

## GSA BBASC/BBEST Recommended Studies

October 2019

1. Developing models to forecast ecological outcomes of various flow scenarios on oysters and sport finfish in the Colorado-Lavaca, Guadalupe-San Antonio, Mission-Aransas, and Nueces estuaries
2. Guadalupe Delta Ecological Assessment of Freshwater Inflows
3. Freshwater Mussels Instream Flow Phased Assessment-Lower Guadalupe River

# Environmental Flows Study Application 2020-2021



**Basin/Bay Area(s):** Colorado-Lavaca, Guadalupe-San Antonio, Nueces

**Project Title:** Developing models to forecast ecological outcomes of various flow scenarios on oysters and sport finfish in the Colorado-Lavaca, Guadalupe-San Antonio, Mission-Aransas, and Nueces estuaries

**Ranking (select one):**      **1**      **2**      **3**      **4**

**Project Description:** Please include a clear description of the project, including details on background information and purpose of the project; specific tasks that will be undertaken to complete the project; a general timeline for completing the project; anticipated outcome of the project; any additional pertinent information about the project.

Response:

**Applicant:** University of Texas Marine Science Institute/Mission-Aransas NERR

**PI:** Lindsay P. Scheef

**Co-PI:** Edward J. Buskey

## Background

During Phase 1 of the project *Assessing the effects of freshwater inflows and other key drivers on the population dynamics of blue crab and white shrimp using a multivariate time-series modeling framework*, a multivariate autoregressive (MAR) model was applied to data from the TPWD Coastal Fisheries Monitoring Program, USGS flow gage stations, and other sources. Model results established that the effects of drivers such as temperature, salinity, and freshwater inputs on blue crab and white shrimp populations must be considered at various time lags. A Phase 2 continuation of the project reformatted the environmental factor and species abundance time-series into seasonal increments reflecting those used for the TCEQ instream flow standards to assess the effects of conditions in specific seasons on blue crab and white shrimp abundances. To accommodate the seasonal time-series, the model framework was refined to include only water temperature and river discharge at lags of up to two years as predictor variables.

The model structure adjustments had minimal effects on the accuracy of blue crab and white shrimp abundance estimates and posed some notable benefits. The reduction of the number of drivers included in the models reduced the potential for cross-correlation and made it easier to interpret model results. The new structure also made it possible to accommodate time-series with missing steps, such as those for species that are only sampled during specific seasons. And ultimately, the changes to the models facilitated their use in a predictive context, where river discharge values from different flow scenarios could be fed into the models to produce new species abundance estimates.

The ability to feed hypothetical river discharge values into the species abundance models makes them a potentially valuable tool to inform environmental flow recommendations. TCEQ's Water Availability Model (WAM) can be used to estimate river discharge at specific gage stations under

various water right usage scenarios. The discharge output from WAM in combination with the species abundance models makes it possible to estimate the effects of different water right use levels on the abundances of estuarine species. Discharge time-series could also be altered to examine how species respond to specific flow standard attainment frequencies under high flow/drought periods.

## Project Scope

The two previous studies focused on blue crab and white shrimp populations in the Guadalupe and Mission-Aransas estuaries. This proposed project will include data from the Colorado-Lavaca and Nueces estuaries in addition to data from the original study areas, and will expand the analysis to include eastern oysters and a selection of finfish species. In addition to developing abundance estimate models for additional species in additional basins, this project will focus on refining the predictive aspect of the analysis.

Specifically, the proposed study will:

1. Update the TPWD species abundance and water temperature datasets and the USGS river discharge datasets to include data from 1982-2019 and data from the Colorado-Lavaca and Nueces estuaries.
2. Format the datasets into seasonal increments that reflect the seasonal divisions used in the TCEQ instream flow standards.
3. Generate models to attempt to identify whether conditions during particular seasons are more influential on species abundances and determine the time lags at which these effects are seen.
4. Estimate species abundances as a function of different hypothetical flow scenarios.
5. Develop the code used to run freshwater inflow scenarios through the species abundance models into a user-friendly format.

Based on patterns seen in the blue crab and white shrimp model results in the previous studies, candidate species on which to focus the new models include red and black drum, spotted seatrout, and southern flounder. The modifications made to the model structure discussed above make it possible to accommodate the spring/fall sampling pattern for these gill net-sampled species. Eastern oysters were not previously included in the models but are identified as a key faunal species in the GSA BBASC work plan. Oyster abundance data will therefore also be considered for inclusion in the new analyses.

TPWD species abundance data will be acquired for red drum, black drum, spotted seatrout, southern flounder, eastern oysters, blue crab, and white shrimp in the Colorado-Lavaca, Guadalupe, Mission-Aransas, and Nueces estuaries for 1982-2019. Each time-series will be examined to determine whether it is suitable for modeling (i.e., adequate number of samples at each time-step, predominantly non-zero values, manageable level of variability, etc.) and then formatted into seasonal time-steps. Separate species models will be estimated for the Colorado-Lavaca,



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Guadalupe, Mission-Aransas, and Nueces estuaries, as well as an overall average model for all four regions.

The species abundance models will be used to assess the responses of each species to a set of different flow scenarios. Flow scenarios may include WAM output for different water right usage levels (e.g., Run 8 current usage and Run 3 maximum usage), measured discharge time-series altered to simulate different flow standard attainment frequencies, time-series with altered flow levels in specific seasons or years, or other scenarios that may be potentially informative for the development of environmental flow standard recommendations.

For continued utility after the completion of this project, the R code used to run discharge time-series through the models to assess the effects of altered flow on species abundances will be refined into a user-friendly format. Ideally, the code will be simplified to one or two functions that a user with no previous experience using R will be able to use and will output data, summaries, and visualizations in readily accessible formats (e.g., csv, pdf, png).

**Consistency with Adaptive Management Work Plan:** Please list the specific task(s) in the BBASC work plan(s) that will be addressed by this project.

Response:

This project falls under the **Bays & Estuaries – Life Cycle Habitat & Salinity Studies for Key Faunal Species** tier 1 study priority in the GSA BBASC work plan.

In addition, this project addresses the following critical information gaps identified by TWDB:

- Assessing environmental flow standards and attainment frequencies under existing/future scenarios of water use and climate variability
- Exploring systematic approaches to linking instream flow and freshwater inflow standards.
- Developing models to forecast ecological outcomes under various flow scenarios.

**Justification:** Please describe how the study will meet the goals of either validating or refining standards or identifying strategies to achieve environmental flows. The statement should describe how the BBASC will utilize the results to adaptively manage the established flow standards. For study topics submitted by non-members of a BBASC, please describe how the project will advance environmental flows and the adaptive management process in Texas.

Response:

The results of this project will help the BBASC assess how specific changes in water right usage and flow standards might affect estuarine species that are indicative of ecosystem health. This information should assist with the refinement of freshwater inflow recommendations aimed at maintaining a “sound ecological environment” in the bays.

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**Expected Deliverables:** Please list specific deliverables for the project, such as draft and final reports on key questions addressed by the study, data, model source code, presentations, workshops, etc.

Response:

- (1) Quarterly Progress Reports, to be submitted no more than 30 days following each State fiscal quarter: June 1 - August 31; September 1 - November 30; December 1 - February 28; March 1 - May 31. Quarterly reports will include a brief statement of the overall progress made and any problems that have been encountered during the reporting period.
- (2) Draft report.
- (3) Final report with revisions as requested by TWDB.
- (4) Data and R code used to generate models and results presented in the final report.
- (5) R functions developed for continued use after project completion.

**Anticipated Cost:** Please provide the total cost anticipated to complete the project, including any cooperative funding, in-kind contributions, or other collaborative efforts that leverage resources, and a brief budget justification that outlines all sources of funding requested and available to the project.

Total Cost: \$135,000

TWDB Funds Requested: \$135,000

Additional Funding/In-kind Contributions (if available): NA

**Budget Justification:** The total \$135,000 requested includes \$98,462 salary for the PIs (17 months effort total), \$29,538 for fringe benefits (estimated as 30% salary), \$1,000 for travel associated with presenting project updates, and \$6,000 for other expenses, including the purchase/upgrade of computers, printing costs related to the draft and final reports, miscellaneous office supplies, and page charges associated with possible peer-reviewed publication. The University of Texas is a State of Texas public university, so TWDB's contract policy of non-compensation of indirect costs applies.



# Environmental Flows Study Application 2020-2021



**Basin/Bay Area(s):** GSA and Nueces Basin & Bay Areas

**Project Title:** Guadalupe Delta Ecological Assessment of Freshwater Inflows

**Ranking (select one):**      1      **2**      3      4

**Project Description:**

Response: A major data gap remaining in the SB 3 process regarding freshwater inflow to the bays and estuaries along the Texas gulf Coast lies in the lack of ecological data in the interface between rivers and bays. This often (as experienced in the GSA recommendations) led to disconnects between riverine and estuarine recommendations. A solid understanding of the faunal communities in Texas estuaries in the open bay is known through the commercial and recreational fisheries sampling conducted by TPWD and others over the years. However, the lacking component has been and continues to be those tidal/delta areas so infrequently sampled, but yet so vitally important as nursery habitat in the estuaries.

Thus, the proposed intent of the seasonal ecological assessment is to collect data within the upper Guadalupe Delta relative to wetland plant productivity, freshwater tidal macroinvertebrates, and juvenile shellfish and finfish utilization. Focused applied research proposed will be designed specially to:

- a) Develop baseline data on marsh productivity (nursery habitat), freshwater tidal macroinvertebrates, and juvenile shellfish and finfish life cycles and habitat utilization in areas of the upper estuary where limited to no sampling has occurred over the years.
- b) Correlate species abundance in relation to physical habitat and salinity found in the freshwater tidal zone and Guadalupe Delta with similar data collected in other Texas estuaries.
- c) Support a validation evaluation of the TCEQ Environmental Flow Standards.

With the TWDB \$75,000 cap per individual study, this study is limited to up to three sampling locations (likely freshwater/tidal interface, and upper, and mid Guadalupe Delta), and three season sampling events (April/May, July/August, and September/October) designed specifically to span one full growing season for marsh vegetation. Activities would include the collection of start of, mid- and end-of-season above ground biomass of wetland plants at up to three study sites in the Guadalupe Delta. Quantification of seasonal macroinvertebrate, juvenile fish and crustacean species abundance and community composition would be conducted via throw trap and benthic sampling within shallow habitats at up to three study sites in the delta in relation of physical habitat and water quality parameters, including salinity. The same sampling locations and seasons would be selected as for concurrent marsh and biological sampling.

**Consistency with Adaptive Management Work Plan:** Please list the specific task(s) in the BBASC work plan(s) that will be addressed by this project.

# Environmental Flows Study Application 2020-2021



Response: This project falls under the *Bays & Estuaries – Distribution and Abundance of Marsh Vegetation in Relation to Salinity & Elevation in the Guadalupe Estuary Delta* and the *Bays & Estuaries – Life Cycle Habitat & Salinity Studies for Key Faunal Species* study priorities in the GSA BBASC work plan.

**Justification:** Please describe how the study will meet the goals of either validating or refining standards or identifying strategies to achieve environmental flows. The statement should describe how the BBASC will utilize the results to adaptively manage the established flow standards. For study topics submitted by non-members of a BBASC, please describe how the project will advance environmental flows and the adaptive management process in Texas.

Response: We concur with the Texas Water Development Board that for workplan studies to have meaning to the SB 3 process, they must be conducted, analyzed and presented in the context of potential application to the existing TCEQ environmental flow standards. This project specifically involves the collection of ecological data at the interface of instream flow and freshwater inflow conditions in the system. This data will allow the GSA BBASC to conduct a joint assessment of the TCEQ environmental flow standards (both instream and freshwater inflow) in the lower basin.

**Expected Deliverables:** Please list specific deliverables for the project, such as draft and final reports on key questions addressed by the study, data, model source code, presentations, workshops, etc.

Response: Deliverables will include quarterly progress reports, draft and final reports, and data collected.

**Anticipated Cost:** Please provide the total cost anticipated to complete the project, including any cooperative funding, in-kind contributions, or other collaborative efforts that leverage resources, and a brief budget justification that outlines all sources of funding requested and available to the project.

Total Cost: \$75,000

TWDB Funds Requested: \$75,000

Additional Funding/In-kind Contributions (if available):

Budget Justification:

# GUADALUPE DELTA ECOLOGICAL ASSESSMENT OF FRESHWATER INFLOWS

## (PROPOSED CONTINUATION – 2020)

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### Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin

**Project Description:** The Guadalupe-Blanco River Authority (GBRA) was selected by the Texas Water Development Board (TWDB) in the previous round of Senate Bill 3 (SB3) environmental flows funding to initiate seasonal ecological sampling with respect to freshwater inflow in the upper Guadalupe Delta. Funding was executed via a TWDB grant to address a priority research need identified in the SB3 Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area (GSA) work plan. Seasonal field work was conducted in 2019 (Spring, Summer and Fall) to assist in establishing a baseline condition of marsh productivity and an improved understanding of juvenile fish and shellfish habitat use within the upper Guadalupe Delta. The 2019 data set provides stakeholders and the Texas Commission on Environmental Quality (TCEQ) with an important first step to characterizing the baseline ecological conditions in the upper Guadalupe Delta. Upon future assimilation with additional data, this information will be valuable in validation exercises with respect to freshwater inflow standards for San Antonio Bay. The intent of the proposed continuation of the seasonal ecological assessment is to expand upon the information collected in 2019 by the inclusion of an additional water year to 1) assess variability in marsh productivity and juvenile shellfish and finfish utilization, and 2) initiate an assessment of coastal bird habitat use of the upper Guadalupe Delta.

Focused applied research will be designed to:

- Continue baseline development on marsh productivity (Nursery habitat), juvenile shellfish and finfish habitat utilization in areas of the upper estuary where limited to no sampling has occurred over the years.
- Initiate a limited avian assessment of available nesting habitat of marsh-related birds to expand upon the ecological linkages to freshwater inflow versus habitat evaluation.
- Correlate species abundance in relation to physical habitat and salinity found in the upper Guadalupe Delta with similar data collected in other Texas estuaries.

With the TWDB \$75,000 cap per individual SB3 project, this study will be limited to the existing three sampling locations in the Guadalupe Delta and three season sampling events (April/May, July/August, and September/October). Activities would include the collection aboveground biomass of marsh vegetation, quantification of juvenile fish and crustacean species abundance and community composition, and nesting bird assessments at three established locations in the delta in relation to physical habitat and water quality parameters, including salinity.

#### Costs:

Guadalupe / San Antonio Basin (TWDB)	\$75,000
Cost-share – GBRA - <i>Will be considered upon selection by TWDB</i>	
Total GSA Basin Project without Cost-share	\$75,000

#### Application Statement:

This project specifically involves the collection of ecological data at the interface of instream flow and freshwater inflow conditions in the Guadalupe basin. This data will provide the GSA BBASC with valuable information to assist in future validation assessments of the TCEQ environmental flow standards in the lower basin.



# FRESHWATER MUSSELS INSTREAM FLOW PHASED ASSESSMENT – LOWER GUADALUPE RIVER

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## Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin

**Background:** The Guadalupe-Blanco River Authority (GBRA) provides stewardship for the lower Guadalupe River which maintains an ecologically diverse community of organisms supported by a dynamic flow regime. Future projects have the potential to alter this dynamic flow regime and thus influence freshwater mussels. As such, GBRA has been and remains committed to studying this key ecological indicator's response to instream flow. As part of a separate Texas Water Development Board (TWDB) grant, GBRA completed a comprehensive Instream Flow study of the Gonzales reach of the lower Guadalupe River. The Texas Instream Flow Program (TIFP) as part of Senate Bill 2 has also conducted instream flow work on the lower river at several locations. Additionally, applied research sponsored by the Texas Comptroller's Office of Public Accounts (TX CPA) focused specifically on physiological requirements of freshwater mussels in several central Texas river basins.

**Project Description:** The intent of the proposed project is to first mine the wealth of existing data on instream flows, water quality, and physiological responses of freshwater mussels in the lower Guadalupe River to pull these studies together and bridge and/or identify data gaps. The second objective is to develop a study plan(s) with respect to supplemental data collection and/or analysis to support a comprehensive assessment of specific instream flow needs for the candidate mussel species in the lower river. With the TWDB \$75,000 cap per individual SB3 project, this effort will require a phased approach starting with the proposed Phase 1 applied research which includes:

- Initial data mining exercise to bridge the data gaps between existing SB2, SB3, other supported TWDB instream flow studies (Gonzales Reach grant), and TX CPA central Texas freshwater mussel study;
- Development of an applied research plan to evaluate additional physiological studies that may be necessary for the candidate species;
- Development of a study plan to evaluate instream flows necessary to support water quality parameters with established tolerances per specific candidate species.
- Initiation of limited physiological studies or field data collection per funding availability.

It is proposed that Phase 1 be performed in this biennium in a manner aimed at seamlessly folding into a second phase which would likely include the development and application of ecological and water quality models with predictive capabilities to forecast ecological outcomes with respect to candidate freshwater mussel species under various flow scenarios.

### Phase 1 Costs:

Guadalupe / San Antonio Basin (TWDB)	\$50,000
Cost-share – GBRA - <i>Will be considered upon selection by TWDB</i>	
Total GSA Basin Project without Cost-share	\$50,000

### Application Statement:

This project specifically addresses two of the TWDB specific 2020/2021 themes including 1) developing targeted monitoring programs to assess ecological indicator response, and 2) developing models to forecast ecological outcomes under various flow scenarios. Ultimately, this data will provide the GSA BBASC with valuable information to assist in future validation assessments of the TCEQ environmental flow standards in the lower basin.