

Characterization of Freshwater Inflow on Water Quality in the Mission-Aransas NERR

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Introduction

South Texas estuarine systems are characterized by their habitat diversity and the influence of freshwater inflows. Many factors influence the residence time, which is a measure of how much time a water mass spends in an estuary before being exported out to sea. The barrier island system located near Port Aransas, TX in particular is characterized by a lack of tidal inlets, and, in recent years, diminished freshwater inflows due to the restrictions on freshwater stores by humans (Mooney 2012). This has caused a dramatic increase in the residence times of Copano and Aransas Bays, which lie within the study system (Figure 1, Bianchi 1999). Winds also play a key role in an area where the influence of the lunar tide is lessened by the diffraction caused by Florida and Cuba, given that these particular tides originate in the middle of the Atlantic. These wind-tides can transport large bodies of water in and out of the bays, which has a direct impact on the water quality, the organics present, and the organisms residing in the estuary. Historical data provided by the Mission-Aransas National Estuarine Research Reserve (MANERR), will be used to determine the temporal changes occurring due to the changing climate and increasing anthropogenic influence on marine systems. The MANERR is the location of a nationally recognized research reserve and represents a unique estuarine ecosystem ripe with opportunities to explore the dynamics that fuel these productive ecosystems.

Using ArcGIS elevation and hydrology functions, the flow characteristics of the two main rivers flowing into Copano Bay, the Mission Rv. and Aransas Rv., were determined. The West reach of Copano Bay was chosen as the bay monitoring site because of its proximity to both the Mission and Aransas river mouths. This site provided salinity data that was used to determine the impact of freshwater inflow on water characteristics in the bay.

Methods

I uploaded the Mission-Aransas National Estuarine Research Reserve (MANERR) watershed boundary from the Centralized Data Management Office (CDMO) for the reserve. I opened it in ArcMap 10.2.2, and set it as my main basin boundary. I added a layer showing available soil water storage provided by the United States Geological Survey (USGS) from the ArcGIS server "<http://landscape2.arcgis.com/arcgis>". Using Arc GIS, I added points for the USGS river discharge monitoring stations at Skidmore, TX on the Aransas River (28° 16' 56" N, 97° 37' 14" W) and at Refugio, TX on the Mission River (28° 17' 30" N, 97° 16' 44" W). As well as the MANERR System Wide Monitoring Program (SWMP) Copano West monitoring station (28° 5' 3" N, 97° 12' 3" W). I delineated a watershed basin for each of the two rivers in the NERR (Mission Rv. and Aransas Rv.) using the USGS river monitoring sites as output gage points. I adjusted the stream flows in these two basins to the National Hydrography Dataset gages at the USGS sites. I also added the 30m National Elevation Dataset (NED) provided by the USGS to show topographical relief in the two delineated river basins. Starting with the 30m NED, I began a hydrologic terrain analysis on the two basins. I began by filling any potential pits in the terrain, then determined the flow direction for each grid cell. By determining the direction that water flows through the basin based on grid cell flow direction, a flow

accumulation value was calculated for each cell. This value is controlled by the number of cells that drain into an individual cell. Flow direction was used to create stream links forming basin drainage lines. I checked the drainage lines with the NHDPlus stream lines and found them to correlate with each other. Furthermore, catchments were created for each of the two basins to delineate the areas draining into each drainage line.

Results

A negative correlation between river discharge in the Mission and Aransas rivers and salinity in West Copano Bay was seen during January 2013 (Figure 1). The Mission-Aransas National Estuarine Research Reserve (MANERR) is composed of diverse wetland, and aquatic ecosystems, in addition to lying adjacent to urbanized areas (Figure 2). Studying soil accumulation data showed that soil in the upstream reaches of the two delineated river basins had a lower water storage capacity than soil at the outputs for the two basins. Overall, it seems as if storage capacity decreases slightly as you approach the respective river mouths (Figure 3). Studying the elevation of the two river basins using the National Elevation Dataset (NED) using 30m grid cells, it can be seen that elevation decreases toward the output of each basin. National Hydrography Dataset (NHD) gage-adjusted flowlines show that flow increases towards the output of each basin (Figure 4). Flow accumulation data allowed for the creation of catchments draining into individual drainage lines. Catchment size increased towards the output area of each basin, correlated with flow direction shown on the drainage lines (Figure 5)

Discussion

The decrease in salinity seen in January 2013 can be explained by the increase in river discharge seen in the Mission and Aransas rivers. The salinity drops in June and November 2013 could be delayed responses to increases in river discharge in May and September 2013, respectively (Figure 1). The sensitive wetland ecosystems found downstream of the two rivers in the study area are crucial to maintaining healthy sport fish and shrimp populations in the estuary, which is why their close proximity to urbanized areas places their ecosystem function in jeopardy (Figure 2). Soil storage capacity is lowest at the upper reaches of the river basins, which makes sense considering the flow direction of water through the basins. This characteristic increases runoff into the streams in these areas. Although storage capacity decreases downstream of the delineated river basins, this can be explained by the marsh/wetland composition of the terrain, which typically stores water above ground (Figure 3). Elevation changes and gage-adjusted flow lines further illustrate the flow of water through each of the river basins (Figure 4). Similarly, catchment and flow line information clearly reinforce the flow paths through the two river basins (Figure 5).

Conclusion

Although a correlation between salinity and river discharge could be seen, perhaps this trend would have been clearer had the complete watersheds been delineated. Due to the desire to use USGS monitoring stations as outputs for the river basins, downstream reaches of these two

watersheds were excluded from the hydrologic terrain analysis. Further avenues of research in this system will include a project determining the “quality” of organic matter entering the system, and determining whether or not this is correlated with freshwater inflows (Waterson 2008).

Figures

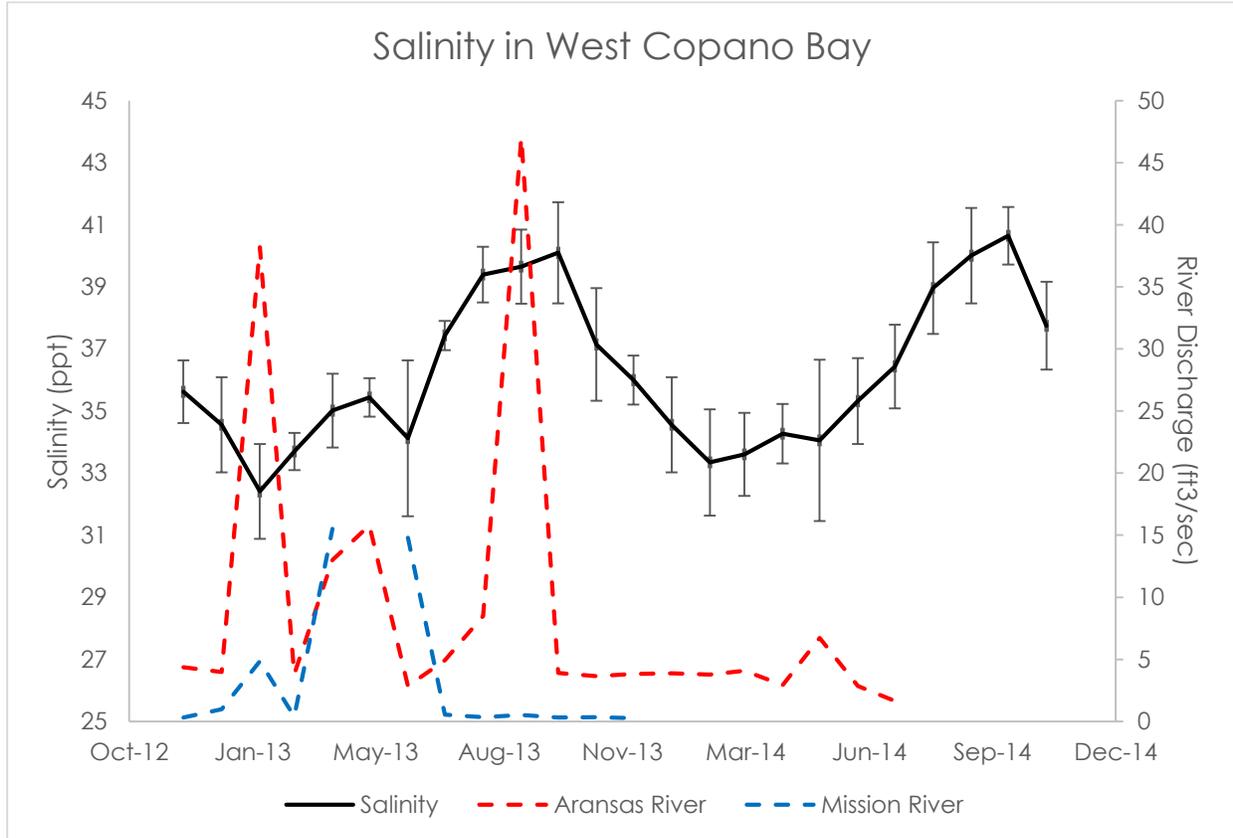


Figure 1. This graph plots monthly salinity averages collected by the MANERR SWMP Copano West monitoring station ($28^{\circ} 5' 3''$ N, $97^{\circ} 12' 3''$ W) from December 2012 to November 2014. Also shown over this time frame is average monthly river discharge data collected by USGS river discharge monitoring stations at Skidmore, TX on the Aransas River ($28^{\circ} 16' 56''$ N, $97^{\circ} 37' 14''$ W) and at Refugio, TX on the Mission River ($28^{\circ} 17' 30''$ N, $97^{\circ} 16' 44''$ W). The omitted point for the Mission River is (May 2013, 348.8 ft³/sec.).

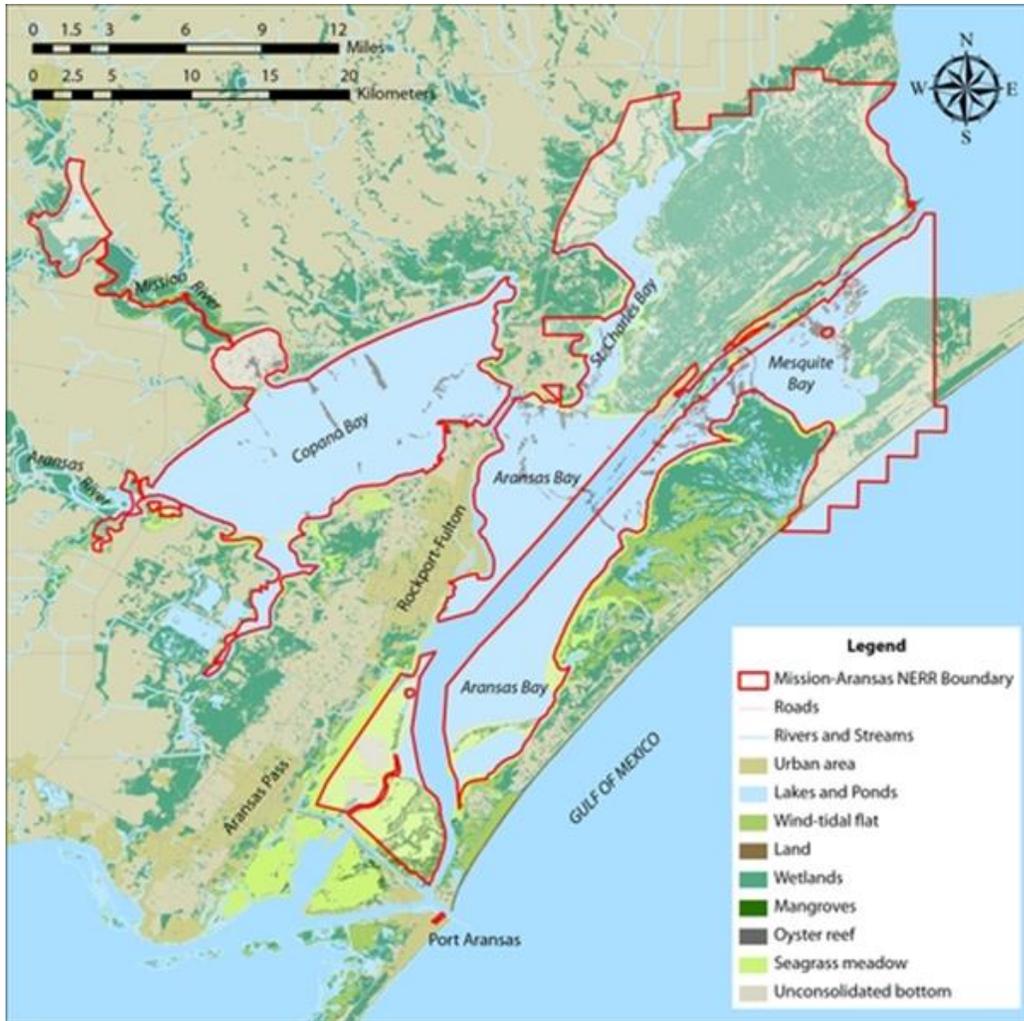


Figure 2. Figure showing the area protected and monitored by the Mission-Aransas National Estuarine Research Reserve as well as land use and composition data. (Mission-Aransas NERR)

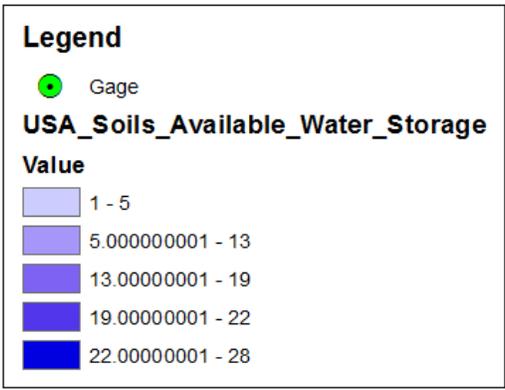
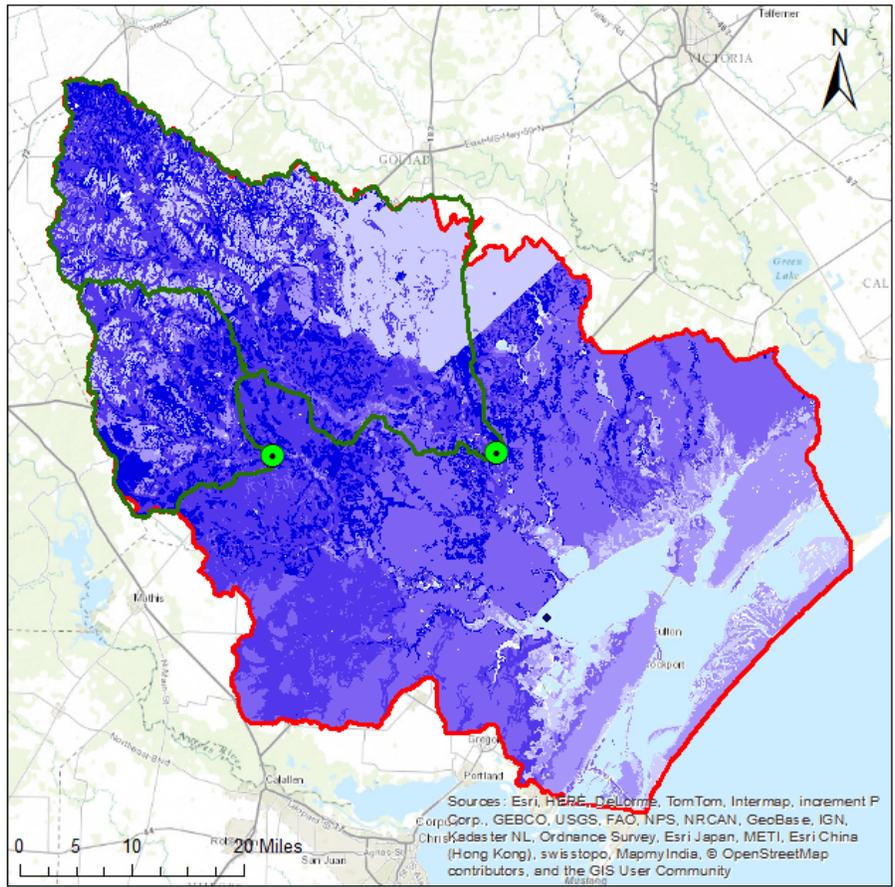


Figure 3. Mission and Aransas watersheds showing available soil water storage data provided by the United States Department of Agriculture – National Resources Conservation Service (USDA - NRCS, Esri, <https://landscape1.arcgis.com:443/arcgis/services/>) and map was created using ArcGIS. Two USGS river monitoring stations are labeled *green* and one MANERR SWMP bay monitoring station is labeled by a *blue* diamond. The main basin boundary is shown in *red*, while the individual river watershed boundaries are shown in *green*.

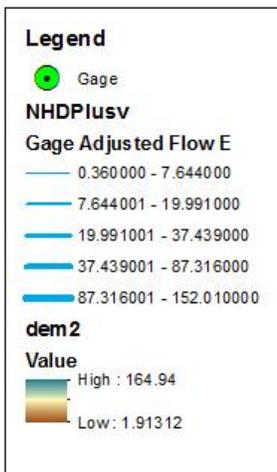
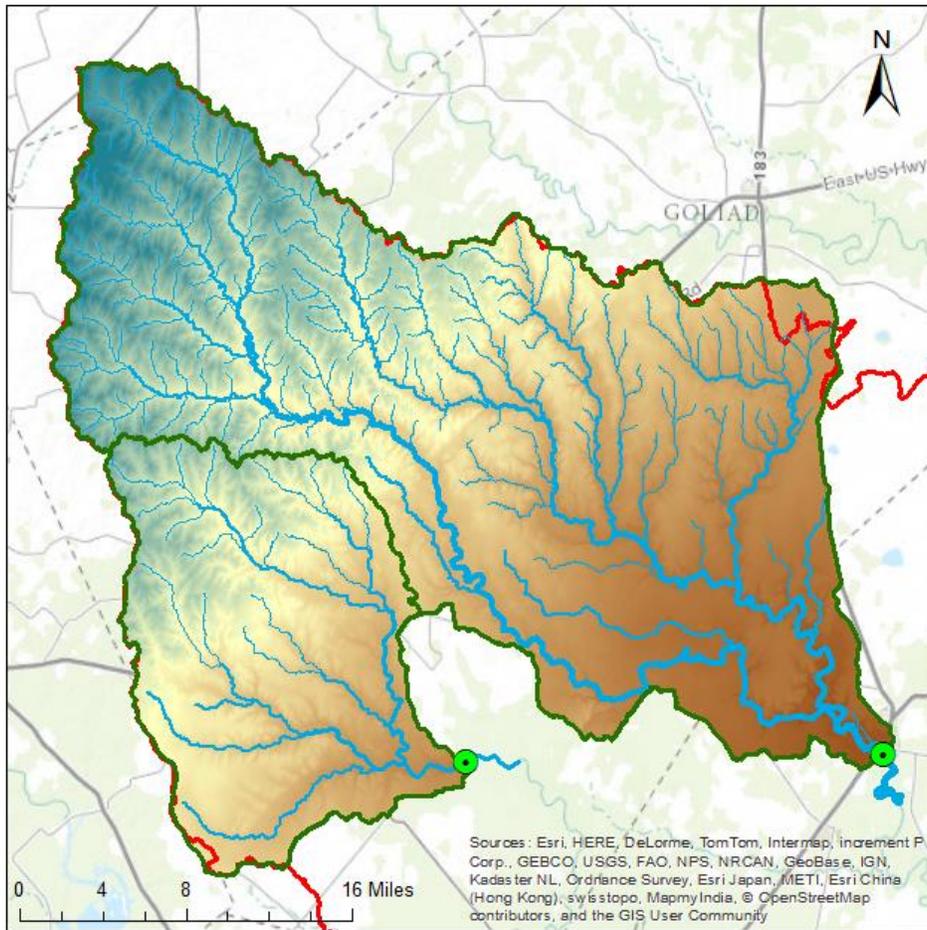


Figure 4. Mission and Aransas watersheds delineated above their respective USGS river monitoring stations (*green*). River flow adjusted to the National Hydrography Dataset gage is shown for the two delineated basins as well as a digital elevation model extracted from the 30m National Elevation Dataset provided by the USGS.

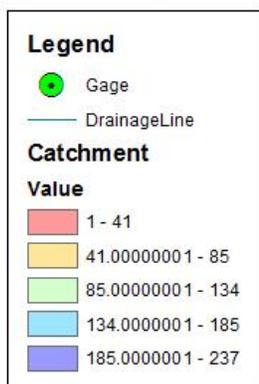
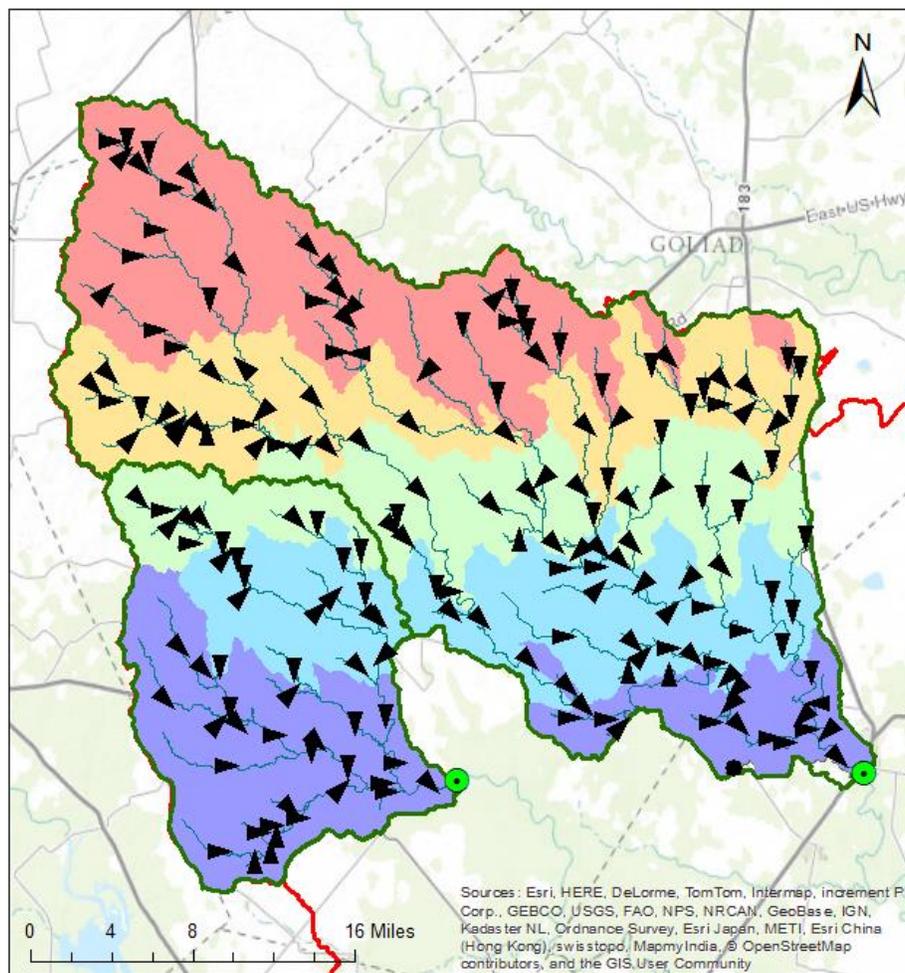


Figure 5. Mission and Aransas watersheds delineated above their respective USGS river monitoring stations (*green*). Flow accumulation data based on the digital elevation model was calculated using ArcGIS, and then used to create catchments for each basin. Drainage lines were similarly created based on the flow direction determined for each drainage cell. Flow direction is shown by the black arrows.

References

- Bianchi, T.S., J. Pennock, and R. Twilley (eds.) 1999. Biogeochemistry of Gulf of Mexico Estuaries. John Wiley & Sons, 428 pp.
- Mooney, R.F., McClelland, J.W. 2012. Watershed export events and ecosystem responses in the Mission-Aransas National Estuarine Research Reserve, South Texas. *Estuaries and Coasts* 35 (6): 1468-1485.
- Waterson, E.J., Canuel, E.A., 2008. Sources of sedimentary organic matter in the Mississippi River and adjacent Gulf of Mexico as revealed by lipid biomarker and $\delta^{13}\text{C}_{\text{TOC}}$ analyses. *Organic Geochemistry*. 39: 422-439.