

The Nature Conservancy and Environmental Law Institute Duck-Pensaukee Watershed Approach Pilot

The Duck-Pensaukee Watershed Approach Pilot Project, lead by The Nature Conservancy (TNC) and Environmental Law Institute (ELI), applied a variety of tools for identifying wetland sites suitable for wetland restoration (reestablishment) and preservation across a range of wetland services. These services included the provision of wildlife habitat, flood abatement, surface water supply, water quality protection, carbon storage, shoreline protection, and provision of fish habitat. In addition, to assess watershed needs for each wetland service, the tool applied a unique method for quantifying historical losses of each service across subwatersheds. The pilot, which TNC and ELI will include as part of a national handbook on watershed approach planning, provides the only application to date of methods for implementing the watershed approach in the Great Lakes coastal region.

OVERVIEW

Lead developer(s): The Nature Conservancy (TNC) and Environmental Law Institute (ELI).¹

Year developed: 2012.¹

Geographic area: Duck-Pensaukee HUC-8 watershed, Green Bay Basin, Wisconsin (Figure 1).¹

Resource types: Wetlands and waterbodies.²

Restoration/conservation: Restoration (reestablishment and rehabilitation), protection.^{1,3}

Stakeholders: Land trusts, local governments/planners/cities/municipalities, Oneida Nation, Wisconsin Department of Natural Resources (WDNR), NGOs (e.g., DU, TNC), regulatory agencies (WDNR, Army Corps of Engineers (the Corps), Interagency Review Team (IRT)), Wisconsin Department of Transportation (WDOT).²

Current status: In April 2012, TNC and ELI released a final draft report documenting methods and results from its pilot project. Results are also available via an online mapping tool at <http://maps.tnc.org/duckpentool/>. Currently, an outreach effort is being launched to work with partners to translate the plan into on-the-ground conservation (<http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/wisconsin/howwework/wisconsin-wetland-conservation-tool.xml>). In addition, the tools demonstrated in the pilot are being applied to select sites for a Great Lakes-scale ecological monitoring project. Plan



Figure 1. TNC, ELI, and collaborators focused their watershed approach pilot on the Duck-Pensaukee watershed in northeastern Wisconsin (shaded above).

developers are communicating with the St. Paul District of the Corps about using the tools to guide selection of mitigation sites.⁴

PRIORITIZATION ANALYSIS

Determination of prioritization objectives: Within the Duck-Pensaukee watershed, the planning team identified seven wetland services to target as part of its prioritization process that were important to humans, wetland-specific, and could be distinguished at a landscape scale using available spatial data. These services included:¹

- Water quality protection
- Flood abatement
- Surface water supply
- Shoreline protection
- Carbon storage
- Fish habitat
- Wildlife habitat

Landscape prioritization tool(s):

Watershed profile tool: To set watershed-wide conservation objectives, the team measured the historic change in magnitude and distribution of four wetland services – water quality protection, flood abatement, surface water quality, and carbon storage functions – using NWI+ LLWW (Landform, Landscape position, Waterbody type, and Water flow path) modifiers together with current and historic wetland polygon data (Table 1). Using LLWW classifications, the team identified the highest performing wetlands for each HUC-12 by applying a set of “functional correlations” between each LLWW classification and the four target functions. For each of these functions, the team calculated historic change in functional performance for each HUC-12 watershed by comparing the current acreage of high functioning wetlands with the historic acreage of high functioning wetlands within each HUC-12. The planning team used this assessment to identify HUC-12s in which wetland restoration and preservation are most needed, opportunities for wetland restoration and protection that could benefit downstream areas, opportunities for wetland restoration and preservation of individual sites that would be most relevant in a watershed context, and opportunities for the conservation community to collaborate to restore and maintain wetland services.¹

Prioritization objectives assessed:

- Historic functional change

Table 1. Historic change in wetland functions was assessed based on the following factors and data sources.^{1,4}

Factor used in analysis	Data source(s)
NWI+ LLWW modifiers	NWI data supplemented with GIS analyses
Current wetlands	WWI wetland map data, converted to NWI format by USFWS
Historical wetlands	WWI wetland map data, converted to NWI format by USFWS; Hydric soils minus current wetlands and non-restorable land uses (e.g., developed

	areas)
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WWI = Wisconsin Department of Natural Resources Wisconsin Wetland Inventory; NWI = National Wetland Inventory; USFWS = U.S. Fish and Wildlife Service

Potentially Restorable Wetlands (PRW) tool: The planning team identified reestablishment opportunities as sites that formerly supported wetland hydrology and vegetation and which currently had appropriate land cover for restoration; these sites were termed Potentially Restorable Wetlands (PRWs). PRWs were identified based on factors such as presence of hydric soils and presence of appropriate current land cover (Table 2) and were integrated into the habitat and functional assessment tools (described below).¹

Prioritization objectives assessed:

- Feasibility of restoration

Table 2. Factors and associated data sources used to prioritize wetland reestablishment opportunities.¹

Factor used in analysis	Data source(s)
Hydric soils	NRCS SSURGO soils data
Is not within an existing wetland	WDNR WWI wetland map data, converted to NWI format by USFWS
Land use reflecting opportunity (e.g., agriculture) or lack of opportunity (e.g., urban, or existing natural cover) for successful wetland restoration	C-CAP (2001) land cover data

WWI = Wisconsin Wetland Inventory; C-CAP = Coastal Change Analysis Program; NRCS = Natural Resource Conservation Service; SSURGO = Soil Survey Geographic (database); WDNR = Wisconsin Department of Natural Resources.

Wetland preservation tool: The planning team considered opportunities for wetland preservation to consist of both existing wetlands in the Duck-Pensaukee watershed as well as areas along the Lake Michigan coast that alternate between upland and wetland conditions. Opportunities for wetland preservation, indicated by the extent of existing wetlands in addition to unmapped potential wetlands along the coast (Table 3), were integrated into the habitat and functional assessment tools (described below).¹

Prioritization objectives assessed:

- Suitability for preservation

Table 3. Factors and associated data sources used to prioritize wetland preservation opportunities.¹

Factor used in analysis	Data source(s)
Current wetlands	Wetlands mapped by Wisconsin Wetland Inventory or National Wetland Inventory
Potential wet areas (PWAs)	Coastal soils that support wetland hydrology and vegetation during high Lake Michigan levels

Wildlife tool: This tool was used to map the capacity of Potentially Restorable Wetlands and preservation wetlands to support a variety of habitat types. The planning team first identified “habitat targets” (e.g., forested swamp) based on priority natural communities listed for the

Duck-Pensaukee watershed in the Wisconsin Wildlife Action Plan (WWAP) in addition to input from local experts. For each of these habitat targets, the team then identified “representative species” based on WWAP-defined Species of Greatest Conservation Need (SGCN) that reflected the habitat, management, and restoration needs of their associated habitat target (e.g., Canada warbler and northern flying squirrel were selected to represent the forested swamp habitat target). The team then engaged local experts who evaluated the strength of association between wildlife representing target habitats (e.g., Canada warblers) and habitats within the watershed for which high-resolution spatial data were available (e.g., evergreen forested wetland); these were recorded in a matrix (Figure 2). Through expert input and literature searches, the team also defined “proximity factors” that were used to incorporate landscape-level requirements for each species into the model (e.g., Canada warblers require extensive forested habitat (upland or wetland) surrounding their primary forested swamp habitat). Together, the matrix and proximity factors were used as part of a GIS-based model to prioritize the importance of PRWs, existing wetlands, and uplands to the representative species.¹ Factors and associated data sources used by the planning team to assess habitat quality are listed in Table 4.¹

Conservation targets & Representative species	Wetlands											Uplands								
	Shrub swamp	Shrub bog	Forested wetland (broadleaf deciduous)	Forested wetland (evergreen)	Forested wetland (tamarack)	Floodplain forest	Forested wetland (ridge & swale)	Emergent wetland	Stream (cold)	Stream (cool)	Stream (warm)	River (warm)	Inland lakes, ponds, impoundments	Coast: Beach	Upland Forest (deciduous)	Upland Forest (mixed)	Upland Forest (evergreen)	Grassland/Herbaceous	Pasture/Hay (surrogate grassland)	Upland Scrub/Shrub
OPEN WETLANDS & WATERS <i>Am. Bittern, Blue-winged Teal, Black Tern</i>		2						3					3					2	2	
BEACHES <i>Caspian Tern, Common Tern</i>								1					1	3						
SHRUB SWAMP <i>Am. Woodcock, Willow/Alder Flycatchers</i>	3		1		1										1					1
FORESTED SWAMP <i>Canada Warbler, Northern Flying Squirrel</i>			3	3	2	1	3		1	1	1	1	1		2	2	2			
INTEGRATED LANDSCAPE <i>Blanding's Turtle</i>	2	2	2		1	1	3	3			1	3	3		2	2	1	3	3	2
RIPARIAN HABITAT <i>Wood Turtle</i>	3	1	2	1	1	3	1	1	3	3	3	3	1		2	2		3	2	2
SHOREBIRD STOPOVER HABITAT	Scores adapted from Migratory Shorebird Stopover Model ¹																			

Figure 2. In collaboration with local experts, the planning team developed this Wildlife Tool Matrix. The matrix rates the strength of association (0 = no association; 3 = significant association) between species representative of habitat targets and available habitats within the Duck-Pensaukee watershed.

Prioritization objectives assessed:

- Habitat quality

Table 4. The Wildlife Tool used the following factors, and associated data sources, to prioritize PRWs, existing wetlands, and uplands for seven habitat targets (listed in Figure 2). Proximity factors were used for all habitat targets except ‘shorebird stopover habitat’.¹

Factor used in analysis	Data source(s)
Wetland reestablishment opportunities (PRWs)	See above
Wetland preservation opportunities	See above
Strength of association between species	Wisconsin Wildlife Action Plan and input

representative of target habitats and available habitats mapped within the Duck-Pensaukee watershed.	from local experts
<i>Proximity factors</i>	
For ‘open wetlands and water’: Grassland or surrogate grassland must be adjacent to wetland and >32 ha; emergent marsh patches must be >10 ha.	Literature and expert input
For ‘beaches’: Emergent wetland and open water must be within 2 miles of beach habitat.	Literature and expert input
For ‘shrub swamp’: Non-shrub-swamp habitats must be within 600m of shrub swamp (otherwise, scored 0).	Literature and expert input
For ‘forested swamp’: Wetland forests must be >6 ha and occur within a patch of contiguous forest (upland and/or wetland) >48 ha. Upland forests must be >48 ha and occur on soils that can support mesic (maple-beech) or wetter forests. Streams & lakes must occur within forest (upland and/or wetland) >28 ha.	Literature and expert input
For ‘integrated landscape’: If "3" wetland types are adjacent to "3" upland types, then all types within 300m receive the indicated scores. If not, then none of the habitat types (wetland or upland) are scored.	Literature and expert input
For ‘riparian habitat’: Rivers/streams must be adjacent to natural land cover. All habitats must be within 300m of "clean" channels (i.e., no 303(d) designation or other polluted status). Ponds/lakes must be <1 ha.	Literature and expert input
For ‘shorebird stopover habitat’: existing prioritized habitat for shorebird species.	WDNR Migratory Shorebird Stopover Model

Flood abatement tool: The planning team assessed the ability of individual PRWs and existing wetlands to perform flood abatement functions by evaluating each site for three types of criteria using a GIS-based approach. These included:¹

- 1) “Opportunity criteria” representing the possibility of provision of flood abatement benefits given the landscape context of each site evaluated (e.g., wetlands in large catchments with large amount of impervious surfaces have the opportunity to receive large amounts of runoff during storms).
- 2) “Effectiveness criteria” representing the capability of wetlands to provide flood abatement benefits given the specific characteristics of each individual site (e.g., wetlands in topographic depressions are more effective at storing floodwaters than those on slopes)
- 3) “Social significance criteria” representing the extent to which flood abatement benefits provided clear societal benefits (e.g., wetlands that lie upstream of developed, flood-prone areas may have a high social significance for flood abatement functions).

Using GIS analysis, the team counted the number of opportunity and effectiveness criteria satisfied at each wetland site, with PRWs and existing wetlands analyzed separately. These counts were divided by the total number of opportunity or effectiveness criteria that could possibly have been satisfied to obtain final scores for each PRW or existing wetland. The team added 0.1 to the resulting scores if any social significance criteria had been met for the site. Assessing PRWs and existing wetlands separately, the team designated the highest scoring quarter of all sites to be “exceptional” and the next quarter of sites to be “high” priorities. The lowest half scoring sites were considered “low” priorities for PRWs (i.e., restoration) and were not considered priorities at all for existing wetlands (i.e., preservation). Factors and data sources used to assess flood mitigation are listed in Table 6.¹

Prioritization objectives assessed:

- Flood abatement

Table 6. Factors and associated data sources used to prioritize for flood mitigation.¹

Factor used in analysis	Data source(s)
Wetland reestablishment opportunities (PRWs)	See above
Wetland preservation opportunities	See above
<i>Opportunity criteria</i>	
Impervious surfaces cover > 10% of the site’s catchment	2001 National Land Cover Database (NLCD) Impervious Surface Dataset from USGS via Data Basin, NHDPlus Catchments (14-digit), NWI, PRW
Slopes within the site’s catchment exceed 15%	demgw930 (30m DEM distributed by WDNR), NHDPlus Catchments (14-digit), NWI, PRW
Site receives point source inflow	NWI+, WI DNR 24k hydro layer, NWI, PRW
The catchment area is large relative to the site (>82% of the catchment is upland)	NHDPlus Catchments (14-digit), NWI, PRW
<i>Effectiveness criteria</i>	
Dominant vegetation is dense and persistent (forest, scrub-shrub, emergent marsh)	NWI+, NWI, PRW
Site is in a topographic depression or floodplain setting	NWI+, Historic Wetland LLWW
Flow through the site is not channelized or incised	NWI+, Historic Wetland LLWW
<i>Social significance criteria</i>	
Developed flood-prone areas occur downstream, within 5 miles or above the nearest dam	NHDPlus Catchments (14-digit), NWI, PRW, Minor Civil Divisions, 24k hydro

Surface water supply tool: This tool scored each potential restoration (PRW) and preservation (existing wetland) site in terms of its ability to provide surface water supply services based on the opportunity and effectiveness criteria (Table 7).¹

Prioritization objectives assessed:

Updated: 6/3/2012

- Surface water supply

Table 7. Factors and associated data sources used to prioritize for maintaining surface water supplies.¹

Factor used in analysis	Data source(s)
Wetland reestablishment opportunities (PRWs)	See above
Wetland preservation opportunities	See above
<i>Opportunity criteria</i>	
Site is in a headwater setting	NWI+, Historic Wetland LLWW
<i>Effectiveness criteria</i>	
Site is in a floodplain or fringe setting	NWI+, Historic Wetland LLWW, PRW
Site is a pond or lake with perennial throughflow or outflow	Historic Wetland LLWW, PRW

Water quality protection tool: This tool scored each potential restoration (PRW) and preservation (existing wetland) site in terms of its ability to provide water quality services based on various opportunity, effectiveness, and social significance criteria (Table 8).¹

Prioritization objectives assessed:

- Water quality protection

Table 8. Factors and associated data sources used to prioritize for water quality.¹

Factor used in analysis	Data source(s)
Wetland reestablishment opportunities (PRWs)	See above
Wetland preservation opportunities	See above
<i>Opportunity criteria</i>	
Point source discharge upstream or directly into site	Wastewater Wisconsin Pollutant Discharge Elimination System (WPDES) Permit Program, NHDPlus Catchments (14-digit), NWI, PRW, 24k hydro
Site subject to nutrient loading from agricultural sources (row crops cover >42% of catchment)	CCAP 2001, NHDPlus Catchments (14-digit)
Impervious surfaces cover > 10% of the site's catchment	2001 NLCD Impervious Surface Dataset from USGS via Data Basin, NHDPlus Catchments (14-digit), NWI, PRW
Site is not buffered by surrounding upland vegetation (<50% of land within 200 feet is in natural cover)	CCAP 2001, Wetlands, PRW
<i>Effectiveness criteria</i>	
Site has seasonally fluctuating water levels	NWI+, Historic Wetland LLWW, PRW
Site occurs in a topographic depression	NWI, PRW
Dominant vegetation is dense and persistent	NWI, PRW

(forest, scrub-shrub, emergent marsh)	
<i>Social significance criteria</i>	
Wetland occurs in or above a catchment containing 303(d) waters.	24k Hydro WI DNR, 303d listed lines and areas from WI DNR
Surface connection to a lake, pond, river, or stream	NWI+, Historic Wetland LLWW, PRW

Carbon storage tool: This tool scored each individual potential restoration (PRW) and preservation (existing wetland) site in terms of its ability to provide carbon storage services based on four effectiveness criteria (Table 9).¹

Prioritization objectives assessed:

- Carbon storage

Table 9. Factors and associated data sources used to prioritize for carbon storage.¹

Factor used in analysis	Data source(s)
Wetland reestablishment opportunities (PRWs)	See above
Wetland preservation opportunities	See above
<i>Effectiveness criteria</i>	
Site contains deep peat or muck layers	SSURGO database soil map unit description
Dominated by high biomass vegetation (forest, scrub shrub)	NWI codes
Substrates are saturated throughout the growing season	NWI codes
Site has potential to serve as a carbon sink (water flow path = isolated or inflow)	NWI+, Historic Wetland LLWW, PRW

Shoreline protection tool: This tool scored each individual potential restoration (PRW) and preservation (existing wetland) site in terms of its ability to provide shoreline protection services based on a variety of criteria (Table 10).¹

Prioritization objectives assessed:

- Shoreline protection

Table 10. Factors and associated data sources used to prioritize for shoreline protection.¹

Factor used in analysis	Data source(s)
Wetland reestablishment opportunities (PRWs)	See above
Wetland preservation opportunities	See above
<i>Opportunity criteria</i>	
Adjacent to or containing a river, stream, or lake	24k Hydro WI DNR, Wetlands, PRWs
<i>Effectiveness criteria</i>	
Adjacent waterbody is large (lakes > 10 acres; streams > 2nd order)	24k Hydro WI DNR, Wetlands, PRWs
Densely rooted emergent or woody vegetation	NWI

Updated: 6/3/2012

(EM, SS, FO)	
<i>Social significance criteria</i>	
Located between (adjacency to) developed area and open water	Wetlands, WROC 2010 18" air photography

Fish habitat tool: This tool ranked potential restoration (PRWs) and preservation sites in terms of their capacity to serve as fish habitat based on one opportunity criterion (connectivity with lakes or streams) and four effectiveness criteria (e.g., wetland inundated in Spring, wetland not 303(d) listed, etc.) (Table 11).¹

Prioritization objectives (and associated data sources) assessed:

- Habitat quality

Table 11. Factors and associated data sources used to prioritize for fish habitat.¹

Factor used in analysis	Data source(s)
Wetland reestablishment opportunities (PRWs)	See above
Wetland preservation opportunities	See above
<i>Opportunity criteria</i>	
Sites is connected or contiguous with a perennial stream or lake	24k Hydro WI DNR, Wetlands, PRWs
<i>Effectiveness criteria</i>	
Wetland is inundated in Spring (water regimes A, C, F, G, H)	NWI+, Historic Wetland LLWW, PRW
Contiguous water body, if present, is NOT 303(d)-listed	24k Hydro WI DNR, 303d listed lines and areas
Adjacent open water is bordered by natural landcover for >50% of its length	Wetlands, CCAP 2001, 24k hydro
Natural cover (forest, shrubland, grassland, or other wetland) comprises >40% of land in the wetland's catchment	CCAP 2001, NHDPlus Catchments (14-digit)

Function variety assessment: For each wetland and PRW, the TNC-ELI DPWAP counted the number of functions (out of the seven described below) performing at “high” or “exceptional” levels by combining the outputs of other tools used in its analysis (Table 5). The resulting scores (which range from 0 to 7) can be used to identify sites at which conservation investment can be targeted to maximize functional gain.¹

Prioritization objectives assessed:

- Habitat quality
- Water quality
- Flood mitigation
- Feasibility of restoration
- Suitability for preservation
- Surface water supply
- Carbon storage

Table 5. The following factors and data sources were used to target sites that maximize functional gain.¹

Factor used in analysis	Data source(s)
Wildlife habitat	See above
Flood abatement	See above
Surface water supply	See above
Water quality protection	See above
Carbon storage	See above
Shoreline protection	See above
Fish habitat	See above

Validation of the landscape prioritization tool(s): Outputs from the model have not yet been validated, though this will likely be a next step for the planning team.² Plans are currently underway to validate the wildlife tool.

Refinement of landscape priorities: The pilot identified priorities using landscape prioritization tools as an initial step in the prioritization process. In the future, the planning team may develop field-based methods for refining landscape prioritization results.²

Prioritization products: A final report (available from <http://conserveonline.org/library/the-duck-pensaukee-watershed-approach-mapping>) provides maps for each function assessed as part of the TNC-ELI evaluation of watershed needs as well as an assessment of specific priority sites for each function/value and/or aquatic resource improvement type (Figure 3).¹ Results are also provided via an online, interactive mapping tool (<http://maps.tnc.org/DuckPenTool/>).

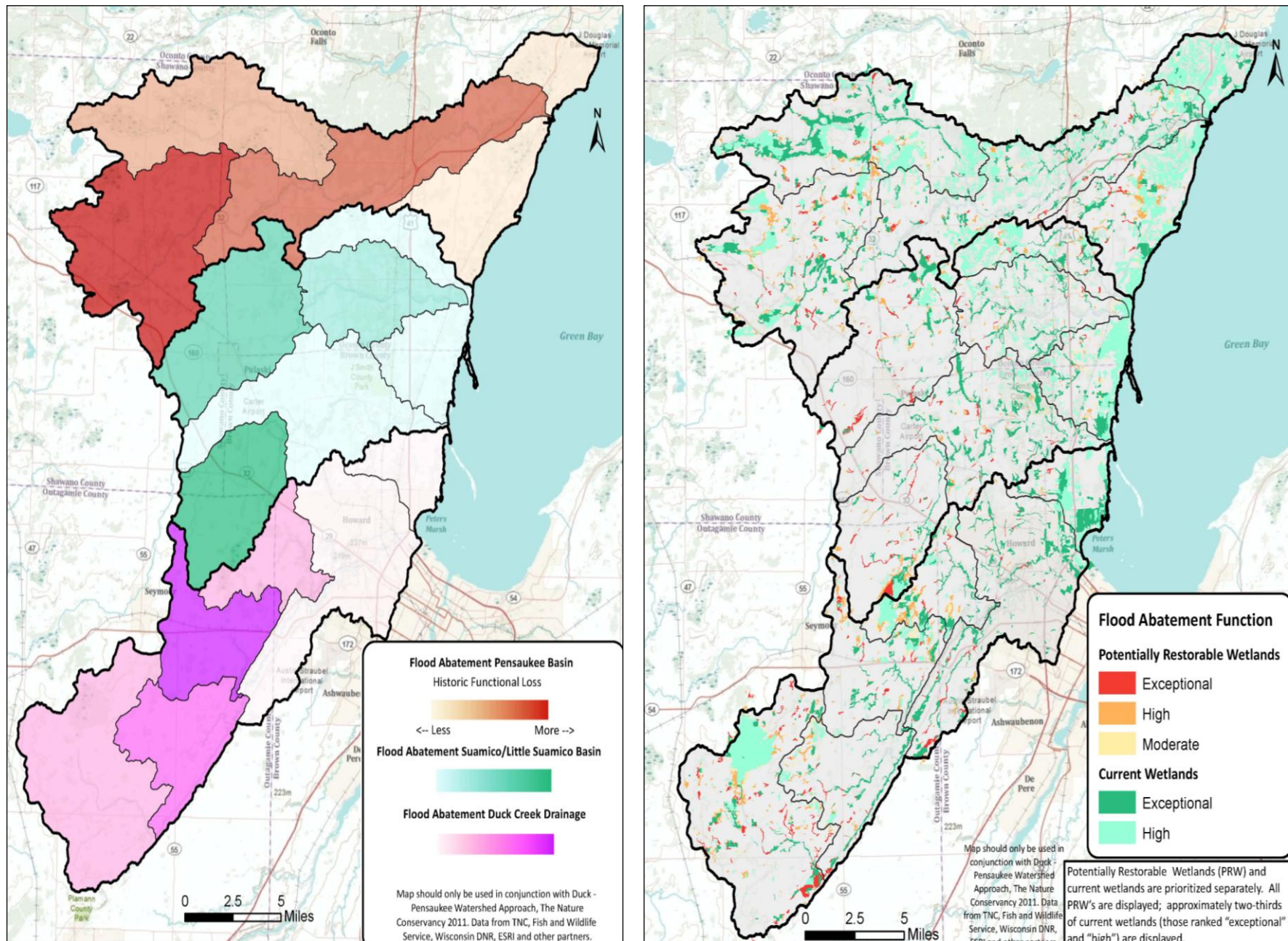


Figure 3. In its 2012 report, TNC-ELI provided output maps from its assessments of watershed needs (i.e., areas of historic functional loss) and tools for identifying site-specific priorities. For example, its assessment of flood abatement needs (left) identifies HUC-12s in which site-specific restoration and preservation priorities for flood abatement (right) might be targeted to promote a watershed approach to regulatory and non-regulatory wetland conservation.

IMPLEMENTATION

Regulatory/non-regulatory applications:

- Section 404 compensatory wetland mitigation
 - Watershed approach: By analyzing historic functional losses within HUC-12 watersheds, the approach identifies areas in which mitigation should be targeted to promote functional replacement of wetland benefits.¹
- Priorities identified by the tools help to inform Wisconsin's State Wildlife Action Plan.²
- Opportunities for increasing effectiveness of conservation investments toward watershed health and functionality.²
- Alignment of regulatory and non-regulatory wetland conservation efforts for the benefit of both.²

Transferability:

- The pilot is one of a number of watershed approach pilots that are being considered and analyzed in the development of a national handbook for watershed approach planning (another ELI/TNC collaboration).²
- The methods demonstrated in the pilot provide the only Great Lakes coastal representation in the current suite of "watershed approach" pilots.²
- The "wildlife tool" is transferable if tailored to other states' Wildlife Action Plans (WAPs). A primary goal of this tool is to tailor WAP goals to individual watersheds.²

Data gaps:

- Improved/updated land use and land cover datasets would significantly improve development of habitat models for the Wildlife Tool.²

Barriers:

- Time required prioritizing sites for each application of the tools.²
- Funding.²

Future goals:

- Apply the tools in all HUC-8 watersheds throughout Wisconsin.²
- Apply/adapt the tools for other Great Lakes states.²
- Resource (time/money) constraints are barriers to meeting these goals.²
- More training of other groups/organization/agencies in application of the methodology and new/better data would be helpful in achieving these goals.²

¹ Miller, N., T. Bernthal, J. Wagner, M. Grimm, G. Casper, and J. Kline. 2012. The Duck-Pensaukee Watershed Approach: Mapping Wetland Services, Meeting Watershed Needs. The Nature Conservancy and Environmental Law Institute, Madison, Wisconsin.

² Feedback received on 3/29/2012 from Nick Miller, Director of Science at The Nature Conservancy.

³ "Wetland creation and enhancement opportunities were not identified as part of this project because coarse-scale GIS analyses cannot reliably distinguish the best opportunities (i.e., opportunities are best identified at the ground level), and because potential functional gains from these activities may occur at the expense of other functions."

⁴ Feedback received on 5/24/2012 from Nick Miller, Director of Science at The Nature Conservancy.