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Introduction

This report is a supplement to previous reports that present the results of surveys completed by The Lake Pontchartrain Basin Foundation (LPBF) since Mardi Gras Pass (MGP) breached to the Mississippi River at mile marker 43.7 in March of 2012. All prior survey reports as well as a comprehensive study of the development of MGP are available for download at www.saveourlake.org. Mardi Gras Pass is located in the Bohemia Spillway, a 11.8-mile unveleed reach on the east bank of the Mississippi River, approximately 45 miles downriver from New Orleans (Figure 1). On November 14, 2016 a bank survey was conducted to map the spatial extent of the pass. On November 15, 2016 a bathymetric survey was conducted to measure bottom elevation and water depth measurements within MGP. As a result of the bank and bathymetric survey, statistics were computed for the entire extent of MGP and for each of the individual five reaches. This survey was conducted to document changes occurring from July through November 2016 which is typical low water season in the Bohemia Spillway.

Figure 1: Location of Mardi Gras Pass in Plaquemines Parish, LA.

Data Collection and Processing

All data points were collected using a Trimble Geo Explorer 6000 GeoXR GPS attached to a Zephyr Model 2 GNSS receiver. Capable of Real Time Kinematic (RTK) data collection, this survey grade GPS system provides latitude, longitude, and elevation (XYZ) of land locations to a high degree of precision. When coupled with the boat mounted fathometer (SonarMite Echo Sounder), depth measurements are simultaneously recorded with the GPS data for each point.
From these measurements, bottom surface elevation can be calculated as the elevation of the water surface minus depth (depth applied elevation).

On November 14, 2016 the GPS unit and receiver were used to complete a bank survey of MGP. Each point consisted of latitude, longitude, and elevation. A total of 254 GPS points were collected at approximately 100 ft. intervals along the bank (Figure 2). A small number of bends were either inaccessible or tree coverage blocked the GPS signal. For reach 4A & 4B, the original Bohemia Spillway Diversion Culverts Conveyance Canal, the banks experienced widening and scour in a few locations. A greater concentration of points was purposely captured at these locations to map the dimensions of the new bank line. The GPS points were imported into a GIS and a polygon feature was computer generated based on the bank survey points (Figure 2). This polygon feature represents the surface extent of MGP for the November 2016 survey.

On November 15, 2016, a bathymetric survey was completed with the fathometer mounted on a 19-foot Cape Horn boat and run in “Continuous Topo” mode while traveling different paths up and down the pass. “Continuous Topo” mode means that the unit obtains data points at a specified distance or time interval. A total of 8,307 data points were collected during the bathymetric survey (Figure 3). Data points were captured every 5 feet while traveling 5 mph or less. The GPS-fathometer combination measured and recorded latitude, longitude, and elevation of the fathometer (approximately 1 ft. below the water surface), and depth (measured by the fathometer) for each point along five survey paths. Parameters were set in the data collector to account for the 1 ft. fathometer drag and the height of the pole mounted GPS receiver to return elevation readings at the water surface. Water depth measurements were subtracted from the water surface elevations to calculate the bottom surface elevation. A visualization of bottom surface elevation of the channel is interpolated from the bathymetric sample points (Figure 4).

Figure 2: Bank survey points of Mardi Gras Pass completed November 14, 2016, along with the polygon representing the extent of the pass.

Figure 3: Bathymetric survey of Mardi Gras Pass completed November 15, 2016, along with the polygon representing the extent of the pass.
Figure 3: Bathymetric survey points of Mardi Gras Pass, obtained November 15, 2016.

Figure 4: Mardi Gras Pass interpolated bottom elevation surface based on bathymetric and bank surveys completed on November 14 & 15, 2016. Interpolated surface was generated using Spatial Analysis Toolbox in ArcGIS 10.4.1.
To interpret the survey data, a series of basic geo-processing steps were completed in the GIS to obtain summary statistics describing the width, depth, and bottom elevation of MGP. To measure width, 48 evenly spaced transects crossing the channel were clipped based on the MGP boundary (Figure 5). These transects were used to compute the average width in each reach as well as the overall average width of MGP.

Figure 5: Transects used to summarize the width of Mardi Gras Pass at various locations and the length (ft.) of each transect (bank-to-bank distance).

To assess the depth of MGP, a set of evenly spaced polygons were clipped using the polygon representing the boundaries of the pass. The resultant polygon layer divided the entire pass into a 140 evenly spaced polygons (Figures 6 & 7). Next, a spatial join with the bathymetric points calculated summary statistics (minimum, maximum, and average) for points within the corresponding polygon. These attributes for the polygon layer provide a generalized summary of the water depths as well as bottom surface elevations observed in the pass.
**Figure 6:** Polygons used to summarize the depths (ft.) of the Mardi Gras Pass in Reaches 1 through 3.
*Depth statistics computed on raw points values.*

**Figure 7:** Polygons used to summarize the depths (ft.) of Mardi Gras Pass in Reach 4A & 4B.
*Depth statistics computed on raw points values.*
November 2016 Results
Along the pass, 48 evenly spaced transects were used for width measurements. Bottom surface elevations and depth measurements were calculated using 140 polygons extending from reach 1 through 4. The transect widths ranged from 128.1 ft. to 281.8 ft. with an average width of 174.8 ft. (Table 1). Reach 1 had the greatest average width at 208.5 ft., while reach 4B had the lowest average width at 146.3 ft.

The average water depth of the individual polygons ranged from 7.7 ft. (in reach 3) to 38.2 ft. (in reach 2). Reach 2 had the greatest average water depth at 29.8 ft., and reach 4A had the lowest average water depth at 19.9 ft. The average water depth for the entire pass was 22.4 ft. (Table 1).

The average bottom elevation for the entire pass was -16.6 ft. (Table 1). Reach 2 has the maximum average bottom elevation at -21.0 ft. while reach 4B has the minimum average bottom elevation at -15.5 ft. For the individual 140 polygons the average bottom elevation ranged from -5.5 ft. (in reach 3) to -25.3 ft. (in reach 4B).

Table 1: Summary statistics by reach for transects and polygons used to assess the width, depth, and bottom elevation of Mardi Gras Pass based on the November 2016 survey.

<table>
<thead>
<tr>
<th>Reach</th>
<th>Number of Width Transects</th>
<th>Avg. Width (ft)</th>
<th>Min. Width (ft)</th>
<th>Max. Width (ft)</th>
<th>Number of Depth Polygons</th>
<th>Avg. Depth (ft) (a)</th>
<th>Min. Depth (ft) (a)</th>
<th>Max. Depth (ft) (a)</th>
<th>Avg. Bottom Elevation (ft) (b)**</th>
<th>Avg. Thalweg Depth (ft) (c)</th>
<th>Approx. Cross Sectional Area (ft^2) (d)***</th>
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</thead>
<tbody>
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<td>174.8</td>
<td>128.1</td>
<td>281.8</td>
<td>140</td>
<td>22.4</td>
<td>7.7</td>
<td>38.2</td>
<td>-16.6</td>
<td>27.5</td>
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<td>14</td>
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Table footnotes
(a) The average, minimum, and maximum depth values refer to summary statistics based on values for the set of polygons in each reach. These depth values utilize the raw points within each polygon. Therefore, the minimum and maximum of each reach refers the minimum and maximum average depth for the set of polygons within the reach and not the minimum or maximum value of the individual points within a polygon or reach.
(b) Bottom Elevation is calculated by subtracting fathometer depth measurements from the elevation of the water surface. Average Bottom Elevation values are the average an interpolated surface of bank and bathymetric points.
(c) For the purposes of this analysis, the Thalweg Depth for each polygon is defined as the average of the five deepest measurements for the polygon, and then the Average Thalweg Depth for each reach is calculated from those values.
(d) For the purpose of this analysis, the Cross Sectional area is calculated by multiplying the average depth and average width. Cross-Sectional area measurements are calculated using raw depth values captured during the bathymetric which are concentrated in the center (deeper) of the channel, and can overestimate the actual cross-sectional area.

A more illustrative assessment of the depths through Mardi Gras Pass can be obtained by analyzing the thalweg depth. (Figures 8 & 9). For the purposes of this analysis, the thalweg depth was calculated as the average of the five deepest measurements for each polygon defining the lowest points along the entire length of the channel. Over the entire pass, the thalweg depth ranges from 16 ft. to 43.7 ft., with an average of 28.2 ft.
Figure 8: Approximate thalweg depths (ft) of Mardi Gras Pass in Reaches 1 through 3.

Figure 9: Approximate thalweg depths of Mardi Gras Pass in Reach 4A & 4B.
A modest decrease in cross-sectional area occurred in MGP since LPBF’s July 2016 survey (Figure 10). For the November 2016 survey, Reach 3 contained the largest cross-sectional area measurement of 6,683 ft$^2$ located at transect 13. Reach 1 contained the smallest cross-sectional area measurement of 1,961 ft$^2$ located at transect 16. Reach 1 as a whole had the largest average cross-sectional area of 5,236 ft$^2$. Reach 4B had the smallest average cross-sectional area of 3,130 ft$^2$.

Only modest changes were observed in MGP by comparing this survey (November 2016) to the prior survey (July 2016). The greatest change in cross-sectional area occurred in R1 at transect 1 with a 23.6 % decrease, which probably indicates aggradation (deposition). The smallest change in cross-sectional area occurred in R3 at transect 9 with a 0.6 % increase. The cross-sectional area of MGP as a whole has decreased by 1%. Reaches 1, 3, and 4A have changed by -7%, -3%, and -11% respectively. Reach 2 and 4B have increased by 2% and 4% respectively. The time period from July 2016 to November 2016 was a period of low stage on the Mississippi River, and apparently resulted in only modest change to MGP, which was net decrease in channel size probably due to deposition.

Figure 10: Cross-sectional area comparison of July 2016 vs. November 2016. The transect numbers on the histogram correspond to the transect locations on the map. Transects are orientated perpendicular to the centerline of the channel. Cross-Sectional Areas for the above graph are calculated by multiplying the average depth by the length of the transect. For this analysis, depth is derived from an interpolation of the bathymetric survey points.

References


