Sanibel Communities for Clean Water Project

2025 Lakes Water Quality and Groundwater Monitoring

SCCF
SANIBEL-CAPTIVA
CONSERVATION FOUNDATION

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For The City of Sanibel Natural Resources Department

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Description of the Project

Community-owned lakes and stormwater collection systems are the receiving waterbodies for much of Sanibel's stormwater runoff. These systems are designed to retain large volumes of stormwater runoff before discharging offsite. Through this process, stormwater is effectively dissipated through evapotranspiration or directed through the soil and into the groundwater system. Factors such as rainfall, tides, irrigation, insufficient vegetation, and poor system design can allow discharges to surrounding surface water. When discharges from these systems occur, stormwater is conveyed to the Sanibel Slough, a waterbody designated as impaired for nutrients by the Florida Department of Environmental Protection (FDEP) with an assigned Total Maximum Daily Load (TMDL), or to the estuarine and gulf waters surrounding Sanibel. The surficial groundwater aquifer on Sanibel is very shallow and effectively connected to most stormwater ponds through porous soils. In this way, groundwater quality and flow is affected by community stormwater systems and lakes. The discharge of groundwater from Sanibel into the estuary and Gulf is estimated to be of nearly equal or greater total annual volume as stormwater runoff. Knowledge of nutrient concentrations and potential loadings from community stormwater systems and lakes is essential for effective management of nutrient loading sources. Poor water quality can negatively impact our environment, wildlife, human health, property values, and overall quality of life; therefore, it is imperative that we educate citizens of Sanibel on the importance of improving water quality at the local scale.

The first goal of this study is to evaluate water quality trends and compare current conditions for 40 sites to water quality criteria. Wet and dry season water quality sampling results will be supplied to the city to be uploaded to the Sanibel Communities for Clean Water website. This website is accessible to the public to provide information on water quality conditions and changes in their community and provides a list of recommended Best Management Practices (BMPs) tailored to specific sites.

Storm surge from Hurricane Ian inundated Sanibel in September 2022. In 2024, Sanibel was completely inundated again two times with Hurricane Helene in September and Hurricane Milton in October. As a result, the freshwater systems on Sanibel have shifted from fresh to salty twice within a three-year period. *The second goal* of this study is to track water quality changes in the former freshwater lakes on Sanibel as they transition from post storm surge conditions. SCCF Marine Laboratory personnel have estimated it may take years for some of the lakes on Sanibel to transition back to freshwater systems with salinity below 3 PSU.

The third goal of this year's study was to evaluate the relationship between groundwater and community lakes. Monitoring wells provide data showing ground water characteristics compared to nearby surface water.

Methods

Surface water samples were taken at 40 unique sites on Sanibel in dry and wet seasons (Table 1; Figure 1). Sites include public and privately owned stormwater systems, ponds, lakes, and reservoirs which have possible interaction with Sanibel's surface water or groundwater. Sampling events were conducted in the dry season (April 2025) and wet season (July 2025). To help evaluate changes after the recent surge events (goal 2), data previously collected in 2018, 2020, 2022, 2023, 2024 is combined with the new 2025 data. Samples were analyzed for total phosphate (TP), total nitrogen (TN), nitrate-nitrite (NOx), ammonia (NH3), and total Kjeldahl nitrogen (TKN) using NELAC certified methods by Benchmark Laboratories in Palmetto Florida. In addition to the nutrient sampling, dissolved oxygen (DO), turbidity, colored dissolved organic matter (CDOM), chlorophyll *a*, pH, salinity and temperature data were collected using a portable YSI EXO data sonde at each sampling site. Chlorophyll *a* analyses were performed using EPA approved methodology at the SCCF Marine Laboratory.

After uploading all data into the SCCF water quality database, it was aggregated within an excel spreadsheet and manipulated for input to Minitab13® software for statistical analyses. Descriptive statistics were produced for each site. Median parameter values were compared to water quality criteria using the nonparametric 1-sample Wilcoxson test. A significance level of 0.05 was used in all comparative analyses.

The Trophic State Index (TSI) is based on chlorophyll *a*, total nitrogen, and total phosphorus levels, and was calculated for each of these study lakes following the procedures outlined on pages 86 and 87 of the Florida's 1996 305(b) report. Each waterbody was assigned a water quality grade based upon this study period's TSI values; values above 80 = F, 70-80 = D, 60-70 = C, 50-60 = B, and under 50 = A (Excellent). The grades are based upon TSI values ranging from oligotrophic (good) to hypereutrophic (bad) waterbodies (Carlson and Simpson 1996). Trends in TSI were evaluated for each site for 2016 through August 2025 If the trend in TSI was significant and increasing, the site was listed as having declining water quality while a decreasing TSI trend was identified as improving water quality (Table 2).

Sample sites were ranked based upon combined mean inorganic phosphorus, inorganic nitrogen, chlorophyll *a* concentrations and TSI scores from both sampling events. The mean value of each of these four parameters was used to assign a rank score to each sample site with rank 1 indicating the poorest score for each parameter. The four rank scores were then added together to produce a total rank for each site. Total scores were listed from lowest to highest with lowest scoring site having overall poorest water quality condition.

Continuously recording water depth loggers (Onset Hobo) are installed in wells at 6 sites to provide insight into groundwater-lake interactions (Figure 1, Table 1).

1. Adjacent to the Murex Lakes area.
2. Adjacent to the Sea Oats area.

3. Adjacent to the Sanctuary Golf Course.
4. Adjacent to the Jordan Treatment Marsh.
5. Adjacent to the Dunes Golf Course.
6. Adjacent Periwinkle Way near Pond Apple Park.

Several times during dry and wet season the data loggers were read out and groundwater elevations were measured using a Trimble RTK GPS unit. The elevation data was downloaded and manipulated in an excel spreadsheet to assess groundwater flow directions at each of the sites. Salinity levels of the groundwater and nearby surface water were measured during each data collection event. In addition, we evaluated groundwater elevation data from 27 monitoring wells located west of Tarpon Bay Road in relation to water elevation within the Western Basin of Sanibel Slough. These wells were installed to compliment ongoing research into the Sanibel Island Rice Rat. Time series groundwater levels were compared to western basin water elevation and plotted along. These plots can be used to show relationships between release of water from the Tarpon Bay weir to effects on water levels on Sanibel's interior wetlands.

Results and Discussion

Current Water Quality and Trends

For the three years following the storm surge events of Ian, Helene and Milton the mean salinity of the monitored lakes was significantly greater than the salinity before Hurricane Ian (Kruskal Wallis, $p < 0.01$, Figure 2). In 2025, salinity ranged from a mean of 32.2 PSU at Annies Pond (SCL32) to 2.9 PSU at the Donax wastewater holding ponds (SCL05). Twenty (20) of the 40 waterbodies monitored have dropped to 5 PSU or less. A significant downward trend in salinity is apparent since April 2025 (Figure 3). Monitoring showed that salinity remained significantly greater in the deeper lakes compared to shallow lakes (Kruskal Wallis, $p < 0.01$, Figure 4). The large volume of high salinity water in deep lakes coupled with small watersheds results in a longer period before they become fresh again. The deep lakes may also interact more significantly with the deepest portion of the surficial aquifer which may have higher salinity.

A time series (Figure 5) of pH since 2016 shows the average pH of lakes sampled is well within acceptable water quality criteria (6.5-8.5). However, pH has been slightly lower since the storm surges. The current pH levels are not harmful to plants or animals, but they indicate that biochemical processes within the lakes are changed after storm surge events, i.e. the instantaneous change from freshwater to saltwater. Anaerobic decomposition of large amounts of new organic matter within the lakes can cause water column pH to be lowered.

Mean chlorophyll *a* (Chla) concentrations for the 2 monitoring events during 2025 ranged from 13.3 ug/l at Dunes Lake 5 (SCL07), to 119.5 ug/l at the Sanibel reclaimed water holding ponds (SCL05) (Table 2). The mean chlorophyll *a* concentration after Hurricane Ian was significantly greater for the monitored sites than previous to Ian (Kruskal-Wallis, $p<0.01$, Figure 6) however the values have been trending downward since Ian. The reason for the current downward trend is not apparent, but monitoring will confirm changes over the long term. As new phytoplankton communities became established in the saltier water after Ian, the increased amounts of carbon and nutrients from hurricane runoff cultivated an increase in the chlorophyll *a*. The Florida DEP chlorophyll *a* water quality criteria for lakes is 20 ug/l while it is 11 ug/l for estuaries (which these lakes more closely resemble due to salinity). Seventy-five percent (75% or 30/40) of lakes monitored for the 2025 report have mean chlorophyll *a* values above the lake water quality criteria. This is a decrease from the 90% of lakes which did not meet water quality criteria during the 2024 monitoring project.

The median total phosphorus (TP) values for the period after Hurricane Ian compared to before could not be found to differ significantly (Kruskal Wallis, $p = 0.376$, Figure 7). Mean TP in the sampled lakes ranged from 0.016 mg/l at Rabbit Road N. Bike Path Lake (SCL51l) to 0.691 mg/l at the Herons Landing Lake (SCL74) (Table 2). Mean TP values at 78% of the lakes were above the FDEP water quality criteria (0.05 mg/l, Figure 7). Thirty-two percent (32%)

were greater than the 90th percentile (0.092 mg/l) of Florida lakes (Hand 2008). This is similar to last year's findings.

The median total nitrogen (TN) values for the period after Hurricane Ian compared to before were found to be significantly lower after the hurricane (Kruskal Wallis, $p < 0.01$ Figure 8). The lower TN after hurricane Ian, Helene and Milton was likely due to dilution with Gulf and estuary waters which have significantly lower nitrogen concentrations than most lakes. The mean TN concentration in lakes ranged from 4.45 mg/l at Annies Pond (SCL32) to 0.66 mg/l at Gumbo Limbo eastern lake (SCL11) (Table 2). Sixty-five percent (65%) of the sites had TN values above the Florida criteria for lakes (1.27 mg/l, Table 2). About 41% of sites had mean TN above the 90^{th} percentile of all lakes in Florida (1.72 mg/l). This is an improvement from the 2024 findings. During the 2025 project period, IN made up an average of 8% of the TN value. This is the same as 2024 and less than the 11% in 2023. Increased IN since the Hurricanes (Figure 9) may be associated with wastewater overflows during surge events, and decomposition of other organic material washed into lakes from the surrounding lands.

TSI scores are meant to be an integrated look at the magnitude of eutrophication in a lake. Phosphorus, nitrogen and chlorophyll *a* are factors used to calculate a TSI value, so it is a good initial estimation of a lake's overall eutrophic condition. FDEP considers scores over 60 to indicate poor water quality and scores greater than 60 trigger evaluation of waterbodies for impairment. Thirty-two out of 40 (80%) lakes sampled this year had TSI scores greater than 60. Scores ranged from 57.2 at the East Rocks western Lake (SCL55) to 92.65 at the Herons Landing Western Lake (SCL74) (Table 2). No significant difference could be found for TSI scores after Hurricane Ian than before (Kruskal Wallis, $p = 0.98$, Figure 10).

The median fluorescent dissolved organic matter (FDOM) values of sampled lakes were found to be significantly greater for the period after Hurricane Ian compared to before (Kruskal Wallis, $p < 0.01$ and, Figure 11). Usually, FDOM is inversely related to salinity, however the colored organic matter which makes up FDOM was flushed into area waterbodies by saltwater surge instead of the usual freshwater precipitation.

Turbidity after Ian was significantly greater than the period before Ian (Kruskal Wallis, $p = 0.01$) (Figure 12). Potential drivers of the increase in turbidity include loss of aquatic vegetation within the lakes, suspended sediment associated with surge and stormwater, debris and altered biological and chemical characteristics of the waterbodies. Months after a hurricane surge event most added suspended solid will settle out, and lake clarity will mainly depend upon the phytoplankton stock (chlorophyll a) more than changes in turbidity or FDOM.

Upon grading Sanibel waterbodies based upon the TSI score, 6 waterbodies (15%) received a water quality grade of B; 18 (45%) received a C, 12 (30%) received a D and 4 (10%) received a grade of F (Table 2). This is an improvement in overall water quality conditions since 2022 (pre-Ian) when 51% of the lakes surveyed were graded D or F. Additionally, trend analysis on TSI scores since 2016 found 11 of the 40 (27%) waterbodies analyzed this year were improving during that period. The three surge events from 2022-2024 are likely to have had the greatest influence on this change, diluting polluted lakes with less polluted water from the Gulf.

Regardless of how an individual lake was ranked relative to other lakes on Sanibel, the water quality grade will give a better indication of its actual current health. If a lake has an F or D water quality grade – the water quality is very poor. A majority of Sanibel's formerly fresh waterbodies are eutrophic, and nutrient-enriched with high primary production leading to algal blooms. This statement was as true before the recent hurricanes as it is afterwards.

The water quality of lakes was ranked following procedures described in the methods section producing a prioritized list of lakes on Sanibel with water quality concerns (Table 2). Those with the highest rank are potentially most polluted and should be afforded the greatest resources in addressing their problems. The current ranked results are in a table with results from 2024, 2023, 2022, 2020, 2018 and 2016 (Table 2).

Groundwater-Surface Water Relationships

As determined in the 2024 Sanibel Communities for Clean Waters study (2024 study - Thompson 2024) groundwater flow direction (hydraulic gradient) in 6 study areas was generally toward nearby lakes (Figures 13-18). Evapotranspiration from a lake produces a virtual pump which carries water away from lake storage. However, areas which were adjacent to the Sanibel Slough could vary greatly in flow direction depending on the antecedent rain and water elevation of the Sanibel Slough. Water levels in the Slough can be held artificially high or low causing groundwater hydraulic gradients away or towards the slough instead of reliably towards a nearby surface water body.

Similarly, the reclaimed water ponds at Pond Apple Park are typically kept filled to an elevation significantly above the surrounding surficial aquifer. This creates a hydraulic gradient which causes water to flow continuously away from the ponds.

As found in the 2024 study, salinity in groundwater was generally lower than in adjacent surface water (Figures 19-20). Combined with the findings that groundwater normally flowed toward surface water, groundwater provides a salinity-reducing effect on adjacent surface waters. Though this lower salinity water flows into saltier lakes – the flowrates can be very low, and the overall dilution effect may be less than effects of surface water inflow or other factors.

Additional Findings

Interpolated maps of lake salinity in September 2024 (before Helene and Milton), October 2024 (after Helene and Milton) and in August 2025 show salt concentrations were lower before the storm surges of late summer 2024 but have now been reduced due to wet season rains (Figure 21). Shallow ponds monitored by SCCF Habitat Management Department show significant decrease in average salinity in those waterbodies (Figure 22). An interpolated map of lake chlorophyll *a* across Sanibel shows lower chlorophyll *a* values across Sanibel in the wet season of 2025 compared to the wet season of 2024 (Figure 23).

Groundwater monitoring wells installed within the West Basin watershed of the Sanibel Slough were used to evaluate the relationship between West Basin stage and groundwater elevation.

During the period in which these wells were providing data (April 2024 to present), the water elevation at the West Basin weir (stage) was generally greater than the 8 groundwater stations nearest the slough (Figure 24). This suggests the water in the West Basin provided groundwater flow from the slough and to surrounding land types such as wetlands. The Sanibel Slough is a channelized canal cut deeper than the average groundwater level on Sanibel. The control weirs on the Sanibel Slough allow the water level to be raised or lowered below the groundwater elevation. If the elevation within the slough is lowered, the interior wetlands become dry, much like the environmental disaster which occurred in the Everglades after canals were dug to drain those wetlands. Figure 25 shows a period in August 2025 when the Western Basin stage was aggressively lowered after large rainfall events. Releases of water from the western slough at the Tarpon Bay Weir resulted in a lowering of the water levels in the interior wetland areas of Sanibel. This is shown by the progression of GIS-generated figures from August 3rd through August 31st, 2025 (Figure 26).

Conclusions

Hurricanes Ian, Helene and Milton had significant water quality impacts on the community lakes and groundwater of Sanibel. On September 28, 2022, the freshwater lakes, wetlands and ponds of Sanibel were instantaneously converted to saline waterbodies. Again in 2024, three surge events (Tropical Storm Debby, Hurricane Helene, and Hurricane Milton) inundated Sanibel. Freshwater ecosystems were destroyed, and transient saline-water ecosystems have now developed. Some lakes and ponds are once again showing a significant decrease in salinity due to the precipitation during 2025. It may be many years before the deeper lakes of Sanibel can support freshwater flora and fauna again. However freshwater wetlands and the Sanibel Slough are well on their way to becoming fresh again as of August 2025. In the lakes which receive inputs of reclaimed wastewater through irrigation, salinity has recovered more quickly. Deep lakes with small watersheds will continue to have estuarine level salinities for the foreseeable future.

Lakes were ranked from poorest (ranked 1st priority) overall water quality to those with the least impairment (ranked 40). The lakes with poorest water quality can be targeted for lake management plan development and other pertinent BMPs once the source of poor water quality is identified. In general, lakes on Sanibel are eutrophic to hyper-eutrophic with relatively high nitrogen and phosphorus concentrations and abundant phytoplankton. The storm surges from recent hurricanes may have changed the salinity characteristics of the lakes, but the persistent phytoplankton blooms and low dissolved oxygen problems during cloudy days continue. Low dissolved oxygen conditions which occasionally develop in Sanibel lakes due to their eutrophic state, will be more likely to cause the death of estuarine fish which are currently in many Sanibel waterbodies.

In general, groundwater on Sanibel currently has lower salinity but higher nutrient concentrations than adjacent surface water. Groundwater normally flows towards lakes as a result of evapotranspiration, and this can help lower lake salinity but can also be detrimental because it will increase nutrient concentrations (and eutrophication) in the lakes. Evapotranspiration rates of vegetation were estimated from monitoring well drawdown using accepted methods. Evapotranspiration from healthy trees can equal rainfall during the wet season and exceed rainfall during dry season (USGS, 2025https://www.usgs.gov/centers/caribbean-florida-water-science-center-%28cfwsc%29/science/science-topics/actual). An analysis by Johnson Engineering (2024) found that Sanibel's vegetation index (NDVI) decreased significantly after hurricane Ian, suggesting its vegetation coverage is significantly reduced. A recovery in NDVI was observed in 2023 but did not reach pre-Ian values before once again decreasing following the storms in 2024. Reduced vegetation coverage would reduce evapotranspiration and thus reduce the rate of stormwater removal from the island. This can result in more standing water for longer periods of time in areas which have reduced vegetation.

Attached file: ComLakesDat_2025.xlsx

Figures and Tables

Table 1. Location of lake and groundwater sampling sites for this project. Table of groundwater monitoring wells and the surface water adjacent to them.

SiteID	Site	Type	Lat	Long
Devitt01	Pond at SCCF Homestead	Lake	26.44440	-82.04939
JM02	Jordan Marsh Effluent	Lake	26.43862	-82.05810
SCL02	BeachRdVillasPnd	Lake	26.44554	-82.04058
SCL03	PeriwnklePrkDuckPnd	Lake	26.44338	-82.04332
SCL05	CityReclaimDschrge	Lake	26.44571	-82.04570
SCL07	DunesLake5	Lake	26.45300	-82.04227
SCL08	DunesLake4	Lake	26.45515	-82.05254
SCL11	GumboLimboEast	Lake	26.44465	-82.05816
SCL13	SanGolfReclmPnd	Lake	26.43910	-82.05151
SCL18	SanibelLakeEst 1806_IbisLn_or_1995_Roseate	Lake	26.4360386	-82.06534666
SCL21	OceansReachCondo	Lake	26.42559423	-82.0675629
SCL23	PeriwinklePlaceSW	Lake	26.43734917	-82.06837736
SCL25	PeriwinklePinesSW	Lake	26.43915036	-82.07039688
SCL26	CasaYbel	Lake	26.42493	-82.07111
SCL29	SanibelCottages	Lake	26.42337	-82.07602
SCL30	Pointe Santos	Lake	26.42268	-82.07734
SCL31	BaileysPond	Lake	26.43361	-82.07880
SCL32	AniPondBailyTract	Lake	26.42813349	-82.08198178
SCL35	SeagullEstates - Daniel Lane _ western small lake	Lake	26.42519685	-82.08647547
SCL37	SmithLkBaileyTrct	Lake	26.43112	-82.08708
SCL41	HurricaneLane at Dock	Lake	26.4265256	-82.09170041
SCL43	PalmLake	Lake	26.42626	-82.09312
SCL45	NPoincianaPond Poinciana off Island Inn	Lake	26.43066475	-82.0943386
SCL46	Brghtwter_IslandInn	Lake	26.4289865	-82.0962015
SCL47	NlakeMurex	Lake	26.433161	-82.096812
SCL48	SLakeMurex	Lake	26.43137	-82.09683
SCL50	StIsabelCathChrch	Lake	26.44117	-82.10718
SCL51	NBikePathlake	Lake	26.43916321	-82.10848682
SCL53	SeaOatsDrSmlLake	Lake	26.43259396	-82.10993543
SCL55	ERockWestEndCoquina	Lake	26.43773	-82.11592
SCL56	WRockEastEndCoquina	Lake	26.43802	-82.11892
SCL57	GulfPines Near Tennis Courts	Lake	26.44434064	-82.12827171
SCL60	WhiteIbisGulfPines	Lake	26.44600475	-82.13462191
SCL62	ChateauSurMerLake	Lake	26.45264	-82.13939
SCL64	TradewindsNLake	Lake	26.45389	-82.14111
SCL69	SanctuaryLake4	Lake	26.47680143	-82.1666622
SCL70	BluCrabLake	Lake	26.47856434	-82.17064221
SCL71	SanctuaryLake7	Lake	26.49135	-82.17098
SCL74	Herons Landing Lake	Lake	26.47001	-82.15974
SCL80	East Hollys Pond	Lake	26.469667	-82.159048

Site ID	Site Type	Description	Lat	Long
GW01	Monitoring Well	South of Reclaim PondsPond Apple	26.445252	-82.045822
GW02	Monitoring Well	West of Reclaim PondsPond Apple	26.446874	-82.046014
GW03	Monitoring Well	North of Reclaim Ponds w BarometricPond Apple	26.447986	-82.045064
GW04	Monitoring Well	East of Reclaim PondsPond Apple	26.446953	-82.043791
GW05	Monitoring Well	Farther East of Reclaim PondsPond Apple	26.447039	-82.042662
GW06	Monitoring Well	NE Corner of Murex LakesLake Murex	26.434401	-82.096562
GW07	Monitoring Well	NE Corner of Murex LakesLake Murex	26.434725	-82.09679
GW08	Monitoring Well	SW Corner of Murex LakesLake Murex	26.430139	-82.103857
GW09	Monitoring Well	SW Corner of Murex LakesLake Murex	26.429453	-82.104676
GW10	Monitoring Well	SW Corner Jordan MarshJordan Marsh	26.438558	-82.057874
GW11	Monitoring Well	Mid JMarsh SouthsideJordan Marsh	26.439291	-82.056822
GW12	Monitoring Well	SW Jmarsh Just N of Sanibel SloughJordan Marsh	26.43779	-82.057742
GW13	Monitoring Well	Mid Sanibel Slough and JMarsh East Jordan Marsh	26.438805	-82.056074
GW14	Monitoring Well	Pond Apple Park just off Bailey RdDunes/PondApple	26.448805	-82.040337
GW15	Monitoring Well	South of Lake 7 in TreesSanctuary	26.489616	-82.170759
GW16	Monitoring Well	West of Lake 7 in MangrovesSanctuary	26.490618	-82.173315
GW17	Monitoring Well	The ShackPond Apple	26.444776	-82.046063
GW18	Monitoring Well	Bailey Rd East of Dunes Lake 5Dunes	26.451082	-82.039014
GW19	Monitoring Well	Bay Rd North of Lake 5Dunes	26.455438	-82.041668
GW20	Monitoring Well	NE Lake 5 near Tennis CourtsDunes	26.453699	-82.040941
GW21	Monitoring Well	S of Lake 5 behind house on SandcastleDunes	26.451326	-82.041229
GW22	Monitoring Well	East of Lake 7 off Wulfert RdSanctuary	26.490834	-82.169861
GW23	Monitoring Well	NE Lake 7 off Wulfert RdSanctuary	26.491958	-82.170398
GW24	Monitoring Well	Southern Well Between Sea Oats and Sanibel SloughSea Oats	26.437196	-82.110271
GW25	Monitoring Well	Middle Well Between Sea Oats and Sanibel SloughSea Oats	26.43762	-82.110539
GW26	Monitoring Well	Northern Well Between Sea Oats and Sanibel SloughSea Oats	26.438274	-82.110956

Groundwater Site	Additional GW Site	Surface Water Site	Surface Water Description
GW01	GW17	SCL05	Pondapple
GW06	GW07	SCL47	Murex
GW10		JM02	JM
GW12		WQ06	EBasin
GW20	GW18	SCL07	Dunes
GW23		SCL71	Sanctuary
GW25		SCL54	SeaOats
GW26		WQ04	WBasin

Figure 1. Sampling locations for this study. Lakes were sampled at 40 representative sites (red points) and 6 long-term groundwater monitoring wells (blue points).

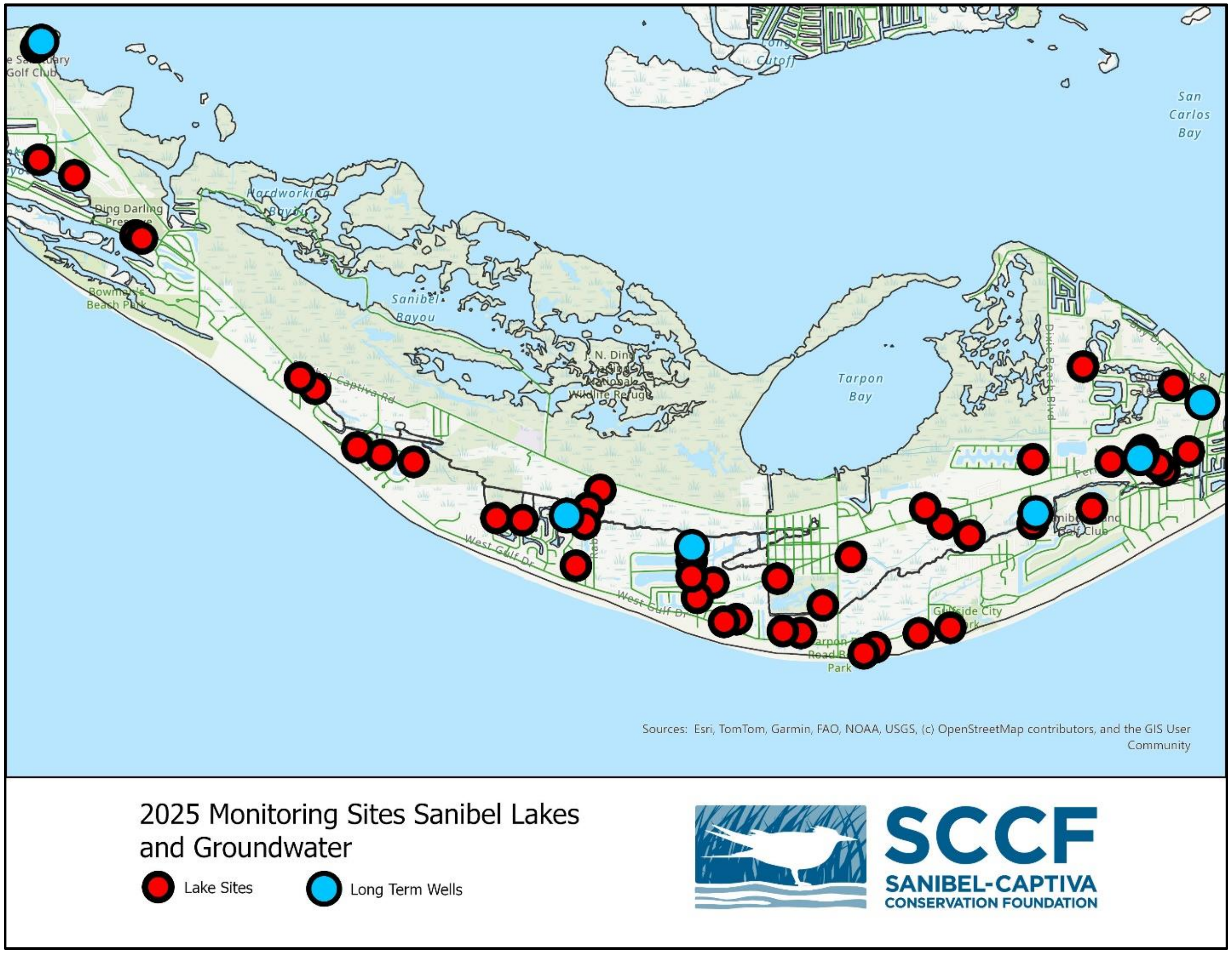


Table 2. Ranking of sample sites from poorest to better water quality showing mean water quality data for 2025. All parameter values shown are averages of wet and dry season results.

Prority Rank	Station	Description	WQ Grade	WQ Trend	IN mg/l	TN mg/l	OP mg/l	TP mg/l	Chla ug/l	TSI	NH3 mg/l	NOx mg/l	TKN mg/l	Salinity PSU	FDOM QSE	DO %	DO mg/l	Turbidity NTU	pH	Water Temp C	IN Rank	TP Rank	Chla Rank	TSI Rank	Total Score	2024 Grade	2023 Grade	2020 Grade	2018 Grade	2016 Grade
1	SCL05	CityReclaimDschrge	F	NC	0.849	2.34	0.387	0.374	119.5	84.1	0.510	0.339	2.00	2.9	159	173	12.3	10.2	8.92	25.0	2	3	1	2	8	F	F	F	F	F
2	SCL74	Herons Landing Lake	F	Better	0.556	2.64	0.753	0.691	93.5	92.7	0.522	0.035	2.60	23.6	268	101	6.6	12.1	7.89	31.5	3	1	4	1	9	F	F	F	F	NR
3	SCL29	SanibelCottages	F	NC	0.084	1.58	0.007	0.356	73.8	83.9	0.063	0.021	1.56	9.6	198	48	3.6	55.3	8.12	27.7	18	4	6	3	31					
4	SCL35	Seagull Est Daniel Ln Western Lake	D	NC	0.181	2.87	0.045	0.095	50.8	76.1	0.171	0.011	2.86	15.5	313	121	8.4	7.2	8.30	30.2	9	13	11	9	42	D		F	F	F
5	SanSlough	West Basin Sanibel Slough	D	NC	0.480	2.45	0.010	0.09	51.6	73.3	0.394	0.1	2.36	20.5		27	2.0	9.0	7.9	26.4	5	15	10	13	43	D	F	D	D	C
6	SCL32	AniPondBailyTract	D	NC	1.010	4.45	0.078	0.098	34.3	74.5	0.989	0.021	4.43	32.2	415	56	3.7	22.9	8.34	28.4	1	12	21	10	44	F		D	F	D
7	SCL80	East Hollys Pond	D	Better	0.155	3.36	0.065	0.092	43.5	77.6	0.132	0.024	3.33	17.2	228	73	4.6	27.2	7.69	34.3	12	14	13	6	45	F		F	F	NR
8	SanSlough	East Basin Sanibel Slough	D	NC	0.325	1.883	0.060	0.135	36	73.6	0.301	0	1.86	14.7		19	1.4	12.0	7.7	26.6	6	10	19	12	47	D	F	D	D	D
9	SCL03	PrwnklePrkDuckPond	F	NC	0.053	2.15	0.008	0.158	108.6	82.0	0.036	0.017	2.14	12.0	272	113	8.1	21.5	8.3	28.9	36	9	3	4	52	D		F	F	D
10	SCL69	SanctuaryLake4	D	NC	0.066	1.42	0.089	0.229	41.0	77.2	0.051	0.015	1.40	10.7	244	69	5.0	8.4	7.88	28.8	25	7	14	7	53	D		F	F	F
11	SCL13	SanGolfReclmPnd	D	NC	0.056	0.98	0.801	0.673	37.3	78.0	0.044	0.012	0.97	3.5	123	223	16.4	9.2	9.19	29.9	32	2	17	5	56	F	F	F	F	F
12	SCL60	WhiteIbisGulfPines	D	NC	0.090	2.50	0.012	0.061	56.3	74.3	0.070	0.020	2.48	13.1	353	36	2.5	11.3	7.82	30.2	17	25	8	11	61	F		D	D	C
13	SCL45	Pond - Poinciana off Island Inn	D	NC	0.118	1.70	0.013	0.054	118.4	72.7	0.105	0.013	1.69	9.7	279	136	10.3	19.1	8.70	-8.2	15	30	2	14	61	D		C	C	C
14	SCL26	CasaYbel	D	NC	0.072	1.22	0.002	0.126	49.9	72.4	0.056	0.016	1.20	6.3	191	39	2.8	13.2	8.03	28.6	22	11	12	16	61	F	C	D	D	D
15	SCL31	BaileysPond	C	NC	0.125	1.52	0.059	0.065	80.9	70.4	0.104	0.021	1.50	13.3	292	48	3.4	27.7	7.46	29.0	13	24	5	20	62	D	D	C	C	C
16	SCL71	SanctuaryLake7	D	NC	0.058	1.55	0.083	0.238	34.7	76.8	0.044	0.014	1.54	8.3	256	105	7.6	4.9	8.27	30.2	31	5	20	8	64	F	D	F	F	F
17	SCL62	ChateauSurMerLake	D	NC	0.073	2.20	0.009	0.061	39.9	72.6	0.059	0.014	2.19	11.2	290	117	8.1	12.0	8.04	31.3	21	26	15	15	77	D	D	D	D	C
18	Devitt01	Pond at SCCF Homestead	D	NC	0.070	1.20	*	0.23	15.3	72.4	0.06	0.015	1.18	4.3	303	89	6.2	7.6	8.39	32.9	23	6	39	17	85	F	F	D	D	C
19	SCL21	OceansReachCondo	C	NC	0.167	1.53	0.002	0.077	23.3	67.9	0.153	0.014	1.51	20.4	209	38	2.6	25.0	8.03	29.1	10	19	32	27	88	D		B	C	C
20	SCL43	PalmLake	C	NC	0.163	1.16	0.027	0.068	29.2	66.7	0.146	0.017	1.15	25.0	130	86	5.6	8.8	8.10	30.8	11	23	25	30	89	D	D	C	C	C

Table 2 (cont.). Ranking sample sites from poorest to better water quality showing mean water quality data for 2025. All parameter values shown are averages of wet and dry season results.

Prority Rank	Station	Description	WQ Grade	WQ Trend	IN mg/l	TN mg/l	OP mg/l	TP mg/l	Chla ug/l	TSI	NH3 mg/l	NOx mg/l	TKN mg/l	Salinity PSU	FDOM QSE	DO %	DO mg/l	Turbidity NTU	pH	Water Temp C	IN Rank	TP Rank	Chla Rank	TSI Rank	Total Score	2024 Grade	2023 Grade	2020 Grade	2018 Grade	2016 Grade
21	SCL64	TradewindsNLake	C	Better	0.059	1.24	0.008	0.071	39.3	69.0	0.044	0.015	1.23	6.4	233	86	6.2	8.9	7.91	30.3	30	20	16	25	91	C	C	D	D	D
22	SCL70	BluCrabLake	C	Better	0.121	1.45	0.007	0.085	23.4	67.0	0.104	0.017	1.43	27.6	266	44	2.8	4.1	7.74	32.7	14	17	31	29	91	D		D	F	F
23	SCL48	SLakeMurex	D	Worse	0.055	1.66	0.022	0.082	34.1	71.4	0.040	0.016	1.64	18.9	121	95	6.7	41.9	8.39	27.6	33	18	23	18	92	D	D	D	C	C
24	JM02	Jordan Marsh Effluent	C	Better	0.097	1.89	*	0.05	33.2	69.8	0.08	0.019	1.87	3.9	279	103	7.1	7.4	8.37	34.2	16	31	24	22	93	C	D			
25	SCL18	SanibelLakeEst Ibis Ln.	C	NC	0.250	1.46	0.044	0.060	26.9	66.0	0.217	0.033	1.43	11.9	321	37	2.6	1.8	7.66	31.3	7	27	28	32	94	C		C	C	C
26	SCL41	HurricaneLane at Dock	C	NC	0.061	1.81	0.052	0.069	29.1	70.2	0.042	0.020	1.79	18.6	192	76	5.1	21.4	8.19	30.8	28	22	26	21	97	D		C	C	C
27	SCL25	PeriwinklePinesSW	C	NC	0.054	1.13	0.035	0.046	66.2	68.8	0.038	0.017	1.12	7.4	245	93	6.4	5.8	8.23	32.1	34	33	7	26	100	C		C	D	C
28	SCL08	DunesLake4	C	NC	0.065	0.91	0.009	0.087	27.3	66.3	0.053	0.012	0.90	16.6	187	87	6.0	7.5	7.82	29.8	26	16	27	31	100	F	F	D	F	D
29	SCL47	NlakeMurex	C	NC	0.054	2.38	0.046	0.036	56.3	69.7	0.031	0.023	2.36	21.0	93	109	7.7	10.1	9.02	28.6	35	37	9	23	104	C		D	D	D
30	SCL23	PeriwinklePlaceSW	C	NC	0.050	0.98	0.002	0.070	37.1	67.3	0.037	0.013	0.97	4.8	220	74	5.4	19.2	8.17	30.4	37	21	18	28	104	D		C	C	B
31	SCL07	DunesLake5	C	NC	0.048	1.16	0.236	0.215	13.3	70.7	0.034	0.014	1.14	12.1	207	74	5.3	8.7	8.11	30.3	38	8	41	19	106	F	D	F	D	D
32	SCL56	WRockEastEndCoquina	C	NC	0.076	3.92	0.010	0.043	22.2	69.0	0.061	0.016	3.91	16.6	170	84	5.8	6.8	7.96	30.0	20	34	33	24	111	D	D	C	D	C
33	SCL30	Pointe Santos	B	Better	0.062	0.71	0.006	0.056	20.0	60.8	0.045	0.018	0.69	8.2	137	89	6.6	11.4	8.53	29.1	27	28	34	38	127	D	D	C	D	C
34	SCL51	NBikePathlake	B	Better	0.227	1.94	0.002	0.016	16.2	58.1	0.203	0.024	1.92	18.7	206	86	5.8	5.3	7.84	31.5	8	42	37	40	127	C		F	D	D
35	SCL37	SmithLkBaileyTrct	B	Better	0.532	1.86	*	0.027	4.8	56.3	0.518	0.014	1.85	16.8	406	50	3.2	2.0	7.60	34.3	4	40	42	42	128	C	C	C	D	C
36	SCL11	GumboLimboEast	B	Better	0.048	0.66	0.003	0.051	34.3	60.8	0.035	0.013	0.65	10.0	216	41	3.0	4.9	7.58	29.5	39	32	22	37	130	C	C	D	D	D
37	SCL57	GulfPines Near Tennis Courts	C	NC	0.083	2.00	0.005	0.031	13.6	61.9	0.068	0.015	1.98	18.8	318	75	5.1	5.5	7.90	30.6	19	39	40	34	132	F		D	D	C
38	SCL50	StIsabelCathChrch	B	Better	0.061	0.90	0.004	0.034	24.7	59.1	0.048	0.013	0.89	14.8	223	67	8.2	16.2	8.13	-8.0	29	38	30	39	136	D	F	F	F	D
39	SCL53	SeaOatsDrSmlLake	C	NC	0.046	1.26	0.026	0.056	18.7	64.4	0.033	0.013	1.25	3.6	221	76	5.6	9.1	7.85	30.1	41	29	35	33	138	C		C	C	C
40	SCL46	Brghtwter_IslandInn	C	NC	0.041	0.90	0.011	0.040	25.4	61.8	0.030	0.012	0.88	14.7	200	78	5.6	11.9	8.13	28.9	42	35	29	35	141					
41	SCL55	ERockWestEndCoquina	B	Better	0.067	1.22	0.003	0.021	15.7	57.2	0.056	0.011	1.21	13.1	197	67	4.7	2.8	7.80	30.1	24	41	38	41	144	C	D	C	D	C
42	SCL02	BeachRdVillasPnd	C	NC	0.047	1.14	0.009	0.039	17.6	61.15	0.031	0.016	1.12	9.5	211	73	5.2	8.9	8.1	29.4	40	36	36	36	148	D	D	B	C	B

Figure 2. Boxplot of mean salinity values for lakes sampled for the Sanibel Communities for Clean Water project during the period 2016 through 2025. In September 2022, Hurricane Ian immediately changed freshwater systems to marine systems and storm surges from TS Debbie, and Hurricanes Helene and Milton in 2024 increased salinity again. Mean values are decreasing but still significantly greater than conditions before September 2022.

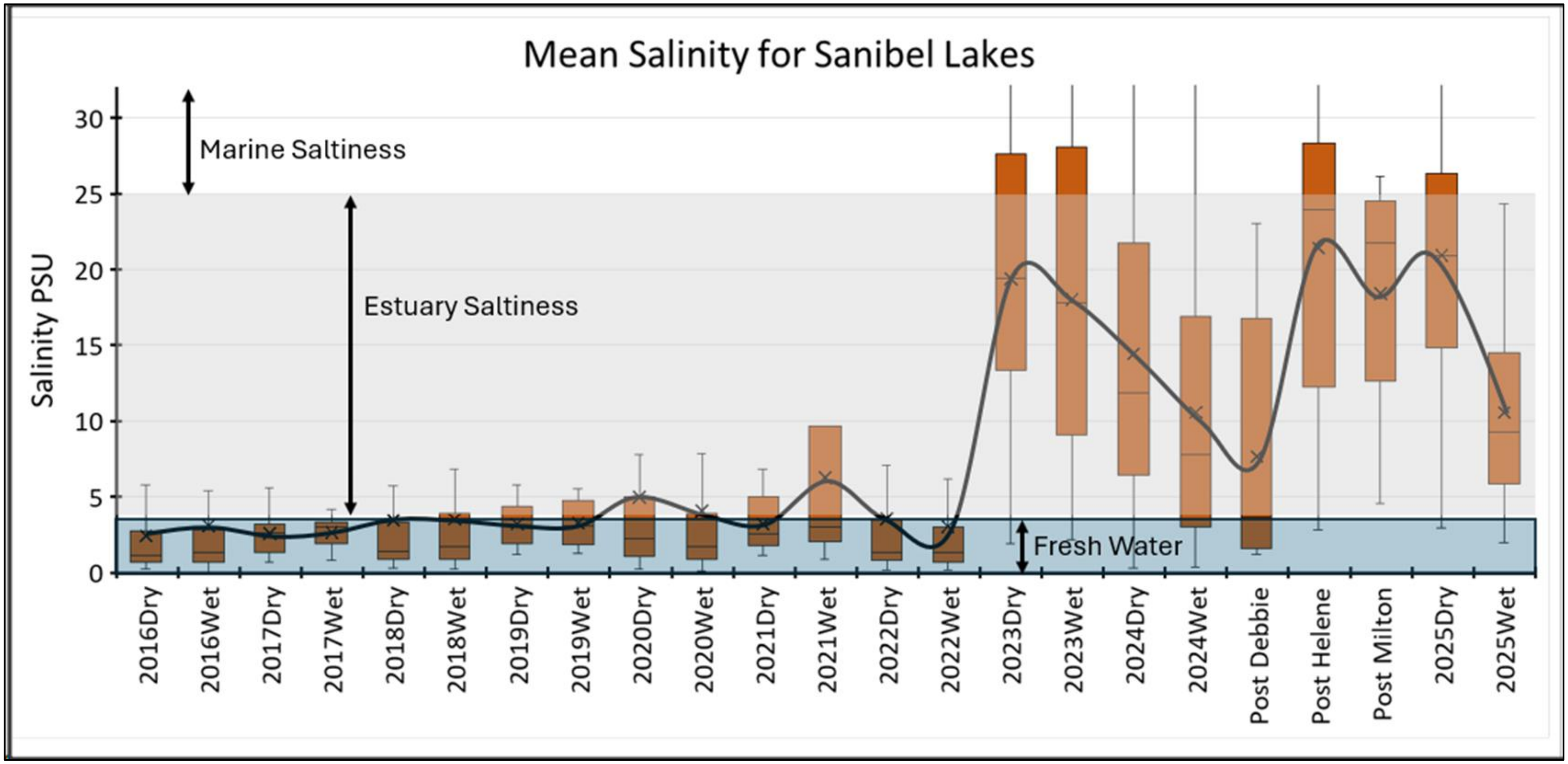


Figure 3. Time series for mean salinity values for waterbodies sampled for the Sanibel Communities for Clean Water project during the period 2016 through August 2025 showing significant downward trend since April 2023.

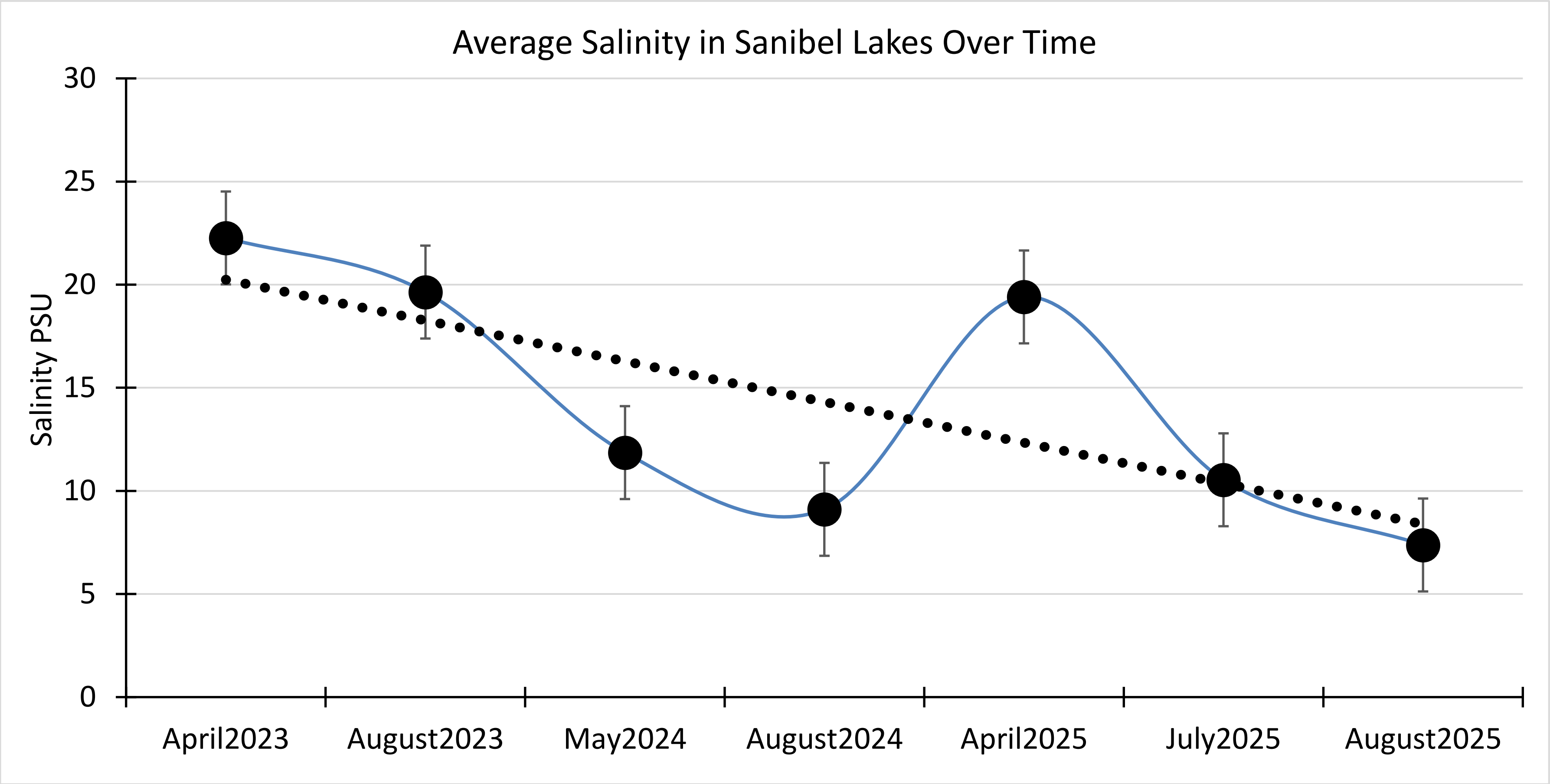


Figure 4. Salinity of shallow lakes vs. deep lakes which were monitored for this report. Classification based upon middle depth greater than 8 feet is deep and less than 4 feet is shallow.

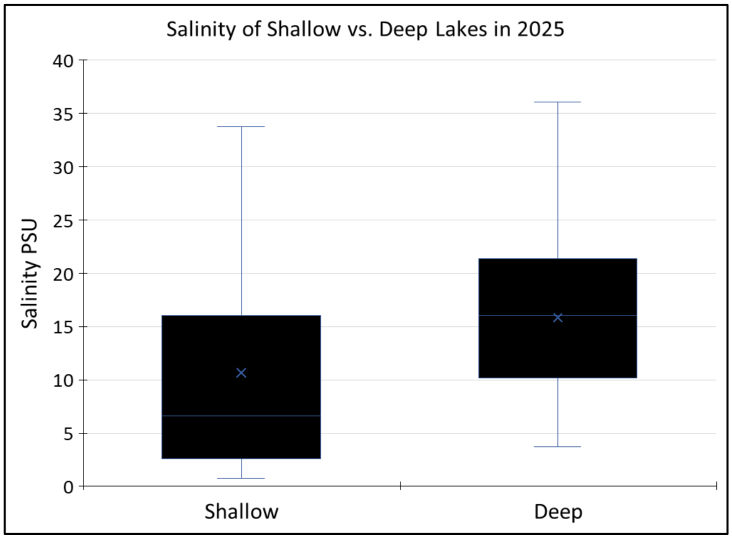


Figure 5. Time series of average pH for monitored lakes.

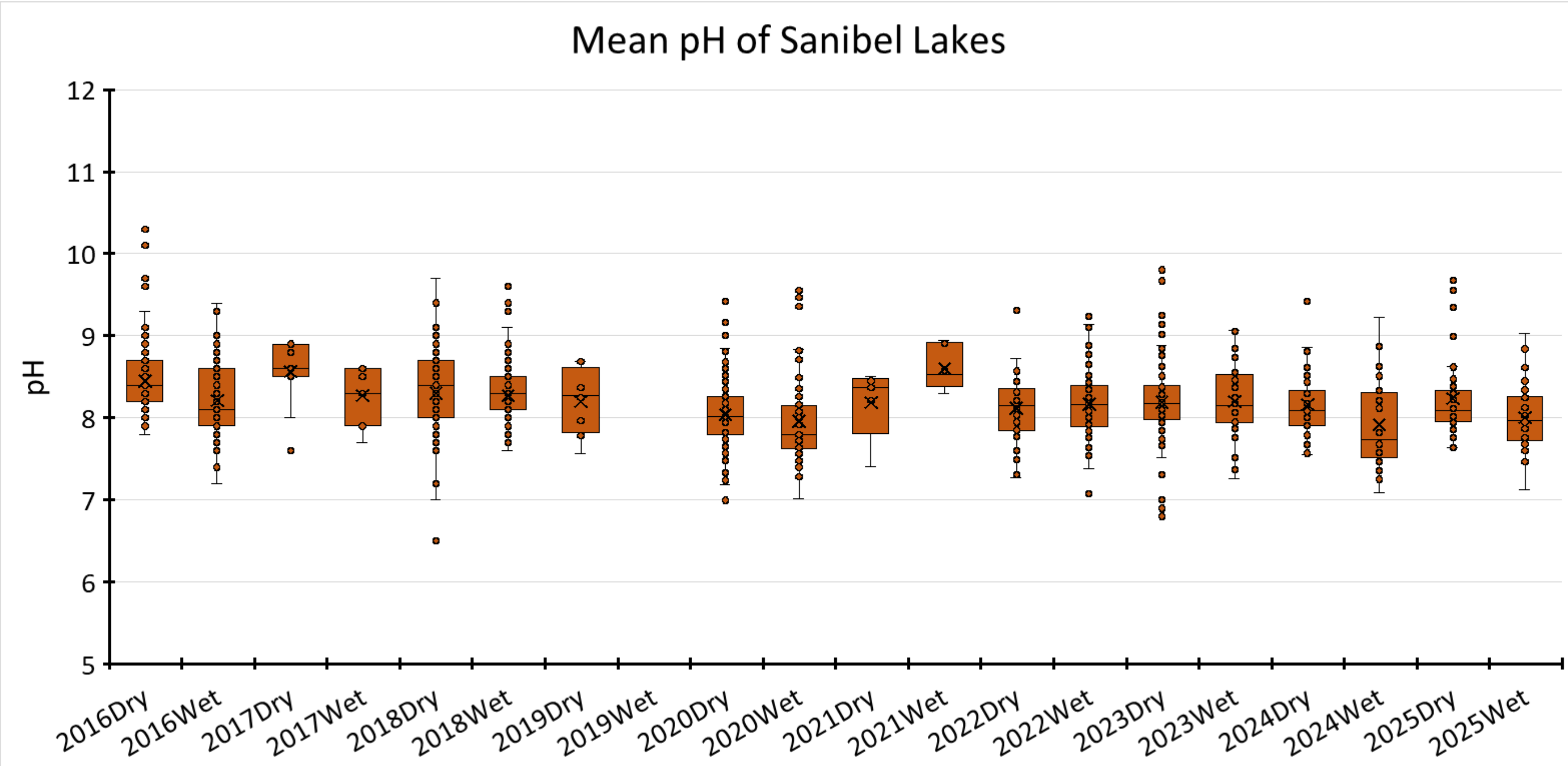


Figure 6. Boxplot of mean chlorophyll *a* concentration per season for the lakes sampled during the Sanibel Communities for Clean Water project.

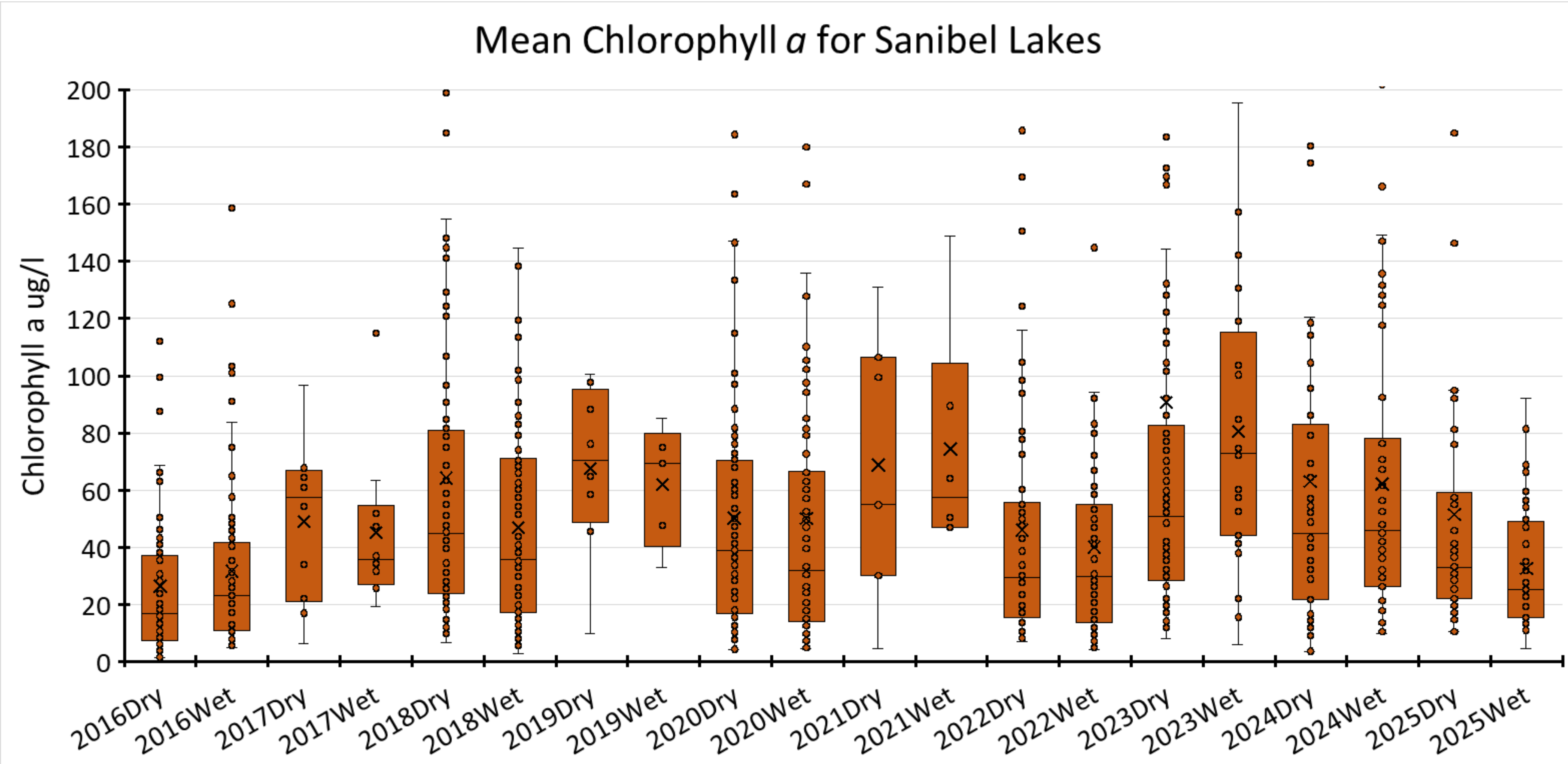


Figure 7. Boxplot of mean total phosphorus concentration per season for the lakes sampled during the Sanibel Communities for Clean Water project. The red line is the Florida state lake water quality criteria maximum for phosphorus.

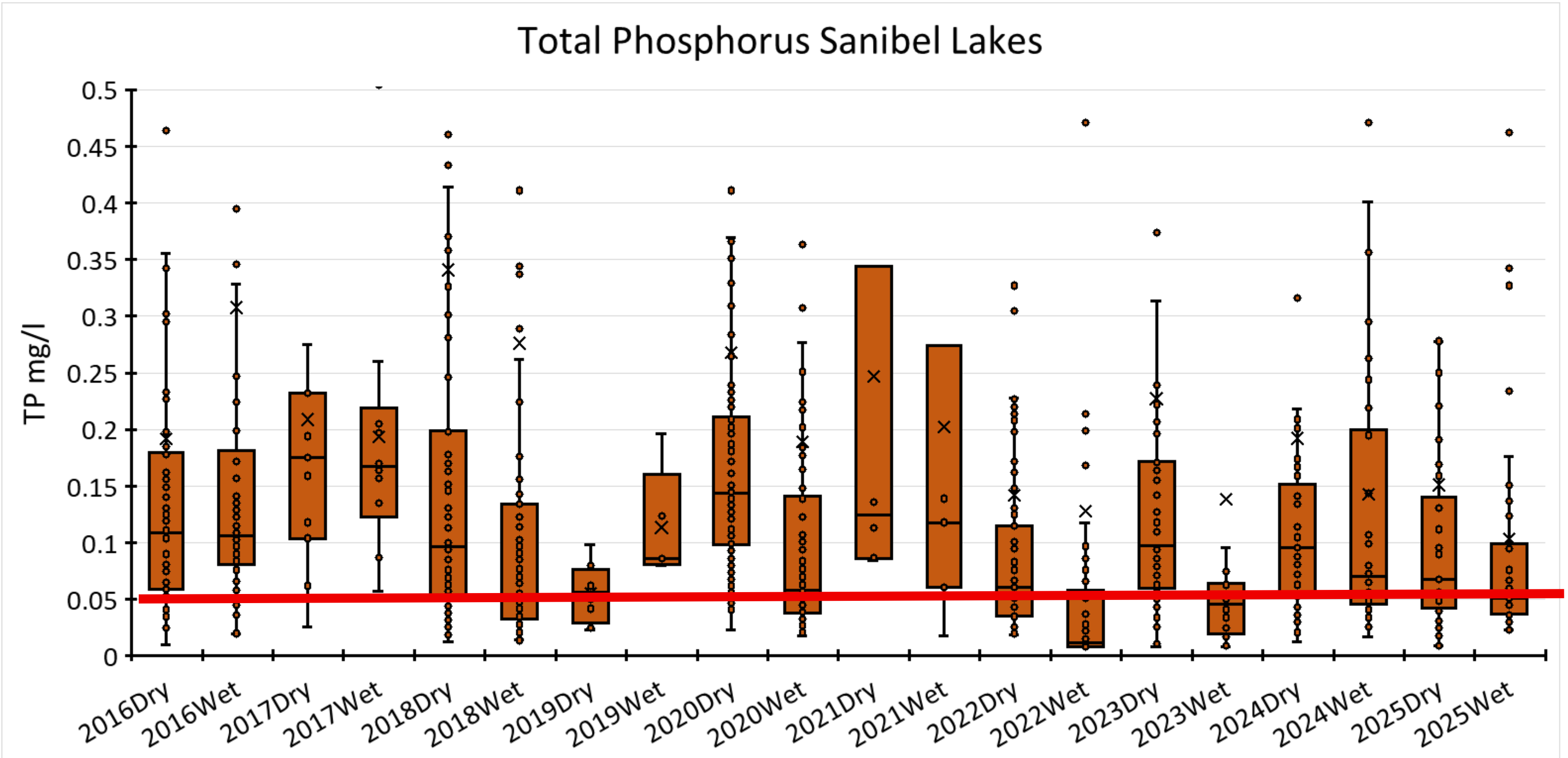


Figure 8. Boxplot of mean total nitrogen concentration per season for the lakes sampled during the Sanibel Communities for Clean Water project. The red line is the Florida state lake water quality criteria maximum for nitrogen.

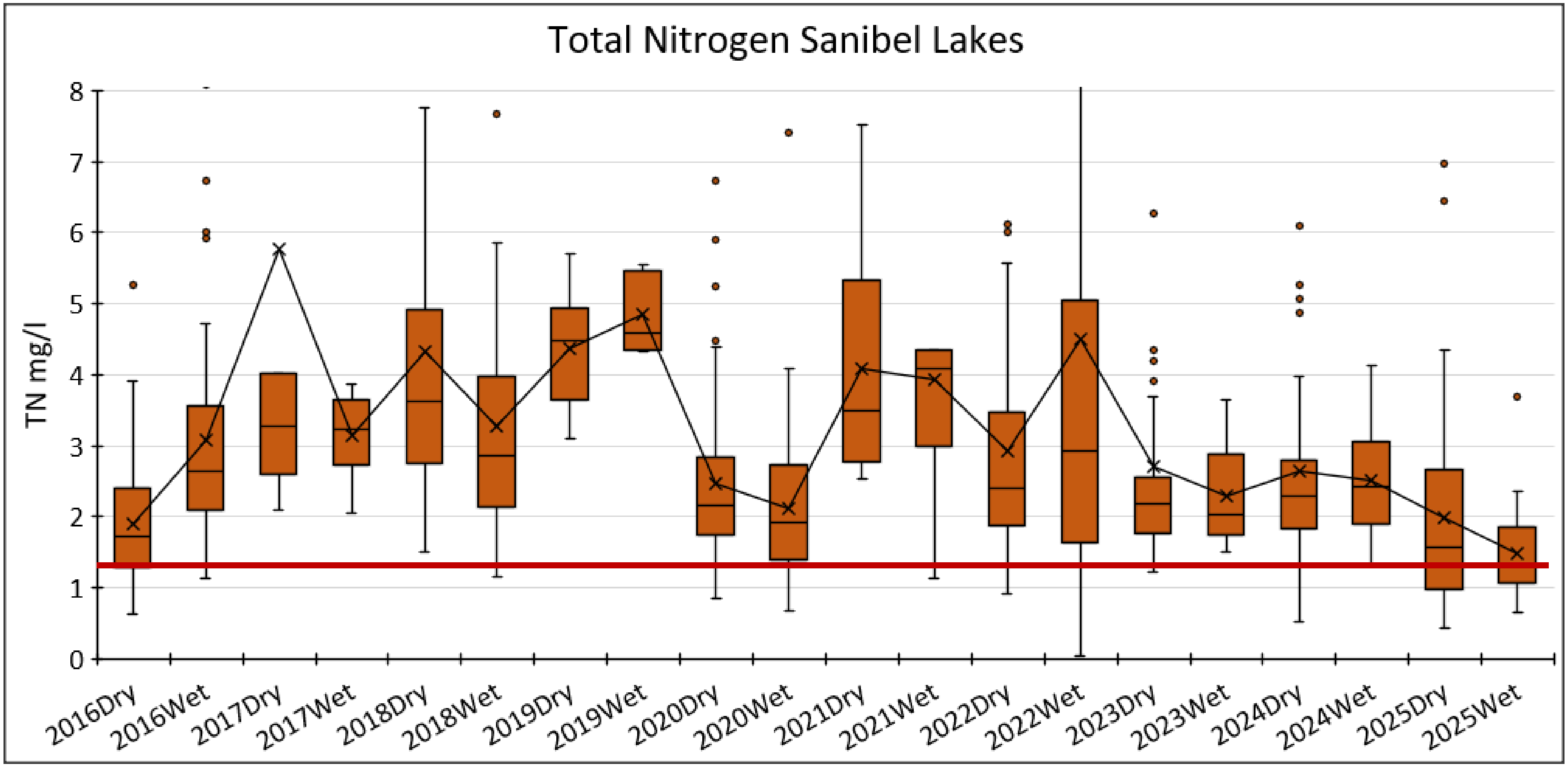


Figure 9. Boxplot of mean inorganic nitrogen concentration per season for the lakes sampled during the Sanibel Communities for Clean Water project.

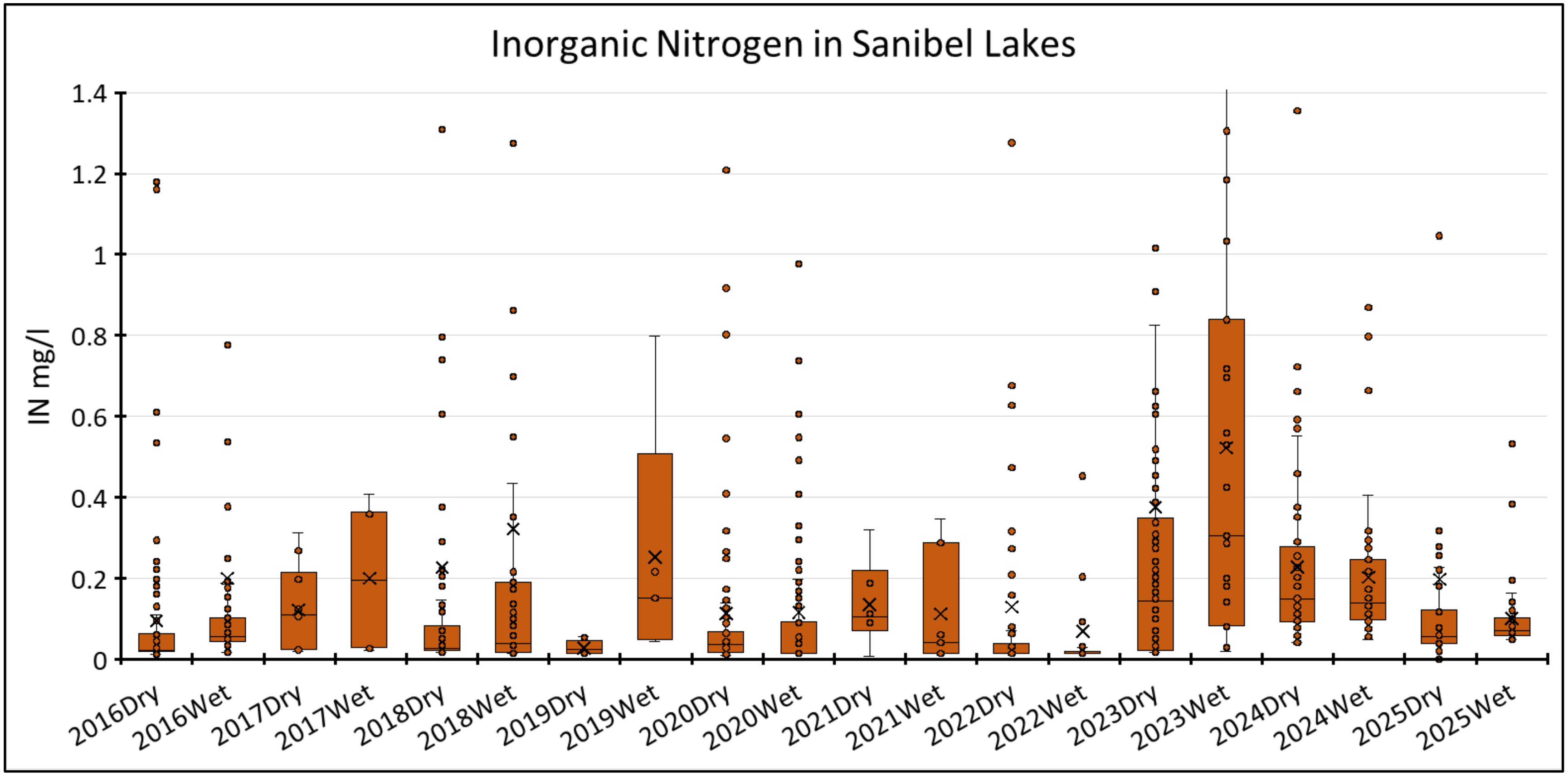


Figure 10. Boxplot of mean trophic state index (TSI) per season for the lakes sampled during the Sanibel Communities for Clean Water project.

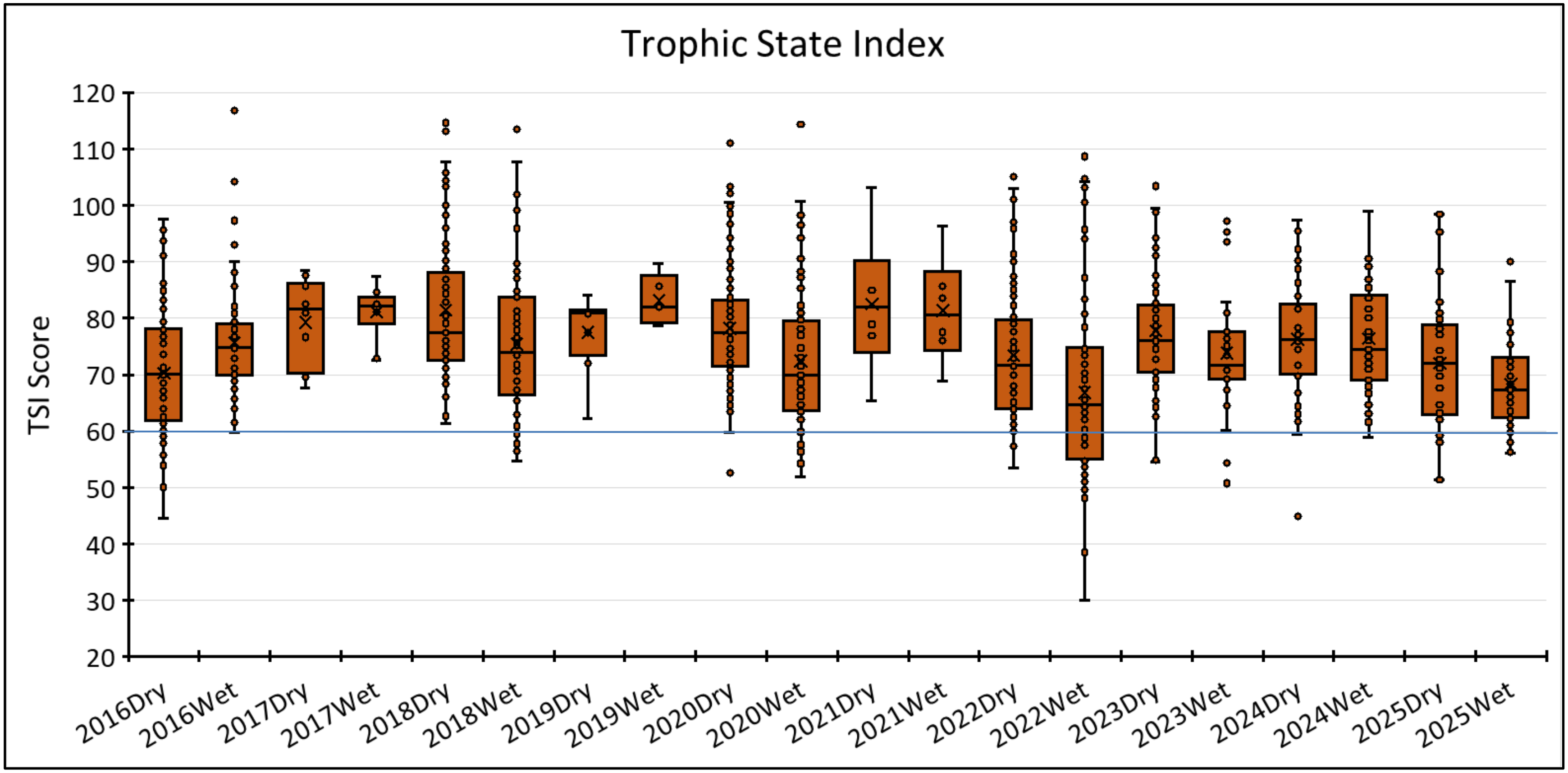


Figure 11. Boxplot of mean fluorometric dissolved organic matter (FDOM) per season for the lakes sampled during the Sanibel Communities for Clean Water project.

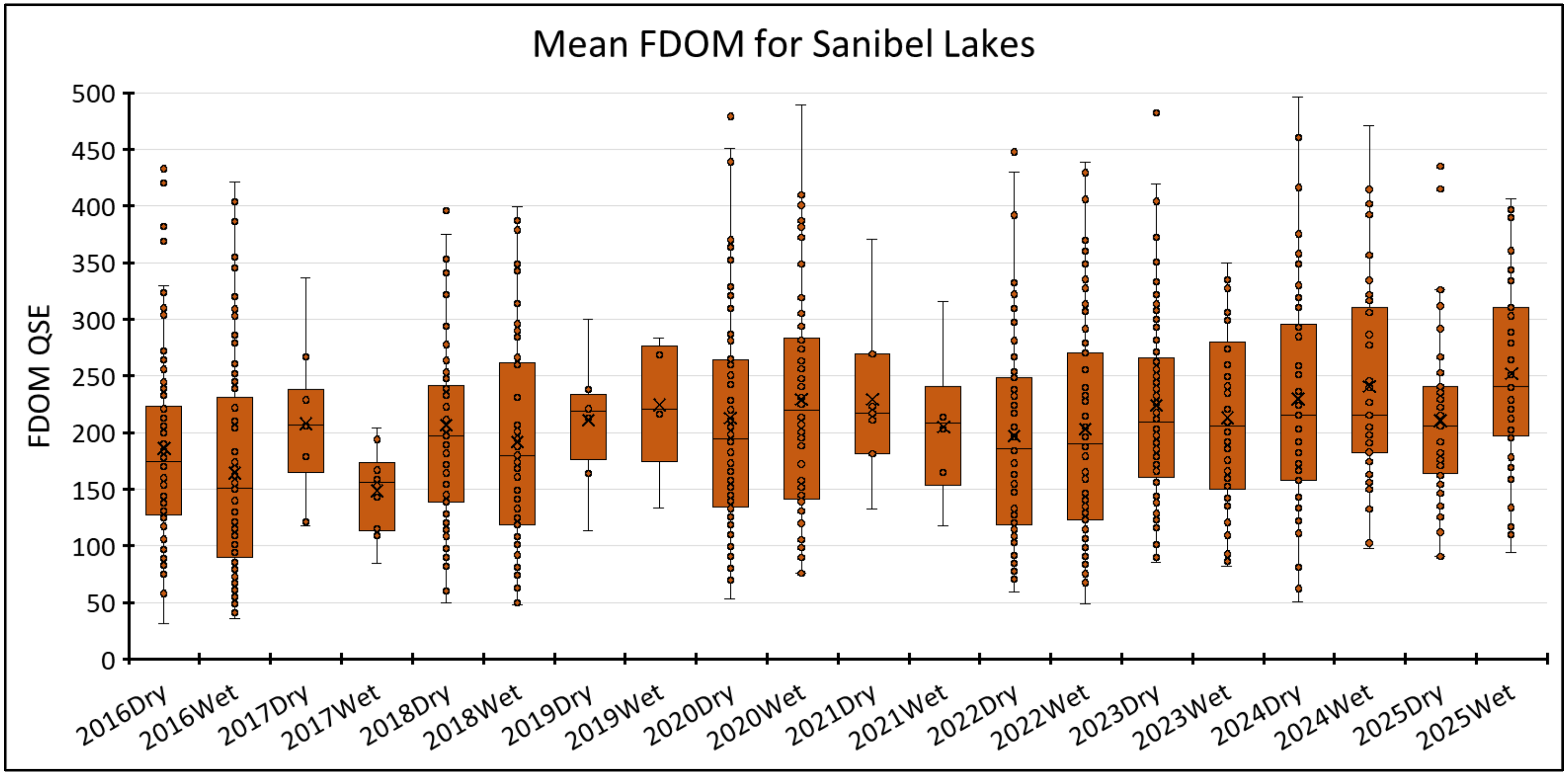


Figure 12. Time series boxplot of Turbidity for the lakes in this study for all periods sampled during the Sanibel Communities for Clean Water project

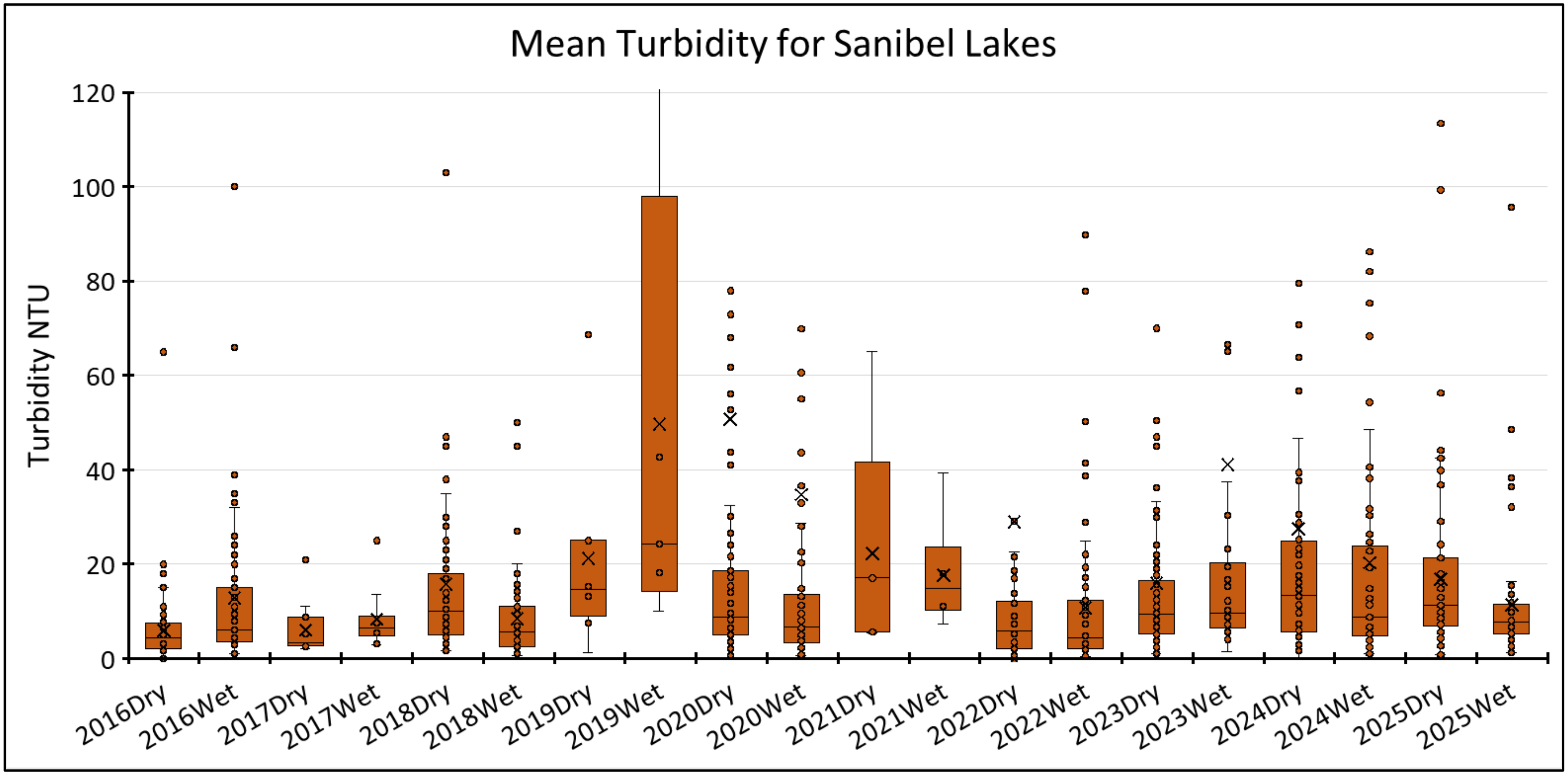


Figure 13. Flow direction in the vicinity of The Dunes Lake 5 for dry season, wet season and immediately after a rainfall event.

Dry Season

Wet Season

After rainfall event

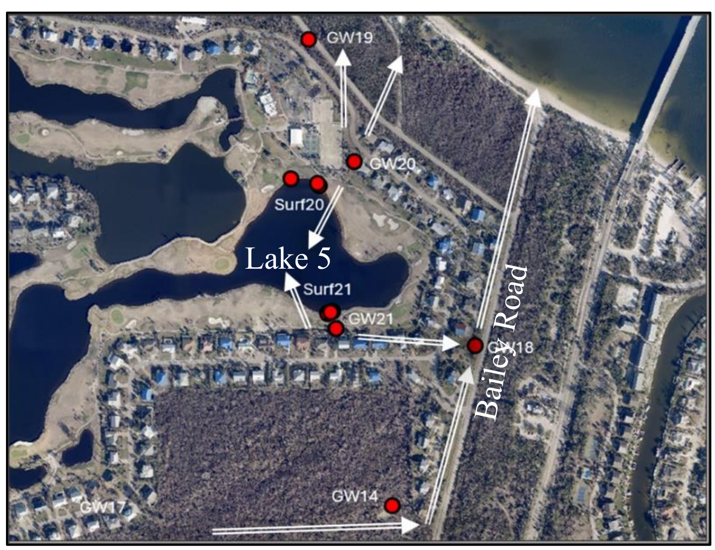
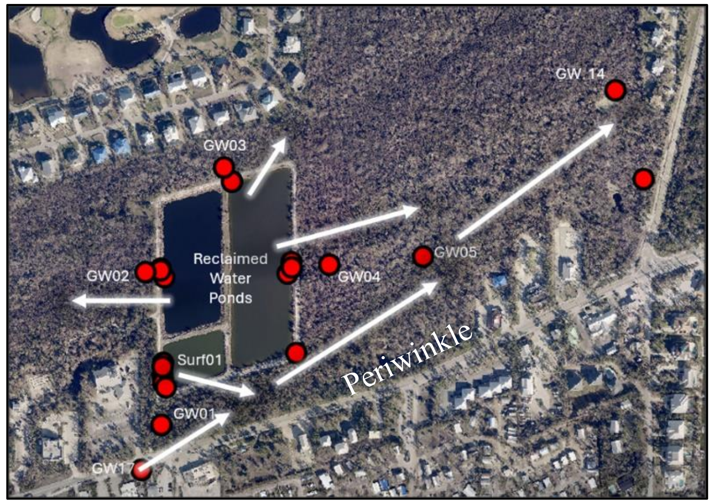
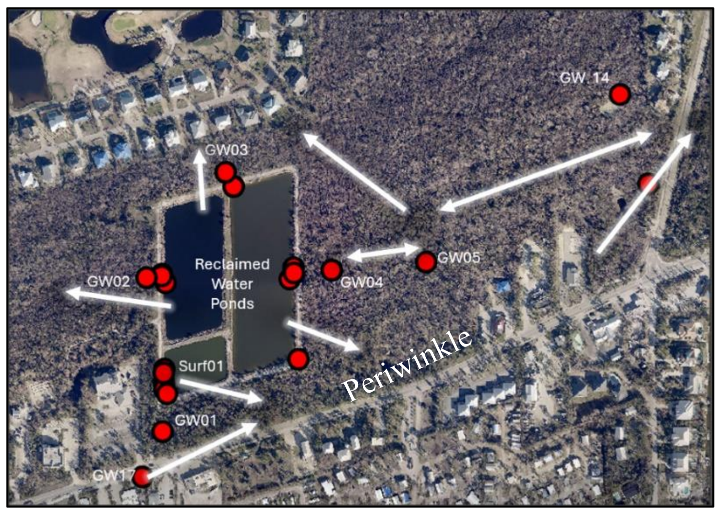


Figure 14. Flow direction in the vicinity of the Pond Apple Park reclaimed water ponds for dry season, wet season and immediately after a rainfall event.

Dry Season



Wet Season



After rainfall event

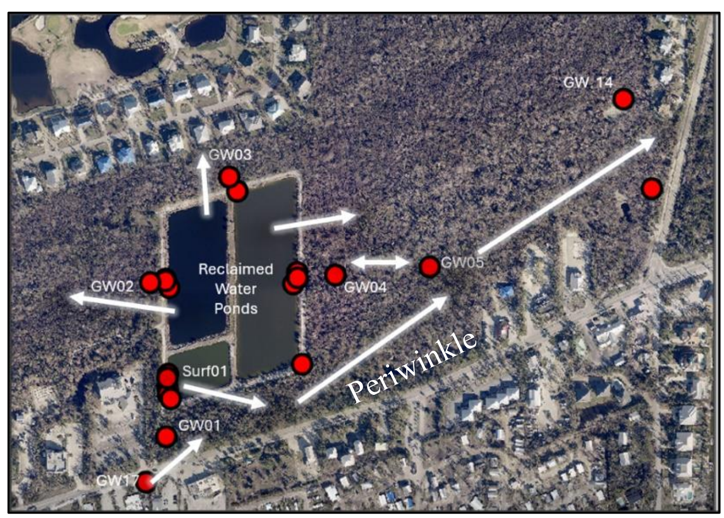
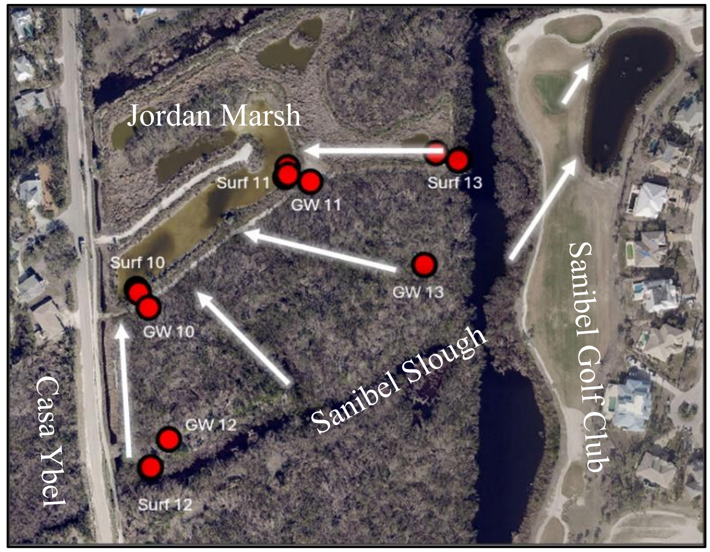
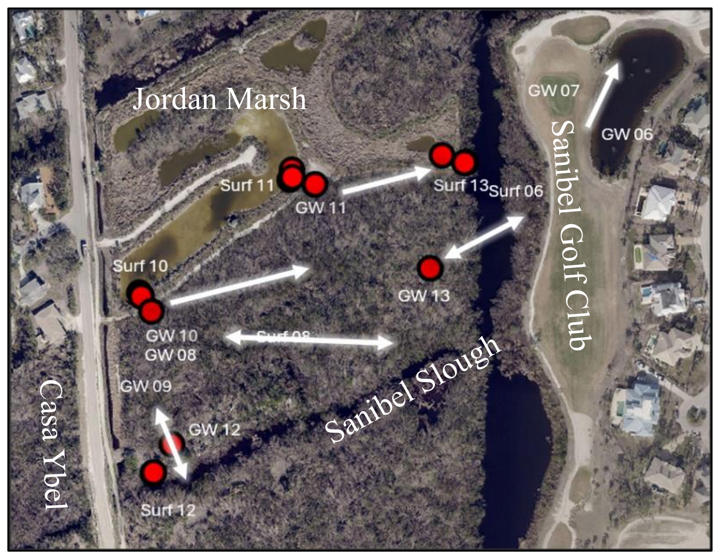


Figure 15. Flow direction in the vicinity of the Jordan Marsh during dry season, wet season and immediately after a rainfall event.

Dry Season



Wet Season



After rainfall event

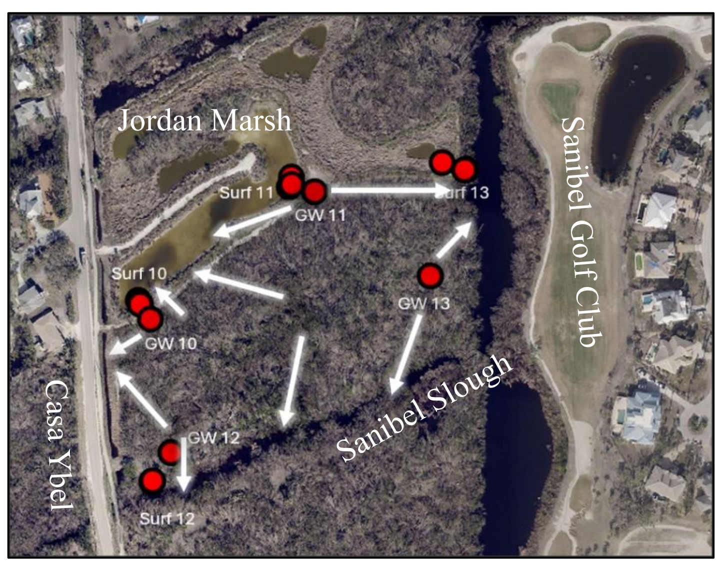


Figure 16. Flow direction in the vicinity of Murex Lakes for dry season, wet season and immediately after a rainfall event.

Dry Season

Wet Season

After rainfall event

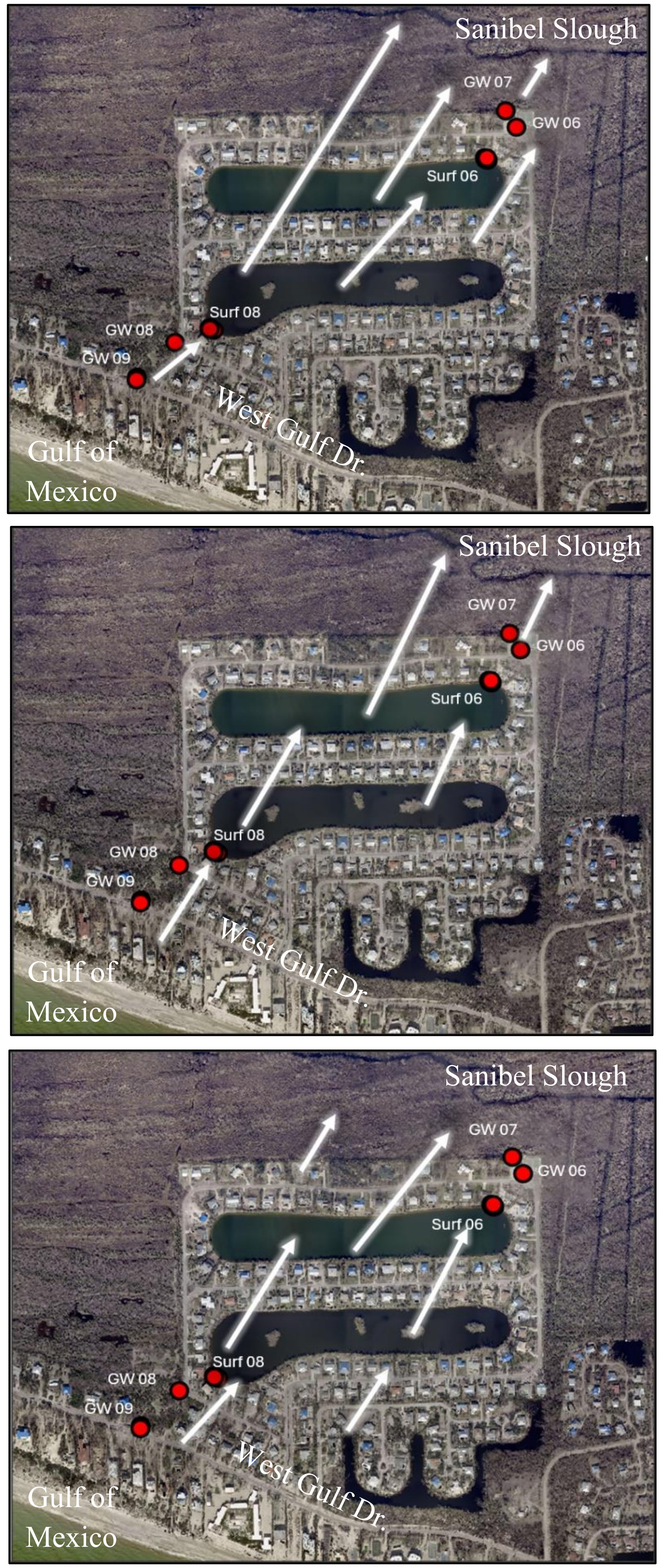


Figure 17. Flow direction in the vicinity of Sea Oats for dry season, wet season and immediately after a rainfall event.

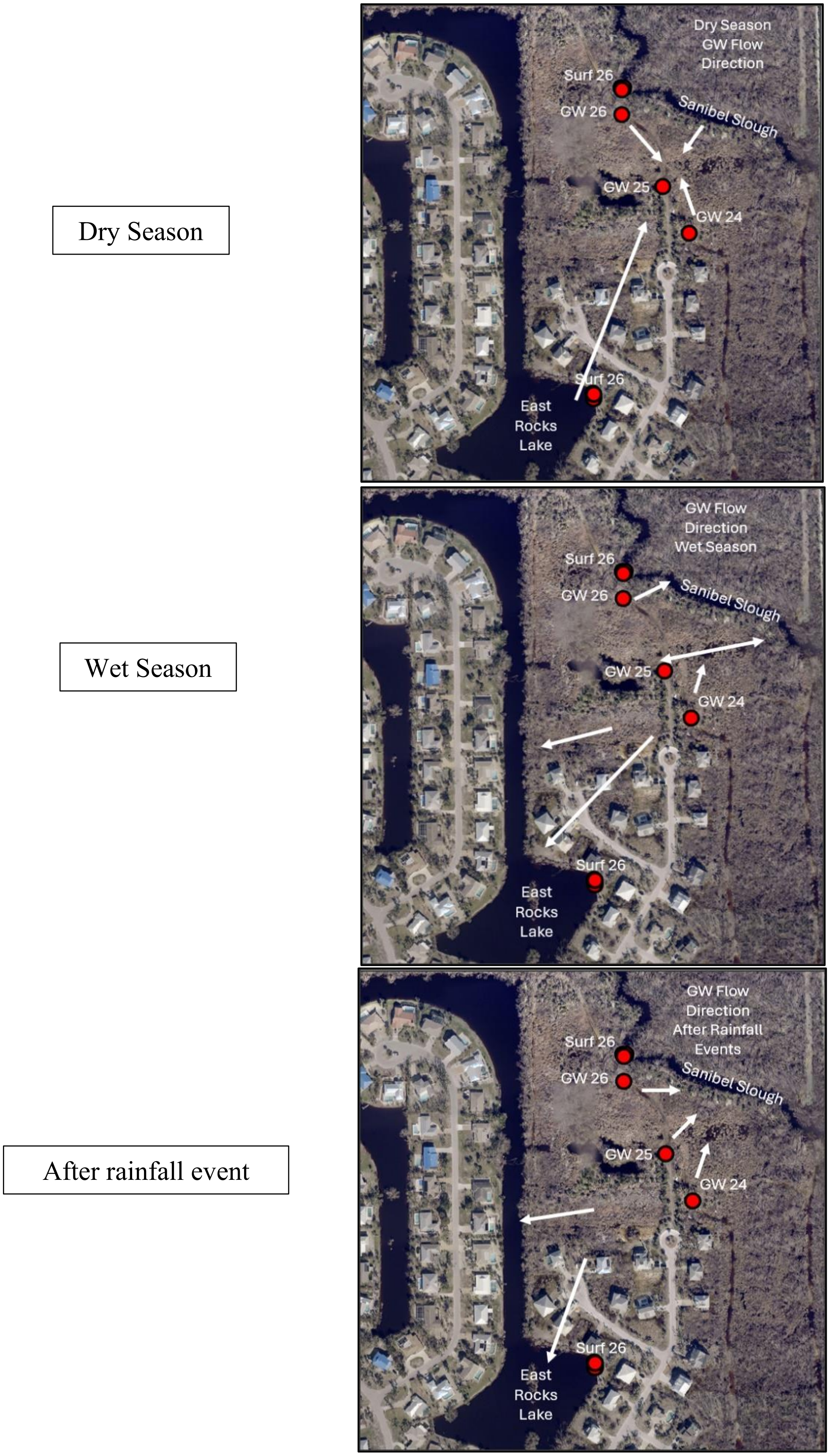
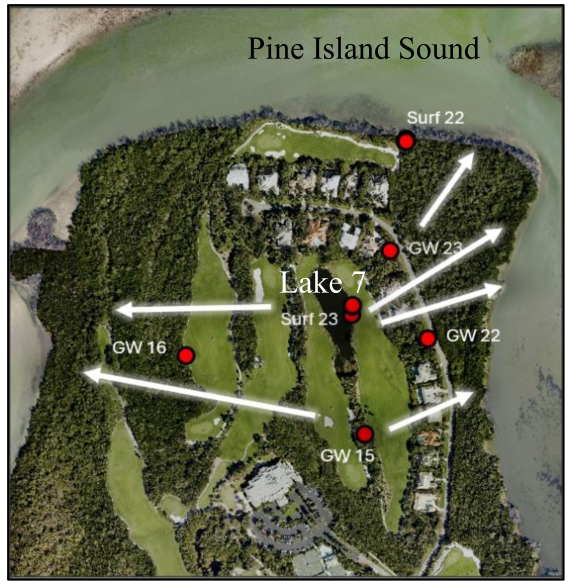


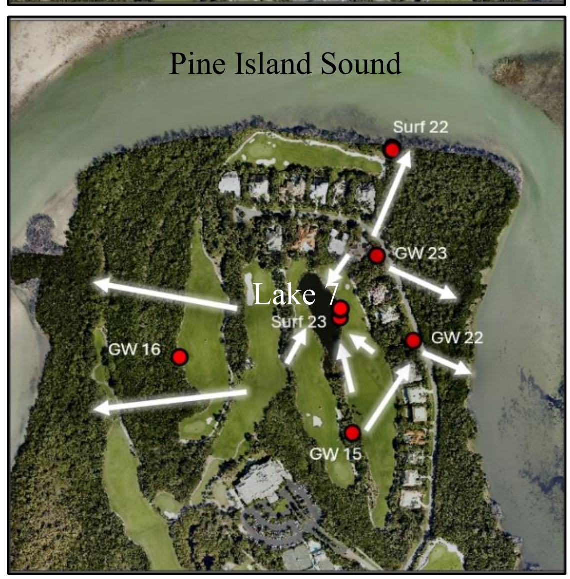
Figure 18. Flow direction in the vicinity of The Sanctuary Lake 7 for dry season, wet season and immediately after a rainfall event.

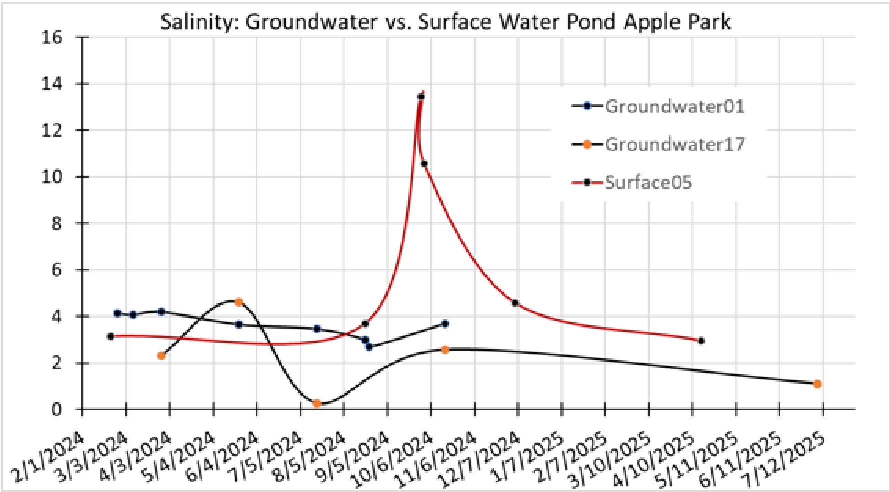
Dry Season



Wet Season

After rainfall event





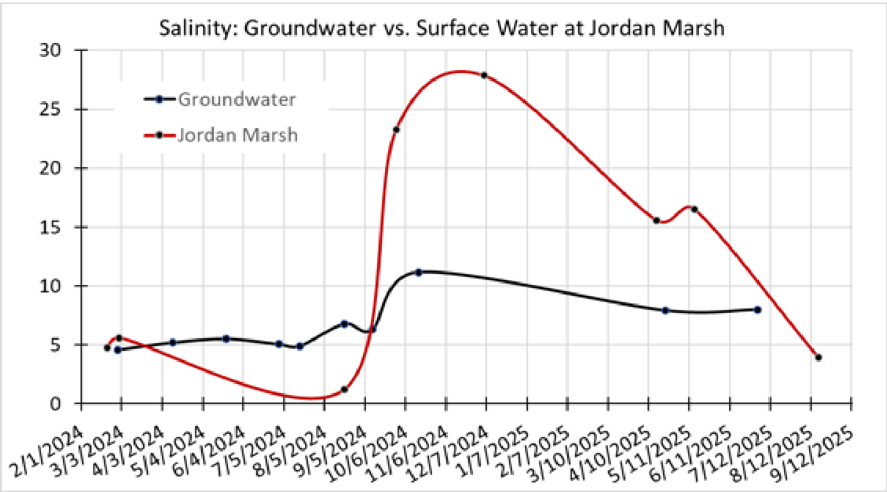
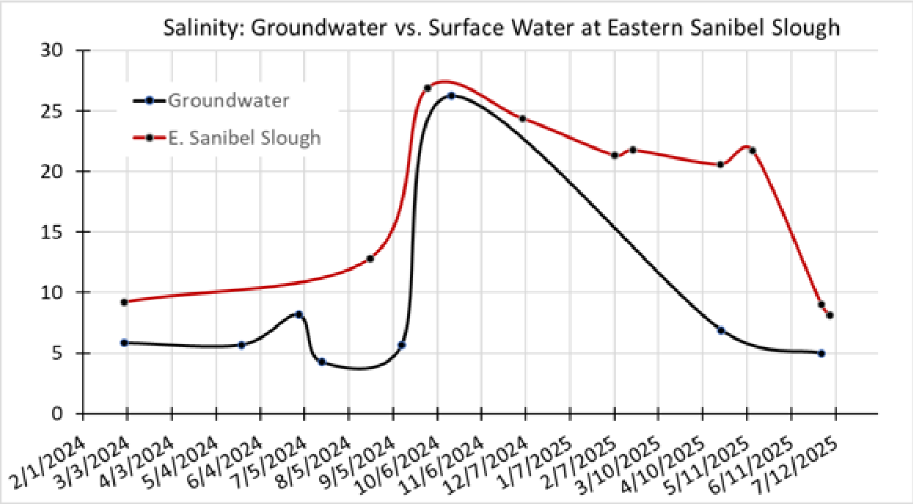
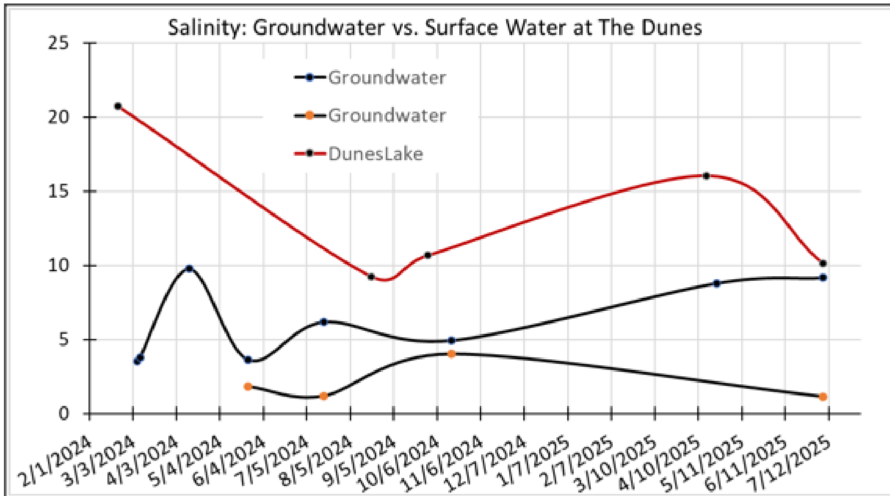


Figure 19: Salinity of groundwater compared to the adjacent surface waterbody salinity at three sites on Sanibel.





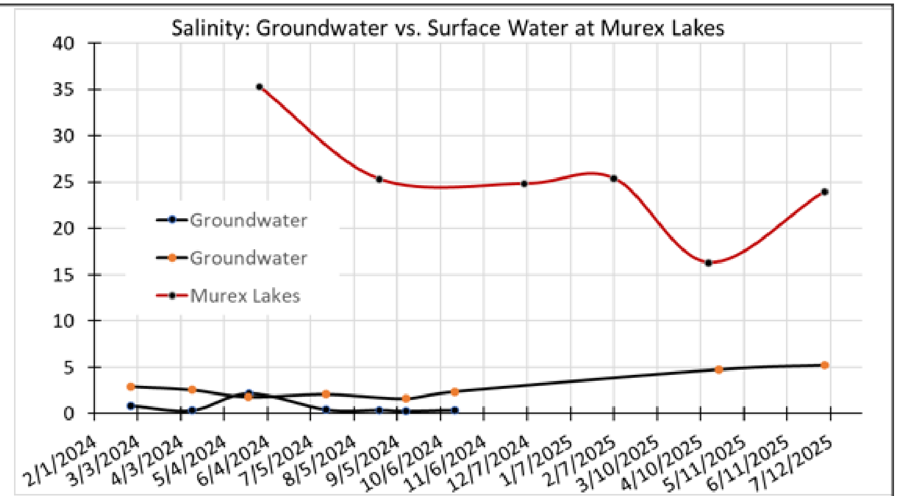


Figure 20: Salinity of groundwater compared to the adjacent surface waterbody salinity at three sites on Sanibel.

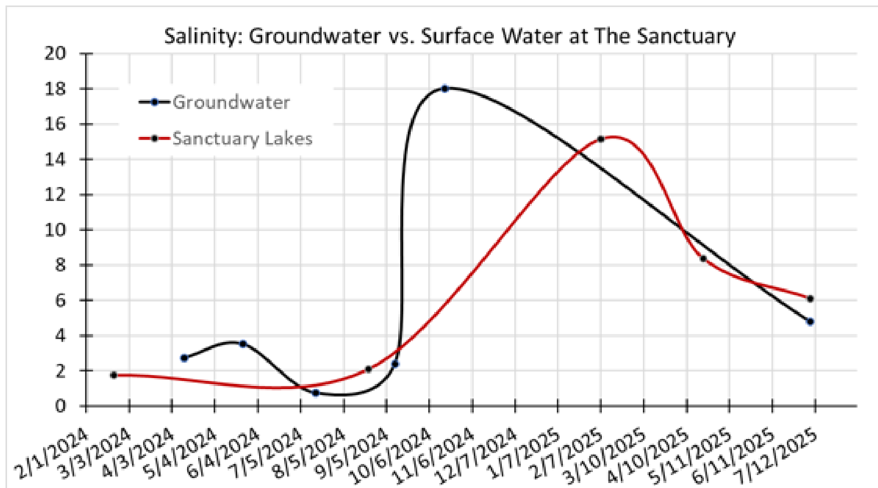


Figure 21. GIS interpolation of lake salinity across Sanibel at three different times in the past year.

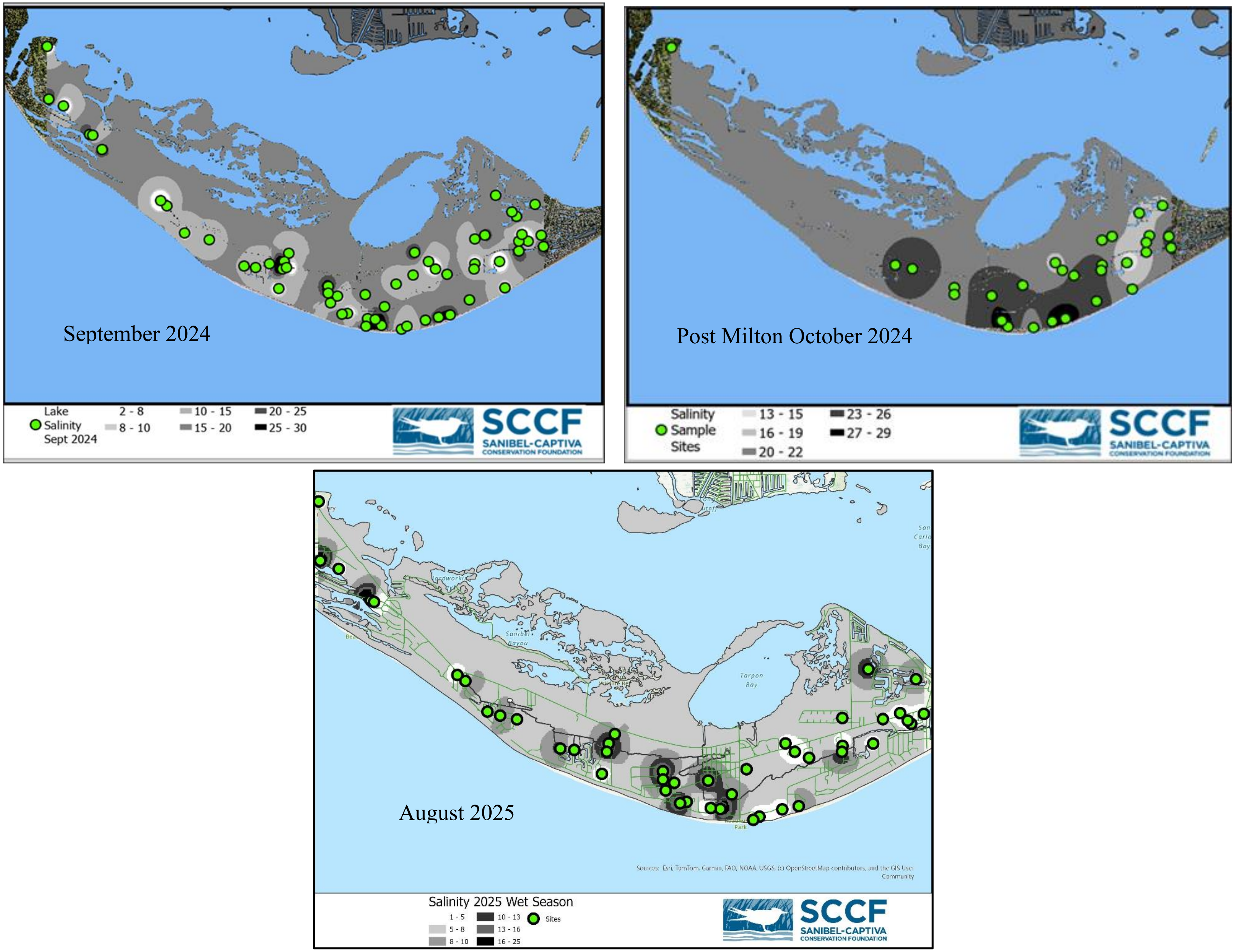


Figure 22. Average salinity of 13 shallow ponds on Sanibel monitored since September 2024. Salinity values of these rain-dependent waterbodies has dropped to near freshwater levels in the wet season of 2025.

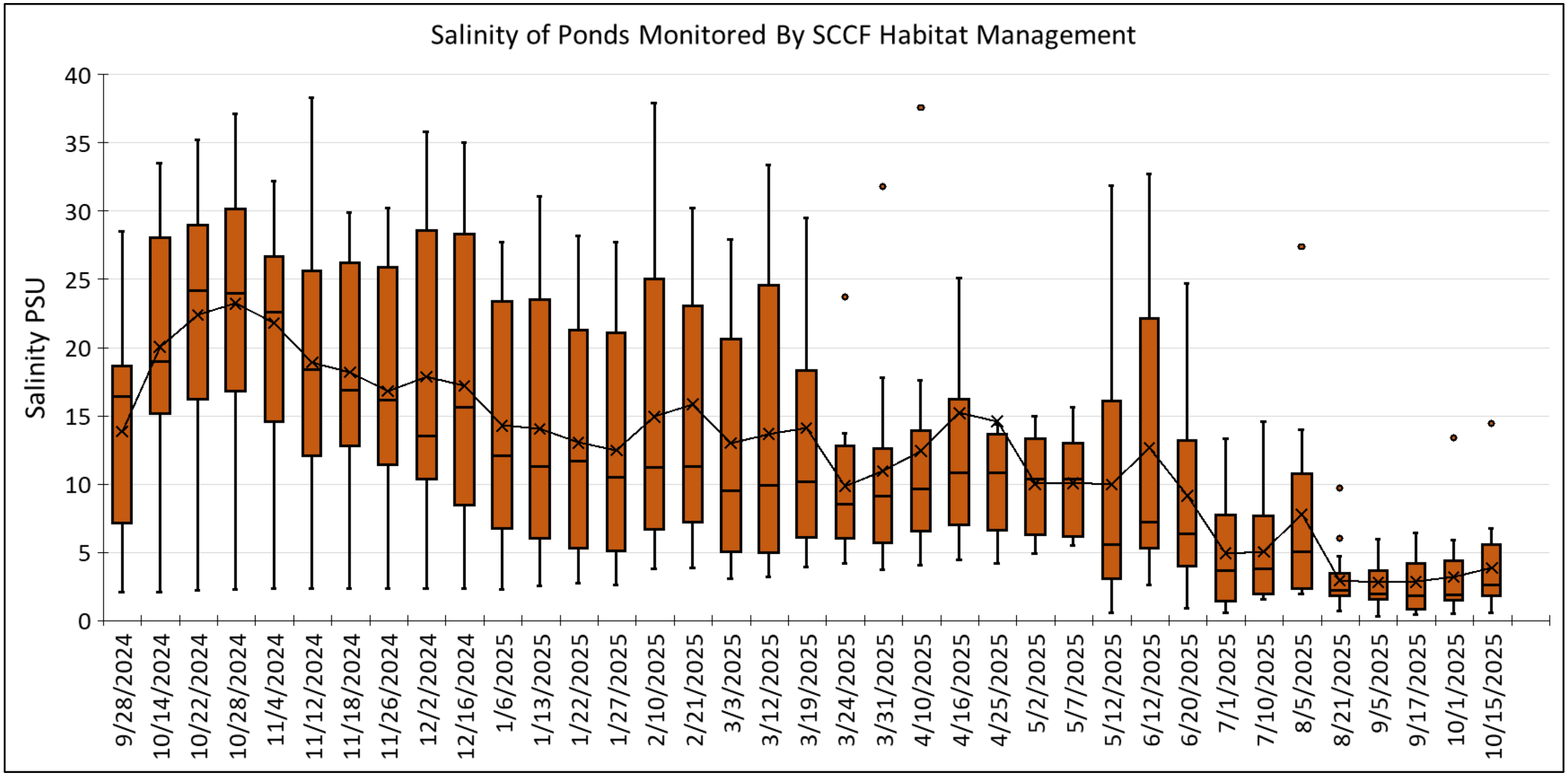


Figure 23. GIS interpolation of chlorophyll *a* across lakes and ponds on Sanibel Island in August 2024 and August 2025. Chlorophyll a values were lower in general in the wet season of 2025 compared to 2024.