

Houston toad
(Bufo houstonensis)

**5-Year Review:
Summary and Evaluation**



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**U.S. Fish and Wildlife Service
Austin Ecological Services Field Office
Austin, Texas**

5-YEAR REVIEW

Houston toad/*Bufo houstonensis*

1.0 GENERAL INFORMATION

1.1 Reviewers:

Lead Regional Office: Southwest Regional Office, Region 2
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1.2 Methodology used to complete the review:

The U.S. Fish and Wildlife Service (USFWS) conducts status reviews of species on the Endangered and Threatened Wildlife and Plants List (50 CFR 17.12) as mandated by section 4(c)(2)(A) of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.) (Act).

Much of the information included in this document was provided to the U.S. Fish and Wildlife Service (Service) through the completion of an Endangered Species Act section 6 grant. This grant was awarded to Dr. Michael Forstner and his collaborators, Dr. James R. Dixon, Dr. James H. Yantis, and Dr. Jeff Hatfield (Status Review Team), to accumulate, summarize, and evaluate existing information relevant to the Houston toad's status since its listing as a federally endangered species in 1970. The Status Review Team used peer reviewed scientific literature, published reports, expert opinion, unpublished manuscripts, available archives of published and unpublished data, and public records to conduct the status review for this species. No new data were collected to complete this review.

In 2010, the Status Review Team provided a draft section 6 report titled "Houston toad (*Bufo houstonensis*) 5-Year Review: Summary and Evaluation" to Texas Parks and Wildlife Department and the Service for review. The Service provided comments to the Status Review Team on this draft. This section 6 report was reviewed in detail as part of this 5-year status review. We included only brief summaries of major points related to the status of the Houston toad presented in the section 6 report.

1.3 Background:

The purpose of this 5-year review is to examine new evidence and document whether the status of the species has changed since the time of its original listing. In addition, the review presents

information regarding the current threats to the species, existing conservation efforts, and the need for future conservation actions.

1.3.1 FR Notice citation announcing initiation of this review:

71 FR 20714 – 20716, April 21, 2006

1.3.2 Listing history

Original Listing

FR notice: 35 FR 16047 – 16048

Date listed: October 13, 1970

Entity listed: *Bufo houstonensis* (Houston toad)

Classification: Endangered with Critical Habitat

Revised Listing – N/A

1.3.3 Associated rulemaking: Critical habitat was designated in the Final determination of Critical Habitat for the Houston Toad, as announced in a January 31, 1978, Federal Register notice (43 FR 4022 – 4026).

1.3.4 Review History: No other 5-year reviews have been prepared for this species.

1.3.5 Species' Recovery Priority Number at start of 5-year review: 2C - A Recovery Priority Number of 2C is indicative of a taxon with a high degree of threat, a high recovery potential, and the taxonomic standing of a species. The C indicates that the species' recovery conflicts with water demands, development projects, or other forms of economic activity.

1.3.6 Recovery Plan or Outline

Name of plan or outline: Houston Toad Recovery Plan

Date issued: September 17, 1984

Dates of previous revisions, if applicable: N/A

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate? Yes.

2.1.2 Is the species under review listed as a DPS? No.

2.1.3 Is there relevant new information for this species regarding the application of the DPS policy? No.

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan? Yes. Although there is a recovery plan that was finalized in 1984, it does not reflect the most up-to-date information on the species' biology, nor does it address all five listing factors that are relevant to the species. A Recovery Plan with updated, measurable, and objective criteria is needed.

2.2.1.1 Does the recovery plan contain objective, measurable criteria? No, there are no recovery criteria in the 1984 Recovery Plan. Instead, the 1984 plan details a series of recovery goals. The relevant information from those recovery goals has been included in section 2.3.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

The Houston toad is 2 to 3.5 inches long. Its general coloration varies from light brown to gray or purplish gray, sometimes with green patches. Houston toads usually have a light mid-dorsal stripe. The pale undersides often have small, dark spots. Males have a dark throat, which appears bluish when distended. This species is inactive during hot, dry seasons and during the coldest months. When inactive, Houston toads occupy burrows in soil or seek refuge in leaf litter or under objects.

It is important to note that habitat requirements differ for different life stages of the Houston toad. Deep sandy soils and overstory vegetation have been identified as important habitat components (Forstner and Dixon 2011). Breeding habitat consists of a body of water supporting the reproductive and larval Houston toad life stages. Eggs and larvae develop in shallow water. For successful breeding, water must persist for at least 60 days. Most breeding occurs from February to April, when the minimum air temperature is above 14 C. However, breeding has been reported as late as June. Larvae hatch in 4 to 7 days and metamorphose in 3-9 weeks, depending on the water temperature. This species locally migrates between breeding and nonbreeding habitats.

The adjacent uplands support adults year round and provide patch connectivity outward from the ponds for juvenile dispersal. Metamorphosed toads probably eat various small terrestrial arthropods. Larvae eat suspended material, organic debris, algae, and plant tissue.

A considerable amount of scientific research on the Houston toad has been completed since 1984 when the Houston Toad Recovery Plan was completed. An annotated bibliography of relevant literature published through 2000 can be found in Allison and Wilkins (2001). Since 2000, much of the research on this species has been conducted by Dr. Michael Forstner and his colleagues at Texas State University – San Marcos and

Texas A&M University. A detailed review of new information collected since 2000 can be found in section 2.3.1 of Forstner and Dixon (2011).

2.3.1.1 New information on the species' biology and life history: New information on the Houston toad's biology and life history is summarized below and can be found throughout section 2.3.1 of Forstner and Dixon (2011).

2.3.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends: There is a considerable amount of new information on these topics pertaining to the Houston toad. Several publications have described juvenile survivorship (described in section 2.3.2.5 of this document; Swannack et al. 2009); a significantly male-biased sex ratio (Swannack and Forstner 2007); and other demographic traits, such as Allee effects (described in section 2.3.2.5 of this document; Gaston et al. 2010). Overall trends for Houston toad abundance are declining across its range (McHenry and Forstner 2009; Forstner and Dixon 2011). Species authorities have provided a wide range of estimates for Houston toad subpopulation and census sizes throughout the years. Only Bastrop County has been surveyed consistently from year to year since the 1970s (see Table 1 in Forstner and Dixon 2011); therefore, most of these estimates refer to Houston toad numbers in this county. In the 1980s, surveyors reported observing 30 to 1,000 Houston toads per breeding pond (Jacobsen 1983; Hillis et al. 1984). Thereafter, estimates of 2,000 Houston toads in all of Bastrop County were reported (Seal 1994). By 2003, Forstner (2003) estimated the number of Houston toads in Bastrop County to be between 100 and 200 individuals.

The 2011 Houston toad breeding/survey season ended May 2011 with only six Houston toads detected in Bastrop State Park (Bastrop County), two Houston toads detected on the Griffith League Ranch (Bastrop County), one Houston toad detected south of the Texas State Highway 290 corridor in Bastrop County, one Houston toad detected in Austin County, one Houston toad detected in Lavaca County and one Houston toad detected on Cade Lakes in Burleson County. A total of 12 Houston toads were detected from extensive surveys in Austin, Bastrop, Burleson, Colorado, Lavaca, Lee, and Milam counties, as well as limited survey attempts in Leon and Robertson counties (Forstner and Dixon 2011; Dr. Michael Forstner, Texas State University, pers. comm. 2011).

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.): McHenry and Forstner (2009) found that connectivity was present among Houston toad populations at some point in the past and that significant genetic variation remains within the species in the Bastrop, Texas area at a minimum (McHenry and Forstner 2009, Forstner and Dixon 2011). However, data also indicated that Houston toads evolved as a large, well-connected population spanning across its range from Bastrop to Milam counties, Texas and northeast toward Leon County, Texas.

2.3.1.4 Taxonomic classification or changes in nomenclature: With regard to the Houston toad, the most significant change in taxonomy stems from Frost et al. (2006), in which, historical subgeneric names are elevated to full generic status. Thus, under this proposed taxonomy, *Bufo houstonensis* would become *Anaxyrus houstonensis*. However, several publications (Smith and Chiszar 2006; Hillis 2007; Pauly et al. 2009) have argued against the Frost et al. (2006) proposal, stating that the name changes are arbitrary and do not reflect the evolutionary history of American anuran species. Pending additional data, analysis, and systematic interpretation by the taxonomic community, we agree with the recommendation made by Forstner and Dixon (2011) to retain *Bufo houstonensis* as the appropriate nomenclature for this species.

2.3.1.5 Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g. corrections to the historical range, change in distribution of the species' within its historic range, etc.): Historically, Houston toads ranged across the central coastal region of Texas. Houston toads disappeared from the Houston area (Harris, Fort Bend and Liberty counties) during the 1960s following an extended drought and the rapid urban expansion of the City of Houston.

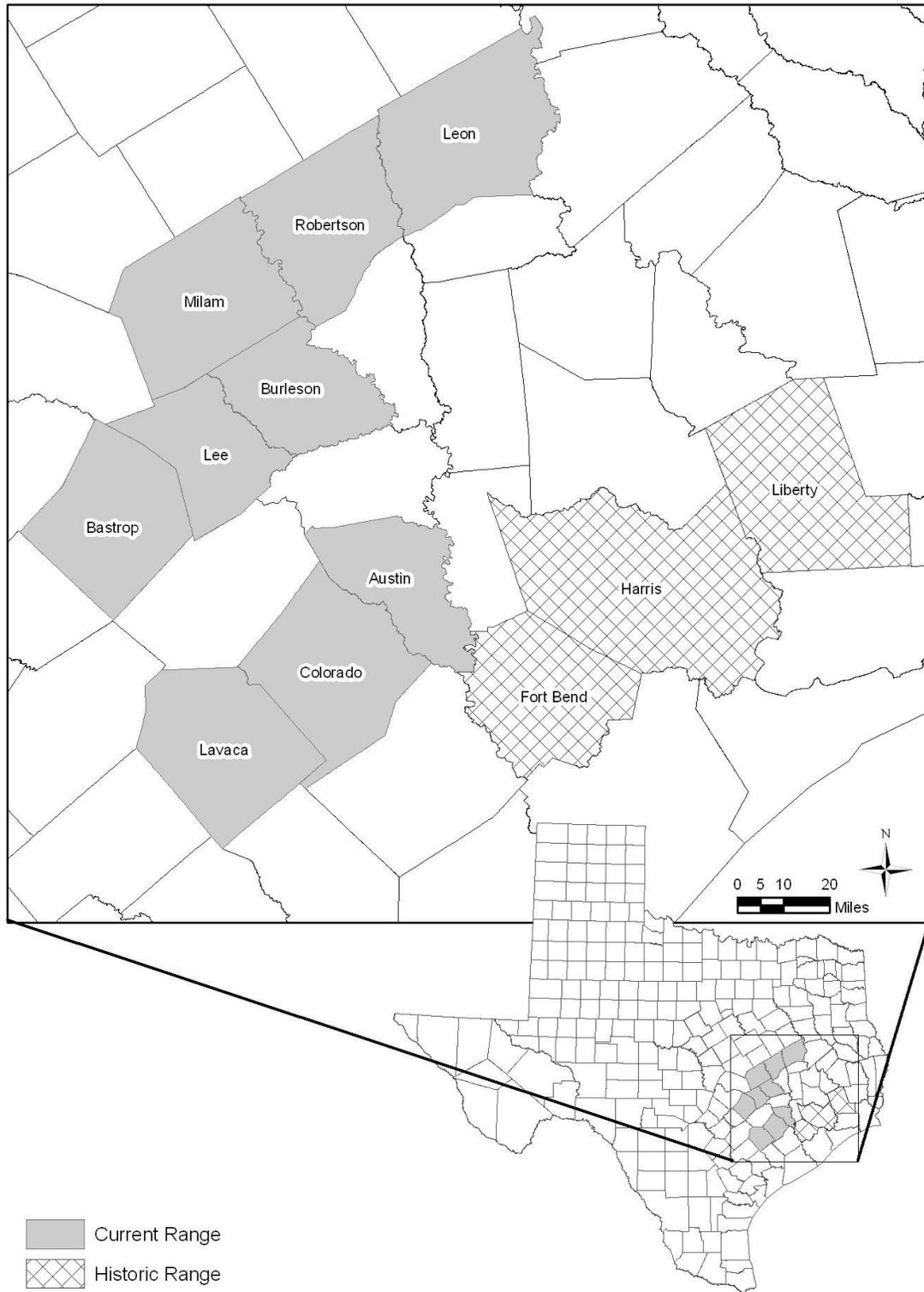
Range-wide surveys completed from 1989-1992 (Yantis 1989, 1990, 1991, 1992; Yantis and Price 1993), resulted in the detection of new localities for the Houston toad in five counties unknown to the authors of the 1984 Recovery Plan (Freestone, Lavaca, Leon, Milam, and Robertson counties). Yantis and Price (1993) also predicted the likely occurrence of the species in Caldwell and Lee counties, which was subsequently substantiated for Lee County (Gaston et al. 2001). Kuhl (1997) detected the Houston toad at the boundary of northern Bastrop County and into Lee County. The occurrence of the Houston toad was subsequently validated as a county record with a road killed voucher in 2001 (Gaston et al. 2001).

The Texas counties from which Houston toads have been reported by species authorities include Austin, Bastrop, Burleson, Colorado, Fort Bend, Harris, Lavaca, Lee, Leon, Liberty, Milam, and Robertson (Figure 1; Forstner and Dixon 2011). It appears likely that the Houston toad is now extirpated from Fort Bend, Harris, and Liberty counties (Forstner and Dixon 2011). Likewise, several of these populations have not been seen since they were first discovered (recorded in Lee County in 2001; Gaston et al. 2001). Of the few remaining populations, the largest is in Bastrop County. It is also expected that Houston toads will soon be extirpated from Lee County, given population trends and habitat loss observed there since 2000 (Forstner and Dixon 2011). Habitat loss and fragmentation continues to occur throughout the species' range. This habitat loss has been recorded as preceding population declines in at least two counties (Forstner and Dixon 2011).

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem): Fire suppression, conversion to agricultural pastures, residential development, and artificial impoundments have contributed to a very different ecosystem and landscape than when the Houston toad was first described in 1953. Early descriptions of Houston toad habitat (Kennedy 1962) differ from current survey and population monitoring results. Kennedy (1962) placed the Houston toad within the Gulf Coastal Prairie ecosystem as primarily a grassland species. Subsequent survey work has not found any current populations of Houston toads to be strongly associated with nor particularly abundant within any modern grassland communities. Buzo (2008) used improved digital soil layer information, high quality aerial imagery, and modern software analyses to conduct GIS modeling of Houston toad habitat. Surveys designed to test the validity of the model predictions showed that most Houston toad locations are in or very near forested habitat. Buzo (2008) also used aerial imagery to calculate considerable declines in canopy cover (i.e., loss of habitat) occurring from 1999 to 2005 in Lee and Bastrop counties, Texas.

2.3.1.7 Other: Drought has been an additional stressor for the Houston toad for many years. Direct effects of drought on this species include dessication, loss of breeding sites, and loss of eggs or tadpoles resulting from pond evaporation. These effects may be exacerbated due to other threats (e.g., habitat fragmentation and degradation) (Forstner and Dixon 2011).

Figure 1. Houston Toad Range Map



2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range: Habitat loss, fragmentation, and degradation have occurred and are ongoing within the Houston toad's range. Paved roads and other forms of urban development can prevent or hinder amphibian dispersal and increase mortality (Van Gelder 1973, Reh and Seitz 1990, Soulé et al. 1992, Fahrig et al. 1995, Yanes et al. 1995, Findlay and Houlihan 1997, Gibbs 1998, Vos and Chardon 1998, Knutson et al. 1999). Other forms of habitat loss or degradation include expanding urbanization, conversion of woodlands to agricultural use, logging, mineral production, alteration of watershed drainages, wetland degradation or destruction, and other processes that contribute to loss of suitable breeding, feeding, or sheltering habitat (Brown 1971, Seal 1994, Forstner and Dixon 2011).

Numerous habitat conservation plans (HCPs) with varying levels of take have been issued for the Houston toad in the last decade. These include, but are not limited to the Lost Pines HCP and the Griffith League Ranch HCP. The Lost Pines HCP was finalized in April 2008 and authorizes Bastrop County to issue certificates of inclusion to private landowners seeking incidental take coverage for the Houston toad under the Act for specific activities within the approximately 124,000-acre (50,181-hectare) permit area. These activities include agricultural, forestry, and wildlife management practices in addition to subdivision development. Through the Lost Pines HCP, 5,736 acres (2,321 hectares) of existing or potential Houston toad habitat was authorized for incidental take. The 5,000-acre (2,023-hectare) Griffith League Ranch (GLR) in Bastrop County, Texas is owned and managed by the Boy Scouts of America/Capital Area Council (BSA/CAC). Through the GLR HCP, 4,283 acres (1,733 hectares) of Houston toad habitat was authorized for incidental take resulting from the development and operation of a Boy Scout camp on the property. Additional information on HCPs issued for the Houston toad is provided in section 2.2.3 (see "Recovery Plan Goal 1.35") of Forstner and Dixon (2011).

Landowner cooperation is critical to implementing habitat management and restoration efforts throughout the Houston toad's range. The Service is partnering with various State and Federal agencies, local governments, and non-governmental organizations to engage private landowners in Houston toad conservation through outreach efforts that provide information on land management and financial incentives for Houston toad conservation (Service 2009). In 2010, a Houston Toad Habitat Delivery Team was formed to help facilitate communication between these entities and to aid in the coordination of Houston toad conservation efforts. The Habitat Delivery Team is working to keep each other informed of partnership opportunities and financial assistance programs that are available for landowners interested in Houston toad recovery efforts. They are also working to develop and disseminate outreach and education

materials, such as a set of Houston toad management guidelines that will likely be finalized and made widely available to landowners in 2011.

Three individual Safe Harbor Agreements have been completed for the Houston toad in Bastrop County and are currently being implemented. The Long Family Safe Harbor Agreement was finalized in 2004 and includes conservation activities on a 540-acre (218 hectares) ranch known to be occupied by Houston toads. The Small Family Safe Harbor Agreement was finalized in 2007 and includes conservation activities on an 836-acre (338 hectares) ranch known to be occupied by Houston toads. The BSA/CAC also enrolled their 541-acre (218 hectares) Lost Pines Scout Reservation in a Safe Harbor Agreement that was finalized in 2007. The Lost Pines Scout Reservation is not known to be occupied by Houston toads, but it is expected that the conservation activities undertaken as part of their Safe Harbor Agreement will create and enhance habitat. It is therefore expected that Houston toads will move onto the property from surrounding areas.

Since 2004, Houston toad habitat has been successfully created, restored, enhanced, and maintained through the implementation of these individual Safe Harbor Agreements. Additionally, they have provided opportunities for researchers and land managers to collect much needed information on the effectiveness of various management activities on the Houston toad and its habitat. A programmatic Safe Harbor Agreement is being developed that will allow landowners to obtain incidental take coverage after committing to one or more conservation activities that are expected to enhance, restore, and create habitat throughout the Houston toad's range.

Some efforts have also been made to purchase land for Houston toad habitat preserves. Through the Endangered Species Act section 6 program, Texas Parks and Wildlife Department (TPWD) purchased a 1,275-acre (516-hectare) property adjacent to Bastrop State Park in 2002. The 454-acre (184-hectare) Welsh Tract was preserved in perpetuity for the conservation of Houston toads in 2003 through the section 6 grant program. This property now serves as a Houston toad preserve and "*in situ*" headstarting facility. A section 6 grant also helped TPWD fund acquisition of an additional 37 acres (15 hectares) for Bastrop State Park in 2004.

In exchange for the authorization of incidental take provided for in the HCPs that have been issued, efforts have been made to manage Houston toad habitat through the HCP implementation. Many of the conservation activities included under the programmatic Safe Harbor Agreement are also included under the agricultural, forestry, and wildlife management guidelines provided in the Lost Pines HCP. These guidelines serve as measures for avoiding or minimizing take of the Houston toad while such activities are conducted. The GLR HCP includes annual population monitoring and management activities on the GLR for the benefit of the Houston toad.

The BSA/CAC has also established a conservation bank on the GLR, which provides a permanent conservation easement for which other project planners may purchase acres from that bank for Houston toad habitat mitigation. Other efforts to manage Houston toad habitat through HCP implementation are described in section 2.2.3 (see “Recovery Plan Goal 1.35”) of Forstner and Dixon (2011).

Although efforts to restore, create, and effectively manage habitat for the Houston toad are currently underway, suitable habitat continues to be degraded or lost within this species’ range. Considerable declines in overstory vegetation have been recorded in both Lee and Bastrop counties. These declines have preceded collapses of large choruses of male Houston toads to only a few individuals at each occupied location in 2011 (Forstner and Dixon 2011). Because of the ongoing declines in suitable habitat and the overall negative response in chorusing, the magnitude of this threat to the species is severe. Since the Houston toad has been and continues to be affected by the degradation and loss of habitat, we consider the imminence of this threat to be immediate.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes: There are no data to indicate that overutilization for commercial, recreational, scientific, or education purposes is affecting the Houston toad now or in the foreseeable future. Therefore, we do not consider this factor to be a threat to this species.

2.3.2.3 Disease or predation: Chytridomycosis or “chytrid fungus” (*Batrachochytrium dendrobatidis*) is a fungal disease that is responsible for killing amphibians worldwide (Daszak et al. 2000). It has been detected in Houston toads (Forstner and Dixon 2011) and in other amphibians occurring within the Houston toad’s range (Gaertner et al. 2009), but thus far, all specimens appear to be asymptomatic for the disease. We have no data to indicate if impacts from this disease may increase in the future, and therefore, whether it is a significant threat affecting the species.

Likely predators of the Houston toad include water snakes (*Nerodia* sp.), bullfrogs (*Rana catesbeiana*), raccoons (*Procyon lotor*), and various species of mesocarnivores (e.g., skunks and foxes) (Forstner and Swannack 2004; Ferguson 2005; Swannack 2007; Ferguson et al. 2008). Red-imported fire ants (*Solenopsis invicta*) are also known to prey on newly-metamorphosed toadlets (Freed and Neitman 1988, Forstner 2002) as well as the invertebrate community that is believed to be an important part of the food base for the Houston toad (Bragg 1960) and for most toad species within the genus *Bufo* (Clarke 1974). For this reason, measures to control red-imported fire ants have been incorporated within habitat conservation plans and safe harbor agreements that have been created for the Houston toad. However, red-imported fire ants are not being controlled throughout the Houston toad’s range.

The presence of many of these predator species are positively correlated with anthropogenic changes to the landscape. Habitat degradation and loss have allowed other negative effects to the Houston toad (e.g., predation) to increase since the time of its listing as a federally endangered species (Forstner and Dixon 2011). We do not consider the magnitude of this threat to be as severe as that of habitat destruction and modification. However, because the threat of predation (particularly predation from red-imported fire ants) is ongoing, we consider the imminence of this threat to be immediate.

2.3.2.4 Inadequacy of existing regulatory mechanisms: The Houston toad is listed by the State of Texas as an endangered species (TPWD 2010); however, this listing affords no protection against the habitat destruction and modification that is the most imminent and significant threat to this species.

2.3.2.5 Other natural or manmade factors affecting its continued existence: The distribution of the Houston toad appears to be naturally restricted as the result of specific habitat requirements for breeding and development. Small, sedentary species with restricted distributions, specialized habitat niches, and narrow climatic tolerances are especially sensitive to changes in habitat conditions (Welsh 1990, deMaynadier and Hunter 1998). These natural restrictions make them particularly vulnerable to the negative effects of human-induced changes that result in habitat loss, degradation, and fragmentation (Hillis et al. 1984). Increases in roadways and traffic within this species' range are likely increasing the amount of direct mortality of its individuals (Forstner and Dixon 2011). Traffic mortality has been shown to cause population declines in amphibians (Carr and Fahrig 2001). Roadway mortality of the Houston toad has been documented both historically (Price 1990) and in recent years (Forstner and Dixon 2011). Although prescribed burning efforts are ongoing in Bastrop State Park and on other properties in Bastrop County (Jones 2006, Taber et al. 2008, Forstner and Dixon 2011), more than 60 years of fire suppression has also considerably altered the forested habitat within the Houston toad's range (Forstner and Dixon 2011).

Survey data show considerable declines in the number of chorusing males in Bastrop County from 2002 to 2009 (Forstner 2002, Forstner 2003, Forstner 2009, Forstner and Dixon 2011). Subpopulation collapses have also been documented in Lee County (Forstner and Dixon 2011). Furthermore, the juvenile survival rate of this species in the wild has been shown to be between 0.0075 and 0.0105 (Swannack et al. 2009). Applying these values to the Hatfield et al. (2004) population viability analysis, which used estimates for juvenile survivorship of 1 percent or less, would result in a high probability of extinction by 2014. Results from this year's extensive rangewide surveys efforts (as presented in section 2.3.1.2 of this document) indicate that this species is headed for extinction within the near future. Population viability analyses for the Houston toad indicate that risk of extinction increases with reduced migration, dispersal, and reproductive success, as well as sustained reduction of available habitat. Maintaining several

relatively large populations of equal sizes that are interconnected so as to allow dispersal and re-colonization can enhance population survival (Seal 1994; Hatfield et al. 2004).

Furthermore, as Houston toad subpopulations have collapsed, these declines have likely been compounded by “Allee effects” to the species (Gaston et al. 2010, Forstner and Dixon 2011). “Allee effects” refer to the phenomenon seen in very small populations wherein reproduction and survival rates of individuals increase with increasing population density (Stephens et al. 1999). Gaston et al. (2010) identified mate-finding Allee effects in that the relative success of Houston toad chorusing is tied to chorusing magnitude at breeding ponds. The addition of permanent livestock tanks within the Houston toad’s range within the last 100 years has contributed to decreasing recruitment in the species. Forstner and Dixon (2011) reported over 1,700 water bodies in the Critical Habitat area of Bastrop County alone. Thus, the sheer number of potential Houston toad chorusing sites available on the landscape has reduced chorusing magnitude needed to attract females to each potential breeding site (Gaston et al. 2010). This has likely contributed to a decline in overall species recruitment (Forstner and Dixon 2011).

Headstarting and/or captive propagation to supplement existing or establish new Houston toad populations in designated priority areas will also likely play a role in preventing the extinction of this species (Service 2009), as it increases survivorship from the egg stage to the juvenile stage and bolsters the number of Houston toads on the landscape. Dr. Forstner and his colleagues at Texas State University – San Marcos together with the Houston Zoo initiated headstarting efforts in 2006. They have also been awarded “Preventing Extinction” grants in both 2007 and 2010 to help fund headstarting efforts. It is unclear if or how these efforts have helped recovery of the Houston toads; however, research is being conducted to study the efficacy of the headstarting program. This research is partially being funded through an Endangered Species Act section 6 grant. The Programmatic Safe Harbor Agreement currently under development will provide incentives (through regulatory assurances) to encourage landowners to allow Houston toad populations to be supplemented or established on enrolled property through headstarting or captive propagation.

Drought is another factor threatening Houston toads. Direct effects of drought on this species include dessication, loss of breeding sites, and loss of eggs or tadpoles resulting from pond evaporation (Forstner and Dixon 2011). Since September 2009, severe to exceptional drought conditions have occurred in the central Texas region within the Houston toad’s range (U.S. Drought Monitor 2011; LCRA 2011). In March 2011, during what is typically the peak of the Houston toad’s breeding season, central Texas received less than 0.10 inch (0.25 centimeters) of rainfall, making this the fourth driest March in the region since 1856 (LCRA 2011). Along with the lack of rain, air temperatures during the Houston toad’s 2011 breeding season have been abnormally high. Soil moisture is very low,

pond levels are dropping, and evaporation rates are high (LCRA 2011). According to the Intergovernmental Panel on Climate Change (IPCC) (2007) “Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level.” Average Northern Hemisphere temperatures during the second half of the 20th century were very likely higher than during any other 50-year period in the last 500 years and likely the highest in at least the past 1300 years (IPCC 2007). It is very likely that over the past 50 years cold days, cold nights and frosts have become less frequent over most land areas, and hot days and hot nights have become more frequent (IPCC 2007). It is likely that heat waves have become more frequent over most land areas, and the frequency of heavy precipitation events has increased over most areas (IPCC 2007). Within the Houston toad’s range, it is possible that alteration of rainfall patterns together with habitat loss may decrease the partitioning of chorusing periods currently in place between Houston toads and other toad species (Forstner and Dixon 2011). Thus, climate change could result in the increase in the likelihood of hybridization events (Forstner and Dixon 2011).

The Houston toad has experienced considerable population declines (Forstner 2006; Forstner and Dixon 2011) since its listing in 1970. Few individuals (12) and no reproductive events were observed during the 2011 breeding season, despite extensive rangewide survey attempts (Forstner and Dixon 2011). Such small numbers of Houston toad individuals remaining with no recruitment and ongoing threats of habitat loss and persistent drought conditions could indicate that extinction of this species is likely within the near future. We therefore consider the magnitude of these threats to be severe. Since the Houston toad has already been and continues to be affected by dwindling population sizes and drought, we consider the imminence of these threats to be immediate.

2.4 Synthesis - Despite attempts to encourage landowner participation in Houston toad recovery, consistent, incremental habitat loss, including forest clearing to allow for pasture conversion and development, is ongoing throughout the Houston toad’s range (Forstner and Dixon 2011). A population viability analysis conducted by Hatfield et al. in 2004 concluded that a minimum of three connected, self-sustaining populations were required to prevent imminent extinction of the Houston toad. However, remaining Houston toad populations have become more geographically isolated (Buzo 2008; McHenry and Forstner 2009; Forstner and Dixon 2011). Most of the chorusing populations detected outside of Bastrop or Milam counties typically consist of 10 or fewer individuals (McHenry and Forstner 2009). In the 2011 breeding season, only 12 individuals and no reproductive events were observed, despite extensive rangewide survey attempts (Forstner and Dixon 2011; Dr. Michael Forstner, pers. comm. 2011).

More rangewide efforts are needed to protect, enhance, and restore the Houston toad’s occupied, breeding, and dispersal habitat. Reintroduction or supplementation of existing populations appears necessary to increase population sizes to prevent immediate extinction of the species. In the decades since its original listing as a federally endangered species, the Houston toad has

experienced localized extirpation events, reductions to available habitat, and detectable declines within even relatively large habitat patches. Given the ongoing, wide-spread destruction of its habitat, dwindling population sizes, and the persistent, severe drought that is ongoing within its habitat, this species continues to be in danger of extinction throughout its range. Therefore, we recommend the classification of the Houston toad as endangered should remain the same.

3.0 RESULTS

3.1 Recommended Classification:

- Downlist to Threatened**
- Uplist to Endangered**
- Delist** (*Indicate reasons for delisting per 50 CFR 424.11*):
 - Extinction*
 - Recovery*
 - Original data for classification in error*
- No change is needed**

3.2 New Recovery Priority Number: No change needed

Brief Rationale: A listed species with a recovery priority number of 2c is one that is facing a high degree of threat and has a high potential for recovery. The Houston toad continues to be threatened by a high degree of habitat destruction, disturbance, and degradation across its range. However, we consider this species' potential for recovery to be feasible through the concerted efforts of Service personnel and our partners to restore, enhance, and protect habitat.

3.3 Listing and Reclassification Priority Number: N/A

Reclassification (from Threatened to Endangered) Priority Number: _____
Reclassification (from Endangered to Threatened) Priority Number: _____
Delisting (Removal from list regardless of current classification) Priority Number:

Brief Rationale: N/A

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS - To prevent extinction, the Service recommends three, interconnected Houston toad populations that include a combined total of 1,000 adult female Houston toads be identified and/or established. Ensuring these populations are connected through corridors of suitable migrating habitat will allow for dispersal and re-colonization to enhance population size and maintain genetic diversity (Service 2009).

The Service's Spotlight Species Action Plan for the Houston toad recommends (1) determining "priority areas" to protect or restore particular habitat based on the potential of each area to provide desired benefits to the species and (2) establishing habitat objectives that directly relate to achieving the Houston toad population targets mentioned above (Service 2009). Pursuing

ways of protecting existing Houston toad habitat or habitat that could be restored to support Houston toads through fee simple purchases, conservation easements, or other means in designated areas were also suggested (Service 2009).

An updated recovery plan that includes objective, measurable recovery criteria is needed for the Houston toad. There is an active recovery team for this species. In 2011, the Service is working with the recovery team to develop a new recovery strategy for the Houston toad and begin drafting an updated recovery plan. This involves working with the recovery team to determine “priority areas” to protect or restore particular habitat based on the potential of each area to provide desired benefits to the species. The Service also plans to work with the recovery team to establish habitat objectives that directly relate to achieving Houston toad population objectives and delineate the priority areas mentioned above.

The Houston Toad Habitat Delivery Team should meet regularly to keep efforts moving forward. Houston Toad Management Guidelines drafted by the Habitat Delivery Team should be finalized and widely distributed to landowners and land managers throughout the Houston toad’s range in 2011. The Service suggests this group meet regularly (at least annually) to facilitate communication and partnership opportunities among the entities involved in Houston toad conservation.

Efforts should be taken to create, enhance, or restore habitat for the Houston toad within the designated priority areas mentioned above. In addition to breeding and occupied habitat within and surrounding water sources, corridors for dispersal between breeding sites must be conserved. To help facilitate this, the programmatic Safe Harbor Agreement should be finalized as soon as possible to alleviate landowner concerns regarding incidental take of the species as a result of their conservation activities and to provide an incentive to landowners by allowing them to return their properties to their baseline conditions after achieving a net conservation benefit for the Houston toad. This agreement will provide Safe Harbor assurances to participating landowners throughout the species’ range. Outreach efforts should be focused in counties where large (i.e., 1,000 acres (405 ha) or more) patches of suitable habitat still remain. Thus, more focus should be given to areas outside of Bastrop County.

Known Houston toad populations should be monitored (i.e., surveyed) every year. Declining populations should be targeted for management strategies that could help them rebound. Increasing the numbers of Houston toads and improving juvenile survivorship in the wild (either through headstarting or captive propagation) should also be a priority. Supplementation, reintroductions, and translocation efforts also will be necessary to aid in the Houston toad’s recovery. Supplementation describes the process wherein individuals are added to an existing population of conspecifics (IUCN/SSC 1998). Reintroductions are attempts to establish a species in an area which was once part of its historical range, but from which it has been extirpated (IUCN/SSC 1998). Translocations are the deliberate and mediated movement of wild individuals to an existing population of conspecifics (IUCN/SSC 1998). A genetics management plan should be finalized prior to implementing such efforts to ensure the genetic makeup of propagated individuals is representative of that in wild populations and that propagated or translocated individuals are behaviorally and physiologically suitable for introduction or translocation.

Additional research will also be useful in the recovery of the Houston toad. Studies on the efficacy of the headstarting program and the effects of prescribed fire on the Houston toad and its ecosystem are underway. More research is also needed to help determine appropriate management options for maintaining, enhancing, and restoring Houston toad habitat. Monitoring the effects of conservation activities through the implementation of the Lost Pines HCP and the Safe Harbor Agreement program will also be useful in this regard. Climate models and their predicted effects on the Houston toad should be analyzed and used for determination of locations for future conservation actions for the species.

5.0 REFERENCES

- Allison, S., and N. Wilkins. 2001. Ecology and management of the endangered Houston toad (*Bufo houstonensis*): a topical index and annotated bibliography. Department of Wildlife and Fisheries Sciences, Texas Cooperative Extension, Texas A & M University System.
- Bragg, A.N. 1960. Feeding in the Houston toad. *Southwestern Naturalist* 5:106.
- Brown, L.E. 1971. Natural hybridization and trend toward extinction in some relict Texas toad populations. *Southwestern Naturalist* 16:185-199.
- Buzo, D. 2008. A GIS model for identifying potential breeding habitat for the Houston toad (*Bufo houstonensis*). Master of Science. Texas State University, Department of Biology.
- Carr, L.W. and L. Fahrig. 2001. Effect of road traffic on two amphibian species of differing vagility. *Conservation Biology* 15:1071-1078.
- Clarke, R.D. 1974. Food habits of toads, genus *Bufo* (Amphibia: Bufonidae). *American Midland Naturalist* 91:140-147.
- Daszak, P., A.A. Cunningham, A.D. Hyatt. 2000. Emerging infection diseases of wildlife – threats to biodiversity and human health. *Science* 287:443-449.
- deMaynadier, P. and M. Hunter. 1998. Effects of silvicultural edges on the distribution and abundance of amphibians in Maine. *Conservation Biology* 12:340-352.
- Fahrig, L. and J. Pedlar, S. Pope, P. Taylor, and J. Wegner. 1995. Effect of road traffic on amphibian density. *Biological Conservation* 73:174-182.
- Ferguson, A. W. 2005. Predation effects and consequences to pit fall survey assessments of vertebrate fauna. Master of Science. Texas State University, Department of Biology.
- Ferguson, A. W., F. W. Weckerly, J. T. Baccus, and M. R. J. Forstner. 2008. Evaluation of predator attendance at pitfall traps in Texas. *Southwestern Naturalist* 53:450-457.
- Findlay, C. and J. Houlahan. 1997. Anthropogenic correlates of species richness in southeastern Ontario wetlands. *Conservation Biology* 11:1000-1009.
- Forstner, M.R.J. 2002. Houston toad research and surveys 2002 data and final report. Report prepared for BSA/CAC-Lost Pines & Griffith League Ranch, Bastrop County, Texas.
- Forstner, M.R.J. 2003. Final: Biology/Ecology of the Houston Toad (*Bufo houstonensis*). Report submitted to Bastrop County, Texas.

- Forstner, M.R.J. 2006. Current status of the Houston toad: a summary of recent research and field determinations with solutions for recovery of the species by programs of active stewardship. Submitted to the U.S. Fish and Wildlife Service.
- Forstner, M. R. J. 2009. Final report. Houston toad 2009 data and final report for the Lost Pines Habitat Conservation Plan monitoring, Bastrop County, TX. Submitted to Bastrop County and USFWS. 16 pgs.
- Forstner, M.R.J. 2011. "ending the year with 12 not 11." E-mail to Paige Najvar. May 25, 2011.
- Forstner, M.R.J. and J. Dixon. 2011. Houston toad (*Bufo houstonensis*) 5-year review: summary and evaluation. Final Report for Section 6 project E-101. Submitted to Texas Parks and Wildlife Department and U.S. Fish and Wildlife Service.
- Forstner, M. R. J., and T. M. Swannack, editors. 2004. The Houston toad in Context. Final Technical Report. Submitted to the Capitol Area Council, Boy Scouts of America and Texas Parks and Wildlife Department in completion of USFWS Section 6 Grant "Habitat use of the Houston toad." 746 pgs.
- Freed, P.S. and K. Neitman. 1988. Notes on predation on the endangered Houston toad, *Bufo houstonensis*. The Texas Journal of Science 40:454-455.
- Frost, D. R., T. Grant, J. Faivovich, R. H. Bain, A. Haas, C. F. B. Haddad, D. Sá, R. Rafael, A. Channing, M. Wilkinson, S. C. Donnellan, C. J. Raxworthy, J. A. Campbell, B. L. Blotto, P. Moler, R. C. Drewes, R. A. Nussbaum, J. D. Lynch, D. M. Green, and W. C. Wheeler. 2006. The amphibian tree of life. Bulletin of the American Museum of Natural History 297:1-370.
- Gaertner, J.P., M.A. Gaston, D. Spontak, M.R.J. Forstner, and D. Hahn. 2009. Seasonal variation in the detection of *Batrachochytrium dendrobatidis* in a Texas population of Blanchard's cricket frog (*Acris crepitans blanchardi*). Herpetological Review 40:184-187.
- Gaston, M., A. Fugli, F.W. Weckerly, M.R.J. Forstner. 2010. Potential component allee effects and their impact on wetland management in the conservation of endangered anuarans. PLoS ONE 5: e10102.
- Gaston, M., J. R. Dixon, and M. R. J. Forstner. 2001. Geographic distribution. *Bufo houstonensis* (Houston toad). Herpetological Review 32:189-190.
- Gibbs, J. 1998. Amphibian movements in response to forest edges, roads, and streambeds in southern New England. Journal of Wildlife Management 62:584-589.

- Hatfield, J.S., A.H. Price, D.D. Diamond, and C.D. True. 2004. Houston toad (*Bufo houstonensis*) in Bastrop County, Texas: need for protecting multiple populations *in* Akçakaya, H.R., M.A. Burgman, Kindvall, O., C.C. Wood, P. Sjögren-Gulve, J.S. Hatfield, and M.A. McCarthy, editors. Species conservation and management. Oxford University Press. New York, New York.
- Hillis, D.M. 2007. Constraints in naming parts of the tree of life. *Molecular Phylogenetics and Evolution* 42:331-338.
- Hillis, D.M., A.M. Hillis, and R.F. Martin. 1984. Reproductive ecology and hybridization of the endangered Houston toad (*Bufo houstonensis*). *Journal of Herpetology* 18:56-71.
- IPCC (Intergovernmental Panel on Climate Change). 2007. Fourth Assessment Report Climate Change 2007: Synthesis Report Summary for Policymakers. Released on 17 November 2007. Available at: http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf
- IUCN/SSC (International Union for the Conservation of Nature/Species Survival Commission). 1998. Re-introduction practitioners directory. 11pp.
- Jacobson, N.L. 1983. Reproductive behavior and male mating success in the Houston toad, *Bufo houstonensis*. Master of Science. University of Texas at Austin.
- Jones, M. 2006. Effects of prescribed burns on small mammal populations with comments on amphibian populations. Master of Science. Texas State University, Department of Biology.
- Kennedy, J. P. 1962. Spawning season and experimental hybridization of the Houston toad, *Bufo houstonensis*. *Herpetologica* 17:239-245.
- Knutson, M., J. Sauer, D. Olsen, M. Mossman, L. Hemesath, and M. Lannoo. 1999. Effects of landscape composition and wetland fragmentation on frog and toad abundance and species richness in Iowa and Wisconsin, U.S.A. *Conservation Biology* 13:1437-1446.
- Kuhl, J. 1997. Houston toad (*Bufo houstonensis*) survey findings in NE Bastrop & SW Lee Counties - 1996-1997. March 24, 1997 memorandum from John Kuhl, Hicks and Company, to Lisa O'Donnell, USFWS. Austin TX.
- LCRA (Lower Colorado River Authority). 2011. Central Texas drought: drought strengthens in lower Colorado River basin. <http://www.lcra.org/water/drought/index.html>. Date Accessed May 9, 2011.
- McHenry, D.J. and M.R.J. Forstner. 2009. Houston toad metapopulation assessment and genetics: data necessary for effective recovery strategies in a significantly fragmented landscape. Final Report for Section 6 project E-76. Submitted to Texas Parks and Wildlife Department and U.S. Fish and Wildlife Service.

- Pauly, G.B., D.M. Hillis, and D.C. Cannatella. 2009. Taxonomic freedom and the role of official lists of species names. *Herpetologica* 65:115-128.
- Price, A.H. 1990. Status survey of the Houston toad (*Bufo houstonensis*) along State Highway 21, Bastrop county, Texas. Final Report. Texas Parks and Wildlife Department. Austin, Texas.
- Reh, W. and A. Seitz. 1990. The influence of land use on the genetic structure of populations of the common frog *Rana temporaria*. *Biological Conservation* 54:239-249.
- Seal, U.S., editor. 1994. Population and habitat viability assessment: Houston toad (*Bufo houstonensis*). Workshop conducted by IUCN/SSC Conservation Breeding Specialist Group in partial fulfillment of USFWS contract #94-172. Apple Valley, Minnesota.
- Service (U.S. Fish and Wildlife Service). 2009. Houston toad spotlight species action plan. U.S. Fish and Wildlife Service. Region 2. Albuquerque, New Mexico.
- Smith, H.M. and D. Chiszar. 2006. Dilemma of name-recognition: why and when to use new combinations of scientific names. *Herpetological Conservation and Biology* 1:6-8.
- Soulé, M.E. A.C. Alberts, and D.T. Bolger. 1992. The effects of habitat fragmentation on chaparral plants and vertebrates. *Oikos* 63:39-47.
- Stephens, P.A, W.J. Sutherland, and R.P. Freckleton. 1999. What is the Allee effect? *Oikos* 87:185-190.
- Swannack, T. 2007. Ecology of the Houston toad (*Bufo houstonensis*). Ph.D. Texas A&M University, Department of Wildlife and Fisheries Sciences.
- Swannack, T.M., and M.R.J. Forstner. 2007. Possible cause for the sex-ratio disparity of the endangered Houston toad (*Bufo houstonensis*). *Southwestern Naturalist* 52:386-392.
- Swannack, T.M., W.E. Grant, and M.R.J. Forstner. 2009. Projecting population trends of endangered amphibian species in the face of uncertainty: a pattern-oriented approach. *Ecological Modeling* 220:148-159.
- Taber, S.W., S.B. Fleenor, and J.L. Privette. 2008. Arthropod abundance following a prescribed burn in the Lost Pines of Central Texas. *Southwestern Entomologist* 33:65-77.
- TPWD (Texas Parks and Wildlife Department). 2010. Endangered and threatened reptiles and amphibians in Texas and the United States. http://www.tpwd.state.tx.us/huntwild/wild/species/endang/animals/reptiles_amphibians/#frog. Date Accessed: February 18, 2011.

- U.S. Drought Monitor. 2011. U.S. Drought Monitor.
<http://www.drought.unl.edu/dm/monitor.html>. Date Accessed: May 9, 2011.
- Van Gelder, J. 1973. A quantitative approach to mortality resulting from traffic in a population of *Bufo bufo*. *Oecologia* 13:93-95.
- Vos, C.C. and J.P. Chardon. 1998. Effects of habitat fragmentation and road density on the distribution pattern of the moor frog *Rana arvalis*. *Journal of Applied Ecology* 35:44-56.
- Welsh, H. 1990. Relictual amphibians and old-growth forests. *Conservation Biology* 14: 309-319.
- Yanes, M., J. Velasco, and F. Suarez. 1995. Permeability of roads and railways to vertebrates: the importance of culverts. *Biological Conservation* 71:217-222.
- Yantis, J. H. 1989. Performance report. A state funded project, Nongame Wildlife Investigations, Job No. 78: Houston toad distribution and habitat status (*Bufo houstonensis*). Texas Parks and Wildlife Department, Austin TX.
- Yantis, J. H. 1990. Performance report. A state funded project, Wildlife Research and Surveys, Job No. 78: Houston toad distribution and habitat status. Texas Parks and Wildlife Department, Austin TX.
- Yantis, J. H. 1991. Performance report. As required by Texas Wildlife Research and Surveys, Job No. 78: Houston toad distribution and habitat status. Texas Parks and Wildlife Department, Austin TX.
- Yantis, J. H. 1992. Performance report. As required by Texas Wildlife Research and Surveys, Job No. 78: Houston toad distribution and habitat status. Texas Parks and Wildlife Department, Austin TX.
- Yantis, J. H., and A. H. Price. 1993. Final report. As required by the Endangered Species Act, Section 6. Texas, Project No: E-1-4. Endangered and Threatened Species Conservation, Job No. 8, Houston Toad (*Bufo houstonensis*) status survey. Texas Parks and Wildlife Department, Austin TX.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of HOUSTON TOAD

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

- Downlist to Threatened
- Uplist to Endangered
- Delist
- No change needed

Appropriate Listing/Reclassification Priority Number, if applicable: N/A

Review Conducted By: Paige A. Najvar, Austin Ecological Services Field Office

FIELD OFFICE APPROVAL:

acting
Lead Field Supervisor, Fish and Wildlife Service

Approve *Phsa Skull* Date 10-28-11

REGIONAL OFFICE APPROVAL:

acting
Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service, Region 2

Approve *Susan Jacobson* Date 11-28-11

Cooperating Regional Director, Fish and Wildlife Service

Concur Do Not Concur

Signature _____ Date _____