Gay Stamp Sands 2016 pond volume estimates using 2016 U.S. Army Corps of Engineers Lidar elevation data

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This document summarizes estimates of pond volume by stamp sands near Gay, Michigan and the potential stamp sand fill capacity of these ponds.

Rasterized topobathy lidar elevations were obtained from the Army Corps of Engineers and collected by the Coastal Zone Mapping and Imaging Lidar (CZMIL) System in the International Great Lakes Datum of 1985 (IGLD-85). The individual tiles were mosaicked together in ArcMap using the Mosaic to New Raster tool. The mosaicked image was reprojected into NAD1983_UTM_Zone_16N with the Project Raster (Data Management) tool and the resampling technique was set to bilinear. The Raster Calculator was used to adjust the elevation data to height and depth by subtracting the average mean water level, 183.735 m, on September 20, 2016 obtained from the National Oceanic and Atmospheric Administration (NOAA) tide gauge in Marquette, MI (https://tidesandcurrents.noaa.gov/).

Pond boundaries were digitized manually in ArcMap using the National Agriculture Imagery Program (NAIP) 2016 near-infrared band 4 and true color images as boundary guidelines. Since there were some gaps in the lidar data within pond boundaries, data gaps were filled with an estimated depth of 1.5 m using the raster calculator (based on the typical bottom depth of other stamp sand ponds). The length of each cell was 0.8381 m, so 0.7023 m^2 was multiplied by the depth raster to obtain a raster layer where each pixel represented the volume.

The Zonal Statistics as Table tool was used to compute the sum of the volume within each pond. The input raster was the layer of volume and the zone field was the pond boundaries. It is important to note that any pixels above mean water level were positive and below were negative. Thus the volume of the pond is representative of the volume below mean water level. The zonal statistics tool was also used to compute the mean depth and the area of ponds using the depth layer as the input in place of the volume layer.

The total volume was 91773 m^3 and could hold 151426 metric tonnes of stamp sands (with a density of 1.65 metric tonnes per m^3). Out of 50 ponds total, 11 had an area greater than 1000 m^3. The volume sum of the 11 ponds contributed to 97.6% of the total pond volume, and thus, further analysis focused on this subset of ponds (table 1; figure 1). Two ponds were located in the section close to the old coal dock (ponds F and J). Pond F has been largely dynamic in the past few years. A portion of the pond that existed in 2014 is now in the lake as the coastline has migrated inland. Ponds B, E, and G, which are located in the northeastern area of ponds, are farther inland. However, lidar data were

not available for the majority of these ponds (with the assumed depth of 1.5 m). Ponds A, C, D, H, I, and K were relatively stable over the past two years and the majority of data were available from the lidar. Pond A was the largest pond, 55014 m^3, which was 58.5% of the total volume.

Table 1. Summary of ponds with an area greater than 1000 m^3

Pond	Mean Depth (m)	Area (m^2)	Volume (m^3)	Percent total Volume (%)	Potential Stamp Sand Capacity (metric tonnes)
A	0.9	78329	55014	58.5	90774
B	0.8	13043	9161	9.7	15115
C	0.7	9368	6580	7.0	10857
D	0.9	6448	4529	4.8	7472
E	0.6	5947	4177	4.4	6891
F	0.8	5422	3808	4.1	6284
G	1.0	3763	2643	2.8	4361
H	0.5	3258	2288	2.4	3776
I	0.2	2738	1923	2.0	3173
J	0.3	1339	940	1.0	1551
K	0.4	1011	710	0.8	1172
Sum	--	130667	91773	--	151426
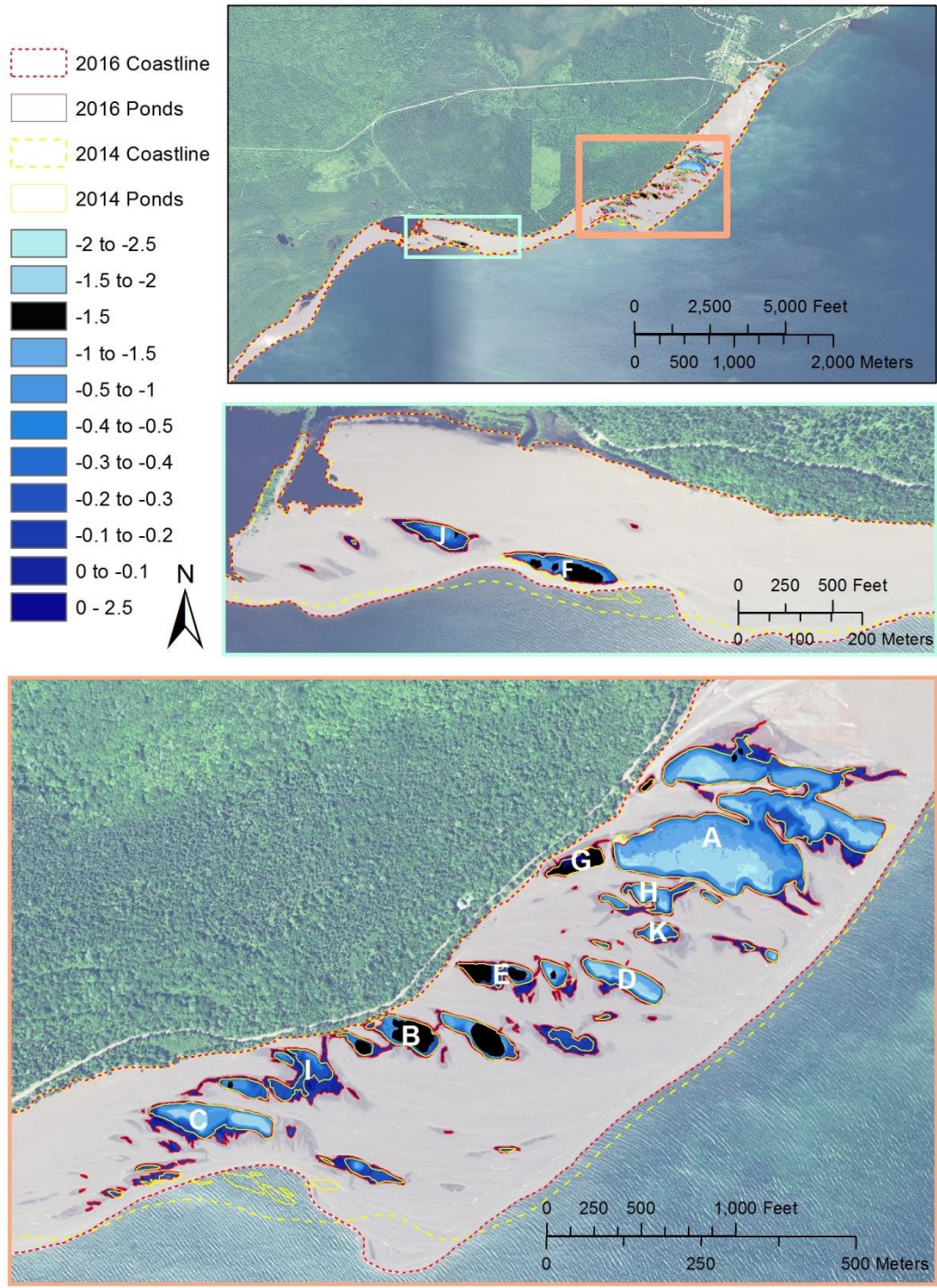
Figure 1. Digitized pond boundaries shown for 2014 (yellow) and 2016 (red) with the respective coastlines show the dynamicity of ponds by stamp sands near Gay, Michigan. Ponds are filled by depth values in meters relative to mean water level. Areas where lidar data were not available are shown in black and values were assumed 1.5 m below mean water level. The 2016 NAIP compressed orthoimage is displayed in the background.