Appendix N | **Literature Review–List of Relevant Articles and Reports Completed since the 2023 Annual Report**

Covered Species Literature

Browne, R. K., Luo, Q., Wang, P., Mansour, N., Kaurova, S. A., Gakhova, E. N., Shishova, N. V., Uteshev, V. K., Kramarova, L. I., Venu, G., et al. (2024). The sixth mass extinction and amphibian species sustainability through reproduction and advanced biotechnologies, biobanking of germplasm and somatic cells, and conservation breeding programs (RBCs). ***Animals*****,** ***14*****, 3395. https://doi.org/10.3390/ani14233395**

Amphibian species face severe declines due to global heating, habitat loss, and other threats driving the sixth mass extinction. This paper explores the role of reproductive biotechnologies, biobanking, and conservation breeding programs (RBCs) in amphibian species restoration and sustainability. Techniques such as sperm cryopreservation, in-vitro fertilization, and assisted evolution offer transformative tools for species conservation. The discussion extends to ethical, cultural, and political considerations, highlighting the need for integrated genetic management and advanced biotechnologies to prevent biodiversity loss.

Chappell, L. E., Leal, E., Tivin, J. D., & Bonner, T. H. (2024). New distributional records for ***Etheostoma fonticola*** **(Fountain Darter) in the San Marcos River, Texas.** ***Southeastern Naturalist*****,** ***23*****(2), N6–N12. https://doi.org/10.1656/058.023.0206**

This study documents new distributional records for fountain darter (*Etheostoma fonticola*) in the San Marcos River, Texas. As an endangered species, understanding its range is critical for conservation efforts. The findings expand knowledge of the fountain darter's current distribution, providing essential data for habitat management and informing conservation strategies for this imperiled species within the Edwards Aquifer region.

Determan, K. (2024). Benthic macroinvertebrate community responses to climate and disturbance gradients: Testing predictions of the Stream Biome Gradient Concept. (Unpublished thesis). Texas State University, San Marcos, Texas.

This study tests the Stream Biome Gradient Concept by examining benthic macroinvertebrate communities across desert, grassland, savanna, and forest biomes in Texas. Using data on invertebrate diversity, water quality, and land use, the research found that local environmental conditions had the strongest influence on taxonomic composition. Richness was highest in forest and savanna biomes, with nestedness driving β-diversity patterns. The findings highlight the interplay of deterministic (environmental filtering) and stochastic (dispersal) processes in shaping macroinvertebrate communities across large-scale environmental gradients.

Dobbins, B. A., Tovar, R. U., Oddo, B. J., Teague, C. G., Sindhi, N. A., Devitt, T. J., Hillis, D. M., & García, D. M. (2024). PAX6 protein in neuromasts of the lateral line system of salamanders (*Eurycea*). ***PLOS ONE, 19*****(8), e0293163. https://doi.org/10.1371/journal.pone.0293163**

This study explores the presence of PAX6 protein in the mechanosensory neuromasts of the lateral line system in two *Eurycea* salamander species (*E. nana* and *E. rathbuni*), listed as threatened or endangered. Using immunohistochemistry and confocal microscopy, the authors found extranuclear localization of PAX6 in neuromast hair cells. The study raises the possibility of an unexplored cytoskeletal role for PAX6 and underscores its importance in understanding sensory systems in these federally protected salamander species.

Evans, A. V. (2024). *The little book of beetles*. Princeton University Press. https://doi.org/10.2307/jj.7616630

This compact, richly illustrated book provides an accessible exploration of global beetle diversity, anatomy, habitat, and conservation. Combining scientific accuracy with engaging visuals, it includes sections on beetles' roles in ecosystems and their cultural significance worldwide. Designed for nature enthusiasts, it offers a concise yet comprehensive overview of one of the planet's most diverse insect groups.

Johnson, J. E. (2024). The influence of environmental variables on high priority areas of conservation for amphibians in North American drylands. MS thesis, Arizona State University.

This study investigates the impact of climate change on amphibian distributions and high-priority conservation areas across dryland ecosystems in the southwest United States and northern Mexico. Using distribution maps, environmental predictors, and complementarity-based methods like Zonation, the study found that water-related variables, temperature, and solar radiation were the strongest indicators of conservation areas. Results highlight climate change's influence on conservation prioritization and provide actionable tools for natural resource managers to monitor and recover critical habitats for amphibians.

Maroti, A., & Hutchinson, J. T. (2024). Evaluating the suppression of *Hydrilla verticillata* by manual removal and planting natives for small-scale restoration efforts in a spring-fed river. *Knowledge & Management of Aquatic Ecosystems*, *425*, 4.

This study investigates the suppression of *Hydrilla verticillata*, an invasive aquatic plant, through manual removal and replanting of native macrophytes in the San Marcos River, Texas. Results show that Texas wild-rice (*Zizania texana*) and water stargrass (*Heteranthera dubia*) can compete with hydrilla but with mixed success, as hydrilla recolonized disturbed plots quickly. While Texas wild-rice demonstrated strong biomass allocation to roots and shoots, hydrilla's rapid shoot growth highlights challenges in its long-term control through manual restoration efforts.

Marshall, T. L., Tovar, R. U., Devitt, T. J., Hillis, D. M., Moore, D. M., Gillis, M. S., & Funk, T. S. (2024). Evaluation of p-Chip microtransponder tags on small-bodied salamanders (*Eurycea* spp.). *Amphibian & Reptile Conservation*, *18*(1), 10–19.

This study evaluates the use of p-Chip microtransponder tags for tracking small-bodied aquatic salamanders, including *Eurycea sosorum*, *Eurycea pterophila*, and *Eurycea rathbuni*. Results show high survival (97–100%), excellent tag retention (97–100%), and unaffected growth after tagging. Novice scanners had varied success in tag readability for *E. sosorum*, though experienced scanners succeeded across species. P-Chip tags offer improved individual identification and reliability compared to traditional visible implant elastomer tags, making them a valuable tool for conservation monitoring.

Pottier, P., Kearney, M. R., Wu, N. C., Gunderson, A. R., Rej, J. E., Rivera-Villanueva, A. N., & Nakagawa, S. (2024). *Vulnerability of amphibians to global warming.* [Unpublished manuscript].

This study examines the vulnerability of amphibians to rising global temperatures, predicting the thermal tolerance of 60% of species and their exposure to overheating events. The results show that a 4°C increase would severely affect 7.5% of amphibian species, particularly tropical species in the Southern Hemisphere. The findings emphasize the importance of preserving vegetation and waterbodies as critical microhabitats to buffer amphibians during heat waves.

Silknetter, S. C., Benson, A. L., Smith, J. A., & Mims, M. C. (2024). Spatial extent drives patterns of relative climate change sensitivity for freshwater fishes of the United States. *Ecosphere*, *15*(3), e4779.

This study systematically evaluates the climate sensitivity of 137 native freshwater fish species in the United States, examining how spatial extent influences sensitivity rankings. While overall rankings were largely consistent across scales, relationships between climate sensitivity, geographic rarity, and species traits were sometimes scale-dependent. The findings highlight the utility of climate sensitivity assessments for identifying overlooked species in need of conservation actions such as monitoring or pre-listing agreements.

Toder, A., & Hutchinson, J. T. (2024). Aquatic invertebrate diversity in isolated and permanent pools along an urban ephemeral stream in Central Texas. *Wetlands Ecology and Management*, *32*, 841–855. https://doi.org/10.1007/s11273-024-10006-3

This study examines aquatic invertebrate diversity in ephemeral and permanent pools along an urban stream in Central Texas. Results show reduced water quality, indicated by high pollution tolerance levels and low EPT (Ephemeroptera, Plecoptera, Trichoptera) taxa abundance. Urban runoff significantly affected aquatic communities, with collector-gatherer-shredders being the dominant feeding group. Findings highlight the ecological importance of ephemeral streams and the threats posed by reduced legal protections following recent regulatory changes.

Conservation Biology Literature

Ashofteh, P. S., Kalhori, M., & Singh, V. P. (2024). Water resources management considering groundwater instability affected by climate change scenarios. *Physics and Chemistry of the Earth, Parts A/B/C*, *135*, N.PAG. https://doi.org/10.1016/j.pce.2024.103606

This study develops a groundwater model for the Khorramabad aquifer in Iran under unsteady conditions, integrating climate change scenarios RCP26 (optimistic) and RCP85 (pessimistic). Using GMS, MODFLOW, and WEAP models, changes in water levels and resource deficits were analyzed for future periods (2040–2069, 2070–2099). Results show water level decreases by up to 1.175 meter under RCP26 and 0.753 meter under RCP85 compared to baseline levels. Water deficits were lowest under RCP26 (7%) and highest under RCP85 (180%), emphasizing the role of integrated modeling in managing water resources in water-scarce environments.

Balakrishnan, J. V., Bailey, R. T., Jeong, J., Park, S., & Abitew, T. (2024). Quantifying climate change impacts on future water resources and salinity transport in a high semi-arid watershed. *Journal of Contaminant Hydrology*, *261*, N.PAG. https://doi.org/10.1016/j.jconhyd.2023.104289

This study quantifies future climate impacts on hydrologic fluxes and salt loads in Colorado's Gunnison River Watershed using the APEX-MODFLOW-Salt model and CMIP5 climate projections (2020–2099). Results show that while surface runoff contributes 65% of streamflow, 73% of salt loading comes from aquifers. Annual salt loads could increase by 4.1–9.6% under future climate scenarios, posing risks to downstream water quality. This study highlights the model's utility in understanding salinity dynamics and predicting hydrologic responses under changing climatic conditions.

Boeri, P. A., Unruh, J. B., Kenworthy, K. E., Blount, A. R. S., Schiavon, M., Reisinger, A. J., & Iannone, B. V., III. (2024). Nitrogen leaching and groundwater recharge of alternative lawn conversions in subtropical climates. ***Crop Science*****,** ***1*****.** https://doi.org/10.1002/csc2.21381

This study evaluates the effects of turfgrass conversion to alternative landscapes on nitrogen leaching and groundwater recharge in Florida's subtropical climate. Pollinator landscapes minimized nitrogen leaching (8.3 kg ha−1 NO3-N year−1) but had higher water use rates. In contrast, mulch-covered landscapes leached more nitrogen (44.7 kg ha−1 NO3-N year−1) but provided erosion control and water conservation benefits. Turfgrass maintained low nitrogen leaching while allowing 35% groundwater recharge, highlighting its role in balancing water quality and quantity in urban landscapes.

Brause, H. (2024). From paralyzing to actionable futures: Facilitating farmer participation in water conservation through a multiscalar horizoning work approach. ***Culture, Agriculture, Food & Environment*****,** ***46*****(1), 3–10.** https://doi.org/10.1111/cuag.12314

In southern New Mexico's Mesilla and Rincon valleys, prolonged drought, climate change, and groundwater competition threaten agricultural water availability. This study uses ethnographic data and concepts of *horizoning work* to examine barriers to water conservation participation. A multiscalar approach to water planning can enable collaborative, localized solutions, encouraging farmer engagement despite water-scarce futures. This highlights the need for temporal and place-based efforts to address agricultural water challenges.

Gordon, G. (Ed.). (2024). ***Rewilding the urban frontier: River conservation in the Anthropocene*****. University of Nebraska Press.** https://doi.org/10.2307/jj.19061271

This edited volume discusses the potential of urban rivers in the United States as critical areas for ecological rewilding in the Anthropocene. By focusing on restoring self-sustaining ecosystems in urbanized landscapes, the book emphasizes opportunities to adapt to human-driven environmental changes and foster biodiversity in heavily affected areas.

Hanes, R. N. (2024). Water reuse in the Hill Country: Lessons from existing reuse facilities in Texas and opportunities to advance reuse in Comal County. ***Texas Water Journal*****,** ***15*****(1).**

This study highlights the opportunities for water reuse in Texas Hill Country, particularly in Comal County, to address aquifer depletion driven by population growth and drought. Through case studies of seven Texas municipalities, the author identifies strategies for expanding reclaimed water use. The analysis underscores water reuse as an underutilized yet critical tool for ensuring sustainable water supplies in aquifer-dependent regions like the Edwards and Trinity aquifers.

Howard, K. (2023). Urban groundwater. ***The Groundwater Project*****.** https://doi.org/10.21083/978-1-77470-038-9

This book explores the role of groundwater in urban environments, addressing challenges such as groundwater recharge, contamination, and overuse in rapidly growing cities. The author discusses the impacts of urbanization, climate change, and population growth on groundwater sustainability. Drawing on over four decades of research, the book highlights solutions like managed aquifer recharge, improved groundwater management practices, and sustainable urban planning to ensure reliable water supplies. The work emphasizes the need for integrated strategies to balance urban water demands with environmental and groundwater resource protection.

Kim, M. (2024). Building resilient and sustainable water infrastructure with district financing in Texas. *Lincoln Institute of Land Policy*. http://www.jstor.org/stable/resrep59864

This report discusses water management challenges in Texas, shaped by water shortages, flood risks, and rapid population growth. Climate change and extreme weather have exacerbated these challenges, necessitating resilient infrastructure for clean water supply and stormwater management. The author emphasizes district financing, particularly through Municipal Utility Districts (MUDs) and Water Control and Improvement Districts) as a viable approach to address these issues. Bridgeland, a master-planned community near Houston, Texas, serves as an example of how these districts support water facilities and drainage infrastructure while addressing broader critiques of special-purpose agencies managing water resources.

Macpherson, E., Cuppari, R. I., Kagawa, V. A., Brause, H., Brewer, W. A., Grant, W. E., Herman, M. N., Livneh, B., Neupane, K. R., Petach, T., Peters, C. N., Wang, H., Pahl, W. C., & Wheater, H. (2024). Setting a pluralist agenda for water governance: Why power and scale matter. *WIRES Water*, *11*(5), 1–15. https://doi.org/10.1002/wat2.1734

This paper examines the challenges facing global water systems, emphasizing the importance of power dynamics and spatial-temporal scales in water governance. Climate change, contamination, and over-allocation of resources exacerbate these challenges. The authors argue for multiscalar, reflexive, and pluralistic policy solutions, highlighting the need to consider intergenerational water planning and integrated surface-groundwater management to effectively address unintended governance outcomes.

Navarro Céspedes, J. M., Hernández Anguiano, J. H., Alcántara Concepción, P. C., Dominguez Sarmiento, C., Morales Martínez, J. L., Knappett, P. S. K., Acosta Reyes, M. A., Li, Y., Piña González, V., & Zha, X. (2024). Influence of climate variability on change in storage of overexploited aquifers in a semi-arid region. *Theoretical and Applied Climatology*, *155*(3), 2087–2103. https://doi.org/10.1007/s00704-023-04749-x

This study examines the impact of climate variability on groundwater storage in overexploited aquifers in semi-arid regions using wavelet analysis and geostatistical modeling. Results show significant relationships between groundwater storage changes and climate indices, which influence precipitation, temperature, and vegetation dynamics. The study highlights the role of extreme climatic conditions, such as El Niño and La Niña, in driving groundwater level responses, providing insights for managing water resources in vulnerable semi-arid regions.

Plastrik, P., & Young, D. (2024). Water conflicts arise for US communities as climate changes arrive. *Innovation Network for Communities.* Retrieved from https://in4c.net

This report highlights the urgent and multifaceted water challenges American cities face due to climate change, including disrupted water supplies, overwhelmed stormwater systems, rising seas, and increased flooding risks. These threats hinder progress on public health, affordable housing, and economic equity while driving migration from vulnerable areas. Cities must adopt integrated "One Water" approaches to build resilience, yet conflicts often arise over water allocation, risk protection, and the high costs of resilience infrastructure. Limited authority and financial resources force cities to rely on partnerships with state, federal, and private entities. Without decisive action, many communities risk being unprepared for worsening climate-driven water crises, jeopardizing their sustainability and residents' well-being.

Strom, S. E. (2024). Forging a sustainable Southwest: The power of collaborative conservation. *University of Arizona Press*. https://doi.org/10.2307/jj.16148251

This book showcases four conservation initiatives in the American Southwest, including the Sonoran Desert Conservation Plan and Malpai Borderlands Group. Through grassroots collaboration, stakeholders balanced ecological, cultural, and economic needs to sustainably manage and protect vital ecosystems. These case studies highlight the power of shared purpose, community involvement, and practical tools in achieving conservation goals in rapidly changing landscapes.

Thapa Magar, N. (2024). Enhancing recharge in karst aquifers: A case study of the Edwards Aquifer. (Unpublished thesis). Texas State University, San Marcos, Texas.

This study investigates managed aquifer recharge as a tool to enhance groundwater recharge in the Edwards Aquifer, a critical karst aquifer in Central Texas. Results demonstrate the importance of recharge structures such as dams and reservoirs, as well as ASR, in mitigating water shortages. The study also emphasizes land conservation's role in protecting recharge areas and water quality, providing key insights for future policy development to sustainably manage karst aquifers.

Wen, N., Marek, G. W., Srinivasan, R., Brauer, D. K., Qi, J., Wang, N., Han, Y., Zhang, X., Feng, P., Liu, D. L., & Chen, Y. (2024). Assessing the impacts of long-term climate change on hydrology and yields of diversified crops in the Texas High Plains. *Agricultural Water Management*, *302*, N.PAG. https://doi.org/10.1016/j.agwat.2024.108985

This study evaluates the impact of climate change on hydrology and crop yields in the Texas High Plains using the SWAT-MAD-CO_2 model under CMIP6 scenarios. Results show mixed changes in evapotranspiration and reductions in irrigation water use for most crops, except irrigated cotton. Crop yields varied, with irrigated cotton and dryland cotton increasing significantly while sorghum and soybean yields declined. The findings highlight the importance of adaptive management strategies to improve agricultural resilience to climate change.

Wight, C., Garmany, K., Arima, E., & Garrick, D. (2024). Texas water markets: Understanding their trends, drivers, and future potential. *Ecological Economics*, *224*, N.PAG. https://doi.org/10.1016/j.ecolecon.2024.108259

This article analyzes surface water market trends in Texas, examining over 2,350 transactions between 1987 and 2022. Results reveal increasing transactional activity driven by factors like drought, population growth, and commodity prices. The study highlights regional differences in water market dynamics, emphasizing the role of groundwater levels, economic drivers, and temperature as predictors of trade. Findings underscore the importance of tailored water market governance to address Texas' evolving water scarcity challenges.

Wilder, F. (2024). Save like San Antonio: Federal intervention empowered the Edwards Aquifer Authority to restrict water waste like no other area of the state. *Texas Monthly*, *52*(8), 70–71.

This article highlights San Antonio's leadership in water conservation, driven by the need to protect endangered species like the blind salamander in the Edwards Aquifer. Legislative actions enabled the establishment of the Edwards Aquifer Authority (EAA), empowering restrictions on groundwater pumping. This intervention serves as a model for water conservation policy, balancing ecological protection and water supply needs in Texas.

Wootten, A. M., Başağaoğlu, H., Bertetti, F. P., Chakraborty, D., Sharma, C., Samimi, M., & Mirchi, A. (2024). Customized statistically downscaled CMIP5 and CMIP6 projections: Application in the Edwards Aquifer region in South-Central Texas. *Earth's Future*, *12*(10), e2024EF004716.

This study presents a methodology for generating region-specific climate projections, addressing the "practitioner's dilemma" of selecting projections for local applications. Using the Edwards Aquifer region as a case study, results show temperature increases of 2.0–4.3°C and 35–70 additional days over 37.8°C by the end of the century. Precipitation changes range from -10.4 to +25.6 millimeters annually. These downscaled projections provide critical data for groundwater and springflow modeling to inform regional climate adaptation strategies.

Wootten, A.M., Başağaoğlu, H., and Bertetti, F.P. (2024). Downscaled Climate Projections for the Edwards Aquifer Region (EAR) using CMIP5 for the years 2006–2100 and CMIP6 for the years 2015–2100. U.S. Geological Survey data release. https://doi.org/10.5066/P13NMKWU

Global climate models (GCMs) simulate climate systems and are adapted for applied research through statistical downscaling. This dataset includes statistically downscaled projections for the Edwards Aquifer region using four GCMs from the CMIP5 archive and six from the CMIP6 archive under various emissions scenarios (RCPs 4.5 and 8.5; SSPs 2-4.5 and 5-8.5). Using equidistant quantile mapping with Daymet v.4 observational data, the projections provide daily high and low temperatures and precipitation on a 1 km^2 grid for South Central Texas, spanning historical baselines (1980–2014) and future periods (2006–2100). These projections enable applied research on climate impacts, including hydrology and crop modeling, while acknowledging limitations in comprehensiveness and warranty.

Zhang, X., Ding, B., Hou, Y., Feng, P., Liu, D. L., Srinivasan, R., & Chen, Y. (2024). Assessing the feasibility of sprinkler irrigation schemes and their adaptation to future climate change in groundwater over-exploitation regions. *Agricultural Water Management*, *292*, N.PAG. https://doi.org/10.1016/j.agwat.2024.108674

This study evaluates the feasibility of sprinkler irrigation to address groundwater overexploitation in the North China Plain. Results show that sprinkler irrigation reduces percolation by 3–37% and increases winter wheat yields under certain irrigation quotas. Future climate scenarios improve yields and groundwater recharge, supporting optimized irrigation strategies. Findings provide a framework for balancing groundwater conservation and food production in overexploited aquifers globally.

Other Relevant Literature

Calderón-Gutiérrez, F., Labonté, J. M., Gonzalez, B. C., Iliffe, T. M., Mejía-Ortíz, L. M., & Borda, E. (2024). Cryptic diversity patterns of subterranean estuaries. *Proceedings of the Royal Society B*, *291*, 20241483. https://doi.org/10.1098/rspb.2024.1483

This study investigates cryptic diversity in subterranean estuaries, which are stratified coastal ecosystems with challenging accessibility. Using molecular species delimitation and DNA barcoding, the authors analyzed gene sequences from species in the Yucatan Peninsula and Cozumel Island. Results revealed high levels of cryptic genetic lineages, taxonomic misidentification, and gaps in biodiversity data, especially for stygobiont species. These findings underscore the need for molecular approaches to better estimate diversity and identify species requiring conservation assessment.

ICF (2024). Re: Revised Recommended Biological Goals and Objectives for the Permit Renewal.

This memorandum outlines proposed revisions to the Biological Goals and Objectives of the Edwards Aquifer Habitat Conservation Plan (EAHCP) as part of the Permit Renewal process. These updated goals align with current U.S. Fish & Wildlife Service (USFWS) Habitat Conservation Plan Handbook guidance and incorporate lessons learned from monitoring and adaptive management since the EAHCP's inception. The revised objectives are clear, measurable, and focused on achieving desired habitat conditions for Covered Species, ensuring the conservation strategy remains robust and adaptive to changing conditions.

Oliva, A., Doolittle, C. M., Medlock, S. A., Aubert, J. F., & Earl, J. E. (2024). Effects of tree leaves, tannins, and water color on chlorophyll concentrations in ponds. *Hydrobiology*, *3*(3), 263–278. https://doi.org/10.3390/hydrobiology3030017

This study evaluates how leaf litter, tannins, and water color influence chlorophyll concentrations (a proxy for phytoplankton biomass) in freshwater ponds. Results indicate that invasive Chinese tallow and red maple leaves leach tannins, reducing chlorophyll concentrations by darkening water and potentially causing light limitation. Tannic acid addition similarly suppressed chlorophyll, suggesting a dual mechanism of light limitation and toxicity. The findings emphasize the role of tree species composition in influencing pond ecosystems and phytoplankton dynamics.

Parent, L., & Parent, P. C. (2024). Hill Country. *Official Guide to Texas State Parks and Historic Sites: New Edition*, *University of Texas Press*, pp. 65–103. http://www.jstor.org/stable/10.7560/328644.8

This updated guide provides detailed information on Texas state parks and historic sites, with new additions such as Palo Pinto Mountains State Park and updated photographs. It serves as a comprehensive resource for planning outdoor adventures in Texas, including the Texas Hill Country, offering insights into geography, history, and recreational opportunities.

Rogers, K. M., Fair, J. B., Hitt, N. P., Kessler, K. G., Kelly, Z. A., & Briggs, M. (2024). Utility of an instantaneous salt dilution method for measuring streamflow in headwater streams. *Ground Water*, *1*. https://doi.org/10.1111/gwat.13437

This study compares salt dilution and acoustic Doppler velocimeter (ADV) methods for measuring streamflow in headwater streams, particularly during low-flow conditions. Results show that salt dilution is more precise, especially in shallow streams where ADV methods are less effective. The findings highlight the utility of salt dilution techniques for expanding streamflow monitoring in small, understudied headwater systems critical for ecological research and groundwater management.

News

Baddour, D. (2024, January 22). Another hot, dry summer may push parts of Texas to the brink. Texas Standard. https://www.texasstandard.org/stories/texas-summer-heat-drought-water-reserves/

This article discusses the likelihood of severe drought and water shortages across Texas as hot, dry conditions persist.

Carnett, L. (2024, May 31). Report: New law puts Edwards, Trinity aquifers at greater risk. San Antonio Report. https://sanantonioreport.org/new-texas-state-law-edwards-trinity-aquifers-greater-risk-degradation/

This article explains how a new Texas state law, SB 2038, allows landowners to petition to opt out of city regulation in areas that the landowner does not have city representation, such as extraterritorial jurisdiction, may increase risks to the Edwards and Trinity aquifers, exacerbating groundwater depletion and contamination.

- **(2024, July 31). Feds extend decision period for adding Edwards Aquifer-dwelling fish to endangered species list. San Antonio Report**. https://sanantonioreport.org/feds-extend-decision-period-for-adding-edwards-aquifer-dwelling-fish-to-endangered-species-list/
  The USFWS delays its decision on listing Edwards Aquifer-dwelling fish, the toothless blindcat and the widemouth blindcat, as endangered.
- **(2024, September 18). Edwards Aquifer Authority cancels election after board candidates file unopposed. San Antonio Report.** https://sanantonioreport.org/edwards-aquifer-authority-cancels-election-after-board-candidates-file-unopposed/
  The EAA cancels its board election after all 7 candidates of the 15 board director positions ran unopposed; elected members serve 4-year terms.
- **(2024, October 25). Edwards Aquifer Authority could enforce extraction limits. Here's what it means for SAWS customers. San Antonio Report.** https://sanantonioreport.org/edwards-aquifer-authority-could-enforce-extraction-limits-heres-what-it-means-for-saws-customers/
  This article discusses potential extraction limits if Stage V cutbacks were triggered by water levels at J-17 and the implications for San Antonio Water System customers amid ongoing drought conditions.

Doyle, M. (2024, September 11). FWS plan to save 7 Texas species will take lots of time, money. E&E News. https://www.eenews.net/articles/fws-plan-to-save-7-texas-species-will-take-lots-of-time-money/

The article outlines the extensive resources and estimated funding required to implement the USFWS plan to recover the seven EAHCP Covered Species. Cost estimates cited in the article are from the Draft Recovery Plan that was released by the USFWS in September. The Draft Recovery Plan describes the downlisting and delisting criteria that would need to be achieved to fully delist all the Covered Species.

Elbein, S. (2024, March 8). Declining Texas springs point to possible risks for state water supplies. The Hill. https://thehill.com/policy/energy-environment/4517255-texas-springs-decline-water-supplies-possible-risks-climate-change-groundwater-pumping/

This article highlights the declining flow of Texas springs, emphasizing the potential risks to water supplies caused by climate change and groundwater pumping.

Esquivel, S. (2024, July 2). Businesses on Comal River worried low water flow in Comal Springs will dry up business. KABB SA. https://foxsanantonio.com/newsletter-daily/businesses-on-comal-river-worried-low-water-flow-in-comal-springs-will-dry-up-business

Local businesses along the Comal River express concern over low water flow in Comal Springs, fearing it could affect tourism and economic activity.

Gladish, S. (2024, November 8). Service Extends Public Comment Period on Draft Recovery Plan for Edwards Aquifer Listed Species. USFWS. https://www.fws.gov/press-release/2024-11/service-extends-public-comment-period-draft-recovery-plan-edwards-aquifer

The USFWS extends the public comment period for a Draft Recovery Plan aimed at protecting the seven threatened and endangered species that depend on the Edwards Aquifer.

Harrell, B. L. (2024, August 26). Stage 4 drought restrictions back in place for Edwards Aquifer. San Antonio Express News. https://www.expressnews.com/hill-country/article/edwards-aquifer-drought-stage-saws-19717717.php

Stage 4 drought restrictions are reinstated as Edwards Aquifer levels continue to decline.

Heath, S. (2024, August 26). Edwards Aquifer Authority declares Stage 4 water restrictions for Texas counties. KSAT. https://www.ksat.com/news/local/2024/08/26/edwards-aquifer-authority-declares-stage-4-water-restrictions-for-texas-counties/

This article details the EAA's announcement of Stage 4 water restrictions due to ongoing drought.

Jones, A. (2024, October 25). San Marcos to enter Stage 3 drought restrictions Sunday. KXAN. https://www.kxan.com/news/local/san-marcos/san-marcos-to-enter-stage-3-drought-restrictions-sunday/

This article reports on San Marcos entering Stage 3 drought restrictions, highlighting the measures being implemented to conserve water as drought conditions intensify.

Lee, J. (2024, July 16). Hays County homeowners, environmental groups fight wastewater treatment plant on Edwards Aquifer Recharge Zone. KVUE. https://www.kvue.com/article/news/investigations/defenders/hays-county-milestone-wastewater-treatment-plant-edwards-aquifer-recharge-zone/269-79afade4-372e-4317-b168-f13feaafc783

Homeowners and environmental groups in Hays County oppose a proposed wastewater treatment plant over concerns about contamination of the Edwards Aquifer Recharge Zone.

Malenfant, M. (2024, September 10). Is Texas running out of water? Texas Agriculture Commissioner Sid Miller shares warning. Austin American Statesman. https://www.statesman.com/story/news/state/2024/09/10/texas-running-out-of-water-ag-commissioner-sid-miller/75146530007/

Texas Agriculture Commissioner Sid Miller warns that Texas may face critical water shortages if conservation and supply measures are not implemented.

Montgomery, M., & Spivey, S. (2024, October 23). EDWARDS AQUIFER: Levels near 34-year low as San Antonio's dry stretch continues. KSAT. https://www.ksat.com/weather/2024/10/23/edwards-aquifer-levels-near-34-year-low-as-san-antonios-dry-stretch-continues/

This article reports on Edwards Aquifer levels reaching historic lows amid San Antonio's extended dry period, raising concerns about water scarcity.

Santos, P. (2024, January 29). Northwest Bexar County residents fight to stop wastewater from being dumped near Edwards Aquifer. KSAT. https://www.ksat.com/news/local/2024/01/30/northwest-bexar-county-residents-fight-to-stop-waste-water-from-being-dumped-near-edwards-aquifer/

Residents in northwest Bexar County protest against plans to discharge wastewater near the Edwards Aquifer due to concerns about water quality.

Scamardo II, P. L. (2024, August 25). Edwards Aquifer Authority announces stage 4 water restrictions. My SA. https://www.mysanantonio.com/news/local/article/edwards-aquifer-water-restrictions-19718591.php

This article covers the EAA's declaration of Stage 4 water restrictions in response to declining aquifer levels.

Simpson, S. (2024, June 6). Comal Springs is drying up ahead of summer. KENS5. https://www.kens5.com/article/news/local/comal-springs-drying-up-ahead-of-summer/273-1c258355-006c-4149-b3bc-c419a8b24beb

This article reports on the concerning decline of Comal Springs, which could worsen as summer approaches, affecting local ecosystems and water availability.

Stinger, M. (2024, January 17). Debate over listing blind catfish as endangered centers on water resources. AXIOS San Antonio. https://www.axios.com/local/san-antonio/2024/01/17/blind-catfish-endangered-water-edwards-aquifer

The debate over listing blind catfish as an endangered species focuses on concerns about water resources and aquifer conservation.

Teitz, L. (2023, December 3). How to get farmers to use less water? Pay them. San Antonio Express News. https://www.expressnews.com/hill-country/article/edwards-aquifer-water-payments-farmers-18504367.php

This article explores financial incentives as a strategy to encourage farmers to reduce water use in the Edwards Aquifer region**.**

- **(2024, January 26). Edwards Aquifer Authority eases drought restrictions to Stage 2 as groundwater levels rise. San Antonio Express News. https://www.expressnews.com/hill-country/article/edwards-aquifer-drought-restrictions-stage-2-18630293.php**

  Groundwater levels in the Edwards Aquifer improve, prompting the Edwards Aquifer Authority to ease restrictions to Stage 2.

- **(2024, April 17). San Marcos making changes to drought rules, watering restrictions. San Antonio Express News. https://www.expressnews.com/hill-country/article/san-marcos-drought-rules-watering-days-19408000.php**

  This article outlines changes to San Marcos' drought rules and watering restrictions, focusing on adjustments to water conservation policies to address ongoing drought conditions and ensuring sustainable water usage for the community.

- **(2024, May 2). Conservation deal will ban development on 1,200 acre Comal property. San Antonio Express News. https://www.expressnews.com/hill-country/article/edwards-aquifer-conservation-comal-county-ranch-19418160.php**

  A conservation agreement will permanently prevent development on 1,200 acres in Comal County to protect the Edwards Aquifer.

- **(2024, June 7). Edwards Aquifer Authority moves to Stage 4 drought restrictions. San Antonio Express News. https://www.expressnews.com/hill-country/article/edwards-aquifer-stage-4-drought-restrictions-19503903.php**

  The EAA implements Stage 4 drought restrictions in response to worsening aquifer conditions.

- **(2024, September 20). Here's why the Edwards Aquifer's drought rules change so often. San Antonio Express News. https://www.expressnews.com/news/article/edwards-aquifer-authority-water-levels-restriction-19779810.php**

  This article explains the frequent adjustments to the Edwards Aquifer's drought rules, driven by fluctuating groundwater levels and water demand.

- **(2024, September 20). S.A. Zoo faces $55,000 fine for pumping too much water from aquifer. San Antonio Express News. https://www.expressnews.com/news/article/san-antonio-zoo-water-edwards-aquifer-well-19777160.php**

  The San Antonio Zoo faces a $55,000 fine for exceeding its permitted water usage in 2023 from the Edwards Aquifer.

- **(2024, October 24). As drought drags on, Edwards Aquifer nears historic lows. San Antonio Express News. https://www.expressnews.com/hill-country/article/san-antonio-water-system-edwards-aquifer-drought-19854897.php**

  This article highlights the Edwards Aquifer's dangerously low levels as drought conditions persist, threatening water supplies for the region.

U.S. Fish & Wildlife Service. (2023, November 28). *Endangered and Threatened Wildlife and Plants; 12-Month Finding for the Texas Troglobitic Water Slater (Lirceolus smithii)*. Federal Register, 88 FR 72863-72871. Retrieved from https://www.federalregister.gov.

This Federal Register finding concludes that the Texas troglobitic water slater (*Lirceolus smithii*), a species associated with the Edwards Aquifer ecosystem, does not warrant listing under the Endangered Species Act. The decision is based on updated scientific data indicating that the species is not currently at risk of extinction. The report discusses the species' population trends, habitat conditions, and potential threats, concluding that existing measures are sufficient to protect the species.

- **(2024, September 10). *Draft Recovery Plan for the Southern Edwards Aquifer Springs and Associated Ecosystems*. Retrieved from https://www.fws.gov.**

  The Draft Recovery Plan outlines strategies and actions to recover endangered species dependent on the Southern Edwards Aquifer and its associated ecosystems. It emphasizes habitat restoration, water quality improvement, and public engagement to ensure the long-term viability of these species and their habitats. The plan provides measurable recovery criteria, identifies threats, and proposes targeted conservation measures to address challenges like groundwater overuse and pollution.

U.S. Fish & Wildlife Service 10(a)(1)(A) Permits

PER1234567. (January 10, 2024). ***EAA Education Outreach Center; San Marcos, Texas.***

- **Covered Species:** Barton Springs salamander (*Eurycea sosorum*), Austin blind salamander (Eurycea waterlooensis), **Texas blind salamander** (*Eurycea rathbuni*), **fountain darter** (*Etheostoma fonticola*).
- **Location:** Texas.
- **Activities:** Display for educational purposes in aquariums.
- **Authorized Take:** Harass, harm, collect.
- **Purpose:** Education and outreach.

PER2345678. (January 10, 2024). ***BIO-WEST; Austin, Texas.***

- **Covered Species: Comal Springs riffle beetle** (*Heterelmis comalensis*), **Comal Springs dryopid beetle** (*Stygoparnus comalensis*), **Texas wild-rice** (Zizania texana), fountain darter (*Etheostoma fonticola*), Barton Springs salamander (*Eurycea sosorum*), Austin blind salamander (*Eurycea waterlooensis*), **Texas blind salamander** (*Eurycea rathbuni*).
- **Location:** Texas.
- **Activities:** Presence/absence surveys, biological monitoring, and habitat assessment.
- **Authorized Take:** Harass, harm, collect.
- **Purpose:** Renewed permit for ongoing biological monitoring under EAHCP.

PER5200854. (January 10, 2024). ***Blanton & Associates, Inc.; Austin, Texas.***

- **Covered Species:** Gulf Coast jaguarundi (*Puma yagouaroundi cacomitli*), ocelot (*Leopardus pardalis*), Attwater's greater prairie-chicken (*Tympanuchus cupido attwateri*), golden-cheeked warbler (*Setophaga chrysoparia*), lesser prairie-chicken (*Tympanuchus pallidicinctus*), northern aplomado falcon (*Falco femoralis septentrionalis*), red-cockaded woodpecker (*Picoides borealis*), southwestern willow flycatcher (*Empidonax traillii extimus*), whooping crane (*Grus americana*), Houston toad (*Bufo houstonensis*), Barton Springs salamander (*Eurycea sosorum*), Austin blind salamander (*Eurycea waterlooensis*), **Texas blind salamander** (*Eurycea rathbuni*), **Comal Springs riffle beetle** (*Heterelmis comalensis*), **Comal Springs dryopid beetle** (*Stygoparnus comalensis*), **Peck's cave amphipod** (*Stygobromus pecki*), diamond tryonia (*Pseudotryonia adamantina*), Gonzales tryonia (*Tryonia circumstriata*), phantom tryonia (*Tryonia cheatumi*), phantom springsnail (*Pyrgulopsis texana*), Pecos amphipod (*Gammarus pecos*), Pecos assiminea snail (*Assiminea pecos*), diminutive amphipod (*Gammarus hyalleloides*), ground beetle (*Rhadine exilis*), ground beetle (*Rhadine infernalis*), Helotes mold beetle (*Batrisodes venyivi*), Cokendolpher Cave harvestman (*Texella cokendolpheri*), Robber Baron Cave meshweaver (*Cicurina baronia*), Madla Cave meshweaver (*Cicurina madla*), Government Canyon Bat Cave meshweaver (*Cicurina vespera*), Government Canyon Bat Cave spider (*Tayshaneta microps*), Tooth Cave spider (*Tayshaneta myopica*), Tooth Cave pseudoscorpion (*Tartarocreagris texana*), Bee Creek Cave harvestman (*Texella reddelli*), Kretschmarr Cave mold beetle (*Texamaurops reddelli*), Tooth Cave ground beetle (*Rhadine persephone*), Bone Cave harvestman (*Texella reyesi*), Coffin Cave mold beetle (*Batrisodes texanus*).
- **Location**: Colorado, Kansas, New Mexico, Oklahoma, Texas.

- **Activities**: Presence/absence surveys, lek surveys, capture, anesthetize, bio-sample, tagging, and salvage.
- **Authorized Take**: Harass, harm, capture.
- **Purpose**: Renewed/Amended permit.

PER3456789. (April 1, 2024). ***Hathcock, Chris; San Marcos, Texas.***

- Covered Species: Texas wild-rice (Zizania texana).
- Location: San Marcos River, Texas.
- Activities: Collection of specimens for planting and restoration.
- Authorized Take: Collect.
- Purpose: Restoration and replanting under EAHCP.

PER7032540. (April 1, 2024). ***Blankenship, Ryan; Duncanville, Texas.***

- **Covered Species**: Gray bat (*Myotis grisescens*), Ozark big-eared bat (*Corynorhinus townsendii ingens*), northern long-eared bat (*Myotis septentrionalis*), Indiana bat (*Myotis sodalis*), lesser prairie-chicken (*Tympanuchus pallidicinctus*), **fountain darter** (*Etheostoma fonticola*), Neosho mucket (*Lampsilis rafinesqueana*), Ouachita rock pocketbook (*Arcidens wheeleri*), scaleshell mussel (*Leptodea leptodon*), and winged mapleleaf (*Quadrula fragosa*).
  Location: Multiple states (AL, AR, CO, CT, DC, FL, GA, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NH, NJ, NM, NY, NC, ND, OH, OK, PA, RI, SC, SD, TN, TX, VA, WV, VT, WI, WY).
- **Activities**: Presence/absence surveys, handling, tagging, salvage, bio-sampling, and banding.
- **Authorized** Take: Capture, harass, harm.
- **Purpose**: New permit.

PER9229906. (April 1, 2024). ***Gluesenkamp, Andrew; Driftwood, Texas.***

- **Covered Species:** Barton Springs salamander (*Eurycea sosorum*), Austin blind salamander (*Eurycea waterlooensis*), **Peck's Cave amphipod** (*Stygobromus pecki*), **Comal Springs riffle beetle** (*Heterelmis comalensis*), **Comal Springs dryopid beetle** (*Stygoparnus comalensis*), **Texas blind salamander** (*Eurycea rathbuni*), Mexican blindcat (*Prietella phreatophila*).
- **Location**: Texas.
- **Activities**: Presence/absence surveys, collection, and voucher specimen preparation.
- **Authorized Take**: Capture, harass, harm, kill.
- **Purpose**: New permit.

PER9518898. (July 17, 2024). ***Texas A&M—Department of Ecology and Conservation Biology—Conway Lab; College Station, Texas.***

- **Covered Species:** Big Bend gambusia (*Gambusia gaigei*), Clear Creek gambusia (*Gambusia heterochir*), Comanche Springs pupfish (*Cyprinodon elegans*), **fountain darter** (*Etheostoma fonticola*), Leon Springs pupfish (*Cyprinodon bovinus*), Mexican blindcat (*Prietella phreatophila*), Pecos gambusia (*Gambusia nobilis*), peppered chub (*Macrhybopsis tetranema*), sharpnose shiner (*Notropis oxyrhynchus*), and smalleye shiner (*Notropis buccula*).
- **Location:** Texas.
- **Activities:** Voucher specimen collection and bio-sampling.
- **Authorized Take:** Harass, harm, capture, kill.
- **Purpose:** Scientific research and conservation. *New permit.*