

## ABSTRACT

Crescent Dune Beach, a stretch of coastline along the southern shore of Lake Michigan in the Indiana Dunes National Park, is among the most erosive beaches in the world (Luijendijk et al. 2018; Robinson et al. 2024). East of the beach, the Michigan City Harbor is impeding the natural littoral transport of sediment. The erosion at Crescent Dune has been compounded by near-record high water levels in 2020, which continue to remain above average. A series of topo-bathymetric surveys involving single beam sonar, backpack terrestrial LiDAR, and a GNSS survey rod were conducted as part of a United States Army Corps of Engineers (USACE) beach nourishment monitoring program. In addition to monitoring the morphology of sand from a subaerial nourishment, this study aims to determine changes to the subaerial beach, nearshore, and Mt. Baldy sand dune through comparisons to historical topo-bathymetric data between 2012 and 2023. The subaerial beach volume change between 2012 and 2020, coinciding with a steady rise in water levels, was the highest compared to other periods, ranging from  $-9 \text{ m}^3/\text{m}/\text{yr}$  to  $-122 \text{ m}^3/\text{m}/\text{yr}$ . Additionally, subaerial erosion is most pronounced along the western sections of Crescent Dune Beach. Sand volume losses for the nearshore region exceeded  $-100 \text{ m}^3/\text{m}/\text{yr}$ , and cross-shore profiles showed a continuing trend of down-cutting in the seafloor between 2012 and 2024. Finally, the crest of the Mt. Baldy sand dune is steadily retreating southward, posing the risk of inundation to National Park Service (NPS) property. The results of this study provide valuable insights into the extent of beach rebuilding and erosion since the near record-high water mark in 2020, reveal morphological changes to the Mt. Baldy sand dune, and contribute to improved outcomes for future nourishment projects. Routine beach nourishments at this site have greatly mitigated erosion, though it remains a concern.