United States Department of the Interior

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In Reply Refer To:
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Memorandum

To: Regional Director, Southwest Region

Through: Assistant Regional Director, Ecological Services, Southwest Region

From: Field Supervisor, Austin Ecological Services Field Office, Southwest Region

Subject: Biological Opinion for the Comal County Regional Habitat Conservation Plan--Permit TE-223267-0 (Consultation No. 21450-2011-F-0281)

Enclosed is the biological opinion for the proposed Comal County Regional Habitat Conservation Plan (RHCP) to avoid, minimize, and mitigate adverse effects to the endangered golden-cheeked warbler (*Dendroica chrysoparia*) and the endangered black-capped vireo (*Vireo atricapilla*) from activities described in the RHCP over a period of 30 years. We appreciate your staff's assistance throughout this consultation. If you have any questions regarding this biological opinion, please contact Tanya Sommer at 512-490-0057, extension 222.

This biological opinion is based on Comal County's RHCP and the accompanying Environmental Impact Statement pursuant to the National Environmental Policy Act of 1969; recommendations provided by the Biological Advisory Team and the Citizens Advisory Committee pursuant to Subchapter B, Chapter 83 of the Texas Parks and Wildlife Code; U.S Fish and Wildlife Service's (Service) files; discussions with species experts; published and unpublished literature available on the species of concern and related impacts; and other sources of information available to the Service. A complete administrative record of this consultation is available at the Austin Ecological Services Field Office.

Attachment

TAKE PRIDE IN AMERICA

This transmits our biological opinion for the issuance of a the U.S. Fish and Wildlife Service's (Service) 10(a)(1)(B) permit for the Comal County Regional Habitat Conservation Plan (RHCP), which proposes to minimize and mitigate, to the maximum extent practicable, effects of the incidental take from proposed activities on the endangered golden-cheeked warbler (*Dendroica chrysoparia;* GCWA) and black-capped vireo (*Vireo atricapilla;* BCVI) pursuant to the Endangered Species Act of 1973, as amended (Act)(16 U.S.C. 1531 et seq.). The issuance of a Service permit to authorize incidental take associated with the proposed RHCP is pursuant to 10(a)(1)(B) of the Act and is the proposed action for this intra-Service consultation pursuant to Section 7 of the Act.

Other species listed as threatened or endangered pursuant to the Act or candidate species that may occur in the action area are: the endangered whooping crane (*Grus americana*), Texas blind salamander (*Eurycea rathbuni*), fountain darter (*Etheostoma fonticola*), Peck's cave amphipod (*Stygobromus pecki),* Comal Springs dryopid beetle (*Stygoparnus comalensis*), Comal Springs riffle beetle (*Heterelmis comalensis*), Texas wild-rice (*Zizania texana*) San Marcos gambusia (*Gambusia georgei*); and the threatened San Marcos salamander (*Eurycea nana*). No effect on whooping cranes is expected by implementation of the RHCP; therefore, this species is not discussed further. The remaining species are dependent on the Edwards and/or Trinity (Hill Country segment) aquifers and are not provided incidental take coverage by the proposed permit, but may be affected by the Covered Activities. If take of these species does occur, a major amendment to the permit would be required.

Consultation History

October 16, 2008	Publication in the *Federal Register* of a Notice of Intent (NOI) to prepare an EIS and initiation of the public scoping comment period;
May 6, 2009	Comal County submitted RHCP application package to the Service;
July 2009 through October 2010	The Service provided review and comments on multiple drafts of the RHCP;
June 3, 2010	The Service posted a Notice of Availability of a Draft EIS, notice of receipt of the draft RHCP and permit application, notice of public hearing, and a public comment period in the *Federal Register;*

Definitions

Habitat Conservation Plan – A Habitat Conservation Plan (HCP) accompanies a request for a Service permit (pursuant to 10(a)(1)(B) of the Act) for non-Federal actions to take listed species while ensuring their long-term survival and enhancement. The purposes of the permit and accompanying HCP are to: (1) reduce conflicts between endangered or threatened species and economic activity, and (2) develop partnerships between the public and private sectors. Take authorized pursuant to a 10(a)(1)(B) permit is incidental to, and not the purpose of, the proposed activity.

Effect – The direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action. These effects are considered along with the environmental baseline and the predicted cumulative effects

to determine the overall effects to the species for purposes of preparing a biological opinion on the proposed action (50 CFR §402.02).

Direct effect – Those effects that are direct or immediate effects of the project on the species or its habitat (Service 1998).

Indirect Effect – Those effects that are caused by, or will result from, the proposed action and are later in time, but are still reasonably certain to occur (50 CFR §402.02).

Take – To harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct (16 USC §1532). *Harm* is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. *Harass* is also further defined as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering (50 CFR §17.3).

BIOLOGICAL OPINION

I. Description of Proposed Action

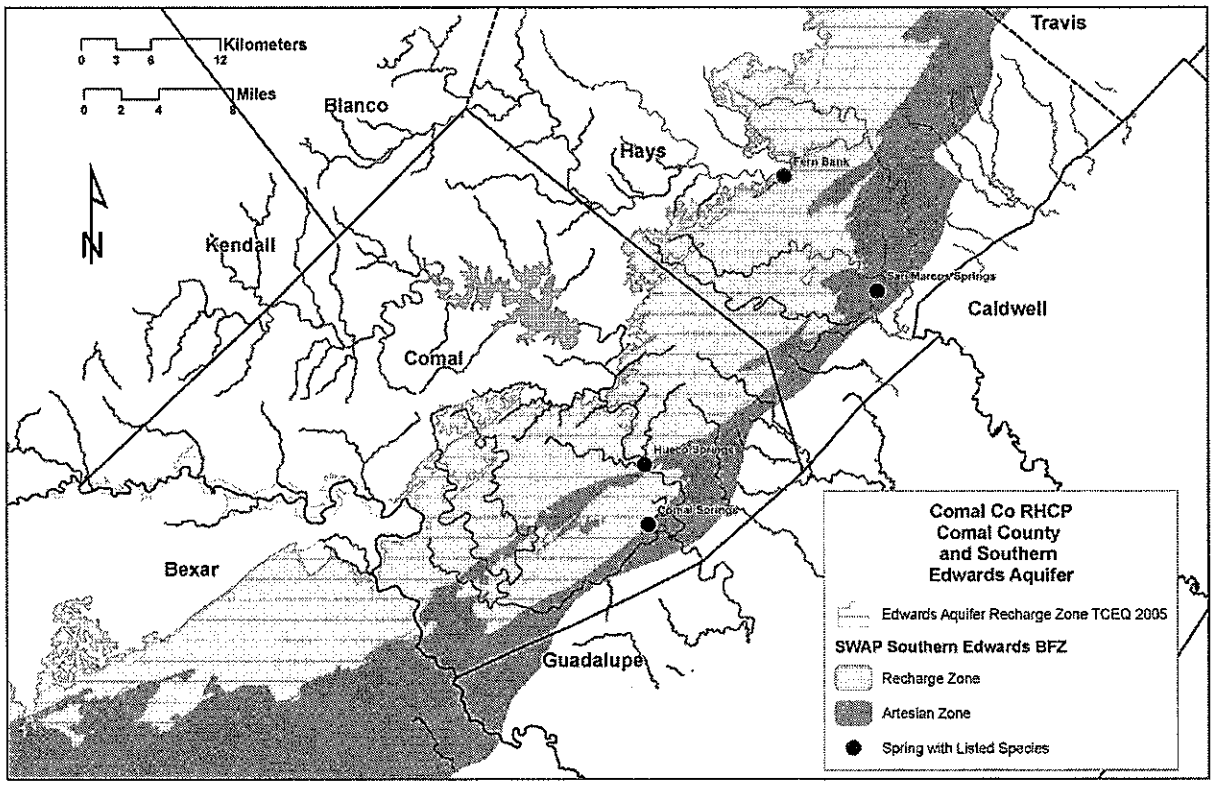
The Service proposes to issue a 10(a)(1)(B) incidental take permit to Comal County. The proposed Federal action associated with the Comal County RHCP and permit application is to issue a section 10(a)(1)(B) incidental take permit (ITP) that will provide a streamlined approach for private citizens, businesses, and other entities in Comal County to comply with the Act when their individual proposed projects may cause adverse effects to the species covered in the proposed RHCP. The proposed RHCP establishes a conservation program that minimizes and mitigates, to the maximum extent practicable, the adverse effects of authorized take of GCWA and BCVI (Covered Species) in Comal County (Permit Area).

Section 7(a)(2) of the Act's implementing regulations defines an action area to be all areas affected directly or indirectly by the Federal action and not merely the immediate area affected by the proposed project (50 CFR § 402.02). For the purposes of this biological opinion, the action area includes the Permit Area and any area where RHCP implementation is expected to affect listed species or designated critical habitat within Comal County. This includes portions of the contributing, recharge, and artesian zones of the Edwards Aquifer in Hays County (Figure 1). This action area does not include the entire Edwards Aquifer because the flow pattern generally trends from west to east. As such, any recharge or water usage occurring in Comal County would only impact the Southern Segment of the Edwards Aquifer in Hays County. There is a geologic divide that occurs in northern Hays County that begins at the Barton Springs segment of the Edwards Aquifer and extends northward. Therefore, water usage in Comal County would not affect the Barton Springs segment (The Edwards Aquifer Area Expert Science Subcommittee for the Edwards Aquifer Recovery Implementation Program [EARIP] 2008).

Population growth in Comal County over the next few decades will drive a variety of new land development and infrastructure projects and result in other land use changes throughout the county. These anticipated land use changes will increasingly come into conflict with sensitive natural resources, including species listed pursuant to the Act. The 30-year permit and accompanying RHCP will provide non-federal project proponents with a streamlined mechanism

to comply with the Act. The RHCP is incorporated here by reference. The following is a summary of the RHCP:

Figure 1. Comal and surrounding counties including the Southern Segment of the Edwards Aquifer and springs with designated critical habitat for species considered in the Biological Opinion.



Non-federal activities covered by the RHCP include, but may not be limited to:

- The construction, maintenance, and/or improvement of roads;
- The installation and maintenance of utility infrastructure, including but not limited to power and cable lines; water, sewer, and natural gas pipelines; and construction of utility plants and other facilities;
- School development or improvement projects; and
- Public and private construction and development.

Section 7 of the Act requires that Federal agencies consult with the Service to ensure that the Federal actions authorized, funded, or carried out by such agencies do not jeopardize the continued existence of any threatened or endangered species or adversely modify or destroy designated critical habitat of such species. Projects that involve Federal agencies must complete section 7 consultation prior to execution of any proposed conservation measures.

Table 1. Summary of the Comal County RHCP elements.

Species	How an Individual Participant's Impacts and Mitigation are Determined	Estimated Impact of the RHCP	Participation Fee Structure	Mitigation Measures
Golden-cheeked Warbler	Based on acres of impact to known and potential habitat patches. Potential impacts will be verified with on-site habitat assessments performed by qualified biologists and will be based on habitat descriptions developed by the TPWD, presence/absence surveys, and/or breeding bird surveys.	Acres of direct and indirect impact: 2,095–5,238 acres[1] Permitted incidental take request: 5,238 acres	Starting at $7,500/acre for impacted golden-cheeked warbler habitat paid by RHCP participants.	Mitigate for impacts up to 5,238 acres of habitat by establishing an estimated 6,548 acres[2] of preserve(s) in the County, normally at a mitigation-to-take ratio of 1:1, but up to 3:1 in some instances[3]. Or mitigate through the purchase of credits from other Service-approved conservation banks whose service areas include Comal County. County will manage all County-owned preserves.
Black-capped Vireo	Same as for golden-cheeked warbler	Acres of direct and indirect impact and permitted incidental take request: 1,000 acres	The County will determine the appropriate fee	Acquire credits from a Service-approved conservation bank; or acquire, preserve, and manage in perpetuity black-capped vireo habitat within the County. Impacts to black-capped vireo habitat would be primarily mitigated at a 1:1 mitigation-to-take ratio (up to 2:1 in some instances).
Evaluation Species[4]	N.A.	N.A.	N.A.	Mitigation measures for Covered Species likely to benefit some or all Evaluation Species. Fund and manage research and public awareness programs. Periodically evaluate effect of beneficial actions and potential need to convert Evaluation Species to Covered Species through a major amendment to the RHCP.

[1] The estimate of impact is based on a projected 50% level of participation in the RHCP, a level that may be exceeded over the life of the RHCP.
[2] The actual preserve acreage will be a function of several unknown factors, including the amount of take eventually authorized through the RHCP, the actual participation rate, future opportunities for land acquisition, and the mitigation ratios to be determined on a project-by-project basis.
3. See the Terms and Conditions of this biological opinion for ratios associated with acreage impacted.
4. Take of these species is not covered by the ITP, nor are they covered by the No Surprises Policy.

Benefits of a Habitat Conservation Plan

The proposed RHCP is anticipated to provide benefits which include, but may not be limited to:

- Conservation of GCWA and BCVI populations in Comal County through perpetual protection and management of habitat for these species;
- Creation of interconnectivity, as recommended by the GCWA Recovery Plan (Service 1992), between larger populations, such as those at Balcones Canyonlands Preserve and Balcones Canyonlands National Wildlife Refuge with those in Hays and Bexar counties;
- Local solutions to endangered species issues that incorporate stakeholder concerns and give long-term permitting assurances pursuant to the Act to the County and RHCP participants;
- New, voluntary options for compliance with the Act that would be available to private citizens, businesses, and other entities in Comal County. These new compliance options would reduce the time and cost associated with obtaining incidental take authorization pursuant to the Act;
- Long-term regional conservation planning to maximize conservation opportunities in a rapidly changing landscape;
- Long-term protection and management of natural resources vital to the health of the region's Hill Country ecosystems, including wildlife, woodlands, and water;
- Protection of open spaces that represent the rural tradition of Comal County and contribute to a high quality of life for all citizens; and,
- Compatibility with other Comal County initiatives to protect open spaces and provide nature-based recreational opportunities.

The proposed RHCP will also compliment other regional conservation efforts in central Texas. Several conservation plans or sustainability programs are under development or currently operating in the region, including the EARIP, the Balcones Canyonlands Conservation Plan (BCP) in Travis County, the Williamson County RHCP, the Hays County RHCP, the Barton Springs-Edwards Aquifer Conservation District HCP (under development), and the Southern Edwards Plateau RHCP (under development). However, the operating areas or missions of these and other central Texas programs do not include incidental take authorization or long-term coordinated protection for the GCWA and BCVI in Comal County.

I. Species Analysis

Because this biological opinion covers both terrestrial and aquatic species, the analysis has been grouped as follows:

A) Terrestrial species (including Status of the Species, Environmental Baseline, and Effects of the Action under each species)
   1) GCWA
   2) BCVI
B) Aquatic species
   1) Background on Aquifers
   2) Status of the Species/Critical Habitat
   3) Environmental Baseline
   4) Effects of the Action
D) Cumulative Effects
E) Conclusion

A. Terrestrial Species

The incidental take that is anticipated to occur over the next 30 years from the Covered Activities are estimates by the applicant and are being authorized as maximum authorized take under this HCP, since not all projects that will be covered by the permit are known at this time. Estimates of the acreage of potential habitat impacted are as described in the Proposed Action section above and in the RHCP.

1. Golden-cheeked warbler

Status of the Species

Species Description and Life History

The golden-cheeked warbler (*Dendroica chrysoparia*, GCWA) was emergency listed as endangered on May 4, 1990 (55 FR 18844). The final rule listing the species was published on December 27, 1990 (55 FR 53160). No critical habitat is designated for this species.

The GCWA is a small, insectivorous songbird, 4.5 to 5 inches long with a wingspan of approximately 8 inches (Pulich 1965 and 1976, Oberholser 1974). Golden-cheeked warblers breed exclusively in the mixed Ashe juniper/deciduous woodlands of the central Texas Hill Country west and north of the Balcones Fault (Pulich 1976). Golden-cheeked warblers require the shredding bark produced by mature Ashe junipers for nest material. Typical deciduous woody species include Texas oak (*Quercus buckleyi*), Lacey oak (*Q. glaucoides*), live oak (*Q. fusiformis*), Texas ash (*Frazinus texensis*), cedar elm (*Ulmus crassifolia*), hackberry (*Celtis occidentalis*), bigtooth maple (*Acer grandidentatum*), sycamore (*Platanus occidentalis*), Arizona walnut (*Juglans major*), and pecan (*Carya illinoinensis*) (Pulich 1976, Ladd 1985, Wahl *et al.* 1990). Breeding and nesting GCWAs feed primarily on insects, spiders, and other arthropods found in Ashe junipers and associated deciduous tree species (Pulich 1976).

Male GCWAs arrive in central Texas around March 1st and begin to establish breeding territories, which they defend against other males by singing from visible perches within their territories. Females arrive a few days later, but are more difficult to detect in the dense woodland habitat (Pulich 1976). Three to five eggs are generally incubated in April, and unless there is a second nesting attempt, nestlings fledge in May to early June (Pulich 1976). If there is a second nesting attempt, it is typically in mid-May with nestlings fledging in late June to early July (Pulich 1976). By late July, GCWAs begin their migration south (Chapman 1907, Simmons 1924). Golden-cheeked warblers winter in the highland pine-oak woodlands of southern Mexico and northern Central America (Kroll 1980).

Historic and Current Distribution

The GCWA's entire breeding range occurs on the Edwards Plateau and Lampasas Cut Plain of central Texas. Golden-cheeked warblers have been confirmed in 39 counties: Bandera, Bell, Bexar, Blanco, Bosque, Burnet, Comal, Coryell, Dallas, Eastland, Edwards, Erath, Gillespie, Hamilton, Hays, Hill, Hood, Jack, Johnson, Kendall, Kerr, Kimble, Kinney, Lampasas, Llano, Mason, McLennan, Medina, Menard, Palo Pinto,

Real, San Saba, Somervell, Stephens, Tom Green, Travis, Uvalde, Williamson, and Young. However, many of the counties where it is known to occur, now or in the past, have only small amounts of suitable habitat (Pulich 1976, Service 1996b, Lasley et. al. 1997). Diamond (2007) estimated that the amount of suitable GCWA habitat across the species' range was approximately 4.2 million acres, much of this habitat occurring on private lands. As a result, the population status for the GCWA on private lands remains undocumented throughout major portions of the breeding range.

Reasons for Decline and Threats to Survival

Before 1990, the primary reason for GCWA habitat loss was juniper clearing to improve conditions for livestock grazing. Since then, habitat loss has occurred as suburban developments spread into prime GCWA habitat. Groce *et al.* (2010) summarized the rates of expected human population growth within the range of the GCWA and found by 2030 the growth rate ranges from 17 percent around the Dallas-Fort Worth area to over 164 percent around San Antonio. As the human population continues to increase, so do associated roads, single and multi-family residences, and infrastructure, resulting in continued habitat destruction, fragmentation, and increased edge effects (Groce *et al.* 2010).

Fragmentation is the reduction of large blocks of habitat into several smaller patches. While GCWAs have been found to be reproductively successful in small patches of habitat (<50 acres), there is an increased likelihood of occupancy and abundance as patch size increases (Coldren 1998, Butcher *et al.* 2010, DeBoer and Diamond 2006). Increases in pairing and territory success are also correlated with increasing patch size (Arnold *et al.* 1996, Coldren 1998, Butcher *et al.* 2010). In addition, while some studies have suggested that small patches that occur close to larger patches are likely to be occupied by GCWAs, the long-term survival and recovery of the GCWA is dependent on maintaining the larger patches (Coldren 1998, Peterson 2001, The Nature Conservancy [TNC] 2002).

As GCWA habitat fragmentation increases the amount of GCWA habitat edge, where two or more different vegetation types meet, also increases. For the GCWA edge is where woodland becomes shrubland, grassland, a subdivision, etc., and depending on the type of edge, it can act as a barrier for dispersal; act as a territory boundary; favor certain predators; increase nest predation; and/or reduce reproductive output (Johnston 2006, Arnold *et al.* 1996). Canopy breaks (the distance from the top of one tree to another) as little as 36 feet have been shown to be barriers to GCWA movement (Coldren 1998). Territory boundaries have not only been shown to stop at edges, but GCWAs are more often farther from habitat edges (Beardmore 1994, DeBoer and Diamond 2006, Sperry 2007).

Other threats to GCWAs include the clearing of deciduous oaks upon which the GCWA forage, oak wilt infection in trees, nest parasitism by brown headed cowbirds (Engels and Sexton 1994), drought, fire, stress associated with migration, competition with other avian species, and particularly, loss of habitat from urbanization (Ladd and Gass 1999). Human activities have eliminated GCWA habitat throughout their range, particularly areas associated with the I-35 corridor between the Austin and San Antonio metropolitan areas.

Range-wide Survival and Recovery Needs

The recovery strategy outlined in the Golden-cheeked Warbler Recovery Plan (Service 1992), which is currently being revised, divides the breeding range of the GCWA into eight regions, or units, and calls for the protection of sufficient habitat to support at least one self-sustaining population in each unit (Figure 2). These recovery units were delineated based primarily on watershed, vegetation, and geologic boundaries (Service 1992).

Based on the Golden-cheeked Warbler Recovery Plan (Service 1992), protection and management of occupied habitat and minimization of degradation, development, or environmental modification of unoccupied habitat necessary for buffering nesting habitat are necessary to provide for the survival of the species. Habitat protection must include elements of both breeding and non-breeding habitat (i.e., associated uplands and migration corridors). Current and future efforts to create new and protect existing habitat will enhance the GCWA's ability to expand in distribution and numbers. Efforts, such as land acquisition and conservation easements, to protect existing viable populations is critical to the survival and recovery of this species, particularly when rapidly expanding urbanization continues to result in the loss of prime breeding habitat.

According to the Golden-cheeked Warbler Population and Habitat Viability Assessment Report (Service 1996b) (Golden-cheeked warbler PHVA) a viable population needs to consist of at least 3,000 breeding pairs. This and other population viability assessments on GCWAs have indicated the most sensitive factors affecting their continued existence are population size per patch, fecundity (productivity or number of young per adult), and fledgling survival (Service 1996b, Alldredge *et al.* 2002). These assessments estimated one viable population will need a minimum of 32,500 acres of prime unfragmented habitat to reduce the possibility of extinction of that population to less than five percent over 100 years (Service 1996b). Further, this minimum carrying capacity threshold estimate increases with poorer quality habitat (e.g., patchy habitat resulting from fragmentation).

Several State and federally owned lands occur within the breeding range of the GCWA, but the overriding majority of the species' breeding range occurs on private lands that have been either occasionally or never surveyed (Service 1992). Currently there are four large GCWA populations receiving some degree of protection: those at the Balcones Canyonlands Preserve in Travis County; the nearby Balcones Canyonlands National Wildlife Refuge (NWR) in Travis, Burnet, and Williamson counties; Camp Bullis Military Installation in Bexar County; and the Fort Hood Military Reservation in Coryell and Bell counties. There are also several conservation banks (CB) whose goal is to protect GCWA habitat (acreages represent the total if the entire bank of credits are sold) : Hickory Pass CB (3,003 acres) in Burnet County, Majestic Ranch CB (495 acres) in Kendall County, and Bandera Canyonlands CB (4,363 acres) in Bandera and Real counties.

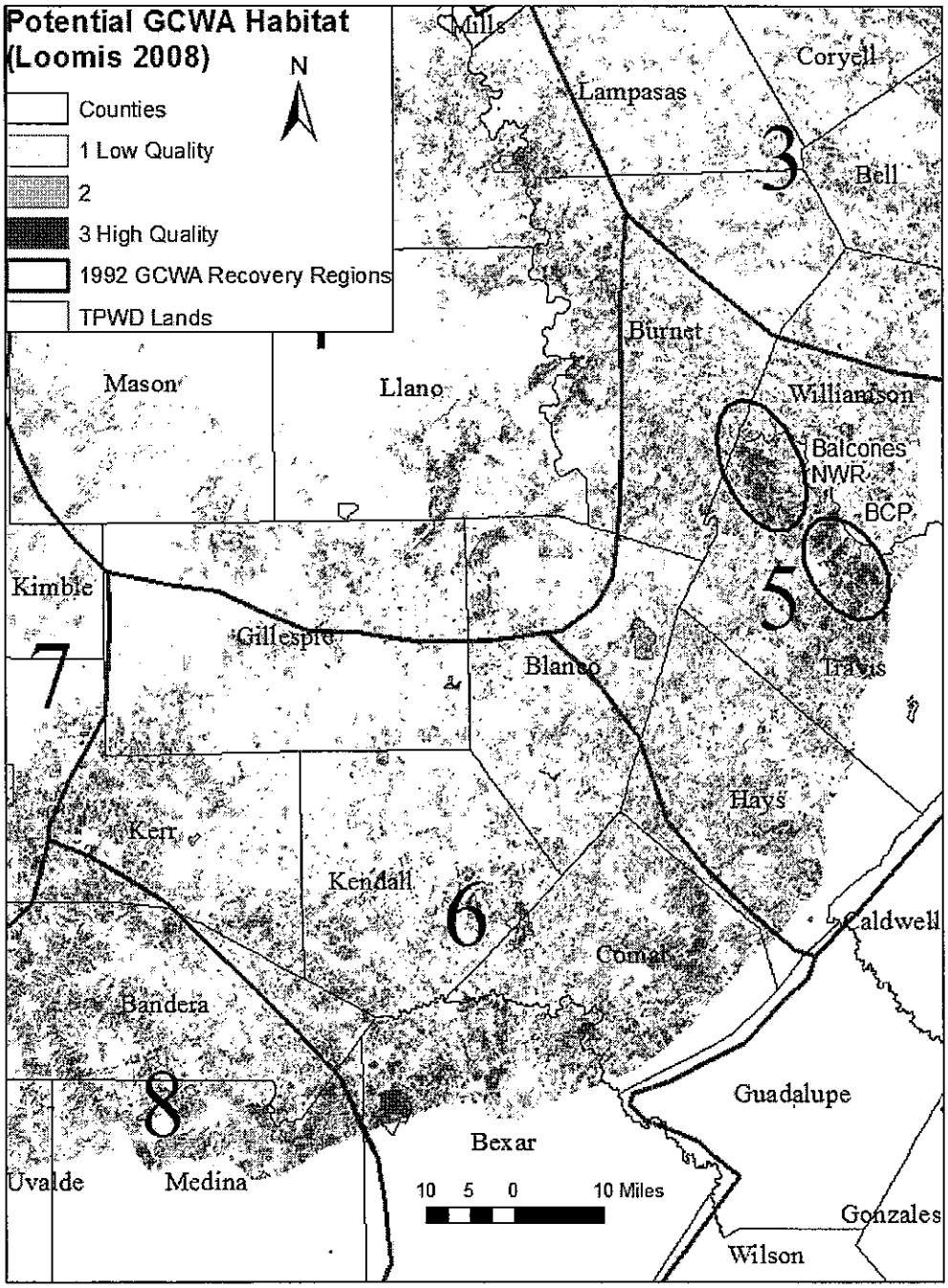


Figure 2: GCWA Recovery Regions (Service 1992) and potential GCWA habitat (Loomis Partners 2008).

Environmental Baseline

No recent county-wide surveys have been conducted and no current population estimates for Comal County have been reported. Pulich (1976) estimated that the GCWA population in Comal County had declined from approximately 1,140 individuals in 1962 to 940 individuals by 1974. In the absence of recent population data, acres of potential habitat are relied upon to estimate species status within the action area.

The GCWA Recovery Plan (Service 1992) places Comal County in Recovery Region 6 along with Kendall County and portions of Gillespie, Blanco, and Kerr counties. The Recovery Plan estimates of potential habitat range from 244,106 acres to 769,581 acres (SWCA 2007, and model "C" in Diamond 2007, respectively). A total of approximately 28,950 acres of public and protected lands within Recovery Unit 6 contain forest land cover that may represent potential GCWA habitat (Groce *et al.* 2010). This estimate, however, includes all forest cover classes, and, therefore, likely overestimates the amount of suitable GCWA breeding habitat.

Estimates of potential habitat within Comal County range from 20,000 acres (Pulich 1976) to as many as 174,410 acres (Loomis Partners 2008). A total of approximately 1,592 acres of potentially suitable habitat are found within public or private lands in Comal County, primarily within TPWD's Honey Creek State Natural Area and Guadalupe River State Park, Bat Conservation International's Braken Bat Cave and Nature Reserve, and Comal County's Morton GCWA Preserve.

According to our consultations tracking database, there have been 48 formal section 7 consultations on the GCWA range-wide. The action area these consultations covered was over 70.8 million acres. Four of these consultations were on Fort Hood; therefore, we've only counted that action area once in the total area covered by formal consultations. One consultation covered almost half of Texas at 60 million acres. Over 60,290 acres of GCWA habitat were authorized to be impacted by these consultations. Several large consultations make up the majority (over 52,000) of this acreage: 1) over 33,000 acres were associated with Fort Hood activities; 2) over 14,000 acres were associated with brush control projects throughout the GCWA's 35 county range; and 3) 5,000 acres were for activities on Camp Bullis, less than 15 percent of which was considered occupied. The result of these consultations is over 63,000 acres of GCWA habitat maintained on Department of Defense (DOD) land and over 68,000 acres of private land preserved and/or maintained for the benefit of the GCWA.

Additionally, we have issued 132 individual 10(a)(1)(B) incidental take permits covering more than 69 million acres (note: this is the permit/action area, not the actual acres of impacted habitat). Since 2006, we've authorized impacts to over 19,500 acres of GCWA habitat, 6,000 of which was authorized under Williamson County's RHCP, 3,000 of which were authorized as part of Oncor's programmatic HCP, 9,000 of which was authorized as part of Hays County's RHCP, and 1,100 of which was part of LCRA's CREZ HCP. The result of all HCPs is over 53,000 acres of land preserved and/or maintained for the benefit of the GCWA.

According to our consultations database, there have been no 10(a)(1)(B) incidental take permits issued within Comal County. However, there has been one formal section 7

consultation on GCWAs in Comal County as part of a flood control project. This consultation authorized impacts to 54 acres of GCWA habitat and resulted in the preservation of 600 acres of GCWA habitat.

Effects of the Action

The Service is authorizing Comal County to directly impact a total of 5,238 acres of GCWA habitat from Covered Activities. See section 2.2.1.4 of the RHCP for the methods used to determine acreage estimates.

Indirect effects of the action include both the direct and indirect impacts of implementing the RHCP. Direct impacts from implementation of the RHCP include habitat removal, degradation, and/or fragmentation. Indirect impacts from implementation of the RHCP could occur from increased edge, which can increase the presence of nest predators and parasites, and reduction in patch quality and overall habitat suitability.

Of the estimated 4.2 million acres (Diamond 2007) of potential GCWA habitat throughout the range, SWCA estimated the action area contains at most approximately 65,581 acres of potential habitat. The amount of habitat proposed to be impacted is 0.12 percent of all GCWA habitat range-wide, 0.68 percent within recovery region 6 (Diamond 2007), and 8 percent of habitat within the action area. Additionally, Comal County will assess habitat suitability and/or occupancy on a project-by-project basis to more accurately quantify take. Furthermore, to reduce adverse impacts to GCWAs from the Covered Activities Comal County will: 1) make available to the public maps of potential habitat; 2) require RHCP participants to abide by the seasonal clearing restrictions to avoid immediate impacts to GCWAs during the breeding season; and 3) develop a public education and outreach program to educate landowners and residents about GCWAs and the RHCP.

With regard to a conservation strategy for the GCWA within Recovery Region 6, there is still a significant amount of potential GCWA habitat (Loomis Partners 2008). So much so, that there could easily be at least two focal areas: one encompassing northeastern Bexar County and Comal County and another encompassing northwestern Bexar County, Medina, Bandera, and Kendall counties. Comal County will play a pivotal role in not only forming a focal area, but also maintaining connectivity with Hays County and the larger preserves of the BCP and Balcones Canyonlands NWR to the north, thus maintaining the genetic diversity between the recovery regions.

While the exact number of acres of GCWA habitat that will be impacted, and will therefore need to be mitigated for, is not currently known, a maximum impact has been estimated for GCWAs. Comal County proposes a base mitigation ratio (acres of habitat preserved to acres impacted) of 1 acre preserved for every 1 acre of impact to GCWA habitat. It is recognized that in some instances impacted habitat will be of a higher quality than the average in Comal County and in these cases a higher mitigation ratio may be justified. In such cases, the County will, based on quantification of habitat values, either: 1) deny participation of a land development project if impacts would preclude realization of biological goals and objectives, or 2) increase the mitigation ratio. Habitat quality will be evaluated by a Service-approved biologist using TPWD guidelines (Campbell 2003), and the appropriate mitigation ratio will be determined by RHCP staff and approved by the Service based on the habitat evaluation. Indirect impacts (impacts

that occur in GCWA habitat adjacent to destroyed or modified habitat) will be assessed at 50 percent of the value of direct impacts for a distance of 300 feet from the edge of the direct impacts.

When an RHCP participant's property is found to contain high-quality habitat and is adjacent to high-quality habitat, and/or is known to support an unusually high density of GCWAs (e.g., 17–20 acres per pair), the mitigation ratio may be adjusted from 1:1 to as much as 3:1. Specifically, high-quality habitat that may require an increased mitigation ratio may be defined as any portion of a block of mature woodland 250 acres or greater in size, or contiguous to a block of woodland 250 acres or greater in size, that supports an overstory canopy of Ashe juniper and mixed hardwoods with average tree heights in excess of 20 feet and with 70–100 percent canopy closure. The highest mitigation ratio would occur when the woodland proposed for impact would be of the highest quality for GCWAs *and* is within or adjacent to an existing RHCP preserve, or within a large and undisturbed patch of habitat that is also occupied by high densities of GCWAs. This level of mitigation supports the conservation strategy for the GCWA and will contribute to overall recovery by permanently preserving more acreage than is removed and by focusing that mitigation into larger parcels, when acreage impacted will likely come from smaller parcels throughout the action area.

Any mitigation will meet a minimum standard of criteria, including blocks of high quality habitat at least 500 acres in size with a low edge to area ratio, confirmation of GCWA presence, a site that is sustainable into the future (such that it has low levels of adjacent urbanization and low oak wilt presence), and will be managed and monitored in perpetuity. Additionally, the mitigation should support the recovery and conservation strategy of the species by protecting habitat in Recovery Region 6 that helps secure a viable population of the species.

Comal County has a goal of establishing a preserve system of up to 6,500 acres over the life of the permit. If all authorized direct take of GCWA habitat is realized, at least 5,238 acres of the preserve system will be GCWA habitat. Lands within the preserve system could be County owned, but may also include preserves owned and/or managed by other cooperators such as local municipalities, conservation organizations, or private landowners that agree to manage in accordance with the RHCP. Regardless of ownership, to count toward the preserve system, the preserve must be managed in perpetuity to benefit one or more of the Covered Species.

Critical habitat has not been designated for the GCWA; therefore no adverse modification of critical habitat will occur.

2. Black-capped vireo

Status of the Species

Species Description and Life History
The BCVI was federally listed as endangered on October 6, 1987 (52 FR 37420-37423). No critical habitat has been designated for this species.

The BCVI is a 4.5 inch long, insectivorous songbird (Service 1991). Although BCVI

habitat throughout Texas is quite variable with respect to plant species, soils, and rainfall, habitat types generally have a similar overall appearance. The BCVI typically inhabits shrublands and open woodlands with a distinctive patchy structure. The shrub vegetation generally extends from the ground to about six feet above ground and covers about 30 to 60 percent of the total area. In the Edwards Plateau, common plants in BCVI habitat include Texas oak (*Quercus texana*), shin oak (*Q. sinuata*), live oak (*Q. virginiana & Q. fusiformis*), mountain laurel (*Sophora secundiflora*), sumac (*Rhus.* sp), redbud (*Cercis canadensis*), Texas persimmon (*Diospyros texana*), mesquite (*Prosopis glandulosa*), and agarita (*Mahonia trifoliata*). In the Edwards Plateau, suitable habitat for the BCVI often includes early successional scrub/shrub created by fire or woodland clearing. Black-capped vireos are opportunistic foragers; however, they prefer insect larvae and seeds (Grzybowski 1995).

Male BCVI arrive in central Texas in late March and begin to establish breeding territories, which they defend against other males by singing within their territories. The females arrive a few days later, but are more difficult to detect in the dense brushy habitat. Three to four eggs are generally incubated in April, and unless there is a second nesting attempt, nestlings fledge in May to early June. In mid-July, BCVI's begin their migration south, beginning with females and young and followed by adult males (Campbell 2003, Graber 1957, Oberholser 1974). Typically, BCVI's are gone from Texas by mid-September.

Historic and Current Distribution

Black-capped vireos breed from Oklahoma south through central Texas to the Edwards Plateau, then south and west to central Coahuila, Nuevo Leon, and southwestern Tamaulipas, Mexico, and they winter on the Pacific slope of Mexico. Populations have been extirpated in Kansas and have been reduced in Oklahoma, suggesting habitat loss and parasitism may be particularly prevalent in that part of the species' range (Grzybowski 1995, Wilkins *et al.* 2006). The current section 7 consultation range of the BCVI includes 67 counties in Texas and 8 counties in Oklahoma. Records indicate that BCVIs are currently known from only 51 counties in Texas and 4 counties in Oklahoma.

Wilkins *et al.* (2006) estimated that in 2005, the known U.S. population of BCVIs was approximately 6,000 males, a marked increase since its listing. It is unknown whether estimated population numbers have increased due to increased survey efforts, increased habitat due to habitat management efforts, or some combination of both. Approximately 75 percent of the known population is known from three locations: two in Texas - Kerr Wildlife Management Area (WMA) and Fort Hood (Ft. Hood), and one in Oklahoma shared between the Wichita Mountains NWR and adjacent DOD Ft. Sill (Wilkins *et al.* 2006). Utilizing records since 2006, there are 31 BCVI populations with more than 30 individuals, 10 of which contain more than 100 individuals. Within Texas many efforts are underway to assist landowners in determining the status of BCVIs on their property and to educate landowners on the implementation of management strategies beneficial to the BCVI. Fully understanding the current distribution of the BCVI in Texas largely depends on the data collected through these various efforts.

Reasons for Decline and Threats to Survival

Threats to the BCVI include habitat loss, fragmentation, and degradation due to development, vegetational succession, poor grazing practices, and brown-headed cowbird

parasitism. A complete summary of the threats to the species can be found in in the Service's 5-year review (Service 2007a).

Range-wide Survival and Recovery Needs
The Black-capped Vireo Recovery Plan (Service 1991) divides the BCVI's Texas breeding range into six regions delineated primarily on physiographic boundaries. Recovery could occur when there is a viable vireo population, greater than 1,000 breeding females, is protected in four of the six Texas regions and one each in Oklahoma and Mexico (Service 1991 and 1995). Additionally, the BCVI's PHVA recommends there be at least three subpopulations with the four regions chosen for recovery (Service 1995).

Based on the Black-capped Vireo Recovery Plan (Service 1991), protection and management of occupied habitat and minimization of further degradation, development, or environmental modification of unoccupied habitat are necessary to provide for the survival of the species. Habitat protection must include elements of both breeding and non-breeding habitat (i.e., associated uplands and migration corridors). Efforts to create new, and protect existing, habitat will enhance the BCVI's ability to expand in distribution and numbers. Efforts; such as land acquisition, conservation easements, active habitat management/maintenance, and enrollment in Environmental Defense's Safe Harbor Agreement; to protect/maintain existing viable populations are critical to the survival and recovery of this species.

There is no research based data to indicate what the minimum patch size of BCVI habitat should be for the purpose of long-term persistence. However, the Service is currently developing guidance that will be available in the near future. The size of the parcel will need to consider: a) patch size, connectivity, and density of birds present for management in perpetuity, b) habitat prescriptions (burn, mechanical) feasible for maintaining at least 75% occupation each breeding season, c) extent of threats such as brown-headed cowbird parasitism, white-tailed deer and non-native species, and how size and location of parcel may influence managing threats. A management goal of a minimum density of males should be set based on known densities on nearby, equivalent healthy populations. Generally, populations in the eastern portion of the range are denser in suitable habitat versus the western portion of the range. In the absence of comparable regional data, a density of = 0.3 males/hectare may be appropriate.

Environmental Baseline

The current population of BCVI in Comal County is unknown, as no county-wide population survey has been completed and no recent observations of the species have been confirmed. The documented presence of the species on private lands throughout the region (Service 2007a) and the occurrence of potential habitat in the County, however, support the likelihood that the species occurs in Comal County (Wilkins *et al.* 2006).

Roadside surveys performed in the late 1990's estimated a total of 3,591 acres of potential BCVI habitat in Comal County (Maresh and Rowell 2000). The limited sample size and survey methods employed to derive this estimate have been challenged, however, and the resulting extrapolation may overestimate the potential habitat in Comal County (Wilkins *et al.* 2006).

The BCVI Recovery Plan described recovery criteria including protection of at least one viable BCVI population composed of at least 500 to 1000 breeding pairs in six described recovery regions in Texas, Oklahoma, and Mexico (Service 1991). Little protection or active management to support BCVI habitat is known from Recovery Region 3, and no areas are known to be managed for this species in Comal County.

Continued threats to BCVIs in the action area include the clearing of breeding habitat, overgrazing, and nest parasitism by brown headed cowbirds. The overall loss and potential fragmentation of native rangeland caused by land use conversion and ownership changes throughout major portions of the species' breeding range, especially in the Edwards Plateau and North-central Texas regions, has likely resulted in an overall decrease in the potential habitat available for the species (Wilkens *et al.* 2006).

No new threats to the BCVI have been identified since listing, and based on the 5-year status review (Service 2007a), it appears the original threats to the species still exist, but the magnitude of the threats has changed, resulting in an overall decrease in threat level. Conservation programs and measures implemented to reduce the threats to the species include a 37-county Safe Harbor Agreement held by Environmental Defense, with 7 enrolled properties actively managing for BCVIs; private lands incentives; cowbird removal programs; and public outreach. Most of these measures have occurred within the species' range in Texas and target the major threats to the species – loss of habitat and brood parasitism.

According to our consultations tracking database, there have been at least 22 formal consultations on BCVIs. The action area these consultations covered was over 61,818,294 acres. One consultation covered almost half of Texas at 60 million acres. Three of these consultations were on Ft. Hood; therefore, we've only counted that action area once. Over 68,761 acres of BCVI habitat were authorized to be impacted by these consultations. Of this acreage 52,900 acres were associated with brush management/prescribed fire consultations. An additional 15,460 acres were associated with activities on Fort Hood. These consultations resulted in over 23,000 acres of habitat managed/maintained specifically for the BCVI and an expectation of a net benefit of over 1.5 million acres in BCVI habitat creation from the brush management/prescribed fire consultations.

Additionally, we have issued 8 individual 10(a)(1)(B) incidental take permits covering more than 69 million acres (note: this is the permit/action area, not the actual acres of effected habitat). The majority of this acreage is attributed to three HCPs: the BCP at 561,000 acres, Oncor at just over 63 million acres, and LCRA at over 5 million acres. In total all 8 permits authorize over 16,800 acres of effects to BCVI habitat and if all take occurs, would result in over 11,700 acres of preserve and $1,000,000 given to the Texas Parks and Wildlife Foundation to perpetually manage BCVI habitat on the 4,500 acre Parrie Haynes Ranch.

Within the action area there have been no formal consultations or individual 10(a)(1)(B) permits.

Effects of the Action

The Service is authorizing Comal County to directly impact a total of 1,000 acres of BCVI habitat from Covered Activities. See section 2.2.2.4 of the RHCP for the methods used to determine acreage estimates.

Indirect effects of the action include both the direct and indirect impacts of implementing the RHCP. Direct impacts from implementation of the RHCP include habitat removal, degradation, and/or fragmentation. Indirect impacts could occur from increased potential for predation, including predation by the red imported fire ant (*Solenopsis invicta*), increased brood parasitism, and competition or changes in the structure or composition of adjacent habitat, which may affect foraging activity.

Of the estimated 1.45 million acres of potential BCVI habitat throughout the range, the action area contains at most approximately 3,591 acres of potential habitat (Maresh and Rowell 2000). The amount of habitat proposed to be impacted is 0.07 percent of all BCVI habitat range-wide, 0.19 percent within recovery region 3 (Diamond 2007), and 28 percent of habitat within the action area. Additionally, Comal County will assess habitat suitability and/or occupancy on a project-by-project basis to more accurately quantify take. Furthermore, to reduce adverse impacts to BCVIs from the Covered Activities Comal County will: 1) make available to the public maps of potential habitat; 2) require RHCP participants to abide by the seasonal clearing restrictions to avoid immediate impacts to BCVIs during the breeding season; and 3) develop a public education and outreach program to educate landowners and residents about BCVIs and the RHCP.

While the BCVI 5-year status review stated the BCVI Recovery Plan (Service 1991) was out-of-date and needed revision, preservation of one population in four of the six regions is still part of our conservation strategy for the species. Comal County is on the far eastern side of the range in Region 3, and BCVI habitat is more abundant in the central and western portions of this region. Therefore, if this region is chosen as one of the four, recovery would likely focus to the west of Comal County where there are large concentrations of vireos on state and private lands, for example around Kerr WMA. However, Comal County could contribute to one of the recommended subpopulations that are considered necessary for maintaining the viability of the source population. Therefore, implementation of Comal County's RHCP will contribute to recovery through discovery and protection of BCVI populations within Comal County, and the maintenance of genetic diversity.

While the exact number of acres of BCVI habitat that will be impacted, and will therefore need to be mitigated for, is not currently known, a maximum impact has been estimated for BCVIs. Comal County proposes to mitigate for the effects of the incidental take of BCVIs from Covered Activities at a 1:1 ratio for direct impacts to BCVI habitat due to loss and a 1:1 ratio for indirect impacts to BCVI habitat, such as disturbance. The base 1:1 mitigation ratio is proposed since: 1) the impacted BCVI habitat is likely to be highly fragmented, while the mitigation habitat will be in large preserves and is expected to support more territories per unit of habitat; 2) the mitigation habitat, once restored, will be protected and maintained over time as BCVI habitat, while the impacted habitat, if not disturbed, would have become unsuitable for BCVIs through natural plant succession; and 3) BCVIs have not been recorded in Comal County. This suggests that the potential BCVI habitat that does exist in the County is limited. It is recognized, however, that in rare instances impacted habitat will be of a higher quality than the Comal County norm,

and in these cases a higher mitigation ratio may be justified. The RHCP reserves the right, based on quantification of habitat values, to either deny participation of a land development project, or increase the mitigation ratio from 1:1 up to 2:1.

Any mitigation will meet a minimum standard of criteria, including blocks of high quality habitat with a low edge to area ratio, confirmation of BCVI presence, a site that is sustainable into the future (such that it has low levels of adjacent urbanization and low oak wilt presence), and will be managed and monitored in perpetuity. Additionally, the mitigation should support the recovery and conservation strategy of the species by protecting habitat in a recovery unit that helps secure a viable population of the species. Mitigation will occur through purchase of mitigation credits from a Service-approved conservation bank or through the purchase of preserve lands in fee title or conservation easement. All preserve acquisitions and assignments of credits will be reviewed and approved by the Service. Comal County has a goal of establishing a preserve system of up to 6,500 acres over the life of the permit. If all authorized direct take of BCVI habitat is realized, at least 1,000 acres of the preserve system will be BCVI habitat. Lands within the preserve system could be County owned, but may also include preserves owned and/or managed by other cooperators such as local municipalities, conservation organizations, or private landowners that agree to manage in accordance with the RHCP. Regardless of ownership, to count toward the preserve system, the preserve must be managed in perpetuity to benefit one or more of the Covered Species.

Critical habitat has not been designated for the BCVI; therefore no adverse modification of critical habitat will occur.

B. Aquatic Species

1. Background on Aquifers

Segments of the Edwards and Trinity aquifers are located beneath GCWA and BCVI habitat throughout Comal County and provide the habitat for, or are the source of the springflows required by the species considered in this analysis (Figure 3). These aquifers will likely provide the groundwater resources for domestic, commercial, agricultural, industrial, and other uses by those seeking to participate in the RHCP (e.g., landowners, developers, water districts).

The Southern Segment of the Edwards Aquifer underlies portions of southwest Texas and is approximately 180 miles long and varies from approximately 5 to 40 miles in width. Water within the Southern Segment generally flows from areas of higher elevation in the southwest to areas of lower elevation to the northeast. The Southern Segment of the Edwards Aquifer is the primary water source for municipal, industrial, agricultural, and domestic uses for over two million people, primarily in the Greater San Antonio area.

The Southern Segment of the Edwards Aquifer has three distinct zones (contributing, recharge, and artesian), each with unique hydrogeological characteristics. The contributing zone is approximately 5,400 square miles and is composed of the watersheds that cross the recharge zone, thereby providing the source of most of the water that will

enter the aquifer as recharge. The recharge zone is approximately 1,250 square miles of

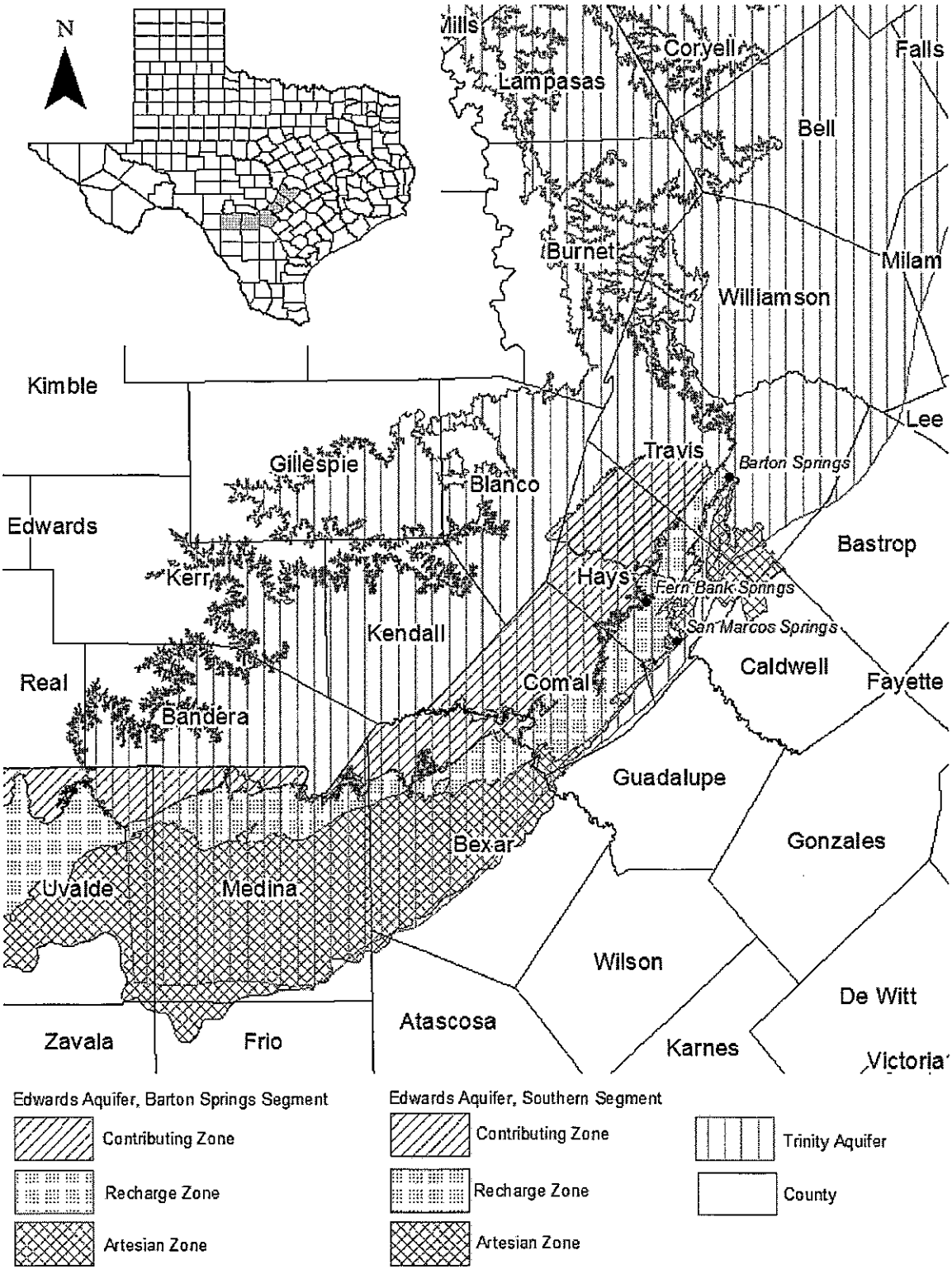


Figure 3: Aquifers in Central Texas.

exposed, porous Edwards Limestone. Recharge occurs when water enters the aquifer by infiltration through the soils and rock strata overlying the aquifer and through recharge features (caves, sinkholes, faults, fractures, and other open cavities). Creeks and streams with these features can lose much or all of their baseflow to the aquifer as they cross the recharge zone. The artesian zone of the Southern Segment is a less permeable geology that confines water and is characterized by high surface springflows resulting from the hydraulic pressure of the confined waters in this zone. Faults and fissures allow these pressurized waters to be released at the surface in numerous springs and seeps.

The Southern Segment of the Edwards Aquifer is the source of water for several major and minor springs, including Pinto and Ft. Clark springs in Kinney County, Leona Springs in Uvalde County, San Antonio and San Pedro springs in Bexar County, Comal and Hueco springs in Comal County, and San Marcos and Fern Bank Springs in Hays County. While only the Comal Springs dryopid beetle, Comal Springs riffle beetle, and Peck's cave amphipod are actually located in Comal County, impacts to water quality and quantity within Comal County could impact Texas wild-rice, San Marcos salamander, Texas blind salamander, and the fountain darter in Hays County, since they are dependent on Edwards Aquifer spring flow and are down gradient from Comal County.

The Southern Segment of the Edwards Aquifer has a high capacity for rapid recharge, and rainfall over the contributing and recharge zones can quickly increase water levels within the aquifer. It is also subject to rapid drops in water levels due to pumping, especially during drought periods.

The Trinity Aquifer stretches across central Texas in a narrow band from the Red River on the Oklahoma border through Hays County and south to Bandera and Medina counties. The Trinity Aquifer underlies and provides much of the available groundwater for the western half of Hays County. In some areas, the Trinity Aquifer is overlaid by the Edwards Aquifer and contributes recharge to the Edwards through faults and fissures (Mace *et al.* 2000). The extent of the mixing and relationship between these aquifers at this interface is poorly understood; though a recent Texas Water Development Board study assessing current groundwater trends for the Trinity modeled current discharge at approximately 60 percent to springs, rivers and reservoirs; 25 percent to wells; and the remaining 15 percent to recharge of the Edwards Aquifer (Anaya and Jones 2009).

Unlike the segments of the Edwards Aquifer, the Trinity Aquifer is recharged very slowly, with only about four to five percent of rainfall in the area recharging the aquifer.

2. Status of the Species/Critical Habitat

a. Comal Springs dryopid beetle

Species Description and Life History

The Comal Springs dryopid beetle (*Stygoparnus comalensis*) was listed as endangered on December 18, 1997 (62 FR 66295). Critical habitat was designated on July 17, 2007, and consists of Comal Springs in Comal County, Texas, and Fern Bank Springs in Hays County, Texas (71 FR 40588). Designated critical habitat at Fern Bank Springs is described as "aquatic habitat and land areas that are within a 50-foot distance from spring outlets, including the main outlet of Fern Bank Springs and its associated seep springs" (Service 2007b).

The Comal Springs dryopid beetle is the only known hypogean- (subterranean) adapted member of the family Dryopidae. Barr and Spangler (1992) described this species based on its unique morphological distinctions including vestigial (rudimentary) eyes and wings. Adult beetles are elongate, parallel-sided and slender, head retractile, with cuticle (skin) coloration reddish-brown and translucent (Barr and Spangler 1992). Larvae are elongate, cylindrical, and yellowish-brown in color (Barr and Spangler 1992). Mature larvae are approximately 0.24 to 0.31 inches long.

Larvae in the family Dryopidae do not have gills and are considered terrestrial, inhabiting moist soil along stream banks, presumably feeding on roots and decaying vegetation (Brown 1987, Ulrich 1986). Vestigial eyes indicate adaptation to subterranean habitats. Barr and Spangler (1992) presumed the microhabitat for the Comal Springs dryopid beetle to be soil, roots, and debris exposed above the waterline on the ceilings of spring orifices. Larval development is unknown for this species.

Adult Comal Springs dryopid beetles are limited to aquatic habitats but are not capable of swimming, instead they move relatively slowly, and respire through a plastron (gas film produced by an area of dense water-repelling hairs) which requires habitats with high dissolved oxygen (Brown 1987, Resh *et al.* 2008). Some wild caught adult specimens have survived in captivity 11-21 months (Barr and Spangler 1992, Fries *et al.* 2004), but true lifespan is unknown.

Dryopid adults typically feed on biofilm (microorganisms and debris) scraped from surfaces such as rocks, wood, and vegetation (Brown 1987). Potential food sources may include detritus (decomposed materials), leaf litter, and decaying roots. However, it is possible that this species may feed on bacteria and fungi associated with decaying plant material (R. Gibson, Service, pers. comm. 2006).

The Comal Springs dryopid beetle relies on high-quality water with no occurrence or minimal levels of pollutants; low salinity with total dissolved solids that generally range from 307 to 368 mg/L and turbidity of less than 5 nephelometric turbidity units (NTUs; measurement of turbidity in a water sample by passing light through the sample and measuring the amount of the light that is deflected); aquifer water temperatures that range from about 68° to 75.2°F; a hydrologic regime that allows spring flows to maintain dissolved oxygen levels to range from 4.0 to 10.0 milligrams/liter; and a food supply that includes, but is not limited to, detritus, leaf litter, and decaying roots (Service 2007b).

Historic and Current Distribution

Comal Springs dryopid beetles were first collected at Comal Springs in New Braunfels, Texas, in 1987 (Service 1996a). Barr (1993) collected specimens at additional spring runs around Comal Springs and also found them at Fern Bank Springs in San Marcos, Texas, in the summer of 1992. Collections during 2003 to 2009 extended the known range of the beetle within the Comal Springs system to all major spring runs; seeps along the western shoreline of Landa Lake; upwellings within Landa Lake, primarily in the Spring Island area; and Panther Canyon Well (EAA 2003, 2004, 2005, 2006, Fries *et al.* 2004, Gibson *et al.* 2008). The extent of the subterranean range of the species is unknown, though it has been suggested that they may be confined to small areas surrounding spring openings (Barr 1993, 62 FR 66295).

Reasons for Decline and Threats to Survival
The primary threat to the Comal Springs dryopid beetle is the reduction of water quantity and quality (62 FR 66295). The primary threats to water quantity are drought and ground water pumping. The general sources of water quality concerns are from land use changes throughout the region that may increase risks of aquifer, springflow, and streamflow contamination. Pollution threats include: 1) groundwater pollution 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.

Range-wide Survival and Recovery Needs
There is no recovery plan for the Comal Springs dryopid beetle. Monitoring of the beetle takes place twice yearly at Comal Springs by netting the major spring orifices and collecting with cotton cloth lures (BIO-WEST 2010). Currently population size determination, genetics analysis, and refugium efforts have not been attempted because this beetle is rarely collected and survival and pupation of larvae in captivity has been unsuccessful.

Critical Habitat
Primary constituent elements, as defined by the critical habitat designation (72 FR 39248), for Comal Springs dryopid beetle are:

1. High-quality water with no or minimal levels of pollutants, such as soaps and detergents and other compounds containing surfactants, heavy metals, pesticides, fertilizer nutrients, petroleum hydrocarbons, pharmaceuticals and veterinary medicines, and semi-volatile compounds, such as industrial cleaning agents, and including:
   (a) Low salinity with total dissolved solids that generally range from about 307 to 368 milligrams per liter (mg/L), and
   (b) Low turbidity that generally is less than 5 NTUs.
2. Aquifer water temperatures that range from approximately 68 to 75 °F.
3. A hydrologic regime that allows for adequate spring flows that provide levels of dissolved oxygen in the approximate range of 4.0 to 10.0 mg/L for respiration.
4. Food supply that includes detritus, leaf litter, living plant material, algae, fungi, bacteria and other microorganisms, and decaying roots.

b. Comal Springs riffle beetle
Species Description and Life History
The Comal Springs riffle beetle (*Heterelmis comalensis*) was listed as endangered on December 18, 1997 (62 FR 66295). Critical habitat was designated on July 17, 2007, and is primarily restricted to surface water in the impounded portion of: 1) Comal Springs (Landa Lake, Comal County), and 2) San Marcos Springs (Spring Lake, Hays County) (72 FR 39248). A total of 30.3 acres of critical habitat were designated at Comal and San Marcos springs; 19.8 acres of Landa Lake and 10.5 acres of Spring Lake.

The Comal Springs riffle beetle is a small, aquatic beetle found in the Comal Springs system, including Landa Lake, in Comal County and Spring Lake in Hays County, Texas.

Examples of this species were first collected by Bosse in 1976 and described in 1988 (Bosse *et al.* 1988). Adult Comal Springs riffle beetles are reddish-brown in color, range in length from 0.067 to 0.83 inches. The sides of the body are approximately parallel and the entire dorsal surface is coated with fine golden-colored setae (hairs) (Bosse *et al.* 1988). The hind wings of Comal Springs riffle beetles are short and non-functional (Bosse *et al.* 1988) and the species is incapable of flying. Larval Comal Springs riffle beetles are elongate, tubular in cross-section and light tan in color. The Comal Springs riffle beetle pupa is pale in color and legs and wing pads project loosely from the body.

The Comal Springs riffle beetle is an epigean (surface-dwelling) species that inhabits fast flowing waters with gravel and cobble substrates (Bowles *et al.* 2003). Food sources include, but are not limited to, detritus, leaf litter, and decaying roots. Little is known of their life history and habitat (Bowles *et al.* 2003). BIO-WEST (2006) reported that riffle beetles may take six months to three years to complete their life cycle from egg, to larvae, to adult. Bowles *et al.* (2003) found all life stages of Comal Springs riffle beetles were represented throughout the year. Some wild caught adult specimens have survived in captivity 17-19 months (Fries 2003), but true lifespan is unknown.

Historic and Current Distribution
Comal Springs riffle beetle was first described from Comal Springs, New Braunfels, Texas (Bosse *et al.* 1988), where it still occurs throughout the spring system, including in Landa Lake (BIO-WEST 2007). Barr (1993) found a single riffle beetle in Spring Lake, San Marcos, Texas, which was long thought to be in error. However, Gibson *et al.* (2008) collected Comal Springs riffle beetles again from Spring Lake and found adults and larvae, indicating the presence of a reproducing population. The Comal Springs riffle beetle is not known from any other locations.

Reasons for Decline and Threats to Survival
Since Comal Springs riffle beetles require flowing water for respiration, the primary threats to Comal Springs riffle are a decrease in water quantity and quality as a result of water withdrawal and/or drought throughout the Southern Segment of the Edwards Aquifer. Although, the absolute low water limits for survival are not known. They clearly survived the drought of the middle 1950's, which resulted in cessation of flow at Comal Springs from June 13 through November 3, 1956. Bowles *et al.* (2003) speculated that the riffle beetle may be able to retreat back into spring openings or burrow down to wet areas below the surface of the streambed. Brown (1987) reported finding adult *Heterelmis* in a dry stream in central Texas by digging to where the gravel substrate was still damp. Given that these beetles are fully aquatic and that no water was present in the springs for a period of several months, they were probably negatively impacted at some unknown level. However, it is not known how adapted the Comal Springs riffle beetle is to surviving long periods of drying that may occur in the absence of a water management plan for the Edwards Aquifer. Although San Marcos Springs have not stopped flowing in recorded history, dewatering of this system would be expected to have a similar negative effect on survival of Comal Springs riffle beetle populations at that location.

Stagnation of water also may be a limiting condition. Stagnation of water and/or drying within the spring runs and the photic (lighted) zone of the spring orifices would probably be limiting for the Comal Springs riffle beetle because natural water flow is considered important to the respiration and therefore survival of this invertebrate species.

Range-wide Survival and Recovery Needs
There is no recovery plan for the Comal Springs riffle beetle. Staff at the Service's San Marcos National Fish Hatchery and Technology Center conduct monitoring of the Comal Springs riffle beetle twice yearly by netting the major spring orifices and collecting with cotton-cloth lures at Comal Springs (BIO-WEST 2010). However, this monitoring has not attempted to determine population size, and this species has not been breed in captivity, although Fries (2003) documented possible reproduction among captive species.

Critical Habitat
Primary constituent elements, as defined by the critical habitat designation (72 FR 39248), for Comal Springs riffle beetle are:

1. High-quality water with no or minimal levels of pollutants, such as soaps and detergents and other compounds containing surfactants, heavy metals, pesticides, fertilizer nutrients, petroleum hydrocarbons, pharmaceuticals and veterinary medicines, and semi-volatile compounds, such as industrial cleaning agents, and including:
   (a) Low salinity with total dissolved solids that generally range from about 307 to 368 mg/L, and
   (b) Low turbidity that generally is less than 5 NTUs.
2. Aquifer water temperatures that range from approximately 68 to 75 °F.
3. A hydrologic regime that allows for adequate spring flows that provide levels of dissolved oxygen in the approximate range of 4.0 to 10.0 mg/L for respiration.
4. Food supply that includes detritus, leaf litter, living plant material, algae, fungi, bacteria and other microorganisms, and decaying roots.
5. Bottom substrate in surface water habitat that is free of sand and silt, and is composed of gravel and cobble ranging in size between 0.3 to 5.0 inches.

c. Peck's Cave Amphipod
Species Description and Life History
Peck's cave amphipod was listed as endangered on December 18, 1997 (62 FR 66295). Critical habitat was designated in 2007 at Comal and Hueco Springs in Comal County, Texas (72 FR 39248).

Holsinger (1967) described Peck's cave amphipod from two female specimens collected at Comal Springs. Verification of this species is usually not possible in the field and usually requires microscopic examination of adult specimens by those with expertise in the taxonomy of subterranean amphipods. Holsinger (1967) characterized the Flagellatus species group to which Peck's cave amphipod belongs as largely cavernicolous (living in subterranean caves or passages) in habitat preference, having restricted ranges, and occupying deep groundwater niches. Mature and immature life stages have been collected only near spring outlets, from seeps along the spring runs, and from a single shallow well (R. Gibson, pers. comm.).

The specific microhabitat of Peck's cave amphipod is unknown, but it may be similar to that of the Comal Springs dryopid beetle (Barr and Spangler 1992), which is soil, roots, and debris exposed above the waterline on the ceilings of spring orifices. Gibson *et al.* (2008) found Peck's cave amphipod in gravel, rocks, and organic debris (leaves, roots,

wood) immediately inside of or adjacent to springs, seeps, and upwellings of Comal Springs and their impoundment, Landa Lake. They were not observed in nearby surface habitats. Gibson *et al.* (2008) collected Peck's Cave amphipod in drift nets at Hueco and Comal springs, implying they were ejected from the spring mouth into the water column. At Panther Canyon Well specimens were collected in a baited bottle trap, implying that free-swimming individuals entered the trap through the opening following the smell of the bait.

Evidence suggests Peck's cave amphipod is likely omnivorous, enabling the amphipod to exist as a scavenger or predator inside the aquifer in addition to using detritus in areas near spring outlets where plant roots interface with spring water (Service 2007b). Potential food sources include detritus, leaf litter, decaying roots, and bacteria and fungi associated with decaying plant material.

Historic and Current Distribution

The type locality of Peck's cave amphipod is Comal Springs in Comal County (Holsinger 1967). Barr (1993) reported Peck's cave amphipod from Hueco Springs in Comal County, and found examples of this amphipod at all four of the primary spring runs at Comal Springs. In a similar study, Arsuffi (1993) found Peck's cave amphipod only at the orifice openings of Comal Spring runs 1 and 3. Recently, researchers confirmed the occurrence of this amphipod at Hueco Springs in addition to discovering the species at Panther Canyon Well in the vicinity of Comal Springs (Gibson *et al.* 2008).

Various researchers have examined amphipod assemblages from springs, caves, and wells in Comal, Hays, and Bexar counties without finding this species (e.g., Holsinger, 1967, 1978; Holsinger and Longley 1980; Barr, 1993; Gibson *et al.*, 2008). These negative findings suggest that the species is not abundant in these areas, though these efforts do not provide conclusive evidence that the species does not occur elsewhere. Cave and groundwater fauna are known to be rare and infrequently collected. Because the drainage basins of Comal and Hueco Springs are extensive, the range of Peck's Cave amphipod could be much larger than previously thought if this species is able to inhabit groundwater conduits far from the spring orifices from where they are currently known. Alternately, the species may be restricted to the downstream portions because of competition with other taxa or unsuitable habitat (e.g., fewer nutrients, different water chemistry parameters).

Reasons for Decline and Threats to Survival

The general threats to this species are a decrease in water quantity and quality as a result of water withdrawal and other human activities throughout the San Antonio segment of the Edwards Aquifer. As described by the critical habitat designation and species listing, the specific primary threats to the survival of this species are associated with water quality (dissolved oxygen, temperature, pollution), water quantity (habitat reduction and drying), and riparian habitat associated with springs and subsurface flowing waters (reduction in nutrient input via roots and allochthonous materials). The potential failure of spring flows due to drought or excessive groundwater pumping could result in loss of aquatic habitat for this species.

Range-wide Survival and Recovery Needs

Monitoring of Peck's Cave amphipod takes place twice yearly by netting the major spring orifices and collecting with cotton cloth lures at Comal Springs (EAA 2009). Genetic analysis using mitochondrial DNA of known Peck's Cave amphipod populations was recently completed (Nice and Ethridge 2011), but more conclusive genetic analysis using nuclear DNA must be undertaken.

Critical Habitat

Primary constituent elements, as defined by the critical habitat designation (72 FR 39248), for Peck's Cave amphipod are:

1. High-quality water with no or minimal levels of pollutants, such as soaps and detergents and other compounds containing surfactants, heavy metals, pesticides, fertilizer nutrients, petroleum hydrocarbons, pharmaceuticals and veterinary medicines, and semi-volatile compounds, such as industrial cleaning agents, and including:
   a. Low salinity with total dissolved solids that generally range from about 307 to 368 mg/L, and
   b. Low turbidity that generally is less than 5 NTUs.
2. Aquifer water temperatures that range from approximately 68 to 75 °F.
3. Food supply that includes detritus, leaf litter, living plant material, algae, fungi, bacteria and other microorganisms, and decaying roots.

d. Texas wild-rice

Species Description and Life History

Texas wild-rice was listed as endangered on April 26, 1978 (43 FR 17910). Critical habitat was designated for this species on July 14, 1980, and consists of Spring Lake and its outflow and the San Marcos River downstream to the confluence with the Blanco River (45 FR 47355).

Texas wild-rice is an aquatic, monoecious (pistillate and staminate flowers are on the same plant), perennial grass, which is generally 3.3 to 6.5 feet long and usually immersed and prostrate in the swift-flowing water of the San Marcos River. Texas wild-rice forms large stands at depths from 0.76 to 3.3 feet and requires clear, relatively cool, thermally constant (approximately 72°F) flowing water. Texas wild-rice prefers gravel and sand substrates overlaying Crawford black silt and clay (Poole and Bowles 1999, Saunders *et al.* 2001; Vaughan 1986).

Spring flow and San Marcos River discharge are critically important for growth and survival of Texas wild-rice (Saunders *et al.* 2001). Texas wild-rice relies on carbon dioxide as its inorganic carbon source for photosynthesis rather than the more commonly available bicarbonate used by most other aquatic plants (TPWD 1994; Seal and Ellis 1997). Edwards Aquifer water contains relatively high levels of carbon dioxide and is readily available near spring openings and in relatively fast-moving waters that transport the dissolved gas downstream. Low flow situations can be carbon limiting for carbon dioxide-using obligates including Texas wild-rice.

Reproduction of Texas wild-rice occurs either asexually (clonally) through stolons or sexually via seeds. Asexual reproduction occurs where shoots arise as clones at the ends of rooting stolons (Emery and Guy 1979). Clonal reproduction appears to be the primary mechanism for expansion of established stands, but does not appear to be an efficient

mechanism for dispersal and colonization of new areas. Texas wild-rice segments have, however, been observed floating downstream and some of these may become established plants; but only if lodged in suitable substrate and physical habitat.

During sexual reproduction, Texas wild-rice flowers above the water surface and wind pollinated florets produce seed. This typically takes place in late spring through fall, though flowering and seed set may occur at other times in warm years (Service 1996a). Triggers for flowering are not well understood. Texas wild-rice seed is not long-lived, and viability begins to drop markedly within one year of production. No appreciable seed bank is therefore expected. In slow moving waters, Texas wild-rice function as annuals, exhibiting less robust vegetative growth, then flowering, setting seed, and dying within a single season.

Historic and Current Distribution

The San Marcos River rises from San Marcos Springs, which are within Spring Lake in San Marcos, Hays County, Texas. The San Marcos River runs approximately 4 miles until it meets with the Blanco River (Upper San Marcos) and then extends another 75 miles until it meets with the Guadalupe River (Lower San Marcos) (Handbook of Texas Online 2012). Based on Terrell *et al.* (1978), Texas wild-rice was first collected in the San Marcos River in 1892. When the species was originally described in 1933, it was reported to be abundant in the San Marcos River, including Spring Lake. By 1967 Emery found only one plant in Spring Lake, only scattered plants in the last 1.5 miles of the Upper San Marcos, and none in the Lower San Marcos (Emery 1967). Emery (1967) stated several reasons for the decline: bottom plowing to keep the lake and river clean for tourists, floating debris from the mowing damages the emergent part of wild-rice preventing it from reproducing, plant collection, and pollution.

By the mid-1970's Beaty (1975) found about 2,580 square feet (0.06 acre) of coverage. In 1976 Emery again checked abundance of Texas wild-rice and found no plants in Spring Lake and calculated 12,161 square feet (0.3 acre) in the Upper San Marcos River (Emery 1977). Subsequent data were gathered by Vaughan (1986) for several years (1984-1986) and overall areal coverage in 1986 was 4,881 square feet (0.1 acre).

Texas Parks and Wildlife Department has monitored area coverage since June 1989, which has ranged from 10,810 to 46,050 square feet (0.25 to 1.1 acre), and rice only now occurs in the Upper San Marcos (Poole and Bowles 1999).

Reasons for Decline and Threats to Survival

Reduced flow of water from the springs is the greatest threat to the survival of Texas wild-rice (Service 1996a). Drought conditions in 1996 killed Texas wild-rice stands in portions of the river that were dewatered. Low flows during this period also allowed floating mats of vegetation, which normally move downriver, to become lodged in wild-rice stands. These mats shaded Texas wild-rice and are thought to have interfered with culm emergence, thereby interfering with sexual reproduction (Power 1996, 2002; Poole 2006). Decreased flows, which expose more of the plant, can also leave Texas wild-rice more susceptible to increased herbivory by waterfowl and non-native nutria, and ramshorn snails, which prefer slow moving water (Rose and Power 1992). Altered flow conditions may also result in competitive advantages for non-native plants when conditions are sub-optimal for Texas wild-rice. Given the historically stable nature of

flow from San Marcos Springs, vulnerability of Texas wild-rice to negative impact from reduced flows is greater than in other aquatic ecosystems accustomed to seasonal changes in water quantity and quality. Conservation of the quantity and quality of Edwards Aquifer water emanating from the springs is fundamental to the preservation of this spring ecosystem (Saunders *et al.* 2001).

There are numerous non-native plant species that occur in the San Marcos River system, which can displace Texas wild-rice through direct competition for space, light and nutrients, and also alter the ecosystem. These species include alligatorweed (*Alternanthera philoxeroides*), giant reed (*Arundo donax*), floating fern (*Ceratopteris thalichtroides*), elephant ear (*Colocasia esculenta*), water trumpet (*Cryptocoryne beckettii*), water-hyacinth (*Eichornia crassipes*), and hydrilla (*Hydrilla verticillati*) (Bowles and Bowles 2001).

An additional threat to Texas wild-rice is recreational use of the San Marcos River. Bradsby (1994) found recreation was related to season, with the highest use during the summer months, especially holidays and weekends. Breslin (1997) sampled impacts from tubing, swimming, boating, fishing, and dogs on wild-rice and found visible damage to plants occurred with 1.92 percent of observed contact. Tubing was found to cause the greatest individual damage and dogs had the highest level of damage proportional to visits (Breslin 1997). While these studies did not quantify effects to the species at various discharge levels, as discharge decreases, which typically occurs during the summer months, a greater percentage of the plants are presumably exposed to recreational users, increasing the potential for adverse effects. In September 2006, a significant loss of Texas wild-rice was recorded due to vandalism (Poole 2006).

Range-wide Survival and Recovery Needs

According to the San Marcos and Comal Springs and Associated Aquatic Ecosystems Recovery Plan (Service 1996a), which includes Texas wild-rice, there are several specific recovery criteria for protecting and recovering Texas wild-rice, including: ensuring adequate flows and water quality in Spring Lake and the San Marcos River; maintenance of genetically diverse reproductive populations in captivity; creation of reintroduction techniques for use in the event of a catastrophic event; removal or reduction of local threats from non-native species, recreational users, and habitat alteration; and maintenance of healthy, self-sustaining, reproductive populations in the wild.

In 1996, a refugium population of Texas wild-rice was created at the Service's San Marcos National Fish Hatchery and Technology Center. A reintroduction plan was drafted and restoration work began in 2007. A total of 66 Texas wild-rice plants were planted; however, there was a less than 20 percent survival rate.

A population of *Cryptocoryne beckettii*, (water trumpet), native to Southeast Asia, has occurred in the San Marcos River near the outfall of the San Marcos Wastewater Treatment Facility since about 1996 (Rosen 2000). This species occupies similar habitats as Texas wild-rice and during the initial decade after its introduction, the areal coverage of this highly invasive species increased several hundred times from 1,840 square feet in 1998 to 6,953 square feet in 2000 (Doyle 2001). However, an active management and removal program instituted by the Service in 2003 has slowed its upstream migration where it could compete with Texas wild-rice (Alexander *et al.* 2008).

The San Marcos River Foundation (SMRF) was founded in 1985 to preserve public access to the San Marcos River and protect the flow, natural beauty, and purity of the river, its watershed, and estuaries for future generations. Volunteers of SMRF conduct regular water quality testing to determine if there is damage or deterioration of the water quality. Once a month, SMRF volunteers remove water hyacinth from the slough and Spring Lake, and daily volunteers read river gauges to determine if there is any collapse or leaking from Rio Vista Dam, an aging dam on the river.

There are several river cleanups each year on the San Marcos River coordinated by the Texas River Protection Association. There are other river cleanups during the year that are coordinated by the City of San Marcos, and many groups adopt a stretch of river that they clean up regularly, like the Lions Club.

Critical Habitat

The critical habitat designation for Texas wild-rice predates the requirement for identification of primary constituent elements that are essential for the conservation of this species. However, the rule designating critical habitat (45 FR 47362) does describe those actions that would adversely modify designated critical habitat, including any actions that would: significantly alter the flow or water quality in the San Marcos River; physically alter Spring Lake or the San Marcos River, such as dredging, bulldozing, or bottom plowing; or physically disturb the plants, such as harrowing, cutting, or intensive collecting. Based on the best available scientific and commercial data available, the primary constituent elements could generally be defined as:

1) Clear water,
2) Uniform annual flow rates,
3) Constant year-round temperature, and
4) Maintenance of the natural substrate.

e. Fountain darter

Species Description and Life History

The fountain darter (*Etheostoma fonticola*) was listed as endangered on October 13, 1970 (35 FR 16047), and received Federal protection with the passage of the Endangered Species Act in 1973. Critical habitat was designated on July 14, 1980, and consists of Spring Lake and its outflow and the San Marcos River downstream to 0.5 mile past Interstate 35 (45 FR 47355).

The fountain darter is usually less than 1 inch standard length (from tip of snout to last vertebrae), and is mostly reddish brown (Page and Burr 1979). Three small dark spots are present on the base of the tail and there is a dark spot on the opercle (a boney flap covering the gills) (Jordan and Gilbert 1886; Gilbert 1887; Jordan and Evermann 1896). Although fountain darters spawn year-round (Schenck and Whiteside 1977b), they appear to have two peak spawning periods, one in August and another late winter to early spring (Schenck and Whiteside 1977b). Dowden (1968) found fountain darter eggs attached to bryophytes and algae in Spring Lake. In a recent study examining egg deposition in the San Marcos River, Phillips and Alexander (Service, unpublished data) observed fountain darter eggs deposited on filamentous algae *Rhizoclonium* sp., *Ludwigia repens*, *Sagittaria* sp., and the endangered Texas wild-rice. After hatching, fry are not free swimming, in part due to the reduced size of their swim bladders.

Data collected during an ongoing variable flow study suggests that fountain darter reproduction may be tied to habitat quality (BIO-WEST 2007). Length frequency data from several sample reaches suggest year-round reproduction in areas of high-quality habitat in both the Comal and San Marcos systems (e.g., Spring Lake, Landa Lake), and a strong spring peak in reproduction (with limited reproduction in summer and fall of most years) in areas of lower quality habitat farther downstream.

Fountain darters prefer undisturbed stream floor habitats; a mix of submergent plants (algae, mosses, and vascular plants), in part for cover; clear and clean water; an invertebrate food supply of living organisms (copepods, dipteran (fly) larvae, and emphemeropteran (mayfly) larvae); constant water temperatures within the natural and normal river gradients; and adequate springflows (Bergin 1996, Schenck and Whiteside 1977a). Fountain darters are rarely found in areas lacking vegetation (BIO-WEST 2007), and in habitat studies within the San Marcos River, Schenck and Whiteside (1976) never found fountain darters in areas without vegetation.

While fountain darters can move between patches of vegetation, they appear to be highly resident fish (Dammayer et al., Service, unpublished data). It is not known if fountain darters are capable of swimming long distances to evade degrading habitat or if the darters can move from patch to patch, if patches are isolated by non-suitable habitat.

Historic and Current Distribution

The range of the fountain darter is the San Marcos and Comal river systems in central Texas (Jordan and Gilbert 1886, Gilbert 1887, Evermann and Kendall 1894). In 1884, Jordan and Gilbert (1886) collected the type specimens of *E. fonticola* in the San Marcos River from immediately below the confluence of the Blanco River. Fountain darters were collected in the Comal River in 1891 (Evermann and Kendall 1894). The present distribution of the fountain darter in the San Marcos River includes Spring Lake downstream to somewhere just before the confluence with the Blanco River, (Service 1994 permit report, C. T. Phillips, Service, unpublished data). Hubbs and Strawn (1957) made the last collection record for the Comal River in 1954, before its apparent extirpation there and subsequent reintroduction into the Comal system from February of 1975 to March of 1976.

During March 1973 through February 1975, Schenck and Whiteside (1976) spent 300 person-hours sampling the Comal River but collected no fountain darters. They proposed that the most likely cause was the cessation of flow from Comal Springs from June to November, 1956, drought of record. This cessation probably caused drastic temperature fluctuations in the remaining pools of water, decreased habitat/water quality, and increased predation of fountain darters. From February 1975 through March 1976 fountain darters were collected from the San Marcos River and about 450 fish were released into the headsprings area of the Comal River, Landa Park and into the old Comal River channel. By June of 1976 five offspring were found a short distance below the headsprings (Schenck and Whiteside 1976), and now fountain darters occupy the entire Comal spring and river system from Landa Lake approximately three miles to the Comal/Guadalupe River confluence.

The population of fountain darters in the San Marcos River, excluding Spring Lake, was estimated to be approximately 103,000 by Schenck and Whiteside (1976) and 45,900 by Linam (1993). In 1991, Janet Nelson conducted scuba-aided underwater surveys in Spring Lake and estimated at least 16,000 fountain darters at the spring openings and another 15,000 in the green algae habitat (J. Nelson, TPWD, personal communication). Linam *et al.* (1993) sampled 7 transects in Landa Lake and the Comal River in 1990 and reported a population estimate of about 168,078 darters above Torrey Mill Dam.

Reasons for Decline and Threats to Survival
The primary threats to fountain darter are related to the quality and quantity of aquifer and spring water. Drought conditions or increased groundwater utilization resulting in reductions to or loss of spring flows could threaten the species. Activities that may pollute the Edwards Aquifer and its springs and stream flows may also threaten the species (45 FR 47355, Service 1996a).

Additional threats include effects from increased urbanization near the rivers, recreational activities, alteration of the rivers, habitat modification (e. g. dams, bank stabilization, flood control), predation, competition, habitat alteration by non-native species, and introduced parasites (Service 1996a). One parasite threatening the fountain darter is a trematode that attacks and damages the darter's gills (Salmon 2000, McDonald *et al.* 2007). The risks posed by these parasites are anticipated to increase during stressful periods of low spring discharge (Cantu 2003) and the parasite's adverse effects may be greater to younger fountain darter life-stages (McDonald *et al.* 2007).

Range-wide Survival and Recovery Needs
According to the San Marcos and Comal Springs and Associated Aquatic Ecosystems Recovery Plan (Service 1996a), which includes fountain darter, specific recovery actions include: ensuring adequate flows and water quality in the San Marcos River; maintenance of genetically diverse reproductive populations in captivity and creation of reintroduction techniques for use in the event of a catastrophic event; removal or reduction of threats due to non-native species, recreational use of the river, and habitat alteration; and maintenance of healthy, self-sustaining, reproductive populations in the wild.

Populations of the fountain darter, as well as invasive snails, are monitored triannually, and monitoring frequency is increased during periods of low flow. Two groups have formed, one for the San Marcos River and another for the Comal River, to draft restoration plans that will integrate habitat restoration efforts that will benefit the fountain darter as well as the other listed species.

A refugium has been established at the Service's San Marcos National Fish Hatchery and Technology Center to serve as a back-up population for the fountain darter. Currently, the refugium houses a standing stock of 150 pairs from the Comal River (75 pairs from Landa Lake and 75 pairs from the main channel) and 150 pairs from the San Marcos River (75 pairs from the upper San Marcos River and 75 pairs from the middle San Marcos River). In the event of a low flow situation, additional refugium stock can and will be collected.

Critical Habitat

The critical habitat designation for fountain darter predates the requirement for identification of primary constituent elements that are essential for the conservation of this species. However, the rule designating critical habitat (45 FR 47362) does describe those actions that would adversely modify designated critical habitat, including any actions that would: significantly reduce aquatic vegetation in Spring Lake and the San Marcos River, impound water, excessively withdraw water, reduce flow, and pollute the water. Based on the best available scientific and commercial data available, the primary constituent elements could generally be defined as:

1) Undisturbed stream floor habitats (including runs, riffles, and pools),
2) A mix of submergent vegetation (algae, mosses, and vascular plants);
3) Clear and clean water;
4) A food supply of small, living invertebrates;
5) Constant water temperatures within the natural and normal river gradients; and
6) Adequate spring flows to maintain the conditions above.

f. San Marcos salamander

Species Description and Life History

San Marcos salamander (*Eurycea nana)* was listed as threatened with designated critical habitat on July 14, 1980 (45 FR 47355). Critical habitat was designated on July 14, 1980, and consists of Spring Lake and its outflow and the San Marcos River downstream 164 feet from Springs Lake Dam (45 FR 47355).

The San Marcos salamander is a member of the family Plethodontidae (lung-less salamanders) and is a neotenic salamander in that it retains its external gills (the larval condition) throughout life. The salamander does not leave the water to metamorphose into a terrestrial form, but instead becomes sexually mature and breeds in the water. This dark reddish-brown salamander has well developed and highly pigmented gills, relatively short, slender limbs, and a slender tail with a well-developed dorsal fin.

San Marcos salamanders are found at San Marcos Springs in the western half of Spring Lake, on a limestone shelf in the northernmost portion of Spring Lake, and in the spillway areas below Spring Lake Dam. Habitat consists of algal mats (Tupa and Davis 1967), where rocks are associated with spring openings (Nelson 1993). Sandy substrates devoid of vegetation and muddy silt or detritus-laden substrates with or without vegetation are apparently unsuitable habitats for this species. 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 spring orifices, protective cover such as that afforded by algal mats and rocks is essential to the survival of the salamander. The flowing spring waters in the principal habitat are slightly alkaline (pH 6.7-7.2), range from 69.8-73.4°F, clear, and dissolved oxygen levels are low (less than 50% saturated, 3-4 mg/L (Tupa and Davis 1967, Najvar 2001, Guyton and Associates 1979, Groeger et al. 1997).

Prey items for the San Marcos salamander include amphipods (scuds or sideswimmers), tendipedid (midge fly) larvae and pupae, other small insect pupae and naiads (an aquatic life stage of mayflies, dragonflies, damselflies, and stone flies), and small aquatic snails (Service 1996a).

Most evidence suggests reproduction occurs throughout the year with a possible peak in May and June (Bogart 1967).

Historic and Current Distribution
C.E. Mohr collected 20 specimens from San Marcos Springs on June 22, 1938 (Bishop 1941). Tupa and Davis (1976) and Nelson (1993) found them distributed throughout Spring Lake among rocks near spring openings, in algal mats. Additionally, San Marcos salamanders have been found in mosses and other plants, and in rocky areas just downstream from the dams (Nelson 1993, BIO-WEST 2010). In total, San Marcos salamanders are found near all of the major spring openings scattered throughout Spring Lake and downstream of the dam to about 500 feet.

Tupa and Davis (1976) estimated the number of San Marcos salamanders in the floating algal mats at the uppermost portion of Spring Lake to be between about 17,000 to 21,000 individuals. Nelson (1993) followed the same procedure used by Tupa and Davis (1976) and estimated the mats were inhabited by about 23,000 salamanders. Additionally, Nelson (1993) found 53,200 salamanders in and just below Spring Lake, including 23,000 associated with algal mats, 25,000 among rocky substrates around spring openings, and 5,200 in rocky substrates within 492 feet below Spring Lake. Seven years of quarterly monitoring of San Marcos salamander populations using visual surveys by divers showed stable visual counts (BIO-WEST 2010).

Reasons for Decline and Threats to Survival
The primary threats to the San Marcos salamander are related to the quality and quantity of aquifer and spring water. The restricted distribution of the species, loss of protective cover, contaminants, siltation, and introduced predators may also threaten the species (45 FR 47355, Service 1996a).

Range-wide Survival and Recovery Needs
According to the San Marcos and Comal Springs and Associated Aquatic Ecosystems Recovery Plan (Service 1996), which includes San Marcos salamander, recovery tasks include: ensuring adequate flows and water quality in San Marcos Springs and the San Marcos River; maintenance of genetically diverse reproductive populations in captivity and creation of reintroduction techniques for use in the event of a catastrophic event; removal or reduction of threats due to non-native species, recreational use of the river, and habitat alteration; and maintenance of healthy, self-sustaining, reproductive populations in the wild.

The Service's San Marcos National Fish Hatchery and Technology Center (NFHTC) has worked on rearing and captive breeding techniques for San Marcos salamander in the event that the natural population at San Marcos Springs is lost. Between 1996 and 2010 the NFHTC has collected a total of 1,631 wild salamanders with an average survival of 74 percent. In 2010, 622 San Marcos salamander eggs were produced from wild stock (69 more eggs than in 2009, 323 more than in 2008, and 491 more than in 2007). Additionally, there are approximately 768 offspring from wild stock. These offspring have been more prolific than the wild stock, producing 2,853 eggs (NFHTC 2011). Techniques for maintaining this species' genetic diversity have been developed. However, the ability to maintain this species in captivity (without supplemental wild

caught individuals) over the long-term is uncertain (Fries 2002). Reintroduction techniques have not been developed.

Critical Habitat
The critical habitat designation for San Marcos salamander predates the requirement for identification of primary constituent elements that are essential for the conservation of this species. However, the rule designating critical habitat (45 FR 47362) does describe those actions that would adversely modify designated critical habitat, including any actions that would: lower the water table; expose algal mats, leading to the desiccation of the species sole habitat; and disturb algal mats or the bottom of the lake, such as from SCUBA divers. Based on the best available scientific and commercial data, the primary constituent elements could generally be defined as:

1) Thermally constant waters;
2) Flowing water;
3) Clean and clear water;
4) Sand, gravel, and rock substrates with little mud or detritus; and
5) Vegetation or rocks for cover.

g. San Marcos gambusia
Species Description and Life History
The San Marcos gambusia was listed as endangered with designated critical habitat on July 14, 1980 (45 FR 47355). Critical habitat for the San Marcos gambusia was designated in the San Marcos River from the Highway 12 bridge downstream to approximately 0.5 miles below Interstate Highway 35 bridge (45 FR 47364).

The San Marcos gambusia is a member of the family Poeciliidae and belongs to a genus of Central American origin having more than 30 species of livebearing freshwater fishes. Scales tend to be strongly crosshatched and their dorsal fins tend to have a prominent dark pigment stripe across the distal edges. A diffuse mid-lateral stripe extending posteriorly from the base of the pectoral fin to the caudal peduncle is also often present, especially in dominant individuals, and a dark subocular bar is visible and is elicited easily from frightened fish. The dorsal, caudal, and anal fins tend to be lemon yellow under certain behavioral patterns (when they are not under stress), but this color can approach a bright yellowish-orange. A bluish sheen is evident in more darkly pigmented individuals, especially near the anterior dorsolateral surfaces of adult females.

The San Marcos gambusia apparently prefers quiet waters adjacent to sections of moving water, but seemingly of greatest importance, thermally constant waters. San Marcos gambusia were found mostly over muddy substrates but generally not silted habitats, and shade from over-hanging vegetation or bridge structures was a factor common to all sites along the upper San Marcos River where apparently suitable habitats for this species occurred (Hubbs and Peden 1969, Edwards et al. 1980).

Historic and Current Distribution
The San Marcos gambusia was described from the upper San Marcos River system in 1969. Of the three species of *Gambusia* native to the San Marcos River, San Marcos

gambusia apparently always has been much less abundant than the others (Hubbs and Peden 1969, p. 364).

The San Marcos gambusia is represented in collections taken in 1884 (Jordan and Gilbert 1884) and as a hybrid in 1925 (Hubbs and Peden 1969). Unfortunately, records of exact sampling localities are not available for these earliest collections, which were merely listed as "San Marcos Springs." During 1953, a single individual was taken below the low dam at Rio Vista Park, approximately one mile downstream from the headwaters. However, since that time, nearly every specimen of the San Marcos gambusia has been taken more than 1,000 feet downstream in the vicinity of the Interstate Highway 35 bridge. The single exception to this was a male taken incidentally with an Ekman dredge (sediment sampler) about 2 miles downstream of Interstate 35 (Longley 1975).

Historically, San Marcos gambusia populations have been extremely sparse; intensive collections during 1978 and 1979 yielded only 18 individuals (Edwards et al. 1980). Collections made in 1981 and 1982 within the range indicated a slight decrease in relative abundance of this species and subsequent samplings have yielded none.

Reasons for Decline and Threats to Survival
The pattern of San Marcos gambusia abundance strongly suggests a decrease beginning prior to the mid-1970s. The increase in hybrid abundance between the San Marcos gambusia and the western mosquitofish (*G. affinis*) and the decrease in the proportion of genetically pure San Marcos gambusia is considered evidence of its rarity. The subsequent decrease in San Marcos gambusia abundance along with their hybrids suggests the extinction of this species.

Many fish species have been introduced into the San Marcos ecosystem (e.g., tilapia, common carp, rock bass, redbreast sunfish, smallmouth bass, sailfin mollies, armored catfish), and some may have competed with the San Marcos gambusia for needed resources (food, breeding habitat) or preyed upon them. Taylor *et al.* (1984) note that introduced fish may also have indirect impacts, inducing changes in habitat characteristics (for example, by removal of vegetation or substrate disturbance) or introducing diseases and parasites.

Introduced elephant ears have been noted in previously recorded localities for the species. Although the exact nature of the relationship between the occurrence and abundance of elephant ears and the disappearance of San Marcos gambusia is unknown, some investigators believe these nonnative plants may have modified essential aspects of the gambusia's habitat.

Range-wide Survival and Recovery Needs
According to the San Marcos and Comal Springs and Associated Aquatic Ecosystems Recovery Plan (Service 1996), which includes San Marcos gambusia, recovery tasks include: ensuring adequate flows and water quality in San Marcos Springs and the San Marcos River; maintenance of genetically diverse reproductive populations in captivity and creation of reintroduction techniques; removal or reduction of threats due to non-native species, recreational use of the river, and habitat alteration; and maintenance of healthy, self-sustaining, reproductive populations in the wild.

Unless and until specimens can be collected for captive rearing and propagation, maintenance of the San Marcos gambusia's habitat is the only achievable recovery goal.

Critical Habitat
The critical habitat designation for San Marcos gambusia predates the requirement for identification of primary constituent elements that are essential for the conservation of this species. However, the rule designating critical habitat (45 FR 47362) does describe those actions that would adversely modify designated critical habitat, including any actions that would: increase vegetation, disrupt the mud bottom, or alter the temperature regime. Based on the best available scientific and commercial data, the primary constituent elements could generally be defined as:

1) Open areas with minimal aquatic vegetation,
2) Mud substrate,
3) Reduced water velocities, and
4) Fairly constant water temperature.

h. Texas blind salamander
Species Description and Life History
The Texas blind salamander (*Eurycea rathbuni*) was listed as endangered on March 11, 1967 (32 FR 4001), and received Federal protection with the passage of the Endangered Species Act in 1973. Critical habitat has not been designated.

The Texas blind salamander is a smooth, unpigmented, stygobitic (cave-adapted obligate aquatic). Adults attain an average length of about 4.7 inches and have a large, broad head, and reduced eyes. The limbs are slender and long with four toes on the forefeet and five toes on the hind feet (Longley 1978). The Texas blind salamander is a neotenic species believed to be adapted to the relatively constant temperatures (69.8°F) of the water-filled subterranean caverns of the Edwards Aquifer in the San Marcos area (Longley 1978). Juveniles have been collected throughout the year, making it likely that this species is sexually active year-round, as expected because of little seasonal change in the aquifer (Longley 1978).

Observations indicate that this salamander moves through the aquifer by traveling along submerged ledges and may swim short distances before spreading its legs and settling to the bottom of the pool (Longley 1978). Observations on captive individuals indicate that Texas blind salamanders feed indiscriminately on small aquatic organisms and do not appear to exhibit an appreciable degree of food selectivity. Prey items for the Texas blind salamander include amphipods, blind shrimp (*Palaemonetes antrorum*), daphnia, small snails, and other invertebrates. Cannibalism has been documented (Service 1996a).

Historic and Current Distribution
The Texas blind salamander was first described by Stejneger (1896) who collected the type specimen in 1895, which was expelled from an artesian well drilled at the Federal Fish Hatchery in San Marcos, Texas, where it was expelled from an artesian well (Longley 1978). The species has been collected at several other locations, all within Hays County, including Ezell's Cave, San Marcos Springs, Rattlesnake Cave, Primer's Fissure, Texas State University's artesian well, and Frank Johnson's well (Russell 1976, Longley 1978). The species had been recorded from Wonder Cave (also known as

Beaver Cave; Longley 1978) but searches in 1977 did not locate any specimens (Longley 1978).

Little is known about the population size or trends in population for this species, since it inhabits that aquifer. However, the distribution of this species has been hypothesized to be as small as 39 square miles beneath and near the city of San Marcos (Longley 1978).

Reasons for Decline and Threats to Survival
Threats to the Texas blind salamander include: loss of suitable habitat and encroachment of the saline interface into historical and currently occupied parts of the Edwards Aquifer, due to a decrease in aquifer level; a decrease in water quality; and a lack of constant temperatures.

Range-wide Survival and Recovery Needs
According to the San Marcos and Comal Springs and Associated Aquatic Ecosystems Recovery Plan (Service 1996a), which includes Texas blind salamanders, recovery tasks include: adequate water levels and quality are assured in the aquifer, captive breeding populations are established to ensure genetic integrity, reintroduction techniques are established, local threats to water quality and quantity are addressed, and self-sustaining populations of this species exist throughout its range.

The Nature Conservancy purchased Ezell's Cave in 1967. In 1972, Ezell's Cave was designated as a National Natural Landmark by the National Park Service.

While the San Marcos National Fish Hatchery and Technology Center has had successful reproduction of the Texas blind salamander in captivity, beginning in 2002, few specimens have been collected and the numbers in captivity are unlikely to maintain good genetic representation (Krejca and Gluesenkamp 2007). No techniques have yet been developed to reintroduce this species back into habitat within the aquifer.

3. Environmental Baseline

a. Groundwater Conservation Districts

Under the authority provided by Texas Water Code (Chapter 36, Subsection 36.101), groundwater conservation districts may limit aquifer withdrawals under rules governed by Chapter 36 and by their enabling legislation to conserve, preserve, and protect groundwater or groundwater recharge, and to prevent waste of the groundwater resource or groundwater reservoirs in their jurisdiction as part of a comprehensive, approved groundwater management plan. There are two groundwater conservation districts in the action area

i. The Edwards Aquifer Authority (EAA)

The EAA was created by the Texas Legislature in 1993 (Chapter 626, Laws of the 73rd Texas Legislature, 1993, as amended by Chapter 621, Laws of the 74th Texas Legislature, 1995). The purpose of the EAA is to manage and issue permits for the withdrawal of groundwater from portions of the Edwards Aquifer for the purposes of water conservation and drought management and to make and enforce rules. The

EAA was designated a special regional management district and charged with protecting terrestrial and aquatic life (including the endangered species at Comal and San Marcos springs), domestic and municipal water supplies, the operation of existing industries, and the economic development of the state. The EAA is mandated to pursue all reasonable measures to conserve water; protect water quality in the aquifer; protect water quality of surface streams provided with spring flows from the aquifer; maximize the beneficial use of water available to be drawn from the aquifer; protect aquatic and wildlife habitat; protect threatened and endangered species under Federal or State law; and provide for instream uses, bays, and estuaries.

Estimates for annual recharge into the Edwards Aquifer range from 635,000 acre-feet (ac-ft) (USGS 1995) to 717,500 ac-ft with an even higher annual average of 965,400 ac-ft from 2000-2009 (EAA 2010). The lowest annual recharge (44,000 ac-ft) occurred during 1956 at the peak of the drought of record, an extended period of drought that lasted 18 months (September 1955 through February 1957), and the highest annual recharge (2,486,000 ac-ft) occurred in 1992. Wells are the principal source of water usage, and are typically used for agricultural, municipal, and industrial uses in the region. Average annual discharge from wells from 1934-2009 was 311,400 ac-ft (44.7 percent of all discharge), in comparison to 384,400 ac-ft (55.3 percent) from spring flow. During droughts, the proportion of well discharge to spring discharge can change considerably. During 1956 at the height of the drought of record, wells contributed 82 percent of the discharge compared to 18 percent for springs, and during the drought of 2008, wells contributed 51 percent of the total discharge, while spring discharge comprised 49 percent (EAA 2010).

In 2007, the Texas Legislature set a cap on how much pumping the EAA could allow from the Edwards Aquifer at 572,000 ac-ft annually (80th Texas Legislature, 2007, Senate Bill HB 3). Additionally, the Texas Legislature amended the EAA Act by passing Senate Bill 3.1, which directs the EAA to adopt and enforce a Critical Period Management plan with withdrawal reduction. For pumpers within Bexar and Medina counties, and portions of Atascosa, Caldwell, Comal, Guadalupe and Hays counties, the following reductions apply during reduced flow events:

Critical Period Stage*	J-17 Index Well (feet above msl)	Comal Springs Flow (cfs)	San Marcos Springs Flow (cfs)	Withdrawal Reduction
I	< 660' msl	< 225 cfs	< 96 cfs	20%
II	< 650' msl	< 200 cfs	< 80 cfs	30%
II	< 640' msl	< 150 cfs	n/a	35%
IV	< 630' msl	< 100 cfs	n/a	40%

* A change to a critical period stage is based on 10-day daily average of spring flows at Comal or San Marcos springs and/or aquifer levels at the J-17 Index Well.

ii. Hays Trinity Groundwater Conservation District

The Hays Trinity Groundwater Conservation District (HTGCD) was created by the Texas Legislature in 1999 (76th Legislature, S.B. 1911, Chapter 1331, 1999 Texas General Laws 4536 and Acts of May 27, 2001, 77th Legislature (S.B. 2), Regular Session, Chapter 966 (Part 3), 2001 Texas General Laws 1880). The HTGCD, whose water influences flows at Fern Bank and San Marcos springs, may exercise any and

all statutory authority or power conferred by its enabling legislation, including the adoption and enforcement of rules under Texas Water Code. The HTGCD works to conserve, preserve, recharge, and prevent waste of groundwater within western Hays County (District). To help accomplish these goals the HTGCD is charged to gather information needed for sound decisions, to provide information to citizens and local agencies, and to insure that groundwater is used efficiently and at sustainable rates.

The estimated annual amount of recharge from precipitation to the District's portion of the Trinity Aquifer is 26,101 ac-ft annually. The estimated volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers is 21,555 ac-ft. The following is a summary of the water budget for the District through 2060 (HTGCD 2010).

Year	2020	2030	2040	2050	2060
Projected Trinity Aquifer Total Availability for the District (ac-ft/year)					
	3,713	3,713	3,713	3,494	3,494
Projected Total Water Supply for the District (ac-ft/year)					
Groundwater	1,497	1,497	1,496	1,270	1,269
Surface water	4,232	4,510	4,779	3,096	3,358
Total	5,729	6,007	6,274	4,366	4,627
Projected Total Water Demand by the District (ac-ft/year)					
	13,924	17,212	20,607	24,799	28,422

Source: SRC Availability table (TWDB 2007)

The HTGCD has several water management strategies to meet projected needs in Hays County. These include renewing contracts and increasing supply from existing water providers, constructing new water lines, purchasing water from new suppliers, increasing pumping from the Trinity, and recycling water. While increasing withdrawals from the Trinity Aquifer is a strategy, it would only account for a small percentage of the total new supply: 0.6 percent in 2020, 0.56 percent in 2030, 1.1 percent in 2040, 1.27 percent in 2050, and 1.4 percent in 2060.

The Texas Water Development Board divided Texas into 16 regional water planning areas lettered A through P. The HTGCD consists of 2 Regions that rely on different measures for determining drought status. The northern region of Hays County falls in Region K, which mainly relies on water from the Colorado River. Drought status for Region K is determined by the Pedernales River discharge rate and the Henly Church well water level. The southern region of Hays County falls within Region L, and drought status is determined by the Blanco River and Jacob's well discharge rates and the Mt. Baldy well water level.

There is a "No-Drought" stage and two drought severity stages: Alarm and Critical. A Water Conservation Period will be in place between May 1 and September 30 of each year, during which 10 percent voluntary reductions in water use are requested of all groundwater users. The implementation of required demand reduction of 20 percent begins in the Alarm stage, and 30 percent reductions are required in the Critical stage.

b. Status of the spring systems

i. Comal Springs

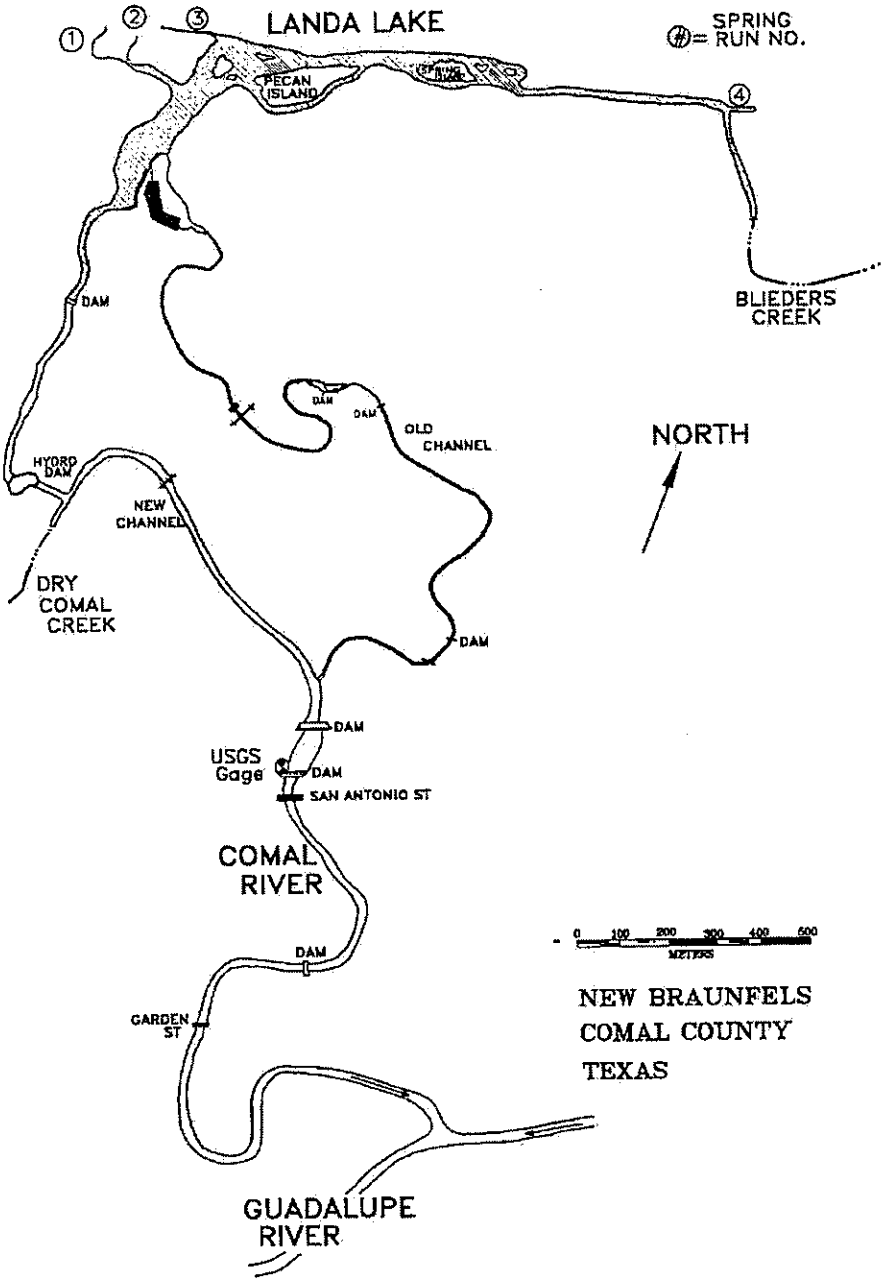
The Comal Springs system is the largest spring system in Texas; is designated critical habitat for Comal Springs dryopid beetle, Comal Springs riffle beetle, and Peck's cave amphipod; and consists of numerous spring openings, collectively called Comal Springs, that originate from the Edwards Aquifer. These spring openings include Brune's Springs j, k, and l (referred to herein as spring runs 1, 2, and 3, respectively; Figure 3). These springs provide flow to three short spring runs that empty into the western end of Landa Lake in Landa Park, a municipal recreational area owned by the city of New Braunfels (Comal County, Texas). Another smaller group of springs, referred to collectively as spring run 4, occur at the eastern end of Landa Lake near the confluence with Blieders Creek. Blieders Creek is about 6.8 miles long and dry except immediately after rains. Numerous small springs and seeps occur in the spring runs, along the banks of Landa Lake, and beneath the Lake (Brune 1981).

Landa Lake was created when the original river channel was dammed in 1847 to create a new channel providing water for Merriwether's Mill. Landa Park was established as a privately owned park open to the public in 1898. The city of New Braunfels acquired the park in 1936. Water emerging from the various springs passes through Landa Lake before flowing into either the old or new channel of the Comal River. The old and new channels merge about 1.6 miles downstream from Landa Lake and the Comal River flows generally south another 1.6 miles before joining the Guadalupe River. A short distance downstream from the headsprings, Dry Comal Creek enters the new channel of the Comal River from the southwest. Dry Comal Creek is an intermittent stream, but it does provide some recharge.

Faulting has, for the most part, hydrologically isolated Comal Springs, although local storms contribute a small recharge component to spring run 3 (Rothermel and Ogden 1987). Brune (1981) and Guyton and Associates (1979) determined the primary recharge area for Comal Springs lays as much as 62 miles to the west of Comal County and includes a large area of the western Edwards Aquifer. In addition to deep confined regional flow coming from Bexar County and westward, there is also a substantial amount of flow from the unconfined Hueco Springs Fault Block that originates in eastern Bexar County and western Comal County (Otera 2007). Evidence also suggests that a portion of the recharge entering the Edwards Recharge Zone in western Comal County included a component of flow sourced from the Trinity Group, juxtaposed against the Edwards along another fault zone.

Flow at Comal Springs has been monitored since the early 1880s and has the greatest mean discharge of any springs in the southwestern United States (George 1952). The average annual discharge from 1928-1989 was 284 cubic feet per second (cfs) with maximum daily springflows of 666 cfs on December 22, 1991, and the highest monthly flow was 467 cfs in 1973 (Edwards Underground Water District, pers. comm.; Guyton and Associates 1979). Much lower flows have been recorded during

Figure 3: Comal Springs System


LANDA LAKE
SPRING
#= RUN NO.
PECAN ISLAND
BLIEDERS CREEK
DAM
OLD CHANNEL
NORTH
HYDRO DAM
NEW CHANNEL
DRY COMAL CREEK
USGS Gage
SAN ANTONIO ST
COMAL RIVER
GARDEN ST
NEW BRAUNFELS
COMAL COUNTY
TEXAS
GUADALUPE RIVER

drought years, and in dry years, flows from Comal Springs can drop very rapidly. Comal Springs ceased flowing from June 13 to November 4, 1956, during the most severe drought on record (Service 1996a, Longley 1995). At that time, all major springs in the Balcones Fault Zone had ceased to flow, with the exception of San Marcos Springs, which had substantially decreased flow (Guyton and Associates 1979).

The mean annual water temperature of Comal Springs is 74°F and is not believed to fluctuate more than about 1°F (George 1952). This nearly constant temperature is significant in maintaining the endangered aquatic species in the Comal Springs ecosystem.

ii. Hueco Springs

Hueco Springs are a smaller group of springs on private property near the Guadalupe River about 3 miles north of New Braunfels, Comal County, Texas (Guyton and Associates 1979). The west spring (Hueco I) flows down a small ravine into a diversion canal to a small lake, from which it spills into the Guadalupe River. The east spring (Hueco II) rises from a deposit of stream gravels between a county road and the Guadalupe River and flows directly to the river.

Springflows at Comal and San Marcos springs are inseparably tied to water usage from the entire Southern Segment of the Edwards Aquifer. The source of Hueco Springs is considered Edwards Aquifer, although the subset of the aquifer supplying Hueco Springs is thought to be smaller than that supplying Comal and San Marcos springs (Guyton and Associates 1979). Lindgren *et al.* (2004) expressed uncertainty about the source of Hueco Springs. Regardless, EAA uses Hueco Springs discharge as part its annual water budget for the Edwards aquifer.

The larger of the two springs, Hueco I, typically exhibits constant flow but has been documented to stop flowing during severe droughts (Ogden *et al.* 1986), such as in 1984. However, Hueco I did not stop flowing during the drought from 1989–1991. Hueco II is an intermittent spring that typically stops flowing during the driest months of the year. (Barr 1993). The spring discharge data for Hueco Springs are less complete than for Comal and San Marcos springs. The U.S. Geological Survey (USGS) reported the annual discharge of Hueco Springs was 1.38 cfs for 1954 and 1955, and zero for 1956. The USGS established a discharge gaging station at Hueco Springs in 2002 and recorded a monthly mean discharge that ranged from 21.8 cfs to 116.6 cfs from 2002-2005 and fell to 3.1 cfs in December 2006. During the state's worst single drought year, 2011, Hueco Springs ceased flowing in September (LCRA 2012, USGS 2011). However, as of February 2012, recent rains have resulted in Hueco Springs discharge is flowing at a rate of 84 cfs (USGS provisional data).

Reported dissolved solids for Hueco Springs are within similar ranges as Comal and San Marcos springs at 253 to 302 milligrams per liter. The average temperature of Hueco Springs is about 70.4° F, with a range from about 68 to 73°F.

iv. San Marcos Springs

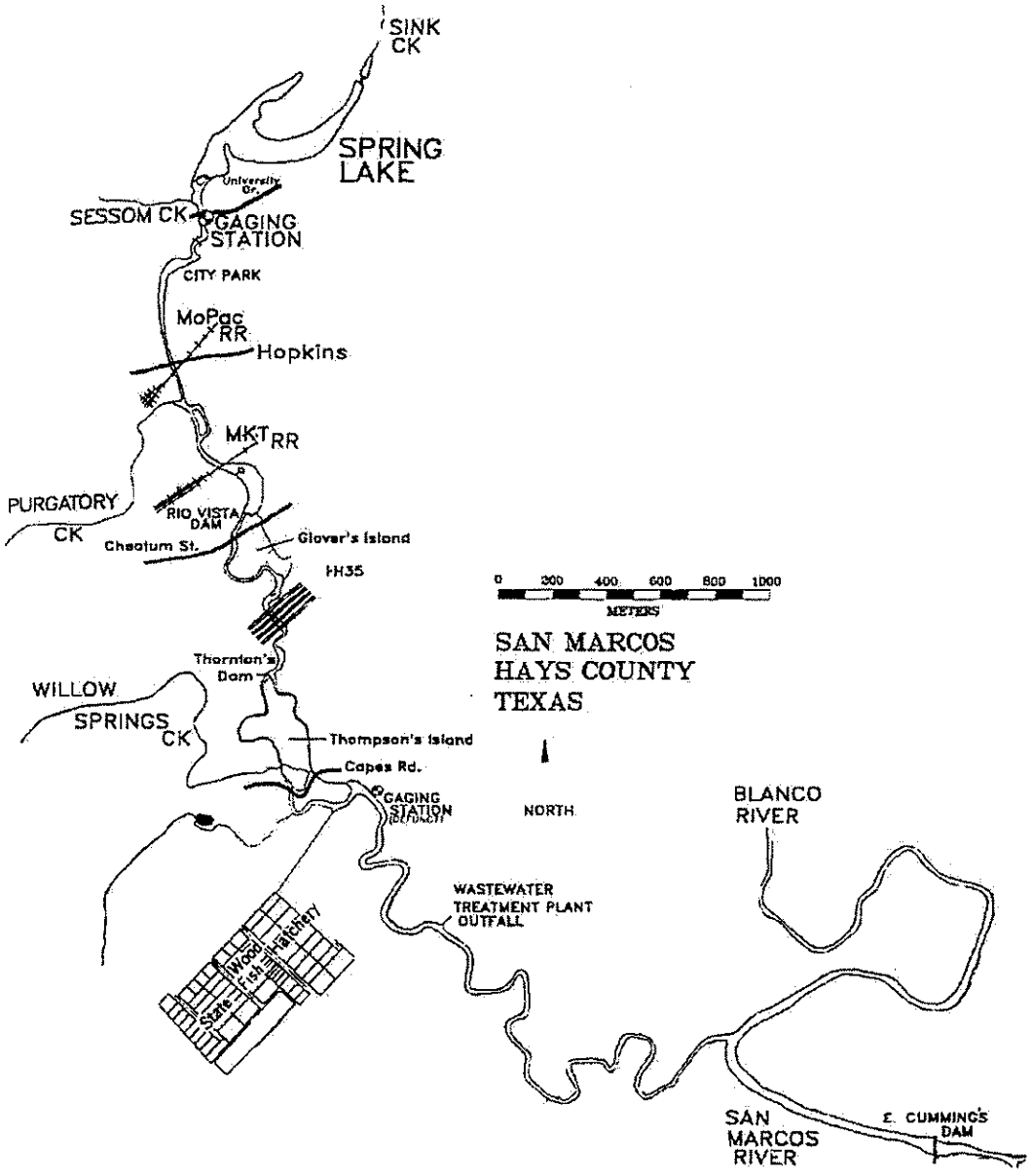
The San Marcos spring system primarily occurs as a series of spring outlets that lie at the bottom of Spring Lake and along its shoreline in the City of San Marcos, Hays County, Texas (Figure 4). Spring Lake is the sight of designated critical habitat for Comal Springs riffle beetle, Texas wild-rice, fountain darter, and San Marcos salamander. The landownership of San Marcos Springs consists entirely of State holdings: the surface water and bottom of Spring Lake are State-owned, and the State-affiliated Texas State University owns the adjacent land surface. The spring outlets associated with San Marcos Springs occur within the main part of the lake, excluding the slough portion that exists as an arm of the lake. San Marcos Springs is the second largest spring system in Texas and historically has exhibited the greatest flow dependability and environmental stability of any spring system in the southwestern United States. Records indicate that the San Marcos Springs have never ceased flowing, although the flow has varied and is tied to fluctuations in the Southern Segment of the Edwards Aquifer.

While Sink Creek, which is upstream of Spring Lake, is normally dry, during periods of high rainfall, it discharges large quantities of storm runoff into Spring Lake. However, the exact areas contributing recharge to San Marcos Springs has not been clearly delineated. Guyton & Associates (1979) determined the majority of recharge for San Marcos Springs was from an area of the aquifer southwest of Comal Springs that flows under Comal Springs and is discharged at San Marcos Springs. These flows are derived primarily from the same sources as the Comal Springs, which likely include the recharge area from rivers and creeks north and west of the City of San Antonio. Radioactive isoptope analysis of water from the San Marcos Springs indicates that some recharge water also originates from other sources such as the Dry Comal, Purgatory, York, and Alligator creek basins; and the Blanco and Guadalupe rivers basins (Guyton and Associates, 1979).

Guyton and Associates (1979) reported an average temperature in the headwaters (within Spring Lake) at 71.6°F that is not believed to fluctuate more than about 1°F. The average discharge at San Marcos Springs during the period of record from 1940 to 2009 was approximately 164 cubic feet per second. During drought years much lower flows occurred, especially in the mid-1950s during the drought of record with a monthly flow of 54 cfs during 1956 and the lowest measured daily flow of 45.5 cfs, which occurred on 15 and 16 August 1956 (Guyton and Associates 1979).

The San Marcos River, which starts at Spring Lake Dam, flows primarily southeastward for about 68 miles before joining the Guadalupe River near Gonzales, Gonzales County, Texas. The upper San Marcos River (from Spring Lake Dam to the confluence with the Blanco River) is about four miles long and is the river portion of designated critical habitat for Texas wild-rice, fountain darter, San Marcos gambusia, and San Marcos salamander (45 FR 47362). The river, which is primarily spring-fed, is rapidly flowing, unusually clear, and varies from about 16.4-49.2 feet wide and up to about 13 feet deep. The river flows mostly over gravel or gravel/sand bottom (Crowe 1994), with many shallow riffles alternating with deep pools. However, there is variability in the substrate, and in areas with lower flows, silt/mud accumulates. Near banks where erosion has occurred and near stormwater drainage points, silt dominated substrates are also found. Along this section of the river, there are four

Figure 4: San Marcos Springs System



named and various unnamed creeks, various storm sewers, and one wastewater treatment plant discharging into the river.

ii. Fern Bank Springs

Fern Bank Springs, designated critical habitat for Comal Springs dryopid beetle, is located about 8 miles northwest of San Marcos Springs and is 0.2 miles east of the junction of the Blanco River and Sycamore Creek on privately-owned land in a predominately rural landscape. The spring system consists of a main outlet and a number of small springs that issue forth from a steep cliff overlooking the Blanco River. The exact water source for Fern Bank Springs is unknown, but may derive its flows from the Glen Rose formation of the Trinity Aquifer, from drainage associated with the Edwards Aquifer recharge zone, or from the Blanco River (Veni in litt. 2006). Fern Bank Springs discharges to the Blanco River just upstream of the Edwards aquifer recharge zone thus, this spring may provide some small contribution to Edwards aquifer recharge.

Fern Bank Springs discharge is not gaged and has only been intermittently measured. Brune (1981) reported Fern Bank spring flow discharge of 4.9 cfs on May 31, 1975, and 0.3 cfs on May 1, 1978. Mace *et al.* (2000) modeled simulated ground water levels over a four decade period. The model estimated a 42 foot drop in water level by 2050 at Fern Bank Springs based on average recharge levels through 2043 and drought of record conditions from 2044 to 2050 (Mace *et al.* 2000). However, a single-family owned the spring site from the late 1800s until 2009, and in 2008, the landowner claimed that the spring never ceased flowing during that time, including the drought of the 1950s.

c. Previous consultations

According to our consultations database there have been at least 17 formal section 7 consultations completed for one or more of the Edwards Aquifer, Southern Segment, aquatic species. Two consultations for the San Marcos and Uvalde National Fish Hatcheries and four for DOD bases in Bexar County were about pumping levels from the Edwards Aquifer. This pumping could not be directly attributed to numbers of species impacted, but rather percentages of total pumping allowed throughout the aquifer and how that would impact both the water quality and quantity of the spring systems. For those consultations that expected actual death or injury to a species (8 authorized take of over 2,000 darters, 1 authorized take of up to 10 beetles, and 2 authorized take of 747 San Marcos salamanders). Minimization measures were put in place to reduce the impacts and species recolonization was typically expected after project completion. Turbidity was also a primary impact expected from most construction projects. Conservation measures, as a result of these consultations, included $200,000 to a conservation entity for funding of studies, creation and maintenance of captive populations, remediation of hazardous areas in ways that would not impact the aquifer, a commitment to reducing water needs from the aquifer by finding alternate water sources, and following Critical Period Management measures during drought. A recent consultation covered the Edwards Aquifer aquatics associated with the Hays County RHCP; however, Hays County did not receive incidental take coverage for these species. This consultation concluded that issuance of the ITP, supported by the Hays County RHCP, was not likely

to jeopardize the continued existence of these species or destroy or adversely modify designated critical habitat.

We have issued one section 10(a)(1)(b) incidental take permit that covers incidental take of the Edwards Aquifer, Southern Segment, aquatic species. The EARIP HCP was issued to the EAA, the City of San Antonio, acting by and through its San Antonio Water System, the City of San Marcos, the City of New Braunfels, and Texas State University. The EARIP HCP covers activities including the regulation and production of groundwater for irrigation, industrial, municipal, domestic, and livestock purposes; the use of the Comal and San Marcos rivers for recreational uses; operational and maintenance activities that could affect Comal and San Marcos springs, and the associated river systems; and activities necessary to manage potential habitat for the covered species.

4. Effects of the Action

This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR § 402.02. Instead, we have relied upon the statutory provisions of the Act to complete the following analysis with respect to designated critical habitat.

There are no direct effects from the issuance of the permit on Comal Springs dryopid beetle, Comal Springs riffle beetle, Peck's cave amphipod, Texas wild-rice, fountain darter, Texas blind salamander, San Marcos gambusia, and San Marcos salamander. Indirect effects of permit issuance on these species from implementation of the RHCP could occur from impacts to the quantity and quality of aquifer water and the resulting spring flows upon which they depend. Threats to water quantity could include, but may not be limited to, pumping, creation of impervious surfaces that alter infiltration rates, and other activities that result in removing water from the aquifer systems. Threats to water quality could include, but may not be limited to, development that affects recharge capability, contaminants/dissolved materials, and changes to water temperature. These could result in loss of natural substrates - mainly due to siltation, alteration of aquatic habitats, shelter sites, and reduction in food supplies for these species.

Water Quantity

Continued human population growth in the region and associated increases in water demand may exacerbate declining spring flows if future water needs are met by increased pumping from the Edwards Aquifer. Current water supplies in Comal County rely on the Edwards Aquifer, water diverted from the Guadalupe River basin, and water pumped by the Guadalupe Blanco River Authority from Canyon Lake in Comal County.

The RHCP will provide incidental take authorization for loss or harm to GCWAs and BCVIs; therefore, participation in the RHCP will only occur in areas with potential habitat. For this analysis areas of potential participation are therefore defined by the potential habitat estimated in the RHCP. Additionally, the RHCP provided projected human population distribution for the requested 30-year permit term. Changes in human population density were determined by dividing the increase in population by the respective acreage of each census tract. Census tracts and modeled potential GCWA habitat were superimposed over aquifer polygons to determine

where participation in the RHCP could occur that may result in effects to the aquifers and therefore to the listed aquifer-associated species.

BCVI habitat in Comal County is likely to be occupied in sub-climax successional vegetation communities that may persist on the landscape for varying time periods. Suitable habitat for this species is therefore often considered a dynamic shifting mosaic of vegetation of suitable structure that moves across the landscape in response to disturbance and land use. The amount and location of potential habitat is expected to change and move during the duration of the proposed permit. Therefore, BCVI habitat, for the purposes of this analysis, is assumed to be evenly distributed within Comal County.

Because the actual location of future participation and the source water for participants is unknowable, for the purposes of this analysis water demand created by participants in the plan is assumed to be met from the aquifer associated with the location of the development. This assumption has the effect of overstating the likely actual water demand, as some participants may be served by municipal utilities that receive some portion of their water from alternate sources. The City of New Braunfels, for example, has initiated diversification of their water supplies and further alternate water sources are anticipated to be secured during the life of the permit.

The effect of RHCP participation on the Edwards Aquifer is summarized in the following table. Given the total number of acres covered under the incidental take permit (6,238 acres, assuming no overlap between GCWA and BCVI), we estimate the number of people that will use the RHCP in habitat, over the Edwards Aquifer, with a density of 0.63 persons per acre, to be 3,925. Given the Region L water consumption rate of 132 gallons per day per person, we estimate the total will result in a water demand of 518,100.2 gallons per day (or 581.6 acre-feet per year). Comparing the annual rate of water demand attributable to the RHCP to the total permitted annual withdrawals by EAA (572,000 acre-feet per year), the water demand strictly attributable to the RHCP is about 0.10 percent of total permitted Edwards withdrawals.

Comal County RHCP	**Water Demand Estimation**
Acres of GCWA habitat over Edwards Aquifer	5,238 acres
Acres of BCVI habitat over Edwards Aquifer	1,000 acres
Total Acres over Edwards Aquifer	6,238 acres
Density of People Per Acre	0.6292
Gallons Per Capita Per Day	132
Number of People Projected to Use RHCP	3,925
Water Demand Attributed to RHCP	518,100.2 gpd
Water Demand Conversion to Acre-Feet per Year	581.6 ac-ft/yr
Total Permitted Water Withdrawals Allowed from Edwards Aquifer	572,000 ac-ft/yr
Percent Demand Attributable to Comal County RHCP of Total Permitted Edwards Aquifer Withdrawals	0.10%

Between 2010 and 2040, annual water demand in the County is estimated to increase from 29,680 to 59,710 acre-feet (South Central Texas Regional Water Planning Group 2006). In an effort to ensure that sufficient water is available for new development, the County requires subdivisions served by individual wells or a new water system not utilizing water regulated by the EAA to submit a Certification of Availability pursuant to 30 TAC § 230.1–230.11 that is documented by a hydrogeologist. In areas where groundwater withdrawal is not regulated by the EAA (i.e., from the Trinity Aquifer), the developer must submit a report by an engineer certifying water availability for 20 years. Despite these measures, the South Central Texas Regional Water Planning Group (2006) believes that current and projected water supplies are inadequate to meet future demand, and estimates that by 2040, Comal County will need to find an additional 30,700 acre-feet annually.

Droughts vary significantly in duration and intensity. While numerous droughts of short intensity have been recorded, at least five droughts of extended duration and extreme intensity have occurred since 1931 on the Edwards Plateau (Riggio *et al.* 1987). Between 1931 and 1985, droughts occurred with following frequencies: three-month droughts varied from 62 to 70 occurrences, six-month droughts varied between 32 and 40 occurrences, and a 12-month drought occurred less than 24 times (Riggio *et al.* 1987). The six-year drought that occurred from 1951 through 1956 is considered the drought of record for the Edwards Aquifer as it resulted in the only known cessation of flow at Comal Springs in 1956 (Longley 1995). However, in general, droughts in the Edwards Aquifer region are generally short in duration and not intense.

A study utilizing dendrochronology (tree-ring analysis) was conducted to evaluate historic drought patterns in the Edwards Aquifer region (Mauldin 2003). An extensive data base of tree-ring data (from 1700–1979) for the southwest was used in the analysis (Cook 2000) and correlated with the Palmer Drought Severity Index (PDSI; a standard measure of soil moisture conditions used to classify drought frequency, intensity, and duration). Over the 280-year period, 25.7 percent of the years were drought years. (Mauldin 2003). During the 280-year period, the Edwards Aquifer region experienced 40 droughts of various lengths (Mauldin 2003). Droughts that lasted only 1 year were more common; however, the average drought was 1.8 years. Long-term droughts, those exceeding 3 years in duration, occurred only four times: three of those were in the 1700s, and the fourth was the drought of record, which lasted 5 years (Mauldin 2003). The drought of record represents only 2.1 percent of the 280-year period analyzed and only 2.5 percent of the 40 droughts.

In response to concerns about the likelihood of another significant drought that could adversely affect the spring systems, the potential for a repeat of the drought of record was analyzed from three perspectives: the long-term regional rainfall pattern based on tree-ring data, the regional pattern of rainfall from the instrumental rainfall records, and a probabilistic analysis based on the characteristics of the historic instrumental data (Cleaveland and Votteler, in preparation). Based on this analysis, it was inferred that if the overall climatic regime during the past eleven years were to continue into the near-term future (approximately 15 years), the probabilities of a recurrence of a year as dry as 1956 is approximately 1.6 percent in any given year. The probabilities of three- or five-year periods as dry as the drought of record are approximately 0.2 percent, and the probabilities of seven- or ten-year periods as dry as the drought of record are 0.1 percent or less (Cleaveland and Votteler, in preparation).

In Feburary 2013, the Service issued a 10(a)(1)(B) incidental take permit to the EAA, the City of San Antonio, acting by and through its San Antonio Water System (SAWS), the City of San Marcos, the City of New Braunfels, and Texas State University (also referred to as the EARIP). The EARIP is a program to minimize and mitigate impacts to southern Edwards Aquifer aquatic species, including maintaining water quantity at Comal and San Marcos springs. Water quantity protection measures include: Critical Period Management regulations that require pumping reduction triggered by certain aquifer and/or springflow levels; use of SAWS Twin Oaks Aquifer Recharge, Storage, and Recovery Facility for springflow protection; and a Voluntary Irrigation Suspension Program that will provide incentives to cooperators for suspending pumping for agriculture. The Service believes these measures will maintain flows at Comal and San Marcos springs, even during drought.

Water Quality

The general sources of water quality concerns are common to all of the aquifer systems in the action area and are considered together here. Land use changes throughout the region may increase risks to the aquifer and springs. Pollution threats include:

(1) increases in sedimentation from runoff;

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

(3) groundwater pollution from land-based hazardous material spills and leaking underground storage tanks; and,

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

Sediment may affect aquatic organisms in a number of ways. Excessive deposition of sediment can physically reduce the amount of available habitat and protective cover for aquatic organisms. Once deposited in large volumes, sediment can become anoxic (devoid of oxygen) and cease to provide suitable habitat. Silt and sediment can clog the interstitial spaces of the substrates surrounding the spring outlets that offer protective cover and an abundant supply of well-oxygenated water for respiration, and can flow downstream reducing natural rocky substrates that plants and animals, like Texas wild-rice and fountain darter, rely on (45 FR 47355).

To prevent pollution and sedimentation of the aquifer, there are several regulations currently in place; the first of which is the Federal Safe Drinking Water Act (1974), which protects sources of public drinking water. This Act was amended in 1996, and mandates enforceable drinking water standards established by the Environmental Protection Agency (EPA). The Texas Commission on Environmental Quality (TCEQ) has responsibility for enforcement of these standards in Texas and has drafted their own rules, sometimes stricter than the EPA's. Under these rules, for certain activities over the recharge, transition, or contributing zones, developers must submit an application including an Aquifer protection plan to TCEQ. Additionally, certain facilities are prohibited from being built in the recharge or transition zones such as municipal solid waste landfills and waste disposal wells.

For any regulated construction activity over the recharge zone, TCEQ also requires a water pollution abatement plan (WPAP). The WPAP must include a geological assessment report

identifying pathways for movement of contaminants and sediment to the Aquifer, and a report on best management practices and measures to prevent pollution of the Aquifer. All activities that disturb the ground or alter a site's topographic, geologic, or existing recharge characteristics are subject to regulation, which would require either sediment and erosion controls or a contributing zone plan (CZP) to protect water quality during and after construction. Exemptions include construction of single-family residences on lots larger than five acres, where no more than one single-family residence is located on each lot; agricultural activities; oil and gas exploration, development, and production; clearing of vegetation without soil disturbance; and maintenance of existing structures not involving additional site disturbance.

Additionally, the EAA has implemented a water quality protection program that includes well construction rules that regulate the construction, operation, maintenance, abandonment, and closure of wells (EAA Rules Chapter 713, Subchapters B, C, and D). The EAA also regulates the reporting of spills (Subchapter E), storage of certain regulated substances on the recharge zone and the contributing zone (Subchapter F), and installation of tanks on the recharge zone (Subchapter G).

Each year the EAA monitors the quality of water in the Southern Segment of the Edwards Aquifer by sampling approximately 80 wells, 8 surface water sites, and major springs across the region. Tests include measurements of temperature, pH, conductivity, alkalinity, major ions, minor elements (including heavy metals), total dissolved solids, nutrients, pesticides, herbicides, volatile organic compounds, and other analytes. Results of the EAA's recent water quality testing did not indicate widespread contamination in the Aquifer. However, elevated nitrate detections (greater than two mg/L) were present in 16 of the 79 wells sampled (EAA 2009). It is not clearly understood what the source of nitrate is, but agriculture, bats, and natural processes are possibilities (Eckhardt 2012). Chemical fertilizers, which contain nitrates, have been used in agriculture for decades. Nitrate levels are generally higher the farther west over the aquifer you go, which has more agricultural areas. However, nitrates can also come from urban areas. Some scientists have suggested that high nitrate levels could originate from bat guano. There are several bat colonies in recharge caves and their excrement piles up on cave floors, so much so that some caves were mined for guano as a source of nitrate for making gunpowder. During major recharge events, the guano could be washed down into the Edwards Aquifer.

In August 2004, the Service and the TCEQ began a collaborative effort to develop voluntary guidelines that, if followed by project planners within the entire Edwards Aquifer region, would result in "no take" of several federally-listed, aquifer-dependent species, including the San Marcos salamander and fountain darter. As a result of this collaboration, the "Optional Enhanced Measures for the Protection of Water Quality in the Edwards Aquifer" were finalized in February 2005, as an addendum to TCEQ's technical guidance document for implementing the Edwards Aquifer Rules. In addition, the Service and TCEQ are committed to a monitoring and adaptive management program. These two agencies have met with many of the groups that are monitoring Edwards Aquifer water quality, and in some cases, biological resources. These groups have committed to sharing the results of their monitoring information, which will be stored in a centralized database and used for trend analyses. If the analysis of the monitoring information indicates water quality degradation that could affect aquifer-dependent species such as the San Marcos salamander, then the TCEQ and the Service would convene an expert group to evaluate the causes. If necessary, the agencies plan to modify the optional water quality measures to ensure the continued protection of these species.

The EARIP also outlines measures to minimize and mitigate impacts to water quality at the San Marcos and Comal springs. These measures include: restoration and maintenance of native aquatic and riparian vegetation, removal of decaying vegetation, dissolved oxygen management, and implementation of water quality and impervious cover limitations.

In addition, significant preservation of land over the Recharge and Contributing Zones has occurred. For example, the City of San Antonio passed two propositions for Edwards Aquifer protection, which have resulted in the preservation of more than 54,000 acres of land. While most of these lands occur outside Comal County, the cumulative benefit for Edwards Aquifer recharge is positive. Further protecting the water quality of the Edwards Aquifer are water quality ordinances passed by the City of San Antonio that require, among other things, an Aquifer Protection Plan must be prepared and approved by the Resource Protection Division of the San Antonio Water System. The ordinances also include impervious cover limitations and require floodplain setbacks, recharge feature protection and buffer zones, and use of best management practices.

Additionally, Comal County has a number of parks, preserves, and privately owned tracts within the contributing and recharge zones of the Edwards Aquifer, which are under easements that protect them as open space. While these tracts may not have the primary purpose of protecting the aquifer, it is likely that the species are receiving some conservation value from the non-developed nature of these parcels. In addition to these existing open spaces, new protected lands for the GCWA and BCVI will be created through the RHCP that will also protect water quality and quantity to the aquifers. Increasing the amount of land preserved in its undeveloped state may result in a reduction in the number of acres of managed landscape and turf (areas that are intensely managed through the use of irrigation, fertilization, or pest control practices) that can serve as a source of pollutants during stormwater runoff or irrigation events.

Critical Habitat/Threats Summary

Water quantity is a PCE for Comal Springs dryopid beetle, Comal Springs riffle beetle, Peck's cave amphipod, Texas wild-rice, fountain darter, San Marcos gambusia, and San Marcos salamander, and a threat for Texas blind salamander. During normal conditions, spring discharge is expected to be near the reported average at each of the springs. During low-flow events, the water levels may decrease, and while this has been shown to be a natural phenomenon, we expect critical period management conditions to go into effect. With these protections of water quantity PCEs, spring flows will fluctuate seasonally and cyclically, but flows are expected to be sufficient to protect designated critical habitat.

Water quality is a PCE for Comal Springs dryopid beetle, Comal Springs riffle beetle, Peck's cave amphipod, Texas wild-rice, fountain darter, San Marcos gambusia, and San Marcos salamander, and a threat for Texas blind salamander. Based on existing water quality laws and regulations, which include both mandatory and voluntary measures, and the number of monitoring efforts that are occurring, we do not expect the water quality to decrease over the life of the permit.

Constant temperature is a PCE for Comal Springs dryopid beetle, Comal Springs riffle beetle, Peck's cave amphipod, Texas wild-rice, fountain darter, San Marcos gambusia, and San Marcos salamander, and a threat for Texas blind salamander. None of the Covered Activities are expected to have an effect on water temperature.

Maintenance of a natural substrate is a PCE for Texas wild-rice, Comal Springs riffle beetle, fountain darter, San Marcos gambusia, and San Marcos salamander. The main threat to maintaining a natural substrate is sedimentation. Based on existing water quality laws and regulations and the number of monitoring efforts that are occurring, we do not expect the Covered Activities to increase sedimentation at the springs or downstream.

Maintenance of a food supply is a PCE for Comal Springs dryopid beetle, Comal Springs riffle beetle, and Peck's cave amphipod, and fountain darter. We expect that if water quality and quantity are maintained, then the food supply should also be maintained. Therefore, we do not expect the Covered Activities to reduce the food supply.

Maintenance of submergent vegetation is a PCE for fountain darter. None of the Covered Activities are expected to effect submergent vegetation.

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.

The RHCP estimates 80,429 acres of Comal County will be developed over the life of the permit, which includes 10,476 acres of potential GCWA habitat. Since there is no good estimate for the amount of BCVI habitat in Comal County, there is no way to predict where, or exactly how much, habitat will be impacted. Therefore, the County has estimated 1,000 acres of BCVI habitat will impacted over the life of the permit. Only a portion (2,095-5,238 acres of GCWA habitat) of those impacts are expected to be covered by the RHCP, due to expected rates of participation (20-50 percent). Therefore, up to 5,238 acres of GCWA habitat and up to 2,591 acres of BCVI habitat may be impacted over the life of the permit, but will not be covered by the RHCP. These loses may alter the habitat or increase incidental take of GCWAs and BCVIs, and may not be subject to Federal authorization or funding. These projects would require their own incidental take coverage, and are, therefore, cumulative to the RHCP. These additional cumulative effects include: (1) unpredictable fluctuations in habitat due to urbanization; (2) increase in impervious cover due to urbanization (i.e., roads); (3) use of pesticides on listed species habitat; (4) changes in land use (conversion); (5) agricultural practices; (6) nest parasitism; and, (7) predation by feral animals and pets.

All 80,429 acres of habitat with future development are expected to occur over one of the zones of the Edwards Aquifer. Therefore, for the aquatic species, additional cumulative effects include: increased pumping demands and impervious cover due to non-participating development within Comal County; recreational activities; contaminated runoff from agriculture and urbanization; aquatic habitat modification (e.g., dams, bank stabilization, flood control); and, habitat alteration by invasive exotic/non-native species. While some of these activities would require consultation with the Service, not all of them do.

Conclusion

After reviewing the current status, environmental baseline, effects of the action, and cumulative effects on the GCWA and BCVI, it is the Service's biological opinion that the proposed action is not likely to jeopardize the continued existence of these species. No critical habitat has been designated for the GCWA or the BCVI; therefore, none will be affected. As stipulated throughout the RHCP, pursuant to section 10(a)(1)(B) of the Act, and the intent to provide some recovery benefit to the covered species, the proposed action is an effort on the part of Comal County to add to the recovery for the GCWA and BCVI. For the GCWA, by mitigating and permanently preserving large blocks of habitat, Comal County will play a pivotal role in connecting the large focal areas to the north and to the south with smaller "stepping stones" of preserved habitat, thus maintaining the genetic diversity between recovery regions. For the BCVI, implementation of Comal County's RHCP will contribute to recovery through discovery and protection of BCVI populations within Comal County, and providing for genetic diversity.

After reviewing the current status of Comal Springs dryopid beetle, Comal Springs riffle beetle, Peck's cave amphipod, Texas wild-rice, fountain darter, San Marcos gambusia, San Marcos salamander, and Texas blind salamander; designated critical habitat; the environmental baseline; the effects of the action; and the cumulative effects, it is Service's biological opinion that issuance of the ITP, supported by the Comal County RHCP, is not likely to jeopardize the continued existence of these species or destroy or adversely modify designated critical habitat. As stated in the Recovery Plan for these species, maintenance of adequate flows and water quality are the primary needs for the species. Water quantity is expected to be maintained at the springs through the EARIP and authority of the local water conservation districts and water quality is expected to remain at or above current standards through state and Federal regulations already in place. However, should new information become available (e.g. critically-low springflow levels) that might suggest incidental take or adverse modification to any designated critical habitat, the Service will reinitiate consultation. If the Service determines that incidental take or adverse modification of designated critical habitat is occurring from implementation of the RHCP, the Service will consider suspension or revocation of the permit if additional conservation measures cannot be developed to avoid the taking or the adverse modification of designated critical habitat.

Permit issuance is not expected to appreciably alter the distribution or population size of any of the aquatic species addressed in this analysis during normal conditions. Indeed, it is likely that permit issuance could result in some benefit to these species if the proposed preserve system of up to 6,500 acres containing potential GCWA and BCVI habitat in Comal County is achieved. Protection of these terrestrial habitats over aquifer resources may provide benefits otherwise unavailable to the aquatic species considered here.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulations pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined by the Service as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is further defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavioral patterns, which include, but are not limited to, breeding, feeding and sheltering (50 CFR §17.3). Harm is also further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by impairing behavioral patterns, including breeding, feeding, and

sheltering. Incidental take is defined by the Service 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 this Incidental Take Statement.

The measures described below are nondiscretionary and must be implemented by the Service so that they become binding conditions of any authorization issued to implement a project covered by this biological opinion, as appropriate, in order for the exemption in section 7(o)(2) to apply. The Service has a continuing duty to regulate the activity covered by this incidental take statement. If the Service (1) fails to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the authorizations, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Service must report the progress of the action and its effect on the species. [50 CFR 402.14(i)(3)].

To the extent that this statement concludes that take of any endangered species of migratory bird will result from the agency action for which consultation is being made, the Service will not refer the incidental take of any such migratory bird for prosecution under the Migratory Bird Treaty Act of 1918, an amended (16 U.S.C. §§ 703-712), if such take is in compliance with the terms and conditions (including amount and/or number) specified herein.

Amount or Extent of Take

The Service anticipates incidental take of GCWA and BCVI will occur as a result of the proposed action. Individual GCWA and BCVI are difficult to detect unless they are observed, undisturbed, in their environment. Most close-range observations of GCWA and BCVI represent chance encounters that are difficult to predict. Because quantifying take of individual GCWA and BCVI is difficult (clearing of habitat typically results in harm or harassment through displacement, not in death or injury of individuals), this biological opinion instead evaluates acres of habitat removed as a surrogate for the level of incidental take. This approach has been used for incidental take of GCWA and BCVI in Travis County (RECON and Service 1996), Williamson County (SWCA 2008) and Hays County (Loomis Partners 2010). The incidental take from the proposed action is expected to occur in the form of harm and harassment through direct loss of habitat and indirect adverse effects resulting from the issuance of an incidental take permit pursuant to 10(a)(1)(B) of the Act. The following amount of incidental take will be authorized by the proposed permit:

1. No more than 5,238 acres of GCWA habitat that occurs within the Comal County may be adversely affected; and,

2. No more than 1,000 acres of BCVI habitat that occurs within the Comal County may be adversely affected.

The Service does not anticipate incidental take of Comal Springs dryopid beetle, Comal Springs riffle beetle, Peck's cave amphipod, Texas wild-rice, fountain darter, San Marcos gambusia, San Marcos salamander, or Texas blind salamander from the issuance of the ITP or implementation of the RHCP. If an activity is anticipated to incidentally take one of these species, the project proponent will need to pursue separate incidental take coverage through section 7 or 10 of the

Act, as appropriate. If that coverage is not obtained, and if conditions exist that are shown to result in incidental take due to actions associated with the RHCP, the Comal County permit may be suspended or revoked in accordance with 50 CFR 13.27 and 13.28, as applicable. All activities associated with the RHCP that are shown to cause unauthorized take must cease until further notice.

The Service recognizes that: (1) the permit applicant does not control pumping from the aquifers within the County, (2) for the period covered under this opinion; water withdrawal associated with permit issuance from the aquifers in Comal County will generally be less than one percent (1%) of total withdrawals. Efforts to reduce withdrawals and provide spring flows for the listed species to reduce the risk of jeopardizing the species or adversely modifying their designated critical habitats is the responsibility of all Edwards Aquifer users. However, it is the applicant's responsibility to avoid unauthorized take of any listed species and avoid adverse effects to designated critical habitat for any listed species within the action area.

Sections 7(b)(4) and 7(o)(2) of the Act generally do not apply to the incidental take of listed plant species like Texas wild-rice. However, protection of listed plants is provided to the extent the Act prohibits the removal, reduction to, and 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.

Effect of the Take

In the accompanying biological opinion, the Service has determined that the level of anticipated take is not likely to result in jeopardy of the GCWA or BCVI due to the long-term beneficial effects associated with the proposed action, most importantly the permanent preservation of large blocks of habitat. No critical habitat has been designated for the GCWA or the BCVI; therefore, none will be affected.

The Service expects that groundwater withdrawals that may result from actions associated with the Comal County RCHP may result in some reduced flows; however, no adverse modification is expected to designated critical habitat for Comal Springs dryopid beetle, Comal Springs riffle beetle, Peck's cave amphipod, Texas wild-rice, fountain darter, San Marcos gambusia, or San Marcos salamander. Additionally, issuance of this permit is not expected to jeopardize the continued existence of Texas blind salamander. Furthermore, due to the implementation of mitigation strategies that will result in preserve lands, the majority of which will occur over the aquifers, the Service anticipates some benefits to aquifer-dependent species over the life of the permit. Since the aquatic species are not covered in the RHCP and were not requested to be included on the permit, the Habitat Conservation Plan Assurances, "No Surprises Rule", (63 FR 8859) is not applicable for these species.

Reasonable and Prudent Measures

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize incidental take of GCWA and BCVI and avoid take of listed aquatic species in the action area. The Service shall:

1. Require that the applicant fully implements the Comal County RHCP and complies with all terms and conditions of the issued section 10(a)(1)(B) incidental take permit; and,

2. Suspend or revoke the applicant's permit if new information becomes available or under new conditions (e.g. critically-low springflow levels, severe drought conditions) it is shown that direct or indirect take or adverse modification of designated critical habitat of listed aquatic species is occurring due to this RHCP. The Service will notify Comal County that their permit is no longer valid as soon as we become aware of such take.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the Service must comply with the following term and condition that implements all of the reasonable and prudent measures described above and outlined reporting/monitoring requirements. This term and condition is non-discretionary. The Service shall:

1.1 Ensure that Comal County fully avoids and minimizes incidental take, in the form of harassment and harm, of GCWAs and BCVIs through full implementation of the *Comal County Regional Habitat Conservation Plan*;

1.2. Ensure that Comal County fully mitigates the effects of the incidental take of GCWAs and BCVIs from all covered activities, as described in the *Comal County Regional Habitat Conservation Plan*;

1.3 Ensure compliance with all terms and conditions contained in the permit;

1.4 Work with the permit holder to monitor conditions and collect data necessary to monitor effects of implementation of the permit on aquatic species to determine future conservation measures and if take is likely to occur;

1.5 Reinitiate consultation on the aquatic species if new information becomes available that indicates reinitiation is needed on the issuance and implementation of the section 10(a)(1)(B) incidental take permit and the *Comal County Regional Habitat Conservation Plan.*

1.6 Ensure that impacts to GCWA habitat authorized under this permit that are adjacent to or in close proximity (within 300 feet) to preserved lands benefitting GCWAs or are part of a patch of habitat of 500 acres or greater shall be mitigated at 3 acres of preserved habitat for every 1 acre impacted;

1.7 Ensure that impacts to GCWA habitat authorized under this permit that are adjacent to or in close proximity (within 300 feet) to preserved lands benefitting GCWAs or or are part of a patch of habitat of between 250-499 acres shall be mitigated at 2 acres of preserved habitat for every 1 acre impacted;

1.8 Ensure that impacts to GCWA habitat authorized under this permit that are adjacent to or in close proximity (within 300 feet) to preserved lands benefitting GCWAs or or are part of a patch of habitat of 250 acres or less shall be mitigated at 1 acre of preserved habitat for every 1 acre impacted; and

1.9 Ensure that Comal County produces and implements a public education/outreach program to inform Comal County citizens and project RHCP participants of the RHCP permit conditions and mitigation strategy proposed by the RHCP.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the effects 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 re-initiation of consultation and review of the reasonable and prudent measures.

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 or threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or designated critical habitat, to help implement recovery plans, or to develop information.

1. The Service with the Permittee should work to institute water conservation designs in residential and business development and landscape projects.

2. The Service recognizes that Fern Bank Springs is located on private property, and urges cooperation with the landowner or party responsible for Fern Bank Springs and/or the U.S. Geological Survey to secure access and institute a regular monitoring program for springflow and the status of the Comal Springs dryopid beetle and its designated critical habitat at this location.

3. The Service should encourage the applicant to ensure compliance with the TCEQ "*Optional Enhanced Measures for the Protection of Water Quality in the Edwards Aquifer*" and "*Optional Enhanced Measures for the Protection of Water Quality in the Edwards Aquifer and Related Karst Features that May Be Habitat for Karst Dwelling Invertebrates*", described above, a component of RHCP participation to best protect the listed aquatic species in Comal and Hays counties.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests notification from Comal County of the implementation of any conservation recommendations.

Review Requirements

The reasonable and prudent measures, with their implementing term and condition, are designed to avoid, minimize, and mitigate effects of incidental take that might otherwise result from the proposed action. If, during the course of the authorized activities, this level of incidental take is exceeded prior to the annual review, such incidental take represents new information requiring review of the reasonable and prudent measure provided. The Service must immediately provide an explanation of the causes of the taking and review the need for possible modification of the reasonable and prudent measures. This biological opinion will expire at the expiration of the incidental take permit issued to implement the RHCP. Issuance of a new biological opinion will be subject to evaluation of the recovery of the species.

Reinitiation Notice

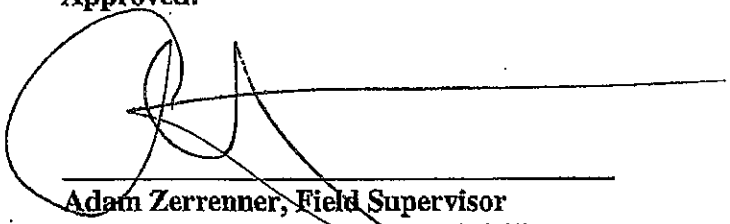
This concludes formal consultation on the issuance of a *Service 10(a)(1)(B) permit for the Comal County Regional Habitat Conservation Plan* to minimize and mitigate, to the maximum extent practicable, adverse effects to the endangered GCWA and BCVI from covered activities described in the RHCP over a period of 30 years. As provided in 50 CFR Sec. 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 consultation; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species not considered in this biological opinion; or, (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

Although critical habitat has been designated for several of the listed aquatic species found within the action area, the Service does not anticipate that the proposed action will adversely modify any designated critical habitat during periods of normal rainfall. However, should springflows significantly decline, as may occur during severe drought, the Service believes the probability of adverse modification as a result of implementing the RHCP will likely increase. If such adverse modification occurs, the Service will reinitiate consultation and notify Comal County that their permit is no longer valid. Should the Permittee become aware of new information (e.g. critically-low springflow levels) indicating that implementation of the RHCP is likely to result in adverse modification of designated critical habitat, the Permittee shall formally notify and meet with Austin ESFO to address any potential adverse modification to designated critical habitat at that time.

Additionally, on July 17, 2007, the Center for Biological Diversity, Citizens Alliance for Smart Expansion, and Aquifer Guardians in Urban Areas provided us with a 60-day notice of intent to sue on the final critical habitat rule for Comal Springs dryopid beetle and Comal Springs riffle beetle. On January 14, 2009, the plaintiffs (*CBD* v. *FWS,* case number 1:09–cv–00031–LY) filed suit in Federal Court (Western District of Texas) alleging that the Service failed to use the best available science and incorrectly made exclusions according to sections 3(5)(A) and 4(b)(2) of the Act. On December 18, 2009, the parties filed a settlement agreement where the Service agreed to submit a revised proposed critical habitat determination for publication in the *Federal Register.* On October 19, 2012, the Service published the revised proposed critical habitat determination (77 FR 64272), which is in accordance with the settlement agreement. Additionally, the Service agreed to submit to the *Federal Register* a final determination on the proposed rule by October 13, 2013. If an alteration in designated critical habitat results in a determination that implementation of this RHCP is adversely modifying the designated critical habitat, then any activities causing such affects must cease, pending reinitiation.

Approved:



Adam Zerrenner, Field Supervisor
Austin Ecological Services Field Office

11/19/13
Date

Concur:

Assistant Regional Director – Ecological Services
Region 2

11/19/13
Date

Not Concur:

_____
Assistant Regional Director – Ecological Services
Ecological Services, Region 2

_____
Date

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