Guardians of the Hill Country

FROM TOP: The Texas blind salamander, the Texas fatmucket and the Mexican blind catfish are all imperiled species Defenders of Wildlife calls the "Texas Treasures".

Protecting Texas Treasures

The Hill Country's vast network of springs, streams and karst aquifers provide clean water to millions of people and to iconic ecosystems. These waters are currently protected by resilient grasslands, oak-juniper woodlands and riparian zones — natural filters and stabilizers that keep the system in balance. But as population booms, development spreads and the need for water intensifies, this delicate system is being pushed to the brink.

We can look to thirteen rare aquatic species at the heart of this ecosystem for help — twelve of the thirteen found only in the Hill Country. Crowned the "Texas Treasures" by Defenders of Wildlife, these species rely on clean, cool and consistent water flow. These species are environmental indicators, revealing the state of our waterways. The Texas Treasures are facing dramatic declines, which signals ecosystem instability that will ultimately affect the growing human population in Central Texas.

Our Texas Treasures

Freshwater Mussels: Guadalupe fatmucket (*Lampsilis bergmanni*), Texas fatmucket (*Lampsilis bracteata*), Texas fawnsfoot (*Truncilla macrodon*), Guadalupe orb (*Cyclonaias necki*), Texas pimpleback (*Quadrula petrina*), False spike (*Quincuncina mitchelli*).
Salamanders: Barton Springs salamander (*Eurycea sosorum*), Austin blind salamander (*Eurycea waterlooensis*), Texas blind salamander (*Eurycea rathbuni)*, Jollyville Plateau salamander (*Eurycea tonkawae*).
Blindcat Fish: Widemouth blindcat (*Satan eurystomus)*, Toothless blindcat (*Trogloglanis pattersoni*), Mexican blindcat (*Prietella phreatophila*).

With the Hill Country's population rapidly increasing, water demand will only increase. Already, the region loses two to three feet of groundwater annually. If Texas Treasures disappear, we risk degraded water quality, altered stream flows, and long-term damage to the water supply for nearly two million people.

Protecting these species is more than an ecological concern — it's an investment in our future. Their specialized adaptations make them essential to understanding and preserving waterway health. By integrating their conservation into water planning and development policy, Texas can ensure that both its natural heritage and communities thrive.

Fortunately, solutions are within reach. Restoring riparian buffers enhances resilience to drought and flood, while Habitat Conservation Plans and regional initiatives help balance growth with environmental protection. By acting now — through science, policy and public engagement — we can protect the Texas Hill Country's water, wildlife and way of life for generations to come.

How to Restore Waterways for Texas Treasures and People

Habitat Protection and Sustainable Water Use – Implement Habitat Conservation Plans and strengthen water management practices that promote responsible groundwater use and storage initiatives.
Research and Monitoring – Strengthen scientific studies and population tracking efforts to inform adaptive management strategies.
Public Engagement and Policy Integration – Incorporate conservation goals into regional planning, invest in water infrastructure funds and raise public awareness.

GUARDIANS OF THE HILL COUNTRY:
Protecting the Texas Treasures

The waterways of the Texas Hill Country are remarkable. They have intricately shaped the landscape, creating unique geology and diverse wildlife habitats. These essential waters are home to wildlife found nowhere else.

The Hill Country is a crystal-clear, spring-fed karst landscape of streams teeming with life — freshwater mussels line riverbeds, quietly purifying streams, while salamanders slip through limestone cracks and native fish weave between swaying aquatic plants.

However, many of the region's iconic places, such as Barton Springs and San Marcos Springs, have seen diminished water flow rates over time, and many aquifers are in decline. Some smaller springs have completely dried up in recent years due to decreased aquifer recharge and over-extraction. Texas water systems are losing at least 572,000 acre-feet of water per year, about twice the area of San Antonio, Texas. The Edwards Aquifer, which supports much of the Hill Country, has seen groundwater levels drop more than 30 feet. According to The Texas Water Development Board, the Trinity Aquifer has had regions report water level declines of 200-400 feet, especially in the lower basin with high groundwater demand.

At the same time, the Hill Country is among the fastest growing regions in the nation. In 2022, the population was estimated to be 3.8 million, a nearly 50 percent increase since the early 2000s. The region is expected to grow by another 35 percent in the next 20 years, scaling to 5.2 million by 2040 (equivalent to the entire population of Costa Rica). It is expected that much of the growth will be concentrated along the Interstate 35 corridor between Austin and San Antonio, ***directly on top of the Edwards Aquifer***

Inspired by Stephen Dobyns' To Keep One's Treasure Protected, Defenders of Wildlife analyzes groups of freshwater species that are the backbone of Hill Country's water health.

Texas Treasures have highly specialized habitats and are extremely sensitive to environmental changes. These species serve as sentinels due to their distinct features: salamanders have permeable skin; freshwater mussels continuously filter water as they breathe and feed; and blindcats are extremely sensitive to water quality changes. Their presence or absence can signal the overall condition of these ecosystems, particularly in terms of water quality and availability.

Since these species depend on clear, clean and stable aquatic environments, any disturbances — such as groundwater depletion, pollution or habitat destruction — can have dramatic impacts on their populations. Protecting these species is critical not only for their survival but also for maintaining the ecological balance of Hill Country water. These species' sensitivity to changes makes them valuable in understanding the broader effects of environmental changes on entire ecosystems. The loss of Texas Treasures would undermine ecological stability. This subject matter report compiles current conservation efforts and emphasizes the vital connection between water resources and Texas Treasures — rare aquatic species found only in the Hill Country. It explores how the region can grow responsibly by using science and stewardship to protect our irreplaceable wildlife. The report includes a summary of each species' listing status, key threats and extinction risk. While not exhaustive, it highlights basic biological traits that help indicate the overall health of freshwater ecosystems.

"Texas Treasures" *a*re indicators of water quality and offer a path toward smarter water management. The Texas Treasures:

Freshwater Mussels: Guadalupe fatmucket (*Lampsilis bergmanni*), Texas fatmucket (*Lampsilis bracteata*), Texas fawnsfoot (*Truncilla macrodon*), Guadalupe orb (*Cyclonaias necki*), Texas pimpleback (*Quadrula petrina),* False spike (*Quincuncina mitchelli*)

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Texas Treasures and Freshwater

Texas Treasures help maintain clean water, reduce treatment costs and stabilize riverbanks — minimizing soil erosion, flood damage and the costly need for infrastructure repairs and waterway restoration. Through their natural filtration services, these species help sustain the health of streams and rivers filled by the Edwards Aquifer, a critical water source for 2.5 million Texans. The loss of these organisms would not only degrade water quality through erosion control and flood mitigation but could also lead to significantly higher costs for drinking water treatment and agricultural irrigation.

According to the 2022 State of the Hill Country Report, about 40 out of more than 2,000 streams in Texas are considered "pristine"— ***with 60% of those found in the Hill Country. Pristine streams,*** or those where phosphorus levels are below 0.01 milligrams per liter, are extremely sensitive to pollutants and require dedicated management. Texas Treasures are vital indicators of water health in Texas. Understanding this relationship is crucial to the importance of conserving Texas Treasures to maintain the delicate balance of freshwater ecosystems.

Salamander skin is particularly vulnerable to habitat changes due to its unique physiological functions and characteristics. This is because Eurycea salamanders are lungless, and the exchange of water, oxygen and other substances occurs entirely through their skin. Toxins such as pesticides or chemicals can easily penetrate their skin and harm them.

Spring and cave-dwelling salamanders absorb oxygen through their skin instead of using lungs, a process called

cutaneous respiration. If water quality deteriorates or the water quantity dwindles, it can reduce their ability to absorb oxygen, leading to stress or death. Salamanders are moisture-dependent and inhabit water ecosystems.

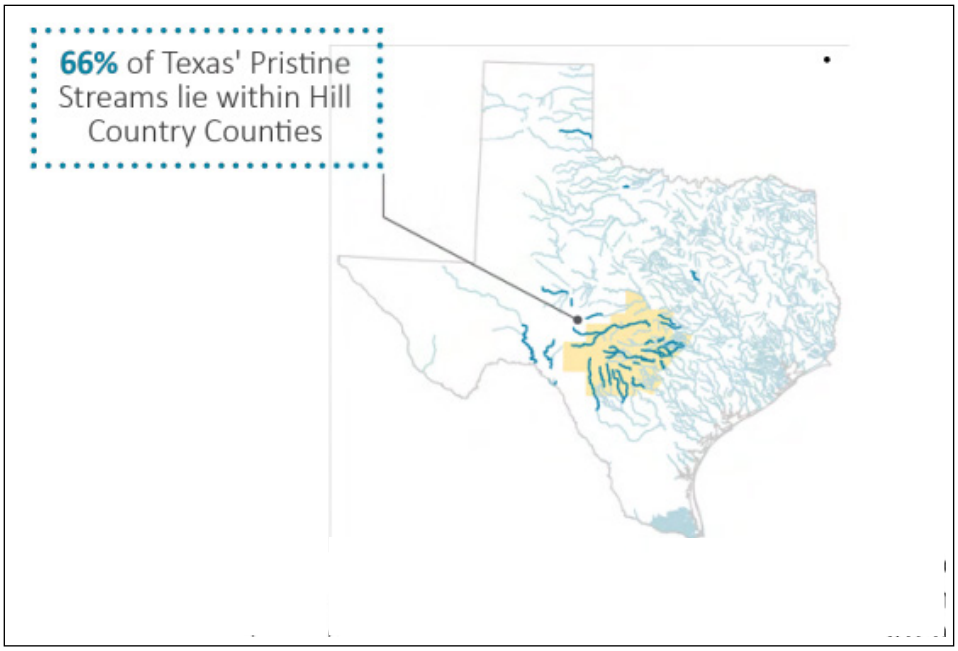
Changes in temperature, humidity or water levels due to drought or habitat destruction can lead to dehydration, skin damage and fungal infections which in turn can severely impact the salamanders' populations. Because their skin lacks protective layers like feathers, fur or scales, salamanders are more susceptible to UV radiation. Habitat changes that reduce shade or increase exposure to sunlight can disrupt their moisture balance.

Freshwater mussels have several physiological traits that make them vulnerable to habitat changes, as well. Fwreshwater mussels are filter feeders and constantly draw in water to extract nutrients. This makes mussels sensitive to pollutants and toxins that can accumulate in their tissues and cause harm like reduced growth, organ alteration and increased mortality rates.

Mussels have long lifespans and slow reproduction rates making it difficult to recover from disturbances like pollution, habitat destruction and changes in water flow. Their dependence on fish hosts to complete their lifecycles make them highly vulnerable to changes in fish populations and can disrupt the mussels' ability to reproduce. Mussels lack the ability to move to escape degraded conditions like other wildlife can. If habitat conditions decline or their habitat changes, they are stuck and often suffer severe population losses.

All three species of blindcats are highly dependent on specific habitat conditions in aquifers, and these underground systems offer no protection from sudden changes in water quality.

They are highly sensitive to many pollutants that can seep into groundwater. Blindcats thrive in habitats with stable water chemistry. Any fluctuations in temperature, pH or dissolved oxygen levels by groundwater depletion or human activity can severely impact their survival. These catfish have a limited range and are confined to a specific cave system or aquifer. They are isolated in their habitats that are over 900 feet underground. They cannot move to new areas if their environment becomes unsuitable. Lastly, the physiological adaptations of blindcats put them at risk of extinction if habitat conditions change. Blindcat fish have fully adapted to the deep, dark conditions of caves and aquifers by losing their eyesight and slowing down their metabolism. They rely heavily on other senses like vibration detection and chemical cues in nutrient-poor waters for a stable and consistent food supply. Disruptions in the delicate habitat of the aquifer, including loss of prey or chemical imbalance, can quickly threaten their survival.



Texas Hill Countrt Alliance

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ECOLOGICAL STABILITY *(PRESENCE AND ABSENCE)*

All three species of blindcat fish contribute to the ecological stability of aquifer ecosystems and groundwater. If they disappeared, we would see severe impacts of slow nutrient cycling, unbalanced food webs, decline in water quality and a loss of habitat indicators which would destabilize the aquifer ecosystem. Blindcats consume small invertebrates and organic matter. By interacting with invertebrates and microorganisms through feeding, blindcat fish help maintain a stable food web. As predators, blindcat fish help regulate populations of other organisms, prevent overpopulation of specific species and maintain a secure food cycle. Additionally, as detritus feeders29 consuming organic material, their waste helps redistribute nutrients in aquifers that supports plant life and microbial communities in a low nutrient environment. Microbial communities break down organic matter and maintain water quality in groundwater habitats. Their presence contributes to the overall stability of aquifer ecosystems by acting as both predator and prey.

Like blindcat fish, the presence of cave, spring-dwelling salamanders sustain food webs, nutrient cycling, water quality and biodiversity in their habitats. Salamanders are also predators and prey in the food chain. As predator, they help to control the populations of several invertebrates that may otherwise overfeed on plant life thus contributing to the balance of the ecosystem. Conversely, their disappearance would deprive predators like birds, turtles and snakes of a food source. Salamanders also contribute to the nutrient flow and quality of water. They help with nutrient cycling in both aquatic and terrestrial habitats by consuming insects and decomposing organic material.

Their absence would lead to slow nutrient flow, impacting soil and water quality, and reducing the health of surrounding plants and vegetation. In addition to being indicators of

habitat conditions, salamanders are also a keystone species. By regulating prey populations, supporting soil health and maintaining nutrient cycles their absence could make habitats more vulnerable to threats.

Given the critical role freshwater mussels have in Texas rivers and streams, their disappearance would profoundly affect the Hill Country ecology. A single freshwater mussel, like the Texas fatmucket, can filter anywhere between eight to 15 gallons of water a day. When they are filter feeding, they remove particles, bacteria and contaminants, which helps maintain clean water in rivers and streams. Without them, water quality would deteriorate leading to increased sediment and harmful algae blooms, affecting other species and human water supply.

They add even more value by excreting dissolved nutrients back into water and fertilizing sediment to support plant and microbial communities. Mussels help stabilize riverbeds and streambeds by burrowing into the sediment. Their presence reduces erosion and helps maintain the structure of river and stream habitats. As keystone species, freshwater mussels preserve food webs, symbiotic relationships and biodiversity in rivers. The loss of these Texas mussels threatens the lifeblood that makes up the Texas Hill Country.

Though specific symbiotic relationships involving blindcat fish are not well-documented due to the difficulty of studying these underground ecosystems, it is likely they engage in mutualistic, commensal and indirect interactions with other cave-dwelling species in the aquifers they inhabit. It could be speculated that bacteria in aquifers may help process organic materials and break down minerals, which could enhance the availability of nutrients for blindcat fish.

Ryan Hagerty/U.S. Fish and Wildlife Service

The Texas blind salamander pictured at the San Marcos Aquatic Resources Center.

Unfortunately, rapid and uncoordinated growth in the region have triggered a cascade of environmental challenges. Overdrawing aquifers, as well as increasing impervious surfaces and toxic runoff from development all reduce water quality and availability. Lower water levels also lead to vegetation loss, erosion and further degradation of aquatic ecosystems. With the Hill Country's heavy dependence on groundwater for both human use and wildlife habitat, these threats put the region's long-term water security and biodiversity at risk.

One of the most effective tools for addressing these challenges is the Habitat Conservation Plan. Habitat Conservation Plans provide a framework for private landowners, local governments and developers to reduce harm to endangered species while still allowing certain land-use activities. By integrating conservation measures — such as maintaining spring flows, protecting recharge zones and preserving critical habitats — Habitat Conservation Plans help minimize ecological damage and support species recovery.

Conserve Habitat, Conserve Water

Habitat Conservation Plans allow private landowners, businesses and local governments to implement measures that reduce harm to endangered species and their habitats while permitting certain land-use activities. While a Habitat Conservation Plan's goal is to minimize and mitigate to the maximum extent practicable, when done well they can contribute to species recovery.

Habitat Conservation Plans provide a structured framework for mitigating habitat loss, promoting responsible land use and ensuring long-term conservation outcomes. They balance conservation with development, encourage proactive habitat management and provide regulatory assurance for permit holders under the Endanagered Species Act (ESA). Other regional Habitat Conservation Plans includes the Balcones Canyonlands Conservation Plan and the Edwards Aquifer Habitat Conservation Plans; both protect species while supporting economic growth.

While not all Texas Treasures species have dedicated recovery plans, several have comprehensive strategies developed by the U.S. Fish and Wildlife Service (FWS). Given that 97% of Texas is privately owned and home to over 100 species listed under the ESA, conservation efforts must prioritize minimizing habitat impacts on private lands.

KEY CONSERVATION ACTIONS INCLUDE:

- Protecting water quality
- Reducing risks from catastrophic water quality threats
- Ensuring sufficient water availability
- Managing and restoring habitat
- Maintaining captive populations for research and reintroduction
- Implementing outreach and community initiatives
- Monitoring species populations and assessing recovery progress

Another tool adopted by several state water authorities and the City of Austin is the Candidate Conservation Agreements with Assurance (CCAA). A CCAA is a voluntary agreement that offers incentives to non-federal landowners who take proactive steps to conserve at-risk species — both those already listed and those likely to be listed under the ESA in the future. In exchange for committing to specific conservation actions that reduce threats to a species, landowners receive a permit, which goes into effect only if the species becomes federally listed. The permit provides assurances that no additional conservation measures will be required without the landowner's consent and includes a certain allowance of incidental take if the listing occurs.

KEY ACTIONS UNDER A CCAA INCLUDE:

- Protecting and enhancing existing populations and habitats
- Restoring degraded habitat
- Creating new habitat
- Augmenting existing populations
- Restoring existing populations
- Not undertaking potentially damaging activity

Water authorities that have shown leadership in this effort include the Brazos River Authority, Lower Colorado River Authority, Trinity River Authority and Tarrant Regional Water District, all of which are engaged in CCAAs for Texas Treasure mussels. Additionally, the City of Austin's Watershed Protection Department holds a CCAA focused on the Jollyville Plateau salamander. By integrating these strategies, communities can improve efficiency and maximize the likelihood of species recovery as well as ensure that water is available to support growth.

SALAMANDER CONSERVATION EFFORTS

The **Austin blind salamander**, **Jollyville Plateau salamander** and **Texas blind salamander** have designated critical habitats in their respective ranges.

All four salamander species are covered in one or more Habitat Conservation Plans and have a recovery plan. All Texas Treasure salamanders have programs around outreach and captive breeding. Their populations are monitored annually with habitat management plans.

False Spike found in the Guadalupe River near Gonzales, Texas.

Gary Pandolfi//U.S. Fish and Wildlife Service

RECOVERY PRIORITIES

HIGH-THREAT, LOW-RECOVERY POTENTIAL: The Texas Blind salamander has a recovery priority of a 5C, indicating high threats from habitat loss, limited habitat availability, difficulty managing threats, or low population numbers. The "C" in 5C designates that the species conflicts with economic activities and conservation efforts may intersect with development or water use requiring careful management strategies.

HIGHT-THREAT, HIGH-RECOVERY POTENTIAL: The Austin Blind Salamander and Barton Springs Salamander have a recovery priority of 2C, meaning they face significant threats but have a strong potential for recovery with effective conservation actions. Protecting these species often requires navigating complex intersections between water management, land use and economic interests. Similarly, the Jollyville Plateau Salamander, with a recovery priority of 2, faces high threats from habitat loss but also has a strong likelihood of recovery if conservation measures are implemented.

ACTIONS IN HABITAT CONSERVATION PLAN

- Ensure adequate water quantity and quality
- Protect and restore habitat in waters and on lands within and adjacent to the management areas.
- Establish and implement captive refugia populations with a captive management plan and reintroduction plan.
- Promote Edwards Aquifer species conservation and recovery through outreach and education.
- Establish and implement effective disease and parasite protocols.
- Monitor progress

NO PROTECTIONS FOR · FRESHWATER MUSSELS

Numerous agencies, non-governmental organizations and stakeholders have engaged in voluntary agreements to restore and enhance habitats for fish and wildlife in the Hill Country. Some publicly and privately-owned watershed lands supporting Central Texas mussels are protected under conservation easements or managed to sustain native species.

Efforts to bolster mussel populations include research into captive propagation methods at FWS hatcheries, as well as studies led by the Texas A&M Natural Resources Institute and Texas State University. Additionally, the Texas Parks and Wildlife Department (TPWD) oversees the Aquatic Resource Relocation Permit process, ensuring freshwater mussels are properly relocated when impacted by development.

RECOVERY PRIORITIES

HIGH-THREAT, LOW-RECOVERY POTENTIAL: **The Guadalupe Fatmucket, Guadalupe Orb, Texas Pimpleback, False Spike** and **Balcones Spike** have a recovery priority of 5C, indicating high threats from habitat loss, drought and water management issues, with low recovery potential due to the intensive management required. Climate change projections further complicate their recovery.

MODERATE-THREAT, HIGH-RECOVERY POTENTIAL: The **Texas Fatmucket** and **Texas Fawnsfoot** have a recovery priority of 8, facing moderate threats but a higher likelihood of recovery, as they have multiple

populations that could become more resilient with targeted conservation efforts.

ACTIONS IN HABITAT CONSERVATION PLAN

- Protect existing mussel populations by minimizing habitat impacts.
- Maintain consistent monitoring and surveying efforts.
- Conduct research to address knowledge gaps and improve conservation strategies.
- Increase public awareness and support for mussel conservation.

The Guadalupe-Blanco River Authority is developing the Guadalupe River Habitat Conservation Plan, a multi-species initiative covering the entire Guadalupe River Basin. The plan will mitigate the effects of water and wastewater services on 11 species, including three mussels (False Spike, Guadalupe Orb, Guadalupe Fatmucket) and two Eurycea salamanders.

BLINDCAT CONSERVATION EFFORTS

Currently, the **Mexican Blindcat** is the only ESA-listed blindcat species, but it does not have a FWS recovery plan in place. According to Texas Parks & Wildlife Code 68.00253, species listed as endangered by the ESA are automatically considered state-listed in Texas. As a result, the **Toothless Blindcat** and **Widemouth Blindcat** do not receive any special protection under state regulations. Recovery efforts for these species largely focus on broader conservation initiatives within their range, as neither species has designated critical habitat. The Toothless blindcat and Widemouth blindcat are not included in the Edwards Aquifer Habitat Conservation Plan since the plan is most applicable to spring-dwelling species that inhibit upper portions of the Edwards Aquifer. However, due to their dependence on the aquifer's water quality and quantity they do have overarching protection since they are sustained by the Comal and San Marcos Springs systems.

The Mexican Blindcat is the only species with a dedicated outreach program and active captive breeding efforts, though there have been no successful breeding outcomes have been achieved to date. In contrast, while Toothless and Widemouth Blindcats benefit from habitat management practices, all three species are monitored through population surveys. Monitoring efforts for the Widemouth and Toothless Blindcats primarily focus on groundwater wells in the San Antonio segment of the Edwards Aquifer.

RECOVERY PRIORITIES

Currently, no blindcat species has an official recovery priority listing. However, based on existing threats, population trends and the FWS Endangered and Threatened Species Listing and Recovery Priority Guidelines, an informed estimate can be made.

HIGHT-THREAT, LOW-RECOVERY POTENTIAL: The Mexican blindcat, Toothless blindcat, and Widemouth blindcat likely fall under recovery priority 5C, facing high threats from declining groundwater quantity and quality, habitat modification, and recreational activates. The "C" in 5C designates that the species conflicts with economic activities and conservation efforts may intersect with development or water use requiring careful management strategies.

ACTIONS IN HABITAT CONSERVATION PLAN

No formal action plan exists for the Mexican Blindcat, conservation measures are in place for the Toothless and Widemouth Blindcats, focusing on maintaining aquifer health and water availability.

A Need For More Information

The University of Texas at Austin houses preserved Texas Treasure specimens, collected over several decades at the Biological Collections Lab. The San Antonio Zoo is leading research in a Mexican Blindcat Project that analyzes at the geographical spread, ecological aspects and conservation status of the species. The zoo currently manages the only captive colony of Mexican Blindcats and conducts ongoing surveys focused on husbandry protocols to establish a breeding population in captivity. The loss of Texas Treasures could reduce funding opportunities for research and diminish the education value in the Hill Country. They bring grants, jobs and economic benefits associated with conservation efforts, academics and research institutions. Preserving these species encourages investment in local conservation programs and environmental education initiatives.

As climate change intensifies, droughts last longer, and as Texas' population continues to grow, the urgency to close research gaps on Texas Treasures and conservation practices increases. Research gaps — whether due to outdated information, unexplored areas or a complete lack of studies — exist for blindcat species, freshwater mussels and salamanders. Identifying these gaps helps direct scientific efforts toward critical unknowns, advancing conservation strategies and refining our understanding of these species. While we identify these gaps, we also highlight the new science driving efforts to protect these species. This section showcases both the most pressing knowledge gaps and the latest research shaping the future of Texas Treasure conservation.

FRESHWATER MUSSELS: Freshwater mussels in Texas, like those across North America, face significant conservation challenges, but key scientific knowledge gaps remain, hindering effective management and recovery efforts. Filling these scientific gaps is essential for conserving Texas' freshwater mussels, many of which are already imperiled. Addressing these research needs will require collaboration among biologists, hydrologists, geneticists and conservationists, as well as long-term monitoring efforts to track population trends and environmental changes.

Many Texas Treasure mussels rely on specific host fish to complete their life cycle, but their hosts remain largely unknown or understudied. While studies have used DNA-based molecular identification to investigate mussel-host fish relationships, and some literature reviews have synthesized existing knowledge, significant gaps remain. Understanding and identifying host fish is critical for conservation efforts, particularly for captive breeding, monitoring popula-

U.S. Fish and Wildlife Service

The Texas pimpleback is only known to occur in the Hill Country's Colorado River and its tributaries.

tions and reproduction, and managing habitat adaptively. Additionally, little research has been done to understand how mussels interact with native fish, invertebrates and invasive species. More studies are needed to determine how environmental changes impact host fish and, in turn, mussel recruitment success.

Another major knowledge gap in freshwater mussel science is population genetics. The taxonomy of many Texas mussels is still unclear, and some may be cryptic species —genetically distinct despite appearing identical. Advances in genetic sequencing are helping to clarify species boundaries and uncover hidden diversity within Texas mussels. Some populations previously thought to belong to the same species may actually represent distinct evolutionary lineages. For instance, the Texas fatmucket and Guadalupe fatmucket were considered a single species, but Inoue et al. (2020) demonstrated how their isolation in the Hill Country led to distinct evolutionary paths, requiring different management strategies. Genetic research is important for defining species boundaries, assessing population diversity and guiding conservation strategies to protect these unique evolutionary lineages.

Mussels are also highly sensitive to changes in water flow, sediment buildup and drought. Drought is one of the most widespread natural disturbances in freshwater ecosystems, yet its full impact on mussel populations remains poorly understood1. Research has shown that mussels tend to have a slow recovery rate after disturbances), but we still don't fully understand how they adapt to Texas' dynamic river systems.

Groundwater loss, shifting stream flows and major floods could significantly impact survival and reproduction, yet research on these effects remains limited. To address this research from Texas A&M AgriLife Research and The Nature Conservancy, with funding from FWS Ecological Services and Science Applications programs, have an ongoing study on how extreme fluctuations in Texas river flows impact rare mussel populations and how climate change may further threaten their survival. Similarly, climate change-driven droughts may threaten mussel populations long-term, yet few studies have explored their adaptive capacity or predicted future trends in the Hill Country. Like many other wildlife, adaptability is heavily influenced by life history and behavior response. New research suggests that incorporating a strategic life-history conservation framework could help mussels to better withstand drought.

Finally, captive breeding and reintroduction efforts show promise, but major knowledge gaps remain regarding survival rates, habitat suitability and long-term population viability. Artificial propagation programs — raising mussels in captivity before releasing them — are still in early stages for Texas river systems (Pease et al. 2014). In spring 2024, the San Antonio River Authority and FWS launched a conservation initiative to restore the health and biodiversity of the San Antonio River Basin by reintroducing propagated mussels to local waterways. However, each river has unique flow patterns, water chemistry and habitat conditions, and researchers are still evaluating how well reintroduced mussels survive and reproduce. Refining these techniques is critical to ensuring long-term population recovery.

SALAMANDERS: Researchers have made great strides in understanding Texas Treasure salamanders, their specialized habitat and conservation needs. While knowledge gaps remain, this report points out key findings and areas needing further study rather than an exhaustive list of new research. Expanding research in these areas could greatly enhance conservation efforts, especially as development increases and climate challenges intensify in the Texas Hill Country.

With salamanders relying heavily on the Edwards and Trinity aquifers, the extent to which groundwater flow patterns influence their habitat connectivity remains unclear. However, efforts are underway to better understand this issue using dye tracing — a method that involves injecting fluorescent dyes into the water to track its movement through underground systems.

Research on minimum flow levels have helped ensure that drought management programs are science-based. As a result, groundwater conservation, like the Barton Springs Edwards Aquifer Conservation District has set minimum flow requirements of 6.5 cubic feet per second during extreme drought to maintain adequate water supplies for endangered salamanders. This is especially important as studies like Devitt et al. 2018 warn that Edwards-Trinity

salamanders face high risk of extinction within the next century due to decreasing spring flow and rising air temperatures. More research is needed to understand how long-term changes in aquifer levels affect salamander movement, population viability and genetic exchange between isolated populations.

Karst aquifers and their hydrology have been extensively studied in the context of climate change. It is well understood that these habitats respond quickly to environmental shifts, especially in rapidly developing areas where additional stress is placed on the system. However, the impacts of prolonged climate-driven droughts, rising temperatures and increased groundwater extraction on Texas Treasure salamanders are still not well understood. Climate influences how species survive, reproduce and interact with their environment. It affects the stability of their habitats, and the behavior of prey and predators. Generally, rising temperatures also decrease the reproductive success of wildlife. Most salamanders cannot tolerate prolonged exposure of about 25°C, which is why Hill Country groundwater districts aim to maintain water temperatures between 18-21°C. As climate change drives more extreme heat and prolonged droughts, suitable habitat availability for Texas Treasures may become increasingly limited. A report by the U.S. Geological Survey assessed the climate change vulnerability of three Texas Treasure salamanders under projected conditions through 2050. The report revealed that the Barton Springs salamander is highly vulnerable to climate change, while the Austin blind salamander and Texas blind salamander are moderately vulnerable. These assessments emphasize the urgent need for conservation strategies and additional research on prolonged impacts of climate change.

Although salamanders are known to be highly sensitive to pollutants, research on the specific effects of contaminants on Texas Treasure salamanders is still developing. Studies have shown that amphibians, particularly in their egg and larval stages, are vulnerable to pollutants such as heavy metals, pesticides, nitrites, salts and petroleum hydrocarbons. Contaminants from human and animal waste, industrial runoff and fertilizers often enter aquatic systems, leading to algal blooms and decreased dissolved oxygen levels. Low oxygen levels can significantly impact salamanders by reducing respiratory efficiency, metabolic energy, reproductive success and overall survival. Additionally, heavy metals have been shown to affect growth, development, behavior and metabolism, with early life stages being the most susceptible. However, there is still limited research on how these pollutants specifically impact Central Texas salamanders, highlighting a gap in conservation science.

Before 2018, population estimations of the Guadalupe Fatmucket were attributed to the Texas Fatmucket, which was once believed to inhabit both the Colorado and Guadalupe River Basins. However, genetic analysis has revealed two distinct species live in each: the Texas fatmucket residing in the Colorado River Basin and the Guadalupe fatmucket in the Gudalupe River Basin. ***The Guadalupe fatmucket currently occupies about 53 miles approximately 16.8% of its presumed historic range,*** *from Gonzalez County upstream to Kerr County, including the North Guadalupe River, Johnson Creek, and the Blanco River.*

BLINDCATS: Groundwater-dependent species are among the least understood in global biodiversity and among the most vulnerable due to the rapid depletion of groundwater. This is especially true for all three blindcat species, which inhibit deep aquifers. The biggest challenge in studying blindcats is their extreme inaccessibility, as they dwell more than 500 feet underground. This makes direct observation and data collection difficult, leaving significant gaps in our understanding of their biology, behavior and conservation needs. While much information about the species remains unknown, initiatives like the Center for Conservation and Research at San Antonio Zoo's Mexican Blindcat Project and the Blindcat Work Group are working to advance research and conservation efforts. Recognizing the need for further study, this section highlights three research gaps that, if addressed, could greatly improve our understanding and protection of blindcats. Although each blindcat fishis unique, they all share the same scientific knowledge gaps.

Due to their distinctively deep habitat, little to no data exists on blindcat population sizes, distribution and phylogenetic relationships (how different species are related to each other based on their evolutionary history).

However, ongoing research at the University of Texas at Austin's Biodiversity Collections is underway to better understand evolutionary adaptations and population genetics. The San Antonio Zoo's Mexican Blindcat Project, is working to learn more about the species by managing the only known captive colony, with hopes of establishing a breeding population in human care. Captive breeding provides a stable environment for species survival and allows researchers to study reproductive behavior patterns. However, long-term captivity may lead to evolutionary changes due to the artificial environment.To date, no successful breeding pairs have been established through the Mexican Blindcat Project.

Basic biological aspects of blindcats, such as growth rates, lifespan and reproductive behaviors remain largely unknown. Several behaviors have been observed in laboratory studies of the Mexican blindcat from Hendrickson et al. 2001. Notably, one documented behavior is jaw-locking, where individuals bite each other and remain motionless in this grip for anywhere from a few minutes to 12 hours. Robert, 2009 noted this kind of atypical activity typically occurs soon after individuals are rearranged into different tanks.

Another observed behavior is torpor, a state of reduced activity characterized by lowered metabolism and body temperature. Blindcats have been seen drifting motionless "playing dead" on their backs in currents, a behavior thought to be an adaptation to their predator-free cave environment. Hendrickson et al. 2001 also documented courtship and spawning events, with eggs observed on multiple occasions. However, in each

University of Texas at Austin

Widemouth Blindcat in Hendrickson lab / Ichthyology Collection at The University of Texas at Austin

instance, the eggs disappeared within 24 hours, likely consumed by other fish in the laboratory tank.

Texas aquifer systems support groundwater-dependent species that play critical roles in water purification, biodegradation and nutrient cycling. Because limestone has irregular formations with cracks and caves that allow water to move unpredictably, contamination can linger for decades, making it harder to pinpoint the direct causes of species decline. With their small distributions and highly specialized environmental needs, blindcats are entirely dependent on these aquifer systems and vulnerable to groundwater changes. Their survival is tied to the stability of underground ecosystems; however, it is still unknown how groundwater depletion, pollution and water quality shifts affect them. Pollution, over-extraction and climate change are altering aquifer conditions — sometimes faster than scientists can study their impacts. Beyond the challenge of accessing aquifers, studying blindcats is difficult because of limited sample sizes. Unlike surface water species, they can't be easily caught with traditional nets or traps. Scientists often rely on rare accidental discoveries, water well extractions, or remote sensing techniques, none of which provide a full picture of their populations23. Since blindcats have rarely been studied, there's little historical data to compare against, making it difficult to track changes over time. Additionally, research funding and conservation priorities often lean toward more accessible or economically significant species, leaving blindcats largely overlooked.

How to Help Our Texas Treasures

Our Texas Treasures provide vital insight into the biodiversity and ecological health of the Texas Hill Country, particularly due to their reliance on aquifer and surface water systems. Despite being historically overlooked, these species have sustained their ecosystems and serve as indicators of environmental change. As the region's population is projected to keep growing, conservation efforts must balance ecological needs with economic and land-use interests. Increasing water demand, groundwater depletion, water quality degradation, habitat loss and climate change threaten their survival.

Failing to protect these species will have cascading effects, including altered stream flows, habitat fragmentation, rising water temperatures and increased pollutants — ultimately jeopardizing the water supply for nearly two million people. The Hill Country already loses two to three feet of groundwater annually, making water conservation an urgent priority.

As the region's population is projected to keep growing, conservation efforts must **balance ecological needs with economic and land-use interests.**

Texas Treasures have specialized adaptations that make them crucial indicators of waterway health.

Their protection and recovery not only safeguard biodiversity but also help maintain water quality and prevent costly infrastructure challenges. Integrating their conservation into water planning is an investment in ecological and economic sustainability.

To ensure their survival, conservation strategies must prioritize habitat protection, sustainable water management and long-term resilience.

Habitat Conservation Plans, regional conservation programs, scientific research, water infrastructure funds and public engagement are essential tools for mitigating threats while allowing for responsible growth. By taking proactive measures and integrating conservation into policy and planning, Texas can safeguard its unique aquatic biodiversity while securing the region's water future for generations to come.

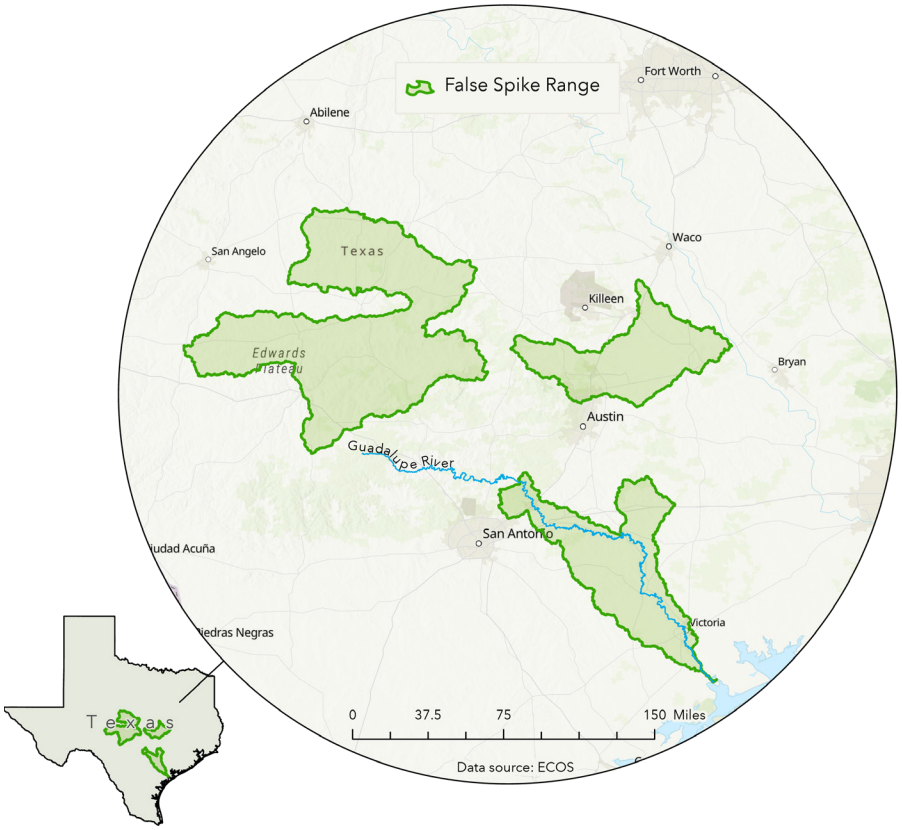
TEXAS TREASURE HISTORIES

FRESHWATER MUSSELS

Freshwater mussels were commonly harvested by early Texans — including the Tonkawa, Lipan Apache and Comanche — for food and tools. By the mid-1900s, however, mussel populations declined significantly due to overharvesting from the button-making industry and increased industrial pollution. More than 50 native freshwater mussel species have been documented in Texas, many of which have experienced significant population declines. Six of these species inhabit the Edwards Aquifer. The FWS proposed to list all six species as endangered on August 26, 2021. As of June 2024, five are listed as endangered, and the sixth, the Texas fawnsfoot, is listed as threatened under the ESA.

False spike *Quincuncina mitchelli*

The False Spike is a medium-sized freshwater mussel native to the Guadalupe River basin in Texas. The False Spike was once considered common wherever it was found; however, beginning in the early 1970s, the species began to be regarded as rare throughout its range and eventually it was indicated that no living populations were documented until 2011. The discovery of seven live False Spike in the Guadalupe River, near Gonzales, Texas, was the first report of living individuals in nearly four decades. The primary threat to this species is habitat loss through changes in water quality and quantitys. False Spike now spans approximately 20% of what is believed to have been its historical distribution across the Guadalupe River basin



Texas fatmucket Lampsilis bracteata

This Texas-endemic freshwater mussel species is only known to occur in tributaries of the Hill Country's Colorado River. Like many other freshwater mussels, the Texas fatmucket, which is currently proposed for endangered listing, has a unique life cycle that requires the use of a host fish, including the Texas-endemic Guadalupe Bass, to transform the immature larva stage into a self-supporting juvenile mussel. The primary threat to this species is habitat loss through changes in water quality and quantity, as well as increased fine sediments.

The Texas fatmucket historically existed in 14 rivers in the upper Colorado River Basin of the east-central portion of the Texas Hill Country. Today, the species is currently restricted to the upper reaches of major tributaries within the Colorado River Basin, with its range now limited to five

known populations across 11 counties in Central Texas. According to FWS Species Status Assessment, two of these populations are in moderately healthy condition, while three are considered unhealthy. The Texas fatmucket now occupies approximately 295 miles of the Colorado River basin, representing only about 20% of its presumed historic range.

Guadalupe fatmucket *Lampsilis bergmanni*

This mussel species was recently discovered to be a separate and distinct species from the Texas fatmucket. Because of the recent split (2019), better information is not yet available. The two species are very similar, but the Guadalupe fatmucket only occurs in the Guadalupe River Basin. The primary threat is habitat loss through changes in water quality and quantity, as well as increased fine sediments.

Before 2018, population estimations of the Guadalupe Fatmucket were attributed to the Texas Fatmucket, which was once believed to inhabit both the Colorado and Guadalupe River Basins.

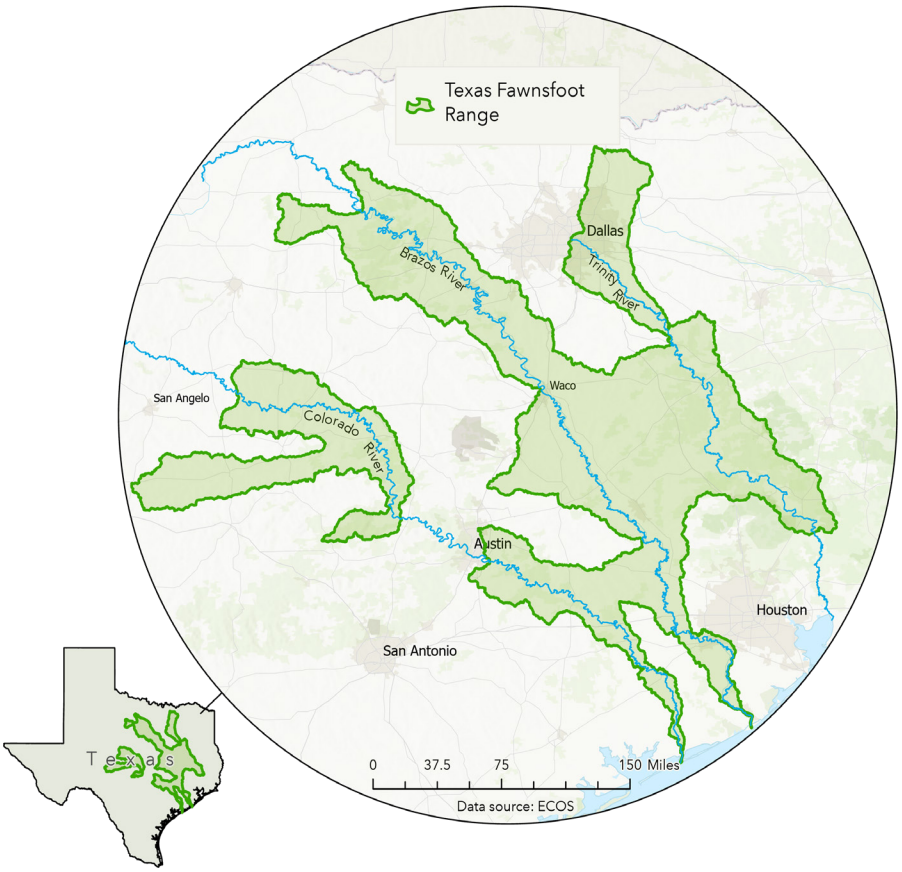
However, genetic analysis has revealed two distinct species live in each: the Texas fatmucket residing in the Colorado River Basin and the Guadalupe fatmucket in the Gudalupe River Basin. The Guadalupe fatmucket currently occupies about 53 miles of stream length in the Upper Guadalupe River, approximately 16.8% of its presumed historic range , from Gonzalez County upstream to Kerr County, including the North Guadalupe River, Johnson Creek, and the Blanco River.

Texas fawnsfoot *Truncilla macrodon*

The Texas fawnsfoot occurs in the Colorado, Brazos and Trinity River Basins of Central Texas. What makes the Texas fawnsfoot unique is that the species is believed to utilize a self-sacrificing reproductive strategy when the females infest a host fish with glochidia immediately before being ingested. The primary threat to this species is habitat loss through changes in water quality and quantity, as well as increased fine sediments.

Named for the way it grows, the Texas fawnsfoot is known to occur in the Colorado, Brazos and Trinity River Basins across 28 counties. Until around 2017, it was only thought to have been present in the Colorado and Brazos River. The Texas fawnsfoot was thought to have been mostly extirpated from its historical range, but recent discoveries of a few individuals in new locations suggest otherwise.

Today the current distribution represents about 18.7% of its presumed historic distribution.



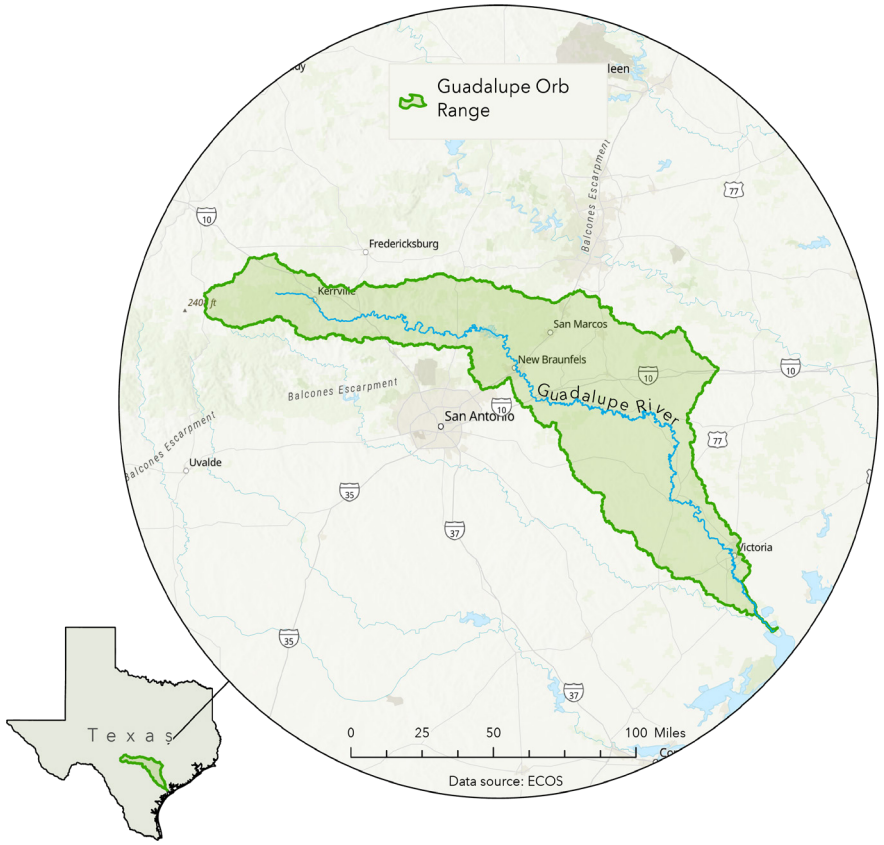
Texas pimpleback *Quadrula petrina*

The Texas pimpleback is only known to occur in the Hill Country's Colorado River and its tributaries. Like many other freshwater mussels, the Texas pimpleback has a unique life cycle that requires the use of a host fish, including catfish species, to transform the immature larva stage into a self-supporting juvenile mussel. The primary threat to this species is habitat loss through changes in water quality and quantity, as well as increased fine sediments.

The Texas pimpleback lacks the characteristic bumps their name suggests. Historically, they were believed to have inhabited both the Colorado and Guadalupe River Basins. Genetic analysis revealed them as a distinct species, setting them apart from the recently identified Guadalupe orb and endemic only to the Colorado River. The current range of the Texas pimpleback now spans approximately 21% of what is believed to have been its historical distribution in the Colorado River Basin.

Guadalupe orb *Cyclonaias necki*

The Guadalupe Orb is a rare mussel that was first identified as a unique species (separate species from the Texas pimpleback) in 2018. This Texas-endemic freshwater mussel species exclusively occurs in the Guadalupe River Basin of Central Texas and has designated critical habitat in the Guadalupe and San Marcos Rivers. There are two separate and isolated populations: The upper Guadalupe River and the lower Guadalupe River. The primary threat to this species is habitat loss through changes in water quality and quantity, as well as increased fine sediments. Before 2018, population estimates of the Guadalupe orb were referred to as the Texas pimpleback. Once identified as the Texas pimpleback, the Guadalupe orb was historically found throughout much of the Guadalupe and Blanco Rivers. Today the current distribution of the Guadalupe orb represents about 54% of its potential historic range. The estimated reduction in the Guadalupe orb's range assumes the species once continuously occupied its entire historical distribution. However, this is unlikely given its specialized habitat preferences.



SALAMANDERS

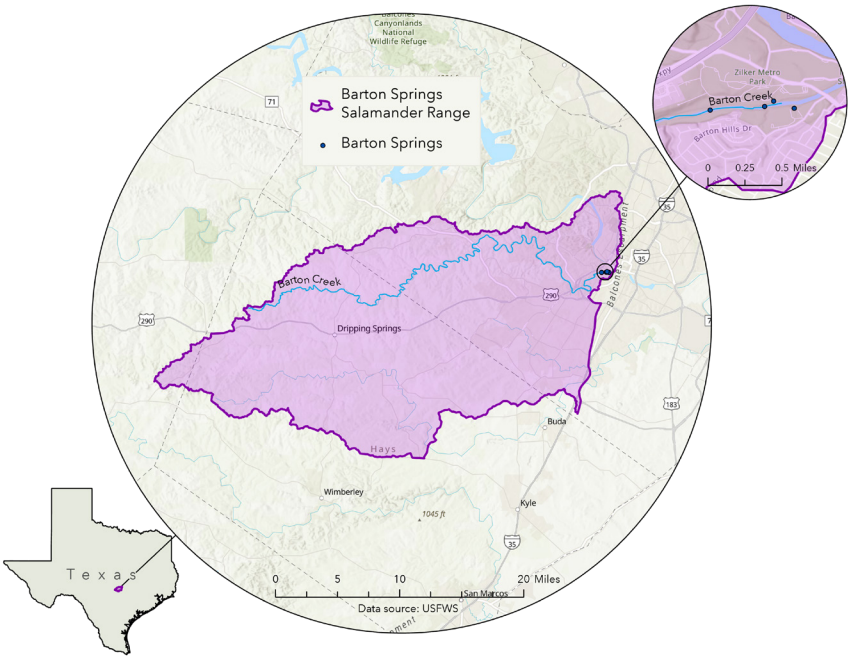
Salamanders like the Texas blind salamander and Austin blind salamander have remained confined to narrow, historic ranges due to their highly specialized habitats in specific aquifers and springs. On the other hand, the Jollyville Plateau salamander and Barton Springs salamander have experienced changes in their range over time, largely due to their ability to persist in both surface and subterranean habitats. While they still rely on

clean, spring-fed water sources, they are more flexible in their habitat use, allowing them to occupy different areas within their respective watersheds

The United States has the highest diversity of salamander species in the world, and 28 of them are found in Texas. All four Texas Treasure species are currently listed under the ESA: three as endangered and one as threatened. In 2021, the five-year review for the Texas blind salamander highlighted concerns about a decline in population. The current population is estimated to be less than 1,000 individuals. The Jollyville Plateau salamander, listed as threatened under the ESA, has experienced a dramatic population decline even within the short period since its discovery in 2000. The salamander is likely two species, or at least two distinct populations divided by a major highway. Estimating the exact number of Eurycea salamanders in the Hill Country is challenging due to their elusive nature and the difficulty accessing their underground habitats. Efforts are ongoing to better assess and protect these populations as they live in specialized habitats. Understanding their exact numbers is a complex and ongoing challenge.

It was not until the mid-1990s that biologists took an interest in understanding the relationship between salamanders and the environment along with their genetic relationships with other species of this group of salamanders. Before that, very little was known about any of the Hill Country's endemic salamanders. Most salamanders in the Edwards Plateau were considered "Texas Salamanders" until the discovery of genetic distinctions throughout the Hill Country. The discrepancy was primarily due to the similar appearance of salamanders located in the Edwards Plateau. Journals like The Biology of Plethodontid Salamanders and Hillis et al. 2001 shed light on some of the first species distinctions.

All four Eurycea salamanders belong to the Plethodontidae family, which is the largest family of salamanders. Biologists discovered that the Texas salamander was composed of several genetically distinct species. The true range of the Texas Salamander is restricted to the springs and caves of Bexar, Comal and Kendall Counties. Two of the newly discovered species were Austin's own — the Jollyville Plateau Salamander and the Barton Springs Salamander. The Barton Springs Salamander is sympatric with (occurs in the same range as) the Austin blind salamander. The Austin blind salamander is closely related to the Texas blind salamander, found in the southern Edwards Aquifer near San Marcos, Texas. Interestingly, the Barton Springs salamander is more closely related to the San Marcos salamander than to either the Austin blind or Texas blind salamanders. Before the invention of DNA testing, differences in appearance, or "morphology," were the basis for distinguishing one species from another. Once scientists learned how to identify and group species based on their genetic relationships, the unique genomic characteristics of each salamander species became known and could be classified.



Salamanders like the Texas blind salamander and Austin blind salamander have remained confined to their narrow, historic ranges due to their highly specialized habitats in specific aquifers and springs. These species are fully aquatic and neotenic, meaning they retain larval characteristics throughout their lives, which makes them highly dependent on stable groundwater conditions. Because they live in deep, dark aquifers with little environmental variation, they have evolved unique traits such as reduced pigmentation and loss of functional eyes. However, this extreme specialization also limits their ability to disperse or adapt to changing conditions, making them particularly vulnerable to habitat degradation and water quality declines.

On the other hand, the Jollyville Plateau salamander and Barton Springs salamander have experienced changes in their range over time, largely due to their ability to persist in both surface and subterranean habitats. While they still rely on clean, spring-fed water sources, they are more flexible in their habitat use, allowing them to occupy different areas within their respective watersheds. This adaptability has enabled them to survive despite increasing development and changes in water availability, though they still face significant conservation challenges. Understanding these differences in habitat use and range dynamics is critical for developing effective conservation strategies that protect each species according to its unique ecological needs.

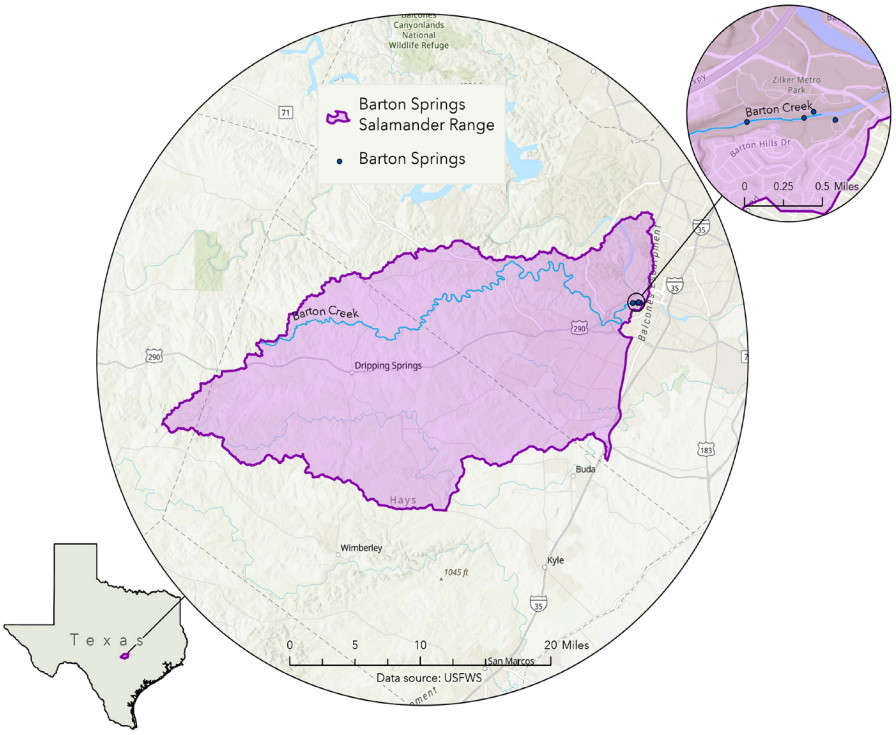
Barton Springs salamander
Eurycea sosorum

The Barton Springs salamander is a fully-aquatic, neotenic (does not transform into a terrestrial form) salamander that is entirely dependent on the Barton Springs Segment of the Edwards Aquifer and its spring openings and surrounding habitats to meet its feeding, breeding and sheltering requirements. This species was federally listed as endangered on April 30, 1997. The primary threat to the Barton Springs salamander was the degradation of quality and quantity of water that makes up its habitat as a result of urban expansion over the watershed. The restricted range of this species makes it vulnerable to both acute and chronic groundwater contamination. It is also vulnerable to potentially catastrophic hazardous material spills, increased water withdrawals from the Edwards Aquifer and various impacts to its surface habitat.

Although some of the first specimens of the Barton Springs salamander were collected in 1946, the species was not formally described until 1993. When the species was first discovered, its population was in the hundreds, but by the 1980s and 1990s, fewer individuals were observed, and more dead salamanders were found.

This decline was largely due to worsening water quality and reduced water levels in the Barton Creek Watershed, which feeds into the Edwards Aquifer. In response, a group of citizens, now known as the Save Our Springs Alliance (SOS), came together to push for stronger environmental protections. Their efforts led to two federal lawsuits that ultimately secured federal protection for the species. The salamander was given the taxonomic name, Eurycea sosorum, in honor of the citizens of Austin, who initiated and passed the SOS Ordinance in 1992 to protect the Edwards Aquifer

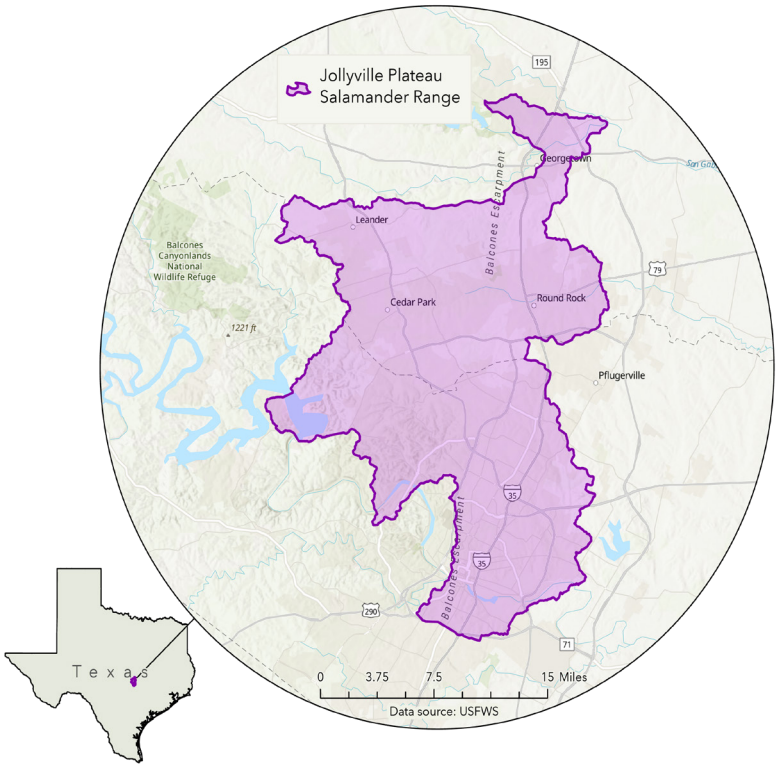
The Barton Springs salamander has shown a slight expansion in its range, now found in 12 additional springs and cave sites across Hays and Travis Counties beyond its original range within the four spring sites of the Barton Springs complex in Austin 's Zilker Park. Although the Barton Springs salamander's range has expanded, researchers believe it likely hasn't returned to its full pre-1970 distribution. The current spread is still limited compared to historical levels, suggesting that while it has adapted to additional nearby habitats, it has not fully reclaimed its original range extent.



Jollyville Plateau salamander
Eurycea tonkawae

The Jollyville Plateau salamander is a neotenic member of the family Plethodontidae. As neotenic salamanders, they retain external gills and inhabit aquatic habitats (springs, springruns and wet caves) throughout their lives. The Jollyville Plateau salamander occurs in the Jollyville Plateau and Brushy Creek areas of the Edwards Plateau in Travis and Williamson Counties, Texas. The Jollyville Plateau salamander was listed federally as threatened on September 19, 2023, under the ESA (32 FR 4001), and with more than 4,000 acres of protected habitat for the species. This designation was determined due to a limited geographical range and degradation of its habitat. Populations have declined in urbanized watersheds but remain stable in undisturbed portions of their range.

In contrast to the Barton Springs salamander, the Jollyville Plateau salamander range has reduced significantly, now confined to smaller portions of its previously broader habitat. While this demonstrates the adaptability of the Barton Springs, the Jollyville Plateau salamander faces increased challenges in its limited habitat. The Jollyville Plateau salamander was historically known for a limited range of six stream drainages. Since it was first described, the species has been found in three additional creek drainages and occurs in 130 springs and caves in two counties. The species is genetically divided into two groups: an eastern group and a western group, each occupying a distinct watershed. This genetic separation highlights their adaptation to spe-



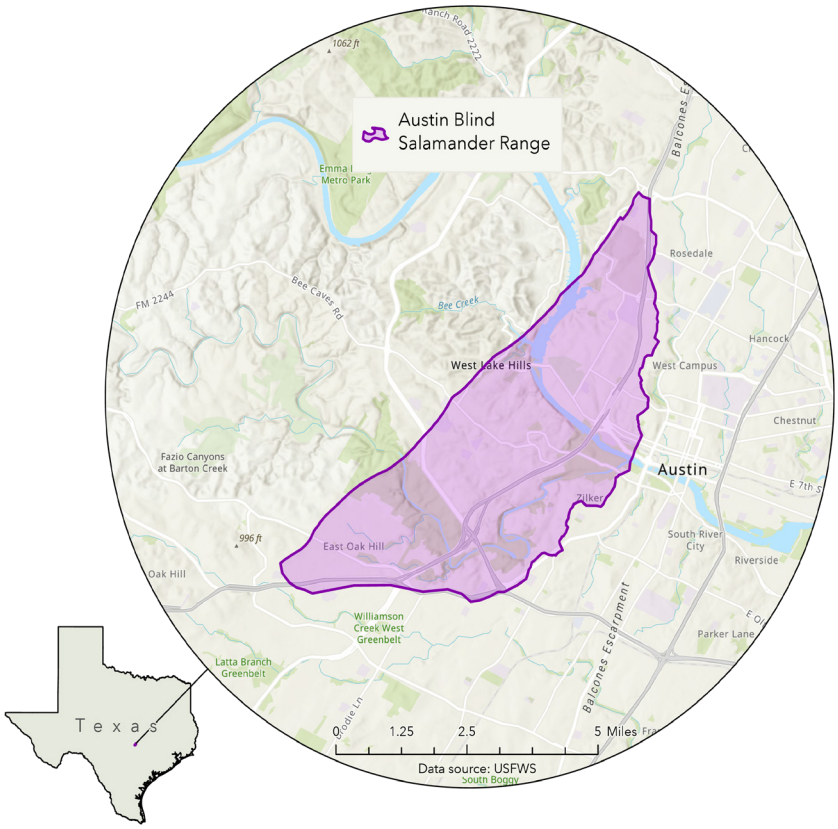
cific environmental conditions within their respective regions.

Austin blind salamander

Eurycea waterlooensis

This species is aquatic its entire life and needs flowing water with a consistent temperature of 70°F to survive. Thought to spend all or most of its life in the aquifer, occasionally individuals have been observed at the surface; may have been washed through the spring outlets. Eggs have been observed in captivity, but not in the wild. The Austin blind salamander was listed as endangered on September 19, 2013, under the ESA of 1973 (77 FR 50768).

Threats to the species include reduced habitat quality due to urbanization and increased impervious cover. The Austin Blind salamander is restricted to four outlets of Barton Springs but is seldom observed near the surface, unlike the Barton Springs salamander. Its subterranean lifestyle reflects adaptations to the aquifer environment. Since its listing, no new occurrences of the Austin Blind salamander have been identified. Like its relative, the Texas Blind Salamander, it is likely confined to the Edwards Aquifer's subterranean cavities.



Texas blind salamander

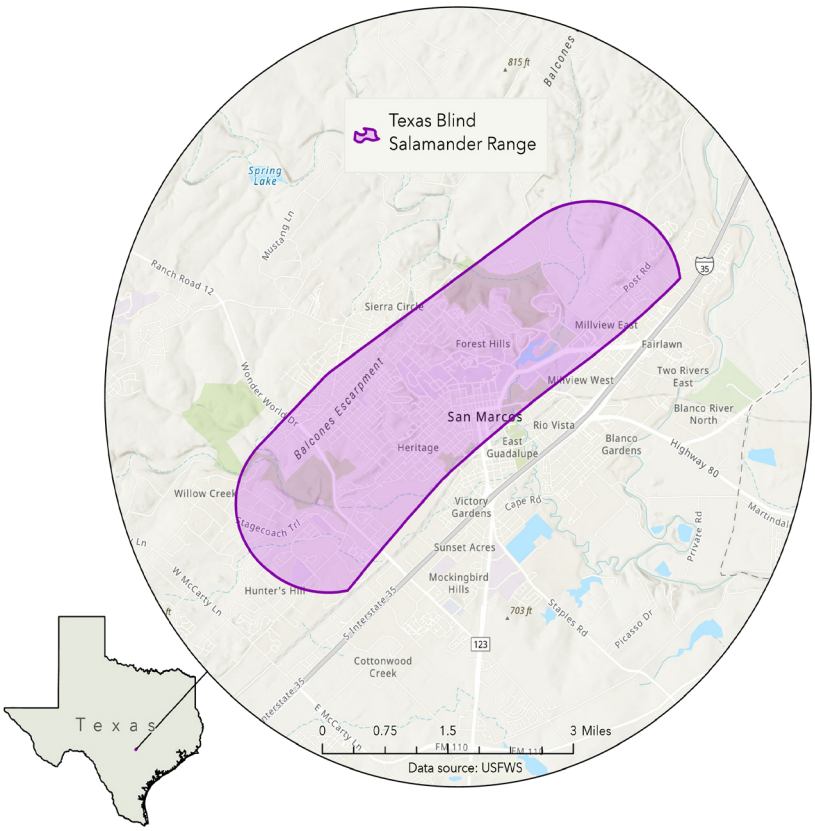
Eurycea rathbuni

Like other central Texas Eurycea salamanders, the Texas blind salamander is strictly aquatic and retains its external gills throughout its life. The Texas blind salamander was listed as Endangered on March 11, 1967, under the Endangered Species Preservation Act of 1966 (32 FR 4001).

The species was subsequently incorporated into the list of species threatened with extinction on October 13, 1970 (35 FR 16047) and was again confirmed as an endangered species on September 26, 1975 (40 FR 44412) after the ESA of 1973 superseded the earlier endangered species statues. Threats to the species include groundwater overconsumption and contamination.

The Texas Blind salamander, once documented in seven locations, is now known to persist in eight sites, including wells, caves and springs. Despite evidence of groundwater connectivity among these sites, studies have not identified individual movement across ranges.

Historical data show population declines at key sites like Ezell's Cave, which has faced threats from over-collecting, visitor disturbances and mismanagement since the 1940s. Ezell's Cave, along with Rattlesnake Cave, have seen further losses due to illegal collecting and nutrient depletion, thus underscoring the challenges of conserving these specialized salamanders in a fragile aquifer system.



There are only four known species of cave-dwelling catfish in North America — and three of them are found only in Texas. These uniquely adapted, fully blindcat fish— the Toothless blindcat, Widemouth blindcat and Mexican blindcat — are the only known troglobitic (cave-adapted) catfish species in the U.S.

The Toothless and Widemouth blindcats likely existed in the tens of thousands, though exact numbers are unknown due to the inaccessibility of their deep aquifer habitats. Today, both species are extremely rare. The FWS estimates that groundwater pumping from wells has resulted in the loss of approximately 535,000 Toothless blindcats and 269,000 Widemouth blindcats — a staggering loss that now places both species on the brink of extinction. The recently-discovered Mexican blindcat has an estimated Texas population in the low hundreds — or possibly fewer.

Like Hill Country salamanders, these fish are the focus of ongoing conservation research aimed at understanding and protecting what little remains of their fragile habitat.

Despite being difficult to study due to their underground location — often more than 900 feet below the surface — blindcats are thought to play important ecological roles. Scientists believe they may engage in mutualistic and commensal relationships with bacteria and invertebrates, contributing to nutrient cycling and food web stability within the aquifer.

In the absence of sunlight, cave-dwelling species like these have evolved remarkable adaptations: blindcats are completely eyeless and instead rely on senses like taste, smell and touch to detect water flow and temperature changes to find food. Without exposure to UV radiation, their skin lacks pigmentation, appearing translucent or pinkish from underlying blood vessels.

The Toothless and Widemouth blindcats were first discovered in the early 1900s when deep wells began drawing water from the San Antonio segment of the Edwards Aquifer. The Mexican blindcat was originally described in 1954 after being found in wells and springs near Melchor Múzquiz, Coahuila, Mexico. It was later listed as endangered by both the Mexican government and FWS.

Rumors of blind, white catfish in Texas wells persisted for decades. It wasn't until 2016 that a live Mexican blindcat was officially documented in Texas — a thrilling discovery for researchers and a major milestone in troglobitic conservation.

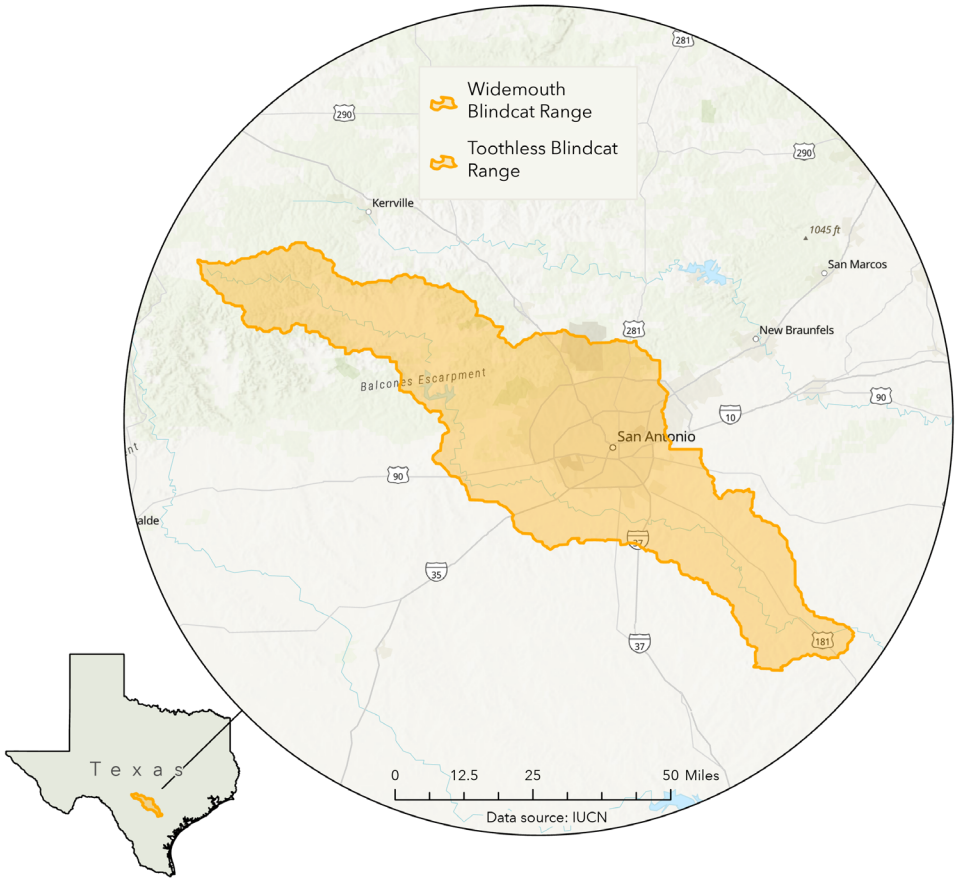
This confirmed what many had long speculated: that interconnected water-filled caves beneath the Rio Grande might link the aquifer systems of Texas and northern Mexico. These aquifers are vital not only to these rare catfish but also to the people who depend on them — making their protection all the more urgent in the face of overuse, pollution and climate change.

Widemouth blindcat *Satan eurystomus*

This rare, eyeless catfish exists in total darkness, 900 feet below the surface under San Antonio, Texas. The widemouth blindcat swims in the groundwater in the Edwards Balcones Fault Zone Aquifer and is presumed to eat invertebrates and serves as a high-trophic level opportunistic predator. This catfish was first observed by capture through agriculture wells and artesian springs that pump groundwater to the surface. Unfortunately, this species has not been observed since 1978. This species was petitioned for listing by the FWS and is undergoing review.

Toothless blindcat *Trogloglanis pattersoni*

This rare, eyeless catfish also exists in total darkness, 900 feet below the surface under San Antonio, Texas. The toothless blindcat swims in the groundwater in the Edwards Balcones Fault Zone Aquifer and is presumed to scavenge food sources both from invertebrates and fungus with its sucker-like, whiskered mouth. This species was discovered



through groundwater pumping. It was petitioned for listing by FWS and is undergoing review.

The Toothless and Widemouth blindcats have a more complex habitat distribution, mainly recorded in groundwater wells within artesian zones. These zones provide high quality freshwater, but the availability fluctuates, leading to uncertainty in estimating their exact habitat range. More research is needed to understand the full extent of their range.

Mexican blindcat *Prietella phreatophila*

This rare, eyeless catfish exists in total darkness, 2,000 feet below the surface in the Edwards-Trinity Aquifer, and is found in Texas and Coahuila, Mexico. Though the species had been known to exist in Mexico since 1954, the first time it had ever been documented in the U.S. was in 2016 when a National Park Service employee spotted the species in a deep limestone cave at Amistad National Recreation Area near Del Rio. Mexican blindcats were protected under the U.S. ESA in Mexico on June 2, 1970 (35 FR 8491).

Mexican blindcat range, estimated between 2,000 and 8,000 square miles, underscores the

All Maps Generated By Defenders of Wildlife's Center for Conservation Innovation

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