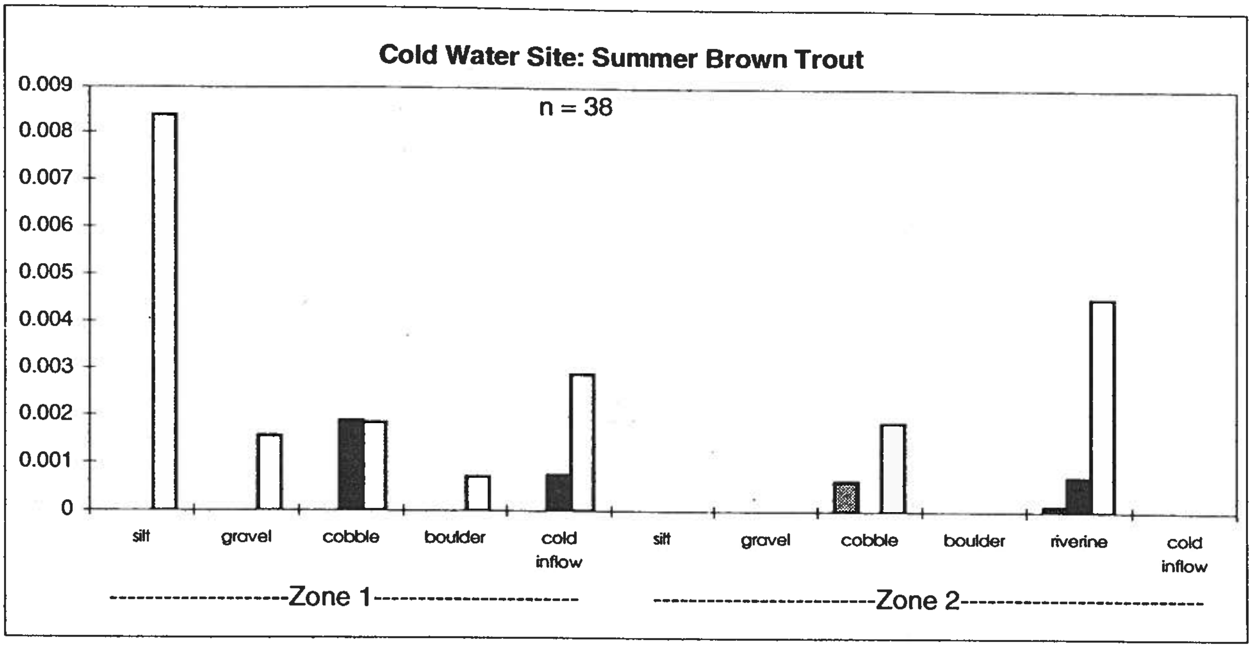


Figure A-6. Relative abundance at sites with cold water influences (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Noxon Rapids Reservoir.





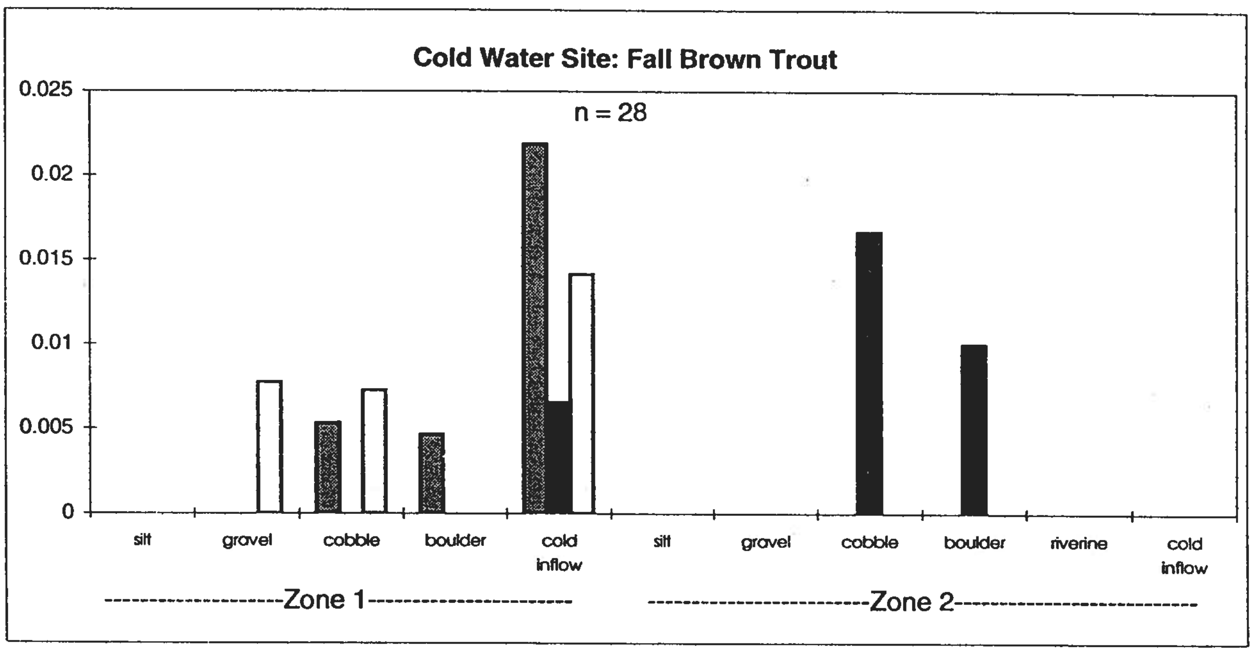
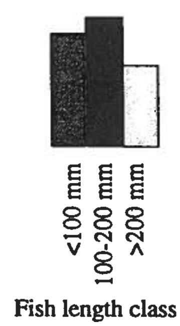
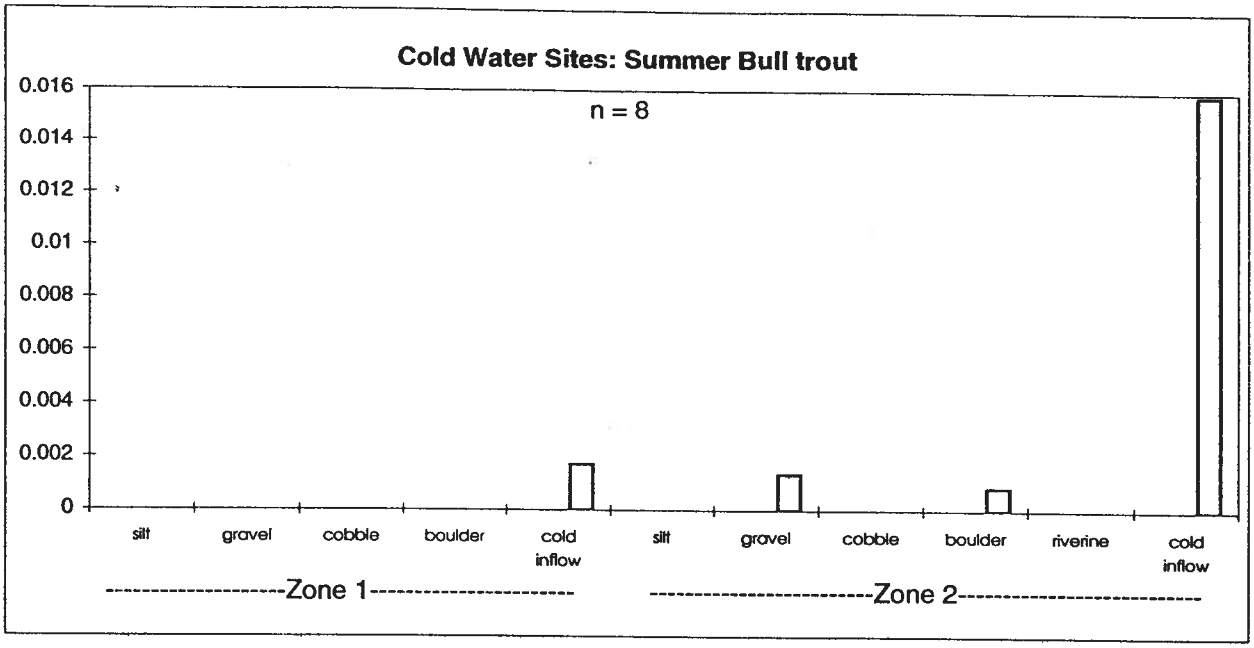


Figure A-6. Relative abundance at sites with cold water influences (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Noxon Rapids Reservoir.





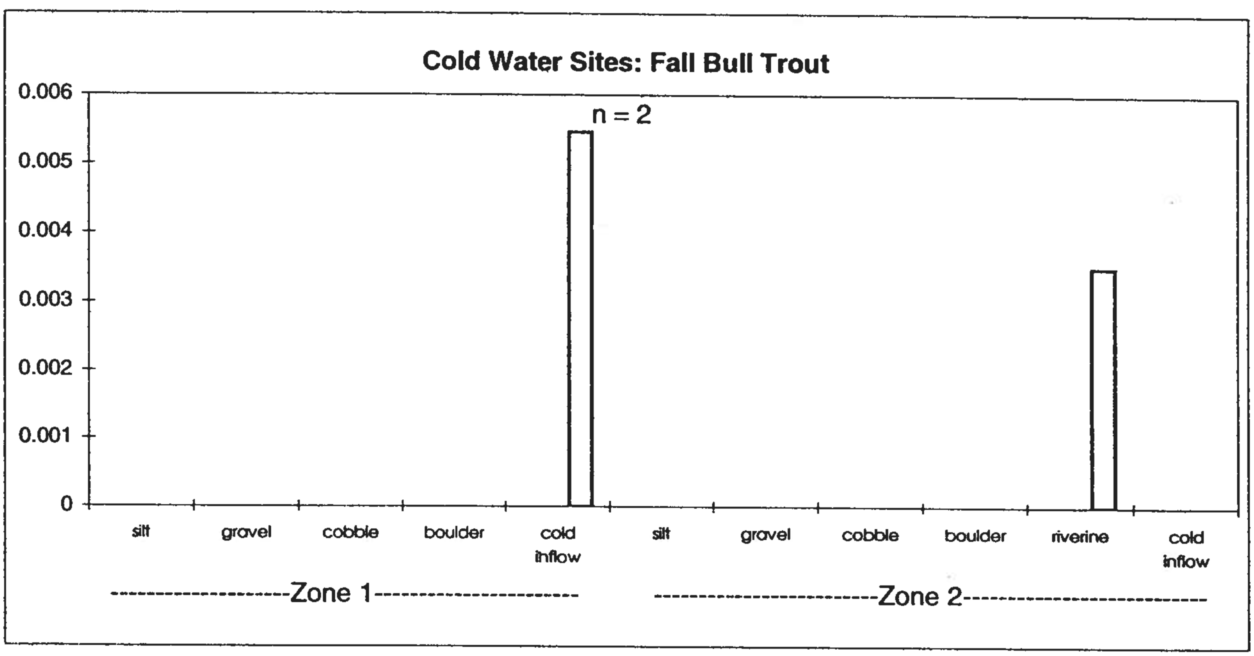
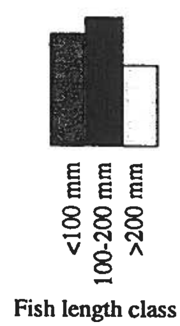


Figure A-6. Relative abundance at sites with cold water influences (combined for electrofishing, beach seining, and gill netting) of fish class sizes from each habitat type in Noxon Rapids Reservoir.



APPENDIX B

CORRELATIONS OF SPECIES CATCH TO HABITAT VARIABLES AND PRINCIPAL COMPONENT PLOTS DEPICTING HABITAT UTILIZATION

Table B-1. Correlations between catches of fishes and habitat variables collected at each sampling site during summer in Noxon Rapids Reservoir . Correlations in bold are significant at $P < 0.05$

Species	Size Class (mm)	Slope	Percent Vegetation	Substrate	Bottom Temperature	Bottom Velocity
Bullhead	< 100	0.03	0.07	-0.09	0.11	-0.09
Bullhead	100-200	-0.19	-0.04	0.09	-0.10	**-0.31**
Bullhead	> 200	**-0.34**	0.18	-0.03	-0.09	**-0.28**
Peamouth	< 100	-0.08	0.04	-0.09	0.09	**0.48**
Peamouth	100-200	0.02	0.06	-0.16	0.10	0.02
Peamouth	> 200	**0.29**	**-0.25**	0.03	-0.20	-0.19
Largescale sucker	< 100	-0.03	-0.09	-0.14	0.15	**0.34**
Largescale sucker	100-200	0.00	-0.10	-0.15	-0.01	0.03
Largescale sucker	> 200	-0.06	0.00	0.02	**-0.43**	0.11
Cutthroat trout	> 200	0.01	0.15	-0.09	-0.06	0.09
Bull trout	> 200	-0.04	-0.11	0.01	**-0.42**	-0.12
Longnose sucker	< 100	0.03	0.08	-0.15	-0.04	-0.06
Longnose sucker	100-200	-0.03	**0.27**	-0.13	-0.16	-0.08
Longnose sucker	> 200	0.23	-0.14	**0.28**	-0.07	-0.08
Brown trout	100-200	-0.15	-0.06	-0.06	-0.05	-0.05
Brown trout	> 200	-0.13	0.07	-0.18	**-0.34**	-0.12
Largemouth bass	< 100	-0.24	**0.46**	-0.18	0.14	-0.19
Largemouth bass	100-200	0.15	0.18	-0.14	**-0.29**	-0.13
Largemouth bass	> 200	-0.06	0.17	-0.10	0.01	**-0.34**
Lake trout	> 200	0.15	-0.09	0.10	0.16	-0.07
Lake whitefish	< 100	-0.03	0.15	-0.09	0.16	0.08
Lake whitefish	> 200	0.05	-0.03	0.01	-0.12	-0.10
Mountain whitefish	< 100	-0.12	-0.09	-0.09	-0.04	**0.37**
Mountain whitefish	100-200	-0.20	-0.09	-0.13	-0.10	0.03
Mountain whitefish	> 200	-0.16	-0.09	-0.08	**-0.33**	-0.04
Northern pike	> 200	**-0.28**	**0.48**	-0.18	-0.05	-0.10
Northern squawfish	< 100	0.04	0.16	-0.18	-0.08	0.18
Northern squawfish	100-200	-0.06	**0.26**	**-0.26**	0.00	0.07
Northern squawfish	> 200	**0.35**	**-0.40**	0.23	**-0.27**	-0.16
Pumpkinseed	< 100	0.04	0.21	-0.13	-0.10	-0.14
Pumpkinseed	100-200	**-0.38**	**0.53**	**-0.35**	0.08	-0.32
Rainbow trout	< 100	-0.15	-0.11	0.00	**-0.31**	-0.07
Rainbow trout	100-200	-0.01	-0.12	-0.08	0.11	**0.71**
Rainbow trout	> 200	0.00	-0.04	-0.02	**-0.33**	0.13
Redside shiner	< 100	-0.13	0.12	-0.15	0.16	**0.52**
Redside shiner	100-200	0.02	0.01	-0.11	-0.03	0.18
Smallmouth bass	< 100	0.13	-0.08	0.19	-0.16	0.13
Smallmouth bass	100-200	**0.36**	-0.13	0.20	**-0.35**	-0.12
Smallmouth bass	> 200	**0.28**	**-0.25**	**0.27**	**-0.28**	-0.04
Walleye	> 200	0.20	-0.21	**0.49**	0.09	0.01
Yellow perch	< 100	**-0.30**	**0.51**	-0.21	0.07	-0.24
Yellow perch	100-200	**-0.33**	**0.59**	**-0.38**	0.07	**-0.32**
Yellow perch	> 200	-0.06	-0.04	-0.11	-0.02	**-0.38**

Table B-2. Correlations between catches of fishes and habitat variables collected at each sampling site during fall in Noxon Rapids Reservoir . Correlations in bold are significant at P < 0.05.

Species	Size Class (mm)	Slope	Percent Vegetation	Substrate	Bottom Temperature	Bottom Velocity
Bullhead	< 100	-0.22	0.31	-0.02	0.31	-0.19
Bullhead	100-200	-0.19	0.29	-0.22	**0.56**	-0.17
Bullhead	> 200	-0.24	0.13	0.00	**0.53**	-0.28
Peamouth	< 100	-0.01	0.11	-0.32	0.18	-0.01
Peamouth	100-200	-0.19	0.33	-0.39	0.45	-0.31
Peamouth	> 200	0.31	0.30	-0.14	0.46	**-0.65**
Largescale sucker	< 100	0.00	-0.19	-0.11	-0.27	0.44
Largescale sucker	100-200	-0.27	0.08	-0.10	-0.18	-0.14
Largescale sucker	> 200	-0.13	**0.60**	-0.15	0.41	-0.47
Cutthroat trout	> 200	0.40	-0.05	0.33	-0.13	0.03
Bull trout	> 200	-0.36	-0.08	-0.15	-0.34	0.48
Longnose sucker	< 100	0.30	0.18	-0.16	0.15	-0.07
Longnose sucker	100-200	0.48	0.29	-0.21	0.18	-0.16
Longnose sucker	> 200	**-0.56**	**0.61**	-0.24	-0.24	-0.17
Brown trout	< 100	-0.06	-0.07	0.10	-0.08	-0.18
Brown trout	100-200	-0.08	-0.08	-0.12	-0.36	-0.16
Brown trout	> 200	-0.27	0.07	-0.22	0.14	-0.28
Largemouth bass	< 100	-0.38	0.47	-0.30	**0.61**	-0.28
Largemouth bass	100-200	-0.38	**0.56**	-0.36	0.36	-0.33
Largemouth bass	> 200	-0.31	0.45	-0.28	**0.62**	-0.20
Lake trout	> 200	0.25	-0.23	-0.14	-0.32	-0.01
Lake whitefish	> 200	-0.05	-0.29	-0.13	-0.40	**0.63**
Northern pike	> 200	-0.29	0.36	-0.21	-0.15	-0.17
Northern squawfish	< 100	-0.02	-0.03	-0.25	-0.24	0.36
Northern squawfish	100-200	0.08	**-0.49**	0.06	**-0.54**	**0.79**
Northern squawfish	> 200	0.17	-0.36	0.42	0.32	-0.20
Pumpkinseed	< 100	0.24	0.48	-0.33	0.33	-0.25
Pumpkinseed	100-200	-0.37	**0.49**	-0.31	**0.61**	-0.26
Rainbow trout	< 100	-0.45	0.45	-0.22	-0.31	0.13
Rainbow trout	100-200	-0.20	0.23	-0.14	-0.02	-0.11
Rainbow trout	> 200	-0.18	-0.16	-0.12	-0.28	**0.78**
Redside shiner	< 100	-0.07	-0.23	-0.06	-0.32	**0.56**
Redside shiner	100-200	-0.27	-0.25	0.05	0.30	-0.03
Smallmouth bass	< 100	0.08	-0.28	0.44	0.06	0.00
Smallmouth bass	100-200	**0.50**	0.00	0.15	0.10	-0.39
Smallmouth bass	> 200	0.06	-0.11	0.29	0.07	-0.18
Walleye	> 200	0.06	-0.09	0.32	0.08	-0.14
Yellow perch	< 100	-0.40	**0.54**	-0.28	0.31	-0.29
Yellow perch	100-200	**-0.55**	**0.85**	-0.41	0.17	-0.31
Yellow perch	> 200	**-0.49**	**0.79**	-0.33	0.11	-0.38

Table B-3. Correlations between catches of fishes and habitat variables collected at each sampling site during summer in Cabinet Gorge Reservoir. Correlations in bold are significant at $P < 0.05$.

Species	Size Class (mm)	Slope	Percent Vegetation	Substrate	Bottom Temperature	Bottom Velocity
Black crappie	100-200	-0.03	0.29	-0.14	0.12	-0.19
Bullhead	< 100	-0.07	0.26	-0.09	-0.05	-0.13
Bullhead	100-200	-0.09	0.19	-0.13	-0.07	-0.19
Bullhead	> 200	-0.13	0.22	-0.06	-0.20	-0.05
Burbot	> 200	**0.31**	-0.20	**0.40**	0.11	-0.04
Peamouth	< 100	0.01	0.02	-0.09	-0.02	0.11
Peamouth	100-200	**-0.45**	**0.47**	**-0.40**	-0.11	**-0.37**
Peamouth	> 200	-0.18	0.23	-0.18	-0.19	-0.11
Largescale sucker	< 100	-0.18	0.05	-0.17	0.15	-0.18
Largescale sucker	100-200	-0.18	0.20	-0.22	-0.09	-0.25
Largescale sucker	> 200	0.02	0.18	-0.20	**-0.37**	0.05
Cutthroat trout	> 200	-0.15	0.01	-0.11	-0.21	0.10
Bull tout	> 200	0.12	0.22	-0.13	**-0.44**	-0.15
Longnose sucker	< 100	-0.22	0.15	-0.15	**0.35**	-0.19
Longnose sucker	100-200	-0.06	0.01	-0.10	**-0.33**	0.11
Longnose sucker	> 200	-0.08	**0.40**	-0.30	**-0.46**	**-0.32**
Brown trout	100-200	-0.10	0.02	-0.09	-0.01	-0.17
Brown trout	> 200	0.04	-0.10	-0.03	**-0.42**	0.19
Largemouth bass	< 100	-0.17	0.29	-0.12	0.15	0.00
Largemouth bass	100-200	-0.16	**0.40**	-0.19	0.03	-0.28
Largemouth bass	> 200	-0.17	**0.42**	-0.24	0.02	-0.26
Lake whitefish	100-200	-0.07	-0.07	-0.02	0.05	0.16
Lake whitefish	> 200	0.26	**-0.37**	**0.35**	-0.14	**0.39**
Mountain whitefish	< 100	-0.13	0.28	-0.11	0.02	-0.14
Mountain whitefish	100-200	-0.10	-0.02	-0.11	-0.17	0.30
Mountain whitefish	> 200	0.15	0.08	-0.09	**-0.57**	-0.08
Northern squawfish	< 100	0.19	-0.24	0.09	0.20	0.05
Northern squawfish	100-200	-0.23	**0.42**	-0.13	-0.26	0.04
Northern squawfish	> 200	0.27	-0.02	0.27	**-0.41**	0.09
Pumpkinseed	< 100	-0.13	**0.36**	-0.17	-0.05	-0.23
Pumpkinseed	100-200	**-0.39**	**0.66**	**-0.38**	0.11	**-0.45**
Rainbow trout	100-200	-0.08	0.08	-0.10	0.02	0.15
Rainbow trout	> 200	-0.03	0.23	-0.16	-0.19	0.03
Redside shiner	< 100	-0.15	0.17	-0.13	-0.19	-0.08
Redside shiner	100-200	0.21	-0.29	0.04	-0.12	0.15
Smallmouth bass	< 100	-0.06	-0.16	-0.10	0.03	**0.53**
Smallmouth bass	100-200	0.19	-0.22	0.30	-0.09	0.26
Smallmouth bass	> 200	0.03	0.04	0.21	-0.16	0.30
Yellow perch	< 100	-0.31	**0.46**	-0.30	-0.01	**-0.38**
Yellow perch	100-200	**-0.43**	**0.64**	**-0.43**	-0.07	**-0.32**
Yellow perch	> 200	-0.08	0.29	-0.19	**-0.37**	0.15

Table B-4. Correlations between catches of fishes and habitat variables collected at each sampling site during fall in Cabinet Gorge Reservoir . Correlations in bold are significant at $P < 0.05$.

Species	Size Class (mm)	Slope	Percent Vegetation	Substrate	Bottom Temperature	Bottom Velocity
Peamouth	< 100	-0.30	0.23	-0.45	0.24	-0.11
Peamouth	100-200	-0.39	0.28	-0.18	0.14	-0.48
Peamouth	> 200	-0.29	0.53	-0.29	-0.08	-0.22
Largescale sucker	< 100	0.10	0.32	-0.21	-0.28	0.20
Largescale sucker	100-200	-0.03	0.33	-0.48	**-0.75**	0.09
Largescale sucker	> 200	-0.50	0.36	-0.48	0.40	-0.16
Cutthroat trout	100-200	-0.08	-0.07	-0.23	0.20	0.11
Longnose sucker	< 100	0.10	-0.01	-0.14	**-0.72**	0.34
Longnose sucker	100-200	0.08	0.30	-0.21	-0.31	0.23
Longnose sucker	> 200	-0.08	0.37	-0.42	**-0.78**	-0.17
Brown trout	< 100	-0.19	-0.48	0.19	0.19	**0.84**
Brown trout	100-200	-0.02	0.54	-0.31	-0.36	0.05
Brown trout	> 200	0.39	-0.05	0.05	**-0.87**	-0.14
Largemouth bass	< 100	-0.25	0.43	-0.31	-0.53	-0.33
Lake whitefish	> 200	-0.15	0.08	-0.21	-0.35	0.24
Mountain whitefish	< 100	-0.32	0.43	-0.46	-0.44	0.21
Mountain whitefish	100-200	-0.39	0.48	-0.61	-0.31	-0.11
Mountain whitefish	> 200	-0.23	-0.43	0.10	0.27	**0.92**
Northern pike	> 200	-0.36	0.40	-0.24	-0.14	-0.25
Northern squawfish	< 100	0.03	0.33	-0.25	-0.18	0.26
Northern squawfish	100-200	-0.25	0.61	-0.45	0.24	0.13
Northern squawfish	> 200	-0.08	**0.73**	-0.36	-0.36	-0.31
Pumpkinseed	< 100	-0.51	0.59	-0.61	0.23	0.04
Pumpkinseed	100-200	-0.19	0.12	-0.35	0.27	0.24
Rainbow trout	> 200	-0.20	-0.56	0.23	0.24	**0.78**
Redside shiner	< 100	0.11	0.11	-0.01	0.28	0.31
Redside shiner	100-200	0.48	-0.55	0.48	0.35	-0.15
Yellow perch	< 100	-0.22	0.48	-0.19	0.08	-0.22
Yellow perch	100-200	-0.29	0.42	-0.53	0.18	0.11
Yellow perch	> 200	-0.59	0.63	-0.61	0.07	-0.16

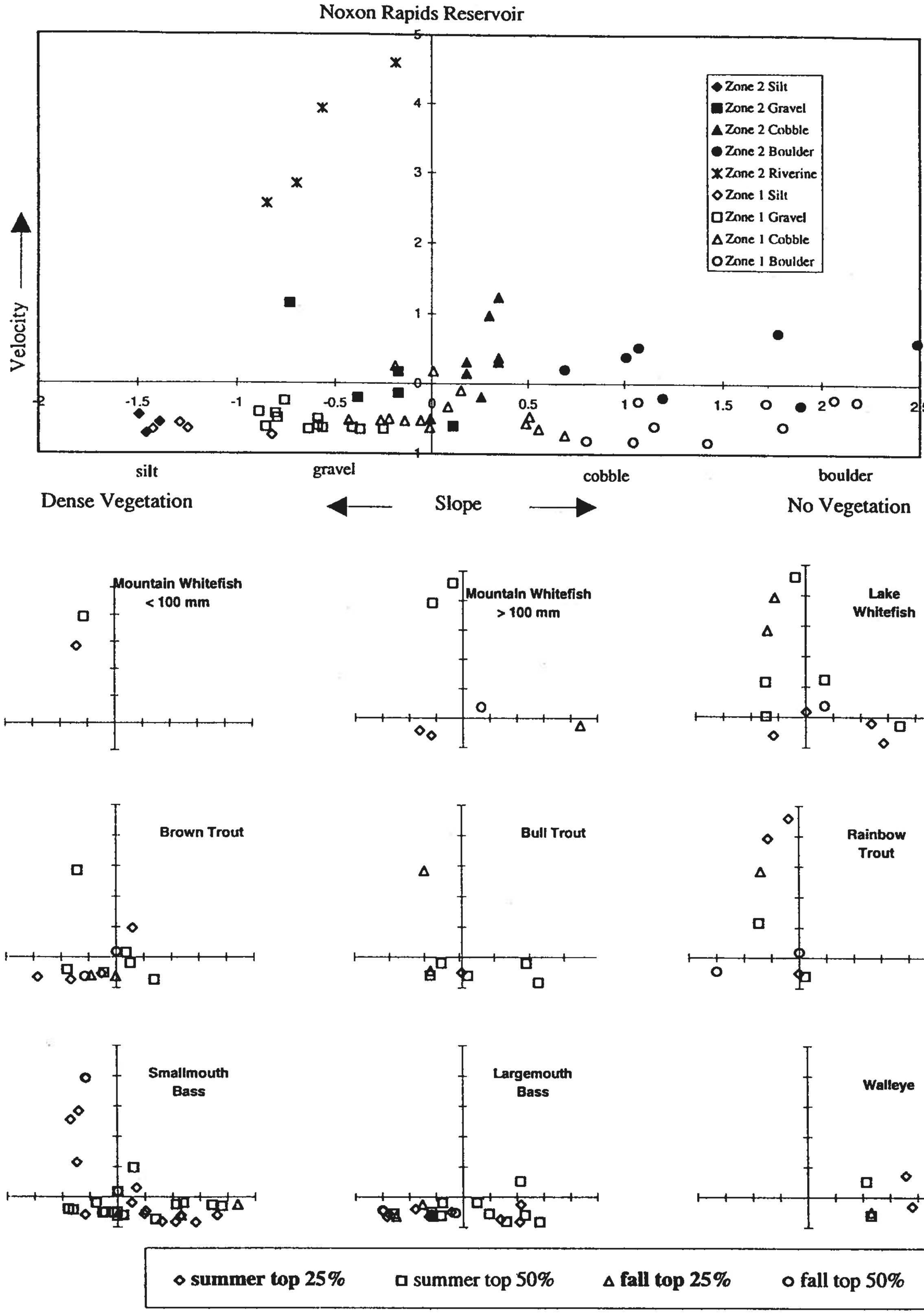


Figure B-1. Plots of principal component scores depicting habitat utilization of the most abundant fishes in Noxon Rapids Reservoir. Plots represent the sites where the highest catches (square and circle symbols - top 50%) occurred with the diamond and triangle symbols representing the top 25%.

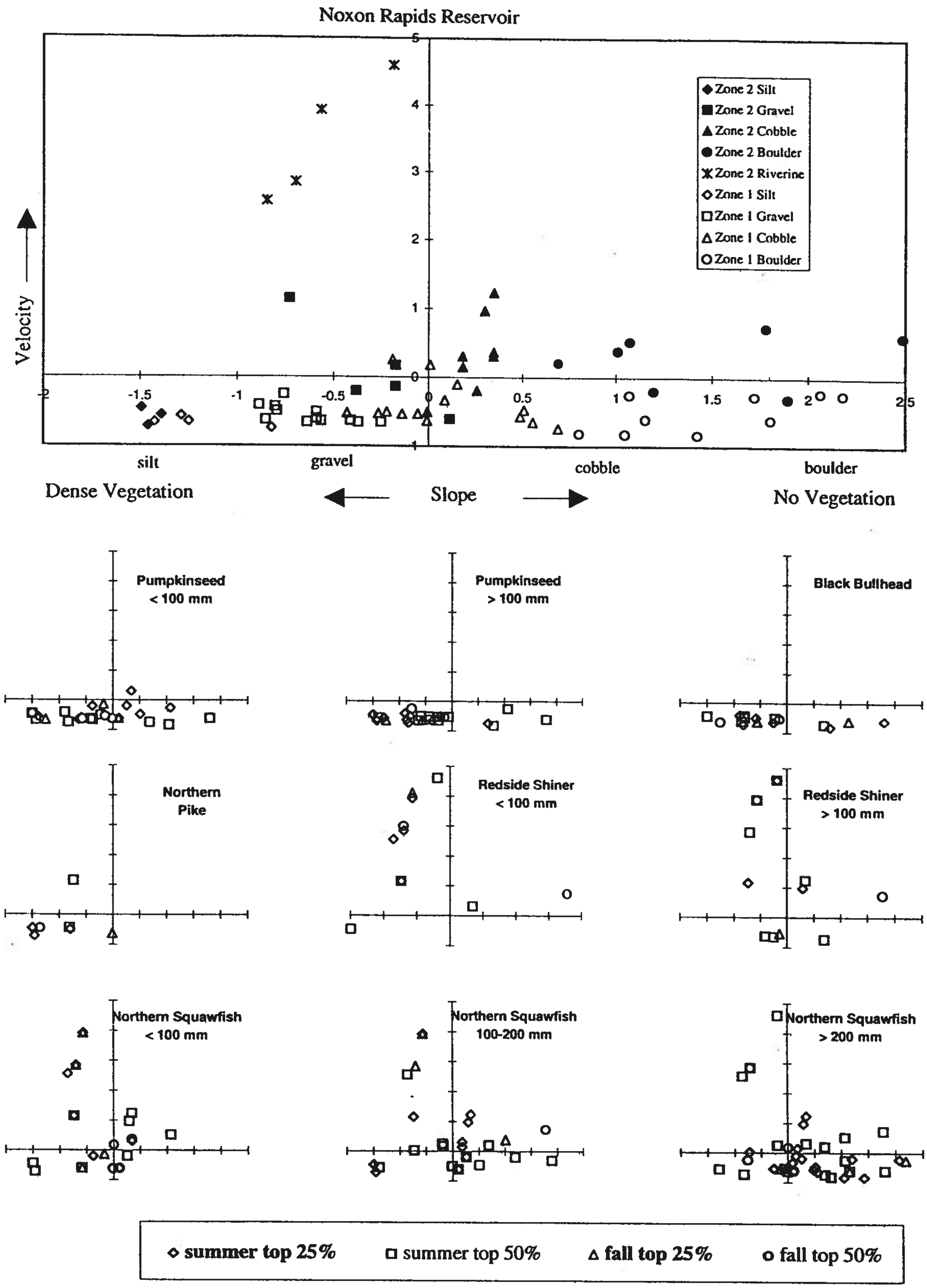


Figure B-1. Plots of principal component scores depicting habitat utilization of the most abundant fishes in Noxon Rapids Reservoir. Plots represent the sites where the highest catches (square and circle symbols - top 50%) occurred with the diamond and triangle symbols representing the top 25%.

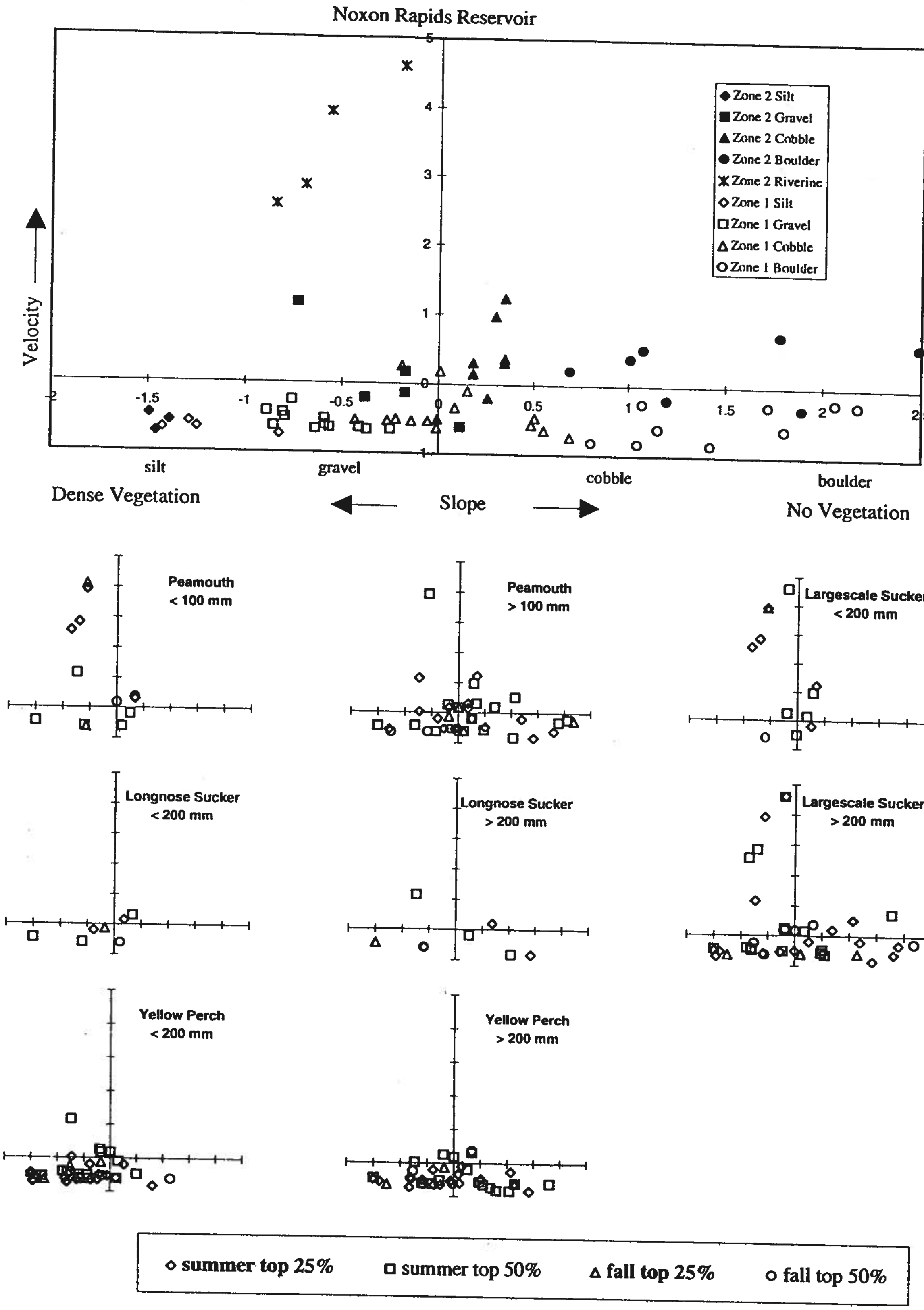
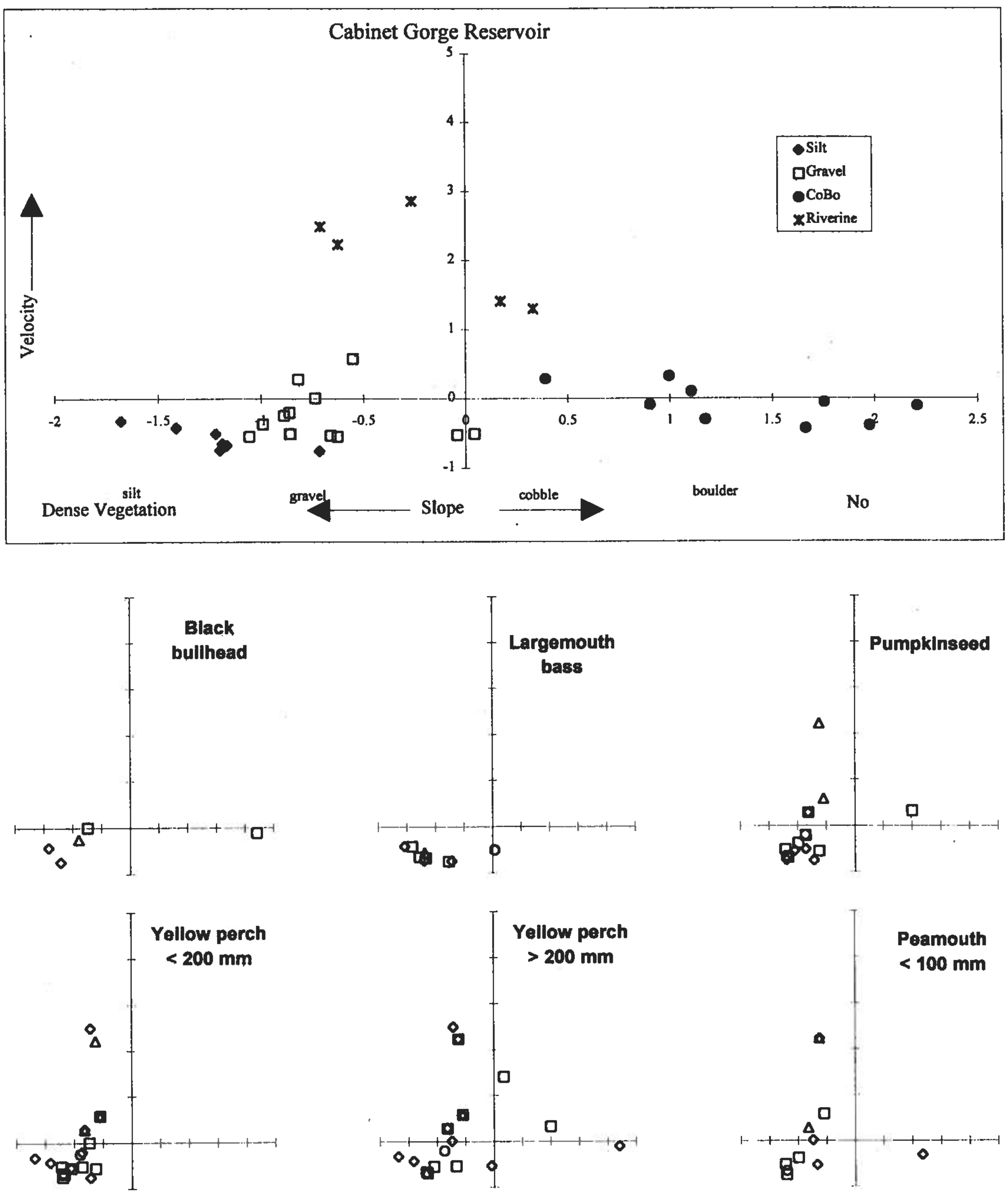
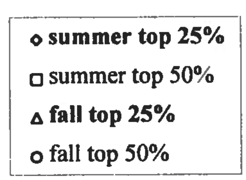


Figure B-1. Plots of principal component scores depicting habitat utilization of the most abundant fishes in Noxon Rapids Reservoir. Plots represent the sites where the highest catches (square and circle symbols - top 50%) occurred with the diamond and triangle symbols representing the top 25%.





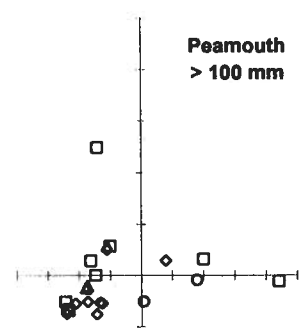
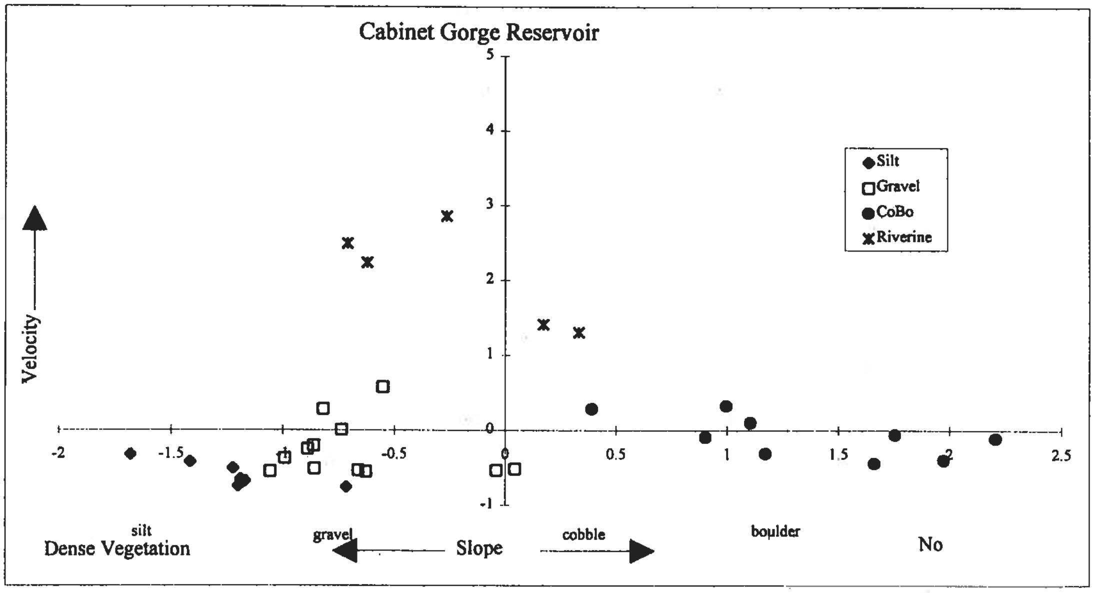
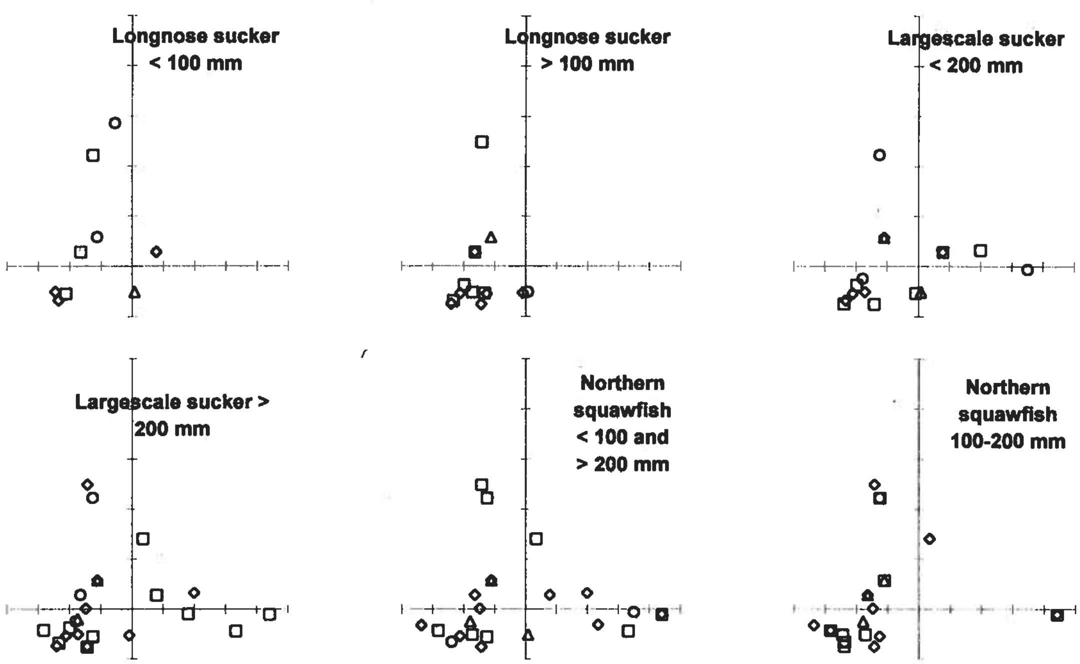
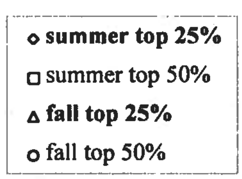


Figure B-2.
Plots of principal component scores depicting habitat utilization of the most abundant fishes in Cabinet Gorge Reservoir. Plots represent the sites where the highest catches (square and circle symbols - top 50%) occurred with the diamond and triangle symbols representing the top 25%.







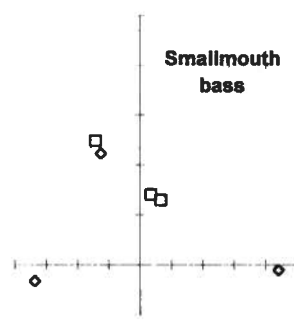
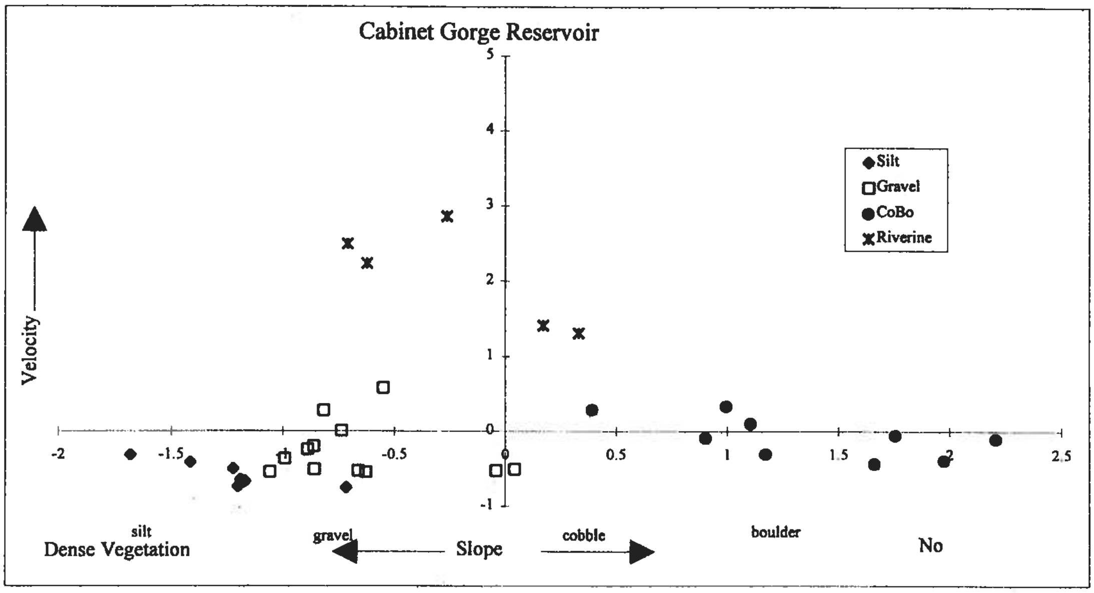
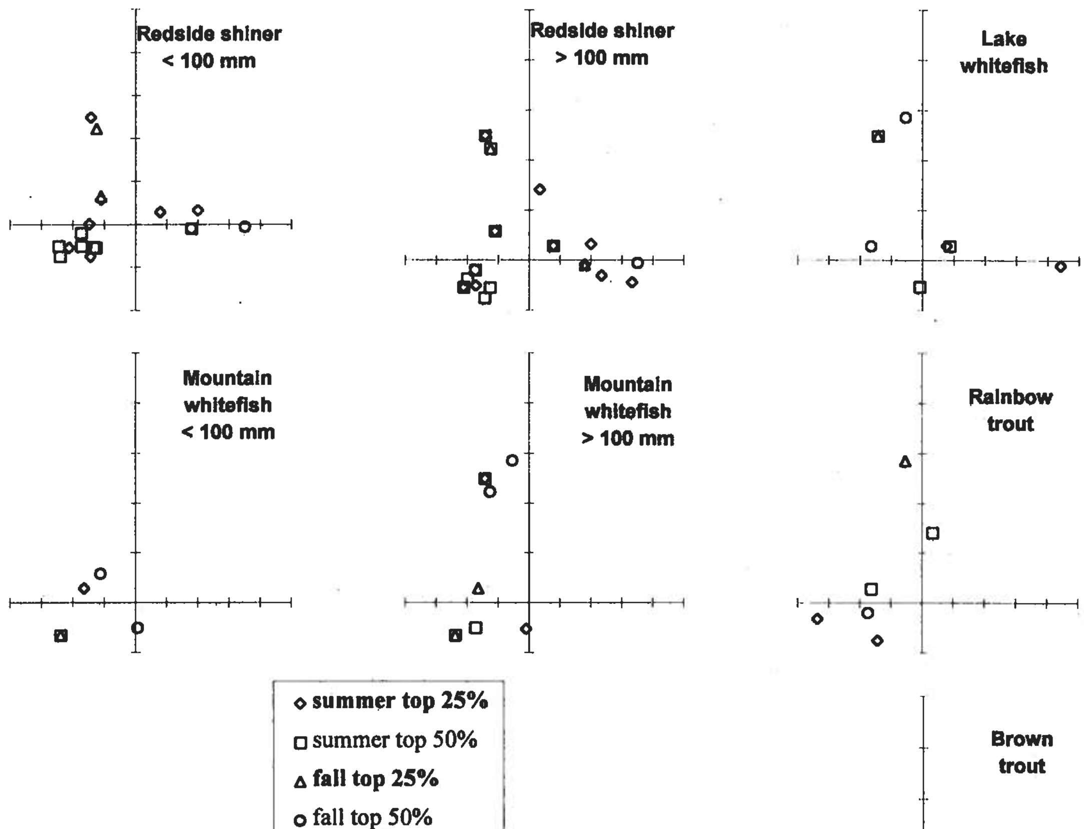
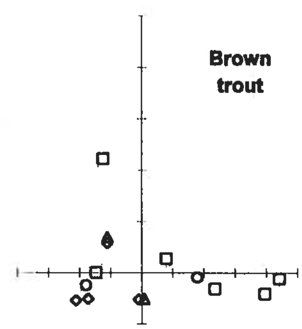


Figure B-2.
Plots of principal component scores depicting habitat utilization of the most abundant fishes in Cabinet Gorge Reservoir. Plots represent the sites where the highest catches (square and circle symbols - top 50%) occurred with the diamond and triangle symbols representing the top 25%.







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Plots of principal component scores depicting habitat utilization of the most abundant fishes in Cabinet Gorge Reservoir. Plots represent the sites where the highest catches (square and circle symbols - top 50%) occurred with the diamond and triangle symbols representing the top 25%.