LAKE PONTCHARTRAIN BASIN FOUNDATION

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Water Quality in Chandeleur Sound in 2008 and 2010

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Introduction

Chandeleur Sound is the shallow-water area between Chandeleur Islands, the Biloxi Marsh and the barrier islands along the Mississippi coast. The sound extends southward behind remnants of the barrier islands, and there the sound is referred to as Breton Sound. At the north end of Chandeleur Sound, the sound's water bottom forms a broad trough which slopes eastward toward the open Gulf of Mexico. This trough narrows westward to the Cat Island Channel just south of Cat Island in Mississippi. Most of the Chandeleur Sound is within Louisiana and is part of the Pontchartrain Basin which LPBF is obliged to monitor for environmental conditions and to restore the natural habitats. This report summarizes water quality for the Chandeleur Sound in 2008 and recently during the summer of 2010.

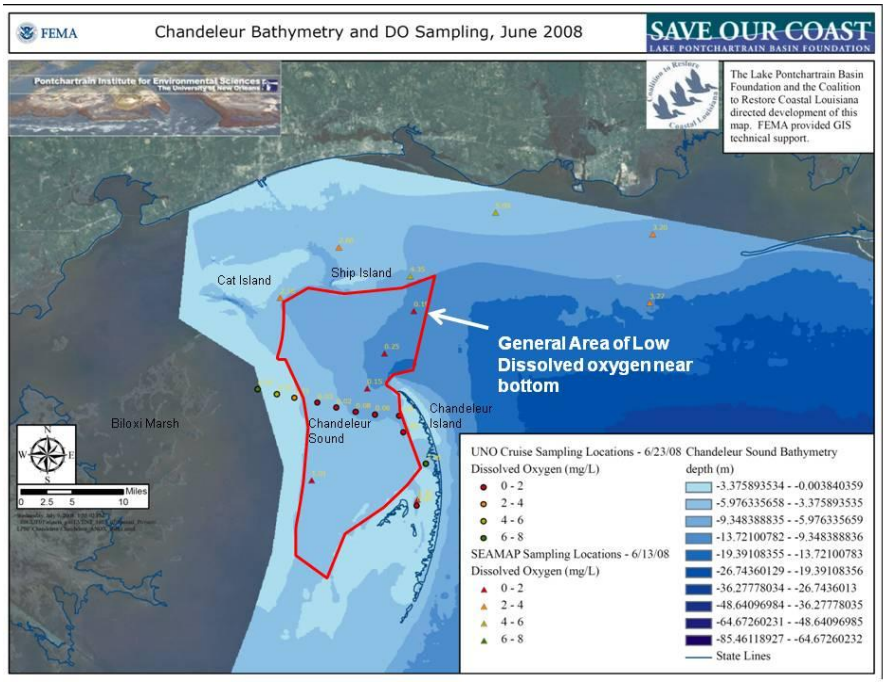

Figure 1: Map of Chandeleur Sound area and the approximate location of low dissoolved oxygen observed in 2008 by University of New Orleans and the University of Southern Mississippi

In 2008, two marine surveys fortuitously documented the occurrence of a low oxygen layer in Chandeleur Sound. In June 2008, the University of Southern Mississippi was conducting shark research and collected environmental data in Chandeleur Sound. Later that month, the University of New Orleans was en route to do research around the Chandeleur Islands and collected water quality data while crossing Chandeleur Sound. These two data sets were provided to the Lake Pontchartrain Basin Foundation and are shown on **Figure 1**. The two surveys indicate a substantial area of the northern Chandeleur Sound was stratified due to density contrast of the shallower and deeper water layers. This resulted in low dissolved oxygen (hypoxia) that may be considered a "dead zone" for marine organisms that live on the water bottom here. In 2008, it was not known if this was a onetime occurrence or if these observations uncovered a potentially re-occurring dead zone.

2010 Water Quality

Methods In 2010, the Lake Pontchartrain Basin Foundation partnered with the Marine Research and Assistance Council (MRAC) to conduct water quality monitoring in Chandeleur Sound. MRAC is a volunteer organization of mariners based in New Orleans which conducts scientific and environmental research and education. LPBF developed sampling transects **(Figure 2)**, a sampling protocol, and a sampling frequency plan. LPBF also purchased a YSI model # 6050000 with a 60 foot cable for the sensor. The sensor cable was marked at 2-foot increments. First, total depth was estimated using two on board acoustic depth finders. Then, the cable was lowered to take measurements at approximately 2 feet above bottom, the midpoint, and 2 feet below the surface. At each location we acquired three measurements of Salinity, DO and Temperature. Two transects were selected which crossed the deepest axial through portions of the Chandeleur Sound. One transect runs through Cat Island Channel to the deep hole near the northern end of Chandeleur Sound. The other transect runs from eastern Ship Island southward to the central area of Chandeleur Sound. A total of 13 stations were acquired in August 25, 2010. One site is located off either transect in the northwest portion of the sound **(Figure 2-** Additional point**).**

In May 2010, MRAC was able to collect water quality data along the Cat Island Channel transect, but only found low oxygen at the very deepest points covering a very small area. In July, the transect running from Ship Island was acquired and a pronounced stratification and low oxygen layer were detected. In August, LPBF collected data on both transects in a single day to confirm the extent of the low oxygen area.

Results**: Figures 3 and 4** illustrates the depth-dependent, segregation of salinity, dissolved oxygen data, which clearly illustrate the pronounced boundary layer. **Figure 2** shows the areal extent of the low oxygen area observed on August 25, 2010 in Chandeleur Sound. It covers 250 square miles or 1/3rd of the areal extent of Chandeleur Sound. The eastern boundary of hypoxia is open to the Gulf of Mexico, which was not monitored. Therefore, the Gulf ward extent of

hypoxia is not known. **Figure 5** illustrates the water quality seen along the transect extending from Ship Island into Chandeleur Sound. The stratification is evident in the character of the lower layer being distinctly higher salinity, lower temperature and lower dissolved oxygen (**Figure 6**). The depth of the boundary layer (pycnocline) ranges from 10 to 24 feet, and appears to be arched upward toward the southern side of the surveyed area. Generally, a boundary layer is caused by a density contrast which would be expected to be near horizontal. The arched boundary layer seen in 2010 suggests there is some additional dynamic influence of tides or currents.

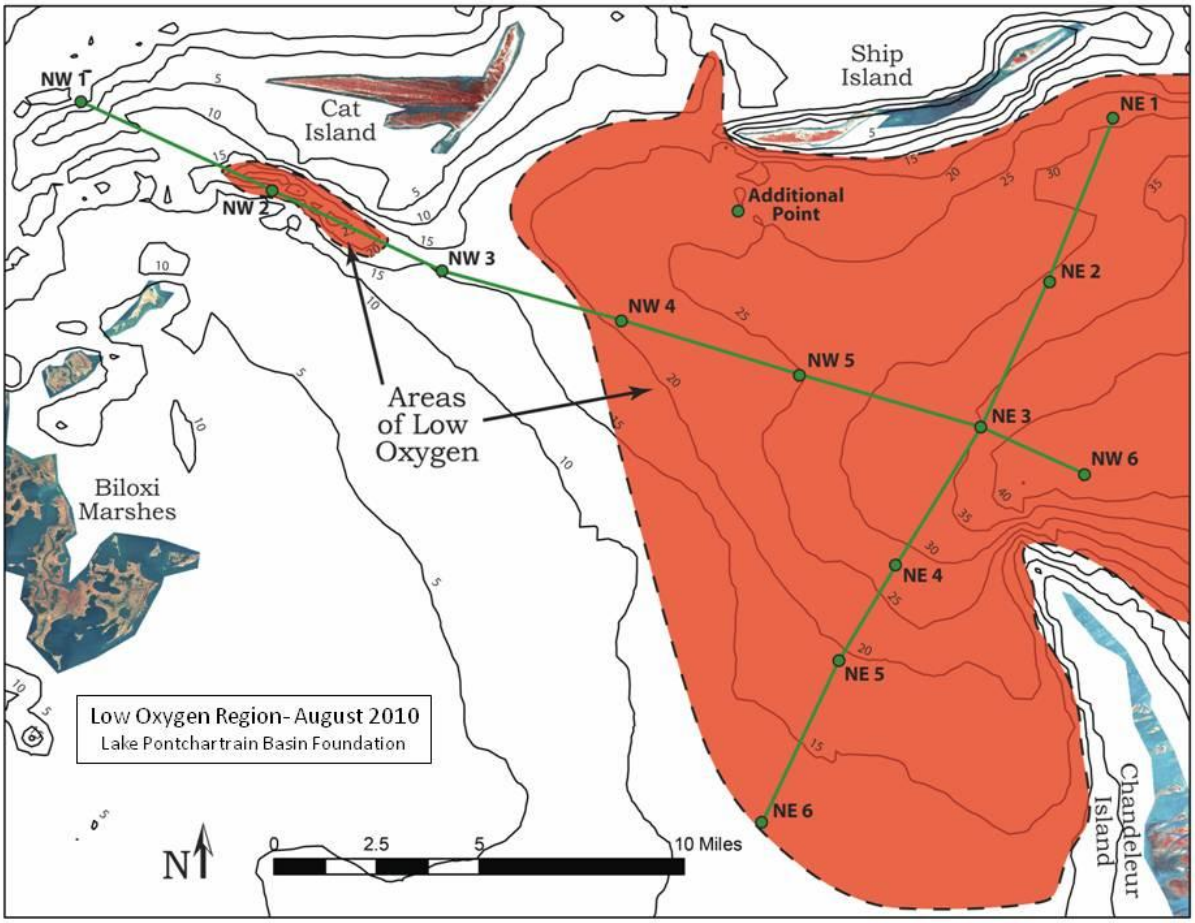

Figure 2: Map of the Chandeleur Sound area bathymetry (feet) and the hypoxic area observed in August 2010. Transects are shown in green.

It should also be noted that an isolated low oxygen area (~ 3 square miles) was detected in the deep portions of Cat Island Channel. The low oxygen water found here had different salinity and temperature than all the other sites. It seems very likely that the occurrence of the low oxygen layer here is simply due to the isolated depression of the Cat Island Channel. Its extent is much less than the dead zone found in Chandeleur Sound, but may be a more continuous occurrence due to the isolation of the water within the deep parts of the channel.

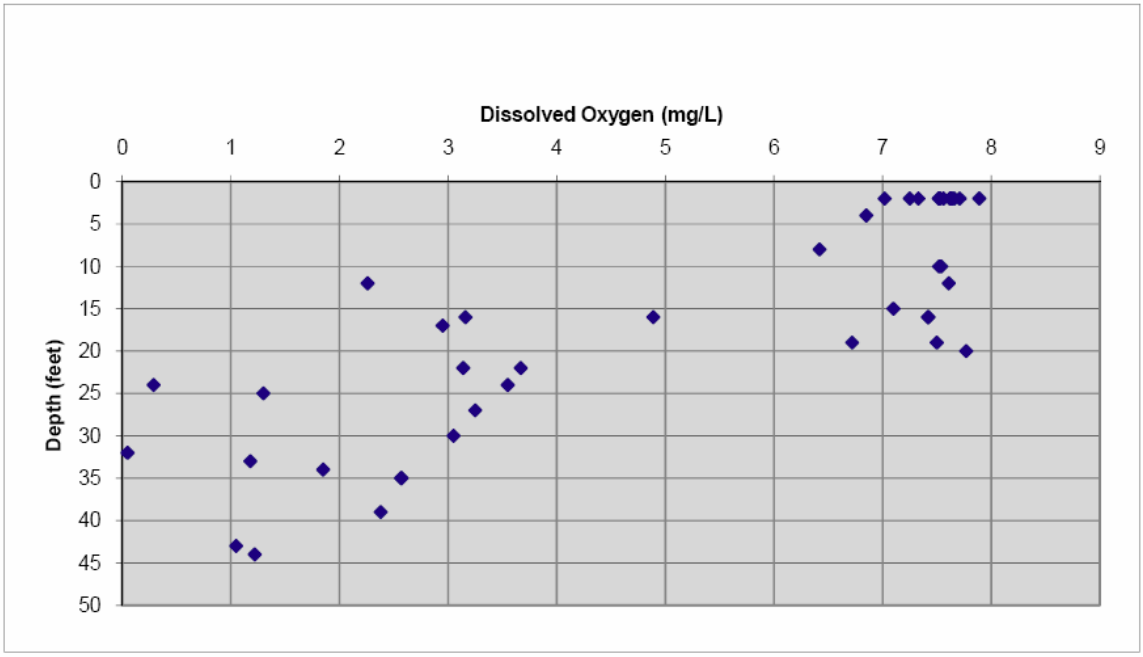

Figure 3: Graph of Depth and Dissolved oxygen observed in 2010 along transects shown in **Figure 2**. Graph illustrates distinct zones of dissolved oxygen as a function of water depth.

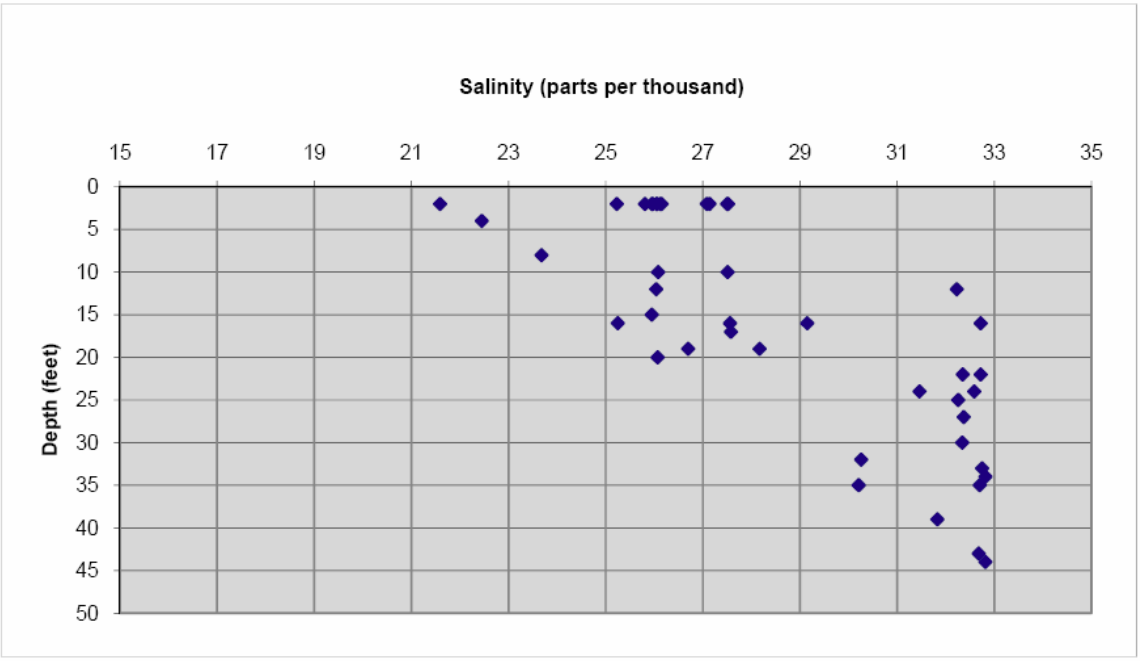

Figure 4: Graph of Depth and Salinity observed in August 2010 along transects shown in Figure 2. Graph illustrates distinct zones of salinity as a function of water depth.

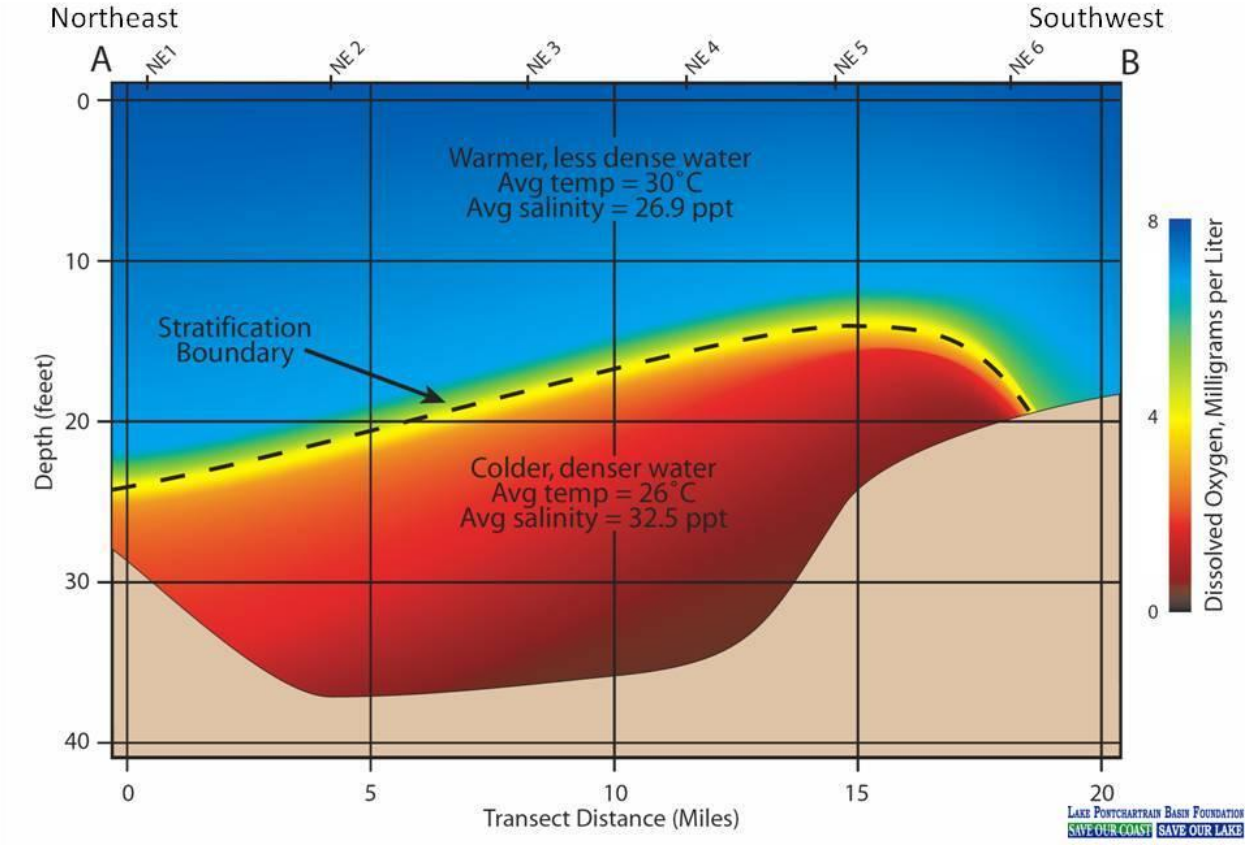

Figure 5: Profile of dissolved oxygen boundary (pycnocline) along the transect running from Ship Island into Chandeleur Sound (right side). Blue region is well oxygenated and lower salinity. Red region has low oxygen and higher salinity. The origin of arched shape of the boundary layer is unknown

	Average Salinity PPT	Average DO Mg/L	Average Temperature
Upper layer	26.4	7.1	30.0
Lower layer	32.5	2.2	25.9
Difference	6.1	4.9	4.1

Figure 6: Summary of water quality measurements on August, 25 2010 along the two transects in Chandeleur Sound

Discussion: Genesis of the Chandeleur Sound "Dead Zone"

The well documented 5,000 to 7,000 square mile dead zone along the Louisiana coast in the Gulf of Mexico is thought to be triggered by excess nutrients and stratification which occurs seasonally in the summer months (Rabalais et al, 2002). Prior to the closure of the Mississippi River Gulf Outlet (MRGO), the well-documented 200 square mile dead zone in Lake

Pontchartrain was triggered by high salinity water which had been allowed to enter Lake Pontchartrain via the MRGO and the Industrial Canal (LPBF, 2006; Poirrer, 1978, 1984). In both the Gulf and Lake dead zones, a lack of circulation and cumulative demand on oxygen within the water column conspired to create very low oxygen deeper in the water column. Any sessile organism that inhabits the water bottom is very likely to be suffocated and die, even with brief periods of low oxygen. Hence these are referred to as "dead zones". In Lake Pontchartrain the dead zone was evident by the absence of large lake clams (*Rangia cuneata*), simply because clams were killed before they could mature.

Although the low oxygen layer in Chandeleur Sound is much smaller than the typical annual dead zone in the Gulf of Mexico, its re-occurrence over a significant portion of Chandeleur Sound may be ecologically significant. Working with MRAC, LPBF will continue seasonal monitoring in 2010 and 2011 to characterize the water quality. The next survey is planned for October 2010. The cumulative observations over several years may begin to shed light on why the Chandeleur Sound dead zone is occurring.

At this time it is speculative to draw conclusions, but a few relevant observations can be made. In 2008, there was unusually high water on the Mississippi River, and the Bonnet Carre Spillway was opened prior to the low oxygen observation in June. The spillway opening undoubtedly added freshwater and additional nutrients to Chandeleur Sound, and so may have contributed to the low oxygen event in 2008. In 2010, the Bonnet Carre spillway was not opened; however, the Mississippi River had extended high water. Due to the BP oil spill response, freshwater diversions such as Caernarvon were operated at their design maximum for an unusually long period which preceded the occurrence of the low oxygen event. The additional freshwater in 2010, may have contributed to the occurrence of the low oxygen event this summer. The hypoxia seems to have developed between May and July in 2010. In early August, there were unofficial reports of "red tide" in Chandeleur Sound indicating possible excess nutrients (Times Picayune, 2010).

Since the low oxygen event occurred in Chandeleur Sound in 2008 without a major oil spill, the oil released from the recent BP spill event may not be a critical factor for its occurrence in 2010, but may have contributed to its extent. The upwardly arched boundary layer suggests a dynamic aspect to the stratification, and suggests that tidal or ocean currents may be influencing the stratification. According to Dr. Ioannis Georgiou at University of New Orleans, in 2009, stratification was observed on the gulf side of the Chandeleur Islands. It seems possible that ocean currents may be contributing to the occurrence of the stratification. It is also likely the occurrence is seasonal, and is more likely to occur in the summer months, especially if there is no significant tropical weather system to circulate the water column.

Conclusion

Initial evidence of an hypoxic region in Chandeleur Sound emerged in 2008. In 2010, the Lake Pontchartrain Basin Foundation partnered with Marine Research and Assistance Council to conduct water quality monitoring in Chandeleur Sound. Surveys in July and August of 2010, found strong evidence of hypoxia in Chandeleur Sound. The low dissolved oxygen is within a deeper stratified layer occurring 10 to 24 feet below the surface, and covers 1/3rd of Chandeleur Sound. It is assumed that some marine mortality has occurred as a result of the hypoxia.

Continued monitoring and hydrologic modeling of Chandeleur Sound is necessary to understand the nature of the low oxygen event, and this may provide a basis for recommendations to reduce the occurrence or environmental impact of the Chandeleur Sound Dead Zone.

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