Assessment of Colorado Pikeminnow and Razorback Sucker Reintroduction Programs in the Gila River Basin

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EXECUTIVE SUMMARY

Since 1991, nearly 23,000, razorback sucker and over 11,000 Colorado pikeminnow have been stocked in the Salt and Verde Rivers of Arizona. Monitoring efforts during this period have resulted in the capture of 87 Colorado Pikeminnow and 283 razorback sucker in the Verde River, and two razorback sucker in the Salt River. Most of these repatriated native fish were captured near common stocking areas, suggesting that re-introduced razorback sucker and Colorado pikeminnow may show high site fidelity to points of introduction. Those that did not exhibit site fidelity were found downstream from stocking sites. Only one fish has ever been recaptured, a razorback sucker in the Verde River near Childs power plant. Lack of recaptures renders assessment of survival and population sizes impossible, but it would appear that adult survival is low and of short duration, and recruitment has not been documented. Future work towards recovery of Colorado pikeminnow and razorback sucker in the Salt and Verde Rivers should focus on predator removal, continued stocking of fish greater than 300 mm in length, physical acclimation of hatchery fish to flow and site acclimation in backwaters, and PIT tag injection of hatchery fish prior to stocking. In addition, the standardized sampling protocol for monitoring activities, implemented in 2003, should be followed in the future.

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Introduction

Since 1981, the Arizona Game and Fish Department and various federal agencies have been committed to re-establishing two big river native fish species in the Salt and Verde Rivers (U.S. Fish and Wildlife Service 1990, 1998). Colorado pikeminnow, *Ptychocheilus lucius*, and razorback sucker, *Xyrauchen texanus*, were extirpated from the Gila River basin by the 1970s as a result of damming, dewatering, and introductions and establishment of non-native aquatic organisms (Vanicek et al. 1970, Holden and Stalnaker 1975, Kaeding and Osmundson 1988). Both of these species are native to the Colorado River basin and were common in the mainstem of the Colorado River and its tributaries until the early 1900's (Minckley 1973). In response to continuing decline of these species, the USFWS listed both as endangered (U.S. Fish and Wildlife Service 1989, 1991). Efforts to reintroduce both species were begun in the early 1980s, but initial stockings were largely unsuccessful, presumably because of predation by non-native fishes on the relatively small, newly released natives. Later efforts (1991–2003) are thought to have met with greater success, in part because size of the stocked individuals was increased to remove much of the threat of predation. The purpose of this project is to assess the success of the Colorado pikeminnow and razorback sucker repatriation program since the stocking of larger individuals was implemented.

Study Area-The study areas on the Salt and Verde rivers are described extensively by Hendrickson (1993) and therefore will only be described briefly here. A map of the study area is provided (Figure 1).

The Upper Salt River was divided into four reaches, based on river morphology and logistical considerations (River miles [RM] taken from maps prepared by AGFD).

Reach 1 U. S. Highway 60 bridge (RM 50.0) downstream to Gleason Flat (RM 32.5). The river flows through deep, narrow canyons dominated by large boulder and bedrock substrates, deep runs, and a high river gradient (28.0 ft./mile);

Reach 2 Gleason Flat (RM 32.5 to 29.8). At Gleason Flat, the canyon flattens and the river slows. This section is characterized by fine alluvium substrates and a lower gradient (20.4 ft./mile);

Reach 3 Gleason Flat (RM 29.8) to Horseshoe Bend (RM 16.5). Reach 3 is similar to reach 1 in river morphology, with narrow canyons, large boulder and bedrock substrates, and a high river gradient (28.2 ft./mile);

Reach 4 Horseshoe Bend (RM 16.5) to AZ HWY 288 bridge. Similar to Gleason Flat (Reach 2), the river is generally wide, with alluvium-dominated substrates and a lower gradient (16.7 ft./mile).

The Verde River was separated into 3 reaches for stocking and monitoring. All river miles were taken from the Recreation Opportunity Guide for the Verde River, 1993.

Reach 1 Perkinsville to Clarkdale (No RM). This stretch is approximately 21 miles long. Beginning at Perkinsville the river is characterized by an abundance of pools separated by shallow, rocky riffles and rapids. Below its' confluence with Sycamore Creek, the flood plain narrows and the river enters a steep-sided basaltic canyon where large, deep pools and boulder cover become the norm. As the river reaches Tapco, the valley widens and the river slows as it proceeds past Clarkdale, the end of reach 1;

Reach 2 Beasley Flat to Childs (RM 60 to RM 42.5). Bedrock substrates and sharp drops in slope through steep, narrow canyons dominate this stretch. Large cobble and gravel bars become exposed at low water;

Reach 3 Childs to Horseshoe Lake (RM 42.5 to 0). Several large tributaries in this reach influence the river. East Verde River and Fossil Creek create large alluvial fans and, with Horseshoe Dam (which creates Horseshoe Lake), help make this reach the most variable of the three with regard to substrate and hydrology.

Methods

***Propagation and Stocking*-**Razorbacks and pikeminnow stocked into the Salt and Verde rivers were produced at both the Bubbling Ponds State Fish Hatchery (BPSH) near Cornville, Arizona and the United States Fish and Wildlife Service's Dexter National Fish Hatchery and Technology Center (DNFHTC) at Dexter, New Mexico. When this project was initiated in 1981, fry and fingerlings were stocked into main channel habitats of the

Salt and Verde rivers (Hendrickson 1993). Many years of failure to detect recruitment (possibly due to predation) lead to a movement of stocking sites to the headwaters of the rivers, where predation was considered less of a threat (Hendrickson 1993). Subsequent monitoring efforts indicated these fingerlings either swam downstream or were transported downstream, where predation may have become a factor once again (Jahrke and Clark 1999).

Since 1991, production protocols have called for the release of larger individuals (at least 300 mm), in an effort to reduce predation. Fish of this size are presumed to be too large for most predators to eat. In addition, beginning in 1994, propagation goals for razorback sucker and Colorado pikeminnow were set at 2,000 individuals per species per year. Switching to larger fish meant fewer individuals were available for stocking, and biologists believed survival might be maximized if all fish produced were stocked in the same geographical reach within a river. For obvious logistical reasons, this amounted to stocking at a few locations that were readily accessible to hatchery vehicles.

Adult razorback sucker collected from Lake Mohave, Arizona, are spawned during Spring at Willow Beach National Fish Hatchery (WBNFH). Swim-up fry are then transported to BPSH where they are grown to 300 mm or greater. Growth to this size takes approximately two years. These fish are typically harvested in late fall or early winter and transported to the Verde River at Childs within 48 hours. Razorbacks are stocked either upstream or downstream of the power plant. Razorbacks were also stocked at the Perkinsville bridge between 1991-1993 (Table 1).

Propagation methods for Colorado pikeminnow are similar to those for razorback sucker. BPSH acquires fingerlings from DNFHTC and places them in small concrete raceways where they are allowed to grow. Once they reach 150 mm, fish are transferred to ponds until they grow to a length of 300 mm. It typically takes Colorado pikeminnow fingerlings three years to reach 300 mm. Similar to razorbacks, the fish are then harvested in late fall or early winter and stocked into the Verde River. The stocking sites for pikeminnow are the Beasely Flat picnic area at the end of Forest Road 334, 8 miles south of Camp Verde, and near Childs either upstream or downstream of the plant. Table 1 provides a summary of all reintroductions since 1991.

Each fish released into the Verde River, beginning in 1994, was implanted with a coded wire tag prior to stocking. Tag location is used to identify when the fish was stocked. In December 1996, Arizona received 2,046 razorback sucker from the state of Utah. Of these 2,046, approximately 700 were PIT tagged. These fish were released into the upper Salt River at Horseshoe Bend and represent the last time razorbacks or Colorado pikeminnow were stocked into the Salt River, since 1990.

Monitoring-Field efforts focused on boat-mounted electrofishing and seining and although the initial plan was to sample each study area on a quarterly basis, sampling was typically only conducted once per year. Electrofishing equipment deployed in this study consisted of a boat mounted Coffelt brand variable voltage pulsator shocker (model VVP-15) powered by a gasoline-powered generator (3500 or 5000 watt). The anodes used in the beginning of this study consisted of 4, 60 cm lengths of 6 mm diameter stainless steel cable fastened together so that each formed one arm of an "X" pattern. A single such anode was suspended from a fiberglass boom so as to be held just under the water surface about 1 to 1.5 m off the bow of the boat. The cathode was a 5 m length of the same cable allowed to trail from the stern of the boat.

Electrofishing equipment and methods were altered in early 1996. The system was changed to a Smith-Root model 5.0 GPP with a 5,000-watt generator. Anode design was converted from simple cable droppers to a stainless steel sphere measuring approximately 30 cm in diameter. Cathode design was modified to strips of aluminum mounted on the side of a canoe. When river conditions mandated that a raft be used instead of a canoe, the cathode design became a combination of spheres and cables hanging off the back of the raft. Block seines were used when electrofishing sites on the upper Verde River (above Clarkdale). Though electrofishing settings varied based on water conductivities and temperatures, the most common settings were 500-600 volts, 4-6 amps, and 15-30 pulses per second. The above set-up allowed survey efforts to overcome very high water conductivities (>3,000 ΦS) encountered on the upper Salt River.

Trammel nets used during this project period were 45.7 m long by 1.8 m deep or 15.2 m long by 1.8 m deep with inner panel bar mesh measuring 6.35 cm. Experimental gill nets measuring 45.7 m long by 1.8 m deep and bar mesh ranging from 2.5 cm to 7.6

cm were also used. Deployment strategies were similar to Hendrickson (1993). Both trammel and gill net sets were often mired by drifting debris, likely reducing their effectiveness.

Trotlines, (lumped under "angling" gear in data summaries [below]), were also employed, primarily on the upper Salt River, to gain additional information on the non-native sport fish populations impacting these reintroduction efforts. Stauffer et al. (1996) showed that flathead catfish could be susceptible to trotlines and angling. Both methods were sometimes used in place of trammel and gill netting on the Salt River. Trotlines were typically set in calm water adjacent to swift currents. A 25-hook line was used with 2-foot spacers between hooks. Hooks were baited with cut carp chunks or small live non-native baitfish collected during seine sampling. Angling was done on both the Verde and Salt rivers. Most common baits used were 2 to 3 inch pumpkin seed colored grubs, crankbaits and spinners on the Verde and cut carp chunks and hellgrammites (insect larvae of the family Megaloptera) on the Salt River.

Captured fishes were measured for total length to the nearest mm, and weighed to the nearest 10 grams. Razorback suckers and Colorado pikeminnow were scanned for presence of wire and PIT tags, injected with a PIT tag (if lacking) and released at the point of capture. PIT tag numbers were recorded. Beginning and ending river mile for each sampled reach were recorded, as well as ending UTM coordinates taken from GPS. Data collected during these monitoring efforts was compiled by Region VI (AGFD) personnel and archived in ACCESS databases held by Region VI.

Results

Reintroduction

Verde River-Since 1991, 22,869 razorback suckers have been released into the Verde River (Table 1). Out of 30 separate stocking events during this period, all but three were of fish measuring 300 mm or greater (mean total length for the batch). Several of these stockings were of fish with a mean total length close to 400 mm.

Since February of 1992, 11,231 Colorado pikeminnow have been stocked into the Verde River. All pikeminnow stockings have been of fish greater than 300 mm. About half the stockings were of fish measuring 400 mm or more.

Salt River-Due to concerns with the release of the endangered razorback sucker expressed by the White Mountain Apache Tribe (Jahrke and Clark 1999), only one stocking of razorback sucker has been made in the Salt River since the late 1980's. This stocking occurred in December 1996 and consisted of 2,046 razorbacks, which were acquired from the state hatchery at Monticello, Utah, and stocked into the Salt River at Horseshoe Bend (Table 1). These fish averaged 285 mm (total length). Colorado pikeminnow have not been stocked in the Salt River since 1990.

Monitoring

Verde River-Since 1990, the number of razorback sucker captured in the Verde River has fluctuated yearly from a high of 104 in 1994 to a low of 2 in 2001 (Table 2). Every razorback capture occurred in the river and not downstream in Horseshoe Reservoir. The majority of these fish were collected using electrofishing equipment. The 103 razorbacks captured by trammel net in 1994 were captured in a pool at Perkinsville bridge. The fish were likely the same fish that had been stocked at that location the previous year (Table 1).

In May of 2002, a previously PIT tagged razorback sucker was captured in the pool at the Childs campground, and represents the first and only recapture of a PIT tagged fish since the initiation of this recovery program. The fish was first tagged in May of 1999 and released in that same pool. Since the first capture in 1999, the fish had grown 36 mm – from 405 mm to 441 mm.

The number of Colorado pikeminnow captured in the Verde River has declined since 1998 when 30 individuals were captured (Table 3). Since 1999, only four pikeminnow have been captured. There have also been a few reports of angling mortalities of pikeminnow, all in the Beasley Flat – Childs area (AGFD, unpublished data).

Most native fish captured in the Verde River were found at or near introduction sites (Figure 2). The only exceptions to this were the 23 Colorado pikeminnow and three razorback suckers captured in Horseshoe Reservoir. Fidelity to stocking sites is fairly well

established by the uniform manner in which sampling gears were employed throughout the Verde River (Figure 3). River miles 60 through 90 of the Verde River are surrounded by the towns of Camp Verde, Cottonwood, and Clarkdale. Numerous diversion dams and private property in this stretch of river make sampling difficult, and explain the paucity of sampling efforts in this area.

Salt River-In February of 1997 a single razorback sucker was captured in Roosevelt Lake, approximately 2 months after and 20 miles downstream of where it was stocked. Since this fish, there have been no further recaptures. The only other razorback of note was a 290 mm (standard length) individual that was removed from the stomach of an 810 mm (total length) flathead catfish collected near Gleason Flat in May of 1994. A coded wire tag was recovered from the razorback.

Sampling efforts in the Salt River, like in the Verde, have been extensive and fairly uniformly distributed throughout the study area (Figure 4). However, because so few native fish have been stocked into the Salt River since the beginning of this project, monitoring efforts have been focused on learning more about the highly piscivorous flathead catfish, which has recently become the most dominant fish in the river. When this reintroduction program was started in 1981, flathead catfish represented less than 5% of fish sampled during monitoring surveys (Hendrickson 1993). Based on recent monitoring surveys, flathead catfish relative abundance in the Salt River may be as high as 90 % (AGFD, unpublished data). This species sits atop the food chain and has apparently been successful in severely reducing or eliminating many species, both native and non-native (Jahrke and Clark 1999).

Discussion

Decline of Native Fish Species-The decline of native fish species has occurred simultaneously with an increase in the number of introduced species. Maddux et al. (1993) reported the introduction of at least 72 fish species, twice the number of native fishes, into the Colorado River basin. Many of these introduced fishes have established successful populations throughout the Colorado River system and now are serious predators of young suckers, chubs, and pikeminnow (Mac et al. 1998). Introductions of non-native fishes,

often for sport fishing, have contributed to the progressive depletion of native fishes. These new fishes compete with, consume, and hybridize with native species which has led to the current situation in which 60 percent of the native fishes in the Southwest are now listed by federal and state agencies as threatened, endangered, or of special concern. The hydrology of the region has been so altered since settlement that in Arizona, 80 percent of mainstream river habitats have been altered either physically or chemically, or have been completely lost through drying. Increased erosion and siltation due to logging and grazing operations add to the degradation of native fish habitat (Rinne and Fletcher 1994). Dams form barriers to migration and spawning, egg laying areas have been destroyed, and larval nursery habitat has been left dry by water diversions (NMDGF 1992).

According to Mac et al. (1998) the most frequently mentioned causes of imperilment and extinction of southwestern fishes includes construction of dams, loss of physical habitat, habitat degradation, chemical pollution, overexploitation, and introduction of nonindigenous species. The most likely causes of decline of razorback sucker are environmental changes resulting from the construction of dams and impoundments, as well as predation by non-native centrarchids and ictalurids (Sublette et al. 1990). The near extinction of Colorado pikeminnow is due to a combination of factors, the most significant being those associated with water development projects that have altered stream morphology, flow patterns, temperatures, water chemistry, and silt loads of most major streams throughout the Colorado basin (Sublette et al. 1990).

Assessment of the Stocking Program-The primary goal of stocking is to reestablish populations. Establishment of a self-sustaining population is dependent on the species' ability to adapt and reproduce under existing environmental conditions. Successful reintroduction of native fishes back into their historic ranges is dependent on recognition of all the factors responsible for their original demise. Three decades of stocking endangered fishes has shown that unless these bottlenecks are identified and adequately addressed, recruitment failure will continue to occur (Mueller 2003).

Approximately 12 million fingerling razorback suckers were stocked into the Verde River between 1981 and 1991 with little or no success (Hendrickson 1993). Losses were assumed to be a result of predation by non-native fishes. Studies conducted in the upper

Colorado River basin found a similar correlation of size with survival (Burdick 2003). Burdick recommended that only suckers larger than 200 mm be stocked and that the role of site acclimation and survival be further investigated. 15 years earlier, Marsh and Brooks (1989) recommended similar actions in the lower basin.

Since 1991, reintroduction efforts in the Salt and Verde rivers have focused on stocking larger razorback suckers and Colorado pikeminnow (300 mm minimum length) in an attempt to offset predation. Of 24,915 razorback sucker stocked in the past 14 years, only one has been recaptured. A pikeminnow has never been recaptured. Although monitoring efforts capture a number of fish each year, these captures are almost always of fish that have only been in the river for a couple of months (i.e. recently stocked). While these captures do prove that at least some razorback and pikeminnow survive in the short-term, they provide no insight into long-term survival.

One of the primary challenges in measuring stocking survival is to recapture adequate numbers of fish (Mueller 2003). Unfortunately, the lack of recaptured fish during this study makes survival impossible to calculate. It is unclear whether the sampling program was ineffective or the fish simply have not survived.

For stocking to result in recovery, two things must occur: (1) stocked individuals must survive, reach sexual maturity, and produce offspring, and (2) offspring must survive, reach sexual maturity, and produce offspring. Since the inception of the Colorado pikeminnow and razorback sucker reintroduction program in 1981, only a handful of fish are known to have survived longer than a few months and recruitment has never been documented.

Methodology Considerations-The current use of coded wire tags to determine stocking location and date should be discontinued. Examination of collection records indicates a large percentage of captured fish either lost their CWT or scanners failed to identify presence of the tag. Instead, PIT tags should be implanted in all fish prior to release. PIT tags allow for recognition of individual fish, and if length and weight data are also measured prior to release, would allow for growth analysis and increase the likelihood of obtaining enough data to calculate estimates of survival and population size.

Over the history of this program, sampling methodologies have changed numerous times making comparisons of data between years difficult and identification of trends impossible. In the future, monitoring efforts should adhere to a strict standardized sampling protocol to allow for meaningful comparisons of data between years.

Obstacles to Success-The use of standard hatchery techniques in the production and stocking of endangered species has drawn considerable attention in recent years (Brown and Day 2002), and numerous researchers have questioned the manner in which hatchery fish are raised and stocked but few studies have examined these issues (Marsh and Brooks 1989; Burdick and Bonar 1997; Mueller and Foster 1999). Past efforts to stock razorback suckers have been plagued by predation and what appears to be poor conditioning that results in chronic fatigue, which may lead to mortality (Marsh and Brooks 1989; Burdick and Bonar 1997; Mueller and Foster 1999). Mueller (2003) suggested that post-stocking dispersal, in the form of downstream drift could be a symptom of chronic stress, especially when fish are released into flowing habitats. Hatcheries are able to produce large numbers of razorback suckers cheaply, but poor survival of hatchery-introduced suckers raises questions regarding their ability to compete and survive. Pond reared suckers are unaccustomed to swimming in currents or foraging for natural foods and may simply lack the necessary stamina and survival skills to survive in the wild (Mueller 2003).

Mueller et al. (2003) examined factors influencing post-stocking dispersal of razorback sucker and found that dispersal can be significantly reduced if fish are preconditioned to flow and stocked in backwater habitats. In addition, physical conditioning may have other attributes, including: increased growth, better stamina, and

more mucus production. Based on these findings, Mueller et al. (2003) recommend that razorback suckers be preconditioned to flow prior to release.

Barriers to migration, such as dams, may also be limiting survival, especially of Colorado pikeminnow. Pikeminnow can display long-distance (up to 322 km) migratory behavior in sexually mature fish and this behavior appears to be important to this species' reproductive cycle (Maddux 1993). Pikeminnow have also been found to demonstrate a fidelity to spawning locations (Tyus 1985; Tyus 1990; Wick et al. 1983), with reproduction occurring in whitewater canyons. If stream barriers prevent Colorado pikeminnow from reaching spawning areas, these fish may not spawn at all.

Timing of larval emergence may also prove to be a hindrance to recovery efforts in the Salt and Verde rivers. In a study on the lower Colorado River, Mueller (2003) observed that razorback sucker larvae appeared prior to larvae of other fishes, making them highly vulnerable to predators.

Other obstacles to recovery include:

1. Lack of suitable nursery areas as a result of dewatering and diversions (floodplain dewatering).
2. Predation and competition by introduced species.
3. Unnatural flow regimes.
4. Habitat preference of razorbacks, juveniles and adults, places them at constant risk of predation because they prefer the same areas as flathead and channel catfish.
5. The present drought in the American southwest has further reduced available habitat for adults and juveniles of both species in the Salt and Verde rivers.

Recommendations

1. Mechanically remove non-native predators from the upper Salt and Verde rivers. Seasonal removal of predators could reduce the abundance of predators and improve survival of reintroduced razorbacks and pikeminnow.
2. Continue to only stock razorback sucker and Colorado pikeminnow that are at least 300 mm or larger.

3. Hatchery produced fish should be physically acclimated to flow and site acclimated in backwaters several weeks, if not months, prior to release. A recent comparison of razorback sucker released in the river with those held one year in closed backwaters suggested held fish survival was nearly 300% better than non-acclimated fish (cited as Modde oral communication in Mueller 2003).
4. Prior to stocking, every fish should be injected with a PIT tag and length and weight should be measured.
5. Monitoring efforts should follow a standardized sampling protocol.
6. A database specific to this reintroduction program should be developed and maintained.

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Table 1. Razorback sucker and Colorado pikeminnow stocking in the Verde and Salt Rivers from 1991 through 2003.

Date	Species[1]	Stocking Location	Number Stocked	Mean Total Length (mm)	Origin[2]	Tag location (CWT=codedwire tag)	Stocking Slip #
				Verde River			
910620	XYTE	Upper Verde	71	356	BPSH		2452
911016	XYTE	Perkinsville	57	356	BPSH		2493
920203	PTLU	Upper Verde	5	406	BPSH		2500
920324	PTLU	Perkinsville	5	432	BPSH		3401
920427	XYTE	Upper Verde	200	330	BPSH		3402
920713	XYTE	Perkinsville	7	381	BPSH		3404
921104	PTLU	Perkinsville	5	406	BPSH		3453
930317	XYTE	Childs	630	356	BPSH		3459
930331	XYTE	Perkinsville	490	76	BPSH		3460
941013	XYTE	Childs	1,935	386	BPSH	CWT nose	5082, 5083
941121	XYTE	Childs	269	324	DNFH	PIT tag data in RVI	?
950202	XYTE	Childs	3,000		BPSH	CWT nose	5101
950323	XYTE	Childs	63	442	BPSH	CWT right cheek	6200
950329	XYTE	Childs	93	432	BPSH	CWT right cheek	6202
951211	PTLU	Beasley	1,000	305	BPSH	CWT nose	5280
951211	PTLU	Childs	1,033	305	BPSH	CWT nose	5281
951221	PTLU	Beasley	329	381	DNFH	CWT right opercle	5282
951222	PTLU	Childs	309	381	DNFH	CWT right opercle	5283
960207	XYTE	Childs	480	254	BPSH	CWT nose	?
961121	PTLU	Beasley	999	362	BPSH	CWT left opercle	5304, 5305, 5306
961125	PTLU	Childs	1,045	362	BPSH	CWT left opercle	5307, 5308
961211	XYTE	Childs	927	325	BPSH	CWT right dorsal	5311
961212	XYTE	Childs	980	325	BPSH	CWT right dorsal	5312
961213	XYTE	Childs	1530	325	BPSH	CWT right dorsal	5347, 5313
970711	PTLU	Childs	33	477	DNFH	CWT right dorsal	5371
970711	XYTE	Childs	765	287	DNFH	CWT left dorsal	5370
971022	XYTE	Childs	320	392	BPSH	CWT left dorsal	6436
971023	XYTE	Childs	556	394	BPSH	CWT left dorsal	6435
971106	PTLU	Beasley	500	445	BPSH	CWT right dorsal	6450
971106	PTLU	Childs	1,000	432	BPSH	CWT right dorsal	6451
971110	PTLU	Beasley	644	430	BPSH	CWT right dorsal	6452
980223	XYTE	Childs	351	330	BPSH	CWT left dorsal	4680
981125	XYTE	Childs	2,040	305	BPSH	CWT left caudal	4713
981217	PTLU	Childs	980	318	BPSH	CWT left caudal	4715
981218	PTLU	Beasley	665	330	BPSH	CWT left caudal	4716
990909	XYTE	Childs	2,000	381	BPSH	UNKNOWN	4741
990914	PTLU	Beasley	364	406	BPSH	UNKNOWN	4742
000907	XYTE	Childs	10	580	Stehr Lake	PIT (data in dbase)	None
001130	XYTE	Childs	968	328	BPSH	CWT nose	4795
001204	XYTE	Childs	896	305	BPSH	CWT nose	4797
001207	XYTE	Childs	257	328	BPSH	CWT nose	4796
011109	XYTE	Childs	74	440	San Pedro	CWT right caudal	4844

Table 1, continued

011212	XYTE	Childs	1,500	300	BPSH	CWT right caudal	4846
020315	PTLU	Beasley	266	300	BPSH	CWT right pectoral	4856
020925	XYTE	Childs	412	350	BPSH	CWT right cheek	4867
021030	XYTE	Childs	1,610		BPSH	CWT right cheek	unknown
030129	PTLU	Beasley	2,049	400	BPSH	CWT left pectoral	4874, 4875
030130	XYTE	Childs	378	330	BPSH	CWT left pectoral	4876
				Salt River			
961206	XYTE	Horseshoe Bend, upper Salt River	2,046	285	BPSH from upper basin	~ 700 were PIT tagged, data at RVI, CWT Nose-all	5309, 5310

[1]XYTE = Xyrauchen texanus; PTLU = Ptychocheilus lucius
[2] BPSH = Bubbling Ponds State Hatchery, DNFH = Dexter National Fish Hatchery

Table 2. Summary of razorback sucker captures in the Verde River, 1990-2003, by gear code. Electrofishing = EF; gill netting = GN; seining = SE; trammel netting = TN.

Year	Total Number Captured	Number Per Gear Type			
		EF	GN	SE	TN
1990	46	9		1	36
1991	3	3			
1992	2	1			1
1993	34				34
1994	104		1		103
1996	3	2			1
1997	28	24			4
1998	20	20			
1999	17	15			2
2000	12	12			
2001	2	2			
2002	9	9			
2003	3	3			

Table 3. Summary of Colorado pikeminnow captures in the Verde River, 1990-2003, by gear code. Electrofishing = EF; gill netting = GN; trammel netting = TN.

Year	Total Number Captured	Number Per Gear Type		
		EF	GN	TN
1992	3	3		
1996	26*	3	19	4
1997	24	21		3
1998	30	22		8
1999	3	2		1
2003	1	1		

*23 captured in Horseshoe Reservoir.

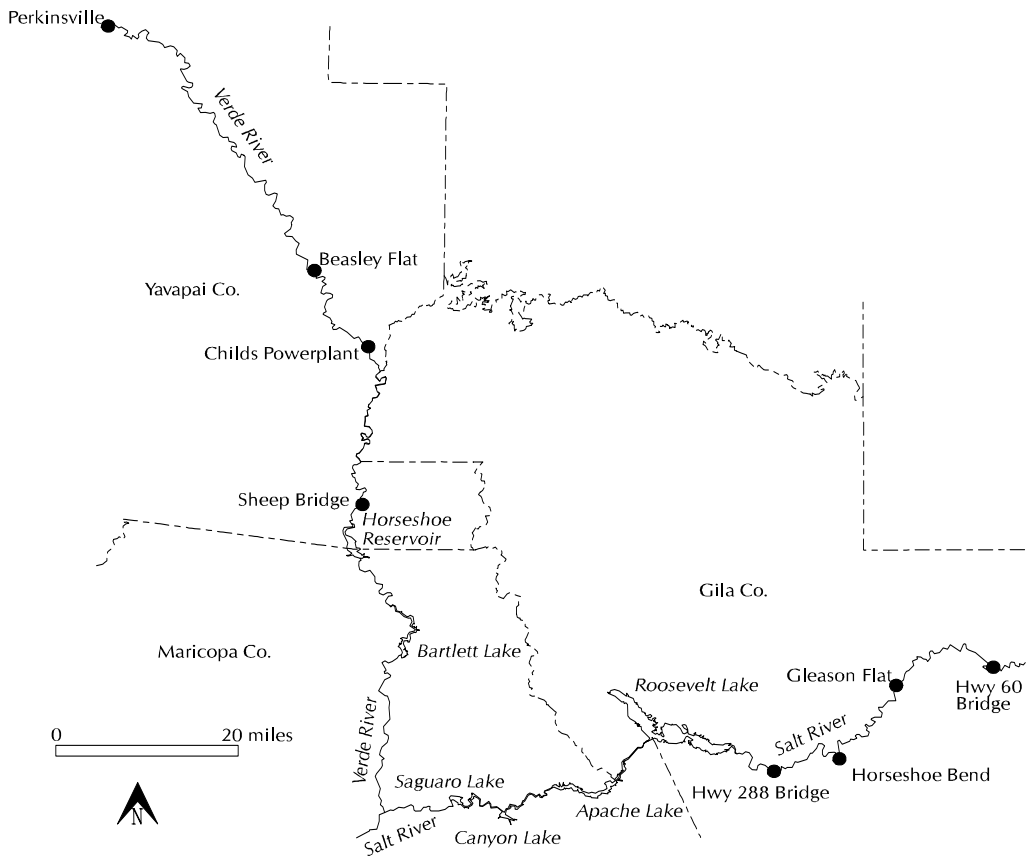

Figure 1. Map of the Salt and Verde Rivers, Arizona (from Jahrke and Clark 1999). Solid circles indicate river access points where razorback sucker and Colorado pikeminnow were stocked.

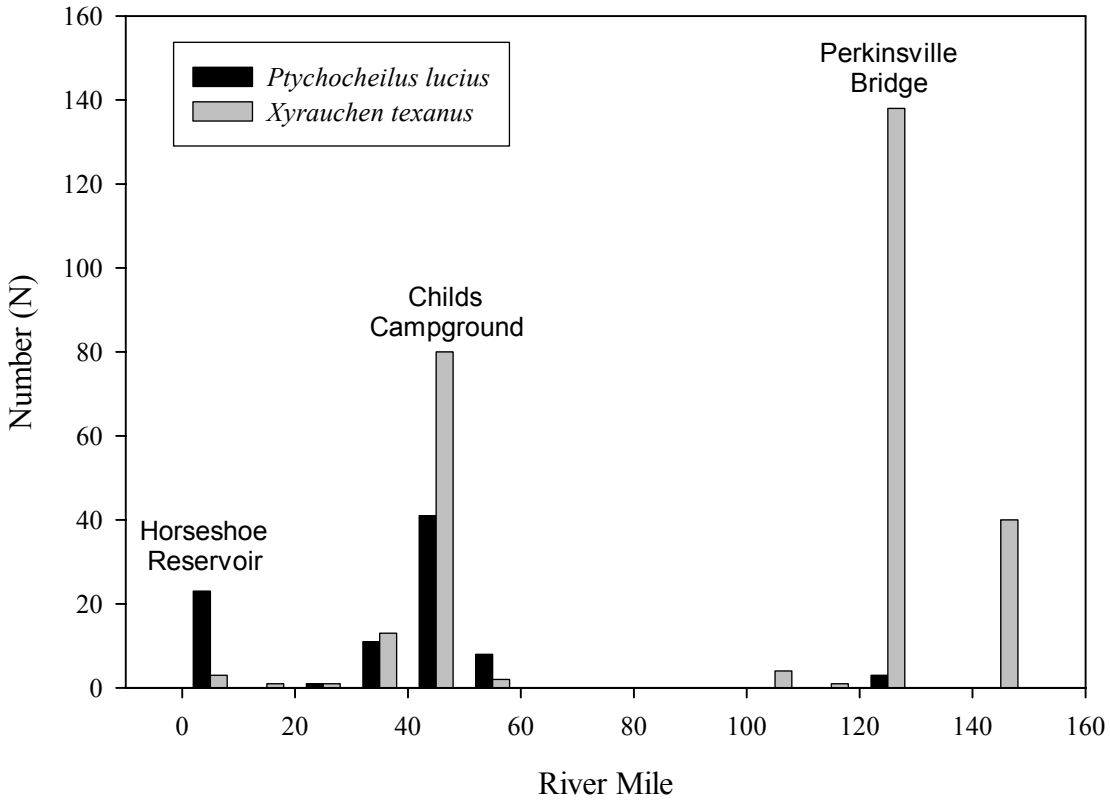

Figure 2. Summary of *Ptychocheilus lucius* and *Xyrauchen texanus* captures in the Verde River, 1990-2003, by river mile.

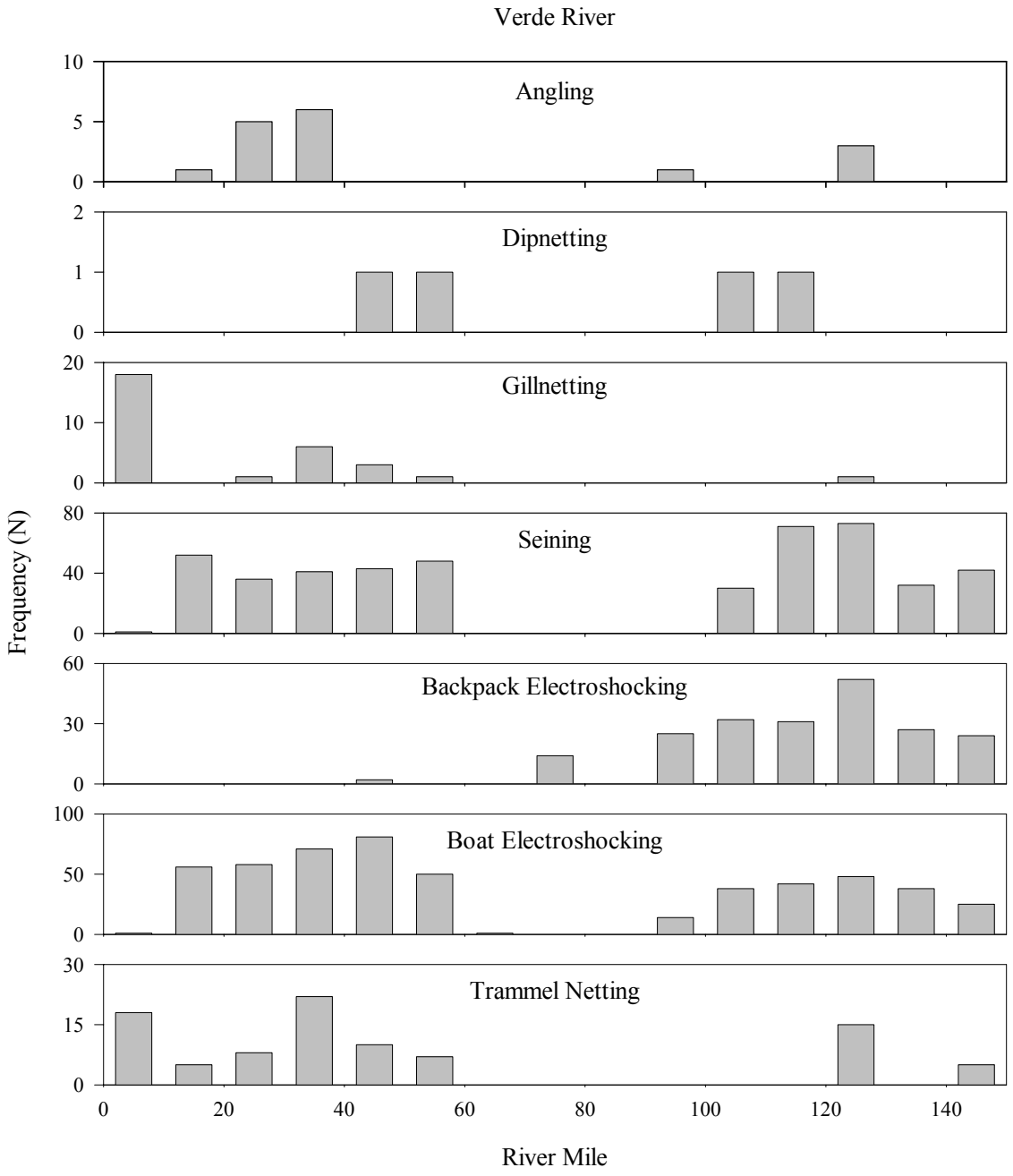

Figure 3. Monitoring effort in the Verde River, 1990 through 2003. The number of individual efforts is denoted by frequency (y-axis). A single effort equals an individual sampling event, independent of hours fished (angling, gillnetting, trammel netting), area sampled (dipnetting, seining) or shock seconds (backpack shocking, boat shocking).

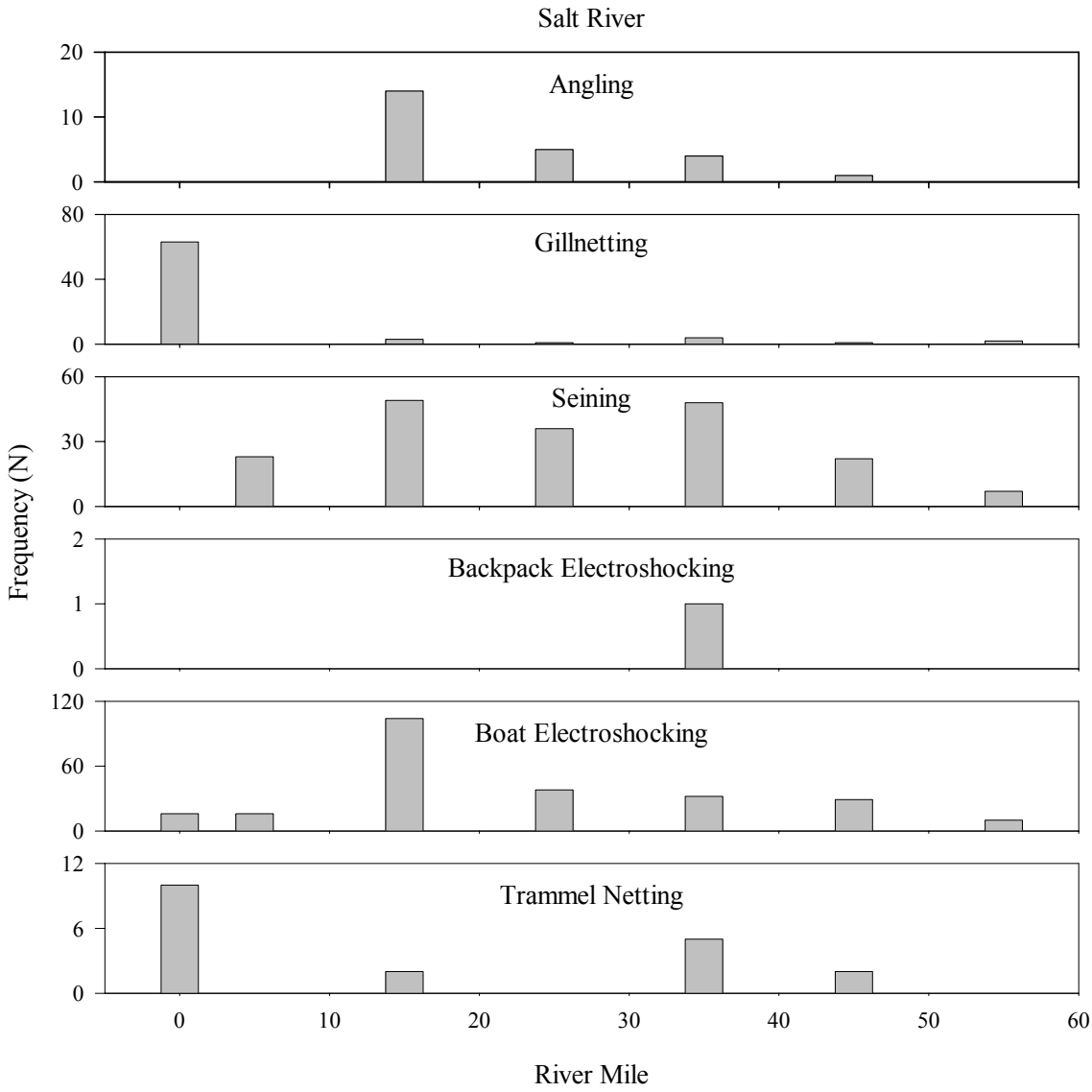

Figure 4. Monitoring effort in the Salt River, 1990 through 2003. The number of individual efforts is denoted by frequency (y-axis). A single effort equals an individual sampling event, independent of hours fished (angling, gillnetting, trammel netting), area sampled (dipnetting, seining) or shock seconds (backpack shocking, boat shocking).