Review of the Draft Study Design
Instream Flow Study of the Middle and Lower Brazos River

Reviewer 3
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The draft study design for the *Instream Flow Study of the Middle and Lower Brazos River* describes an investigation of ecological functions of streamflow in the Brazos River from Lake Brazos at Waco, Texas to the Gulf of Mexico. The study area is divided into 4 areas, each of which are further subdivided into reaches. The study design is based on assessing the influence of streamflow on series of indicators of ecological function that are grouped into five topical areas: hydrology, biology, physical processes, water quality, and connectivity. Hydraulic and habitat modeling and instream flow sampling are proposed for five reaches. Baseline riparian assessment is proposed in three reaches. Hydrologic and biological indicators will be address largely through these components of the study. Physical processes will be assessed in terms of historical channel migration, sediment transport modeling and budgeting, mapping of geomorphic features, and estimating the inundation area associated with overbank flows. Water quality will be addressed through sensitivity analysis (e.g., how do water quality parameters vary with instream flow) using a water quality model. Connectivity will be assessed by simulating flood flows to estimate floodplain and off-channel habitat inundation. Six numerical models are proposed in the study design: a one-dimensional hydraulic model to examine overbank flooding; a one-dimensional sediment transport model to investigate sediment dynamics; a two-dimensional hydraulic model for selected study sites; a coupled habitat availability model implemented for multiple guilds; a two-dimensional sediment transport model to examine form-scale processes (bar deposition, pool scour); and a water quality model.

Overall, the study design does not have a well-developed over arching framework to integrate the results of various components. An overarching framework for the study would identify the specific results from the technical analysis and how these results will inform flow recommendations. For example, the results of the hydraulic and habitat modeling will show how usable habitat varies with flow for various species or guilds. There is no specific guidance about how this will be used to inform recommendations (e.g., how will usable habitat as a function of flow inform recommendations about daily variability in base flow conditions as called for on p. 69?). Moreover, the hydraulic-habitat analysis will not produce specific information about how much habitat is needed to sustain a population. In contrast, the floodplain analysis will produce inundation maps that may allow the frequency of inundation required for floodplain vegetation to be determined along with the magnitude of floods required for inundation. Without such an over-arching framework, it will be difficult:

- to assess whether the various components will produced comparable results and whether the results will be adequate for informing flow recommendations;
- to reconcile different flow requirements for different ecological functions; and
- to foresee how the results will be used in a management context such that the analysis can be targeted to produce more relevant information.

Ideally the over-arching framework would identify how each study component will contribute to flow recommendations. If a component is intended for improved understanding, the application of this understanding to subsequent steps of the study should be clarified. The four components of a hydrologic regime (p., 69) would be a good starting point for the framework. The analyses used to support flow recommendations for each component should be included along with some description of whether the analysis will provide quantitative or qualitative guidance for flow recommendations and whether there will be multiple recommendations for different functions under each flow component.

Because of logistical, administrative, and technical challenges in implementing this ambitious study design, there should be a clear implementation plan that identifies the sequencing of tasks. As part of an implementation plan, there should be explicit decision points to re-evaluate and confirm presumptions that will provide justification for successively more detailed investigations. The overriding focus on hydraulic conditions as the principal factor governing habitat utilitization and the status of biological communities should be justified by initial activities. For example, detailed biological surveys should be conducted prior to hydraulic modeling to confirm that that there are well-defined microhabitat preferences in terms of water depth and velocity , to ascertain the appropriate spatial resolution of modeling, and to establish the necessary accuracy required from hydraulic modeling to support the analysis of streamflow required to maintain aquatic habitats.

Given the assortment of products from this study design, it is likely that the results of different components will have variable precision. It is not clear that the precision of each component is being driven by either scientific theory (e.g., the principal function of streamflow is maintenance of aquatic habitat under subsistence and base flow levels and this function is principally sensitive to flow rates) or by management needs for information with variable precision (e.g., baseflows can be regulated more precisely than flood flows).

The study design is uneven with very detailed explanation of hydraulic modeling and biological sampling but comparatively vague descriptions of other components. The unevenness of the study design is also apparent in the selected indicators: some indicators have specified, measurable attributes (e.g., hydrologic indicators) while others lack measurable attributes (e.g., flow sensitive fish species). Measureable attributes should be identified for all indicators.

The hydraulic model study sites should represent areas of the greatest biological value within reaches. There is little point in assessing occupation of marginal habitats, or the sensitivity of depth and velocity to streamflow in marginal habitats. Thus again, it will be valuable to have wide ranging biological surveys to identify the most diverse and productive areas in the river and its floodplain.

The study design would benefit from a broader perspective of river and riparian ecosystems that includes longitudinal connectivity, trophic relations, and a fuller suite of habitat conditions. It would appear that none of the species in this system ranges over

multiple reaches and that neither network connectivity nor longitudinal transport (e.g., seeds, eggs, invertebrate drift) is important for maintaining populations. Energy (food) resources are not identified as a significant issue. Temperature is lacking from the fish and mussels surveys, but may be imperative for understanding habitat preferences. Without a broader appreciation of both the near-field (e.g., microhabitat) and far-field (e..g, effective population range, network routing) controls, the study is unlikely to draw strong inference about the streamflow requirements for sustaining the riverine and floodplain communities of the middle and lower Brazos.