Living Shorelines and the Future Restoration of Coney Island Creek

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Abstract

Coney Island Creek is a small inlet around the western tip of Coney Island in Brooklyn, New York. During the catastrophic events of Hurricane Sandy in 2012, flooding from the Creek greatly affected the local community. Since this major storm event, New York City has set forth plans for coastal resiliency for future events, including plans specific to the Coney Island Creek, through professional feasibility studies and community workshops. Living shorelines are a form of shoreline stabilization treatment that makes use of natural materials and allows for natural habitat functions to take place. Living shorelines form part of the Coney Island Creek resiliency plan, which also includes hardened measures such as seawalls and a constructed tidal barrier. More recent findings of the benefits of living shorelines highlight their "blue" carbon capability (sequestration of carbon at tidal marshes) and empirically demonstrated effectiveness as nursery habitat for local marine life. Given the importance of living shorelines to both aquatic life and local community needs and interests, this paper synthesizes the work the city has done on coastal resilience for the Coney Island Creek, the ecological and protective role of living shorelines in this local context, and these more recent findings of the benefits of living shorelines, underscoring the importance of ensuring that living shorelines are a part of future plans for Coney Island Creek resiliency and restoration.

Introduction

On February 4, 2017, a community board meeting involving residents of famed Coney Island in Brooklyn, New York took place to discuss aspects of the future remediation of the Coney Island Creek, a neglected body of water long-suffering from sewer overflow and illegal dumping (Spivack, 2016; Wellington, 2014). When Hurricane Sandy hit New York City in 2012, the Creek overflowed into the surrounding neighborhood due to storm surges and overflow, damaging property and contributing to the submerging of the area under a five-foot high water mark (Steinberg, 2015).

Coney Island Creek is a small inlet around the western tip of Coney Island flowing from Gravesend Bay, part of lower New York Bay (Fig. 1). Coney Island itself, located on the southwestern shore of the borough of Brooklyn in New York City, has been long renowned as the "people's playground," owing to its history as the original amusement park area of the United States (Cudahy, 2009). With its long stretch of beaches, recreational attraction to the area began with humble retreats and quiet hotels transforming into a grand amusement area of electric-lit parks, roller coasters, sideshows, and entertainment in the years before and after the turn of the 20th century (Cudahy, 2009). Coney Island Creek was originally a tidal strait, separating the sand dunes and salt marshes of Coney Island from the mainland (Steinberg, 2015). Development of toll roads as early as the 1820s began the process of filling in the marshes, making the island part of the mainland (Steinberg, 2015). Subsequently, attention to the declining conditions of the Creek fell by the wayside. One recent analysis described it as having the dirtiest water in New York City (Wellington, 2014).

Fig. 1 Location of Coney Island Creek in Brooklyn, NY

(Credit: Fountains of Bryn Mawr / Wikimedia Commons / CC BY-SA 4.0)

Protection from storm surges and flooding waterways is of utmost concern to both local residents and city officials (Feuer, 2014). The various shorelines of New York City also face flooding threats from nor'easter storms, erosion, and sea-level rise that may reach nearly two-feet by the 2050s (NYC Department of City Planning & Burden, 2013). Federal money has been earmarked towards investigating flood barrier protection in Coney Island properties, grants

for plans to assist residents, and flood-prevention plans along Coney Island Creek (Feuer, 2014). Additionally, the health and water-quality of the Coney Island Creek is important to area residents—as recently as last year, a local apartment complex was discovered illegally dumping 200,000 gallons of sewage per day into Coney Island Creek (Spivack, 2016).

The New York Department of City Planning put together a strategy plan for coastal climate resilience in 2013. This city document evaluates shoreline remediation strategies that includes living shorelines (NYC Department of City Planning & Burden, 2013). This paper will synthesize the work the city has since done to strategize for coastal resilience specific to the Coney Island Creek, the potential role of living shorelines as natural treatments for flood protection and ecological improvement in this local context, and more recent findings of the benefits of living shorelines to consider.

What Are Living Shorelines and their Benefits?

Living shorelines are a form of shoreline stabilization treatment that makes use of natural materials and allows for natural habitat functions to take place (National Oceanic and Atmospheric Association, n.d.). As pointed out in Richardson (2014) and O'Donnell (2017), there are a number of methods involved and a number of ways that the term "living shorelines" has been defined. Generally speaking, living shorelines help protect from coastal erosion through the use of both man-made and natural components. Often, the natural components include native plants and vegetation and the man-made elements may include stone, sand, or degradable material made from fiber or coir (National Oceanic and Atmospheric Association, n.d.; O'Donnell, 2017; Richardson, 2014). In other instances, concrete structures that anchor natural organisms like oysters, may be used (Swann, 2008), although others may term this an artificial reef (NYC Department of City Planning & Burden, 2013).

Prior to the advent of living shorelines, "hard" structures such as seawalls and bulkheads were commonly used to buffet shorelines, sometimes resulting in negative effects that included

habitat loss and even further erosion (Richardson, 2014; Swann, 2008). In contrast, living shorelines mimic the “soft” features of natural shorelines that allow for human access and living ecosystems (NYC Department of City Planning & Burden, 2013).

The stability benefits of living shorelines, especially when inclusive of breakwater features like oyster reefs, include erosion control, absorption of wave energy, provide a buffer zone, and trap sediment (Ray-Culp, 2007). Combined oyster and *Spartina* marshgrass systems were shown to reduce 67% of wave energy from boats in a test setup (Manis, Garvis, Walters, & Jachec, 2014). In a visible observation of bulkhead damage and marsh elevation measurements in response to Hurricane Irene, researchers concluded that the constructed marsh and breakwater system fared better and recovered quickly (Gittman, Popowich, Bruno, & Peterson, 2014). As outlined in O’Donnell (2017), living shorelines support natural habitat and it is this role in supporting natural ecosystems, where fish, crustaceans, and other organisms can thrive (Gittman et al., 2016), that mainly characterize living shorelines.

Living Shorelines and NYC Coastal Strategy

Urban Waterfront Adaptive Strategies, a guide published in 2013 by New York City’s Department of City Planning, evaluated various strategies and their applicability in the context of NYC’s coastline for the purpose of planning for future resilience in the face of flood protection and sea level rise, but also within the larger context of public needs and ecological function (NYC Department of City Planning & Burden, 2013). Given the 520 miles of shoreline of varying typology of New York City, and the need for management strategies to consider the existing urban structure and high-density population of the city, the guide noted that "there is no one size fits all approach" to address the needs of particular areas (NYC Department of City Planning & Burden, 2013). The study examined strategies such as living shorelines in addition to upland waterfront parks, more traditional bulkheads and seawalls, to off-shore floating islands and artificial reefs and observed that living shorelines and artificial reefs are new for the city and require further evaluation (NYC Department of City Planning & Burden, 2013).

Currently (and at the time of the 2013 guide), the shoreline treatments at Coney Island Creek mainly consist of bulkheads, revetments (large set of piled stones or concrete blocks), or shoreline beach (NYC Economic Development Corporation & Mayor's Office of Recovery & Resiliency [NYCEDC], 2015). In the *Urban Waterfront Adaptive Strategies* guide, Coney Island Creek is not specifically mentioned in regard to living shorelines. Rather, an existing case study is presented about a new waterfront park, Brooklyn Bridge Park, where there is an installed salt marsh whose purpose is to lessen wave impact and filter storm water runoff (NYC Department of City Planning & Burden, 2013). However, in summarizing the effects of Hurricane Sandy in this case study, the document mainly highlights the effectiveness of design features that were elevated above the flood line. In general, the guide evaluates living shorelines as suitable for erosion control, shoreline stabilization, minor wave force protection, low storm surge protection, and in sheltered areas where vegetation can take hold.

Living Shorelines and Coney Island Creek Resiliency Strategy

After the 2013 publication of the NYC Department of City Planning's guide, subsequent activities, including resiliency studies and community involvement, took place (NYCEDC, 2014; NYCEDC, 2015; NYCEDC, 2016a; NYCEDC, 2016b). In 2014, the NYC Economic Development Corporation and others began a feasibility study specific to Coney Island Creek with multiple goals. Among these goals were mitigating flooding, waterfront improvements, and improvements to natural habitats (NYCEDC, 2014).

From 2014 to 2016, the study, conducted with Arcadis, an engineering and management consultant company, held community events and presentations, and published findings (NYCEDC, 2016a; NYCEDC, 2016b). Draft and final forms of the study, called the *Coney Island Creek Resiliency Study*, were called "an early step in a long-term strategy to protect the life, property, and livelihoods" of local communities with the aim of protecting the area from flooding while also taking advantage of the situation to improve ecology and public areas, what

the study terms creating “flood protection with secondary benefits” (NYCEDC, 2016b). Creek wildlife, which includes shorebirds, horseshoe crabs, fish, crustaceans, mollusks, along with plants and other organisms, were noted as “a valued resource that the local community members are proud of and wish to protect” (NYCEDC, 2016b).

Components of the strategy outlined in the Coney Island Creek plan follow the “no one size fits all” approach of the city’s earlier, 2013 coastal resilience guide (NYC Department of City Planning & Burden, 2013), and include both “hard” and “soft” approaches (Wilcox, 2016). The main standout of the plan is a tidal barrier across the mouth of the Creek that would close in the event of a storm to protect from storm surges and flooding (NYCEDC, 2016b). Living shorelines and constructed wetlands are included. However, noting that their study’s calculations showed that such wetland features would not provide enough reflecting of wave energy and flood protection, these features are included as complementary aspects of overall flood protection but ones that provide the secondary benefits quoted above to support habitat and water quality and soil improvements (NYCEDC, 2016b). This was still “a key priority for community members” and so it was stressed that any tidal barrier would not disturb normal water flow and habitat (NYCEDC, 2016b; Wilcox, 2016).

While the protection of life and property is of paramount concern to both residents of Coney Island and city government, the inclusion of living shorelines within future resiliency plans testifies to the complementary shoreline protection benefits that living shorelines do provide in addition to an understanding of their ecological importance to both aquatic life and local community appreciation. In this light, it is helpful to examine some newer investigations of the benefits of living shorelines to underscore the importance of ensuring that living shorelines are a part of future plans for Coney Island Creek resiliency and restoration.

New Knowledge Benefits – “Blue” Carbon

Given that climate change and resultant storm surges are relevant issues to Coney Island

Creek, evidence that living shorelines may also provide carbon capture benefits to mitigate climate change (Davis, Currin, O'Brien, Raffenburg, & Davis, 2015) may yet be another service they can provide. In a recent study of the sequestration benefits of living shorelines, the authors examined living shoreline capacity for carbon sequestration in *Spartina* marshes in North Carolina, in their view, "the first published account of blue carbon sequestration in living shorelines" (Davis, Currin, O'Brien, Raffenburg, & Davis, 2015).

According to the article, tidal wetlands appear to be good carbon sequestration sites, sequestration being relevant for mitigating the effects of climate change and reaching international goals to reduce CO^2 in the atmosphere (Davis, Currin, O'Brien, Raffenburg, & Davis, 2015). Living shorelines are a narrower, newer example of tidal wetlands.

The authors studied several marsh sites ranging in age from a dozen years to nearly forty. These sites included ones created expressly as living shorelines while other sites were created prior to the conception of living shorelines but function as such due to their characteristics (Davis, Currin, O'Brien, Raffenburg, & Davis, 2015). Through a process that calculated the carbon stock of these marshes and dividing that by the marsh age when known, the researchers arrived at a 100-year sequestration rate of around 75 grams of carbon per square meter per year. This result, for the kinds of living shorelines studied (six miles worth), translate to "a cumulative annual carbon benefit of 18.75 metric tons, equivalent to the removal of 64 metric tons of CO2 … offset[ing] the equivalent of 7,525 gallons of gasoline consumption each year" (Davis, Currin, O'Brien, Raffenburg, & Davis, 2015). The researchers suggest adding this benefit among the benefits provided by living shorelines in comparison to hardened strategies like bulkheads.

<u>New Knowledge Benefits – Estuarine Nurseries</u>

As noted above, supporting natural habitat is one benefit of the use of living shorelines. In a study published last year, Gittman et al. (2016) aimed to empirically quantify the effectiveness of living shorelines in supporting aquatic habitat for fish and other species. Their

more recent results provide specific evidence that living shorelines support natural habitat for aquatic life along with particular characteristics of this kind of created habitat.

In their study, Gittman et al. (2016) contrasted the diversity and abundance of fish and crustaceans caught at living shorelines, control marshes, and bulkheads using fyke nets and minnow traps (similar kinds of nets used to trap small fish and aquatic organisms). Their results reported greater abundance and diversity at the living shoreline examined in their study compared to control marshes and bulkheads (Gittman et al., 2016).

Important to their study are two additional factors. One, their study noted that prior studies made shorter term inquiries into ecological function and by sampling at living shoreline sites that differed in period of construction (less than one year at one site compare to greater than three years at several other sites) they observed greater results at the living shorelines older than three years (Gittman et al., 2016). This observation carries implications about living shorelines as pertains to supporting aquatic habitat, in both when to expect a functioning system will take hold and for how long to monitor a site.

The second important factor stemming from their results reflects the age of certain species caught. Based on species identification, measured length, and other factors of the caught specimens, the majority of particular species were identified as juveniles. The researchers conclude that these living shorelines are acting as nursery habitat (Gittman et al., 2016). Taken together, their results lead the researchers to promote living shorelines "wherever feasible" and one that is the "preferred option" for supporting natural, aquatic habitat for fish and other organisms (Gittman et al., 2016).

Further Discussion

Given some evidence of the helpful protective measures of living shorelines during a hurricane event (Gittman, Popowich, Bruno, & Peterson, 2014), however moderate, living

shorelines should have a place within the group of restoration and resiliency plans for Coney Island Creek. But in light of and even beyond the new knowledge benefits presented above, living shorelines could provide additional benefits to the local community and marine life. Renderings of the city's plan to include living shorelines, open spaces, and other waterfront features speak to the desire and health benefits of living in closer proximity to nature, as demonstrated in some empirical studies (de Vries, Verheij, Groenewegen, & and Spreeuwenberg, 2003). The fish and crustacean species observed by Gittman et al. (2016) in their living shoreline study in North Carolina match many of the species resident or traveling through New York waters, including flounder, perch, mummichog, and killifish (NY State Department of Environmental Conservation, 2016) and so could be assumed to inhabit a Coney Island living shoreline environment. Furthermore, an outdoor classroom along Coney Island Creek is planned (NYC Economic Development Corporation & Mayor's Office of Recovery & Resiliency, 2016) and the educational value and wildlife-watching opportunities of other constructed marshes and functioning shorelines has been observed at a living shoreline/oyster reef site in Alabama (Swann, 2008).

Conclusion

In addressing future resiliency plans for the Coney Island Creek, New York City is including living shorelines as part of a mixed set of strategies to counter negative effects of storm surge flooding while also promoting natural spaces for people and wildlife alike. In a feasibility study and related presentations, it is clear that the city has arrived at the conclusion that formerly common, "hard" shoreline features such as bulkheads will not altogether solve the issues or fully benefit the local community. Living shorelines can be a part of the solution through the benefits they offer in regards to shoreline stability, moderate wave dampening ability, and support of natural, functioning habitat for aquatic fauna and flora. Additionally, given long-time area voices asking for cleanup, living shorelines would be part of a more pleasant waterfront experience.

At Coney Island Creek, work on following through on the city's plans has not yet begun.

In this interim, as city budgets get debated and other issues arise, there can be concern that plans can change or be reduced in scope. Yet few other sites nationwide offer such an urban context testing ground for the role living shorelines can play. And in the light of the new knowledge benefits that living shorelines may provide, it is important that the city stay committed to ensuring that living shorelines are a part of future plans for Coney Island Creek resiliency and restoration.

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