Report
HIGHLIGHTS
December 2016

Review of the Edwards Aquifer Habitat Conservation Program: Report 2

Responding to advice provided in a 2015 report from the National Academies, the Edwards Aquifer Authority has made several improvements to its 15-year Habitat Conservation Plan, the goal of which is to protect endangered species while supporting water needs in the region. This new report finds that good progress has been made in ecological modeling, in biological and water quality monitoring, and in implementation of the plan's minimization and mitigation measures. Areas for continued improvement are identified, including a recommendation to validate and improve hydrologic models by testing them against the 2011 to 2015 period, which includes both very dry and wet years.

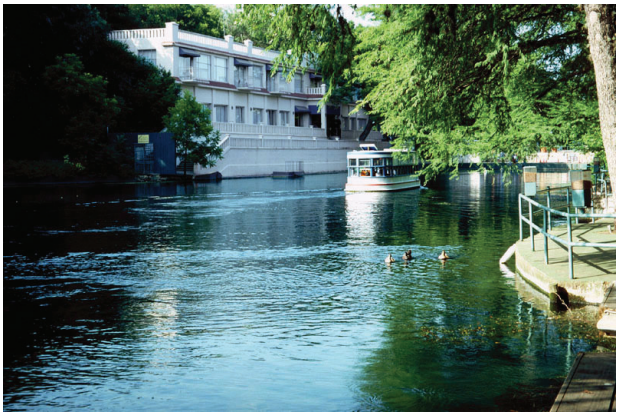

Photo and caption courtesy of Gregg Eckhardt

One of the greatest outflows from the Edwards Aquifer is the San Marcos Springs, which today lie at the bottom of Spring Lake and are viewed through the floor of glass-bottomed boats. The Springs and the short 3.8 mile San Marcos River below them have been designated as critical habitat for five listed species: the Fountain Darter, the Texas Blind Salamander, the San Marcos Salamander, the San Marcos gambusia, and Texas Wild Rice.

The Edwards Aquifer in south-central Texas is the primary source of drinking water for over 2.3 million people in San Antonio and its surrounding communities, and it supplies irrigation water to thousands of farmers and livestock operators in the region. Aquifer waters also supply two large spring systems that are home to fish, amphibians, insects, and plants found nowhere else in the world.

Underlain by porous, permeable limestone rock known as "karst," large volumes of water can move through the Edwards Aquifer's fractures, conduits, and cavities in just days. As a result the aquifer responds quickly to both rainfall events and to drought and pumping. Because periodic droughts can dramatically reduce stream flow, eight of the region's species are listed as threatened or endangered under the federal Endangered Species Act: the fountain darter, the San Marcos gambusia (presumed extinct), the Texas blind salamander, the San Marcos salamander, the Comal Springs dryopid beetle, the Comal Springs riffle beetle, the Peck's Cave amphipod, and Texas wild rice.

To protect the listed species, The Edwards Aquifer Authority (EAA) and four other entities created a 15-year Habitat Conservation Plan (HCP), which outlines a broad array of programs designed to help maintain the endangered species while managing withdrawals from the aquifer. This report is the second of a three-phase study to provide advice to the EAA on various scientific aspects of the HCP, including progress made since the first report from the National Academies (the 2015 report).

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HYDROLOGICAL MODELING

The groundwater model of the Edwards Aquifer is meant to reproduce known spring flows and predict future flows under a variety of conditions. The HCP calls for improvements to the existing groundwater model to better predict: (1) the effects of potential future climate change and droughts on spring flow, and (2) how management actions to protect listed species will affect groundwater levels and spring flows.

The 2015 report recommended more careful evaluation of recharge estimation, further extension of uncertainty analysis, incorporation of conduits, and improved descriptions of the modeling plans. While some steps have been taken in these directions, this report offers further guidance to the EAA on implementing these recommendations. Furthermore, the report outlines several scenarios to be run in the groundwater model, the most important of which is to test the model against the 2011 to 2015 period, which was not used in model calibration. This period, which includes both very dry and wet years, offers a remarkable opportunity to validate the model and enhance confidence in the model for future applications.

The EAA Five-Year plan for the hydrologic model should include formal versioning and a decision support system that will be useful in future phases of the HCP. The model should be updated every five years, with each new version including a peer-reviewed report and permanent archive of the numerical model that is available to the public.

ECOLOGICAL MODELING

One of the major efforts set forth by the HCP is the creation of predictive ecological models for the Comal and San Marcos spring systems. The models are designed to predict species populations in response to a variety of conditions brought about by such things as groundwater withdrawal, recreation activities, and restoration actions. The initial efforts of the ecological modeling team—guided in part by the 2015 report and by an interim report from the National Academies produced in mid-2016—have focused on modeling the population dynamics of the fountain darter and key submersed aquatic vegetation (SAV) species.

In general, the report finds that ecological modeling efforts have made good progress and that scientifically sound frameworks and approaches for the SAV and fountain darter models are in place. Model development is an iterative process. It is hoped that the models will continue to reflect new knowledge and understanding (beyond the originally anticipated timeframe) in order to fully reap their benefits.

The report describes seven scenarios for the fountain darter model that demonstrate how the model can be used to examine the ways in which extreme flows, process rates, environmental factors, SAV habitat, and episodic population reductions affect fountain darter population dynamics. These results can then be merged with the expected effects of minimization and mitigation measures to identify the robustness and redundancies of the entire suite of actions.

Figure 1. The Edwards Aquifer covers an area about 180 miles long and from five to 40 miles wide. The primary water source for over 2.3 million people in San Antonio and its surrounding communities, the aquifer also supplies irrigation water to thousands of farmers and livestock operators in the region and supplies the Comal and San Marcos Springs. In this map, the red line indicates the jurisdiction of the Edwards Aquifer Authority.

Listed endangered species in the Edwards Aquifer region include the fountain darter (left, photo courtesy USFWS), Texas wild rice (middle, photo by Laura Ehlers) and the Texas blind salamander (right, photo by Joachim Nerz).

BIOLOGICAL AND WATER QUALITY MONITORING

The biological and water quality monitoring programs are intended to provide the observational data needed to assess whether the HCP is meeting its goals of protecting the covered species. Monitoring in the Edwards Aquifer spring systems has been ongoing since 2000 and is now even more comprehensive as a result of the HCP.

The 2015 report comments on the design, purpose, integration, and adequacy of the two monitoring programs. In particular it raised concerns about the lack of integration between the water quality and biological monitoring programs, insufficient detection limits for phosphorous and nitrogen, and the inability to determine population densities of invertebrates such as the Comal Springs riffle beetle.

In response, the EAA established two working groups to assess the water quality and biological monitoring programs, respectively, and make necessary modifications. Many of the recommendations were addressed, and the Comal Spring riffle beetle was made the subject of all Applied Research for 2016. For further improvement, the monitoring program should include the measurements needed to monitor the performance of the broad suite of minimization and mitigation measures. In addition, long-term data collected by the monitoring program will be critical to continuously assessing and refining the ecological model.

APPLIED RESEARCH PROGRAM

The Applied Research Program created by the HCP has several goals, including filling gaps in knowledge about particular listed species, increasing understanding of key processes that affect their population dynamics, and providing data and information that can be used to parameterize and validate the ecological models. The overall goal of the program is to generate useful information to be able to make well-informed decisions about the direction of the HCP in the future. Projects to date have been evenly split between the fountain darter, Texas wild rice, other SAV species, and the Comal Springs riffle beetle.

The EAA responded positively to recommendations from the first report and has continued to devote resources to this program. Especially commendable are the changes made by the EAA regarding the procedures to identify, solicit, and review the projects in the Applied Research Program. Also as recommended, EAA is developing a database management system that will provide data storage, curation, and access into the future.

Modeling efforts should become more integral to consideration of future Applied Research projects. Projects in the Applied Research Program can provide data and information to help design model scenarios, to improve parameter estimation and model formulation, and to enable model calibration and validation.

Monitoring the effectiveness of minimization and mitigation measures such as removal of exotic species, sediment control, and riparian conservation should be done through integration into the existing biological and water quality monitoring programs, rather than through one-off studies conducted through the Applied Research Program.

MINIMIZATION AND MITIGATION EFFORTS

The HCP lists 38 minimization and mitigation measures that when implemented are meant to protect the listed species from the impacts of both human-caused and natural disturbances to the Edwards Aquifer spring systems. In general, implementation of key minimization and mitigation measures is moving in the right direction, with the various programs being characterized by competent project teams and sustained effort.

The report recommends that for every minimization and mitigation measure implemented, performance monitoring should be done not only for the first year, but regularly during implementation, with a comprehensive synthesis of the monitoring data about every five years that goes beyond the simple trends analyses found in the HCP annual reports.

The following recommendations pertain to individual minimization and mitigation measures:

SAV Removal and Restoration. Substantial progress has been made removing non-native vegetation from both the Comal and San Marcos systems and replacing it with native SAV species. Nonetheless, despite this sustained effort, there is not enough new habitat from native plantings to maintain populations of fountain darter to balance non-native SAV removal.

Sediment Management. In general, sediment removal activities should be limited to areas where ongoing upland sources or natural stream dynamics will NOT lead to deposition of new sediment within a matter of years.

Dissolved Oxygen Management in Landa Lake. Aeration should not be used routinely as a mitigation measure. If floating mats cover more than 25 percent of the surface of Landa Lake and dissolved oxygen concentrations decrease, then manual breaking up and removal of the floating mats should be considered as a mitigation measure.

Voluntary Irrigation Suspension Program Option. When the HCP is reviewed for renewal, it may be appropriate to re-evaluate the time period that the VISPO trigger is based on using a decision support system. Consideration should be given to redefining the trigger to use additional information, such as groundwater elevation from a longer time frame, precipitation and recharge data, and groundwater model projections of future conditions.

Aquifer Storage and Recovery. (1) At a minimum of annually, determine specific injection at each ASR well to assess if there are any long-term changes in ASR well performance, (2) design and implement water quality monitoring for arsenic and related constituents in monitoring wells during recharge and storage events, and (3) design and implement water quality monitoring in ASR wells during recovery events.

COMMITTEE TO REVIEW THE EDWARDS AQUIFER HABITAT CONSERVATION PLAN

Danny D. Reible (*Chair*), Texas Tech University, Lubbock; **Jonathan D. Arthur**, Florida Department of Environmental Protection, Tallahassee; **M. Eric Benbow**, Michigan State University, East Lansing; **Robin K. Craig**, University of Utah, Salt Lake City; **K. David Hambright**, University of Oklahoma, Norman; **Lora A. Harris**, University of Maryland Center for Environmental Science, Solomons; **Timothy K. Kratz**, University of Wisconsin, Madison; **Andrew J. Long**, U.S. Geological Survey, Rapid City, SD; **Jayantha Obeysekera**, South Florida Water Management District, West Palm Beach; **Kenneth A. Rose**, Louisiana State University, Baton Rouge; **Laura Toran**, Temple University, Philadelphia, PA; **Greg D. Woodside**, Orange County Water District, Fountain Valley, CA; **Laura J. Ehlers** (*Study Director*), **Brendan McGovern** (*Senior Program Assistant*), National Academies of Sciences, Engineering, and Medicine

For More Information . . . This Report Highlights was prepared by the Water Science and Technology Board based on the report *Review of the Edwards Aquifer Habitat Conservation Program: Report 2.* The study was sponsored by the Edwards Aquifer Authority. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authoring committee and do not necessarily reflect those of the sponsor. Copies of the report are available from the National Academies Press, (800) 624-6242; **http://www.nap.edu**.

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