NES
ECOLOGICAL SERVICES
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Lower Menominee River Area of Concern
Menekaunee Harbor Restoration Project
Great Lakes Restoration Initiative Grant
Grant/Project No. GL-00E01312-0

Prepared for

City of Marinette
1905 Hall Avenue
Marinette, Wisconsin 54143
Project No. 13775005

Authored By:
NES Staff

January 4, 2017

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Project Overview

NES Ecological Services (NES) – A Division of Robert E. Lee and Associates, Inc. (REL), was contracted by the City of Marinette to provide vegetation monitoring services at Menekaunee Harbor located in Sections 4 & 9, T30N, R24E, City of Marinette, Marinette County, Wisconsin (Figure 1). The City began restoration at Menekaunee Harbor (herein referred to as the "Harbor") as part of a Great Lakes Restoration Initiative (GLRI) Grant to restore the Lower Menominee River Area of Concern (AOC). In the summer of 2015 NES/REL finalized a Restoration Plan for the Harbor and the Quality Assurance Project Plan (QAPP) was signed in October 2015. The Project is approximately 9.39 acres in size and is designed to encompass 2.08 acres of emergent aquatic, 1.26 acres of emergent aquatic- wild rice, 0.05 acres of ephemeral pool, 0.32 acres of mesic to wet-mesic prairie, 0.81 acres of northern sedge meadow, 1.22 acres of wet mesic forest, 2.81 acres of open water, 0.32 acres of prairie, 0.51 acres of shrub-carr, 0.027 acres of submergent aquatic & 1.22 acres of wet mesic forest. Construction began in the late summer of 2015 and was completed in the early summer of 2016.

NES ecologists conducted the first year of monitoring on July 5 and August 22, 2016. The completion and submittal of this monitoring report (Year 1), satisfies the requirements outlined in the (QAPP). Report submittals are required for three consecutive post-construction growing seasons.

Goals, Objectives & Performance Standards

Goals

The purpose of the Menekaunee Harbor ecological restoration is to restore native vegetation and habitat to a degraded wetland complex. Per the QAPP, the goals of the site are as follows:

- Long-term protection is in place for natural areas and wetlands within the AOC.
- Nesting populations of a diverse array of wetland-dependent and riparian-associated birds are consistently present within the AOC.
- The lake sturgeon (*Acipenser fulvescens*) population is enhanced.
- Diverse and functional native fish and mussel assemblages are present in the AOC that sustain natural recruitment.
- A healthy and diverse native vegetation community has been restored.

Objectives

In support of these goals, the objectives and related target criteria of this restoration are as follows:

1. Restore benthic habitats for use by invertebrates and native fish species, which historically utilize the harbor: walleye (*Sander vitreus*), yellow perch (*Perca flavescens*), muskellunge (*Esox masquinongy*), smallmouth bass (*Micropterus dolomieu*), largemouth bass (*Micropterus salmoides*), northern pike (*Esox lucius*), and bluegill (*Lepomis macrochirus*).

    a) Eliminate contaminated sediments and establish water depths averaging 6-7 feet.
    b) Install fish sticks, log structures, woody debris and rock structures to increase cover and feeding opportunities.
    c) Establish small populations of submergent native vegetation in the harbor.
    d) Eliminate and control invasive species within emergent aquatic communities, while establishing native plants to provide spawning habitat.

2. Establish healthy and diverse native vegetation communities.
    a) Restore/create community types found to be high priority communities within the Northern Lake Michigan Coastal Ecological Landscape.
    b) Install a variety of ferns, grasses, sedges, forbs, shrubs, and trees currently and historically found within Marinette County. Wild rice (*Zizania palustris*) was historically found within the Menominee River; therefore, an attempt will be made to re-establish a viable population.
    c) Increase plant diversity by adding a few species typically found more often within southern Wisconsin to account for temperature increases due to global climate shifts.
    d) Absolute cover of invasive species will be < 15% within each community type.
3. Restore wetland and upland habitat for use by invertebrates, amphibians, reptiles, mammals and birds.
    a) Native vegetation capable of providing a variety of food and cover will be established throughout the restored/created communities.
    b) Existing snags will be left and protected to provide food sources and potential future nesting sites.
    c) Rock and brush piles will be added to provide cover.
    d) Downed woody debris will be placed in the emergent aquatic and wet meadow communities to provide sites for loafing and basking.
    e) Nesting boxes and platforms will be installed to increase suitable nesting sites.
    f) Bat houses will be erected to provide roosting sites.

Over the course of the monitoring period it is expected that site functions will improve in all of the above categories.

Ecological Performance Standards

Performance standards are the measures utilized to determine whether desired objectives regarding the overall mitigation goal have been met. Post-construction monitoring activities are performed throughout the duration of a project to evaluate progress toward achieving the functional objectives. The below performance standards in Table 1, as outlined in the approved QAPP, will be used to verify the success of the emergent aquatic, emergent aquatic- wild rice, open water & submergent aquatic, ephemeral pool, mesic to wet mesic prairie & prairie, northern sedge meadow, wet mesic forest, and shrub-carr communities.

Table 1. Status of Ecological Performance Standard Achievement

Ecological Performance Standards (PS) For Year One	PS Achievement 2016	2017	2018	Monitoring Results			Discussion of Monitoring Results/Trends
Aerial coverage of invasive, non-native species such as giant reed grass, reed canary grass, cattail spp., purple loosestrife and spotted knapweed will not be >5% after one year.	Y	--	--	**Invasive, non-native species**	**% Cover**	**% Relative Cover**	The five main invasive species of concern currently have <5% total coverage within the project area.
				Giant reed grass	0.28	0.22	
				Reed canary grass	0.69	0.54	
				Cattail spp.	0.69	0.54	
				Purple loosestrife	0.56	0.43	
				Spotted knapweed	0	0	
After one year, >75% of the vegetative cover within the restoration site will be native species, <25% of the cover will be invasive, non-native species.	Y	--	--	**Species**	**Percent cover**		Vegetative cover is currently exceeding the 75% minimum native species cover after one year. *Elodea canadensis,* a submergent aquatic is accounting for the largest portion of vegetative cover of native species with 13.85% relative cover.
				Native	85.4		
				Invasive / Non-native	14.6		
Eighty percent of the site will be vegetated within one year.	Y	--	--	Sum of average percent cover across all plots = 128%			Based on the sum of average percent cover across all plots this criterion has been met. The lowest percent cover across all plots were plot 5 (Shrub-Carr) at 79% cover, plot 6 (Emergent Aquatic) at 60% cover and plot 16 (Ephemeral Pool) at 68% cover.
585 of the 650 planted shrubs within the Shrub-Carr community will be present and healthy one year after installation.	Y	--	--	Only 8 dead shrubs were observed during the vegetation survey			99% survival rate meets the performance standard
900 of the 1,000 planted trees and shrubs within the Wet-Mesic Forest community will be present and healthy after one year of installation.	Y	--	--	78 dead trees/shrubs were observed during the vegetation survey			92% survival rate meets the performance standard
The Open Water with Submergent Vegetation community shall have a minimum of 5 native, non-invasive species present.	Y			Community had 8 species identified during the vegetation survey			Planted species along with naturally occurring species allowed this performance standard to be met.
The Emergent Aquatic, Northern Sedge Meadow, Shrub-Carr, Wet-Mesic Forest and Mesic to Wet Mesic Prairie & Prairie communities shall each have a minimum of 15 native, non-invasive species present.	P	--	--	**Community**	**Number of Native, Non-invasive Species**		The Emergent Aquatic community is the only community that does not currently meet this standard. Due to an additional rise in water levels some planted species were displaced. However, as the site continues to develop additional species will likely become established in all communities including the Emergent Aquatic zone.
				Emergent Aquatic	14		
				Northern Sedge Meadow	34		
				Shrub-Carr	43		
				Wet-Mesic Forest	26		
				Mesic to Wet Mesic Prairie & Prairie	24		
To ensure the restored communities have natural significance, the floristic quality index (FQI) and Coefficient of Conservatism (Mean C) for each shall be ≥ 20 and ≥ 3.5, respectively, after one year. FQI values will be calculated utilizing all species present: non-native species will be assigned a value of zero.	P	--	--	**Community**	**FQI**	**Mean C**	Some but not all of the criteria have been met for this performance standard. Due to the site still being in the early stages of development the plant communities will likely trend in the direction of fulfilling the requirement. The most concerning community at this time are the Prairie communities; however, because they were seeded it is expected that the first few years will be dominated by annual weeds.
				Emergent Aquatic	19.78	5.29	
				Emergent Aquatic – Wild Rice	15.33	5.11	
				Northern Sedge Meadow	21.04	3.21	
				Shrub-Carr	24.18	3.32	
				Wet-Mesic Forest	18.08	2.97	
				Mesic to Wet Mesic Prairie & Prairie	11.90	1.67	
				Open Water w/Submergent Veg	15.20	5.38	

NA = Not Applicable IP = In Progress P = Performance Standard is Partially Met Y = Performance Standard is Met

Summary Data

Methods

Vegetation/Floristic Diversity

Meander and plot-based vegetation surveys were conducted within the project area to gather a representative sample of the floristic diversity of each plant community. In early July a survey was conducted so a list of plant species found within each community could be compiled. The plant species list accumulated during the survey was then combined with the species list generated during the vegetation plot survey to create a comprehensive species list (Appendix A).

On August, 18 sample plots (1 Open Water/Submergent Aquatic, 4 Emergent Aquatic, 3 Emergent Aquatic- Wild Rice, 2 Northern Sedge Meadow, 3 Shrub-Carr, 2 Wet-Mesic Forest, 2 Mesic to Wet-Mesic Prairie & Prairie, 1 Ephemeral Pool (Figure 2) were randomly established in the eight community types within the project area. All plots, except Plot 18, were used as photo stations with pictures taken in each cardinal direction to document change over time. Plots were marked with a wooden stake and located with a Trimble GPS (sub-meter accuracy) unit to allow for the analysis of temporal trends within the communities. At each five-foot radius sized sample plot, the plant species present, including invasive plants, and their coverage were recorded. Coverage was determined using the perpendicular projection to the ground from the outline of the aerial parts of the plant species and reported as the percent of the total area (e.g., substrate or water surface) covered. The Daubenmire methodology will rank estimated foliage cover based on the percentages found in Table 2. By providing a range of percent foliage cover for each rank, the Daubenmire Classification Scheme will help minimize errors due to observer bias with visual estimations. Plant species dominance within each community type was determined by applying the 50/20 rule.

Table 2. Daubenmire Classification Scheme Cover Ranking System.

Percent Foliage Cover	Rank
0-5	1
5-25	2
25-50	3
50-75	4
75-95	5
95-100	6

Tree & Shrub Survey

In the fall of 2015, 15 species of native trees and 19 species of native shrubs were planted in the project area. A total of 1,000 bare-root and potted plants (600 trees and 400 shrubs) were planted throughout the Wet-Mesic Forest community, while another 650 bare-root and potted shrubs were planted in the Shrub-Carr community. Construction specifications indicated a total of 400 bare-root and potted shrubs were to be installed in the Shrub-Carr community, an increase of 150 plants from the original Restoration Plan. Live stakes (400) were also to be installed. However, a rise in water levels throughout the 2015 growing season reduced the woody species planting area within the community; therefore, the number of shrubs installed was reduced to the original quantities specified in the Restoration Plan found in Appendix C of the QAPP. Due to availability, live stakes were also replaced with bare-root and potted material. Appendix B contains a list of the species and quantities installed in the Harbor. The change in quantity is

also reflected in the warranty and Performance Standard requirements of a 90% survival rate. During the summer of 2016 a woody species survey was completed to determine these rates.

Results

Vegetation/Floristic Diversity

A list of species found during the meander survey along with the vegetation data collected at each sample plot and a summary of each community type can be found in Appendix A. These data were used to compute the information reported in Table 3 below. A total of 185 plant species were recorded during the 2016 surveys of which 130 species were recorded during the community plot survey.

Photos (Appendix C) documenting existing site conditions were taken at each sample plot, except Plot 18 (Figure 2).

Table 3. Vegetation Data Summary.

Community	# Total Species	# Native Species	FQI	Mean C	% Native Coverage	% Invasive Species Coverage
Open Water & Submergent Aquatic	8	8	15.20	5.38	100.0	0.0
Emergent Aquatic	14	14	19.78	5.29	100.0	0.0
Emergent Aquatic- Wild Rice	9	9	15.33	5.11	100.0	0.0
Northern Sedge Meadow	43	34	21.04	3.21	81.0	19.0
Shrub-Carr	53	43	24.18	3.32	92.2	7.8
Wet-Mesic Forest	37	26	18.08	2.97	73.3	26.7
Mesic to Wet-Mesic Prairie & Prairie	51	24	11.90	1.67	51.0	49.0
Ephemeral Pool	4	3	5.5	2.75	96.4	3.6
Entire Site	**130**	**96**	**35.87**	**3.15**	**85.4**	**14.6**

Native Species Dominance

All communities had a greater coverage of native plant species. All dominant species in the Open Water & Submergent Aquatic, Emergent Aquatic, Emergent Aquatic - Wild Rice, and Ephemeral Pool were native while the Northern Sedge Meadow, Shrub-Carr, Wet-Mesic Forest, and Mesic to Wet-Mesic Prairie & Prairie contained a mix of both native and non-native species. Table 4 contains a list of dominant species found within the Harbor communities. Additional information pertaining to the percent areal coverage of native and invasive species can be found in the sample plot and community summary data (Appendix A).

Table 4. Plant Species Dominance.

Community Type	**Dominant Species**
Open Water & Submergent Aquatic	*Heteranthera dubia*
	Myriophyllum sibiricum
Emergent Aquatic	*Elodea canadensis*
	Stuckenia pectinata
Emergent Aquatic- Wild Rice	*Myriophyllum sibiricum*
	Nymphaea odorata
	Potamogeton natans
Northern Sedge Meadow	*Acer negundo*
	Agrostis stolonifera
	Elodea canadensis
	Phalaris arundinacea
	Phragmites australis
	Sagittaria latifolia
Shrub-Carr	*Agrostis stolonifera*
	Bidens cernua
	Boehmeria cylindrica
	Calamagrostis canadensis
	Carex aquatilis
	Erechtities hieraciifolia
	Juncus balticus
	Juncus nodosus
	Populus deltoides
	Schoenoplectus tabernaemontani
Wet-Mesic Forest	*Agrostis stolonifera*
	Calamagrostis canadensis
	Juncus balticus
	Populus deltoides
Mesic to Wet-Mesic Prairie & Prairie	*Agrostis stolonifera*
	Calamagrostis canadensis
	Conyza canadensis
	Cyperus bipartitus
	Juncus balticus
	Juncus brevicaudatus
	Melilotus alba
	Plantago major
	Populus deltoides
	Setaria faberi
	Setaria pumila
	Trifolium repens
	Triticum aestivum
Ephemeral Pool	*Schoenoplectus tabernaemontani*

Invasive/Non-native Species

Based on the information in Table 3, there are currently 34 invasive and/or non-native species found within the plots of five of the eight communities with an overall coverage is 14.6%. An additional 13 non-native species were identified within the Harbor communities while conducting the meander survey; however, three of the communities (Open Water & Submergent Aquatic, Emergent Aquatic & Emergent Aquatic – Wild Rice) had no invasive species recorded. Please see the plot data sheets in Appendix A for specific sample plot percentages. Table 5 includes a list of those species that are either of the greatest concern for invasion or were recorded as occurring frequently within the communities. Several of the species listed below often invade newly seeded sites such as the Prairie communities which have the largest number of non-native species present; however, many of these biannual and perennial weeds, including the 2 most commone species - spreading bent grass (*Agrostis stolonifera*) and white sweetclover (*Melilotus alba*), quickly disappear with proper maintenance and native species establishment. Birdsfoot trefoil (*Lotus corniculatus*), glossy buckthorn (*Frangula alnus*), plumeless thistle (*Carduus acanthoides*), spotted knapweed (*Centaurea maculosa*) and Tartarian honeysuckle (*Lonicera tatarica*) were also found on the site but not recorded at the sample plots (Table 5). Continued monitoring and management of these species will eliminate or suppress their threat to spread throughout the site.

Table 5. Invasive/Non-native Species Coverage (%).

Species		Community				
Common Name	Scientific Name	Northern Sedge Meadow	Shrub-Carr	Wet-Mesic Forest	Mesic to Wet-Mesic Prairie & Prairie	Ephemeral Pool
Bull Thistle	*Cirsium vulgare*	-	-	-	0.69	-
Canada Thistle	*Cirsium arvense*	1.19	-	-	0.69	-
Common Reed	*Phragmites australis*	2.38	-	-	-	-
Creeping Wild Rye	*Elymus repens*	-	-	-	0.69	-
Birdsfoot Trefoil	*Lotus corniculatus*	-	-	-	-	-
Glossy Buckthorn	*Frangula alnus*	-	-	-	-	-
Narrow-Leaf Cattail	*Typha angustifolia*	1.19	0.85	0.74	0.69	3.57
Purple Loosestrife	*Lythrum salicaria*	1.19	0.85	0.74	0.69	-
Queen Anne's-Lace	*Daucus carota*	-	-	-	0.69	-
Reed Canary Grass	*Phalaris arundinacea*	2.38	-	0.74	0.69	-
Plumeless Thistle	*Carduus acanthoides*	-	-	-	-	-
Spotted Knapweed	*Centaurea maculosa*	-	-	-	-	-
Spreading Bent	*Agrostis stolonifera*	7.14	5.98	15.56	4.14	-
Tartarian Honeysuckle	*Lonicera tatarica*	-	-	-	-	-
White Sweetclover	*Melilotus alba*	-	-	0.74	10.34	-

Tree Survey

The contractor, Applied Ecological Services (AES), is responsible for replacing dead trees and shrubs during the first year after planting if mortality exceeds 90%. In the fall of 2016, NES ecologists assessed the tree & shrub plantings. All species planted within the Shrub-Carr and Wet-Mesic Forest communities (Appendix B) were observed; however, a few species, especially tamarack (*Larix laricinia*), are struggling to survive. High water levels are likely responsible. A total of 86 dead woody species were noted within the two communities. Table 6 contains a breakdown of the number of dead shrubs/trees in

each community. Based on the count, each community had >90% survival; therefore, both the contractor warranty and performance standard were met.

Table 6. Tree & Shrub Survival.

Community	Number of Shrubs/Trees Planted	Number of Dead Shrubs/Trees
Shrub-Carr	650	8
Wet-Mesic Forest	1000	78

Conclusions & Recommendations

Overall, the condition of the Harbor one year after restoration is relatively normal. Native species can take 2-3 years to begin developing after seeding and planting. During that time many non-native upland and wetland species can become established due to the high levels of disturbance during initial restoration efforts, which negatively impacts the coverage of native species. Native species coverage has proven to be quite high at such an early stage of development in all of the planted and seeded communities with the exception of the prairie communities (51.0%). Since restoration efforts included only seeding within these communities, the number of annual, non-native species was expected to be higher during the first few years of establishment. Routine maintenance activities to be conducted by AES during the next two growing season should eliminate many of these species and encourage native species development. Although not very abundant, species such as reed canary grass, *Phragmites*, purple loosestrife, spotted knapweed and narrow-leaf & hybrid cattail will need to continue to be aggressively treated throughout the upcoming growing season. Herbicide treatments and mowing operations should be conducted at the appropriate time of year to achieve best results. In some cases, maintenance activities should be conducted 2 or 3 times throughout the growing season in order to more effectively reduce populations. Continuation of invasive species control will be critical while planted and seeded communities fill in with desirable plant species.

Although observations at the 18 sample plots captured a lot of good data to characterize the communities, it appears many species were not recorded. A total of 42 native and 13 non-native species were noted during the meander survey, but not observed within the sample plots. Our recommendation is to add 5 or 6 additional sample plots in 2017 to more accurately depict community types. In particular, plots should be added to the Northern Sedge Meadow, Open Water Submergent Aquatic, Prairie and Wet Mesic Forest communities. In addition to extra sample plots, we recommend re-assessing mapped community types throughout the Harbor. Sample plots established in 2016 may not represent the same habitat type in 2017 due to rising water levels that have shifted community boundaries. Sample plots established in 2016 will continue to be utilized; but some, especially those found in the Northern Sedge Meadow community, may not accurately characterize the community based on the dominant vegetation species recorded. If this is found to be correct, additional sample plots within these communities will ensure proper representation.

In an attempt to re-establish Wild rice (*Zizania aquatica*) within the Harbor, seed was sown in the fall of 2015. Plants were observed growing within the designated community zone; however, since the species is an annual plant we are concerned the limited growth will not be enough to adequately establish a permanent, robust population due to a lack of seed production. Although water levels increased after the initial seeding, we believe site conditions are still suitable for the species since some germination and growth was noted. Water depths should be re-assessed during the late summer of 2017 and additional seed sown within suitable areas to help bolster establishment of this very important species both for cultural and wildlife value.

During the 2016 growing season additional planting and invasive species control areas were added to the Harbor restoration project. Invasive species control was conducted over an additional 7 acres (Figure 3) to the south and to the west of the original project extent. Additionally, Northern Sedge Meadow and Aquatic Emergent communities were added around the northern portion of the pond that is located to the south of the original project boundary. Lastly, a shady woodland planting zone roughly 0.22 acres in size (Figure 3) was added just south of the southwest corner of the original project boundary. Because these areas are in the process of being restored and/or enhanced, it would be beneficial to add vegetation sample plots within these areas to monitor changes during the next two (2017 & 2018) growing seasons. To adequately capture the communities, we recommend adding nine sample plots as indicated in Figure 3.