Incorporating Resiliency into Coastal Beach Restoration

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ABSTRACT

Traditional beach assessments have historically focused on the identification of point and non-point pollution sources impacting water quality from a microbiological (regulatory) perspective. However, changing weather patterns and water levels will require beach managers to examine not only methods to reduce beach advisories but also ways to ensure that any structural or environmental alterations will be sustainable. Racine, WI has purposely worked to create a resilient shoreline during the restoration of Samuel Myers Park. Located in an embayment on the shore of Lake Michigan, successive waves of accretion and periodic reliction resulted in the accumulation of sediments at the shoreline (Figure 1), allowing the formation of wetlands. However, wetland function was impaired, it being primarily comprised of non-native species. Surface water quality was also unsupportive of recreational uses. In 2009, a 4-year intensive monitoring program to identify pollution sources, delineate the wetland, develop engineering plans and secure permits began. More frequent and intense storms required incorporation and/or amendment of design elements with the ability to absorb the force of and accommodate the volume of water associated with these events, e.g. supplementing an existing breakwater, constructed wetlands, rain gardens and dune features with a dredged spoil core. Completed in November 2017, the restoration has resulted in reduced nutrient loading, improved surface water quality, and the return of fish, amphibians and increased migratory bird diversity. Improved wetland function has been aided by the development of successive coastal ecosystems (upland, dry prairie, interdunal/constructed wetlands and dunes), preventing direct stormwater runoff from reaching the shoreline. The creation of hydrologic connectivity between the wetland features has proven protective water level changes resulting from storm surges and seiches, through successive storm events. Nearshore water quality has improved by 50%, resulting in the removal of a decades long swim ban and the designation of an offshore "boaters beach".

INTRODUCTION

Beginning with the removal of approximately 5 acres of Phragmites in 2013, the City of Racine Public Health Department worked diligently to secure funding and make engineering redesign plans become a reality during the lifetime of our permits (2014 – 2017). While great success occurred for several initiatives, e.g. reducing invasive species to <10% of their original cover, attracting migratory birds (including piping plovers and a bald eagle) and planting over 50,000 native upland, wetland, dune and sand (dry) prairie plants/trees to infiltrate stormwater and reduce nutrient loading, frequent/intense coastal storms resulted in additional time and expense; site improvements were necessary to create resiliency. While traditional recreational water monitoring and beach sanitary survey have focused on the protection of public health and identification of pollution sources influencing surface water quality, implementation of resultant mitigation measures must account for changing weather patterns in order to fully actualize the benefits of coastal beach restoration as well as maintaining site sustainability/utility over time.

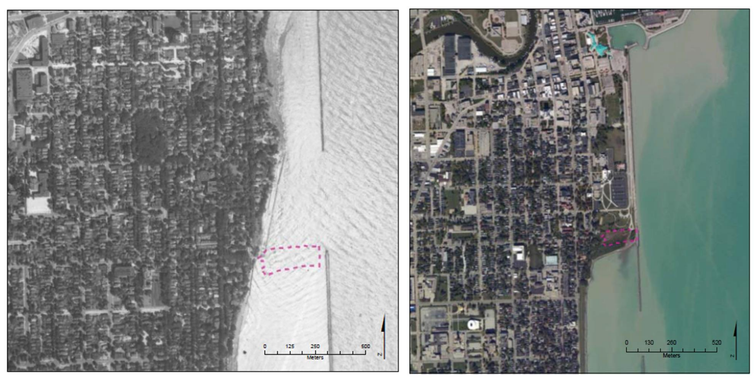

Figure 1. Samuel Myers Park was created through successive periods of infill by the City of Racine , beginning in the 1950's. The image on the left shows the future location of Samuel Myers Park in 1937 (purple box). The image on the right shows Samuel Myers Park as it appeared in 2014, at the start of the project. Connecting the breakwater to the land in 1972 resulted in significant accretion of sand along the shore as well as migration of sands associated with a beach to the south due to the interruption of alongshore currents and hydrologic changes.

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APPROACH

Insufficient water quality and public access led to underutilization and a permanent swim ban at Samuel Myers Park. Intensive monitoring (BEACH Act, routine and annual beach sanitary surveys), conducted in 2007 and from 2010 – 2012, identified multiple factors contributing to poor water quality including: sedimentation, resident wildlife populations and NPS runoff. Based on this information, a comprehensive, adaptive, science driven redesign plan (Figure 2) was crafted with these designated outcomes: 1) improving water quality through the control of NPS pollution, 2) removing invasive species, 3) restoring coastal habitat, 4) enhancing public access and 5) maximizing public utility via cross demographic recreational opportunities. Adopted by the City of Racine Parks Board in 2013, the engineering plans were crafted to be implemented in multiple Phases (Phases I – XI), with each Phase being discreet and of public benefit while remaining integral to the whole. While knowledge of the pollution sources/behaviors and public desire with respect to access and parks programming allowed for development of science driven beach redesign plans and a set of recommended best management practices to improve surface water quality, restore coastal habitat, improve aesthetics, and provide adequate public access to a variety of passive and active recreational opportunities, they did not account for the potential force and volume of water that resulted from more frequent and intense storm event as well as almost historic high water levels (Figure 3). In order to enhance resiliency, amendments to existing and additional (green) infrastructure components were added.

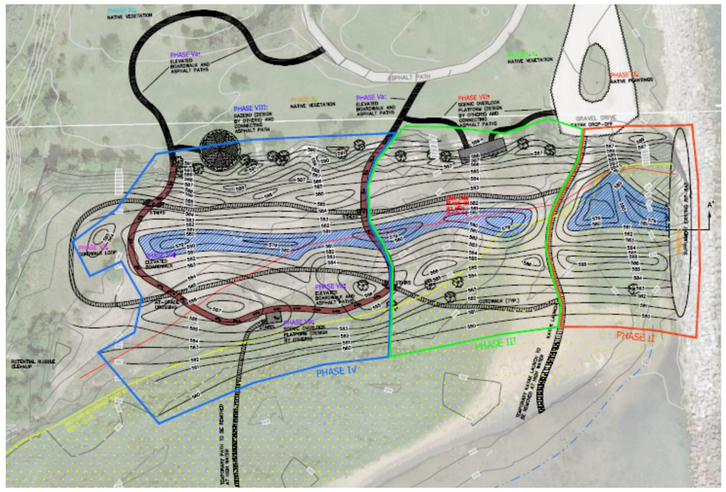

Figure 2. Original conceptual redesign plan showing phased implementation (above). Figure 3. Intense storms can dramatically raise water levels via a variety of mechanisms, e.g. storm surge, runoff, and wave run up (below).

RESULTS

The addition of a return flow channel and creation of hydrologic connectivity between the three wetlands via a culvert and swale system has proven protective from storm surges, water level changes and resulting hydraulic head through successive storm events (Figure 4). Fully implementing the redesign plans has significantly improved water quality, resulting in the removal of a decades long swim ban in 2017 and the designation of an offshore "boaters beach" in 2018 (Figure 5).

Figure 4. Examples of coastal resiliency measures – Samuel Myers Park (Clockwise from top left: return flow channel, culvert, bioswale, rain garden, French drain and energy dissipators.

Site	Year	Sample Depth (ft.)	n	Median *E. coli* (MPN)	No. Advisories	%
SM-E3	2015	3	14	178.5	6	42.9
SM-E3	2016	3	8	108.5	1	12.5
SM-E3	**2017**	**3**	**13**	**41**	**1**	**7.7**

Figure 5. Dramatic recreational water quality improvements have been actualized since 2015 as a result of engineering redesign plan implementation.

CONCLUSIONS

Supplementation of an existing breakwater, and addition of constructed wetlands, a 4500 SF rain garden, bioswale, a dry prairie transition (to wetlands) and dune features has resulted in ease of invasive species management, reduced nutrient loading, improved surface water quality, and the return of fish, reptiles, amphibians and increased migratory bird diversity. Improved wetland function has been aided by the development of successive coastal ecosystem plant communities (upland, dry prairie, interdunal/constructed wetlands and dunes), preventing direct stormwater runoff from reaching the shoreline. Samuel Myers Park is no longer an "off limits" stretch of coast but a well utilized recreational venue and outdoor classroom benefitting present and future residents due to the incorporation of coastal resiliency into this beach restoration project.