3.2.1 PREDICTIVE ECOLOGICAL MODEL(S) FOR THE COMAL AND SAN MARCOS SPRINGS ECOSYSTEMS

Background and History

On January 11, 2013, the United States Fish and Wildlife Service (FWS) issued a Record of Decision approving the issuance of an Incidental Take Permit (ITP) to the City of San Marcos, the City of New Braunfels, the EAA, Texas State University, and the San Antonio Water System (SAWS) for the use of the Edwards Aquifer and associated spring systems.. The ITP is supported by the Edwards Aquifer Habitat Conservation Plan (EAHCP). The EAHCP was developed by a consensus-based stakeholder process involving some forty stakeholder groups or individuals.

The EAHCP is an essential document for preparing a proposal for this project. A successful applicant is expected to have familiarized themselves with at least Chapters 4, 5, and 6 of this document and the role of the ecological model in that process. *See* http://www.eahcp.org for digital copies of the EAHCP.

The following is a brief overview of the EAHCP. It should not, however, be used as a substitute for the actual document.

The EAHCP establishes long-term biological goals and objectives for each of the species covered by the ITP as well as defines measures designed to minimize and mitigate the impacts of the use of the aquifer and associated spring systems. These covered species include: the fountain darter, San Marcos salamander, San Marcos gambusia,[1] Texas blind salamander, Peck's cave amphipod, Comal Springs dryopid beetle, Comal Springs riffle beetle, Texas wild-rice, Edwards Aquifer diving beetle, Comal Springs salamander, and Texas troglobitic water slater.

The term of the EAHCP is 15 years. The implementation of the EAHCP is divided into two phases. In the first phase, habitat protection measures to increase the viability of the species will be implemented immediately at Comal and San Marcos springs. These measures will include habitat restoration, maintenance of dissolved oxygen through removal of decaying aquatic vegetation during low flows, sediment removal, predator control, fountain darter gill parasite control, minimization of the impacts of recreation at low flows and water quality measures.

In addition, the first phase will include a package of actions to ensure continuous minimum springflow during a repeat of the drought of record. The flow protection measures include a voluntary irrigation suspension program during severe drought, a regional municipal conservation program, the use of the SAWS Aquifer Storage and Recovery facility to store water to offset pumping during severe drought, and emergency Stage V Critical Period Management cutbacks.

[1] The San Marcos gambusia has not been collected since 1982 and may be extinct.

All of the measures will be evaluated through a comprehensive monitoring program and adjustments made through a robust adaptive management process (AMP). The AMP will include an applied research program to test the assumptions underlying the biological goals and objectives. The research will focus on the biological effects of low flows on species and habitat. In addition, the existing MODFLOW model will be improved. The mechanistic ecological model will be developed and used to evaluate all of the impacts on habitat.

In the second phase, the permittees will implement any additional measures determined during Phase I needed to achieve the biological goals. The decision regarding whether any additional measures are needed will be based on the best available science at that time and will rely heavily on scientific information developed in the AMP, including the ecological modeling. The decision regarding any Phase II adjustments to the HCP will be made by Year 7 of the permit.

The understandings among the permittees as to how the plan will be managed and implemented are set out in the Funding and Management Agreement (FMA). The implementation of the EAHCP will be overseen and managed by an Implementing Committee consisting of the permittees and the Guadalupe-Blanco River Authority, as a non-voting member. The EAA will have primary responsibility for managing the day-to-day activities related to the EAHCP and responsibility for certain flow protection measures, and monitoring and modeling programs including the ecological modeling program.

The Funding and Management Agreement also creates an independent Science Committee. The primary function of the Science Committee is to advise and make recommendations to the Program Manager, Implementing Committee, and Stakeholder Committee.

The Role of Ecological Model in the EAHCP Process

Chapter 6 of the EAHCP calls for the creation of a mechanistic ecological model to evaluate potential adverse effects to the covered species and their critical habitats and to the extent such effects are determined to occur to quantify their magnitude and develop alternative strategies. EAHCP at § 6.3.3. To begin developing such a model, a meeting was held at the Edwards Aquifer Authority on August 28-29, 2012. The purpose of the meeting was to receive input from a panel of ecological modeling experts regarding the development of a decision-making tool to evaluate the available data regarding the effectiveness of the EAHCP. The expert panel consisted of: George Ward, University of Texas at Austin; Bill Grant, Texas A&M University; Anthony Starfield, Retired, formerly from the University of Minnesota; Terry McLendon, Texas Tech University; Mac McKee, Utah State University.

At the conclusion of these discussions, the expert panel made the following recommendations:

1. Use Simple Models to Identify Knowledge Gaps and Understand Existing Data.

Begin the process by identifying a finite number of key questions to be answered. For each question identify the state of knowledge and identify models that have been or may need to be developed. Analyze how those models have been used to guide the next step in the direction of answering the questions.

2. Comprehensive Data Management and Computation Framework

Decide if a comprehensive data management and computation framework is necessary by evaluating prototypes (simple models) and assessing data holdings. Such a framework would have the capabilities to handle the mathematics of solving coupled models, and to transfer data and model results among the components.

3. Data Mining

Formulate specific questions and have existing data reevaluated to determine if the answers can be identified from existing data.

4. Integrative Complex Ecological Model

When sufficient information is obtained through Recommendation #1 regarding the efficacy of the prototype (simple models), decide if an integrative complex ecological model or series of linked simple models would be useful.

In response to the first recommendation, the Implementing Committee retained Mr. Ed Oborny at BIO-WEST and Dr. Thom Hardy from the Meadows Institute at Texas State University. They prepared a Technical Memorandum (Attachment 1) that set out the initial questions that are anticipated to be asked with the model and described the existing data and available models. They also made certain recommendations as to how to proceed and included a comprehensive list of relevant literature. The final draft of the Technical Memorandum was reviewed by the Science Committee. The comments of the Science Committee and Oborny's and Hardy's responses were included in the Technical Memorandum.

This Scope of Work is based largely on the Technical Memorandum and the recommendations therein.

Questions to be Asked by the Ecological Model

The ecological model will address at least the following seven questions during the initial years of Phase I of the HCP:

(1) What will be the response/dynamics of native and key non-native aquatic vegetation during extended periods of low flow followed by increased flows as projected under the HCP?

(2) What will be the response/dynamics of the aquatic macroinvertebrate community to potential responses/dynamics of the aquatic vegetation during the projected flow regimes of the HCP?

(3) What will be the response/dynamics of fountain darter populations relating to growth, survival, and movement during projected flow conditions as anticipated under the HCP during a repeat of the drought of record?

(4) What will be the response/dynamics of Comal Springs riffle beetles to projected flow conditions as anticipated under the HCP during a repeat of the drought of record?

(5) How successful will native aquatic vegetation restoration (EAHCP § 6.3.4.3) and Texas wild-rice enhancement (EAHCP § 6.3.5) be?

(6) What will be the response/dynamics of gill parasites and non-native host snails (EAHCP § 6.3.6) to projected flow conditions as anticipated under the HCP during a repeat of the drought of record?

(7) What will be the response/dynamics of fountain darter populations relative to aquatic vegetation, macroinvertebrate, gill parasite, and non-native species reactions to projected flow conditions as anticipated under the HCP during a repeat of the drought of record? This question will also include an evaluation of alternative scenarios related to human activity impacts such as recreation and water quality changes.

PROJECT REQUIREMENTS

A. No later than _____, and each month thereafter, the Consultant shall submit a monthly "invoice packet" to the EAA for each previous month's activities. Each invoice packet shall contain, at a minimum:

(1) a progress report containing:

- a description of the work completed in each Task during the billing cycle;
- a monthly update of the work schedule as it relates to achievement of the deliverables;
- an estimate of the percent completion of each Task; and
- a discussion of any issues or problems that may result in a change in the deliverable due date;

(2) documentation of all costs and expenses incurred during the billing cycle, including supporting documentation; and

(3) a certified invoice summary sheet.

B. The monthly invoice packet will be submitted electronically in Adobe Acrobat (pdf) format via email to the Senior HCP Coordinator.

C. Computer Models, Data Submission, Statement of Assumptions, and Project Notebook

(1) All computer model and spreadsheets developed as a part of this project, shall be submitted to the EAA. **User manuals shall be submitted by the Consultant to EAA providing complete documentation of computer models developed under this project. The user manuals shall also contain the source code language and the type of computer equipment necessary to operate the model(s).**

(2) All data collected during this study shall be submitted to the EAA in electronic format compatible with its associated software. (*i.e.*, spreadsheets will be in MS Excel format, etc.). Data shall be delivered via digital media and shall be labeled to provide sufficient detail to access the information. Data, datasets, etc. are due on the same date as the final report.

(3) All computer models, databases, and spreadsheets developed herein (written and digital formats) are due on the same date as the final report.

(4) To facilitate the EAA's accurate evaluation of the Consultant's work product, computations, conclusions and recommendations, the Consultant shall:

- Include in the final report a section describing the assumptions and methodology used by the Consultant in generating the data and conclusions contained in that chapter.

- Prepare a project notebook containing a description of the assumptions and methodologies used in the study analysis. The notebook shall be organized in such a way as to allow replication of the steps, calculations, and procedures used by the Consultant to reach conclusions, described in the draft final report. The project notebook shall be submitted with the draft final report.

SCOPE OF WORK

Task 1. Meetings and Presentations

The Consultant shall attend a minimum of 2 meetings to provide information to the Science Committee, Implementing Committee, and Stakeholder group when requested by the HCP Director. The budget should include the cost of two one-day meetings either in San Antonio, San Marcos, or New Braunfels.

Task 2. Literature Review

The Consultant shall gather and review pertinent scientific literature with respect to two issues: (1) identifying a modeling approach for predicting aquatic macroinvertebrate responses to changing physical, chemical, and biotic (i.e., aquatic vegetation dynamics). This review should focus on potential modeling approaches and life history parameters that may have potential for adaptation to specific applications, including general life histories of communities or individual macroinvertebrate species; and (2) existing modeling approaches that may have potential for modification to address the EAHCP specific applications regarding the Comal Springs riffle beetle response/dynamic, even if the literature does not specifically address the Comal Springs riffle beetle.

Task 3. External Data Acquisition

The EAA will be the primary clearinghouse for the majority of all data related to the modeling efforts described in Task 4. However, other complementary data may exist that are valuable to this project. The Consultant shall be responsible for the acquisition of any data that are external to the HCP program.

Task 4. Modeling Efforts

This task consists of four separate modeling efforts, identified as subtasks, with each model designed to address a specific area of concern. However, all models developed or modified during this task should have the capacity to be linked to the other models developed in this task.

Subtask 4.1 U.S. Army Corps of Engineers Model Modification

The Consultant shall modify and/or adapt specific models developed by U.S. Army Corps of Engineers' Aquatic Plant Control Research Program for application to the Comal and San Marcos springs ecosystem. These models were developed to simulate plant biomass over a 1- to 5-year period and include equations describing vegetation responses to flow velocity, aerial cover, and depth. They have been recalibrated to include species specific values to plant responses.

Subtask 4.2 Fountain Darter Response/Dynamics Model

The Consultant shall review and assess available fountain darter, aquatic vegetation, and water quality data for the potential of “data mining” to see if any of the model parameters

can be updated. Following this exercise, the fountain darter model developed by Mora *et al.* (or an equivalent model), should be updated to be spatially and temporally explicit in terms of the available two-dimensional hydrodynamic models, aquatic vegetation mapping data and models, water temperature model outputs and then calibrated and validated against the EAA variable flow study monitoring results.

Note: This model is not in the public domain. The proposal should include a discussion of how the Consultant intends to gain access to this model or a description of an equivalent model that will be used.

Subtask 4.3 Texas Wild Rice Parameters

Utilizing the modified models identified during subtask 3.1, the Consultant shall simulate the characteristics of Texas wild-rice and identify potential research necessary to parameterize Texas wild-rice dynamics.

Subtask 4.4 Gill Parasite and Non-Native Snails Response/Dynamics Model

The Consultant shall develop the model structure and associated model parameters that will allow an evaluation of the response/dynamics of gill parasites and non-native host snails to projected flow conditions anticipated under the EAHCP.

Task 5. Recommendations and Future Work

The Consultant shall provide recommendations developed during the course of this project. The Consultant shall also provide recommendations for work that should be completed by the EAA or its contractors to continue or enhance the modeling efforts completed during this project.

Task 6. Draft and Final Reports

With respect to Task 2, the Consultant shall submit to the EAA two (2) copies of a final report describing the results of all work completed in this study no later than 120 days of the execution of the contract.

With respect to Tasks 3 and 4, the Consultant shall submit to the EAA two (2) copies of the draft report no later than 300 days from the execution of the contract. The report shall discuss any changes to existing models, all modeling results, all data used in calibrating and validating the models, and all assumptions used in the development or adaptation of the models including report describing the modification to the USACE model(s) necessary to simulate the characteristics of Texas wild-rice and identify potential research necessary to parameterize Texas wild-rice dynamics

After receipt and incorporation of EAA's review comments, the Consultant will submit the final report to the EAA on or before 365 days from the execution of this contract.

Task 7. Deliverables

Linked models that can assess:

a) the response/dynamics of native and key nonnative aquatic vegetation during extended periods of low flow;

b) the response/dynamics of fountain darter populations relating to growth, survival, and movement during projected flow conditions while incorporating a spatially explicit aquatic vegetation component for the Comal and San Marcos systems;

c) identify potential research necessary to parameterize Texas wild-rice dynamics; and

d) the response/dynamics of gill parasites and non-native host snails to projected flow conditions anticipated under the EAHCP.

All models developed and/or modified under the tasks described herein, must be provided to the EAA as executable "turn key" files with all associated datasets fully populated.

Additional Information for Proposers

Proposals shall discuss the process and methodology for completing the tasks described in this RFP. It should identify all subcontractors that will be used on the project and the task on which each subcontractor will be used. If subcontractors are proposed to develop or modify the model, the prime contractor will be responsible for ensuring that the models developed and used are compatible and can be linked.

For each task, milestones and a schedule should be included in the proposal. If a task cannot be completed within 12 months, the proposal should explain why the work cannot be completed in 12 months and what part of the Task can be completed within that time frame.

The contract will be a time and material contract with specified “not to exceed” amount. The budget should be set out by tasks. The estimated cost for personnel, supplies, equipment, and travel should be set out for each task. The personnel should be identified by name or position title and the hourly rate for each person should be specified. The budget should clearly indicate the indirect costs or overhead charged for the work. The amount of any indirect costs relative to the cost of the actual work can significantly affect the success of the proposal.