Sanibel Community Lakes Baseline Water Quality Report

Sanibel-Captiva Conservation Foundation

Marine Laboratory

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For The City of Sanibel Natural Resources Department

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Description of the Project

Nutrient loads from Sanibel's stormwater runoff have been estimated as a component of development of the Sanibel Comprehensive Nutrient Management Plan. The central freshwater body on Sanibel, known as the Sanibel River (Slough), has been monitored by the City of Sanibel and analyzed to determine nutrient concentrations. Recent studies by the SCCF Marine Lab have estimated nutrient loading rates from surface and groundwater discharge for land use types found on the island. In addition, the SCCF Marine Lab has recently (2015) installed flow monitoring equipment at the two discharge points for the Sanibel Slough that will allow more accurate estimates of nutrient loadings into the estuary.

Community-owned lakes and stormwater collection systems are the receiving waterbodies for much of Sanibel's stormwater runoff. These systems are designed to retain significant volumes of stormwater runoff before discharging water 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 and poor design may cause significant surface water discharges from these systems. When discharges occur, stormwater from these systems ends up in the Sanibel Slough or the estuary surrounding Sanibel. Groundwater quality and flow is likely affected by these community stormwater systems and lakes. Groundwater discharges into the estuary and Gulf from Sanibel were recently estimated to be as significant as direct stormwater runoff. Knowledge of nutrient concentrations and potential loadings from community stormwater systems and lakes is essential for effective management of nutrient loading sources.

In this project we develop baseline water quality knowledge for the community stormwater lakes of Sanibel. Most of the natural and man-made lakes on the island were sampled during this study. This document serves as an information transfer outlining results and highlighting significant findings. In the Phase 4 final report, findings from this study will be linked to previous findings and an integrated hotspot analyses will be undertaken for use in Sanibel Comprehensive Nutrient Management Plan.

Methods

Surface water samples were taken at 72 unique sites around Sanibel (Table 1; Figure 1). Sites included community and privately owned stormwater systems, ponds, lakes and reservoirs which have possible interaction with Sanibel's surface water or groundwater.

Sampling consisted of approximately 25 unique site visits per event with 3 events occurring during each season (wet and dry). Wet season sampling (August) corresponded to the fertilizer ban period from July through September. Sampling was scheduled to occur within 48 hours of a rain event of at least 0.5 inches. All samples were analyzed for orthophosphate (OP), total phosphate (TP), nitrate-nitrite (NOx), ammonia (NH3), and total Kjeldahl nitrogen (TKN) using NELAC certified methods by Benchmark Laboratories in Palmetto Florida. Benchmark entered data into Florida DEP STORET. In addition to the nutrient sampling, SCCF analyzed each sample for DO, turbidity, CDOM, chlorophyll *a*, pH, salinity and temperature.

Results were compared with Florida DEP typical values for lakes (Hand 2008). Hotspots were determined based on relative parameter values plotted in a GIS map. Raw and summarized data is provided in an Excel workbook. A GIS map package is also provided as part of this data transfer.

Trophic State Index (TSI) scores are based on lake chlorophyll *a*, total nitrogen, and total phosphorus levels, and were calculated for each of these study lakes following the procedures outlined on pages 86 and 87 of the Florida's 1996 305(b) report.

Data was aggregated within an excel spreadsheet and manipulated for output into Minitab13® software for statistical analyses. Sample sites were ranked based upon mean inorganic phosphorus, inorganic nitrogen and chlorophyll a concentrations and TSI scores. The mean value of each of these four parameters was used to assign a rank score to each sample site with rank 1 being highest concentration (poorest). 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 nutrient water quality condition.

Descriptive statistics were produced for each site and for each factor used for comparison purposes. A general linear model ANOVA coupled with Tukey's multiple factor comparison method was used to detect differences in parameter values. A significance level of 0.05 was used in all tests. Factors used for comparison purposes were fertilizer period (application/no application), reclaimed irrigation water used (yes/no), and land use classification for the area surrounding each sample site. The legal fertilizer application period is October through June. Residential application of fertilizer is banned July through September. A site was classified as using reclaimed water for irrigation if over 50,000 gallons per month were used on average (City of Sanibel 2013 data). Wet season/dry season comparisons were not made due to an exceptionally wet period through February 2016 (normal dry season) when the "dry" season sampling took place. However, the fertilizer/no fertilizer periods correspond to normal wet and dry seasons on Sanibel.

Results and Discussion

Mean total phosphorus (TP) in the sampled lakes ranged from 0.02 mg/l at SCCF's Devitt Pond and Venus Dr. pond (natural land use types) to 6.49 mg/l in the Sanibel Bayous lake downstream of a former package wastewater treatment plant (WWTP) (Table 2). Eighty nine percent of the mean TP values were above the Florida criteria for lakes (0.05 mg/l) and 53 % were greater than the 90% percentile (0.092 mg/l) of Florida lakes (Figure 2). TP concentrations were higher for 70% of the August samples compared to the February samples. The mean increase in TP between sampling events was 80%. A dilution effect brought about by the record precipitation in February may account for lower concentrations at that time.

Mean TP was significantly greater for lakes within high density developments (GLM ANOVA, $p = 0.03$) compared to other land classifications (Figure 3). Many high density developments and golf courses on Sanibel use reclaimed wastewater to irrigate their lawns.

Significantly greater concentrations of TP were found in lakes in the vicinity of reclaimed water irrigation (Figure 4; GLM ANOVA, $p = 0.02$). Within the City of Sanibel's wastewater treatment plant (the source of reclaimed irrigation water) TN is reduced by a greater proportion than TP, resulting in irrigation water that is actually lower in TN than much of the ambient waters of Sanibel but TP concentrations which are much higher than ambient waters. The reclaimed water supplied to customers will more likely have a measurable impact on phosphorus levels and previous studies related to development of Sanibel's Comprehensive Nutrient Management Plan have shown significant positive relationships between reclaimed water use and phosphorus in stormwater and groundwater (Thompson et al. 2014, 2015). No significant difference was found for TP in lakes sampled during the fertilizer ban period from July through September than during the non-ban period (Figure 5)

TP concentrations in lakes on golf courses and natural land use types were lower in general than TP in adjacent surficial groundwater (Figure 3 and 6). However TP levels in high density development lakes was higher than the groundwater surrounding them. The difference in groundwater flow for these land use types may explain this finding. Sanibel golf courses and natural areas are located on high organic content, hydric soils. These soils are poor conductors of groundwater and tend to hold (and concentrate nutrients). The groundwater under these land use types reflect that condition and have higher TP levels. The high density developments on Sanibel are concentrated on the Gulf shoreline with sandy soils and high groundwater flows. The flushing associated with high groundwater flows in these areas keep phosphorus levels relatively lower than lake concentrations.

A GIS plot of relative TP concentrations in lakes (Figure 7) shows the highest concentrations occur near golf courses, high density development and WWTP associated facilities. These plots are being used in combination with previously obtained information on groundwater, stormwater runoff and surface water to delineate nutrient hotspots. The Phase 4 report will contain an integrated analysis of all nutrient data collected to date.

The mean total nitrogen (TN) concentration in sampled lakes ranged from 0.9 mg/l in the pond behind the Periwinkle Place shopping center to 8.6 in the pond adjacent the bike path at West Gulf and Hurricane Lane (Table 2). Eighty nine percent of the mean TN values were above the Florida criteria for lakes (1.27 mg/l) and 67 % were greater than the 90% percentile (1.72 mg/l) of Florida lakes (Figure 8). Total nitrogen concentrations were higher for 96% of the August samples compared to the February samples. The mean increase in nitrogen between sampling events was 90%. A dilution effect brought about by the record precipitation in February may account for lower concentrations at that time.

Lakes on golf courses and low density development had significantly greater TN than lakes in high density developments (Figure 9). In general, the lakes on natural lands were as high in TN as those on developed lands. The mean concentration of TN on natural lands was not significantly different from those for low density developments (Figure 9). This can be attributed to the high dissolved organic content in the waters primarily due to decaying vegetation input.

Mean TN concentrations were greater for golf courses and low density residential lands compared to high density developments. Two separate factors may be driving this result. The application of fertilizer may account for the higher TN at golf courses while, the more natural low density residential land types are contributing large loads of vegetation-associated organics plus small amounts of fertilizer to the lakes. Lake sites in the vicinity of reclaimed water irrigation were not found to have significantly greater concentrations of TN (Figure 10; GLM ANOVA, $p = 0.626$). However, significantly greater TN was found during the fertilizer ban period than during the period of allowed fertilizer use as represented by the February sampling event (Figure 11; GLM ANOVA, $p < 0.01$). Only two sampling events were conducted at the 72 sites and the unusually wet dry season may have affected results through dilution masking any positive effects the wet season fertilizer ban has on lake nutrient concentrations.

TN in golf course lakes was lower than the groundwater TN beneath golf courses (Figures 9 and 12). However, TN in high density development lakes and natural lakes was similar to groundwater levels. This may be explained by groundwater flow differences and type of nitrogen. The organic rich, hydric soils beneath Sanibel golf courses are poor conductors of groundwater flow and tend to hold (and concentrate) nutrients. Although nitrogen is more soluble in water than phosphorus, the ammonia form of nitrogen associated with fertilizer application and anaerobic conditions is less mobile and will concentrate in the soil and surrounding slow-moving groundwater. The sandy soils of high density developments on Sanibel have higher flushing and aerobic conditions which keep nitrogen (in the water soluble NOx form) flowing to the Gulf resulting in intensities similar to the lake. Natural land types have high levels of dissolved organic nitrogen which moves easily with groundwater flow, also resulting in less nitrogen buildup in the soil.

A GIS plot of relative TN concentrations in lakes (Figure 13) shows highest concentrations near WWTP associated facilities, golf courses and low density development. These plots are being used in combination with previously obtained information on groundwater, stormwater runoff and surface water to delineate nutrient hotspots. The Phase 4 report will contain an integrated analysis of all nutrient data collected to date.

The mean chlorophyll *a* (Chla) concentration ranged from 1.6 ug/l at the SCCF pond on Venus Drive, to over 200 ug/l at lakes on Blue Crab Drive and in the Tradewinds subdivision (Table 2). Sixty percent of the mean Chla values were above the Florida criteria for lakes (1.27 mg/l) and 45% were greater than the 90% percentile (1.72 mg/l) of Florida lakes (Figure 14).

Mean Chla was significantly greater for lakes within golf courses, and on low and medium density development compared to natural lands (Figure 15; GLM ANOVA, $p < 0.05$). No significant differences could be found for Chla concentrations in lakes with reclaimed water irrigation nearby or for the fertilizer ban period compared to the no ban period (Figures 16 and 17). Positive but weak correlations were found between Chla and TP ($r^2 = 0.21$) and TN ($r^2 = 0.19$). The greatest Chlorophyll *a* levels were found in lakes with lower N:P ratios (Table 2), suggesting lakes with higher phosphorus relative to nitrogen (not P-limited) may be more susceptible to large phytoplankton blooms.

A GIS plot of relative Chla concentrations in the sampled lakes (Figure 18) shows highest concentrations near golf courses, and WWTP associated facilities. These plots are being used in combination with previously obtained information on groundwater, stormwater runoff and surface water to delineate nutrient hotspots. The Phase 4 report will contain an integrated analysis of all nutrient data collected to date.

TSI scores ranged from 44.6 at SCCF's Venus Drive pond to 116.8 for the Sanibel Bayous pond downstream of the former package WWTP (Table 2). The overall mean TSI score for lakes in this study was 72.5. Florida DEP considers scores over 60 to be poor water quality and scores greater than 60 trigger evaluation of waterbodies for impairment.

Ranking the sampled lakes following procedures described in the methods section produced a list of lakes on Sanibel with water quality concerns (Table 2). The lowest ranking lakes (poorest water quality) were associated with golf courses, reclaimed water use, or wastewater treatment (Figure 19; Table 2). Lakes situated on natural land use types were not within the 20 lakes with poorest water quality and were in general near the bottom of the list (Table 2).

A number of lakes displayed high mean nitrogen and/or phosphorus concentrations with low chlorophyll concentrations. Algaecide use may keep phytoplankton levels artificially low. Lakes which are found to have had algaecide treatments regularly should be considered for further evaluation of toxics (i.e. copper) in sediments and the water column which may inhibit a healthy lake ecosystem.

Conclusions

Lakes were ranked from those with poorest overall water quality to those with the best. 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. Lakes associated with former or current wastewater treatment facilities displayed relatively high nutrient and chlorophyll *a* concentrations. In addition, lakes in high density development areas and on golf courses ranked near the top of the poor water quality list. Most of these lakes were associated with reclaimed water irrigation, and significantly greater phosphorus was found in these waterbodies.

A high percentage of lakes sampled (89%) were above state nutrient criteria for lakes and 53-67% were above the 90th percentile of all Florida lakes for phosphorus and nitrogen. Samples collected in August showed higher levels of nitrogen, phosphorus and chlorophyll in general than the February samples. The February sampling event occurred during record precipitation and but was during the period of allowed fertilizer application on residential lands.. A dilution effect may have been evident during the February sampling events.

There was a positive but weak association between phosphorus and nitrogen concentrations and chlorophyll a (phytoplankton) levels. This relationship has been documented in many nutrient-waterbody studies and is the justification for nutrient management activities to reduce algae blooms.

Lakes on Sanibel are in general marginally eutrophic to eutrophic with relatively high nitrogen and phosphorus concentrations. Any discharges (to estuarine waters) from community lakes on the eastern half and Gulf shore of the island should be of concern. Lakes and surficial groundwater interact continuously and both should be considered when developing a nutrient mass balance.

Figures and Tables

Table 1. Location of 72 sampling sites used in this project.

Table 1 (cont.). Sampling sites use in this project.

Site ID	Site	Lat	Long	Description
SCL01	LightHsePtCondo	26.45230	-82.01787	Lighthouse Pt Condo Pond Periwinkle
SCL58	RMI-BaileyTrct	26.42818	-82.08785	MiddleLakeBailyTract_TrailAdjAirplaneCrl

Figure 1. Sampling locations for this study. 72 total sites were sampled twice in 2016.

Table 2. Sample sites with associated mean nutrient concentration results, TSI scores, N:P ratios, and salinity. Land use associated with each site and status of reclaimed water use for irrigation at that location is show.

Ranking of Concern	Station	Description	IN (mg/l)	OP (mg/l)	Chla_Cor (ug/l)	TSI	TN (mg/l)	TP (mg/l)	N:P	Salinity (PSU)	Reclaimed Water	Land Use
1	SCL68	Sanibel Bayous_100m_South_Entrance	2.798	1.999	135.4	106.2	5.35	3.711	1.4	2.4	NR	WWTP
2	SCL13	Sanibel_Golf_Reclaimed_Water_Pnd	0.399	0.885	91.6	96.5	2.62	1.250	2.1	0.9	R	GlfCrse
3	SCL05	City_Reclaimed_Dscharge_Pond	1.812	1.965	39.2	97.6	3.72	2.440	1.5	0.9	R	WWTP
4	SCL03	PeriwnklePark_Duck_Pond	0.364	0.633	64.3	88.1	2.74	0.832	3.3	1.0	NR	High
5	SCL63	Tradewinds_South_Lake_Tahiti	0.070	0.13	135.2	87.4	3.88	0.192	20.2	0.5	NR	Medium
6	SCL36	Sande_Pointe_Condo	0.086	0.396	22.1	86.1	2.73	0.673	4.1	0.8	R	High
7	SCL72	Sanibel Bayous Pond at Former WWTP	0.066	0.068	101.1	88.1	6.73	0.109	61.7	7.0	NR	WWTP
8	SCL71	Sanctuary_Lake7 (Discharge to Estuary)	0.045	0.391	36.9	85.4	2.12	0.552	3.8	0.8	R	GlfCrse
9	SCL29	Sanibel_Cottages	0.094	0.459	19.8	78.4	1.18	0.542	2.2	0.4	R	High
10	SCL70	Blue_Crab_Ct._Lake	0.044	0.092	141.8	82.5	3.97	0.201	19.8	20.4	NR	Low
11	SCL07	Dunes_Lake5	0.061	0.086	53.5	80.7	2.81	0.147	19.1	2.2	R	GlfCrse
12	SCL52	RabbitRd_South_Bike_Path_Lake	0.188	0.098	25.4	76.7	3.87	0.121	32.1	3.8	NR	Low
13	SCL51	RabbitRd_North_Bike_Path_Lake	0.054	0.094	47.7	80.5	3.26	0.126	25.8	5.0	NR	Low
14	SCL69	Sanctuary_Lake4_Near_Weir	0.048	0.289	27.5	81.1	2.04	0.353	5.8	1.5	R	GlfCrse
15	DL09	Dunes_Lake9	0.099	0.067	47.0	78.5	2.88	0.120	24.0	3.6	R	GlfCrse
16	SCL35	Seagull_Estates_West_Daniel_Dr.	0.036	0.085	68.0	86.5	4.67	0.181	25.8	3.3	NR	Low
17	SCL64	Tradewinds_North_Lake_Tahiti	0.066	0.044	78.3	78.1	2.89	0.121	24.0	0.4	NR	Medium
18	SCL16	Sundial_East_Condo	0.033	0.202	26.5	78.3	1.92	0.318	6.0	0.5	R	High
19	SCL65	North_Bayous_Lake_Wild_Lime	0.311	0.325	6.1	74.4	1.91	0.429	4.5	14.8	NR	Low
20	SCL33	ByTheSea_Condo	0.049	0.368	10.1	76.0	1.33	0.807	1.6	0.7	R	High
21	DLHS	Dunes_Horseshoe_Lake_Pelican Dr.	0.049	0.08	29.6	73.9	2.30	0.122	18.8	3.5	NR	Medium
22	SCL20	GulfSidePark_AdjBikePath	0.081	0.119	13.5	71.9	2.28	0.136	16.7	2.1	NR	Natural
23	SCL38	RMP_Lake_BaileyTract	0.279	0.164	7.4	73.2	3.41	0.200	17.1	6.6	NR	Natural
24	SCL66	Bayous_Middle_Lake_1901SanBayous	0.356	0.088	11.6	71.0	1.92	0.203	9.5	1.8	NR	Low
25	SCL14	Sanibel_GC_SanSlough	0.036	0.088	32.0	75.1	2.08	0.123	17.0	1.1	R	Medium
26	SCL11	Gumbo_Limbo_Eastern_Lake	0.042	0.073	46.7	73.5	1.67	0.100	16.7	1.4	NR	Medium
27	SCL15	Panama_Canal_Middle_Gulf_at_Trail	0.025	0.088	35.4	76.5	2.01	0.145	13.9	0.6	R	Medium
28	SCL26	CasaYbel_Resort_LargePond	0.022	0.101	37.3	73.8	1.29	0.158	8.2	0.4	R	High
29	SCL04	PeriwnklePark_RVPond	0.038	0.04	59.6	78.0	2.02	0.124	16.3	0.7	NR	High
30	SCL45	Poinciana_Circle_Pond_Off Island Inn	0.206	0.036	25.3	71.4	3.21	0.059	54.8	1.6	NR	Low
31	SCL43	Palm_Lake	0.601	0.049	15.0	70.7	3.22	0.067	48.4	1.1	NR	Low
32	SCL10	Whisperwood_Pond	0.031	0.097	18.7	74.7	2.00	0.178	11.3	1.8	NR	Medium
33	SCL62	ChateauSurMer_Lake_Discharge	0.046	0.076	21.6	70.9	2.07	0.083	24.9	1.1	NR	GlfCrse
34	SCL08	Dunes_Lake4	0.043	0.081	17.8	72.8	2.15	0.138	15.6	5.1	R	GlfCrse
35	SCL40	RobinWoodLake	0.032	0.071	25.8	74.8	2.78	0.117	23.8	1.4	NR	Low

Table 2 (Cont). Sample sites with associated mean nutrient concentration results, TSI scores, N:P ratios, and salinity. Land use associated with each site and status of reclaimed water use for irrigation at that location is show.

Ranking of Concern	Station	Description	IN (mg/l)	OP (mg/l)	Chla_Cor (ug/l)	TSI	TN (mg/l)	TP (mg/l)	N:P	Salinity (PSU)	Reclaimed Water	Land Use
36	SCL60	WhiteIbisWest_GulfPines	0.047	0.081	13.4	70.5	1.74	0.200	8.7	1.2	NR	Low
37	SCL37	SmithLake_BaileyTrct	0.176	0.077	8.2	67.1	2.57	0.102	25.3	3.4	NR	Natural
38	SCL39	LongAcreLake	0.035	0.062	30.8	70.2	1.70	0.071	24.1	1.1	NR	Low
39	SCL32	AniPond_BailyTract	0.027	0.103	8.3	74.0	3.89	0.186	20.9	10.6	NR	Natural
40	SCL50	St_Isabel_Church_Lake	0.042	0.043	18.8	73.1	3.10	0.087	35.6	1.2	R	Comm
41	SCL58	SCCFHaasPondAmerLegion	0.088	0.055	10.4	66.5	2.74	0.065	42.5	2.0	NR	Natural
42	SCL47	North_Lake_Murex	0.023	0.083	13.9	72.7	2.65	0.123	21.6	3.7	NR	Medium
43	SCL12	Gumbo_Limbo_West_Lake	0.075	0.107	4.1	62.4	1.40	0.122	11.4	2.8	NR	Medium
44	SCL67	Nortern_Pond_Wulfert&SanCap	0.053	0.06	12.3	66.3	1.81	0.071	25.7	27.8	NR	Natural
45	SCL59	GulfPines_SloughGageStation	0.056	0.063	10.7	65.6	2.08	0.069	30.4	1.3	NR	GlfCrse
46	SCL34	Seagull_Estates_East_Daniel_Dr.	0.042	0.029	28.0	69.3	2.48	0.050	50.0	1.1	NR	Low
47	SCL53	SeaOats_Dr._SmallLake	0.038	0.028	24.3	70.5	1.51	0.144	10.5	0.5	NR	Low
48	SCL19	GulfsideCityPark_MangrovePond	0.037	0.098	5.4	70.1	2.26	0.270	8.4	3.1	NR	Natural
49	SCL57	Gulf_Pines_OldBanyon_Bridge	0.095	0.042	9.0	65.4	2.17	0.083	26.1	1.3	NR	Low
50	SCL21	OceansReach_Condo	0.110	0.046	8.4	64.5	1.27	0.145	8.8	0.9	NR	High
51	SCL31	Pond_Behind_Baileys	0.026	0.033	27.3	70.0	1.91	0.086	22.2	0.3	NR	Comm
52	SCL48	South_Lake_Murex	0.105	0.029	7.8	67.0	2.92	0.078	37.6	0.8	NR	Medium
53	SCL17	RestaShore_MiddleGulf_SouthOfCowry	0.103	0.008	16.8	60.0	1.28	0.033	38.9	0.3	NR	Low
54	SCL41	HurricaneLane_Lake	0.020	0.033	32.2	68.8	1.85	0.056	33.0	0.8	NR	Low
55	SCL42	PondAdj_BikePath_at_HurricaneLn	0.042	0.053	8.4	67.6	8.63	0.070	124.1	0.7	NR	Low
56	SCL54	East_Rocks_NorthEnd_Durion	0.015	0.055	19.6	68.2	2.02	0.071	28.7	0.6	NR	Medium
57	SCL06	Roadside_Park_Pond_Island_Water	0.038	0.086	6.8	65.1	1.81	0.094	19.3	1.4	NR	Natural
58	SCL30	Pointe_Santos_W.Gulf	0.056	0.013	21.3	61.7	1.02	0.064	16.0	0.4	R	High
59	SCL18	SanibelLakes_End_Ibis	0.034	0.063	10.0	65.7	1.79	0.083	21.6	1.4	NR	Medium
60	SCL55	EastRocks_WestEndCoquina	0.031	0.048	14.0	67.0	1.67	0.079	21.2	0.6	NR	Medium
61	SCL28	SanibelCommunityHousePark_Pond	0.043	0.064	6.5	65.0	2.46	0.091	27.0	1.5	NR	Comm
62	SCL44	TwinPondEastLake_Off_Island_Inn	0.060	0.039	10.0	61.2	1.68	0.041	41.0	1.1	NR	Low
63	SCL24	Periwinkle_Properties_Sunrise_Circle	0.058	0.047	6.9	63.6	1.47	0.088	16.8	1.5	NR	Comm
64	SCL46	Brightwater_Lake_Barra_Circle	0.023	0.053	16.8	65.0	1.49	0.061	24.4	0.8	NR	Low
65	SCL27	City_Hall_Lake_Dock	0.036	0.054	9.8	64.1	2.01	0.081	24.9	6.4	NR	Comm
66	SCL09	SCCFPond_VenusDr.	0.241	0.024	4.7	56.1	2.61	0.034	76.8	17.9	NR	Medium
67	SCL01	LightHousePoint_Condo	0.022	0.058	11.8	64.7	1.16	0.101	11.5	1.1	NR	High
68	DevittPnd	Pond at SCCF Homestead	0.028	0.019	18.5	64.5	1.82	0.053	34.6	1.3	NR	Natural
69	SCL56	WestRocks_EastEndCoquina	0.024	0.049	9.1	62.0	1.68	0.058	29.2	0.8	NR	Medium
70	SCL25	PeriwinklePines_Pond_Egret_offDunlop	0.038	0.04	7.8	61.9	1.54	0.061	25.5	0.6	NR	Medium
71	SCL23	Periwinkle_Place_Pond	0.032	0.018	15.1	55.0	0.90	0.025	36.8	0.3	NR	Comm
72	SCL02	BeachRd_Villas_Pnd	0.020	0.023	8.2	54.8	1.46	0.037	39.3	0.6	NR	Low

Figure 2. Mean total phosphorus (TP) for each site with reference lines for state water quality criteria and the 90th percentile concentration value for lakes in Florida.

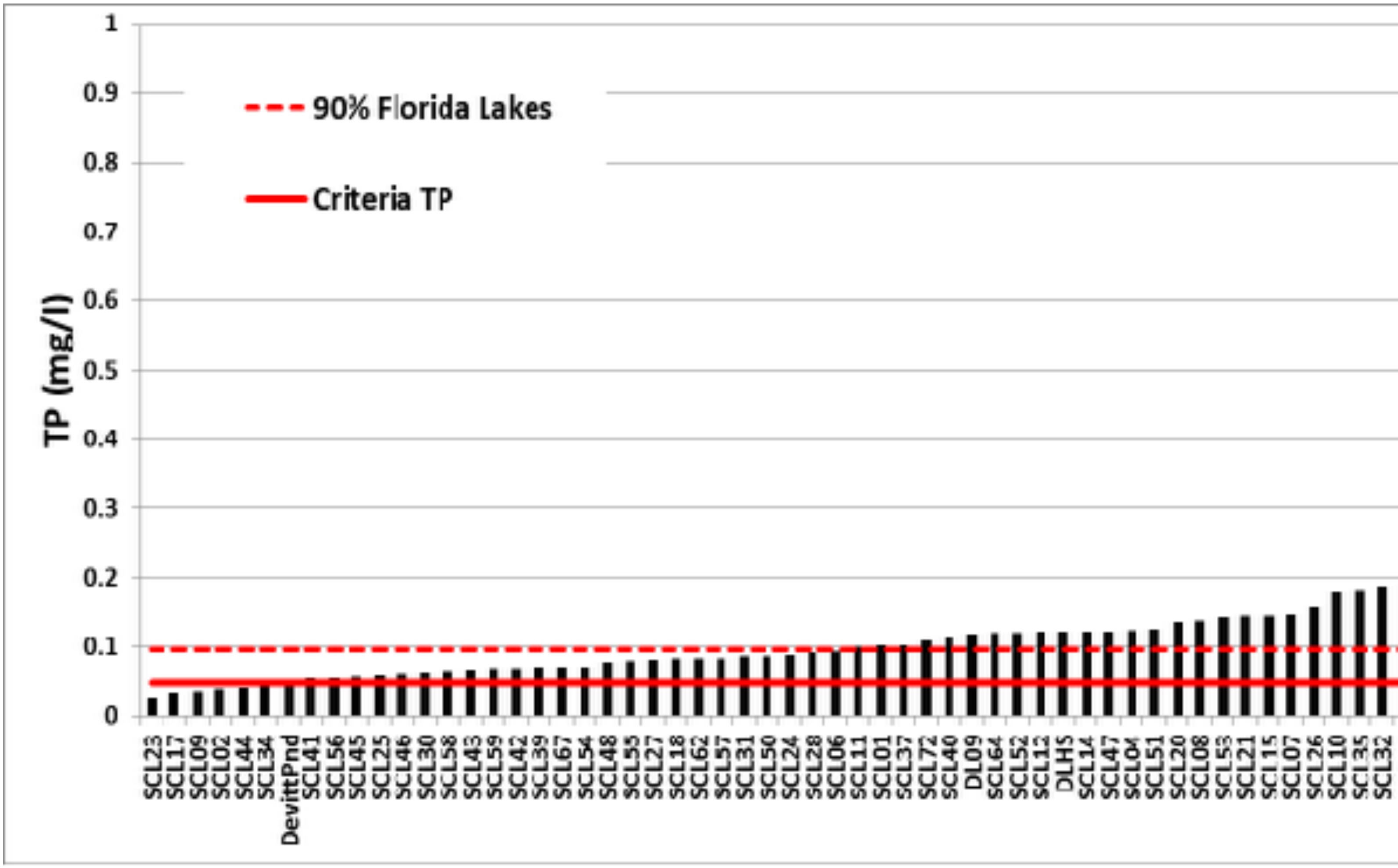


Figure 3. Mean TP (mg/l) in community lakes grouped by land use classification. High density development land classes had significantly greater TP than other classes.

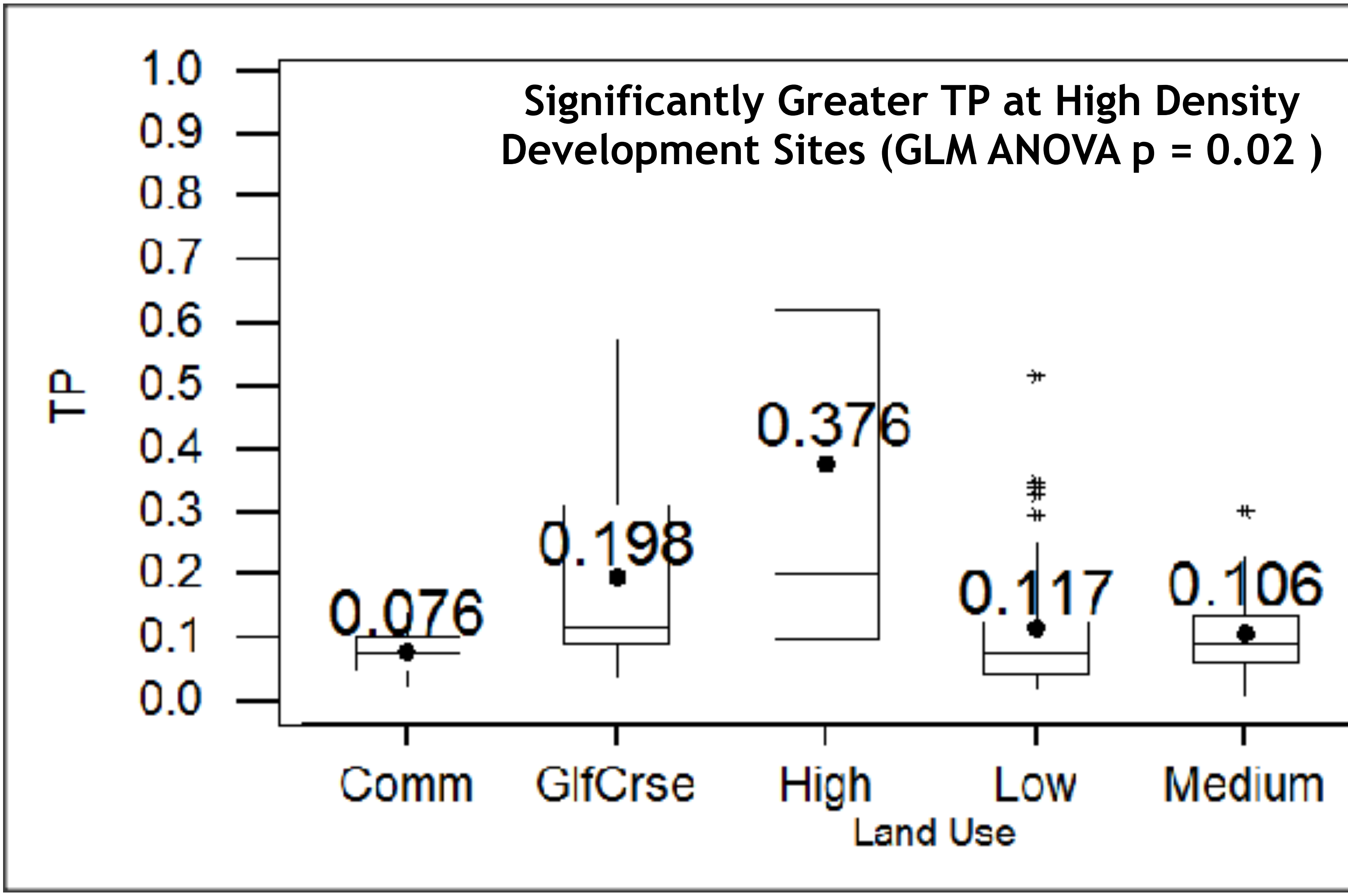


Figure 4. Mean TP (mg/l) at sites using reclaimed water for irrigation verses sites that did not. Significantly greater concentrations were found in lakes near reclaimed water irrigation.

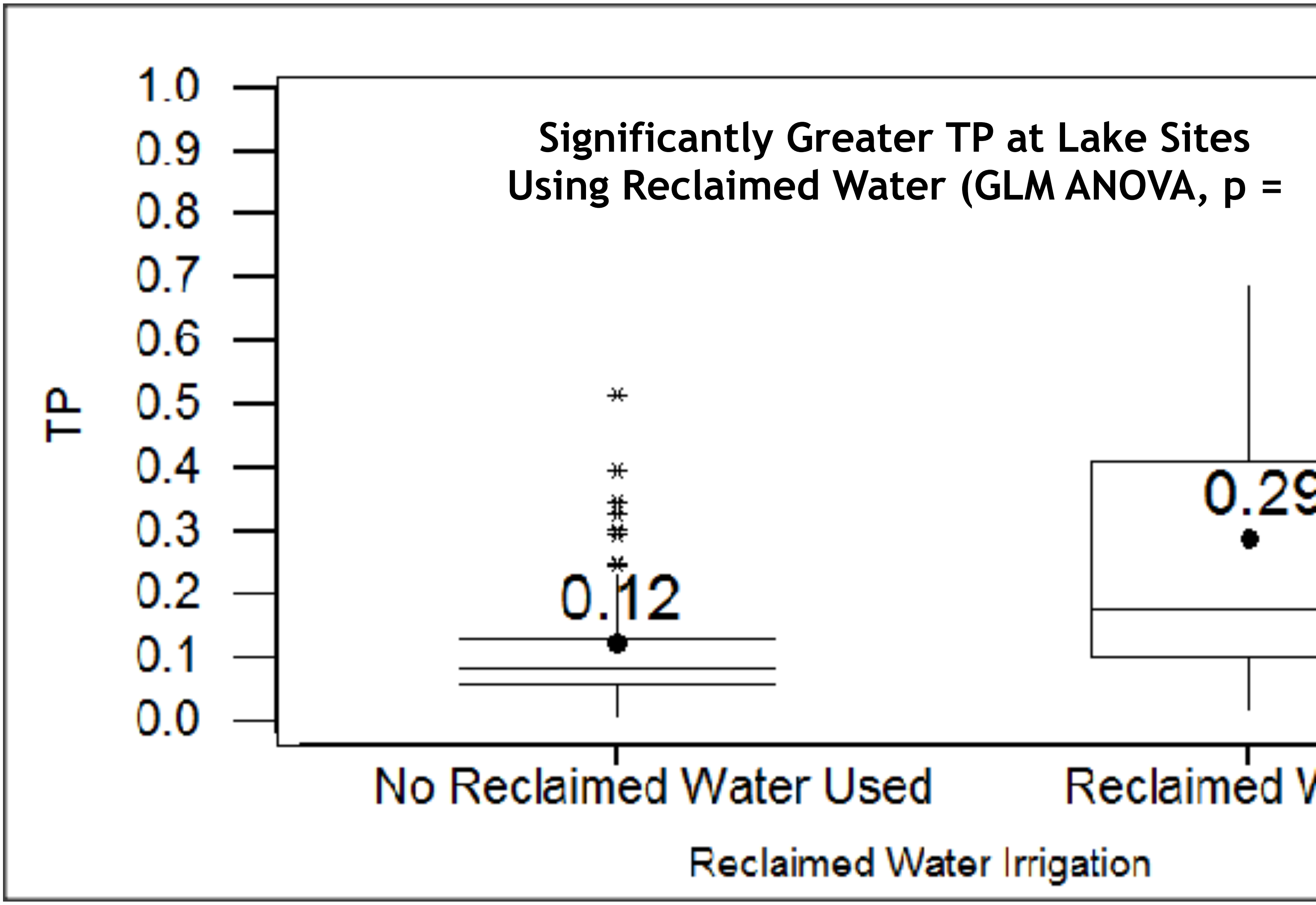
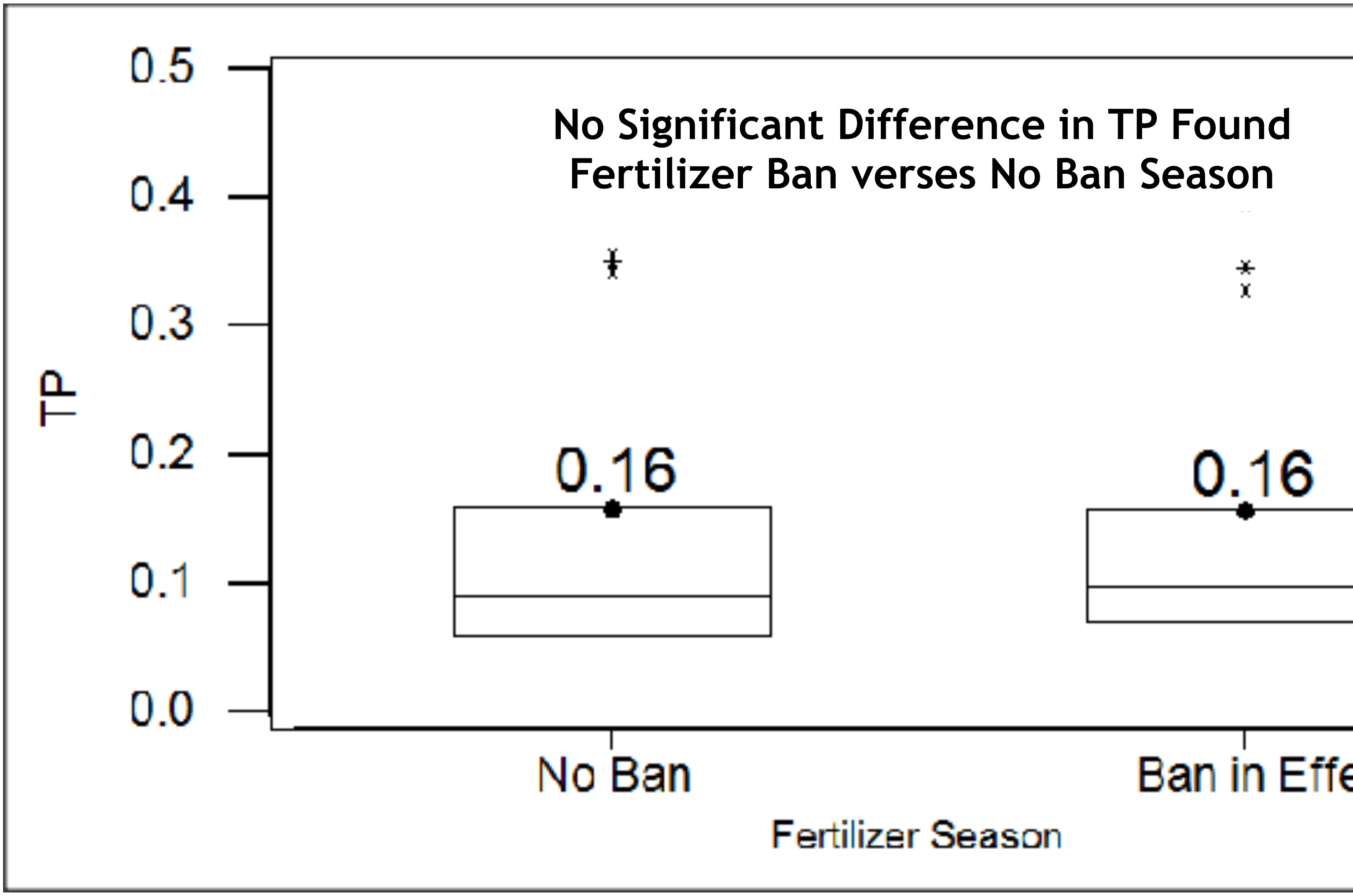


Figure 5. Mean TP (mg/l) at sites during the fertilizer ban period (July-September) versus the non-ban period.



No significant differences were found.

Figure 6. Groundwater TP (mg/l) by land use class. Mean represented by dot, median by horizontal line within box, 25th and 75th quartiles by upper and lower boundaries of box, and range by vertical line. Golf course (GC), High density residential (H), Medium density (M), Low density (L), Natural (Nat), Recreation (Rec), and wastewater treatment (WWTP).

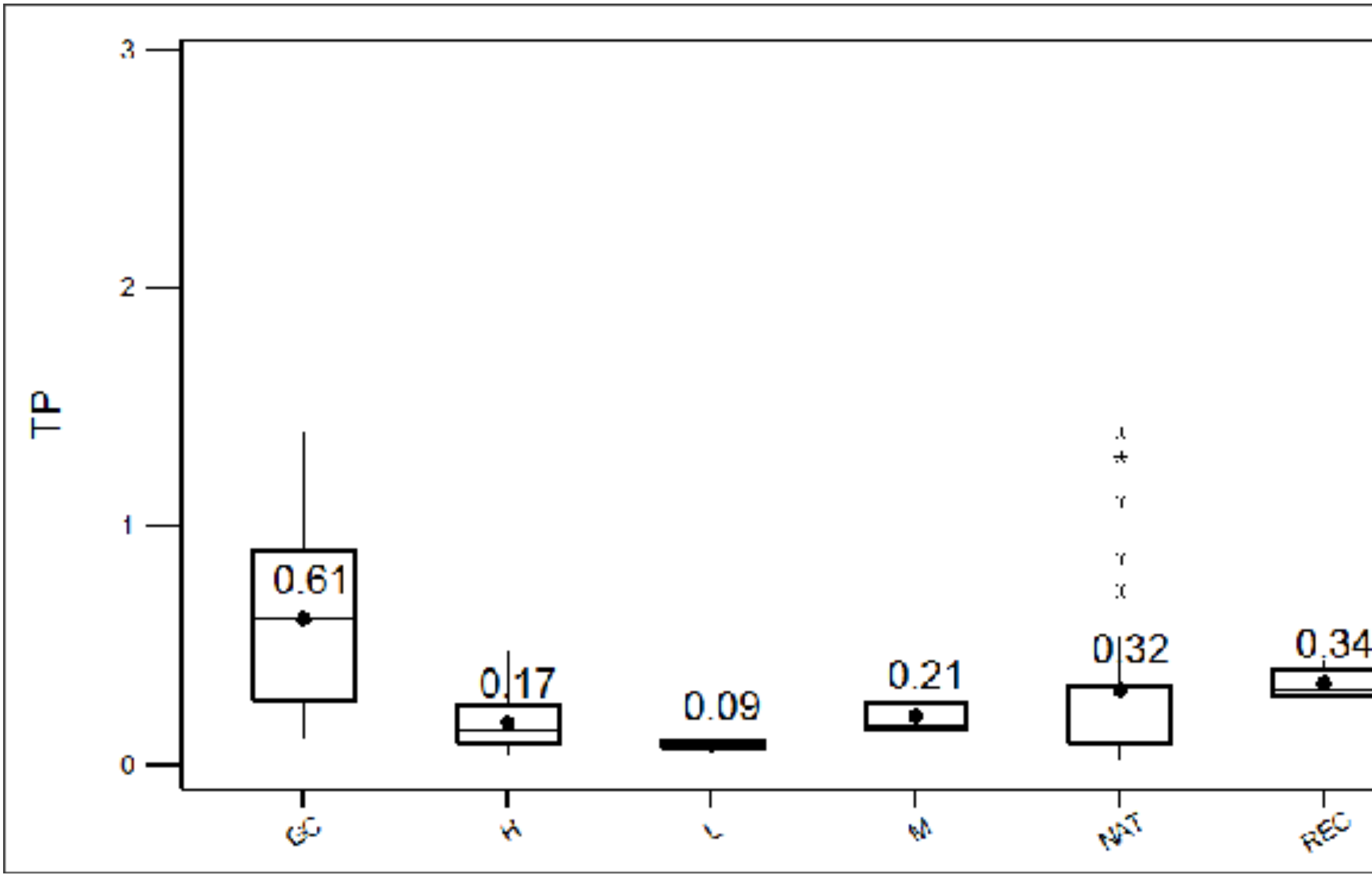


Figure 7. Mean TP concentrations (mg/l) by location in Sanibel community lakes.

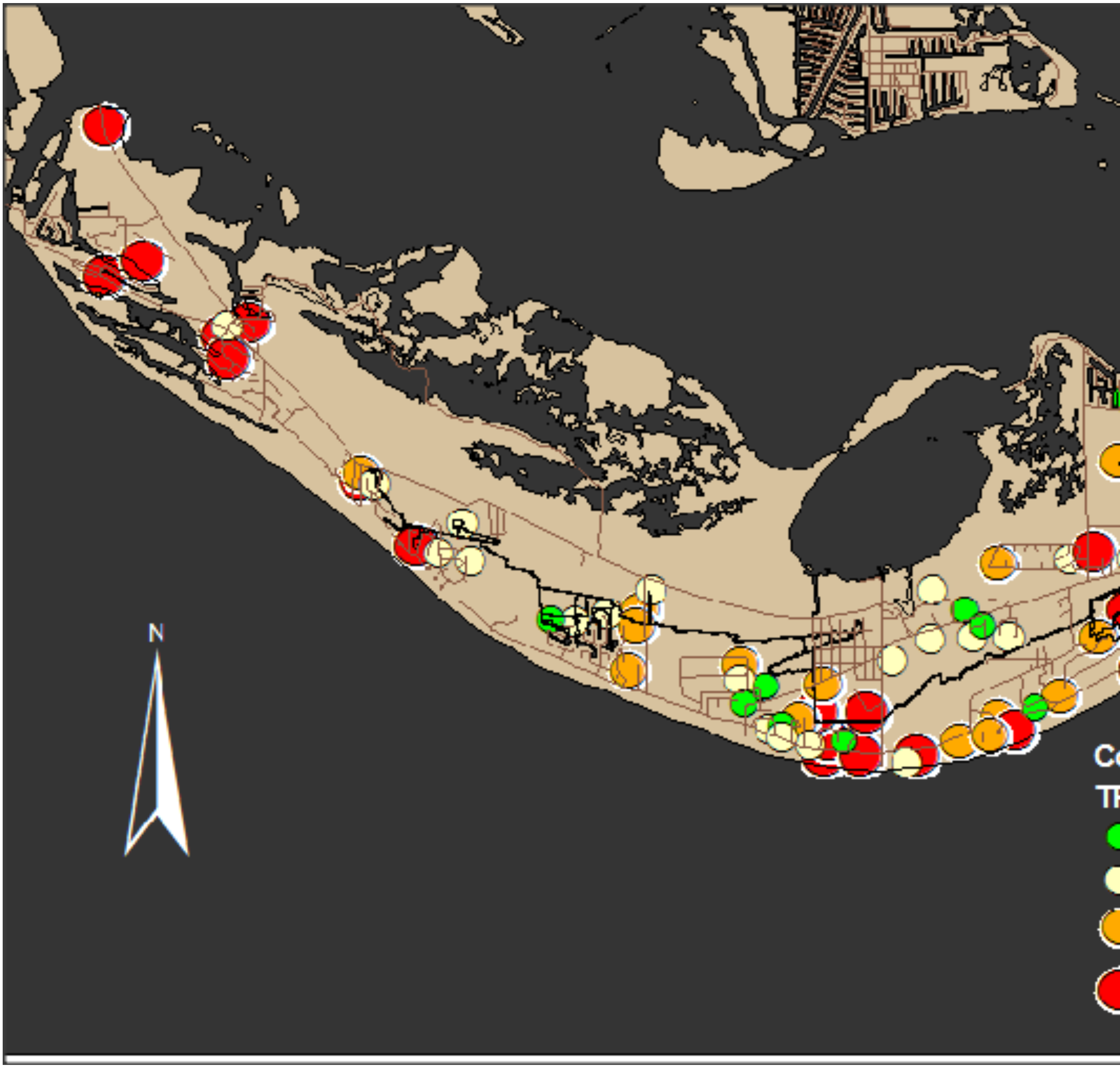


Figure 8. Mean total nitrogen (TN) for each site with reference lines for state water quality criteria and the 90th percentile concentration value for lakes in Florida.

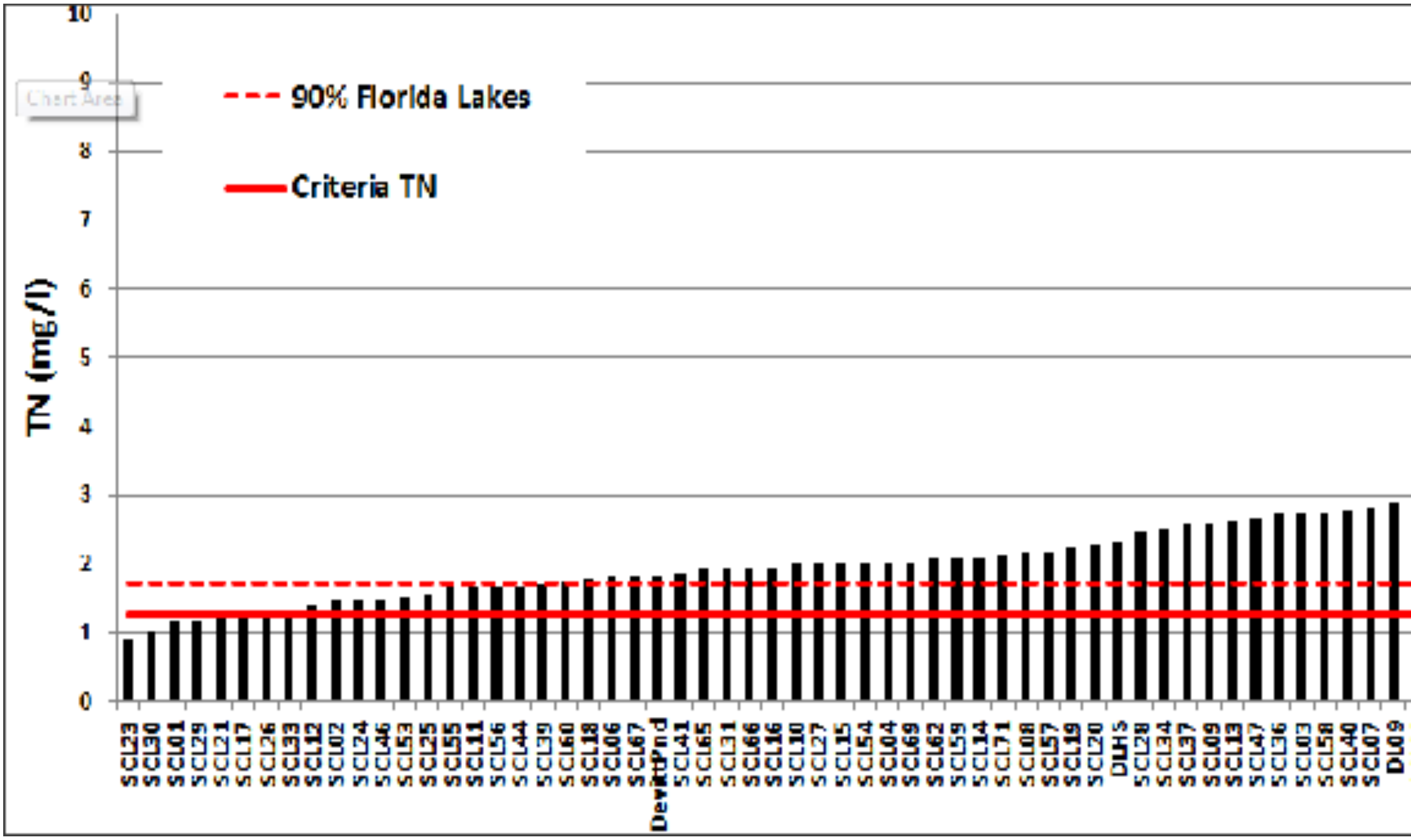
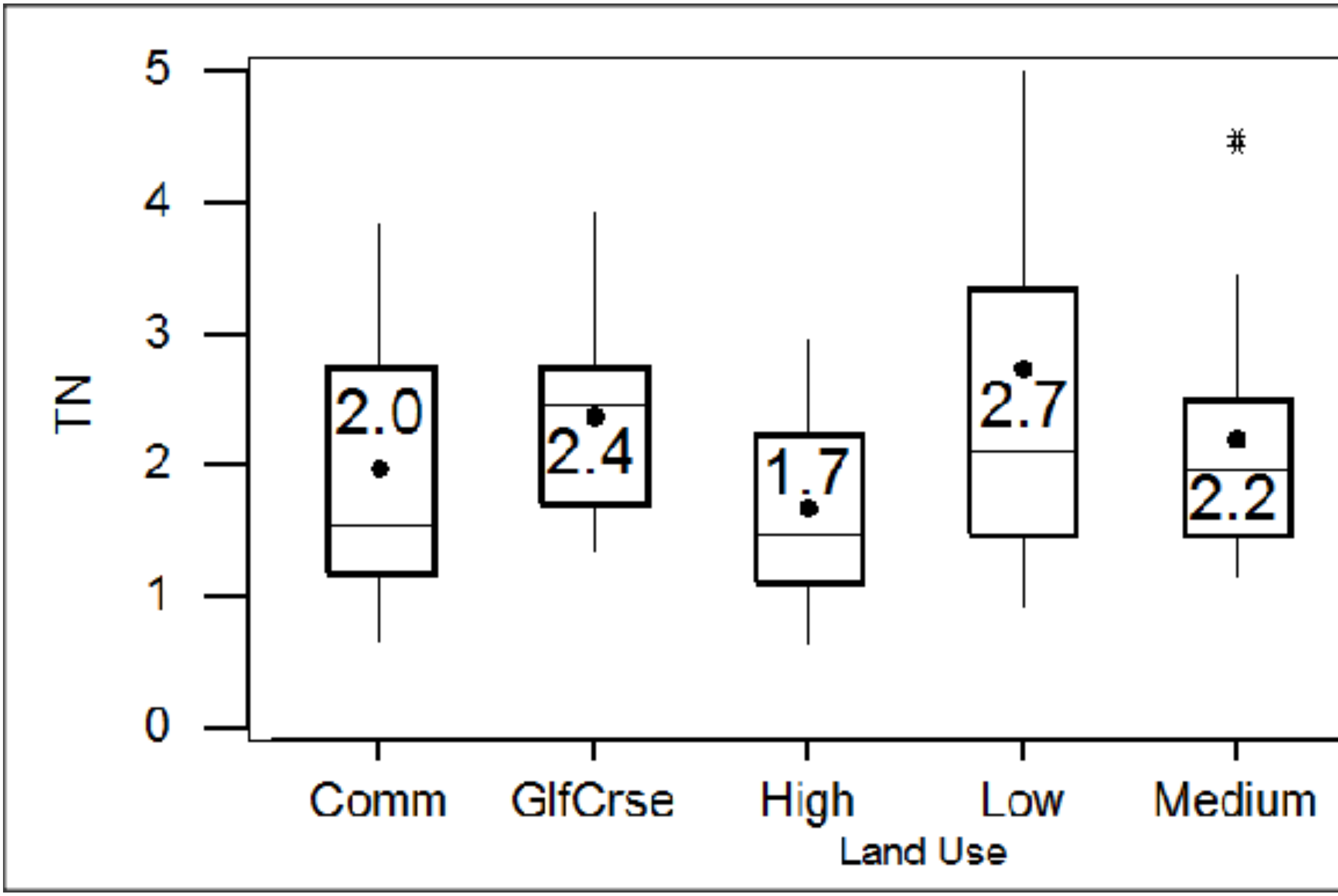


Figure 9. Mean TN (mg/l) in community lakes grouped by land use classification. Lakes on golf courses and in low density developments had significantly greater TN than high density development lakes. No other



significant differences were found between land use types.

Figure 10. Box plot showing mean TN (mg/l) at sites using reclaimed water for irrigation verses sites that did not. No significant difference was found for this factor.

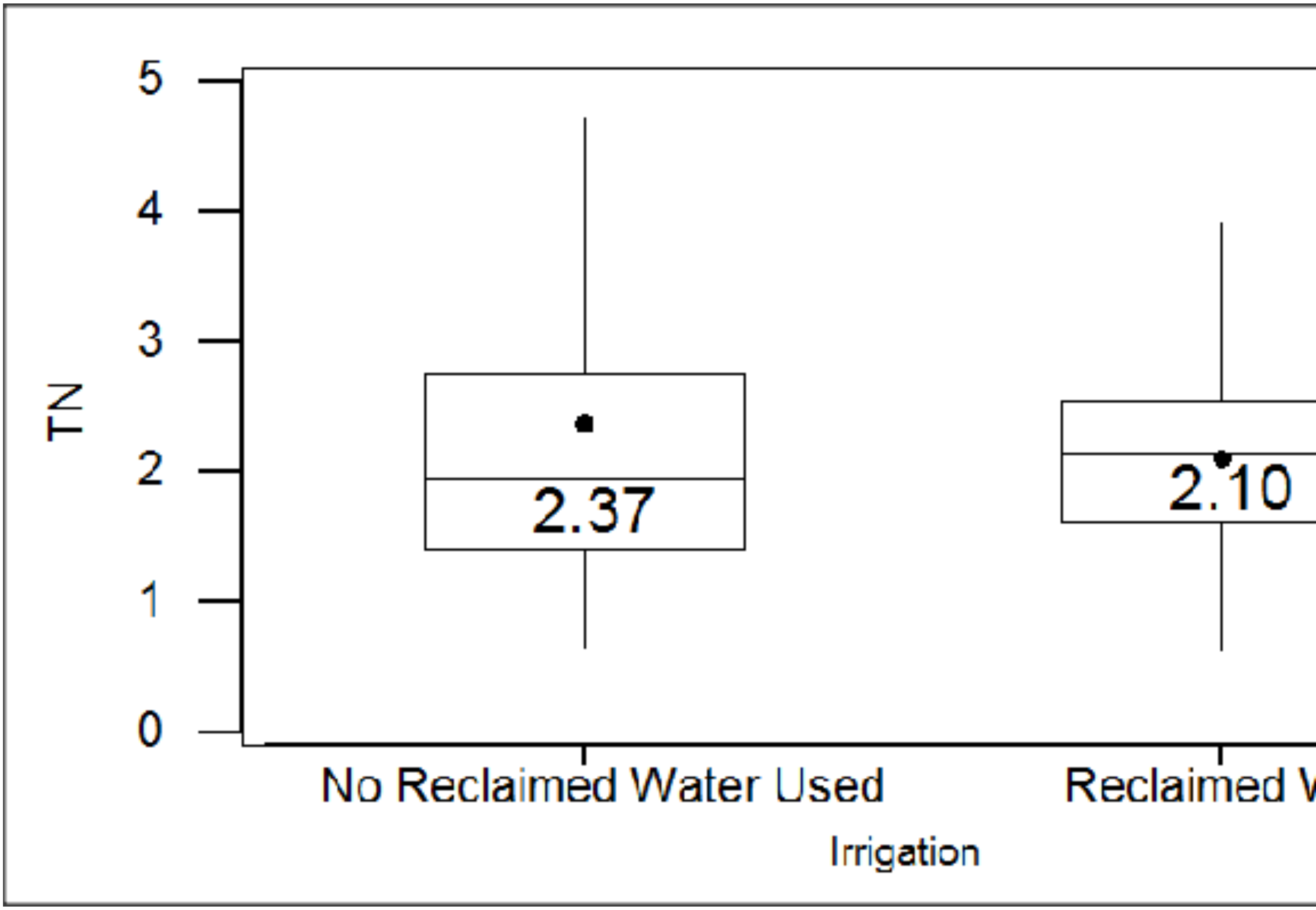


Figure 11. Mean TN (mg/l) at sites during the fertilizer ban period (July-September) versus the non-ban period. Significantly greater levels of TN were found in lakes during the ban period compared to the no ban period.

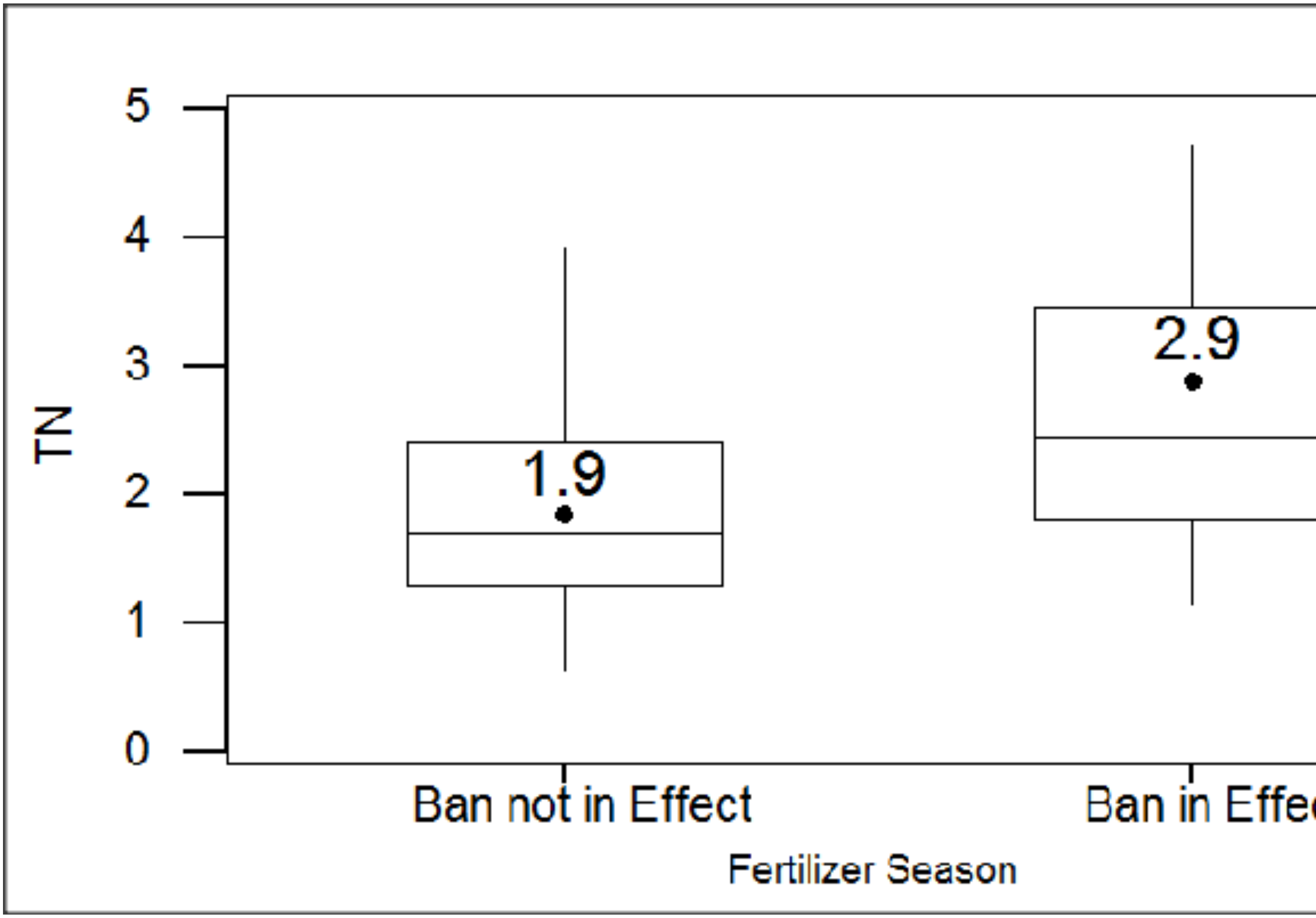


Figure 12. Groundwater total nitrogen (TN) by land use class. Mean represented by dot, median by horizontal line within box, 25th and 75th quartiles by upper and lower boundaries of box, and range by vertical line. Golf course (GC), High density residential (H), Medium density (M), Low density (L), Natural (Nat), Recreation (Rec), and wastewater treatment (WWTP).

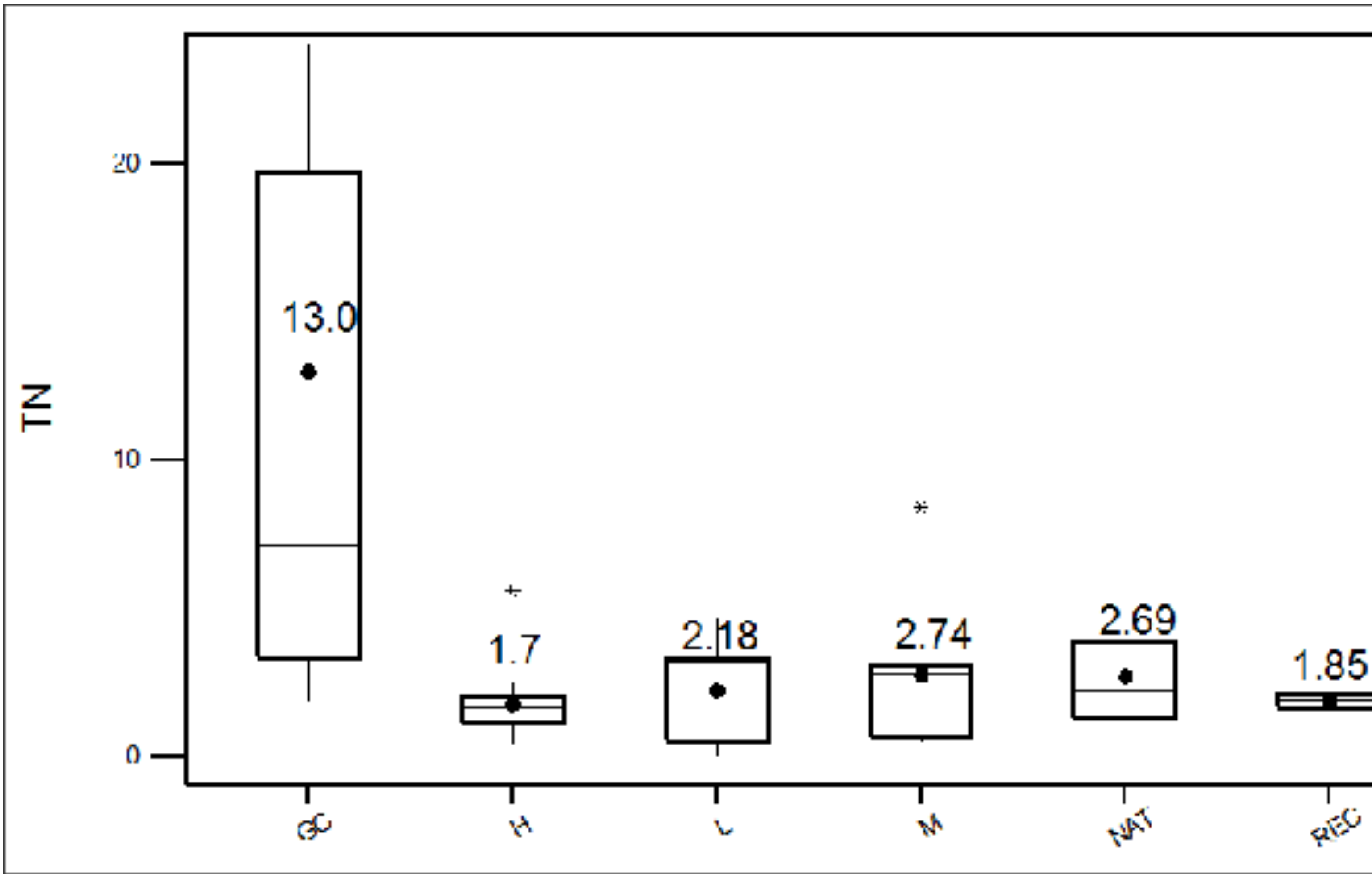


Figure 13. Mean TN concentrations (mg/l) by location in Sanibel community lakes.

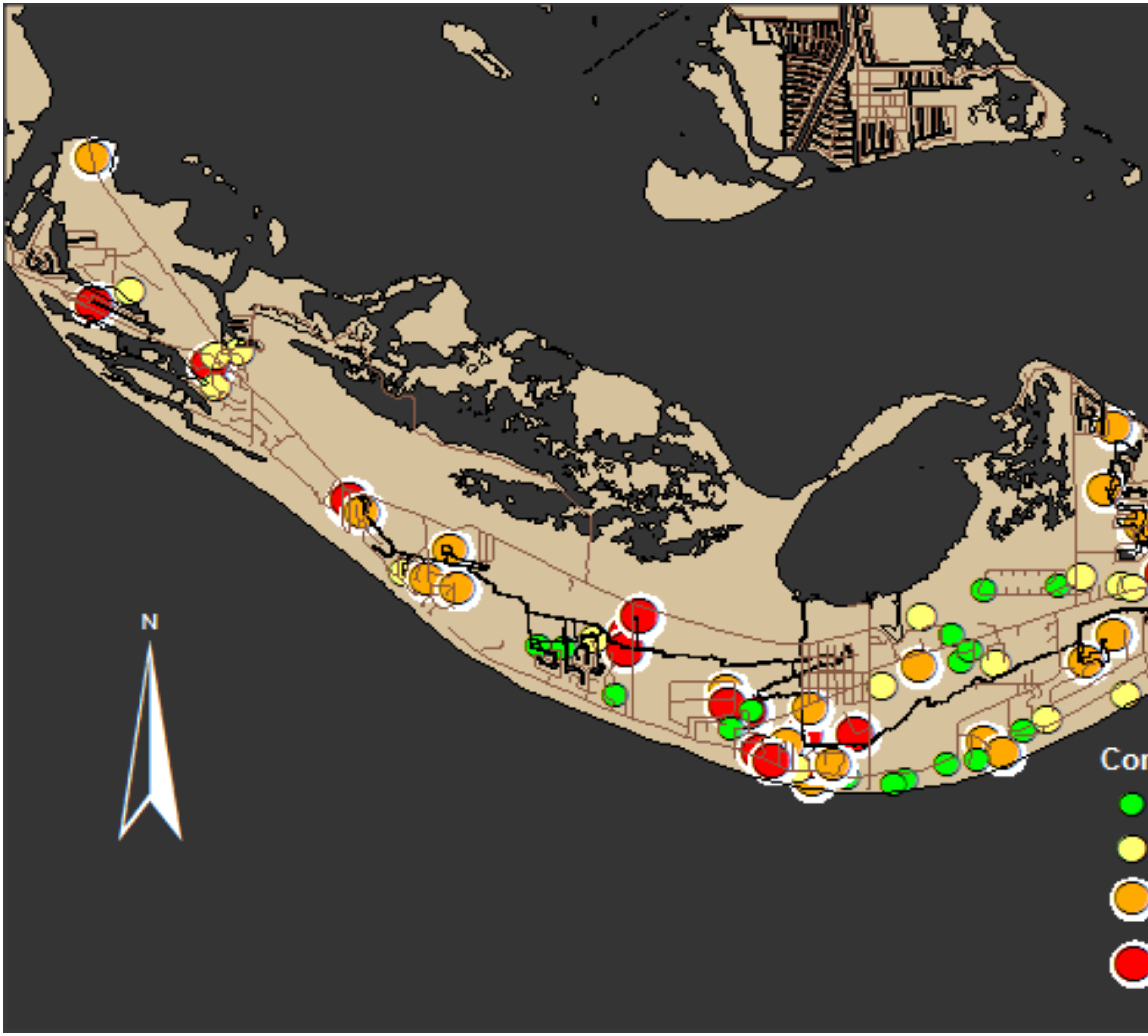


Figure 14. Mean chlorophyll *a* (Chla) for each site with reference lines for state water quality criteria and the 90th percentile concentration value for lakes in Florida.

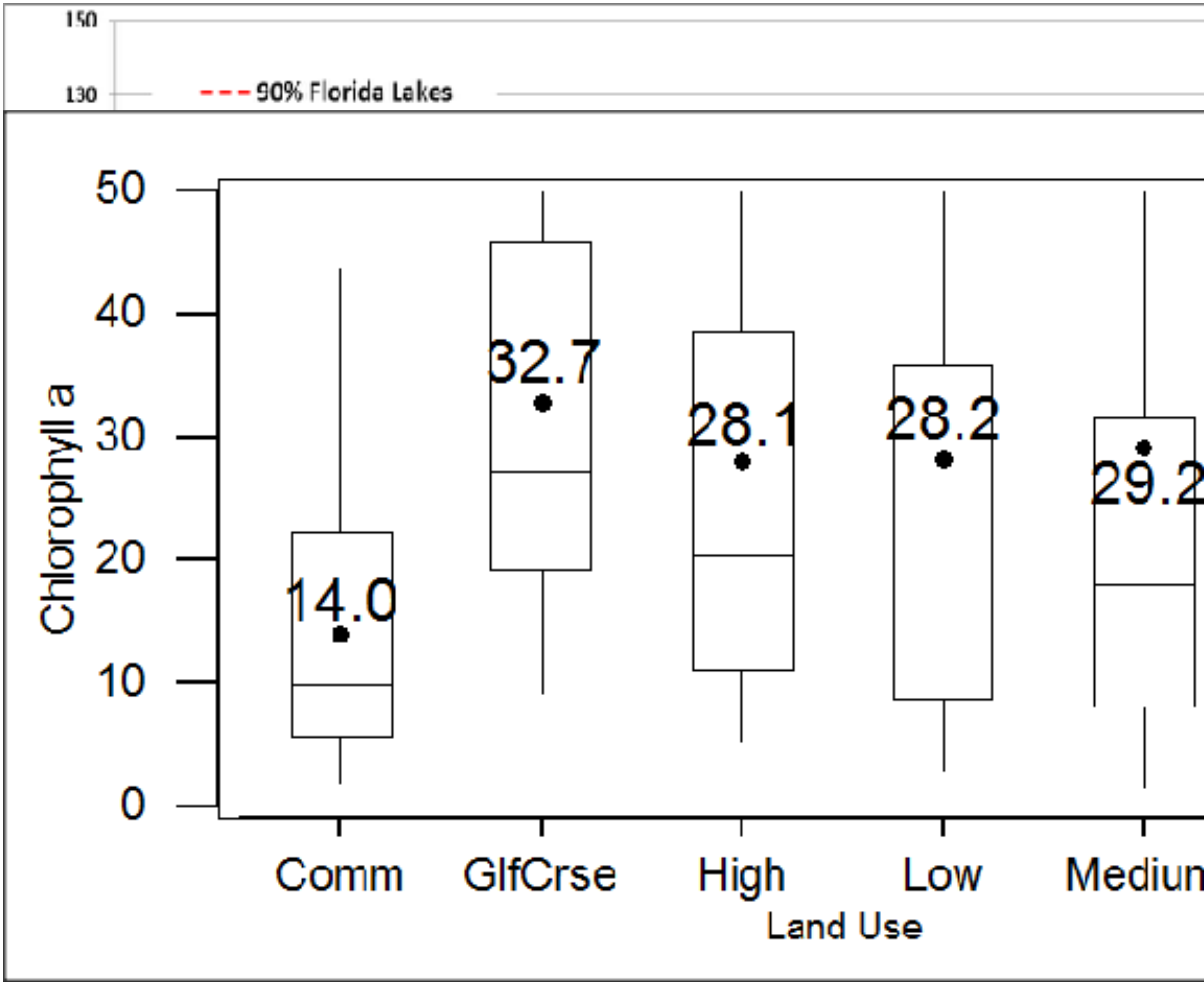


Figure 15. Mean chlorophyll a (ug/l) in community lakes grouped by land use classification. Lakes on golf courses, and in low and medium density developments had significantly greater chlorophyll a than lakes on natural land use types. No other significant differences were found between lakes on other land use types.

Figure 16. Box plot showing mean chlorophyll a (ug/l) at sites using reclaimed water for irrigation verses sites that did not. No significant difference between lakes using these two irrigation regimes was found.

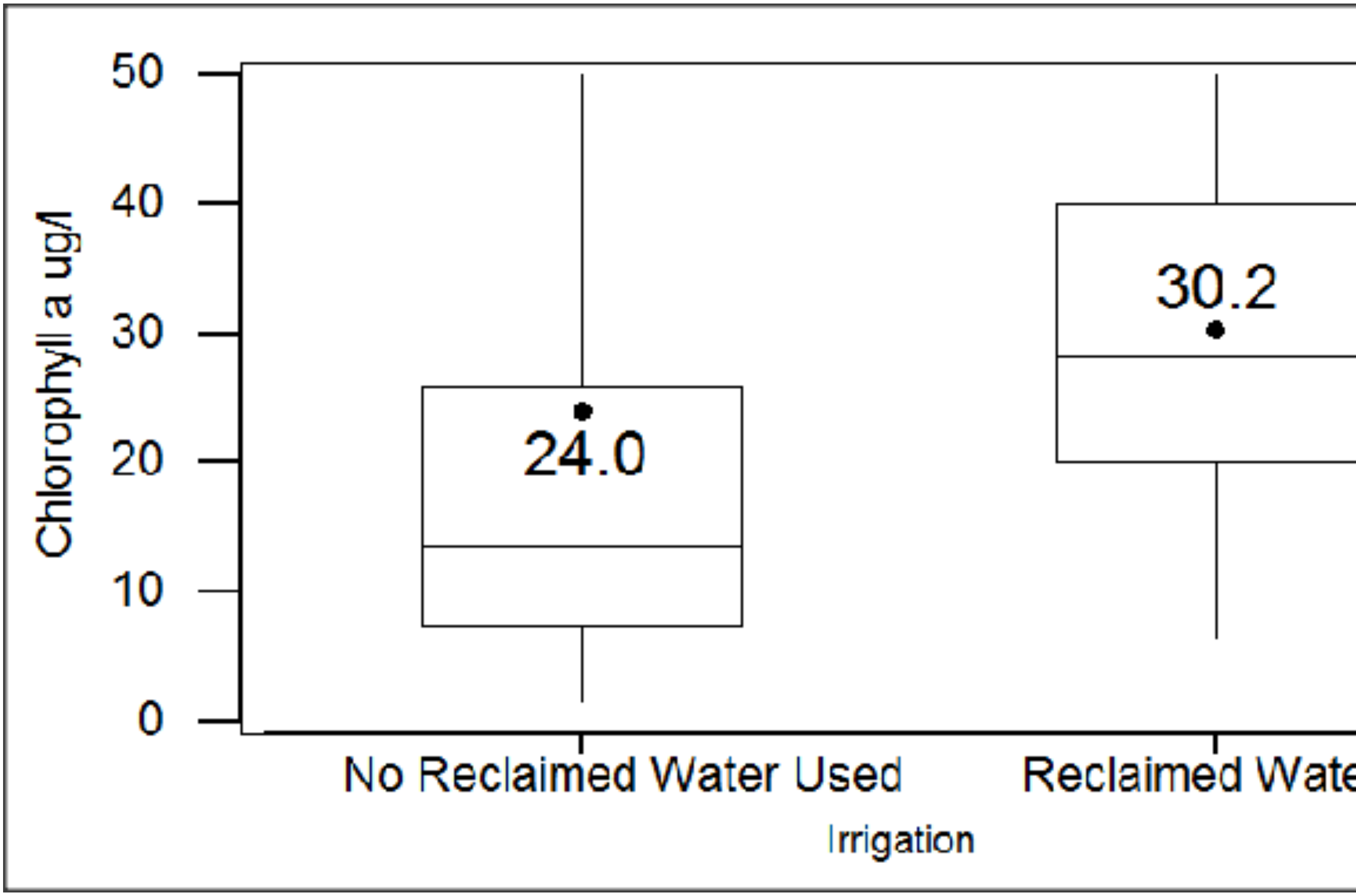


Figure 17. Box plot showing mean chlorophyll a (ug/l) at sites during the fertilizer ban period (July-September) compared to the period allowing fertilizer application. When comparing these two periods, no significant difference was found between mean lake chlorophyll a.

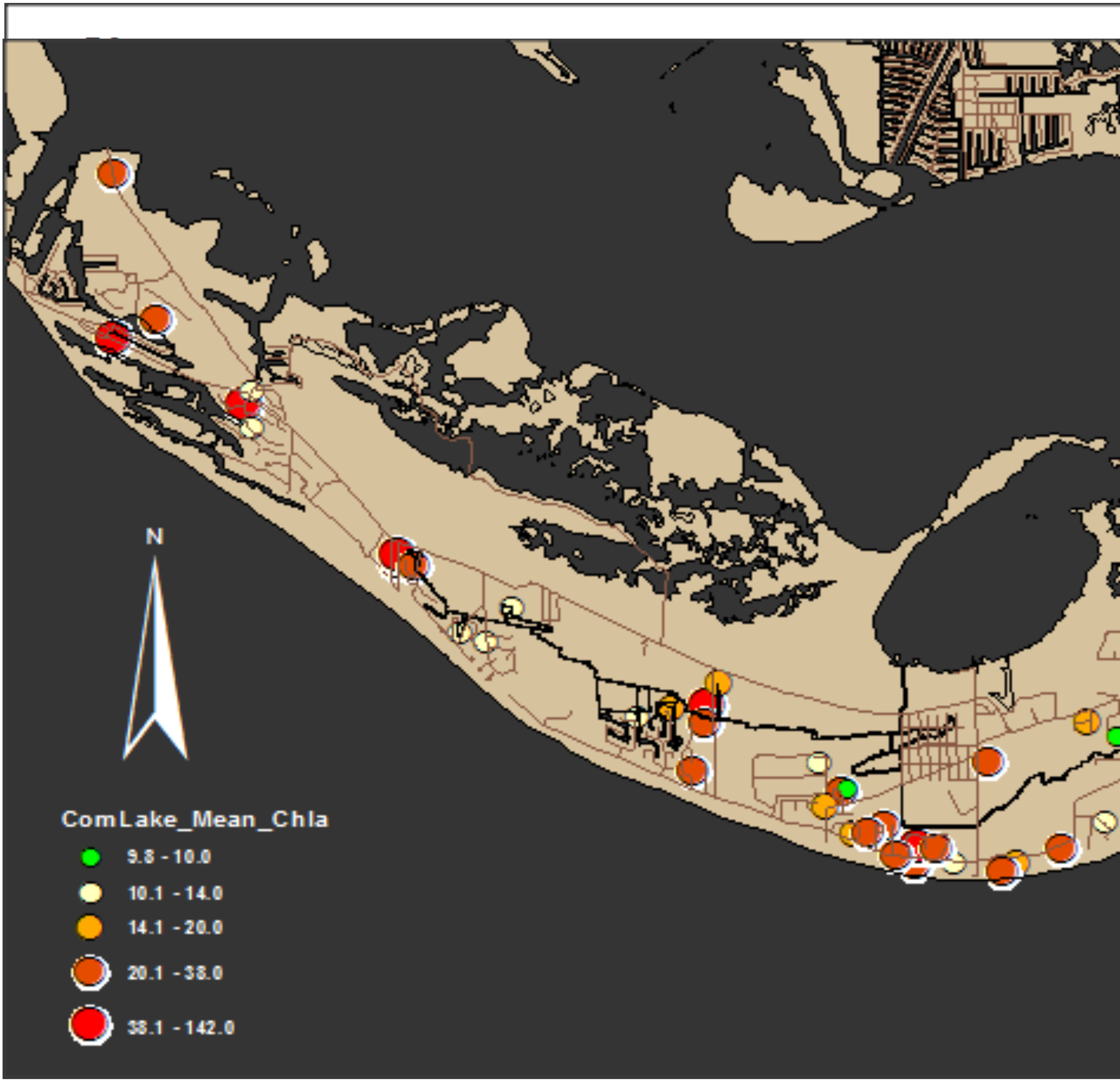
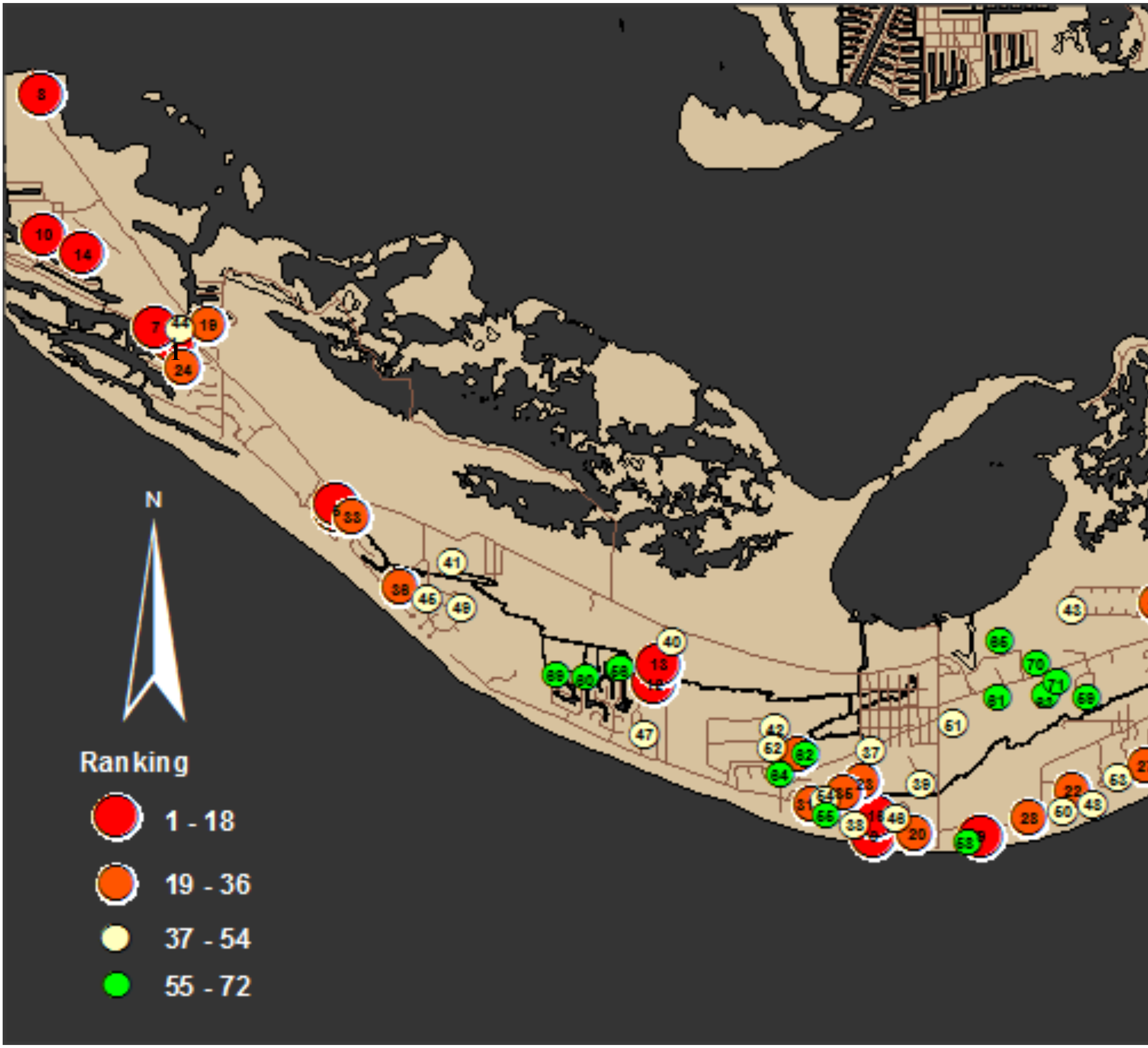


Figure 18. Mean chlorophyll a concentrations (ug/l) by location in Sanibel community lakes.

Figure 19. Ranking the community lakes on Sanibel by water quality values. The highest ranked lakes have the poorest water quality and are represented by red and orange dots.


N
Ranking
1 - 18
19 - 36
37 - 54
55 - 72