Little Bay Water Quality Characterization

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Introduction

This study summarizes the water quality and light characteristics of Little Bay located in Rockport, Texas. Little Bay is a small, shallow bay, partially surrounded by the Key Allegro housing development that includes a large marina and numerous canals. The bay is connected to Aransas Bay through two outlets to the north and east. Little Bay also serves as the primary recipient of storm water drainage from the town of Rockport through Tule Creek and multiple storm water outfalls, discharge from the municipal wastewater treatment facility, and runoff from the adjacent subdivision, Key Allegro. The seagrass community in Little Bay is a monoculture of *Halodule wrightii*. Historically the extent of seagrass beds in the bay has fluctuated, but the seagrass abundance remained dense. In the past 15 years, seagrass abundance has been steadily declining, especially in the last five, and is now extremely sparse. The bay is a major recreational area and is home to many migratory birds and juvenile fish populations. Numerous local communities concerned about the loss of seagrass partnered to commission Mission-Aransas NERR and the University of Texas Marine Science Institute to study the possible causes of this decline. The commissioned study analyzed indicators of seagrass condition, including water quality. The data collected for this report was designed to supplement the study to assess seagrass condition. Through a previously established relationship, Mission-Aransas NERR contracted Texas A&M University, Division of Nearshore Research (DNR) to install equipment to provide continuous water quality data available to the public via their website.

Seagrass habitat decline is a world wide issue, and can be related to numerous causes. Among these are the consequences of eutrophication caused by increased nutrient inputs into an estuary (Alongi 1998). Eutrophication can lead to hypoxic conditions and cause decreased light levels due to increased particulates in the water column and phytoplankton blooms. This monitoring effort was designed to determine possible causes of the environmental degradation in Little Bay. We established a continuous monitoring study to measure standard water quality parameters including temperature, salinity, dissolved oxygen, turbidity, and pH, as well as light availability to the seagrass. The water quality station was setup and conducted using the same methods as the Mission-Aransas NERR's System Wide Monitoring Program (SWMP) for comparison purposes.

Methods

Study Locations

Little Bay is extremely shallow throughout most of the bay (<0.6 m) with the exception being a water skiing basin around the center islands and the channel from Aransas Bay to the Key Allegro canals, which are between 1.5 and 3.0 meters deep. The light sensor site was chosen based on depth, adjacency to seagrass beds, water level, and recreational boat active location. The light station was placed between two islands in the middle of Little Bay at N 28.03211 W 97.04128 (Fig. 1). The water quality monitoring site was also chosen for its ideal depth and location. It continues to collect data and is mounted to a piling at a private residence in Key Allegro at N 28.03702 W 97.03257, where it is easily accessed and remains submerged year round (Fig. 1).

Continuous Water Quality Station

The continuous water quality station consists of a multiparameter datasonde, suspended ½ meter from the bottom (YSI 6600 V2-4). All continuous water quality parameters and 24-hr composite parameters were sampled in accordance with the *Central Data Management Office(CDMO) NERR SWMP Data Management Manual (2008).*

The steps involved in quality control of data collection were to: 1) calibrate the sondes before field measurements (pre-deployment calibration), 2) start data logging, 3) log for a latent period in 100% saturated DO environment, 4) deploy in field and log field measurements, 5) log for post-deployment period in 100% saturated DO environment, 6) stop logging, download data, and 7) post-calibrate probes. Data were checked using the CDMO QAQC process and were determined to be of acceptable quality when: 1) the pre- and post-deployment latent period data equilibrate to the same levels, and 2) pre- and post-deployment calibration values are the same or within acceptable ranges of each other.

The pre-calibration was done one day before a deployment so that the latent period was at least one day, and the post calibration was done within one day of retrieval. YSI datasondes are deployed for two weeks to a month, depending on the time of year and amount of biological fouling present. The station logs at 15 minute intervals for 24 hours a day, and all dataloggers were equipped to report temperature, conductivity, salinity, dissolved oxygen % saturation and concentration, turbidity, pH, and chlorophyll. Continuous Water Quality Data was collected from October 19, 2009 through December 31, 2010.

The *CDMO NERR SWMP Data Management Manual (2008)* and Mission-Aransas NERR SWMP Data can be found at http://cdmo.baruch.sc.edu/documents/manual.pdf and http://cdmo.baruch.sc.edu/

Continuous Light Station

Continuous light intensity data were collected from May 28, 2009 through December 31, 2010. The light station recorded both underwater irradiance and surface irradiance. The LI-COR light sensors are calibrated yearly and the conversion coefficient for each sensor is programmed into the datalogger to automatically convert voltage readings to irradiance measures. Underwater irradiance data were collected using a LI-1938A Spherical Quantum sensor and were recorded on a LI- 1000 or LI-1400 datalogger (LI-COR Inc., Lincoln, Nebraska, USA) at the site. The underwater sensor was mounted on a PVC pole and positioned just above the sediment, at an average depth of .4 meters. Instantaneous Photosynthetically Active Radiation (PAR, including wavelengths of 400 to 700 nm) measurements were taken at 1 min intervals and integrated over a 1 hour period. Coincident surface PAR measurements were collected using a LI-190SA terrestrial cosine sensor and recorded on the same LI-1000 data logger located on shore. The terrestrial sensor was mounted on top of a piling adjacent to the underwater sensor. These measurements were also taken at 1 min intervals and integrated over a 1 hour period. Although the continuous light station recorded data beginning in May 2009, the Quality Assurance Project Plan (QAPP) approval date was not until September 16, 2009. There was also partial data corruption from mid-September through December 2010, and the final dataset presented in this report is from May 2009 through September 2010.

Data retrieval occurred via two methods. During the time period that the LI-1000 was deployed, the datalogger was changed out and brought back to the lab for data retrieval. During the time period the LI-1400 was deployed, the datalogger remained in the field and the data was downloaded via a laptop. Cleaning maintenance was performed every two weeks on sensors. Transparent Whirlpak bags were placed over the underwater PAR sensor to prevent fouling and replaced regularly.

The PAR readings from the underwater and terrestrial sensors were used to calculate % Surface Irradiance to determine light attenuation. The calculation is performed as follows:

$$\% \text{ Surface Irradiance} = (LI_{UW}/LI_{TERR}) * 100$$

where LI=PAR readings

Results

Water quality parameters

Depth of the sonde reflected tidal fluctuation with an average depth of 1.23 meters (Fig 2 and Table 1). In 2010, storm surges occurred on July 1st and 7th and September 7th and 19th, coinciding with Hurricane Alex, Tropical Depression 2, Tropical Storm Hermine, and Hurricane Karl, respectively. Water temperature ranged from 4.1 to 33.4 degrees C, with an average of 22.2 degrees C (Fig 2 and Table 1). Salinity varied greatly, from 7.05 to 38.05 psu (Fig 3). For the most part salinity was in the 10-25 psu range, with an average salinity of 18.41 psu (Table 1). Dissolved Oxygen percent saturation fluctuated daily, remaining generally high for the duration of the sampling period with an average of 96.06 % (Fig 4.). No periods of hypoxia were recorded. The average pH was 8.3, but at times exhibited unusually high and low values of 9.0 and 7.6 (Fig 5 and Table 1). Turbidity ranged from 0.1 to 74.2 NTU, with an average of 8.97 NTU (Fig 5 and Table 1). There were a few periods of high turbidity, most of which coincided with storm and wind events. *In vivo* chlorophyll a concentrations varied widely from 0.0 to 144.6 µg/l, with an overall average of 14.59 µg/l (Fig 6 and Table 1).

Light Attenuation

% Surface Irradiance (%SI) for daylight hours was averaged monthly (Fig 7). February 2010 had the lowest %SI at 15.62% while March 2010 had the highest at 63.31%. The average %SI for the entire duration of the study was 40.73%.

Discussion

The continuously monitored water quality data in Little Bay is highly comparable to a nearby Mission-Aransas NERR SWMP site in Aransas Bay. Before extensive development of Key Allegro and Rockport Beach Park, Little Bay had a higher amount of connectivity to Aransas Bay (Dunton and Wilson 2010). Historically, conditions in Little Bay were likely similar to the surrounding Aransas Bay waters that currently support many healthy seagrass beds.

Average turbidity in Little Bay is almost less than half the average for Aransas Bay during the same time period (Table 1). This suggests that light attenuation due to particulate matter in the water does not impede seagrass growth in Little Bay, which is reinforced by results from a simultaneous study conducted by Dr. Ken Dunton and the Mission-Aransas NERR. In that study it was found that *in situ* levels of total suspended solids were low in Little Bay (Dunton and Wilson 2010). Dissolved oxygen percentages were very similar to those of Aransas Bay and fluctuated around 100% for the majority of the study (Table 1). No periods of hypoxia were observed, suggesting that if there is any eutrophication occurring in the bay it is not enough to effect oxygen levels and in turn, seagrass beds.

Two parameters, chlorophyll concentration and salinity, were noticeably different in comparison to Aransas Bay averages (Table 1). Average chlorophyll levels were approximately 5 µg/l greater in Little Bay than in Aransas Bay. Although this is considerably higher, it is not a high enough concentration to suggest that phytoplankton blooms were affecting light availability to the seagrass. Average salinity levels were about 5 psu lower in Little Bay than in Aransas Bay. Although Little Bay does experience periods of higher salinity associated with droughts, it also experiences very low salinities during rain events. *H. wrightii* is rarely found in waters less than 20 ppt. (Dunton and Wilson 2010). It is believed that they can tolerate fluctuations, but perhaps do not proliferate when exposed to extended periods of lower salinities. The fact that the average salinity of Little Bay for the period of the study was 18.41 suggests that perhaps salinity is a contributing factor the decline of seagrass. This evidence suggests it is wise to continue water quality monitoring to describe the salinity regime of Little Bay in greater detail. Water quality parameters measured at the continuous station were analogous to those measured in the simultaneous Little Bay study, which also suggests that this water quality station is a good proxy for conditions in the rest of the bay (Dunton and Wilson 2010).

Turbidity levels indicated that light availability is sufficient for seagrass growth. Light availability is one of the most important factors in determining suitable habitat for seagrasses. The light meter deployed during this study confirmed the data from the turbidity readings and there appears to be sufficient light to support seagrass. On the Texas Coast, *Halodule wrightii* grows well and proliferates at 20% surface irradiation (SI) or above (Dunton 1994). The average % SI in Little Bay for the duration of the study was in higher than this minimum, at 40.73% (Figure 7). However, there were three months during the study period when the % SI was below 20% (Figure 7). The turbidity readings did not correlate with this decline in surface irradiance. Field notes taken at sampling times describe the presence of heavy algal mats on the surface of the sediment or floating on the surface of the water. These mats persisted for four months of the study, first recorded on December 18, 2009 and continuing through April 21, 2010. Not all of these months had low %SI on average, but all had days in which the light data trends exhibited signs that there could have been shading of light sensor from floating matter in the water column. The presence of algal mats has been shown to negatively effect seagrass growth and cause bare patches in seagrass beds (Kopecky 2006). However, the time period in which these mats were observed does not correspond to the seagrass growing period and it is difficult to conclude the effect they would have on seagrass growth. The simultaneous Little Bay Study correlated these algal mats with high sediment porewater ammonium concentrations (Dunton and Wilson 2010). Future projects in Little Bay should examine the interactions between these algal mats and the seagrass beds.

References

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Table 1: Average values for water quality parameters at Little Bay and NERR Aransas Bay site for 10/19/09 - 12/31/10.

	Little Bay	Aransas Bay
Temperature (C)	22.2 +/- 6.9	21.9 +/- 6.8
Depth (m)	1.23 +/- .16	2.55 +/- .17
Salinity (psu)	18.41 +/- 5.41	23.4 +/- 6.2
Dissolved Oxygen (% Saturation)	96.06 +/- 18.86	97.2 +/- 11.5
Turbidity (NTU)	8.97 +/- 6.71	17 +/-25
pH	8.3 +/- .2	8.2 +/- .2
Chlorophyll (ug/l)	14.59 +/- 7.34	10.89 +/- 14.43

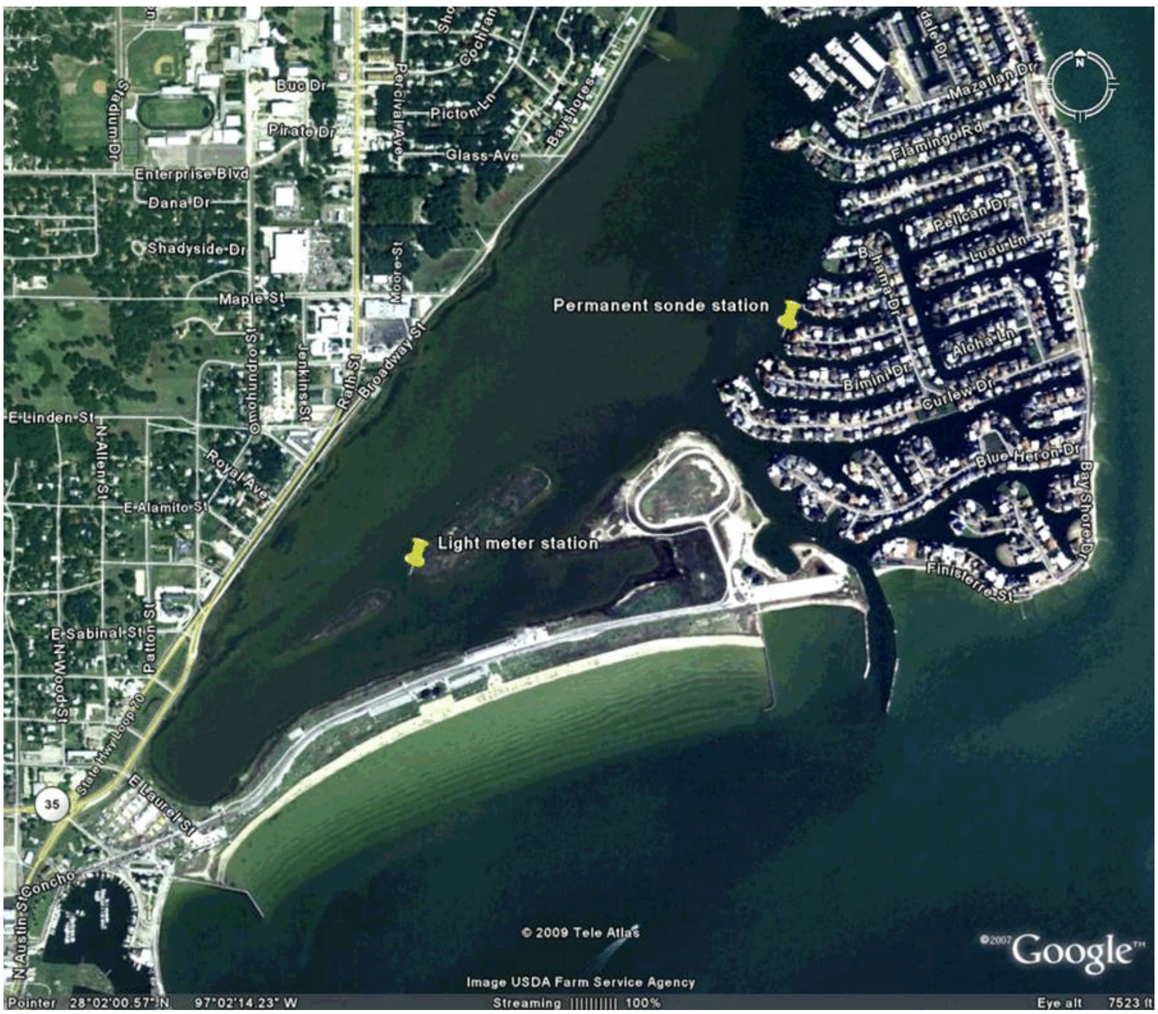

Figure 1. Location of sampling sites in Little Bay.

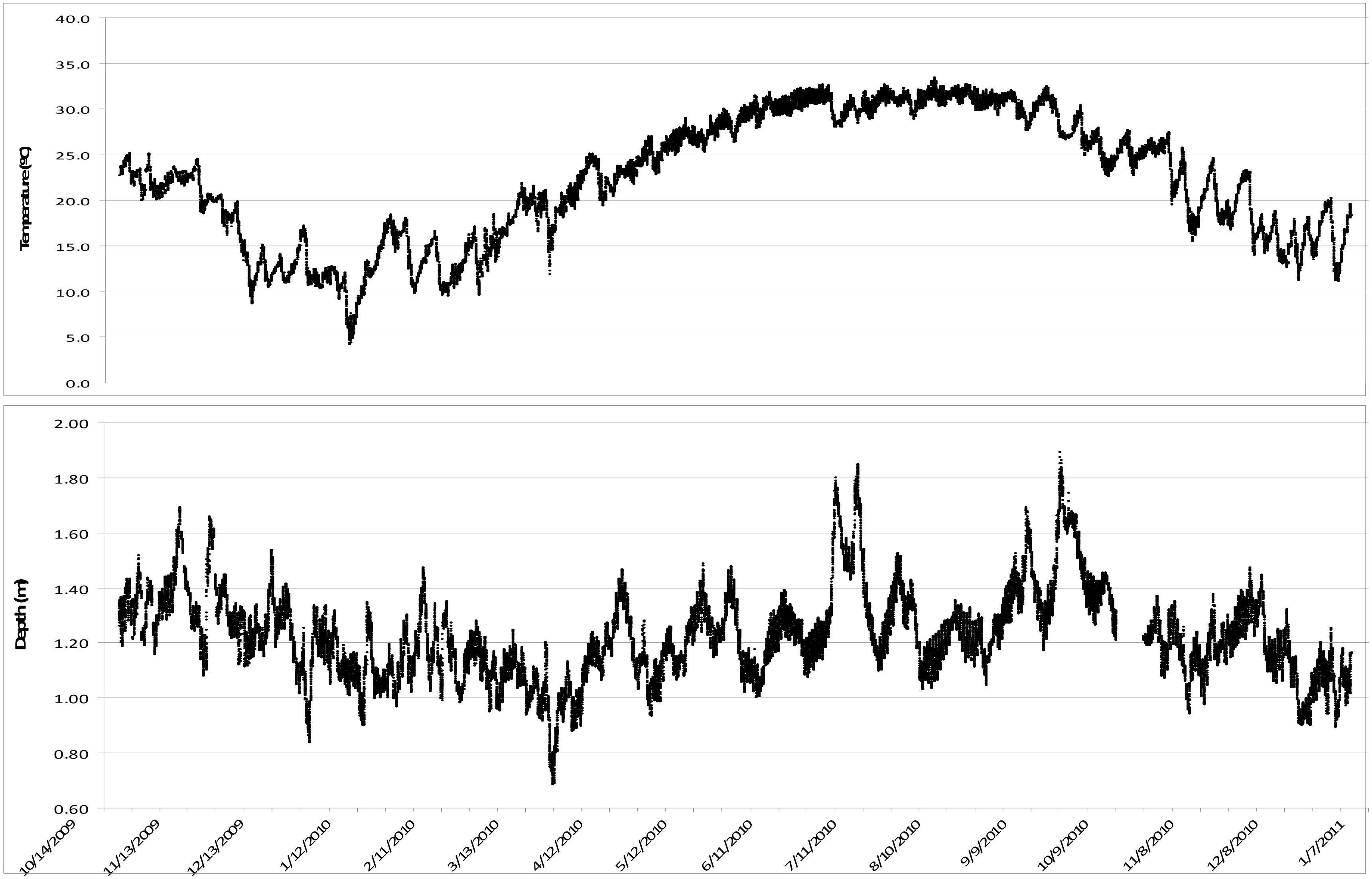

Figure 2. Continuous water quality data 10/19/09-12/31/10 for temperature and depth.

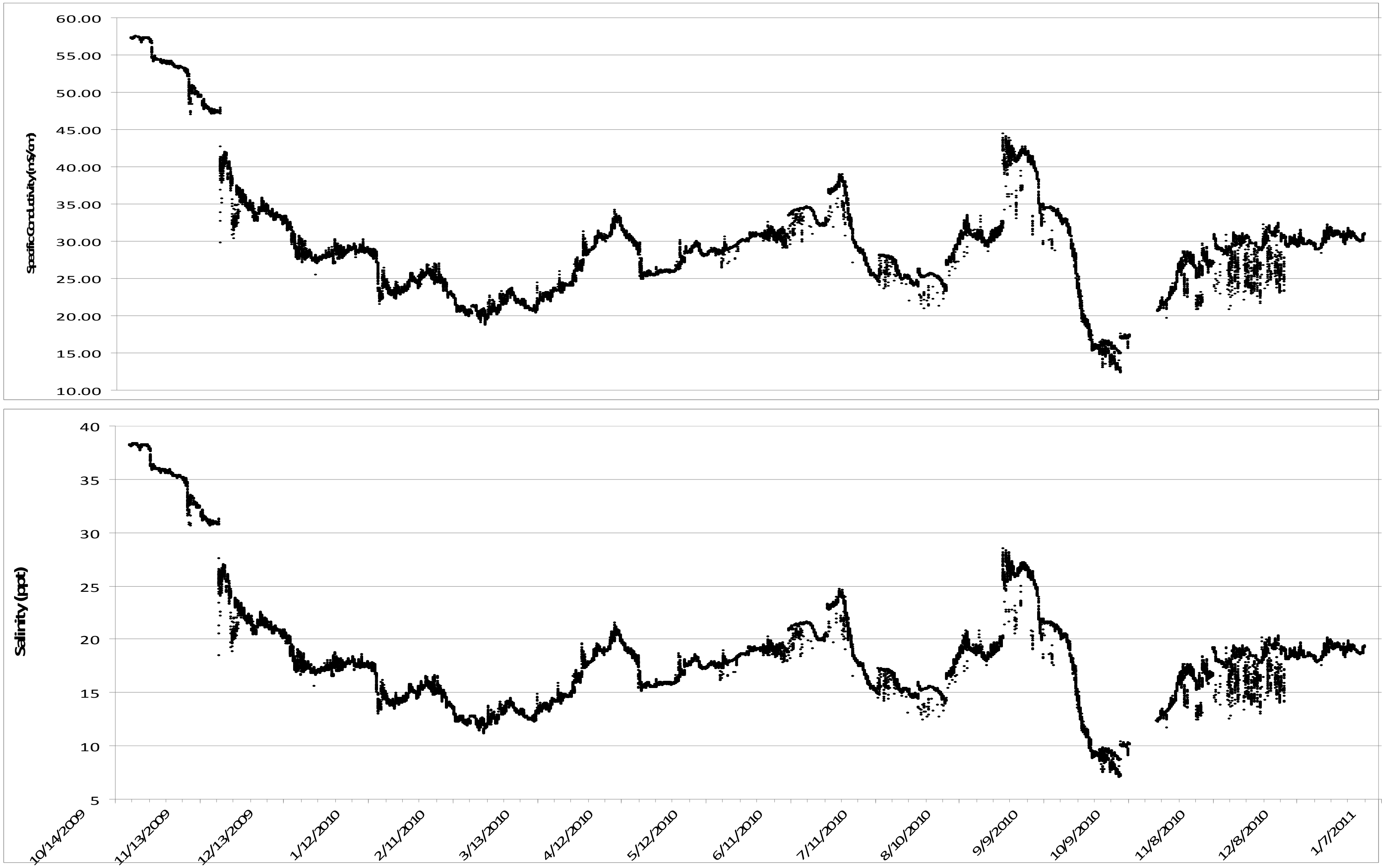

Fig 3: Continuous water quality data 10/19/09-12/31/10 for specific conductivity and salinity.

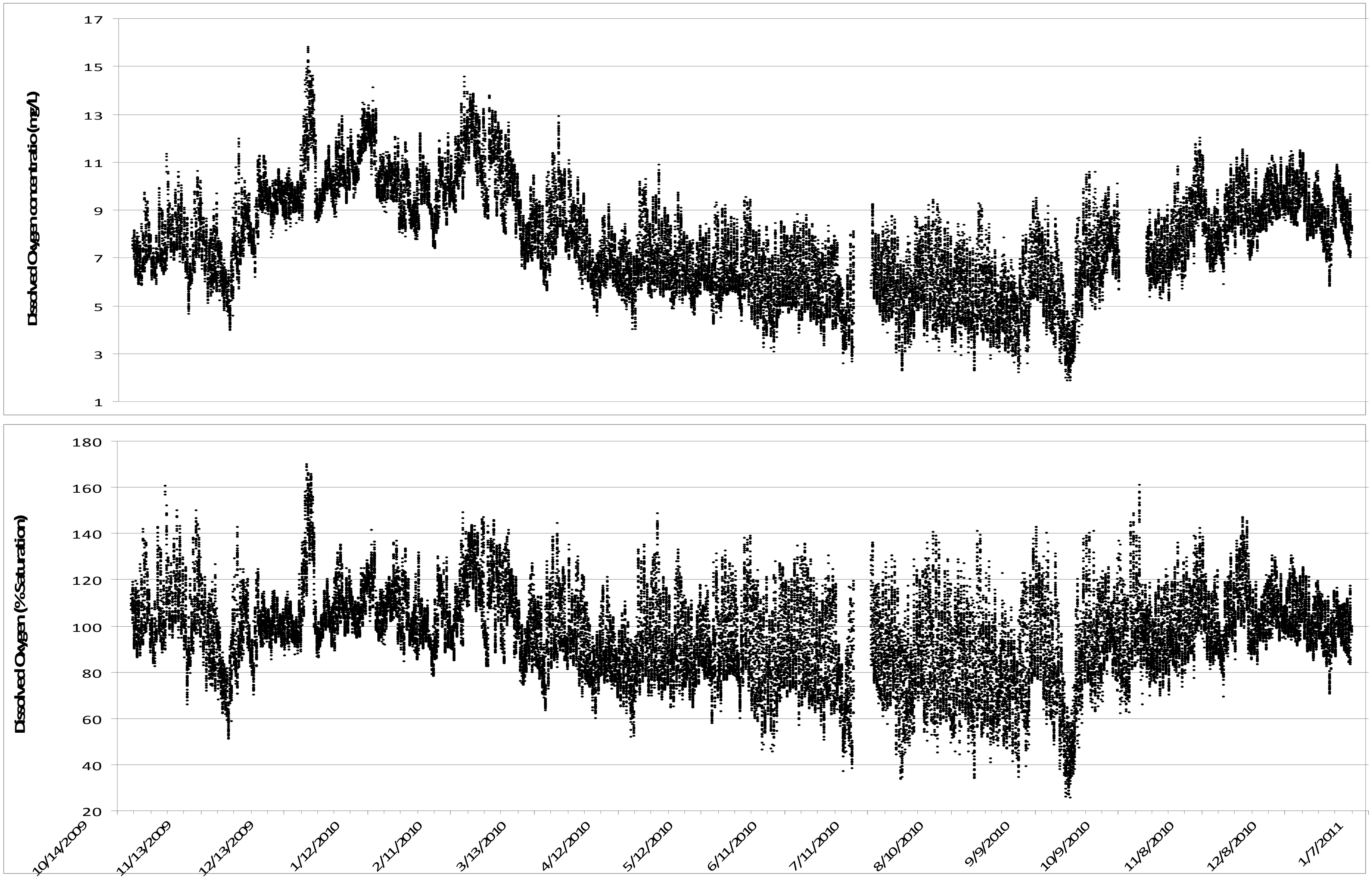

Figure 4. Continuous water quality data 10/19/09-12/31/10 for dissolved oxygen concentration and percent saturation.

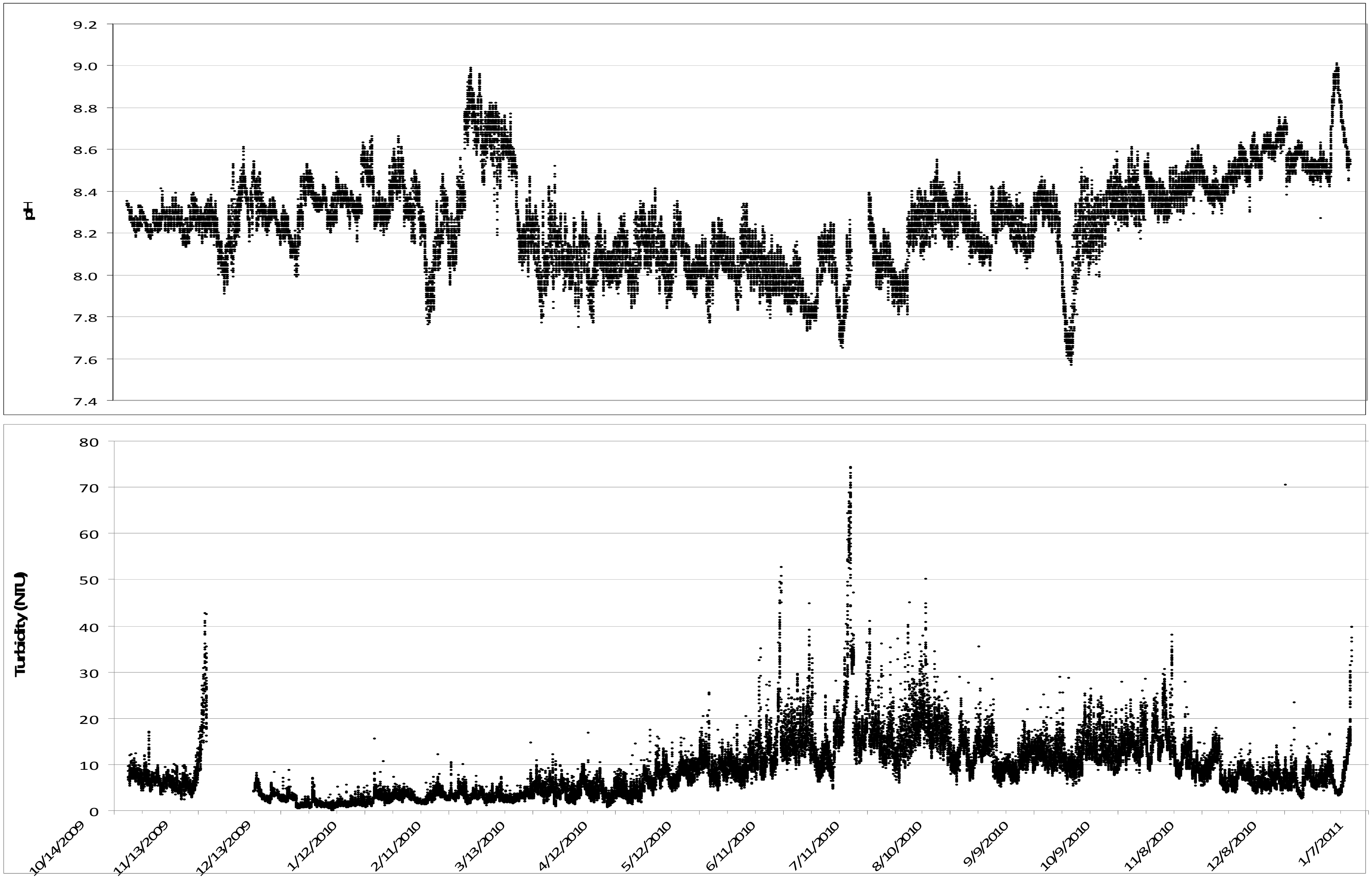

Figure 5. Continuous water quality data 10/19/09-12/31/10 for pH and turbidity.

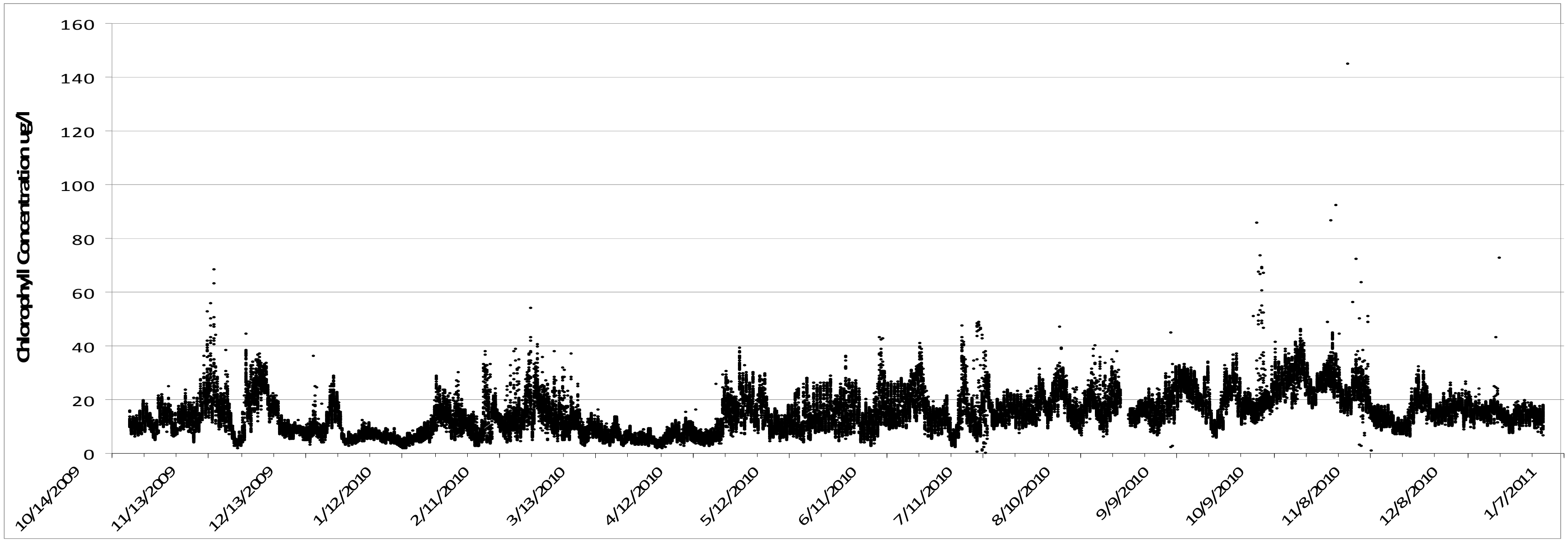

Figure 6. Continuous water quality data 10/19/09-12/31/10 for in vivo chlorophyll a concentration.

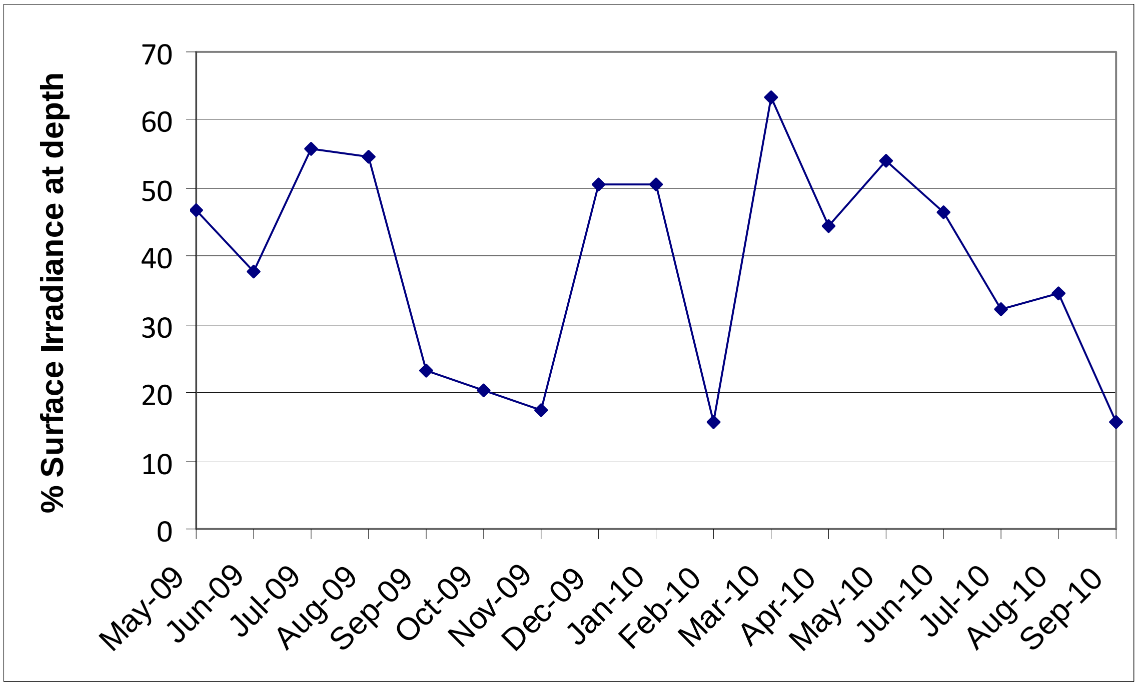

Figure 7. Monthly averages of continuous surface irradiance (PAR) data.