

Habitat Characteristics of the Houston Toad
(*Anaxyrus=Bufo houstonensis*)

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Introduction

The purpose of this document is to provide information on the habitat characteristics of the Houston toad (*Anaxryus houstonensis*). This document may be updated as new scientific information becomes available. The U.S. Fish and Wildlife Service (Service) welcomes new information that would improve or update this information. New information can be provided to the Service's Austin Ecological Services Field Office Recovery and Candidate Conservation Branch. We hope that you find this document useful and we appreciate your efforts to conserve the Houston toad.

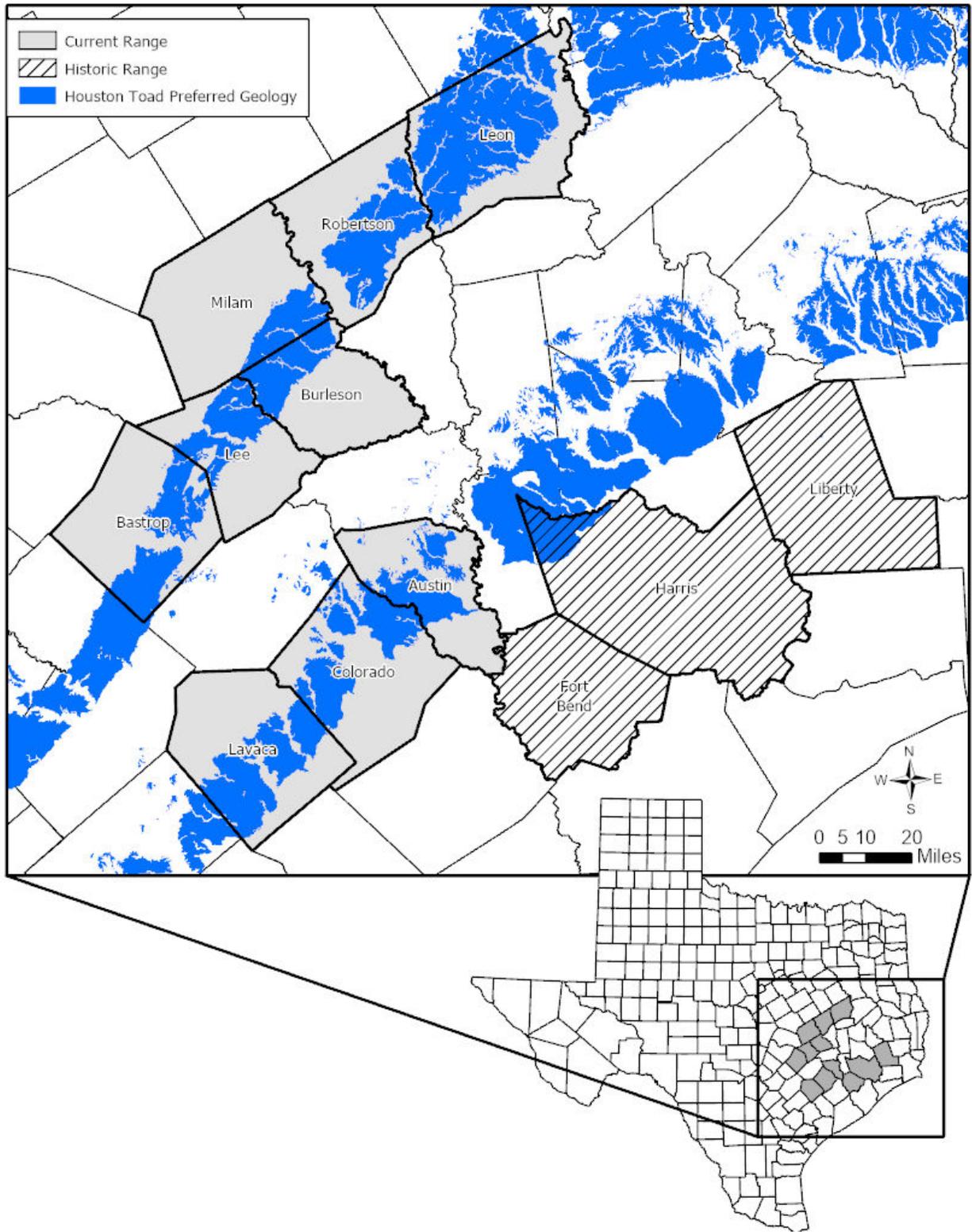
General Habitat Characteristics

Houston toad habitat is generally characterized as rolling uplands covered with pine and/or oak forests underlain by deep sandy soils. Although Houston toads are associated with forests and sandy soils (Kennedy 1962, p. 241; Brown 1971, p. 196), they may also breed in and move across sparsely wooded and even cleared, open areas (Dixon et al. 1990, p. 20). Because Houston toads are ectotherms (species that depend on environmental heat sources to control their body temperatures) and their skin is highly vulnerable to desiccation (extreme dryness), they become dormant during harsh weather conditions, such as winter cold (hibernation) and summer heat and drought (estivation). They seek protection during these periods by burrowing into sand or hiding under rocks, leaf litter, logs, or in abandoned animal burrows (Hillis et al. 1984, pp. 64-65; Swannack 2007, p. 33). Houston toads spend a majority of their time in terrestrial habitat for sheltering, feeding, and dispersal, which is common among semi-aquatic amphibians (Semlitsch and Bodie 2003 pp. 1221–1222).

Geology and Soils

Current Houston toad populations primarily occur along two geologic formations dominated by sandy soils, however are not limited to these formations, as evidenced by the species historic range (Figure 1). The northern band runs through Bastrop, Lee, Burleson, Milam, Robertson, and Leon Counties and includes the Carrizo, Queen City, Reklaw, Sparta, and Weches Formations. The southern band runs through Lavaca, Colorado, and Austin Counties and includes the Willis and Goliad Formations (Forstner 2003, p. 3). It is not clear if the Houston toad requires sandy soils to persist in an area or if its distribution is correlated to sandy soils because these soils within the Houston toad's range typically support forests. Either way, it is likely that both sandy soils and the vegetation they support are key components to defining the Houston toad's habitat (Forstner and Dixon 2011, p. 37).

Figure 1. Houston toad range map with Houston toad preferred geologic formations.



Forests

Amphibians can be found in many different types of habitats. Some amphibian species have adapted to survive in forests. The association between forests and certain amphibian species has been well-established (Fahrig et al. 1995, p. 181; Findlay and Houlihan 1997, pp. 1,004-1,006; Semlitsch 1998, pp. 1,116-1,117; Knutson et al. 1999, pp. 1,443-1,444). As an essential component of amphibian habitats, forests help stabilize temperatures, moderate evaporation rates of aquatic habitats, contribute and recycle organic matter, and support diverse plant and animal communities (Knutson et al. 1999, pp. 1,443-1,444). Forests also function as a “life zone” for amphibians like the Houston toad, which Semlitsch (1998, p. 1,117) describes as habitat that is critical for feeding, growing, sheltering, and maturation as well as survival of the entire juvenile and adult breeding populations.

Canopy cover appears to be a necessary component of Houston toad habitat. Most Houston toad locations are in, or very near, forested patches of habitat (Buzo 2008, p. 65; Forstner and Dixon 2011, p.37). Those locations outside of forested areas were documented historically (prior to 1990) and were likely within woodlands or forested habitat at the time they were recorded (Buzo 2008, pp. 66-67; Forstner and Dixon 2011, p. 37). Though primarily found in canopied habitat, telemetry data has also shown that Houston toads move along drainages within pastures, provided that some canopy cover is present (Swannack 2007, p. 67; Forstner and Dixon 2011, p. 37).

Not only does canopy cover provide essential habitat for the Houston toad, the loss of forested habitat can lead to a variety of threats. For example, red-imported fire ants, which threaten Houston toad survival, are known to select for open and edge habitats (Porter et al. 1988, p. 916; Stiles and Jones 1998, pp. 343-344; Brown et al. 2012, p. 146). In addition, hybridization and competition between the Houston toad and the Woodhouse’s toad (*Bufo woodhousii*) occurs primarily along habitat edges where forests have been cleared (Service 1994, p. 78). Thus, habitat areas with greater canopy cover and less edge may reduce red-imported fire ant predation pressure and decrease the threat of hybridization and competition with other toad species with overlapping ranges.

The amount and type of canopy cover beneficial for Houston toad survival is uncertain. It is unclear what percentage of canopy cover is necessary to allow Houston toads to persist in an area, as the species has been observed in areas with relatively low overstory, grading from an open woodland with considerable herbaceous plant growth (forbs) into closed canopy gallery forests with 100 percent cover (Forstner and Dixon 2011, p. 37).

It is possible that the species is adaptable to a wide variety of overstory vegetation types. Tree species typically found within Houston toad habitat vary, but often include loblolly pine (*Pinus taeda*), post oak (*Quercus stellata*), blackjack oak (*Q. marilandica*), and/or sandjack oak (*Q. incana*) (Forstner 2003, p. 4). Although the Houston toad does not appear to be tied to the presence of a particular tree species, pine is dominant in the Lost Pines region of Bastrop County (Thomas 1977, p. 4), which has once been known to support large populations of Houston toads (Hillis et al. 1984, p. 70).

Herbaceous Vegetation

Herbaceous vegetation on the forest floor also plays an important role in Houston toad habitat, as it supports native arthropod species (invertebrate species, such as insects) (Harris 1984, p. 19) that comprise the Houston toad's food supply (Bragg 1960, p. 106; Clarke 1974, pp 141-146). Studies have shown that canopy cover allowing light to penetrate the forest floor can result in increased herbaceous plant diversity (Halls and Schuster 1965, pp. 282-283). The diversity of the arthropod community has been shown to increase with increasing plant diversity (Siemann et al. 1998, p. 738). Also, increases in arthropod density and biomass have been correlated to increases in the biomass of herbaceous vegetation in prairie ecosystems (Kirchner 1977, p. 1,342). Therefore, we assume that the availability of herbaceous vegetation on the forest floor can influence the amount of arthropods available as a food source for Houston toads within their habitats.

Water

Water is an essential component to the Houston toad's habitat. Rainfall has been shown to stimulate breeding (Kennedy 1962, p. 240; Price 1992, pp. 1, 5), movement (Quinn et al. 1984, p. 4; Swannack 2007, p. 33), and foraging (Swannack 2007, p. 33). Rainfall increases breeding habitat, as ephemeral ponds and wetlands may only appear after rainfall. Ephemeral ponds and wetlands may stimulate increased movement because of their impermanence (Daversa et al. 2012 p. 662). Survival of eggs, tadpoles, and juveniles in ephemeral bodies of water may be higher because of the lower likelihood of resident predators (Forstner 2003, p. 10). Survival of eggs, tadpoles, and emerging juveniles in permanent water bodies, on the other hand, may be lower because they are more likely to harbor predators (Forstner 2003, p. 10), such as birds, mammals, snakes, turtles, fish, aquatic invertebrates, and bullfrogs (Ferguson et al. 2008, p. 452) and potential competitors and hybridizers, such as Woodhouse's and Gulf Coast toads (Hillis et al. 1984, p. 57).

Permanent water bodies also have an increased probability of livestock usage (Forstner 2003, p. 10), which can negatively influence the quality of habitat along the edges of breeding ponds (Forstner 2001, p. 3; Forstner 2003, p. 10). Livestock wading and defecation can prevent vegetation from establishing around the pond's perimeter, and result in high levels of nitrogen (from urine and manure), increased turbidity, decreased water quality, and an overall adverse environment for amphibian egg and tadpole development (Knutson et al. 2004, p. 677; Schmutz et al. 2008, p. 8). Elevated ammonia, nitrate, and nitrite levels are known to affect amphibian embryo and larvae survival and larval body size (Jofre and Karasov 1999, pp. 1,808-1,810). Livestock wading into breeding areas leads to habitat alteration in the form of vegetation loss and soil compaction at the pond's edge that deters Houston toad breeding activity (Forstner 2001, p. 3). It may also result in the destruction of egg clutches and mortality of tadpoles, juveniles, and adults (Bull 2009, p. 243).

Habitat Types

Aquatic Habitat

Breeding and Nursery Habitat

Adult Houston toads require aquatic habitats to breed and reproduce. Rainfall is essential in preventing desiccation of potential breeding sites. These breeding habitats are usually composed of standing or still water, as found in a pond or wetland (Forstner and Dixon 2011, p. 39). Houston toads are known to breed in small pools of water and ephemeral ponds (Kennedy 1962, p. 241; Brown 1971, p. 190; Forstner 2003, p. 10). They also have been heard calling from or have been captured in ditches, lakes, puddles in roads, moist areas in yards, flooded pastures, potholes, streams, stock tanks, and permanent ponds (Forstner 2001, p. 2; Forstner 2003, p. 10). The presence of water during and after breeding is required for egg deposition, egg hatching, tadpole development, and emergence of tadpoles from a breeding site. Water is necessary for successful emergence, although not all chorusing events result in successful emergence (Forstner and Dixon 2011, p. 21).

Terrestrial Habitat

Terrestrial habitat is used by the Houston toad for sheltering, feeding, and dispersal. This habitat is often overlooked in amphibian conservation (Semlitsch and Bodie 2003, p. 1221), but is important for the persistence of pond-breeding amphibians because these habitats are where amphibians spend the majority of their life cycles (Semlitsch 1998, p. 1,116; Semlitsch 2000, p. 624). Terrestrial habitat within 1.6 km (0.99 mi) of a breeding pond is considered occupied habitat, though dispersing toads can be found past 1.6 km (0.99) from a breeding pond (Forstner and Dixon 2011, p. 6).

Feeding and Sheltering

Habitat used for feeding and sheltering can be defined as canopied habitat with the appropriate sandy soils discussed earlier. Ideal habitat will have a high diversity of herbaceous cover to support native arthropods (Siemann et al. 1998, p. 738), which comprise most of the Houston toad's diet (Bragg 1960, p. 106; Clarke 1974, pp 141-146).

There is little to no information on home range size of Houston toads. Swannack (2007, pp. 67 and 106) did not find this species beyond 200-meters from a breeding pond using radio telemetry within the breeding season. However, adult Houston toads can move 1.85 kilometers (km) within a breeding season and juveniles have been found to move 1.3 km over a five-week period (Price 2003 pp. 6–7; Vandewege et al. 2012 p. 117). Research is needed to determine the extent of Houston toad home ranges, as there are no published papers on the subject.

There is a myriad of literature on the distance toads move from a breeding pond and home range with large variation between studies and species of toad: common toad (500m, 0.67-2.46ha, Daversa et. al. 2012, pp. 662-663) American toad (400-1000m, 0.07ha, Forester et. al. 2006, pp. 63-64), Boreal toad (218-721m, 13.8ha, Muths 2003, p. 162; 100m, 1.74ha, Goates et. al. 2007, pp. 478 and 480), and western toad (581-1105m, Bartelt et. al. 2004, p. 460). Home ranges are

often multinuclear, i.e. toads use multiple spatially separated areas, and will use narrow corridors of habitat to reach activity centers (Indermaur et al. 2009, p.64; Forester et al. 2006, p. 66). Patch distribution of shelter and prey along with inter and intra-competition among individuals may affect the size of a home range (Indermaur et al. 2009, pp. 67-68). If habitat is fragmented and patchy around a body of water, the core area and home range may be larger because of decreased resources (Indermaur et al. 2009, pp. 67-68). Habitat fragmentation affects the Houston toad across its range, which likely affects the size of Houston toad home ranges and movement from a breeding pond.

Dispersal Habitat

Maintaining dispersal habitat is critical for the persistence of anuran species, especially in fragmented and disturbed landscapes (Semlitsch 2008 p. 265, Walston and Mullin 2008 p. 141). Houston toad dispersal habitat is comprised of the corridors through which unidirectional movements of juvenile and adults take place (McHenry and Forstner 2009, p. 83), creating a matrix of suitable habitat connecting breeding ponds. Movement and dispersal habitat is necessary for population survival, recruitment, immigration, genetic exchange, and maintaining the metapopulation dynamics of anuran populations (Reading et al. 1991 pp. 210–211, Rothermel and Semlitsch 2002 pp. 1330–1331, Funk et al. 2005 p. 15, Semlitsch 2008 pp. 264–265, Indermaur et al. 2009 p. 69).

During peak activity periods from February to April, Houston toads have been described as “vagrant,” with significant overland movement occurring (Yantis and Price 1993 pp. 5–6). Historically, adult Houston toads have been observed moving as far as 490m in 24 hours (Yantis and Price 1993 p. 5), and have been recorded moving up to 1.85km in one breeding season through suitable habitat (Price 2003 pp. 6–7). The longest juvenile Houston toad dispersal distance recorded was 1.34km in five weeks (Vandewege et al. 2012 p. 117), while another study found an adult 950m from its natal pond where it was marked 1-2 years earlier as a juvenile (Swannack 2007 p. 64). These long distance movements signify that dispersal habitat can span long distances between breeding ponds.

Forests are a necessary component of the Houston toad’s ecosystem because they maintain dispersal corridors (Welsh 1990, pp. 315-317; deMaynadier and Hunter 1999, p. 448; Gibbs 1998, pp. 265-268; Knutson et al. 1999, p. 1,444). Drainages and forested habitats are the most likely corridor routes for dispersing Houston toads because they provide moisture that can prevent desiccation. Hillis et al. (1984, pp. 66-67) observed Houston toad adults and juveniles using gulleys leading to ponds, and telemetry data have also shown that adults use drainages for dispersal (Swannack 2007, p. 67). Juvenile amphibians emigrating from experimental ponds have been shown to select closed-canopy forested habitat over open fields or partially-closed canopy forests (deMaynadier and Hunter 1999, p. 446; Rothermel and Semlitsch 2002, p. 1,330). Walston and Mullin (2008, p. 144) also monitored movement patterns of newly metamorphosed amphibians and found that dispersing juveniles selected areas with greater forested habitats to move through rather than habitats with both forested and open areas. Microhabitat conditions within interior forest habitats, where soil moisture is greater and temperatures are less variable, are likely more hospitable to amphibians than open habitats or areas along a forested edge (Knutson et al. 1999, pp. 1,443-1,444; Gibbs 1998, pp. 265-268).

Houston toads are explosive breeders (Wells 1977, pp. 667-669; Jacobson 1989, p. 377; Price 2003, p. 1), which results in a high number of juveniles at a breeding site. Due to an abundance of juveniles at individual sites, juveniles may have to leave suitable habitat to find new suitable habitat (Bull 2009, p. 245). Adult Houston toads have been observed moving across unsuitable habitat and breeding in unfavorable ponds (Dixon et al. 1990 p. 20). They may not be restricted to contiguous areas of deep sandy soils, but likely require some overstory components to prevent desiccation (Forstner and Dixon 2011, p. 41), as has been documented for other amphibian species (Rothermel and Semlitsch 2002, p. 1,330).

Movement and dispersal habitat can be hard to define because it is less restrictive than breeding, feeding, and sheltering habitat; ideal habitat may not be available in increasingly fragmented habitat. The ideal dispersal habitat includes forested areas and/or drainages that connect breeding habitat. However, Houston toads can move through a variety of habitat types that may not be thought of as “classic” Houston toad habitat. For example, Houston toads have been observed moving along drainages within pastures, provided that some canopy cover is present (Swannack 2007, p. 67; Forstner and Dixon 2011, p. 37). A dispersing toad will likely have to move through a mosaic of habitat types to reach new, suitable habitat.

Summary

When assessing potential Houston toad habitat a macro approach should be used. The first level of analysis should include forested habitat with the correct sandy soils that we know are used by adult Houston toads. The second level of analysis should look at potential dispersal corridors, such as drainages. A third level of analysis should look at habitat that is not generally considered Houston toad habitat, such as pastures, and assess any potential for juvenile dispersal in that area from proximal habitat or dispersal corridors.

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