

Stamp Sands Mapped from 2009 and 2016 Using Remote Sensing Data

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To quantify percentage change of stamp sand extent in the Buffalo Reef region of Grand Traverse Bay 2009 NAIP color photography and 2016 Sentinel-2 ocean color satellite data were used to map the bottom type substrate. Depth correction procedures were applied to both data sets to identify stamp sand deposits. Due to varying water clarity during 2009 and 2016 the observable area of the lake bottom varied between the two dates. To allow for inter-comparison between the 2009 and 2016 bottom type maps the analysis was constrained to the bottom area visible on both images. The total area of Buffalo Reef is 9.2 km² while the area visible on both images is 4.83 km² or approximately 52%.

The figure summarizes the analysis of the 2009 NAIP and 2016 satellite data. The left two panels represent the 2009 analysis reported in Kerfoot et al. 2012, while the bottom center and right panels are the classification of the 2016 satellite data. Note from the lower panels on the figure that the stamp sands (red) appear to be more uniformly distributed in 2016 throughout the area successfully resolved by the remote sensing systems. The percent of stamp sands successfully identified in Buffalo Reef in 2009 is approximately 33%, while the 2016 analysis indicates approximately 35% dense stamp sand and a 20% stamp sand/native sand mixture for an approximate total of 55%. Note, the portion of Buffalo Reef shown in brown is where the bottom was not detectable to the sensors. Due to uncertainties in the remote sensing analysis (water clarity changes, sensor resolution, sensor fidelity) caution should be taken in respect to utilizing specific the percentages presented. The table summarizes the comparisons present in the figure.

The Total Area of Buffalo Reef (polygon) is 9.2 km ²	Imagery Date	
	2009	2016
Area of Buffalo Reef Identified (km ²)	4.83	4.83
Dense Stamp Sand Area Identified in Buffalo Reef (km ²)	1.6	1.72
Mixed Stamp Sand Area Identified in Buffalo Reef (km ²)		0.94
Percent of Dense Stamp Sands in Identified Buffalo Reef	33%	35%
Percent of Total Stamp Sands Identified in Buffalo Reef	33%	55%

Classification of Stamp Sands near Gay, Michigan

Comparison of the 2009 and 2016 bottom type classification of stamp sands in Buffalo Reef in Traverse Bay. Images on the left show 2009 classification from NAIP imagery at 1 m resolution as described in Kerfoot et al. (2012) and images on the upper right, bottom center, and bottom right show 2016 classification obtained from the 10 m resolution Sentinel-2 collected on May 19, 2016. The images were depth corrected and normalized to represent the area where the bottom was detected by both sensors, NAIP and Sentinel-2 (2009 and 2016). The percentage of dense stamp sand coverage observed in 2009 and 2016 are 33% and 35% within the detectable area, respectively. The percentage of mixed area for 2016 is 20% within detectable area, and thus total stamp sand coverage (2016) is 55% within the detectable area. The extent of Buffalo Reef is outlined in black. Brown represents the no data areas within Buffalo Reef where the bottom was not visible and the area was not detected by either sensor, NAIP in 2009 or Sentinel-2 in 2016.

