644

RED TIDE STUDIES IN CHARLOTTE HARBOR AND ADJACENT GULF OF MEXICO WATERS

SECOND ANNUAL REPORT

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INTRODUCTION:

Potent neurotoxins produced by the Florida red tide organism, *Gymnodinium breve* (*G. breve*), cause massive fish kills, contamination of shellfish and severe respiratory irritation to people and marine mammals exposed to toxin-containing marine aerosols. This study was undertaken as a Charlotte Harbor supplement to an on-going red tide study along the Florida coast of the Gulf of Mexico. The 1998-99 study focused on a red tide bloom that occurred in Charlotte Harbor and adjacent Gulf of Mexico from November, 1998 through February, 1999. The study focused on *G. breve* cell counts, toxin distribution and concentration, algal pigments for identification of harmful algae and hydrologic conditions to provide insight into the factors influencing the initiation, development and termination of red tide blooms. Satellite imagery was obtained to correlate with near-shore Gulf of Mexico circulation conditions. These results will be used to supplement data from the Federal initiative, Ecology and Oceanography of Harmful Algal Blooms (ECOHAB)-Florida.

RED TIDE BLOOM ASSESSMENT:

Charlotte Harbor

A survey was conducted. Inside of Charlotte Harbor in association with a persistent bloom between November 1998 and February 1999. Surface toxin concentration, *G. breve* abundance, salinity, temperature, dissolved oxygen and chlorophyll concentration (derived from *in-situ* fluorescence) were determined at each station. No relationship existed (based on linear regressions) between the hydrographic properties and cell abundance. Toxin concentration was loosely correlated to salinity however ($r^2 = 0.64$) and qualitatively, *G. breve* appeared to be most abundant at the stations which had the highest salinities (**Figure 1**). Tidal forces may account for the *G. breve* distribution observed. Cell abundances were highest at the two stations between Boca Grande and Captiva Pass.

Three weeks prior to the Charlotte Harbor survey an ECOHAB Process cruise (Process D) aboard the R/V Suncoaster detected and surveyed a bloom of *G. breve* in the coastal waters outside of Charlotte Harbor (west of Captiva Island). This bloom may have been transported into Charlotte Harbor from coastal waters due to tidal forces. Resulting in a high cell abundance in Pine Island sound in the proximity of Boca Grande and Captiva Pass. Cell abundances and salinity measurements support this hypothesis, however, the presence of *G. breve* cells in low salinity water north of Pine Island show that other factors are also involved. The close comparison of toxin concentration with cell abundance indicate theat the presence of toxins was dependent on the presence of viable *G. breve* cells. These results have important ramifications relative to the effects of red tide blooms on manatees, showing that in low bloom events the toxins were associated with viable cells and not transported in water masses void of *G. breve* cells.

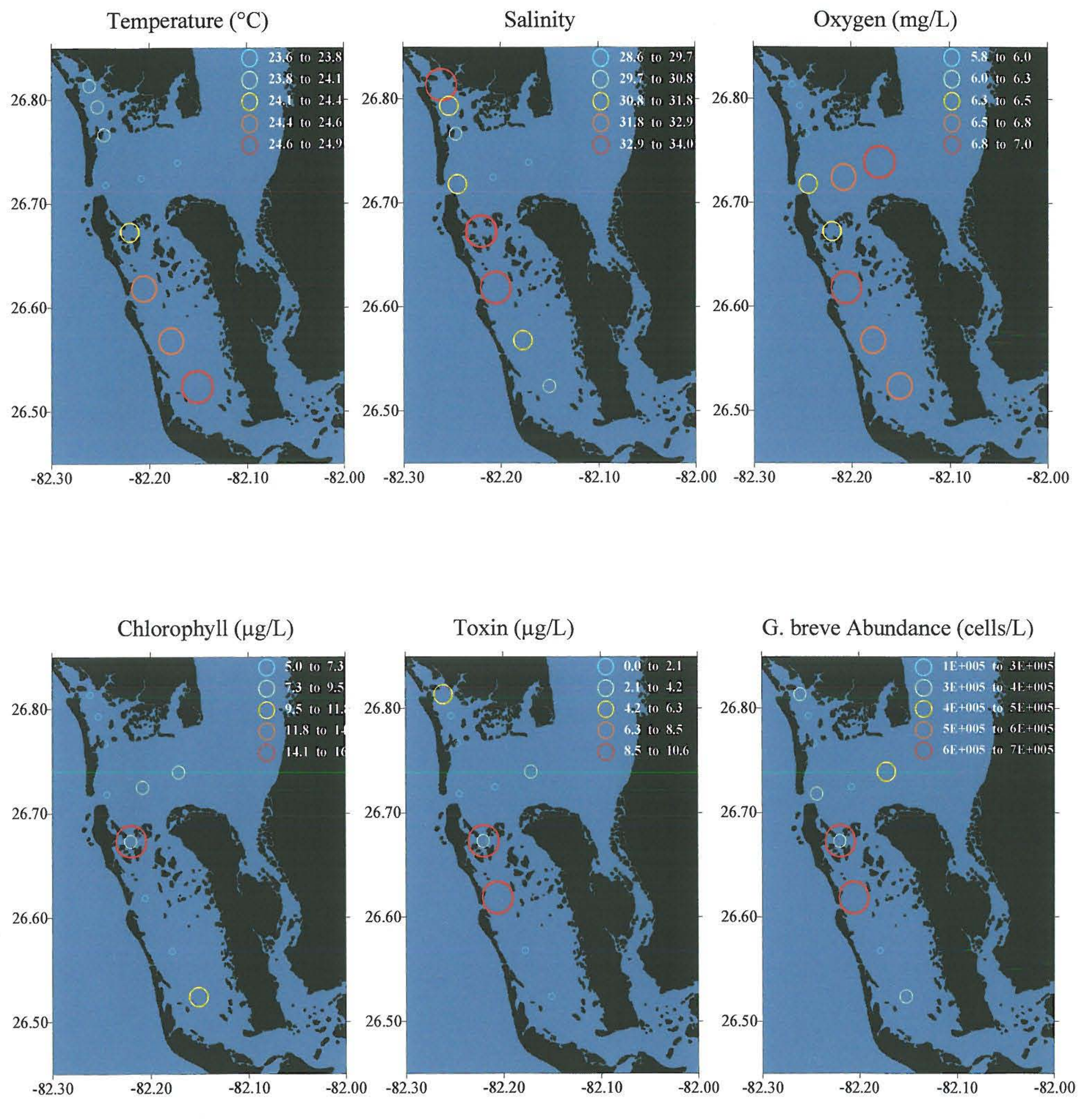

Figure 1. Charlotte Harbor Hydrographic Properties, 12/08/98

Process Cruises

Five process cruises aboard the R/V Suncoaster were conducted between October 5, 1998 and January 27, 1999. Cruises A and B took place October 5 through 12, 1998 and were designed to locate a bloom of the red tide organism *Gymnodinium breve* and characterize the hydrographic and biological conditions associated with any bloom found. Similarly, process C was scheduled for 5 days beginning October 18 but inclement weather and equipment failure caused this cruise to be cut short. During November 1998 and January 1999, process cruises D and E respectively, surveyed blooms of *G. breve* identified in proximity of Charlotte Harbor.

Values for a number of hydrographic and biological variables were determined during each of the process cruises. A Sea-Bird SBE 19 CTD was set up to gather surface hydrographic data in flow through mode. The CTD was linked to the ship's flow through system and salinity, temperature, photosynthetically available radiation (PAR), turbidity, dissolved oxygen concentration, chlorophyll concentration (determined by fluorescence), latitude and longitude were recorded every 30 seconds along the ship track. Samples for *G. breve* cell count, HPLC pigment analyses and spectral absorption were also taken at discrete stations. Data were contoured and mapped to identify spatial and temporal patterns.

Cruises A though C provided information concerning non-bloom conditions since no blooms of *G. breve* were found on the west Florida continental shelf (out to ~60 miles) between October 5 and 19, 1998. Chlorophyll concentrations were low for most of the area surveyed and values above 6.0 $\mu g\ l^{-1}$ were found only within one mile of shore near Lido Key (**Figure 2**). Contours of chlorophyll indicate that phytoplankton abundances were highest near the regions of outflow of both Tampa Bay and Charlotte Harbor. The flow through CTD proved to be a valuable diagnostic tool for mapping chlorophyll and other hydrographic properties between stations.

The data collected during cruises D and E provided an excellent opportunity to compare pigment concentrations and distributions found in a low level bloom of *G. breve*. Both data sets support the use of the algal pigment gyroxanthin-diester as a biomarker for *G. breve* abundance. Millie et al. (1997) demonstrated that a linear relationship existed between gyroxanthin-diester concentration and *G. breve* abundance natural mixed populations. The pigment data from cruises D and E corroborates these findings. Plotting gyroxanthin-diester concentration against *G. breve* abundance yields an r^2 value of 0.879 (**Figure 3**). Using gyroxanthin-diester as a marker will allow differentiation of *G. breve* from the rest of phytoplankton community within pigment studies.

Pigment concentrations and *G. breve* abundance were also contoured and mapped in order to compare their distributions. During November 1998 (process D) the flow through CTD identified a concentrated patch of chlorophyll in proximity of Boca Grande and Captiva Pass (**Figure 4**). Although the CTD data had a much higher spatial resolution, contours of chlorophyll (derived from both HPLC and fluorescence) and *G. breve* abundance (cell counts and gyroxanthin-diester) show very similar distributions.

It is clear that a strong relationship existed between chlorophyll and *G. breve*. However, this particular bloom was clearly a mixed assemblage of phytoplankton. Distributions of pigments not known to be associated with *G. breve* also showed similar patterns to that of chlorophyll (**Figure 5**). Zeaxanthin, alloxanthin and peridinin appeared to have higher concentrations near Boca Grande and Captiva Pass. The difference between these pigments (alloxanthin in particular) and gyroxanthin-diester becomes apparent south of Sanibel Island where the phytoplankton community is dominated by species other than *G. breve*. Diadinoxanthin is a major pigment in diatoms, prymnesiophytes and dinoflagellates. Although *G. breve* has been shown to contain diadinoxanthin the distribution of this pigment varies from that of *G. breve* as well indicating that organisms containing diadinoxanthin are prevalent in waters outside of the bloom.

The data from process E was treated in the same manner as cruise D. The major difference between these cruises is the location of the bloom and the resolution with which the pigment data was collected. Both chlorophyll and *G. breve* abundance were highest inside Charlotte Harbor during January 1999 (**Figure 6**). Peridinin however, was the only other pigment that was most concentrated inside of the bay (**Figure 7**). Presumably the water sampled inside of Charlotte Harbor was dominated by both *G. breve* and dinoflagellates containing peridinin. It is important to note that few samples were taken from the regions outside of Charlotte Harbor during cruise E and contours of this information may therefor be misleading. Gyroxanthin-diester, *G. breve* abundance and peridinin all show blank areas in their contour maps. Such areas are most likely an artifact of the contouring program and lack of information (no samples) within those regions.

The information obtained during the process cruises will prove invaluable for discerning the factors controlling red tide blooms. The flow through system and contour maps provide spatial imagery of data that can be used for tracking blooms as well as verification of remote sensing. Pigment analyses and the use of gyroxanthin-diester as a biomarker will allow easy identification of community composition within and outside of *G. breve* blooms. Continued monitoring of hydrographic conditions in the presence and absence of red tide blooms will give insight to the processes that govern bloom initiation and decline.

FUTURE STUDIES:

Studies during the 1999/2000 continuation of this project will continue to focus on sampling during different stages of red tide blooms in Charlotte Harbor, with satellite imagery for monitoring surface water circulation on the Florida shelf. Specific studies also will be directed toward the manner in which manatees may be exposed to brevetoxins during an intensive red tide bloom.

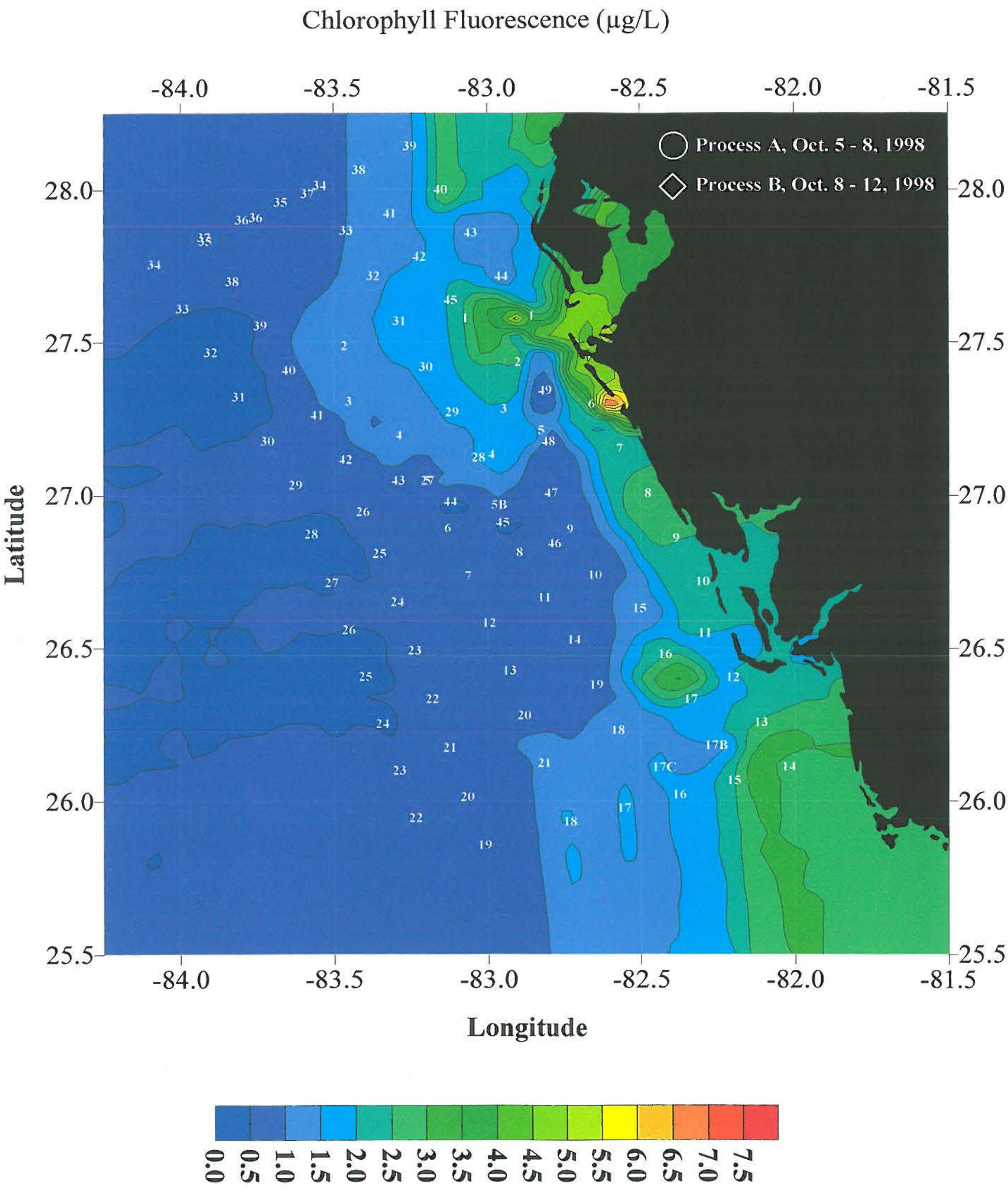

Figure 2. Ecohab Process Cruise, Oct. 5 - 12, 1998

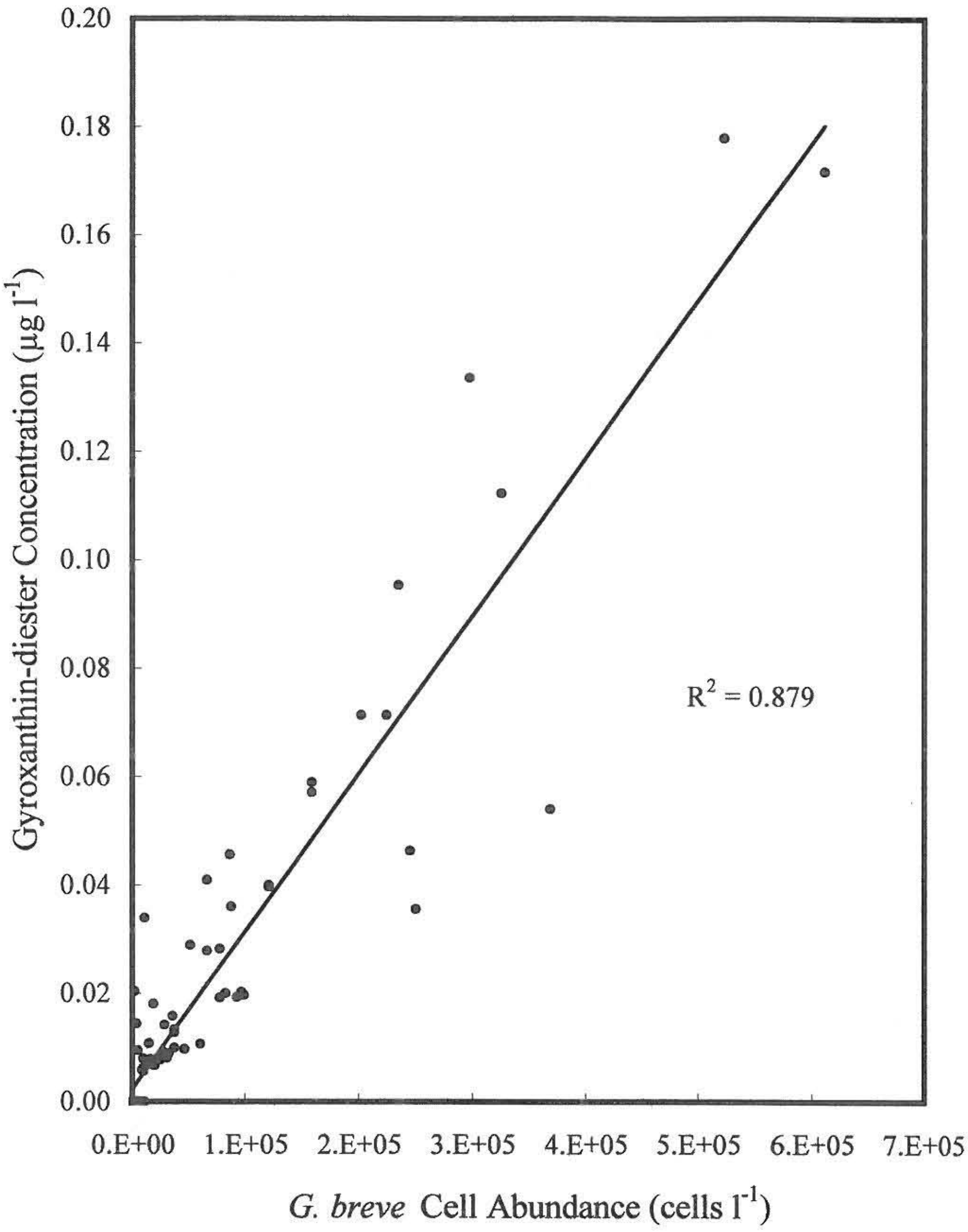

Figure 3. Comparison of Gyroxanthin -diester concentration with *G. breve* cell abundance

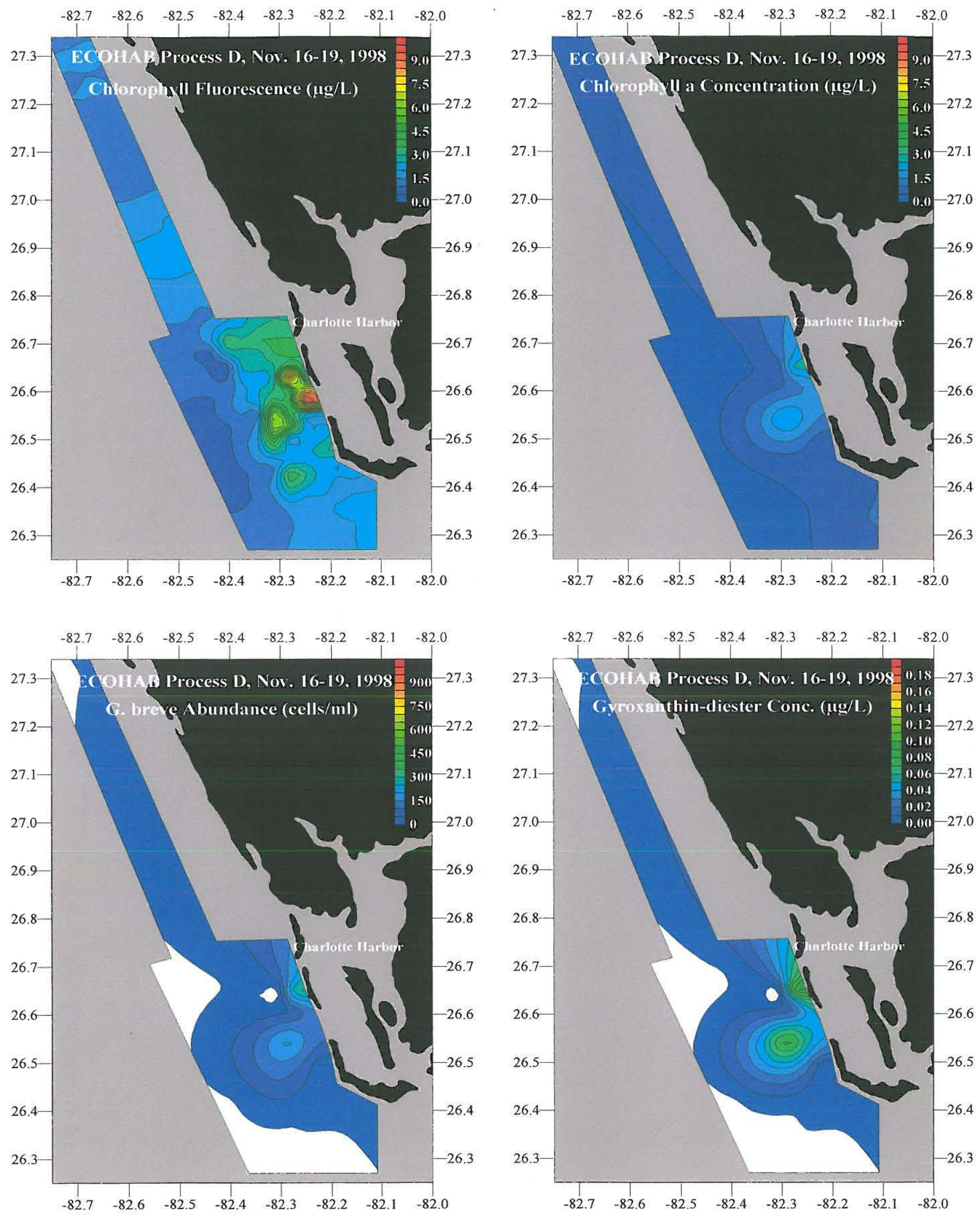

Figure 4. Chlorophyll, Gyroxanthin- diester and G. breve Concentrations During the November, 1998 Process Cruise.

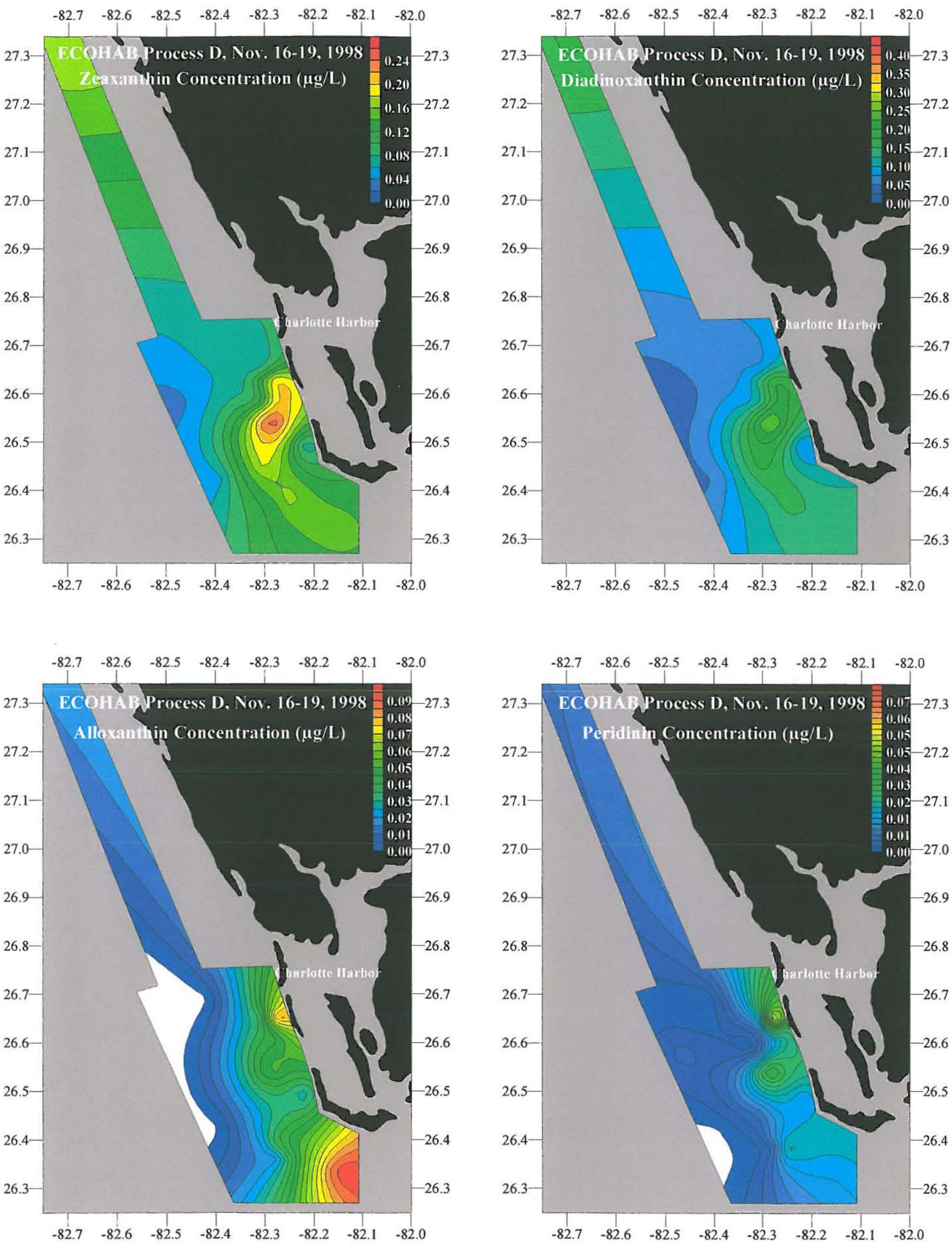

Figure 5. Phytoplankton Pigment Analysis During the November, 1998 Process Cruise

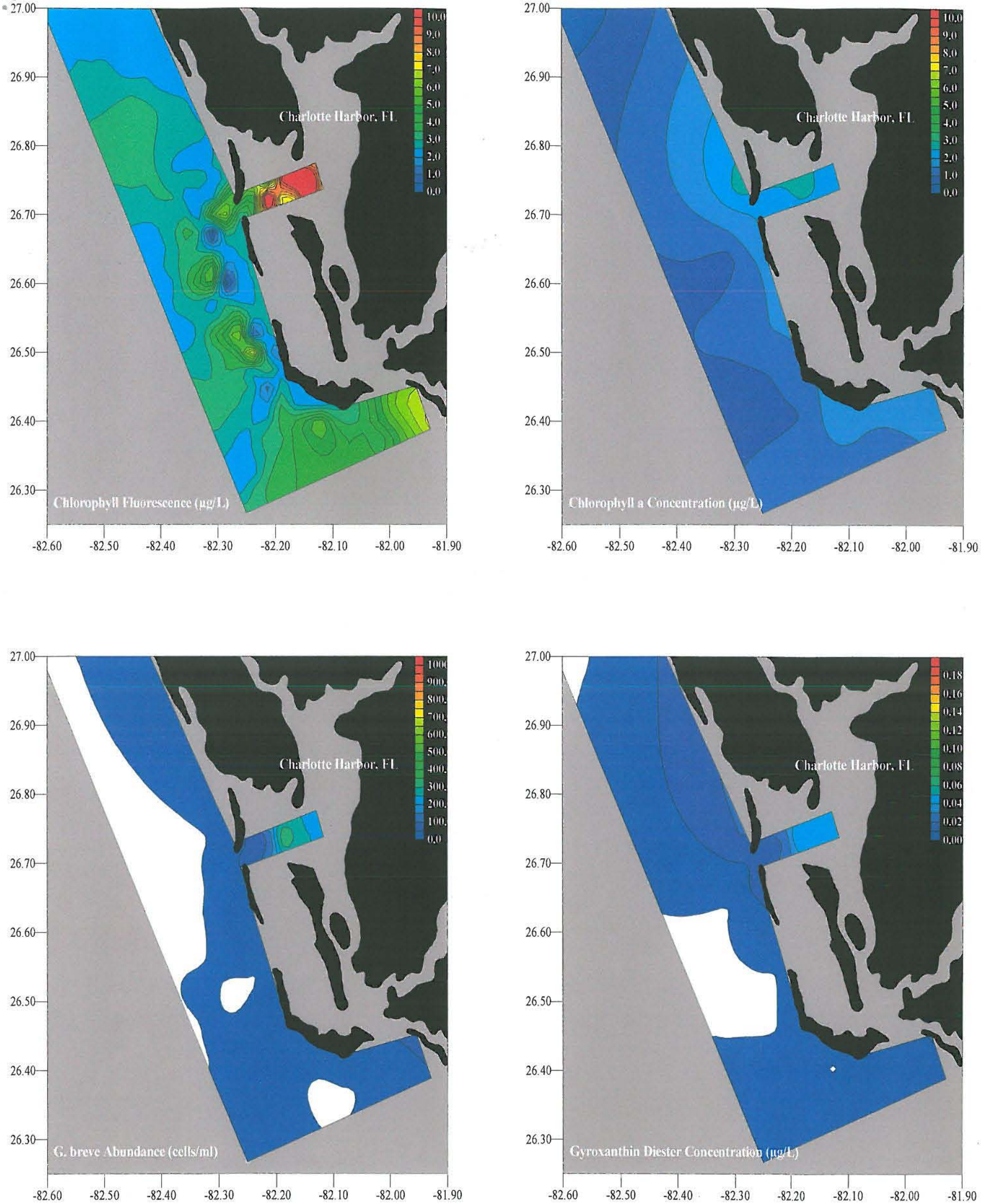

Figure 6. ECOHAB Process E (January 24 - 27, 1999)

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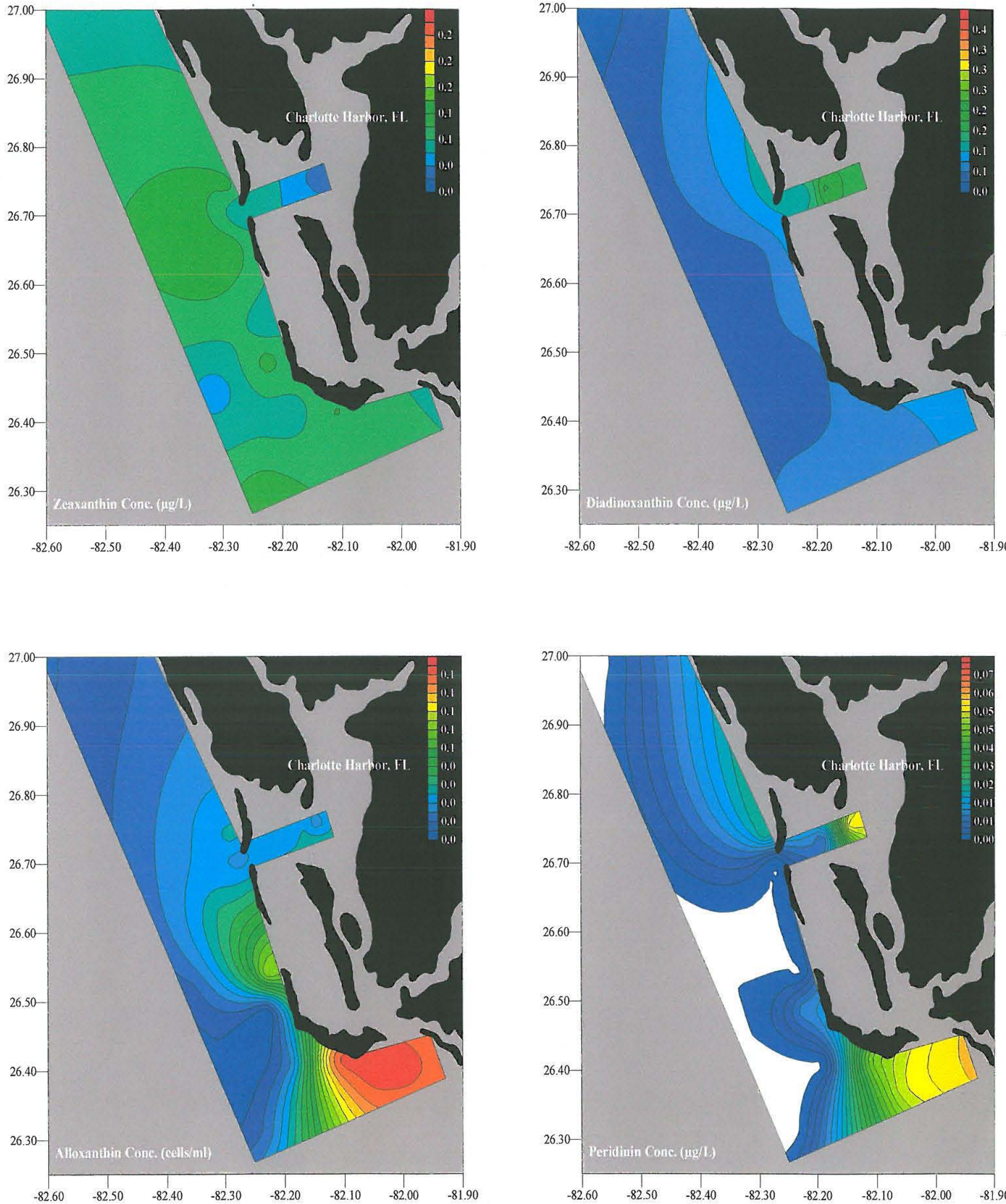

Figure 7. ECOHAB Process E (January 24 - 27, 1999)