Shallow Groundwater and Surface Water Comparison of a Master-planned Community in Bonita Springs, Florida

Lane Davis[1], Rachel Rotz[1], Serge Thomas[1], James Douglass[1], Jasmine Morejon[1], Janelys Lopez[1], Megan Piquiet[1]
[1]Florida Gulf Coast University, The Water School, Fort Myers, Florida

ABSTRACT

The master-planned community of Bonita Bay Community Association (BBCA) (Fig 1.) in Southwest Florida was harmoniously integrated into the natural landscape including the protected Imperial River and Spring Creek drainage systems which feed Estero Bay and the Gulf of Mexico. Recent environmental concerns including harmful algal blooms, diminishing sea grass, oyster population decline, and high amounts of red tide in Estero Bay have raised concerns by the Bonita Bay Community on its contribution of pollutants to the region. This study focused on the groundwater quality of the Bonita Bay community and was part of a larger, extensive investigation to determine the efficacy of the imposed drainage system and the effect of fertilizers, bacteria, and reclaimed wastewater on the surface and subsurface waters of Estero Bay. This study was initiated and supported by the Bonita Bay Community Association as a way for the academic and residential communities to collaborate on environmental problems in the area.

OBJECTIVES

- To characterize the groundwater of BBCA.
- To compare the groundwater quality to the pond water quality.
- To compare the groundwater and pond water to the surface waters (i.e., Spring Creek, Imperial River) flowing into Estero Bay.
- To create a foundation by which to analyze the role of groundwater on contaminants and estuary health in Estero Bay.

STUDY SITE

Bonita Bay Community, Southwest Florida

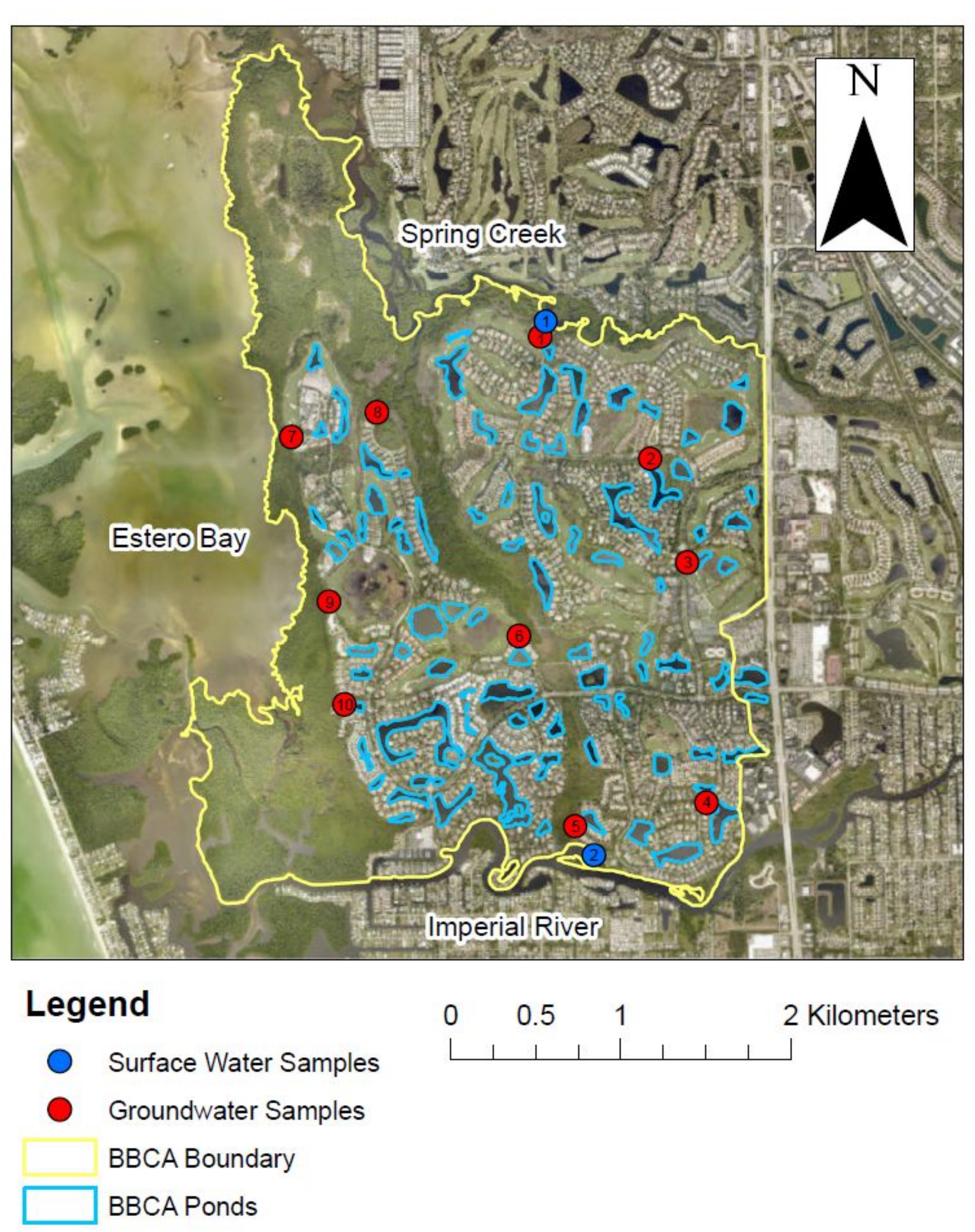

Fig 1. Map of the surface water and groundwater sampling points at the Bonita Bay community.

METHODOLOGY

- Collected water samples from each site using a groundwater sampling kit with a temporary piezometer (Fig. 2).
- Surveyed each piezometer location with a Carlson GNSS device for base elevation.
- Measured length to top of casing and depth to water table for each well.
- Measured temperature, conductivity, salinity, pH, and ORP using a YSI meter, flow cell, and peristaltic pump (Fig. 3).
- Conducted a nutrient analysis on the collected water samples using an AA500 AutoAnalyzer. Recorded the total nitrogen, total phosphorus, NO_x, ammonia, phosphate, nitrate and nitrite (Fig. 4)

Fig 2. Daniel Thomas with the piezometer.

Fig 3. Lane Davis collecting a groundwater sample.

RESULTS

Station	Temp. (°C)	Conductivity (us/cm)	Sal (ppt)	pH	ORP (mv)	TN	Nox (µg/L)	Ammonia (µg/L)	PO4 (µg/L)	Nitrite (µg/L)	Nitrate (µg/L)	TP
BBCAGW01	26.7	1181	0.57	6.21	-157.10	3.86	22.81	450.25	36.22	9.97	12.84	70.43
BBCAGW02	27.5	1186	0.56	7.04	-123.30	3.03	18.79	133.91	94.24	28.79	-10.00	154.44
BBCAGW03	28.5	1381	0.64	7.31	-270.30	2.41	6.30	441.51	317.17	5.33	0.97	957.35
BBCAGW04	27.3	3379	1.68	7.31	-184.20	2.25	5.93	372.25	42.58	3.43	2.50	37.33
BBCAGW05	26.4	1539	0.74	7.37	-242.80	3.26	22.59	500.77	137.68	12.20	10.40	232.40
BBCAGW06	29.9	2167	1.00	7.47	-223.60	2.91	10.70	422.87	318.40	4.47	6.23	794.94
BBCAGW07	28.7	2135	1.01	7.37	-225.60	4.47	5.71	490.23	99.70	9.17	-3.46	303.24
BBCAGW08	26.7	1650	0.80	6.57	-230.20	5.99	54.09	218.28	278.39	82.48	-28.39	948.06
BBCAGW09	27.9	1814	0.87	6.98	-239.60	3.53	5.61	466.56	151.74	10.11	-4.50	162.39
BBCAGW10	27.4	1329	0.63	7.03	-227.70	1.56	4.43	466.67	102.00	1.09	3.34	105.19
BBCASW01	28.9	21187	11.67	7.28	-135.50	0.81	40.83	113.80	52.32	16.99	23.84	73.79
BBCASW02	29.1	21587	11.87	7.15	-243.60	0.89	22.67	75.64	47.70	9.78	12.90	60.08

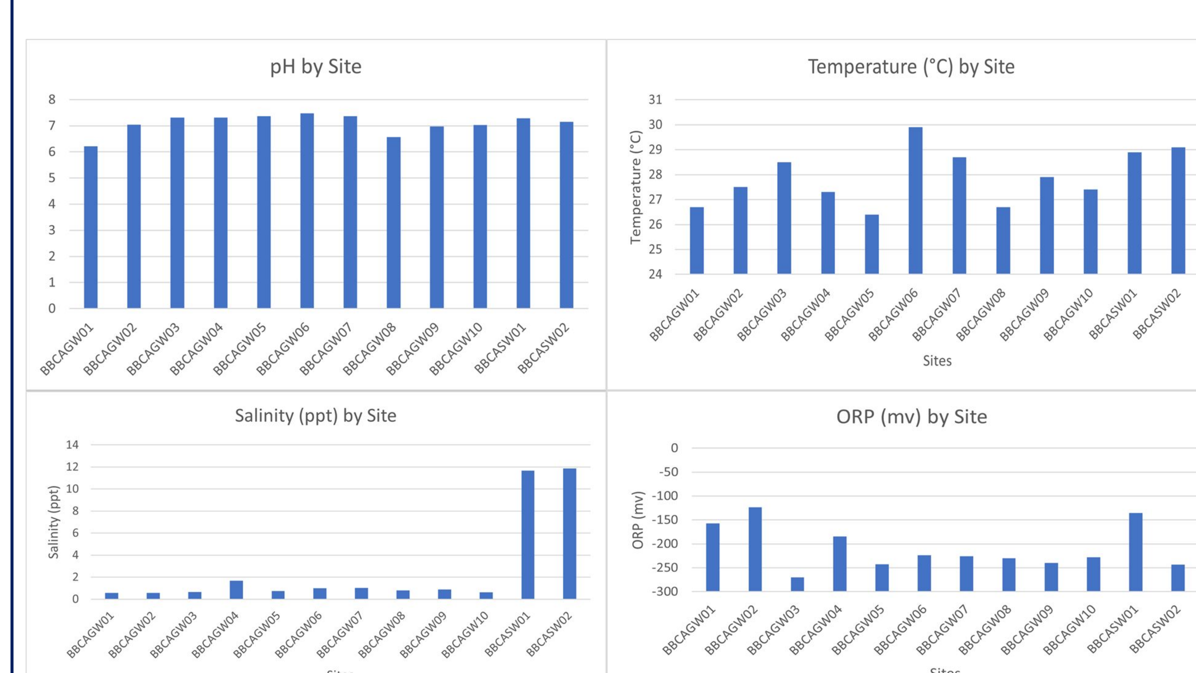

Fig 4. Top, data table of all parameters measured. Bottom, groundwater characterization by site (GW) and two river sites (SW).

RESULTS (continued)

Fig 5. Comparison of groundwater (green) and surface water (blue) closest to the wells. Phosphate (top left), ammonia (top right), NO_x (bottom left), and nitrite (bottom right). The numbers above the bars are the pond or well number, respectively. The red lines (Spring Creek, dashed; Imperial River, solid) are the concentrations measures from the surface water.

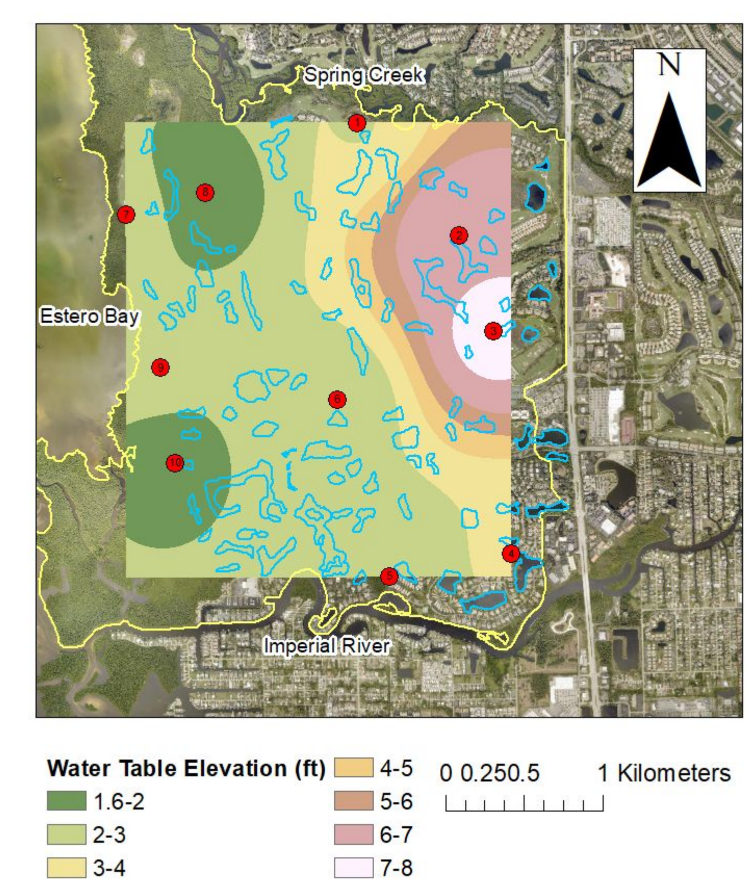

Fig. 6. Interpolated map of the water table elevation to understand the flow direction of groundwater.

Fig 7. Spatial distribution of ammonia (ug/L) in groundwater (left) and phosphate (ug/L) (right). Note, the surface water drainage flows into the Spring Creek and Imperial Rivers.

RESULTS (continued)

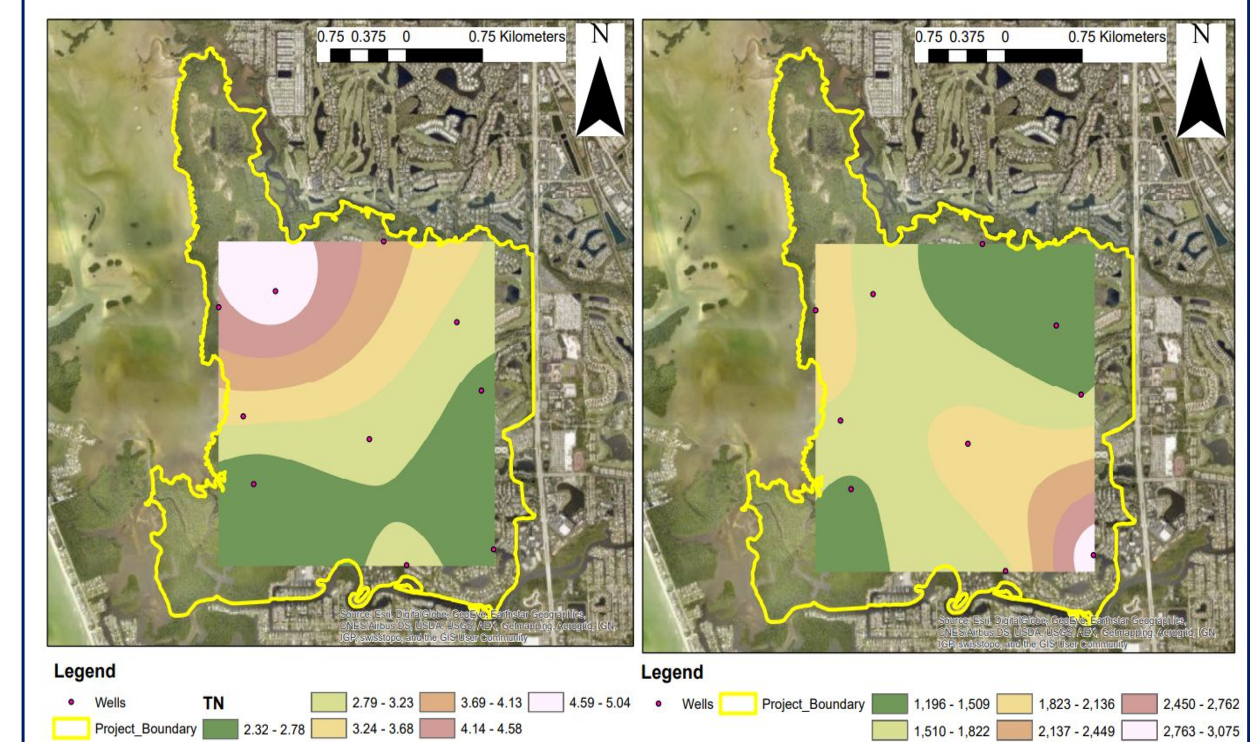

Fig. 8. Interpolated map of Total Nitrogen (ug/L) in groundwater (left) and Conductivity (ug/L) (right).

CONCLUSION AND DISCUSSION

- Groundwater contained higher levels of ammonia and phosphate than the ponds closest to the well sites, but varied with nitrogen (Fig. 5, 8).
- Increased levels of ammonia may be associated with slow moving groundwater as it flows towards Estero Bay at lower elevations (Fig. 5,6).
- NO_x levels in both Spring Creek and the Imperial River were relatively high compared to groundwater levels, and in some cases pond levels, indicating surface runoff may play a larger role to nitrogen contribution to the bay (Fig. 5).
- The spatial distribution of ammonia indicates accumulation primarily on the edges of the community in lower elevation areas (Fig. 6).
- The spatial distribution of phosphate shows concentrations in the central and eastern locations of the community and may indicate a point source (Fig. 7).

FUTURE WORK

- Create a water table elevation and flow path map to understand the movement of contaminants in the subsurface.
- Investigate the relationships between groundwater quality and the tributaries in the lager context of water quality and estuarine health (i.e., seagrass, oysters) over a longer time scale.
- Discuss the impacts of fertilization on surface and groundwater within master-planned communities on the through reporting and outreach.

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