Science Committee of the
Edwards Aquifer Habitat Conservation Plan

Scientific Evaluation Report:
Nonroutine Adaptive Management Proposal for the
EAHCP Submerged Aquatic Vegetation Restoration Programs

September 9, 2016

Introduction

According to the Funding and Management Agreement, the Adaptive Management Science Committee (Science Committee) is tasked with evaluating all Nonroutine Adaptive Management (AMP) proposals. These evaluations result in a "Scientific Evaluation Report" for presentation to the Stakeholder Committee. The Stakeholder Committee considers this report in their decision whether to recommend the Nonroutine AMP proposal to the Implementing Committee for final approval.

This Scientific Evaluation Report is issued in response to the Nonroutine AMP proposal[1] submitted by the Program Manager, dated September 1, 2016 related to the submerged aquatic vegetation (SAV) restoration programs in the Comal and San Marcos systems. The following sections in this report summarize the Science Committee's evaluation of this Nonroutine AMP proposal.

Once approved by the Chair and Vice-Chair of the Science Committee following the September 9, 2016 Science Committee meeting, this Scientific Evaluation Report will be presented to the Stakeholder Committee at its meeting on September 15, 2016.

Nonroutine Adaptive Management Proposal

On September 1, 2016, the EAHCP Program Manager submitted the attached Nonroutine AMP proposal to the Science, Stakeholder and Implementing Committees. It involves modifications to the SAV restoration programs which affect the Long-term Biological Goals (LTBGs) for the fountain darter (*Etheostoma fonticola*) in the Comal and San Marcos systems and which affects the flow-split in the Old and New Channels of the Comal system.

[1] This Nonroutine AMP proposal reflects the consideration by the Program Manager of several different sources of information, including: (1) *Submerged Aquatic Vegetation Analysis and Recommendations* (BIO-WEST, Inc. & Watershed Systems Group, Inc., 2016); (2) Input from the Science, Stakeholder, and Implementing Committees; (3) Discussions with the United States Fish & Wildlife Service (USFWS); (4) Discussions with Texas Parks & Wildlife Department (TPWD); (5) The original EAHCP SAV analysis, conducted back in 2009, for the creation of the Long-term Biological Goals (LTBGs; Recon Environmental, Inc., Hicks & Company, Zara Environmental, LLC, & BIO-WEST, Inc. 2012); (6) Hydraulic models and habitat suitability criteria for individual plant species, performed by Hardy, which show preferred habitat based on depth, velocity, and substrate (Recon Environmental, Inc., Hicks & Company, Zara Environmental, LLC, & BIO-WEST, Inc. 2012); (7) Historical aquatic vegetation maps over time for the LTBG reaches, combined to generate a persistence factor for each vegetation type (BIO-WEST, Inc. Biological Monitoring, 2000-2015); (8) Knowledge gained through restoration experiences to date for each proposed LTBG reach (E. Oborny & T. Hardy, personal communication, July 2016).

Scientific Evaluation of the Nonroutine Adaptive Management Proposal

The purpose of this report is to provide the Science Committee's evaluation of the merits of the proposed modifications presented in the Nonroutine AMP proposal, as compared to possible alternatives. Possible alternatives were explicitly developed in the *Submerged Aquatic Vegetation Analysis and Recommendations* ("SAV Report;" BIO-WEST, Inc. & Watershed Systems Group, Inc., 2016), as "scenarios."

The SAV Report identifies three scenarios—Scenarios "1," "2," and "3." A fourth scenario, "Scenario 4," was produced in an addendum to the SAV Report. As will be discussed in greater detail later in this section, comparison between each of these four scenarios provides the basis for the Science Committee's evaluation of this Nonroutine AMP proposal.

Background

The following summarizes all four SAV restoration scenarios evaluated by the Science Committee, plus the adjustment to the flow-split management for the Old and New Channels of the Comal system. The accompanying table (Table 1) summarizes the estimated fountain darter counts that would be achieved through each of the following scenarios.

1. **Scenario 1 -** Status Quo
    - Includes planting and maintenance of non-native SAV species
        - *Hydrilla verticillata, Hygrophila polysperma,* and *Vallisneria* sp. are non-native species in the San Marcos system
        - *Hygrophila polysperma* is a non-native species in the Comal system
    - Not achievable due to competition between *Zizania texana* (Texas wild-rice) and other SAV species for physical space
    - Cannot be achieved within the term of the Incidental Take Permit (ITP) due to space limitations
    - Potential for an estimated 34,325 fountain darters in the three San Marcos system Long-term Biological Goal (LTBG) reaches (see Table 1)
    - Potential for an estimated 176,150 fountain darters in the four Comal system LTBG reaches (see Table 1)

2. **Scenario 2 –** Removes Non-Native Requirements
    - Removes non-natives in the San Marcos system from the LTBGs (*Hydrilla verticillata*, *Hygrophila polysperma*, and *Vallisneria* sp.) and replaces them with natives (*Heteranthera dubia* and *Zizania texana*)
    - Integrates *Zizania texana* and SAV restoration for a realistic and achievable regime
    - Removes a non-native in the Comal system from the LTBGs (*Hygrophila polysperma*) and replaces it with a native (*Potamogeton illinoensis*)
    - Potential for an estimated 29,300 fountain darters in the San Marcos system LTBG reaches (see Table 1)

  - Represents a potential decrease of an estimated 5,025 darters in the three San Marcos LTBG reaches
- Potential for an estimated 176,718 fountain darters in the four Comal system LTBG reaches (see Table 1)
  - Represents a potential increase of an estimated 568 darters in the Comal LTBG reaches

3. **Scenario 3 –** Includes Additional Restoration Reaches
   - All of Scenario 2, plus the below
   - Maintains the lower-end of the range (9,480 m^2) of the *Zizania texana* LTBGs
   - Defines "proportional expansion" as required by the Key Management Objectives as additional restoration in newly created "restoration reaches"
     - Adds five restoration reaches to the San Marcos system
       - Potential for an estimated 10,925 additional fountain darters in the San Marcos system within the restoration reaches beyond LTBG numbers (see Table 1)
     - Adds three restoration reaches to the Comal system
       - Potential for an estimated 3,462 additional fountain darters in the Comal system within the restoration reaches beyond LTBG numbers (see Table 1)

4. **Scenario 4 –** Includes Additional Restoration Reaches and *Hydrocotyle*
   - All of Scenario 3, with the following changes (applicable only to San Marcos):
   - *Hydrocotyle umbellata* as a replacement for *Hydrilla verticillata, Hygrophila polysperma*, and *Vallisneria* sp., rather than *Heteranthera dubia*
   - Potential for an estimated 29,270 fountain darters in the San Marcos system LTBG reaches (see Table 1)
     - Represents a potential decrease of an estimated 5,055 darters in the San Marcos LTBG reaches
   - Add five restoration reaches in the San Marcos system
     - Potential for an estimated 9,910 additional fountain darters in the San Marcos system within the restoration reaches beyond LTBG numbers (see Table 1)

Table 1. Fountain Darter Counts by Restoration Scenario

Comal System			
Scenario	LTBG Reaches	Restoration Reaches	Total
EAHCP	176,150	N/A	176,150
Scenario 1	176,150	N/A	176,150
Scenario 2	176,718	N/A	176,718
Scenario 3	176,718	3,462	180,180
Scenario 4	176,718	3,462	180,180
Proposal	176,718	3,462	180,180
San Marcos System			
Scenario	LTBG Reaches	Restoration Reaches	Total

EAHCP	34,325	N/A	34,325
Scenario 1	34,325	N/A	34,325
Scenario 2	29,300	N/A	29,300
Scenario 3	29,300	10,925	40,225
Scenario 4	29,270	9,940	39,210
Proposal	29,270	9,940	39,210

5. Adjustment to Flow-Split Management of the Old and New Channels

- Involves a modification to the flow requirements set by EAHCP Table 5-3
- The maximum controlled flow in the Old Channel would be reduced from 80 cfs to 65 cfs
- The minimum controlled flow in the Old Channel would remain the same - 20 cfs

Evaluation

As a strategy for evaluating the merits of this Nonroutine AMP proposal, the Science Committee identified a list of criteria by which each of the four scenarios, as well as the proposed modifications to the flow-split management in the Comal system, could be evaluated according to the scientific merit inherent to each. The following discussion presents the Science Committee's rationale associated with each of the selected criteria used to evaluate the restoration scenarios in comparison with the Nonroutine AMP proposal (Proposal).

- **Responds to issues/challenges/obstacles** refers to whether the scenario seeks to proactively address challenges encountered by implementation (as opposed to adhering to the status quo). The Science Committee endorses responsiveness to challenges and as such, adaptation-responsive management actions are viewed more highly than those which are not (e.g., Scenario 1).

- **Utilizes an appropriate native SAV in San Marcos (SM) system** refers to the use of *Hydrocotyle umbellata* as a replacement for *Hydrilla verticillata, Hygrophila polysperma*, and *Vallisneria* sp. in the San Marcos SAV restoration program, rather than *Heteranthera dubia*, as originally had been proposed. Given (1) the growth habit of *Heteranthera dubia*, which make it a suspected competitor with other SAV species such as *Zizania texana*, as well as (2) the lack of documentation of *Heteranthera dubia* ever having naturally occurred in the upper San Marcos River (Lemke, 1989; Espey, Huston and Associates, Inc. 1975), the Science Committee believes *Heteranthera dubia* would be an inappropriate choice for the San Marcos SAV restoration program. By contrast, *Hydrocotyle umbellata* features a growth habit that appears to make it less likely competitor with other SAV species, and importantly, has historically been recorded as a native component of the SAV community of the upper San Marcos River (Espey, Huston and Associates, Inc. 1975).

- **Addresses spatial limitations** refers to the finding that it may not be possible to ever meet the original LTBGs in certain reaches of the Comal and San Marcos. Original calculations for areal coverage goals for different SAV species by reach were based on historical maxima for each plant species within the given reaches. Although these historically-recorded data provided aspirational goals for the SAV restoration programs, they did not consider conflicting factors outside the immediate scope of the SAV restoration activities. Examples include the eventual establishment of the permanent access points in the San Marcos system, which interact with restoration areas due to recreationist traffic patterns, as well as competing goals from other Conservation Measures, such as "Texas Wild-rice Enhancement and Restoration," which is treated separately in the EAHCP from other SAV species. Again, the Science Committee endorses responsiveness to the challenges of implementation.

- **Treats *Zizania texana* as fountain darter habitat** refers to the fact that existing EAHCP programs do not acknowledge that *Zizania texana* provides habitat for the fountain darter (i.e., *Zizania texana* is left out of the LTBGs for SAV areal coverage for fountain darter habitat). This fails to account for a significant portion of restored fountain darter habitat that created through the Texas Wild-rice Enhancement and Restoration Conservation Measure. The Science Committee recognizes that Texas wild-rice provides habitat for the fountain darter.

- **Plants only appropriate natives** refers to removing non-native plant species (*Hydrilla verticillata*, *Hygrophila polysperma*, and *Vallisneria* sp.) from the LTBGs for fountain darter habitat, and replacing them with native plant species (*Hydrocotyle umbellata* and *Zizania texana* in the San Marcos system, and *Potamogeton illinoensis* in the Comal system.) As part of an ecological restoration project, programs restoring only native vegetation are to be preferred, as opposed to programs supporting non-native, exotic species which may have deleterious effects on the ecological community including threatened and endangered species. The Science Committee recognizes a diversity of native vegetation as optimal habitat for both systems.

- **Removes non-natives** refers to the same as the above. The Science Committee recognizes a diversity of native vegetation as optimal habitat for both systems.

- **Proportional Expansion: "Restoration Reaches"** refers to geographically defining the reaches to which the term "proportional expansion" applies. This term is used in the HCP, but is not fully defined. For example, in discussing the LTBGs for the fountain darter in both systems (EAHCP §§4.1.1.1 and 4.1.1.2), the HCP specifies that SAV restoration is to "extend beyond the study reaches in equal proportion to effort expended per study area in relation to the total area of" the river segment (e.g., Landa Lake study area/ Landa Lake, IH-35 study area/Rio Vista Dam to IH-35 reach). The Science Committee recognizes the benefits of geographically identifying the restoration reaches as the proportional expansion because, when implemented, it will contribute significantly to the SAV restoration programs in both systems.

- **Provides a timeline for implementation** refers to having a detailed schedule which lays out targets for SAV restoration progress with annual milestones through the end of the ITP (2028). The existing SAV restoration programs (Scenario 1) do not have a timeline for implementation.

- **Reflects consultation with stakeholders** refers to the input received from EAHCP Committee members concerning the proposed recommendations for adaptive management. This process allows for all sides to be considered in the process of developing a final Nonroutine AMP proposal, ultimately helping to ensure a more balanced and sustainable outcome. The Science Committee recognizes the importance of this input.

- **Includes flexibility if *Hydrocotyle* unsuccessful** refers to having the City of San Marcos and Texas State University, in minimal amounts, proactively field test two other native SAV species to replace *Hydrocotyle umbellata* in the event it is unsuccessful. The two species to be tested will be determined through collaboration between the City of San Marcos, Texas State University, the Program Manager, and Texas Parks & Wildlife Department. If *Hydrocotyle umbellata* is not succeeding by 2019, without utilizing the AMP process, one of the two test species will be used as a replacement for *Hydrocotyle umbellata*, after meeting the following criteria:
    1. The test species is identified as native in existing literature and research
    2. The test species is endorsed as an appropriate replacement species by the EAHCP Science Committee
    3. The test species is endorsed as an appropriate replacement species by the United States Fish & Wildlife Service (USFWS)
    4. The Implementing Committee approves submittal of the appropriate documentation associated with the replacement, if necessary, to the USFWS

- **EAHCP Long-term Biological Goals achievable** refers to scenarios for which those constraints which would preclude the attainment of the LTBGs by the end of the ITP period in 2028 are accounted for. The SAV Report determined that existing LTBGs would likely not be attainable; thus, the Science Committee endorses the revised LTBGs for the fountain darter as a more viable option to pursue.

- **Improves efficiencies/benefit to Old Channel** refers to establishing a flow management system for the Old and New Channels of the Comal system that is geared to avoid scouring or otherwise unduly disturbing restored SAV in the Old Channel streambed, while also ensuring that flow management does not unduly impact Spring Island, which lies upstream of the Old Channel in Landa Lake, and provides important habitat for the Comal Springs riffle beetle (CSRB; *Heterelmis comalensis*).

- **Protects CSRB habitat around Spring Island** refers to the same as the above.

The following table, (Table 2) presents each of these criteria, alongside whether each scenario and the Proposal fulfills (✓), lacks (X), is uncertain (?) or is not applicable (NA) with regards to the given criterion.

As stated, the Proposal involves modifications to the SAV restoration programs which affect the LTBGs for the fountain darter in the Comal and San Marcos systems, and which affects the flow-split in the Old and New Channels in the Comal system. Specifically, these modifications are based on Scenario 4 of the SAV Report. Additionally, the Proposal includes flexibility if *Hydrocotyle umbellata* is not succeeding in the San Marcos system, and includes modifications to the flow-split management in the Comal system to provide maximum benefit to sustaining fountain darter habitat in the Old Channel, while keeping CSRB habitat around Spring Island wetted. Refer to Attachment 1—Nonroutine Adaptive Management Proposal for the Submerged Aquatic Vegetation Restoration Programs—for a complete description.

Table 2. Analysis Matrix

Evaluation Criteria	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Proposal
Responds to issues/challenges/obstacles	X	X	✓	✓	✓
Utilizes an appropriate native SAV in SM system	X	X	X	✓	✓
Addresses spatial limitations	X	✓	✓	✓	✓
Treats *Zizania texana* as fountain darter habitat	X	✓	✓	✓	✓
Plants only appropriate natives	X	?	?	✓	✓
Removes non-natives	X	✓	✓	✓	✓
Proportional Expansion: "Restoration Reaches"	X	X	✓	✓	✓
Provides a timeline for implementation	X	✓	✓	✓	✓
Reflects consultation with stakeholders	X	X	X	✓	✓
Includes flexibility if *Hydrocotyle* unsuccessful	X	X	X	X	✓
EAHCP Long-term Biological Goals achievable	X	X	✓	✓	✓
Improves efficiencies/benefit to Old Channel	NA	NA	NA	NA	✓
Protects CSRB habitat around Spring Island	NA	NA	NA	NA	✓

Recommendation of the Science Committee

Based on the assessment presented in the previous section, the Science Committee recommends the Nonroutine AMP Proposal (listed as “Proposal” in Table 2).

References

BIO-WEST, Inc. & Watershed Systems Group, Inc. 2016. Submerged aquatic vegetation analysis and recommendations. Including SAV Addendum (Section 3.1.2) and revised Appendix B. Prepared for Edwards Aquifer Authority, San Antonio, TX.

Recon Environmental, Inc., Hicks & Company, Zara Environmental, LLC, & BIO-WEST, Inc. 2012. Edwards Aquifer Recovery Implementation Program: Habitat Conservation Plan – November 2012. Prepared for Edwards Aquifer Recovery Implementation Program, San Antonio, TX.

List of Attachments

- Nonroutine Adaptive Management proposal dated September 1, 2016
- Minutes from the September 9, 2016 Science Committee Meeting
- *Submerged Aquatic Vegetation Analysis and Recommendations and Addendum* (BIOWEST, Inc. & Watershed Systems Group, Inc., 2016)

Summary of Science Committee Discussion of the Proposal

Overview

At the September 9, 2016 Science Committee, EAHCP Program Manager Nathan Pence provided a comprehensive presentation, *Submerged Aquatic Vegetation Nonroutine Adaptive Management* to the Science Committee. This presentation covered (1) the background to the AMP built into the EAHCP, (2) the commissioning of the SAV Report, (3) the findings of the SAV report, (4) the stakeholder-driven process, whereby the eventual Nonroutine AMP proposal was developed, and finally, (4) the elements of the Nonroutine AMP proposal itself.

The following sections provide a lightly-edited summary of the Science's Committee's discussion of the Nonroutine AMP proposal, organized according to the main themes that emerged over the course of the discussion. This section concludes with the final motions (including associated final recommendations) made by the Science Committee concerning the Nonroutine AMP proposal and this Scientific Evaluation Report.

Acknowledging Zizania texana as Fountain Darter Habitat

In the course of the presentation, Mr. Pence pointed out that one of the issues the SAV Report took into account was the fact that the original EAHCP SAV LTBGs for fountain darter habitat did not include habitat created by *Zizania texana* EAHCP restoration activities (treated separately within the Texas Wild-rice Enhancement & Restoration Conservation Measure). Dr. Tom Arsuffi expressed surprise that USFWS reviewers did not capture this oversight during the approval process for the HCP.

To this comment, Jackie Poole stated that, to the contrary, she remembered that in early research in the spring system, early data ranked *Zizania texana* among some of the poorer SAV species for fountain darter habitat. Mr. Pence responded that through the long-term biological monitoring program, we now have more and higher quality data supporting *Zizania texana* as a viable SAV species for fountain darter habitat. Doyle Mosier added that a modeling report was produced for *Zizania texana* that also provided indirect support for this SAV species as fountain darter habitat, since the habitat requirements in terms of flow for *Zizania texana* are compatible with those of the fountain darter. Mr. Pence acknowledged that, overall, although the data show that *Zizania texana* may not be one of the top-ranking SAV species for fountain darter habitat, *Zizania texana* does provide fountain darter habitat nonetheless.

Regarding revisions to the *Zizania texana* LTBGs presented in the proposal, Dr. Jacquelyn Duke asked for clarification whether by "lower range," what is meant is that the existing goals would not be being changed, but rather, the lower range of the existing goals would be attained. Mr. Pence confirmed that this was indeed the correct interpretation of the proposal as presented.

Considerations Concerning Fountain Darter SAV Density

Concerning sources of data for *Zizania texana*, Dr. Conrad Lamon asked Mr. Pence if Dr. Thom Hardy of the Texas State University Meadows Center for Water and the Environment would have this data; Mr. Pence answered that besides the EAHCP's biological monitoring program, the San Marcos Observation System (SMOS) might be a source of ongoing data collection with bearing on *Zizania texana* in the San Marcos system.

Concerning the density values used in the SAV Report for average number of darters per SAV type, Dr. Lamon asked if the calculation of these density values was produced using a model akin to those developed by Dr. Hardy in other contexts, to, for example, model for the density of fountain darters within *Zizania texana*. Mr. Pence responded that a model was not used for the density values, but clarified that the *Zizania texana* density values in the scenarios presented by the SAV Report did incorporate new data. Mr. Pence also clarified that the fountain darter LTBGs in the SAV Report scenarios do not represent maxima for SAV coverage by reach, as had been the case in the original coverage LTBGs set in the EAHCP.

Concerning the table comparing the EAHCP LTBGs with estimated fountain darter counts that are potentially achievable under Scenario 4, Dr. Lamon asked for clarification whether, since the EAHCP value was based on the maximum historically-recorded areal coverage of SAV species, the Scenario 4 fountain darter count estimations can be considered to not actually represent a real loss. Mr. Pence confirmed this was indeed the case.

Dr. Janis Bush asked whether the SAV density values included *Hydrocotyle umbellata*. Mr. Pence replied that yes, this was included. Chad Norris asked Mr. Pence about his

comment that we already have data on *Hydrocotyle umbellata* observed fountain darter density. Mr. Pence confirmed that this data has been collected through the biological monitoring program, and that the EAHCP will continue monitoring this habitat type going forward.

Dr. Glenn Longley commented that he is skeptical whether SAV type is as important as it is purported to be in the SAV restoration program, citing the robust population growth of fountain darters kept in raceways at the Texas State University Freeman Aquatic facility. These raceways only had water and some algae and yet, from a starter stock of a few darters, they could reproduce to number in the hundreds. Based on this experience, Dr. Longley stated that he is not convinced that fountain darters need a variety of specific plants—perhaps, as long as darters are provided with the right flow conditions and food source, they can withstand considerable perturbations in their environment.

Dr. Lamon commented that differences in fountain darter density observed by SAV type could be due to different plant species featuring different detection probabilities (for example, due to differing morphological characteristics between species). Using a hierarchical analysis approach that would split this factor out could give a better reading on actual SAV preferences among darters. Mr. Pence noted previous work has been done demonstrating that preferred plant types hold preferred food sources for darters, which supports existing knowledge of SAV preferences among darters.

Dr. Lamon asked whether information on the standard error or standard deviation of fountain darters per SAV type is available. Mr. Norris replied that we already use the median. Dr. Lamon stated that it would be helpful to examine the original data collected by Dr. Hardy in the studies used during the development of the EAHCP. Mr. Norris commented that he believed Dr. Hardy's reports were based on data collected through the biological monitoring program, through drop-net sampling for the darters.

Identifying Species Names

Referencing a slide in Mr. Pence's presentation that listed SAV genera without identifying species names, Mr. Mosier noted the importance of identifying species names in the EAHCP process. Mr. Pence stated that staff had incorporated this recommendation (which had come up in earlier meetings) throughout other documents already drafted in support of this Nonroutine AMP action, and that although incorporated elsewhere, the species identifications had not made it to the slides in the presentation. Dr. Longley asked what particular species of *Potamogeton* was used for the SAV restoration programs; Daniel Large replied that *Potamogeton illinoensis* was the species used.

Community Assembly Rules

Dr. Arsuffi brought up the importance of considering ecological community assembly rules when dealing with issues of SAV restoration program design. Dr. Arsuffi stated

that he identified this as a deficiency in the SAV report. Considering community assembly rules, such as succession, functional traits, niche partitioning, and other elements will, in general, improve the effectiveness and the efficiency of a variety of studies concerning the ecology of the springs systems. Mr. Pence stated that in talking with the authors of the SAV Report, issues of the type Dr. Arsuffi referred to have been considered, but perhaps not to the extent to which Dr. Arsuffi was advocating. Dr. Arsuffi commented that having gone through the exercise of justifying replacement species (as would have been done if community assembly were considered) might have helped avoid the selection of *Heteranthera dubia*, which ultimately proved to have been a problematic choice of SAV for the San Marcos SAV restoration program.

There was more discussion concerning the inclusion of *Heteranthera dubia* in the SAV Report as a replacement native SAV species in the San Marcos system. Dr. Arsuffi asked for clarification whether the authors of the SAV Report had only considered SAV selection criteria *after* the Science Committee had raised concerns about the appropriateness of using *Heteranthera dubia* (as had come up at one of its previous meetings). Mr. Pence replied that the report authors had taken SAV selection criteria into account from the start of their analysis; however, as Program Manager, he communicated the concerns of the Science Committee to the authors, leading them to revise their plans. *Heteranthera dubia* had originally appeared to be “low hanging fruit” for the SAV restoration program, as it is a plant that the SAV restoration team in San Marcos had some experience with previously. Mr. Mosier commented that due to the various exotics that have been introduced in the San Marcos system over the years, there can be a lack of clarity concerning the native SAV community, which could add difficulty to the task of selecting appropriate species to plant in the system.

Mr. Mosier asked if there is active removal of *Colocasia esculenta* in the San Marcos system, since this plant would invade the habitat preferred by *Hydrocotyle umbellata* and likely outcompete it. Mr. Pence answered yes, that while efforts to remove *Colocasia esculenta* in the San Marcos are ongoing, efforts to date have nearly eradicated this exotic invasive plant species above IH-35. Dr. Duke asked if any of the *Heteranthera dubia* that was already planted has been removed; Mr. Pence replied that no, it has not been removed, but that planting has stopped going forward.

Comment on the SAV Restoration Reaches

During Mr. Pence’s discussion of the establishment of geographically defined restoration reaches for the proportional expansion of the SAV restoration efforts, Dr. Duke commented that the proposed expansion appears to be quite a significant increase in the areas that will receive SAV restoration, which Mr. Pence agreed.

Acknowledging the Ecological Dynamism of the Springs Systems

As an overarching recommendation concerning the SAV restoration programs and other ecology-related EAHCP activities, Dr. Arsuffi emphasized the importance of recognizing that the river systems are inherently dynamic. Dr. Arsuffi expressed the concern that we

are trying to "over-engineer" the systems by assuming that we can attain stable levels of different plant species, when in reality, plant populations will inevitably ebb and flow with the incursion of various system disturbances. Given this, Dr. Arsuffi recommended the EAHCP should incorporate greater consideration of inherent variability (e.g., changing abundances of SAV species over time). Mr. Pence countered that the EAHCP needs to have defined metrics to establish compliance, but acknowledged that Dr. Arsuffi's point was well made, and that how to balance defined metrics with ecological dynamism in practice is the challenge.

Dr. Arsuffi suggested ranges (+/-) associated with goals as one possible strategy to accommodate for dynamism versus measuring compliance. Dr. Floyd Weckerly commented that this could also be accomplished using quartiles or standard deviation values for the goals. Dr. Lamon noted that effectively using defined, discrete values for goals requires an understanding of the probability of attainment/compliance—and that without uncertainty analyses, using discrete values is on tenuous footing. Mr. Pence suggested adding wording to the Scientific Evaluation Report that would represent the Science Committee's concern that the inherent flux of the systems should be accounted for, and that staff could try to revisit this in the future. Mr. Pence made the point to commend USFWS for being understanding of the variability the EAHCP faces in attaining compliance within the Comal and San Marcos systems.

Dr. Weckerly suggested establishing an experimental reach where EAHCP suspends restoration activities to provide a control environment that would facilitate comparison of how the ecological community changes between EAHCP restoration areas and the "untreated" area. Melani Howard expressed concern that if this is done before all of the *Hydrilla* and *Hygrophila* is removed from the system, we already know what the end point will be in such an experiment—total invasion by the exotic invasive SAV species. Once removed, she noted, only then might there be a point to establishing such an experimental reach.

Dr. Duke asked if the management adaptations being proposed would be revisited. Mr. Pence answered that yes, on our end, we're considering this through the biological monitoring program.

Details of Flow-split Infrastructure Management

Mr. Mosier asked what valves are present within the Landa Lake flow infrastructure that permit the management of the flows from the lake to the Old and New Channels of the Comal River. Mr. Pence answered that there is (1) a culvert from around the 1990s; (2) another in the spring-fed swimming pool; and (3) two pipes, currently capped, that are being repaired, for a total of four pipes that control flows from the lake to the Comal River. There is also a small weir across from the parks office on the lake, which has a bypass valve that can also be manipulated for the purposes of the program. By pinching this particular valve, the level of the lake can be manipulated.

Discussion of Table 2 (Analysis Matrix)

Dr. Arsuffi presented Table 2 as part of the Scientific Evaluation Report to the Committee. He stated that, by illustrating the benefits and drawbacks of each of the different scenarios, Table 2 makes the choice of final recommendation very clear. Dr. Arsuffi invited his colleagues on the Committee to chime in if they have questions concerning any of the criteria. There were no questions.

Final Motions by the Committee

Dr. Longley motioned to recommend the Nonroutine AMP proposal as presented, with the inclusion of the following Science Committee recommendations:

(1) That species names in EAHCP documents and processes be identified whenever possible;

(2) That consideration of community assembly rules is incorporated in the future, where appropriate, in activities involving ecological issues within the Comal and San Marcos systems (e.g., the selection of SAV species);

(3) That the dynamic nature of the Comal and San Marcos rivers as natural systems is considered in the future, such as by considering expressing goals as +/- ranges, or some other means;

(4) That establishing an experimental reach as a control, in which EAHCP restoration activities would be suspended, is investigated as a possible project; and

(5) That the relatively resilient nature of the fountain darter in the face of habitat fluctuations be recognized.

Provided the recommendations as stated above, Dr. Weckerly seconded Dr. Longley's motion to recommend the Nonroutine AMP proposal. There were no further comments. All were in favor. Motion passed.

Dr. Duke motioned to endorse the expedited process to prepare and submit this Nonroutine AMP Scientific Evaluation Report to the Stakeholder Committee. Dr. Weckerly seconded Dr. Duke's motion. All were in favor. Motion passed.

Following the meeting, this draft of the Scientific Evaluation Report was approved by the Chair and Vice-Chair of the Science Committee for submission to the Stakeholder Committee.