Environmental Restoration and Protection Areas – Alternative Research Approaches

The ability to conduct applied research is a key component of the Comal River and San Marcos River Habitat Conservation Plan, currently under development by the Edwards Aquifer Recovery Implementation Program (EARIP). A number of proposed activities of the EARIP HCP that focus on ERPAs and basic research have been proposed (BIO-WEST 2011, Hardy 2011). Several of the proposed activities are related to fountain darter/vegetation dynamics in Landa Lake and the old channel and involve research to address identified uncertainties in the ecosystem response under low flow conditions associated with a sustained drought (Hardy 2011). Research related to the Comal Springs riffle beetle and in particular the ERPA of experimental channels within the old channel of the Comal River have been questioned and may be difficult to implement due to a variety of issues. Furthermore, the underlying hypotheses being addressed by this research and ERPAs may be difficult to test as currently proposed and alternative experimental approaches specifically designed to evaluate the underlying mechanisms are likely more suitable in controlled laboratory and experimental facilities.

Texas State University was asked to assess if their research facilities could be utilized in lieu of proposed field based ERPAs for the experimental channels and focused research on Comal Springs riffle beetles to assist the EARIP in meeting critical research questions. Descriptive field assessments and manipulative laboratory studies have generated a large body of knowledge on the biotic and abiotic processes of Comal and San Marcos spring and riverine ecosystems and will continue to be integral in the evaluation and adaptive management processes of the HCP. In addition, EARIP expressed interest in the ability to use mesocosms for testing multivariate and multifactor hypotheses in environments maintained under more natural conditions. Mesocosms are artificial, simplified ecosystems that are used to simulate and predict the behavior of natural ecosystems under controlled conditions. Open or closed mesocosms provide an experimental area for ecologists to study natural ecological processes. Mesocosm studies can be very useful to study the effects of disturbance or to determine the ecological role of key species. The size and physical nature of the mescosms are designed to allow the specific testing of the hypothesis in question. For example, the assessment of aquatic vegetation dynamics under varying flow fields that approximate the low flow conditions within Landa Lake is ideally suited to medium scale mescosms.

The purpose of this paper is to provide an overview of mesocosm infrastructure needs, current infrastructure that can be used for mesocosm research, potential space available for the future infrastructure, and cost estimations for additional infrastructure on the campus of Texas State University-San Marcos.

Benefits in locating mesocoms research on Texas State University include convenient access for faculty and graduate students, ability to use existing water rights (see Appendix 1 for summary),

security of infrastructures through the University Police Department, and outreach opportunities for the general public.

Infrastructure needs:

Constructed mesocosms should be sufficient to accommodate multifactor experimental designs with replications for studies intended for publication in peer-reviewed journals. In addition, mesocosm design should have the capacity to be rearranged and reconfigured depending on particular question or questions of various studies. Actual study design would be determined through a collaborative process with oversight of a technical review panel as currently proposed in the EARIP ERPA feasibility study (BIO-WEST 2011).

Mesocosm design should accommodate numerous dependant variables, such as vegetation (native and exotic) establishment, growth, abundance, and dispersion; macroinvertebrate abundance, dispersion, behavior; and fish (native and exotic) abundance, fecundity, growth, condition, movement, behavior, feeding, competition, and predator avoidance. Likewise, mesocosm will accommodate the manipulation of numerous environmental parameters, such as geomorphic units (i.e., run, pool, riffle) substrate, vegetation, current velocity, depth, nutrients, water temperature, CO_2 and DO concentrations, turbidity, and specific conductance

Current Infrastructure:

Freeman Aquatic Biology Building (FAB) is located on the main campus of Texas State University. The 30,000 square-foot building is devoted entirely to teaching and research related to the Aquatic Resources Program within the Department of Biology. FAB contains faculty and student offices, conference rooms, three teaching laboratories, six research laboratories, a large lecture room, and an array of instrumentation for aquatic studies, including atomic absorption spectrophotometers, gas chromatographs, liquid scintillation counters, nutrient autoanalyzers, total carbon analyzers, recording spectrophotometers, electronic microbalances, environmental chambers, toxicity bioassay unit, compound microscopes with phase contrast, epifluorescence and image analyses capability, a variety of research grade microscopes, and computer facilities.

FAB Outdoor Resources: Existing infrastructure located near FAB includes four research ponds and 12 concrete raceways. Use of the infrastructure is granted through a FAB committee, composed of faculty within the Aquatic Resources Program, and research projects must be approved by Texas State Institutional Animal Care and Use Committee. Water source for these aquatic systems is from an artesian well from the Edwards Aquifer, located next to FAB.

	Depth (ft)	Length (ft)	Width (ft)	Substrate	Security
Ponds:					
A	3.5	100	50	natural	none
B	3.5	100	100	natural	none
C	3.5	90	40	concrete	high fence
D	3.5	90	90	concrete	high fence
Outdoor Raceways:					
A	3.5	130	7	concrete	Predator fence
B	3.5	130	7	concrete	Predator fence
Indoor Raceways:					
N = 10 raceways	1.5	16	2	concrete	Enclosed

We believe these facilities can be utilized to accommodate a variety of experimental designs to specifically address the underlying research questions associated with the Comal Springs riffle beetle as well as vegetation dynamics – fountain darter responses to sustained low flow conditions anticipated in Landa Lake. These facilities will accommodate the ability to establish both control and multiple replicates for either stream or lake like conditions.

Infrastructure Costs

Depending on the experimental designs that would be formalized and approved by the proposed EARIP technical oversight committee, retrofitting of the existing facilities at FAB or construction of additional mesocosms are anticipated to be substantially less than the costs estimated for these ERPAs as proposed for the Comal River system (BIO-WEST 2011).

We anticipate that infrastructure costs for experiments addressing the Comal Springs riffle beetle would be on the order of $50,000 or less and monthly operational costs of approximately $8,000.

We anticipate that infrastructure costs for experiments on vegetation dynamics and fountain darter responses within the existing FAB raceways and pond structures to be substantially less than that proposed for these ERPAs on the Comal River due to the existing FAB infrastructure. Although exact estimates are not possible pending the specific development and approval of the experimental designs by the EARIP technical committee, we anticipate the costs to be on the order of $100,000 or less. Monthly operational costs are not anticipated to be more than $30,000.

Appendix 1: Tx State surface water right certificates (Information provided by Texas State University—Facilities).

Spring Lake (Certificate 18-3865):

- Tx State has a 100 ac-ft/yr irrigation water right. A pump house located adjacent to green #8 (Figure 9) diverts 100 ac-ft/yr of water for the purpose of irrigating the 70-acre Aquarena golf course. The water is pumped at a maximum of 150 gpm. A 0.25"mesh screen covers the intake. Fountain darters have not been observed when the screen is cleaned, however there is a possibility for capture of adults against the screen, but not pulled into the pipeline.

- Tx State has a 513 acre-feet/year municipal water right that is not currently utilized.

- Tx State has a 534 ac-ft/yr industrial permit with a maximum permitted diversion rate of 600 gallons per minute. Tx State only uses 250 ac-ft/yr of this industrial permit for two chiller plants (East Chill Plant and Cogen Plant). The water is pumped from an intake site located just above the Spring Lake dam. To access this intake site, a pipeline has been bored from the existing site and extended to the Freeman Building area, where it is pumped to the chiller plants. A 0.25 mesh screen is used at the intake. Fountain darters have not been seen on the screen when cleaned. Cooling tower water is held in a reservoir. A majority of this water evaporates and the remainder is periodically released into the City of San Marcos sanitary system.

- Tx State also has 64,370 acre-feet hydroelectric at the Saltgrass location. They do not exercise this right and have transferred 33,108 acre-feet to the Texas Water Trust (see Appendix C). This action was being taken in cooperation with the Texas Parks and Wildlife Department.

- Tx State is authorized to impound 150 acre-feet in Spring Lake.

- There was an artificial waterfall used in shows by the previous owner located in the Designated Training Area that is permitted for 700 acre-feet/year. This right will not be exercised by Tx State.

<u>San Marcos River (Certificate 18-3866)</u>
- Tx State has a 20 acre-feet irrigation right used to irrigate a ten-acre field by the Armory.

- Tx State 60 acre-feet industrial used to fill and replenish seven off-channel reservoirs (old fish hatchery ponds) for biological research and related educational purposes.

<u>Oyster Creek (Certificate 18-3892):</u>
- Tx State has a 587 acre-feet impoundment right. This certificate is jointly owned with adjacent property owners. The impoundment, located at the Muller Farm east of IH-35, is used solely for recreation.

- Tx State also has groundwater rights through the Edwards Aquifer Association (EAA). They are authorized to pump 1237.5 acre-feet/year which is subject to EAA drought restrictions. Tx

State pumps 128 million gallons/year from two wells adjacent to Jackson Hall that is used for campus drinking water. Tx State also obtains 19 million gallons from the City. A partially-capped artesian well is located behind the Freeman Aquatic Building with a 666.8 acre-feet/year water right. Ninety gpm flows from this well into the wet-lab in Freeman and into Sessom Creek.