SPAWNING, MOVEMENT AND POPULATION STRUCTURE OF FLANNELMOUTH SUCKER IN THE PARIA RIVER

BY

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ABSTRACT

Spawning flannelmouth sucker, *Catostomus latipinnis*, in the Paria River averaged 478 mm (n = 246) total length (TL). This was 53 mm longer ($p < 0.001$) than the mean length of spawning fish taken from this same location in 1981 (425 mm, TL, n = 286). Sub adult flannelmouth were common in the Paria in 1981 but no post-larval fish < 379 mm, TL were caught in 1992 or 1993. There is no evidence that juvenile flannelmouth have reared in the Paria River/Glen Canyon Area in the last 12 years. However, some adult fish appear to enter the population from downstream locations.

In 1992 and 1993, spawning occurred throughout the lower 10 kilometers of the Paria. Young-of-year were seen in 1992 but could not be found shortly after hatching. No young-of-year were seen in 1993.

Growth of adult sized fish is very slow. Based on extrapolations from recaptures, longevity may approach 30 years. Recaptures from fish marked in other studies were originally tagged as far as 229 km downstream from the mouth of the Paria.

INTRODUCTION

The flannelmouth sucker, *Catostomus latipinnis*, (Baird and Girard 1853), is the only endemic so-called "big river" fish native to the Colorado River that is still commonly found throughout the Grand Canyon. Introduction of exotic fish and the construction of Hoover and Glen Canyon dams have severely altered the ecosystem to the detriment of the native fish fauna. Four species have been extirpated or nearly so: Colorado squawfish, *Ptychocheilus lucius*, razorback sucker, *Xyrauchen texanus*, bonytail chub, *Gila elegans*, and roundtail chub, *Gila robusta*. The humpback chub, *Gila cypha*, remains abundant only in and near the Little Colorado River. Bluehead sucker, *Catostomus discobolus*, and speckled dace, *Rhinicthys osculus*, remain common but they are generally more abundant in small streams than in the main river.

The U. S. Fish and Wildlife Service lists the flannelmouth sucker as a candidate category 2 species. This means that the Service is considering adding the species to the endangered species list but that too little information is currently available to support such a listing (USFWS 1993).

Holden and Stalnaker (1975) described the flannelmouth as "by far the most abundant large native species" in their

1967-73 survey of the upper and middle Colorado River Basin.

In the Grand Canyon the flannelmouth had abundant reproducing populations throughout the mainstem and its tributaries (Minckley and Blinn 1976, Carothers and Minckley 1981). It was listed as common or abundant in eight separate surveys from 1958 to the present (Maddux et al. 1987). Despite these reports of relative abundance, the flannelmouth's range has been drastically reduced (Minckley 1973) and hybridization with the introduced white sucker, *Catostomus commersoni*, in the upper basin constitutes a threat to its survival (Prewitt 1977).

The flannelmouth is a non-guarding, open-substrate, lithophilic breeder with demersal eggs which are initially adhesive (Snyder and Muth 1990). Eggs of the flannelmouth are the largest (3.8-3.9 mm) of all catostomids found in the Colorado Basin. Published data on spawning migrations, habitat and behavior are not available. Analyses of stomach contents in the upper basin indicate a diet consisting largely of algae, and unidentified debris (McDonald and Dotson 1960, Carlson et al. 1979, Jacobi and Jacobi 1981). In the Grand Canyon, Carothers and Minckley (1981) found similar stomach contents but in addition found that *Gammarus lacustris* (an amphipod) and Chironomidae (midge larvae) often comprised significant portions of the diet.

Ripe flannelmouth often have been caught at the confluence of the Paria and Colorado Rivers (Suttkus and Clemmer 1976, Carothers and Minckley 1981, Maddux et al. 1987) and unpublished data (Baucom 1981) document a spawning run up the Paria River. This spawning run is the largest for which data are available and may be especially important to the survival of the species in the Grand Canyon. The Paria River also produced one of the few recent riverine sightings of the endangered razorback sucker in the Grand Canyon. In June 1978, 1 adult razorback, a gravid female, was caught and several others observed 100 m upstream from the mouth (Minckley and Carothers 1979). Several years prior, 3 razorback suckers (later determined to be hybrids) were collected at the mouth of the Paria (Suttkus and Clemmer 1976). Hybridization between flannelmouth and the endangered razorback sucker has been well documented where they co-occur (Hubbs and Miller 1953, Vanicek 1967, Suttkus and Clemmer 1976, Buth 1986).

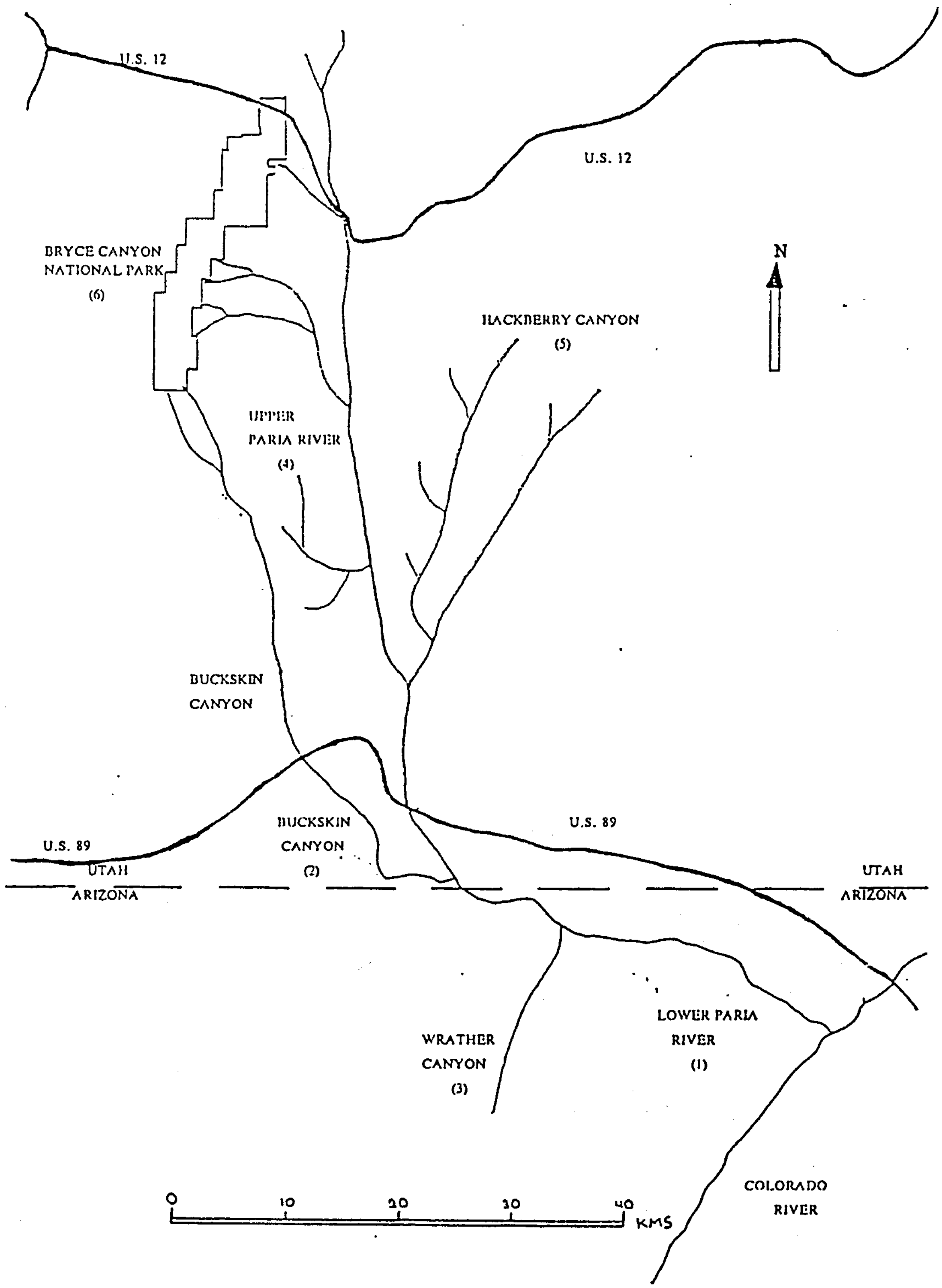
The Paria River remains an unstudied system though it most closely resembles the pre-dam Colorado in temperature patterns, sediment loads, and nearly all water chemistry parameters (Cole and Kubly 1976). Easy access, an excellent hydrographic record, and a confluence area subject to the fluctuating release flows from Glen Canyon Dam make the Paria River an excellent site to study a native fish that is utilizing both an altered environment (mainstem Colorado River) and a relatively undisturbed portion of its historic habitat (Paria River).

My primary objectives were to: 1) document the timing and location of spawning of the flannelmouth sucker in the Paria River with reference to season, flow, temperature, depth, and substrate; 2) document the use of confluence area by native fishes across varying flows of the Colorado River; 3) analyze the demographics of the population to determine if successful recruitment is occurring; 4) compare the current flow and temperature regimes of the Paria and Colorado Rivers to the historical conditions in which these fish evolved; and 5) survey the upper Paria basin for the presence of native fishes and invertebrates (Appendix B).

STUDY SITE

The Paria River originates from a series of springs that flow from the base of cliffs in the Wasatch formation of Bryce Canyon National Park in southern Utah. The stream flows approximately 88 km and drains an area of 3650 km^2 (Figure 1). Perennial water begins at elevations of 2200-2600 m. At the Paria headwaters, the drainage is augmented by a 19 km long canal from the East Fork of the Sevier River. Below Bryce Canyon, the Paria flows through a

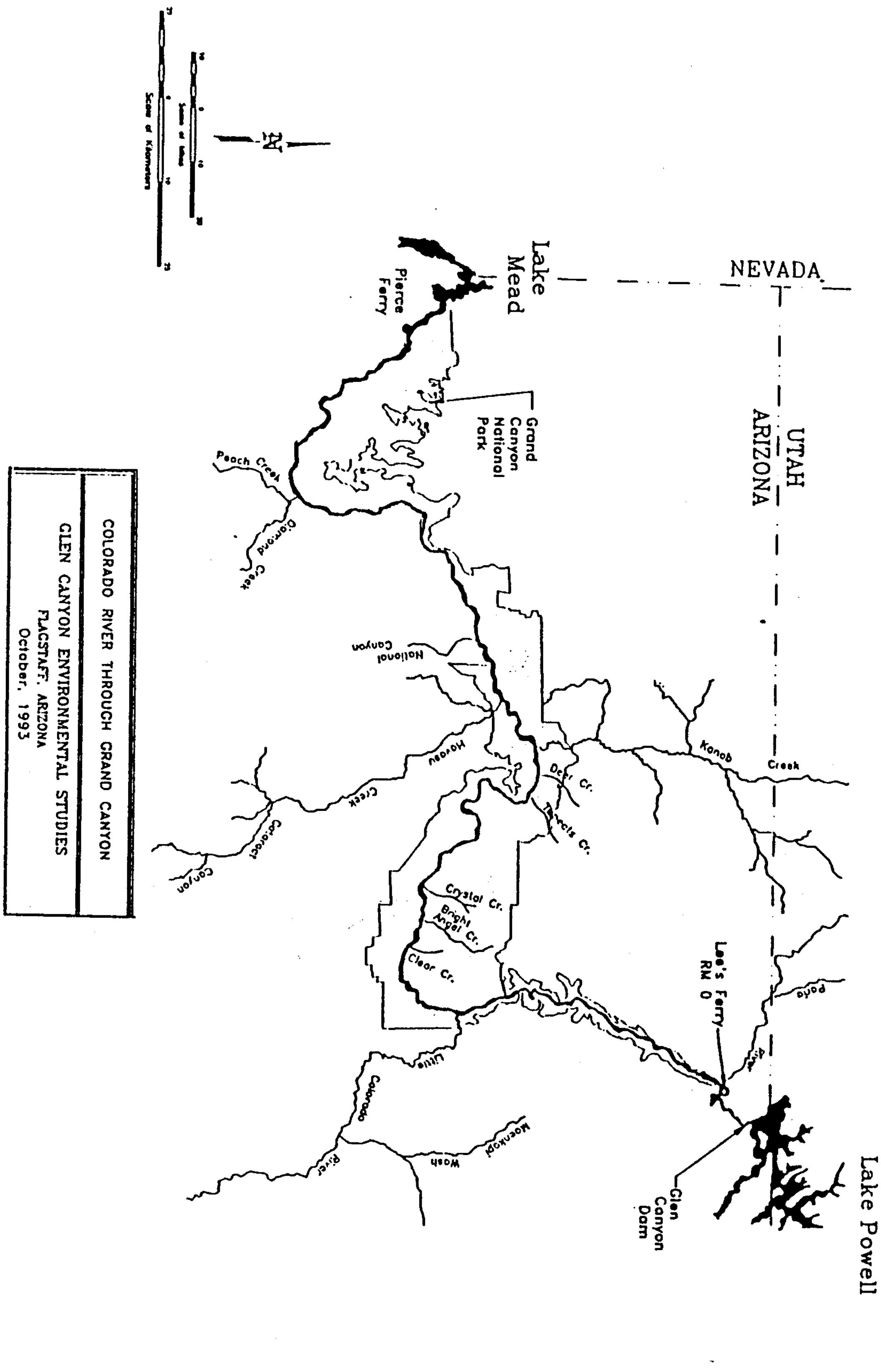
Figure 1. The Paria River drainage basin.



plateau at 1800 m elevation past the towns of Cannonville and Tropic, Utah. The drainage is then dominated by canyons as the stream bed cuts through the Navajo sandstone, Kayenta, Moenave, and Chinle formations dropping to an elevation of about 1100 m. The Bureau of Land Management administers much of the surrounding land, a portion of which is contained in the Paria River-Vermillion Cliffs Wilderness Area. Additional locations, notably Hackberry Canyon, are under Wilderness Study Area designations. The last 16 km of the Paria are low gradient (< 1.0%) and it flows through relatively open desert before entering the Colorado River from the north, 25 km below Glen Canyon Dam at an elevation of 984 m (Figure 2). The last 2 km of stream are contained in the Glen Canyon National Recreation Area.

The drainage is dominated by gypsiferous sediments giving the Paria an ionic composition of 40% SO_4, 15.5% Ca, 17.8% Na and K, 16.9% Mg, 8.1% alkalinity, and 2.1% Cl (Maddux et al. 1987). Concentrations of both phosphates and nitrates were the highest among all the Grand Canyon tributaries (Cole and Kubly 1976, Maddux et al. 1987,). The Paria is extremely turbid with a mean discharge-weighted suspended sediment concentration of 114,000 ppm at its mouth (Cole and Kubly 1976). Daily mean concentrations during floods have been recorded as high as 780,000 mg/l (approx. ppm)(Graf et al. 1991).

Figure 2. The Colorado River throught the Grand Canyon.



The Paria River is considered perennial with a base flow of 3.5-35.3 cubic feet per second (cfs) (Graf et al. 1991). There are numerous water diversions in the Utah portions of the Paria drainage primarily near the towns of Tropic and Cannonville. Despite these diversions the river remains perennial at its mouth in most years as numerous springs in the Paria Canyon recharge the system. Instantaneous flows during my study varied from 2.5 cfs to 1790 cfs (USGS raw data). In recent studies, discharge at the mouth ranged from 7.9 cfs to 34.9 cfs (Maddux et al. 1987). Historically discharges have ranged from 0 to 16,000 cfs (Cole and Kubly 1976). Flash floods, defined as flows greater than 50 cfs (Bureau of Land Management 1983), are common in summer and were very common during my study. Mean daily flows exceeded 100 cfs on 21 days in 1992 and 43 days in 1993 with peak mean flows of 559 and 599 respectively (USGS raw data). Water temperatures in the Paria River ranged from 0 to 34°C.

Colorado River flows during my study ranged from 5,000 to 20,000 cfs. River temperatures were relatively constant between 6 and 12°C.

METHODS

Habitat availability

The Paria River was visited on 24 occasions between January 1992 and August 1993. Habitat availability transects were systematically established every 500 m from the mouth (0.0 km) of the Paria River to 10.0 km upstream. "Point/pole" estimates of depth, velocity, and substrate size were taken at 1-meter intervals along each transect beginning 0.1 m from the downstream left bank (Gorman 1988). Habitat availability transects were measured 5 times throughout my study. On April 10 1993, a Marsh McBirney flow meter was used to calibrate all categorical velocity estimates. These measurements were used to standardize "point/pole" estimates and to more accurately estimate velocity availability versus use by spawning flannelmouth.

"Point/pole" estimates of depth, substrate, and velocity were also taken along transects within fish sampling site locations. These measurements were taken in the same way as in habitat availability transects. These transects were evenly spaced and established at the top, middle, and bottom of each fish sample location.

Flow rates (raw data) were obtained from 2 U.S. Geological Survey gauges, one at Lee's Ferry on the mainstem of the Colorado River and one approximately 2 km up the

Paria River. Flow values were used to judge the comparability of habitat transect data over time and as an independent environmental variable when analyzing CPUE of flannelmouth suckers at the mouth of the Paria River. Mean daily flow values were also used to relate flow to the timing of spawning runs.

Spawning habitat

On April 10 1993, two spawning locations (2.8 and 6.0 km from the mouth of the Paria) were marked. Five transects located at evenly spaced intervals perpendicular to stream flow were established at each site and 5 point measurements made at 0.5-m intervals along each transect. Transects were 1.3 m apart at the 2.8-km site and 3 m apart at the 6.0-km site. At each point, a Marsh McBirney flow meter was placed at 0.6 of the depth to estimate mean column velocity. An additional measurement was taken at 3.5 cm (the shallowest depth permitted by the gauge itself) from the bottom to estimate bottom velocity. Bottom velocity has been shown to be a more reliable indicator for fish habitat relationships than mean column or surface velocity (Baldes and Vincent 1969, Gosse and Helm 1981). Substrate size was measured to the nearest 2 mm with a vernier caliper and depth was measured to the nearest centimeter.

Fish sampling sites

Sample sites for fish were originally 100 m in length and were systematically chosen at 0,2,4,6,8, and 10 km from the mouth of the Paria River. Systematic samples from natural populations can have less variation than stratified random samples when environmental gradients are low and the population is randomly distributed (Cochran 1977). We had no prior knowledge of the system from which to make distribution assumptions but initial habitat analyses revealed no environmental gradients in the three parameters measured. Additional locations at 0.7, 1.2, 2.4, 2.8, 3.2, 4.4, and 5.3 km from the mouth of the Paria, that had been previously established by the Arizona Game and Fish Department in 1991, also were sampled for fish to facilitate long term comparisons. These sites were apparently initially chosen on the basis of terrestrial landmarks that facilitated relocation. To facilitate long term monitoring efforts, a description of all sample sites is given in Appendix C. In addition to these sites, opportunistic sampling was conducted during the spawning run to maximize the number of fish tagged. Data from systematically chosen sites were separated from those taken from all other sites for analysis of longitudinal distribution of target fishes.

Fish capture methods

On January 12 and March 20 1992, the 100-m sites were sampled with a (20-ft long, 4-ft deep, 3/16-in mesh), seine. Many suckers were lost as we tried to complete a 100-m haul. Therefore the length of all sites was shortened. Sites ranged from 20-60 m in length dependant on the location of a suitable low gradient shoreline to end the seine haul. A (15-ft long, 4-ft deep, 1/8-in mesh), seine was used to capture small fishes and a (40-ft long, 4-ft deep, 1 1/2-in mesh), seine was used to capture adult suckers. To standardize effort, the total surface area sampled was estimated in square meters. Catch per unit effort was then calculated on an area basis.

On 3 dates in the spring of 1993, hoop nets, (1-m long, 50-cm diameter, 6.3-mm mesh,) were also set. These nets were used in an attempt to catch flannelmouth on their downstream migration from spawning areas in the Paria. On March 28 two nets were set (1900 hours, 0.7 km up from the mouth). They were checked at 0700 on March 29. On March 31 (2000 hours, 60 m up from the mouth), two similar nets were set. They were checked at 0800 on April 1. On April 8 one hoop net was placed (1600 hours, 2.4 km up from the mouth) facing upstream, with 15-m wings, blocking off the entire creek. This net was checked at 0900 on April 9.

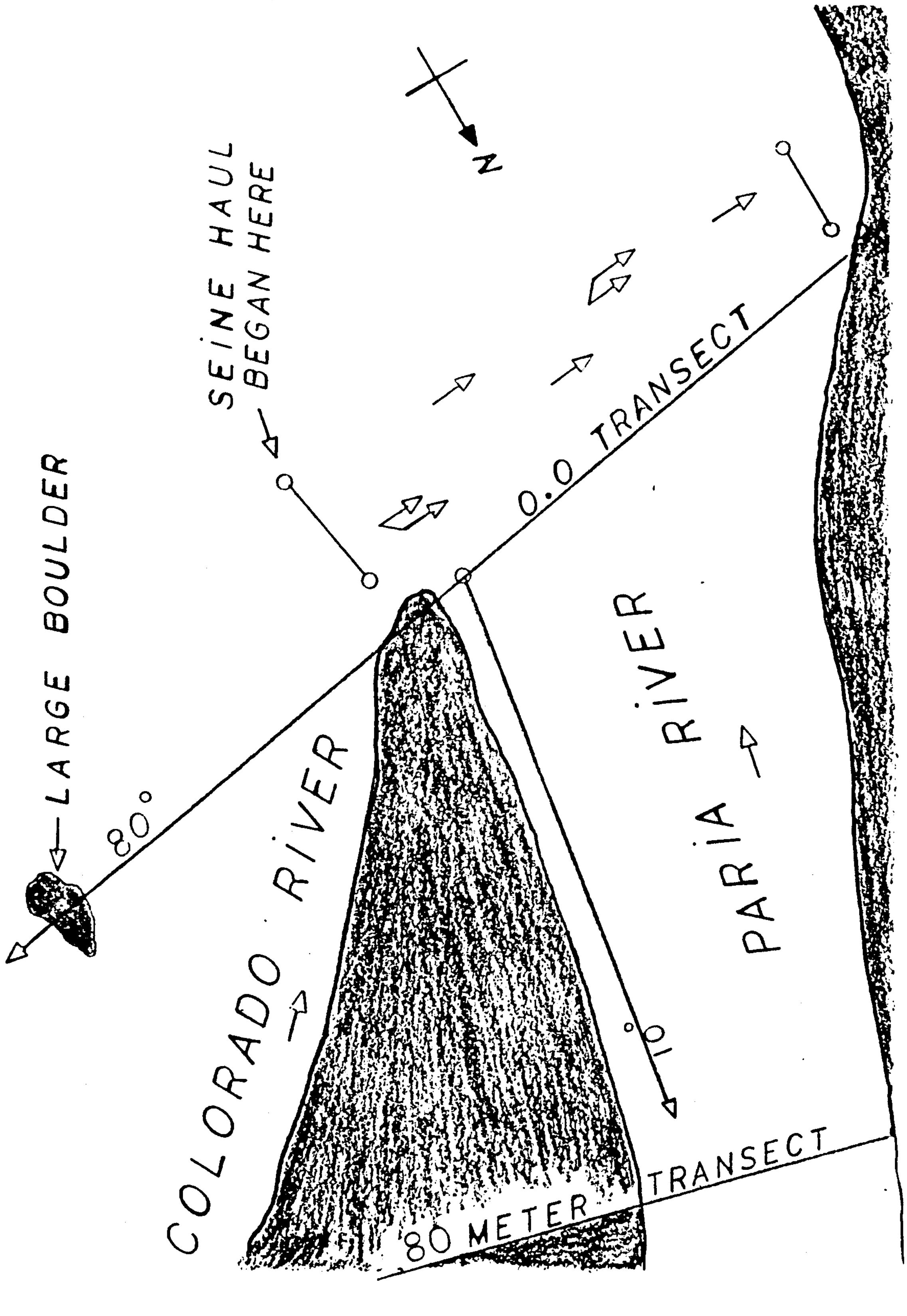
During April and May of 1993 I intensifly searched for young-of the-year (YOY) flannelmouth. A 3/16-in mesh seine was used on March 31 and April 25 and the 1/8-in mesh seine was used on May 10 and May 30. On April 17-18 I walked 6 km of stream and repeatedly dip netted in backwaters and eddies in search of YOY fish. Three plankton nets set near the confluence area were run at 1/2 hour intervals. These nets were set between 2100 and 2400 hours on April 17 through May 10.

Confluence sampling

Fish sampling and habitat measurement had to be altered at the confluence because of highly variable flow and water level. During 1992, seine passes perpendicular to the Paria flow were made every 20 m from the mouth to a location 80 m upstream. From January 1992 until September 1992, a 1/8-in mesh or 3/16-in mesh seine was used. In August 1992 I observed (underwater observation) a school of flannelmouth sucker in the Colorado River just beyond the mouth of the Paria. These fish were not being caught by my seining efforts. I also observed, with the aid of a lantern, that the fish moved into the shallower water of the confluence area after dark. Therefore, night sampling began on a regular basis on September 30 1992. Night sampling allowed me to capture and mark more fish, as well as to avoid anglers, bathers, and picnickers. Some daytime sampling was continued for comparative purposes. Also in September 1992, I began to use a longer (40-ft) and larger mesh (1-1/2-in mesh) seine at the confluence. The large mesh increased catch of large fish and alleviated the problem of the seine filling up with fine silt.

Beginning in January 1993, I used compass oriented transect lines for seining irrespective of the location of the stream bed. A 0.0 transect (the estimated juncture of the Paria and Colorado rivers) was established at an 80° bearing. This bearing began at a tamarisk on the near shore and ran through a large boulder 300-400 m upstream in the middle of the Colorado River (Figure 3). This bearing was used as a reference point for all subsequent transects. To avoid frightening fish, I began the 0.0 transect haul in the Colorado River and swept back along the transect line to the near shore (Figure 3). The area sampled varied from 200-600 m^2 dependent on water levels. The area sampled in 1992 by several seine hauls, was now sampled with a single seine haul. This seine haul began 80 m up the Paria and ended at the 0.0 transect. At Colorado flows of about 16,000-20,000 cfs the Paria was inundated to a point 160 m from the mouth. Under these conditions, an additional seine haul was made beginning at 160 m from the mouth of the Paria and ending 80 meters downstream from that location.

Figure 3. The confluence area of the Paria and Colorado rivers.



Fish measurements and tagging

Total length in millimeters was taken on all catostomids and weights were estimated to the nearest 0.10 kg. Fish were weighed with a Pesola spring scale after being placed in a wetted and tared nylon net bag. Sex determination of flannelmouth sucker was based on either expression of gametes or on the presence and location of tubercles. Most of the year, male fish had at least a few tubercles on the anal fin and lower lobe of the caudal fin. Female fish had tubercles on the ventral side of the caudal peduncle. Fish with ambiguous characters were defined as "unknown" sex.

Beginning on September 30 1992, all suckers were scanned for "PIT" (passive integrated transponder) tags, and untagged fish were tagged. PIT tags were inserted in an anterior direction just left of the ventral midline and just anterior to the pelvic girdle. A "RAL-O-GUN", normally used for cattle hormone implants, was fitted with a 10-gauge hollow, beveled, pointed needle to insert PIT tags. PIT tags were loaded in several 24 chambered cartridges before each tagging operation. Preloaded cartridges greatly reduced the holding and handling time of fish as well as tag loss compared to standard methods utilizing individually loaded hyperdermic needles. A solution of 10% Betadine was used to sterilize the needles between each tagging. Fishes other than catostomids were counted and released.

Fish catch analysis

The number of fish caught per seine haul was divided by surface area seined to obtain an estimate of catch per unit effort (CPUE). The total number of fish caught per sample period also was converted to catch per unit effort (Table 1 and 2). CPUE values were averaged across hauls for both statistical analysis and graphical display (Table 3). This method retains the variance of catch between seine hauls. Pooling the hauls by stream reach or other target variables and dividing by the total area sampled masks the variance. CPUE values at the confluence were graphically compared between day and night sampling and across trips for both 1992 and 1993. Parametric methods of analysis were not possible because of a non-normal distribution of CPUE. In addition I could not assume that seining was equally efficient under varying conditions (Parsley et al. 1989). Ordered rank analysis has been suggested to ascertain differences in organismic abundance under such conditions (Green 1979). Several nonparametric methods were used to make one-way comparisons of CPUE at the confluence area. The CPUE values for day and night catches were averaged over hauls and a Mann-Whitney (M-W) Rank Sum test was used to

Table 1. Summary of catch, effort and pooled CPUE of adult flannelmouth sucker at the confluence of the Paria and Colorado Rivers in 1992 and 1993.

Date	# FMS	# Seine Hauls	Total Area m^2	Catch/100m^2
1992				
Jan	0	1	915	0.0
March	11	8	514	2.1
May	0	4	720	0.0
June	10	6	1729	0.6
July	26	5	632	4.1
August	3	21	2806	0.1
Sept	24	16	4565	0.5
Nov	25	9	4950	0.5
Dec	1	3	1380	0.1
TOTALS	100	73	18,211	0.6
1993				
Feb	12	5	2200	0.6
March 1	46	8	4520	1.0
March 13	32	8	4100	0.8
March 27	118	10	5600	2.1
April 8	106	4	2300	4.6
April 24	51	6	2900	1.7
May 10	99	5	2420	4.0
May 30	18	2	900	2.0
June	64	3	1800	3.5
July	68	5	3700	1.8
August	60	22	10,890	0.6
TOTALS	674	76	41,330	1.7

Table 2. Summary of catch, effort and pooled CPUE of adult flannelmouth sucker upstream from the mouth of the Paria River for 1992 and 1993.

Date	# FMS	# Seine Hauls	Total Area m^2	Catch/100m^2
1992				
Jan	0	4	2903	0.0
March 19	30	7	3995	0.7
March 27	0	10	4900	0.0
May	3	21	3696	0.1
June	0	15	2545	0.0
July	0	22	1519	0.0
August	0	13	2211	0.0
Nov	0	10	1344	0.0
TOTALS	33	92	21,769	0.2
1993				
Feb	1	11	1553	0.1
March 1	61	16	5188	1.2
March 13	65	28	8382	0.8
March 27	43	28	4912	0.9
April 8	75	14	2254	3.3
April 24	12	11	1428	0.8
May 10	0	13	1851	0.0
May 30	0	11	1614	0.0
June 29	0	10	1287	0.0
TOTALS	257	142	28,469	0.9

Table 3. CPUE (averaged across hauls) by reach for flannelmouth suckers in 1993.

Reach	Date	# Hauls	Total Area m^2	# Fish	CPUE
0	Feb 12	5	2200	12	0.6
0	Mar 1	8	4520	46	1.2
0	Mar 13	8	4100	32	0.9
0	Mar 27	10	5600	118	2.3
0	Apr 8	4	2300	106	5.3
0	Apr 25	6	2900	51	1.8
0	May 10	5	2420	99	3.7
0	May 30	2	900	18	2.2
0	Jun 29	3	1800	64	3.0
0	Jul 8	5	3700	68	1.8
0	Aug 16	21	10,090	60	0.6
Total	**1993**	**77**	**40,530**	**674**	**1.7**
1	Feb 12	5	905	1	0.2
1	Mar 1	6	1576	22	1.7
1	Mar 13	9	2330	33	1.6
1	Apr 1	6	1027	20	0.1
1	Apr 8	3	455	2	0.4
1	Apr 25	2	208	0	0.0
1	May 10	2	195	0	0.0
1	May 30	2	220	0	0.0
1	Jun 29	3	350	0	0.0
Total	**1993**	**38**	**7,266**	**60**	**0.7**

Table 3 Continued. CPUE (averaged across hauls) by reach for flannelmouth suckers in 1993.

Reach	Date	# Hauls	Total Area m^2	# Fish	CPUE
2	Feb 12	4	448	0	0.0
2	Mar 1	5	1857	25	1.6
2	Mar 13	6	2168	15	0.7
2	Mar 27	8	1303	14	1.3
2	Apr 8	5	777	27	2.6
2	Apr 25	4	579	1	0.4
2	May 10	4	740	0	0.0
2	May 30	4	694	0	0.0
2	Jun 29	4	630	0	0.0
Total	**1993**	**44**	**9196**	**82**	**0.8**
3	Feb 12	2	200	0	0.0
3	Mar 1	3	1245	11	1.0
3	Mar 13	4	1696	10	0.6
3	Apr 1	7	942	25	3.7
3	Apr 8	4	698	39	7.5
3	Apr 25	3	403	10	3.3
3	May 10	5	611	0	0.0
3	May 30	5	700	0	0.0
3	Jun 29	3	307	0	0.0
Total	**1993**	**36**	**6802**	**87**	**2.0**

Table 3 Continued. CPUE (averaged across hauls) by reach for flannelmouth suckers in 1993.

Reach	Date	# Hauls	Total Area m^2	# Fish	CPUE
4	Feb 12	0	0	0	0.0
4	Mar 1	2	510	3	0.4
4	Mar 13	7	1550	6	0.8
4	Mar 27	6	1490	6	0.1
4	Apr 8	1	60	0	0.0
4	Apr 25	1	88	1	1.1
4	May 10	1	80	0	0.0
Total	**1993**	**18**	**3778**	**16**	**0.5**
1-4	Feb 12	11	1473	1	0.1
1-4	Mar 1	20	6488	61	1.4
1-4	Mar 13	27	8182	66	1.0
1-4	Apr 1	12	2191	43	1.4
1-4	Apr 8	15	2254	95	3.4
1-4	Apr 25	11	1428	2	1.2
1-4	May 10	15	1851	0	0.0
1-4	May 30	13	1614	0	0.0
1-4	Jun 29	12	1287	0	0.0
Total	**1993**	**136**	**26,768**	**268**	**1.0**

test for differences. All statistical analyses were done using the SPSS statistical program (SPSS release 4.1 for VMS/VAX). Colorado River flows, which drastically affected the size of the confluence area, were arbitrarily divided into three categories; < 9,000 cfs, 9,000-12,000 cfs, and > 12,000 cfs. The CPUE during these flows was averaged over hauls and a Kruskal-Wallis H statistic (K-W) was used to test for differences. I also developed several scatter plots to graphically display CPUE against river flows during both day and night.

Overall, I grouped fish sampling effort by 5 stream reaches. Reach zero was at the confluence. The confluence began at the 0.0 transect approximating the location of the confluence of the Paria and Colorado Rivers. High flows of the Colorado (16,000-20,000 cfs) inundated the Paria River about 160 m up from the mouth. This 160-m level was chosen as the upper boundary of the confluence area. Reaches above the confluence were defined as follows: Reach 1 = (0.16 to 2.0 km), Reach 2 = (2.1 to 4.0 km), Reach 3 = (4.1 to 6.0 km) and Reach 4 = (6.0 to 10.0 km). Data from systematically chosen sample sites were separated from those from all other sites. A K-W test was used to test for differential longitudinal use, by stream reach, in the lower 10 km of the Paria River during the spawning run of 1993.

These tests were run on both types of sites separately and combined.

Fish lengths were divided into 10-mm categories. An independent T-test was used to test for differences in mean length between males and females, between flannelmouth caught at the confluence and those caught further upstream, and between spawning flannelmouth caught during my study and spawning flannelmouth caught at the Paria River in 1981.

A weight to length relationship was calculated to test for differences in fish condition between seasons. A Fulton type condition factor (K) was calculated for each sex, using the formula: $K = \text{Weight} \times 10^5 / \text{Length}^3$ (Anderson and Gutreuter 1983). These data were used to document the timing of reproduction assuming that K was highest during maximum gonadal development and lowest post-spawning.

PIT tag numbers, fish locations, lengths, weights and sex of all tagged fish were recorded (Appendix A). Distances moved by recaptured fish and changes in length over time were also recorded. Errors in measurement were recognized when fish caught and recaptured over short time intervals (several days) demonstrated differences in total length. Some of these differences resulted in negative growth values. These negative growth values were retained to calculate average growth rates and regression equations.

Recapture frequencies (cumulative and per trip) were plotted against catch. Total lengths of all recaptured fish were plotted against days expired since the initial marking. In addition to PIT tagged recaptures, a number of fish marked prior to my study with floy tags, were also recaptured. Data from these fish were combined with additional data provided by several agencies. A predictive regression of growth over time was then calculated. Fish were divided into pre and post spawning size classes and a multiple regression analysis was used to determine if growth rates differed between these two size classes. The size class division was determined from McAda and Wydoski (1986), Chart and Bergerson (1992), and my data.

Information collected with small mesh (3/16-in or 1/8-in) seines was used to calculate a CPUE for speckled dace on a per trip and stream reach basis.

Habitat analysis

Two sample Kolmogorov-Smirnov (K-S) tests were used to compare cumulative frequency distributions of depth, velocity, and substrate sizes along habitat availability transects with similar data from habitat use transects within spawning sites. On selected dates, data from systematically chosen transects were similarly compared to those from transects within fish sampling locations. These comparisons were done to determine if sample sites reflected habitat heterogeneity present in the system. Data from transects within fish sampling sites were pooled by stream reaches to determine if there was longitudinal variation in environmental parameters. A K-S test was run on each pair-wise combination of stream reaches (1-4) for each of the 3 habitat variables to determine if habitat parameters varied by stream reach. These comparisons resulted in 6 pair-wise tests for each habitat variable. The adjusted p-value needed to retain a 0.05 level of significance across all tests was 0.008 using the formula: $p = 0.05/n$, where n equals the number of combinations (Ott 1988).

During the 1993 spawning season, t-tests and ANOVA were used to test for differences in mean velocities, mean depth and mean substrate sizes at the two spawning sites. Pooled data of continuous variables (velocities and depth) from the spawning sites at 2.8 and 6.0 km were similarly compared to data on habitat availability from April 10. Substrate was categorized (Table 4) and cumulative frequency distributions compared to the availability data from April 10 using a two sample (K-S) tests. Continuous variables (velocity and depth) were also categorized (Table 5) and compared with availability data from April 10. Frequency histograms were created to display the above relationships. Data from

Table 4. Substrate categories in the Paria River.

Category	Description	Particle size (mm)
0	silt	<0.06
1	silty-sand	0.06 - 0.1
2	sand	0.10 - 2.0
3	gravel	2.0 - 16.0
4	pebble	16.0 - 32.0
5	rock	32.0 - 100
6	cobble	100 - 256
7	boulder	256 - 1m
8	large boulder	1m - 3m
11	bedrock	bedrock

Table 5. Water velocity categories in the Paria River.

Category	Description	Range (m/s)
0	zero	<0.02
1	very slow	0.02 - 0.10
2	slow	0.10 - 0.30
3	moderate	0.30 - 0.70
4	fast	0.70 - 1.20
5	torrential	>1.20

habitat availability transects were not comparable to each other because flows varied between sampling events.

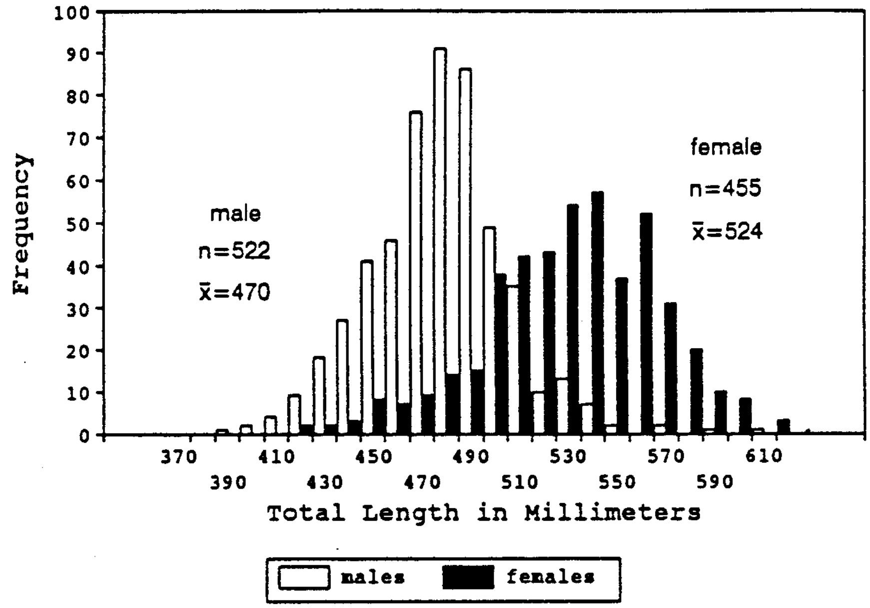
RESULTS

A total of 1,063 flannelmouth suckers were caught (January 1992 to August 1993) in or at the mouth of the Paria River. Mean total length (TL) was 495 mm. Females (mean TL = 524 mm, n = 455) were larger ($p < 0.001$) than males (mean TL = 470, n = 522). Fish taken in the confluence (mean TL = 501 mm, n = 787) were larger ($p < 0.001$) than spawners (mean TL = 476, n = 246) from upstream areas (Figure 4 and Table 6). Fish spawning in upstream areas in the Paria in 1993 were larger ($p < 0.001$), than those spawning in the Paria in 1981 (mean TL = 425, n = 286) (raw data, Frank Baucom, Figure 5 and Table 6).

1992 Spawning observations

Ripe flannelmouth suckers were first caught in the Paria River on March 20; over 80% of the fish caught (n = 30) were "running ripe" (gametes expelled with little or no manual pressure; Tyus and Karp 1990). Fish were caught primarily at two locations; 4 km and 6 km from the mouth of the Paria. At the 4.0-km site, fish were first seen in pairs, with dorsal fins protruding from the water, and their

Figure 4. Length frequency of flannelmouth sucker by sex and location (all fish 1992-93).



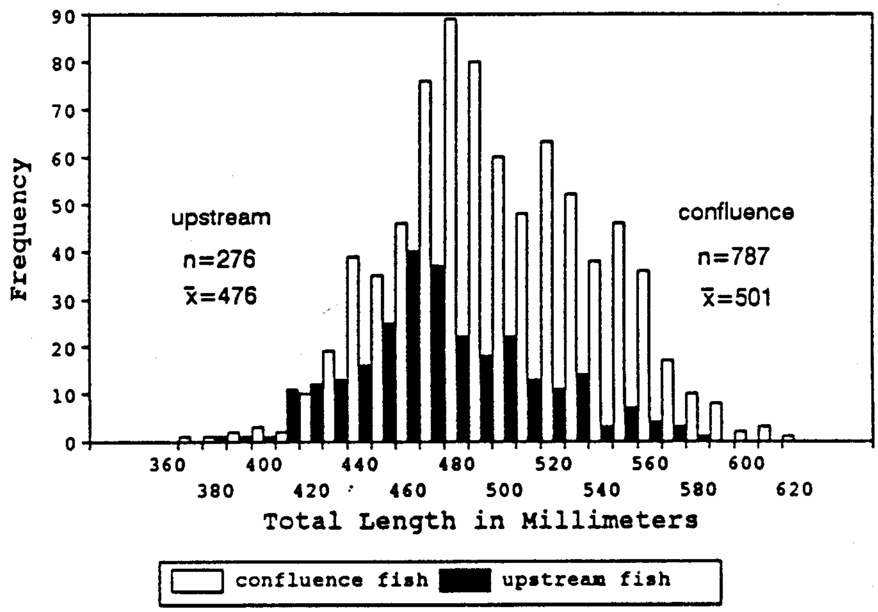
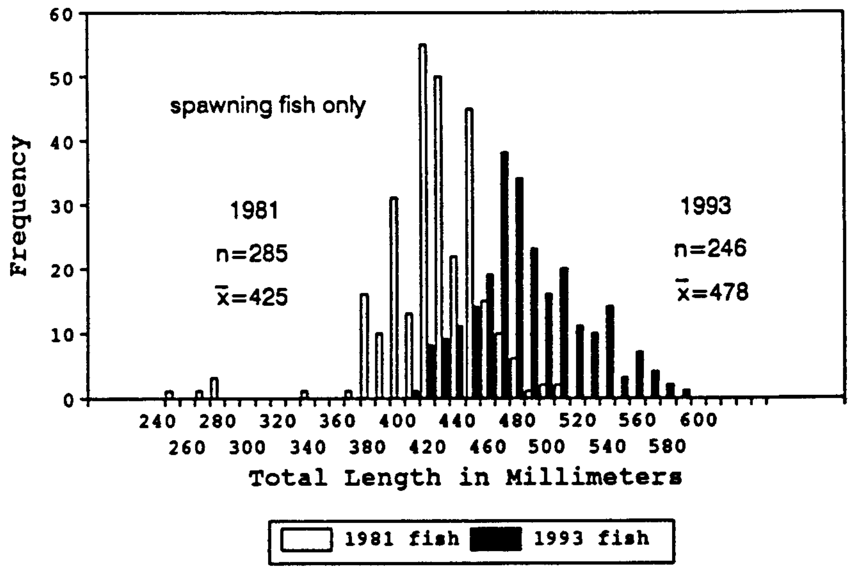


Figure 5. Length frequencies of spawning fish in 1981 versus spawning fish caught in my study and all fish in my study.



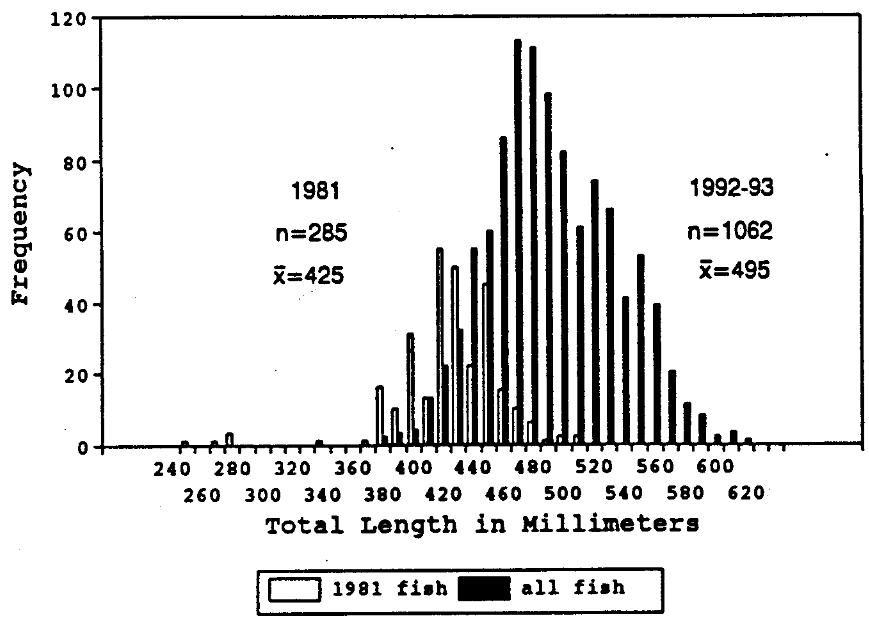


Table 6. T-test statistics for length frequency comparisons.

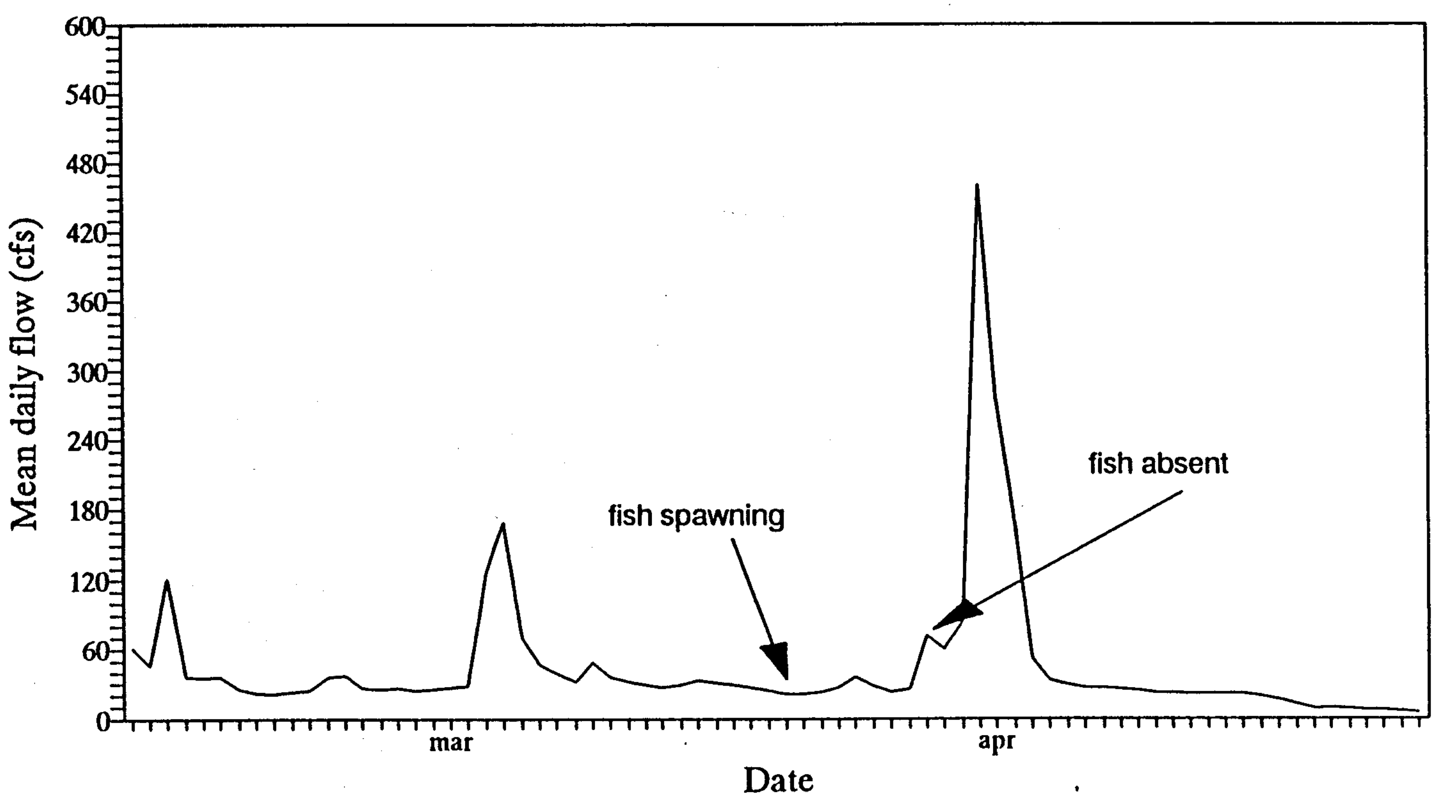
Group	Cases	Mean	Std	SE	T	D.F.	Prob.
1992-93 Males	522	470	34.6	1.516	23.90	951	0.00
1992-93 Females	455	524	35.3	1.656			
1992-93 Reach 0	787	501	41.1	1.466	7.94	430	0.00
1992-93 Reach 1-4	276	476	47.2	2.843			
1993 spawning	246	478	47.4	3.025	14.75	431	0.00
1981* spawning	285	425	33.4	1.980			
1992-93 all fish	1062	495	44.1	1.355	29.05	578	0.00
1981* spawning	285	425	33.4	1.980			

* Raw Data supplied by Frank Baucom USFWS Phoenix.

bodies slapping against one another. All fish were in a 25-m long, 2-m wide channel, in water 10-20 cm deep and over a substrate of sand and fine gravel (category 2 to 3). Mean depth (5 transects, 65 points) was 11 cm. The water temperature was 16°C. One seine haul through the 50-m^2 channel yielded 16 adult flannelmouth (mean TL = 452 mm, 8 males and 8 females), all running ripe. A second seine haul (450 m^2) in the main channel yielded no suckers. At the 6.0-km site, fish were also seen in the act of spawning. Fish were spawning in slightly deeper water (mean depth = 15 cm, n = 45) and over courser substrate (category 2 to 4). Thirteen adult flannelmouth (6 females and 7 males, mean TL = 454 mm) and 1 bluehead sucker (TL = 250 mm) were caught. The smallest male flannelmouth caught at both sites was 385 mm and the smallest female was 410 mm.

Eleven adults were caught at the confluence on the night of March 26. One of 5 females was ripe and 4 of 5 males were ripe. On March 27, stream flow was rising and water temperatures were cooler than a week earlier (a relatively steady 8-9°C). No adult flannelmouth were caught on that date and it appeared that spawning had ended abruptly; the fish had left the river just prior to a flash flood (Figure 6). Reconnaissance seining over approximately 20 km of the Paria revealed one adult fish at about 14 km.

Figure 6. Mean daily flow (cubic feet per second) of the Paria River during the 1992 spawning period.



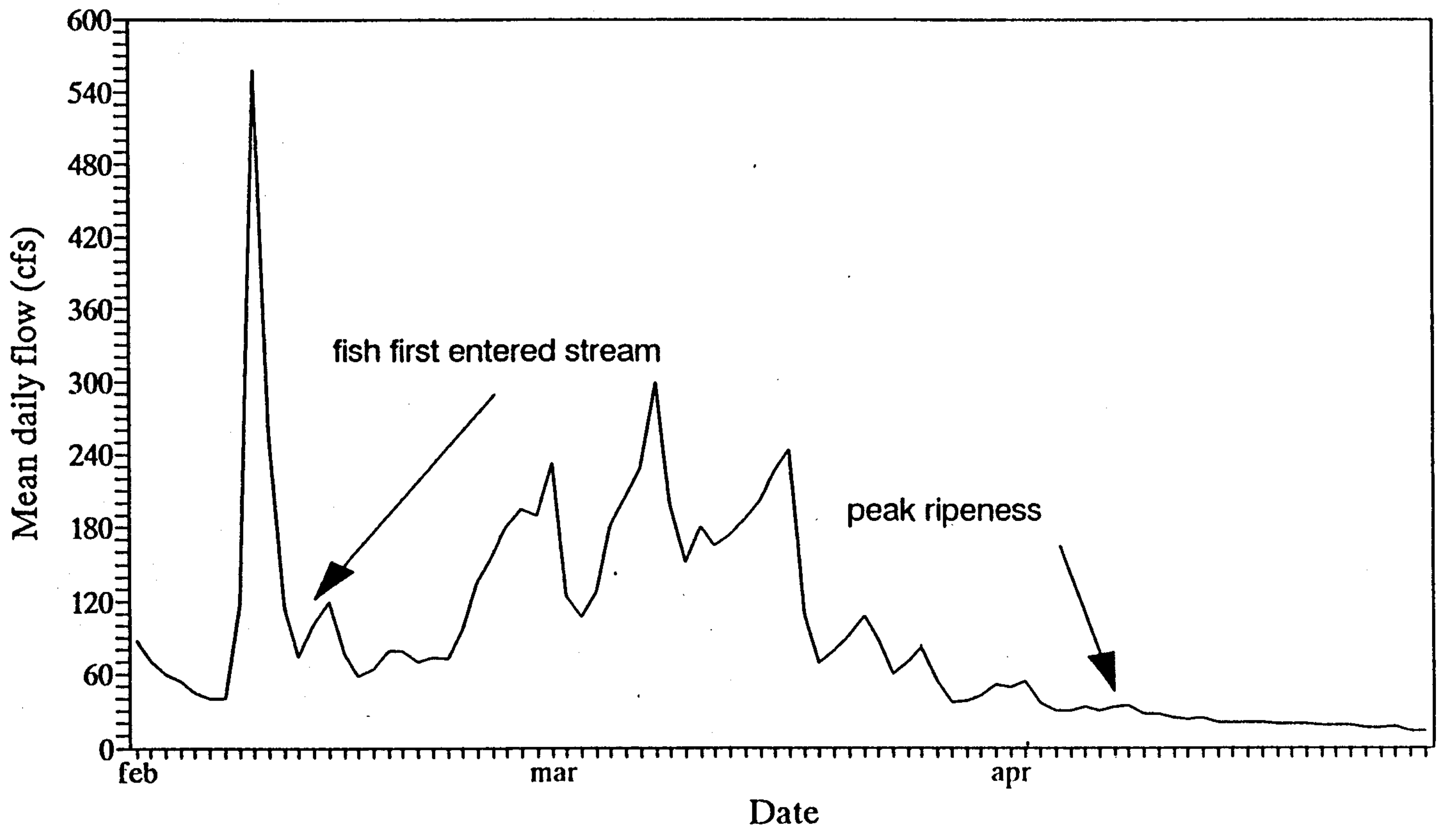
No adult flannelmouth were caught upstream of the confluence area during the remainder of 1992.

A few post-larval flannelmouth sucker were caught in the lower Paria during spring 1992. Juveniles were caught at 1.1, 2.8, and 5.3 km from the mouth of the Paria. These fish were between 22 and 37 mm TL (n = 5). On June 8, 3 additional juvenile flannelmouth (42, 44, and 45 mm TL) were caught 60-80 m from the mouth of the Paria. The area had slack flow, a silt substrate, and a water temperature of 20°C. No other YOY flannelmouth were caught during 1992.

1993 Spawning observations

Adult male flannelmouth were first caught entering the Paria on February 13 just after a flash flood (Figure 7). Water temperatures varied between 2 and 8°C. Females were first caught on March 1 when water temperatures ranged from 6 to 12°C. Females that were running ripe were caught only between March 28 and April 10. Flannelmouth were first seen spawning on March 28 at river kilometer 2.8. Several fish were in shallow water; dorsal fins were out of the water. A seine haul yielded 2 ripe females and 3 ripe males. The fish were located in a 5-m^2 area 20-25 cm deep, with moderate flow over gravel and cobble. The water temperature was 9°C. Three days later at the same spot, 7 ripe males were caught (one fish recaptured from the previous date).

Figure 7. Mean daily flows (cubic feet per second) of the Paria River during the 1993 spawning period.



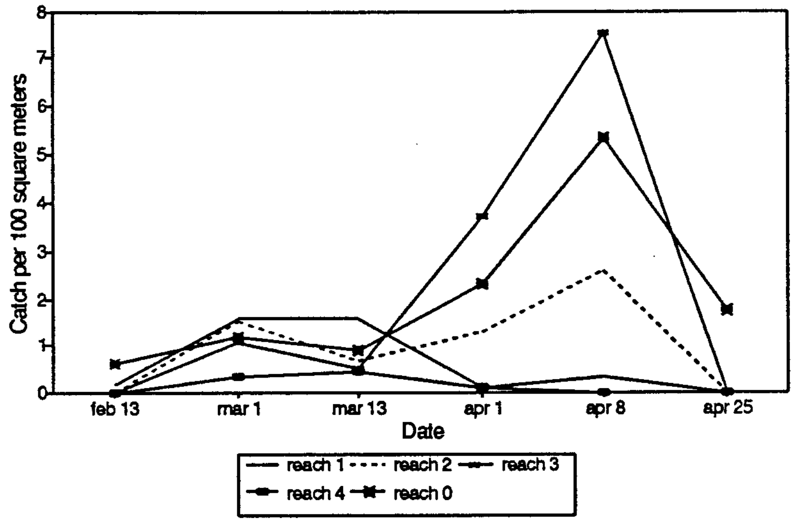
On March 29, at 4.8 km from the mouth of the Paria, I caught 26 flannelmouth (24 ripe) in an 88-m^2. Spawning activity was not verified at this site but fish were against the shallow shoreline over gravel and cobble (category 3-4).

Percentage ripeness and CPUE peaked on April 8-10 when water temperatures ranged from 8 to 20°C (Figures 8 and 9). On April 9, a single seine haul (130-m_2) at the 6.0-km site yielded 39 spawning flannelmouth. Fish were in shallow water with their backs out of the water and their bodies against one another. Spawning occurred against the shallow shoreline over sand and gravel. The water temperature was 18°C. An additional school of spawning fish was observed on April 8-10 at approximately 9.2 km.

Spawning fish appeared to be concentrated in the upper reaches (Figure 8), and no fish were observed spawning in reach 1. No flannelmouth were caught above reach 0 after April 26. Overall males outnumbered females approximately 2 to 1 above the confluence area during the spawning season (Figure 10). The smallest male taken was 404 mm and the smallest female was 442 mm.

During the spawning run the sex ratio at the confluence slightly favored females but the percentage of ripe females remained below 50% (Figures 11 and 12). No ripe female fish were caught after April 26. Most male fish taken at the confluence during the spawning run were ripe; some ripe

Figure 8. CPUE for flannelmouth suckers by reach and date for the 1993 spawning season.



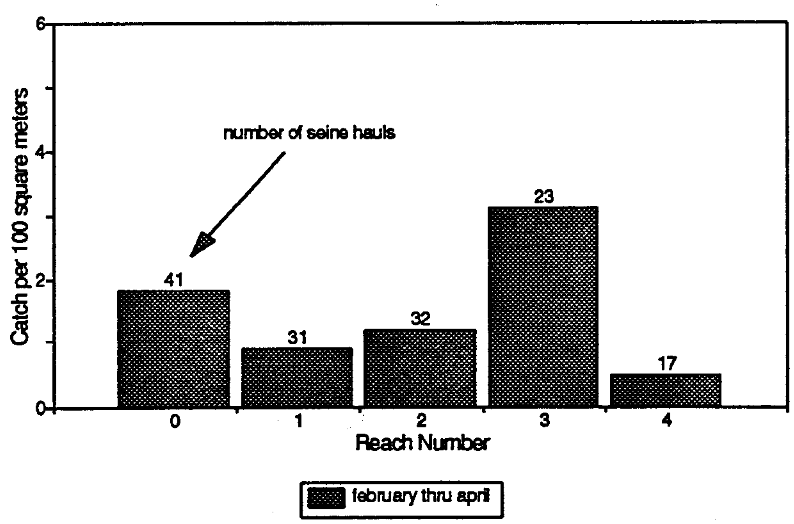
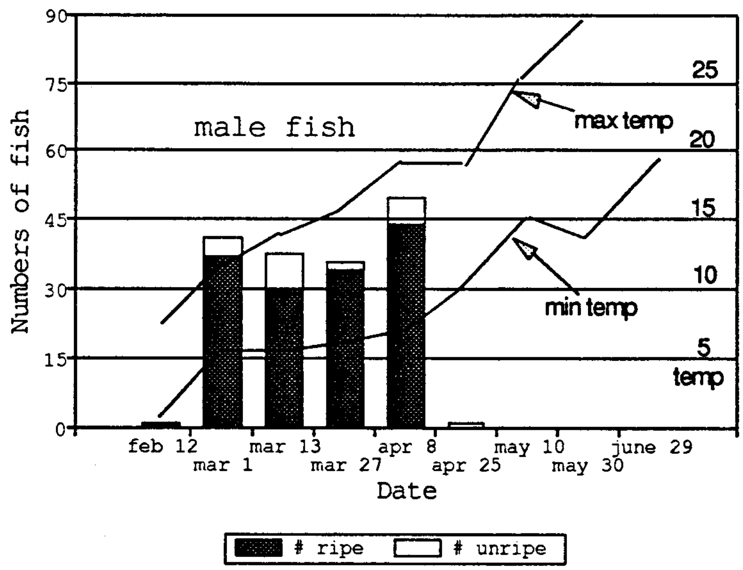


Figure 9. Percentage of ripe male and female flannelmouth suckers as a function of temperature (reaches 1-4).



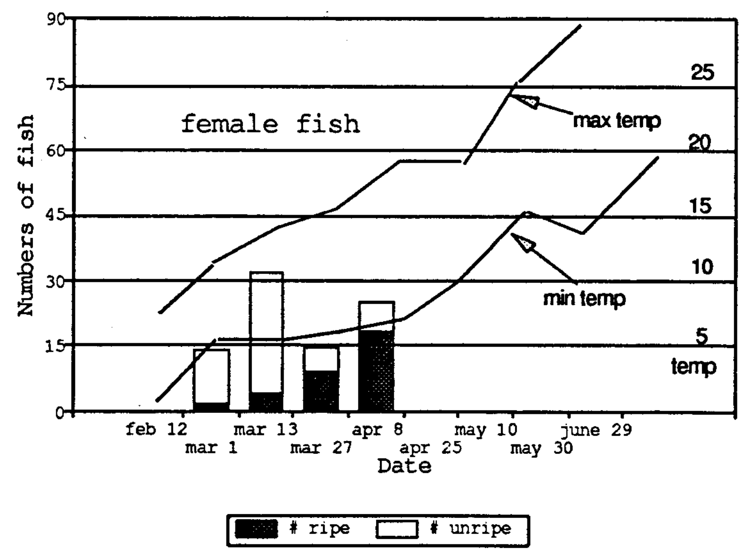


Figure 10. Sex ratio of flannelmouth sucker during the 1993 spawning season.

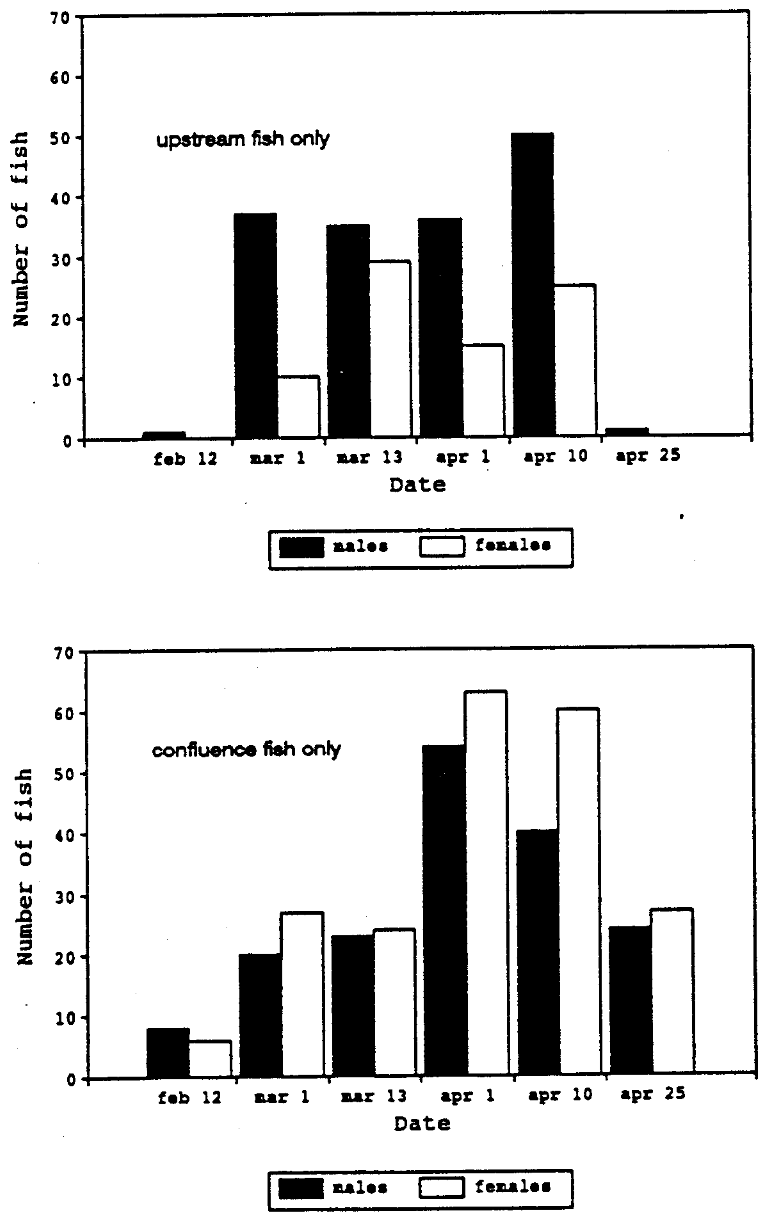


Figure 11. Sex ratio of the flannelmouth sucker at the confluence during 1993.

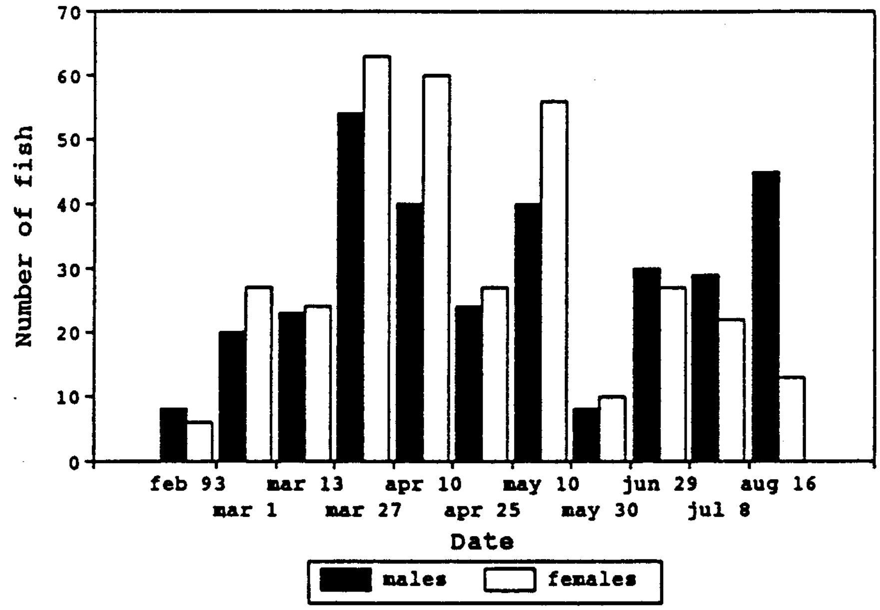
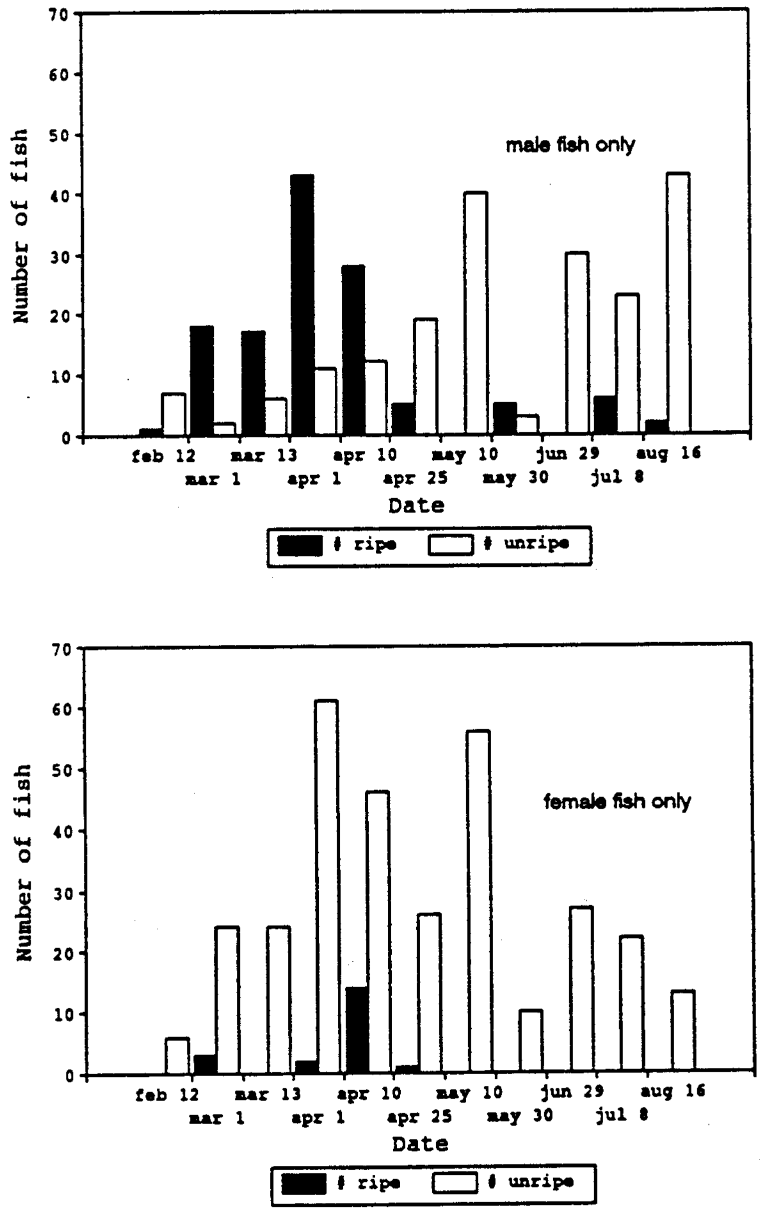


Figure 12. Number of ripe flannelmouth sucker at the confluence in 1993.



males were taken throughout the summer. I caught no YOY flannelmouth in 1993.

Condition factors were highest for both male and female fish on March 27-April 1 (1.03 for males, 1.05 for females). The condition factor was lowest for males on April 8-10 (0.94) and for females on May 30-June 3 (0.95).

Spawning habitat

There was no significant difference in mean substrate size between the spawning sites (2.8 and 6.0 km); substrate size was 17 and 23 mm respectively (Table 7). Mean column velocity at the 6.0-km spawning site was faster, 0.57 m/s compared to 0.40 m/s ($p < 0.05$), at the 2.8-km spawning site, but mean bottom velocity was comparable, 0.42 m/s to 0.35 m/s ($p = 0.06$). There was no significant difference in mean depth, 16.1 cm compared to 14.6 cm ($p = 0.28$) (Table 7). However, the Kolomogorov-Smirnoff (K-S) tests showed a significant difference in the frequency distributions of depth between spawning sites ($p = 0.04$)(Table 8).

K-S tests showed there were significant differences between depth, substrate sizes and bottom velocity at the spawning sites and the systematic habitat availability transects ($p = 0.04$, $p < 0.001$, and $p < 0.01$) respectively (Figure 13,14, Table 8). Continuous variables (depth and velocity) were also significantly different between spawning

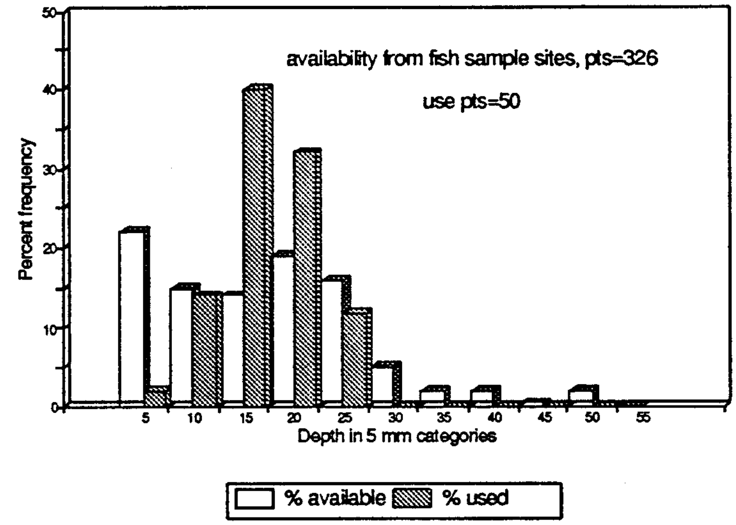
Table 7. T-Tests of habitat use between spawning sites and for the spawning sites combined vs availability. (Vel M = mean column velocity, Vel B = bottom velocity, Sub= substrate in mm, Depth = depth in cm).

Site	Var	N	Mean	STD	SE	T	Prob
2.8km	Sub mm	25	23.2	22.7	4.5	0.76	0.45
6.0km		25	16.6	37.1	7.4		
2.8km	Vel M cfs	25	0.57	0.25	0.05	2.96	<0.05
6.0km		25	0.40	0.15	0.03		
2.8km	Vel B cfs	25	0.42	0.13	0.03	1.94	0.059
6.0km		25	0.35	0.12	0.03		
2.8km	Depth cm	25	16.1	6.3	1.2	1.09	0.29
6.0km		25	14.6	2.4	0.49		
2.8 + 6.0	Vel M cfs	50	0.48	0.22	0.03	3.01	<0.05
all		203	0.87	1.75	0.12		
2.8 + 6.0	Vel B cfs	50	0.38	0.13	0.02	6.86	<0.05
all		203	0.57	0.19	0.02		
2.8+ 6.0	Depth cm	50	15.3	4.8	0.68	1.06	0.289
all		203	16.3	9.6	0.68		

Table 8. K-S tests of substrate, velocity and depth at spawning sites versus habitat availability (All= availability measured at systematic transects, sample sites= tranects measured within fish sample sites).

Site	Var	N	% Df	P
2.8 + 6.0 km	Sub Cat	50	0.34	<0.001
All		203		
2.8 + 6.0 km	VelM Cat	50	0.21	0.06
All		196		
2.8 + 6.0 km	VelB Cat	50	0.27	0.01
All		196		
2.8 + 6.0 km	Depth	50	0.22	0.04
All		203		
2.8 + 6.0 km	Sub Cat	50	0.41	<0.001
sample sites		326		
2.8 + 6.0 km	Vel Cat	50	0.14	0.36
sample sites		326		
2.8 + 6.0 km	Depth	50	0.22	0.03
sample sites		326		
2.8 km	Sub Cat	25	0.24	0.47
6.0 km		25		
2.8 km	Depth	25	0.4	0.04
6.0 km		25		
2.8 km	Vel Cat	25	0.08	1.0
6.0 km		25		

Figure 13. Depths used by spawning flannelmouth suckers versus those avalailable.



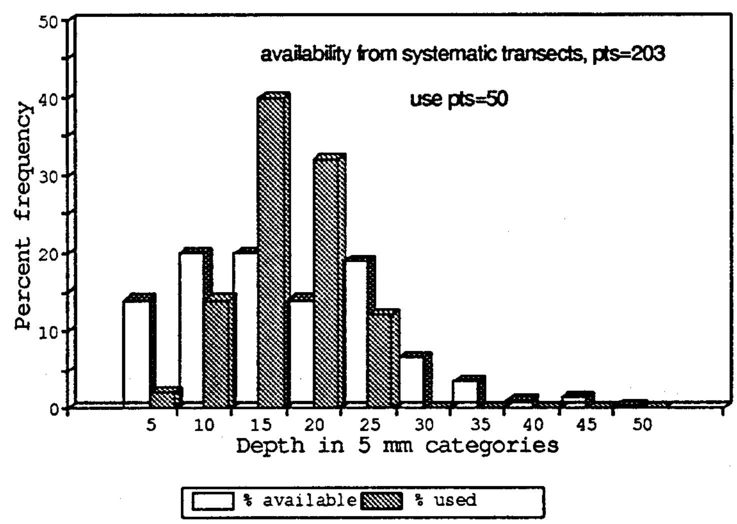
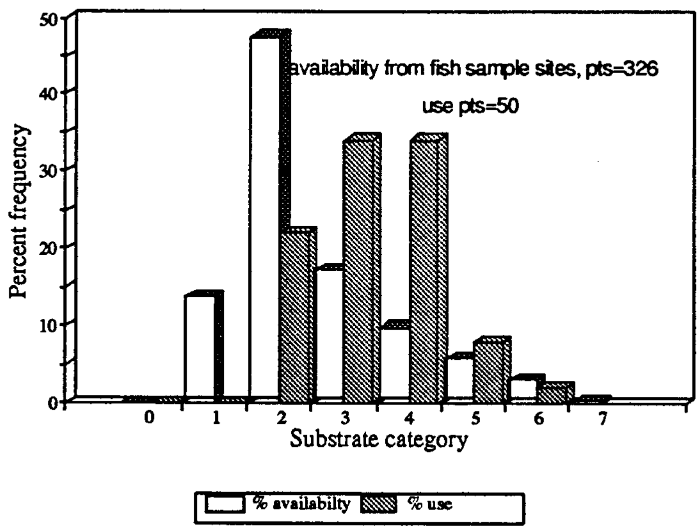


Figure 14. Substrate by spawning flannelmouth versus those available.



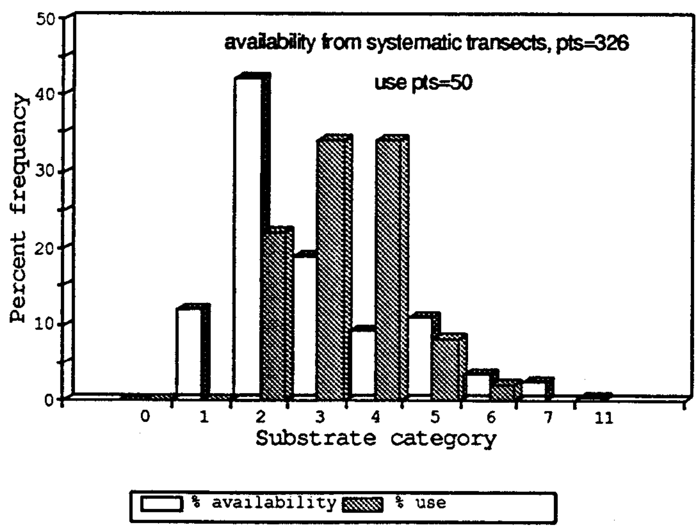
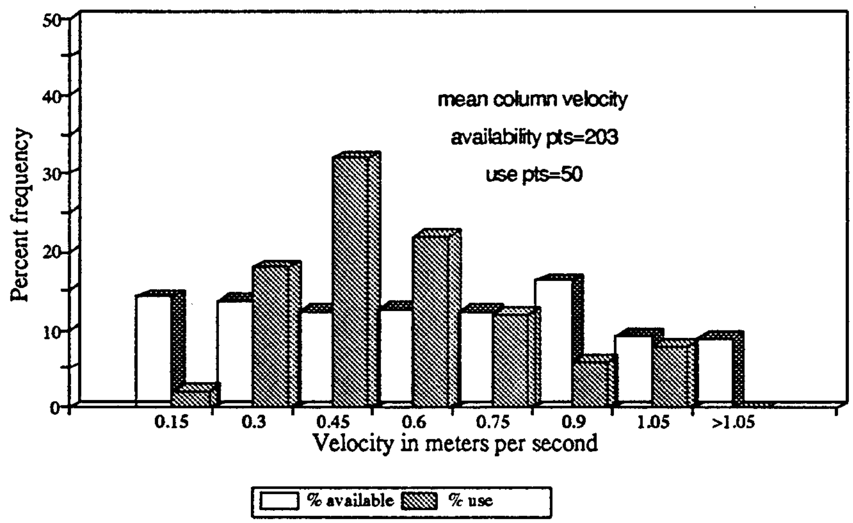
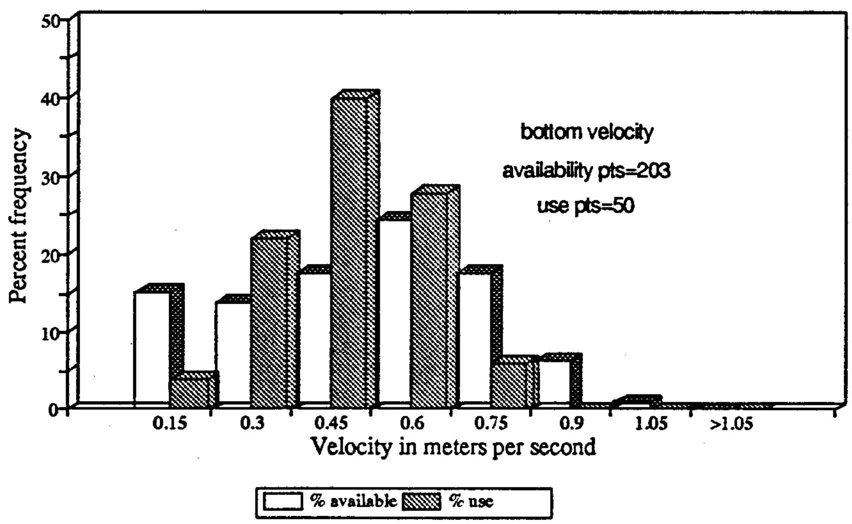


Figure 15. Velocity used by spawning flannelmouth versus those available.





sites and at habitat availability transects ($p < 0.05$). Mean column velocity was significantly slower at spawning sites (0.48 m/s) than across availability transects (0.87 m/s), as was bottom velocity (0.38 m/s compared to 0.57 m/s) (Figure 15, Table 7). There was no difference in the mean depths used by spawning fish verses the depth available ($p = 0.29$)(Table 7).

There was no significant difference in CPUE for systematically chosen sites compared to that for all other sites. There was borderline significance ($p = 0.05$) in CPUE between stream reaches during the spawning season for systematic sites but there were no significant differences ($p = 0.43$) among pooled data from other sites (Tables 9 and 10). When all sites were pooled by stream reach the CPUE was not significantly different ($p = 0.55$).

Confluence sampling

Use of the confluence area by flannelmouth suckers was erratic during daylight hours and appeared to be affected by both season and flows of the Colorado River (Figures 16 and 17). The mean CPUE during daylight was 0.65 fish/100 m^2 Seventy-three of 93 seine hauls (78%) yielded no fish (Figure 18). The mean CPUE after dark (2.3 fish/100 m^2) was greater than that in daylight ($p < 0.001$). Only 11 of 56 (20%) seine hauls yielded no fish (Figure 19). Catches were

Table 9. Mean CPUE by stream reach during the spawning season (February 13 to April 26 1993) for fish taken from systematically chosen sites versus those taken from all other sites.

Site type	Reach	Mean CPUE	STD	# Hauls
Systematic	1	0.60	1.04	7
	2	1.24	2.77	5
	3	8.63	12.13	5
	4	0.51	0.95	8
Total		2.30	6.06	25
Other	1	0.97	1.30	24
	2	1.17	1.66	27
	3	1.60	4.77	18
	4	0.49	0.82	14
Total		1.09	2.50	83

Table 10. Kruskal-Wallis H statistic for CPUE by stream reach for fish taken from systematically chosen sites and those taken from all other sites.

Site type	Reach	Mean Rank	Cases
Systematic	1	11.07	7
	2	10.60	5
	3	20.40	5
	4	11.56	8

<u>not-corrected for ties</u> Chi-Sq. 6.3 Sig 0.09 — <u>corrected for ties</u> Chi-Sq. 7.72 Sig 0.05

Site type	Reach	Mean Rank	Cases
Other	1	44.38	24
	2	45.98	27
	3	38.42	18
	4	34.86	14

<u>not-corrected for ties</u> Chi-Sq. 2.59 Sig 0.46 — <u>corrected for ties</u> Chi-Sq. 2.79 Sig 0.43

Figure 16. CPUE (1993) for flannelmouth suckers at the confluence of the Colorado and Paria rivers (day vs. night).

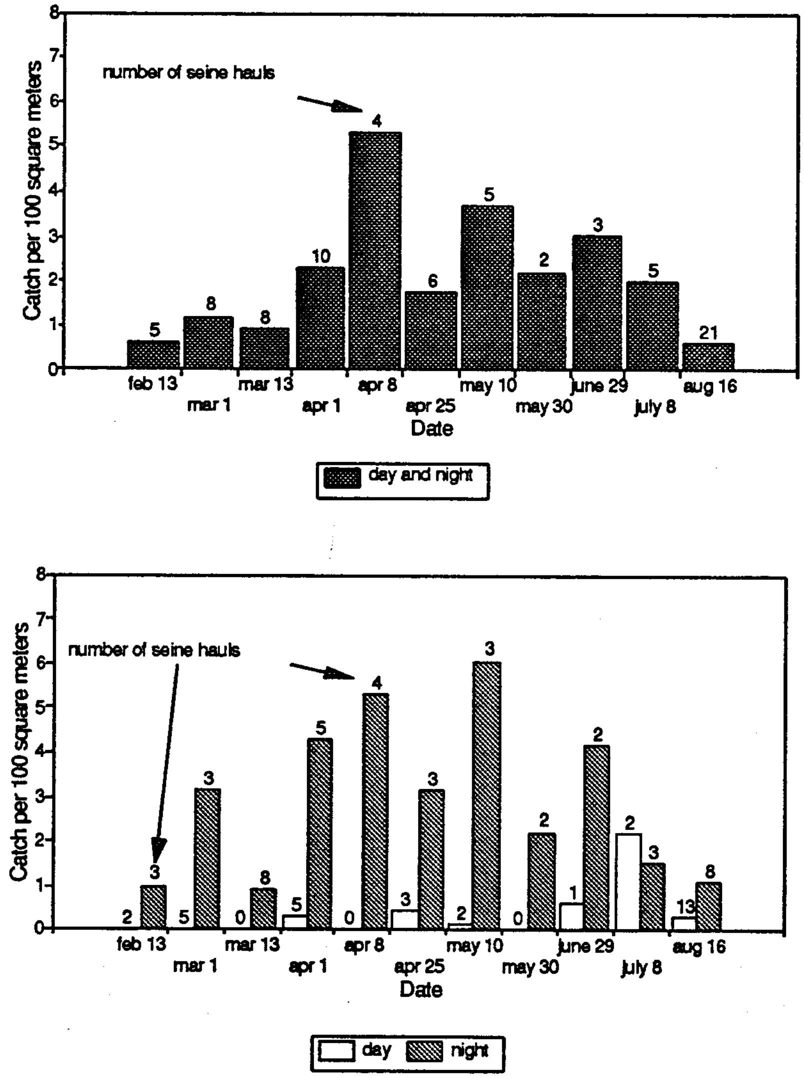
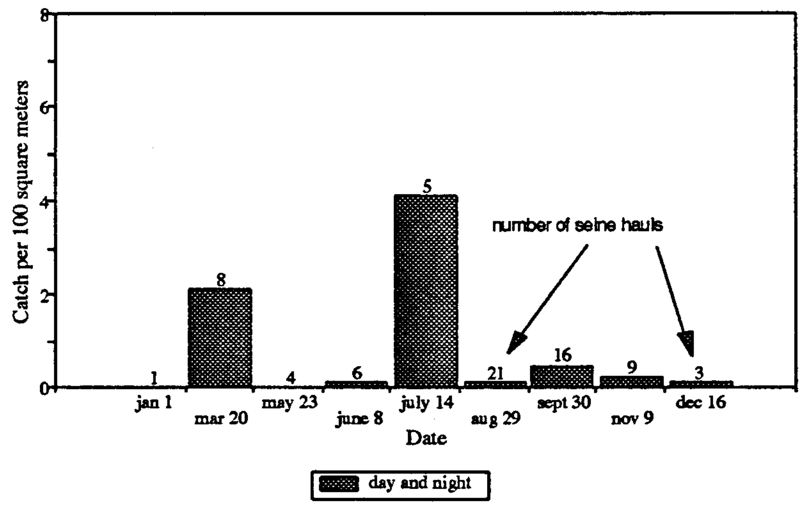


Figure 17. CPUE (1992) for flannelmouth suckers at the confluence of the Colorado and Paria rivers (day vs night).



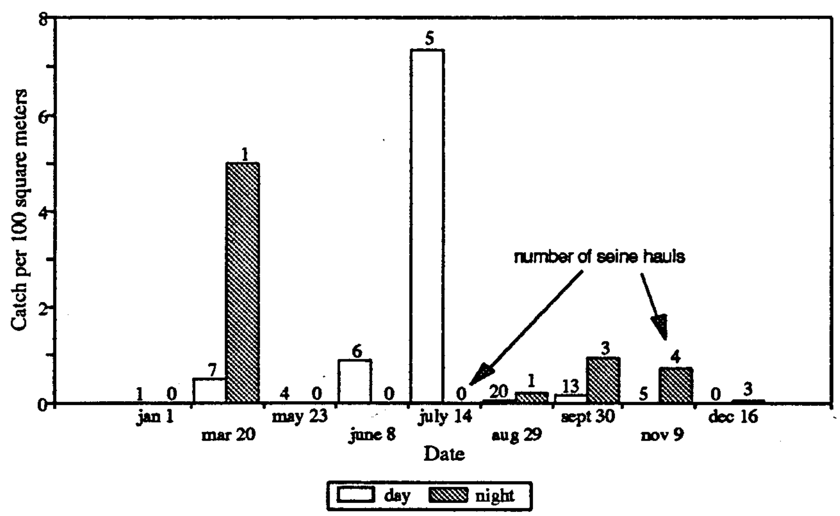


Figure 18. Catch per unit effort as a funtion of daytime flow for adult flannelmouth suckers.

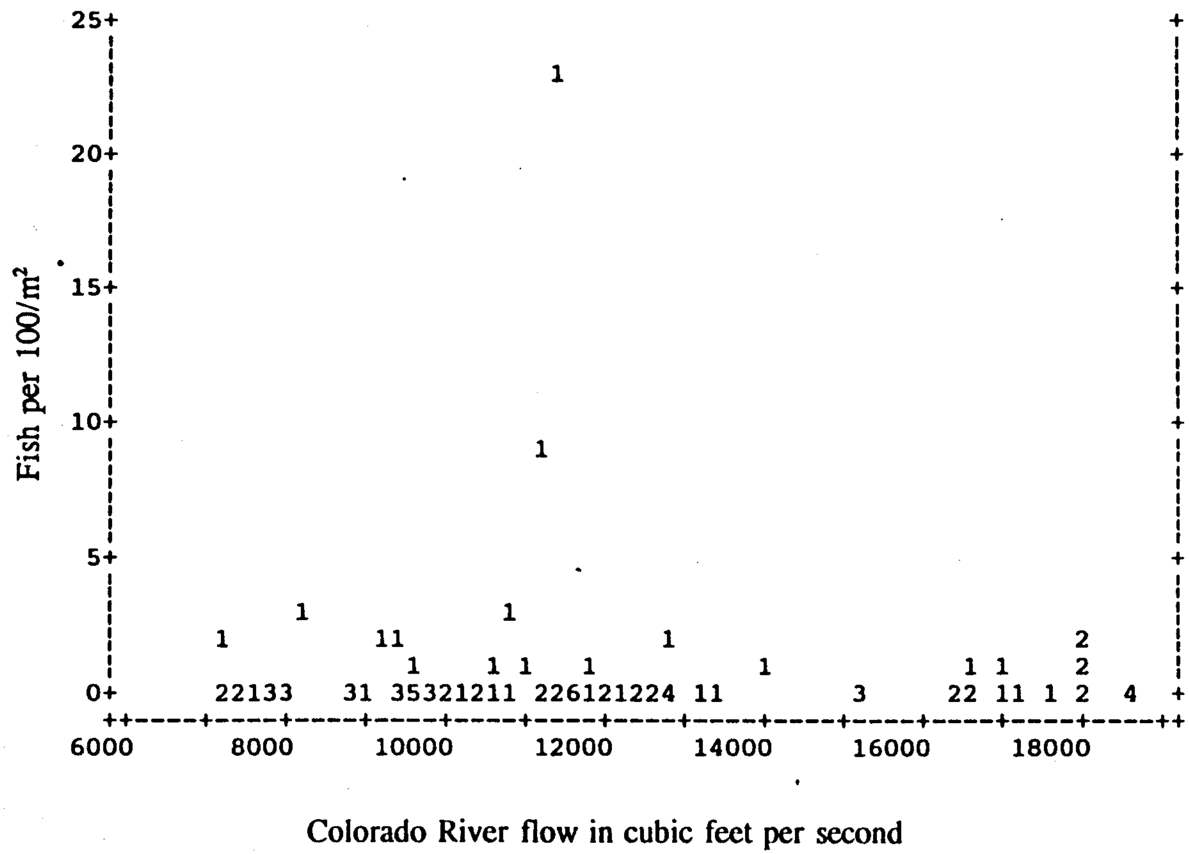
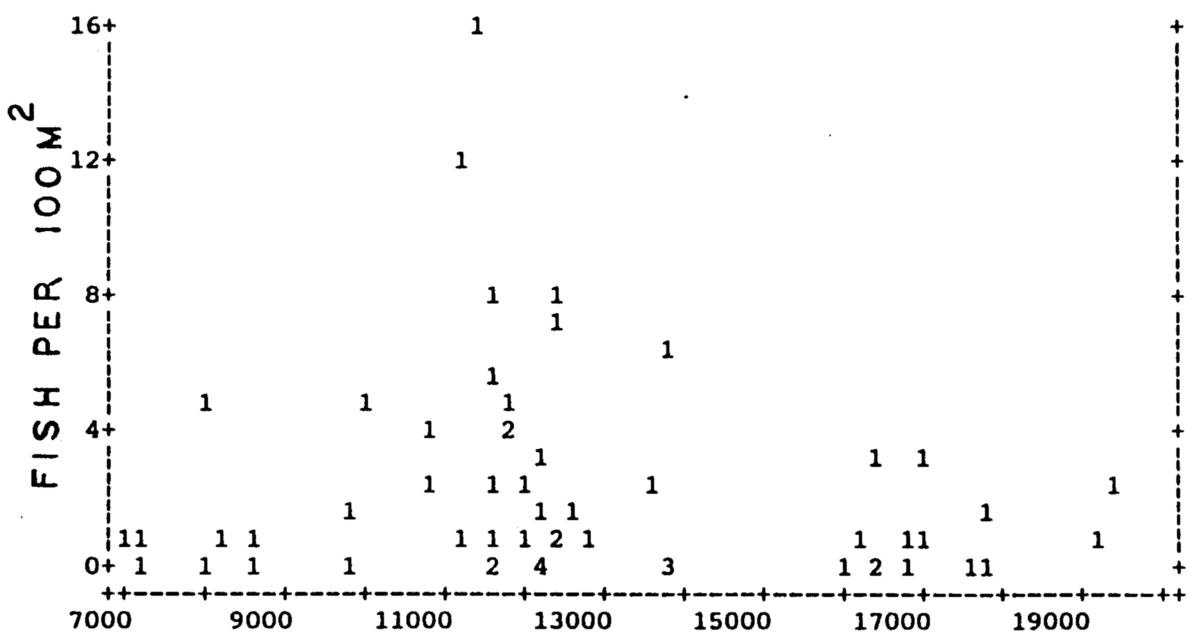


Figure 19. Catch per unit effort as a function of nightime flows for adult flannelmouth suckers.



Colorado River flow in cubic feet per second also higher ($p = 0.001$) at the 0.0 transect than at other portions of the confluence.

The mean CPUE at the three flow levels were 0.54 fish/100 m^2, 1.94 fish/100 m^2, 0.92 fish/100 m^2, respectively for low, medium, and high flows. A K-W statistic showed no significant relationship between CPUE and Colorado River flow level. However, the ten highest individual CPUE's at the confluence (between 5 and 25 fish/100 m^2) occurred when river flows were between 10,000 and 14,000 cfs. The highest catches during both day and night also occurred at medium flow levels (10,000 to 13,000 cfs).

Daytime use of the confluence was high during July of both 1992 and 1993. In July the Colorado River flows were high and the Paria had high water temperatures. The highest CPUE in the confluence (23 fish/100 m^2) occurred on July 14, 1992 at 0900. The flow in the Colorado was 11,000 cfs. Temperatures taken at 20-m intervals from the mouth of the Paria upstream for 100 m ranged from 15 to 24°C. Fish were caught throughout this area. The highest catch by numbers (80 fish, 16/100 m_2) occurred on April 10, 1993 after dark. The flow in the Colorado River at this time was 9,280 cfs.

Recaptures

The cumulative recapture rate for PIT-tagged flannelmouth was 7% at the end of the study. The per trip recapture rate ranged between 11 and 17 % for the last 4 sampling trips (Figure 20). No measurable growth (Figure 21) was observed in the 77 fish marked and recaptured in the Paria during my study (Sept 30 1992 to August 18, 1993) (Table 11). I captured 27 fish originally PIT-tagged by other researchers. Growth rates for these fish averaged 0.1 mm/day for mature fish and 0.15 mm/day for fish tagged as sub-adults. The original tagging date and location could not be determined for 8 of these fish. Recaptured fish came from as far away as Kanab Creek, 228 km downstream. Fifteen of these fish were originally tagged in the Little Colorado River (LCR). One fish which had been caught several times in the (LCR) (up to 6 km above the mouth) was recaptured during the 1993 spawning run in the Paria River at a location 10 km up from the mouth. Seven fish tagged in my study have been recovered by other researchers in the Canyon. All of these fish were caught in or near the LCR. One fish was recaptured in the LCR 21 days after being initially tagged while spawning 5 km up the Paria.

Seven fish floy tagged earlier by other researchers were also recaptured. The original date and location of capture could not be found for 3 of these fish. One fish tagged in 1986 had grown approximately 30 mm in the 7 years between captures. Data from these recaptures were combined

Figure 20. Cumulative and per trip recapture percentage of PIT tagged flannelmouth.

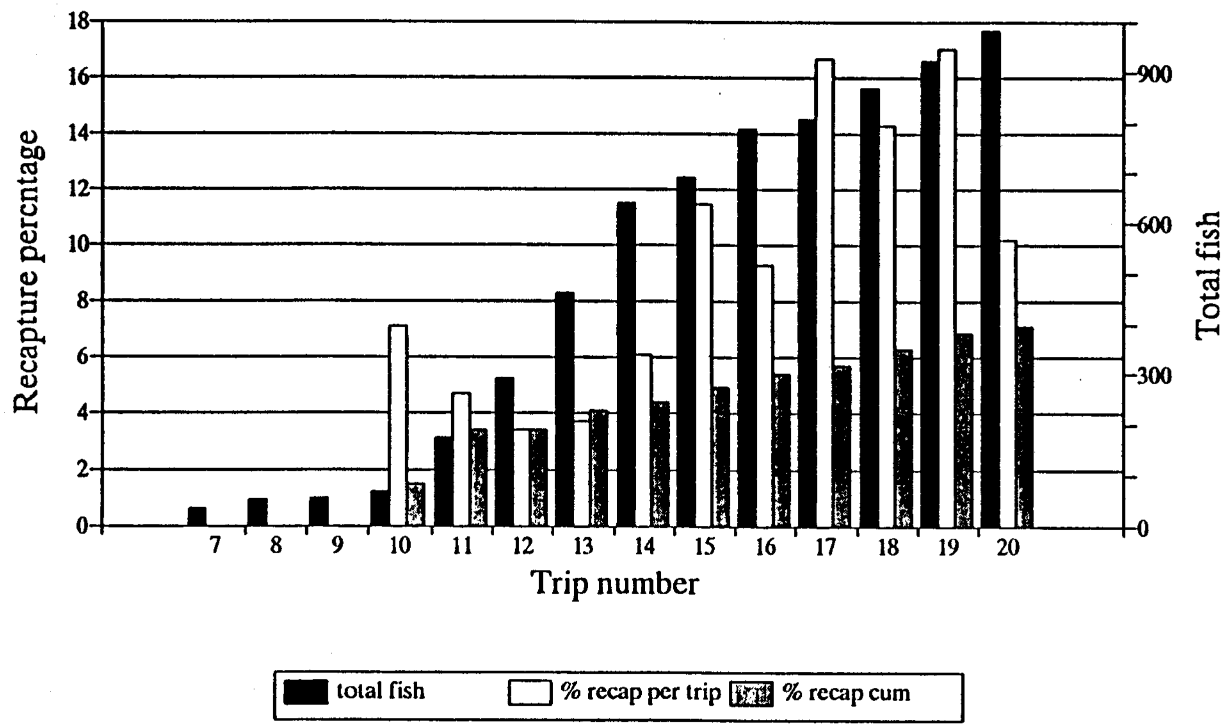


Figure 21. Change in length verse time (days) for tagged flannelmouth sucker in the Paria River.

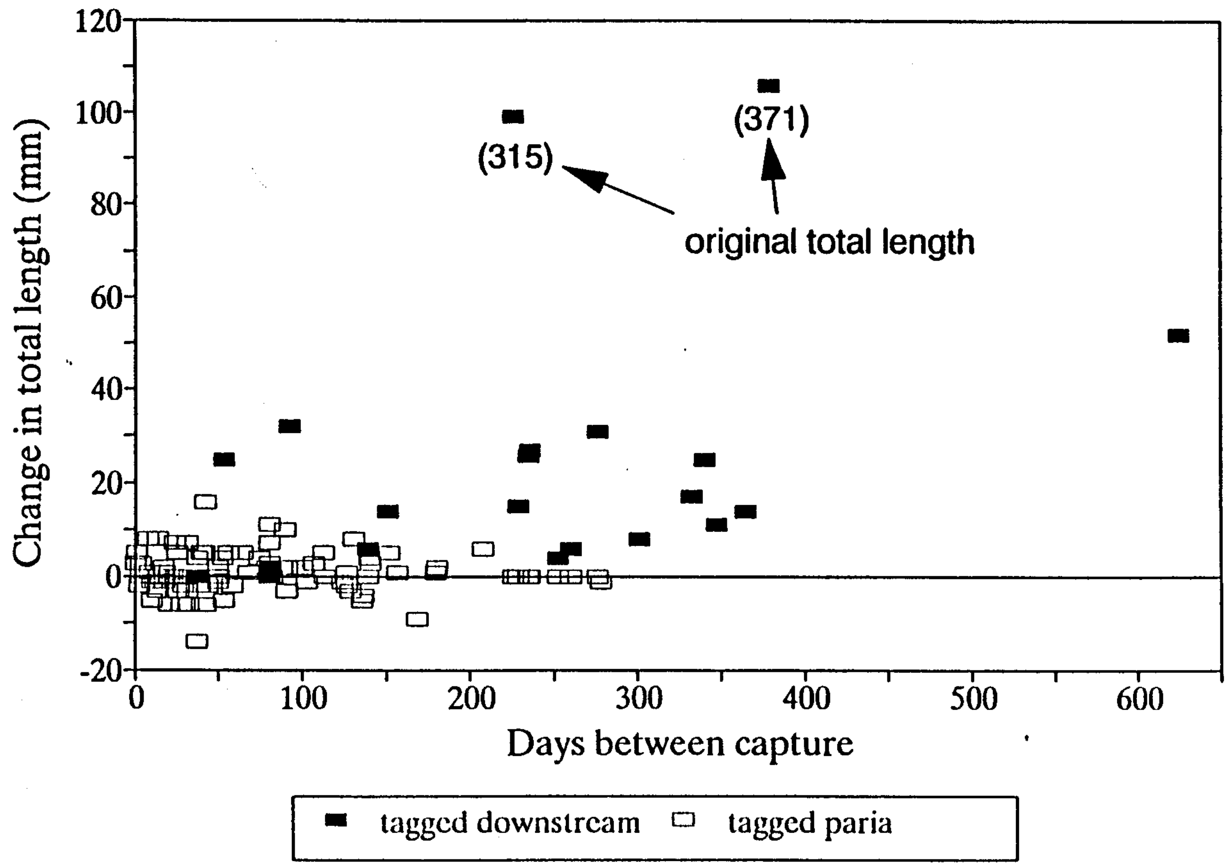


Table 11. Tagged flannelmouth suckers recaptured during this study (TL=total length, km=kilometers up the Paria, DATE2=recapture date, CHTL=change in length, DAYS= days at large, CHLOC=change in location).

TAG#	DATE1	TL	km	DATE2	TL	CHTL	DAYS	CHLOC
7F7D3C4215	UNKNOWN			930807	452			0.08
1F0C6F5412	UNKNOWN			930816	495			0.08
7F7D3C402B	UNKNOWN			930426	426			0
1F0F7C0049	UNKNOWN			930817	592			0.08
1F0F60787B	UNKNOWN			930629	562			0
1F0F66244B	UNKNOWN			930629	521			0.08
7F7B01684C	UNKNOWN			930629	470			0.08
7F7F1F162F	930408	438	0.9	930629	440			0
7F7D3E6775	UNKNOWN			930629	530			0.08
7F7D437016	UNKNOWN			930629	487			0
7F7B021626	920930	515	0	930213	510	-5	136	0
7F7B081B2E	920930	475	0	930301	480	5	152	0
7F7D444F66	920930	466	0	930426	472	6	208	7.9
7F7D437010	920930	494	0	930318	485	-9	169	0
7F7B035D15	921109	523	0	930303	523	0	114	0
7F7B02413B	921109	531	0	930314	530	-1	124	1
7F7D440834	921111	456	0	930708	455	-1	278	0.08
7F7D3F7B17	921111	476	0	930328	472	-4	137	4.1
7F7D3E6F75	921216	526	0	930301	530	4	75	0
7F7B034E4B	930213	462	0	930303	463	1	18	3
7F7B034E4B	930213	462	0	930510	.	.	86	0
7F7B026064	930301	563	0	930807	560	-3	129	0.08
7F7B021849	930301	558	0	930408	544	-14	38	0
7F7B016023	930303	476	2.1	930510	477	1	68	0
7F7D3C4154	930303	565	2.7	930807	563	-2	127	0.08
7F7B023527	930303	450	3	930426	445	-5	54	0
7F7B081618	930303	475	3	930708	476	1	127	0.08
7F7B034965	930303	418	2.1	930314	417	-1	11	2
7F7B026B3F	930303	516	0	930410	520	4	38	0
7F7D40057B	930304	463	0.5	930316	462	-1	12	0
7F7D40122F	930304	490	0.5	930304	493	3	0	0.6
7F7B016239	930314		2.2	930408	448	.	25	4
7F7B080C63	930314	510	1.1	930408	507	-3	25	4
7F7B08262B	930314	457	1	930629	460	3	107	0
7F7D441659	930314	512	1.1	930426	506	-6	43	0
7F7B020F22	930314	495	1.1	930318	495	0	4	1
7F7B016068	930314	499	3.7	930603	510	11	81	0
7F7D441459	930315	477	6	930329	474	-3	14	5.8
7F7B081559	930315	500	8	930510	505	5	56	0
7F7D3C3756	930316	493	0	930410	496	3	25	0
7F7D441940	930316	538	0	930331	538	0	15	0
7F7B08171D	930316	478	0	930409	485	7	24	10
7F7B081C51	930316	515	0	930330	515	0	14	0
7F7D400170	930318	556	0	930408	556	0	21	0
7F7D44171B	930318	473	1	930408	467	-12	21	2.7
7F7D44171B	930318	473	1	930510	470	-3	53	0
7F7D40042E	930318	565	1	930629	564	-1	103	0.08
7F7D7D3145	930318	534	1.1	930426	532	-2	39	0
7F7B03750B	930318	486	0	930510	490	4	53	0
7F7D3C4322	930328	466	2.7	930331	464	-2	3	2.7
7F7B037B6E	930328	553	0	930426	551	-4	29	0
7F7D400921	930328	418	4.8	930510	432	14	43	0
7F7B013E44	930328	612	0	930511	610	-2	44	0

Table 11. Continued.

7F7B02630B	930329	460	5.8	930425	457	-3	27	0
7F7D3C416B	930329	472	5.8	930426	466	-6	28	0
7F7D40166B	930329	485	5.8	930510	490	5	42	0
7F7B025261	930329	480	5.8	930409	475	-5	11	6
7F7B19250D	930330	478	0	930629	480	2	91	0.08
7F7B1B414F	930330	515	0	930603	520	5	65	0
7F7B197915	930330	477	0	930807	479	2	100	0.08
7F7B1B414F	930330	515	0	930708	520	5	100	
7F7B1B606B	930331	485	0	930510	490	5	40	0
7F7B02684E	930331	563	0	930426	568	5	26	0
7F7F27073F	930331	510	0	930408	518	8	8	0
7F7B1B0B15	930331	563	0	930629	573	10	90	0.08
1F0F7C795D	930408	445	0	930708	442	-3	91	0.08
1F0936455D	930408	486	0	930511	480	-6	33	0
1F0F70055D	930408	505	0	930510	512	7	32	0
1F0F6B491E	930408	500	0	930629	500	0	83	0.08
1F0F6D3B2B	930409	461	6	930629	464	3	81	0.08
1F0F6E2143	930409	453	6	930629	460	7	81	0.08
1F0F5F165D	930426	495	0	930510	503	8	14	0
1F0F7D0B4B	930510	495	0	930511	500	5	1	0
1F0F6F095B	930510	548	0	930629	550	2	50	0.08
1F0F703032	930510	488	0	930629	487	-1	50	0
1F0F62727E	930530	525	0	930603	528	3	4	0
1F0F665B11	930629	431	0	930708	432	1	9	0
7F7D3F7E7C	930930	540	0	930329	541	1	180	0
7F7D3C5610	930930	555	0	930330	557	2	181	0

with published data from other floy tag recaptures (Maddux et al. 1987) and raw data from ASU, Biowest, and AGFD and plotted against years at large. The multiple regression model displayed a significant difference ($p < 0.001$) in growth rate between adult and sub-adult fish (Figure 22,23). A second order polynomial: $y = -13x^2 + 107x - 44$ (multiple r = 0.956) where x equals years at large and y equals change in total length in mm, best described the growth rate for sub-adult fish (< 407 mm). A linear equation best fits the data for adult fish: $y = 7.3x - 0.45$ (multiple r = 0.838). The interaction terms between both linear and quadratic year effects and group (adult and sub-adult) were highly significant ($p < 0.0001$).

Other species

Speckled dace were found in the Paria River throughout the year at temperatures ranging from near 0 to 34°C. CPUE for speckled dace varied little between stream reaches but varied widely between sampling events (Figure 24). Catches were highest in Reach 3 during spring and fall but differences in CPUE were not significant.

Incidental catches during the study included both bluehead sucker (n = 3) rainbow trout, *Oncorhynchus mykiss* (n ≈ 24) and common carp, *Cyprinus carpio* (n = 1). In

Figure 22. Change in length vs time (years) for floy tagged flannelmouth sucker from the Grand Canyon.

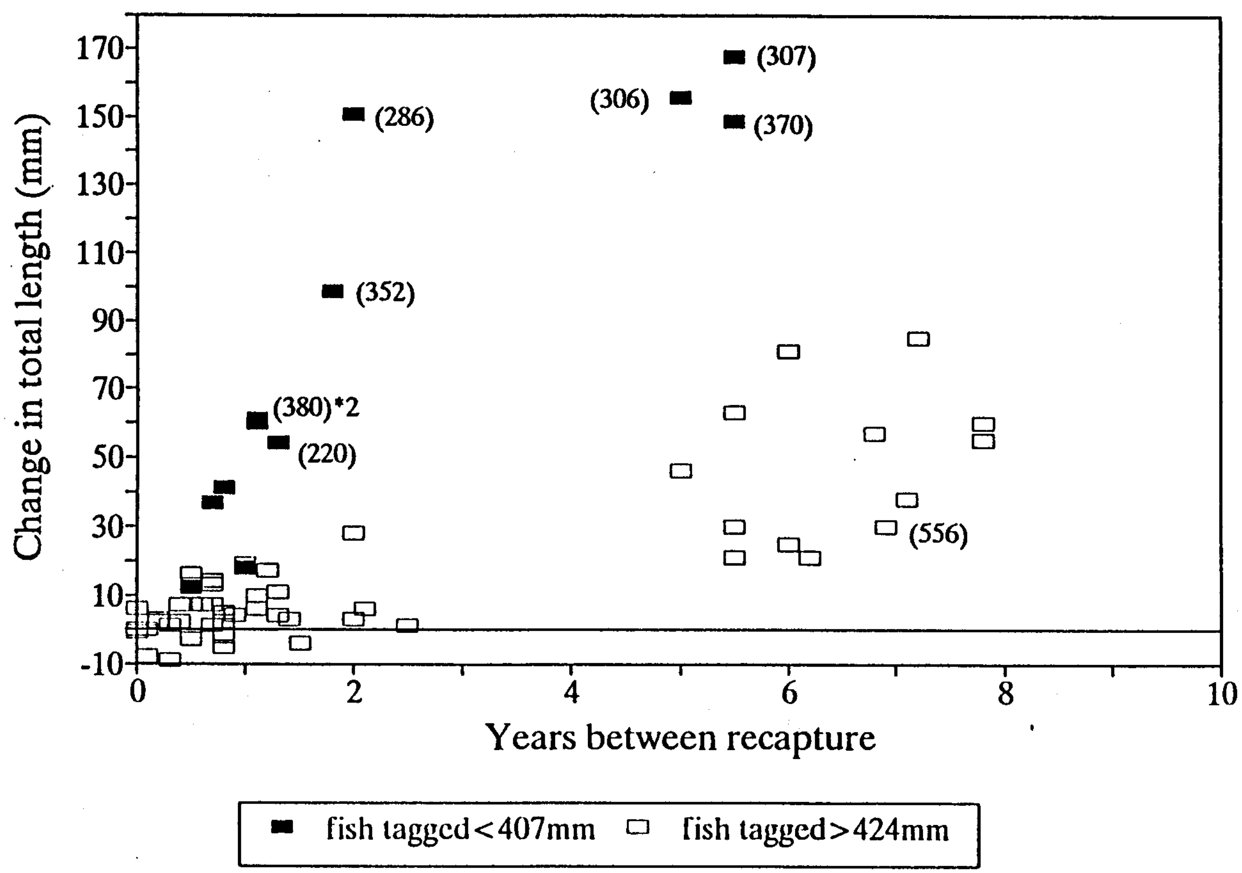


Figure 23. Predictive regressions of growth versus time for pre- and post-spawning size classes of flannelmouth sucker.

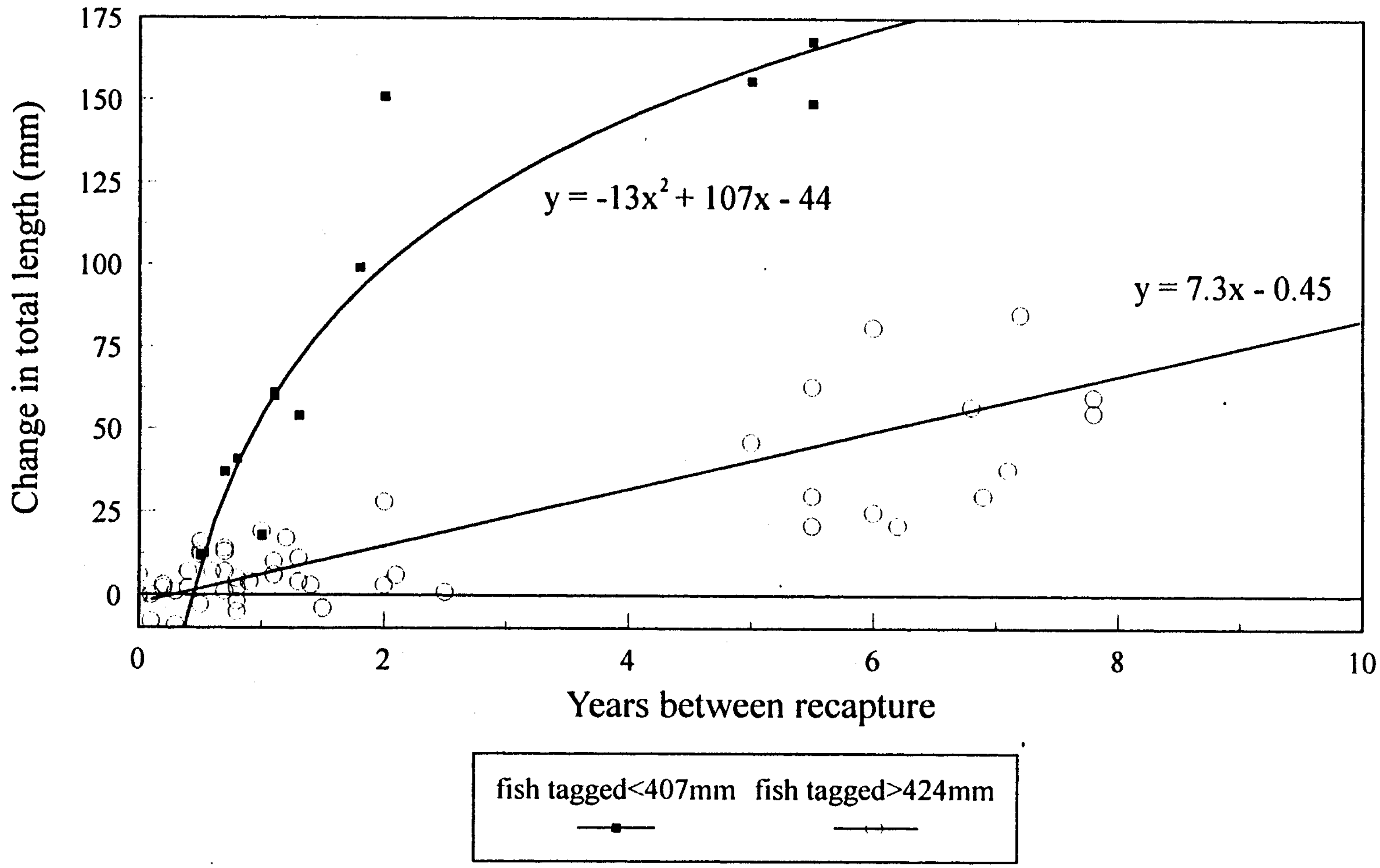
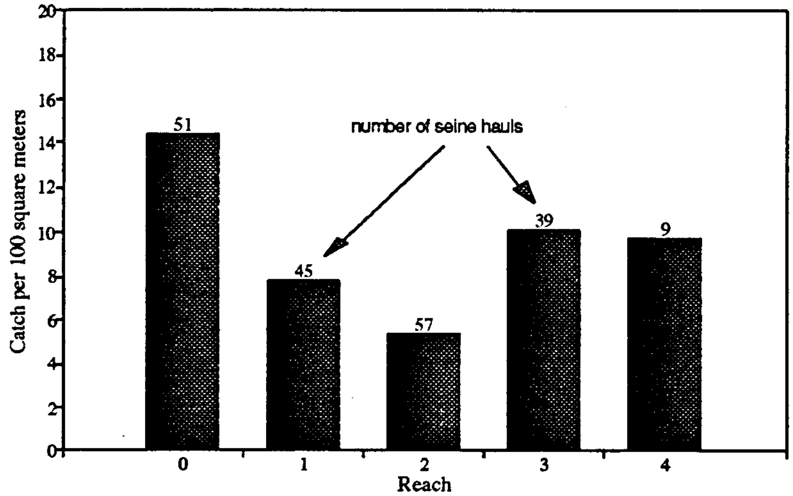
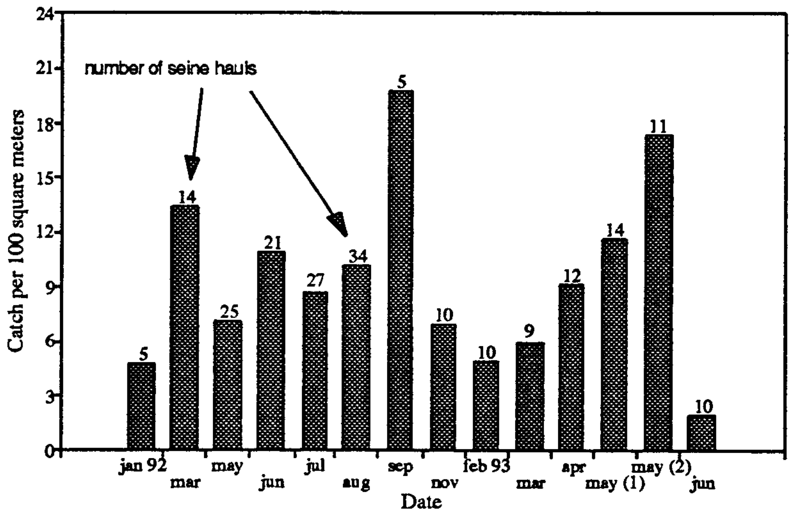


Figure 24. Mean CPUE of speckled dace by reach and sample period.





addition a single moribund striped bass (stomach empty) was found at mouth of the Paria in September of 1992.

Habitat availability

Data from habitat availability transects and transects measured within fish sampling sites (depth, velocity, substrate) were compared on 4 dates (Table 12). Eight of 12 comparisons showed no significant differences. Two of the four significant differences occurred on the March 19-20 trip when three different technicians took measurements. The other two differences were between data from June and July. Frequency distributions of depth, velocity and substrate varied with stream flow (Figures 25,26,27).

The pair-wise K-S tests on 3 habitat variables between 4 stream reaches showed that there were no differences in 15 of the 18 combinations. Two of the 3 pair-wise comparisons which showed significant differences were in reach 1 which contained a deep hole.

Mean daily flow rates of the Paria River during this study varied from 3.7 to 599 cfs (Figure 28 and 29). Maximum rates ranged from 5.4 to 1790 cfs. Flow rates varied widely even within a day. Heavy snows and subsequent thawing in Bryce Canyon resulted in daily pulse flows for weeks in the spring of 1993. On March 17 during sampling, instantaneous flow estimates went from 84 to 244 cfs in 15

Table 12. K-S tests of habitat sampled versus habitat available (% Df=max. absolute difference of the cumulative frequency distribution, Fish= fish samples sites, Syst=overall availability).

Date	Var	Type	N	Avg Cfs	Max Cfs	% Df	P
1/12/92	DEPTH	Mic	200	12	20	0.06	0.88
1/13/92		Mac	215	10	23		
3/19/92		Mic	221	24?	27	0.06	0.78
3/20/92		Mac	255	27?	25		
6/8/92		Mic	125	6	8	0.32	<0.01
7/14/92		Mac	184	4	4.5		
4/8/93		Mic	326	37	49	0.09	0.28
4/10/93		Mac	203	42	53		
1/12/92	VELOCITY	Mic	200	12	20	0.67	0.73
1/13/92		Mac	215	10	23		
3/19/92		Mic	221	24?	27	0.18	<0.01
3/20/92		Mac	255	27?	25		
6/8/92		Mic	125	6	8	0.07	0.85
7/17/92		Mac	184	4	4.5		
4/8/93		Mic	326	37	49	0.06	0.74
4/10/93		Mac	203	42	53		
1/12/92	SUBSTRATE	Mic	200	12	20	0.11	0.17
1/13/92		Mac	215	10	23		
3/19/92		Mic	221	24?	27	0.22	<0.01
3/20/92		Mac	255	27?	25		
6/8/92		Mic	125	6	8	0.26	<0.01
7/17/92		Mac	184	4	4.5		
4/8/93		Mic	326	37	49	0.07	0.54
4/10/93		Mac	203	42	53		

Figure 25. Depth distributions (availability) in the Paria River (systematic transects 0.5 to 10 kilometers).

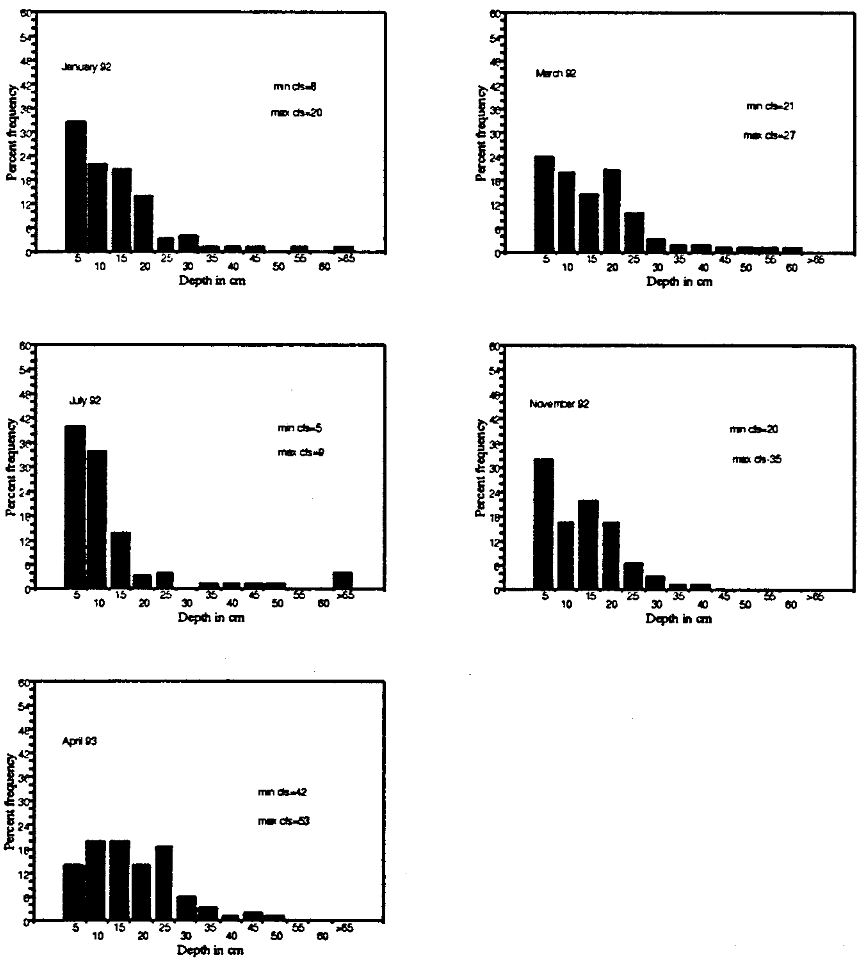


Figure 26. Velocity distributions (availability) in the Paria River (systematic transects 0.5 to 10 kilometers).

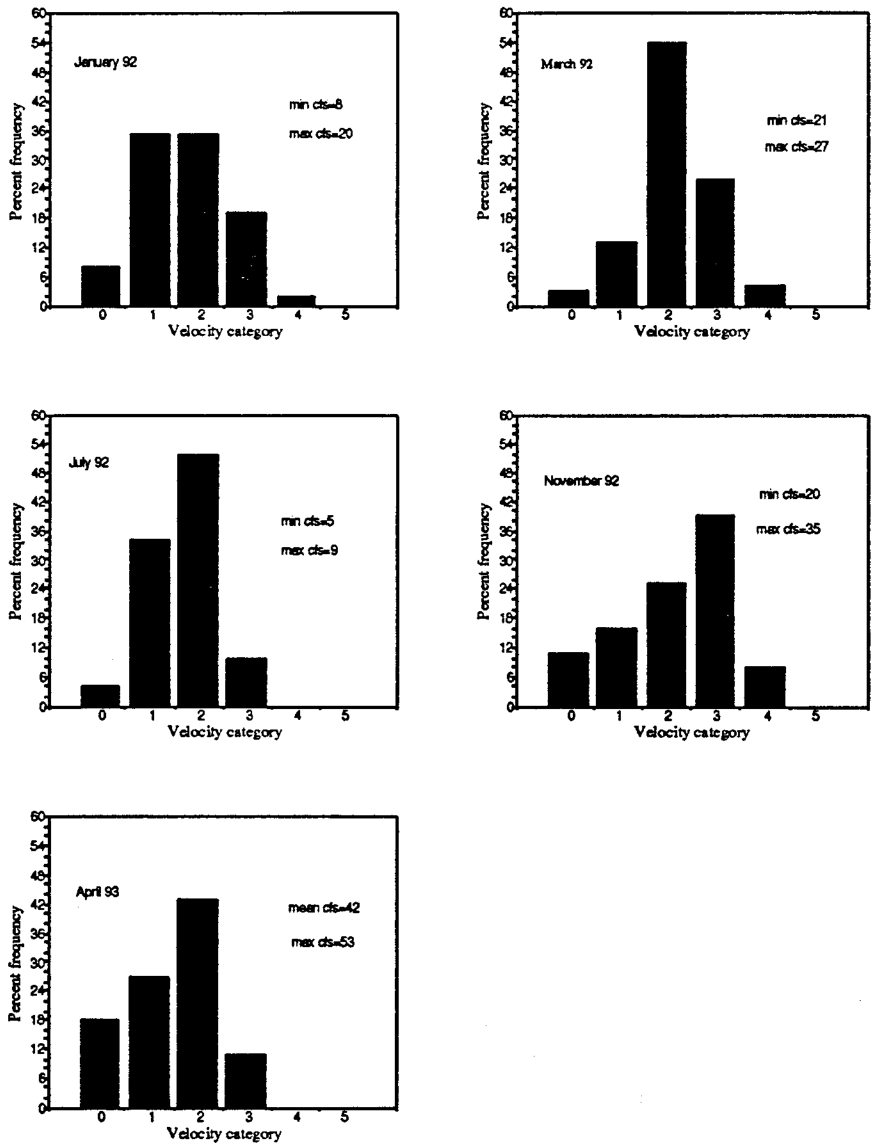


Figure 27. Substrate distributions (availability) in the Paria River (systematic transects 0.5 to 10 kilometers).

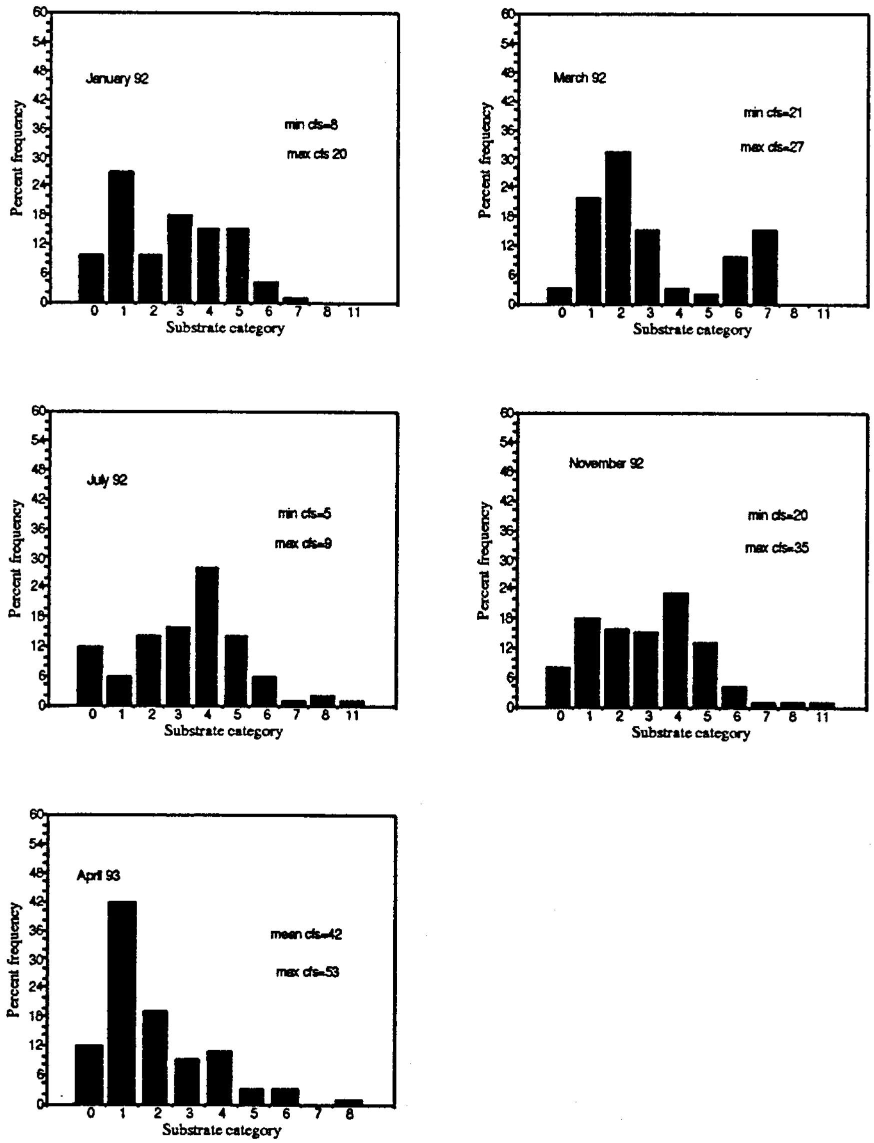


Figure 28. Mean daily flows (cubic feet per second) of the Paria River in 1992.

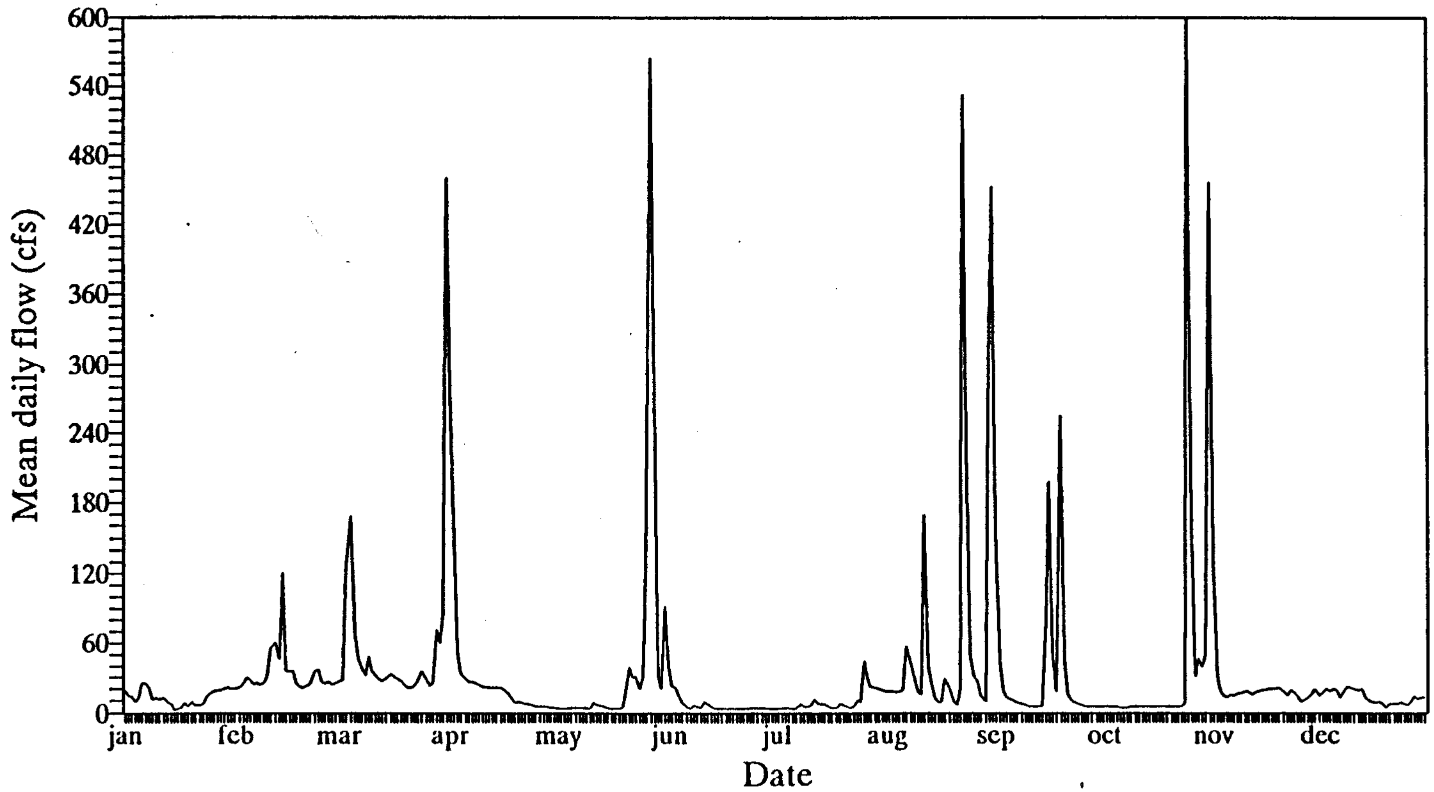
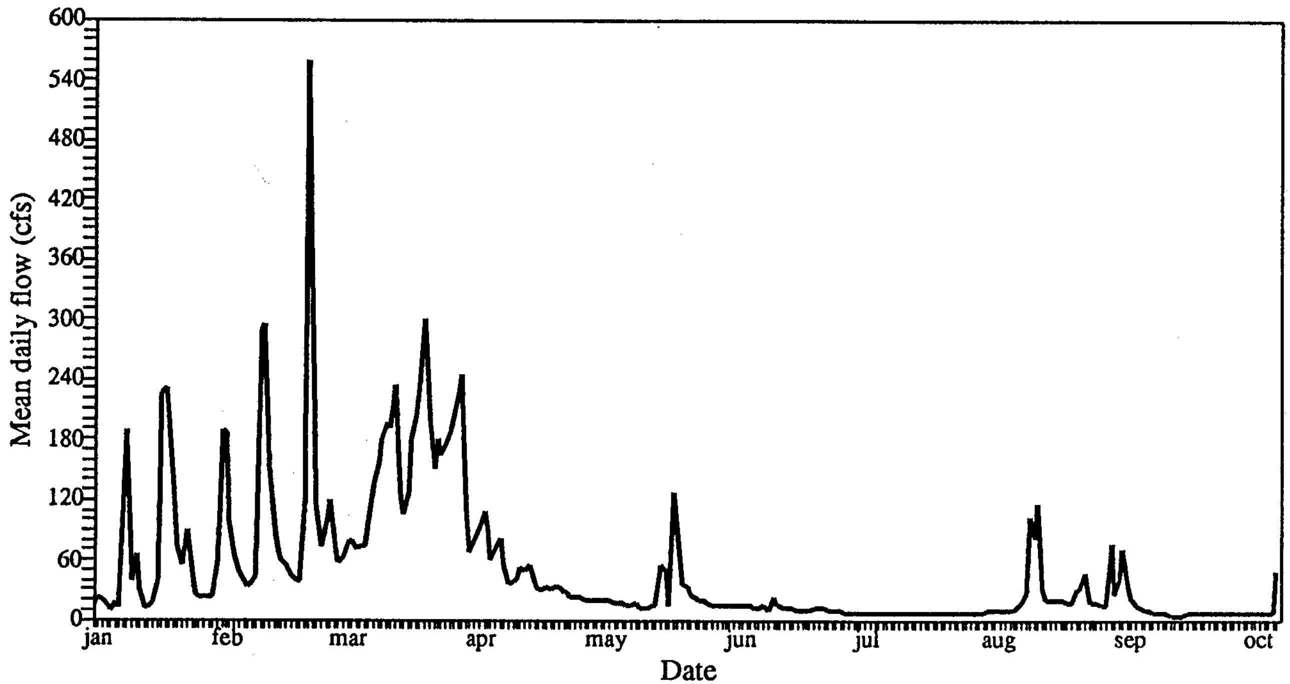


Figure 29. Mean daily flows (cubic feet per second) of the Paria River in 1993.



minutes. Even during periods of moderate to low flows and apparent stability, flows often varied 2 to 3 fold during a day.

DISCUSSION

Spawning

The Paria River is utilized by spawning flannelmouth each spring. The timing of the spawning run varies but during this study fish ascended the stream beginning in February. Spawning occurred from the middle of March through early April. Spawning occurred during the same time of year in both 1981 and 1991 (raw data AGFD, Baucom 1981). Water temperatures in the Paria River were extremely variable over a 24 hour period but the temperatures during spawning were similar to those reported during spawning in the upper basin. Ripe females were not found in the Paria River until minimum stream temperatures warmed to 6°C. Peak spawning occurred on days when temperatures reached a minimum of 7°C and a maximum of 19°C. McAda (1977) reported flannelmouth sucker spawning in the upper basin in May and June when water temperatures ranged from 6 to 15°C. Tyus and Karp (1990) found ripe flannelmouth and ripe razorback suckers at temperatures between 9 and 17°C in the Green and Yampa rivers.

Flannelmouth appeared to spawn in pairs, 1 female to 1 male, but catch data indicated a nearly 2 to 1 male to female ratio in upstream spawning sites. Otis (unpublished data) observed multiple males associated with a spawning female in Bright Angel Creek. Geen et al. (1966) also noted multiple males accompanying a spawning female longnose sucker, *Catostomus catostomus*.

Flannelmouth were observed spawning in shallow water (< 25 cm) with their dorsal fins or even backs protruding from the water. Fish appeared to be spawning against or near the shallow shoreline of the site. Otis (unpublished data) found flannelmouth spawning in deeper water (22 to 38 cm) in Bright Angel Creek and the data of several agencies (catches of ripe adults and larvae) suggest that spawning occurs in deeper turbid waters in the LCR. Carlson et al. (1979) found flannelmouth spawning in 0.5 to 1.5 m of water in the White River in Colorado. White sucker have been reported to spawn at depths < 30 cm in British Columbia. The congeneric large scale sucker, *Catostomus machrocheilus*, spawned at depths of 60 to 82 cm (Nelson 1968).

The Paria River was extremely turbid during both years when spawning was observed and visibility into the water column was virtually zero. Low visibility precluded any observations of spawning at depths > 25 cm. However, few areas with depths > 25 cm were present in the study area. An ANOVA of mean depth for 20 habitat availability transects located from 0.5 to 10.0 km from the mouth showed significant differences in depth only at the 2.0-km transect. This transect was a few meters above the USGS gauge station, and had a depth of > 0.5 m during 1992. Such deep pockets occur where the river channel is constricted by bedrock on one side and the substrate of fine sand or silt is alternately scoured and filled in. These sites were filled with sand during 1993. The fact that deeper sites often have bottoms of sand and occur in very limited quantities makes it unlikely that much spawning occurs in water deeper than 25 cm in the Paria River.

Both substrate size and velocity appear to be important in the selection of spawning sites by flannelmouth sucker. Substrate in categories 3 and 4, (mean size 16.6 mm and 23 mm at two sites) were utilized in greater proportion then their availability at both spawning sites. The spawning fish at 9.2 km used substrate sizes similar to those at the 2.8 and 6.0 km spawning sites. There are no previously published measurements of substrate sizes used in flannelmouth spawning areas but Otis (unpublished data) found flannelmouth spawning over substrates averaging about 49 mm in Bright Angel Creek.

Velocities at the spawning sites ranged from 0.3 m/s to 0.6 m/s, 3.5 cm off the bottom. There were differences ($p = 0.005$) between bottom velocities at the spawning sites and those measured at the 20 habitat availability transects.

Otis (unpublished data) found flannelmouth spawning in mean column velocities of 0.57 m/s in Bright Angel Creek. Geen (1966) found longnose sucker spawning in velocities of 0.3 to 0.45 m/s over gravel of 5 to 100 mm in diameter. Significance between mean column velocity at the spawning sites compared to availability was borderline ($p = 0.059$). The same comparisons using velocity categories showed no significant differences ($p = 0.36$). The failure of categorical data to reveal differences may demonstrate that the categories were broader than the differences detected by the fish. For example, velocity category 3 ranged from 0.30 m/s to 0.70 m/s. This range encompassed nearly 80% of the available velocities. Bottom velocities would seem to be a more appropriate measure of spawning habitat than mean column velocity; especially for a bottom spawning fish.

Adult flannelmouth were caught in all stream reaches (1-4) during the spawning run. However, no fish were observed spawning in reach 1. There was a higher CPUE in reach 3 than in other reaches across systematically chosen sites. However, there was no difference in CPUE between reaches when the data from all sites were considered (Table 9 and 10). Spawning activity was clustered. During the peak spawning period (March 28 to April 9) when CPUE was as high as 30 fish /100 m^2, 74% of the seine hauls yielded 0 or 1 fish.

No spawning was observed in the confluence area. Carothers and Minckley (1981) stated that the spawning of flannelmouth sucker in the Paria River is adversely effected by fluctuating water levels of the Colorado River which exposes the spawning area to desiccation. However, during this study, substrate in the confluence area inside the 0.0 transect was 100% fine sand or silt. Such substrate provides an unlikely place for flannelmouth to attempt to spawn. The Paria is perennially sediment loaded and the confluence area is an area of sediment deposition. Therefore, it is unlikely this area is currently utilized for flannelmouth spawning. However, under historical spring flow conditions it may have been used for spawning. Under current conditions, access to the Paria should not be a problem for flannelmouth even at low flows of the Colorado River; there are no potential low flow barriers at the mouth.

Variations in flow may affect the timing and success of flannelmouth spawning in the Paria River. During 1992, spawning fish exited quickly before an incoming cold front and subsequent large flash flood (Figure 6). In 1993, spawning was more prolonged and took place during relatively stable flows.

In the Paria River, flannelmouth suckers may attempt to minimize their vulnerability to unpredictable stream discharges and heavy sediment loads by beginning to spawn during falling flows and cease spawning and leave the river on rising flows. In 1993, flannelmouth spawning peaked during receding flows (Figure 7). In the Green and Yampa rivers, spawning of native cyprinids and catostomids has been associated with receding flows and rising temperatures (Tyus and Carp 1989). However, several authors (Raney and Webster 1942, Harris 1962, Baily 1969) have stated that stream discharge was not important in the timing of catostomid spawning migrations. Nelson (1968) cited the work of Geen et al. (1966) who stated "....changes [in migration timing] were apparently not related to creek discharge since the level declined over most of the period of migration each year". However, the figures displayed in Geen (1966) clearly show that spawning took place during receding flows during both years. Geen (1966) reported that minimum stream temperature was a more reliable predictor than flow, of the initiation of the spawning migrations of both longnose and white suckers. However, Barton (1980) found that temperature x discharge was a better predictor of spawning than either variable alone.

Spring flows vary from year to year in the Paria River and the occurrence of flash floods at first appears not to be predictable. However, Graf et al. (1991) examined the climatology and flow patterns of the Paria drainage from

Figure 30. Mean daily discharge and sediment loads in the Paria River from 1923 to 1986 (Graf et al. 1991).

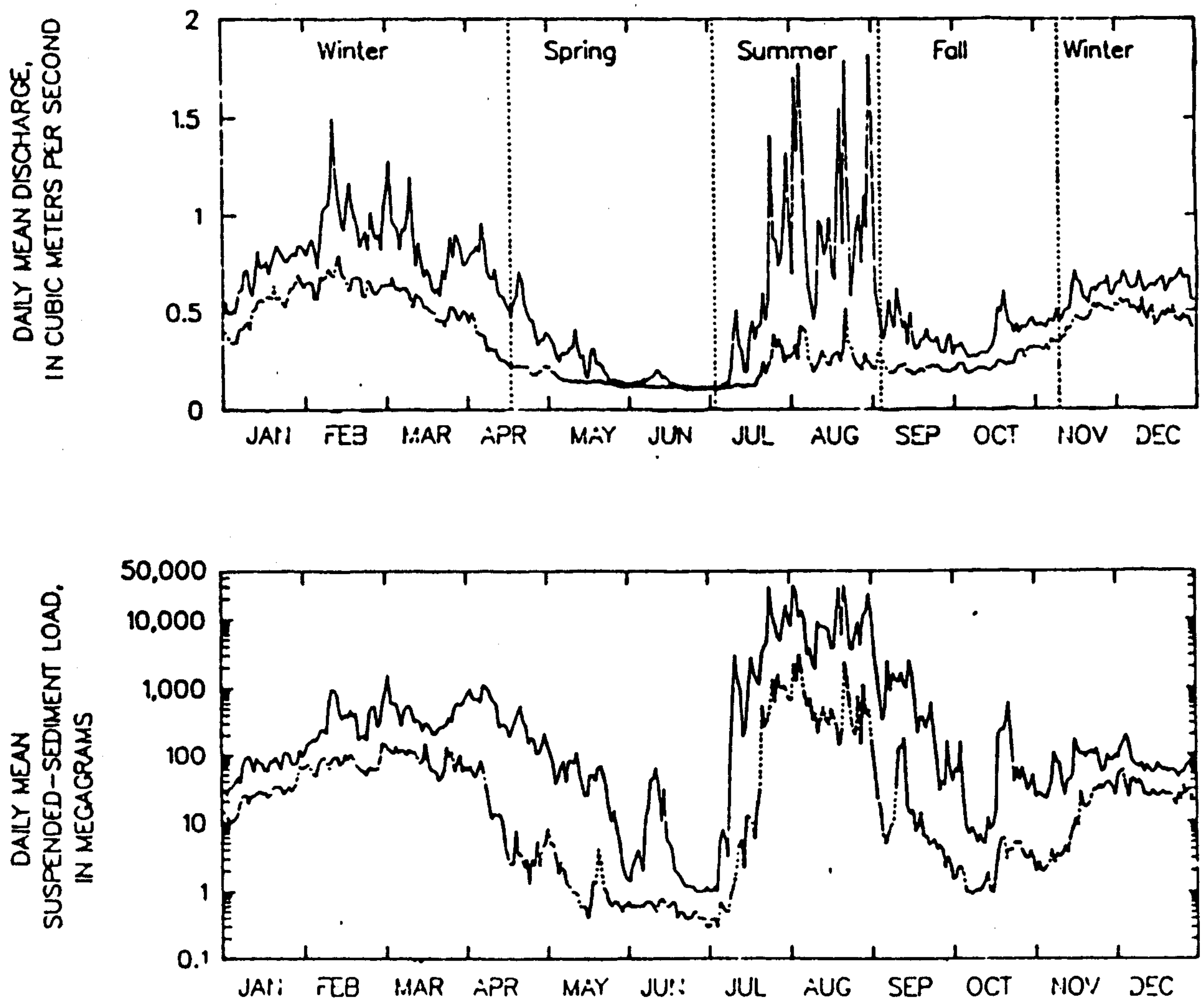
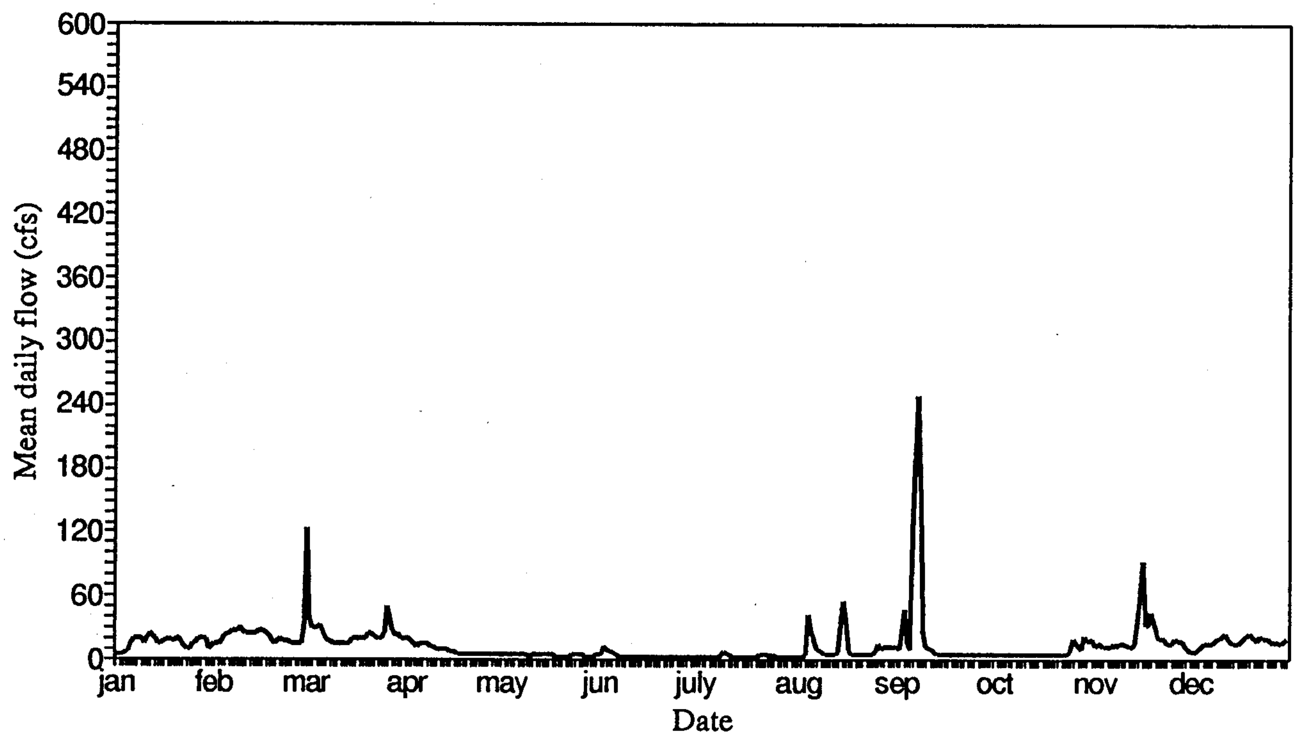


Figure 31. Mean daily flows (cubic feet per second) of the Paria River in 1991.



in 1993. Hence, the highest catches of YOY flannelmouth were made in the year with the most stable flows. Strange et al. (1992) found recruitment success of the tahoe sucker, *Catostomus tahoensis*, strongly tied to discharge. It is possible that high flows and floods are detrimental to successful incubation, hatching or larval survival of flannelmouth suckers in the Paria River.

YOY flannelmouth were not reared in the Paria River in 1991 through 1993 beyond June (AGFD raw data and my own data). Movement out of the Paria is a sensible strategy when faced with the high likelihood of flash flooding in summer. YOY fish may have adapted to unpredictable stream discharges by leaving the system and seeking backwater habitats in the mainstem before the beginning of summer when flooding would invariably occur. Thus, flannelmouth may spawn in the Paria when conditions for survival are optimal for early life history stages; the spring, when the river is least susceptible to flash floods, high sediment loads and high temperatures. I recorded a maximum temperature of 34°C in 1993 and temperatures consistently exceeded 30°C by the end of May.

Numerous studies have addressed the response of both native and introduced stream fishes to flooding events (John 1964, Harrell 1978, Fisher et al. 1982, Matthews 1986, Minckley and Meffe 1987, Fausch and Bramblett 1991). Native fishes in flood prone systems have been shown to persist through flooding events or, quickly re-establish themselves afterwards. However, all of these studies examine responses of resident stream fishes to floods. Flannelmouth are not resident in the Paria and only utilize it as a spawning ground. The adaptive response to flooding in this case may be avoidance (achieved by the timing of the spawning) rather than persistence or resilience.

While the long term persistence of native fishes subject to flooding events is not questioned, loss of individual year classes can certainly occur. YOY fishes can be especially vulnerable (Harvey 1987). Pearsons et al. (1992) have recently illuminated the importance of habitat complexity in buffering the impacts of flooding on resident fish assemblages and spawning success of cyprinids and catostomids. The lower Paria River is relatively homogenous with a low gradient (< 1%), few deep pools, highly erosive banks, and almost no permanent or stable structure. If structural complexity is an important component of a system's ability to buffer the impacts of floods, then YOY fish and especially larvae or eggs may be particularly vulnerable to these events in the Paria River. However, considering the long life span of flannelmouth sucker, recruitment need not occur every year to sustain a population. Hence, failed recruitment, in any given year, may be of little importance to the long term persistence of the species.

Confluence area

Adult flannelmouth were caught at the confluence of the Paria and Colorado rivers throughout the year (Table 1). I believe catches were more consistent in 1993 than 1992 for a number of reasons. First, the area sampled in 1993 included the deeper water just beyond the mouth of the Paria River proper. This area contained a school of flannelmouth throughout much of the year. These fish were susceptible to seining efforts depending on flow conditions. Second, sampling efforts were intensified during evening hours in 1993. Third, in 1993 I used a 40-ft large mesh seine. The larger mesh allowed me to cover a large area quickly and increase the probability that fish would become entangled in the mesh.

Other data suggest that flannelmouth are present throughout the year in the area at, or just beyond, the 0.0 transect at the mouth of the Paria. At times when fish could not be caught, they were often seen in the deeper water of the Colorado River. A daytime snorkeling effort in late summer of 1992, revealed a large school of flannelmouth in the lower half of the water column over course substrate (Category 5-7). During the spring of 1993 an electro-fishing effort by Bio/West in the vicinity of the Paria River mouth showed that flannelmouth occurred across the entire Colorado River channel in front of the Paria. Therefore flannelmouth do not restrict their use to the shallow or slack water of the confluence area.

The data appear to show that the use of the Paria channel during daylight hours occurred only when backwater habitat was created by high Colorado River flows. However, there are several factors complicating this assessment. The ability of the Colorado River to inundate the Paria River and create a backwater was dependant on both the flow of the Paria and the degree of buildup of sediment from the most recent flash floods. For example, during high summer flows of 1993, the Colorado breached the peninsula between the two rivers and cut a new channel 80 m upstream of the confluence area. At a flow level between 11,000 and 14,000 cfs, water from the Colorado passed through this new channel and inundated the lower Paria with swift flowing cold clear water. Flannelmouth were not captured inside the 0.0 transect during these conditions. The characteristics of this inundation pattern was much different than those observed during previous months.

In addition, Paria flows exceeding 100 cfs prevented the Colorado from backing up the Paria. During these high spring flows in the Paria no flannelmouth were caught inside the 0.0 transect. Such dynamic changes probably occur every year and would make it difficult to establish any linear relationship between Colorado River flow and use of the confluence area by fish.

Daytime use of the confluence area may have been associated with feeding. During several occasions when flannelmouth were caught in daylight hours in the confluence, fish appeared to be feeding on the sediments in slack water. Caudal and/or dorsal fins protruded from the water surface as fish were burrowing headfirst into the sediments. Similar behavior has been described by Marsh (1987) for razorback sucker in a hatchery setting. The Paria, especially in summer months, is rich in algae and detritus and presumably epiphytic diatoms. Epiphytic diatoms were the predominant component of the flannelmouth's diet in both the canyon (Carothers and Minckley 1981) and the upper basin (Carlson et al. 1979).

Flannelmouth sucker appeared to shift behaviors after dark. They were more likely to be found in shallow slack water, and over fine substrates (category 1-3) at night than during the day. They also rested on the bottom and were not frightened by our presence at night. Marrin (1983) and Emory (1973) reported similar shifts in habitat and behavior for the tahoe sucker and white sucker respectively in lake environments. Maddux et al. (1987) reported higher catches during evening electro-fishing efforts for flannelmouth sucker.

Growth and Longevity

Flannelmouth sucker PIT tagged and recovered during this study did not appear to grow but growth was apparent in the recaptured fish from downstream locations. The differences in water temperatures between the Glen Canyon area (6 to 12°C) and the LCR (8 to 24C°) may account for these observed growth differences.

The small changes in total length of floy tagged fish known to be at large for several years also indicated a very slow growth rate. These data along with personal communication from other researchers in the Grand Canyon (Chuck Minckley USFWS, Rich Valdez Bio/West, Bill Persons AGFD, Paul Marsh and Mike Douglas ASU,) indicate that flannelmouth sucker are long lived fish (>20 years).

Scale aging of other catostomids has been long known to be problematic (Raney and Webster 1942, Beamish 1969, Beamish 1973, Quinn and Ross 1982) and aging by Usher et al. (1981) and McAda and Wydoski (1985), of flannelmouth sucker, using back calculations of scale or opercular radii and total length, appear to have underestimated maximum age. However, the age at maturity suggested by Carothers and Minckley (1981) and McAda and Wydoski (1985) for flannelmouth may be reliable. Catostomids have been shown to grow exponentially up to the age of maturity and subsequently show little or no growth (Quinn and Ross 1982). The exponential growth of flannelmouth that were floy tagged as sub-adults would seem to substantiate this pattern (Figure 22). Data from floy tagged fish indicate that growth after age of maturity slows to a linear rate averaging 7.3 mm/year. Tyus (1987) reported a growth rate of 2.2 mm/year for adult razorback sucker in the Green River.

If we assume this linear rate of growth (7 mm/yr) begins when a fish reaches 400 mm (4-6 years of age), and that the maximum size is 600 mm, then the maximum age obtained would be 30 years. Scoppottone (1988) aged 31 flannelmouth from the Green River and found a maximum age of 28 years. Razorback sucker have been aged up to 44 years and they displayed the same dichotomy in growth rates between mature and immature size classes (McArthy and Minckley 1987). If flannelmouth reach sexual maturity at 4-6 years old and remain reproductively viable until death, then they would have 20-25 years in which to successfully reproduce. Such a life history strategy, developed within a highly stochastic environment allows for failed year classes while still maintaining a viable population.

Population structure

The length frequency distribution of flannelmouth sucker I captured is uni-modal and gives no opportunity to discern age classes. The mean size (495 mm TL) is larger than that for other populations in the Grand Canyon or Upper Basin (MaCada and Wydoski 1985, Maddux et al. 1987, and unpublished data; AGFD, ASU, Bio/West). Such a distribution is expected if a population has many year classes with overlapping size ranges. Female flannelmouth averaged 54 mm TL more than males. There was no significant difference in wieght-length relationship between the sexes. McAda and Wydoski (1985) also found no difference in weight-length relationships between male and female flannelmouth in the upper basin. Skewed size distributions in favor of females are common for catostomids throughout North America (Raney and Webster 1942, Geen et al. 1966, Hauser 1969). Baily (1969) suggested that females live longer than males. However data associated with age validation in catostomids show that females are larger regardless of age (Quinn and Ross 1982, McArthy and Minckley 1987, Scoppettone 1988).

The sex ratio of fish above the confluence area was skewed nearly 2 to 1 in favor of males. Fish in the confluence area during the spawning run had a slightly higher ratio of females. After spawning, males dominated the confluence area. Quinn and Ross (1985) hypothesized a non-annual spawning strategy for female white suckers to explain similar skewed sex ratios.

The significant difference in total length of fish caught at the confluence compared to those caught spawning upstream was not a result of a skewed sex ratio. Females at the confluence were larger (mean = 527 mm, TL) than females taken upstream (mean = 511 mm, TL; $p < 0.001$). Males taken at the confluence were also larger (mean = 477 mm, TL) than those taken upstream (mean = 457 mm, TL; $p < 0.001$). No fish over 580 mm were caught above the confluence in the Paria. These differences in size between fish at the confluence and spawning fish are conservative estimates because all of the smaller fish moving upstream had to pass through the confluence area and hence affect the length frequency observed at the confluence. Different sub-populations of fish may be using the confluence and upstream areas.

Twenty one fish between 580 mm and 620 mm were caught at the confluence area. Several of the large (> 580 mm) fish at the confluence showed characteristics that have been previously attributed to hybridization between flannelmouth sucker and razorback sucker. These fish had scales intermediate in size between flannelmouth and razorback and a raised keel anterior to the dorsal fin (Suttkus and Clemmer 1976, Carothers and Minckley 1981, Tyus and Carp

1989, Dennis Kubly, personal communication). If these large fish were hybrids they may be reluctant to enter a small shallow tributary to spawn. Razorback sucker have not been recorded spawning in shallow tributaries (Tyus and Karp 1989, Muellar 1989).

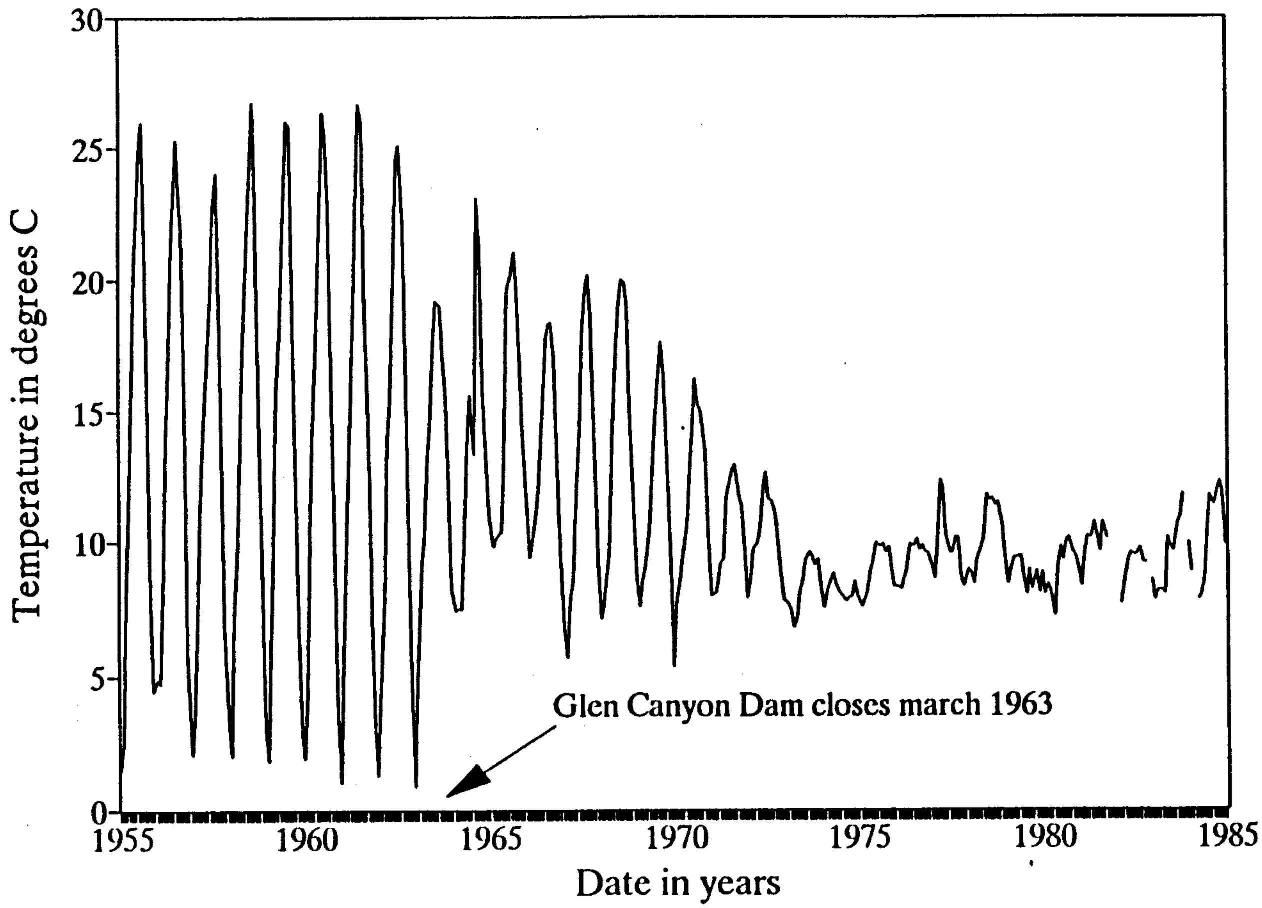
Recruitment

A significant shift in mean length (+ 53 mm) occurred between adult spawners in 1981 and 1993. Considering the slow growth rate and the similar shape of the length frequency histograms, there is a possibility that a significant portion of the 1981 population is still present in the 1993 population. This shift in mean TL could indicate that successful recruitment is not presently occurring in the Paria River/Glen Canyon Area and the present population is exceedingly old. The catch during the 1981 spawning season also contained many sub-adult fish. However, I caught no post-larval fish (< 379 mm) nor have recent AGFD or Bio/West sampling efforts produced any sub-adults between Glen Canyon Dam and the Paria River. The last record of sub-adults, (2 fish, 186 mm (TL) and 262 mm (TL) respectively), caught in the vicinity of the Paria, occurred in October 1984. However, in the spring of 1983 releases from Glen Canyon Dam approached 100,000 cfs. These flows may have created backwaters and increased turbidity to levels that were similar to historical conditions. Releases have not approached these values since 1984. A review of AGFD catch records through the 1980's reveals no other sub-adult flannelmouth caught in the area (Maddux et al. 1987, AGFD unpublished data).

Glen Canyon Dam was closed in March of 1963 and this date is often cited as the end of natural conditions in the canyon (Carothers and Minckley 1981, Carothers and Brown 1987). However, the hypolimnetic releases of the dam, that have depressed temperatures down to 8 to 9°C at the tailrace, and have been shown to be detrimental to the early life history stages of the endangered Colorado River fishes, (Marsh 1985) did not become established for nearly a decade after the closure of the dam (Figure 32). Turbidity also initially remained high because it took a number of years for the dam releases to scour the sediments and beach deposits from the Glen Canyon area above the Paria River.

Several records from AGFD creel census suggest that the river in this area still supported YOY and subadult flannelmouth into the early 70's. Sub-adult flannelmouth were taken in and near the mouth of the Paria River in the late 60's (Stone 1966, Stone 1967, Stone and Queenan 1968). Stone and Queenan (1968) caught 7 flannelmouth (178 to 292 mm) together with 85 channel catfish in the mouth of the Paria in June of 1967. Gill netting at Lee's Ferry produced

Figure 32. Mean monthly tempertaure of the Colorado River at Lee's Ferry.



261 flannelmouth (mean 396 mm TL) in 1966 and 1967 (Stone 1967).

These data also suggest that exotic fish did not eliminate juvenile flannelmouth sucker. Channel catfish, carp, and numerous centrachids were commonly caught in the 1960's and early 1970's but all are now absent in the reach between the dam and the Paria River. Additionally, the rainbow trout fishery was established through stockings in the Colorado River upstream of the Paria in 1964 (Haden 1992) but subadult flannelmouth suckers continued to be produced until the hydrographic conditions stabilized into the current patterns. Despite the strong evidence that predators, especially ictalurids, are limiting razorback sucker recruitment elsewhere in the lower basin (Marsh and Langhorst 1988, Marsh and Brooks 1989, Marsh and Minckley 1989), flannelmouth sucker appeared to have successfully recruited in the presence of substantial numbers of exotic predators including channel catfish in the Glen Canyon reach until the early 1980's. This persistence suggests that exotic species alone cannot be blamed for eliminating young flannelmouth from this section of the canyon. Historic temperatures, and the predation cover provided by turbidity, may have initially provided conditions suitable for the rearing of flannelmouth throughout the river. Currently however, these conditions may only be available in the lower reaches of the mainstem and in the LCR.

Despite the lack of captures of sub-adult flannelmouth in the past 12 years (inclusive of my data), catches consistently contain 380 to 400 mm fish. These fish are presumably entering the population at the age of maturity from downstream locations. There are several, not necessarily exclusive, explanations for this recruitment. The Paria may be serving as a spawning area but nursery areas may be located in the Colorado River downstream from the mouth of the Paria. In this explanation, fish return to the Paria only after reaching a reproductive size of 380 to 400 mm. Maddux et al. (1987) suggested a similar scenario to explain why larval and YOY flannelmouth were primarily caught in the lower reaches of the Colorado River while adult flannelmouth were most abundant in the upper reaches between Glen Canyon Dam and the Paria River. Observations of spawning migrations of other catostomids of the sub-genus *Catostomus*, document quick downstream movement of larvae or YOY fish into lakes or larger rivers for rearing (Baily 1969).

A second explanation consistent with these data is that flannelmouth dispersing from downstream populations visit the Paria when they reach the age of maturity. They then imprint on that spawning ground, and then, either remain as residents in the area or, return to the Paria each year to spawn. A mechanism for such behavior was explored by Werner (1979) who experimentally demonstrated the ability of white suckers to imprint on a previously visited spawning ground through olfactory cues. Chart and Bergerson (1992) reported that movement of flannelmouth in the White River appeared to be random and primarily occurred when fish reached the 300-400 mm size range. As flannelmouth approach maturity they may disperse in search of an adequate spawning ground.

My recapture data do not allow me to discriminate between these two hypotheses. In addition to some fish being resident at the mouth of the Paria throughout the year, there is a definite migration of spawning fish to the Paria River from downstream. Seven flannelmouth tagged in the Paria during the spawning run (mean = 501 mm, TL) were recaptured in the LCR soon after spawning. These fish apparently migrated to the Paria River from the LCR for the purpose of spawning. In addition, all but one of the recaptured fish (n = 15) originally tagged in downriver locations (mostly the LCR) were captured at the Paria between February and May and thus presumably were there to spawn. Therefore, the spawning run in the Paria River appears to be made up of some fish resident to the Glen Canyon Area and others resident to the LCR. This dual source of spawning fish is particularly interesting because the LCR appears to have a complete size class structure of flannelmouth. These data would seem to indicate that there are adequate spawning and rearing conditions in the LCR. Flannelmouth may be dispersing from the LCR because the spawning habitat is saturated, or, fish may be induced to migrate, in search of their natal grounds. In either case, it is apparent that some fish are moving from downstream and then establishing themselves in the Glen Canyon Area (by evidence of the 380 to 400 mm sized recruits) while others are maintaining a migratory behavior pattern.

Additional clues to the explanations of these movements and demographics may lie in the physical and biological gradients that have been recently established in the mainstem Colorado. It is well documented that the Colorado River in the vicinity of the Paria is presently the most productive region of the river in the canyon (Cole and Kubly 1976, Maddux et al. 1987, Carothers and Brown 1991). This productivity is based on the presence of Cladophora beds and associated benthic organisms that have developed in the clear water below Glen Canyon Dam. These abundant food resources may be inducing residency in large flannelmouths that have been spawned or reared elsewhere in the Canyon. The attraction of large flannelmouth to this area of the canyon may be a recent phenomenon. Large adult flannelmouth were conspicuously absent from the 1981 catch data (Baucom

1981); no fish were caught over 510 mm and, additionally scarce in the catch records of the 60's (Stone 1966, Stone 1967, Stone and Queenan 1968).

It is apparent that the environmental conditions in the Colorado River and their relationship to the flannelmouth sucker cannot be described simply in terms of pre and post dam scenarios. The life span of some of the flannelmouth sucker currently extant in the population, overlaps the changes brought on by the dam. Hence the population's response to these changes may still be in process. In addition, the varied reproductive strategy, in terms of migratory and non-migratory behavior, complicate any attempt to summarize the species' status.

SUMMARY

The Paria River is utilized by flannelmouth sucker on a seasonal basis for spawning. Spawning flannelmouth ascend the Paria up to at least 10 km from it's confluence with the Colorado River. Spawning occurs in shallow water < 25 cm, over clean gravel (mean size 16 and 23 mm), and at moderate flows 0.3 m/s to 0.6 m/s. The timing of the spawning event appears related to both temperature and flows. Flash flooding events may have a detrimental impact on the success of the spawn.

The spawning run in the Paria River is comprised of fish from a population in the Glen Canyon reach of the Colorado River, plus migrants from downstream locations. Migrants came primarily from the LCR (97 km downstream), but from as far downstream as Kanab Creek (229 km). The present size class structure of spawning fish in the Paria River has shifted over 50 mm from 1981 to 1993.

There is no evidence that juvenile or subadult flannelmouth have successfully reared in the Paria River/Glen Canyon Area in the last 12 years. However, adult sized fish (380 mm) enter the population each year. These fish presumably come from downstream locations. The mechanism for this recruitment is not clear but may involve dispersal from downstream populations and/or migration of individuals previously hatched in the Paria River.

Some flannelmouth utilize the mouth of the Paria River throughout the year. Use of the confluence area is erratic in the daylight but more consistent after dark.

Growth of pre-spawning sized flannelmouth appears to be logistic. Growth of sexually mature fish appears to be very slow (7 mm/year). Based on extrapolations from recaptures, longevity may approach 30 years.

APPENDIX A: PIT TAG NUMBERS OF FLANNELMOUTH SUCKER TAGGED IN THE PARIA RIVER IN 1992 AND 1993.

Table 13. PIT tag numbers of flannelmouth sucker tagged in the Paria River (Loc=km up Paria, rcp=Paria recap,rco=other recap).

TAG #	Date	Trip	TL	Wgt	Sex	Ripe	Loc	rcP	rcO
1F08140441	40893	14	499	1.05	2	1	2.8	0	0
1F084A236C	51093	16	447	0.9	1	0	0	0	0
1F09361111	60393	17	397	0.63	1	1	0	0	0
1F09362B77	40993	14	545	1.5	2	1	6	0	0
1F0936455D	40893	14	486	1.3	1	1	0	0	0
1F0936455D	51193	16	480	1.3	1	0	0	1	0
1F093647FB	40993	14	531	1.32	2	1	10	0	0
1F09365A48	40893	14	480	0.9	1	1	0	0	0
1F09365B47	40893	14	425	0.55	1	1	0	0	0
1F0937051C	51093	16	524	1.5	2	0	0	0	0
1F09372F72	41093	14	498	1.2	1	1	0	0	0
1F09375B46	40993	14	418	0.7	1	1	6	0	0
1F09376F32	40893	14	534	1.75	2	0	0	0	0
1F0937732E	40893	14	513	1.4	1	1	0	0	0
1F09377F22	51193	16	520	1.25	2	0	0	0	0
1F09381808	51093	16	458	0.9	1	0	0	0	0
1F0938257B	40993	14	462	0.9	1	1	10	0	0
1F09382779	51093	16	534	0	2	0	0	0	0
1F0938316F	40993	14	457	0.78	1	1	6	0	0
1F09383868	51093	16	530	1.55	2	0	0	0	0
1F09384060	42693	15	480	1.05	2	0	0	0	0
1F09384F57	51093	16	546	0	2	0	0	0	0
1F09385947	51093	16	537	1.5	2	0	0	0	0
1F0938613F	42693	15	487	0.93	1	0	0	0	0
1F093A011D	40993	14	441	0.73	1	1	6	0	0
1F093A1509	51093	16	540	1.4	2	0	0	0	0
1F093A4559	40893	14	474	1.1	0	0	0	0	0
1F093A5D41	51193	16	530	1.68	1	0	0	0	0
1F093A702E	40993	14	520	1.05	2	1	6	0	0
1F093A7628	62993	18	540	0	2	0	0	0	0
1F093B0518	40893	14	475	0.93	1	0	0	0	0
1F093B435A	40893	14	490	1.15	1	1	0	0	0
1F0C5C2E4B	42693	15	538	1.55	2	0	0	0	0
1F0C5C3544	51093	16	498	1.1	1	0	0	0	0
1F0C5C4138	51193	16	503	1.43	1	0	0	0	0
1F0C5D0870	40993	14	454	0.98	2	1	6	0	0
1F0C692745	40893	14	467	0.9	1	0	4	0	0
1F0C692844	40893	14	502	1.22	1	1	0	0	0
1F0C692E3E	62993	18	520	1.4	1	0	0	0	0
1F0C6E0364	62993	18	520	0	0	0	0	0	0

Table 13. *Continued.*

1F0C6E0A5D	51093	16	557	0	2	0	0	0	0
1F0C6F0264	40993	14	570	1.47	2	0	0	0	0
1F0C6F0561	51093	16	454	0.9	1	0	0	0	0
1F0C6F0F57	51093	16	443	0.95	1	0	0	0	0
1F0C6F6D79	42693	15	496	1	1	1	0	0	0
1F0C6F7C6A	40893	14	577	2.05	2	1	0	0	0
1F0C702045	51093	16	520	0	2	0	0	0	0
1F0C702441	40893	14	550	1.3	2	0	0	0	0
1F0C702A3B	40893	14	480	1.15	1	0	0	0	0
1F0C704223	51093	16	425	0.8	1	0	0	0	0
1F0C70471E	51093	16	528	0	2	0	0	0	0
1F0C704A1B	40993	14	460	1.02	1	1	6	0	0
1F0C705411	41093	14	484	1.1	1	0	0	0	0
1F0C71273D	40893	14	480	1.15	1	0	4	0	0
1F0C72144F	40993	14	498	1.05	2	1	10	0	0
1F0C72471C	40993	14	490	1.07	1	1	6	0	0
1F0C734B17	40993	14	443	0.78	1	1	6	0	0
1F0C74075A	51193	16	492	0.83	2	0	0	0	0
1F0C740A57	40893	14	527	1.4	2	0	0	0	0
1F0C744819	51193	16	492	1.23	1	0	0	0	0
1F0C745011	40993	14	487	1.12	1	1	6	0	0
1F0C745E03	40893	14	525	1.3	2	0	2.8	0	0
1F0C751D43	40893	14	585	1.95	2	0	0	0	0
1F0C754818	40893	14	580	2	2	0	0	0	0
1F0C754F11	51093	16	559	1.8	2	0	0	0	0
1F0C756878	40993	14	484	1.02	1	0	6	0	0
1F0C75746C	60393	17	612	2.5	2	0	0	0	0
1F0C76134C	60393	17	456	0.9	1	1	0	0	0
1F0C762D32	40893	14	478	1	1	1	2.8	0	0
1F0C763F20	51093	16	525	1.3	2	0	0	0	0
1F0C76401F	62993	18	556	0	2	0	0	0	0
1F0C764F10	40893	14	562	1.7	2	0	0	0	0
1F0C76550A	41093	14	505	1.07	1	1	0	0	0
1F0C77035B	40993	14	466	0.9	1	0	6	0	0
1F0C77045A	62993	18	494	0	1	0	0	0	0
1F0C775707	40893	14	474	1.02	1	1	0	0	0
1F0C776777	42593	15	480	1.12	2	0	0	0	0
1F0C780756	41093	14	490	0.95	2	1	0	0	0
1F0C780954	51093	16	551	0	2	0	0	0	0
1F0C78637A	42693	15	494	1.05	2	1	0	0	0
1F0C787A63	51193	16	492	1.18	2	0	0	0	0

Table 13. *Continued.*

1F0C787E5F	41093	14	510	1.5	2	0	0	0	0
1F0C790C50	41093	14	543	1.62	2	0	0	0	0
1F0C793626	40893	14	580	1.95	2	0	0	0	0
1F0C794A12	41093	14	470	0.9	1	0	0	0	0
1F0C79510B	40893	14	470	1.05	1	0	0	0	0
1F0C795804	40893	14	467	1.07	1	1	0	0	0
1F0C79617B	62993	18	533	0	2	0	0	0	0
1F0C796379	40893	14	513	1.22	2	0	0	0	0
1F0C796973	51093	16	536	1.6	2	0	0	0	0
1F0C7A0358	42693	15	480	1.42	1	0	0	0	0
1F0C7A1249	42693	15	438	1.77	2	0	0	0	0
1F0C7A2833	51193	16	573	1.85	2	0	0	0	0
1F0C7A5803	40893	14	476	0.95	1	1	0	0	0
1F0C7A5902	51093	16	499	0	2	0	0	0	0
1F0C7A607B	40993	14	490	1	1	1	6	0	0
1F0C7A6873	41093	14	466	1	1	0	0	0	0
1F0C7B1545	51093	16	525	0	2	0	0	0	0
1F0C7B1743	42693	15	493	1.05	2	0	0	0	0
1F0C7B1941	42693	15	461	1.1	1	0	0	0	0
1F0C7B2B2F	42693	15	447	0.83	1	0	0	0	0
1F0C7B3A20	40893	14	553	1.55	2	1	0	0	0
1F0C7B4911	51193	16	450	0.95	1	0	0	0	0
1F0C7B4F0B	40993	14	462	0.83	1	1	6	0	0
1F0C7C2138	40993	14	480	0.93	1	1	6	0	0
1F0C7C3C1D	40893	14	522	1.5	2	0	0	0	0
1F0C7C5009	42693	15	471	1.15	1	0	0	0	0
1F0C7D0D4B	40893	14	510	1.3	0	0	0	0	0
1F0C7D1444	40993	14	485	0.98	1	1	6	0	0
1F0C7D5206	40893	14	456	0.9	1	1	0	0	0
1F0C7D795E	51093	16	547	1.5	2	0	0	0	0
1F0C7E1047	51193	16	525	1.4	2	0	0	0	0
1F0C7E1B3C	40893	14	528	1.5	2	0	0	0	0
1F0C7E490E	51093	16	529	1.3	2	0	0	0	0
1F0C7E5502	51093	16	485	1.17	1	0	0	0	0
1F0C7E7760	60393	17	507	1.25	2	0	0	0	0
1F0C7F0551	40893	14	507	1.3	2	0	0	0	0
1F0E5A6811	51093	16	490	1.2	2	0	0	0	0
1F0E5A7C7D	51093	16	552	1.32	2	0	0	0	0
1F0F5E4C28	51093	16	574	1.77	2	0	0	0	0
1F0F5E7400	51093	16	473	0.95	1	0	0	0	0
1F0F5E7D77	40893	14	530	1.7	1	1	0	0	0

Table 13. *Continued.*

1F0F5E7F75	41093	14	483	1.15	1	0	0	0	0
1F0F5F066D	40993	14	518	1.2	2	1	10	0	0
1F0F5F165D	51093	16	503	1.32	2	0	0	1	0
1F0F5F165D	42693	15	495	1.22	2	0	0	0	0
1F0F5F3340	51193	16	551	1.65	2	0	0	0	0
1F0F5F3C37	41093	14	531	1.47	2	0	0	0	0
1F0F5F4E25	51093	16	547	1.65	2	0	0	0	0
1F0F60234F	40893	14	561	1.55	2	0	0	0	0
1F0F605D15	40893	14	535	1.7	1	1	0	0	0
1F0F60737F	51093	16	478	0	2	0	0	0	0
1F0F61036E	42693	15	532	1.4	2	0	0	0	0
1F0F613A37	51093	16	448	0	1	0	0	0	0
1F0F613E33	40993	14	480	1.1	2	1	6	0	0
1F0F61432E	40993	14	533	1.5	2	0	4.8	0	0
1F0F614A27	40893	14	550	1.62	2	0	0	0	0
1F0F620A66	42593	15	475	1.02	1	0	0	0	0
1F0F623838	42693	15	485	1.32	1	0	0	0	0
1F0F623D33	41093	14	535	1.35	2	1	0	0	0
1F0F625818	40893	14	473	1.1	1	1	0	0	0
1F0F626010	51193	16	456	0.9	1	0	0	0	0
1F0F626B05	42693	15	535	1.62	2	0	0	0	0
1F0F62727E	60393	17	528	1.2	2	0	0	1	0
1F0F62727E	53093	17	525	1.2	2	0	0	0	0
1F0F63135C	40893	14	586	1.85	2	0	0	0	0
1F0F63214E	42693	15	490	1.1	2	0	0	0	0
1F0F632D42	42693	15	445	0.9	1	0	0	0	0
1F0F64046A	42693	15	472	1	1	0	0	0	0
1F0F640D61	40993	14	425	0.73	1	1	6	0	0
1F0F641B53	41093	14	520	1.15	2	0	0	0	0
1F0F644A24	40893	14	493	1.17	1	1	0	0	0
1F0F644F1F	42693	15	510	1.25	2	0	0	0	0
1F0F646509	40893	14	545	1.65	2	0	0	0	0
1F0F65105D	41093	14	543	1.4	2	0	0	0	0
1F0F651D50	51093	16	503	0	2	0	0	0	0
1F0F65224B	41093	14	480	1.22	1	0	0	0	0
1F0F656904	40893	14	543	0.87	1	1	0	0	0
1F0F65717C	51093	16	433	0.95	1	0	0	0	0
1F0F66026A	51093	16	508	0	2	0	0	0	0
1F0F661359	51093	16	479	1.02	1	0	0	0	0
1F0F662448	42693	15	510	1.3	2	0	0	0	0
1F0F663A32	40893	14	478	1.25	1	1	0	0	0

Table 13. *Continued.*

1F0F664B21	40893	14	468	0.85	1	0	0	0	0
1F0F66501C	51093	16	510	0	2	0	0	0	0
1F0F665913	40893	14	510	1.22	2	1	0	0	0
1F0F665B11	62993	18	431	0.65	1	0	0	0	0
1F0F670C5F	62993	18	547	0	0	0	0	0	0
1F0F670D5E	51093	16	460	0.88	1	0	0	0	0
1F0F671C4F	40893	14	595	2.15	2	0	0	0	0
1F0F673239	40893	14	478	1	1	1	0	0	0
1F0F67402B	40993	14	463	0.85	1	1	6	0	0
1F0F675417	51093	16	518	0	2	0	0	0	0
1F0F675E0D	40993	14	473	1.02	1	1	6	0	0
1F0F677279	51093	16	515	1.27	2	0	0	0	0
1F0F677D6E	51093	16	500	1.2	1	0	0	0	0
1F0F681D4D	42693	15	490	1.25	2	0	0	0	0
1F0F683B2F	40893	14	570	2.05	2	0	0	0	0
1F0F685317	42693	15	475	1.07	1	0	0	0	0
1F0F685317	40893	14	475	1.05	1	1	0	0	0
1F0F691950	51193	16	512	1.35	2	0	0	0	0
1F0F692A3F	41093	14	504	1.1	2	0	0	0	0
1F0F693138	40893	14	546	1.55	2	0	0	0	0
1F0F693831	40893	14	547	1.6	2	0	0	0	0
1F0F6A2A3E	51093	16	488	1.2	1	0	0	0	0
1F0F6A5117	51093	16	540	1.57	2	0	0	0	0
1F0F6A6C7C	51093	16	440	1.05	1	0	0	0	0
1F0F6B2146	51093	16	470	0.9	1	0	0	0	0
1F0F6B2E39	40993	14	463	1	1	1	6	0	0
1F0F6B491E	40893	14	500	1.35	1	0	0	0	0
1F0F6B5413	40893	14	442	0.85	2	0	4	0	0
1F0F6B5C0B	42693	15	476	1.05	1	0	0	0	0
1F0F6B5D0A	40893	14	485	0.95	1	1	0	0	0
1F0F6C0E58	42693	15	488	1.3	1	0	0	0	0
1F0F6C4C1A	51093	16	545	0	2	0	0	0	0
1F0F6C5412	40993	14	550	1.4	2	1	6	0	0
1F0F6C6F77	42693	15	440	0.82	1	0	0	0	0
1F0F6D1550	41093	14	490	1.15	1	1	0	0	0
1F0F6D184D	42693	15	495	1.12	1	0	0	0	0
1F0F6D1D48	40893	14	545	1.55	2	0	0	0	0
1F0F6D2D38	42693	15	515	1.5	2	0	0	0	0
1F0F6D3B2A	40993	14	461	0.85	1	1	6	0	0
1F0F6D4124	41093	14	556	1.97	2	0	0	0	0
1F0F6D4520	41093	14	534	1.57	2	0	0	0	0

Table 13. *Continued.*

1F0F6D461F	40893	14	552	1.95	2	0	0	0	0
1F0F6D6203	51093	16	470	1	1	0	0	0	0
1F0F6D7273	42693	15	477	0.9	1	1	0	0	0
1F0F6E2143	40993	14	453	0.88	1	1	6	0	0
1F0F6E362E	51093	16	490	1.07	2	0	0	0	0
1F0F6E6202	40893	14	452	1.05	1	1	2.8	0	0
1F0F6E687C	40893	14	536	1.7	2	0	0	0	0
1F0F6E6A7A	40893	14	462	0.83	1	0	0	0	0
1F0F6E7E66	40993	14	435	0.73	1	1	6	0	0
1F0F6F095A	51093	16	548	1.5	2	0	0	0	0
1F0F6F471C	51193	16	558	1.6	2	0	0	0	0
1F0F6F491A	40893	14	500	1.35	2	0	0	0	0
1F0F6F4E15	40993	14	479	0.98	2	1	6	0	0
1F0F6F667D	42693	15	575	1.9	2	0	0	0	0
1F0F70055D	40893	14	505	1.15	2	0	0	0	0
1F0F70055D	51093	16	512	1.47	2	0	0	1	0
1F0F70243E	40893	14	493	1.2	1	1	0	0	0
1F0F703032	62993	18	487	1.15	1	0	0	1	0
1F0F703032	51093	16	488	1.22	1	0	0	0	0
1F0F704220	40893	14	560	1.7	2	0	0	0	0
1F0F705909	51093	16	552	1.67	2	0	0	0	0
1F0F706C76	60393	17	485	1.1	1	1	0	0	0
1F0F72154B	42593	15	442	0.9	2	0	0	0	0
1F0F72253B	40893	14	517	1.1	2	1	0	0	0
1F0F737D62	42693	15	538	1.75	2	0	0	0	0
1F0F74124C	40993	14	443	0.7	1	1	6	0	0
1F0F741648	40993	14	460	0.83	1	1	6	0	0
1F0F75411C	40893	14	487	1.2	1	1	0	0	0
1F0F754E0F	40893	14	460	0.81	1	1	2.8	0	0
1F0F756677	40993	14	427	0.65	1	1	6	0	0
1F0F757A63	51093	16	546	1.55	1	0	0	0	0
1F0F76015B	51093	16	422	0.77	2	0	0	0	0
1F0F760A5?	40893	14	549	1.85	2	0	0	0	0
1F0F764E0E	40893	14	590	2.15	2	0	0	0	0
1F0F766F6D	40893	14	545	1.7	2	0	0	0	0
1F0F767C60	40893	14	540	1.6	2	1	0	0	0
1F0F770A51	42693	15	553	1.6	2	0	0	0	0
1F0F771C3F	60393	17	493	1.15	2	0	0	0	0
1F0F773625	40993	14	496	1.07	2	1	6	0	0
1F0F77401B	42693	15	538	1.55	2	0	0	0	0
1F0F776E6D	51093	16	438	0.83	1	0	0	0	0

Table 13. *Continued.*

1F0F777269	51093	16	560	0	2	0	0	0	0
1F0F782C2E	40993	14	452	0.83	1	1	6	0	0
1F0F783129	40993	14	480	0.93	1	1	6	0	0
1F0F787169	51093	16	468	0	1	0	0	0	0
1F0F787C5E	62993	18	496	0	1	0	0	0	0
1F0F790C4D	40993	14	430	0.78	1	1	6	0	0
1F0F791940	40993	14	461	0.9	1	1	6	0	0
1F0F797366	40893	14	560	1.75	2	1	0	0	0
1F0F7A3F19	51093	16	525	1.3	2	0	0	0	0
1F0F7A4A0E	42693	15	535	1.5	2	0	0	0	0
1F0F7A6D6B	40893	14	535	1.42	2	0	0	0	0
1F0F7A6F69	62993	18	487	0	1	0	0	0	0
1F0F7B1A3D	51093	16	465	0	1	0	0	0	0
1F0F7B1D3A	51093	16	560	1.7	2	0	0	0	0
1F0F7B3522	42693	15	490	1.12	2	0	0	0	0
1F0F7B5E79	51093	16	512	1.45	2	0	0	0	0
1F0F7C0353	41093	14	551	1.72	2	0	0	0	0
1F0F7C074F	51093	16	518	1.4	2	0	0	0	0
1F0F7C084E	60393	17	541	1.8	2	0	0	0	0
1F0F7C0D49	53093	17	590	1.9	2	0	0	0	0
1F0F7C1343	40893	14	563	1.57	2	0	0	0	0
1F0F7C1640	51193	16	576	1.98	2	0	0	0	0
1F0F7C193D	51093	16	482	0	2	0	0	0	0
1F0F7C292D	51093	16	509	1.07	1	0	0	0	0
1F0F7C3224	40893	14	477	1.12	1	1	0	0	0
1F0F7C577F	51093	16	477	1.07	1	0	0	0	0
1F0F7C795D	40893	14	445	0.88	2	0	0	0	0
1F0F7C7E58	40893	14	440	0.85	1	1	0	0	0
1F0F7D074E	40893	14	560	1.6	2	1	0	0	0
1F0F7D094C	60393	17	490	1.3	1	1	0	0	0
1F0F7D0B4A	51193	16	500	1.15	1	0	0	1	0
1F0F7D0B4A	51093	16	495	1.5	2	0	0	0	0
1F0F7D193C	42693	15	486	1.15	1	0	0	0	0
1F0F7D3025	40893	14	452	0.85	1	1	2.1	0	0
1F0F7D381D	51093	16	507	1.4	1	0	0	0	0
1F0F7E0D47	51093	16	575	1.8	2	0	0	0	0
1F0F7E4F05	40893	14	532	1.57	2	0	0	0	0
1F0F7E587C	40893	14	542	1.55	2	1	0	0	0
1FOC73372B	60393	17	485	1.05	2	0	0	0	0
1F07634E29	62993	18	505	1.4	2	0	0.08	0	0
1F08716F79	62993	18	511	0	2	0	0.08	0	0

Table 13. *Continued.*

1F09371A07	81693	20	463	0.9	1	0	0.08	0	0
1F09372100	70893	19	562	2	2	0	0.08	0	0
1F0937554C	81793	20	481	1.05	1	0	0	0	0
1F0938316F	81893	20	465	1	1	0	0	1	0
1F0939001F	70893	19	460	0.95	1	1	0.08	0	0
1F0939514E	81693	20	518	1.2	1	0	0.08	0	0
1F093A5846	62993	18	550	0	2	0	0.08	0	0
1F0A122421	70893	19	492	1.15	1	0	0.08	0	0
1F0C500276	62993	18	538	1.45	2	0	0.08	0	0
1F0C5C3742	81893	20	486	1.33	1	0	0	0	0
1F0C5C3A3F	81893	20	521	1.3	1	0	0	0	0
1F0C692E3E	62993	18	520	1.4	1	0	0	0	0
1F0C6E0265	70893	19	555	1.83	2	0	0	0	0
1F0C6E392E	81793	20	505	1.23	1	0	0	0	0
1F0C6F5412	81693	20	495	1.13	1	0	0.08	0	1
1F0C6F7472	81793	20	479	1.15	1	0	0	0	0
1F0C70580D	70893	19	550	1.95	2	0	0.08	0	0
1F0C71283C	81793	20	486	1.08	1	0	0	0	0
1F0C733E24	81893	20	525	1.43	2	0	0	0	0
1F0C735005	62993	18	527	1.33	2	0	0.08	0	0
1F0C740B56	70893	19	491	1.08	1	0	0.08	0	0
1F0C740E53	81793	20	535	1.35	2	0	0	0	0
1F0C75015F	60393	17	450	0.88	1	0	0	0	0
1F0C75213F	81793	20	520	1.45	1	0	0	0	0
1F0C760C53	81793	20	529	1.48	2	0	0	0	0
1F0C763629	70893	19	405	0.58	1	0	0.08	0	0
1F0C765200	62993	18	460	0	1	0	0.08	0	0
1F0C775608	81893	20	537	1.3	2	0	0	0	0
1F0C776E70	81693	20	433	0.9	1	0	0.08	0	0
1F0C777666	62993	18	501	1.23	2	0	0.08	0	0
1F0C782637	81693	20	486	1.43	1	0	0.08	0	0
1F0C79114B	62993	18	525	0	1	0	0.08	0	0
1F0C79114B	81893	20	524	1.25	1	0	0	0	0
1F0C793F1D	81693	20	470	0.98	1	0	0	0	0
1F0C796478	81693	20	465	0.8	1	0	0.08	0	0
1F0C796C70	81693	20	403	0.63	1	0	0.08	0	0
1F0C7A706B	81793	20	483	1.05	1	0	0	0	0
1F0C7A7269	62993	18	501	1.05	2	0	0.08	0	0
1F0C7A7A61	70893	19	509	1.23	1	0	0.08	0	0
1F0C7B1545	62993	18	525	1.38	2	0	0.08	1	0
1F0C7B6A70	70893	19	466	0.85	1	1	0.08	0	0

Table 13. *Continued.*

1F0C7B6A70	70893	19	465	0.9	1	1	0.08	0	0
1F0C7B7367	62993	18	493	1	1	0	0.08	0	0
1F0C7C4019	62993	18	521	1.25	2	0	0.08	0	0
1F0C7C6A6F	81893	20	498	1.08	1	0	0	0	0
1F0C7D4414	62993	18	445	0.9	1	0	0.08	0	0
1F0C7D5B7D	62993	18	577	1.75	2	0	0.08	0	0
1F0C7E1740	62993	18	471	1	1	0	0.08	0	0
1F0C7E4116	81893	20	588	2	2	0	0.08	0	0
1F0C7E480F	70893	19	525	1.38	2	0	0.08	0	0
1F0C7F094D	62993	18	418	0	1	0	0.08	0	0
1F0E597901	70893	19	570	1.93	2	0	0	0	0
1F0E601D56	70893	19	546	1.8	2	0	0.08	0	0
1F0F5E3D37	81793	20	481	1.13	1	0	0	0	0
1F0F5F6F04	81793	20	482	0.95	1	0	0	0	0
1F0F601959	62993	18	508	0	2	0	0.08	0	0
1F0F60787A	70893	19	562	1.6	2	0	0.08	0	1
1F0F607E74	62993	18	491	0	2	0	0.08	0	0
1F0F613C35	62993	18	492	1.23	1	0	0.08	0	0
1F0F614031	70893	19	526	1.25	2	0	0.08	0	0
1F0F62630D	81893	20	481	1.08	1	0	0.08	0	0
1F0F626B05	62993	18	545	0	2	0	0.08	0	0
1F0F63026D	70893	19	506	1.38	1	0	0.08	0	0
1F0F631659	70893	19	471	1.1	1	0	0.08	0	0
1F0F632E41	62993	18	486	0	1	0	0.08	0	0
1F0F64303E	81793	20	607	2.15	1	0	0	0	0
1F0F64412D	70893	19	525	1.55	2	0	0.08	0	0
1F0F65006D	70893	19	575	2	2	0	0.08	0	0
1F0F65036A	81793	20	495	1.25	1	0	0.08	0	0
1F0F650964	70893	19	507	1.1	1	0	0.08	0	0
1F0F657B72	70893	19	520	1.25	1	1	0.08	0	0
1F0F660666	70893	19	508	1.15	1	0	0.08	0	0
1F0F660E5E	62993	18	443	0.8	0	0	0	0	0
1F0F660E5E	62993	18	443	0.8	0	0	0	0	0
1F0F66244B	62993	18	521	1.43	2	0	0.08	0	1
1F0F662B41	81693	20	474	1.1	1	0	0.08	0	0
1F0F665B11	70893	19	432	0.65	1	1	0.08	1	0
1F0F66600C	70893	19	503	1.63	2	0	0.08	0	0
1F0F667973	62993	18	439	1.4	2	0	0.08	0	0
1F0F672546	62993	18	590	0	2	0	0.08	0	0
1F0F672C3F	81693	20	464	1.08	1	0	0	0	0
1F0F674D1E	81793	20	485	1.05	1	0	0	0	0

Table 13. *Continued.*

1F0F676902	70893	19	476	1.05	1	0	0.08	0	0
1F0F6A7B6D	70893	19	510	1.25	2	0	0.08	0	0
1F0F6B2542	62993	18	466	0	1	0	0.08	0	0
1F0F6B2D3A	70893	19	540	1.43	2	0	0	0	0
1F0F6B481F	70893	19	485	1.08	1	0	0	0	0
1F0F6B491E	62993	18	500	1.23	1	0	0.08	1	0
1F0F6B5C0B	81793	20	481	0.95	1	0	0	1	0
1F0F6B6502	70893	19	555	1.65	2	0	0.08	0	0
1F0F6C2541	81693	20	483	1.15	1	0	0.08	0	0
1F0F6C786E	81893	20	506	1	1	0	0	0	0
1F0F6D3B2A	62993	18	464	1.03	1	0	0.08	1	0
1F0F6D5312	70893	19	483	1.15	1	0	0.08	0	0
1F0F6D5F06	70893	19	547	1.48	2	0	0.08	0	0
1F0F6E164E	70893	19	444	0.8	2	0	0.08	0	0
1F0F6E2143	62993	18	460	0.95	1	0	0.08	1	0
1F0F6E6E96	70893	19	467	1.15	2	0	0.08	0	0
1F0F6E7F65	62993	18	509	0	2	0	0.08	0	0
1F0F6F095A	62993	18	550	0	2	0	0.08	1	0
1F0F6F3A29	81793	20	493	1.1	1	0	0.08	0	0
1F0F6F580B	51093	16	523	1.8	2	0	0	0	0
1F0F6F5B08	81793	20	507	1.2	2	0	0.08	0	0
1F0F6F6003	42693	15	575	1.9	2	0	0	0	0
1F0F6F6B78	62993	18	545	0	2	0	0.08	0	0
1F0F6F766D	81793	20	555	2	2	0	0	0	0
1F0F70263C	62993	18	558	1.6	2	0	0.08	0	0
1F0F703032	81993	20	487	1.23	1	0	0	1	0
1F0F70560C	62993	18	440	1	1	0	0.08	0	0
1F0F733D22	81793	20	481	1	1	0	0	0	0
1F0F73401F	62993	18	457	0	1	0	0.08	0	0
1F0F736778	70893	19	478	1.2	1	0	0	0	0
1F0F736778	70893	19	478	1.2	1	0	0	0	0
1F0F741846	62993	18	565	1.53	1	0	0.08	0	0
1F0F742539	81693	20	483	0.93	1	0	0.08	0	0
1F0F750657	70893	19	489	1.18	1	0	0.08	0	0
1F0F75233A	62993	18	563	0	2	0	0.08	0	0
1F0F752E2F	70893	19	520	1.4	2	0	0.08	0	0
1F0F75726B	70893	19	534	1.33	2	0	0.08	0	0
1F0F77302B	62993	18	506	1.25	1	0	0.08	0	0
1F0F77510A	62993	18	500	1.25	2	0	0.08	0	0
1F0F790554	81793	20	496	1.05	1	1	0	0	0
1F0F7A2E2A	81793	20	537	1.65	2	0	0	0	0

Table 13. *Continued.*

1F0F7A6B6D	81693	20	480	1.05	1	0	0.08	0	0
1F0F7C0D49	81793	20	592	2.15	2	0	0.08	1	0
1F0F7C292D	70893	19	507	1.18	1	0	0.08	1	0
1F0F7C3C1A	70893	19	520	1.33	1	0	0.08	0	0
1F0F7C795D	70893	19	442	1	2	0	0.08	1	0
1FoC701D48	70893	19	480	0.85	2	0	0.08	0	0
1FoC74520F	81793	20	591	1.85	2	0	0	0	0
1FoF665B11	62993	18	431	0.65	1	0	0	0	0
1FoF6B481F	70893	19	485	1.08	1	0	0	0	0
7E7B01672C	31493	12	503	1.37	2	1	2.2	0	0
7E7B024B3D	31493	12	474	1	1	1	1.1	0	0
7E7B082245	31493	12	512	1.25	1	1	1.1	0	0
7E7D3C402A	31493	12	427	0.75	1	1	2	0	0
7F7A191D71	33093	13	481	2.1	2	0	0	0	0
7F7A191D7A	33193	13	507	1.42	2	0	0	0	0
7F7A191F0D	33093	13	473	1.12	1	1	0	0	0
7F7A192076	33193	13	565	1.55	2	1	2.1	0	0
7F7A19250D	33093	13	528	1.52	1	0	0	0	0
7F7A197371	33093	13	585	1.9	2	0	0	0	0
7F7A19737A	33093	13	505	1.3	2	0	0	0	0
7F7A197443	33093	13	469	1.07	1	0	0	0	0
7F7A197445	32993	13	470	1.12	2	0	0.06	0	0
7F7A197458	33093	13	460	1.05	1	1	0	0	0
7F7A197657	33093	13	512	1.37	2	0	0	0	0
7F7A197801	33193	13	455	0.98	1	1	2.8	0	0
7F7A197964	32993	13	470	1.05	1	1	0.06	0	0
7F7A197A1B	33193	13	563	1.77	2	0	0	0	0
7F7A197A2A	33093	13	510	1.52	1	1	0	0	0
7F7A197A4C	33193	13	457	0.95	1	1	2.8	0	0
7F7A197C41	33093	13	487	1.17	1	1	0	0	0
7F7A197C55	33093	13	480	1.2	2	0	0	0	0
7F7A197D2F	33193	13	464	1.05	1	1	2.8	0	0
7F7A197D58	40893	14	550	1.3	2	0	4	0	0
7F7A197F10	33193	13	476	1.2	1	1	0	0	0
7F7A197F7C	33093	13	526	1.9	2	0	0	0	0
7F7A1A015C	33093	13	459	1.37	2	0	0	0	0
7F7A1A0203	33093	13	563	1.87	2	0	0	0	0
7F7A1A024A	32993	13	503	1.22	1	0	0	0	0
7F7A1A0259	32993	13	515	1.6	2	0	0	0	0
7F7A1A02A?	33093	13	525	1.77	2	0	0	0	0
7F7A1A0311	33093	13	502	1.35	2	0	0	0	0

Table 13. *Continued.*

7F7A1A0359	33093	13	537	1.65	2	0	0	0	0
7F7A1A035E	60393	17	495	0.95	1	0	0	0	0
7F7A1A036E	33093	13	558	1.67	2	0	0	0	0
7F7A1A0411	33093	13	464	1.2	1	1	0	0	0
7F7A1A044B	33093	13	487	1.17	1	1	0	0	0
7F7A1A0674	33093	13	442	0	2	0	0	0	0
7F7A1A073D	33093	13	555	2	2	0	0	0	0
7F7A1A080D	33093	13	474	1.25	2	0	0	0	0
7F7A1A0A15	33193	13	563	2.07	2	0	0	0	0
7F7A1A0A3A	33093	13	465	1.05	1	1	0	0	0
7F7A1A0A73	33093	13	468	1.12	1	1	0	0	0
7F7A1A0A7A	33193	13	485	1.15	1	1	2.8	0	0
7F7A1A0B11	33193	13	460	1.05	1	1	0.06	0	0
7F7A1A0B7B	33093	13	498	1.47	2	0	0	0	0
7F7A1A0D6E	33093	13	502	1.2	1	1	0	0	0
7F7A1A0E19	40893	14	508	1.15	1	1	2.8	0	0
7F7A1A0E1B	33093	13	508	1.32	2	0	0	0	0
7F7A1A0E21	33193	13	488	1.05	1	1	2.8	0	0
7F7A1A0E52	33093	13	525	1.6	2	0	0	0	0
7F7A1A0F54	33093	13	456	0.9	1	1	0	0	0
7F7A1A0F69	33093	13	522	1.4	2	0	0	0	0
7F7A1A102E	33193	13	461	1	1	0	0	0	0
7F7A1A1103	33093	13	520	1.25	2	0	0	0	0
7F7A1A122E	33193	13	487	1.2	2	0	0	0	0
7F7A1A1262	32993	13	470	1.2	1	1	0	0	0
7F7A1A1403	33193	13	566	1.92	2	0	0	0	0
7F7A1A1413	33093	13	482	1.12	1	0	0	0	0
7F7A1A1440	33093	13	550	1.7	2	1	0	0	0
7F7A1A145C	33193	13	426	0.82	1	1	0	0	0
7F7A1A1520	33093	13	478	1.2	1	1	0	0	0
7F7A1A1664	42693	15	441	0.85	1	1	0	0	0
7F7A1A177C	40893	14	505	1.15	1	1	2.8	0	0
7F7A1A1813	33193	13	455	1.1	1	1	0	0	0
7F7A1A1874	33193	13	495	1.07	1	1	0	0	0
7F7A1A4044	32993	13	470	1.07	1	0	0.06	0	0
7F7A1A4067	32993	13	560	1.9	2	0	0.06	0	0
7F7A1A414F	33093	13	515	1.65	1	1	0	0	0
7F7A1A414F	60393	17	520	1.55	1	1	0	1	0
7F7A1A4571	33093	13	530	1.67	2	0	0	0	0
7F7A1A4930	33093	13	505	1.3	1	1	0	0	0
7F7A1A4A7A	40893	14	530	1.25	1	1	2.8	0	0

Table 13. *Continued.*

7F7A1A4B35	33093	13	586	1.9	2	0	0	0	0
7F7A1A4B36	32993	13	505	1.55	1	0	0	0	0
7F7A1A532D	40893	14	542	1.6	0	0	0	0	0
7F7A1A5516	51193	16	475	0.9	1	0	0	0	0
7F7A1A5602	60393	17	524	1.4	2	0	0	0	0
7F7A1A562E	40893	14	485	1.2	0	0	0	0	0
7F7A1A5B01	60393	17	442	0.7	1	0	0	0	0
7F7A1A5C4C	42693	15	440	0.85	1	0	0	0	0
7F7A1A5E1C	41093	14	556	1.72	2	0	0	0	0
7F7A1A5F23	51093	16	461	1.08	1	0	0	0	0
7F7A1B023D	42693	15	460	1	2	0	0	0	0
7F7A1B0F7C	42693	15	500	1.4	1	0	0	0	0
7F7A1B2123	33093	13	557	1.75	2	0	0	0	0
7F7A1B2158	33193	13	506	1.25	1	1	0.06	0	0
7F7A1B2173	33093	13	480	1.22	1	1	0	0	0
7F7A1B4015	33093	13	473	1.12	2	0	0	0	0
7F7A1B450D	32993	13	440	0.95	0	0	0	0	0
7F7A1B453A	32993	13	480	1.1	1	1	0	0	0
7F7A1B4667	33093	13	492	1.47	1	1	0	0	0
7F7A1B4947	33093	13	480	1.17	1	1	0	0	0
7F7A1B4952	33093	13	490	1.35	1	1	0	0	0
7F7A1B497E	33093	13	590	2.02	2	0	0	0	0
7F7A1B4A16	33093	13	489	1.22	2	0	0	0	0
7F7A1B4A6B	33193	13	514	1.17	2	0	0.06	0	0
7F7A1B4C1F	33093	13	487	1.25	1	1	0	0	0
7F7A1B4D0B	33093	13	480	1.37	1	1	0	0	0
7F7A1B4E7A	33193	13	433	0.77	1	1	0.06	0	0
7F7A1B4F4D	33193	13	510	1.37	2	0	0.06	0	0
7F7A1B5076	33093	13	510	1.37	2	0	0	0	0
7F7A1B5276	33193	13	470	0.93	1	1	2.8	0	0
7F7A1B554E	33093	13	553	1.62	2	0	0	0	0
7F7A1B5720	33093	13	545	1.7	2	0	0	0	0
7F7A1B5F69	33193	13	485	1.2	1	1	0	0	0
7F7A1B5F79	33093	13	530	1.37	2	0	0	0	0
7F7A1B606B	51093	16	490	1.32	2	0	0	1	0
7F7A1B606B	33193	13	485	1.35	2	0	0	0	0
7F7A1B6110	33193	13	496	1.22	2	0	0	0	0
7F7A1B6138	33193	13	483	1.17	1	1	0	0	0
7F7A1B6150	33093	13	561	1.77	2	0	0	0	0
7F7A1C5A26	40993	14	434	0.63	1	1	6	0	0
7F7B013E44	32893	13	612	2.5	2	0	0	0	0

Table 13. *Continued.*

7F7B013E44	51193	16	610	2.33	2	0	0	1	0
7F7B015905	32993	13	412	0.67	1	1	4.8	0	0
7F7B015905	31593	12	416	0.65	1	1	6	0	0
7F7B01597C	32993	13	486	1.17	1	0	0	0	0
7F7B015A67	31693	12	510	1.22	2	0	0	0	0
7F7B015D25	31693	12	450	0.77	2	0	0	0	0
7F7B015F66	110992	8	440	0	2	0	0	0	0
7F7B016023	51093	16	477	1.05	1	0	0	1	0
7F7B016023	30393	11	476	1	1	1	2.1	0	0
7F7B01603B	32993	13	470	1	1	1	4.8	0	0
7F7B016068	31493	12	499	1.25	2	0	3.7	0	0
7F7B016068	60393	17	510	1.18	2	0	0	1	0
7F7B016237	93092	7	557	1.45	2	0	0	0	0
7F7B016239	31493	12	0	0	1	1	2.2	0	0
7F7B016239	40893	14	448	0.9	1	1	4	1	0
7F7B01644C	31393	12	591	2	2	0	0	0	0
7F7B016521	30293	11	459	0.9	0	0	0	0	0
7F7B016729	32993	13	506	1.35	2	0	6	0	0
7F7B016846	32993	13	460	1	1	1	4.8	0	0
7F7B016922	32993	13	442	0.83	1	1	0.06	0	0
7F7B016B28	32993	13	435	0.88	1	1	4.8	0	0
7F7B016E47	31493	12	520	1.37	2	0	3.7	0	0
7F7B017223	30193	11	476	1.15	2	0	0	0	0
7F7B017500	111192	8	480	0	0	0	0	0	0
7F7B017F56	93092	7	481	1.15	1	0	0	0	0
7F7B02006A	30193	11	514	1.5	2	0	0	0	0
7F7B020119	111192	8	528	0	0	0	0	0	0
7F7B02011A	32993	13	550	1.62	2	0	0.06	0	0
7F7B02011F	30393	11	468	0.9	1	1	2.7	0	0
7F7B02033C	31493	12	510	1.2	2	0	3	0	0
7F7B02056F	31893	12	522	1.75	2	0	0	0	0
7F7B020644	30493	11	468	0.95	1	1	0.6	0	0
7F7B020722	40893	14	579	1.55	2	1	2.8	0	0
7F7B020750	31393	12	477	0.98	1	1	0	0	0
7F7B020751	31693	12	538	1.65	2	0	0	0	0
7F7B020835	93092	7	425	0	0	0	0	0	0
7F7B020905	93092	7	478	0	0	0	0	0	0
7F7B020951	31893	12	489	1.17	1	1	0	0	0
7F7B02096B	30393	11	467	1.15	1	1	0	0	0
7F7B020A12	32993	13	547	1.52	2	0	0	0	0
7F7B020A6B	32993	13	530	1.75	2	1	4.8	0	0

Table 13. *Continued.*

7F7B020C26	33193	13	490	1.3	1	1	0	0	0
7F7B020C37	33193	13	570	1.95	2	0	0	0	0
7F7B020F22	31893	12	495	1.1	2	0	1.1	1	0
7F7B020F22	31493	12	495	1.07	2	1	1.2	0	0
7F7B02100F	31493	12	428	0.8	1	1	1.2	0	0
7F7B021201	32993	13	484	1.22	2	1	8.4	0	0
7F7B02124D	30393	11	481	1.22	1	1	2.7	0	0
7F7B02137D	30393	11	474	1	1	1	0	0	0
7F7B02150C	31693	12	420	0.8	1	1	0	0	0
7F7B02151C	30393	11	530	1.27	2	0	0	0	0
7F7B021605	21293	10	490	1.05	2	0	0	0	0
7F7B021626	21393	10	510	1.25	2	0	0	1	0
7F7B021626	93092	7	515	0	2	0	0	0	0
7F7B021849	40893	14	544	1.85	2	1	0	1	0
7F7B021849	30193	11	558	1.77	2	0	0	0	0
7F7B021C44	30393	11	465	1	1	1	2	0	0
7F7B021E67	32993	13	425	0.75	1	1	8.5	0	0
7F7B021E7D	93092	7	475	0.95	1	0	0	0	0
7F7B02253D	31493	12	487	1.15	0	0	1.1	0	0
7F7B022D62	30293	11	484	1.15	0	0	0	0	0
7F7B023068	30393	11	586	2	2	0	0	0	0
7F7B023315	31393	12	420	0.83	0	0	0	0	0
7F7B02337E	30393	11	440	0.9	1	1	3	0	0
7F7B023527	42693	15	445	0.8	1	0	0	1	0
7F7B023527	30393	11	450	0.8	1	1	3	0	0
7F7B02355D	30193	11	450	0.93	1	1	0	0	0
7F7B023672	30493	11	470	1.02	1	1	0.7	0	0
7F7B023801	31893	12	553	1.82	2	0	1.2	0	0
7F7B02387D	30393	11	470	1.12	1	1	3	0	0
7F7B02413A	110992	8	531	0	0	0	0	0	0
7F7B02413A	31493	12	530	1.47	2	0	1.1	1	0
7F7B024355	31593	12	460	1	1	1	4.4	0	0
7F7B024507	21393	10	454	0.9	1	1	0	0	0
7F7B02457E	93092	7	480	0.8	1	0	0	0	0
7F7B02457E	93092	7	480	0.8	1	0	0	0	0
7F7B02462C	31493	12	472	1.15	1	0	1.1	0	0
7F7B024746	32893	13	450	1	1	1	5.5	0	0
7F7B024B07	93092	7	490	0	0	0	0	0	0
7F7B024D5F	93092	7	469	1	1	0	0	0	0
7F7B024D73	31693	12	470	1.12	1	1	0	0	0
7F7B025047	30393	11	525	1.45	2	0	2	0	0

Table 13. *Continued.*

7F7B025070	31593	12	505	1.15	2	0	4.4	0	0
7F7B02522C	33193	13	573	2.02	2	0	0	0	0
7F7B025261	32993	13	480	1.07	1	1	4.8	0	0
7F7B025261	40993	14	475	0.9	1	1	6	1	0
7F7B025734	30393	11	470	0.93	1	1	4.3	0	0
7F7B025743	30393	11	508	1.45	1	1	0	0	0
7F7B025836	32893	13	538	1.62	2	0	4.8	0	0
7F7B025878	40893	14	534	1.25	2	0	4	0	0
7F7B025958	30393	11	471	1	1	1	3	0	0
7F7B025A0E	31493	12	508	1.3	1	1	1.2	0	0
7F7B025C03	93092	7	530	0	2	0	0	0	0
7F7B025C76	33193	13	487	1.32	1	1	0	0	0
7F7B025D4E	30393	11	463	0.9	1	1	7.8	0	0
7F7B025E64	30393	11	500	1.37	1	1	3	0	0
7F7B026064	30193	11	563	1.8	2	1	0	0	0
7F7B02612A	30393	11	470	1.02	1	1	5.2	0	0
7F7B02625E	30393	11	521	1.7	2	0	0	0	0
7F7B02630A	32993	13	460	1.1	1	1	4.8	0	0
7F7B02630A	42593	15	457	0.98	1	1	0	1	0
7F7B026700	21393	10	490	1.3	2	0	0	0	0
7F7B026707	32993	13	520	1.45	1	0	0	0	0
7F7B026827	30393	11	575	1.67	2	1	0	0	0
7F7B02684E	42693	15	568	1.82	2	0	0	1	0
7F7B02684E	33193	13	563	1.95	2	0	0	0	0
7F7B026B3F	30393	11	516	1.3	0	0	0	0	0
7F7B026B3F	41093	14	520	1.22	2	1	0	1	0
7F7B026E2C	30393	11	442	0.83	1	1	0	0	0
7F7B026E71	93092	7	495	1.15	1	0	0	0	0
7F7B026F49	32893	13	565	1.9	2	1	2.8	0	0
7F7B027042	30393	11	451	0.95	1	1	3	0	0
7F7B03206F	30393	11	532	1.52	2	0	0	0	0
7F7B032453	30393	11	530	1.55	2	0	0	0	0
7F7B032520	32993	13	558	2	2	0	0	0	0
7F7B032552	30392	11	470	1.07	1	1	7.8	0	0
7F7B032925	31493	12	475	1.07	1	1	3.7	0	0
7F7B032D0A	93092	7	500	1	1	0	0	0	0
7F7B032F3E	30393	11	458	0.9	1	1	5.2	0	0
7F7B033051	31893	12	474	1.1	0	0	0	0	0
7F7B033C51	30393	11	523	1.35	2	0	0	0	0
7F7B033E22	40893	14	465	1.05	1	1	4	0	0
7F7B033F6A	111192	8	445	0	0	0	0	0	0

Table 13. *Continued.*

7F7B034016	93092	7	490	0	2	0	0	0	0
7F7B034054	30293	11	508	1.45	2	0	0	0	0
7F7B034056	31493	12	473	1.17	1	1	1.2	0	0
7F7B03435E	31593	12	464	1.02	1	1	6	0	0
7F7B034743	30393	11	504	1.2	2	0	3	0	0
7F7B03491E	40893	14	492	1	2	0	4	0	0
7F7B034965	31493	12	417	0.7	1	1	2	1	0
7F7B034965	30393	11	418	0.7	1	1	2.1	0	0
7F7B034969	30193	11	480	1.2	1	1	0	0	0
7F7B034E4A	30393	11	463	0.92	1	1	3	1	0
7F7B034E4A	21393	10	462	0.85	1	0	0	0	0
7F7B034F62	30393	11	493	1.2	1	1	0	0	0
7F7B035109	31893	12	434	0.85	1	1	1.4	0	0
7F7B03536E	111192	8	498	0	0	0	0	0	0
7F7B03555D	40893	14	483	1.1	1	1	4	0	0
7F7B035654	32993	13	500	1.25	2	0	6	0	0
7F7B03584A	93092	7	495	1.1	2	0	0	0	0
7F7B035B0F	31693	12	444	0.98	1	1	0	0	0
7F7B035B60	30293	11	485	1.1	0	0	0	0	0
7F7B035C14	31893	12	575	2	2	0	0	0	0
7F7B035C17	31893	12	540	1.55	2	0	0	0	0
7F7B035D09	30193	11	477	1.05	1	1	0	0	0
7F7B035D15	110992	8	523	0	0	0	0	0	0
7F7B035D15	30393	11	523	1.3	2	0	0	1	0
7F7B035D28	31893	12	470	1.05	2	0	0	0	0
7F7B035E32	40893	14	550	1.3	2	1	1.2	0	0
7F7B036C63	30493	11	439	0.83	1	1	0.6	0	0
7F7B036C65	93092	7	464	0.9	1	0	0	0	0
7F7B036F76	21293	10	430	0.75	1	0	0	0	0
7F7B03704B	93092	7	455	0.9	0	0	0	0	0
7F7B03706C	30393	11	502	1.3	2	1	7.8	0	0
7F7B03750A	51093	16	490	0	1	0	0	1	0
7F7B03750A	31893	12	486	1.02	1	1	0	0	0
7F7B037557	32993	13	436	0.77	1	1	4.8	0	0
7F7B03762D	32993	13	550	1.65	2	1	4.8	0	0
7F7B037743	30293	11	535	1.3	2	1	0	0	0
7F7B037A18	31893	12	470	1.15	1	1	0	0	0
7F7B037B6E	32893	13	553	1.7	2	0	0	0	0
7F7B037B6E	42693	15	551	1.8	2	0	0	1	0
7F7B073E22	30193	11	550	1.75	2	0	0	0	0
7F7B073F4A	30193	11	490	1.1	1	1	0	0	0

Table 13. *Continued.*

7F7B075308	30193	11	560	1.65	2	0	0	0	0
7F7B080931	111092	8	478	0	2	0	0	0	0
7F7B080961	31493	12	465	1.07	1	1	2.4	0	0
7F7B080971	21393	10	511	1.25	2	0	0	0	0
7F7B080A27	30393	11	535	1.4	2	0	2.1	0	0
7F7B080A7B	31693	12	490	1.05	1	1	0	0	0
7F7B080A7F	30193	11	505	1.35	2	0	0	0	0
7F7B080B6B	93092	7	562	1.6	0	0	0	0	0
7F7B080C30	40893	14	479	1.05	1	0	4	0	0
7F7B080C63	31493	12	510	1.5	2	0	1.2	0	0
7F7B080C63	40893	14	507	1.4	2	1	4	1	0
7F7B080C7C	111192	8	450	0	1	0	0	0	0
7F7B080E78	30393	11	455	1.05	1	1	4.3	0	0
7F7B080F3C	30393	11	429	0.8	1	1	6	0	0
7F7B08115E	30393	11	510	1.3	0	0	2.4	0	0
7F7B081236	30393	11	524	1.37	2	1	3	0	0
7F7B081250	32993	13	470	0	1	1	4.8	0	0
7F7B08127B	40893	14	475	1.17	1	1	4	0	0
7F7B081327	111192	8	490	0	0	0	0	0	0
7F7B081334	33193	13	514	1.4	1	0	0	0	0
7F7B081345	30393	11	484	1.12	1	1	0	0	0
7F7B081358	31893	12	558	1.6	2	0	1.1	0	0
7F7B08135C	31693	12	468	1	1	1	9	0	0
7F7B081417	30193	11	480	0.85	0	0	0	0	0
7F7B081530	93092	7	535	1.6	2	0	0	0	0
7F7B081545	31893	12	498	0	2	0	0.06	0	0
7F7B081559	31593	12	500	1.25	2	1	8	0	0
7F7B081559	51093	16	505	0	2	0	0	1	0
7F7B081578	32993	13	475	1.07	1	1	0.06	0	0
7F7B081608	33193	13	543	1.5	2	1	0	0	0
7F7B081618	30393	11	475	1.05	1	1	3	0	0
7F7B08171D	31693	12	478	1.3	1	1	0	0	0
7F7B08171D	40993	14	485	1.25	1	1	10	1	0
7F7B08174E	93092	7	465	1	1	0	0	0	0
7F7B08181B	33193	13	508	1.52	1	1	0	0	0
7F7B081860	31693	12	500	1.25	1	0	0	0	0
7F7B08193D	110992	8	510	0	0	0	0	0	0
7F7B08194F	31493	12	503	1.25	0	0	1.1	0	0
7F7B081971	31893	12	508	1.25	2	0	1.9	0	0
7F7B081A08	21293	10	435	0.85	1	0	0	0	0
7F7B081A20	31493	12	526	1.52	2	0	3.7	0	0

Table 13. *Continued.*

7F7B081B19	31393	12	456	0.95	1	1	0	0	0
7F7B081B2E	93092	7	475	0.95	1	0	0	0	0
7F7B081B2E	30193	11	480	0.98	1	0	0	1	0
7F7B081B39	30193	11	446	0.93	1	1	0	0	0
7F7B081C39	93092	7	496	1.2	2	0	0	0	0
7F7B081C51	33093	13	515	1.4	2	0	0	1	0
7F7B081C51	31693	12	515	1.35	2	0	0	0	0
7F7B081E2E	30393	11	420	0.8	1	1	3	0	0
7F7B08207D	31893	12	560	1.9	2	0	0	0	0
7F7B082118	32893	13	480	1.15	1	1	0	0	0
7F7B082246	32893	13	488	1	1	1	2.8	0	0
7F7B082247	31693	12	510	1.45	2	0	4.7	0	0
7F7B08231E	32993	13	468	0.85	1	1	4.8	0	0
7F7B08244D	31793	12	543	1.32	2	0	0	0	0
7F7B082619	32993	13	473	1.05	1	1	0	0	0
7F7B08262A	31493	12	457	0.9	1	1	1.1	0	0
7F7B082930	31693	12	472	1.14	1	0	4.7	0	0
7F7B082969	31693	12	465	0.9	1	1	4.7	0	0
7F7B082A6B	32993	13	463	1	1	0	4.8	0	0
7F7B082C31	30393	11	505	1.2	2	0	3	0	0
7F7B082D1B	110992	8	480	0	1	0	0	0	0
7F7B082D45	32993	13	485	1.1	1	1	4.8	0	0
7F7B0D3853	30193	11	521	1.55	1	0	0	0	0
7F7B0D4464	30293	11	513	1.3	0	0	0	0	0
7F7B150D41	30193	11	537	1.45	2	0	0	0	0
7F7B1F0E17	40893	14	497	1.35	1	1	0	0	0
7F7B20383A	51093	16	508	1.12	1	0	0	0	0
7F7B90241C	30393	11	493	1.2	0	0	6	0	0
7F7D073B73	31593	12	501	1.32	2	0	6	0	1
7F7D074054	41093	14	515	1.17	2	1	0	0	0
7F7D075B0D	31693	12	445	0.9	2	0	7	0	0
7F7D075C53	30493	11	458	0.95	1	1	0.6	0	1
7F7D077101	32893	13	477	1	2	1	2.8	0	1
7F7D085530	32993	13	537	1.45	2	1	4.8	0	0
7F7D173631	82992	7	484	1.09	2	0	0	0	0
7F7D174C22	82992	7	456	0.97	1	0	0	0	0
7F7D174C44	82992	7	464	0.78	2	0	0	0	0
7F7D22604B	41093	14	468	1	2	1	0	0	1
7F7D226A4B	31693	12	414	0.55	1	0	9	0	1
7F7D240C5C	33093	13	530	1.62	2	0	0	0	1
7F7D2B6231	40993	14	467	0.78	1	1	6	0	1

Table 13. *Continued.*

7F7D302576	41093	14	467	1.2	2	0	0	0	1
7F7D3C3608	30393	11	456	0.95	1	1	0	0	0
7F7D3C3756	41093	14	493	1.2	1	1	0	1	0
7F7D3C3756	31693	12	493	1.32	1	0	0	0	0
7F7D3C3B6A	32893	13	497	1.12	2	0	0	0	0
7F7D3C3D1D	30293	11	495	1.05	1	1	0	0	0
7F7D3C3E23	31693	12	437	0.8	1	1	0	0	0
7F7D3C3E30	32993	13	534	1.42	2	1	4.8	0	0
7F7D3C3E43	30393	11	437	0.85	1	1	2.1	0	0
7F7D3C3F2A	31393	12	477	1.25	2	0	0	0	0
7F7D3C402A	42693	15	426	0.75	1	0	7.9	0	1
7F7D3C4048	31693	12	536	1.67	2	0	0	0	0
7F7D3C4148	31693	12	522	1.45	2	0	0	0	0
7F7D3C4154	30393	11	565	1.6	2	0	2.7	0	0
7F7D3C416B	32993	13	472	1.05	1	1	4.8	0	0
7F7D3C416B	42693	15	466	0.95	1	0	0	1	0
7F7D3C4322	32893	13	466	1.02	1	1	2.8	0	0
7F7D3C4322	33193	13	464	1	1	1	2.8	1	0
7F7D3C440C	31493	12	510	1.15	1	1	2.2	0	0
7F7D3C446E	30393	11	454	0.95	1	1	0	0	0
7F7D3C460C	30393	11	420	0.85	1	1	6	0	0
7F7D3C467E	30493	11	480	1	2	0	0.7	0	0
7F7D3C467E	30293	11	482	1	0	0	0	0	0
7F7D3C4A38	31493	12	448	0.9	1	1	7	0	0
7F7D3C4C2A	32893	13	495	1.45	1	1	2.8	0	0
7F7D3C4D2A	31693	12	438	0.95	1	0	0	0	0
7F7D3C4F7E	30293	11	436	0.8	0	0	0	0	0
7F7D3C5006	30393	11	533	1.6	2	0	0	0	0
7F7D3C5008	31393	12	450	0.88	1	0	0	0	0
7F7D3C501D	30393	11	555	2	2	0	0	0	0
7F7D3C517B	30293	11	456	0.9	0	0	0	0	0
7F7D3C5203	32993	13	533	1.52	2	0	0.06	0	0
7F7D3C520D	31893	12	490	1.2	2	0	0	0	0
7F7D3C5268	31393	12	470	0.88	1	1	0	0	0
7F7D3C5314	110992	8	527	0	0	0	0	0	0
7F7D3C5326	31893	12	525	1.45	2	0	0	0	0
7F7D3C5361	110992	8	565	0	0	0	0	0	0
7F7D3C5468	31493	12	465	0.95	1	1	1.2	0	0
7F7D3C552F	31493	12	520	1.27	2	1	3	0	0
7F7D3C5610	33093	13	557	1.62	2	0	0	1	0
7F7D3C5610	93092	7	555	0	2	0	0	0	0

Table 13. *Continued.*

7F7D3E601C	31693	12	496	1.2	1	1	0	0	0
7F7D3E6365	31493	12	527	1.62	2	0	3.7	0	0
7F7D3E664C	31393	12	454	0.9	1	1	0	0	0
7F7D3E6C25	32993	13	462	0.95	1	1	4.8	0	0
7F7D3E6F75	30193	11	530	1.35	2	0	0	1	0
7F7D3E6F75	121692	9	526	0	0	0	0	0	0
7F7D3E7974	32993	13	466	0.9	1	0	4.8	0	0
7F7D3E7B3C	31493	12	445	0.88	1	1	3	0	0
7F7D3F785B	30393	11	440	0.98	1	1	6	0	0
7F7D3F7A17	32893	13	472	1.07	1	1	4.1	1	0
7F7D3F7A17	111192	8	476	0	1	0	0	0	0
7F7D3F7A2C	31893	12	476	1.05	1	1	1.9	0	0
7F7D3F7B76	31893	12	582	1.45	2	0	0	0	0
7F7D3F7C7E	33193	13	521	1.4	2	0	0	0	0
7F7D3F7D51	32993	13	525	1.42	2	1	4.8	0	0
7F7D3F7E15	93092	7	534	0	2	0	0	0	0
7F7D3F7E24	31393	12	533	1.35	1	0	0	0	0
7F7D3F7E2C	31493	12	492	1.25	1	0	2	0	0
7F7D3F7E2E	40893	14	505	1.05	2	1	1.1	0	0
7F7D3F7E35	40893	14	521	1.3	2	0	2.8	0	0
7F7D3F7E4F	93092	7	505	1.1	0	0	0	0	0
7F7D3F7E7C	93092	7	540	1.6	2	0	0	0	0
7F7D3F7E7C	32993	13	541	1.8	2	0	0	1	0
7F7D40004D	30393	11	470	0.95	1	1	2.7	0	0
7F7D400170	31893	12	556	1.65	2	0	0	0	0
7F7D400170	40893	14	556	1.6	2	0	0	1	0
7F7D40032D	31593	12	510	1.3	2	0	10	0	0
7F7D400347	30393	11	452	0.95	1	1	0.08	0	0
7F7D40042E	31893	12	565	1.77	2	0	1.1	0	0
7F7D400475	30393	11	542	1.7	2	0	0	0	0
7F7D40057B	31693	12	462	1.15	2	0	0	1	0
7F7D40057B	30493	11	463	1.2	2	0	0.5	0	0
7F7D400616	31593	12	449	0.83	1	1	5.3	0	0
7F7D400630	32993	13	475	1.02	1	1	4.8	0	0
7F7D40086E	32793	13	435	0.83	1	1	1.2	0	0
7F7D400921	51093	16	432	0.88	1	0	0	1	0
7F7D400921	32893	13	418	0.85	1	1	4.85	0	0
7F7D400D47	31893	12	456	0.88	1	1	0	0	0
7F7D400E12	32893	13	491	1.2	1	1	0	0	0
7F7D400E33	110992	8	523	0	2	0	0	0	0
7F7D400E57	21293	10	432	0.8	1	0	0	0	0

Table 13. *Continued.*

7F7D40122F	30493	11	490	1.35	1	1	0.5	1	0
7F7D40122F	30493	11	493	1.37	1	1	0.6	0	0
7F7D401238	111192	8	506	0	0	0	0	0	0
7F7D401252	40893	14	575	1.95	2	1	4	0	0
7F7D401273	30393	11	465	1	1	1	0	0	0
7F7D401347	30393	11	463	0.95	1	1	2	0	0
7F7D40147C	32893	13	485	1.17	2	0	3.1	0	0
7F7D401543	21393	10	470	1.05	1	0	0	0	0
7F7D40166A	32993	13	485	1.1	1	1	4.8	0	0
7F7D40166A	51093	16	490	1.17	1	0	0	1	0
7F7D40176B	32993	13	425	0.75	1	1	0.06	0	0
7F7D401771	32993	13	466	0.92	1	1	4.8	0	0
7F7D40195E	31893	12	446	0.95	0	0	0	0	0
7F7D436A30	31493	12	478	1.1	1	1	1.2	0	0
7F7D436B22	33193	13	510	1.32	1	1	0	0	0
7F7D436E45	30193	11	557	1.8	2	0	0	0	0
7F7D437000	93092	7	410	0	0	0	0	0	0
7F7D437010	93092	7	494	0	0	0	0	0	0
7F7D437010	31893	12	485	1.2	1	1	0	1	0
7F7D437016	62993	18	487	0	0	0	0	0	1
7F7D437108	33193	13	485	1.12	1	0	0	0	0
7F7D437150	31893	12	506	1.12	2	0	0.6	0	0
7F7D43725C	31693	12	467	1.05	2	0	0	0	0
7F7D440834	111192	8	456	0	0	0	0	0	0
7F7D440A5F	30393	11	441	0.93	1	1	0.08	0	0
7F7D440B15	31693	12	465	0.9	1	0	9	0	0
7F7D440B5B	31893	12	511	1.35	1	1	0	0	0
7F7D440D05	111192	8	491	0	0	0	0	0	0
7F7D440E48	32993	13	500	1.2	1	1	4.8	0	0
7F7D440E57	30393	11	497	1.32	2	0	0.08	0	0
7F7D44100B	93092	7	460	0.8	1	0	0	0	0
7F7D44106B	30393	11	456	0.85	1	1	2.1	0	0
7F7D441321	31693	12	435	1.5	2	0	0	0	0
7F7D441358	30493	11	473	1.1	1	1	0.6	0	0
7F7D44136F	31493	12	502	1.17	2	0	1.2	0	0
7F7D441459	31593	12	477	0.93	0	0	6	0	0
7F7D441459	32993	13	474	0.93	1	1	4.8	1	0
7F7D44145D	93092	7	497	1.2	1	0	0	0	0
7F7D44152D	32993	13	452	0.95	1	1	4.8	0	0
7F7D441659	42693	15	506	1.2	2	0	0	1	0
7F7D441659	31493	12	512	1.35	2	0	1.2	0	0

Table 13. *Continued.*

7F7D44171A	31893	12	473	1.05	1	1	1.1	0	0
7F7D44171A	40893	14	467	1.1	1	1	2.8	1	0
7F7D44171A	51093	16	470	0	0	0	0	1	0
7F7D44176A	30193	11	550	1.65	2	0	0	0	0
7F7D441940	31693	12	538	1.42	2	0	0	0	0
7F7D441940	33193	13	538	1.52	2	0	0	1	0
7F7D441A7D	30293	11	443	0.9	1	1	0	0	0
7F7D441B57	31693	12	505	1.25	1	0	0	0	0
7F7D444F66	42593	15	472	0.85	1	1	0	1	0
7F7D444F66	93092	7	466	0	1	0	0	0	0
7F7D44577A	30393	11	451	0.85	1	1	6	0	0
7F7D446704	30393	11	537	1.35	2	0	0	0	0
7F7D45264F	31893	12	567	1.7	2	0	0	0	0
7F7D452753	31693	12	459	0.9	1	1	8.5	0	0
7F7D452936	31493	12	492	1.02	2	0	3	0	0
7F7D452A60	30393	11	557	1.4	2	0	0	0	0
7F7D453352	31493	12	530	1.35	2	0	2.4	0	0
7F7D45345D	31893	12	440	0.93	1	1	1.1	0	0
7F7D7C0079	30393	11	480	1	0	0	2.1	0	0
7F7D7C1676	30393	11	487	1.1	1	1	2.7	0	0
7F7D7C1A3D	21393	10	432	0.9	1	0	0	0	0
7F7D7C1B56	31493	12	476	1.2	1	1	1.1	0	0
7F7D7C1E21	32893	13	551	1.8	2	0	4.8	0	0
7F7D7C1E27	111192	8	533	0	0	0	0	0	0
7F7D7C2530	93092	7	460	0	0	0	0	0	0
7F7D7C2737	32993	13	495	1.32	1	1	4.8	0	0
7F7D7C2E44	40893	14	580	1.9	2	1	2.8	0	0
7F7D7C3325	30393	11	530	1.6	2	0	2.7	0	0
7F7D7C353E	31493	12	545	1.52	2	0	1.1	0	0
7F7D7C3972	40893	14	435	0.75	1	0	4	0	0
7F7D7C4464	31893	12	447	0.85	1	1	1.9	0	0
7F7D7D3145	31893	12	534	1.5	2	0	1.2	0	0
7F7D7D3145	42693	15	532	1.35	2	0	0	1	0
7F7DBC4215	21392	10	445	0.87	1	0	0	0	0
7F7F0F580F	40893	14	486	1.17	1	0	0	0	0
7F7F1F153F	40993	14	445	0.85	1	1	6	0	0
7F7F1F162F	62993	18	440	1	1	0	0	0	1
7F7F1F1757	21393	10	425	0.8	2	0	0	0	1
7F7F212B1B	21393	10	470	1.3	2	0	0	0	1
7F7F27073F	40893	14	518	1.3	2	0	0	1	0
7F7F27073F	33193	13	510	1.37	2	0	0	0	0

Table 13. *Continued.*

7F7F27150E	30393	11	411	0.65	0	0	5.2	0	1
7F7F284637	31493	12	404	0.68	1	1	2.2	0	1
7F7F290031	33193	13	518	1.5	2	0	0	1	0
7F7F290031	31493	12	516	1.4	2	0	1.2	0	0
7F7F29032D	30393	11	513	1.3	1	1	6	0	1
7F7F330429	93092	7	502	1.2	2	0	0	0	1
7F7F3E5A2E	40993	14	531	1.2	2	1	10	0	1
7F8D440D5D	93092	7	457	0	2	0	0	0	0
7F7A197915	70893	19	479	1.18	1	0	0.08	1	0
7F7A197915	33093	13	477	1.3	1	1	0	0	0
7F7A1A0A15	62993	18	573	1.8	2	0	0.08	1	0
7F7A1A1103	81793	20	524	1.13	2	0	0	1	0
7F7A1A1520	62993	18	480	0.95	1	0	0.08	1	0
7F7A1A414F	70893	19	520	1.45	1	0	0.08	1	0
7F7A1A5074	81793	20	441	0.78	1	0	0	0	0
7F7A1A5344	62993	18	486	0	1	0	0.08	0	0
7F7A1A5D61	70893	19	502	1.1	1	1	0.08	0	0
7F7A1B5668	70893	19	448	0.88	1	0	0.08	0	0
7F7A1B6138	81993	20	486	1.13	1	0	0	1	0
7F7B01684C	62993	18	470	0	1	0	0.08	0	1
7F7B026064	70893	19	560	1.95	2	0	0.08	1	0
7F7B034E4A	51093	16		0.98	1	0	0	1	0
7F7B077472	81893	20	499	1.4	1	0	0.08	0	0
7F7B081618	70893	19	476	0.98	1	0	0.08	1	0
7F7B08262A	62993	18	460	0	1	0	0.08	1	0
7F7B1C2370	62993	18	450	0	0	0	0.08	0	0
7F7B1F152E	81693	20	490	1.2	1	0	0.08	0	0
7F7D17235E	81893	20	425	0.8	1	0	0	0	0
7F7D1D4008	81993	20	477	0.98	1	1	0	0	0
7F7D1D5A43	81893	20	546	1.4	2	0	0	0	0
7F7D1E2F2B	81993	20	483	1	1	0	0	0	0
7F7D364F47	32993	13	443	1	1	1	0	0	0
7F7D3C4154	70893	19	563	1.4	0	0	0.08	1	0
7F7D3C4215	70893	19	452	0.9	1	0	0.08	0	1
7F7D3E6775	62993	18	530	0	1	0	0.08	0	1
7F7D3F785B	40993	14	437	0.8	1	1	6	0	0
7F7D3F7E24	81793	20	534	1.18	1	0	0	1	0
7F7D40042E	62993	18	564	1.75	2	0	0.08	1	0
7F7D440834	70893	19	455	0	1	0	0.08	1	0
7F7D7C306A	32793	13	540	1.47	2	0	1.2	0	0
7F7F290A20	81793	20	378	0.63	0	0	0	0	1

Table 13. *Continued.*

7F7F475D70	70893	19	430	0	0	0	0.08	0	1

APPENDIX B: AQUATIC SURVEY OF THE PARIA BASIN

METHODS

The Paria Basin was surveyed for fish and aquatic invertebrates from Bryce Canyon National Park in Utah to Lee's Ferry, Arizona. An attempt was made to sample the entire range of habitat types to qualitatively define the diversity of aquatic macroscopic (those visible to the naked eye) organisms. Organisms were collected primarily with fine mesh aquarium dip nets or a long handled "D" shaped benthic sampling net. Organisms were sorted in the field, preserved in 95% ETOH and taken to the lab for identification. Assistance with insect identification was provided by Carl Olsen and Gene Hall (Department of Entomology, University of Arizona). Identification of crustaceans was verified by Dana DeKoven (assistant curator of the invertebrate collection, Department of Ecology and Evolutionary Biology, University of Arizona). Collection sites were divided into general areas defined by either major changes of elevation or separate canyons. All taxa were noted as collected in either mainstream or spring sites.

RESULTS

No fish other than speckled dace were found upstream of the "rock slide" called "bushhead falls" just south of Paria Canyon about 16 km upstream from its juncture with the Colorado River. No speckled dace were found north of Highway 12 in Utah.

Aquatic organisms collected represented 12 orders and 54 families. Several non-aquatic taxa, notably Aranea were also encountered. Fifty eight organisms were described to genus and 17 to species. A description of each general area and a taxa list referenced to collection site is given below.

Table 14a. Location code for invertebrate samples.

Code

All sites located on figure 2.

1- Paria lower	The mainstem of the Paria River below Paria Canyon including the confluence with the Colorado River.
1s- Paria lower springs	Spring sites within area 1.
2- Paria narrows	From U.S. Highway 89 in Utah, downstream to the end of Paria Canyon including Buckskin Gulch.
2s- Paria narrows springs	Spring sites within area 2.
3- Wrather Canyon	Wrather Canyon from its confluence with the Paria River up to Wrather Arch.
4- Paria upper	From U.S. Highway 89 in Utah, upstream to U.S. Highway 12 including Kitchen and Starlight Canyons.
4s- Paria upper springs	Spring sites within area 4.
5- Hackberry Canyon	Hackberry Canyon and Cottonwood Wash.
5s- Hackberry springs	Spring sites within area 5.
6- Bryce Canyon	Bryce Canyon National Park.
6s- Bryce Springs	Springs within Area 6.

Table 14b. Distribution of invertebrate taxa taken from the Paria River drainage.

ORDER FAMILY *Genus spp.* *subspecies*	1	*	2	*	3	4	*	5	*	6	*
EPHEMEROPTERA	X	X	X	X	X	X	X	X	X	X	X
BAETIDAE	X	X	X	X	X	X	X	X	X	X	X
Baetis sp.		X	X	X				X	X	X	X
Baetis bicaudatus											X
HEPTAGENIIDAE										X	X
Cinygmula sp.										X	X
SIPHLONURIDAE										X	X
Siphlonurus sp.										X	X
ODONATA	X	X	X		X	X		X	X	X	X
COENAGRIONIDAE	X	X			X	X		X	X	X	X
Argia sp.	X	X			X	X		X			X
LESTIDAE						X					
Archilestes sp.						X					
GOMPHIDAE									X		
LIBELLULIDAE			X						X		
Sympetrum sp.									X		
Sympetrum costiferum			X								
AESHNIDAE						X			X		
Oplonaeschna sp.						X			X		
Aeshna multicolor						X					
CORDULEGASTRIDAE					X						
Cordulegaster sp.					X						
ORTHOPTERA	X										
TETRIGIDAE	X										
PLECOPTERA										X	X
PERLODIDAE										X	
CHLOROPERLIDAE											X

Table 14b. Continued

ORDER FAMILY *Genus spp.* *subspecies*	1	s	2	s	3	4	s	5	s	6	s
TAENIOPTERYGIDAE											X
Taenrauema sp.											X
NEMOURIDAE										X	X
Amphinemoura sp.										X	
Nemoura sp.											X
HEMIPTERA	X	X	X	X	X	X	X	X	X	X	X
GERRIDAE	X	X	X	X	X	X	X	X	X	X	X
Gerris remigis	X	X	X	X	X	X	X	X	X	X	X
MACROVELIDAE	X	X									
Macrovelia hornii	X	X									
CORIXIDAE			X			X					X
Corisella sp.											X
Corisella inscripta						X					
NOTONECTIDAE	X		X		X	X		X	X		
Notonecta kirbyi			X		X	X			X		
Buenoa sp.	X										
VELIIDAE	X	X	X	X	X	X	X	X	X	X	X
Microvelia sp.	X	X	X	X	X	X	X	X	X	X	X
TRICHOPTERA	X						X	X	X	X	X
HYDROPSYCHIDAE							X	X		X	X
Hydropsyche sp.	X						X				
Ceratopsyche sp.											X
Parapsyche sp.											X
LIMNEPHILIDAE							X			X	X
Hesperophylax sp.										X	X
Onocosmoecus sp.										X	
Limnephilus sp.											X
PHRYGANEIDAE											X

Table 14b. Continued

ORDER FAMILY *Genus spp.* *subspecies*	1	s	2	s	3	4	s	5	s	6	s
BRACHYCENTRIDAE										X	X
PHSYCHOMYIIDAE							X				
Tinodes sp.							X				
LEPIDOSTOMIDAE											X
Lepidostoma sp.											X
HYDROPTILIDAE										X	
SERICOSTOMIDAE										X	
Gumaga sp.										X	
COLEOPTERA	X	X	X	X	X	X		X	X	X	X
DYSTISCIDAE			X	X	X	X		X	X	X	X
Agabus sp.		X									X
Agabus lugens			X					X			
Agabus cordatus										X	X
Agabus semivittatus											X
Rhantus sp.									X		
Rhantus gutticollis			X	X					X		
Hygrotus sp.										X	
Laccophilus maculosus shermani			X			X					
Eretes sticticus	X										
Hydroporous sp.						X					X
Deronectes strictellus						X		X			
HYDROPHILIDAE	X		X	X	X			X	X		X
Berosus sp.			X					X			
Hydrochara sp.									X		
Hydrochara lineatus					X			X			
Cymbiodyta sp.					X						X
Tropisternus ellipticus				X				X			
Helophorus sp.			X								

Table 14b. Continued

ORDER FAMILY *Genus spp.* *subspecies*	1	s	2	s	3	4	s	5	s	6	s
Anacaena signaticollis									X		
HALIPLIDAE											X
Peltodytes sp											X
SCRITIDAE											X
STAPHYLINIDAE										X	
CARABIDAE										X	X
DRYOPIDAE			X			X		X			
Helichus immsi			X			X		X			
ELMIDAE											X
Heterelmis sp.										X	
DIPTERA	X	X	X	X	X	X	X	X	X	X	X
CHIRONOMIDAE	X .	X	X	X	X	X	X	X	X	X	X
TABANIDAE	X			X				X		X	
DOLICHOPODIDAE	X	X		X					X		
TIPULIDAE	X	X		X		X	X	X	X	X	X
Ctenophora sp.										X	X
Tipula sp.											X
PSYCHODIDAE		X									
STRATIOMYIDAE		X		X	X				X		
SIMULIIDAE	X				X	X	X	X	X	X	
MUSCIDAE	X		X			X		X			
DIXIDAE	X										
CULICIDAE	X		X			X			X	X	X
ASILIDAE				X							
CERATOPOGONIDAE	X										
CECIDOMYIDAE											X
SYPHRIDAE									X		
ARANEA	X			X		X		X		X	

Table 14b. Continued

ORDER FAMILY *Genus spp.* *subspecies*	1	s	2	s	3	4	s	5	s	6	s
TETRAGNATHIDAE	X			X		X		X			
LYCOSIDAE						X				X	
GASTROPODA						X					X
PHYSIDAE											X
Physa gyrina											X
PELECYPODA											X
SPHAERIIDAE											X
Sphaerium sp.											X
Pisidium casertanum											X
AMPHIPODA	X						X			X	X
TALITRIDAE										X	X
Hyalella azteca										X	
Gammarus lacustris	X										
OSTRACODA											X
DAPHNIDAE											X
BRANCHINECTIDAE											
Branchinecta lindahli											

APPENDIX C: DESCRIPTION OF SAMPLE SITE LOCATIONS IN THE PARIA RIVER

Table 15. Description of sample site locations in the Paria River (DRL= down river left, DRR= down river right, "*"= AGFD site, "**" systematically chosen site).

0.7 km- * At downstream side of bridge crossing Paria. DRL tag on large clump of Tamarisk. DRR tag on small bush against concrete foundation slab of bridge. Site began at tags and ended approximately 20 m downstream on DRR beach.

1.22 km-* Tags marked on both sides of a water pipeline crossing 2 m above the Paria. Site began here and ended approximately 40 m downstream on DRR beach.

2.0 km-** Tags on both sides of cable across Paria just above the USGS gauging station. Site began at cable and ended 10 m below gauging station on DRR gravel bar.

2.4 km- * Site divided in two parts. Lower tag on DRR on cable attached to old water pump. The lower site began here and ended on first beach on DRR bank approximately 20 m downstream. The upper site began just above a 6-m tall cottonwood on DRL bank. The seine was dragged along vertical wall on DRL bank, site length approximately 15-20 m.

2.85 km-* Site began parallel with old outhouse next to corral and ranch site. Site length was approximately 60 m ending on DRL beach. The last 15 m of this run on the DRL side was a **spawning site**.

3.2 km- * Site began at 90 degree DRL elbow of river against red shelf rock. Site ended approximately 45 m downstream. Tag on Russian Olive DRL side.

4.0 km-** Straight stretch of stream. DRL tag on a group of 7-8 cottonwood trunks. DRR tag on a Russian olive directly across from DRL tag. Historic Cabin remains are visible from site 500 m downstream. The stream is about 150 m from the trail. This was a **spawning site** in both 1992 and 1993.

4.4 km- * Best approached by walking up the river corridor from 4.0. Vertical rock wall on DRL. Flagged and tagged on both sides on small cottonwoods directly across from each other. Site began 20 m upstream ended 40 m downstream on DRR.

Table 15. *Continued*

4.8 km- This was not a standard site but may have been a significant **spawning area** during the peak of the spawn. Tag on DRL tamarisk 2 m above river about 60 m downstream from DRR vertical red wall with cable remains of mining slough. Site began 35 m up from tag and ended at tag.

5.3 km- * This was the uppermost AGFD site. It is just upstream from a trail crossing and has an overhanging diving board like rock 60 m above river on DRL. Tag on small tamarisk coming out of a rock on DRL. DRR tag on a large Russian Olive opposite DRL tag. Site began 35 m upstream just above DRL vertical wall.

6.0 km-** Just downstream from a trail crossing near a line of large old cottomwoods on DRL. Tags on small tamarisks on opposite sides of stream. There is a DRR vertical red wall just downstream from site and a DRL vertical red wall 2-3 hundred meters upstream. Site began 20 m upstream from tag and ended 20 m downstream. This was the most significant **spawning site** in both 1992 and 1993.

8.0 km-** Trail is on DRL side of river. Long bedrock shelf on DRR side for several hundred meters below site. Large rectangle conglomerate rocks at site on DRR side. TAG on 5-m tall cottomwood sticking out of conglomerate rock on DRR side. DRL tag on small tamarisk opposite cottonwood 2 m up from river. Site began 20 m up from tag against DRR shelf rock and ended at tag. This site was difficult to sample and yielded few fish.

10 km-** Trail on DRR bank passes a man-made rock wall 100 m below site. Trail turns away from river going upstream just before reaching site. DRL bank is vertical sculpted bedrock. Flag on Russian Olive on DRR bank. Site began 40 m upstream and ended a tag. **Spawning fish** were sited and caught 20 m below tag against DRL bank.

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