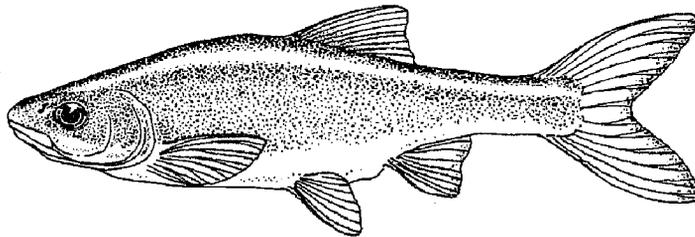


# ARAVAIPA CREEK FISH MONITORING AND SURVEY RESULTS FROM 1999 AND 2000

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# ARAVAIPA CREEK FISH MONITORING AND SURVEY RESULTS FROM 1999 AND 2000

Jeremy B. Voeltz and Rebecca F. Davidson

## INTRODUCTION

Aravaipa Creek is a spring-fed tributary of the San Pedro River. Beginning at its headwaters near Klondyke (Graham Co.) and continuing nearly 75 km to its confluence with the San Pedro River (Pinal Co.), Aravaipa Creek winds its way through the remote and rugged Galiuro Mountains (Fig. 1). It is one of the few remaining unaltered perennial streams in Arizona, and unique in supporting the most diverse assemblage of native fishes in a single stream, anywhere in the desert Southwest. Seven natives, including two federally listed as threatened (loach minnow, *Tiaroga cobitis*; and spikedace, *Meda fulgida*), and five other native species (roundtail chub, *Gila robusta*; desert sucker, *Pantosteus clarki*; Sonora sucker, *Catostomus insignis*; longfin dace, *Agosia chrysogaster*; and speckled dace, *Rhinichthys osculus*) inhabit the stream.

Over the last several decades, native fish populations in the Southwest have drastically declined due to destruction and alteration of aquatic habitats and the effects of introduced fish species (Minckley and Deacon 1991). Until recently, Aravaipa Creek has remained relatively free of nonnative fishes, due to its isolation and to a natural hydrograph containing flash floods (Fig. 2, showing mean and maximum monthly discharge data for 1999-2000 [USGS 2001], illustrating the bimodal spates typical of the Aravaipa Creek hydrograph). However, more recently, fathead minnow (*Pimephales promelas*), green sunfish (*Lepomis cyanellus*), yellow bullhead (*Ameiurus natalis*), and red shiner (*Cyprinella lutrensis*) have been increasing in occurrence and frequency of observation. Also reported, but to a lesser extent, are common carp (*Cyprinus carpio*), black bullhead (*Ameiurus melas*), mosquitofish (*Gambusia affinis*), and largemouth bass (*Micropterus salmoides*) (Bettaso and others 1995). These nonnatives are suspected of moving through the Aravaipa system in opportunistic and pulsed invasions.

The red shiner, a nonnative fish to Arizona (native to the Mississippi-Rio Grande basins), has been a species of particular concern to the Aravaipa system. This nonnative has been implicated in the decline of numerous native fishes of the Southwest, including spikedace (Douglas and others 1994) and loach minnow (Bettaso and others 1995). Recent investigations documented the propensity of red shiner to predate on larval suckers in the upper Colorado River (Ruppert and others 1993, Marsh and others 1989), and cause displacement of spikedace into less suitable habitats by direct competition and negative interactions (Douglas and others 1994). A protocol was developed in 1990 through a cooperative initiative between Arizona State University (ASU), Arizona Game and Fish Department (AGFD), Bureau of Land Management (BLM), The Nature Conservancy (TNC), U.S. Fish and Wildlife Service (USFWS), and U.S. Bureau of Reclamation (USBR) to monitor effects of the invasion by red shiner and other nonnatives, to identify population changes over time, to document interactions between natives and nonnatives, and to study the response of fishes to variations in stream discharge volume and pattern.

In 1994, a USFWS Biological Opinion (B.O.) found that transportation and delivery of Central Arizona Project (CAP) water to the Gila River basin would result in jeopardy to the razorback sucker (*Xyrauchen texanus*), Gila topminnow (*Poeciliopsis occidentalis*), spikedace, and loach minnow, and adversely modify critical habitat for the razorback sucker, spikedace, and loach minnow (USFWS 1994). A reasonable and prudent alternative, with five elements, was presented in the 1994 B.O. that included physical barriers, monitoring, recovery in-lieu of threat removal, management against nonnative species, and information and education. USFWS, USBR, AGFD, and other interested parties resumed discussions and planning for construction of a fish barrier on Aravaipa Creek. The Environmental Assessment for construction of the barrier was completed in November 1998 (USFWS 2001). Construction of the barrier began in November 2000 and was completed in early April 2001 (R. Clarkson, pers. comm.).

The results of the last two years of sampling (1999 and 2000) will provide baseline data for the fish community of Aravaipa Creek at the time of barrier construction, and can be used in the future to determine the effectiveness of the completed fish barrier over time.

#### METHODS

The AGFD, BLM, TNC, and volunteers monitored Aravaipa Creek on October 18-20, 1999; and November 27-29, 2000. In 2000, sampling was first attempted October 10-11, but a large flash flood moved through the canyon, and the trip was cancelled and rescheduled for November. Sampling was conducted at nine set stations dispersed through the perennial portions of Aravaipa Creek (Appendix A).

The nine set sampling stations were divided between three reaches of Aravaipa Creek that correspond with the creek's three distinct geomorphic reaches: 1) the upper reach, flowing through a broad valley for about 17 km, 2) the middle reach, flowing through the narrow, sheer-walled Aravaipa Canyon for about 10 km, and 3) the lower reach, flowing through a steep-sided valley (Barber and Minckley 1966, Siebert 1980, Williams 1991, Kubly 1995). Each of the three reaches comprised three sampling stations: the upper reach (East End) - includes the Guest House, Chimney Rock, and Turkey Creek stations; the middle reach (Wilderness Area) - includes the Hell Hole, Horse Camp, and Painted Cave stations; and the lower reach (West End) - includes the Wagner Ranch, White's Ranch, and Sycamore Tree stations.

At each station, a 200-m reach of stream was measured and divided into subhabitats classified sequentially as run, rifle, or pool (adapted from McCain and others 1990). Within each subhabitat, the following information was recorded: subhabitat length, up to three widths, dominant substrates (see Appendix B for the code sheet used to classify different substrates), maximum water depth, and available cover. Cover types identified were overhanging vegetation (OV) within 1 m above the stream surface, bedrock ledge (BL), undercut bank (UB), woody debris (WD), and emergent vegetation (EV). Each cover type was measured to determine the amount in square meters of cover available. A summary of subhabitat measurements recorded is provided in Appendix D.

Beginning at the upstream end of each station, all subhabitats within the 200-m station were seined (seines used were primarily 15 ft x 4 ft x ¼ in, and a standard seine haul covered approximately twice the length of the seine) in a downstream direction to the end of the station. Within each subhabitat type, we estimated the actual area sampled in comparison to the total area available. Once the seining portion of sampling was complete, the lower half of the sampling station (100 m) was then shocked with a Smith-Root Model 12 backpack electrofisher. Where stream flow was swift, a seine was used to block the downstream end about 10 m below the shocker. The electrofisher then proceeded downstream stunning fish and allowing the current to carry them into the net. All fish captured by seining or electrofishing were identified by species, noted as adult or juvenile (see Appendix C for the code sheet used to define the total lengths separating adults from juveniles per species), enumerated, and released (nonnative fishes were removed permanently, or in the case of red shiner, preserved in 10% formalin and deposited at the ASU Museum of Fishes).

Six photographs were taken at each station. Photographs were taken looking upstream and downstream at the upper, middle, and lower portions of the station. A photolog is on repository at AGFD's Native Fish Program, with color negatives available upon request for duplication.

## RESULTS AND DISCUSSION

Tabular and graphical results of the 1999-2000 Aravaipa Creek Fish Monitoring Project are presented in Tables 1-13 and Figures 3-17.

The following abbreviations are used to identify fish species in both tables and figures: AGCH = *Agosia chrysogaster* (longfin dace), CAIN = *Catostomus insignis* (Sonora sucker), GIRO = *Gila robusta* (roundtail chub), MEFU = *Meda fulgida* (spikedace), PACL = *Pantosteus clarki* (desert sucker), RHOS = *Rhinichthys osculus* (speckled dace), TICO = *Tiaroga cobitis* (loach minnow), AMNA = *Ameiurus natalis* (yellow bullhead), CYLU = *Cyprinella lutrensis* (red shiner), GAAF = *Gambusia affinis* (mosquitofish), and LECY = *Lepomis cyanellus* (green sunfish).

### TRENDS IN THE FISH COMMUNITY

Overall, fish collection numbers were lower in 2000 than in 1999 (Table 1). The most plausible reason for the lower numbers of fish collected in 2000 is that sampling took place in November of 2000, while in 1999 sampling took place in October. Based on quarterly sampling conducted at Aravaipa Creek by Bettaso and others (1995) during 1992-1994, fish collection numbers generally reached their highest point in August, followed by sharp decline throughout the autumn and winter months, with collection numbers rising in the late spring and early summer months.

#### Loach Minnow

The loach minnow, federally listed as threatened (USFWS 1986a), was once common throughout mainstem and perennial tributaries of the Verde, Salt, San Pedro, San Francisco, and Gila rivers, occupying turbulent riffles with gravel or cobble substrates (AGFD 2001a). Despite a severe reduction in range due to habitat loss and competition with nonnative species, the loach minnow

maintains a fairly stable population in Aravaipa Creek. Critical habitat designated for the loach minnow includes Aravaipa Creek and the lower reaches of Deer and Turkey creeks, both tributaries of Aravaipa Creek (USFWS 2000).

Loach minnow were one of the most common fish collected at the East End reach in 1999 and 2000, as were longfin dace and spikedace. It was also the most common fish collected in the Wilderness Area reach in 1999, but in 2000 was only the fourth-most common fish collected in the Wilderness Area. The difference in abundances of loach minnow that we noted between years in the Wilderness Area may be accounted for by the decline in riffle habitat in 2000 (Fig. 20).

Electrofishing captured substantially more loach minnow than did seining. For example, loach minnow catch-per-unit-effort (CPUE, number of fish per 10 m<sup>2</sup> of habitat) was 20 times higher for electrofishing versus seining at the Chimney Rock station in 1999 (Tables 11, 12). Percent relative abundance for loach minnow captured by electrofishing was as high as 51.9% (East End, 2000) and as low 9.2% (West End, 1999) (Figs. 7-8). Temporally, loach minnow percent relative abundance was higher in 2000 than in 1999 (23.8% of the overall catch in 2000 and 16.8% of the overall catch in 1999) (Fig. 17).

#### Spikedace

The spikedace, federally listed as threatened (USFWS 1996b), was formerly widespread in the Gila River basin, occupying midwater habitats of runs, pools, and eddies (AGFD 2001b). Despite a severe reduction in range due to habitat loss and competition with nonnative species, the spikedace maintains a fairly stable population in Aravaipa Creek. Critical habitat designated for the spikedace includes approximately 45.3 kilometers (km) of Aravaipa Creek, extending upstream from the confluence with the San Pedro River (USFWS 2000).

The total number of spikedace collected in 1999 was 15 times greater than the number collected in 2000 (1025 collected in 1999 versus 68 in 2000) (Table 1). Overall percent relative abundance for spikedace dropped from 24.7% of the total catch in 1999 to 5.2% of the total catch in 2000 (Fig. 17). This reduction in relative abundance is likely not caused by differences in habitat characteristics, as temporal variability in spikedace abundance has been noted in other studies (McNatt 1993, Bettaso and others 1995, Propst 1999).

Spatially, spikedace were more common in the East End and Wilderness Area stations, and almost completely absent from the West End stations. In both 1999 and 2000, seining captured over twice as many spikedace as did electrofishing (Table 1).

#### Roundtail Chub

The largest cyprinid in Aravaipa Creek is the roundtail chub. Once common throughout the Colorado River basin and its tributaries, the roundtail chub's range and distribution has shrunk substantially, although there are still streams where the roundtail chub remains common to abundant (Voeltz 2002).

Roundtail chubs were infrequently caught during this study. Chubs consistently comprised less than three percent of the catch (both seining and electrofishing), and at several stations no chubs were collected (Figs. 5-17). Chubs were found in their highest numbers at the East End reach, lower numbers in the Wilderness Area, and absent from the West End reach in both years of sampling (Table 1).

The low number of chubs collected in Aravaipa Creek may reflect their ability to outswim seine nets or dive deep into cover and out of the range of electrofishers. Additionally, the presence of pools, a primary chub habitat, comprised only a very small portion of all habitat types at the stations sampled (Fig. 18). Overall, adults were more frequently captured than juveniles, and electrofishers captured more chubs than seines.

#### Longfin Dace

The longfin dace is one of the most common native fishes in Arizona, occupying a fairly wide range of habitats from intermittent desert streams to clear, cool streams at higher elevations (AGFD 2001c).

Overall, longfin dace was the most collected species, representing 37.9% of the total number of fish caught in 1999 and 51.6% of the total number of fish caught in 2000 (Fig. 17). Longfin dace were more frequently caught at the East End or West End stations than in the Wilderness Area (Table 1). In both 1999 and 2000, only around 10% of all the longfin dace caught were from the Wilderness Area. This may be explained by the general differences in habitat structure between the East and West End sites versus those in the Wilderness Area. The sites that comprise the upper and lower reaches are generally flatter and more alluvial than that of the middle reach, and contain more shallow, braided sections with a higher percentage of sand and smaller sized substrates, providing ideal habitats for longfin dace.

Seining and electrofishing were similarly effective at collecting longfin dace in 1999 and 2000 (Table 13): Seining 1999 - 0.698 CPUE per 10 m<sup>2</sup>; Electrofishing 1999 - 0.987 CPUE per 10 m<sup>2</sup>; Seining 2000 - 0.363 CPUE per 10 m<sup>2</sup>; Electrofishing 2000 - 0.462 CPUE per 10 m<sup>2</sup>.

#### Speckled Dace

The speckled dace is considered the most ubiquitous fish in the western United States, occupying riffles, runs, and shallow pools in small to medium rivers (Page and Burr 1991). In Arizona, the speckled dace is found throughout the Bill Williams, Little Colorado, and Gila River basins (AGFD 2001d).

Despite the above generalizations, the speckled dace was the least encountered native fish during the two sampling trips, similar to the findings by Bettaso and others (1995). Speckled dace comprised less than 1% of the total number of fish collected in both 1999 and 2000 (Fig. 17). Because speckled dace captures were rare, it is difficult to interpret their spatial or temporal distribution or patterns of habitat use/preference. All of the speckled dace were caught at the East End reach, with electrofishing capturing over five times as many speckled dace as seining.

### Sonora Sucker

The Sonora sucker is found throughout the Bill Williams and Gila River basins, occupying a variety of habitats from warm water rivers to cool, high elevation streams in pools or deep runs with gravelly substrates (AGFD 2001e).

Of the two native suckers found in Aravaipa Creek, the Sonora sucker appears to be the rarer species, comprising only 5.7% and 4.9% of all fish species collected in both 1999 and 2000 (Fig. 17), respectively. Only roundtail chub and speckled dace were less frequently captured than Sonora sucker in 1999 and 2000.

Sonora suckers were more frequently found in the Wilderness Area in 2000 (Fig. 8), perhaps due to a slight increase in run habitat (Fig. 20) from 1999. In 1999, electrofishing captured five times as many Sonora suckers as did seining. In 2000, electrofishing captured 13 times as many Sonora suckers as did seining.

### Desert Sucker

The desert sucker is found throughout the Bill Williams and Gila River basins, occupying riffles or flowing pools with gravel/cobble substrates (AGFD 2001f).

Desert suckers, though not common, were not as rare as Sonora suckers, roundtail chubs, or speckled dace, and comprised 8.9% and 10.9% of all fish collected in 1999 and 2000 (Fig. 17), respectively. Desert suckers were the second most common fish collected in the Wilderness Area in 2000 (Table 1), perhaps due to subtle changes in habitat types within and between reaches. With the exception of 2000 in the Wilderness Area, electrofishing was the most effective gear type for collecting desert suckers (in 2000, electrofishing captured 28.2%, seining captured 30.0%) (Figs. 11-16).

### Nonnative Fish Species

The three species of nonnative fishes that were collected in 1999 and 2000 were yellow bullhead, red shiner, and green sunfish. Mosquitofish were collected in 1999, but not in 2000. Generally, nonnative fish abundance was highest at the West End stations, lower in the Wilderness Area, and absent from the East End stations, with the exception of one green sunfish collected at the Turkey Creek station in 1999. Electrofishing captured more yellow bullhead and green sunfish, and seining captured more red shiner and mosquitofish.

Red shiners, absent from all collections during 1992-1994 (Bettaso and others 1995), were collected in 1999 from the Painted Cave, Wagner Ranch, and White's Ranch stations. In 2000, red shiners were collected from the Painted Cave, Wagner Ranch, White's Ranch, and Sycamore Tree stations. The completion of the fish barriers on lower Aravaipa Creek should reduce the likelihood of a new influx of red shiners entering Aravaipa Creek from the San Pedro River; however, the relative abundance of red shiner was over 10% below the fish barriers during sampling conducted in October 2001 by USBR (Messing 2001).

## HABITAT

Appendix D contains the tabulations of habitat data collected during the 1999-2000 monitoring of Aravaipa Creek. Figure 18 compares macrohabitat percentages for Aravaipa Creek by year, and Figures 19-21 compare macrohabitat percentages, by reach, for 1999 and 2000. Appendix D differentiates habitat available vs. habitat sampled. Tables 8-13 give total area of habitat sampled and numbers of fish collected in each habitat type, for each year.

In 1999, runs totaled 8666 m<sup>2</sup> of habitat available, riffles totaled 5793 m<sup>2</sup>, pools totaled 529 m<sup>2</sup>, and backwaters totaled 78 m<sup>2</sup>. In 2000, runs totaled 8104 m<sup>2</sup>, riffles totaled 2966 m<sup>2</sup>, pools totaled 4 m<sup>2</sup>, and backwaters totaled 130 m<sup>2</sup>.

In 1999, the East End sampling reach had the highest percentage of run habitat (70.5%), while the West End had the highest percentage of riffle habitat (51.9%). The West End also had the greatest percentage of pool habitat (4.4%), while the East End comprised the greatest percentage of backwater habitat (1.1%). Note that these percentages include habitat measurements collected at the Sycamore Tree site for 1999 (These percentages differ slightly from Figure 21). Because these measurements were not collected in 2000 at the Sycamore Tree site, Figure 21 depicts the data without the 1999 Sycamore Tree measurements, so that two years of data can be compared.

In 2000, the Wilderness Area sampling reach had the highest percentage of run habitat (78.2%), while the East End reach had the highest riffle habitat percentage (32.0%). The East End was the only reach with pool habitat, comprising only 0.1% of the total habitat for that reach, while the Wilderness area comprised the greatest percentage of backwater habitat (3.2%).

## MANAGEMENT OPTIONS

The data compiled within this report were collected before fish barriers at the West End were constructed and finalized. At that time, the threat of nonnative species invasion continued to stem from the movement of fish from the confluence of the San Pedro River into the western portions of Aravaipa Creek. Now that barriers are in place, we believe that monitoring efforts should focus on the areas of Aravaipa Creek above, below, and in-between the fish barriers to determine their effectiveness in preventing nonnative fish species from entering Aravaipa Creek from the San Pedro River.

In addition to routine monitoring of the creek itself, a systematic and comprehensive watershed fish survey (including cattle tanks) should be completed, with data disseminated to interested parties and agencies, especially if nonnative fishes are a continual presence above the new barriers. If warranted, a nonnative fish eradication project should be conducted in the watershed.

The data collected from 1999 and 2000 should be added to a larger data set, including all historic AGFD, BLM, TNC and ASU collections over the last several decades. These data, incorporated with current information on the effectiveness of the barriers, can then be used to determine past, current, and future trends of the native fish communities of Aravaipa Creek.

One of the greatest opportunities for the protection of Aravaipa Creek fishes lies with public education and public relations. The Aravaipa Canyon Wilderness Area, under the management of BLM, is located within an easy drive of Arizona's two largest metropolitan centers. Urban growth, coupled with an increasing desire among urban dwellers to escape the city for weekend forays into natural areas, has the potential to negatively impact Aravaipa Creek. Currently, BLM allows for permitted use with the Aravaipa Canyon Wilderness Area of 50 people per day. Given the present and projected recreation use of the Aravaipa Canyon Wilderness Area, much more is needed in the way of interpretive displays, posters, brochures, and guided nature hikes/talks conducted by personnel from AGFD, BLM, and TNC.

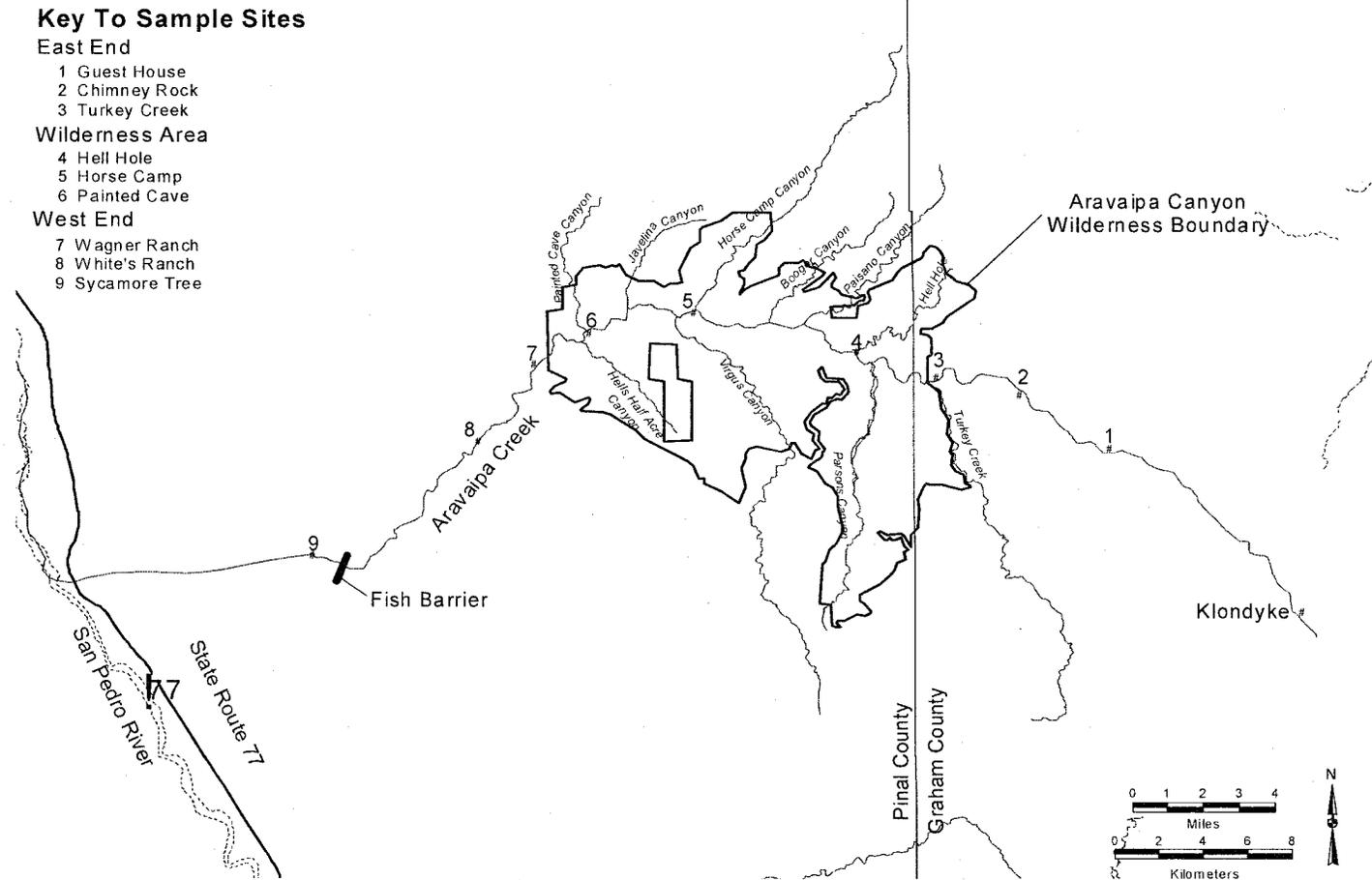


Figure 1. Map of Aravaipa Creek, Graham and Pinal Counties, Arizona; showing sampling sites and major tributaries.

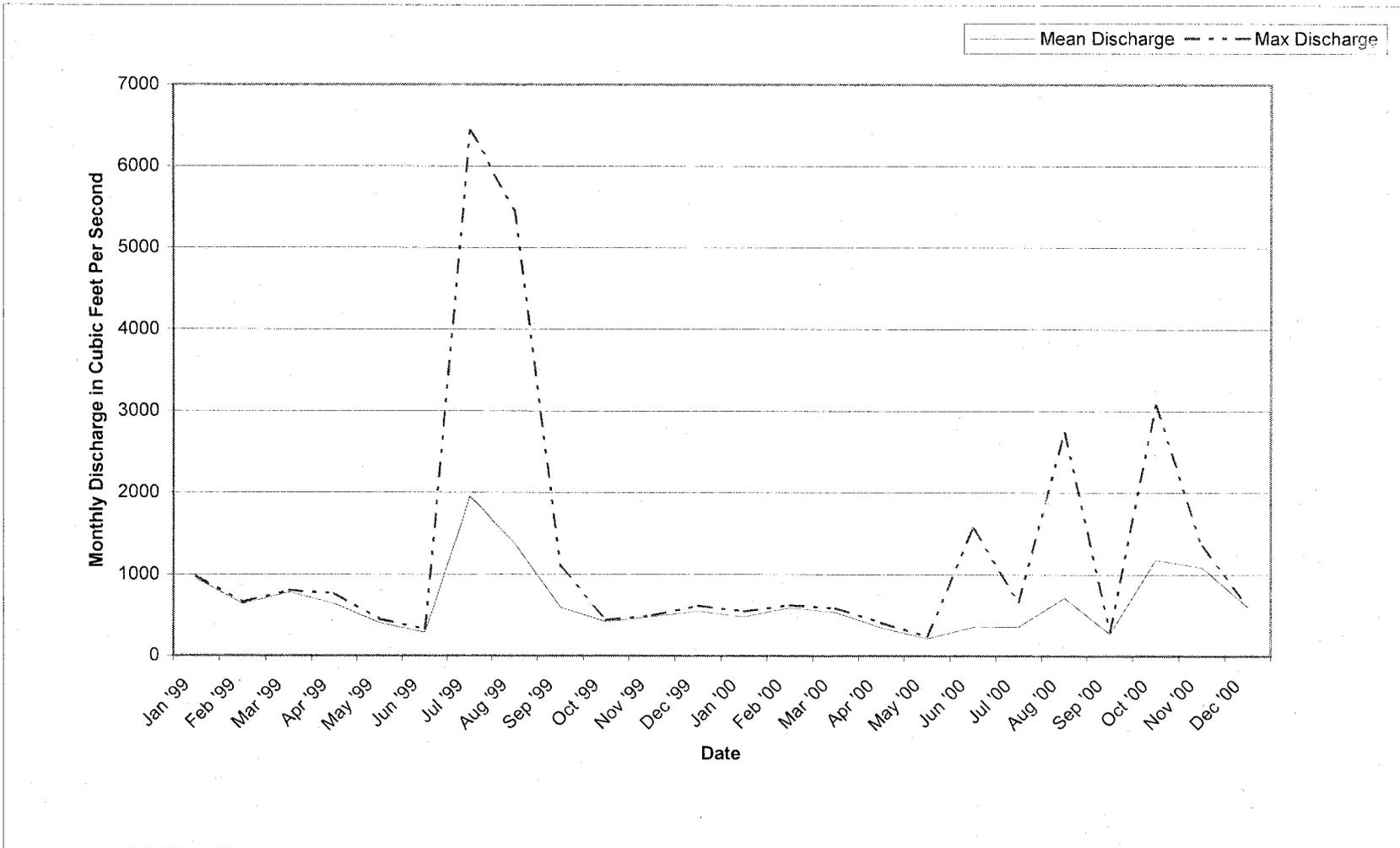


Figure 2. Hydrograph of monthly mean and maximum discharge for Aravaipa Creek for 1999-2000 (USGS 2001).

Table 1. Total number of fish collected by electrofishing and seining, by reach, from Aravaipa Creek, 1999-2000.

Electrofishing								
Species	East End		Wilderness Area		West End		Total	
	1999	2000	1999	2000	1999	2000 <sup>a</sup>	1999	2000
AGCH	203	116	89	54	477	98	769	268
CAIN	110	16	29	35	58	10	197	61
GIRO	25	2	10	2	0	0	35	4
MEFU	188	12	148	7	2	0	338	19
PACL	208	18	99	50	27	25	334	93
RHOS	20	11	0	0	0	0	20	11
TICO	423	189	160	21	62	63	645	273
AMNA	0	0	0	2	30	1	30	3
CYLU	0	0	2	0	7	0	9	0
GAAF	0	0	0	0	3	0	3	0
LECY	0	0	0	6	11	2	11	8
Seining								
Species	East End		Wilderness Area		West End		Total	
	1999	2000	1999	2000	1999	2000 <sup>a</sup>	1999	2000
AGCH	277	285	43	49	476	73	801	407
CAIN	13	0	2	3	25	0	40	3
GIRO	6	0	3	0	0	0	9	0
MEFU	619	23	68	26	0	0	687	49
PACL	24	5	8	42	4	3	36	50
RHOS	5	1	0	0	0	0	5	1
TICO	41	23	7	9	7	7	55	39
AMNA	0	0	0	1	0	0	0	1
CYLU	0	0	4	0	32	9	36	9
GAAF	0	0	0	0	82	0	82	0
LECY	1	0	0	10	2	0	3	10

<sup>a</sup> Does not include fish collected at the Sycamore Tree Station in the West End of Aravaipa Creek in 2000. No habitat measurements were collected and fish were not sorted by habitat type. An additional 218 AGCH, 28 PACL, 14 AMNA, 13 CYLU, and 1 LECY were collected electrofishing, and an additional 138 AGCH, 5 PACL, and 33 CYLU were collected seining at the Sycamore Tree Station.

Table 2. Total number of fish species, adult and juvenile, collected at the East End sites, by electrofishing, from Aravaipa Creek, 1999-2000.

Species		Site Name						Reach Name	
		Guest House		Chimney Rock		Turkey Creek		East End Total	
		1999	2000	1999	2000	1999	2000	1999	2000
AGCH	Adult	72	18	115	47	0	1	187	66
	Juvenile	0	0	13	48	3	2	16	50
	Total	72	18	128	95	3	3	203	116
CAIN	Adult	32	14	38	0	9	0	79	14
	Juvenile	11	2	20	4	0	0	31	2
	Total	43	16	58	4	9	0	110	16
GIRO	Adult	10	2	0	0	4	0	14	2
	Juvenile	8	0	2	0	1	0	11	0
	Total	18	2	2	0	5	0	25	2
MEFU	Adult	56	8	86	0	42	3	184	11
	Juvenile	0	0	1	1	3	0	4	1
	Total	56	8	87	1	45	3	188	12
PACL	Adult	56	7	26	0	42	2	124	9
	Juvenile	23	7	54	2	7	0	84	9
	Total	79	14	80	2	49	2	208	18
RHOS	Adult	16	1	4	9	0	0	20	10
	Juvenile	0	0	0	1	0	0	0	1
	Total	16	1	4	10	0	0	20	11
TICO	Adult	129	34	212	75	78	62	419	171
	Juvenile	0	1	4	12	0	5	4	18
	Total	129	35	216	87	78	67	423	189
AMNA	Adult	0	0	0	0	0	0	0	0
	Juvenile	0	0	0	0	0	0	0	0
	Total	0	0	0	0	0	0	0	0
CYLU	Adult	0	0	0	0	0	0	0	0
	Juvenile	0	0	0	0	0	0	0	0
	Total	0	0	0	0	0	0	0	0
GAAF	Adult	0	0	0	0	0	0	0	0
	Juvenile	0	0	0	0	0	0	0	0
	Total	0	0	0	0	0	0	0	0
LECY	Adult	0	0	0	0	0	0	0	0
	Juvenile	0	0	0	0	0	0	0	0
	Total	0	0	0	0	0	0	0	0

Table 3. Total number of fish species, adult and juvenile, collected at the East End sites, by seining, from Aravaipa Creek, 1999-2000.

Species		Site Name						Reach Name	
		Guest House		Chimney Rock		Turkey Creek		East End (Total)	
		1999	2000	1999	2000	1999	2000	1999	2000
AGCH	Adult	89	47	30	144	5	13	124	204
	Juvenile	35	1	100	78	18	2	153	81
	Total	124	48	130	222	23	15	277	285
CAIN	Adult	2	0	0	0	2	0	4	0
	Juvenile	2	0	3	0	4	0	9	0
	Total	4	0	3	0	6	0	13	0
GIRO	Adult	0	0	0	0	2	0	2	0
	Juvenile	1	0	0	0	3	0	4	0
	Total	1	0	0	0	5	0	6	0
MEFU	Adult	129	3	196	1	245	19	570	23
	Juvenile	3	0	14	0	32	0	49	0
	Total	132	3	210	1	277	19	619	23
PACL	Adult	8	1	2	0	0	2	10	3
	Juvenile	3	1	11	1	0	0	14	2
	Total	11	2	13	1	0	2	24	5
RHOS	Adult	0	0	4	0	0	0	4	0
	Juvenile	1	1	0	0	0	0	1	1
	Total	1	1	4	0	0	0	5	1
TICO	Adult	20	5	17	6	0	12	37	23
	Juvenile	1	0	3	0	0	0	4	0
	Total	21	5	20	6	0	12	41	23
AMNA	Adult	0	0	0	0	0	0	0	0
	Juvenile	0	0	0	0	0	0	0	0
	Total	0	0	0	0	0	0	0	0
CYLU	Adult	0	0	0	0	0	0	0	0
	Juvenile	0	0	0	0	0	0	0	0
	Total	0	0	0	0	0	0	0	0
GAAF	Adult	0	0	0	0	0	0	0	0
	Juvenile	0	0	0	0	0	0	0	0
	Total	0	0	0	0	0	0	0	0
LECY	Adult	0	0	0	0	1	0	1	0
	Juvenile	0	0	0	0	0	0	0	0
	Total	0	0	0	0	1	0	1	0

Table 4. Total number of fish species, adult and juvenile, collected at the Wilderness Area sites, by electrofishing, from Aravaipa Creek, 1999-2000.

Species		Site Name						Reach Name	
		Hell Hole		Horse Camp		Painted Cave		Wilderness Area Total	
		1999	2000	1999	2000	1999	2000	1999	2000
AGCH	Adult	54	7	0	3	26	42	80	52
	Juvenile	6	1	0	0	3	1	9	2
	Total	60	8	0	3	29	43	89	54
CAIN	Adult	2	4	20	10	0	11	22	25
	Juvenile	1	0	0	9	6	1	7	10
	Total	3	4	20	19	6	12	29	35
GIRO	Adult	0	0	10	2	0	0	10	2
	Juvenile	0	0	0	0	0	0	0	0
	Total	0	0	10	2	0	0	10	2
MEFU	Adult	140	7	0	0	0	0	140	7
	Juvenile	8	0	0	0	0	0	8	0
	Total	148	7	0	0	0	0	148	7
PACL	Adult	28	4	42	11	4	13	74	28
	Juvenile	14	2	6	4	5	16	25	22
	Total	42	6	48	15	9	29	99	50
RHOS	Adult	0	0	0	0	0	0	0	0
	Juvenile	0	0	0	0	0	0	0	0
	Total	0	0	0	0	0	0	0	0
TICO	Adult	92	9	33	7	35	8	160	24
	Juvenile	0	0	0	0	0	1	0	1
	Total	92	9	33	7	35	9	160	25
AMNA	Adult	0	0	0	2	0	0	0	2
	Juvenile	0	0	0	0	0	0	0	0
	Total	0	0	0	2	0	0	0	2
CYLU	Adult	0	0	0	0	2	0	2	0
	Juvenile	0	0	0	0	0	0	0	0
	Total	0	0	0	0	2	0	2	0
GAAF	Adult	0	0	0	0	0	0	0	0
	Juvenile	0	0	0	0	0	0	0	0
	Total	0	0	0	0	0	0	0	0
LECY	Adult	0	0	0	1	0	0	0	1
	Juvenile	0	0	0	5	0	0	0	5
	Total	0	0	0	6	0	0	0	6

Table 5. Total number of fish species, adult and juvenile, collected at the Wilderness Area sites, by seining, from Aravaipa Creek, 1999-2000.

Species		Site Name						Reach Name	
		Hell Hole		Horse Camp		Painted Cave		Wilderness Area Total	
		1999	2000	1999	2000	1999	2000	1999	2000
AGCH	Adult	17	12	5	3	2	19	24	34
	Juvenile	17	14	2	1	0	0	19	15
	Total	34	26	7	4	2	19	43	49
CAIN	Adult	0	0	1	1	0	0	1	1
	Juvenile	0	1	1	1	0	0	1	2
	Total	0	1	2	2	0	0	2	3
GIRO	Adult	0	0	2	0	0	0	2	0
	Juvenile	0	0	1	0	0	0	1	0
	Total	0	0	3	0	0	0	3	0
MEFU	Adult	59	21	0	0	5	0	64	21
	Juvenile	4	5	0	0	0	0	4	5
	Total	63	26	0	0	5	0	68	26
PACL	Adult	0	19	4	0	1	10	5	29
	Juvenile	1	10	2	0	0	3	3	13
	Total	1	29	6	0	1	13	8	42
RHOS	Adult	0	0	0	0	0	0	0	0
	Juvenile	0	0	0	0	0	0	0	0
	Total	0	0	0	0	0	0	0	0
TICO	Adult	6	1	0	2	1	4	7	7
	Juvenile	0	2	0	0	0	0	0	2
	Total	6	3	0	2	1	4	7	9
AMNA	Adult	0	0	0	0	0	0	0	0
	Juvenile	0	0	0	1	0	0	0	1
	Total	0	0	0	1	0	0	0	1
CYLU	Adult	0	0	0	0	4	0	4	0
	Juvenile	0	0	0	0	0	0	0	0
	Total	0	0	0	0	4	0	4	0
GAAF	Adult	0	0	0	0	0	0	0	0
	Juvenile	0	0	0	0	0	0	0	0
	Total	0	0	0	0	0	0	0	0
LECY	Adult	0	0	0	5	0	0	0	5
	Juvenile	0	0	0	5	0	0	0	5
	Total	0	0	0	10	0	0	0	10

Table 6. Total number of fish species, adult and juvenile, collected at the West End sites, by electrofishing, from Aravaipa Creek, 1999-2000.

Species		Site Name						Reach Name	
		Wagner Ranch		White's Ranch		Sycamore Tree		West End Total	
		1999	2000	1999	2000	1999	2000	1999	2000 <sup>a</sup>
AGCH	Adult	310	57	115	29	29	217	454	86
	Juvenile	6	12	17	0	0	1	23	12
	Total	316	69	132	29	29	218	477	98
CAIN	Adult	4	7	2	0	2	0	8	7
	Juvenile	37	3	9	0	4	0	50	3
	Total	41	10	11	0	6	0	58	10
GIRO	Adult	0	0	0	0	0	0	0	0
	Juvenile	0	0	0	0	0	0	0	0
	Total	0	0	0	0	0	0	0	0
MEFU	Adult	2	0	0	0	0	0	2	0
	Juvenile	0	0	0	0	0	0	0	0
	Total	2	0	0	0	0	0	2	0
PACL	Adult	1	4	2	0	0	13	3	4
	Juvenile	21	20	2	1	1	14	24	21
	Total	22	24	4	1	1	27	27	25
RHOS	Adult	0	0	0	0	0	0	0	0
	Juvenile	0	0	0	0	0	0	0	0
	Total	0	0	0	0	0	0	0	0
TICO	Adult	57	44	5	19	0	0	62	63
	Juvenile	0	0	0	0	0	0	0	0
	Total	57	44	5	19	0	0	62	63
AMNA	Adult	2	0	2	0	13	0	17	0
	Juvenile	5	1	7	0	1	0	13	1
	Total	7	1	9	0	14	0	30	1
CYLU	Adult	6	0	1	0	0	13	7	0
	Juvenile	0	0	0	0	0	0	0	0
	Total	6	0	1	0	0	13	7	0
GAAF	Adult	0	0	0	0	3	0	3	0
	Juvenile	0	0	0	0	0	0	0	0
	Total	0	0	0	0	3	0	3	0
LECY	Adult	1	2	3	0	3	0	7	2
	Juvenile	4	0	0	0	0	1	4	1
	Total	5	2	3	0	3	1	11	2

<sup>a</sup> Total does not include numbers of fish that were collected from Sycamore Tree station, as no habitat measurements were collected, and fish were not sorted by habitat type.

Table 7. Total number of fish species, adult and juvenile, collected at the West End sites, by seining, from Aravaipa Creek, 1999-2000.

Species		Site Name						Reach Name	
		Wagner Ranch		White's Ranch		Sycamore Tree		West End Total	
		1999	2000	1999	2000	1999	2000	1999	2000 <sup>a</sup>
AGCH	Adult	121	35	77	32	56	121	254	67
	Juvenile	170	3	50	3	2	17	222	6
	Total	291	38	127	35	58	138	476	73
CAIN	Adult	5	0	1	0	0	0	6	0
	Juvenile	10	0	9	0	0	0	19	0
	Total	15	0	10	0	0	0	25	0
GIRO	Adult	0	0	0	0	0	0	0	0
	Juvenile	0	0	0	0	0	0	0	0
	Total	0	0	0	0	0	0	0	0
MEFU	Adult	0	0	0	0	0	0	0	0
	Juvenile	0	0	0	0	0	0	0	0
	Total	0	0	0	0	0	0	0	0
PACL	Adult	0	0	0	0	0	1	0	3
	Juvenile	2	3	2	0	0	4	4	0
	Total	2	3	2	0	0	5	4	3
RHOS	Adult	0	0	0	0	0	0	0	0
	Juvenile	0	0	0	0	0	0	0	0
	Total	0	0	0	0	0	0	0	0
TICO	Adult	5	5	2	2	0	0	7	7
	Juvenile	0	0	0	0	0	0	0	0
	Total	5	5	2	2	0	0	7	7
AMNA	Adult	0	0	0	0	0	0	0	0
	Juvenile	0	0	0	0	0	0	0	0
	Total	0	0	0	0	0	0	0	0
CYLU	Adult	3	1	0	8	29	26	32	9
	Juvenile	0	0	0	0	0	7	0	0
	Total	3	1	0	8	29	33	32	9
GAAF	Adult	0	0	0	0	82	0	82	0
	Juvenile	0	0	0	0	0	0	0	0
	Total	0	0	0	0	82	0	82	0
LECY	Adult	0	0	2	0	0	0	2	0
	Juvenile	0	0	0	0	0	0	0	0
	Total	0	0	2	0	0	0	2	0

<sup>a</sup> Does not include fish collected from Sycamore Tree station in 2000, as no habitat measurements were collected.

Table 8. Total number of fish species collected by habitat type at the East End stations, 1999-2000.

East End - Electrofishing								
Species	Macrohabitat type (m <sup>2</sup> )							
	Run		Riffle		Pool		Backwater	
	1999 (1526 m <sup>2</sup> )	2000 (1049 m <sup>2</sup> )	1999 (318 m <sup>2</sup> )	2000 (475 m <sup>2</sup> )	1999 (13 m <sup>2</sup> )	2000 (0 m <sup>2</sup> )	1999 (0 m <sup>2</sup> )	2000 (0 m <sup>2</sup> )
AGCH	196	97	6	19	1	N/A	N/A	N/A
CAIN	98	16	0	0	12	N/A	N/A	N/A
GIRO	23	2	0	0	2	N/A	N/A	N/A
MEFU	179	9	7	3	2	N/A	N/A	N/A
PACL	188	8	19	10	1	N/A	N/A	N/A
RHOS	20	10	0	1	0	N/A	N/A	N/A
TICO	351	87	72	102	0	N/A	N/A	N/A
AMNA	0	0	0	0	0	N/A	N/A	N/A
CYLU	0	0	0	0	0	N/A	N/A	N/A
GAAF	0	0	0	0	0	N/A	N/A	N/A
LECY	0	0	0	0	0	N/A	N/A	N/A
East End - Seining								
Species	Macrohabitat type (m <sup>2</sup> )							
	Run		Riffle		Pool		Backwater	
	1999 (2700 m <sup>2</sup> )	2000 (2362 m <sup>2</sup> )	1999 (1028 m <sup>2</sup> )	2000 (1113 m <sup>2</sup> )	1999 (58 m <sup>2</sup> )	2000 (4 m <sup>2</sup> )	1999 (42 m <sup>2</sup> )	2000 (0 m <sup>2</sup> )
AGCH	260	203	16	82	5	0	1	N/A
CAIN	6	0	1	0	1	0	5	N/A
GIRO	1	0	0	0	4	0	1	N/A
MEFU	433	22	58	1	128	0	0	N/A
PACL	16	2	8	3	0	0	0	N/A
RHOS	5	0	0	1	0	0	0	N/A
TICO	37	18	4	5	0	0	0	N/A
AMNA	0	0	0	0	0	0	0	N/A
CYLU	0	0	0	0	0	0	0	N/A
GAAF	0	0	0	0	0	0	0	N/A
LECY	0	0	0	0	0	0	1	N/A

Table 9. Total number of fish species collected by habitat type at the Wilderness Area stations, 1999-2000.

Wilderness Area - Electrofishing								
Species	Macrohabitat type (m <sup>2</sup> )							
	Run		Riffle		Pool		Backwater	
	1999 (1295 m <sup>2</sup> )	2000 (1741 m <sup>2</sup> )	1999 (1567 m <sup>2</sup> )	2000 (607 m <sup>2</sup> )	1999 (0 m <sup>2</sup> )	2000 (0 m <sup>2</sup> )	1999 (0 m <sup>2</sup> )	2000 (88 m <sup>2</sup> )
AGCH	51	49	38	4	N/A	N/A	N/A	1
CAIN	7	25	22	0	N/A	N/A	N/A	10
GIRO	2	0	8	0	N/A	N/A	N/A	2
MEFU	63	4	85	3	N/A	N/A	N/A	0
PACL	14	33	85	4	N/A	N/A	N/A	13
RHOS	0	0	0	0	N/A	N/A	N/A	0
TICO	51	14	109	7	N/A	N/A	N/A	0
AMNA	0	0	0	0	N/A	N/A	N/A	2
CYLU	2	0	0	0	N/A	N/A	N/A	0
GAAF	0	0	0	0	N/A	N/A	N/A	0
LECY	0	0	0	0	N/A	N/A	N/A	6
Wilderness Area - Seining								
Species	Macrohabitat type (m <sup>2</sup> )							
	Run		Riffle		Pool		Backwater	
	1999 (1879 m <sup>2</sup> )	2000 (3206 m <sup>2</sup> )	1999 (1023 m <sup>2</sup> )	2000 (763 m <sup>2</sup> )	1999 (125 m <sup>2</sup> )	2000 (0 m <sup>2</sup> )	1999 (20 m <sup>2</sup> )	2000 (130 m <sup>2</sup> )
AGCH	23	43	20	3	0	N/A	0	3
CAIN	1	1	1	0	0	N/A	0	2
GIRO	0	0	1	0	2	N/A	0	0
MEFU	21	22	47	4	0	N/A	0	0
PACL	5	35	3	7	0	N/A	0	0
RHOS	0	0	0	0	0	N/A	0	0
TICO	4	5	3	4	0	N/A	0	0
AMNA	0	0	0	0	0	N/A	0	1
CYLU	4	0	0	0	0	N/A	0	0
GAAF	0	0	0	0	0	N/A	0	0
LECY	0	0	0	0	0	N/A	0	10

Table 10. Total number of fish species collected by habitat type at the West End stations, 1999-2000.

West End - Electrofishing								
Species	Macrohabitat type (m <sup>2</sup> )							
	Run		Riffle		Pool		Backwater	
	1999 (1991 m <sup>2</sup> )	2000 <sup>a</sup> (824 m <sup>2</sup> )	1999 (818 m <sup>2</sup> )	2000 <sup>a</sup> (1012 m <sup>2</sup> )	1999 (255 m <sup>2</sup> )	2000 <sup>a</sup> (0 m <sup>2</sup> )	1999 (12 m <sup>2</sup> )	2000 <sup>a</sup> (0 m <sup>2</sup> )
AGCH	348	68	129	30	0	N/A	0	N/A
CAIN	34	10	19	0	4	N/A	1	N/A
GIRO	0	0	0	0	0	N/A	0	N/A
MEFU	1	0	1	0	0	N/A	0	N/A
PACL	8	21	19	4	0	N/A	0	N/A
RHOS	0	0	0	0	0	N/A	0	N/A
TICO	23	31	39	32	0	N/A	0	N/A
AMNA	24	1	0	0	6	N/A	0	N/A
CYLU	7	0	0	0	0	N/A	0	N/A
GAAF	0	0	0	0	3	N/A	0	N/A
LECY	11	2	0	0	0	N/A	0	N/A
West End - Seining								
Species	Macrohabitat type (m <sup>2</sup> )							
	Run		Riffle		Pool		Backwater	
	1999 (2011 m <sup>2</sup> )	2000 <sup>a</sup> (2536 m <sup>2</sup> )	1999 (2331 m <sup>2</sup> )	2000 <sup>a</sup> (1090 m <sup>2</sup> )	1999 (255 m <sup>2</sup> )	2000 <sup>a</sup> (0 m <sup>2</sup> )	1999 (0 m <sup>2</sup> )	2000 <sup>a</sup> (0 m <sup>2</sup> )
AGCH	318	59	150	14	8	N/A	N/A	N/A
CAIN	21	0	4	0	0	N/A	N/A	N/A
GIRO	0	0	0	0	0	N/A	N/A	N/A
MEFU	0	0	0	0	0	N/A	N/A	N/A
PACL	1	3	3	0	0	N/A	N/A	N/A
RHOS	0	0	0	0	0	N/A	N/A	N/A
TICO	4	3	3	4	0	N/A	N/A	N/A
AMNA	0	0	0	0	0	N/A	N/A	N/A
CYLU	6	9	1	0	25	N/A	N/A	N/A
GAAF	46	0	4	0	32	N/A	N/A	N/A
LECY	2	0	0	0	0	N/A	N/A	N/A

<sup>a</sup> Habitat measurements were not collected at the Sycamore Tree site in 2000, and are not included in these tables.

Table 11. Catch per unit effort (CPUE, number of fish per 10 m<sup>2</sup>) for all fish species collected by electrofishing, by reach and by station, from Aravaipa Creek, 1999-2000.

Species	East End					
	Guest House		Chimney Rock		Turkey Creek	
	1999	2000	1999	2000	1999	2000
	710 m <sup>2</sup>	488 m <sup>2</sup>	693 m <sup>2</sup>	699 m <sup>2</sup>	454 m <sup>2</sup>	337 m <sup>2</sup>
AGCH	1.014	0.369	1.847	1.359	0.066	0.089
CAIN	0.606	0.328	0.837	0.057	0.198	0
GIRO	0.254	0.041	0.029	0	0.110	0
MEFU	0.789	0.164	1.255	0.014	0.991	0.089
PACL	1.113	0.287	1.154	0.029	1.079	0.059
RHOS	0.225	0.020	0.058	0.143	0	0
TICO	1.187	0.717	3.117	1.245	1.718	1.988
AMNA	0	0	0	0	0	0
CYLU	0	0	0	0	0	0
GAAF	0	0	0	0	0	0
LECY	0	0	0	0	0	0
Species	Wilderness Area					
	Hell Hole		Horse Camp		Painted Cave	
	1999	2000	1999	2000	1999	2000
	1475 m <sup>2</sup>	1166 m <sup>2</sup>	567 m <sup>2</sup>	684 m <sup>2</sup>	820 m <sup>2</sup>	586 m <sup>2</sup>
AGCH	0.407	0.069	0	0.044	0.354	0.734
CAIN	0.020	0.034	0.353	0.278	0.073	0.205
GIRO	0	0	0.176	0.029	0	0
MEFU	1.003	0.060	0	0	0	0
PACL	0.285	0.051	0.847	0.219	0.110	0.495
RHOS	0	0	0	0	0	0
TICO	0.624	0.077	0.582	0.102	0.427	0.154
AMNA	0	0	0	0.029	0	0
CYLU	0	0	0	0	0.024	0
GAAF	0	0	0	0	0	0
LECY	0	0	0	0.088	0	0
Species	West End					
	Wagner Ranch		White's Ranch		Sycamore Tree	
	1999	2000	1999	2000	1999	2000 <sup>a</sup>
	1146 m <sup>2</sup>	916 m <sup>2</sup>	1090 m <sup>2</sup>	920 m <sup>2</sup>	840 m <sup>2</sup>	NR <sup>a</sup>
AGCH	2.757	0.075	1.211	0.315	0.345	NR
CAIN	0.358	0.109	0.101	0	0.071	NR
GIRO	0	0	0	0	0	NR
MEFU	0.017	0	0	0	0	NR
PACL	0.192	0.262	0.037	0.011	0.012	NR
RHOS	0	0	0	0	0	NR
TICO	0.497	0.480	0.046	0.207	0	NR
AMNA	0.061	0.011	0.083	0	0.167	NR
CYLU	0.052	0	0.009	0	0	NR
GAAF	0	0	0	0	0.036	NR
LECY	0.044	0.022	0.028	0	0.036	NR

<sup>a</sup> habitat measurements not recorded (NR) for Sycamore Tree station (2000)

Table 12. Catch per unit effort (CPUE, number of fish per 10 m<sup>2</sup>) for all fish species collected by seining, by reach and by station, from Aravaipa Creek, 1999-2000.

Species	East End					
	Guest House		Chimney Rock		Turkey Creek	
	1999	2000	1999	2000	1999	2000
	1301 m <sup>2</sup>	815 m <sup>2</sup>	1308 m <sup>2</sup>	1336 m <sup>2</sup>	1219 m <sup>2</sup>	1328 m <sup>2</sup>
AGCH	0.953	0.589	0.994	1.662	0.189	0.123
CAIN	0.031	0	0.023	0	0.049	0
GIRO	0.008	0	0	0	0.041	0
MEFU	1.015	0.037	1.606	0.007	1.862	0.143
PACL	0.085	0.025	0.099	0.007	0	0.015
RHOS	0.008	0.012	0.031	0	0	0
TICO	0.161	0.061	0.153	0.045	0	0.090
AMNA	0	0	0	0	0	0
CYLU	0	0	0	0	0	0
GAAF	0	0	0	0	0	0
LECY	0	0	0	0	0.008	0
Species	Wilderness Area					
	Hell Hole		Horse Camp		Painted Cave	
	1999	2000	1999	2000	1999	2000
	1335 m <sup>2</sup>	1682 m <sup>2</sup>	959 m <sup>2</sup>	1331 m <sup>2</sup>	753 m <sup>2</sup>	1086 m <sup>2</sup>
AGCH	0.255	0.155	0.073	0.030	0.027	0.175
CAIN	0	0.006	0.021	0.015	0	0
GIRO	0	0	0.031	0	0	0
MEFU	0.472	0.155	0	0	0.066	0
PACL	0.007	0.172	0.063	0	0.013	0.120
RHOS	0	0	0	0	0	0
TICO	0.045	0.018	0	0.015	0.013	0.037
AMNA	0	0	0	0.008	0	0
CYLU	0	0	0	0	0.053	0
GAAF	0	0	0	0	0	0
LECY	0	0	0	0.075	0	0
Species	West End					
	Wagner Ranch		White's Ranch		Sycamore Tree	
	1999	2000	1999	2000	1999	2000 <sup>a</sup>
	1770 m <sup>2</sup>	1911 m <sup>2</sup>	1336 m <sup>2</sup>	1715 m <sup>2</sup>	1491 m <sup>2</sup>	NR <sup>*</sup>
AGCH	1.644	0.199	0.951	0.204	0.389	NR
CAIN	0.085	0	0.075	0	0	NR
GIRO	0	0	0	0	0	NR
MEFU	0	0	0	0	0	NR
PACL	0.011	0.016	0.015	0	0	NR
RHOS	0	0	0	0	0	NR
TICO	0.028	0.026	0.015	0.012	0	NR
AMNA	0	0	0	0	0	NR
CYLU	0.017	0.005	0	0.047	0.195	NR
GAAF	0	0	0	0	0.550	NR
LECY	0	0	0.015	0	0	NR

<sup>a</sup> habitat measurements not recorded (NR) for Sycamore Tree station (2000)

Table 13. Catch per unit effort (CPUE, number of fish collected per 10 m<sup>2</sup>) for fish collected by electrofishing and seining, by reach, from Aravaipa Creek, 1999-2000.

Electrofishing								
Species	East End		Wilderness Area		West End		Total	
	1999	2000	1999	2000	1999	2000*	1999	2000*
	1857 m <sup>2</sup>	1524 m <sup>2</sup>	2862 m <sup>2</sup>	2436 m <sup>2</sup>	3076 m <sup>2</sup>	1836 m <sup>2</sup>	7795 m <sup>2</sup>	5796 m <sup>2</sup>
AGCH	1.093	0.761	0.311	0.222	1.551	0.534	0.987	0.462
CAIN	0.592	0.105	0.101	0.144	0.119	0.054	0.253	0.105
GIRO	0.135	0.013	0.035	0.008	0	0	0.045	0.007
MEFU	1.102	0.079	0.517	0.029	0.007	0	0.434	0.033
PACL	1.120	0.118	0.346	0.205	0.088	0.136	0.428	0.160
RHOS	0.108	0.072	0	0	0	0	0.026	0.019
TICO	2.290	1.240	0.559	0.086	0.202	0.343	0.827	0.471
AMNA	0	0	0	0.008	0.098	0.005	0.038	0.005
CYLU	0	0	0.007	0	0.023	0	0.012	0
GAAF	0	0	0	0	0.010	0	0.004	0
LECY	0	0	0	0.025	0.036	0.011	0.014	0.014

Seining								
Species	East End		Wilderness Area		West End		Total	
	1999	2000	1999	2000	1999	2000*	1999	2000*
	3828 m <sup>2</sup>	3479 m <sup>2</sup>	3047 m <sup>2</sup>	4099 m <sup>2</sup>	4597 m <sup>2</sup>	3626 m <sup>2</sup>	11,472 m <sup>2</sup>	11,204 m <sup>2</sup>
AGCH	0.724	0.819	0.141	0.120	1.035	0.201	0.698	0.363
CAIN	0.034	0	0.007	0.007	0.054	0	0.172	0.003
GIRO	0.016	0	0.010	0	0	0	0.031	0
MEFU	1.617	0.066	0.223	0.063	0	0	0.295	0.044
PACL	0.063	0.014	0.026	0.102	0.009	0.008	0.291	0.045
RHOS	0.013	0.003	0	0	0	0	0.017	0.001
TICO	0.107	0.066	0.023	0.022	0.015	0.019	0.045	0.035
AMNA	0	0	0	0.002	0	0	0	0.001
CYLU	0	0	0.013	0	0.070	0.025	0.031	0.008
GAAF	0	0	0	0	0.178	0	0.071	0
LECY	0.003	0	0	0.024	0.004	0	0.003	0.009

\* Habitat measurements were not taken for the Sycamore Tree station during the 2000 sampling. Therefore, CPUE calculated for the West End, and for the total CPUE will not include those fish captured at Sycamore Tree during the 2000 sampling.

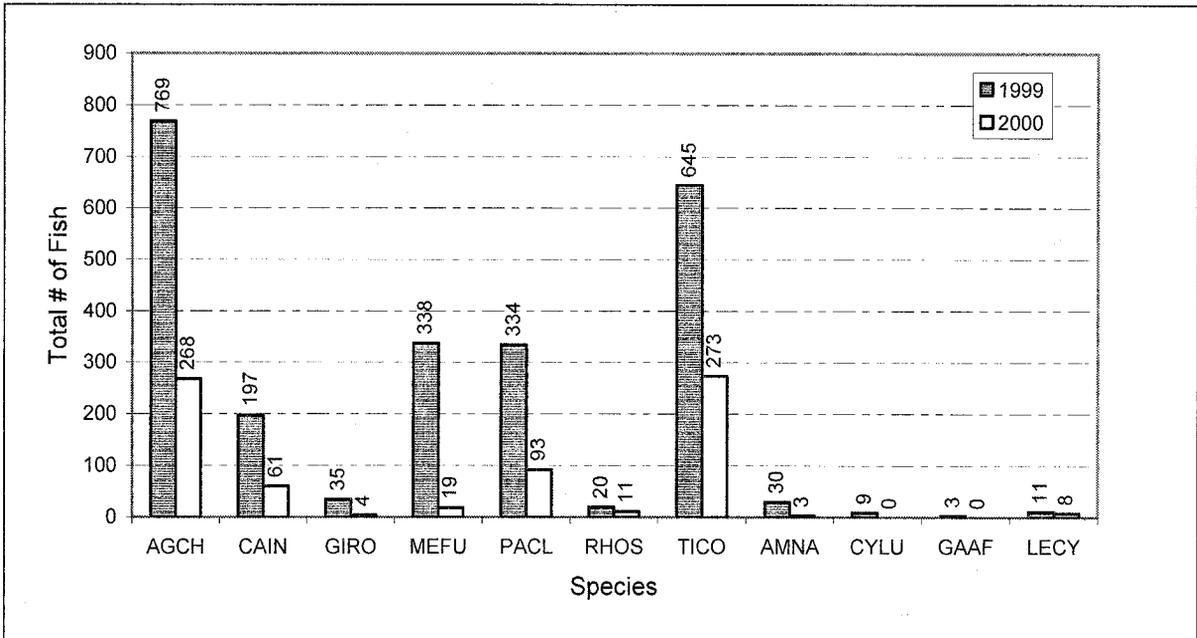


Figure 3. Total number for all fish species collected by electrofishing, by year, from Aravaipa Creek, 1999-2000.

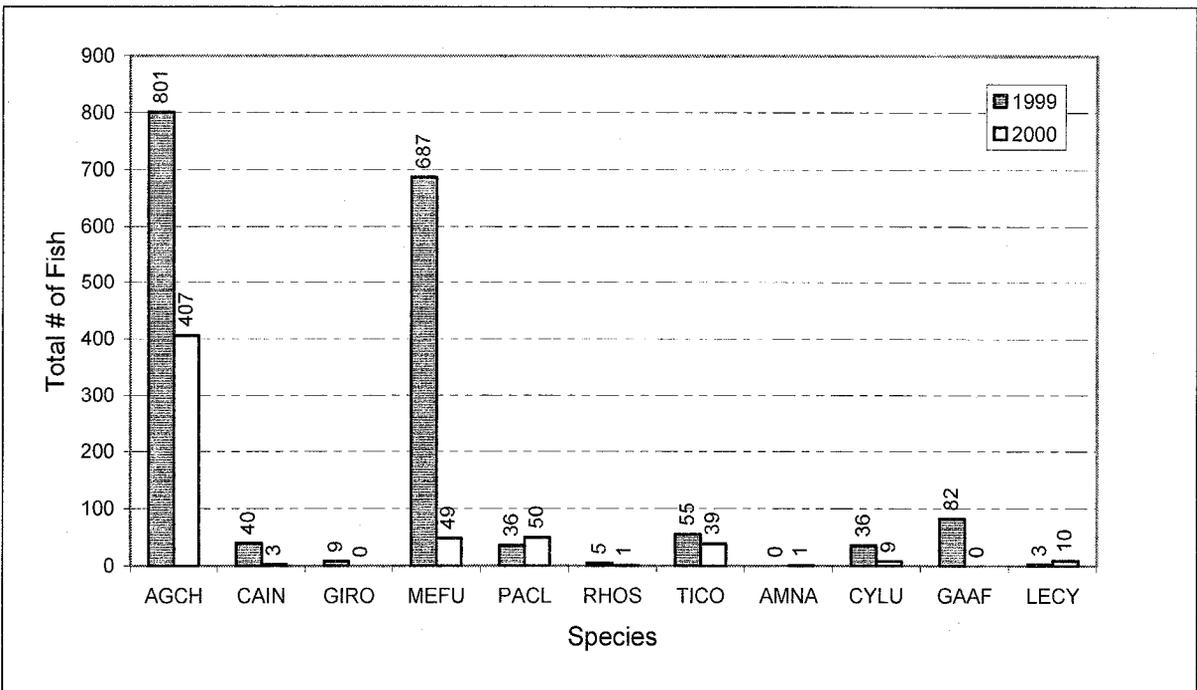


Figure 4. Total number for all fish species collected by seining, by year, from Aravaipa Creek, 1999-2000.

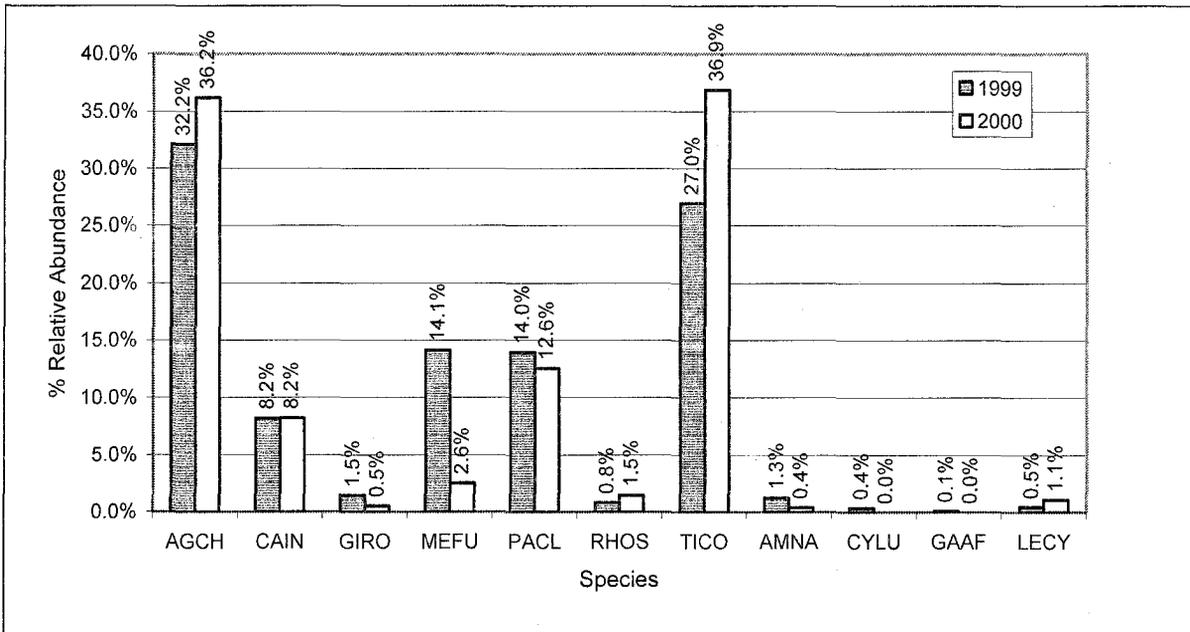


Figure 5. Percent relative abundance for all fish species collected by electrofishing, by year, from Aravaipa Creek, 1999-2000.

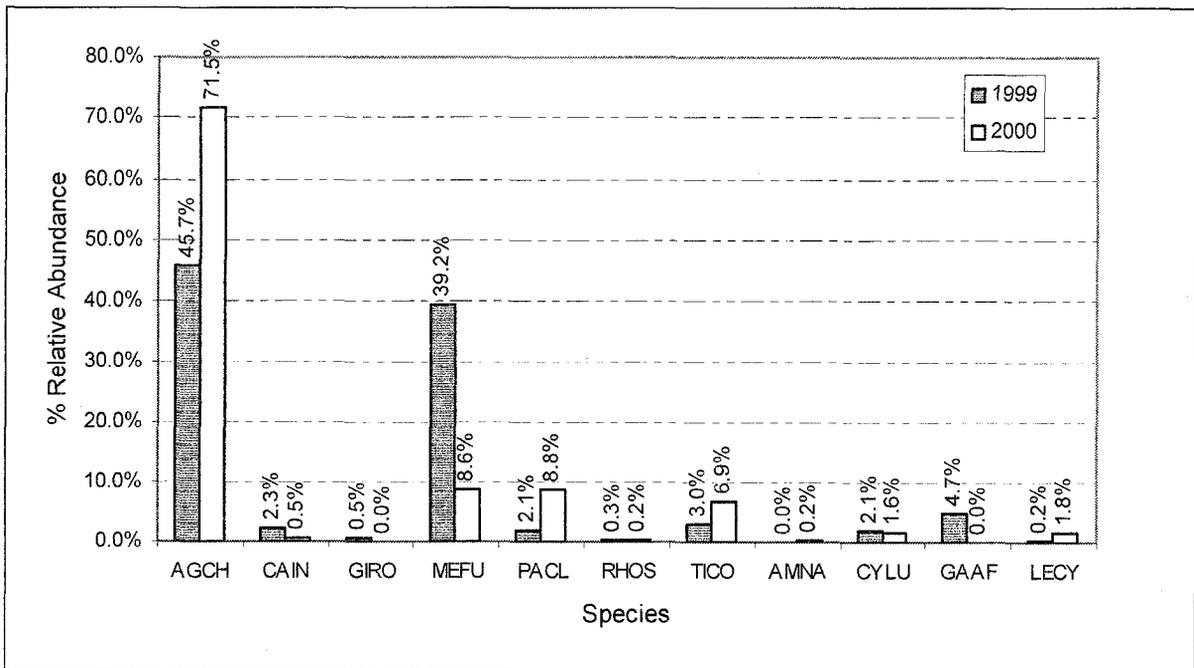


Figure 6. Percent relative abundance for all fish species collected by seining, by year, from Aravaipa Creek, 1999-2000.

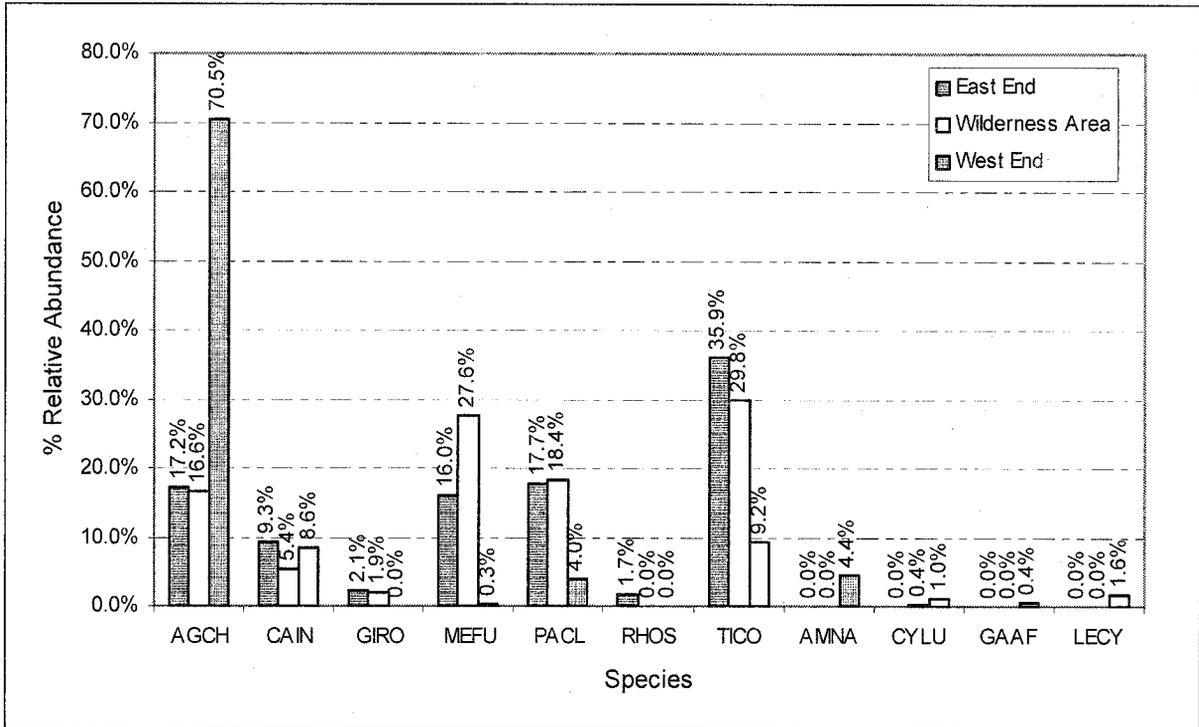


Figure 7. Percent relative abundance for all fish species collected by electrofishing, by reach, from Aravaipa Creek, 1999.

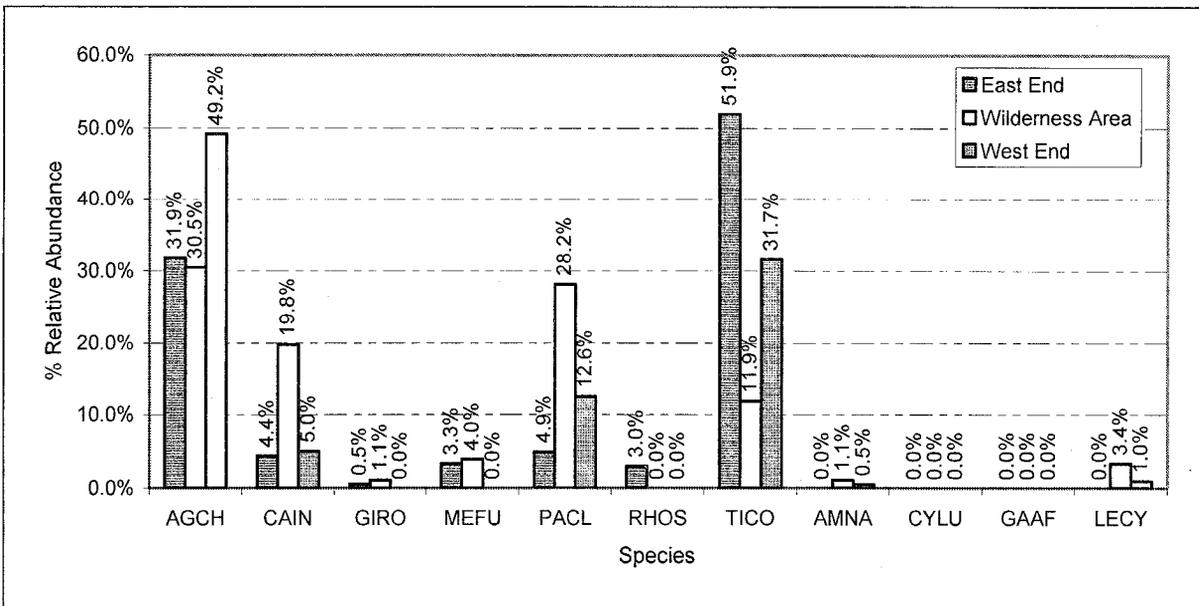


Figure 8. Percent relative abundance for all fish species collected by electrofishing, by reach, from Aravaipa Creek, 2000.

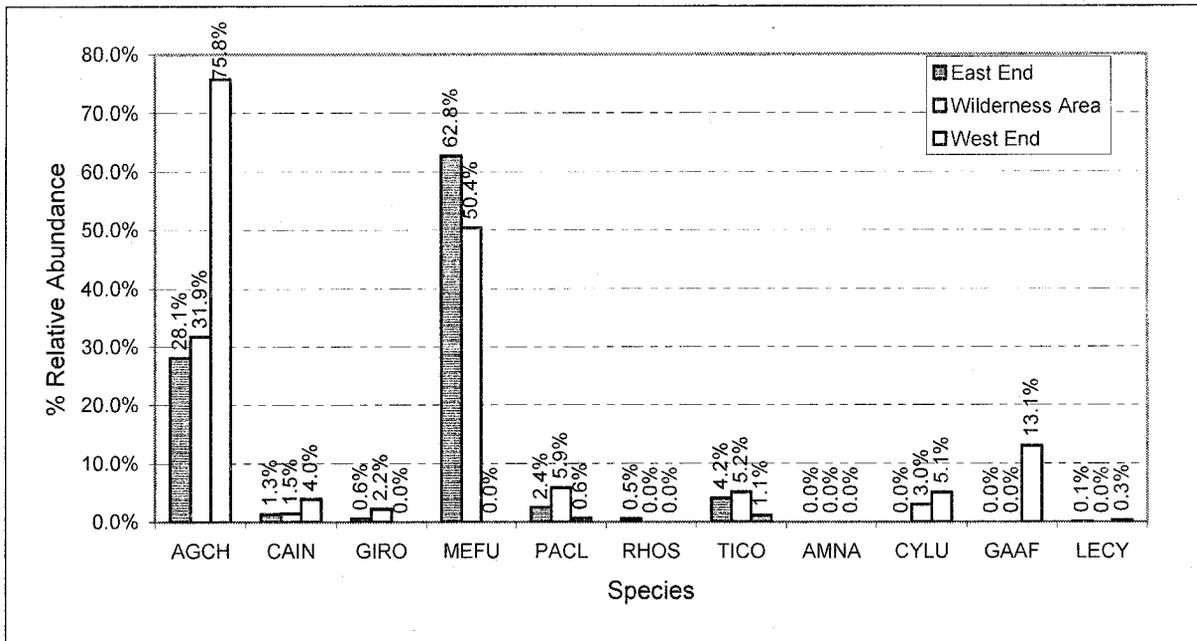


Figure 9. Percent relative abundance for all fish species collected by seining, by reach, from Aravaipa Creek, 1999.

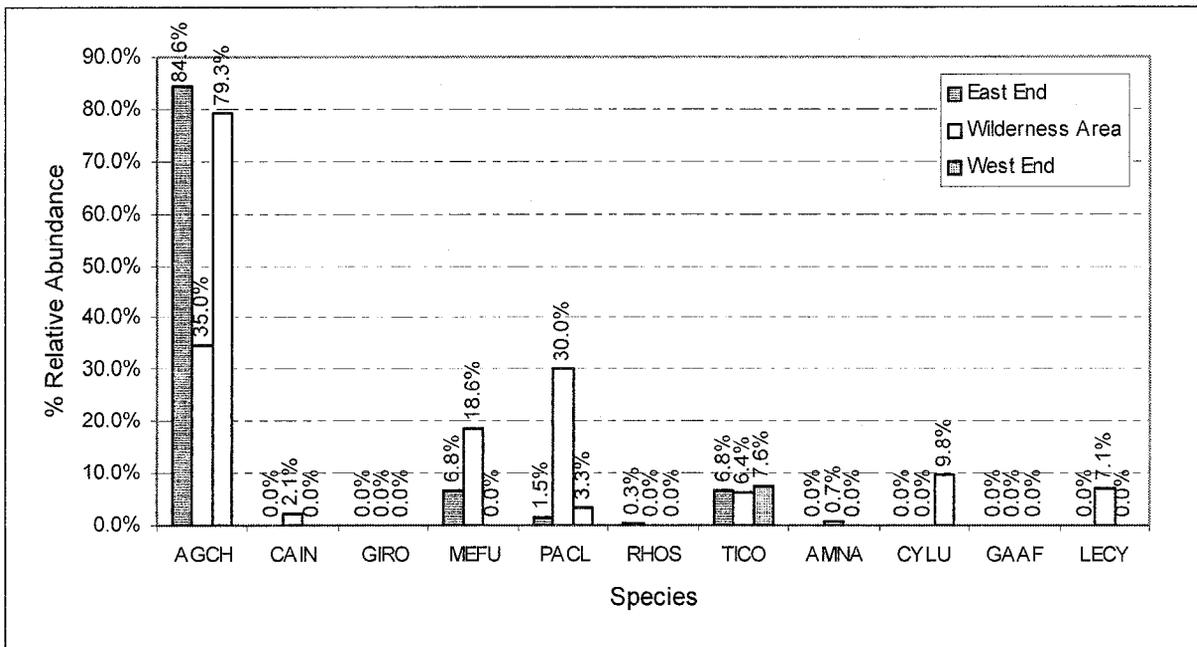


Figure 10. Percent relative abundance for all fish species collected by seining, by reach, from Aravaipa Creek, 2000.

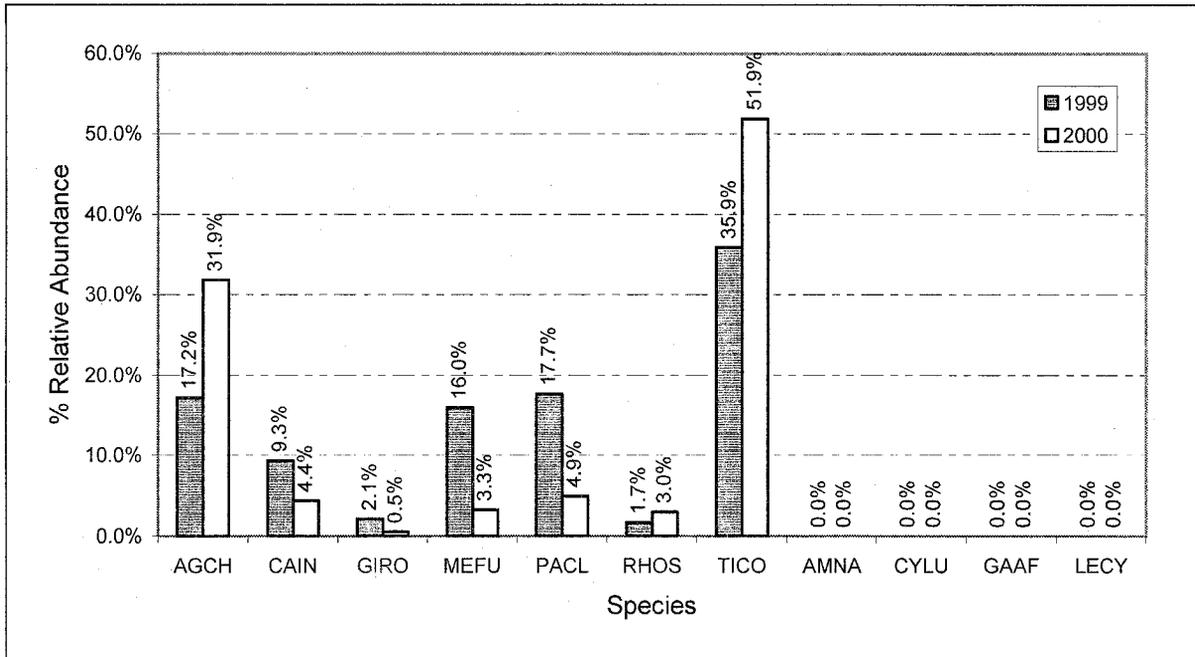


Figure 11. Percent relative abundance for all fish species collected at the East End sites, by electrofishing, from Aravaipa Creek, 1999-2000.

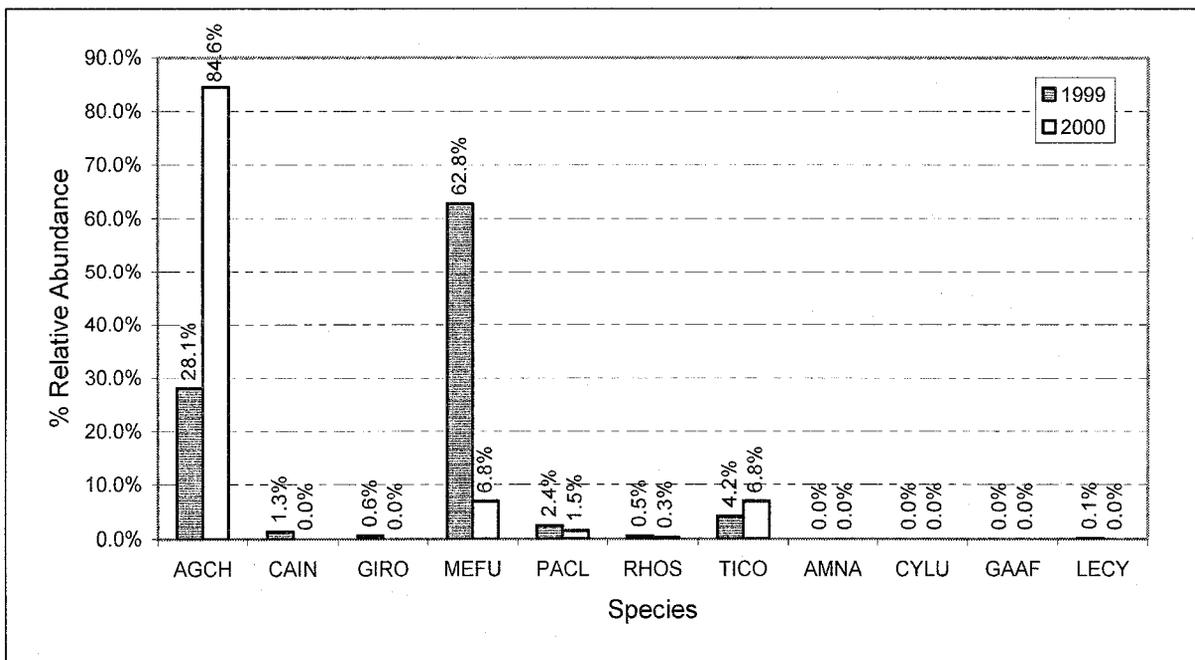


Figure 12. Percent relative abundance for all fish species collected at the East End sites, by seining, from Aravaipa Creek, 1999-2000.

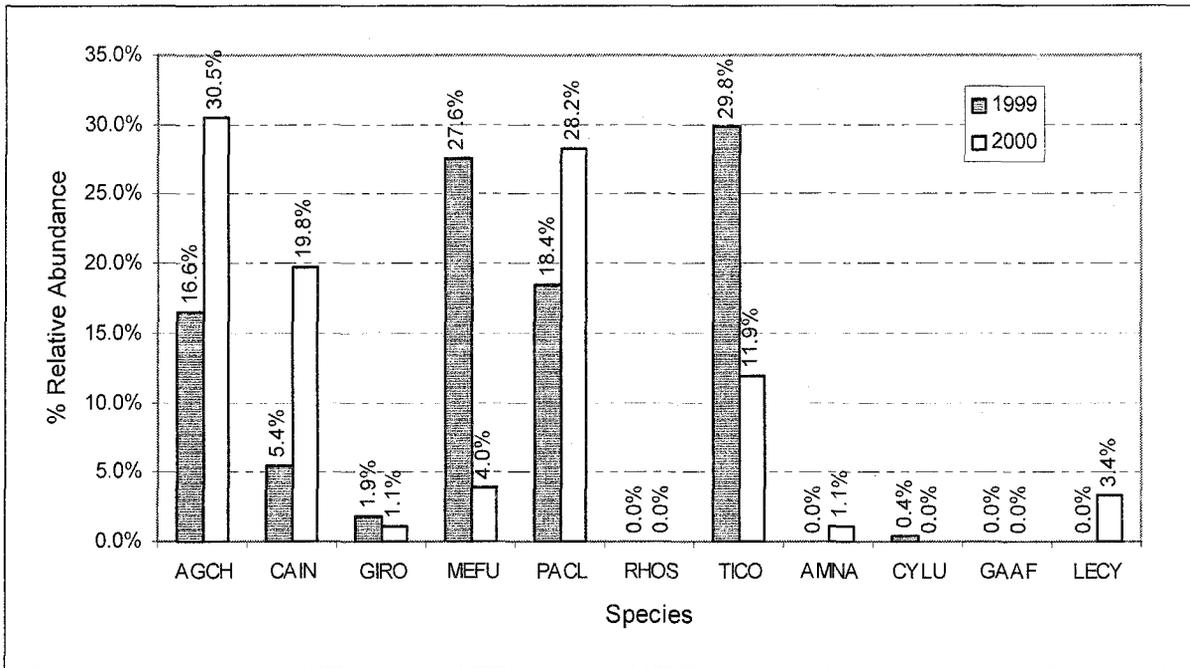


Figure 13. Percent relative abundance for all fish species collected at the Wilderness Area sites, by electrofishing, from Aravaipa Creek, 1999-2000.

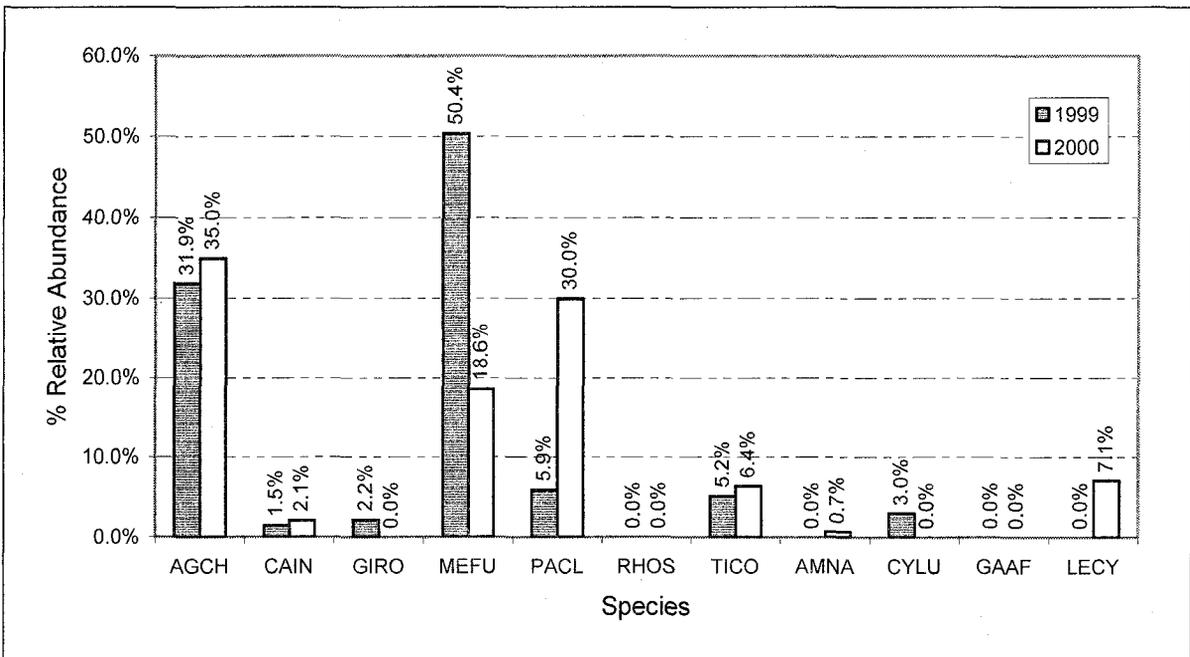


Figure 14. Percent relative abundance for all fish species collected at the Wilderness Area sites, by seining, from Aravaipa Creek, 1999-2000.

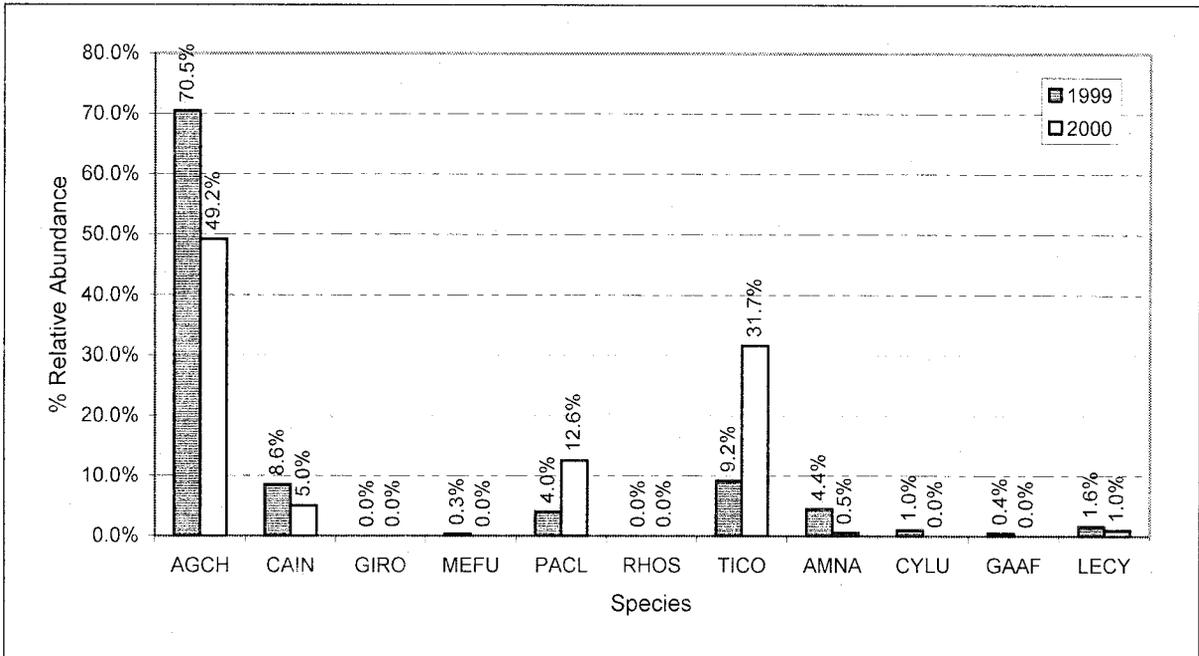


Figure 15. Percent relative abundance for all fish species collected at the West End sites, by electrofishing, from Aravaipa Creek, 1999-2000.

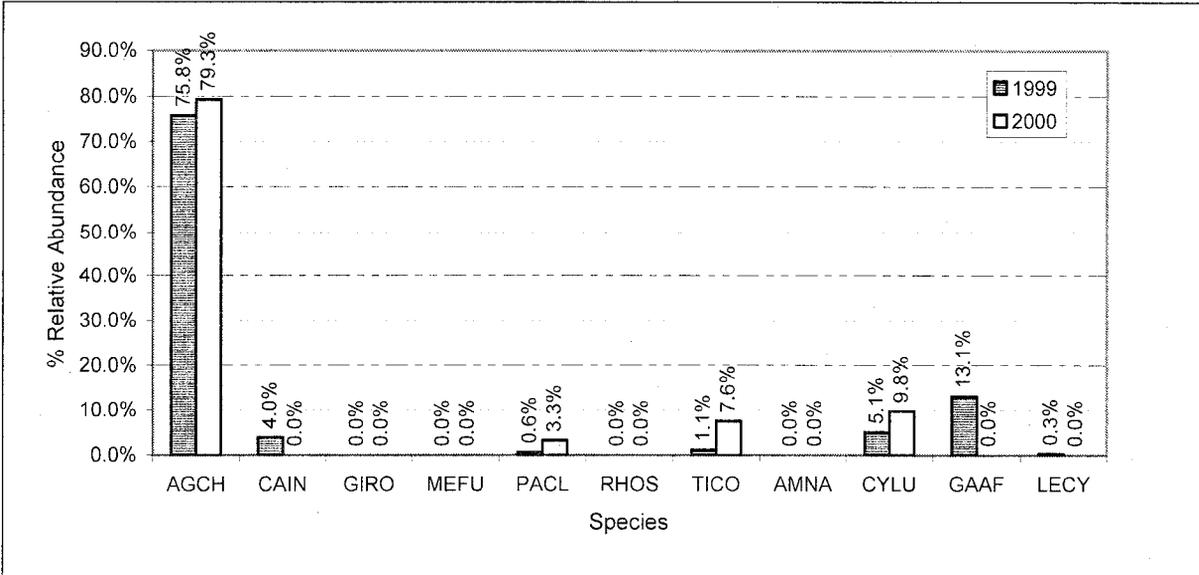


Figure 16. Percent relative abundance for all fish species collected at the West End sites, by seining, from Aravaipa Creek, 1999-2000.

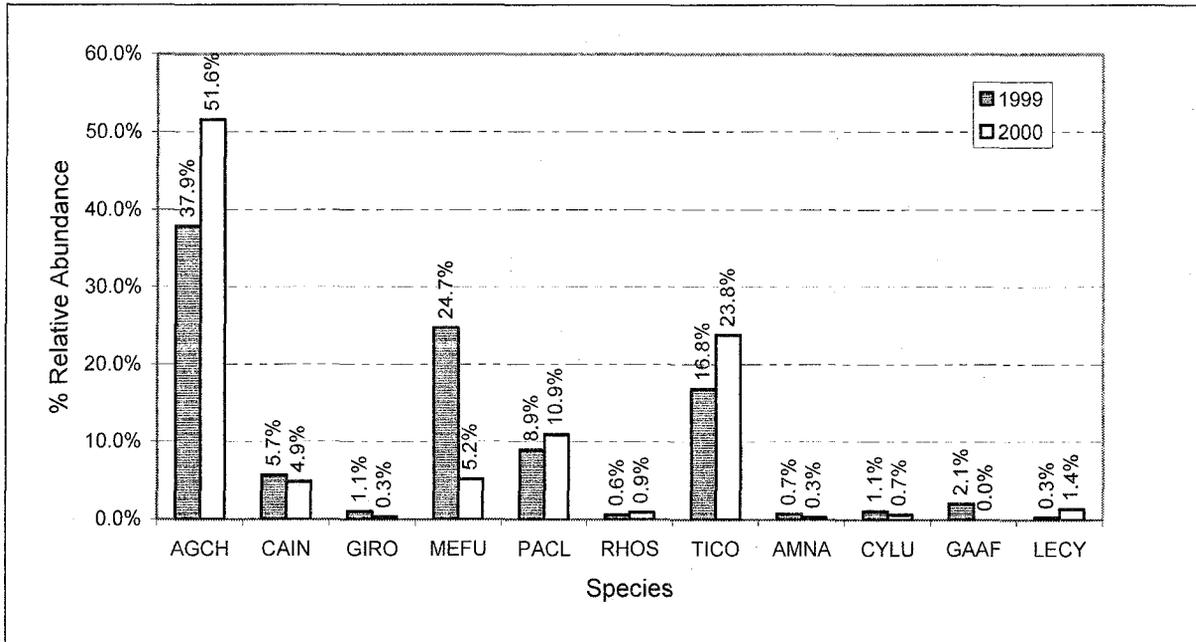


Figure 17. Percent relative abundance for all fish collected, by year, from Aravaipa Creek, 1999-2000.

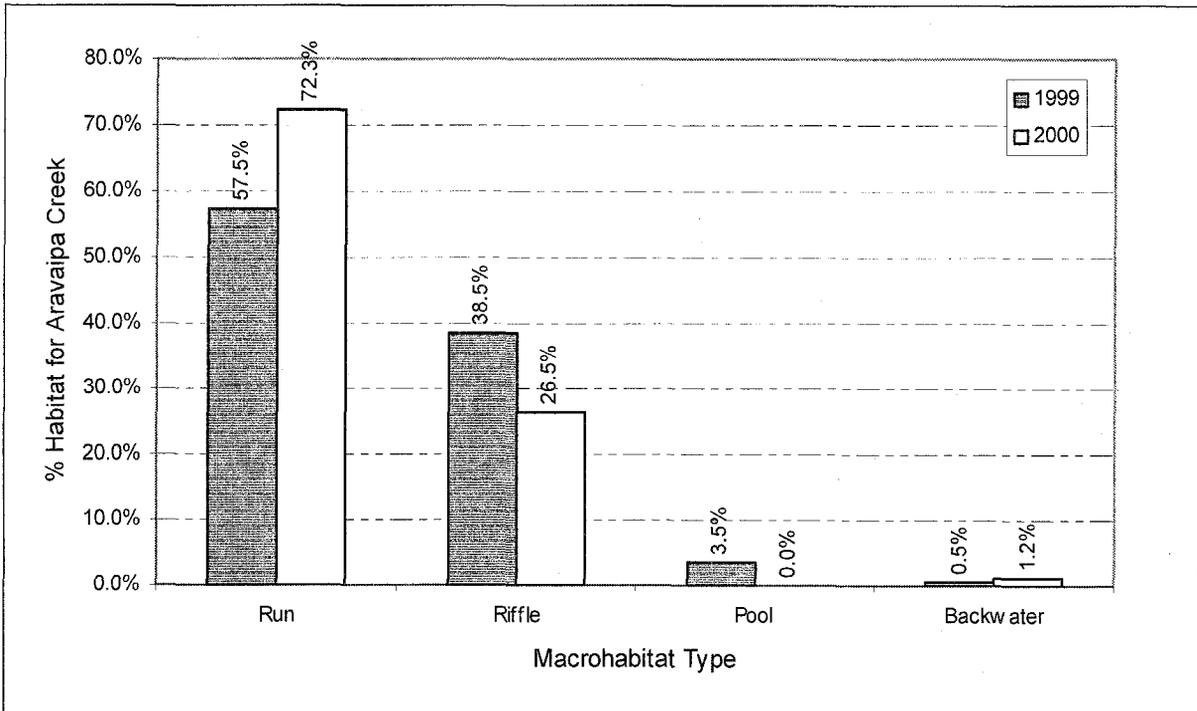


Figure 18. Percent of total available habitat of each macrohabitat type, for all sampling stations, at Aravaipa Creek, 1999-2000.

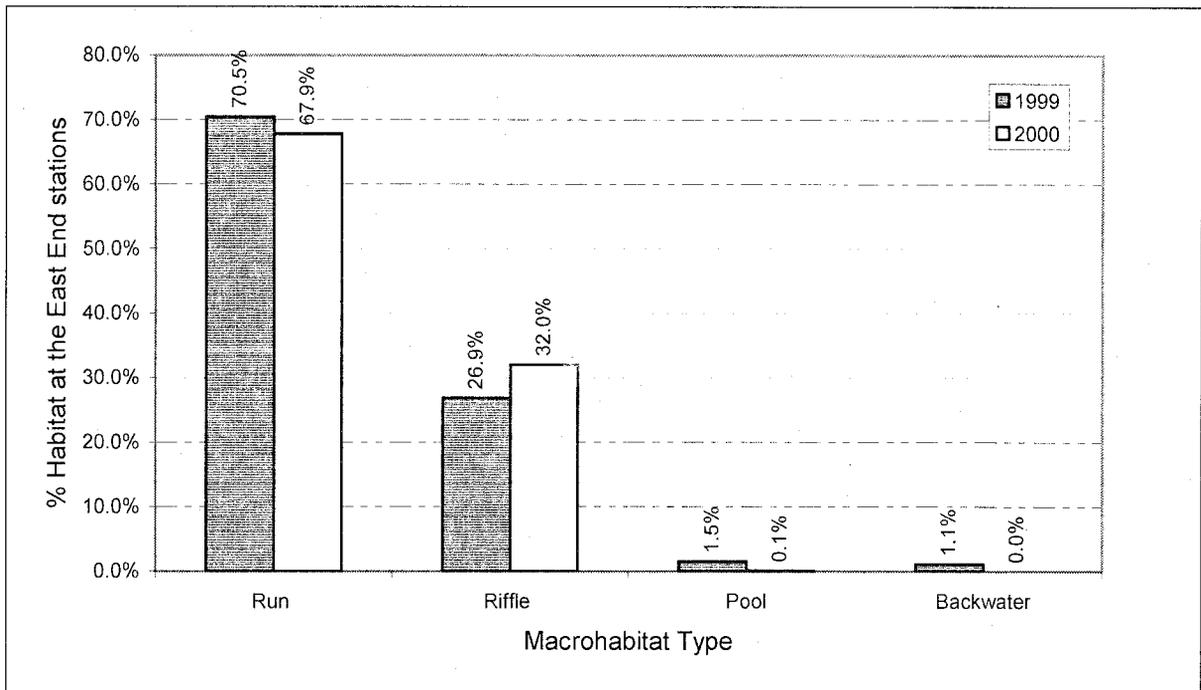


Figure 19. Percent of total available habitat for each macrohabitat type, at the East End stations, at Aravaipa Creek, 1999-2000.

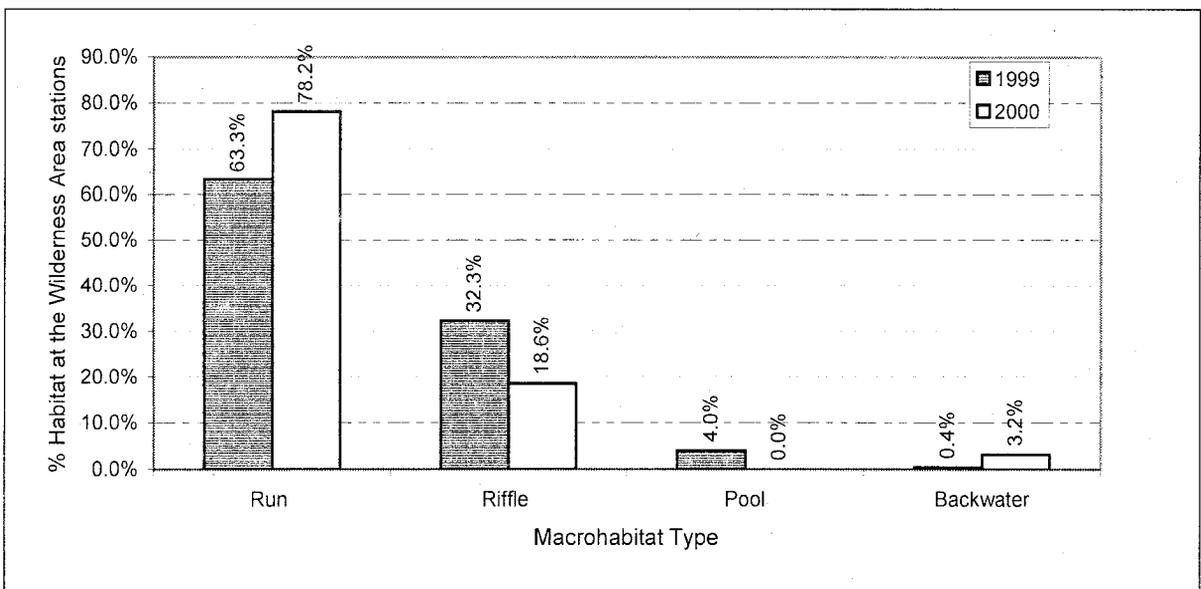


Figure 20. Percent of total available habitat for each macrohabitat type, at the Wilderness Area stations, at Aravaipa Creek, 1999-2000.

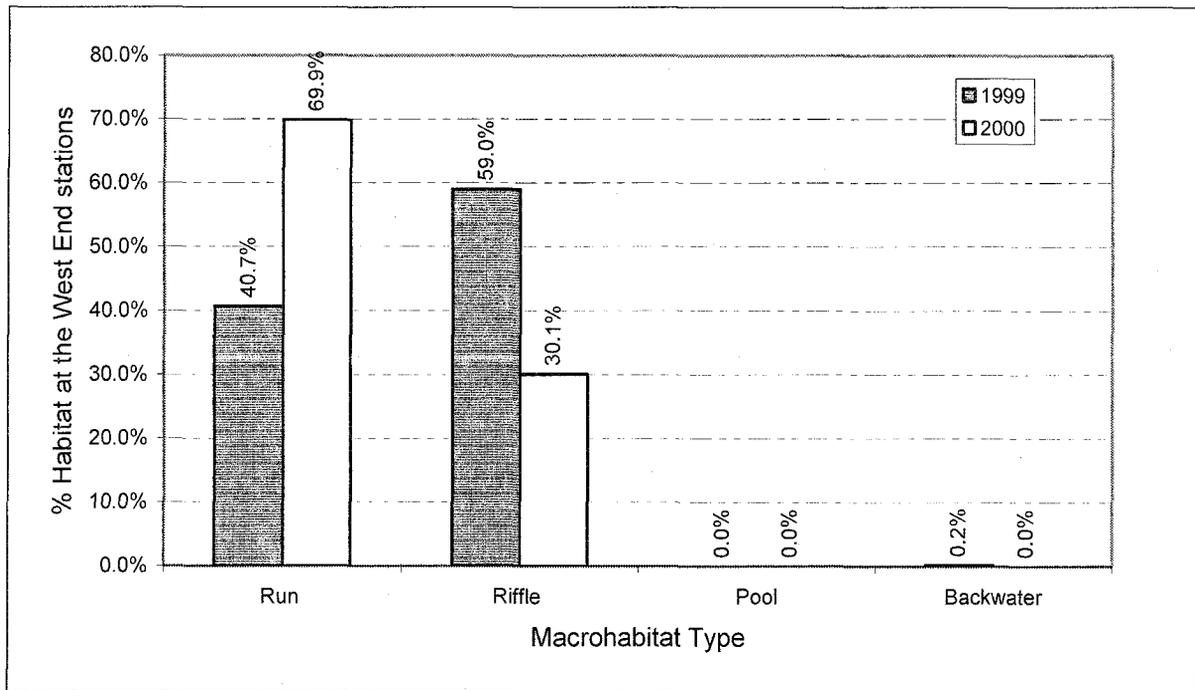


Figure 21. Percent of total available habitat of each macrohabitat type, at the West End stations, at Aravaipa Creek, 1999-2000<sup>a</sup>.

<sup>a</sup> habitat measurements were not collected at the Sycamore Tree station during 2000. Therefore, the habitat measurements taken at Sycamore Tree in 1999 are not included.

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#### PERSONAL COMMUNICATIONS

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Appendix A. Sampling station locations and description of station boundaries for Aravaipa Creek Monitoring, October 1999 and November 2000.

Station Name	Description of station boundaries
Guest House	Located near the main TNC guest cabin. The downstream station boundary is located directly beneath the power lines that cross Aravaipa Creek. There is also a bedrock outcropping located here. We measured upstream 200 m from the power line.
Chimney Rock	Located near the old Salazar Ranch, Chimney Rock is difficult to miss. Our station began directly across from the base of the chimney perpendicular to the stream flow and extended for 200 m downstream.
Turkey Creek	Located near the Turkey Creek confluence and Wilderness area boundary. Our station began at the barbed wire fence crossing Turkey Creek downstream from the 90-degree bend in the stream and canyon wall. It extended for 200 m upstream from the fence boundary
Hell Hole	Located at the Deer Creek confluence. The station was measured 100 m upstream and downstream from the center of the confluence.
Horse Camp	Near Horse Camp Canyon there is a huge boulder on the right hand side as you walk west (downstream). The boulder was used as a marker for the site. We worked up one hundred meters and worked downstream one hundred meters from the boulder. This site is also marked with a BLM sign on the left hand side of the stream. The sign indicates Horse Camp. The BLM sign is located on a large sand bar with mesquite trees and riparian trees and plants. The sign would be very easy to overlook if you weren't looking for it.
Painted Cave	The site that was sampled was .25 to .5 km downstream of Hells Half Acre Canyon. The site had a sandbar on the left hand side as you head west (downstream). The site is bordered by canyon walls and there was a large tree trunk in the middle of the water. This was the center of the site and 100 m was measured upstream and downstream from the tree. Future samplings should be done at the confluence with Painted Cave Canyon with the confluence as the middle and station ends 100 m up and downstream.
Wagner Ranch	Located at the USGS Gage near Wagner Ranch. The gage was the upstream boundary of this station and we measured downstream from there for 200 m.
White's Ranch	Upper end of this station begins at White's Ranch barn. Draw a line from the downstream wall of his barn, across the creek perpendicular to the stream and measure 200 m downstream from there.
Sycamore Tree	Although the Sycamore Tree is long gone, there is still a small mesquite bosque and frequently utilized camping area just off the Aravaipa Road. Our station began where the road would cross Aravaipa Creek if it continued. We measured upstream for 200 m from this point.

Appendix B. Substrate codes and size classifications.

Substrate	Substrate Code	Size
Bedrock	BE	Can not be rolled
Boulder	BO	> 1 meter (m)
Rubble	RU	256 millimeters (mm) – 1 m
Cobble	CO	128 mm – 256 mm
Pebble	PE	64 mm – 128mm
Gravel	GR	3 mm – 64 mm
Sand	SA	< 3 mm
Silt	SI	Flour

Appendix C. Estimated total lengths (TL) in millimeters (mm) for fishes used in field recording as “juvenile” vs. “adult.”

Native Species	TL, mm	Nonnative Species	TL, mm
TICO	38	GAAF	25
AGCH, MEFU, RHOS	45	CYLU	38
PACL	125	PIPR	45
CAIN, GIRO	150	LECY	100
		AMME, AMNA	125
		MISA	250

Appendix D. Habitat Summary Table. Habitat numbers (Hab. #) are measured downstream to upstream. Habitat types (Hab. types) are as follows: run (RU), riffle (RI), pool (PO), side-channel run (S-RU), side-channel riffle (S-RI), side-channel backwater (S-BW), and isolated backwater (I-BW). Substrate codes are provided in Appendix B. Type of cover codes are provided in-text.

Station Name-Date	Hab. #	Hab. Type	Length (m)	Avg. Width (m)	Max. depth (m)	Area Seined (m <sup>2</sup> )	Area Shocked (m <sup>2</sup> )	Total Area Available (m <sup>2</sup> )	Shock Sec.	Dominate substrates	Type of Cover				
											OV (m <sup>2</sup> )	WD (m <sup>2</sup> )	UB (m <sup>2</sup> )	BL (m <sup>2</sup> )	EV (m <sup>2</sup> )
Guest House 1999 10-19	01	RU	80.0	7.0	0.65	560	560	560	505	SA GR	0	0	0	0	0
	02	RI	10.0	8.7	0.20	87	87	87	64	RU GR	3	0	0	0	0
	03	RU	71.0	6.3	0.45	447	63	447	28	GR SA RU	10	24	55	0	0
	04	RI	14.0	7.3	0.40	102		102	----	RU GR SA	0	0	0	0	0
	05	RU	25.0	4.2	0.30	105		105	----	GR SA RU	0	1	9	0	0
Guest House 2000 11-27 11-28	01	RU	27.2	4.8	0.40	131	131	131	151	GR	0	8.5	0	0	0
	02	RI	5.3	4.6	0.35	24	24	24	27	CO	0	1.5	0	0	0
	03	RU	17.5	4.7	0.30	82	82	82	71	GR	2	0	0	0	0
	04	RI	10.5	4.9	0.30	51	51	51	36	CO	0	0	0	0	0
	05	RU	60.5	5.0	0.25	303	200	303	169	GR	7	0.2	0	0	0
	06	PO	2.4	1.6	0.40	4		4	----	SA	0	0	0	0	0
	07	RU	22.0	3.5	0.40	77		77	----	GR	0	0	0	0	0
	08	RI	28.5	5.0	0.35	143		143	----	CO	0	0	0	0	0
Chimney Rock 1999 10-18	01	RU	28.0	6.2	0.28	174	174	174	89	GR SA RU	1	0	0	0	0
	02	RI	8.0	8.0	0.10	64	64	64	43	GR RU SA	0	0	0	0	0
	03	RU	111.0	6.9	0.33	766	442	766	145	GR SA	72	128	6	0	4.5
	04	PO	1.5	1.2	0.30	2	2	2	12	SA GR	1	1	0	0	0
	05	PO	8.2	1.4	0.40	11	11	11	45	SA	4	5	0	0	0
	06	RI	57.0	5.1	0.25	291		291	----	GR RU CO	8.5	5.5	0	0	0
Chimney Rock 2000 11-27	01	RU	65.0	6.6	0.30	429	429	429	382	GR	4.4	0	0	0	0
	02	RI	41.0	7.7	0.24	316	270	316	87	GR	0	0	0	0	0
	03	RU	45.0	6.4	0.28	288		288	----	SA	9	0.3	0	0	0
	04	RI	49.0	4.8	0.25	235		235	----	SA	1	0	0	0	0
	05	S-RU	26.0	2.6	0.06	68		68	----	GR	0	0	0	0	0

Appendix D (continued). Habitat Summary Table.

Station Name-Date	Hab. #	Hab. Type	Length (m)	Avg. Width (m)	Max. depth (m)	Area Seined (m <sup>2</sup> )	Area Shocked (m <sup>2</sup> )	Total Area Available (m <sup>2</sup> )	Shock Sec.	Dominate substrates	Type of Cover				
											OV (m <sup>2</sup> )	WD (m <sup>2</sup> )	UB (m <sup>2</sup> )	BL (m <sup>2</sup> )	EV (m <sup>2</sup> )
Turkey Creek 1999 10-18	01	RI	24.1	4.0	0.25	96	96	96	85	RU GR SA	0	0	0	0	0
	02	RU	22.1	4.1	0.90	91	91	91	99	GR RU SA	0	0	0	10	0
	03	RI	15.4	4.6	0.25	71	71	71	49	GR RU CO	0	0	0	0	0
	04	RU	54.2	5.1	0.45	276	196	276	216	GR SA RU	1	2.5	0	0	0
	05	RI	28.9	7.6	0.25	220		220	----	RU GR CO	0	0	0	0	0
	06	RU	19.6	4.8	0.30	94		94	----	GR RU SA	3	3	0	0	0
	07	I-BW	4.1	3.6	0.60	15		15	----	GR SI SA	0	0	0	1.5	0
	08	S-BW	7.8	3.4	1.10	27		27	----	GR SI SA	0	0	0	9	0
	09	RI	20.7	4.7	0.25	97		97	----	GR SA RU	3	0	0	0	0
	10	PO	5.2	3.1	0.62	16		16	----	SA GR	0	0	1	0	0
	11	PO	7.6	3.8	0.60	29		29	----	SA GR	0	0	0	1	0
	12	RU	30.2	6.2	0.65	187		187	----	GR SA PE	0	0	0	0	0
Turkey Creek 2000 11-27 11-28	01	RU	33.5	4.5	0.40	151	151	151	90	GR	2	1	0	0	0
	02	RI	6.2	5.3	0.30	33	33	33	90	SA	0	0	0	0	0
	03	RU	18.0	3.1	0.70	56	56	56	20	SA	0	0	0	0	0
	04	S-RI	18.0	5.4	0.10	97	97	97	133	GR	0	0	0	0	0
	05	RU	45.9	6.2	0.37	285		285	----	SA	0	1	0	0	0
	06	RU	16.5	6.4	0.34	106		106	----	SA	0	0	0	0	0
	07	RI	16.5	8.3	0.25	137		137	----	SA	2	0	0	0	0
	08	RU	39.8	7.3	0.39	291		291	----	SA	6	0	0	0	0
	09	RI	13.7	5.6	0.27	77		77	----	SA	1	0	0	0	0
	10	RU	21.1	4.5	0.34	95		95	----	GR	0	0	0	0	0
Hell Hole 1999 10-19	01	RU	107.0	8.8	0.40	471	62	942	37	SA GR CO	30	10	2	0	0
	02	RI	38.0	10.5	0.25	279	399	399	189	GR SA CO	3	1	2	0	0
	03	RU	12.0	11.7	0.25	84	140	140	58	GR SA CO	3	20	0	0	0
	04	RI	43.0	15.4	0.38	331	662	662	263	GR SA CO	5	0	1	0	0
	05	RI	12.0	17.7	0.35	170	212	212	66	GR SA BO	2	0	3	0	0

Appendix D (continued). Habitat Summary Table.

Station Name-Date	Hab. #	Hab. Type	Length (m)	Avg. Width (m)	Max. depth (m)	Area Seined (m <sup>2</sup> )	Area Shocked (m <sup>2</sup> )	Total Area Available (m <sup>2</sup> )	Shock Sec.	Dominate substrates	Type of Cover				
											OV (m <sup>2</sup> )	WD (m <sup>2</sup> )	UB (m <sup>2</sup> )	BL (m <sup>2</sup> )	EV (m <sup>2</sup> )
Hell Hole 2000 11-28	01	RU	7.1	5.9	0.45	42	42	42	58	GR SA PE	0	3	0	0	0
	02	RI	37.8	8.2	0.30	310	310	310	189	CO PE GR	0	0	0	0	0
	03	RI	15.0	8.1	0.28	122	122	122	97	GR CO PE	0	0	0	0	0
	04	RU	6.9	9.0	0.25	62	62	62	125	GR CO	0	0	0	0	0
	05	RI	17.0	7.8	0.78	133	133	133	74	GR CO PE	0	0	0	0	0
	06	RU	45.3	6.7	0.18	304	304	304	NR	GR CO PE	0	0	0	0	0
	07	S-RU	19.5	5.9	0.25	115	115	115	47	GR SA	0	0	0	0	0
	08	S-RU	4.3	6.0	0.40	26	26	26	85	CO GR	0	0	0	0	0
	09	S-RU	15.9	3.3	0.40	52	52	52	36	GR PE	12	8	0	0	0
	10	S-RI	5.8	3.8	0.25	22		22	----	PE CO GR	0	0	0	0	0
	11	S-RU	9.1	5.2	0.25	47		47	----	GR	0	0	0	0	0
	12	RU	54.7	7.4	0.52	405		405	----	GR PE	25	18	37	0	0
	13	S-BW	17.3	2.4	0.32	42		42	----	GR SA	0	1	0	0	0
Horse Camp 1999 10-19	01	RI	20.0	5.9	0.50	65	118	118	187	CO BO GR	35	0	1	0	0
	02	RU	24.0	4.6	0.40	61	110	110	64	GR CO SA	26	0	3	0	0
	03	RI	32.0	5.5	0.40	79	176	176	86	CO GR SA	50	0	0	0	0
	04	RU	52.0	6.8	0.35	230	163	354	80	GR SA CO	2	0	0	3	0
	05	PO	83.0	2.6	1.00	125		216	----	SI GR BO	16	0	0	0	0
	06	RI	17.0	7.7	0.40	79		131	----	GR SA CO	2	0	0	0	0
	07	S-BW	14.0	1.7	0.25	20		24	----	SI GR	28	2	0	0	0
	08	RU	55.0	7.8	0.25	300		429	----	GR SA CO	20	10	1	0	0
Horse Camp 2000 11-28	01	RU	47.5	3.9	0.60	185	185	185	NR	CO PE GR	21	0	0	1	0
	02	RI	6.1	4.6	0.35	28	28	28	NR	CO PE	8	0	0	0	0
	03	RU	61.8	6.2	0.82	383	383	383	NR	GR	2	1	0	9	0
	04	S-BW	3.0	2.9	0.87	9	9	9	NR	SA GR	0	2	3	0	0
	05	S-BW	0.9	4.4	0.40	4	4	4	NR	BE GR	0	0	0	4	0
	06	S-BW	8.7	8.6	0.42	75	75	75	NR	BE GR	0	0	0	2	0
	07	RI	18.4	7.3	0.31	134		134	----	CO GR PE	3	0	0	0	0
	08	RU	70.2	7.3	0.44	513		513	----	GR PE	12	2	6	0	0

Appendix D (continued). Habitat Summary Table.

Station Name-Date	Hab. #	Hab. Type	Length (m)	Avg. Width (m)	Max. depth (m)	Area Seined (m <sup>2</sup> )	Area Shocked (m <sup>2</sup> )	Total Area Available (m <sup>2</sup> )	Shock Sec.	Dominate substrates	Type of Cover				
											OV (m <sup>2</sup> )	WD (m <sup>2</sup> )	UB (m <sup>2</sup> )	BL (m <sup>2</sup> )	EV (m <sup>2</sup> )
Painted Cave 1999 10-19	01	RU	100.0	8.2	0.75	410	820	820	393	GR SA CO	6	0	0	100	0
	02	RI	9.0	6.4	0.60	20		58	----	GR BO SA	36	0	0	9	0
	03	RU	91.0	7.1	0.45	323		646	----	CO BO SA	30	0	0	9.1	0
Painted Cave 2000 11-29	01	RU	44.9	6.8	0.95	305	305	305	326	GR PE	2	1	22	30	0
	02	RI	1.7	8.4	0.35	14	14	14	25	PE GR	0	0	0	0	0
	03	RU	153.4	5.0	0.75	767	267	767	437	CO BO GR	31	9	0	4	0
Wagner Ranch 1999 10-20	01	RU	173.0	11.2	0.55	316	316	316	130	GR SA CO	25	0	70	0	0
	02	S-BW	6.0	2.0	0.20		12	12	30	SA SI GR	2	0	0	0	0
	03	RI	27.0	11.7	0.20	1454	818	1938	403	GR CO SA	2	0	6	0	0
Wagner Ranch 2000 11-29	01	RU	17.2	6.6	0.30	114	114	114	55	GR	10	0	0	0	0
	02	S-RU	22.5	2.4	0.10	54	54	54	52	SA	0	0	0	0	0
	03	RI	11.5	8.0	0.20	92	92	92	71	GR CO	0	0	0	0	0
	04	RU	116.0	9.2	0.45	1067	656	1067	361	GR	22	4	0	0	0
	05	S-RU	19.0	4.0	0.30	76		76	----	SA	1	0	0	0	0
	06	S-RI	3.3	4.1	0.15	14		14	----	CO	0	0	0	0	0
	07	RU	45.3	10.9	0.45	494		494	----	SA	67	0	0	0	0
Whites Ranch 1999 10-20	01	RU	112.0	10.9	0.40	794	1090	1221	528	GR SA CO	20	1	0	15	0
	02	RI	68.0	8.9	0.45	411		605	----	GR SA BO	0	0	0	0	0
	03	RU	20.0	10.9	0.45	131		218	----	GR SA BO	0	0	0	0	0
Whites Ranch 2000 11-29	01	RI	107.0	9.2	0.34	984	920	984	561	CO	2	0	0	0	0
	02	S-RU	47.2	2.7	0.12	127		127	----	GR	0.1	0	0	0	0
	03	S-RU	10.6	2.5	0.08	27		27	----	SA	0	0	0	0	0
	04	RU	93.0	6.2	0.50	577		577	----	SA	4	0	0	0	0

Appendix D (continued). Habitat Summary Table.

Station Name-Date	Hab. #	Hab. Type	Length (m)	Avg. Width (m)	Max. depth (m)	Area Seined (m <sup>2</sup> )	Area Shocked (m <sup>2</sup> )	Total Area Available (m <sup>2</sup> )	Shock Sec.	Dominate substrates	Type of Cover				
											OV (m <sup>2</sup> )	WD (m <sup>2</sup> )	UB (m <sup>2</sup> )	BL (m <sup>2</sup> )	EV (m <sup>2</sup> )
Sycamore Tree 1999 10-19	01	PO	26.0	9.8	0.70	255	255	255	216	GR SA	18	18	10	0	0
	02	RU	87.0	7.9	0.81	687	585	687	682	GR SA RU	91	21	60	0	0
	03	RI	74.0	6.3	0.45	466		466	-----	CO RU GR	10	0	0	0	0
	04	RU	13.0	6.4	0.25	83		83	-----	RU GR SA	0	0	0	0	0
Sycamore Tree 2000 11-29	01	RU	No Habitat Measurements Taken			Seined	Shocked		Total Shock Time = 700 sec	Not Recorded	No Habitat Measurements Taken				
	02	RI					Shocked								
	03	RU					Shocked								
	04	RI					Shocked								
	05	RU				Seined									
	06	S-RU													
	07	S-BW				Seined									