EARLY LIFE HISTORY
FISHERIES SURVEY OF THE SAN JUAN RIVER, NEW MEXICO AND UTAH, 1995

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by

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Executive Summary

The San Juan River low-velocity habitat fish community was sampled during four trips in 1995. Two hundred ninety one low-velocity habitats were sampled in the San Juan River. A total of 49,043 fish were collected representing seven families (four native and ten non-native species). No Colorado squawfish were collected during low-velocity sampling. Seven individual roundtail chubs were collected between RM. 114.9 and RM 12.8. Five of the seven were captured in the lower canyon below Johns canyon. All five of these specimens were between 11mm and 14mm and captured during the second week in August. The capture of these individuals in the lower canyon at such a small size suggest the possibility of a mainstem spawning population of roundtail chub.

The fish community in low-velocity habitats was again dominated by non-native species in 1995. During the September monitoring trip, catch rates and percent composition for native bluehead suckers and flannelmouth suckers were up from 1994, but down compared to 1993 data. Catch rates for red shiners and fathead minnows were down considerably from 1994 levels, to densities similar to those seen during September of 1991 and 1992.

In the four nursery habitat reaches available backwater habitat declined considerably from August to September. A large portion of this reduction in available habitat was the result of monsoon rain events during September and the associated silt loads. These reductions in available habitat further crowded the fish community in backwater habitats, which likely increased competition and predation by non-natives.

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INTRODUCTION

Early life history information on native fish in the San Juan River has been collected intensively since 1987. In 1991, the Utah Division of Wildlife Resources (UDWR) took the lead in those investigations. The purpose of this study was to evaluate the biological response of the early life stages of the San Juan ichthyofauna, particularly the rare species, Colorado squawfish *(Ptychocheilus lucius)*, razorback sucker *(Xyrauchen texanus)*, and roundtail chub *(Gila robusta)* to a variety of flow conditions. This report summarizes information from the fifth year of data collection.

Study Objectives

This study is based on earlier results from work on the San Juan River (Meyer and Moretti 1988; Roberts and Moretti 1989; Platania 1990; Bunjter 1993; Bunjter et al. 1994; Archer et al. 1995) and on other Upper Basin rivers. The study addresses the objectives outlined below.

Nursery Habitats

1. Empirically monitor the annual recruitment of young-of-the-year (YOY).
   Colorado squawfish in relation to flow patterns in the San Juan River.
2. Characterize the early-life stage icthyofaunal community in low-velocity (nursery) habitats.
3. Characterize nursery habitats and their use in the San Juan River system.

Low-velocity Habitats: Fall monitoring

1. Characterize the fish community in low-velocity habitats in the San Juan River.
2. Monitor trends of ichthyofaunal community in the San Juan River.
3. Determine YOY and juvenile native species distribution and abundance in the San Juan River.

STUDY AREA

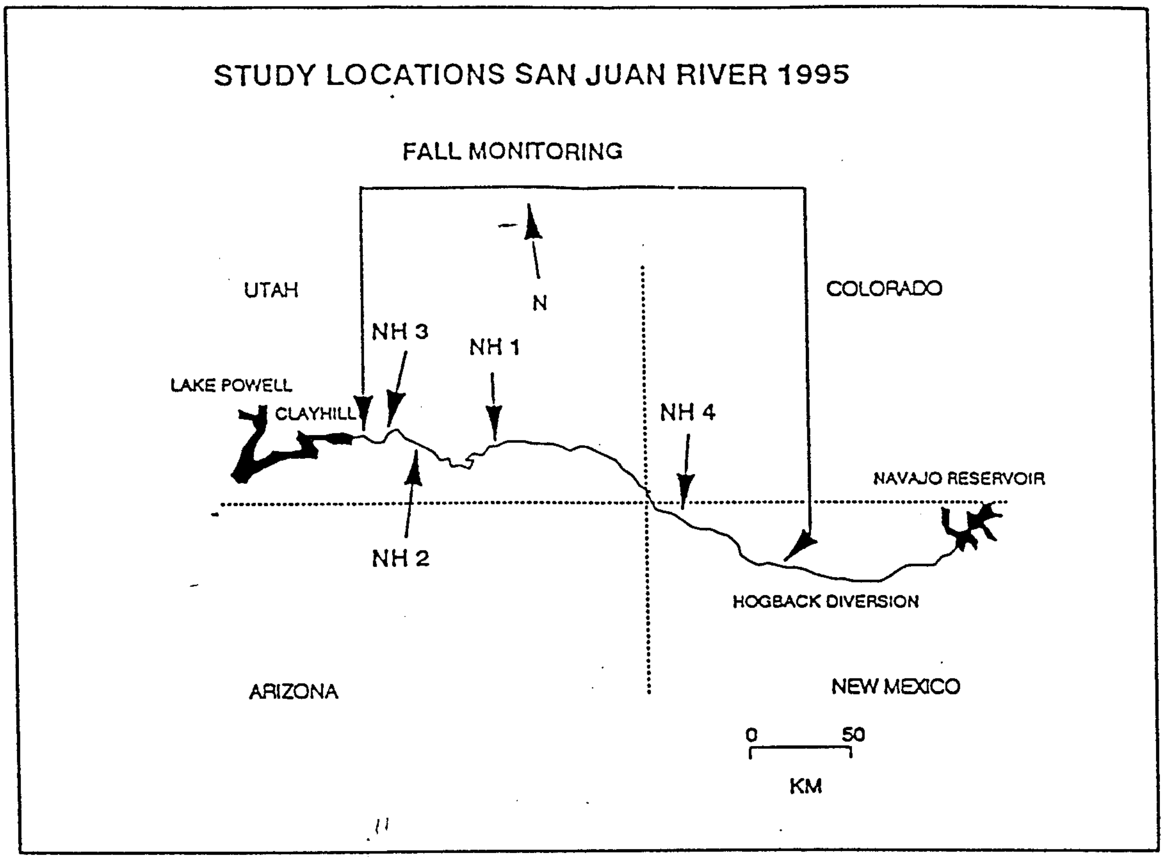

Figure 1. Location of study areas used during 1995 sampling of of low-velocity habitats San Juan River

Nursery Habitat

Four, 8 km (5 mi) sections of the San Juan River were chosen for nursery habitat analysis: Reach 1 (RK 143.3-135.2; RM 89.0 - 84.0); Reach 2 (RK 40.25 -32.2; RM 25.2 - 20.2); Reach 3 (RK 21.0 - 13.0; RM 13.0 - 8.0) and Reach 4 (RK 210.8 - 202.8; RM 131.0 - 126.0). Reach 1 is located approximately 80 RK (50 RM) below the Colorado squawfish spawning bar in a broad floodplain with braided channels. Reach 2 and 3 are both located in the lower reaches where the river is generally confined to a single channel within steep-sided canyons. Reach 3 is located below the high water level of Lake Powell. Reach 4 which was added in 1995, was chosen for intensive sampling because of its proximity to the only known spawning sites for Colorado squawfish in the San Juan River. This section has also been shown to be an important area for the other native fishes of the San Juan, i.e., flannelmouth sucker *(Catostomus latipinnis)*, bluehead sucker *(Catostomus discobolus)*, and speckled dace *(Rhinichthys osculus)*, (Buntjer et al., 1994;, Archer et al., 1995). Selection of the four reaches was based on available habitat during the 1993 and 1994 field seasons (Buntjer et al., 1994, Archer et al., 1995) and known collection sites for YOY Colorado Squawfish (Platania 1990).

Low-velocity: Fall monitoring

The study area included approximately 252 km (156 mi) of the San Juan River from the Hogback Diversion, New Mexico, to Clay Hills Crossing, Utah, (Figure 1). River bed elevation ranged from 1524 m above mean sea level (AMSL) at Hogback Diversion to 1,103 m AMSL at Clay Hills Crossing. The study area was divided into six reaches based on major geomorphic features, such as topography, geology and gradient (figure 2). Two reaches were established in New Mexico-Colorado (reaches 1A and 1B) and four in Utah (reaches 2, 3, 4, and 5). The two New Mexico-Colorado reaches were originally described as one reach (Platania 1990). The four Utah reaches were first described by Meyer and Moretti (1988). The approximate length of each reach was: 1A = 42.2 km (26.2 mi); 1B = 20.9 km (13.0 mi); 2 = 81.6 km (50.7 mi); 3 = 25.0 km (15.5 mi); 4 = 61.3 (38.1 mi); and 5 = 18.3 km (11.7). The three upstream reaches (1A, 1B and 2) were located in a broad floodplain with frequently braided channels. The three downstream reaches (3, 4 and 5) were generally confined to a single channel within steep-sided canyons. For a more detailed description of the study reaches see Meyer and Moretti (1988) and Platania (1990). Each reach was further sub-divided into 8K (5 mile) sections. Aerial photographs were used in the field to identify sample section boundaries. River distances used in this study include revised measurements by the Bureau of Reclamation (BOR) and differ from those previously reported (Meyer and Morretti 1988; Platania 1990; Roberts and Moretti 1989). The lower 18.3 km (11.7 mi) of the San Juan River study area is inundated by Lake Powell when the reservoir is at full capacity (1128 m, 3700 ft.). Consequently, sediment deposits associated with the reservoir have changed the physical character of the San Juan River downstream of Grand Gulch and water level fluctuations in Lake Powell influence the extent of fish habitat in this stretch of river.

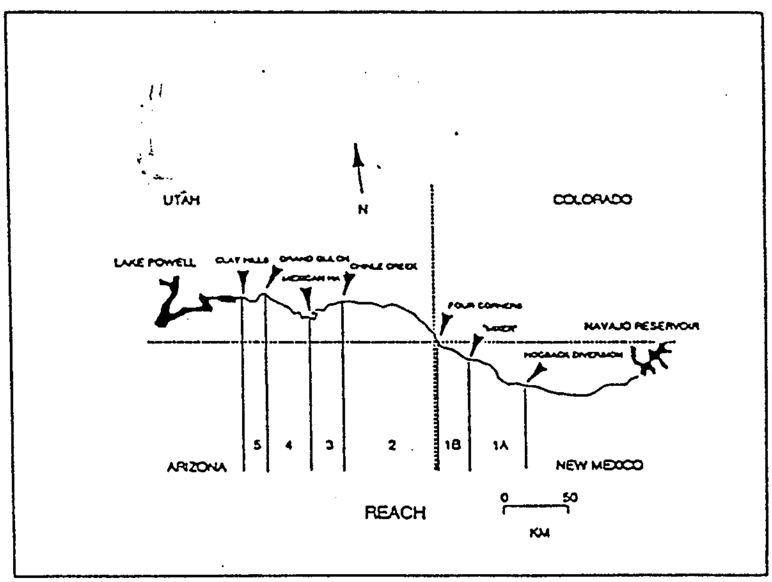

Figure 2. Reach delineations, 1A through 5, in the San Juan River study area, New Mexico, Colorado, and Utah

METHODS

Nursery Habitat

All backwater habitats throughout the three, eight kilometer reaches were sampled during March (March 28-April 1), four reaches were sampled during August (August 7-16), and September (September 22-29).

Specific habitats sampled included backwaters, eddies shorelines and flowthroughs. Habitats were classified according to the scheme developed for the Green River by geomorphologist Jack Schmidt (USU). The classification system relates types of habitats back to the hydrological process that formed them (Table 1). At each site, the number of samples (N=1-4) was dependent on the size of the habitat.

Table 1. List of habitat types used for nursery habitat study as defined by Jack Schmidt, geomorphologist, Utah State University.

Secondary Channel (SC) - Habitats formed by the erosion/ deposition cycle of secondary channels during passage of a flood, and revealed by receding water levels. Usually relatively deep and permanent. Secondary channel should be further divided.

Secondary chute channel (SCC) - Smaller version of S.C. habitat formed by erosion/deposition cycle of small channel behind large alternating sandbar. Scoured out during floods and revealed during receding water.

Migrating Sand Waves (MS) - Habitats formed by the relative movement of adjacent migrating sand waves. Relatively shallow and ephemeral.

Horseshoe Vortex (HS) - Habitats formed by scour holes generated at high flows at the upstream ends of islands due to development of horseshoe vortex patterns. Moderately deep and semi-permanent.

Flood Plain (FP) - Habitats formed by the inundation of abandoned channels or floodplains. Related to seasonal high flows or rainfall events.

Flooded Tributary Mouth (FT) - Habitats formed by rising river levels flooding into tributary mouths. Related to seasonal high flows or rainfall events.

Shoreline Eddy (SE) - Habitats formed by recirculating areas due to irregularities of the bank.

Constricted Reach Eddy (CE) - Habitats formed by large eddies generated by constriction of the channel by debris fans.

Shoreline (SH) - Shallow, sloping shoreline areas.

Table 2. Classification of substrate sizes used for low-velocity habitat sampling in the San Juan River, New Mexico, Colorado, and Utah, 1995. Size categories are from a modified Brusven Substrate index (Bovee 1982).

Substrate type	Substrate size (mm)
Silt	(< 1)
Sand	(1-4)
Gravel	(4-75)
Cobble	(76-300)
Boulder	(> 300)

Sampling procedures were similar to those used for the nursery habitat studies conducted on the Green and Colorado rivers. Physical habitat measurements were collected at three transects: the mouth; 1/3 and 2/3 of the length of the habitat. Depth measurements were taken at the point of maximum depth and 1/2 the distance either way along the transect. Both water depth and water-plus-substrate depth were measured. At each depth measurement, primary and secondary substrate particle sizes were estimated and recorded using the Brusven substrate index (Bovee 1982; Table 2). Surface temperature was recorded (^{0}C) at the midpoint of each transect. Turbidity was gaged at each transect on a scale of 0 to 2. A value of 0 denotes clear visibility to the bottom, 1 indicates approximately 6" of visibility and 2 denotes virtually no visibility. Temperature and turbidity of the adjacent main channel were also recorded.

All native fish identified in the field were measured and released. Non-native fishes were recorded as either sub-adult or adult or preserved in 10% formalin for later identification. Fish density (fish/100 m^2) was computed for all species by reach. All preserved fishes were identified and counted at either the UDWR Moab field office laboratory or Utah State University. Samples were then sent to the University of New Mexico for verification and curation in the Museum of Southwestern Biology. Because verification of the samples is not complete; all fish identification data should be considered preliminary.

In addition to the standard nursery habitat sampling, a secondary channel from RM 127.3-126.5 was sampled during both summer trips. Incidental seining within the nursery habitat reaches, also occurred during both trips. All encountered habitat types were sampled. Data collected included habitat type, size, Depth max (Dmax) and area seined. Fish collected were not included in fish density rates for nursery habitat trips.

Low velocity habitats: Fall monitoring

The fish community in low velocity habitats in the San Juan River was sampled during a single trip, between Hogback diversion RK 255, (RM 158) and Clayhills crossing RK 5 (RM 3) between 9 September and 18 September.

This study was designed to evaluate longitudinal changes in catch rate and species composition. Calculations of fish species composition and density were based on all seine hauls made in each reach.

Two low-velocity habitats were sampled in each eight kilometer (five mile) section, with the exception of nursery habitat reaches, which were not sampled. Habitat type definitions used in this study are listed in Table 3. Backwaters were targeted for sampling in this study because YOY Colorado squawfish have been shown to be most abundant in these habitats in the Green and Colorado rivers (McAda and Tyus 1984, Tyus and Haines 1990, Tyus and Karp 1991). All sample locations were located to the nearest 0.1 mi.

Post-larval and YOY fishes were collected using 1.6 mm mesh (4 m long x 1 m deep) or 0.8 mm mesh (1 m long x 0.5 m deep) seines. Samples were preserved using 10% formalin; only specimens that could be reliably identified in the field were counted and released. Fishes collected in the first 1.6 mm and 0.8 mm hauls in each 8 km section were measured. The number of seine hauls at each site varied from one to three, depending on the size of the habitat. For each seine haul, seining efficiency was recorded on a scale of 0 to 3, with "0" being the most efficient and "3" being the least efficient, dependent on water and mud depth. Physical habitat measurements were recorded for each sample site. These included length, mean width, and maximum depth of the habitat. The length, width, and depth of each seine haul was also recorded. Depth measurements included the maximum water depth and the depth one-half the distance from the maximum depth to the end of the seine hauls. The orientation of each seine haul relative to the long axis of the habitat (i.e., across or parallel) was recorded. At each depth measurement, primary and secondary substrate particle sizes were estimated and recorded using the Brusven substrate index (Bovee 1982; Table 2). Other measurements included habitat and main channel water temperatures (^{0}C). Fish density (# of fish/100 m^2) was computed for all species.

RESULTS

Nursery Habitat

A total of 398 seine hauls were made in 257 low-velocity habitats in nursery habitat reaches 1-4 in 1995 (Table 4). A total of 36,134 fish, representing 14 species, were collected (Table 5). Backwater surface temperatures ranged from 9-32 (^{0}C). In August, five YOY roundtail chubs were collected in reaches 2 and 3 (Table 7). No other rare species were collected from nursery habitats in 1995. In March, red shiners (Cyprinella lutrensis) were the most abundant species in all three reaches. Red shiners and fathead minnows combined, accounted for 99% of the total catch in all three reaches (Appendix 1). Native species were poorly represented throughout the river during this spring trip (Figure 3). Native catostomids were collected infrequently with blueheads absent from reaches 2 and 3. By August, red shiner and fathead minnow abundance had declined markedly in all reaches. Red shiners and fathead minnows combined, accounted for 15% of the total catch in reach 4, 91% in reach 1, 65% in reach 2 and 95% in reach 3 (Appendix 1). Speckled dace was the most abundant native species in reaches 1 and 3, while bluehead suckers dominated native collections in reaches 4 and 2, with a catch rate of 200 fish/100 m^2 and 34 fish/100 m^2, respectively. Bluehead suckers comprised 58% of the total catch in reach 4 during August with a total of 2242 collected.

Flannelmouths were nearly non-existent, with a total of 10 collected. Both native catostomids were collected in all reaches with the exception of blueheads in reach 3. Largemouth bass *(Micropterus salmoides)* were collected in reaches 1 and 3 during August in very low numbers, with 3 being collected from reach 3. Young of the Year channel catfish *(Ictaurus punctatus)* were captured in reaches 3 and 4 only. Threadfin shad *(Dorosoma petenense)* were collected in five separate habitats in reach 3 during August. All five habitats were deep backwaters (Dmax > 1.0m) with silt and sand substrate. Largemouth bass, green sunfish, and channel catfish were also collected in some of these deeper, more thermally stable, and persistent backwaters. In 1994 four of five YOY Colorado squawfish captured were collected in backwaters with a Dmax > 1.0m. During August native bluehead suckers, flannelmouth suckers, and speckled dace were widely distributed across most habitat depths and sizes, but seem to be selecting habitats with a average Dmax of < 0.5m (Appendix 2).

In September, red shiner catch rates increased in all reaches, with the exception of reach 2. Fathead minnow densities increased in all reaches. Red shiners and fathead minnows, combined, accounted for 93% of the total catch in reach 4, 96% in reach 1, 98% in reach 2, and 97% in reach 3(Appendix 1).

Table 3. Classification used for habitats sampled during fish monitoring trip in the San Juan River, New Mexico, Colorado, and Utah, 1995.

Habitat	Abbreviation	Description
Main channel	MC	Primary river course that carries majority of the flow.
Side channel	SC	Secondary channel, often in a braided river reach that carries appreciable flow during high water. Often provides low velocity and backwater habitat during low flow.
Backwater	BA	A body of water adjacent to the main river channel with no measurable flow. Often created by a drop in water level which cuts off flow through a side channel.
Flow through	FT	A backwater with measurable flow, usually a "trickle" fed side channel.
Eddy	ED	A section of river with a distinct whirlpool current.
Pool	PO	A "deep," quiet stretch of water usually between two riffles.
Run	RU	Stretch of "fast" laminar flow.
Riffle	RI	Shallow stretch of river where water surface is broken as it flows over course substrate.
Shoreline	SH	Shallow, low-velocity areas near shore, usually on the inside of a river bend.
Isolated pool	IP	Body of water isolated from main or side channel, usually formed during declining flows.
Embayment	EM	A backwater with mouth-width wider than length of habitat.

Native bluehead suckers and speckled dace catch rates declined from August in all reaches. Bluehead suckers were collected in only reach 4 at a catch rate of 2.1 fish/100 m^2. Flannelmouth suckers catch rates increased in all reaches except reach 2 (Figure 3). This increase was due mostly to the capture of many age 1 (> 50mm). All flannelmouth suckers collected in reaches 1 and 2 were likely age 1. Nineteen of 21 flannelmouths collected in reach 3 had total lengths > 50 mm with the majority of these between 80 mm and 100 mm. It is likely that these were spawned in 1994. No rare species were captured during the September nursery habitat sampling.

Mean daily discharge at the Bluff gaging station for trips 1-3 was 2728 cfs, 1330 cfs, and 955 cfs, respectively (USGS 1995). Backwater habitats declined in Reach 4 from 28 in August to 10 in September. Reach 1 also showed declining numbers of backwaters from August to September. During April, 14 backwaters were sampled; in August, 22; but in September only 9 backwaters remained. Reach 2 followed a similar pattern with 10 backwaters in April, 23 in August, and 14 during September. Reach 3 showed declining numbers of backwater habitats from April to September sampling, with 36 backwaters in April, 24 in August, and 17 in September.

Mean area and volume (Figure 4) of sampled habitats in reach 4 increased from August to September. While reach 4 contained large numbers of backwaters during August, the majority were small and ephemeral and, therefore, few persisted through September. Mean area and volume of sampled habitats also increased steadily over the sampling period in reach 1. In April, six sampled backwaters had areas greater than 100 m^2, in August eight backwaters had areas greater than 100 m^2, and by September only one remained (Appendix 7). Habitat mean maximum depth in reach 1 was the lowest of all reaches. In April and September, no habitats had a mean maximum depth greater than 0.5 m. During August one sampled habitat had a mean maximum depth greater than 0.5 m (Appendix 3). Habitat numbers in reach 2 varied over the summer. Ten habitats were sampled in April, 23 in August and 14 in September (Table 6).

Mean habitat area (Figure 4) and volume increased slightly in reach 2 from April to August, but declined by September. Reach 2 contained three backwater habitats with areas greater than 100 m^2 in April, five in August and four in September (Figure 8). The number of habitats in reach 2 with mean depth maximum (Dmax) greater than 0.5 m during April, August, September sampling was one, ten and three, respectively (Appendix 4). Rain events during the second week in September transported large amounts of silt into the river, which eliminated many backwater habitats and greatly reduced the depth of the remaining backwaters. Low velocity habitat numbers in reach 3 declined steadily from April to September. During April, 36 backwater habitats were sampled; 24, in August; and 17, in September (Table 6). Reach 3 had the highest mean area and volume of backwaters habitats during all three sampling trips (Figure 4). Mean area and volume of sampled habitats peaked during August and decreased slightly in September. During April, reach 3 contained 12 backwater habitats with an area greater than 100m^2. In August, 10 such habitats existed with the number decreasing to seven in September (Figure 7). Reach 3 contained the greatest number of habitats with maximum depth of greater than 0.5 m. Five backwaters had a mean maximum depth greater than 0.5 m, in April, while seven in August and September did. Silt loads present during September eliminated many of the shallower backwaters in reach 3. However, many of the deeper habitats persisted during September (Appendix 5), likely because the spike in the hydrograph during September was large enough to top many of the existing sandbars which create backwater habitats in this reach of the San Juan River. This likely scoured many of the deeper habitats lessening the effects of the silt load. During the peak of the spike, however, backwater habitat in reach 3 was likely very scarce or non-existent, displacing fishes downstream.

Incidental seining efforts for trip 1 (August) and 2 (September), totaled 242m^2 and 186m^2 respectively. During trip 1 the sampled secondary channel at RM 127.3 contained high numbers of speckled dace and both species of catostomids.

Large numbers of adult red shiners were also collected from several large pools. During September sampling, high numbers of speckled dace and red shiners were again present, but catosomids were rare.

Table 4. Total number of sites, samples and area sampled (m^2) by reach, for Spring (Trip 1), Summer (Trip 2), and Fall (Trip 3) 1995.

	# of sites			# of samples			# Hab./mile			Area sampled (m^2)		
Trip/ Reach	1	2	3	1	2	3	1	2	3	1	2	3
4		34	14		49	23		6.8	2.8		1118	677
1	20	22	11	40	38	16	4.0	4.4	2.2	1032	1192	520
2	12	20	18	19	32	31	2.4	4.0	3.4	407	698	645
3	43	26	20	58	42	35	8.6	5.2	4.0	1531	1806	1454
Total	75	102	63	117	161	105				2970	4814	3296

Table 5. Species list of fish collected in low-velocity habitats in the San Juan River, New Mexico, Colorado, and Utah, 1995.

Scientific name	Common name	Status	Abbreviation
Cyprinidae			
Cyprinella lutrensis	red shiner	I	RS
Cyprinus carpio	common carp	I	CP
Gila robusta	roundtail chub	N	RT
Pimephales promelas	fathead minnow	I	FH
Ptychocheilus lucius	Colorado squawfish	EN	CS
Rhinichthys osculus	speckled dace	N	SD
Catostomidae			
Catostomus discobolus	bluehead sucker	N	BH
Catostomus latipinnis	flannelmouth sucker	EN	FM
Catostomus spp.	white sucker hybrid	I	WS
	unknown sucker		SU
Ictaluridae			
Ameiurus melas	black bullhead	I	BB
Ictalurus punctatus	channel catfish	I	CC
Cyprinodontidae			
Fundulus zebrinus	plains killifish	I	PK
Poeciliidae			
Gambusia affinis	mosquitofish	I	GA
Centrarchidae			
Lepomis cyanellus	green sunfish	I	GS
Micropterus salmoides	largemouth bass	I	LG
Clupeidae			
Dorosoma petenense	threadfin shad	I	TS

N = native to Colorado River drainage
EN = endemic to Colorado River drainage
I = introduced to Colorado River drainage

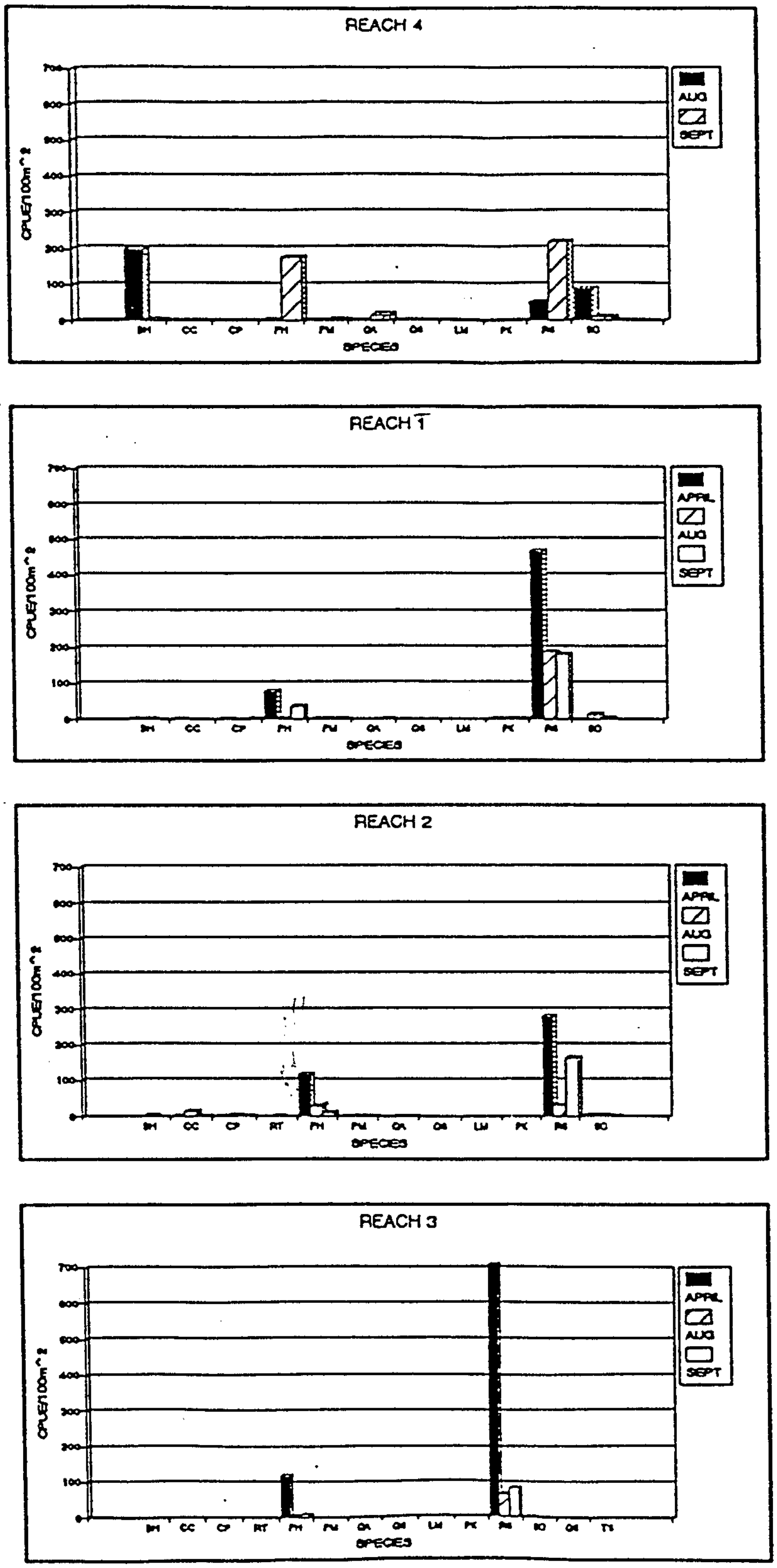

Figure 3. Fish density (Fish/100m²) for Nursery Habitat reach 4,1, 2 and 3, Spring, Summer, and Fall sampling, 1995.

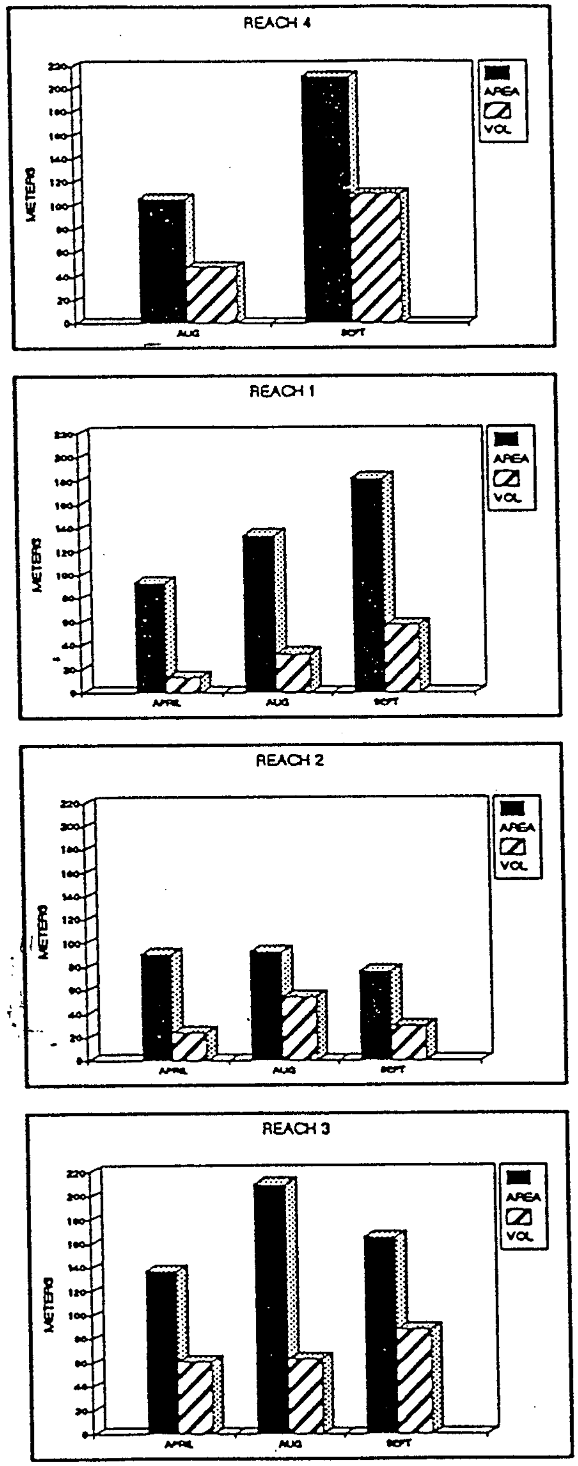

Figure 4. Mean area and volume of low velocity habitats sampled Nursery Habitat reaches 1-4 Spring, Summer, and Fall San Juan River, 1995.

Low velocity habitat: Fall monitoring

Fifty-one sites were sampled, resulting in 121 seine hauls between Hogback diversion and Clayhills crossing during the September monitoring trip. Daily mean discharge at the Bluff gaging station decreased from 2080 cfs to 1200 cfs between the 12th and 18th of September (USGS 1995). A total of 12,919 fish representing six families and thirteen species were collected (Table 5). Of that total, 1,369 fish were natives, accounting for slightly less than 11% (Table 7). Two roundtail chubs were collected, one at RK 184.9 (RM 114.9) and a second at RK 110.4 (RM 68.6) (Table 8). Speckled dace were collected in all six reaches with the highest density in reaches 1A and 2 and a total catch rate river wide of 32.8 fish/100 m^2 (Table 7). Bluehead suckers were collected in only the top four reaches with a total density of 8.1 fish/100 m^2 (all reaches combined). Flannelmouth suckers were captured in low numbers in all reaches except 5, resulting in a density of 4.1 fish/100 m^2 for all reaches combined (Table 8). The highest densities of native Catostomids were in reach 1A, (23.6 fish/100 m^2) with very low numbers throughout the rest of the river. Densities for red shiners were highest in reaches 1A and 2. Red shiner total catch rate was 227 fish/100 m^2 for all reaches combined. Total fathead density for all reaches combined was 137 fish/100 m^2 (Table 7).

As in 1994, the fish community monitoring trip was during a descending hydrograph, caused by September rains in the upper reaches. Flows at the Bluff gage peaked at 2980 cfs two days prior to our launch at Hogback. One week prior to the fish community monitoring trip the flows a Bluff were 1070 cfs. Rain events caused several major washes to dump large amounts of silt and debris into the river. Sampling efficiency in 1995 was greatly reduced due to the silt loads in backwaters. During the 1994 Fish community trip conditions were very similar. A large portion of the smaller habitats present during August were eliminated. This was particularly true in the upper three reaches. This was the second spike in the hydrograph due to summer rains, on 30 August the Bluff gage peaked at 2550 cfs (USGS 1995). Backwater surface temperature ranged from 16-29 ^{0}C during the September fish community sampling trip. These temperatures were within the ranges experienced in previous years (Buntjer et al. 1993, Archer et al. 1995) and within the range of temperatures of other Upper Colorado River Basin rivers where Colorado squawfish are abundant (Bates et al. 1991).

Six backwater habitats sampled during the September fish monitoring trip were seined by ERI (Ecosystem Research Institute) personnel either one or two days prior to our sampling. Catch rates for these habitats were not significantly different from non-sampled habitats so they were included in fish density estimates. However, such sampling conflicts could result in lowered catch rates and should be avoided in the future.

Table 6. Catch rates and percent composition of seine collections made in low-velocity habitats during fall monitoring trip 12-18 September 1995 in the San Juan River.

Species	REACH 1A	1B	2	3	4	5	Total
	Catch rate (number/100m$_2$)						
BB	.8	-	.3	-	-	-	.3
BH	23.6	5.2	3.7	.3	-	-	8.1
CC	-	2.4	11.2	7.5	8.1	-	6.4
CP	.5	-	.1	-	-	-	.2
FH	216.8	65.6	138.0	37.4	121.4	5.8	137.0
FM	12.7	.5	1.3	.3	.8	-	4.1
GA	19.0	10.8	7.1	.0	4.9	-	9.4
GS	.1	-	-	-	.2	-	-
LG	.1	-	-	-	-	-	-
PK	-	-	.3	-	3.4	-	.6
RS	136.3	73.1	370.6	189.2	172.3	76.5	227.1
RT	-	-	.1	.3	-	-	-
SD	73.6	25.0	29.0	2.3	1.5	3.9	32.8

Species	REACH 1A	1B	2	3	4	5	Total
Percent composition							
BB	.2	-	.3	-	-	-	*
BH	4.9	2.8	.7	.1	-	-	1.9
CC	.1	-	*	1.9	1.5	.3	1.5
CP	*	*	*	.1	-	-	*
FH	44.8	35.9	24.0	15.7	39.4	6.8	32.0
FM	2.6	.3	.2	.1	.3	-	1.0
GA	3.9	5.9	1.3	.4	1.6	-	2.2
GS	*	*	-	-	*	-	*
LG	.1	-	-	-	-	-	*
PK	-	-	.3	-	1.1	-	.6
RS	28.1	40.1	66.0	79.4	56.0	88.6	53.6
RT	*	*	-	-	-	-	*
SD	15.2	13.7	5.2	.9	.5	4.5	8.0

- = no individuals of this species collected
* = less than 0.05 percent

Table 7. Capture location of roundtail chubs (*Gila robusta*) including characterization of capture sites in the San Juan River 1995. BA = backwater.

RK (RM)	Date	Habitat Type	Length (m)	Width (m)	Max Depth (m)	N	TL (mm)
38.3 (23.8)	Aug 14	BA	8	13.0	1.0	1	15
35.8 (22.3)	Aug 15	BA	14	9.3	.6	1	14
35.7 (22.2)	Aug 15	BA	56	10.6	1.2	1	14
33.8 (21.0)	Aug 15	BA	9	3.3	.75	1	14
20.6 (12.8)	Aug 15	BA	35	8.1	.25	1	11
184.9 (114.9)	Sep 14	BA	8	4.0	.18	1	55
110.4 (68.6)	Sep 16	BA	100	15.0	.43	1	30

DISCUSSION

No Colorado squawfish or razorback suckers were collected during the 1995 low velocity habitat sampling. A total of seven roundtail chubs were captured during August and September, between RK 184.9 (RM 114.9) and RK 20.6 (RM 12.8). Five of the seven were captured below Johns Canyon in nursery habitat reaches 2 and 3. Capture of these five YOY roundtail chubs in the lower canyon again suggests the possibility of a mainstem spawning population (Buntjer et al 1994).

Catch rates during the first nursery habitat trip, (April) indicated that red shiners and fathead minnows were still at extremely high densities going into spring run-off. Densities of red shiners and fathead minnows during September 1994 were greater than in any of the previous three years of the study. Very high numbers of adult and YOY red shiners were captured throughout trip 1 (April). This was particularly true in reaches 1 and 3 with catch rates for red shiners of 467 fish/100 m^2 and 784 fish/100 m^2, respectively. Fathead densities had declined markedly from September. In August, red shiner densities were down dramatically in all reaches. Catch rates for reaches 1 and 3 were 188 fish/100 m^2 and 66 fish/100 m^2, respectively. A large percentage of the red shiners that were captured in backwater habitats during August were age 1 (1994 year class). Adult red shiners (> 40mm) were extremely rare. Incidental seining efforts located high densities of adult red shiners occupying smaller secondary channel pools. Given low population densities, it seems that backwaters are not the preferred habitat for adult red shiners. It also appears that the flows during the spring of 1995 may have had a large impact on the existing non-native cyprinid populations. It is unclear weather the magnitude of the peak or the duration was responsible for this reduction in non-native cyprinid populations. The peak in 1994 was 8290 cfs and occurred during the first week in June, compared to 1160 cfs peak on 19 June 1995 which is the highest peak discharge during this study. During the spring of 1995, warm temperatures and large snowpack resulted in a longer shoulder on both ends of the hydrograph than in 1994. Flows at the Bluff USGS gage were greater than 2000cfs from the second week in March until near the end of July 1995.

Native species were poorly represented during spring sampling comprising 0.53% of specimens collected. Native speckled dace densities were slightly higher than in the spring (April) of 1994 in all reaches except reach 1. Native Catostomid densities were lower in all reaches with the exception of flannelmouth suckers in reach 1.

During trip 2 in August 1995, very high numbers of speckled dace and bluehead suckers were captured in reach 4. Catch rates were similar to that observed during the middle of July 1994 sampling (Archer et al. 1995). Densities of all natives dropped off quickly, moving down river. In reach 3 densities of all native species were less than 1 fish/100 m^2. Our data again show that the upper reaches are a very important area for native species reproduction (Bunjter et al. 1994, Archer et al. 1995). By late September 1995 native densities were down to very low numbers in all reaches. This is very similar to the pattern observed during 1994 sampling when native species numbers declined dramatically by the first week in September. During nursery habitat trip 3, September 1995, native species were again very poorly represented throughout the river (Figure 3). In reach 4 catch rates for bluehead suckers had declined from 200 fish/100 m^2 (Figure 3) in August, representing 58% (Appendix 1) of the total catch, to 2.1 fish/100 m^2 representing 0.4% of the total catch. Catch rates for native castostomids were lower in September 1995 than in 1994 in all reaches. Channel catfish numbers collected during 1995 nursery habitat sampling were down considerably from 1994 levels in all reaches during all trips.

The seining effort in 1995 in reaches 1 and 2 was greater than during all three trips during 1994 nursery habitat sampling. Effort was down in reach 3, because of fewer low velocity habitats. During 1995 the amount of area sampled in reach 3 was 4791 m^2 compared to 6960 m^2 in 1994.

Mean discharge at the USGS Bluff gage was considerably higher in 1995 during the March and August trip than in 1994 and similar during September sampling. Mean discharge during 1995 trips 1-3 was 2728cfs, 1330cfs, and 955cfs respectively, compared to 585cfs, 531cfs, and 1040cfs during spring, summer, and fall sampling in 1994. Habitat availability in the nursery habitat reaches is directly related to discharge. Reach one contained greater numbers of low-velocity habitats during all three trips in 1995, primarily because the higher flows inidated many secondary chute channels which are dry at lower discharge. Reach 1 contained 14, 22, and 9, backwater habitats during March, August, and September 1995 sampling, compared to 21, 13, and 2 for April, August and September sampling during 1994. During 1995 sampling reach 3 contained far fewer backwater habitats than during 1994 sampling. During March 1995, sampling reach 3 contained 36 backwaters, 24 during August, and 17 in September. In 1994 reach 3 contained 56, 36, and 28 backwaters during spring, summer and fall sampling respectively. A large portion of this reduction in available habitat was due to higher flows inidating many of the mid-stream sandbars.

Backwater habitat numbers in 1995 showed a similar pattern to 1994, with major reductions in the amount of available habitat over the summer. Silt loads as a result of summer rain events were responsible for this loss in habitat as was the case in 1994.

During April 1995 reach 1 contained no habitats with mean Dmax of greater than 0.4m. In 1994 3 habitats had mean Dmax greater than 0.4m. During all three trips Reach 2 contained greater numbers of backwaters in 1995 than in 1994, but mean area for sampled backwaters was less. Reach 2 however, contained greater numbers of backwaters with a mean Dmax of greater than 0.5m in 1995. In 1995, reach 2 contained 1, 9, and 3 backwaters with a mean Dmax greater than 0.5m. during March, August, and September respectively, compared to 1, 5, and 3 for March, August, and September 1994. Reach 3 contained fewer backwaters in 1995 during all three sampling trips than in 1994. Mean area was also lower in 1995, with the exception of the spring trip. The number of backwater habitats with mean Dmax greater than 0.5m in 1994 was equal to or greater than 1995 during all trips. In 1995 reach 3 had 5, 7, and 7 backwaters with mean Dmax of greater than .5m during March, August, and September sampling. During 1995 reach 3 contained 7, 12 and 7 such habitats for trips 1-3 respectively. The pattern of habitat disappearance observed during 1995 was very similar to that observed during the 1994 field season (Archer et al. 1995). In 1994, four of the five YOY Colorado squawfish captured during summer sampling were captured in backwater habitats with a maximum depth of greater than 1.0m.

Fish presence/absence data indicate that habitat depth seems to be more important than area in determining which habitats are utilized by native species. During August native bluehead suckers and speckled dace occupied nearly all habitats in reach 4. In reach 2 during August, native species were most common in habitats between 0.3m and 0.5m mean depth max (Appendix 4). No conclusions could be drawn in reach 3 because of very low numbers of native species (Appendix 5). In reach 1 natives were most common in habitats with mean Dmax of less than .2m. Native species were uncommon in reaches 2 and 3 during September, however, flannelmouth suckers were most common in backwaters with a mean Dmax of >.5m in reach 3. Flannelmouths and speckled dace were also present in 2 out of 3 flow through habitats sampled.

During the 1995 fish community trip seining conditions were very similar to those encountered during 1994 with large amounts of silt greatly reducing sampling efficiency. Catch rates for native bluehead suckers were higher in all reaches where present. Total densities for all reaches combined were 8.1 fish/100 m^2 for 1995 and 3.0 fish/100 m^2 for 1994 (Appendix 10). In 1993, which was a relatively good year for native species, bluehead sucker were captured in all reaches, resulting in a total density of 8.4 fish/100 m^2. Flannelmouth sucker densities were higher than 1994 numbers, but far short of 1993 levels. Catch rate for flannelmouth suckers during 1993, 1994, and 1995 September monitoring trips were 18.5 fish/100 m^2, .8 fish/100 m^2, and 4.1 fish/100 m^2, respectively (Appendix 10). Speckled dace densities were lower than in both 1993 and 1994. Red shiner densities were far less than during 1993 and 1994, but similar to catches during 1991 and 1992 September monitoring trips. Fathead minnow densities were similar to those observed in previous years of the study with the exception of 1994 when fathead densities were extremely high going into winter. Channel catfish numbers were down again in 1995 with a density of 6.4 fish/100 m^2 compared to 12.1 fish/100 m^2 in 1994 and 27.2 fish/100 m^2 in 1993.

The rise in the level of Lake Powell in 1995 had no effect on low velocity habitat in nursery habitat reach 3. During August sampling pool level was (3695 ft. AMSL) and appeared to be near RM 7. If Lake Powell level had reached full pool (3700 ft. AMSL) it likely would have had major impacts on the availability of backwater habitats in nursery habitat reach 3. Backwater habitat from RM 7 to Clayhills crossing RK 5 (RM 3) was non-existent except for one wash at RM 4.

During 1994 and 1995, summer rain events increased flows significantly. These spikes in the hydrograph, which likely created some new low-velocity habitats, likely virtually eliminated all existing habitats, particularly in reach 3, therefore displacing fishes downstream. In every year since 1991 spikes in the hydrograph between September and February have reach levels nearly half that of the peak discharge during spring run-off of that year. In 1994, a year of known Colorado squawfish reproduction the capture of four YOY Colorado squawfish during August sampling from RM 122.6 to RM 9.8 indicates wide species distribution. During two September sampling trips only one YOY squawfish was captured at RM 8.0 in the last backwater sampled in reach 3.

The absence of YOY Colorado squawfish in 1995 seine haul collections, indicates very limited reproductive success. Since 1991, 17 of 19 YOY Colorado squawfish captured (excluding larval drift captures) have been captured below the full pool elevation of Lake Powell (3700 AMSL). This pattern of Colorado squawfish YOY captures indicates that the Lake Powell inflow area (below Grand Gulch) is an important nursery habitat area for YOY Colorado squawfish in the San Juan River. It is our opinion that persistence of suitable nursery habitat throughout the river, and below Grand Gulch in particular, is a possible limiting factor in the recruitment of Colorado squawfish in the San Juan River.

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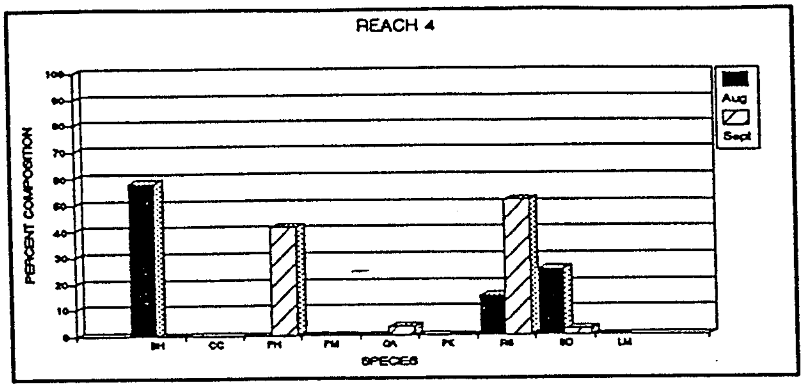
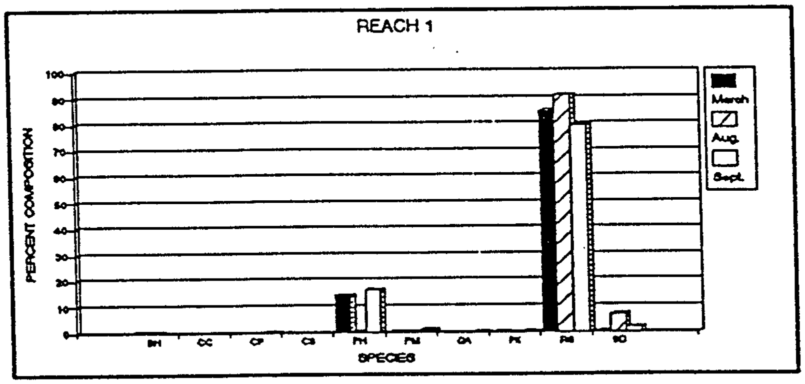
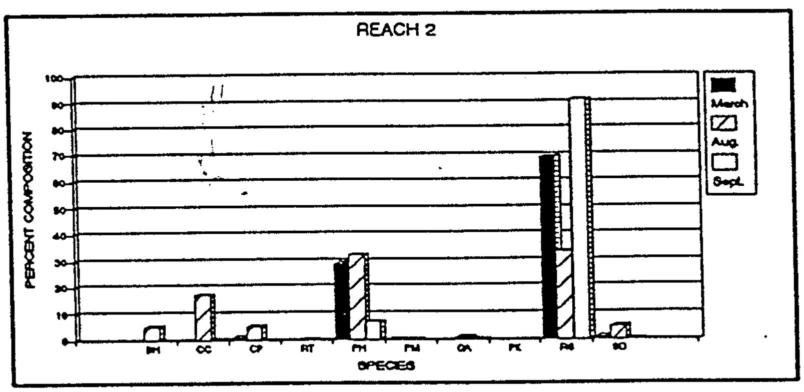
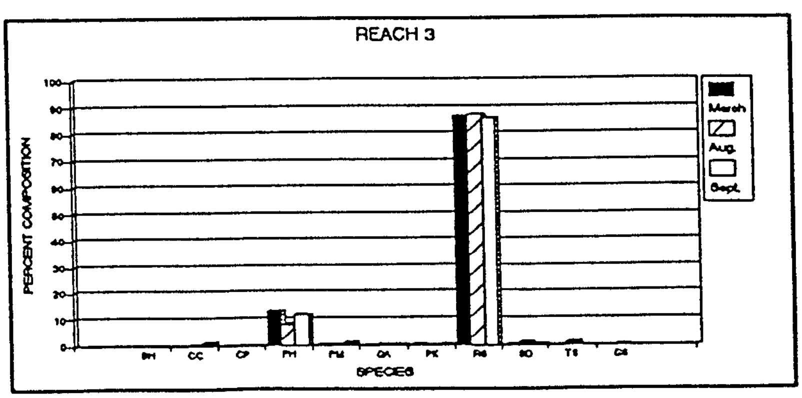
APPENDIX I Percent composition by reach and trip for Nursery habitat trips 1-3 1994.

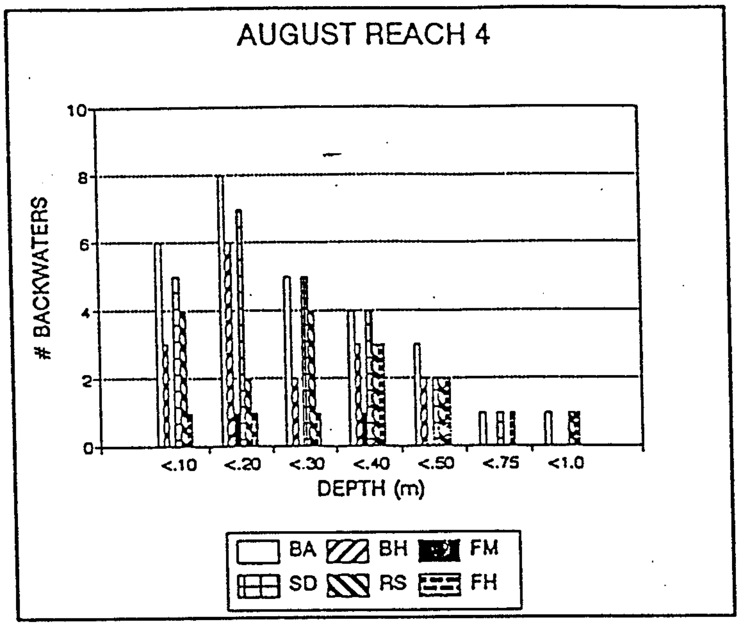


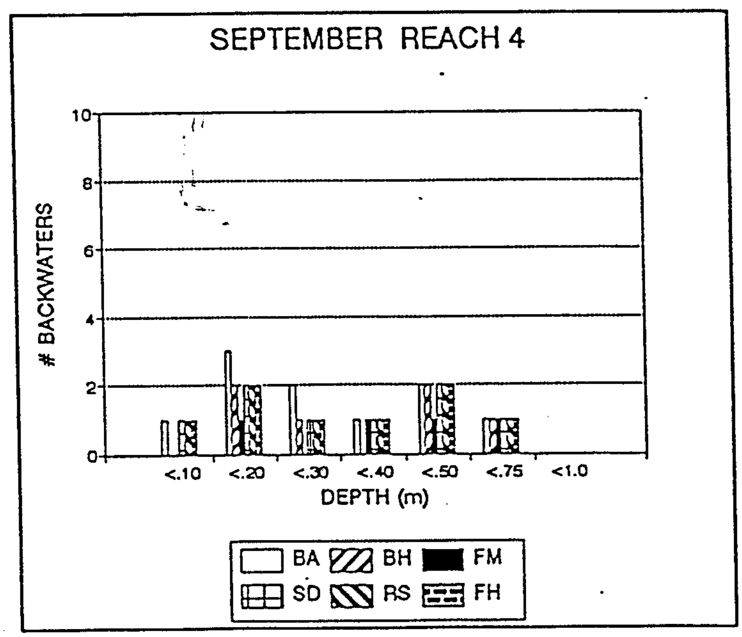




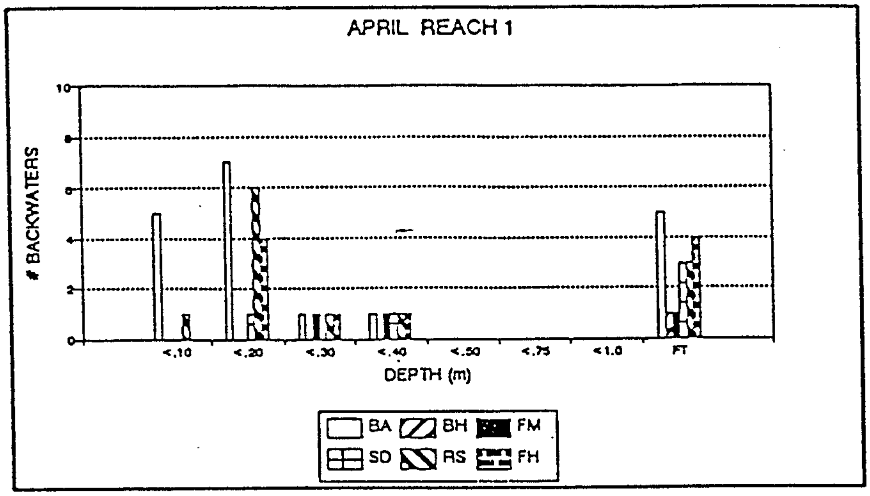


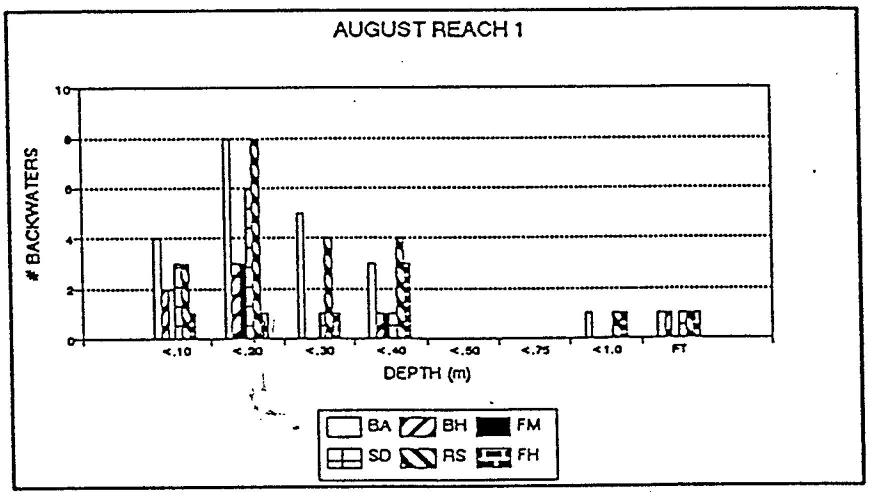
APPENDIX II Habitat utilization as a function of the mean of three depth maximum measurements in backwater habitats sampled during Nursery habitat trip 2-3 1995, reach 4 (BA= # Backwaters, FT= Flow through low velocity habitats).

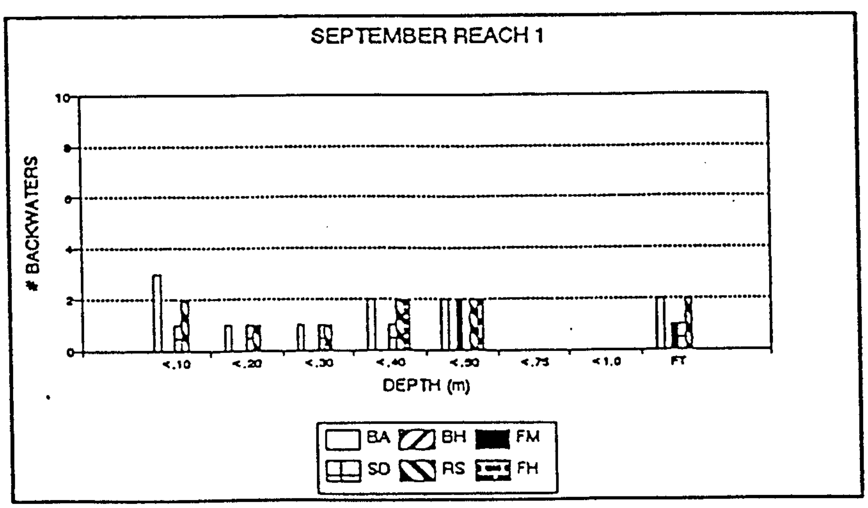




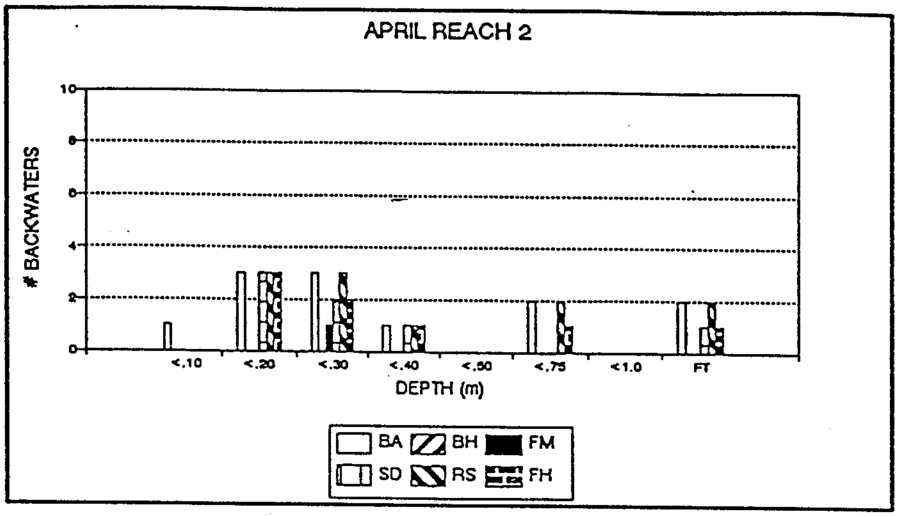
APPENDIX III Habitat utilization as a function of the mean of three depth maximum measurements in backwater habitats sampled during Nursery habitat trip 1-3 1995, reach 1 (BA= # Backwaters, FT= Flow through low velocity habitats).

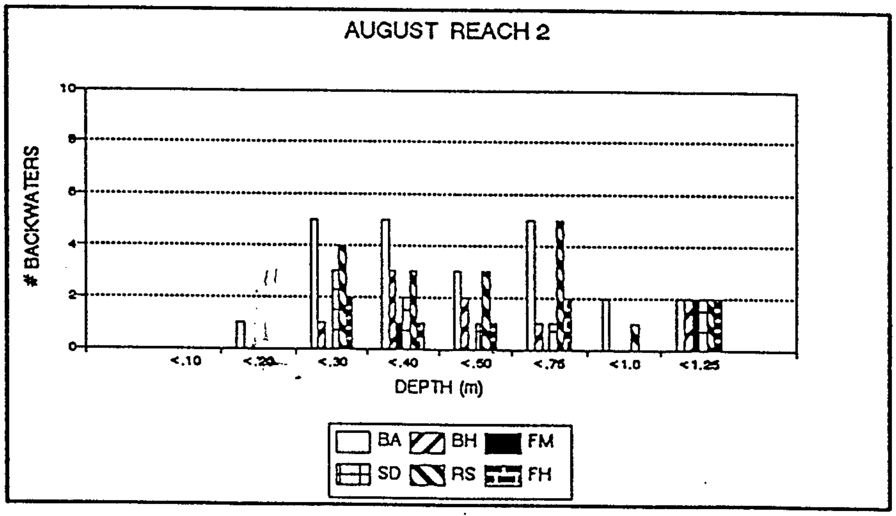


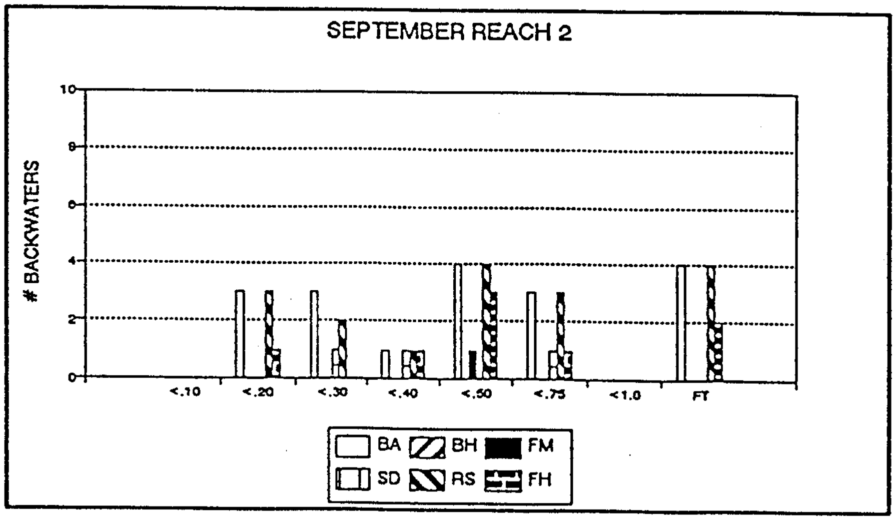




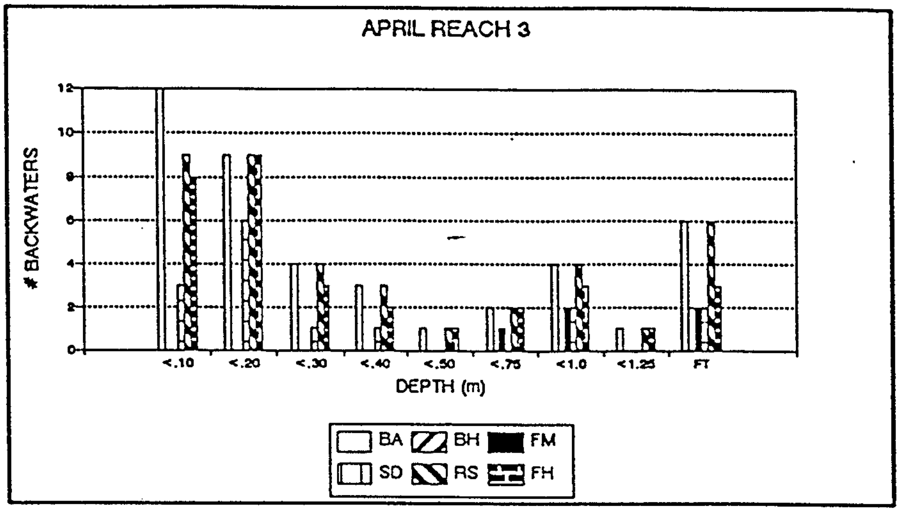
APPENDIX IV Habitat utilization as a function of the mean of three depth maximum measurements in backwater habitats sampled during Nursery habitat trip 1-3 1995, reach 2 (BA= # Backwaters, FT= Flow through low velocity habitats).

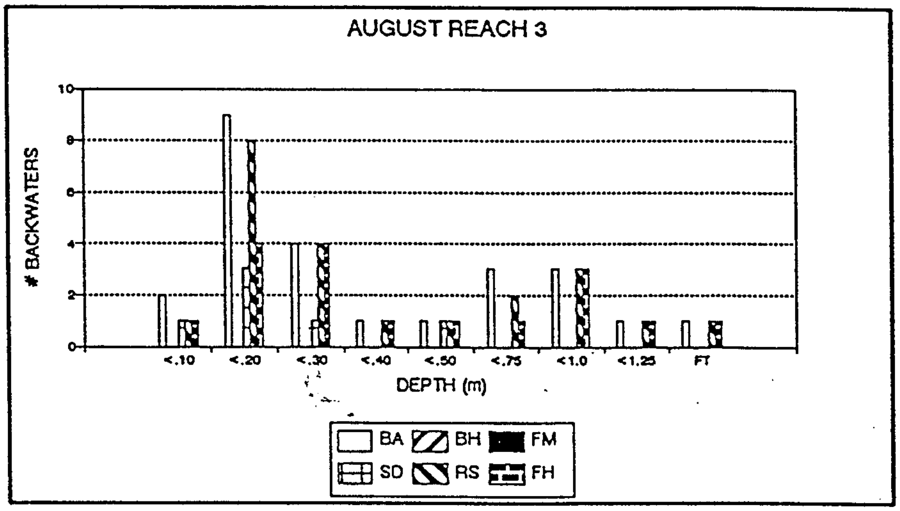


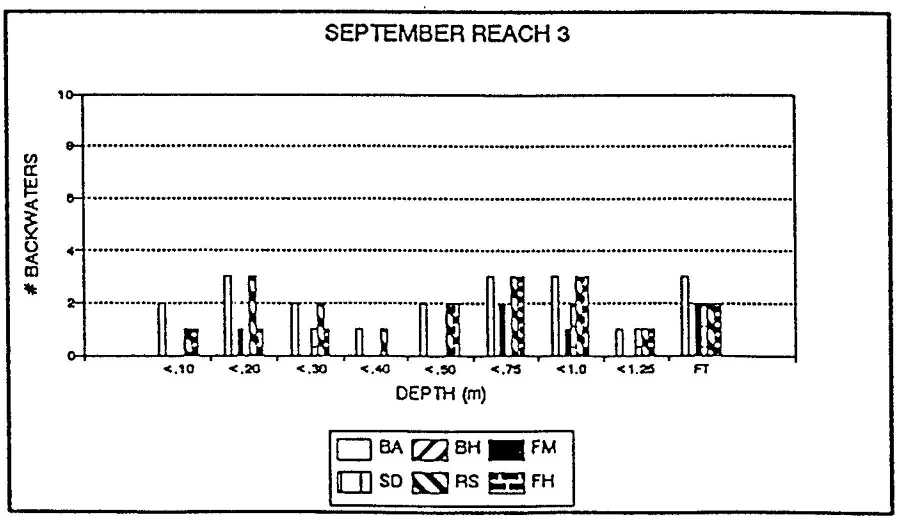




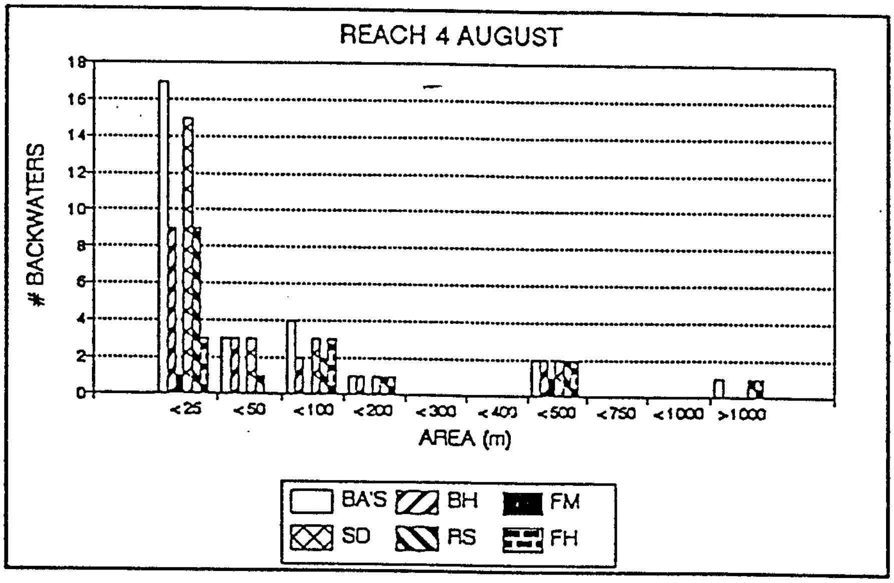
APPENDIX V Habitat utilization as a function of the mean of three depth maximum measurements in backwater habitats sampled during Nursery habitat trip 1-3 1995, reach 3 (BA= # Backwaters, FT= Flow through low velocity habitats).

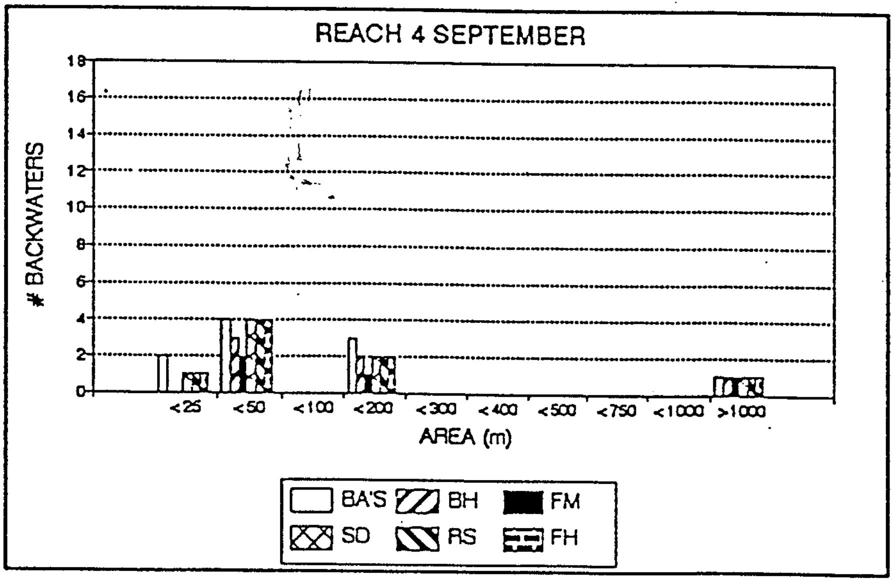




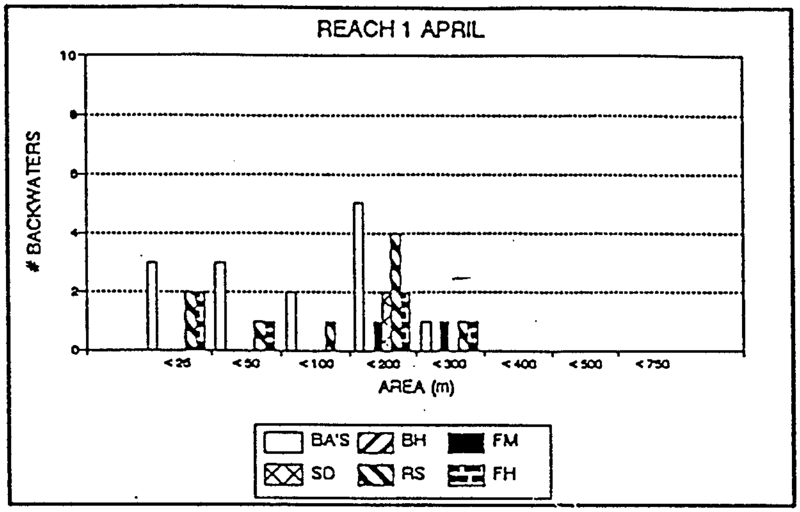


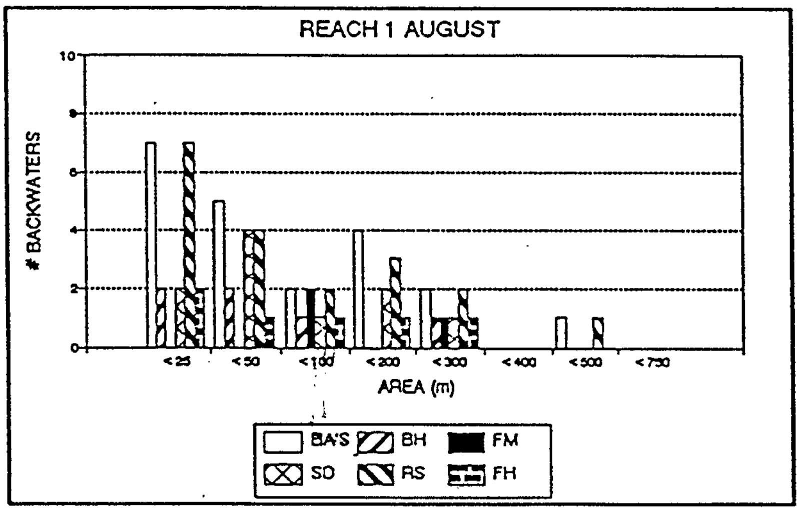
APPENDIX VI Habitat utilization as a function of the area (m²) of backwater habitats sampled reach 4 for Nursery habitat trips 2-3 1995. (BA= # Backwaters).

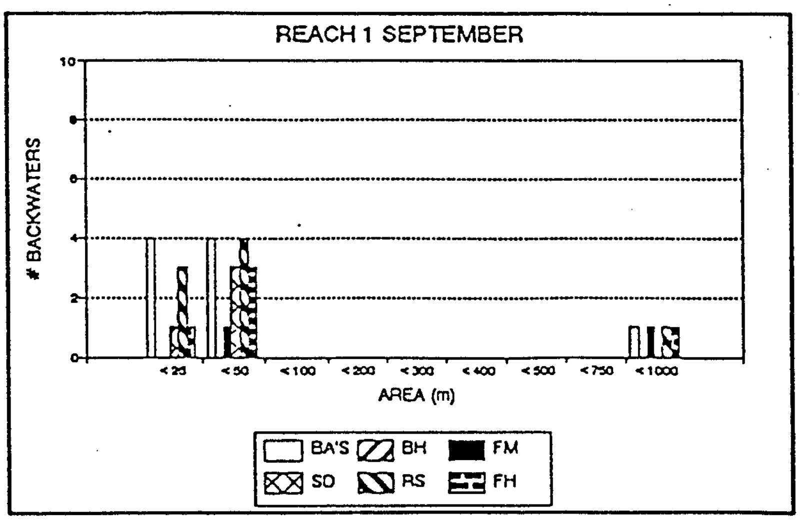




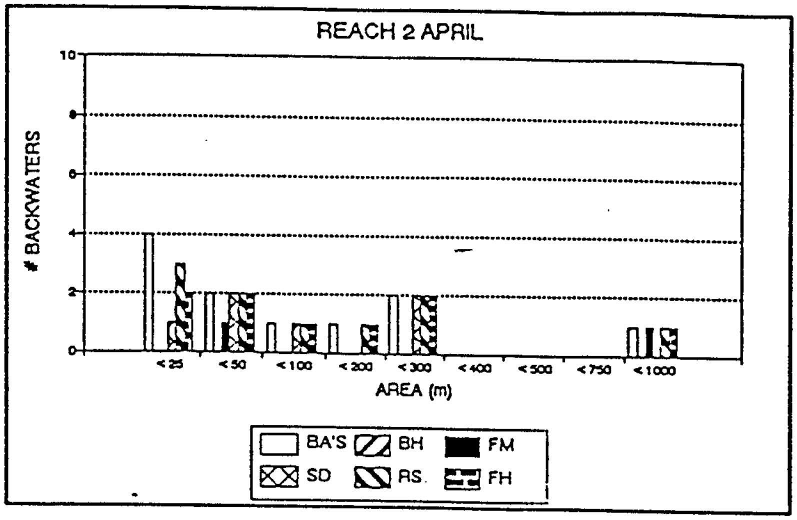
APPENDIX VII Habitat utilization as a function of the area (m^2) of backwater habitats sampled reach 1 for Nursery habitat trips 1-3 1995. (BA= # Backwaters).

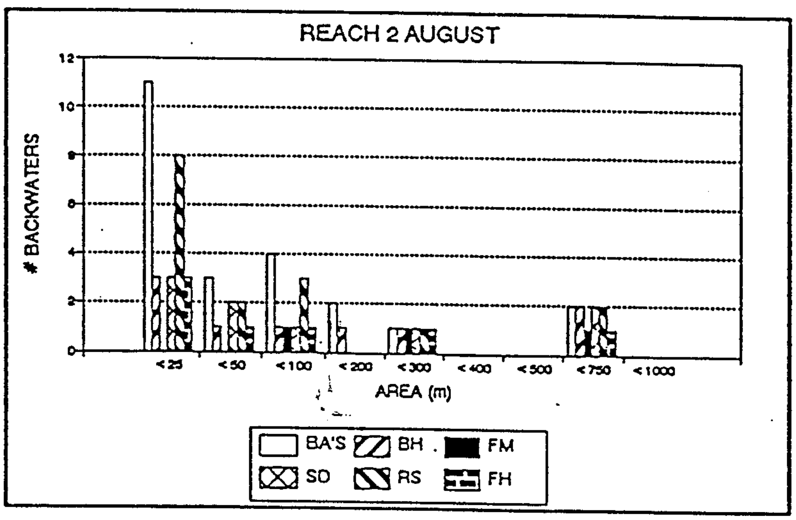


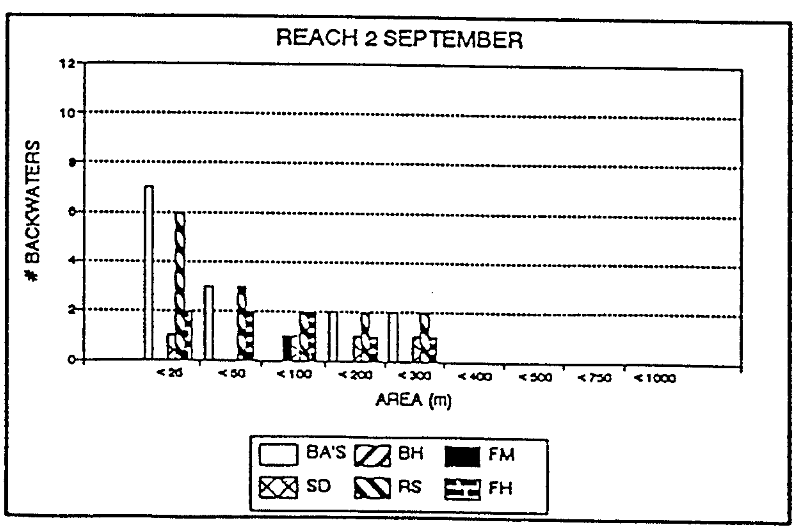




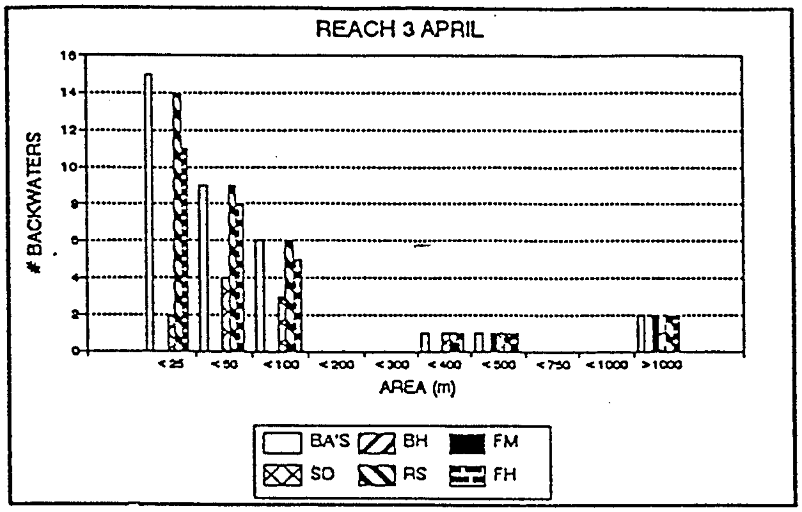
APPENDIX VIII Habitat utilization as a function of the area (m^2) of backwater habitats sampled reach 2 for Nursery habitat trips 1-3 1995. (BA= # Backwaters).

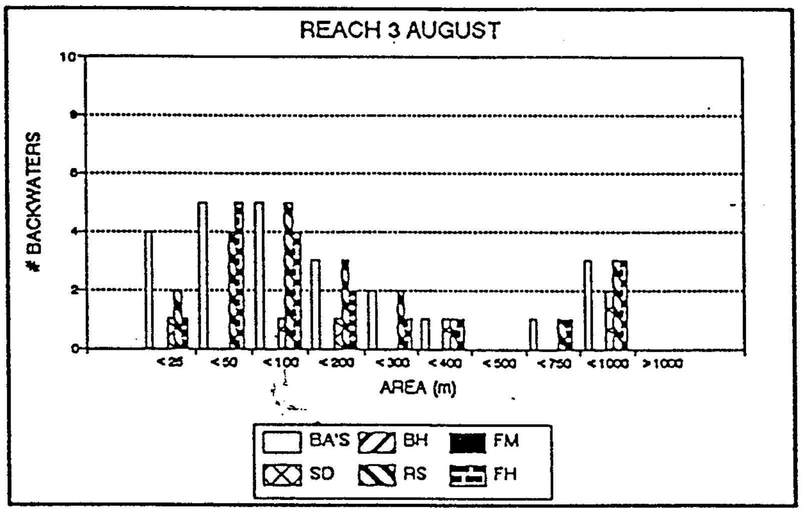


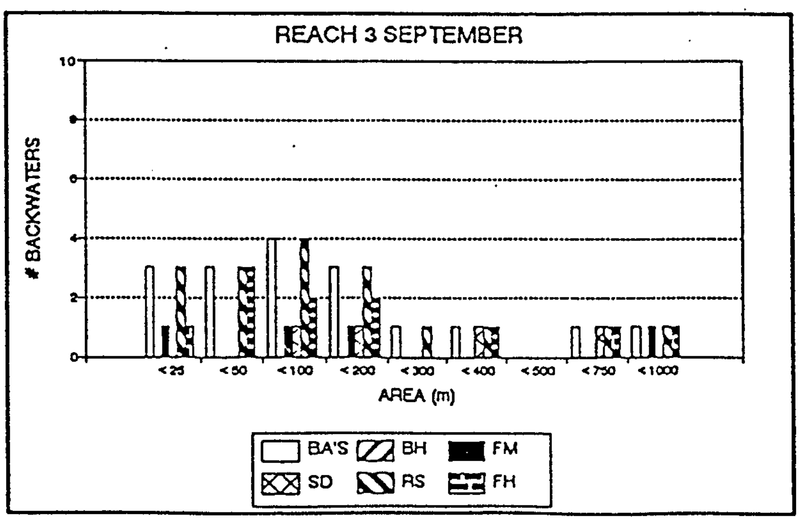




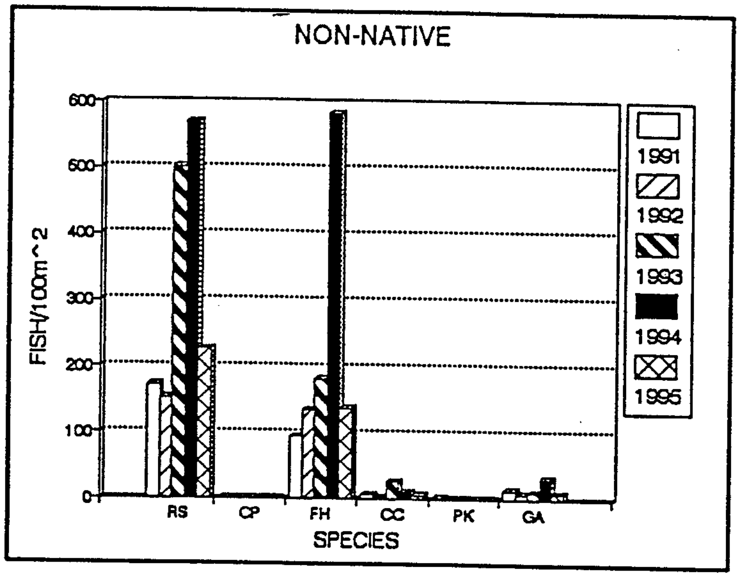
APPENDIX IX Habitat utilization as a function of the area (m^2) of backwater habitats sampled reach 3 for Nursery habitat trips 1-3 1995. (BA= # Backwaters).

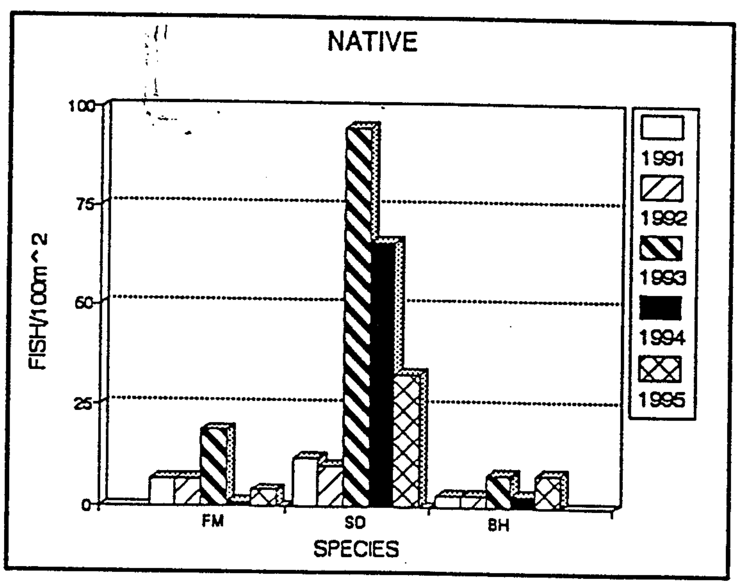






APPENDIX X Catch rate (Fish/100 m^2) for all seine haul collections during September fall monitoring trip from Hogback diversion to Clayhills crossing 1991-1995.





APPENDIX XI Percent composition of seine haul collections made during September monitoring trip from, Hogback diversion to Clayhills crossing 1991-1995.