PRELIMINARY ASSESSMENT OF EROSIONAL PROCESSES ON WISCONSIN POINT - COMPARISON OF SHORELINE AND LiDAR DATA (2008 – 2019)

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Purpose:

The purpose of this analysis is to determine if there is a habitat need for beach nourishment along Wisconsin Point's lakeward shoreline between the Superior Entry and Morrison Creek. I quantified shoreline movement metrics and sediment deposition/erosion dynamics within the evaluation area with results and interpretation presented below.

Methodology:

Shoreline Change Analysis – I conducted shoreline change analyses using the U.S.G.S. Digital Shoreline Assessment System (Himmelstoss et al 2021; version: 5.1.20200720.0030) with datasets derived from National Agriculture Imagery Program (NAIP) imagery collected in 2008, 2010, and 2018. I extracted the NAIP for the Wisconsin Point evaluation area and used the ISO Unsupervised Classification Tool (ArcGIS Pro 2.8.0) to create land and water classifications. Visual shoreline delineation was necessary when automated classification failed accurately identify the shoreline boundary. I used the resulting shoreline datasets as inputs for DSAS analyses following guidelines in Himmelstoss et al. (2021) and implemented in ArcGIS Desktop 10.6.1. Specifically, I calculated net shoreline movement (NSM) and linear regression rate (LRR) of shoreline contraction/expansion.

Sediment Dynamics Assessment – I compared topobathymetry derived from LiDAR data collected in 2009 and 2019. I created digital elevation models from the LiDAR point cloud data using linear triangulation methods to interpolate between points. I then used a simple raster calculation to identify deposition (+) and erosion (-) zones within the evaluation area. All data manipulation and analyses were conducted in ArcGIS Pro 2.8.0.

Results:

Shoreline Change Analysis – There has been an overall contraction of shoreline within the evaluation area amounting to an estimated 2.45m (±0.82 SE) between 2008 and 2018. The rate of change across the entire evaluation area was estimated at -0.55m/year (±0.09 SE). Sixty six of the 140 transects evaluated showed some degree of contraction (47.14%; Figure 1).

Although shoreline expansion was also detected, there were two focus areas along the length of the evaluation area that warranted further investigation: Parking Lot #1 (Figure 2) and Schafer Beach (Figure 3). Transects within each of the two focus areas were extracted and shoreline change statistics were calculated for each (Table 1). The Schafer Beach focus area has

experienced the greatest net shoreline movement and rate of change with the Lot 1 focus area also showing considerable contraction when compared to the contraction and rate of change for the overall evaluation area.

Sediment Dynamics Assessment – Sediment transport estimation corroborated the results of the shoreline change analysis. The largest net loss of sediment overlapped with the greatest contraction of shoreline, namely the two focus areas identified during the shoreline change analysis (Figures 4 & 5).

Interpretation:

This shoreline change analysis and sediment dynamics assessment for Wisconsin Point indicates that erosional processes are reducing the amount of beach habitat. The lakeward shoreline across from Park Lot #1 and Schafer Beach exhibited strong evidence of habitat loss and warrant consideration for beach nourishment. Interestingly, much of the remaining shoreline exhibited a relatively stable shoreline extent.

It is important to note that water level conditions have changed considerably during the time window that we examined for this analysis (Figure 6). From 2008 to 2019 the annual average hit its lowest in 2011 at 183.25m above sea level and peaked at 173.76m in 2018. Higher water levels during the latter dataset would have influenced shoreline placement and estimation. However, when examined alongside the LiDAR analysis, we see that erosional processes are most severe in areas proximal to shoreline recession. Together, these two datasets tell confirm that erosional processes are occurring near Lot #1 and along portions of Shafer Beach.

This type of analysis provides a starting point for evaluating the need for beach nourishment and habitat restoration management actions and could be combined with more sophisticated analyses to elucidate ongoing sediment transport, erosion, and shoreline contraction patterns and identify priority areas for the beneficial use of dredge material.

Table 1. Shoreline change statistics calculated at specific segments along Wisconsin Point using the USGS DSAS software package (version: 5.1.20200720.0030) to evaluate shoreline imagery from 2008, 2010, and 2018.

Focus Area	Segment Length (m)	Number of Transects	Average Contraction (m)	Rate of Change (m/yr)
Lot 1	939.57	20	9.68 (±1.75 SE)	-1.15 (±0.16 SE)
Schafer Beach	982.42	21	15.36 (±1.81 SE)	-2.22 (±0.19 SE)
Evaluation Area	3,705.47	140	2.45 (±0.82 SE)	-0.55 (±0.09 SE)

Wisconsin Point Shoreline Evaluation (2008 - 2018)

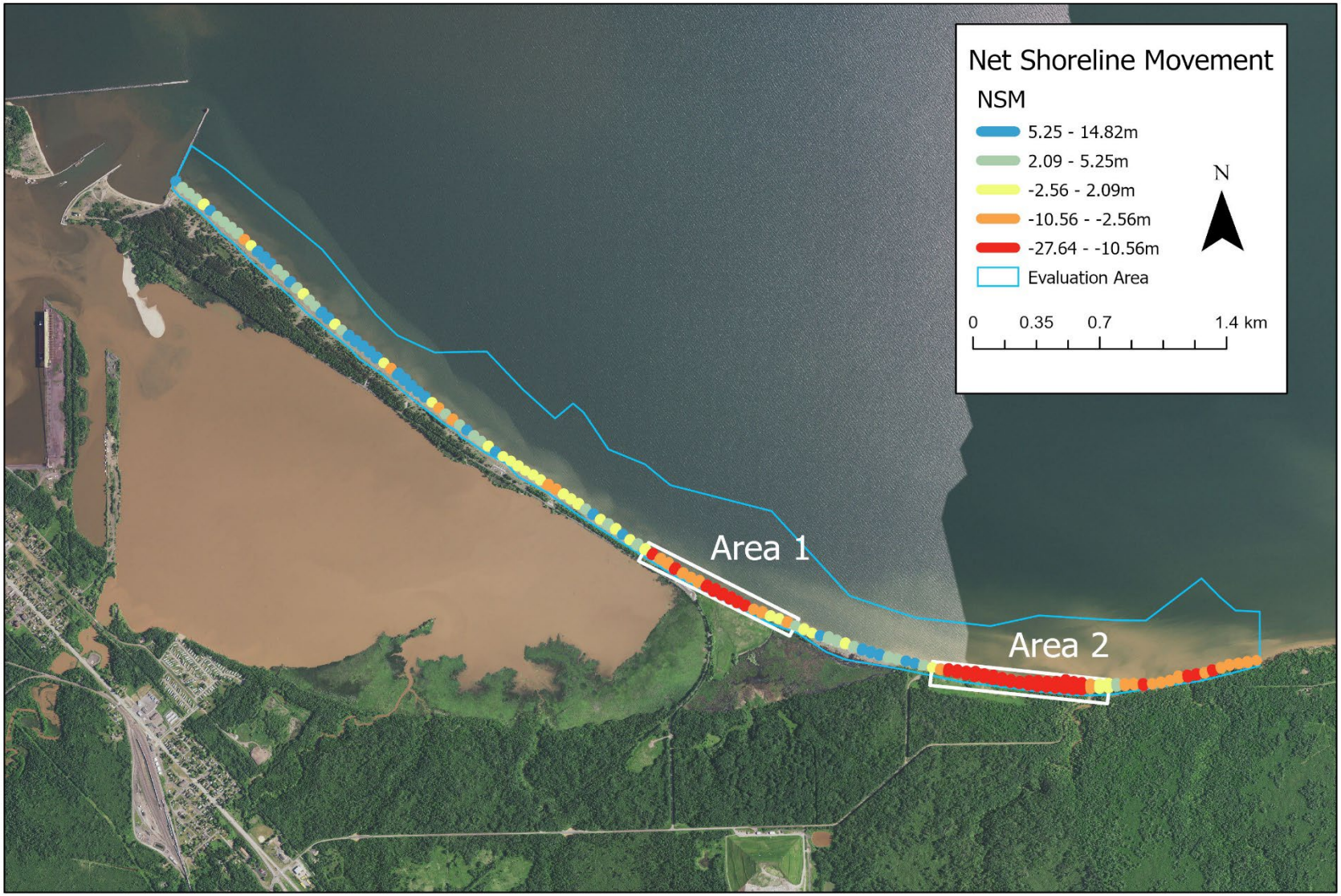

Figure 1. Net shoreline movement (NSM) calculated for the Wisconsin Point shoreline change assessment area derived from shoreline data from 2008, 2010, and 2018.

Wisconsin Point Shoreline Evaluation (2008 - 2018)

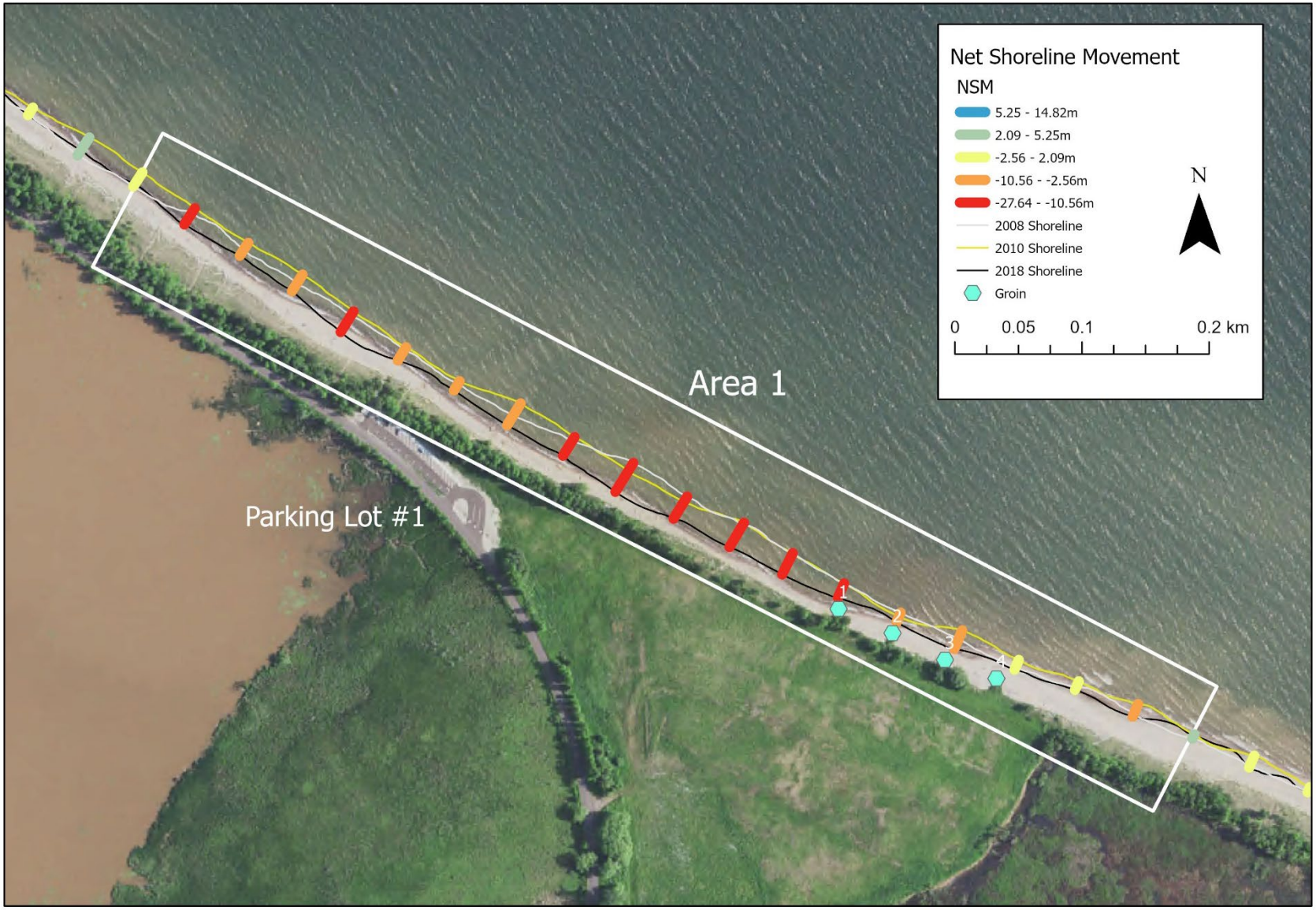

Figure 2. Net shoreline movement (NSM) calculated for Focus Area #1 within the Wisconsin Point evaluation area with metrics derived from shoreline data from 2008, 2010, and 2018.

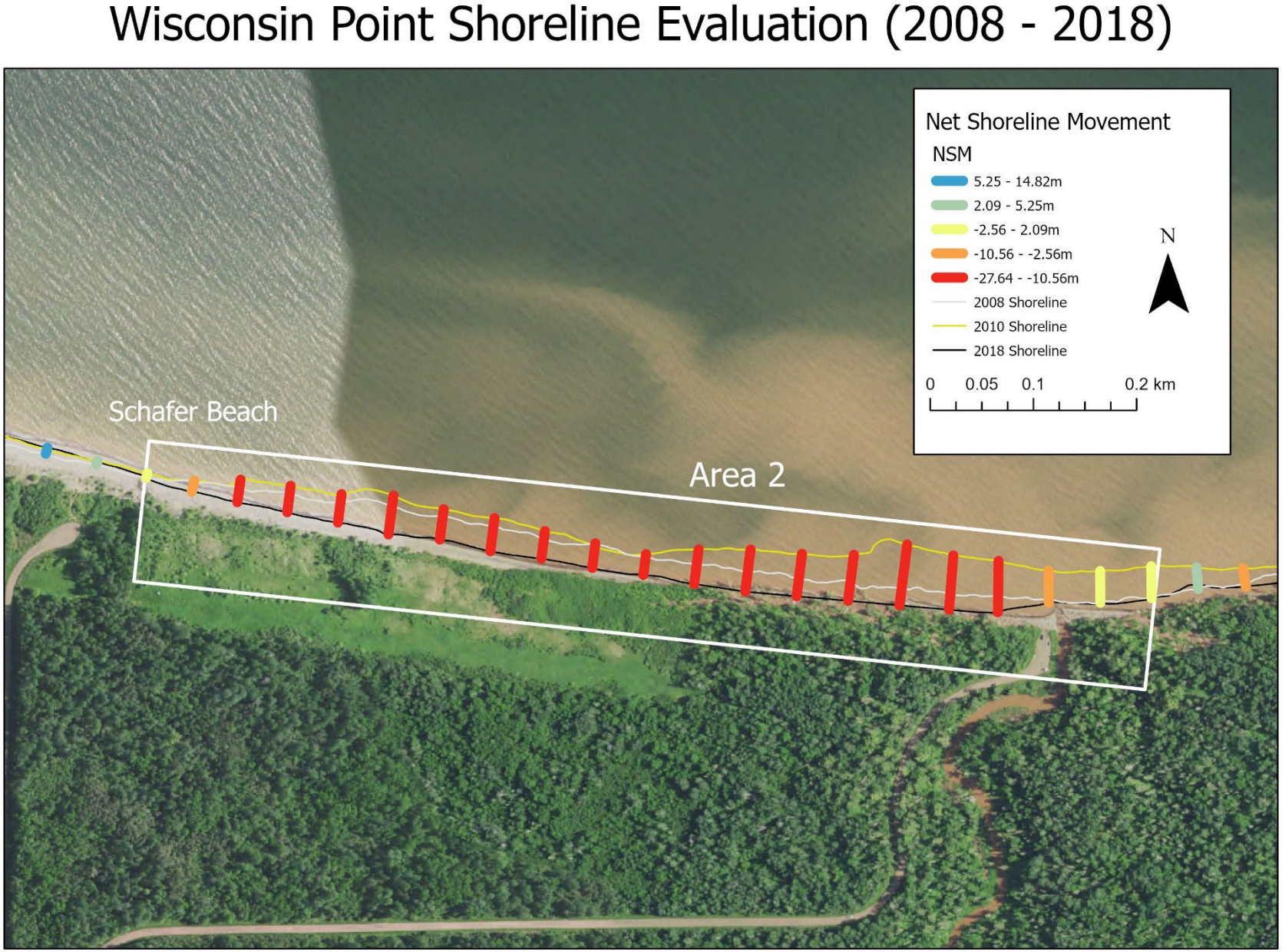

Figure 3. Net shoreline movement (NSM) calculated for Focus Area #2 within the Wisconsin Point evaluation area with metrics derived from shoreline data from 2008, 2010, and 2018.

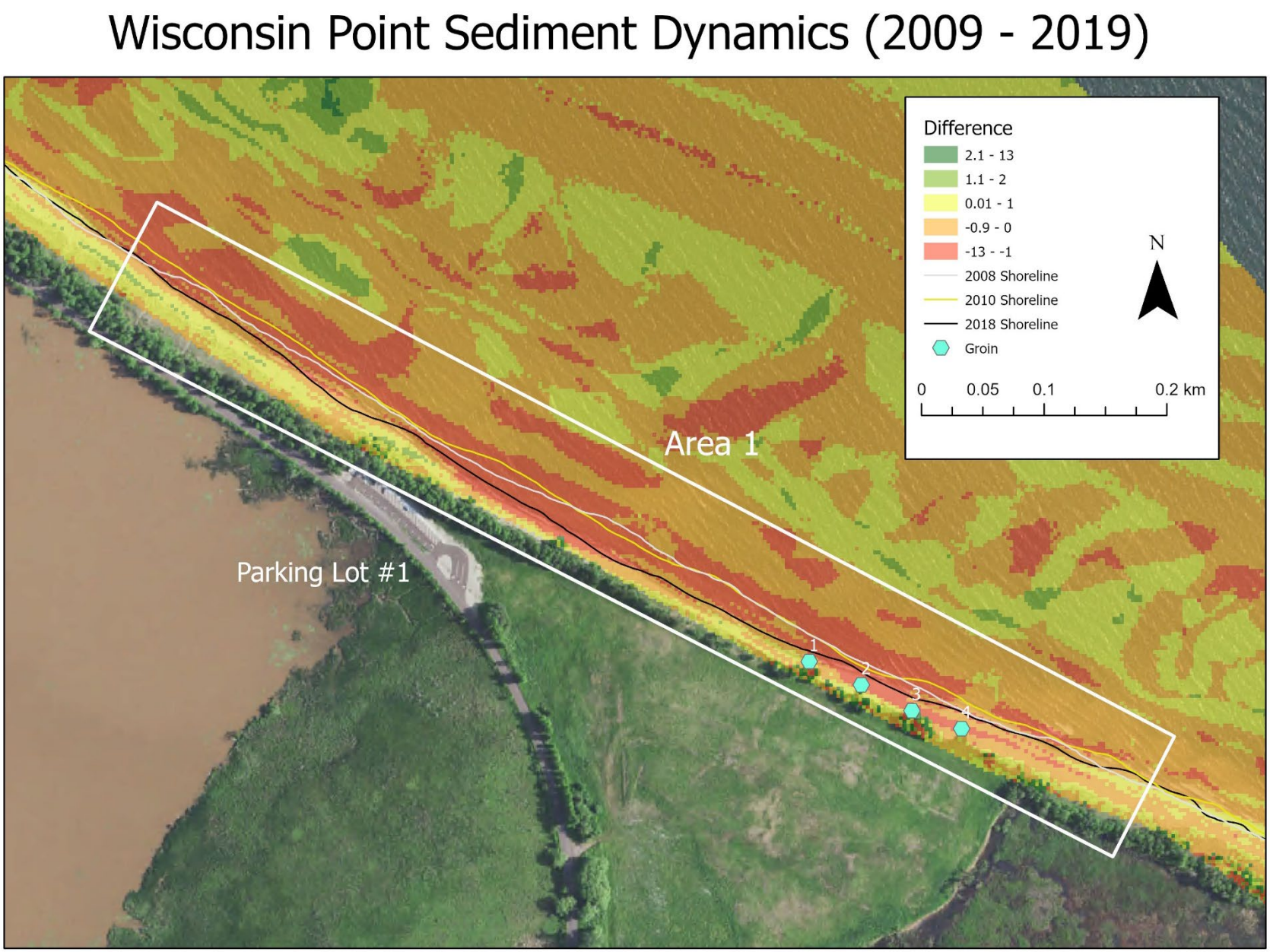

Figure 4. Sediment deposition (+) and erosion (-) estimated for Focus Area #1 based on a comparison of 2009 and 2019 LiDAR datasets within the Wisconsin Point evaluation area.

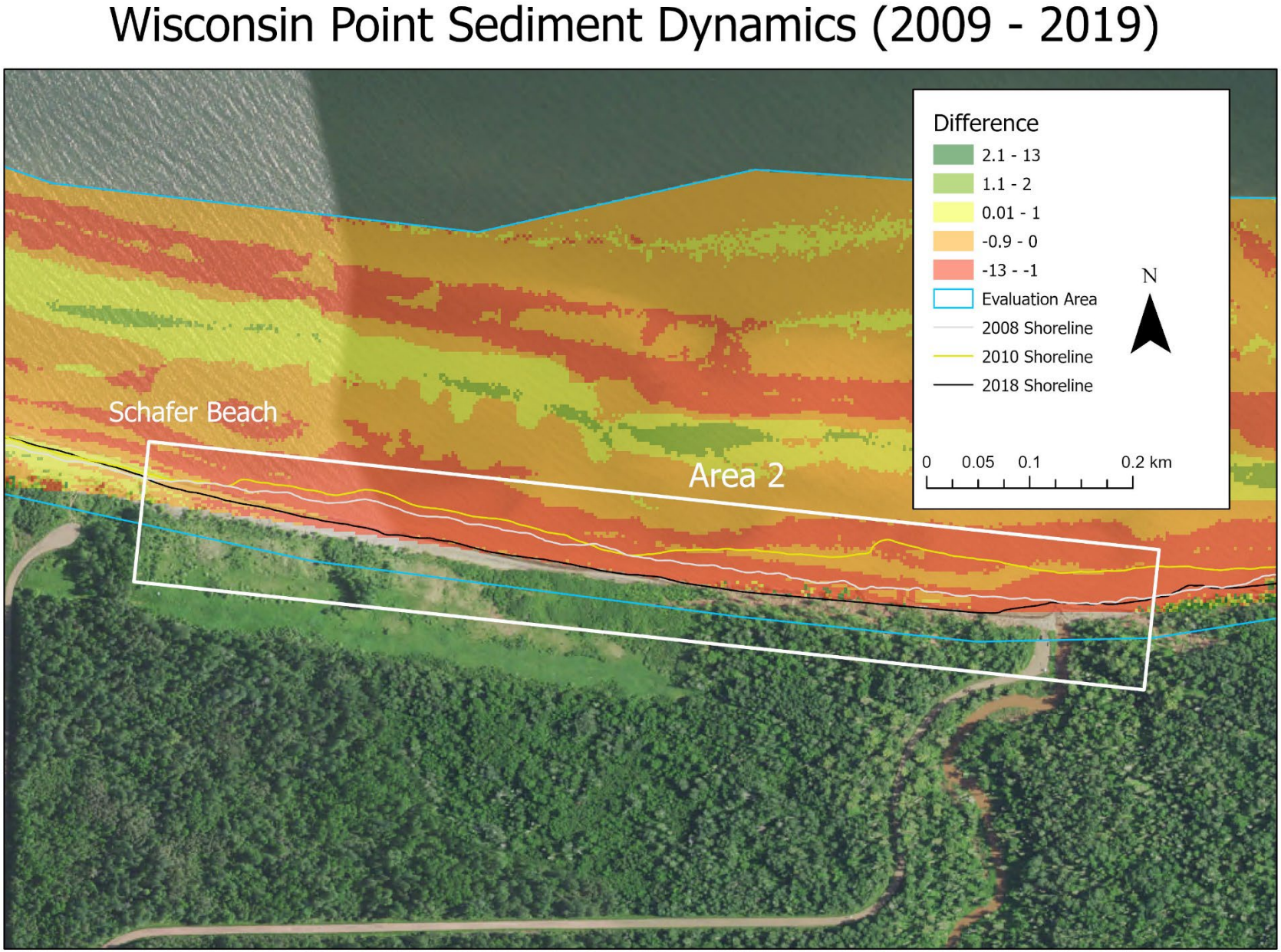

Figure 5. Sediment deposition (+) and erosion (-) estimated for Focus Area #2 based on a comparison of 2009 and 2019 LiDAR datasets within the Wisconsin Point evaluation area.

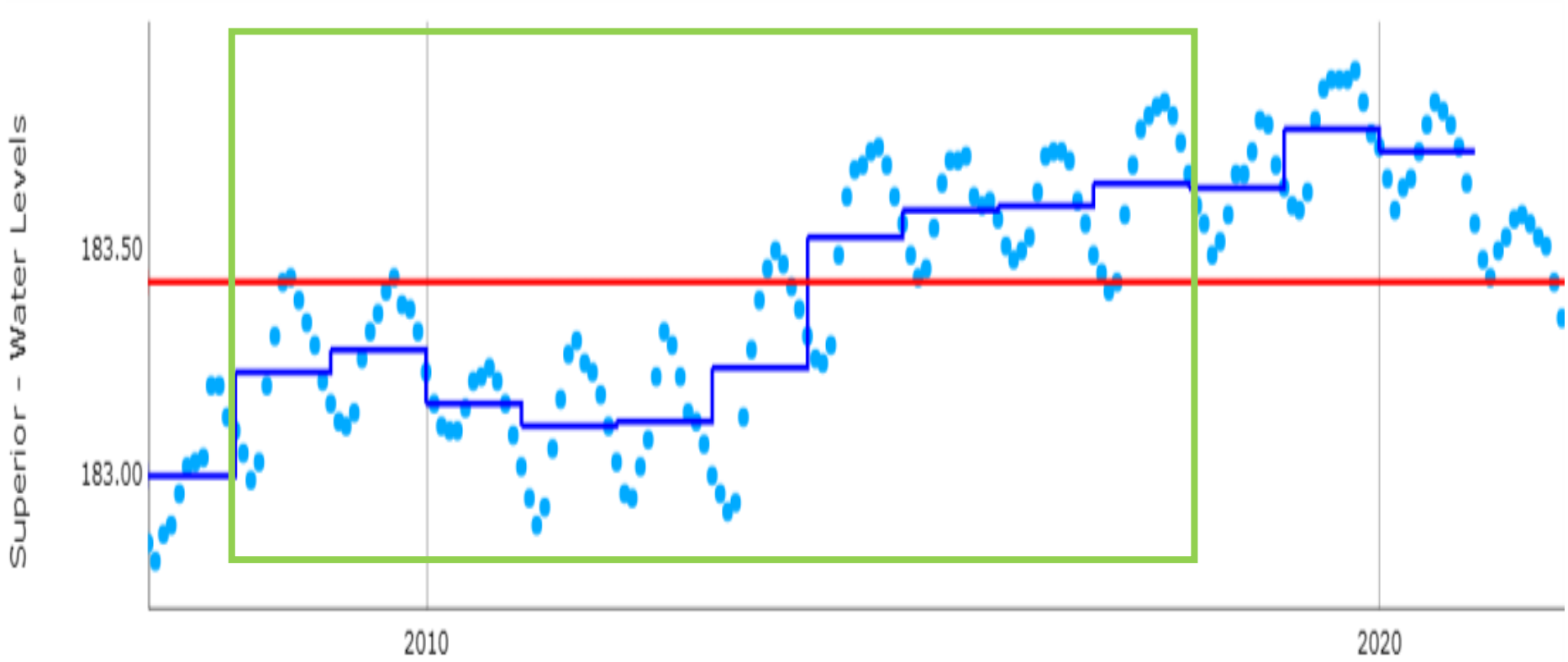

Figure 6. Annual water depth data for Lake Superior obtained from the NOAA Great Lakes Environmental Research Laboratory's Great Lakes Dashboard (link: https://www.glerl.noaa.gov/data/dashboard/GLD_HTML5.html). The green rectangle identifies the time period examined in our shoreline and LiDAR analyses for the Wisconsin Point assessment area.