Supporting Efforts to Install Green Infrastructure at Great Lakes Marinas

Michigan Sea Grant, Wisconsin Sea Grant, Ohio Sea Grant

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The primary goal of this project, Advancing Stormwater Management at Marinas in the Great Lakes, was to expand implementation of onsite stormwater management at marinas in the Great Lakes region. A key part of this effort was to support construction of four green infrastructure projects at marinas in Michigan, Ohio, and Wisconsin to demonstrate how these techniques can improve resiliency at marinas by boosting their ability to capture stormwater to improve water quality and reduce flooding on site.

Unfortunately, marinas typically lack the time, financial resources, and expert knowledge to review the multitude of available GI practices, test them, and decide which will work best for their site. As a result, for this project, a collaborative team was convened with an established network of Clean Marina programs in the Great Lakes region, including Sea Grant extension staff, staff at participating marinas, and local organizations and government near project sites. This group supported implementation of these projects by providing financial and technical information needed by the marinas and by sharing innovations and outcomes of the project with the broader communities to encourage adoption of these practices.

For this project, the team actively engaged four marinas in three states across the Great Lakes in the selection, development, and installation of GI so that these businesses can provide peer-to-peer knowledge transfer about innovative stormwater management approaches into the future. The team developed and implemented workshops, presentations, and GI practices used as demonstrations to encourage further adoption of these practices and technologies.

Although the installations were successful, this project highlighted how difficult it may be for marinas to implement green infrastructure projects, even with support. Most importantly, key lessons learned are the importance of regular and frequent communication with project partners and understanding the unique needs of each marina to ensure successful expansion of green infrastructure practices at these facilities**.**

Collaboration and Support for Projects

High season for marinas typically runs from April to boat pull out around the end of October. This schedule leaves little opportunity for marina management to apply for grants through the Great Lakes Protection Fund, or to investigate and plan for installation of green infrastructure projects. Fortunately, Sea Grant staff was able to champion this effort to help get state demonstration projects going in Wisconsin, Ohio, and Michigan. The goal of this effort was to show marinas that these projects are feasible and can be done in other communities.

Sea Grant's main role, as it almost always is, was facilitation, coordination, and leveraging partnerships. The project team worked with many local organizations, including: Erie County Soil and Water Conservation District; Old Woman Creek National Estuarine Research Reserve; Grand Traverse Bay Watershed Center; Michigan Department of Natural Resources –

Charlevoix Fisheries; Green Elk Rapids; Drummond Carpenter Engineering; Wisconsin Department of Natural Resources; and Lake Superior National Estuarine Research Reserve as well as local governments included the City of Superior, City of Charlevoix, and the Village of Elk Rapids.

This high level of collaboration was critical to ensuring successful installation at each marina. For example, the Barker's Island Marina project would not have been possible without the collaboration of the marina and City of Superior staff. The marina owner helped to coordinate timing of the re-paving and regrading of the capture area, worked closely with the Ohio State University engineering team in the design phase, and privately funded raising of the fuel tank.

Even with a high level of involvement and collaboration, all of the projects ran into some form of challenges, including construction delays, which perhaps may not have been avoided but should have been considered in overall planning. The project teams also experienced some challenges with site selection and identification of appropriate green infrastructure options because of unpredictable weather, high lake levels, and changes in marina staff. The challenges were overcome by engaging with new partners and staff to get them vested in the project and waiting for a more appropriate time to conduct site visits.

Among the biggest issues, however, was ensuring local staff had a plan for and understanding of long-term maintenance of the site – this critical step required a high involvement from all stakeholders, including working closely with them to ensure thorough understanding of the plants and their required maintenance. As a result of this need, a basic plant palette that requires as little maintenance as possible is likely one key to success. Also, ensuring that marina staff and wonders were on board and were aware of all aspects of the project from the beginning was key. Below are summarized what worked at each site and ways that the project could have been improved. This information would be useful to future organizations seeking to support implementation of green infrastructure at marinas.

Wisconsin

Barker's Island Marina, Superior, Wisconsin. Barkers Island Marina, which is the largest marina on Lake Superior, is a critical part of the economy in the Duluth Superior area. Because they are part of the Clean Marina program, Sea Grant staff knew they were a potential candidate for managing stormwater using innovative green infrastructure practices on the property. This location in particular, highlights the importance of understanding the unique situation at each marina. For example, Barker's Island Marina has a naturally high water table that causes flooding at the marina during high water level years. Since the elevation difference between the paved service area and water table is small, infiltration-based green infrastructure practices, such as bioretention or tree box filters, were not practical. Without the willingness of the marina owner and city to allow GI placement in an underutilized area of the property, site conditions could have prevented the success of an installation at this marina.

The process for selection and design of GI practices with the Barker's Island marina took considerably longer than anticipated due to complexity of project, number of partners involved, and unforeseen circumstances that arose such as local permitting issues. The Wisconsin Coastal Management has played a key role in overcoming these challenges of managing the Wisconsin project.

Fortunately, in May 2021, the team was able to install a constructed wetland (~9,000 square foot) at this private marina located on city-owned property to capture and treat stormwater runoff from 96,000 square feet of maintenance building and paved service area. Locally sourced, native wetland wildflowers, grasses, sedges, and shrubs were planted following construction. Fencing was necessary to deter geese during the first growing season. Integrated Pest Management, including invasive plant removals and plant replacement, was conducted three times throughout the growing season in 2021, 2022, and 2023 to control weeds.

Caption: Barker's Island Marina, Superior, Wisconsin, green infrastructure installation nearing completion. Credit: Julia Noordyk, Wisconsin Sea Grant.

The treatment wetland was constructed as a two-pond system with the dynamic nature of Great Lakes water levels in mind. The first pond was designed to be a wetland at all times and

received all the runoff and most of the sediment. The second pond acts like a wetland when lake levels are high, but acts more like a bio-infiltration basin during low-water years. For most small, frequent rains there may be little or no flow out of the second pond. Over time, two distinct plant communities should develop in each of the ponds because of the differences in hydrology. In addition, stormwater improvements were also completed for a retention pond located on the north side of the marina to mitigate flooding and ice formation in the parking lot and capture sediment. The improvements have resulted in improved public safety and water quality entering Lake Superior.

Overall, installation at this site went well, which project team members attributed to regular, and early communication from before the project began throughout installation, and after plants were installed. The marina owner and City of Superior staff both provided input into the design, which ultimately helped preserve a grove full of birch trees adjacent to the practice. The City of Superior also bid and oversaw construction of the practice which was critical for successful installation. Staff from Lake Superior National Estuarine Research Reserve played a key role in monitoring. Each organization and individual gained knowledge and respect as to one another's role and expertise throughout the project, ultimately leveraging that expertise to achieve an on-the-ground success story that - without this level of collaboration - may have likely failed.

Ohio

Holiday Harbor Marina, Huron, Ohio. At this marina, two side-by-side infiltrating GI practices were installed to address stormwater runoff from a parking lot, including a traditional bioretention cell and a high rate biofiltration cell. The projects were installed in a nearshore, traditionally mowed grass area between the parking lot and the waterway. Runoff from the parking lot and surrounding area include stormwater from the marina office building, service yard, and maintenance shop. An asphalt curb was installed such that two, similarly sized sub-watersheds were established, enabling the practices to be compared side-by-side for water quality and quantity impacts. While still treating the same amount of stormwater, the high rate biofiltration cell is much smaller than the traditional bioretention cell due to the high infiltration rate of its media. The research carried out on the performance of these systems will provide insight as to how the novel high rate biofiltration compares to traditional bioretention. Local, native, low-maintenance plants were utilized in both treatment practices, and signage is to be placed near the parking lot as this location is in a highly visible area in the marina.

At Holiday Harbor Marina, the staff had significant limitations in funding and time that precluded a rigorous long-term maintenance schedule. The project team worked with the local soil and water conservation district and marina staff to develop a project that was informed by nearby GI performance and executed a realistic and achievable path forward for the landowner. As a result plantings were simplified from a diverse variety of plants to just two plants known for low maintenance, minimizing the number of plants the marina staff had to train to upkeep.

The staff and local officials supported the project because it was considered to be good stewardship for the lake and the local economy. Although there was interest initially, the marinas

did not have the necessary knowledge about the funding opportunities and filtering systems, which is why the partnership with Sea Grant was so important – having the right people on board for that through Ohio Sea Grant allowed the marina to put all the pieces together for project implementation.

Caption: Completed rain garden at Holiday Harbor Marina, Huron, Ohio. Credit: Sarah Orlando, Ohio Sea Grant.

Michigan

Unfortunately, the Michigan sites ran into several challenges, including those related to construction issues; lack of communication between team members, the public, and the marinas; and lack of awareness among staff/marina personnel regarding ongoing maintenance of the constructed green infrastructure. In particular, significant confusion emerged after installation among those who would maintain the plants, which led to rain gardens not being looked after properly, lack of knowledge among locals and slip renters about the constructed practices, and disappointment over the loss of trees in the parking lot islands in Charlevoix among local residents. Many of these issues could have been solved by more regular and better communication among all involved parties.

Edward C. Grace Memorial Harbor Marina, Elk Rapids, Michigan. This public "grant-in-aid" marina on Village land treated one low industrial drainage area with one bioretention cell. The Village of Elk Rapids has partnered with The Watershed Center Grand Traverse Bay to install green infrastructure practices throughout the village with the goal of reducing stormwater volume and its effects on water quality in Grand Traverse Bay. These projects included bioretention cells (BRCs) and rain gardens, which are shallow stormwater basins that use soil and vegetation to capture and treat runoff. In 2020, several rain gardens were installed along River Street and a BRC was installed near the main pavilion at the west side of the Edward C. Grace Memorial Harbor using a variety of funding sources. Additionally, a rain garden was installed in the upper parking lot of the harbor using Sea Grant funding.

Unfortunately, the rain garden that was installed for this project is no longer a functioning raingarden – it has been transitioned into "landscaped garden" by the local harbormaster team. Although it provided good sediment removal, the original rain garden and plant selection required more long-term maintenance than was possible for limited available staff time. Despite on-the-ground support from The Watershed Center GT Bay, which are leaders in installation of rain gardens and bioswales, plants were removed and replaced. This project shows how important it is for close collaboration with the team that will be responsible for long-term maintenance. This collaboration should include ensuring a mutual understanding of the benefits of a true rain garden – which provides removal efficiencies – and how it differs from other types of gardens.

Part of the challenges met in this project were due to a loss in continuity in communications with the local members of the community. For example, the harbormaster team was not brought in from the beginning, so they were not a ready advocate for the installations with the local team or the public. In addition, during the course of the project installation, a change in village management caused additional problems in both continuity and communication. For example, slip customers nearest the original installations were unaware of the project and the importance of the rain garden and the various plants.

Like many of the other projects, this installation also ran into some construction delays and issues. For example, upon breaking ground, engineers found the soil was not as expected and the installation team ended up with wetland conditions and drought resistant plants. The ground became spongy and difficult to walk across and mosquitoes were an issue at one point. Unfortunately, when combined with staff changes and communication challenges, these barriers exacerbated the challenges that the team met.

Caption: View of the rain garden at Edward C. Grace Memorial Harbor Marina, Elk Rapids, Michigan. Credit: Mark Breederland, Michigan Sea Grant.

In the end, although the local team removed and replaced all the plants, the underlying systems should still work, and if the rain garden plants are replanted, then the installations should work as intended. If outreach and communication had been more detailed and regular from the beginning of the project, many of these issues likely could have been avoided.

Charlevoix, Michigan, Municipal Boat Launch. This location was a second site selected in Michigan when additional funding became available after the work was done in Elk Rapids. Located about 45 minutes north of Elk Rapids, the Charlevoix boat launch included installation of two bioretention cells (BRCs) – a type of shallow stormwater basin that uses soil and vegetation to capture and treat runoff – in the downhill islands of the parking lot. This lot receives daily use by boaters using the public access boat launch in Charlevoix. This parking lot is also used to store snow during winter months, which means there's a lot of accumulated sediment and the associated heavy metals, as well as sand and deicing salts from "dirty" that accumulates on city streets as a result of snow plowing.

At this location, plant selection, installation, and guidance was perhaps not optimal for long-term maintenance by village maintenance staff. At one point, the rain garden became considerably

overgrown, but the public works manager was later looped into the situation and seemed knowledgeable about the plants and had plans to provide ongoing maintenance. In addition, other BRC cells in town proved that the city was experienced in dealing with these types of installations.

Another challenge encountered at this site was local concern about loss of trees in the area where the cells were installed. Better communication with the public, including understanding their concerns and getting their input while providing some education about the benefits of the installations likely could have avoided this problem.

Caption: Installation sign at Charlevoix, Michigan, Boat Launch. Credit: Mark Breederland.

Lessons Learned

The primary intent of this project was to change behaviors and attitudes about green infrastructure, increase adoption of these types of practices, and address stormwater runoff in the Great Lakes watershed. One unanticipated benefit of this work included the connections that were forged between the various parties involved, including Sea Grant extension staff, staff at participating marinas, and local organizations and government near project sites. In addition,

this project showed the value of a public-private model that can bring together funding, with university, agency and local expertise, and education and outreach to support the installation of four GI practices and additional stormwater improvements at private marinas along the Great Lakes.

In the end, the team was able to successfully install GI practices tailored to the marina environment and improved water quality in collaboration with many on-the-ground partners that will help encourage similar applications. However, these projects were not without their challenges. There are several aspects of the project the team agrees could be improved, including expanding and improving outreach to better engage stakeholders in order to streamline implementation. In addition, ensuring funding was sufficient for the project goals and maintenance and increasing sampling for more robust results would have further strengthened this project.

Communications support for the local marina staff would go a long way to helping with the local communities' understanding and support of these projects. This support includes ensuring sufficient understanding and staff capacity for communications with local leaders and communities. In particular, providing guidance to village and city managers on how to talk with long-time marina slip-renters about the value of green stormwater treatment would be helpful. If marina managers can speak to peers and others about green infrastructure practices in a positive light, then it will help these projects spread to other marinas. In addition, if they can reach out to boaters and other stakeholders near the project site at the beginning of the project, then that could ensure support through construction, tree removals, and other related disruptions. Site visits and tours for the public and other stakeholders are especially informative as they provide an on-the-ground experience to a variety of audiences with the practice and can include the marina owner’s perspective on the project.

From a technical perspective, the sites were more complex than expected because of the number of partners and activities needed. These complexities include local and state permitting requirements, re-paving of the site, moving fuel tanks, and pipe placement under a road. Marinas may be limited in the types of GI available given constraints of their site (e.g., real estate, high water table, contaminated soils, etc.). This project helped demonstrate how smaller, high-flow systems provide similar performance to traditional systems. The amount of time it took to coordinate the different aspects of the projects, finalize design plans, and navigate university processes while accounting for appropriate construction seasons, ultimately led to construction being delayed. Lessons learned – it takes a lot of time and consistent communication to coordinate these activities among diverse partners. Local partners are critical to the implementation of these projects.

Summary

Overall, the green infrastructure practices constructed for this project reduced annual pollutant loads from the marinas. Real, measurable reduction in stormwater impacts were seen,

including the reduction of pollutants like sediment, nutrients, and heavy metals entering the Great Lakes (more details can be found in the final report). In particular, this project also showed how green infrastructure can reduce heavy metals entering the Great Lakes from marinas. In turn, these pollutant reductions will reduce the harmful impact heavy metals can have on biodiversity. These practices will continue to provide water quality benefits for decades if they are properly maintained.

Of greatest importance,the team learned how critical the need was for a high level collaboration with local groups to implement the GI practices and create tools and outreach materials that are suitable for their needs. Good outreach and communication from the outset of the project is critical. This communication should include being strategic about the rationale behind the projects and being straightforward in terms of vocabulary and guidance for this group of stakeholders (marinas). Finally, engaging end users early and often and having a point of contact who will stay in touch with them after the project is over is key to long-term success.

Overall, the project achieved significant successes in promoting the adoption of green infrastructure practices among marinas in the Great Lakes region and reducing stormwater impacts on water quality. However, it also faced challenges such as delays, communication issues, and sampling limitations that affected project efficiency and effectiveness. Moving forward, lessons learned from these experiences can inform future projects, emphasizing the importance of thorough planning, effective communication, and collaboration with local stakeholders to ensure successful outcomes in stormwater management initiatives.

In addition to these on-the-ground installation projects, the project team also developed an online toolkit and suite of resources to support these efforts. In the end, this project: 1) developed a set of educational resources geared to stormwater management at marinas including development of a decision support tool to identify appropriate marina GI practices; 2) supported marinas in working with contractors to design and implement GI practices at four Great Lakes marinas; 3) monitored the effects of the GI practice on water quality; and 4) installed educational signage at each GI installation to encourage public understanding and support of these efforts.