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<tbody>
<tr>
<td>Research Priorities Moving Forward</td>
<td>Some specific applied research topics are especially important given the HCP’s management objectives.</td>
<td>1</td>
<td>The 2017 project to establish better relationships between the fountain darter and the different species and coverages of submerged aquatic vegetation (including Ludwigia) in both systems is critically important.</td>
<td>General agreement; Population studies should try to include all species.</td>
<td>Done and may potentially be examined further through future Applied Research.</td>
<td>No</td>
<td>Yes, with the caveat that budget only extends until 2019.</td>
<td>Yes</td>
<td></td>
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<td></td>
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<td>2</td>
<td>Research to better understand the life history of listed species and identifying effective sampling techniques rightfully deserves high priority.</td>
<td>General agreement; see 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.</td>
<td>No action required</td>
<td>No</td>
<td>Yes, with the caveat that budget only extends until 2019.</td>
<td>Yes</td>
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<td></td>
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<td>3</td>
<td>The Comal Springs riffle beetle temp and oxygen study’s use of surrogates is of questionable relevance for the Comal Springs riffle beetle.</td>
<td></td>
<td>No action required</td>
<td>No</td>
<td>Yes, with the caveat that budget only extends until 2019.</td>
<td>Yes</td>
<td></td>
<td>HCP staff agrees with this comment.</td>
</tr>
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<td></td>
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<td>4</td>
<td>The Comal Springs riffle beetle temp and oxygen study’s use of lab environments may not provide a relevant test of Comal Springs riffle beetle behavior in its natural environment.</td>
<td></td>
<td>No action required</td>
<td>No</td>
<td>Yes, with the caveat that budget only extends until 2019.</td>
<td>Yes</td>
<td></td>
<td>HCP staff agrees with this comment.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>Areas where Hygrophila is of concern should be targeted for Ludwigia establishment where restoration efforts are being carried out.</td>
<td></td>
<td>In process</td>
<td>No</td>
<td>Yes, with the caveat that budget only extends until 2019.</td>
<td>Yes</td>
<td></td>
<td>The submerged aquatic vegetation research was conducted by members of the modeling team.</td>
</tr>
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<td>6</td>
<td>The competitive advantage of Ludwigia against Hygrophila should be communicated to the submerged aquatic vegetation modeling team and incorporated into their efforts.</td>
<td></td>
<td>Done</td>
<td>No</td>
<td>Yes, with the caveat that budget only extends until 2019.</td>
<td>Yes</td>
<td></td>
<td>HCP staff agrees with this comment.</td>
</tr>
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<td></td>
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<td>7</td>
<td>Additional consideration of the interactions between Hydrilla and Ludwigia is needed before conclusions are made or further application of this research occurs.</td>
<td></td>
<td>In process</td>
<td>No</td>
<td>Yes, with the caveat that budget only extends until 2019.</td>
<td>Yes</td>
<td></td>
<td>This recommendation is available to NB and SM/TXSTATE for consideration as they implement the submerged aquatic vegetation schedule/regime established through AMP.</td>
</tr>
<tr>
<td>Application and Limitations to Application for Existing Applied Research Results</td>
<td>Applied research study results and should be used to inform management efforts; in some cases, caution is warranted in applying these results, however.</td>
<td>8</td>
<td>Ludwigia should be seriously considered for use in the San Marcos system.</td>
<td></td>
<td>In process</td>
<td>No</td>
<td>Yes, with the caveat that budget only extends until 2019.</td>
<td>Yes</td>
<td></td>
<td>This recommendation will be made available to SM/TXSTATE for consideration as they implement the submerged aquatic vegetation schedule/regime established through AMP.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>NHDOT oxygen sensors in Landa Lake and Upper Spring Run should be continued as part of a routine integrated water quality and biological monitoring program.</td>
<td></td>
<td>Yes</td>
<td>No</td>
<td>Yes, with the caveat that budget only extends until 2019.</td>
<td>Yes</td>
<td></td>
<td>EAHCP added a sonde to Landa Lake; CONB plans to add through 2018 Work Plans (not yet approved).</td>
</tr>
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<td></td>
<td></td>
<td>10</td>
<td>The Committee recommends that aeration not be used routinely as a mitigation measure.</td>
<td></td>
<td>TBD through Landa Lake DO Mgmt. Plan, Upper Spring Run Mgmt. Plan under development.</td>
<td>No</td>
<td>Yes, with the caveat that budget only extends until 2019.</td>
<td>Yes</td>
<td></td>
<td>EAHCP is currently conducting research to establish a DO Mgmt. Plan for Landa Lake and may pursue AMP next year.</td>
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<tr>
<td>Comal Springs riffle beetle Population and Sampling Techniques</td>
<td>Several issues remain to be addressed with regards to Comal Springs riffle beetle population and sampling.</td>
<td>11</td>
<td>There should be a method to provide standardized data that accounts for the amount of time that the cotton lure has been deployed.</td>
<td>General agreement, and the following specific comments: A study noting specific changes in the time period for an RFP to be open to final deadline should be undertaken.</td>
<td>Done</td>
<td>No</td>
<td>Yes, with the caveat that budget only extends until 2019.</td>
<td>Yes</td>
<td>Done through the 2016 Comal Springs riffle beetle Cotton Lure SOP Work Group.</td>
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<td></td>
<td>The window of time for an RFP to be open to final deadline should be extended.</td>
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<td></td>
<td>The time period will be extended by 3 weeks to 6-8 weeks for 2018/2019 RFPs.</td>
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<td></td>
<td>The HCP is not required to produce population estimates of the Comal Springs riffle beetle. However, the HCP has a current and ongoing research program on the springs and creating a long-term trend line for the Comal Springs riffle beetle. The HCP is required to produce population estimates of the Comal Springs riffle beetle. Any changes to this project will be addressed by the EAA and TPWD.</td>
</tr>
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<td>The HCP is not required to produce population estimates of the Comal Springs riffle beetle. However, the HCP has a current and ongoing research program on the Comal Springs riffle beetle. Any changes to this project will be addressed by the EAA and TPWD.</td>
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<td>The window of time for an RFP to be open to final deadline should be extended.</td>
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</table>

**Considerations Associated with the Applied Research Program**

- Done through the 2016 Comal Springs riffle beetle Cotton Lure SOP Work Group (EAHCP, 2016).
- The HCP is not required to produce population estimates of the Comal Springs riffle beetle. However, the HCP has a current and ongoing research program on the Comal Springs riffle beetle. Any changes to this project will be addressed by the EAA and TPWD. |
- The time period will be extended by 3 weeks to 6-8 weeks for 2018/2019 RFPs. |
- The window of time for an RFP to be open to final deadline should be extended. |
### Report 2 Implementation Matrix
Amended August 22, 2017

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<td>Methodological Issues Associated with Water Quality Monitoring</td>
<td>Additional methodological considerations should be taken into account in the WQ monitoring program.</td>
<td>26</td>
<td>If the EAA is to use Clean Rivers Program water quality (WQ) data, it should be located in sampling space and time.</td>
<td>Evaluate Clean Rivers Program (CRP) data on a predetermined time series analyses to identify trends that adversely affect the river system.</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>TBD</td>
<td>TBD</td>
<td></td>
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<tr>
<td></td>
<td>If the EAA is to use Clean Rivers Program water quality (WQ) data, it should be located in sampling space and time.</td>
<td>27</td>
<td>All nutrient analyses be performed on the same water sample(s).</td>
<td>Yes</td>
<td>No</td>
<td>TBD</td>
<td>TBD</td>
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</table>

**ATTACHMENT 9**

**Report 2 Implementation Matrix**

---

**Synopsis**

The EAA should continue to look for ways to remove conditions that restrict the pool of potential Applied Research applicants.

- \[\text{FFP's, creating multi-year contracts, including specifications regarding invoicing, payments, reporting, and deliverables; EAA should develop a method to access and fund MIS and PID students to conduct research in the springs, thereby making new scientific familiar with the springs and creating more data from their research. }\]

**Implementation Strategy**

Done - continual

**Comments**

- \[\text{There have been no issues since additional precations and upgrades were implemented by T3STATE; a report was provided by Juan Guerra detailing measures taken (unpublished).}\]

---

**Synopsis**

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.

- \[\text{Compliance-oriented: Yes} ; \text{Fiscally-feasible: Yes} ; \text{Feasible: No} ; \text{Implementation: TBD} \]

**Implementation Strategy**

Currently there are no plans or resources to make the database accessible online. However, EAA is committed to providing all data when requested.

---

**Synopsis**

The cause for the large mortalities of Comal Springs riffle beetle at the FAB still need to be definitively identified and resolved through additional study.

- \[\text{Compliance-oriented: Yes} ; \text{Fiscally-feasible: Yes} ; \text{Feasible: No} ; \text{Implementation: TBD} \]

**Implementation Strategy**

There have been no issues since additional precations and upgrades were implemented by T3STATE; a report was provided by Juan Guerra detailing measures taken (unpublished).

---

**Synopsis**

The EAA should be prepared to invest in additional research projects in the history of listed species and sampling technique that span multiple years, if necessary.

- \[\text{Compliance-oriented: Yes} ; \text{Fiscally-feasible: Yes} ; \text{Feasible: No} ; \text{Implementation: TBD} \]

**Implementation Strategy**

This research is already funded through the refugia program. Comal Springs riffle beetle life history study (BDI-WEST, Inc., 2016) began that two years in Applied Research and will continue through Bidaso; other studies undertaken through Refugia as well.

---

**Synopsis**

Monitoring effectiveness of M&M measures should not be part of the Applied Research Program, but should instead be incorporated within long term monitoring programs.

- \[\text{Compliance-oriented: Yes; however, certain exceptions may be warranted for specific projects} ; \text{Fiscally-feasible: Yes} ; \text{Feasible: Yes} ; \text{Implementation: Done} \]

**Implementation Strategy**

While this may be true for long term monitoring, the Applied Research program may be useful for snapshot monitoring of the source data (e.g., sediment study).

---

**Synopsis**

Resources for ongoing data management activities will need to be allocated throughout the lifetime of the HCP.

- \[\text{Compliance-oriented: No} ; \text{Fiscally-feasible: No, but prudent as long as within existing resources and looking for additional funding opportunities} ; \text{Feasible: Yes} ; \text{Implementation: Done} \]

**Implementation Strategy**

Currently there is no resource for ongoing database upgrades or maintenance; however, database management activities will continue.

---

**Synopsis**

Modeling efforts should become more integral to consideration of future Applied Research projects; referring to providing data and informing operating, refining, and expanding models.

- \[\text{Compliance-oriented: TBD} ; \text{Fiscally-feasible: Yes; with the caveat that the Applied Research budget only extends until 2019} ; \text{Feasible: Yes} ; \text{Implementation: TBD} \]

**Implementation Strategy**

Modeling has been supported to date, but no Applied Research projects; may be looked at in the future. The model is updated in the future. There is a placeholder in the 2018-2019 research program in case this would be needed, but is not anticipated.
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<td>30</td>
<td>Frequency and extent of high concentrations of PAHs should be established by more extensive sampling in areas where elevated levels have been identified.</td>
<td>To be determined if problems are detected.</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>The monitoring program should include the long-term data required to test and inform continuous implementation. The water quality monitoring work group discussed PAHs, based on local knowledge, they identified areas for consideration for re-sampling. EAHCP will continue to test at current levels for PAHs in sediment sampling. If any problem is detected, the adaptive management process will be used to address the concerns. Bioavailability is being assessed through tissue sampling. Sources are being addressed by EAA, COE, and potentially CDNR. The EAA should consider deploying the miniDOT dissolved oxygen (DO) sensors used in the Landa Lake dissolved oxygen study as part of the routine monitoring program.</td>
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<tr>
<td>31</td>
<td>If it is not possible to substantially reduce polycyclic aromatic hydrocarbon (PAH)-concentrations through sediment removal and source control, evaluation of bioavailability of the PAHs in the sediment should be considered.</td>
<td>In progress - Fish tissue sampling</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>EAHCP recognizes that PAHs could be bioavailable to understand and eliminate.</td>
<td></td>
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<tr>
<td>Administrative Considerations Associated with the Monitoring Program</td>
<td>The monitoring program would benefit from some administrative considerations taken into account.</td>
<td>Value in having a standing work group to evaluate and make decisions in the monitoring programs and effectiveness of conservation measures. Done, and to be continued again in the future.</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>The 2016 monitoring work groups could be reconvened, if needed.</td>
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</tr>
<tr>
<td>Integration of Monitoring with Other HCP Programs</td>
<td>Synergies can and should be obtained through integration of monitoring efforts with other aspects of HCP's programming.</td>
<td>Value in having a standing work group to evaluate and make decisions in the monitoring programs and effectiveness of conservation measures. Done, and to be continued again in the future.</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Representation from eco model team attended bio monitoring work group meetings.</td>
<td></td>
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<tr>
<td>33</td>
<td>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.</td>
<td>Value in having a standing work group to evaluate and make decisions in the monitoring programs and effectiveness of conservation measures. Done, and to be continued again in the future.</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
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<td>34</td>
<td>The monitoring program should include the long term data required to test and inform continuous refinements of the ecological model.</td>
<td>Value in having a standing work group to evaluate and make decisions in the monitoring programs and effectiveness of conservation measures. Done, and to be continued again in the future.</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
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<td>35</td>
<td>The EAA should consider deploying the miniDOT dissolved oxygen (DO) sensors used in the Landa Lake dissolved oxygen study as part of the routine monitoring program.</td>
<td>Value in having a standing work group to evaluate and make decisions in the monitoring programs and effectiveness of conservation measures. Done, and to be continued again in the future.</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
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<td>36</td>
<td>All M&amp;MS measures that are implemented as part of the HCP should be integrated into one conceptually unified monitoring program.</td>
<td>Value in having a standing work group to evaluate and make decisions in the monitoring programs and effectiveness of conservation measures. Done, and to be continued again in the future.</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
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<td>Submerged Aquatic Vegetation &amp; Related Conservation Measures</td>
<td>Additional monitoring effectiveness assessment, and integration should be considered in these measures.</td>
<td>27</td>
<td>The performance monitoring of NMMF measures should be integrated into the existing water quality and biological monitoring programs.</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>This is our plan.</td>
<td></td>
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<td>28</td>
<td>NMFS effectiveness monitoring should be done periodically with a comprehensive synthesis of the monitoring data every five years or so.</td>
<td>The goal of the non-native vegetation removal and native vegetation restoration is to strictly increase fountain darter numbers, but better normalize the ecosystem and maintain health of the system - a holistic sedimentary approach, but also integrated into NMFS comments.</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>The EAHCP conducts annual monitoring, with full mapping every 5 years.</td>
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<td>29</td>
<td>We recommend continuing to compute ratios from data such as those reported in BID-KVST Habitat &amp; Watershed Systems Group (2016), further refining the data to be as species specific as possible.</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Through CONB and CONB/ODS Work Plans and Annual Report.</td>
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<td>30</td>
<td>In light of October 2015 flooding damage, upstream erosion and stormwater runoff control measures may need to be considered.</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Contractors will implement.</td>
<td></td>
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<td>31</td>
<td>There is not enough new habitat from native plantings to maintain populations of fountain darter to balance non-native plant removal.</td>
<td>No</td>
<td>Yes</td>
<td></td>
<td></td>
<td>Yes</td>
<td>USFWS has approved the new submerged aquatic vegetation removal plan and increased biological goals and habitat availability.</td>
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<td>32</td>
<td>Habitat availability for the fountain darter should be verified by considering the carrying capacity of the various submerged aquatic vegetation species (both native and non-native) for fountain darter.</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Was part of the submerged aquatic vegetation AMP process.</td>
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<td>33</td>
<td>It is important to track the difference between the area of non-native plants removed and the sustained native coverage (reported as m²).</td>
<td>Yes; in progress continually</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Biological monitoring and submerged aquatic vegetation mapping.</td>
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<td>34</td>
<td>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.</td>
<td>Yes; in progress continually</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Biological monitoring and submerged aquatic vegetation mapping.</td>
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<td>35</td>
<td>Non-native vegetation should be considered as fountain darter habitat when it comes to maintaining and increasing habitat availability for the fountain darter.</td>
<td>Yes and no</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Biological monitoring and submerged aquatic vegetation mapping.</td>
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<td>36</td>
<td>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.</td>
<td>No; sediment removal is no longer going to be conducted.</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Sediment removal is being considered and appropriate steps will be taken to ensure a before and after comparison can be conducted.</td>
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<tr>
<td>Springflow Protection Measures</td>
<td>Additional analysis of the performance and capacity of the ASR system are needed; also, a more systematic approach to Phase 2 decisions is warranted.</td>
<td>51</td>
<td>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.</td>
<td>Yes and no through Work Plan</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Possible Adaptive Mgmt. action;</td>
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<td></td>
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<td>52</td>
<td>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.</td>
<td>General disagreement in value of NAS</td>
<td>Yes and no</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
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<td></td>
<td></td>
<td>53</td>
<td>The Committee recommends that the ASR operation &amp; VISPO triggers be considered and appropriate steps will be taken to ensure a better system performance.</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
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<td></td>
<td></td>
<td>54</td>
<td>The Committee recommends that the ASR operation &amp; VISPO triggers be considered and appropriate steps will be taken to ensure a better system performance.</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
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<td></td>
<td>55</td>
<td>The Committee recommends that the ASR operation &amp; VISPO triggers be considered and appropriate steps will be taken to ensure a better system performance.</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
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<td></td>
<td></td>
<td>56</td>
<td>The Committee recommends that the ASR operation &amp; VISPO triggers be considered and appropriate steps will be taken to ensure a better system performance.</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
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Report 2 Implementation Matrix
Amended August 22, 2017

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<tr>
<td>87</td>
<td>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.</td>
<td></td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>TBD; recommended for consideration by the Stakeholder and Implementing Committees</td>
<td>The recommendation appears to be recommending both an operational and a financial audit. Permittess and Partners are committed to transparency in the HCP process. Internal audits are being regularly conducted.</td>
</tr>
<tr>
<td>86</td>
<td>The Committee recommends to design and implement water quality monitoring for arsenic and related constituents in monitoring wells during recharge and storage events.</td>
<td></td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>TBD</td>
<td>TBD; recommended for consideration by the Stakeholder and Implementing Committees</td>
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<tr>
<td>85</td>
<td>The Committee recommends to design and implement water quality monitoring in ASR wells during recovery events.</td>
<td></td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>TBD</td>
<td>TBD; recommended for consideration by the Stakeholder and Implementing Committees</td>
</tr>
<tr>
<td>84</td>
<td>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.</td>
<td></td>
<td>Yes</td>
<td>No</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD; recommended for consideration by the Stakeholder and Implementing Committees</td>
</tr>
<tr>
<td>Modeling for Phase 2 Decisions</td>
<td>MODFLOW should be used to help develop strategic decisions associated with adaptive management and resilience for minimization and mitigation measures.</td>
<td>61</td>
<td>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.</td>
<td>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., PRRP, SPRP, from Monitoring/Mitigation group). - In addition to using model output to predict cessation of springflow, these data should be examined to determine if there are measurable early warning signs.</td>
<td>No</td>
<td>Yes</td>
<td>Not in Phase I; however, may be considered in Phase II.</td>
<td>Conduct the Phase II Strategic AAP, recognizing that EAA has model uses beyond the HCP.</td>
<td>Triggers are based on benefit-to-risk analysis to prioritize and prioritize additional social-economic factors outside of EAHCP purview. Many of the groundwater-level-based triggers are derived from the EAA Act and can only be changed through legislative action.</td>
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<tr>
<td>62</td>
<td>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.</td>
<td></td>
<td>No</td>
<td>Yes</td>
<td>Not in Phase I; however, may be considered in Phase II.</td>
<td>Conduct the Phase II Strategic AAP, recognizing that EAA has model uses beyond the HCP.</td>
<td>Triggers are based on benefit-to-risk analysis to prioritize and prioritize additional social-economic factors outside of EAHCP purview. Many of the groundwater-level-based triggers are derived from the EAA Act and can only be changed through legislative action.</td>
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<td>63</td>
<td>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.</td>
<td></td>
<td>No</td>
<td>Yes</td>
<td>Not in Phase I; however, may be considered in Phase II.</td>
<td>Conduct the Phase II Strategic AAP, recognizing that EAA has model uses beyond the HCP.</td>
<td>Triggers are based on benefit-to-risk analysis to prioritize and prioritize additional social-economic factors outside of EAHCP purview. Many of the groundwater-level-based triggers are derived from the EAA Act and can only be changed through legislative action.</td>
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<tr>
<td>64</td>
<td>MODFLOW should be used to evaluate sceen SC-3:03 scenarios that help understand what processes are important in the system. Examples would include applying the model to testing concepts, parameters, and system conditions, not just producing predictions, which can be highly uncertain.</td>
<td></td>
<td>No</td>
<td>Yes</td>
<td>Not in Phase I; however, may be considered in Phase II.</td>
<td>Conduct the Phase II Strategic AAP, recognizing that EAA has model uses beyond the HCP.</td>
<td>Triggers are based on benefit-to-risk analysis to prioritize and prioritize additional social-economic factors outside of EAHCP purview. Many of the groundwater-level-based triggers are derived from the EAA Act and can only be changed through legislative action.</td>
<td>1. At the workshop, a DSS utilizing model predictions was discussed with many favorable comments. This may be a valid future tool. 2. However, triggers and mitigation strategies are annual, not monthly.</td>
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Amended August 22, 2017

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<tr>
<td>Modeling Scenarios</td>
<td>Optimizing the bottom-up package of the four spring flow protection measures (scenarios to test: hydrologic model).</td>
<td>65</td>
<td>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 mitigation and mitigation measures.</td>
<td>A comparison of the old versus new model should be conducted with the minimum springflow pumped to current minimum allowable pumped and a run with the maximum permitted pumping. It is important to highlight that during the bottom-up package run we assume maximum permitted pumping is only 575.000 acre feet. In addition to examining the bottom-up package we should consider future extreme weather (floods and droughts).</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Conduct the Phase II Strategic AMP.</td>
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<td>66</td>
<td>There is currently no information on any attempt to optimize the combination of measures including the magnitude and spatial implementation of all or a few 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.</td>
<td>Only to the extent it is part of the Phase II process. It is an EAA effort, not required by the DOR.</td>
<td>No</td>
<td>No</td>
<td>Not in Phase I; however, may be considered in Phase II.</td>
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<td>67</td>
<td>The Committee recommends that the EAA undertake an optimization analysis of various combinations of the bottom-up package. From the exercise 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.</td>
<td></td>
<td>No</td>
<td>No</td>
<td>Not in Phase I; however, may be considered in Phase II.</td>
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<td>68</td>
<td>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.</td>
<td>The committee can answer the question “Which wells have the greatest influence on index wells or discharges from the springs?”</td>
<td>No</td>
<td>No</td>
<td>Not in Phase I; however, may be considered in Phase II.</td>
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<tr>
<td>Concept/Scenario Testing</td>
<td>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.</td>
<td>69</td>
<td>The groundwater model should be tested against the 2011 to 2015 period. This period, which includes both dry and wet years, offers a remarkable opportunity to validate the model and enhance confidence in the model for future applications.</td>
<td>Instead of focusing on the drought of record in 1950s we may consider focusing our efforts on modeling future drought scenarios. The success of spring protection measures provided by the baseline data and the expert opinion in the model for adaptive management and for other applications in Phase 2 of the HCP.</td>
<td>In progress / Done</td>
<td>Yes</td>
<td>Yes</td>
<td>EAA modeling staff is currently conducting</td>
<td>This is being conducted as a validation exercise. Will be documented in the Groundwater Modeling Report. 2011 was already included in calibration; 2012-2015 has been added.</td>
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<td>70</td>
<td>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 project responses during such linear extremes may demonstrate its applicability in characterizing seasonal hydrologic variability and management in the model for adaptive management and for other applications in Phase 2 of the HCP.</td>
<td>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 project responses during such linear extremes may demonstrate its applicability in characterizing seasonal hydrologic variability and management in the model for adaptive management and for other applications in Phase 2 of the HCP.</td>
<td>In progress / Done</td>
<td>Yes</td>
<td>Yes</td>
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<td>71</td>
<td>A hydrologic scenario that simulates climatic and socioeconomic conditions more severe than the DDR should be designed to test the model. The DDR may not represent the true worst-case scenario as the baseline for hydrologic modeling (Report 1).</td>
<td>A hydrologic scenario that simulates climatic and socioeconomic conditions more severe than the DDR should be designed to test the model. The DDR may not represent the true worst-case scenario as the baseline for hydrologic modeling (Report 1).</td>
<td>No</td>
<td>No</td>
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<td>72</td>
<td>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.</td>
<td>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.</td>
<td>No</td>
<td>No</td>
<td>No</td>
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<td>73</td>
<td>Climate scenarios should be designed considering the results of climate-model predictions available from regional climate models that are nested within general circulation models.</td>
<td>1</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Not within HCP’s scope and budget. However, EAA is conducting significant work with recharge rates in the model which effectively simulates spatial variability in recharge.</td>
<td>Includes in discussions for HCP rollout.</td>
<td>The EAHCP IC has not made any decisions about climate change. These discussions will be held with community stakeholders, stakeholders, and the HCP participation.</td>
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<td>74</td>
<td>Spatial variability in rainfall within the Edwards Aquifer region should also be explored in scenario investigations.</td>
<td>Done</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td></td>
<td></td>
<td>Spatial variability in rainfall will be accounted for through variations in recharge estimates during the calibration process. Simulations explicitly examining spatial distribution may be useful, but aren’t required for Phase II.</td>
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<td>75</td>
<td>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 a change in recharge amount due to changing land use impact spring flow?”</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td></td>
<td>This question was examined previously by The Nature Conservancy (Ryan Smith, unpublished). Uncertainty involved in recharge would drown out land-use impacts.</td>
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<td>76</td>
<td>Use telescoping grids in hydrologic model. Modifying smaller areas can address some of the NAS Report 1 Work Group’s concerns about cost and feasibility in testing conceptual models because there is no need to recompute the entire HCP model.</td>
<td>The Work Group acknowledges the integrity of this recommendation but, although it does not fit within the HCP’s scope, it may be examined separately (e.g., through Permittees).</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Will be undertaken by the EAA.</td>
<td>EAA begins its next iteration of model building in 2017; it will at that time investigate all new and historic modeling platforms as well as examining the conceptual model. Use of telescoping grids will be considered.</td>
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<tr>
<td>Recharge Methods</td>
<td>A recharge estimation ensemble should be created using as many different recharge estimation methods as feasible, and varied uncertain recharge parameters within these methods.</td>
<td>1</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>1. The EAA is currently exploring numerous methods to establish a better recharge estimates water balance, refined recharge estimates, and uncertainty. 2. The recharge estimate is the most critical input to the model, so the EAA is using an ensemble approach to bracket the range of recharge. 3. It is understood that recharge is an area of uncertainty in the model and therefore needs to be refined as resources allow. 4. DAYMET would not be an appropriate source of precipitation during the WSR-88 NEXRAD record. DAYMET uses interpolation schemes from fixed ground stations, as opposed to the spatially explicit measurements provided by radar. 5. Would require a great deal of investment in staff time and investment in software that may not have such a large user base.</td>
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<tr>
<td>77</td>
<td>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.</td>
<td>In progress</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>1. The EAA is currently exploring numerous methods to establish a better recharge estimates water balance, refined recharge estimates, and uncertainty. 2. The recharge estimate is the most critical input to the model, so the EAA is using an ensemble approach to bracket the range of recharge. 3. It is understood that recharge is an area of uncertainty in the model and therefore needs to be refined as resources allow. 4. DAYMET would not be an appropriate source of precipitation during the WSR-88 NEXRAD record. DAYMET uses interpolation schemes from fixed ground stations, as opposed to the spatially explicit measurements provided by radar. 5. Would require a great deal of investment in staff time and investment in software that may not have such a large user base.</td>
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<td>78</td>
<td>EAA Five-Year Modeling Plan</td>
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<td>81</td>
<td>The Five-Year plan needs to show an iterative approach between data collection and model updates; it does not do so now.</td>
<td>Yes. This is an EAA effort, not an HCP requirement.</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>4. The EAA 5-year modeling plan is not an EAHCP requirement. 5. 5-Year Plan does incorporate an iterative approach, and is strategically updated every year. 6. A DSS for making decisions in Phase II will be considered (W3).</td>
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<td>82</td>
<td>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.</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
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<td>83</td>
<td>A decision support system should be included in the Five-Year plan.</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
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<td>84</td>
<td>Interactions between Modeling &amp; 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.</td>
<td>None.</td>
<td>In progress - EAA is currently conducting a peer review of the model and will produce a report specific to this version of the model.</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>1. EAA is currently conducting a peer review of the model and will produce a report specific to this version of the model.</td>
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<td>85</td>
<td>Additional Data - The importance of collecting additional field data to improve the groundwater model was discussed in some detail in Report 1.</td>
<td>None.</td>
<td>Yes - as data and resources allow.</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>EAA is currently conducting an interinformation flow study that will provide data related to the Edwards-Trinity interaction. 1. Will be included to the extent practical in the next major update.</td>
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<td>86</td>
<td>All available pumping data should be incorporated to improve the groundwater model.</td>
<td>Yes - as data and resources allow.</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
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<td>87</td>
<td>Rainfall variation data from the past few years should be high priority for incorporation in the groundwater model.</td>
<td>Yes; in progress</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>2012-2015 recharge estimates have been added to the model.</td>
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<td></td>
<td>88</td>
<td>Conduit and barrier features in the MODFLOW model were adjusted based on FEFLOW modeling, but additional evaluation of these features could be considered.</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Conducts are not a priority; establishing areas of high transmission and refining other high priority areas of the model will come first. The two models were not based on each other.</td>
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<td>89</td>
<td>Sensitivity Analysis - Use additional calibration and validation metrics.</td>
<td>None.</td>
<td>Yes; in progress</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>5. The EAA should conduct a sensitivity analysis involving 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).</td>
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<td>90</td>
<td>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.</td>
<td>Yes - in progress.</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Could be considered by the EAA in the future; however, a logistical constraint is the fact that pumping must occur at a disproportionately huge rate to influence resulting index well or springflow levels.</td>
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<tr>
<td>Uncertainty Analysis</td>
<td>An ensemble approach should be used to analyze sensitivity to help quantify uncertainty.</td>
<td>91</td>
<td>Conduct more explicit sensitivity analysis. Techniques to quantitatively assess model uncertainty that should be used and presented in formal EAA documents.</td>
<td></td>
<td>Yes</td>
<td>No</td>
<td>?</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uncertainty Analysis</td>
<td>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 decreases uncertainty.</td>
<td>92</td>
<td>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?</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>The Implementing and Stakeholder Committees need to have a future overarching discussion with input from the Science Committee about when to use uncertainty analysis and error bars, and for what purpose.</td>
<td></td>
</tr>
<tr>
<td>Uncertainty Analysis</td>
<td>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.</td>
<td>93</td>
<td>Recharge estimates from the HSPF method should be included in the ensemble approach being used for uncertainty analysis.</td>
<td>Done</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Uncertainty Analysis</td>
<td>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.</td>
<td>94</td>
<td>Recharge estimates from the HSPF method should be included in the ensemble approach being used for uncertainty analysis.</td>
<td>In progress</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Uncertainty Analysis</td>
<td>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.</td>
<td>95</td>
<td>Show error bars on spring-flow and water-level predictions. 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.</td>
<td>In progress</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Uncertainty Analysis</td>
<td>Show error bars on spring-flow and water-level predictions. 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.</td>
<td>96</td>
<td>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.</td>
<td>In progress</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Uncertainty Analysis</td>
<td>Show error bars on spring-flow and water-level predictions. 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.</td>
<td>97</td>
<td>Show error bars on spring-flow and water-level predictions. 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.</td>
<td>TBD by Committees</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Single Model</td>
<td></td>
<td>98</td>
<td>FEFLOW stratigraphic data should be incorporated into the current MODFLOW model.</td>
<td>Notice.</td>
<td>Not within HCP’s scope; however, could apply for EAA</td>
<td>Not within HCP’s scope; however, could apply for EAA</td>
<td>Yes</td>
<td>Yes</td>
<td>EAA will update the model or move to another modeling platform once enough new data has been collected.</td>
<td></td>
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<tr>
<td>Single Model</td>
<td></td>
<td>99</td>
<td>Lessons learned from incorporating the contributing zone in FEFLOW should be articulated so that they can be used to inform the current MODFLOW model.</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>EAA will update the model or move to another modeling platform once enough new data has been collected.</td>
<td></td>
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<tr>
<td>Single Model</td>
<td></td>
<td>100</td>
<td>Devote future resources to a single model.</td>
<td>EAA has moved to one model</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>EAA will update the model or move to another modeling platform once enough new data has been collected.</td>
<td></td>
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<tr>
<td><strong>Ecological Model Scenario Testing</strong></td>
<td>There are several different scenarios and/or issues that should be investigated using the ecological model.</td>
<td>101</td>
<td>To explore how submerged aquatic vegetation habitat affects fountain darter, the timing of the existing events could be switched within simulations to determine whether simulated fountain darter population dynamics are sensitive to sub-regional scale and interannual variability in the observed submerged aquatic vegetation (habitat) record.</td>
<td>Low flow and spring flow protection measures should be simulated.</td>
<td>Not in Phase I; however, selected projects may be undertaken in Phase II through small grants.</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.</td>
<td>1. The Ecological Model was designed specifically for the Phase III process to ensure that the modeling can be conducted after Phase II and used to evaluate aspects of Conservation Measures. The goal of modeling is to provide a tool for answering significant and investment in resources, does not simply entail testing a dial on the model and hitting “run.”</td>
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<td>102</td>
<td>A scenario could be run to force fountain darter 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.</td>
<td>The model can be used to simulate conditions to approximate different climate change scenarios, and to use the results to determine the purpose and targeting of conservation measures that would begin sooner, rather than later, to begin building the data to support the renewal of the ITP.</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.</td>
<td>2. Currently, the Ecological Model contract has expired and there are no remaining dedicated resources to do further development on the Ecological Model or run additional scenarios; 3. Exploratory modeling is not part of the EAHCP; However, it is possible that modeling could be conducted after Phase II and used to evaluate aspects of Conservation Measures. The goal of modeling is to provide a tool for answering significant and investment in resources, does not simply entail testing a dial on the model and hitting “run.”</td>
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<td>103</td>
<td>Running the model under low flows and for flow protection measures to evaluate the impact on predicted submerged aquatic vegetation is a critical question for the fountain darter model.</td>
<td>The Ecological Model should be used to verify darter density per submerged aquatic vegetation metrics, not just the habitat.</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.</td>
<td>4. Any one scenario requires additional scenarios; 5. Some specific questions might be addressed sooner if resources are available, the Science Committee will be used to vet these.</td>
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<td>104</td>
<td>Pushing the model to catastrophic scenarios – for example where submerged aquatic vegetation is only present in refugia – might reveal some insights regarding recovery following such an event.</td>
<td>The Ecological Model should be used to verify darter density per submerged aquatic vegetation metrics, not the habitat.</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.</td>
<td>5. Some specific questions might be addressed sooner if resources are available, the Science Committee will be used to vet these.</td>
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<td>105</td>
<td>Examining simulated maps of submerged aquatic vegetation representative of “good” and “bad” years or various virtual time series should be done in a dynamic submerged aquatic vegetation model.</td>
<td>Streambed morphology should be assessed as a tool to identify whether velocity thresholds, would be appropriate to simulate in the Inner Channel, Busse, Headwaters, and all other tributary systems.</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.</td>
<td>1. The Ecological Model was designed specifically for the Phase III process to ensure that the modeling can be conducted after Phase II and used to evaluate aspects of Conservation Measures. The goal of modeling is to provide a tool for answering significant and investment in resources, does not simply entail testing a dial on the model and hitting “run.”</td>
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<td>106</td>
<td>As possible useful application of the model would be to better understand the degree of long-term maintenance that might be required to sustain non-native species.</td>
<td>The Ecological Model should be used to verify darter density per submerged aquatic vegetation metrics, not the habitat.</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.</td>
<td>2. Currently, the Ecological Model contract has expired and there are no remaining dedicated resources to do further development on the Ecological Model or run additional scenarios; 3. Exploratory modeling is not part of the EAHCP; However, it is possible that modeling could be conducted after Phase II and used to evaluate aspects of Conservation Measures. The goal of modeling is to provide a tool for answering significant and investment in resources, does not simply entail testing a dial on the model and hitting “run.”</td>
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<td>107</td>
<td>The EAH should explore the diagnostic abilities of this mechanistic model to better understand the environmental forcing that influence vegetation, and to identify future applied research questions that might best serve management goals.</td>
<td>The Ecological Model should be used to verify darter density per submerged aquatic vegetation metrics, not the habitat.</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.</td>
<td>4. Any one scenario requires additional scenarios; 5. Some specific questions might be addressed sooner if resources are available, the Science Committee will be used to vet these.</td>
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<td>108</td>
<td>An additional scenario could be designed to examine whether there are measurable thresholds of submerged aquatic vegetation acreage in a given reach that result in dramatic increases or decreases in fountain darter abundance.</td>
<td>The Ecological Model should be used to verify darter density per submerged aquatic vegetation metrics, not the habitat.</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.</td>
<td>5. Some specific questions might be addressed sooner if resources are available, the Science Committee will be used to vet these.</td>
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<td>108</td>
<td>Historical flows outside of the calibration and validation time periods should be used to assess fountain darter response under a wider range of previously observed historical flow conditions.</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.</td>
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<td>109</td>
<td>The effects of the SPA a so-called &quot;bottom-up package&quot; of flow protection measures should be imposed in the model and compared to fountain darter population dynamics without the package.</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.</td>
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<td>110</td>
<td>A specific set of flow scenarios should be designed to determine what conditions of low flows lead to high risk for fountain darter.</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.</td>
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<td>111</td>
<td>A scenario could be designed that varies the growth, mortality, reproduction, and movement rates of the individual fountain darter within the model under a suite of flows and other environmental conditions.</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.</td>
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<td></td>
<td>112</td>
<td>A scenario could be designed that varies the growth, mortality, reproduction, and movement rates of the individual fountain darter within the model under a suite of flows and other environmental conditions.</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.</td>
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<td>113</td>
<td>Factors like low dissolved oxygen, sediment removal, algal blooms, gill parasites, and shifts in prey and predator composition can be examined with the fountain darter model.</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.</td>
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<td>114</td>
<td>To explore how submerged aquatic vegetation habitat affects fountain darter, observed submerged aquatic vegetation habitat maps could be retained in simulations, but altered growth, mortality, or reproduction of the fountain darter individuals to reflect when they are in the area where submerged aquatic vegetation is expected to respond to the management actions.</td>
<td>Done</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.</td>
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<tr>
<td>115</td>
<td>To explore how submerged aquatic vegetation habitat affects fountain-darter, existing submerged aquatic vegetation habitat maps could be used, and manipulated to reflect expected changes based on the management actions.</td>
<td></td>
<td>Yes</td>
<td>Done</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.</td>
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<td>116</td>
<td>A first effort to evaluate the impact of changed coverage by native versus non-native submerged aquatic vegetation species on fountain-darter populations could be useful given recent submerged aquatic vegetation AMP.</td>
<td></td>
<td>Yes</td>
<td>Done</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.</td>
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<td>117</td>
<td>The focus on using the fountain darter model to predict the responses of fountain darter abundance to alternative HCP flow control packages is useful, but there are other uses of such mechanistic models that should be considered.</td>
<td></td>
<td>Yes</td>
<td>Done</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.</td>
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<td>118</td>
<td>The conceptual and predictive ecological models should be used to evaluate the minimization and mitigation (M&amp;I) measures, both in terms of appropriateness and efficacy.</td>
<td></td>
<td>Yes</td>
<td>Only to the extent it is part of the Phase II process</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.</td>
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<td>119</td>
<td>Scenario analysis should be used as part of a broader iterative process inherent in all ecological modeling.</td>
<td></td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.</td>
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<td>120</td>
<td>Scenarios should be defined based on the management needs, to advance our understanding, and to identify critical data gaps.</td>
<td></td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.</td>
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</table>

**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.

- 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 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.

- "Low-Flow" 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 (e.g. instead of being described as HCP’s "hard" being done; the model itself is inherently iterative; therefore, when you quantify, then you could call the model "done").

- It is critical to note that the effort has been made in editorial reviews of the final report to make output understandable and meaningful (e.g., Grant, Swannack, Wang, Hardy, Ward, Dupey, Bonner, & BIDWEST, Inc., 2017). A separate uncertainty analysis is not being done and there is no budget for it (#136).
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<td>125</td>
<td>Sources of stochasticity represented in each scenario should be identified and acknowledged to account for expected variability.</td>
<td></td>
<td>Yes</td>
<td>Staff agree</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Currently there is no additional uncertainty analysis planned for the Eco Model.</td>
<td></td>
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<tr>
<td>126</td>
<td>Dimensions of uncertainty in each scenario should be tracked and acknowledged to account for variability.</td>
<td></td>
<td>Yes, but to the extent practical and as resources allow (however, see strategy)</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Currently there is no additional uncertainty analysis planned for the Eco Model.</td>
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<tr>
<td>127</td>
<td>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.</td>
<td></td>
<td>Yes, can be implemented going forward.</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Heading items 121-133: extra effort has been made in editorial reviews of the final report to make output understandable and meaningful (see Grant, Swannack, Wang, Hardy, Ward, Doyle, Bonner, &amp; BIO-WEST, Inc., 2017).</td>
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<td>128</td>
<td>Predictions for scenarios should include, at some level, model-based explanations of why the predicted response occurred.</td>
<td></td>
<td></td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Heading items 121-133: extra effort has been made in editorial reviews of the final report to make output understandable and meaningful (see Grant, Swannack, Wang, Hardy, Ward, Doyle, Bonner, &amp; BIO-WEST, Inc., 2017).</td>
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<td>Administrative/Logistical Considerations Associated with the Ecological Model</td>
<td>There are some overarching logistical and/or administrative considerations that must be taken into account to ensure the model is used appropriately.</td>
<td></td>
<td>prediction run and outcome need to be communicated to key 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 levels of uncertainty are acceptable. Care should be taken in interpreting results around extreme (e.g. low flows). It's wise to meet again to revisit the eco-model once it's uncertainty is quantified, to have an open and honest discussion.</td>
<td>Done - in model report</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Heading items 121-133: extra effort has been made in editorial reviews of the final report to make output understandable and meaningful (see Grant, Swannack, Wang, Hardy, Ward, Doyle, Bonner, &amp; BIO-WEST, Inc., 2017).</td>
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<td>130</td>
<td>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 fountain darter and submerged aquatic vegetation models.</td>
<td></td>
<td></td>
<td>Agreed - in progress</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Heading items 121-133: extra effort has been made in editorial reviews of the final report to make output understandable and meaningful (see Grant, Swannack, Wang, Hardy, Ward, Doyle, Bonner, &amp; BIO-WEST, Inc., 2017).</td>
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<td>131</td>
<td>The temporal and spatial scales of the submerged aquatic vegetation and fountain darter 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.</td>
<td></td>
<td></td>
<td>Done - in model report</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Heading items 121-133: extra effort has been made in editorial reviews of the final report to make output understandable and meaningful (see Grant, Swannack, Wang, Hardy, Ward, Doyle, Bonner, &amp; BIO-WEST, Inc., 2017).</td>
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<td>132</td>
<td>The issues and recommendations described in NAS interim eco model report should be adequately addressed prior to running the scenarios.</td>
<td></td>
<td></td>
<td>Done - to the extent applicable</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Heeding item 121-133: the interim report was provided to the Eco Model team to allow for incorporation of appropriate recommendations.</td>
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<td>133</td>
<td>All model results should be carefully labeled according to the nomenclature described in Report 2.</td>
<td></td>
<td></td>
<td>Done</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Heading items 121-133: extra effort has been made in editorial reviews of the final report to make output understandable and meaningful (see Grant, Swannack, Wang, Hardy, Ward, Doyle, Bonner, &amp; BIO-WEST, Inc., 2017).</td>
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<td>Directions for Further Development of the Ecological Model</td>
<td>The ecological model program would benefit from additional work to refine the model.</td>
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<td>Currently, the Eco Model contract has expired and there are no remaining dedicated resources to do further work on the Eco Model. Further development may be undertaken in future ITPs.</td>
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<td>134</td>
<td>Sexual and vegetative reproduction should be represented in the dynamic submerged aquatic vegetation model.</td>
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<td></td>
<td>Currently, the Eco Model contract has expired and there are no remaining dedicated resources to do further work on the Eco Model. Further development may be undertaken in future ITPs.</td>
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<td>Category</td>
<td>Synopsis</td>
<td>#</td>
<td>Recommendation</td>
<td>Workshop Input</td>
<td>Implementation Recommended</td>
<td>Compliance-oriented</td>
<td>Fiscally-feasible</td>
<td>Feasible</td>
<td>Implementation Strategy</td>
<td>Comments</td>
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<td>The EAA should continue with the conceptualization of the overall ecosystem by building on the fountain darter and submerged aquatic vegetation conceptual models.</td>
<td>component is critical to the eco model - Site need to draw a line on how far we go in responding to National Academy of Sciences input</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>None at this time.</td>
<td>#135: Current sampling meets USFWS metrics. If metrics change, sampling strategies might need to change. Consideration may be given to this if funds are available.</td>
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<td>The current habitat suitability analysis for TWR should be treated as a hypothesis and tested for robustness throughout the San Marcos River.</td>
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<td>No</td>
<td>No</td>
<td>No</td>
<td>None at this time.</td>
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<td></td>
<td>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.</td>
<td></td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>None at this time.</td>
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<td>A better Comal Springs riffle beetle sampling approach is needed for determining ITP compliance, estimating the current Comal Springs riffle beetle population, and projecting future changes.</td>
<td>Comal Springs riffle beetle module not included in the model at this time.</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>None at this time.</td>
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<td>The EAA should be prepared to develop detailed monitoring plans for the other covered species if the Comal Springs riffle beetle is abandoned as an indicator species.</td>
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<td>No</td>
<td>No</td>
<td>No</td>
<td>None at this time.</td>
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<td>Explicit treatment of how actions directed at submerged aquatic vegetation would affect fountain darter through the coupled models is recommended.</td>
<td></td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>None at this time.</td>
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<td>The use of an individual-based approach embedded within a 2-D spatial grid for full-life cycle simulations of fountain darter population dynamics is a scientifically sound framework for the questions being asked, but there remain some important steps (related to how submerged aquatic vegetation is represented) to link the fountain darter dynamics to their habitat.</td>
<td></td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>None at this time.</td>
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<td>The representation of the processes of fountain darter growth, mortality, reproduction, and movement presently in the model are well-rounded but may be too simple and not sufficiently linked to changes in habitat and flow to answer some of the important management questions.</td>
<td></td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>None at this time.</td>
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<td>The submerged aquatic vegetation model is not yet far enough along in its development for detailed suggestions regarding scenarios.</td>
<td></td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>None at this time.</td>
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<td>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.</td>
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<td>No</td>
<td>No</td>
<td>No</td>
<td>None at this time.</td>
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<td>Category</td>
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<td>145</td>
<td>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.</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>None at this time.</td>
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<td>146</td>
<td>Thresholds in process representations should be used cautiously because they can erroneously create nonlinear population responses and unrealistic sensitivities to changes in habitat &amp; flow.</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>None at this time.</td>
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<td>147</td>
<td>The representation of density dependence and how its effects on individuals manifest at the population level needs further evaluation.</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>None at this time.</td>
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<td>148</td>
<td>Calibration and validation of the fountain-darter 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.</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>None at this time.</td>
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<td>149</td>
<td>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 stressors, and restoration and mitigation activities are expected to interact with the indicator species, as well as with all covered species.</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>None at this time.</td>
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<td>150</td>
<td>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.</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>None at this time.</td>
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<td>151</td>
<td>A much deeper understanding of the Comal Springs riffle beetle’s natural history should be obtained in order to be able to include the Comal Springs riffle beetle in a mechanistic model.</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>None at this time.</td>
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