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NONNATIVE INVASION BETWEEN LAKE POWELL AND THE SAN JUAN RIVER, 1996

Completion Report

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Introduction

In 1988, as lake levels started to recede the San Juan River cut a new channel over a rock ledge that created a 25-30 foot waterfall that became a barrier to fish migrations. This waterfall barrier effectively blocked fish migration from the fall of 1988 to the spring/summer of 1995 when the lake approached full pool (3700 feet AMSL). In 1995, the lake reached a level of 3694 feet AMSL and covered the waterfall at a lake elevation of about 3675-3680. During the winter of 1996, lake levels dropped to 3672 but the waterfall did not reappear. This is probably due to sediments that covered the waterfall and river channel. As the lake again declined the meandering river found a new course or did not scour the sediment adequately to expose the waterfall. Because the waterfall did not reappear fish in Lake Powell had access to the San Juan River from July 1995 through 1996.

Possible effects that breaching the migration barrier may have on native fish in the San Juan River are higher competition and predation rates from Lake Powell species (Tyus et al. 1982). Competition and predation from nonnative species is believed to be a major factor that has led to the decline of many native species in the Colorado River Basin (Minckley 1991). To evaluate the possible effects that elimination of the migration barrier might have on the San Juan River fish community we attempted to monitor the fish community in the river to see how it changed

over time. We hoped to obtain information regarding the numbers of fish that migrated into and out of the lower portion of the San Juan River and timing of the migrations.

STUDY AREA

The San Juan River is one of the major tributaries to Colorado River. It is a high gradient river that originates in Colorado then flows through New Mexico and Utah before entering Lake Powell. Two endangered species have been documented in the San Juan River, Colorado squawfish (Ptychocheilus lucius) and razorback sucker (Xyrauchen texanus) which are encountered rarely (Platania 1990). Other native species include flannelmouth sucker (Catostomus latipinnis), bluehead sucker (Catostomus discobolus), speckled dace (Rhinichthys osculus), and roundtail chub (Gila robusta) (Platania 1990). River miles (RM) for this and other current studies on the San Juan River begin near where the waterfall was located and the old Piute Farms marina. This study sampled the river from RM 35 (the approximate boundary of the Glen Canyon Recreation Area) to RM 0 (inundated waterfall). We divided the river into two reaches (upper and lower) at RM 17 due to a change in gradient and habitat similar to Bliesner and Lamarra (1996). From RM 17 to the inflow with Lake Powell (lower reach) the river gradient decreases and the river channel widens

somewhat. The substrate is dominated by sand and fine sediment deposits that form large sand bars in this reach. In the upper reach the gradient is steeper and the substrate is dominated by gravel, cobble, and boulders.

METHODS

The river was sampled monthly using electrofishing to monitor the change in the fish community. Initially, we tried to sample within the high water mark of Lake Powell (approximately RM 15) using the Lake Powell electrofishing boat. During the March sample, flows were low (500-600 cfs) and we were not able to access the river with our electrofishing boat. We attempted to collect fish with gill nets but we were not able to find areas with reduced flows and nets set in the current quickly clogged with leaf debris. During the April and May sampling trips spring runoff had increased flows and we were able to access the river with our electrofishing john boat but only up to RM 7 and 14, respectively. From June to October the river was sampled from RM 35 to Clay Hills Crossing (RM 2.9) using an Avon raft equipped for electrofishing. June and July trips were conducted with the U.S. Fish and Wildlife Service (USFWS) out of Grand Junction and Albuquerque. We borrowed a electrofishing raft from the USFWS out of Grand Junction to sample in September and October. The August sampling trip was canceled due to low flows and high water

temperatures that were placing stress on the fish. The Bureau of Land Managment (BLM) reported a fish kill near Bluff and Mexican Hat, Utah between August 4-10. To ~~pervent~~ prevent putting additional stress to the fish we canceled the August trip. Also, the BLM recommended against putting rafts on the river due to the low flows.

The first trips in April and May were performed with a john boat launched at Clay Hills and motored up stream as far as possible. We then sampled segments of the river as we moved back down stream. Each segment varied in length (mean=0.44 mi range=0.25-0.8 mi) depending on the accessability of the john boat to a continuous section of deeper water near the shore. We attempted to catch all the fish we turned while electrofishing. At the end of each section all fish were identified, weighed, measured, and released back into the river.

For the latter four trips we put on the river at Mexican Hat and traveled down stream until we reached RM 35 were we began collecting data for this study. The river was sampled for a continuous mile. At the end of the mile the captured fish were identified, counted and classified as adult, juvenile, or young of the year (YOY). Beginning randomly within the first five miles, then every fifth mile thereafter, all fish were weighed and measured before being released. Every fish considered to be a "Lake Powell Predator" (walleye, striped bass, largemouth bass, and green sunfish) was weighed and measured before being

released. In June, two electrofishing rafts were used to sample both shore lines, while only one raft was used to sample during the July, September, and October, trips. During the last three trips one shore line was randomly chosen for sampling and we sampled that shore as much as possible. Below RM 17 the river gradient decreased and the channel widened. At low flows we were forced to follow the main channel as it meandered around sand bars. Consequently, we sampled both shores and also the middle of the river channel as we crossed back and forth. In June the average catch of the two boats was calculated to determine the catch per unit effort (CPUE, fish caught/mile).

Since different methods and equipment were used to collect data between the April/May and June/July/September/October sampling trips, the data was analyzed separately. The last four months of the study were analyzed using ANOVA I blocked by reach (due to differences between the upper and lower reaches) to test month effects. To determine differences between monthly CPUE Ryan-Einot-Gabriel-Welsch (REGWQ) post-hoc multiple range tests were performed. Dependant variables analyzed were the CPUE of "Lake Powell predators" (LPP), natives, and all nonnatives excluding red shiners. Red shiners were excluded from the analysis because they were not effectively captured using electrofishing techniques. Often the red shiners would pass through the dip net because they were too small or not seen due to the turbidity of the water. The data was transformed using

Log_{10}(CPUE+1) to conform to the assumptions of normality. Statistical analysis were performed using the statistical program, SAS (SAS Institute, 1988).

Results

Three endangered fish were captured during this study, 2 Colorado squawfish and 1 razorback sucker. Both Colorado squawfish were juveniles and were caught in the lower reach at RM 8 and 12.9 in June and July respectively. Sizes of the Colorado squawfish were 363 mm total length (TL) 700 g and 432 mm TL 688 g. Both Colorado squawfish were PIT tagged and released. The only razorback sucker was caught at RM 27.3, it was 492 mm TL, weighed 1350 g. This fish had already been PIT tagged. During this study we caught 3130 fish representing 13 species and 7 families (Table 1 and 2).

The CPUE for LPR peaked in the spring (May/June) then decreased throughout the summer and fall (Figure 1). The mean CPUE was significantly higher in June than it was for July, September and October ($F = 8.62$ *d.f.* 3, $P = 0.0001$; REGWQ Multiple range test). The mean CPUE for April and May in the lower reach was considerably higher than any of the other months and reach (Figure 1) but we are not sure whether this is attributed to higher densities or more effective sampling methods or a combination of the two. There was not a significant

difference in the mean CPUE of LPP between the upper and lower reach *of the river* ($F = 0.47$ *d.f.* 1, $P = 0.4929$) in the 4 latter months. The most frequently captured LPP was green sunfish, followed by walleye, striped bass and largemouth bass. The mean length, weight and condition factor of LPP can be found in table 3.

The condition factor of LPP in the river was lower than those sampled in the lake. Condition factor for fish from the lake was calculated using captures from 1996 annual spring and fall gill netting conducted by the Utah Division of Wildlife Resources (unpublished data). It is important to note that gill netting was conducted prior to spawning in the spring and just prior to the winter season when condition should be high. Fish captured during this study would have been spawning or post spawn when condition would be expected to be low.

Table 1. List of species and that were captured during the nonnative invasion study in the San Juan River. Also, included are the common name, abbreviation, and the source (N=native, EN=endemic and I=introduced).

Scientific name	Common name	Abbreviation	Source
Catostomidae			
Catostomus latipinnis	Flannelmouth sucker	FM	EN
Catostomus discobolus	Bluehead sucker	BH	N
Xyrauchen texanus	Razorback sucker	RB	EN
Cyprinidae			
Cyprinella lutrensis	Red shiner	RS	I
Cyprinus carpio	Common carp	CP	I
Ptychocheilus lucius	Colorado squawfish	CS	EN
Rhinichthys osculus	Speckled dace	SD	N
Ictaluridae			
Ictalurus punctatus	Channel catfish	CC	I
Centrarchidae			
Lepomis cyanellus	Green sunfish	GS	I
Micropterus salmoides	Largemouth bass	LG	I
Percichthyidae			
Morone saxatilis	Striped bass	SB	I
Percidae			
Stizostedion vitreum	Walleye	WE	I
Clupeidae			
Dorosoma petenense	Threadfin shad	TS	I

Table 2. The total catch of all species in the upper and lower section between April and October.

	UPPER	LOWER	TOTAL
NATIVES			
Flannelmouth sucker	1056	107	1163
Bluehead sucker	43	3	46
Speckled dace	14	0	14
Colorado squawfish	0	2	2
Razorback sucker	1	0	1
NONNATIVES			
Channel catfish	711	210	921
Red shiners	131	342	473
Carp	100	262	362
Threadfin shad	8	52	60
LAKE POWELL PREDATORS			
Green sunfish	3	30	33
Walleye	10	11	21
Striped bass	12	8	20
Largemouth bass	6	8	14
TOTALS	2095	1035	3130

Table 3. Mean length, weight, and condition factor (K) of "Lake Powell predators" caught in the San Juan river in 1996. Also the condition factor of the same 4 species that were captured during annual spring (March) and fall (November) gill netting in Lake Powell.

Species	**Length (TL mm)**	**Weight (g)**	**K River**	**K Lake**
Green sunfish	99	16	1.45	1.78
Walleye	509	1247	0.92	1.02
Striped bass	586	1880	0.92	1.05
Largemouth bass	196	134	1.04	1.31

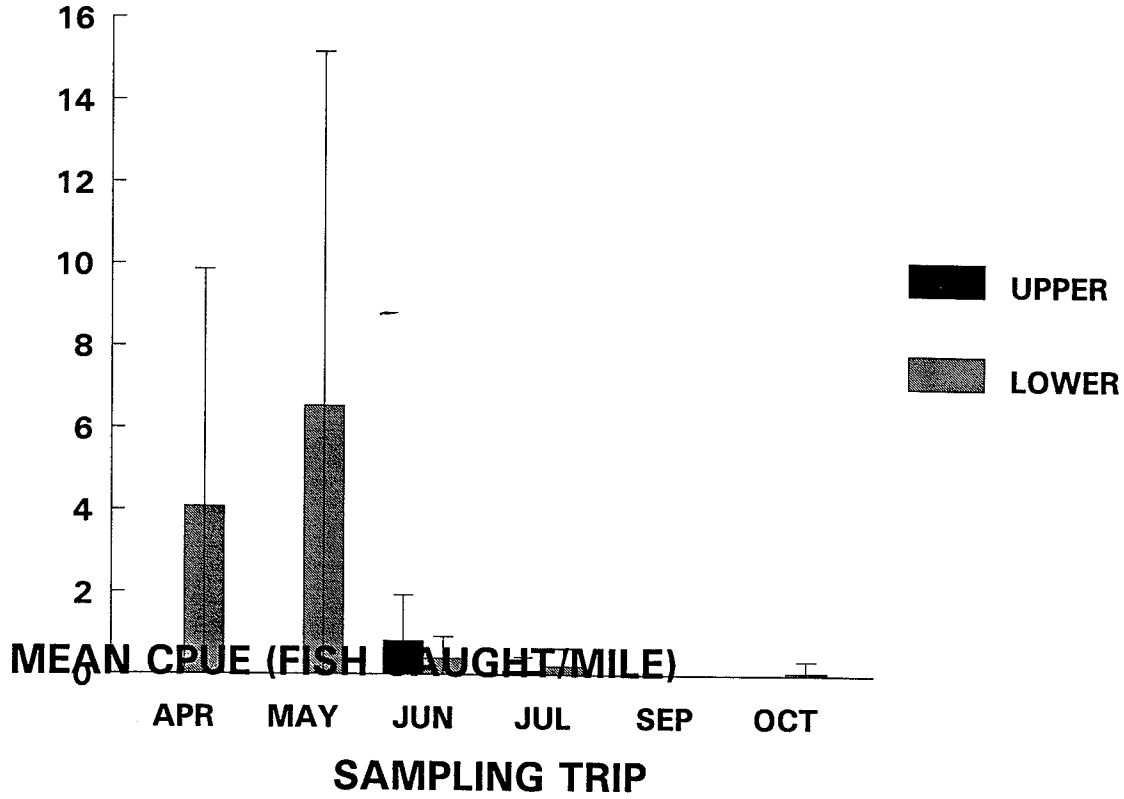

Figure 1. Mean CPUE of Lake Powell predators in the upper and lower reach of the San Juan river. Error bars are SD.

The mean CPUE for native species was higher in the upper reach (mean=10.7) than it was in the lower (mean=0.8) (F = 302.57 $d.f.$ 1, P = 0.0001). The CPUE was highest in June in the upper reach (F = 12.33 $d.f.$ 3, P = 0.0001), CPUE decreased through July, and September then rose again in October (Figure 2). Natives were poorly represented in the lower reach averaging less than 2.5 native species per mile over the length of this study.

In the lower reach the CPUE peek occurred in May and had increased notably from the April trip. The notable decrease between May and June trip again may be attributed to using different methods and equipment. Flannel mouth suckers were the most common species captured during this trip representing 37% of all fish and 95% of native species (Table 2).

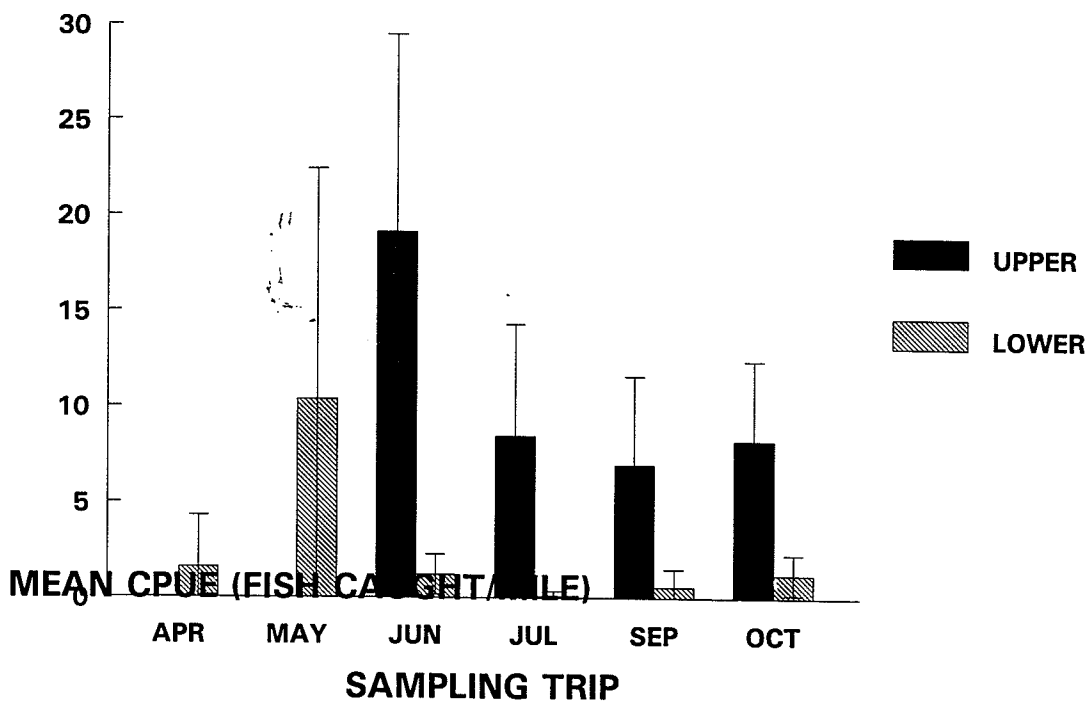

Figure 2 Mean CPUE of native species in the upper and lower reach of the San Juan river. Error bars are SD.

Nonnatives were well represented throughout the river

however, there were both seasonal and reach differences in the CPUE. The CPUE in upper reach was significantly higher (mean=8.4) than the lower reach (mean=2.2) (F = 113.83 $d.f.$ 1, P = 0.0001). July had the highest mean CPUE of the 4 latter months (F = 12.91 $d.f.$ 3, P = 0.0001) but May and April had the highest mean CPUE of all the months (Figure 3). Channel catfish were the most common nonnative captured (48%) followed by red shiners (25%). However, it appeared that both channel catfish and red shiners were ineffectively captured using the methods of this study and were probably under represented.

Discussion

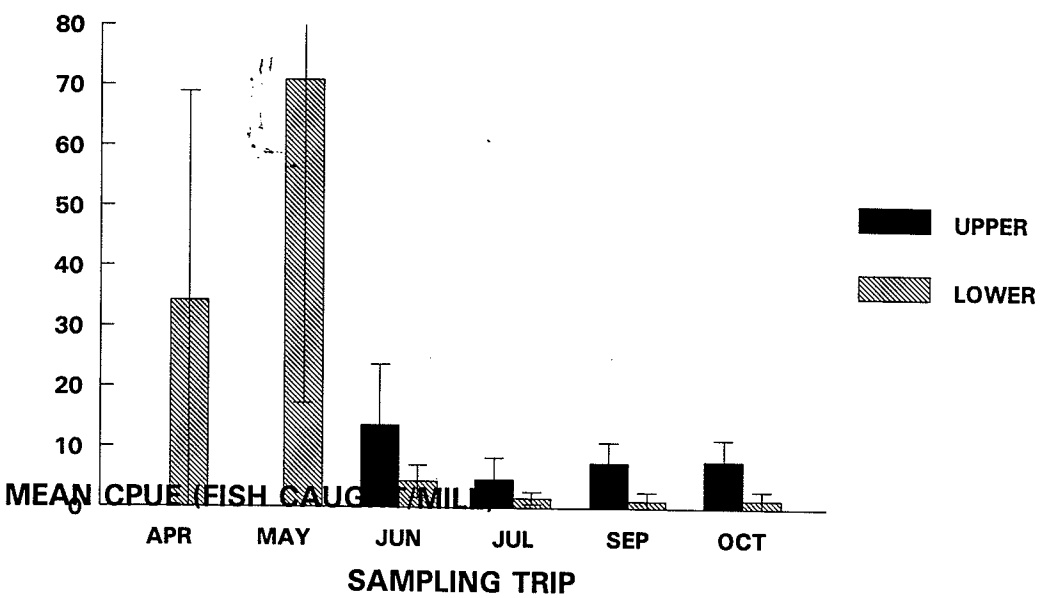

Figure 3 Mean CPUE of nonnative species including Lake Powell predators and excluding red shiners, in the upper and lower reach of the San Juan river. Error bars are SD.

It does appear that piscivorous predators from Lake Powell are migrating into the San Juan Rivers when the opportunity presents itself. Due to higher lake levels and inundation of the waterfall fish invaded the river beginning in the summer of 1995. Ryden and Pfeifer (1996) documented the presence of both striped bass and walleyes shortly after the waterfall was inundated (about the last week of June 1995). By late July 1995, during an adult fish monitoring trip they caught 34 striped bass and 14 walleye (Ryden and Pfeifer, 1996). Between 1991 and 1994 Ryden and Pfeifer did not catch any striped bass or walleye in the San Juan River therefore, they were assumed to have migrated up from Lake Powell.

In 1996, LPP were present in the San Juan River between April and June but by July there were very few left. This is considerably different than what Ryden and Pfeifer saw in 1995 and may be attributed to low flows in 1996. The LPP probably moved in during spring run-off and left as flows declined. In August flows were very low and water temperatures increased causing a reported fish kill near Bluff and may have forced the remaining LPP back to the lake or may have become part of the fish kill.

This completion report is based on only one year's data and very little can be inferred about what is really going on in the river. In 1996, LPP would have had little affect on YOY native species but may have had a considerable impact on yearling

natives. Spring run-off in 1997 is expected to be high and the LPP may be able to stay in the river for a longer period of time similar to 1995 and potentially have a large impact on native fish. It would have been good to collect data during a high run-off year to see if there was difference in distribution of LPP and timing of movements.

It is probable that LPP are having an impact on native species. Many of the LPP (especially walleyes) captured by the USFWS during adult monitoring trips have had native species in their stomachs. Of stomachs from 8 walleyes captured in 1995, 7 contained native suckers, the other had a YOY channel catfish (Buntjer and Ryden Pers. Comm). In annual nursery habitat sampling conducted Schaugaard and Archer (Pers. Comm.) native species numbers were down from previous years. Lake Powell predators may have attributed somewhat to the decline along with low flows and lack of spawning success. However, LPP may have more impact on juvenile life stage rather than the YOY. The suckers in the stomachs of walleye ranged in size from 150 mm standard length (SL) to 250 mm SL.

To limit the effect of Lake Powell predators on the native fish community lake elevation could be regulated to maintain the presence of the waterfall, which reappeared during winter of 1996-97. Even then, the river could eventually find its way around the rock ledged and follow the old river channel and once again eliminate the barrier. Therefore, the waterfall would not

be a reliable way to control nonnative invasion into the San Juan River in the long-run.

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