An Inventory of Fish Species Within the San Antonio Missions National Historical Park

Final Report
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Prepared by

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ABSTRACT

Under contract to the National Park Service, biologists of the San Antonio River Authority Environmental Services Department conducted a series of fish collections at representative sites along watercourses in or adjacent to the San Antonio Missions National Historical Park properties in Bexar and Wilson counties, Texas. Fishes were collected from October 2003 to September 2004 at five sites along the San Antonio River and at three tributary sites utilizing electro-fishing and seining techniques. Fish community composition, habitat and water quality were evaluated. The survey collected 27 species totaling 4912 individuals. Non-native species collected during this survey made up 37% of all species collected and 36% of all individuals collected. The survey was able to document 69% of the fishes previously collected from the Upper San Antonio River and collected four species (*Notropis Buchanani, Notropis texanus, Notropis amabilis, Tilapia zilli)* not previously listed by the San Antonio River Authority. No darter species or species of management concerns were collected. The San Antonio River Authority developed an inventory of fishes collected from streams within or adjacent to San Antonio Missions National Historical Park properties as a project deliverable to the National Park Service.

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PREFACE

According to the National Park Service (NPS), no formal park-wide fish surveys have been previously conducted or documented within the boundaries of the San Antonio Missions National Historical Park (Park) and no voucher specimens for a reference collection have been collected inside the Park boundaries. As a part of its mission to preserve and protect aquatic resources within the San Antonio River Basin, the San Antonio River Authority (SARA) routinely monitors fish species diversity and fish community composition in the San Antonio River and its tributaries (SARA 1992, 1994, 1996a, 2000b). In the past SARA has conducted fish collections in watercourses adjacent to and near the San Antonio Missions National Historical Park (SARA 1996a, 2000b), but no recent records of fish sampling in the creeks, acequias, or other watercourses within the Park have been documented.

Since the time the Missions were built, the aquatic ecosystems in nearby watercourses have changed considerably due to human activities. These changes include farming, ranching, and urban development. Additional changes to the aquatic ecosystems have occurred since the acquisition of the Missions by the National Park Service. The City of San Antonio wastewater effluent outfalls have been relocated downstream of the Bexar County park property, wastewater collection systems have been upgraded, raw sewage overflows have been curtailed, and measures to abate non-point source pollution have been developed. Currently the Parklands around the Missions in San Antonio are 727 acres and the nearby Mission reach of the San Antonio River is an improved floodway. Along the watercourses within the Park are dense riparian habitats that contribute to an improved aquatic ecosystem. There is one additional Park property downstream. El Rancho de las Cabras consists of 99 acres in Wilson County at the confluence of the San Antonio River and Picosa Creek.

The San Antonio River Basin is host to over 70 species of fishes (Gonzales 1988, SARA 1996a), many introduced or exotic. All fishes of the San Antonio River Basin are used by SARA as biotic indicators of aquatic ecosystem health (SARA 1988, 1996a, 2000b).

The following report is intended to provide the National Park Service, San Antonio Missions National Historical Park Managers, and the scientific and academic community with scientifically based data and information about the current status of the fish community and the aquatic ecosystems occurring adjacent to and within the Park.

PROJECT OBJECTIVES

The objectives for the fish species inventory project are to:

1) Identify and document the fish species that are permanent or transient residents in the San Antonio River, the San Antonio River bypass channel, the Espada Acequia, Piedras Creek, and Picosa Creek as representative of water courses within or adjacent to the San Antonio Missions National Historical Park (Bexar County) and Rancho de las Cabras (Wilson County).

2) Collect voucher specimens of those fish species collected from watercourses within, and adjacent to, all San Antonio Missions National Historical Park properties.

3) Determine a general fish species distribution, abundance and community composition for each sampling site established in the aforementioned watercourses. Use fish community composition as an indicator of aquatic ecosystem health.

STUDY AREA DESCRIPTION

The portion of the San Antonio River that flows through the San Antonio Missions National Historical Park is within State of Texas Stream Segment 1911. The San Antonio River originates as free flowing artesian water from the Edwards Aquifer south of the Balcones Fault Zone (north of downtown San Antonio), then flows southeast through the Gulf Coastal Plains. Physical characteristics surrounding the project survey area include geological formations consisting of limestone, dolomitic limestone, marl, and shale. (SARA 1996a)

The area surrounding the upper portions of the San Antonio River is heavily urbanized. Immediately below South Alamo Street, the River flows through a flood control project pilot channel, where banks are high, steep and well armored with rip-rap shorelines to prevent erosion. Riparian vegetation along the floodway is limited to invasive weeds and grasses; aquatic vegetation is very limited and only occasional emergent plant species can be found. Stream characteristics under normal conditions are a limited pool and run flow regime (SARA 1996a).

Below Ashley Road and adjacent to Mission San Juan, is a natural remnant of the San Antonio River. Dense vegetation, woody debris and submerged logs are common through the reach. The riparian habitat is extensive and undisturbed providing a closed canopy over most of the reach.

Piedras Creek is a small tributary to the San Antonio River that flows through the Park beneath the Espada Aqueduct. The bottom substrate is sandy with occasional boulders. Woody debris and submerged logs are common. The immediate banks are well vegetated and the riparian habitat is a dense mostly closed canopy of native trees and shrubs.

As the San Antonio River flows south of Loop 410, it becomes wide and deep with a natural bed and bank. The stream bed changes from the characteristic bed rock limestone substrate of the flood control channel to the characteristic cobble, gravel, sand and silt substrate of a natural river. The flow regime returns to an alternating riffle, run, and pool sequence. The natural stretch of river from just south of Loop 410 provides a reference of how the San Antonio River would exist upstream had it not been channelized. (SARA 1996a).

Approximately 30 km downstream from Loop 410, in Wilson County, is Picosa Creek, a tributary to the San Antonio River located approximately 4.5 km west of Floresville, Texas. Picosa Creek is an intermittent stream that flows through the Park property,

Rancho de Las Cabras, during non drought conditions. The bottom substrate is dominated by deep deposits of mud, clay and silt with immediate banks steep, muddy and lacking vegetation. Some woody debris is scattered along the streambed that progressively deepens as it approaches the confluence with the San Antonio River. Riparian vegetation, extensive on both sides of the creek, is dominated by native grasses, forbs and hardwood trees which provide a dense canopy over the creek.

TECHNICAL APPROACH

The project began with a literature search to document fish species collections previously conducted in the San Antonio River. At the same time an examination of reference collections kept at the SARA Regional Laboratory in San Antonio, Texas, and at the Freeman Aquatic Station at Texas State University in San Marcos, Texas, was conducted. Following the literature search and reference collection study, SARA aquatic biologists conducted a cursory survey of the San Antonio Missions National Historical Park properties to determine optimum sampling locations in the watercourses that can support a viable fish community.

SARA had previously sampled at two locations near the San Antonio Missions National Historical Park-- in the San Antonio River at Ashley Road, near Mission San Juan, and in the San Antonio River at Interstate Highway Loop 410 South, near Mission Espada-- and had familiarity with the fish species found in the San Antonio River and the habitats preferred by each species.

Eight project sampling sites were established. The sampling locations included all aquatic habitat types (pools, runs, riffles, glides, etc.) available to the fish community within or adjacent to all San Antonio Missions National Historical Park properties. At each sampling site established, a 100 meter sampling reach was determined and thoroughly sampled by the most appropriate sampling method for each habitat type within each sampling reach. Sampling methods included minnow seines, bag seines, riffle seines, electro-fishing, and dip-nets. During the course of the project, sampling sites and reaches were adjusted, moved or abandoned if seasonal variations, stream conditions or other factors warranted. The establishment of all sampling locations, sampling reach delineations and any adjustments were documented in field notes and identified with a global positioning system.

Sample collections were conducted at each sampling site twice during the growing season (March through October), when weather and stream conditions are likely to yield an optimum variety of fish species. However, sampling during extreme summer heat (July & August) or drought conditions was avoided. At each sampling site and for each sampling reach, a digital photograph of each species collected was taken. Collected fishes were discretely identified and enumerated in the field. With the exception of any fish specimens retained for laboratory identification or preserved for a reference collection, all fishes collected were released at the location of collection.

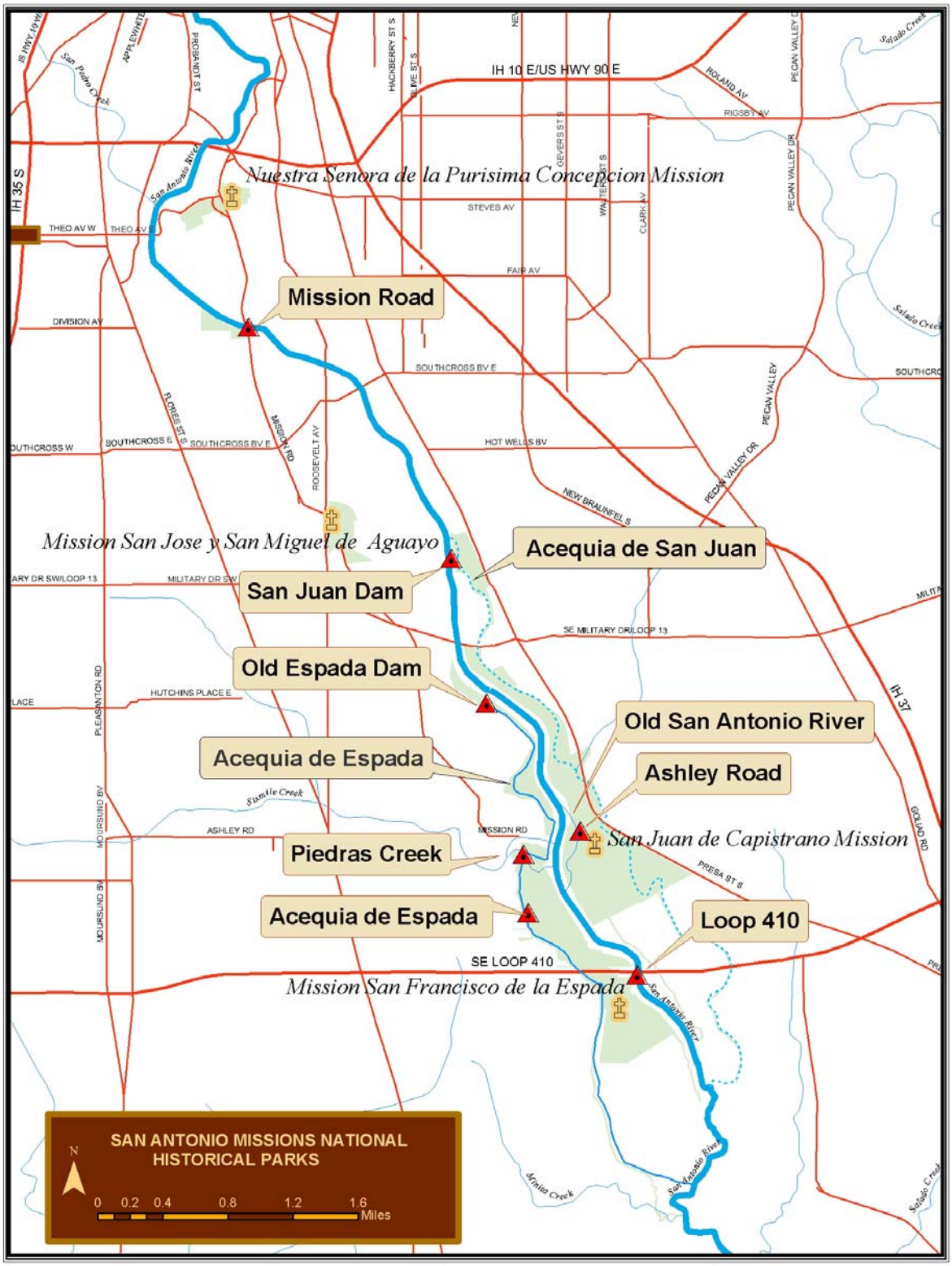

Figure 1 Map of Bexar County Survey Area.

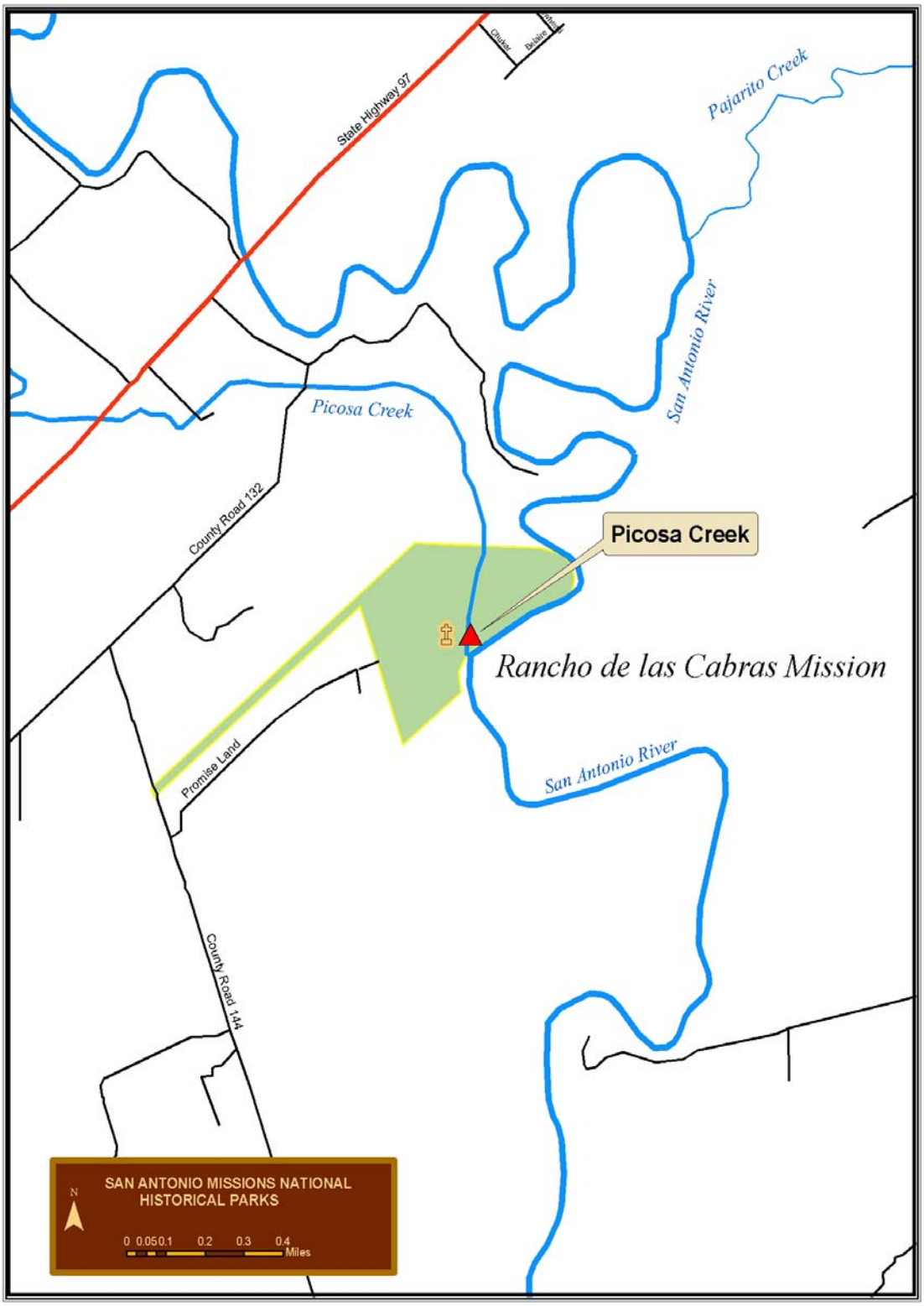

Figure 2 Map of Wilson County Survey Area.

LITERATURE REVIEW SUMMARY

The San Antonio River Watershed is host to over 70 species of fishes (Gonzales 1988, SARA 1996), many introduced or exotic. All the fishes of the San Antonio River Watershed are used by SARA as biotic indicators of aquatic ecosystem health (SARA 1988, 1996a, 2000b). Hubbs, et. al., 1978 discussed the survival of introduced fishes in the San Antonio River. Gonzales, 1988 examined the Biotic Integrity of the Upper San Antonio River in a Masters Thesis at Texas State University. SARA has completed thirteen reports from 1988 to 2003 that have assessed the water quality and stream conditions of the Upper San Antonio River (SARA, 1988, 1989, 1992,1994, 1995, 1996a, 1996b, 1997, 2000a, 2000b, 2000c, 2001, 2003). Much of this work has been funded by the Texas Commission on Environmental Quality (TCEQ), formerly the Texas Natural Resource Conservation Commission (TNRCC) as part of the Clean Rivers Program (CRP) (SWA 2001).

Other work has been completed by Roark, Andrews and Guttman, 2001 in a paper describing the genetic structure of *Gambusia affinis* in a channelized portion of the San Antonio River. In the same year Edwards, 2001 looked at new additions of introduced fish and the persistence of previously introduced fish in the San Antonio River (SWA 2001).

Formal fish collection surveys have been previously conducted by SARA aquatic biologists in the San Antonio River and its tributaries in and near the San Antonio Missions National Historical Park. A reference collection of fish species collected in the San Antonio River Basin and a documented fish species checklist for the San Antonio River (Appendix 1) are maintained at the SARA Regional Laboratory. This information is used for management decisions regarding natural resource protection, preservation and conservation, as well as education and outreach to the public. The efforts of SARA personnel have laid part of an important foundation for the development of monitoring programs designed to effectively ensure the continued long term health and availability of aquatic natural resources within the San Antonio River Watershed.

SARA has compiled a listing of the fishes found in the Upper San Antonio River (Table 1) and presents the information in its 1996 report (SARA, 1996a). Not all of these species would be expected to be common in the San Antonio Missions National Historical Park. Each species listed in Table 1 has been designated an estimate of potential occurrence within the survey area (i.e., high, moderate, low). Hubbs et al., 1978 found that introduced fishes comprised 35% of the sample population in the Upper San Antonio River. Of the 35 species listed in Table 1, at least nine are known to be introduced. Among the fish are common species caught for recreation and food, especially Micropterus sp. (bass), Ictalurus sp. (catfishes), and Lepomis sp. (sunfishes). Many of the other species listed serve as food for the major predator fish. The diversity exhibited does indicate an aquatic habitat capable of sustaining a recreational fishery.

FISH COLLECTION METHODOLOGY

The purpose of sampling a fish community is generally to illustrate short and long term trends in water quality or ecosystem health for different areas as expressed by the composition/integrity of the fish community (USEPA 1989). The fish community information can also be used in conjunction with physical and chemical data to determine if the waters with designated aquatic life uses are meeting criteria for those uses (TCEQ 2004).

For this report, the method by which fish species were collected will depended on several factors including stream flow, water quality, habitat type, depth, and bottom substrate. Minnow seining, bag seining, riffle seining and electro-fishing were employed. At each sampling site the methods of collection and level of effort applied were documented in order to assure that sampling in future efforts can be comparable. Field notes describe the collection method including the equipment used, areas sampled, the manner in which the equipment was applied, stream conditions, weather, time spent sampling and a description of the habitat. If seining was not possible, the reasons were noted. If electro-fishing was not possible due to high conductivity, the seining effort was increased. The following equipment applied to fish species collections are generally recognized by the fisheries science community as being the most effective for assessing the composition and integrity of fish communities:

- Twenty-five foot minnow seine with quarter inch mesh
- Forty foot bag seine with quarter inch mesh
- Dip-nets with quarter inch mesh
- Twelve foot riffle seine with one-eighth inch mesh
- Backpack electro-fisher.

FISH COLLECTION PROCEDURES

Because the objective of the project was to develop an inventory of the fish community inhabiting the watercourses in and near the San Antonio Missions National Historical Park, SARA biologists collected, identified and enumerated all fishes possible in as many habitats as possible to ensure thoroughness and eliminate selectivity or bias. Fish collection procedures were according to The State of Texas Surface Water Quality Monitoring Procedures Manual (TNRCC 1999) and Nielson and Johnson (1983).

Permits: SARA is in possession of a State of Texas Scientific Collection Permit issued by the Texas Department of Parks and Wildlife. The Scientific Collection Permit authorizes SARA biologists to sample, for scientific and data gathering purposes, any and all water bodies within the San Antonio River Basin. The SARA principal investigator, co-investigators, biologists and technicians assigned to this proposed project are named on the scientific collection permit.

In addition, SARA obtained verbal permission to conduct fish community and water quality sampling on Park property from the Park Manager of the San Antonio Missions National Historical Park.

Seining: In most habitats, a minimum of 5 seine hauls (or until repeated seining does not produce additional species) were applied at each sampling site. Seining continued until all seine-able habitat types within a sampling reach had been thoroughly sampled. The size of the seine and mesh size varied due to stream width or depth. Seining targets fish species that may not be captured effectively by electro-fishing.

Electro-fishing: In wadeable streams, where conductivity falls within an acceptable range, a backpack electro-fisher was implemented. SARA personnel utilized their Smith Root PC 15-B POW Electro-fisher. The electro-fisher is usually applied in an upstream movement with dip netters behind the electrode handler to minimize fish avoidance. A minimum of three SARA personnel are required to effectively sample with electro-fishing equipment. All available stream cover (e.g. brush piles, logs, boulders, undercut banks) were sampled using direct current (DC) when possible. SARA biologists find it advantageous to approach targeted habitat cover by moving with the power on but the circuit off and then energizing the electrodes at the habitat cover for an element of surprise. Attempts were made to sample at as many different habitat types as possible in each stream (e.g. brush piles, runs, riffles, under cut banks). Streams were electro-fished for a distance, usually 100 meters, sufficient to ensure that all habitats associated with inside and outside stream bends were sampled. The length of the sampling effort was a minimum of 15 minutes shocking time (longer if stream conditions or habitat warranted), recording each effort as time over a fixed distance.

Specimen Preservation and Processing: Whenever possible the fish species collected were identified, enumerated and digitally photographed at the sample site. If it was not possible to make field identification, the specimen was preserved in 10% formalin and returned to the SARA laboratory for examination and identification. Reference specimens were kept in 10% formalin for one week for fixation. When necessary, larger specimens were injected with 40% formalin, with a syringe, before being placed in 10% formalin. Following identification and fixation, specimens to be kept as vouchers for reference collections were placed in 70% ethyl alcohol for long term storage.

FISH COMMUNITY ASSESSMENT METHODOLOGY

One objective of this project was to evaluate the stream ecosystem health implementing methodology proposed by Karr (1981) that uses fish community composition and structure to evaluate the quality of an aquatic ecosystem.

Fishes are considered a valuable component of the aquatic biota for the purpose of assessing the conditions of a stream ecosystem (Karr et al. 1987, Angermeier et al. 1986, Hendricks et al. 1980, Hocutt 1981). Structurally and functionally diverse fish communities provide direct and indirect evidence of all environmental perturbations that impact the stability of the aquatic ecosystem (Hocutt 1981). By monitoring the fish community, it is possible to rapidly assess the health (biotic integrity) of a local water resource. The ability of a stream to sustain a balanced fish community is an excellent indicator for the evaluation and monitoring of water resources.

Table 1 List of fishes occurring in the San Antonio River (SARA, 1996a). Scientific and common names according to Robins et. al. (1991).

Species	Common Name	Potential for Occurrence
Lepisosteus spatula	Alligator Gar	Low
Lepisosteus osseus	Longnose Gar	Medium
Lepisosteus oculatus	Spotted Gar	High
Dorosoma cepedianum	Gizzard Shad	Medium
Astyanax mexicanus	Mexican tetra*	High
Cyprinella lutrensis	Red Shiner	High
Notropis volucellus	Mimic Shiner	Medium
Cyprinella venustus	Blacktail Shiner	Medium
Dionda episcopa	Roundnose Minnow	Low
Pimephales vigilax	Bullhead Minnow	Medium
Pimephales promelas	Fathead Minnow	Medium
Ictalurus punctatus	Channel Catfish	High
Ictalurus furcatus	Blue Catfish	Medium
Ameiurus natalis	Yellow Bullhead	High
Pylodictis olivaris	Flathead Catfish	Medium
Noturus gyrinus	Tadpole Madtom	Low
Gambusia affinis	Western Mosquitofish	High
Poecilia latipinna	Sailfin Molly*	High
Poecilia formosa	Amazon Molly*	High
Micropterus salmoides	Largemouth Bass	High
Moxostoma congestum	Gray Redhorse	Medium
Lepomis gulosus	Warmouth	Medium
Lepomis cyanellus	Green Sunfish	High
Lepomis microlophus	Redear Sunfish	Medium
Lepomis macrochirus	Bluegill	High
Lepomis auritus	Redbreast Sunfish	High
Lepomis megalotis	Longear Sunfish	High
Lepomis punctatus	Spotted Sunfish	Medium
Cichlasoma cyanoguttatum	Rio Grande Cichlid*	High
Tilapia aurea	Blue Tilapia*	High

Table 1 (Continued)

Species	Common Name	Potential for Occurrence
Tilapia mossambica	Mozambique Tilapia*	Medium
Cyprinus carpio	Common Carp*	High
Campostoma anomalum	Central Stoneroller	High
Hypostomus plecostomus	Suckermouth Catfish*	High
Xiphophorus helleri	Green Swordtail*	Medium

* Introduced Species

EPA Rapid Bioassessment Protocol (RBP) V was used for the fish community assessment and is based on Karr's (1981) work with the Index of Biotic Integrity (IBI). RBP V allows for quick and accurate determination of biological integrity and involves careful standardized fish collection, species identification, and data analysis. Data generated from IBI assessments can be used to:

- Assess use attainment
- Develop biological criteria
- Prioritize sites for further evaluation
- Provide a reproducible impact assessment
- Assess fish community status and trends (USEPA 1989).

Lotic ecosystems that lack biological integrity are often degraded, and when perturbed by human-induced activities, the aquatic ecosystem is likely to rapidly change to a less desirable state (Toth et al. 1982). Good biotic integrity is usually measured in those aquatic ecosystems in which fish community composition, structure and function have not been impacted by human activities. When combined with physico-chemical information and habitat assessments, biotic integrity can be equated with ecological integrity.

Use of the Index of Biotic Integrity (IBI) assessment system as introduced by Karr (1981) assumes that a fish sample will represent the entire fish community. Variations in stream size and habitats require different collecting techniques. Each sampling effort must reflect a representative sample of the fish community within the aquatic habitat. Karr (1981) stresses the importance of sampling the fish population from a representative stream segment that includes major local habitats such as pools, runs and riffles.

The IBI methodology was developed for low gradient, warm water, Midwestern streams affected by intense agricultural activity (Karr 1981). The system was also designed so its metrics could be modified to reflect the biotic health (integrity) of other stream types in other geographic areas based on the species composition of the local fish community (Leonard and Orth 1986).

All twelve of the original IBI metrics (Karr 1981) were applied in scoring the fish sampling efforts. But as encouraged by Karr et al. (1986), modifications to some of the metrics and respective scoring criteria were implemented in order to more accurately apply the IBI methodology to the existing conditions in the San Antonio River Basin zoogeographic region (Gonzales 1988).

Scoring criteria for the metrics (Table 2) applied in this study (species richness and composition categories) were determined from previously reported fish collections in the San Antonio River Basin (Young et al. 1973, Hubbs et al. 1978, EH&A 1983, TDWR 1984a, Edwards 1987, Gonzales 1988, TPWD 1988, SARA 1989, SARA 1990, SARA 1996a). Scoring criteria and metrics were determined based on the maximum species richness collected from previous fish sampling efforts. When the total number of fish species collected from least-disturbed stream sites was greater than 50 percent of the maximum species richness, scoring criteria of five was assigned for the total number of fish species (Metric 1). Conversely, when the total number of fish species collected was less than 25 percent of the maximum species richness, a scoring criterion of one was assigned for the metric. Fish species collections that were between 25 and 50 percent of the maximum species richness were assigned scoring criteria of 3 for Metric 1.

Scoring criteria for the number and identity of darter species (Metric 2), number and identity of sunfish species (Metric 3), number and identity of sucker species (Metric 4), and number and identity of intolerant species (Metric 5) were also determined from maximum species richness for each species category (>50% = 5, 50%-25% = 3, <25% =1).

Metric 6 replaced green sunfish with cichlid species (Gonzales 1988), Metric 8 included species of the genus Notropis as insectivores (Gonzales 1988), and Metric 10 scoring criteria was adjusted to be comparable with scoring criteria applied by other state agencies (TPWD 1988). The remaining metrics (7, 9, 11 and 12) were applied as originally introduced by Karr (1981).

Data collected from the fish population of each sampling event was then used to rate each of the twelve metrics as 5, 3 or 1 according to whether its value approximates, deviates somewhat from, or deviates strongly from the value expected at the relatively undisturbed site. Scores for each metric were then totaled and the sampling site was then assigned to an integrity class (Table 3).

Table 2 Metrics used to assess fish communities in the San Antonio River Basin (Modified from Karr 1986).

CATEGORY	METRIC	SCORING CRITERI [a]		
		5	3	1
Species richness and composition	1. Total number of fish species	>50% MSR[b]	25-50 % MSR	<25% MSR
	2. Number and identity of darter species	>50% MSR	25-50 %MSR	<25% MSR
	3. Number and identity of sunfish species	>50% MSR	25-50% MSR	<25% MSR
	4. Number and identity of sucker species	>50% MSR	25-50% MSR	<25% MSR
	5. Number and identity of intolerant species	>50% MSR	25-50% MSR	<25% MSR
	6. Proportion of individuals as cichlid species	<5%	5-20%	>20%
Trophic composition	7. Proportion of individuals as omnivores	<20%	20-45%	>45%
	8. Proportion of individuals as insectivorous cyprinids	>45%	20-45%	<20%
	9. Proportion of individuals as piscivores (top carnivores)	>5%	1-5%	<1%
Fish abundance and Condition	10. Number of individuals in sample	>200	51-200	<51[c]
	11. Proportion of individuals as hybrids	<1%	1-2%	>2%
	12. Proportion of individuals with disease	<2%	2-5%	>5%

[a]Ratings of 5, 3, and 1 are assigned to each metric according to whether its value approximates, deviates somewhat from, or deviates strongly from the value expected at a comparable site that is relatively undisturbed.
[b]MSR – Maximum Species Richness

Table 3 Total IBI scores, integrity classes, and the attributes of those classes (Modified from Karr 1981).

TOTAL IBI SCORE (sum of the 12 metric ratings)	**INTEGRITY CLASS**	**ATTRIBUTES**
58-60	Excellent	Comparable to the best situations without human disturbance; all regionally expected species for the habitat and stream size, including the most intolerant forms, are present with a full array of age (size) classes; balanced trophic structure.
53-57 48-52	Very Good Good	Species richness somewhat below expectations, especially due to the loss of the most intolerant forms; some species are present with less than optimal abundances or size distributions; trophic structure shows some signs of stress.
45-47 39-44	Good to Fair Fair	Signs of additional deterioration include loss of intolerant forms, fewer species, highly skewed trophic structure (e.g., increasing frequency of omnivores and cichlids or other intolerant species); older age classes of top predators may be rare.
36-38 28-35	Fair to Poor Poor	Dominated by omnivores, tolerant forms, and habitat generalists; few top carnivores; growth rates and condition factors commonly depressed; hybrids and diseased fish often present.
24-27 12-23	Poor to Very Poor Very Poor	Few fish present, mostly introduced or tolerant forms; hybrids common; disease, parasites, fin damage, and other anomalies regular.
	No Fish	Repeated sampling finds no fish.

WATER QUALITY ANALYSIS METHODOLOGY

Water quality samples were collected according to TCEQ approved procedures specified in the TCEQ Surface Water Quality Monitoring Procedures Manual (TNRCC 1999) and in the SARA Stream Monitoring Quality Assurance Project Plan. Field and laboratory analyses were conducted according to TCEQ and/or EPA approved methodologies listed on Table 4. All laboratory analyses were conducted at the SARA Laboratory.

Table 4 Water quality parameters measured and methods used in the survey.

Parameter	Method
Dissolved Oxygen	EPA 360.1
Temperature	EPA 170.1
pH	EPA 150.1
Specific Conductance	EPA 120.1
Total Kjeldahl Nitrogen	EPA 351.2
Nitrate as Nitrogen	EPA 300.0
Nitrite as Nitrogen	EPA 300.0
Total Phosphorus	EPA 365.2
Total Dissolved Solids	by calculation

HABITAT EVALUATION METHODOLOGY

Habitat, as affected by instream and surrounding topographical features, is a major determinant of aquatic community potential. Both the quality and quantity of available habitats affect the structure and composition of resident biological communities. The goal of this study's stream habitat evaluation was to assess habitat quality and determine to what extent it may impact water quality and influence the fish community. This information will provide baseline habitat data for streams within the San Antonio Missions National Historical Park.

The habitat characterization format used was divided into three principal categories: primary, secondary and tertiary parameters. Primary parameters were those that characterized the stream "micro scale" habitat and had the greatest direct influence on the structure of the indigenous communities. The primary parameters included characterization of the bottom substrate, available cover, and estimation of the flow or velocity and depth regime. Secondary parameters measured the "macro scale" habitat such as stream channel morphology characteristics. These parameters evaluated channel alterations, bottom scouring and deposition, and stream sinuosity. Tertiary parameters evaluated riparian and bank structure and comprise three parameters: bank stability, bank vegetation, and stream side cover (Table 5).

Habitat assessments encompassed the biological collection area and included as many different geomorphic hydrologic units (riffles, runs, etc.) as possible. Six transect lines were placed perpendicular to the stream channel at equally spaced intervals throughout the survey area. Habitat descriptions and evaluations were performed along each transect line and are limited to three meters either side of each transect line. Evaluations are first made on instream habitat, followed by channel morphology, and finally on structural features of the bank and riparian vegetation.

Habitat data collected in the field was then summarized. Once individual metrics (Table 5) were summarized and scored, the total habitat score was derived by adding all individual metric scores. The habitat was then assigned to a Habitat Quality Index Category (Table 6).

Table 5 Habitat quality index parameters and metrics

Habitat Parameter	Scoring Category			
Available Instream Cover	**Abundant** > 50% of substrate favorable for colonization and fish cover; good mix of several stable (not new fall or transient) cover types such as snags, cobble, undercut banks, macrophytes	**Common** 30 - 50% of substrate supports stable habitat; adequate habitat for maintenance of populations; may be limited in the number of different habitat types	**Rare** 10-29.9% of substrate supports stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed	**Absent** <10% of substrate supports stable habitat; lack of habitat is obvious; substrate unstable or lacking
Score:_____	4	3	2	1
Bottom Substrate Stability	**Stable** > 50% gravel or larger substrate, i.e., gravel, cobble, boulders; dominant substrate type is gravel or larger	**Moderately Stable** 30-50% gravel or larger substrate; dominant substrate type is mix of gravel with some finer sediments	**Moderately Unstable** 10-29.9% gravel or larger substrate; dominant substrate type is finer than gravel, but may still be a mix of sizes	**Unstable** <10% gravel or larger substrate; substrate is uniform sand, silt, clay or bedrock
Score:_____	4	3	2	1
Number of Riffles To be counted, riffles must extend>50% the width of the channel and be at least as long as the channel width	**Abundant** ≥ 5 riffles	**Common** 2 - 4 riffles	**Rare** 1 riffle	**Absent** No riffles
Score:_____	4	3	2	1
Dimensions of Largest Pool	**Large** Pool covers more than 50% of the channel width; maximum depth is >1 meter	**Moderate** Pool covers approximately 50% or slightly less of the channel width; maximum depth is 0.5 - 1 meter	**Small** Pool covers approximately 25% of the channel width; maximum depth is <0.5 meter	**Absent** No existing pools; only shallow auxiliary pockets
Score:_____	4	3	2	1
Channel Flow Status	**High** Water reaches the base of both lower banks; <5% of channel substrate is exposed	**Moderately** Water fills > 75% of the channel; or < 25% of channel substrate is exposed	**Low** Water fills 25-75% of the available channel and / or riffle substrates are mostly exposed	**No Flow** Very little water in the channel and mostly present in standing pools or stream is dry
Score: _____	3	2	1	0

Table 5 continued

Habitat Parameter	Scoring Category			
Bank Stability	**Stable** Little evidence (<10%) of erosion or bank failure; bank angles average <30 ^{0}	**Moderately Stable** Some evidence (10-29.9%) of erosion or bank failure; small areas of erosion mostly healed over; bank angles average 30 - 39.9 ^{0}	**Moderately Unstable** Evidence of erosion or bank failure is common (30 - 50%); high potential of erosion during flooding; bank angles average 40 - 60 ^{0}	**Unstable** Large and frequent evidence (>50%) of erosion or bank failure; raw areas frequent along steep banks; bank angles average >60 ^{0}
Score:_____	3	2	1	0
Channel Sinuosity	**High** ≥ 2 well-defined bends with deep outside areas (cut banks) and shallow inside areas (point bars) present	**Moderate** 1 well-defined bend or ≥3 moderately-defined bends present	**Low** <3 moderately-defined bends or only poorly-defined bends present	**None** Straight channel; may be channelized
Score:_____	3	2	1	0
Riparian Buffer Vegetation	**Extensive** Width of natural buffer is > 20 meters	**Wide** Width of natural buffer is 10.1-20 meters	**Moderate** Width of natural buffer is 5 - 10 meters	**Narrow** Width of natural buffer is <5 meters
Score: _____	3	2	1	0
Aesthetics of Reach	**Wilderness** Outstanding natural beauty; usually wooded or unpastured area; water clarity is usually exceptional	**Natural Area** Trees and / or native vegetation are common; some development evident (from fields, pastures, dwellings); water clarity may be slightly turbid	**Common Setting** Not offensive; area is developed, but uncluttered such as in an urban park; water clarity may be turbid or discolored	**Offensive** Stream does not enhance the aesthetics of the area; cluttered; highly developed; may be a dumping area; water clarity is usually turbid or discolored
Score: _____	3	2	1	0
Total Score:_____				

Table 6 Habitat Quality Index Categories.

Index Category	Total Score
Exceptional	26-31
High	20-25
Intermediate	14-19
Limited	$\leq$13

SAMPLING SITE DESCRIPTIONS

The study area is located within the Upper San Antonio River, Segment 1911 (Figure 1). Seven sampling sites were selected within the southern fringes of the urban portion of the City of San Antonio from Loop 410 upstream to Mission Road and one was selected on Picosa Creek within Rancho de Las Cabras west of Floresville, Texas. Within the urban portion of the City of San Antonio, the San Antonio River has been channelized and is relatively shallow and wide. Instream flow regimes are represented by alternating pools, riffles and run. Base flow was maintained throughout the sampling period (October 2003-September 2004) by the headwater springs near Brackenridge Park and San Pedro Creek. Many seeps and springs along the stream banks flow within and upstream of the survey reach. Stream banks along the channelized portion of the San Antonio River are high and steep and vegetation is limited to native grasses and forbs. Riparian canopy exists only within portions of the survey reach that were not channelized. The Wilson County sampling site on Picosa Creek is within Rancho de las Cabras and is surrounded by a natural riparian habitat.

San Antonio River at Mission Road

This site is located 1.35 km downstream of the San Pedro Creek Confluence (Figure 1). The stream channel is approximately 18 m wide with few bends within the sampling reach due to channelization, and the average stream depth is 0.4 m. In-stream habitat types are represented by pools, runs and glides. The streambed is dominated by gravel, cobble and boulders. Some out-cropping of clay is also present along the west bank. The immediate stream banks are lined with rip-rap and are sparsely vegetated within those areas not covered by rip-rap. Signs of erosion due to flooding are along both banks and groundwater seeps are commonly found along both banks. The riparian habitat is limited to native grasses and forbs and is routinely mowed to prevent the growth of woody vegetation. No riparian canopy exists at this sampling site.

San Antonio River at San Juan Dam

This site is located approximately 1.46 km downstream of White Avenue (Figure 1). The stream channel is approximately 40 m wide with no bends and the average stream depth is 0.61 m. Instream habitat types are influenced by the remains (footing) of San Juan Dam. Upstream of these concrete remains, the sample site is dominated by a large pooled area that extends beyond the sampling area. The river then flows swiftly through

a narrow pilot channel within the footing of San Juan Dam creating runs, riffles and glides downstream of the dam. The streambed is dominated by gravel, cobble, boulders (rip-rap) and deposits of sand within back water areas. Stream banks are lined with rip-rap along the water's edge and covered with native grasses and forbs within the upper reaches. These areas are routinely mowed to prevent the growth of woody vegetation. No riparian canopy exists at this sampling site.

San Antonio River below the Old Espada Dam

This site is located approximately 1.6 km downstream of San Juan Dam (Figure 1). The stream channel is approximately 6.7 m wide with moderate bends and an average depth of 0.36 m. This sampling site is located downstream of the old Espada Dam on a remnant of the original San Antonio River channel. This channel is very narrow (approximately 6 to 7 m wide) unlike that portion of the stream which has been channelized (approximately 50 m wide). Instream habitat types at the site included rifles, runs, and glides. The streambed is dominated by gravel, cobble and woody debris. Corbicula (sp.) shells make up a large portion of the substrate composition within some portions of this site. Emergent plants are present along the bank and within the stream. The immediate stream banks are well vegetated with native grasses and forbs. The riparian habitat along the west bank is dense and undisturbed unlike that of the east bank which is covered by a parking lot separated from the stream by a narrow strip of land sparsely covered by trees and native ground cover. Except for the area near the Old Espada Dam, the sampling reach is densely covered by the riparian canopy primarily from the west bank.

Acequia de Espada

This site is located approximately 0.34 km downstream of the Espada Aqueduct (Figure 1). The stream channel is approximately 3.6 m wide with no bends and is approximately 0.49 m deep. Used primarily for irrigation, it is dominated by glides and lacks riffles and runs. Banks are muddy and steep and substrates consist of clay and silt littered with woody debris. Throughout most of the sampling site, large concentrations of Hydrilla are present. Throughout the survey reach, the entire water column is densely overgrown with Hydrilla, making it very difficult to wade through the stream. Immediate stream banks are well vegetated with trees, native grasses and forbs. The riparian habitat is dense along both banks and provide a mostly closed canopy over the entire sampling reach.

San Antonio River at Ashley Road

This site is located approximately 1.8 km downstream of Espada Dam on an original remnant of the San Antonio River adjacent to Mission San Juan (Figure 1). The stream channel is approximately 13 m wide with moderate bends and an average stream depth of 0.54 m. The substrate is densely littered with Corbicula shells within the upper reaches of the sampling site and is dominated by clay, silt and sand within the lower reaches. Woody debris and submerged logs are common throughout the reach. The immediate stream banks are well vegetated and signs of erosion are minimal. In some areas it is difficult to define the immediate banks due to the abundance of vegetation. Except for

the upper reaches of the sampling site near Ashley Road, the riparian habitat is extensive and undisturbed providing a dense mostly closed canopy over the entire reach.

Piedras Creek

Piedras Creek is a tributary of Six Mile Creek that flows beneath the Espada Aqueduct (Figure 1). This sampling site is located immediately downstream of the Espada Aqueduct. The channel is approximately 5 m wide with moderate bends and an average stream depth of 0.2 m. The substrate is dominated by sand throughout the sampling reach and large boulders within the upper reach near the aqueduct. Woody debris and submerged logs are common throughout the reach. The immediate banks are well vegetated and deeply undercut primarily within the upper reaches. The riparian habitat is represented by a dense mostly closed canopy of native trees and shrubs. Native grasses and forbs are well established.

San Antonio River at Loop 410

This site is located approximately 0.32 km downstream of Loop 410 immediately below the low water crossing at Camino Coahuilteca (Figure 1). The stream is channelized and is approximately 21 m wide with few bends within the sampling reach. Average stream depth is 0.33 m. The substrate is dominated by gravel and cobble with some clay outcrops along the west bank. Signs of severe erosion are noted primarily along the west bank due to flooding while other areas were covered with rip-rap to prevent erosion. A small tributary, once the original channel of the San Antonio River, flows into the sampling site from the west bank. The riparian zone is dominated by native grasses and forbs that are routinely mowed to prevent the growth of woody plants. No riparian canopy exists at this site.

Picosa Creek

Picosa Creek is a tributary of the San Antonio River located approximately 4.5 km west of Floresville, Texas at Rancho de las Cabras (Figure 2). Within the sampling reach, the stream channel is approximately 1.9 m wide with moderate bends and an average depth of 0.1 m. At the time of sampling, the stream occupies a very small portion of the channel. The substrate is dominated by deep deposits of mud, clay and silt, and the immediate banks are steep and muddy, void of vegetation. Some woody debris is scattered throughout the streambed and the creek channel progressively deepens as it approaches the confluence with the San Antonio River. The deep deposits of silt and mud as well as the lack of vegetation along the immediate banks are likely due to frequent flooding from the San Antonio River as it backs up into Picosa Creek. Some signs of erosion are also noted, possibly due to flooding from the San Antonio River. The riparian habitat was extensive on both sides of the creek and is dominated by native grasses, forbs and hardwood trees which provide a dense mostly closed canopy over the creek.

Table 7 SARA GPS Coordinates for Fish Sampling Locations in the San Antonio Missions National Historical Park. UTM-NAD 83

Location	Upstream coordinates	Downstream Coordinates
SAR at Mission Road (Bexar County)	14549569E 3250170N	14549708 3250140N
Piedras Creek (Bexar County)	14552307E 3244936N	14552320E 3244886N
SAR at San Juan Dam (Bexar County)	14551574E 3247901N	14551588E 3247821N
SAR below Espada Dam (Bexar County)	14551897E 3246463N	14552069E 3246450N
SAR at Ashley Road (Bexar County)	14552817E 3245181N	14552826E 3245052N
Acequia de Espada (Bexar County)	14552245E 3244526N	14552293E 3244396N
SAR at S Loop 410 (Bexar County)	14553561E 3243473N	14553684E 3243405N
Picosa Creek (Wilson County)	14581375E 3219360N	14581312E 3219109N

EVALUATION OF WATER QUALITY, HABITAT AND FISH COMMUNITY DATA

SARA biologists conducted stream surveys within the San Antonio Missions National Historical Park properties on September 4, 2003, to determine optimal sampling locations. The survey included portions of the San Antonio River (SAR) from Loop 410 upstream Mission Road, as well as portions of the original stream channel below the Old Espada Dam. Portions of the Acequia de Espada from the Espada Aqueduct to Mission Espada, as well as Picosa Creek at Rancho de las Cabras were included in the survey. Sampling site selection was based on accessibility, wade ability, and quality and diversity in habitat types (pools, runs, riffles, glides, etc.). The sampling site on the SAR adjacent to Rancho de Las Cabras was dropped due to high flows, lack of accessibility and wadeable habitats but was replaced with the lower portion of Picosa Creek near the confluence with the SAR but within the Rancho de las Cabras Park boundary. The SAR at Mission Road was dropped after one sampling event. No new species were collected at this site (October 2003) and habitat conditions closely resembled those of the site near San Juan Dam. Biological sampling was temporarily halted following the October 2003 sampling events and resumed March 2004 during the growing season (March through October) to optimize maximum species representation. Stream reaches were sampled twice with the exception of Mission Road and Picosa Creek.

WATER QUALITY ASSESSMENT

Distinct differences in water quality are noted between the San Antonio River, Piedras Creek and Picosa Creek (Tables 8 & 9). Phosphorous concentrations within Piedras Creek, Acequia de Espada and Picosa Creek tend to be slightly higher than those found within the SAR. Piedras Creek Watershed is heavily urbanized and, during baseline conditions, stream flows within the Creek are almost unnoticeable. Minor rain events and non-point source pollution from within the Watershed coupled with antecedent low flow conditions have a concentrating effect of nutrients within Piedras Creek. During the October 7, 2003 sampling event, foam was seen floating on the water surface at this site indicating that water quality was influenced by non-point source pollution carried by storm water runoff. The low dissolved oxygen concentration and the elevated phosphorous concentration also support this theory.

Flow within the Acequia de Espada originates from a San Antonio River diversion upstream of Espada Dam. Adjacent lands to the acequia are mostly rural but become more populated downstream of the Espada Aqueduct. Water quality within this portion of the acequia reflects a slightly higher phosphorous concentration than that at the SAR at Espada Dam which is in the vicinity of the diversion for the Espada Acequia. Non-point sources and possible point sources from the adjacent community could be influencing water quality within Espada Acequia. The low dissolved oxygen level that was documented on June 15, 2004 was due to a lack of flow within the acequia.

Picosa Creek is located along the west bank of the SAR west of Floresville, Texas at Rancho de Las Cabras. Land adjacent to this creek is primarily rural ranch land and most creeks in the area are normally dry creeks and flow only following major rain events. Water quality at this site reflects a higher concentration of total dissolved solids (TDS) and conductivity than any of the other sites within the survey area. These levels of TDS and conductivity are likely influenced by the ground water sources which provide the base flow for Picosa Creek.

Water quality at all sites within the SAR reflects low nutrient concentrations and dissolved oxygen concentrations well above the 5 mg/l state stream standard. Water quality within the SAR is influenced primarily by the springs during this survey. Unusually high spring flow at the headwaters increase the base flow of the SAR during this survey helping to maintain lower nutrient concentrations and dissolved oxygen concentrations well above the 5 mg/l state stream standard for the upper SAR.

Table 8 Water quality field parameter data.

Location	Date	D.O. mg/l	Temp. °C	pH std u	Cond. uS/cm	Flow cfs
SAR at Mission Rd.	10/07/03	9.0	24.6	8.0	533	116
Piedras Creek	10/07/03 05/20/03	3.8 6.8	25.5 27.3	7.3 7.8	897 968	1.7 1.1
SAR at San Juan Dam	10/21/03 06/24/04	10.9 10.1	24.0 29.2	8.3 8.6	555 478	113 125
SAR at Espada Dam	10/28/03 05/18/04	9.0 9.3	20.5 25.8	8.2 8.2	537 527	12 27
SAR at Ashley Rd.	03/23/04 03/24/04 07/15/04 07/28/04	10.0 9.6 9.6 7.7	20.9 21.2 27.8 26.4	7.9 8.3 8.1 7.7	552 547 529 546	95 - 118 102
SAR at Loop 410	04/13/04 06/29/04	10.6 7.7	20.3 26.4	8.2 7.6	433 443	127 159
Acequia de Espada	05/06/04 06/15/04	7.2 1.4	23.6 26.9	8.0 7.5	528 497	2.40 0.04
Picosa Ck at Rancho	09/16/04	7.9	31.1	8.2	2926	0.04

Table 9 Water quality laboratory parameter data.

Location	Date	TDS mg/l	T-PO4 mg/l as P	NO2N mg/l	NO3N mg/l	TKN mg/l
SAR at Mission Rd.	10/07/03	346	<0.06	<0.02	1.89	<0.20
Piedras Creek	10/07/03 05/20/04	583 629	0.364 <0.06	0.383 0.036	0.368 0.569	3.37 0.635
SAR at San Juan Dam	10/21/03 06/24/04	361 311	<0.06 <0.06	<0.02 <0.02	1.89 1.76	<0.2 0.352
SAR at Espada Dam	10/28/03 05/18/04	349 343	<0.06 <0.06	<0.02 <0.02	1.72 1.62	0.341 <0.2
SAR at Ashley Rd.	03/23/04 03/24/04 07/15/04 07/28/04	359 356 344 355	<0.06 - <0.06 <0.06	- <0.02 - <0.02	- 1.82 - 1.75	<0.20 - 0.302 0.300
SAR at Loop 410	04/13/04 06/29/04	281 288	0.092 0.136	<0.02 0.021	1.39 1.54	0.29 0.421
Acequia de Espada	05/06/04 06/15/04	343 323	0.084 0.732	<0.02 <0.02	1.64 <0.02	0.348 1.75
Picosa Ck at Rancho	09/16/04	1902	<0.06	<0.02	<0.02	0.562

HABITAT ASSESSMENT

Habitat scores fall within the intermediate habitat index category at all but one site (Table 10). All sites on the SAR fall within the intermediate habitat index category. With the exception of the site at Ashley Road, the SAR is represented by better instream habitat scores than riparian scores. Most portions of the SAR within the Park have been channelized and only invasive grasses have been allowed to grow within the riparian zone. The site at Ashley Road is a remnant of the original SAR channel that has not been channelized and is represented by good instream and riparian habitats but suffers from a lack of riffles, pools and sinuosity. Habitat along the Acequia de Espada is represented by good instream cover but lacks runs and riffles and is densely overgrown with Hydrilla. The riparian buffer habitat is dense but narrow along the western bank and the stream lacks sinuosity. The habitat at Piedras Creek is the only site that rated high. This creek is represented by good instream habitat diversity and a dense, well established riparian habitat. At the time of sampling, pools are lacking and signs of scouring are evident. Picosa Creek is represented by greater riparian diversity than instream habitat diversity. Throughout the survey portion of Picosa Creek, immediate stream banks are high and steep lacking in vegetation due to frequent flooding from the SAR. Much of the stream bed consists of fine sediments from 1 to 2.5 feet deep with very little instream habitat. At the time of sampling, channel flow status is low (water fills 25-75% of the available channel) and very little water is flowing through the channel. This portion of Picosa Creek is subject to frequent flooding due to its proximity to the SAR and is subject to extreme changes in depth and flow velocities.

FISH COMMUNITY ASSESSMENT

Following the collection of a representative sample of the fish community at each site, fish species and trophic composition data is generated and used to determine an IBI score and Integrity Class (Table 3) for each sampling event. The fish community is sampled once at Mission Road and Picosa Creek; all other sites were sampled twice. Biotic Integrity Classes ranged from Good to Poor; most events were classed in the Fair category (Table 11).

One event on the SAR (Loop 410, 06/29/04) and one on Picosa Creek (Rancho de Las Cabras, 09/16/04) score in the Good (48-52) category. The IBI Score is 48 at Loop 410 and Picosa Creek. In both cases, tolerant individuals make up the majority of the population (93% at Loop 410, 94% at Picosa Creek). Fourteen species are represented at Picosa Creek and seventeen are represented at Loop 410. Omnivores (11% at 410, 7.3% at Picosa Creek) make up a smaller portion of the community while insectivores (67% at 410, 58% at Picosa Creek) make up a much larger portion. Of the two sites, habitat and water quality conditions at Loop 410 appear to be capable of supporting a greater number of intolerant species (4 at Loop 410, 2 at Picosa Creek) as well as a greater number of individuals (629 at Loop 410, 342 at Picosa Creek).

Table 10 Habitat assessment index data.

Parameters	Stations						
	2 06/24/04	3 05/18/04	4 05/06/04	5 07/15/04	6 05/20/04	7 04/13/04	8 09/16/04
Available Instream Cover	3	3	4	3	3	3	1
Bottom Substrate Stability	4	2	2	3	3	4	1
Number of Riffles	1	2	1	1	3	2	3
Dimension of Largest Pool	1	1	1	1	1	1	1
Channel Flow Status	3	3	3	3	3	3	1
Bank Stability	3	3	2	2	2	2	2
Channel Sinuosity	0	2	0	1	2	1	2.5
Riparian Buffer Vegetation	1	2	2	3	2	2	3
Aesthetic of Reach	1	1	2	2	2	1	3
Score Attribute	17 Inter-mediate	19 Inter-mediate	17 Inter-mediate	19 Inter-mediate	21 High	19 Inter-mediate	17.5 Inter-mediate

Station Key

2-SAR at San Juan Dam
3-SAR below Espada Dam
4-Acequia de Espada
5-SAR at Ashley Rd
6-Piedras Creek
7-SAR at Loop 410
8-Picosa Creek

Two events on the SAR (Loop 410, 04/13/04 and Ashley Road, 07/15/04) score in the Good to Fair category (45-47). The IBI Score is 46 at Loop 410 and Ashley Road. In both cases, tolerant individuals make up the majority of the population (89% at Ashley Road, 74% at Loop 410). Seventeen species are collected at Ashley Road and twelve were collected at Loop 410. Insectivores (78% at Ashley Road, 82% at Loop 410) make up a larger portion of the community than omnivores (12% at Ashley Road, 10.9% at Loop 410). Habitat and water quality conditions at the SAR at Ashley Road support a greater number of intolerant species (5 at Ashley Road, 3 at Loop 410) while the site at Loop 410 supports a greater number of individuals (114 at Ashley Road, 276 at Loop 410).

A total of seven sampling events score in the Fair category (39-44); four events on the SAR, two on Piedras Creek and one on the Acequia de Espada. The IBI score at the SAR at San Juan Dam (06/24/04) is 44, SAR below Espada Dam (10/28/03) is 44, SAR below Espada Dam (05/18/04) is 42, Acequia de Espada (06/15/04) is 40, SAR at Ashley Road (03/23/04) is 42, Piedras Creek (10/07/03) is 40 and Piedras Creek (05/20/04) is 42. The total number of species range from eight at the Acequia de Espada to 15 at the SAR at Espada Dam on 10/28/03. With the exception of one site (25% at Acequia de Espada), the remaining six are dominated by tolerant individuals (73% at San Juan Dam, 72% and 65% at Espada Dam, 88% at Ashley Road, 91% and 63% at Piedras Creek). Of all seven sampling events, insectivores (66% at San Juan Dam, 55% and 54% at Espada Dam, 92% at the Acequia de Espada, 92% at Ashley Road, 49% and 54% at Piedras Creek) make up a larger portion of the community than omnivores (3.7% at San Juan Dam, 15% and 9.2% at Espada Dam, 2.2% at the Acequia de Espada, 7.1% at Ashley Rd, 18% and 29% at Piedras Creek). Of the sampling events scoring in the Fair category, better diversity is found at the SAR at San Juan Dam (4 species) on 06/24/04 and the SAR below Espada Dam (4 species) on 10/28/03. These two sampling events are also represented by the highest number of individuals collected (747 at San Juan Dam and 835 at Espada Dam). The improved diversity and higher sample collection numbers are attributed to good water quality and a more natural habitat.

Two events (SAR at San Juan Dam on 10/21/03 and the Acequia de Espada on 05/06/04) score in the Fair to Poor category (36-38). The IBI score is 38 at San Juan Dam and 36 at the Acequia de Espada. Fourteen species are collected at San Juan Dam and six are collected from the Acequia de Espada. Tolerant individuals make up 87% at San Juan Dam and 37% at the Acequia de Espada. Insectivores are found in much greater numbers than omnivores within the Acequia de Espada (92% insectivores, 2% omnivores) but only slightly greater than omnivores at San Juan Dam (28% insectivores, 21% omnivores). Habitat and water quality conditions at San Juan Dam support a greater number of intolerant species (2 at San Juan Dam, 1 at Acequia de Espada) and a greater number of individuals (921 at San Juan Dam, 49 at the Acequia de Espada) than habitat and water quality conditions within the Acequia de Espada. The lack of diversity and poor representation of total individuals at the Acequia de Espada is likely due to the lack of habitat diversity and the over abundance of Hydrilla.

The one sampling event on the SAR at Mission Road (on 10/07/03) scores in the poor category (28-35). The IBI score is 34 at Mission Road. Ten species are represented in a sample population of 188 individuals. Ninety-nine percent of the individuals collected at Mission Road are considered tolerant to habitat and water quality degradation. The

percentage of insectivores was slightly greater than the percentage of omnivores (46% insectivores, 45% omnivores). Concentrations of omnivores greater than 45% are typically associated with poor habitat and or poor water quality conditions. Although the water quality of the SAR at Mission Road was good, the habitat was lacking.

Table 11 Fish community composition data.

Species	Stations						
	1 10/07/03	2 10/21/03	2 6/24/04	3 10/28/03	3 05/18/04	4 05/06/04	4 06/15/04
Astyanax mexicanus *		25	171	238	1		
Cyprinella lutrensis	85	220	293	208	107		
Notropis texanus			1				
Pimephales vigilax				5			
Campostoma anomalum	2	114	195	222	71		
Ictalurus punctatus	1	1	1				
Ameiurus natalis			2	1	4		1
Gambusia affinis	2	4	25	6	6	11	11
Poecilia latipinna *	11	346	31	20	3	2	
Poecilia formosa *	42	135		35			
Micropterus salmoides		2		2			2
Micropterus punctulatus					3		2
Lepomis Gulosus	2	3					
Lepomis Cyanellus	1	4		4	2	1	1
Lepomis macrochirus						3	5
Lepomis megalotis		9	1	3	4	31	70
Cichlasoma cyanoguttatum	40	52	23	66	16	1	1
Oreochromis mossambicus		1		14			
Tilapia zilli	2	5	2	6			
Hypostomus plecostomus			2	5			
Total Individuals	188	921	747	835	217	49	93
Total Species	10	14	12	15	10	6	8
IBI Score	34 Poor	38 Fair-Poor	44 Fair	44 Fair	42 Fair	36 Fair-Poor	42 Fair

* Introduced Species

Station Key

1-SAR @ Mission Rd
2-SAR @ San Juan Dam
3-SAR below Espada Dam
4-Acequia de Espada

Table 11 (Continued)

Species	Stations						
	5 03/23/04	5 07/15/04	6 10/07/03	6 05/20/04	7 04/13/04	7 06/29/04	8 09/16/04
Astyanax mexicanus *	8	4	3			15	7
Dorosoma cepedianum							1
Cyprinus carpio		1					
Notropis amabilis		1					
Cyprinella lutrensis	200	34	17	8	159	138	9
Notropis volucellus		3					
ghost shiner		36				70	
Pimephales vigilax	25				59	7	
Campostoma anomalum		5	3		12	35	
Ictalurus punctatus	7	3			1	2	
Ameiurus natalis	1	1	8	24		1	
Gambusia affinis	6	8	39	6	5	121	205
Poecilia formosa	2	2	39	9	5	170	55
Poecilia latipinna *	1		10		20	1	22
Micropterus salmoides		1	1				4
Lepomis Gulosus		1		1	1		2
Lepomis Cyanellus	1		3	6	2	10	4
Lepomis macrochirus		2			2	12	1
Lepomis auritus				2			
Lepomis megalotis	7	1	10	34	1	2	6
Cichlasoma cyanoguttatum	10	9	7	3	9	34	
Oreochromis mossambicus *						2	10
Tilapia zilli *						6	3
Pterygoplichthys multiradiatus							13
Hypostomus plecostomus *		2				3	
Total Individuals	268	114	140	93	277	629	342
Total Species	11	17	11	9	13	17	14
IBI Score	42 Fair	46 Good-Fair	40 Fair	42 Fair	46 Good-Fair	48 Good	48 Good

Station Key

5-SAR @ Ashley Rd
6-Piedras Creek
7-SAR @ Loop 410
8-Picosa Creek

Table 12 List of fish species collected from streams in or adjacent to the San Antonio Missions National Historical Park. Scientific and common names according to Nelson et al. (2004).

Species	Common Name
Dorosoma cepedianum	gizzard shad
Campostoma anomalum	central stoneroller
Cyprinella lutrensis	red shiner
Cyprinus carpio	common carp*
Notropis amabilis	Texas shiner+
Notropis Buchanani	ghost shiner+
Notropis texanus	weed shiner+
Notropis volucellus	mimic shiner
Pimephales vigilax	bullhead minnow
Astyanax mexicanus	Mexican tetra*
Ictalurus punctatus	channel catfish
Ameiurus natalis	yellow bullhead
Hypostomus plecostomus	suckermouth catfish*
Pterygoplichthys multiradiatus	sailfin catfish*
Gambusia affinis	western mosquitofish
Poecilia latipinna	sailfin molly*
Poecilia formosa	Amazon molly*
Lepomis auritus	redbreast sunfish*
Lepomis Cyanellus	green sunfish
Lepomis Gulosus	warmouth
Lepomis macrochirus	bluegill sunfish
Lepomis megalotis	longear sunfish
Micropterus punctulatus	spotted bass
Micropterus salmoides	largemouth bass
Cichlasoma cyanoguttatum	Rio Grande cichlid*
Oreochromis mossambicus	Mozambique tilapia*
Tilapia zilli	redbelly tilapia*+

** Introduced Species*
+ New Species

DISCUSSION

In 1988, a fish community analysis of the Upper San Antonio River (Segment 1911) from Hildebrand Avenue to Lone Star Boulevard identified 21 species totaling 4945 individuals (Gonzales 1988). Other previous surveys within the Brackenridge Park and River Road areas noted populations of non-native species from 35% and 43% (Hubs, et al., 1977) to 61% (Edwards 2001).

The current survey collected 27 species totaling 4912 individuals. Non-native species collected during this survey made up 37% of all species collected as well as 36% of all individuals collected. *Poecilia latipinna*, the most abundant non-native species collected during this survey, made up 23% of all non-native individuals and was collected at all but one event.

Cyprinella lutrensis were the most abundant native species collected within the Park boundaries and made up 31% of all individuals collected within the survey area. The *Gambusia affinis* was the only species collected at all sampling events. Tolerant individuals made up 80% of all individuals collected within the survey area and intolerant individuals made up 20% of all collected individuals.

The *Campostoma anomalum* was the most abundant intolerant species found within the survey area and was collected at six of the eight stations. The *Campostoma anomalum* was found in greater numbers at the SAR at San Juan Dam and below Espada Dam where gravel and riffle habitats are common. Its absence at the Acequia de Espada and Picosa Creek was likely due to the lack of appropriate habitat (gravel-riffle habitats) (Table 9). The *Lepomis megalotis* an intolerant species was collected at all sites except Mission Road and was most abundant at the Acequia de Espada and Piedras Creek. Sampling events reflecting the greatest diversity occurred at Ashley Road on July 15, 2004 and Loop 410 on June 29, 2004. Both events were represented by 17 species and were dominated by insectivores. The site with the least diversity occurred at the Acequia de Espada. Excessive growth of Hydrilla and the lack of instream habitat diversity (Table 9) is likely limiting diversity of the fish community within the Acequia de Espada. The survey was able to collect and document 69% of the fishes previously collected from the Upper San Antonio River (Appendix 1) and collected four species (*Notropis Buchanani, Notropis texanus, Notropis amabilis, Tilapia zilli)* not previously listed by SARA biologists. No darter species or species of management concerns were collected within the Park boundaries.

CONCLUSION

Overall the fish community composition data from the watercourses within or adjacent to the Park are similar to data previously collected (SARA 2003) from other reaches of the Upper San Antonio River and associated tributaries. Physico-chemical water quality parameters measured during the survey indicate conditions that can support a high aquatic life use. Variations and limitations in fish community composition are attributed to associated habitats. The four new fish species not previously collected within the

Upper San Antonio River Watershed are indicative of an increased biodiversity attributed to continuing improvements in water quality and habitat.

TAXONOMIC INVENTORY OF FISHES COLLECTED

ORDER CLUPEIFORMES
Family Clupeidae (herrings)

A. General Comments
Two species of Clupeidae have been collected in the San Antonio River (Young et al. 1973, TDWR 1984b, TPWD 1991) and some of its tributaries (SARA 1996).

B. Clupeidae species found during this survey
Only one species, *Dorosoma cepedianum* (gizzard shad), was collected during the Park survey.

C. Species accounts
1. *Dorosoma cepedianum* (gizzard shad)

Taxonomic comments: Considered a pollution tolerant omnivore, forage species, most abundant in large rivers and reservoirs. No subspecies have been described.

Distribution within the Park: Collected in Picosa Creek (Table 10) in Wilson County.

Estimate of abundance: Limited within preferred habitats, rare with in the Park.

Park habitat: Picosa Creek is a tributary of the San Antonio River. Within the sampling reach, the stream channel is approximately 1.9 m wide with moderate bends and an average depth of 0.1 m. At the time of sampling, the stream occupied a very small portion of the channel. The riparian habitat was extensive on both sides of the creek and was dominated by native grasses, forbs and hardwood trees which provided a dense mostly closed canopy over the creek.

Comments: During the survey, the San Antonio River flows were higher than normal due to higher than normal rainfall events. It is suspected that the high flow conditions allowed *Dorosoma cepedianum* to migrate upstream into Picosa Creek.

D. Other possible species
It is possible that *Dorosoma petenense* (Threadfin shad) might also be collected within the Park. *Dorosoma petenense* has been collected in tributaries to the San Antonio River (SARA 1996a).

ORDER CYPRINIFORMES
Family Cyprinidae (carps and minnows)

A. General Comments
This family of fishes is characterized for having jaws without teeth and cycloid scales. Eight species were collected and identified during sampling in the San Antonio River and tributaries.

B. Cyprinidae species found during this survey
1. *Campostoma anomalum* (central stoneroller)
2. *Cyprinella lutrensis* (red shiner)
3. *Cyprinus carpio* (common carp*)
4. *Notropis amabilis* (Texas shiner+)
5. *Notropis Buchanani* (ghost shiner+)
6. *Notropis texanus* (weed shiner+)
7. *Notropis volucellus* (mimic shiner)
8. *Pimephales vigilax* (bullhead minnow)

C. Species accounts
1. *Campostoma anomalum* (central stoneroller)

Taxonomic comments: Considered herbivorous; intolerant to poor water quality conditions and sensitive to pollution. No subspecies are described.

Distribution within the Park: Collected in the San Antonio River at San Juan Dam (station 2), Espada Dam (station 3), Mission Road (station 1), Ashley Road (station 5), and Loop 410 (station 7); also collected at the Piedras Creek site (station 6).

Estimate of abundance: Common in preferred habitats.

Park habitat: Collected in the San Antonio River on areas dominated with gravel or smaller substrate with a depth approximately 4 to 18 inches in riffle, run, or glide habitats. The width of the river ranged from approximately 5 to 22 meters, but this organism was localized to reaches described above. Found in Piedras Creek at locations with similar attributes.

Comments: Grow to 9 inches and common in small streams using its blade-like lower jaw for scraping algae and other microorganisms from the surfaces of rocks and other hard surfaces (Williams 2002).

2. *Cyprinella lutrensis* (red shiner)

Taxonomic comments: An insectivore tolerant to a wide range of water quality conditions. One subspecies, *Cyprinella lutrensis blairi*, formerly found in the Big Bend region, is now thought to be extinct (Chilton 1997).

Distribution within the Park: Collected at all sampling locations *except* the Acequia de Espada (station 4).

Estimate of abundance: Common within preferred habitats.

Park habitat: Range from wide slow-moving stream habitats to shallow riffles with high flow velocity and in areas with relatively large amounts of organic matter. Stream width was approximately 3 to 25 meters wide and 2 to 36 inches deep with <5% of the channel substrate exposed. The stream banks showed some evidence of erosion and low to moderate sinuosity. Commonly a wide zone of riparian buffer vegetation (10 to 20 m) in an aesthetically natural area with native vegetation present with some development evident.

Comments: Native to central North America ranging throughout Texas. Often used by anglers as a bait fish because it is important forage for larger fish (Chilton 1997).

3. *Cyprinus carpio* (common carp*)

Taxonomic comments: Exotic species considered a tolerant omnivore. No subspecies have been described.

Distribution within the Park: Collected in the San Antonio River at Ashley Road (station 5) and has been previously collected in other reaches of the San Antonio River in deeper pools.

Estimate of abundance: Common throughout the reach of the San Antonio River adjacent to the Park.

Park habitat: Ashley Road – This reach is a remnant of the original San Antonio River meander. It is unchannelized and closely resembles the natural habitat of the river. The water course is approximately 13 m wide with moderate bends and the substrate is densely littered with Corbicula shells in the upper reaches of the sampling site. Extensive riparian habitat provides mostly closed canopy with densely grown vegetation providing moderately stable banks, except in the upper reaches where there is moderate fishing pressure. Instream cover is common and supports viable fish populations.

Comments: Introduced into fisheries in Texas around the late 1800's as a food fish by the U.S. Fish Commission and now found statewide (Kemp 1971). May live in excess of 47 years and the Texas bow fishing record is 41.75 pounds (Chilton 1997).

4. *Notropis amabilis* (Texas shiner+)

Taxonomic comments: An insectivore considered intolerant to poor water quality and pollution. No subspecies have been described.

Distribution within the Park: Collected only in the San Antonio River at Ashley Road (Station 5).

Estimate of abundance: Limited within available habitats, uncommon within the Park.

Park habitat: Ashley Road – This reach is a remnant of the original San Antonio River meander. It is unchannelized and closely resembles the natural habitat of the river. The water course is approximately 13 m wide with moderate bends and the substrate is densely littered with Corbicula shells in the upper reaches of the sampling site. Extensive riparian habitat provides mostly closed canopy with densely grown vegetation providing moderately stable banks, except in the upper reaches where there is moderate fishing pressure. Instream cover is common and supports viable fish populations.

Comments: *Notropis amabilis* range extends from primarily the Edwards Plateau streams to tributaries of the Rio Grande in Mexico, but fairly common in clear waters of springs and spring-fed streams. The large eye is believed to be an adaptation for sight feeding in fast swift waters (Chilton 1997).

5. *Notropis Buchanani* (ghost shiner+)

Taxonomic comments: Considered a pollution tolerant insectivore. No subspecies have been described.

Distribution within the Park: Collected in the San Antonio River at Ashley Road (station 5) and at Loop 410 (station 7).

Estimate of abundance: Common among naturally available habitats.

Park habitat: Ashley Road - This reach is a remnant of the original San Antonio River meander. It is unchannelized and closely resembles the natural habitat of the river. The channel is approximately 13 m wide with moderate bends and the substrate is densely littered with Corbicula shells in the upper reaches of the sampling site. Extensive riparian habitat provides mostly closed canopy with densely grown vegetation supporting moderately stable banks, except in the upper reaches where there is moderate fishing pressure. Instream cover is common and supports maintenance fish populations. Loop 410 – Within the Park the San Antonio River is channelized and is approximately 21 m wide with few bends within the sampling reach. The substrate is dominated by gravel and cobble with some clay outcrops along the west bank. The riparian zone is dominated by invasive grasses and forbs that are routinely mowed to prevent the growth of woody plants. No riparian canopy exists at the collection site.

Comments: Very small; rare to 2 ½ in. and has a translucent milky white body with a fairly large eye. The species can be found from the Mississippi River basin to New Mexico; and Wisconsin to the Rio Grande and Northern Mexico (Page and Burr 1991).

6. *Notropis texanus* (weed shiner+)

Taxonomic comments: Considered an insectivore that is moderately tolerant to pollution. No subspecies have been described.

Distribution within the Park: This species was collected in the San Antonio River at San Juan Dam (station 2), but has been collected in other reaches of the San Antonio River.

Estimate of abundance: Common within preferred habitats.

Park habitat: The San Antonio River below the San Juan Dam is approximately 33 m. wide and averages 0.61 m deep at the sampling point. The substrate is dominated by gravel with cobble, and boulders common on the stream edges. The flow is characterized as swift through the center 1/3 of the stream due to a concrete pilot channel just upstream with calm and pooled areas immediately downstream on both sides of the pilot channel from the San Juan Dam. The banks have been stabilized with boulder size riprap and the riparian zone is 100% native grasses and forbs growing on the stream edges. The riparian area is frequently mowed to inhibit the growth of woody vegetation preventing canopy cover in the entire reach.

Comments: *Notropis texanus* range extends from Winnipeg River in Canada to south Texas and east to northern Florida. However, it was first collected in Texas giving it the scientific name, *texanus* (Williams 2002).

7. *Notropis volucellus* (mimic shiner)

Taxonomic comments: An insectivore considered intolerant to poor water quality and pollution. Subspecies *Notropis volucellus wickliffi* is usually treated as a large-river subspecies of the mimic shiner. It has a deeper and broader body, deeper caudal peduncle, and no or only a faint stripe along the midline of the nape (Williams 2002).

Distribution within the Park: Collected in the San Antonio River at Ashley Road (station 5) and at Loop 410 (station 7).

Estimate of abundance: Common within preferred habitats.

Park habitat: <u>Ashley Road</u> - This reach is a remnant of the original San Antonio River meander. It is unchannelized and closely resembles the natural habitat of the river. The channel is approximately 13 m wide with moderate bends and the substrate is densely littered with Corbicula shells in the upper reaches of the sampling site. Extensive riparian habitat provides mostly closed canopy with dense vegetation supporting moderately stable banks, except in the upper reaches where there is moderate fishing pressure. Instream cover is common and supports fish populations.

Comments: Important forage species especially for bass, terns, and other birds (Williams 2002).

8. *Pimephales vigilax* (bullhead minnow)

Taxonomic comments: An insectivore considered intolerant to pollution. No subspecies have been described.

Distribution within the Park: Collected in the San Antonio River at Espada Dam (station 3), Ashley Road (station 5), and Loop 410 (station 7).

Estimate of abundance: Common in preferred habitats.

Park habitat: All three stations contained a good amount of instream cover capable of maintaining existing populations. Substrates ranged from dominantly silt at Espada Dam to dominantly gravel at Loop 410 to dominantly Corbicula shells (other) at Ashley Road. Less than 5% of the substrate was exposed with all stations having little sinuosity. They range in riparian vegetation from extensive riparian habitat providing mostly closed canopy with densely grown vegetation at Ashley Road to a moderate amount of riparian vegetation blended with manicured Park-like settings and the impervious cover of an adjacent Parking lot at Espada Dam to a riparian zone dominated by invasive grasses and forbs that are routinely mowed to prevent the growth of woody plants at Loop 410.

Comments: *Pimephales vigilax* was present on the main channel of the San Antonio River, but not present in the Acequia de Espada which runs parallel to the San Antonio River in that same reach.

D. Other possible Species

Notropus venustus (blacktail shiner), *Notemigonus crysoleucas* (golden shiner), and *Pimphales promelas* (fathead minnow), have been previously collected in the San Antonio River or its tributaries (SARA 1988, 1994, 1996, 2000). It is possible that *Carassius auratus* (Gold fish) could also be collected as the species is commonly used for baitfish by local anglers. Additionally the Catostomidae, *Moxostoma congestum* (gray redhorse) has also been collected in San Antonio River tributaries (SARA 1996).

ORDER CHARACIFORMES

Family Characidae (characins)

A. General Comments

No species of Characidae are native to the survey area or the San Antonio River Basin.

B. Characidae species found during this survey

1. *Astyanax mexicanus* (Mexican tetra*)

C. Species accounts

1. *Astyanax mexicanus* (Mexican tetra*)

Taxonomic comments**:** Not native to the San Antonio River Basin; originally limited to the Nueces and Rio Grande Rivers.

Distribution within the Park**:** *Astyanax mexicanus* was collected at six of the eight sampling stations established for the survey (Table 10). The absence of the species at the Mission Road site is attributed to limited habitat. Dense aquatic vegetation and predation by *Lepomis megalotis* seem to be excluding *Astyanax mexicanus* from the Acequia de Espada (station 4). The species is commonly collected in the San Antonio River (Young, et al. 1973, TDWR 1981, 1984, SARA 1988, 1994, 1996a).

Estimate of abundance**:** Common in most habitats

Park habitat: *Astyanax mexicanus* can be found in the more open water habitats of the San Antonio River. The species has a preference for rock and sand bottomed pools (Peterson 1991).

Comments: *Astyanax mexicanus* is an opportunistic invasive insectivore species that seems to be able to displace native species in ecologically stressed stream reaches.

D. Other possible Species
None

ORDER SILURIFORMES
Family Ictaluridae (North American catfishes)
Family Loricariidae (suckermouth armored catfishes)

A. General Comments
Seven species of Ictaluridae have been documented in the San Antonio River Basin (Young et al.1973, TDWR 1981, 1984, Gonzales 1988, SARA 1988, 1994, 1996, 2000, 2003).

B. Ictaluridae species found during this survey
1. *Ameiurus natalis* (yellow bullhead)
2. *Ictalurus punctatus* (channel catfish)

C. Species accounts
1. *Ameiurus natalis* (yellow bullhead)

Taxonomic comments**:** Considered a pollution tolerant omnivore. Distinguished from *Ameiurus melas* (Black bullhead) by the white chin barbells.

Distribution within the Park: *Ameiurus natalis* was collected at four of five sampling sites established on the San Antonio River. The species absence at the Mission Road site (station 1) was attributed to high stream flows and lacking habitat. *Ameiurus natalis* was

not collected in Piedras Creek or Picosa Creek but was collected in the Acequia de Espada.

Estimate of abundance: Common within preferred habitats.

Park habitat: Most reaches of the San Antonio River within the Park have depths and habitats that are amenable to *Ameiurus natalis*. However the species is absent from tributaries lacking adequate flow and depth.

Comments: *Ameiurus natalis* have only slight importance to anglers for sport or food. Their distribution is common throughout Texas (Chilton 1997).

2. *Ictalurus punctatus* (channel catfish)

Taxonomic comments: Considered a pollution tolerant omnivore. *Ictalurus punctatus* rank very high in angling importance as a game fish and for food.

Distribution within the Park: *Ictalurus punctatus* was located at four of the eight established sampling sites (Table 10). However larger concentrations of the species were collected in areas with higher habitat scores (Table 10).

Estimate of abundance: Common within preferred habitats.

Park habitat: The San Antonio River is the only stream within the Park that has the type of habitat suitable for *Ictalurus punctatus.* The species prefers pooled areas of larger streams with low or moderate current (Chilton 1997).

Comments: *Ictalurus punctatus* are native to the San Antonio River Basin and currently range throughout Texas.

D. Other possible Species

It is likely that five other Ictaluridae, *Amerius melas* (Black bullhead), *Polydictus olivaris* (Flathead catfish), *Ictalurus furcatus* (Blue catfish) *Noturus nocturnus* (Freckled madtom) and *Noturus gyrinus* (Tadpole madtom) will eventually be found within the Park boundaries as they are known to inhabit the San Antonio River (Young et al. 1973, EH&A 1983, Gonzales 1988, SARA 1996).

Family Loricariidae (suckermouth armored catfishes)

A. General Comments

Two species of Loricariidae have been documented in the San Antonio River (Hubbs et al 1978, Gonzales 1988, SARA 1994, 1996, 2000). Neither species is native to Texas but both have established breeding populations in the San Antonio River.

B. Loricariidae species found during this survey

1. *Hypostomus plecostomus* (suckermouth catfish*)

2. *Pterygoplichthys multiradiatus* (Orinoco sailfin catfish*)

C. Species accounts
1. *Hypostomus plecostomus* (suckermouth catfish*)

Taxonomic comments: Considered a pollution intolerant herbivorous species. No subspecies described.

Distribution within the Park: Limited to preferred stable habitats in the San Antonio River (Table 10).

Estimate of abundance: Common in required habitats.

Park habitat: *Hypostomus plecostomus* is limited to the deeper and temperature stable habitats of the San Antonio River (Table 10).

Comments: As *Hypostomus plecostomus* is pollution and temperature intolerant fish that feeds on algae and periphyton. Although not native to Texas, SARA biologists use the species as an indicator of good ecosystem health with in the San Antonio River Basin (Gonzales 1988, SARA 1996, 1998, 2003)

2. *Pterygoplichthys multiradiatus* (Orinoco sailfin catfish*)

Taxonomic comments: Considered a pollution intolerant herbivorous species. No subspecies described.

Distribution within the Park: Limited to preferred stable habitats in the San Antonio River (Table 10).

Estimate of abundance: Common in required habitats. Less common than *Hypostomus plecostomus*.

Park habitat: *Pterygoplichthys multiradiatus* is limited to the deeper and temperature stable habitats of the San Antonio River (Table 10).

Comments: Pollution and temperature intolerant species that often succumbs to extremes in Texas weather conditions.

D. Other possible Species
None.

ORDER CYPRINODONTIFORMES
Family Poeciliidae (livebearers)

A. General Comments

Poeciliidae occur in both fresh and brackish water, most species occur in the tropics and some species are very tolerant to habitat and water quality degradation.

B. Poeciliidae species found during this survey

1. *Gambusia affinis* (western mosquitofish)
2. *Poecilia formosa* (Amazon molly*)
3. *Poecilia latipinna* (sailfin molly*)

C. Species accounts

1. *Gambusia affinis* (western mosquitofish)

Taxonomic comments: Insectivorous species, native to Texas and very tolerant to degraded aquatic habitats and poor water quality. A close relative, *Gambusia georgei* (San Marcos gambusia), is considered extinct.

Distribution within the Park: Collected at all sampling sites with in the Park.

Estimate of abundance: Very abundant in all habitat types.

Park habitat: *Gambusia affinis* is a pollution tolerant opportunistic species that was collected in all Park habitats but has preferences for open, still water areas near aquatic/emergent vegetation, cut banks or overhanging tree limbs.

Comments: *Gambusia affinis* has been introduced to other areas to control mosquitoes.

2. *Poecilia formosa* (Amazon molly*)

Taxonomic comments: An all female introduced omnivorous species considered a hybrid between *Poecilia latipinna* and *Poecilia mexicana* (shortfin molly).

Distribution within the Park: Collected at all sampling sites with the exception of Acequia de Espada.

Estimate of abundance: Abundant in all open water habitat types.

Park habitat: *Poecilia formosa* was collected in all Park habitat types but was more common in open water areas of the San Antonio River. The species was not collected where dense aquatic vegetation (Acequia de Espada) was present.

Comments: The species is opportunistic and is tolerant of degraded habitat and water quality conditions. *Poecilia formosa* has been collected in stressed aquatic environments through out the lower San Antonio River Basin (SARA 1996, 1998, 2003).

3. *Poecilia latipinna* (sailfin molly*)

Taxonomic comments**:** Introduced pollution tolerant species with a widespread distribution that feeds primarily on algae and organic debris.

Distribution within the Park: Collected at all sampling sites with in the Park.

Estimate of abundance: Abundant at all sampling sites.

Park habitat: *Poecilia latipinna* was collected in all Park habitat types but was more common in still water areas.

Comments: The species is opportunistic and is tolerant of degraded habitat and water quality conditions. *Poecilia latipinna* has been recorded as a relatively dominant species in stressed aquatic environments(SARA 1996, 1998, 2003).

D. Other possible Species
Xiphophorus helleri (Green swordtail) has been previously collected in tributaries of the San Antonio River (SARA 1996).

ORDER PERCIFORMES
Family Centrarchidae (sunfishes)
Family Cichlidae (cichlids)

A. General Comments
Eleven Centrarchidae species are commonly collected and identified in Texas (Chilton 1997). Of those, eight have been previously collected in the Upper San Antonio River (SARA 1996). During this survey, six of those eight were identified and an additional species was collected and added to the list. Centrarchidae (sunfishes) are the most widespread and popular group of freshwater sport fishes in North America. They are also the most widely distributed family of fishes (Williams 2002).

B. Centrarchidae species found during this survey
1. *Lepomis auritus* (redbreast sunfish*)
2. *Lepomis cyanellus* (green sunfish)
3. *Lepomis gulosus* (warmouth)
4. *Lepomis macrochirus* (bluegill sunfish)
5. *Lepomis megalotis* (longear sunfish)
6. *Micropterus punctulatus* (spotted bass)
7. *Micropterus salmoides* (largemouth bass)

C. Species accounts
1. *Lepomis auritus* (redbreast sunfish*)

Taxonomic comments: Considered an insectivore tolerant to pollution and an exotic introduced to the San Antonio River. No subspecies have been described.

Distribution within the Park: Collected at Piedras Creek sampling site (station 6), but expected to be found in other reaches within the Park boundaries.

Estimate of abundance: Common in preferred habitats.

Park habitat: Piedras Creek is a natural creek that is approximately 5 m wide and with an average depth of 0.2 m. Water travels through moderate stream bends exposing less than 5% of the substrate which is stable and dominated by sand with areas of gravel throughout the reach. Available instream cover and riffles are common and support maintenance populations of fish communities. The stream banks are moderately stable and show some evidence of erosion caused by high flows. They are supported by a wide buffer zone of riparian habitat consisting of native grasses, forbs, shrubs, and trees that provide extensive canopy cover.

Comments: Native range is in freshwater streams along the east coast. At one time was raised in Texas fish hatcheries by the Texas Parks and Wildlife Department and widely distributed (Kemp 1971). Successfully competes with the native *Lepomis megalotis* (longear sunfish) for habitat (Williams 2002).

2. *Lepomis cyanellus* (green sunfish)

Taxonomic comments: Considered a predatory species tolerant to pollution. No subspecies have been described.

Distribution within the Park: Collected at all eight sample locations within the Park.

Estimate of abundance: Rare but not limited by habitats in the Park reach.

Park habitat: Instream habitats range from wide, slow-moving water with glides to shallow riffles and runs with high flow velocity and in areas with relatively large amounts of organic matter or submerged vegetation. Stream width ranged from approximately 3 to 25 m wide and 2 to 36 in deep with <5% of the channel substrate exposed. A mixture of habitat is present from open water to complex with log jams, undercut banks, submerged vegetation, and snags. Turbidity ranged from clear to turbid. The stream banks showed some evidence of erosion and low to moderate sinuosity. A wide zone of riparian buffer vegetation (10 to 20 m) is common in an aesthetically natural area with native vegetation present and some developmental impact evident.

Comments: A versatile and prolific species able to adapt to a wide variety of environmental conditions. Often overpopulate small habitats so growth becomes stunted; rarely reach desirable size for angling (Chilton 1997).

3. *Lepomis gulosus* (warmouth)

Taxonomic comments: Considered a predatory species tolerant to pollution. No subspecies have been described.

Distribution within the Park: Collected in the San Antonio River at Mission Road (station 1), San Juan Dam (station 2), Ashley Road. (station 5), and Loop 410 (station 7). Also collected in Piedras Creek (station 6) and Picosa Creek (station 8).

Estimate of abundance: Common in all habitats in the Park.

Park habitat: Instream habitats range from wide, slow-moving water with glides to shallow riffles and runs with high flow velocity and in areas with relatively large amounts of organic matter or submerged vegetation. Stream width ranged from approximately 3 to 25 m wide and 2 to 36 in deep with <5% of the channel substrate exposed. A mixture of habitat is present from open water to complex with log jams, undercut banks, submerged vegetation, and snags. Turbidity ranged from clear to turbid with poor clarity. The stream banks showed some evidence of erosion and low to moderate sinuosity. A wide zone of riparian buffer vegetation (10 to 20 m) is common in an aesthetically natural area with native vegetation present and some developmental impact evident.

Comments: Range is from Wisconsin to south Texas and from the east coast to west Texas (Chilton 1997). A small number were collected during these sampling events, but they are expected to occur in greater numbers wherever complex instream cover is present.

4. *Lepomis macrochirus* (bluegill sunfish)

Taxonomic comments: Considered an important sport and forage species tolerant to pollution. Three subspecies have been described: *Lepomis macrochirus macrochirus* native to the northeastern half of the state, *Lepomis macrochirus speciosus* native to the central, southern, and western portions of the state, and *Lepomis macrochirus purpurescens* native to the Atlantic Coast freshwater streams and introduced in Texas (Chilton 1997).

Distribution within the Park: Collected in the San Antonio River at Ashley Road (station 5) and Loop 410 (station 7); also collected at Acequia de Espada (station 4) and Picosa Creek (station 8). The species is also expected to occur in other reaches of the Park boundaries.

Estimate of abundance: Common within available habitats.

Park habitat: Ashley Road and Picosa Creek are unchannelized and closely resemble the original habitat of the river. The channel ranges from approximately 3 to 13 m wide with moderate bends and the substrate is densely littered with organic matter at Ashley Road, 8 to 12 in. of mud and sand in Picosa Creek. Extensive riparian habitat provides mostly closed canopy with densely grown vegetation supporting moderately stable banks. Instream cover is common and supports maintenance fish populations. Loop 410 – Within the Park the San Antonio River is channelized and is approximately 21 m wide

with few bends within the sampling reach. The substrate is dominated by gravel and cobble with some clay outcrops along the west bank. The riparian zone is dominated by invasive grasses and forbs that are routinely mowed to prevent the growth of woody plants. No riparian canopy exists at the collection site.

Comments: One of the most common and popular freshwater sport fish in Texas, especially among pre-license age anglers (Williams 2002). When conditions are right, the bluegill, like Lepomis *cyanellus* (green sunfish), can overpopulate available habitat and stunt its growth making it too small to eat (Kemp 1970).

5. *Lepomis megalotis* (longear sunfish)

Taxonomic comments: An insectivore considered intolerant to pollution. No subspecies have been described.

Distribution within the Park: Collected at all sampling locations *except* the San Antonio River at Mission Road (station 1).

Estimate of abundance: Common in all habitats in the Park reach.

Park habitat: Instream habitats range from wide, slow-moving water with glides to shallow riffles and runs with high flow velocity and in areas with relatively large amounts of organic matter or submerged vegetation. Stream width ranged from approximately 3 to 25 m wide and 2 to 36 in deep with <5% of the channel substrate exposed. A mixture of habitat is present from open water to complex with log jams, undercut banks, submerged vegetation, and snags. Turbidity ranged from clear and transparent to green with poor clarity. The stream banks showed some evidence of erosion and low to moderate sinuosity. A wide zone of riparian buffer vegetation (10 to 20 m) is common in an aesthetically natural area with native vegetation present and some developmental impact evident.

Comments: A relatively small sunfish (rarely > 6 in), but like most Lepomis species, important for young anglers learning to fish and fly fisherman because of surface feeding habits; also a prized baitfish for trotlines (Chilton 1997).

6. *Micropterus punctulatus* (spotted bass)

Taxonomic comments: Considered a pollution tolerant predator. Three subspecies have been described. *Micropterus punctulatus punctulatus* in Mobile Bay below Fall Line, Alabama; *Micropterus punctulatus henshalli* in Georgia, Alabama, and Mississippi; *Micropterus punctulatus wichitae* in Cache Creek, southwest Oklahoma (Page and Burr 1991).

Distribution within the Park: Collected in the San Antonio River below Espada Dam (station 3) and Acequia de Espada (station 4).

Estimate of abundance: Common in preferred habitat.

Park habitat: Both areas are off the main channel of the San Antonio River and retain many attributes of the original river. San Antonio River below Espada Dam is approximately 6.7 m wide and 0.36 m deep. Habitat types include runs, riffles, and glides while dominated by gravel with areas of cobble and woody debris. Water color is clear and clarity is good to excellent throughout the sampling area. Emergent vegetation is common along the banks which are stabilized by native vegetation. The riparian habitat on the west bank is extensive and remains undisturbed while the east bank is supported by approximately 5m of riparian zone before transitioning into a Parking lot for Park visitors.

Acequia de Espada is a narrow water body with no bends approximately 4m wide and 0.5m deep. Instream habitat is glide without riffles, runs, or pools. The banks are steep and composed of mud and clay. The substrate is dominated by approximately 8 to 12in of silt and soft clay. Dense Hydrilla dominated the water column and was abundant throughout the sampling reach. Extensive riparian habitat was present on the east bank and the west bank was similar throughout except for approximately 50m cleared for livestock and stables. Canopy cover was complete and present in the entire sampling reach.

Comments: While these sampling efforts only yielded *Micropterus punctulatus* (spotted bass) off the main channel of the San Antonio River, they are assumed to be found in other preferred habitats within the Park boundary.

7. *Micropterus salmoides* (largemouth bass)

Taxonomic comments: Considered a pollution tolerant predator. Two subspecies have been described. *Micropterus salmoides salmoides* is common throughout the range from the Great Lakes to south Texas and west Texas to east coast streams. *Micropterus salmoides floridanus* is native to peninsular Florida, but has been widely introduced because of its larger size and sport/game value to anglers (Page and Burr 1991).

Distribution within the Park: Collected in the San Antonio River at San Juan Dam (station 2), below Espada Dam (station 3), and Ashley Road (station 5). Also collected in Acequia de Espada (station 4), Piedras Creek (station 6), and Picosa Creek (station 8).

Estimate of abundance: Common in preferred habitats.

Park habitat: Attributes such as stream width range from 3 to 40m and depth from 0.1 to 0.61m. Instream habitats are dominated by glides, runs, and riffles with excellent to fair clarity. Riparian habitat ranges from only native grasses and forbs with no woody vegetation (station 2) to extensive riparian habitat with complete canopy cover (station 6). Dominant substrates ranged from clay and silt (stations 8 and 4, respectively) to organic materials (station 5) to gravel (stations 2, 6, and 3). All stations where Micropterus *salmoides* (largemouth bass) were collected contain instream habitat

including submerged or emergent vegetation, woody debris, snags, boulders, and other items that allow the fish to feed from instream cover locations.

Comments: Although the largemouth is called a bass, it is actually the largest member of the sunfish family. *Micropterus salmoides* (largemouth bass) is the most popular sport fish in Texas (Kemp 1971).

D. Other possible Species
Lepomis microlophus (redear sunfish)
Lepomis punctatus (spotted sunfish)
From the family Percidae, *Percina Caprodes* (logperch)

Family Cichlidae (cichlids)

A. General Comments
Three species of Cichlidae have previously been collected in the San Antonio River Basin (SARA 1996), none of which are native to the study area.

B. Cichlidae species found during this survey
1. *Cichlasoma cyanoguttatum* (Rio Grande cichlid*)
2. *Oreochromis mossambicus* (Mozambique tilapia*)
3. *Tilapia zillii* (redbelly tilapia*+)

C. Species accounts
1. *Cichlasoma cyanoguttatum* (Rio Grande cichlid*)
Taxonomic comments: Native to South Texas along the Rio Grande River, but has been introduced to the San Antonio River and its tributaries.

Distribution within the Park: *Cichlasoma cyanoguttatum* was collected at all sampling sites.

Estimate of abundance: Abundant in most habitat types.

Park habitat: *Cichlasoma cyanoguttatum* was present in all Park habitat types sampled. The species is opportunistic and can quickly dominate in degraded habitats that can stress native species.

Comments: *Cichlasoma cyanoguttatum* is a pollution tolerant omnivorous species used by SARA biologists as an indicator of an unbalanced or stressed ecosystem. The species has been observed to displace native Centrarchidae and dominate when aquatic conditions are less than optimum.

2. *Oreochromis mossambicus* (Mozambique tilapia*)

Taxonomic comments: Native to Africa and introduced to the San Antonio River Basin.

Distribution within the Park: *Oreochromis mossambicus* was collected in the San Antonio River at the San Juan Dam (station 2), below Espada Dam (station 3) and at Loop 410 (station 1). The species was also collected in Picosa Creek in Wilson County (station 8).

Estimate of abundance: The species is abundant in preferred habitats.

Park habitat: *Oreochromis mossambicus* was readily collected at the sites with slow moving water and habitats broken into run, riffle, and glide regimes. The species also seemed to have a preference for stream reaches with rocky bottoms. Additionally the species was also collected in the back water, mud bottom habitat in Picosa Creek.

Comments: The species is a pollution tolerant omnivore but is temperature sensitive. Fish kills are common in shallow areas when the air temperature remains below freezing for extended periods.

3. *Tilapia zilli* (redbelly tilapia*+)

Taxonomic comments: Native to Africa originally introduced to Arizona and California as a weed control measure in canal systems.

Distribution within the Park: *Tilapia zilli* was collected in the San Antonio River at the San Juan Dam (station 2), below Espada Dam (station 3) and at Loop 410 (station 1). The species was also collected in Picosa Creek in Wilson County (station 8).

Estimate of abundance: Common in preferred habitats.

Park habitat: *Tilapia zilli* was readily collected at the sites with slow moving water and habitats broken into run, riffle and glide regimes. The species also seemed to have a preference for stream reaches rocky bottoms. Additionally the species was also collected in the back water, mud bottom habitat in Picosa Creek

Comments: Although not a common as *Oreochromis mossambicus*, *Tilapia* zilli seems to have the same habitat and temperature preferences.

D. Other possible Species

Oreochromis aureus (blue tilapia), commonly collected in other reaches of the San Antonio River.

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APPENDIX 1 SARA Checklist of Fishes Found in Segment 1911 – Upper San Antonio River.

Checklist of fish found in Segment 1911 - Upper San Antonio River		
Species (Trophic Level)	*Common Name* (Tolerance)	*Reference*
Lepisosteus spatula (C)	alligator gar (T)	Young et. al. 1973.
Lepisosteus osseus (C)	longnose gar (T)	SARA 1988a.
Lepisosteus oculatus (C)	spotted gar (T)	EH&A 1983. SARA 1994a. TDWR 1981.
Dorosoma cepedianum (O)	gizzard shad (T)	TDWR 1981.
Astyanax mexicanus (I)	Mexican tetra (T)	SARA 1988. SARA 1994a. Young et. al. 1973. TDWR 1981. TDWR 1984.
Cyprinella lutrensis (I)	red shiner (T)	EH&A 1983. SARA 1988a. SARA 1994a. Young et. al. 1973. TDWR 1984a & b.
Notropis volucellus (I)	mimic shiner (I)	SARA 1988a. TDWR 1984a & b.
Notropis venustus (I)	blacktail shiner	TDWR 1984a & b.
Dionda episcopa (O)	roundnose minnow (I)	TDWR 1984a & b.
Pimephales vigilax (I)	bullhead minnow (I)	SARA 1994a.
Pimephales promelas (O)	fathead minnow (T)	SARA 1988a. SARA 1994a.
Ictalurus punctatus (O)	channel catfish (T)	SARA 1988a. SARA 1994a Young et. al. 1973. TDWR 1984a & b. TDWR 1981.
Ictalurus furcatus (C)	blue catfish	SARA 1988a.

Ameiurus natalis (O)	yellow bullhead	SARA 1988a. SARA 1994a. TDWR 1981.
Pylodictis olivaris (C)	flathead catfish	SARA 1994a.
Noturus gyrinus	tadpole madtom	SARA 1996a
Gambusia affinis (I)	Western mosquitofish (T)	SARA 1988a. SARA 1994a. EH&A 1983. Young et. al. 1973. TDWR 1984a & b. TDWR 1981.
Poecilia latipinna (O)	sailfin molly (T)	SARA 1988a. SARA 1994a. EH&A 1983. Young et. al. 1973. TDWR 1984a & b. TDWR 1981.
Poecilia formosa (O)	Amazon molly (T)	SARA 1994a.
Mictropterus salmoides (C)	largemouth bass	SARA 1988a. SARA 1994a. Young et. al. 1973. TDWR 1984a & b. TDWR 1981.
Moxostoma congestum	gray redhorse	SARA 1996a
Lepomis gulosus (C)	warmouth (T)	SARA 1988a. SARA 1994a. Young et. al. 1973.
Lepomis cyanellus (C)	green sunfish (T)	SARA 1988a. SARA 1994a. TDWR 1984a & b. TDWR 1981.
Lepomis microlophus (I)	redear sunfish (I)	TDWR 1984a & b.
Lepomis macrochirus (I)	bluegill sunfish (T)	SARA 1988a. SARA 1994a. TDWR 1981.
Lepomis auritus (I)	redbreast sunfish (T)	SARA 1988a. SARA 1994a. TDWR 1981.
Lepomis megalotis (I)	longear sunfish (I)	SARA 1988a. TDWR 1984a & b.
Lepomis punctatus (I)	spotted sunfish (I)	SARA 1988a.

Cichlasoma cyanoguttatum (I)	Rio Grande cichlid (T)	SARA 1988a. SARA 1994a. Young et. al. 1973. TDWR 1984a & b. TDWR 1981.
Tilapia mossambica (O)	Mozambique tilapia (T)	SARA 1988a. SARA 1994a. TDWR 1984a & b. TDWR 1981.
Tilapia aureau (O)	blue tilapia (T)	SARA 1988a.
Cyprinus carpio (O)	common carp (T)	Hubbs 1982.
Campostoma anomalum (H)	central stoneroller (I)	SARA 1994a.
Hypostomus plecostomus (H)	suckermouth catfish (I)	SARA 1988a. SARA 1994a.
Xiphophorus helleri (O)	green swordtail (T)	SARA 1994a.

NOTES:

1. Scientific and Common names are according to Robins et. al. 1980.

2. Trophic Level (Feeding Group)
   (C) Carnivore
   (H) Herbivore
   (I) Insectivore
   (O) Omnivore
   (P) Planktivore

3. Tolerance Level (To Pollution)
   (T) Tolerant
   (I) Intolerant

   Those species without a tolerance designation are considered intermediate.

4. Shaded areas are exotic or introduced species (Non-native).

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APPENDIX 2

Photographs of Fish Species Collected in Waters in or Adjacent to the San Antonio Missions National Historical Park

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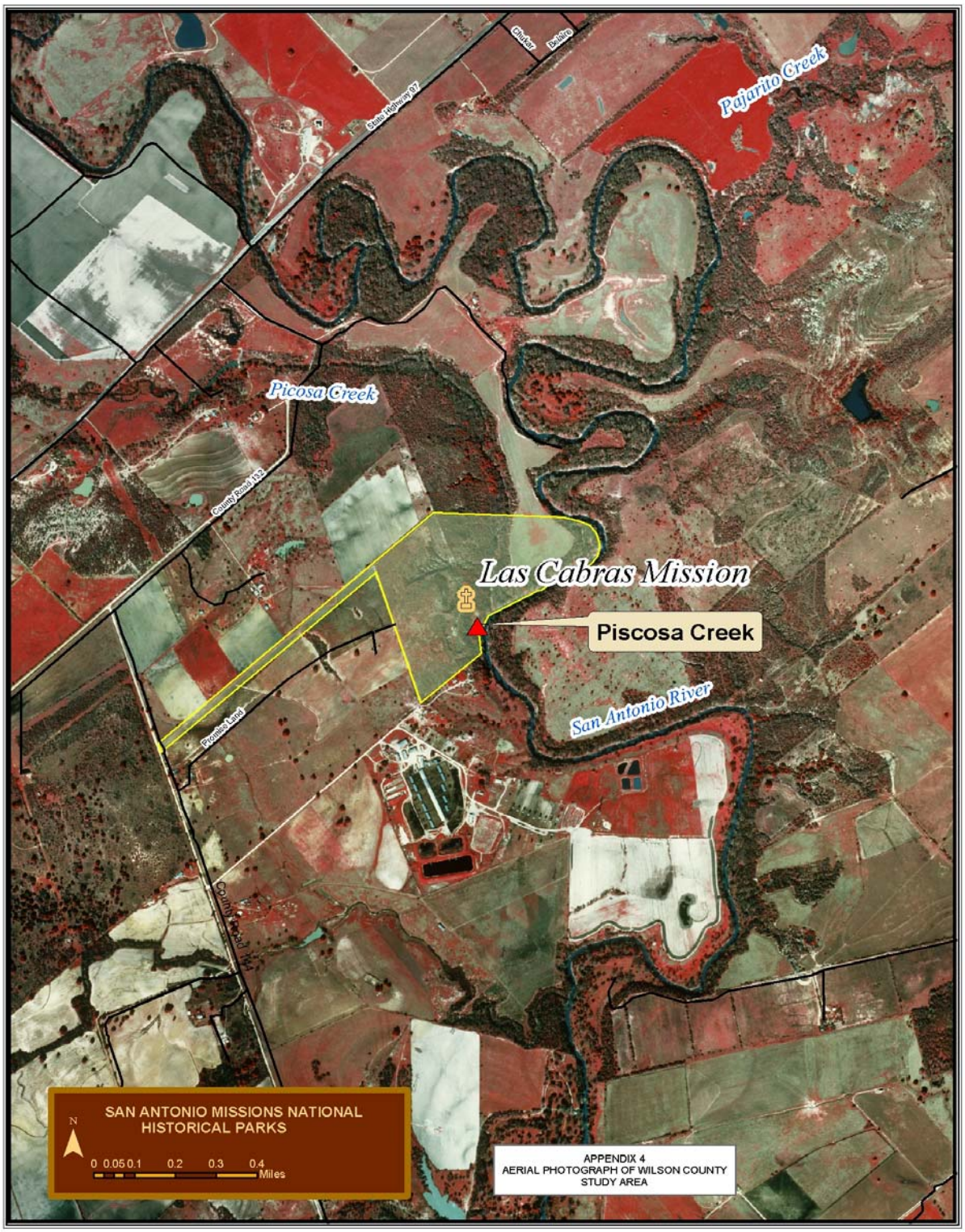
Photographs of the following species collected during this project were not successful.

Dorosoma cepedianum	Gizzard Shad
Notropis amabilis	Texas Shiner+
Notropis Buchanani	Ghost Shiner+
Notropis volucellus	Mimic Shiner
Pterygoplichthys multiradiatus	sailfin catfish*
Lepisosteus oculatus	spotted gar

APPENDIX 3 Aerial Photograph of the Bexar County Survey Area.

APPENDIX 4 Aerial Photograph of Wilson County Survey Area.