Future of the Great Lakes: Prioritizing Prevention, Protection, and Restoration Activities

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For years, policy makers, researchers, industrial representatives, environmental advocates and citizens in the Great Lakes Basin have worked to understand and reduce the stresses that have long posed threats to the Basin ecosystem. More recent findings indicate that the stresses may be pushing the ecosystem close to a tipping point of irreversible change. These sources of stress present scientists and managers with a complicated and complex problem. Building a common understanding of the issues affecting the entire Great Lakes ecosystem and identifying remedies to major problems requires sound technical analysis as well as judgment regarding the likelihood of a project's success in reducing stresses.

To discuss development of screening criteria to help evaluate and identify the highest priority protection and restoration needs of the Lakes, the Healing Our Waters (HOW) Coalition organized a meeting of a small group of scientists in Grand Rapids, MI on June 8, 2006. The criteria draw primarily from key concepts defined in the white paper released in December 2005 *Prescription for Great Lakes Ecosystem Protection and Restoration: Avoiding the Tipping Point* (hereafter, "the Prescription Paper", and available at http://restorethelakes.org/PrescriptionforGreatLakes.pdf)

The drafters of this report purposefully developed selection criteria that are applicable to a broad range of scales, locations, and types of stresses. While we anticipate these criteria will be used as one set of inputs to the HOW Coalition for mobilizing support for restoration and protection efforts, they may also be used by other stakeholders. Other criteria such as feasibility, readiness, and level of public support, will also be important in the overall selection process of protection and restoration projects.

We envision three categories of projects associated with Great Lakes protection and restoration: Prevention, Protection, and Restoration, as briefly defined below.

Prevention: This category includes efforts to prevent additional stress such as new invasive species, new chemicals, and new physical modifications. Examples could be development of an innovative shipping strategy that minimizes or eliminates threats of introductions of invasive species via ballast water, or development of an innovative green chemistry program preventing new inputs of certain toxic chemicals.

Protection: This category includes efforts to protect areas of the Great Lakes that currently possess the characteristics we are striving for in restoration. An example could be protection of a coastal zone in Lake Superior with relatively minimal historic or contemporary developmental or other impacts.

Restoration: This category includes efforts to restore areas that are clearly degraded and have a greatly diminished ability to assimilate additional stress. That is, they have lost resiliency and one or more of their primary ecological functions. Examples would be plans to address impairments in any of the Areas of Concern around the Basin.

The criteria identified below should be applicable across all three categories.

Characteristics to consider for all projects:

- *Does the project improve and/or protect ecosystem resiliency, function, and sustainability?*

A primary goal outlined in the Prescription Paper is to restore the natural resiliency of the Great Lakes in order to maintain essential ecosystem functions and biodiversity over the long term, and thus be able to assimilate stress. In many places, the natural buffering capacity and resiliency of the Lakes has been lost, particularly in nearshore areas. Restoration activities that restore resiliency and lead to improved ecosystem sustainability are of the highest priority..

- *Does the project recognize and attempt to address all known and relevant stresses?*

Cumulative impacts and interactions among stressors are now recognized as major factors that affect the ability of the lake ecosystems to recover. To be most effective, projects need to address these cumulative impacts and interactions, or at least address key multiple stresses that can individually prevent attainment of restoration targets. Projects should be designed to ensure that management decisions affecting one stress do not lead to conditions that exacerbate another stress. One potentially significant challenge is that additional stressors may only be recognized once a project is underway. Ideally, strong project proposals will note the potential for many such stresses to affect project outcomes, based on previous experience and the scientific literature on relevant topics, and employ an adaptive management paradigm as the project is implemented and monitoring detects unpredicted outcomes.

- *Does the project clearly address significant and well-documented current or anticipated impacts?*

While many projects are designed to address presumed stresses, the highest priorities should be those projects that demonstrate clear connections between the proposed actions and impacts. While the inherent complexity of the system will not allow for perfect predictions of future states in response to management actions, these connections should be explored with scientifically rigorous assessments.

- *Is there a plan to measure, assess, and communicate results?*

Many if not most protection and restoration projects are likely to be long-term in nature, and therefore need to be designed in an adaptive framework. To be adaptive, there needs to be a clear plan to monitor activities and the target impacts, assess progress, and potentially make adjustments as necessary in order to maximize likelihood of project success. In addition, to maintain stakeholder support for the effort, these results and assessments need to be communicated to decision makers and the public.

Category-specific criteria: There are additional considerations for each category, as noted on the following page.

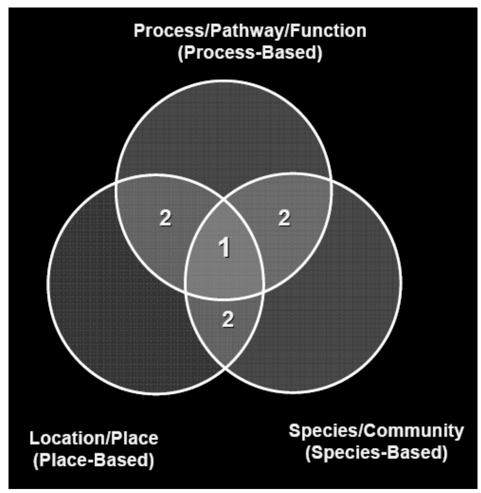
Prevention - The highest priorities are to prevent new stresses that have impacts at watershed, lake, or basin scales. For invasive species, for example, projects that contribute to prevention of introduction of a new species that can potentially impact the entire Basin may rank higher than a project to prevent the spread of an invasive species already established in one part of the Basin.

Protection - The highest priorities are for projects that clearly identify regions that currently maintain, for the most part, resilient, well-functioning ecological processes. Certain nearshore areas of Lake Superior, for example, could be examples of locations where such protection projects would be encouraged.

Restoration - Highest priority projects will address nearshore (terrestrial and aquatic) regions, tributaries and their watersheds, and connecting waters.

It is also important that all known stresses be considered. For example, stresses coming from the watershed (e.g., polluted runoff) and even outside the watershed (e.g., atmospheric deposition of heavy metals, pesticides, and other toxic chemicals which may have both local and more distant sources) may make attainment of site-specific restoration goals difficult if they are not considered.

Restoration projects also need to address all three elements of effective restoration (see figure):



1) Defines an appropriate location. *For example, is the project specific to a segment of a connecting waterway, or lakewide?*

2) Targets key species, communities, or ecosystems. *For example,* a p*roject might aim to restore a native species such as lake sturgeon or a coastal wetland community*.

3) Ensures ecological processes, pathways, and functions are restored. *For example, a project goal might be to remove shoreline structures that otherwise prevent more natural sediment loading patterns to nearshore waters*.

The highest priority projects are those that address all three elements, in addition to having a nearshore emphasis as noted above. Special consideration should be placed on those projects whose positive impacts will extend to other processes, places and species/ communities.

Ongoing Restoration Projects and How They Might Be Analyzed by the Criteria:
An assessment of the effectiveness of the screening criteria in prioritizing projects was done by evaluating several ongoing restoration projects in the Basin (i.e., the third category established above). These projects are not considered to be representative of all restoration projects undertaken in the Great Lakes over the past 10-15 years, but are thought to include the types of projects that may more likely meet a number of the criteria identified in this process.

To be useful as part of a prioritizing tool, the criteria identified above may need to be evaluated with a general scoring system for each project assessed, given that there would likely be a gradation of results for a given criterion rather than a simple dichotomous finding (i.e., does or does not meet criterion). For this basic assessment of potential projects, a very simple qualitative scoring system (i.e., yes, partially, no) was utilized for each project.

Lake Sturgeon Habitat Restoration in the Detroit River

Lake sturgeon are native to the Great Lakes, and were historically important fish species in nearshore waters of the lakes, prior to significant pressures (including habitat destruction or alteration, overfishing, dam construction and pollution) in the late 19th and early 20th Centuries. Continuing stresses that have limited lake sturgeon recovery in more recent decades include ongoing habitat limitations, chemical pollution and thermal pollution in riverine habitats (e.g., discharges of cooling water or effluents from wastewater treatment plants), and altered flows (e.g., slowing of water velocity due to deepening of the channel for navigation).

The Detroit River is an area where lake sturgeon habitat was significantly reduced through the decades: channeling, navigational dredging and gravel and cobble removal during the construction of urban areas along the river removed significant habitat for the fish. Some information indicates that the river historically supported a significant population of the fish, and a recent assessment confirmed one spawning site on the river near Zug Island (Caswell et al., 2004). One effort to restore suitable sturgeon habitat in the river is the Detroit River Sturgeon Spawning Habitat Project, an effort coordinated by University of Michigan Sea Grant, and with partners that include the U.S. Geological Survey (USGS) Great Lakes Science Center, U.S. Army Corps of Engineers, Great Lakes Fishery Trust, City of Detroit, Michigan Department of Natural Resources, and DTE Energy. The project has involved creation of three artificial reefs in 2004 near Belle Isle in the northern section of the river (Boase, 2005). It has been recognized that a number of factors must be considered in restoring these and other fish populations, including suitable spawning and larval habitat, connectivity between them, flow and temperature, and contaminants (HEC, 2006).

Evaluation of Lake Sturgeon Habitat Restoration in the Detroit River Project

Criteria	Evaluation	Comments
Does the project improve and/or protect ecosystem resiliency, function, and sustainability?	Yes	• Habitat reconstruction would provide habitat for lake sturgeon as well as other important native species (e.g. walleye) • Increased benthic habitat should allow for increased biodiversity in river • If done on larger scale, could help support flow regimes closer to pre-development conditions
Does the project recognize and attempt to address all known and relevant stresses?	Yes, partially	• Some additional stresses have been considered in broad assessments of Detroit River (e.g., limitations in habitat connectivity, flow, and temperature), but it is not clear that they have been or can be addressed through this particular project

Does the project clearly address significant and well-documented current or anticipated impacts?	Yes	• Habitat insufficiency is clearly limiting for successful recovery of lake sturgeon populations • If done on sufficient scale and considering additional stresses, increased sturgeon numbers would be expected over long-term
Is there a plan to measure, assess, and communicate results?	Yes	• Regular, ongoing monitoring of sturgeon community (including tagging) planned • Assessment and communication plan with other scientists, local community planned
For restoration projects:		
Addresses nearshore, tributary, or connecting channel	Yes	• Detroit River is both tributary and connecting channel
Additional restoration criteria:		
1. Location defined	Yes	• Upper Detroit River
2. Species/community targeted	Yes	• Lake sturgeon (with potential additional benefits to other species (e.g., walleye, darters))
3. Process/pathway/functions restored	Yes, partially	• Importance of benthic habitat, thermal structure, flow regimes recognized and partially addressed • However, beyond local habitat reconstruction, additional factors may need to be addressed (e.g., cooler water temperatures, higher water flows, habitat connectivity)

<u>References</u>

Boase, J., Research Ready to Continue at the Lake Sturgeon Spawning Reef on the Detroit River, U.S. Fish and Wildlife Service, FY 05 Alpena FRO Accomplishment Summary, available at: http://www.fws.gov/midwest/alpena/documents/FY05-AqSpCons-ARS.pdf

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Restoration of Metzger Marsh, Lake Erie

Coastal development and agriculture have destroyed or altered between 60 and 80 percent of Great Lakes coastal wetlands. Diking and other activities have prevented coastal wetland from functioning as a single ecosystem, leading to degraded water quality and species diversity. Missing or degraded wetlands cannot provide supporting functions to the nearshore waters, including serving as fish habitat and collecting polluted runoff that would otherwise reach the open waters. One restoration project involving multiple objectives has been the restoration of Metzger Marsh, a coastal marsh located 48 km east of Toledo, OH. Portions of the marsh had been diked and farmed prior to 1940; the marsh was then allowed to revert to wetland. A natural barrier beach that had remained in place eventually eroded due to high water levels in the early 1970s as well as shoreline armoring preventing additional local sediment input; elimination of the barrier beach allowed for greater erosion of the wetland itself. In addition, infestation of zebra mussels in the Great Lakes in the late 1980s had lead to significant declines in native unionid clam populations in nearshore areas (Nichols and Amberg, 1999).

A multi-agency restoration project that included the U.S. Fish and Wildlife Service, Ohio Division of Wildlife, and the U.S. Geological Survey was initiated in the marsh in 1994. The project included creation of a dike to mimic the original barrier beach (with openings to allow for hydrological connectivity) and dewatering to promote germination of emergent plants. During dewatering, larger than expected numbers of unionid clams were found (in spite of relatively high rates of zebra mussel colonization as well), and a project was initiated to store, return following wetting, and monitor these individuals, given their potential to serve as a "seed" for more widespread restoration of the native clam species in the Great Lakes (Nichols and Amberg, 1999; Nichols and Wilcox, 2002). In addition, the dike was to include a fish passage structure to allow for transit between the marsh and nearshore waters. As of November 2002, 45 species from 16 fish families had been identified in the structure (Wells et al., 2002). An assessment of this project through the screening criteria identified above is given in the table below.

Evaluation of Restoration of Metzger Marsh, Lake Erie, Project

Criteria	**Evaluation**	**Comments**
Does the project improve and/or protect ecosystem resiliency, functioning, and sustainability?	Yes	• Dike construction mimics original barrier beach, providing erosion protection for marsh • Openings in dike allow for hydrological connectivity to be maintained (as well as fish passage) • Dewatering and rewetting allowed for establishment of native emergent plants. • Fully functioning wetland could again provide for habitat as well as help protect nearshore waters from upstream watershed stresses

Does the project attempt to address all known and relevant stresses?	Yes, largely	• Has considered earlier anthropogenic (diking, agriculture), more recent anthropogenic (e.g. zebra mussel infestation), and natural (e.g., wave erosion) stresses • Additional potential stresses on the wetland and nearshore waters could be any nearby development or agricultural activity
Does the project clearly address significant and well-documented current or anticipated impacts?	Yes	• Decimation of unionid clam populations • Promotion of habitat (and access to it) for native fish species • Provision of wetland habitat for wildlife species
Is there a plan to measure, assess, and communicate results?	Yes	• Monitoring of unionids and fish species has been conducted at least through 2002 • Project described via papers, reports, Web sites • Not clear if monitoring is ongoing
For restoration projects:		
Addresses nearshore, tributary, or connecting channel	Yes	• Connected to nearshore area of Western Lake Erie
Additional restoration criteria:		
1. Location defined	Yes	• Metzger Marsh, approximately 48 km east of Toledo, OH
2. Species/community targeted	Yes	• Unionid clam, numerous fish species, healthy wetland community
3. Process/pathway/functions restored	Yes, largely	• Protection of wetland from erosion • Importance of hydrological connectivity recognized • Links between wetland and surrounding terrestrial habitat less clearly described

References

Nichols, S.J., and Amberg, J., 1999, Co-existence of zebra mussels and freshwater unionids: population dynamics of Leptodea fragilis in a coastal wetland infested with zebra mussels, Canadian Journal of Zoology, 77(3):423-432.

Nichols, S.J., and Wilcox, D., 2002, Reestablishing the Freshwater Unionid Population of Metzger Marsh, Lake Erie, Project report IAG No. DW14947830-01, available at: http://www.epa.gov/grtlakes/ecopage/wetlands/metzger/

Wells, S.E., McClain, J.R., and Hill, T.D., 2002, Fish Passage Between Lake Erie and Metzger Marsh: Monitoring of an Experimental Fish Passage Structure, 1999-2002, Final Report, available at: http://www.epa.gov/grtlakes/ecopage/wetlands/metzger/

Restoration of Cootes Paradise/Hamilton Harbour, Lake Ontario

Cootes Paradise in Hamilton Harbour is a 250 hectare drowned river mouth marsh at the western end of the harbor, and is the largest coastal marsh in Western Lake Ontario. Due to development pressures over the past 150 years, Cootes Paradise and other marshes on the lake suffered significant losses; for example, emergent and submergent vegetation in the marsh had declined to 85 percent of the marsh by the 1930s, and to only 15 percent by 1985. The vegetation loss was accompanied by loss of stream channels, and declines in fish and wildlife populations. A number of stresses had impacted the marsh:

- Streams contaminated with sewage effluent, agricultural runoff, and eroding soil
- Elimination of many marsh plants due to feeding and spawning activity of common carp (an invasive species)
- Wave action and carp activity stirred up sediment, limiting light penetration and further stressing plants
- Changes in stream and lake flooding patterns
- Invasion by other non-native species

Hamilton Harbour had been declared an Area of Concern by the International Joint Commission in the 1980s, and development of a Remedial Action Plan was begun. The goal was to restore a "fully functional, balanced, and self-sufficient aquatic ecosystem" (Royal Botanical Gardens, 2001). The overall project entailed addressing the marshes, floodplains, streams, and the harbor. The process was to include:

- Restoring marsh habitat (including re-establishment of emergent and submergent vegetation, marsh river channels, and large woody debris); this would ideally lead to establishment of the yellow perch as the dominant fish species
- Reintroduction of fish species (e.g., walleye, muskie, golden shiner) where population recovery would not likely be attained even with suitable habitat
- Reducing nutrient and sediment input from wastewater treatment plants and nonpoint sources
- Reconnecting ditched creeks to their floodplains
- Eliminating nonnative species (e.g., carp, purple loosestrife); For carp, this was accomplished through construction of a fishway, preventing migration of adult carp from the harbor into the marsh (Royal Botanical Gardens, 1998, 2001).

Additional issues of importance in the restoration of the marsh include accounting for water levels and wave energy, which can effect establishment/maintenance of submerged aquatic vegetation (Chow-Fraser, 2005), and multiple factors affecting the marsh food web (Lougheed et al., 2004).

An assessment of this project through the screening criteria identified above is given in the table on the following page.

Evaluation of Restoration of Cootes Paradise/Hamilton Harbour, Lake Ontario, Project

Criteria	**Evaluatio**	**Comments**
Does the project improve and/or protect ecosystem resiliency, functioning, and sustainability?	Yes	• Fishway construction allows for hydrological connectivity to be maintained (as well as fish passage of native species, but impaired movement for carp) • Marsh restoration will promote habitat for native species, as well as increase protective functions for Lake Ontario • Additional introductions could support more sustainable populations of native fish species
Does the project attempt to address all known and relevant stresses?	Yes, largely	• Considered importance of invasive species (plant and animal) • Considered importance of having hydrological connection with Lake Ontario • Considered allochtonous sources that can impair the marsh (e.g., nutrient and sediment inputs from the watershed) • Does not appear that changing water levels (and effect of climate) were explicitly considered in early phase
Does the project clearly address significant and well-documented current or anticipated impacts?	Yes	• Addresses degradation of emergent and submergent plant populations • Addresses significant biological stress (carp, and its contribution to turbidity) • Successful restoration should lead to increased habitat for both native fish and wildlife species
Is there a plan to measure, assess, and communicate results?	Yes	• Monitoring of fish species movement through Fishway has been conducted • Research on food web has been ongoing • Results conveyed through reports, papers, Web site • Not clear if monitoring ongoing
For restoration projects:		
Addresses nearshore, tributary, or connecting channel	Yes	• Connected to both tributary and nearshore waters of Lake Ontario
Additional restoration criteria:		•
1. Location defined	Yes	• Cootes Paradise marsh, within Hamilton Harbour, Ontario
2. Species/community targeted	Yes	• Yellow perch, other native fish species, healthy wetland community
3. Process/pathway/functions restored	Yes, largely	• Maintain hydrological connectivity to Lake Ontario • Healthy wetland functions to be restored • Further work accounting for potential effects of changes in climate and water levels, as well as food web changes, may be necessary

References

Chow-Fraser, P., 2005, Ecosystem response to changes in water level of Lake Ontario marshes: lessons from the restoration of Cootes Paradise Marsh, *Hydrobiologia*, 539:189-204.

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Royal Botanical Gardens, 2001, Coastal Marshes, Natural Fish Hatcheries, Fact Sheet, available at: http://www.rbg.ca/pages_sci_conserv/sci_conserv_fishway.html