

Water Quality Standards

Water quality standards consist of specified uses and the chemical, physical, and biological criteria designed to protect the specified uses. In Louisiana's Terrebonne Basin, all bodies of water are specified for the protection of fish and wildlife propagation, and have a dissolved oxygen (DO) criteria of either 4 mg/L (for estuarine waters) or 5 mg/L (for freshwater and coastal marine waters). DO is the amount of oxygen dissolved in water and is necessary for maintenance of aquatic life. Thirty-two bodies of water within the basin do not meet the DO criteria, thus requiring additional controls. However, DO levels that meet the criteria may not be possible even in the highest quality waters in the basin, and therefore the current DO criteria may not be appropriate. Thus, a study was conducted to collect information that can be used as a basis for adjusting the DO criteria for water bodies within the basin to better reflect natural conditions.

Choice of Reference Locations

The first step in this process was to determine appropriate reference locations to reflect the highest quality bodies of water in the Terrebonne Basin. Factors in the choice of reference locations included the land use, the size of the body of water, the vegetation type and the salinity of the water.

Table 1. Classification of Reference Locations

Site	Description	Classification	
		Salinity/ Vegetation ¹	Size
C-1	Choctaw Bayou	Freshwater	Intermediate stream
C-2	Upper Grand River	Freshwater	Large stream
C-3	Pat Bay	Freshwater	Bay/Open water
C-4	Lower end of Lower Flat River	Freshwater	Intermediate stream
C-5	Bay off of Lower Grand River	Freshwater	Large stream
C-6	Little Bayou Long/Grande Bayou	Mixed	Intermediate stream
C-7	Grassy Lake	Mixed	Intermediate stream/Open water
C-8	South Lake Verret	Mixed	Intermediate canal/Open water
C-9	Lake Palourde	Mixed	Open water
C-10	Bay Wallace	Mixed	Small stream/bay
C-11	Bayou Tambour	Saline	Intermediate stream
C-12	Jude's Cut	Saline	Intermediate stream
C-13	Bayou Platt	Saline	Intermediate stream
C-14	Fred Bayou	Saline	Intermediate canal
C-15	Off of Bayou Dularge	Saline	Large stream

¹ Salinity ranges are: 0 to 0.5 ppt for freshwater; 0 to 10 ppt but with tidal influence for mixed; ≥ 10 ppt for saline



Figure 1. Location of Reference Sites

A reconnaissance was conducted to assure the highest quality waters were chosen. Bodies of water located in agricultural, industrial, or urban areas were not considered. A total of 15 reference locations were chosen (5 freshwater, 5 mixed salinity and 5 saline). These locations are indicated on the map in Figure 1 and described further in Table 1. The applicable DO criterion as defined by the state of Louisiana is 5 mg/L for Sites C-1 – C-10 and 4 mg/L for Sites C-11 – C-15.

Sampling Program

The most important or critical season to collect information to evaluate the appropriateness of the DO criteria is during the summer. Information was collected four times: summer 2005, winter 2006, spring 2006, and summer 2006. (The summer 2005 sampling event was interrupted by Hurricanes Katrina and Rita). Physical, chemical, and hydrological measurements were collected during each sampling event. Habitat assessment and biological sampling was performed only during the critical season (summer) events.



Assessment of Dissolved Oxygen, Physical Habitat and Biological Characteristics for Man-Made Canals and Unaltered Streams in the Terrebonne Basin, Louisiana



Freshwater location (C-3)



Mixed salinity location (C-8)



Saline location (C-12)

Hydrologic measurements

Light penetration, water depth, water body width (for channelized streams), flow (where measurable), and GPS coordinates were recorded during all four sampling events.

Physical/chemical measurements

Measurements of DO, temperature, pH, salinity, conductivity and turbidity were made using continuous monitoring equipment. Average DO was determined as the average over the 48-hour continuous monitoring period; minimum DO was the lowest reading during the same period. Grab samples of water were collected for analysis of chemical parameters, including biochemical oxygen demand, total suspended solids, chlorophyll *a*, nutrients (nitrate, nitrite, ammonia, total Kjeldahl nitrogen, total phosphorus). Grab samples of sediment were collected for analysis of total organic carbon and grain size.

Habitat assessment

Observations were recorded on aspects of the habitat such as bottom substrate/in-stream cover, pool/bottom substrate characterization, channel sinuosity, bank stability, streamside cover, riparian zone width, vegetation (submerged, emergent, floating), sediment parameters, salinity, and tidal influence.

Biological assessment

Fish and small animals, such as insects living on the bottom (benthic macroinvertebrates), were collected at all locations. At the freshwater and mixed salinity locations, fish were collected using electroshocking (a method using electricity to stun the fish). At the saline locations, where electroshocking is not possible, the fish were collected using trawls and gill nets. Benthic macroinvertebrates were collected at each location using nets and dredges. Numbers and types of organisms collected were recorded.

Results

The results of water quality analyses indicated that the selected sites did represent "least impacted" conditions with respect to basic water quality parameters. With respect to DO, however, average DO dropped below the 5 mg/L criterion at some time (usually during the

summer) at almost all of the freshwater and mixed salinity sites (C-1 – C-10). Minimum DO was also below the criterion but usually above 2 mg/L. At the saline sites (C-11 – C-15), average DO was always above the 4 mg/L criterion, although minimum DO was often below the criterion.

The percentage of time that DO values were below the applicable criterion during the critical season was evaluated by constructing a cumulative distribution function (CDF). Based upon these CDFs, the following observations were made regarding the critical period (summer) DO results:

Freshwater/Mixed Salinity Sites

- Average DO below 5 mg/l criterion:
 - 55% of time (2005)
 - 75% of time (2006)
- Minimum DO below 5 mg/l criterion:
 - 100% of time (2005)
 - 100% of time (2006)

Saline Sites

- Average DO below 4 mg/l criterion:
 - 0% of time (2005)
 - 0% of time (2006)
- Minimum DO below 4 mg/l criterion:
 - 58% of time (2005)
 - 100% of time (2006)

Compliance with the DO criterion is evaluated based upon the minimum DO. During the critical period, the minimum DO was always below the criterion at the freshwater and mixed salinity sites. Approximately 90% of the time, the average DO was at or above 3.2 – 4.1 mg/L for these sites (Figures 2a and 2b). For the saline sites, the minimum DO was always below the criterion in 2006 but not in 2005. The average DO was at or above 4 mg/L for the saline sites 100% of the time (Figures 2c and 2d).

The benthic macroinvertebrate data indicated that most of the freshwater and mixed sites were characterized by a moderate or high abundance and moderate or high species richness. The saline sites were characterized by a range of conditions. In general, the dominant invertebrates at all sites were those that could

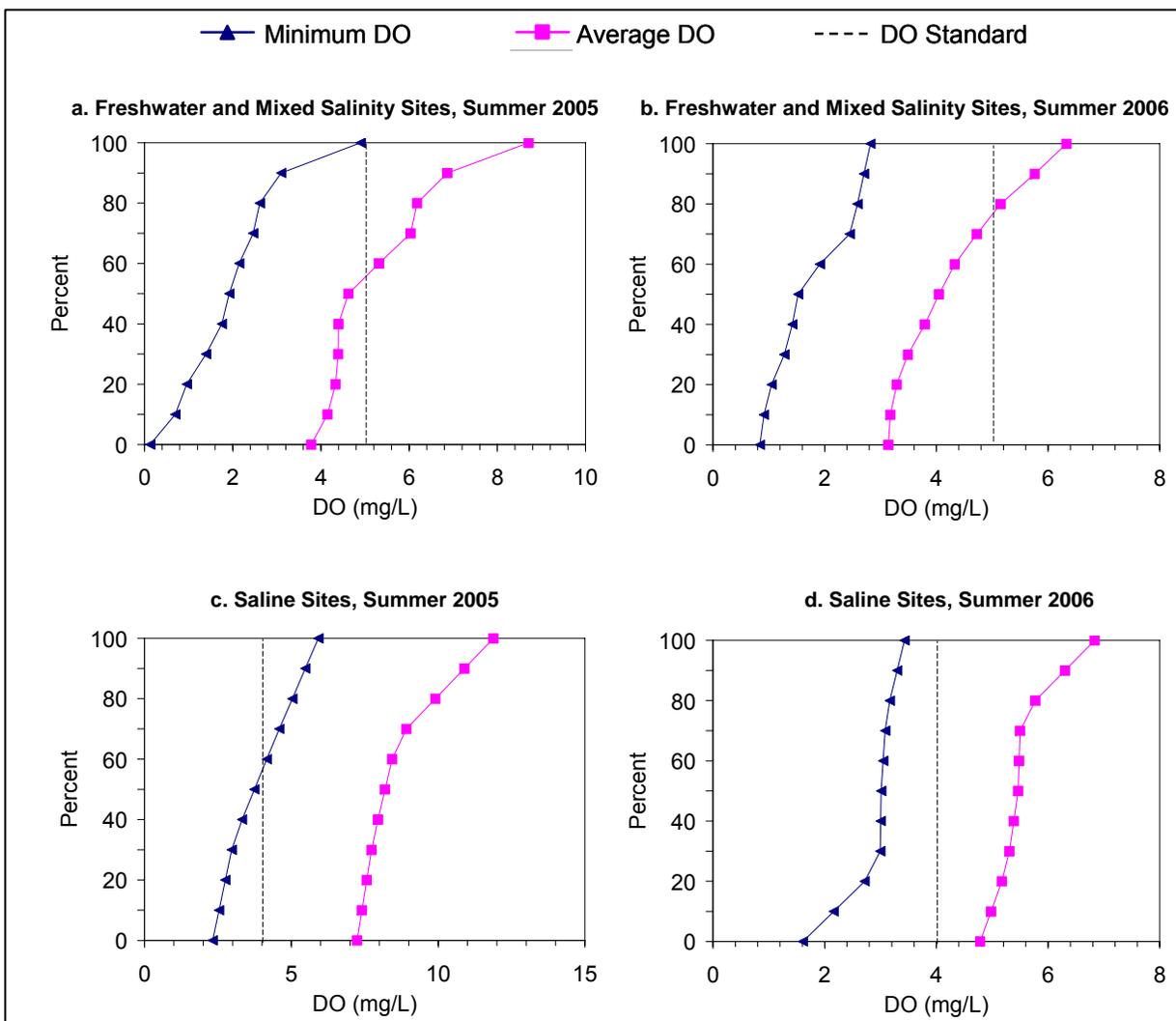


Figure 2. Cumulative Distribution Function for Minimum and Average DO Concentrations

be considered tolerant of low DO. Fish species that can be considered sensitive to low DO were observed at all of the freshwater/mixed sites except one. For the saline sites, DO-sensitive fish species were found at three of the five sites.

Bivariate plots were prepared to examine correlations between DO and species richness and diversity, using both average DO and minimum DO. Examples are provided in Figures 3 and 4. None of these plots revealed any clear biologically significant relationships between DO and the biological communities that were found.

Conclusions

The majority of the selected reference sites in the Terrebonne basin supported a reasonably diverse and healthy biological community, despite the fact that DO is below the current standard. Neither minimum DO nor average DO below 4 - 5 mg/L appears to be correlated with reductions in species richness or diversity. The biological communities documented during this study appear to be comparable to historical data for the region. It is likely that the existing biological communities are adapted to the periods of low DO that occur during the critical season. The sites were dominated by benthos that are tolerant of low DO. Fish, being mobile, can escape from areas of temporarily low DO; thus, it is not surprising that sensitive fish species were found throughout the study area.

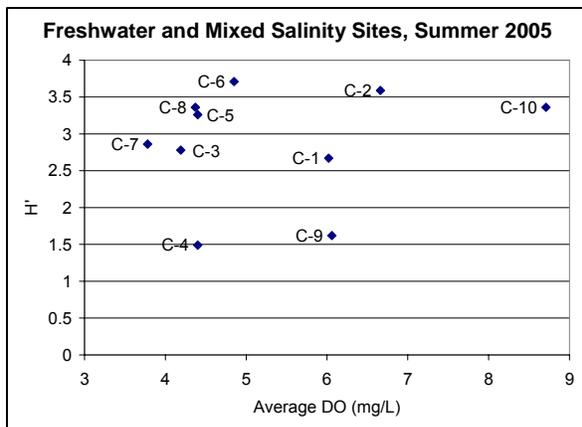


Figure 3. Example Bivariate Plot of Average DO and Benthic Macroinvertebrate Diversity

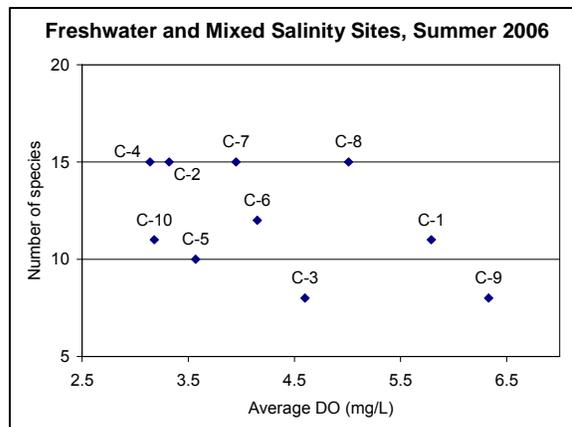


Figure 4. Example Bivariate Plot of Average DO and Fish Species Richness

The results of this investigation indicated that the existing DO criteria for reference locations in the waterbodies in the Terrebonne basin are not currently met, especially if applied strictly as a single “not to exceed” value. During the critical period, at freshwater and mixed salinity locations, the average DO did not meet the applicable criterion of 5 mg/L most of the time, and the minimum DO never met the criterion. At saline locations, the average DO always met the 4 mg/L criterion although the minimum DO typically did not. The refinement of DO criteria, especially for those waterbodies subject to the 5 mg/L criterion, and especially since criteria attainment is currently based upon the minimum DO, thus appears warranted. It is likely that multiple approaches will be required to address refinement of DO criteria in south Louisiana water bodies such as the Terrebonne basin. Potential approaches include the following:

- Use of laboratory data as a basis for the DO criteria. This would require assembling available data from laboratory studies on the response of biota found in the Terrebonne basin to varying levels of DO, with verification conducted using field data obtained during this study.
- Definition of a lower DO criterion, potentially time dependent. The duration of exposure to low DO as well as the magnitude of DO depression are important. The results of this study suggest that the reference locations exhibit reasonably diverse communities and that the average DO was at or above 3.2 to 4.1 mg/L approximately 90% of the time during the critical period at freshwater and mixed salinity sites and at or above 4 mg/L 100% of the time during the critical period at saline sites.

- Use of biological assessment data to determine attainment of DO criteria, including selection of indicator species and development of a biological index sensitive to DO. A preliminary evaluation of indicator species sensitive to DO indicates that sufficient data are available for the possible development of such an index for the Terrebonne basin.
- Development of tiered aquatic life uses and corresponding DO criteria. Tiered aquatic life uses (TALUs) are bioassessment-based statements of expected biological condition in specific waterbodies. TALU, supported by appropriate criteria, can define the conditions across a continuum ranging from “totally pristine” to “completely degraded” and allow the appropriate management actions to be implemented to obtain the desired level of protection. Under the TALU approach, Louisiana could further distinguish between the “fish and wildlife propagation” use and the “limited aquatic wildlife use,” adopting different DO criteria for each. The successful implementation of TALU in Louisiana would likely include the use of biological information as the basis for the use designations, numeric biocriteria for each use, and development of tiers based on data from an extensive monitoring program.

Some combination of these approaches may prove most useful in refining the DO criteria for the Terrebonne basin.

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For more information on this project, please contact Dr. Jessica Franks, EPA Region 6 at (214) 665-8335 or Philip Crocker at (214) 665-6644.