Appendix N | **Literature Review—List of Relevant Articles and Reports Completed since the 2022 Annual Report**

Covered Species Literature

- **Adcock, Z.C., M.E. Adcock, and M.R.J. Forstner. 2023. Development and Validation of an Environmental DNA Assay to Detect Federally Threatened Groundwater Salamanders in Central Texas. *PLoS ONE* 18(7):1–21. doi:10.1371/journal.pone.0288282.**

  This study developed and validated an environmental DNA (eDNA) assay, employing quantitative PCR, for three federally threatened Eurycea *salamander species (E. chisholmensis, E. naufragia, and E. tonkawae) in the northern segment of the Edwards Aquifer in Central Texas. The assay demonstrated specificity, sensitivity, and correlation with salamander density at field sites. The research suggests potential applications in formal survey protocols for these salamander species, acknowledging the need for further refinement and consideration of site-specific variations in eDNA evaluation.*

- **Dobbins, B.A., D.M. Moore, and R.U. Tovar. 2023. *Eurycea Rathbuni*. *Herpetological Review* 54(2):237–238.**

  This article investigated cannibalism observed in Eurycea rathbuni within the Edwards Aquifer in West-Central Texas as a strategy for survival in the extreme habitat.

- **Edwards, C.R., and T.H. Bonner. 2022. Vegetation Associations of the Endangered Fountain Darter *Etheostoma fonticola*. *Endangered Species Research* 47:1–13.**

  This study quantified fountain darter occurrences and abundances among vegetated habitats using the concept of obligate and facultative habitat use. Fountain darters occurred in vegetation more than expected among wadeable and non-wadeable habitats in the majority of reaches within the San Marcos and Comal rivers. They were positively associated with bryophytes and negatively associated with Texas wild-rice, but associations with other vegetation taxa varied by river and were possibly influenced by other variables.

- **Kuczek, A. and A. White. 2023. Examining Threats to Cryptic Cave Salamanders in Central Texas to Petition for their Protection. Master's project. Duke University, Durham, North Carolina.**

  In this article, researchers conducted a twofold analysis in geospatial and statistical contexts to assemble a species distribution model and rank variables by importance to 14 Eurycea *species. The analyses support that* Eurycea *are found where they are due to evolutionary processes rather than habitat selection methods. Protection by the Save Our Spring (SOS) Alliance should thus seek to conserve individual habitats to avoid local extinctions.*

- **Nair, P., J.R. Gibson, B.F. Schwartz, and W.H. Nowlin. 2023. Temperature Responses Vary between Riffle Beetles from Contrasting Aquatic Environments. *Journal of Thermal Biology* 112.**

  This research article examined the effects of elevated temperatures on four riffle beetle species native to central and west Texas, including Heterelmis comalensis*. The results indicate that the spring-associated* H. comalensis *is most sensitive to elevated temperatures while the more cosmopolitan* Microcylloepus pusillus *is least sensitive. The findings contribute insights into the environmental tolerance of invertebrates in spring habitats.*

- **Pustka, L. 2023. *Relative Contributions of Ecological and Spatial Factors to Genetic Variation among Hyporheic Populations of* Lirceolus *spp. across Central and Southwest Texas*. Unpublished thesis. Texas State University, San Marcos, Texas.**

  This study focused on the groundwater obligate isopod genus Lirceolus *in central Texas, utilizing a combination of morphology and population genomic data to investigate population structure, connectivity, and the congruence of nominal taxonomy with genomic information. Despite historically identifying six species within Texas, the study revealed deep divergences within the genus, suggesting a complex evolutionary history with distinct lineages that do not align neatly with nominal taxonomy.*

- **Sparks, K. 2023. *Distribution and Occurrence of Stygobionts in Hyporeheic Systems Downstream of Karst Regions.* Unpublished thesis. Texas State University, San Marcos, Texas.**

  This study aimed to determine whether non-karst alluvial sites in the San Marcos River could host stygobionts and how their abundance and diversity were related to the distance from karst. The researcher collected 55 hyporheic invertebrate samples from 11 non-karst alluvial sites and measured environmental parameters such as temperature, dissolved oxygen, pH, specific conductivity, and hydraulic conductivity. The findings indicated that stygobiont abundance and diversity were significantly influenced by hydraulic conductivity, dissolved oxygen, and distance from karst. The study expanded the known ranges of several uncommon stygobionts and highlighted the importance of evaluating alluvial habitats downstream from karst systems for the presence and abundance of stygobionts, especially for species of conservation concern.

- **Wolter, W. 2023. *The Use of Biomonitoring Data to Inform Species Distributions, Habitat Associations, and Threats*. Unpublished thesis. Texas State University, San Marcos, Texas.**

  This study assessed a biomonitoring program spanning 2014–2022, focusing on the federally endangered fountain darter in the upper reaches of the San Marcos and Comal rivers. Key findings include spatial and temporal variations in fountain darter densities, with higher densities in upper reaches and fluctuating trends. Flow levels had minimal impact, while non-wadeable reaches with high instream recreation showed lower densities. The study established density thresholds for communicating population health, offering insights for future biomonitoring.

Conservation Biology Relevant Literature

- **Arend, W.A., R.D. Mangold, C.L. Riggins, C. Garoutte, Y. Rodriguez, T.C. Heard, N. Menchaca, J. Williamson, D. McDonald, D. Daugherty, M. McGarrity, K.W. Conway, and J.S. Perkin. 2023. Sexual Dimorphism in an Invasive Population of Suckermouth Armored Catfish: Implications for Management. *North American Journal of Fisheries Management*.**

  *This research article investigated sexual dimorphism and population sex ratios for an invasive armored catfish (*Hypostomus *sp.) in the upper San Marcos River as a means of advancing on-going management of the population. Morphometrics based on dorsal- and anal-fin sizes can be used to infer sex externally from hundreds of catfish removed per year to evaluate long-term population management success.*

- **Chappell, L. 2023. *Hydrology and Geology as Structuring Mechanisms of Semi-arid Fish Communities.* Unpublished thesis. Texas State University, San Marcos, Texas.**

  This study investigated the impact of hydrological periods on fish communities and habitats in the semi-arid Edwards Plateau. Focusing on spring-associated fishes, the research explores longitudinal and geological gradients during a Wet Hydrological Period (2015–2016) and a Dry Hydrological Period (2021–2022) across three river systems (Nueces, Sabinal, and Frio). Results reveal distinct habitat variations and fish community dynamics, emphasizing the resilience of spring-associated species even in losing reaches during exceptional drought conditions. The findings challenge previous interpretations and underscore the conservation value of losing reaches as refugia for endemic fauna in the Edwards Plateau.

- **Di Lorenzo, T., M. Avramov, D.M.P. Galassi, S. Iepure, S. Mammola, A.S.P. Reboleira, and F. Hervant. 2023. Physiological Tolerance and Ecotoxicological Constraints of Groundwater Fauna. In *Groundwater Ecology and Evolution* (pp. 457–479). Academic Press.**

  This chapter explores the physiological tolerance of groundwater species to human-induced stress, encompassing temperature changes, chemical and other environmental contamination, and changes in environmental conditions in a laboratory setting.

- **Guadalupe-Blanco River Authority. 2023. *Technical Memorandum: Assessment of Wastewater Treatment Facility and Their Potential to Impact* Eurycea *Salamander Habitat*.**

  For this assessment, researchers analyzed seven wastewater treatment facilities and Eurycea *salamander locations, flow paths, water quantity, and water quality. The intent was to assess whether effluent discharge could impact salamanders. The results suggest that the potential for effluent from the seven facilities is unlikely to result in take of* Eurycea *salamanders.*

- **Hillis, D.M. 2023. *Armadillos to Ziziphus: A Naturalist in the Texas Hill Country*. University of Texas Press.**

  This book is a collection of essays and photos showcasing the ecology, biodiversity, and restoration of the Texas Hill Country.

- **Kankanamge Epa, U.P., and A.S. Premarathna. 2023. Use of Ethanol (95%) Extract of *Anacardium occidentale* (Linnaeus 1753) to control *Centrocestus formosanus* (Nishigori 1924) Infection in *Xiphophorus hellerii* (Heckel 1848). *International Journal of Aquatic Biology* 11(1):1–10.**

  This study investigates the effectiveness of a 95 percent ethanol extract from Anacardium occidentale *(cashew apple) in controlling* Centrocestus formosanus*, a parasitic trematode affecting aquarium fish. The research demonstrates that the plant extract significantly reduces mortality and parasitic intensity in infected* Xiphophorus hellerii *fish. The findings suggest that* A. occidentale *apple extract, particularly at concentrations around 340 mg/L, can be an effective control measure for* C. formosanus *infections in aquarium fish, potentially offering a sustainable solution for fish farmers worldwide.*

- **Kolisi, S., S. Motitsoe, M. Mlambo, and T. Zengeya. 2023. Predicting the Global Spread of Two Aggressive *Thiaridae* Invaders Using Ensemble Models. Presentation Abstract from *International Researchers Conference on Invasive Species*, pp. 58–59.**

This study focuses on the invasive gastropods Tarebia granifera *and* Melanoides tuberculata*, originating from southeast Asia and Africa, respectively. The research uses Species Distribution Models to predict the potential range expansion of these invasive snails worldwide, emphasizing the role of temperature in their successful spread. The results provide valuable insights for early detection, risk assessment, and prioritizing management efforts to control the global spread of these invasive species.*

- **Maroti, A., and J.T. Hutchinson. 2023. Evaluating the Suppression of *Hydrilla verticillata* by Manual Removal and Planting an Endangered and Common Native Aquatic Plant for Small-Scale Restoration Efforts in a Spring-Fed River. Texas Parks and Wildlife Department.**

  This study examined the ability of two native species (Texas wild-rice and water stargrass) to suppress hydrilla in the San Marcos River in plots where variable ranges of hydrilla were removed (0–100 percent). They found no evidence that either species gained a competitive advantage over hydrilla unless 100 percent of hydrilla was removed. The results of the study did indicate that hydrilla coverage was highest in plots where 100 percent of the hydrilla was removed at the start of the study, indicating the species has an ability to quickly invade a disturbed site.

- **Metz, D.C., A.V. Turner, A.P. Nelson, and R.F. Hechinger. 2023. Potential for Emergence of Foodborne Trematodiases Transmitted by an Introduced Snail (*Melanoides tuberculata*) in California and Elsewhere in the United States. *The Journal of Infectious Diseases* 227(2):183–192.**

  *This study reveals the widespread presence of three human-infectious trematodes, along with their introduced first intermediate host snail (*Melanoides tuberculata*), in southern California. Among the identified parasites,* Haplorchis pumilio *and* Centrocestus formosanus *are recognized as significant human pathogens, while the third,* Philophthalmus gralli*, poses a risk of eye infection in humans. The findings underscore the importance of considering the public health implications of the introduced snail and its associated parasites, emphasizing the potential for additional pathogenic trematodes to be introduced to the United States through this snail, particularly in regions where it has been introduced.*

- **Moscovitz, S., H. Glassner, R.M. Wokam Njomgang, E. Aflalo, O. Ovadia, and A. Sagi. Community Composition of Invasive, Eruptive, and Non-Pest Snails Species Along a Source Spring-to-Fishpond Gradient in a Spatially Structured Aquacultural Region. *Journal of Environmental Management* 351.**

  This study conducted in northern Israel, focuses on the interaction between agricultural lands, aquaculture, and natural areas, specifically addressing the issue of pest snails in fishponds. The invasive and outbreak-endemic snail species in the region (including Melanoides tuberculata*) are known carriers of fish diseases. The findings reveal a significant increase in pest snail abundances upstream towards the springs, indicating active invasion.*

- **Musgrove, M., B.C. Jurgens, and S.P. Opsahl. 2023. Karst Groundwater Vulnerability Determined by Modeled Age and Residence Time Tracers. *Geophysical Research Letters* 50(18):1–10. doi:10.1029/2023GL102853.**

  Using environmental age tracers, the research assesses the susceptibility of the aquifer to land-surface contamination, considering the unique hydrogeologic features of karst aquifers. Despite the complexities of karst hydrogeology, the vulnerability patterns of the Edwards Aquifer resemble those of porous-media

aquifers, with shallow and unconfined areas being more susceptible to contamination compared to deeper and confined regions. The findings contribute to understanding groundwater contamination risks in karst aquifers globally, emphasizing the importance of considering both hydrogeologic characteristics and age tracers in vulnerability assessments.

- **Perez, K.E., Y. Guerrero, R. Castañeda, P.H. Diaz, R. Gibson, B. Schwartz, and B.T. Hutchins. 2023. Two New Phreatic Snails (*Mollusca, Caenogastropoda, Cochliopidae*) from the Edwards and Edwards-Trinity aquifers, Texas. *Subterranean Biology* 47:1–27.**

  This study introduces a new genus and two cavesnail species from Central Texas, utilizing an integrated taxonomic approach. Vitropyrgus lillianae *gen. et sp. nov., found in Comal Springs and Fessenden Springs (Kerr County), displays a glassy, intricately sculptured shell and distinct penial morphology.* Phreatodrobia bulla *sp. nov., identified in Hidden Springs (Bell County), features a smooth teleoconch, flared lip, and concave operculum.*

- **Rogowski, D.L. 2023. Aquatic Mollusc Control through Desiccation: It Is Not the Amount of Time Out of Water, It Is the Amount of Water Out of the Mollusc. *Hydrobiologia* 1–10.**

  *This study presents a practical method for assessing the desiccation tolerance of invasive molluscs, specifically focusing on the red-rimmed melania (*Melanoides tuberculata*) and the quilted melania (*Tarebia granifera*). Unlike traditional constant humidity studies, this approach involves measuring water loss over time, offering a more realistic representation of natural environmental conditions. By establishing a correlation between length–weight relationship and desiccation tolerance, the study calculates the predicted desiccated weight associated with 95 percent mortality. This methodology, applicable across various invasive organisms, provides a valuable tool for control measures independent of temperature or humidity fluctuations.*

- **Ruthsatz, K., R. Rico-Millan, P.C. Eterovick, and I. Gomez-Mestre. 2023. Exploring Water-Borne Corticosterone Collection as a Non-Invasive Tool in Amphibian Conservation Physiology: Benefits, Limitations and Future Perspectives. *Conservation Physiology* 11(1).**

  *This study addresses the global biodiversity crisis, focusing on amphibian population declines as a key indicator of environmental stressors. The research introduces water-borne corticosterone (CORT) as a non-invasive method to assess physiological stress in amphibians, specifically in the common frog (*Rana temporaria*) larvae. The findings demonstrate the validity of water-borne CORT sampling as a promising tool for studying late-stage amphibian larvae, although the study highlights the importance of considering contextual factors that may influence the reliability of this method.*

- **Simbo, C.W. 2023. Hydrogeochemical Evaluation of Aquifer Storage and Recovery in Edwards Aquifer, New Braunfels, Texas. *Ground Water*: 1. doi:10.1111/gwat.13372.**

  This research investigates the feasibility of aquifer storage and recovery (ASR) in the brackish section of the Edwards Aquifer in New Braunfels, Texas, focusing on hydraulic properties, aquifer heterogeneity, and geochemical processes. The study explores the chemistries of native groundwater and injectant during ASR operations, estimating aquifer layer hydraulic properties and assessing recovery rates for groundwater meeting total dissolved solids thresholds. The findings reveal hydrochemical facies shifts during ASR operations, suggesting potential connections between formations and preferential pathways in the targeted

storage zone aquifer. The study underscores the importance of understanding hydrogeological conditions and geochemical processes for successful ASR implementation in brackish carbonate multi-aquifer fractured systems.

- **Tivin, J. 2023. Effects of Extreme Flow Events on Community Composition and Habitat Complexity of Groundwater Dominated Systems. Unpublished thesis. Texas State University, San Marcos, Texas.**

  The purpose of this study was to assess how extreme flow events affect habitat complexity and the fish community within the San Marcos and Comal rivers using a 9-year dataset. Results indicate that habitat complexity in hydrologically stable rivers support greater densities and diversity of fishes to hydrologically variable rivers, but habitat complexity and fish community were more resistant and resilient to extreme flow events in stable rivers than in variable rivers.

- **Votteler, T.H. 2023. Hands across the Water: How the 57-Year Dispute over the Edwards Aquifer Began, Persisted, and Was Resolved. *Water* 20734441 15(10):1835.**

  This article summarizes the historical water dispute and subsequent governance initiatives related to the Edwards Aquifer, a crucial water source in south-central Texas. Originating from the 1956 drought, the conflict led to the creation of the Edwards Aquifer Authority in 1993, tasked with regulating groundwater withdrawals. In 2007, legislative intervention mandated a collaborative stakeholder process resulting in the Edwards Aquifer Habitat Conservation Plan (EAHCP). The EAHCP exemplifies successful collaboration among diverse stakeholders addressing water management and environmental conservation challenges.

- **Yang, C., and F.P. Bertetti. 2023. Climate Elasticity Assessment on Groundwater Recharge to the Edwards Balcones Fault Zone Aquifer, United States*. Journal of the American Water Resources Association* 59(6):1273–1286. doi:10.1111/1752-1688.13142.**

  This study analyzed precipitation, temperature, and groundwater recharge characteristics in the recharge zone of the San Antonio segment of the Edwards Balcones Fault Zone Aquifer. Spanning from 1895 to 2019 for precipitation and temperature and 1934 to 2019 for groundwater recharge, the research examined decadal variability. Climate elasticity estimates suggested that a 1 percent change in annual precipitation could result in a 2 percent change in groundwater recharge, providing an alternative approach for assessing climate impacts on aquifer recharge.

Other Relevant Literature

- **Acosta-Pérez, J., J. De-la-Rosa-Arana, V. Vega-Sánchez, N. Reyes-Rodríguez, A. Zepeda-Velázquez, and F. Gómez-De-Anda. 2023. Tilapia, High Socio-Economic Cichlid Fish, as Host of Trematode Parasites with Zoonotic Potential. *Abanico veterinario* 13.**

  This work conducted a bibliographic review on the prevalence, distribution, and hosts involved in the life cycle of trematode helminths with potential zoonotic transmission in tilapia consumption. The review, based on analysis of 1,044 articles, identified tilapia as the intermediate host for 15 species of trematodes affecting humans, with six parasites at the genus level and two at the family level.

- **Barclay, M.V.L., and P. Bouchard. 2023. Beetles of the World: A Natural History. Princeton University Press.**

  This book provides concise accounts of all major families of beetles (including Heterelmis *spp.).*

- **Benavides, J.A., J. Karges, K.B. Mayes, H.S. Rifai, and C.V. Castro. 2023. Gulf Coast Rivers of the Southwestern United States. In *Rivers of North America* (pp. 176–224). Academic Press.**

  This book chapter summarizes the key characteristics and features of Gulf Coast rivers (including the San Marcos River) in the southwestern United States, examining distinct physiological and ecological attributes shaped by temperature and precipitation gradients.

- **Gonzalez, I. 2023. Remember the Swimming Pigs! Interpreting the Dwindling Remains of Aquarena Springs. Unpublished thesis. Texas State University, San Marcos, Texas.**

  This historical account traces the significance of San Marcos Springs over 10,000 years. The study emphasizes the underrepresentation of certain historical periods, notably the mid-20th-century Aquarena Springs amusement park, which—despite being a major attraction with national impact—is insufficiently preserved and interpreted by the university managing the site.

- **Jerstad, R. 2023. Comal River Watershed Data Report. Guadalupe-Blanco River Authority.**

  This summary by Guadalupe-Blanco River Authority outlines the response of the City of New Braunfels to the escalating litter pollution caused by the high recreational use of the Comal River for tubing. New Braunfels enacted an ordinance prohibiting single-use food and beverage containers on the river. To address bacterial impairments in Dry Comal Creek and the lower Comal River since 2010 and 2016, respectively, the City secured Clean Water Act 319 funding in 2014 to develop a Watershed Protection Plan (WPP). The WPP aimed for a 50 percent reduction in bacteria loading on the Comal River and a 34 percent reduction on Dry Comal Creek based on load duration curves. A bacterial source tracking study revealed wildlife as the primary source of bacteria, with additional contributions from livestock, pets, and humans. Following the study, the City of New Braunfels implemented various best management practices, including a wildlife feeding ban, educational campaigns on pet waste removal, and targeted removal of wildlife feces near the river.

- **Lobato-de Magalhães, T., K. Murphy, A. Efremov, T.A. Davidson, E. Molina-Navarro, K.A. Wood, J. Tapia-Grimaldo, D. Hofstra, H. Fu, and I. Ortegón-Aznar. 2023. How on Earth Did that Get There? Natural and Human Vectors of Aquatic Macrophyte Global Distribution. *Hydrobiologia 850*(7): 1515–1542.**

  This article analyzed current macrophyte species distributions in relation to a set of human-related and natural vectors to assess the hypothesis that natural rather than human-related transfer vectors act as the primary long-distance drivers of global movement of aquatic macrophytes. Results indicate that although natural transport vectors (e.g., birds) are predominant in facilitating long-distance movement of macrophyte species, human interference occurring since the 15th century has played a substantial role in altering the world distribution of macrophyte species.

- **Lopez, C.W., M.T. Wade, and J.P. Julian. 2023. Nature–Human Relational Models in a Riverine Social–Ecological System: San Marcos River, TX, USA. *Geographies 3*(2):197–245.**

  This study explored the diverse environmental values shaping nature–human relationships in the San Marcos River by applying relational models to different visitor and stakeholder groups. Analyzing responses from 3,145 participants, the research identifies predominant relational models such as stewardship (59 percent), utilization (34 percent), and wardship (6 percent), highlighting the complexity of nature–human interactions beyond traditional ecosystem service frameworks and dualistic valuations. The findings emphasize a common preference among respondents to protect the natural habitat, water quality, and the river's aquifer water source, contributing to a more holistic understanding of environmental valuation.

- **Moghadam, S.V., A. Jafarzadeh, M. Akanksha, S. Dessouky, J. Hutchinson, and V. Kapoor. 2023. Water Quality Performance Assessment of Two Stormwater Detention Basins Located in the Recharge Zone of a Karst Aquifer. *Chemosphere* 339:N.PAG. doi:10.1016/j.chemosphere.2023.139772.**

  This study assesses the water quality and hydrologic performance of stormwater detention basins, specifically the Kyle and TPC basins, situated in the recharge zone of the Edwards Aquifer in San Antonio, Texas. Over a 1-year period, automated sampling during storm events measured various water quality parameters. Both basins demonstrated significant reductions in ammonia, total suspended solids, and chemical oxygen demand, while nitrate and phosphorus concentrations exhibited a net export. TPC showed greater reductions in specific parameters compared to Kyle, highlighting the importance of basin design and characteristics. The study underscores the effectiveness of these basins in removing particulate pollutants but also emphasizes their potential as sources of dissolved pollutants, particularly nitrate, with implications for the operation and maintenance of stormwater basins in karst aquifer recharge zones.

- **Plasynski, J., and E. Keleske. 2023. *The Cost to Comply: Habitat Conservation Plans under the Endangered Species Act*. Unpublished thesis. Duke University, Durham, North Carolina.**

  This project examined the costs associated with habitat conservation plans (HCPs) under the Endangered Species Act (ESA), particularly focusing on the pre-implementation and implementation expenses incurred by non-federal stakeholders, such as EPRI (Electric Power Research Institute). Through interviews and research, the study aimed to estimate these costs and streamline future data collection. This project contributes valuable insights for informing policy recommendations and enhancing understanding of ESA compliance costs.

- **Worsham, M.L., A. Bond, J.R. Gibson, and D.G. Huffman. 2023. Biogeography of Selected Spring Endemics in Texas Interglacial-drought Refugia with Unexpected Insights from a Spring-dependent Nematode Parasite. *Hydrobiology* 2(1):97–133.**

  This study examines the distribution of crenobiontic endemics in central Texas, investigating factors influencing habitat occupancy. Utilizing intermediate host distribution, geological records, lab experiments, and museum specimens, the research attributes the current distribution of central Texas crenobionts to the impact of severe droughts since the Wisconsin glaciations.