DRAFT

Historical Occurrence of Native Fish in Pima County

Sonoran Desert Conservation Plan

Pima County, Arizona
November 2000

Pima County, Arizona
Board of Supervisors
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County Administrator
Chuck Huckelberry

MEMORANDUM

Date: December 20, 2000

To: The Honorable Chair and Members
Pima County Board of Supervisors

From: C.H. Huckelberry
County Administrator

Re: **Historical Occurrence of Native Fish in Pima County**

Background

The attached report on the *Historical Occurrence of Native Fish in Pima County* provides a snapshot of past and current conditions, and it represents the very best of collaborative efforts between the expert community and County staff. It is our privilege to issue this study, which was made possible by a gift from Dr. Wendell Minckley of a database that provided information about all known surveys of native fish within Pima County, including the species, river basin, drainage, date, number of specimens collected, collector, museum catalogue number, citations, locality, and any comments made. Dr. Minckley, Professor Emeritus of Biology at Arizona State University, reviewed and contributed to the report, along with some of the great biologists in their field: Dr. Phillip Rosen, Doug Duncan, Adele Girmendonk, and Gail Kobetich. David Scalero of the Pima County Flood Control District is the lead author of *Historical Occurrence of Native Fish in Pima County*. Julia Fonseca of the Flood Control District assisted Mr. Scalero in another outstanding team effort by these members of County staff.

Report

Divided into several major sections, the *Historical Occurrence of Native Fish in Pima County* study:

- Describes the baseline conditions of the Pima County streams and cienegas, including the San Pedro basin, the Santa Cruz basin, the Altar-Avra Valley drainage, and the Western drainage basins.

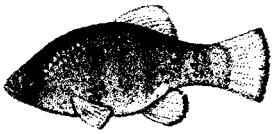
- Profiles native fish species that have occurred in Pima County during the last century along with species that were known to occur in the San Pedro River: Longfin dace, Gila chub, Roundtail chub, Spikedace, Pikeminnow, Speckled dace, Loach minnow, Sonora sucker, Flannelmouth sucker, Desert Sucker, Razorback sucker, Gila topminnow, Quitobaquito pupfish, and the Desert pupfish.

- Provides narrative accounts and a table reflecting the historic locations of native fish within the San Pedro River and its tributaries near Pima County; seven locations along the Santa Cruz River; five locations along the Rillito Creek; and five locations along the Cienega Creek.

- Summarizes the effects of these human activities in aquatic environments: agriculture, grazing; mining; urbanization; groundwater pumping; bank protection; and nonindigenous species introductions.

Status and Trends

DESERT PUPFISH



In summarizing the status of the species, the study finds that "with the changing climate and a number of negative human influences on aquatic ecosystems, native fish populations in Pima County today are but shadows of their former selves."

Natural populations are extremely rare:

- "Only a small portion of the San Pedro River that is in the County remains perennial. Longfin Dace still occur in the basin tributary of Buehman Canyon. Both suckers (Sonora and desert), longfin dace, spikedace and Gila chub occur in Redfield Canyon ...."

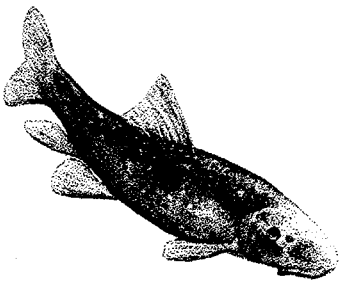
- "The Santa Cruz basin in Pima County no longer supports the extensive natural perennial flows and wetlands once found in historic times. The Santa Cruz River and Rillito Creek have no natural flows apart from runoff during large storm events, and therefore, no longer support native fish species. Effluent flows occur along the Santa Cruz River below the Roger Road and Ina Road wastewater treatment plants, but no native fish species have been reported along these reaches, although with proper management they could be re-established there."

- "The majority of native fish in the county still occur in some of the tributary watercourses such as Sabino Canyon and Cienega Creek. Non-native fish species threaten the existence of Gila chub in Sabino Canyon, the last remaining native fish in this stream. Cienega Creek and its tributaries support the most significant natural populations of native fish left in the county, with longfin dace found along the lower portion of the creek within the Cienega Creek Natural Preserve and Gila chub, Gila topminnow and longfin dace occurring in the upper portions of the creek near the Empire-Cienega Ranch."

- "Quitobaquito Springs continues to support the only known population of Quitobaquito pupfish. With the disappearance of Desert pupfish and the Monkey Springs pupfish, this is the last known natural population of this sensitive genus in Arizona."

Attempts to re-establish populations are described on pages 23 through 24 of the report. Finally, a discussion of captive populations, the majority of which are kept in artificially made aquatic habitats, is found on pages 24 through 26.

Conclusion



DESERT SUCKER

The *Historical Occurrence of Native Fish in Pima County* effectively portrays the fact that one half of our native fish species no longer exist in natural conditions, and it is foreseeable that all native fish within the region will become extirpated or extinct in the near future, unless there is a serious and sustained commitment to a comprehensive recovery process for aquatic systems. County staff is working with the expert community to formulate native fish reintroduction programs as part of the Sonoran Desert Conservation Plan in the hope that the collaborative effort that led to this report can continue and lead to benefits for native fish populations.

Historical Occurrence of Native Fishes in Pima County Arizona

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Acknowledgments

This report was prepared by Pima County staff to help provide a small picture of the former glory of aquatic habitats and the occurrence of native fish in Pima County. Preparers include David Scalero, Donald Ward, Neva Connolly and Julia Fonseca (Pima County Flood Control District). The report was reviewed internally by Julia Fonseca and Thomas Helfrich (Pima County Flood Control District).

This report could not have been accomplished without the extensive research on fish biology and collection records provided by Dr. Wendell L. Minckley. These records are included in their entirety as Appendix A.1 with the permission of Dr. Minckley. Significant contributions were also provided by fisheries and aquatic species biologists including: Dr. W. L. Minckley (Arizona State University), Doug Duncan (U. S. Fish and Wildlife Service), Dr. Phillip C. Rosen (University of Arizona), Gail Kobetich (U. S. Department of the Interior), and Adele Girmendonk (Arizona Game and Fish Department).

To reduce confusion, only the common names of species were used within the text. For a list of scientific and common names of species mentioned within the report, please see the table on the following page.

Scientific and Common Names of Species

Native Species

Scientific Name	Common Name
Salmo apache	Apache trout
Agosia chrysogaster	longfin dace
Gila elegans	bonytail chub
Gila robusta	roundtail chub
Gila intermedia	Gila chub
Gila ditaenia	Sonora chub
Meda fulgida	spikedace
Ptychocheilus lucius	Colorada squawfish (pikeminnow)
Rhinichthys osculus	speckled dace
Tiaroga cobitis	loach minnow
Catostomus insignis	Sonora sucker
Catostomus latipinnis	flannelmouth sucker
Pantosteus clarki	desert sucker
Xyrauchen texanus	razorback sucker
Ictalurus pricei	Yaqui catfish
Poeciliopsis occidentalis	Gila topminnow
Cyprinodon eremus	Quitobaquito pupfish
Cyprinodon macularius	desert pupfish
Cyprinodon sp.	Monkey Spring pupfish

Nonindigenous Species

Scientific Name	Common Name
Kinosternon sp.	Mud turtle
Pseudemys scripta elegans	red ear slider
Rana catesbeiana	bullfrog
Salmo gairdneri	rainbow trout
Carassius auratus	goldfish
Notemiqonus crysoleucus	beautiful shiner
Ictalurus sp.	bullhead catfish
Gambusia affinis	mosquitofish
Lepomis cyanellus	green sunfish
Lepomis macrochirus	bluegill
Orconectes virilis	crayfish
Tamarix sp.	tamarisk

Introduction

The story of fishes in Southern Arizona essentially began in 1904 with Frederic Morton Chamberlain's survey of fishes at about twenty locations within the state. Although records of fish locations exist that pre-date the turn of the century, Chamberlain's work was the first by a bona fide aquatic biologist to study Arizona fishes. In his day, Chamberlain was able to count a total of 16 native species[1]. Today, more than half of these are either extirpated or federally listed as threatened or endangered (Minckley, 1999).

In Pima County, the story of fishes is similar to that of the state as a whole. Historic records indicate the presence of 8 fish species, 4 of which no longer occur under natural conditions. Of the 4 still existing, two are federally listed as endangered and one is a candidate for listing under the Endangered Species Act. Without a dramatic turnaround in circumstances, it is foreseeable that all of the native fishes in this region will become extirpated or extinct in the not-too-distant future.

Looking at current conditions of watercourses across Pima County, it is hard to believe that any fish could have occurred here if these had been the natural conditions. Most streambeds in Tucson and the surrounding areas are dry channels, which flow only during storm events. The few watercourses with perennial flow occur mainly as rather small streams in mountain and foothill canyons. A review of historic records, however, indicates that aquatic habitats were once much more prevalent in the county, with perennial flows occurring in the lowlands as well as mountains, and native fish species dispersed throughout the area. Only within the last one hundred year or so, with settlement of Angloamericans in the region, did this once extensive aquatic system give way to the dry conditions we see today.

This report provides an overview of native fishes within and near the borders of Pima County to support conservation and restoration efforts for aquatic environments in the area. Emphasis is first given to historical documentation of aquatic habitats and fish occurrence in the area, to provide some picture of what the area was like prior to significant habitat disturbance. This is followed by the human activities over the past century which have disrupted natural aquatic systems and the current status and trends for native fish that have resulted from these activities. Discussion is then focussed on the importance of native fish habitats to the area and the importance of native fish to conservation and restoration measures.

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[1] To date, a total of 34 species (including subspecies) of fish have been identified as native to Arizona.

Setting

Historically, most fish habitats in Arizona consisted of flowing streams and cienegas (Hendrickson and Minckley, 1984). Springs with pools or ponds were uncommon and small in size, and closed-basin lakes were essentially absent from the natural setting (Minckley, 1973). In Pima County, lower elevation grassland or desert streams were once more permanent, with multiple channels often flowing though broad and marshy floodplains (Hastings, 1959; Hastings and Turner, 1965). These streams provided habitat to a unique assemblage of fishes adapted to the extremes of flood, drought, heat and even cold that are created by the harsh desert climate.

Although many of the early records are obscure in their descriptions of natural history, they contain bits of information that, when pieced together, are useful in describing the environments and wildlife prior to European settlement of the area (Davis, 1982). Since many of the early explorers relied on natural sources of water for provisions (both food and water) and as a means of subsistence (beaver pelts), aquatic and semi-aquatic habitats are some of the best described areas during this time period. A review of historic records reveals that aquatic and semiaquatic habitats were once quite extensive in eastern Pima County, with both the valleys of the San Pedro and the Santa Cruz Rivers containing long stretches of perennial flow and wetlands (Figure 1). Below are descriptions of some of the major watersheds in Pima County.

<u>San Pedro Basin</u>
From its headwaters originating near Cananea Mexico (approximately 25 miles south of the International Boundary), the San Pedro River drains a little less than 3,000 square miles to a point near Redington, Arizona (USGS, 1998). The stream then flows approximately 125 miles from the International Border to its confluence with the Gila River near Winkelman, with a 12-mile segment running through the northeast corner of Pima County. Elevations along this reach vary from 3,000 feet where it enters Pima County to about 2,700 feet where it exits into Pinal County (Tellman et. al., 2000). The portion flowing through Pima County is bordered by the Santa Catalina Mountains and Rincon Mountains to the west, and the Galiuro Mountains to the east.

Many historical records tend to indicate that the San Pedro River had perennial surface flow along much of its length. Descriptions from early explorers portray the San Pedro as marshy, or boggy, with running water at least a few inches in depth if not more (Hendrickson and Minckley, 1984). Cooke (1938) reviewed the Mormon Battalion's first camp site in the San Pedro Valley as being "in a marshy bottom with plenty of grass and water." Both Cooke (1938) and Bliss (1931) mention an abundance of fishes in the stream, which they named "salmon trout", taken by members of the

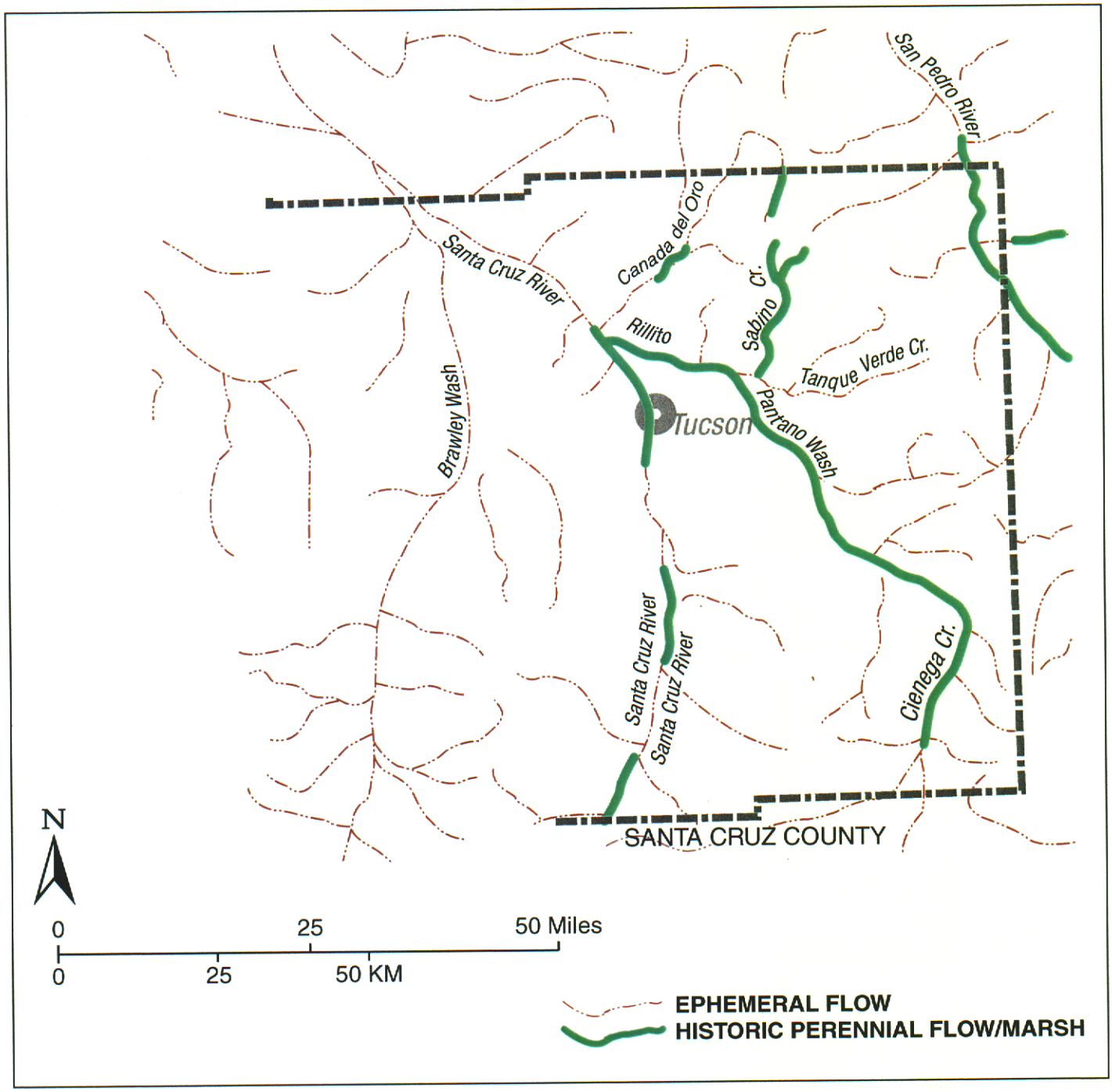

Figure 1. Aquatic and Semiaquatic Habitats in the Santa Cruz and San Pedro River Valleys before 1890 (Hendrickson and Minckley, 1984).

battalion along the river[2]. Accounts from Etz (Hendrickson and Minckley, 1984) and Davis (1982) indicate the presence of beaver and beaver dams along the entire stretch of the San Pedro River.

Santa Cruz Basin

Headwaters for the Santa Cruz River originate on the eastern side of the Santa Rita Mountains, where they drain the north, west and south slopes of the Canelo Hills, and all sides of the Patagonia and Santa Rita Mountains. The stream then heads into Sonora Mexico and loops south of the Patagonia Mountains to flow back into Arizona, receiving flows from the Huachuca Mountain and the western flank of Canelo Hills via Sonoita Creek. The valley broadens as the stream passes between the Santa Rita and Sierrita Mountains and continues north towards Tucson (Hendrickson and Minckley, 1984). Rillito Creek enters the Santa Cruz River just north of Tucson, bringing drainage from a number of tributaries in the Santa Rita Mountains (Cienega Creek and Pantano Wash), Rincon Mountains (Pantano Wash and Tanque Verde Creek) and Santa Catalina Mountains (Sabino Creek and other smaller tributaries). As it continues north out of Tucson, the Santa Cruz River picks up drainage from the western flank of the Santa Catalina Mountains via Canada del Oro, and from the southern and western portions of the Tortillita Mountains. Total drainage area is a little over 3,600 square miles at Trico Road Bridge near Marana, approximately 2.5 miles upstream of the Pinal County Line (USGS, 1998).

Unlike the San Pedro River, the Santa Cruz was documented as perennial in small stretches along its length. Historical descriptions go scarcely beyond the documentation of marshes existing in the area (Hendrickson and Minckley, 1984). Much of the Santa Cruz River had already been substantially diverted by prehistoric farmers (i.e., Hohokom) to irrigate their crops in a manner similar to the Angloamericans of the Nineteenth Century (Wood et. al., 1999). In his 1904 survey of fish, Chamberlain describes the flow in the stream at two different locations in Pima County, at San Xavier del Bac (~9 miles upstream of Tucson) and a site two miles south of Tucson. The stream flow in these areas was generally shallow, from 10 to 15 feet in width, and the course contained a number of small pools from two to 4 feet in depth (Minckley, 1999). A representative view of the Santa Cruz River near Tucson in 1904 is provided in Figure 2.

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[2] These fish could only have been Colorado squawfish, which were formerly abundant in the Colorado River basin, but are now approaching extinction (Hendrickson and Minckley, 1984).

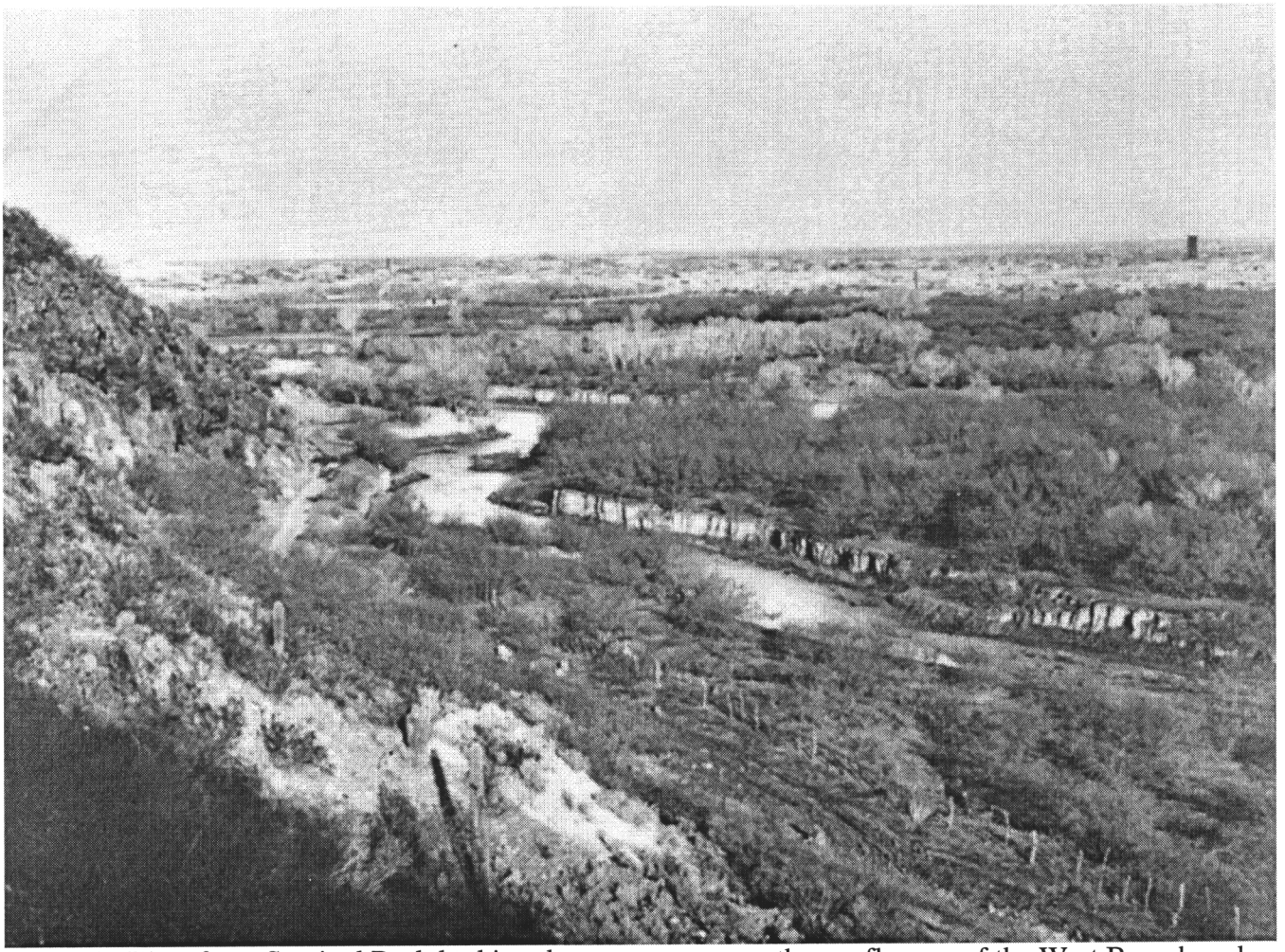

Figure 2. View from Sentinel Peak looking downstream across the confluence of the West Branch and the Santa Cruz River, 1904. Arizona Historical Society.

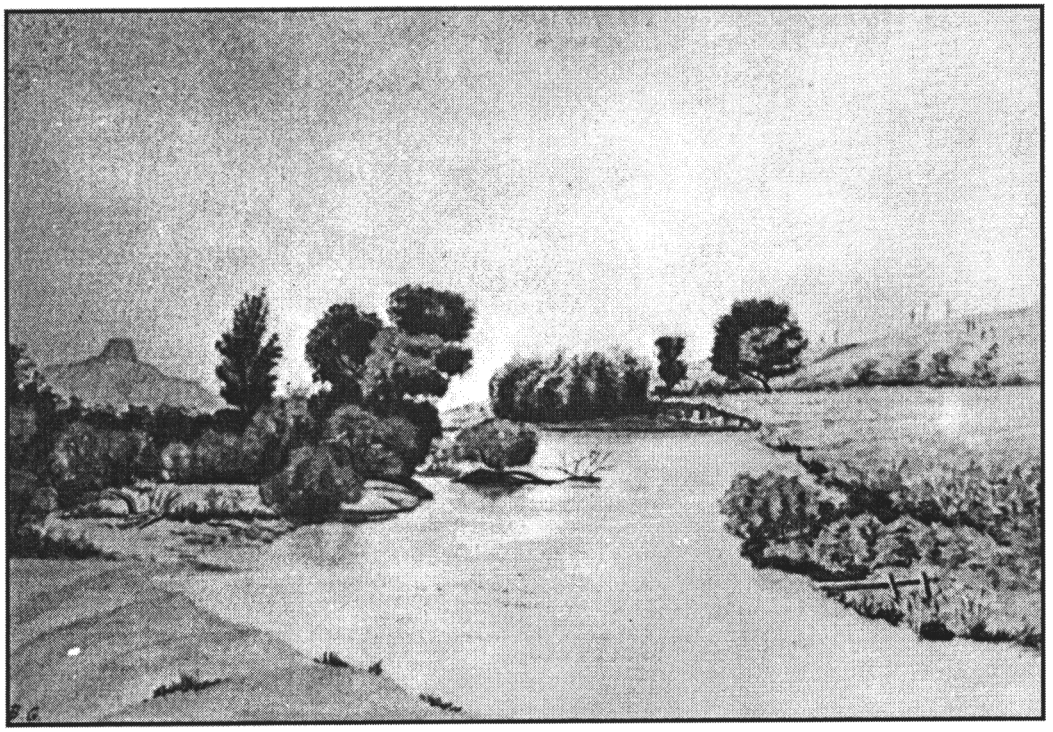

Figure 3. "Rillito Creek near Fort Lowell." Watercolor by Post Surgeon J.B.Girard, 1875.

Marshy conditions most likely occurred all along the watercourses of Rillito Creek, Pantano (Spanish for "swamp") Wash and Cienega Creek[3], which were collectively known in historic times as the "Cienegas de los Pimas" (Hendrickson and Minckley, 1984). Records indicate that Rillito Creek, now only a dry river bed, was once perennial near Fort Lowell to its confluence with the Santa Cruz River (Condes de La Torre, 1970). Post Surgeon J. B. Girard painted a watercolor in 1875 that displays the wet nature of Rillito Creek in this area (Figure 3). Robert Eccleston, an early explorer, first entered the basin at Cienega Creek in 1849 and followed it 5 miles downstream (Davis, 1982). He had this to say about the area: "The water was in marshes, coming from springs and a little brackish....The grass, or rather cane, was some 6 feet high..." (Hendrickson and Minckley, 1984). During a stagecoach trip in 1858, Way (1960) described the valley as "a delightful looking place and its cool water, green foliage and scrubby trees look like paradise to the weary traveler over the hot and parched up plain." G. E. P. Smith, another early visitor to Cienega Creek described the valley as "an unbroken forest, principally of mesquite, with a good growth of gramma and other grasses between the trees. The River course was indefinite,-a continuous grove of tall cottonwood, ash, willow and walnut trees with underbrush and sacaton and galleta grass, and it was further obstructed by beaver dams..." (Hendrickson and Minckley, 1984). Remnants of this once expansive system still exist today along the upper and lower reaches of Cienega Creek.

Altar-Avra Valley

The Altar-Avra Valley is a broad, north-flowing drainage running parallel and to the west of the Santa Cruz River. The major watercourse is the Brawley Wash which drains the Baboquivari, Coyote and Roskruge Mountains to the west and the Tucson, Sierrita, Cerro Colorado, Las Guijas and San Luis Mountains to the east (Tellman et. al., 2000). Puertocito Wash, Altar Wash and Arivaca Creek make up the major tributaries south of Brawley Wash, which has an estimate drainage area of 776 square miles (USGS, 1998) near Three Points, Arizona (approximately 23 miles west of Tucson along Highway 86). Drainage from the Altar-Avra Valley empties into the Santa Cruz River north of the Pima-Pinal County Line via the Los Robles Wash.

Near the upper end of this watershed, there lies an isolated cienega named Arivaca Creek. In 1869, Brown described the area as a "rich meadow land bordering on a never failing stream; it is well watered with oak, walnut, ash, cottonwood and mesquite" (Hendrickson and Minckley, 1984). Way's (1960) diary had an entry from 1858 that described the ranch in the area as having more than "...seventeen thousand acres of agricultural land, with permanent water, wood and grass." A small stretch of perennial flow continues to this day near the town of Arivaca. Just south of

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[3] The term "cienega" is commonly used to describe a variety of aquatic habitats in the area of Spanish influence (Hendrickson and Minckley, 1984).

Arivaca, lies a mostly-dry meadow edged by huge cottonwood trees which is considered to be a remnant of the formerly more extensive cienega in the area (Hendrickson and Minckley, 1984).

Western Drainage Basins

Compared to the eastern half, western Pima County receives very little precipitation and, therefore, has limited water resources for aquatic life. The most notable area in this portion of the county is Quitobaquito Springs, which is located in the Organ Pipe Cactus National Monument, less than 200 feet north of the international boundary between the United States and Mexico (Fonseca and Scalero, 2000). These springs occur in the Rio Sonoyta drainage basin which, unlike most other watersheds in Pima County, flows southward from Arizona into Mexico. Much of the rest of western Pima County consists of low lying mountains with broad alluvial valleys, which only receive flows during storm events.

Quitobaquito Springs were an important source of water for people traveling from Caborca, Mexico to Yuma, Arizona. The springs were dammed in 1860 to form a pond, with the water being used to grow crops nearby until the 1950's. In 1957, the National Park Service bought Quitobaquito from a Hia-Ced O'odam named Jim Orosco, and incorporated it into the Organ Pipe Cactus National Monument (Fonseca and Scalero, 2000). Early photographs show the pond as shallow and broad, and surrounded by little vegetation. Once acquired by the National Park Service, the open water was drained, bulldozed and diked into a discrete pond (Johnson et. al., 1983). The elimination of farming and grazing allowed dense riparian vegetation to establish around the pond. A 1983 survey found stands of mesquite with a shrubby understory and large, isolated cottonwood trees (Fonseca and Scalero, 2000).

Native Fish Species

Historic records indicate that 8 native fish species have occurred within the borders of Pima County over the last century. Another 6 species were known to occur in the San Pedro River just upstream of the county, and are presumed to have once swam through the short reach extending into Pima County's jurisdiction. The following are brief descriptions of these fish based on available information (Note: an asterisk beside the name indicates those species which were recorded just upstream of Pima County):

Longfin Dace status: none

The longfin dace is a small (less than 4 inches long) silvery minnow with a dark back and white on the belly. A dark band will sometimes be located along the sides above the midsection and gold flecks may appear on the upper sides of both sexes. Breeding males have some yellow on the lower parts of their fins (Minckley, 1973).

Longfin dace occupy a range of habitats from intermittent low-desert streams to clear and cool brooks at higher elevations. This fish is among the hardiest of native fish. Rinne and Minckley (1991) describe it as having "a remarkable capability to disperse into new habitats, appearing a few hours or days after flow reestablishes itself in formerly dry stream channels." They go further to state that "longfin dace were once recorded to survive in tiny volumes of water beneath mats of algae, then reproduce a few days after summer rains rejuvenate the stream" (Rinne and Minckley, 1991).

Gila Chub status: candidate
The Gila chub is a moderately chunky and dark-colored minnow, which can reach lengths of up to 10 inches. Breeding males will have red or orange on their bellies and sides, with yellow on the cheeks, lips and bases of paired fins (Minckley, 1973).

Gila chubs normally occur in the headwaters of smaller streams, cienegas, springs and marshes along the Gila River Basin (AGFD, 1999). Adults have been collected from deep pools with heavy vegetation along the margins and undercut banks. Young fish have been collected from riffles, pools and undercut banks. In larger streams, these fish will utilize heavily vegetated backwaters for cover and feeding (Minckley, 1973).

Roundtail Chub* status: none
The roundtail chub has a thick body that is moderately streamlined. It can reach body lengths up to 20 inches, but usually ranges from 10 to 14 inches. Its coloration is dark and gray, often with blotches on the back and sides (Minckley, 1973).

The roundtail chub occurs in medium to large rivers throughout the Colorado River Basin. In Arizona, these fish "tend to occur in pools and eddies, often concentrating in relatively swift, swirling waters below rapids..." (Minckley, 1973).

Spikedace* status: threatened
The spikedace is a silvery minnow, with an olive-gray to brownish back, white belly and vertically elongated black specks running along the sides. The body is slim and slightly compressed near the tail (Minckley, 1973).

This fish appears to prefer shallow, moving water, often concentrating near the downstream end of riffles or in eddies. In large rivers, spikedace have only been caught below the mouths of creeks. In the spring, they tend to frequent swift and shallow waters over sand and fine gravels (Minckley, 1973).

Colorado Squawfish or Pikeminnow* status: endangered
Commonly called "salmon" by local people in historic times, the Colorado squawfish is one of the world's largest minnows. It can reach lengths of up to 6 feet and weights near 100 pounds. Its body is long and compressed, and it has a flattened

head and elongated mouth. Its skin has a leather texture, with an olive color on the back, yellowish sides and a white belly (Minckley, 1973).

At one time, this predatory fish was abundant in large river channels within the Colorado River Basin, including the San Pedro River. Adult fish occur in deep waters (greater than 3 feet) with strong to moderate currents. Young are frequently found in backwaters where currents are slight or absent (Minckley, 1973).

Speckled Dace status: none
The speckled dace is an olive colored minnow covered with dark blotches or speckles. Barbels are present on its upper lip, and a single or double lateral line runs through its sides. Breeding males have bright red coloring at the base of the fins and mouth (Minckley, 1973).

Speckled dace usually occur in shallow, swift moving water. They were once found in drainages below 5,000 feet, but now reach peak abundance between 6,000 to 8,000 feet elevations in swift creeks with medium-sized pools and riffles (Minckley, 1973).

Loach Minnow* status: threatened
The loach minnow is an olive colored minnow with numerous dark blotches. The mouth is very small and unlike its close relative, the speckled dace, has no barbels. Breeding males have bright red to red-orange markings on the bases of fins, on the mouth and lower head, and often on the abdomens. Reproducing females will have some yellowing on the fins (Minckley, 1973).

The loach minnow is generally restricted to riffles along gravelly bottoms in small to moderately large creeks and rivers. It is most often caught in beds of algae in the main channels of swift, shallow reaches or along the margins of stronger rapids (Minckley, 1973).

Sonora Sucker status: none
The Sonora sucker is similar in coloration and appearance to the Desert Sucker described above. These fish can be anywhere from 8 to 31 inches in length, and can weigh up to a little over 4 pounds. As with Desert Suckers, their most distinctive feature is their mouths, which are large, fleshy and covered with taste buds (Minckley, 1973).

The Sonora sucker utilizes a variety of habitats, from warm water rivers to cold water streams. It prefers rivers or streams with deep and quiet, rocky or gravely pools. This species is also intolerant of lake conditions created by dams (Minckley, 1973).

Flannelmouth Sucker* status: none
The flannelmouth sucker has an elongated body which is thicker near the head and thin at the tail. Its head is relatively short, and it has a large, fleshy mouth, covered with tastebuds. Coloration is typically light gray or tan on top and lighter below (Minckley, 1973).

Flannelmouth suckers are characteristic of large, strong-flowing streams which no longer occur in Pima County. This fish seems to do poorly in reservoirs (Minckley, 1973).

Desert Sucker status: none
The desert sucker has a long, chunky body that is olive-brown in color on top and deep-yellow below. Scales on the upper half have dark spots which form faint, dashed lines. Its most distinctive feature is the lower lip, which is about 3 times as thick as the upper lip. Depending on the habitat, this fish can be anywhere from 8 to 31 inches in length, and can weigh up to a little over 4 pounds (Minckley, 1973).

Desert suckers are found in a variety of habitats from warm water rivers to trout streams. It prefers rivers or streams with rocky or gravely runs and deeper pools. The species is intolerant of lake conditions and studies suggest that it has a low tolerance for reduced oxygen levels (Minckley, 1973).

Razorback Sucker* status: none
One of the larger species of suckers in North America, the razorback sucker can reach lengths of 3 feet and weights up to 12 pounds. Both the head and body are elongated, with a sharp-edged keel developing in adult fish behind the back side of the head. As in other suckers, this fish has a large fleshy, mouth that is covered with tastebuds. Its color is olive to brownish-black above and lighter (often yellow) below (Minckley, 1973).

Razorback suckers no longer occur in the Gila River basin. Habitat for adult fish is believed to have been in eddies and backwaters of large rivers, where waters are more than 3 feet deep and the bottoms consist of sand, mud or gravel. Juveniles appear to swim in large schools along the margins of streams or reservoirs (Minckley, 1973).

Gila Topminnow status: endangered
The Gila topminnow is a small, guppy-like fish that reaches lengths of up to 2 inches. The body is generally tan to olive in color, with the back usually dark and the underbelly often white. A fairly thick, dark band occurs along both sides of the fish. Breeding males are dark to jet black in color (Minckley, 1973).

Gila topminnows occupy headwater springs and vegetated margins and backwater areas of intermittent and perennial streams and rivers. Adults tend to congregate in

areas of moderate current, below riffles and along margins of flowing streams in accumulated algae mats. They can withstand water temperatures from near freezing to 100°F, and salinities ranging from tap water to sea water (Minckley, 1973).

Quitobaquito Pupfish status: endangered
The Quitobaquito pupfish is similar to the Desert Pupfish, except that it has a broader head, mouth and body. Its fins tend to be smaller, the head deeper and the jaw longer than other pupfish (Minckley, 1973). Coloration and overall length are the same as the desert pupfish (see below).

In Pima County, the Quitobaquito pupfish is found in small ponds, springs and streams. This fish may have formerly occurred in a range of shallow water habitats including springs, small streams, marshes and even in the backwaters of rivers. As with other pupfish, Quitobaquito pupfish can tolerate high temperatures (>95°F) and salinity levels 3 times that of seawater (Minckley 1973).

Desert Pupfish status: Endangered
The desert pupfish is a small fish (approximately 2 inches in length) with a smoothly rounded body shape and mouth armed with small, tricuspid teeth. Females and juveniles have tan to olive colored backs and silvery sides with dark and narrow vertical bars. Their fins are generally colorless except for an eye-like spot on the dorsal (top) fin, and rarely a dark spot on the anal (bottom) fin. Breeding males are blue on the backs and sides, and have yellow to orange (sometimes red-orange) fins (Minckley, 1973).

Desert pupfish occupy shallow waters of springs, small streams and marshes. They are often associated with areas of soft channel bottoms and clear water (USDI, 1993). They can tolerate extreme environmental conditions including water temperatures over 95°F and salinity levels 3 times that of seawater (Minckley, 1973).

All of the fish mentioned above have developed special characteristics and behaviors that have allowed them to adapt to the harsh conditions of the desert southwest. With limited water sources available for much of the year, these fish have become adapted to living in small streams and associated pools. A number of them are known to expand into new habitats once flows have reestablished into formerly dry channels. Species such as the desert pupfish and Gila topminnow have evolved tolerances for both extreme temperatures and high salinities (Minckley, 1973). All of the native fish are omnivorous, eating both insects and plants, and can take advantage of food sources as they become available. These and other such adaptations have allowed native fish to survive changes in both climate and the surrounding land forms (e.g. geomorphology and vegetation), thus creating a unique fauna in the arid and semiarid regions of Pima County.

Historic Locations of Native Fish

Historic fish locations for this report are taken from a database provided by Dr. Wendell Minckley, Professor Emeritus of Biology at Arizona State University. This database presents the following information regarding all known surveys of native fish within Pima County: genus, species, river basin, drainage, date, number of specimens collected, collector, museum catalogue number, citation(s), locality and any comments made. This database does not include introduced or captive populations, which will be described later in the report. Taxonomy for native fish species was updated, as needed, by Dr. Minckley on August 23, 2000. Appendix A.1 provides the complete list of records provided for this report.

Figure 4 displays all of the known and presumed historic locations of native fish in Pima County based on the records provided by Dr. Minckley. Presumed locations are based on more recent records, with the assumption being that native fish occurred in these areas historically. These are used for sites where historical records are not provided. The current populations in the presumed locations are believed to be remnants of the once, more widespread populations.

Historic records describe a wide variety of fishes along the San Pedro River and its tributaries (Table 1). As mentioned previously, early explorers described an abundance of native fishes along the San Pedro River upstream of Benson, Arizona. During his 1904 survey of fish along the San Pedro, Frederic Morton Chamberlain was able to identify 7 species of fish including longfin dace, Sonora sucker, spikedace, loach minnow, Gila chub and razorback sucker (Minckley, 1999). Other reports indicate the occurrence of Colorado squawfish along this stream (Cooke, 1938 and Bliss, 1931). Although no historic records exist for areas in Pima County, it can be assumed that many of these same species existed within the borders of this county. Only 5 of these species (longfin dace, speckled dace, desert sucker, Sonora sucker and Gila chub) are known to occur in isolated canyon tributaries of the San Pedro near this area. These populations were much larger during historic times.

Table 1. Native fish recorded in the San Pedro River and its tributaries in and near Pima County

Locality	Fish
San Pedro River	longfin dace, Gila chub, Colorado squawfish, spikedace, loach minnow, specked dace, Sonora sucker, flannelmouth sucker, razorback sucker and desert pupfish
Buehman Canyon	longfin dace
Redfield Canyon, large pool directly below the ranch house	Gila chub, Sonora sucker and desert sucker

Table 1. Native fish recorded in the San Pedro River and its tributaries in and near Pima County (continued)

Locality	Fish
Redfield Canyon, approximately 7 miles upstream of Redington	longfin dace, Gila chub, speckled dace, desert sucker and Sonora sucker
Redfield Canyon Creek, Galiuro Mountains, 10.5 miles E of Redington	speckled dace

Although there are no records of fishes for the San Pedro River in Pima County, there are records from areas just upstream of the county. Pima County's Bingham Cienega Natural Preserve currently includes a flowing reach of the San Pedro River which could be sampled for native fish. County staff have observed fish along this reach of the river. Surveys of the mainstem could confirm whether any of the native species known to exist in the tributaries still occur in the San Pedro River itself.

Records for all 6 species of native fish known to occur along the Santa Cruz River are shown in Table 2. The most extensive survey along this stream was performed by Frederic Morton Chamberlain in 1904, who caught longfin dace, Gila chub, Gila topminnow, Sonora sucker and desert sucker in a number of pools located outside of Tucson (approximately 2 miles south) and near San Xavier Mission (Minckley, 1999). He did not find any desert pupfish, which were last recorded in the Tucson area in 1893. The last known records of fish along this watercourse are from 1943 at Midvale Farms irrigation system, located 7 miles south of Tucson, where longfin dace and Gila topminnow were discovered in the canals which took water from the Santa Cruz River.

Table 2. Native fish recorded in the Santa Cruz River in Pima County

Locality	Native Fish
Santa Cruz River, Tucson	Gila chub, desert sucker, Gila topminnow and desert pupfish
Santa Cruz River, 2 miles south of Tucson	longfin dace, Gila chub, Sonora sucker, desert sucker and Gila topminnow
Santa Cruz River, 8 miles south of Tucson	longfin dace, Gila chub, Sonora sucker, desert sucker and Gila topminnow
Santa Cruz River near San Xavier Mission	longfin dace, Gila chub, Sonora sucker and desert sucker
Midvale Farms irrigation system, 7-10 miles south of Tucson (water from Santa Cruz River)	longfin dace and Gila topminnow
Santa Cruz River, 12 miles south of Tucson on the Papago Indian Reservation	longfin dace
From a ditch 30 miles south of Tucson at 3000 feet altitude	Gila topminnow

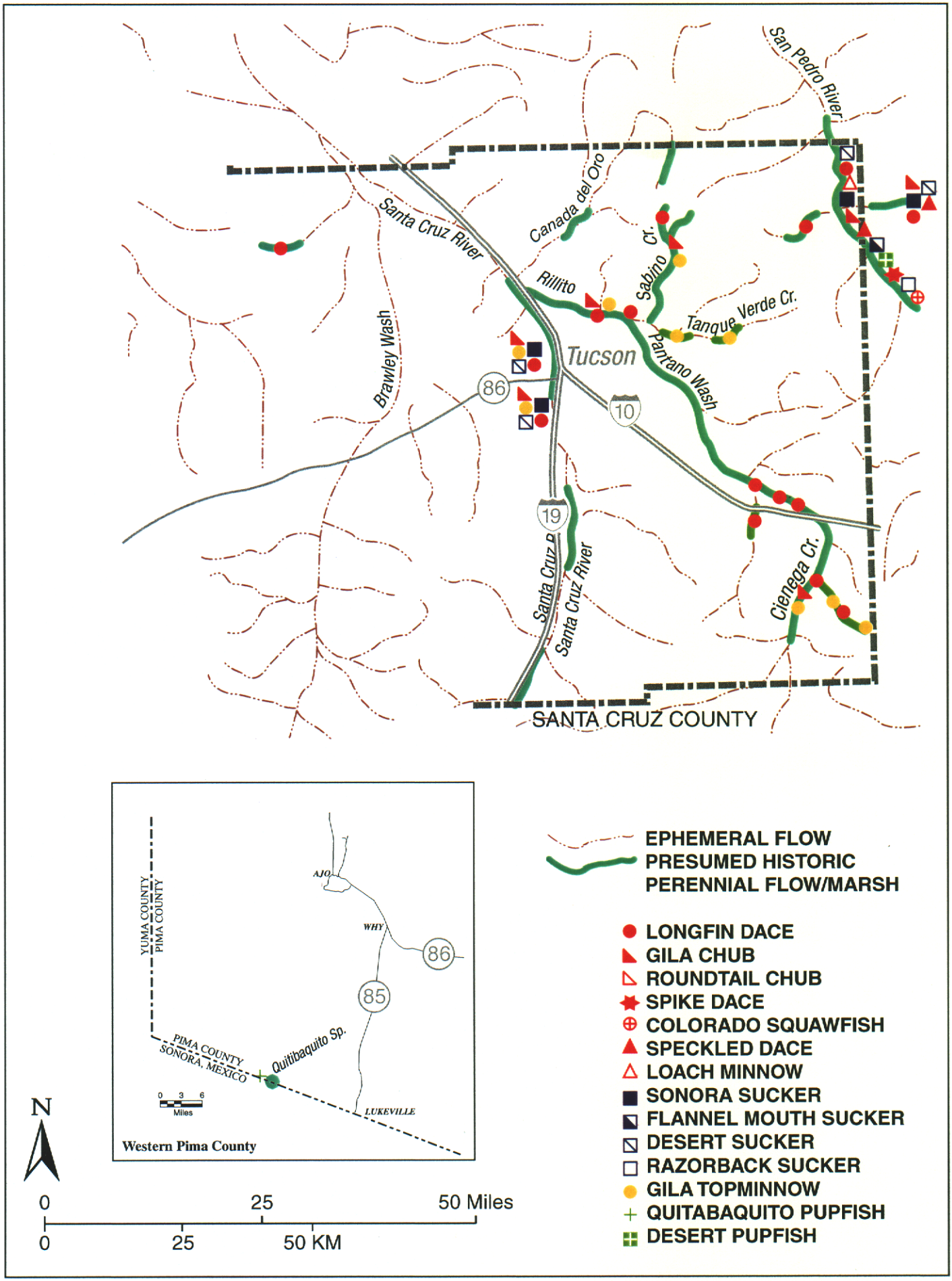

Figure 4. Locations of native fishes in Pima County, Arizona (1848 - Present).

Longfin dace, Gila chub and Gila topminnow were all known to occur along Rillito Creek and some of its major tributaries that drain the Santa Catalina and Rincon Mountains (Table 3). Most historic records are from Sabino Canyon, which is still home to the Gila Chub. The longfin dace and the Gila topminnow no longer occur in this creek. Another tributary, Tanque Verde Creek, was home to the Gila topminnow, which was last seen along this stream near Tanque Verde Guest Ranch in 1943. Rillito Creek itself was also home to all 3 of these fish, which were recorded at Binghampton Pond in 1943 (Figure 5).

Table 3. Native fish recorded in Rillito Creek and its tributaries

Locality	Native Fish
Rillito River near Camp Lowell	longfin dace
Sabino Canyon Creek in the Santa Catalina Mountains	longfin dace, Gila chub and Gila topminnow
Binghampton Pond, 3 miles north of Tucson	longfin dace, Gila chub and Gila topminnow
Tanque Verde Creek, 3 ½ miles east of Tanque Verde	Gila topminnow
Springs west of Tanque Verde Creek near the Tanque Verde Ranch	Gila topminnow

There are numerous records of native fish species occurring along Cienega Creek and some of its tributaries (Table 4). Longfin dace are found along both the upper and lower reaches of the stream, while Gila chub and Gila topminnow are only found in the upper reach. There are no records prior to 1971 for this area, but these native fishes clearly existed here during historic times.

Table 4. Native fish recorded in Cienega Creek and its tributaries

Locality	Native Fish
Lower Cienega Creek	longfin dace
Davidson Canyon	longfin dace
Upper Cienega Creek	longfin dace, Gila chub and Gila topminnow
Mattie Canyon - tributary to Cienega Creek	longfin dace, Gila chub and Gila topminnow
Cold spring adjacent to Cienega Creek in the mouth of Mattie Canyon	Gila chub

Due to its isolation from the main routes taken by early explorers, very little historic information on stream habitats exists for the Altar and Avra Valleys. More recent studies from 1969 to 1975 reported the presence of Gila topminnow and longfin dace along Cocio Wash, a small tributary to the Brawley Wash. Longfin dace disappeared from the Cocio Wash area sometime after 1975 and the Gila topminnow were said to be extinct from the area by 1982 (Fonseca, 2000). Minckley (1973) mentions a re-

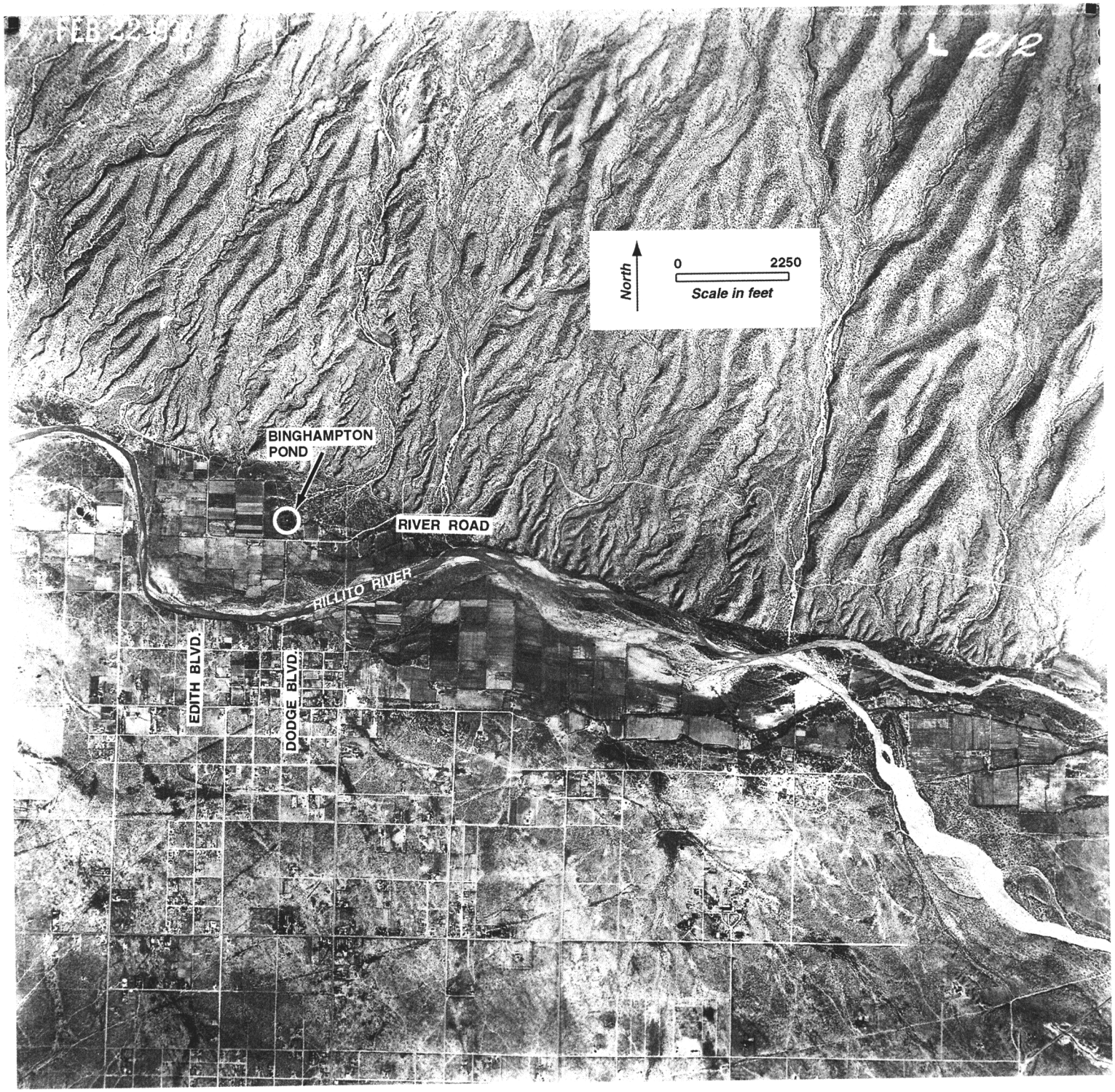

Figure 5. Location of Binghampton Pond. 1936 aerial photo.

established population of Gila topminnow in Arivaca Creek, but these fish were soon extirpated by introduction of the non-native mosquitofish. There are no records of any natural populations of fish in Arivaca Creek or any of the other major washes in these valleys.

Much of western Pima County was recorded by early explorers as being a dry and desolate area. Very little water resources were available to harbor aquatic life. The only areas where fish were (and still are) known to exist are Quitobaquito Springs and Rio Sonoyta. Records from 1930 to 1989 indicate only one species, the Quitobaquito pupfish, occurring in Quitobaquito Spring. Quitobaquito pupfish, longfin dace and some introduced fishes are found in Rio Sonoyta, which passes a little over one mile from Quitobaquito.

Human Activities in Aquatic Environments

Historical evidence indicates a much wider distribution of aquatic habitats than what occurs today in Pima County. The disappearance of perennial streams and riverine marshlands over the years has been well documented, without any consensus as to the ultimate factors of causation (Hendrickson and Minckley, 1984). Although activities by aboriginal man and the Spanish missionary have been discussed, they are mostly ignored as having major impacts on the landscape. Angloamerican settlement, and its related activities, has been the focus for much of the causes for environmental change, and it is these activities that will be discussed in this report.

Agriculture

Through time, agriculture in the area changed from the production of crops for local consumption to primarily cash crops for sale in other parts of the country. This change increased the need for more land clearing and diversion of water for irrigation. By the beginning of the twentieth century, the U. S. Geological Survey reported no regular flows along the Santa Cruz River past the Congress Street Bridge as a result of water diverted mostly for agricultural purposes (Tellman et. al., 2000). The improvement of pumping technology allowed farmers to tap into groundwater resources, which further added to the decline of surface water and the subsequent destruction of natural aquatic ecosystems.

The diversion of natural streamflows for agricultural purposes dates as far back as aboriginal man, who built canals stemming from flowing streams to planted crops. This activity intensified with the settlement of Angloamericans in the late 1800's, who continuously dammed and diverted the waters of the San Pedro and Santa Cruz Rivers to irrigate their farmlands. In 1904, Frederic Morton Chamberlain describes a number of human disturbances to natural flows along the Santa Cruz River including the construction of dams and irrigation ditches, and the pumping of river water from wells

located near the banks (Minckley, 1999). Construction of an irrigation ditch and reservoir (Binghampton Pond) began in 1901 to irrigate lands located along Rillito Creek at the bend near present day Country Club and Alvernon Way (BRHDAB, 1993).

Cattle Grazing

Since the introduction of cattle and horses by the Spanish in the late seventeenth century, ranching has been an important land use in this area (Tellman et. al., 2000). Cattle tend to stay close to water, usually utilizing range that is less than 3 miles from a source. Since the use of stock tanks in the cattle industry did not occur until near the turn of the century, it can be assumed that there were high concentrations of cattle near natural streams (Hendrickson and Minckley, 1984). Impacts from cattle on a watercourse may include: 1) trampling and consumption of vegetation leading to increased soil erosion, 2) the degradation of water quality from both soil erosion and bacteria build-up from defecation, 3) competition with wildlife for food and pressures to remove predators (Tellman et. al., 2000) and 4) large numbers of cattle drinking from small water sources may effectively drink a place dry, especially in dry years (Rosen, personal communication, 2000). The first two activities especially have an impact on fish, which need sheltered areas to escape the heat of the day and sufficient water quality to survive. Severe effects on fish, however, are unlikely with moderate to carefully regulated grazing (Rosen, personal communication, 2000).

Mining

Mining can also have a profound affect on aquatic ecosystems. A number of abandoned prospecting holes and mines exist throughout the mountain ranges of Pima County, displaying the rich history of mining for minerals since Spanish occupation. Although silver was sought during early times, copper has been the primary mineral extracted in the area for the last one hundred years, along with various other minerals found with copper such as zinc and molybdenum (Tellman et. al., 2000). Although the extraction of minerals has a negative impact on the landscape, it is the processing of the ore that greatly impacts aquatic resources. Most of the mining in Pima County is performed using open pit mines, which process the ore via a flotation process using water. The rejected materials from this process are then discarded into tailings ponds where the water evaporates, leaving a large pile of mineralized materials. Possible impacts on aquatic habitats from mining include the reduction of water resources from increased groundwater pumping and the siltation of streams and reduced water quality due to runoff from the tailings piles.

The loss of native fish along Cocio Wash is a good example of the potentially damaging effects that mining can have on aquatic ecosystems. Summer floods in July and August 1981 swept gray clay sediments from a Silverbell Mine tailings pond into the wash where Gila topminnow were discovered in the early 1970's. Studies by the Bureau of Land Management in 1982 discovered no topminnows in the area. BLM

biologist Bill Kepner later reported, "Our studies indicate that the Cocio Wash topminnow population is now extinct in that habitat due to recurrent mine spills and inundations by mine tailings..." (Fonseca, 2000).

Urbanization

Urbanization has had the greatest impact on watercourses in Pima County and, therefore, been the most destructive of aquatic habitats. As the human population of Tucson increased over the past century, the surrounding landscape changed from rural homesteads and irrigated fields to urbanized development. Groundwater pumping continues to increase as the population increases, further reducing water resources. Many of the watercourses within the expanded city limits have been altered in order to optimize the use of the surrounding lands. Channelization and bank protection have created dry, sterile channels with little or no vegetation and no overbank storage for recharging water levels depleted by pumping. Increased flows and velocities through these channels remove a lot of the vegetation, but in some cases the vegetation is intentionally removed as it is perceived as an obstruction to the flow of flood waters. Runoff from city streets can contain many heavy metals and other toxins that are harmful to fish populations downstream.

A number of channel changes can be attributed to increased urbanization. Channelization and bank protection stabilize the position of a stream channel by preventing any lateral movement in response to increased flows. This not only maintains a straight channel, but it also increases the streams erosive power by shortening the length of flow and reducing sediment concentrations (Wood et. al., 1999). The placement of fill and/or riprap along channel margins can produce similar effects. Artificial diversions may be created to divert flows to a different route or to a reservoir for the purpose of flood control, protection from erosion or for irrigation. This can alter the direction of flood waters and, ultimately, create a new stream channel. Highways, roads and railroads that run perpendicular to watercourses can act as barriers to flow, thereby inundating areas upstream and reducing flood patterns downstream (Wood et. al., 1999). Sand-and-gravel operations, which remove sediment from channels to provide materials for construction, can alter channel gradients and reduce sediment concentrations of a stream channel. Many of these activities can both deepen and widen stream channels, thus having a profound affect on current and/or re-established aquatic ecosystems.

Rillito Creek and the portion of the Santa Cruz River that runs through the city of Tucson are two prime examples of the effects that urbanized development can have on watercourses. From 1941 to 1998, urban encroachment and soil cement bank protection have straightened out the channels and dramatically reduced the surrounding vegetation of the Santa Cruz River and some of its tributaries (Figure 6). Only the West Branch of the Santa Cruz River has retained its natural character over

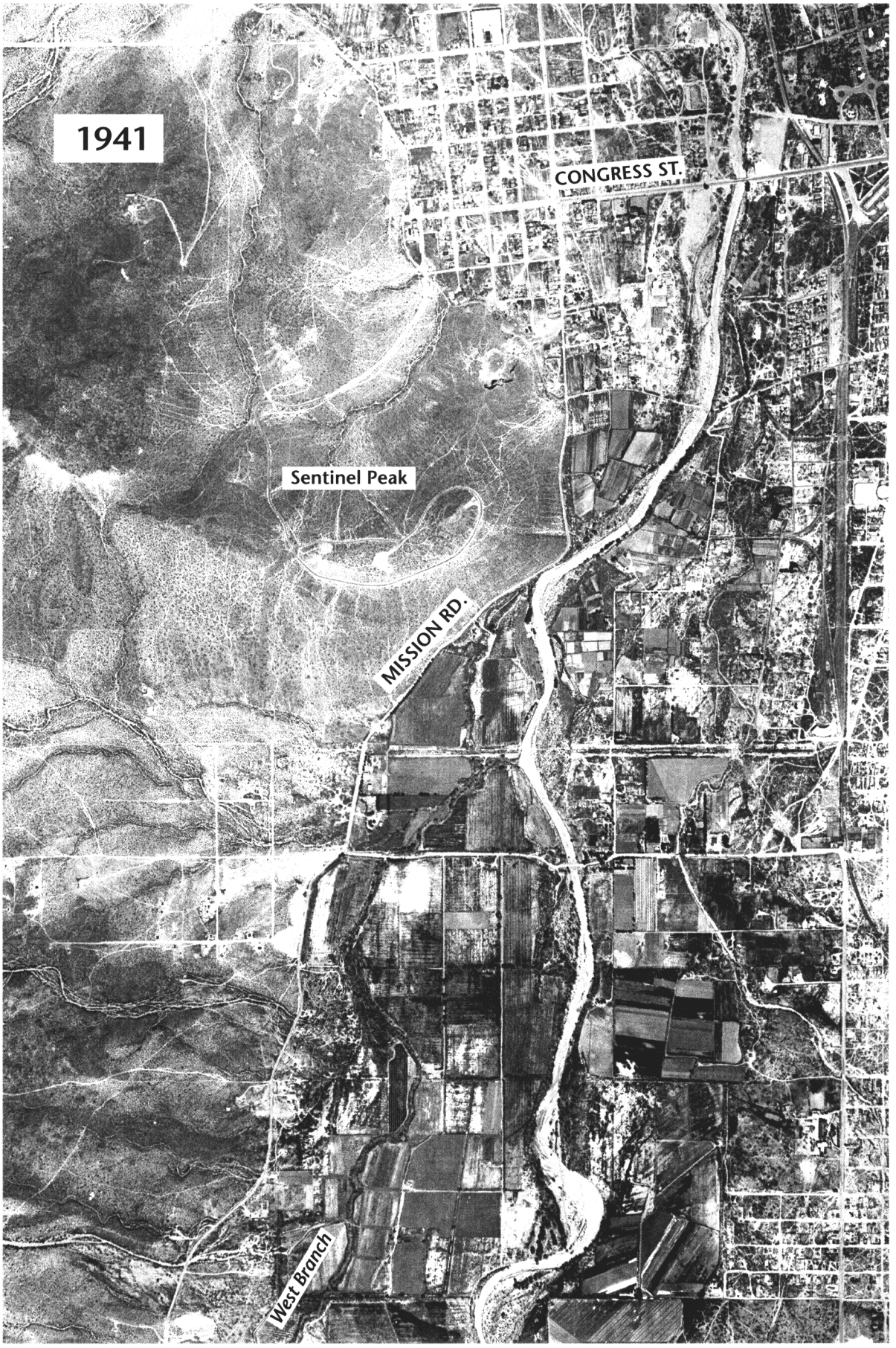

Figure 6. Santa Cruz River at Sentinel Peak, 1941.
By 1941 the river was dry and most of the floodplain was under cultivation or in the process of being urbanized.

this time period (Fonseca, 1999). Similar effects have occurred along Rillito Creek, where almost the entire reach is soil cemented and development has encroached right up to the banks of the channel. The magnitude of change upon these two watercourses is even more dramatic considering that urbanization and clearing for agriculture had already occurred by the mid 1930's (Figure 5).

Nonindigenous Species Introductions

As far back as the turn of the twentieth century, people have been introducing Nonindigenous fish species into natural streams or man-made impoundments for both recreation and sport. Frederic Morton Chamberlain identified carp in impoundments along the Santa Cruz River in 1904, and mentions other attempts to stock catfish (Santa Cruz River) and rainbow trout (Sabino Canyon) to satisfy local demands for sport fishing in Tucson (Minckley, 1999). As the population in the area increased, more demands for this recreation increased and people continued to stock Nonindigenous game fishes into their favorite fishing holes. Bullfrogs were also introduced to the area for sport and for food. Along with direct fish stockings, "bait" items such as crayfish have also been introduced into aquatic ecosystems.

Not all Nonindigenous species introductions are related to sport fishing. Mosquitofish, first discovered in Arizona in 1926 (Minckley, 1973), were introduced ostensibly worldwide to combat mosquito problems. Pet fish (i.e., goldfish) have been either directly released into the wild or have escaped into the wild from private ponds. Tamarisk, notable for its devastating effects on water levels and chemistry, was introduced into the southwest for erosion control along river banks (Stein, 1996) and as windbreaks.

Introduced species cause disruptions to the native environment and, in many cases, can completely take over and eliminate native species populations. Invasive fish such as mosquitofish and green sunfish are highly predatory and have been implicated in the disappearance and/or reduction of native fish populations. The crayfish's appetite for larval fish, aquatic plants and insects can negatively impact native fish and aquatic ecosystems. Bullfrogs compete with native fish for food, and may prey directly on native fish themselves. Although not directly harmful to fish, tamarisk can disrupt aquatic habitats in which they live by reducing water levels and changing water chemistry. With virtually no native predators and high reproduction rates, these non-native species are able to successfully invade aquatic ecosystems and severely disrupt, if not completely destroy, native fish populations.

Many Nonindigenous aquatic species are introduced into areas that have been degraded by human activities. In general, the introduced species are selected based on their ability to survive in the degraded habitats, and therefore do quite well. Native aquatic species are often disrupted by the degradation of their environments, thus

making them more susceptible to invasions by the introduced species (Aquatic Nuisance Species Task Force, 1994). As an example, the formation of reservoirs created by the damming of creeks and streams has a negative effect on native fish, such as longfin dace and Gila chub, which are use to environments with running water. This makes them less able to resist invasions by introduced species that are adapted to lake conditions such as the green sunfish and bluegill.

Status and Trends

With the changing climate and a number of negative human influences on aquatic ecosystems, native fish populations in Pima County today are but shadows of their former selves. Little or no natural flows occur in the lowland streams of the San Pedro, Santa Cruz and Rillito that once harbored a diversity of native fishes, but no longer support even small populations. It is most likely that these lowland streams were once the sources of native fish species for the tributary streams where some few native fish persist today. With source populations now occurring in the smaller tributaries, native fish have become more susceptible to local extirpation; and the mountain tributaries are unsuitable for some of the most endangered forms, like topminnow and pupfish.

Natural Populations

Only a small portion of the San Pedro River that is in the county remains perennial. No records of native fish occurring in the stream are available, but it remains unsurveyed. Longfin Dace still occur in the basin tributary of Buehman Canyon. Both suckers (Sonora and desert), longfin dace, spikedace and Gila chub occur in Redfield Canyon, well above its confluence with the San Pedro (approximately 7 miles east of Redington).

The Santa Cruz basin in Pima County no longer supports the extensive natural perennial flows and wetlands once found in historic times. The Santa Cruz River and Rillito Creek have no natural flows apart from runoff received during large storm events and, therefore, no longer support native fish species. Effluent flows occur along the Santa Cruz River below the Roger Road and Ina Road wastewater treatment plants, but no native fish species have been reported along these reaches, although with proper management they could be re-established there..

The majority of native fish in the county still occur in some of the tributary watercourses such as Sabino Canyon and Cienega Creek. Non-native fish species threaten the existence of Gila chub in Sabino Canyon, the last remaining native fish in this stream. Cienega Creek and its tributaries support the most significant natural populations of native fish left in the county, with longfin dace found along the lower portion of the creek within the Cienega Creek Natural Preserve and Gila chub, Gila

topminnow and longfin dace occurring in the upper portions of the creek near the Empire-Cienega Ranch.

Cocio Wash, a tributary of Brawley Wash, no longer supports the two fish species discovered there in the early 1970's. Invasion of green sunfish and stormwater runoff from tailings ponds nearby have been implicated in the disappearance of longfin dace and Gila topminnow from this currently dry stream.

Quitobaquito Springs continues to support the only known population of Quitobaquito pupfish. With the disappearance of Desert pupfish and the Monkey Springs pupfish, this is the last known natural population of this sensitive genus in Arizona.

Re-established Populations

A few attempts have been made in the past to re-establish native fish species into the wild (Table 5). These efforts have met with little to no success. Most populations disappeared almost immediately, while others survived for 5 to 10 years before eventually dying out. Reasons for failure of re-established populations include drying of the water source, flooding, non-native species invasions, cattle overuse, dredging, low oxygen and other unknown factors. The unifying problem in this effort appears to have been that most of the selected ponds and springs were so small that they were inherently vulnerable to natural and human-induced factors leading to extinction (Fonseca, 2000).

Table 5. Re-established populations of native fish in Pima County

Common Name	Year	Status	Locality Stocked
Gila topminnow	1936	Not extant	Arivaca Creek
Gila topminnow	1976	Not extant	Apache Canyon, East Fork
Gila topminnow	1982	Not extant	Alambre Tank
Gila topminnow	1982	Not extant	The Lake
Gila topminnow	1982	Not extant	Government Tank
Gila topminnow	1982	Not extant	Buehman Canyon
Gila topminnow	1982	Not extant	Canada del Oro
Gila topminnow	1982	Unknown	Romero Canyon
Gila topminnow	1982	Not extant	Sabino Canyon
Gila topminnow	1982	Extirpated	Yellowstone Tank near Redington Road
Gila topminnow	1982	Extirpated	White Tank #2 near Redington Road
Gila topminnow	1987-Pre	Not extant	Madrona Canyon (Rincon Mountains
Gila topminnow	1987	Not extant	Rincon
Gila topminnow	1988	Not extant	Little Nogales Spring
Gila topminnow	1988	Not extant	Nogales Spring
Gila topminnow	1960's	Not extant	Williams Spring

Table 5. Re-established populations of native fish in Pima County (continued)

Common Name	Year	Status	Locality Stocked
desert pupfish	Late 1960's, Early 1970's	Not extant	Blanketship Ranch
desert pupfish	Late 1960's. Early 1970's	Not extant	Bonita Well
desert pupfish	1977	Not extant	Gachado Tank
desert pupfish	1978	Not extant	Bates Well
desert pupfish	1989	Unknown	Buehman Canyon

Sources: USDI, 1993; Weedman and Young, 1997; Weedman, 1998

Captive Populations

A small number of public and private groups hold captive populations of native fish in the Tucson area. The fish are kept in artificially made aquatic habitats including ponds and streams (Figure 7). The majority of these populations are maintained as exhibits for parks and museums and are also used for educational purposes. A summary of the various captive fish populations is provided in Table 6 (see Appendix B.1 for a more complete description of captive populations).

Table 6. Captive native fish populations in Pima County

Locality	Maintaining Party	Water Source	Native Fish
Arizona-Sonora Desert Museum	Ken Wintin, ASDM Heidi Blasius, AGFD	Non-chlorinated well water	bonytail chub, speckled dace, Sonora chub, Gila chub, desert sucker, Yaqui catfish, Gila topminnow, and desert pupfish
International Wildlife Museum	Heidi Blasius, AGFD	Domestic potable water	Gila topminnow and desert pupfish
Flowing Wells Junior High School	Janet Slingerland	Filtered and recycled domestic potable water	desert pupfish
Tohono Chul Park	Lee Mason Jo Falls	Domestic potable water and some stormwater	Gila topminnow, Quitobaquito pupfish and desert pupfish
Arizona Historical Society	Ron Regan	Domestic potable water and small amounts of stormwater	desert pupfish
Palo Verde High School	Heidi Blasius		Gila Topminnow and desert pupfish

With the severe reduction of native fish populations in the southwestern deserts, stocks of native fish are being kept in hatcheries such as that shown in Figure 8. These stocks are maintained in order to insure the continued existence of native fish species in the case that native populations become extirpated or contaminated. Stocked populations could be used to re-establish native fish populations into restored aquatic habitats.

Figure 7. Native fish are held in captivity at several institutions in Pima County. Top, the pond at International Wildlife Museum has several native fish species. Bottom, a child looks at pupfish at the Arizona-Sonora Desert Museum.

Figure 8. The status of native fish in the Southwestern desert is so dire that stocks of fish are being maintained in tanks at the Dexter National Fish Hatchery in New Mexico against the potential demise or contamination of remaining populations.

Nonindigenous Populations

Scarcely 25 kinds of freshwater fish were known to occur in the rivers and streams of Arizona during the historic wanderings and settlements of indigenous peoples. Today, there are more than 4 times as many species of fish swimming in the state, as a result of both intentional and accidental introductions by Angloamericans (Minckley, 1973). This same scenario can be said for the lands within Pima County, which have seen numerous introductions in both natural (i.e., streams) and man-made (i.e., lakes and stock ponds) aquatic ecosystems. Many of the introductions of Nonindigenous fish and other aquatic organisms have come as a serious detriment to native fish species in this county, with a number of native species disappearing or on the brink of extirpation. Figure 9 displays all of the known natural areas where Nonindigenous aquatic species occur in Pima County.

Nonindigenous species can also be a threat to future restoration efforts. Mosquitofish were discovered by U. S. Geological Survey along the effluent dominated reaches of the Santa Cruz River (Cordy, 2000). Pima County staff has observed fish (most likelymosquitofish, but not confirmed) in the effluent channel of the Santa Cruz River near Sander's Road and was also informed of the presence of non-native fish in effluent ponds adjacent to the main channel. Many non-native species of fish occur in the Central Arizona Project canal, which brings water from the Colorado River to Phoenix and then to Tucson. Efforts would have to be made to remove non-native species from these water sources prior to their use in any future restoration efforts.

Discussion

During its recent history, the region encompassing Pima County has seen a dramatic reduction in its native fish populations. The once perennial streams of the lower deserts have become mostly dry channels, no longer able to support aquatic life. With the loss of these lower streams, some native fish have nonetheless persisted in smaller tributary streams of mountain canyons. Climatic change and continued human activities threaten to further reduce even these small areas, making native fish highly susceptible to extirpation from the county.

Although the disappearance of aquatic ecosystems can be linked to changes in climate, most of the damage to these environments has been inflicted by the activities of humans. Utilization of both land and water resources have affected many of the characteristics of stream channels (hydrology, geomorphology, vegetation, etc.) which, in turn, have affected the associated aquatic ecosystems. Urbanization and its related activities have a negative impact on water quality, which can be a threat to restoration efforts of native fish within and downstream of urbanized areas. Non-native species introductions for sport and recreation have also been implicated in the disappearance, or severe reduction, of many native fish from a number of streams and ponds that remain in the county.

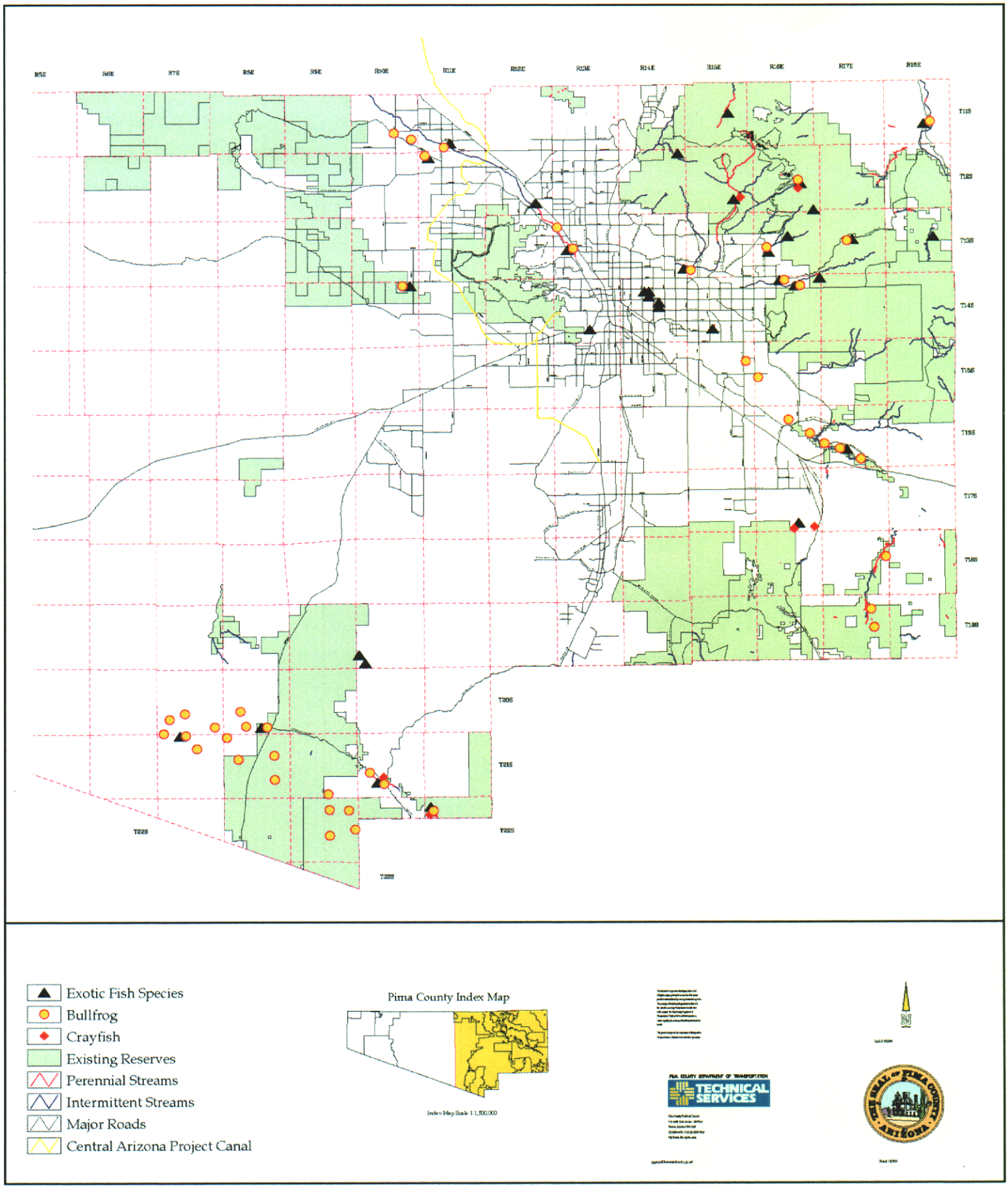

Figure 9. Locations of non-native species in Pima County.

Aquatic ecosystems, and their associated riparian vegetation, are an important and scarce resource in the deserts of the southwest. A disproportionate number of species occur in these areas relative to surrounding landscapes, because of the availability of more food, water and shelter available in these areas. Other species may occur along the fringes of aquatic environments, taking advantage of the abundant resources. In many cases, aquatic and semiaquatic systems are used by wildlife species as corridors to move from one place to another, thus making these linkages valuable to the distribution of wildlife resources. Even humans can benefit from the presence of aquatic ecosystems through their aesthetic qualities and as sources of recreational and educational activities.

The re-establishment of native fish populations can be an important component of Pima County's conservation and restoration efforts to protect and expand these depleted aquatic ecosystems. Native fishes can be used to help control mosquito hazards created by the development of aquatic systems in the urban setting[4]. Many of these fish are highly adapted to the harsh conditions of the desert, such as extreme temperatures and cycles of flooding and drying, making them ideal candidates for restoration projects in or along lowland streams in the Tucson basin. Smaller native fish, such as longfin dace, are accustomed to living in small streams with or without occasional small pools and shifting, sandy bottoms. These habitats are ideal for sustaining populations of other native aquatics, such as the rare lowland leopard frog, and negating the impacts of Nonindigenous species which are more suited to large ponds.

The presence of native fishes was once quite extensive in Pima County compared to today. Although climatic changes have occurred over the last century according to historic records, it is most likely that the loss of aquatic habitats and subsequent fish declines have resulted due to activities associated with human settlement. No one is sure of what the next several decades will bring in the way of temperatures and precipitation, but it is quite clear that fish populations will depend highly on the future activities of people on the landscape. With continued scientific research and careful resource planning, people can reverse the trends they have set for native fishes and begin to rebuild the aquatic ecosystems necessary for maintaining the unique and diverse assemblage of plants and animals characteristic of the Southwestern desert wetlands.

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[4] Native fish such as the Gila topminnow and desert pupfish are known to eat mosquito larvae and may possibly be just as effective as the non-native mosquitofish in controlling mosquito populations (Rosen, 2000; Wolters and Legner, 1980).

References

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Appendix A.1

PIMA CO FISH
W8BNMSWD
DATABASE DUMP FOR PIMA COUNTY, ARIZONA (INCLUDES AGFD RECORDS, NOT CHECKED)
Taxonomy corrected by W. L. Minckley, 23 AUGUST 2000

genus; species; county; river basin; drainage; date; number of specimens (0 = not counted); collector museum catalog number; citation(s); locality; comments

CYPRINIDAE

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 91874 5
Rutter JM MCZ36247 Camp Lowell paratypes Hyborhynchus siderius ident CR Gilbert MCZ

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 24031904 44
Chamberlain FW USNM 129989+92 Chamberlain 1904 Santa Cruz River 2 miles south Tucson - USNM prim lit

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 4291904 0
F W Chamberlain * Miller 1961 Santa Cruz River 8 miles south of Tucson Miller's compilation of data including cataloged but unreported specimens see paper for details prim lit

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 27071917 23
Wright AH CORNU71084 Sabino Canyon in Santa Catalina Mts. - CU

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 1926 2
LW Moffitt UMMZ 080826 Vicinity of Tucson 39 & 46 mm ID CL Hubbs UMMZ

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 4091931 1
W Turnage UMMZ 097192 Sabino Canyon 15 mi E Tucson 47 mm ID CL Hubbs UMMZ

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 2071934 7
Wright AH Webole LP CORNU5623 Sabino Canyon north Tucson ident WJ Koster CU

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 4251937 0
A R Phillips * Miller 1961 Santa Cruz River 8 miles south of Tucson Miller's compilation of data including cataloged but unreported specimens see paper for details prim lit

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 7121939 1220
RR FH Miller J Davis UMMZ 137056 - Santa Cruz River at road crossing ESE San Xavier Mission near Tucson 14-59 mm Orig M39-38 ID RR Miller UMMZ

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 7121939 0
R R Miller * Miller 1961 Santa Cruz River 8 miles south of Tucson Miller's compilation of data including cataloged but unreported specimens see paper for details prim lit

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 4241943 66 JR Simon UMMZ 146646 - Binghampton Pond 3 mi north Tucson 32-80 mm ID RR Miller UMMZ

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 4291943 107 JR Simon UMMZ 146669 - Santa Cruz River 12 mi S Tucson on Papago Indian Reservation 17-54 mm ID RR Miller UMMZ

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 4291943 19 JR Simon UMMZ 146670 - Midvale Farms Irrigation system 7 mi S Tucson (water from Santa Cruz River) 28-70 mm ID RR Miller UMMZ

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 26091949 7 Hock RJ UAZ95-99 - Sabino Canyon Ck. - UAZ

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 6051971 0 Findley LT UAZ71-119 - Cienega Ck. (upper Pantano Wash) ca. 25-26 miles SE downtown Tucson - UAZ

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 14041975 0 Lewis M ASU6573 - Cocio Wash

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 6061980 0 Hendrickson DA Meffe GK ASU8372 - Cienega Ck. middle border S19-30 T16SR17E 3 miles northeast Mountain View

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 6061983 0 DeMarais BD Meffe GK ASU11958 - Cienega Ck. at concrete road 80 mm

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 26071987 16 Bagley B Simons LH ASU15099 - Cienega Ck. at lower end Narrows on Empirita Ranch 20-60 mm SL

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 18081988 1 Bagley B Young KL ASU15554 - Cienega Ck. 20 mm SL

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 28091989 59 Minckley WL ASU13219 - Empire Ranch Cienega Ck. Canal 40-60 mm SL

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 25051991 128 Timmons RJ Craft LJ ASU13390 - Cienega Ck. Location 1

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 19061995 2 Simms JR Womack JD ASU16517 - Mattie Canyon trib. Cienega Ck.

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 19061995 1 Simms JR Womack JD ASU16520 - Mattie Canyon trib. Cienega Ck.

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 2071934 – AH Wright & LP Webole CORU5623 - Sabina Canyon N of Tucson - CORU

Agosia chrysogaster -- Pima Gila Sta. Cruz 22041929 9 + Kranzthor Myers USNM130028 –
Sabino Canyon Near Tucson Removed From 94272 Part of Lot 163 USNM

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 19850731 –1 STRINGER/BROOKS Cienega Cr. 314930 1103410 AZGF

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 19880818 148 BEB,TRJ,KLY. Cienega Cr., near Sanford Canyon T18SR17ES23NE4 NE4 315136 1103423 AZGF

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 19881009 168 Redfield Canyon, 7 MI Upstream of Reddington as crow flies T11SR19ES35SW4 322555 1102242 AZGF

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 19890724 309 K. Simms, J. Simms, Cienega Cr. T18SR17ES12 AZGF

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 19890724 77 P. WARREN, J. Simms, Cienega Cr. T19SR17ES10SE4 SE4 314730 1103515 AZGF

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 19891021 300 KS,JS,TN,SW,KB,TA,PV Cienega Cr., confluence of Cienega Cr. & Mattie Canyon T18SR17ES23NE4 NE4 SW4 315106 1103435 AZGF

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 19890705 0 BAGLEY Buehman Canyon T12SR18ES5SW4 322505 1103200 AZGF

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 19910207 0 MRB Buehman Canyon T12SR18ES5SW4 322505 1103200 AZGF

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 19920618 DAW JNY SES Cienega Cr. T18SR18ES6SE4 SW4 315325 1103247 AZGF

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 19930804 880 DAW FJA Buehman Canyon T12SR18ES5SW4 322505 1103200 AZGF

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 19941013 443 JS,SS,MF,BH Cienega Cr., at Mattie Canyon T18SR17ES23NE4NE4 AZGF

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 19941021 216 K Simms, J Simms, DD Cienega Cr., between Gardner & Springwater Canyon T19SR17ES10SE4NE4 AZGF

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 19941012 165 J Simms, K Simms Cienega Cr., between Oak Tree Canyon & Empire Gulch T19SR17ES3SE4NE4 AZGF

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 19941020 33 J Simms, K Simms Cienega Cr., downstream of Pump Canyon T18SR17ES13NW4 AZGF

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 19941014 133 J Simms, K Simms SJH Cienega Cr., Upstream of Fresno Canyon T18SR17ES12E2 AZGF

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 19951101 768 J. Simms, J. SACCO Cienega Cr., at Mattie Canyon T18SR17ES23NE4NE4 AZGF

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 19951016 271 J Simms, K Simms Cienega Cr., at Pump Canyon T18SR17ES13NW4 AZGF

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 19951017 24 JS,TT,JR,JW Cienega Cr., between Gardner & Springwater CanyonS T19SR17ES10SE4NE4 AZGF

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 19951017 15 J Simms,TT,JW,JR Cienega Cr., between headwaters & Gardner Canyon T19SR17ES15NE4NE4 AZGF

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 19951017 15 JS,DD,KS Cienega Cr., between Pump & Fresno Canyon T18SR17ES12E2 AZGF

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 19951026 772 J Simms,TH,JW Mattie Canyon, headwaters T18SR17ES26NW4NE4 AZGF

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 19960819 1 DAW DD DS Cienega Cr., ABOVE DAVIDSON Canyon T17SR17ES35NW4SW4 AZGF

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 19960819 1 DAW DD Cienega Cr., DAVIDSON Canyon T16SR17ES19ALL 320110 1103900 AZGF

Agosia chrysogaster -- Pima Co., Gila basin, Santa Cruz drainage, 19980618 314 RJT, MRS Buehman Canyon T12SR18ES5SW4 322505 1103200 AZGF

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 1800s 0 A L Heermann 222 Girard 1856 Girard 1859 Tucson Sonora collected in the 1800s ID as Tigoma intermedia prim lit

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 1894 5 William Wightman Price * Rutter 1896 Sabino Canyon provides morphological notes as Leuciscus intermedius prim lit

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 24031904 2 Chamberlain FW USNM 12990+3 Chamberlain 1904 Santa Cruz River 2 miles south Tucson as Leuciscus intermedius USNM prim lit

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 4291904 0 F W Chamberlain *Miller 1961 Santa Cruz River 8 miles south of Tucson Miller's compilation of data including cataloged but unreported specimens see paper for details prim lit

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 4091910 1 Pilsbry HA ANSP36909 - Santa Cruz River Tucson ident HW Fowler ANSP

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 1926 5 LW Moffitt UMMZ 080827 - Vicinity of Tucson 29-43 mm ID CL Hubbs UMMZ

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 7071934 5 Wright AH Webole LP CORNU5624 - Sabino Canyon north Tucson - CU

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 9061938 6 CL Hubbs Family UMMZ 125043 - Sabino Ck. trib. Rillito Cr Santa Catalina Mts ca 16 mi NE Tucson above Picnic Grounds 17-48 mm A 8(6) Orig No M38-203 ID CLHubbs UMMZ

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 4251943 2
JR Simon J Hendrickson UMMZ 146642 - Desert Shores Pond in Tucson 24-24 mm ID RR Miller UMMZ

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 4241943 39
JR Simon UMMZ 146647 - Binghampton Pond 3 mi north Tucson 36-111 mm A 7(8) 8(31) ID RR Miller UMMZ

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 4181943 100
JR Simon UMMZ 146651 - Sabino Ck. trib. Rillito Cr Santa Catalina Mts. 15 mi NE Tucson 38-74 mm A 7(2) 8(96) 9(2) ID RR Miller UMMZ

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 6191943 96
JR Simon UMMZ 146688 - Sabino Ck. in Sabino Canyon 1/2 mi above end of road 21-103 mm A 7(1) 8(22) 9(2) partial count 2 given to U of A RC Snyder ID RR Miller UMMZ

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 1051943 5
Simon Hendrickson UAZ95-82 - Sabino Canyon Ck. - UAZ

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 6061943 0
Simon J UAZ95-86 - Sabino Canyon Ck. - UAZ

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 26091949 7
Hock RJ UAZ95-99 - Sabino Canyon Ck. - UAZ

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 61966 0
Winkler UAZ66-133 - Upper Sabino Canyon Santa Catalina Mts. - UAZ

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 27041974 0
Minckley WL McNatt RM ASU6279 - Cienega Ck. at Cienega Ranch where cold spring enters stream near mouth Mattie Canyon

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 18051974 0
Minckley WL Constantz GC ASU6747 - Cienega Ck. at Cienega Ranch part to Tulane Univ

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 28061974 0
Minckley WL ASU6859 - Cienega Ck. at Cienega Ranch

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 27041974 4
Minckley WL ASU13152 - Cienega Ranch

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 18051974 3
Minckley WL ASU15581 - Cienega Ck. 30 mm SL

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 27041974 5
WL Minckley et al TNHC21692 - Cienega Ck. at Cienega Ranch - TNHC

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 4061976 0
Kepner WG Landye JJ ASU6860 - Cienega Ck. on Cienega Ranch just above where cold spring enters in mouth Mattie Canyon WK 76-2 sta 2

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 4061976 0
Kepner WG Landye JJ ASU6861 - cold spring adjacent to Cienega Ck. in mouth Mattie Canyon WK 76-1 sta 1

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 22101980 0
Hendrickson DA Minckley RL ASU8450 - Sabino Canyon 2 miles above Visitor Center northeast Tucson held in aquarium 2 weeks before preservation Gila & Lepomis not sympatric at collection site

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 22101980 53
Hendrickson DA ASU13182 - Sabino Canyon north Tucson 30-90 mm SL guts removed

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 3171982 12
S Belfit G Meffe UMMZ 209808 - Junction of Cienega & Stevensons creeks T18SR17E S23NW 99 1/2-134 mm UMMZ

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 6061983 1
DeMarais BD Meffe GK ASU10364 - Cienega Ck. skel

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 6061983 1
DeMarais BD Meffe GK ASU10365 - Cienega Ck. skel 95 mm female

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 6061983 1
DeMarais BD Meffe GK ASU10366 - Cienega Ck. skel 126 mm female

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 6061983 1
DeMarais BD Meffe G ASU10367 - Cienega Ck. skel 148 mm female

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 6061983 1
DeMarais BD Meffe GK ASU10368 - Cienega Ck. skel 118 mm female

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 6061983 1
DeMarais BD Meffe GK ASU10369 - Cienega Ck. skel 116 mm female

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 6061983 1
DeMarais BD Meffe GK ASU10370 - Cienega Ck. skel 112 mm female

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 6061983 1
DeMarais BD Meffe GK ASU10371 - Cienega Ck. skel 123 mm male

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 6061983 1
DeMarais BD Meffe GK ASU10372 - Cienega Ck. skel 107 mm female

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 6061983 1
DeMarais BD Meffe GK ASU10373 - Cienega Ck. skel 116 mm male

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 6061983 8
Meffe GK DeMarais BD ASU11519 - Cienega Ck. at ranch house 70-100 mm

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 6061983 8
DeMarais BD Meffe GK ASU11959 - Cienega Ck. at concrete road ca. 75 mm

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 26051991 42
Timmons RJ Craft LA ASU13125 - Cienega Ck.

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 25051991 2
Timmons RJ Craft LJ ASU13391 - Cienega Ck. Location 1

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 26041992 20
Anderson A Maes R ASU15977 - Sabino Canyon Coronado National Forest

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 29041992 20
Anderson A Maes R ASU15979 - Cienega Ck. T18S R17E NW 1/4 S23 into S14

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 18051974 39 WL Minckley & Party TU107289 - Cienega Ck. at Cienega Ranch. - TU

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 19850731 -1 STRINGER/BROOKS Cienega Cr. 314930 1103410 AZGF

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 19880818 12 BEB,TRJ,KLY. Cienega Cr., near Sanford Canyon T18SR17ES23NE4 NE4 315136 1103423 AZGF

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 19881009 3 Redfield Canyon, 7 MI Upstream of Reddington as crow flies T11SR19ES35SW4 322555 1102242 AZGF

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 19881009 1 JRC,MRC,BD,TM,SO Redfield Canyon, LARGE POOL DIRECTLY BELOW THE RANCH HOUSE T11SR19ES35NE4 SE4 SW4 322557 1102215 AZGF

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 19890724 42 P. WARREN, J. Simms, Cienega Cr. T19SR17ES10SE4 SE4 314730 1103515 AZGF

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 19890724 11 J. Simms, K. Simms, Cienega Cr. T18SR17ES35NW4, NW4 314950 1103508 AZGF

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 19891021 17 KS,JS,TN,SW,KB,TA,PV Cienega Cr., confluence of Cienega Cr. & Mattie Canyon T18SR17ES23NE4 NE4 SW4 315106 1103435 AZGF

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 19901029 14 JW,JS,CC Sabino Canyon, between BRIDGES 8 & 9 322000 1104722 AZGF

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 19920618 -1 DAW JNY SES Cienega Cr. T18SR18ES6SE4 SW4 315325 1103247 AZGF

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 19921109 205 DAW,BPD,volunteers Sabino Canyon, RECREatION AREA T13SR15ES 9NE4NE4 321834 1104838 AZGF

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 19941013 12 JS,SS,MF,BH Cienega Cr., at Mattie Canyon T18SR17ES23NE4NE4 AZGF

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 19941021 26 K Simms, J Simms, DD Cienega Cr., between Gardner & Springwater Canyon T19SR17ES10SE4NE4 AZGF

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 19941021 8 JS,KS,DD Cienega Cr., between headwaters & Gardner Canyon T19SR17ES15NE4NE4 AZGF

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 19941012 15 J Simms, K Simms Cienega Cr., between Oak Tree Canyon & Empire Gulch T19SR17ES3SE4NE4 AZGF

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 19941012 10 J Simms, K Simms Cienega Cr., headwaters T19SR17ES15SE4 AZGF

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 19941014 4 J Simms, K Simms SJH Cienega Cr., Upstream of Fresno Canyon T18SR17ES12E2 AZGF

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 19940111 24 DAW,MAL,Sabino VOL Sabino Canyon Recreation Area T13SR15E AZGF

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 19941018 29 MAL,DJB,DA,JS,KR Sabino Canyon, RECREatION AREA T13SR15E AZGF

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 19951101 28 J. Simms, J. Sacco Cienega Cr., at Mattie Canyon T18SR17ES23NE4NE4 AZGF

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 19951016 34 J Simms, K Simms Cienega Cr., at Pump Canyon T18SR17ES13NW4 AZGF

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 19951017 14 J Simms,TT,JW,JR Cienega Cr., between headwaters & Gardner Canyon T19SR17ES15NE4NE4 AZGF

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 19951017 25 JS,DD,KS Cienega Cr., between Pump & Fresno Canyon T18SR17ES12E2 AZGF

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 19951018 48 JS,KS,DD Cienega Cr., headwaters T19SR17ES15SE4 AZGF

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 19951026 71 J Simms,TH,JW Mattie Canyon, headwaters T18SR17ES26NW4NE4 AZGF

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 19951024 12 Sabino Canyon T13SR15ES9 AZGF

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 18051891 1 Jouy PL USNM044094 - Santa Cruz R For Exchange USNM

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 5051891 1 Jouy PL USNM044090 - Small Trib Santa Cruz R Tucson - USNM

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 19041891 2 Jouy PL USNM044088 - Small Trib Santa Cruz R Tucson - USNM

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 19041891 3 Jouy PL USNM044089 - Small Trib Santa Cruz R Tucson - USNM

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 19041891 1 Jouy PL USNM044092 - Small Trib Santa Cruz R Tucson - USNM

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 20111893 7 Mearns EA USNM045440 - Tucson Santa Cruz R - USNM

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 29031904 40 + Chamberlain FM USNM129987 - Santa Cruz R San Xavier - USNM

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 22041929 2 Kranzthor GM Myers GS USNM094272 - Sabino Canyon Santa Catalina Mts Nr Tucson See Accession Papers For Full Data On All These Fishes USNM

Gila intermedia -- Pima Co., Gila basin, Santa Cruz drainage, 2071934 – AH Wright & LP Webole CORU5624 - Sabina Canyon N of Tucson – CORU

Rhinichthys osculus -- Pima Gila San Pedro 13101950 2 Lowe CH UAZ95-105 – Redfield Canyon Ck. Galiuro Mts. 10 1/10 miles E Reddington - UAZ
Rhinichthys osculus -- Pima Gila San Pedro 19881009 8
Redfield Canyon, 7 MI Upstream of Reddington as the crow flies
T11SR19ES35SW4 322555 1102242 AZGF

CATOSTOMIDAE
Catostomus insignis -- Pima Co., Gila basin, Santa Cruz drainage, 24031904 0
Chamberlain FW - Chamberlain 1904 Santa Cruz River 2 miles south Tucson - prim lit
Catostomus insignis -- Pima Co., Gila basin, Santa Cruz drainage, 4291904 0
F W Chamberlain * Miller 1961 Santa Cruz River 8 miles south of Tucson Miller's compilation of data including cataloged but unreported specimens see paper for details prim lit
Catostomus insignis -- Pima Co., Gila basin, Santa Cruz drainage, 0 2
Mearns EA USNM083604 - Tucson - USNM
Catostomus insignis -- Pima Co., Gila basin, Santa Cruz drainage, 29031904 5
Chamberlain FM USNM129984 - Santa Cruz R San Xavier - USNM
Catostomus insignis -- Pima Gila San Pedro 19881009 16
Redfield Canyon, 7 MI Upstream of Reddington as the crow flies
T11SR19ES35SW4 322555 1102242 AZGF
Catostomus insignis -- Pima Gila San Pedro 19881009 11
JRC,MRC,BD,TM,SO Redfield Canyon, large pool directly below the ranch house
T11SR19ES35NE4 SE4 SW4 322557 1102215 AZGF

Pantosteus clarki -- Pima Co., Gila basin, Santa Cruz drainage, 1851 1
Clark JH MCZ2261 - Rio Santa Cruz (Gila River drainage) probably at Tucson note in Proc Acad Nat Sci Phil 7:27 MCZ
Pantosteus clarki -- Pima Co., Gila basin, Santa Cruz drainage, 24031904 0
Chamberlain FW - Chamberlain 1904 Santa Cruz River 2 miles south Tucson - prim lit
Pantosteus clarki -- Pima Co., Gila basin, Santa Cruz drainage, 4291904 0
FW Chamberlain * Miller 1961 Santa Cruz River 8 miles south of Tucson
Miller's compilation of data including cataloged but unreported specimens see paper for details prim lit
Pantosteus clarki -- Pima Co., Gila basin, Santa Cruz drainage, - 1
Clark J H HU2261 - Rio Santa Cruz Gila River drainage probably at Tucson Syntype HU
Pantosteus clarki -- Pima Co., Gila basin, Santa Cruz drainage, 29031904
10 + Chamberlain FM USNM129985 - Santa Cruz R San Xavier Topotypes USNM

Pantosteus clarki -- Pima Co., Gila basin, Santa Cruz drainage, 19881009 4 Redfield Canyon, 7 MI Upstream of Reddington as the crow flies T11SR19ES35SW4 322555 1102242 AZGF

Pantosteus clarki -- Pima Co., Gila basin, Santa Cruz drainage, 19881009 14 JRC,MRC,BD,TM,SO Redfield Canyon, large pool directly below the ranch house T11SR19ES35NE4 SE4 SW4 322557 1102215 AZGF

CYPRINODONTIDAE

Cyprinodon eremus -- Pima Gila Quitobaquito, 19890729 -1 J. Mitton, B. Bagley Quitobaquito Springs 315630 1130111 AZGF

Cyprinodon eremus -- Pima Co., Sonoyta basin, Quitobaquito, 1930 6 Phillips JC MCZ33287 - Quitobaquito Spring near Monument - MCZ

Cyprinodon eremus -- Pima Co., Sonoyta basin, Quitobaquito, 4141950 1 RR & FH Miller HE Winn UMMZ 162661 - Spring-fed pond at Quitobaquito, ca 14 mi W Ajo-Sonoyta Road 40 mm Orig M50-37 Holotype ID RR Miller UMMZ

Cyprinodon eremus -- Pima Co., Sonoyta basin, Quitobaquito, 4141950 386 RR Miller HE Winn UMMZ 162662 - Spring-fed pond at Quitobaquito, ca. 14 mi W Ajo-Sonoyta Road 24-46 mm Orig M50-37 paratopotypes ID RR Miller UMMZ

Cyprinodon eremus -- Pima Co., Sonoyta basin, Quitobaquito, 14041950 10 Miller RR Miller FH Winn HE FMNH97069 - Spring-fed pond at Quitobaquito, ca. 14 miles west Ajo-Sonoyta Road - FMNH

Cyprinodon eremus -- Pima Co., Sonoyta basin, Quitobaquito, 14041950 10 Miller RR Miller FH Winn HE ANSP158520 - Spring-fed pond at Quitobaquito, ca. 14 miles west Ajo-Sonoyta Road paratypes ANSP

Cyprinodon eremus -- Pima Co., Sonoyta basin, Quitobaquito, 21031959 0 – UAZ95-76 - Quitobaquito Spring in Organ Pipe Cactus National Monument - UAZ

Cyprinodon eremus -- Pima Co., Sonoyta basin, Quitobaquito, 1071959 2 Heath WG UAZ95-175 - Quitobaquito Spring - UAZ

Cyprinodon eremus -- Pima Co., Sonoyta basin, Quitobaquito, 5001964 0 Cole Whiteside * Cole & Whiteside 1965 Quitobaquito Spring & pool N lat 31o55 long 113o01 - prim lit

Cyprinodon eremus -- Pima Co., Sonoyta basin, Quitobaquito, 10071969 0 Schoenherr AA ASU4685 - Quitobaquito Spring west northwest Lukeville

Cyprinodon eremus -- Pima Co., Sonoyta basin, Quitobaquito, 10121969 0 AZGFD ASU4686 - Quitobaquito Spring west northwest Lukeville

Cyprinodon eremus -- Pima Co., Sonoyta basin, Quitobaquito, 10121969 0 AZGFD ASU4687 - Quitobaquito Spring west-northwest Lukeville held at ASU few hrs before pres

Cyprinodon eremus -- Pima Co., Sonoyta basin, Quitobaquito, 5201982 4 RR Miller T McMahon UMMZ 211156 - Spring-fed pond at Quitobaquito, ca 14 mi W Ajo-Sonoyta Road 30-36 mm Orig M82-87 paratypes ID RR Miller Nuptial females inaddition to usually brilliant metallic blue on back & upper sides had yellow on c fin encroac UMMZ

Cyprinodon eremus -- Pima Co., Sonoyta basin, Quitobaquito, 14041950 10 RR Miller FH Miller HE Winn FMNH97069 - Spring fed pond at Quitobaquito, ca 14 mi W of Ajo Sonoyta road Paratypes FMNH

Cyprinodon eremus -- Pima Co., Sonoyta basin, Quitobaquito, 14111970 1 M Langworthy TU64969 - Quitobaguito Springs Organ Pipe Cactus National Monument. - TU

Cyprinodon eremus -- Pima Co., Sonoyta basin, Quitobaquito, 28031959 27 C L Hubbs D Jonas SIO59-43 - Quitobaquito, Organ Pipe Cactus NM 32ˆ00.0'N 112ˆ55.0'W SIO

Cyprinodon eremus -- Pima Co., Sonoyta basin, Quitobaquito, 14041950 10 Miller RR Miller FH Winn HE USNM279473 - Spring Fed Pond At Quitobaquito, Ca 14 Mi W of Ajo-Sonoyta Road -- Pima CO Author: Miller Date of Publication: 1987 Title: Description And Conservation Status of Cyprinodon macularius eremus A New Subspecies of Pupfish From Organ Pipe Type Status: Paratype USNM

Cyprinodon macularius -- Pima Co., Gila basin, Santa Cruz drainage, 1848? 2 Schott A USNM021315 - Yuscan (= Tucson) Old Specimen USNM

Cyprinodon macularius -- Pima Co., Gila basin, Santa Cruz drainage, 1893 2 Brown H USNM045441 - Tucson Santa Cruz R - USNM

POECILIIDAE

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 1848 0 Arthur Schott under Major Emory * Girard 1859 Tucson Sonora as Girardinus occidentalis prim lit

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 1848 0 A L Heermann under Lt J G Parke * Girard 1859 collected at Tucson as Girardinus occidentalis prim lit

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 1894 5 William Wightman Price * Rutter 1896 Sabino Canyon as Poecilia occidentalis prim lit

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 24031904 139 Chamberlain FW USNM 129991+4 Chamberlain 1904 Santa Cruz River 2 miles south Tucson as Poecilia Topotypes USNM prim lit

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 4291904 0 F W Chamberlain * Miller 1961 Santa Cruz River 8 miles south of Tucson Miller's compilation of data including cataloged but unreported specimens see paper for details prim lit

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 4091910 53 Pilsbry HA ANSP38841 - Santa Cruz River Tucson ident HW Fowler ANSP

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 1926 0 - Hubbs 1926 Sabino Canyon in Santa Catalina Mts. No precise date prim lit

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 1926 0 - Hubbs 1926 at Tucson No precise date prim lit

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 2071934 7 Wright AH Webole LP CORNU5618 - Sabino Canyon north Tucson ident WJ Koster CU

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 1940 0 – * Nichols 1940 Hubbs & Miller 1941 Tanque Verde Ck. 3 1/2 miles east Tanque Verde No precise date critique & synonymization of type of Arizonichthys psammophilus Nichols new genus & species prim lit

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 1940 0 - * Nichols 1940 see Hubbs & Miller 1941 Tanque Verde Ck. 3 1/2 miles east Tanque Verde No precise date Description of Arizonichthys psammophilus Nichols new genus & species need original publication to complete citation prim lit

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 10171943 1289 JR Simon & party UMMZ 141725 - Spring 50 ft W Tanque Verde Ck. Tanque Verde Ranch ca 17 mi E Tucson 13-32 mm Orig No I ID RR Miller UMMZ

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 10171943 2391 JR Simon & party UMMZ 141726 - Spring 200 ft W Tanque Verde Ck. Tanque Verde Ranch ca 17 mi E Tucson 15-32 mm Orig No II ID RR Miller UMMZ

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 4251943 114 JR Simon J Hendrickson UMMZ 146644 - Desert Shores Pond in Tucson 22-43 mm ID RR Miller UMMZ

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 4241943 209 JR Simon UMMZ 146645 - Binghampton Pond 3 mi north Tucson 20-49 mm ID RR Miller UMMZ

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 4181943 5 JR Simon UMMZ 146650 - Sabino Ck. trib. Rillito Cr Santa Catalina Mts 15 mi NE Tucson 29-38 mm ID RR Miller UMMZ

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 4291943 87 JR Simon UMMZ 146671 - Midvale Farms Irrigation system 7 mi S Tucson (water from Santa Cruz River) 20-36 mm ID RR Miller UMMZ

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 29041943 7 Simon UAZ95-81 - Midvale Farms irrigation system Santa Cruz R 10 miles S Tucson - UAZ

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 9051947 4 Tinkham ER ANSP71814 - Sabino Canyon 1 mile northeast Tucson ident HW Fowler ANSP

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 25031935 24 Griswold J A HU34649 - from ditch 30 miles south of Tucson at 3000 feet altitude - HU

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 4001969 2 K Hanks UMMZ 190820 - Spring-fed rockpool in Cocio Wash ca 40 mi NNW Tucson T12SR9E S20 24 & 28 mm ID RR Miller UMMZ

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 6101972 0 McNatt RM Constantz GC ASU6271 - 1 mile east Silver Bell 30 miles northwest Tucson

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 10051973 10 Constantz GD ASU10182 - Cocio Wash

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 20101973 10 Constantz GD ASU10183 - Cocio Wash

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 20101973 10 Constantz GD ASU10184 - Cocio Wash east base of tailing pond

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 27041974 0 Minckley WL McNatt RM ASU6278 - Cienega Ck. at Cienega Ranch where cold spring enters stream near mouth Mattie Canyon

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 18051974 0 Minckley WL Constantz GC ASU6748 - Cienega Ck. at Cienega Ranch

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 18051974 136 Minckley WL ASU12043 - Cienega Ck. pool adjacent to creek near mouth Mattie Canyon

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 26051974 10 Constantz GD ASU10187 - Cocio Wash

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 24071974 10 Constantz GD ASU10188 - Cocio Wash maintained under high density in greenhouse experiment before preservation

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 18081974 15 Constantz GD ASU10189 - Cocio Wash

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 18081974 10 Constantz GD ASU10190 - Cocio Wash

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 18081974 20 Constantz GD ASU10191 - Cocio Wash

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 18081974 50 Constantz GD ASU10192 - Cocio Wash isolated in upstream pool

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 14091974 25 Constantz GD ASU10193 - Cocio Wash

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 1111974 20 Constantz GD ASU10194 - Cocio Wash

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19101974 20 Constantz GD ASU10195 - Cocio Wash

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19101974 15 Constantz GD ASU10196 - Cocio Wash

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19101974 15 Constantz GD ASU10197 - Cocio Wash

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19101974 10 Constantz GD ASU10198 - Cocio Wash

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19101974 15 Constantz GD ASU10199 - Cocio Wash

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19101974 10 Constantz GD ASU10200 - Cocio Wash

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 23111974 25 Constantz GD ASU10201 - Cocio Wash

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19121974 15 Constantz GD ASU10202 - Cocio Wash

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19121974 10 Constantz GD ASU10203 - Cocio Wash

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19121974 20 Constantz GD ASU10204 - Cocio Wash

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19121974 15 Constantz GD ASU10205 - Cocio Wash

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 18051974 10 Constantz GD ASU10228 - Cienega Ck. above below 7-ft falls

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 18051974 10 Minckley WL ASU10229 - Cienega Ck. above below 7-ft falls

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 1021975 25 Constantz GD ASU10185 - Cocio Wash

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 17051975 10 Constantz GD ASU10186 - Cocio Wash combined stations

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 22031980 34 – ASU14641 - Cienega Ck. confluence Mattie Wash Bell Spring Site C 20-40 mm SL permit PRT-2-649

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 22031980 5 ASU15189 - Cienega Ck. Site B

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 6061983 17 DeMarais BD Meffe GK ASU11960 - Cienega Ck. at concrete road

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 15071986 0 Hendrickson DA Simons L ASU11247 - Cienega Ck. on Empire Ranch

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 26071987 150 Bagley B Simons LH ASU15100 - Cienega Ck. at lower end Narrows on Empirita Ranch

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 18081988 42 Bagley B Young KL ASU15555 - Cienega Ck.

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 25051991 21 Timmons RJ Craft LJ ASU13392 - Cienega Ck. Location 1

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 18061992 21 AZGF ASU12943 - Cienega Ck. north Pump Canyon T18S R17E S12 SE 1/4 NE 1/4

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 18061992 26 AZGF ASU12945 - Cienega Ck. Narrows T18S R18E S6 SE 1/4 SW 1/4

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 18061992 22 AZGF ASU12946 - Cienega Ck. Narrows T19S R17E S10 SE 1/4 NE 1/4

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 12101994 133 Simms JR (BLM) ASU16123 - Cienega Ck. headwaters T19S R17E S15 SE 1/4

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 21071994 22 AZGFD ASU14252 - Cienega Ck. T18S R18E sec 6 SE4 SW4 JNY001-2940721

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 21071994 36 AZGFD ASU14254 - Cienega Ck. T19S R17sec 15 NE4 SE4 JNY001-01940721

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19061995 6 Simms JR Womack JD ASU16518 - Mattie Canyon trib. Cienega Ck.

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19061995 20 Simms JR Womack JD ASU16519 - Mattie Canyon trib. Cienega Ck.

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 24071995 17 AZGFD ASU14268 - Cienega Ck. T18S R17E secs 12 & 14 DAW001950724

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 2071934 – AH Wright & LP Webole CORU5618 - Sabino Canyon N of Tucson - CORU

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 1893 8 Brown H USNM045444 - Tucson Santa Cruz R - USNM

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 22041929 9 Kranzthor GM Myers GS USNM094273 - Sabino Canyon Santa Catalina Mts Nr Tucson See Accession Papers For Full Data On All These Fishes USNM

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19850731 –1 STRINGER/BROOKS Cienega Cr. 314930 1103410 AZGF

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19880818 216 BEB,TRJ,KLY. Cienega Cr., near Sanford Canyon T18SR17ES23NE4 NE4 315136 1103423 AZGF

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19890724 124 K. Simms, J. Simms, Cienega Cr. T18SR17ES12 AZGF

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19890724 383 P. WARREN, J. Simms, Cienega Cr. T19SR17ES10SE4 SE4 314730 1103515 AZGF

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19891021 2272 KS,JS,TN,SW,KB,TA,PV Cienega Cr., confluence of Cienega Cr. & Mattie Canyon T18SR17ES23NE4 NE4 SW4 315106 1103435 AZGF

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19941013 3208 JS,SS,MF,BH Cienega Cr., at Mattie Canyon T18SR17ES23NE4NE4 AZGF

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19941021 472 K Simms, J Simms, DD Cienega Cr., between Gardner & Springwater Canyon T19SR17ES10SE4NE4 AZGF

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19941021 39 JS,KS,DD Cienega Cr., between headwaters & Gardner Canyon T19SR17ES15NE4NE4 AZGF

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19941012 40 J Simms, K Simms Cienega Cr., between Oak Tree Canyon & Empire Gulch T19SR17ES3SE4NE4 AZGF

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19941020 95 J Simms, K Simms Cienega Cr., downstream of Pump Canyon T18SR17ES13NW4 AZGF

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19941012 2521 J Simms, K Simms Cienega Cr., headwaters T19SR17ES15SE4 AZGF

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19941014 455 J Simms, K Simms SJH Cienega Cr., Upstream of Fresno Canyon T18SR17ES12E2 AZGF

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19951101 1892 J. Simms, J. SACCO Cienega Cr., at Mattie Canyon T18SR17ES23NE4NE4 AZGF

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19951016 214 J Simms, K Simms Cienega Cr., at Pump Canyon T18SR17ES13NW4 AZGF

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19951017 22 JS,TT,JR,JW Cienega Cr., between Gardner & Springwater CanyonS T19SR17ES10SE4NE4 AZGF

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19951017 564 J Simms,TT,JW,JR Cienega Cr., between headwaters & Gardner Canyon T19SR17ES15NE4NE4 AZGF

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19951017 14 JS,DD,KS Cienega Cr., between Pump & Fresno Canyon T18SR17ES12E2 AZGF

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19951018 2754 JS,KS,DD Cienega Cr., headwaters T19SR17ES15SE4 AZGF

Poeciliopsis occidentalis -- Pima Co., Gila basin, Santa Cruz drainage, 19951026 2 J Simms,TH,JW Mattie Canyon, headwaters T18SR17ES26NW4NE4 AZGF

Appendix B.1

Captive Fish Population Summary for Pima County, Arizona

Captive Population in the Tucson Area

1. Arizona-Sonora Desert Museum
2. International Wildlife Museum
3. Flowing Wells Junior High School
4. Tohono Chul Park
5. Arizona Historical Society

Fish Species Identified
Desert Pupfish
Gila Topminnow
Yaqui Catfish
Sonora Chub
Colorado Squawfish
Razorback Sucker
Bonytail Chub
Apache Trout
Speckled Dace
Gila Chub
Desert Sucker
Beautiful Shiner

Exotic Species Identified
Mud Turtle
Red Ear Slider
Crayfish
Goldfish
Unknown Frog Species

Aquatic Problems
- Aquatic vegetation buildup (not identified as an aquatic problem, but a visual).
- Winter die-off of aquatic vegetation causing nitrate poisoning of the Desert Pupfish at Tohono Chul Park.
- High chlorine content of potable water supply.
- Desert Pupfish - Adult predation of young-relates to lack of the available food supply (algae). This was identified as caused by algae being killed by the chlorinated water supply.

Habitats and Water Supplies - The aquatic habitats include ponds and artificial streams. Water supplies are domestic and generally fresh filtered, recycled, and filtered recycled water.

Population Augmentation - Populations of Gila Topminnows are expanding at most sites. The Desert Pupfish is more sensitive to water quality (chlorination) and available food, but generally are maintaining their numbers. All populations are maintained as exhibits for the parks and museums and are also used for educational purposes.

ARIZONA-SONORA DESERT MUSEUM

Contact: Barbara Tarkanian **Phone:** (520)883-2702

Fish Represented - All fish species are kept separated. Sinaloan Cichlid - Non-native kept in a separate pond: Desert Pupfish, Beautiful Shiner, Yaqui Catfish, Sonora Chub, Gila Topminnow, Colorado Squawfish, Razorback Sucker, Bonytail Chub, Apache Trout, Speckled Dace, Gila Chub, and Desert Suckers.

History - Currently being researched by staff at the ASDM. We should have this in approximately one week (9-25 through 9-29).

Pima County Native	Names of Stocking	Dates	Population	Stocking Source
Yes	Desert Pupfish			
No	Beautiful Shiner			
No	Yaqui Catfish			
No	Sonora Chub			
Yes	Gila Topminnow			
No	Colorado Squawfish		1	
No	Razorback Sucker		6	
No	Bonytail Chub		1	
No	Apache Trout		1	
Yes	Speckled Dace		12	
Yes	Gila Chub			
Yes	Desert Sucker			

Who maintains the native fish populations/program?
Ken Wintin, ASDM (520)883-2702
Heidi Blasius, AG&F Department (520)628-5377, Ext. 136

Exotic aquatic problems? No, except there is one artificial stream with crayfish. ASDM plans to get rid of this population.

Any die-off problems? Fish populations are stable except for the Gila Topminnow. System cleaning stresses the Gila Topminnow with noted die-off.

Who designed the program or what prompted the project? The populations have evolved over time. Larson & Co. consultants are responsible for some programs. The ASDM educational program is responsible for other populations. Heide Blasins of the AG&F Department has coordinated some of the populations.

Water Supply - Water is well water and non-chlorinated - no surface drainage.

Any need to augment populations? There is some concern that these small populations may inbreed. The species with 12 or fewer fish are for demonstration only and will be replaced as die-off occurs.

What is the purpose of having these fish populations? Species maintained for public viewing and to represent native species of the area; although, the Colorado Squawfish, Razorback sucker, and the Apache Trout are not Pima County natives, they are Arizona natives.

FLOWING WELLS JUNIOR HIGH SCHOOL

Contact: Janet Slingerland **Phone:** (520)690-2316

Fish Represented - Desert Pupfish.

Who started the populations/program? Karma Slayman Bone was responsible for the program and started the population about 1988/89. The pupfish were obtained from the Arizona Game and Fish Department from the San Pedro River.

Who maintains the population? Janet Slingerland maintains the population. Fish are maintained in a pond approximately 6' x 4' x 4' deep. The pond is occupied by aquatic vegetation which requires periodic cleaning to maintain some open water. The population is maintained as part of the science department.

Exotic aquatic problems? None.

Any die-off? No. However, there is some when aquatic vegetation is removed, but the population recovers.

Who designed the program? Karma Bone started the project as part of the school's science program.

Water Supply - The supply is domestic potable water only. This source is very low in chlorine content and has caused no problems for the fish.

Any need to augment the population? No.

What is the purpose of maintaining the population? The population is maintained by the school's science department as a science demonstration.

TOHONO CHUL PARK

Contact: Russ Buhrow, Curator **Phone:** (520)690-2316
Lee Mason 850-0663 (Cell)
Jo Falls ?

Fish Represented - Gila Topminnow, Quitobaquito, and Desert Pupfish.

Who started the populations/program? Unknown. Started prior to 1989.

Who maintains the population? Lee Mason and Jo Falls.

Exotic aquatic problems? Goldfish and unknown species of frogs have been introduced by unknown public sources.

Other Problems - Chlorinated water from the domestic water supply has affected the pupfish requiring the addition of a filter. Adult pupfish predation of young is a problem because chlorination interferes with the desired algae buildup needed as a food source.

Any die-off? Yes. Muck buildup during the winter causes a nitrate poisoning problem and requires cleaning the ponds annually.

Who designed the program? Unknown.

Water Supply - The supply is domestic potable water and is filtered and recycled (same water refiltered).

Any need to augment the population? Gila Topminnows self sustaining. The pupfish population is affected by seasonal nitrate poisoning and adult predation of young pupfish, but restocking was not indicated at this time.

What is the purpose of maintaining the native population? The main purpose is public display of native fish with the opportunity for school programs and public education of native fish.

INTERNATIONAL WILDLIFE MUSEUM

Contact: Heidi Blasius **Phone:** (520)628-5377, Ext 136

Fish Represented - Gila Topminnow and Desert Pupfish.

History - The population was started by the Arizona Game and Fish Department and the International Wildlife Museum.

Pima County Native	Names of Stocking	Dates	Population	Stocking Source
?	Desert Pupfish	8-23-99	85	Unknown
		9-10-99	105	Unknown
?	Gila Topminnow	01-05-99	260	Peck Canyon
		03-25-99	63	Peck Canyon

The ponds were originally stocked with non-native species. To introduce native fish, the ponds were drained and then non-natives removed.

Who started the populations/program? Heidi Blasius.

Who maintains the population?

Exotic aquatic problems? One Red ear slider turtle egg hatched after the pond was refilled. Two additional Mud Turtles are now in the ponds from unknown sources, but the turtles pose no problems. Unauthorized stocking of unknown species has not been a problem, but the ponds are monitored by a camera for security.

Other aquatic problems? Currently, the system is functioning properly. There will possibly be some vegetation removal this fall to improve park visuals, but not to remedy any aquatic problems.

Any die-off?

Who designed the program?

Water Supply - The water is mainly domestic potable water, but the ponds are located where stormwater may enter the system.

Any need to augment the population? Populations are self sustaining. The Gila Topminnow population is expanding rapidly. The pupfish populations are maintaining, but will have additional pupfish stocked to increase numbers.

What is the purpose of maintaining the native population? The fish population are used mainly for educational programs in schools. Public viewing is also encouraged.

ARIZONA HISTORICAL SOCIETY

Contact: Ron Regan **Phone:** (520)617-1174

Fish Represented - Desert Pupfish.

History - The program was started in 1974 and stocked with unknown varieties of pupfish. Ron Regan, Arizona Game and Fish, restocked the ponds in 1992. At that time, the ponds were chlorinated to kill the existing pupfish population. The ponds were drained and refilled prior to restocking.

Pima County Native	Names of Stocking	Dates	Population	Stocking Source
?	Desert Pupfish	1992	50	AG&F
		1974	Unknown	Unknown

Who started the populations/program?

Who maintains the population?

Exotic aquatic problems? No. The population is expanding, and there are no non-native predators.

Any die-off? None.

Who designed the program? The 1974 program is unknown. Ron Regan has been with the Society for approximately 15 years and was responsible for starting the 1992 program with the help of AG&F.

Water Supply - The water is mainly domestic potable water. Some stormwater runoff , confined to runoff within the atrium, also enters the system; however, the amount is very small.

Any need to augment the population? No. The population is expanding and Ron Regan suggested that this could be a source for pupfish stock.

What is the purpose of maintaining the native population? The main purpose is public display and information about native fish.