SMALL-BODIED FISH MONITORING
SAN JUAN RIVER

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EXECUTIVE SUMMARY

Small-bodied fishes likely comprise a substantial proportion of the prey base for larger piscivorous fishes of the San Juan River, including Colorado pikeminnow. Though total biomass of small fish is a small percentage of what the river supports, numerically, small fish are the dominant residents in the San Juan. The primary objectives of young of year and small-bodied fish monitoring in San Juan River are to characterize responses of small-bodied and young-of-year fish to changes in flow regime of San Juan River, characterize long-term trends in autumn abundances of native and nonnative fishes in the San Juan River, and document occurrence and habitat of rare native fishes (i.e., roundtail chub, Colorado pikeminnow, and razorback sucker).

The small-bodied fish monitoring data are collected annually during autumn, usually late September and early October. Annual autumn monitoring of the small-bodied fish assemblages of San Juan River primary channel and secondary channels between Shiprock, New Mexico and Sand Island, Utah began in 1998. In 1999, backwater sampling was added to the monitoring effort and the study reach was extended upstream to the confluence of Animas and San Juan rivers (Farmington, New Mexico) and downstream to Clay Hills Crossing, Utah.

Fishes were collected with drag seines at each sample location (100 to 200-m sites every third river mile in primary channel, all secondary channels (>200m in length), and all backwaters (>50m^2). Primary channel collections were made from shoreline habitats while secondary channel fishes were collected across the breadth of the channel. All mesohabitats present within a site were sampled in rough proportion to their availability. Readily identified native fishes were measured (total length, mm) and released alive; all

other fishes were retained for identification and measurement in the laboratory. In addition to traditional collection of fishes with drag seines, electrofishing into a bag seine was added in 2004. Electrofishing collections were made in riffles, runs, and shoals.

Discharge rarely exceeded 5,000 cfs during the past 5 years. In 2002, spring monthly average mean daily discharge did not exceed 1,000 cfs. In contrast, spring monthly average mean daily spring discharge was >5,000 cfs from 1993 through 1995, and nearly so in 1997. In 1998 and 1999, average mean daily discharge during summer was comparatively high; that of 1999 (4333 cfs) was greater than average mean daily discharge that spring (2712 cfs). Since 1999, San Juan River summer discharge has been characterized by periods of extended low discharge, interspersed with large-volume storm-induced flow spikes.

Overall, red shiner was the most common species collected in primary channel, secondary channels, and backwaters. Its abundance was frequently an order of magnitude greater than the next-most common species. Other comparatively common nonnative species were fathead minnow, channel catfish, and western mosquitofish. Bullhead catfishes and centrarchids were rare, but found in most years. Speckled dace was typically the most common native species. Bluehead sucker and flannelmouth sucker were collected more frequently in the past three years than previously. Specimens of Colorado pikeminnow and roundtail chub were collected in 1998 and1999, and only Colorado pikeminnow in 2000. In 2004, Colorado pikeminnow were collected in both primary and secondary channels. No razorback sucker has been collected during autumn small-bodied fishes monitoring efforts.

In the primary channel, native fish density (0.65 fish/m^2) was twice as high in 2004 than in previous years. In secondary channels in 2004, native fish density (0.89 fish/m^2) was more than three times that previously found. The lowest density (0.05 fish/m^2) of native fishes in the primary channel in 2000 and lowest secondary channels density (0.093 fish/m^2) was in 1999. Nonnative densities were the highest in primary channels (2.43 fish/m^2) and secondary channels (6.00 fish/m^2) in 2002. Lowest densities of nonnatives in primary channels (0.24 fish/m^2) and secondary channels (0.22 fish/m^2) was in 1999.

Overall, autumn density of nonnative fishes, primarily red shiner, was significantly and negatively associated with summer flows in Reach 6 primary, Reach 5 primary, Reach 5 secondary, Reach 4 secondary (only red shiner) and Reach 3 secondary channels. Nonnative densities were also significantly, and negatively, related to spring flows and positively related to number of days discharge <500 cfs in Reach 6 secondary channels. Autumn density of flannelmouth sucker had a positive relationship with the number of low flow days in Reach 5 secondary and Reach 2 primary channels.

Densities of commonly collected native fishes generally declined as sampling progressed downstream. Nonnative fish densities did not show longitudinal trends, with the exception of channel catfish, which showed slight density increases in downstream sections.

Habitat velocity associations of fishes varied among channel types and reaches. Generally, native fishes were found in all water velocities and were distributed among habitat velocities according to their proportional abundance in the samples. Nonnative fishes tended to be more common in slower velocities.

INTRODUCTION

Following completion of the San Juan River Seven Year Research Program in 1997, the need to monitor San Juan River fish assemblages was recognized by the San Juan River Basin Recovery Implementation Program Biology Committee. Accordingly, autumn sampling of San Juan River small- and large-bodied fishes was conducted in 1998 following procedures used during the Seven Year Research Program. In 1999, autumn sampling of fish assemblages followed procedures detailed in the draft San Juan River Monitoring Plan and Protocols. Beginning in 2000, autumn fish assemblage monitoring followed the protocols detailed in the San Juan Monitoring Plan and Protocols (Propst et al. 2000). Electrofishing to collect small-bodied fishes was added to the sampling methods in 2004.

In 1998, primary and secondary channels sampling was limited to Reaches 5 through 2. In 1999, autumn monitoring of the primary channel was extended upstream to confluence of San Juan and Animas rivers near Farmington and downstream to Clay Hills Crossing. Also beginning in 1999, backwaters, as a distinct habitat, were sampled from Farmington to Clay Hills. Beginning in 2000, small-bodied fishes monitoring has followed the protocols detailed in Propst et al. (2000). Data on small-bodied fishes reported herein were collected from primary channel shoreline habitats, secondary channels, and backwaters since 2000. Other than general reference to 1998 and 1999 collections, this annual report focuses on data collected from 2000 through 2004.

Autumn sampling of small-bodied fishes in San Juan River primary and secondary channels, as well as backwaters and embayments, was conducted to aid in the characterization and quantification of responses of native and nonnative fishes to flow regimes designed to mimic a natural hydrograph. Specific objectives of this monitoring effort include documenting occurrence of protected species (i.e., roundtail chub, Colorado pikeminnow, and razorback sucker), particularly age-0 individuals; characterizing mesohabitats occupied by protected species and other small-bodied fishes; determining effects of different flow regimes on autumn densities of commonly collected native and nonnative species; and comparing densities of commonly-collected species among primary and secondary channels. Data collected will be used to characterize long-term trends in status (abundance, population size-structure, and recruitment) of individual species.

METHODS

In 1998, autumn monitoring of small-bodied fishes in San Juan River primary and secondary channels and backwaters (including embayments) occurred from Shiprock, New Mexico (RM 149, Reach 5) downstream to Chinle Creek, Utah (RM 68, Reach 3). In 1999, autumn monitoring was extended upstream to the San Juan-Animas rivers confluence (RM 180, Reach 6) and downstream to Clay Hills Crossing (RM 3, Reach 1). The primary channel was sampled at each sampled secondary channel or at 3-mile intervals (designated miles) if no secondary channel was present in a 3-mile reach. In 1999, a secondary channel was sampled only if it occurred within the 1-mile reach to be sampled in every third mile. This protocol, however, excluded a large proportion of secondary channels (30 to 50%, depending upon point that 3-mile intervals for sampling began). Beginning in 2000, all secondary channels longer than 200 m having surface water were sampled. All backwaters (greater than 50 m^2), regardless of occurrence within designated miles, were sampled.

From 2000 through 2004, small-bodied fishes were collected from primary channel habitats at 3-mile intervals. Starting point of 3-mile interval count cycled among years such that sampling would begin at RM 180 one year, RM 179 the next year, and RM 178 the third, and back to RM 180 the following year to repeat the cycle. In 2004, additional collections were made by electrofishing into a bag seine in riffle, run, and shoal habitats. Primary channel electrofishing collections were made every 6 miles.

Primary channel sample sites were about 200 m long (measured along shoreline). Secondary channel sample site length was variable, depending upon extent of surface

water, but normally 100 to 200 m. Within each site (primary and secondary channels), all mesohabitats (see Bliesner and Lamarra 2000 for definitions) present were sampled in rough proportion to their surface area within in a site. Beginning in 2003, data (including fishes collected) from each sampled mesohabitat were recorded separately. Most primary channel mesohabitats sampled were along stream margins, but off-shore riffles and runs (<0.75 m deep) were also sampled. Secondary channel sampling was across the breadth of the wetted channel. All mesohabitats within each site were sampled and sampled area of each was roughly proportional to its total area within a site. Some mesohabitats (e.g., debris pools and riffle eddys) were sampled in greater proportion than their availability. Normally, 5 seine hauls were made at each sample site; however, if habitat was homogeneous, fewer seine hauls were made. All backwaters >50 m^2 associated with the primary channel were sampled and categorized separately, as their own channel type. Typically, 2 seine hauls were made in each backwater; one near its mouth and the second in its upper half. Fish collection data from embayments were grouped with backwater data in 2003 and 2004. Smaller backwaters were included within primary and secondary data sets, as backwater mesohabitats.

Fishes were collected with a drag seine (3.05 x 1.83 m, 3.2 mm mesh) from each mesohabitat. Each catch was inspected to determine presence of protected species and other native fishes >75 mm total length (TL). Length of each native fish found (protected and >75 mm TL) was determined, recorded, and specimen released. All other specimens were fixed in 10% formalin and returned to laboratory. Length and width of each seine haul was delimited with surveyor flags. Following specimen collection, seined area of each sampled mesohabitat was determined and recorded. Retained specimens were

identified and enumerated in the laboratory. Total length was determined for all retained specimens, except collections having more than 250 specimens of a species. For these collections, lengths were obtained for a sub-sample (at least 200 specimens). Personnel of UNM-MSB, Division of Fishes, verified identification of retained protected species. All retained specimens were accessioned to the NMGF Collection of Fishes.

Attributes of spring and summer discharge were obtained from USGS Water Resources Data, New Mexico (1998 et seq.). Shiprock gauge (#09368000) data were used for all calculations. Spring was 1 March through 30 June and summer was from 1 July through 30 September. Species density data were segregated by Geomorphic Reach (Bliesner and Lamarra 2000). Densities (number of fish per m^2) presented in tables were determined by dividing total number of specimens by total area sampled within a reach. . Shannon-Weiner Diversity Index (H; proportional values transformed to natural log) values were calculated for each Geomorphic Reach each year. Regression analysis was used to compare spring and summer discharge attributes to autumn density of commonly collected secondary and primary channel species from 2000 through 2004. To reduce the effect of disproportionately large values, fish densities were $\log_{10}(x + 1)$ transformed.

Mesohabitats were grouped into four categories based on water velocity. Rapid-velocity mesohabitats included riffle, riffle-plunge, and riffle-run; moderate-velocity included run, mid-channel run, shore run, shoal, and pool-run; slow-velocity included riffle eddy, eddy, and pool; and embayments and isolated pools were grouped with backwaters. Percent of each commonly collected species in a mesohabitat class was plotted alongside percent that mesohabitat was of total area sampled in each geomorphic reach to provide a crude estimate of habitat use patterns of each species.

To plot the abundance of species among years in primary and secondary channels, mean density (average autumn density) of each commonly collected species was calculated by averaging densities of each species from all samples (individual mesohabitats) within a reach. Standard error of density estimate of each species from each reach was standard deviation of mean reach density divided by the square root of the number of samples (number of mesohabitats sampled, not number of sites) within respective reach. Paired t tests were utilized to characterize differences between primary and secondary channel fish densities for the years sampled.

RESULTS

DISCHARGE

2004 was a relatively low run-off year; however, flows were greater than the preceding two years (Table 1). Spring mean daily discharge has not exceeded 5000 cfs since 2001. Since 1998, spring mean daily discharge has not exceeded 10,000 cfs for a single day and exceeded 8,000 cfs only one day in 2001.

Table 1. Mean daily discharge (cubic feet/second; cfs) of San Juan River during spring runoff and attributes of spring discharge, 1998 - 2004. Data from USGS Shiprock gage (#09368000).

	WATER YEAR						
MONTH	98	99	00	01	02	03	04
March	1141	869	941	1033	664	653	1071
April	1425	1087	1652	1384	533	532	1842
May	5250	3175	2311	4781	644	1621	2652
June	3970	5716	2011	4760	433	1243	1836
Mean (cfs) – Mar-June	2947	2712	1729	2989	569	1015	1828
Days Q >3,000 cfs	48	41	18	47	0	9	8
Days Q >5,000 cfs	24	26	1	29	0	0	0
Days Q >8,000 cfs	0	0	0	1	0	0	0
Days Q >10,000 cfs	0	0	0	0	0	0	0

For the past five years (2000-2004), mean daily summer flows have averaged less than 1000 cfs. There have been only four days when summer flows exceeded 5000 cfs, none of these occurred in 2004 (Table 2). Summer flows were much higher in 1999; thirty-one days exceeded 5000 cfs, with average mean daily flow of 4333 cfs for July, August, and September.

Table 2. Mean daily discharge (cubic feet/second; cfs) of San Juan River during summer and attributes of summer discharge, 1998 – 2004. Data from USGS Shiprock gage (#09368000).

	YEAR						
MONTH	98	99	00	01	02	03	04
July	1665	3116	324	690	378	575	585
August	959	5725	602	1132	368	642	398
September	655	4157	649	552	1126	1286	1018
Mean (cfs) – Jul-Sept	1089	4333	525	791	624	829	667
Days Q >5,000 cfs	0	31	0	0	2	2	0
Days Q >4,000 cfs	1	42	0	0	2	3	1
Days Q >3,000 cfs	1	71	0	0	2	3	1
Days Q >2,000 cfs	11	89	0	5	3	3	6
Days Q >1,000 cfs	37	92	1	18	7	13	11
Days Q <1,000 cfs	55	0	91	74	85	79	80
Days Q <750 cfs	42	0	80	59	79	67	70
Days Q <500 cfs	15	0	45	23	74	44	49
Number Q spikes	4	1	1	1	1	4	1
Spike duration (days)	37	92	7	18	13	12	4
Spike mean (cfs)	1802	4333	850	1596	2130	2645	2988

PRIMARY CHANNEL FISHES

In 2004, four native and nine nonnative fish species were collected in the primary channel (Table 3). Native speckled dace, bluehead sucker, and flannelmouth sucker were captured in all years since 1998, roundtail chub was found in 1998 and 1999, and mottled sculpin in 1999. Colorado pikeminnow was collected in 2004, its first occurrence in small-bodied primary channel sampling since 1998. Native razorback sucker has not been collected during primary channel small-bodied fish sampling. Nonnative red shiner, fathead minnow, and channel catfish were collected in all years. Plains killifish and western mosquitofish were found in all years, except 1999. Other nonnative fish species (largemouth bass, green sunfish, black bullhead, and common carp) were collected in one-half, or fewer, of years since 1998; all were collected in 2004.

Table 3. Occurrence of small-bodied fishes in San Juan River primary channel during autumn, 1998-2004. I = introduced and N = native. Six-letter code derived from first three letters of genus and second three from species.

COMMON	SCIENTIFIC	CODE	STATUS	1998	1999	2000	2001	2002	2003	2004
Common carp	*Cyprinus carpio*	CYPCAR	I		X	X		X		X
Red shiner	*Cyprinella lutrensis*	CYPLUT	I	X	X	X	X	X	X	X
Roundtail chub	*Gila robusta*	GILROB	N	X	X					
Fathead minnow	*Pimephales promelas*	PIMPRO	I	X	X	X	X	X	X	X
Colorado pikeminnow	*Ptychocheilus lucius*	PTYLUC	N	X						X
Speckled dace	*Rhinichthys osculus*	RHIOSC	N	X	X	X	X	X	X	X
Bluehead sucker	*Catostomus discobolus*	CATDIS	N	X	X	X	X	X	X	X
Flannelmouth sucker	*Catostomus latipinnis*	CATLAT	N	X	X	X	X	X	X	X
Flannelmouth x bluehead	*C. lattipinnis* x *C. discobolus*	LATDIS			X				X	
Black bullhead	*Ameiurus melas*	AMEMEL	I					X		X
Channel catfish	*Ictalurus punctatus*	ICTPUN	I	X	X	X	X	X	X	X
Plains killifish	*Fundulus zebrinus*	FUNZEB	I	X		X	X	X	X	X
Western mosquitofish	*Gambusia affinis*	GAMAFF	I	X		X	X	X	X	X
Green sunfish	*Lepomis cyanellus*	LEPCYA	I		X				X	X
Largemouth bass	*Micropterus salmoides*	MICSAL	I				X			X
Mottled sculpin	*Cottus bairdi*	COTBAI	N		X					
NATIVE			6	5	5	3	3	3	3	4
NONNATIVE			9	5	5	6	6	7	6	9

Red shiner has been consistently the most commonly collected species in small-bodied sampling in the primary channel of the San Juan, usually comprising over half of fishes collected (Table 4). Speckled dace has been the most abundant native species in collections. Fathead minnow and channel catfish have been commonly collected, ranking

3rd and 4th in abundance in 2004. Bluehead and flannelmouth suckers were not as commonly collected as speckled dace, but have been found in all years since 1998.

Table 4. Fishes collected in San Juan River primary channel during autumn inventories, 1998 – 2004. Geomorphic Reaches 6 and 1 not sampled in 1998.

1998		1999		2000		2001		2002		2003		2004	
Species	N	Species	N	Species	N	Species	N	Species	N	Species	N	Species	N
CYPLUT	590	CYPLUT	1071	CYPLUT	20114	CYPLUT	3102	CYPLUT	7124	CYPLUT	1715	CYPLUT	9924
RHIOSC	461	RHIOSC	395	GAMAFF	1025	RHIOSC	342	PIMPRO	1116	RHIOSC	511	RHIOSC	4690
ICTPUN	187	PIMPRO	48	PIMPRO	1490	PIMPRO	136	RHIOSC	533	ICTPUN	366	PIMPRO	1119
PIMPRO	32	CATLAT	8	RHIOSC	161	GAMAFF	59	ICTPUN	231	CATLAT	142	ICTPUN	597
CATLAT	8	ICTPUN	8	CATLAT	33	CATLAT	20	GAMAFF	165	PIMPRO	90	CATDIS	284
PTYLUC	4	GAMAFF	6	ICTPUN	35	CATDIS	8	CATLAT	141	GAMAFF	37	CATLAT	254
CATDIS	5	CATDIS	3	CATDIS	18	ICTPUN	13	CATDIS	61	CATDIS	28	GAMAFF	129
GAMAFF	2	CYPCAR	1	CYPCAR	8	FUNZEB	3	CYPCAR	23	FUNZEB	21	FUNZEB	29
GILROB	1	GILROB	1	FUNZEB	3	CYPCAR	1	FUNZEB	15	LEPCYA	2	CYPCAR	6
FUNZEB	1	LATDIS	1			MICSAL	1	AMEMEL	4	LATDIS	1	MICSAL	4
		LEPCYA	1									PTYLUC	4
		COTBAI	1									AMEMEL	2
												LEPCYA	1
TOT N	1291		1544		22887		3685		9413		2913		17042
AREA	1601		4883		4510		3091		3564		3935		8096
DENSITY	0.81		0.32		5.07		1.19		2.64		0.74		2.19

Over 8000 m^2 of primary channel habitat was sampled in 2004 in reaches 6 through 1. This area was comprised of thirteen mesohabitats, with moderate-velocity shore run habitats representing nearly one fourth of the area sampled (Table 5). Rapid-velocity habitats (riffle, riffle plunge, and riffle run) accounted for 24% of the total area. Moderate-velocity habitats (run, mid-channel run, shore run, shore, and pool run) made up over 60%, and slow-velocity mesohabitats (riffle eddy, eddy pool, and pools) comprised only 5.5% of the sampled area. Backwaters and embayments accounted for just under 10% of the sampled area in 2004.

Table 5. Mesohabitat area sampled in San Juan River primary channel during autumn 2004 monitoring. Mesohabitats are arranged from rapid (left) to slow (right) water velocity.

			Mesohabitat													
			Rapid Velocity				Moderate Velocity			Slow Velocity				Backwater		
Reach	Reach Length (km)	Total area (m^2)	Riffle	Riffle plunge	Riffle run	Run	Mid channel run	Shore run	Shoal	Pool run	Riffle eddy	Eddy	Pool	Embayment	Backwater	Isolated pool
6	40	1106	235.12	0	13.2	108	41.36	408.82	195	0	48.1	40.48	0	16	0	0
5	38.4	1352	201.5	17.25	239.72	262.72	45.1	282.64	175.08	0	31.4	15.4	4.4	19.46	57.2	0
4	38.4	1563	209.06	17.82	238.24	21	62.7	455.6	440.96	0	34.98	23.24	0	45.32	13.64	0
3	62.4	2363	347.46	17.16	143.46	388.89	90.2	223.3	526.68	15.18	121.44	23.32	10.8	185.68	269.06	0
2	81.6	1436	97.82	10.12	137.72	9.9	93.5	458.72	383.46	10.56	63.8	12.54	7.92	134.21	15.4	0
1	27.2	276	0	15.4	0	26.4	8.8	124.08	63.8	0	0	0	8.8	0	28.6	0
	Habitat Percent		13.5%	1.0%	9.5%	10.1%	4.2%	24.1%	22.1%	0.3%	3.7%	1.4%	0.4%	4.9%	4.7%	0.0%

SECONDARY CHANNELS

The fish species found in secondary channels in 2004 were much the same as found in the primary channel(Table 6). Four native species (specked dace, flannelmouth sucker, bluehead sucker, and Colorado pikeminnow) were collected. Colorado pikeminnow had not been collected in secondary channel habitats since 2000. Native roundtail chub and mottled sculpin have not been collected since 1999. Nine nonnative species were collected in secondary channels in 2004. Six of these, red shiner, common carp, fathead minnow, channel catfish, western mosquitofish, and plains killifish have been collected consistently for the past five years. Largemouth bass and black bullhead have been collected four out of the last five years.

For the past five years, red shiner and fathead minnow have been the most commonly collected fishes in secondary channels of the San Juan River (Table 7). Red shiner represented over 50% of fishes collected in secondary channels in 2004. Specked dace has been the most commonly collected native species in secondary channels. Three species (red shiner, fathead minnow, and specked dace) have comprised over 90% of fishes collected in all years, except 2003 when they comprised 88% of fishes collected. In 2004, the next four most-commonly collected species (western mosquitofish, bluehead sucker, flannelmouth sucker, and channel catfish) comprised less than 5% of the fishes collected.

Table 6. Occurrence of fishes in San Juan River secondary channels during autumn inventories, 1998 – 2004. N = native and I = nonnative. Six-letter code derived from first three letters of genus and species of each taxon.

COMMON	SCIENTIFIC	CODE	STATUS	1998	1999	2000	2001	2002	2003	2004
Red shiner	*Cyprinella lutrensis*	CYPLUT	I	X	X	X	X	X	X	X
Common carp	*Cyprinus carpio*	CYPCAR	I	X		X	X	X	X	X
Roundtail chub	*Gila robusta*	GILROB	N	X	X					
Fathead minnow	*Pimephales promelas*	PIMPRO	I	X	X	X	X	X	X	X
Colorado pikeminnow	*Ptychocheilus lucius*	PTYLUC	N	X	X	X				X
Speckled dace	*Rhinichthys osculus*	RHIOSC	N	X	X	X	X	X	X	X
Flannelmouth sucker	*Catostomus latipinnis*	CATLAT	N	X	X	X	X	X	X	X
Bluehead sucker	*Catostomus discobolus*	CATDIS	N	X	X	X	X	X	X	X
Rainbow trout	*Oncorhynchus mykiss*	ONCMYK	I				X			
Black bullhead	*Ameiurus melas*	AMEMEL	I	X			X	X	X	X
Yellow bullhead	*Ameiurus natilis*	AMENAT	I	X			X			
Channel catfish	*Ictalurus punctatus*	ICTPUN	I	X	X	X	X	X	X	X
Plains killifish	*Fundulus zebrinus*	FUNZEB	I	X		X	X	X	X	X
Western mosquitofish	*Gambusia affinis*	GAMAFF	I	X	X	X	X	X	X	X
Green sunfish	*Lepomis cyanellus*	LEPCYA	I	X	X					X
Largemouth bass	*Micropterus salmoides*	MICSAL	I			X	X		X	X
Mottled sculpin	*Cottus bairdi*	COTBAI	N		X					
NATIVE				6	5	5	6	4	3	3	4
NONNATIVE				11	8	9	5	7	10	7	9

Table 7. Fishes collected in San Juan River secondary channels during autumn sampling 1998 – 2004.

1998		1999		2000		2001		2002		2003		2004	
Species	N	Species	N	Species	N	Species	N	Species	N	Species	N	Species	N
CYPLUT	741	CYPLUT	272	CYPLUT	11135	CYPLUT	1847	CYPLUT	6424	CYPLUT	1627	CYPLUT	7080
RHIOSC	597	RHIOSC	114	PIMPRO	1503	PIMPRO	226	PIMPRO	1781	PIMPRO	310	PIMPRO	2127
PIMPRO	162	PIMPRO	20	GAMAFF	1314	RHIOSC	193	GAMAFF	470	RHIOSC	232	RHIOSC	1351
ICTPUN	138	CATDIS	4	CYPCAR	309	GAMAFF	113	RHIOSC	224	CATLAT	153	GAMAFF	133
GAMAFF	113	CATLAT	4	RHIOSC	158	CATLAT	27	CATLAT	99	ICTPUN	65	CATDIS	122
CATLAT	13	ICTPUN	4	CATLAT	45	ICTPUN	20	FUNZEB	60	GAMAFF	32	CATLAT	122
FUNZEB	4	GAMAFF	3	ICTPUN	27	FUNZEB	19	CATDIS	53	CATDIS	24	ICTPUN	115
CYPCAR	2	COTBAI	2	CATDIS	17	CATDIS	11	ICTPUN	37	FUNZEB	11	FUNZEB	32
GILROB	2	GILROB	1	MICSAL	9	AMEMEL	3	CYPCAR	27	AMEMEL	7	CYPCAR	10
CATDIS	2	PTYLUC	1	FUNZEB	5	CYPCAR	2	AMEMEL	8	CYPCAR	2	AMEMEL	6
AMENAT	2	LEPCYA	1	PTYLUC	3	AMENAT	1			MICSAL	1	MICSAL	6
PTYLUC	1					ONCMYK	1					PTYLUC	4
LEPCYA	1					MICSAL	1					LEPCYA	1
TOT N	1178		426		14508		2464		9183		2464		11109
AREA	1904		1356		1914		1346		1468		1480		1802
DENSITY	0.934		0.315		7.58		1.831		6.255		1.665		6.165

A total of 1781 m^2 were sampled in thirteen mesohabitat types in San Juan River secondary channels in 2004 (Table 8). Rapid-velocity mesohabitats (riffle, riffle plunge, and riffle run) were 18.4% of those sampled, moderate-velocity mesohabitats (run, mid channel run, shore run, shoal, and pool run) accounted for 63%, slow-velocity mesohabitats (riffle eddy, eddy pool, and pool) accounted for 14.3%, and backwaters and embayments were 3.5%. Shore run habitats made up 27.6% of the sampled habitat.

Table 8. Mesohabitats (percent of total habitat sampled in respective reach) sampled in San Juan River secondary channel during autumn 2004 monitoring. Mesohabitats are arranged from rapid (left) to slow (right) water velocity.

			Mesohabitat												
			Rapid Velocity				Moderate Velocity				Slow Velocity			Backwater	
Reach	Number of secondaries	Total area (m^2)	Riffle	Riffle plunge	Riffle run	Run	Mid channel run	Shore run	Shoal	Pool run	Riffle eddy	Eddy	Pool	Embayment	Backwater
6	8	186	50.86	4	18.7	7.8		29.6			13.2	38.72	3.3		20.1
5	9	258	10	10.2		13.2	33	75.2	50.6			51.81	11	3	
4	5	763	71.66			44	160.2	264.6	44.88	39.6	21.31	46.86	29.7	6	34.52
3	3	574	61.38	15	87.5	28.8	182.4	123.4	22.44	12	33.88		7.4		
	Habitat Percent		10.8%	1.64%	6.0%	5.2%	21.0%	27.6%	6.6%	2.9%	3.8%	7.7%	2.8%	0.5%	3.0%

BACKWATER FISHES

A total of 291 m^2 of backwater and embayment habitat was sampled in 2004. Three native and 6 nonnative species were collected in large San Juan backwaters (≥50 m^2) and embayments (Table 9). Data from small backwaters (<50 m^2) within primary and secondary channel sample sites are reported with those efforts. Native speckled dace, flannelmouth sucker, and bluehead sucker have been found consistently for the past five years in backwaters. Colorado pikeminnow has not been collected in backwater sampling since 2000. Nonnative red shiner, fathead minnow, western mosquitofish, and channel catfish were found in all years. Other nonnative fish species were found less frequently. Red shiner was the most common species and fathead minnow was second-most common in backwaters in all years (Table 10). Native fish species were typically uncommon in backwaters, comprising less than 2% of fishes collected.

Table 9. Occurrence of fishes in San Juan River backwaters during autumn inventories, 1999 – 2004. N = native and I = nonnative. Six-letter code derived from first three letters of genus and species of each taxon.

COMMON	SCIENTIFIC	CODE	STATUS	1999	2000	2001	2002	2003	2004
Red shiner	*Cyprinella lutrensis*	CYPLUT	I	X	X	X	X	X	X
Common carp	*Cyprinus carpio*	CYPCAR	I		X	X	X		X
Fathead minnow	*Pimehales promelas*	PIMPRO	I	X	X	X	X	X	X
Colorado pikeminnow	*Ptychocheilus lucius*	PTYLUC	N	X	X				
Speckled dace	*Rhinichthys osculus*	RHIOSC	N	X	X	X	X	X	X
Flannelmouth sucker	*Catostomus latipinnis*	CATLAT	N	X	X	X	X	X	X
Bluehead sucker	*Catostomus discobolus*	CATDIS	N		X	X	X	X	X
Black bullhead	*Ameiurus melas*	AMEMEL	I		X	X	X	X	
Channel catfish	*Ictalurus punctatus*	ICTPUN	I	X	X	X	X	X	X
Plains killifish	*Fundulus zebrinus*	FUNZEB	I		X	X	X		X
Western mosquitofish	*Gambusia affinis*	GAMAFF	I		X	X	X	X	X
Green sunfish	*Lepomis cyanellus*	LEPCYA	I			X	X	X	
Bluegill	*Lepomis macrochirus*	LEPMAC	I		X				
Largemouth bass	*Micropterus salmoides*	MICSAL	I		X				
NATIVE			4	3	4	3	3	3	3
NONNATIVE			10	3	9	9	7	6	6

Table 10. Fishes collected in San Juan River backwaters during autumn inventories, 2000 – 2004.

1999		2000		2001		2002		2003		2004	
Species	1999	Species	N	Species	N	Species	N	Species	N	Species	N
Species	N	CYPLUT	23898	CYPLUT	4408	CYPLUT	4453	CYPLUT	309	CYPLUT	1031
CYPLUT	438	PIMPRO	878	PIMPRO	401	PIMPRO	1634	PIMPRO	129	PIMPRO	319
PIMPRO	10	GAMAFF	659	CATDIS	71	GAMAFF	132	GAMAFF	17	FUNZEB	24
RHIOSC	8	AMEMEL	106	GAMAFF	39	CYPCAR	35	AMEMEL	12	GAMAFF	15
ICTPUN	2	ICTPUN	44	RHIOSC	19	RHIOSC	37	ICTPUN	10	ICTPUN	10
PTYLUC	1	CYPCAR	46	CATLAT	6	ICTPUN	40	CATLAT	6	RHIOSC	10
		CATLAT	33	CYPCAR	4	AMEMEL	14	CATDIS	3	CYPCAR	3
		CATDIS	27	ICTPUN	4	CATLAT	22	RHIOSC	3	CATDIS	2
		MICSAL	24	FUNZEB	3	CATDIS	5	LEPCYA	1	CATLAT	1
		RHIOSC	5	AMEMEL	3	FUNZEB	9				
		FUNZEB	3	LEPCYA	1	LEPCYA	3				
		LEPMAC	2								
		PTYLUC	1								
N	459		25727		4957		6385		490		1415
Area	242		1576		607		559		313		271
Density	1.897		16.324		4.855		11.422		1.565		5.21

REACH 6—PRIMARY CHANNEL

Eleven species were collected in the primary channel in Reach 6 in 2004, the most in five years (Table 11). Largemouth bass and green sunfish were collected, neither of which had been collected in Reach 6 for the past 5 years. Density of fishes in 2004 was higher than in any of the past 4 years, but only half the density collected in 2000. Red shiner and speckled dace were the most commonly collected species in 2004, comprising nearly 90% of fishes collected. No Colorado pikeminnow or razorback sucker was collected in Reach 6 primary channel in 2004.

There were few correlations of stream flow attributes and autumn density estimates for the past five years (Table 12). There was a significant negative relationship between density of nonnative fishes and red shiner density with mean daily summer discharge. Species diversity was lower in 2004 than in the previous three years (Figure 1). The relative abundance of native as compared to nonnative species was closer in 2004 than in the previous 4 years. The only year that relative abundance of native species exceeded that of nonnatives in Reach 6 was 2003.

Of the 1064 m^2 of habitat sampled in Reach 6 primary channel, nearly 70% was moderate velocity. In 2004, each commonly collected species was most frequently collected in the most commonly available mesohabitat (Figure 2).

Table 11. Number and density (number/m^2) of fishes in San Juan River primary channel in Geomorphic Reach 6 during autumn, 2000– 2004.

2000			2001			2002			2003			2004		
SPECIES	N	DENSITY	SPECIES	N	DENSITY	SPECIES	N	DENSITY	SPECIES	N	DENSITY	SPECIES	N	DENSITY
CYPLUT	2058	7.221	PIMPRO	51	0.108	CYPLUT	316	0.704	RHIOSC	123	0.302	CYPLUT	2530	2.377
GAMAFF	202	0.712	RHIOSC	48	0.102	PIMPRO	229	0.510	CATLAT	101	0.248	RHIOSC	1914	1.798
PIMPRO	38	0.133	CYPLUT	35	0.074	CATLAT	74	0.164	CYPLUT	55	0.136	PIMPRO	238	0.224
RHIOSC	2	0.007	GAMAFF	26	0.055	GAMAFF	40	0.089	CATDIS	21	0.052	CATLAT	117	0.110
CATLAT	2	0.007	CATLAT	12	0.026	CATDIS	35	0.078	GAMAFF	19	0.047	CATDIS	94	0.088
CATDIS	1	0.004	CATDIS	5	0.011	RHIOSC	33	0.073	PIMPRO	14	0.034	GAMAFF	43	0.040
FUNZEB	1	0.004	CYPCAR	1	0.002	FUNZEB	5	0.011				MICSAL	3	0.003
			FUNZEB	1	0.002							FUNZEB	2	0.002
												ICTPUN	2	0.002
												CYPCAR	1	0.001
												LEPCYA	1	0.001
TOTAL N	2304			179			732			333			4945	
AREA	285			471			449			407.2			1064	
DENSITY	8.084			0.380			1.786			0.818			4.64	
H	0.401			1.649			1.435			1.498			1.076	

Table 12. Regression analysis results for density of commonly collected native and non-native fish species in San Juan River Reach 6 primary channel (2000-2004) versus average mean daily spring discharge, average mean daily summer discharge, and days mean daily summer discharge less than 500 cfs. *indicates significant relationships at α = 0.05.

	SPRING Q		SUMMER Q		<500 CFS	
	R	*p*	R	*p*	R	*p*
NATIVES	-0.070	0.911	0.130	0.835	0.141	0.821
CATDIS	-0.580	0.306	0.068	0.914	0.668	0.217
CATLAT	-0.730	0.162	0.481	0.412	0.466	0.429
RHIOSC	0.068	0.914	0.101	0.872	0.027	0.966
NONNATIVES	-0.048	0.935	-0.920*	0.029	0.197	0.750
CYPLUT	-0.038	0.967	-0.880*	0.049	0.169	0.786
GAMAFF	0.023	0.971	-0.760	0.138	-0.010	0.990
PIMPRO	-0.530	0.355	-0.450	0.452	0.839	0.075

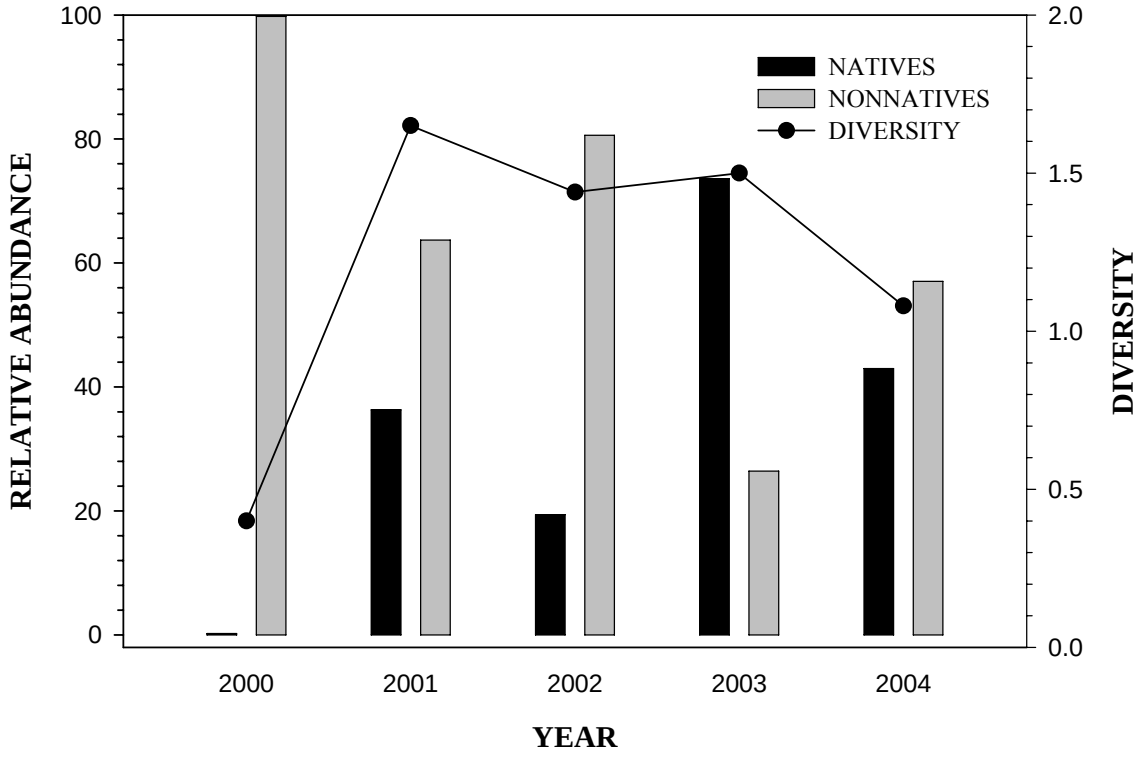

Figure 1. Relative abundance of native and nonnative fishes and assemblage diversity in the primary channel of Reach 6, San Juan River, 2000 – 2004.

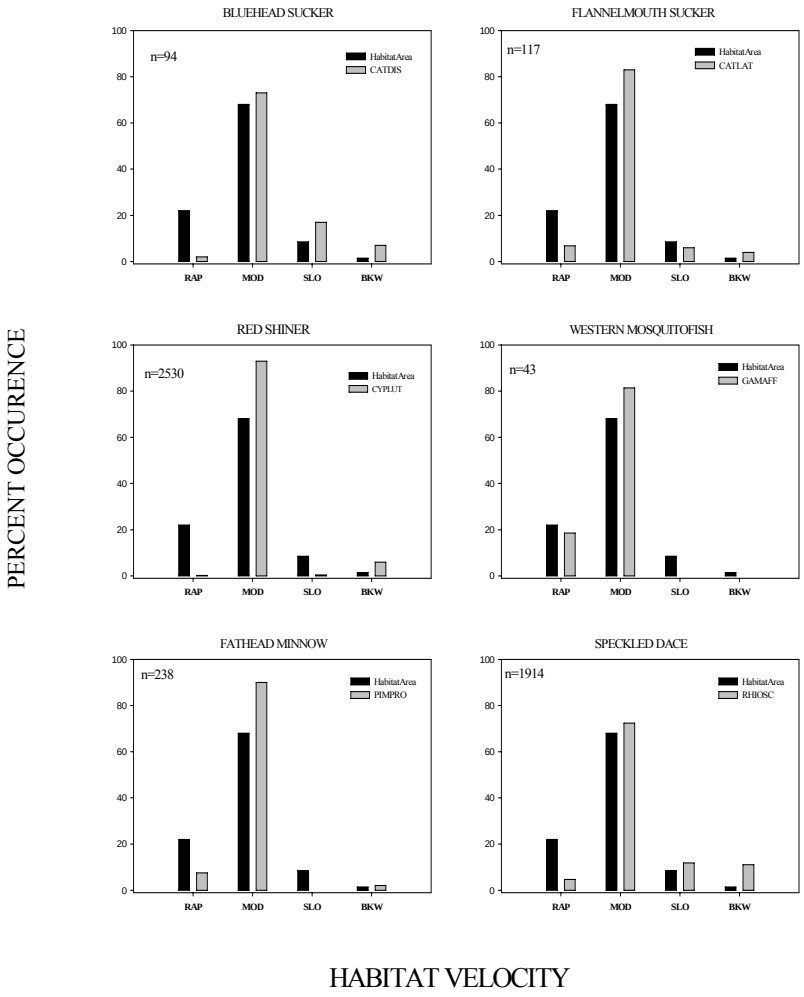

Figure 2. Occurrence of commonly collected fishes in Reach 6 primary channel mesohabitats, San Juan River, 2004.

REACH 6—SECONDARY CHANNELS

Nine species were collected in Reach 6 secondary channels in 2004. Fathead minnow was the most commonly collected species and speckled dace were the second most common (Table 13). Native species (speckled dace, bluehead sucker, and flannelmouth sucker) comprised nearly 30% of the collections.

Table 13. Number and density (number/m^2) of fishes in San Juan River secondary channels in Geomorphic Reach 6 (RM 180 – RM 155) during autumn 2000-2004.

2000			2001			2002			2003			2004		
Species	N	Density	Species	N	Density	Species	N	Density	Species	N	Density	Species	N	Density
GAMAFF	87	0.713	GAMAFF	25	0.073	PIMPRO	415	4.428	CYPLUT	570	2.421	PIMPRO	638	3.426
CYPLUT	58	0.475	RHIOSC	20	0.058	GAMAFF	269	2.892	CATLAT	100	0.425	RHIOSC	279	1.498
CYPCAR	9	0.074	CYPLUT	19	0.056	CYPLUT	246	2.631	RHIOSC	64	0.272	CYPLUT	269	1.445
PIMPRO	5	0.041	PIMPRO	18	0.053	FUNZEB	36	0.387	PIMPRO	54	0.229	CATDIS	52	0.279
MICSAL	4	0.033	CATDIS	9	0.026	CATLAT	29	0.312	GAMAFF	21	0.089	CATLAT	51	0.274
RHIOSC	2	0.016	FUNZEB	2	0.006	CATDIS	27	0.289	CATDIS	19	0.081	GAMAFF	42	0.226
CATLAT	1	0.008	MICSAL	1	0.003	RHIOSC	8	0.086	CYPCAR	2	0.008	FUNZEB	4	0.021
CATDIS	1	0.008	ONCMYK	1	0.003	CYPCAR	5	0.053	MICSAL	1	0.004	MICSAL	4	0.021
												CYPCAR	1	0.005
N	168			94			1035			831			1340	
Area	122			342			93			235.4			186	
Density	1.377			0.275			11.129			3.530			7.204	
H	1.203			1.649			1.434			1.090			1.402	

Autumn density of no commonly collected native species was related to average mean daily spring discharge, average mean daily summer discharge, or days mean daily summer discharge less than 500 cfs (Table 14). Nonnative fish density, however, was positively related to days mean daily summer discharge less than 500 cfs. Red shiner was the only species whose autumn density was related to a discharge attribute (average mean spring daily discharge).

For the past five years of sampling, nonnative relative abundance was always substantially greater than that of native fishes (Figure 3). Assemblage diversity (H) was fairly similar across years. Proportional occurrence of commonly collected native species was similar to that of mesohabitat categories. Nonnative species were most common in slow-velocity habitats (Figure 4).

Table 14. Regression analysis results for density of commonly collected native and non-native fish species in San Juan River Reach 6 secondary channel (2000-2004) versus average mean daily spring discharge, average mean daily summer discharge, and days mean daily summer discharge less than 500 cfs. *indicate significant relationships at $\alpha = 0.05$.

	SPRING Q		SUMMER Q		<500 CFS	
	R	*p*	R	*p*	R	*P*
NATIVES	-0.280	0.261	0.101	0.872	0.350	0.564
CATDIS	-0.523	0.365	-0.145	0.816	0.747	0.147
CATLAT	-0.761	0.135	0.335	0.581	0.573	0.312
RHIOSC	0.021	0.973	0.074	0.906	0.072	0.909
NONNATIVES	-0.800	0.102	-0.256	0.677	0.937*	0.019
CYPLUT	-0.919*	0.026	0.065	0.917	0.789	0.112
GAMAFF	-0.649	0.236	-0.588	0.297	0.866	0.058
PIMPRO	-0.507	0.382	-0.267	0.664	0.781	0.118

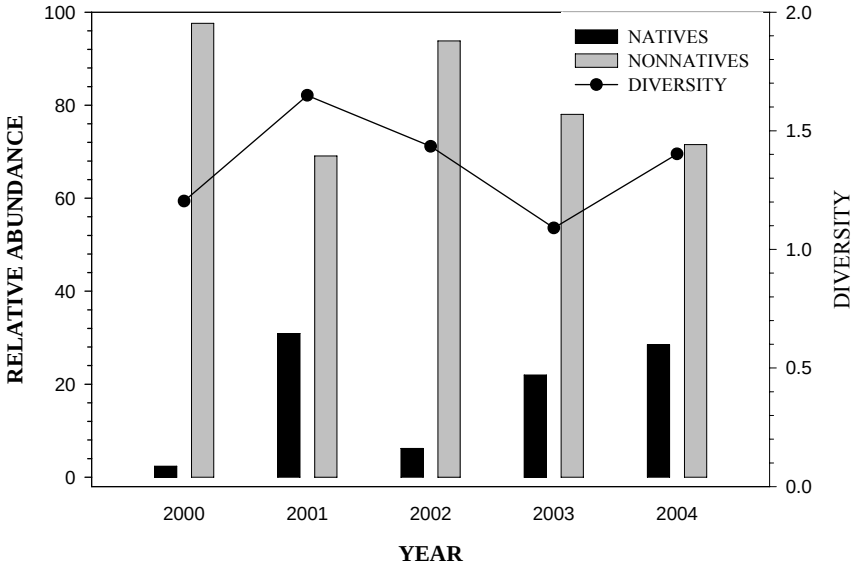

Figure 3. Relative abundance of native and nonnative fishes and assemblage diversity in Reach 6 secondary channels, San Juan River 2000-2004.

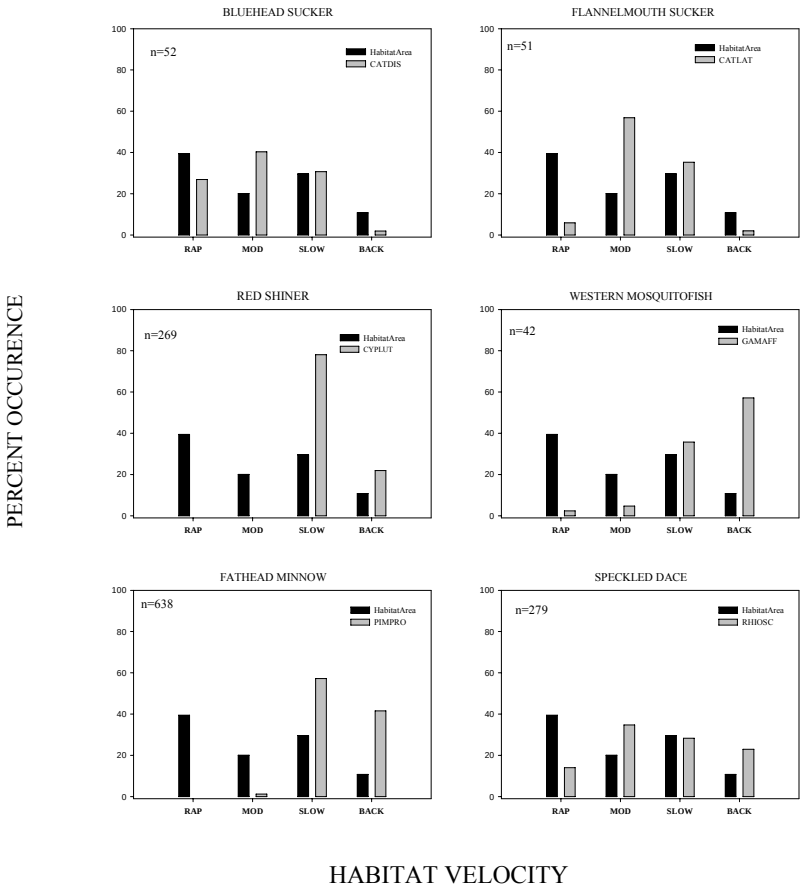

Figure 4. Occurrence of commonly collected fish species in Reach 6 secondary channel mesohabitats, San Juan River, 2004.

BACKWATERS—REACH 6

No backwater was present in Reach 6 in 1999, 2002, or 2004. Nonnative red shiner and fathead minnow were first- and second-most abundant in backwaters, when present (Table 15). Except for 2001, when bluehead sucker was moderately common, native fish species were rare or absent in Reach 6 backwaters.

Table 15. Number and density (number/m^2) of fishes in San Juan River backwaters in Geomorphic Reach 6 (RM 180 – RM 155) during autumn, 1999 – 2004.

1999	2000			2001			2002	2003			2004
	SPECIES	N	DEN	SPECIES	N	DEN		SPECIES	N	DEN	
N							**N**				**N**
O	CYPLUT	481	4.076	CYPLUT	708	23.6	**O**	CYPLUT	10	0.333	**O**
	PIMPRO	162	1.373	PIMPRO	191	6.367		PIMPRO	8	0.267	
B	GAMAFF	66	0.56	CATDIS	70	2.333	**B**	CATLAT	2	0.067	**B**
A	MICSAL	16	0.136	GAMAFF	25	0.833	**A**	GAMAFF	2	0.67	**A**
C	CATDIS	6	0.051	FUNZEB	2	0.067	**C**				**C**
K	CYPCAR	5	0.042	CYPCAR	1	0.033	**K**				**K**
W	RHIOSC	2	0.017	RHIOSC	1	0.033	**W**				**W**
A	CATLAT	2	0.017	CATLAT	1	0.033	**A**				**A**
T	FUNZEB	2	0.017	AMEMEL	1	0.033	**T**				**T**
E							**E**				**E**
R							**R**				**R**
S							**S**				**S**
BKWS											
N			3			2				2	
N			741			1001				22	
AREA			118			30				30	
DENSIT			6.28			33.367					
Y										0.733	
H			1.025			0.885				1.162	

REACH 6—PRIMARY AND SECONDARY COMPARISONS

Channel catfish has not been collected in Reach 6 small-bodied fish sampling in five years. Since 2002, density of flannelmouth and bluehead sucker has been greater in secondary channels than the primary, but speckled dace was more common in the primary channel over the same years. The 2004 primary and secondary channel densities of flannelmouth and bluehead suckers were similar to those found in 2002. Speckled dace density (secondary and especially primary) in 2004 was considerably greater than in any preceding year (Figure 5). Commonly collected nonnative fishes were slightly more common in secondary than primary channel in 2004 (Figure 6). Across years, neither

native nor nonnative species densities were significantly different in secondary versus primary channels.

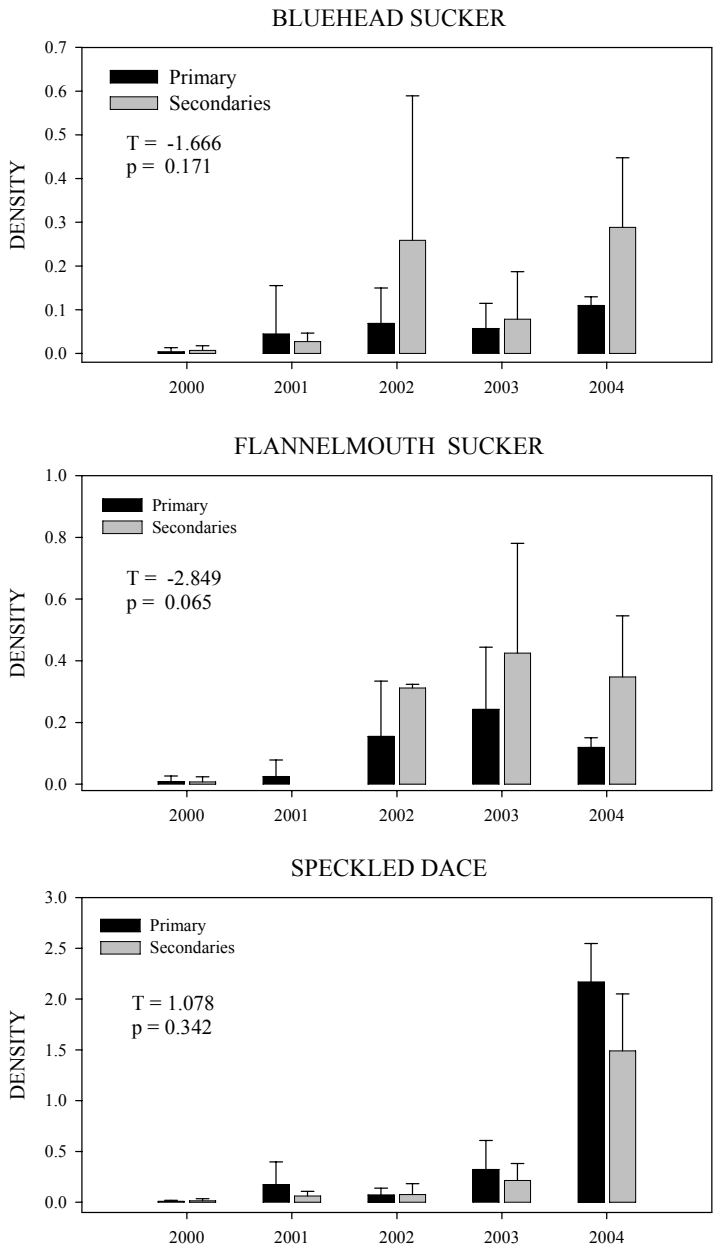

Figure 5. Average autumn densities of commonly collected native fish in primary and secondary channels, Reach 6, San Juan River, 2000-2004. Error bars represent standard error. Paired t tests were performed between primary and secondary channel sample densities.

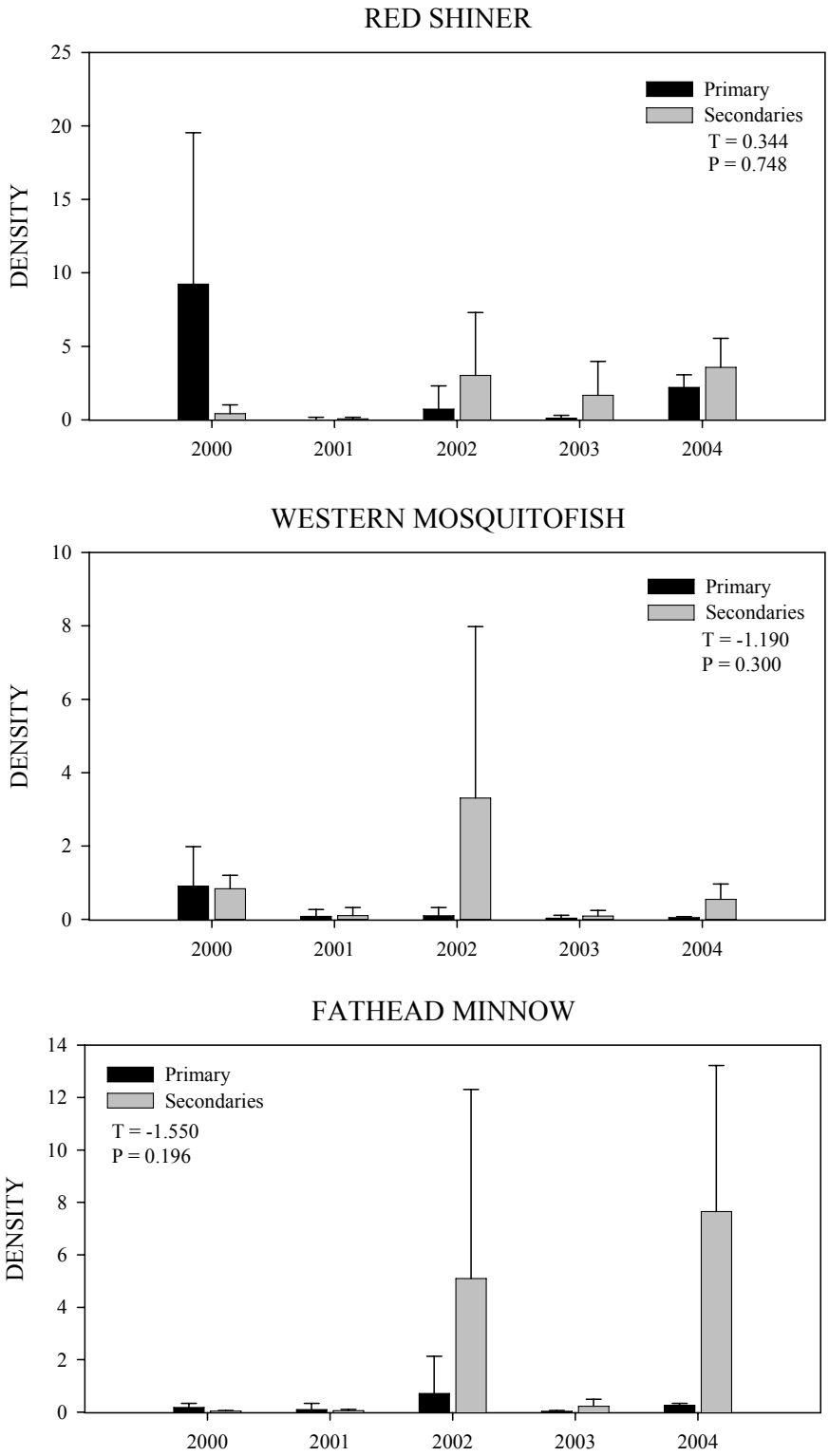

Figure 6. Average autumn densities of commonly collected nonnative fish in primary and secondary channels, Reach 6, San Juan River, 2000-2004. Error bars represent standard error. Paired t tests were performed between primary and secondary channel sample densities.

REACH 5—PRIMARY CHANNEL

Eleven fish species were collected in Reach 5 primary channel in 2004 (Table 16). Native species included speckled dace, bluehead sucker, flannelmouth sucker, as well as Colorado Pikeminnow. Colorado pikeminnow had not been collected since 1998. Red shiner has been the most commonly collected species for the past five years, comprising over 70% of the fishes collected in 2000 through 2003 and 62% in 2004.

As in previous years, relative abundance of nonnative fishes was greater than that of native fishes in 2004 sampling (Figure 7). Relative abundance of native fishes has gradually increased since 2002. Autumn abundance of nonnative fishes, mainly red shiner, was negatively related to summer flow levels (Table 17). No other species displayed significant relationships with flow attributes.

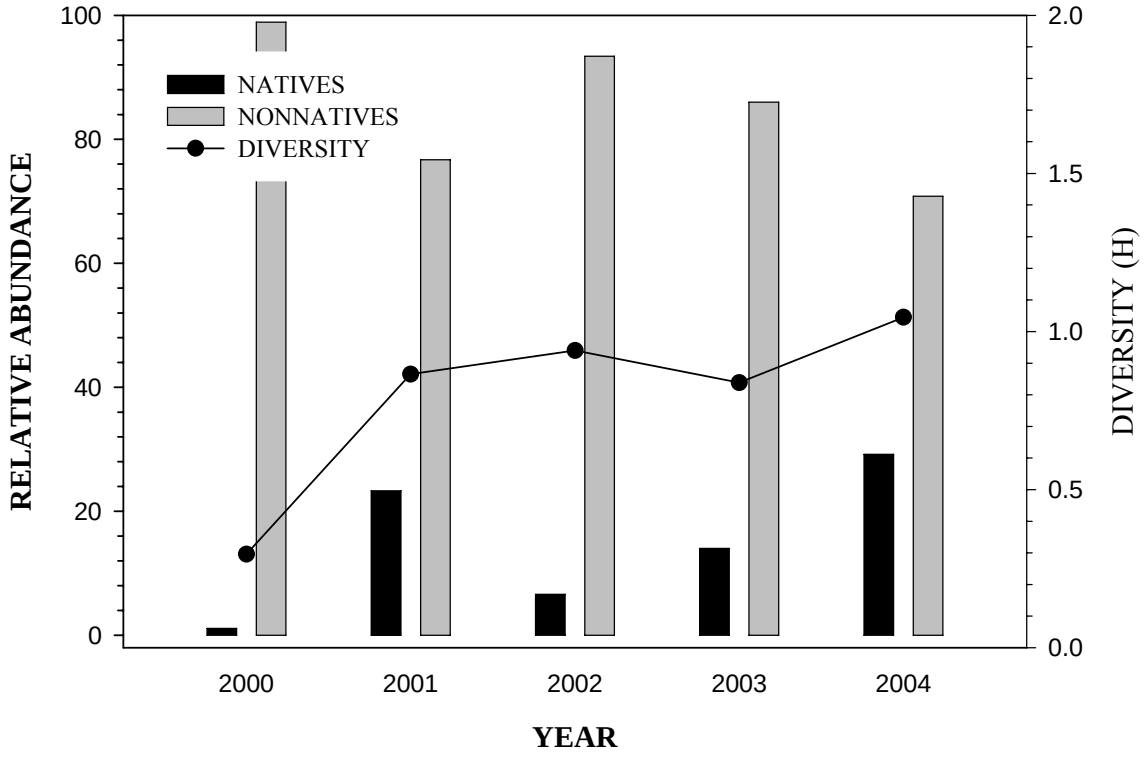

Figure 7. Relative abundance of native and nonnative fishes and assemblage diversity in Reach 5 primary channel, San Juan River, 2000-2004.

Table 16. Number and density (number/m^2) of fishes in San Juan River primary channel in Geomorphic Reach 5 during autumn, 2000 – 2004.

2000			2001			2002			2003			2004		
SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN
CYPLUT	5219	10.522	CYPLUT	376	0.855	CYPLUT	1033	2.311	CYPLUT	363	0.929	CYPLUT	3325	2.522
GAMAFF	250	0.504	RHIOSC	122	0.277	PIMPRO	206	0.461	RHIOSC	49	0.125	RHIOSC	1421	1.078
RHIOSC	44	0.088	PIMPRO	19	0.043	GAMAFF	80	0.179	GAMAFF	15	0.038	PIMPRO	321	0.244
PIMPRO	42	0.085	GAMAFF	14	0.032	RHIOSC	76	0.170	CATLAT	14	0.036	CATDIS	95	0.072
CATLAT	10	0.020	CATDIS	2	0.005	CATDIS	10	0.022	ICTPUN	14	0.036	ICTPUN	84	0.064
CATDIS	6	0.012	ICTPUN	2	0.005	CATLAT	8	0.018	PIMPRO	7	0.018	GAMAFF	44	0.033
FUNZEB	1	0.002	CATLAT	1	0.002	ICTPUN	7	0.016	CATDIS	2	0.006	CATLAT	39	0.030
			MICSAL	1	0.002	CYPCAR	2	0.005				FUNZEB	5	0.004
												CYPCAR	3	0.002
												PTYLUC	3	0.002
												MICSAL	1	0.001
TOTAL N	5572			537			1428			464			5341	
AREA	496			440			447			390.8			1318	
DENSITY	11.234			1.220			3.195			1.187			4.045	
H	0.296			0.865			0.940			0.838			1.045	

Table 17. Regression analysis results for density of commonly collected native and non-native fish species in San Juan River Reach 5 primary channel (2000-2004) versus average mean daily spring discharge, average mean daily summer discharge, and days mean daily summer discharge less than 500 cfs. *indicates significant relationship at $\alpha = 0.05$.

	SPRING Q		SUMMER Q		<500 CFS	
	R	*p*	R	*P*	R	*p*
NATIVES	0.200	0.747	-0.000	0.984	0.009	0.989
CATDIS	-0.050	0.941	-0.250	0.685	0.288	0.638
CATLAT	-0.630	0.253	0.045	0.942	0.374	0.535
RHIOSC	0.256	0.677	0.028	0.964	-0.040	0.955
NONNATIVES	-0.120	0.842	-0.930*	0.023	0.248	0.687
CYPLUT	-0.120	0.851	0.930*	0..023	0.245	0.691
GAMAFF	-0.180	0.778	-0.850	0.067	0.239	0.699
PIMPRO	-0.540	0.344	-0.460	0.431	0.863	0.061

Moderate-velocity mesohabitats represented nearly 60% of those sampled in Reach 5 primary channel (Figure 8). All common fish species were fairly evenly distributed among the mesohabitats in all velocity categories except for western mosquitofish, which was under-represented, proportionally, in moderate-velocity habitats, having a greater likelihood of being sampled in rapid and slow habitats. Fathead minnow was more likely to be found in slow habitats and was rare in rapid-velocity habitats.

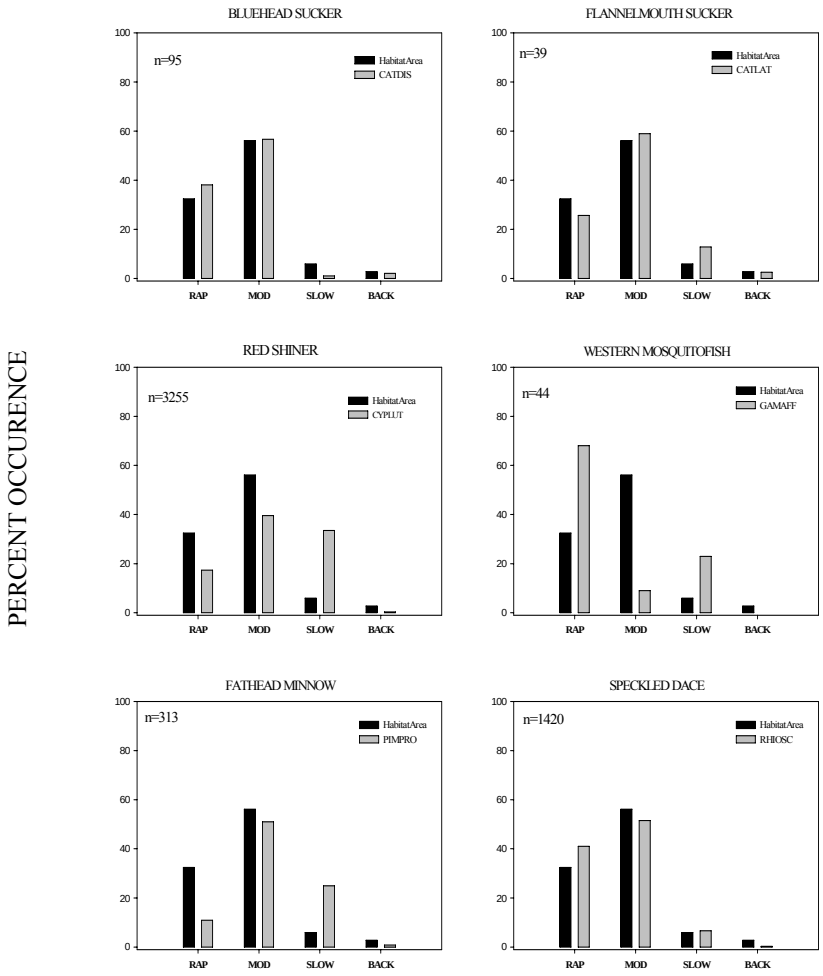

Figure 8. Occurrence of commonly collected fish species in Reach 5 primary channel mesohabitats, San Juan River, 2004.

REACH 5—SECONDARY CHANNELS

Thirteen fish species were collected in Reach 5 secondary channels, including three Colorado pikeminnow (Table 18). This was the first collection of Colorado pikeminnow in Reach 5 secondary channels since 1999. Red shiner was the most commonly collected species, comprising 66% of fishes collected in 2004. Total fish density in 2004 was the highest (10.01/m^2) since 2000, when it was 27.95 fish/m^2.

Table 18. Number and density (number/m^2) of fishes in San Juan River secondary channels in Geomorphic Reach 5 (RM 155 – RM 131) during autumn 2000 - 2004.

2000			2001			2002			2003			2004		
SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN
CYPLUT	8984	22.074	CYPLUT	219	0.619	CYPLUT	2790	6.906	CYPLUT	426	1.410	CYPLUT	1723	6.68
PIMPRO	1352	3.322	PIMPRO	38	0.107	PIMPRO	592	1.465	PIMPRO	143	0.473	PIMPRO	460	1.78
GAMAFF	812	1.995	RHIOSC	35	0.099	GAMAFF	195	0.483	RHIOSC	81	0.268	RHIOSC	319	1.24
CYPCAR	160	0.393	GAMAFF	29	0.082	CATLAT	51	0.126	ICTPUN	6	0.020	GAMAFF	39	0.15
RHIOSC	48	0.118	FUNZEB	2	0.006	RHIOSC	49	0.121	GAMAFF	4	0.013	CATDIS	19	0.07
CATLAT	10	0.025	CATLAT	1	0.003	FUNZEB	16	0.040	CATDIS	3	0.010	CATLAT	15	0.06
CATDIS	8	0.020	ICTPUN	1	0.003	CATDIS	14	0.035	CATLAT	3	0.010	ICTPUN	9	0.03
MICSAL	3	0.007				CYPCAR	11	0.027	FUNZEB	3	0.010	CYPCAR	7	0.03
						AMEMEL	1	0.002				FUNZEB	7	0.03
												PTYLUC	3	0.01
												AMEMEL	2	0.01
												LEPCYA	1	0.00
												MICSAL	1	0.00
TOTAL N	11377		325			3719			669			2605		
AREA	407		354			404			302			258		
DENSITY	27.953		0.918			9.205			2.214			10.097		
H	0.725		1.039			0.842			1.018			1.036		

Relative abundance of natives and nonnatives in 2004 in Reach 5 secondary channels was similar to values in previous years; nonnative fishes outnumbering native fish by 8 to 1 (Figure 9). Species diversity remained relatively constant. Autumn density of nonnative fish species (red shiner, fathead minnow, and western mosquitofish) was significantly, and negatively, related to mean daily summer discharge. Flannelmouth sucker autumn density was positively related to number of days summer flow <500 cfs (Table 19).

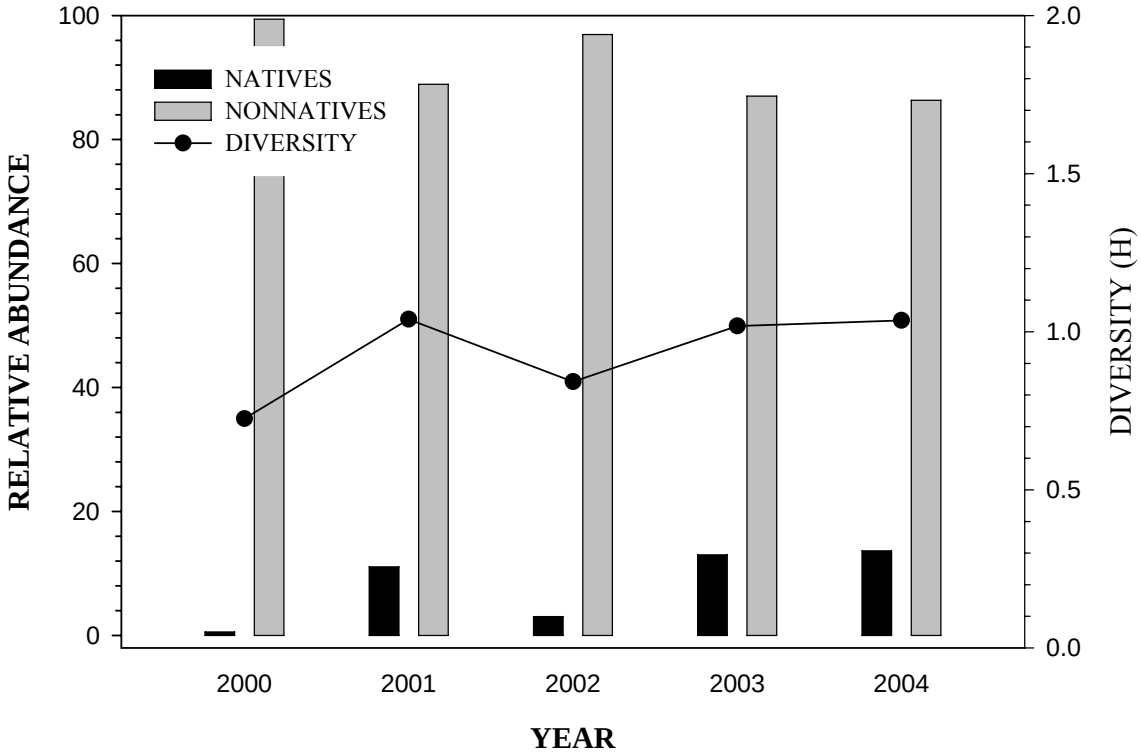

Figure 9. Relative abundance of native and nonnative fishes and assemblage diversity in Reach 5 secondary channels, San Juan River, 2000-2004.

Table 19. Regression analysis results for density of commonly collected native and non-native fish species in San Juan River Reach 5 secondary channel (2000-2004) versus average mean daily spring discharge, average mean daily summer discharge, and days mean daily summer discharge less than 500 cfs. *indicate significant relationships at $\alpha = 0.05$.

	SPRING Q		SUMMER Q		<500 CFS	
	R	*p*	R	*p*	R	*p*
NATIVES	-0.050	0.941	-0.080	0.901	0.195	0.753
CATDIS	-0.280	0.654	-0.410	0.495	0.519	0.370
CATLAT	-0.650	0.238	-0.470	0.429	0.920*	0.027
RHIOSC	0.033	0.957	0.012	0.984	0.068	0.914
NONNATIVES	-0.300	0.622	-0.970*	0.007	0.467	0.428
CYPLUT	-0.340	0.574	-0.960*	0.008	0.513	0.377
GAMAFF	-0.110	0.864	-0.890*	0.045	0.210	0.734
PIMPRO	-0.350	0.563	-0.940*	0.019	0.509	0.382

Distribution of commonly collected species among habitat categories was similar to the proportion of habitats sampled in Reach 5 secondary channels (Figure 10). The most notable exception was western mosquitofish, which was more prevalent in fast-velocity habitats than in slow habitats. Moderate-velocity habitats comprised 56% and rapid velocity comprised 32% of the 258 m^2 of Reach 5 secondary channel habitat sampled in 2004.

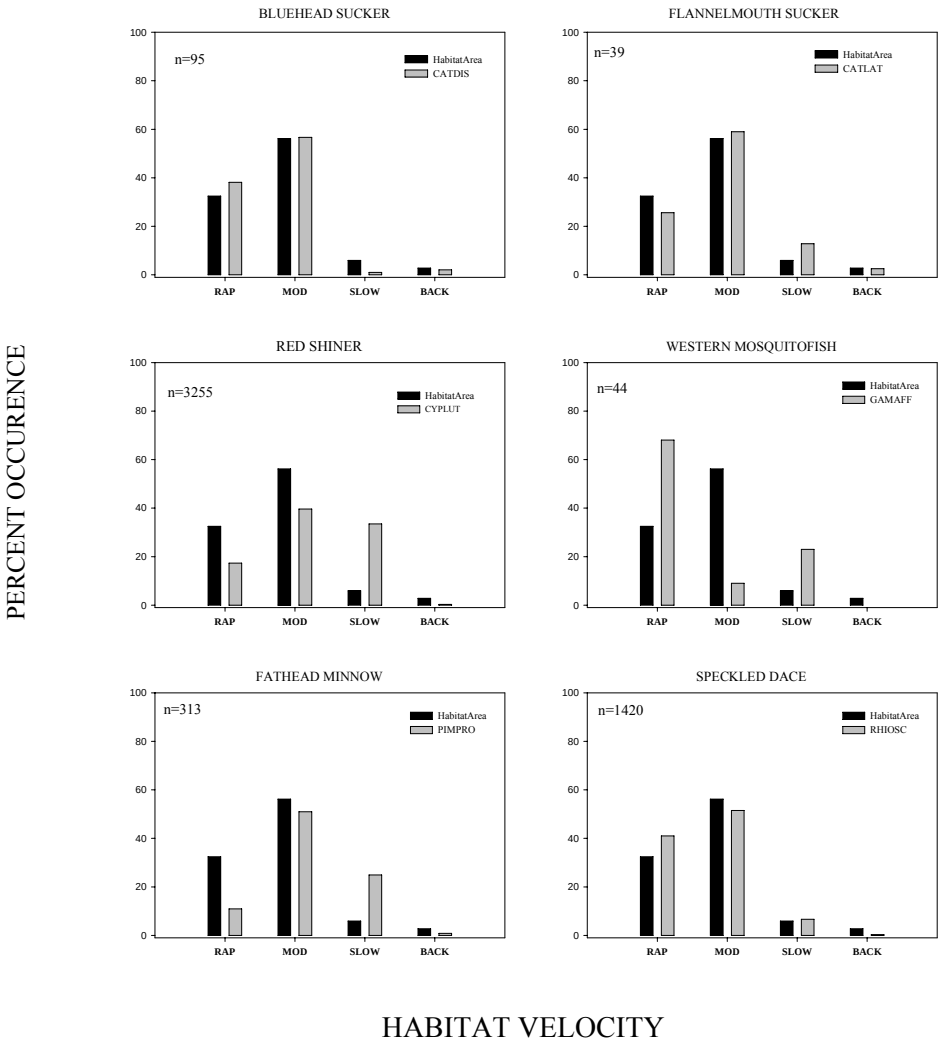

Figure 10. Occurrence of commonly collected fish species in Reach 5 secondary channels, San Juan River, 2004.

REACH 5—BACKWATERS

Only two backwaters were sampled in Reach 5 in 2004. Greatest density of fishes in backwaters occurred in 2000, but was also high in 2002 (Table 20). Red shiner was the most-common species in Reach 5 backwaters in all years, except 2003 when fathead minnow was most common. Other than red shiner, fathead minnow was the only comparatively common species in Reach 5 backwaters. Native fish species were rare or absent.

Table 20. Number and density (number/m^2) of fishes in San Juan River backwaters in Geomorphic Reach 5 (RM 155 – RM 131) during autumn, 2000 – 2004.

2000			2001			2002			2003			2004		
SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN
CYPLUT	4965	15.965	CYPLUT	909	5.476	CYPLUT	875	8.413	PIMPRO	101	0.842	CYPLUT	262	7.005
PIMPRO	274	0.881	PIMPRO	65	0.392	PIMPRO	250	2.404	CYPLUT	98	0.817	PIMPRO	36	0.963
GAMAFF	118	0.379	RHIOSC	3	0.018	GAMAFF	12	0.115	CATLAT	4	0.033	RHIOSC	6	0.160
CATDIS	8	0.026	CATDIS	1	0.006	CATLAT	7	0.010	GAMAFF	4	0.033	GAMAFF	3	0.080
CYPCAR	4	0.013	CATLAT	1	0.006	CATDIS	1	0.010	CATDIS	2	0.017	CATDIS	2	0.053
CATLAT	3	0.010	GAMAFF	1	0.006	CYPCAR	1	0.010	RHIOSC	1	0.008	CYPCAR	2	0.053
RHIOSC	1	0.003	LEPCYA	1	0.006	FUNZEB	1	0.010				ICTPUN	1	0.027
ICTPUN	1	0.003												
MICSAL	1	0.003												
BKWS N	9		6			6			5			2		
N	5375		983			1147			210			312		
AREA	311		166			104			120			37.4		
DENSITY	17.289		3.944			11.058			1.750			8.342		
H	0.333		0.310			0.636			0.928			0.600		

REACH 5—PRIMARY AND SECONDARY CHANNEL COMPARISONS

Average autumn densities of bluehead sucker and speckled dace were greater in both primary and secondary channels in 2004 than in any preceding year since 2000 (Figure 11). Flannelmouth sucker 2004 density was comparable to that found in 2003. Nonnative fish species had similar densities in the primary channel and in secondary channels of Reach 5 in 2004 (Figure 12). Greatest densities of commonly collected nonnatives were in 2000; in subsequent years, nonnative densities were lower, especially in secondary channels.

Six specimens of Colorado pikeminnow were collected in Reach 5 in 2004, three in primary and three in secondary channels. In Reach 5, black bullhead and green sunfish were found only in secondary channels. Red shiner was the most commonly collected fish in both channels, while speckled dace was second-most common in primary channels and fathead minnow was second-most common in secondary.

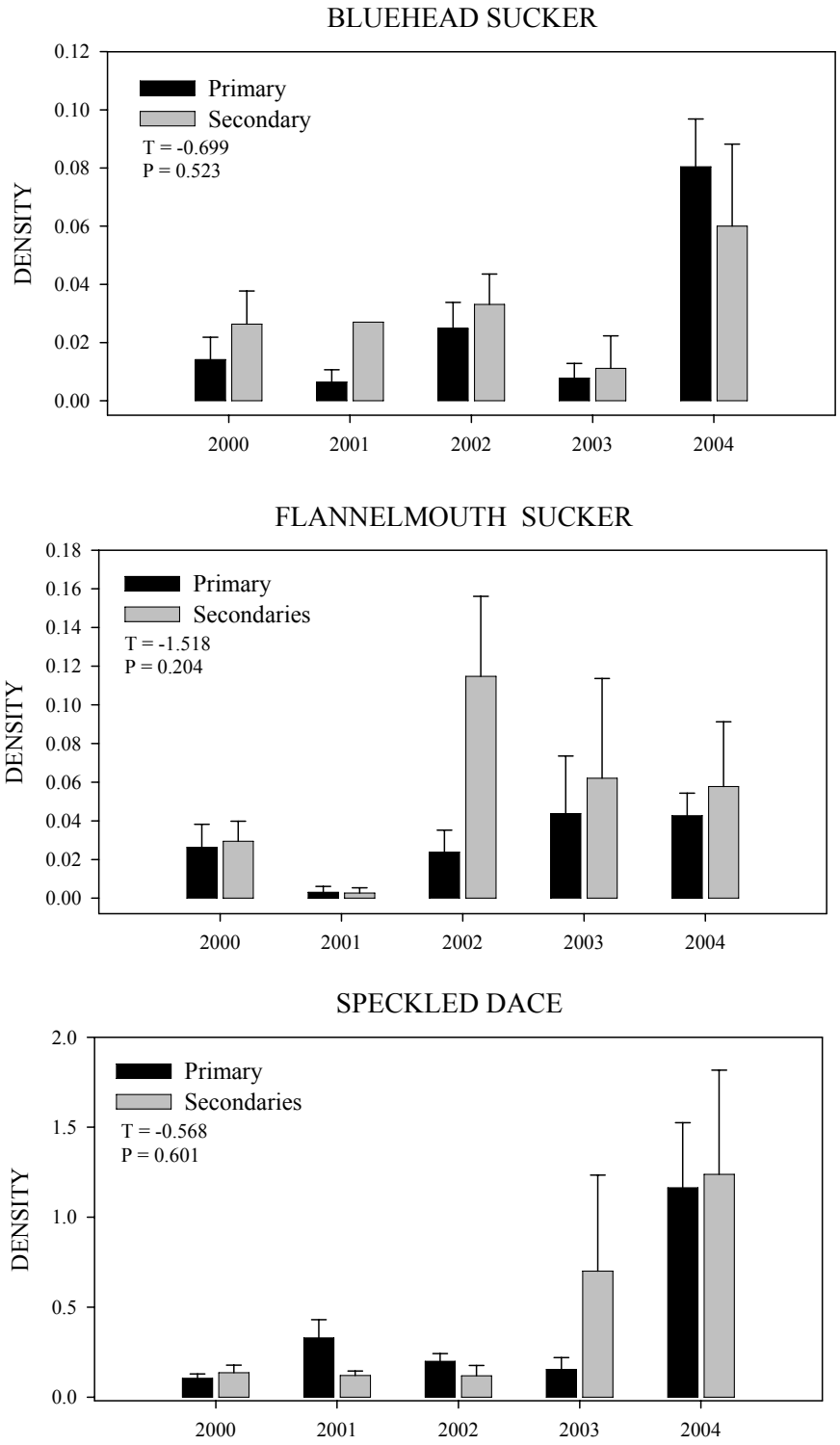

Figure 11. Average autumn densities of commonly collected native fish in primary and secondary channels of Reach 5, San Juan River 2000-2004. Error bars represent standard error. Paired t tests were performed between primary and secondary channel sample densities.

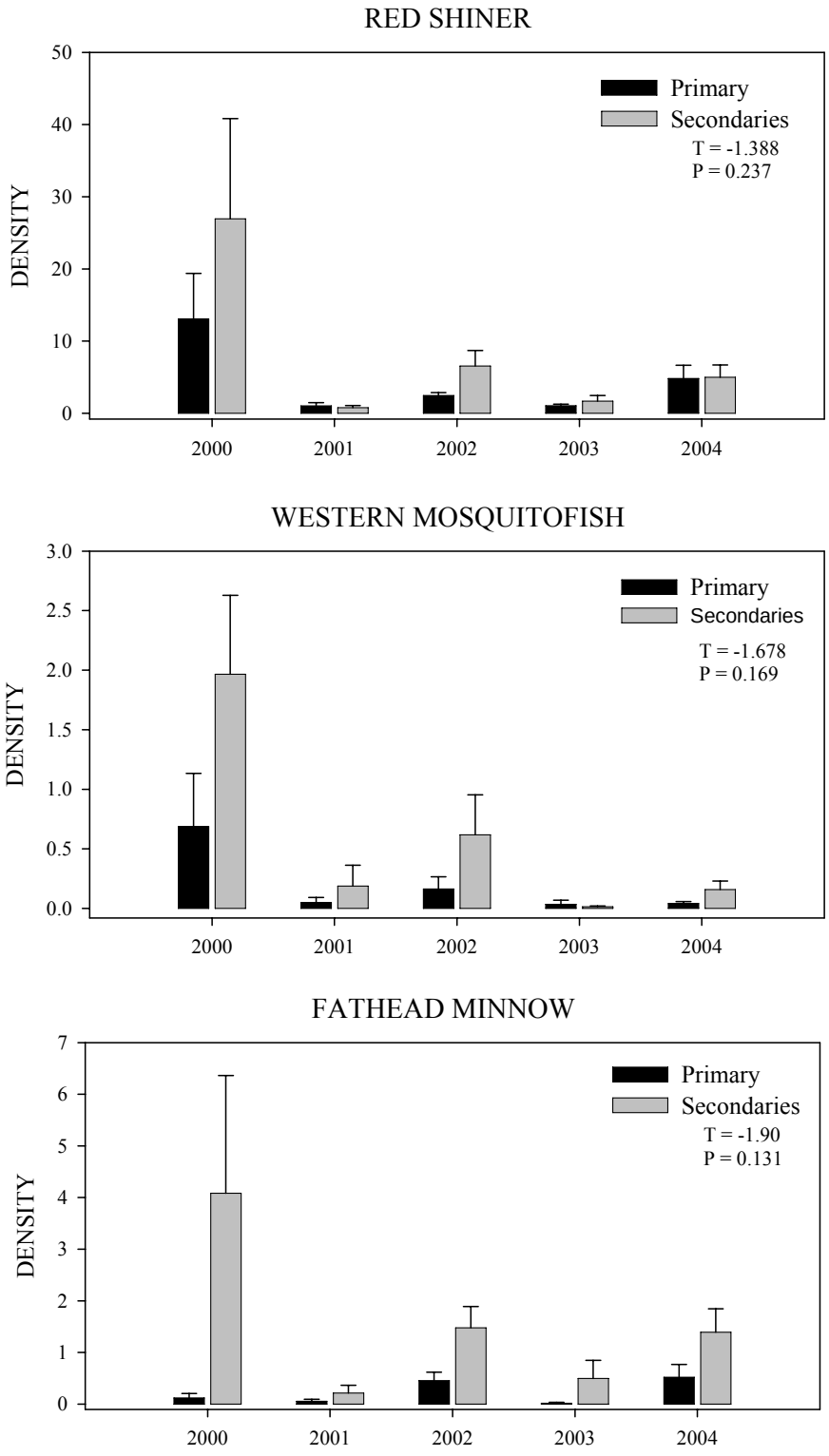

Figure 12. Average autumn densities of commonly collected nonnative fish in primary and secondary channels of Reach 5, San Juan River 2000-2004. Error bars represent standard error. Paired t tests were performed between primary and secondary channel sample densities.

REACH 4—PRIMARY CHANNEL

Four native and six nonnative species were collected in Reach 4 primary channel in 2004 (Table 21). A single Colorado pikeminnow was found in 2004, the first since 1998. A total of 1562 m^2 was sampled in 2004, which was the largest area sampled, to date, in this reach. Total fish density was approximately 2 fish/m^2 in 2004, about the average for the preceding 4 years. Nonnative fish density continued to be higher than that of native fishes in the primary channel of Reach 4, but native fish density has generally increased since 2000 (Figure 13). Species diversity has increased for the past five years of sampling (2000-2004).

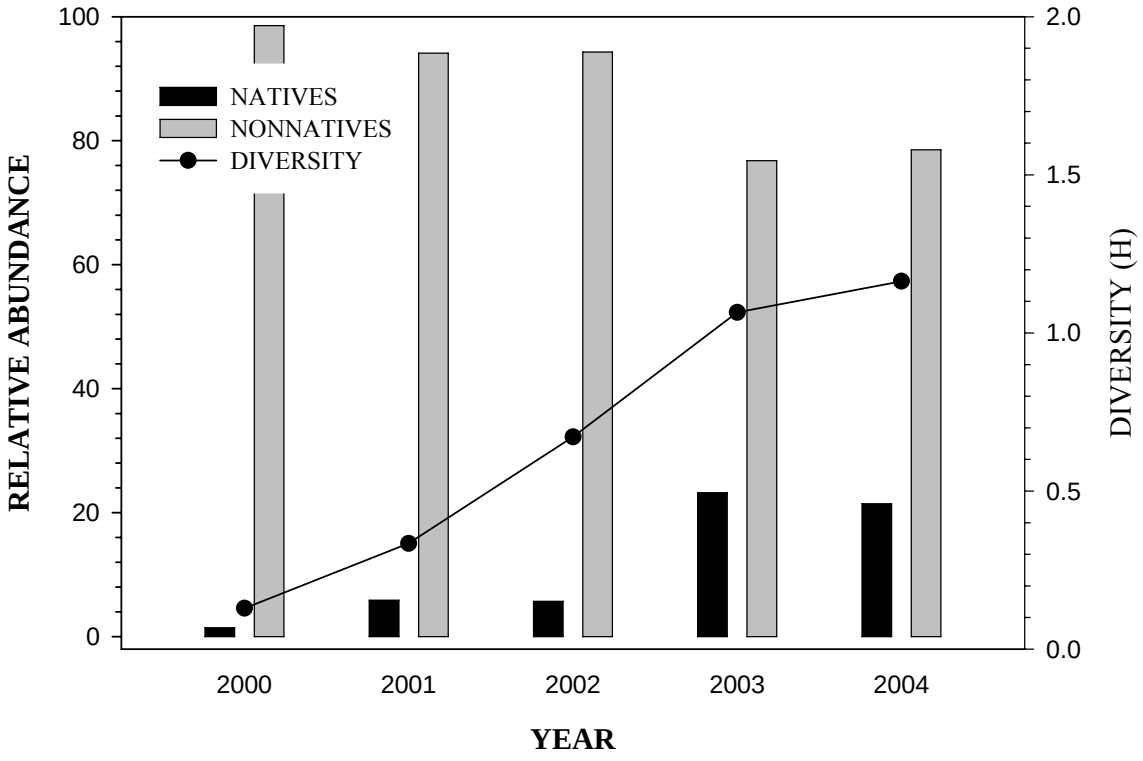

Figure 13. Relative abundance of native and nonnative fishes and assemblage diversity in Reach 4 primary channel, San Juan River, 2000-2004.

Table 21. Number and density (number/m^2) of fishes in San Juan River primary channel in Geomorphic Reach 4 during autumn, 2000 – 2004.

2000			2001			2002			2003			2004		
SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN
CYPLUT	3616	3.649	CYPLUT	1007	3.334	CYPLUT	1704	3.221	CYPLUT	370	0.698	CYPLUT	1955	1.252
RHIOSC	50	0.051	RHIOSC	62	0.205	PIMPRO	151	0.327	RHIOSC	127	0.240	RHIOSC	641	0.410
GAMAFF	11	0.011	PIMPRO	12	0.040	RHIOSC	92	0.200	ICTPUN	37	0.070	PIMPRO	419	0.268
CYPCAR	4	0.004	GAMAFF	5	0.017	ICTPUN	34	0.074	PIMPRO	30	0.057	ICTPUN	119	0.076
CATLAT	4	0.004	CATLAT	2	0.007	GAMAFF	17	0.037	CATLAT	5	0.009	CATLAT	34	0.022
ICTPUN	4	0.004	FUNZEB	2	0.007	CATLAT	17	0.037	FUNZEB	4	0.008	GAMAFF	27	0.017
PIMPRO	3	0.003				CATDIS	7	0.015	CATDIS	2	0.004	CATDIS	19	0.012
CATDIS	1	0.001				CYPCAR	4	0.009	LATDIS	1	0.002	FUNZEB	18	0.012
FUNZEB	1	0.001				FUNZEB	2	0.004	LEPCYA	1	0.002	AMEMEL	1	0.001
						AMEMEL	1	0.002				PTYLUC	1	0.001
TOTAL N	3794			1090			2029			577			3234	
AREA	991			302			461			530			1562	
DENSITY	3.828			3.609			4.401			1.091			2.070	
H	0.129			0.334			0.671			1.065			1.163	

There was no significant relationship between autumn density of any commonly collected species and flow attributes in Reach 4 primary channels (Table 22). Roughly 60% of the area sampled in Reach 4 primary channel was moderate-velocity; rapid velocity comprised 30%, and slow velocity and backwaters represented less than 10% of total area. Bluehead sucker and flannelmouth sucker were more likely to be sampled in moderate velocity habitats than in rapid- or slow-velocity areas. Western mosquitofish and fathead minnow were disproportionably more common in backwater habitats while red shiner and speckled dace occurrence tracked habitat abundance (Figure 14).

Table 22. Regression analysis results for density of commonly collected native and non-native fish species in San Juan River Reach 4 primary channel (2000-2004) versus average mean daily spring discharge, average mean daily summer discharge, and days mean daily summer discharge less than 500 cfs. *indicates significant relationship at $\alpha = 0.05$.

	SPRING Q		SUMMER Q		<500 CFS	
	R	*p*	R	*p*	R	*p*
NATIVES	-0.080	0.903	0.364	0.548	0.173	0.781
CATDIS	-0.641	0.249	-0.235	0.704	0.848	0.070
CATLAT	-0.600	0.288	-0.210	0.737	0.842	0.073
RHIOSC	0.012	0.985	0.449	0.448	0.051	0.935
NONNATIVES	0.183	0.662	0.560	0.321	0.053	0.932
CYPLUT	0.175	0.645	0.570	0.315	0.020	0.975
GAMAFF	-0.219	0.717	-0.410	0.497	0.613	0.271
PIMPRO	-0.070	0.912	0.068	0.913	0.399	0.506

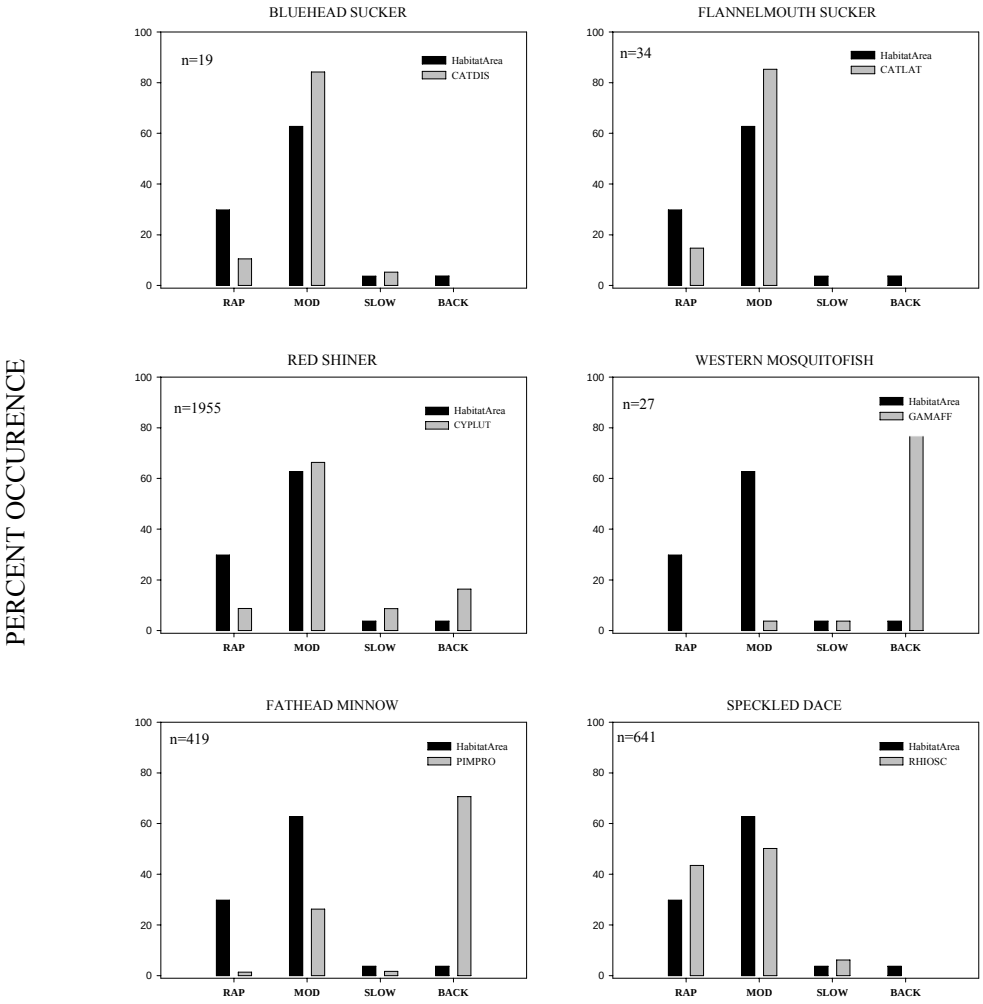

Figure 14. Occurrence of commonly collected fish species in Reach 4 primary channel, San Juan River, 2004.

REACH 4—SECONDARY CHANNELS

Five native and nine nonnative fish species have been collected in Reach 4 secondary channels since 2000 (Table 23). Twelve species were collected in 2004, 8 nonnative and 4 native species, including Colorado pikeminnow. Total density of fishes was higher in 2004 than in previous years. Red shiner was the most common species in all years, comprising over 50% of fishes collected each year. Fathead minnow has been the second most-common species since 2001. Nonnative fishes numerically dominated Reach 4 secondary channel assemblages by 9 to 1 or more (Figure 15).

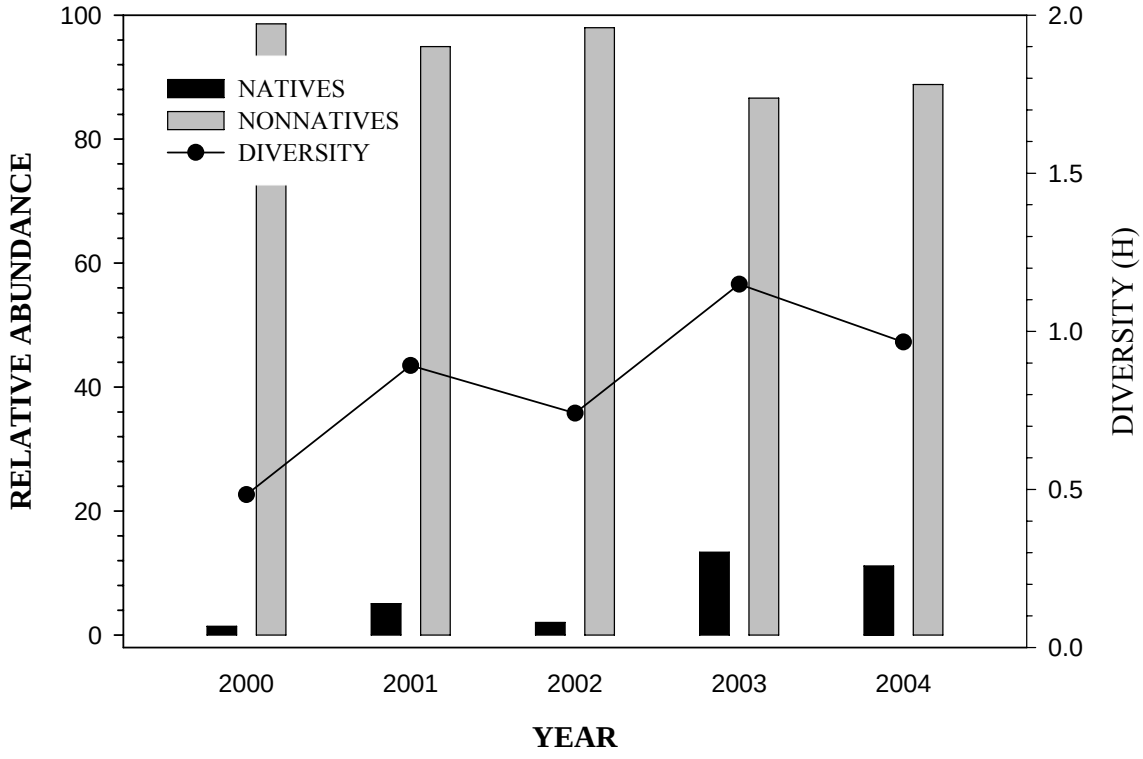

Figure 15. Relative abundance of native and nonnative fishes and assemblage diversity in Reach 4 secondary channels, San Juan River, 2000-2004.

Table 23. . Number and density (number/m^2) of fishes in San Juan River secondary channels in Geomorphic Reach 4 (RM 131 – RM 106) during autumn, 2000 – 2004.

2000			2001			2002			2003			2004		
SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN
CYPLUT	2792	5.132	CYPLUT	708	2.192	CYPLUT	1502	4.457	CYPLUT	467	0.981	CYPLUT	3943	5.356
CYPCAR	118	0.217	PIMPRO	131	0.406	PIMPRO	509	1.510	PIMPRO	102	0.214	PIMPRO	1008	1.369
GAMAFF	77	0.141	RHIOSC	43	0.133	RHIOSC	24	0.071	CATLAT	48	0.101	RHIOSC	578	0.785
PIMPRO	74	0.136	GAMAFF	38	0.118	CATLAT	10	0.030	RHIOSC	44	0.092	ICTPUN	58	0.079
RHIOSC	31	0.057	FUNZEB	16	0.050	CYPCAR	8	0.024	ICTPUN	25	0.053	GAMAFF	46	0.062
MICSAL	11	0.020	CATLAT	4	0.012	CATDIS	8	0.024	FUNZEB	7	0.015	CATDIS	34	0.046
CATLAT	9	0.016	ICTPUN	3	0.009	ICTPUN	6	0.018	AMEMEL	4	0.008	CATLAT	26	0.035
PTYLUC	3	0.005	CATDIS	1	0.003	AMEMEL	3	0.009	GAMAFF	4	0.008	FUNZEB	21	0.029
CATDIS	2	0.004	AMENAT	1	0.003	GAMAFF	3	0.009	CATDIS	2	0.004	AMEMEL	4	0.005
ICTPUN	2	0.004	CYPCAR	1	0.003	FUNZEB	2	0.006				CYPCAR	2	0.003
FUNZEB	1	0.002										MICSAL	1	0.001
												PTYLUC	1	0.001
TOTAL N	3111		946			2075			703			5722		
AREA	544		323			337			476			736		
DENSITY	5.719		2.929			6.220			1.477			7.774		
H	0.483		0.892			0.741			1.149			0.966		

There was no relationship between autumn density of any commonly collected fish with mean daily spring or summer flows or with number of low flow days, except that red shiner density was negatively correlated with mean daily summer discharge (Table 24). Approximately 70% of the habitat sampled was moderate-velocity. Overall, occurrence of commonly collected species was proportional to habitats sampled (Figure 14).

Table 24. Regression analysis results for density of commonly collected native and non-native fish species in San Juan River Reach 4 secondary channel (2000-2004) versus average mean daily spring discharge, average mean daily summer discharge, and days mean daily summer discharge less than 500 cfs. *indicates significant relationship at $\alpha = 0.05$.

	SPRING Q		SUMMER Q		<500 CFS	
	R	*p*	R	*p*	R	*p*
NATIVES	0.107	0.863	0.047	0.940	0.031	0.961
CATDIS	-0.211	0.741	-0.238	0.700	0.477	0.417
CATLAT	-0.519	0.370	0.576	0.309	0.105	0.867
RHIOSC	0.203	0.744	0.004	0.985	-0.020	0.972
NONNATIVES	-0.110	0.864	-0.820	0.087	0.517	0.372
CYPLUT	-0.040	0.952	-0.880*	0.048	0.435	0.465
GAMAFF	0.775	0.123	-0.370	0.541	-0.63	0.258
PIMPRO	-0.320	0.603	-0.180	0.773	0.642	0.242

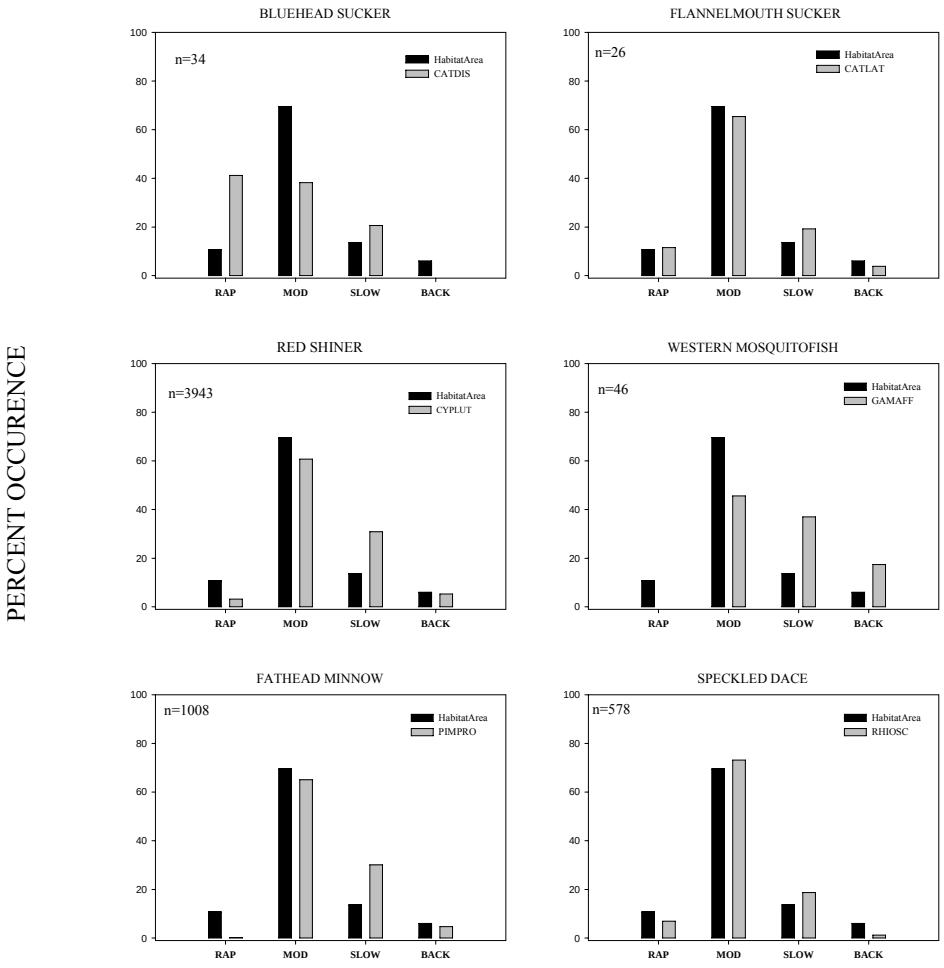

Figure 16. Occurrence of commonly collected fish species in Reach 4 secondary channels, San Juan River, 2004.

REACH 4—BACKWATERS

Three native and seven nonnative fishes have been collected in Reach 4 backwaters since 2000. There was no backwater sampled in Reach 4 in 2004. Density of fishes in Reach 4 backwaters peaked in 2000 at 32.9 fish/m^2, when red shiner comprised almost 98% of fishes collected. Red shiner was the most common species in Reach 4 backwaters in all years and fathead minnow was second-most common (Table 25). Flannelmouth sucker and bluehead sucker were always rare or absent. No protected species was found in Reach 4 backwaters. Channel catfish was collected only in 2002.

Table 25. Number and density (number/m^2) of fishes in San Juan River backwaters in Geomorphic Reach 4 (RM 131 – RM 107) during autumn, 2000 – 2004.

2000			2001			2002			2003			2004		
SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN
												N		
CYPLUT	7979	32.173	CYPLUT	611	4.629	CYPLUT	1442	12.325	CYPLUT	123	1.640	**O**		
PIMPRO	157	0.633	PIMPRO	31	0.235	PIMPRO	455	3.889	PIMPRO	16	0.213			
CYPCAR	11	0.044	RHIOSC	11	0.083	CYPCAR	14	0.120	AMEMEL	11	0.145	**B**		
CATLAT	5	0.020	CYPCAR	1	0.008	GAMAFF	9	0.077	CATDIS	1	0.013	**A**		
GAMAFF	3	0.012				AMEMEL	7	0.060	RHIOSC	1	0.013	**C**		
CATDIS	1	0.004				CATLAT	6	0.051				**K**		
						RHIOSC	4	0.034				**W**		
						ICTPUN	3	0.026				**A**		
						CYPCAR	3	0.026				**T**		
						CATDIS	3	0.026				**E**		
						FUNZEB	1	0.008				**R**		
						LEPCYA	1	0.008				**S**		
BKWS N	5			6			6			3		0		
N	8156			654			1945			152				
AREA	248			132			117			75				
DENSITY	32.887			4.954			16.624			2.027				
H	0.085			0.213			0.443			0.664				

REACH 4—PRIMARY AND SECONDARY CHANNELS COMPARISIONS

Average autumn densities of commonly collected species were higher in secondary channels than the main channel in 2004. Additionally, there were twelve species in secondary channels, but only ten in the primary channel. Secondary channel density of bluehead sucker and speckled dace in both primary and secondary channels was greater in 2004 than in any previous year (Figure 17). Flannelmouth sucker density in both primary and secondary channels in 2004 was about its average density for 2000 through 2004.

In 2004, density of all commonly collected nonnative fish species (red shiner, western mosquitofish, and fathead minnow) was greater in secondary than primary channel (Figure 18). Secondary channel 2004 densities were about the average for 2000 through 2004. Primary channel density of red shiner in 2004 was less than most preceding years, western mosquitofish density was near average for the period, and fathead minnow density was greater.

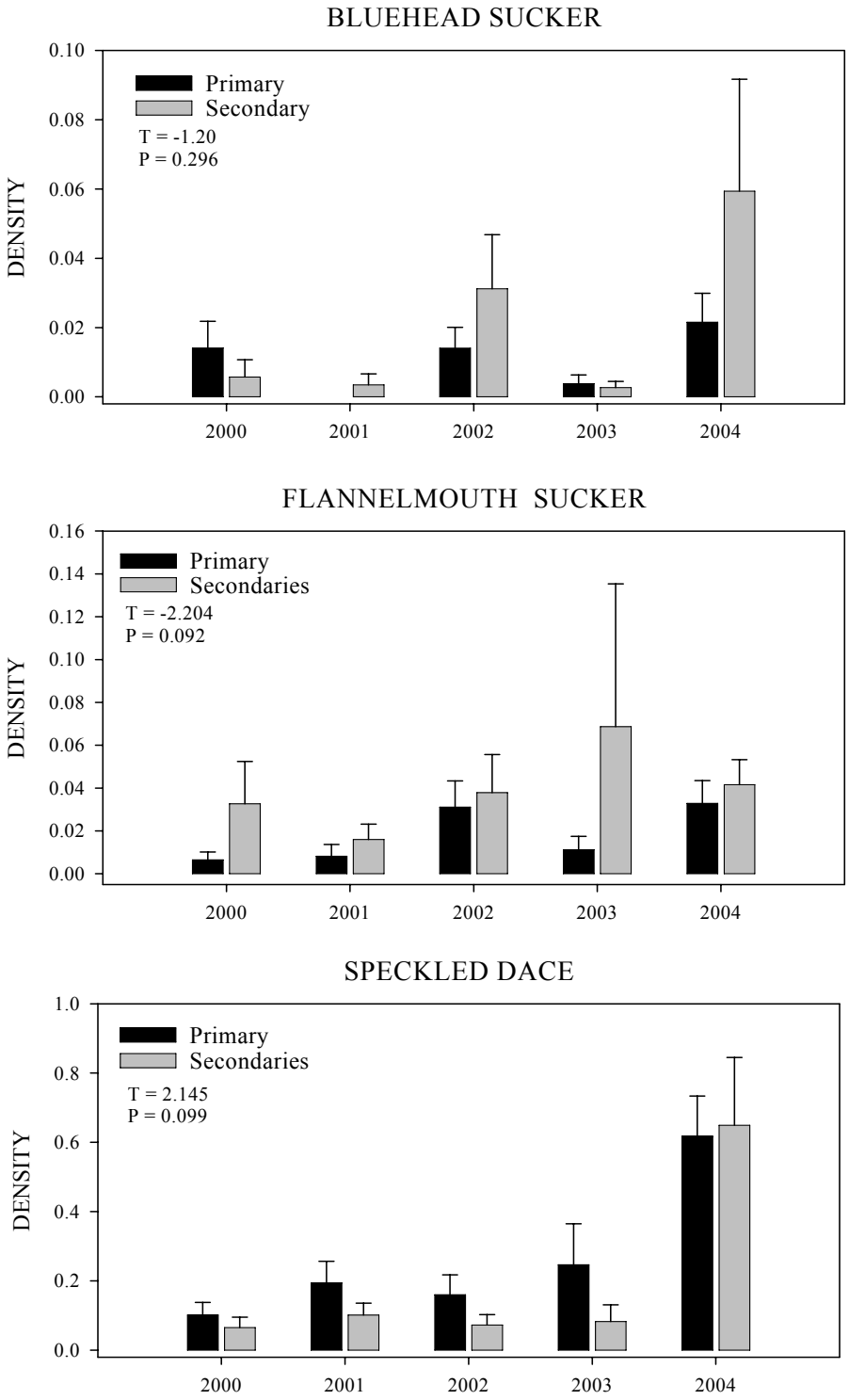

Figure 17. Average autumn densities of commonly collected native fishes in Reach 4 primary and secondary channels, San Juan River, 2000-2004. Error bars represent standard error. Paired t tests were performed between primary and secondary channel sample densities.

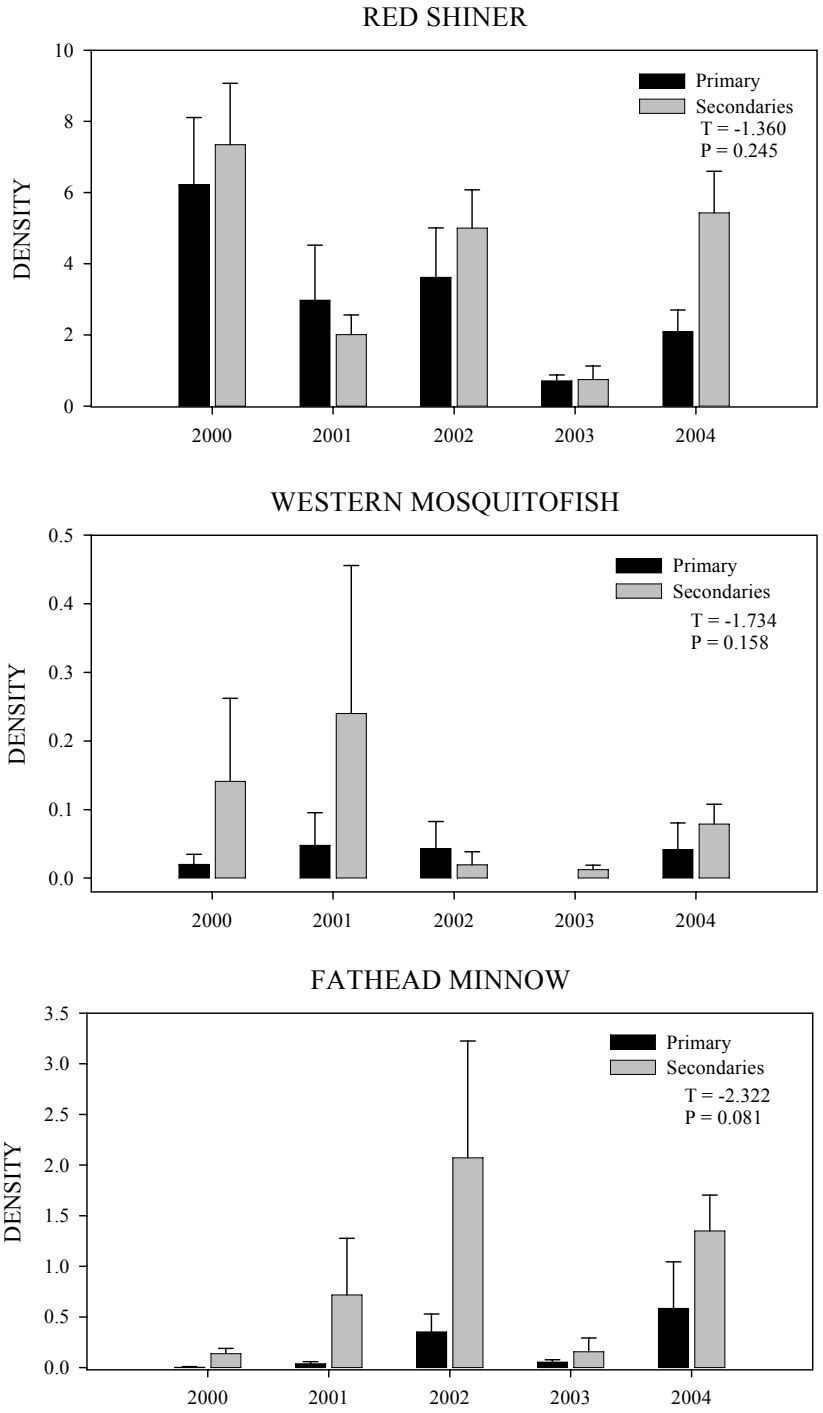

Figure 18. Average autumn densities of commonly collected nonnative fishes in Reach 4 primary and secondary channels, San Juan River, 2000-2004. Error bars represent standard error. Paired t tests were performed between primary and secondary channel sample densities.

REACH 3—PRIMARY CHANNEL

Between 2000 and 2004, four native and seven nonnative species were collected the Reach 3 primary channel (Table 26). Red shiner was the most common species collected in 2004, comprising over 55% of fishes collected, as it has been since 2000. Native specked dace was the second-most common species in Reach 3 primary channel in all years except 2000 and 2002. No Colorado pikeminnow was collected in Reach 3 primary channel between 2000 and 2004. Channel catfish was comparatively common for the past two years, but was uncommon in other years. Assemblage diversity has increased over the past five years, concurrent with an increase in relative abundance of native species (Figure 19).

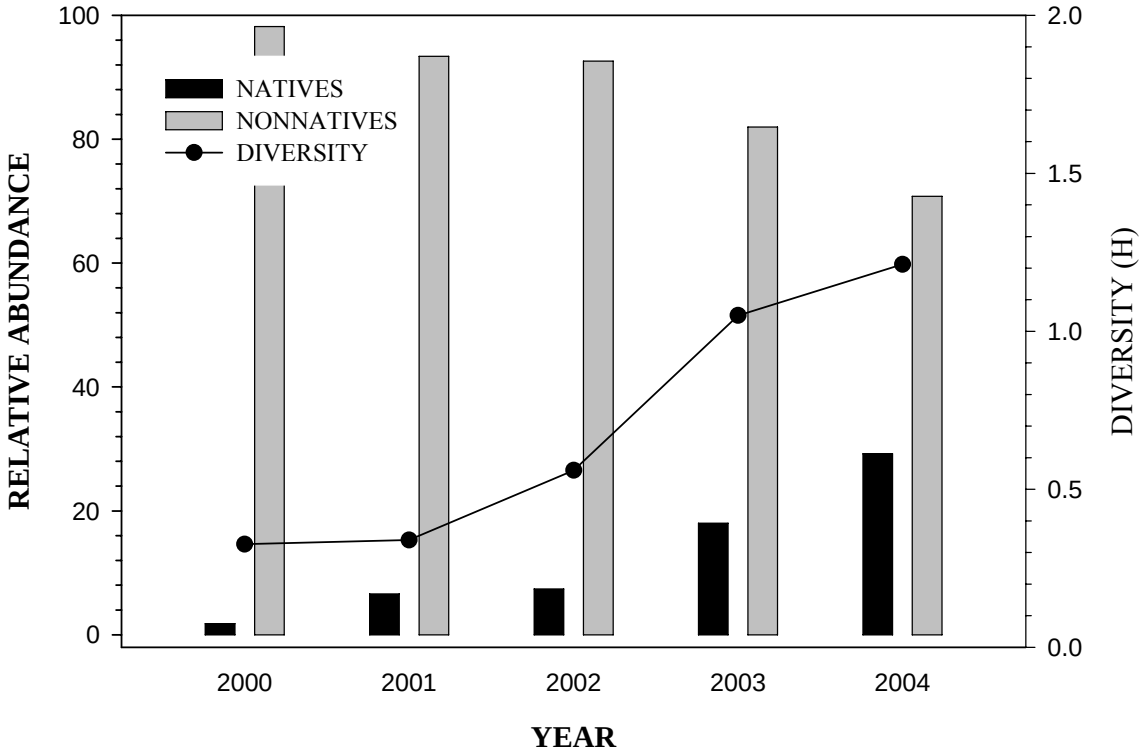

Figure 19. Relative abundance of native and nonnative fishes and assemblage diversity in Reach 3 primary channel, San Juan River, 2000-2004.

Table 26. Number and density (number/m^2) of fishes in San Juan River primary channel in Geomorphic Reach 3 during autumn, 2000 – 2004.

2000			2001			2002			2003			2004		
SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN
CYPLUT	3247	3.286	CYPLUT	1298	1.940	CYPLUT	3162	3.639	CYPLUT	719	0.668	CYPLUT	1425	0.690
GAMAFF	182	0.184	RHIOSC	93	0.139	PIMPRO	413	0.475	RHIOSC	181	0.168	RHIOSC	639	0.309
PIMPRO	69	0.070	PIMPRO	43	0.064	RHIOSC	269	0.310	ICTPUN	117	0.109	ICTPUN	205	0.099
RHIOSC	48	0.049	GAMAFF	11	0.016	ICTPUN	55	0.061	PIMPRO	37	0.034	PIMPRO	130	0.063
CATLAT	14	0.014	CATLAT	3	0.005	GAMAFF	25	0.028	CATLAT	12	0.011	CATLAT	55	0.026
ICTPUN	7	0.007	ICTPUN	2	0.003	CATLAT	21	0.024	FUNZEB	12	0.011	CATDIS	39	0.019
CATDIS	3	0.003				CYPCAR	13	0.014	CATDIS	2	0.002	GAMAFF	9	0.004
CYPCAR	3	0.003				FUNZEB	8	0.009	GAMAFF	2	0.002	FUNZEB	4	0.002
						CATDIS	4	0.004				CYPCAR	2	0.001
						AMEMEL	2	0.002						
TOTAL N	3573			1450			3972			1082			2508	
AREA	988			669			869			1077			2066	
DENSITY	3.616			2.167			4.571			1.005			1.214	
H	0.326			0.339			0.560			1.050			1.212	

There was no significant relationship for density of any commonly collected species and flow attributes for the past five years (Table 27). In 2004, 60% of the sampled area was moderate-velocity habitats. Western mosquitofish was absent from this habitat, being disproportionably represented in rapid- and slow-velocity habitats (Figure 20). Native suckers (bluehead and flannelmouth) had high densities in moderate-velocity habitats. Of the six commonly collected species, fathead minnow had the greatest occurrence in primary channel backwaters of Reach 3.

Table 27. Regression analysis results for density of commonly collected native and non-native fish species in San Juan River Reach 3 primary channel (2000-2004) versus average mean daily spring discharge, average mean daily summer discharge, and days mean daily summer discharge less than 500 cfs. *indicates significant relationship at $\alpha = 0.05$.

	SPRING Q		SUMMER Q		<500 CFS	
	R	*p*	R	*p*	R	*p*
NATIVES	-0.420	0.484	0.033	0.957	0.622	0.263
CATDIS	-0.051	0.939	-0.230	0.719	0.243	0.694
CATLAT	-0.569	0.315	-0.510	0.381	0.806	0.099
RHIOSC	-0.410	0.496	0.111	0.859	0597	0.288
NONNATIVES	-0.191	0.754	-0.680	0.208	0.421	0.480
CYPLUT	-0.121	0.853	-0.649	0.231	0.341	0.575
GAMAFF	0.039	0.954	-0.781	0.122	0.006	0.993
PIMPRO	-0.590	0.290	-0.350	0.569	0.819	0.090

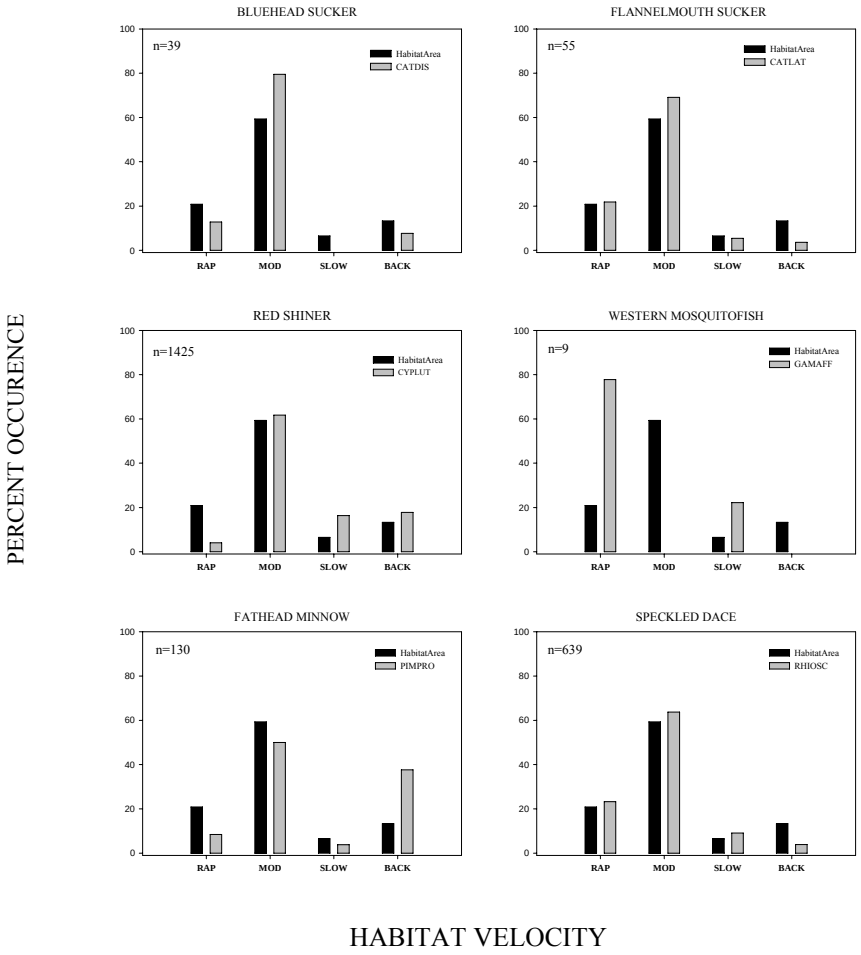

Figure 20. Occurrence of commonly collected fish species in Reach 3 primary channel, San Juan River, 2004.

REACH 3—SECONDARY CHANNELS

Three native and eight nonnative fish species were collected in Reach 3 secondary channels between 2000 and 2004 (Table 28). Red shiner was the most common species in all years. Only seven species of fish were collected in 2004, the fewest in 5 years. However, total density of fishes in 2004 was equal to the average density from 2000 through 2003. Colorado pikeminnow has not been collected in Reach 3 secondary channels since 2000. Relative abundance of nonnative fishes has been considerably

greater than that of native fishes for the last five years (Figure 21). Assemblage diversity generally increased from 2000 through 2003, but decreased in 2004.

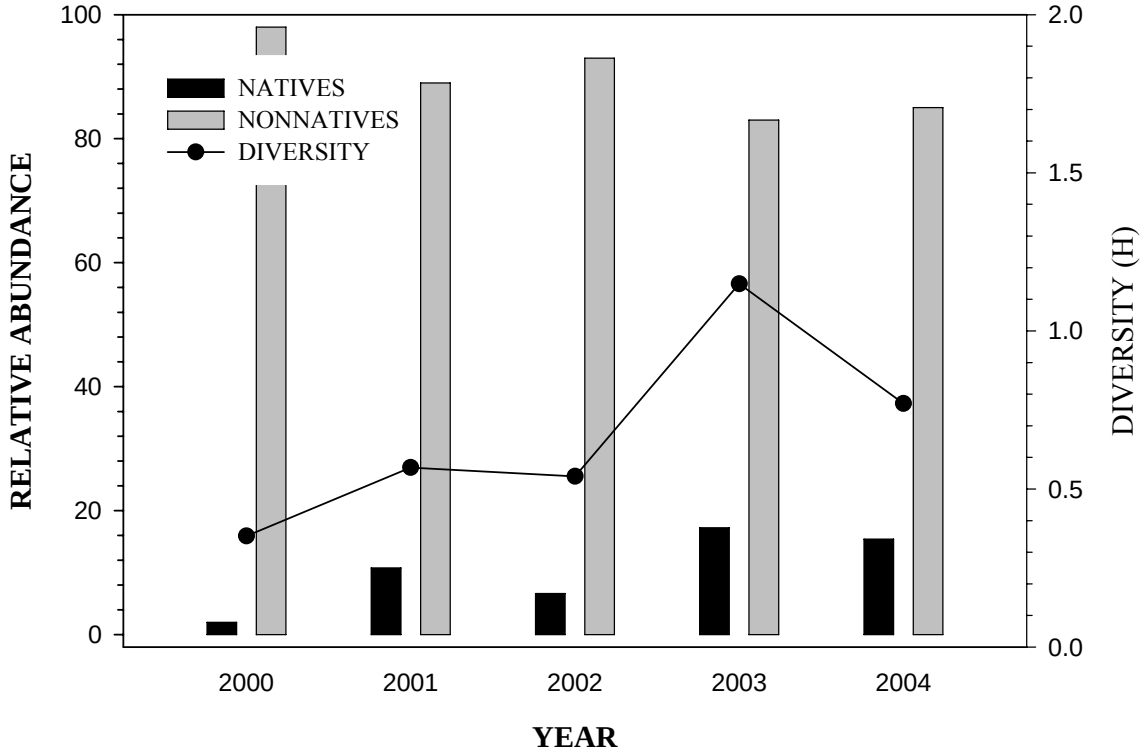

Figure 21. Relative abundance of native and nonnative fish species and assemblage diversity in Reach 3 secondary channels, San Juan River, 2000-2004.

Table 28. Number and density (number/m^2) of fishes in San Juan River secondary channels in Geomorphic Reach 3 (RM 106 – RM 68) during autumn, 2000 – 2004.

2000			2001			2002			2003			2004		
SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN
CYPLUT	4885	5.073	CYPLUT	901	1.347	CYPLUT	1886	3.742	CYPLUT	164	0.351	CYPLUT	1145	2.129
GAMAFF	338	0.351	RHIOSC	95	0.142	PIMPRO	265	0.526	RHIOSC	43	0.092	RHIOSC	175	0.325
RHIOSC	77	0.080	PIMPRO	39	0.058	RHIOSC	143	0.283	ICTPUN	34	0.073	ICTPUN	48	0.071
PIMPRO	72	0.75	CATLAT	22	0.033	ICTPUN	31	0.061	PIMPRO	11	0.024	CATLAT	30	0.056
CATLAT	25	0.026	GAMAFF	21	0.031	CATLAT	9	0.018	AMEMEL	3	0.006	PIMPRO	21	0.039
ICTPUN	25	0.027	ICTPUN	16	0.024	FUNZEB	6	0.012	GAMAFF	3	0.064	CATDIS	17	0.032
CYPCAR	22	0.023	AMEMEL	2	0.003	CATDIS	4	0.008	CATLAT	2	0.004	GAMAFF	6	0.011
CATDIS	6	0.006	CYPCAR	1	0.001	AMEMEL	4	0.008	FUNZEB	1	0.002			
FUNZEB	3	0.003	CATDIS	1	0.001	CYPCAR	3	0.006						
						GAMAFF	3	0.006						
N	5456			1099			2354			261			1442	
AREA	963			669			504			467			537	
DENSITY	5.666			1.643			4.671			0.559			2.685	
H	0.351			0.568			0.540			1.149			0.770	

Autumn density of nonnative fishes, mainly red shiner, had a significant, and negative, relationship with summer flow levels. Autumn density of no other commonly collected native or nonnative species was related to any discharge attribute (Table 29). Backwaters were the most common habitat (60%) sampled in Reach 3 secondary channels in 2004. Moderate-velocity mesohabitats comprised 31% of the area sampled in Reach 3 secondary channels (Figure 22). No sample was taken in slow-water habitats. Bluehead sucker and speckled dace showed the greatest affinity for moderate-velocity habitats, while western mosquitofish was absent from these habitats.

Table 27. Regression analysis results for density of commonly collected native and non-native fish species in San Juan River Reach 3 primary channel (2000-2004) versus average mean daily spring discharge, average mean daily summer discharge, and days mean daily summer discharge less than 500 cfs. *indicates significant relationship at $\alpha = 0.05$.

	SPRING Q		SUMMER Q		<500 CFS	
	R	*p*	R	*p*	R	*p*
NATIVES	-0.420	0.484	0.033	0.957	0.622	0.263
CATDIS	-0.051	0.939	-0.230	0.719	0.243	0.694
CATLAT	-0.569	0.315	-0.510	0.381	0.806	0.099
RHIOSC	-0.410	0.496	0.111	0.859	0597	0.288
NONNATIVES	-0.191	0.754	-0.680	0.208	0.421	0.480
CYPLUT	-0.121	0.853	-0.649	0.231	0.341	0.575
GAMAFF	0.039	0.954	-0.781	0.122	0.006	0.993
PIMPRO	-0.590	0.290	-0.350	0.569	0.819	0.090

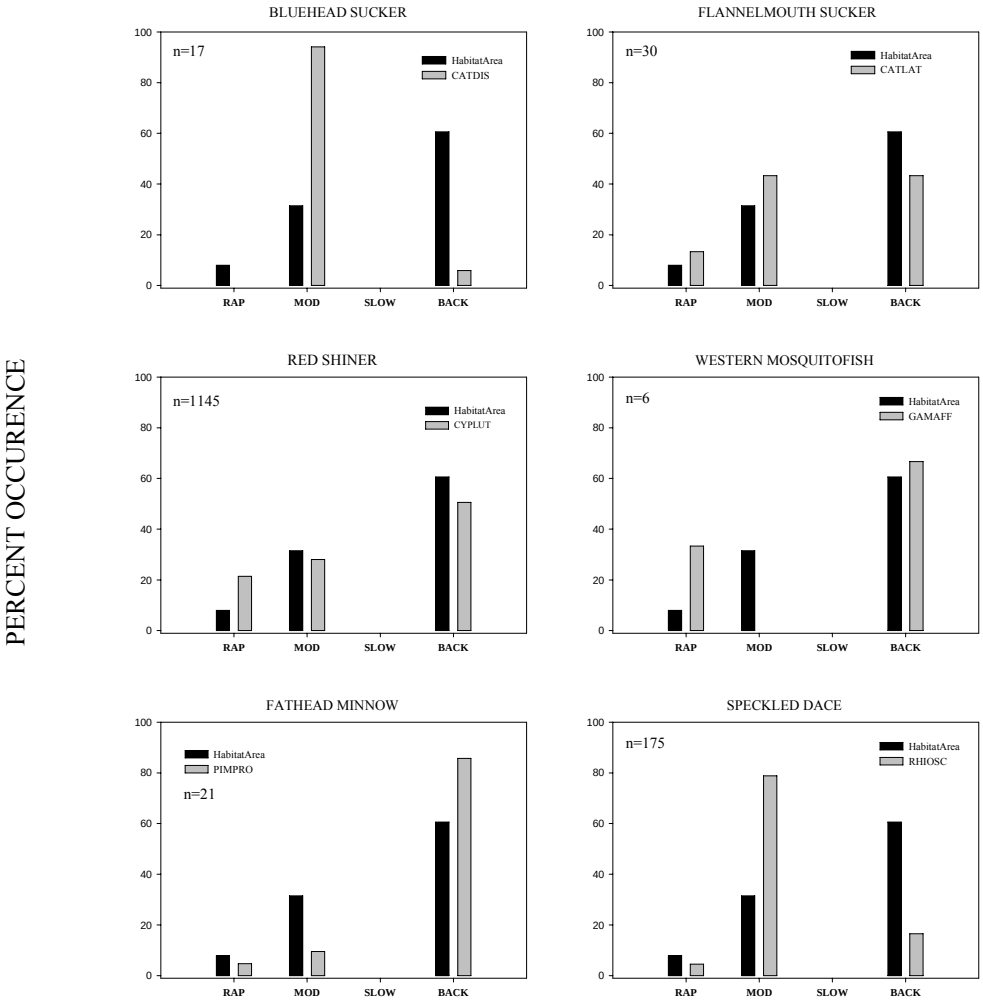

Figure 22. Occurrence of commonly colleted fish species in Reach 3 secondary channels, San Juan River, 2004.

REACH 3—BACKWATERS

Between 2000 and 2004, four native and seven nonnative fish species were collected in Reach 3 backwaters (Table 30). Eight species were collected in 2004, with red shiner comprising nearly 70% of the total catch. Total fish density was high from 2000 through 2002, but was comparatively low in 2003. Fish density in 2004 increased somewhat. Nonnative fishes (red shiner, fathead minnow, and western mosquitofish) numerically dominated collections in all years. Native fish species, if present, were never represented by more than a few individuals. One specimen of Colorado pikeminnow was collected in 2000.

REACH 3—PRIMARY AND SECONDARY CHANNELS COMPARISONS

Average autumn densities of native suckers (bluehead and flannelmouth) in primary and secondary channels was greater in 2004 in Reach 3 than in previous years (Figure 23). Speckled dace density remained similar to levels in previous years. In Reach 3, native suckers tended to be more common in secondary channels than the primary channel. Nonnative fishes and speckled dace were more evenly distributed between the two channels with no significant differences in densities among years (Figure 24).

Table 30. Number and density (number/m^2) of fishes in San Juan River backwaters in Geomorphic Reach 3 (RM 107 – RM 68) during autumn, 2000 – 2004.

2000			2001			2002			2003			2004		
SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN
CYPLUT	2606	7.642	CYPLUT	2053	12.293	CYPLUT	1881	8.214	CYPLUT	63	1.340	CYPLUT	763	3.484
GAMAFF	267	0.783	PIMPRO	104	0.623	PIMPRO	674	2.943	GAMAFF	11	0.234	PIMPRO	281	1.283
PIMPRO	83	0.243	GAMAFF	12	0.072	GAMAFF	45	0.196	PIMPRO	3	0.064	FUNZEB	24	0.110
AMEMEL	106	0.311	RHIOSC	3	0.018	RHIOSC	28	0.122	ICTPUN	2	0.043	GAMAFF	12	0.055
CATLAT	5	0.015	CYPCAR	1	0.006	ICTPUN	22	0.096	AMEMEL	1	0.021	ICTPUN	9	0.041
CYPCAR	4	0.012	ICTPUN	1	0.006	CYPCAR	17	0.074	RHIOSC	1	0.021	RHIOSC	4	0.018
ICTPUN	2	0.006	FUNZEB	1	0.006	AMEMEL	6	0.026				CATLAT	1	0.005
PTYLUC	1	0.003				CATLAT	6	0.026				CYPCAR	1	0.005
FUNZEB	1	0.003				FUNZEB	5	0.022						
						LEPCYA	2	0.009						
						CATDIS	1	0.004						
BKWS N	8			8			8			2			5	
N	3072			2175			2687			81			1095	
AREA	341			167			229			47			219	
DENSITY	9.009			13.024			11.734			1.723			5.000	
H	0.447			0.190			0.582			0.789			0.807	

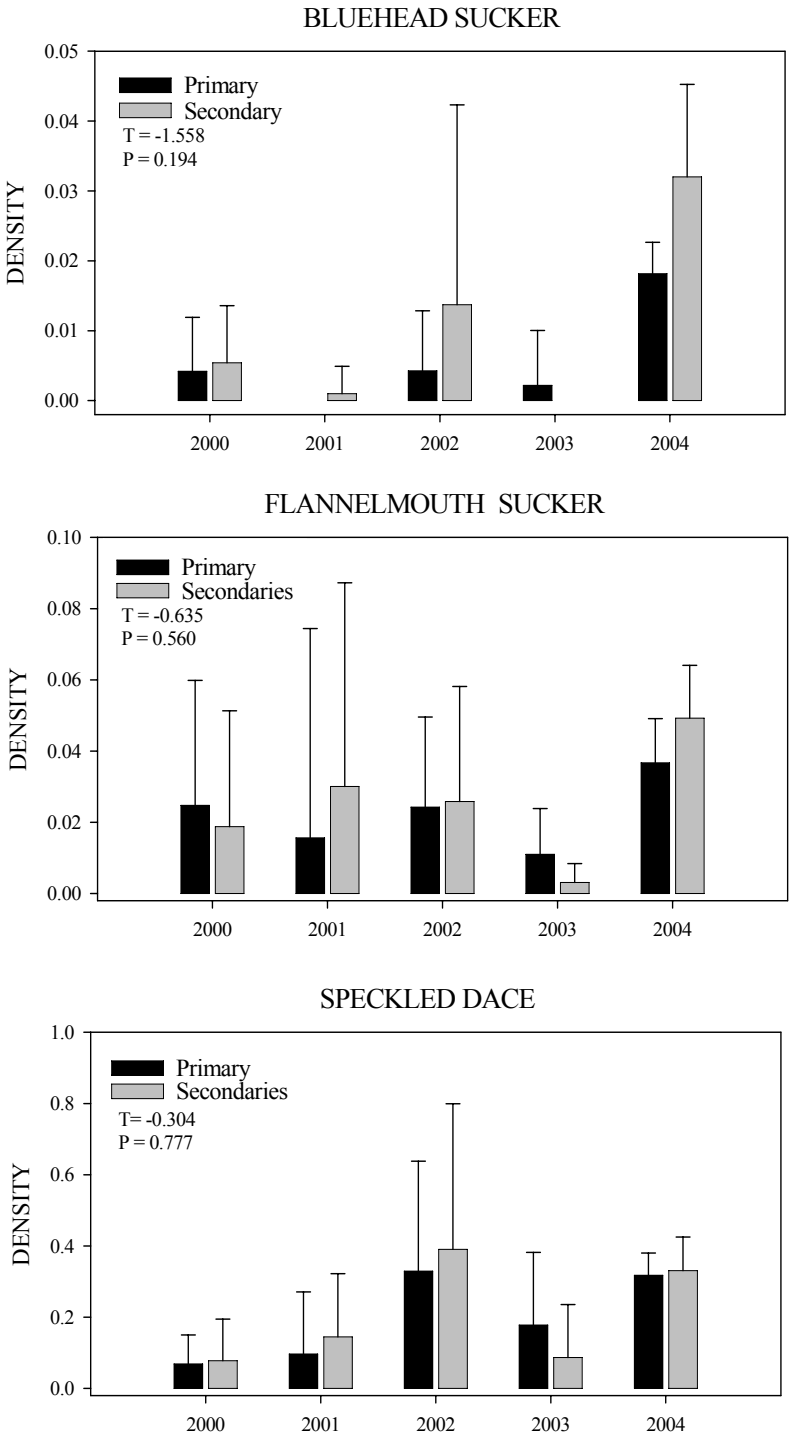

Figure 23. Average autumn densities of commonly collected native fish species in Reach 3 primary and secondary channels, San Juan River, 2000-2004. Error bars represent standard error. Paired t tests were performed between primary and secondary channel sample densities.

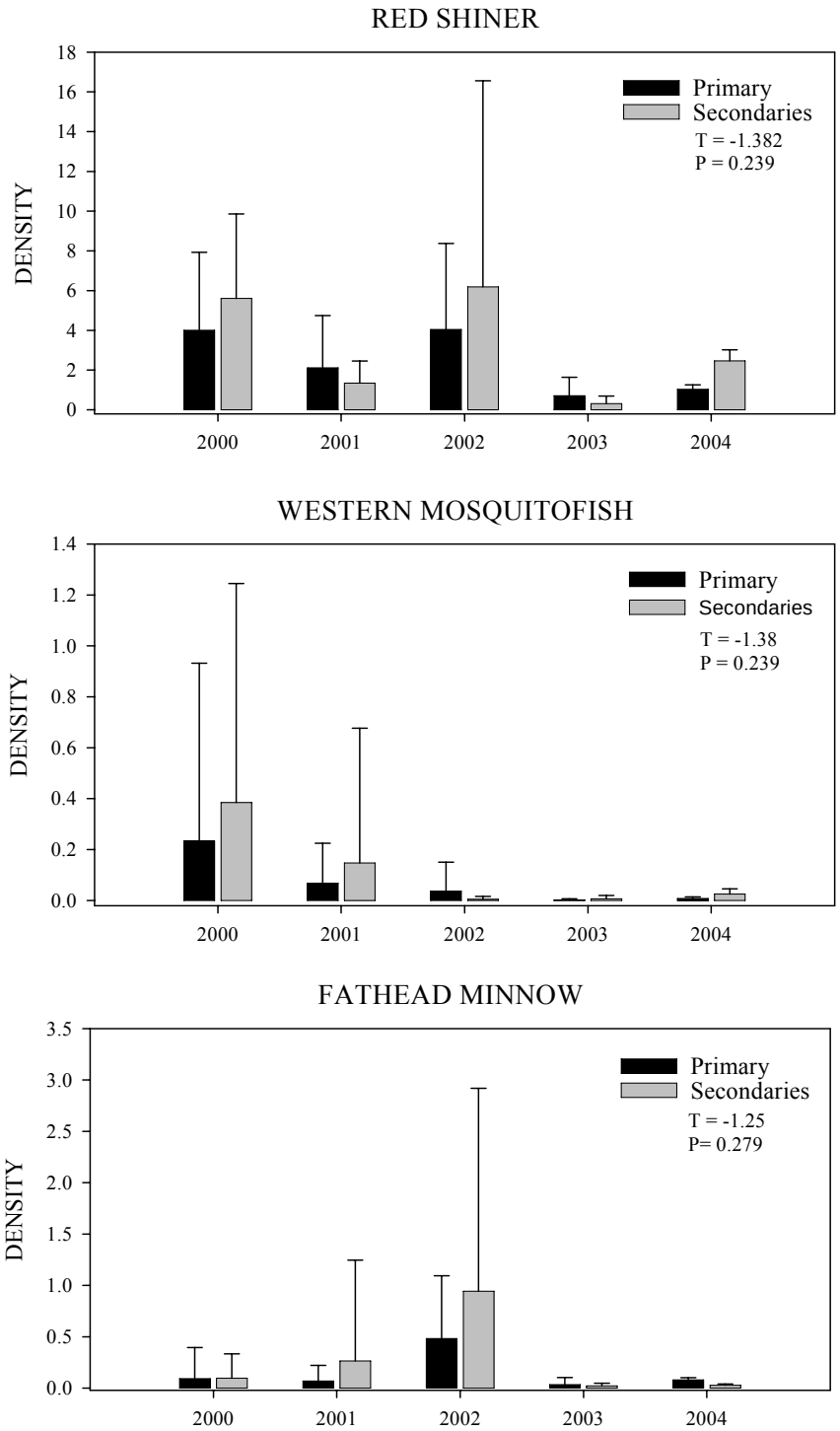

Figure 24. Average autumn densities of commonly collected nonnative fish species in Reach 3 primary and secondary channels, San Juan River, 2000-2004. Error bars represent standard error. Paired t tests were performed between primary and secondary channel sample densities.

REACH 2—PRIMARY CHANNEL

Three native and eight nonnative species were collected in Reach 2 primary channel between 2000 and 2004 (Table 31). Greatest density of fishes occurred in 2000 and least in 2003. Eight species of fish were collected in Reach 2 primary channel in 2004. Red shiner was the most common species in all years, comprising greater than 65% of the sample, except 2003 when speckled dace and channel catfish were more common. Densities of other commonly collected nonnative species were comparatively low in all years in Reach 2 primary channel. No protected species was collected in Reach 2 primary channel between 2000 and 2004. Relative abundance of native fishes and nonnative fishes remained relatively constant for the past three years, 2002 through 2004, at a proportion of approximately 9 nonnatives to 1 native fish (Figure 25). Assemblage diversity has increased slightly for the past five years.

Table 31. Number and density (number/m^2) of fishes in San Juan River primary channel in Geomorphic Reach 2 during autumn, 2000 – 2004.

2000			2001			2002			2003			2004		
SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN
CYPLUT	2310	1.577	CYPLUT	638	0.637	CYPLUT	407	0.380	ICTPUN	162	0.141	CYPLUT	546	0.466
GAMAFF	44	0.030	RHIOSC	18	0.018	ICTPUN	105	0.098	CYPLUT	132	0.115	ICTPUN	149	0.127
ICTPUN	20	0.014	PIMPRO	16	0.016	RHIOSC	43	0.040	RHIOSC	29	0.086	RHIOSC	73	0.062
PIMPRO	19	0.013	ICTPUN	7	0.007	PIMPRO	32	0.030	CATLAT	8	0.007	CATDIS	34	0.029
RHIOSC	16	0.011	GAMAFF	3	0.003	CATLAT	17	0.016	FUNZEB	4	0.003	GAMAFF	6	0.005
CATDIS	6	0.004	CATDIS	1	0.001	CATDIS	4	0.004	GAMAFF	1	0.001	CATLAT	5	0.004
CATLAT	2	0.001				GAMAFF	3	0.003	LEPCYA	1	0.001	AMEMEL	1	0.001
						CYPCAR	3	0.003	PIMPRO	1	0.001	PIMPRO	1	0.001
						AMEMEL	1	0.001						
N	2417		683			615			338			815		
AREA	1465		1002			1072			1147			1171		
DENSITY	1.650		0.682			0.574			0.295			0.696		
H	0.205		0.264			0.810			0.771			1.012		

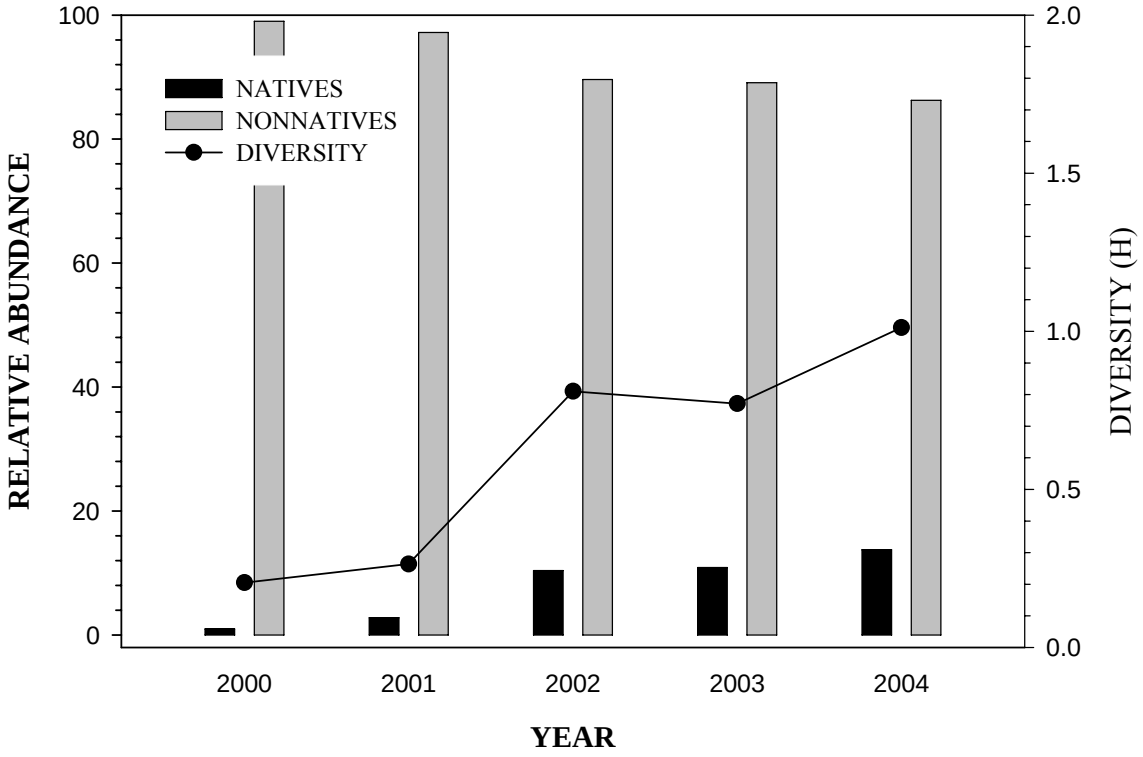

Figure 25. Relative abundance of native and nonnative fishes and assemblage diversity in Reach 2 primary channel, San Juan River, 2000-2004.

Average autumn density of bluehead sucker in 2004 in Reach 2 primary channel was higher than it had been since 2000 (Figure 26). Flannelmouth sucker density peaked in 2002 , but decreased in 2003 and 2004. In 2004, speckled dace increased slightly from 2003 levels. Autumn densities of commonly collected nonnative fishes in Reach 2 primary channel were generally low as compared to previous years.

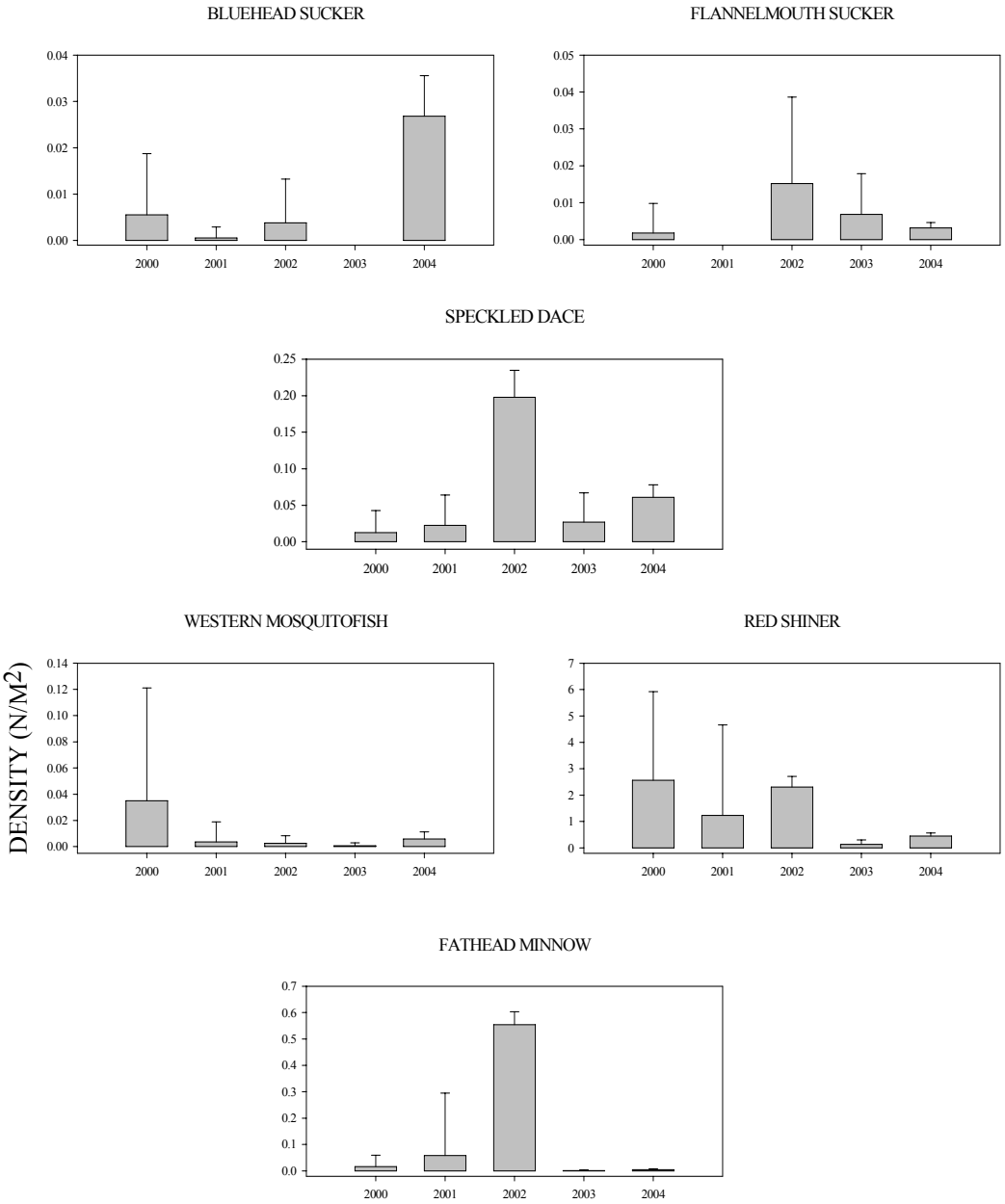

Figure 26. Average autumn densities of commonly collected fish species in Reach 2 primary channel, San Juan River, 2000-2004. Error bars represent standard error.

Autumn density of flannelmouth sucker was significantly, and positively, related to days of summer discharge less than 500 cfs (Table 32). Densities of no other native or nonnative species was related to any discharge attribute.

Table 32. Regression analysis results for density of commonly collected native and non-native fish species in San Juan River Reach 2 primary channel (2000-2004) versus average mean daily spring discharge, average mean daily summer discharge, and days mean daily summer discharge less than 500 cfs. *indicates significant relationship at $\alpha = 0.05$.

	SPRING Q		SUMMER Q		<500 CFS	
	R	*p*	R	*p*	R	*p*
NATIVES	-0.521	0.367	0.360	0.552	0.376	0.532
CATDIS	0.075	0.904	-0.233	0.707	0.153	0.805
CATLAT	-0.861	0.064	-0.081	0.897	0.892*	0.042
RHIOSC	-0.503	0.396	0.548	0.339	0.223	0.718
NONNATIVES	0.339	0.577	-0.750	0.143	-0.130	0.767
CYPLUT	0.384	0.524	-0.750	0.147	-0.200	0.743
GAMAFF	0.165	0.791	-0.720	0.167	-0.141	0.825
PIMPRO	-0.20	0.750	-0.370	0.538	0.451	0.446

Sampled Reach 2 primary channel mesohabitats were largely (68%) moderate-velocity. Slow-velocity areas comprised 6% of area sampled, rapid 16%, and backwaters 2% (Figure 27). All western mosquitofish and fathead minnow specimens were collected in moderate-velocity habitats in Reach 2. Bluehead sucker and speckled dace numbers were disproportionably high in rapid-velocity habitats in Reach 2.

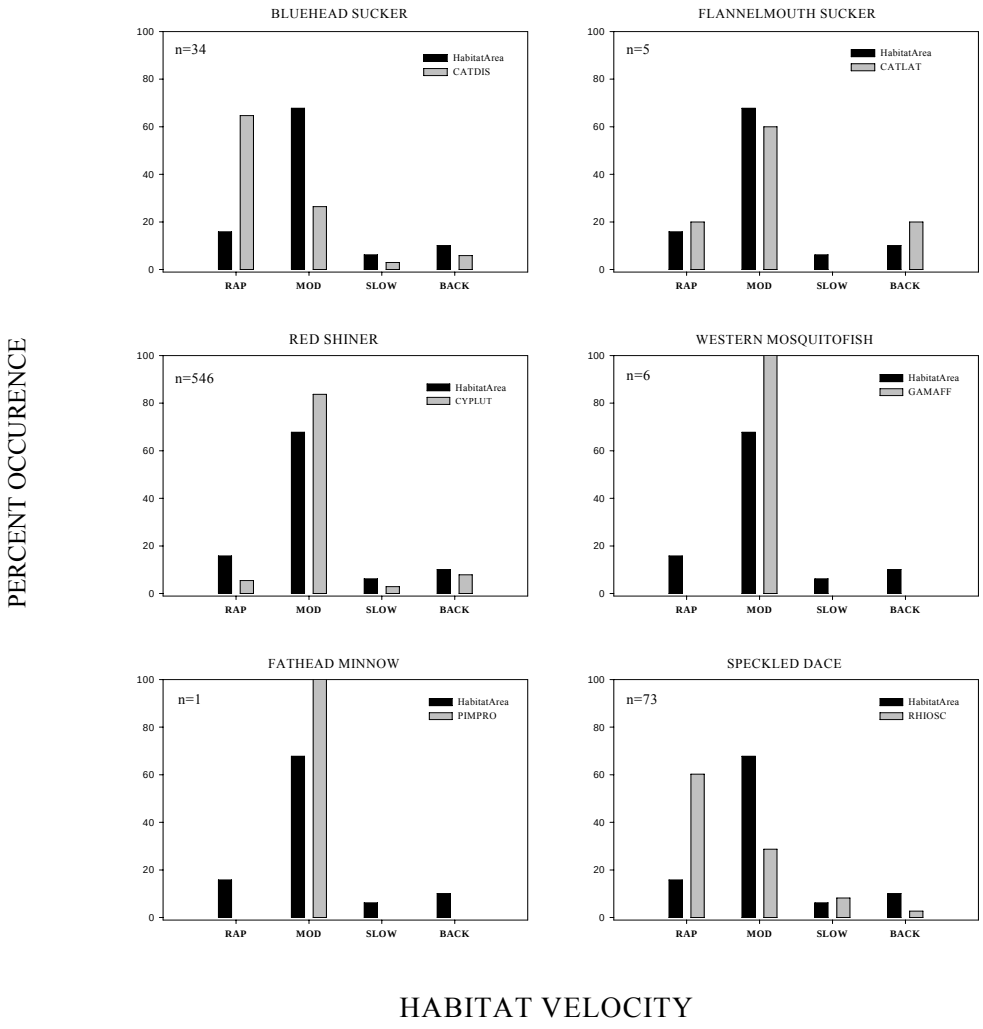

Figure 27. Occurrence of commonly collected fish species in Reach 2 primary channel, San Juan River, 2004.

REACH 2—BACKWATERS

Three native and seven nonnative fish species were collected in Reach 2 backwaters between 2000 and 2004 (Table 33). Only two species (red shiner and fathead minnow) were collected in 15 m^2 of habitat in 2004. Fish density was greatest in 2000 and least in 2001. Red shiner was the most common species in all years. No protected species was found in Reach 2 backwaters from 2000 through 2004.

Table 33. Number and density (number/m^2) of fishes in San Juan River backwaters in Geomorphic Reach 2 (RM 68- RM 17) during autumn, 2000– 2004.

2000			2001			2002			2003			2004		
SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN
CYPLUT	2750	8.567	CYPLUT	30	0.417	CYPLUT	49	0.754	CYPLUT	18	0.439	CYPLUT	6	0.390
PIMPRO	144	0.449	PIMPRO	9	0.125	PIMPRO	36	0.554	ICTPUN	8	0.195	PIMPRO	2	0.130
GAMAFF	114	0.355	CATLAT	1	0.014	CYPCAR	2	0.031	PIMPRO	1	0.024			
ICTPUN	37	0.115				CATLAT	1	0.015	LEPCYA	1	0.024			
CATLAT	9	0.028				ICTPUN	1	0.015						
CYPCAR	5	0.016												
CATDIS	3	0.009												
RHIOSC	2	0.006												
MICSAL	1	0.003												
BKWS N	8			5			4			2			2	
N	3065			40			89			25			8	
AREA	321			72			65			41			15.4	
DENSITY	9.548			0.556			1.369			0.610			0.519	
H	0.351			0.428			0.467			0.317			0.562	

REACH 1—PRIMARY CHANNEL

Three native and six nonnative fishes were collected in Reach 1 primary channel from 2000 through 2004 (Table 34). Greatest total fish density occurred in 2000 and least in 2003. Six species were collected in 2004; three non-native species were most abundant and less than 5% of the fishes collected were native species. No protected species was found in Reach 1 primary channel habitats. Red shiner was the most commonly collected species in all years. Channel catfish levels have been fairly consistent for the past three years. Native sucker density increased slightly in 2004 samples (Figure 28). Red shiner and speckled dace densities remained fairly constant over the last 3 years. Other than 2002 when speckled dace density peaked, their levels have remained around 0.01/ m^2. Western mosquitofish have been absent from samples since 2000.

Despite an increase in relative abundance from less than 1% in 2000 to 4% in 2003, total number of native fishes has never exceeded 20 specimens in Reach 1 (Figure 29). Sampling in 2004 produced results similar to 2003. Autumn density of fish species was not significantly related to any discharge attribute, except for fathead minnow, which was negatively associated with summer flows (Table 35).

Table 34. Number and density (number/m^2) of fishes in San Juan River primary channel in Geomorphic Reach 1 during autumn, 2000– 2004.

2000			2001			2002			2003			2004		
SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN
CYPLUT	3664	12.856	CYPLUT	142	0.686	CYPLUT	502	2.154	CYPLUT	76	0.198	CYPLUT	143	0.531
GAMAFF	336	1.179	PIMPRO	3	0.014	ICTPUN	30	0.113	ICTPUN	36	0.094	ICTPUN	38	0.141
PIMPRO	17	0.060	CATLAT	2	0.010	PIMPRO	15	0.056	CATLAT	2	0.005	PIMPRO	10	0.037
CATLAT	2	0.007	ICTPUN	2	0.010	RHIOSC	15	0.056	RHIOSC	2	0.005	CATLAT	4	0.015
RHIOSC	1	0.004	RHIOSC	1	0.005	CATLAT	3	0.011	CATDIS	1	0.003	CATDIS	3	0.011
CATDIS	1	0.004	FUNZEB	1	0.005	CATDIS	1	0.004	FUNZEB	1	0.003	RHIOSC	2	0.007
FUNZEB	1	0.004				CYPCAR	1	0.004	PIMPRO	1	0.003			
N	4025			151			567			119			200	
AREA	285			207			266			383			269	
DENSITY	14.123			0.729			2.132			0.311			0.743	
H	0.245			0.259			0.387			0.906			0.892	

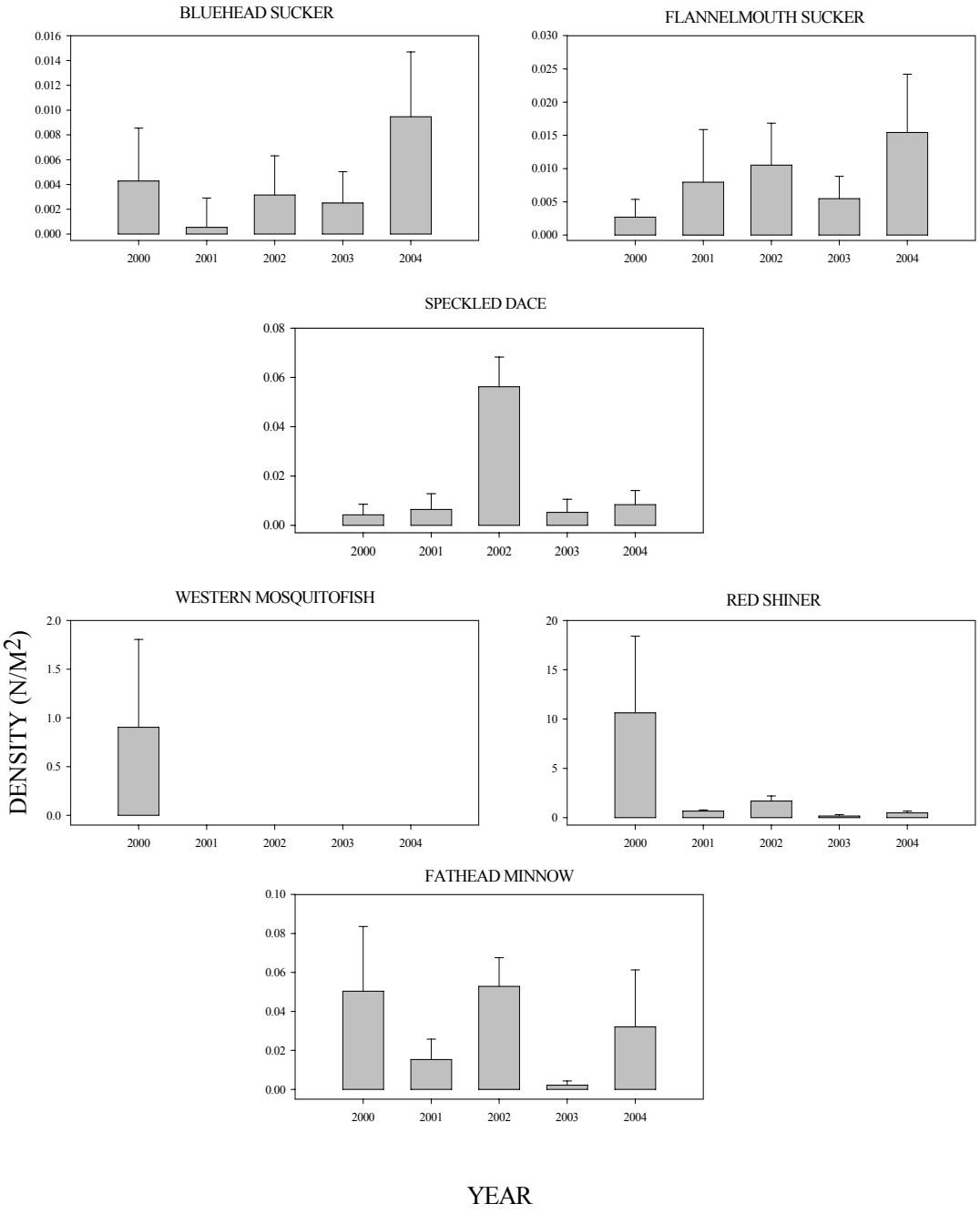

Figure 28. Densities of commonly collected fish species in Reach 1 primary channel, San Juan River 2000-2004. Error bars represent standard error.

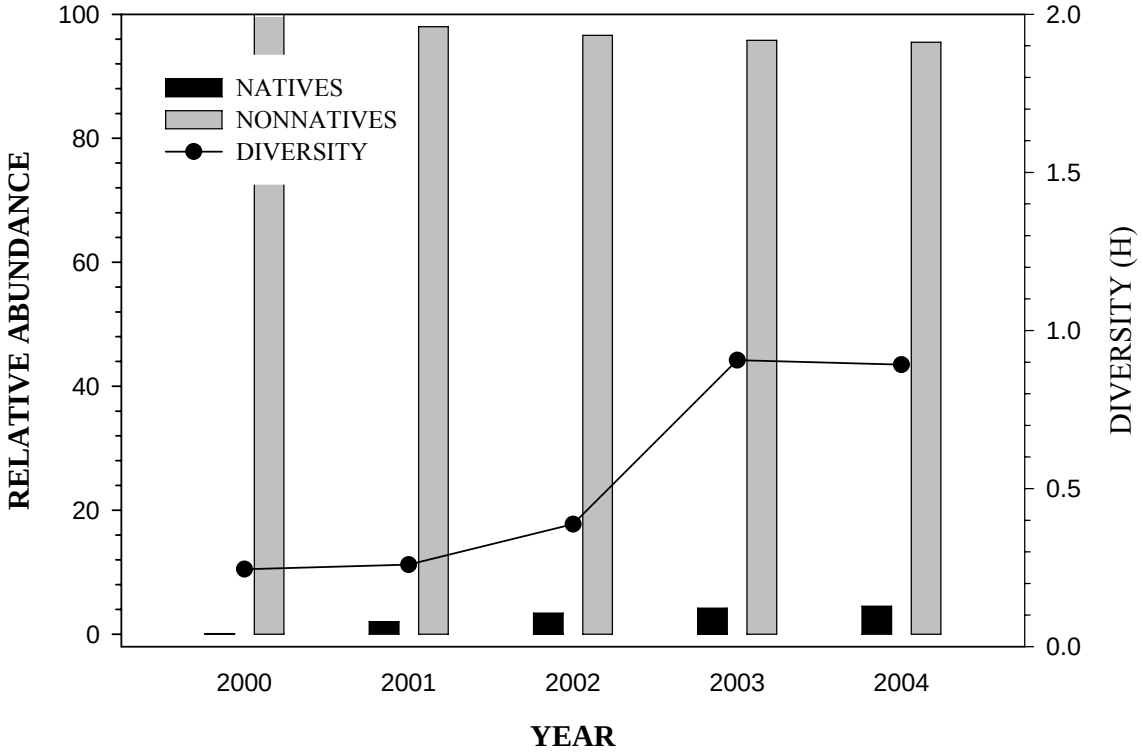

Figure 29. Relative abundance of native and nonnative fish species in Reach 1 primary channel, San Juan River, 2000-2004.

Table 35. Regression analysis results for density of commonly collected native and non-native fish species in San Juan River Reach 1 primary channel (2000-2004) versus average mean daily spring discharge, average mean daily summer discharge, and days mean daily summer discharge less than 500 cfs. *indicates significant relationship at $\alpha = 0.05$.

	SPRING Q		SUMMER Q		<500 CFS	
	R	*p*	R	*p*	R	*p*
NATIVES	-0.60	0.287	-0.339	0.572	0.867	0.057
CATDIS	-0.230	0.708	-0.351	0.564	0.386	0.521
CATLAT	0.191	0.759	-0.201	0.744	0.207	0.738
RHIOSC	-0.639	0.245	-0.270	0.655	0.837	0.077
NONNATIVES	-0.048	0.939	-0.839	0.072	0.130	0.835
CYPLUT	-0. 071	0.911	-0.871	0.055	0.188	0.762
GAMAFF	0.062	0.920	-0.730	0.161	-0.061	0.922
PIMPRO	-0.30	0.622	-0.970*	0.003	0.612	0.273

Seventy seven percent of the area sampled in Reach 1 was moderate velocity. Rapid-velocity mesohabitats made up 6% of the area sampled and slow-velocity areas and backwaters were 6% and 2% of area sampled. Few native fishes were collected and almost all were found in moderate-velocity mesohabitats (Figure 30). Fathead minnow was mainly found in backwater areas, while red shiner was found in habitats in proportion to area sampled.

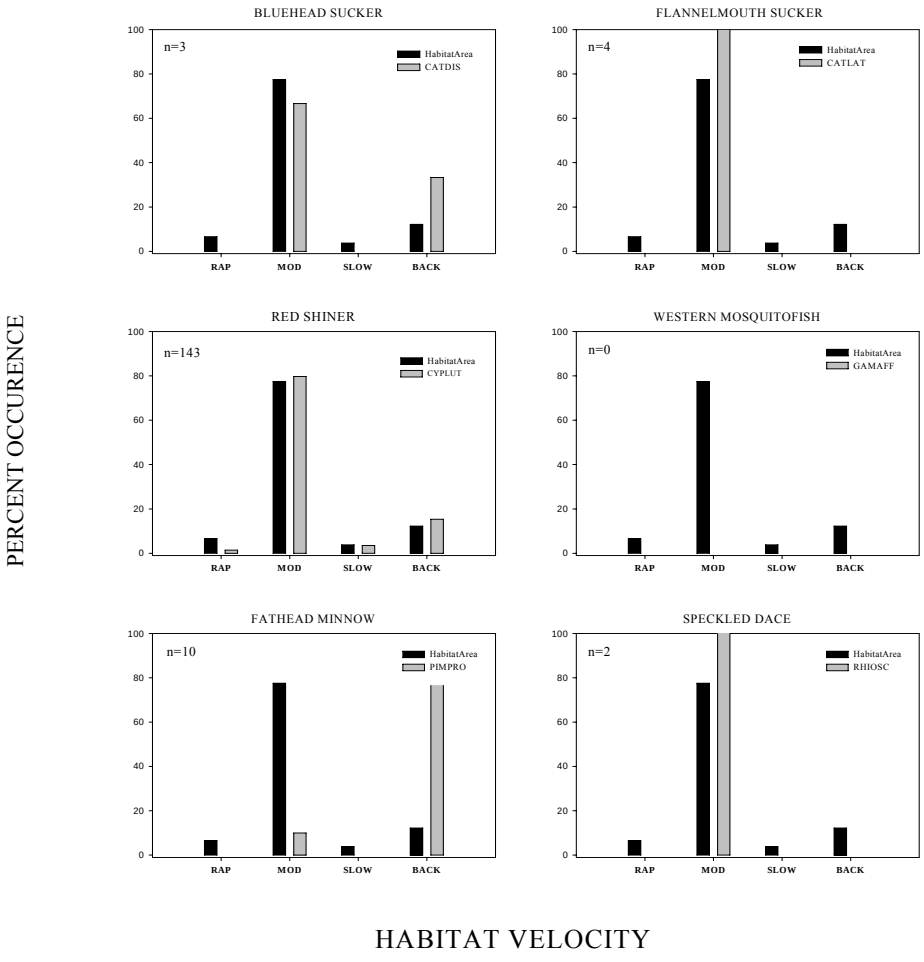

Figure 30. Occurrence of commonly collected fish species in Reach 1 primary channel, San Juan River, 2004.

REACH 1—BACKWATERS

No backwater was present in Reach 1 in 2003 or 2004. From 2000 through 2002, red shiner was the most common species in Reach 1 backwaters (Table 36). Greatest total density of fishes occurred in 2000, when red shiner comprised over 96% of the collections. No native fish species was common and none was present in all years. No protected species has been found in Reach 1 backwaters.

Table 36. Number and density (number/m^2) of fishes in San Juan River backwaters in Geomorphic Reach 1 (RM 17 – RM 0) during autumn, 2000 – 2004.

2000			2001			2002			2003	2004
SPECIES	N	DEN	SPECIES	N	DEN	SPECIES	N	DEN		
CYPLUT	4769	31.977	CYPLUT	97	2.425	CYPLUT	99	2.25	**N**	**N**
GAMAFF	91	0.419	PIMPRO	1	0.025	PIMPRO	14	0.318	**O**	**O**
PIMPRO	57	0.263	RHIOSC	1	0.025	ICTPUN	8	0.182		
CATLAT	9	0.042	ICTPUN	1	0.025	CYPCAR	1	0.023	**B**	**B**
CATDIS	9	0.042	GAMAFF	1	0.025	AMEMEL	1	0.023	**A**	**A**
ICTPUN	4	0.018	CATLAT	1	0.025	GAMAFF	1	0.023	**C**	**C**
CYPCAR	3	0.014							**K**	**K**
LEPMAC	2	0.009							**W**	**W**
									A	**A**
									T	**T**
									E	**E**
									R	**R**
									S	**S**
BKWS N	7		4			2				
N	4944		104			124				
AREA	217		40			44				
DENSITY	22.783		2.6			2.818				
H	0.157		0.325			0.501				

SPECIES LONGITUDINAL DISTRIBUTIONS—2004

In general, average autumn densities of native species densities were greater in upstream reaches than downstream. Native suckers had higher densities in secondary channel samples (Figure 31). Speckled dace levels were similar between channels, except in Reach 6 where primary channel densities were more than twice as high as secondary channel densities. There were few longitudinal trends apparent in densities of commonly collected nonnative species in 2004 (Figure 32). Channel catfish density increased slightly downstream in both primary and secondary channels. Western mosquitofish density had no discernablelongitudinal pattern, but it was absent in samples taken in Reach 1 in 2004.

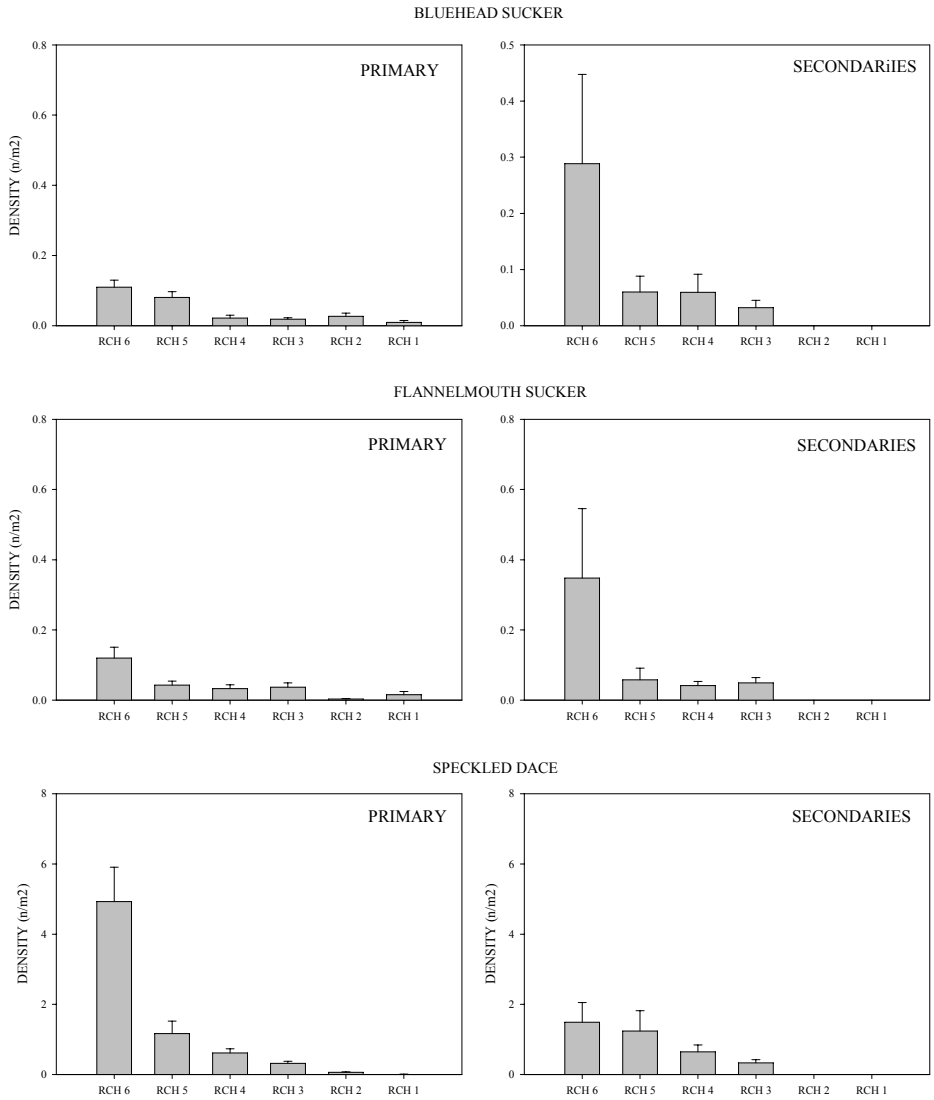

Figure 31. Longitudinal density patterns of commonly collected native fish species in primary and secondary channels, San Juan River, 2004. Error bars represent standard error of sample densities.

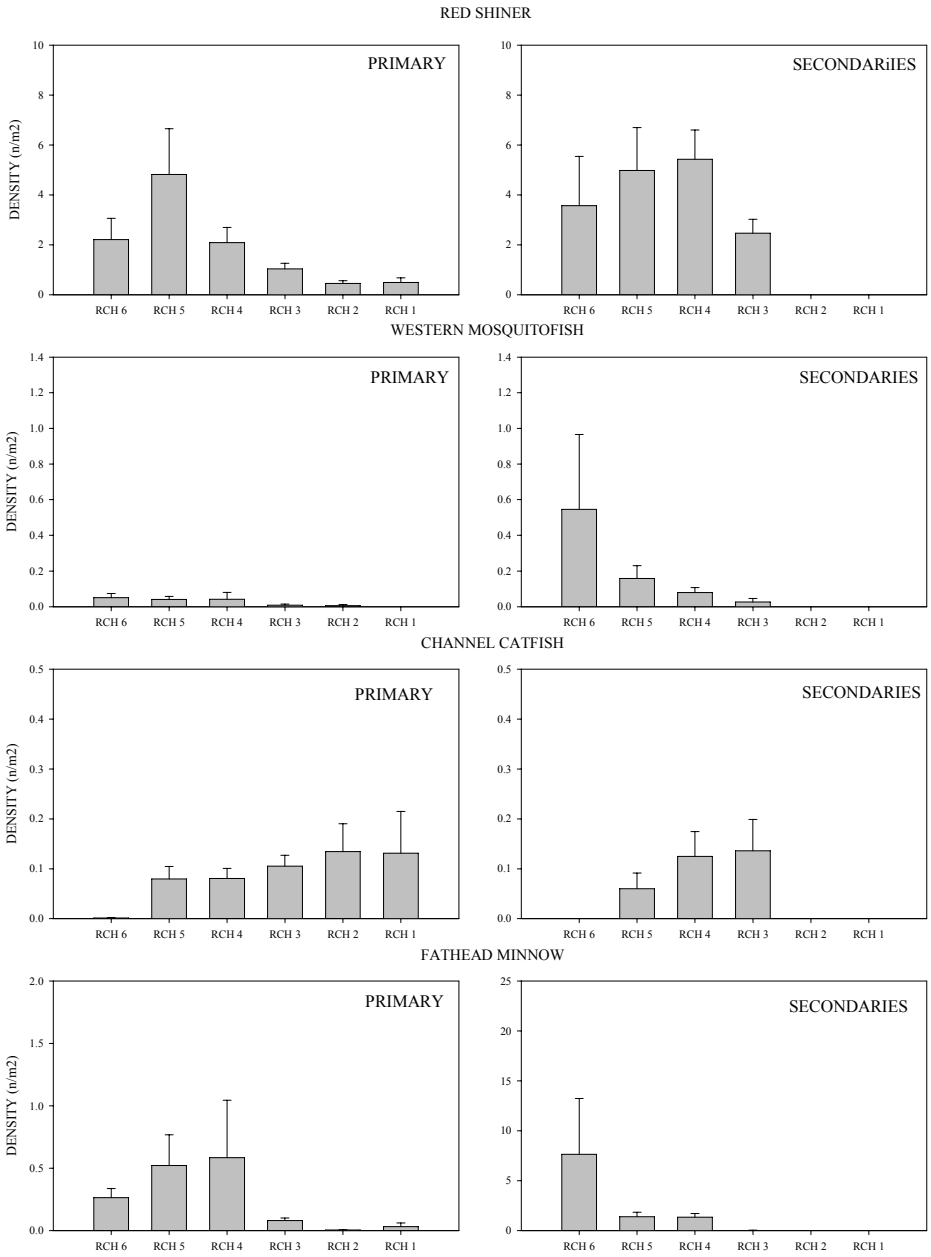

Figure 32. Longitudinal density patterns of commonly collected nonnative fish species in primary and secondary channels, San Juan River, 2004. Error bars represent standard error of sample densities.

ELECTROFISHING AND SEINING COMPARISON – 2004

In 2004, electrofishing into a bag seine was added to sampling methods. This method was added to determine if gear bias influenced the species and size of fishes collected in small-bodied fishes monitoring. Initial comparisons indicate slightly, but not significantly, higher densities of all fish species in seine than electrofishing samples in riffle-run, riffle, run, shoal, and shore run habitats of the primary channel (Figure 33). Six species (black bullhead, common carp, plains killifish, green sunfish, largemouth bass, and Colorado pikeminnow) were collected only with seines.

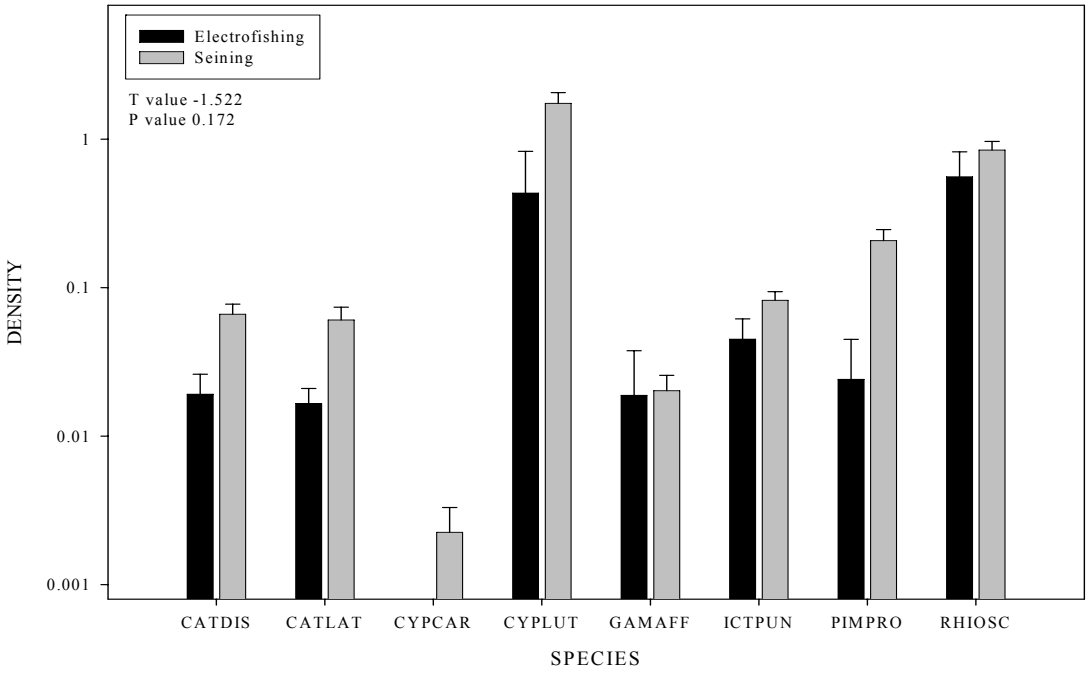

Figure 33. Average densities of fish species using electrofishing and seining methods in similar habitat of the primary channel of the San Juan River, 2004. Note that density (Y) axis is on a log scale. Error bars represent standard error. Paired t tests were performed between electrofishing and seining sample densities.

Though not significant, there may be a slight gear bias in length of specimens collected; mean total lengths of bluehead sucker, flannelmouth sucker, and channel catfish specimens captured electrofishing were slightly greater than those captured seining (Figure 34). Average lengths of bluehead sucker, flannelmouth sucker, and channel catfish were slightly, though not significantly, higher in those samples collected with the aid of electrofishing (t=3.69, P=0.066).

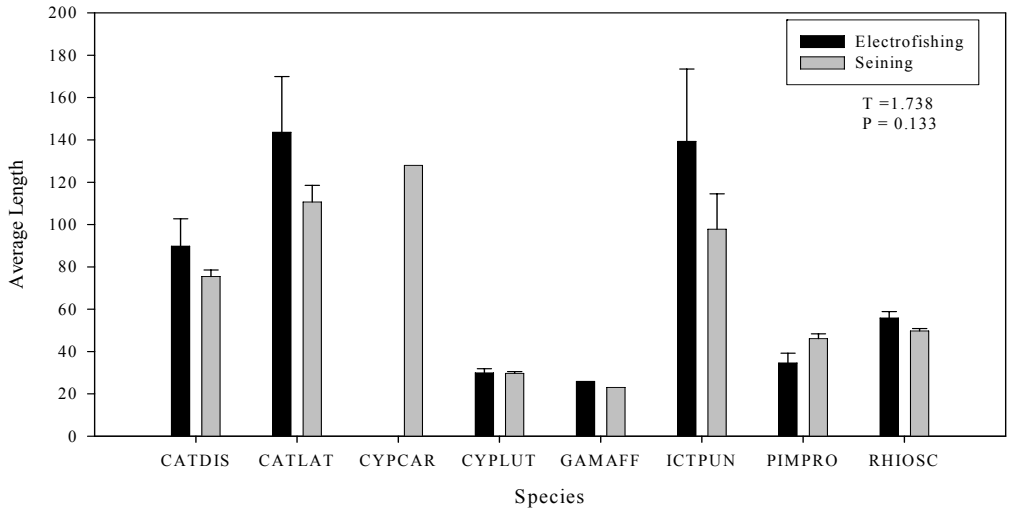

Figure 34. Average length of fish species sampled in the primary channel of the San Juan River, 2004. Error bars represent standard error. Paired t tests were performed between fish caught using electrofishing vs. seining techniques.

SUMMARY

PRIMARY CHANNEL

1. Since 1998, six native and nine nonnative fishes have been captured in San Juan River primary channel during small-bodied monitoring (Reaches 6 through 1).
2. In 2004, four native (speckled dace, bluehead sucker, flannelmouth sucker, and Colorado pikeminnow) and six nonnative (red shiner, fathead minnow, channel

catfish, plains killifish, western mosquitofish, and green sunfish) species were captured in San Juan River primary channel (Reaches 6 through 1). More specimens were collected in 2004 (n = 17,042) than in any previous year, except 2000 (n = 22,887).

3. Greatest total fish density (5.07 fish/m^2) in San Juan River primary channel was in 2000 and least (0.32 fish/m^2) was in 1999. Fish density of samples taken in 2004 were slightly higher (2.19 fish/m^2) than the average of the 6 previous years of sampling (1.80 fish/m^2).
4. Greatest native fish density (0.65 fish/m^2) was in 2004 and least (0.05 fish/m^2) was in 2000. Greatest nonnative fish density (5.02 fish/m^2) was in 2000 and least (0.23 fish/m^2) was in 1999.
5. In 2004, native fish density in San Juan River primary channel was 0.65 fish/m^2 and nonnative fish density was 1.54 fish/m^2.
6. Red shiner was the most common species in all years and speckled dace was second-most common in all years, except 2000 (western mosquitofish) and 2002 (fathead minnow).
7. Bluehead sucker and flannelmouth sucker were uncommon (<50 individuals/year) from 1998 through 2001, but flannelmouth sucker was comparatively common (>100 individuals/year) in 2002, 2003, and 2004 and bluehead sucker in 2004.
8. Channel catfish was comparatively common (>100 individuals/year) in 1998 (0.117 fish/m^2), but was uncommon from 1999-2001 (<0.01 fish/m^2). From 2002-2004 average autumn channel catfish densities were considerably greater (>0.06 fish/m^2).

9. Four Colorado pikeminnow specimens were collected in San Juan primary channel in 1998 and 2004.
10. One specimen of roundtail chub was found in each 1998 and 1999.
11. No razorback sucker specimen has been collected in primary channel during small-bodied fishes autumn monitoring.
12. Other than channel catfish, black bullhead was the only other ictalurid found (2002) in San Juan River primary channel from 1998 through 2004.
13. Centrarchids (green sunfish and largemouth bass) were rare (<5 individuals/year). 2004 was the first year that both species were collected.
14. In 2004, greatest density of each commonly collected native fish species was in Reach 6. Density of each generally declined in a downstream direction.
15. In 2004, density of red shiner in primary channels was greatest in Reach 5 and from there, generally declined in a downstream direction. Fathead minnow density was higher in Reaches 6 through 4 than in Reaches 3 through 1.
16. Channel catfish was absent in Reach 6, slightly increased from Reach 5 through 2, and decreased slightly in Reach 1. Western mosquitofish density was almost equal in Reaches 6 through 4, and was zero, or nearly zero in downstream reaches.
17. The only association of native fishes density and flow attributes in the primary channel was that autumn density of flannelmouth sucker had a positive relationship with the number of low flow days in Reach 2.

18. Overall autumn density of nonnative fishes, primarily red shiner, was significantly and negatively associated with summer flows in Reach 6 primary and Reach 5 primary.
19. Most samples were collected in moderate-velocity habitats in 2004. Native fishes were more commonly associated with moderate-velocity and rapid-velocity mesohabitats than with slower-velocity habitats.
20. Collections of nonnative fishes were less consistent in their association with various habitat types in Reaches 6-1. Fathead minnow and western mosquitofish were disproportionably found in backwaters in Reach 4 and Reach 1 (fathead only). Red shiner densities were distributed fairly evenly with the percentage of habitat sampled.

SECONDARY CHANNELS

1. Since 1998, six native and 11 nonnative fish species have been captured in San Juan River secondary channels (Reaches 6 through 3).
2. In 2004, four native (speckled dace, bluehead sucker, flannelmouth sucker, and Colorado pikeminnow) and nine nonnative (red shiner, common carp, fathead minnow, black bullhead, channel catfish, plains killifish, western mosquitofish, green sunfish, and largemouth bass) fish species were collected in San Juan River secondary channels.

3 Greatest fish density (7.58 fish/m^2) in San Juan River secondary channels was in 2000 and least (0.32 fish/m^2) was in 1999.

3. Greatest native fishes density was in 2004 (0.89 fish/m^2) and least (0.09 fish/m^2) was in 1999. Total native fishes density has steadily increased since 1999.
4. In 2004, total native fishes density was 0.89 fish/m^2, the highest since 1998 (0.32 fish/m^2). Total nonnative fishes density was 5.28 fish/m^2 in 2004
5. Red shiner was the most common fish species in all years. Speckled dace was second-most common in 1998 and 1999, but fathead minnow was second-most common in subsequent years.
6. Bluehead sucker and flannelmouth sucker were uncommon (<50 individuals/year) from 1998 through 2001. In 2004, more bluehead sucker specimens were collected (n = 122) than in any previous year for a density of (0.07 fish/m^2). Flannemouth sucker densities were higher in 2002 through 2004 (average = 0.08 fish/m^2) than in the three previous years sampling (average = 0.02 fish/m^2).
7. 2004 was the first year >100 channel catfish specimens were collected in secondary channels. In secondary channels, channel catfish densities have increased each year, from < 0.01 fish/m^2 in 1999 to 0.06 fish/m^2 in 2004.
8. Colorado pikeminnow specimens were collected in San Juan River secondary channels in 1998 (n = 1), 1999 (n = 1), 2000 (n = 3), and 2004 (n=4).
9. Roundtail chub has not been collected since 1999 in San Juan River secondary channels.
10. Black bullhead and yellow bullhead were found in low numbers (<10 individuals) in most years.

11. Green sunfish and largemouth bass were the only centrarchids found in San Juan River secondary channels and neither was common. Both species were collected in 2004.
12. In 2004, greatest secondary channel density of native fishes was in Reach 6 and declined through Reach 3. Bluehead and flannelmouth suckers were considerably more common in Reach 6 than downstream reaches.
13. Fathead minnow density was greatest in Reach 6 while greatest density of red shiner was in Reach 4. Channel catfish was absent in Reach 6 and increased in density from Reach 5 through 3. Western mosquitofish density was greatest in Reach 6 and declined through Reach 3.
14. The only association of native fishes density and discharge attributes in secondary channels was that autumn density of flannelmouth sucker had a positive relationship with the number of low flow days in Reach 5.
15. Overall autumn density of nonnative fishes, primarily red shiner, was significantly and negatively associated with summer flows in Reach 5 secondary, Reach 4 secondary (only red shiner) and Reach 3 secondary channels. Nonnative densities were also significantly negatively related to spring flows and positively related to low flow days in Reach 6 secondary channels.
16. Commonly collected native fish species were commonly found in all secondary channel mesohabitat velocity categories in 2004. Distribution of native fish was proportional to the area of habitat sampled, except in Reach 6where fish were more likely to be collected in moderate-velocity habitats than rapid-velocity.

17. In Reaches 6 through 4, nonnative species were much more common in slow-velocity habitats, than fast-velocity. In Reach 3, red shiner and western mosquitofish were sampled more often in rapid-velocity habitats while fathead minnow was found more often in backwaters.

BACKWATERS

1. Comparatively few backwaters were present in 2004. Fourteen backwaters and one embayment were sampled in Reaches 6 through 1; greatest number (n = 10) was in Reach 3 and none was in Reaches 6, 4, or 1.
2. Since 1999, four native and 10 nonnative fish species have been collected in San Juan River backwaters (including embayments and isolated pools) in Reaches 6 through 1.
3. In 2003, three native (speckled dace, bluehead sucker, and flannelmouth sucker) and six nonnative (red shiner, common carp, fathead minnow, channel catfish, western mosquitofish, and green sunfish) fish species were collected in San Juan River backwaters.
4. Greatest total fish density (16.32 fish/m^2) in backwaters occurred in 2000, but total fish density (11.42 fish/m^2) was also high in 2002. Lowest total fish density (1.56 fish/m^2) was in 2003. Density in 2004 was 5.21fish/m^2.

5. Greatest native fish density (0.16 fish/m^2) was in 2001 and least (0.04 fish/m^2) was in 2003. Native fishes density was 0.05 fish/m^2 in 2004. Greatest nonnative fish density (16.28 fish/m^2) was in 2000 and least (1.53 fish/m^2) was in 2003. Nonnative fish densities was 5.16 fish/m^2 in backwaters in 2004.
6. Red shiner and fathead minnow were first- and second-most common in all years.
7. Native fish species were uncommon (<50 individuals/year) in all years. Speckled dace was most common (n = 37) in 2002, bluehead sucker (n = 71) in 2002, and flannelmouth sucker was most common (n = 33) in 2000. All native fish species were uncommon ($\leq$ 10 individuals/species) in 2004.
8. One specimen of Colorado pikeminnow was collected in each 1999 and 2000.
9. Black bullhead was collected in all years, except 1999 and 2004, and was comparatively common (n = 106) in 2000.
10. At least one centrarchid specimen (bluegill, green sunfish, or largemouth bass) was collect in all years, except 1999 and 2004.

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