

Fossil Creek Fish Monitoring

2006 Annual Report

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Pertinent Findings

Fossil Creek was chemically treated in autumn 2004 to eliminate non-native fishes above a constructed fish barrier, and historical flow of about 43 cubic feet per second (cfs) was restored to the stream in summer 2005. We sampled in spring (May-June) and autumn (October) 2006 with minnow traps and hoop nets among three stream reaches within the treatment reach. Findings from autumn (September) 2005 are provided in a prior summary report. The purpose of our surveys was to document post-project composition and status of the fish community, with emphasis on documenting success of the non-native removal. Five fish species, all native, were encountered within the study area: headwater chub *Gila nigra* plus roundtail chub *Gila robusta*,¹ speckled dace *Rhinichthys osculus*, Sonora sucker *Catostomus insignis*, and desert sucker *Pantosteus clarki*. All species were in upper and middle reaches, while only chub and Sonora sucker were in the lower reach. The composite seasonal samples comprised 3,098 individuals (1,751 and 1,347 in spring and autumn, respectively). Small adults predominated in the catch of all species in spring, while the autumn sample was comprised primarily of young-of-year. Seasonal differences in relative abundance were remarkably small: chubs comprised about 76 & 74%, speckled dace 2 & 8%, Sonora sucker 19 & 16%, and desert sucker 3 & 3% of total numbers in spring and autumn, respectively. Total catch per unit effort (CPE, number of fish per overnight set) was greatest for both seasons and both methods in the middle reach, intermediate in the upper reach, and lowest in the lower reach. CPE of chubs was about an order of magnitude greater in the middle reach than in the lower, while CPE of speckled dace, Sonora sucker and desert sucker differed among species but within a species was similar across reaches. Non-native northern crayfish *Orconectes virilis* was taken only in the lower and middle reaches, and native Sonora mud turtle *Kinosternon sonoriense* was collected in all reaches. All animals were released at the site of capture.

¹ Headwater and roundtail chubs are difficult to differentiate in the field without harm to individual fish, and we did not separate the two. A protocol was established during the Fossil Creek planning effort that assumed chub above Irving were *G. nigra*, and those below Irving were *G. robusta*. We chose not to follow that convention until the species' respective local geographic distributions can be verified and refer here to the two species collectively as "chub."

Introduction

Fossil Creek (Fig. 1) is a perennial, spring-fed stream located in Gila and Yavapai counties, Arizona, and tributary to Verde River in the Gila River basin. The stream is home to a suite of six native fish species (Table 1) including four minnows (headwater chub, roundtail chub, longfin dace, speckled dace) and two suckers (desert sucker, Sonora sucker). Native Gila topminnow and razorback sucker also have been stocked (Minckley and Brooks 1985, Barrett and Maughan 1995). Non-native fishes that have been documented from Fossil Creek include common carp, green sunfish, smallmouth bass, flathead catfish, and yellow bullhead (Roberson et al. 1996; Table 1). Only green sunfish and smallmouth bass have been found in the reach above the constructed barrier.² Fossil Creek is relatively well studied, in part because of its intrinsic values, unique physical chemistry, and intact native fish fauna, but largely and most recently as a result of a hydropower decommissioning project (see below). A large and rich suite of published and gray literature has been produced on the stream and its biota (see, for example Arizona Public Service [APS] 1992, Chamberlain 1904, Bouchard and Associates 1995, EnviroNet 1998, Federal Energy Regulatory Commission 2004, FWS unpublished; Anon 2005, and abundant references therein). Land ownership along Fossil Creek is Coconino and Tonto National Forests on the north and south, respectively, interspersed with at least one small private parcel. Access to the stream is on foot or at bridge crossings of Forest Road (FR) 708.

A fish barrier was constructed on lower Fossil Creek in autumn 2004 and a portion of the stream, tributaries, constructed channels, and watershed stock tanks were treated with ichthyocides to eliminate non-native fishes in autumn-winter 2004-2005 as part of a larger hydroelectric facility decommissioning and flow/native fish restoration project. Native fishes salvaged prior to the renovation were repatriated to the stream at the end of the project. The overall project included restoration in June 2005 of approximately 43 cfs of spring flow to the stream channel, and future lowering by 1.3 m and eventual removal of a 7.6-m high diversion dam. Discharge in the channel prior to flow restoration was primarily seepage of about 2 cfs below the diversion dam, augmented downstream by spring and tributary inputs to about 5 cfs at the fish barrier. Fossil Springs (the primary stream source) is at river kilometer (RK) 22.4 above the Verde River, into which Fossil Creek flows, the diversion dam is at RK 22.1, and the fish barrier is at RK 7.4. A small hydroelectric power generation facility, now out of service, is located at Irving, near RK 17.

This report presents results of 2006 annual post-project (i.e., stream renovation, native fish repatriation, and flow restoration) fish monitoring. The study was implemented specifically to detect the presence of nonnative fishes and assess the status of the repatriated native fish assemblage.

² Yellow bullhead is known from lowermost Fossil Creek. Several documents also mention its occurrence upstream in the reach between Sally Mae Wash and the constructed fish barrier, but none cites an original capture record and there are no voucher specimens; we consider the record spurious until or unless there is reliable verification.

Methods

A standardized fish monitoring protocol was developed by the authors and finalized in cooperation with Reclamation (Marsh 2005). That protocol was implemented for the first time in autumn (September) 2005 (Marsh et al. 2006), and followed with few and minor modifications as related in this report. The protocol is subject to future refinement as appropriate or required by experience or other considerations, and any such modifications or other changes will be detailed in future reports. The protocol is summarized here as performed during May 29 – June 1 and October 2 -5, 2006.

Three sample reaches (Fig. 1, Table 2) were designated along the approximately 11.3 km (7.0 mile) stream course between the constructed fish barrier and the “High Falls” located about 1.9 km upstream from Irving at RK 18.4. Reaches were designated lower (down-) to upper (upstream) as “Above (constructed) Barrier,” “Below Irving” and “Below High Falls.” Standard gears were deployed within a discrete portion of each reach, and opportunistically elsewhere. Universal Transverse Mercator (UTM) coordinates (NAD27) were acquired for each reach using a handheld Garmin GPS receiver.

Standard methods were minnow trapping, hoop netting, and snorkeling. Gears were deployed to represent available habitat types and as appropriate for each gear type, and in a consistent manner so that similar effort was expended in each reach. These collections were supplemented by other, opportunistic sampling.

Minnow traps were 18-inches long x 10-inches diameter and either $\frac{1}{8}$ or $\frac{1}{4}$ -inch mesh galvanized hardware cloth. Traps were suspended at various depths and in a variety of calm water habits within the stream channel, and baited with a small handful of Aquamax pellets either loose or contained in a small bag of fine nylon mesh, tethered by a length of nylon twine. Sixteen (May-June) or ten (October) traps were set in each reach, typically deployed in the afternoon and retrieved the following morning.

Hoop nets were 48-inches long with a single throat and two, 24-inch diameter steel hoops set 30 inches apart. Netting was $\frac{1}{4}$ -inch Ace knotless nylon mesh. Hoop nets were deployed in a variety of quiet-to-swift water habitats with the cod end upstream, and baited with a small handful of Aquamax pellets either loose or contained in a small bag of fine nylon mesh, tethered by a yoke at the open end and single line at the cod end. Ten hoop nets were set in each reach, typically deployed in the afternoon and retrieved the following morning, i.e., 15 to 20 hrs of immersion.

Fishes retrieved from collection gears were identified to species, enumerated by age (size) class according to the convention 0 = young-of-year of species that attain relatively large adult body size, and 1 = post young-of-year of fish that attain large body size; fish that remain relatively small throughout life were not aged. For practical purposes, we considered fish shorter than about 10 cm to represent age-0 and fish longer than 10 cm to represent age-1. All captured fish were released unharmed near the site of capture. Total length (TL) of some individuals was visually estimated. Data were recorded individually for each set of each gear type.

Fish collections were augmented by visual observations obtained by snorkeling. One or two large pools was designated in each sample reach, and 2-5 persons each spent 10 or more minutes inspecting all available habitats and assessing presence, sizes, and subjective abundance of each species encountered. A brief narrative of observations was recorded.

Field data were tabulated and summarized. Mean minnow trap or hoop net set times did not differ among reaches for the autumn 2005 sample (two-sample t-test, $df = 9$, $\alpha > 0.10$; Noether 1971) and 2006 set times were similar, so catch per unit effort (CPE, number of fish per overnight minnow trap or hoop net set) was calculated and presented for each standardized monitoring data set for each reach (see Marsh et al. 2006). No statistical treatment was applied to the 2006 data. Results are presented separately for each season.

Monitoring Results

Spring 2006 minnow traps and hoop nets

Above Barrier (lower reach, Fig. 1).--The stream upon our arrival in this reach on the afternoon of May 29 was at base flow of approximately 43 cfs, clear, and lacked aquatic vegetation except for localized marginal stands of cattail *Typha latifolia* and horsetail *Equisetum* sp. Substrate in non-riffle/cascade reaches contained much sand, and there were accumulations of silt in slack water areas. Active travertine formation was evident. Surfaces of larger rocks were mostly granular with little apparent diatom film or "Aufwuchs" community development. Twelve minnow traps and eight hoop nets were set near and downstream from pool 28 (Fig. 1) and four minnow traps plus two hoop nets were deployed upstream from pool 26 between 1530 and 1800 hrs. Sets were in margins of runs to 1-meter deep and flowing pools of similar or greater depth; one hoop was placed in a backwater-type habitat. Minnow traps were in similar but shallower and generally quieter places.

Minnow traps and hoop nets were retrieved between 0820 and 1100 hrs on May 30; mean set time for each individual device was 16.8 hrs. Chubs and Sonora sucker were captured; both species were in hoop nets but only the sucker was in minnow traps (Tables 3 & 4). Total minnow trap catch was 70 individuals (range 0-26 per trap) and catch per unit effort (CPE, number of fish per overnight set) was 4.4 (Figs. 2 & 3). Total hoop net catch was 66 fish (3 chubs and 63 suckers; range 0-14 per net) and CPE was 6.6 (Figs. 2 & 4). All chubs were age-1 (Fig. 4) and estimated maximum size was 13 cm. Among the suckers there were approximately equal numbers of age-0 and age-1 and older fish (Fig. 4); the largest individual was estimated to be ca. 22 cm TL.

Northern crayfish also were in 6 of 16 minnow traps and 6 of 10 hoop nets (Table 4). There were 0-5 per minnow trap (16 total, CPE = 1.0) and 0-10 per hoop net (22 total, CPE = 2.2). One Sonora mud turtle was in a hoop net.

Below Irving (middle reach, Fig. 1).--The stream upon our arrival in this reach early in the afternoon on May 30 was at base flow and exceptionally clear. Monospecific stands

of cattail, horsetail *Equisetum* sp., and common reed *Phragmites australis* were sparse-to-dense along margins or run-type habitats. Substrate in many areas was abundant inorganic fines, some gravels and larger materials, and Coarse Particulate Organic Material (CPOM) such as leaves, twigs, stick and branches. Travertine deposition since autumn 2005, particularly in small dams, was notable. In some areas, this has resulted in increased wetted channel width and braiding. Sixteen minnow traps and 10 hoop nets were set between 1420 and 1550 hrs in runs to 1-meter deep and flowing pools of similar depth.

Minnow traps and hoop nets were retrieved between 0800 and 0925 hrs on May 31; mean set time for each individual device was 17.7 hrs. Chub, specked dace, Sonora sucker, and desert sucker were captured³ (Table 3 & 5), and specimens were in all devices except for one minnow trap. All four species were in minnow traps while only chubs and Sonora suckers were in hoop nets. Total minnow trap catch (all species combined) was 759 individuals (range 0-92 per trap) and CPE was 47.4 (Figs. 2 & 3). Total hoop net catch (all species combined) was 695 fish (range 1-216 per net) and CPE was 69.5 (Figs. 2 & 5).

Chubs were in all but one minnow trap and in all hoop nets, and were the most abundant species overall in minnow traps (86% of catch, CPE = 40.8) and in hoop nets (91% of catch, CPE = 63.4), and were the most abundant species in each individual capture device with exception of one hoop net (Table 5). The great majority of chubs (89% in minnow traps and 94% in hoop nets) were small, age-1 adults (Fig. 4). Speckled dace was the third most abundant fish in minnow traps (total catch = 18, CPE = 1.1), and was absent from hoop nets. Sonora sucker comprised 11% of fish in minnow traps (total catch = 84, CPE = 5.3) and was in all but four of these devices (range 1-22 individuals per trap). Similarly, Sonora sucker comprised about 9% of fish in hoop nets (total catch = 61, CPE = 6.1) and was in all but one hoop (range 0-16 individuals per net). Most Sonora suckers (92% in minnow traps and 89% in hoop nets) were small, age-1 adults (Fig. 4). Desert sucker was rare and represented in only two minnow traps (one age-0 and three age-1, CPE = 0.3); it was absent from hoop nets.

Northern crayfish was notably absent from minnow traps and occurred in only four hoop nets. No Sonora mud turtles were encountered in the middle reach.

High Falls (upper reach, Fig. 1).--Upon our arrival in this reach early in the afternoon on May 31, conditions were unchanged from those noted previously at other reaches. Water was clear. Monospecific stands of cattail, horsetail, and common reed were sparse-to-dense along margins of run-type habitats, especially in the first several hundred meters upstream from Irving. Sixteen minnow traps and 10 hoop nets were set between 1430 and 1610 hrs in runs to 1-meter deep and flowing pools of similar depth.

Minnow traps and hoop nets were retrieved between 0800 and 1020 hrs on June 1; mean set time for each individual device was 18.1 hrs. Chub, specked dace, Sonora sucker, and

³ One hybrid between *Catostomus insignis* and *Pantosteus clarki* was among the suckers captured; data for this individual are included with those for the former taxon.

desert sucker were captured (Table 3 & 6), and specimens were in all devices except four minnow traps and one hoop net that were fishless (Table 6). Total minnow trap catch (all species combined) was 68 individuals (range 0-27 per trap) and CPE was 4.25 (Figs. 2 & 3). Total hoop net catch (all species combined) was 93 fish (range 0-39 per net) and CPE was 9.3 (Figs. 2 & 5).

Chub was in six of 16 minnow traps and six of 10 hoop nets, was the second most abundant species in both minnow traps (total catch = 12, CPE = 0.8) and hoop nets (total catch = 29, CPE = 2.9). Speckled dace was the third most abundant fish in minnow traps (16% of total catch, CPE = 0.7). Speckled dace was uncommon in hoop nets (total catch = 7, CPE = 0.6), and was taken by two of 10 sets (Table 6). Sonora sucker was the most abundant species overall (37% of total catch), comprised 62% of fish in minnow traps (total catch = 42, CPE = 2.6) and was in five of 16 of these devices (range to 23 individuals per trap). In contrast, Sonora sucker comprised about 18% of fish in hoop nets (total catch = 17, CPE = 1.7), and was in seven hoops (range to 7 individuals per net). Desert sucker was uncommon in minnow traps (total catch = 3, CPE = 0.2), but common in hoop nets (total catch = 40, CPE = 4.0, range to 25 individuals per net). About half of chubs and suckers in minnow traps were age-0 and half were age-1 (Fig. 4), while all individuals of these species in hoop nets were age-1 adults. Two chubs were estimated to be 20 cm TL, much larger than the size of fish from downstream reaches.

Northern crayfish was absent from minnow traps and from hoop nets in this reach. Non-native bullfrog *Rana catesbeiana* tadpoles were present, and two were taken by minnow trap and one was taken by hoop net. Two hoop nets also contained 1 or 2 native Sonora mud turtle (total catch of 3).

Spring 2006 underwater observations

We snorkeled four pools during the sample period. One pool was within our “Above Barrier” reach, two were within the “Below Irving” reach, and one was in the “High Falls” reach. Narratives are provided below, down- to upstream.

The large, deep, steep sided, rock pool at approximately UTM 439526E-3804165N (designated pool no. 28 in the 2004 AZGFD stream reach 4A treatment protocol; Fig 1) was selected for snorkeling in the “Above Barrier” reach, and it was examined from 1000 to 1030 on May 30 by three persons (0.67 hrs total effort). The entire perimeter of the pool was examined, and the thalweg (channel) was traversed head-to-tail several times. Visibility was excellent. The pool was greater than 3-m deep with a strong current, and a substrate comprised of sand, fine materials, and CPOM, mostly leaves and twigs from terrestrial vegetation. Small schools of up to perhaps a dozen plus a few singles of juvenile (to ca. 8 cm, likely young-of-year of 2005) Sonora sucker were seen, mostly associated with shoreline cover, exposed roots, and cut banks. Much smaller individuals, 15-20 mm-long and representing young-of-year from 2006 also were seen. Two large adults 25-30 cm TL also were observed; both were sedentary on the bottom. No other fish species was detected. Northern crayfish was present but few; those seen were large.

We snorkeled the large pool below the FSR 708 bridge crossing downstream of Irving at approximate UTM 4422164E, 3805847N (pool no. 16 in AZGFD stream reach 3A; Fig. 1) from 1050 to 1105 hrs (4 persons, total effort 1.0 hrs) on May 31. This pool was clear, very deep (5 to 6 meters), with a swift laminar current. Aquatic vegetation was lacking; substrate was either soft organic materials (leaves and twigs), sand or bedrock. About one-half of the circumference of the pool was vertical bedrock. Fishes that were present were observed mostly around the periphery of the pool or in the inlet and outlet areas; few were in the deepest parts. Chub young-of-year were abundant; mostly 3 to 5-cm long, but a few large fish to perhaps 20 cm in length also were seen. Small Sonora sucker also were common, mostly around the periphery, and four large (ca 40 cm TL) individuals were observed patrolling the bottom. Desert sucker was uncommon on walls and rock faces where a few adult individuals were actively feeding. Speckled dace was not encountered. Northern crayfish was not observed

We snorkeled in the large, deep, steep sided, rock pool below the falls at Irving (approximately UTM 439526E, 380416N; pool no. 1 in AZGFD stream reach 3A; Fig. 1). It was examined from 1325 to 1650 hrs by five persons (2.5 hrs total effort) on May 30. Visibility was exceptional. The pool was greater than 5-m deep, with very strong and complex currents resulting from the 3-m waterfall at the head of the pool, and substrate comprised predominately of fine materials and CPOM, mostly leaves and twigs; cobble was present along the perimeter and tail of the pool. About three-quarters of the circumference of the pool was vertical bedrock. Chubs of all sizes including young-of-year and adults were abundant throughout the water column in the pool and pool tail. Several large (ca. 30-cm long) adult chub were seen, some with characteristic breeding coloration, and all in deep water near the bottom. Speckled dace of all ages and sizes were abundant among cobbles in the swift, shallow (less than 0.5-meter deep) water in the stream channel at the downstream end of the pool. Sonora sucker was abundant and desert sucker was common, and both were represented by numerous young-of-year and yearlings plus larger adults. Suckers were on the bottom, along rock walls of the pool, and along shallow cobble edges. No other fish species was detected. Crayfish were present, but uncommon.

We snorkeled in the large, deep, steep sided, rock pool below the high falls above Irving (approximately UTM 444433E 3808075N; pool no. 24 in AZGFD stream reach 2; Fig. 1). It was examined from 1400 to 1410 hrs by one person (0.17 hrs effort) on May 31 and from 1030 to 1040 by three persons (0.5 hrs effort) on June 1 (total effort = 0.7 hrs). The pool was deeper than 5-m, with a very strong circular current, and a substrate comprised of fine materials and CPOM, mostly leaves and twigs; cobble and gravel were present along about 25% of the circumference and in the tailrace. The substrate in the pool tail was heavily cemented with travertine. Juvenile chub, mostly 5-6 cm long, were present but uncommon throughout the water column in the pool. A few larger, adult fish also were seen. Speckled dace of all ages and sizes were common among cobbles in the swift, shallow (less than 0.5-meter deep) water in the stream channel at the downstream end of the pool. Sonora sucker was common and represented by all sizes from small juveniles to large adults. Desert sucker was the most abundant species in the pool and was on the bottom and along rock walls; most individuals were juveniles 10-15 cm long,

but some larger adults also were seen. No other fish species was detected. Crayfish were not encountered.

Autumn 2006 minnow traps and hoop nets

Above Barrier (lower reach, Fig. 1).--The stream upon our arrival in this reach on the afternoon of October 2 was at base flow, clear, and lacked aquatic vegetation except for localized marginal stands of cattail *Typha latifolia* and horsetail *Equisetum*. Recent flood debris up to 1.5 m above the stream was evidence of high flows since the May 2006 site visit, but there were no apparent in-stream changes. Bottoms were rock-boulder to small sand-gravel in swiftly flowing areas. Substrate in non-riffle/cascade reaches contained much sand, and there were accumulations of silt in slack water areas. Active travertine formation was not evident, although surfaces of larger rocks were covered with an uneven thin film of travertine and with little apparent diatom film or “Aufwuchs” community development. Eight minnow traps and eight hoop nets were set near and downstream from pool 28 (Fig. 1) and two minnow traps plus two hoop nets were deployed upstream from pool 26 between 1445 and 1610 hrs. Sets were in margins of runs to 1-meter deep and flowing pools of similar or greater depth; one hoop was placed in a backwater-type habitat. Minnow traps were in similar but shallower and generally quieter places. Suitable places to set nets are limited in this reach, so sites generally were the same as those used during prior monitoring in autumn 2005 and spring 2006.

Minnow traps and hoop nets were retrieved between 0815 and 0935 hrs on October 3; mean set time for each individual device was 20.1 hrs. Chubs and Sonora sucker were captured; both species were in hoop nets but only the sucker was in minnow traps (Tables 7 & 8). Total minnow trap catch was 50 individuals (range 0-19 per trap) and catch per unit effort (CPE, number of fish per overnight set) was 5.0 (Figs. 2 & 3). Total hoop net catch was 88 fish (4 chubs and 84 Sonora sucker; range 0-26 per net) and CPE was 8.8 (Figs. 2 & 5). All chubs were age-1 fish (Fig 4). Approximately 80% of the Sonora suckers in minnow traps were age-0, while there were approximately equal numbers of age-0 and age-1 (and older fish) in hoop nets (Fig. 4).

Northern crayfish also were in 6 of 10 minnow traps and 7 of 10 hoop nets (Table 8). There were 0-5 per minnow trap (14 total, CPE = 1.4) and 0-10 per hoop net (25 total, CPE = 2.5). One juvenile Sonora mud turtle was in each of two hoop nets.

Below Irving (middle reach, Fig. 1).--The stream upon our arrival in this reach early in the afternoon on October 3 was at base flow and clear. Monospecific stands of cattail, horsetail *Equisetum* sp., and common reed *Phragmites australis* were sparse-to-dense along margins or run-type habitats. Riparian debris suggested recent high flows, but there was no in-channel indication of such an event. Substrate in many areas was abundant inorganic fines, some gravels and larger materials, and CPOM such as leaves, twigs, stick and branches. Many of the travertine dams forming in the reach just downstream of Irving have become 30-60 cm tall and multiple channels, sloughs, and marshy side areas are becoming more extensive. Ten minnow traps and 10 hoop nets

were set between 1400 and 1520 hrs in runs to 1-meter deep and flowing pools of similar depth.

Minnow traps and hoop nets were retrieved between 0825 and 0915 hrs on October 4; mean set time for each individual device was 18.7 hrs. Chub, specked dace, Sonora sucker, and desert sucker were captured (Tables 7 & 9), and specimens were in all devices (Table 9). All four species were in minnow traps while speckled dace were absent from hoop nets. Total minnow trap catch (all species combined) was 347 individuals (range 9-57 per trap) and CPE was 34.7 (Figs. 2 & 3). Total hoop net catch (all species combined) was 673 fish (range 2-259 per net) and CPE was 67.3 (Figs. 2 & 5).

Chubs were in all minnow traps and in all hoop nets, were the most abundant species overall in minnow traps (93% of catch, CPE = 31.8) and in hoop nets (95% of catch, CPE = 63.9), and were the most abundant species in each individual capture device (Table 9). The great majority of chubs (94% in minnow traps and 79% in hoop nets) were small, age-0 fish (Fig. 4), but a few adults in breeding color were noted. Speckled dace was overall the third most abundant fish in minnow traps (total catch = 6, CPE = 0.6). Speckled dace was absent from hoop nets. Sonora sucker comprised 6% of fish in minnow traps (total catch = 22, CPE = 2.2) and was in all but four of these devices (range 1-8 individuals per trap). Similarly, Sonora sucker comprised about 4% of fish in hoop nets (total catch = 29, CPE = 2.9) and was in all but three hoops (range to 7 individuals per net). Most Sonora suckers (63% in minnow traps and 61% in hoop nets) were small, age-0 fish (Fig. 4). Desert sucker was rare and represented in only one minnow trap (one age-1, CPE = 0.1) and in three hoop nets (1 or 3 fish per net, 5 total fish, all age-1; CPE = 0.5).

Northern crayfish was absent from minnow traps and hoop nets. Two Sonora mud turtles were taken from hoop nets in the middle reach.

High Falls (upper reach, Fig. 1).--Upon our arrival in this reach late in the morning on October 4, conditions were unchanged from those noted previously at other reaches. Water was clear. Active travertine deposition was evident in many areas, including travertine/algae stalactites forming on the face of the high falls. Monospecific stands of cattail, horsetail, and common reed were sparse-to-dense along margins of run-type habitats, especially in the first several hundred meters upstream from Irving. Flood debris was in riparian vegetation to over a meter above the stream, but there were no obvious in-channel changes. Two minnow traps and two hoop nets were set between 1125 and 1130 hrs, and eight minnow traps and eight hoop nets were set between 1445 and 1515 hrs in runs to 1-meter deep and flowing pools of similar depth.

Minnow traps and hoop nets were retrieved between 0750 and 0920 hrs on October 5; mean set time for each individual device was 20.1 hrs. Chub, specked dace, Sonora sucker, and desert sucker were captured (Table 7 & 10), and specimens were in all devices except two minnow traps. Total minnow trap catch (all species combined) was 108 individuals (range to 46 per trap) and CPE was 10.8 (Figs. 2 & 3). Total hoop net

catch (all species combined) was 81 fish (range 1-28 per net) and CPE was 8.1 (Figs. 2 & 5).

Chub was in two of 10 minnow traps and three of 10 hoop nets, and was the least abundant species in minnow traps (total catch = 4, CPE = 0.4), but the second most abundant in hoop nets (total catch = 22, CPE = 2.2). Most chub (88%) were age-1 fish (Fig. 4). Speckled dace was the most abundant fish in minnow traps (83% of total catch, CPE = 8.9). Speckled dace was uncommon in hoop nets (total catch = 14, CPE = 1.4), but was taken by eight of 10 sets (1-3 fish per net, Table 10). Sonora sucker was the third most abundant species overall (14% of total catch), comprising 7% of fish in minnow traps (total catch = 7, CPE = 0.7) in three of 10 of these devices (range to 5 individuals per trap) and 25% of fish in hoop nets (total catch = 20, CPE = 2.0), in seven hoops (range to 7 individuals per net). Desert sucker was common in minnow traps (total catch = 8, CPE = 0.8) and in hoop nets (total catch = 25, CPE = 2.5, range to 13 individuals per net). The majority of chubs (88%), Sonora sucker (89%), and desert sucker (75%) were age-1 fish (Fig. 4). Two chubs were estimated to be 20 cm TL, much larger than the size of fish from downstream reaches.

Northern crayfish was absent from minnow traps and from hoop nets in this reach. One hoop net contained a single native Sonora mud turtle.

Autumn 2006 underwater observations

We snorkeled four pools during the sample period. One pool was within our “Above Barrier” reach, two were within the “Below Irving” and one was in the “High Falls” reach. Narratives are provided below, down- to upstream.

The large, deep, steep sided, rock pool at approximately UTM 439526E-3804165N (designated pool no. 28 in the 2004 AZGFD stream reach 4A treatment protocol; Fig 1) was selected for snorkeling in the “Above Barrier” reach, and it was examined from 1000 to 1020 on October 3 by three persons (1.0 hr total effort). About half the pool was in shade, the other half in sunlight. Water temperature was 19C at 1030 hrs. The entire perimeter of the pool was examined, and the thalweg (channel) was traversed head-to-tail several times. Visibility was good. The pool was greater than 3-m deep with a strong current, and a substrate comprised of sand, fine materials, and CPOM, mostly leaves and twigs from terrestrial vegetation. Two observers saw no fish, and a third observed approximately two dozen juvenile-to-18 cm-long Sonora sucker adjacent to a brush pile at the downstream end of the pool. No crayfish were seen during snorkeling, but a large adult was seen in this pool while setting nets the previous day

We snorkeled the large pool below the FSR 708 bridge crossing downstream of Irving at approximate UTM 4422164E, 3805847N (pool no. 16 in AZGFD stream reach 3A; Fig. 1) from 1100 to 1120 hrs (3 persons, total effort 1.0 hrs) on October 3. This pool was clear, very deep (5 to 6 meters), with a swift laminar current. Aquatic vegetation was lacking; substrate was either soft organic materials (leaves and twigs), sand, or bedrock. About one-half the perimeter of the pool was vertical bedrock. The pool was in full

sunlight at the time of our visit. Fishes that were present were concentrated around the margins of the pool or in the inlet and outlet areas; few were in the deepest parts. Chub young-of-year were abundant; numbers were estimated in the hundreds. Most chub were age-0, but many larger fish, to perhaps 25 cm in length, were also seen. Sonora sucker of all sizes also were common, mostly around the periphery; largest fish were near bottom. Desert sucker was relatively uncommon on walls and rock faces where a few adult and smaller individuals were actively feeding. Speckled dace was not encountered. A single, very large (ca. 5 cm carapace length) and bright blue northern crayfish was observed.

We snorkeled in the large, deep, steep sided, rock pool below the falls at Irving (approximately UTM 439526E, 380416N; pool no. 1 in AZGFD stream reach 3A; Fig. 1). It was examined from 1020 to 1050 hrs by four persons (2.0 hrs total effort) on October 4. Visibility was excellent. The pool was greater than 5-m deep, with very strong and complex currents resulting from the 3-m waterfall at the head of the pool, and substrate comprised predominately of fine materials and CPOM, mostly leaves and twigs; cobble was present along the perimeter and tail of the pool. About three-quarters of the circumference of the pool was vertical bedrock. The total number of fish seen was in the thousands. Adult chubs were common and young-of-year plus juveniles (age-0) were abundant throughout the water column in the pool. Large (ca. 30-cm long) adult chub were seen, some with characteristic breeding coloration, and all in deep water near the bottom. Speckled dace of any ages or sizes were uncommon and mostly found among cobbles in the swift, shallow (less than 0.5-meter deep) water in the stream channel at the downstream end of the pool. Sonora suckers were common and desert suckers were uncommon, and both were represented by young-of-year, juveniles, and larger adults. Suckers were on the bottom, along rock walls of the pool, and along shallow cobble edges. No other fish species was detected. No crayfish were seen in the stream channel, but two small individuals were observed in the seep below the old power-plant outfall.

We snorkeled in the large, deep, steep sided, rock pool below the high falls above Irving (approximately UTM 444433E 3808075N; pool no. 24 in AZGFD stream reach 2; Fig. 1). It was examined from 1420 to 1430 hrs by four persons (0.7 hrs effort) on October 4. The pool was deeper than 5-m, with a very strong circular current, and a substrate comprised of fine materials and CPOM, mostly leaves and twigs; cobble and gravel were present along about 25% of the circumference and in the tailrace. Visibility was good. The number of fish in the pool was estimated to exceed 1,000 individuals, and these were distributed throughout. Chub of all sizes were common-to-abundant; some very large adults were observed. Speckled dace was uncommon and mostly seen among cobbles in the swift, shallow (less than 0.5-meter deep) water in the stream channel at the downstream end of the pool. Sonora sucker was common-to-abundant, and represented by all sizes from small juveniles to large adults. Desert sucker was common in the pool and was on the bottom and along rock walls. Larger adults of both sucker species also were seen. No other fish species was detected. Crayfish were not encountered.

Three Sample Comparison

Monitoring has been conducted three times since completion of the stream restoration project: in autumn (September or October) 2005 and 2006, and in spring (May-June) 2006. Chub were encountered in the lower reach for the first time in spring 2006 and were uncommon in that reach in both spring and autumn 2006 (Table 11). Neither desert sucker nor speckled dace have yet been encountered in the lower reach. It is unknown why all species that occur upstream have not dispersed downstream to occupy that lowermost reach. Conversely, crayfish were found commonly only in the lower reach and are rare in the middle and upper reaches. Crayfish appeared fewer and more restricted in distribution in autumn 2006 than autumn 2005. Chub are consistently the most abundant fish in the stream and they are concentrated in the middle reach. Upstream movement of fish is stopped at Irving by a 3-m waterfall. There have been temporal variations but few notable changes in catch per unit effort for each species within each reach for either minnow traps or hoop nets over the period, and a general trend of lower minnow trap CPE is not reflected in hoop net CPE (Table 11, Figs. 6 & 7). Age-0 young-of-year comprised a much greater proportion of the catch in autumn than spring samples (e.g., Fig. 4), and variation in abundance of this age/size group may account for the disparity in CPE between minnow traps and hoop nets. Additional seasonal samples may help determine if these are consistent patterns or reflections of normal sample variation.

Summary

No non-native fishes were detected in the treatment reach of Fossil Creek during monitoring surveys performed May-June and October 2006, and there are no verifiable reports of any non-native fish in the stream since it was treated in autumn 2004. Five native fishes, headwater chub plus roundtail chub, speckled dace, Sonora sucker, and desert sucker were present, primarily as age-1 (including large juveniles plus adults) in spring, and as age-0 (young-of-year) in autumn. The autumn sample indicated successful reproduction and recruitment of all native species (and especially of chub) since completion of the stream renovation and fish repatriation project.

Only two fish taxa, chubs and Sonora sucker, were present in the lowermost reach. Numbers of chubs were fewer than in the two upstream reaches, while numbers of Sonora suckers were similar or greater than in upper reaches. If all post-project repatriation sites were upstream of Irving, then Sonora sucker apparently was the only species that had dispersed downstream by the time of our first monitoring in autumn 2005. Chubs now have re-occupied the lower reach as well. Results of future sampling may allow comparison of dispersal dynamics among these and other native fishes, and lead to recommendations to enhance future projects that repatriate native stream fishes.

Finally, we again note the absence from collections of longfin dace, which was known to occupy Fossil Creek historically and at the time of project implementation. Fewer than two dozen longfin dace were repatriated into Fossil Creek post treatment. Because this native fish has not been found during three consecutive monitoring events spanning two

spawning seasons over a period of more than a dozen months, we recommend its immediate reintroduction from an appropriate, geographically proximate population. Such reintroduction could be simultaneous with introduction of other species including threatened loach minnow *Tiaroga cobitis* and spikedace *Meda fulgida*, which were deemed suitable for the stream in the Environmental Assessment developed for the project (FERC 2004), but should not be delayed in anticipation of authorization to stock these latter species. Other species that should be stocked in a timely manner include Gila topminnow and razorback sucker.

Acknowledgements

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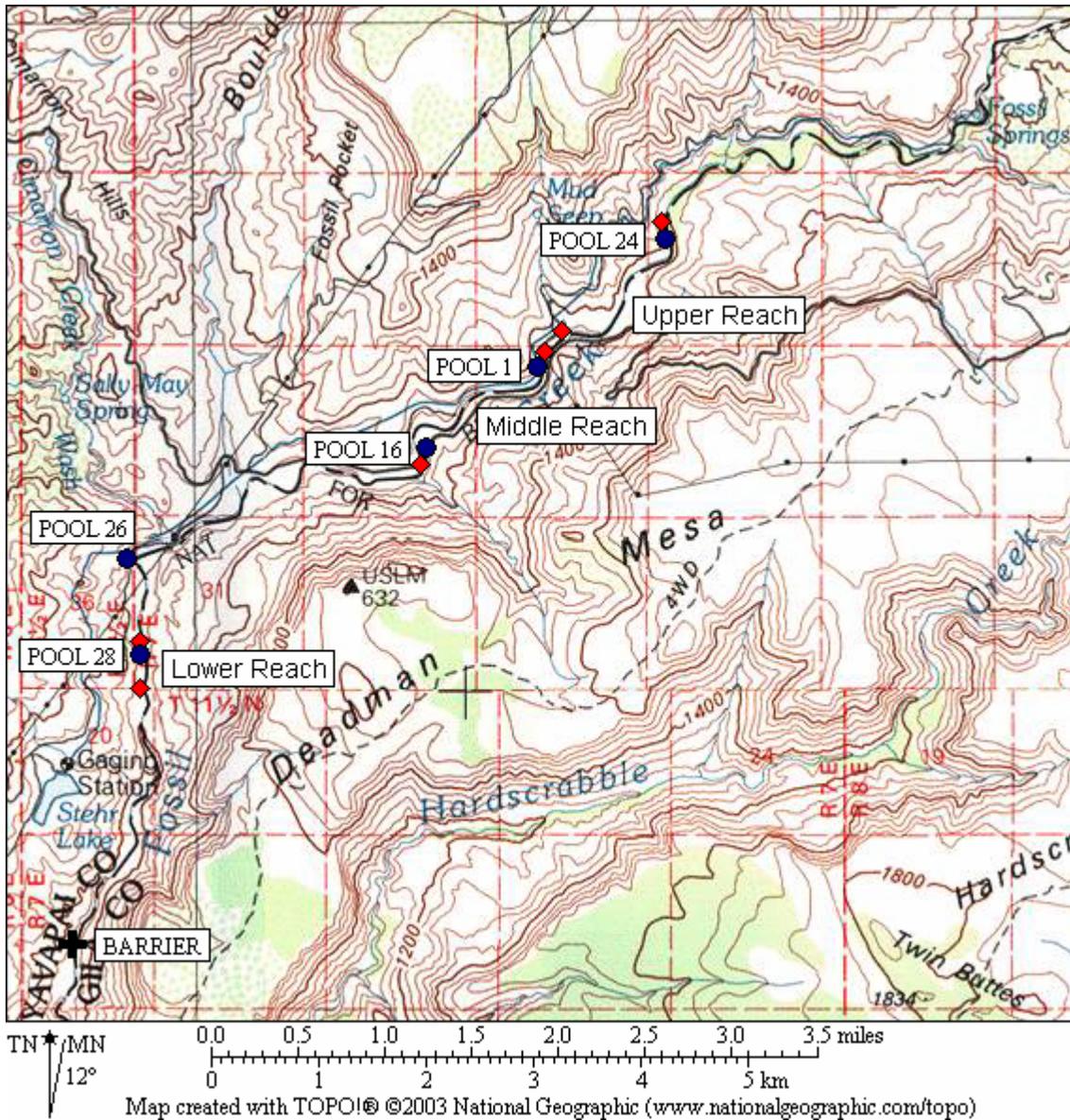


Figure 1. Map of Fossil Creek, Gila and Yavapai counties, Arizona, from Fossil Springs downstream to a constructed fish barrier (+), showing approximate upper, middle, and lower reach boundaries (red diamonds) and pools (blue circles) related to fish monitoring May-June and October 2006. See text and Table 2 for additional information, reach designations, and boundary coordinates.

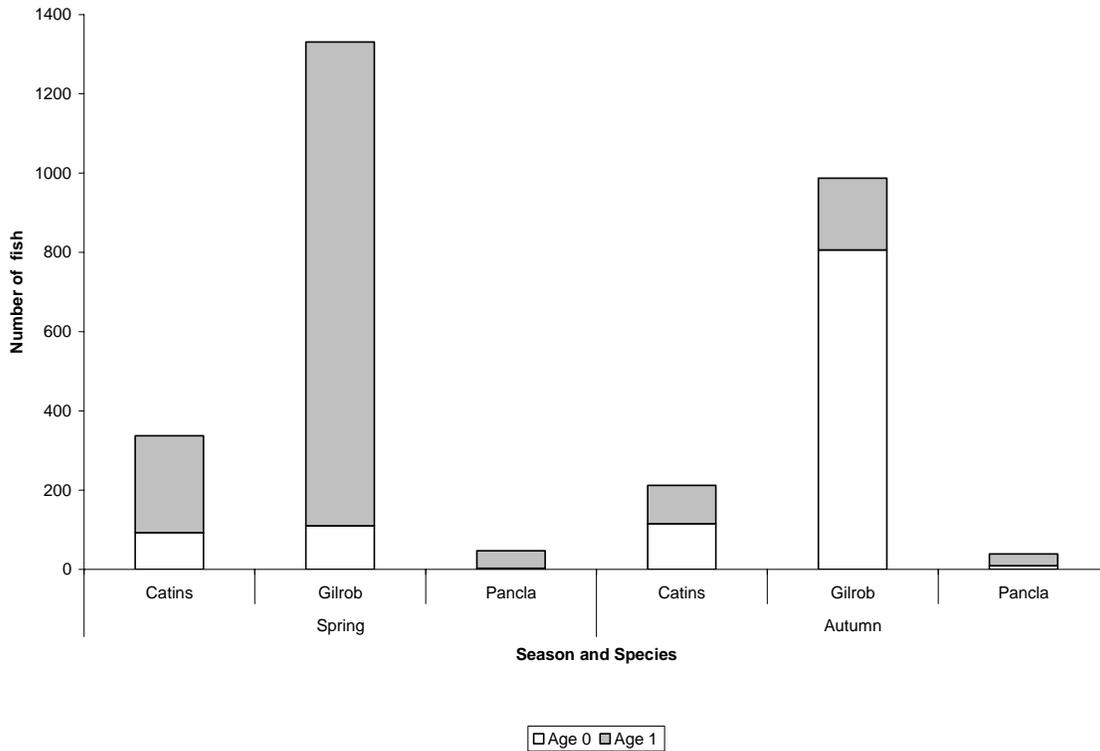


Figure 2. Total fish catch (number) of age-0 and age-1 fish by season (spring = May-June 2006; autumn = October 2006) and species, Fossil Creek, Arizona.

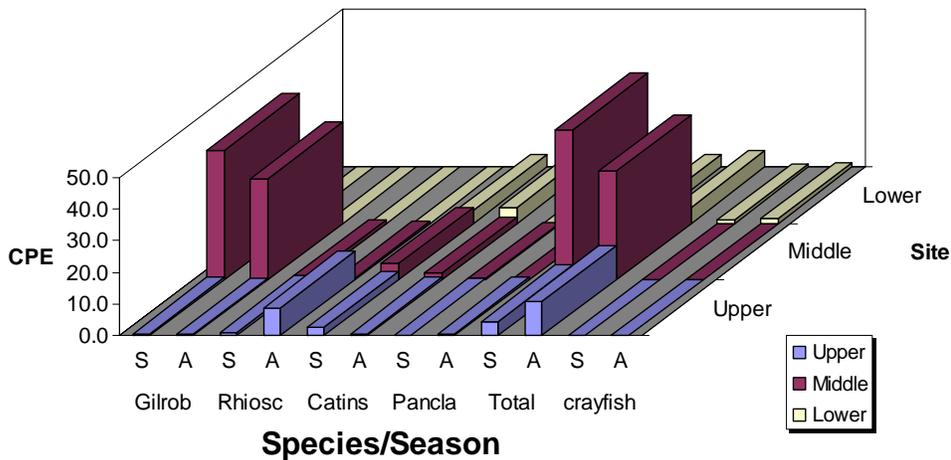


Figure 3. Minnow trap catch per unit effort (CPE, number per set) in 2006 by species and season (S = Spring, May-June; A = Autumn, October) for upper, middle, and lower reaches of Fossil Creek, Arizona.

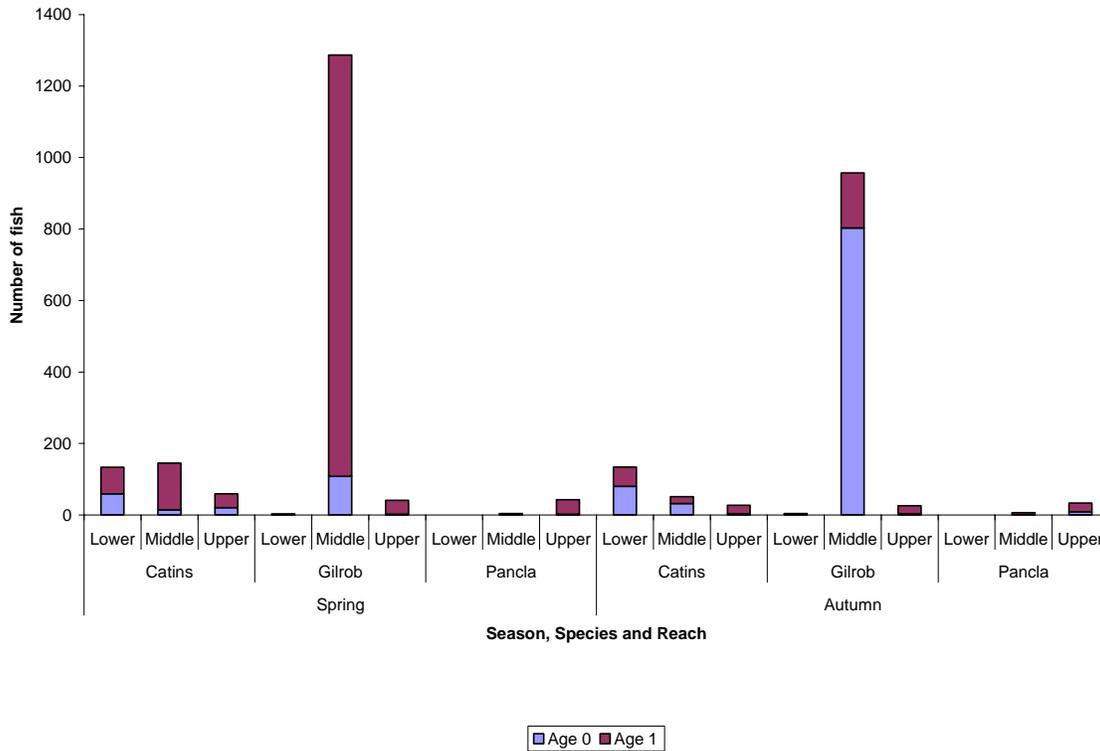


Figure 4. Total catch (number of fish) by species of Age-0 and Age-1 individuals by season (Spring = May-June 2006; Autumn = October 2006) among lower, middle, and upper reaches of Fossil Creek, Arizona.

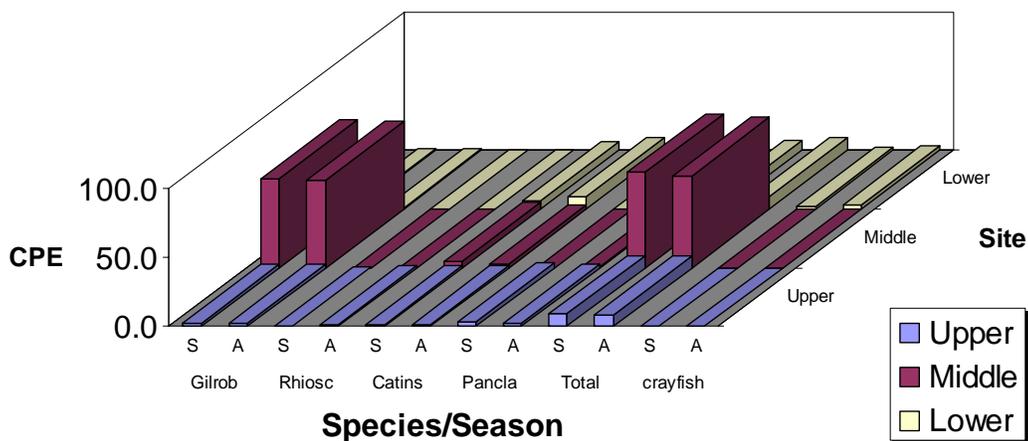


Figure 5. Hoop net catch per unit effort (CPE, number per set) in 2006 by species and season (S = Spring, May-June; A = Autumn, October) for upper, middle, and lower reaches (sites) of Fossil Creek, Arizona.

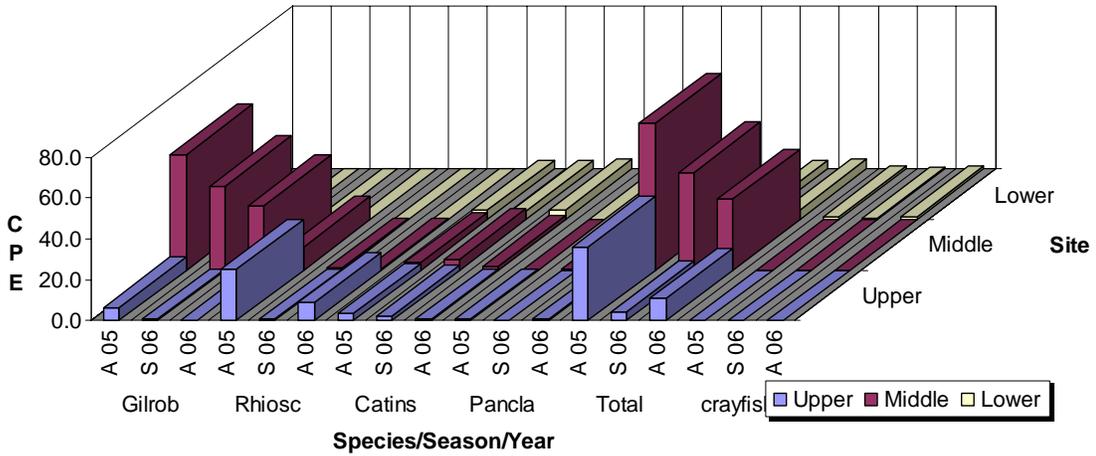


Figure 6. Minnow trap catch per unit effort (CPE, number per set) by species and season (S = Spring, May-June 2006; A = Autumn, September 2005 and October 2006) for upper, middle, and lower reaches (sites) of Fossil Creek, Arizona. See Tables 3C, 7C, and 11 for raw data.

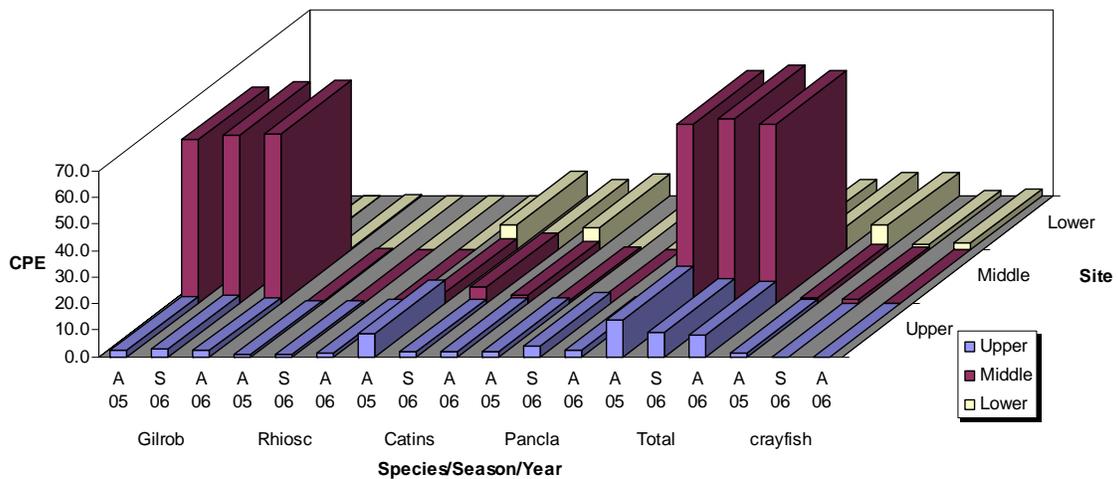


Figure 7. Hoop net catch per unit effort (CPE, number per set) in 2005 and 2006 by species and season (S = Spring, May-June 2005; A = Autumn, September 2005 and October 2006) for upper, middle, and lower reaches (sites) of Fossil Creek, Arizona. See Tables 3C, 7C, and 11 for raw data.

Table 1. Common and scientific names of families and species of native (indicated by *) and non-native fishes known from Fossil Creek, Arizona, and abbreviations used in tables. See footnote on page 1 relative to treatment of headwater and roundtail chubs.

Minnows (Cyprinidae)

- *Longfin dace, *Agosia chrysogaster*
- Common carp, *Cyprinus carpio*
- *Headwater chub, *Gila nigra* (gilasp)
- *Roundtail chub, *Gila robusta* (gilasp)
- *Speckled dace, *Rhinichthys osculus* (rhiosc)

Suckers (Catostomidae)

- *Sonora sucker, *Catostomus insignis* (catins)
- *Desert sucker, *Pantosteus clarki* (pancla)
- *Razorback sucker, *Xyrauchen texanus*

Catfishes (Ictaluridae)

- Yellow bullhead, *Ameiurus natalis*
- Flathead catfish, *Pylodictis olivaris*

Livebearers (Poeciliidae)

- *Gila topminnow, *Poeciliopsis occidentalis*

Basses and Sunfishes (Centrarchidae)

- Green sunfish, *Lepomis cyanellus*
 - Smallmouth bass, *Micropterus dolomieu*
-

Table 2. Approximate lower (downstream) and upper (upstream) limits and approximate lengths of each monitoring reach sampled along Fossil Creek, Pinal and Yavapai counties, Arizona, 19-23 September 2005. Universal Transverse Mercator coordinates (UTMs) in NAD27 datum, Zone 12S.

Reach designation	Lower UTM	Upper UTM	Length (km [mi])
Above Barrier (lower)	439523E-3803732N	439526E-3804165N	0.45 (0.28)
Below Irving (middle)	442157E-3805817N	443295E-3806787N	1.87 (1.16)
High Falls (upper)	443493E-3807060N	444433E-3808074N	1.69 (1.05)

Table 3. Summary of Fossil Creek fish monitoring data, May 29-June 1, 2006.

Table 3A. Total catch by reach and method, all standard samples; mt = minnow trap, hoop = hoop net

	age (0/1)	Upper Reach		Middle Reach		Lower Reach		Total
		Mt	hoop	mt	hoop	mt	hoop	
Gilrob	0	2	0	70	38	0		110
	1	10	29	583	596	0	3	1221
Rhiosc	n/a	11	7	18	0	0	0	36
Catins	0	20	0	7	7	30	29	93
	1	22	17	77	54	40	34	244
Pancla	0	2	0	1	0	0	0	3
	1	1	40	3	0	0	0	44
Total		68	93	759	695	70	66	1751

Table 3B. Total catch by reach, methods combined, all standard samples

	age (0/1)	Upper Reach	Middle Reach	Lower Reach	Total
Gilrob	0	2	108	0	110
	1	39	1179	3	1221
Rhiosc	n/a	18	18	0	36
Catins	0	20	14	59	93
	1	39	131	74	244
Pancla	0	2	1	0	3
	1	41	3	0	44
Total		161	1454	136	1751

Table 3C. Catch per unit effort (no. fish per standard overnight minnow trap or hoop net set) by reach and by method. mt = minnow trap, hoop = hoop net

	age (0/1)	Upper Reach		Middle Reach		Lower Reach	
		mt	hoop	mt	hoop	mt	hoop
Gilrob	0	0.13	0.00	4.38	3.80	0.00	0.00
	1	0.63	2.90	36.44	59.60	0.00	0.30
Rhiosc	n/a	0.69	0.70	1.13	0.00	0.00	0.00
Catins	0	1.25	0.00	0.44	0.70	1.87	2.90
	1	1.38	1.70	4.81	5.40	2.50	3.40
Pancla	0	0.13	0.00	0.06	0.00	0.00	0.00
	1	0.06	4.00	0.19	0.00	0.00	0.00
Total		4.25	9.30	47.56	69.50	4.38	6.60
Crayfish		0.00	0.00	0.00	0.00	1.00	1.80

Table 4. Fossil Creek standard fish monitoring data, Above Barrier (lower) reach, May 29-30, 2006.

Gear type: minnow trap (n = 16)

Mean set/run times: 1530-0820 Mean set duration: 16.6 hours

Species	age (0/1)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total	CPE
Catins	0	1	0	0	0	2	0	0	0	0	0	3	1	0	6	10	7	30	1.87
	1	0	0	0	0	2	0	0	0	0	0	2	10	0	0	0	26	40	2.50
Total	1	1	0	0	0	4	0	0	0	0	0	5	11	0	6	10	33	70	4.38
Crayfish		2	0	1	0	3	0	0	3	3	0	0	0	0	0	0	4	16	1.00

Gear type: hoop net (n = 10)

Mean set/run times: 1530-0820 Mean set duration: 16.6 hours

Species	age (0/1)	1	2	3	4	5	6	7	8	9	10	Total	CPE
Gilrob	1	0	1	1	0	0	0	0	0	1	0	3	0.30
Catins	0	3	2	5	6	8	3	2	0	0	0	29	2.90
	1	11	4	1	0	4	3	4	0	0	7	34	3.40
Total	2	14	7	7	6	12	6	6	0	1	7	66	6.60
Crayfish		0	0	2	0	1	3	10	0	2	4	22	2.2
Mud turtle		0	0	0	0	0	0	0	0	1	0	1	0.10

Table 5. Fossil Creek standard fish monitoring data, Below Irving (middle) reach, May 30-31, 2006.

Gear type: minnow trap (n = 16)

Mean set/run times: 1420-0800 Mean set duration: 17.6 hr

Species	age (0/1)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total	CPE
Gilrob	0	0	0	0	0	10	18	15	4	0	7	5	2	2	7	0	0	70	4.38
	1	16	22	22	10	51	35	15	39	78	60	35	40	77	75	8	0	583	36.43
Rhiosc	n/a	8	1	3	1	1	0	2	2	0	0	0	0	0	0	0	0	18	1.13
Catins	0	0	0	0	0	0	0	0	0	2	0	2	0	3	0	0	0	7	0.44
	1	0	0	4	2	1	3	4	15	10	22	7	4	1	4	0	0	77	4.81
Pancla	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0.06
	1	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	3	0.19
Total		24	23	29	13	63	56	36	60	91	92	49	46	83	86	8	0	759	47.56

Gear type: hoop net (n = 10)

Mean set/run times: 1420-0800 Mean set duration: 17.6 hr

Species	age (0/1)	1	2	3	4	5	6	7	8	9	10	Total	CPE
Gilrob	0	0	0	4	0	4	0	29	1	0	0	38	3.80
	1	85	46	2	5	196	1	70	4	64	123	596	59.6
Catins	0	0	0	2	0	3	0	1	1	0	0	7	0.70
	1	7	6	2	1	13	0	1	4	16	4	54	5.4
Total		92	52	10	6	216	1	101	10	80	127	695	69.5
Crayfish		0	1	1	0	0	0	1	0	10	1	13	1.3

Table 6. Fossil Creek standard fish monitoring data, High Falls (upper) reach, May 31-June 1, 2006.

Gear type: minnow trap (n = 16)

Mean set/run times: 1610-1020 Mean set duration: 18.1 hrs

Species	age (0/1)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total	CPE
Gilrob	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0.13
	1	2	0	1	0	1	0	0	0	0	0	1	4	1	0	0	0	10	0.63
Rhiosc	n/a	2	0	1	0	1	1	0	4	0	0	0	0	1	0	0	1	11	0.69
Catins	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	20	1.25
	1	0	0	0	0	0	0	0	3	2	1	13	3	0	0	0	0	22	1.38
Pancla	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0.13
	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0.06
Total		4	0	2	0	2	1	0	27	2	1	15	7	2	0	2	3	68	4.25
Bullfrog larva		0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0.13

Gear type: hoop net (n = 10)

Mean set/run times: 1610-1020 Mean set duration: 18.1 hrs

Species	age (0/1)	1	2	3	4	5	6	7	8	9	10	Total	CPE
Gilrob	1	1	20	4	0	0	2	1	0	0	1	29	2.90
Rhiosc	n/a	0	1	0	0	0	0	0	0	0	6	7	0.70
Catins	1	0	2	2	0	0	1	3	1	1	7	17	1.70
Pancla	1	0	7	1	1	0	2	3	1	0	25	40	4.00
Total		1	30	7	1	0	5	7	2	1	39	93	9.30
Bullfrog larva		0	0	0	0	0	0	0	1	0	0	1	0.10
Mud turtle		0	0	0	1	2	0	0	0	0	0	3	0.30

Table 7. Summary of Fossil Creek fish monitoring data, October 2-5, 2006.

Table 7A. Total catch by reach and method, all standard samples; mt = minnow trap, hoop = hoop net

	age (0/1)	Upper Reach		Middle Reach		Lower Reach		Total
		Mt	hoop	mt	hoop	mt	hoop	
Gilrob	0	3	0	299	504	0	0	806
	1	1	22	19	135	0	4	181
Rhiosc	n/a	89	14	6	0	0	0	109
Catins	0	1	2	15	17	39	41	115
	1	6	18	7	12	11	43	97
Pancla	0	2	7	0	0	0	0	9
	1	6	18	1	5	0	0	30
Total		108	81	347	673	50	88	1347

Table 7B. Total catch by reach, methods combined, all standard samples

	age (0/1)	Upper Reach	Middle Reach	Lower Reach	Total
Gilrob	0	3	803	0	806
	1	23	154	4	181
Rhiosc	n/a	103	6	0	109
Catins	0	3	32	80	115
	1	24	19	54	97
Pancla	0	9	0	0	9
	1	24	6	0	30
Total		189	1020	138	1347

Table 7C. Catch per unit effort (no. fish per standard overnight minnow trap or hoop net set) by reach and by method. mt = minnow trap, hoop = hoop net

	age (0/1)	Upper Reach		Middle Reach		Lower Reach	
		mt	hoop	mt	hoop	mt	hoop
Gilrob	0	0.30	0.00	29.90	50.40	0.00	0.00
	1	0.10	2.20	1.90	13.50	0.00	0.40
Rhiosc	n/a	8.90	1.40	0.60	1.70	0.00	0.00
Catins	0	0.10	0.20	1.50	0.00	3.90	4.10
	1	0.60	1.80	0.70	1.20	1.10	4.30
Pancla	0	0.20	0.70	0.00	0.00	0.00	0.00
	1	0.60	1.80	0.00	0.50	0.00	0.00
Total		10.80	8.10	34.70	67.30	5.00	8.80
Crayfish		0.00	0.00	0.00	0.00	1.40	2.50
Mud turtle		0.00	0.00	0.00	0.20	0.00	0.20

Table 8. Fossil Creek standard fish monitoring data, Above Barrier (lower) reach, October 2-3, 2006.

Gear type:		minnow trap (n = 10)											
Mean set/run times:												Mean set duration: 17.5 hours	
Species	age (0/1)	1	2	3	4	5	6	7	8	9	10	Total	CPE
Catfins	0	1	0	0	1	0	3	19	4	0	11	39	3.90
	1	0	1	0	3	0	6	0	0	1	0	11	1.10
Total	1	1	1	0	4	0	9	19	4	1	11	50	5.00
Crayfish		0	1	0	5	0	0	2	3	2	1	14	1.40

Gear type:		hoop net (n = 10)											
Mean set/run times:		1445-0815										Mean set duration: 17.5 hours	
Species	age (0/1)	1	2	3	4	5	6	7	8	9	10	Total	CPE
Gilrob	1	0	0	0	0	1	0	1	0	0	2	4	0.40
Catfins	0	0	2	5	0	5	1	23	3	0	2	41	4.10
	1	0	2	1	1	12	0	3	0	22	2	43	4.30
Total	2	0	4	6	1	17	1	26	3	22	4	88	8.80
Crayfish		0	1	2	0	1	6	10	0	3	2	25	2.50
Mud turtle		0	0	0	0	0	0	1	1	0	0	2	0.20

Table 9. Fossil Creek standard fish monitoring data, Below Irving (middle) reach, October 3-4, 2006.

Gear type: minnow trap (n = 10)
 Mean set/run times: 1400-0845 Mean set duration: 18.7 hr

Species	age (0/1)	1	2	3	4	5	6	7	8	9	10	Total	CPE
Gilrob	0	3	16	45	43	35	53	32	21	25	26	299	29.90
	1	4	3	0	3	0	2	0	2	5	0	19	1.90
Rhiosc	n/a	0	0	0	0	0	0	2	0	2	2	6	0.60
Catins	0	2	3	8	1	0	1	0	0	0	0	15	1.5
	1	0	0	0	0	4	1	0	2	0	0	7	0.70
Pancla	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	1	0	0	0	0	1	0	0	0	0	0	1	0.10
Total		9	22	53	47	40	57	34	25	32	28	347	34.7

Gear type: hoop net (n = 10)
 Mean set/run times: 1400-0845 Mean set duration: 18.7 hr

Species	age (0/1)	1	2	3	4	5	6	7	8	9	10	Total	CPE
Gilrob	0	1	199	67	15	21	39	58	77	2	25	504	50.40
	1	1	53	9	5	2	5	16	3	18	23	135	13.50
Catins	0	0	7	3	0	1	0	1	3	2	0	17	1.70
	1	1	0	0	0	0	3	7	1	0	0	12	1.2
Pancla	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	1	0	0	0	0	0	3	0	1	0	1	5	0.50
Total		3	259	79	20	24	50	82	85	22	49	673	67.3
Mud turtle		1	0	1	0	0	0	1	0	0	0	3	0.3

Table 10. Fossil Creek standard fish monitoring data, High Falls (upper) reach, October 4-5, 2006.

Gear type: minnow trap (n = 10)
 Mean set/run times: 1145-0750 Mean set duration: 20.1 hrs

Species	age (0/1)	1	2	3	4	5	6	7	8	9	10	Total	CPE
Gilrob	0	0	0	2	0	0	1	0	0	0	0	3	0.30
	1	0	0	1	0	0	0	0	0	0	0	1	0.10
Rhiosc	n/a	43	2	3	0	1	5	32	0	2	1	89	8.90
Catins	0	1	0	0	0	0	0	0	0	0	0	1	0.10
	1	0	0	0	0	1	5	0	0	0	0	6	0.60
Pancla	0	0	1	0	0	0	1	0	0	0	0	2	0.2
	1	2	0	0	0	4	0	0	0	0	0	6	0.60
Total		46	3	6	0	6	12	32	0	2	1	108	10.8

Gear type: hoop net (n = 10)
 Mean set/run times: 1145-0750 Mean set duration: 20.1 hrs

Species	age (0/1)	1	2	3	4	5	6	7	8	9	10	Total	CPE
Gilrob	1	1	0	16	0	0	0	0	0	5	0	22	2.20
Rhiosc	n/a	1	2	3	1	1	0	0	2	3	1	14	1.40
Catins	0	0	0	0	0	0	0	2	0	0	0	2	0.20
	1	0	0	1	0	4	2	0	1	7	3	18	1.80
Pancla	0	1	4	2	0	0	0	0	0	0	0	7	0.70
	1	0	0	0	0	0	1	0	1	13	3	18	1.80
Total		3	6	22	1	5	3	2	4	28	7	81	8.10
Mud turtle		0	1	0	0	0	0	0	0	0	0	1	0.1

Table 11. Comparison by species of minnow trap (mt) and hoop net (hoop) total CPE between autumn (A: September 2005 and October 2006) and spring (S: May-June 2006) among three reaches of Fossil Creek, Arizona (age classes combined).

		Upper Reach		Middle Reach		Lower Reach	
		Mt	hoop	mt	hoop	mt	hoop
Gilrob	A 2005	6.7	2.6	56.4	61.5	0.0	0.0
	S 2006	0.8	2.9	40.8	63.4	0.0	0.3
	A 2006	0.4	2.2	31.8	63.9	0.0	0.4
Rhiosc	A 2005	25.0	0.8	11.4	0.6	0.0	0.0
	S 2006	0.7	0.7	1.1	0.0	0.0	0.0
	A 2006	8.9	1.4	0.6	0.0	0.0	0.0
Catins	A 2005	3.5	8.8	3.6	4.3	4.6	9.4
	S 2006	2.6	1.7	5.3	6.1	4.4	6.3
	A 2006	0.7	2.0	2.2	2.9	5.0	8.4
Pancla	A 2005	0.8	1.8	0.1	1.1	0.0	0.0
	S 2006	0.2	4.0	0.3	0.0	0.0	0.0
	A 2006	0.8	2.5	0.1	0.5	0.0	0.0
Total	A 2005	36.0	14.0	71.5	67.5	4.6	9.4
	S 2006	4.3	9.3	47.6	69.5	4.4	6.6
	A 2006	10.8	8.1	34.7	67.3	5.0	8.8
Crayfish	A 2005	0.0	1.3	0.0	2.1	1.7	9.1
	S 2006	0.0	0.0	0.0	1.3	1.0	2.2
	A 2006	0.0	0.0	0.0	0.0	1.4	2.5