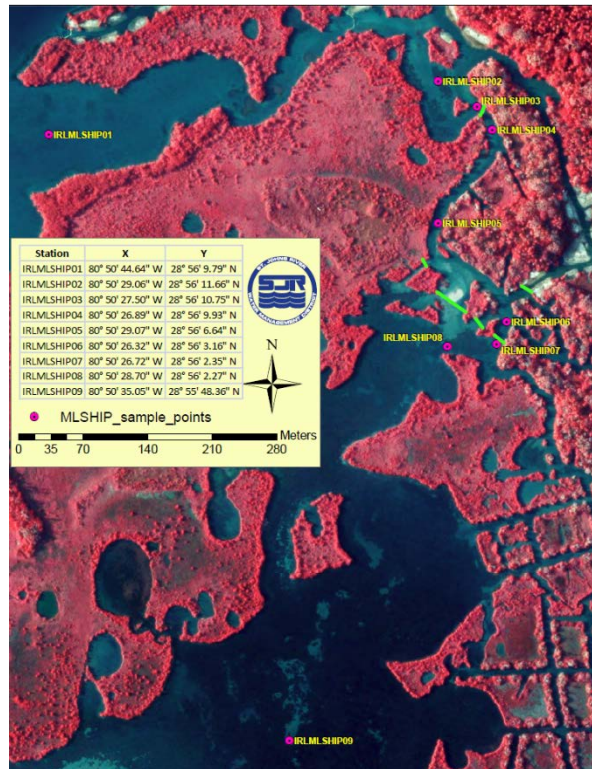


## Effects on Water Quality

At Shipyard Island within Canaveral National Seashore in Volusia County, samples to document differences in key parameters were collected before and during restoration at sites that were near and far from the activity (see figure below). The sites were located within the area delimited by turbidity barriers and at 5 meters (~16 feet), 50 meters (~160 feet), 500 meters (~1,600 feet) and ~3 kilometers (~9,800 feet) outside the area being restored. If restoration caused ecologically important changes, an appropriate statistical test should identify a significant interaction between sites and time (before and during restoration). In other words, adverse effects from restoration should be worse during the restoration and near it. Lack of an interaction suggests that differences among sites or times were due to natural variation rather than restoration. Such natural variation is known to occur.



Location of sites near the area restored.

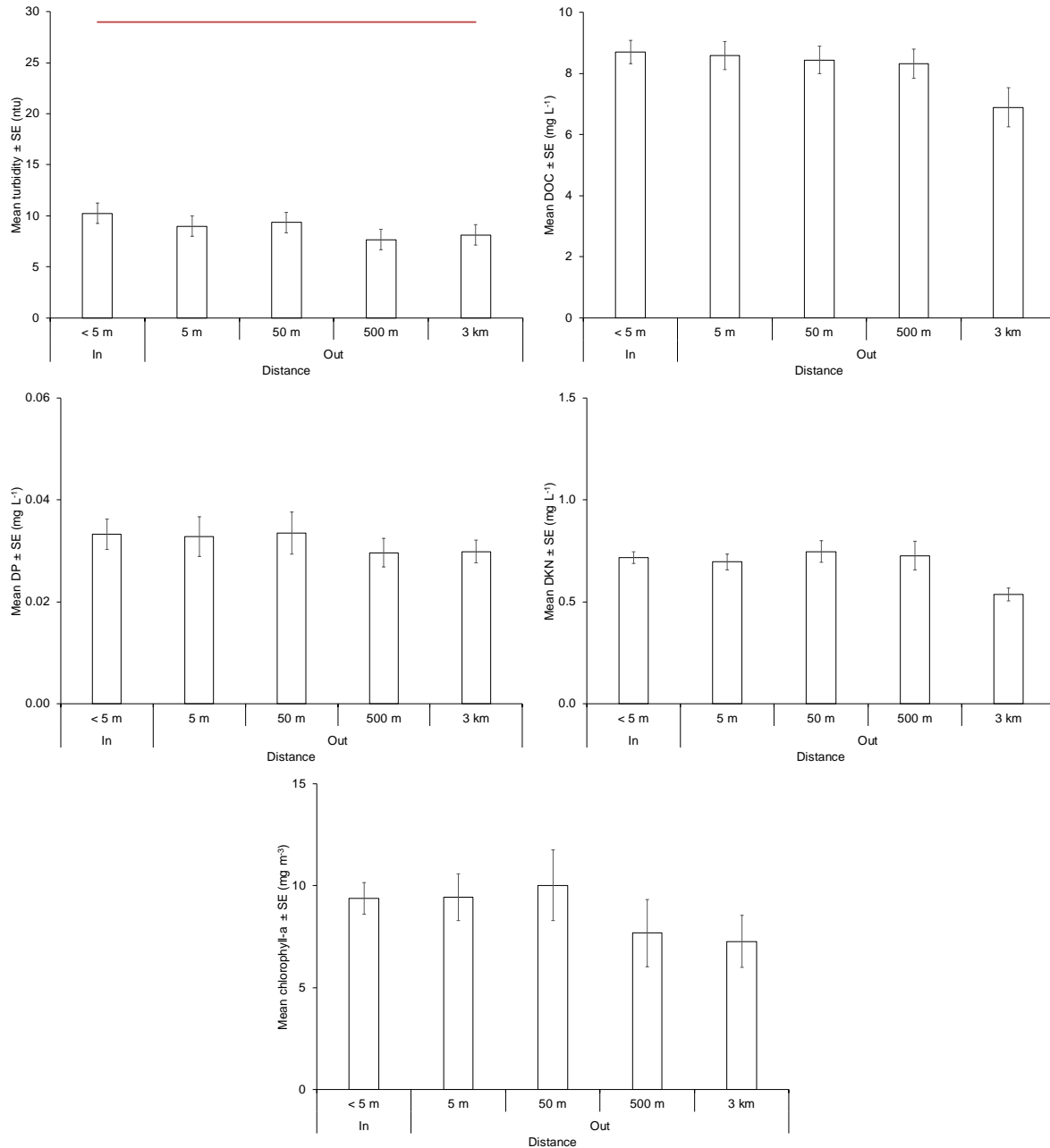
The sites are red dots, and the green lines mark the location of turbidity barriers.

A multivariate, permutation analysis of variance was performed, and the results indicated that sampling was sufficient to detect differences among sites and between times ( $p > 0.05$ , see table below). Thus, water quality did vary but not in a manner consistent with an adverse effect from restoration.

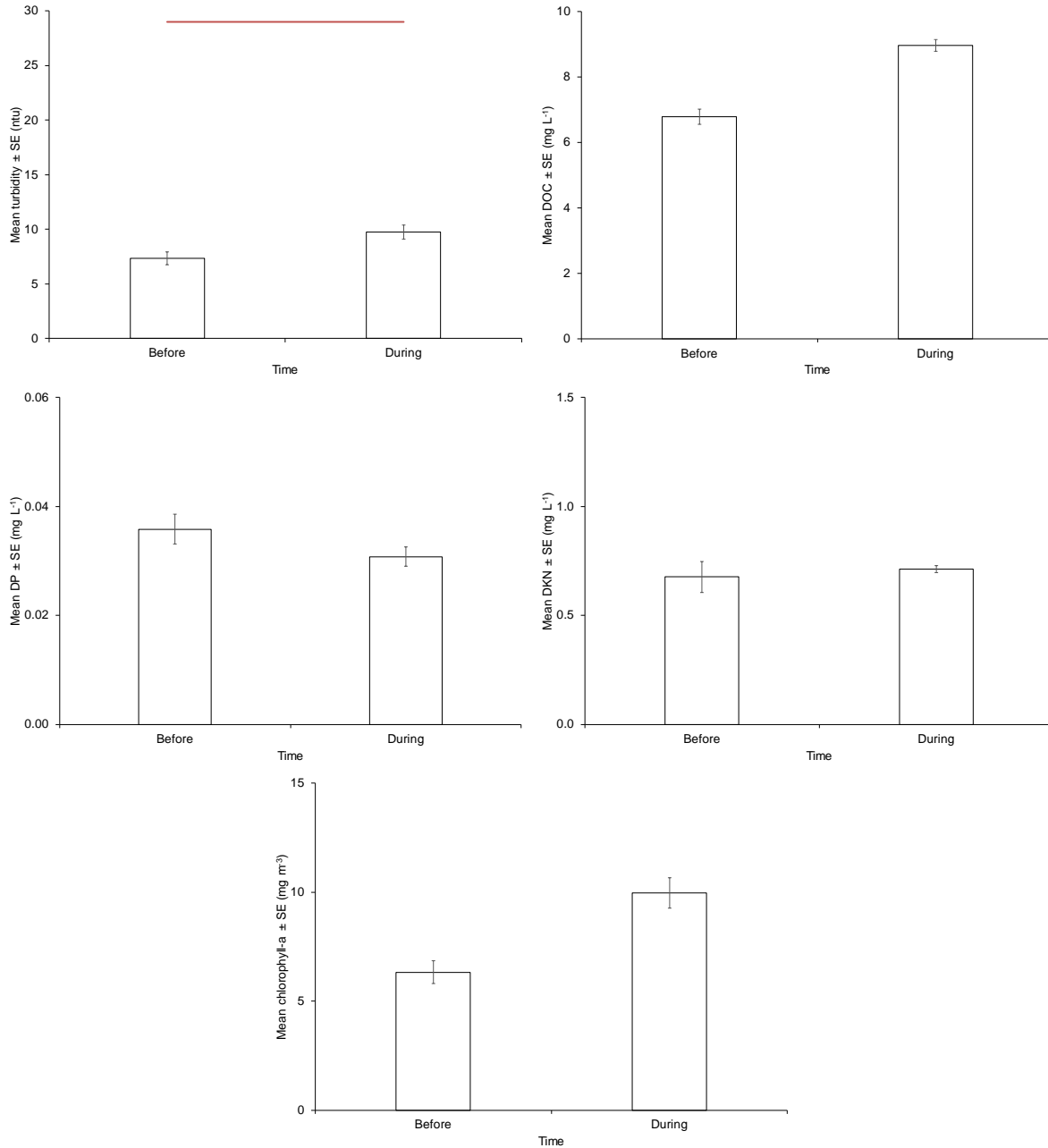
Results of a multivariate, permutation analysis of variance.

Source	df	SS	MS	F	p	Unique permutations
Site	4	3,233	808	2.05	0.036	997
Time	1	5,135	5,135	13.00	0.001	999
Site x Time	4	2,513	628	1.59	0.110	998
Residual	30	11,847	395			
Total	39	22,728				

Examination of means for the parameters illustrated the differences among sites that were consistent for both times and the differences between times that were consistent across all sites (see figures below). Means for all parameters at sites near restoration were not substantially or consistently larger than means for more distant sites, and variation between times was relatively small. Mean turbidity remained below 15 nephelometric turbidity units (ntu), so it was well within the limit set by the permit (29 ntu above background, with 29 ntu above zero shown as a red line in the appropriate figures).

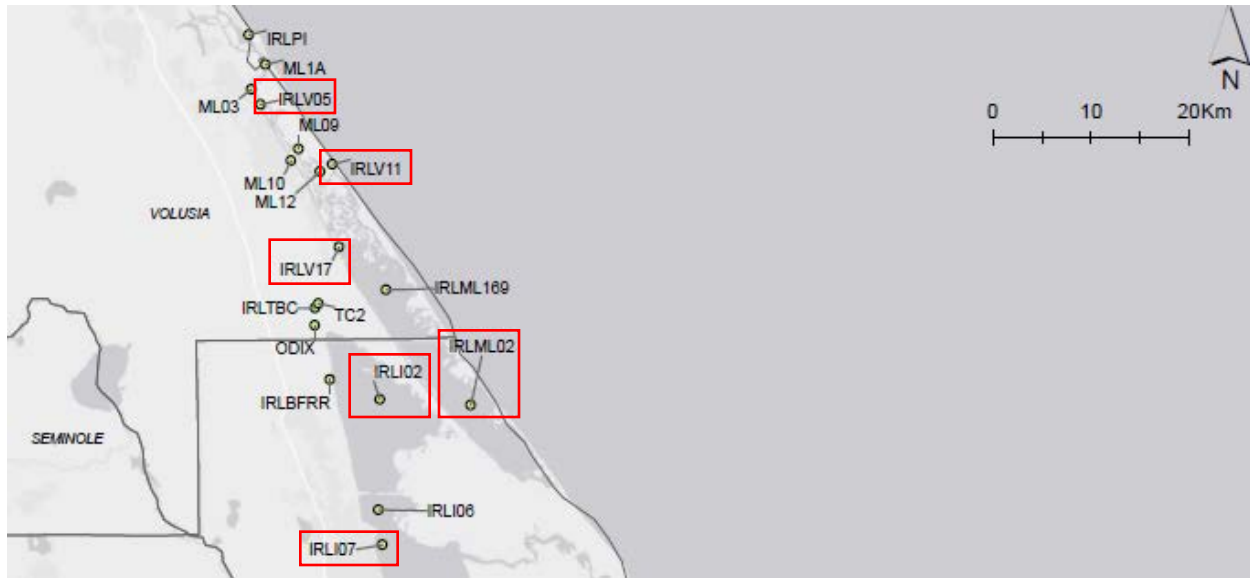


Mean values for water quality parameters  $\pm$  standard errors (SE) at five sites. DOC = dissolved organic carbon, DP = dissolved phosphorus, DKN = dissolved Kjeldahl nitrogen (ammonium and organic nitrogen), ntu = nephelometric turbidity unit, mg = milligram, L = liter, m = meter, km = kilometer



Mean values for water quality parameters  $\pm$  standard errors (SE) at two times.  
 DOC = dissolved organic carbon, DP = dissolved phosphorus, DKN = dissolved Kjeldahl nitrogen (ammonium and organic nitrogen), ntu = nephelometric turbidity unit, mg = milligram, L = liter, m = meter

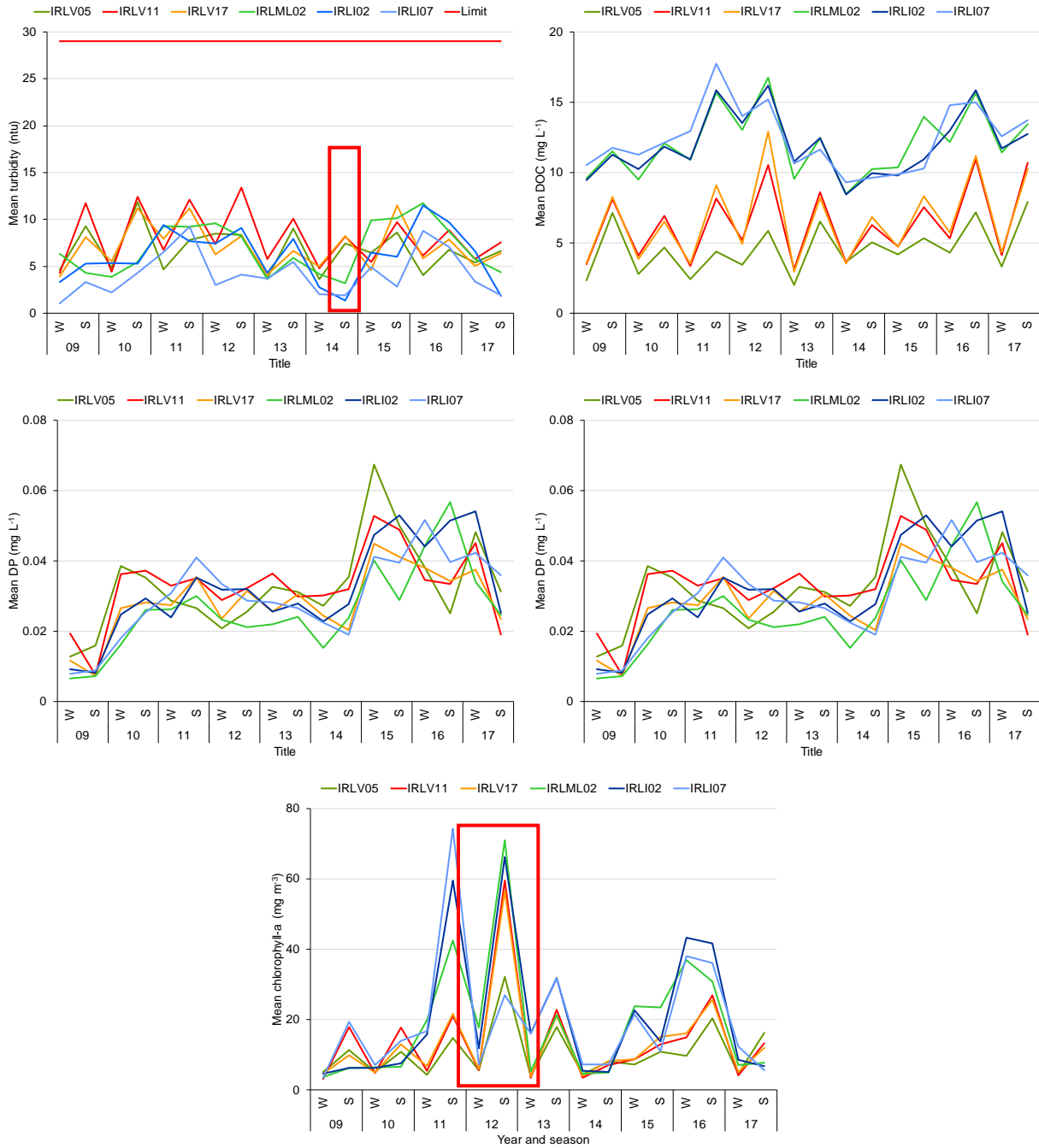
Data from monthly sampling provides a look at a longer timeframe and the regional scale. Sites labelled IRLV11 and IRLV17 were closest to the restoration done in Mosquito Lagoon during the summer of 2014, sites IRLV05 and IRLML02 bracket those sites, and sites IRLI02 and IRLI07 were near Haulover Canal that connects Mosquito Lagoon to the Indian River Lagoon (see figure below).



Locations where samples were taken marked by red boxes.

Across nine years at this spatial scale, there is no evidence that restoration in 2014 had detrimental effect on water quality. Again, functional wetlands promote improved water quality, but functional wetlands cannot overcome excessive loads of nutrients. In the waters near these sites, excessive nutrient loads are being addressed by an adopted basin management action plan for the northern Indian River Lagoon (BMAP, <https://floridadep.gov/sites/default/files/north-IRL-bmap.pdf>) and a reasonable assurance plan that is in development for Mosquito Lagoon (RAP, see background information at: <https://floridadep.gov/dear/watershed-assessment-section/content/4b-assessments-raps>).

More insights can be gained by looking at graphs of mean values through time, with a focus on 2014, which is when restoration was done (see figures below). Mean turbidity varied, with relatively low values everywhere in summer 2014, and all values were below 15 ntu so the conditions of the permit were met. Concentrations of DOC, DP, and DKN also varied, but means at the sites nearest the restoration were lower than or essentially equal to values from further south. Higher chlorophyll-a concentrations, which are a key indicator of eutrophication, tended to occur at all six sites at about the same times. Also, note that the sites nearest the restoration (IRLV11 and IRLV17) tended to have lower concentrations than sites further south. One exception was an intense brown tide that caused chlorophyll-a concentrations greater than 50 micrograms per liter at multiple sites in 2012–2013.



Mean values for water quality parameters, with patterns denoted by red boxes.  
 DOC = dissolved organic carbon, DP = dissolved phosphorus, DKN = dissolved Kjeldahl nitrogen  
 (ammonium and organic nitrogen), ntu = nephelometric turbidity unit, mg = milligram, L = liter,  
 m = meter