2014 Great Lakes Wetlands Day

PROCEEDINGS | FEBRUARY 4, 2014

GREAT LAKES WETLANDS
Conservation Action Plan

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PREFACE

Wetland conservation in the Great Lakes Basin is now more important than ever. The State of Ontario's Biodiversity 2010 reports on the status and trends of 29 indicators related to pressures on Ontario's biodiversity, the state of Ontario's biodiversity, and conservation and sustainable use. The wetland indicator, based on analysis conducted by Ducks Unlimited Canada, revealed that despite their importance, wetlands in the Mixedwood Plains continue to be lost or destroyed due to development. By 2002, the wetland area in southern Ontario was estimated to have been reduced by over 1.4 million hectares (72 percent) of the total pre-settlement wetland area.

The Great Lakes Wetlands Conservation Action Plan (GLWCAP) was developed in 1994 to enable government and non-government partners to work together more effectively to conserve the remaining wetlands in the Great Lakes Basin. Implementation of the GLWCAP is coordinated by a team of representatives from Environment Canada (Canadian Wildlife Service), the Ontario Ministry of Natural Resources, Conservation Ontario, Ontario Nature, the Nature Conservancy of Canada, and Ducks Unlimited Canada.

These organizations and several others in Ontario have complete or ongoing wetland conservation initiatives across Ontario's Great Lakes Basin. These initiatives provide insights into the state of Ontario's wetlands, but are not always readily accessible or known. For GLWCAP to effectively deliver wetland-related priorities, it is important to continually advance our collective understanding of wetland matters in Ontario. On February 4, 2014, a GLWCAP steering committee brought together wetland experts to provide insights on recent advancements in (1) monitoring and research, (2) policy, (3) management, and (4) restoration for wetlands in Ontario's Great Lakes Basin. This document is a compilation of extended abstracts submitted by presenters.

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GREAT LAKES WETLANDS
Conservation Action Plan

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Factors Affecting Use of Wetland Habitat by Fish and Wildlife in Coastal Wetlands of Georgian Bay

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Introduction

Great Lakes coastal wetlands are productive ecosystems supporting a high diversity of freshwater species. The majority of these wetlands have been lost or degraded as a result of human disturbance; however, most coastal wetlands in Georgian Bay (Lake Huron) remain abundant and in pristine condition (Cvetkovic and Chow-Fraser 2011). The McMaster Coastal Wetland Inventory (MCWI) reveals that there are more than 3700 aquatic marshes in eastern and northern Georgian Bay, and almost 90% of these are < 2 ha in size (Fig. 1; Midwood et al. 2012). Despite their small size, they provide high-quality reproductive and foraging habitat for fish and wildlife, including species at risk. These coastal wetlands are typically low nutrient and dystrophic, reflecting inputs from forested catchments on Precambrian Shield bedrock, and minimal human settlement along the Georgian Bay coast (DeCatanzaro and Chow-Fraser 2011). Their hydrology and water chemistry are also heavily influenced by large-lake processes through direct hydrological connection that lead to large variations in water levels on a daily, seasonal and annual basis. These hydrologic connections play an important role in maintaining aquatic biodiversity in the wetlands by preventing monocultures of emergent vegetation from forming, by facilitating frequent exchange of chemical constituents between the wetlands and lakes, and by allowing daily and seasonal migration of fish in and out of the wetlands (Fracz and Chow-Fraser 2013a). The coastal wetlands of Georgian Bay are still among the least human-disturbed in the Great Lakes, but expansion of road networks, increases in cottage and residential development, invasion by non-native species, and a sustained drop in water level of close to 1 metre over the past 14 years are threatening the integrity of these sensitive ecosystems.

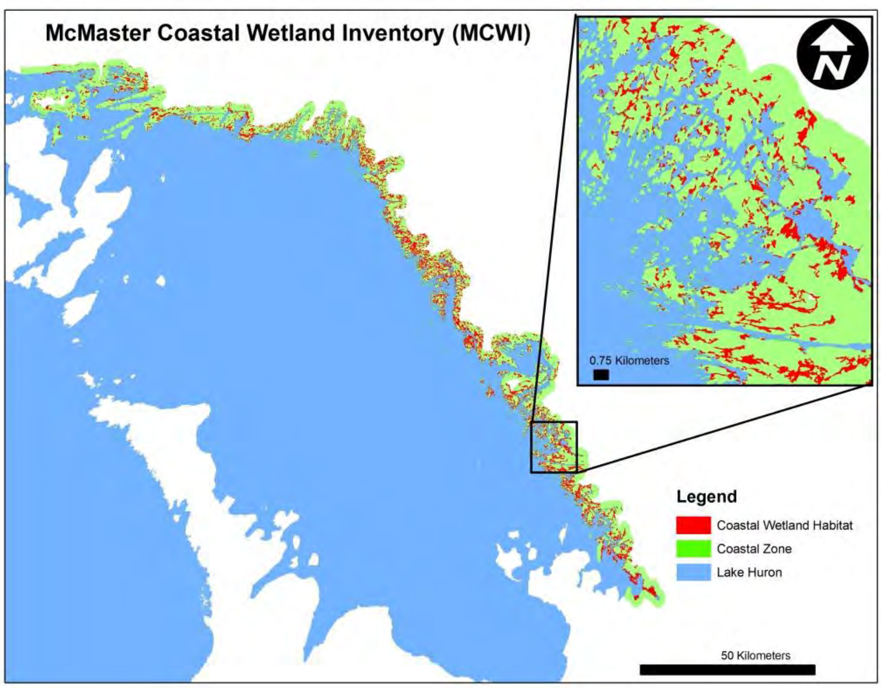

Figure 1. Map showing all coastal wetland habitat (red) and coastal zones (green) of eastern and northern Georgian Bay within the McMaster Coastal Wetland Inventory (MCWI; Midwood et al. 2012).

Methods

Wetland Digitizing – The McMaster Coastal Wetland Inventory (MCWI) was developed by Midwood et al. (2012) to provide a comprehensive dataset of Georgian Bay's unique assembly of pristine coastal wetlands. High-resolution (1 m) IKONOS satellite images of the entire eastern coast of Georgian

Bay from 2002-2008 were used to manually delineate wetland boundaries on ArcGIS 9.2 (ESRI™, Redlands, CA, USA). To make this inventory useful for monitoring changes in fish habitat, wetlands were digitized into low-marsh (permanently inundated fish habitat), high-marsh zones (seasonally inundated meadow habitat), and upstream habitat.

Wetland Indices – The literature indicates that a negative relationship exists between wetland health and anthropogenic activity (Minns et al. 1994, Trebitz et al. 2007, Danz et al. 2007, Morrice et al. 2008). Cvetkovic and Chow-Fraser (2011) compared the health of 181 coastal marshes across all 5 Great Lakes sampled over a 13-year period (1995-2008) using three published ecological indices developed specifically to evaluate coastal wetlands in the Great Lakes: the Water Quality Index (WQI; Chow-Fraser 2006), the Wetland Macrophyte Index (WMI; Croft and Chow-Fraser 2007), and the Wetland Fish Index (WFI; Seilheimer and Chow-Fraser 2007). Water quality parameters were measured at all sites, including primary nutrients (phosphorus and nitrogen), water clarity (chlorophyll), total suspended solids, total inorganic suspended solids, turbidity, as well as physical parameters (temperature, pH, conductivity). Each site was surveyed and identified for macrophytes following the methods outlined by Croft and Chow-Fraser (2007, 2009), and paired fyke nets (two large sets, one small) set parallel to shore were deployed to assess the fish community following a standardized protocol described by Seilheimer and Chow-Fraser (2007). These data have been used to calculate scores for their associated indices, and were used to compare wetland quality across the Great Lakes Basin.

Comparing Historic Water Levels to Coastal Wetland Habitat – Water levels in Lake Huron have been declining over the past decade (Fig. 2). This has altered wetland plant assemblages in Georgian Bay coastal wetlands that provide critical fish and wildlife habitat. Midwood and Chow-Fraser (2012) compared IKONOS satellite images of eastern Georgian Bay from different years (2002 and 2008) to identify changes in wetland vegetation (meadow, emergent, high-density floating, and low-density floating) associated with decreasing water levels. Since 1999, water levels have persisted at extremely low levels, and this has resulted in many of the coastal wetlands being disconnected hydrologically from Georgian Bay. Fracz and Chow-Fraser (2013a) applied a site-specific approach to determine the amount of fish habitat

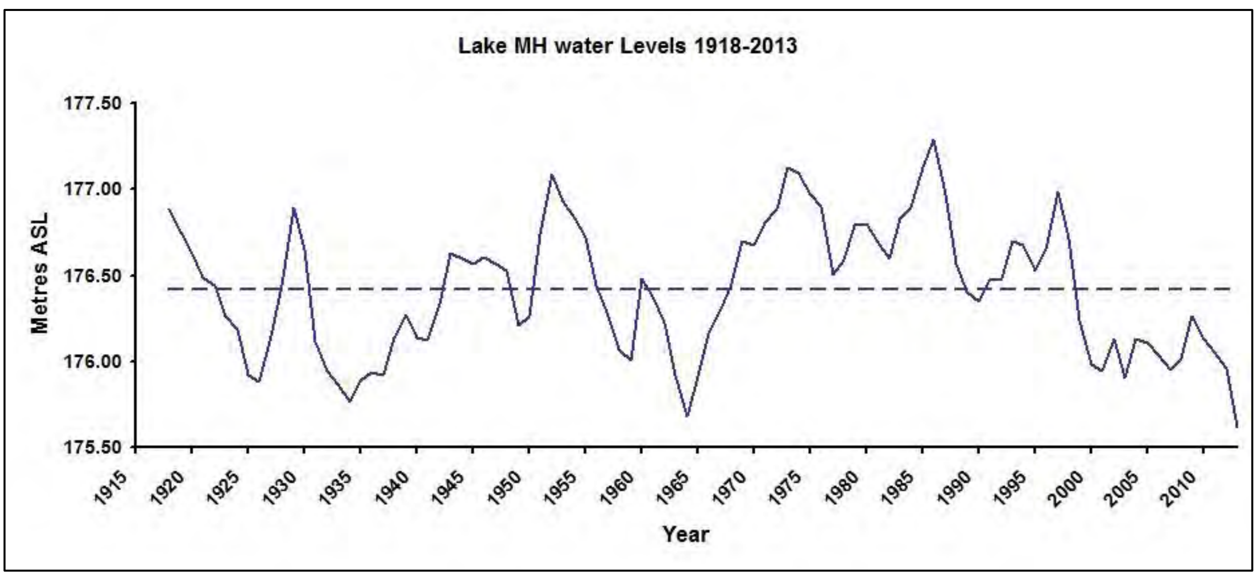

Figure 2. Mean annual water levels for Lake Huron from 1918 to 2013. The dotted line indicates the average water level for this time period. Persistent low water levels below average are observed over the last decade. Data were obtained from National Oceanic and Atmospheric Administration (NOAA; 2013).

in seven representative wetlands of eastern Georgian Bay, and was able to calculate the amount of fish habitat that has been lost between high water levels and the current low water levels. They also used a regional model to predict the magnitude of habitat loss if water levels were to continue to decrease. To study the effect of hydrological disconnection on the water chemistry of coastal marshes, Fracz and Chow-Fraser (2013b) sampled 34 coastal marshes in protected embayments (forested watersheds, minimal human disturbance), 17 of which were beaver-impounded. They used a YSI 6600 multiprobe (YSI, Yellow Springs, Ohio) to measure pH and conductivity at all sites, while turbidity was measured with a turbidimeter (LaMotte, Chestertown, Maryland, USA). Nutrient samples were also collected and analyzed, and included total nitrate nitrogen (TNN), total ammonia nitrogen (TAN), total suspended solids (TSS), total phosphorus (TP), and soluble reactive phosphorus (SRP). They compared water chemistry in a beaver-impounded wetland both above and below the dam to determine the effects of impoundment on water chemistry in coastal marshes.

Results

Inventory of Georgian Bay Coastal Wetlands – The MCWI (Midwood et al. 2012) determined that four times as many wetland complexes exist in eastern and northern Georgian Bay (> 700) than had previously been included in the Great Lakes Coastal Wetlands Consortium (GLCWC) inventory. Results revealed that there are over 3700 aquatic marshes along the shoreline of eastern and northern Georgian Bay, 90% of which are < 2 ha (a size restraint that excluded these from GLCWC inventory). To date, the MCWI is the most comprehensive inventory of coastal wetlands in eastern Georgian Bay, providing zonal habitat separation allowing long-term changes in fish and plant communities to be monitored and compared.

Coastal Wetland Quality Across the Great Lakes Basin – The health of Great Lakes coastal marshes is directly related to the extent of anthropogenic activities, such as urbanization and agricultural development in the region. WQI, WMI, and WFI scores gave an indication of the general condition of the wetlands. Statistical analyses indicated that wetland quality between the Great Lakes differed significantly. WQI scores for each Great Lake revealed that > 50% of marshes in lakes Michigan, Erie, and Ontario were in degraded condition, while over 70% of marshes in Lake Superior, Lake Huron, and Georgian Bay were minimally impacted. The highest proportion of very good and excellent quality wetlands, and the least number of degraded wetlands existed in Georgian Bay (Fig. 3).

Hydrologic Disconnectivity – Sustained low water levels in the recent decade have significantly impacted vegetation and fish assemblages in coastal wetlands of eastern Georgian Bay (Midwood and Chow-Fraser 2012). Between 2002 and 2008, we saw a significant decrease in low-

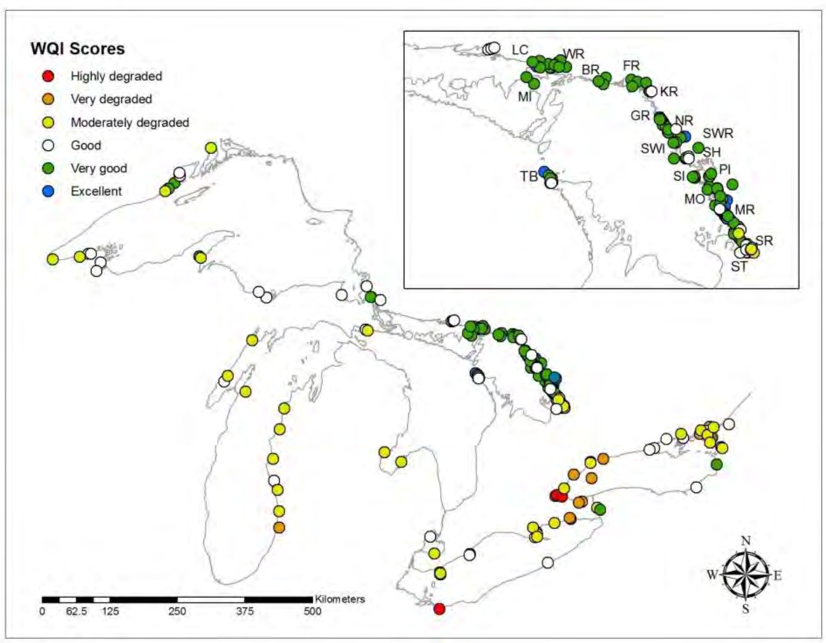

Figure 3. Comparison of **WQI** scores across 181 coastal wetlands sampled between 1995 and 2008. Inset is an expansion of Georgian Bay with the highest scores (figure taken from Cvetkovic and Chow-Fraser 2011).

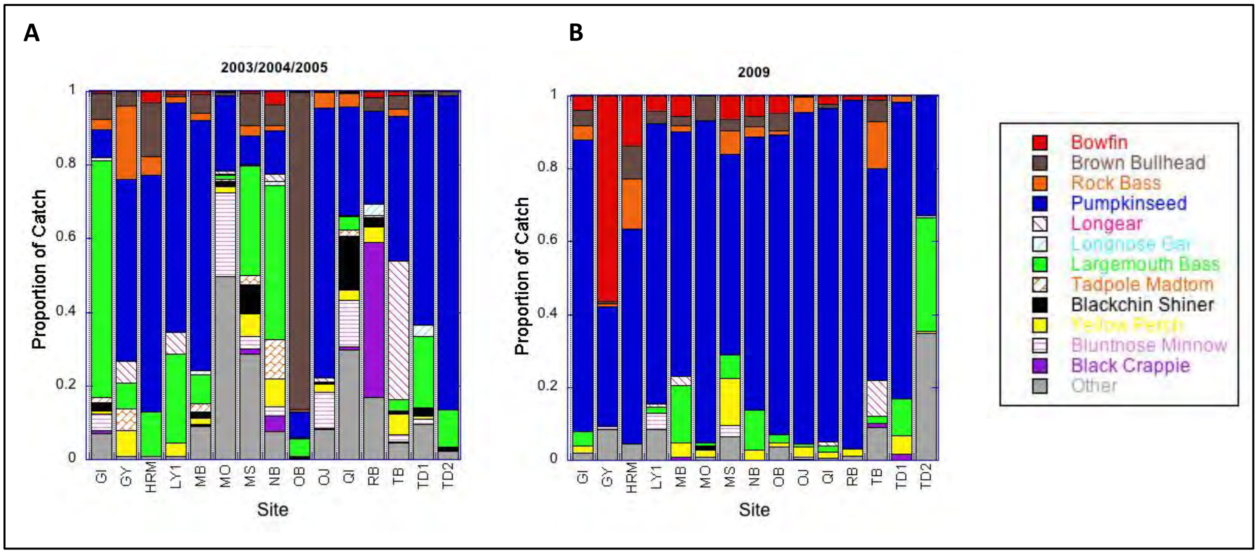

Figure 4. Proportion of catch represented by each species in each wetland sampled in a) 2003-2005 and b) 2009. Figures indicate a significant decrease in species richness from the early to late sampling period (figure taken from Midwood and Chow-Fraser 2012).

density floating vegetation with a concomitant increase in meadow and high-density floating vegetation. A greater coverage of high-density floating vegetation also replaced small patches of low-density floating vegetation. These changes coincided with a decrease in species richness of the fish community, along with a shift in species composition, with a significant increase in pumpkinseeds and bowfin species with declining water levels and a decrease in largemouth bass, blackchin shiner and tadpole madtom (Fig. 4).

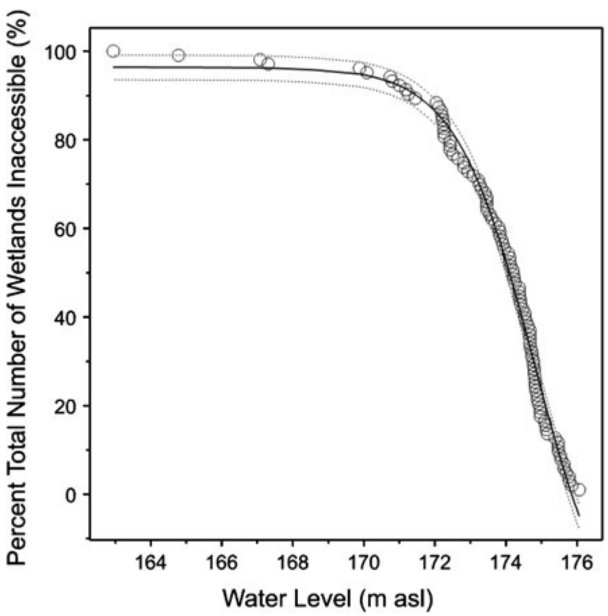

Figure 5. Total number of wetlands (%) that become inaccessible to fish as a function of water level for 103 coastal wetlands in eastern Georgian Bay (figure taken from Fracz and Chow-Fraser 2013).

Fracz and Chow-Fraser (2013a) determined the relationship between amounts of wetland habitat that would be stranded (i.e. no longer connected to Georgian Bay) as a function of declining water levels (Fig. 5). The greatest rate of wetland stranding is associated with water levels between 173.5 and 176.5 m asl. For all seven wetlands surveyed, an average loss of 24% surface area between 2010 (176.11 m) and the historic water level high (177.5 m) has already occurred. If water levels were to drop to 174.0 m, as predicted by the Global Circulation Models (GCM), access to an additional 50% of the wetlands would be lost. The record low water level of 175.7 m reported in January 2013 was associated with a loss of 12% compared to 2010 levels. Hydrologic disconnectivity due to beaver impoundments prevented water in embayments to be mixed with open water of Georgian Bay, and led to significantly higher concentrations of TP, SRP, TSS, turbidity, and chlorophyll, but significantly lower pH, nitrates, and conductivity. These results indicate that water chemistry above impoundments in Georgian Bay is nutrient rich and ion-poor, while water before the impoundment was nutrient poor and ion-rich.

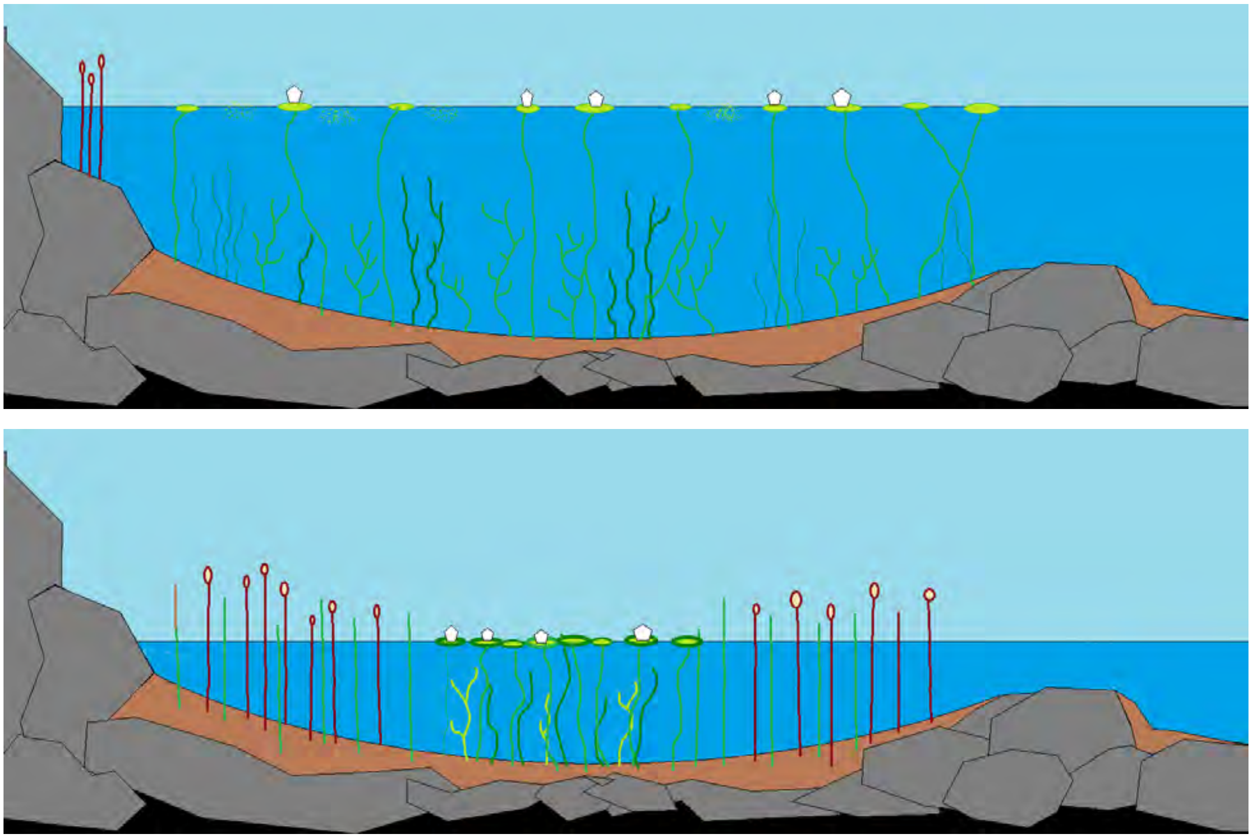

Figure 6. Top panel: Graphic illustrating how wetland vegetation is distributed during high water-level scenarios in a coastal wetland that develops behind a rock-lined sill. Bottom panel: Graphic illustrating how low water levels would lead to decreased habitat complexity and densification of floating and emergent vegetation, with loss of submerged aquatic vegetation (Prepared by D. Taylor).

Discussion

Climate change is predicted to cause further decline in water levels in the Great Lakes, particularly in Lake Huron (Sellinger et al. 2008). These persistent low water levels will continue to alter vegetation structure and coverage in the coastal wetlands of Georgian Bay. Completion of the MCWI by Midwood et al. (2012) demonstrates how a comprehensive habitat-based inventory of coastal wetlands can be used to provide a regional model of how wetlands would respond to changes in water levels. Monitoring changes in the amount of low-marsh (aquatic) and high-marsh (emergent) allows us to monitor changes in critical habitat for the fish, marsh birds and turtles. Monitoring changes in high marsh habitat will allow us to examine the role played by upstream wetlands in controlling downstream water quality. Water chemistry in coastal wetlands is the result of both dynamic offshore processes as well runoff from upstream habitat, and can be affected by the morphology of wetland, the size and slope of watersheds, and land use within the watershed such as amount of farmed or forested land and road density (DeCatanzaro and Chow-Fraser 2011). Due to the as yet low level of human impact in most regions in Georgian Bay, water quality scores reveal healthier coastal wetlands compared to the other Great Lakes. Our comparison of wetland quality across the Great Lakes Basin revealed that wetlands in the Lower Great Lakes (Lake Erie, Lake Ontario) where development and human disturbance is highest are also the most degraded (Cvetkovic and Chow-Fraser 2011).

Sustained low water levels over the past 15 years have impacted navigation and local economies, as well as caused large-scale negative ecological impacts on near shore habitats. Decreasing water levels have increased vegetation density and led to a more homogenous macrophyte community, with a greater abundance of meadow vegetation that was previously aquatic habitat (Fig. 6). This loss of aquatic habitat is problematic for fish, especially when growth of canopy forms of submerged aquatic vegetation (SAV) become scarce, since these wetland plants disproportionately provide shelter and foraging habitat for many fish species. Aquatic habitat that is dominated by dense floating vegetation is less suitable as fish habitat because they are less structurally diverse than either emergent or SAV. The fish communities following the period of low water levels have become increasingly more homogeneous, as indicated by decreased species richness, and this is likely a consequence of reduced habitat complexity in the coastal wetlands (Midwood and Chow-Fraser 2012).

Fracz and Chow-Fraser (2013a) confirmed that declining aquatic habitat from sustained low water levels can lead to a net loss of fish habitat. GCMs indicate that water levels will continue to decline over the next decades, and this will certainly lead to greater losses of wetland fish habitat due to disconnection with Georgian Bay. Since hydrologic disconnectivity of coastal wetlands can result in altered water chemistry (Fracz and Chow-Fraser 2013b), impounded wetlands are expected to be significantly more nutrient rich and ion-poor compared to unimpounded marshes, reflecting reduced mixing with open waters of Georgian Bay. Hence, in addition to being a barrier to spring migrations of Great Lakes fish, impoundments can also affect the distribution of wetland biota through alteration of water chemistry within the marsh. Results of these studies illustrate the importance of routine monitoring programs to track changes in the health of coastal wetlands, so that we can prevent further loss and degradation of critical fish and wildlife habitat in eastern Georgian Bay.

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Literature Cited

Croft, M. V. and P. Chow-Fraser. 2007. Use and development of the wetland macrophyte index to detect water quality impairment in fish habitat of Great Lakes coastal marshes. Journal of Great Lakes Research 33 (3):172-197.

Croft, M. V. and P. Chow-Fraser. 2009. Non-random sampling and its role in habitat conservation: a comparison of three wetland macrophyte sampling protocols. Biodiversity and Conservation. 18 (9):2283-2306.

Cvetkovic, M. and P. Chow-Fraser. 2011. Use of ecological indicators to assess the quality of Great Lakes coastal wetlands. Ecological Indicators 11 (6):1609-1622.

Danz, N. P., G. J. Neimi, R. R. Regal, T. Hollenhorst, L. B. Johnson, J. M. Hanowski, R. P. Axler, J. J. H. Ciborowski, T. Hrabik, V. J. Brady, J. R. Kelly, J. A. Morrice, J. C. Brazner, R. W. Howe, C. A. Johnston and G. E. Host. 2007. Integrated measures of anthropogenic stress in the U.S. Great Lakes basin. Journal of Environmental Management 39:631-647.

DeCatanzaro, R. and P. Chow-Fraser. 2011. Effects of landscape variables and season on reference water chemistry of coastal marshes in eastern Georgian Bay. Canadian Journal of Fisheries and Aquatic Science 68 (6):1038-1050.

DeCatanzaro, R., M. Cvetkovic and P. Chow-Fraser. 2009. The relative importance of road density and physical watershed features in determining coastal marsh water quality in Georgian Bay. Journal of Environmental Management 44 (3):456-467.

Fracz, A. and P. Chow-Fraser. 2013a. Impacts of declining water levels on the quantity of fish habitat in coastal wetlands of eastern Georgian Bay, Lake Huron. Hydrobiologia 702 (601):151-169.

Fracz, A. and P. Chow-Fraser. 2013b. Changes in water chemistry associated with beaver-impounded coastal marshes of eastern Georgian Bay. Canadian Journal of Fisheries and Aquatic Science 70 (6):834-840.

Midwood, J. D. and P. Chow-Fraser. 2012. Changes in aquatic vegetation and fish communities following 5 years of sustained low water levels in coastal marshes of eastern Georgian Bay, Lake Huron. Global Change Biology. 18 (1):93-105.

Midwood, J. D., D. Rokitnicki-Wojcik, and P. Chow-Fraser. 2012. Development of an inventory of coastal wetlands for eastern Georgian Bay, Lake Huron. ISRN Ecology: Article ID 950173. http://dx.doi.org/10.5402/2012/950173.

Minns, C. K., V. W. Cairns, R. G. Randall, and J. E. Moore. 1994. An index of biotic integrity (IBI) for fish assemblages in the littoral zone of Great Lakes' Areas of Concern. Canadian Journal of Fisheries and Aquatic Science 51:1804-1822.

Morrice, J. A., N. P. Danz, R. R. Regal, J. R. Kelly, G. J. Niemi, E. D. Reavie, T. Hollenhorst, R. P. Axler, A. S. Trebitz, A. M. Cotter and G. S. Peterson. 2008. Human influences on water quality in Great Lakes coastal wetlands. Journal of Environmental Management 41:347-357.

The National Oceanic and Atmospheric Administration (NOAA). 2013. Historical Water Level Data. http://www.glerl.noaa.gov/data/now/wlevels/levels.html.

Seilheimer, T. S. and P. Chow-Fraser. 2007. Application of the wetland fish index to northern Great Lakes marshes with emphasis on Georgian Bay coastal wetlands. Journal of Great Lakes Research 33 (3):154-171.

Sellinger, C. E., C. A. Stow, E. C. Lamon, and S. S. Qian. 2008. Recent water level declines in the Lake Michigan-Huron system. Environmental Science and Technology 42 (2):367-373.

Trebitz, A. S., J. C. Brazner, A. M. Cotter, M. L. Knuth, J. A. Morrice, G. S. Peterson, M. E. Sierzen, J. A. Thompson and J. R. Kelly. 2007. Water quality in Great Lakes coastal wetlands: basin-wide patterns and responses to an anthropogenic disturbance gradient. Journal of Great Lakes Research 33 (3):67-85.