Edwards Aquifer Habitat Conservation Plan

April 18, 2017 Workshop
To Receive Comments
On NAS Report 2

Report Submitted by:
Center for Public Policy Dispute Resolution
at the University of Texas School of Law
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Report

The workshop on April 18, 2017 brought together members of the Science and Stakeholder Committees of the Edwards Aquifer Habitat Conservation Plan (EAHCP) as well as members of the general public. The stated purpose of the meeting was (1) to receive comments from individual members of the EAHCP Stakeholder Committee and Science Committee and the public to inform the implementing Committee as it develops an implementation plan related to the National Academy of Science (NAS) Report 2; and (2) to provide opportunity for participants to gain information about and discuss key recommendations in the NAS Report 2. The meeting was attended by 31 people from the following: six (6) Science Committee members/alternates, eight (8) Stakeholder Committee members/alternates, and 17 public members including representatives from various federal, state, regional and local governmental entities. Also attending were nine (9) EAHCP staff and two (2) facilitators from Center for Public Policy Dispute Resolution. The meeting notice and agenda is attached as Appendix A.

The workshop was organized around the following elements:

- Overview of the purpose and main conclusions of the National Academy of Sciences – National Research Council *Review of the Edwards Aquifer Habitat Conservation Plan: Report 2* (NAS Report 2) provided by the Executive Director, EAHCP Program.[1]
- Morning and afternoon segments for small group discussions around the topics of the NAS 2 recommendations. Participants divided into these groups based on two of the subject matters that interested them. Each small group was facilitated by a member of the EAHCP staff, and included a subject matter expert to answer questions and provide background.[2] These segments consisted of the following:
    - For approximately 60 minutes, each group discussed the NAS Report 2 recommendations, seeking to share knowledge and to understand each other's' perspectives on those recommendations or to understand the subject matter more generally.
    - During the final 15 minutes, each group generated specific comments that members wanted to be recorded. Comments were recorded by the facilitator, along with how many people in the group agreed with the comments. While there was no requirement for the groups to reach consensus on the comments, all comments recorded were, in fact, consensus comments of the groups. A tabular formatting of the recorded comments (aligned with the NAS recommendation to which they apply) is provided as Appendix B. Although not required to reach consensus, the groups generally did reach agreement on the recorded comments.
- Oral reports by the facilitators to the entire workshop of the main conclusions of the small groups.

[1] Participants received a summary of the NAS 2 Report recommendations developed by EAHCP staff, which is provided as Appendix D.
[2] The Ecological Model small group did not have a subject matter expert.

- A formal public comment period.

Participants also provided written comments on cards available at the meeting, and in writing to infor@eahcp.org by May 1. Appendix C provides a transcription of the oral comments received at the Workshop, and written comments received by email.

Participants completed a meeting evaluation form. The evaluations, including general comments provided following the meeting by Edwards Aquifer Authority staff and EAHCP staff in attendance, are summarized in Appendix

Appendix A: Meeting Notice and Agenda

NOTICE OF OPEN MEETING
Available at eahcp.org

As required by Section 7.8.4 and 7.9.3 of the Funding and Management Agreement (FMA), an interlocal agreement made pursuant to Texas Government Code Chapter 791 by and among the Edwards Aquifer Authority (EAA), the City of New Braunfels (New Braunfels), the City of San Marcos (San Marcos), the City of San Antonio acting by and through its San Antonio Water System (SAWS), Texas State University, and the Guadalupe-Blanco River Authority (GBRA), a joint meeting of the **Stakeholder Committee** and of the **Science Committee** of the **Edwards Aquifer Habitat Conservation Plan Program** is scheduled for **9:00 a.m. on Tuesday, April 18, 2017 at the San Antonio Water System building , 2800 U.S. Hwy 281 North, San Antonio, TX.** If you have not already done so and expect to attend, please RSVP to spayne@edwardsaquifer.org to help us with meeting planning.

The purpose of this meeting is to:

- Receive comments from individual members of the EAHCP Stakeholder Committee and Science Committee and the public to inform the Implementing Committee as it develops an implementation plan related to the National Academy of Science (NAS) Report 2.
- Provide opportunity for participants to gain information about and discuss key recommendations in the NAS Report 2.

At this meeting, the following business may be considered. **Times noted are approximate. Items may be taken up earlier or later than noted.**

8:30 Sign In

9:00 Call to order

Welcome, overview of NAS report/what it means to HCP/ workshop purpose, agenda and format

10:30 Breakout Session #1: Small group discussion and capture of comments on the NAS Report 2

11:45 Lunch available in the SAWS cafeteria

12:30 Breakout Session #2: Small group discussion and capture of comments on the NAS Report 2

2:00 Reports from the small group discussions

2:45 Formal public comment

3:15 Summary, next steps, adjourn

The EAHCP Implementing Committee additionally welcomes written comments submitted to: info@eahcp.org Comments received by May 1 will be included in the workshop report presented to the Work Group and Implementing Committee.

Copies of the NAS report and additional background information on the NAS report may be found at http://www.eahcp.org/A

Appendix B: Notes from Breakout Group Discussions

During the morning and afternoon, participants divided into smaller groups based on two of the subject matters that interested them. Each small group was facilitated by a member of the EAHCP staff, and included a subject matter expert to answer questions and provide background.[3] For approximately 60 minutes, each group discussed the NAS Report 2 recommendations, seeking to share knowledge and to understand each other's perspectives on those recommendations or to understand the subject matter more generally. During the final 15 minutes, each group generated specific comments members wanted preserved. While there was no requirement for the groups to reach consensus on the comments, all comments recorded were, in fact, consensus comments of the groups. The number of participants in the morning and afternoon meetings of each subject-matter group is noted, as well as whether they agreed to the comments recorded. However, morning and afternoon groups did not necessarily review or agree to the comments made by the other group, and no attempt is made in the tabular listing of comments to differentiate which are from the morning and which are from the afternoon groups.

The following tabular formatting represents the recorded workshop comments. The facilitator, which assistance from EAHCP staff, has assigned the comments to a general NAS recommendation – a categorization that was not specifically undertaken in the small group note-taking.

Summaries of the oral and written comments received at the meeting or following the meeting, which are provided in full in Appendix C, are also summarized in the table to provide an easy reference for the Work Group and Implementing Committee, which will be considering all comments in its work on the Implementation Plan.

[3] The Ecological Model small group did not have a subject matter expert.

Applied Research

Morning session *(All 5 participants in general agreement on all comments)*
Afternoon session *(Both participants in general agreement with all comments)*

Comments represent general agreement of all participants in either the morning or afternoon sessions, unless otherwise noted.

Topic	*Recommendation*	*Comments from Workshop*
Research Priorities Moving Forward	Some specific applied research foci are especially important given the HCP's management objectives	General agreement. Population studies should try to include all species, not just the CSRB, for use as a baseline (using an empirical model)

Application and Limitations to Application for Existing Applied Research Results	Applied research study results can and should be used to inform management efforts; in some cases, caution is warranted in applying these results, however.	General agreement, and the following specific comments:
		• The Spring Communities should
		  ○ maintain focus on planting and using native plant species in both systems
		  ○ promote native plant species for restoration but not to the detriment of surrounding species

CSRB Population and Sampling Techniques	Several issues remain to be addressed with regards to CSRB population and sampling	General agreement, and the following specific comments: • A study looking CSRB population abundance using a model that incorporated the entire system, not just the sample reached identified in the HCP. • Ensure continued use and implementation of a CSRB sampling Standard Operating Procedure. • A large scale population/abundance study on CSRB is needed.
Administrative/Logistical Considerations Associated with the Applied Research Program	There are several administrative and/or logistical considerations that should be considered for the improvement of the Applied Research Program	General agreement and the following specific comments: • The EAA should make changes to the procurement process to attract academic institutions by allowing longer response times to RFPs, creating multi-year contracts, reducing specifications regarding invoicing, payments, reporting, and deliverables. • EAA should develop a method to access and fund MS and PhD students to conduct research in the springs, thereby training new scientists familiar with the springs and creating more data from their research. • Request a reduction of overhead/indirect costs to make it more affordable to work with universities. • There should be a way to try to integrate new data with existing data

Monitoring/ Mitigation and Minimization Measures

Morning session *(All 10 participants in general agreement on all comments)*
Afternoon session *(All 9 participants in general agreement on all comments)*

Comments represent general agreement of all participants in either the morning or afternoon sessions, unless otherwise noted.

Topic	*Recommendation*	*Comments from Workshop*
Methodological Issues Associated with Water Quality Monitoring	Additional methodological considerations should be taken into account in the WQ monitoring program	• Evaluate Clean Rivers Program data on a predetermined time series analysis to identify trends that adversely affect the systems • There is value to the NAS recommendation regarding PAHs in sediment as an impact on life-cycle of beetles and salamanders • In regards to PAH and other nutrient concentrations in sediment, it is more important to determine source than to identify effect o Consider understanding research and monitoring data before making management decisions • Determine what information is available regarding PAH movement and bioavailability
Administrative Considerations Associated with the Monitoring Program	The monitoring program would benefit from some administrative considerations taken into account	• Value in having a standing work group to evaluate cohesion between monitoring programs and effectiveness of conservation measures.

Integration of Monitoring with Other HCP Programs	Synergies can and should be obtained through integration of monitoring efforts with other aspects of HCP's programming	• Integrate monitoring programs spatially and temporally
		  o Focus on trend analysis and make data available on website (nutrients specifically)
		  o Focus on non-duplication of efforts in gathering data (internally and externally)
		• Look into informal collection of information by other (non-monitoring) contractors to bolster monitoring data collection (e.g. dumping charcoal from BBQs)

Submerged Aquatic Vegetation & Related Conservation Measures	Additional monitoring effectiveness assessment, and integration should be considered in these Measures	• The goal of the non-native vegetation removal and native vegetation restoration is not to strictly increase fountain darter numbers, but rather normalize the eco system and increase health of the system.
		  o Not dismissing NAS comment, but a broader view of the ecosystem is necessary.
		• Focus specifically on sediment sources prevention rather than removal
		  o Current reevaluation through AMP process was noted and encouraged.
		• To be able to remove enough sediment in the systems is futile. Reducing watershed sources is a better use of funds
		  o Importance in communicating outside organization efforts that complement the HCP efforts (MS4 and SAWS ASR)
		• In regards to the non-native vs. native restoration concern staff should remind NAS that the ITP requires less than or equal to 10% of habitat disturbance in any given year.

		• Landa Lake aeration is ineffective, especially during low dissolved oxygen (DO) as seen in past years
		  ○ DO management plan is currently in effect
		  ○ Mini Dot oxygen loggers are a good plan
		  ○ Should add additional temperature loggers

Springflow Protection Measures	Additional analysis of the performance and capacity of the ASR system should be conducted; also a more systematic approach to Phase 2 decision sis warranted.	• General disagreement in value of NAS recommendation regarding ASR operation & VISPO triggers. • ASR/HCP concern is with species, SAWS concern is to maintain supply and fulfill contract

Hydrological Model

Morning session *(All 8 participants in general agreement on all comments)*
Afternoon session *(All 8 participants in general agreement on all comments)*

Comments represent general agreement of all participants in either the morning or afternoon sessions, unless otherwise noted.

Topic	*Recommendation*	*Comments from Workshop*
Modeling for Phase 2 Decisions	MODFLOW should be used to help develop strategic decisions associated with adaptive management and revisions to minimization and mitigation measures	• Regardless of how the phase II decision is made with respect to MODFLOW output, clarity and transparency should be at a maximum. • A regional scale decision support system incorporating MODFLOW predictive output would be useful. • Reevaluate the benefits of other springflow protection measures (i.e. RWCP, VISPO) (from Monitoring/Mitigation group)[4] • In addition to using model output to predict cessation of spring flows, the empirical record should be examined to determine if there are measurable early warning signs.[5]
Modeling Scenarios	Optimizing the bottom-up package of the four spring flow protection measures (scenario to test hydrologic model)	• A comparison of the old versus new model should be conducted with respect to the bottom up package. • It is important to highlight that during the bottom up package runs we assume maximum permitted pumping. In reality we don't near (?) the maximum permitted pumpage of 572,000 acre feet. • In addition to examining the bottom up package we should consider future extreme weather (floods and droughts)
Concept/Scenario Testing	MODFLOW should be used to test a variety of scenarios to improve the confidence in the model itself once current improvements to the model are complete.	• Instead of focusing on the drought of record in the 1950s we may consider focusing our efforts on modeling future drought scenarios. • The success of springflow protection measures provided by the HCP should be documented using the 2011-2014 drought. • We should consider the possibility of future reduced reliance on Edwards water sources. Municipalities are beginning to diversify.

[4] This comment was generated as a parking lot item, but appears to the facilitator and EAHCP staff to be more appropriately placed as a comment in the hydro model section. It was not necessarily generated by the small groups which discussed the hydro model, and did not necessarily receive a consensus agreement
[5] See footnote 5.

Recharge Methods	A recharge estimation ensemble should be created using as many different recharge estimation methods as feasible, and varied uncertain recharge parameters within these methods.	• How could artificial recharge protect springflow?
EAA Five-year Modeling Plan	The five-Year plan should provide more details about what updates are going to be incorporated.	
Interactions between Modeling & Monitoring	There should be a modeling team member who communicates regularly with the monitoring team about how current research can be incorporated into the model.	
Additional Data	The importance of collecting additional field data to improve the groundwater model was discussed in some detail in Report 1.	
Sensitivity Analysis	Use additional calibration and validation metrics.	
Uncertainty Analysis	An ensemble approach should be used to analyze sensitivity to help quantify uncertainty.	• Uncertainty analysis should be considered in the permit rollover and be a guiding principle in the direction of future research. • Where does EAA model output exist on space of uncertainty?
Single Model	Single model would incorporate the best concepts from existing models, rather than two "competing" models.	
General Comments		• Formally document work that has been done

Ecological Model

Morning session *(All 7 participants in general agreement on all comments)*
Afternoon session *(All 11 participants in general agreement on all comments)*

Comments represent general agreement of all participants in either the morning or afternoon sessions, unless otherwise noted.

Topic	*Recommendation*	*Comments from Workshop*
Ecological Model Scenario Testing	There are several different scenarios and/or issues that should be investigated using the ecological model.	• Low flow and spring flow protection measures should be simulated • Catastrophic simulation would be a useful exercise for refugia planning (e.g., to model reintroduction and population growth) • Eco model should look at a range of flows, not just extremes. • It would be useful to use a wider lens to apply eco model to a variety of different questions (not just darter populations) • The eco model can be used to simulate conditions to approximate different climate change scenarios, and should be used for this purpose—planning for climate

		change should begin sooner, rather than later, to begin building new data to support the renewal of the ITP • Eco model should be used to verify darter density per submerged aquatic vegetation metrics • High flows, such as flooding, should be simulated • Streambed morphology should be examined with a view to identifying whether velocity shelters would be appropriate to situate in the river channel to provide additional protection to Covered Species, such as the darter • Eco model should be used to identify what environmental factors are most critical for influencing darter populations (e.g. under low flows, are certain parameters most critical to manage for?) • Eco model should include impacts of runoff on water quality • The general orientation towards the model should be one of maximizing its usefulness to answer a variety of ecological questions relevant for management, not just a strict, narrow "compliance focus"
Definitions, Clarity, and Nomenclature in Ecological Modeling	Definitions of terms, clarity and transparency of model assumptions, and standardized language should be used in the ecological modeling program.	• "Low flows" should be defined • Uncertainty associated with model predictions must be provided • The model is not "done" and care must be taken representing it as such (might instead be described as HCP's "task" being done; the model itself is inherently iterative). • Once uncertainly has been quantified, then you could call the model "done"
Administrative/Logistical Considerations Associated with the Ecological Model	There are some overarching logistical and/or administrative considerations that must be taken into account to ensure the model is used appropriately.	• Model runs and outcomes need to be communicated to stakeholders and the public • There should be a public process for vetting the benchmarking of acceptable levels of risk/ uncertainty • It's important to put into perspective what the decision context is when adjudicating what level(s) of uncertainty is/are acceptable • Care should be taken in interpreting results around extremes (e.g. low flows) • We need to meet again to revisit the eco model once it's operational and once uncertainty is quantified, to have a more informed and timely discussion
Directions for Further Development of the Ecological Model	The ecological model program would benefit from additional work to refine the model	• Scope creep is inevitable; therefore, it is important to keep an eye on budget and goals. • To expand and build model, it would be appropriate to involve other agencies • The submerged aquatic vegetation component is critical to the eco model • We need to draw a line on how far we go in responding to National Academy of Sciences input

Appendix C: Oral, Written and Parking Lot Comments

Oral Comments

The following is a transcript of oral comments received during time allotted at the end of the April 18 workshop.

Charles Kreitler

Re: Hydro Modeling

I've done previous minority reports for the last 20 years. And just some comments on the hydro group and our modeling efforts and a lot of discussion here on uncertainty. Uncertainty is a very interesting issue, in that there is uncertainty in the variables and parameters that go into the model. There is uncertainty as to what the true drought of record will look like, whether it's tree ring related, whether it's 2000-2011, 12, 13, whether it's the 50-56, there's an awful lot of variables out there. And to go in and do additional uncertainty analysis, this is a very reasonable direction to move in. In part, though, when we do have an automobile that looks real good and drives very nicely, it's calibrated and a lot of work went into it in revising the Lindgren model and it's really a fabulous model. And we have to be using it now for a variety of issues that should have priority over worrying about new hubcaps for this wonderful vehicle. And we have this whole bottom up approach, we have a number of different parameters in there, we didn't make the cut-off, the threshold of zero CFS, we're -2 right now. Maybe that's real, maybe that's not real. Big issue. But we have a variety of techniques which have been proposed, CPM, regional conservation, VISPO, ASR, SAWS ASR, etc. etc. And we need to be working with those as to can we increase EAA ASR. We need to even worry about regional conservation. And not only in the context of availability of water at the springs, but how much it costs. And how much does VISPO cost? Is it cost effective? We see that it doesn't really change the bottom up approach when we put it through the drought of record. And I don't know how much it costs. Is it worthwhile doing? Is it because we got some much production out, we're trying to take production out west of the Knippa Gap and try to have that as a remediation approach? To me that doesn't make as much sense as an EAA forbearance ASR of water that's being pumped in San Antonio and Bexar County. We're getting a heck of a lot better bump on water levels and spring flow from that, and I didn't have to do an uncertainty analysis to get there. And to me it says that uncertainty analysis is important, it's the next step in further refining this model, but there are a lot of things this model can be used for right now to evaluate the efficiency of the bottom up approach and trying to get to that neutral point of we're going to save the species because of the need for the 50 CFS. So, that's my comment.

Myron Hess, National Wildlife Federation

Re: Eco & Monitoring

Really it's harkening back to something I talked about in the hydro modeling context. So we have right now a sort of have a focus on moving into Phase 2 and what information do we need to inform Phase 2. And it makes sense that that should be our focus. But it's also thinking about that this is an initial 15 year

term incidental take permit. And the whole idea is that we're going to be rolling that into a future incidental take permit so that this will be ongoing. And it just occurs to me that we need to be thinking now about the information we need to inform that future term permit. Because we've got to collect that during this initial term, at some point. It doesn't have to be right now. And so we really need to be thinking about what additional pieces of information to we need to bring to bear. And maybe in this initial term we're not really going to deal with climate change because it's a 15 year term and we sort of know what we're dealing with. But, for that future one, that's going to be less true, so I just think it's really important that we start thinking about those issues now, identifying what information do we need to be collecting that's going to allow us during Phase 2 to be developing the application information we're going to need for that future component. So it just really occurred to me that we need to start thinking of some of those things now, and as we're gathering information, not just to be gathering information that we need right now to inform decisions for Phase 2, but what information is it going to take to help us develop information for future applications. I just wanted to through that out there.

E. Conrad Lamon, III, Statistical Ecology Assoc., LLC
Re: Hydro & Eco modeling

My comment is in response to Charlie's comment I guess. I'll have more detailed comment later. When you say the hydro model is a perfectly good automobile, and there's a lot of things you can use it for right today, I would probably agree with that as long as you don't include making a rational decision based on it in that list of things you can do with it. I think quantified uncertainty is a requirement for making a rational decision with a model. If you don't know how uncertain your prediction is you can't really evaluate the risk of some uncertain state of nature in the future that may obtain. If you don't know the probability of a state of nature you don't really like, you can't really calculate what the potential cost of making that decision in the present is. So, I would just stress that uncertainty analysis and quantification of forecast uncertainty is really essential in using these things as a management tool to make management decisions regarding resources. I will probably expand on that in a written comment later, but just in a general sense it's not to attack anybody, I'm just saying that in terms of making a rational decision with data and modeling, you really need to know how good the model is. You can do that without knowing that, but there's a large camp of people that would say that is an irrational act.

Written Comments

The following written comments were received either at the April 18 Workshop or directly to the EAHCP via email.

Ken Diehl, SAWS
Re: Mitigation & Minimization

Evaluate if any implications to the HCP/endangered species are or could occur with the TCEQ designation of Segment 1811 Dry Comal as recreational impaired (>126 E. coli) CFU.

E. Conrad Lamon III, Statistical Ecology Assoc., LLC

The NAS vol. 2 report refers to a calibrated version of the fountain darter IBM being available. At present, the science committee has not seen this reported. The interim report received by the committee during 2016 presented a "calibration like" exercise in which model parameters were adjusted to fit the maximum possible densities of FDs. This was done by "killing off" (truncating) FD's that became too crowded, as a result of growing and/or reproducing at a rate greater than in the real physical systems in question. Calibration and adjustment of FD model parameters should be done using observed data from the specific systems in question. Adjustments of parameters should proceed until the model predictions fit the observations as closely as possible over the entire calibration period. Once a calibrated version is obtained, it should be used, unaltered, to predict a second set of system specific observations from a separate time period from that used for calibration. The fit obtained using the validation or verification (second) set of observations can provide an estimate of the prediction error we may expect when using the calibrated and validated model in making management decisions. Such an estimate is a crucial component if we wish to use this model for decision making, as they provide an estimate of the uncertainty in these predictions that will allow the manager to estimate risks associated with potential management actions.

This point was made clear in the first volume report of the NAS team (p 85, and elsewhere):

"An individual based approach also has some critical challenges, especially when embedded into management decision making situations. The idea of following individuals through time and space is intuitively appealing but the confidence in model predictions relies on the availability of data and information to enable calibration and validation of both individual-level variables (e.g., movement tracks) and population-level variables (e.g., abundance, spatial distributions, density-dependence). The extensive data and information needed for model calibration and validation are rarely available for a species in a specific location. Thus, such analyses are better suited for predicting the relative changes in population abundances for specific times (years) and locations. This should be kept in mind when making management decisions that require absolute numbers of individuals expected in the system in a given year."

Since the simulation of FD during the drought of record is a top priority for the HCP, the need for a calibrated and verified model for use in decision making cannot be overstated. In fact, it is standard practice to include calibration and verification as part of the model building procedure, beforeany application of the model (see attached, Lamon, E.C. [6]). The interim report on the ecomodel, like the

[6] The following text was attached to Mr. Lamon's comment:

General Considerations for developing a scope of work for any modeling/data analysis project

Purpose of Modeling

The purpose of the proposed model building/data analysis effort needs to be explicitly described. Models may provide information or understanding, predictions, and /or an organized view of the system. Models may also be a basis for hypothesis testing, enhance communication and provide a basis for data acquisition. None of these purposes preclude the others, and in fact, the best models may accomplish all these purposes.

Steps of model development to be performed by contractor.

1. Model development should begin with a determination of the objectives of modeling.
2. System definition and development of a conceptual model.
3. Construction or acquisition of the mathematical model.
4. Calibrate (estimate) the model.
5. Test ("verify") the model.
6. Apply the model

Issues to consider in model selection and evaluation

excerpt from Vol 1 above, also mentions the lack of data relative to number of parameters (p). Sparse data should not preclude the attempt at calibration and validation (steps 4 and 5) enumerated in the attached file (Lamon, E.C.). Certainly lack of data should not make us focus in on the relative ups and downs predicted by an uncalibrated and unvalidated model that may not represent the system under study very accurately.

Any use of the model should be predicated on the ability of the model to predict abundance with an associated estimate of uncertainty in those predictions. The claim of the NAS team that relative changes in abundance predicted by an uncalibrated and unvalidated model are useful in management is suspect. Models may be thought of as sets of hypotheses, represent by mathematical structures designed to represent a real system. These mathematical structures must be populated by unknown model parameters (coefficients), which cannot be measured in the field, but may be estimated from the system specific data (preferred) or selected from published literature. When model parameters are selected from literature published using data from other systems, the only test of the hypotheses represented by the chosen model structure and its associated parameters is goodness of fit to data from the system under study. While "relative changes in abundance" predicted by the model in association with proposed management activities may be interesting to researchers, there is no guarantee that the choices of structure and parameter values made in model development represent a system that in any way resembles the system under study (or any other system for that matter). Such models are inadequate for decision making because we have no assurance that even a small change in predicted abundance will not result in an unacceptable risk to the population. In short, if the model cannot predict historical observations with an associated uncertainty that is known, we should have little confidence using the model to predict the (unobserved) future. With only point estimates of abundance, without reliable uncertainty estimates, it is impossible to assess the probability of zero abundance of FD (in one or all habitat types), and therefore impossible to measure attainment of Biological goals.

It may be considered hubris to believe that our selection of a single set of parameters from the literature represents the right choice (i.e. all of our hypotheses regarding model structure and parameter values are exactly correct), especially in the context of a mechanistic approach where the number of unknown model parameters (p) is quite large relative to the number of observations (n) available. Such over- parameterization of the model may rapidly result in a condition called

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Assumptions – Models are simplifications of physical/biological systems. What assumptions were made? Are they of consequence?
Causality-Correlation – Is the model consistent with theory? Is there a basis for drawing causal conclusions? Is correlation, not causality the basis for a predictive model?
Precision – Uncertainty – The value of information from a model is inversely related to the uncertainty in the predicted response.
Complexity and Precision - “Large” (multi-equation) mechanistic models are complex, but they may be less precise than simple (single equation) empirical models.
Simplicity – select the simplest model that adequately addresses the problem.
Costs – Value of Information – The more complex the model, generally, the higher the costs for calibrating and running the model. Is the additional cost (beyond that for a simple model) justified in terms of resultant information?
Calibration – Should site-specific data be obtained to estimate model parameters, or should “default” parameter values be selected?
Verification (Confirmation) – How different were the calibration conditions from the verification conditions? Were formal statistical tests used for verification?

equifinality (see Beven and Freer), in which there are a very large number of unique sets of model parameters that produce the same model output (predicted abundances). Approaches for evaluating parameter uncertainty in water quality models (Stow, et al.), separate from prediction uncertainty mentioned above in the discussion of calibration and validation, may be useful in making decisions regarding future modeling and monitoring efforts in the current modeling framework.

Beven, K.J. and Freer, J., 2001a. Equifinality, data assimilation, and uncertainty estimation in mechanistic modelling of complex environmental systems, Journal of Hydrology, 249, 11–29.

Lamon, E.C., "General Considerations for developing a scope of work for any modeling/data analysis project", transmitted 6-10-2016 to EAHCP senior staff, adapted from lecture #1 notes from my graduate Water Quality Modeling for Management course, attached to this email.

C.A. Stow, K.H. Reckhow, S.S. Qian, E.C. Lamon, G.B. Arhonditsis, M.E. Borsuk, and D. Seo, 2007. Approaches to evaluate water quality model parameter uncertainty for adaptive TMDL implementation. Journal of the American Water Resources Association, 43(6):1-9.

Parking Lot

The following list represents comments not directly related to the NAS Report 2 focus of the workshop, or questions for EAHCP staff.

- PAH in sediment data to be provided to the springs communities for presentations (from Monitoring/Mitigation group)
- EAHCP should mention in the annual report all BMPs and mitigation efforts regardless of whether they were solely paid for by the EACHP or whether they were requirements of MS4 permits, with the Cities paying for them.
- We spend a lot of time discussing how to make sure the springs don't drop below 30 cfs for the time periods prescribed in the HCP. Should we be evaluation whether 30 cfs is the correct number?

Appendix D: Summary of NAS Recommendations

Applied Research Recommendations

Italicized text indicates recommendations repeated from NAS Report 1

Topic	Recommendation	Details
Research Priories Moving Forward	Some specific applied research foci are especially important given the HCP's management objectives.	The 2017 project to establish better relationships between the fountain darter and the different species and coverages of SAV (including Ludwigia) in both systems is critically important.
		Research to better understand the life history of listed species and identifying effective sampling techniques rightfully deserves high priority.
Application and Limitations to Application for Existing Applied Research Results	Applied research study results can and should be used to inform management efforts; in some cases, caution is warranted in applying these results, however.	The CSRB temp and oxygen study's use of surrogates is of questionable relevance for the CSRB.
		The CSRB temp and oxygen study's use of lab environments may not provide a relevant test of CSRB behavior in its natural environment.
		Areas where Hygrophila is of concern should be targeted for Ludwigia establishment where restoration efforts are being carried out.
		The competitive advantage of Ludwigia against Hygrophila should be communicated to the SAV modeling team and incorporated into their efforts.
		Additional consideration of the interactions between Hydrilla and Ludwigia is needed before conclusions are made or further application of this research occurs.
		Ludwigia should be seriously considered for use in the San Marcos system.
		miniDOT oxygen sensors in Landa Lake and Upper Spring Run should be continued as part of a routine integrated water quality and biological monitoring program
		The Committee recommends that aeration not be used routinely as a mitigation measure.
		There should be a method to provide standardized data that accounts for the amount of time that the cotton lure has been deployed.
		The CSRB trophic study should be looked at with a view to possibly identifying an alternative sampling approach for the CSRB that could be a reasonable reflection of population densities.

CSRB Population and Sampling Techniques	Several issues remain to be addressed with regards to CSRB population and sampling.	Identifying the type, and estimate the relative amount, of organic matter near or at the cotton lure placement locations should be included as part of the cotton-lure SOP for CSRB.
		A validation study encompassing repeated sampling from the same and new spring outlets to account for potential life history and flow effects on the population estimates is highly recommended.
		Studies on the importance of Peck's cave amphipod-predation on the CSRB may be warranted.
		Key lab experiments involving the CSRB (e.g., connectivity study) should be validated using creative field studies where variables can be manipulated.
		Attempts to understand the population abundances of the CSRB should be undertaken.
		Attempts to better quantify the CSRB population densities should be undertaken.
		Attempts to better calibrate the cotton-lure method of sampling to be efficient and reliable for estimating populations should be made.
Administrative/Logistical Considerations Associated with the Applied Research Program	There are several administrative and/or logistical considerations that should be considered for the improvement of the Applied Research program.	The window of time for an RFP to be open to final deadline should be extended.
		The EAA should continue to look for ways to remove conditions that restrict the pool of potential Applied Research applicants.
		The EAA should use the data management system being implemented to allow greater data discovery and access by the outside scientific community and the public.
		The cause for the large mortalities of CSRB at the FAB still needs to be definitively identified and resolved through additional study.
		The EAA should be prepared to invest in additional research projects in life history of listed species and sampling techniques that span multiple years, if necessary.
		Monitoring effectiveness of M&M measures should not be part of the Applied Research Program.
		Resources for ongoing data management activities will need to be allocated throughout the lifetime of the HCP.
		Modeling efforts should become more integral to consideration of future Applied Research projects.

Monitoring and Mitigation

Italicized text indicates recommendations repeated from NAS Report 1

Topic	Recommendation	Details
Methodological Issues Associated with Water Quality Monitoring	Additional methodological considerations should be taken into account in the WQ monitoring program.	If the EAA is to use Clean Rivers Program WQ data, it should co-located in sampling space and time.
		All nutrient analyses be performed on the same water sample(s).
		Frequency and extent of high concentrations of PAHs should be established by more extensive sampling in areas where elevated levels have been identified.
		If it is not possible to substantially reduce PAH concentrations through sediment removal and source control, evaluation of bioavailability of the PAHs in the sediment should be considered.
Administrative Considerations Associated with the Monitoring Program	The monitoring program would benefit from some administrative considerations taken into account.	The EAA should consider forming a standing working group on monitoring that would meet as needed to provide advice and outside perspective on the EAA's monitoring program.
Integration of Monitoring with Other HCP Programs	Synergies can and should be obtained through integration of monitoring efforts with other aspects of HCP's programming.	The eco modeling team should have been represented in the monitoring work groups.
		The monitoring program should include the long-term data required to test and inform continuous refinements of the ecological model.
		The EAA should consider deploying the miniDOT dissolved oxygen sensors used in the Landa Lake dissolved oxygen study as part of the routine monitoring program.
		All M&M measures that are implemented as part of the HCP should be integrated into one conceptually unified monitoring program.
		The performance monitoring of M&M measures should be integrated into the existing water quality and biological monitoring programs.
		M&M effectiveness monitoring should be done periodically with a comprehensive synthesis of the monitoring data every five years or so.
		We recommend continuing to compute ratios from data such as those reported in BIO-WEST and Watershed Systems Group (2016), further refining the data to be as species specific as possible.

Submerged Aquatic Vegetation & Related Conservation Measures	Additional monitoring, effectiveness assessment, and integration should be considered in these Measures.	In light of October 2015 flooding damage, upstream erosion and stormwater runoff control measures may be needed to protect planting and sediment control efforts downstream.
		There is not enough new habitat from native plantings to maintain populations of fountain darter to balance non-native plant removal.
		Habitat availability for the FD should be verified by considering the carrying capacity of the various SAV species (both native and non-native) for fountain darter.
		It is important to track the difference between the area of non-native plants removed and the sustained native coverage (reported as m2).
		It is important to track the number of plants planted, resulting sustained area, coverage of vegetation from baseline maps in 2013, and lessons learned regarding new species or techniques.
		Non-native vegetation should be considered as fountain darter habitat when it comes to maintaining and increasing habitat availability for the fountain darter.
		Bank pins and turbidity loggers could be used to evaluate sediment deposition where background knowledge is not currently available. Water depth and sediment accumulation should be monitored in areas being considered for sediment removal as well as post-removal as well.
		All sediment removal actions should be coupled to monitoring efforts to demonstrate their efficacy.
		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.
		The Committee recommends that aeration not be used routinely as a mitigation measure, but be held in reserve to be used only in case of severe low oxygen conditions throughout all of Landa Lake.
		Manual breaking up and removal of the floating mats should be considered as a mitigation measure if floating mats cover more than 25 percent of the surface of Landa Lake and dissolved oxygen concentrations decrease.

Springflow Protection Measures	Additional analysis of the performance and capacity of the ASR system should be conducted; also, a more systematic approach to Phase 2 decisions is warranted.	The Committee recommends that Phase 2 of the HCP implement a Decision Support System to replace the triggers for the spring flow protection measures (e.g., VISPO), or possibly when the HCP is reviewed for renewal.
		Due diligence should be applied to verify the future long-term reliability of the ASR system given the importance of the ASR performance to the success of the HCP.
		The EAA and SAWS should give consideration to whether geochemical reactions between the Edwards Aquifer injected/recharged water and the aquifer permeable matrix may cause adverse water quality issues in the short or long term (especially as the storage volume increases to encounter aquifer matrix not yet exposed to the Edwards Aquifer groundwater).
		The EAA and SAWS should give consideration to whether there are any geochemical reactions between the injected Edwards Aquifer groundwater and native Carrizo Aquifer groundwater that may cause adverse water quality issues in the short or long term.
		The EAA and SAWS should give consideration to whether there is any evidence of mineral precipitation in the aquifer or on well materials (e.g., models or projections of porosity declines in the ASR storage zone) that may affect long-term system performance.
		The EAA and SAWS should give consideration to what the long-term trends in ASR well performance are.
		The Committee recommends that 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.
		The Committee recommends to design and implement water quality monitoring for arsenic and related constituents in monitoring wells during recharge and storage events.
		The Committee recommends to design and implement water quality monitoring in ASR wells during recovery events.
		The Committee recommends that compliance of the parties participating in the spring flow protection measures be audited due to the high expense of the spring flow protection measures and their importance to the HCP's success.

Hydrologic Modeling Recommendations

Italicized text indicates recommendations repeated from NAS Report 1

Topic	Recommendation	Details
Modeling for Phase 2 Decisions	**MODFLOW should be used to help develop strategic decisions associated with adaptive management and revisions to minimization and mitigation measures.**	**Developing a more refined framework that incorporates modeling into the decision criteria for triggers rather than relying on triggers based on measured groundwater elevations at specific wells should be considered in planning for Phase 2 of the HCP.**
		A decision support system (DSS) should be developed to be used in Phase 2 of the HCP in order to apply the model to short-term decisions (e.g., a one-month time frame) related to determining springflow protection triggers.
		A DSS would clearly direct these decisions on the basis of different model outcomes. A good DSS is developed and applied with the understanding that model predictions, although uncertain, represent the best available science on which to base management decisions.
		MODFLOW should be used to evaluate scenarios that help understand what processes are important in the system. Examples would include applying the model for testing concepts, parameters, and system conditions, not just producing predictions, which can be highly uncertain.
Modeling Scenarios	**Optimizing the bottom-up package of the four spring flow protection measures (scenario to test hydrologic model).**	**Testing a variety of scenarios will not only improve the confidence in the model itself but also will help develop strategic decisions associated with adaptive management and revisions to minimization and mitigation measures.**
		There is currently no information on any attempt to optimize the combination of measures including the magnitude and spatial implementation of each or the order in which they might be implemented. In such an analysis, the objective function could be formulated to minimize the deviations of the spring flow and water level targets.
		From this exercise a different combination of measures with different magnitudes may emerge as the optimal combination which minimizes the deviations from the spring flow targets or cost of implementation.

		An optimization modeling exercise should be conducted using pumping sensitivity analysis results to determine the combination of wells and wellfields that would be most effective in achieving the hydrologic goals of the HCP. A comprehensive analysis of this could provide useful information for developing various options for implementing flow protection measures during future droughts. This scenario can answer the question "Which wells have the greatest influence on index wells or discharges from the springs?"
Concept/ Scenario Testing	**MODFLOW should be used to test a variety of scenarios to improve the confidence in the model itself once current improvements to the model are complete.**	**The groundwater model should be tested against the 2011 to 2015 period. 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.**
		Past droughts of shorter duration with more or less intensity are also of interest in understanding the effectiveness of flow protection measures and to test the model's accuracy. Testing how well the model can predict responses during such lesser extremes may demonstrate its applicability to a variety of climatic conditions and further enhance the confidence in the model for adaptive management and for other applications in Phase 2 of the HCP.
		A hydrologic scenario that simulates climatic and socioeconomic conditions more severe than the DOR should be designed to test the model. Performance of the system under a variety of drought conditions. The DOR may not represent the true worst-case scenario as the baseline for hydrological modeling (Report 1).
		The use of paleo data (e.g., tree rings) and possibly stochastic modeling of rainfall patterns should be explored for the development of extreme modeling scenarios.
		Climate scenarios should be designed considering the results of climate-model predictions available from regional climate models that are nested within general circulation models.
		Spatial variability in rainfall within the Edwards Aquifer region should also be explored in scenario investigations.
		A scenario with projected land use changes and likely change in climate (but no change in water withdrawals by well pumping) over the next two to three decades should be simulated to answer the question "How would changes in recharge amount due to changing land use impact spring flows?"

		Use telescoping grids in hydrologic model. Modeling smaller areas can address some of the RRWGs concerns about cost and feasibility in testing conceptual models because there is no need to reconceptualize the entire HCP model.
Recharge MethodsA18:C24	A recharge estimation ensemble should be created using as many different recharge estimation methods as feasible, and varied uncertain recharge parameters within these methods.	The ensemble will provide a range of possible outcomes for spring flows, and this range can be examined for calibration periods, validation periods, and most importantly for future scenarios predicted by the model.
		Daymet data should be considered for recharge estimation instead of NEXRAD. Daymet data contains gridded weather parameters for the United States at a 1-km resolution for 1980 to the present.
		USGS' soil-water-balance (SWB) model should be used to enhance the ensemble for estimating recharge. This model estimates spatially distributed daily recharge on the basis of gridded weather and soils data.
EAA Five-year Modeling Plan	The Five-Year plan should provide more details about what updates are going to be incorporated.	Providing more specifics about what updates will occur enhances communication.
		The Five-Year plan needs to show an iterative approach between data collection and model updates; it does not do so now.
		It may be necessary to update the Five-Year plan more frequently than every five years (e.g., every two to three years) if new information becomes available and the original plan becomes outdated.
		A decision support system should be included in the Five-Year plan.
Interactions between Modeling+A25: C32 & Monitoring	There should be a modeling team member who communicates regularly with the monitoring team about how current research can be incorporated into the model.	A formal versioning system should be used, consisting of a model archive and peer-reviewed report identified by a unique version number, with a model update occurring about every five years. Once the model moves from the development and calibration stage to operational mode, it should be formally documented as a public record at a high level of transparency.
Additional Data	*The importance of collecting additional field data to improve the groundwater model was discussed in some detail in Report 1.*	*Data associated with characterizing conduits and evaluating Trinity-Edwards hydraulic connections should be incorporated to improve the groundwater model.*
		All available pumping data should be incorporated to improve the groundwater model.
		Rainfall variation data from the past few years should be high priority for incorporation in the groundwater model.
		Conduit and barrier features in the MODFLOW model were adjusted based on FEFLOW modeling, but additional evaluation of these features could be considered.

Sensitivity Analysis	*Use additional calibration and validation metrics.*	It is essential that the EAA strives to improve the predictive skills of the model for the anticipated refinements to the flow protection measures that may be necessary in Phase 2. The MODFLOW model is expected to continue to be the primary groundwater modeling tool for the HCP.
		The EAA should conduct a sensitivity analysis involves field tests using a set of wells thought to have the highest sensitivity to water levels at index wells and flows at springs. Pumping at these wells could be increased by some percentage for a certain length of time (e.g., one-two months).
		Conduct more explicit sensitivity analysis. Technique(s) to quantitatively assess model uncertainty should be used and presented in formal EAA documents.
Uncertainty Analysis	*An ensemble approach should be used to analyze sensitivity to help quantify uncertainty.*	Public misunderstanding about uncertainty analysis should not be used as an excuse to limit best practices in modeling. Moreover, techniques should be applied to improve model design and data collection that decrease uncertainty.
		One of the 5 methods of uncertainty analysis recommended in Report 1. There was no indication that other conceptual-model parameters, boundary conditions, or other assumptions will be included in an ensemble approach for uncertainty analysis.
		Recharge estimates from the HSPF method should be included in the ensemble approach being used for uncertainty analysis.
		No new progress on HSPF modeling since the first Committee meeting (February 2014) has been presented. The EAA spent considerable time developing recharge estimates using HSPF.
		Using PEST predictive uncertainty analysis. One of the 5 methods of uncertainty analysis recommended in Report 1. The RRWG identified uncertainty analysis in the Five-Year plan, but only the ensemble approach is mentioned.
		Show error bars on spring-flow and water-level predictions. One of the 5 methods of uncertainty analysis recommended in Report 1….the Five-Year plan does not mention error bars, and modeling results shown at the committee meeting on February 2, 2016 did not incorporate them.
Single Model	*Single model would incorporate the best concepts from existing models, rather than two "competing" models.*	FEFLOW stratigraphic data should be incorporated into the current MODFLOW model.
		Lessons learned from incorporating the contributing zone in FEFLOW should be articulated so that they can be used to inform the current MODFLOW model.
		Devote future resources to a single model.

Ecological Modeling Recommendations

Italicized text indicates recommendations repeated from NAS Report 1

Topic	Recommendation	Details
Ecological Model Scenario Testing	**There are several different scenarios and/or issues that should be investigated using the ecological model.**	**To explore how SAV habitat affects FD, the timing of the existing maps could be switched within simulations to determine whether simulated FD population dynamics are sensitive to sub-regional scale and interannual variability in the observed SAV (habitat) record.**
		A scenario could be run to force FD population reductions (simply remove individuals on a day in certain areas) and determine the time period that the population remains below a threshold and the subsequent rate of recovery of the population to a healthier value.
		Running the model under low flows and for flow protection measures to evaluate the impact on predicted SAV is a critical question for the FD model.
		Pushing the model to catastrophic scenarios – for example where SAV is only present in refugia – might reveal some insights regarding recovery following such an event.
		Examining simulated maps of SAV representative of "good" and "bad" years in various virtual time series should be done in a dynamic SAV model.
		A possible useful application of the model would be to better understand the degree of long-term maintenance that might be required to eradicate non-native species.
		The EAA should explore the diagnostic abilities of this mechanistic model to better understand the environmental forcings that influence vegetation, and to identify future applied research questions that might best serve management goals.
		An additional scenario could be designed to examine whether there are measureable thresholds of SAV acreage in a given reach that result in dramatic increases or declines in FD abundance.
		Historical flows outside of the calibration and validation time periods should be used to assess FD responses under a wider range of previously observed historical flow conditions.
		The effects of the EAA's so-called "bottom-up package" of flow protection measures should be imposed in the model and compared to FD population dynamics without the package.
		A specific set of flow scenarios should be designed to determine what conditions of low flows lead to high risk for FD.

		A scenario could be designed that varies the growth, mortality, reproduction, and movement rates of the individual FD within the model under a suite of flows and other environmental conditions.
		Factors like low dissolved oxygen, sediment removal, algal blooms, gill parasites, and shifts in prey and predator composition can all be examined with the FD model.
		To explore how SAV habitat affects FD, observed SAV habitat maps could be retained in simulations, but adjust growth, mortality, or reproduction of the FD individuals to reflect when they are in the areas where SAV is expected to respond to the management actions.
		To explore how SAV habitat affects FD, existing SAV habitat maps could be used, and manipulated to reflect expected changes based on the management actions.
		A first effort to evaluate the impact of changed coverage by native versus non-native SAV species on FD populations could be useful given recent SAV AMP.
		The focus on using the FD model to predict the responses of FD abundance to alternative HCP flow control packages is useful, but there are other uses of such mechanistic models that should be considered.
		The conceptual and predictive ecological models should be used to evaluate the minimization and mitigation (M&M) measures, both in terms of appropriateness and efficacy.
		Scenario analysis should be used as part of a broader iterative process inherent in all ecological modeling.
		Scenarios should be defined based on the management needs, to advance our understanding, and to identify critical data gaps.
	Definitions of terms, clarity	All scenario questions should be well defined.
		The conditions under which the model was developed should be compared to the conditions for which the model will be used in scenarios, in order to determine the degree to which the model is within in its domain of applicability
		There should be an explanation of the expected effects of a scenario on and what and how these effects are represented in the model (either explicitly or implicitly).
		There should be confirmation that the major effects are represented in a reasonable way for each scenario.
		Sources of stochasticity represented in each scenario should be identified and acknowledged to account for expected variability.

Definitions, Clarity, and Nomenclature in Ecological Modeling	and transparency of model assumptions, and standardized language should be used in the ecological modeling program.	Dimensions of uncertainty in each scenario should be tracked and acknowledged to account for variability.
		The baseline conditions and dimensions of the predictions (temporal and spatial scales; absolute or relative terms) should be clearly stated as part of specifying each scenario.
		Predictions for scenarios should include, at some level, model-based explanations of why the predicted response occurred.
Administrative/Logistical Considerations Associated with the Ecological Model	There are some overarching logistical and/or administrative considerations that must be taken into account to ensure the mode is used appropriately.	General information regarding sensitivity analyses that should be used to inform the limits and expectations for model runs should be made available.
		A simple one-time transfer of the models from the developers to the EAA should be avoided because this can result in inefficient, and even possibly erroneous, use of the FD and SAV models.
		The temporal and spatial scales of the SAV and FD models are reasonable but the representativeness of selected reaches and the variance properties associated with the use of QUAL2E outputs as model inputs should be clearly documented.
		The issues and recommendations described in NAS' interim eco model report should be adequately addressed prior to running the scenarios.
		All model results should be carefully labeled according to the nomenclature described in Report 2.
		Sexual and vegetative reproduction should be represented in the dynamic SAV model.
		The EAA should continue with the conceptualization of the overall ecosystem by building on the FD and SAV conceptual models.
		The current habitat suitability analysis for TWR should be treated as a hypothesis and tested for robustness throughout the San Marcos River.
		The EAA should return to Report 1 for a thorough evaluation and recommendations on their earlier approach and consider new methods that have evolved to address some of the issues with the classical habitat suitability approach if the suitability analyses are pursued in the future.
		A better CSRB sampling approach is needed for determining ITP compliance, estimating the current CSRB population, and projecting future changes.
		The EAA should be prepared to develop detailed monitoring plans for the other covered species if the CSRB is abandoned as an indicator species.
		Explicit treatment of how actions directed at SAV would affect FD through the coupled models is recommended.

Directions for Further Development of the Ecological Model	The ecological model program would benefit from additional work to refine the model.	The use of an individual-based approach imbedded within a 2-D spatial grid for full life-cycle simulations of FD population dynamics is a scientifically sound framework for the questions being asked, but there remain some important steps (related to how SAV) is represented) to link the FD dynamics to their habitat.
		The representation of the processes of FD growth, mortality, reproduction, and movement presently in the model are well-founded but may be too simple and not sufficiently linked to changes in habitat and flow to answer some of the important management questions.
		The SAV model is not yet far enough along in its development for detailed suggestions regarding scenarios.
		The historical time period used for calibration had relatively similar environmental conditions from year-to-year, which limits the range of conditions of scenarios feasible for exploration by the model.
		The representation of flow effects in the model seems too limited in potential effects due to reliance on having site-specific empirical evidence for the effects.
		Thresholds in process representations should be used cautiously because they can erroneously create nonlinear population responses and unrealistic sensitivities to changes in habitat & flow.
		The representation of density-dependence and how its effects on individuals manifest at the population level needs further evaluation.
		Calibration and validation of the FD model to date shows the model can reproduce the historical abundances, but additional confidence is needed to most effectively use the model for management purposes.
		As a top priority the EAA should develop an ecosystem-based conceptual model, or a series of conceptual models of increasing resolution, that show how water quality and quantity, other biota, and restoration and mitigation activities are expected to interact with the indicator species, as well as with all covered species.
		The habitat suitability analyses done for the fountain darter should be used as a "back-up" to the individual-based modeling and provide additional quasi-independent results to support a weight-of-evidence approach for the fountain darter.
		A much deeper understanding of the CSRB's natural history should be obtained in order to be able to include the CSRB in a mechanistic model.

Appendix E: Evaluations

Participant Evaluation

Edwards Aquifer HCP
Workshop on National Academy of Science Report 2
April 18, 2017

	Strongly agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
The meeting achieved the goal of receiving comments on the NAS report to inform the Implementing Committee.	7	10	1			
The meeting provided an opportunity to gain information about the NAS report.	10	8	1			
The meeting provided an opportunity to discuss key recommendations in the NAS report.	11	8				
The small group discussion about NAS report topics was beneficial.	10	9				
There was sufficient time to discuss the topics.	6	8	3	2		
The meeting allowed me to understand the views of others related to the NAS report.	10	9				
I had sufficient opportunity to make formal comments.	10	8	1			
The meeting was well organized and run.	13	6				
The notice for the meeting was timely and sufficient.	12	5	2			

Please elaborate on any of the answers above:

- More time needed to dig into details more
- An overview of the NAS comments at beginning of workshop to help maximize participation
- Some of the discussion was dominated by subject-matter experts; We could've used 15 more minutes in afternoon session
- Small group discussion good but equally as valuable was having the SMEs in the group
- Thank you. The format was a good one: interactive and informational and minimized power points
- It would have helped me to receive the handouts in advance
- One of the best opportunities to exchange information and brainstorm solutions

What was most useful about the meeting?

- Discussion with others
- Group discussions with SMEs
- Hearing others experience
- The organization of the material; the familiarity of Shaun with the NAS Report
- Small group setting allowed sharing of information and explanation of different ideas and viewpoints
- Facilitators at each table; insight from subject-matter experts
- Facilitator and SME approach made sure dialogue was directed and with sufficient depth
- The small groups
- Great facilitation; good summary handouts
- The format for the day was excellent. Thank you.

The Edwards Aquifer Authority and EAHCP staff who attended the workshop provided the following feedback separately after the meeting.

- It would have also been prudent to have a EcoModel summary or the executive EcoModel summary from the model documentation.
- Provide definitions of acronyms.
- Perhaps, after their RSVP, assign people to tables based on their preference but with consideration to the group composition/dynamics.
- A subject matter expert should have been assigned to the EcoModel table.
- Participants should have been encouraged to switch tables.
- Participants liked focusing on their topics of interest.
- Did not need to take a vote – facilitators were aware if they had reached a consensus.
- Increase the participation in the public comment.
- Evaluate the rules and guidance for SME's.
- Make the report of the workshop public – present to the IC.
- Should have identified those NAS recommendations already completed.
- It was beneficial for the facilitator to ask each participant their opinion of the NAS recommendations: What recs did they agree with? What recs did they have concerns with?