This is to certify that the
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Evaluation of Partners for Fish and Wildlife Wetland
Restoration Efforts in the Saginaw Bay Watershed

presented by

Katherine F. Thompson

has been accepted towards fulfillment
of the requirements for the

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Kelly A. Millenbah
Major Professor's Signature

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Date

EVALUATION OF PARTNERS FOR FISH AND WILDLIFE WETLAND RESTORATION EFFORTS IN THE SAGINAW BAY WATERSHED

By

Katherine Ford Thompson

A THESIS

Submitted to
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ABSTRACT

EVALUATION OF PARTNERS FOR FISH AND WILDLIFE WETLAND RESTORATION EFFORTS IN THE SAGINAW BAY WATERSHED

By

Katherine Ford Thompson

Since 1987, the U.S. Fish and Wildlife Service Partners for Fish and Wildlife Program has provided technical assistance to private landowners to voluntarily restore wetlands on their property. However, monitoring and evaluation of these projects has been limited. To determine the success of past Partner's wetland restoration projects in the Saginaw Bay watershed of Michigan, both broad and intensive-level evaluations were conducted that compared restored and natural reference wetlands. Furthermore, through landowner surveys, the relationship of landowner perception and experience to the broad and intensive ecological evaluations was explored. Ecological evaluation revealed water depth and percent open water were greater ($P<0.05$) on restored than reference sites. Conversely, percent total vegetation cover was less ($P<0.05$) on restored than reference sites. Restored and reference sites supported similar mean avian species richness and avian diversity, however, restored sites supported higher ($P<0.05$) densities of wetland dependent birds. Although water depth and land cover characteristics on restored sites did not approximate conditions on reference sites, avian response to these areas suggests that restored sites are able to support avian use similar or better than natural wetlands. Overall, landowner surveys had lower ($P=0.02$) estimates of percent total cover than broad evaluations. However, percent open water was not different among the three evaluation techniques. Landowner surveys, broad and intensive evaluation techniques can all be used to effectively monitor and evaluate restored wetlands on private lands.

For my husband, Brad, for his unwavering support, love, and patience.
Thank you for believing in me.

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I am thankful for the dedication, patience, and hard work of my two summer field assistants, Nathan Pfost and David Myers. Gratitude is extended to Jim Hazelman from the U.S. Fish and Wildlife Service (Service) and Barry Loper from the Michigan Department of Natural Resources for their assistance with identification of wetland sites. The permission of landowners to investigate wetlands on their property is most appreciated. Other contributors to this project include the Service's Private Lands Office, Jim Hudgins, David Newkirk, Dr. Dan Hayes, and Meegan Dorn.

I owe a special thanks to Laura Hudy and Nikki Lamp for their field assistance and hard work. I am thankful to the members, new and old, of Team Millenbah for their understanding, laughter, friendship and support. I would also like to thank my family for their constant love, encouragement and free dinners. Finally I would like to thank my husband, Brad, for his love, patience, constant encouragement, and helping me put things into perspective.

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CHAPTER 1
EVALUATION OF PARTNERS FOR FISH AND WILDLIFE WETLAND RESTORATION EFFORTS IN THE SAGINAW BAY WATERSHED

INTRODUCTION

Starting in the early nineteenth century, pioneers settling the Midwest transformed the landscape with the most significant change resulting in the conversion of wetlands into agricultural land through ditching and tile draining (Prince 1997). It was estimated that approximately 215 million wetlands existed within the United States prior to settlement (McCorvie and Lant 1993). Since then more than 50% of wetlands have been lost due to dredge and fill activities, drainage, development, pollution, and natural causes (Kusler and Kentula 1990, Patrick 1994). In Michigan, a similar trend exists. In 1780, Michigan had approximately 4,532,480 ha of wetlands and by 1980 between 28 - 50% of the pre-settlement wetlands were lost (Comer 1996, Dahl 1990, McCorvie and Lant 1993).

The transformation of our landscape, over the past four centuries, is reflective of public attitudes and perspectives towards wetlands (Prince 1997, Vileisis 1997). Both past and present perceptions of wetlands have been a result of how people have used the land (Prince 1997, Tiner 1998, Vileisis 1997). In the eighteenth century, wetlands were highly valued by French and British fur traders, and by naturalists and artists who recognized the unique beauty wetlands offered (Prince 1997, Vileisis 1997). However, in the nineteenth century, American pioneers who sought farmsteads viewed wetlands as malaria infested wastelands, worthless for farming, and unfit for human use (Patrick 1994, Prince 1997). Once farms were established, the public felt that wetlands were a hindrance to future development and proceeded to drain and fill these areas, converting them to other uses, such as agriculture.

In the past few decades, negative attitudes towards wetlands gradually changed as more information has became available about the values and functions these systems provide and the important role they play in the landscape. Wetlands have important ecological functions such as sediment trapping and water quality improvement by removing and recycling chemicals and excess nutrients from surface run-off (Mitsch and Gosselink 1993). Wetlands function to control floodwaters by acting as a hydrologic sponge. They intercept and temporarily store storm water run-off and release floodwaters gradually to downstream systems. This results in a much lower flood-peak that is extended over a longer time period. Wetlands are important food sources, nesting sites, nurseries, and refuges for a diversity of plant and animal species, including threatened and endangered species, such as the Hines emerald dragonfly (*Somatochlora hineana*) (Kusler and Kentula 1990). Wetlands also offer opportunities for education and research activities by serving as outdoor classrooms (Cwikiel 1997).

As a result of the high rate of wetland loss around the country in conjunction with changing attitudes and polices such as "no net loss", wetland restoration has become recognized as an important tool necessary to increase wetland habitat. The term "restoration" is commonly used to describe a variety of techniques that are used to transform drained and degraded wetlands back to a functional state. Therefore, it is important to define each term and to clarify how "restoration" is used in this document. In Wetland Creation and Restoration: the Status of Science, Lewis (1990) defined the following terms:

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Restoration: Returned from a disturbed or totally altered condition to a previously existing natural, or altered condition by some action of man.

Rehabilitation: Refers to the conversion of uplands to wetland where wetland previously existed.

Enhancement: The increase in one or more values of all or a portion of an existing wetland by man's activities, often with the accompanying decline in other wetland values.

Creation: The conversions of a persistent non-wetland area into a wetland through some activity of man. The conversion of a non-wetland habitat type into wetlands where wetlands never existed.

For the purpose of this document the term restoration will include wetlands that were restored, rehabilitated and enhanced on private lands.

Several studies have shown that restored wetlands can eventually function at a similar level as natural wetlands (e.g., increased wildlife habitat and water quality improvement) (Brawley et al. 1998, Brown and Smith 1998, White and Bayley 1999). Research from a tidal marsh restoration project in Connecticut indicated that, given time, the restored marsh was equivalent to similar reference wetlands with regard to wetland bird abundance and ecological functions (Brawley et al. 1998). In another study, Brown and Smith (1998) found that newly restored wetlands supported a diversity and abundance of bird species comparable to naturally occurring wetlands. Wetland restoration projects can also serve a dual role to satisfy both ecological and economic goals. In Canada, a prairie wetland was restored to treat municipal wastewater and increase wildlife diversity. The success of the prairie restoration project is reflected in the increase in abundance and species richness of shorebirds, waterfowl and raptor species (White and Bayley 1999).

Over the years, millions of acres of wetlands have been degraded and lost throughout the United States. Restoration efforts seek to return wetland ecosystems back to a biologically viable and sustainable condition. Due to the valuable benefits that humans derive from wetlands, not only ecologically but also economically, and the role they play in maintaining a balanced and healthy ecosystem, wetland restoration should be of utmost importance to natural resource management agencies and organizations.

Value of Private Land Restorations

Approximately three-quarters of the Nation's remaining wetlands in the lower 48 States are privately owned (Heimlich et al. 1998, U.S. Department of Agriculture 1992). Therefore, private landowners can play a significant role in wetland conservation. The Michigan Department of Environmental Quality estimates that over 78% of Michigan's wetlands are privately owned (Michigan GAP state land ownership (stewardship) digital geospatial data 2000). Probably an even greater percentage of the potentially restorable wetlands occur on private property (Cwikiel 1997). Although many federal and state regulations exist (Clean Water Act, Goemaere-Anderson Wetlands Protection Act) that enforce and protect these resources, private landowners can have a significant impact on the level of protection that a particular wetland receives and whether or not a former wetland will be restored on their property (Cwikiel 1997). Working with private landowners on a voluntary basis represents the greatest opportunity to improve Michigan's wetland resources through wetland restoration, enhancement, and creation activities.

An understanding held by many organizations, (i.e., Ducks Unlimited (DU), U.S. Fish and Wildlife Service (Service)), involved with habitat conservation and restoration is that gover

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that government and non-profit programs which target private landowners are vitally important to the future of wildlife and wetlands. As the public's understanding and appreciation for wetlands increases, there have been a growing number of voluntary programs to help landowners act as stewards of their land by conserving and restoring wetlands (U.S. Department of Agriculture 1992). Both the Service and DU have developed programs that lend habitat restoration assistance to private landowners (e.g., Service's Partners for Fish and Wildlife Program).

U.S. Fish and Wildlife Service Partners for Fish and Wildlife Program

The mission of the Service is, by working with others, to conserve, protect, and enhance fish and wildlife and their habitats for the continuing benefit of the American people (http://partners.fws.gov.htm). To help achieve this mission, the Service's Partners for Fish and Wildlife Program offers technical and financial assistance to private landowners to voluntarily restore wetlands and other fish and wildlife habitats on their land (http://partners.fws.gov.htm). The program emphasizes the reestablishment of native vegetation and ecological communities for the benefit of fish and wildlife while meeting the needs and desires of private landowners (http://partners.fws.gov.htm). Restoration projects improve habitat for trust resources of the Service including waterfowl and other migratory birds, certain fish species, and threatened and endangered species. Projects may also benefit adjacent Service owned lands. Since the program's inception in 1987, the Service has worked with over 23,000 landowners to restore wetlands, as well as native grasslands, stream banks and riparian areas. Of the 404,685 ha of habitat restored, over 202,345 ha have been wetlands (http://partners.fws.gov.htm).

According to the Service, working with landowners on a voluntary basis is a critical element in meeting the Nation's wetland restoration goals (http://partners.fws.gov.htm). As vital habitats on private lands are restored, a trust and cooperative partnership among landowners, the Service, and other conservation partners is strengthened (http://partners.fws.gov.htm).

Ducks Unlimited

The mission of DU, a non-profit organization, is to fulfill the annual life cycle needs of North American waterfowl by protecting, enhancing, restoring and managing important wetlands and associated uplands (http://www.ducks.org). To meet their mission, DU is involved in a variety of conservation practices such as restoring grasslands, replanting forests, restoring watersheds, working with landowners, working with other organizations and agencies, obtaining conservation easements, and acquiring land.

DU understands the importance of private landowners in restoring critical habitat and therefore lends their support to many programs like the Conservation Reserve Program and the Partners for Fish and Wildlife Program. Recognizing the importance of these federal programs, DU is working with elected officials to expand existing programs and to enact new programs (http://www.ducks.org). Through their efforts, DU has helped conserve over 3,000,000 ha of wetlands in North America (http://www.ducks.org).

As another avenue to further the advancement of conservation and restoration, DU established the Institute for Wetland and Waterfowl Research (IWWR), which has become the "science arm" of the organization (http://www.ducks.org). The mission of the IWWR is to help guide conservation of waterfowl and wetlands by developing and sustainin

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sustaining a premier program of research and by educating professionals in wetlands and waterfowl biology (http://www.ducks.org). The information gathered from research conducted by IWWR is then applied to various DU projects including private land restoration projects.

The Service and DU Partnership

Partnerships between agencies and conservation organizations, like the Service and DU, are valuable to the future conservation of our natural resources, particularly wetlands. Through the efforts put forth by the Service, DU and other partners, thousand of hectares of wetlands in Michigan have been restored. Both organizations have helped further the advancement of conservation and restoration practices among the public and encourage wetland protection and conservation. However, due to limited time and staff constraints there is insufficient knowledge concerning the "success" of past private wetland restorations and landowner satisfaction with these projects. By evaluating the success of past wetland restoration projects, both ecologically and socially, the Service and DU can use the information to improve the effectiveness of future restoration projects.

Overview of Performance Standards Used in Wetland Restoration Projects

Wetlands are diverse and complex ecosystems that exhibit variation in the degree to which they perform numerous functions, such as nutrient cycling. These variations are due to a diverse set of factors such as geology, climate, soil properties and vegetation properties, which result in each wetland having site-specific qualities. Researchers are often challenged when evaluating similar wetland types due to the varying qualities of individual wetlands. To determine the success of restored wetlands, systematic comparis

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comparisons between restored and natural wetlands, using multiple performance standards, has become the most frequently used method for evaluation (Delphey and Dinsmore 1993, LaGrange and Dinsmore 1989). However, monitoring and analysis of wetland restorations have been scarce (Brown and Smith 1998). Therefore, comparisons between restored and reference wetlands, in the absence of complete historic site records, are necessary to further understand wetland characteristics and help assess success of wetland restorations. Several performance standards commonly selected to measure success of restored wetlands are relative abundance and productivity of avian species, percent cover of vegetation, and water depth (Brown et al. 1995, Brown and Dinsmore 1986, LaGrange and Dinsmore 1989, Leschisin et al. 1992). The determination of success is based on whether restored wetlands approximate conditions on existing natural wetlands.

A primary objective of many wetland restoration projects is increasing habitat for waterfowl and other avian species (Brown and Smith 1998). Avian populations have been used as indicators of biological richness of a given habitat due to their dependence on the presence of multiple environmental factors (Graber and Graber 1976). For example, studies have shown that when vegetation has been successfully established on restored wetlands, there is significant increase of birds using the area (Brown et al. 1995). In addition, restored wetlands that support breeding avian communities can be used as another important indicator of success. Due to the importance of the nesting habitat in increasing a population, Brown et al. (1995) determined that a restored wetland could not be compared appropriately to a natural wetland until it supported breeding birds.

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Vegetative interspersion and percent cover have also been identified as important performance standards in many wetland restoration projects. Development of diverse vegetation communities has been shown to lead to wetland stability over a wide range of hydrologic conditions (i.e., high and low water depths over time) (Reinartz and Warne 1993). Studies of vegetation interspersion have documented that the hemi-marsh stage, with 40 - 60 % of the wetland covered with emergent vegetation, supports the highest avian diversity and greatest invertebrate species richness (Brawley et al. 1998, Brown and Dinsmore 1986, Hemesath and Dinsmore 1993, Kaminski and Prince 1981). Vegetation percent cover > 30% has been shown to be a good predictor of wetland use by mammals, such as muskrats, which prefer similar wetland conditions ideal for waterfowl (Bishop et al. 1979).

Water depth, another important performance standard, has both positive and negative effects on avian use of wetlands, vegetation composition and invertebrate distribution and abundance (Brawley et al. 1998, Brown et al. 1995, Brown and Dinsmore 1986, Weller 1979). Wetlands need both periods of high and low water to maintain ecological integrity. Wetland sites designed for diverse communities of wetland birds should include persistent open water, especially during periods of drought (Brown et al. 1995). Persistent open water is important not only for waterfowl but also for invertebrate habitat and for reducing the amount of emergent vegetation. In periods of drought, some invertebrate survival is dependent on pockets of standing water (Brown et al. 1995). Weller (1979) documented that waterfowl populations were the lowest when water levels were low and emergent vegetation was dense. Likewise, Weller (1979) noted that breeding bird species richness was greatest during periods of high water.

However, periods of low water depths are also necessary because it allows waterfowl to consume exposed invertebrates and emergent vegetation (Brown et al. 1995). Maintenance of hemi-marsh conditions is also dependent upon fluctuating water depths. During periods of low water, emergent vegetation is allowed to grow and flourish. High water levels restart marsh successional patterns, resulting in ideal vegetative cover conditions for waterfowl, invertebrates and mammals.

Using Landowner Survey Responses to Evaluate Wetland Restoration Projects

There have been many surveys conducted documenting the public's perceptions, attitudes, behavior and motivation regarding the Nation's natural resources. Several studies focused on ways to motivate the private landowner to manage for wildlife and wildlife habitat on their property (Applegate 1981, Shelton 1981, Svoboda 1981) while others have focused on understanding the values and beliefs of landowners and how that relates to their perception of natural resources (Kelley 1981, Kirby et al. 1981, Pease 1992, Wywialowski and Dahlgren 1985). However, little is known regarding the use of landowner surveys in place of intensive biological studies to evaluate ecological success of restored wetlands. In the past, landowners involved with the Partners for Fish and Wildlife Program have been surveyed to understand the motivation behind participation in the program and to determine their attitudes toward conservation related issues such as outdoor recreation and the environment (Arkin 1996). However, if landowner surveys can be used to evaluate the success of restored wetlands, socially and ecologically, this can have a profound effect on increased monitoring of wetlands and accumulation of pertinent information regarding wetland restoration.

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GOAL AND OBJECTIVES

The overall goal of this project is to evaluate the success of the Partners for Fish and Wildlife Program's private land wetland restoration projects in the Saginaw Bay watershed, Michigan, ecologically and socially. The specific objectives are to:

1) Compare restored wetlands to natural reference wetlands using selected performance standards to determine if differences exist,
2) Determine landowner attitudes and perceptions toward their wetland restoration project and compare responses to the evaluated ecological and non-ecological performance standards of the project site to explore the use of landowners in the evaluation process, and
3) Compare three evaluation techniques, ranging from general to intensive, to explore the similarities and differences between each technique and how they can be used to evaluate restored wetlands.

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STUDY AREA

Research was conducted on 58 restored and 13 reference wetlands from April through August 2001 and 2002 throughout the Saginaw Bay watershed (Figure 1.1). The Saginaw Bay watershed covers all or parts of 22 counties in Michigan. Study sites are located within the county-line boundaries of the watershed; therefore some projects may lie outside the Saginaw Bay watershed. Restored sites evaluated in this study, including those surveyed through the landowner surveys, were idle fields (previously converted), Conservation Reserve Program (CRP) lands, and lands there were converted for agricultural use (i.e., corn and soybeans). Restored sites were located on private property in the following counties of Michigan: Clare, Genesee, Gladwin, Gratiot, Huron, Iosco, Lapeer, Mecosta, Montcalm, Osceola, Sanilac (Figure 1.1). Reference (i.e., natural) wetlands were selected based on similar size and vegetation characteristics to restored wetlands (Brown and Smith 1998, LaGrange and Dinsmore 1989). Reference sites were located on Michigan Department of Natural Resources State Game Areas with the exception of one site, which was located on private property, in the following counties: Gratiot, Montcalm, Lapeer (Figure 1.1). Reference and restored wetlands were classified as emergent wetlands (as identified by the Cowardin et al. (1979) classification system), ranging in size from 0.02 – 2.02 ha.

The Saginaw Bay watershed is Michigan's largest watershed and includes a diversity of wetlands that resulted from glacial stream sediments of silt and clay approximately 10,000 to 16,000 years ago (Prince and Burton 1995). This area is characterized geographically as nearly level to rolling (Albert 1995). Soils in the area are well drained to poorly drained loamy and sandy soils (Albert 1995). Total rainfall and snowfall in the study area, averaged over 12 months, ranges from 74 - 81 cm and 52 –

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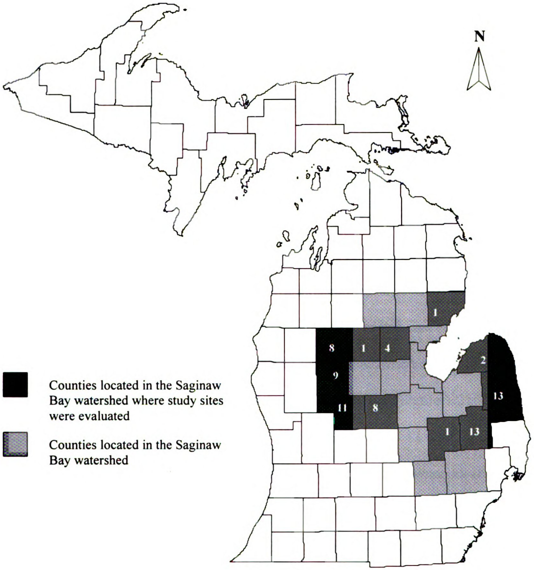

Fig. 1.1. Location of study sites in the Saginaw Bay watershed within Michigan's Lower Peninsula, summer 2001 and 2002. Numbers represent wetlands evaluated in each county.

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STUDY DESIGN

This project was structured using a three-tiered approach that ranged from intensive to broad evaluations of selected restored and reference wetlands (Figure 1.2). Intensive evaluations are time consuming, can only evaluate a small sample size and many times cannot be applied to a wide geographical range. The project was structured to determine how general an evaluation could be while still providing the level of information usually captured in intensive studies. Imbedded in the structure is the evaluation of wetland restoration success. For this project restoration success will be determine by comparing the similarity of wetland functions of restored sites to reference sites. This proposed design may help organizations and agencies involved with wetland restorations increase monitoring programs due to more time and cost efficient evaluation methods. Landowner surveys, which were sent to 387 landowners involved with the Partners for Fish and Wildlife Program, comprised the top tier (Figure 1.2). The second tier involved a broad evaluation of 71 wetlands (58 restored and 13 reference) with the restored wetlands selected from those who responded to the landowner survey, divided into 3 age categories (1 - 2 year-old, 3 - 5 year-old, and ≥ 6 year-old) (Figure 1.2). Different age classes allowed for the evaluation of wetland restoration success (i.e., level of success at each age class) as the sites matured. The third tier was an intensive study of 35 wetlands (25 restored and 10 reference wetlands) (Figure 1.2). The 25 restored wetlands were selected from the ≥ 6 year-old category in the second tier sample (Figure 1.2).

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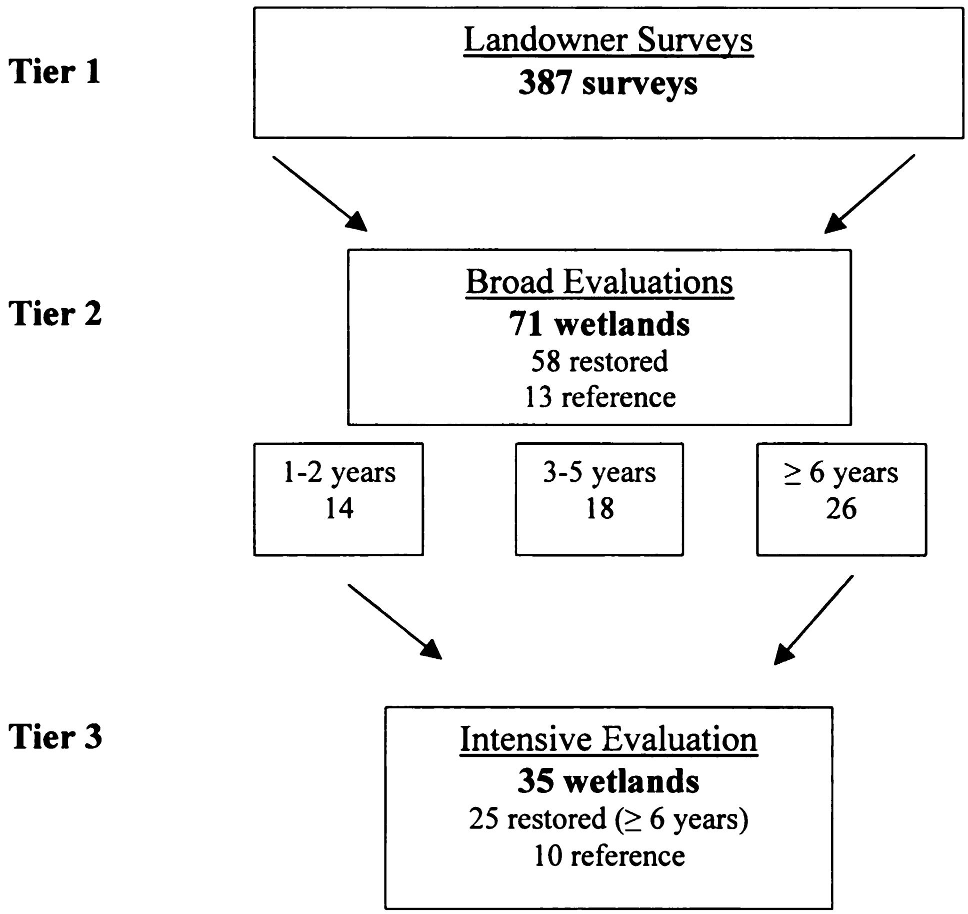

Fig. 1.2. Project study design divided into three tiers: landowner surveys, broad evaluations, and intensive evaluation.

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LITERATURE CITED

ALBERT, D. A. 1995. Regional landscape ecosystems of Michigan, Minnesota, and Wisconsin: a working map and classification. North Central Forest Experimental Station. Forest Service-U.S. Department of Agriculture. General Technical Report NC-178.

APPLEGATE, J.E. 1981. Landowners behavior in dealing with wildlife values. Pages 64-72 *in* R.T. Dumke, G.V. Burger, and J.R. March *(eds.).* Wildlife Management on Private Lands. LaCrosse Printing Co., LaCrosse, WI.

ARKIN, L. 1996. Attitudes, knowledge, motivation and satisfaction of Ohio landowners participating in the Partners for Wildlife Program. M.S. Thesis. Ohio State University, Columbus, Ohio, USA.

BISHOP, R., R. ANDREWS, AND R. BRIDGES. 1979. Marsh management and its relationship to vegetation, waterfowl, and muskrats. Iowa Academy of Science 86(2):50-56.

BRAWLEY, A. H., R. S. WARREN, AND R. A. ASKINS. 1998. Bird use of restoration and reference marshes within the barn island wildlife management area, Stoningtion, Connecticut, USA. Environmental Management 22(4):625-633.

BROWN, S., B. L. BEDFORD, AND M. E. RICHMOND. 1995. Ecological evaluation of the U.S. Fish and Wildlife Service wetland restoration program in New York state: detailed summary of research findings and management recommendations. Department of Natural Resources, Ithaca, New York, USA.

BROWN, M. AND J. DINSMORE. 1986. Implications of marsh size and isolation for marsh bird management. Journal of Wildlife Management 50(3): 392-397.

BROWN, S. C. AND C. R. SMITH. 1998. Breeding season use of recently restored versus natural wetlands in New York. Journal of Wildlife Management 62(4):1480-1491.

COMER, P. 1996. Wetland trends in Michigan since 1800: A preliminary assessment. Michigan Natural Features Inventory, Lansing, Michigan, USA.

CORDER, P. G. 1979. Soil survey of Clare County, Michigan. United States Soil Conservation Service, Washington D.C., USA.

CORDER, P. G. 1984. Soil survey of Mecosta County, Michigan. United States Soil Conservation Service, Washington D.C., USA.

COWARDIN, L., V. CARTER, AND C. GRIFFIN. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

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CWIKIEL, W. 1997. Living with Michigan's wetlands: a landowners guide. Tip of the Mitt Watershed Council. Conway, Michigan, USA.

DAHL, T. E. 1990. Wetland losses in the United States 1780's to 1980's. U.S. Department of Interior, Fish and Wildlife Service, Washington D.C., USA.

DELPHEY, P., AND J. DINSMORE. 1993. Breeding bird communities of recently restored and natural prairie potholes. Wetlands 13:200-206.

DUCKS UNLIMITED HOME PAGE. http://www.ducks.org (10 May 2000).

EARLE, G. H. 1972. Soil survey of Lapeer County, Michigan. United States Soil Conservation Service, Washington D.C., USA.

FEENSTRA, J. E. 1969. Soil survey of Gratiot County, Michigan. United States Soil Conservation Service, Washington D.C., USA.

GRABER, J. W., AND R. R. GRABER. 1976. Environmental evaluation using birds and their habitats. Pages 2-39 *in* Illinois Natural History Survey Biological Notes 97, Champaign, Illinois, USA.

HEIMLICH, R. E., K. D. WIEBE, R. CLAASSEN, D. GADSBY, AND R. M. HOUSE. 1998. Wetlands and agriculture: private interests and public benefits. Economic Research Service, U.S. Department of Agriculture, Washington, D.C., USA.

HEMESATH, L., AND J. DINSMORE. 1993. Factors affecting bird colonization of restored wetlands. The Prairie Naturalist 25(1):1-11.

KAMINSKI, R., AND H. PRINCE. 1981. Dabbling duck activity and foraging responses to aquatic macroinvertebrates. Auk 98:115-126.

KELLEY, R.G. 1981. Forests, farms and wildlife in Vermont: a study of landowner values. Pages 102-110 *in* R.T. Dumke, G.V. Burger, and J.R. March *(eds.)*. Wildlife Management on Private Lands. LaCrosse Printing Co., LaCrosse, WI.

KIRBY, S.B., K.M. BABCOCK, S.L. SHERIFF, AND D.J. WITTER. 1981. Private land and wildlife in Missouri: a study of farm operator values. Pages 88-97 *in* R.T. Dumke, G.V. Burger, and J.R. March *(eds.)*. Wildlife Management on Private Lands. LaCrosse Printing Co., LaCrosse, WI.

KUSLER, J., AND M. KENTULA. (eds.) 1990. Wetland creation and restoration: the status of science. Island Press, Washington D.C., USA.

LAGRANGE, T., AND J. DINSMORE. 1989. Plant and animal community responses to restored Iowa wetlands. Prairie Naturalist 21(1):39-48.

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LESCHISIN, D., G. WILLIAMS, AND M. WELLER. 1992. Factors affecting waterfowl use of constructed wetlands in northwestern Minnesota. Wetlands 12(3):178-183.

LEWIS, R. R. 1990. Wetlands restoration/creation/enhancement terminology: suggestions for standardization. Pages 417-422 *in* J. Kusler and M. Kentula (*eds*). Wetland creation and restoration: the status of science. Island Press, Washington D.C., USA.

LINSEMIER, L. H. 1980. Soil survey of Huron County, Michigan. United States Soil Conservation Service, Washington D.C., USA.

MCCORVIE, M. R., AND C. L. LANT. 1993. Drainage district formation and the loss of Midwestern wetlands, 1850-1930. Agricultural History 67(4): 13-39.

MCLEESE, R. L., AND S. W. TARDY. 1985. Soil survey of Isabella County, Michigan. United States Soil Conservation Service, Washington D.C., USA.

METTERT, W. 1969. Soil survey of Osceola County, Michigan. United States Soil Conservation Service, Washington D.C., USA.

MICHIGAN GAP STATE LAND OWNERSHIP (STEWARDSHIP) DIGITAL GEOSPATIAL DATA. 2000. Michigan Department of Natural Resources' Land and Minerals Services Office, Lansing, Michigan, USA.

MITCH, W. L., AND J. G. GOSSLINK. 1993. Wetlands. Van Nostrand Reinhold, New York, New York, USA.

PARTNERS FOR FISH AND WILDLIFE PROGRAM: Voluntary Habitat Restoration in Cooperation with Private Landowners. http://partners.fws.gov.htm (10 May 2000).

PATRICK, W. 1994. From wastelands to wetlands. Environmental Quality 23: 892-896.

PEASE, J.L. 1992. Attitudes and behaviors of Iowa farmers toward wildlife. Ph.D. Dissertation. Iowa State University, Ames, Iowa.

PRINCE, H. 1997. Wetlands of the American Midwest. The University of Chicago Press, Chicago, Illinois, USA.

PRINCE, H. H., AND T. M. BURTON. 1995. Wetland restoration in the coastal zone of Saginaw Bay: final report. Michigan State University, East Lansing, Michigan, USA.

REINARTZ, J., AND E. WARNE. 1993. Development of vegetation in small created wetlands in southeastern Wisconsin. Wetlands 13(3): 153-164.

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SHELTON, R. 1981. Motivating the landowner/manager to manage for wildlife. Pages 301-306 *in* R.T. Dumke, G.V. Burger, and J.R. March *(eds.)*. Wildlife Management on Private Lands. LaCrosse Printing Co., LaCrosse, WI.

SVOBODA, F.J. 1981. A look at incentives for wildlife management of private lands. Pages 384-394 *in* R.T. Dumke, G.V. Burger, and J.R. March *(eds.)*. Wildlife Management on Private Lands. LaCrosse Printing Co., LaCrosse, WI.

TINER, R. 1998. In search of swampland. Rutgers University Press, New Brunswick, New Jersey, USA.

U.S. DEPARTMENT OF AGRICULTURE.1992. Private landowner's wetlands assistance guide: voluntary options for wetlands stewardship in Maryland. Maryland, USA.

VILEISIS, A. 1997. Discovering the unknown landscape: A history of America's wetlands. Island Press, Washington D.C., USA.

WELLER, M. W. 1979. Birds of some Iowa wetlands in relation to concepts of faunal preservation. Iowa Academy of Science 86:81-88.

WHITE, J. S. AND S. E. BAYLEY. 1999. Restoration of a Canadian prairie wetland with agricultural and municipal wastewater. Environmental Management 24(1): 25-37.

WYWIALOWSKI, A.P. AND R.B. DAHLGREN. 1985. Beliefs about wildlife management among Iowans with differing attitudes toward hunting. Wildlife Society Bulletin 13: 328-332.

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CHAPTER 2
EVALUATION OF PARTNERS FOR FISH AND WILDLIFE WETLAND RESTORATION EFFORTS IN THE SAGINAW BAY WATERSHED USING BROAD AND INTENSIVE EVALUATION TECHNIQUES

ABSTRACT

Since 1987, the Partners for Fish and Wildlife Program in Michigan has attempted to restore privately owned wetlands back to biologically viable and sustainable conditions. To determine the success of Partners restored wetlands in the Saginaw Bay watershed I conducted broad and intensive-level evaluations where I compared restored wetlands to natural reference wetlands, using selected performance standards. Water depth and percent open water were greater ($P<0.05$) on restored than reference sites. Consequently, percent total vegetation cover was less ($P<0.05$) on restored than reference sites. Restored and reference sites supported similar mean avian species richness and avian diversity, however, restored sites supported higher ($P<0.05$) densities of wetland dependent birds. Although water depth and land cover characteristics on restored sites did not approximate conditions on natural sites, avian response to these areas suggests that restored sites are able to support avian use similar or better to natural wetlands. Furthermore, higher densities of wetland-dependent species may indicate that restored wetlands are providing better avian habitat when compared to existing natural wetlands.

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INTRODUCTION

In the late 1980's, with the adoption of no-net-loss policy, our country experienced a shift in the national perspective regarding wetlands (Vileisis 1997). The no-net-loss policy introduced the concept of compensatory restoration, meaning that for every wetland destroyed, a new one would be created or restored to reduce the loss of these natural systems (Hey and Philippi 1999, MacKinnon 2000). Restoration programs such as the Water Bank Act of 1970, Section 404 of the Clean Water Act, the Swampbuster provision of the 1985 Food Security Act, the Wetland Reserves Program, the Partners for Fish and Wildlife Program, and the Small Wetland Acquisition Program, predated the announcement of no-net-loss (Beck 1994, Environmental Protection Agency 1980, Vileisis 1997). However, the new policy strengthened these efforts and led to an increase in wetland restorations on both public and private lands (Beck 1994, Environmental Protection Agency 1980, Vileisis 1997).

To achieve the goal of no-net-loss, wetland restoration has become an acceptable and viable means to mitigate for damaged and degraded habitat (Hey and Philippi 1999). In response, many national and state agencies and organizations have developed their own wetland restoration programs. Although there are many programs involved with wetland restoration, the Partner's program has made a significant contribution to the number of wetlands restored nationally as well as in Michigan. Nationwide over 220,470 ha of wetlands have been restored since 1987 (http://partners.fws.gov.htm). From 1987 to 2000, the Partners program in Michigan completed over 1,400 wetland restoration projects and restored approximately 2,280 hectares. (http://partners.fws.gov.htm). While the number of wetland restoration projects dramatically increased over the past 20 years, limited fund

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limited funding led to scarce and inconsistent monitoring and evaluation of wetland restoration projects. (Brown et al. 1995, MacKinnon 2000).

Monitoring of restored wetlands is a critical but often neglected component of a successful project. Monitoring projects are important for several reasons. Evaluations of projects post-restoration can aid biologists in understanding the restoration process (Galatowitsch and van der Valk 1994). This information assesses how closely a restored wetland resembles a natural wetland in composition and function. Second, examination of the restoration process improves site selection criteria and project design for wetland restorations (Galatowitsch and van der Valk 1994). Finally, project visits determine if structural or biological problems have occurred (Galatowitsch and van der Valk 1994). Discovering and fixing problems early increases the chance of success of restored wetlands.

Previous evaluations and research have primarily occurred in the prairie pothole region of the United States (Brown and Dinsmore 1986, Delphy and Dinsmore 1993, Galatowitsch and van der Valk 1996, Hemesath 1991, LaGrange and Dinsmore 1989, Schreiber 1994, Sewell and Higgins 1991, Van Rees-Siewart 1993), Ohio (Shieldcastle and Shieldcastle 1998), Indiana (DuBowy and Hartman 1994, Weiss 1995), New York (Brown et al. 1995, Brown and Smith 1998) and Pennsylvania (Campbell et al. 2002, Cashen 1998). Currently, only one other published study evaluated restored wetlands in Michigan. MacKinnon (2000) investigated avian use of Partners restored wetlands in central lower Michigan and found that restored wetlands are being used by both migratory and breeding birds. However, the study does not address how closely avian use on restored wetlands compares with avian use on natural wetlands.

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Comparisons between restored and natural wetlands are necessary to further understand wetland characteristics and help assess success of wetland restoration projects. Although, it is impossible to restore a wetland that completely duplicates a naturally-occurring wetland, natural wetlands serve as a benchmark or guide to determine wetland restoration success (Kusler and Kentula 1990). Galatowitsch and van der Valk (1994) stated that the definitive test of success is how closely restored wetlands resemble and function like natural wetlands. To determine whether plant and animal communities were characteristic of unaltered wetlands, LaGrange and Dinsmore (1989) stated that it is important to compare species present in restored wetland with natural wetlands. Delphy and Dinsmore (1993) stated in their study of breeding bird communities of restored and natural potholes that "systematic comparisons between restored and natural wetland facilitate evaluations of restoration success."

Therefore, the specific objective of this study was to determine the success of Partners restored wetlands in the Saginaw Bay watershed by comparing restored wetlands to natural reference wetlands. Using selected performance standards, comparisons would be made by conducting broad and intensive-level evaluation. Refer to Chapter 1 for a complete description of the performance standards selected for the broad and intensive evaluations.

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METHODS

Two different evaluation techniques were used to collect data: broad and intensive. The use of the terms broad and intensive relates to the sampling protocol used to collect the data. At both levels similar performance standards are used, i.e., water levels, vegetation, and wildlife variables. However, the methods used to collect the data differ in intensity. Methods for the broad evaluation were developed based on intensive methods.

Broad Evaluation

A broad evaluation of 71 wetlands (58 restored, 13 reference), selected from the landowner survey sample, (see Chapter 1 for complete description of design), was completed in 2002 (Figure 1.2). Restored wetlands were divided into 3 age categories, 1 - 2 year-old, 3 - 5 year-old, and ≥ 6 year-old (Figure 1.2). Wetlands were visited monthly from May-July. Broad performance standards evaluated at each wetland include water depth, vegetative percent cover, wildlife presence, and restoration design structures. These performance standards were selected because they routinely can be used to evaluate wetland success, whereas, wetland functions such as water quality improvement and flood storage, cannot be as easily assessed (Galatowitsch and van der Valk 1994).

Water depth recordings were taken during each visit using a staff gauge constructed of a 2-meter length of plastic PVC pipe marked every 5 cm that was placed in the center of each wetland. Percent vegetation cover and the dominant species of vegetation were visually estimated and recorded in July, when vegetation had become fully established. Vegetative percent cover was grouped into the following categories: percent trees, percent shrubs, percent cattails, percent grass-like, percent other, percent bare soil and percent open water. Restoration design structures were visually evaluated in May to det

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in May to determine the condition of such structures. The four main structural designs that the Service uses to restore wetlands are water control structures, spillways, berm construction, and constructed islands. Assessment categories, which ranged from nil to extensive, were developed to help determine the extent of the damage (Appendix 2.A.). The surrounding upland area within property boundaries of each wetland was described based on vegetation composition and topography. Wildlife species observed and/or heard during each visit were recorded.

Intensive Evaluation

An intensive evaluation of 35 wetlands (25 restored, 10 reference) was selected from the broad evaluation sample group (Figure 1.2) and was conducted in the summers 2001 and 2002. The following performance standards were evaluated.

Water Depth

Water depth has been found to have a significant effect on invertebrate densities, waterfowl densities, vegetative diversity, and vegetative percent cover (Brown et al. 1995). Therefore, water depth measurements were conducted once per month on all sites from May to July, every 5 m along 3 permanently established transects. (Brown and Dinsmore 1986, Leschisin et al. 1992). The main transect traversed through the center of the wetland. Two additional transects were placed on either side of the main transect, equidistantly from the main transect to the wetland edge (LaGrange and Dinsmore 1989). Measurements were taken using a staff gauge constructed of a 2-meter length of plastic PVC pipe marked every 5 cm.

Vegetation Percent Cover and Composition

The most common vegetation variable measured in projects evaluating wetland success is percent cover (Brawley et al. 1998, Leschisin et al. 1992, Reinartz and Warne

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1993). The amount of vegetation cover of wetlands is one of many important factors that determine bird use of an area. Brawley et al. (1998) found a positive relationship between waterfowl abundance, vegetative diversity and an interspersion of open water and vegetation. Vegetative percent cover and composition were determined in each wetland between July and August, when vegetation had become adequately established, using a 1m^2 plastic frame located at 5 m intervals along the 3 permanent transect established for water depth samples (LaGrange and Dinsmore 1989, Reinartz and Warne 1993). The main transect traversed the center of the wetland. Two additional transects were placed on either side of the main transect, equidistantly from the main transect to the wetland edge (LaGrange and Dinsmore 1989). Within each quadrat, percent vegetation cover was visually estimated and species and genera were recorded (Appendix 2.B.) as well as percent bare ground and percent open water. Vegetative percent cover was grouped into the following categories: percent wood, percent grass, percent sedge and rush and percent herbaceous forb.

Avian Surveys

Avian communities were surveyed using 30 m fixed-radius (0.28 ha) circular plots (Brown and Dinsmore 1986, Delphey and Dinsmore 1993, Hemesath and Dinsmore 1993, Reynolds et al. 1980). The first circular plot was placed randomly from the shoreline and the rest were placed equidistantly within the wetland (Brown and Dinsmore 1986, Delphey and Dinsmore 1993, Hill 2000). For each subsequent visit, the same approximate plot areas were used. Plots were located at least 30 m apart, from the edge of one circle to the edge of the next circle, with no more than 5 plots established per wetland (Brown and Dinsmore 1986, Delphey and Dinsmore 1993, Hill 2000). Each wetland wa

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wetland was visited three times from sunrise to 3 hours post-sunrise during the months of May-July.

Each census consisted of a 10-minute count period where all birds heard and/or seen within the plot and location to observer were recorded to the nearest meter. Species that were seen or heard outside of the plot boundary were noted but not included in the actual count. Tape recordings of secretive birds such as the Least Bittern (*Ixobrychus exilis*), American Bittern *(Botaurus lentiginosus*), King Rail (*Rallus elegans*), Virginia Rail (*Rallus limicola*) and Sora *(Parzana carolina*) were played for approximately 3 minutes during the middle of the count to elicit responses (Brown and Dinsmore 1986, Brown and Smith 1998, LaGrange and Dinsmore 1989). Before entering the wetland, the area was surveyed for waterfowl presence.

Avian species observed during point counts were classified into 3 groups: wetland dependent, wetland associated, and nonwetland (Brown and Smith 1998). Wetland dependency was determined by utilizing a list of wetland-dependent birds developed by Crowley et al. (1996). Wetland associated and nonwetland birds were classified based on research by Brown and Smith (1998) and habitat use information in Ehrlich et al. (1988) and Brewer et al. (1991). The complete list of birds in each category is provided in Appendix 2.C.

To evaluate waterfowl use of restored wetlands pair counts were conducted between mid-March to late-April (Kantrud and Stewart 1984, Leschisin et al. 1992, Stewart and Kantrud 1972). Pair counts were conducted from a single location where the entire wetland area could be observed (Brown and Smith 1998, Stewart and Kanturd

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1972). Each wetland was visited once, beginning at sunrise, for approximately 20 – 30 minutes.

To measure productivity, nest searches and brood counts were conducted at each wetland. Nest searches were performed by walking through emergent vegetation in circles of decreasing radii, starting at the wetland's outer edge and ending in the center or when open water was reached (Delphey and Dinsmore 1993, Hill 2000). Upland cover occurring within at least 50 m from the wetland edge, was also searched for nests by dragging a 15 m steel cable in concentric circles around the wetland to flush nesting birds (Galatowitsch and van der Valk 1994, MacKinnon 2000). Active nests are those that included eggs, nestlings, or strong evidence of use including the presence of fledglings or family groups (Craig and Beal 1992). Birds were classified as breeding if there was evidence of active nests or flightless young (Hemesath and Dinsmore 1993, LaGrange and Dinsmore 1989).

Nest searches were performed at each wetland on the same day as the avian observation procedure in May and June, resulting in 2 nest searches at each wetland. Brood counts, a common method used to determine waterfowl breeding success, were conducted on the same day as point counts, nest searches and vegetation sampling. (Kantrud and Stewart 1984, Leschisin et al. 1992, Stewart and Kantrud 1972). Before entering the wetland, the basin was surveyed from a single vantage point for waterfowl brood presence.

Analysis

Broad

Water depth and land cover categories were compared between restored and reference wetlands using a Mann-Whitney U test ($\alpha = 0.05$) (Siegel 1956). A Kruskal-

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Wallis (KW) one way analysis of variance ($\alpha = 0.05$) (Siegel 1956) was used to determine if there were significant differences in water depth and percent cover categories among the 3 age categories of restored wetlands.

Intensive

Physical conditions, such as weather, vegetation characteristics, and avian use, can vary between months, therefore, analysis for water depth, avian density, diversity, and species richness was calculated for each month (May, June, July) to account for these differences.

Results from wetland point counts were used to calculate avian density, species richness, species diversity, and similarity indices. Avian species observed and/or heard within a plot, excluding "flythrough" species, were used to determine density.

Avian densities were calculated for each species on a survey plot basis and averaged across study site and wetland type (i.e., restored or reference) for each month of the study. Density was calculated by dividing the count of each species at a survey plot by 0.28 ha to obtain a density per hectare. In addition, mean avian density per wetland was calculated and averaged across wetland type for each month. Mean avian density per wetland based on avian wetland dependency categories was also calculated and averaged across wetland type for each month. Density was calculated by dividing the total number of species present per survey plot by 0.28 to obtain a density per hectare.

Avian richness was calculated by summing the total number of species detected at each wetland and averaging across wetland type. Avian diversity for each wetland was calculated using the Shannon Index of diversity (Shannon and Weaver 1949). The index was calculated as follows:

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where p_i denotes the proportion of the sample belonging to the *i*-th taxon (Shannon and Weaver 1949).

Avian density, mean species richness and diversity were compared between restored and reference sites for each month by using a Mann-Whitney U test ($\alpha = 0.05$) (Siegel 1956).

The presence and abundance of avian species were compared between restored and reference using a Renkonen percentage similarity index (Krebs 1999), which takes into account the relative percent of a particular species observed:

$$P = \Sigma \text{ minimum } (p_{1i}, p_{2i})$$

where P = percentage similarity between 1 and 2, p_{1i} = percentage of species *i* in community sample 1, and p_{2i} = percentage of species *i* in community sample 2.

The result of the similarity index calculation is a percentage between 0 and 100% where 0% indicates no similarity and 100% indicates complete similarity (Krebs 1999).

To determine whether the number of nests per wetland was the same on both restored and reference wetlands a chi-square analysis was calculated.

Water depth and percent cover categories were compared between restored and reference wetlands using a mixed model procedure to perform an analysis of variance (ANOVA) for unbalanced data ($\alpha = 0.05$) (SAS 1990). Monthly water depth and land cover category values, including associated standard errors, were estimated using least-square means statements (SAS 1990).

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Species richness and a Floristic Quality Assessment (FQA) were calculated for vegetation identified on restored and reference wetlands. Species richness was calculated by summing the number of species present per wetland and averaging across wetland type. Floristic Quality Assessment is a tool to assist in assessing floristic and natural significance of any give area throughout Michigan (Herman et al. 2001). When conducting a FQA, two variables are calculated: a mean coefficient of conservatism ($\overline{C}$) and a floristic quality index (FQI) from an inventory of plants (Herman et al. 2001). Each native Michigan species is assigned a coefficient of conservatism (C) that ranges from 0 (plants that can be found anywhere) to 10 (plants that are restricted to pre-settlement remnants) (Herman et al. 2001). A $\overline{C}$ is calculated by summing the C values of the plant inventory and dividing by the total number of plant taxa ($\overline{C} = \Sigma\ C/n$) (Herman et al. 2001). Therefore, a low $\overline{C}$ value indicates an area with little native vegetation present and a high $\overline{C}$ value indicates an area with a high quality native habitat. The $\overline{C}$ is then multiplied by the square root of the total number of plants to yield a FQI (FQI = $\overline{C}\sqrt{n}$) (Herman et al. 2001). An FQI is calculated so that areas of different sizes can be compared (Herman et al. 2001).

RESULTS

Broad Evaluation

Comparisons Between Restored and Reference Sites

Water depth was greater ($P \leq 0.01$) on restored than reference sites for all months (May, June, July) in 2002 (Table 2.1). In addition, restored sites had a wider range of water depth readings then reference sites in all months, ranging from 0 to 213 cm (Figure 2.1, 2.2, 2.3). Furthermore, restored sites had higher percentage ($P \leq 0.01$) of open water and lower percentage ($P \leq 0.01$) of total vegetation cover than reference sites (Table 2.1). Within percent total cover, only percent grass-like vegetation cover was greater ($P < 0.01$) on reference than restored sites (Table 2.1).

Comparisons among Age Categories

Of the possible water depth and vegetation variables, only percent bare ground was different among age categories (Table 2.2). Percent bare ground was greater ($P < 0.01$) on 1 - 2 and 3 - 5 year-old sites than on ≥ 6 year-old sites (Table 2.2).

Structural Evaluations

Overall, evaluations of restoration design structures revealed that the majority of structures were functioning well and exhibited only minor problems. Ninety-five percent of water control structures evaluated had no visible signs of seepage around the structure (Table 2.3). Eighty percent of water control structures showed no visible signs of deterioration, including rust, rot and cracking, and 100% showed no visible signs of material settling around the structure (Table 2.3). Furthermore, only 10% of water control structures were rated as having significant damage (Table 2.3). Water control structures evaluated for erosion and sediment and/or other items reducing the capacity of

Table 2.1. Mean (SE) monthly water depth and percent land cover characteristics of restored and reference wetlands in the Saginaw Bay watershed, Michigan, summer 2002.

Variables	Restored (n=58)	Reference (n=13)	P-value
Water Depth (cm)			
May*	113.7 (5.4)	57.4 (6.9)	<0.01
June*	105.3 (5.3)	49.0 (7.4)	<0.01
July*	84.0 (5.8)	31.4 (6.9)	<0.01
% Total Cover*	48.9 (3.0)	77.3 (3.9)	<0.01
% Tree Cover	4.5 (0.9)	5.6 (1.4)	0.15
% Shrub Cover	3.1 (0.8)	3.6 (2.2)	0.81
% Cattail Cover	13.5 (2.1)	13.4 (4.2)	0.99
% Grass-like Cover*	19.2 (2.4)	46.5 (6.4)	<0.01
% Other Cover	8.6 (0.9)	8.3 (1.3)	0.06
% Open Water*	45.9 (3.1)	17.3 (3.8)	<0.01
% Bare Ground	5.2 (1.0)	5.4 (2.7)	0.48

* significantly different (Mann-Whitney U (MWU) test, $P \leq 0.05$)

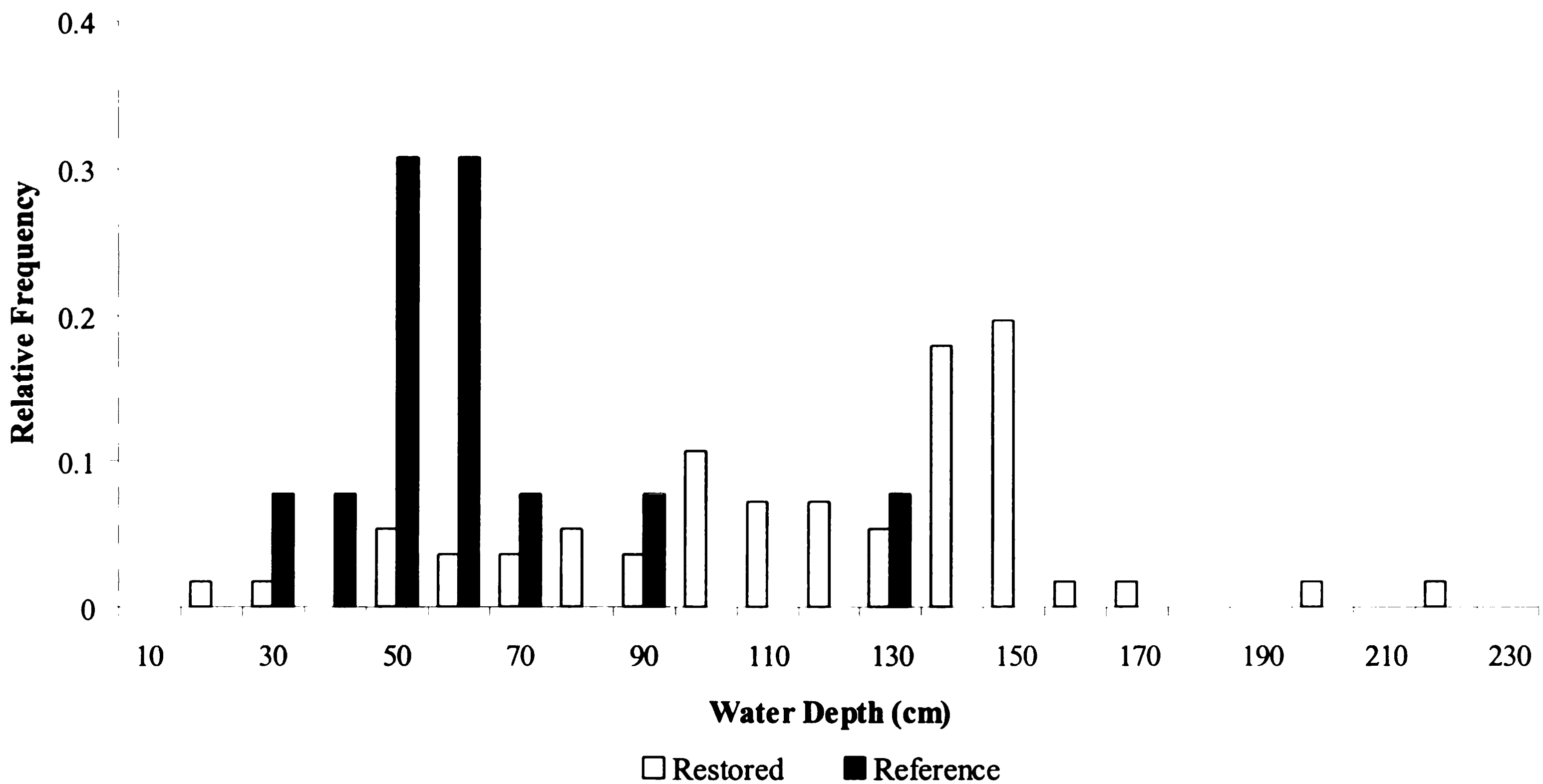

Fig. 2.1. Relative frequency of May broad water depth measurement between restored and reference wetlands in the Saginaw Bay watershed, summer 2002.

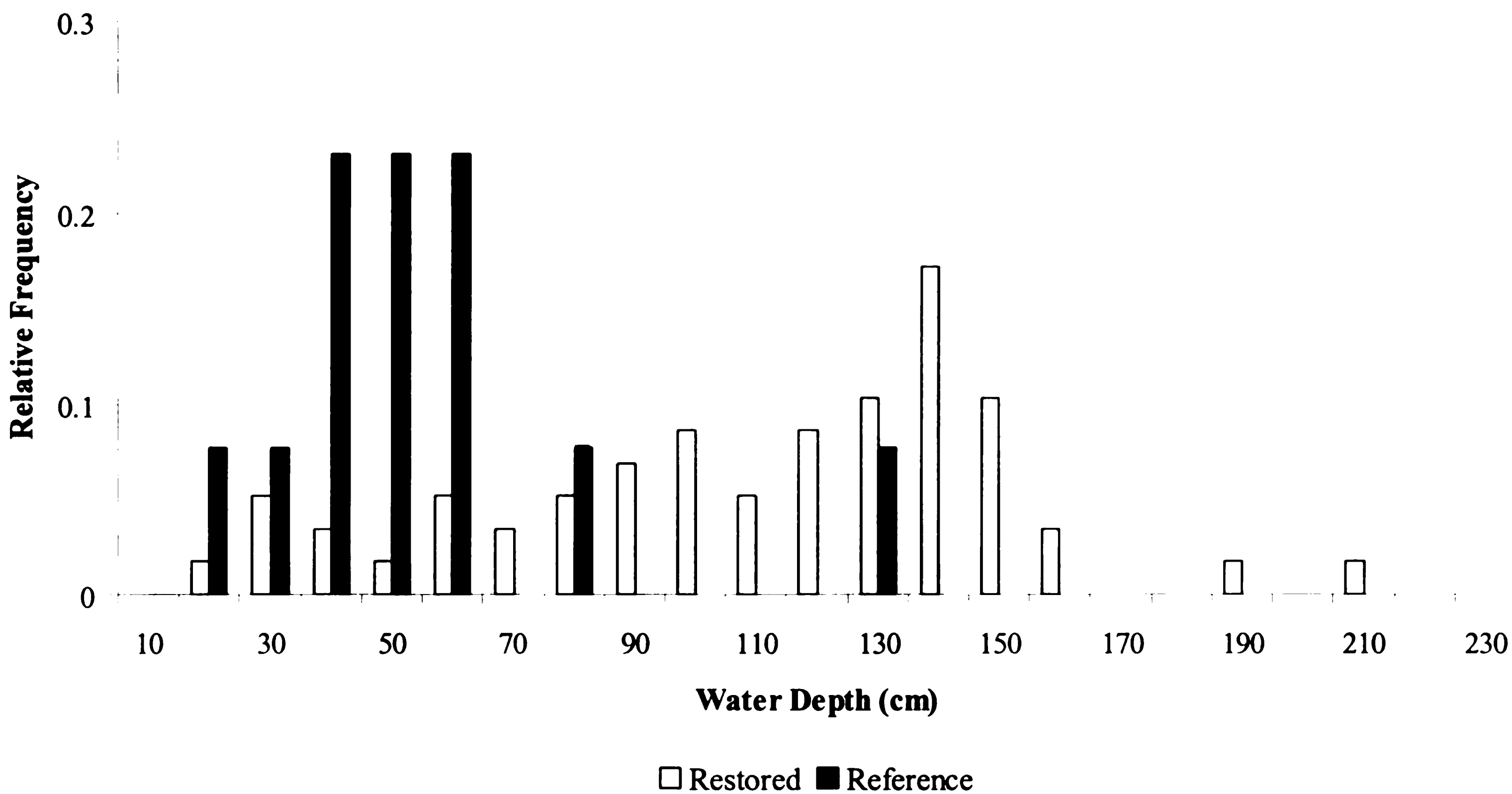

Fig. 2.2. Relative frequency of June broad water depth comparisons between years for restored wetlands in the Saginaw Bay watershed, summer 2002.

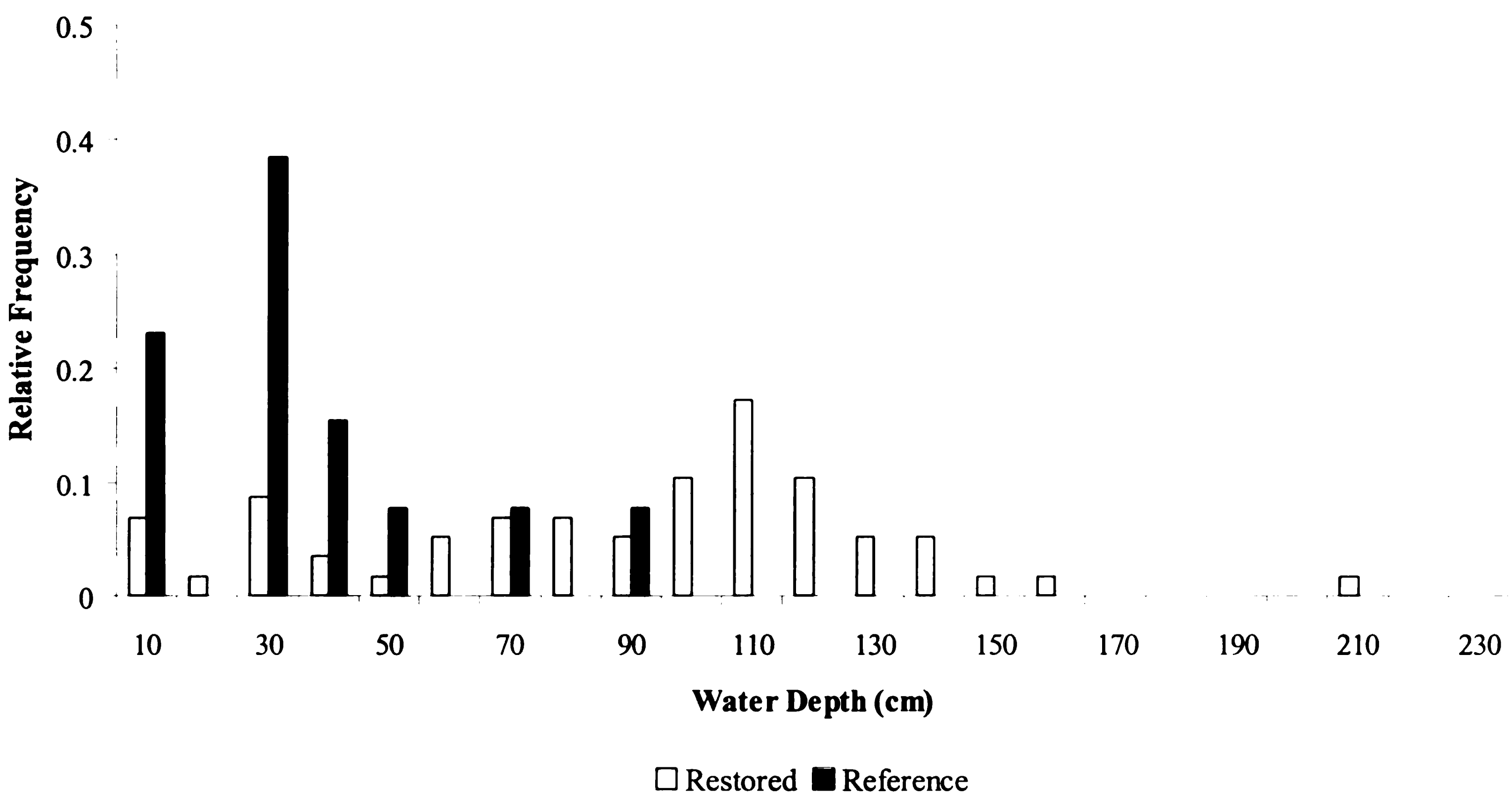

Fig. 2.3. Relative frequency of July broad water depth comparisons between years for restored wetlands in the Saginaw Bay watershed, summer 2002.

Table 2.2. Mean (SE) monthly water depth and land cover characteristics among years of restored wetlands in the Saginaw Bay watershed, Michigan, summer 2002.

Characteristics	Wetland Age 1-2 (n = 16)	3-5 (n = 16[1])	≥ 6 (n = 26[2])	P-value
Water Depth (cm)				
May	118.8 (10.1)	116.9 (10.5)	108.4 (8.1)	0.83
June	109.6 (10.5)	102.3 (10.5)	104.6 (8.2)	1.00
July	86.6 (11.1)	79.6 (11.1)	85.1 (8.7)	1.00
% Total Cover	42.2 (5.8)	51.5 (5.8)	51.3 (4.5)	0.42
% Tree Cover	5.5 (1.8)	4.3 (1.8)	4.0 (0.9)	0.92
% Shrub Cover	3.5 (1.6)	3.5 (1.6)	2.7 (1.2)	0.92
% Cattail Cover	12.6 (3.9)	7.1 (3.9)	17.9 (3.0)	0.09
% Grass-like Cover	13.5 (4.6)	25.0 (4.6)	19.0 (3.6)	0.36
% Other Cover	7.0 (1.8)	11.6 (1.8)	7.8 (1.4)	0.08
% Open Water	50.9 (5.8)	38.7 (5.8)	47.3 (4.6)	0.30
% Bare Ground*	6.9^{A} (1.6)	9.8^{A} (1.6)	1.3^{B} (1.3)	<0.01

[1] n=15 for 3-5 year restored wetlands for May 2002

[2] n=25 for >6 year restored wetlands for May 2002

*significantly different among years (Kruskal-Wallis (KW) one-way analysis of variance, P≤ 0.05). Within a row, means having the same letter are not significantly different (multiple comparison z-test, z>1.96).

Table 2.3. Percent of U.S. Fish and Wildlife Service's Partner's for Fish and Wildlife Wetland Restoration Program sites within each assessment class for different broad evaluation structural design categories in the Saginaw Bay watershed, MI. See Appendix A for description of assessment classes.

	Assessment Class				
Category	Extensive	Significant	Moderate	Slight	Nil
Water Control Structures/Pipe installation (n=20)					
Seepage around structure	0	5	0	0	95
Deterioration (rust/rot/cracking)	0	5	5	10	80
Settling	0	0	0	0	100
Erosion	0	0	10	25	65
Sediment reducing capacity of conduit	0	5	15	30	50
Other items clogging conduit	0	10	10	20	60
Spillway (n=53)					
Erosion	0	6	15	28	51
Berm Construction (n=56)					
Erosion	0	4	27	35	34
Seepage	0	5	5	4	86
Sloughing	0	2	4	4	90
Undercutting	0	4	0	0	96
Settlement Apparent	0	0	2	4	94
Animal Damage	0	7	12	9	72
Constructed Island (n=4)					
Settling Apparent	0	0	25	0	75
Erosion	0	0	25	0	75

the conduit had values that ranged more broadly from significant to no damage (Table 2.3). Although only 15% were rated as having significant damage, 45% received moderate to slight damage scores (Table 2.3). Seventy-nine percent of spillways evaluated had slight to no visible erosion damage (Table 2.3). Eighty-six percent of constructed berms had no visible problems with seepage, undercutting, sloughing and settlement of material (Table 2.3). However, berms experienced a greater range of erosion damage. Approximately 60% of all berms were evaluated as having significant to moderate damage (Table 2.3). Although few berms showed visible signs of animal damage, specifically muskrats, approximately 19% experienced significant to moderate damage (Table 2.3). Approximately 75% of constructed islands had no visible damage with only 25% having moderate damage.

Habitat Variables and Wildlife Observed

Reed canary grass (*Phalaris arundinacea*), narrow and broad leaved cattail (*Typha augustifolia, T. latifolia*), sedges and rushes were the dominant types of vegetation found on restored and reference wetlands. Reed canary was present in 50% of restored and 60% of reference sites. Narrow and broad leaved cattails were present in 35 of 58 restored and 6 of 13 reference sites. Sedges and rushes, which included common hop sedge (*Carex lupulina*), common fox sedge *(Carex stipata)*, path rush (*Juncus tenuis*), knotted rush (*Juncus nodosus*) and green bulrush (*Scripus atrovirensa*), were present on 40% of restored sites and 70% of reference sites.

The upland habitat immediately surrounding restored wetlands can be characterized as fallow fields, pasture and/or grasses with a mix of trees. Four restored wetlands were in the middle of agricultural fields surrounded by a 10 – 20 m buffer of upland grasses. About one-fifth of the landowners were still actively farming or producing livestock on their property. The upland habitat surrounding reference wetlands was mostly forested with the exception of one site, which was surrounded by a mix of grasses.

A variety of wildlife were observed using both restored and reference wetlands. White-tailed Deer (*Odocoileus virginianus*) and the Common Muskrat (*Ondatra zibethicus*) were the most abundant mammals utilizing restored wetlands (Table 2.4). The most common amphibians observed on restored and reference sites were Bullfrogs (*Rana catesbeiana*) and Green Frogs (*Rana clamitans*) (Table 2.4). Red-winged Blackbirds (*Agelaius phoeniceus*) were found on 54 of 58 restored sites and 7 of 13 reference sites (Table 2.4). Other common bird species were the Canada Goose (*Branta Canadensis*), Mallard (*Anas platyrhynchos*), Tree Swallow (*Tachycineta bicolor*), American Robin (*Turdus migratorius*), Common Yellowthroat (*Geothlypis trichas*), and Yellow Warbler (*Dendroica petechia*) (Table 2.4).

Intensive Evaluation

Water Depth

Restored sites had higher (Mixed Procedure, F=12.39, 19.42, 17.26, $P < 0.01$) water levels for all months (May, June, July) than reference sites (Table 2.5). Average water depth for restored sites was highest in June (59 cm) and lowest in July (43 cm) (Table 2.5). Average water depth for reference sites was highest in May (36 cm) and decreased monthly through July (15 cm) (Table 2.5). Reference sites had a higher percentage of shallow water depth readings than restored sites in all months (Figure 2.4, 2.5, 2.6). Mean water depth levels among reference sites ranged from 24.8 - 52.6 cm in

Table 2.4. Number of restored and reference wetlands where wildlife were observed during broad evaluations on restored and reference wetlands in the Saginaw Bay watershed, summer 2002.

Type	Common Name	*Scientific Name*	Restored (n=58)	Reference (n=13)
Avian	American Crow	*Corvus brachyrhynchos*	0	1
	American Dipper	*Cinclus mexicanus*	1	0
	American Goldfinch	*Cardurlis tristis*	10	1
	American Robin	*Turdus migratorius*	10	4
	Barn Swallow	*Hirundo rustica*	14	0
	Belted Kingfisher	*Ceryle torquata*	8	2
	Black-capped Chickadee	*Parus atricapillus*	1	3
	Blue Jay	*Cyanocitta cristata*	1	1
	Blue-wing Teal	*Anas discors*	8	0
	Bobolink	*Dolichonyx oryzivorus*	11	0
	Canada Goose	*Branta canadensis*	18	2
	Cedar Waxwing	*Bombycilla cedrorum*	2	0
	Common Grackle	*Quiscalus quiscula*	2	0
	Common Merganser	*Mergus serrator*	4	0
	Common Moorhen	*Gallinula chloropus*	1	0
	Common Yellowthroat	*Geothlypis trichas*	8	5
	Downy Woodpecker	*Picoides pubescens*	1	2
	Eastern Bluebird	*Sialia sialis*	2	0
	Eastern Kingbird	*Tyrannus tyrannus*	9	1
	Field Sparrow	*Spizella pusilla*	4	0
	Gray Catbird	*Dumetella carolinensis*	6	0
	Great Blue Heron	*Ardea herodias*	17	1
	Great Horn Owl	*Bubo virginianus*	1	0
	Green Heron	*Butorides striatus*	17	1
	Hermit Thrush	*Catharus guttatus*	1	0
	Killdeer	*Charadrius vociferus*	11	1
	Least Bittern	*Ixobtychus exilis*	2	0
	Mallard	*Anas platyrhynchos*	21	4
	Marsh Wren	*Cistothorus palustris*	1	0
	Mourning Dove	*Zenaida macroura*	11	2
	Northern Cardinal	*Cardinalis cardinalis*	4	3
	Northern Flicker	*Colaptes auratus*	4	1
	Pied-billed Grebe	*Podilymbus podiceps*	3	0
	Pileated Woodpecker	*Drycopus pileatus*	3	0
	Redhead	*Aythya americana*	1	0
	Red-tailed Hawk	*Buteo jamaicensis*	3	0
	Red-winged Blackbird	*Agelaius phoeniceus*	54	7
	Ring-necked Pheasant	*Phasianus colchicus*	13	1
	Ruffed Grouse	*Bonasa umbellus*	2	1
	Sandhill Crane	*Grus canadensis*	1	0
	Sedge Wren	*Cistothorus platensis*	1	0
	Semi-palmated Sandpiper	*Calidris pusilla*	2	0
	Song Sparrow	*Melospiza melodia*	11	3
	Sora	*Porzana carolina*	5	2
	Swamp Sparrow	*Melospiza georgiana*	2	1
	Tree Swallow	*Tachycineta bicolor*	29	1
	Turkey Vulture	*Cathartes aura*	1	0
	Virginia Rail	*Rallus limicola*	5	0

Table 2.4. Cont'd.

Type	Common Name	*Scientific Name*	Restored (n=58)	Reference (n=13)
	Wild Turkey	*Meleagris gallopavo*	8	1
	Wilson's Phalarope	*Phalaropus tricolor*	1	0
	Wood Duck	*Aix sponsa*	7	2
	Wood Thrush	*Hylocichla mustelina*	2	0
	Yellow Warbler	*Dendroica petechia*	12	2
Mammals	Common Muskrat	*Ondatra zibethicus*	16	0
	Common Raccoon	*Procyon lotor*	8	0
	Eastern Cottontail Rabbit	*Sylvilagus floridanus*	3	0
	Eastern Fox Squirrel	*Sciurus niger*	0	1
	Red Fox	*Vulpes vulpes*	1	0
	White-tailed Deer	*Odocoileus virginianus*	39	4
Amphibians	Black-rat Snake	*Elaphe obsolete*	0	1
	Blandings Turtle	*Emydoidea blandingi*	2	2
	Bullfrog	*Rana catesbeiana*	17	3
	Green Frog	*Rana clamitans*	17	3
	Painted Turtle	*Chrysemys picta*	10	0

Table 2.5
reference

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Table 2.5. Mean (SE) monthly water depth and land cover characteristics of restored and reference wetlands in the Saginaw Bay watershed, Michigan, summer 2001 and 2002.

Variables	Restored (n = 25[1])	Reference (n = 10)	P-value
Water Depth			
May*	57.5 (5.3)	35.7 (3.3)	< 0.01
June*	58.9 (4.9)	30.5 (7.0)	< 0.01
July*	42.5 (4.8)	15.3 (4.5)	< 0.01
% Total Cover*	48.6 (4.6)	70.2 (5.5)	< 0.01
% Forb Cover*	29.4 (3.8)	33.9 (9.4)	<0.01
% Grass Cover*	11.9 (3.8)	21.8 (5.4)	<0.01
% SRC[2] Cover*	4.9 (1.2)	10.1 (3.9)	<0.01
% Wood Cover*	2.0 (0.5)	4.4 (1.1)	< 0.01
% Open Water*	47.6 (4.9)	17.3 (4.7)	< 0.01
% Bare Ground*	3.8 (0.6)	12.4 (4.0)	<0.01

[1] n=24 for restored wetlands for May 2002
[2] SRC = sedge and rush cover
*significantly different (P≤ 0.05) as determined by ANOVA

0.3

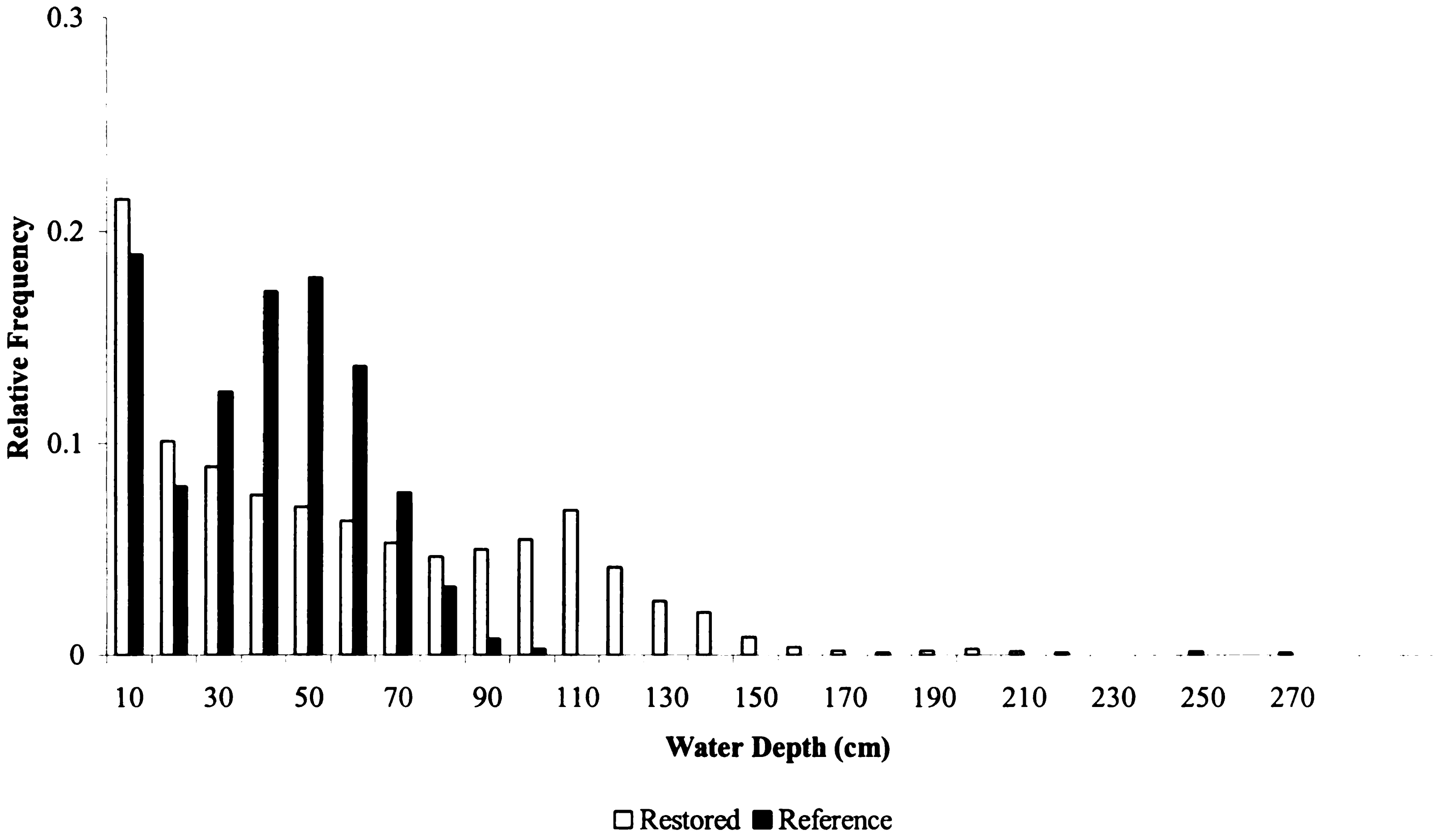

Fig. 2.4. Relative frequency of May water depth comparisons between restored and reference wetlands in the Saginaw Bay watershed, summers 2001 and 2002.


0.3

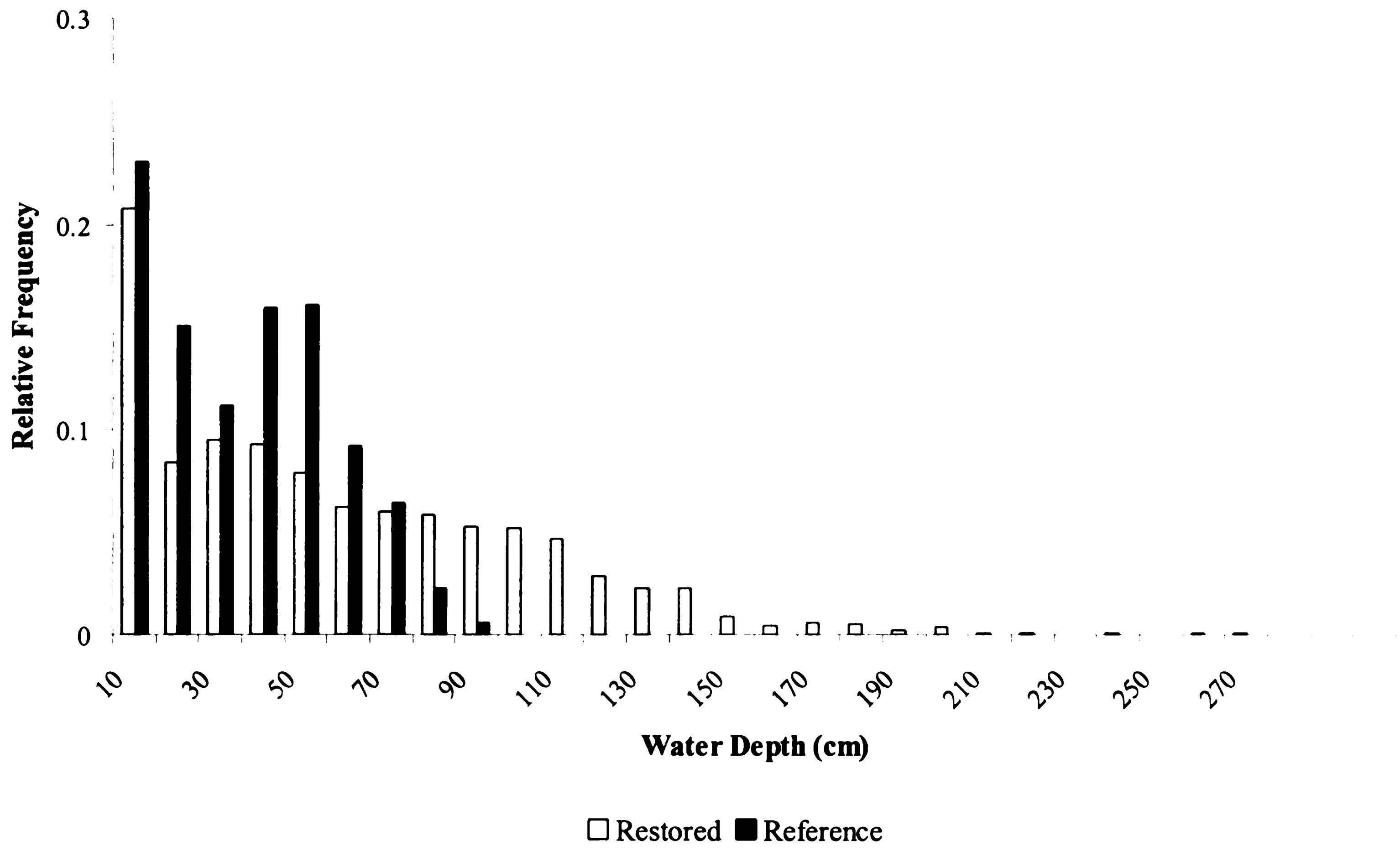

Fig. 2.5. Relative frequency of June water depth comparisons between restored and reference wetlands in the Saginaw Bay watershed, 2001-2002.

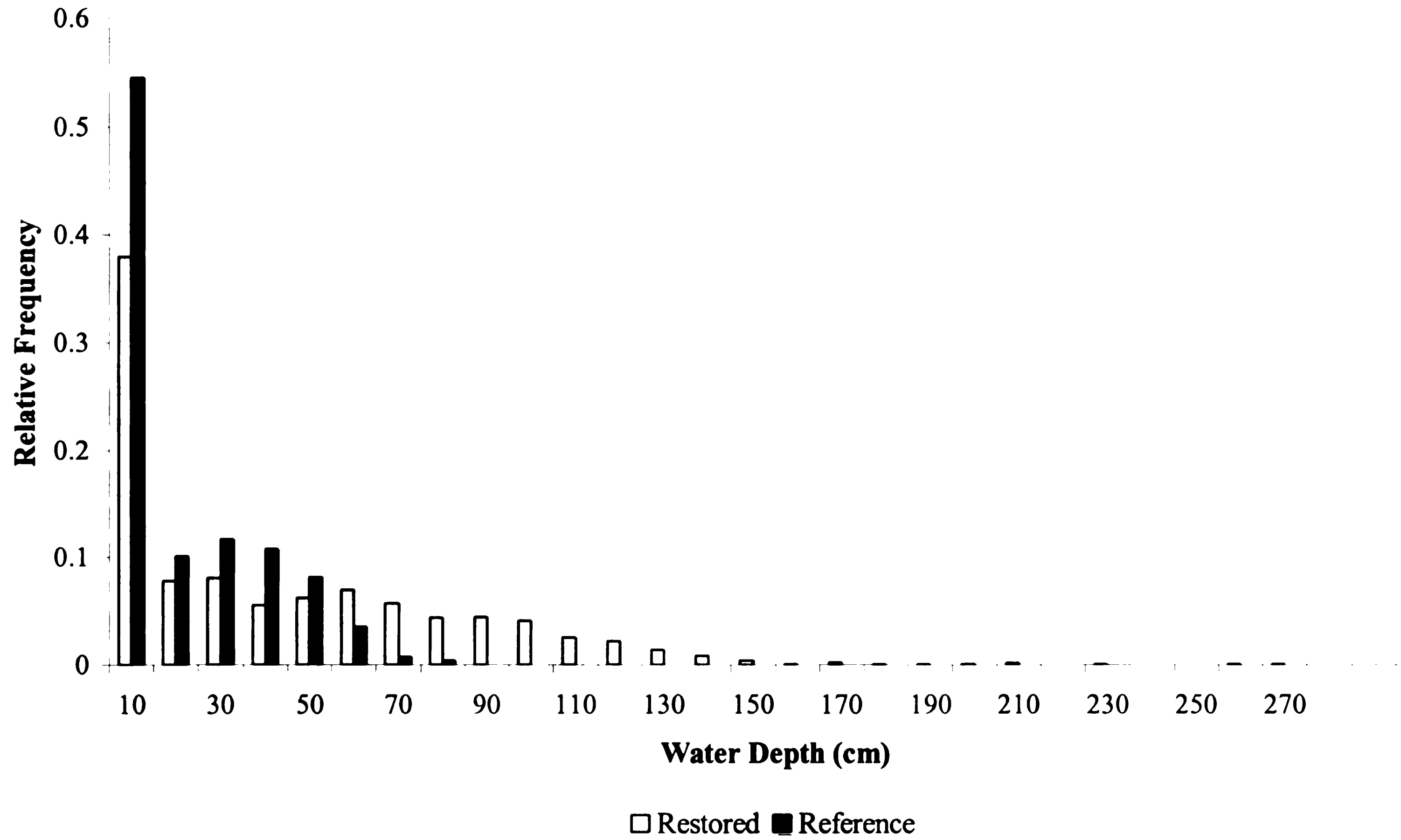

Fig. 2.6. Relative frequency of July water depth comparisons between restored and reference wetlands in the Saginaw Bay watershed, summers 2001 and 2002.

May to 0 - 35.1 cm in July (Figure 2.4, 2.5, 2.6). Restored sites had a wider range of water depth readings then reference sites in all months. Mean water depth levels among restored sites ranged from 15.2 - 103.4 cm in May to 1.34 - 90.1 cm in July.

Vegetative Percent Cover and Composition

Reference wetlands had a greater percentage of total vegetative cover (Mixed Procedure, F=9.12, $P < 0.01$) and bare ground cover (Mixed Procedure, F=4.51, $P < 0.01$) and less open water (Mixed Procedure, F=20.03, $P < 0.01$) than restored wetlands (Table 2.5). Reference sites supported greater (Mixed Procedure, F=0.19, $P< 0.01$) percent forb cover, (Mixed Procedure, F=2.26, $P < 0.01$) grass cover, (Mixed Procedure, F=1.63, $P < 0.01$) sedge and rush cover, and (Mixed Procedure, F=3.62, $P < 0.01$) wood cover than restored sites (Table 2.5).

One-hundred and eighty plant species were identified on restored and reference sites (See Appendix 2.B for list of species). Restored and reference sites supported 142 and 113 vegetative species, respectively. Sixty-seven species were unique to restored sites and 38 species were unique to reference sites. Narrow and broad leaved cattails were present in 23 of 25 restored and 7 of 10 reference wetlands. Reed canary grass was also established in 80% of restored and reference sites. Black willow (*Salix nigra*), common hop sedge, common fox sedge, soft rush (*Juncus tenuis*), green bulrush, soft-stem bulrush (*Scripus validus*), swamp milkweed (*Asclepias incarnata*) and lesser and greater duckweed (*Lemna minor, Spirodela polyrhiza*) were the dominant vegetation types established in all 25 restored wetlands. Black willow, sandbar willow (*Salix exigua*), meadowsweet *(Spiraea alba*), southern three-lobed bedstraw (*Galium tinctorium*), marsh skullcap (*Scutellaria galericulata*), bristly sedge (*Carex comosa*), and lesser and

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lesser and greater duckweed were the dominant vegetation types established at all 10 reference wetlands.

A Floristic Quality Assessment (FQA) was calculated for restored and reference wetlands in which a mean coefficient of conservatism ($\overline{C}$) and a floristic quality index (FQI) are calculated (Herman 2001). Restored and reference wetlands had similar $\overline{C}$'s, (3.65 and 3.95, respectively) and FQI's, (40.3 and 39.5, respectively) (Table 2.6). Furthermore, mean vegetation species richness was not different between restored and reference wetlands (Table 2.6).

Avian Surveys

One-thousand seven-hundred sixty-three individual birds were observed within survey plots during this study. Sixty-three avian species were observed during monthly point counts (Appendix 2.C). Thirty-six species were observed at both restored and reference wetlands. In comparison, 18 species were only observed at restored sites and 9 species were only observed at reference sites. Of the 63 avian species identified, 15 species were considered actively breeding according to the breeding bird criteria of Brown and Dinsmore (1986) (Table 2.7). Fourteen breeding species were observed at restored wetlands and six species were found at reference wetlands (Table 2.7).

Seventy waterfowl pairs were observed using restored wetlands in April 2001 and 2002 (Table 2.8). Waterfowl pairs were observed at 13 of the 25 restored sites. The most abundant species observed was the Blue-winged Teal (*Anas discors*) (22) and least abundant was the Bufflehead (*Bucephala albeola*) (2) (Table 2.8).

Eighteen broods were observed at nine of the 25 restored wetlands. The Canada Goose was present the most (12) whereas the Wood Duck and Common Merganser

Table 2.6. Mean (SE) vegetation species richness, mean coefficient of conservatism ($\overline{C}$), and floristic quality index (FQI) of restored and reference wetlands in the Saginaw Bay watershed, Michigan, summer 2001 and 2002.

	Restored (n=25)	Reference (n=10)	P-value
Species richness	24.6 (2.8)	24.3 (3.4)	0.65
$\overline{C}$	3.7	4.0	
FQI	40.3	39.5	

Table 2.7.
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Virginia
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Table 2.7. Presence of nests at restored and reference wetlands in the Saginaw Bay watershed, Michigan, summer 2001 and 2002.

Common Name	*Scientific Name*	Restored (n=25)	Reference (n=10)
Canada Goose	*Branta canadensis*	X	
Common Grackle	*Quiscalus quiscula*	X	X
Common Merganser	*Mergus serrator*	X	
Eastern Bluebird	*Sialia sialis*	X	
Field Sparrow	*Spizella pusilla*	X	
House Wren	*Troglodytes aedon*	X	
Mallard	*Anas platyrhynchos*	X	X
Pied-billed Grebe	*Podilymbus podiceps*	X	
Red-winged Blackbird	*Agelaius phoeniceus*	X	X
Song Sparrow	*Melospiza melodia*	X	
Sora	*Porzana carolina*	X	X
Tree Swallow	*Tachycineta bicolor*	X	X
Virginia Rail	*Rallus limicola*	X	
Wild Turkey	*Meleagris gallopavo*		X
Wood Duck	*Aix sponsa*	X	

Table 2.8
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Table 2.8. Number of waterfowl pairs found on restored wetlands in the Saginaw Bay watershed, spring 2001 and 2002.

Common Name	*Scientific Name*	Restored (n=25)
Blue-winged Teal	*Anas discors*	22
Bufflehead	*Bucephala albeola*	2
Canada Goose	*Branta canadensis*	14
Hooded Merganser	*Lophodytes cucullatus*	2
Mallard	*Anas platyrhynchos*	6
Ring-necked Duck	*Aythya collaris*	16
Wood Duck	*Aix sponsa*	8

(*Mergus merganser*) were observed the least (1 each) (Table 2.9). Waterfowl broods were not observed at any reference sites.

Mean avian species richness was not different ($P > 0.05$) between restored and reference sites across all months (Table 2.10). Mean species richness ranged from 5.9 - 6.3 on restored sites and 4.7 - 6.7 on reference sites. Likewise, avian diversity did not differ ($P > 0.05$) between restored and reference sites across all months (Table 2.11). However, mean avian density was greater ($P \leq 0.01$) at restored sites than reference sites in May and July (Table 2.12).

Individual species density were compared between restored and reference sites across all months (Table 2.13, 2.14, 2.15). The seven most abundant species observed on restored and reference sites were Red-winged Blackbird, Tree Swallow, Canada Goose, Barn Swallow *(Hirundo rustica*), Mallard, Yellow Warbler and Common Yellowthroat (Table 2.13, 2.14, 2.15). In May, the Red-winged Blackbird and Tree Swallow had greater ($P \leq 0.03$) mean densities at restored than reference sites, whereas reference sites supported a greater ($P < 0.01$) mean density of Rose-breasted Grosbeak (Table 2.13). In June, the Red-winged Blackbird, Tree Swallow and Barn Swallow had greater ($P \leq 0.03$) mean densities at restored than reference sites, whereas the American Goldfinch (*Cardurlis tristis),* American Robin, Baltimore Oriole (*Icterus galbula*), Common Yellowthroat, Blue Jay (*Cyanocitta cristata*), and Downy Woodpecker (*Picoides pubescens*) had greater ($P \leq 0.03$) mean densities at reference sites (Table 2.14). In July, the Red-winged Blackbird, Tree Swallow and Barn Swallow had greater ($P \leq 0.02$) mean densities at restored than reference sites, whereas reference sites supported greater ($P \leq 0.04$) mean densities of the Common Yellowthroat, Blue Jay, Gray Catbird (*Dumetella*

Table 2.9. Number of avian broods found on restored and reference wetlands in the Saginaw Bay watershed, summer 2001 and 2002.

Common Name	*Scientific Name*	Restored	Reference
Canada goose	*Branta canadensis*	12	0
Common merganser	*Mergus serrator*	1	0
Mallard	*Anas platyrhynchos*	3	0
Wood duck	*Aix sponsa*	1	0

Table 2.10. Mean (SE) avian species richness and of restored and reference wetlands in the Saginaw Bay watershed, Michigan, summer 2001 and 2002.

Month	Restored (n = 25[1])	Reference (n = 10)	P-value
May	6.3 (0.6)	4.7 (1.0)`	0.07
June	5.9 (0.6)	6.7 (1.1)	0.57
July	5.9 (0.5)	6.3 (1.3)	0.97

[1] n=24 for restored wetlands for May 2002

*significantly different (Mann-Whitney U (MWU) test, P≤ 0.05)

Table 2.11. Mean (SE) avian diversity at restored and reference wetlands in the Saginaw Bay watershed, Michigan, summer 2001 and 2002.

Month	Restored (n = 25[1])	Reference (n = 10)	P-value
May	1.39 (0.08)	1.18 (0.14)	0.16
June	1.23 (0.12)	1.61 (0.12)	0.07
July	1.17 (0.10)	1.50 (0.15)	0.13

[1] n=24 for restored wetlands for May 2002

*significantly different (Mann-Whitney U (MWU) test, P≤ 0.05)

Table 2.12. Mean (SE) avian density based on the number of species per wetland at restored and reference wetlands in the Saginaw Bay watershed, Michigan, summer 2001 and 2002.

Month	Restored (n = 25[1])	Reference (n = 10)	P-value
May*	31.0 (4.5)	18.5 (4.8)	0.01
June	29.3 (3.0)	20.4 (3.2)	0.11
July*	34.6 (3.7)	17.6 (2.7)	< 0.01

[1] n=24 for restored wetlands for May 2002

*significantly different (Mann-Whitney U (MWU) test, $P \leq 0.05$)

Table 2.13. May mean avian density (SE) for each species and the percent similarity of species observed on restored and reference sites, Saginaw Bay Watershed, summer 2001 and 2002.

Type	Common Name	*Scientific Name*	Restored	Reference	P
Wetland dependent	Alder Flycatcher	*Empidonax alnorum*	0.00 (0.00)	0.00 (0.00)	1.00
	American Coot	*Fulica americana*	0.00 (0.00)	0.00 (0.00)	1.00
	Bank Swallow	*Riparia riparia*	0.00 (0.00)	0.00 (0.00)	1.00
	Belted Kingfisher	*Ceryle torquata*	0.09 (0.06)	0.00 (0.00)	0.38
	Blue-winged Teal	*Anas discors*	0.03 (0.03)	0.07 (0.07)	0.55
	Canada Goose	*Branta canadensis*	3.36 (0.99)	0.86 (0.71)	0.18
	Common Merganser	*Mergus serrator*	0.00 (0.00)	0.00 (0.00)	1.00
	Common Snipe	*Gallinago gallinago*	0.03 (0.03)	0.00 (0.00)	0.56
	Common Yellowthroat	*Geothlypis trichas*	0.10 (0.10)	0.14 (0.10)	0.18
	Great Blue Heron	*Ardea herodias*	0.03 (0.03)	0.00 (0.00)	0.56
	Green Heron	*Butorides striatus*	0.13 (0.10)	0.00 (0.00)	0.38
	Hooded Merganser	*Lophodytes albellus*	0.00 (0.00)	0.00 (0.00)	1.00
	Least Bittern	*Ixobtychus exilis*	0.04 (0.04)	0.00 (0.00)	0.56
	Mallard	*Anas platyrhynchos*	0.89 (0.27)	0.43 (0.36)	0.33
	Marsh Wren	*Cistothorus palustris*	0.04 (0.04)	0.00 (0.00)	0.63
	Red-winged Blackbird*	*Agelaius phoeniceus*	15.54 (1.88)	8.00 (2.33)	0.03
	Sedge Wren	*Cistothorus platensis*	0.00 (0.00)	0.00 (0.00)	0.00
	Sora	*Porzana carolina*	0.90 (0.26)	0.81 (0.43)	0.86
	Swamp Sparrow	*Melospiza georgiana*	0.00 (0.00)	0.00 (0.00)	1.00
	Tree Swallow*	*Tachycineta bicolor*	2.87 (0.78)	0.71 (0.71)	0.02
	Virginia Rail	*Rallus limicola*	0.00 (0.00)	0.00 (0.00)	1.00
	White-rumped Sandpiper	*Calidris fuscicollis*	0.15 (0.15)	0.00 (0.00)	0.56
	Willow Flycatcher	*Empidonax traillii*	0.00 (0.00)	0.00 (0.00)	1.00
	Wood Duck	*Aix sponsa*	0.41 (0.30)	0.32 (0.22)	0.62
Wetland associated	Barn Swallow	*Hirundo rustica*	0.98 (0.28)	0.21 (0.21)	0.07
	Common Grackle	*Quiscalus quiscula*	0.22 (0.13)	0.29 (0.29)	0.95
	Eastern Kingbird	*Tyrannus tyrannus*	0.23 (0.13)	0.00 (0.00)	0.27
	Gray Catbird	*Dumetella carolinensis*	0.22 (0.16)	0.57 (0.40)	0.34
	House Wren	*Troglodytes aedon*	0.00 (0.00)	0.00 (0.00)	1.00
	Killdeer	*Charadrius vociferus*	0.05 (0.05)	0.00 (0.00)	0.63
	Yellow Warbler	*Dendroica petechia*	0.91 (0.50)	0.19 (0.13)	0.50
Nonwetland	American Goldfinch	*Cardurlis tristis*	0.63 (0.25)	1.20 (0.48)	0.25

Table 2.13. Cont'd

Type	Common Name	*Scientific Name*	Restored	Reference	P Value
	American Robin	*Turdus migratorius*	0.18 (0.10)	0.86 (0.47)	0.18
	Baltimore Oriole	*Icterus galbula*	0.69 (0.36)	0.00 (0.00)	0.19
	Black-capped Chickadee	*Parus atricapillus*	0.04 (0.04)	0.71 (0.48)	0.13
	Blue Jay	*Cyanocitta cristata*	0.19 (0.15)	0.14 (0.14)	0.91
	Bobolink	*Dolichonyx oryzivorus*	0.06 (0.06)	0.00 (0.00)	0.56
	Cedar Waxwing	*Bombycilla cedrorum*	0.00 (0.00)	0.00 (0.00)	1.00
	Cooper's Hawk	*Accipiter cooperii*	0.00 (0.00)	0.00 (0.00)	1.00
	Dark-eyed Junco	*Junco jyemalis*	0.00 (0.00)	0.00 (0.00)	1.00
	Downy Woodpecker	*Picoides pubescens*	0.15 (0.15)	0.07 (0.07)	0.58
	Eastern Bluebird	*Sialia sialis*	0.22 (0.16)	0.00 (0.00)	0.38
	Eastern Wood-Pewee	*Contopus virens*	0.19 (0.11)	0.00 (0.00)	0.27
	Eurasian Blackbird	*Turdus merula*	0.00 (0.00)	0.00 (0.00)	1.00
	European Starling	*Sturnus vulgaris*	0.07 (0.07)	0.00 (0.00)	0.56
	Field Sparrow	*Spizella pusilla*	0.07 (0.07)	0.00 (0.00)	0.56
	Great Crested Flycatcher	*Myiarchus crinitus*	0.00 (0.00)	0.18 (0.18)	0.14
	Hairy Woodpecker	*Picoides villosus*	0.00 (0.00)	0.00 (0.00)	1.00
	Hermit Thrush	*Catharus guttatus*	0.00 (0.00)	0.00 (0.00)	1.00
	House Sparrow	*Passer montanus*	0.15 (0.15)	0.00 (0.00)	0.57
	Indigo Bunting	*Passerina cyanea*	0.00 (0.00)	0.00 (0.00)	1.00
	Mourning Dove	*Zenaida macroura*	0.10 (0.10)	0.00 (0.00)	0.56
	Northern Cardinal	*Cardinalis cardinalis*	0.15 (0.10)	1.07 (1.07)	0.85
	Northern Flicker	*Colaptes auratus*	0.10 (0.08)	0.07 (0.07)	0.94
	Pileated Woodpecker	*Drycopus pileatus*	0.00 (0.00)	0.07 (0.07)	0.14
	Red-bellied Woodpecker	*Melanerpes carolinas*	0.00 (0.00)	0.00 (0.00)	1.00
	Red-shouldered Hawk	*Buteo lineatus*	0.00 (0.00)	0.00 (0.00)	1.00
	Rose-breasted Grosbeak*	*Pheuticus ludovicianus*	0.00 (0.00)	0.71 (0.48)	0.03
	Ruby-throated Hummingbird	*Archilochus colubris*	0.00 (0.00)	0.00 (0.00)	1.00
	Scarlett Tanager	*Piranga olivacea*	0.00 (0.00)	0.00 (0.00)	1.00
	Song Sparrow	*Melospiza melodia*	1.06 (0.47)	0.36 (0.36)	0.21
	White-breasted Nuthatch	*Sitta carolinensis*	0.00 (0.00)	0.36 (0.36)	0.14
	Yellow-rumped Warbler	*Dendroica coronata*	0.11 (0.08)	0.00 (0.00)	0.38
	Renkonen Percent Similarity	**69.0 %**			

*significantly different (Mann-Whitney U (MWU) test, $P \leq 0.05$)

Table 2.14. June mean avian density (SE) for each species and the percent similarity of species observed on restored and reference sites in the Saginaw Bay Watershed, summer 2001 and 2002.

Type	Common Name	Scientific Name	Restored	Reference	P
Wetland dependent	Alder Flycatcher	*Empidonax alnorum*	0.00 (0.00)	0.09 (0.09)	0.13
	American Coot	*Fulica americana*	0.04 (0.04)	0.00 (0.00)	0.57
	Bank Swallow	*Riparia riparia*	0.28 (0.18)	0.00 (0.00)	0.28
	Belted Kingfisher	*Ceryle torquata*	0.04 (0.04)	0.00 (0.00)	0.57
	Blue-winged Teal	*Anas discors*	0.15 (0.14)	0.00 (0.00)	0.39
	Canada Goose	*Branta canadensis*	2.32 (1.25)	0.00 (0.00)	0.20
	Common Merganser	*Mergus serrator*	0.07 (0.07)	0.00 (0.00)	0.57
	Common Snipe	*Gallinago gallinago*	0.00 (0.00)	0.00 (0.00)	1.00
	Common Yellowthroat*	*Geothlypis trichas*	0.18 (0.15)	0.80 (0.39)	0.03
	Great Blue Heron	*Ardea herodias*	0.12 (0.07)	0.00 (0.00)	0.28
	Green Heron	*Butorides striatus*	0.13 (0.10)	0.09 (0.09)	0.91
	Hooded Merganser	*Lophodytes albellus*	0.00 (0.00)	0.00 (0.00)	1.00
	Least Bittern	*Ixobtychus exilis*	0.00 (0.00)	0.00 (0.00)	1.00
	Mallard	*Anas platyrhynchos*	0.78 (0.41)	0.71 (0.48)	0.94
	Marsh Wren	*Cistothorus palustris*	0.06 (0.04)	0.09 (0.09)	0.68
	Red-winged Blackbird*	*Agelaius phoeniceus*	15.41 (2.52)	5.80 (1.77)	0.01
	Sedge Wren	*Cistothorus platensis*	0.00 (0.00)	0.00 (0.00)	0.00
	Sora	*Porzana carolina*	0.18 (0.08)	0.36 (0.2)	0.59
	Swamp Sparrow	*Melospiza georgiana*	0.07 (0.07)	0.00 (0.00)	0.57
	Tree Swallow*	*Tachycineta bicolor*	3.15 (0.63)	0.89 (0.48)	0.02
	Virginia Rail	*Rallus limicola*	0.07 (0.05)	0.00 (0.00)	0.39
	White-rumped Sandpiper	*Calidris fuscicollis*	0.00 (0.00)	0.00 (0.00)	1.00
	Willow Flycatcher	*Empidonax traillii*	0.00 (0.00)	0.09 (0.09)	0.13
	Wood Duck	*Aix sponsa*	0.90 (0.48)	0.80 (0.80)	0.56
Wetland associated	Barn Swallow*	*Hirundo rustica*	1.05 (0.36)	0.00 (0.00)	0.03
	Common Grackle	*Quiscalus quiscula*	0.23 (0.19)	0.36 (0.36)	0.88
	Eastern Kingbird	*Tyrannus tyrannus*	0.92 (0.24)	0.27 (0.19)	0.29
	Gray Catbird	*Dumetella carolinensis*	0.26 (0.16)	0.27 (0.19)	0.63
	House Wren	*Troglodytes aedon*	0.00 (0.00)	0.00 (0.00)	1.00
	Killdeer	*Charadrius vociferus*	0.17 (0.10)	0.00 (0.00)	0.36
	Yellow Warbler	*Dendroica petechia*	0.60 (0.21)	1.52 (1.07)	0.77
Nonwetland	American Goldfinch*	*Cardurlis tristis*	0.44 (0.23)	1.79 (0.60)	0.03

Table 2.14. Cont'd

Type	Common Name	Scientific Name	Restored	Reference	P Value
	American Robin*	*Turdus migratorius*	0.14 (0.10)	0.89 (0.38)	< 0.01
	Baltimore Oriole*	*Icterus galbula*	0.00 (0.00)	0.54 (0.38)	0.03
	Black-capped Chickadee	*Parus atricapillus*	0.00 (0.00)	0.71 (0.71)	0.13
	Blue Jay*	*Cyanocitta cristata*	0.05 (0.05)	0.98 (0.47)	< 0.01
	Bobolink	*Dolichonyx oryzivorus*	0.00 (0.00)	0.00 (0.00)	1.00
	Cedar Waxwing	*Bombycilla cedrorum*	0.07 (0.07)	0.36 (0.36)	0.50
	Cooper's Hawk	*Accipiter cooperii*	0.00 (0.00)	0.18 (0.18)	0.13
	Dark-eyed Junco	*Junco jyemalis*	0.00 (0.00)	0.18 (0.18)	0.13
	Downy Woodpecker*	*Picoides pubescens*	0.00 (0.00)	0.45 (0.36)	0.03
	Eastern Bluebird	*Sialia sialis*	0.18 (0.15)	0.00 (0.00)	0.39
	Eastern Wood-Pewee	*Contopus virens*	0.14 (0.14)	0.00 (0.00)	0.57
	Eurasian Blackbird	*Turdus merula*	0.00 (0.00)	0.00 (0.00)	1.00
	European Starling	*Sturnus vulgaris*	0.12 (0.08)	0.36 (0.36)	0.82
	Field Sparrow	*Spizella pusilla*	0.00 (0.00)	0.00 (0.00)	1.00
	Great Crested Flycatcher	*Myiarchus crinitus*	0.00 (0.00)	0.18 (0.18)	0.13
	Hairy Woodpecker	*Picoides villosus*	0.00 (0.00)	0.09 (0.09)	0.13
	Hermit Thrush	*Catharus guttatus*	0.00 (0.00)	0.36 (0.36)	0.13
	House Sparrow	*Passer montanus*	0.00 (0.00)	0.00 (0.00)	1.00
	Indigo Bunting	*Passerina cyanea*	0.00 (0.00)	0.00 (0.00)	1.00
	Mourning Dove	*Zenaida macroura*	0.12 (0.08)	0.09 (0.09)	0.91
	Northern Cardinal	*Cardinalis cardinalis*	0.14 (0.14)	0.09 (0.09)	0.56
	Northern Flicker	*Colaptes auratus*	0.08 (0.06)	0.18 (0.12)	0.37
	Pileated Woodpecker	*Drycopus pileatus*	0.00 (0.00)	0.00 (0.00)	1.00
	Red-bellied Woodpecker	*Melanerpes carolinas*	0.00 (0.00)	0.00 (0.00)	1.00
	Red-shouldered Hawk	*Buteo lineatus*	0.00 (0.00)	0.00 (0.00)	1.00
	Rose-breasted Grosbeak	*Pheuticus ludovicianus*	0.00 (0.00)	0.00 (0.00)	1.00
	Ruby-throated Hummingbird	*Archilochus colubris*	0.21 (0.16)	0.18 (0.18)	0.91
	Scarlett Tanager	*Piranga olivacea*	0.00 (0.00)	0.18 (0.18)	0.13
	Song Sparrow	*Melospiza melodia*	0.75 (0.23)	0.36 (0.24)	0.36
	White-breasted Nuthatch	*Sitta carolinensis*	0.00 (0.00)	0.00 (0.00)	1.00
	Yellow-rumped Warbler	*Dendroica coronata*	0.00 (0.00)	0.00 (0.00)	1.00
	Renkonen Percent Similarity	**52.0%**			

*significantly different (Mann-Whitney U (MWU) test, $P \leq 0.05$)

Table 2.15. July mean avian density for species observed on restored and reference sites in the Saginaw Bay watershed, July 2001 and 2002.

Type	Common Name	Scientific Name	Restored	Reference	P-Value
Wetland dependent	Alder Flycatcher	*Empidonax alnorum*	0.00 (0.00)	0.00 (0.00)	1.00
	American Coot	*Fulica americana*	0.00 (0.00)	0.00 (0.00)	1.00
	Bank Swallow	*Riparia riparia*	0.81 (0.72)	0.00 (0.00)	0.39
	Belted Kingfisher	*Ceryle torquata*	0.13 (0.07)	0.00 (0.00)	0.28
	Blue-winged Teal	*Anas discors*	0.00 (0.00)	0.00 (0.00)	1.00
	Canada Goose	*Branta canadensis*	2.38 (1.94)	0.09 (0.09)	0.94
	Common Merganser	*Mergus serrator*	0.00 (0.00)	0.00 (0.00)	1.00
	Common Snipe	*Gallinago gallinago*	0.00 (0.00)	0.00 (0.00)	1.00
	Common Yellowthroat*	*Geothlypis trichas*	0.26 (0.11)	1.34 (0.52)	0.04
	Great Blue Heron	*Ardea herodias*	0.26 (0.11)	0.36 (0.36)	0.60
	Green Heron	*Butorides striatus*	0.50 (0.21)	0.18 (0.12)	0.64
	Hooded Merganser	*Lophodytes albellus*	0.10 (0.10)	0.00 (0.00)	0.57
	Least Bittern	*Ixobtychus exilis*	0.00 (0.00)	0.00 (0.00)	1.00
	Mallard	*Anas platyrhynchos*	1.37 (0.52)	0.09 (0.09)	0.10
	Marsh Wren	*Cistothorus palustris*	0.03 (0.03)	0.00 (0.00)	0.63
	Red-winged Blackbird*	*Agelaius phoeniceus*	16.56 (3.30)	4.73 (1.78)	< 0.01
	Sedge Wren	*Cistothorus platensis*	0.04 (0.04)	0.00 (0.00)	0.57
	Sora	*Porzana carolina*	0.18 (0.07)	0.18 (0.12)	0.89
	Swamp Sparrow	*Melospiza georgiana*	0.30 (0.20)	0.18 (0.18)	0.89
	Tree Swallow*	*Tachycineta bicolor*	2.19 (0.62)	0.00 (0.00)	0.02
	Virginia Rail	*Rallus limicola*	0.32 (0.17)	0.00 (0.00)	0.20
	White-rumped Sandpiper	*Calidris fuscicollis*	0.00 (0.00)	0.00 (0.00)	1.00
	Willow Flycatcher	*Empidonax traillii*	0.00 (0.00)	0.18 (0.18)	0.13
	Wood Duck	*Aix sponsa*	0.13 (0.07)	0.09 (0.09)	0.84
Wetland associated	Barn Swallow*	*Hirundo rustica*	1.13 (0.36)	0.00 (0.00)	0.02
	Common Grackle	*Quiscalus quiscula*	0.36 (0.24)	0.71 (0.71)	0.76
	Eastern Kingbird	*Tyrannus tyrannus*	0.12 (0.08)	0.18 (0.18)	0.68
	Gray Catbird*	*Dumetella carolinensis*	0.14 (0.14)	0.90 (0.48)	0.03
	House Wren	*Troglodytes aedon*	0.05 (0.05)	0.18 (0.18)	0.50
	Killdeer	*Charadrius vociferus*	0.03 (0.03)	0.00 (0.00)	0.63
	Yellow Warbler	*Dendroica petechia*	0.14 (0.14)	0.36 (0.36)	0.53
Nonwetland	American Goldfinch	*Cardurlis tristis*	1.14 (0.42)	2.50 (0.80)	0.06
	American Robin	*Turdus migratorius*	0.17 (0.10)	0.90 (0.90)	0.82

Table 2.15. Cont'd

Type	Common Name	Scientific Name	Restored	Reference	P-Value
	Baltimore Oriole	*Icterus galbula*	0.21 (0.21)	0.00 (0.00)	0.57
	Black-capped Chickadee*	*Parus atricapillus*	0.00 (0.00)	0.80 (0.47)	< 0.01
	Blue Jay*	*Cyanocitta cristata*	0.14 (0.14)	1.07 (0.54)	0.03
	Bobolink	*Dolichonyx oryzivorus*	0.00 (0.00)	0.00 (0.00)	1.00
	Cedar Waxwing	*Bombycilla cedrorum*	0.39 (0.18)	0.00 (0.00)	0.14
	Cooper's Hawk	*Accipiter cooperii*	0.00 (0.00)	0.00 (0.00)	1.00
	Dark-eyed Junco	*Junco jyemalis*	0.00 (0.00)	0.00 (0.00)	1.00
	Downy Woodpecker	*Picoides pubescens*	0.14 (0.10)	0.89 (0.48)	0.08
	Eastern Bluebird	*Sialia sialis*	0.05 (0.05)	0.00 (0.00)	0.57
	Eastern Wood-Pewee	*Contopus virens*	0.00 (0.00)	0.18 (0.18)	0.13
	Eurasian Blackbird	*Turdus merula*	0.05 (0.05)	0.00 (0.00)	0.57
	European Starling	*Sturnus vulgaris*	2.14 (2.14)	0.00 (0.00)	0.57
	Field Sparrow	*Spizella pusilla*	0.11 (0.11)	0.09 (0.09)	0.56
	Great Crested Flycatcher	*Myiarchus crinitus*	0.00 (0.00)	0.00 (0.00)	1.00
	Hairy Woodpecker	*Picoides villosus*	0.07 (0.07)	0.09 (0.09)	0.56
	Hermit Thrush	*Catharus guttatus*	0.00 (0.00)	0.00 (0.00)	1.00
	House Sparrow	*Passer montanus*	0.14 (0.14)	0.00 (0.00)	0.57
	Indigo Bunting	*Passerina cyanea*	0.14 (0.14)	0.00 (0.00)	0.57
	Mourning Dove	*Zenaida macroura*	0.14 (0.14)	0.00 (0.00)	0.57
	Northern Cardinal	*Cardinalis cardinalis*	0.08 (0.06)	0.09 (0.09)	0.91
	Northern Flicker	*Colaptes auratus*	0.07 (0.07)	0.18 (0.12)	0.16
	Pileated Woodpecker	*Drycopus pileatus*	0.00 (0.00)	0.00 (0.00)	1.00
	Rose-breasted Grosbeak	*Pheuticus ludovicianus*	0.00 (0.00)	0.00 (0.00)	1.00
	Red-bellied Woodpecker	*Melanerpes carolinas*	0.05 (0.05)	0.00 (0.00)	0.57
	Red-shouldered Hawk	*Buteo lineatus*	0.29 (0.29)	0.71 (0.71)	0.53
	Ruby-throated Hummingbird	*Archilochus colubris*	0.00 (0.00)	0.00 (0.00)	1.00
	Scarlett Tanager	*Piranga olivacea*	0.14 (0.14)	0.00 (0.00)	0.57
	Song Sparrow	*Melospiza melodia*	1.20 (0.33)	1.96 (0.71)	0.28
	White-breasted Nuthatch*	*Sitta carolinensis*	0.00 (0.00)	0.45 (0.36)	0.03
	Yellow-rumped Warbler	*Dendroica coronata*	0.00 (0.00)	0.00 (0.00)	1.00
	Renkonen Percent Similarity	**41.0 %**			

*significantly different (Mann-Whitney U (MWU) test, $P \leq 0.05$)

carolinensis), Black-capped Chickadee (*Parus atricapillus*), and White-breasted Nuthatch (*Sitta carolinensis*) (Table 2.15).

Twenty-nine of the 67 avian species detected were classified as either wetland dependent or wetland associated (Crowley et al. 1996, Elrich et al. 1988, Brewer et al. 1991) (Table 2.13, 2.14, 2.15). Of which, restored sites supported 28 and reference sites supported 20 wetland dependent and wetland associated species (Table 2.13, 2.14, 2.15). Restored sites supported greater ($P < 0.01$) densities of wetland dependent species than reference sites in all months (Table 2.16). In June and July, reference wetlands supported higher ($P \leq 0.04$) densities of non-wetland species than restored sites (Table 2.16).

Using the Renkonen index, similarity of avian species presence and abundance, between restored and reference sites were found to be similar (69.0% and 52.0%, respectively) in May and June, but decreased in similarity (41.0%) in July (Krebs 1999).

Nest Productivity

The nests of 15 species were located on restored and reference sites in 2001 and 2002 (Table 2.7). Five species were common to both restored and reference. Nine nesting species were unique to restored sites whereas only the Wild Turkey *(Meleagris gallopavo*) was a unique nester at reference sites. During this period 437 nests were located, of which 270 were considered active. Restored sites supported significantly greater number of nests per wetland then reference sites (X^2=4.96, df=1). Restored sites supported an average of 11 nests per wetland whereas reference sites supported an average of 5.5 nests per wetland. Red-winged Blackbird nests were the most abundant on both restored and reference sites, comprising over 82.0 % of all active nests found.

Table 2.16. Mean (SE) avian diversity based on avian wetland dependency categories at restored and reference wetlands in the Saginaw Bay watershed, Michigan, summer 2001 and 2002.

Category	Restored (n = 25[1])	Reference (n = 10)	P-value
May			
Wetland Dependent*	24.6 (2.2)	11.3 (3.2)	<0.01
Wetland Associated	2.3 (0.4)	1.5 (0.9)	0.17
Non-wetland	4.2 (0.9)	5.6 (1.6)	0.23
June			
Wetland Dependent*	26.9 (3.5)	9.7 (2.7)	<0.01
Wetland Associated	3.6 (0.7)	2.3 (1.3)	0.21
Non-wetland	2.4 (0.5)	8.4 (1.5)	<0.01
July			
Wetland Dependent*	25.6 (3.6)	7.4 (2.3)	<0.01
Wetland Associated	2.0 (0.9)	2.1 (0.9)	1.00
Non-wetland	6.9 (2.7)	7.6 (0.9)	0.04

[1] n=24 for restored wetlands for May 2002

*significantly different (Mann-Whitney U (MWU) test, $P \leq 0.05$)

Waterfowl species accounted for only 4.0% of nest observed on restored sites and 2.0% on reference sites.

DISCUSSION

Structural Evaluations

Evaluation of structural design components of restored wetlands revealed that most restored wetlands showed signs of only minor structural damage. The most common problem observed at restored sites was erosion problems with spillways, berms, and around water control structures. Although a small percentage of ≥ 6 year-old sites received higher erosion ratings for berms and water control structures, overall, older restored sites (6 – 13 years-old) did not seem to have more structural problems than younger restored sites (≤ 5 years-old) (Table 2.3). These results are similar to a Wisconsin evaluation of the Partners program in which wetland restoration failure rates were analyzed by year to determine whether older restorations tended to have higher failure rates (Kitchen 1999). Kitchen (1999) determined that there were no significant differences among age classes.

None of the restored sites evaluated had extensive structural damage that would lead to complete failure of the project; however, structures should be monitored periodically to ensure that moderate damage to structures does not develop into significant problems that may affect the long-term success of a restoration project.

Comparisons among Age Categories

I expected more recently restored wetlands, 1 - 2 year-olds and 3 - 5 year-olds, to have shallower water depth levels than the ≥ 6 year-old sites based on excavation practices during the early years of the Partners Program (personal communication, J. Hazelman, Service). However, when mean water depth was compared among the 3 age categories of restored wetlands, 1 - 2 year-old, 3 - 5 year old, and ≥ 6 year-old, no differences were found. This result could be due to at least two possibilities. First, there may not be differences in depth among age groups. Second, and maybe more likely, is that the sampling protocol, one sample each month per wetland, used to collect water depth information will not detect significant differences in depth between wetlands. However, recording a single water depth measurement can be useful for evaluating temporal changes in water levels within a wetland.

VanRees-Siewart (1993) and Reinartz and Warne (1993) found that percent emergent cover increased significantly with wetland age. VanRees-Siewart (1993) also reported that the average cover of emergent vegetation for 2 - 3 year-olds was between 30 - 50% and most 4 year-old wetlands averaged over 63% emergent cover. In this study, however, percent total vegetation cover was similar (42 - 52%) among the three age categories. One reason why vegetation cover estimates are different may relate to differences in water depths between wetland restoration sites in Iowa and Michigan.

In northern Iowa, Delphey and Dinsmore (1993) found that 1 – 3 year-old restored wetlands had more areas of bare ground than older natural wetlands. Similarly, VanRees-Siewart (1993) observed that 1 year-old wetlands were largely devoid of emergent vegetation, which most likely leads to increased bare ground. This was also evident in this study where 1 – 2 year-old and 3 – 5 year-old sites had greater percent bare ground than older sites. The percentage of bare ground on wetlands will most likely decrease as wetlands mature and vegetation coverage increases.

Comparisons Between Restored and Reference Wetlands

Water Depth and Vegetative Characteristics

Comparisons between restored and reference wetlands, using broad and intensive evaluations, showed that restored wetlands had deeper water depth levels than reference wetlands

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wetlands (Tables 2.1 and 2.5). These differences in water depth levels may help explain why restored wetlands had greater percentage of open water and lower vegetation cover than reference wetlands (Table 2.5). In July, reference wetlands had a mean water depth of 15 cm whereas restored wetlands had a mean depth of 43 cm. The deeper water levels of restored wetlands prohibit many emergent plants from growing in the center of the wetland whereas shallower reference wetlands are able to support more emergent growth throughout the wetland basin.

Another possible explanation for differences in water depth, total vegetation cover and open water between restored and reference wetlands may be the result of natural successional changes, one of the many ways wetland plant communities change over time (Tiner 1998). Overtime wetlands experience an accumulation of organic material from plant production (Mitch and Gosselink 1993). This can result in shallower water depths, increased emergent vegetation cover, elevation and substrate differences, as were observed in reference wetlands. In contrast, restored sites have relatively smooth, compacted basins and deeper water depth levels due to restoration practices such as excavation (when the Partners program was first established, restored wetlands were excavated to have deep basins, based on concerns expressed by landowners over low water levels and a desire to see more open water areas (personal communication, J. Hazelman, Kitchen 1999)). Furthermore, Partners restored sites in Michigan are relatively young (1 - 14 years-old) compared to existing natural wetlands.

Although the mean total vegetation percent cover on > 6 year-old wetlands was approximately 50%, this percentage does not reflect the interspersion patterns between vegetation cover and open water. Approximately 65% of restored sites evaluated in the intensiv

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intensive portion of this study had areas of deep water with vegetation growing around the edges of the wetland.

Vegetative species richness and FQA's are useful tools to compare species composition and the floristic importance of the vegetation present between restored and reference wetlands. Both this study and LaGrange and Dinsmore's (1989) study of restored Iowa wetlands, found an average of 24 species per wetland. Reference sites also supported similar number of species as restored sites. However these results are different than the findings from a study done by Galatowitsh and van der Valk (1996) in northern Iowa that compared restored and natural wetland vegetation communities. They found that natural sites supported an average of 46 species per wetland whereas restored sites supported 27 species per wetland.

Although reference wetlands have a higher number of native species present than restored, the $\overline{C}$ values suggest that both types of wetlands have remnant natural quality characteristics. This is further supported by the FQI values calculated for restored and reference sites which are twice as high as the majority of Michigan's undeveloped lands which have FQI's of less than 20 (Herman et al. 2001). According to Herman et al. (2001) and Wilhelm and Masters (1995) areas with a $\overline{C}$ of 3.5 or higher or an FQI of 35 or more, have sufficient floristic quality to be at least of marginal natural area quality. Although the FQA results indicate that restored wetlands have some floristic importance, the FQA does not provide species density information. Therefore, FQA's should be used as a tool to help managers make conclusions regarding an area of land and not as a definitive measure of importance or success.

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Avian Surveys

Sixty-seven avian species were observed on restored and reference wetlands of which 55 were found at restored sites. This number falls within the range of species found in similar studies of restored wetlands in New York (35 species, Brown et al. 1995), Iowa (42 species, VanReese-Siewert and Dinsmore 1996), Ohio (79 species, Shieldcastle and Shieldcastle 1998), Indiana (80 species, Dubowy and Hartman 1994), and Michigan (86 species, MacKinnon 2000). The number of avian species observed in this study is most likely lower than the number MacKinnon (2000) observed because she conducted avian surveys over a longer season and visited her wetlands more frequently.

The mean number of breeding birds species using restored and reference wetlands was similar (0.5 and 0.6, respectively). This is lower than the mean number of breeding birds species found in restored wetlands in New York (8.5, Brown et al. 1995), Iowa (4.5, Delphey 1991; 6.1, Van-Reese-Siewert and Dinsmore 1996), Indiana (5.2, Dubowy and Hartman 1994), and Michigan (11.0, MacKinnon 2000).

The differences in mean number of breeding bird species may be due to a variety of reasons. Although this study and the others mentioned above had similar definitions of an active nest (included eggs, nestlings, or strong evidence of use including the presence of fledglings or family groups), many of these studies determined breeding status based on the number of times a species was observed utilizing the wetland during the duration of the study. I was unable to make the same determination of breeding status due to the limited number of times I surveyed the avian communities at restored and reference wetlands as well as the small search area due to property boundaries. Regional differences of waterfowl populations among the study sites may also play a role in the observation of low numbers of breeding waterfowl on restored and reference wetlands.

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Waterfowl densities in Michigan have been lower over the past few years than in previous years (Soulliere and Luukkonen 2003). Further research focused on breeding bird communities should be conducted to determine how well restored wetlands, in comparison to natural wetlands, are able to support breeding bird communities.

Mean avian species richness (Table 2.10) and diversity (Table 2.11) were similar between restored and reference sites across all months. These results suggest that restored and reference wetlands are supporting similar numbers of species and providing habitat for certain avian groups. Other studies (Brown et al. 1995, Delphey and Dinsmore 1993, Hartman 1994, Hemesath 1991, Ratti et al. 2001, Schreiber 1994) have shown that bird species responded quickly to newly restored wetlands and that species richness and diversity was similar between restored and reference wetlands.

When the degree of similarity of species composition was compared, restored and reference sites supported slightly similar types of species in May and June but decreased in similarity in July. Furthermore, when densities of wetland type species (i.e., wetland dependent, wetland associated, non-wetland) were compared, restored wetland supported greater densities of wetland dependent species than reference sites in all months, whereas reference sites supported higher densities of non-wetland species in June and July (Table 2.16). Brown et al. (1995) found that although the total number of avian species was similar between restored and natural sites, the species composition between wetland types was different. Furthermore, natural wetlands had higher percentages of wood cover and more total vegetation cover than restored wetlands, which may contribute to the avian community differences observed between the wetland types (Table 2.5).

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Overall, individual avian densities were similar on restored and reference wetlands. However, when density was averaged based on the number of species per wetland, restored sties supported higher bird densities in May and July than reference sites (Table 2.12). Higher avian densities at restored sites may be attributed to a greater number using restored wetlands in May during the spring migration. Based on the number of active nests found on restored wetlands, July avian densities are most likely a result of successful reproduction by species such as the Red-winged Blackbird and Tree Swallow. Both species had higher densities at restored sites than reference sites in all months (Table 2.13, 2.14, 2.15).

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CONCLUSIONS

The main objective of the study was to determine the "success" of the Partners private land restoration projects in the Saginaw Bay watershed. The determination of success of a wetland or group of wetlands can vary based on the criteria on which the restoration is evaluated. For example, a wetland that may not be suitable to support breeding waterfowl may be ideal for reptiles and amphibians. Success can be a difficult term to define and therefore should be based on pre-determined goals and objectives. There are a variety of ways in which success can be determined based on this approach. Brown et al. (1995) stated that restored sites could not be considered successful or comparable to natural sites until it supported similar breeding bird communities. Campbell et al. (2002) measured success by comparing soils and vegetation of created and natural wetlands in Pennsylvania to determine how well created wetlands functioned like natural wetlands. Galatowitsch and van der Valk (1994) stated that the definitive test of success is how closely restored wetlands resemble and function like natural wetlands, using specific criteria. Galatowitsch and van der Valk (1994) further discussed the use of certain standards such as presence of water, similar vegetation species, and the presence of a target wildlife species as ways to determine success.

The most common approach to determine if restored wetlands are successful is to make comparisons between restored and natural wetlands, using selected criteria. For this study, I determined success by comparing water depth and avian and vegetation variables of restored and natural wetlands. I found that water depth and land cover characteristics on restored sites did not approximate conditions on natural sites. Restored wetlands were deeper and had less total cover than reference sites. If the determination of success is based strictly on comparisons with reference wetlands, the Partners wetland restora

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restoration projects do not successfully resemble the physical characteristics of natural sites. However, when the results of this study are compared with results from other wetland restoration studies, my estimate of 50% total vegetation cover on restored wetlands is within the range that supports the highest avian density (Brawley et al. 1998, Brown and Dinsmore 1986, Hemesath and Dinsmore 1993, Kaminski and Prince 1981). Furthermore, deeper water levels, characteristic of the restored wetlands in this study, are recommended to ensure persistent open water areas that provide habitat for wetland birds, especially during periods of drought (Brown et al. 1995). Although results from the avian surveys suggest that restored and reference wetlands support similar numbers of avian species and diversity, restored sites supported higher densities of wetland-dependent avian species than natural sites. Therefore, the noted differences in physical habitat of restored wetlands may be more suitable for wetland birds than in existing natural wetlands.

The use of natural wetlands as a guide in determining restoration success can be both useful and practical (Whisenant 1999). Some researchers have argued that using reference sites as a means of assessing restored habitat is necessary (Aronson et al. 1995) while others believe that their use leads to unattainable goals (Prickett and Parker 1994, Hobbs and Norton 1996). When possible, undisturbed reference sites should be selected for appropriate comparisons (Whisenant 1999). However, in certain landscapes, the selection of undisturbed reference sites that approximate desired conditions can prove challenging. For this study, it was difficult to find undisturbed emergent natural wetlands that were similar in size and surrounding upland cover as the selected restored sites. In addition, many natural wetlands in Michigan probably have been degraded and poten

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potentially drained at some point in history. Although representative of existing natural wetlands in the area, the selected reference wetlands were disturbed and surrounded by forested uplands. In the absence of pristine reference sites, it may not be appropriate to use reference sites as an absolute benchmark of success. Rather, the use of reference sites could be used to illustrate that restored sites are potentially providing better habitat for certain species than on existing natural wetlands. In conclusion, the Partners program is successfully restoring critical wetland habitat that is able to support avian use similar to natural wetlands. Furthermore, higher densities of wetland-dependent species may indicate that restored wetlands are providing better avian habitat when compared to existing natural wetlands.

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MANAGEMENT RECCOMENDATIONS

To facilitate future evaluations of wetland restoration success biologists and landowners should specify site-specific restoration objectives that identify the type of wetland to be restored as well as plant or animal communities that are targeted for restoration. It is important for both the landowner and biologist to understand the goals and objectives that are important to each other. By establishing predetermined objectives, the success of a restored wetland can be measured based on attainment of objectives. In addition, an evaluation of a project will determine if the goals and objectives are being met, and whether these goals and objectives should be adjusted.

A major goal of wetland restoration projects is to provide breeding habitat for populations of waterfowl and other bird species. Additional studies are needed to determine if the restored wetlands are able to support sufficient breeding habitat for waterfowl and other nesting species. In addition, an in-depth study of the surrounding upland is also encouraged to determine how land use is affecting breeding success. Furthermore, research evaluating the use of restored wetlands by small mammals, invertebrates, aquatic insects and reptiles and amphibians may provide additional support in determining the success of restoration projects in Michigan.

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LITERATURE CITED

ARONSON, J. C., S. DHILLON, AND E. L. FLOC'H. 1995. On the need to select an ecosystem of reference, however imperfect: a reply to Pickett and Parker. Restoration Ecology 3:1-3.

BECK, R. E. 1994. The movement in the United States to restoration and creation of wetlands. 34 Natural Resources Journal 781.

BRAWLEY, A. H., R. S. WARREN, AND R. A. ASKINS. 1998. Bird use of restoration and reference marshes within the barn island wildlife management area, Stoningtion, Connecticut, USA. Environmental Management 22(4):625-633.

BREWER, R., G. A. MCPEEK, AND R J. ADAMS, JR. 1991. The atlas of breeding birds of Michigan. Michigan State University Press, East Lansing, Michigan, USA.

BROWN, S., B. L. BEDFORD, AND M. E. RICHMOND. 1995. Ecological evaluation of the U.S. Fish and Wildlife Service wetland restoration program in New York state: detailed summary of research findings and management recommendations. Department of Natural Resources, Ithaca, New York, USA.

BROWN, M., AND J. DINSMORE. 1986. Implications of marsh size and isolation for marsh bird management. Journal of Wildlife Management 50(3): 392-397.

BROWN, S. C., AND C. R. SMITH. 1998. Breeding season use of recently restored versus natural wetlands in New York. Journal of Wildlife Management 62(4):1480-1491.

CAMPBELL, D. A., C. A. COLE, AND R. P. BROOKS. 2002. A comparison of created and natural wetlands in Pennsylvania, USA. Wetlands Ecology and Management 10: 41-49.

CASHEN, S. T. 1998. Avian use of restored wetlands in Pennsylvania. M.S. Thesis. The Pennsylvania State University. State College, Pennsylvania, USA.

CRAIG, R. J., AND K. G. BEAL. 1992. The influence of habitat variables on marsh bird communities of the Connecticut River estuary. Wilson Bulletin 104(2): 295-311

CROWLEY, S., C. WELSH, P. CAVANAGH, AND C. GRIFFIN. 1996. Weighing-birds: habitat assessment procedures for wetland-dependent birds in New England. Department of Forestry and Wildlife Management, University of Massachusetts, Amherst, Massachusetts, USA.

DELPHEY, P., AND J. DINSMORE. 1993. Breeding bird communities of recently restored and natural prairie potholes. Wetlands 13:200-206.

DUBOWY, P. J. , AND M. R. HARTMAN. 1994. Avian utilization of restored wetlands in northern Indiana. Final Report to the U.S. Fish and Wildlife Service.

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EHRLICH, P. R., D. S. DOBKIN, AND D. WHEYE. 1988. The birder's handbook: a field guide to the natural history of North American birds. Simon and Schuster, New York, New York, USA.

ENVIRONMENTAL PROTECTION AGENCY. 1980. Section 404 program strategy. Office of Water Regulations and Standards, Criteria and Standards Division, Washington, D.C. EPA 440/ 5-81-001.

GALATOWITSCH, S. M., AND A. G. VAN DER VALK. 1994. Restoring prairie wetlands: an ecological approach. Iowa State University Press, Ames, Iowa, USA.

GALATOWITSCH, S.M., AND A.G. VAN DER VALK. 1996. Vegetation of restored and natural prairie wetlands. Ecological Applications 6:102-112.

HEMESATH, L. M. 1991. Species richness and nest productivity of marsh birds on restored prairie potholes in northern Iowa. M.S. Thesis, Iowa State University, Ames, Iowa, USA.

HEMESATH, L. M., AND J. DINSMORE. 1993. Factors affecting bird colonization of restored wetlands. The Prairie Naturalist 25(1): 1-11.

HERMAN, K. D., L. A. MASTERS, M. R. PENSKAR, A. R. REZNICEK, G. S. WILHELM, W. W. BRODOVICH, AND K. P. GARDINER. 2001. Floristic quality assessment with wetland categories and examples of computer applications for the state of Michigan. Michigan Department of Natural Resources, Wildlife Division, Natural Heritage Program, Lansing, Michigan, USA.

HEY, D. L., AND N. S. PHILIPPI. 1999. A case for wetland restoration. John Wiley and Sons, New York, New York, USA.

HILL, J. 2000. Avian use of purple loosestrife (*Lythrum salicaria*) in southern Michigan wetland complexes. M.S. Thesis. Michigan State University, East Lansing, Michigan, USA.

HOBBS, R. J., AND D. A. NORTON. 1996. Towards a conceptual framework for restoration ecology. Restoration Ecology 4:93-110.

KAMINSKI, R., AND H. PRINCE. 1981. Dabbling duck activity and foraging responses to aquatic macroinvertebrates. Auk 98:115-126.

KANTRUD, H., AND R. STEWART. 1984. Ecological distribution and crude density of breeding birds on prairie wetlands. Journal of Wildlife Management 48(2):426-437.

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KITCHEN, A. 1999. An assessment of landowner participation and habitat accomplishments. Monitoring report for Wisconsin Partners for Fish and Wildlife Program. U.S. Fish and Wildlife Service, Wisconsin Private Lands Office, Madison, Wisconsin, USA.

KREBS, C. J. 1999. Ecological methodology. Addison-Welsey Educational Publishers, Inc., New York, New York, USA.

KUSLER, J., AND M. KENTULA. (eds.) 1990. Wetland creation and restoration: the status of science. Island Press, Washington D.C., USA.

LAGRANGE, T., AND J. DINSMORE. 1989. Plant and animal community responses to restored Iowa wetlands. Prairie Naturalist 21(1):39-48.

LESCHISIN, D., G. WILLIAMS, AND M. WELLER. 1992. Factors affecting waterfowl use of constructed wetlands in northwestern Minnesota. Wetlands 12(3):178-183.

MACKINNON, S. M. 2000. Avian utilization of restored wetlands in central lower Michigan. M.S. Thesis. Central Michigan University, Mount Pleasant, Michigan, USA.

MITCH, W. L., AND J. G. GOSSLINK. 1993. Wetlands. Van Nostrand Reinhold, New York, New York, USA.

PARTNERS FOR FISH AND WILDLIFE PROGRAM: Voluntary Habitat Restoration in Cooperation with Private Landowners. http://partners.fws.gov.htm.

PICKETT, S. T. A., AND V. T. PARKER. 1994. Avoiding the old pitfalls: opportunities in a new discipline. Restoration Ecology 2:75-79.

RATTI, J. T., A. M. ROCKLAGE, J. H. GIUDICE, E. O. GARTON, AND D. P. GOLNER. 2001. Comparison of avian communities on restored and natural wetlands in North and South Dakota. Journal of Wildlife Management 64(4): 676-684.

REYNOLDS, R. E., J. M. SCOTT, AND R. A. NUSSBAUM. 1980. A variable circular-plot methods for estimating bird numbers. Condor 82: 309-313.

REINARTZ, J., AND E. WARNE. 1993. Development of vegetation in small created wetlands in southeastern Wisconsin. Wetlands 13(3): 153-164.

SAS INSTITUTE. 1990. SAS/STAT user's guide. Version 6, fourth ed. Vol.2. SAS Institute, Cary, North Carolina, USA.

SCHREIBER, J. A. 1994. Structure of breeding bird communities on natural and restored Iowa wetlands. M.S. Thesis, Iowa State University, Ames, Iowa, USA.

SEWELL, R. W., AND K. F. HIGGINS. 1991. Floral and faunal colonization of restored wetlands in westcentral Minnesota and northeastern South Dakota. Pages 108-133 *in* F.J. Webb, Jr. (*ed*). Proceedings of the 18th Annual Conference on Wetland Restoration and Creation. Hillsborough Community College, Tampa, Florida, USA..

SHANNON, C, E, AND W. WEAVER. 1949. The mathematical theory of communication. University of Illinois Press, Urbana, Illinois, USA.

SHIELDCASTLE, J., AND M. SHIELDCASTLE. 1998. Evaluation of selected natural and restored wetlands in Williams, County, Ohio for bird use during migration and breeding seasons. Final project report submitted to the U.S. Fish and Wildlife Service.

SIEGEL, S. 1956. Nonparametric statistics for the behavioral sciences. McGraw-Hill Book Company, New York, New York, USA.

SOULLIERE, G. J., AND D. R. LUUKKONEN. 2003. Michigan waterfowl habitat and hunting season report, 2002-03. Michigan Department of Natural Resources Wildlife Report No. 3395, Lansing, Michigan, USA.

STEWART, R., AND H. KANTRUD. 1972. Population estimates of breeding birds in North Dakota. Auk 89:766-788.

TINER, R. 1998. In search of swampland. Rutgers University Press, New Brunswick, New Jersey, and London, 264pp.

VANREES-SIEWERT, K. L. 1993. The influence of wetland age on bird and aquatic macro invertebrate use of restored Iowa wetlands. M.S. Thesis. Iowa State University, Ames, Iowa, USA.

VANREES-SIEWERT, K. L., AND J. DINSMORE. 1996. Influence of wetland age on bird use of restored wetlands in Iowa. Wetlands 16(4):577-582.

VILEISIS, A. 1997. Discovering the unknown landscape: A history of America's wetlands. Island Press, Washington D.C., USA.

WEISS, R. A. 1995. The status and distribution of rails and other marsh birds in natural and restored wetlands in northern Indiana. Ph.D. Dissertation. Ball State University, Muncie , Indiana, USA.

WHISENANT, S. G. 1999. Repairing damaged wildlands: a process-orientated, landscape-style approach. Cambridge University Press, New York, New York, USA.

WILI

WILHELM, G. S. AND L. A. MASTERS. 1995. Floristic quality assessment in the Chicago Region and application computer programs. *In* K. D. Herman, L. A. Masters, M. R. Penskar, A. R. Reznicek, G. S. Wilhelm, W. W. Brodovich, and K. P. Gardnier (*eds.*) Floristic quality assessment with wetland categories and computer application programs for the state of Michigan. Michigan Department of Natural Resources, Wildlife Division, Natural Heritage Program, Lansing, Michigan, USA.

Appendix 2.A. Assessment classes used to evaluate restored wetland structural components, Saginaw Bay watershed, summer 2002

Appendix 2.A. Assessment classes used to evaluate restored wetland structural components, Saginaw Bay watershed, summer 2002.

	Assessment Class				
Structural Component	1	2	3	4	5
BERM					
Erosion	**Extensive;** numerous rills/gullies, <25% vegetation cover.	**Significant;** significant signs of rill and gully erosion, 26-50% vegetated.	**Moderate;** moderate signs of sheet/rill/gully erosion, 51-75% vegetated.	**Slight;** infrequent signs of sheet/rill erosion, >75% vegetated.	**Nil;** no visible evidence of erosion, >90% vegetated.
Seepage	**Extensive;** visible signs of water flow and high erosion, berm failure.	**Significant;** numerous wet areas with significant signs of erosion.	**Moderate;** multiple areas of seepage present slight erosion.	**Slight;** patchy areas of wetness.	**Nil;** no visible evidence of seepage.
Sloughing	**Extensive;** large sections of berm material in wetland.	**Significant;** significant amount of berm material eroded away.	**Moderate;** multiple areas of berm with visible section missing.	**Slight;** infrequent signs of sloughed material.	**Nil;** no visible evidence of sloughing.
Muskrat Damage	**Extensive;** >7 muskrat holes, berm becoming unstable with numerous signs of erosion and seepage.	**Significant;** 5-7 muskrat holes. Berm becoming lumpy with visible signs of erosion and seepage.	**Moderate;** 3-5 muskrat holes. Berm relatively stable with minimal erosion and seepage.	**Slight;** 1-2 muskrat holes, berm stable.	**Nil;** no visible evidence of damage.
Settling	**Extensive;** berm is unstable with extreme sunken depressions.	**Significant;** berm becoming unstable with numerous sunken areas.	**Moderate;** moderate amount of sunken areas.	**Slight;** infrequent signs of sunken areas.	**Nil;** no visible evidence of settling.
Undercutting	**Extensive;** berm is unstable with large deep sections missing.	**Significant;** numerous areas with deep undercuts.	**Moderate;** few areas with material missing.	**Slight;** infrequent signs of undercutting.	**Nil;** no visible evidence of undercutting.

Appendix A. Cont'd

	Assessment Class				
	1	2	3	4	5
SPILLWAY					
Erosion	**Extensive;** numerous deep rills/gullies, water does not fan, forms pools, <25% vegetated/rock-lined.	**Significant;** significant signs of rill and gully erosion, 26-50% vegetated/rock-lined.	**Moderate;** soil is becoming exposed with water pooling, 51-75% vegetated/rock-lined.	**Slight;** infrequent signs of rill erosion, >75% vegetated/rock-lined.	**Nil;** No visible evidence of erosion, >90% vegetated/rock-lined. .
CONSTRUCTED ISLAND					
Erosion	**Extensive;** numerous rills/gullies, <25% vegetated, sloughing of material.	**Significant;** significant signs of rill and gully erosion, 26-50% vegetated.	**Moderate;** moderate signs of sheet/rill/gully erosion, 51-75% vegetated.	**Slight;** infrequent signs of sheet/rill erosion, >75% vegetated.	**Nil;** no visible evidence of erosion, >90% vegetated.
Settling	**Extensive;** island is unstable with extreme sunken depressions.	**Significant;** island becoming unstable with numerous sunken areas.	**Moderate;** moderate amount of sunken areas.	**Slight;** infrequent signs of sunken areas.	**Nil;** no visible evidence of settling.
WATER CONTROL STUCTURE					
Seepage	**Extensive;** deep rills/gullies around structure, concentrated water flow through berm.	**Significant;** numerous wet areas with significant signs of erosion.	**Moderate;** rills/gullies present, water seeping through berm.	**Slight;** infrequent signs of erosion around structure, patchy areas of wetness.	**Nil;** no visible evidence of seepage.
Deterioration (rust/rot/cracking)	**Extensive;** extensive damage to structure, no longer functioning.	**Significant**; numerous areas of deterioration present, affecting function.	**Moderate;** multiple areas of deterioration, starting to affect function of structure.	**Slight;** infrequent signs of deterioration, does not interfere with function of structure.	**Nil;** no visible evidence of deterioration

Appendix A. Cont'd

Appendix A. Cont'd

	Assessment Class				
	1	2	3	4	5
Settling	**Extensive;** extreme sunken depression around structure.	**Significant;** area around structure becoming unstable with numerous sunken areas.	**Moderate;** moderate amount of sunken areas.	**Slight;** infrequent signs of sunken areas.	**Nil;** no visible evidence of settling.
Erosion	**Extensive;** numerous rills and gullies.	**Significant;** significant signs of rill and gully erosion.	**Moderate;** moderate signs of sheet/rill/ gully erosion.	**Slight**; infrequent signs of sheet/rill erosion.	**Nil;** no visible evidence of erosion
Sediment reducing capacity of conduit	**Extensive;** extreme blockage of pipe, minimal to no water flow.	**Significant**; significant blockage of pipe.	**Moderate;** sediment is actively affecting water flow.	**Slight;** slight build-up of sediment, not impeding flow.	**Nil;** very little to no sediment present.
Other obstructions to conduit	**Extensive;** extreme blockage of pipe, minimal to no water flow.	**Significant**; significant blockage of pipe,	**Moderate;** moderate amount of build-up starting to affect water flow.	**Slight;** slight build-up of sediment, not impeding flow.	**Nil;** very little to no obstructions present.

Appendix 2.B. Vegetation list found on restored and reference wetlands during intensive evaluations, Saginaw Bay watershed, summer 2001 and 2002.

Common Name	*Scientific Name*
Alga pondweed	*Potamogeton confervoides*
Alsike clover	*Trifolium hybridum*
Alternate-leaved dogwood	*Cornus alternifolia*
American bur-reed	*Sparganium americanum*
American mannagrass	*Glyceria grandis*
American water-horehound	*Lycopus americanus*
Autumn olive	*Elaeagnus umbellata*
Bigleaf pondweed	*Potamogeton amplifolius*
Birdsfoot tre-foil	*Lotus corniculatus*
Bittersweet nightshade	*Solanum dulcamara*
Black willow	*Salix nigra*
Black-eyed susan	*Rudbrckia hirta*
Blue beech	*Carpinus caroliniana*
Blue skullcap	*Scutellaria lateriflora*
Blue spruce	*Picea punges*
Blue vervain	*Verbena hastata*
Boneset	*Eupatorium perfoliatum*
Bristley sedge	*Carex comosa*
Broom sedge	*Carex scoparia*
Bur-reed sp.	*Sparganium spp.*
Buttonbush	*Cephalanthus occidentalis*
Canada anemone	*Anemone canadensis*
Carey's hearts-ease	*Polygonum careyi*
Carolina foxtail	*Alopecurus carolinianus*
Chara spp.	*Chara spp.*
Cinquefoil spp.	*Potentilla spp.*
Clover spp.	*Trifolium spp.*
Club moss	*Lycopodium spp.*
Common arrowhead	*Sagittaria latifolia*
Common bladderwort	*Utricularia vulgaris*
Common bur sedge	*Carex grayi*
Common cat-tail	*Typha latifolia*
Common dandelion	*Taraxacum officinale*
Common fox sedge	*Carex stipata*
Common hop sedge	*Carex lupulina*
Common horsetail	*Equisetum arvense*
Common ragweed	*Ambrosia artemisiifolia*
Common reed	*Phargmites australis*
Common St. John's-wort	*Hypericum perforatum*
Common water-hemlock	*Cicuta maculata*
Common water purslane	*Didiplis diandra*
Common water weed	*Elodea Canadensis*

Appendix 2.B. Cont'd.

Common Name	*Scientific Name*
Coontail	*Ceratophyllum demersum*
Creeping buttercup	*Ranunculus repens*
Crested oval sedge	*Carex cristatella*
Curled dock	*Rumex crispus*
Curly pondweed	*Potamogeton crispu*
Dandelion spp.	*Taraxacum spp.*
Diamond willow	*Salix eriocephala*
Ditch-stonecrop	*Penthorum sedoides*
Dock-leaved smartweed	*Polygonum lapathifolium*
Downy willow-herb	*Epilobium srictum*
Ear-leaved brome	*Bromus altissimus*
Eastern cottonwood	*Populus deltoides*
Fancy wood fern	*Dryopteris intermedia*
Field Bindweed	*Convolvulus arvensis*
Field-mint	*Mentha arvensis*
Flatsedge spp.	*Cyperus spp.*
Floating pondweed	*Potamogeton natans*
Fowl bluegrass	*Poa palustris*
Fox sedge	*Carex vulpinoidea*
Fringed loosestrife	*Lysimachia ciliata*
Giant bur-reed	*Sparganium eurycarpum*
Goldenrod spp.	*Solidago spp.*
Goosefoot spp.	*Chenopodium spp.*
Grass spp.	*Poa spp.*
Great lobelia	*Lobelia siphilitica*
Greater duckweed	*Spirodela polyrhiza*
Green ash	*Fraxinus pennsylvanica*
Green bulrush	*Scripus atrovirensa*
Halberd-leaved tearthumb	*Polygonum arifolium*
Hardstem bulrush	*Scirpus acutus*
Heart-leaf plantain	*Plantago cordata*
Hemlock-parsley	*Conioselinum chinense*
Hollow-stemmed Joe-pye-weed	*Eupatorium maculatum*
Horned bladderwort	*Urticularia cornuta*
Iris spp.	*Iris spp.*
Knotted rush	*Juncus nodosus*
Lesser duckweed	*Lemna minor*
Linear-leaf willow-herb	*Epilobium leptophyllum*
Longleaf pondweed	*Potamogeton nodosus*
Marsh fern	*Thelypteris palustris*
Marsh skullcap	*Scutellaria galericulata*

Appendix 2.B. Cont'd.

Common Name	*Scientific Name*
Marsh thistle	*Cirsium palustre*
Marsh-horsetail	*Equisetum palustre*
Meadow horsetail	*Equisetum pratense*
Meadowsweet	*Spiraea alba*
Nannyberry	*Viburnum lentago*
Narrow leaf cattail	*Typha augustifolia*
Narrow-leaf dock	*Rumex stenophyllus*
Northern mannagrass	*Glyceria borealis*
Northern water-nymph	*Najas flexilis*
Orange hawkweed	*Hieracium aurantiacum*
Panic grass spp.	*Panicum spp.*
Paper birch	*Betula papyrifera*
Path rush	*Juncus tenuis*
Peach-leaf willow	*Salix amygdaloides*
Pickerel-weed	*Pontederia cordata*
Pin oak	*Quercus palustris*
Plantain spp.	*Plantago spp.*
Pondweed spp.	*Potamogeton spp.*
Posion ivy	*Toxicodendron radicans*
Purple loosestrife	*Lythrum salicaria*
Purple-leaf willow-herb	*Epilobium coloratum*
Queen anne's lace	*Daucus carota*
Rasberry spp.	*Rubus spp.*
Rattlesnake-mannagrass	*Glyceria canadensis*
Red clover	*Trifolium pratense*
Red maple	*Acer rubrum*
Red oak	*Quercus rubra*
Red osier dogwood	*Cornus stolonifera*
Redbud	*Cercis canadensis*
Redtop	*Agrostis gigantean*
Reed canary	*Phalaris arundinacea*
Rice cut grass	*Leersia oryzoides*
Riverbank grape	*Vitis riparia*
Rock elm	*Ulmus thomasii*
Rough avens	*Geum laciniatum*
Royal fern	*Osmunda regalis*
Running strawberry	*Euonymus obovatus*
Rush spp.	*Juncus spp.*
Sago-pondweed	*Potamogeton pectinatus*
Sandbar-willow	*Salix exigua*

Appendix 2.B. Cont'd.

Common Name	*Scientific Name*
Sand-spurrey spp.	*Spergularia spp.*
Sassafras	*Sassafras albidum*
Sedge spp.	*Carex spp.*
Sensitive fern	*Onoclea sensibilis*
Shinning willow	*Salix lucida*
Showy milkweed	*Asclepias speciosa*
Silky dogwood	*Cornus amomum*
Silver maple	*Acer saccharinum*
Skullcap spp.	*Scutellaria spp.*
Slough sedge	*Carex atherodes*
Small sundrop	*Oenothera perennis*
Small waterwort	*Elatine minima*
Small white morning glory	*Ipomoea lacunose*
Smartweed spp.	*Polygonum spp.*
Smooth goldenrod	*Solidago gigantean*
Soft rush	*Juncus effusus*
Soft-stem bulrush	*Scripus validus*
Southern three-lobed bedstraw	*Galium tinctorium*
Sow thistle spp.	*Sonchus spp.*
Spike-rush spp.	*Eleocharis spp.*
Square-stem monkey-flower	*Mimulus ringens*
Star-duckweed	*Lemna trisulca*
Stinging nettle	*Urtica dioica*
Streambank wild rye	*Elymus riparius*
Sugar maple	*Acer saccharum*
Sulphur cinquefoil	*Potentilla recta*
Swamp dewberry	*Rubus hispidus*
Swamp oval sedge	*Carex muskingumensis*
Swamp rose	*Rubus palustris*
Swamp white oak	*Quercus bicolor willd.*
Swamp-milkweed	*Asclepias incarnata*
Swamp-thistle	*Cirsium muticum*
Sweet flag	*Acorus calamus*
Tag alder	*Alnus incana*
Taper-tip rush	*Juncus acuminatus*
Three way sedge	*Dulichium arundinaceum*
Tick trefoil	*Desmodium glutinosum*
Tickle grass	*Agrostis hyemalis*
Tufted hairgrass	*Deschampsia cespitosa*
Virginia creeper	*Parthenocissus quinquefolia*
Water smartweed	*Polygonum amphibium*

Appendix 2.B. Cont'd.

Common Name	*Scientific Name*
Water willow	*Justicia americana*
Water-dock; swamp-dock	*Rumex verticillatus*
Water-horehound spp.	*Lycopus spp.*
Water-meal	*Wolffia spp.*
Water-milfoil	*Myriophyllum spp.*
Water-parsnip	*Sium suave*
Water-plantain	*Alisma plantago-aquatica*
White water-lily	*Nymphaea odorata*
Wild ginger	*Asarum canadense*
Wild red raspberry	*Rubus idaeus*
Wild white violet	*Viola macloskeyi*
Wool-grass	*Scirpus cyperinus*
Woolly sedge	*Carex lanuginosa*
Yarrow	*Achillea millefolium*
Yellow avens	*Geum aleppicum*
Yellow water buttercup	*Ranunculus flabellaris*
Yellow water-lily	*Nuphar advena*

Appendix 2.C. List of common and scientific names of avian species observed on restored and reference sites during intensive evaluations, Saginaw Bay watershed, summer 2001 and 2002.

Type	Common Name	Scientific Name	Restored	Reference
Wetland dependent	Alder Flycatcher	*Empidonax alnorum*		X
	American Coot	*Fulica americana*	X	
	Bank Swallow	*Riparia riparia*	X	
	Belted Kingfisher	*Ceryle torquata*	X	
	Blue-winged Teal	*Anas discors*	X	X
	Canada Goose	*Branta canadensis*	X	X
	Common Merganser	*Mergus serrator*	X	
	Common Snipe	*Gallinago gallinago*	X	
	Common Yellowthroat	*Geothlypis trichas*	X	X
	Great Blue Heron	*Ardea herodias*	X	X
	Green Heron	*Butorides striatus*	X	X
	Hooded Merganser	*Lophodytes albellus*	X	
	Least Bittern	*Ixobtychus exilis*	X	
	Mallard	*Anas platyrhynchos*	X	X
	Marsh Wren	*Cistothorus palustris*	X	X
	Red-winged Blackbird*	*Agelaius phoeniceus*	X	X
	Sedge Wren	*Cistothorus platensis*	X	
	Sora	*Porzana carolina*	X	X
	Swamp Sparrow	*Melospiza georgiana*	X	X
	Tree Swallow*	*Tachycineta bicolor*	X	X
	Virginia Rail	*Rallus limicola*	X	
	White-rumped Sandpiper	*Calidris fuscicollis*	X	
	Willow Flycatcher	*Empidonax traillii*		X
	Wood Duck	*Aix sponsa*	X	X
Wetland associated	Barn Swallow	*Hirundo rustica*	X	X
	Common Grackle	*Quiscalus quiscula*	X	X
	Eastern Kingbird	*Tyrannus tyrannus*	X	X

Appendix C. Cont'd.

Type	Common Name	Scientific Name	Restored	Reference
	Gray Catbird	*Dumetella carolinensis*	X	X
	House Wren	*Troglodytes aedon*	X	X
	Killdeer	*Charadrius vociferus*	X	
	Yellow Warbler	*Dendroica petechia*	X	X
Nonwetland	American Goldfinch	*Cardurlis tristis*	X	X
	American Robin	*Turdus migratorius*	X	X
	Baltimore Oriole	*Icterus galbula*	X	X
	Black-capped Chickadee	*Parus atricapillus*	X	X
	Blue Jay	*Cyanocitta cristata*	X	X
	Bobolink	*Dolichonyx oryzivorus*	X	
	Cedar Waxwing	*Bombycilla cedrorum*	X	X
	Cooper's Hawk	*Accipiter cooperii*		X
	Dark-eyed Junco	*Junco jyemalis*		X
	Downy Woodpecker	*Picoides pubescens*	X	X
	Eastern Bluebird	*Sialia sialis*	X	
	Eastern Wood-Pewee	*Contopus virens*	X	X
	Eurasian Blackbird	*Turdus merula*	X	
	European Starling	*Sturnus vulgaris*	X	X
	Field Sparrow	*Spizella pusilla*	X	X
	Great Crested Flycatcher	*Myiarchus crinitus*		X
	Hairy Woodpecker	*Picoides villosus*	X	X
	Hermit Thrush	*Catharus guttatus*		X
	House Sparrow	*Passer montanus*	X	
	Indigo Bunting	*Passerina cyanea*	X	
	Mourning Dove	*Zenaida macroura*	X	X
	Northern Cardinal	*Cardinalis cardinalis*	X	X
	Northern Flicker	*Colaptes auratus*	X	X

Appendix C. Cont'd.

Type	Common Name	Scientific Name	Restored	Reference
	Pileated Woodpecker	*Drycopus pileatus*		X
	Red-bellied Woodpecker	*Melanerpes carolinas*	X	
	Red-shouldered Hawk	*Buteo lineatus*	X	X
	Rose-breasted Grosbeak*	*Pheuticus ludovicianus*		X
	Ruby-throated Hummingbird	*Archilochus colubris*	X	X
	Scarlett Tanager	*Piranga olivacea*	X	X
	Song Sparrow	*Melospiza melodia*	X	X
	White-breasted Nuthatch	*Sitta carolinensis*		X
	Yellow-rumped Warbler	*Dendroica coronata*	X	

CHAPTER 3
EVALUATION OF PARTNERS FOR FISH AND WILDLIFE WETLAND RESTORATION EFFORTS IN THE SAGINAW BAY WATERSHED USING LANDOWNER SURVEYS

ABSTRACT

The Partners for Fish and Wildlife Program provides technical and financial assistance to landowners who voluntarily wish to restore wetlands on their property. However, monitoring and evaluation of these projects has been scarce as a result of budget and personnel shortages that limit the ability to effectively monitor projects. Therefore, it is important to explore alternative evaluation methods that can provide ecological information biologists can use to determine the condition of wetland restoration projects. I explored the relationship between landowner satisfaction and the ecological and non-ecological conditions of their restored wetland. Furthermore, I compared landowner surveys, which incorporated ecological questions, to broad and intensive ecological evaluation techniques. Approximately 60% of landowners responded that they were satisfied to very satisfied with their wetland restoration project. Specifically, the surveys revealed that landowners cared most about providing wildlife habitat and ensuring water was present on their property. Comparisons between ecological evaluations and landowner surveys on environmental variables (e.g., percent total cover) were similar. Landowner surveys, broad and intensive evaluation techniques can all be used to effectively monitor and evaluate restored wetlands on private lands. The objectives of the study, budget and personnel availability will determine which technique is the most appropriate to use to gather the necessary information.

INTRODUCTION

Approximately 78% of Michigan's land base is privately owned, including 75% of all wetlands (Covell 1997, Cwikiel 1997, Michigan GAP State Land Ownership (Stewardship) Digital Geospatial Data 2000). Therefore, it is ultimately the landowner's decisions, within the context of the law that will determine the fate of wetland habitat on private land (Applegate 1981). This presents a challenge to agencies and organizations interested in conserving and restoring wetlands. While the majority of wetlands in Michigan occur on private land, the benefits of protecting wetlands, such as maintenance of ground water quality, flood storage, nutrient cycling and wildlife habitat; serve the public good (Pease et al. 1997). The goal for government agencies is to determine what types of incentives are valued by private landowners, in combination with regulatory restrictions, that allow for both private and public needs to be meet and results in wetland conservation (Pease et al. 1997). As a result of stronger wetland regulations, such as President Carter's 1977 Executive Order on Wetlands (E.O. 11990) directing federal agencies to avoid adverse impacts on wetlands, and the passage of the Food, Agriculture, Conservation and Trade Act of 1990, federal and state governments were given the opportunity to the develop wetland restoration programs geared toward private landowners (Pease et al. 1997, Vileisis 1997).

The Wetland Reserve Program (WRP) and the Partners Program are two well-known existing wetland restoration programs. The WRP is a voluntary restoration program geared toward agricultural landowners that promotes governmental purchase of permanent or long-term conservation easements of wetland acres (Beck 1994, Environmental Protection Agency 1980, Vileisis 1997). The Partners program, a cooperation between the Service, state fish and wildlife agencies, local agencies, communities and private conservation organizations, provides technical and financial assistance to landowners who voluntarily wish to restore wetlands on their property (MacKinnon 2000, http://partners.fws.gov.htm). Under the Partners program landowners sign a 10-year agreement to maintain the restoration.

As a result of programs like the WRP and Partners, over 250,000 ha of wetlands have been restored and protected nationally (http://partners.fws.gov.htm). Unfortunately, evaluation of wetland restoration projects has been scarce. Many state and federal agencies face budget and personnel shortages that limit their ability to effectively monitor projects. Due to these constraints, biologists are unable to conduct intensive field evaluation of projects. Therefore, it is important to explore alternative evaluation methods that can provide ecological information biologists can use to determine the condition of wetland restoration projects.

There have been many surveys conducted documenting the public's perceptions, attitudes, behavior and motivation regarding the Nation's natural resources. Several studies focused on ways to motivate the private landowner to manage for wildlife and wildlife habitat on their property (Applegate 1981, Shelton 1981, Svoboda 1981). Others have focused on understanding the values and beliefs of landowners and how that relates to their perception of natural resources (Kelley 1981, Kirby et al. 1981, Pease 1992, Wywialowski and Dahlgren 1985). There has been an increase in the number of studies that surveyed landowner's motivations for restoring wetlands (Kraft et al. 1996, Mooney 1996, Napier et al. 1995, Pate 1996, Pease et al. 1997). To date, there has not been a survey of the Partner's program conducted that asks landowners quantitative ecological questions regarding their restored wetland. In addition, few studies have compared landowner survey responses of these questions to field-collected parameters. Therefore, the specific objectives of this study were to 1) determine landowner attitudes and perceptions toward their wetland restoration project, 2) relate landowner satisfaction to the ecological and non-ecological conditions of their restored wetland, and 3) compare landowner surveys, broad and intensive evaluation techniques to explore the similarities and differences between each technique (Figure 1.2).

METHODS

Landowner Survey

In September of 2001 a pilot survey was sent to 20 landowners in Michigan involved with the Partners program, asking them to complete a survey and critique a range of aspects such as, format, language, and clarity of the questions. Of the 20 sent, 10 were returned with various comments and suggestions for improving the survey. In mid-October of 2001 the final survey was sent to all landowners from the Saginaw Bay watershed who were participants in the Partners Program. Names and addresses for the landowners were obtained from the Service with the provision that the landowners selected and their survey responses were confidential (UCRISH IRB # 00-708). Of the 401 landowners who were participants in the program and lived within the watershed boundaries, only 387 surveys were sent due to incomplete address information. All 22 counties of the Saginaw Bay watershed were represented in the survey distribution (Figure 1.1).

The survey (Appendix 3.A.) consists of 38 questions on 11 pages. Twenty-eight questions required respondents to check or circle the answer, with short blanks to fill in on 8 questions. One question asked the landowners to draw a map of where their wetland is located on the property and to note wetland acreage. Of the 38 questions on the survey, 14 questions asked respondents for specific biological information regarding their restored wetland. Respondents were asked to estimate the amount of vegetation cover present on their wetland, whether water depth levels fluctuated, presence of avian species, and if structural problems existed. One of the last questions asked landowners if they would be willing to allow access to their property for the field portion of the project. The last question provided space for respondents to write additional comments.

The methods used to gather information from the landowners were based on the Total Design Method by Dillman (Salant and Dillman 1994). A letter was sent to each landowner a week before the survey was distributed to introduce the project to the landowners and inform them of the upcoming survey (Salant and Dillman 1994). Two weeks after the survey was sent a reminder letter and a new survey were mailed to non-respondents (Salant and Dillman 1994). Of the 387 surveys sent, 47 were undeliverable. Of the remaining 340, 239 (70%) landowners returned surveys using this method. Some surveys were returned with incomplete answers, so percentages do not reach 100% in every category.

Non-response bias was assessed by comparing landowner project information such as wetland size, project location, and age of wetland between respondents and non-respondents. Comparisons of these parameters demonstrated relatively few differences between respondents and non-respondents. The average wetland size was not different ($P = 0.07$) between respondents (1.3 ha) and non-respondents (1.7 ha). The average wetland age was also not different ($P = 0.2$) between respondents (4.9 yrs) and non-respondents (4.3 yrs). Furthermore, project location trends were very similar between respondents and non-respondents. The counties with the largest number of potential projects (Sanilac, Lapeer, Osceola, and Mecosta) were also the counties that represented the highest number of returned surveys. Data were analyzed using SPSS 10.0.7. for Windows software for social statistics (SPSS 2000).

Comparison of Evaluation Techniques

A three-tiered study design was developed to evaluate restored wetlands that incorporated three different evaluation techniques that ranged from general to intensive

(Figure 1.2). Although the sample size varied within each level (landowner survey n=240, broad n=58, intensive n=25), a group of 24 wetlands were evaluated at each level. For a detailed explanation of intensive and broad evaluation methods refer to Chapter 2.

To explore the similarities and differences among the three levels, similar parameters were selected that could be used to quantitatively and qualitatively compare results, using the group of 24 wetlands, among the three levels. There were three general areas that could be compared between all three techniques, wetland cover categories, water depth and wildlife (Table 3.1). Specifically, percent total vegetation, open water and bare ground were compared among the 3 evaluation levels, as well as, percent wood (i.e., trees and shrubs) and grass-like (i.e., grasses, sedges and rushes) vegetation (Table 3.1). Percent cattail cover was compared between the landowner survey and broad evaluation (Table 3.1). There were 3 water depth questions asked of landowners responding to the survey: 1) does your wetland experience fluctuating water levels, 2) what month is the water level of your wetland the highest, and 3) what month is the water level of your wetland the lowest (Table 3.1)? These questions were compared to the monthly broad evaluation and the monthly mean intensive water depth readings to determine when water levels were high/low and if wetlands experienced fluctuating water levels throughout the summer (Table 3.1). Wildlife sightings during intensive evaluations, wildlife observations during broad evaluation visits and presence of wildlife indicated by landowners in the survey were also compared (Table 3.1). In addition, structural problems were compared between the landowner survey and broad evaluations (Table 3.1). Structural problems reported by the landowner were compared to the structural problems identified during the broad evaluation (Table 3.1). A Kruskal-Wallis

Table 3.1. List of parameters that were compared among landowner surveys, broad and intensive ecological evaluations to determine similarities and differences among techniques, Saginaw Bay watershed, Michigan, summer 2001 and 2002.

	Evaluation Level		
Parameter	Landowner Survey	Broad Evaluation	Intensive Evaluation
Percent Wetland Cover Categories	%TC[1], %BG[2], %OW[3]	%TC, %BG,%OW	%TC, %BG, %OW
Vegetation Cover Categories	% wood (%tree + %shrub)	% wood (%tree + %shrub)	% wood
	% grass-like (%grass + % src[4])	% grass-like (%grass + %src)	% grass-like (%grass +%src)
	% cattail	% cattail	
Water Depth	*Question: does your wetland experience fluctuating water levels?*	Compare to 3 monthly readings	Compare to 3 monthly means
	Question: what month is the water level the highest?	Compare to the highest reading	Compare to the highest mean
	Question: what month is the water level the lowest?	Compare to the lowest reading	Compare to the lowest mean
Wildlife	Wildlife observed by landowners	Wildlife observed during field collection	Wildlife observed during field collection
Structural Problems	Structural problems identified by landowners	Structural problems identified during site visits	

[1] Total Cover
[2] Bare Ground
[3] Open Water
[4] Sedge and Rush Cover

one-way analysis of variance ($\alpha = 0.05$) was used to compare the mean percent total vegetation cover, wood cover, grass-like cover, open water and bare ground among the 3 evaluation techniques (Siegel 1956). Percent cattail cover was compared between landowner surveys and broad evaluations using a Mann-Whitney U test ($\alpha = 0.05$) (Siegel 1956). All other data were qualitatively compared among the three evaluation techniques using SPSS 10.0.7. for Windows software for social statistics (SPSS 2000).

RESULTS

Landowner Survey

Landowner Demographics

Surveys were returned from 20 of the possible 22 counties within the Saginaw Bay watershed (Figure 1.2). Approximately 60% of surveys came from landowners in Lapeer, Mecosta, Osceola and Sanilac counties (Table 3.2). Thirty-two percent of landowners learned about the Partner's program from contact with a friend/neighbor or contact and 40% from a public/private conservation organization (Table 3.3). Thirteen percent received information from an organizational newsletter (Table 3.3). The majority of landowners owned 120 or less hectares of land, with an average ownership of 48 hectares (range: 0.4 - 405 ha) (Table 3.4). Only one landowner reported owning more than 405 ha (Table 3.4). This is consistent with other surveys, which reported that the majority of landowners who restored wetlands and other wildlife habitat on their property owned small- and medium-sized farms (Pease 1992, Pease et al. 1997). Furthermore, 63% of landowners reported that they did not receive income from agricultural production on their land (Table 3.5). Of the remaining landowners that indicated receiving income from their property, 60% lease all or some portion of their property to others (Table 3.5).

Landowners reported that the primary uses of the wetland prior to restoration were row crops (27%), fallow field (18%), brush (14%) and pasture (12%) (Table 3.6). Additionally, landowners reported similar uses of the surrounding upland prior to restoration (Table 3.6). Overall, the male member of the household completed and returned the survey, as only 7% of the respondents were female (Table 3.7).

Table 3.2. Number of surveys sent to and returned per county by landowners who participated in the Partners program, Saginaw Bay watershed, Michigan, 2001.

County	No. of sent surveys (n=387)	No. of returned surveys (n=239)	Percent of returned surveys
Arenac	6	3	50.0
Bay	2	1	50.0
Clare	8	3	37.5
Genesee	20	14	70.0
Gladwin	26	14	53.8
Gratiot	16	14	87.5
Huron	17	10	58.8
Iosco	3	2	66.7
Isabella	8	5	62.5
Lapeer	38	27	71.1
Livingston	2	1	50.0
Macomb	1	0	0.0
Mecosta	29	22	75.9
Midland	6	4	66.7
Montcalm	13	11	84.6
Oakland	1	0	0.0
Ogemaw	3	3	100.0
Osceola	34	24	70.6
Saginaw	4	3	75.0
Sanilac	93	66	71.0
Shiawassee	5	3	60.0
Tuscola	5	5	100.0
N.A.*		4	
Returned Mail	47		

* N.A.= Not Available

Table 3.3. Sources of information where landowners first heard about the Partners program, Saginaw Bay watershed, Michigan, 2001.

Source of Information	No. of landowners (n=239)	Percent of total
Contact with public/private conservation organization	92	39.5
Friend, relative or neighbor	77	32.2
Organization newsletter	30	12.6
Other	22	9.4
Radio, newspaper or TV	6	2.5
Workshop or meeting	6	2.5
Internet web site	0	0.0
N.A.*	6	2.5

* N.A.= Not Available

Table 3.4. Total hectares of land owned by landowners who restored wetlands through the Partners program, Saginaw Bay watershed, Michigan, 2001.

Range of hectares	No. of landowners (n=239)	Percent of total
0 - 40	154	64.4
41 - 121	59	24.7
122 - 202	15	6.3
203 - 405	5	2.1
> 405	1	0.4
N.A.*	5	2.1

* N.A.= Not Available

Table 3.5. Percentage of landowners in the Partners program that received income from agricultural production and/or leased their property for agricultural production, Saginaw Bay watershed, Michigan, 2001.

Parameter	No. of landowners (n=239)	Percent of total*
Was any household income from agricultural production?		
No	152	63.6
Yes	80	33.5
If yes, do you lease your property?		
No	49	20.5
Yes	32	13.4
If yes, what percentage of property is leased?		
0 - 24%	11	4.6
25 - 49%	12	5.0
50 - 74%	13	5.4
75 - 100%	13	5.4

*Percents vary due to "no answer" in each category

Table 3.6. Former uses of land on which wetlands were restored through the Partners program and the surrounding upland, Saginaw Bay watershed, Michigan, 2001.

Parameter	No. of landowners (n=239)	Percent of total
Use of wetland prior to restoration		
Row crops	64	26.8
Other	44	18.4
Fallow Field	42	17.6
Brush	33	13.8
Pasture	28	11.7
Woods	18	7.5
N.A.*	10	4.2
Use of surrounding upland prior to restoration		
Row crops	85	35.6
Fallow field	38	15.9
Other	36	15.0
Woods	33	13.8
Pasture	23	9.6
Brush	14	5.9
N.A.*	10	4.2

* N.A.=Not Available

Table 3.7. Demographic parameters of landowners who restored wetlands through the Partners program, Saginaw Bay watershed, Michigan, 2001.

Parameters	No. of landowners (n=239)	Percent of total*
Sex		
Male	215	90.0
Female	17	7.1
Age Range		
20 - 30 yrs.	3	1.3
31 - 40	18	7.5
41 - 50	65	27.2
51 - 60	60	25.1
61 - 70	58	24.3
71 - 80	22	9.2
80+	3	1.3
Education		
School less than high school	6	2.5
Some high school	9	3.8
High school diploma	55	23.0
Some college	75	31.4
College diploma	48	20.1
Advance degree in college	37	15.5

*Percents vary due to "no answers" in each category

Approximately 76% of landowners restoring wetlands on their property were between the ages of 41 and 70 years (Table 3.7). Less then 3% of landowners were younger than 30 or older than 80 years of age (Table 3.7).

The majority of landowners (90%) received a high school diploma (Table 3.7). Sixty-seven percent had some college training, or received a college or advanced degree (Table 3.7).

When asked if they would be willing to allow access to their property for the field portion of this study, 61% percent responded "yes", 29% responded "maybe", and 10% responded "no".

Landowner Motivation

Landowners were asked to rate the importance, ranging from very important to very unimportant, of a list of potential benefits that prompted them to restore a wetland on their property. Overall, landowners indicated that they were motivated to restore wetlands on their property due to the importance of wildlife and scenic beauty. About 85% of landowners felt that wildlife habitat and wildlife viewing were important to very important benefits to restoring wetlands (Table 3.8). Furthermore, 64% were motivated by the foreseen scenic beauty of having wetland habitat on their property (Table 3.8). Approximately half of the landowners felt that fishing, trapping, and financial benefits were unimportant to very unimportant benefits from restoring wetlands (Table 3.8).

Landowners were also asked to rate the importance, ranging from very important to very unimportant, of factors that influenced their decision to participate in the Partner's program. Over three-quarters of respondents rated environmental benefits, wildlife and fish habitat, and low participation cost as important to very important influences for

Table 3.8. Percentage of landowners' responses, who participated in the Partners program, rating the importance of certain benefits of restoring wetlands on their property, Saginaw Bay watershed, Michigan, 2001.

	Percent answering:					
Benefits	Very Important	Important	Moderately Important	Neutral	Unimportant	Very Unimportant
Wildlife viewing	55.2	28.0	5.4	4.2	0.0	0.0
Scenic beauty	37.7	26.4	13.8	7.1	2.9	1.7
Wildlife habitat	71.1	18.0	1.7	2.1	0.0	0.0
Ground water recharge	16.3	15.5	13.4	21.3	11.3	4.6
Flood storage	10.9	11.3	13.0	23.4	18.8	5.4
Hunting	26.8	16.3	18.4	10.0	7.1	9.2
Erosion control	7.9	11.7	17.6	18.8	19.7	7.1
Fish habitat	11.7	8.8	12.1	16.7	18.0	15.5
Nutrient recycling	5.0	15.5	13.0	24.3	14.6	8.4
Fishing	7.1	4.6	9.2	17.2	23.8	18.0
Financial benefits	4.6	5.4	5.4	16.7	24.7	23.8
Trapping	2.5	1.7	8.4	17.2	26.8	25.9

restoring wetlands on their property (Table 3.9). Also of importance was the Partners program handling of construction and permitting procedures (Table 3.9). Landowners reported they were not influenced by the actions of their neighbors. About half the landowners felt that a neighbor also having restorations was unimportant to very unimportant in influencing their decisions (Table 3.9). Likewise, about 60% were either neutral or stated that having supportive neighbors was unimportant to very unimportant in making the decision to restore wetlands (Table 3.9).

Landowner Satisfaction

Imbedded in the survey were multiple questions that asked landowners to rate how satisfied they were with the project and service of the biologist. They were also asked to state why they chose a particular satisfaction rating. When asked how satisfied they were with the completed project approximately 60% of landowners stated that they were satisfied to highly satisfied, whereas less then 10% of landowners felt dissatisfied or highly dissatisfied (Table 3.10). Landowners were asked to list the single most important reason for their satisfaction rating of the completed project. Of the landowners that were satisfied to highly satisfied, the main reasons for their ratings were: completed, well-organized project (35.3%), increase in wildlife (28.6%), and excellent work done by the biologist (11.3%) (Table 3.11). Of those that were dissatisfied to highly dissatisfied, 40.0% listed work did not go according to the plan and 20.0% said construction was poorly done as their main reasons for their dissatisfaction (Table 3.11).

The next question asked landowners how satisfied they were with the service provided by the biologist. Eight-two percent of landowners stated that they were satisfied to very satisfied and approximately 5% were not satisfied with the service provided by

Table 3.9. Percentage of landowners' responses, who participated in the Partners program, rating the importance of factors that influenced them to restore their wetland, Saginaw Bay watershed, Michigan, 2001.

	Percent answering:					
Reason	Very Important	Important	Moderately Important	Neutral	Unimportant	Very Unimportant
Low cost to participate	48.5	28.0	9.2	2.5	3.8	0.4
Increase property values	8.4	10.5	15.5	24.7	20.5	7.9
Environmental benefits	53.1	25.1	7.1	4.2	1.3	0.0
Wildlife & fish habitat	66.5	20.1	2.9	1.3	0.0	0.4
Recreation opportunities	19.2	16.3	21.8	15.1	8.4	5.0
Partners handled construction	31.0	30.1	12.6	11.3	2.5	1.7
Partners handled permitting	28.9	28.9	11.7	12.1	2.9	2.5
Supportive neighbors	6.7	10.9	10.0	30.5	16.7	12.6
Neighbors had restorations	3.8	6.7	7.1	25.9	22.2	18.8

Table 3.10. Landowner satisfaction ratings about their wetland restored through the Partners program, Saginaw Bay watershed, Michigan, 2001.

Satisfaction Question	Percentage* of Landowner Responses (n=239)
Landowner satisfaction with completed project	
Highly Satisfied	38.5
Satisfied	23.8
Neutral	5.0
Dissatisfied	3.8
Highly Dissatisfied	4.6
N.A.	24.3
Landowner satisfaction with the service provided by biologist.	
Very Satisfied	52.3
Satisfied	30.5
Somewhat satisfied	6.3
Not satisfied	4.6
N.A.	6.3
Landowner satisfaction with the project today compared to when the project was first completed.	
More Satisfied	40.6
About the Same	40.2
Less Satisfied	13.0
N.A.	6.2

*Percentages vary due to "No Answers" in each category

Table 3.11. Landowner's reasons for their satisfaction ratings of their Partners restored wetland, Saginaw Bay watershed, Michigan, 2001.

Reason for Satisfaction Rating	Percentage of Landowner Responses
Highly Satisfied/Satisfied (n=133)	
Project was completed as planned	35.3
Increase in wildlife	28.6
Excellent work by biologist	11.3
Wildlife viewing	8.3
Minimal cost	4.5
Project improved land	3.0
Wetland had standing water	3.0
Other	6.0
Neutral (n=6)	
Increase in wildlife	16.6
Wildlife viewing	16.6
Wetland too small	16.6
Project did not go according to plan	16.6
Wetland does not hold water	33.6
Highly Dissatisfied/Dissatisfied (n=15)	
Project did not go according to plan	40.0
Construction was poorly done	20.0
Wetland does not hold water	13.3
Wetland too small	13.3
Other	13.4

the biologist working on their restored wetland (Table 3.10). Landowners were asked how satisfied they were today with their restored wetland compared to when the project was first completed. About 80% of landowners stated that they were more satisfied (40.0%) or felt about the same (40.0%) compared to 13% were said that they were less satisfied (Table 3.10). Of those that stated they felt about the same, 91% had also marked that they were very satisfied to satisfied with the work provided by the biologist.

Landowners that stated they were more satisfied with the project listed an increase in wildlife (45%), project exceed expectations (19%), and satisfaction with project water levels (11%) as reasons for their satisfaction rating (Table 3.12). Of those that felt about the same, 43% were satisfied with the results, 20% enjoying viewing wildlife on their wetland, and 16% were satisfied with the water levels of the wetland (Table 3.12). Lack of water was the number one reason why landowners were less satisfied along with structural problems and dissatisfaction with completed project (3.12).

Satisfaction ratings (how satisfied they were today with their restored wetland compared to when the project was first completed) were qualitatively compared with structural problems reported by the landowners. Approximately half of the landowners reported no structural problems with their wetlands (Table 3.13). Of those that did report structural problems the majority were muskrat or other animal related damage (26%), inability of the wetland to hold water (11%), spillway/berm erosion (16%), and leaks in the berm (8%) (Table 3.13). Although structural problems existed on half of the sites, most landowners were still satisfied with their wetland. Forty percent and 41% of landowners who reported berm erosion and animal damage, respectively, also marked that they were more satisfied with their project (Table 3.14). However, 65% of

Table 3.12. Reasons why landowners were satisfied and/or dissatisfied about their Partners project now than when project was first completed, Saginaw Bay watershed, Michigan, 2001.

Reason for Satisfaction Rating	Percentage of Landowner Responses
More Satisfied (n=92)	
Increase in wildlife	44.5
Project exceeded expectations	18.5
Satisfied with water levels	11.0
Minimal cost	12.0
Aesthetics	5.4
Wildlife viewing	1.0
Other	7.6
	100
About the Same (n=61)	
Satisfied with results	42.6
Wildlife viewing	19.7
Satisfied with water levels	16.4
Increase in wildlife	5.0
Project not completed	3.2
Lack of wildlife	1.6
Other	11.5
	100
Less Satisfied (n=29)	
Lack of water	55.2
Dissatisfied with completed project	24.1
Structural problems	10.3
Lack of wildlife	7.0
Other	3.4
	100

Table 3.13. Percentage of landowners that reported structural problems with their Partners restored wetland, Saginaw Bay watershed, Michigan, 2001.

Structural Problems Observed	Percentage of Landowner Responses* (n=239)
None	48.5
Muskrat or other animal damage to dikes	26.4
Inability of wetland to hold water	10.9
Leak in dam	8.4
Spillway Erosion	7.5
Dike Erosion	6.7
Other	5.9
Poor plant growth on disturbed areas	2.5
Beaver plugging water control structures	1.7
Vandalism to restoration structures	0.4

*Numbers add to more than 100% because landowners may have observed more than one problem.

Table 3.14. Percentage of landowners that reported structural problems with their Partners restored wetland compared with their satisfaction answers on how they feel about their wetland now than when first restored, Saginaw Bay watershed, Michigan, 2001.

	Satisfaction Rating		
Structural Problems Observed	More Satisfied	About the same	Less Satisfied
None (n=111)	47.7	45.0	7.3
Berm Erosion (n=15)	40.0	40.0	20.0
Spillway Erosion (n=18)	50.0	44.4	5.6
Animal damage to berms (n=56)	41.1	44.6	14.3
Leak in berm (n=17)	29.4	41.2	29.4
Inability of wetland to hold water (n=23)	26.1	8.7	65.2
Vandalism to restoration structures (n=1)	100.0	0.0	0.0
Beaver plugging water control structures (n=3)	100.0	0.0	0.0
Poor plant growth on disturbed areas (n=6)	16.6	16.6	66.8
Other (n=12)	16.6	16.6	66.8

landowners that had wetlands that would not hold water were less satisfied with their project (Table 3.14).

Ecological Responses

Landowners were asked a series of ecological questions, (i.e., water levels, bird use), about their restored wetlands. The first set of ecological questions required landowners to answer questions about the vegetation characteristics of their restored wetland. Landowners were asked to select the statement that best characterizes their wetland vegetation during the first week in July. Approximately 40% stated that solid, large stands of vegetation were present on their wetland during the first week of July (Table 3.15). Vegetation around the outside edge of the wetland characterized about 22% of landowner's sites and about 22% stated that their wetland had scattered clumps near the shoreline and in the central area (Table 3.15).

Landowner's were asked to visually estimate the percent vegetative cover of their wetland during the same time period in July. Fifty-three percent of landowners estimated that their wetlands had 40% or less vegetative cover (Table 3.16). Only 10% estimated that vegetation covered over 80% of their wetland. About 40% of landowners estimated that their wetlands had 40% or less open water areas (Table 3.16). Most wetlands had less then 20% bare ground (Table 3.16). Overall, restored wetlands had an average of 46% open water areas, 44% vegetative cover and 10% bare ground (Table 3.16).

Vegetation percent cover was furthered divided into four categories (percent tree, shrub, cattail, and grass-like cover) that added to 100%. Eight-eighty and 80% of landowners estimated that trees and shrub cover on their wetland was less than 20%,

Table 3.15. Description of vegetation cover patterns observed by landowners of their Partners restored wetlands, Saginaw Bay watershed, Michigan, 2001.

Wetland Vegetation Description	No. of Landowner (n=239)	Percent of total
Scattered clumps near the shoreline and in the central area	52	21.8
Only a ring around the shoreline	52	21.8
Solid, large stands of vegetation	94	39.3
Other	28	11.8
N.A.*	13	5.4

* N.A.=Not Available

Table 3.16. Percentage (number) of landowners that estimated the percent cover categories of their Partners restored wetland during the first week of July, Saginaw Bay watershed, Michigan, 2001, (n=239).

	Cover Variable		
Range of Percent Cover	Open Water	Vegetation	Bare Ground
0 – 20	23.8 (57)	21.8 (52)	83.3 (199)
20 – 40	17.2 (41)	31.0 (74)	8.4 (20)
40 – 60	20.8 (67)	18.8 (45)	1.7 (4)
60 - 80	20.5 (49)	14.2 (34)	0.8 (2)
80 - 100	5.9 (14)	9.6 (23)	1.3 (3)
N.A.*	4.6 (11)	4.6 (11)	4.6 (11)
Mean	45.9	44.3	9.8

* N.A.=Not Available

respectively (Table 3.17). About 76% of landowners estimated that cattail cover was between 0 - 20% cover (Table 3.17). Approximately 78% of the landowners estimated that grass cover was between 0 - 40% (Table 3.17). Overall, restored wetland had an average of 7% tree cover, 16% shrub cover, 27% cattail cover and 49% grass-like cover (Table 3.17). The final vegetation question asked landowners how certain they were about the answers regarding wetland vegetation coverage. Over 80% of the landowner stated that they were certain to very certain about their answers, whereas less than 10% said they were uncertain to very uncertain (Table 3.18).

Landowners were asked to place a check by the wildlife they observed utilizing their restored wetland. The Canada Goose and Mallard were the most common waterfowl observed by landowners, followed by the Great Blue Heron and Red-winged Blackbird (Table 3.19). Over 90% of landowners reported White-tailed Deer using their wetlands. Muskrats and Raccoons were also observed at restored wetlands by at least 60% of all landowners (Table 3.19). The most common amphibians and reptiles observed were frogs, turtles and snakes (Table 3.19). Landowners were also asked to estimate how often they were likely to observe certain birds using their restored wetland. Twenty-eight percent of landowners said that they were likely to observe mallards at least 66% of the time using the wetlands and 23% said they were likely to see mallards between 33-66% of the time (Table 3.20). The least likely waterfowl to be observed at restored wetland were Blue-winged Teal (Table 3.20). Forty-one percent of landowners marked that they were most likely to observed songbirds greater than 66% of the time (Table 3.20). When asked how certain they were about correctly identify wetland birds,

Table 3.17. Percentage (number) of landowners that estimated percent vegetative cover categories of their Partners restored wetland during the first week of July, Saginaw Bay watershed, Michigan, 2001, (n=239).

	Vegetation Categories			
Percent Cover	Tree	Shrub	Cattail	Grass
0 – 20	87.9 (210)	79.5 (190)	75.7 (181)	56.1 (134)
20 – 40	1.3 (3)	6.7 (16)	10.5 (25)	21.3 (51)
40 – 60	2.1 (5)	3.8 (9)	3.8 (9)	5.4 (13)
60 - 80	0.0 (0)	0.8 (2)	1.3 (3)	5.4 (13)
80 - 100	0.4 (1)	0.8 (2)	0.4 (1)	3.3 (8)
N.A.*	8.4 (20)	8.4 (20)	8.4 (20)	8.4 (20)
Mean	7.4	16.1	27.2	49.3

* N.A.=Not Available

Table 3.18. Landowner certainty of their answers regarding wetland vegetation coverage, wetland birds observed, and water depth of their Partners restored wetlands, Saginaw Bay watershed, Michigan, 2001, (n=239).

	Percent Answering*				
	Very Certain	Certain	Neutral	Uncertain	Very Uncertain
Landowner certainty with answers regarding wetland vegetation coverage	52.3	30.5	6.3	4.6	4.6
Landowner certainty with answers regarding wetland birds	40.2	27.6	13.4	6.7	5.0
Landowner certainty with answers regarding water depth	54.0	25.9	9.6	3.8	3.8

*Percentages vary due to "no answer" in each category

Table 3.19. Percentage of landowners who reported seeing the following wildlife utilizing their Partners restored wetland since it was first completed, Saginaw Bay watershed, Michigan, 2001.

Wildlife Observed	No. of Landowners (n=239)	Percent of total
Birds		
Mallard	209	87.4
Canada Goose	200	83.7
Blue-winged Teal	62	25.9
Wood Duck	138	57.7
Other Waterfowl	101	42.3
Great Blue Heron	184	77.0
Shorebirds	105	43.9
Red-winged Blackbirds	174	72.8
Pheasant	136	56.9
Other Birds	141	59.0
Animals		
Muskrat	142	59.4
Raccoon	159	66.5
Mink	44	18.4
Deer	220	92.1
Beaver	22	9.2
Bear	1	0.4
Coyote	75	31.4
Other	40	16.7
Reptiles and Amphibians		
Frogs	226	94.6
Toads	157	65.7
Other Amphibians	37	15.5
Turtles	172	72.0
Snakes	148	61.9
Other Reptiles	17	7.1
Young-of-the-year		
Ducklings	154	65.4
Goslings	105	43.9
Other	44	18.4

Table 3.20. Percentage of landowners that observed birds utilizing their Partners restored wetlands during May, Saginaw Bay watershed, Michigan, 2001, (n=239).

	Percent Answering					
Bird Type	Observed > 66%	Observed 33%-66%	Observed <33%	Did not observe	Don't Know	N.A.*
Mallard	27.6	22.6	26.4	8.4	4.6	10.5
Canada Goose	18.4	20.1	25.9	14.2	3.3	18.0
Blue-winged Teal	2.5	4.2	14.6	30.1	12.6	36.0
Wood Duck	12.6	11.3	22.6	18.4	9.6	25.5
Other Waterfowl	7.5	10.0	24.3	14.6	8.4	35.1
Wading Birds	10.9	20.9	36.0	11.7	3.3	17.2
Shorebirds	12.1	10.9	23.0	20.1	7.5	26.4
Songbirds	41.0	20.1	10.0	8.4	5.0	15.5

* N.A.=Not Available

68% stated that they were certain to very certain (Table 3.18). Less then 15% of landowners said they were uncertain to very uncertain of their answers (Table 3.18).

Landowners were asked about the water depth levels of their restored wetland and how closely it resembled what they were told to expect by the project biologist. The majority of landowners said that water depth was at the level the biologist said it would be (Table 3.21). About 7% said water levels were higher than expected and 24% stated that water levels were lower than expected (Table 3.21). Landowners were also asked if the water levels of their restored wetland fluctuated throughout the year. Eight-five percent answered yes (Table 3.22). If they marked yes, they were asked which month, between March and August, were water levels the highest and the lowest. Approximately 80% of landowners said that water levels were highest between April and May and lowest in July and August (Table 3.22). Landowners were then asked how certain they were regarding their water depth answers. About 80% stated that they were certain to very certain about their answers, whereas less than 10% were uncertain to very uncertain (Table 3.18).

Comparison of Evaluation Techniques

Vegetation Characteristics

Overall, broad evaluations had higher ($P=0.02$) estimates of percent total cover than landowner surveys (Table 3.23). This is evident by the 75% of broad evaluations that had higher percents of total cover compared with landowners' estimates (Figure 3.1). The percent total cover estimated by intensive evaluations was not different from either the landowner surveys or the broad evaluations (Table 3.23). When estimates for each wetland were compared, approximately half of the landowner surveys reported

Table 3.21. Landowner's expectations of Partners restored wetland water levels based on information from project biologist, Saginaw Bay watershed, Michigan, 2001.

Water Depth Level	No. of landowners (n=239)	Percent of total
About the level the biologist said it would be	154	64.4
Higher than the biologist said it would be	16	6.7
Lower than the level the biologist said it would be	56	23.4
N.A.*	13	5.4

* N.A.=Not Available

Table 3.22. Water depth trends observed by landowner of their Partners restored wetland, Saginaw Bay watershed, Michigan, 2001.

Water Depth Levels	No. of Landowners	Percent of total
Does your wetland experience fluctuating water depth levels?		
No	27	11.3
Yes	202	84.5
N.A.*	10	4.2
If yes, what month are water depth levels highest?		
March	51	21.3
April	96	40.2
May	41	17.2
June	3	1.3
July	2	0.8
August	8	3.3
N.A.	1	0.4
If yes, what month are water depth levels lowest?		
March	1	0.4
April	1	0.4
May	5	2.1
June	0	0.0
July	41	17.2
August	153	64.0
N.A.	1	0.4

* N.A.=Not Available

Table 3.23. Mean (SE) wetland cover characteristics of restored wetlands among three evaluation techniques, Saginaw Bay watershed, Michigan, 2001 and 2002.

Characteristics	Evaluation Technique: Landowner Survey	Evaluation Technique: Broad Evaluation	Evaluation Technique: Intensive Evaluation	P-value
% Total Cover[1]	35.6 (4.5)^{A}	54.4 (4.7)^{B}	48.8 (4.7)^{AB}	0.02
% Wood Cover[1]	5.1 (1.2)^{AB}	7.3 (1.2)^{A}	2.3 (1.2)^{B}	< 0.01
% Grass-like Cover	15.6 (3.7)	17.0 (3.7)	19.6 (3.7)	0.86
% Cattail Cover	14.6 (2.3)	17.2 (3.5)	N.A.[2]	1.00
% Open Water	55.4 (5.0)	44.6 (5.0)	47.8 (5.0)	0.32
% Bare Ground[1]	9.2 (1.6)^{A}	1.0 (1.6)^{B}	3.8 (1.6)^{B}	< 0.01

[1] significantly different among techniques (Kruskal-Wallis (KW) one-way analysis of variance, $P \leq 0.05$). Within a row, means having the same letter are not significantly different (multiple comparison z-test, $z > 1.96$).

[2] Not Available

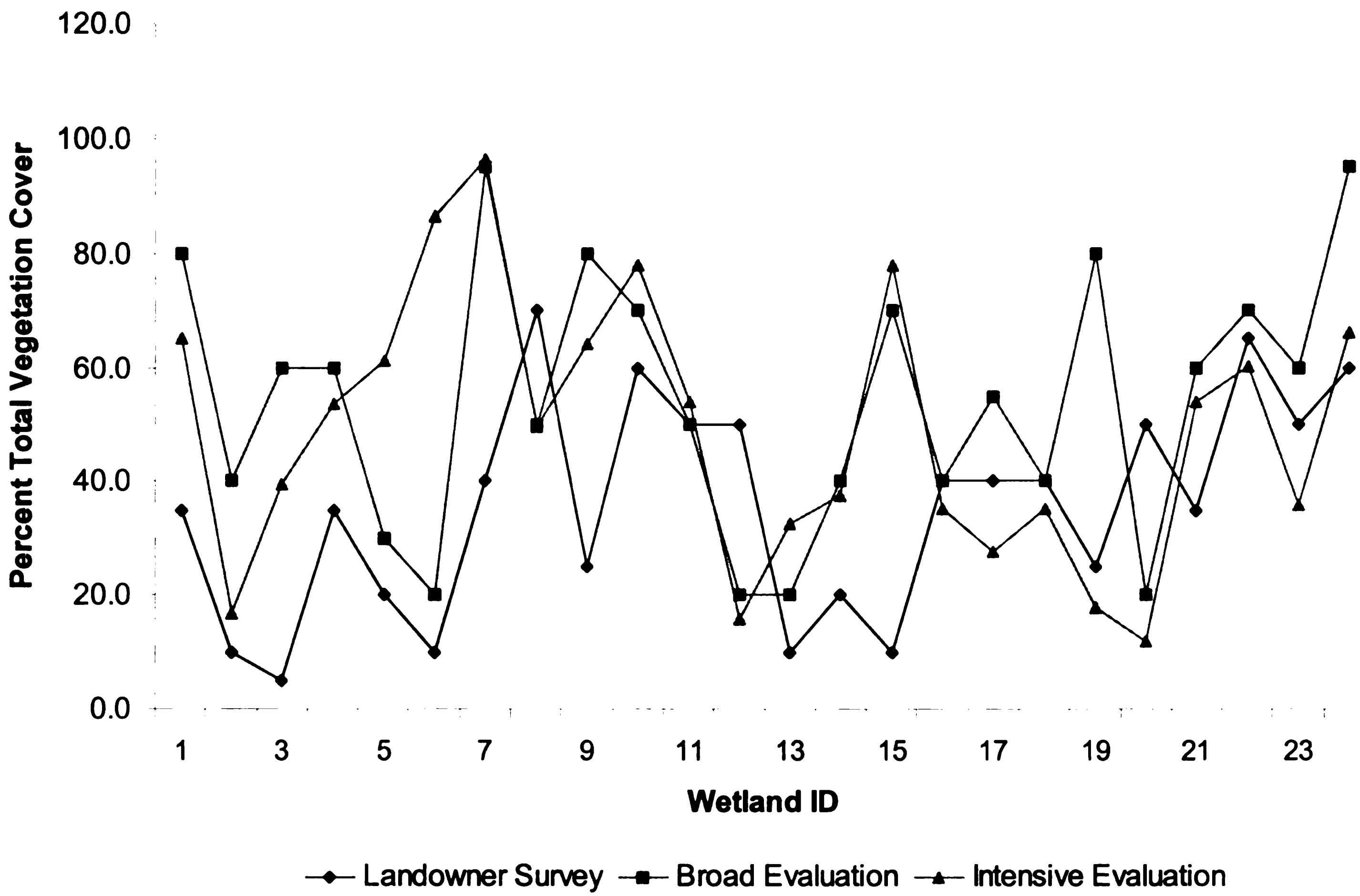


Fig. 3.1. Percent total vegetative cover comparisons between the landowner survey, broad and intensive evaluations, Saginaw Bay watershed, Michigan, 2001 and 2002.

lower estimates and half of the broad evaluations reported higher estimates of total vegetation cover than the intensive evaluations (Figure 3.1).

Broad evaluations had higher ($P<0.01$) percentages of wood cover than intensive evaluations (Table 3.23). This is further supported by the 83% of broad evaluations that had higher estimates of wood cover than intensive surveys (Figure 3.2). Although 70% of broad evaluations had higher percentages of wood cover than the landowner surveys, the mean percent wood cover was not different between the two techniques (Table 3.23). Estimates using the landowner survey, broad and intensive evaluation techniques ranged from 0 – 18%, 0 – 35%, and 0 – 9%, respectively (Figure 3.2).

Percent grass-like vegetation did not differ among evaluation techniques (Table 3.23). Estimates of percent grass-like vegetation, using the landowner surveys, broad and intensive evaluation techniques ranged from 0 – 35%, 3 – 76%, and 2 – 86% (Figure 3.3). Percent cattail cover, which was only compared between landowner surveys and broad evaluations, was not different between the techniques (Table 3.23). Estimates of percent cattail reported by landowner surveys and broad evaluations ranged from 0 – 34% and 0 – 57%, respectively (Figure 3.4)

Percent open water was not different among the three evaluation techniques (Table 3.23). When techniques were compared among wetlands, approximately half of the landowners reported higher estimates of percent open water than intensive evaluations (Figure 3.5). Likewise, 50% of broad evaluations had lower estimates of percent open water than intensive evaluations (Figure 3.5). Estimates reported by landowner surveys, broad and intensive evaluations ranged from 10 – 95%, 5 – 80%, and 1 – 86%, respectively (Figure 3.5).

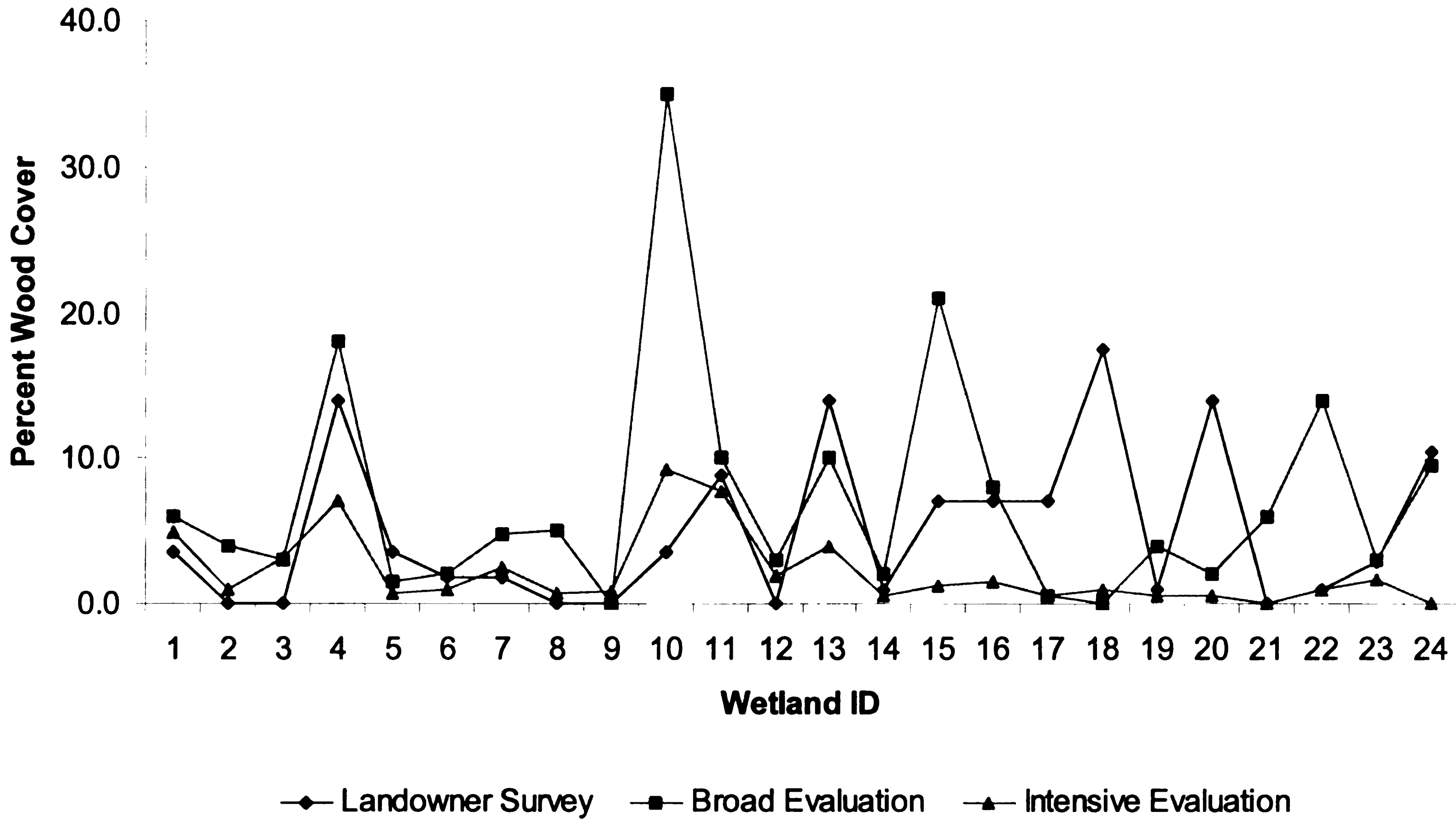


Fig. 3.2. Percent wood comparisons between the landowner survey, broad and intensive evaluations, Saginaw Bay watershed, Michigan, 2001and 2002.

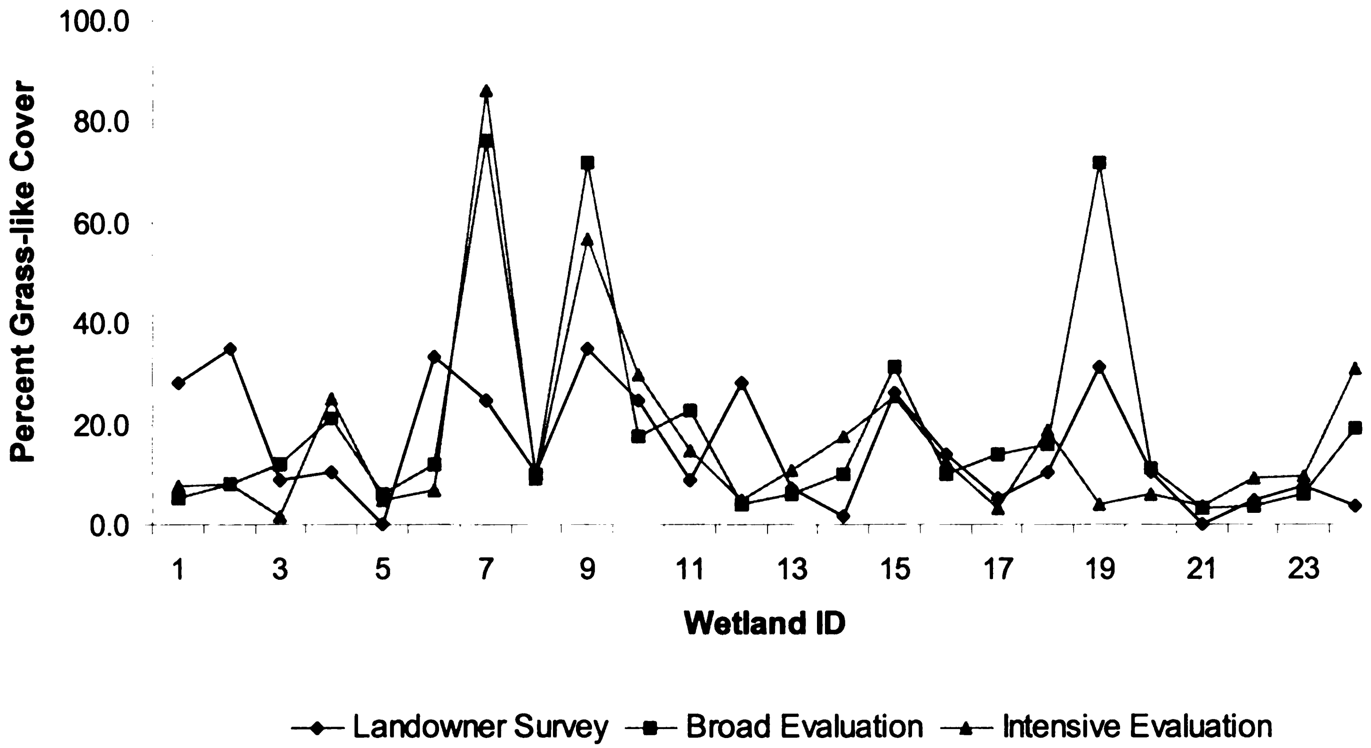


Fig. 3.3. Percent grass-like cover comparisons between the landowner survey, broad and intensive evaluations, Saginaw Bay watershed, Michigan, 2001and 2002.

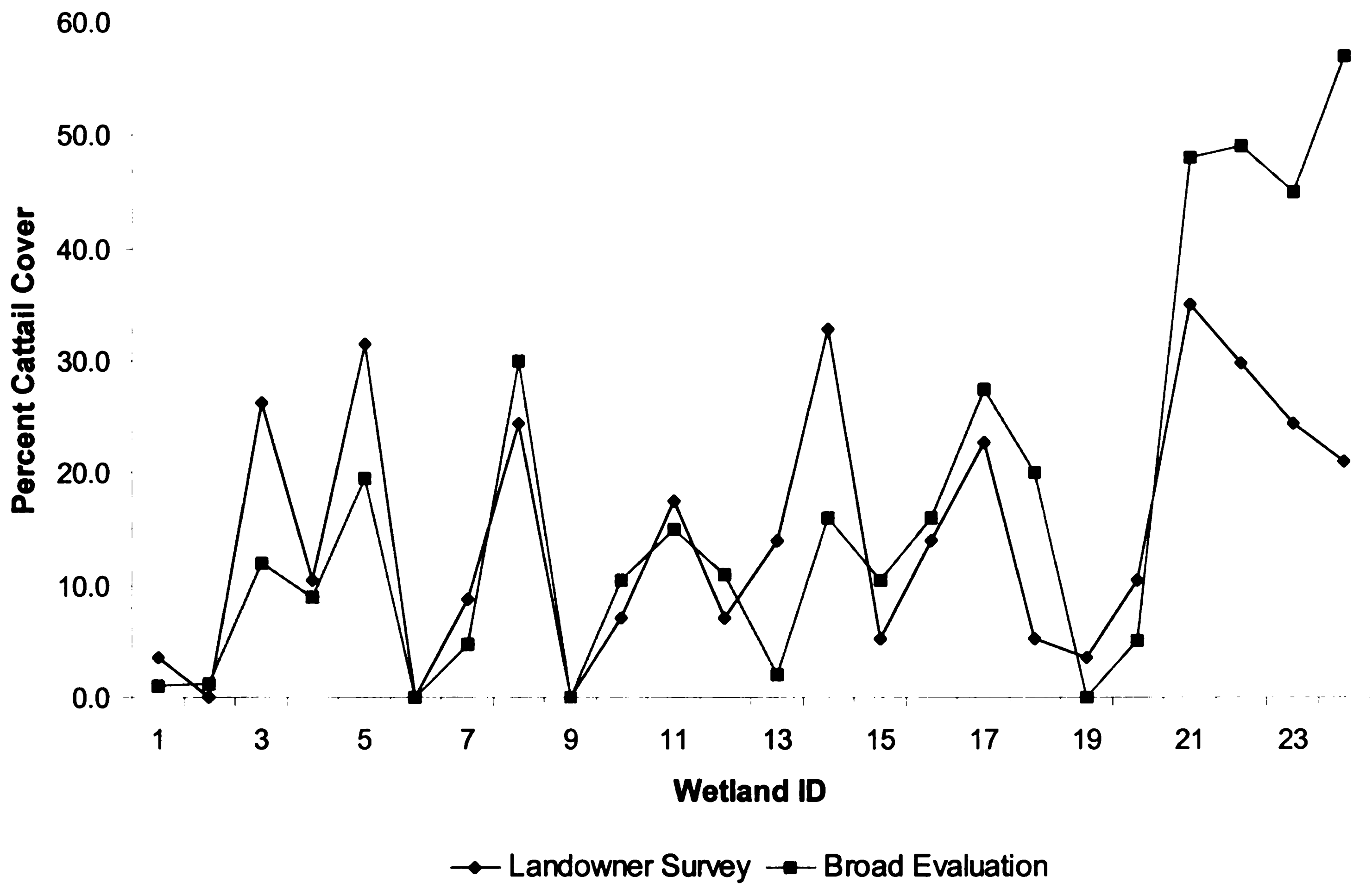


Fig. 3.4. Percent cattail cover comparisons between the landowner survey and broad evaluation, Saginaw Bay watershed, Michigan, 2001 and 2002.

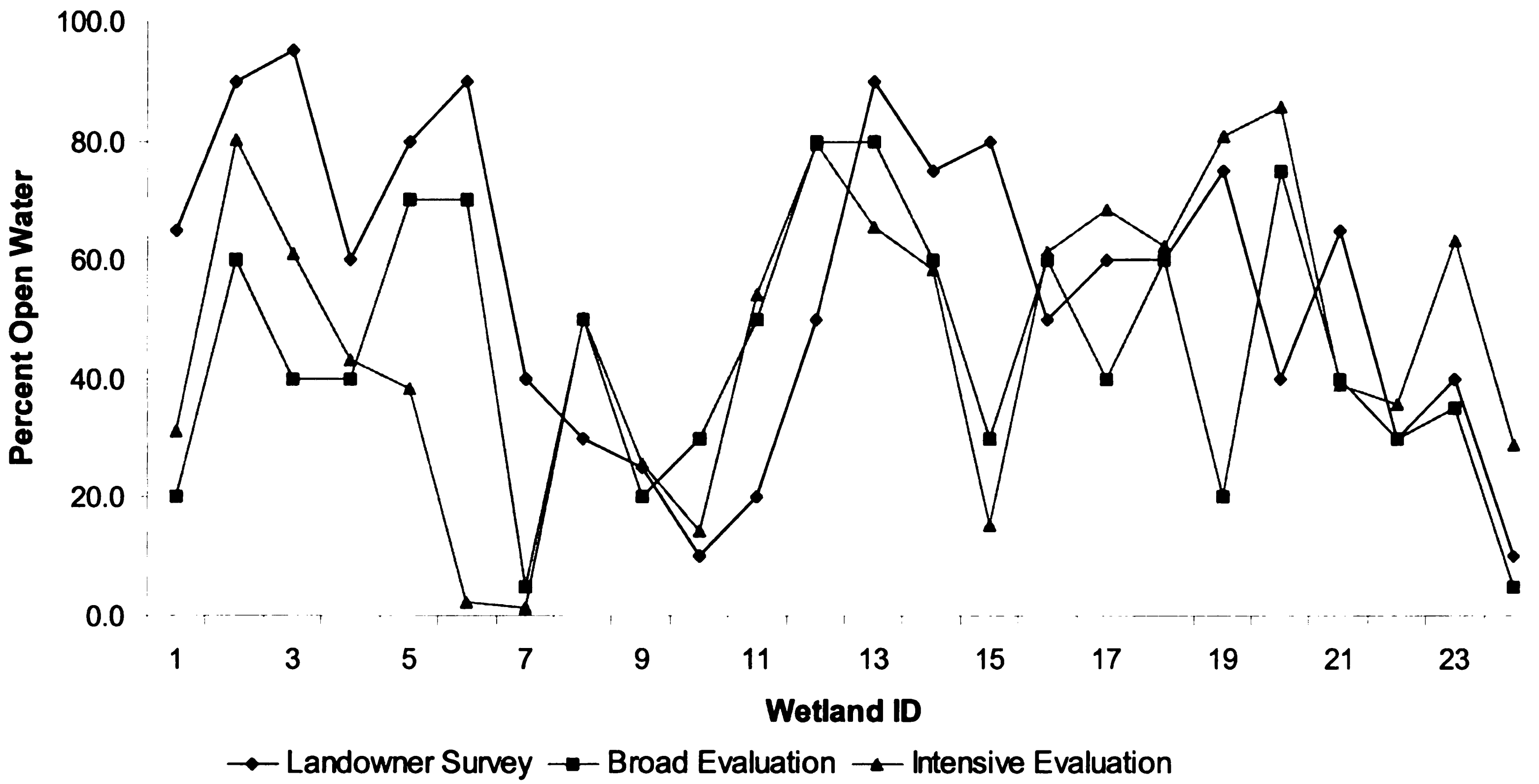


Fig. 3.5. Percent open water comparisons between landowner survey, broad and intensive evaluations, Saginaw Bay watershed, Michigan 2001 and 2002.

Landowner surveys had higher ($P < 0.01$) percentages of percent bare ground than either the broad or intensive evaluations (Table 3.23). However, when techniques were compared between each wetland, about 80% of the estimates were similar among evaluation techniques (Figure 3.6). The mean percent bare ground cover for landowner surveys was skewed by five landowners who had reported much higher estimates of bare ground then either the broad or intensive surveys (Figure 3.6). When the five wetlands were removed from the sample, the mean percent bare ground was similar among techniques.

Water Depth

Twenty of the 24 landowners surveyed stated that their wetland experienced water level fluctuations throughout the year. These answers were consistent with the monthly broad evaluation and the mean monthly intensive water depth readings, which fluctuated in depth from May to July (Table 3.24).

The majority of landowners stated that water levels were the highest in spring (March/April) and lowest in late summer (July/August) (Table 3.24). The results from the broad and intensive water depth measurements also showed higher water depth readings in May and lower readings in July (Table 3.24). Furthermore, broad and intensive measurements showed decreasing water levels on three of the four wetlands where landowners had indicated that water levels stayed the same throughout the summer (Table 3.24). Although both broad and intensive water depth readings show the same decreasing trend from May through July, broad readings are much higher than intensive. (Table 3.24). These differences are reflective of how the data was collected for each technique. Broad evaluations took a single water depth reading in the center of the

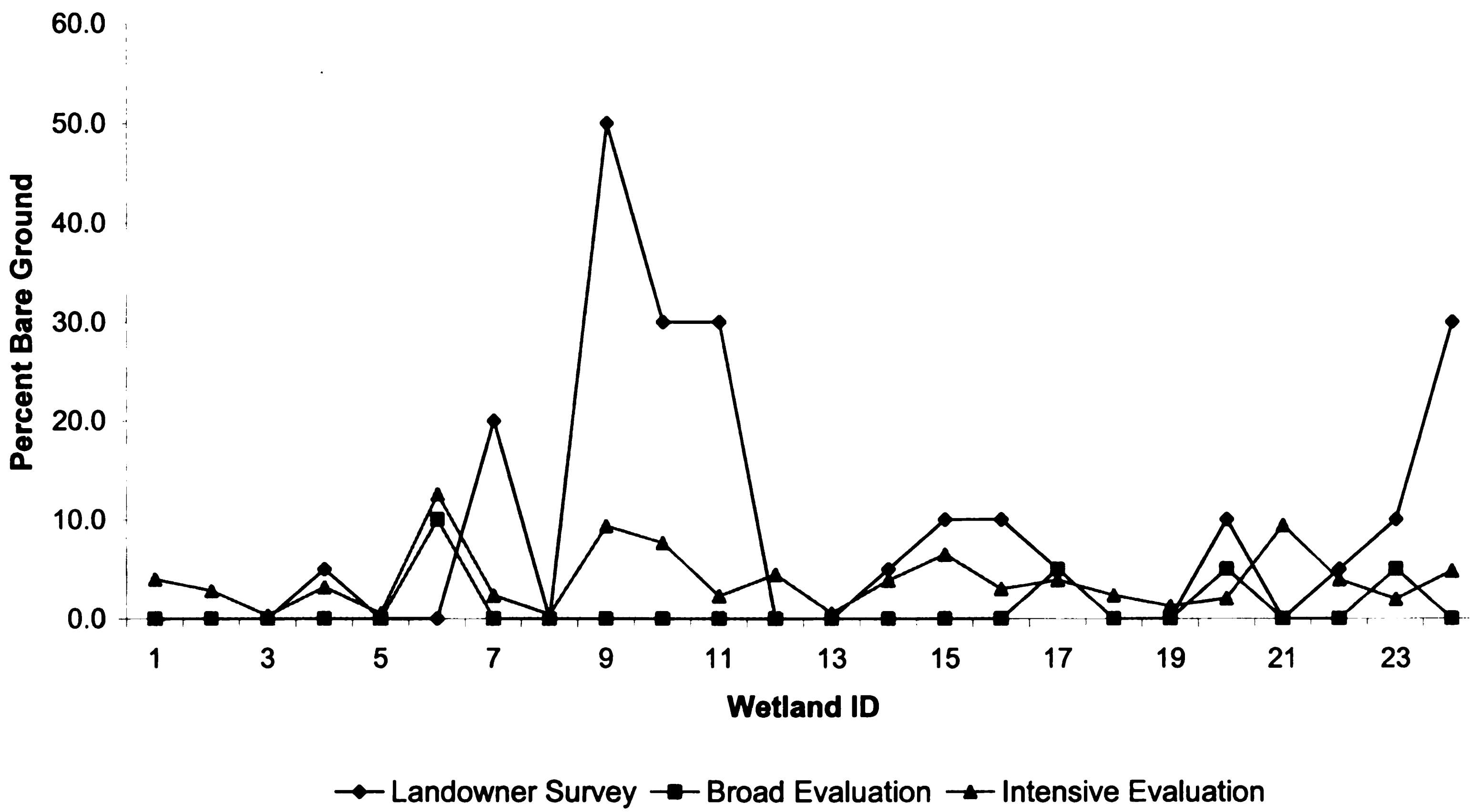


Fig. 3.6. Percent bare ground comparisons between the landowner survey, broad and intensive evaluations, Saginaw Bay watershed, Michigan, 2001 and 2002.

Table 3.24. Water level comparisons between landowner survey responses and broad and intensive water depth readings, Saginaw Bay watershed, Michigan, summer 2001 and 2002.

	Landowner Survey* (n=24)			Broad Evaluation (n=24)			Intensive Evaluation (n=24)		
Wetland ID	Fluctuating water levels	Month water was the highest	Month water was the lowest	May	June	July	May	June	July
1	Yes	April	August	145	124	99	81	75	50
2	Yes	April	August	89	84	54	81	71	51
3	**No**			**140**	**141**	**126**	**92**	**90**	**79**
4	Yes	April	August	115	126	98	58	48	38
5	Yes	April	August	100	96	84	83	65	52
6	Yes	April	August	97	94	74	66	62	40
7	Yes	April	August	19	19	0	16	17	1
8	Yes	March	August		138	107		98	73
9	Yes	March	August	48	40	22	18	24	10
10	Yes	April	August	58	21	26	22	24	14
11	Yes	April	August	141	135	118	51	57	31
12	**No**			**147**	**144**	**114**	68	68	63
13	Yes	April	August	79	75	55	44	56	39
14	Yes	June	August	108	127	108	67	74	45
15	Yes	April	August	72	65	51	36	33	18
16	Yes	March	August	136	131	105	62	59	46
17	Yes	July	August	149	135	105	76	87	56
18	**No**			**148**	**144**	**116**	**75**	**88**	**67**
19	Yes	April	August	115	105	89	94	82	76
20	Yes	March	August	213	205	205	103	92	90
21	**No**			**91**	**85**	**71**	**51**	**48**	**28**
22	Yes	March	August	133	130	108	32	36	27
23	Yes	April	July	153	155	145	47	54	39
	Yes	April	August	26	26	0	15	14	2

*bold variables indicate dissimilarity

wetland whereas intensive evaluations were able to calculate an average based on data points sampled from transect lines.

Wildlife

The most common avian species observed by landowners were the Canada Goose, Mallard, Great Blue Heron, and Red-winged Blackbird (Table 3.25). These same species were also commonly observed during intensive and broad evaluations (Table 3.25). Although over 90% of landowners reported White-tailed Deer using their wetlands, they were observed on only 58% and 42% of wetlands during broad and intensive evaluations, respectively (Table 3.25). Muskrats and Raccoons were also observed on wetlands by at least 60% of all landowners (Table 3.25). Muskrat presence was observed on approximately 17% and 30% of wetlands during the intensive and broad evaluations, respectively (Table 3.25). The most common amphibians and reptiles observed using all three evaluation techniques were frogs, turtles and snakes (Table 3.25). The majority of landowners observed duck broods and Canada Goose broods utilizing their wetland (Table 3.25). However, duck broods were only observed on 2 wetlands during both broad and intensive evaluations (Table 3.25). Canada Goose broods were observed on 6 wetlands during broad and 3 wetlands during intensive evaluations (Table 3.25).

Structural Problems

The two most common responses by landowners, when asked to select structural problems observed on their wetland, were none and muskrat damage to dikes (Table 3.26). Fifteen landowners indicated similar structural problems that were also identified during the broad evaluation (Table 3.26). Another eight landowners indicated no problems were evident with wetland structures although erosion problems were observed

Table 3.25. The number of wetlands that supported wildlife observed by evaluation technique, Saginaw Bay watershed, Michigan, 2001 and 2002.

	Evaluation Technique		
Wildlife Observed	Landowner Survey (n=24)	Broad Evaluation (n=24)	Intensive Evaluation (n=24)
Birds			
Mallard	23	7	12
Canada Goose	23	11	8
Blue-winged Teal	5	3	2
Wood Duck	17	4	3
Other Waterfowl	10	5	3
Great Blue Heron	23	9	6
Shorebirds	12	13	10
Red-winged Blackbirds	18	21	10
Pheasant	11	7	3
Other Birds	9	24	24
Animals			
Muskrat	17	7	4
Raccoon	17	0	0
Mink	8	0	0
Deer	22	14	10
Beaver	3	1	1
Bear	0	0	0
Coyote	8	0	0
Other	4	1	1
Reptiles and Amphibians			
Frogs	24	8	6
Toads	17	0	0
Other Amphibians	5	0	0
Turtles	17	5	5
Snakes	17	2	1
Other Reptiles	2	0	0
Young-of-the-year			
Ducklings	18	2	2
Goslings	16	6	3
Other	3	4	3

Table 3.26. Comparisons of structural problems reported in landowner survey and problems observed during broad evaluations, Saginaw Bay watershed, Michigan, summer 2001 and 2002.

Wetland ID	Landowner Survey Response	Broad Evaluation Results
1	None*	None
2	Dike erosion	Significant dike erosion
3	Muskrat/Beaver damage to dike	Slight dike/spillway erosion / Muskrat damage
4	**None**	**Slight dike erosion**
5	**None**	**Slight dike and spillway erosion**
6	Spillway erosion / Muskrat damage	Moderate spillway/dike erosion / Significant muskrat damage
7	None	None
8	Muskrat damage to dike	Slight dike erosion / Moderate muskrat damage
9	**None**	**Slight dike erosion**
10	Muskrat damage to dike / Overflow on to neighbors	Slight deterioration of water control structure / Slight dike erosion
11	Muskrat damage to dike	Slight dike erosion / Moderate muskrat damage
12	**None**	**Slight dike erosion**
13	Muskrat damage to dike	Slight deterioration around water control structure
14	Muskrat damage and leak to dike	**None**
15	Muskrat damage to dike	Moderate deterioration of water control structure
16	Muskrat damage to dike	Slight dike erosion / Moderate muskrat damage
17	**None**	**Slight spillway erosion**
18	**None**	**Moderate spillway erosion**
19	Muskrat damage to dike	Moderate dike and water control structure erosion
20	**None**	**Slight dike, spillway & water control struc. erosion**
21	None	None
22	**None**	**Slight muskrat damage**
23	None	None
24	Spillway erosion / Muskrat damage to dike / Leak in dike	Significant seepage and erosion around water control structure / Moderate sloughing of dike

*bold parameters indicate dissimilarity in responses during the broad evaluation (Table 3.26). However, signs of erosion were slight and would most likely go unnoticed by the landowner. There was only one wetland where structural problems were not observed during the broad evaluation and the landowner observed both muskrat damage and leaks in wetland dikes (Table 3.26).

DISCUSSION

Landowner Survey

Landowner Demographics

The percentage of surveys returned per county was similar to the number of projects completed in each county within the Saginaw Bay watershed, with the majority of projects occurring in Sanilac, Lapeer, Mecosta and Osceola counties (personal communication, J. Hazelman). The results of several demographic parameters (i.e., age, education level, acres of land owned) are consistent with findings from similar studies of landowner's participating in the Partners programs (Arkin 1996, Pease 1992, Pease et al. 1997). Many of the landowners that participated in the Partner's program were predominately middle-aged males, received at least a high school diploma, and owned small-to medium-sized farms (Table 3.4, Table 3.7).

The assumption within the Partners program is that most landowners become interested in participating in the program from friends or neighbors and from local conservation districts. This belief is supported by the 72% of survey respondents that stated they learned about the program from either contact with a friend/neighbor or contact with a conservation organization (Table 3.3). Furthermore, Pease et al. (1997) found that the majority of information about the Partners program came directly from conservation personnel rather than brochures, newspaper articles or website/email services. Although only a small sample of respondents indicated they received information via newsletters about the Partners program, there is potential to further utilize this resource. There are a wide variety of sources where landowners receive information, ranging from outdoor recreation opportunities to conservation initiatives that could highlight the Partners program. Landowners that indicate they learned about the Partners program through newsletters included the following sources: Pheasants Forever, DU, County Conservations Districts, Soil Conservation Service, USDA, and the Saginaw Bay Watershed Initiative Network.

Landowner Motivation

Most landowners who restored wetlands on their property were motivated by the possibility of viewing wildlife and providing habitat (Table 3.8). Several studies evaluating landowner motivation found similar results. In a study evaluating motivation of Ohio landowners who were participants in the Partner's program, Arkin (1996) found that approximately 99% of respondents either agreed or strongly agreed with the statement: I participated in this program because it provided habitat for wildlife. In a national survey on why landowners restore wetlands, 84% of landowners stated that providing habitat for wildlife was extremely important in their decision to restored wetlands (Pease et al. 1997). Low cost to participate in the Partners program was a primary reason why landowners decided to participate in the program (Table 3.9). Arkin (1996) and Pease et al. (1997) also found that at least 75% of landowners agreed that low cost was an important influence in their decision.

Landowner Satisfaction

Overall, landowners were satisfied with their wetland restoration projects on their property and with the service provided by the project biologist. These findings are similar to a study by Kitchen (1999), who found that 68% of landowners were satisfied with their participation in the Partners program. There were a variety of reasons why landowners were satisfied with their wetland restoration project, with wildlife use and with project planning:

"To have a place for wildlife to use and stay, we have ducks and deer [using the wetland] and its fun to watch."

"[The wetland] was done the way the plan said it would be and it immediately began to attract all kinds of wildlife"

"This was a well conceived and planned project brought to completion expediently."

Although only a small percentage of landowners indicated that they were unsatisfied with the completed project and/or were more unsatisfied today then when the project was first completed, the most common complaint was the lack of water and project planning:

"At the wettest times, [the wetland] has shrunk to a small mud puddle with poplar's springing up. Most of the year it's bone dry."

"Project seems to be over constructed, more and higher dike work than necessary, excavation too deep and doesn't hold water."

Some of these complaints may be the result of miscommunication or misunderstanding between the biologist and the landowner. Several landowners commented that they expected deeper pools of water and possible fishing habitat, which are common characteristics of ponds not wetlands. Landowners may not completely understand the unique and often variable attributes of wetlands or that wetland water levels fluctuate within a season and from year to year. Project satisfaction, although already high, could be improved by improving communication and information exchange between biologists and program participants.

Comparison of Evaluation Techniques

Vegetation Characteristics

Estimation differences among the three techniques may be explained by examining the difficulties involved with determining wetland boundaries and estimating total vegetation cover, including specific categories of vegetation. Landowners potentially reported lower percentages of vegetative cover than both the broad and intensive evaluations because they were unsure of wetland boundaries and may be unable to distinguish between wetland and upland vegetation. Some wetlands have a distinctive edge between wetland and upland vegetation that is relatively easy to identify. However, many wetlands gradually transition into upland habitat making it difficult to determine the wetland edge. A trained investigator will have the ability to discern wetland boundaries more readily than some landowners, which would lead to a different estimate of total cover.

Overall, the three evaluation techniques had similar estimates of percent open water. Percent open water may be easier for landowners and the broad evaluation to estimate because water boundaries are more readily identifiable compared to vegetation boundaries. However, intensive evaluations may more accurately estimate percent open water on wetlands with dense stands of vegetation compared to landowners or the broad evaluation, which would mostly likely miss pockets of open water.

In general, estimates of percent bare ground were similar among evaluation techniques although several landowners observed much higher estimates than either the broad or intensive evaluations. There are several possible explanations why a few landowners differed with their estimates of percent bare ground. Landowners were asked to estimate bare ground coverage for summer 2001, whereas the broad survey was conducted in summer 2002. Percent bare ground may have been different between summers. However, intensive evaluations were conducted on three of the five wetlands during summer 2001 and did not report the high percentages that landowners observed. Another reason could be attributed to differences between the landowner and the biologist's perception of what constitutes bare ground present within wetland boundaries.

Water Depth

Although landowner's were able to report water depth trends that corresponded to water depth readings measured by both broad and intensive evaluations, this type of descriptive information is limiting and cannot provide the quantitative information that is needed for wetland management. Broad evaluations are similar to landowner surveys in that only water depth trends are reported, however, broad evaluations provide water depth readings that can be used to track water level changes over time. However, broad evaluations are not accurate predictors of the overall water depth of wetlands based on the higher numbers observed compared to intensive water depth measurements. Even though intensive evaluations are time consuming they can provide water depth trends as well as water profile data and average water depth, which is useful for waterfowl and other wildlife management.

Wildlife

In general, broad evaluations had the lowest number of each type of wildlife compared with landowner surveys and intensive evaluations. The low number of wildlife observed during broad evaluations is most likely due to the length of time the observer is present. Landowners who live on their property or frequently visit their property are able to observe a variety of wildlife utilizing their wetland and may observe wildlife that are missed during the broad and intensive evaluations. However, they may not be able to report reliable numbers of species.

Structural Problems

In general, landowners noticed similar structural problems with their wetland as the broad evaluations. Broad evaluations will provide a more detailed and in-depth assessment of wetland structures, however, landowners are able to identify moderate to extensive damage and have a general idea of the structural integrity of their wetlands. In addition, landowners are the best source for reporting problems they observe with wetland structures based on the amount of time landowners spend visiting/observing their wetland compared to biologists. The challenge to biologists is encouraging landowners to report structural problems.

CONCLUSIONS

Landowner surveys, broad and intensive evaluation techniques can all be used to effectively monitor and evaluate restored wetlands on private lands. The objectives of the study, budget and personnel availability will determine which technique is the most appropriate to use to gather information.

Surveys are a valuable tool to collect information regarding landowner attitudes, satisfaction, motivation and perceptions about their restored wetland as well as ecological information. However, there might be limitations as to the detail and what types of ecological questions landowners can be expected to answer. Landowners are able to provide general observations regarding percent vegetative cover, water depth trends, presences/absence of wildlife, and structural problems.

Broad evaluations are essentially a rapid assessment tool that allows biologist to gather ecological information on many restored wetlands and document changes over time. The greatest limitation of the broad evaluation is the minimal amount of information that can be collected regarding wildlife use of the wetlands. Intensive evaluations enable the investigator to collect data that can be used to calculate estimates such as density and diversity whereas broad evaluations can provide presence/absence data of a variety of wildlife species. However, lists of species observed at restored sites are still useful and can be compared to a list of species found at natural sites of approximately the same size and wetland type to determine differences and/or similarities between wetland types (Galatowitsch and van der Valk 1994). The more similar the list of species is to natural wetlands, the more successful the restoration (Galatowitsch and van der Valk 1994).

An intensive evaluation is the best technique to collect detailed information about a variety of wetland attributes. Intensive studies allow for in-depth analysis on vegetation cover, wildlife use, breeding habitat, etc., that can be helpful to determine success or at least help biologist learn more about the restoration process. However, intensive evaluations require time, funds and personnel, which many organizations and agencies do not have.

Therefore agencies and organizations can utilize all three evaluation techniques to monitor and evaluate the success of a wetland restoration program. Selection of one of these techniques should be dependent upon the current objectives and the financial and human resources available.

LITERATURE CITED

APPLEGATE, J. E. 1981. Landowners behavior in dealing with wildlife values. Pages 64-72 *in* R. T. Dumke, G. V. Burger, and J. R. March *(eds.)*. Wildlife Management on Private Lands. LaCrosse Printing Co., LaCrosse, Wisconsin, USA.

ARKIN, B. S. 1996. Attitudes, knowledge, motivation and satisfaction of Ohio landowners participating in the Partners for Wildlife Program. M.S. Thesis. The Ohio State University, Columbus, Ohio, USA.

BECK, R. E. 1994. The movement in the United States to restoration and creation of wetlands. 34 Natural Resources Journal 781.

COVELL, D. F., R. L. RUFF, AND S. R. CRAVEN. 1997. Private lands management: Adapting a premier woodland cooperator program to restore and manage wetlands. Transaction of the North American Wildlife and Natural Resources Conference. 62:84-92.

CWIKIEL, W. 1997. Living with Michigan's wetlands: a landowners guide. Tip of the Mitt Watershed Council. Conway, Michigan, USA.

ENVIRONMENTAL PROTECTION AGENCY. 1980. Section 404 program strategy. Office of Water Regulations and Standards, Criteria and Standards Division, Washington, D.C. EPA 440/ 5-81-001.

GALATOWITSCH, S. M., AND A. G. VAN DER VALK. 1994. Restoring prairie wetlands: an ecological approach. Iowa State University Press, Ames, Iowa, USA.

KELLEY, R. G. 1981. Forests, farms and wildlife in Vermont: a study of landowner values. Pages 102-110 *in* R. T. Dumke, G. V. Burger, and J. R. March *(eds.)*. Wildlife Management on Private Lands. LaCrosse Printing Co., LaCrosse, Wisconsin, USA.

KITCHEN, A. 1999. Partners for Fish and Wildlife Program: an assessment of landowner participation and habitat accomplishments. Monitoring report for Wisconsin. U.S. Fish and Wildlife Service, Madison, Wisconsin, USA.

KIRBY, S. B., K. M. BABCOCK, S. L. SHERIFF, AND D. J. WITTER. 1981. Private land and wildlife in Missouri: a study of farm operator values. Pages 88-97 *in* R.T. Dumke, G. V. Burger, and J. R. March *(eds.)*. Wildlife Management on Private Lands. LaCrosse Printing Co., LaCrosse, Wisconsin, USA.

KRAFT, S. E., C. LANT, AND K. GILLMAN. 1996. WQIP: an assessment of its chances for acceptance by farmers. Journal of Soil and Water Conservation 51(6): 494-498.

MACKINNON, S. M. 2000. Avian utilization of restored wetlands in central lower Michigan. M.S. Thesis. Central Michigan University, Mount Pleasant, Michigan, USA.

MICHIGAN GAP STATE LAND OWNERSHIP (STEWARDSHIP) DIGITAL GEOSPATIAL DATA. 2000. Michigan Department of Natural Resources' Land and Minerals Services Office, Lansing, Michigan, USA.

MOONEY, R. J. 1996. Landowner interest in establishing more than a dozen wetlands enhancement practices: statewide survey results. (Abstract). Journal of Soil and Water Conservation 51(4): 354.

NAPIER, T. L., S. E. MCCARTER, AND J. R. MCCARTER. 1995. Willingness of Ohio land owner-operators to participate in a wetlands trading system. Journal of Soil and Water Conservation 50(6): 648-656.

PARTNERS FOR FISH AND WILDLIFE PROGRAM: Voluntary Habitat Restoration in Cooperation with Private Landowners. http://partners.fws.gov.htm (10 May 2000).

PATE, D. J. 1996. Iowa SWCS chapter leadership in an "Adopt a Wetland: program. (Abstract) Journal of Soil and Water Conservation 51(4): 354.

PEASE, J. L. 1992. Attitudes and behaviors of Iowa farmers toward wildlife. Ph.D. Dissertation. Iowa State University, Ames, Iowa, USA.

PEASE, J. L., M.L. RANKIN, J. VERDON, AND R. REISZ. 1997. Why landowners restore wetlands: a national survey. Iowa State University Extension, Department of Animal Ecology EDC-107. Ames, Iowa, USA.

SALANT, P. AND D. A. DILLMAN. 1994. How to conduct your own survey. John Wiley and Sons, New York, New York, USA.

SHELTON, R. 1981. Motivating the landowner/manager to manage for wildlife. Pages 301-306 *in* R. T. Dumke, G. V. Burger, and J. R. March *(eds.)*. Wildlife Management on Private Lands. LaCrosse Printing Co., LaCrosse, Wisconsin, USA.

SIEGEL, S. 1956. Nonparametric statistics for the behavioral sciences. McGraw-Hill Book Company, New York, New York, USA.

SPSS, Inc. 2000. SPSS for Windows, Release 10.0.7, standard version. SPSS, Inc. Chicago, Illinois, USA.

SVOBODA, F. J. 1981. A look at incentives for wildlife management of private lands. Pages 384-394 *in* R. T. Dumke, G. V. Burger, and J. R. March *(eds.)*. Wildlife Management on Private Lands. LaCrosse Printing Co., LaCrosse, Wisconsin, USA.

VILEISIS, A. 1997. Discovering the unknown landscape: A history of America's wetlands. Island Press, Washington D.C., USA.

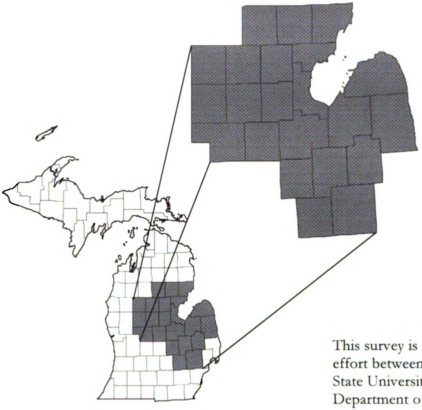
WYWIALOWSKI, A. P., AND R. B. DAHLGREN. 1985. Beliefs about wildlife management among Iowans with differing attitudes toward hunting. Wildlife Society Bulletin 13: 328-332.

APPENDIX A:

2001 Landowner Survey

2001 Landowner Survey Instrument

Evaluation of Wetland Restoration Efforts on Private Lands in the Saginaw Bay Watershed



This survey is a cooperative effort between Michigan State University Department of Fisheries and Wildlife, Ducks Unlimited, and the U.S. Fish and Wildlife Service

1

1. Please mark the county(ies) where your Partners for Fish and Wildlife (PFW) restored wetland(s) is located. (Check all that apply.)

❑ Arenac	❑ Iosco	❑ Oakland
❑ Bay	❑ Isabella	❑ Ogemaw
❑ Clare	❑ Lapeer	❑ Osceola
❑ Genesee	❑ Livingston	❑ Roscommon
❑ Gladwin	❑ Mecosta	❑ Saginaw
❑ Gratiot	❑ Midland	❑ Sanilac
❑ Huron	❑ Montcalm	❑ Shiawassee
		❑ Tuscola

2. How many total acres of land do you own within the above counties?

_______acres

3. Please check the source from which you FIRST learned about PFW wetland restorations? (Check one)

1 ❑ Radio, newspaper or TV
2 ❑ Friend, relative or neighbor
3 ❑ Organization newsletter (org. name ______________________________)
4 ❑ Internet web site (org. name ___________________________________)
5 ❑ Contact with public/private conservation organization
(org. name ____)
6 ❑ Workshop or meeting (org. name ____________________________)
7 ❑ Other (please explain ____________________________________)

The next series of questions directly relates to the PFW wetlands found on your property.

4. Do you have multiple wetlands on your property that were restored through the PFW Program?

1 ❑ No ***(If 'No' please skip to 6)***
2 ❑ Yes ***(If 'Yes', please proceed to 5)***

5. ***(If Yes)*** Please list the approximate acreage of your PFW wetlands. If you have multiple PFW wetlands please list all of them individually.

1. ________acres	4. ________ acres	7. ________acres
2. ________acres	5. ________ acres	8. ________acres
3. ________acres	6. ________ acres	9. ________ acres

Special Instruction: If you have multiple PFW restored wetlands on your property, please pick **only one non-forested wetland closest to 5 acres** when answering the remaining survey questions. Proceed to question 6.

6. Please draw a map of where your wetland is located on your property and note wetland acreage in the box provided below. (Please include road boundaries, building locations, driveways.)

________ acres

N ↑

7. How many days between May 1st and August 31st 2001 did you visit your wetland? (Please write your best estimate of days visited next to each month.)

______ May	______ July
______ June	______ August

8. Please check the ONE **primary** land use (in the past 10 years) of your restored wetland prior to restoration. (Check only one).

1 ❑ Row Crops
2 ❑ Pasture
3 ❑ Fallow Field
4 ❑ Brush
5 ❑ Woods
6 ❑ Other (explain ______________________________)

9. Please check the ONE **primary** land use of the uplands immediately surrounding the wetland prior to restoration. (Check only one).

1 ❑ Row Crops
2 ❑ Pasture
3 ❑ Fallow Field
4 ❑ Brush
5 ❑ Woods
6 ❑ Other (explain ______________________________)

10. Please chronicle the wetland restoration process by writing the month and year in the space next to each project phase and indicate your satisfaction with the process. (Check one response for each phase.)

Project Phase	Approx. Month/Yr	1 Highly Satisfied	2 Satisfied	3 Neutral	4 Dissatisfied	5 Highly Dissatisfied	Don't Know
First contact with PFW Biologist/Other							
Follow-up planning visit by PFW Biologist/Other							
Plan completion							
Construction							
Completed Project							

11. What is the single most important reason for your satisfaction rating of the **completed project**?

____

12. Are you satisfied with the service provided by the U.S. Fish and Wildlife Service biologist or the representative from another agency/organization? (Please check one.)

1 ❑ Very satisfied
2 ❑ Satisfied
3 ❑ Somewhat satisfied
4 ❑ Not satisfied

13. Compared to the project when it was first completed, how satisfied are you today with your restored wetland? (Please check one.)

Would you say you are:
1 ❑ More satisfied
2 ❑ About the same
3 ❑ Less satisfied

14. What is the single most important reason for your rating?

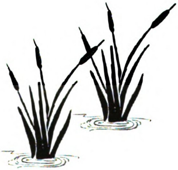
____

____

Wetland Vegetation Coverage

15. Which ONE statement best characterizes your wetland vegetation during the first week of July 2001?

1 ❑ Scattered clumps near the shoreline and in the central portion
2 ❑ Only a ring around the shoreline
3 ❑ Solid, large stands of vegetation
4 ❑ Other (explain ______________________________)



16. A wetland will typically have areas of open water and areas of vegetation. **Vegetation may be found in patches throughout the wetland or sometimes around the outside edge.** Please estimate, to the best of your ability, the percent of open water, percent vegetation and percent bare soil (i.e, mud flat) that was present in your wetland during the first week of July 2001.

1. Open Water ____________%

2. Bare Soil ____________%

3. Vegetation ____________%

Total = 100%

EXAMPLE:

Open Water	50%
Bare Soil	10%
Vegetation	**40%**
	100%

17. Using the vegetation percentage listed above, please further estimate, to the best of your ability, the percentage of each type of vegetation that was present in your wetland during the first week of July 2001.

WOODY

a. Trees ____________%

b. Shrubs and Bushes ____________%
(ex:: dogwood, willow)

NON-WOODY

c. Cattails ____________%

d. Grass-like vegetation ____________%
(ex: sedges, reed canary)

Total = 100%

EXAMPLE:
Of the **40%,** listed above, how much are the following:

WOODY	
Trees	15%
Shrubs	20%
NON-WOODY	
Cattails	50%
Grass-like	15%
	100 %

18. On a scale of 1 to 5, how CERTAIN are you of your answers regarding wetland vegetation coverage?

	(Very certain)				(Not certain)
Wetland vegetation type	1	2	3	4	5

Wetland Wildlife

19. What kinds of wildlife have you seen at your wetland since the restoration was completed? (Please check all that apply.)

BIRDS	ANIMALS	REPTILES & AMPHIBIANS	YOUNG-OF-THE-YEAR
❑ mallards	❑ muskrat	❑ frogs	❑ ducklings
❑ Canada geese	❑ raccoon	❑ toads	❑ goslings
❑ blue-winged teal	❑ mink	❑ other amphibians	❑ other
❑ wood ducks	❑ deer	❑ turtles	
❑ other waterfowl	❑ beaver	❑ snakes	
❑ great blue herons	❑ bear	❑ other reptiles	
❑ shorebirds	❑ coyote		
❑ redwing blackbirds	❑ other		
❑ pheasants			
❑ other birds			

20. For each category, please indicate how likely you were to see the following birds utilizing your wetland on a given day during May 2001. See example below. (Check one response for each.)

	1 Observed more than 66%	2 Observed 33% to 66%	3 Observed less than 33%	4 Did not observe	5 Don't Know
Mallards					
Geese					
Blue-winged Teal					
Wood Ducks					
Other Waterfowl					
Wading Birds (ex: herons, cranes)					
Shorebirds (ex: sandpiper, snipe)					
Songbirds (ex: red-winged black bird)					

Example: During May I visited my wetland 6 times. On all six visits I observed mallards (mark "more than 66%"). On 3 of the 6 visits I observed wood ducks (mark "33% to 66%"). On 1 of the six visits I observed a sandpiper (mark "less than 33%").

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21. On a scale of 1 to 5, how CERTAIN are you that you correctly identified the birds listed previously? (Please circle one.)

	(Very certain)	....	....	....	(Not certain)
Wetland bird type	1	2	3	4	5

Wetland Water Depth

22. In general, what is the water level in your wetland? (Please check one)

1 ❑ About at the level the biologist said it would be.
2 ❑ Higher than the level the biologist said it would be.
3 ❑ Lower that the level the biologist said it would be.

23. Wetlands may experience water level fluctuations throughout the year. Since the completion of your restored wetland, have you observed a general trend of changing water levels?

1 ❑ No, water level stays about the same throughout the year.
(If 'No' please skip to 26)

2 ❑ Yes, water levels will change throughout the year.

24. ***(If Yes)*** Please circle the month in 2001 that your wetland water level was the **highest.** (Circle one.)

March April May June July August

25. ***(If Yes)*** Please circle the month in 2001 that your wetland water level was the **lowest.** (Circle one.)

March April May June July August

26. On a scale of 1 to 5, how CERTAIN are you of your answers regarding wetland water depth? (Please circle one.)

	(Very Certain)...				...(Not Certain)
Wetland water depth	1	2	3	4	5

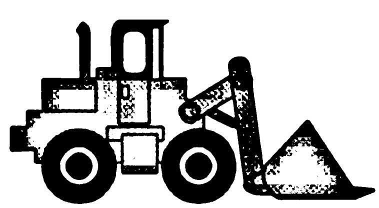
Wetland Construction

27. Have you noticed any structural problems? (Check all that apply)

1 ❑ None
2 ❑ Dike erosion
3 ❑ Spillway erosion
4 ❑ Muskrat or other burrow animal damage to dikes
5 ❑ Leak in dam
6 ❑ Inability of wetland to hold water
7 ❑ Vandalism to restoration structures
8 ❑ Beaver plugging water control structures
9 ❑ Poor plant growth on disturbed areas
10 ❑ Other (please specify) ______________________________

28. Please check the techniques used in your wetland restoration. (Check all that apply.)

1 ❑ Don't know
2 ❑ Dig up and remove private drain tile
3 ❑ Build dike or dam to hold water
4 ❑ Spillway/pipe to allow excess waters to cross dike or dam
5 ❑ Excavation to create deep water area or obtain fill for dike
6 ❑ Other (please explain) ______________________



Wetland Benefits

29. Please rate the importance of the following potential benefits that prompted you to restore a wetland on your property. (Check one response for each.)

	1 Very Important	2 Important	3 Moderately Important	4 Neutral	5 Unimportant	6 Very Unimportant
Wildlife viewing						
Scenic beauty						
Wildlife habitat						
Ground water						
Flood storage						
Hunting						
Erosion control						
Fish habitat						
Nutrient recycling						
Fishing						
Financial benefits						
Trapping						

30. What influence did each of these factors have on your decision to participate in the Partners for Fish and Wildlife wetland restoration program? (Check one response for each.)

	1 Very Important	2 Important	3 Moderately Important	4 Neutral	5 Unimportant	6 Very Unimportant
Low cost to participate						
Increased property values						
Environmental benefits						
Wildlife & fish habitat						
Recreation opportunities						
PFW handled construction						
PFW handled permitting						
Supportive neighbors						
Neighbors had restorations						

Background Information

The questionnaire will finish with some demographic questions so we can compare your situation to those in similar circumstances.

31. What year were you born? 19____

32. Are you: 1 ❑ Male
 2 ❑ Female

33. Please mark the one response that best represents your education background.

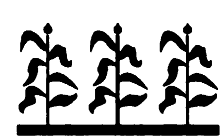
1 ❑ School less than high school diploma
2 ❑ Some high school
3 ❑ High school diploma
4 ❑ Some college
5 ❑ College diploma
6 ❑ Advance degree in college
7 ❑ Other, please list ________________

34. Was any of your household income in 2000 from agricultural production on your land?
1 ❑ No ***(If 'No' please skip to 37)***
2 ❑ Yes

35. **(*If Yes*)** Do you lease all or some of your property to others for agricultural purposes?

1 ❑ No ***(If 'No' please skip to 37)***
2 ❑ Yes

36. **(*If Yes*)** Approximately how much of your land is leased?
1 ❑ 0 – 24%
2 ❑ 25% - 49%
3 ❑ 50% - 74%
4 ❑ 75% - 100%



37. Another aspect of this project is a field evaluation of restored wetlands. Participation involves one or two researchers gaining access to your restored wetland during the period April to August 2002. Types of evaluation activities include bird counts, vegetation measurements and water depth measurements. If you would be willing to allow such access it would be greatly appreciated.

Would you be willing to allow your wetland to be used in the field portion of this study?

1 ❑ NO
2 ❑ YES
3 ❑ MAYBE, but I would like more information

38. Please provide any other comments.

Thank you for your participation.

Please return this survey in the enclosed addressed and stamped envelope.

If you have additional questions or comments you can contact me or my advisor at:

Kate Thompson
13 Natural Resources Building
Michigan State University
East Lansing, MI 48824-1222

Dr. Kelly Millenbah
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CHAPTER 4
RECOMMENDATIONS TO FACILITATE COMMUNICATION BETWEEN LANDOWNER AND BIOLOGIST ENGAGED IN PARTNERS FOR FISH AND WILDLIFE RESTORATION PROJECTS

The main goal of this research was to evaluate the success of the Partners for Fish and Wildlife Program's private land wetland restoration projects in the Saginaw Bay watershed, Michigan, ecologically and socially. This project was structured using a three-tiered approach that involved landowner surveys and broad and intensive ecological evaluations. In the preceding chapters the specific data that was collected from the landowner surveys and ecological evaluations was presented and discussed in detail. The goal of this final chapter is to synthesize the aforementioned information and discuss the implications for landowners and biologists involved in the Partners program.

A major theme has emerged from conducting the ecological evaluations and the landowner surveys: communication deficiencies between landowner and biologist. Although problems with communication does not seem to affect overall satisfaction ratings (60% stated that they were satisfied to very satisfied) the results from the ecological and landowner surveys suggests that not only do landowners want more information, they are frustrated with the lack of communication with the biologist and the agency/organization responsible for the restoration. The most common complaint heard during the ecological evaluations was the lack of follow-up from the biologist. It was clear from conversations with landowners that many had questions and wanted additional information about their restored wetland but did not know how to obtain the information. Landowners have a vested interest in their wetland and want it to be "successful" but they lack to tools and information to ensure its success. Landowners and biologist tend to value different characteristics of a wetland restoration (landowners value pieces of a wetland restoration whereas biologists value the overall impact the restoration will have on the environment), therefore it is important for biologists to gain a better understanding of what landowners find important, which factors drive their satisfaction and use this information to more effectively to communicate the expected results from restoring a wetland.

Landowners tend to focus on specific results from wetland restorations whereas biologists focus on the overall ecological value the wetland is providing to the surrounding environment. Specifically, the surveys revealed that landowners cared most about providing wildlife habitat and ensuring water was present on their property. Many landowners want or expect water to be present year round, even during the dry season, and are dissatisfied when water levels are low. Low or nonexistent water levels were the number one reason landowners said they were dissatisfied with their wetland restoration. It is important that biologists spend a significant amount of time explaining to landowners how water levels will vary between wetlands and seasons. Although the program is specific about not creating ponds and fish habitat, many landowners still desired these characteristic and even complained about the negative attitude of the biologist about the creation of ponds and fish habitat. This may be an area that biologists need to spend more time explaining to landowners.

Another significant area that landowners care deeply about is providing wildlife habitat and observing wildlife on their property. In fact, observing wildlife was the top reason why landowners were motivated to restore a wetland on their property and for their increased satisfaction with the project. Landowners want and expect to see wildlife using their wetland. However, there is a wide range of wildlife that utilize wetlands, from deer and waterfowl, which are visible, to secretive birds and amphibians, which are harder to observe. It is unclear whether landowners would be satisfied if their wetland was providing critical habitat for less visible wildlife.

Another important factor that influences landowner participation in the Partners Program is the environmental benefits wetland provide. Wetlands have important ecological functions such as sediment trapping, water quality improvement and flood control. In addition, wetlands are important food sources, nesting sites, nurseries, and refuges for a diversity of plant and animal species. Landowners stated in the survey that environmental benefits influenced their decision to participate in the program. However, it is unclear whether they would be satisfied if the primary function of their wetland was to provide flood storage or nutrient cycling with minimal wildlife use. How many landowners would agree to restore a wetland on their property if they were informed that the opportunity to observe wildlife would be minimal even though the restoration would be a tremendous benefit to the environment? This is an important point to consider when discussing goals and objectives with landowners. Although landowners are concerned about the environment there are still fundamental characteristics that landowners want from their restored wetland.

The following recommendations are provided to facilitate communication between landowner and biologist and to enhance landowner understanding of the restoration process.

1. Information packets should be developed and given to landowners upon completion of their wetland restoration. The packets should include information such as frequently asked questions about wetland restorations, what to expect

from their restoration, what types of wildlife to expect in their area, how can landowners become more involved with monitoring, and contact information. In addition landowners need to be encouraged to call if they have problems or questions regarding their restored wetland. Make sure this information is included in the packet and expressed by the biologist.

2. A newsletter should be sent out on a quarterly/annual basis to landowners including such items as highlighting restoration events in Michigan, providing interesting facts/information about wetlands, explaining to landowners what to look for at different times of the season, and listing the most common questions asked from landowners.

3. Currently, most landowners receive information from printed materials rather the Internet. However, as new generations, who are proficient in computer-based technology, begin to restore habitat on their property, the Internet (i.e. the creation of a website for landowners) may become an avenue for communicating information in the future.

4. Landowners want to help manage and maintain their wetland. There is a great opportunity to utilize landowners in the evaluation and monitoring process. Landowners felt certain answering water depth and vegetation questions, as indicated in the landowner surveys (landowner and ecological evaluations reported similar results in these areas). Landowners felt less certain answering

questions about how often wildlife visits their property; however they will be able to provide a comprehensive presence/absences list of wildlife observed. To facilitate landowner participation in the monitoring process staff gauges could be installed in each wetland so landowners can recorded water depth or provide landowners with journals to record their observations.

In conclusion, improved communication between landowners and biologists will benefit the Partners program by increasing satisfaction levels of participants and minimizing misconceptions and misunderstandings about the program. Furthermore, future wetland restoration projects will benefit from the knowledge gained from increased landowner participation in the monitoring and evaluation process. Landowners are genuinely excited about the Partners Program and feel strongly about their role in conserving wetlands in Michigan. By including them in all phases of the restoration process this excitement and dedication will continue and will ultimately play a role in encouraging others to participate.