2010

Ecological Benefits of Habitat Modification

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STATE of the STRAIT

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DETROIT RIVER AND WESTERN LAKE ERIE

2010

Cover photos: DTE's River Rouge Power Plant in Michigan by Chris Lehr/Nativescape LLC; Lower left: Legacy Park in Windsor, Ontario by Essex Region Conservation Authority; Lower middle: Elizabeth Park in Trenton, Michigan by Emily Wilke/Detroit River International Wildlife Refuge; Lower right: Fort Malden in Amherstburg, Ontario by Essex Region Conservation Authority.

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Preface

Managing the Detroit River and Western Lake Erie as a Home

Scientist or nonscientist, we all have an intuitive sense of habitat. It is a place—river, lake, pond, wetland, woods, grassland—where environmental conditions are right for life, growth, and reproduction of the plants and animals dwelling there. Put another way, it is a location where all attributes (i.e., physical, chemical and biological) occur to support a particular species. From a resource management perspective, habitat is the physical substrate that supports a biological community of organisms. For aquatic biota, habitat is typically depicted as three-dimensional, including both the physical substrate and the overlying water. For all life, habitat is home.

We all also understand that an alarming amount of habitat has been destroyed or seriously degraded; hence, the importance of this conference and report on the ways and means of rehabilitating habitats in the Detroit River corridor and adjacent western Lake Erie.

Yet, ironically, habitat has no home. Habitat falls between the cracks of a myriad of federal, state, provincial, regional, and local authorities and responsibilities. Piecemeal approaches to habitat protection and rehabilitation, together with a high degree of municipal, industrial, and agricultural development, have resulted in the loss, degradation, and fragmentation of habitats observed today in the Detroit River corridor and western Lake Erie.

The ecosystem approach was first articulated in the Great Lakes basin as a more holistic way of planning, research, and management (Research Advisory Board 1978). This concept was embodied in the purpose (Article II) of the Canada-U.S. Great Lakes Water Quality Agreement of 1978 (and in revision by Protocol in 1987), which is "…to restore and maintain the chemical, physical, and biological integrity of the waters of the Great Lakes Basin Ecosystem" (Canada and the United States 1987). From the outset, the ecosystem approach was criticized for being too impractical for implementation. To overcome such criticism, a workshop was held in 1983 that resulted in advice and recommendations on implementing the ecosystem approach that appeared in a publication entitled, "Managing the Great Lakes Basin as a Home" (Christie et al. 1986). That's our challenge today. Can we rehabilitate habitats and manage the Detroit River strait as a home, our home?

There is no single, widely accepted definition of the ecosystem approach, but the concept that was conceived for the Great Lakes basin is now widely adopted and accepted as a strategy for resource management in international agreements throughout the world. For example, the International Convention on Biodiversity has adopted the ecosystem approach as its operating principle that "is generally understood to encompass the management of human activities based on the best understanding of ecosystem structure and functions for the benefit of present and future generations....It recognizes that humans, with their cultural diversity, are an integral component of ecosystems" (www.cbd.int/ecosystem/).

With the ecosystem approach so widely accepted worldwide, what is the status of the ecosystem approach in the Great Lakes basin? Its implementation is just as spotty and fragmented as habitat. The opportunity is at hand to build upon the habitat restoration tools and success stories in this report and for the Detroit-Windsor community to take the lead in habitat protection and rehabilitation in the Detroit River strait. If significant habitat improvements can be achieved in such a heavily populated region, the Detroit River strait can serve as a model for such activities elsewhere in the Great Lakes basin and around the world. Managing habitat as a home is crucial to achieving environmentally sustainable economic development and the well-being of our children and our children's children. Is the Detroit-Windsor community up to the challenge?

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- Mary Bohling, Michigan Sea Grant
- Matthew Child, Essex Region Conservation Authority

- Jan Ciborowski, University of Windsor
- Anna Cook, U.S. Fish and Wildlife Service
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- Sandra Morrison, U.S. Geological Survey
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- Beth Olson, International Wildlife Refuge Alliance
- Roberta Urbani, DTE Energy
- Michael Zarull, Environment Canada, Conference Co-Chair

We would especially like to thank those who contributed their data and knowledge through presentations, posters and displays. The highly relevant information they provided was essential to the overall success of the conference and is invaluable to current and future conservation projects.

Furthermore, we wish to thank everyone who attended the conference – local citizens, environmental and conservation organizations, researchers, government and industry representatives, and students from both Canada and the United States – for their significant role in making this conference a success. Their questions, comments and suggestions enhanced the topics presented and showed a strong commitment towards improving local habitats.

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1.0 Executive Summary

At the 2009 centennial celebration of the 1909 Boundary Waters Treaty, U.S. Congresswoman Louise Slaughter and Canadian Member of Parliament Rick Dykstra stated that "the water that flows between our two great countries carries with it commerce, friendship, and shared values and ideals that make North America strong and prosperous" (International Joint Commission 2009). Out of these shared values and ideals has come a long history of cooperative conservation and environmental stewardship. It is in this spirit of binational cooperation that the State of the Strait Conference is held every two years to bring together key Canadian and U.S. stakeholders to assess ecosystem status and provide advice to improve research, monitoring, and management of the Detroit River and western Lake Erie. The 2009 conference was held at the University of Windsor and its theme was "Ecological Benefits of Habitat Modification."

The Detroit River and western Lake Erie are part of a unique ecological corridor that links the upper and the lower Great Lakes. Despite the substantial loss of habitat, the area remains critically important for migratory and resident fish and wildlife. The river and lake are at the intersection of two major North American bird migration flyways – the Atlantic and Mississippi. Furthermore, the area continues to be a significant fish migration corridor. The Detroit River and western Lake Erie also have a long history of environmental pollution and natural resource degradation on both sides of the border. Considerable loss and degradation of habitats have resulted. Over the past three decades, much has been done to restore lost habitats and improve existing conditions. However, the ecological improvements resulting from these projects, as well as the cumulative effects of these changes, have yet to be quantified or evaluated against goals or targets of existing plans or programs.

Quantitative goals and objectives should direct the selection and implementation of habitat restoration and enhancement techniques, and should provide the benchmarks for measuring project success. These goals and objectives should be based on an assessment of what originally existed in the area and should be achievable ecologically and socioeconomically, given the available resources and extent of community support for the project. All project stakeholders must endorse and actively support these quantitative goals and objectives to ensure clear project focus, provide broad-based support for project completion, avoid misunderstandings, and increase efficiency and effectiveness. It was therefore recommended that greater emphasis be placed on quantifying habitat targets in order to help evaluate and select appropriate habitat restoration/rehabilitation techniques, and to measure progress.

A critical requirement of habitat modification is to perform a detailed initial assessment of existing conditions. From the initial assessment, monitoring can be performed to track ecological changes and measure progress toward achievement of established goals and targets. The monitoring program will undoubtedly need to remain in place for some time as recovery may be slow and adjustments to management actions may be necessary, as part of an adaptive management strategy.

The Crosswinds Marsh case study (i.e., restoring wetlands as part of a mitigation project for airport expansion) and the Metzger Marsh case study (i.e., constructing a barrier dike to replace an eroded beach for protecting a coastal marsh) both highlighted the importance of having pre- and post-construction monitoring included in the permit for habitat restoration. This legal permit requirement was the impetus for monitoring ecological effectiveness that has been sustained beyond permitting requirements on a voluntary and professional basis. Therefore, based on these two experiences, it is recommended that pre- and post-project monitoring requirements be added to all federal, state, and provincial permits for habitat modification. It is also recommended that funding agencies ensure that monitoring is an integral part of each habitat modification project by explicitly accounting for monitoring in the project budget. Further, it is recommended that, at the outset of each habitat modification project, agencies consider signing a partnership agreement or memorandum of understanding that clearly lays out commitments and responsibilities for pre- and post-project monitoring of ecological effectiveness.

Today, many habitat projects are implemented with limited resources, and monitoring is often the first thing to be eliminated when there are budget constraints. To address these limitations and constraints, partnerships are being established to share responsibilities for both the restoration activities and monitoring efforts. These arrangements can be formalized, particularly if there are a number of partners, to ensure that each understands their role in the project. Experience at the Ojibway Prairie case study showed that partners developed a cooperative synergy and when one began a monitoring study, others followed and collaborated. It is therefore recommended that partnerships be established for monitoring effectiveness of each habitat modification project.

The conference's keynote address presented by Karen Rodriguez pointed out our limited knowledge of ecosystems. Although we have large knowledge gaps, we cannot reasonably wait to act if we are to conserve what remains and to change habitat losses into gains. It is essential to use scientific rigor in all habitat modification projects if we are to adequately document ecological responses, persuade partners and potential financial supporters to further invest in this activity, and effectively practice adaptive management.

The work in Crosswinds Marsh and the Oak Openings of northwest Ohio demonstrated very clearly that quantitative targets, followed by a robust monitoring program, will help guide corrective actions and ensure desired project success. It is through careful scientific assessment that our understanding improves. Such careful assessment, along with adequate communication of results, allows us to be more effective in achieving our restoration goals, while making most efficient use of limited resources. Therefore, it is recommended that habitat modification initiatives become more strongly coupled with scientific method through quantitative assessments and long-term monitoring.

Considerable work has been completed or is under way on habitat restoration and enhancement. However, habitat management (conservation, restoration, enhancement) remains a fragmented responsibility among many agencies and interests, and this fragmentation is often an obstacle to realizing ecological improvements, recovery, and sustainability. Additionally, cumulative habitat modifications are not reviewed often enough with respect to their impacts on the goals and targets established in existing policies, plans and programs, as well as their impacts on ecosystem response. Clearly, there is a need to bring stakeholders together to share habitat modification experiences, synthesize and disseminate science, learn from mistakes and successes, coordinate efforts, and transfer knowledge on successful practices and ecological effectiveness. Therefore, it is recommended that technology-transfer and science-transfer sessions be convened on a regular basis among researchers, managers, and nongovernmental organizations to share ideas and knowledge, and to achieve cooperative learning relative to habitat restoration and enhancement.

2.0 Introduction

When Europeans first arrived and settled on the shores of western Lake Erie and the Detroit River over 300 years ago, they saw opportunity in its beautiful waters, productive land, and bountiful resources. The French explorer Antoine de La Mothe Cadillac described the area as being rich in biodiversity with ten species of forest trees, many wet prairies (marshes), an abundance of fish, numerous birds, and bison. Historical records indicate that in 1815, nearly 100 years after European settlement, there were coastal wetlands up to 1.6 km in width along both sides of the 51 km long Detroit River connecting channel (Manny 2001). Development and degradation of the land, water and its resources happened relatively quickly. Today, only 3% of the coastal wetlands that once existed in the Detroit River remain, due to centuries of these anthropogenic stressors, and this habitat loss has, in turn, negatively impacted biodiversity (Manny 2001; Manny 2003).

The construction of shipping channels, the hardening of shorelines, dumping of dredge spoils, in-filling of wetlands, pollution, and urban sprawl have all contributed to significant habitat loss in the region. However, with the implementation of pollution control/abatement programs, conservation efforts, and increased public awareness, we have been able to make some significant habitat improvements in the Detroit River and western Lake Erie. For example, the Detroit River International Wildlife Refuge has grown from 123 hectares (304 acres) in 2001 to over 2,268 hectares (5,604 acres) of marshes, wetlands, islands, shoals, and uplands in 2009, protecting high quality habitat for important species, including bald eagles (Hartig et al. 2007; U.S. Fish and Wildlife Service and International Wildlife Refuge Alliance 2008). Habitat enhancement (e.g., construction of fish spawning reefs and soft shoreline engineering) in the Detroit River has contributed to the return of reproductive walleye, lake whitefish, and lake sturgeon. Furthermore, there is evidence of the return of bald eagles and peregrine falcons that suffered from tremendous population declines in the 1970s due to the pesticide DDT. In fact, in 2009 a pair of peregrine falcons nested and successfully produced two chicks within Windsor city limits—a first for the city. With continued effort and support from government agencies, environmental organizations, industries, researchers, and the public, these habitat modifications will continue to have a positive impact on the local ecosystem.

The local ecosystem of the Detroit River, however, is also internationally important as a waterway for migration. In terms of fish migration, it serves as part of the St. Clair–Detroit River connecting channel linking the upper and lower Great Lakes. For birds, it is situated at the intersection of the Atlantic and Mississippi Flyways. Over 300,000 diving ducks, 75,000 shorebirds, and hundreds of thousands of landbirds and fall raptors frequent the area to rest, nest, and feed along the unique shoreline habitats, including many islands and marshes (U.S. Fish and Wildlife Service and International Wildlife Refuge Alliance 2008). Over 30 species of waterfowl, 23 species of raptors, 31 species of shorebirds, and 160 species of songbirds are found along or migrate through this corridor (U.S. Fish and Wildlife Service and International Wildlife Refuge Alliance 2008). In addition, 117 species of fish are found in or migrate through the Detroit River (Manny 2003). Furthermore, the Detroit River and western Lake Erie have been recognized for their biodiversity in the North American Waterfowl Management Plan, the United Nations Convention on Biological Diversity, the Western Hemisphere Shorebird Reserve Network, the Biodiversity Investment Area Initiative of Environment Canada, the U.S. Environmental Protection Agency, and most recently as North America's only international wildlife refuge – the Detroit River International Wildlife Refuge.

This biodiversity and the diversity of habitats that have given the region international acclaim also present a challenge for resource managers faced with intense and growing human impacts and pressures. Much of the shoreline is artificially hardened, providing no or limited habitat and creating a barrier to fish spawning. Navigation is the primary use of the main part of the river, especially the shipping channels. Clearly, wildlife was not taken into account when the shipping channels were constructed in the early 1900s and the river bottom was first dredged. This caused changes in river flow disrupting species movement, as well as the destruction of substrate important to fish populations. In addition, most of the lakeplain prairies and oak savannas that were so appreciated by Cadillac have been replaced by urban and residential development, industries, and agricultural fields. This development has resulted in remnant habitat made up of small sites disconnected from similar places; this fragmentation hinders species movement and ultimately gene flow. Since the Detroit River is such a critical migratory corridor, the negative effects of hindered species movement have impacts well beyond the local ecosystem.

Public outcries over the mounting impacts of environmental degradation, such as the negative effects on fish and wildlife, led to the 1972 Canada-U.S. Great Lakes Water Quality Agreement (GLWQA) which called for pollution control in the Great Lakes basin. In 1987, amendments to the GLWQA reaffirmed the commitment to restore and enhance water quality in the Laurentian Great Lakes and called for the development and implementation of remedial action plans (RAPs) and lakewide management plans (LaMPs) to restore impaired beneficial uses using "a systematic and comprehensive ecosystem approach" (Canada and the United States 1987). The RAPs are implemented to restore impaired beneficial uses within specific geographic Areas of Concern (AOCs) (e.g., degraded locations in the Great Lakes that fail to meet water quality objectives), whereas the LaMPs are developed and implemented to restore impaired beneficial uses in open lake waters (i.e., Lakes Superior, Michigan, Huron, Erie, and Ontario). However, to foster use of an ecosystem approach, the Detroit River AOC is also included in the Lake Erie LaMP because it is in (and affects) the Lake Erie basin. The significant "Loss of Fish and Wildlife Habitat" is listed as one of the impairments to beneficial uses of the Detroit River. The need to remediate the negative impacts of habitat loss in the Detroit River/Lake Erie ecosystem is one of the reasons the Detroit River was designated an AOC.

The Lake Erie LaMP is a binational initiative coordinated by federal (U.S. Environmental Protection Agency and Environment Canada), state (Ohio, Michigan, Pennsylvania, and New York) and provincial (Ontario) government agencies, along with numerous stakeholders, to manage, restore and protect the Lake Erie ecosystem for future generations. Contributing information toward Lake Erie LaMP implementation, the Lake Erie Millennium Network (LEMN) is a cooperative, binational approach involving experts, regulatory agencies, academics and the public, to define and understand Lake Erie environmental issues. Several past workshops have examined issues relating to eutrophication, contamination, watershed use, and habitat. In 2008, nearly 200 participants gathered for the LEMN 5th Biennial Conference to discuss recent biological and environmental changes relating to the Lake Erie ecosystem and to understand research and monitoring needs for the "2009 Lake Erie Intensive Monitoring Year."

The Detroit River is one of five binational AOCs (i.e., St. Marys River, St. Clair River, Detroit River, Niagara River, and St. Lawrence River). Remediation of the Great Lakes AOCs is guided by RAPs. RAPs are an important tool toward "restoring and maintaining the chemical, physical and biological integrity of the Great Lakes Basin Ecosystem" by providing the basis for remedial action within an AOC, and by documenting changes in environmental conditions that result in restoring beneficial uses, such as "Loss of Fish and Wildlife Habitat." On the Canadian side of the Detroit River, the RAP is implemented by the Detroit River Canadian Cleanup (DRCC), a community-based partnership among government (federal and provincial), municipalities, industry, scientists, environmental organizations, and concerned citizens. The U.S. Detroit River RAP is a collaborative effort between the Friends of the Detroit River, U.S. EPA, Michigan Department of Environmental Quality (MDEQ), industry, and other interested stakeholders. In addition to the numerous projects that have been completed in the Detroit River AOC over the last 20 years to restore fish and wildlife habitat, U.S. and Canadian RAP teams have recently established strategic targets that, collectively, will be necessary for long-term sustainable habitat recovery.

It should also be noted that management of the Detroit River International Wildlife Refuge is guided by a Comprehensive Conservation Plan (CCP). This CCP has set a land conservation target of 4,856 hectares (12,000 acres) for the U.S. side (i.e., the U.S. Fish and Wildlife Service has identified 4,856 hectares of marshes, wetlands, islands, shoals, and uplands that could potentially be conserved through acquisitions, easements, and cooperative agreements). Land conservation remains a top priority while opportunities still exist and considerable efforts are under way to restore degraded habitats throughout the Refuge (U.S. Fish and Wildlife Service 2005).

The LaMP and RAP programs, and the Detroit River International Wildlife Refuge, are good examples of collaborative efforts to address habitat issues in the Detroit River and western Lake Erie. Table 1 following this section presents a summary of various workshops and planning efforts over the last 15 years that address this habitat issue. It is worth noting both the long history of binational collaboration on the habitat issue and the commitment to cooperative learning and strengthening the science-policy linkage relative to this issue (Table 1).

A keystone for collaboration on the Detroit River is the biennial State of the Strait (SOS) Conference. The conference brings together Canadian and U.S. managers, scientists, environmental organizations, industrial representatives, municipal leaders, students, and concerned citizens to address key issues on the Detroit River and the western basin of Lake Erie. The SOS Conferences continue to be successful with over 200 participants attending each biennial conference. Previous SOS Conferences have explored the status of key environmental indicators for the Detroit River and western Lake Erie, monitoring for sound management, and strengthening science-management linkages.

The 4th Biennial SOS Conference was held at the University of Windsor on April 28, 2009 (see conference program in Section 6.0). Over 200 people attended. The purpose of the conference and this subsequent report is to highlight numerous efforts under way to rehabilitate and restore habitat in the Detroit River and western Lake Erie, and to provide knowledge, lessons, and rationale for future habitat rehabilitation, restoration, and enhancement projects throughout the region. Specifically, the conference was designed to address ecological benefits of habitat modification. Presentations focused on the ecological responses of habitat modification across a diverse range of habitat types, including building fish spawning reefs, soft shoreline engineering projects, wetland restorations, and wildlife habitat enhancements.

It is our hope that out of the conference and report we can recruit new people, organizations, and corporations to habitat conservation and restoration, identify new projects, develop new habitat champions to lead and facilitate projects, and help ensure that there is an adequate knowledge base and proper assessment component to guide such efforts.

Finally, with the current transformation from predominantly a manufacturing economy to one that is more diversified, the strong community support for reconnecting people on both sides of the river to their waterfronts (e.g., Detroit RiverWalk and Windsor's Chrysler Canada Greenway Trail), the priority being placed on brownfield cleanup and urban renewal, new Great Lakes funding through the U.S. Environmental Protection Agency and other sources, and the promise of an updated Canada-U.S. Great Lakes Water Quality Agreement, the time is truly right to undertake this evaluation of ecological benefits of habitat modification and to make recommendations for additional work to further restore and enhance this ecosystem, and to reap the numerous environmental, economic, recreational, and societal benefits.

Table 1. A summary of workshops, conferences, initiatives, and projects undertaken to synthesize knowledge and further efforts to rehabilitate, restore, and enhance habitats in the Detroit River-western Lake Erie watershed.

Habitat Project/Initiative	Year	Focus	Reference
State of the Lakes Ecosystem Conference	1994—present	The State of the Lakes Ecosystem Conferences (SOLEC) and State of the Great Lakes reports are produced jointly by the U.S. Environmental Protection Agency and Environment Canada on behalf of the United States and Canada. They provide independent, science-based reporting on the state of the health of the Great Lakes basin ecosystem, including the St. Clair-Detroit River Corridor. Four objectives for the SOLEC process are: to assess the state of the Great Lakes ecosystem based on accepted indicators; to strengthen decision making and environmental management concerning the Great Lakes; to inform local decision makers of Great Lakes environmental issues; and to provide a forum for communication and networking among all the Great Lakes stakeholders.	www.epa.gov/solec/ www.on.ec.gc.ca/solec/
Workshop on the Science and Management for Habitat Conservation and Restoration Strategies (HabCARES) in the Great Lakes	1994	This workshop synthesized the understanding of the linkages between habitat, production, and structure of aquatic and wetland communities, identified successful habitat restorations and enhancements, identified and filled important gaps in scientific knowledge, and provided recommendations for resource managers to effectively conserve, restore, and enhance aquatic habitat.	Kelso (1996)
Rehabilitating and Conserving Detroit River Habitats	1998	This conference shared success stories of habitat rehabilitation and conservation from the Detroit River, summarized available information on ecological effectiveness, identified opportunities to link habitat enhancement with remedial activities, and identified priorities for research, funding, and further action to rehabilitate and conserve Detroit River habitats.	Tulen et al. (1998)
Soft Shoreline Engineering Along the Detroit River	1999	This binational workshop provided insights and technical advice to local governments, developers, planners, consultants, and industries on when, where, why, and how to incorporate soft engineering of shorelines into shoreline redevelopment projects and reap subsequent benefits.	Caulk et al. (2000)
Great Lakes Fishery Commission, Lake Erie Committee - Habitat Task Group	2000—present	The Habitat Task Group consists of fisheries scientists from state, provincial, federal and university agencies conducting research on Lake Erie. The Habitat Task Group addresses fisheries habitat issues/management in Lakes Erie and St. Clair and connecting waters. Among their charges is to document habitat-related projects being conducted or proposed in the Lake Erie basin, and develop strategic and research direction for Environmental Objectives.	http://www.glfc.org/ lakecom/lec/HTG.htm

Table 1 (continued). A summary of workshops, conferences, initiatives, and projects undertaken to synthesize knowledge and further efforts to rehabilitate, restore, and enhance habitats in the Detroit River-western Lake Erie watershed.

Habitat Project/Initiative	**Year**	**Focus**	**Reference**
Lake Erie Millennium Network Workshop Series 3	2002—2006	A series of experts' research needs workshops were convened to provide guidance on current and future research needs and to develop a long-term strategy to identify and assess high-quality aquatic and fish habitats within the Huron-Erie Corridor. Specific topics have addressed: • Planning needs for a research strategy to understand habitats in the Lake Erie basin • Developing an integrated habitat classification system for the Lake Erie basin • Development of an integrated program to evaluate habitat-related processes and status in the Lake Erie basin.	Mackey et al. (2006)
Biodiversity Atlas for the Lake Huron - Lake Erie Corridor	2003	The Biodiversity Atlas is an interpretive guidebook to the natural communities of the St. Clair River, Lake St. Clair, and Detroit River watersheds. It is designed to cultivate a greater public awareness of the region's natural resources and the steps that can be taken to protect them.	Appel et al. (2003)
Huron - Erie Corridor (HEC) Initiative	2005—present	This initiative is an annual international science-based workshop composed of federal, tribal, state, provincial, local, and nongovernmental participants committed to protect, restore, and improve the ecological function and resilience of the HEC ecosystem. Through collaborative partnerships and the development and application of relevant science, the HEC Initiative assists resource managers in making decisions concerning restoration of native aquatic species and their habitats.	http://huron-erie.org/
Status of Beneficial Use Impairments in the Detroit River	2006	This workshop provided an update of monitoring and research data relating to the status of the 14 beneficial use impairments in the Detroit River Area of Concern.	Leney and Haffner (2006)
State of the Strait – Detroit River-Western Lake Erie Basin Indicator Project	2007	This project compiled long-term trend data on 50 indicators, interpreted the data, and translated the science for policymakers and the public. It included a comprehensive and integrative assessment of ecosystem health.	Hartig et al. (2007)

Table 1 (continued). A summary of workshops, conferences, initiatives, and projects undertaken to synthesize knowledge and further efforts to rehabilitate, restore, and enhance habitats in the Detroit River-western Lake Erie watershed.

Habitat Project/Initiative	**Year**	**Focus**	**Reference**
Detroit River Canadian Delisting Criteria Workshop	2007	This workshop reviewed the existing Canadian delisting criteria and proposed modifications in consultation with other DRCC committees, scientists, and the public.	Detroit River Canadian Cleanup Monitoring and Research Work Group (2008)
Detroit River Area of Concern Canadian Priority Habitat Sites	2007	This initiative updated existing information about priority habitat sites in the Detroit River AOC to guide future habitat-related actions, including protection, restoration, and/or acquisition.	Habitat Work Group (2007)
Delisting targets for loss of habitat and population beneficial use impairments of the Detroit River Area of Concern	2008	This effort reviewed available data and information, and developed delisting targets for the use impairments of "Loss of Fish and Wildlife Habitat" and "degraded fish and wildlife populations."	Environmental Consulting & Technology, Inc. (2009)
State of the Strait – Ecological Benefits of Habitat Modification	2009	This conference reviewed data and information from case studies of habitat modification in the Detroit River-western Lake Erie watershed and prepared recommendations for furthering restoration and conservation of habitats, and for addressing research needs.	This report

3.0 Synthesis and Recommendations

Background

Historic patterns and practices of human use and development along the shores of the Great Lakes resulted in considerable loss and degradation of fish and wildlife habitat. More recently, there has been a concerted effort to restore, enhance, rehabilitate, and conserve these areas. In general, these efforts result in many ecological improvements, including increasing biodiversity, improving biological productivity, enhancing ecosystem stability, and promoting sustainability. In addition, such habitat modification efforts can result in concomitant economic and social benefits. Examples of economic benefits of habitat modification include improving sport fishing, birding, and hunting opportunities, and enhancing ecotourism. Examples of social benefits include creating "green" vistas founded on a sense of place along urban waterfronts, developing unique gathering places for wildlife and people that enhance community pride and contribute to livable communities, and creating unique destinations with learning stations focused on teaching conservation, environmental protection, and sustainability.

The Detroit River and western Lake Erie form a biologically important linkage between the upper and the lower Great Lakes, and despite the enormity of habitat losses, the area remains critical for migratory species and highly significant for resident populations. The area also has a long history of environmental pollution and natural resource degradation. Such environmental degradation and habitat loss have affected our local communities and economies, and will limit future use and enjoyment of this ecosystem. In more recent years, the area has benefited from substantial pollution prevention and control efforts on both sides of the border.

Clearly, this corridor is ecologically significant and has considerable Canada-U.S. interest in further restoration, rehabilitation, enhancement, and protection. Therefore, with the environmental and natural resource improvements that are being documented (Hartig et al. 2007), along with the binational interest in furthering this ecological recovery and achieving sustainability, the time was right to:

- review what has been done to modify habitats through a series of case studies;
- evaluate the effectiveness;
- learn from these case study experiences;
- share this knowledge; and
- identify where we go from here in the spirit of adaptive management.

Presented below are the key findings and SOS Steering Committee recommendations based on the case study presentations and discussions at the conference.

A Clear and Measurable Definition of Project Success

Habitat restoration to a close approximation of its original state or to a desired future state is experiencing a groundswell of support throughout Canada and the United States. The number of river shoreline, streambank, and lakefront restoration projects increases yearly. However, far too many of these restoration and enhancement projects have been started without clear definition of restoration goals and quantitative targets for success (Covington et al. 1999). For example, 34 of the 43 Great Lakes AOCs identified in the 1990s documented loss of fish and wildlife habitat as an impaired beneficial use; and of those 34 AOCs, only five had established quantitative objectives or targets for fish and wildlife habitat (Hartig et al. 1996). The International Joint Commission (2003) acknowledged that numerous habitat restoration projects were being implemented in most Great Lakes AOCs, but habitat restoration targets and clearly defined endpoints were mostly lacking. All U.S. AOCs were required by the end of 2008 to have a fish and wildlife habitat plan and some of them include quantitative targets.

It is well accepted that quantitative goals and objectives should direct the selection and implementation of habitat restoration and enhancement techniques, and should provide the benchmarks for measuring project success. Simple conceptual models are often a useful starting point to define the problems (including extent and severity), identify and evaluate habitat restoration and enhancement options, and develop a plan/strategy with quantitative goals and objectives. A broad-based team of project stakeholders should then evaluate the options and select the preferred option to best accomplish the project's quantitative goals and objectives. The project goals and objectives should be achievable ecologically, grounded with a historical perspective of what originally existed in the area, and achievable socioeconomically given the available resources and extent of community support for the habitat restoration or enhancement project. All stakeholders affected by the project should understand and support the quantitative goals and objectives to provide clear project focus, ensure broad-based support for project completion, avoid misunderstandings, and increase efficiency and effectiveness.

Most of the SOS Conference case studies highlighted the need to set specific goals and objectives for habitat restoration and modification. For example, in the Oak Openings case study (Kromer et al. 2009), The Nature Conservancy of Ohio set quantitative targets for wetland restoration in a former pig farm. Project success would be indicated by a species richness greater than 90 native species and by hydrophytic species representing 50% or greater of the species richness in the wetland. In addition, the site would have at least ten species with a Floristic Quality Assessment Index value of six or greater and the average Floristic Quality Assessment Index value for the entire site would be greater than 25. Site monitoring was planned for one, three, and five years following restoration. Such quantitative restoration and enhancement targets provide clear direction for habitat restoration activities and provide requisite rigor for the project. Without such clear and quantitative direction, restoration management is flying blind.

Experience has shown that a clear and measurable definition of project success must be established early on in the habitat modification project and must be agreed to by all project partners. **Therefore, it is recommended that greater emphasis be placed on quantifying habitat targets and objectives to help evaluate and select appropriate habitat restoration and rehabilitation techniques, and to measure project success.**

Assessment and Monitoring

The theme of the 2004 SOS Conference was "Monitoring for Sound Management." A major conclusion from that conference was that monitoring is essential for effective and defensible management. Management agencies will not know what actions to take to restore or protect the health of the river and lake without a fundamental understanding of their condition. This is especially important in considering both habitat status and actions to modify habitat.

A critical requirement for assessing the ecological effectiveness of habitat modification is to do a detailed initial assessment of existing conditions. This not only includes a description of the existing physical environment, but also the existing biological communities and their ecological performance or health. In addition to detailed documentation of existing conditions, it is also important to understand both the historical state and significance of the area to be modified/restored, as well as its current state relative to nearby reference ecosystems. Further, this initial assessment will also likely affect what is achievable. Knowledge of economic development plans and existing habitat protection and restoration policies and plans also should be seen as a critical part of a detailed initial assessment. For example, in the small-scale habitat enhancements case study, Lebedyk and Groves (2009) showed the importance of using the Essex Biodiversity Conservation Strategy to undertake a comprehensive assessment and to prioritize habitat rehabilitation and enhancement projects for the corridor.

From an initial assessment of existing conditions, measurable objectives and/or targets can be established, habitat modification options can be identified and evaluated, and a preferred option selected. Once the preferred option has been implemented resulting in modification of the physical, biological, and/or chemical components of habitat, monitoring the changes that follow, and evaluating these against previously established measurable objectives and targets, is essential. The monitoring program will undoubtedly need to remain in place for some time as recovery may be slow and adjustments to management actions may be necessary. Further, such a monitoring program is an essential part of an adaptive management strategy that all ecological restoration projects should follow. For example, in the fish spawning habitat case study (Manny 2009), six years of post-project monitoring of the Belle Isle spawning reef was needed to fully document the reproductive success of 14 species of fish – a major benefit to the river. In the Fighting Island case study, DeLisle (2009) showed how long-term monitoring was needed to document the island's recovery over a 20-year time frame.

The soft shoreline engineering case study (Zarull et al. 2009) documented that only six of 36 soft shoreline engineering projects (17%) completed in the last 13 years had any quantitative assessment of post-project ecological effectiveness. The remaining 30 soft shoreline engineering projects either had no post-project monitoring of effectiveness or only a qualitative assessment through visual site inspections or photographic documentation of results. This low rate (17%) found in the survey of soft shoreline engineering projects is one indicator of the very limited quantification of ecological benefits of habitat modification. Clearly, much more emphasis must be placed on measuring ecological effectiveness of habitat modification projects.

Further, all case studies and speakers highlighted the need to practice adaptive management, where conditions and status are assessed, habitat modification priorities are set, and habitat management actions are taken in an iterative fashion for continuous improvement. Speakers noted that if one does not continue to monitor, it is impossible to make midcourse corrections and ensure continuous improvement. For example, in the *Phragmites* control case study (Fahlsing and Kowalski 2009), it was learned that achieving desired restoration goals frequently requires follow-up treatments coupled with sufficient monitoring in the spirit of adaptive management. In the common tern case study (Norwood and Szczechowski 2009), long-term monitoring was essential to understand all the factors limiting productivity, including predation. **Therefore, it is recommended that organizations and agencies explicitly commit to long-term monitoring to be able to "walk the talk" of practicing adaptive management.**

The Crosswinds Marsh case study (Bauer et al. 2009) involved restoring wetlands as part of a mitigation project for airport expansion. Pre-construction monitoring and five years of post-construction monitoring were a requirement of the U.S. Army Corps of Engineers and Michigan Department of Environmental Quality permits. This legal permit requirement was the impetus for monitoring ecological effectiveness. Detroit Metropolitan Wayne County Airport staff then continued monitoring after the permit requirements expired to further track progress and make midcourse corrections. Similarly, the Metzger Marsh case study (Kowalski and Wilcox 2009) involved constructing a barrier dike to replace the protective function of an eroded barrier beach. Pre-construction monitoring and five years of post-construction monitoring were a requirement of the U.S. Army Corps of Engineers' permit. This legal permit requirement was the impetus for the original involvement of U.S. Geological Survey's Great Lakes Science Center in assessing ecological effectiveness. Great Lakes Science Center researchers then continued monitoring after the permit requirements expired as a professional research interest.

Based on these two experiences of the Crosswinds and Metzger Marsh case studies, it is recommended that pre- and post-project monitoring requirements be added to all federal, state, and provincial permits for habitat modification. Further, it is recommended that at the outset of each habitat modification project, agencies consider signing a partnership agreement or memorandum of understanding that clearly lays out commitments and responsibilities for pre- and post-project monitoring of ecological effectiveness. The investment in assessment and monitoring at the outset of projects helps ensure that the restoration or enhancement project is grounded by science, and helps ensure that new knowledge, new techniques/practices, and midcourse corrections are considered.

Partnerships

Many habitat projects are implemented today with limited resources and monitoring is often the first thing to be cut when there are budget constraints. Therefore, partnerships are becoming the standard operating procedure for both restoration and monitoring.

One suggestion was to bring all the key partners and stakeholders together at the outset of the project to agree on the significant aspects of the project under consideration (e.g., purpose, goals/objectives, assessment, etc.). If there are numerous partners, it might be appropriate to consider a formal partnership agreement that lays out the project purpose, goals/objectives, scope, proper assessment, monitoring, roles and responsibilities of each partner organization, and other relevant elements. If the number of project partners is fairly small, perhaps the group can just agree to a concept plan that lays out the pertinent information. This technique has been successfully used in several of the soft shoreline engineering projects (Zarull et al. 2009). One critical lesson to remember is that an explicit commitment to perform pre- and post-project monitoring must be made or, as experience has shown, it will not be undertaken.

In the Ojibway Prairie case study (Pratt and Cedar 2009), it was learned that Windsor's Department of Parks and Recreation has formed a unique partnership with Friends of Ojibway Prairie, the Ontario Ministry of Natural Resources, Parks Canada's Point Pelee National Park, and the Essex Region Conservation Authority to assist in restoration and, most importantly, monitor status, trends, and ecological effectiveness. Experience at the Ojibway Prairie has shown that partners "feed off" each other – when one gets started in monitoring, others jump in and want to help and collaborate. This monitoring synergy should be created at most habitat modification projects.

In the bald eagle (*Haliaeetus leucocephalus*) case study (Roberts 2009), it was learned that Essex County Field Naturalists' Club and Bird Studies Canada formed a partnership with the Detroit River Canadian Cleanup Public Outreach Committee and the City of Windsor to enhance and monitor the reproductive success of bald eagles along the Detroit River, including bald eagle nesting platforms constructed in places like Peche Island. Experience from this project has shown that the partnership increased the capacity of Bird Studies Canada to perform this vital work. Further, this unique partnership has shown that construction of bald eagle nesting platforms is a good tool to retain nest pairs in marginal habitats and can help increase productivity or fledging success by securing a tree and nest from failure. This also demonstrates the value and benefit of the partnership in furthering the practice of adaptive management.

It is therefore recommended that partnerships be established for monitoring effectiveness of each habitat modification project. Again, this could be accomplished by signing a partnership agreement at the beginning of the project that includes clear roles, responsibilities, monitoring frequencies, and reporting requirements. Greater emphasis should also be placed on attracting university students to get involved through independent studies, directed studies, master's theses, *practica*, and class projects, and on involving nongovernmental organizations and conservation clubs in monitoring ecological effectiveness. Greater emphasis on forming partnerships for monitoring and assessment up front in project planning and gaining commitments for sustained monitoring will result in a better foundation for quantifying the value and benefit of each project.

There are many examples of good opportunities to promote citizen involvement in habitat modification. For example, the National Wildlife Federation (2009) provides practical advice on creating schoolyard habitat and using it as a living laboratory for environmental education. The Wildlife Habitat Council (2009) has promoted a backyard conservation program that offers practical advice on how to enhance wildlife habitat in urban and suburban backyards. The National Audubon Society (2009) offers advice on practical suggestions to improve backyard bird habitat. In addition, student involvement in habitat rehabilitation provides both firsthand experience with restoration work and the opportunity to measure before-and-after project effectiveness. One good example is the Downriver Stream Team involvement in river shoreline restoration. **Therefore, it is recommended that greater effort be expended on citizen and student involvement in habitat modification and monitoring ecological effectiveness.**

Coupling of Habitat Modification and the Scientific Method

The conference's keynote address (Rodriguez 2009) pointed out that we need to recognize our ignorance of the very natural resources we are protecting and restoring. Although we have large gaps in our knowledge, we cannot reasonably wait to act if we are to conserve what remains and to change habitat losses into gains. It is essential to use scientific rigor in all habitat modification projects if we are to adequately document ecological responses, persuade partners and potential financial supporters to further invest in this activity, and effectively practice adaptive management.

The work in Crosswinds Marsh (Bauer et al. 2009) and the Oak Openings of northwest Ohio (Kromer et al. 2009) demonstrated very clearly that a preestablished series of targets, followed by a robust monitoring program, will allow corrective actions to be taken to achieve success. In addition, it is through the careful documentation of projects such as this that our scientific understanding moves forward and, by communicating results, allows us to be more effective in achieving our restoration requirements while making more efficient uses of limited resources.

In addition, it is important that cumulative progress in geographical areas be reviewed in reference to larger conservation and restoration plans for the region. This will help prioritize habitat restoration efforts and will help reevaluate regional policies, plans, and projects in a quantitative and objective fashion.

Actions to rehabilitate and restore degraded habitats should be based on the understanding of causes and predicted results. Adequate assessment, research, and monitoring are essential to define problems, establish cause-and-effect relationships, evaluate remedial options, select remedial actions, and document effectiveness. Such assessment, research, and monitoring are the foundation of ecosystem-based management, and, in the end, have often proven to save money for both the public and private sectors (Zarull 1994). The cost alone of habitat modification underscores the need for effective assessment and monitoring (Hartig et al. 1996). For example, a total of $16.5 million was spent on 36 soft shoreline engineering projects in the last 13 years, including 10 projects in the $0–$50,000 range, nine in the $51,000–$100,000 range, seven in the $101,000–$500,000 range, seven in the $501,000–$1,000,000 range, and three at greater than or equal to $2 million (Zarull et al. 2009).

Therefore, there is a need for a stronger coupling of habitat modification initiatives and the scientific method. **Hartig et al. (1996) recommended that this could be addressed by:**

- **Placing a higher priority on establishing quantitative habitat and biological objectives, targets, and endpoints to help evaluate and select appropriate habitat restoration and rehabilitation techniques;**
- **Increasing research and pre- and post-project assessment efforts to quantify habitat-related problems, establish cause-and-effect relationships, evaluate and select appropriate habitat restoration and rehabilitation techniques, and quantify ecological effectiveness; and**
- **Pooling available data on habitat restoration and rehabilitation effectiveness on a regular basis to help provide the rationale for other projects.**

Knowledge and Technology Transfer

Considerable work is under way in habitat modification and restoration. There is a need to provide opportunities to share experiences, synthesize science, learn from mistakes and successes, and transfer knowledge on best practices and ecological effectiveness. One good example in the science transfer arena was the workshop on the science and management for Habitat Conservation and Restoration Strategies (HabCARES) in the Great Lakes (Kelso 1996). The purpose of the HabCARES workshop was to:

- synthesize the understanding of the linkages between habitat, production, and structure of aquatic and wetland communities;
- identify successful habitat restorations and enhancements;
- identify and fill important gaps in scientific knowledge; and
- provide recommendations for resource managers to effectively conserve, restore, and enhance aquatic habitat.

The HabCARES workshop was very well received and subsequently catalyzed many habitat modification projects.

In the technology transfer arena, a workshop on soft shoreline engineering was held in 1999 to provide insights and technical advice to local governments, developers, planners, consultants, and industries on when, where, why, and how to incorporate soft shoreline engineering into waterfront redevelopment projects and reap subsequent benefits (Hartig et al. 2001). The workshop produced a best management practices manual (Caulk et al. 2000) and catalyzed 36 soft shoreline engineering projects within the Detroit River watershed (Zarull et al. 2009).

Another good example of technology transfer relates to the concept of adding habitat features to existing or planned structures (often called *incidental habitat*). Submerged portions of navigation structures such as harbor or marina walls, breakwaters, and piers provide limited fish habitat. Experience has shown that the quality and usefulness of these structures can be significantly improved for fish habitat with proper planning. Too often a proposal to modify the structure or its design is offered too late in the project (e.g., once construction has begun or construction is complete). Because planning for such navigational structure projects often takes years, therefore, fishery biologists must get involved early on in the planning and design phases of a project to provide input for modifying materials used in construction or maintenance that enhance fish cover or spawning habitat.

In 1994, an Incidental Habitat and Access Workshop was held to explore the ways and means of modifying engineered structures in the Great Lakes to provide an economical and ecological “win-win” situation, and to purposely improve the habitat and recreational value of the structures without adversely affecting their primary engineered purpose (Moy 2000). The workshop was well received and effectively transferred critical information on ways and means of enhancing incidental habitat.

Therefore, it is recommended that technology-transfer and science-transfer sessions be convened on a regular basis among researchers, managers, and nongovernmental organizations to share ideas and knowledge, and to achieve cooperative learning relative to habitat modification and restoration.

Concluding Remarks

Smaller habitat modification/restoration projects play an important role in not only providing cumulative habitat gains for a region, but also in contributing to the establishment of core habitat areas, buffer zones, and wildlife corridors. Indeed, such an approach is similar to the approach being followed through the Rouge River RAP (Rouge RAP Advisory Council 1994) where the short-term goal is to protect the remaining relatively healthy headwaters, biotic refugia (i.e., areas with undisturbed healthy habitats that serve as refuges for biodiversity), riparian areas, floodplains, and smaller intact river habitats throughout the watershed. After protection of these healthy habitats is complete, efforts are undertaken to rehabilitate the areas between them to link these healthy portions together. The long-term goal is to protect and rehabilitate sufficient habitat to achieve a healthy watershed that sustains wildlife.

These smaller habitat projects provide improvement to the overall value of the surrounding landscape in terms of habitat quality or dispersal opportunities by increasing biodiversity, community stability, and ecosystem sustainability. In addition, collectively these projects result in regional economic benefits through enhanced sportfishing, hunting, and ecotourism. They also provide regional social benefits through promoting “citizen science” and environmental education, and offering unique places where people can reconnect with nature (Cabrera and Reive 2009). This, in turn, helps develop the next generation of conservationists and sustainability entrepreneurs, and helps leave a legacy of green spaces rather than concrete jungles.

Habitat management (i.e., conservation, restoration, enhancement, mitigation) remains a fragmented responsibility among many agencies and interests, and is often an obstacle to realizing ecological improvements, recovery, and sustainability. Additionally, the cumulative habitat modifications are not reviewed often enough with respect to their impacts on the goals and targets established in existing policies, plans, and programs, as well as their impacts on ecosystem response. Yet, as this conference has clearly demonstrated, there are many excellent small habitat improvements under way in the Detroit River and western Lake Erie watersheds that can serve as building blocks for undertaking larger and more coordinated and comprehensive habitat efforts to achieve long-term goals. Habitat modifications are much like any continuing education process where we need to learn from evaluation and assessment of ongoing habitat conservation and restoration projects. The key is to apply continuous and vigorous oversight to ensure that: 1) habitat is properly addressed within agency and organizational programs; and 2) habitat modifications and outcomes are regularly reviewed and adjustments and adaptations made according to habitat plans, policies, and programs to achieve long-term goals.

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5.1 Keynote Address: The Detroit River and Western Lake Erie: Restoring to the Future

Introduction

Detroit River and western Lake Erie ecosystems have been impacted by overfishing, industrialization, and growth and expansion of the human population throughout the watershed (Manny et al. 1988; Hartig and Stafford 2003). Despite the degradation of these ecosystems, this region has been resilient in many ways and numerous indicators show ecological recovery despite continued pressures (Hartig et al. 2007). Remnant natural features still exist where additional benefits of restoration can be realized from the species to the ecosystem level, including improvements to the quality of life for over six million people who live in the region. Ecological restoration in the Detroit River and western Lake Erie seeks to reconstruct areas into functioning ecosystems to reclaim habitats, restore species, and enhance ecosystem services.

Although there are many definitions of ecological restoration, the most common one comes from the Society for Ecological Restoration International (Society for Ecological Restoration International 2004):

> *Ecological restoration is the process of assisting with the recovery of an ecosystem that has been degraded, damaged or destroyed.*

SER International considers ecological restoration the intentional recovery of the health, integrity and sustainability of ecosystems (Society for Ecological Restoration International 2004). In this view, restoration is driven by attempts to resume lost ecosystem functions and processes.

Ecological restoration takes many different forms: invasive species are controlled; barriers to fish passage eliminated; native species reintroduced; and shorelines and landscapes modified. In some regions, reintroducing land use practices of indigenous people and the transferring of indigenous ecological knowledge to the next generation is an important part of ecological restoration (Society for Ecological Restoration International 2004).

The benefits of ecological restoration go beyond the preservation of plant, animal, and natural communities. Society directly benefits from these ecosystems in the form of economic, social, and health services. The U.S. Environmental Protection Agency (2009a) defines ecosystem services as functions and processes ecosystems provide that ensure our health and well-being. Some of these services come in the form of water quality improvement, flood control, pollinator diversity, pest control, soil fertility, and mental health.

This extended abstract presents a summary of the keynote address delivered at the 2009 State of the Strait Conference, including: an overview of the area's biodiversity; the importance of ecological restoration and its relationship to the greening of communities and industry, public-private partnerships, education, and project planning and implementation; and the need for regional involvement in planning and resource management. Finally, this abstract will offer a perspective on ecological restoration as it relates to our culture and the value of nature.

Centerpiece of the Great Lakes

The *Rivière du Détroit*, or "River of the Strait," and western Lake Erie are situated in a geographically unique place. They lie between the upper and lower Great Lakes and are shared by both Canada and the United States. Natural communities include remnant marshes, shoals, islands, lakeplain prairies and oak savannas (Comer et al. 1995). The North American Waterfowl Management Plan, the United Nations Convention on Biological Diversity, the Western Hemisphere Shorebird Reserve Network, and the Biodiversity Investment Areas Program of Environment Canada and the U.S. Environmental Protection Agency all acknowledge the region's wildlife significance (U.S. Fish and Wildlife Service and International Wildlife Refuge Alliance 2008).

The region contains numerous natural features of ecological significance, including fish spawning and nursery areas, waterfowl staging areas, extensive submersed aquatic macrophyte beds, migratory bird stopover habitats, and unique Great Lakes coastal wetland plant and animal communities to name a few. The Detroit River and its tributaries, including the Rouge, Little, and Ecorse rivers, Conner, Marsh, and Turkey creeks, and the River Canard, drain approximately 2,000 square km. Lake whitefish recently successfully spawned (Roseman et al. 2007) and the threatened lake sturgeon has a small population in the Refuge (Caswell et al. 2004). Walleye, bass, steelhead and salmon migrate through the river each year. Bald eagles are nesting along the river again (Best and Wilke 2007). The region is highly significant as a staging and wintering area for North America's canvasback, redhead, greater and lesser scaup, and American black duck populations (U.S. Fish and Wildlife Service 2005).

Restoring to the Future

The Great Lakes have a rich history in environmental initiatives. The Great Lakes Water Quality Agreement is a commitment between Canada and the United States "to restore and maintain the chemical, physical, and biological integrity of the waters of the Great Lakes Basin Ecosystem." Great Lakes Areas of Concern (AOC) are severely degraded areas of the basin that are defined in the agreement as "geographic areas that fail to meet the general or specific objectives of the agreement where such failure has caused or is likely to cause impairment of beneficial use of the area's ability to support aquatic life" (U.S. Environmental Protection Agency 2009b). More recently in the U.S., the Great Lakes Regional Collaboration and now the Great Lakes Restoration Initiative are working to implement long-term plans for Great Lakes restoration.

These major initiatives have accelerated implementation of many restoration projects that have been in the planning phase and have also catalyzed many new ones. The Stewardship Network exposes volunteers and organizations to expert knowledge and techniques for restoring habitat. The Wildlife Habitat Council works with industry partners to certify projects and help with restoration projects.

The Ojibway Prairie Remnants Area of Natural and Scientific Interest is a 127-hectare complex of parks and nature reserves (Ojibway Nature Center 2007). The area holds some of the last remaining prairie habitat in the Detroit River-western Lake Erie basin.

The Rouge River is a major tributary that flows into the Detroit River. Numerous restoration projects have been completed on this tributary, including the Rouge River National Wet Weather Demonstration Project, the rebuilding of Ford Motor Company's Rouge Plant as a model of green manufacturing and as an ecotourism destination, the restoration of an oxbow at The Henry Ford – Greenfield Village, streambank stabilization at the Henry Ford Community College, a new state-funded Environmental Interpretive Center and a fish ladder around a landmark dam on the University of Michigan–Dearborn campus.

Restoring the Detroit River and western Lake Erie requires a multi-stakeholder approach. The numerous landowners, including local, state, and federal governments, industry, and private citizens along many stretches of the river, present an enormous challenge and require innovative, strategic, and often very novel conservation efforts (U.S. Geological Survey 2009).

The Detroit River International Wildlife Refuge is the only international wildlife refuge in North America. The Refuge consists of islands, wetlands, shoals and river habitats scattered along 77 km of the Detroit River and western Lake Erie (U.S. Fish and Wildlife Service 2009). Restoration of fish and wildlife habitat, including new approaches such as soft shoreline engineering in the Refuge's over 5,600 acres, is a major priority for the Refuge. Another top priority is to conserve 12,000 acres through acquisitions, easements, and cooperative agreements. Recently in 2009, Waste Management donated 145 hectares (358 acres) of coastal wetlands, one of the last coastal wetland sites in Wayne County, to the Refuge.

Ecological restoration also includes addressing contaminant and other pollution issues. Urban and industrial development in the watershed, contaminated sediment, brownfields, combined sewer overflows, stormwater runoff, and municipal and industrial discharges are major sources of contaminants within the Detroit River AOC. Environment Canada, U.S. Environmental Protection Agency, Ontario Ministry of Environment, and Michigan Department of Environmental Quality are working to restore impaired beneficial uses within the AOC. Since 2005, the Friends of the Detroit River has been the coordinator of the Public Advisory Council for the U.S. In Canada, the Essex Region Conservation Authority supports Detroit River cleanups and enhancements, and has developed partnerships for river-related actions (Essex Region Conservation Authority 2009).

In 2005, the "Black Lagoon" on the Detroit River was cleaned up and was the first fully-funded project under the Great Lakes Legacy Act (U.S. Environmental Protection Agency 2009c). The U.S. Environmental Protection Agency's Great Lakes National Program Office and the Michigan Department of Environmental Quality coordinated the removal of 87,924 cubic meters (115,000 cubic yards) of contaminated sediment from a small embayment on the Trenton Channel at a cost of $9.3 million. Following sediment remediation, the City of Trenton received a $151,000 grant to restore a natural shoreline on the Black Lagoon. In recognition of this cleanup, the Black Lagoon was renamed Ellias Cove and is now a place to recreate instead of avoid.

Funding for restoration is available through a variety of grant programs in the National Oceanic and Atmospheric Administration, U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, Natural Resources Conservation Service, and the U.S. Forest Service. All of these agencies have grant programs and are preparing for the next round of requests for proposals. In Canada, the next Canada-Ontario Agreement is now being negotiated to provide funding for restoration.

Observations and Final Thoughts

On February 7, 2009, Doug Ladd of The Nature Conservancy of Missouri gave the keynote address at the Chicago Wilderness Wild Things Conference (Ladd 2009). He relayed several important personal observations about natural resource restoration to an audience of natural resource managers and restoration volunteers. He stated that we need to recognize our ignorance of the very natural resources we are protecting and restoring. We have so much to learn, yet we can't always wait to act because if we wait too long these resources will be gone or altered forever. I believe that action should be guided by the best that science can currently provide.

Two key ideas stated not only by Ladd but by restorationists the world over are: do no harm to existing natural areas and be vigilant in protecting the irreplaceable. This means avoiding the "false prophets of universal greenery." "Nature," in Ladd's words, "is never simple and never universal." People are and always have been a part of the biological system; nature is always being shaped by the actions of a diversity of peoples. We need to think and grow beyond the borders of the individual sites we work on. We need, therefore, to nurture a permanent stewardship ethic that is built into our culture.

Finally, we need "sacred places" (Swan 1990).

> *When we save a river, we save a major part of an ecosystem, and we save ourselves as well because of our dependence—physical, economic, spiritual—on the water and its community of life.*
>
> Tim Palmer, *The Wild and Scenic Rivers of America* (Palmer 1993)

Are sacred places possible in the Detroit River and western Lake Erie? Yes. In Northwest Indiana off of Interstate 94 lies Gibson Woods Nature Preserve. It's a noisy place, with constant airplane, train and automobile noises, surrounded by chemical plants, steel mills and homes. But it's a lovely oak savanna with an abundance of yellow ladyslipper orchids and a small population of the federally endangered Karner blue butterfly. A volunteer once told me that this is her Yellowstone, her retreat, her place to gather strength and reflect. Be assured that the places we are protecting and restoring here will be appreciated by urban dwellers as sacred places, perhaps for the abundant fish, maybe for the thousands of migrating birds, most probably for the joy of being in a wild place. This is restoring to the future. This is our future.

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5.2 Soft Shoreline Engineering: We Built It, Have They Come?

Introduction

Loss and degradation of habitat is a major issue throughout much of the Great Lakes, especially in urban and industrial areas. One of the most dramatic examples of habitat loss has been anthropogenic shoreline development. For example, Manny (2003) has documented a 97% loss of coastal wetland habitats along the Detroit River due to human shoreline development.

Historically, many urban river/lakefront shorelines were stabilized and hardened with concrete and steel to protect developments from flooding and erosion, or to accommodate commercial navigation or industry (i.e., hard shoreline engineering). Typically, shorelines were developed for a single purpose. Today, there is growing interest in developing shorelines for multiple purposes so that additional benefits can be accrued. Soft shoreline engineering is the use of ecological principles and practices to reduce erosion and achieve the stabilization and safety of shorelines, while enhancing wetland habitat, improving aesthetics, and even saving money (Caulk et al. 2000; Hartig et al. 2001). The purpose of this paper is to summarize the available data and information on ecological effectiveness of 36 soft shoreline engineering projects completed in the Detroit River-western Lake Erie watershed over the last 13 years and to share lessons learned.

Methods

In 2008–2009, a survey of soft shoreline engineering projects in the Detroit River-western Lake Erie watershed was conducted to document practical experiences, summarize data and information on ecological effectiveness based on pre- and post-project monitoring, and document lessons learned.

Results and Discussion

In 1999, a group of U.S. and Canadian researchers and natural resource managers convened a conference on soft shoreline engineering and developed a best management practices manual (Caulk et al. 2000) to encourage and catalyze use of soft shoreline engineering techniques. Since then, 36 soft shoreline engineering demonstration projects have been implemented in the Detroit River-western Lake Erie watershed, including 28 along the Detroit River, five along the Rouge River, one along the Little River, one along the Frank and Poet Drain, and one along the River Raisin (Table 1). In total, $16.5 million was spent on these soft shoreline engineering projects, including ten projects in the under $50,000 range, nine in the $51,000–$100,000 range, seven in the $101,000–$500,000 range, seven in the $501,000–$1,000,000 range, and three at greater than or equal to $2 million. Each of these projects had at least one of their goals to improve riparian or aquatic habitat, although the primary impetus may have been some other purpose (e.g., stabilize shoreline and enhance habitat – 24 projects; restore a natural shoreline – 3; remediate contaminated sediment and enhance habitat – 2; treat storm water and enhance habitat – 2; restore an oxbow – 2; undertake a "Supplemental Environmental Project" as part of the settlement – 2; and build stream crossing and enhance habitat – 1). Of the 36 soft shoreline engineering projects implemented, only six (17%) had any quantitative assessment of post-project ecological effectiveness. The remaining 30 soft shoreline engineering projects either had no post-project monitoring of effectiveness or only a qualitative assessment through visual site inspections or photographic documentation of results.

Conclusions

These soft shoreline engineering projects were undertaken through a variety of management tools to enhance/improve riparian or aquatic habitat, including erosion protection, protection of roads, nonpoint source control, Supplemental Environmental Projects (i.e., a regulatory tool that implements an environmental improvement project instead of paying fines and penalties to a general fund), contaminated sediment remediation, improvement of parks, enhancement of private developments, "greening" projects by industry, and greenway trail projects. These innovative soft shoreline engineering projects were implemented by many public and private partners, and all have been well received by the public. All provide "teachable moments" for the value and benefits of habitat.

Key lessons learned through the implementation of these 36 projects include:

- Involve habitat experts up front in the design phase of waterfront planning;
- Establish multiple objectives for shoreline engineering;
- Ensure sound multidisciplinary technical support throughout the project (e.g., the Natural Resources Conservation Service's Soil Bioengineering Team);
- Start with demonstration projects and attract many partners to leverage resources;
- Involve citizen scientists, volunteers, university students, and/or researchers in monitoring, and obtain commitments for post-project monitoring of effectiveness up front in project planning;
- Measure benefits and communicate successes; and
- Promote education and outreach, including public events that showcase results and communicate benefits.

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Table 1. A survey of soft shoreline engineering projects implemented in the Detroit River-western Lake Erie watershed, 1996–2009.

Location	Project Goals	Project Description and Cost	Timeframe	Partners	Monitoring	Contact
BASF Park, Wyandotte, Michigan	Demonstrate use of Elastocoast (Elastomeric revetment that stabilizes shorelines and enhances habitat by increasing interstitial spaces) along the Detroit River shoreline of BASF Park	Stabilized shoreline to a depth of 37 centimeters with five-centimeter crushed limestone bound together with the Elastocoast product; $6,000	2008	BASF Corporation, City of Wyandotte	Qualitative	BASF Corporation
BASF Riverview, Trenton Channel, Riverview, Michigan	Remediate a contaminated site, add incidental habitat to steel sheet piling walls, and create one acre of fish spawning habitat	Following remediation of a contaminated site, incidental habitat was added to 366 meters of steel sheet piling, and one acre of walleye, smallmouth and largemouth bass, and sturgeon spawning habitat was created; $100,000	2007–2008	BASF Corporation	None	BASF Corporation
Blue Heron Lagoon on Belle Isle, Michigan	Restore emergent wetland shoreline and enhance wildlife habitat	Controlled invasive species, planted native species in the upland buffer area, and placed logs along shoreline to provide habitat to native turtles; $34,000	2000	Detroit Recreation Department, U.S. Fish and Wildlife Service (USFWS), Michigan Sea Grant, and seven other partners	Qualitative	Michigan Natural Features Inventory
Dean Construction Site, LaSalle, Ontario	Naturalize 550 meters of shoreline and create a 0.45-hectare storm water management system to treat runoff	Restored 550 meters of natural shoreline using soft engineering techniques, reestablished 0.55 kilometers of riparian vegetation along the natural shoreline and created a storm water pond to improve the quality of the storm water before it enters the Detroit River; $62,000	1997–1998	Dean Construction, Environment Canada, and Ontario Ministry of Natural Resources	Qualitative	Dean Construction

Table 1 (continued). A survey of soft shoreline engineering projects implemented in the Detroit River-western Lake Erie watershed, 1996–2009.

Location	Project Goals	Project Description and Cost	Timeframe	Partners	Monitoring	Contact
Detroit RiverWalk - Stroh River Place, Detroit, Michigan	Build a section of the Detroit RiverWalk in front of Stroh River Place and enhance riparian habitat	Built a 305-meter section of the Detroit RiverWalk using a cantilever design with habitat features beneath the cantilevered RiverWalk; $1 million	2006–2007	Detroit Riverfront Conservancy, Stroh Companies, Inc., Omni Hotel, and Tallon Industries	None	Detroit Riverfront Conservancy
Detroit RiverWalk - West of William G. Milliken State Park, Detroit, Michigan	Stabilize the shoreline along the Detroit RiverWalk and enhance aquatic habitat	Stabilized 152 meters of shoreline with varying sizes of rock armor stone and enhanced aquatic habitat; $100,000	2003–2004	Detroit Riverfront Conservancy and General Motors Corporation	None	Detroit Riverfront Conservancy
Detroit River waterfront (between Lincoln and Langlois Ave.), Windsor, Ontario	Restore 500 meters of shoreline using soft engineering techniques and enhance fish habitat	Converted old vertical seawalls into gently sloping irregular rock shoreline configurations and enhanced fish habitat by planting native species; $70,000	1998	City of Windsor, University of Windsor, Dean Construction, and Ontario Ministry of Natural Resources	Qualitative	City of Windsor
DTE Energy Power Plant, River Rouge, Michigan	Remove broken concrete and asphalt, stabilize shoreline, and enhance habitat	Reconstructed 61 meters of natural shoreline using soft engineering techniques and reestablished a natural riparian buffer made up of four Michigan native plant communities; $30,000	2005	DTE Energy, Nativescape, USFWS, Department of Environmental Quality (MDEQ), Michigan Sea Grant, and five other partners	Qualitative	Nativescape
DTE Energy Power Plant, Monroe, Michigan	Restore 152 meters of natural shoreline and enhance fish and migratory bird habitat	Restored 152 linear meters of the River Raisin shoreline, created a wetland edge and a five-meter-wide upland buffer area where native species were planted; $68,000	2007–2008	Metropolitan Affairs Coalition, City of Monroe, USFWS, MDEQ, International Wildlife Refuge Alliance, and eight other partners	Qualitative	Nativescape

Table 1 (continued). A survey of soft shoreline engineering projects implemented in the Detroit River-western Lake Erie watershed, 1996–2009.

Location	Project Goals	Project Description and Cost	Timeframe	Partners	Monitoring	Contact
Ellias Cove, Trenton, Michigan	Remediate mercury, lead, zinc and PCB contaminated sediment from Ellias Cove and restore the shoreline using soft engineering techniques	Removed 88,000 cubic meters of sediment and disposed contaminated sediment in special contaminant cell at Pointe Mouillee Confined Disposal Facility in western Lake Erie and restored shoreline habitat, including nursery habitat for fish; $150,000 for habitat portion	2006	U.S. Environmental Protection Agency, MDEQ, Great Lakes Basin Program for Soil Erosion and Sediment Control, and seven other partners	Qualitative	City of Trenton
Elizabeth Park Canal Shoreline, Trenton, Michigan	Restore natural shoreline using soft engineering techniques, rehabilitate wildlife habitat and improve water quality in canal	Restored a natural shoreline using soft engineering techniques; reduced erosion and runoff with creation of a buffer zone of native trees, shrubs, wildflowers, and grasses; and enhanced fish and wildlife habitat; $40,000	2007–2008	Wayne County Parks, Nativescape, Michigan Sea Grant, USFWS, and International Wildlife Refuge Alliance	Qualitative	Wayne County Parks
Elizabeth Park - North River Walk, Trenton, Michigan	Stabilize and enhance 183 meters of shoreline and enhance underwater fish habitat	Removed a 1910 concrete breakwall from the north end of Elizabeth Park, stabilized the shoreline using soft engineering techniques, and created two oxbow islands for nursery habitat for fish; $1 million	2001	Clean Michigan Initiative and Wayne County Parks	Quantitative	Wayne County Parks
Fort Malden Shoreline, Amherstburg, Ontario	Stabilize shoreline and enhance fish habitat by constructing offshore lake sturgeon spawning habitats	Stabilized 300 meters of shoreline, constructed an armor rock revetment and offshore deepwater rock/cobble shoals to enhance fish habitat and create lake sturgeon spawning habitats; $290,000	2004	Essex Region Conservation Authority (ERCA) and Parks Canada	Quantitative	Essex Region Conservation Authority

Table 1 (continued). A survey of soft shoreline engineering projects implemented in the Detroit River-western Lake Erie watershed, 1996–2009.

Location	Project Goals	Project Description and Cost	Timeframe	Partners	Monitoring	Contact
Frank and Poet Drain, Trenton, Michigan	Streambed, bank, and upland habitat restoration	Excavated and stabilized shoreline, planted emergent wetland plants and created an upland buffer area with wildflowers and prairie grasses; $80,000	2007–2009	Friends of the Detroit River, National Fish and Wildlife Foundation, and seven other partners	Qualitative	Friends of the Detroit River
Gibraltar Bay, Detroit River, Michigan	Restore native plant community and promote education and stewardship	Restored 357 meters of shoreline using biodegradable "soil sock" and clean-composted recycled yard waste to create a new aquatic shelf and planted 1,400 emergent plants; $80,000	Phase 1: 2003; Phase 2: 2004–2005	Grosse Ile Nature and Land Conservancy, Nativescape, and eight other partners	Qualitative	Nativescape
Goose Bay in Windsor, Ontario	Stabilize shoreline and enhance fish habitat	Protected shoreline with riprap and native plantings, and enhanced fish habitat; $205,000	1999–2000	ERCA, City of Windsor and Environment Canada's Great Lakes Cleanup Fund	Quantitative	Essex Region Conservation Authority
Lake Muskoday on Belle Isle, Michigan	Control erosion and enhance shoreline habitat	Stabilized shoreline using soft engineering techniques, removed invasive plant species such as *Phragmites australis*, and planted native wetland plants, shoreline plants and seeds; $30,000	2000–2001	Detroit Recreation Department, Greater Detroit American Heritage River Initiative, and five other partners	Qualitative	Michigan Natural Features Inventory
Little River at Twin Oaks, Windsor, Ontario	Stabilize 1,150 meters of shoreline, reestablish the natural floodplain, and reestablish the riparian vegetation to improve fish and wildlife habitat	Created a "Natural Channel Design" which stabilized the natural floodplain, planted riparian native species and placed granular stone at bottom of the meandering stream to improve habitat for fish; $1 million	1997–1998	City of Windsor, ERCA, Environment Canada's Great Lakes Cleanup Fund, University of Windsor, and five other partners	Qualitative	Essex Region Conservation Authority

Table 1 (continued). A survey of soft shoreline engineering projects implemented in the Detroit River-western Lake Erie watershed, 1996–2009.

Location	Project Goals	Project Description and Cost	Timeframe	Partners	Monitoring	Contact
Maheras Gentry Park, Detroit, Michigan	Create an oxbow and restore fish and wetland habitat as mitigation for the construction of Conner Creek Combined Sewer Overflow control facility	Removed 38,300 cubic meters of soil for an oxbow, planted native vegetation to improve fish habitat, and created fish spawning and nursery areas; $2.3 million	2000–2004	Detroit Water and Sewerage Department and Detroit Parks and Recreation	Qualitative	Detroit Recreation Department
McKee Park, Windsor, Ontario	Enhance shoreline habitat and submerged fish habitat for lake sturgeon and other species	Protected 182 meters of natural shoreline by constructing offshore barriers using large and small quarry rock to reduce high energy currents and to improve spawning and nursery habitat for fish; $182,000	2003	ERCA, City of Windsor, University of Windsor, and eight other partners	Quantitative	Essex Region Conservation Authority
Northeast Shore of Fighting Island, LaSalle, Ontario	Stabilize shoreline and enhance aquatic habitat	Shoreline sinuosity was increased by constructing limestone groynes along the shoreline that increased stability and enhanced habitat; $60,000	1996	BASF Corporation and ERCA	None	BASF Corporation
Northwest Shore of Fighting Island, LaSalle, Ontario	Demonstrate use of Elastocoast (Elastomeric revetment that stabilizes shorelines and enhances habitat by increasing interstitial spaces) along the Detroit River shoreline of Fighting Island	Stabilized shoreline to a depth of 37 centimeters with five-centimeter crushed limestone bound together with the Elastocoast product; $6,000	2007	BASF Corporation	Qualitative	BASF Corporation
Rouge River at Fairway Park, Birmingham, Michigan	Stabilize shoreline using soft engineering techniques, manage woody debris, create a native buffer zone, and remove invasive species	Stabilized two separate 15-meter lengths of stream shoreline, planted a buffer zone of native plants approximately eight meters wide above the bank at both sites, and removed invasive species along the central wooded area between the two plantings; $30,000	2006	Friends of the Rouge and City of Birmingham	Qualitative	Friends of the Rouge

Table 1 (continued). A survey of soft shoreline engineering projects implemented in the Detroit River-western Lake Erie watershed, 1996–2009.

Location	Project Goals	Project Description and Cost	Timeframe	Partners	Monitoring	Contact
Rouge River at Ford Field, Michigan	Stabilize eroding streambanks along lower Rouge River and enhance wildlife habitat	Stabilized 274 meters of streambank using soft engineering techniques (using a live fascine, a brush mattress and a vegetative geogrid), installed rock toe, and planted native species and wildflowers; $108,000	1998–2000	City of Dearborn, Friends of the Rouge, U.S. Environmental Protection Agency, Ford Motor Company, and four other partners	Qualitative	City of Dearborn
Rouge River at Hines Park, Michigan	Stabilize eroded streambanks and improve fish and wildlife habitat	Stabilized ten severely eroded sections of streambank along 70 meters of shoreline using soft engineering techniques and enhanced 11 hectares of fish and wildlife habitat; total for all ten sites: $780,530; average per site: $78,000	2003–2004	Wayne County Department of Environment and Department of Public Services Parks Division	Qualitative	Wayne County Department of Environment
Rouge River at Shiawassee Park, Farmington, Michigan	Stabilize the riverbank with soft engineering techniques and woody debris, create an adjacent buffer zone of native plants, and enhance aquatic habitat	23 meters of the riverbank was stabilized by grading back the bank and burying bundles of dormant shrubs (live fascines) in the bank, planted a buffer zone of native plants approximately eight meters wide above the bank at both sites and removed invasive species along the central wooded area between the two plantings; $10,000	2004	City of Farmington, City of Farmington Hills, MDEQ, Friends of the Rouge, and seven other partners	Qualitative	Friends of the Rouge
Rouge River Oxbow at Greenfield Village, Dearborn, Michigan	Restore fish and wildlife habitat, including wetlands	Restored 671 meters of oxbow shoreline, 1.2 hectares of wetlands and four hectares of uplands; $2 million	Oxbow construction: 2002; fish stocking: 2003	Wayne County, The Henry Ford, Clean Michigan Initiative, and six other partners	Quantitative	Wayne County Department of Environment

Table 1 (continued). A survey of soft shoreline engineering projects implemented in the Detroit River-western Lake Erie watershed, 1996–2009.

Location	Project Goals	Project Description and Cost	Timeframe	Partners	Monitoring	Contact
Solutia Plant, Trenton, Michigan	Stabilize shoreline and enhance habitat	Stabilized berm walls on two existing ponds located on the Detroit River using a variety of limestone riprap to enhance shoreline habitat (in lieu of concrete breakwalls or steel sheet piling); $50,000	2000	Solutia Chemical Company	None	Solutia Chemical Company
St. Rose Beach Park, Windsor, Ontario	Stabilize shoreline and enhance wildlife habitat	Reconstructed shallow beach area, replaced concrete retaining wall with a rock riprap shore, and added fish habitat features; $196,000	2000–2001	City of Windsor and ERCA	Quantitative	City of Windsor
Stream crossing at Humbug Marsh Unit, Trenton, Michigan	Build a stream crossing to connect the Refuge Gateway with Humbug Marsh Unit, including the use of vegetated gabion baskets as wing walls to ensure stability and enhance streambank habitat	Installed a four-meter aluminum box culvert that included 4×3 meter wing walls and planted seedlings of red osier dogwood and black willow to further increase stability and enhance habitat; $30,000	2008	Navy Seabees, Mid-American Group, NTH Consultants, Logs to Lumber & Beyond Inc., DTE Energy , and USFWS	None	U.S. Fish and Wildlife Service
Street-End Parks, Trenton, Michigan	Construct three street-end parks and enhance fish habitat to improve fishing opportunities	Created three pocket parks, stabilized shoreline and rehabilitated habitat in the Detroit River; $816,000	2001-2002	City of Trenton, Clean Michigan Initiative, Michigan Natural Resources Trust Fund, and Michigan Coastal Zone Management Program	None	City of Trenton

Table 1 (continued). A survey of soft shoreline engineering projects implemented in the Detroit River-western Lake Erie watershed, 1996–2009.

Location	Project Goals	Project Description and Cost	Timeframe	Partners	Monitoring	Contact
U. S. Steel Shoreline West of Belanger Park, River Rouge, Michigan	Restore 610 meters of shoreline and enhance fish and wildlife habitat	Restored 335 linear meters of Detroit River shoreline; created wetlands that provide spawning and fingerling habitat, and created an upland buffer area to provide water quality protection; $211,000	2004–2005	U.S. Steel, Nativescape and USFWS	Qualitative	U. S. Steel
William G. Milliken State Park, Detroit, Michigan	Demonstrate innovative storm water management and aquatic habitat rehabilitation	Constructed an innovative storm water retention basin that treated runoff from adjacent neighborhood and rehabilitated shoreline habitat using soft engineering techniques; $1 million	2008–2009	Michigan Department of Natural Resources, Detroit Riverfront Conservancy and MDEQ	None	Michigan Department of Natural Resources
Windsor Riverfront (Langlois Ave.), Ontario	Stabilize shoreline and enhance fish habitat	Created a sloping rock revetment, sloping rock beach and submerged shoal features; planted native plant species; $800,000	2001	City of Windsor - Department of Parks and Recreation, ERCA and Detroit River Canadian Cleanup Committee	Qualitative	City of Windsor-Department of Parks and Recreation
Windsor Riverfront – Legacy Park (near Caron Ave.) Ontario	Stabilize shoreline and enhance fish habitat	Created a sloping rock revetment, cobble and sand beach, sheltering structures and submerged shoal features; planted native species; $3.4 million	2006	ERCA, City of Windsor-Department of Parks and Recreation, and Detroit River Canadian Cleanup Committee	Qualitative	Essex Region Conservation Authority
Zug Island, at the confluence of the Rouge and Detroit Rivers	Stabilize shoreline of Zug Island and enhance aquatic habitat	Placed recycled bricks from steel plant in front of existing concrete shoreline to create habitat for aquatic life and to serve as a berm to further protect the shoreline from erosion; $10,000	2000	U.S. Steel Corporation	None	U.S. Steel

5.3 Re-creating Coastal Processes to Restore Degraded Coastal Wetland Habitat: A Case Study at Metzger Marsh

Introduction

Over 95% of the original wetland habitats along the U.S. shoreline of western Lake Erie have been lost since the 1860s (Herdendorf 1987; Mitsch and Wang 2000). Most of the few remaining un-diked coastal wetland habitats are severely degraded (Herdendorf 1987; Maynard and Wilcox 1997; Kowalski and Wilcox 1999), which negatively impacts many species of Great Lakes fish and wildlife. Therefore, restoration of these habitats is a high priority for many governmental and nongovernmental agencies.

The Metzger Marsh project in western Lake Erie is a good example of habitat restoration that includes a critical examination of conditions (i.e., monitoring) before, during, and after management actions occurred. In 1994, a dike was constructed along the lakeward margin of the 300-hectare (741-acre) Metzger Marsh, one of the few remaining coastal wetlands along the Ohio shore of Lake Erie (Figure 1), to replace the protective function of the eroded barrier beach. The dike also allowed restoration of wetland plant communities by drawdown of water levels. However, the protective barrier across the mouth of the marsh contains a water-control structure that maintained hydrologic connections with the lake and fish access to the wetland following restoration. It was anticipated that construction of the barrier and initial management of water levels to affect restoration would alter environmental conditions in the wetland and result in habitat restoration. The status of wetland conditions before, during, and after dike construction at Metzger Marsh was therefore investigated.

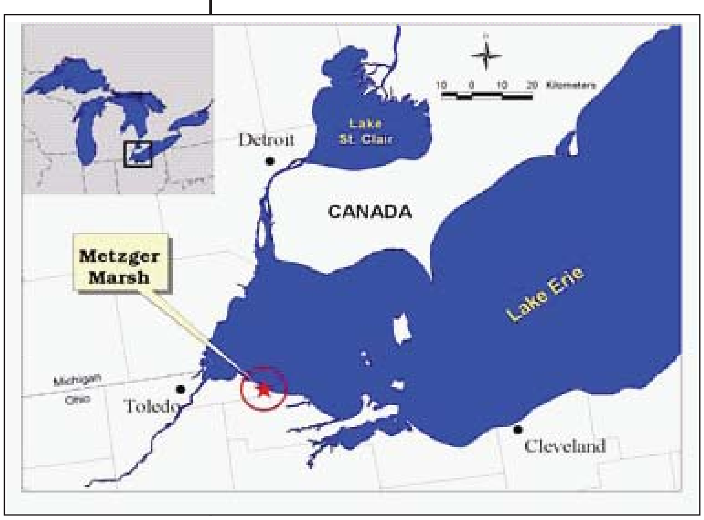

Figure 1. Location map of Metzger Marsh.

Methods

Historical aerial photographs dating back to 1940 were collected and analyzed to identify conditions in the marsh well before the restoration project began. Large-scale color-infrared aerial photos were also collected from 1994 through the end of the mandatory monitoring period in 2002. The study boundaries, ground control points, and major vegetation associations were delineated in each photo-series using a mirror stereoscope. This device uses mirrors and magnification lenses to give the user a three-dimensional view of features observed in sequential aerial photographs. Delineations from each photo within a series were combined to create a mosaic that covered the entire study area. The delineations were digitized into ArcInfo geographic information system (GIS) software (ESRI, Redlands, California) using a high-resolution backlit digitizer. ArcInfo was used for all data editing and transformation to real-world coordinates, and ArcView (ESRI, Redlands, California) was used for basic analysis and map production.

Figure 2. Quantitative sampling of wetland vegetation (Photo credit: Kurt Kowalski).

Each major vegetation association (i.e., group of similar vegetation types) identified in the marsh from 1994 through 2002 (i.e., before, during, and after the Metzger dike and water-control structure were built) was sampled quantitatively by determining the species present and percent cover in a series of 1-m^2 quadrats (Figure 2). The number of quadrats sampled in each association ranged from 10 to 20, depending on the amount of area each covered and relative diversity of plant species. Locations of the individual quadrats within each association were determined using a haphazard design. Percent cover data for each species within a vegetation association were summarized using an importance value that incorporated relative frequency and relative mean cover. The importance value then represented the relative dominance of each species within a specific vegetation association. Fish, birds, and amphibians/reptiles also were sampled by project collaborators, but only the plant results are presented here.

Results and Discussion

Analysis of the historical data revealed that the extent of wetland vegetation was reduced from 108 hectares (267 acres) in 1940 to approximately 33 hectares (82 acres) in 1994, due primarily to high water levels and destruction of the protective barrier beach (Kowalski and Wilcox 1999). Examination of the historical record contributed to the management decision to include a water-control structure in the Metzger Marsh dike that, when open, maintains the critical hydrologic connection between Lake Erie and coastal wetland habitat.

There was a tremendous response from the seed bank after the first year of drawdown (i.e., water was removed from the marsh) after the dike was constructed (Figure 3).

Figure 3. Before drawdown and one year after drawdown at Metzger Marsh (Photo credit: Doug Wilcox).

Pictures like these show a significant change in the amount of vegetated area after the restoration project began, but quantitative data are needed to get enough detail to characterize fully the response to habitat alteration.

Based on analysis of color-infrared aerial photographs, open water covered over 85% of Metzger Marsh prior to the first water-level drawdown in 1996. The first drawdown exposed a large amount of marsh sediment and allowed seeds from the seed bank and wind-blown seeds to germinate throughout the marsh. Over half of the marsh was mapped as vegetated in 1996, with subsequent years showing similar amounts of wetland vegetation. Many different taxa of herbaceous plants, shrubs, and trees were found in Metzger Marsh, with the first year of drawdown producing the greatest species richness. Richness remained relatively steady from 1997 to 1999, dropped in 2000, and then increased in 2001. Mudflat plant taxa germinating in 1996 were replaced largely by wetland grasses and tree seedlings during the second year of drawdown in 1997. By the time the water-control structure was opened in 1998, trees and common reed (*Phragmites australis*) were overtaking the marsh. Trees replaced *Schoenoplectus* spp. (bulrush) in the central part of the marsh and covered a large area despite the application of herbicide. In areas treated with herbicide, *Phragmites* later became the dominant species.

Phragmites continued to expand through 2001, although areas that remained open water became dominated by submersed aquatic species. Core areas of established narrow-leaved cattail (*Typha angustifolia*) in the western portion of the marsh have resisted invasion by *Phragmites* so far, likely because they are well-established patches.

Finally, a particularly interesting mixed emergent community developed in the inner marsh. This area was open water in 1994 and was first exposed during the 1996 drawdown. A diverse assemblage of short emergent plants developed the first three years, even though surrounding areas were already covered with *Phragmites* and reed canarygrass (*Phalaris arundinacea*). For unknown reasons, this area was composed of many noninvasive wetland plant species, resisted invasion by narrow-leaved cattail, reed canarygrass, and *Phragmites*, and continued to expand through 2001. In fact, over 50% of the species identified in 2000 were found in this area.

Conclusions

- An analysis of historical conditions is needed to understand what a study area looked like before becoming degraded and what components of the ecosystem need to be modified to mimic historical conditions and restore coastal processes.
- Quantitative monitoring before, during, and after a habitat modification is needed to characterize the ecological benefits of the management actions.
- Monitoring in Metzger Marsh revealed the extent of the *Phragmities* invasion and characterized the composition and abundance changes that occurred during the monitoring period.
- Areas of high species richness were persistent in the marsh and resisted invasion by *Phragmites*, narrow-leaved cattail, and other aggressive taxa.
- Monitoring data were critical to the identification of emerging problems and helped wetland managers to take action in a timely manner.

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5.4 Wetland Restoration in the Oak Openings Region: A Case Study in Making a Silk Purse Out of a Sow's Ear

Introduction

A wetland restoration took place at The Nature Conservancy's 324-hectare (800-acre) Kitty Todd Preserve located in Spencer Township, Lucas County, Ohio (Figure 1). The preserve is in northwest Ohio's Oak Openings Region, an area of beach ridges formed approximately 14,000 years ago by glacial Lake Warren, a predecessor to Lake Erie. The Oak Openings Region has one of the highest concentrations of rare species in Ohio and is characterized by a mosaic of prairie, savanna and wetland habitats.

The highly degraded 0.81-hectare (2-acre) restoration site functioned as a residence and pig farm for many years until it was purchased by the Conservancy in 1996. The previous owner had created a small pond, covered nearly half of the property with 0.61–0.91 m of soil and debris, constructed a rubble road through the middle of the parcel, and stored several thousand railroad ties on the property. The area was dominated by aggressive native and nonnative species.

Figure 1. Oak Openings Region with the star indicating the project location.

Based on earlier aerial photos, soil surveys, and wetland maps, the Conservancy determined that this parcel had once been part of a larger wetland complex and had high restoration potential. Using available mitigation funds, plans were developed to restore the sandy wetlands on the site. Project results on adjacent property owned by a gun club, the Toledo Muzzle Loaders, Inc., were considered in designing the restoration. In the 1970s, club members scraped areas to create dirt embankments for use as backstops for shooting. A short time later, many rare plant species appeared in the wet, scraped areas indicating that the sandy soils had a well established seed bank that responded favorably when exposed to light. It was assumed that a similar outcome could be achieved at the pig farm site by removing the fill and debris, thereby exposing a well developed and diverse seed bank.

The entire 2-acre site would be restored to wet meadow and sand dune habitat. Restoration success would be evaluated on establishment of a list of indicator species that included herbaceous vegetation such as bluejoint (*Calamagrostis canadensis*), woolly sedge (*Carex pellita*), and other *Carex* spp., rushes (*Juncus* spp.), bulrushes (*Scirpus* spp.), and spikerushes (*Eleocharis* spp.), as well as seedbox (*Ludwigia alternifolia*) and other forbs. A few wet meadows in the Oak Openings, including the gun club property, have small areas of sphagnum moss (*Sphagnum* spp.) with spatulate-leaved sundew (*Drosera intermedia*), northern appressed club-moss (*Lycopodiella subappressa*) and other rare wetland plants. Since it is difficult to predict the establishment of these rare species due to a lack of certainty about their germination requirements and presence in the seed bank, their appearance in the restoration site would be considered beneficial, rather than essential, to the vegetation goal. Nonnative invasive species, such as common reed (*Phragmites australis*), purple loosestrife (*Lythrum salicaria*), glossy buckthorn (*Rhamnus frangula*), and reed canary grass (*Phalaris arundinacea*) would be removed if found in the restoration site.

Methods

Project Design

A wetland restoration plan was developed to provide varied elevations and slopes for diverse hydrologic levels, and restore natural contours to the site. The elevations were determined by using available information from an on-site wetland delineation (Cipollini 2001), historical maps, and conditions at the gun club's adjacent wetland. The plan also called for redistribution of soil removed from the wetland area to form dune habitat along the edge of the property. All of the railroad ties, debris, and the rubble road would be removed from the site. Restoration was completed in 2002.

Monitoring Objectives

Success would be measured by plant species richness greater than 90 native species, and hydrophytic species representing 50% or greater of the species richness in the wetland. In addition, the site would have at least ten species with a Floristic Quality Assessment Index (FQAI) value (Andreas and Lichvar 1995; Andreas et al. 2004) of 6 or greater and the FQAI for the site would be greater than 25.00. Site monitoring was planned for 1, 3, and 5 years following restoration.

Monitoring Methods

Five 50 m transects placed south to north across the restoration site were established prior to the restoration. A 1-m^2 quadrat was placed every 5 m along each transect starting at 1 m. Quadrats were placed on the east side of the transect. All plants rooted in the quadrat were recorded. Frequency data and FQAI were used to quantify the quality of the overall site.

Results and Discussion

Pre-Restoration Results

The area was dominated by aggressive native and nonnative species including *Solidago canadensis*, *Solidago rugosa*, and *Euthamia graminifolia* (goldenrods), *Melilotus alba* and *officinalis* (sweet clovers), *Setaria* spp. (foxtails), *Agrostis gigantea* (redtop), *Panicum* spp. (panic grasses), and *Ambrosia artemisiifolia* (common ragweed). Species richness was 115 species, of which 92 were native species. The FQAI for the site was 23.87, with ten species with a Coefficient of Conservatism (CoC) rating of 6 or higher. Richness in conservative species (CoC) is a factor in determining the FQAI and a reflection of the quality of an area.

Post-Restoration Results

Results exceeded expectations because nonnative species were rare and high quality wetland species, including some rare species, occurred in the restored area. The floristic quality of the site (FQAI) after one year was 31.7, well above the project's goal of 25.00. Ninety-five native species and 17 species with a CoC greater than 6 were recorded. All values were greater than pre-restoration conditions.

To date, at least 135 native plant species have been found growing at the site. In 2004, 17 Ohio state-listed plant species (ranked as endangered, threatened, or potentially threatened) were found in the restoration site, well above the five recorded pre-restoration (Table 1). Many of these state-listed plant species increased significantly in number from 2002 to 2004. Table 2 provides a summary comparison of pre- and post-restoration results.

Table 1. List of Ohio state-listed vascular plants found within the restoration site.

Species	State Status	2000	2002	2004
Agalinis skinneriana (Skinner's-foxglove)	E	0	*	0
Aster dumosus (Bushy Aster)	E	0	0	*
Drosera intermedia (Spatulate-leaved Sundew)	T	0	0	3
Euthamia remota (Great Lakes Goldenrod)	T	1	1	1
Hypericum canadense (Canada St. John's-wort)	E	0	0	1
Hypericum kalmianum (Kalm's St. John's-wort)	T	0	0	1
Juncus greenei (Greene's Rush)	T	0	0	3
Lechea pulchella (Leggett's Pinweed)	T	2	2	2
Lipocarpha micrantha (Dwarf Bulrush)	T	0	0	6
Lycopodiella subappressa (Northern Appressed Club-moss)	E	0	0	*
Polygala cruciata (Cross-leaved Milkwort)	E	0	0	*
Prunus pumila (Sand Cherry)	E	0	0	1
Rhynchospora recognita (Tall Grass-like Beak-rush)	E	0	0	7
Scleria pauciflora (Few-flowered Nut-rush)	P	0	0	1
Scleria triglomerata (Tall Nut-rush)	P	1	1	4
Sisyrinchium atlanticum (Atlantic Blue-eyed-grass)	E	*	0	6
Viola lanceolata (Lance-leaved Violet)	P	1	0	4
Xyris torta (Twisted Yellow-eyed-grass)	E	0	1	6

*Present at site but not recorded in quadrats. State Status based on 2008–2009 Rare Plant List (Ohio Division of Natural Areas & Preserves 2008). (E = endangered, T = threatened, P = potentially threatened)

Table 2. Summary comparing restoration indicators to determine project success.

Indicator Measures of Success	Pre-restoration	Year 1 Post-restoration	Year 3 Post-restoration
Native Species Richness	92	95	134
Percent Hydrophytic Species	41%	45%	46%
# species with FQAI value > or = 6	10	17	31
FQAI value for site	23.87	31.70	41.29

Invasive species appear in small numbers annually, most likely from seeds that originated from nearby private properties. Narrow-leaved cattail (*Typha angustifolia*) and Eastern cottonwood (*Populus deltoids*) are hand pulled or treated with herbicide. Several purple loosestrife (*Lythrum salicaria*) and *Phragmites* plants appeared the first two years after the wetland restoration, but they were treated with herbicide and have not reappeared.

Conclusions

Based on the results to date, the restoration of this highly degraded site has greatly exceeded original expectations. While this was a small project, it illustrates the resiliency of oak openings habitat and the potential to successfully restore high quality wetlands at any scale in this region.

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5.5 Monitoring Wetland Development and Wildlife Populations at the Crosswinds Marsh Wetland Mitigation Site

Introduction

In 1990, the Michigan Department of Natural Resources (MDNR) issued a permit to allow wetlands to be filled that were associated with the expansion of the Detroit Metropolitan Wayne County Airport (DMWCA). This permit established the requirements for the creation of 189 hectares (467 acres) of new wetlands (Figure 1) to compensate for the loss of 126 hectares (311 acres) of wetlands at the airport site. The requirements associated with this permit stated that the Detroit Metropolitan Wayne County Airport shall be responsible for the monitoring of the mitigated wetlands for a period of five years after the completion of the project based on the agreed-upon criteria. This abstract will review the monitoring data for the Crosswinds Marsh wetland mitigation site from 1994 to 1998.

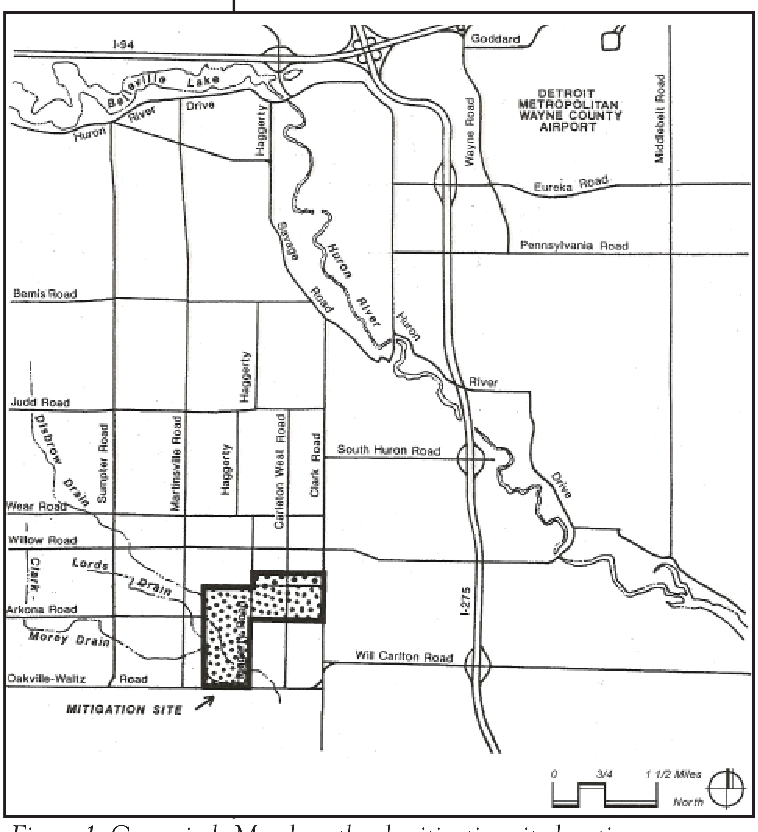

Figure 1. Crosswinds Marsh wetland mitigation site location.

Methods

Vegetation

The Wetland Mitigation Plan called for the creation of various wetland habitat types through seeding, planting and natural succession. To evaluate the development of vegetation in the mitigated wetlands, eleven permanent transects were established in a broad spectrum of wetland habitats. The eleven transects contained a total of 193 monitoring plots, one meter squared, and spaced 15.24 m apart. Vegetation surveys were conducted in late August from 1994 to 1998. Within each plot, all identifiable vascular plant species were recorded and relative abundance of each species and plot percent cover were estimated.

Wetland Indicator Codes were used to determine which vegetation species were wetland plants. A plus or minus sign was used to indicate a greater (+) or lesser (–) affinity for wetlands with codes showing obligate wetland species, those that are facultative to some degree, and upland species. Numeric values were assigned to quantify the degree to which the vegetation is dominated by wetland species. The Wetland Indicator Codes used were OBL (-5), FACW+ (-4), FACW (-3), FACW- (-2), FAC+ (-1),

FAC (0), FAC- (1), FACU+ (2), FACU (3), FACU- (4), UPL (5). If the average is greater than zero, the vegetation primarily consists of non-wetland species (FAC- to UPL). If the average is less than zero, the vegetation primarily consists of wetland species (FAC+ to OBL). The Wetland Mitigation Plan provided measurable criteria and goals for vegetation established in each of the five years of wetland monitoring.

Water Quality

Water quality was monitored at five locations in May, August and September from 1994 to 1998. At each location, temperature, dissolved oxygen (DO_2), pH, and conductivity measurements were taken with a water meter. Grab samples were analyzed for ammonia (NH_3), nitrate (NO_3), nitrite (NO_2), total Kjeldahl nitrogen (TKN), total oxidized nitrogen (TON), orthophosphate (PO_4), total phosphorus (TP), total solids (TS), total dissolved solids (TDS), total suspended solids (TSS), arsenic (As), cadmium (Cd), copper (Cu), lead (Pb), zinc (Zn) and hardness as Calcium Carbonate ($CaCO_3$). In 1997, it was determined that pesticides and metals (except copper) did occur at levels to warrant future sampling, and arsenic, cadmium, lead, and zinc were omitted from testing.

Temperature and dissolved oxygen measurements were also taken at 0.5 m intervals in the deepwater areas, to determine if the water had thermally stratified and whether dissolved oxygen concentrations were high enough to sustain fish populations at deeper levels. Secchi disk measurements were also taken at this station to measure water clarity.

Aquatic Macroinvertebrates

Aquatic macroinvertebrates were monitored at six locations in July, from 1994 to 1998. A dip net was used to sample each location for 30 minutes or until no new organisms were collected on three consecutive dips. Gastropods (snails) and larval dipterans (midges) were identified to the family level. All other organisms were identified to the genus level.

Birds

Bird surveys were conducted for one day in early June, mid-September and mid-November from 1995 to 1998. Observations ran for six hours beginning one-half hour before sunrise. Birds were identified by vocalizations and sightings along vegetation transects. The location of individual birds was recorded with reference to habitat.

Results and Discussion

Vegetation

Table 1 shows the target percent vegetation cover ranges for each monitoring year. Table 2 shows the target wetland indicator code ranges for each monitoring year.

Table 1. Wetland Mitigation Plan criteria for percent vegetation cover.

Wetland Type	Target Percent Vegetation Cover Ranges				
	1994	1995	1996	1997	1998
Forested	30 to 50	40 to 60	50 to 70	60 to 80	70 to 90
Wet Meadow	30 to 50	40 to 60	50 to 70	60 to 80	70 to 90
Emergent	30 to 50	40 to 60	50 to 70	60 to 80	70 to 90
Shallow Water	30 to 50	40 to 60	50 to 70	60 to 80	70 to 90

Table 2. Wetland Mitigation Plan criteria for wetland indicator numbers.

Wetland Type	Target Wetland Indicator Code Ranges				
	1994	1995	1996	1997	1998
Forested	1.00 to -1.00	1.00 to -1.00	0.00 to -2.00	0.00 to -2.00	0.00 to -2.00
Wet Meadow	1.00 to -1.00	0.00 to -2.00	0.00 to -2.00	-1.00 to -3.00	-1.00 to -3.00
Emergent	1.00 to -1.00	0.00 to -2.00	-1.00 to -3.00	-2.00 to -4.00	-3.00 to -4.00
Shallow Water	-4.00 to -5.00	-4.00 to -5.00	-4.00 to -5.00	-4.00 to -5.00	-4.00 to -5.00

Percent vegetation cover and wetland indicator numbers shown in Table 3 are an average of the monitoring plots in each wetland type. Percent vegetation cover met or exceeded the yearly goals for each wetland habitat type except shallow water wetlands. The lack of vegetation found in the shallow water wetlands was probably attributed to high levels of turbidity, which limits light penetration and inhibits the growth of submergent vegetation. The average percent vegetation cover across all wetland types steadily increased from 1994 to 1998. The wetland indicator numbers met or exceeded the yearly goals for emergent and shallow water wetlands. Wetland indicator numbers for wet meadows were negative for 1994 to 1997, indicating a predominance of wetland vegetation, but only met the target goals for 1994 to 1996. The wetland indicator numbers for forested wetlands were positive and show a predominance of upland vegetation. The average wetland indicator numbers across all wetland types were consistently negative from 1994 to 1998, indicating a predominance of wetland vegetation.

Table 3. Average percent vegetation cover and wetland indicator numbers for each wetland habitat type.

Wetland Type	Avg. Percent Vegetation Cover					Avg. Wetland Indicator No.				
	1994	1995	1996	1997	1998	1994	1995	1996	1997	1998
Forested	79.94	96.61	98.48	95.66	98.79	0.88	0.94	1.07	1.11	0.83
Wet Meadow	69.35	91.10	92.41	96.22	97.86	-0.16	-0.09	-0.14	-0.04	0.07
Emergent	47.82	78.72	65.48	81.84	90.06	-2.85	-3.71	-3.79	-2.31	-3.64
Shallow Water	9.00	28.75	51.11	54.59	49.50	-5.00	-5.00	-5.00	-5.00	-5.00
Average	51.52	73.80	76.87	82.08	84.05	-1.78	-1.97	-1.97	-1.56	-1.94

Since monitoring began in 1994, several invasive plant species such as purple loosestrife (*Lythrum salicaria*) and common reed (*Phragmites australis*) have reached nuisance levels within the study area. An intensive management strategy is needed to control these invasive plants.

Water Quality

Measurements of dissolved oxygen were above the MDNR Guideline Level (MDNR 1990) of 5 mg/l, for the duration of the study (Table 4). This is the minimal level needed to sustain a healthy community of warm-water organisms. Levels of pH, nutrients and metals were below MDNR Guideline Levels. Turbidity levels remained high for the duration of the study, but clearing was observed along the edges of wetlands that contained emergent and submergent vegetation.

Table 4. Average water quality parameter measurements for each sampling station.

Water Parameters	**Average Water Quality Parameter Values**				
	1994	1995	1996	1997	1998
Temp. (C)	ND	24.3	19.1	21.5	22.6
DO_2 (mg/l)	ND	5.66	5.59	5.69	6.60
pH	ND	7.16	7.87	7.63	7.30
Cond. (us/cm)	ND	0.41	0.47	0.48	0.43
NH_3 (mg/l)	ND	0.08	0.18	0.22	0.09
NO_3 (mg/l)	ND	0.08	0.01	0.01	0.62
NO_2 (mg/l)	ND	0.02	0.02	0.02	0.01
TKN (mg/l)	ND	0.71	2.37	0.80	ND
TON (mg/l)	ND	ND	ND	2.15	0.40
PO_4 (mg/l)	ND	0.01	0.05	0.14	0.02
TP (mg/l)	ND	0.05	0.10	0.40	0.11
TS (mg/l)	ND	590.6	617.6	376.60	332.60
TDS (mg/l)	ND	562.9	651.27	304.43	317.33
TSS (mg/l)	ND	27.8	33.67	42.33	17.13
$CaCO_3$ (mg/l)	ND	ND	222.50	212.15	223.33
Cu (mg/l)	ND	ND	ND	0.02	0.002

A period of thermal stratification was recorded during the spring monitoring period each year. Temperature measurements gradually decreased, then stabilized at a depth of 1.2 m to 1.4 m (Table 5). Dissolved oxygen decreased to nearly zero at a depth of 3.0 to 3.5 m. The absence of dissolved oxygen below 3 to 4 meters restricts the species and abundance of fish that can occupy this area. The lower two-thirds of the deepwater habitat remains unsuitable for the establishment of a healthy community of warm-water organisms. As turbidity improves and submergent vegetation colonizes the bottom, dissolved oxygen levels should also improve.

Table 5. Average dissolved oxygen and temperature measurements in deepwater areas.

Depth (meters)	**Average Dissolved Oxygen (mg/l)**				
	1994	1995	1996	1997	1998
1.0	ND	6.7	6.8	6.6	6.4
1.5	ND	6.4	7.1	6.7	6.5
2.0	ND	4.3	6.4	7.0	5.1
2.5	ND	2.0	4.5	6.7	4.2
3.0	ND	1.2	0.3	0.5	3.4
3.5	ND	1.0	0.0	0.0	0.2
4.0	ND	0.6	0.0	0.0	0.1
4.5	ND	0.0	0.0	0.0	0.0
5.0	ND	0.0	0.0	0.0	0.0

Aquatic Macroinvertebrates

Aquatic macroinvertebrate diversity increased at all six monitoring locations from 1994 to 1996 (Table 6). A decline in species richness was observed at five locations in 1997. This decline may be due to the high levels of turbidity and low levels of precipitation from 1996 to 1997. High turbidity tends to eliminate macroinvertebrate species that depend on sight to capture food. Below-normal levels of precipitation may have reduced the amount of suitable habitat. In 1998, diversity of aquatic macroinvertebrates increased at all transects, and was the highest recorded at four of the six locations for the five-year study.

Table 6. Average diversity of aquatic macroinvertebrates for each transect, 1994–1998.

Sampling Location	Average Aquatic Macroinvertebrate Diversity				
	1994	1995	1996	1997	1998
Transect 1	ND	21	23	19	23
Transect 2	11	16	21	24	25
Transect 3	8	21	23	14	30
Transect 4	9	23	24	11	23
Transect 6	14	23	23	21	40
Transect 7	16	18	22	20	24
Average	11.6	20.3	22.7	18.2	27.5

Birds

There was a substantial increase in total birds observed from 1995 to 1996, then a large decline in 1997 (Table 7). There are a number of explanations for this increase in 1996, and could have been the result of differences in seasonal or local weather patterns. A comparison of the number of species is a better indicator of the avian community. There was a steady increase in the number of bird species, from 95 in 1995, to 119 in 1998. From 1995 to 1998 a total of 154 different species were observed. The number of wetland bird species also increased from 36 to 46 during the study. This increase in species richness may be an indicator of improving wetland conditions.

Table 7. Number of birds observed and number of bird species observed, 1995–1998.

Monitoring Year	All Birds		Wetland Birds	
	Total Observed	No. of Species	Total Observed	No. of Species
1995	1,018	95	506	36
1996	2,240	105	1,522	41
1997	1,211	112	648	44
1998	1,773	119	1,050	46

Conclusions

The Crosswinds Marsh Wetland Mitigation Site was created to compensate for unavoidable wetland impacts associated with the Detroit Metropolitan Wayne County Airport expansion. Ideally, we would like to eliminate or at least limit these negative impacts on natural wetlands, but these impacts are often inescapable and mitigation becomes necessary. However, this study has shown that mitigated wetlands can be successful and productive wetland ecosystems.

The wetland vegetation at Crosswinds Marsh is steadily becoming more diverse and abundant. The quality of the vegetation in most areas is approaching that of natural wetlands. In general, the wetlands, flora and fauna are becoming more characteristic of natural wetlands. High turbidity and low dissolved oxygen continue to be a problem in deeper water. However, as submergent vegetation becomes established, turbidity and dissolved oxygen should improve. Diverse communities of aquatic macroinvertebrates continue to thrive in the wetlands. The diversity of aquatic macroinvertebrates increased throughout the five-year monitoring period indicating the health of the wetland is improving. Aquatic macroinvertebrates play an important role in the overall health of aquatic ecosystems and their diversity and abundance can be used to measure overall ecosystem health. The wetland complex continues to provide outstanding habitat for a broad range of birds. The number of bird species and their abundance has steadily increased throughout the study.

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5.6 Tallgrass Prairie Restoration in the Ojibway Prairie Nature Reserve, Windsor, Ontario

Introduction

Located in Windsor, Ontario, Ojibway Prairie Complex is a collection of five closely situated remnant natural areas within a ten-minute drive from downtown. The Windsor Department of Parks & Recreation's Ojibway Nature Centre administers three of these areas: Ojibway Park, Tallgrass Prairie Heritage Park, and Black Oak Heritage Park, totaling approximately 127 hectares (315 acres). The adjacent Ojibway Prairie Provincial Nature Reserve, owned by the Ontario Ministry of Natural Resources, adds more than 105 hectares (230 acres) of additional prairie and savanna. The total area is continually growing as the City of Windsor and the Ministry of Natural Resources acquire more land for protection. Rounding out the complex is the 117-hectare (289-acre) Spring Garden Natural Area. Collectively, these sites are designated as the Ojibway Prairie Remnants Area of Natural and Scientific Interest (ANSI).

There is only 7% natural forest cover in Essex County (in extreme southern Ontario). It is also estimated that less than 0.5% of the original prairies and savannas remain in southwestern Ontario (Bakowsky and Riley 1994). The largest relicts which survived were those on lands controlled by native aboriginal peoples, such as Walpole Island, and those wedged between the developed urban portions of Windsor and LaSalle, the Ojibway Prairie Complex.

The most striking aspect of Ojibway Prairie Complex is the tremendous variety of its vegetation and animal life. Wetlands, forest, savanna and prairie provide habitat for a great number of rare plants, insects, reptiles, birds, and mammals. The prairie habitat is a product of the soil and moisture conditions, as well as periodic fire. Ojibway Prairie is situated on sandy soil over a thick bed of clay which is saturated in spring, but very dry by mid-summer. The plant communities present are adapted to these conditions and frequent fire.

Fire provides a tremendous protection to the prairie. Without the aid of fire to burn back the invading woody plants, the prairie would never have been able to maintain its tenuous foothold in Ontario. Today, Ojibway continues to use fire to manage woody vegetation, while leaving some habitats intact for species that would otherwise be adversely affected. Systematic monitoring was set up in the Provincial Nature Reserve in 1984 to help track succession and evaluate management of the tallgrass prairie.

Methods

The southern portion of the nature reserve had been used for cropland prior to the reserve's acquisition in 1974. It was hoped that native prairie species would invade this area once the land was no longer farmed and that prescribed burns would hasten this transformation.

Another restoration method was selected for a 450 square meter test plot created in 1982. This former crop site was ploughed in the fall of 1981 and then disked four times in early 1982.

Seeds of 29 native prairie plant species were locally harvested in 1981 and planted into the restoration plot in early July 1982. The 29 plant species are as follows: *Andropogon gerardii, Schizachyrium scoparium, Aristida purpurascens, Elymus canadensis, Sorghastrum nutans, Spartina pectinata, Asclepias tuberosa, Coreopsis tripteris, Gentiana andrewsii, Gentianopsis crinita, Gerardia cf. flava, Gerardia purpurea, Gerardia tenuifolia, Liatris aspera, Liatris spicata, Lithospernum canescens, Ludwigia alternifolia, Monarda fistulosa, Penstemon digitalis, Penstemon hirsutus, Potentilla arguta, Ratibida pinnata, Silphium laciniatum, Silphium terebinthinaceum, Sisyrinchium albidum, Solidago riddellii, Solidago rigida, Thalictrum polyganum,* and *Veronicastrum virginicum.*

The plot contains 20 square meter quadrats, marked with steel location rods. A species presence list was prepared by conducting a thorough examination of the vegetation. Frequency was recorded as the presence or absence of a species in each quadrat and expressed as a percentage for all quadrats. Any species found within the plot boundaries, but not in any quadrat, was assigned a 1% frequency and 0.0% cover. A percent cover class was also determined for each species in each quadrat.

An Index of Similarity was calculated to help in comparing this restoration plot with the results obtained from an undisturbed mesic prairie plot located in the northern portion of the nature reserve. This Index of Similarity, for the purposes of this assessment, was expressed as the ratio of twice the sum of the total frequency measurements which are common to the two plots being compared, namely the restoration plot and mesic prairie plot (C), to the sum of the total frequency measurements in each plot (A and B) and was expressed as a percentage:

$\{(2C/A+B)*100\}$

Results and Discussion

By 1991, 22 of the 29 species planted were established in the restoration plot.

Follow-up monitoring was done in 2008 that documented further changes as follows: The frequency of species typical of abandoned farmland such as *Achillea millifolium* decreased from 20% to 1%; *Daucus carota* decreased from 80% to 1%; and *Solidago canadensis* decreased from 100% to 50%. Native prairie species such as *Schizachyrium scoparium* increased from 35% to 75%; *Coreopsis tripteris* increased from 15% to 35%; and *Andropogon gerardii* increased from 75% to 100%.

This Index of Similarity for the restoration plot remains low despite the general appearance of the plot that is now dominated by tall native grasses *Sorghastrum nutans* and *Andropogon gerardii* (index value of 33.6% in 1991 after nine years, increasing to 41.0% in 2008 after 26 years).

Fire has proven to be an effective tool in the management of tallgrass prairie. Prairies recover quickly from prescribed burns and fire helps to prevent the establishment of woody vegetation. The restoration plot has the lowest frequency and cover values for woody plants of any site in the nature reserve. This is due to the abundant fuel supply provided by the dominant prairie grasses. However, as succession continues, it becomes imperative to make a commitment to continue long-term monitoring and biological assessments. Partnerships are key to sustaining monitoring programs and an adaptive management approach is necessary to achieve long-term goals.

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5.7 Strategies to Improve Wetland Habitats by Managing Invasive Common Reed (*Phragmites australis*): A Case Study at Sterling State Park

Introduction

William C. Sterling State Park is located on the western shore of Lake Erie, adjacent to the city of Monroe, Michigan. The park is located 27 km north of Toledo, Ohio, and 40 km south of Detroit. Most of the 502-hectare (1,240-acre) park lies within the delta of the River Raisin. The River Raisin Delta was once a complex of Great Lakes marsh and lakeplain prairie with a few areas of lowland hardwoods (wet-mesic flatwoods).

European settlement of the area began in the early 1700s. Alteration of the delta soon followed. The marsh and river were dredged to facilitate boat travel and commerce. Marshes were dredged, diked and water levels manipulated for agriculture and waterfowl hunting. Large areas of marsh were dredged by the Works Progress Administration (WPA) to create upland recreational land for the state park. In the 1980s, two large confined disposal facilities were constructed within the park by the U.S. Army Corps of Engineers. After 300 years of alteration to meet human needs and desires, little if any of the River Raisin Delta remains undisturbed.

While significantly degraded, there are small areas of Sterling State Park that have retained many native species, including several rare plants and animals. Rare plants include: American lotus, *Nelumbo lutea* (state threatened); trailing bean, *Strophostyles helvula* (state special concern); swamp rose-mallow, *Hibiscus moscheutos* (state special concern); and arrowhead, *Sagittaria montevidensis* (state threatened). Rare animals include: the Eastern fox snake, *Pantherophis gloydi* (state threatened); marsh wren, *Cistothorus palustris* (state special concern); king rail, *Rallus elegans* (state endangered); common moorhen, *Gallinula chloropus* (state special concern); and osprey, *Pandion haliaeetus* (state threatened). The bald eagle, *Haliaeetus leucocephalus* (state threatened) nests just south of the park and frequently fishes within the park.

A legislatively mandated mission of Michigan State Parks is to preserve the unique natural resources of Michigan. In 2003, the Michigan Department of Natural Resources, Parks and Recreation Division, Stewardship Unit began an ecological restoration of the native ecosystems of Sterling State Park.

The goal is to restore or re-create Great Lakes marsh and lakeplain prairie, while improving the park for recreation and preserving a part of southeast Michigan's natural heritage. A major component of our ecological restoration efforts is control of common reed (*Phragmites australis*).

Phragmites is a tall perennial grass that is native to wetlands in the temperate and tropical regions of the world, including Michigan. A nonnative invasive variety of *Phragmites* is becoming widespread in Michigan. This invasive *Phragmites* is displacing native *Phragmites* as well as many other native wetland plants species. It forms dense and extensive monocultures that can simplify native ecosystems and alter hydrology and sediment deposition. Plants can exceed 4 meters in height. Amazingly, almost as much biomass of a *Phragmites* stand is found belowground as aboveground. This makes established stands of *Phragmites* difficult to eradicate.

Phragmites control at Sterling State Park began in 2003 and annual follow-up treatments are ongoing. All treatments were conducted under Department of Environmental Quality permits.

Methods

Our protocol was to treat *Phragmites* with glyphosate herbicide in late summer (between the last week of August until killing frost). Typically we see 80% to 90% reductions in *Phragmites* cover from a single glyphosate application. Ideally, areas sprayed with herbicide are treated with a prescribed burn in winter or spring. The purpose of the burning is twofold: 1) to remove the massive amounts of biomass to facilitate access for follow-up treatment, and 2) to stimulate seed germination and resprouting, which increases the effectiveness of follow-up treatment. To sustain *Phragmites* control, annual follow-up treatments are performed.

Phragmites control at Sterling State Park involved several treatment methods. Large monoculture stands of *Phragmites* were treated by means of a helicopter. *Aqua Star*®, an aquatic formulation of glyphosate with *Cygnet Plus*® added as a penetrant and surfactant, was applied at 7.01 L per hectare (6 pints per acre). Application occurred during the first week of September. Fifty-three hectares (130 acres) were treated by aerial application. Treatments were primarily performed by private contractors.

Smaller monoculture stands intermixed with desirable native vegetation were treated with "ground base" spray rigs including boats, all-terrain vehicles, marsh vehicles and backpack sprayers. A 2% active ingredient mix of glyphosate (*Aqua Neat*®, *AquaPro*® or *Glypro*®) with *Cygnet Plus*® was used for ground-based application. Hand swiping was used to apply herbicide to widely scattered *Phragmites* stems. A 5% active ingredient mix of glyphosate (*Aqua Neat*®, *AquaPro*® or *Glypro*®) with *Cygnet Plus*® was used for hand swiping. Applications occurred each year during September. Two hundred and eighty acres were treated by ground-based foliar spray and hand swiping. Annual follow-up treatments have all been ground-based spray or hand swiping.

A monitoring protocol is in place to gauge the success of our *Phragmites* control project at Sterling State Park. The purpose of our monitoring is to inform adaptive management. Our monitoring is not designed or intended to test a scientific hypothesis. Monitoring at Sterling State Park has only been qualitative. Seventeen photo-monitoring locations have been established at Sterling State Park to document the change in *Phragmites* cover. At each photo-point, photographs are taken with a camera at a standard height and facing specific compass bearings. Baseline photographs were taken in 2003 and in each subsequent year. Photographs are taken at approximately the same calendar date. Additional photographs were taken to document the response to treatments. A sequence of photo-monitoring photographs is presented in Figure 1.

8 August 2003

5 September 2003

17 November 2003

24 March 2004

6 May 2004

19 August 2004

Figure 1. Photo-monitoring sequence of Phragmites *control.*

18 August 2005

24 August 2006

11 September 2007

30 August 2008

Figure 1 (continued). Phragmites *control photo-monitoring sequence.*

Results and Discussion

Phragmites cover declined dramatically after the first herbicide and prescribed fire treatments. After one year of follow-up treatment, in most areas *Phragmites* cover was reduced to less than 15%. After two years of follow-up treatment, *Phragmites* had been eliminated in many areas and occurred in stunted, scattered stands where it persisted. Photo-monitoring documented that in many areas a fairly diverse collection of native wetland species returned. However, in some areas, reed canarygrass (*Phalaris arundinacea*) and narrow-leaved cattail (*Typha angustifolia*) emerged as the new dominant species. Monitoring after the third year of follow-up treatment documents many areas becoming highly dominated by narrow-leaved cattail. It may be worthwhile to include control of aggressive species in the first few years of follow-up treatment to provide less aggressive, more desirable native plants sufficient time to establish.

We found that it is more difficult to achieve eradication or percent cover reduction greater than 80% for some stands of *Phragmites*. The lower efficacy of herbicide treatment appears to be correlated with how long the stand has been established, which is indicative of how much root biomass the stand has amassed. We also found the efficacy of herbicides to be less when applied to *Phragmites* growing in standing water.

At our Bay City Recreation Area, 20 point-intercept transects have been established to monitor *Phragmites* control. Results of this quantitative monitoring are noteworthy. *Phragmites* cover was reduced from a baseline condition of 74% *Phragmites* cover (2005) to 11% (2006) after a single herbicide treatment followed by a spring prescribed fire. After the first year of follow-up treatment, *Phragmites* cover increased to 22% (2007). After the second year of follow-up treatment, *Phragmites* cover was reduced to 15% (2008). The spike in *Phragmites* cover may be attributed to differences in contractor performance, water levels, stimulation of regrowth from the root system after the prescribed fire, or the amount of dead vegetation cover, but the exact cause is not understood. After three treatments, very few dense patches of *Phragmites* remained and the remaining plants are stunted and scattered. However, the amount of *Phragmites* cover remained near but above our target of less than 15%. In 2008, the decision was made to adapt our management strategy. A combination of imazapyr (*Habitat*® 1%) and glyphosate (*Aqua Neat*® 2%) was used to see if greater control could be achieved.

Cost for herbicide treatments varied significantly. Variation is influenced by application methods, density of *Phragmites*, mobilization costs, accessibility of the treatment area, size of the treatment area(s) and the contractor used. Aerial herbicide application at Sterling State Park had a cost of $135/acre (130 acres treated; 1 acre=0.40 ha) in 2003. In 2005, aerial herbicide application at the Bay City Recreation Area had a cost of $235/acre (24 acres treated). Mobilization costs for aerial treatment are generally the same regardless of the total acreage treated. Ground-based herbicide treatment varied from $38/acre (348 acres treated) to $136/acre (222 acres treated) at Sterling State Park. At Bay City Recreation Area, cost per acre for ground-based herbicide treatment varied from $308/acre (24 acres treated) to $425/acre (40 acres treated). The cost of ground-based herbicide is very dependent on the conditions of the individual treatment area.

Our original expectation was that cost for *Phragmites* treatment would be most expensive for the first treatment and then diminish correspondent with the cover of *Phragmites*. This has proven not to be the case. We have found that aerial application is less expensive per acre than ground-based application, but a minimum number of acres are needed to overcome the fixed mobilization costs associated with aerial application. Stand density and accessibility greatly influence the per acre cost of ground-based herbicide treatment. Ground-based cost per acre declines with *Phragmites* density to a point and then remains fairly constant as the hours required for treating a given area plateau. Contractor time applying herbicide is replaced by contractor time searching for *Phragmites*.

Funding for *Phragmites* control at Sterling State Park was provided by a Great Lakes Coastal Restoration Grant provided through the Michigan Coastal Management Program; Michigan Department of Environmental Quality; National Oceanic and Atmospheric Administration; U.S. Department of Commerce; the Clean Michigan Initiative (CMI); Michigan DNR, Parks and Recreation Division, State Park Stewardship Unit; and State Wildlife Grant dollars.

Conclusions

- Expect 80%–90% reduction in *Phragmites* cover from a single foliar application of glyphosate (2% active ingredient) applied in late summer.
- Older *Phragmites* stands are more difficult to control.

- Cost per acre does not diminish correspondent with diminishing *Phragmites* cover.
- Cost per acre varies widely depending on treatment method, density of *Phragmites* and difficulty of accessing *Phragmites* stands.
- Prescribed fire is a useful tool to facilitate physical access for re-treatment.
- Fire stimulates *Phragmites* resprouting and seed germination. This is good or bad depending on the overall control strategy.
- The quality/diversity of the seed bank is critical to success of restoring native marsh.
- The "next" most aggressive species often will replace the *Phragmites* as the dominant species (narrow-leaved cattail, reed canarygrass, etc.). Controlling aggressive undesirable species may be needed to allow less aggressive native species time to colonize.
- Despite low germination rates frequently mentioned in the literature, *Phragmites* easily colonizes new sites by means of seed dispersal.

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5.8 Small-Scale Habitat Enhancements within the Canadian Detroit River Area of Concern

Introduction

"It was realized in the latter half of the nineteenth century that too much timber had been wastefully cut; in many cases only to reveal land that was not profitable to farming. Some criticized earlier generations which had 'ripped away' the forest. They believed that the solutions to the problems lay in replacing the trees" (ERCA 1986). This paraphrasing of the Bureau of Forestry in 1885 reveals the fact that the negative consequences of human settlement on the environment and on sustainable land use has long been realized. How far have we come with respect to "replacing the trees" since 1885? The natural area status of the Essex Region today can best be described as still fragmented and degraded with one of the lowest percentages of natural cover in all of Ontario — 7.5%.

Objectives

In 1998, Environment Canada, the Ontario Ministry of Natural Resources, and the Ontario Ministry of Environment and Energy produced a document entitled, "A Framework for Guiding Habitat Rehabilitation in Great Lakes Areas of Concern" (1998). This document was further published as a second edition in 2004 entitled, "How Much Habitat is Enough?" (Environment Canada 2004). These documents provided the science-based guidelines from which the Essex Biodiversity Conservation Strategy was developed (ERCA 2002). The purpose of the Biodiversity Conservation Strategy (BCS) was to produce a spatial database of all natural areas within the Essex Region and, utilizing the Environment Canada framework, conduct an analysis of the terrestrial, wetland, and riparian habitats to identify the extent of existing natural vegetation and prioritize opportunities for habitat rehabilitation and enhancement. The objective was to increase the size, extent, and quality of key natural heritage features, natural corridors, and greenway linkages, thereby improving the ecosystem diversity and ecological functions of the Essex Region. In addition, by applying the framework to the Detroit River Area of Concern, the BCS is assisting in addressing and delisting the impaired beneficial use — loss of fish and wildlife habitat.

By adapting the BCS to the Essex Region landscape, we now have a vision for the future with respect to core natural areas, buffers and linkages, which builds upon what currently exists in the landscape. Prior to European settlement, the Essex Region primarily consisted of a Pin Oak (*Quercus palustris*) swamp with some areas of upland Carolinian forest and tallgrass prairie existing on the drier sandier soils. Although there are still remnants of these significant ecosystems left in our region, extensive tile drainage for agriculture has significantly altered the region's natural hydrology, and therefore the opportunity for pure "restoration" may be extremely difficult. Nevertheless, by applying the guidelines to our region, we should see a positive response.

General BCS Guidelines include (Figure 1):

- Forest shape and proximity to other areas: circular or square in shape and in close proximity to adjacent patches (within 2 km; 1.2 miles);
- Fragmented landscapes and the role of corridors: minimum 100-meter-wide corridors designed to facilitate species movement;
- Percent of natural vegetation along first- to third-order streams: 75% of stream length should be naturally vegetated – either woody or grassy;
- Amount of natural vegetation adjacent to streams: generally, 30 meters of naturally vegetated buffer on both sides would be optimal; and
- Amount of natural vegetation adjacent to wetland: 240 meters.

The Biodiversity Conservation Strategy focuses primarily on riparian and upland habitats. In-water habitats and the organisms that rely on them for all or parts of their life cycles were not specifically addressed. In order to address fish habitat, a separate Fisheries Management Planning process will need to be undertaken.

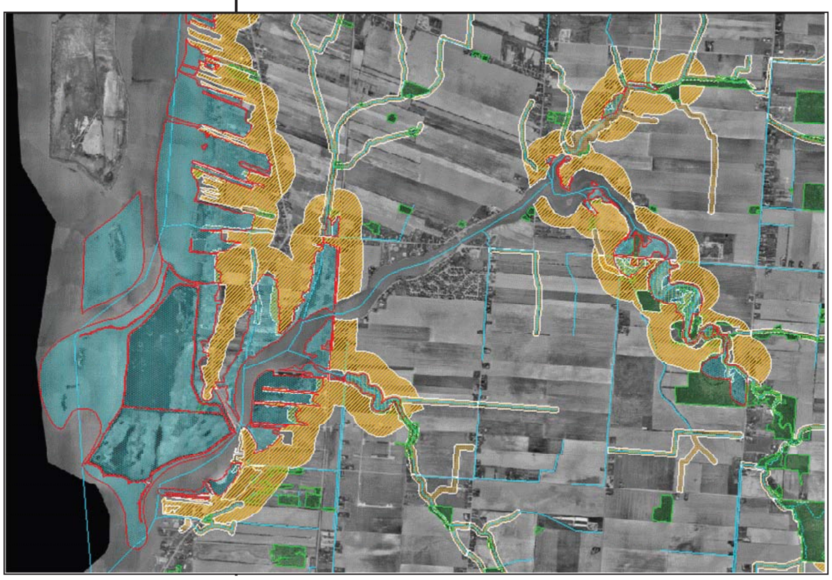

Figure 1. Application of the restoration guidelines at the mouth of the Canard River in Amherstburg, Ontario and along the Detroit River. Textured areas are those that fit BCS guidelines.

Specifically, implementation of the Biodiversity Conservation Strategy will result in an increase in:

- Wetland and upland vegetation cover;
- Natural vegetation adjacent to wetlands and along first- to third-order streams;
- First- to third-order streams with buffers up to 30-meters-wide; and
- Linkage/connectivity of disjunct habitat fragments.

Methods

In 1996, the Ontario Ministry of Natural Resources created a private land stewardship program, called Ontario Stewardship, from three pilot projects. These pilot projects have grown to 45 community-based councils across southern Ontario and a network that is expanding in the north.

These stewardship councils are guided by local farmers, landowners, naturalists and sportsmen who work with interested parties and partner groups to improve their local environments. The councils foster an ethic of caring for the land, requiring the personal actions and commitments to sustain the land for future generations. These voluntary actions are structured in a way that the landowners can influence the local stewardship actions. Respecting the property owner's rights is one of the key goals to making stewardship action sustainable and successful.

With the landowners, community partners, NGOs, provincial and federal governments, the Essex County Stewardship Network (ECSN) is working at a grassroots level to create needed habitat within the county. These projects also work to assist with local water quality and quantity concerns, deal in a positive manner with Species at Risk, and provide youth engagement opportunities.

Meeting with the landowners, the ECSN begins to work with them to plan out the owners' ideas for their land. Once council support has been achieved, the resources of the ECSN are guided in obtaining funding, permitting, and other expertise from partners to complete the project. The ECSN uses the BCS, along with the Carolinian Canada's The Big Picture, The Nature Conservancy of Canada's Binational Conservation Blueprint and Conservation Action Plan for Essex County, along with local knowledge from adjacent projects to complete design and assist with implementation.

Habitat projects include wetland creation, wetland restoration, reforestation, and meadow and tallgrass prairie plantings. Youth and public engagement projects are also part of the ECSN council's mandate. Plantings include up to 18 species of trees and shrubs along with 25 species of grasses and forbs to aid in and preserve local biodiversity. These projects are working collectively to meet the delisting criteria of the Detroit River AOC and its partners through the Biodiversity Conservation Strategy.

Results and Discussion

The Sanson Estate Winery project is a 13.35-hectare (33-acre) restoration project involving wetlands, meadows and forest. The project addresses the Beneficial Use Impairments numbers 3, 11, 14 and 15. The goals of the project were to improve habitat for nature and recreation, settle agricultural sediments from water prior to entering into the Canard watershed, and restore the floodplain hydrology. This multiyear project has involved nine partners and funders, numerous volunteers and the landowner's friends and family.

The Caba Property project involved a rural nonfarm landowner's goals to improve his property's habitats for recreation and nature, and to improve local diversity by adding small wetlands and vernal pools to a site that has been artificially drained (Figure 2). The landowner has undertaken most of the work himself and asked for some funding and permitting support. This was also a multiyear project with work underway since 2002 in two-year stages. Monitoring of the site by neighbors has noted over 128 species of birds using the site at different times of the year.

Figure 2. Caba vernal pool created in 2005. Photo from June 2008.

The Gesto Connection project involved four separate landowners and five properties in the mid-reaches of the Canard River. Habitat fragmentation was the key AOC Beneficial Use

Impairment addressed by this project with 6 hectares (15 acres) of woodland, vernal pools and meadows being planted to connect two fragmented woodlands back into the Canard River valley. 1.1 km of riparian habitat was created along a private farm drain enhanced with vernal pools to slow drainage, keeping sediments from the river system.

The ECSN has completed numerous projects within the Detroit River AOC since the 2001 start of the Canard and Detroit River Stewardship Initiative (Table 1). This initiative funded in part by the Great Lakes Sustainability Fund, the Canada-Ontario Agreement Fund, the Ontario Ministry of Natural Resources, and other local sources has completed:

- 15 ha (37.1 acres) of wetland creation and restoration;
- 35.7 ha (88.2 acres) of reforestation;
- 31.86 ha (78.7 acres) of meadow and tallgrass prairie plantings; and
- 16.75 ha (41.4 acres) of riparian plantings.

Table 1. The extent of projects that have been completed from 2001 to 2008 which have assisted in implementing the BCS restoration recommendations.

Project (watershed)	**In Water**	**Riparian/ Upland**	**Wetland**	**Total area ac=acres**	**Fiscal Year**
Roberts Site (Canard)			2ha/5ac	2ha/5ac	2001/02
Brunet Park (Turkey)		1.6ha/4ac		1.6ha/4ac	2001/02
Turkey Creek Enhancement (Turkey)		2.7ha/6.7ac		2.7ha/6.7ac	2001/02
McGregor Lagoons (Canard)		40ha/100ac	1.2ha/3ac	41.2ha/103ac	2001/02
Canadian Signs Site (Little)		5.7ha/14ac	0.4ha/1ac	6.1ha/15ac	2001/02
Fackrell (Canard)	0.6ha/1.5ac	16.6ha/41ac	1.2ha/3ac	18.4ha/45.5ac	2002/03
McKee Park (Detroit)	1ha/2.5ac	0.2ha/0.5ac		1.2ha/3ac	2002/03
Aalbers Site (Canard)		3ha/7ac		3ha/7ac	2002/03
Rocheleau Site (Canard)		8ha/20ac	0.8ha/2ac	8.8ha/22ac	2002/03
Bovenkamp Site (Canard)		12.1ha/30ac		12.1ha/30ac	2002/03
Aalbers Site (Canard)		28ha/70ac		28ha/70ac	2003/04
Fort Malden (Detroit)	0.8ha/2ac			0.8ha/2ac	2003/04
Riding (Canard)		1.6ha/4ac	0.4ha/1ac	2ha/5ac	2003/04
Coates (Detroit)		6ha/13ac		6ha/13ac	2004/05
Higgs-Poling (Canard)		4ha/10ac		4ha/10ac	2004/05
Smith (Canard)		12ha/30ac		12ha/30ac	2004/05
McCormick (Canard)		5ha/12ac		5ha/12ac	2004/05
Vollmer (Canard)		4ha/10ac		4ha/10ac	2004/05
Minnett (Canard)		4ha/10ac		4ha/10ac	2005/06
Vollmer (Canard)		12ha/30ac		12ha/30ac	2005/06
Various landowners (Canard)		4.5ha/11ac		4.5ha/11ac	2005/06
Various landowners		30ha/75ac		30ha/75ac	2006/07
Various landowners		20ha/50ac		20ha/50ac	2007/08
Total Area	2.4ha/6ac	220ha/546ac	6ha/15ac	229ha/566ac	2001-2008

Conclusions

Working with community partners, interested people and landowners, the ERCA and the ECSN are making progress in addressing habitat loss and fragmentation through the BCS. Enhancing environmental initiatives provides opportunity for local people to become involved in partnerships for the restoration of habitats in Essex County. These partnerships, through sharing and cooperation, are helping to extend limited funds to the maximum number of partners. The community partners working together and using the BCS are creating a healthier, sustainable and more ecologically diverse environment for the county.

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5.9 Ecological Results of Restoring Fighting Island

Introduction

BASF Corporation and its predecessor companies have owned Fighting Island since 1918. The southern three-quarters of the island were divided into three settling beds (Figure 1). The beds serve as the final disposition for alkaline by-products predominantly from the manufacture of soda ash and other lime-based products used for the manufacture of plate glass. The beds were in service between 1924 and 1982. The beds hold approximately 15.3 million cubic meters of material.

The alkaline by-products consist mostly of calcium chloride, sodium chloride, coke ashes, unreacted limestone, and limestone impurities such as silica, alumina, and metallic oxides. These by-products were pumped in slurry form to Fighting Island where they were allowed to dry and decant. The grain size typically is in the silt to fine silt range.

Figure 1. North bed in the 1950s.

Habitat projects on the 486-hectare (1,200-acre) Fighting Island site benefit wildlife and increase environmental awareness among employees, community members, students and government agencies through implementation of a cohesive, long-term wildlife management plan.

The original management strategy for the site, implemented from the early to mid-twentieth century, included setting aside 121 hectares (300 acres) of land for hunting programs and using the remaining 364 hectares (900 acres) for storage of lime tailings. BASF's current goal for Fighting Island, which is located on the Canadian side of the Detroit River, is to provide a native vegetative cover that eliminates dusting concerns, protects the surface of the dikes and settling beds from erosion, and provides habitat for wildlife while enhancing the community in which the island resides.

BASF planted more than 340,000 seedlings, including *Populus* (poplar), and native and berry-producing shrubs on the island. Between 1982 and the present, vegetative cover of the island increased from 30% to 80%. Employees placed thousands of bales of straw, hay, alfalfa, and scattered leaves from the nearby town of LaSalle, Ontario, to increase the amount of organic material in the soil. They also introduced 300 wild turkeys (*Meleagris gallopavo*) to the island habitat, and 5,000 ring-necked pheasants (*Phasianus colchicus*) are introduced each year. Recently developed projects will convert existing runoff canals into wetlands, control invasive weed species on existing artificial marshes, manage habitat for migratory birds, and add habitat components for cavity-nesting species.

Opportunities

The three settling beds, North, Middle, and South, have unique challenges. The North bed was shut down in 1980 at a 7.6-meter elevation above river level. The Middle bed was shut down in 1953 at 10.7 meters above river level. The South bed was shut down in 1982, twenty years before its original plan, which kept it bowl-shaped and regularly accumulating water.

Since the 1970s, BASF has actively encouraged revegetation on Fighting Island. The early efforts targeted increasing the stability of the perimeter containment dikes. The revegetation goals included reducing dust problems, increasing wildlife habitat, controlling runoff, and enhancing the physical appearance.

Many factors discourage vegetative growth in these materials, including: high pH, high moisture content, the absence of organic components, high concentrations of salts, and the very smooth ground surface. The smooth surface promotes transport by wind and discourages resident time for seeds to root. The high moisture content, along with the materials' fine grain size, combined to inhibit any kind of large-scale tilling.

Methods

BASF's primary methods for increasing vegetative cover fall into six categories. A discussion for each method follows.

1) *Reduce the water content of surficial deposits to promote plant growth:* Assessments by the Ontario Ministry of Environment beginning in 1982 concluded that the high moisture content significantly inhibited plant growth. BASF reduced the soil's moisture content by building and excavating channels through the beds. These channels enhance drainage on all the beds and carry excess water to the decant channels.

2) *Build windbreaks at strategic locations to catch dust, seeds, and blowing soil:* BASF brought in thousands of bales of hay and straw to build approximately 9.7 km of windbreaks that catch dust and seeds. As the windbreaks decay, they provide good organic base matter for plant growth. Additionally, several thousand stick and mulch plots on the beds acted as small isolated windbreaks.

3) *Transplant trees and shrubs to develop deeper root and soil zones:* Since the mid-1980s, BASF has planted approximately 340,000 trees and seedlings on Fighting Island. Early survival rates were marginal, but several species did very well. These species include *Populus* (poplars) and *Elaeagnus angustifolia* (Russian olive). BASF purchased most seedlings and saplings from the Seedling Nursery Stock Program through the Essex Region Conservation Authority. BASF transplanted a significant number of trees and shrubs from the northern marsh area on Fighting Island to the settling beds. Native berry-producing tree and shrub seedlings are now strategically planted each year to provide cover and habitat for wildlife.

4) *Acquire and apply yard wastes from local communities to increase organic content:* BASF acquired and maintains an Organic Soils Conditioning Permit to apply leaves on the island. Beginning in the early 1990s, BASF began accepting leaves from the town of LaSalle free of charge. The leaves are spread inside the perimeter dikes and are allowed to decay for a few years. BASF then seeds the decayed leaves with grasses. Branches are

placed in humps across the beds where they act as small windbreaks and seed areas. The branches also help increase the organic content of surface soils.

5) *Acquire and apply organic biosolids (wastewater treatment plant sludge) if available to increase organic content*: BASF worked with several local groups to increase the fertility of the lime beds through the application of biosolids. In 1981 and 1982, BASF participated in a pilot-scale project using biosolids from the City of Detroit. The sludge was blended with the soils at various percentages to find the optimum mix ratio, and test plots were planted with a variety of vegetation. Although the pilot project was declared an overall success, the project was discontinued because of elevated concentrations of metals in the sludge and perceived political complications. Two additional opportunities arose in the 1990s to apply biosolids from the Windsor Wastewater Treatment Plant to Fighting Island. These initiatives, in cooperation with the Fighting Island Development Group (Dean Construction Company), also were unsuccessful, primarily due to budget concerns in Windsor's City Council.

6) *Encourage use of the island by waterfowl:* Waterfowl and colonial waterbird use is increasing on Fighting Island. Herring gulls (*Larus argentatus*) and ring-billed gulls (*L. delawarensis*) have significant nesting colonies. The contribution of biosolids from this source has been an unexpected benefit to increasing organic content of the soils. Since realistic estimates of the gull population began in 1991, their numbers have increased by over 230% (estimated at over 350,000 individuals; C. Weseloh pers. comm.). While BASF encourages gulls to live on Fighting Island, BASF in fact discourages them from congregating on its other riverfront properties, most notably on the North Works facility.

Results and Discussion

Overall vegetative cover on the southern three-quarters of the island increased from less than 40% in 1987 to nearly 95% in 2008. The fruits of these rehabilitation efforts include decreased runoff of alkaline waters into the Detroit River, decreased incidents of dust rising from the lime beds that once caused problems for local residents, increased habitat for resident and migratory birds, and a more aesthetically pleasing appearance for residents on both sides of the Detroit River (Figure 2).

Figure 2. Fighting Island in 2006.

In 2007, the Fighting Island settling beds were inventoried by two biologists as part of the recertification process for the Wildlife Habitat Council. Table 1 presents a partial list of plants recently found on Fighting Island that provides evidence that the once barren beds show significant ecological results.

Table 1. Fighting Island Inventory, 29-Jun-07, Martha Gruelle, Kathy Koelbl-Crews, Wildlife Habitat Council.

North and Middle Beds		
Native or Alien	**Scientific Name**	**Common Name**
N	*Achillea millefolium*	yarrow
N	*Asclepias syriaca*	common milkweed
N	*Asclepias tuberosa*	butterfly milkweed
N	*Asclepias verticillata*	whorled milkweed
N	*Calystegia sepium*	hedge bindweed
N	*Carex aurea*	golden sedge
A	*Centaurea biebersteinii*	spotted knapweed
N	*Cornus drummondii*	roughleaf dogwood
A	*Daucus carota*	Queen Anne's lace
A	*Elaeagnus angustifolia*	Russian olive
N	*Erigeron philadelphicus*	common fleabane
A	*Hieracium piloselloides*	tall hawkweed
A	*Hypericum perforatum*	common St. John's wort
N	*Juniperus virginiana*	eastern redcedar
A	*Lotus corniculatus*	bird's-foot trefoil
A	*Melilotus alba*	white sweet-clover
N	*Penstemon digitalis*	foxglove beardtongue
N	*Phalaris arundinacea*	reed canarygrass
A	*Phleum pratense*	timothy
A	*Phragmites australis*	common reed
A	*Populus alba*	white poplar
N	*Populus deltoides*	eastern cottonwood
N	*Populus tremuloides*	trembling aspen
A	*Rhamnus frangula*	glossy buckthorn
N	*Rhus typhina*	staghorn sumac
A	*Rosa multiflora*	multiflora rose
N	*Rubus occidentalis*	black raspberry
A	*Sonchus sp.*	sowthistle
A	*Verbascum thapsus*	common mullein
N	*Vitis riparia*	riverbank grape
N	*Parthenocissus quinquefolia*	Virginia creeper
A	*Cirsium arvense*	Canada thistle
N	*Toxicodendron radicans*	poison ivy
N	*Acer negundo*	boxelder
N	*Morus rubra*	red mulberry
A	*Festuca rubra*	red fescue
A	*Ulmus pumila*	Siberian elm
N	*Apocynum cannabinum*	Indian hemp
A	*Nepeta cataria*	catnip

South Beds		
Native or Alien	**Scientific Name**	**Common Name**
N	*Rhus glabra*	smooth sumac
N	*Sambucus canadensis*	common elderberry
A	*Xanthium strumarium*	common cocklebur
N	*Rubus occidentalis*	black raspberry
N	*Galium aparine*	cleavers
N	*Fragaria virginiana*	wild strawberry
A	*Plantago lanceolata*	English plantain
A	*Trifolium pratense*	red clover
A	*Hypericum perforatum*	common St. John's wort
A	*Elaegnus umbellata*	autumn olive
A	*Pastinaca sativa*	wild parsnip
A	*Tragopogon pratensis*	yellow goat's beard
A	*Cirsium vulgare*	bull thistle
A	*Rumex crispus*	curly dock
A	*Leonurus cardiaca*	motherwort
N	*Rudbeckia hirta*	black-eyed Susan
A	*Phragmites australis*	common reed
N	*Asclepias syriaca*	common milkweed
N	*Convolvulus sepium*	hedge bindweed
A	*Melilotus alba*	white sweet clover
N	*Vitis riparia*	riverbank grape
N	*Cornus drummondii*	roughleaf dogwood
A	*Daucus carota*	Queen Anne's lace
N	*Achillea millefolium*	yarrow
N	*Rhus typhina*	staghorn sumac

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5.10 Ecological Benefits of Constructing Fish Spawning Habitat in the Detroit River

Introduction

In the 1800s, huge runs of lake whitefish (*Coregonus clupeaformis*) and other native fish spawned in the Detroit River (Goodyear et al. 1982; Roseman et al. 2007). Since then, hundreds of millions of cubic meters of rock and gravel were removed from the Detroit River to construct over 97 km of deep-draft shipping channels in the 51-km river for commercial navigation (Larson 1981; Bennion and Manny 2009). Because many of the 40+ species of fish that spawn in this river (Manny et al. 1988) prefer to broadcast their demersal eggs over rock and gravel on the river bottom to protect their eggs from predation and dislodgement by water currents (Manny et al. 2009), we postulated that lack of suitable spawning habitat was the factor most limiting the reproduction of fish in the Detroit River. In 2001, this hypothesis was supported by the discovery of the first and only known spawning ground of lake sturgeon (*Acipenser fulvescens*) in the Detroit River on a man-made bed of coal cinders (Manny and Kennedy 2002; Caswell et al. 2004) and by further research that revealed the amount of spawning habitat in the Detroit River may be the factor most limiting reproduction by State- and Provincially-threatened lake sturgeon in that river (McClain and Manny 2000). Loss of fish and wildlife habitat was then identified by the International Joint Commission as a Beneficial Use Impairment in the Detroit River (Manny 2003). In 2003, to remediate this water-use impairment and provide suitable spawning habitat for lake sturgeon and other native fish in the river, the Belle Isle/Detroit River Sturgeon Habitat Restoration, Monitoring, and Education Project was developed with support from the NOAA Great Lakes Coastal Restoration Grant Program and the Great Lakes Fishery Trust. This project included limnology and fishery measurements for two years before and after construction of three demonstration fish spawning beds near Belle Isle in June 2004 (Manny et al. 2005).

The goals of the project were to construct fish spawning habitat in the Detroit River using three materials known to be used by lake sturgeon for spawning elsewhere in the Great Lakes basin: broken limestone 41–61 cm in diameter (Bruch and Binkowski 2002); rounded, igneous cobble 15–25 cm in diameter (like that beneath the Blue Water Bridge in the upper St. Clair River (USGS, Great Lakes Science Center, unpublished data); and coal cinders 2–8 cm in diameter (Nichols et al. 2003). The project was constructed in an area where water current velocity fell into the range preferred by spawning lake sturgeon (0.61–0.84 m/s; LeHaye et al. 1992) at a water depth great enough to prevent plant growth on the materials (6.7–7.3 m). We assessed limnological conditions, fish egg deposition per unit area of river bottom, and the presence of adult fish in spawning-ready condition before and after construction of the spawning habitat. Minimum habitat criteria of spawning lake sturgeon were recently defined by Bruch and Binkowski (2002) as: (1) clean, rocky substrates layered to provide interstitial, void space; (2) water current velocity in excess of 0.5 m/s; (3) water temperature of 12–16° C; and (4) accessible to adults. The purpose of our project was to enhance fish productivity in the Detroit River by providing layered spawning habitat with enough interstitial (void) space (operationally defined as > 30 cm; Manny and Kennedy 2002) to protect fish eggs from predation and dislodgement during incubation. Although this project was designed with lake sturgeon in mind, we expected that other native fish would also be attracted to and spawn on the constructed habitat.

Methods

Monitoring efforts included limnological and biological measurements for two years before and after construction of the spawning beds. We postulated that: 1) the study area was devoid of rock-rubble and gravel substrates; 2) water current velocity in the study area was in the optimum range for spawning lake sturgeon (0.1–1.1 m/s; LaHaye et al. 1992); 3) little sediment would accumulate at the site or among the spawning substrates, owing to continuous, high water current velocity; and 4) no sturgeon and few other fish would use the study area before construction. Our null hypothesis was that no fish would spawn in the study area before or after construction of the sturgeon spawning habitat.

In April–May 2003, we fished gill nets, setlines, minnow traps and five egg mats where each of the three spawning beds would be constructed (15 mats total). In April–May 2004, we again fished five egg mats where each of the three spawning beds would be constructed but no gill nets, setlines or minnow traps. In June 2004, three spawning beds were constructed by Faust Corporation at the study site (42° 20' 40" N; 82° 57' 12" W). Our study design consisted of a control area of natural river bottom 200 m upstream of the limestone bed, a cobble bed 121 m downstream of the limestone bed, and a cinder bed 73 m downstream of the cobble bed. Design criteria for each of the three beds of spawning substrate included a size of 15×24 m with the long axis in the direction of the water current, each placed downstream of a leading edge of large (> 1 m in diameter) anchor stone to protect the bed from dislodgement by ice scour or water currents. Accurate placement of bed materials was accomplished by using a GPS-guided dredge aboard a studded barge next to a companion barge containing the spawning bed materials. (See www.miseagrant.umich.edu/sturgeon/background.html)

During April–June 2005 and 2006, we fished twelve egg mats on the upstream control area and on each of the three constructed spawning beds (48 mats total). We also fished a variable-mesh gill net and a setline approximately 100 m upstream of the control area and downstream of the cinder bed. With every set, three minnow traps were attached to each setline except in 2005 when 23 minnow traps were fished alternately on each of the three beds. During the temperature window for spawning by lake sturgeon (9–16° C), we fished 20-cm and 25-cm mesh gill nets and the variable-mesh gill nets upstream, between the spawning beds and Belle Isle, and downstream of the spawning beds. Gill nets were set overnight; setlines and minnow traps, baited with dead round goby (*Neogobius melanostomus*) and chunks of cheddar cheese, respectively, were set for 1–7 days, and egg mats were fished continuously on the river bottom for 2–3 months but inspected weekly. Egg mats were retrieved by boat; fish eggs were removed from the mats by hand with forceps and cultured at the USGS Great Lakes Science Center in Ann Arbor, Michigan. All sac-fry that hatched from these cultured eggs were identified following Auer (1982).

Results and Discussion

Limnological measurements confirmed that: 1) river bottom substrates in the study area were largely hardpan clay or bedrock, overlain by thin patches of sand, silt, or zebra mussels (*Dreissena polymorpha*); 2) water velocity near the bottom of the water column throughout the study area was in the optimum range for spawning lake sturgeon; 3) little sediment accumulated on the river bottom in the study area, prior to bed construction; 4) beds were constructed at the proper water depth to design specifications; 5) cinders used in the project were the same size but more dense than century-old cinders used for spawning by lake sturgeon in the lower St. Clair River; 6) water depth where each bed was constructed exceeded 5 m, the approximate depth of the photic zone (depth of water exposed to sufficient sunlight for photosynthesis to occur) in the Detroit River; 7) all beds were constructed at about the same water depth (6.7–7.3 m); and, 8) all beds were constructed according to design specifications within the allotted time.

Unfortunately, by June 2006, about one third of the upstream end of the limestone bed and the leading edge of the cobble bed filled in with fine sand and silt. Hence, the limestone and cobble beds were not self-cleaning and the long-term usefulness of a leading edge of large, anchor stone upstream of each bed of spawning materials in this part of the Detroit River is questionable.

Biological measurements demonstrated that, prior to construction of the spawning beds in June 2004, the study area was little used by fish and devoid of spawning fish. In April–May 2003, two lake sturgeon were seen in or near the study area but fish sampling with gill nets, minnow traps, and setlines in the study area yielded a total of only 16 small fish (three species), a few crayfish and an aquatic salamander. One fish larvae and one fish egg were collected from the 15 egg mats fished during April–May 2003 where the three spawning beds would be constructed in the study area. During April–May 2004, another adult lake sturgeon was seen near the study area and 136 walleye eggs were collected on 15 egg mats deployed at the same three bed locations.

After bed construction, during April–June 2005, with about the same amount of fishing effort as was used in 2003, we collected 280 adult fish (15 species) in gill nets and minnow traps, and over 4,700 fish eggs on 48 egg mats set in the study area. Seven species of adult fish were in spawning-ready condition, i.e., ripe and running with gametes. Sac-fry of six fish species hatched from the eggs we collected on egg mats.

The next year, during April–June 2006, with about the same amount of effort as in 2003, we collected more than 370 adult fish (15 species) in gill nets and minnow traps, and over 850 fish eggs on 48 egg mats set in the study area. Ten of the adult fish species were in spawning-ready condition. Sac-fry of nine fish species hatched from the eggs we collected on egg mats. Two lake sturgeon were caught on setlines in the study area.

Catches of fish in 2005 and 2006 represent more than a 100-fold increase in fish use of the study area after construction of the spawning beds at Belle Isle, compared to fish use of the study area prior to construction of the spawning beds. Our results clearly demonstrate that construction of the spawning beds enhanced reproduction by twelve species of native fishes and two invasive fishes. Seven additional fish species not in spawning-ready condition were caught in the study area after construction of the spawning beds. Hence, although no lake sturgeon has spawned on the constructed spawning habitat as of yet, the design of these constructed beds was adequate to attract lake sturgeon at spawning time and enhance reproduction by a large number of fish species that are valued by licensed sport and commercial fishers.

Remediation of fish spawning habitat in the Detroit River could increase the species diversity and ecological resiliency of native fish populations in the Detroit River and enhance meta-populations of many native fish in Lake Erie, including migratory lake whitefish and walleye (Roseman et al. 2008; Manny et al. 2009).

Construction of fish spawning habitat is an effective tool for increasing the number of adult spawning fish, number of fish eggs deposited, and sac-fry produced per unit area of river bottom.

Conclusions

- Fishery production in the Detroit River is limited by the lack of layered, rocky, spawning substrates on the river bottom.
- Fish rapidly found and utilized the constructed spawning habitat for reproduction.
- The constructed habitat provided enough interstitial void space for successful incubation of eggs from many native and two exotic fish species.
- Loss of fish spawning habitat can be remediated in the degraded, urban, Detroit River by construction of layered, rocky, fish spawning habitat.
- Lack of fish spawning habitat can be remediated in the Detroit River to enhance populations of valuable, migratory fish, including lake whitefish and walleye.

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5.11 The Southern Flying Squirrel (*Glaucomys volans*) at Point Pelee National Park: Conservation Efforts, Habitat Modifications, and Biological Results

Introduction

Southwestern Ontario is considered one of the most deforested areas in Canada (Kerr and Cihlar 2004). With less than 6% of forest cover, the remaining ecosystems struggle to survive in small, fragmented, isolated and stressful environmental conditions. The once dominant and extensive Carolinian Forest Zone in the southernmost natural region of Canada is now confined to a few protected areas. This region has a high density of endangered species and many have already disappeared (Kerr and Cihlar 2004). The southern flying squirrel (*Glaucomys volans*), a typical animal component of the Carolinian zone, was extirpated from the Essex region by 1940 as a result of the dramatic substitution of mature deciduous forest to extensive agriculture and cottage development.

In this extended abstract, we present a synthesis of the conservation efforts coordinated by the Parks Canada Agency/Point Pelee National Park to protect and recover the flying squirrel from regional extinction by: 1) protecting and restoring Point Pelee's deciduous forest; 2) reintroducing the flying squirrel into the park; and 3) sustaining scientific research and implementing an ecological integrity monitoring program.

Figure 1. Hundreds of cottages were removed from Point Pelee National Park to promote the regeneration of the unique Carolinian forest and associated biodiversity. Photo credit: Parks Canada archives.

Methods

Protecting and restoring Point Pelee's deciduous forest

Point Pelee National Park was established in 1918 to protect significant natural resources and ecological processes. The park consists of 420 hectares (1,039 acres) of Carolinian forest and 1070 hectares (2,644 acres) of freshwater marsh. However, early protection did not insulate Point Pelee from the intensive development pressures of southern Ontario. By the 1950s, hundreds of cottages and extensive farming areas were developed within the park's boundaries. Recreational activities also increased with detrimental consequences for the local flora and fauna. As a response to the accelerated deterioration the park was suffering, by the mid-1960s, a conservation-directed management regime became more prevalent and an active program of cottage and roads removal and the cessation of extractive activities was initiated (SoPR 2006) (Figure 1). By using geographic information systems (ArcInfo, ver. 9), a series of images (aerial photography from 1931, 1977 and Landsat satellite images from 2004) were analyzed to understand the change in mature deciduous forest cover between 1931 and 2004.

Following demolition and removal, diverse sites in the park were left undisturbed and allowed to regenerate in what is called *passive restoration* (McLachlan and Bazely 2003).

Active restoration has been implemented as well since 1988 by the removal of nonnative species, the reconstruction of former topography and hydrology, and the planting of native tree species.

Reintroducing the flying squirrel into the park

Point Pelee National Park decided to assume the responsibility of reintroducing the flying squirrel as part of its mandate to restore the Carolinian forest and biodiversity components. With diverse allies like the Friends of Point Pelee, Pelee Island Winery and the University of Guelph, 99 individuals of the flying squirrel were collected from the Haldimand-Norfolk region (200 km east of Point Pelee) and released in the park between 1993 and 1994. A combination of nest boxes and feeders were used to facilitate the reintroduction of the species to the Pelee park (Figure 2). For technical details on the reintroduction of the flying squirrel, please see Adams and Nudds (1993).

Figure 2. A nest box occupied by a flying squirrel in Point Pelee National Park. Photo credit: Parks Canada archives.

Sustaining scientific research and implementing an ecological integrity monitoring program

Since the reintroduction of the flying squirrel to Point Pelee, diverse research programs and monitoring efforts (mostly biennial) have been implemented in collaboration with the University of Guelph to evaluate the population growth and genetic condition of the introduced squirrels (Adams 1997; Bednarczuk 2000, 2002, 2003; Bednarczuk and Stephens 2004; Parks Canada 2007, 2008). A mark-recapture program was established to monitor the squirrel's population after its reintroduction. By using trapping grids and lines (4–6) with Sherman small-mammal live traps (5–10 traps each) for five nights every two weeks for three months (June–August), an estimate of the flying squirrels' abundance is presented in Figure 3.

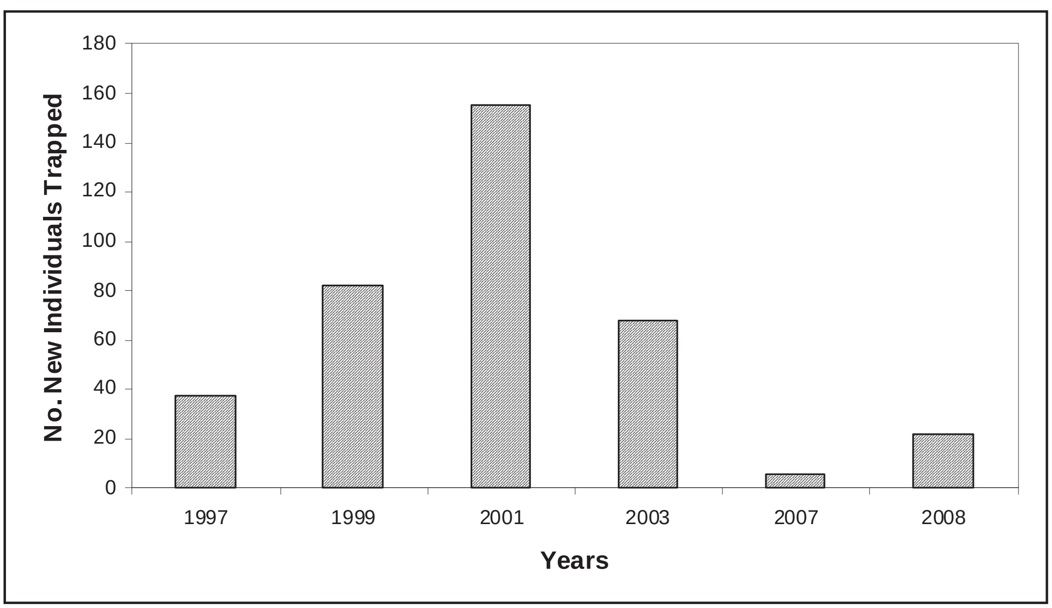

Figure 3. Number of new individuals of flying squirrels trapped in Point Pelee National Park for the last ten years.

Results and Discussion

Protecting and restoring Point Pelee's deciduous forest

Results indicate that the restoration efforts in Point Pelee National Park have allowed the flying squirrel's habitat to increase in area extent and on appropriate vegetation conditions, such as higher densities of mature trees and tree cavities. Point Pelee's deciduous forest increased from 20 hectares (49 acres) in 1931 to 214 hectares (529 acres) in 2004.

Reintroducing the flying squirrel into the park

The squirrel showed positive population growth in the years following the reintroduction. By 2001, the population had increased to 591 individuals or near 70% of the carrying capacity estimated for the population (Bednarczuk 2003). However, a decline in the squirrel population was detected in 2003 and it was most likely due to environmental factors, including the 2002 drought and cold winter in 2003 (Bednarczuk 2004, p. 17). For the surveys of 2007–2008, the detected numbers of new individuals were low again. Further research is being undertaken (e.g., to establish population thresholds) to investigate if the squirrel population may be declining or just fluctuating (very likely due to demographic and environmental factors) and has yet to stabilize (SoPR 2006), or if the reduced sampling effort from the last two years has had an impact on the flying squirrel abundance estimation.

Sustaining scientific research and implementing an ecological integrity monitoring program

In collaborative research with York University, McLachlan and Bazely (2001, 2003) investigated the outcomes of forest restoration at Point Pelee by comparing the understory plant communities in 28 restored sites with controls in less disturbed forests. These authors demonstrated the effectiveness of restoration efforts by finding a significant increase in the similarity of the plant assemblages of the restored sites to the controls.

Conclusions

The protection and restoration of Point Pelee's deciduous forest can be considered successful, as native plant communities have returned to the park and improved forest conditions facilitated the reintroduction and viability of the flying squirrel.

Monitoring of the established flying squirrel population continues and is in the process of being improved and integrated with other measures (for example, tree health) to better understand the species' habitat requirements and future forest management needs, if any; and also to evaluate and learn from this species' reintroduction experience. The flying squirrel is currently considered a monitoring measure for the park's forest indicator.

The flying squirrel represents an opportunity to communicate relevant ecological information to the public, but also an opportunity to engage people in community-based monitoring activities and in the end, reintroduce *people* into Nature.

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5.12 Restoration and Management of an Urban Common Tern (*Sterna hirundo*) Colony

Introduction

Common terns (*Sterna hirundo*) in the lower Great Lakes have declined in the last fifty years (Cuthbert et al. 2003) and have transitioned to artificial nesting sites that are isolated from the mainland (Shugart and Sharf 1983; Courtney and Blokpoel 1983; Karwowski et al. 1995). Isolated piers, jetties, breakwalls, and platforms offer the only nesting opportunities where developed shorelines exist. However, recent evidence from Michigan indicates that terns have better success in natural sites than artificial ones, even though the risk of flooding is reduced (Lamp et al. 2003). The particular stressors in colonies of the Detroit River, Michigan, are unknown and could include elevated populations of raccoons, gulls, and rodents, excessive boat, vehicle, and pedestrian traffic, and contaminants. Despite many species of colonial waterbirds adapting to highly disturbed sites (Nisbet 2000), predation, productivity and management efforts have not been studied and evaluated in the Detroit River.

Common terns began nesting on urban, artificial islands at two sites in the Trenton Channel of the Detroit River sometime during the late 1990s and early 2000s (D. Best, pers. comm.). The total number of breeding pairs at these sites has fluctuated from a high of 316 in 2003 (Szczechowski and Bull 2007) to 135 in 2008 (Cuthbert and Wires 2008). One of the two colonies, located below the Wayne County Free Bridge (free bridge), was known to have had 20 to 30 pairs in an area of large cobble (Szczechowski 2007) prior to the beginning of this study.

We sought to measure the effectiveness of substrate improvement that occurred in 2003 by measuring the number of common terns nesting at the free bridge. Nest success was determined (except 2006) and the type of predation was documented by observations at the colony and communications with Wayne County bridge-workers. Upon identifying black-crowned night herons (*Nycticorax nycticorax*) as a key predator, a nonlethal structure was devised to deter them in 2008. We report the results of these efforts and recommendations for management of common terns in the Detroit River.

Methods

Study Site

The study colony is located in the Trenton Channel of the Detroit River, where terns nest on two cribs beneath Wayne County's Grosse Ile swing bridge (free bridge) that connects the cities of Trenton and Grosse Ile (42.127° N, -83.174° W).

The cribs on the free bridge are positioned parallel to the river's flow and serve to protect the bridge's central support whenever the bridge is opened for boat passage. The south crib is approximately 40 m long by 17 m wide and the north crib is 40 m long by 12 m wide. In 2003, an area 12 m by 11 m on the south crib was covered with crushed limestone chips in an attempt to diversify and improve the substrate for nesting terns.

Breeding Population, Nest Surveys, Productivity

The number of breeding pairs was determined by weekly to biweekly counts of adults between 2003 and 2007. In 2008, breeding pairs were determined by subtracting the number of initiated nests by the number of failed nests, which assumes each failed pair renested and indicates the most conservative estimate of the number of breeding pairs.

Nests were located on the cribs through observation of adults and during weekly to biweekly nest visits between 2003 and 2007 (with the exception of 2006, in which productivity was not determined). Productivity was assessed only to the midpoint of the season (18 June), as there is typically much lower productivity for terns nesting later in the season (Szczechowski and Bull 2007). In 2008, the status of every nest throughout the season (6 August in 2008) on both cribs was also documented with periodic viewing from the bridge-keeper's office to minimize disturbance while tracking hatching and nesting success. Each nest received a number and was followed through the entire nesting cycle. Hatching success was determined by the total number of hatched eggs divided by the number of total eggs laid. A chick was determined fledged upon seeing the bird fly or knowing it to survive 21 days of age. Fledglings were followed with relative confidence from known hatching dates as well as the spacing of nests on the cribs, natural territory barriers, and favorite chick feeding sites. Fledging success was determined by dividing the total number of fledged young by the total number of chicks. Lastly, reproductive success calculated the percent of eggs that made it to fledging status. Due to uncertainty of the fate of particular nests and chicks, the results of hatching and fledging success are reported in a range.

Figure 1. The rope-lattice structure of one side of the swing bridge used to deter black-crowned night heron predation.

Lattice Structure

In 2008, a 23 m by 11 m limestone and cobble-covered area of the south crib was overlaid with yellow braided nylon rope in a crisscross (lattice) design having 81 cm^2 openings to prevent black-crowned night heron predation. The rope grid was suspended approximately 1.5 meters above the crib's surface, which exhibited extensive vegetative growth as the season progressed (Figure 1).

Results and Discussion

Between 2003 and 2007, total breeding pairs were 25, 65, 165, 165, and 35 (Figure 2). Utilizing a more rigorous and conservative estimate of the number of breeding pairs in 2008, 37 pairs were documented, although counts of adults also indicated approximately 35 to 40 established pairs. Construction occurred on the bridge in 2007 and terns had

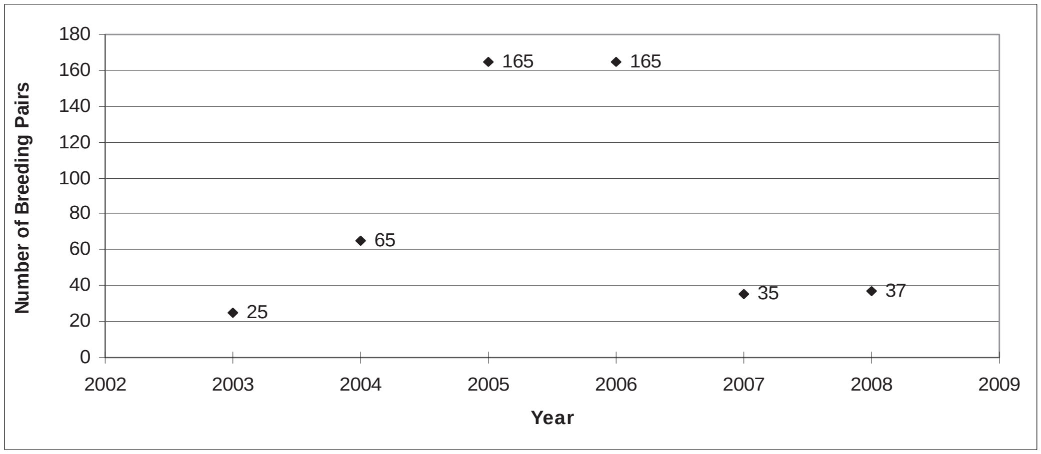

Figure 2. Number of common tern pairs from 2003 to 2008 at Grosse Ile Free Bridge. Data from 2003 to 2005 from Szczechowski and Bull 2007.

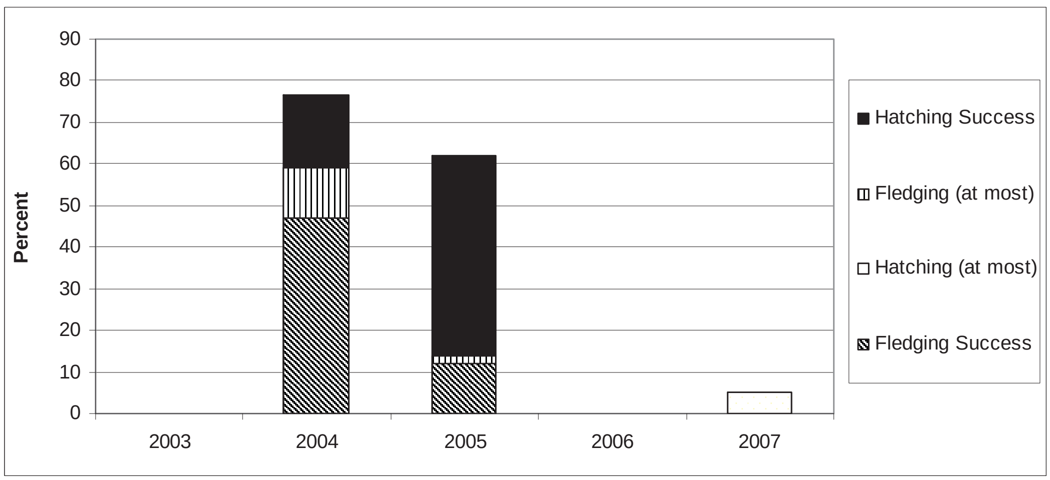

Figure 3. Hatching and fledging success from 2003 to 2007 showing the most and least conservative estimates. Productivity was not assessed in 2006, and 2008 is not included because there was significantly more effort in monitoring that year.

to be discouraged from nesting, resulting in only twelve nests found, but 35 pairs were present in mid-May. Subsequent trips revealed that most terns abandoned the colony due to bridge construction. At least four black-crowned night herons were documented eating eggs or chicks in 2004 and 2005. Productivity during 2003–2007 was only assessed until the midpoint of the season, but data showed that it was repeatedly low (Figure 3).

The rope lattice initially deterred establishment by common terns for the 37-pair minimum in 2008. There were no established territories or tern activity under or surrounding the lattice by 29 April, despite the north crib containing ten established pairs by that date. The first wave of nests with eggs on 4 and 5 May confirmed that the terns preferred the opposite crib, with nine nests on the north crib, but none under the lattice. Despite deterring the first pairs, new arrivals on 2 May immediately established territories under the lattice with ten nests by 14 May. By this time, birds appeared evenly spaced on both cribs, with eleven pairs nesting under the lattice, five adjacent to it, and thirteen on the north crib, accounting for 55% of the total nests laid over the entire breeding season. However, there was preference for renesting/late nesting outside of the crib and included only an additional three under the lattice, seven adjacent, and fourteen on the north crib with 68% of those laid between 16 and 29 May. The last nest was initiated on 9 July on the south crib adjacent to the lattice.

Six of the eleven active nests under the lattice were predated on 15 May when 50% of the lattice had only parallel ropes. Chick/egg loss was attributed to mink after the initial predation event of 15 May, after four more nests were subsequently found to contain missing eggs. Thirteen nests with eggs were abandoned sometime during the incubation period. It is unknown if nocturnal desertion occurred in 2008, although it had been well documented in 2004 and 2005, which coincided with black-crowned night heron predation during those two years. However, we were able to determine approximate incubation periods of fifteen of the twenty-two hatched nests. Nine of the fifteen were over thirty days in length. Mean completed clutch size was 2.54 eggs. The first wave of nests (n=29) had a mean clutch size of 2.75, while the second (n=24) had a mean clutch size of 2.37.

There were 53 initiated nests for both cribs with a 35.0–37.6% hatching success, 29.5–41.5% fledging success, and 11.1–14.5% reproductive success. Figure 4 displays the fate of the 53 nests.

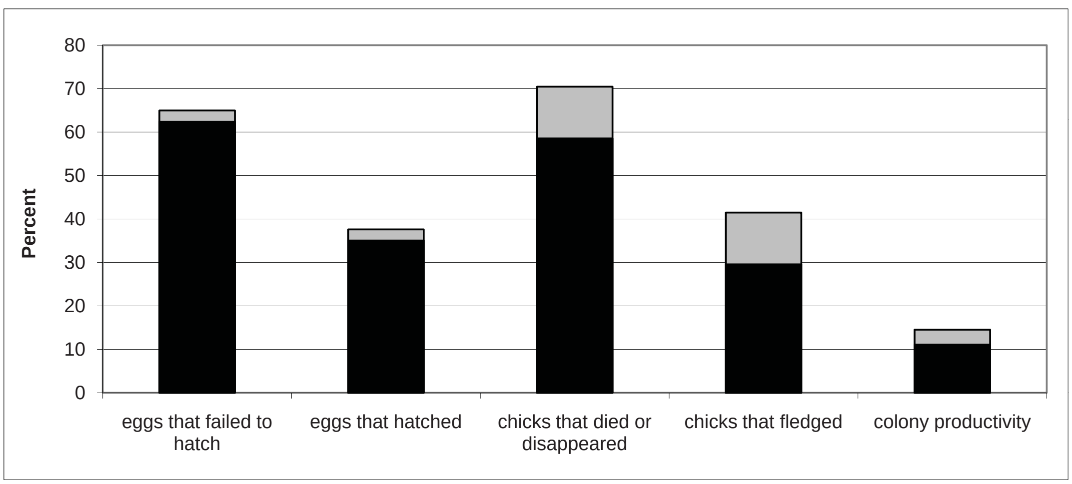

Figure 4. Common tern productivity in 2008. Gray areas show least and most conservative estimates.

The breeding population in the Detroit River rose to a peak at the third and fourth year after crushed limestone was provided. The population declined by approximately 80% between 2006 and 2007. This was due to bridge construction during the summer of 2007. Although bridge construction did not occur in 2008, only 37 pairs attempted to nest. It is possible that the inability of most birds to nest at the site in 2007 led to the similarly low number of pairs in 2008.

From 2003 to 2007, productivity fluctuated and varied from zero to approximately 50% of chicks fledging. No year showed the absence of egg loss and chick mortality from predators. Predation from more than one black-crowned night heron caused the majority of the chick mortality in 2004 and 2005. At least four herons have been seen at one time at the colony in 2005 and a significant breeding colony of between 250 and 400 pairs exists just over 13 km away at Pointe Mouillee State Game Area (Cuthbert and Wires 2008) and a smaller colony of approximately 60 nests 8 km away on Turkey Island (C. Weseloh, pers. comm.).

In 2008, the mink is presumed to have caused all chick mortality and was likely the cause of the 13 abandoned nests which has been found in other studies (Hunter and Morris 1976; Shealer and Kress 1991). This colony demonstrates that monitoring is required to identify the specific predator.

Although one season is not enough time to determine the efficacy of our rope-lattice structure, we did not see its failure. However, it deterred initial establishment of terns in an area previously holding the highest nest density. Birds showed preference to renest outside of the rope lattice. More seasons are needed to assess the long-term response of these birds to the structure and if black-crowned night herons are deterred from entering it.

Other disturbance was noted at the site and will be the basis of more detailed studies of this urban colony. Although we did not document whether nocturnal desertion was occurring in 2008, it did occur in 2004 and 2005. Nocturnal desertion has been well described when predators of adult terns are active in the colony at night (Marshall 1942; Nisbet and Welton 1984; Southern and Southern 1979; Holt 1994). This may indirectly cause poor productivity because it prolongs incubation periods, exposes eggs to weather, and has been linked to less nest attentiveness during the day (Morris and Wiggins 1986). Of the 15 hatched nests in which we were able to record the start and hatching with confidence, 60% were over 30 days in length. In the absence of disturbing factors, mean incubation periods should be approximately 22–23 days (Nisbet and Cohen 1975; Courtney 1979), indicating poor nest attentiveness in our sample of our hatched nests.

Contaminants have been studied at these colonies and it is unclear if they diminish fitness of common terns in the Detroit River, although PCBs and pp'-DDE are elevated at these colonies versus those in northern Lake Michigan (Szczechowski 2007). We are currently studying how substrate, vegetation characteristics, and nest initiation dates also relate to nest attentiveness and productivity.

Conclusions

To encourage source populations of this species in the lower Great Lakes, predation clearly is the most urgent problem for this urban colony. The following is necessary for productive common terns in the Detroit River:

- Yearly monitoring to identify specific predators in a given year;
- Trapping of mammalian predators is required to increase productivity of the colony and should occur before arrival of common terns;
- Vegetation should be controlled to create suitable conditions through the nesting cycle each year with further studies on substrate and vegetation preference and how it relates to productivity; and
- There must be investment in understanding all of the factors that are contributing to lower productivity beyond simply identifying the specific predators. This includes

behavioral adaptations to the more urban environment that may be limiting success. Nest attentiveness, feeding frequency, vegetation and substrate suitability, colony size, proximity to quality feeding areas, and contaminants must be addressed and could be responsible for more cryptically limiting productivity.

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5.13 State of Detroit River Bald Eagles (*Haliaeetus leucocephalus*) with Canadian Birth Certificates

Introduction

The Essex County Field Naturalists' Club and Bird Studies Canada undertook a project in partnership with the Detroit River Canadian Cleanup Public Outreach Committee and the City of Windsor in creating a unique opportunity to monitor bald eagles (*Haliaeetus leucocephalus*), a provincially-endangered species that nests on the Detroit River.

The project was designed to improve the capabilities of local and regional monitors and biologists to better understand and assess the health of nesting bald eagles on the Detroit River using satellite telemetry, banding and blood analysis. Even though the relative productivity of eagles on the Detroit River (and Essex County) had significantly increased, there were no known local birds returning to established or newly occupied territories. The satellite tracking program would assess survivorship after fledging and post-season dispersal. The project also was designed to provide the residents of the region an opportunity to "log into" the lives of specific eagles as a medium for greater public understanding of the Detroit River as an Area of Concern; as well as increasing awareness of ongoing environmental issues.

To accomplish this for specified nest sites along the Detroit River and at Point Pelee National Park, habitat improvement measures were undertaken to secure bald eagles in preferred nest sites and provide safer access for the monitoring team to assess active nests.[1] This was intended to be accomplished by constructing artificial platforms in currently occupied nest territories. Monitors realized that bald eagles occupying breeding territories had built nests in trees compromised by age and weather damage, as these typically were the biggest trees available to them. Almost all were eastern cottonwoods (*Populus deltoides*) and several nest failures in three separate locations resulted from the failure of the tree.

Bald eagles had returned to the Detroit River and all the major wetlands of Essex County with the exception of Point Pelee National Park. When nest sites were plotted using aerial geomatic images, it was discovered that there was some commonality to nest location and a preference had been identified. Of nine nesting territories in Essex County, seven were in close proximity to a very large water body (Lake Erie, Lake St. Clair or the Detroit River) and positioned on the barrier beach of an associated wetland complex or within the wetland itself. The other observed preference was that nests occurred at elevations of 22 m or greater aboveground. Of the five nest sites on the Detroit River, two had tree failures causing the loss of eggs or chicks for that breeding season.

[1] This extended abstract only discusses the habitat enhancement portion of the associated Destination Eagle Project in keeping with the theme of the 2009 State of the Strait Conference.

Methods

Sites for the prospective artificial nests were assessed on available quality trees with the opportunity to install a platform at least 21.3 m aboveground, close to open water and wetland habitat, and where bald eagles were currently occupying territory. Sites for artificial platforms were developed for Peche Island (City of Windsor) and Point Pelee National Park. Boblo Island (Town of Amherstburg) was also considered but difficulties in finding a suitable nest location and tree ultimately resulted in structurally reinforcing the existing nest tree, particularly the major limb supporting the nest itself. The National Park site was an exception to the site selection criteria in that bald eagles had not nested in the park for over 60 years and it was determined that recruitment to an artificial platform was not going to have the same degree of success as having established birds use a platform erected in their current breeding territory.

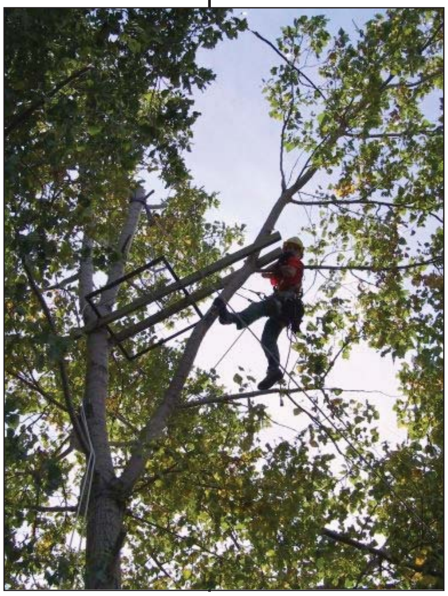

Figure 1. Suitable leaf arrangement was necessary to allow the constructed nest to be placed close to the tree's trunk.

Trees were selected based on their location, general health and structure. Structurally, the tree needed to have a limb arrangement to allow the nest platform to be placed close to the main trunk (Figure 1) and provide (or have limbs removed) a suitable open canopy which allowed an approach in and out of the nest for adults. The intersection of the main trunk and scaffold limbs also needed to be greater than 21.3 m. The platform itself is a 0.91 m × 0.91 m square, constructed of 6.35 cm angle iron welded at the corners with a 15.24×15.24 cm welded wire mesh (concrete mesh) welded into the bottom. The metal framework and mesh were painted flat black to make it less conspicuous and protect it from rusting. The platform is loosely U-bolted to two 5.1×15.24 cm pressure-treated wood "rails" which are bolted through the tree trunk and scaffold limb with threaded rod. The tree climber(s), once the platforms were installed, then had nest material hoisted to them. Two large (1.5 m or greater) limbs are attached to the frame of the platform (with plastic tie wraps) at diagonal corners overhanging the frame. This and the open mesh of the bottom of the frame were then filled with course sticks and increasingly less course material up to the final "nesting layer," which was mainly composed of leaf litter and soft twigs (Figure 2). A light line was placed in the tree to allow a climbing rope to be attached from the ground and pulled up for later access by the monitoring team.

Figure 2. Leaf litter was placed in the constructed nest.

Results and Discussion

It has generally been recognized that the local (Essex County) bald eagle population has been expanding, with relatively high productivity. It has also been observed that breeding territory abandonment, specifically on Peche Island, has been observed after four consecutive years of nest failure, due to loss of the nest tree. The construction of artificial nests from a habitat enhancement perspective has helped to secure breeding birds in habitats with compromised conditions and in one case, Point Pelee National Park, recruited a breeding pair of birds to an otherwise unoccupied territory.

Peche Island did not have adults occupy the artificial nest structure because they had relocated elsewhere in the territory, but the platform is serving as a foraging perch. Fish and bird remains are routinely found in and under the platform. The location of the active nest in this territory is known. It is the intention of the monitoring team to reposition this nest to make it higher and hopefully attract the adults back to the island from the current mainland site, which is increasingly more disturbed.

Point Pelee National Park recruited a new breeding pair of adults to the artificial nest in the first season it was erected. Bald eagles occupying nest sites in that region were known to have nested, thus proving the recruitment of a new pair. The platform was unoccupied during the second season, but a pair of eagles was regularly observed.

Boblo Island had two naturally occurring nest locations. One tree failed and the other has remained the active nest site in 2007 and 2008. It has not been possible to place a platform at Boblo because there are no trees of suitable height. However, the current nest tree has been assessed and some structural reinforcement (limb removal/cabling) added to help prevent the nest from failing.

Despite the success of recruiting a pair of bald eagles to Point Pelee National Park, it is unlikely that habitat enhancement, specifically the construction of artificial nesting platforms, will attract bald eagles to breed. The habitat features surrounding the site may prove not to be suitable for bald eagle nesting. However, habitats that have eagles foraging or loafing may have a much better chance of recruitment. Habitat enhancement has proven to be a good tool to retain nesting pairs in marginal habitats and increases productivity by creating a secure nest or improving the structure of the nest tree.

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6.0 State of the Strait Conference Program

State of the Strait Conference
April 28, 2009
University of Windsor, Windsor, Ontario

8:00-9:00	**Registration and Refreshments**
9:00-9:05	**Introductory Remarks** Lynda D. Corkum, University of Windsor
9:05-9:20	**Opening and Welcome** Marlys Koschinsky, Dean of Science, University of Windsor
9:20-9:50	**Keynote Address** Karen Rodriguez, U.S. Environmental Protection Agency
Session #1:	**Session Chair- Rose Ellison, U.S. Environmental Protection Agency**
9:50-10:15	**Shoreline engineering: We built it, have they come?** Michael A.Zarull, Environment Canada *John H. Hartig, U.S. Fish and Wildlife Service Anna Cook, U.S. Fish and Wildlife Service Mary Bohling, Michigan Sea Grant
10:15-10:40	**Re-creating coastal processes to restore degraded coastal wetland habitat: a case study at Metzger Marsh** *Kurt P. Kowalski, USGS Doug Wilcox, SUNY- Brockport
10:40-11:10	**BREAK**
Session #2:	**Session Chair- Michael A. Zarull, Environment Canada**
11:10-11:35	**Wetland restoration in the oak openings region; a case study in making a silk purse out of a sow's ear** Marleen Kromer, The Nature Conservancy *Gary Hasse, The Nature Conservancy Richard Gardner, Ohio Department of Natural Rescources

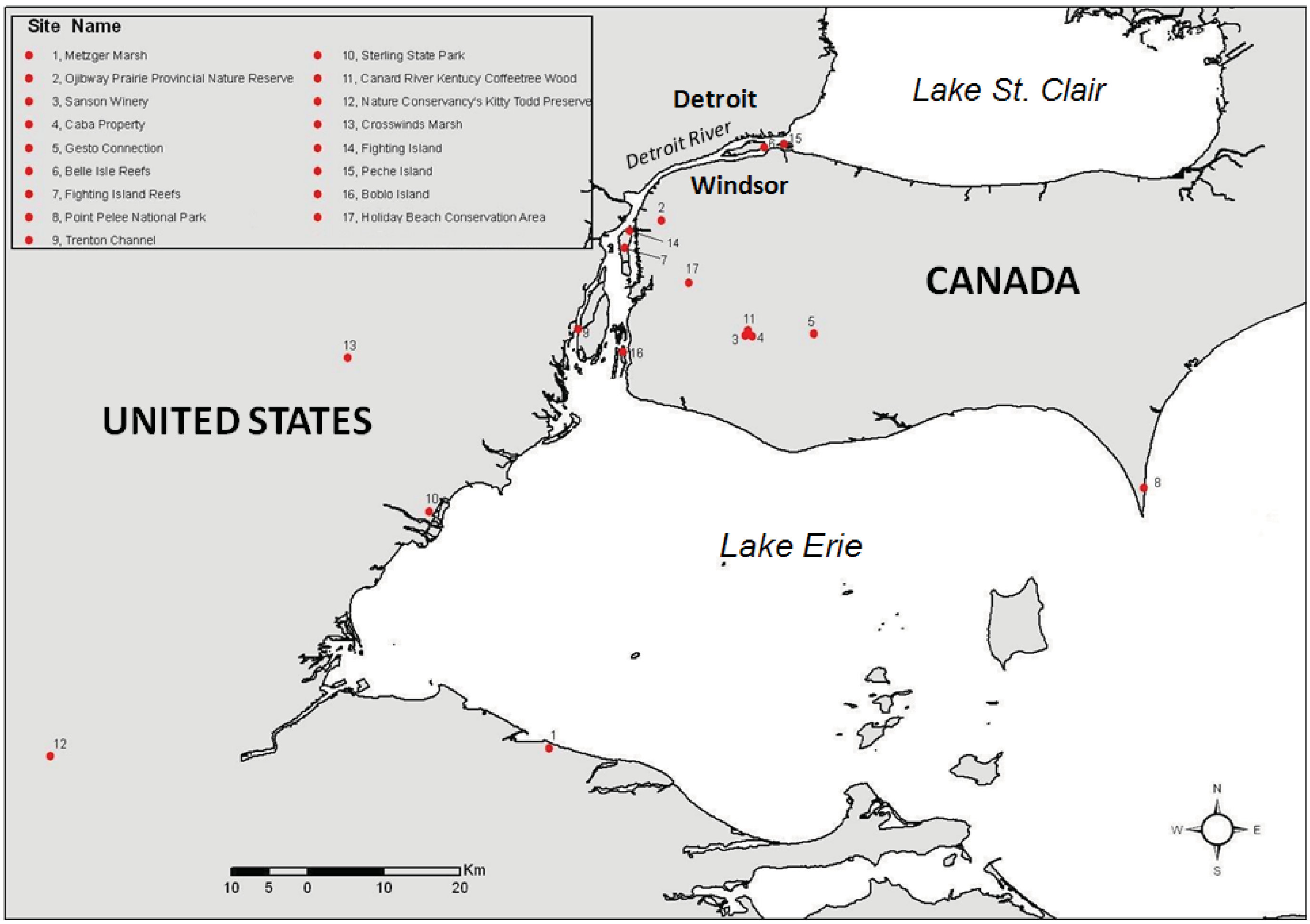
11:35-12:00	**Monitoring and development of wetlands and wildlife; Crosswinds Marsh Wetland Mitigation Project** Bryan Wagoner, Wayne County Airport Authority Don Tilton, Environmental Consulting and Technology Inc. Darrin Bauer, Wayne County Parks, Crosswinds Marsh
12:00-13:00	**LUNCH**
Session #3:	**Session Chair- Mary Bohling, Michigan Sea Grant**
13:00-13:25	**Tallgrass prairie restoration in the Ojibway Prairie Provincial Nature Reserve, Windsor, Ontario** *Paul Pratt, Ojibway Nature Centre Karen Cedar, Ojibway Nature Centre
13:25-13:50	**Strategies to improve wetland habitats by managing invasive** *Phragmities austrailis* **(common reed)** *Ray Fahlsing, Michigan Department of Natural Resources Kurt Kowalski, USGS
13:50-14:15	**Small scale habitat enhancements within the Candaidan Detroit River Area of Concern** Dan Lebedyk, Essex Region Conservation of Authority Brett Groves, Ontario Ministry of Natural Resources
14:15-14:40	**Ecological results of restoring Fighting Island** Frederick C. DeLisle, BASF Corporation
14:40-15:05	**Restoration of fish spawning habitat in the Detroit River** Bruce Manny USGS Greg Kennedy, USGS Sandra Morrison, USGS
15:05-15:35	**BREAK**
Session #4:	**Session Chair- Natalie Green, Detroit River Canadian Cleanup**
15:35-16:00	**The southern flying squirrel (***Glaucomys volans***) at Point Pelee National Park: conservation efforts, habitat modifications, and biological results** *Leonardo Cabera Garcia, Point Pelee National Park Dan Reive, Point Pelee National Park
16:00-16:25	**Restoration and management of an urban common tern (***Sterna hirundo***) colony; disturbance, predation, and productivity** *Greg Norwood, U.S. Fish and Wildlife Service Bruce Szcezechowski, Downriver Stream Team
16:25-16:50	**State of Detroit River Bald Eagle with Canadian Birth Certificates** *Phil Roberts, Essex County Field Naturalists' Club Jody Allair, Bird Studies Canada

16:50-17:00	**CLOSING REMARKS** John H. Hartig, U.S. Fish and Wildlife Service
17:00-18:00	**RECEPTION**

*** Presenter**

7.0 Case Study Locations

The figure below depicts the locations of case studies highlighted in Section 5.



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