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Review

Habitat management lessons from the environs of the Detroit River International Wildlife Refuge

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ABSTRACT

The Detroit River and western Lake Erie, located in the heart of the Great Lakes basin, support a great diversity of fish and wildlife, and their habitats, despite the enormity of habitat losses due to urban development and industrialization. This ecosystem also links Canada and the U.S. who share a long history of cooperative conservation. The river and lake are: at the intersection of two major North American bird migration flyways (i.e., the Atlantic and Mississippi); a significant fish migration corridor; and well recognized for their unique biodiversity. Over the past three decades much has been done to improve environmental conditions and to restore and conserve habitats. This paper reviews habitat management efforts within the environs of the Detroit River International Wildlife Refuge and provides advice to improve such efforts in the future. Ecological improvements resulting from these habitat projects, as well as the cumulative effects of these changes, have yet to be quantified or evaluated against existing program goals or targets. Habitat management remains a fragmented responsibility among many agencies and interests, which is often an obstacle to realizing ecological improvements, recovery, and sustainability. Moreover, cumulative habitat modifications are not reviewed often enough with respect to their impacts on the goals and targets established in existing programs, as well as their impacts on ecosystem results (e.g., fish or wildlife productivity). Clearly, there is a need to share experiences, synthesize science, learn from mistakes and successes, coordinate activities, and transfer knowledge on best practices and ecological effectiveness of habitat management.

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Introduction

Historic patterns of human use and development along the Great Lakes resulted in considerable loss and degradation of fish and wildlife habitat (Hartig et al., 1996). More recently, there has been a concerted effort to restore, enhance, rehabilitate, and conserve these areas (Kelso and Wooley, 1996). 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 management efforts can result in concomitant economic (e.g., improving sport fishing, birding, and hunting opportunities, and enhancing ecotourism) and social benefits (e.g., creating "green" urban waterfront vistas founded on a sense of place, developing unique gathering places for wildlife and people that enhance community pride and contribute to livable communities, and creating unique destinations with learning stations that teach conservation and biological 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. As well, there are significant resident populations of both fish and wildlife, which have responded favorably to environmental improvements (DeLisle, 2010; Hartig et al., 2009; Manny, 2010). The river and lake are at the intersection of two major North American bird migration flyways — the Atlantic and Mississippi. Over 300,000 diving ducks, 75,000 shorebirds, and hundreds of thousands of land birds and fall raptors frequent the area to rest, nest, and feed along the unique shoreline habitats, including many islands and marshes (Hartig et al., 2010a). Further, 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. In addition, 117 species of fish are found in or migrate through the Detroit River (Hartig et al., 2010a). This biodiversity and the diversity of habitats to support these biota have given the region international acclaim in the North American Waterfowl Management Plan, the United Nations Convention on Biological Diversity, the Western Hemispheric Shorebird Reserve Network, the Biodiversity Investment Area Program of Environment Canada and U.S. Environmental Protection Agency, and, most recently, with the designation as North America's only International Wildlife Refuge — the Detroit River International Wildlife Refuge.

Canadian and U.S. scientists and managers have partnered on a number of binational projects in the corridor to both improve and restore essential fish and wildlife habitat, and focus attention on ecological improvements and remaining challenges. A keystone of this binational collaboration on the corridor 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 purpose of the most recent Conference (2009) was to address ecological benefits of habitat modification by highlighting numerous efforts underway to rehabilitate and restore habitat in the Detroit River and western Lake Erie, and by providing lessons learned and rationale for future habitat rehabilitation, restoration, and enhancement projects throughout the region. Presented here are the key issues and recommendations from the conference, as well as other relevant regional conferences addressing issues affecting habitat management.

Approach

To address the ecological benefits achieved through habitat modification in the Detroit River and western basin of Lake Erie, 12 case studies were examined (Table 1). For the purposes of this manuscript, habitat modification means any efforts to conserve, restore, enhance, mitigate, or rehabilitate habitats. Some of the case studies, like soft shoreline engineering or small-scale habitat enhancements, were a collection of similar size projects. Others were single, much larger scale projects. The case studies were also chosen for their geographic coverage of the

Table 1
A summary of habitat modification case studies presented at the 2009 State of the Strait Conference.

Site(s)	Location	Habitat type	Scope/size	Reference
Soft shoreline engineering projects	35 locations in the Detroit River watershed and one location in the River Raisin (tributary to western Lake Erie)	River and stream shoreline habitat	30–1150 m of shoreline habitat enhanced for habitat	Zarull et al. (2010)
Metzger Marsh	Western basin of Lake Erie, Lucas County, Ohio	Coastal wetlands	300 ha coastal marsh restoration	Kowalski and Wilcox (2010)
Kitty Todd Preserve	Lucas County, Ohio	Oak openings' wetlands	0.8 ha wetland restoration in a 324 ha nature preserve	Kromer et al. (2010)
Crosswinds Marsh	Adjacent to Detroit Metropolitan Airport, Wayne County, Michigan	Wetlands	189 ha wetland mitigation to compensate for airport expansion	Bauer et al. (2010)
Ojibway Prairie Provincial Nature Preserve	Windsor, Ontario	Tallgrass prairie	105 ha tallgrass prairie restoration	Pratt and Cedar (2010)
Sterling State Park	Monroe County, Michigan	Coastal wetlands	53 ha herbicide treatment of *Phragmites australis*	Fahlsing and Kowalski (2010)
Canadian portion of Detroit River area of concern	Essex County, Ontario	Wetlands, forests, meadows and prairies, and riparian habitats	23 projects ranging from 0.2 to 40 ha	Lebedyk and Groves (2010)
Fighting Island	LaSalle, Ontario	Uplands and wetlands	486 ha island restoration	DeLisle (2010)
Belle Isle waters of Detroit River	Detroit, Michigan	Lake sturgeon spawning habitat	Three spawning reefs each 15 × 25 m in size	Manny (2010)
Point Pelee National Park	Leamington, Ontario	Flying squirrel habitat	214 ha of deciduous forest habitat enhanced for southern flying squirrel	Carbrera and Reive (2010)
Wayne County Bridge in Trenton Channel of Detroit River	Grosse Ile, Michigan	Common tern nesting habitat	Two nesting sites were constructed on two cribs beneath a swing bridge: one 12 × 11 m in size and one 23 × 11 m in size	Norwood and Szczechowski (2010)
Peche Island, Boblo Island, and Point Peele National Park	Windsor, Amherstburg, and Leamington, Ontario, respectively	Artificial nesting habitat for bald eagles	Constructed artificial nests at three locations within known nesting territories in Essex County	Roberts (2010)

Note: More detailed information on the case study descriptions can be obtained from Hartig et al. (2010b), which can be downloaded from the State of the Strait web site at www.stateofthestrait.org.

area of interest; habitat type (e.g., terrestrial upland, wetland, shoreline, river bottom, etc.), improvement goal (e.g., general physical, plant communities, fish, waterfowl, etc.), and quantitative project objectives and monitoring. The following discussion results from an analysis of their common issues and challenges.

Issues and challenges

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, stream bank, 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).

In 1987, Canada and the United States listed 43 Great Lakes Areas of Concern (AOC) as being environmentally degraded when measured against one or more of 14 beneficial uses, including fish and wildlife habitat. Under the Great Lakes Water Quality Agreement (United States and Canada, 2012), both countries are committed to restoring and protecting these AOCs specifically, as well as the waters of the Great Lakes in general. Thirty-four of the AOCs have documented loss of fish and wildlife habitat (Hartig et al., 1996). Of these, 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 U.S. Environmental Protection Agency to have a fish and wildlife habitat plan, and some quantitative targets, by the end of 2008.

Ideally, quantitative goals and objectives direct the selection and implementation of habitat restoration and enhancement techniques, and provide 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 restoration 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 measurable goals and objectives for habitat restoration and management. For example, in the oak openings restoration project organized by The Nature Conservancy of Ohio (Kromer et al., 2010), quantitative targets were established *a priori* and used to assess success in wetland restoration. Project success was gauged by achieving a species richness greater than 90 native and hydrophytic species representing 50% or greater of the wetland's species richness. 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 (Andreas et al., 2004). Site monitoring was planned and executed at one, three, and five year intervals following restoration. Such quantitative restoration and enhancement targets provide clear direction for habitat restoration activities and the requisite rigor for the project. Experience with such case studies has shown that a clear and measurable definition of project success must be established early on in the habitat modification project and agreed to by all project partners.

Assessment, monitoring and adaptive management

The theme of the 2004 SOS Conference was *monitoring for sound management* (Hartig et al., 2010a,b). 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 ecological condition. This is especially important in considering both habitat status and actions to modify the amount and kinds of desired habitat (Eedy et al., 2005).

A critical requirement for assessing the ecological effectiveness of habitat modification is to do a detailed assessment of initial existing conditions. This assessment 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 a detailed documentation of existing conditions, it is also important to understand the historical state and significance of the area to be modified/restored, as well as its current state relative to nearby reference ecosystems, which will also likely reveal what restoration goals are achievable. Knowledge of economic development plans, as well as existing habitat protection and restoration policies and plans, should be seen as a critical part of a detailed initial assessment. For example, in the small-scale habitat enhancements' case study, Lebedyk et al. (2010) 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. After the preferred option has been implemented resulting in modification of the physical, biological, and/or chemical components of habitat, changes that follow can be monitored and evaluated against previously established measurable objectives and targets. The monitoring program will need to remain in place for some time as recovery may be slow and adjustments to management actions may be necessary. A post implementation monitoring program is therefore 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, 2010), 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 (2010) showed how long-term monitoring was needed to document the island's recovery over a 20-year timeframe.

The soft shoreline engineering case study (Zarull et al., 2010), documented that only a limited number of soft shoreline engineering projects in the watershed had any quantitative assessment of post-project ecological effectiveness. Recent data show that only six of 51 soft shoreline engineering projects (12%) undertaken since 2000 had quantitative assessment of post-project ecological effectiveness (University of Windsor, 2013). The remaining 45 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 (12%) of post-project assessment is inconsistent with the scientific method and adaptive management (i.e., a management process where conditions and status are assessed, priorities are set, and actions are taken in an iterative fashion for continuous improvement). Clearly, more emphasis should be placed on measuring ecological effectiveness of habitat modification projects (Hartig et al., 2011; Kerr et al., 1997).

All case studies and speakers highlighted the need to practice adaptive management. Speakers noted that if one does not continue to monitor, it is impossible to make mid-course corrections and ensure continuous improvement. For example, in the *Phragmites* control case study, Fahlsing and Kowalski (2010) learned that achieving desired restoration goals frequently requires follow-up treatments coupled

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with sufficient monitoring, as part of an adaptive management strategy. In the common tern case study (Norwood and Szczechowski, 2010), long-term monitoring was essential to understand all the factors limiting tern productivity, including predation. Therefore, it is recommended that organizations and agencies explicitly commit to long-term monitoring to be able to practice adaptive management.

The Crosswind Marsh case study (Bauer et al., 2010) 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 mid-course corrections. Similarly, the Metzger Marsh case study (Kowalski and Wilcox, 2010) involved constructing a barrier dike to re-establish the protective function of an eroded barrier beach. Pre-construction monitoring and five years of post-construction monitoring was a requirement of the U.S. Army Corps of Engineers' permit for that project. Great Lakes Science Center researchers then continued monitoring after the permit requirements expired, as a professional research interest.

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 could be to bring all the key partners and stakeholders together at the outset of a project to agree on the monitoring aspects of the project (e.g., purpose, goals/objectives, assessment, etc.). If there are many partners, a formal partnership agreement could lay 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 small, perhaps the group can just agree to a concept plan that lays out the minimum project goals, objectives, and monitoring required. This technique has been successfully used in several of the soft shoreline engineering projects (Zarull et al., 2010). An explicit commitment to perform pre- and post-project monitoring must be made or, as experience has shown, it will not be performed.

In the Ojibway Prairie case study (Pratt and Cedar, 2010), it was learned that Windsor's Department of Parks and Recreation formed a unique partnership with Friends of Ojibway Prairie, Ontario Ministry of Natural Resources, Parks Canada's Point Pelee National Park, and the Essex Region Conservation Authority to assist in restoration, monitor status and trends, and evaluate ecological effectiveness. The Ojibway Prairie case study showed that partners create a synergy that not only results in their assisting one another, but also their incorporation of elements from other projects into their own.

In the bald eagle (*Haliaeetus leucocephalus*) case study (Roberts, 2010), the 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 Isle. This project showed that the partnership increased the capacity of Bird Studies Canada to perform this vital work, that construction of bald eagle nesting platforms is a good tool to retain nest pairs in marginal habitats, and that increased productivity or fledging success results from securing a tree and nest from failure. This study also demonstrated the value and benefit of the partnership in furthering the practice of adaptive management.

The commitment to collaboration could be manifested 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 pursue independent studies, directed studies, master's theses, practica, and class projects, and to involve nongovernmental organizations and conservation clubs in monitoring ecological effectiveness of each project. The formation of partnerships for monitoring and assessment, up front in project planning, and gaining commitments for sustained monitoring after restoration, lays the foundation for quantifying the value and benefit of each project.

Coupling of habitat modification and the scientific method

Rodriguez (2010) pointed out that we need to recognize our limited knowledge 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., 2010) and the Oak Openings of northwest Ohio (Kromer et al., 2010) demonstrated very clearly that a pre-established series of targets, followed by a robust monitoring program will allow corrective actions to be taken to achieve success. Careful documentation of projects such as this, increase our scientific understanding, 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-scale conservation and restoration plans for the region. This will help prioritize habitat restoration efforts and will help re-evaluate 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, have often saved money for both the public and private sectors (Sutherland et al., 2004; 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 $13 million was spent on these soft shoreline engineering projects in the Detroit River watershed in 10 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., 2010). Therefore, there is a need for a stronger coupling of habitat management initiatives and the scientific method to ensure desired ecological goals.

Knowledge and technology transfer

Many habitat restoration projects are underway in the corridor. 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 of science transfer 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:

- Understand 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 habitats.

The HabCARES workshop was very well received and led to many habitat restoration projects (e.g., Thunder Bay (Lake Superior), Toronto Harbour (Lake Ontario), Hamilton Harbour (Lake Ontario), St. Marys River, and Detroit River).

In the technology transfer arena, a Canada–U.S. 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 societal benefits (Hartig et al., 2001). This soft shoreline engineering workshop produced a best management practices manual (Caulk et al., 2000) and catalyzed 51 soft shoreline engineering projects in the Detroit River watershed (University of Windsor, 2013).

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 improved for fish habitat with proper planning. Too often a proposal to modify the structure or its design is offered too late in the process (e.g., once construction has begun or construction was complete). Because planning for such navigational structure projects often takes years, 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 improve the habitat and recreational value of the structures, without adversely affecting their primary engineered purpose (Moy, 2000). The workshop effectively transferred critical information on ways and means of enhancing incidental habitat.

Concluding remarks and conference recommendations

Despite efforts to protect productive habitat for fish and wildlife in this area, habitat losses continue throughout the region at an alarming rate. Clearly, a greater level of habitat protection must occur in surrounding areas, if there is to be any real hope of ecological rehabilitation.

In any area with this magnitude of habitat loss and continued anthropogenically-induced ecological stress, 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 Remedial Action Plan (i.e., management plan developed to restore impaired beneficial uses using an ecosystem approach)(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 fish and wildlife.

Smaller habitat projects also 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. Collectively these projects result in regional economic benefits through enhanced sports fishing, 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, 2010). Such benefits also can help develop the next generation of conservationists and sustainability entrepreneurs.

Habitat management remains a fragmented responsibility among many agencies and interests, and is often an obstacle to realizing ecological improvements, recovery, and sustainability. 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, there are many excellent small habitat improvements underway in the Detroit River and western Lake Erie watersheds that can serve as building blocks for larger, 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 accordingly to habitat plans, policies, and programs to achieve long-term goals.

Specific conference recommendations included:

1. Greater emphasis needs to be placed on quantifying habitat targets and objectives to help evaluate and select appropriate habitat restoration and rehabilitation techniques, and to measure project success.
2. Pre- and post-project monitoring requirements should be added to all federal, state, and provincial permits for habitat modification. The investment in assessment and monitoring at the outset of projects helps ensure that the habitat project is grounded in science and also helps ensure that new knowledge, new techniques/practices and mid-course corrections are considered.
3. Partnerships should be established at the outset for monitoring the effectiveness of each habitat modification project. Agencies should sign a partnership agreement or memorandum of understanding that clearly lays out commitments and responsibilities for pre- and post-project monitoring of ecological effectiveness. Greater effort should be expended on citizen and student involvement in projects, including monitoring ecological effectiveness.
4. There is a need for stronger coupling of habitat management initiatives and the scientific method. 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 (Hartig et al, 1996).
5. Technology- and science-transfer sessions should be convened regularly among researchers, managers, and nongovernmental organizations to share ideas and knowledge, and to achieve cooperative learning relative to habitat management.

Disclaimer

The findings and conclusions in this article are those of the authors and do not necessarily represent the views of the U.S. Fish and Wildlife Service.

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