Wetland Habitat Assessments at the Rochester Embayment Area of Concern on the South Shore of Lake Ontario, USA

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Wetlands in urban areas along Lake Ontario have been subject to various forms of degradation. The Great Lakes Water Quality Agreement (GLWQA) of 1972 between the United States and Canada was initiated to address the degradation of the physical, chemical, and biological integrity of the Great Lakes. The GLWQA of 1987 (Annex 2) identified locations that have serious contamination and other degradation issues to a greater degree than the rest of the Great Lakes basin, and designated these locations as Areas of Concern (AOCs). AOCs are assessed through preparation of remedial action plans (RAPs) to determine which of 14 "beneficial uses" related to human and intrinsic values of the ecological system remain impaired, and to identify actions that will restore beneficial uses. The Rochester Embayment is one of several areas designated as an AOC. The RAP for the Rochester Embayment Area of Concern (REAOC) provides investigation and remediation strategies for 12 beneficial use impairments (BUIs) including the "Loss of Fish and Wildlife Habitat" BUI (Beal and Stevenson 1997; MCDPD 1993; MCDPH 2011; USEPA 2014). Among BUI removal criteria and recommended

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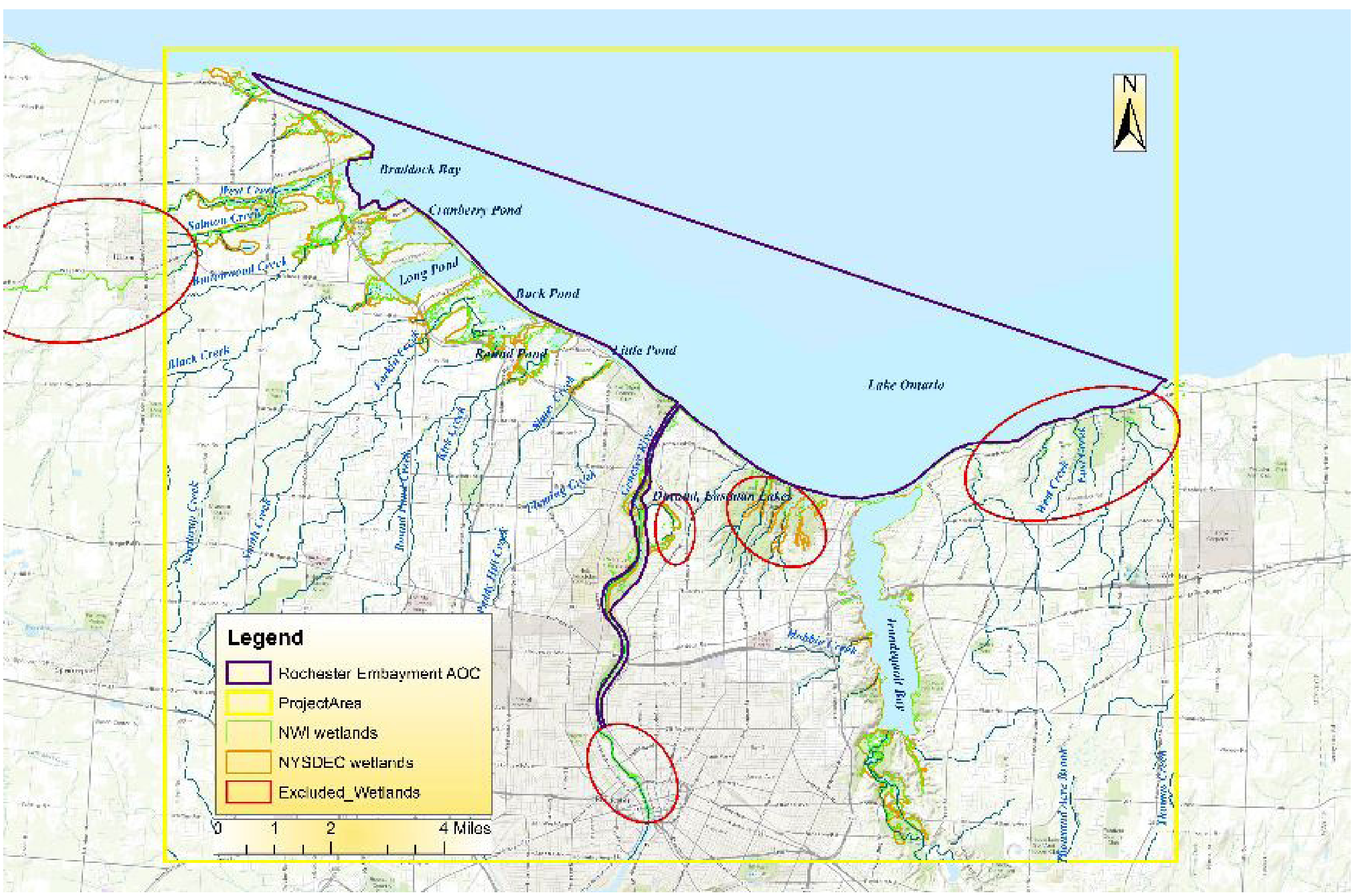

Figure 1. Project area for the USFWS wetland assessment at the Rochester Embayment Area of Concern. Indicated wetlands were excluded because associated waterbodies are small, constructed, and/or are not contiguous with the REAOC proper.

actions for the habitat loss BUI are requirements to assess trends in wetland size and condition, and rank wetland habitats for protection and restoration (E&E 2011; MCDPH 2011). In 2012, the U.S. Environmental Protection Agency (USEPA) Great Lakes National Program Office (GLNPO) requested that the U.S. Fish and Wildlife Service (USFWS) New York Field Office (NYFO) conduct these assessments under Great Lakes Restoration Initiative funding.

In 2012-2013, NYFO conducted assessments in wetlands associated with waterbodies in the immediate vicinity of the REAOC. The project area was defined by the extent of New York State Department of Environmental Conservation (NYSDEC) and USFWS National Wetlands Inventory (NWI) mapped wetlands in the REAOC, and contiguous wetlands in connected waterbodies (Figure 1). The project addressed the following objectives: (1) determine whether (a) wetland extent or (b) wetland quality is in decline at the REAOC; and (2) rank current habitat condition of the wetlands for restoration and preservation prioritization. The final report – "Wetland assessment in the Rochester Embayment Area of Concern in support of the Loss of Fish and Wildlife Habitat BUI Removal Evaluation" is available on the NYFO web site (http://www.fws.gov/northeast/nyfo/ec/glri.htm). This article summarizes key findings.

Change in Emergent Wetland Extent

Change in wetland extent was evaluated in 14 waterbodies by comparing emergent marsh delineations from 1951 aerial imagery against 2011 delineations. The analysis focused on emergent wetlands, since delineation of the historical extent of submerged wetlands and many wooded wetlands was not possible using historical aerial photographs alone. Delineations and interpretations using aerial imagery were conducted consistent with methods used by the National Wetlands Inventory (NWI).

Historical wetland signatures were delineated from October 1951 black and white aerial photographs, with other imagery used to assist in interpretation where necessary. Existing data compiled by the University of Massachusetts from 2011 color infrared imagery served as the base delineation for current wetland extent. Where the 2011 CIR coverage was incomplete, we used 2011 orthographic true color imagery to fill in gaps (ArcGIS 10.0 Bing base map, June 2011). The most recent leaf-off imagery (e.g., 2009 orthographic aerials and 2005 CIR) was also consulted for reference as needed.

The project area experienced a total net loss of approximately 280 acres of emergent wetland from 1951 (2,263 acres) to 2011 (1,982 acres). Both losses and gains were

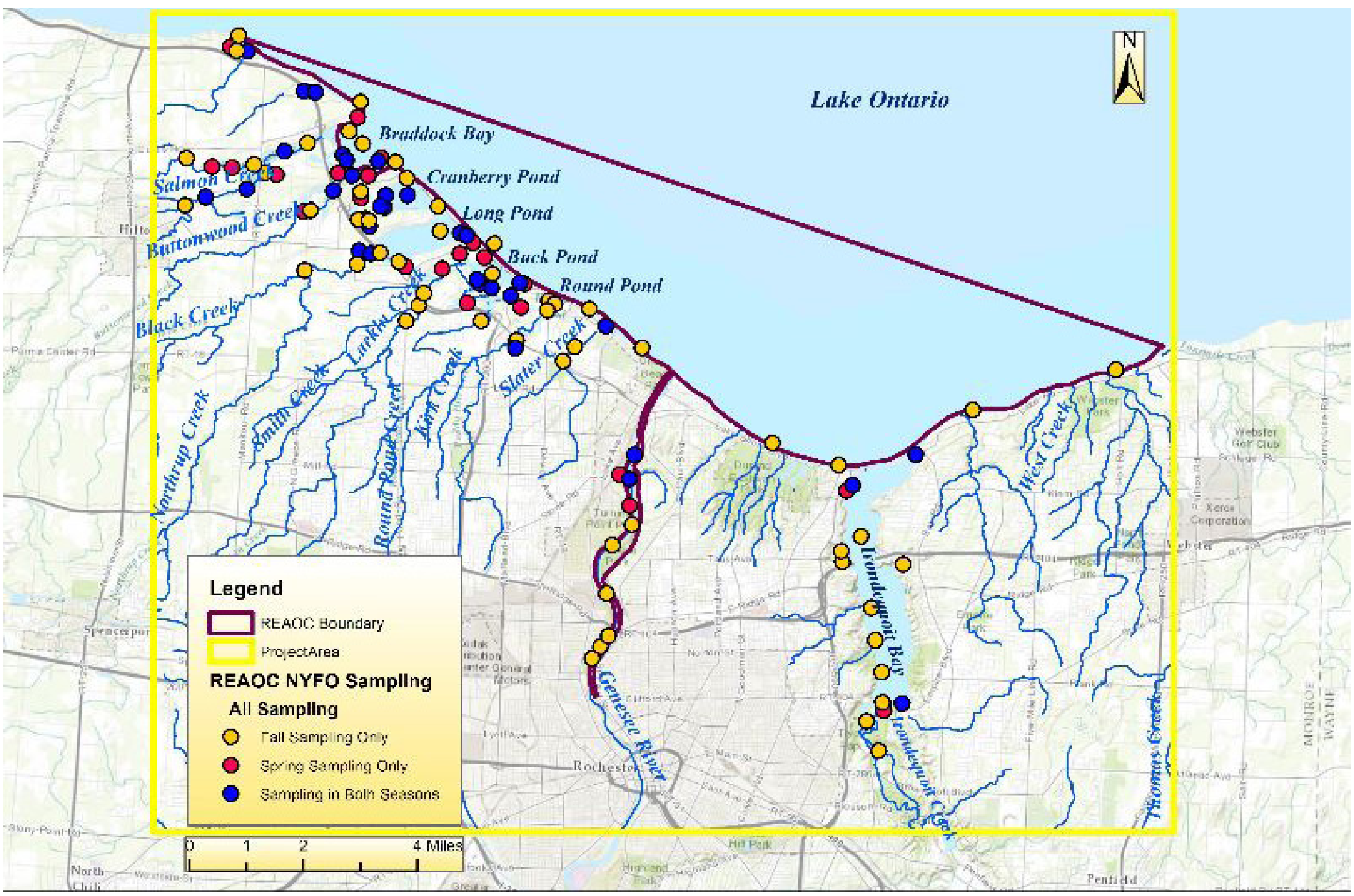

Figure 2. Distribution of 112 stations sampled in fall 2012 or spring 2013 for structural and vegetative habitat, water quality, and/or animal communities in order to rank wetland quality among waterbodies in the immediate vicinity of the REAOC. Points are differentiated by sampling season.

observed in different areas within most waterbodies. Net losses ranging from 1 to 121 acres were seen in 11 of the 14 waterbodies evaluated, while net gains ranging from 11 to 40 acres were observed in three of the waterbodies (Table 1). Most of the lost acreage was due to road construction and other development, erosion potentially resulting from water level regulation in Lake Ontario initiated in the 1960s, and natural dynamic shifts at wetland margins (Table 2).

Change in Wetland Quality

Change in wetland quality was explored in 16 waterbodies through evaluation of 19 individual metrics characterizing structural habitat condition, water quality, and animal communities. Trend analysis of time series data was conducted for water quality (1991-2009) and animal community metrics. Animal community metrics of wetland habitat quality were derived using existing guidance (Burton 2008; Grabas et al. 2008; GLC 2008; Timmermans et al. 2008) from call count data for both birds and amphibians collected within the project area during 1995-2011 by the Great Lakes Marsh Monitoring Program (BSC 2000). High variability typical of water quality and animal call count data was dampened by computing mean values for each metric by waterbody for each year sampled. Mean values were plotted over time, and apparent trends were statistically evaluated using the Mann-Kendall non-parametric trend test (Gilbert 1987; Nielson 2006). Change in structural habitat was interpreted by comparing current to historical aerial imagery (2011 to 1951) at a total of 79 stations distributed across the project area. Three structural habitat metrics indicative of habitat resiliency and complexity were evaluated: Percent of Assessment Area (AA) with a Buffer, Buffer Width, and Patch Mosaic Complexity. These metrics are included in the USA Rapid Assessment Method (RAM) (USEPA 2011), as applied for the National Wetland Condition Assessment.

There was no overall temporal trend in wetland quality in the project area as a whole, although obvious trends were detected within individual waterbodies (Table 3). Both improvements and declines in quality were observed in each waterbody considered, depending on the specific metric observed. Water quality improved in seven of the

Wetland Complex	Waterbody	Emergent Wetland Acreage in 1951	Emergent Wetland Acreage in 2011	Net Change in Emergent Wetland Acres since 1951*	Acres Lost	Acres Gained	% Change since 1951 in Emergent Wetland Extent
Braddock Bay	Braddock Bay	290.63	223.42	-67.21	-100.13	32.92	-23.13%
	Salmon Creek**	99.80	140.26	40.46	-8.63	49.09	40.54%
	West Creek**	24.70	35.65	10.95	-1.77	12.72	44.32%
	Buttonwood Creek	151.08	136.34	-14.74	-15.85	1.10	-9.76%
Buck/Round	Buck Pond	626.90	505.43	-121.47	-124.25	2.78	-19.38%
	Round Pond	222.22	201.25	-20.98	-29.76	8.79	-9.44%
Cranberry/Long	Cranberry Pond	209.13	193.85	-15.28	-16.93	1.65	-7.31%
	Long Pond	88.13	64.16	-23.97	-30.83	6.87	-27.20%
Genesee River		130.25	83.85	-46.40	-59.10	12.70	-35.62%
Irondequoit	Irondequoit Bay	63.24	52.62	-10.62	-37.29	26.68	-16.79%
	Irondequoit Creek and Eastern Trib**	195.08	208.53	13.45	-36.59	50.05	6.90%
Bogus Point	Bogus Pond Marsh	36.16	35.26	-0.90	-2.88	1.98	-2.49%
	Payne Beach Marsh	105.48	89.57	-15.91	-15.91	0.00	-15.08%
Slater Creek		20.59	11.65	-8.94	-12.90	3.96	-43.43%
REAOC Overall		**2263.38**	**1981.83**	**-281.55**	**-492.84**	**211.29**	-12.44%

*Submerged aquatic vegetation was not considered due to the difficulty of accurately measuring historic extent of aquatic beds. Only areas with high certainty of cover type in both sets of imagery were utilized to calculate change in emergent wetland extent.

**Water level in 1951 imagery for Salmon, West, and Irondequoit Creeks appeared higher than in 2011 imagery, leading to calculated wetland gains.

Table 1. Estimated acreage and summary of changes in emergent wetland extent from 1951 to 2011, by waterbody in the REAOC project area.

eight waterbodies considered, but absolute nutrient levels remained excessively high in a few of those waterbodies despite improving trends. Patterns in structural habitat and animal community trends were less clear, except in a few waterbodies. Among the clearest patterns were net declines in wetland quality in Irondequoit Creek and West Creek, and a broad improving tendency in Irondequoit Bay, Buck Pond, and Cranberry Pond. Specific metrics that declined most consistently across waterbodies were patch mosaic complexity, bird species diversity, bird focal species richness, and bird index of biological integrity (IBI).

Ranking Current Wetland Quality

Wetlands were ranked for restoration and preservation prioritization using metrics of structural habitat condition, water quality, and/or animal communities (Table 4). Metrics were derived from data collected in 2012 and 2013 at a total of 112 sampling stations distributed across the project area. Standardized field methods were selected that were: designed for extensive sampling across large areas, rapidly implemented, and readily repeatable. Structural habitat quality was assessed using the USEPA's USA Rapid Assessment Method, which has been utilized in

Loss Type	Loss Cause[1]	Acreage by Cause
Mowed	Development	0.42
Fill	Development	57.31
	Uncertain	2.17
	Road	63.15
	Stream Channelized	5.03
Hydrological shift	Development	0.47
	Road	15.48
Hydrological change with Fill	Uncertain	26.21
Made Land	Development	30.04
	Road	24.29
Residential	Development	6.39
	Stream Channelized	3.90
Shift	Delineation	0.03
Shoreline	Erosion	2.89
Conversion of wetland to water	Development	26.72
	Dredge	16.11
	Dynamic shift	93.38
	Erosion	82.85
	Road	20.76
	Stream Channelized	3.25
	Water Level	11.99
TOTAL of LOSSES		**492.84**

Table 2. Loss in wetland acreage between 1951 and 2011 across entire REAOC project area, tallied by attributed cause.

Waterbody	Structural Habitat			Water Quality			Bird Community								Amphibian Community				
	% AA With Buffer	Buffer Width	Patch Mosaic	Total P	SRP	TSS	Total Call Count	NAF Call Count	MNO Call Count	Total Species Richness	Focal Species Richness	AMNO Species Richness	Diversity Index	Index of Biotic Integrity	Total call count	Total Species Richness	Woodland Species Richness	Diversity Index	Index of Biotic Integrity
Bogus Pond	NT	NT	NT																
Payne Beach Marsh	NT	NT	I																
Braddock Bay	I	I	D	I	I	NT													
West Creek	NT	NT	I				D	D	D	NT	NT	NT	NT	NT	NT	NT	D	NT	D
Salmon Creek	NT	I	NT																
Buttonwood Creek	I	I	I				NT	NT	D	D	D	D	D	NT	NT	NT	NT	NT	NT
Cranberry Pond	I	I	I	I			I	I	I	I	D	D	NT	D	I	NT	I	NT	I
Long Pond	I	NT	D	I	I	NT									D	D	D	D	D
Northrup Creek	NT	D	D	I															
Buck Pond	I	I	D	I			I	I	NT	I	D	D	D	NT	I	I	I	I	I
Larkin Creek	NT	NT	NT																
Round Pond	I	I	D																
Slater Creek	NT	NT	NT																
Genesee River	NT	D	D	I	I	I									D	NT	NT	I	NT
Irondequoit Bay	D	D	I	I	I	NT	I	I	I	I	I	I	NT	NT	NT	NT	NT	NT	I
Irondequoit Creek	D	D	D	NT	D		I	I	NT	NT	D	NT	NT	D	I	D	D	NT	NT

Table 3. Summary of changes in mean values of wetland habitat quality metrics[1] (D=Decline, I=Increase, NT=No Trend, blank=data insufficient to evaluate trend). Associated waterbodies are listed approximately west to east. 1. *Acronym definitions are provided in the on-line final report.*

Structural Habitat	Water Quality	Animal Communities	
		Birds	Amphibians
Percent of Assessment Area having a Buffer	Total Phosphorus	Species Diversity Index	Species Diversity Index
Buffer Width	Total Suspended Solids	Index of Biological Integrity	Index of Biological Integrity
Stress to the Buffer Zone	Total Dissolved Solids	Species Richness (All)	Species Richness (All)
Topographic Complexity	pH	Focal Species Richness	
Patch Mosaic Complexity	Dissolved Oxygen		
Vertical Complexity	Nitrite		
Plant Community Complexity	Ammonia		
Stress to Water Quality			
Alterations to Hydroperiod			
Habitat/Substrate Alterations			
Percent Cover of Invasive Species			
Vegetation Disturbance			

Table 4. Metrics used to rank current wetland quality in the REAOC project area.

System	Structural Habitat EPA RAM	Water Quality YSI/grab	Animal Communities MMP	
			Birds	Herps
Lentic	Long Pond	Long Pond		Long Pond
	Buck Pond	Buck Pond	Braddock Bay	Braddock Bay
	Irondequoit Bay	Round Pond	Irondequoit Bay	Irondequoit Bay
Lotic	Genesee River	Genesee River		Genesee River
	Irondequoit Creek	Irondequoit Creek	Irondequoit Creek	Irondequoit Creek
	Braddock Bay Tributaries	West Creek	Buttonwood Creek	

Table 5. Summary showing the lowest ranked waterbodies in each habitat assessment category; the colors link waterbodies to a common watershed.

the National Wetland Condition Assessment. Water quality parameters were measured consistent with a 2011 QA/QC protocol of the analytical lab. Bird and amphibian communities were characterized using the Marsh Monitoring Protocol (BSC 2000).

Both metrics and waterbodies were ranked. Low-ranking metrics provided guidance to restoration planning by identifying which wetland attributes scored lowest, hence most in need of improvement. For example, a low score for patch mosaic complexity indicated that increasing the interspersion of habitat types would be an appropriate restoration objective. Ranking habitat quality by waterbody identified where restoration and protection are most needed.

Factors consistently found to be responsible for driving down wetland quality scores across waterbodies included ammonia, total phosphorus, and dissolved oxygen (DO) levels, and the following structural habitat metrics: patch mosaic complexity, stress to the buffer zone, topographic complexity, vertical (plant strata) complexity, and plant community (taxonomic) complexity. This set of low-scoring habitat metrics indicated a degradation of overall habitat complexity and resiliency. We deconstructed the lowest scoring structural habitat metrics to identify specific field indicators most responsible for driving down habitat quality scores across the project area; specific restoration recommendations were based on this analysis.

Poor structural habitat complexity broadly translated into limited habitat edge and low habitat diversity, hence, limited capacity for robust and diverse plant and animal communities. This interpretation was supported in the trend analysis of animal community metrics, which identified broadly declining trends in marsh bird diversity, focal species richness, and IBI scores across waterbodies in the project area. These findings suggested that activities for restoring habitat should focus on improving structural and vegetative complexity, and where feasible, mitigating up-gradient nutrient loadings and rehabilitating degraded buffers as well as protecting intact buffers.

Weight-of-evidence analysis identified principal candidate waterbodies for wetland habitat restoration within the project area: Braddock Bay and its tributaries, Long Pond, Genesee River, Irondequoit Bay, Irondequoit Creek, and Buck Pond (Table 5). Cranberry Pond was the best candidate for wetland protection, as it ranked relatively high across assessment metrics.

Ongoing Activities

We are now coordinating construction projects and efficacy monitoring in consultation with interagency technical advisors based on the findings from this wetland assessment, in order to improve habitat for diverse wetland wildlife within the project area. ■

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