<u>Hypoxic Conditions Detected Using RECON in the Caloosahatchee River</u>

By SCCF Marine Lab Staff

Hypoxic conditions, or hypoxia, can be defined as the amount of dissolved oxygen in the water is low enough to be detrimental to organisms living in the affected area. On June 2, 2009 the Fort Myers RECON station reported hypoxic conditions.

Under certain circumstances, levels of oxygen in water can be so low that few if any species can survive. The oxygen in the water that can be used for respiration is called dissolved oxygen (DO). DO concentrations in water are affected by exchanges with the atmosphere and by biological/chemical processes in the water column itself. Increases in dissolved oxygen can result from diffusion or mixing from the atmosphere or from photosynthesis. Oxygen is a byproduct of photosynthetic reactions carried out by seagrass, algae, and phytoplankton, which release it into the surrounding water. Oxygen is consumed through respiration (including plant and animal respiration) and decomposition and by oxidation reactions with elements such as nitrogen, iron and sulfur. (See http://recon.sccf.org/definitions/dissolved_oxygen.shtml for more information on dissolved oxygen and recent dissolved oxygen measurements)

There are no universal thresholds that define hypoxia. A recent review article by Raquel Vaquer-Sunyer and Carlos M. Duarte (2008) examined literature dealing with hypoxia and found that various authors used thresholds that ranged from 0.28 mg/l to 4 mg/l. They suggest that the convention 2 mg/l threshold used is too low and fails to reflect a level at which hypoxia-derived mortality can occur. Based on recommendations by Vaquer-Sunyer and Duarte we consider hypoxia to occur when levels are less than 3 mg/l (Figure 1).

In warm weather, when sediment or water column oxygen demand is high, and freshwater is flowing over saltier water, water column stratification can occur. Oxygen concentrations drop in the lower (near bottom) water column layers due to reduced mixing with the surface waters. Hypoxia is exacerbated by nutrient loading and low spring freshwater flow and drainage from adjacent canals which contribute cumulatively to stratification of the water column.

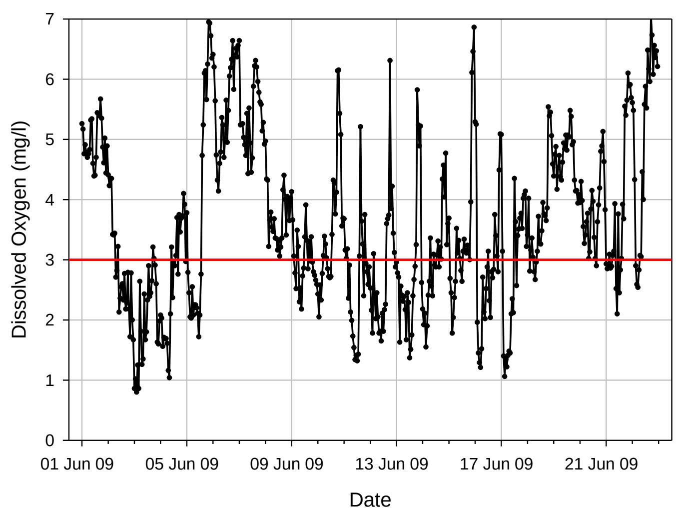

Figure 1. The Fort Myers RECON site consistently experienced hypoxic conditions (DO levels below 3 mg/l) during a two week period in June 2009.

The dissolved oxygen at the Fort Myers RECON in June 2009 were negatively correlated with salinity (Figure 2), thus a positively correlation between salinity and hypoxia .

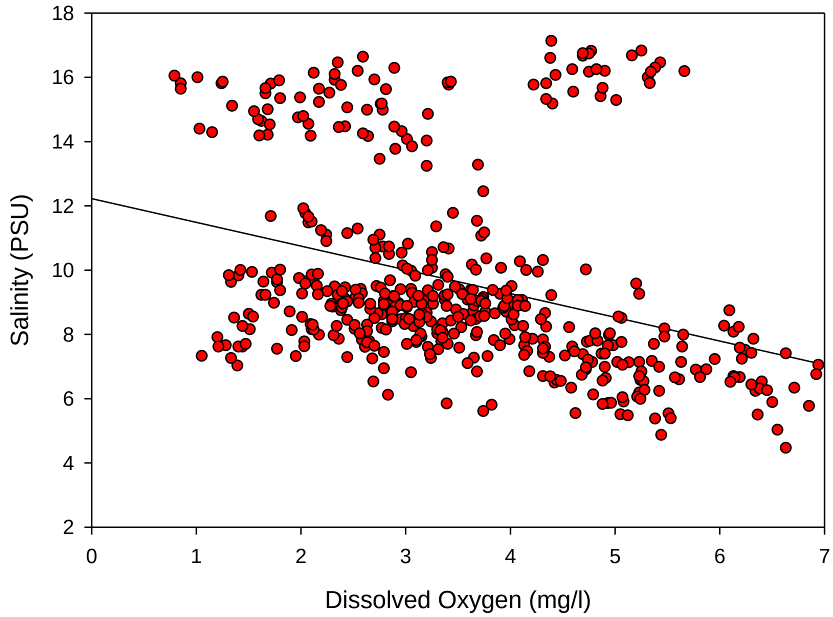

Figure 2. Dissolved Oxygen was negatively correlated with salinity. This suggests that hypoxic conditions are present in the lower part of the water column, associated with higher densities.

This pattern suggests that hypoxic conditions are present in the lower part of the water column, associated with higher density water. At flood tides, the denser, saltier gulf water acts like a wedge and sinks below the less dense freshwater lens (Figure 3). This wedge migrates daily with the tides.

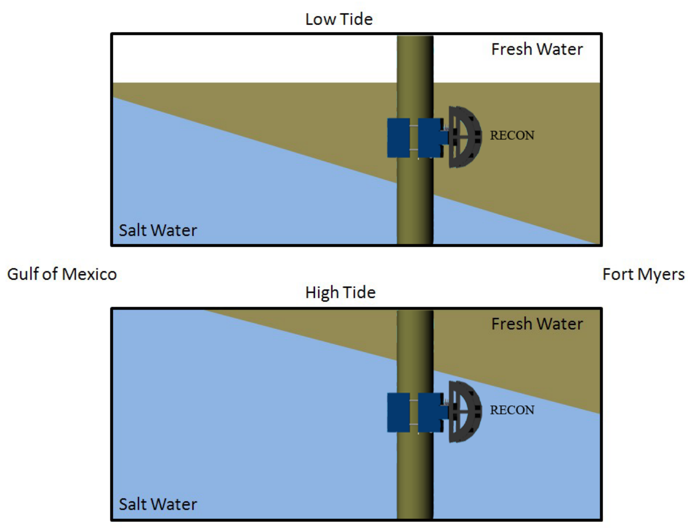

Figure 3. Basic illustration of a cross section of the Caloosahatchee River (left = Gulf of Mexico, right = Fort Myers). The salt "wedge" flows under fresher river water as the tide comes in. During low tides the Fort Myers RECON sensor is sampling the fresher, less dense water; while at high tides the saltier, denser water is sampled.

The wedge is located in different areas of the river throughout the year. During the wet season it located closer the mouth depending on flow from small freshwater tributaries and from the rest of the watershed through the Franklin Dam structure, while in the dry season it is less pronounced as the river is more a mixed estuary with more vertical salinity gradients. During the hypoxic event in June 2009, the wedge was located close enough to the Fort Myers RECON sensor to be detected. Since the RECON sensor is at a fixed distance from the bottom, it was sampling the fresher river water in the surface layer when the tide was low, and saltier water in the lower layer when the wedge moved forward and thickened. Hypoxic conditions were detected regularly, for over two weeks, whenever the saltier layer of the water column extended up to the RECON sensor depth during high tides.

One of the unique features of RECON is that the data is available in near real-time allowing us to observe the hypoxic conditions as they happen, as opposed to after the fact when using more traditional sensors. Because we were aware of the hypoxia, we were then able to conduct additional sampling to determine the extent of the hypoxic zone. On the 12 June 2009, we conducted discrete sampling using a handheld dissolved oxygen sensor. Starting from the downstream edge of the hypoxic zone, the zone extended at least 12.5 km upstream where DO levels were lowest (0.17 mg/l) (Figure 4).

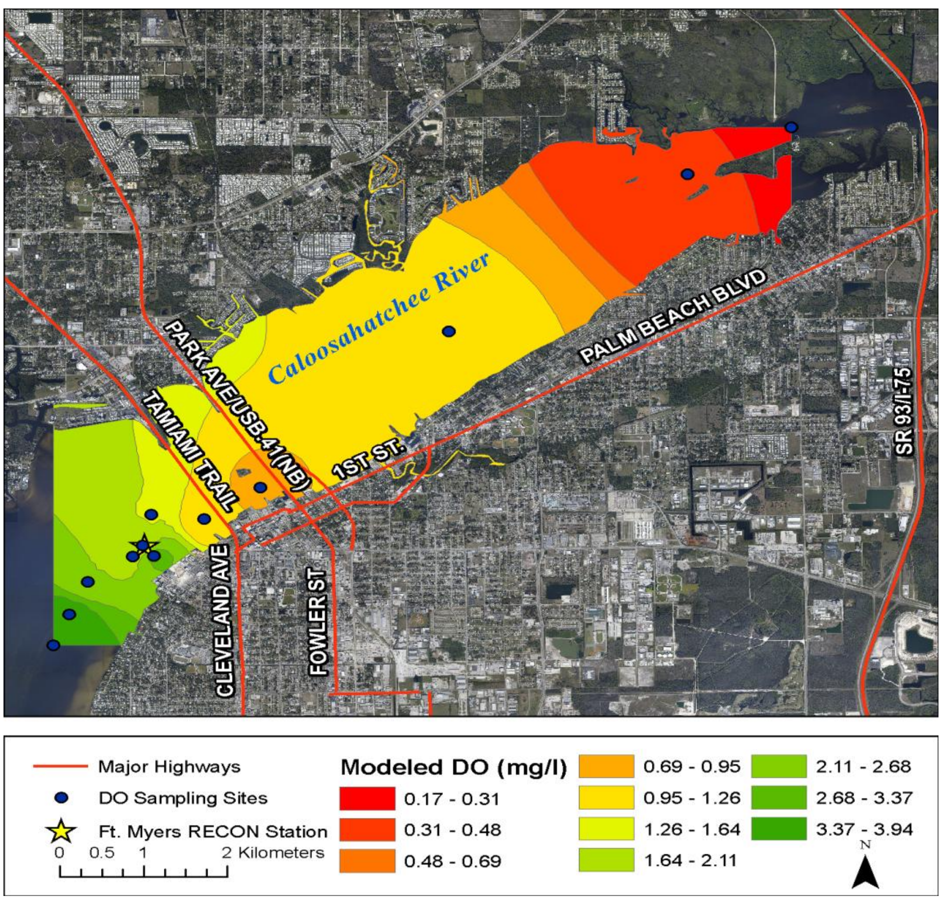

Figure 4. Dissolved oxygen concentrations in the lower layer of the water column near the

bottom in the Caloosahatchee River on June 12, 2009. Contours extrapolated from 12 sampling sites. Note that the hypoxic layer included depths below 1.5 m, so hypoxia would not usually extend up to the shoreline.

The hypoxic zone was usually below 1 m depth, but in a shallow area, it extended to the surface. The size of the area affected was estimated to be approximately 9.65 km^2 (6 square miles).

At one of our experimental sites for Widgeon grass (*Ruppia maritima*) restoration and monitoring (see http://sccf.org/content/84/Research.aspx for more information on this project) we counted over 550 dead *Polymesoda caroliniana* clams per square meter. This die off could easily be attributed to the combination of rapid salinity drop, high temperatures, and hypoxia.

Reference

Vaquer-Sunyer, R. and C. M. Duarte (2008): Thresholds of hypoxia for marine biodiversity. Proceedings of the National Academy of Sciences, 105: 15452-15457.