GSA BBASC Project Update Sept/Oct 2016

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: Phase 2

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Project Summary

This project is a continuation of the Phase 1 effort (conducted in the previous biennium, fiscal years 2014-2015) that used the Texas Parks and Wildlife Department (TPWD) Coastal Fisheries monitoring data and a multivariate autoregressive (MAR) modeling framework to verify that the effects of freshwater inflows on blue crab and white shrimp abundances must be assessed in conjunction with other drivers and at time lags of up to two years. The goal of Phase 2 is to refine the models developed during the previous study to improve their utility in informing freshwater inflow recommendations. Specifically, this project aims to:

1. Update the datasets used in the original models with 2014-2015 data and rerun the models to verify the previous results.
2. Reformat the datasets from the seasonal divisions used in the original study to reflect the seasonal divisions used in the Texas Commission on Environmental Quality (TCEQ) instream flow standards.
3. Generate MAR models using the new seasonal divisions.
4. Attempt to identify whether conditions during particular seasons are more influential on overall focal species abundances.
5. Modify the analysis so that trends in focal species abundances can be estimated as a function of different hypothetical freshwater inflow conditions.

Phase 1 Summary

During Phase 1 of this project, completed in August 2015, data from the Texas Parks and Wildlife Department (TPWD) Coastal Fisheries monitoring program, U.S. Geological Survey (USGS) flow gage stations, and several other sources were acquired for 1982–2013 and analyzed using multivariate autoregressive (MAR) models to assess the effects of various predators and environmental parameters on blue crab and white shrimp abundances in the Mission-Aransas and Guadalupe estuaries (Buskey et al. 2015). The models detected significant lagged effects of predators, water temperature, salinity, and river discharge on the abundances of both these focal species, indicating that the effects of freshwater inflows on focal species abundances must be assessed in conjunction with other drivers and at time lags of up to two years.

Due to the short duration of the project, variability in the TPWD survey data was managed by averaging the values over relatively large spatial and temporal scales and a limited number of temporal increments and model configurations were examined. Further refinement of the variability in the datasets and the extension of the time-series by two years better allows for finer temporal increments to be modeled.

Phase 2 Timeline

Dates	*Accomplishments*
2016 Apr–May	✓ Project start ✓ Update datasets and rerun original models
2016 Jun–Aug	✓ Reformat datasets to reflect TCEQ inflow standard seasonal increments
2016 Sep–Dec	✓ Run new sets of MAR models using reformatted data ✓ Assess whether particular seasons are more influential on focal species abundances
2017 Jan–Jun	• Present results at national meeting • Model adaptation for inflow scenario assessment
2017 Jul–Oct	• Prepare final report • Present results to GSA BBASC • Submit final report • Submit data and annotated R code

Thus far, work on the Phase 2 portion of the project has progressed according to schedule. The TPWD datasets used in the Phase 1 models were updated with 2014-2015 data and the original models were rerun to verify that the results remained similar with the addition of the new information. The datasets were then reformatted into seasonal averages that reflect the seasonal divisions used to set the TCEQ freshwater instream flow standards: Jan-Mar (winter), Apr-Jun (spring), Jul-Sep (summer), and Oct-Dec (fall). We have begun to run new sets of MAR models with these reformatted data to determine the impacts of different seasons on focal species abundances at different time lags.

Updated Data

Data used in the final models of the Phase 1 study included time-series of focal and predator species abundances as well as temperature, salinity, and river discharge that spanned 1982–2013. The TPWD Costal Fisheries monitoring program was the source for the species abundance data and water quality data, and river discharge data were derived from USGS flow gage station measurements. Below are plots of these time-series updated with 2014-2015 values. General temporal trends as well as MAR model results generated from these updated data are similar to those seen in the results of the Phase 1 study.

Focal Species

Overall temporal trends for blue crab and white shrimp were not greatly affected by the addition of the new data (Figure 1). Generally, decreasing trends persisted in the blue crab time-series, and no increasing or decreasing trends emerged in the white shrimp time-series. For the 2014-2015 time period, blue crab abundance estimates were below the overall average during 2014, and, with the exception of blue crab in the otter trawl samples, values were above average during 2015. For white shrimp, trawl sample estimates were below average in 2014 and slightly above average in 2015, and seine sample estimates were above average for both years.

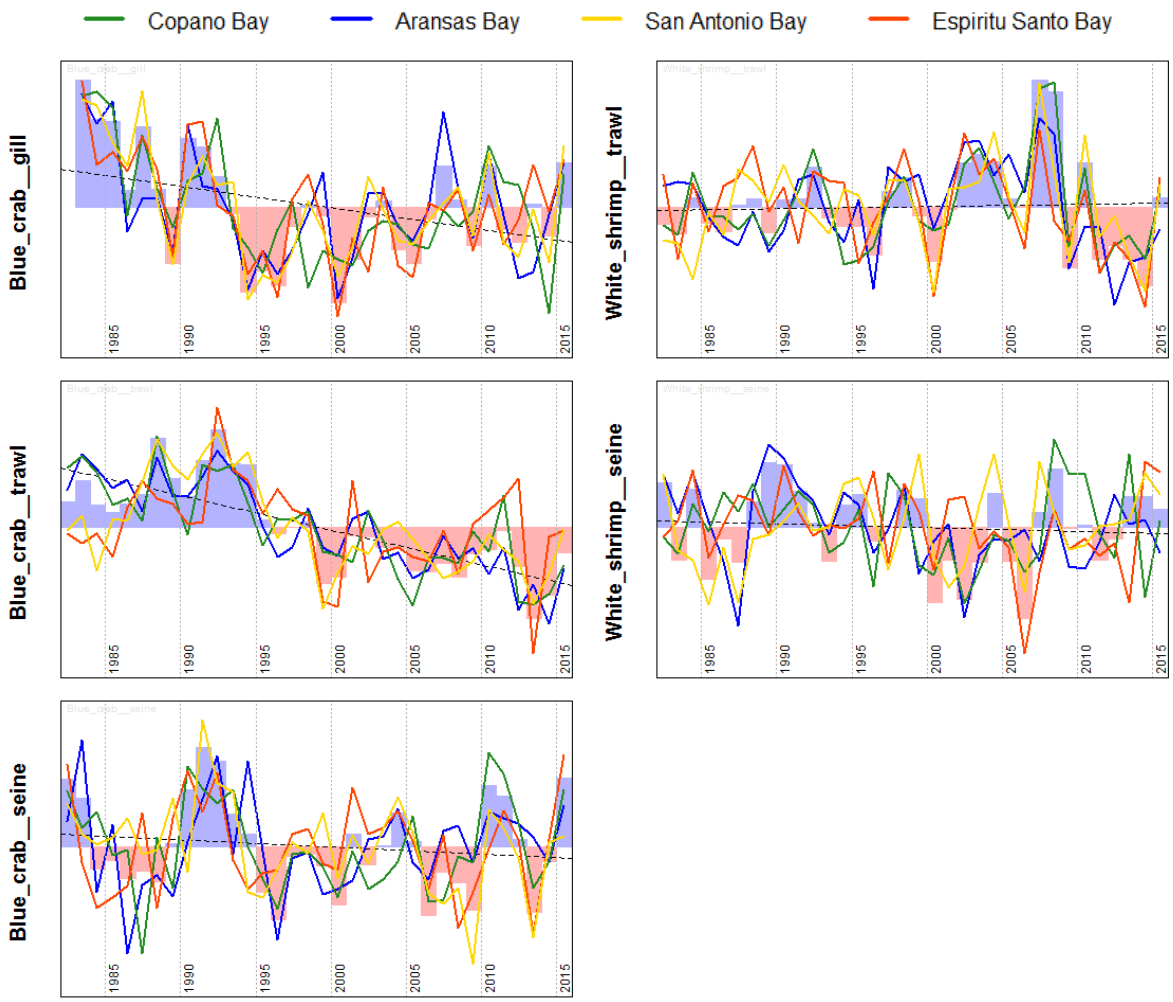

Figure 1 Updated focal species abundance trends (Z-scored yearly means) for blue crab gill, trawl, and seine samples and white shrimp trawl and seine samples. Lines represent mean abundances for Copano (green), Aransas (blue), San Antonio

(yellow), and Espiritu Santo (red) bays. Yearly means across all four bays are represented by bars colored to indicate whether values fall above (blue) or below (red) the overall mean for the time-series. Regression lines for the bay-averaged time-series are shown as black dotted lines.

Predator Species

Overall, increasing abundance trends continue to be seen for all of the selected predators, with the exception of southern flounder, which demonstrates a decreasing trend (Figure 2). Red drum abundance estimates were consistently below average for 2014-2015, extending a sequence of below average abundance values at the end of the time-series to 4 years. After a 7 year period of above average abundances starting in 2008, black drum abundance fell below average in 2015. Spotted seatrout abundance estimates were slightly above average in 2014 and slightly below average in 2015. Southern flounder abundance was below average in 2014 and above average in 2015, making 2015 one of only 3 years of above average abundance since 2005.

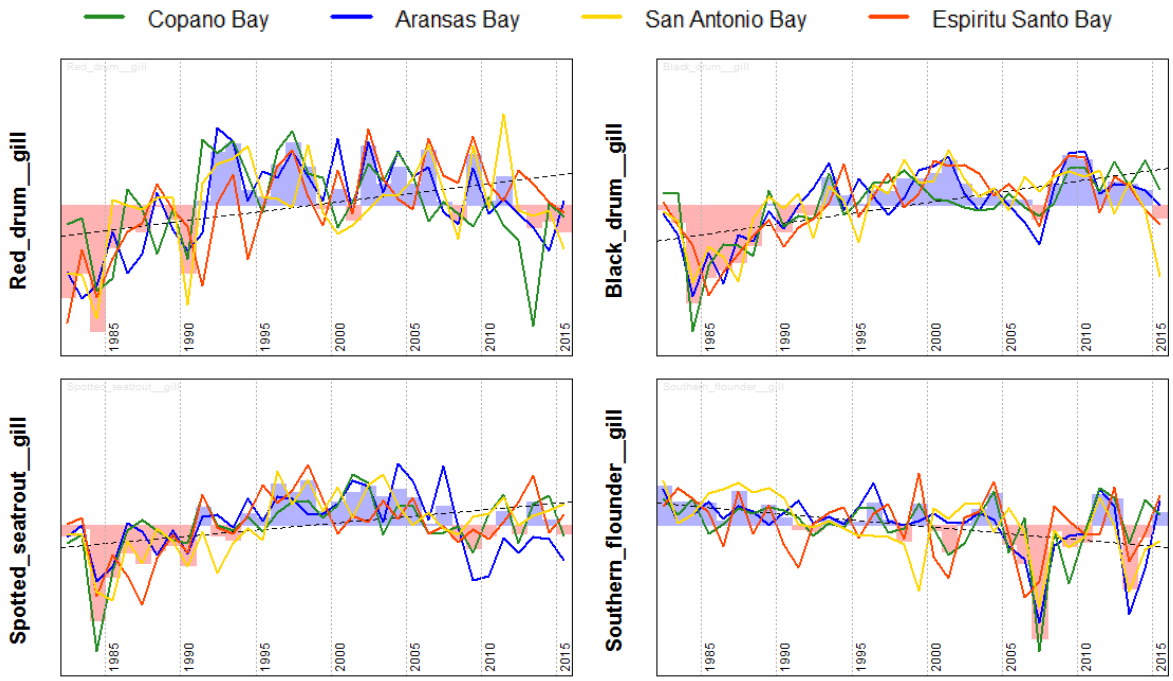

Figure 2 Updated abundance trends (Z-scored yearly means) for predator species included in final MAR models in Phase 1 of the project. Lines represent mean abundances for Copano (green), Aransas (blue), San Antonio (yellow), and Espiritu Santo (red) bays. Yearly means across all four bays are represented by bars colored to indicate whether values fall above (blue) or below (red) the overall mean for the time-series. Regression lines for the bay-averaged time-series are shown as black dotted lines.

Water Quality

The overall increasing trends in both water salinity and temperature persist with the additional 2014-2015 data (Figure 3). A sequence of above average water salinities that began in 2011 continued through 2014, but heavy rains in early 2015 drove mean salinity for the year below average. Water temperature was below average in 2014, as it had been in 2013, but was above average again in 2015.

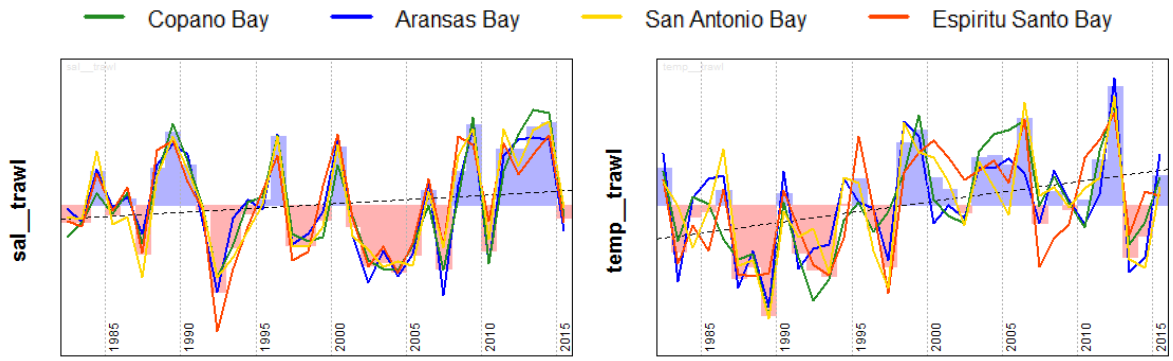

Figure 3 Updated temporal trends (Z-scored yearly means) for TPWD trawl sample water quality parameters included in final MAR models in Phase 1 of the project. Lines represent means for Copano (green), Aransas (blue), San Antonio (yellow), and Espiritu Santo (red) bays. Yearly means across all four bays are represented by bars colored to indicate whether values fall above (blue) or below (red) the overall mean for the time-series. Regression lines for the bay-averaged time-series are shown as black dotted lines.

River Discharge/Surface Inflow

Slight decreasing trends in river discharge (USGS flow gages) and estimated surface inflow (TWDB) are seen in the overall time-series of these two parameters (Figure 4). A period of below average river discharge and surface inflow that began in 2011 continued through 2014. River discharge was above average in 2015. Presumably, this high 2015 discharge value will be reflected in the surface inflow time-series when it is updated (pending data availability).

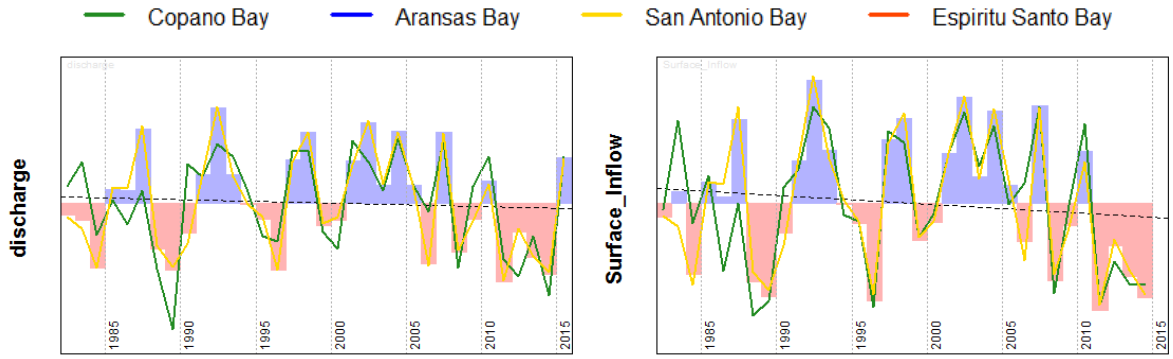

Figure 4 Updated temporal trends (Z-scored yearly means) for river discharge and estimated surface inflows. Lines represent means for Copano Bay (green) and San Antonio Bay (yellow). Overall yearly means for each variable are represented by bars colored to indicate whether values fall above (blue) or below (red) the overall mean for the time-series. Regression lines for the averaged time-series are shown as black dotted lines.

New MAR Models

We have begun running a series of models to examine potential lagged effects of conditions during individual seasons on focal species abundances. For these models, abundances of species sampled with gill nets (which are only sampled in the spring and fall) were estimated for all seasons using a smoothed spline. An example of this interpolation is shown below for red drum for 1989-1991 (Figure 5).

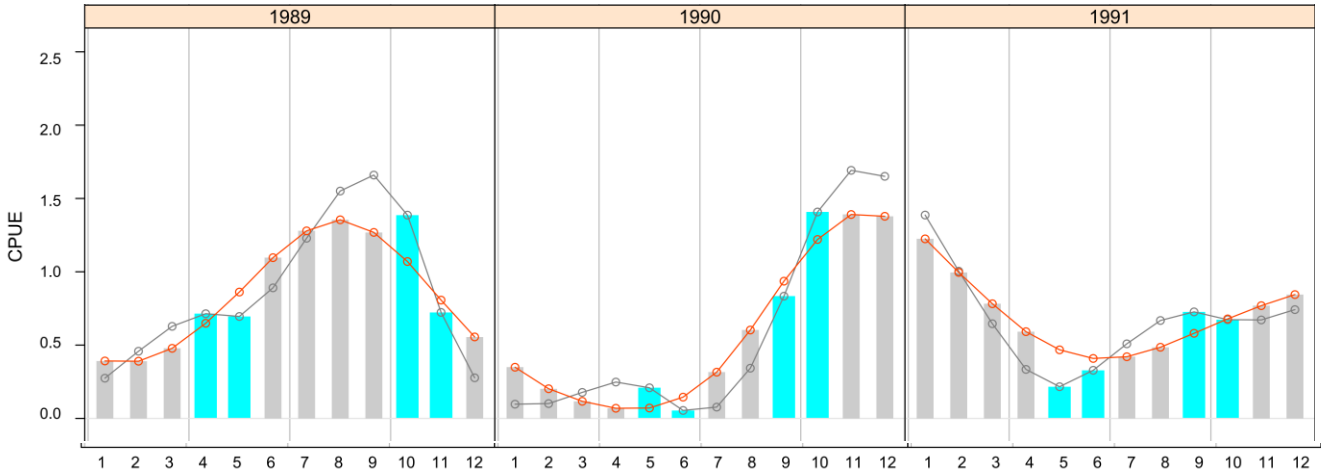

Figure 5 Monthly estimates (gray bars) of red drum Catch Per Unit Effort (CPUE) determined from a smoothed spline of sample CPUE values (blue bars). The raw spline is shown as a gray curve, and the smoothed spline is shown as an orange curve. Seasonal divisions are indicated by vertical gray lines. Gray/blue bar values averaged within each season were the seasonal abundance estimates used in the MAR models.

Results of the seasonal MAR models are preliminary and not shown here. However, the results generally appear to indicate that fall conditions during the preceding year have important effects on blue crab abundances, and winter conditions within a given year have the strongest effects on white shrimp abundances.