Summary of Observed Channel Dimensions of Mardi Gras Pass in the Bohemia Spillway, Southeast Louisiana: January 2024 Update

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https://scienceforourcoast.org/

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Introduction

This report supplements previous reports that present the results of surveys completed by the Pontchartrain Conservancy (PC) since Mardi Gras Pass (MGP) formed at Mississippi River (MSR) 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 https://scienceforourcoast.org/pc-programs/coastal/technical-reports/. This report documents changes occurring from January 1, 2023 to January 1, 2024. The flood season (river at or above bank full stage) for 2023 lasted from March 9th until March 27th and April 1st until April 22nd for a total of 41 days (**Figure 1**).

Mardi Gras Pass is located in the Bohemia Spillway, an 11.8-mile un-leveed reach on the east bank of the Mississippi River, approximately 45 miles downriver from New Orleans (**Figure 2**). During January 2023, PC conducted a bathymetric survey to measure bottom elevation within MGP and the MSR. A bank survey was also conducted to map the spatial extent of the pass. Bank and bathymetric survey statistics were computed for the entire extent of MGP and for each of the individual five reaches **(Figure 2)**.

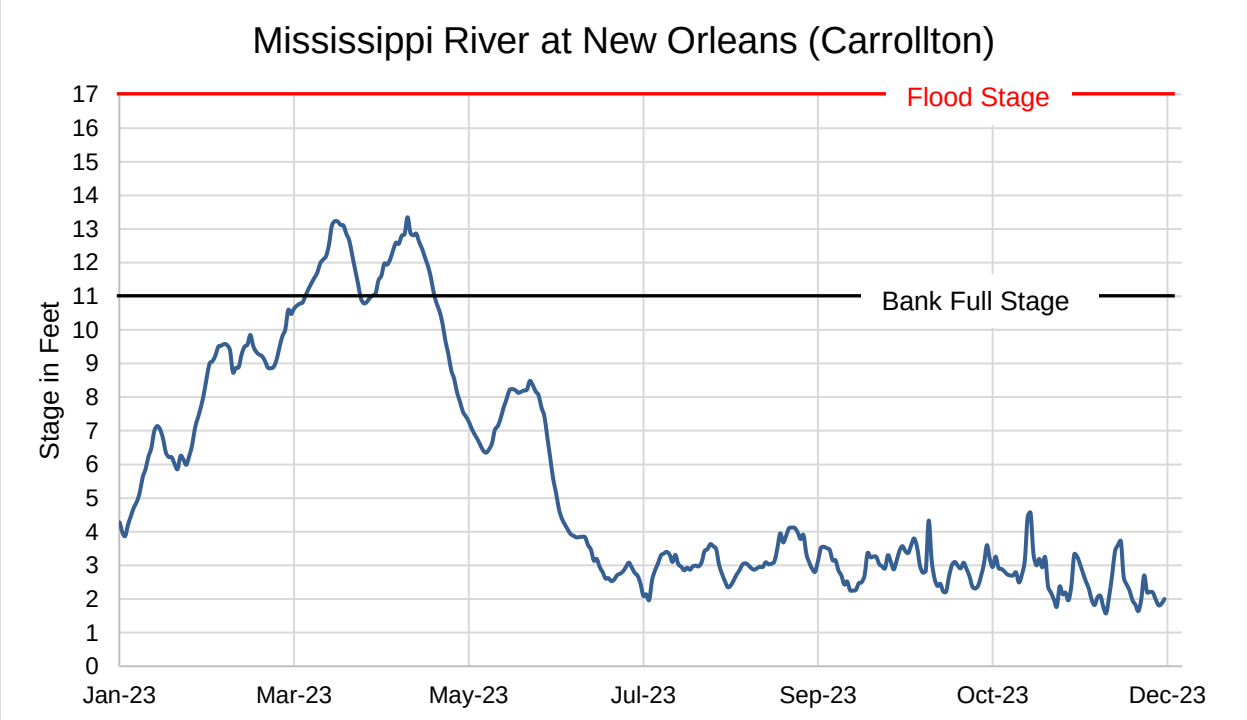

Figure 1: Stage of the Mississippi River at New Orleans from the US Army Corps of Engineers - New Orleans District

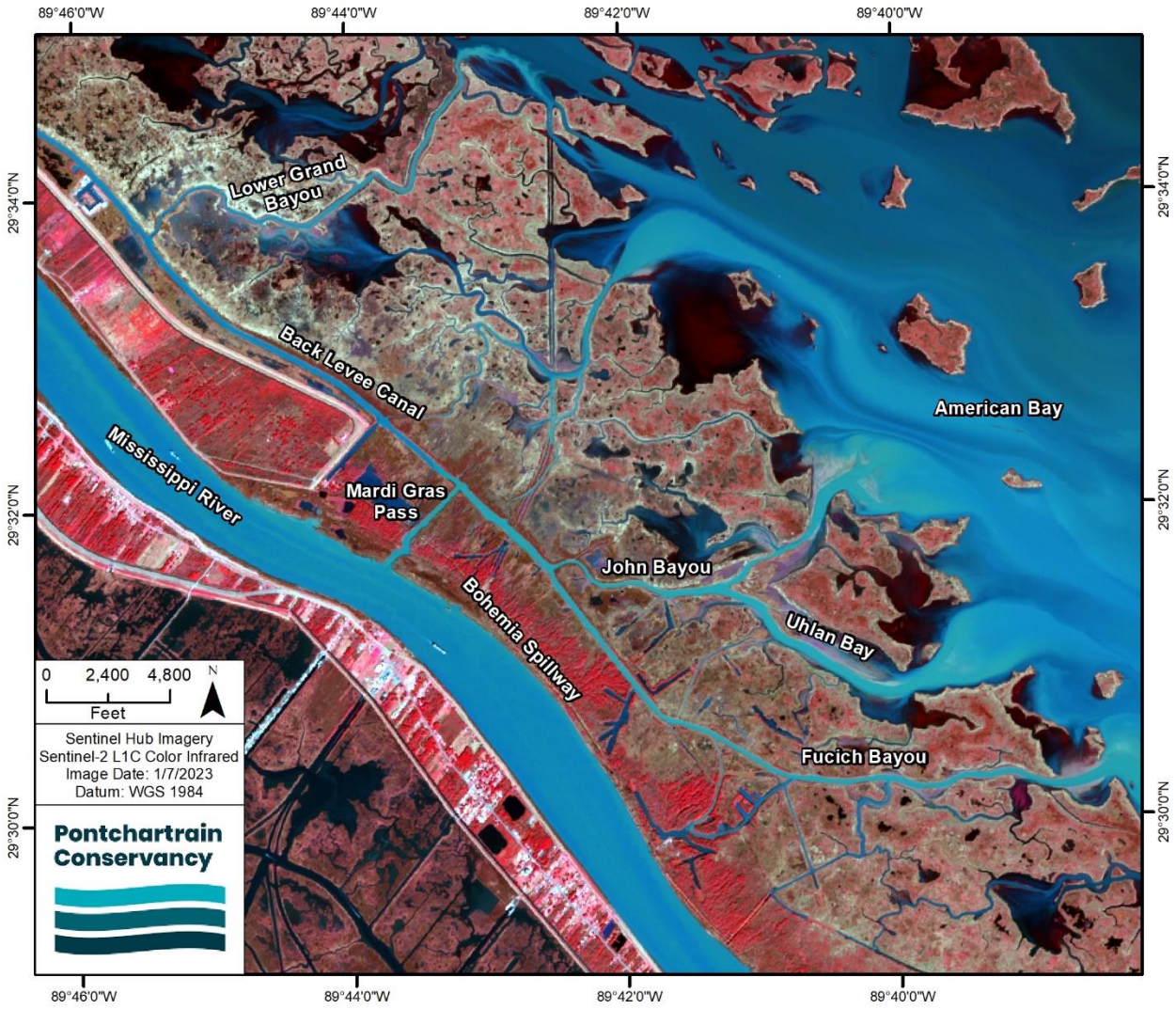

Figure 2: Color infrared imagery of Mardi Gras Pass and its receiving basin in Plaquemines Parish, LA. Sentinel Hub Imagery date January 7, 2023.

Data Collection, Processing, and Results

All data points were collected using a Carlson RT4 data collector attached to a Carlson BRx7 GNSS receiver. Using an internet connection to access LSU's C4G real-time network (RTN) the unit was capable of Real Time Kinematic (RTK) data collection. RTK data collection means that when surveying, real time corrections are acquired from nearby base stations and post processing collected data is not necessary. This survey grade GPS system provides latitude, longitude, and elevation (XYZ) measurements to a high degree of precision. When coupled with the boat-mounted fathometer (SonarMite Echo Sounder), water bottom elevations are simultaneously recorded for each point. Quality assurance was set in the Carlson unit manually for both horizontal (2 inches) and vertical (3 inches) accuracies, if the accuracies were not at or below the set limit data was not recorded. The GPS points were then imported into ESRI ArcMap and a polygon feature was generated based on the bank survey

points (**Figure 3**). This polygon feature represents the surface extent of MGP for the January 2024 survey.

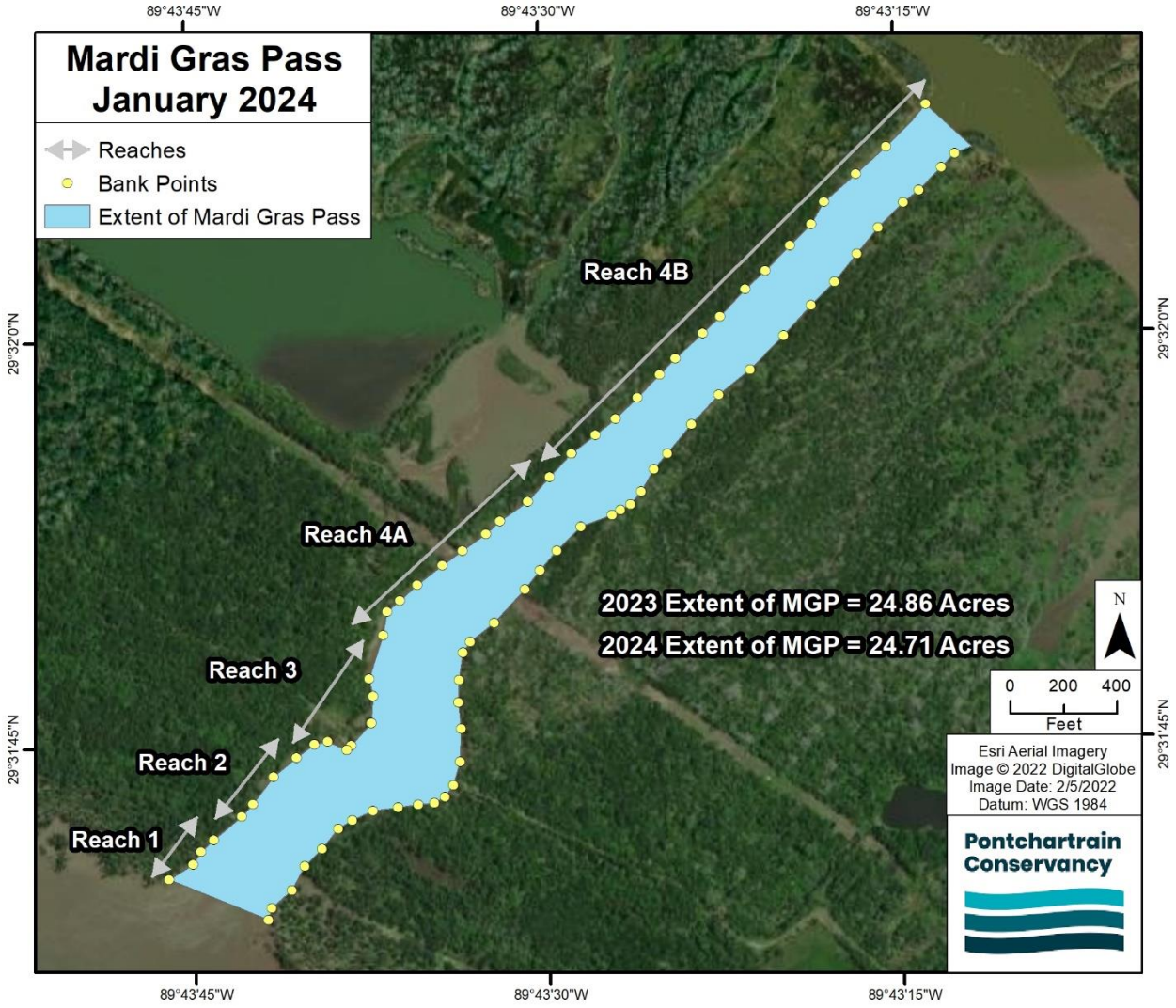

Figure 3: Bank survey points of Mardi Gras Pass along with the polygon representing the extent of the pass.

Bathymetric surveys were conducted with the fathometer operated in "Continuous Topo" mode while traveling different paths along the pass. The GPS-fathometer combination measured and recorded latitude, longitude, and water bottom elevation for each point along the survey paths. Parameters were set in the data collector to account for the 1-foot fathometer drag and the height of the pole mounted BRx7 receiver. A visualization of bottom surface elevation of the channel is interpolated from the bathymetric and bank survey points (**Figure 4**).

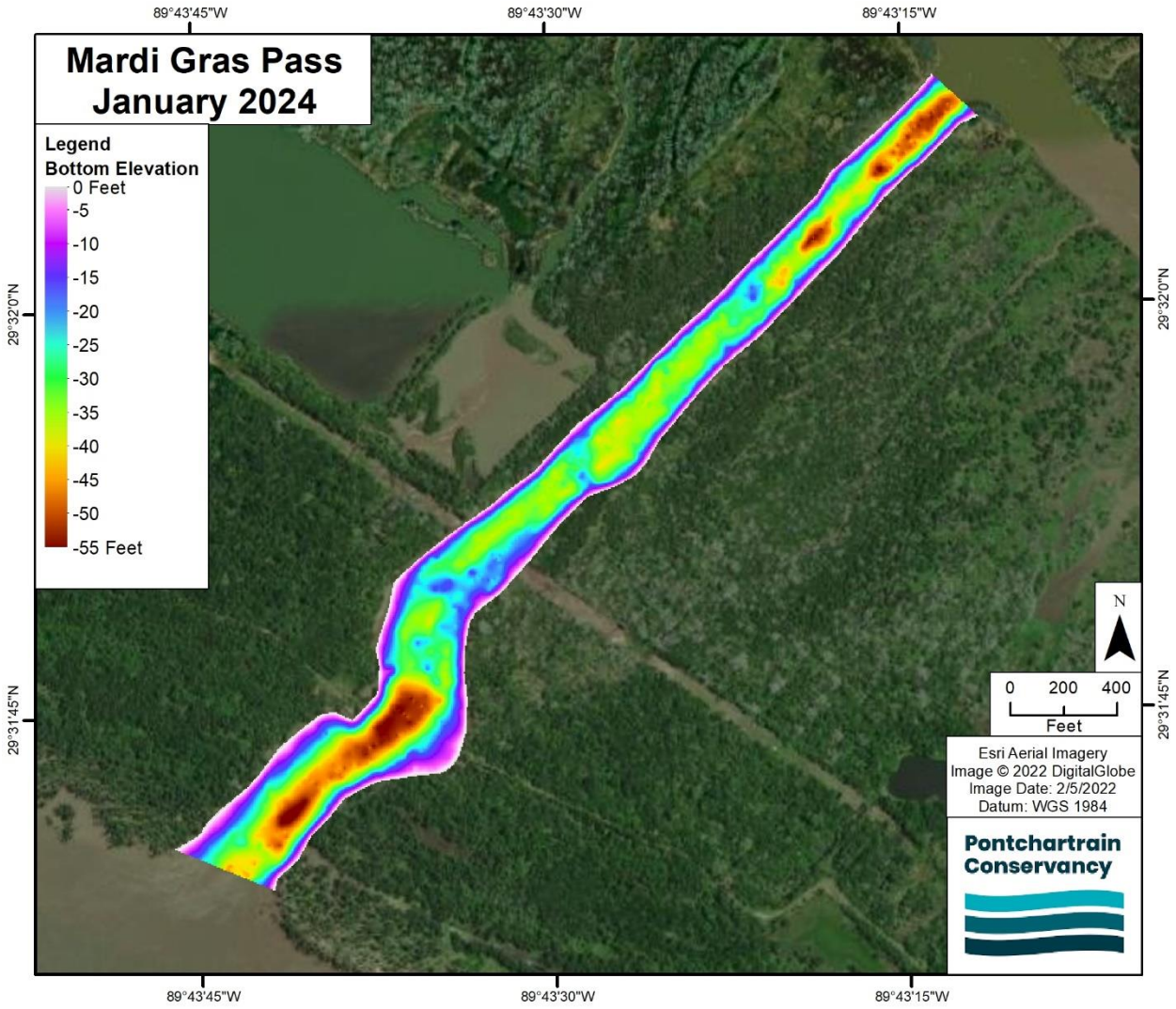

Figure 4: Mardi Gras Pass interpolated bottom elevation based on bathymetric surveys completed January 2024.

Using the spatial analyst toolbox, the minus tool was used to create a raster showing changes in bottom elevation from the January 2023 survey to the January 2024 survey (**Figure 5**). The minus tool subtracts the value of the second input raster from the value of the first input raster cell-by-cell. Using each year's bottom elevation data, the minus tool is able to show areas where deposition and erosion have occurred. The largest amounts of deposition took place in Reaches 1, 2, and 3. This was due to the slight widening and straightening of MGP. As the channel thalweg migrates southeast, areas where the old thalweg was located fill in. The mild 2023 flood season resulted in an even balance of both deposition and erosion throughout MGP. The erosion that did occur was mostly deepening along the banks as well in Reaches 4A and 4B. The single elevated spot areas of erosion are likely due to the loss of fallen underwater trees that are no longer present and vice versa for single elevated spot areas of deposition.

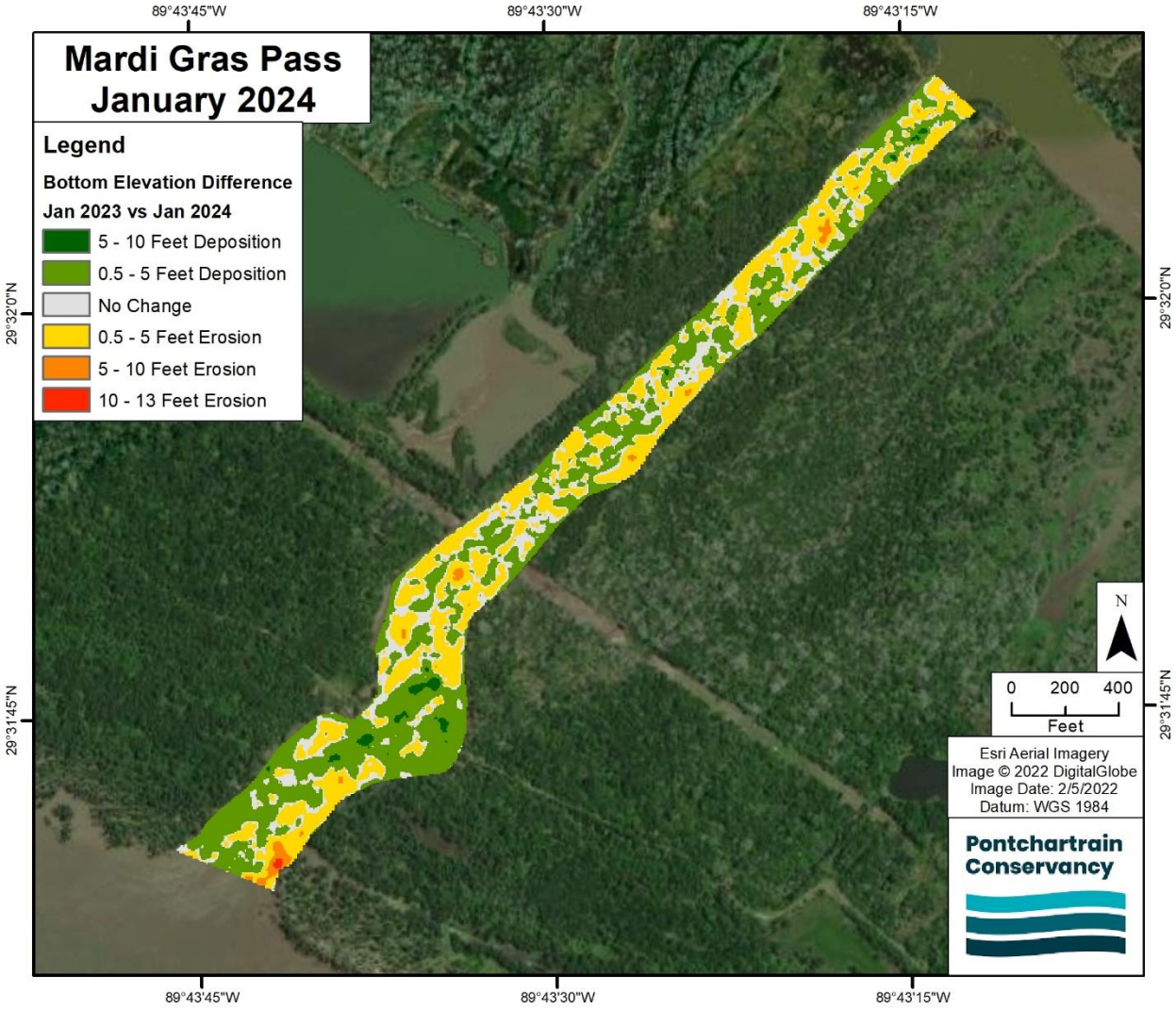

Figure 5: Mardi Gras Pass bottom elevation difference map that shows change in bottom elevation from the January 2023 interpolation compared to the January 2024 interpolation.

To interpret the survey data, a series of geo-processing steps were completed in ArcGIS to obtain summary statistics describing the width, depth, and bottom elevation of MGP. To measure width, 45 transects across the channel were clipped based on the MGP bank boundary **(Figure 6)**. These transects were used to compute the average width in each reach as well as the average width of MGP.

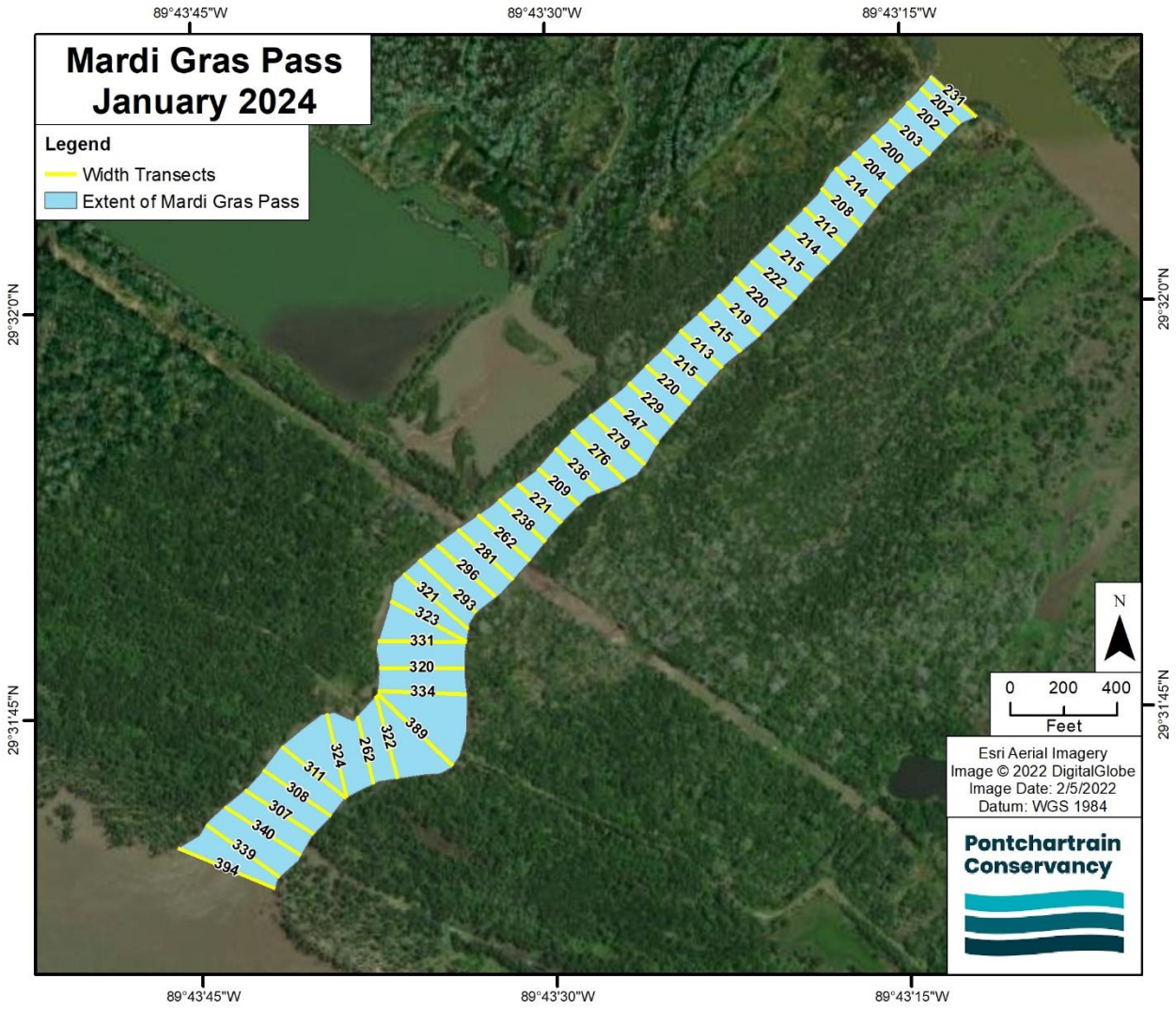

Figure 6: Transects used to summarize the width of Mardi Gras Pass at previous reported locations and the length (ft) of each transect (bank-to-bank distance).

Transect Analysis Method Using Interpolated Bathymetry

The Transect Analysis Method Using Interpolated Bathymetry is used to obtain the most accurate cross-sectional area measurements of MGP by creating an interpolation from the bathymetry data by using the 3D Analyst toolbox in ArcMap. The Interpolation produces a continuous bottom elevation surface for MGP by interpolating where bathymetry data could not be collected due to the area being too shallow or inaccessible due to trees. With an interpolated surface, we are able to analyze depths and bottom elevation along the entire transect producing a more realistic data set and cross-sectional area.

For the Transect Analysis Method, bottom elevation is analyzed only along the width transects (**Figure 6**). Using the Zonal Statistics tool in the Spatial Analyst Toolbox in ArcGIS average, minimum, and

maximum values were acquired for bottom elevation from the interpolated surface raster data set along each transect. The completed tool outputs a table that contains the average, minimum, and maximum values for each transect, reach, and the entirety of Mardi Gras Pass. Values were only used if they were directly on the width transect. This method results in the best possible representation of the channel and cross-sectional area.

January 2024 Transect Analysis Results Using Interpolated Bathymetry

The average interpolated bottom elevation of Mardi Gras Pass was -23.6 ft with a deepest interpolated bottom elevation of -52.8 (Reach 1). Reach 2 had the deepest average interpolated bottom elevation at -26.8 ft, and Reach 4A had the shallowest average interpolated bottom elevation at -20.0 ft. The average width of MGP was 263 ft and the average cross-sectional area was 6,201 ft^2 (**Table 1**).

Table 1: Summary statistics by reach for transects used to assess the width, depth, and bottom elevation of Mardi Gras Pass based on the interpolated surface raster of the January 2023 survey.

Reach	Number of Width Transects	Avg. Width (ft)	Min. Width (ft)	Max. Width (ft)	Avg. Bottom Elevation (ft) (a)	Deepest Bottom Elevation (ft) (a)	Average Cross-Sectional Area (ft^2) (b)
1 - 4B	45	263	200	394	-23.6	-52.8	6,201
1	4	345	307	394	-25.0	-52.8	8,508
2	4	301	262	324	-26.8	-48.3	8,058
3	6	337	320	389	-24.7	-48.9	8,340
4A	9	262	209	321	-20.0	-33.5	5,197
4B	22	221	200	279	-23.9	-46.9	5,271

Table footnotes

a. Bottom Elevation is recorded using the Carlson GPS system attached to a SonarMite Echo Sounder. Average and Deepest Bottom Elevation values are derived from an interpolated surface of the bathymetric points.

b. For the purpose of this analysis, the Summation Method is used to calculate cross-sectional area for all 45 transects at 5-foot intervals. Cross-sectional area for the transects is then averaged per reach and for the entire pass. The interpolated surface fills in gaps between collected data and can potentially underestimate cross-sectional area.

Cross-sectional Area Comparison

The Summation Method was used to calculate cross-sectional area for each transect at 5-foot intervals and was compared to cross-sectional area values from the January 2023 survey (**Figure 7**). Bottom elevation values were used to calculate cross-sectional area rather than depth values due to the constant fluctuation water level in Mardi Gras Pass from Mississippi River and tidal influences. Bottom elevation is only changed by erosional or depositional processes rather than water level which is a more

realistic representation of the changes in cross-sectional area from the January 2023 survey to the January 2024 survey. For the January 2024 survey, Reach 3 contained the largest cross-sectional area measurement of 10,536 ft^2 located at transect 10 and Reach 4B contained the smallest cross-sectional area measurement of 3,852 ft^2 located at transect 33. Reach 1, as a whole, had the largest average cross-sectional area of 8,508 ft^2. Reach 4A had the smallest average cross-sectional area of 5,197 ft^2 (**Table 1**).

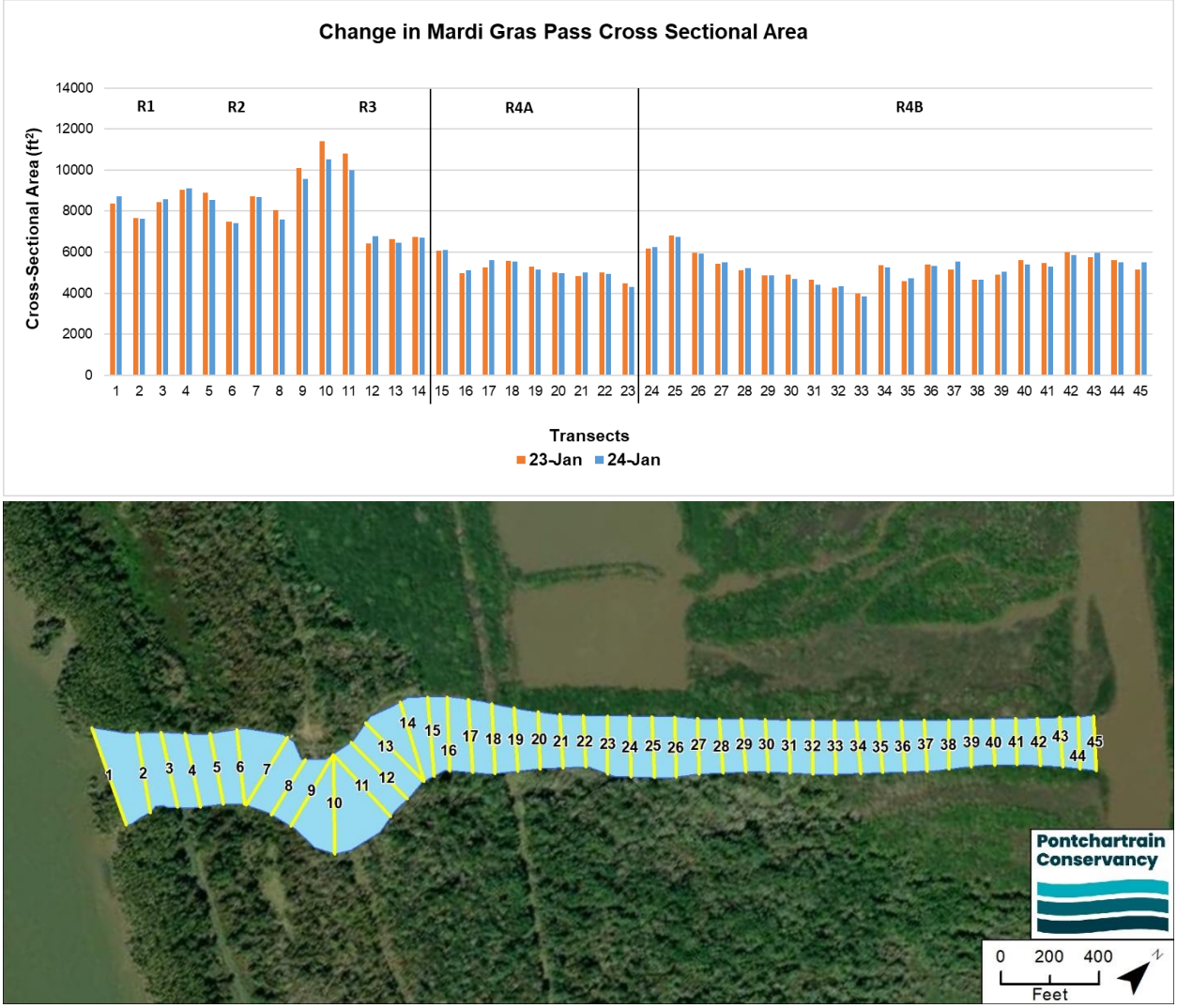

Figure 7: Cross-sectional area comparison of January 2023 vs. January 2024.

Percent change was calculated for all transects and reaches of MGP. Mardi Gras Pass as a whole had a decrease in cross-sectional area from the January 2023 survey by 0.7 %. The greatest increase in cross-sectional area occurred in Reach 4B at transect 37 with a 7.6% increase. The greatest decrease in cross-sectional area occurred in Reach 3 at transect 10 with a 7.6% decrease. Reach 2 (2.7%) and Reach 3 (4.0%) both had a decrease in cross-sectional area while Reach 1 (1.5%), Reach 4A (0.5%) Reach 4B (0.1%) had an increase in cross-sectional area (**Table 2 and 3**).

Table 2: Cross-sectional area percent change by reach from January 2023 to January 2024.

Reach	Jan-24 CSA	Jan-23 CSA	% Change
MGP	6,201	6,247	-0.7%
1	8,508	8,386	1.5%
2	8,058	8,282	-2.7%
3	8,340	8,683	-4.0%
4A	5,197	5,170	0.5%
4B	5,271	5,264	0.1%

Table 3: Cross-sectional area percent change for each transect from January 2023 to January 2024.

ID	Jan-24 CSA	Jan-23 CSA	% Change	ID	Jan-24 CSA	Jan-23 CSA	% Change	ID	Jan-24 CSA	Jan-23 CSA	% Change
1	8,715	8,372	**4.1%**	16	5,100	4,990	**2.2%**	31	4,416	4,643	**-4.9%**
2	7,623	7,669	**-0.6%**	17	5,619	5,270	**6.6%**	32	4,346	4,276	**1.6%**
3	8,597	8,455	**1.7%**	18	5,555	5,572	**-0.3%**	33	3,852	3,972	**-3.0%**
4	9,097	9,049	**0.5%**	19	5,170	5,286	**-2.2%**	34	5,265	5,360	**-1.8%**
5	8,536	8,895	**-4.0%**	20	4,967	5,001	**-0.7%**	35	4,729	4,577	**3.3%**
6	7,418	7,480	**-0.8%**	21	5,009	4,830	**3.7%**	36	5,346	5,416	**-1.3%**
7	8,700	8,719	**-0.2%**	22	4,938	5,000	**-1.2%**	37	5,524	5,135	**7.6%**
8	7,579	8,035	**-5.7%**	23	4,303	4,496	**-4.3%**	38	4,669	4,668	**0.0%**
9	9,588	10,086	**-4.9%**	24	6,262	6,171	**1.5%**	39	5,061	4,890	**3.5%**
10	10,536	11,401	**-7.6%**	25	6,750	6,813	**-0.9%**	40	5,396	5,608	**-3.8%**
11	9,989	10,801	**-7.5%**	26	5,918	5,953	**-0.6%**	41	5,301	5,482	**-3.3%**
12	6,783	6,429	**5.5%**	27	5,490	5,420	**1.3%**	42	5,870	5,997	**-2.1%**
13	6,449	6,640	**-2.9%**	28	5,224	5,105	**2.3%**	43	5,960	5,766	**3.4%**
14	6,696	6,743	**-0.7%**	29	4,853	4,877	**-0.5%**	44	5,523	5,600	**-1.4%**
15	6,116	6,087	**0.5%**	30	4,694	4,911	**-4.4%**	45	5,506	5,159	**6.7%**

Bottom Elevation Cross-sections and Profiles

Using the bottom elevation interpolation of Mardi Grass Pass and the Mississippi River several graphs were created to show size comparisons, bottom profiles, and bottom profile changes. To show size comparison (**Figure 8**) the smallest and largest cross-sections of Mardi Gras Pass were graphed on top of the Mississippi River cross-section adjacent to Mardi Gras Pass. Bottom elevations along Transect 33 (smallest) and Transect 10 (largest) were extracted from the interpolation and graphed, bottom elevation was also used for the Mississippi River cross-section just north of Mardi Gras Pass. Transect 33 (smallest) cross-sectional area is 2.2% of the Mississippi River and Transect 10 (largest) cross-sectional area is 6.4% of the Mississippi River.

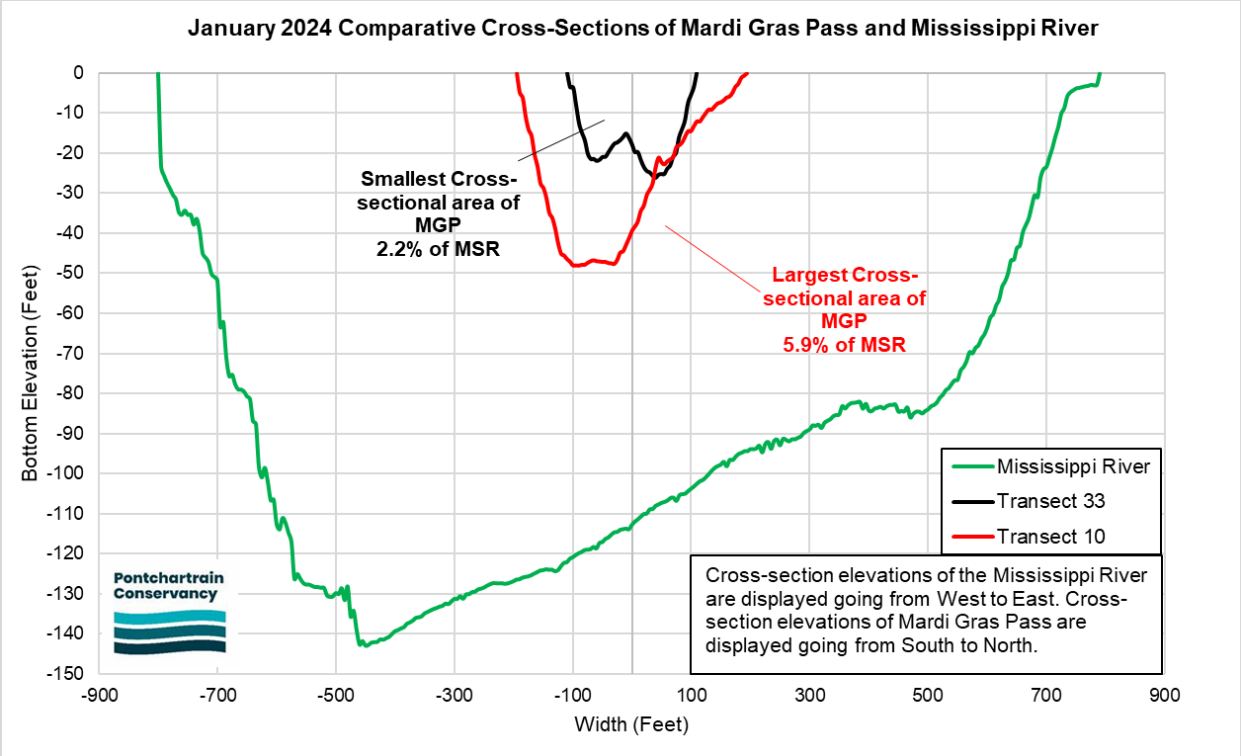

Figure 8: Comparative cross-sections of Mardi Gras Pass and the adjacent Mississippi River. The black line represents the smallest cross-sectional area found in Mardi Gras Pass and the red line represents the largest.

To examine the longitudinal profile of Mardi Gras Pass centerline points were created at the center of the width transect lines (**Figure 6**) and plotted against the distance between the transects from the Back Levee Canal to the west bank of the Mississippi River. The January 2023 profile from the previous report was superimposed with the January 2024 profile in order to compare the surveys and look for deposition or erosion along the bottom of Mardi Gras Pass (**Figure 9**).

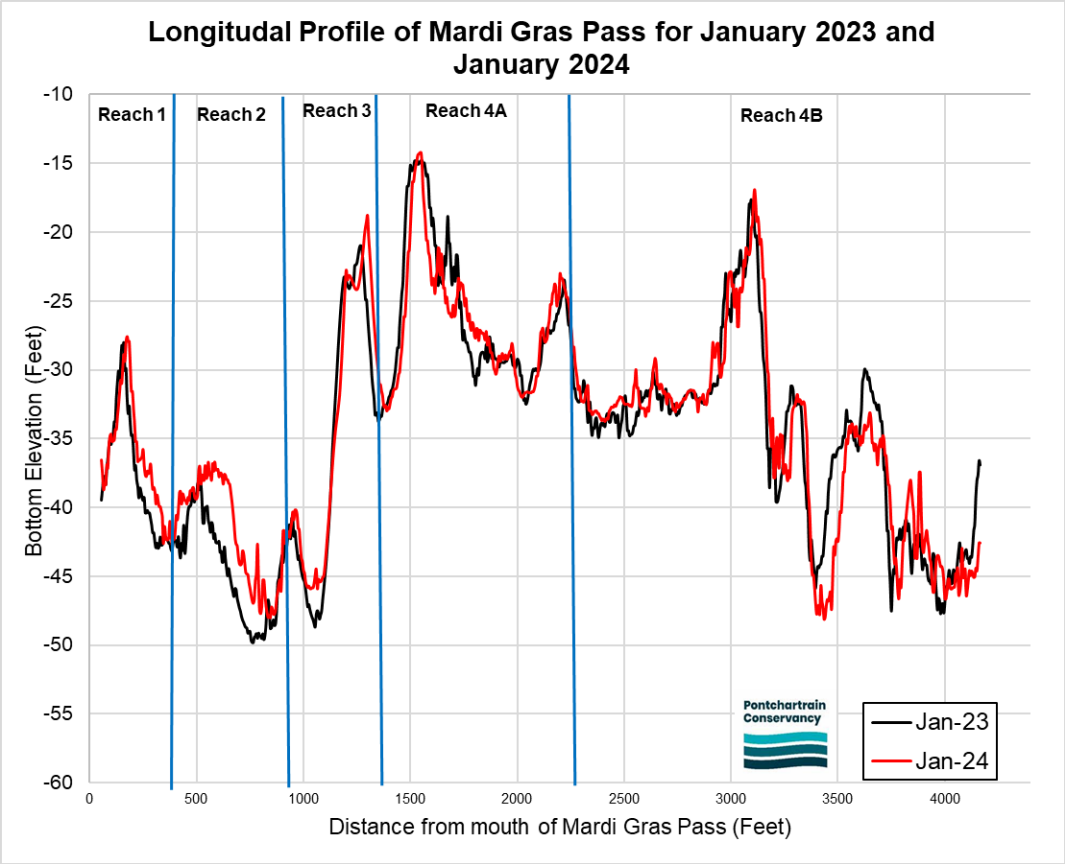

Figure 9: Comparative bottom elevation profiles of Mardi Gras Pass for both the January 2023 survey and January 2024 survey. Both profiles are down the respective centerline of Mardi Gras Pass and to scale.

Conclusion

The time period from January 2023 to January 2024 was a period of both high and low water on the Mississippi River. The 2023 flood season at New Orleans lasted 41 days and never reached the 17ft flood warning stage. A severe drought followed the 2023 flood season and caused lower than normal water levels on the Mississippi River. From the January 2023 to January 2024 survey, changes were overall minimal. The average width of MGP stayed the same (from 263 ft to 263 ft), while it experienced a decrease in average bottom elevation (from -23.8 ft to -23.6), and a decrease in average cross-sectional area (from 6,247 square ft to 6,201 square ft). The decrease in average cross-sectional area and average bottom elevation are due to deposition of sediment carried by the Mississippi River. The cross-sectional area of MGP now ranges from 2.2% to 5.9% of the adjacent Mississippi River. For a 2nd consecutive year MGP saw a decrease in cross sectional area, this is likely due to sequential (2021, 2022, and 2023) modest flood seasons on the Mississippi River compared to above average flood seasons as seen in 2016, 2019, and 2020. The modest flood seasons allowed for more deposition to take place. Given the recent changes from this survey and the previous survey it appears that MGP is reaching a state of equilibrium. PC will continue to monitor Mardi Gras Pass through the 2024 flood season and low water time period.