SYSTEMATIC INVESTIGATIONS OF WARMWATER FISH COMMUNITIES

FW-17-R-36

PERFORMANCE REPORT

1 JULY 2008—30 JUNE 2009

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STEPHANIE M. CARMAN, & NIKOLAS D. ZYMONAS

CONSERVATION SERVICES DIVISION

NEW MEXICO DEPARTMENT OF GAME AND FISH

SANTA FE, NEW MEXICO

14 AUGUST 2009

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STATE: New Mexico **GRANT NUMBER:** FW-17-R-36

GRANT TITLE: Vertebrate Wildlife Studies

PROJECT TITLE: Systematic Investigations of Warmwater Fish Communities

PROJECT PERIOD: 1 July 2008 **TO:** 30 June 2009

PROJECT STATEMENT

To investigate and document the status and dynamics of warmwater stream fish communities, describe the biology and habitat associations of resident species through long-term monitoring inventories and systematic monitoring, and use this information to develop and improve management strategies for sport fishes in warmwater streams.

OBJECTIVES/PROCEDURES

A. Conduct ichthyological inventories of warmwater streams in New Mexico to document the occurrence, range, and status of resident nongame and game species. Emphasis will be upon drainages, or drainage segments that have not been systematically inventoried in the past.

GILA RIVER DRAINAGE

In 2006, New Mexico Department of Game and Fish received funding, exclusive of FW-17-RD, to systematically inventory the East, Middle, and West forks of the Gila River. Inventories of each have been completed and a final report detailing findings of this effort will be provided in a subsequent performance report.

SOUTH CANADIAN RIVER DRAINAGE

During 2004-2007, the Canadian River drainage of northeast New Mexico was systematically surveyed to document distribution and status. Support for this work was provided by State Wildlife Grants. When the final report for this inventory is completed, and based upon recommendations of the contractor, permanent sites will be selected for annual monitoring of fish assemblages.

B. Establish a monitoring protocol for each stream system after it has been thoroughly inventoried and permanent monitoring sites have been selected. Specific protocol for each stream depends upon species and macrohabitats present and relative size of stream.

Annual monitoring of San Juan River fish assemblages is accomplished each year in September and October following procedures set forth in Propst et al. 2000. Within this monitoring effort, New Mexico Department of Game and Fish has responsibility for sampling small-bodied fishes in primary and secondary channels and backwaters. Data obtained from this effort (partially supported by FW-17-RD) is reported annually.

Annual monitoring of permanent sites in the Gila River drainage has followed established protocols since 1988. Five sites (Tularosa River at Eagle Peak Road, San Francisco River at Glenwood Ranger Station, Middle Fork Gila River at Trailhead, and East Fork Gila River at Fall Spring) were established in 1988. A sixth site (West Fork Gila River at Cliff Dwellings) was established in 1989. Two additional sites were established in 1997 in cooperation with U.S. Bureau of Land Management (USBLM). These sites were located on the Gila River at Middle Box mouth and at Fisherman's Overlook (in Lower Gila Box). From 1997 through 2001, data collected at these two sites were provided to USBLM in annual reports. Beginning in 2002, both sites were added to the sites sampled in the Gila River drainage as part of FW-17-R.

Between 1998 and 2001, eight permanent sites on the Pecos River between Old Fort State Park (near Fort Sumner) and Brantley Reservoir were sampled quarterly. This monitoring was accomplished in cooperation with the U.S. Fish and Wildlife Service (NM Fisheries Resource Office). This work was funded under a separate project and results were not reported in FW-17-R performance or completion reports. Based upon power analysis of data collected at 18 Pecos River sites over a 10-year period (1991-2001; R.K. Dudley, pers. comm.), it was determined that an appropriate monitoring regime for Pecos River fish assemblages (Fort Sumner to Brantley Reservoir reach) required sampling each of 15 sites 6 times a year. Accordingly, a protocol for sampling these sites was developed. Beginning in 2004, monitoring of permanent Pecos River sites was accomplished under FW-17-R. These data are being compiled by USFWS NM Fisheries Resource Office and NMGF CSD personnel and will be provided in a separate report. Currently, 14 permanent sites are monitored bimonthly on the Pecos River from near Pecos downstream to near Delaware River confluence.

Assessment of the distribution and abundance of large-bodies fishes in the lower Pecos River large pools and reservoirs was begun in 2000 and continued through 2006. Extensive fish kills associated with blooms of golden algae *Prymnesium parvum* on the Pecos River began occurring in 2002. Monitoring of large-bodied fishes in the lower Pecos River large pools and reservoirs began in 2007, to document recovery from the fish kills.

When the final report on distribution and status of Canadian River fishes is provided, permanent monitoring sites will be selected and annually sampled.

San Juan River

The annual report for 2008 monitoring of San Juan River small-bodied fishes was submitted to the San Juan River Basin Recovery Implementation Program in March 2009 (Appendix I).

Gila River

Fish assemblages at eight permanent sites in the Gila River drainage were sampled, following established protocols, in October 2008. Data collected on fish assemblages since sampling began at each site were summarized and are presented herein.

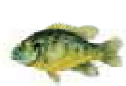
Tularosa River—Eagle Peak Road

Annual monitoring of the fish assemblage at the Tularosa River Eagle Peak Road site began in 1988 and has occurred annually, in autumn, since then. High discharge during sampling in 2000 likely diminished collection efficiency.

Five native and four nonnative fish species have been collected at this site since 1988. From 1988 through 1999, each native species was present each year, but in 2000 neither loach minnow nor desert sucker was collected. Their absence in 2000 may have been a consequence of reduced sampling efficiency during high discharge. Loach minnow was collected in 2008, the first time it has been collected since 2002. No nonnative species was collected in 2008. Rainbow trout was the only game species collected at the site, and it was found only in 1996.

Table 1. Occurrence of fishes at Tularosa River Eagle Peak Road site, Catron County, New Mexico, 1988 – 2008

Species	Year																				
Native	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**
Longfin dace	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Speckled dace	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Loach minnow	X	X	X	X	X	X	X	X	X	X	X	X		X	X						X
Sonora sucker	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Desert sucker	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Nonnative																					
Fathead minnow					X				X	X			X		X					X	
Rainbow trout										X											
Western mosquitofish		X		X	X		X		X					X	X	X	X			X	
Brook stickleback															X						



Density of native fishes averaged 1.242 fish/m^2 (SE = 0.17, n = 21) at the site and that of nonnatives was 0.030 (SE = 0.01, n = 21). Relative abundance of native fishes was greater than 90% in all years, except 2001 and 2003 (Table 2).

Table 2. Density (fish/m^2) and relative abundance of native and nonnative fishes collected at Tularosa River Eagle Peak road permanent site, Catron County, New Mexico, 1988-2007.

Year	Total N	Area (m^2)	% Native	% Nonnative	Density Natives	Density Nonnatives
1988	594	704	100	0	0.844	0
1989	995	619	99.9	0.2	1.080	0.003
1990	452	625	100	0	0.723	0
1991	1172	617	99.8	0.2	1.897	0.003
1992	854	598	92.6	7.4	1.322	0.105
1993	446	500	100	0	0.893	0
1994	360	410	99.7	0.3	0.877	0.002
1995	850	214	100	0	3.978	0
1996	364	324	98.9	11.1	1.112	0.012
1997	220	358	99.1	0.9	0.608	0.006
1998	387	196	100	0	1.975	0
1999	336	298	100	0	1.128	0
2000	93	226	93.6	6.4	0.385	0.026
2001	183	397	89.6	10.4	0.413	0.048
2002	262	319	93.1	6.5	0.765	0.065
2003	632	292	88.3	11.7	1.911	0.253
2004	387	220	96.4	3.6	1.696	0.064
2005	262	217	100	0	1.207	0
2006	170	273	100	0	0.622	0
2007	341	350	95.9	4.1	0.959	0.041
2008	697	414	100	0	1.684	0

San Francisco River—Glenwood

Annual monitoring of the fish assemblage at the San Francisco River Glenwood site began in 1988. High discharge precluded sampling in autumn 2000 and necessitated postponing sampling in 2006 until November (and discharge remained comparatively high and likely reduced sampling efficiency). In autumn 2001, the site was moved downstream about 300m. Since 1988, five native and four nonnative fish species have been collected at the San Francisco River Glenwood site (Table 3). Each native species was collected in 2007, and nonnative fathead minnow was also collected. Since sampling at this location began, nonnative species were irregularly collected; of these, rainbow trout was most frequently collected. Largemouth bass has not been collected at the site since 1993. All rainbow trout collected were $\leq$230 mm total length. Only native fishes were collected in 2008 (Table 4). Native fish density averaged 0.862 fish/m^2 (SE = 0.18, n = 20) and nonnative 0.006 (SE<0.01, N = 20) since 1988.

Table 3. Occurrence of fishes at San Francisco River Glenwood Ranger Station site, Catron County, New Mexico, 1988-2008.

Species	Year																				
Native	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**
Longfin dace	X	X	X	X	X	X	X	X	X	X	X	X	**N O**		X	X		X		X	X
Speckled dace	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X
Loach minnow	X	X	X	X	X	X	X	X	X	X	X	X	**C O**	X	X	X	X	X	X	X	X
Sonora sucker	X	X	X	X	X	X	X	X	X	X	X	X	**L L**	X	X	X	X	X	X	X	X
Desert sucker	X	X	X	X	X	X	X	X	X	X	X	X	**E C**	X	X	X	X	X	X	X	X
Nonnative													**T**								
Fathead minnow	X	X						X					**I O**							X	
Rainbow trout			X	X	X		X				X	X	**N**	X							
Western mosquitofish	X		X				X					X				X					
Largemouth bass				X		X															

Table 4. Relative abundance and density (fish/m^2) of native and nonnative fishes at San Francisco River Glenwood Ranger Station site, Catron County, New Mexico, 1988-2008.

Year	Total N	Area (m^2)	% Native	% Nonnative	Density Natives	Density Nonnatives
1988	451	1473	99.6	0.4	0.305	0.001
1989	1184	1423	100	0	0.832	0
1990	658	962	99.4	0.6	0.680	0.004
1991	888	700	99.8	0.2	1.265	0.003
1992	399	1226	99.8	0.2	0.325	0.001
1993	587	739	99.7	0.3	0.892	0.003
1994	424	635	99.5	0.5	0.665	0.003
1995	532	205	99.6	0.4	2.589	0.010
1996	951	500	100	0	1.903	0
1997	1032	497	100	0	2.076	0
1998	617	232	99.2	0.8	2.633	0.021
1999	113	329	95.6	4.4	0.344	0.015
2000				**NO COLLECTION**		
2001	155	313	99.4	0.6	0.492	0.003
2002	152	482	100	0	0.315	0
2003	89	218	86.5	13.5	0.362	0.055
2004	73	536	100	0	0.136	0
2005	105	293	100	0	0.517	0
2006	42	320	100	0	0.131	0
2007	141	322	98.6	1.4	0.131	0.007
2008	183	282	100	0	0.649	0

West Fork Gila River—Cliff Dwellings

Annual monitoring of the fish assemblage at West Fork Gila River Cliff Dwellings site began in 1989. Elevated discharge may have diminished sampling efficiency in 2000. Seven native and five nonnative fish species have been collected at this site since 1989 (Table 5). Among native fishes, only speckled dace and desert sucker have been collected in all years. Sonora sucker was absent one year and longfin dace and spikedace were absent two years. Loach minnow was last collected in 2001 and headwater chub was present in about one-half the collections since 1989. From 2001 through 2003, several wildfires (e.g., Cub, and Dry Lakes Complex) burned large portions of West Fork Gila River drainage (J.A. Monzingo, pers. comm.). Ash flows (caused by intense convectional summer storms and spring snowmelt) have likely negatively affected native and nonnative fishes in West Fork Gila River. Within the sample site, deposits of fine silt were considerably more extensive and cobble substrata more armored between 2001 and 2003 than in previous years. High discharge during 2007 and 2008 mobilized fine sediments and cleansed interstitial spaces. Number of fish collected (and density) was greater in 2005 than in any year since 1998, but considerably fewer were collected in 2006 and 2007. Fish abundance was higher in 2008, but still considerably less than in late 1980s-early 1990s (Table 6). Warmwater nonnative fishes were rarely found at West Fork Gila River Cliff Dwellings site, but salmonids were found in most years. Many rainbow trout captured during 1990s were likely hatchery-produced fish, but since then most captures were likely wild fish (Figure 1). All brown trout captured were wild fish (Figure 2). Native fish density averaged 0.719 fish/m^2 (SE = 0.72, n = 20) and that of nonnatives averaged 0.025 (SE < 0.01, n = 20).

Table 5. Occurrence of fishes at West Fork Gila River Cliff Dwellings site, Catron County, New Mexico, 1989 – 2008.

Species	Year																			
Native	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**
Longfin dace	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X
Headwater chub			X	X			X				X		X		X	X	X	X		X
Spikedace	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X		X	X
Speckled dace	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Loach minnow	X	X	X	X	X	X	X	X	X	X	X		X							
Sonora sucker	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X
Desert sucker	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Nonnative																				
Rainbow trout	X	X	X	X	X	X	X	X	X	X	X		X			X			X	X
Brown trout				X	X	X	X	X	X	X	X	X	X	X			X	X	X	X
Yellow bullhead		X					X	X	X											
Western mosquitofish			X	X								X								
Smallmouth bass	X		X	X	X				X							X	X			

Table 6. Relative abundance and density (fish/m^2) of native and nonnative fishes at West Fork Gila River Cliff Dwellings site, Catron County, New Mexico, 1989-2008.

Year	Total N	Area (m^2)	% Native	% Nonnative	Density Natives	Density Nonnatives
1989	1164	393	99.7	0.3	2.954	0.008
1999	717	1635	97.8	2.2	0.429	0.010
1991	837	662	98.6	1.4	1.246	0.018
1992	817	1118	93.2	6.8	0.681	0.050
1993	638	561	93.1	6.9	1.059	0.078
1994	387	586	89.2	10.8	0.589	0.072
1995	681	344	97.8	2.2	1.935	0.044
1996	145	490	95.9	4.1	0.284	0.012
1997	288	373	96.5	3.5	0.745	0.027
1998	427	290	99.3	0.7	1.461	0.010
1999	129	502	96.1	3.9	0.247	0.010
2000	94	226	95.6	4.4	0.385	0.018
2001	177	420	98.9	1.1	0.417	0.005
2002	66	411	95.5	4.5	0.153	0.045
2003	30	423	100.0	0.0	0.071	0.000
2004	73	442	97.3	2.7	0.161	0.005
2005	277	420	98.9	1.1	0.652	0.007
2006	58	311	94.6	5.4	0.093	0.005
2007	91	299	81.3	18.7	0.247	0.057
2008	287	500	97.6	2.4	0.574	0.014

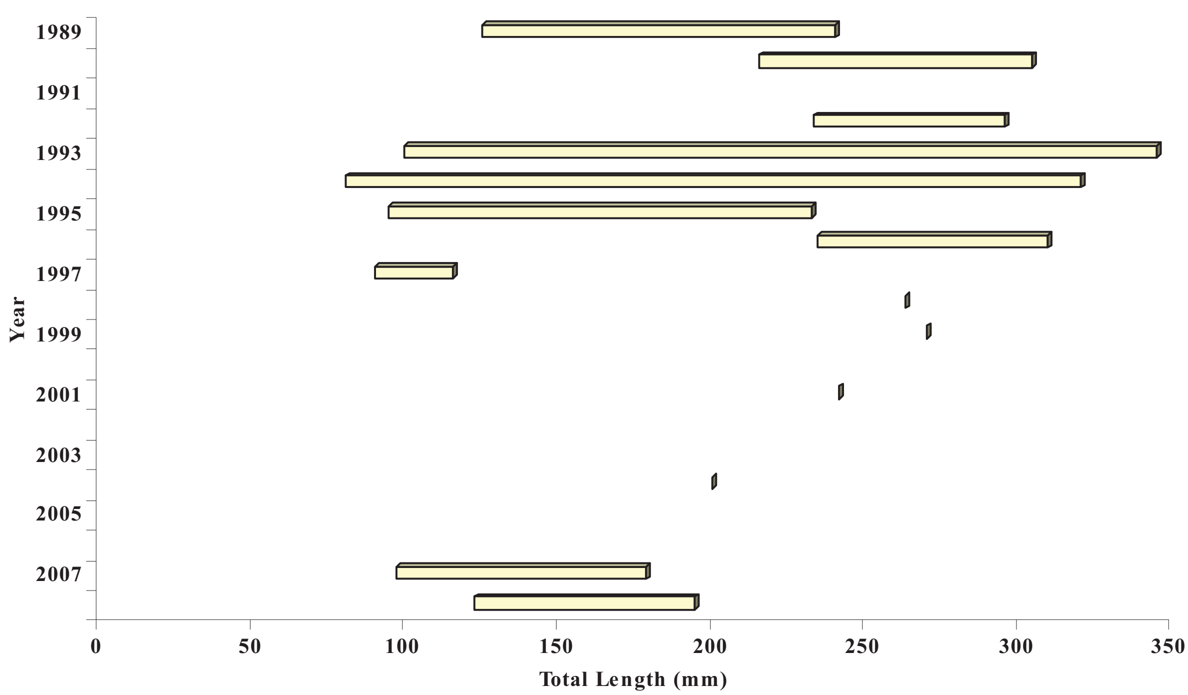


Figure 1. Total length (mm) range of rainbow trout captured at West Fork Gila River – Cliff Dwellings, Catron County, New Mexico, 1989- 2008.

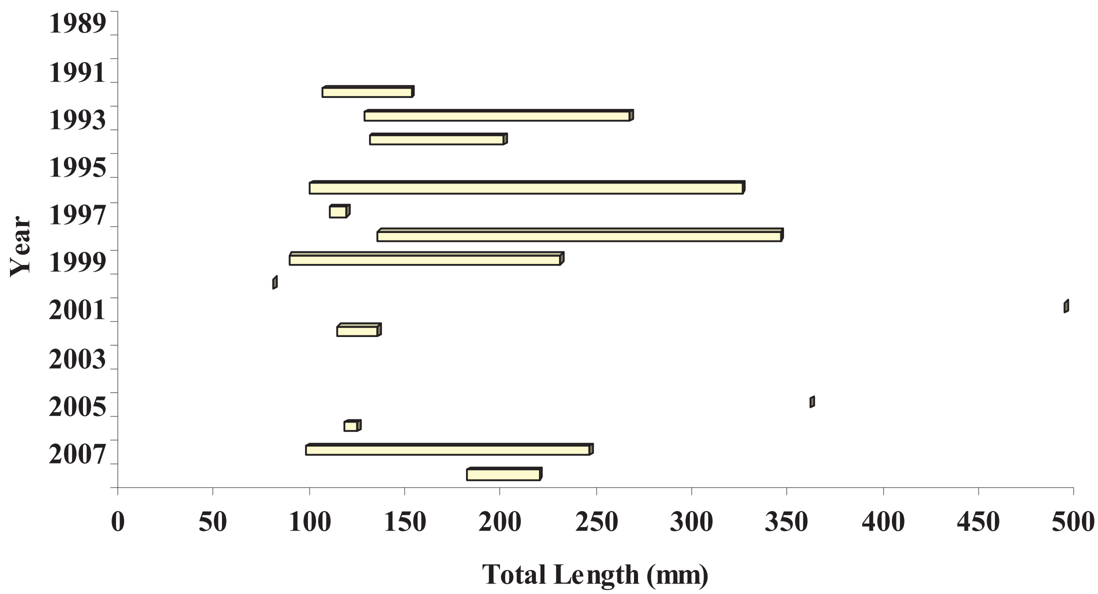


Figure 2. Total length range of brown trout captured at West Fork Gila River -- Cliff Dwellings, Catron County, New Mexico, 1989 – 2008.

<u>Middle Fork Gila River—Trailhead</u>

The Middle Fork Gila River Trailhead site has been sampled annually since 1988. High discharge in 2000 may have diminished sampling efficiency that year. Seven native and eight nonnative fish species have been collected at Middle Fork Gila River Trailhead site since 1988 (Table 7). From 1988 through 1995, all native species were present in all years, except spikedace in 1991 and 1994. From 2003 through 2005, Sonora and desert suckers were the only native species found at Trailhead site. In 2006, Sonora sucker was the only native species collected. In 2007, four native species were collected; both sucker species, longfin dace (last collected in 1997), and headwater chub (last collected in 2002). Another two native fishes (longfin dace and speckled dace) were found in 2008; loach minnow was the only native species not found in 2008. Sonora sucker was the only native species collected in all years. Nonnative yellow bullhead and smallmouth bass, both game fishes, were collected in all years. Collectively, these two piscivorous nonnatives were likely an important reason for absence of most native species at the site and low abundance of all fishes (including nonnative species) from the late 1990s through 2006. In addition, drought likely contributed to low abundance of all fishes during the same period. Native fish relative abundance was greater than 75% in all years, except 1990 (25%), from 1988 through 1993, but from 1994 through 2006 exceeded 50% only in 1995 (Table 8). With higher flows in 2007 and 2008, native fish abundance was similar to that found in late 1980s and early 1990s. Total fish density has not exceeded 1.000 fish/m^2 at Trailhead site since monitoring began at the site. Greatest native fish density was in 2008 (0.645 fish/m^2) and least (0.003 fish/m^2) in 2006. In 2006, native fish relative abundance was 5.9%, the lowest since monitoring began at this site. From 1988 through 2008, native fish density averaged 0.147 fish/m^2 (SE = 0.04, n = 21). Nonnative fish density generally increased from

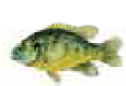
1988 (0.006 fish/m^2) through 1999 (0.275 fish/m^2), but since then has averaged only 0.068 fish/m^2. Nonnative fish density averaged 0.095 fish/m^2 (SE = 0.02, n = 21) at Middle Fork Gila River Trailhead site since 1988. Most yellow bullhead captured were between 100 and 200 mm TL, but several larger individuals were found (Figure 3). In most years, smallmouth bass captured ranged in length from about 75 to 250 mm TL, but larger individuals were often found (Figure 4).

Table 7. Occurrence of fishes at Middle Fork Gila River Trailhead site, Catron County, New Mexico, 1988-2008.

	Year																				
Species	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**
Native																					
Longfin dace	X	X	X	X	X	X	X	X		X											X
Headwater chub	X	X	X	X	X	X	X	X	X	X	X	X		X	X					X	X
Spikedace	X	X	X		X	X		X												X	X
Speckled dace	X	X	X	X	X	X	X	X			X										X
Loach minnow	X	X	X	X	X	X	X	X	X	X	X										
Sonora sucker	X	X	X	X	X	X	X	X	X	X	X	X			X	X		X		X	X
Desert sucker	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Nonnative																					
Fathead minnow	X			X		X															
Rainbow trout		X				X					X	X	X								X
Brown trout	X	X	X			X														X	X
Yellow bullhead	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Western mosquitofish		X			X		X		X		X	X	X	X	X	X					X
Green sunfish					X					X							X			X	
Bluegill					X																
Smallmouth bass	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Table 8. Relative abundance and density (fish/m^2) of native and nonnative fishes at Middle Fork Gila River Trailhead site, Catron County, New Mexico, 1988-2008.

Year	Total N	Area (m^2)	% Native	%Nonnative	Density Native	Density Nonnative
1988	170	1608	94.1	5.9	0.043	0.003
1989	468	1010	77.1	22.9	0.357	0.106
1990	182	1541	24.7	75.3	0.029	0.089
1991	259	1792	90.4	9.6	0.115	0.027
1992	777	2105	89.2	10.8	0.330	0.039
1993	391	670	91.6	8.4	0.534	0.049
1994	119	966	45.4	54.6	0.056	0.068
1995	159	779	59.4	40.6	0.102	0.069
1996	172	573	30.4	69.6	0.091	0.210
1997	110	299	34.6	64.4	0.124	0.244
1998	151	351	46.0	54.0	0.255	0.258
1999	146	557	15.0	85.0	0.050	0.212
2000	11	213	9.1	91.9	0.005	0.047
2001	46	458	28.3	71.7	0.028	0.072
2002	47	394	25.5	74.5	0.028	0.091
2003	25	333	32.0	68.0	0.024	0.051
2004	69	492	27.5	72.5	0.042	0.112
2005	44	504	31.8	68.2	0.028	0.060
2006	17	218	5.9	94.1	0.003	0.06
2007	51	207	80.4	19.6	0.198	0.049
2008	261	363	89.7	10.3	0.645	0.074



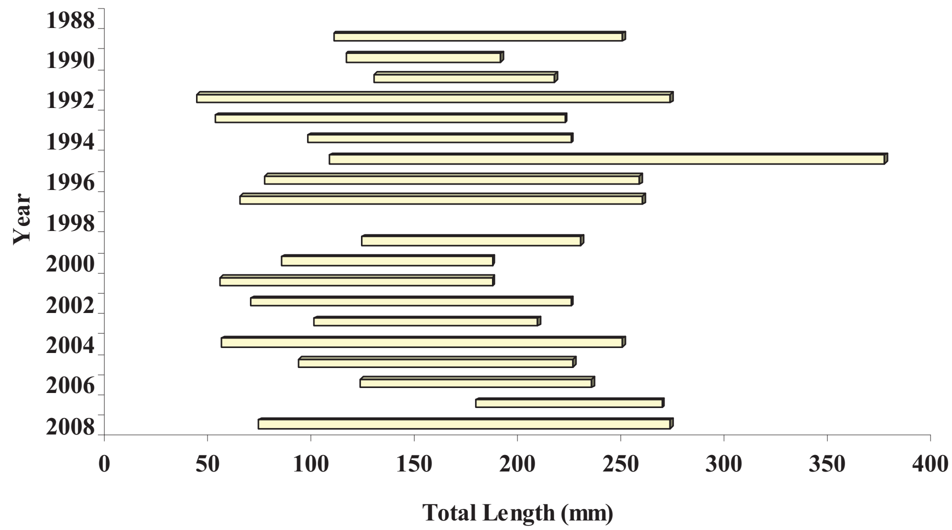


Figure 3. Total length (mm) range of yellow bullhead captured at Middle Fork Gila River – Trailhead, Catron County, New Mexico, 1988- 2008.

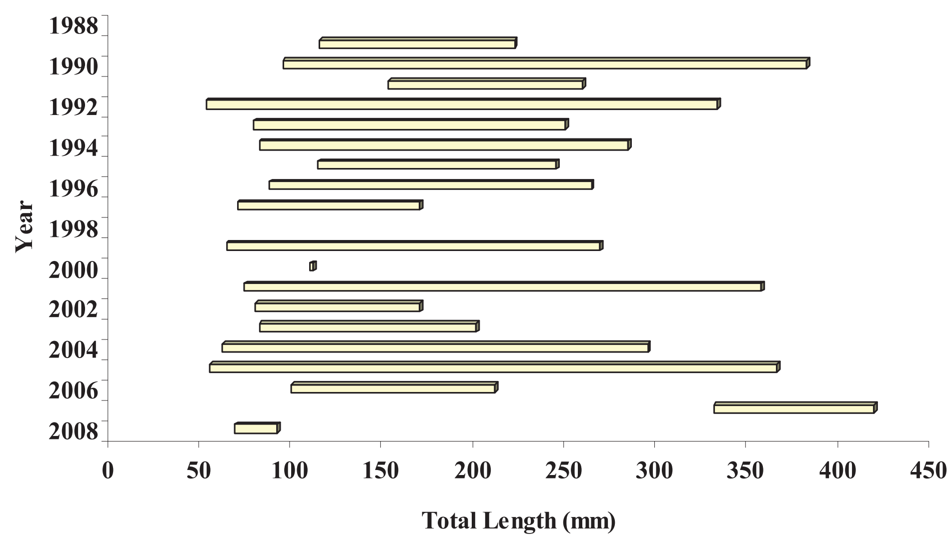
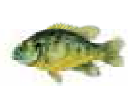


Figure 4. Total length (mm) range of smallmouth bass captured at Middle Fork Gila River – Trailhead, Catron County, New Mexico, 1988- 2008.



East Fork Gila River—Fall Spring

Annual monitoring of the fish assemblage of the upper East Fork Gila River began in 1988 at a site about 2.0 km downstream of the confluence of Beaver and Taylor creeks. Sampling at this site continued through 1995. No sampling occurred in 1996. Sampling at the current location (Fall Spring), about 4.0 km downstream of the initial site, began in 1997. Desert sucker and Sonora sucker were the only native species collected in all years at both the upper and lower East Fork Gila River sites (Table 9). Longfin dace, collected each year through 2000, has been intermittently found since 2000. Spikedace has not been collected since 2000, speckled dace since 2002, and loach minnow since 1999. Headwater chub was absent in 2002 and 2003, but otherwise present. No nonnative species was collected at both locations in all years, but western mosquitofish was found at the upper site in all years and at the lower site all years, except 1997 and 2005. Nonnative Chihuahua catfish, an undescribed species, was commonly found at the upper site, but was less frequently collected at the lower site. Smallmouth bass was present most years at both upper and lower sites. Yellow bullhead was present in 2003, 2004, 2006, 2007, and 2008. Native fish relative abundance exceeded 80% in most years from 1988 through 1999, steadily declined from 2000 through 2003, and increased somewhat since then (Table 10). In 2002 and 2003, nonnative relative abundance was greater than 75% of each year's collection. Native fish density was variable, ranging from a low of 0.225 (1997) to 1.876 fish/m^2 (1999) from 1988 through 2000, but from 2001 through 2003 was less than 0.200 fish/m^2 each year. In 2005, native fish density was 0.513 fish/m^2, the highest since 2000. Native fish density was comparatively high in 2007, but in 2008 was second-lowest (0.136) since sampling began at the site. Nonnative fish density was likewise variable among years, but was never greater than 1.000 fish/m^2. Native fish density has averaged 0.554 fish/m^2 (SE = 0.11, n = 20) and nonnative was 0.185 (SE = 0.05, N = 20) since 1988. Comparatively large smallmouth bass (>200 mm TL) were collected at the site, particularly from 1998 through 2008 (Figure 5).

Table 9. Occurrence of fishes at East Fork Gila River Fall Spring site, Catron County, New Mexico, 1988-2008.

	Year																				
Species	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**
Native																					
Longfin dace	X	X	X	X	X	X	X	X	**N**	X	X	X	X					X		X	
Headwater chub	X	X	X	X	X	X	X	X	**O**	X	X	X	X	X			X	X	X	X	X
Spikedace	X	X	X			X						X	X								
Speckled dace	X								**C**					X	X						
Loach minnow		X	X						**O**		X	X									
Desert sucker	X	X	X	X	X	X	X	X	**L**	X	X	X	X	X	X	X	X	X	X	X	X
Sonora sucker	X	X	X	X	X	X	X	X	**L**	X	X	X	X	X	X	X	X	X	X	X	X
									E												
Nonnative									**C**												
Fathead minnow	X		X			X			**T**				X								
Yellow bullhead									**I**			X				X	X		X	X	X
Channel catfish	X	X							**O**												
Chihuahua catfish			X	X	X	X	X	X	**N**				X				X	X		X	
Western mosquitofish	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X		X	X	X
Green sunfish																	X	X		X	X
Smallmouth bass				X	X	X	X	X		X		X	X	X	X	X	X	X	X	X	X
Largemouth bass						X				X								X			

Table 10. Relative abundance and density (fish/m²) of native and nonnative fishes at East Fork Gila River Fall Spring site, Catron County, New Mexico, 1988 – 2008.

Year	Total N	Area (m^2)	% Native	% Nonnative	Density Native	Density Nonnative
1988	324	253	89.8	10.2	1.152	0.131
1989	534	773	94.9	5.1	0.656	0.035
1990	382	734	71.5	28.5	0.372	0.149
1991	624	666	62.2	37.8	0.582	0.354
1992	310	424	81.3	18.7	0.595	0.137
1993	673	505	97.8	2.2	1.304	0.030
1994	289	571	91.0	9.0	0.461	0.046
1995	125	299	81.6	18.4	0.342	0.077
1996	NO COLLECTION					
1997	44	182	93.2	6.8	0.225	0.017
1998	151	151	88.1	11.9	0.881	0.119
1999	509	240	90.0	10.0	1.876	0.208
2000	313	193	56.9	43.1	0.922	0.700
2001	97	290	50.5	49.5	0.169	0.166
2002	143	221	23.8	76.2	0.154	0.762
2003	41	251	19.5	80.5	0.032	0.131
2004	44	176	79.6	20.4	0.199	0.051
2005	120	199	85.0	15.0	0.513	0.091
2006	74	253	40.5	59.5	0.119	0.174
2007	100	167	65.0	35.0	0.389	0.209
2008	69	285	56.5	53.5	0.136	0.105

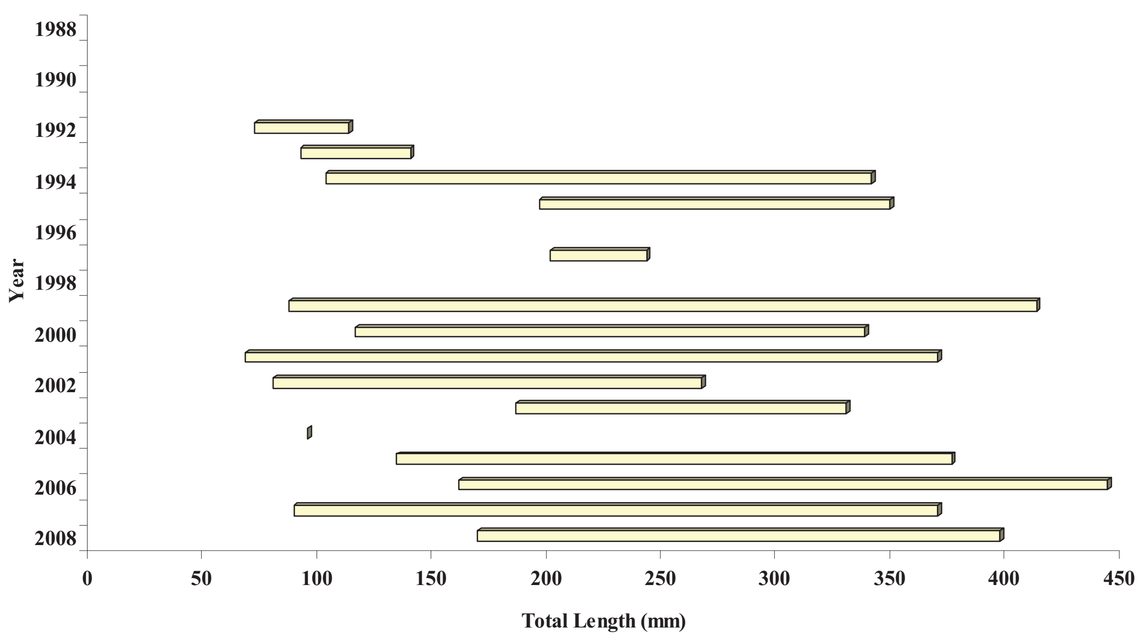


Figure 5. Total length (mm) range of smallmouth bass captured at East Fork Gila River – Fall Spring, Catron County, New Mexico, 1988- 2008

Gila River—Riverside

Monitoring of the fish assemblage at the Gila River Riverside site began in 1988, and occurred in all subsequent years, except 2000. High discharge precluded sampling in 2000. Since 1988, six native and 11 nonnative fishes have been collected at the Gila River Riverside site (Table 11). In 2008, five native and two nonnative fish species were found. Native fish density was higher (2.254/m^2) in 2008 than in any preceding year. Desert sucker and Sonora sucker were the only native species collected in all years. Longfin dace, spikedace, and loach minnow were found in all years (except 1997 and 2002, and 1996, respectively). Western mosquitofish was the most frequently collected nonnative species; it was absent in 1997, 2006, and 2008. Red shiner has been more frequently collected since 1995 than it was between 1988 and 1994, but it was not found in 2008. No game fish species was regularly found at the Gila River Riverside site. Centrarchids were irregularly found at the site. Ictalurids (yellow and black bullheads) were most recently collected in 1999. One flathead catfish ((238 mm TL) and one smallmouth bass (128 mm TL) were collected in 2008. From 1988 through 1997, native fish relative abundance was 75% or more in all years, but one (1994). Since 2000, native fish relative abundance has exceeded 75% in all years, except 2003 (Table 12). In each year nonnative fish abundance exceeded 25% (including 2003), western mosquitofish was the numerically dominant nonnative species collected. Since 1988, native fish density has averaged 0.700 fish/m^2 (SE = 0.15, n = 20) and nonnative density has averaged 0.101 fish/ m^2 (SE = 0.04, n = 20). Greatest nonnative density (0.618 fish/m^2) was in 1998.

Table 11. Occurrence of fishes at the Gila River Riverside site, Grant County, New Mexico, 1988-2008.

Species	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08
Native																					
Longfin dace	X	X	X	X	X	X	X	X	X	X	X	X	**N**	X	X	X	X	X	X	X	X
Roundtail chub				X									**O**								
Spikedace	X	X	X	X	X	X	X	X	X	X	X	X		X		X	X	X	X	X	X
Loach minnow	X	X	X	X	X	X	X	X		X	X	X	**C**	X	X	X	X	X	X	X	X
Desert sucker	X	X	X	X	X	X	X	X	X	X	X	X	**O**	X	X	X	X	X	X	X	X
Sonora sucker	X	X	X	X	X	X	X	X	X	X	X	X	**L**	X	X	X	X	X	X	X	X
													L								
Nonnative													**E**								
Common carp				X			X						**C**								
Red shiner			X			X		X	X		X	X	**T**		X	X			X	X	
Fathead minnow											X	X	**I**						X		
Black bullhead												X	**O**								
Yellow bullhead												X	**N**								
Channel catfish	X																				
Flathead catfish	X			X							X										X
Western mosquitofish	X	X	X	X	X	X	X				X	X		X	X	X	X	X		X	
Green sunfish		X		X																	
Smallmouth bass		X		X	X												X				X
Largemouth bass			X	X	X																

Table 12. Relative abundance and density (fish/m^2) of native and nonnative fishes at Gila River Riverside site, Grant County, New Mexico, 1988-2008.

Year	Total N	Area (m^2)	% Native	% Nonnative	Density Native	Density Nonnative
1988	410	2266	97.6	2.4	0.177	0.004
1989	767	2020	92.1	7.9	0.350	0.030
1990	540	3753	98.0	2.0	0.141	0.003
1991	649	1967	88.4	11.6	0.292	0.038
1992	488	2545	94.9	5.1	0.182	0.010
1993	211	720	97.6	2.4	0.286	0.007
1994	277	793	27.1	72.9	0.095	0.255
1995	898	400	97.0	3.0	2.178	0.068
1996	139	401	99.0	1.0	0.990	0.010
1997	114	572	99.1	0.9	0.198	0.002
1998	787	787	38.3	61.7	0.383	0.618
1999	445	506	32.8	67.2	0.289	0.591
2000	NO COLLECTION					
2001	292	429	96.2	3.8	0.655	0.026
2002	57	623	86.0	14.0	0.079	0.013
2003	185	481	62.2	37.8	0.239	0.145
2004	528	285	95.4	4.6	1.767	0.084
2005	607	444	98.3	1.7	1.345	0.022
2006	112	334	81.2	18.8	0.272	0.063
2007	552	298	98.7	1.3	1.823	0.023
2008	1296	575	99.8	0.2	2.254	0.003

Gila River—Middle Box

Annual sampling of the Gila River Middle Box site, in cooperation with U.S. Bureau of Land Management (USBLM), began in 1997. Through 2001 work at this site was supported by USBLM, but has been accomplished under FW-17-RD since then. Since 1997, five native and five nonnative species have been collected at the Gila River Middle Box site (Table 13). Longfin dace and desert sucker were the most frequently collected native fishes. Red shiner was the most commonly collected nonnative species. Channel catfish was the most frequently-collected game species. In 1999, 2001, 2002, and 2008, native fishes were a comparatively large portion of the collection, but in 2003 and 2004 native fishes represented less than 10% of the collection (Table 14). Native fish relative abundance has steadily increased from a low of 1.4% in 2006. Nonnative fish density was greatest in 2003, and comparatively high in 2008. Since 1999, native fish density has averaged 0.204 fish/ m^2 (SE = 0.09, n = 9) and nonnative density has averaged 0.451 fish/ m^2 (SE = 0.15, n = 9). Channel catfish was the only sport fish regularly captured at the site, and most specimens were <150 mm TL.

Table 13. Occurrence of fishes at Gila River Middle Box site, Grant County, New Mexico, 1997-2008.

	Year											
Species	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**
Native				**N**								
Longfin dace	X	X	X	**O**	X	X	X	X	X	X	X	X
Spikedace	X	X	X		X		X	X				X
Loach minnow	X	X	X	**C**	X	X	X		X		X	X
Desert sucker	X	X	X	**O**	X	X	X	X	X		X	X
Sonora sucker	X	X	X	**L**	X	X	X					X
				L								
Nonnative				**E**								
Red shiner	X	X	X	**C**	X	X	X	X	X	X	X	X
Common carp				**T**							X	
Fathead minnow		X		**I**	X		X	X	X		X	X
Channel catfish		X	X	**O**	X	X	X	X	X		X	X
Flathead catfish				**N**	X	X	X		X			
Western mosquitofish					X	X	X					X

Table 14. Relative abundance and density (fish/m²) of native and nonnative fishes at Gila River Middle Box site, Grant County, New Mexico, 1999-2008.

Year	Total N	Area (m²)	% Native	% Nonnative	Density Native	Density Nonnative
1999	117	405	53.0	47.0	0.153	0.136
2000			NO COLLECTION			
2001	135	569	80.7	19.3	0.192	0.046
2002	57	360	73.7	26.3	0.106	0.053
2003	567	398	6.4	93.6	0.091	1.334
2004	293	359	4.8	95.2	0.039	0.777
2005	142	276	35.9	64.1	0.185	0.330
2006	278	328	1.4	98.6	0.012	0.835
2007	120	268	28.3	71.7	0.127	0.291
2008	463	389	78.4	21.6	0.933	0.257

Gila River—Lower Box

Annual sampling of the Gila River Lower Box site, in cooperation with U.S. Bureau of Land Management (USBLM), began in 1997. Through 2001 work at this site was supported by USBLM, but has been accomplished under FW-17-RD since then. No native species was collected at the Lower Box permanent site in 2004, 2005 or 2007, but longfin dace was present in 2008 (Table 16). Nonnative red shiner, fathead minnow, and channel catfish were collected in 2008. Native fish density has been low, or zero, in all years at this site (mean = 0.036, SE = 0.02, n = m8), but nonnative density was comparatively high in most years (mean = 0.402. SE =

0.15, n = 8; Table 17). Channel catfish, the only sport fish collected in 2008, was not common (n = 5), and all individuals were <150 mmTL.

Table 16. Occurrence of fishes at Gila River Lower Box site, Grant County, New Mexico, 1997-2008.

Species	97	98	99	00	01	02	03	04	05	06	07	08
Native												
Longfin dace	X	X	X	**N**	X	X				X		X
Spikedace		X		**O**								
Loach minnow		X					X					
Desert sucker	X	X		**C**	X	X						
Sonora sucker	X	X	X	**O**	X	X						
				L								
Nonnative				**L**								
Red shiner	X	X	X	**E**	X	X	X	X	X	X	X	X
Common carp		X		**C**								
Fathead minnow		X		**T**	X	X	X		X			X
Yellow bullhead	X			**I**								
Channel catfish	X	X	X	**O**	X		X	X	X			X
Flathead catfish	X	X	X	**N**	X		X					
Western mosquitofish	X	X	X		X	X	X					

Table 17. . Relative abundance and density (fish/m²) of native and nonnative fishes at Gila River Lower Box site, Grant County, New Mexico, 2001-2007.

Year	Total N	Area (m²)	% Native	% Nonnative	Density Native	Density Nonnative
2001	294	318	4.4	95.6	0.041	0.884
2002	36	188	16.7	83.3	0.032	0.157
2003	520	520	0.4	99.6	0.004	0.996
2004	131	131	0.0	100	0.000	1.000
2005	49	203	0.0	100	0.000	0.241
2006	10	176	30.0	70.0	0.017	0.040
2007	3	259	0.0	100	0.000	0.012
2008	106	188	34.9	65.1	0.196	0.367

Pecos River

Pecos River Fish Community Monitoring – Small-Bodied Fishes

Monitoring of permanent sites on the Pecos River between Old Fort State Park and Brantley Lake, a cooperative effort of NMGF and USFWS NM Fisheries Resource Office, under FW-17-RD, began in 2003. Seven permanent sites between Roswell and Fort Sumner are sampled on a monthly basis, five sites between Roswell and Brantley Lake are sampled bimonthly, and two additional sites north of Roswell are sampled biannually (Table **1**). Fishes are collected by mesohabitat using a 1 x 3 m fine-mesh seine. All mesohabitats at a site are sampled in rough proportion to their availability. Nine species were commonly collected (greater than half the sites) July through December of 2008 (specimens collected in 2009 are currently being processed): red shiner, speckled chub, Rio Grande shiner, Pecos bluntnose shiner, plains minnow, Arkansas River shiner, plains killifish, channel catfish, and sand shiner (Table **2**). Plains minnow was the most abundant species and comprised a larger proportion of samples in 2008 than in 2005, 2006, or 2007. The federally threatened and state endangered Pecos bluntnose shiner decreased in relative abundance and density in July through December of 2008 compared with previous years.

An expanded set of sites from below Pecos, NM downstream to the Delaware River confluence is sampled (as above) each autumn to monitor distribution of fishes across the extent of the warmwater portion of the Pecos River within New Mexico (Table **1**). Highest species richness in 2007 was generally found at sites between Sumner Dam and Brantley Reservoir (Figure **1**). Upstream of Fort Sumner, species compositions and abundances were highly variable. While in recent years, the Pecos River downstream of Brantley Dam, with the exception of the Six Mile Dam site, was almost devoid of fish, apparently the result of toxic golden algae blooms in early October, several mainstem lower Pecos River sites showed diversity similar to sites upstream.

Lower Pecos River Large-Bodied Fish Monitoring

The lower Pecos River has been subject to repeated and extensive fish kills, attributed to golden algae *Prymnesium parvum* blooms, beginning in 2002. To document the response of both sport and non-game fish species to these events, surveys in river pools and reservoirs of the lower Pecos River were conducted using trammel nets during July and September of 2008 and June of 2009. Species presence and relative abundance varied considerably among sites (Figure 2). Catch rates were low for most species at Carlsbad Municipal Lake, the pool below Six Mile Reservoir, Ten Mile Reservoir, and the pool at Fisherman's Lane; empty, or nearly empty, nets were common. The largest and most consistent catches were found at Six Mile Reservoir, where largemouth bass, common carp, and gray redhorse numerically dominated. Large numbers of river carpsucker and gizzard shad were present at the Black River confluence with the Pecos River. Blue sucker, flathead catfish, and smallmouth buffalo were not found in the Pecos River during any sampling event during the reporting period; their presence has not been documented since 2006. Gray redhorse was captured only in and immediately below Six Mile Reservoir and

Table 1. Small-bodied fish sampling conducted in the Pecos River drainage July 2008 through June 2009. Sites arranged upstream (top) to downstream (bottom).

	2008						2009					
Site	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**
Above Santa Rosa												
S. San Ysidro				X								
Villanueva												
Dilia Hwy 84 XG				X								
River Ranch				X								
Santa Rosa Lake				X								
Santa Rosa to Sumner												
Below Santa Rosa Dam												
El Rito Confluence				X								
El Rito Creek				X								
El Rito CreekBlue Hole				X								
PDL Hwy 91 XG				X								
PDL Gage				X								
Sumner to Roswell												
HWY 60 XG										X		X
Old Fort Park				X						X		X
Willow	X	X	X	X	X			X	X	X	X	X
Six Mile Draw	X	X	X	X	X				X	X	X	X
Crockett Draw	X	X	X	X	X			X	X	X	X	X
Cortez					X				X		X	
Bosque Draw	X	X	X	X				X	X	X	X	X
Gasline	X	X	X	X	X			X	X	X	X	X
Hwy 70 XG	X	X	X	X	X			X	X	X	X	X
BLNWR North Bound											X	
Scout Camp	X	X	X	X				X	X	X	X	X
Roswell to Brantley Reservoir												
Hwy 380 XG		X		X		X		X		X		X
Dexter		X		X		X		X		X		X
Lake Arthur		X		X		X		X		X		X
Hwy 82 XG		X		X		X		X		X		X
Brantley Inflow		X		X		X				X		X
Below Brantley Dam												
CR 30 XG				X		X						
Rocky Arroyo				X								
Bataan Dam (below)	X											
Above Six Mile Lake	X											
Six Mile Dam (below)				X								
Black River Confl.	X											
Black River	X			X								
Malaga Bend				X								
Delaware Confl.				X								

Table 2. Mean relative abundance (proportion of total number caught of all species) and frequency of occurrence (proportion of all sampling events) for fishes collected in the middle Pecos River between Ft. Sumner and Brantley Lake during August through December of 2005 (N = 34 sampling events), 2006 (N = 37), 2007 (N = 45) and 2008 (N=43).

Species		Mean Relative Abundance				Site Occurrence			
		2005	2006	2007	2008	2005	2006	2007	2008
Red shiner	*Cyprinella lutrensis*	0.51	0.33	0.7	0.24	1	0.97	0.98	0.98
Rio Grande shiner	*Notropis jemezanus*	0.09	0.18	0.24	0.19	0.97	0.92	0.98	0.98
Western mosquitofish	*Gambusia affinis*	0.08	0.03	0.06	0.01	0.71	0.68	0.51	0.42
Plains minnow	*Hybognathus placitus*	0.07	0.09	0.06	0.32	0.91	0.81	0.84	0.98
Speckled chub	*Macrohybopsis aestivalis*	0.06	0.17	0.07	0.07	0.94	0.97	0.96	0.98
Arkansas River shiner	*Notropis girardi*	0.04	0.03	0.03	0.02	0.85	0.78	0.84	0.79
Plains killifish	*Fundulus zebrinus*	0.04	0.03	0.05	0.04	0.79	0.51	0.64	0.81
Pecos bluntnose shiner	*Notropis simus*	0.03	0.07	0.21	0.06	0.88	0.86	0.93	0.95
Sand shiner	*Notropis stramineus*	0.03	0.02	0.01	0.02	0.5	0.41	0.58	0.58
River carpsucker	*Carpiodes carpio*	0.02	0.01	0.02	0.01	0.5	0.38	0.53	0.44
Fathead minnow	*Pimephales promelas*	0.01	0.01	0.03	0	0.74	0.38	0.64	0.33
Channel catfish	*Ictalurus punctatus*	0.01	0.01	0.01	0.01	0.44	0.54	0.60	0.56
Rainwater killifish	*Lucania parva*	0.01	0	0	0	0.15	0.11	0.04	0.14
Pecos pupfish	*Cyprinodon pecosensis*	0	0.01	0	0	0.09	0.08	0.04	0.07
Bigscale logperch	*Percina macrolepida*	0	0	0	0	0.06	0.08	0.00	0
Flathead catfish	*Pylodictis olivaris*	0	0	0	0	0.06	0.05	0.11	0
Green sunfish	*Lepomis cyanellus*	0	0	0	0	0.06	0.05	0.04	0.09
Inland silversides	*Menidia beryllina*	0	0.01	0	0	0.03	0.16	0.07	0
Spotted bass	*Micropterus punctatus*	0	0	0	0	0.03	0.08	0.04	0.02
Common carp	*Cyprinus carpio*	0	0	0.01	0	0.03	0.08	0.18	0.09
Gizzard shad	*Dorosoma cepedianum*	0	0.01	0.02	0.01	0	0.14	0.27	0.12
Central stoneroller	*Campostoma anomalum*	0	0	0	0	0	0.03	0.02	0
Mexican tetra	*Astyanax mexicanus*	0	0	0	0	0	0.11	0.09	0.02
White bass	*Morone chrysops*	0	0	0	0	0	0.05	0.11	0.02
Bluegill	*Lepomis macrochirus*	0	0	0	0	0	0.03	0.04	0
Suckermouth minnow	*Phenacobius mirabilis*	0	0	0	0	0	0.03	0.00	0

at the confluence of the Black River. Longnose gar was previously common in much of the Pecos River between Brantley Lake and the Black River confluence, but was captured exclusively in the pool below Six Mile Reservoir during the reporting period.

Low sample sizes limit the comparison of fish population size-structures among sites for most species and most sites. Six Mile Reservoir appears to act as a refuge from golden algae for the large-bodied fish species of the Pecos River and offers the best example of an intact fishery. Largemouth bass showed a fairly restricted size distribution (Figure 3). Gray redhorse have a wider side distribution, indicating multiple age-classes.

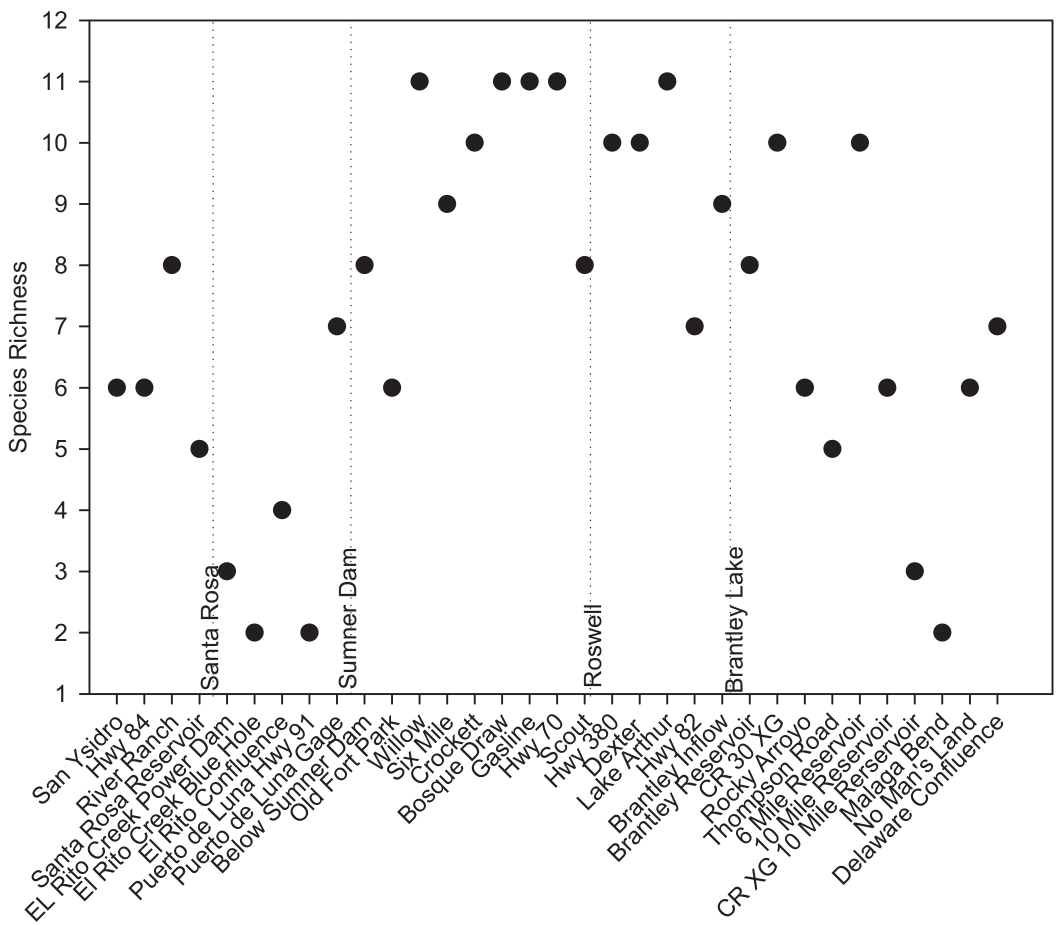
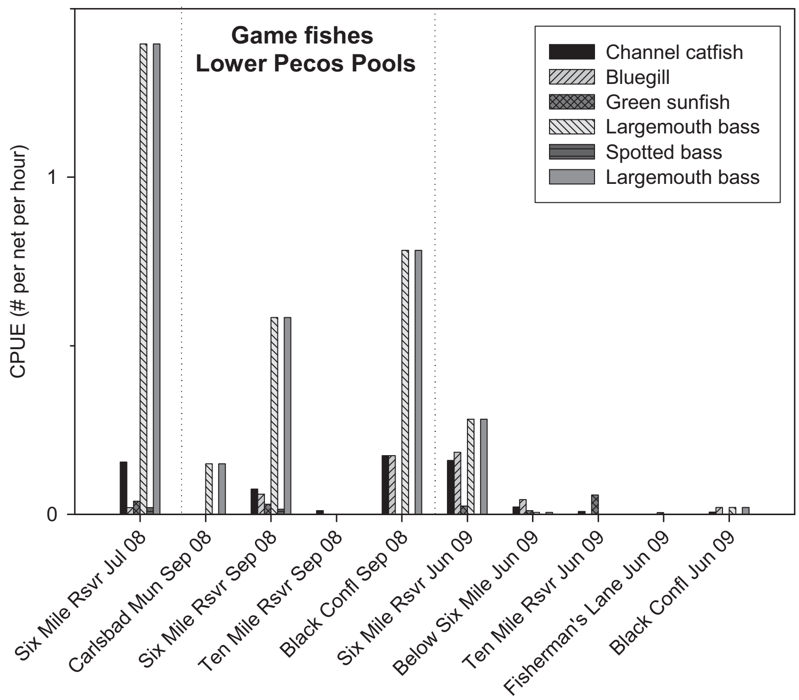


Figure 1. Species richness for small-bodied fish collections made during October 2008. Sites arranged from upstream (left) to downstream (right).



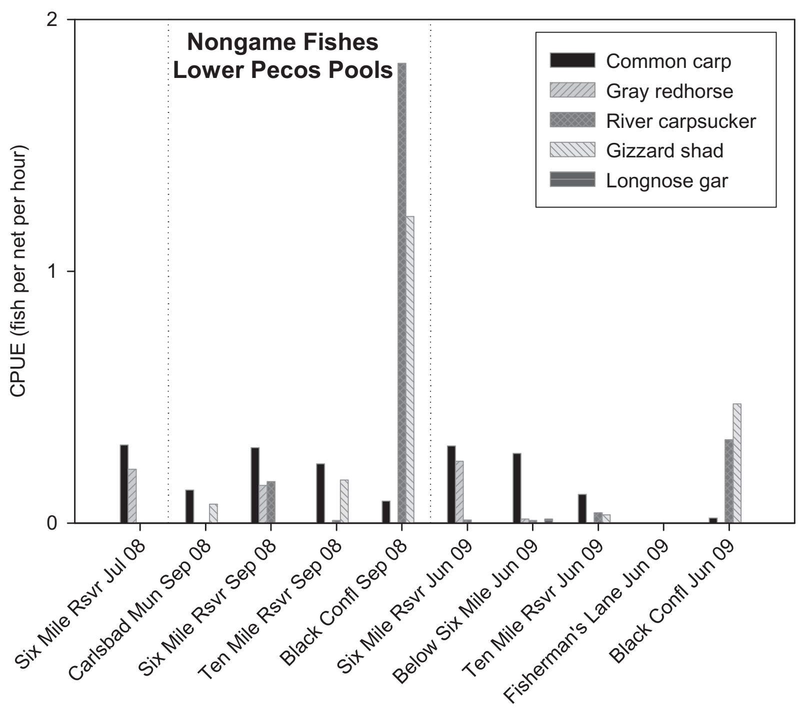


Figure 2. Abundance of game (top) and nongame (bottom) fishes in reservoirs and large pools of the lower Pecos River, New Mexico July 2008-June 2009. Fish captured using 100-foot trammel nets set for one to three hours. Sites arranged upstream (left) to downstream, dotted lines distinguish sampling efforts. All species captured shown.

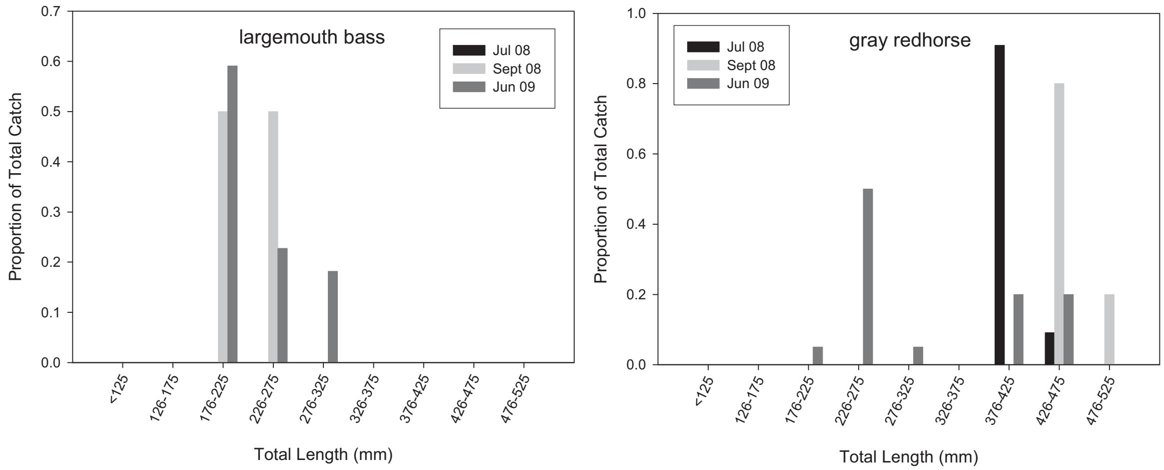


Figure 3. Length frequencies for largemouth bass (left) and gray redhorse (right) July 2008-June 2009 at Six Mile Reservoir.

C. Characterize species and habitat associations, species population and community dynamics, species interactions, and changes in species status and distributions.

No work was completed under Objective C. from July 2008 through June 2009.

D. A performance report summarizing data collected between 1 July 2008 and 30 June 2009 will be prepared.

This document constitutes the Performance Report for FW-17-RD-36, Job 3, for the period between 1 July 2008 and 30 June 2009.

Literature Cited

Propst, D.L., S.P. Platania, D. Ryden, and R. Bliesner. 2000. San Juan monitoring plan and protocols. San Juan River Basin Recovery Implementation Program, U.S. Fish and Wildlife Service, Albuquerque, NM.

Acknowledgements

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Systematic Investigations of Warmwater Fish Communities, FW-17-RD-36
Performance Report (1 July 2008 – 30 June 2009)

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APPENDIX I

SMALL-BODIED FISH MONITORING, SAN JUAN RIVER

September – October 2008

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Conservation Services Division
New Mexico Department of Game and Fish
Santa Fe, New Mexico

March 2009

SAN JUAN RIVER BASIN RECOVERY IMPLEMENTATION PROGRAM
U.S. FISH AND WILDLIFE SERVICE, REGION 2
ALBUQUERQUE, NEW MEXICO

EXECUTIVE SUMMARY

Monitoring of small-bodied fished was conducted in the San Juan River from 1998 through 2008. Native fish numbers remained relatively stable for the duration of the study, though there was a slight decline in flannelmouth sucker in the primary channel from 2003 through 2008. Nonnative small-bodied fishes (mainly red shiner and fathead minnow) became increasingly rare in the San Juan; the greatest decline occurred between 2005 and 2006. Density of age-0 channel catfish changed little.

No age-0 razorback sucker were collected during small-bodied fishes monitoring, although spawning was documented in each of the last 11 years (Brandenburg and Farrington 2008). Other sucker species in the river, bluehead and flannelmouth suckers, were collected in sufficient numbers to track cohorts across years (using data from larval and adult monitoring efforts). The 2004 year classes of flannelmouth and bluehead sucker were the last that recruited well into the adult population. Larval densities of these species were not good predictors for abundance of these species in autumn monitoring or recruitment into the adult population.

Age-0 Colorado pikeminnow were collected in 1998, 2000, and 2007. All were likely stocked individuals. Age-1+ pikeminnow were collected each year beginning in 2004. Abundance of small fishes that are potential prey for Colorado pikeminnow was lower in 2006 through 2008 than previous years (2003 through 2005).

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INTRODUCTION

Small-bodied and age-0 fishes numerically dominate the San Juan River fish assemblage and likely are essential to recovery of Colorado pikeminnow and influence abundance of razorback sucker young. Small-bodied fishes are an important component of the diet of young Colorado pikeminnow, but also may prey on or compete with larval and age-0 razorback sucker and Colorado pikeminnow (Franssen et al. 2007). Annual autumn sampling of shallow-water habitats is undertaken to obtain information on fishes that occur in these habitats as well as relating this information towards the progress of recovery of Colorado pikeminnow and razorback sucker and conservation of the native fish assemblage of the San Juan River.

As set forth in Section 5.7 of the San Juan River Basin Recovery Implementation Program (SJRIP) Long-Range Plan, a long-term monitoring program "to identify changes in the endangered and other native species populations, status, distributions and habitat conditions" was to be developed by the SJRIP Biology Committee. The ichthyofaunal monitoring portion of the San Juan River Monitoring Plan and Protocols (Propst, et al., 2000) was divided into three primary areas; larval fishes, young-of-year/small-bodied fishes, and sub-adult and adult/large-bodied fishes. The portion of the San Juan River to be monitored extends from the confluence of the Animas and San Juan rivers (Farmington) to Lake Powell (Clay Hills Crossing) (Figure 1).

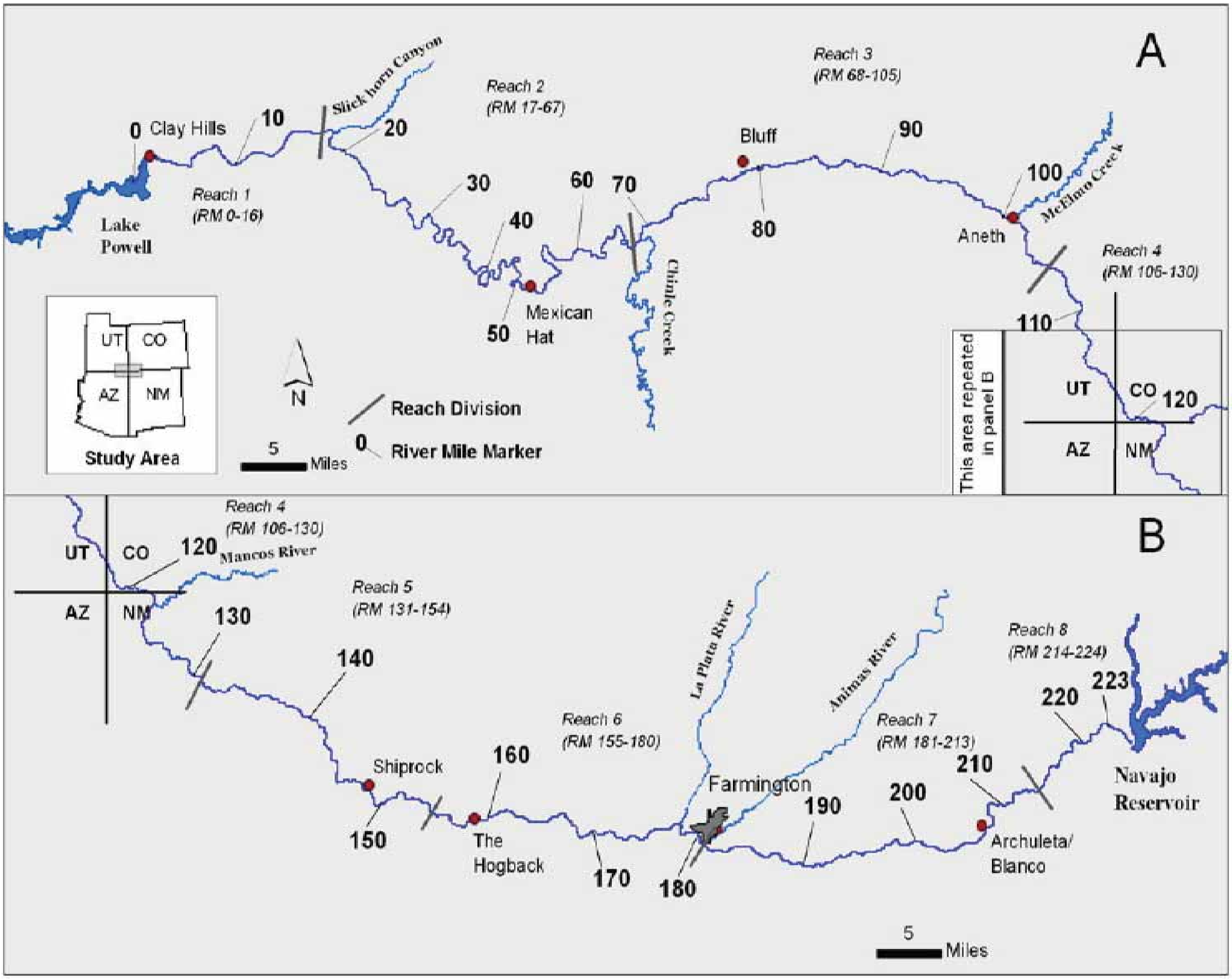


Figure 1. Map of the San Juan River. Study area begins at the confluence of the Animas River near Farmington, NM downstream to Clay Hills Crossing, UT.

Autumn monitoring of small-bodied and age-0 fishes of the San Juan River is designed to characterize survival and recruitment of wild-spawned Colorado pikeminnow and razorback sucker, survival of stocked age-0 Colorado pikeminnow, provide information on habitat use by wild and stocked individuals, monitor status and habitat use by potential Colorado pikeminnow prey and competitors of both Colorado pikeminnow and razorback sucker, and provide data to assess the effects of flow on density of small-bodied and age-0 fishes. Specific objectives of the small-bodied/young-of-year portion of the San Juan River monitoring effort are to:

1. document primary channel shoreline and near-shoreline mesohabitat, secondary channel, and backwater use by age-0 Colorado pikeminnow, razorback sucker, and roundtail chub;

2. obtain data that will aid in the evaluation of the responses (e.g., reproduction, recruitment, and growth) of native and nonnative fishes to different flow regimes and other management actions (e.g., impediment modification);

3. track trends in species populations (e.g., abundance and relative condition), and

4. characterize patterns of mesohabitat use by common native and nonnative small-bodied fishes (including age 0 flannelmouth sucker, bluehead sucker, common carp, and channel catfish).

Data obtained during small-bodied fishes monitoring efforts will be available to all San Juan River Basin Recovery Implementation Program researchers and may be used in conjunction with data obtained in other studies to evaluate management activities.

To date this study has documented the decline in the density of small-bodied nonnative fishes (red shiner and fathead minnow) starting in 2005. Native fish densities have been stable. The February 2009 Biology Committee meeting requested that annual reports in 2009 focus on information that may pertain to recovery of Colorado pikeminnow and razorback sucker. Summary information on all species is included, but specific information is focused around these two species. Analyses in this report mainly focus on data collected since 2003. Earlier data (1998-2002) are available and may be obtained from New Mexico Department of Game and Fish.

METHODS

In 1998, autumn monitoring of small-bodied fishes in wadeable habitats of the San Juan River primary and secondary channels and backwaters (including embayments) occurred from Shiprock, New Mexico (RM 147.9, Reach 5) downstream to Chinle Creek, Utah (RM 68.6, 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 excluded a large proportion of secondary channels (30 to 50%, depending upon the starting point of the 3-mile sampling interval). To adequately sample these habitats, beginning in 2000, all secondary channels longer than 200 m and having surface water during monitoring were sampled. All backwaters (greater than 50 m^2), regardless of occurrence within designated miles, were sampled.

Small-bodied fishes were collected from primary channel habitats at 3-mile intervals. Small-bodied monitoring occurs in conjunction with adult monitoring. Sample intervals are coordinated to occur in miles that are skipped by the adult monitoring crews. All collections were made by pulling a seine through a mesohabitat or kicking into a seine. There were several years that exploratory methods were added. In 2004 and 2005, additional collections were made by electrofishing into a bag seine in riffle, run, and shoal habitats. Primary channel electrofishing collections were made every sixth mile. In 2007 and 2008, additional sampling was conducted using a combination of bag-block seining, similar to methods used by Robertson and Holden (2007), and straight seining in an effort to capture more age-1+ Colorado pikeminnow than might be captured during standardized monitoring. There was no significant difference detected between the collections made with these additional methods so all data was grouped for analysis.

Primary channel sample sites were about 200 m long (measured along shoreline). The length of secondary channel sample sites varied depending upon extent of surface water, but was normally 100 to 200 m. River mile, GPS readings (UTM NAD83), and water quality information (pH, conductivity, and temperature) were recorded for each site. 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 a site. Beginning in 2003, data (including fishes collected) from each sampled mesohabitat within a site were recorded separately.

Most primary channel mesohabitats sampled were along stream margins, but off-shore riffles and runs (<0.75 m deep) were sampled also. Secondary channel sampling was across the breadth of the wetted channel. All available wadeable mesohabitats within a site were sampled. Uncommon mesohabitats (e.g., debris pools and backwaters were sampled in greater proportion to their availability than common mesohabitats (e.g., runs). Normally, at least five seine hauls (= five mesohabitats) were made at each sample site; however, if habitat was homogeneous, fewer seine hauls sometimes were made. Where there was comparatively high habitat diversity, more seine hauls frequently were made. The intent was to sample all mesohabitat types available at a site. All large backwaters >50 m^2 associated with the primary channel were sampled. Typically, two 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 through 2008.

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. Total length (TL) of each native fish was measured, recorded, and the specimen released. Subsamples of at least 50 individuals of speckled dace collected were measured for each reach; the remainder were counted and released. Nonnative fishes were fixed in 10% formalin and returned to the laboratory. Following specimen collection, the seined area of each sampled mesohabitat was measured and recorded. Retained specimens were identified and enumerated in the laboratory. Total length was measured for all retained specimens, except collections having more than 250 specimens of a species. For these collections, lengths were obtained for a sub-sample (a haphazard selection of at least 200 specimens). In 2008, small catostomids were preserved to verify identification in the laboratory. Personnel of UNM-MSB, Division of Fishes, verified identification of retained specimens. All retained specimens were accessioned to the University of New Mexico Museum of Southwestern Biology—Division of Fishes. For each seine haul, habitat type, area seined, depth in 5 locations within seined area, dominant substrate, and any cover associated with the habitat were recorded.

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 1 July through 30 September. Species density data were segregated by Geomorphic Reach (Bliesner and Lamarra 2000).

Mean sample density from 2003-2008 was calculated as the mean of individual seine haul densities. Mean sample densities were used in regression analysis of summer discharge to autumn density of commonly collected secondary and primary channel species from 2003 through 2008. Regression of density and discharge from 2000 through 2008 was computed using mean sample density plotted with time (density prior to 2003 was calculated as number of fish divided by total area sampled).

Mesohabitats were grouped into general categories (shoal, run, riffle, pool, eddy, backwater). There were several specialized pockets of habitat that did not fall into these general categories (e.g., debris piles and plunge pools). These were excluded from habitat graphs because of low number of samples from these mesohabitats. For each mesohabitat class, the mean sample density of each species in it was plotted for each year. This representation of mesohabitat association provided a crude estimate of habitat use by each species. ANOVA was used to determine if there were differences in the densities of each species among the various habitats.

Regression, correlation, ANOVA, and post hoc analyses (Tukey HSD) were performed using STATISTICA® software. Due to the natural variability seen with age-0 fish populations, probability values of <0.10 were considered significant (Brown and Guy 2007). Analyses in this report mainly focused on data collected since 2003. Earlier data (1998-2002) are available from New Mexico Department of Game and Fish.

RESULTS AND DISCUSSION

PRIMARY CHANNEL SUMMARY

Four native and seven nonnative species were collected in the primary channel of the San Juan River in 2008 (Table 1). No young-of year razorback sucker has been collected in this study; a single razorback sucker adult was captured in 2005. Colorado pikeminnow were collected from 1998 through 2000 and 2004 through 2007. Young-of-year were collected in 1998, 2000 and 2007; likely all stocked individuals. Roundtail chub and mottled sculpin have not been collected since 1999.

Native fishes numerically dominated collections from 2006 through 2008 (Table 2). Speckled dace was nearly three times more common in 2007 and 2008 than the next most abundant species, channel catfish. Red shiner was the most common species collected from 1998 through 2005, but in 2006 and 2007 it was third-most common. Fathead minnow were rare in collections from 2006 through 2008.

Table 1. Species collected during small-bodied fishes autumn monitoring of San Juan River primary channel, 1998-2007. 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***	***2005***	***2006***	***2007***	***2008***
Red shiner	*Cyprinella lutrensis*	CYPLUT	I	X	X	X	X	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	X	X	X	X
Colorado pikeminnow	*Ptychocheilus lucius*	PTYLUC	N	X						X	X	X	X	X
Speckled dace	*Rhinichthys osculus*	RHIOSC	N	X	X	X	X	X	X	X	X	X	X	X
Bluehead sucker	*Catostomus discobolus*	CATDIS	N	X	X	X	X	X	X	X	X	X	X	X
Flannelmouth sucker	*Catostomus latipinnis*	CATLAT	N	X	X	X	X	X	X	X	X	X	X	X
Flannelmouth x bluehead	*C. latipinnis* x *C. discobolus*	LATDIS			X				X					
Razorback sucker	*Xyrauchen texanus*	XYRTEX	N								X			
Black bullhead	*Ameiurus melas*	AMEMEL	I					X		X	X	X		X
Yellow bullhead	*Ameiurus natalis*	AMENAT	I									X		
Channel catfish	*Ictalurus punctatus*	ICTPUN	I	X	X	X	X	X	X	X	X	X		X
Plains killifish	*Fundulus zebrinus*	FUNZEB	I	X		X	X	X	X	X	X			X
Green sunfish	*Lepomis cyanellus*	LEPCYA	I		X				X	X	X			X
Largemouth bass	*Micropterus salmoides*	MICSAL	I				X			X			X	
Western mosquitofish	*Gambusia affinis*	GAMAFF	I	X		X	X	X	X	X	X	X	X	X
Mottled sculpin	*Cottus bairdi*	COTBAI	N		X									
NATIVE			7	5	5	3	3	3	3	4	5	4	4	4
NONNATIVE			9	5	5	6	6	7	6	9	8	6	4	7

Table 2. Fishes and mean sample densities (number/m^2) collected in San Juan River primary channel during autumn inventories, 2003 – 2008

	2003			2004			2005			2006			2007			2008		
Species	N	Density	StdError	N	Density	StdError	N	Density	StdError	N	Density	StdError	N	Density	StdError	N	Density	StdError
CYPLUT	1706	0.5243	0.0801	9830	1.8335	0.3551	2521	0.8478	0.2573	164	0.0357	0.0061	204	0.0310	0.0072	190	0.0314	0.0084
CYPCAR				6	0.0012	0.0006	3	0.0005	0.0004							2	0.0006	0.0004
PIMPRO	90	0.0353	0.0137	1119	0.2416	0.0749	281	0.0920	0.0322	44	0.0058	0.0049	32	0.0043	0.0026	24	0.0053	0.0036
PTYLUC				4	0.0005	0.0002	2	0.0003	0.0002	8	0.0013	0.0005	23	0.0031	0.0010	3	0.0004	0.0002
RHIOSC	511	0.1655	0.0292	4690	0.7643	0.1026	1234	0.2689	0.0412	2401	0.7378	0.4880	2177	0.2653	0.0377	1192	0.2007	0.0244
CATDIS	27	0.0068	0.0021	283	0.0463	0.0056	90	0.0267	0.0160	154	0.0404	0.0229	53	0.0066	0.0017	58	0.0158	0.0098
CATLAT	140	0.0622	0.0231	255	0.0441	0.0072	111	0.0289	0.0131	62	0.0120	0.0028	227	0.0221	0.0073	101	0.0117	0.0039
LATDIS	1	0.0002	0.0002															
XYRTEX							1											
AMEMEL				2	0.0005	0.0004	1	0.0006	0.0006	3	0.0004	0.0004				1	0.0005	0.0005
ICTPUN	366	0.0912	0.0144	603	0.0887	0.0161	401	0.0960	0.0245	336	0.0695	0.0090	697	0.0835	0.0109	533	0.0718	0.0096
FUNZEB	21	0.0056	0.0028	30	0.0051	0.0034	1	0.0003	0.0003							2	0.0001	0.0001
LEPCYA	2	0.0004	0.0003	1	0.0004	0.0004	1	0.0003	0.0003							1	0.0001	0.0001
MICSAL				4	0.0009	0.0005							1	0.0004	0.0004			
GAMAFF	37	0.0093	0.0059	127	0.0239	0.0075	16	0.0067	0.0035	4	0.0009	0.0007	8	0.0012	0.0009	5	0.0034	0.0028
Total N	2913			17042			4639			3175			2766			2217		
Total Area	3994			7768			5985			5446			9038			7469		
Density	0.73			2.19			0.78			0.58			0.31			0.36		

SECONDARY CHANNELS SUMMARY

Most fish species found in the San Juan River primary channel also were found in its secondary channels (Table 3). Colorado pikeminnow was collected in secondary channels in each of the past four years. Roundtail chub and mottled sculpin have not been collected in San Juan River secondary channels since 1999. Razorback sucker has never been collected in a secondary channel during small-bodied fishes monitoring. Four native and 10 nonnative species were found in secondary channels in 2008. Largemouth bass and plains killifish, both nonnative species and not collected since 2004, were collected in 2008.

Speckled dace was the most abundant species in San Juan River secondary channels from 2006 through 2008 (Table 4). Red shiner was the most common species from 1998 through 2005. In 2007 and 2008 speckled dace was six times more abundant than red shiner in secondary channels.

Table 3. Species collected during small-bodied monitoring in San Juan River secondary channels during autumn, 1998-2007. 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	2005	2006	2007	2008
Red shiner	*Cyprinella lutrensis*	CYPLUT	I	X	X	X	X	X	X	X	X	X	X	X
Common carp	*Cyprinus carpio*	CYPCAR	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	X	X	X	X
Colorado pikeminnow	*Ptychocheilus lucius*	PTYLUC	N	X	X	X				X	X	X	X	X
Speckled dace	*Rhinichthys osculus*	RHIOSC	N	X	X	X	X	X	X	X	X	X	X	X
Bluehead sucker	*Catostomus discobolus*	CATDIS	N	X	X	X	X	X	X	X	X	X	X	X
Flannelmouth sucker	*Catostomus latipinnis*	CATLAT	N	X	X	X	X	X	X	X	X	X	X	X
Black bullhead	*Ameiurus melas*	AMEMEL	I	X			X	X	X	X	X			X
Yellow bullhead	*Ameiurus natalis*	AMENAT	I	X			X				X	X		X
Channel catfish	*Ictalurus punctatus*	ICTPUN	I	X	X	X	X	X	X	X	X	X	X	X
Rainbow trout	*Oncorhynchus mykiss*	ONCMYK	I				X							
Plains killifish	*Fundulus zebrinus*	FUNZEB	I	X		X	X	X	X	X				X
Green sunfish	*Lepomis cyanellus*	LEPCYA	I							X				
Largemouth bass	*Micropterus salmoides*	MICSAL	I						X	X				X
Western mosquitofish	*Gambusia affinis*	GAMAFF	I	X	X	X	X	X	X	X	X	X	X	X
Mottled sculpin	*Cottus bairdi*	COTBAI	N		X									
NATIVE			6	5	6	4	3	3	3	4	4	4	4	4
NONNATIVE			11	9	5	7	10	8	8	8	6	5	4	9

Table 4. . Fishes and mean sample densities (number/m^2) collected in San Juan River secondary channel during autumn inventories, 2003 – 2008

	2003			2004			2005			2006			2007			2008		
Species	N	Density	StdError	N	Density	StdError	N	Density	StdError	N	Density	StdError	N	Density	StdError	N	Density	StdError
CYPLUT	1636	1.6186	0.4463	7171	4.2304	0.6358	921	0.9532	0.3283	154	0.1205	0.0368	168	0.0691	0.0194	221	0.0820	0.0434
CYPCAR	2	0.0016	0.0011	10	0.0088	0.0040										5	0.0029	0.0015
PIMPRO	325	0.2417	0.0930	2239	1.8800	0.7865	106	0.1218	0.0502	27	0.0347	0.0233	4	0.0017	0.0017	117	0.0383	0.0183
PTYLUC				4	0.0046	0.0023	1	0.0005	0.0005	2	0.0011	0.0008	15	0.0083	0.0027	6	0.0013	0.0006
RHIOSC	238	0.2454	0.06121	1364	07976	0.1667	172	0.2013	0.0507	251	0.2131	0.0410	821	0.4256	0.1042	1017	0.5288	0.1178
CATDIS	24	0.0167	0.0082	123	0.0827	0.0259	7	0.0064	0.0033	62	0.0256	0.0134	13	0.0057	0.0024	87	0.0202	0.0115
CATLAT	145	0.1103	0.0531	124	0.0899	0.0293	25	0.0278	0.0099	61	0.0296	0.0131	87	0.0410	0.0205	195	0.0602	0.0295
AMEMEL	9	0.0057	0.0024	6	0.0050	0.0031	3	0.0045	0.0031	4	0.0049	0.0030				3	0.0018	0.0013
AMENAT							1	0.0010	0.0010							3	0.0017	0.0011
ICTPUN	79	0.0551	0.0139	116	0.0991	0.0278	114	0.2099	0.1086	42	0.0193	0.0053	225	0.0935	0.0163	110	0.0387	0.0119
FUNZEB	11	0.0048	0.0025	32	0.0295	0.0173										4	0.0021	0.0014
LEPCYA				1	0.0007	0.0007												
MICSAL	1	0.0016	0.0016	6	0.0037	0.0020										10	0.0073	0.0052
GAMAFF	32	0.0258	0.0099	154	0.1584	0.0618	45	0.0463	0.0437	4	0.0058	0.0038	1	0.0004	0.0004	80	0.0236	0.0088
Total N	2464			11109			1400			607			1334			1858		
Area	1438			1789			1009			1679			2525			2619		
Density	1.71			6.21			1.38			0.36			0.53			0.71		

OVERALL TRENDS IN PRIMARY AND SECONDARY CHANNELS

Riverwide densities of native fishes varied year to year. Speckled dace was the most abundant native fish in all years (Figure 2). From 2003 through 2008 there was a slight decrease in the density of flannelmouth sucker in the primary channel (Table 5). Density of Colorado pikeminnow increased from zero in 2003 through 2007, but was substantially lower in 2008 than 2007.

Small-bodied nonnative fishes, red shiner and fathead minnow, have significantly decreased in the San Juan from 2003 through 2008 (Table 5); the greatest decrease in abundance occurred in 2006 (Figure 3). From 2000 to 2008 there was a strong negative relationship between summer discharge at the Shiprock Gage (appendix Figuer A1 & Table A1) and density of red shiner and fathead minnow in primary and secondary channels (r >[-0.715], p<0.03). Mean summer daily discharge between 2000 and 2004 (692 cfs) was lower ($t_{(7)}$=2.36, p=0.002) than 2005 through 2008 (1079 cfs). There was no detectable change in the density of channel catfish.

Table 5. Results of regression analysis on mean sample density of fishes over time from 2003-2008. (Degrees of freedom 1, 2010). Shaded area indicates significant results.

		Primary		Secondary	
	SPECIES	*r*	*p*	*r*	*p*
Native	CATDIS	-0.024	0.278	-0.070	0.066
	CATLAT	-0.081	0.000	-0.056	0.143
	PTYLUC	0.055	0.013	0.040	0.297
	RHIOSC	-0.018	0.413	0.015	0.709
Introduced	CYPLUT	-0.131	0.000	-0.284	0.000
	ICTPUN	-0.026	0.244	-0.043	0.262
	PIMPRO	-0.078	0.000	-0.100	0.009

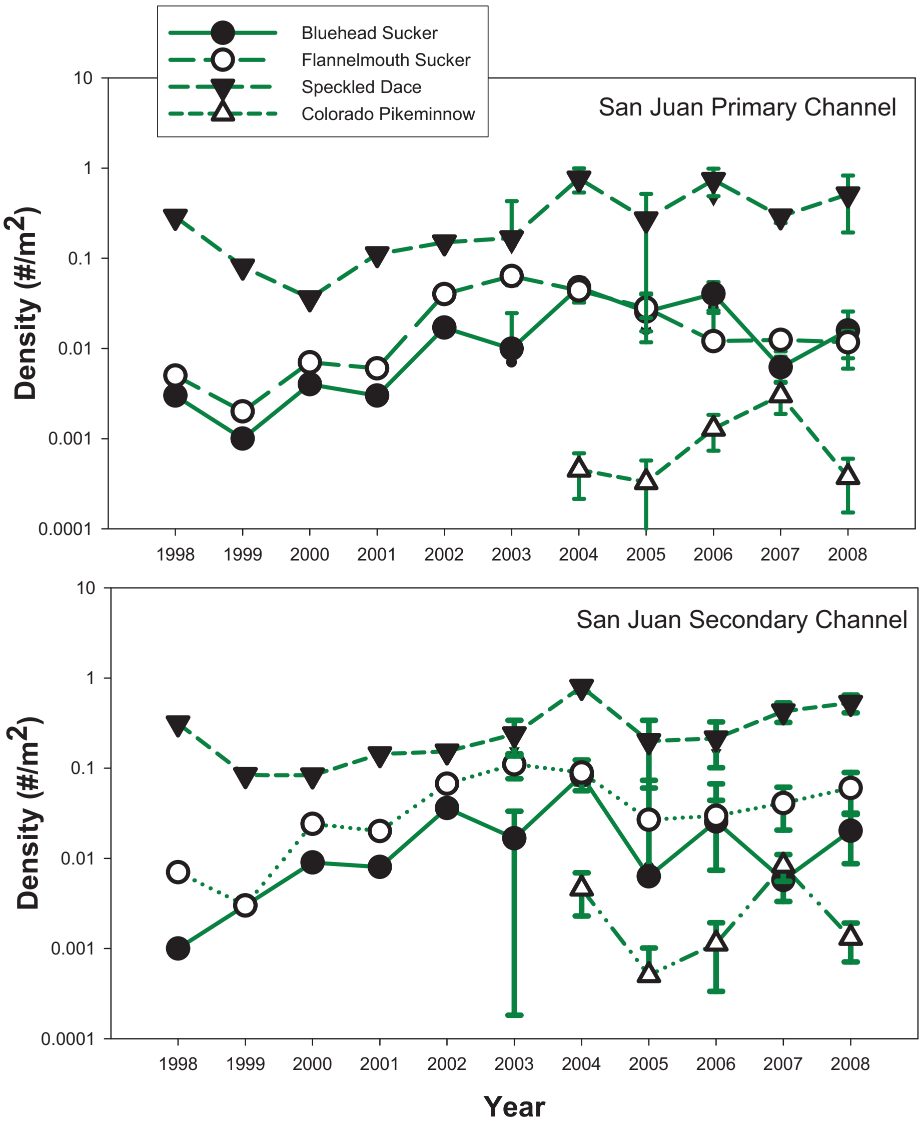


Figure 2. River-wide density (total number/total area sampled) from 1998 through 2002 and mean seine-haul density (and associated standard error) from 2003 through 2008 of commonly collected native fishes in autumn sampling of the San Juan River. Note log scale for density. Error bars represent $\pm$ 1 SE.

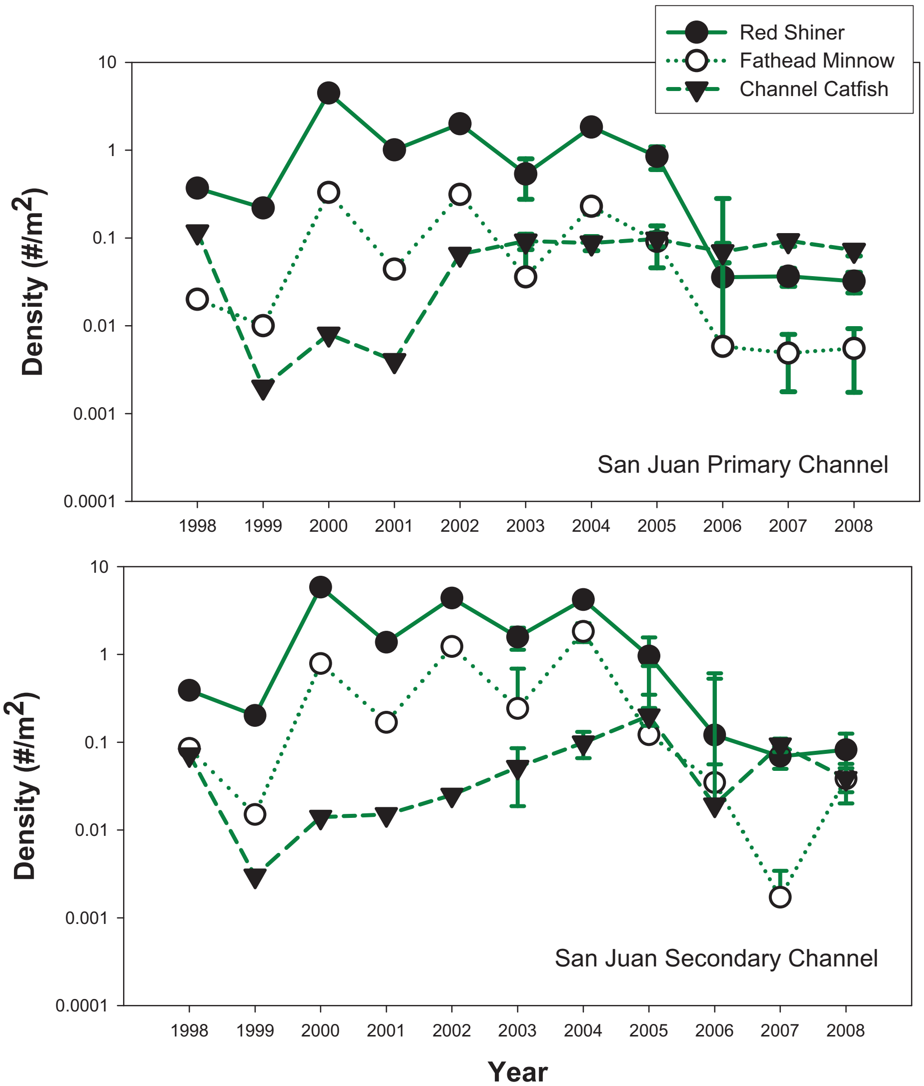


Figure 3. River-wide density (total number/total area sampled) from 1998 through 2002 and mean seine-haul density (and associated standard error) from 2003-2008 of commonly collected nonnative fishes in autumn sampling of the San Juan River. Note log scale for density. Error bars represent $\pm$ 1 SE.

LARGE BACKWATER SUMMARY

Four native and eight nonnative species were collected in San Juan River large backwaters in 2008. One age-1+ Colorado pikeminnow was collected in 2008. Twenty-one Colorado pikeminnow were collected in large backwaters in 2007, 18 of these were age-0 (almost certainly recently stocked individuals). Prior to 2007 Colorado pikeminnow had not been collected in a large backwater since 2000 (Table 6). Red shiner was the most abundant species in large backwaters in all years (Table 7).

Table 6. Species collected in San Juan River backwaters during autumn, 1999 – 2008, inventories. 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***	***2005***	***2006***	***2007***	***2008***
Red shiner	*Cyprinella lutrensis*	CYPLUT	I	X	X	X	X	X	X	X	X	X	X
Common carp	*Cyprinus carpio*	CYPCAR	I		X	X	X		X	X		X	X
Fathead minnow	*Pimephales promelas*	PIMPRO	I	X	X	X	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	X	X	X
Bluehead sucker	*Catostomus discobolus*	CATDIS	N		X	X	X	X	X	X		X	X
Flannelmouth sucker	*Catostomus latipinnis*	CATLAT	N	X	X	X	X	X	X	X		X	X
Black bullhead	*Ameiurus melas*	AMEMEL	I		X	X	X	X					
Yellow bullhead	*Ameiurus natalis*	AMENAT	I									X	
Channel catfish	*Ictalurus punctatus*	ICTPUN	I	X	X	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					X
Bluegill	*Lepomis macrochirus*	LEPMAC	I		X								
Largemouth bass	*Micropterus salmoides*	MICSAL	I		X					X			X
NATIVE			4	3	4	3	3	3	3	3	1	4	4
NONNATIVE			10	3	9	9	7	6	6	7	2	5	8

Table 7. Fishes and mean sample densities collected in San Juan River backwaters during autumn inventories, 2003 – 2008.

	2003			2004			2005			2006			2007			2008		
Species	***N***	***Den***	***Std. Error***	***N***	***Den***	***Std. Error***	***N***	***Den***	***Std. Error***	***N***	***Den***	***Std. Error***	***N***	***Den***	***Std. Error***	***N***	***Den***	***Std. Error***
CYPLUT	301	1.7454	0.4953	1033	3.6789	0.1984	566	1.2821	0.2102	3	0.0725	0.0513	67	0.0845	0.0054	288	0.5588	0.1032
CYPCAR				3	0.0102	0.0020	1	0.0053	0.0012				1	0.0032	0.0005	2	0.0051	0.0008
PIMPRO	241	2.4151	1.3993	319	1.0457	0.0721	122	0.2182	0.0163	2	0.0394	0.0063	12	0.0129	0.0015	35	0.1122	0.0691
PTYLUC													21	0.0280	0.0024	1	0.0026	0.0026
RHIOSC	4	0.0182	0.0094	10	0.0345	0.0164	12	0.0179	0.0110	1	0.0242	0.0242	30	0.0407	0.0159	116	0.2098	0.1114
CATDIS	3	0.0431	0.0276	2	0.0081	0.0022	69	0.1346	0.0265				1	0.0010	0.0002	6	0.0126	0.0011
CATLAT	6	0.0431	0.0276	1	0.0038	0.0010	114	0.1556	0.0207				4	0.0049	0.0005	26	0.0654	0.0071
AMEMEL	12	0.0472	0.0445															
AMENAT													1	0.0036	0.0036			
ICTPUN	10	0.0373	0.0305	10	0.0411	0.0050	1	0.0022	0.0005				64	0.0991	0.0061	36	0.0773	0.0078
FUNZEB	1	0.0043	0.0043	24	0.0603	0.0098	3	0.0034	0.0008							1	0.0033	0.0033
LEPCYA	1	0.0108	0.0108													1	0.0030	0.0030
MICSAL							2	0.0132	0.0030							6	0.0154	0.0111
GAMAFF	20	0.1342	0.0812	17	0.0583	0.0059	26	0.0499	0.0077							23	0.0156	0.0100
Total N	490			1415			876			6			198			541		
Area	245			274			489			53			723			486		
Density	2.00			5.16			1.79			0.11			0.27			1.11		

In 2008, nearly 60% of fishes collected in the primary and 70% in secondary channels were native (Figure 4). The lowest proportion of native fishes in primary and secondary channels occurred in 2000 (<2%) whereas the greatest proportion of native fishes occurred in the primary channel in 2006 (83%). The first year the proportion of native fishes was noticeably higher in secondary channels than the primary channel was 2008. Backwaters were numerically dominated by nonnative species in all years. The period of lowest native density coincides with years of low summer discharge.

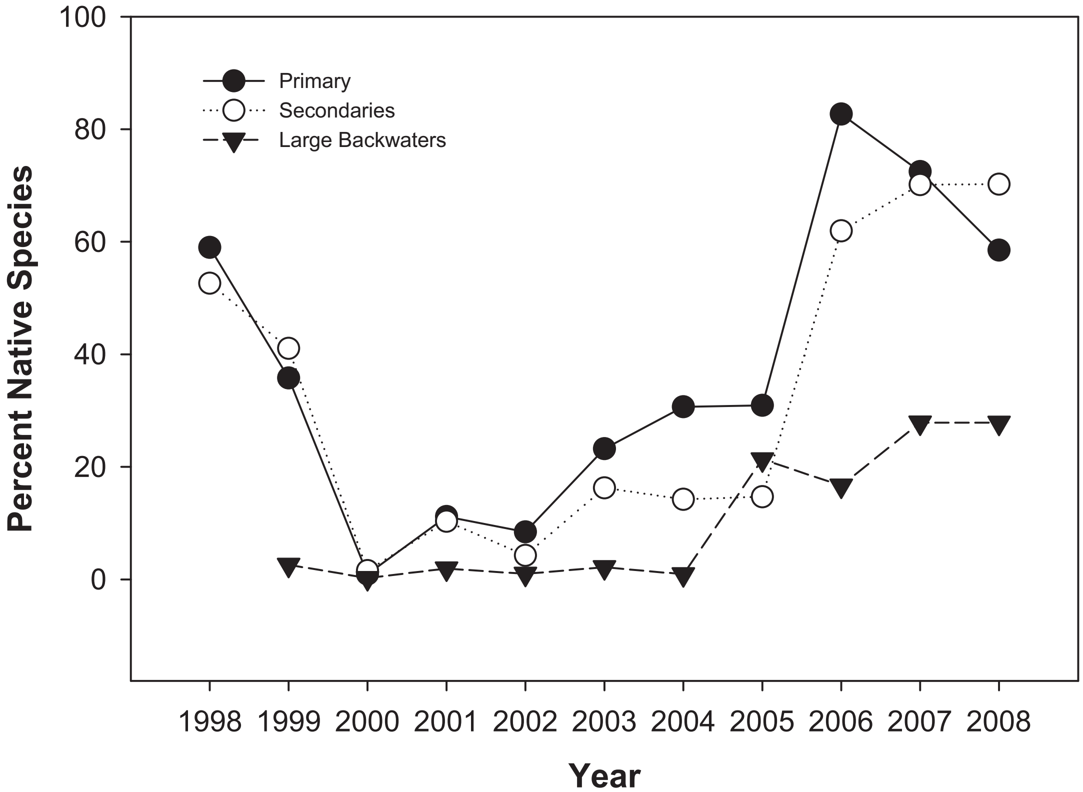
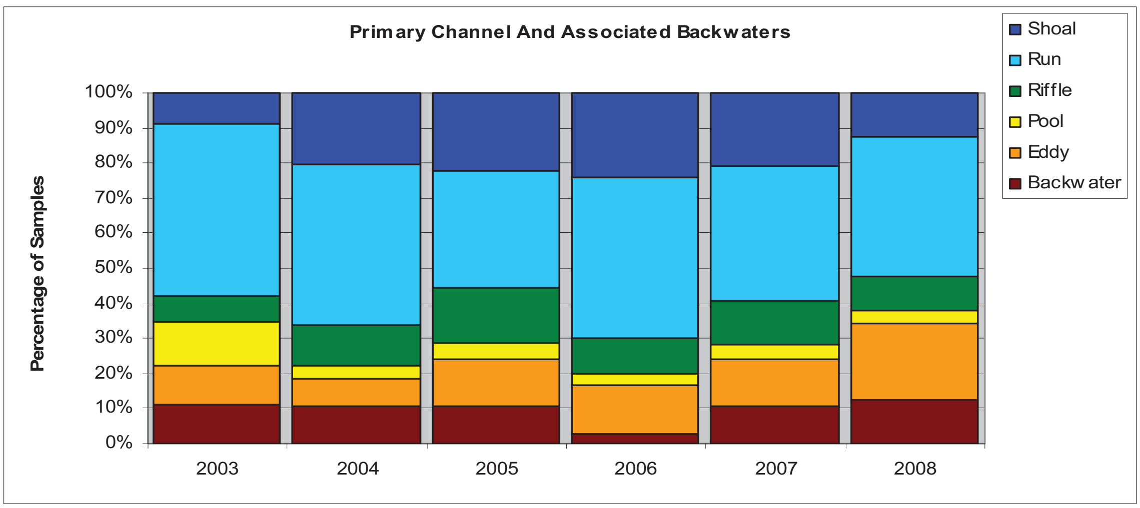


Figure 4. Percent of native species collected in autumn sampling on the San Juan River from 1998 through 2008.

HABITAT

The proportion of samples taken in each habitat type was relatively consistent from 2003 through 2008. The greatest number of samples was taken in run habitats in primary and secondary channels (Figure 5); approximately 80% of the San Juan River is comprised of run habitats (Bliesner and Lamarra 2007). In all years, except 2006, approximately 10% of the samples are taken in backwaters associated with the primary channel. Riffle habitats generally comprised 10% of the samples in primary and secondary channels.



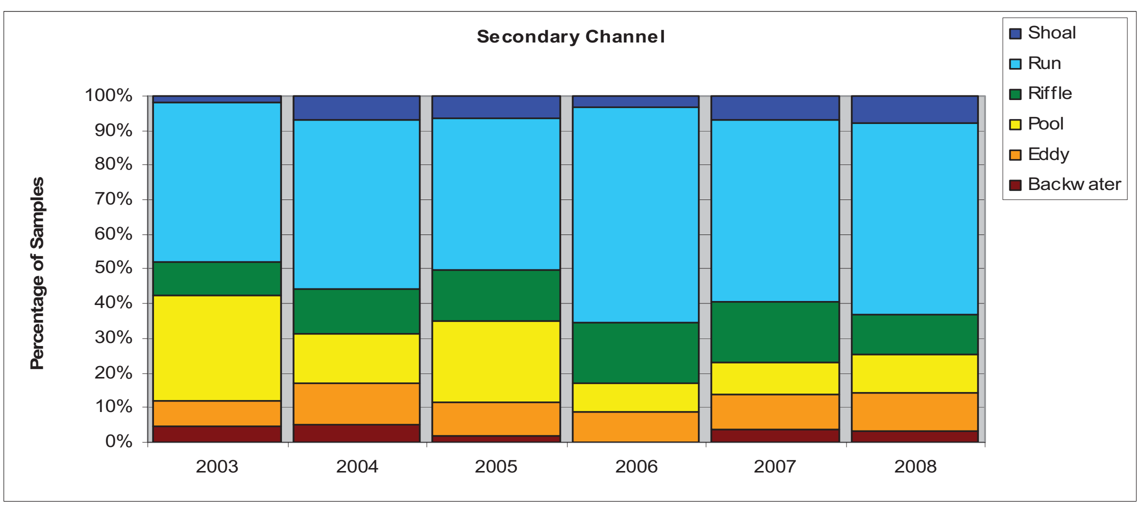


Figure 5. Proportion of samples taken within various habitats in primary and secondary channels of the San Juan River (2003-2008).

RARE FISHES INFORMATION SUMMARY

Razorback sucker and other native suckers

No young-of-year razorback sucker has been collected during small-bodied monitoring on the San Juan River though one adult razorback sucker was collected in 2005. Larval razorback sucker were collected by larval sampling for the past 11 years (Brandenburg and Farrington 2008). However, no young-of-year razorback sucker has been collected by larval sampling later than July in any year.

Similarly, numbers of commonly collected sucker species generally decrease in larval collections in late summer months. The majority of these individuals are possibly moving into habitats that are not sampled by larval fish crews, which concentrate on low-velocity, near-shore habitats. There is little information on habitat use of juvenile razorback sucker in the San Juan. Larval sampling crews collected single specimens of age-1 razorback sucker in 2004 and 2006. One was collected in an edge pool and the other in a shore run habitat.

Adult razorback sucker in the Green River were observed mainly in habitats greater than 1 m deep, with sandy substrates (Tyus 1987). Collections of juvenile razorback suckers are throughout its range. In the upper Colorado River basin, studies indicate that floodplain habitats are important habitats for development of larval razorback sucker, although nonnative predators within the floodplain decreased recruitment success (Christopherson et al. 2004). Floodplain areas were often warmer and had greater abundance of zooplankton than the main channel habitats, presumably enabling faster growth. Tributary streams may also provide important habitats for spawning and rearing (Minckley 1973). McElmo Creek was noted as a likely spawning location for razorback sucker in the San Juan (Brandenburg and Farrington 2008).

BLUEHEAD AND FLANNELMOUTH SUCKER

Although young-of-year razorback sucker have not been collected during San Juan River small-bodied monitoring there is likely relevant information that can be gleaned from collections of common suckers. Bluehead and flannelmouth suckers were collected in various habitat types (Figures 6 & 7). Large aggregations of both sucker species were periodically found in low-velocity habitats, including backwaters and pools. The density of flannelmouth sucker in the primary channel was greatest in pools and backwaters associated with the primary channel ($F_{(2, 2086)}=39.217$, $p<0.01$), but not in secondary channels. There were no significant relationships between bluehead sucker density and habitat types in either channel type.

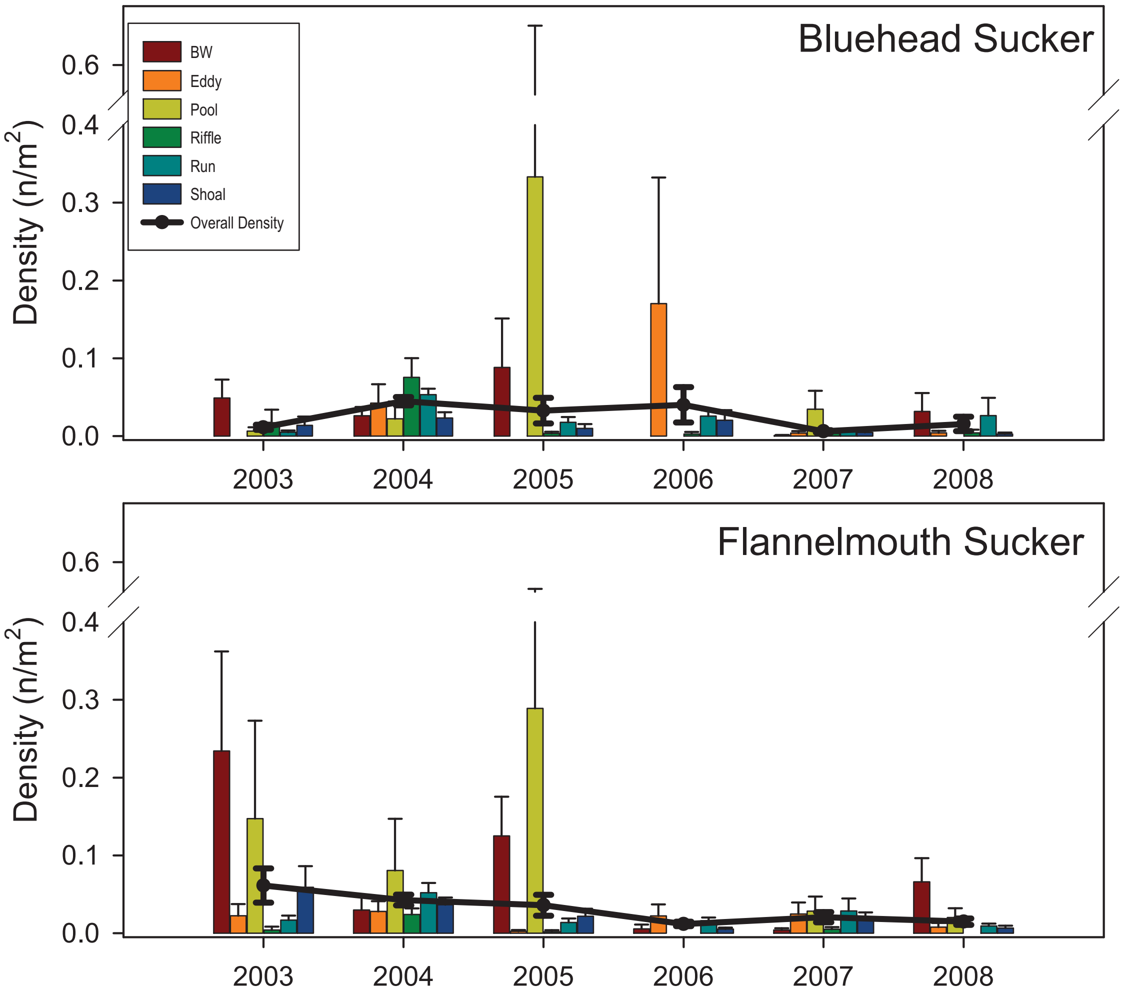


Figure 6. Density of bluehead and flannelmouth sucker in habitats associated with the primary channel (including large backwaters) of the San Juan River, 2003-2008. Error bars are 1 standard error.

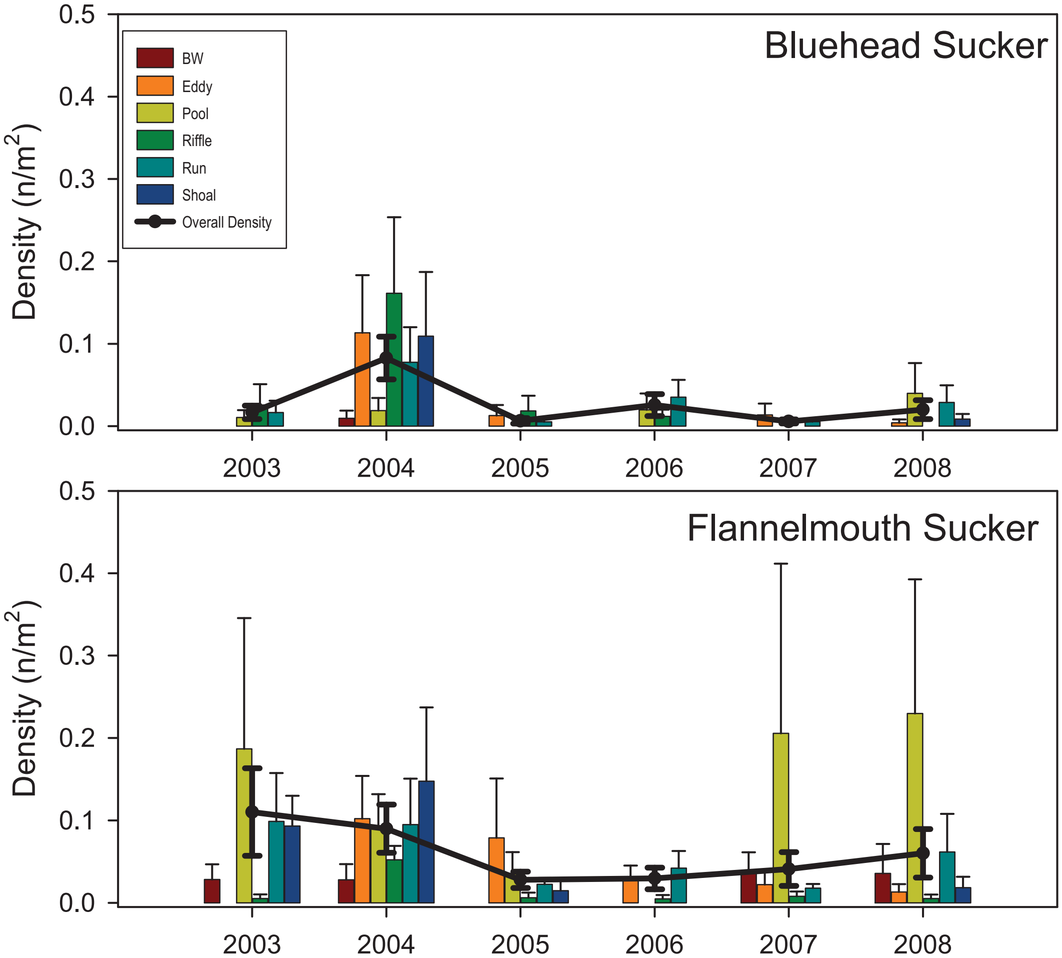


Figure 7. Density of bluehead and flannelmouth sucker in habitats associated with secondary channels of the San Juan River, 2003-2008. Error bars are 1 standard error.

The mean depth habitats from which small-bodied fishes were collected was 0.301 m (SE = 0.003). The maximum depth that collections are obtained is about 1.5 meters, but seining efficiency in unconfined habitats greater than 0.75m deep was likely low. The mean depth of samples containing bluehead sucker was 0.278 meters (SE = 0.008), and those containing flannelmouth sucker was 0.285 meters (SE = 0.008). Both sucker species were collected in habitats with various substrate types (Figure 8). Although large samples of flannelmouth sucker were periodically collected in slow-water habitats with sand and silt substrates, there was no significant effect of substrate on density of flannelmouth or bluehead sucker ($F_{(4df)}<1.57$, $p>0.19$).

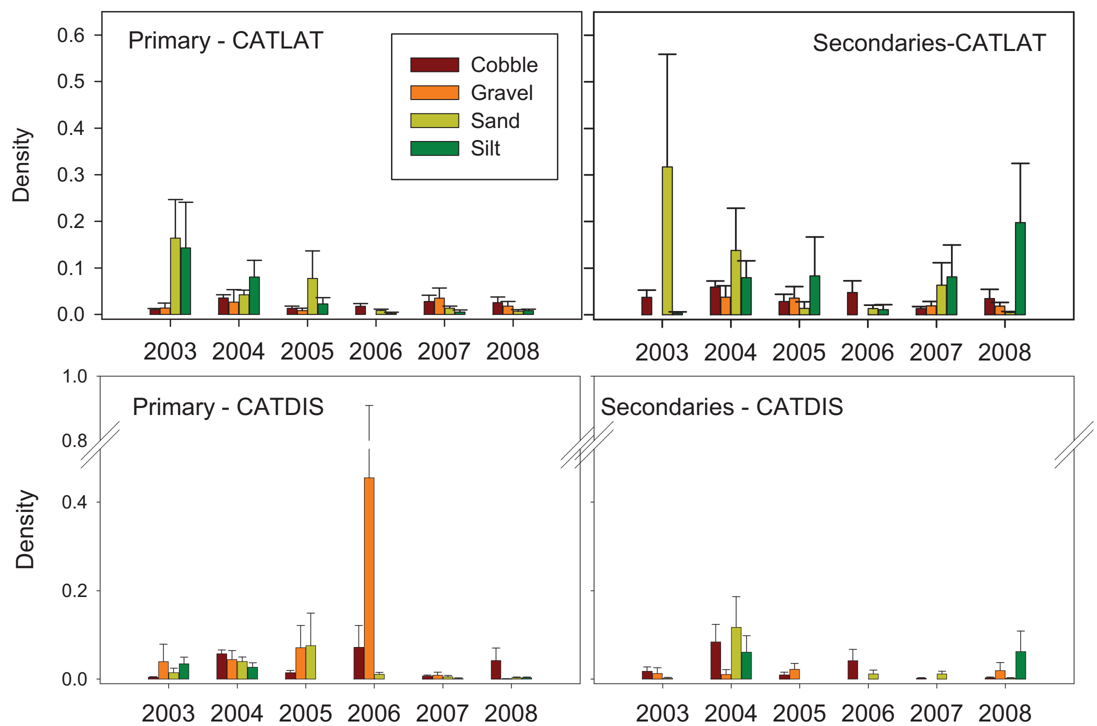


Figure 8. Density of flannelmouth sucker and bluehead sucker captured over various substrates in the San Juan River, 2003-2008. Error bars represent 1 standard error. Note change in Y-axis scale.

Recruitment of larval fish into the adult population is an important aspect of recovery that has been problematic for razorback sucker in the San Juan. There was not a clear relationship between the catch-per-unit-effort (CPUE) of commonly collected suckers captured during larval fish monitoring and CPUE for young-of-year suckers captured during small-bodied monitoring (Figure 9 & 10).

To aid in discerning potential relationships between larval CPUE (and thus, reproductive success) and small-bodied CPUE (and thus recruitment success, at least to early juvenile), a simple model (appendix Table A2) was developed to determine how well CPUE of larvae at various times of year predicted the CPUE of young-of year collected during autumn monitoring. For both species, the CPUE of young-of-year collected in August was the best predictor of how many were collected during fall monitoring; expected values were within confidence intervals 6 of 6 years for flannelmouth sucker and 5 of 6 years for bluehead sucker. For example, average CPUE for young-of-year flannelmouth sucker in small-bodied monitoring from 2003 through 2008 was 2.14 (SE 1.82) times the CPUE of August larval surveys. The only year that larval razorback suckers were collected in August was 2005. If detection/retention of razorback sucker was similar to flannelmouth sucker calculations, 4 ± 8 razorback would have been collected by small-bodied monitoring in 2005. Although there was not a clear relationship, it appeared that sucker CPUE in autumn small-bodied and adult monitoring was correlated with their August CPUE.

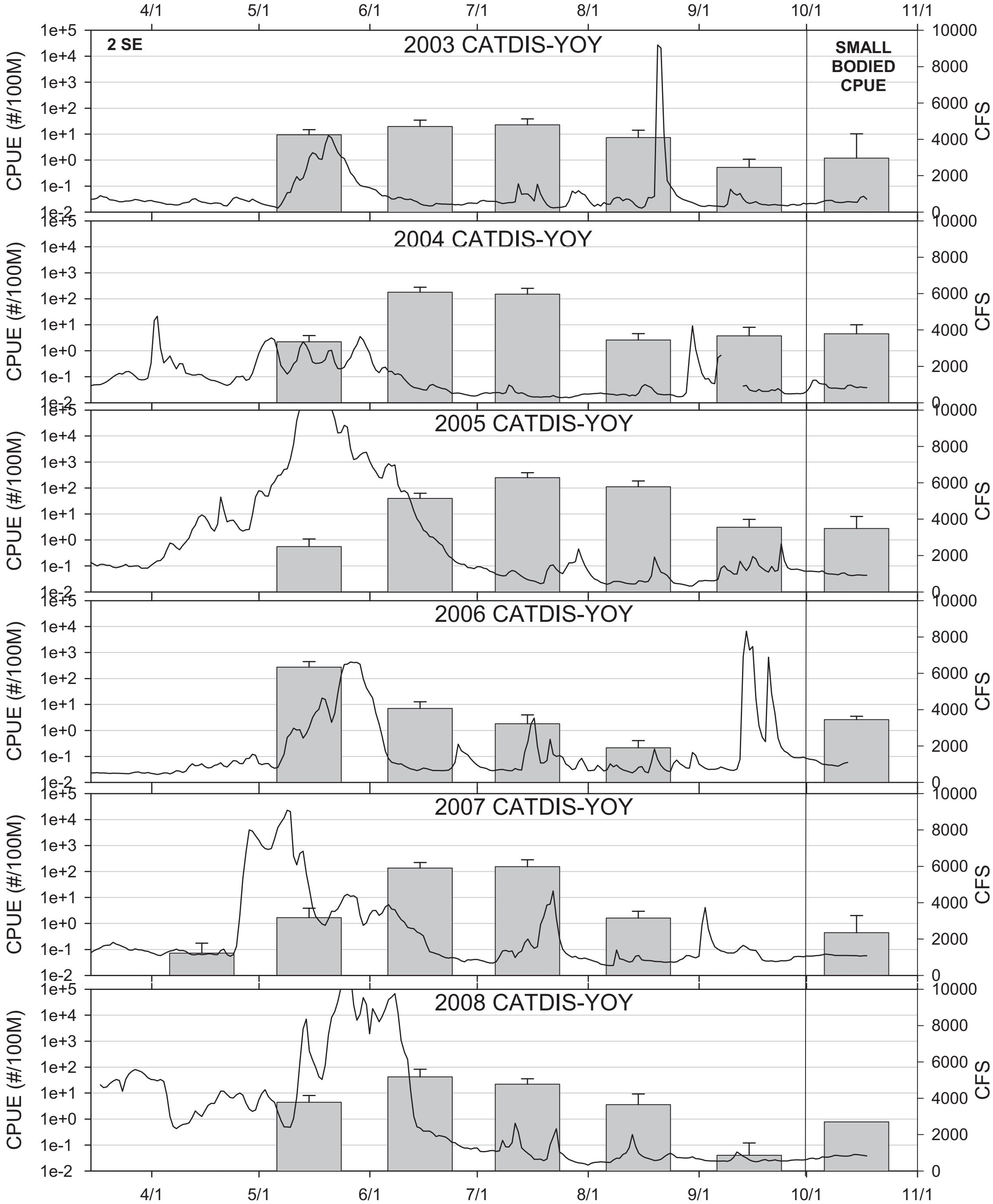


Figure 9. Bars represent catch-per-unit-effort for young-of-year bluehead sucker during San Juan River larval and small-bodied monitoring. Error bars represent 2 standard errors. Line represents discharge at Shiprock Gage, NM in the San Juan River 2003-2008.

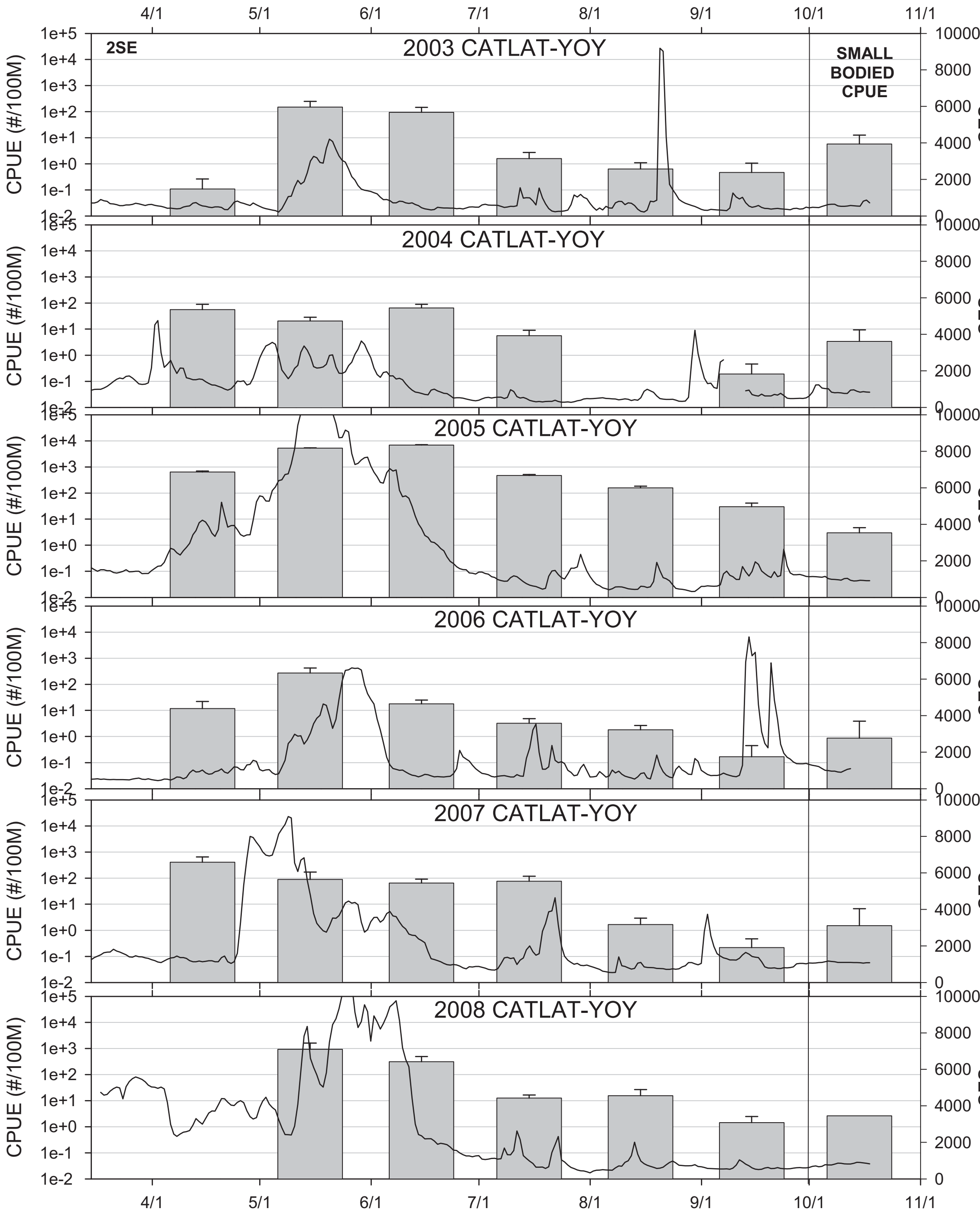


Figure 10. Bars represent catch-per-unit-effort for flannelmouth sucker young-of-year during San Juan River larval and small-bodied monitoring. Error bars represent 2 standard error. Line represents discharge at Shiprock Gage, NM in the San Juan River 2003-2008.

Year classes were tracked through time using length-frequency histograms. There was a strong cohort of bluehead sucker in 2004 that carried through 2008 (Figure 11). Flannelmouth sucker had strong year classes both in 2003 and 2004 (Figure 12). Neither species had good recruitment for the 2005 year class, although both had relatively abundant young-of-year in autumn 2005. Recruitment appeared to be low for 2006 and 2007 as well.

Young-of-year suckers were generally less than 100 mm TL by autumn. Young-of-year for both species were smaller in 2005 and 2008 than other years (Figure 13). Flannelmouth sucker spawned in 2004 were larger than young-of-year collected in other years. Larger larvae may be more successful at surviving to next year, and thus to the adult population than smaller individuals; faster growth rates may reduce the time that larvae are vulnerable to predation by co-occurring small-bodied fish and invertebrate predators in nursery areas (Bestgen 2008, Christopherson et al. 2004). Time of spawning also has an effect on size of young-of-year suckers in autumn. Spawning for all sucker species extended over a longer period in 2005 than 2004 (Brandenburg and Farrington 2008).

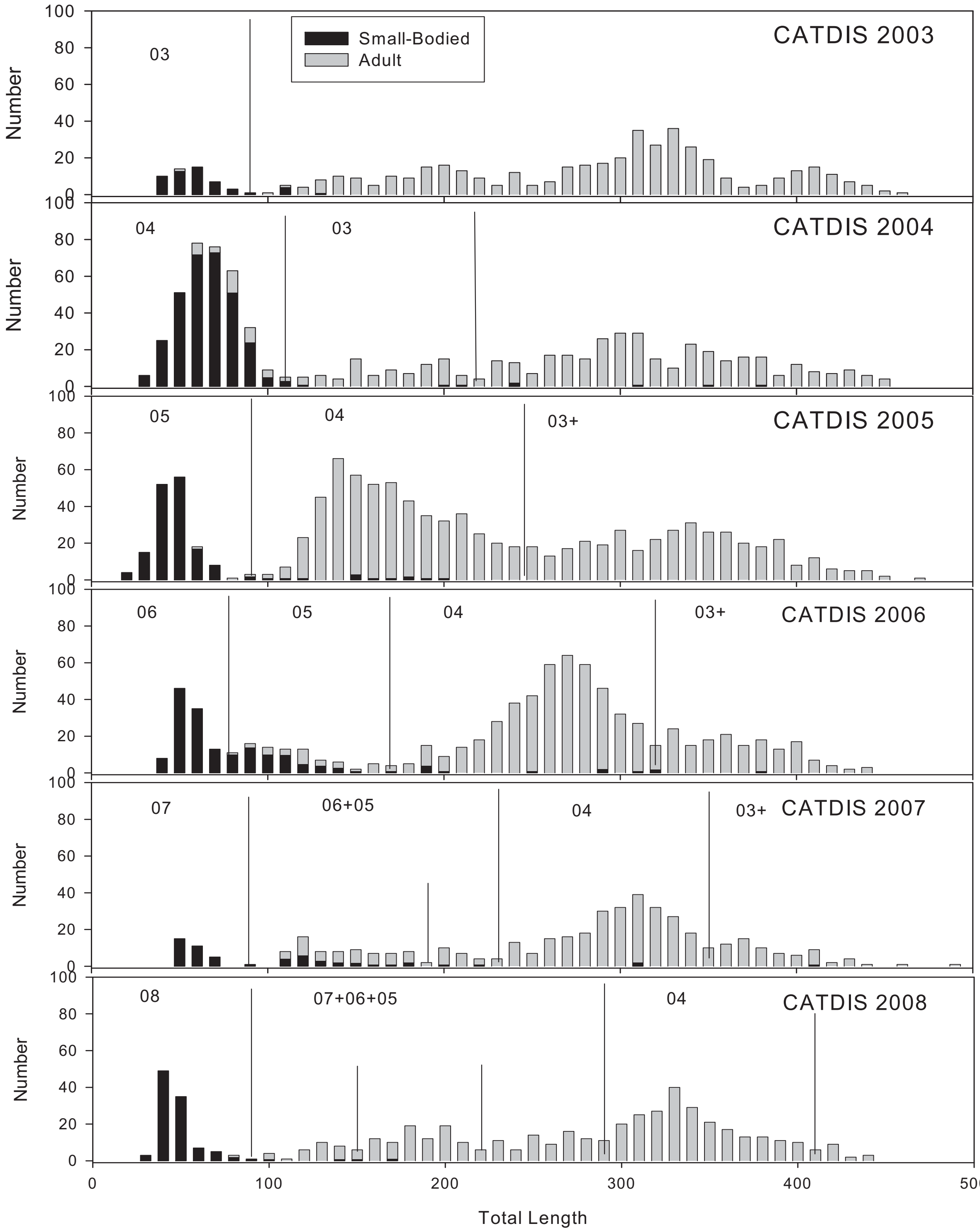


Figure 11. Length frequency histogram and approximate year class for bluehead sucker collected during fall monitoring by small-bodied and adult monitoring efforts on the San Juan River, 2003-2008. Vertical bars approximate breaks in year class cohorts.

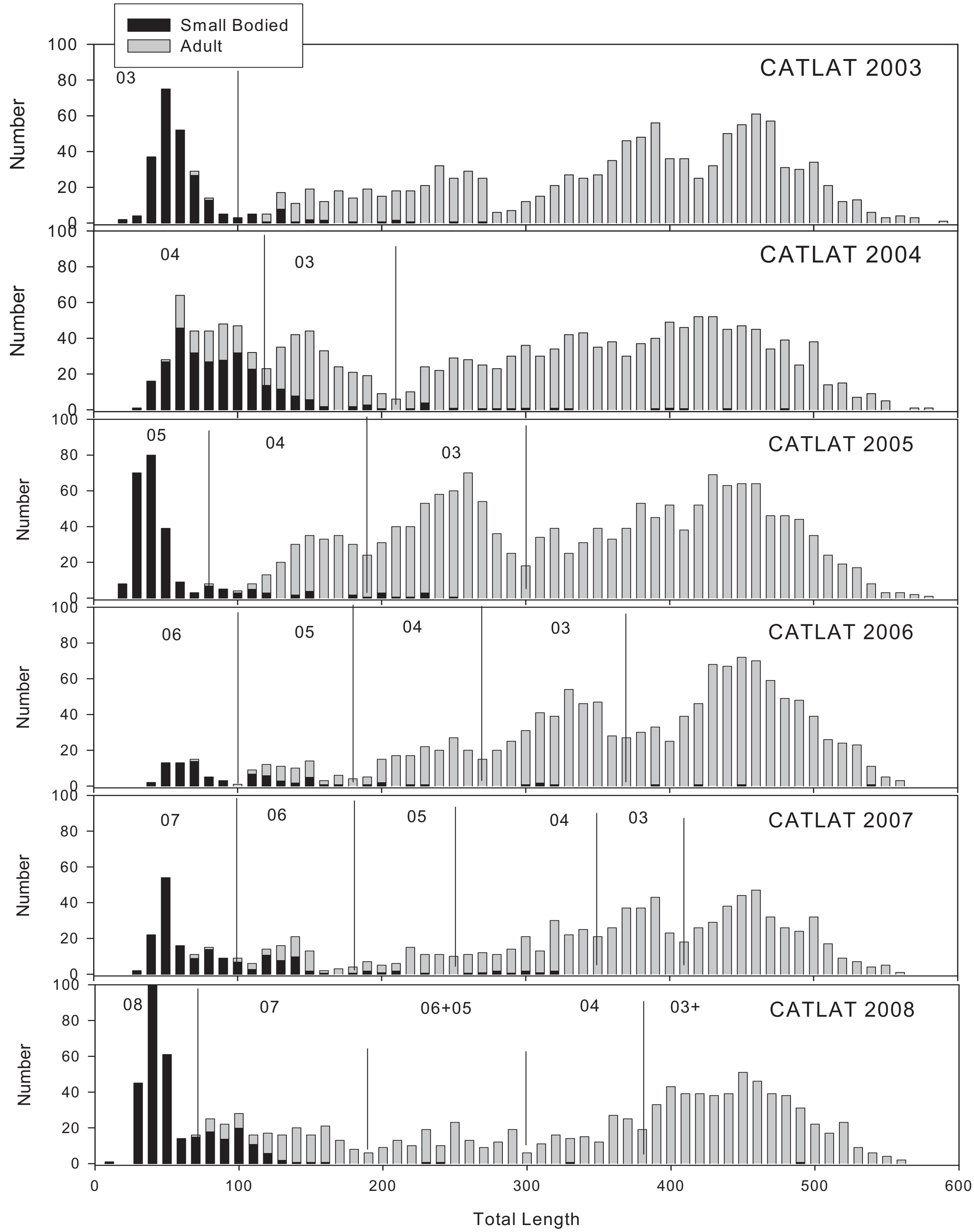


Figure 12. Length frequency histogram and approximate year class for flannelmouth sucker collected during fall monitoring by small-bodied and adult monitoring efforts on the San Juan River, 2003-2008. Vertical bars approximate breaks in year class cohorts.

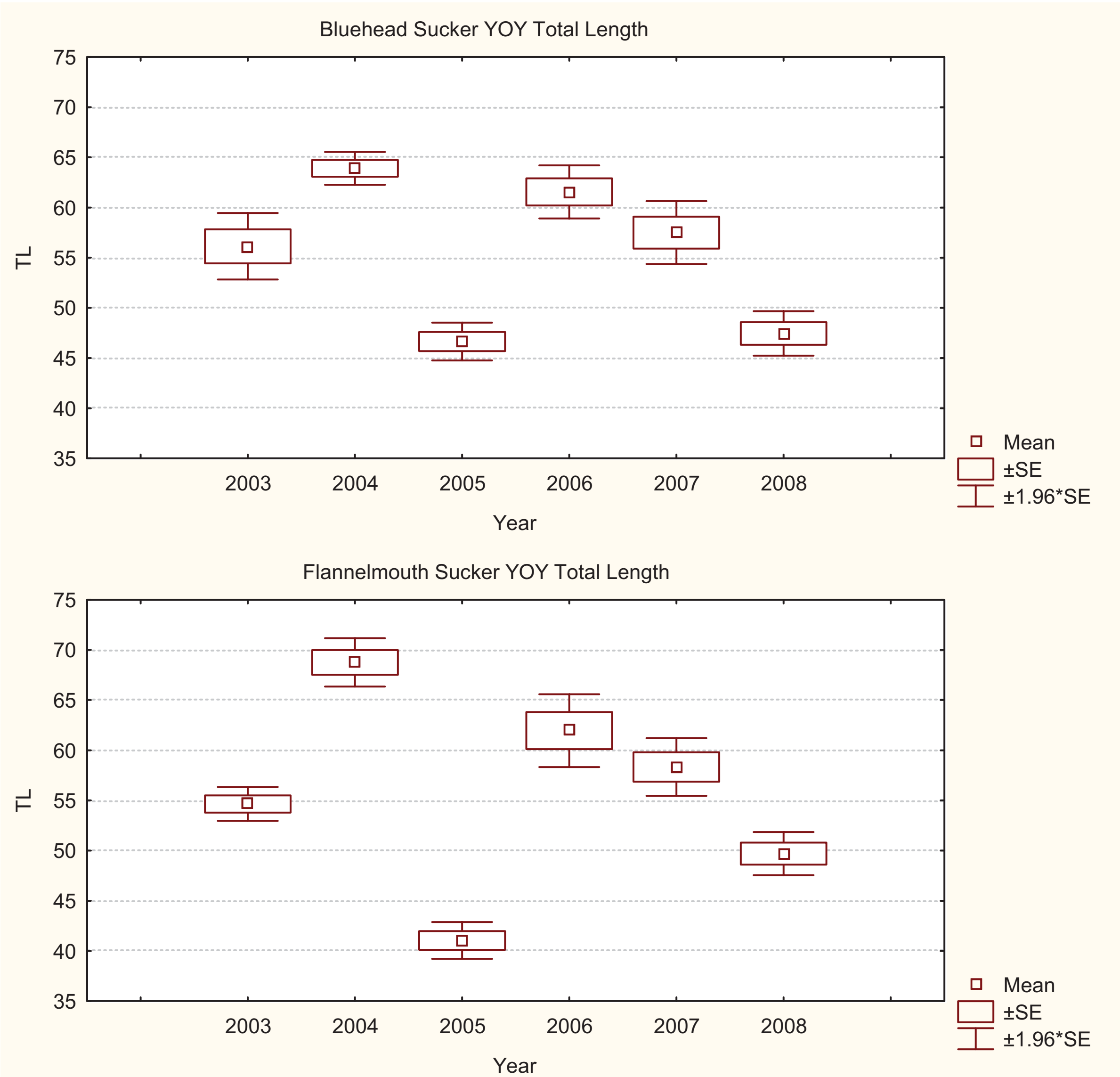


Figure 13. Mean total length of young-of-year bluehead and flannelmouth sucker in the San Juan River 2003-2008.

Colorado Pikeminnow

Young-of-year Colorado pikeminnow were collected by small-bodied monitoring in 1998, 2000, and 2007 (Table 8). Stocking of larval or young-of-year Colorado pikeminnow occurred in each of these years prior to small-bodied monitoring, so it is probable that these specimens were captive-bred individuals (Ryden 2006). Total length of these fish averaged 50 mm (SE 1.74). Twenty-four young-of-year Colorado pikeminnow were captured in September and October from 1987 through 1994, prior to initiation of small-bodied monitoring in 1998 (Table 9) (Platania et al., 2000). These fish were smaller than captures since 1996, averaging 26 mm (SE 1.21) in September and 32 mm (SE 1.76) in October.

Age-1+ Colorado pikeminnow were collected by small-bodied monitoring in each year, except 2001, 2002, and 2003. Most age-1+ Colorado pikeminnow were captured in Reach 5. Only one age-1+ and one recently stocked young-of-year have been collected in Reach 1.

Table 8. Summary of Colorado pikeminnow captures by small-bodied monitoring in the San Juan River, 1998 -2008. Blue highlight indicates recently stocked young-of –year.

Year	Length Category	Reach 6	5	4	3	2	1	Grand Total
1998	70			1				5
	80				1			
	130		2	1				
1999	120		1					2
	230		1					
2000	50			1				2
	90				1			
2004	160		2					8
	170			1				
	180		2					
	200		1					
	210		1					
	230			1				
2005	170				1			3
	180			1				
	290					1		
2006	140	1	1					10
	150	1	1					
	180		1		1			
	190					1		
	200	1						
	210				1			
	280				1			
2007	40				6	2		59 Total, (*28 Recently Stocked YOY)
	50				17	2	1	
	120	2						
	130		1					
	140	1	4					
	150	2	6		2			
	160	2		1	1		1	
	170	1	1	3	1			
	180		1		1			
2008	130		1					10
	140	1	1	1				
	150		2	1	1			
	170		1					
	210				1			
Grand Total		12	27	9	34	6	2	90

Table 9. Size of young-of year Colorado pikeminnow collected in September and October in the San Juan River, 1987-1994 (Platania 2000).

	September		October	
Year	***Number***	***Total Length***	***Number***	***Total Length***
1987	16	17-32mm	2	28-38
1990	1	34		
1992	1	23		
1993	5	19-32	4	29-36
1994	1	25		
Total	24		6	
Mean		26.1		32.2
SE		1.21		1.76

The density of Colorado pikeminnow captured in the primary channel was greatest in backwater habitats ($F_{(5, 2081)}$=5.3269, p<0.01), although most of these captures were recently stocked age-0 individuals in 2007 (Figure 14). If these individuals were removed from the analysis, there was no significant difference in the density of age-1+ Colorado pikeminnow across habitat types in the primary channel ($F_{(5, 2037)}$=.69188, p=0.63). In secondary channels, the density of pikeminnow in shoal habitats was higher than other habitat types ($F_{(5, 658)}$=2.8045, p=0.02).

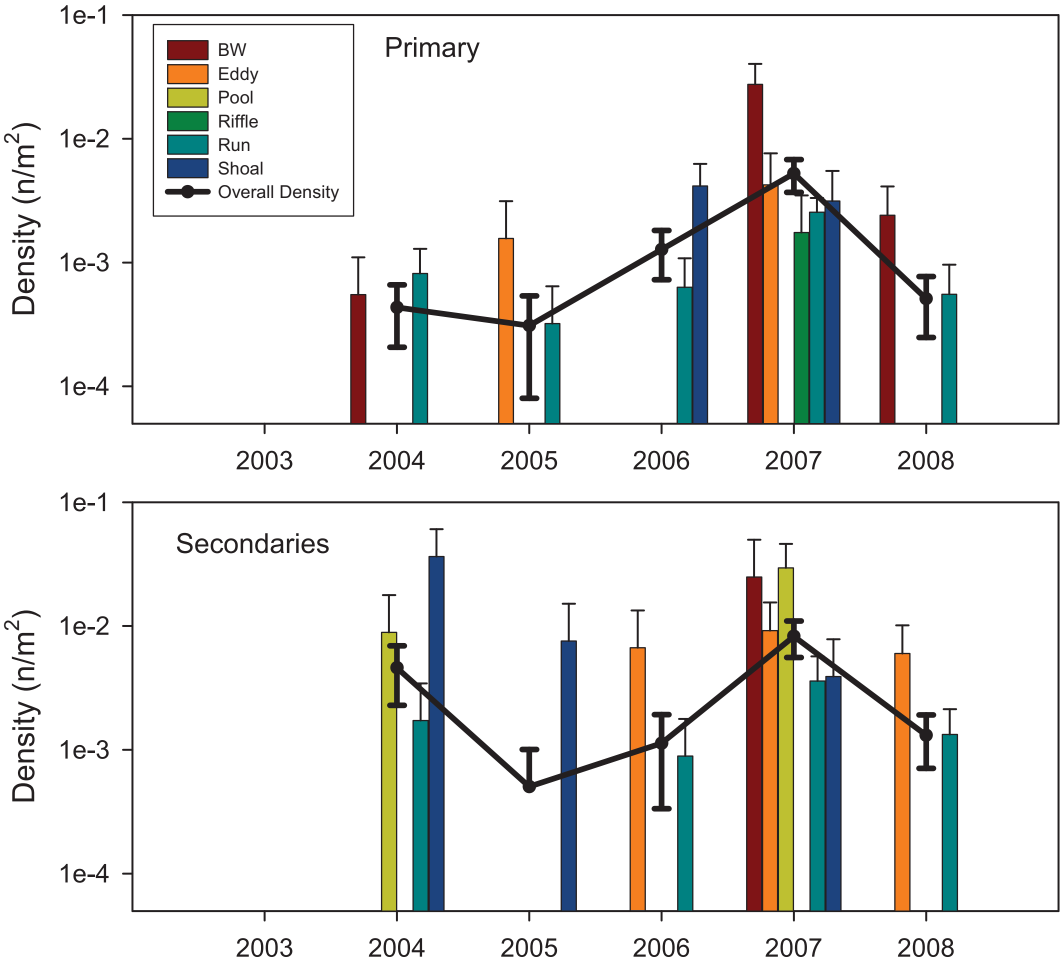


Figure 14. Density of Colorado pikeminnow in habitats associated with primary (including large backwaters) and secondary channels of the San Juan River 2003-2008. Error bars are 1 standard error, note log scale on Y-axis.

There was no significant effect of substrate on density of Colorado pikeminnow collected in the primary channel, but there were higher densities associated with sand and silt substrates in secondary channels ($F_{(3, 640)}$=3.4002, p=0.02) (Figure 15). The average depth of samples that contained Colorado pikeminnow was 0.263 m (SE 0.02).

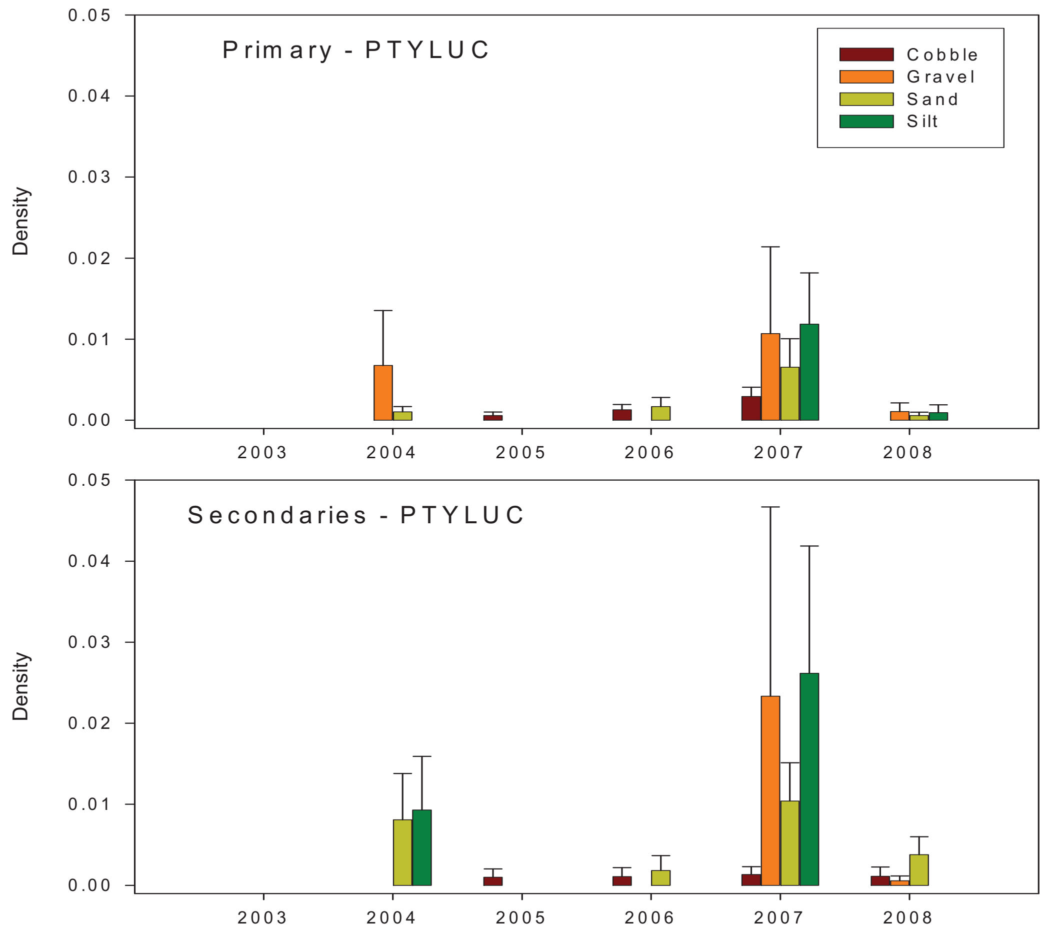


Figure 15. Density of Colorado pikeminnow captured over various substrates in the San Juan River, 2003-2008. Error bars represent 1 standard error.

Young Colorado pikeminnow are thought to switch from insectivory to primarily piscivory between 50-200 mm total length (Vanicek and Kramer 1969, Franssen et al. 2007). Franssen et al. (2007) reported that the maximum prey size for Colorado pikeminnow was dependant on the prey species. Colorado pikeminnow could consume red shiner up to 37% and native suckers up to 43% of their total length.

Figures 16 and 17 demonstrate the availability of potential prey with total length less than 40% of Colorado pikeminnow total length up to 200 mm from 2003-2008. All species captured were considered potential prey except channel catfish and species of bullhead catfishes. In most years, reaches 6 and 5 contained the greatest density of small fishes, 2005 being the exception. The density of small fishes in reaches 2 and 1 was less than 0.01 for the past two years. For all years, there was not a suitable prey base of small fish in autumn for Colorado pikeminnow stocked as age-0; survival of these fish was therefore largely, if not entirely, dependent on macroinvertebrates. Appropriate-sized fish prey were not available until the following spring, when larval fish of appropriate size for small Colorado pikeminnow to consume were present.

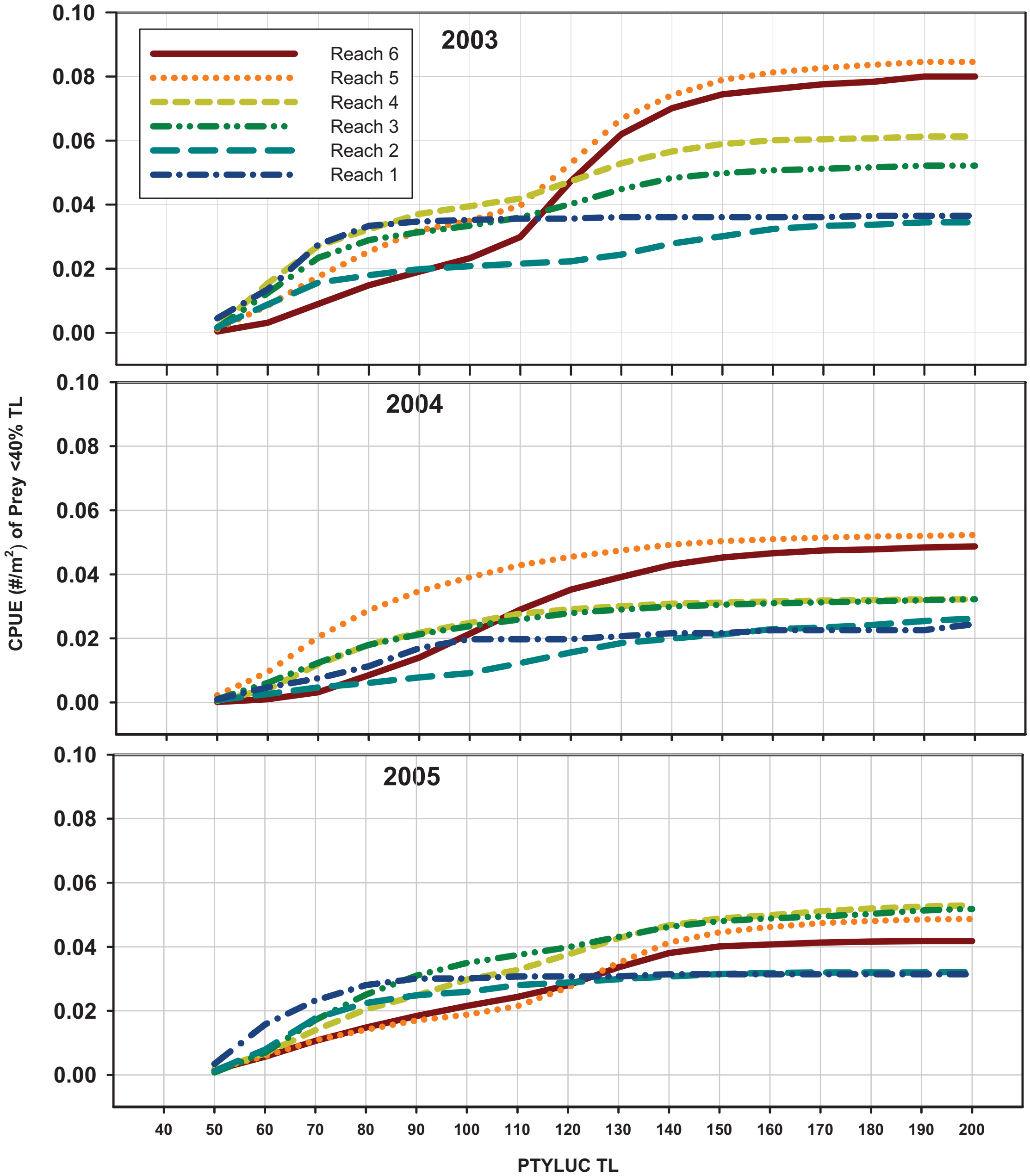


Figure 16. Density of prey species <40% TL of Colorado pikeminnow TL for each reach in the San Juan River from 2003-2005.

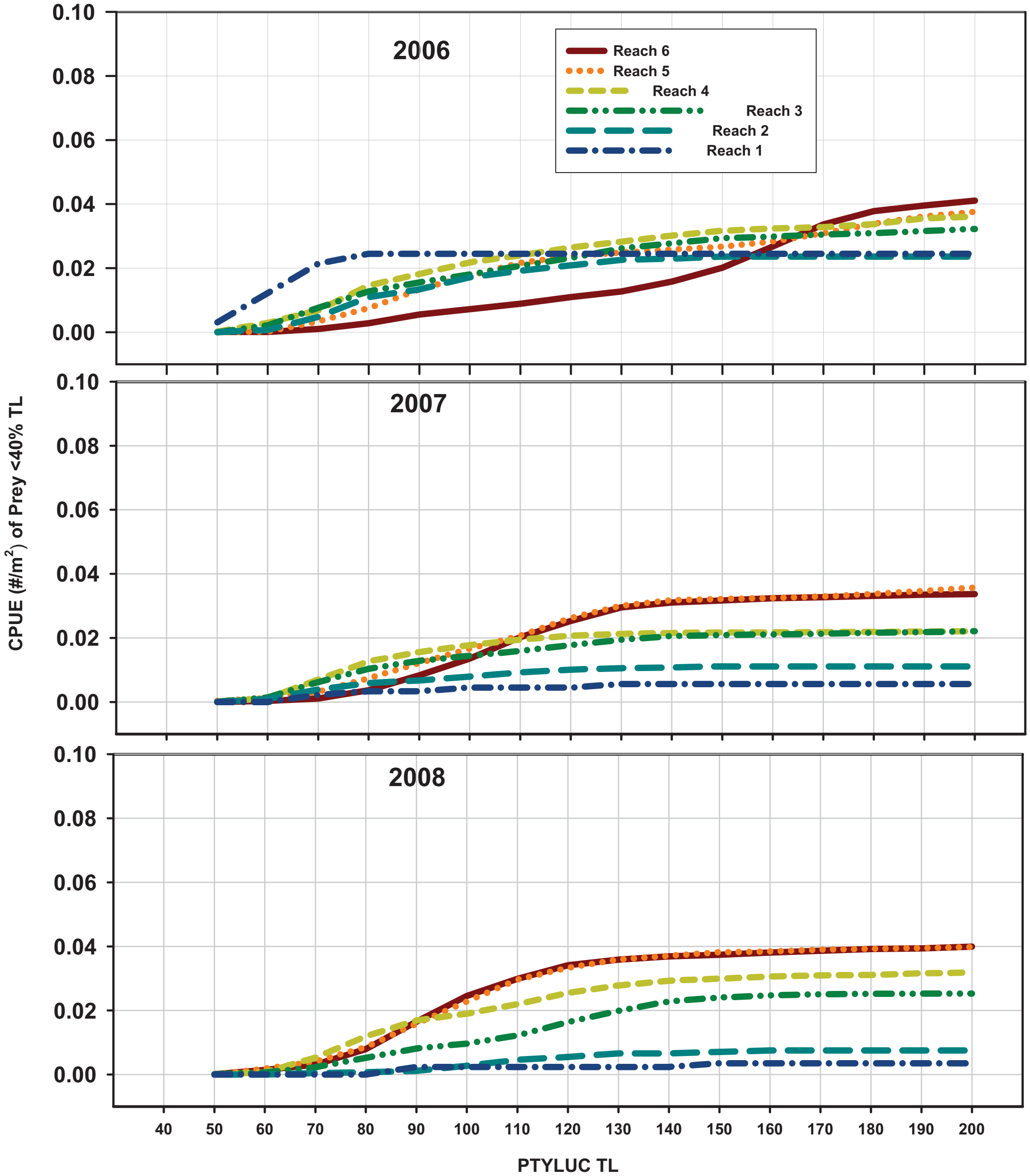


Figure 17. Density of prey species <40% TL of Colorado pikeminnow TL for each reach in the San Juan River from 2006-2008.

RECOMMENDATIONS

The data set associated with small-bodied monitoring is useful for filling information gaps between larval fish collections and recruitment into the adult population. There is a wealth of information that might be inferred about the community dynamics of the San Juan River that may prove to be useful in understanding the factors that are important to the recovery of Colorado pikeminnow and razorback sucker.

In order to detect occurrence of post-larval stages of razorback sucker there may need to be focused studies to determine the most effective sampling methods. If suckers are habitat generalists or mainly using habitats that are common in the river (i.e. runs) it is unlikely that many will be collected without intense effort. Current sampling methods appear appropriate for detecting presence young-of-year Colorado pikeminnow, who tend to use low-velocity habitats. Alternative sampling methods, particularly for age-0 (early juvenile) razorback sucker, should be evaluated. However, any changes in current methods should be designed to minimally compromise the integrity of the existing dataset for riverwide community monitoring.

Paucity of small fish prey in the fall and winter may compromise survival of stocked Colorado pikeminnow, especially if macroinvertebrate densities are low as well. A study to investigate relationship of food availability for young Colorado pikeminnow and their survival may shed some light on the apparent low recruitment into the adult population. Food abundance for developing razorback sucker also may be limiting because of the rarity of high-productivity inundated floodplain habitats.

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APPENDIX A

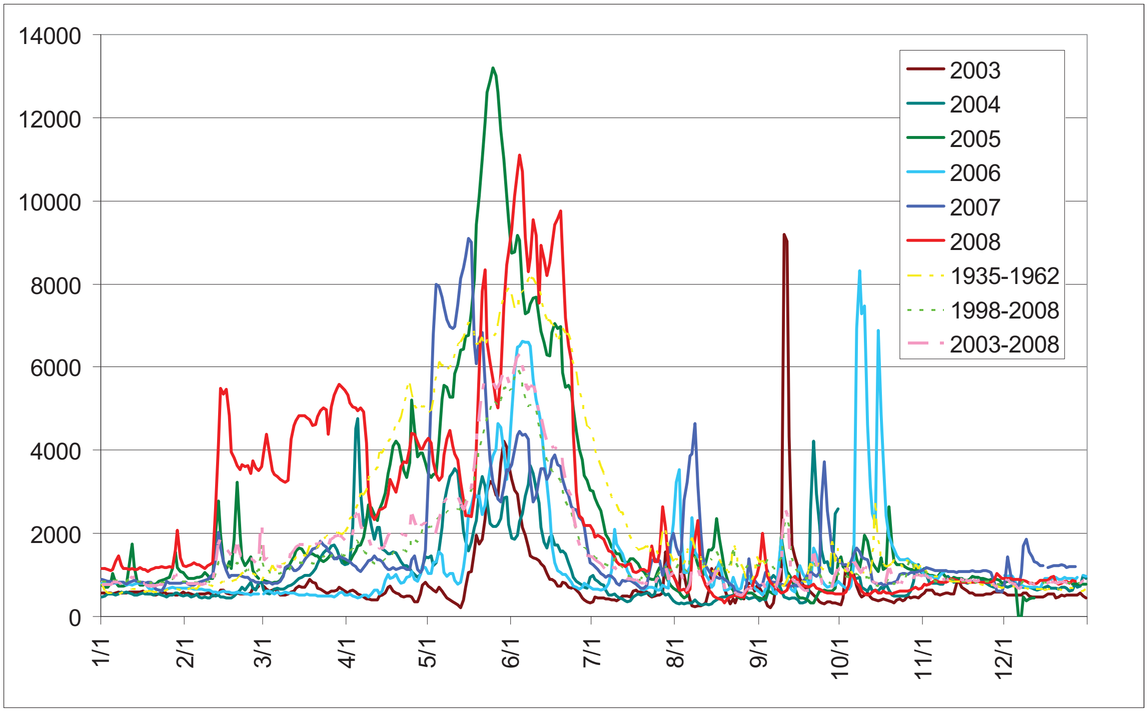

Figure A1. Mean daily discharge at Shiprock gage (USGS 936800) for the San Juan River 2003-2008.

Table A1. Mean daily discharge data from Shiprock gage (USGS 936800) for the San Juan River 1998-2008.

	YEAR											MEAN		
Month	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***1935-1962***	***1998-2008***	***2003-2008***
March	1141	882	941	1033	664	653	1043	1278	537	1276	4483	1540	1265	1598
April	1425	1160	1652	1384	533	532	1829	3026	760	1244	3789	4017	1609	1988
May	5250	3238	2311	4781	644	1621	2406	7983	2284	6050	4780	6517	3530	3815
June	3970	5876	2011	4760	433	1243	1836	6380	3136	3250	7450	6884	3710	4010
Spring Average	2951	2777	1727	2988	570	1015	1778	4666	1675	2967	5117	4728	2526	2850
July	1665	3116	326	690	358	575	585	1461	967	1054	1463	2319	1121	1010
August	959	5731	602	1132	368	642	398	966	1196	1518	740	1278	1273	788
September	644	4298	649	552	1126	1301	1120	684	904	1178	787	1109	1207	960
Summer Average	1094	4383	524	794	612	834	696	1041	1024	1251	999	1574	1200	919
Spring (March - June)														
Days>3000	48	41	18	47	0	9	14	76	23	48	102	84	34	36
Days>5000	24	26	1	29	0	0	0	50	9	21	47	63	16	21
Days>8000	0	0	0	1	0	0	0	18	0	5	22	3	0	0
Days>10000	0	0	0	0	0	0	0	11	0	0	4	0	0	0
Summer (July - September)														
Days>5000	0	31	0	0	2	2	0	0	0	0	0	0	0	0
Days>4000	1	42	0	0	2	3	1	0	0	1	0	2	0	0
Days>3000	1	72	0	0	2	3	1	1	2	6	0	7	0	0
Days>2000	10	90	0	5	3	3	6	6	5	9	5	16	3	2
Days>1000	36	92	1	18	7	12	11	41	33	41	37	77	71	29
Days<1000	55	0	91	74	85	79	80	50	59	51	55	14	19	61
Days<750	42	0	80	61	80	67	70	40	36	13	41	2	0	30
Days<500	15	0	45	23	74	43	49	17	0	0	11	0	0	0

Table A2- Simplistic model for predicting fall CPUE for young-of-year catostomid species in the San Juan River.

	Average Ratio				Predicted Numbers											
trip	CATLAT	LAT-Se	Count	Year	2003	+/- 2SE	2004	+/- 2SE	2005	+/- 2SE	2006	+/- 2SE	2007	+/- 2SE	2008	+/- 2SE
	smb/larval	YOY	sampled	CATLAT	217		229		222		55		150		286	
04/15	10.60619	4.600957	5		612	531	1047	909	794	689	761	661	1304	1131	1179	1023
05/15	0.037861	0.043945	6		2	5	4	9	3	7	3	6	5	11	4	10
06/15	0.032447	0.043895	6		2	5	3	9	2	7	2	6	4	11	4	10
07/15	0.788638	0.746003	6		46	86	78	147	59	112	57	107	97	183	88	166
08/15	2.148453	1.818758	5		124	210	212	359	161	272	154	261	264	447	239	404
09/15	7.321775	3.277034	6		422	378	723	647	548	490	526	470	900	806	814	729
trip	CATDIS	DIS-SE	Count													
04/15	6.113354	2.361245	1		353	272	604	466	457	353	439	339	751	580	680	525
05/15	1.262266	1.088376	6		73	126	125	215	94	163	91	156	155	268	140	242
06/15	0.091984	0.12751	6		5	15	9	25	7	19	7	18	11	31	10	28
07/15	0.263733	0.270675	6		15	31	26	53	20	41	19	39	32	67	29	60
08/15	2.433718	2.953211	6		140	341	240	583	182	442	175	424	299	726	271	657
09/15	5.93842	2.357277	4		343	272	586	465	444	353	426	338	730	579	660	524
				Area Sampled	5769.53		9873.3		7482.96		7178.48		12290.29		11117.84	
		YOY	sampled	CATDIS	49		349		155		138		39		104	
		YOY	sampled	CATLAT	217		229		222		55		150		286	

	Ratio of EXPECTED/OBSERVED							
trip	2003	2004	2005	2006	2007	2008	Average	SE
04/15	2.82	4.57	3.58	13.84	8.69	4.12	6.27	1.73
05/15	0.01	0.02	0.01	0.05	0.03	0.01	0.02	0.01
06/15	0.01	0.01	0.01	0.04	0.03	0.01	0.02	0.01
07/15	0.21	0.34	0.27	1.03	0.65	0.31	0.47	0.13
08/15	0.57	0.93	0.72	2.80	1.76	0.84	1.27	0.35
09/15	1.95	3.16	2.47	9.56	6.00	2.85	4.33	1.19
04/15	7.20	1.73	2.95	3.18	19.27	6.54	6.81	2.64
05/15	1.49	0.36	0.61	0.66	3.98	1.35	1.41	0.55
06/15	0.11	0.03	0.04	0.05	0.29	0.10	0.10	0.04
07/15	0.31	0.07	0.13	0.14	0.83	0.28	0.29	0.11
08/15	2.87	0.69	1.17	1.27	7.67	2.60	2.71	1.05
09/15	6.99	1.68	2.87	3.09	18.71	6.35	6.62	2.57

xyrtex cpue larval

		conversion	se	2003 average		2004 se	average	2005 se	average	2006 se	average	2007 se	average	2008 se	average	se
04/15	04/15			0	0	0	0	0	0	0.449877	0.369813	0.025253	0.025253	0	0	
05/15	05/15	1.41	0.985	16.69424	5.510263	0.841314	0.482344	0.195385	0.112364	7.053048	2.808988	2.038815	1.237067	5.313268	2.14943	
06/15	06/15	0.075	0.25	8.044627	6.951236	1.315299	0.56942	0.605436	0.318957	0	0	4.534841	1.344031	2.296102	0.68802	
07/15	07/15	0.5	0.5	0	0	0	0	0.292649	0.21257	0	0	0.032603	0.032603	0.106199	0.076031	
08/15	08/15	2.14	1.8	0	0	0	0	0.029193	0.029193	0	0	0	0	0	0	
09/15	09/15	11	3	0	0	0	0	0	0	0	0	0	0	0	0	

	PREDICTIONS OF OCT XYRTEX		pred	+/- 2SE	pred	+/- 2SE	pred	+/- 2SE	pred	+/- 2SE	pred	+/- 2SE	pred	+/- 2SE
04/15	04/15		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05/15	05/15		1358.08	626.30	117.12	93.82	20.62	16.56	713.89	397.24	353.31	299.52	832.92	470.77
06/15	06/15		34.81	200.53	9.74	28.11	3.40	11.93	0.00	0.00	41.80	82.59	19.15	38.25
07/15	07/15		0.00	0.00	0.00	0.00	10.95	15.91	0.00	0.00	2.00	4.01	5.90	8.45
08/15	08/15		0.00	0.00	0.00	0.00	4.67	7.86	0.00	0.00	0.00	0.00	0.00	0.00
09/15	09/15		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Average	232.15	137.80	21.14	20.32	6.61	8.71	118.98	66.21	66.19	64.35	142.99	86.25

Sum of YOY?	Species	
Year	CATDIS	CATLAT
2003	49	217
2004	349	229
2005	155	222
2006	138	55
2007	39	150
2008	104	286
Grand Total	834	1159