

## **Memorandum**

**To: Environmental Flows Advisory Group (EFAG)**  
**From: Texas Environmental Flows Science Advisory Committee (SAC)**  
**Date: May 3, 2011**  
**Re: Review comments on Guadalupe and San Antonio Rivers, San Antonio Bay and Aransas-Copano Bay Basin and Bay Expert Science Team (BBEST) Environmental Flows Recommendations Report dated March 1, 2011**

### **Introduction**

The Guadalupe and San Antonio Rivers, San Antonio and Aransas-Copano Bays BBEST submitted its environmental flow analyses and environmental flow regime recommendations to its Stakeholder Committee, the EFAG and the Texas Commission on Environmental Quality (TCEQ) on 2 March 2011. Texas Water Code Sec. 11.02362 (q), as added by Senate Bill 3 in the 80<sup>th</sup> Texas Legislature, 2007 (SB 3), provides that “In accordance with the applicable schedule...the advisory group, with input from the science advisory committee, shall review the environmental flow analyses and environmental flow regime recommendations submitted by each basin and bay expert science team. If appropriate the advisory group shall submit comments on the analyses and recommendations to the commission for use by the commission in adopting rules under Section 11.1471. Comments must be submitted not later than six months after the date of receipt of the analyses and recommendations.” This memorandum represents the SAC’s input to the EFAG based on our review of the BBEST report.

The timeframe dictated by SB 3 presents a challenge to the BBEST. They have only 12 months from their appointment to organize themselves, develop their agenda for addressing the requirements placed on them under the statute, conduct their analyses and report their results. In many respects, the Guadalupe/San Antonio BBEST was the best-prepared of all to undertake this assignment. A high proportion of its members had previous experience addressing the nuances of environmental flow analyses, including some with prior BBEST experience; the information bases for both the basin and bay are especially rich, members of the BBEST being among the principal contributors; and SB2 studies were underway within the basin to provide a source for detailed field observations. In addition, the BBEST was provided substantial staff support from TWDB, TPWD, TCEQ, SARA, SAWS and GBRA.

### **SAC Review and Comments**

These comments are organized following the *Framework for SAC review of BBEST work products (2nd ed. 12/17/2010)*, and conclude with a summary. The SAC also had the opportunity to visit with BBEST leadership and ask for further explanation of their work at our meeting on April 13 as we prepared these comments.

**1. Do the environmental flow analyses conducted by the BBEST appear to be based on a consideration of all reasonably available science, without regard to the need for water for other uses?**

**1.1 Has the BBEST identified and considered available literature and data? Were relevant scientific data and/or analyses discounted by the BBEST?**

The literature reviews are excellent. The organization and presentation of the physical and biological systems encompassed in this basin are very well done. The reviews of the riparian environment and the candidate estuarine organisms are particularly good. It is noteworthy that SB2 results from San Antonio were made available to the BBEST and were considered in its work. Moreover, several state agencies (notably TWDB and TPWD) assisted in performing analyses and modeling runs, and in conducting field surveys of river cross sections to improve the hydraulic data base.

**1.2 Are the data sources and methods adequately documented?**

Data sources are very well described, and much of the data are provided in various appendices. The extent to which the methods are described is variable. Figure 1 and 2 diagram the apparent logical sequence by which the recommendations are formulated, for Instream Flows and Estuary Inflows, respectively.

The methods for determination of instream flow recommendations are especially disappointing, given the importance of these recommendations and the substantial data resources available to this BBEST. While an impressive body of work is presented in the determination of physical-habitat requirements as a function of flow, as schematized in the right side of Fig. 1, the only justification for adopting (or defaulting to) the historical HEFR base flows is the sentence:

Results of habitat modeling for both the SB2/LSAR and GSA guild sets at two locations on the San Antonio River (Elmendorf and Goliad) and two locations on the Guadalupe River (Gonzales and Victoria) indicate that the statistically derived base flows will maintain suitable habitat for all of the habitat guilds considered. (p. 6.19)

How exactly the detailed depictions of WUA curves for the various guilds resulted in (or “indicated”) the recommendation of maintenance of the historical HEFR flows is the crux, and the above sentence is quite inadequate. Members of the BBEST have informed the SAC that these recommendations were based upon consideration of the WUA results together with professional judgment, but that these were insufficiently documented due to the press of time.

In the case of the estuary, a novel analysis was carried out by the BBEST using an estuary equivalent of weighted usable area, defined in terms of the proportion of salinity coverage of species-dependent fixed-habitat zones, in which the weight is based upon a salinity preference diagram for the species. Documentation of the data sources (salinity model results from the TWDB hydrodynamic/salinity model, literature reviews of salinity dependence of the species, and data-based

# INSTREAM FLOW DETERMINATION

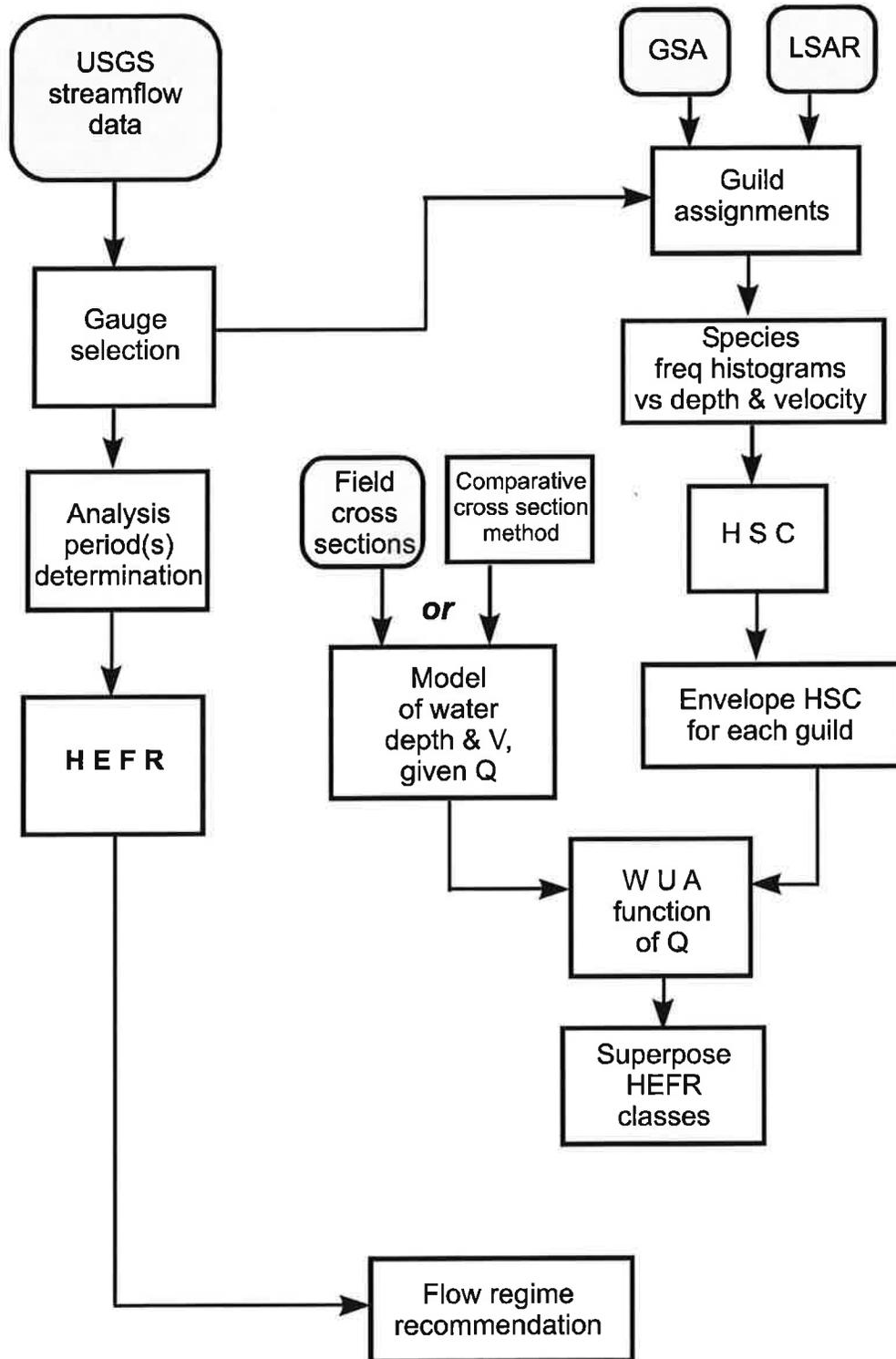


Figure 1 - Decision path for instream flow recommendations

# ESTUARY INFLOW DETERMINATION

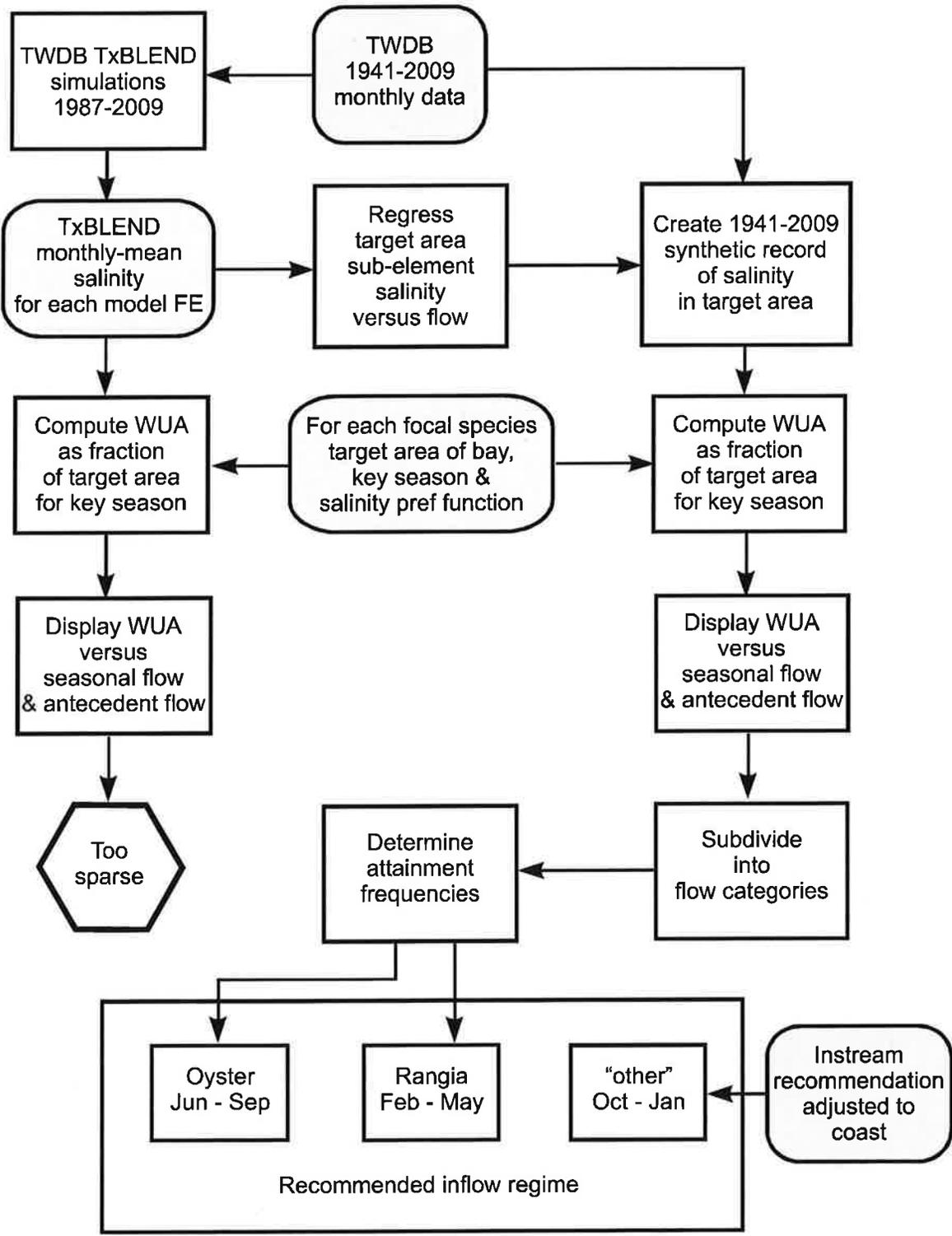


Figure 2 - Decision path for estuary inflow recommendations

identification of the zones of greatest abundance in the estuaries) and the analytical methodology is generally thorough.

**1.3 To what extent has the BBEST considered factors extraneous to the ecosystem, especially societal constraints, such as other water needs?**

External societal factors did not play any role in the scientific issues addressed or in the methodologies. Several scenarios of alternative recommendations and/or hypothetical projects were evaluated, but only as a detailed demonstration of how the recommendations could be applied.

**2. Did the BBEST perform an environmental flow analysis that resulted in a recommended environmental flow regime adequate to support a sound ecological environment and to maintain the productivity, extent and persistence of key aquatic habitats in and along the affected water bodies?**

**2.1 How is a sound environment defined and assessed for both riverine (lotic) and estuarine systems? What metrics of ecosystem health were used?**

The report contains thorough discussions of the definition(s) and metrics for a sound environment. A thoughtful overview of the concept and its definition(s) is presented at the outset of the report (Section 1.3). Instream flows are based on the Physical Habitat Simulation System (PHABSIM) approach, using physical requirements, mainly depth and velocity, of several guilds of fish. Flows to estuaries are based on salinity versus inflow relations, together with literature results for salinity preference mainly for sessile or limited-motility focal organisms, viz. oyster (*Crassostrea virginica*) and the clam *Rangia*. Other species are considered in overlay sections.

**2.2 How were locations selected for environmental flow analysis? Are these shown to be representative of and adequate to protect the basin? Was the process and rationale for selection adequately described? Were environmental flow regimes recommended for each selected site? Was a procedure presented by which the flow regime at other locations could be estimated?**

For instream flows, the assessment of gauge locations was based upon distribution, period of record and the representativeness of the gauge, and the presentation was very well done, including a good survey of available gauge records. HEFR-type regimes are defined and the initial HEFR analyses presented in Appendix 3.2-1. A procedure for flow regime determination at other locations is not stated. However, a brief paragraph (Section 3.1.2.6) recommends that the TCEQ develop “appropriate methods for interpolation of flow conditions ...” (p. 3.8).

In the estuary, flow determination was linked to habitat zones in which the focal species are typically present in greatest abundance. There are two estuaries within the geographical responsibility of this BBEST, San Antonio Bay and Aransas-Copano Bay. For the latter, flow determination posed a complex problem due to influence of San Antonio Bay river inflows, which enter Aransas

Bay from San Antonio Bay, as well as the direct inflows into the Aransas-Copano system. This was well-handled by the BBEST.

**2.3 How were the historical flow periods defined and evaluated? How was a particular period selected as the basis for determining the flow regime?**

A transition date was established demarcating the beginning of substantial anthropogenic effects on the flow, namely (1) date of reservoir construction in the Guadalupe (1965), (2) approximate date of urban expansion in San Antonio (1970). Generally, the full period of record was selected for analysis, except on the San Antonio River where the pre-development period (up to 1970) was used because of lower municipal return flows.

One feature of the hydroclimatology of the two river basins is that there has been an upward trend in inflow over the past seven decades, due to increased rainfall and associated runoff. The mean flow has nearly doubled in the Guadalupe (as measured at Victoria) and has increased about a factor of 2.4 in the San Antonio (as measured at Goliad). In the latter, part of the increase is doubtless driven by the accelerated urbanization in the San Antonio area and the associated increase in return flows, but the majority of the increase is hydroclimatological (see Appendix 5.1-1).

**2.4 Was a sound ecological environment determined to exist at each selected site during the selected period? If not, were the underlying causes and/or modifications needed identified?**

This conclusion is forwarded at the outset of the report in Section 1.3, in which the scientific basis is presented for both the riverine and estuarine environments. In the body of the report, notably in the “overlay” sections, additional supporting information is presented.

In the case of the riverine environment, the concept of community “intactness” is invoked in the opening chapter and repeatedly in Chapter 3. Nowhere is this concept defined nor a procedure for its determination cited. In Section 3.3.5.1, it is stated that “relative intactness” was assessed (p. 3.49), but no results of this assessment are shown. The “intactness” of the Guadalupe aquatic ecosystem was offered as justification for employing the entire period of record (along with the “best representation of the natural hydrograph”), despite the above-noted increasing trends in inflow.

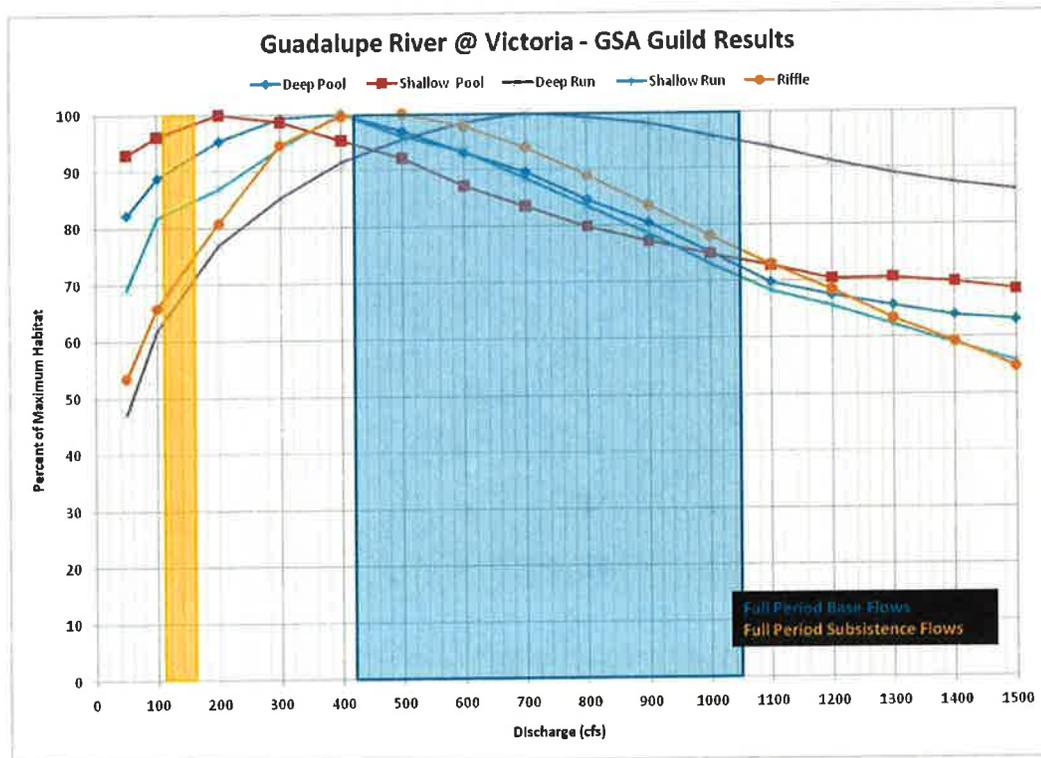
**2.5 Was a functional relationship between flow regimes and ecological health developed? Or, were proxy or intermediate variables used? Are assumptions underlying the methodology clearly stated? To what extent were overlay considerations (sediment transport, water quality, nutrients, etc.) addressed?**

For instream flows, a version of PHABSIM was used, in which the measure of ecological health was, in effect, abundance of guilds of fish and associated habitat requirements, namely depth and current speed. The report itself does not contain a discussion of how the WUA curves were evaluated or otherwise considered by

the BBEST nor does it explain the logic by which the BBEST defaulted to HEFR-based recommendations.

An example of the WUA results of the analysis is shown in Figure 3. The blue rectangle plots the full range of historical baseflows over all seasons and hydroclimate classes. This would seem to allow the interpretation that baseflows are generally higher than they need to be, considering their relationship with the flows necessary to achieve maximum habitat for most guilds. The BBEST advises that such an interpretation based strictly on maximizing habitat for most guilds would be wrong. Indeed, there is a variety of displacements of WUA's and the corresponding baseflow range shown in the report (pp 3.53-73), none of which, the SAC is advised, was deemed sufficient to modify the hydrology-based results. Rather, it seems that the WUA results were viewed as simply not contradicting the adequacy of the HEFR flows.

For this reason, our schematic of the decision path shown in Fig. 1 indicates no logic path from the WUA analyses to the flow recommendations, which are entirely the default HEFR results. The BBEST has acknowledged that its discussion of the use of the WUA's in the report was incomplete due to press of



**Figure 3 - Weighted Usable Area curves for a station on the Guadalupe (p 3.56 in the BBEST report). Guilds are named for the physiographic area in which the fish are generally found. The two rectangles show the range of subsistence flows (yellow) and base flows (blue) from the HEFR analysis.**

time, and that it intends to work with the BBASC as necessary to clarify its recommendations.

The SAC believes that the WUA methodology and its use should be clearly delineated in the Workplan, its deficiencies noted, and any necessary data collection and methodological revisions, as well as further analysis, should be high-lighted as an important part of future adaptive management strategy.

The overlays for instream flows are generally well done. The water quality analysis is thorough, its presentation succinct, and demonstrates the general high quality of river water in the basin, even under low-flow conditions. The riparian overlay (Section 3.6) is a well-written discourse on the vegetation of the riparian community and its dependence upon river flow. Its greatest weakness is the much greater proportion of text of a general and tutorial nature compared to information specific to the basin. The BBEST notes (p 3.123) that field data from the basin are still in the process of analysis. In its present state, this section is inconclusive and did not affect the decision path for flow recommendations. However, information such as Figs. 3.6-14 and 3.6-15, and Table 3.6-6 beg to be populated with real data specific to the basin including topography and associated inundation stages.

The geomorphology overlay (Section 3.5) contains the results of a number of hydrological scenarios, including two HEFR cases with 2 and 5 tiers of flood pulses and several WAM simulations for hypothetical river developments. These results would have general value in other contexts, and it is puzzling why they were not presented in their own section, then referenced as necessary. The geomorphology analysis is a sediment transport modeling exercise, in which the historical sediment-versus-discharge relations are used to compute sediment load under the various hydrological scenarios. As one would expect, sediment transport diminishes with increased impact on flood pulses. The BBEST concludes that the channel will remain stable (i.e., not change) so long as sediment load does not change more than 10%. A single literature source is cited for this judgment (which is based on channel-forming flows, a concept which its authors acknowledge “is not universally accepted”).

The report appears ambiguous on whether the geomorphology overlay is incorporated into the environmental flow recommendations. In Section 6.1, only the HEFR-based regime tables are presented, with no additional conditions. Yet in the discussions of Section 6.4 addressing hypothetical projects, suggestions are proffered as to how the hypothetical project might be constrained to reduce its effect on sediment load to within the 10% range. The SAC feels that the BBEST should clarify for the stakeholders and TCEQ whether this and any other additional conditions are to be applied to the flow recommendations.

If, indeed, it is the intention of the BBEST to apply this condition, the SAC observes that the basis for the rather stringent constraint of being within 10% of

historical sediment load is limited, being based upon one didactic reference, in which the 10% limit is suggested without observational basis or literature citation, hardly the “preponderance of literature within the published scientific literature [*sic*]” that is claimed in the BBEST report (page 7.5).

For the estuary, an extensive and detailed analysis was carried out for occurrence of salinity preference as a function of (bivariate) inflows. The focal organisms oyster and *Rangia* primarily defined the regime, though other organisms were used as overlays. Oyster and *Rangia* have different seasonal requirements, and together define the recommendations for February – September. The recommendations are presented as seasonal flows with associated attainment-frequency goals. These will not be directly applicable to operational use, but would be employed in long term simulations to determine the effect (e.g. achievement of recommended attainment frequencies) of a proposed diversion or impoundment. There were also detailed analyses of a number of species or parameters which ultimately did not play a role in the inflow recommendations. This is not a criticism of the work as a comprehensive approach is clearly valuable and much good information is presented. In particular, a lot of effort was expended on blue crab because of its important role in San Antonio Bay foodwebs, and while it is clear that salinity plays a role in disease, growth, and reproduction, there was insufficient data available to use blue crab as an indicator species.

**2.6 Was a sound ecological environment demonstrated to be achieved at each selected site under conditions of the recommended flow regime?**

No. However, to a certain extent, this was moot, since the systems were determined to be presently healthy, and the recommendation was to revert to historical-data-based flows (HEFR statistics for the instream flows and historical frequencies of flows that achieve target salinity zones for the estuary), even though strict adherence to the HEFR-based flows and associated attainment frequencies does not specifically preserve the historical statistics of all flows. On the other hand, it also has not been demonstrated that all of the flow components of the recommended instream flow regimes, including three levels of base flow and up to five levels of high-flow pulses, are necessary to protect a sound ecological environment.

**2.7 Is uncertainty in the analyses described or quantified? Where models were employed, was the extent of validation and associated predictive errors described and quantified?**

We acknowledge the attempt by the BBEST to address the issue of uncertainty at various places in the report, albeit largely qualitative. Uncertainty in these analyses is important, and we appreciate the suggestions for future studies, etc. which might ameliorate some of the inherent uncertainty. It would have been helpful if known uncertainty had been presented as a quantified qualifier to the recommended regime.

As there is no relation between the WUA results and the instream flow recommendation values, a quantitative expression of uncertainty would be difficult. Members of the BBEST have indicated that the number of cross sections available for the WUA calculations in the instream flow regime substantially affects the uncertainty of the results, and that the one or two cross sections for many of the stations rendered the results imprecise.

The salinity-flow relations in the estuary were based on modeled salinities, not data. (Reliance on data alone would have not have allowed the BBEST the specificity of geographic salinity zones needed for its analysis.) While the accuracy of the model is quantified in an appendix (as variance of the data about the predicted values), and the accuracy of the regressions of modeled salinity on flows was determined (again, as a variance), the two were not combined and translated into the effective confidence of the inflows.

## **Summary and Conclusions**

The general philosophy of the BBEST in its approach to environmental flow determination is characterized by statements throughout the report, e.g.:

- Adoption of the natural flow paradigm, in which the dynamic variation exhibited in the natural hydrograph is used to identify key regime components, also qualitatively consistent with the conceptual treatment of streamflow dynamics in the Texas Instream Flow Program, considered necessary to maintain natural habitats. [pp 3.25-3.28]
- Selection of the entire period of record upon which to base flow recommendations, because "...longer periods of record likely capture the natural variation in precipitation and discharge." [p 3.49]
- For the estuary, "historical flow patterns of magnitude, timing, frequency, and duration should be passed through to the estuary, but they should not be artificially modified or exacerbated by water management operation." [p 4.9]

Given this philosophy, it is perhaps not surprising that the BBEST chose to recommend environmental flows based on historical values.

It is sobering, however, that the best-equipped BBEST thus far could not make a quantifiable recommendation founded upon a clear connection between levels of flow and metrics of ecosystem health that could be defended as adequate, which is the goal of Senate Bill 3 with regard to the BBEST charge, and instead recommended little, if anything, more than default HEFR flow regimes based on historical hydrology.

It is the SAC's opinion that the BBEST has achieved excellence in its report, except for the following items that are of concern to the SAC:

- While an impressive body of technical work on WUA's of important guilds has been developed, there is no logical connection presented between these results and the (default) HEFR flows ultimately recommended.
- The variety of relationships displayed between the WUA's and the range of baseflows raises the question: what kind of relationship would be necessary to yield a flow recommendation different from HEFR?
- In the estuary, a convincing presentation of the dependence of preferable salinities within key habitat zones on the inflows (more precisely, the time history of inflows) was made for each of the focal species oyster and *Rangia*. However, the attainment frequency for each of these was essentially the historical statistics, which is equivalent to specifying the historical occurrence of the corresponding flow classes.

In closing, we observe that much new analysis was developed by this BBEST of potentially great value in future environmental flow studies in this basin, and we particularly appreciate the inclusion of Chapter 7 which introduces potential content of a work plan for the basin as required by SB3. It is also possible, even probable, that the work of the BBEST was more complete than its report would suggest. This should be communicated directly to the BBASC by the BBEST membership, and we encourage a robust interaction with the stakeholders as they undertake development of recommended Standards and Strategies. (We do note the *faux pas* that the BBEST fails to acknowledge in the introduction to Section 6 that the BBASC is a primary recipient of the BBEST recommendations). Finally, that the BBEST report falls short of the potential is an indication of the difficulty of the SB3 task, the complexity of the present state of the science, and the limitations of resources and time within which the BBEST must work.