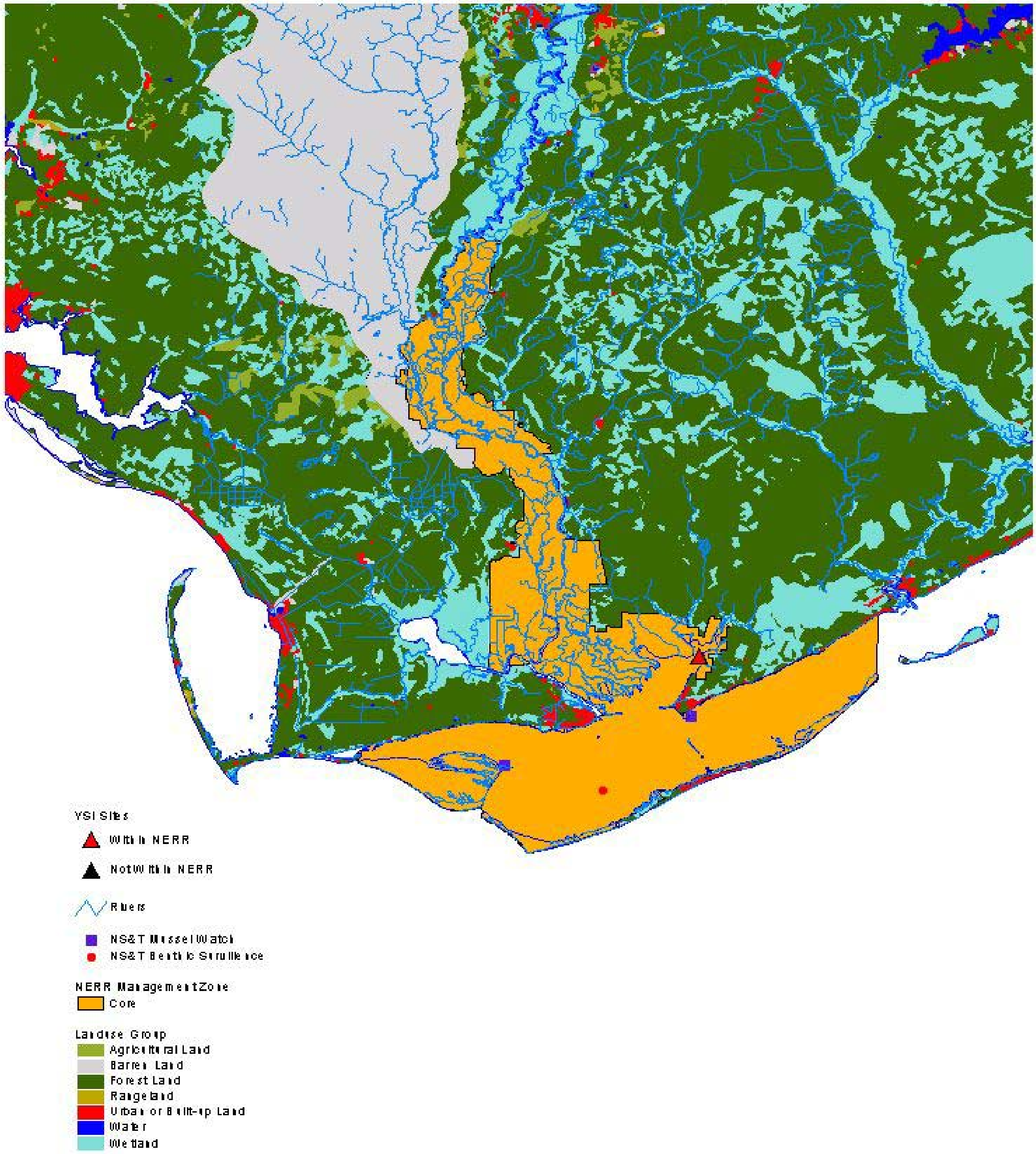
Apalachicola Bay



Apalachicola Bay, East Bay Bottom (APAEB)

Characterization (Latitude = 29°47'09"N; Longitude = 84°52'31"W)
East Bay is 8.2 km long, has an average depth of approximately 1 m MHW, and an average width of 1.8 km. At the sampling site, the depth is 2.2 m MHW and the width of the bay is 1 km. The tides in the system are mixed; thus, the number of tides can range from one to five tides during a 24 hour period and are not evenly distributed throughout the day. This site is in upper East Bay. The bottom habitat at this bay site is primarily soft silt and clay, with no bottom vegetation. The dominant marsh vegetation near the sampling site is *Juncus roemerianus* and *Cladium jamaicense*. The dominant upland vegetation is primarily pineland forests which includes slash pine, saw palmetto and sand pine. Upland land use near the sampling site includes conservation and silviculture, with some single-family residential homes in the lower East Bay area. The sampling site is influenced by local runoff from Tates Hell Swamp, the East Bay marshes, and distributary flow, some of which comes from the Apalachicola River via the East River. Tates Hell Swamp was ditched, diked, and altered back in the late 1960's and early 1970's by timber companies. These changes shortened the drainage period and allowed increased runoff with a concomitant decrease in pH and increase in color, which had a drastic affect on the biological communities in East Bay. Restoration of Tates Hell Swamp began in 1995 to reduce non-point source runoff.

Descriptive Statistics
Fifty-seven deployments were made at this site between January 1996 and November 1998, with equal coverage during all seasons (Figure 155). Mean deployment duration was 18 days. No deployments were less than 10 days.

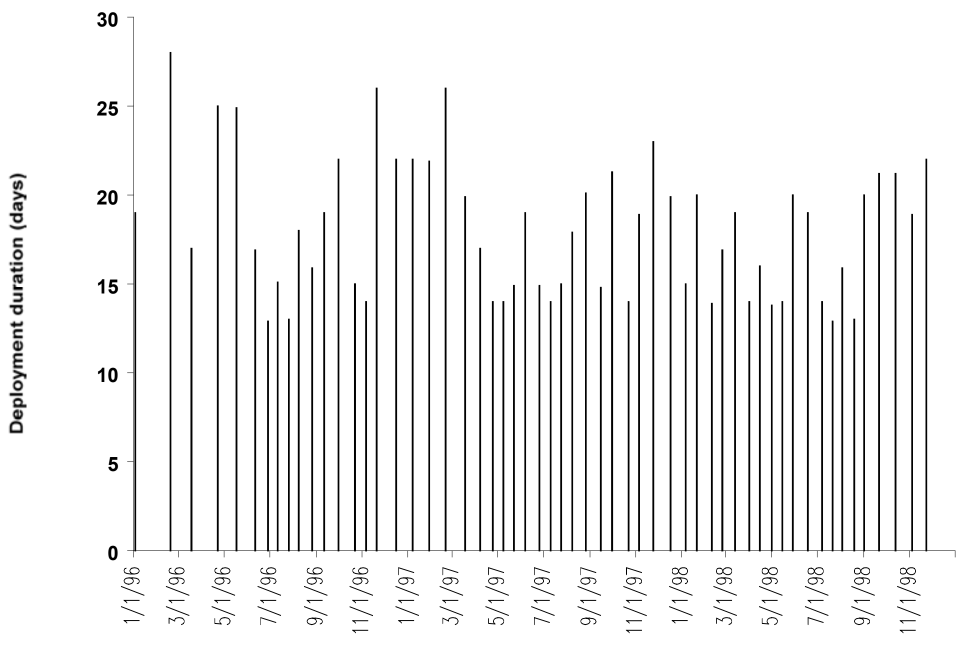


Figure 155. Apalachicola, East Bay bottom deployments (1996-1998).

Ninety-two percent of annual depth data were included in analyses (83% in 1996, 99.7% in 1997, and 94% in 1998). Sensors were deployed at a mean depth of 1.8 m below the water surface. Moderate fluctuations (0.5-1 m) were evident for daily and bi-weekly cycles from scatter plots. Harmonic regression analysis attributed 54% of depth variance to interaction between 12.42 hour and 24 hour cycles, 24% of depth variance to 12.42 hour cycles, and 22% of depth variance to 24 hour cycles.

Ninety-six percent of annual temperature data were included in analyses (87% in 1996, 99.7% in 1997, and 99.5% in 1998). Water temperature followed a seasonal cycle, with mean water temperature 14-16°C in the winter and 28-30°C in the summer (Figure 156). Minimum and maximum water temperatures were 5.7°C (Jan, Mar 1996) and 33.2°C (Aug 1998), respectively. Scatter plots suggest strong fluctuation (2°C) in daily water temperature and even stronger fluctuation (5-10°C) in bi-weekly water temperature, with greatest variability in fall and winter. Harmonic regression analysis attributed 61% of temperature variance to 24 hour cycles, 36% of temperature variance to interaction between 12.42 hour and 24 hour cycles, and 3% of temperature variance to 12.42 hour cycles.

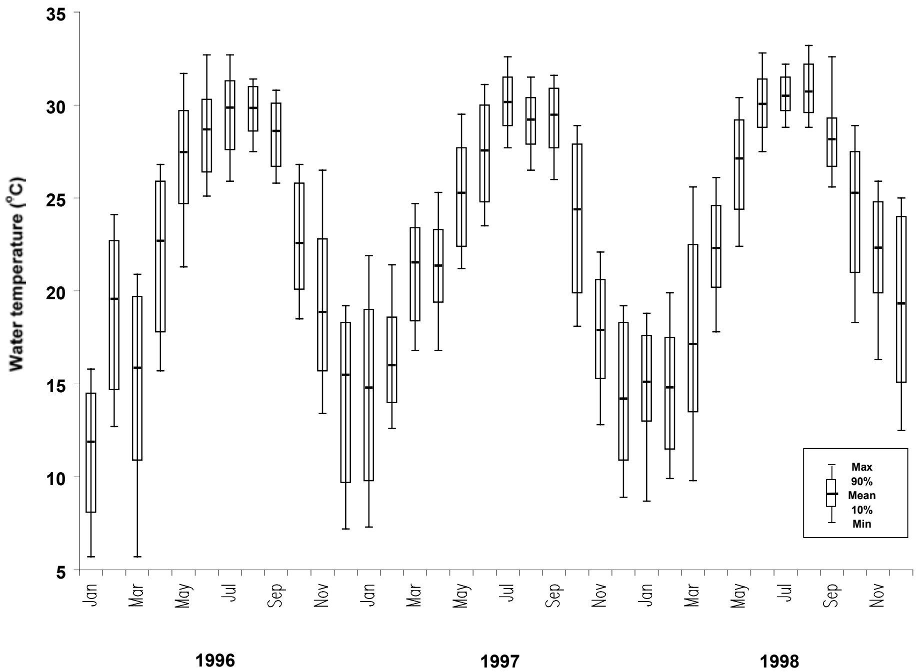


Figure 156. Water temperature statistics for East Bay bottom, 1996-1998.

Ninety-six percent of annual salinity data were included in analyses (87% in 1996, 99.7% in 1997, and 99.5% in 1998). Mean salinity followed a seasonal cycle; however large variances in salinity values were associated with mean readings (Figure 157). Mean salinity was greatest in Sep-Oct (15-18 ppt) and least in winter and spring (<2 ppt) in 1996 and 1998. Mean salinity in fall 1998 remained elevated and did not decrease below 14 ppt as was observed in fall 1996 and 1998. Minimum and maximum salinity observed between 1996-1998 was 0 ppt and 32.2 ppt, respectively. Scatter plots suggest daily and bi-weekly salinity fluctuations (5-15 ppt) were comparable to annual variation in mean salinity readings (0-18 ppt) and occurred throughout the year. Harmonic regression analysis attributed 60% of salinity variance to interaction between 12.42 hour and 24 hour cycles, 31% of salinity variance to 24 hour cycles, and 9% of salinity variance to 12.42 hour cycles.

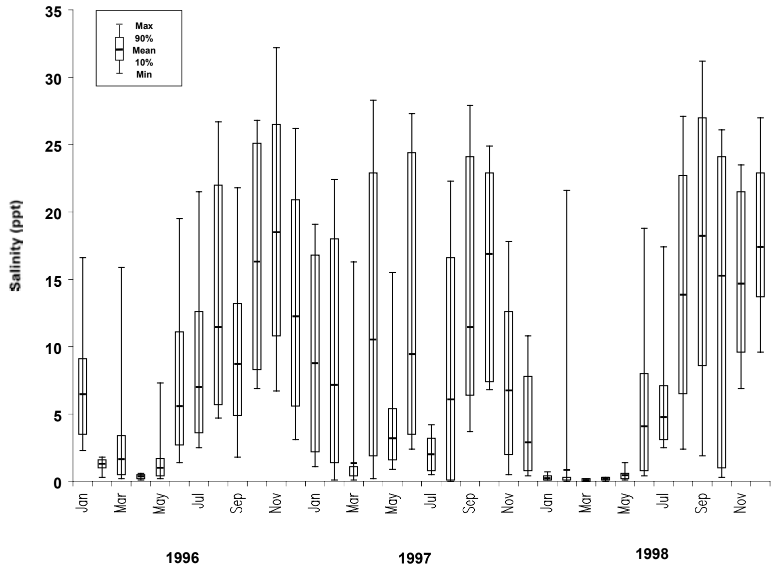


Figure 157. Salinity statistics for East Bay bottom, 1996-1998.

Fifty-one percent of annual dissolved oxygen (% saturation) data were included in analyses (37% in 1996, 47% in 1997, and 71% in 1998). Mean DO was lowest (50-74% saturation) in September and greatest (83-127% saturation) in Jan-Mar. On one occasion (Mar 1996), DO exceeded 180% saturation and on several occasions DO was less than 10% saturation. Minimum and maximum DO between 1996-1998 was 2% (Sep 1997) and 185.4% (Mar 1996), respectively. Hypoxia was only observed in Aug 1997 and persisted for 32% of the first 48 hours post-deployment (Figure 158). Supersaturation was frequently observed in all seasons and, when present, persisted 32% of the first 48 hours post-deployment on average. Scatter plots suggest minor fluctuation (20%) in daily DO readings and moderate fluctuation (≥50%) in bi-weekly DO in all seasons. Harmonic regression analysis attributed 41% of DO variance to 24 hour cycles, 15% of DO variance to 12.42 hour cycles, and 44% of DO variance to interaction between 12.42 hour and 24 hour cycles.

Photosynthesis/Respiration

Over two thirds (66%) of the data used to calculate the metabolic rates fit the basic assumption of the method (heterogeneity of water masses moving past the sensor). During winter when river flow was high, the data were less likely to fit the assumptions. In addition, instrument drift was a problem at this site. There was a significant difference in total respiration rates between the first 2 days of the deployment and the total length of the deployment. Because of this, only the first 2 days of each deployment (8% of the observations) were used to estimate net production, gross production, total respiration and net ecosystem metabolism (Table 30). Respiration rates exceeded production rates at East Bay bottom; thus, the net ecosystem metabolism and P/R ratio indicated that this is a heterotrophic site (Figure 159). Temperature was significantly ($p<0.05$) correlated with gross production and total respiration, but not net ecosystem metabolism. Gross production and respiration increased as temperature increased. Metabolic rates generally followed a seasonal pattern with the highest rates during summer months and the lowest rates during winter. Salinity was significantly ($p<0.05$) correlated with gross production, total respiration and net ecosystem metabolism. Metabolic rates were higher, but net ecosystem metabolism was more autotrophic at higher salinity.

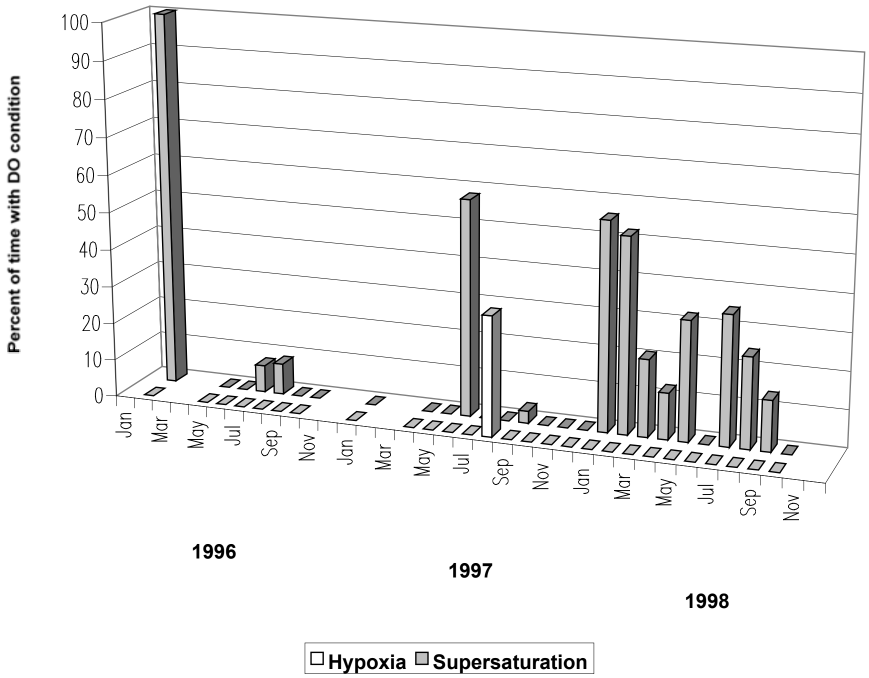


Figure 158. Dissolved oxygen extremes for East Bay bottom, 1996-1998.

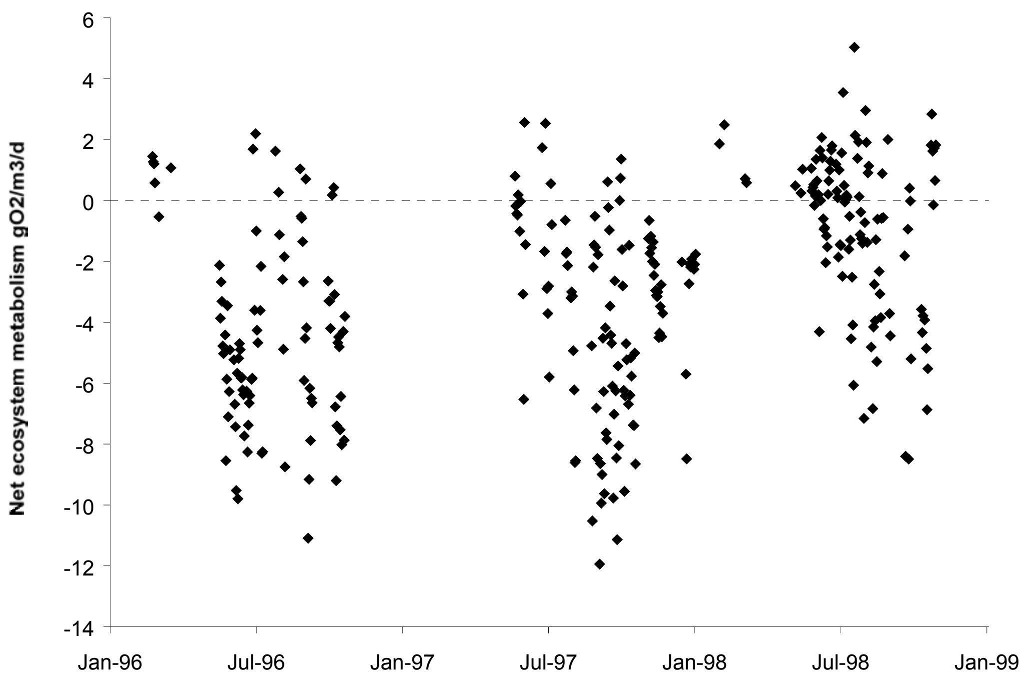


Figure 159. Net metabolism at Apalachicola Bay bottom, 1996-1998.

Table 30. Summary of metabolism data and statistics at Apalachicola Bay bottom, 1996-1998.

Bottom	mean	s.e.
Water depth (m)	2.0	
Net production gO_2/m3/d	0.50	0.08
Gross production gO_2/m3/d	2.92	0.12
Total respiration gO_2/m3/d	4.48	0.17
Net ecosystem metabolism g O_2/m3/d	-1.56	0.12
Net ecosystem metabolism g C/m2/y	-344	
P/R	0.65	
Statistical results		
Drift – paired t-test		
Gross production	ns	
Total respiration	$p<0.001$	
Net ecosystem metabolism	ns	
Percent useable observations	66%,8%	
Paired t-test on gross production and total respiration	ns	
Correlation coefficient	Temperature	Salinity
Gross production	0.27	0.20
Total respiration	0.23	0.29
Net ecosystem metabolism	ns	0.22

<u>Apalachicola Bay, East Bay Surface (APAEB)</u>

Characterization -- See characterization for East Bay Bottom

Descriptive Statistics

Fifty-eight deployments were made at this site between January 1996 and November 1998, with equal coverage during all seasons (Figure 160). Mean deployment duration was 17.9 days. Only one deployment (Mar 1998) was less than 10 days.

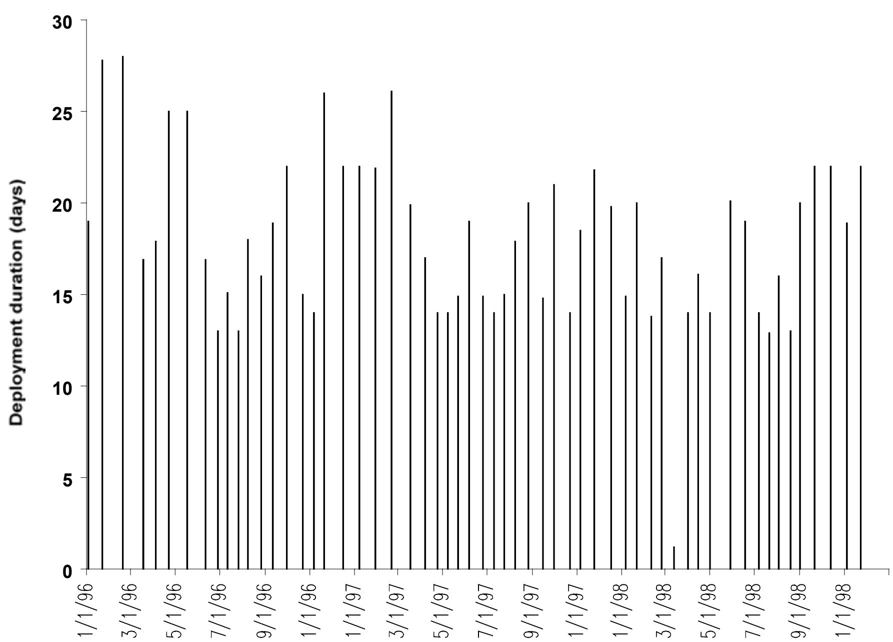


Figure 160. Apalachicola, East Bay surface deployments, 1996-1998.

Ninety-six percent of annual depth data were included in analyses (96% in 1996, 97% in 1997, and 79% in 1998). Sensors were deployed at a mean depth of 0.6 m below the water surface. Strong fluctuations (0.75-1.25 m) were evident in 1996 and 1997. In 1998, fluctuations in depth were closer to 0.5 m, with notable exceptions in Jan-Mar and Sep when fluctuations ranged from 1.5-3.7 m. Harmonic regression analysis attributed 25% of depth variance to 12.42 hour cycles, 53% of variance to interaction between 12.42 hour and 24 hour cycles, and 22% of variance to 24 hour cycles.

Ninety percent of annual water temperature data were included in analyses (94% in 1996, 95% in 1997, and 80% in 1998). Water temperature followed an expected seasonal cycle, with mean water temperatures 13-15°C in winter and 28-30°C in summer (Figure 161). Minimum and maximum water temperatures between 1996-1998 were 2.9°C (Jan 1996) and 33.6°C (Aug 1998), respectively. Scatter plots suggest strong fluctuation (3°C) in daily water temperature and even stronger fluctuation (5-10°C) in bi-weekly water temperatures in all seasons, with greatest variability in fall and winter. Harmonic regression analysis attributed 55% of temperature variance to 24 hour cycles, 40% of temperature variance to interaction between 12.42 hour and 24 hour cycles, and 5% of temperature variance to 12.42 hour cycles.

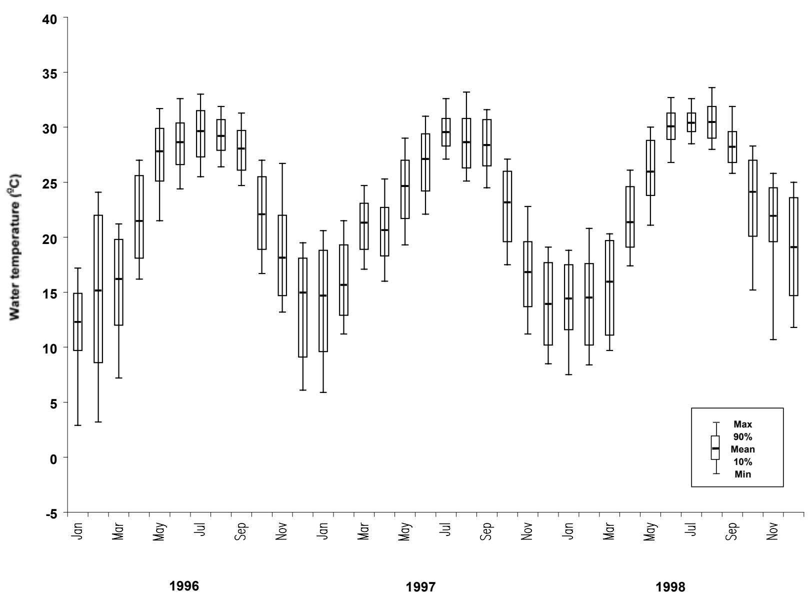


Figure 161. Water temperature statistics for East Bay surface, 1996-1998.

Eighty-nine percent of annual salinity data were included in analyses (94% in 1996, 95% in 1997, and 78% in 1998). Mean salinity followed a seasonal cycle; however, large variances were associated with mean salinity (Figure 162). Mean salinity was greatest in Oct-Nov (14-15 ppt) and least in winter/spring (<1 ppt). In fall 1998, mean salinity remained elevated between 11-15 ppt rather than decrease to 5-8 ppt as observed in fall 1996-97. Minimum and maximum salinity was 0 ppt and 30.6 ppt, respectively. Strong fluctuations in daily and bi-weekly salinity were observed year round and were comparable to, and occasionally exceeded, annual variation in mean salinity (0-15 ppt). Harmonic regression analyses attributed 69% of salinity variance to interaction between 12.42 hour and 24 hour cycles, 22% of variance to 24 hour cycles, and 9% of variance to 12.42 hour cycles.

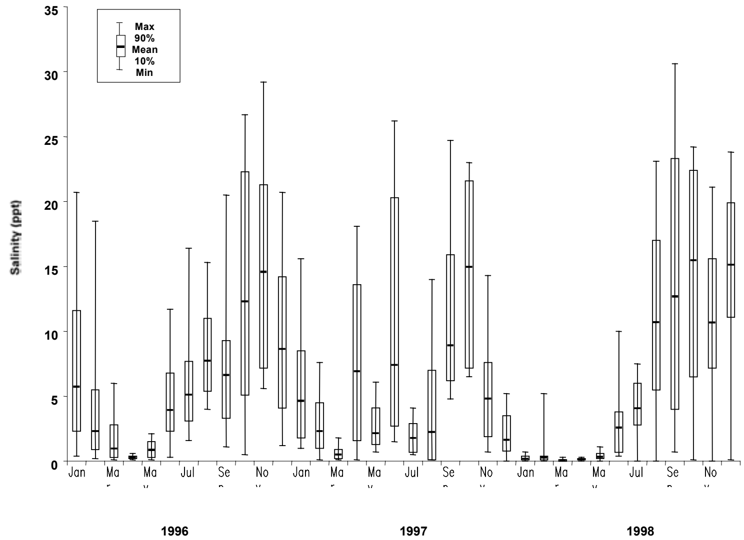


Figure 162. Salinity statistics for East Bay surface, 1996-1998.

Sixty-eight percent of annual dissolved oxygen (% saturation) data were included in analyses (68% in 1996, 64% in 1997, and 72% in 1998). Dissolved oxygen did not follow a well-defined seasonal pattern and mean DO readings were typically between 75-100% saturation. Hypoxia was infrequently observed (4 events) and lasted, when present, about 5% of the first 48 hours post-deployment on average (with one notable exception in Aug 1997, Figure 163). Supersaturation was frequently observed and, when present, lasted 23% of the first 48 hours post-deployment on average. Scatter plots indicate that DO often fluctuated dramatically (≥20% sat) on daily cycles and even more dramatically (40-150% sat) on bi-weekly cycles. Strongest fluctuations in daily and bi-weekly DO occurred in spring/summer 1996 and 1997. Harmonic regression analysis attributed 53% of DO variance to interaction between 12.42 hour and 24 hour cycles, 37% of DO variance to 24 hour cycles, and 10% of DO variance to 12.42 hour cycles.

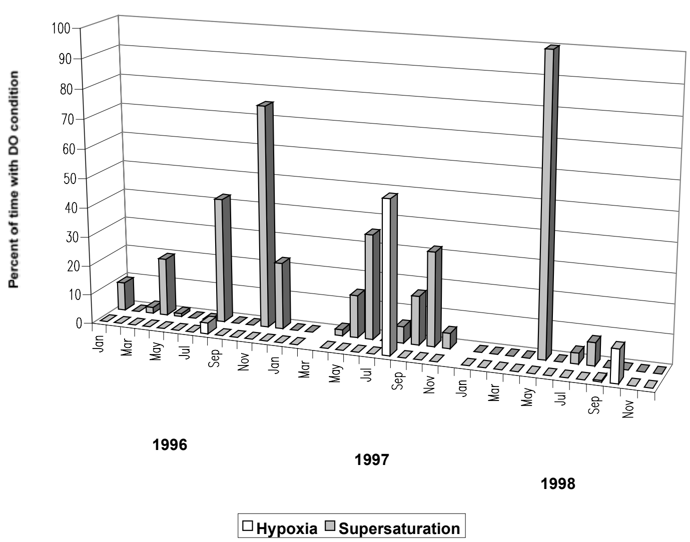


Figure 163. Dissolved oxygen extremes, East Bay surface, 1996-1998.

Photosynthesis/Respiration

Nearly three quarters (73%) of the data used to calculate the metabolic rates fit the basic assumption of the method (heterogeneity of water masses moving past the sensor) and were used to estimate net production, gross production, total respiration and net ecosystem metabolism (Table 31). Instrument drift during the duration of the deployments was not a significant problem at this site. Respiration rates exceeded production rates at East Bay surface; thus, the net ecosystem metabolism and P/R ratio indicated that this is a heterotrophic site (Figure 164). Temperature was significantly ($p<0.05$) correlated with gross production, total respiration and net ecosystem metabolism. Gross production and respiration increased as temperature increased, while net ecosystem metabolism became more heterotrophic as temperatures increased. Salinity was significantly ($p<0.05$) correlated with gross production, but not respiration or net ecosystem metabolism. Gross production was higher at higher salinity. Metabolic rates were generally the highest rates during summer months and the lowest during winter when temperature and salinity were low and river flow was high.

Table 31. Summary of metabolism data and statistics at Apalachicola Bay surface, 1996-1998.

Surface	mean	s.e.
Water depth (m)	2.00	
Net production gO_2/m3/d	0.39	0.06
Gross production gO_2/m3/d	2.22	0.08
Total respiration gO_2/m3/d	3.50	0.11
Net ecosystem metabolism g O_2/m3/d	-1.28	0.09
Net ecosystem metabolism g C/m2/y	-112	
P/R	0.64	
Statistical results		
Drift – paired t-test		
Gross production	ns	
Total respiration	ns	
Net ecosystem metabolism	ns	
Percent useable observations	77	
Paired t-test on gross production and total respiration	p<0.001	
Correlation coefficient	Temperature	Salinity
Gross production	0.39	0.19
Total respiration	0.32	0.11
Net ecosystem metabolism	-0.12	ns

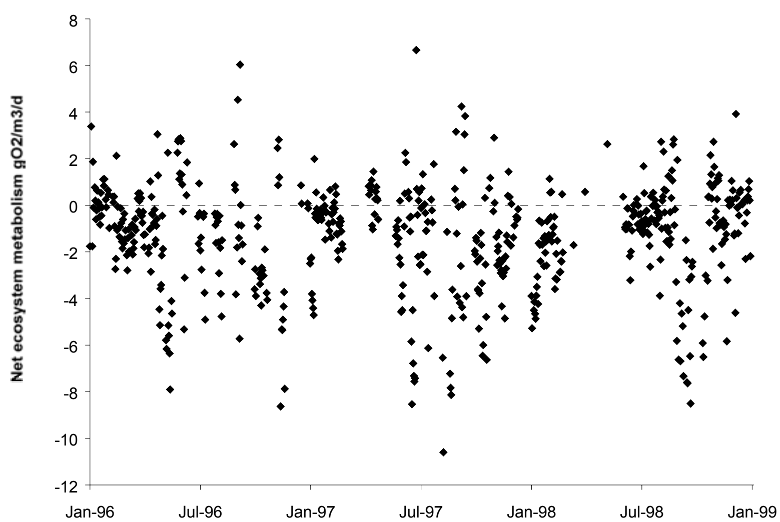


Figure 164. Net metabolism at Aplachicola Bay surface, 1996-1998.