

# Water Quality Trends Along a Salinity Gradient in the Tidal Arroyo Colorado

Paulina Ocadiz<sup>1</sup>, Alejandro Vansquez<sup>1</sup>, Alison McClellan<sup>1</sup>, Jessica Ayala<sup>1</sup>, Nicholas Vanhee<sup>1</sup>, Paulina Sanchez<sup>1</sup>, and Joseph L. Kowalski<sup>1,2</sup>  
<sup>1</sup>The International Baccalaureate Program at Lamar Academy, McAllen I.S.D., McAllen, Texas  
<sup>1,2</sup>The University of Texas Rio Grande Valley, Edinburg, Texas

## Introduction

The Arroyo Colorado (AC) is one of the most impaired water bodies in the state of Texas. Inorganic nutrients and fecal bacteria concentrations often exceed environmental thresholds. These conditions can lead to algal blooms, diminished light levels, hypoxia, and subsequent increased respiration rates. Salinity can moderate some impairment effects. We investigated a possible relationship between increasing salinity and water column inorganic nutrients (nitrate, ammonia and phosphate), underwater light, dissolved oxygen (DO), and partial CO<sub>2</sub> (pCO<sub>2</sub>) at four sites in the Arroyo Colorado along a salinity gradient.

## Materials and Methods

### Water Quality

Water samples taken at three Arroyo Colorado sites and one on the Laguna Madre (Fig. 1)  
 Salinity, dissolved oxygen (DO), pH measurements were made with a calibrated Hydrolab Quanta multiprobe  
 Water column nutrients (PO<sub>4</sub><sup>3-</sup>, NO<sub>3</sub><sup>-</sup>, and NH<sub>3</sub> assayed with Hach test strips  
 pCO<sub>2</sub> measured with calibrated Turner Designs submersible C-sense pCO<sub>2</sub> sensor providing data to a Turner Designs DataBank Data logger (see images below)  
 Light data (PAR) collected from a LiCor SA193 spherical light sensor providing data to a LiCor LI-1000 datalogger as μmol photons m<sup>-2</sup> s<sup>-1</sup>  
 Secchi depth recorded with a 20 cm diameter disc



Turner Designs C-sense submersible pCO<sub>2</sub> and DataBank Datalogger

Table 1. Surface water quality measurements for pH, phosphate, nitrate, and ammonia, dissolved oxygen, and Secchi depth, from three Arroyo study sites and one from the Lower Laguna Madre, Texas, September 2017.

Site	PO <sub>4</sub> <sup>3-</sup> (ppm)	NO <sub>3</sub> <sup>-</sup> (ppm)	pH	NH <sub>3</sub> (ppm)	Dissolved Oxygen (mg l <sup>-1</sup> )	Secchi Depth (cm)
AC 5	45	0	7	3	10.30	23
Thomae Ramp	30	8	8	1	7.60	30
AC 15	25	5	8	1	9.36	29
Arroyo Mouth	30	5	8	1	6.04	50

## Acknowledgements

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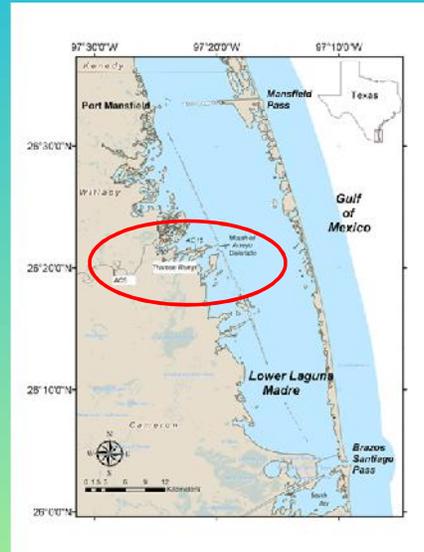


Figure 1. Map of Lower Laguna Madre, Texas, showing location of the Arroyo Colorado and study sites in the Arroyo (within red oval).

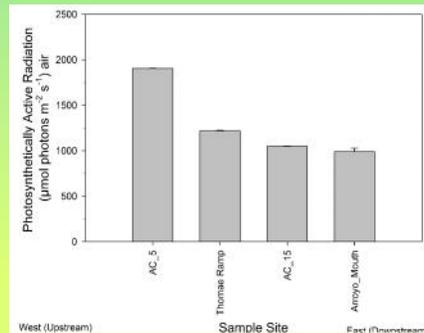


Figure 2: Surface photosynthetically active radiation at four Arroyo Colorado sites, September 2017.



## Results

- Salinity was lowest (18) at AC\_5 and increased to 39 in the Laguna Madre.
- Phosphate concentrations were abundant at all study sites, ranging from 25 to 45 ppm. No spatial trends in phosphate. (Table 1).
- Nitrate undetectable farthest upstream, but increased to the Laguna Madre.
- Ammonia was highest farthest upstream (3 ppm), but remained a 1 ppm at all other sites.
- DO was highest upstream but decreased to the Laguna Madre (Table 1).
- Surface and underwater light decreased by about half from the time of sampling at AC\_5 to the Laguna Madre (Fig. 2).
- The underwater light environment at Arroyo sites were significantly lower than that of the Laguna Madre, regardless of the time of day (Fig. 3).
- Significant differences in pCO<sub>2</sub> between sites and surface and measurements at 2 m depth.
- pCO<sub>2</sub> for both surface and 2 m depth at AC\_15 two-fold lower than all other sites (Fig. 4)

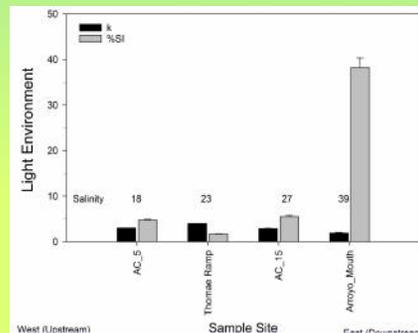


Figure 3: Light Environment (percent surface irradiance and attenuation coefficient - k m<sup>-1</sup>) as a function of salinity for three Arroyo sites and one in the Laguna Madre, studied in September 2017. Values are means ± one standard error. Where no error appears, error is smaller than the symbol.

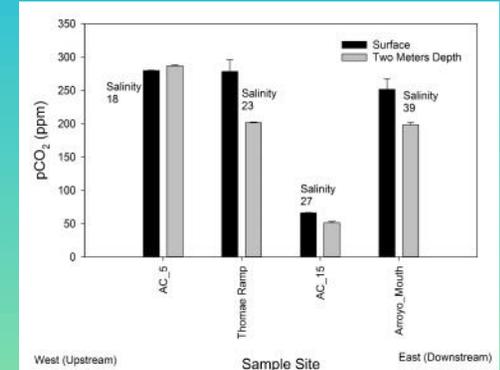


Figure 4. Surface and 2 m depth pCO<sub>2</sub> concentrations as a function of salinity for three Arroyo sites and one in the Laguna Madre, studied in September 2017. Values are means ± one standard error. Where no error appears, error is smaller than the symbol

## Discussion

Underwater light was highly variable, but was lowest at the Arroyo sites and highest at the mouth of the Arroyo. There was a clear decreasing trend in DO from supersaturated concentrations at the site farthest upstream to the mouth of the Arroyo. We used pCO<sub>2</sub> concentrations as a proxy for respiration. pCO<sub>2</sub> at the sites farthest upstream were nearly identical, but dropped significantly closer to the Laguna Madre. pCO<sub>2</sub> concentration in the Laguna Madre was nearly as great as the upstream sites. Arroyo water was strongly colored, suggestive of bloom conditions. Nitrate concentrations below detection could suggest rapid uptake. High photosynthetic rates could have been overwhelmed by substantially greater respiration rates.

