APPENDIX B
USFWS COORDINATION ACT REPORT
AND BIOLOGICAL OPINION

United States Department of the Interior

FISH AND WILDLIFE SERVICE
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JUN 23 2005

William Fickel, Jr.
Planning, Environmental, and
Regulatory Division
Fort Worth District, Corps of Engineers
P.O. Box 17300
Fort Worth, Texas 76102-0300

Consultation # 2-15-F-2005-0087

Dear Mr. Fickel:

We enclose the final biological opinion for the proposed aquatic ecosystem restoration project at Spring Lake, in San Marcos, Hays County, Texas in partnership with Texas State University – San Marcos. We have mailed a copy of the final biological opinion to Mr. Pat Fogarty, Assistant Vice President Facilities at Texas State University – San Marcos.

If you have any questions regarding this biological opinion, please contact Dawn Whitehead at (512) 490-0057, extension 222.

Sincerely,

Robert T. Pine
Supervisor

Enclosure

cc: Regional Director, Service, Albuquerque
Pat Fogarty, Texas State University – San Marcos

United States Department of the Interior

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William Fickel, Jr.
Planning, Environmental, and
Regulatory Division
U.S. Army Corps of Engineers
P.O. Box 17300
Fort Worth, Texas 76102-0300

Dear Mr. Fickel:

This document transmits the U.S. Fish and Wildlife Service's (Service) biological opinion based on: (1) our review of the U.S. Army Corps of Engineers (USACE) funding of a proposed aquatic ecosystem restoration project at Spring Lake, in San Marcos, Hays County, Texas, and its vicinity in partnership with Texas State University – San Marcos (TxStU) and (2) the project's effects on four federally listed species. Those species are Texas wild-rice (*Zizania texana*), Comal Springs riffle beetle (*Heterelmis comalensis*), fountain darter (*Etheostoma fonticola*), and San Marcos salamander (*Eurycea nana*).

Funding would potentially be made available under the USACE's Continuing Authorities Program and section 206 of the Water Resources Development Act of 1996 (33 U.SC. 2330). In accordance with section 7 of the Endangered Species Act of 1973, as amended (Act) (16 U.S.C. 1531 et seq.), the USACE has prepared a biological assessment (BA) and requested formal consultation in a January 13, 2005 letter.

This biological opinion is based on information from: (1) the biological assessment (BA) for the Spring Lake Section 206 Aquatic Ecosystem Restoration Project San Marcos (December 2004), (2) conversations with USACE, its consultant (Gulf South Research Corporation, Baton Rouge) and TxStU, (3) site visits, (4) information meetings, (5) field investigations, (6) letters, and (7) other sources of information. A complete administrative record of this consultation is on file at our office.

Consultation History

USACE and TxStU have been in dialogue with the Service and other agencies/entities regarding proposed aquatic ecosystem restoration for several years. USACE hired Gulf South Research Corporation to prepare the biological assessment for aquatic restoration measures proposed in the Detailed Project Report and Integrated Environmental Assessment. A number of meetings on the proposed restoration measures have occurred. USACE provided comments on the draft biological opinion in an April 26, 2005 letter.

Species Not Part of this Opinion
The proposed action will not affect the San Marcos gambusia (*Gambusia georgei*) since this species is not likely to occur in the action area. Also, this project is not likely to adversely affect the Texas blind salamander (*Typhlomolge rathbuni*), which depends on the Edwards aquifer, based on our understanding that the proposed actions are not likely to impact groundwater quality or quantity. These species will not be covered in this opinion.

BIOLOGICAL OPINION

I. Description of Proposed Action
Spring Lake and Aquarena Center are located at the headwaters of the San Marcos River in the City of San Marcos, Hays County, Texas (Figures 1 and 2). The following is excerpted from Section 1.3.1 of the BA, which provides a description of the proposed restoration measures.

Restoration activities proposed for the Aquarena Center area include demolishing and removing most structures and associated hard surfaces, such as select buildings, parking lots, and the tramway; removing the submarine theater and underwater structures; restoring the peninsula area to a native prairie habitat, and removing exotic, terrestrial plant species throughout the project area. The project area provided in the BA is estimated at 15.8 hectares (39 acres). The estimated area of various aspects are included parenthetically (area in meter ^{2}, rounded to nearest whole meter^2)

The steps required to remove and demolish the Aquarena Center are:

1. Demolish the buildings and parking areas located on land -

    a. gift shop (616),
    b. administrative office (226),
    c. restaurant & public restroom area (1,120),
    d. turtle building (42),
    e. tent pavilion (477),
    f. the Landing (328),
    g. Skyline Ride structure (280),
    h. shed (99),
    i. covered bridge (53),
    j. storage shed (14),
    k. Texana Village building foundation (193),
    l. Skyline towers (on the grounds) (8),
    m. asphalt benches area (167),
    n. fences,
    o. parking lot (9,200),
    p. sidewalks,
    q. octagonal structure (14),
    r. stone pump houses (9),

s. stonework structure (7),
t. concrete columns (25),
u. ticket booth (12),
v. concrete debris (20),
w. steel tank (5);

2. Load pieces of buildings and parking areas onto trucks for disposal;
3. Prepare area of shoreline, the "Landing Site", to receive structures removed from lake;
4. Remove the underwater submarine and submerged structures (229)
   a. assemble an equipment barge,
   b. mount a 45 to 60 ton crane on the equipment barge,
   c. assemble another deep deck barge,
   d. launch barges at the improved boat ramp (40),
   e. using a crane, lift the sunken structure pieces and place on second barge,
   f. maneuver barges (using large industrial outboard motors) to the "Landing Site" area and offload pieces onto trucks,
   g. remove any other miscellaneous sunken material using cranes and barges - where necessary divers would assist by cutting and disassembling pieces underwater;
5. Remove the submarine theater structure (122)from the water using the same floating barge and crane -
   a. place structure on three or more floating barges for ballast removal and disassembly,
   b. transport barges to "Landing Site" and unload submarine theatre pieces onto trucks for disposal.

The proposed actions involve the potential for water quality degradation through: (1) the suspension of sediment in Spring Lake (e.g., while enlarging boat ramp and during ingress/egress of barges), (2) introduction of petroleum hydrocarbons from outboard motors and hydraulic systems, and (3) suspended sediment in stormwater from restoration efforts on peninsula that reaches Spring Lake and San Marcos River.

Proposed conservation measures include: (1) actions to minimize potential impacts of stormwater during demolition and initial land disturbance such as adherence to a Stormwater Pollution Prevention Plan (SWPPP), adequately constructed/monitored silt fences and other measures to reduce sediment in runoff reaching the San Marcos River system; and (2) actions to ultimately improve the general quality of runoff from the site such as replacement of parking lots with native grasses and use of natural vegetation buffers between the golf course and Spring Lake.

II. Status of the Texas Wild-Rice, Fountain Darter, San Marcos Salamander, and their Critical Habitats

Texas Wild-Rice

Species and critical habitat description

Texas wild-rice is known only from the upper San Marcos River system and was first collected by G.C. Neally in August 1892. The plant was formally described and named as *Zizania texana* by Hitchcock (1933). All specimens were collected from the San Marcos River (Terrell et al. 1978).

Historical Distribution

Texas wild-rice forms large clumps rooted in the limestone sand and gravel river bottom, which overlays Crawford black silt and clay (Vaughan 1986). According to Hitchcock (1933) and Silveus (1933), Texas wild-rice occurred in Spring Lake and its irrigation waterways. Poole (1992) and Poole and Bowles (1996, 1999) have reported Texas wild-rice from many sites from the upper San Marcos River.

Critical habitat has been designated for Texas wild-rice as, "Texas, Hays County; Spring Lake and its outflow, the San Marcos River, downstream to its confluence with the Blanco River." Appendix 1 includes figures delineating critical habitat designated for Texas wild-rice, fountain darter, and San Marcos salamander.

Life history and habitats

In the upper portion of the San Marcos River, Texas wild-rice occurs with pondweed (*Potamogeton illinoensis*), wild celery (*Vallisneria americana*), delta arrowhead (*Sagittaria platyphylla*), hydrilla (*Hydrilla verticillata*), common hornwort (*Ceratophyllum demersum*), elodea (*Egeria densa*), and water primrose (*Ludwigia repens*) (Terrell et al. 1978, Vaughan 1986). In the lower portion of the river, Texas wild-rice is most often found in isolated clumps (Terrell et al. 1978, Vaughan 1986).

Silveus (1933) states that wild-rice was growing in the swiftest currents. Poole and Bowles (1999) found that Texas wild-rice was found in habitats with higher water velocities compared to sites sampled that lacked Texas wild-rice.

Elephant ears (*Colocasia esculenta*) was introduced to the upper San Marcos River over 100 years ago and currently occupies a significant extent of the habitat along the banks. In some reaches, such as near Thompson Island (see Figure 1), elephant ears dominate and effectively exclude other plants including Texas wild-rice. Hydrilla, elodea, and West Indian hygrophila (*Hygrophila polysperma*), which were introduced in more recent times, have formed extensive stands in a variety of habitats in Spring Lake and the upper San Marcos River (Lemke 1979, 1998; Angerstein and Lemke 1994; Poole and Bowles 1999, Doyle 2001).

Common tree species that shade the river, include sycamore (*Platanus occidentalis*), pecan (*Carya illinoensis*), cottonwood (*Populus deltoides*), sugar hackberry (*Celtis laevigata*), bald cypress (*Taxodium distichum*), black willow (*Salix nigra*), American elm (*Ulmus americana*), Chinese tallow tree (*Sapium sebiferum*), and plateau (= Texas) live oak (*Quercus virginiana* var *fusiformis*) (Vines 1960, Vaughan 1986). It is not known whether survival of Texas wild-rice is influenced by the degree of shading by the tree canopy. Significant wild-rice stands occur in shadier reaches of the river. Vaughan (1986) examined the relationship of light to depth, but not surface light incidence. Poole and Bowles (1999) found turbidity to be higher in areas without wild-rice compared to areas with wild-rice but attribute this to the number of non-wild-rice transects sampled below the City of San Marcos municipal wastewater treatment plant outfall.

Reproduction

Texas wild-rice produces new plants either sexually via seeds or asexually via stolons. When reproducing sexually, the long rigid culm bends upward at its nodes, emerges above the water surface, and produces a 20 to 30 cm (8 to 12 inch) flowering panicle (Beaty 1975). Asexual reproduction occurs where shoots arise at the ends of stolons. While asexual reproduction has been noted and some plants have produced culms for inflorescences, plants have not successfully been producing or setting seed in the San Marcos River (J. Poole, Texas Parks and Wildlife Department (TPWD) pers. comm., 1995). Emery and Guy (1979) studied reproduction in Texas wild-rice and reported the species is predominantly outbreeding and wind-pollinated. They found no indication of apomixis (selfing) or any reproductive anomaly. Pollen and megaspore development as well as pollination and early embryo development appear normal. Pollen fertility is good (81.6 percent), and they concluded the failure of wild-rice to produce seed in the wild is probably not due to any genetic, cytological, or embryological problems, but rather to some extrinsic factor or factors. Plants grown in raceways at Southwest Texas State University's Aquatic Station at reduced water velocities successfully bloom and set seed, and seed have been observed to drop in place and subsequently germinate (P. Power, currently with the National Park Service, previously with San Marcos National Fish Hatchery and Technology Center, pers. comm. 1995), but this may be an induced stress response resulting from lower water velocities.

Status and distribution

Jackie Poole, TPWD, has surveyed Texas wild-rice downstream of Spring Lake every summer (ca. early July) for the past 16 years (Poole 1992, Poole and Bowles 1996). BIO-WEST surveyed Texas wild-rice in 2004 (BIO-WEST 2005). Figure 3 shows the general distribution in the upper San Marcos River in 2004. Poole and Bowles (1999) described the physical habitats associated with extant Texas wild-rice.

Current wild-rice distribution extends from just upstream of Spring Lake Dam to a point near the municipal wastewater outfall. One stand of wild-rice was located downstream of the municipal wastewater outfall as recently as 1995, but was found missing the following year (Poole and Bowles 1996). Near Spring Lake Dam, Texas wild-rice stands occur about 12 meters (40 feet) upstream of the western spillway headgates. Stands also occur about 6 meters (20 feet) upstream of the upstream edge of the eastern spillway.

Jackie Poole has provided TPWD's estimates of Texas wild-rice coverage summarized by segment. The most upstream segment (Segment A) does not include Spring Lake. Segment A is the reach of the San Marcos River between Spring Lake Dam and University Drive bridge. Figure 4 shows the estimated annual areal coverage for the period 1989 through 2004.

Documented threats to wild-rice include herbivory, sedimentation, interference with photosynthesis by epiphytic algae and floating mats of vegetation, damage from recreationists, and competition from exotic aquatic plant species. In addition, damage in the past decade can be attributed to Cape's Dam failures, low instream flows, and especially the October 1998 flood (Slade and Persky 1999). Breslin (1997) documented direct damage to wild-rice caused by recreationists, particularly by tubing and dogs in the river.

Texas wild-rice went from a summer (pre-flood) 1998 estimate of 1,949 meter ^{2} (20,979 feet ^{2}) to 1,645 meter ^{2} (17,707 feet ^{2}) in 1999, to 1,791 meter ^{2} (19,278 feet ^{2}) in 2000. On December 31, 1999, Cape's Dam (the first dam downstream of IH-35) partially failed. Its backwater effect dropped and the water surface elevation also dropped in the segment of river upstream from Cape's Dam exposing Texas wild-rice plants. Short-term emergency repairs to Cape's Dam were made in January and February 2000. Further repairs may be made if funding is available and necessary permits/authorizations can be obtained.

Comal Springs Riffle Beetle

Description and Life History

The Comal Springs riffle beetle is a small, aquatic beetle known from Comal Springs and San Marcos springs. Adult Comal Springs riffle beetles are about 2 millimeters (0.13 inch) long, with females slightly larger than males. It occurs in the gravel substrate and shallow riffles in spring runs. Some riffle beetle species can fly (Brown 1987), but the hind wings of *H. comalensis* are short and almost certainly non-functional, making the species incapable of this mode of dispersal (Bosse et al. 1988).

Larvae have been collected with adults in the gravel substrate of the spring headwaters and from springs in the bed of Landa Lake in New Braunfels, Comal County and Spring Lake (BIO-WEST 2005, Service 2005). Water depth in occupied habitat is evidently variable and future surveys in deeper parts of Spring Lake may extend the known range in the San Marcos Springs system. Populations are reported to reach their greatest densities from February to April (Bosse et al. 1988). The Comal Springs riffle beetle has been collected from spring runs 1, 2, and 3 at Comal Springs in Landa Park, springs on the bottom of Landa Lake, and from Spring Lake associated with a group of springs near the Aquarena Inn.

Species Distribution

The current range of the Comal Springs riffle beetle includes: (1) the springs and spring runs of Landa Lake (BIO-WEST 2005), and (2) an undetermined number of springs in Spring Lake in San Marcos (Service 2005) (Figure 5, yellow crosshatched area is the extent of the Service's surveys in 2004). On October 5th, 2000, Kristin Terpening and Lori Tolley-Jordan surveyed for riffle beetles in the aquatic habitats where dam repairs were proposed (Terpening 2000). Their survey indicated that while another riffle beetle was present, the Comal Springs riffle beetle was not found in the cascade habitat downstream from Spring Lake Dam. To date, critical habitat has not been designated. However, pursuant to a court agreement, the Service will begin work on the critical habitat determination for the Comal Springs riffle beetle on or before October 1, 2005.

Fountain Darter

Species Distribution and Critical Habitat Description

The current range of the fountain darter is restricted to the Comal and upper San Marcos rivers. Historic and present distributions of the fountain darter are presented in the *San Marcos & Comal Springs and Associated Aquatic Ecosystems (Revised) Recovery Plan* (Recovery Plan) (Service 1996). Historically within the San Marcos River, the fountain darter is known from the headwaters (Spring Lake) down to the vicinity of Martindale in Caldwell County (Service 1996). Current distribution extends from Spring Lake to a point between the San Marcos Waste Water Treatment Plant (WWTP) outfall and the confluence with the Blanco River (Figure 1, Service 1996). That downstream limit of fountain darters in the San Marcos River in 1996 was determined by the Service to be about 1,524 river-meters (5,000 river-feet) above the confluence of the San Marcos and Blanco rivers. Fountain darters have been collected below the WWTP outfall during July 1994, November 1994, February 1995, April 1995, and September 1996 by the Service.

The current distribution of fountain darters in the upper San Marcos River includes all of section 1 through 12 and the upper reaches of section 13 in Figure 1.

The fountain darter was listed as endangered on October 13, 1970, and critical habitat was designated on July 14, 1980. Critical habitat was designated in Hays County and includes Spring Lake and its outflow, the San Marcos River, downstream to about 805 meters (0.5 mile) below the Interstate Highway 35 bridge. A field identifier of the downstream end of critical habitat is considered to be the defunct U.S. Geological Survey gaging station. There is no critical habitat designated for this species in the Comal Springs system.

Life History

The fountain darter is a small, reddish brown fish, averaging about 29 millimeters (about 1.25 inch) total length. Habitat requirements described in the recovery plan (Service 1996) include: undisturbed stream floor habitats; a mix of submergent plants (algae, mosses, and vascular plants), in part for cover; clear and clean water; food supply of living organisms; constant water temperatures within the natural and normal river gradients; and adequate springflows.

Fountain darters feed primarily during daylight in response to visual cues (Schenck and Whiteside 1977*a*). Bergin (1996) investigated the fountain darter's diet in detail. The food items selected depended on the size of the individual, but primarily included copepods, dipteran (fly) larvae, and emphemeropteran (mayfly) larvae (Bergin 1996).

Fountain darters use and prefer a mix of submergent vegetation including algae, mosses (e.g., *Riccia* sp.), and vascular (higher) plants such as Texas wild-rice (Schenck and Whiteside 1976, Linam et al. 1993, Linam 1993, Service Austin Field Office unpublished data). Schenck and

Whiteside (1976) found that young fish prefer vegetated habitats in areas with little water velocity.

Although natural populations of fountain darters spawn year-round (Schenck and Whiteside 1977*b*), they appear to have two peak spawning periods, in August and late winter to early spring (Schenck and Whiteside 1977*b*). Bonner et al. (1998) described the effects of temperature on egg production and early stages of the fountain darter.

Status and Population Dynamics

The original population of fountain darters in the Comal River was extirpated (Schenk and Whiteside 1976). The primary cause of extirpation is thought to be the 1956 drought, when springflow ceased for 144 days. Cessation of flow probably caused large temperature fluctuations in residual downstream pools. In 1954, rotenone was applied to remove non-native and exotic fish. Although fountain darters were seined and held during rotenone application, the total number of fountain darters probably was reduced since all darters were not caught (Ball et al. 1952; Service 1996). The Comal population was re-established by Dr. Bobby Whiteside of TxStU (with about 500 individuals from the San Marcos River) in 1975 and 1976, and the species now occupies Landa Lake downstream to the vicinity of the confluence of the Comal and Guadalupe rivers. Linam et al. (1993) estimated that the Comal River population was about 168,078 individuals above Clemens Dam (site of the municipal tube chute) based on their 1990 survey.

The population of fountain darters in the San Marcos River was estimated to be about 103,000 by Schenck and Whiteside (1976) and 45,900 (downstream of and excluding Spring Lake) by Linam (1993). Darter densities appear to be highest in the upper segments of the river and decrease markedly in an area below Cape's Dam (Linam 1993, Whiteside et al. 1994).

Dr. Thomas Brandt (Service, San Marcos National Fish Hatchery and Technology Center (SMNFH&TC), in litt. 1997) has described some of the parasite problems faced by the fountain darter. Further research by the SMNFH&TC, TxStU (Salmon 2000), and the U.S. Department of Agriculture's Harry K. Dupree Stuttgart National Aquaculture Research Center (Mitchell et al. 2000) shows how a fluke is attacking fountain darter gills in the Comal and San Marcos river systems. Since 1996, virtually every fountain darter collected in the Comal system is parasitized. To date, the San Marcos system has not seen the same widespread presence of this trematode with less than 5 percent parasitism rate among fountain darters examined. The risk posed by these parasites will likely increase during stressful periods of low spring discharge (Mitchell et al. 2000, Salmon 2000).

San Marcos Salamander

Species Distribution and Critical Habitat Description

The San Marcos salamander (*Eurycea nana*) is a member of the family Plethodontidae (lungless salamanders) and is found only in spring dominated sections of Spring Lake and areas immediately downstream of Spring Lake. Sweet (1978) indicated that a population of *Eurycea* inhabiting Comal Springs in New Braunfels is very similar to *E. nana* and probably conspecific.

However, recent biochemical, molecular, and morphometric studies (Chippindale et al. 1992, 1993, 1994) indicate that the salamander at Comal Springs is clearly a different species. The only other San Marcos salamander populations other than spring dominated portions of Spring Lake, are the two associated with the eastern and western spillways of Spring Lake Dam (Figure 6).

Nelson (1993) found San Marcos salamanders throughout the part of Spring Lake associated with springs. Within Spring Lake, San Marcos salamanders are not known from the area known locally as the slough, which is the part of the lake associated with the lowest reach of Sink Creek. *E. nana* was found in most samples taken from "Deep Spring" in Spring Lake. Dowden (1968) and Tupa and Davis (1976) found *E. nana* in the dense mats of filamentous alga (*Lyngbya* sp.) along the shallow area adjacent to the northern bank of Spring Lake, especially in the uppermost region of the lake in front of the Aquarena Springs Inn (Hotel). Nelson (1993) found the salamanders distributed throughout Spring Lake among the rocks near spring openings, in the algal mats where Tupa and Davis found salamanders, and in the rocky areas just downstream from the dam. Unlike Tupa and Davis (1976), Nelson (1993) used SCUBA to observe salamanders in Spring Lake, which may explain the different distributions seen in these studies.

Critical habitat for the San Marcos salamander has been designated as follows (Vol. 45 Federal Register No. 136 - p. 47,364): Texas, Hays County; Spring Lake and its outflow, and the San Marcos River, downstream approximately 50 meters (164 feet) from the Spring Lake Dam. Only those parts of Spring Lake dominated by springflow represent suitable habitat for the San Marcos salamander (see study section 1 on Figure 1).

San Marcos salamanders in the wild are found mostly within the boundaries of their designated critical habitat. As discussed below, San Marcos salamanders are sometimes found downstream of the downstream boundary of federally designated critical habitat.

Life History

The various species of *Eurycea* are known as brook salamanders. *Eurycea nana* is a neotenic form and retains its external gills (the larval condition) throughout life. The salamander does not leave the water to metamorphose into a terrestrial form, but becomes sexually mature and breeds in the water. The specific name *nana* is from the Greek nanos or Latin nanus, meaning dwarf, referring to the small adult size (up to 59.6 millimeters [2.32 inches] total length) of these salamanders (Brown 1967).

Prominent external features of the small, slender salamander are moderately large eyes with a dark ring around the lens, well developed and highly pigmented gills, relatively short, slender limbs with four toes on the forefeet and five on the hind feet, and a slender tail with well developed dorsal fin. Compared to other neotenic *Eurycea* from Texas, the San Marcos salamander is smaller and more slender, different in coloration, has larger eyes relative to the size of its head, a greater number of costal grooves, and fewer pterygoid and premaxillary teeth. Detailed morphological descriptions of this species are found in Bishop (1941, 1943), Baker (1957, 1961), Mitchell and Reddell (1965), Schwetman (1967) and Tupa and Davis (1976).

The San Marcos salamander occurs in Spring Lake where rocks are associated with spring openings, and in rocky areas up to 150 meters (492 feet) downstream of the dams at Spring Lake (Dowden 1968, Longley 1978, Tupa and Davis 1976, Nelson 1993). San Marcos salamanders in the wild can be grouped into five habitat patches: three patches associated with spring clusters in Spring Lake, one patch associated with the Clear Springs spillway, and one patch associated with the main spillway. It should be noted that these last two patches are somewhat isolated from each other and from Spring Lake salamander habitats. We are concerned that if either or both of the populations downstream from the dam were extirpated, natural recolonization may not occur for a long time (years).

The San Marcos salamander requires: (1) thermally constant, clean and clear water equilibrated to Edwards aquifer conditions; (2) flowing water; (3) sand, gravel, and rock substrates with little mud or detritus; (4) vegetation for cover and habitat of its food supply; and (5) an adequate food supply.

The salamander is also found in shallow spring areas on the uppermost (northernmost) portion of Spring Lake on a limestone shelf in an area immediately in front of Aquarena Springs Inn (Hotel). The substrate in this area is sand and gravel interspersed with large limestone boulders. Concrete banks in front of the hotel and boulders in shallow (1-2 meters or 3.3-6.6 feet) water support a lush growth of an attached aquatic moss (*Leptodictyium riparium*). Interspersed with the moss and blanketing the shallow sandy substrate are thick filamentous mats of a coarse, filamentous blue-green alga, the dark reddish-brown color of which almost perfectly matches the dark dorsal coloration of the San Marcos salamander.

Spirogyra sp. and a few other larger filamentous green algae species, as well as the carnivorous angiosperm known as bladderwort (*Utricularia gibba*), are present in small amounts in the aquatic moss. A wide variety of rooted aquatic macrophytes occur on the periphery of the salamander habitat at 1-3 meters depths. The macrophytes include delta arrowhead, parrot's feather (*Myriophyllum brasiliense*), water primrose, and wild celery. In deeper water, Carolina fanwort (*Cabomba caroliniana*) and hydrilla become the dominant macrophytes of the mud and detritus-laden benthic region.

The salamanders are abundant within the wiry mesh of the aquatic moss and the filamentous mats of *Lyngbya* sp. in the shallow headwaters area. Sandy substrates devoid of vegetation and muddy silt or detritus-laden substrates with or without vegetation are apparently unsuitable habitats for *E. nana*. Specimens occasionally are collected from beneath stones in predominantly sand and gravel areas. In view of the abundance of predators (primarily larger fish, but also crayfish, turtles, and aquatic birds) in the immediate vicinity of the springs, protective cover such as that afforded by the moss and cyanophycean bacteria (= blue–green algae) is essential to the survival of the salamander. This vegetation also supports a plentiful food supply for the salamander.

Flowing water is apparently a prerequisite for suitable *E. nana* habitat, as no specimens have been found in still water areas of the lake or river. The flowing spring waters in the principal habitat are slightly alkaline (pH 7.2), stenothermal (narrow range of temperatures) at 21-22 °C (69.8-71.6 °F), and clear. Around springs, the oxygen content of the water is about 4 mg/L or greater (about 40-50 percent saturated with oxygen). In preliminary observations in captivity, these salamanders appear to become stressed at temperatures above 30 °C (86 °F). Oxygen consumption by *E. nana* was greatest at water temperatures of 25 °C (77 °F) as compared with 20 or 30 °C (68 or 86 °F) (Norris et al. 1963). Critical thermal maximum (CTM) is defined as the "arithmetic mean of the collective thermal points at which locomotor activity becomes disorganized and the animals lose their ability to escape from conditions that will promptly lead to their death" (Hutchison 1961). San Marcos salamander CTM investigations by Berkhouse and Fries (1995) determined that juveniles had a lower CTM, 35.8 °C (96.4 °F), than adults (37.2 °C or 99 °F).

Fountain darters occupy some of the same habitats as *E. nana* (Tupa and Davis 1976), and display many of the same feeding and protective concealment habits of the salamander. Unlike other fishes in the area but like the salamanders, fountain darters are found within the aquatic moss growths and *Lyngbya* mats, as well as beneath and alongside stones. Like the fountain darters, the salamanders in the lake habitat eat amphipods (Tupa and Davis 1976).

Associated with the salamander and fountain darter in the moss and algal vegetation are crayfish of varying sizes, two species of small freshwater shrimp (*Palaemonetes* sp.), many tendipedid larvae, a variety of other insect larvae, a very large number (particularly in the moss) of amphipods (*Hyalella azteca*), water mites, and many small aquatic snails. Leeches (*Placobdella* sp. and others) and planarians (*Dugesia* sp.) are also numerous, especially in samples taken over rocky substrates (Tupa and Davis 1976).

Most larger associated species are predators and occur in the vicinity of the salamander habitat. These include several species of sunfishes (family Centrarchidae) and cichlids (family Cichlidae), which feed on insect larvae, amphipods, terrestrial isopods, aquatic snails, freshwater shrimp, fountain darters, and San Marcos salamanders. Turtles such as Texas river cooters (*Pseudemys texana*) and stinkpots (*Sternotherus odoratus*) occasionally are present in the salamander habitat as are yellow bullheads (*Ameiurus natalis*) and largemouth bass (*Micropterus salmoides*) (Tupa and Davis 1976). Non-native blue catfish (lacking normal pigmentation) have been introduced into Spring Lake and may prey on *Eurycea*. The exotic blue tilapia (*Oreochromis aureus*) are a common part of the Spring Lake and San Marcos fish fauna as well. Blue tilapia are omnivorous and likely prey on *Eurycea*.

<u>Population Estimates</u>
Tupa and Davis (1976) estimated the number of *E. nana* in the floating algal mats at the uppermost portion of Spring Lake to be between about 17,000 and 21,000 individuals. Nelson (1993) followed the same procedure used by Tupa and Davis (1976) and estimated that the mats were inhabited by about 23,000 salamanders. Nelson (1993) also searched rocky substrates around the spring openings throughout Spring Lake and estimated an additional 25,000 *E. nana*

in this type of habitat. She also estimated the population below Spring Lake associated with rocky substrates to be about 5,200 individuals. These estimates give a combined population total for Spring Lake of 53,200. Nelson's population estimates of the rocky substrate habitat are believed to be underestimates (Nelson 1993 and G. Longley, TxStU, in litt. 1994), since salamanders are known to wriggle down into interstitial spaces of rocks and gravels. Captive salamanders from Comal springs are found as far as 1.3 meters (4 feet) down in simulated spring habitats (Longley, TxStU, in litt. 1994).

BIO-WEST (2005) reported estimated densities for San Marcos salamanders from two sites in Spring Lake and the area below the eastern spillway of Spring Lake Dam for the period Fall 2000 through Fall 2004 (Table 1).

Table1. Estimated densities (individuals per m^2) of San Marcos salamanders observed in each site 2000-2004 (BIO-WEST 2005).

Sample Period	Sample Area 2	Sample Area 14	Sample Area 21
Fall 2000	19.4	3.4	5.2
Winter 2001	8.7	No Sample	2.6
Spring 2001	9.4	13.9	0.4
Summer 2001	16.6	11.1	1.5
Fall 2001	10.0	6.7	3.2
High-flow 2001	9.7	8.6	1.0
Winter 2002	6.1	6.5	0.9
Spring 2002	20.2	8.5	0.6
Summer/High Flow 2002	17.7	4.2	0.7
Fall 2002	16.8	8.7	3.0
Spring 2003	7.9	11.9	1.0
Summer 2003	20.1	6.8	2.0
Fall 2003	11.3	9.5	2.7
Spring 2004	14.6	9.9	7.1
Summer 2004	10.9	9.2	7.0
Fall 2004	11.7	13.7	4.5

Status of San Marcos salamander and critical habitat

San Marcos salamander status in recent years is inferred to be stable as evidenced by surveys (Table 1) and above average levels in the Edwards aquifer. The proposed removal of submerged structures may uncover springs and if macrophytes are established, a significant amount of suitable habitat will be come available.

Similarly, San Marcos salamander critical habitat is currently believed to be stable. Management of well discharges from the Edwards aquifer, the most serious threat to critical habitat, is under the purview of the Edwards Aquifer Authority (EAA), which is preparing a Habitat Conservation Plan pursuant to section 10(a)(1)(B) of the Act.

Status of the species within the action area

Texas Wild-rice
The range of Texas wild-rice is wholly contained within the action area. Prof. Robert Doyle and his assistants have mapped aquatic vegetation including Texas wild-rice in the upper San Marcos River including Spring Lake and the area upstream of University Drive bridge. TPWD has mapped Texas wild-rice downstream of the dam. BIO-WEST, Inc (2005) has provided a recent map of Texas wild-rice plants downstream of Spring Lake Dam.

A large stand of Texas wild-rice occurs immediately downstream of the University Drive Bridge.

Comal Springs Riffle Beetle
The range of the Comal Springs riffle beetle is partially contained within action area.

Fountain Darter
The range of the fountain darter is partially contained within the action area.

Fountain darter densities for Spring Lake and upper San Marcos River are provided in Table 3. The study sections are shown in Figure 1. These samples were made using a 1 meter (3.28 feet) wide, 2 meter (6.56 feet) long drop net, which was open on the bottom and top with adjustable height (up to 1.5 meters (5 feet)). Darters, other fish, and invertebrates were captured by clearing the area enclosed with a dip net. Each section had samples with no fountain darters found. Collections by the Service and cooperators in 1994, 1995, and 1996 were pooled for Table 3.

Table 3.

Study Section Description	Service Study Section No.	Mean Density Fountain Darters per meter ^{2}	No. of Samples	Maximum No. Fountain Darters per Cell (2 meter ^{2})
Spring Lake (main)	1	7.9 *	26	85
Spring Lake (slough)	2	4.4	31	51
Spring Lake Dam to University Dr.	3	3.9	25	37

* used in estimating number of fountain darters affected in this biological opinion

San Marcos Salamander
The range of the San Marcos salamander is wholly contained within the action area.

III. Environmental Baseline

Historical Hydrology of the Edwards Aquifer (Balcones Fault Zone) and San Marcos Springs - River

The Edwards aquifer is a large carbonate aquifer found in south central Texas (Maclay and Land 1988) and currently provides drinking water to more than 1.7 million people in the San Antonio region (EAA 2005; http://www.edwardsaquifer.org). Reference to the Edwards aquifer herein refers to the aquifer in the San Antonio region (Balcones Fault Zone) that reaches from Kinney County in the west to the vicinity of Kyle in Hays County in the northeast. Lindgren et al (2004) provide a recent review of hydrology and new model that better simulates flow to San Marcos Springs.

San Marcos Springs Hydrology

Springflows at San Marcos and Comal springs are part of a regional system and their springflows are inseparably tied to water usage from the entire San Antonio Segment of the Edwards aquifer. The discharge of groundwater from wells in the aquifer decreases the flow of water from the springs. Generally, total withdrawal from the aquifer has increased since 1934, when total well discharge was 101,900 acre-feet, and it reached a maximum of about 542,400 acre-feet in 1989.

Because of the anticipated continued population growth in the Edwards aquifer region, and an associated increase in water use, the trend of declining spring discharge will continue if those water needs are met from the Edwards aquifer. South Central Texas regional water planning is underway pursuant to state legislation (Texas SB 1–http://www.watershedexperience.com).

A number of studies have modeled springflow at Comal and San Marcos springs (Thorkildsen and McElhaney 1992, Wanakule 1988, Wanakule 1990, Wanakule and Anaya 1993, Kabir et al. 1999, and LBG-Guyton Associates 2000). The most recent model was developed by the USGS (Lindgren et al 2004) and its simulated San Marcos springflows were compared favorably to the GWSIM model for the periods 1947-59 and 1978-89.

As part of a February 1, 1993, Judgement (as amended on May 26, 1993) in the case of Sierra Club vs. Secretary of the Interior (No. MO-91–CA-069, U.S. Dist. Ct., W.D. Texas), the Service used its best professional judgement and available information to determine minimum springflows needed to prevent take, jeopardy, or adverse modification to critical habitat of listed species. Determinations of take and jeopardy vary from species to species depending on each species' unique requirements, ecology, and life history. In addition, factors associated with the specific action such as magnitude, timing, duration, frequency, and extent also affect a specific take or jeopardy determination. Table 2 contains the Service's determination of minimum springflows necessary to prevent take, jeopardy, or adverse modification of critical habitat for the Edwards aquifer dependent endangered and threatened species (the specifics are contained in our letters dated April 28, 1993 and June 25, 1993).

Water Quality of the San Marcos Springs - River

Slattery and Fahlquist (1997) and Groeger et al. (1997) summarized water quality in the upper reaches of the San Marcos River. The springflows are described as among the most pristine in

Texas and are similar in water quality to Comal Springs (Fahlquist and Slattery 1997). Water produced by the springs has concentrations of ions characteristic of limestone aquifers. Groeger et al. found that temperature near the springs was close to the findings of Hannan and Dorris (1970). Data gathered by the USGS in 1993 and 1994 show that Comal and San Marcos springs had little natural variation in water quality. Their data show that parameters like temperature, specific conductivity, total dissolved solids, and major ions generally vary less than 10 percent and usually less than 5 percent from the mean. Groeger et al. (1997) also investigated and discussed turbidity and nutrient loading to the San Marcos River.

Threats to Edwards Aquifer Dependent Species

The revised San Marcos and Comal recovery plan (Service 1996) identifies several local and regional threats to the aquifer and spring systems, and to the threatened and endangered species dependent on these ecosystems. The main regional threats are related to the quality and quantity of aquifer and spring water. Decreased and potential cessation of springflows threaten the survival of the aquatic species. Activities that may pollute the Edwards aquifer and its springs and streamflows may also threaten or harm the species.

Significant additional threats also occur on the more local scale level and include impacts from increased urbanization near the rivers, recreational activities (Breslin 1997), alteration of the rivers, habitat modification (for example, dams, bank stabilization, flood control), predation, competition, introduced parasites, and habitat alteration by non-native species (for example, elephant ears, giant ramshorn snails, nutria (*Myocastor coypus*), and tilapia).

The implementation of an aquifer management plan that significantly influences the magnitude and duration of springflows of Comal and San Marcos springs is considered to be among the most important actions needed. Another important effort underway is the development and implementation of a Comal River Management Plan and a San Marcos River Management Plan to address local threats. Other actions needed include control of certain limiting factors such as non-native species. Significant control of non-native species would help minimize and/or eliminate threats from these species, such as loss or alteration of essential habitat, increased predation, disruption of normal behaviors, or hybridization.

USGS data have indicated a high water quality for the springflows and aquifer in general. However, there are increasing risks of aquifer, springflow, and streamflow contamination. Pollution threats include:

(1) groundwater pollution of the Edwards aquifer from land-based hazardous material spills and leaking underground storage tanks;

(2) cumulative impact of urbanization (road runoff, leaking sewer lines, residential pesticide and fertilizer use, etc.);

(3) increased impact of contaminants due to decreased dilution from smaller volumes of water in the aquifer and springflows; and,

(4) surface, stormwater, and point and nonpoint source discharges into the streamflows.

Although the aquifer is generally not contaminated to exceed Federal drinking water standards, certain contaminants have been found with greater frequency in the aquifer in recent years. Many of the threats by urbanization to aquifer water quality also threaten spring-based streamflows. Runoff from streets, highways, and commercial and residential landscapes, and potential spills of hazardous materials (above and below ground) pose the greatest risks to streamflow quality. Ockerman et al. (1999) characterized stormwater runoff in the Edwards aquifer recharge zone in Bexar County. Ogden et al. (1986) investigated stormwater runoff water quality including nutrients and fecal coliform bacteria. In general, the fecal group colony levels rose in response to rain events and the authors recommended that contact recreation in the San Marcos River be avoided for several days after a rain. Data collected by the City of San Marcos from September and early October 2000 indicate that despite not having found any sanitary sewer leaks, San Marcos River fecal counts exceeded the State of Texas surface water quality standards for contact recreation from Spring Lake downstream to the Thompson Island area below IH-35 (Melissa Millecam, City of San Marcos, in litt.).

Factors Affecting Species Environment Within the Action Area

Factors affecting these species and their respective habitats can be divided into two classes: regional and local. The regional factors include impacts to the hydrology and water quality of the Edwards aquifer. Local factors include, but are not limited to, impacts to the species and their habitats such as storm water pollution, water recreation impacts to habitats (especially to submergent plants such as Texas wild-rice and Illinois pondweed), and impacts from non-native and exotic species. Spring Lake is prized by SCUBA divers for its clear water. Groeger et al. (1997) reported turbidity values (n = 4) less than 5 ntu in Spring Lake. On occasion, construction activities in and along Sink Creek (upstream of Spring Lake) have resulted in elevated turbidity for several days.

We have completed formal consultation with the Department of Defense related to the operation of its missions in the San Antonio region and use of the Edwards aquifer (Service, in litt. December, 1999).

We have consulted with ourselves on use of Edwards aquifer as a water supply for the San Marcos National Fish Hatchery and Technology Center and Uvalde National Fish Hatchery and have finalized a biological opinion covering those Service activities. We have consulted with the USACE and Federal Emergency Management Agency (FEMA) on the emergency repairs to Spring Lake Dam.

IV. Effects of the Action

This section includes an analysis of the direct and indirect effects of the proposed action on the species and/or critical habitat and its interrelated and interdependent activities.

Factors to be considered
Contractor specific planning for removal of the submarine theater will take place following issuance of the final biological opinion and funding by USACE and TxStU. This will allow for permanent restoration of: (1) parts of Spring Lake historically impacted by previous owners, and (2) a significant subset of the developed upland parts of Aquarena Center.

Analyses for effects of the action
The following analyses are based on the areal extent of various impacts of the action and the densities of listed species in those areas. The densities are based on best available information including Service research on the fountain darter, observations by staff of the San Marcos National Fish Hatchery and Technology Center, research by Jackie Poole, Prof. Robert Doyle, Janet Nelson, and Diana Tupa. The salamander-Comal Springs riffle beetle surveys by BIO-WEST, and Joe Fries were particularly useful.

Effects to Texas wild-rice and its critical habitat
Extant Texas wild-rice in the wild is entirely within the boundaries of its critical habitat. The constituent element of Texas wild-rice critical habitat that may be affected by the project is water quality. Clean water may be affected by suspended silt and sediment from construction related activities. Some sediment will likely be carried downstream due to project related actions in Spring Lake.

Some of the project related suspended sediment may settle on Texas wild-rice in this stand. If it does, photosynthesis may be impaired.

Effects to fountain darter and its critical habitat

Fountain darters may be harmed, injured, and killed in several areas during removal of submarine theater and other structures: (1) through impacts to water quality such as turbidity, suspended sediment, and dissolved oxygen; and (2) through removal of the submarine theater and other structures due to attached algae/mosses and associated darter habitats. Turbidity would interfere with the fountain darter feeding since they are known to select microcrustacean prey based on visual cues. Feeding would be interrupted as long as turbidity interfered with visual cues. Dissolved oxygen may be decreased locally if suspended sediment results in increased oxygen demand. The surfaces of the submerged structures have become habitat as algae and plants have colonized their sides. Removal of these artificial habitats will simply return the habitats in Spring Lake to a more natural configuration.

Bell (1986) described avoidance "as a reluctance or refusal of fish to move from one place or situation to another". Fish may not recognize areas as dangerous and may enter and remain in a location "whether good or bad" (Bell 1986). Some, perhaps most, of the fountain darters in the work area may leave the disturbed area. However, some fraction of fountain darters will remain in the area that will be subjected to episodes of higher turbidity that will effectively prevent darters from feeding. Fountain darters observed while snorkeling appear to generally move less than 3 meters before stopping. Additionally, fish are known to swim into silty and turbid areas.

Once in turbid areas, fish may remain until turbidity subsides, which, in parts of Spring Lake, may be minutes, hours, or days. Longer episodes of turbidity have been noted after disturbance of ditches along roads in the Sink Creek watershed.

Vertical Surfaces

The BA estimates the potential habitat on the vertical sides of the submerged structures as 209 meters ^{2} (2,250 feet ^{2}). We estimate the potential habitat on the sides of submerged structures as 390.2 meters ^{2} (4,200 feet ^{2}) by using the surface described by a vertical extent of 2 meters around the perimeter of submerged structures. The density of fountain darters in the vertical habitats as 5.4 individuals per meter ^{2} and we estimate the number of fountain darters on the sides of submerged structures as 2,107.

Non-vertical Surfaces

We estimate the total roughly horizontal area of submerged structures with a 2 meter buffer as 914.4 meters ^{2} (9,843 feet ^{2}). This includes the Submarine Theater, the Sunken Structure and associated fountains, and the Fountain Structure further down the lake. We estimate the total wetted habitat affected at the improved boat ramp (egress point for barges) as 39.9 meters ^{2} (430 feet ^{2}). The sum of these areas is 954.3 meters ^{2} (10,272 feet ^{2}). The density of fountain darters in these habitats is estimated as 7.9 individuals per meter ^{2} and the total number of fountain darters associated with non-vertical surfaces is 7,539.

Fountain Darter Incidental Take

We estimate the total number of fountain darters associated with impacted areas in Spring Lake as 9,646. Additionally, we estimate that as many as 10 percent of these may be harmed, harassed, and/or killed by restoration efforts, yielding an incidental take of 965 fountain darters. We anticipate that fountain darters will recolonize the areas immediately adjacent to the removed structures soon after restoration related disturbances end. A more detailed analysis using varied microhabitat types constrained by macrophyte coverage and plant species present would provide a better estimate. However, specific data on the areal extent and configuration of those microhabitats are not available.

While the number of fountain darters potentially affected may seem large, it should represent less than one percent of the Spring Lake population.

Critical Habitat

Fountain darter critical habitat includes 7.7 hectares (19 acres) of lake habitat (Spring Lake) and 3,810 river-meters (12,500 river-feet) of riverine habitat downstream of Spring Lake. The project-related impacts are anticipated to involve less than 394 meter ^{2} (4,241 feet ^{2}) of aquatic habitat in the spring dominated reach of Spring Lake. The area directly affected by the project is less than 1 percent of the lacustrine critical habitat.

Effects to San Marcos salamander and its critical habitat

The expected effects are generally similar to those faced by fountain darters in the immediate structure removal area. It is likely that San Marcos salamanders occur below and near the submerged structures.

San Marcos salamander densities for sites in Spring Lake and its eastern spillway are provided in Table 1 with data taken from BIO-WEST (2005). The locations of these sites sampled (purple dots) are provided in Figure 6. The location labeled "Across from Boat Dock" is the closest to the submerged structures and the average San Marcos salamander density for all reported samples at that site is 8.9 individuals per meter ^{2} (2.7 per feet ^{2}). The habitat around the submerged structures may be less suitable habitat (compared to the reference site Across from Boat Dock area) because it does not have as many springs.

The BA provides an estimate for the probability of take in this area as 1 percent. The BA further states that this is based on their small size and ability to avoid impacts. Organisms such as fountain darters and San Marcos salamanders may use environmental cues (e.g., turbidity) to guide some movement. However, not all individuals are expected to behave in identical ways and some will likely move in to areas where they may be harmed or killed.

Vertical Surfaces

The BA estimates that the area of the lower half of the submerged structures as about 185 meters ^{2} (2,000 feet ^{2}). We estimate that the vertical habitat most likely to be used by San Marcos salamanders can be described by a surface one meter in the vertical extent (nearest the lake bed) surrounding the perimeter of the submerged structures, or about 195.1 meters ^{2} (2,100 feet ^{2}). Assuming a San Marcos salamander density of 7.7 individuals per meter ^{2}, we estimate the number of San Marcos salamanders associated with sides of submerged structures as 1,502.

Non-vertical Surfaces

The BA estimates the area of salamander habitat affected by the removal of submerged structures in Spring Lake is 209 meter ^{2} (2,250 feet ^{2}). We estimate the total roughly horizontal area of submerged structures with a 2 meter buffer as 755.7 meters ^{2} (8,134 feet ^{2}). This includes the Submarine Theater, the Sunken Structure and associated fountains. This does not include the Fountain Structure further down the lake since San Marcos salamanders are not known from that area. Assuming a San Marcos salamander density of 7.7 individuals per meter ^{2}, we estimate the number of San Marcos salamanders associated with these habitats as 5,819.

San Marcos Salamander Incidental Take

We estimate the total number of San Marcos salamanders associated with impacted areas in Spring Lake as 7,321. Additionally, we estimate that as many as 10 percent of these may be harmed, harassed, or killed by restoration efforts, yielding an incidental take of 732 San Marcos salamanders. We anticipate that San Marcos salamanders will recolonize the areas occupied by and adjacent to the removed structures soon after restoration related disturbances end.

Based on an expectation that *Eurycea* will generally limit their movement from disturbed areas, we anticipate the number of salamanders harmed or killed by the restoration activities will not exceed 732. It will be difficult to determine the extent of San Marcos salamander morbidity or mortality result from efforts to remove individuals from the attached algae and mosses on the submerged structures.

San Marcos Salamander Critical Habitat

We estimate the areal extent of San Marcos salamander critical habitat at 77,226 meter ^{2} (831,338 feet ^{2}) for Spring Lake and 2,750 meter ^{2} (29,604 feet ^{2}) for the area designated downstream of Spring Lake Dam. The slough has a few seeps but lacks large springs. We consider the slough as generally not suitable habitat for San Marcos salamanders. About 40 percent of Spring Lake (30,890 meter ^{2} or 332,531 feet ^{2}) is suitable habitat for San Marcos salamanders. The submerged structure removal aspect of the project is estimated to impact less than 0.3 percent of the critical habitat for San Marcos salamanders.

The constituent elements of San Marcos salamander critical habitat that are most likely to be affected are physical habitat and water quality. Some sediment may be suspended for hours or even days during portions of the project. The duration of the turbidity would be affected by total spring discharge and the extent of the sediment suspension. Turbidity in proximity of spring orifices, where San Marcos salamanders occur, would be generally less than elsewhere in the lake downstream of the structures while they are being removed.

Effects Summary

The number of fountain darters that may be incidentally taken during restoration efforts is 965. Incidental take of San Marcos salamanders is estimated as 732.

V. Cumulative Effects

Cumulative effects include the effects of future State, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act (e.g., permits for the City of San Marcos and TxStU to discharge pollutants in stormwater to the San Marcos River under the Clean Water Act as implemented by the Texas Commission on Environmental Quality and their Texas Pollution Discharge Eliminations System (TPDES) permits).

The recovery plan for these species (Service 1996) discusses the various regional and local threats to these species. Overpumping from the Edwards aquifer remains as one of the most significant regional threats. The Edwards Aquifer Authority recently issued the first of its initial regular permits for groundwater users. Given current aquifer conditions, we believe that the San Marcos springs discharge is not likely to fall below our springflow determinations for the late Judge Lucius Bunton (Table 3) during this calendar year (2005). It is difficult to predict the aquifer conditions during restoration since they may not be realized until 2007. In this biological opinion, we assume that San Marcos springflows (estimated as daily mean discharge) will not fall below 120 cubic feet per second during actual restoration efforts in Spring Lake. If this project is not realized until after December 31, 2008, there may be a need to review and possibly reinitiate formal consultation.

This is based on: (a) an assumption that the Edwards Aquifer Authority management of groundwater will adequately curtail pumping (including flowing artesian discharges), (b) an expectation of average recharge over the next three years, and (c) a review of current aquifer conditions and historical traces of springflows following years of lower than average recharge.

The Bexar County Index Well (J-17) Edwards aquifer level read 697.0 feet mean sea level on April 5, 2005 (29.1 above historical monthly mean). The daily mean discharge of San Marcos Springs was provisionally estimated by the USGS as 293 cubic feet per second for April 3, 2005. The level of the Edwards aquifer is currently above the historical average. However, the Edwards aquifer fell from a record high in 1992 (based in Bexar County Index Well Level) to levels that resulted in mid-1996 San Marcos springflows falling below 80 cubic feet per second (daily mean discharge). In less than four years of less than average recharge, the Edwards aquifer can drop from near its all time high to seriously low levels putting aquifer dependent species at risk.

The population and developments in and around San Marcos are predicted to grow significantly in the near future as the Austin – San Antonio corridor evolves. The upper San Marcos River will continue to be visited by thousands of people floating the river in inner tubes, canoeing / kayaking, swimming and wading. Bradsby (1994) estimated that more than 18,000 people recreated in the San Marcos River (upstream from IH-35) from the end of May 1984 through the first of September 1984. He also estimated that the area currently fenced off (TPWD's Segment A - which he referred to as "Peppers") attracted 15 percent of all users.

Planning for a habitat conservation plan and authorization for incidental take of Texas wild-rice, fountain darters, and San Marcos salamanders is progressing on regional (Edwards Aquifer Authority) and local (City of San Marcos and TxStU) fronts. The Edwards Aquifer Authority is pursuing a section 10(a)(1)(B) permit for impacts to threatened and endangered Edwards aquifer dependent species resultant from its management of wells producing Edwards aquifer water in the region. The City of San Marcos and TxStU are currently planning a joint section 10(a)(1)(B) permit application to cover impacts to threatened and endangered species resulting from university and municipal actions in and near the upper San Marcos River. The take of listed species due to impacts of water recreation could also be addressed and covered by that habitat conservation plan and incidental take permit. Currently, the proposed Texas Rivers Center adjacent to Spring Lake, which is planned to be built as a joint venture of TxStU and Texas Parks and Wildlife Department, may not involve Federal funding. However, it may involve Federal permitting, which would trigger section 7 of the Act and formal consultation.

VI. Conclusion

After reviewing the current status of Texas wild-rice, Comal Springs riffle beetle, fountain darter, and San Marcos salamander, the environmental baseline for the action area, the effects of the proposed action, and cumulative effects, it is the Service's biological opinion that the aquatic ecosystem restoration efforts of the USACE and TxStU at Spring Lake, as proposed, are not likely to jeopardize the continued existence of these species. This is based on: (1) the limited areal extent of the project impacts relative to the areas currently occupied by these species; (2) the likelihood of post-disturbance recolonization of the aquatic habitats near removed structures by fountain darters and San Marcos salamanders; and (3) the assumption of adequate recharge and moderation of groundwater demand.

It is our biological opinion that the project is not likely to adversely modify critical habitats for: (1) Texas wild-rice, (2) fountain darter, and (3) San Marcos salamander. This is based primarily on our understanding of (1) the extent of project related water quality impacts; (2) the limited habitats affected in Spring Lake; and, (3) the short duration of direct effects.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary, and must be undertaken by the USACE so that they become binding conditions of any grant and/or permit issued to the TxStU, as appropriate, for the exemption in section 7(o)(2) to apply. The USACE has a continuing duty to regulate the activity covered by this incidental take statement.

If the USACE: (1) fails to assume and implement the terms and conditions or (2) fails to require TxStU to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. To monitor the impact of incidental take, TxStU must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR §402.14(i)(3)].

Sections 7(b)(4) and 7(o)(2) of the Act generally do not apply to listed plant species. However, limited protection of listed plants from take is provided to the extent that the Act prohibits the removal and reduction to possession of Federally listed endangered plants or the malicious damage of such plants on areas under Federal jurisdiction, or the destruction of endangered plants on non-Federal areas in violation of State law or regulation or in the course of any violation of a State criminal trespass law.

Amount or Extent of Take Anticipated
The Service anticipates that no more than 965 fountain darters will be incidentally taken during construction. We believe that no more than 732 San Marcos salamanders (all from Spring Lake) will be incidentally taken as a result of construction related impacts of the proposed action.

We believe that if impact avoidance measures of proposed construction are used, no damage to nor destruction of Texas wild-rice will occur as a result of the proposed construction. The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. USACE must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

Effect of the take
In the accompanying biological opinion, we have determined that this level of anticipated take is not likely to result in jeopardy to the species. We have also determined that the level of anticipated take will not result in destruction nor adverse modification of critical habitat.

REASONABLE AND PRUDENT MEASURES
Pursuant to section 7(b)(4) of the Act, we believe the following reasonable and prudent measures (RPM) are necessary and appropriate to minimize impacts of incidental take of fountain darters and San Marcos salamanders.

1. Spatial and temporal disturbance of the (a) hydrology, (b) water quality, (c) plants and (d) animals of the San Marcos River due to construction shall be avoided when possible and reduced to the maximum practicable extent where disturbance is unavoidable.

2. Site work will be done with coordination with USACE, and Service.

Terms and conditions
To be exempt from the prohibitions of section 9 of the Act, the USACE, and its partner (TxStU) must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

Terms and conditions that implement RPM #1 (Since the areas of impact are known, limiting the duration of disturbance minimizes impacts . For example, if native vegetation is established in restoration areas soon after clearing, it will be less likely that stormwater will move sediments from the peninsula to the lake-river.):

(1) Work will be actively monitored by a representative from the USACE and/or Texas State University – San Marcos, who will help ensure that actions taken on site are consistent with approved plans and this biological opinion.

(2) Equipment will be readied and mobilized in a manner to minimize the duration for disturbance; an estimate of the time needed to demobilize equipment must be developed and reported to Service with the notification that work is beginning; equipment will be demobilized if a precipitation event and runoff is likely to flood the area.

(3) Work is to be done with careful staging of heavy equipment by the lake and inspections for leakage of hydrocarbons, coolants, and any other fluids is required. If fluid leakage is detected, equipment needs to be repaired and cleaned prior to working in or along the river.

(4) Remove fountain darters and San Marcos salamanders from the surfaces of structures removed from Spring Lake and release in a manner that avoids predation by larger fish. This can be done by releasing darters or salamanders with aquarium nets near plant cover on the lake bed. Another recommendation is to exclude larger fish from an area getting treated with a large (tall) seine.

(5) Sweep habitats vegetation immediately prior to structure removal (within one hour of removal) and repatriate trust species to cover (avoiding predators).

Terms and conditions that implement RPM #2 (Practicable efforts are to be made to minimize pollution risks and physical habitat disturbances to the San Marcos River aquatic community. The turbidity in the San Marcos River due to sediment suspension (as measured on the downstream side of University Drive Bridge) should not exceed 20 nephlometric turbidity units (ntu) for more than 4 hours. Monitoring for turbidity is directed solely at restoration related sources and neither TxStU nor its contractor are considered responsible for extraneous sources of turbidity such as a runoff event in the Sink Creek watershed.):

(1) The stands of Texas wild-rice immediately downstream of the spillways will be monitored for siltation during structure removal. If suspended sediments attributable to restoration efforts are significant enough to prevent photosynthesis by Texas wild-rice, a reassessment of BMPs employed is indicated and more effective measures (revamped or better BMPs) to minimize these impacts should be used and the Service should notified.

(2) Written notification should be made to the Austin Field Office of the Service of: (a) the beginning of work, (b) the end of work, and (c) any notable or unforeseen event that may affect the aquatic community in a manner not considered in this biological opinion. An example of a notable event would be the need to alter the water surface level of Spring

Lake to accommodate boats or barges. Similarly, if it is deemed necessary to disturb aquatic habitats in a manner not described in the project description, we should be notified.

(3) Two surveys for San Marcos salamanders in the vicinity of the Submarine theater will be made following methods described in Nelson (1993). The Service will be available for close coordination with USACE and/or Texas State University to implement appropriate survey personnel, techniques, equipment, and required authorizations/permits. The first survey will take place about one month before structure removal begins. The second survey will take place within one month of the completion of removal of submerged structures. The results of the surveys will be reported to the Service with the annual report of the surveyor-biologist. The report needs to describe the area surveyed, dates and times of surveys, findings, and estimate the local population size based on number of salamanders found beneath rocks overturned and an estimate of the number of rocks available in aquatic habitats.

Persons involved in the effort for term and condition #3 (implementing RPM#2) should have proper equipment and authorizations/permits from the Service (section 10(a)(1)(A) of the Act; 50 CFR 402.14(i)(1)) and Texas Parks and Wildlife Department (Scientific Permits pursuant to Texas Parks and Wildlife Code Chapter 43, subchapter C).

Conservation Recommendations

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. Implementation of the first recommendation may be economical since similar equipment may be used for restoration efforts. We provide the following conservation recommendations:

1. Install the newly fabricated corrugated plastic pipe over Diversion Springs to facilitate the collection and conservation of Edwards aquifer species including the Texas blind salamander;

2. Install and maintain a means of preventing downstream movement (e.g., with an engineered boom—trash rack) from parts of Spring Lake of floating mats of aquatic plants--fragments. This would promote the health and habitat values provided by Texas wild-rice and other rooted macrophytes downstream;

3. Install and maintain structural best management practices to improve the water quality of stormwater runoff from remaining parking lots at the Aquarena Center.

4. Support efforts to further resolve the distribution and habitats of Comal Springs riffle beetles in the vicinity of Spring Lake;

5. Support efforts to protect and conserve habitats of the Texas blind salamander, including Rattlesnake Cave; and,

6. Support efforts to protect and enhance stands of Texas wild-rice in and below Spring Lake.

We request notification of the implementation of any conservation recommendations so we may be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats.

Reinitiation Notice
This concludes formal consultation on the actions outlined in the request. As provided in 50 CFR § 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. If the final action to be carried out differs from the proposed action that our opinion is based on, USACE needs to communicate with the Service to make sure the effects to species and the amount of take are not changed. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation. Reinitiation would be indicated if final plans differ from the proposed action in a manner that additional aquatic habitats or species numbers are impacted.

Thank you for your efforts to protect our nation's trust resources and restore this valuable ecosystem. If you have any questions regarding this biological opinion, please contact Dawn Whitehead of my staff at (512) 490-0057, extension 222.

Sincerely,

Robert T. Pine
Supervisor

Enclosures

cc: Regional Director, Service, Albuquerque, NM

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List of Tables

<u>List of Figures</u>

<u>Appendix</u>

1) Figures from 1980 Critical habitat designations for

1. Texas wild-rice
2. San Marcos gambusia
3. fountain darter, and
4. San Marcos salamander

FEDERALLY LISTED SPECIES	SPRING SYSTEM CASE	To Avoid Take of Animal Species and Avoid Damage to & Destruction of Plant Species	To Avoid Appreciable Reduction of Survival & Recovery ≈ JEOPARDY	To Avoid Adverse Modification of Critical Habitat
		Minimum Springflow CFS	Minimum Springflow CFS	Minimum Springflow CFS
TEXAS WILD-RICE	SAN MARCOS ⊕ ➋	100	100	100
TEXAS WILD-RICE	SAN MARCOS ◊ ➋		< 100 ♦ ⏲	< 100 ♦
FOUNTAIN DARTER	COMAL ⊕ ➊	200		
FOUNTAIN DARTER	COMAL ▣ ➊	150		
FOUNTAIN DARTER	COMAL ⊕ ➋		150 ⏲	
FOUNTAIN DARTER	COMAL ▣ ➋		60 ⏲	
FOUNTAIN DARTER	SAN MARCOS ⊕ ➋	100	100	100
FOUNTAIN DARTER	SAN MARCOS ⊕ ➋		< 100 ⏲	< 100 ♦ ⏲
SAN MARCOS GAMBUSIA	SAN MARCOS ⊕ ➊	100		
SAN MARCOS GAMBUSIA	SAN MARCOS ⊕ ➋		100	100
SAN MARCOS GAMBUSIA	SAN MARCOS ◊ ➋		< 100 ♦ ⏲	< 100 ♦ ⏲
TEXAS BLIND SALAMANDER	EDWARDS AQUIFER ➊	50 ‡		
TEXAS BLIND SALAMANDER	EDWARDS AQUIFER ➋		50 ‡	
SAN MARCOS SALAMANDER	SAN MARCOS ⊕ ➊	60		
SAN MARCOS SALAMANDER	SAN MARCOS ⊕ ➋		60	60

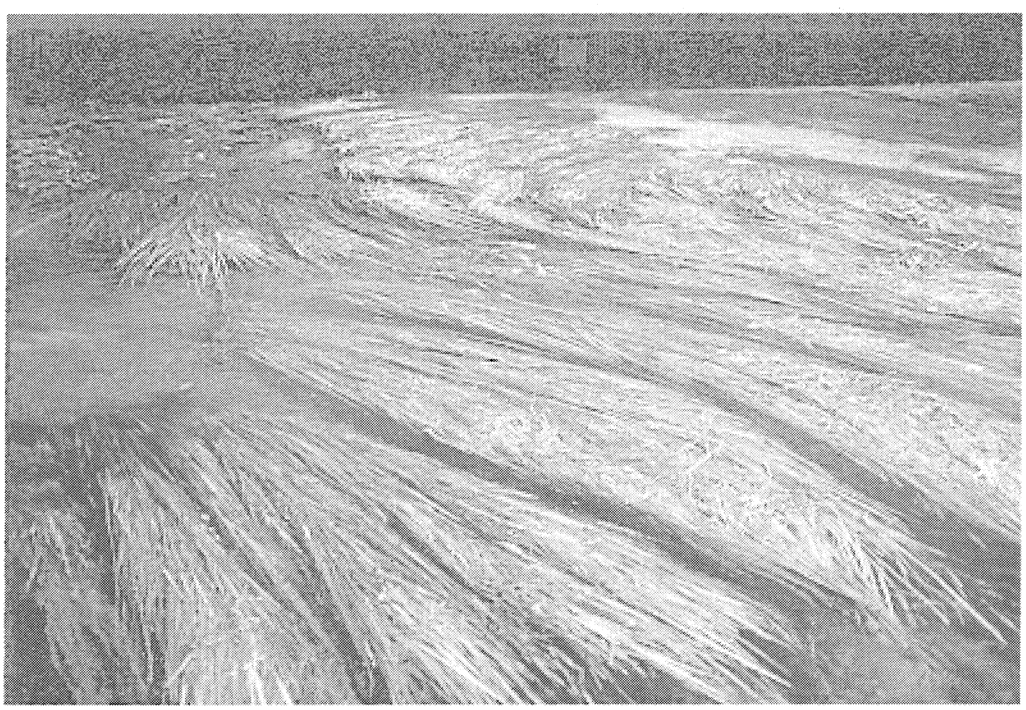
➊ ⇒ 15 April 1993 Letter ➋ ⇒ 15 June 1993 Letter
⊕ ⇒ Given Current [1993] Conditions
▣ ⇒ With Control of snail *Marisa* ◊ ⇒ With Edwards Aquifer Management Plan & Control of Exotics
♦ ⇒ Currently, Cubic Feet per Second (CFS) spring discharge undefined
⏲ For Short (Undefined) Periods of Time ‡ ⇒ Refers to San Marcos Springflow

N.B. These determinations predate the listing of the Comal Springs riffle beetle, Comal Springs dryopid beetle, and Peck's cave amphipod

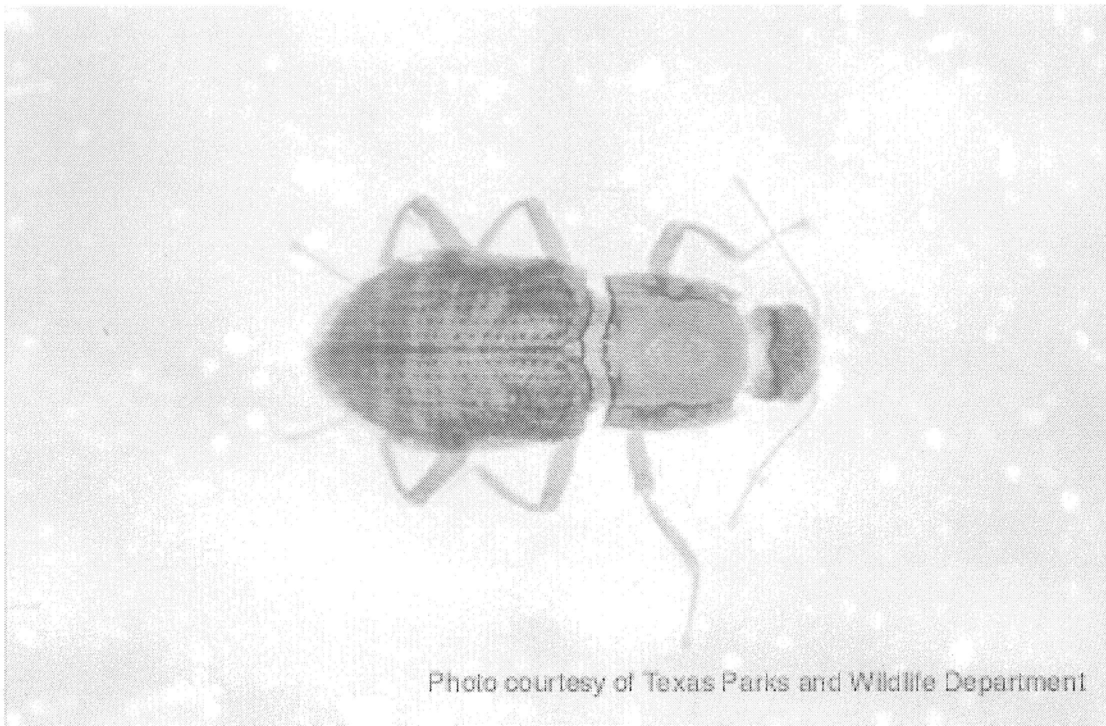
S:\Section 7\Dept of Defense including Corps of Engineers\USACE et al\Hays Co\Spring Lake Sec206 aquatic ecological restoration 2005\FINAL_BO\Final BO ver 13 Spring Lake Aq Eco Restor.doc

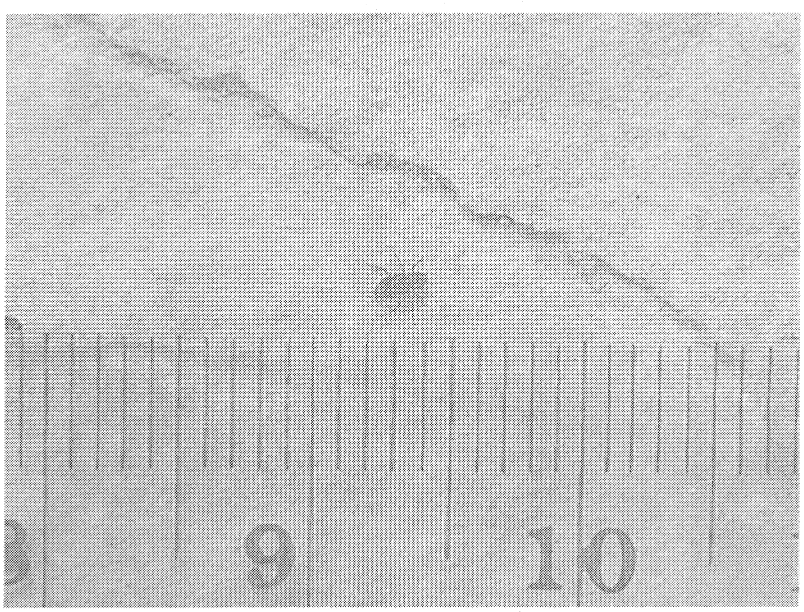
22 June 2005 -- 12:28:55 PM

Texas wild-rice

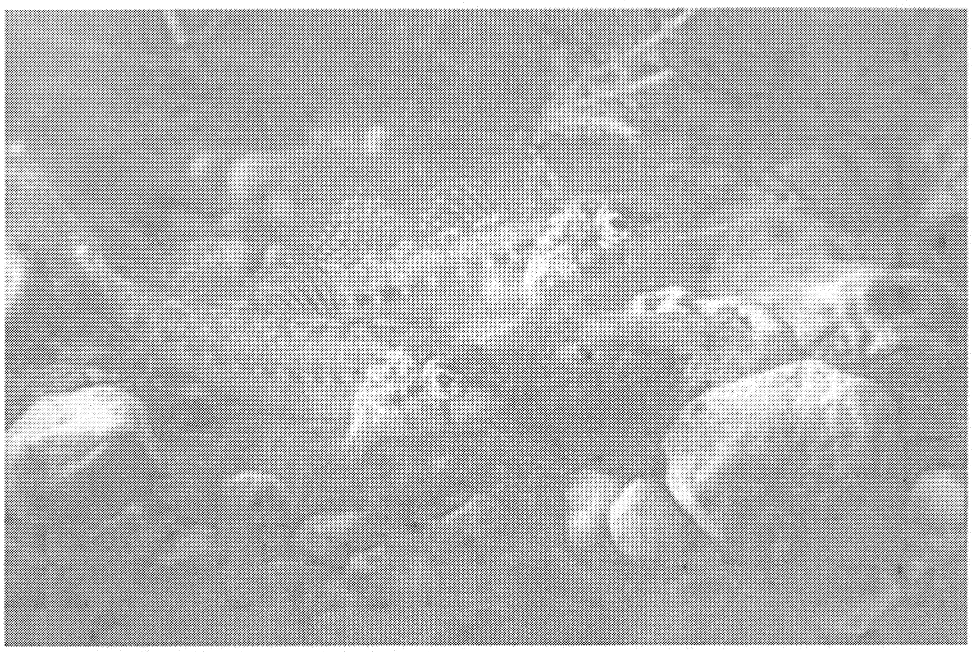


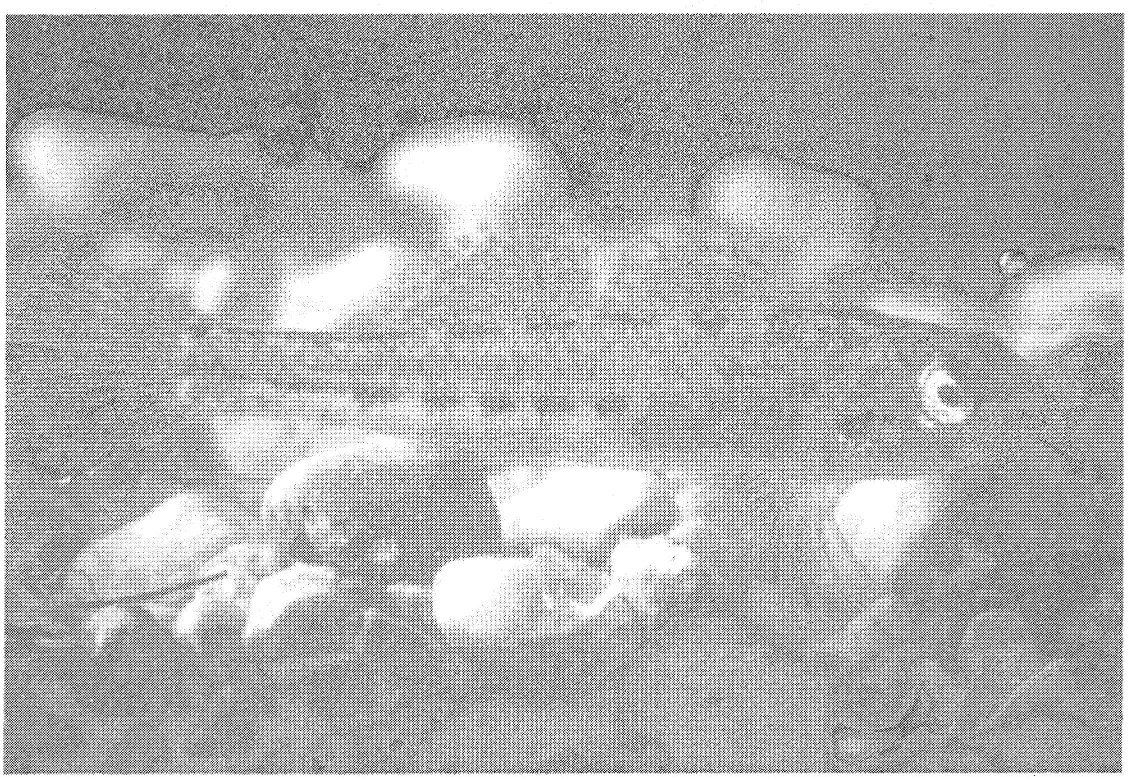
Comal Springs Riffle Beetle



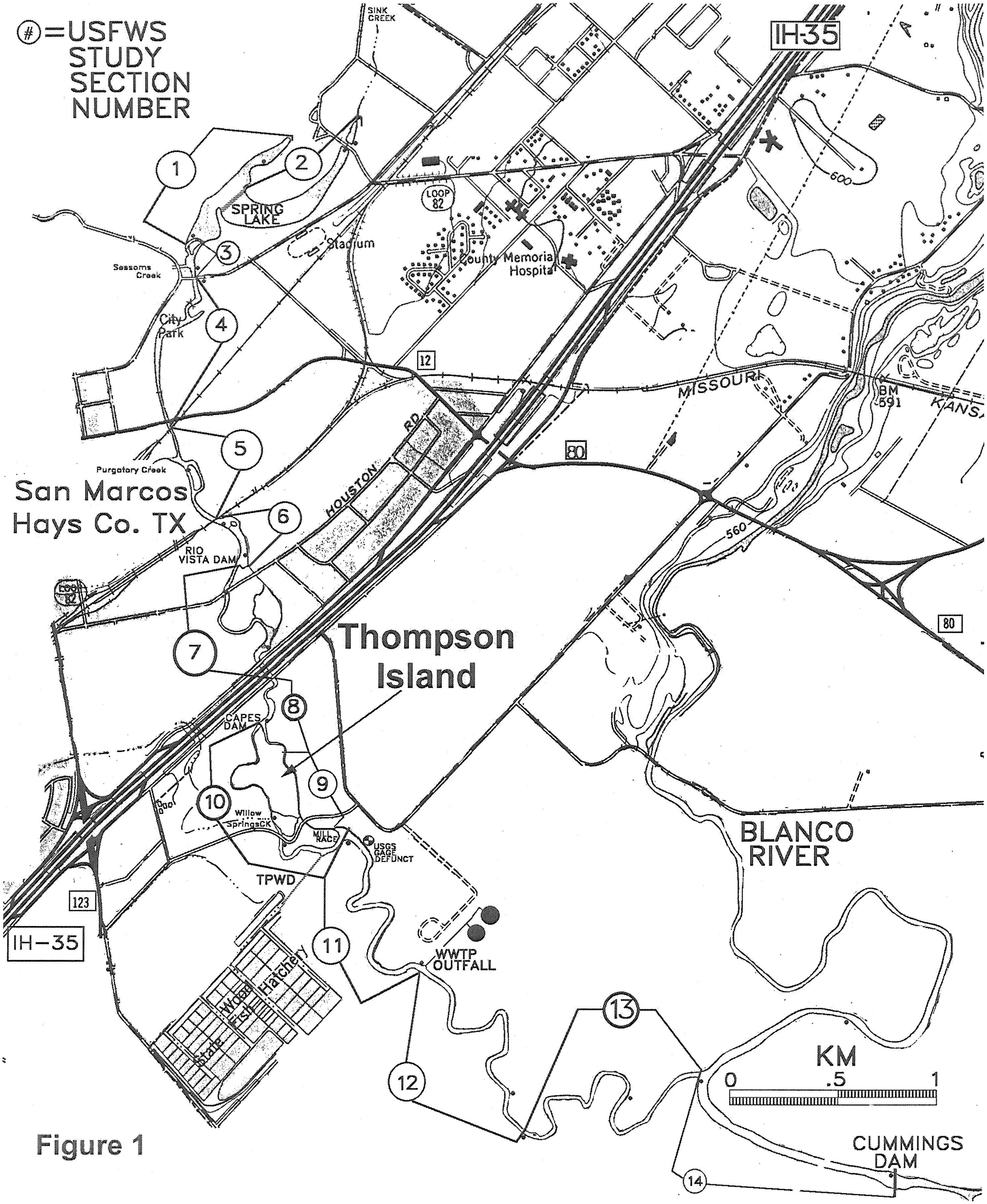


Fountain Darter





San Marcos Salamander



#=USFWS STUDY SECTION NUMBER
SINK CREEK
IH-35
SPRING LAKE
Stadium
LOOP 82
County Memorial Hospital
Sessoms Creek
City Park
12
MISSOURI
BM 591
KANSAS
600
HOUSTON RD
80
Purgatory Creek
San Marcos Hays Co. TX
RIO VISTA DAM
560
Thompson Island
CAPES DAM
Willow SpringsCK
MILL RACE
USGS GAGE DEFUNCT
TPWD
123
IH-35
WWTP OUTFALL
BLANCO RIVER
KM
0
.5
1
CUMMINGS DAM
1
2
3
4
5
6
7
8
9
10
11
12
13
14

Figure 1


Figure 2 - Aquarena Center
U.S. Army Corps of Engineers
Sec. 206 Project Spring Lake
Hays Co. Texas
Submerged_Structures_Removed
Depth-Feet
1 - 2
3
4
5 - 6
7 - 8
9
10
11 - 12
13 - 14
15
16
17
18 - 19
20 - 21
22 - 23
24 - 25
Aquarena Center
N
Meters
0 50 100 200 300 400

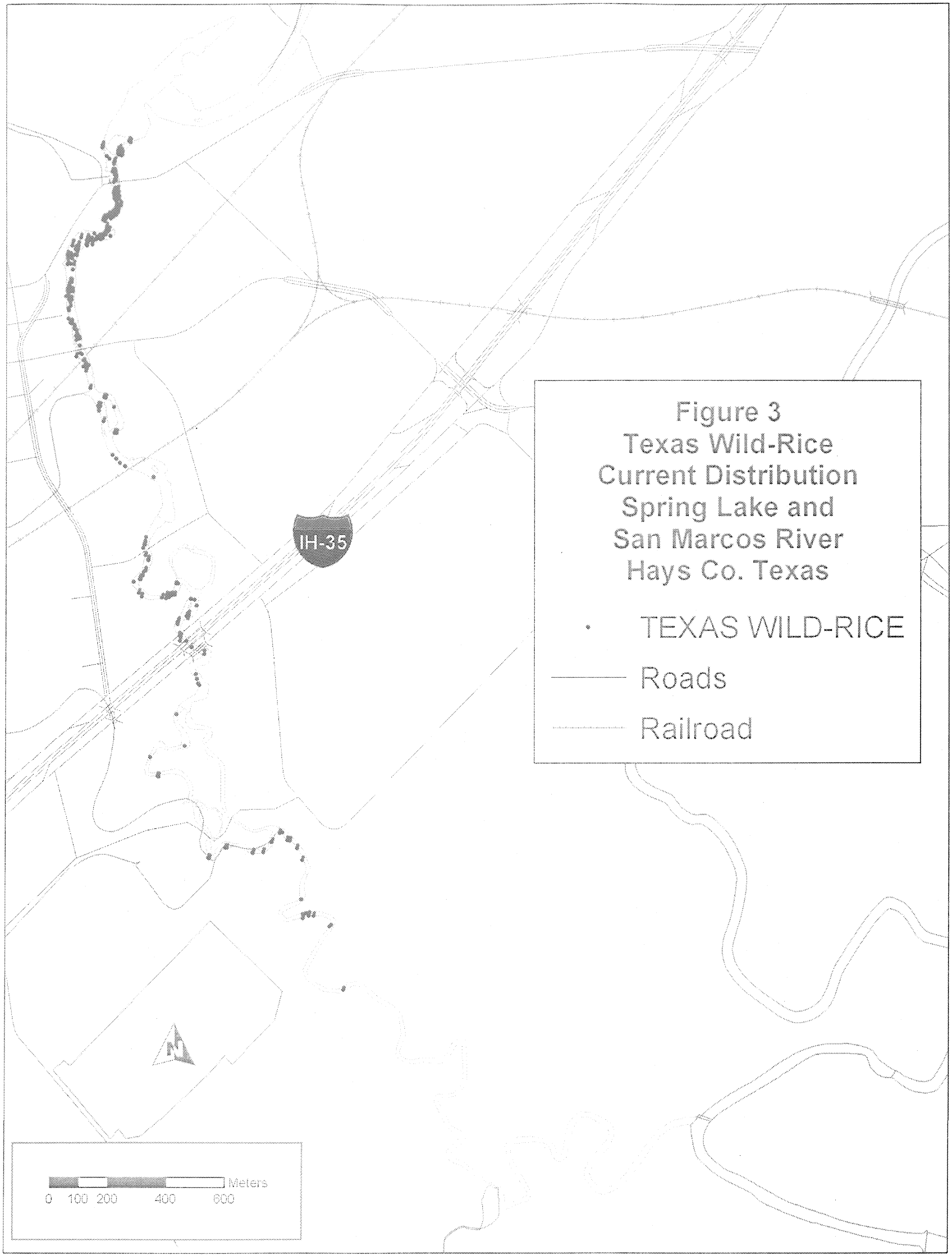


Figure 3
Texas Wild-Rice
Current Distribution
Spring Lake and
San Marcos River
Hays Co. Texas
TEXAS WILD-RICE
Roads
Railroad
IH-35
Meters
0 100 200 400 600

Figure 4

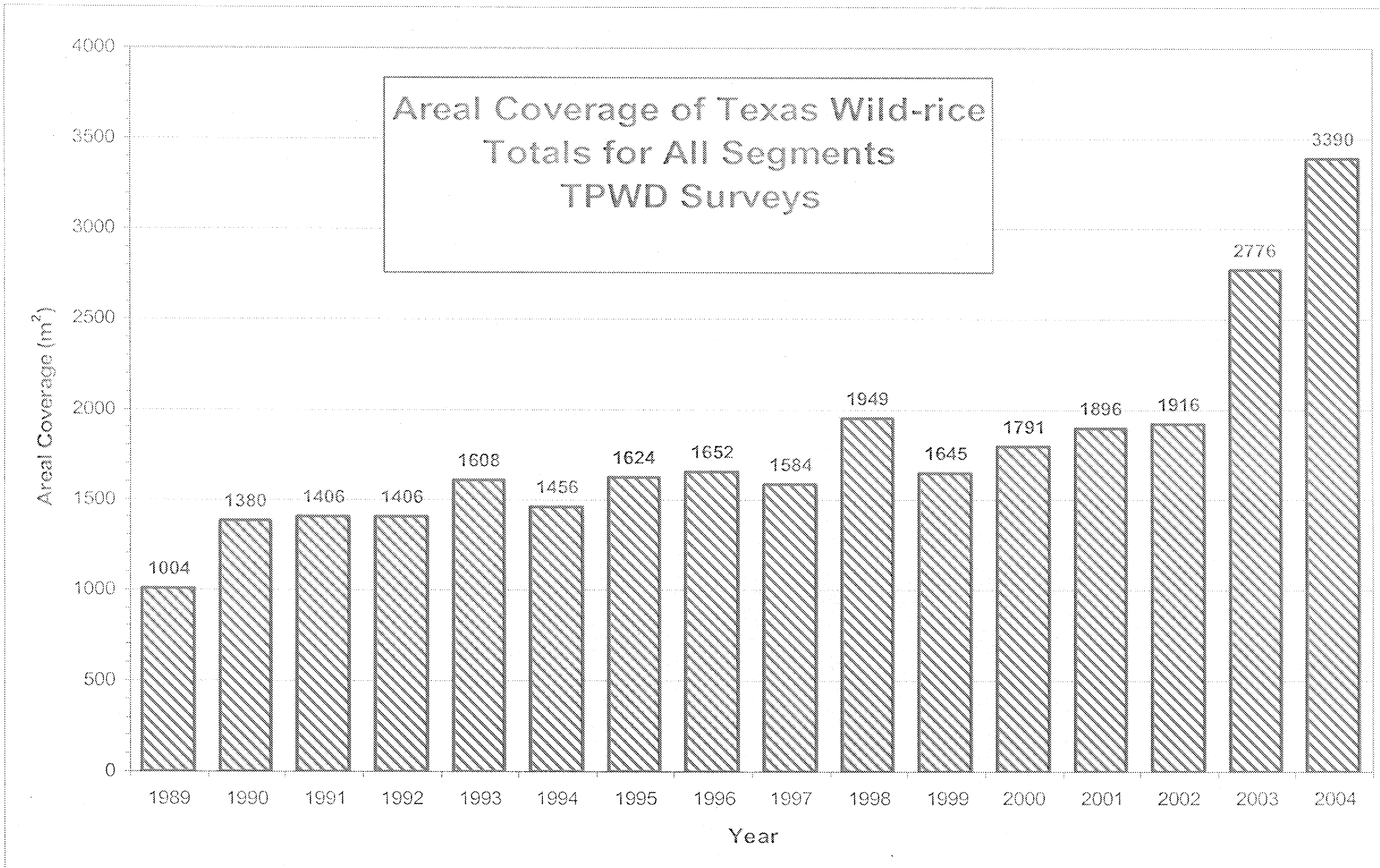

Areal Coverage of Texas Wild-rice
Totals for All Segments
TPWD Surveys
Areal Coverage (m²)
4000
3500
3000
2500
2000
1500
1000
500
0
1004
1380
1406
1406
1608
1456
1624
1652
1584
1949
1645
1791
1896
1916
2776
3390
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
Year

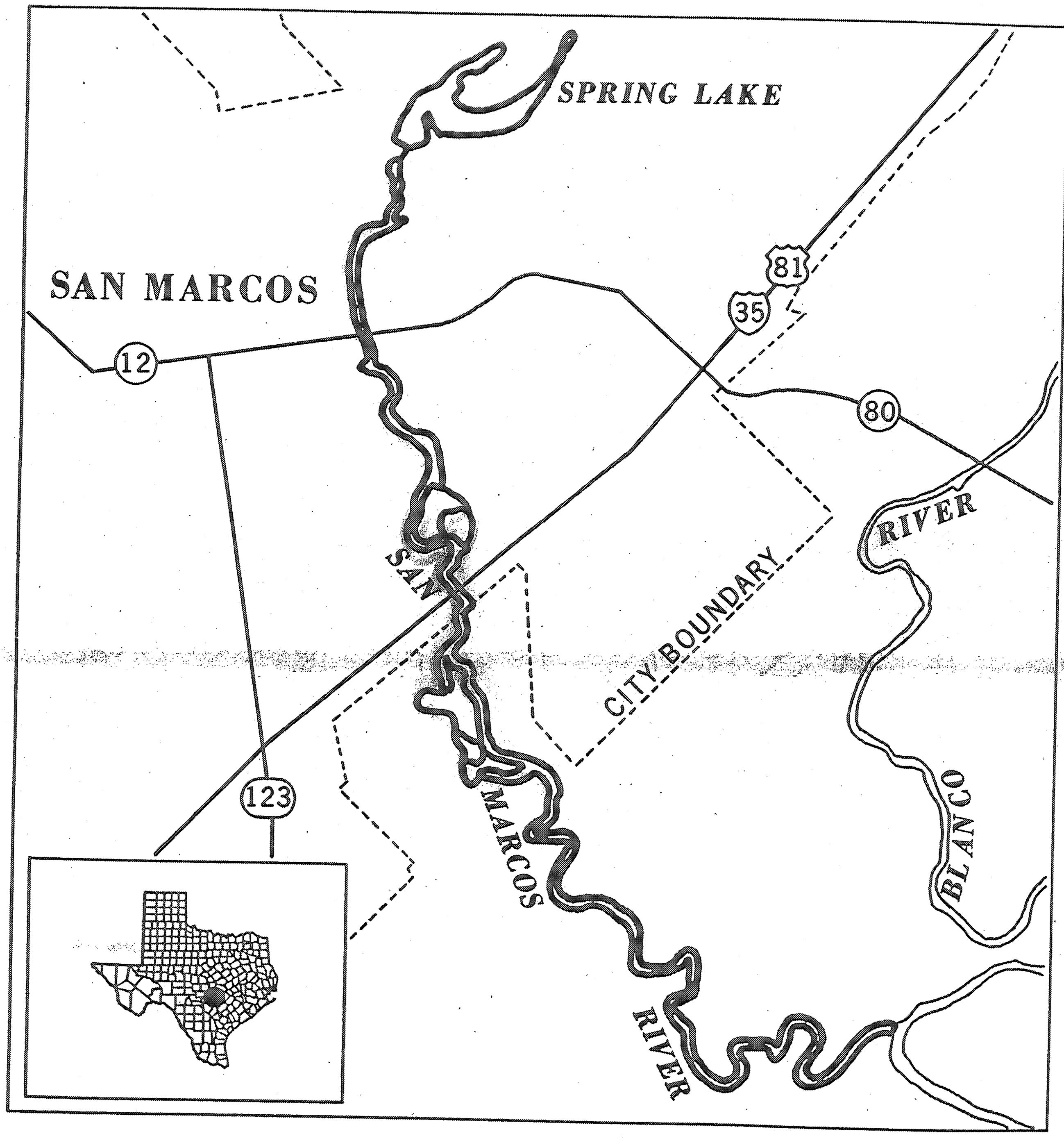
Figure 5
Comal Springs
Riffle Beetle
Recent Sitings
Spring Lake
Hays Co. Texas
Color Image From
LBG-Guyton (2004)
Report

Figure 6
San Marcos Salamander
Sites In and Just Below
Spring Lake Hays Co. Texas

Federally Designated Critical Habitat
(45 FR 47355-47364; July 14, 1980) for

TEXAS WILD RICE

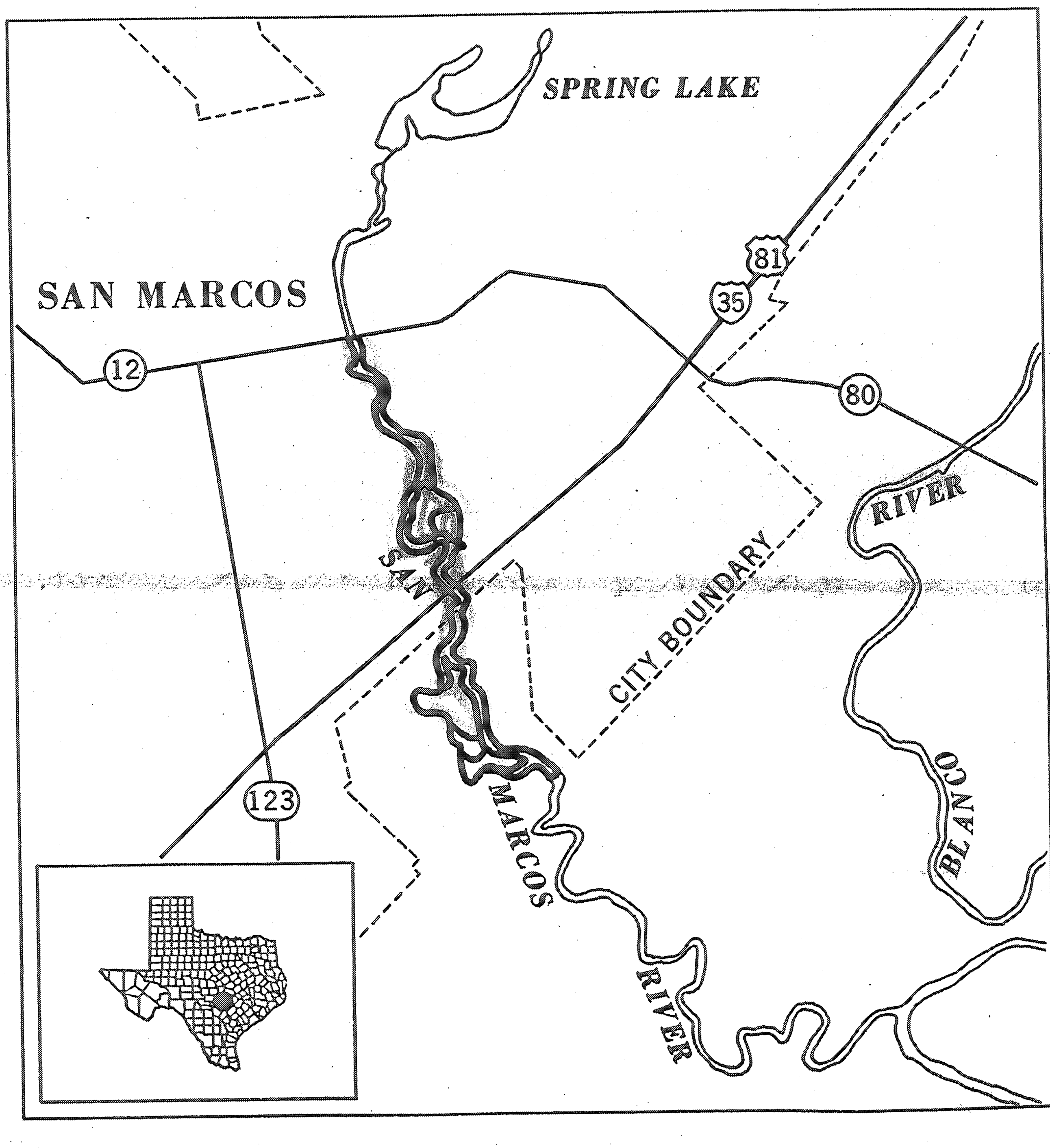
Hays County, TEXAS



Federally Designated Critical Habitat
(45 FR 47355-47364; July 14, 1980) for

SAN MARCOS GAMBUSIA

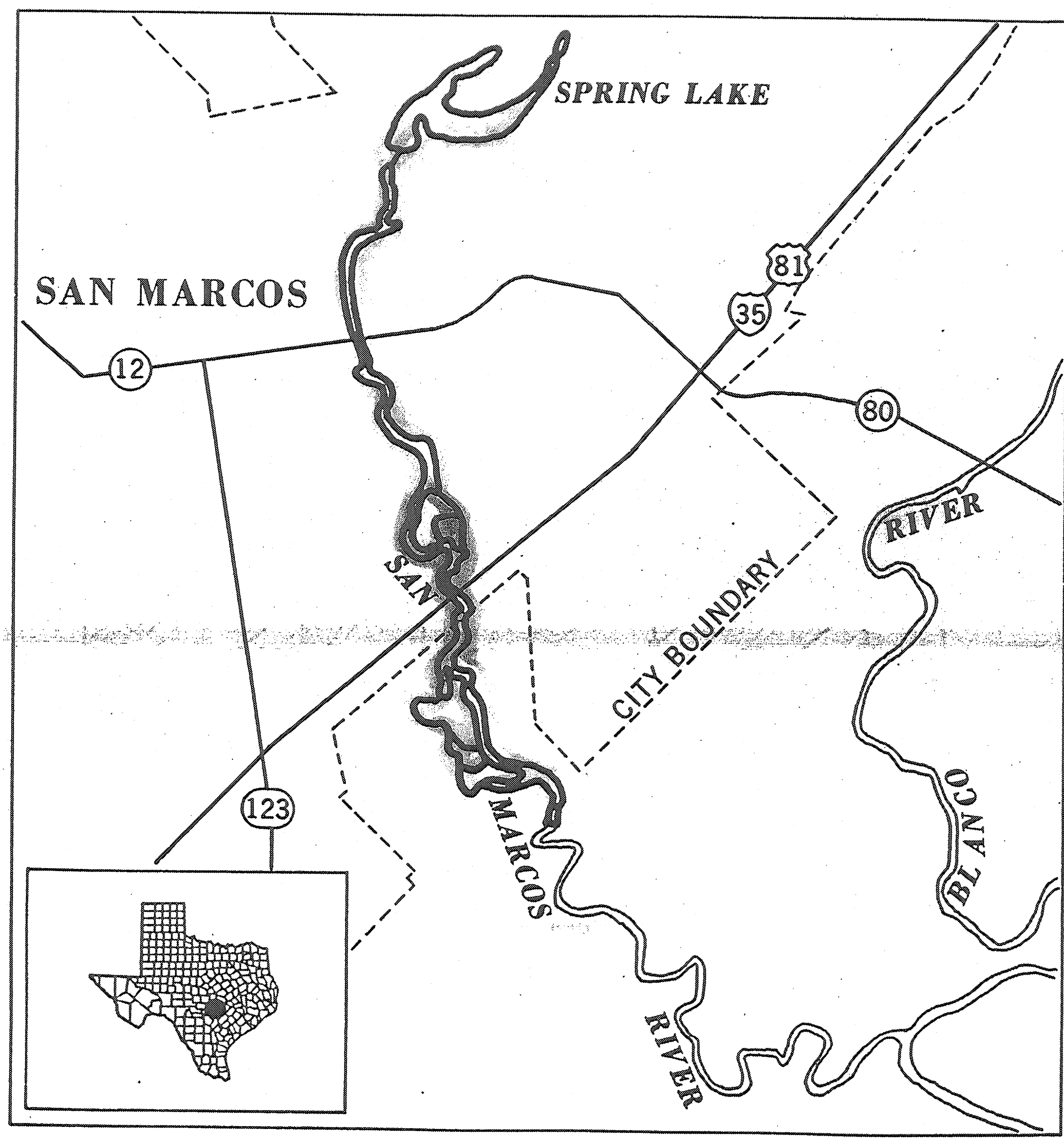
Hays County, TEXAS



Federally Designated Critical Habitat
(45 FR 47355-47364; July 14, 1980) for

FOUNTAIN DARTER

Hays County, TEXAS



Federally Designated Critical Habitat
(45 FR 47355-47364; July 14, 1980) for

SAN MARCOS SALAMANDER

Hays County, TEXAS