Journal of Great Lakes Research 38 (2012) 243–250

Contents lists available at SciVerse ScienceDirect

Journal of Great Lakes Research

journal homepage: www.elsevier.com/locate/jglr

Development of a submerged aquatic vegetation community index of biotic integrity for use in Lake Ontario coastal wetlands

Greg P. Grabas [a,*], E. Agnes Blukacz-Richards [a], Satu Pernanen [b]

[a] Canadian Wildlife Service, Environment Canada, 4905 Dufferin Street, Toronto, ON, Canada
[b] Pernanen Biological Consulting, 635 Dundee Avenue, Oshawa, ON, Canada

ARTICLE INFO

Article history:
Received 24 May 2011
Accepted 8 February 2012
Available online 29 March 2012

Communicated by Anett Trebitz

Index words:
Index of biotic integrity
Submerged aquatic vegetation
Coastal wetlands
Lake Ontario
Breeding bird biodiversity
Wetland management

ABSTRACT

Submerged aquatic vegetation (SAV) supports biodiversity in the Great Lakes basin by providing an important source of food and habitat for breeding marsh birds and fish and it is desirable to have indices enabling reporting on the condition of SAV, to complement already available indices for the condition of fish, aquatic macroinvertebrate, and bird communities and water quality. We developed a SAV index of biotic integrity (SAV IBI) with 6 years of quadrat-based vegetation species composition data (2003, 2005–2009) collected across 46 coastal wetlands on the Canadian side of Lake Ontario. We evaluated the suitability of thirteen potential metrics that described species richness, floristic quality, and cover. Metrics with a significant linear or non-linear response to disturbance (as assessed by a water quality index; WQI) were retained for use in the SAV IBI. Retained metrics included turbidity-intolerant species richness, native species richness, coefficient of conservatism, and total cumulative coverage. Lower SAV IBI scores indicated poorer coastal wetland conditions. Coastal wetlands in poor condition were located in more urbanized watersheds (e.g., Durham Region) relative to wetlands in more natural watersheds. Fish and breeding bird community condition showed strong significant relationships with the SAV IBI, suggesting that SAV was an important component of fish and bird biodiversity. Our SAV assessment index and its relationship to faunal diversity can be used to inform conservation decisions.

Introduction

Coastal wetlands of the Lower Great Lakes are an interface between terrestrial and aquatic systems. They reduce nutrient loading and enable groundwater recharge (Burton, 1985). These wetlands also support biodiversity by providing habitat for birds, mammals, reptiles, and amphibians (Gibbs et al., 1992; Hanowski et al., 2007; Hecnar, 2004) as well as critical spawning and nursery areas for fish (Jude and Pappas, 1992). Submerged aquatic vegetation (SAV) in these wetlands provides spawning structure for fish, refugia for fish larvae and young fish, and habitat for invertebrates (e.g., epiphytic macroinvertebrates) that serve as prey (Casselman and Lewis, 1996; Trebitz et al., 2009). The SAV community also provides marsh-dependent birds with habitat for activities related to breeding and feeding (Bannor and Kiviat, 2002; Brisbin et al., 2002; Mowbray, 1997; Rohwer et al., 2002). The continuing loss of Great Lakes coastal wetlands and degradation of coastal wetland habitat are substantial concerns.

To conserve coastal wetlands, environmental management agencies require indices that can support effective routine monitoring and reporting to stakeholders and the public. Relevant indices simplify multivariate data on water quality (Chow-Fraser, 2006), invertebrates (Burton et al., 1999), zooplankton (Lougheed and Chow-Fraser, 2002), breeding birds (Burton et al., 2008), and fish (Minns et al., 1994; Uzarski et al., 2005). Chow-Fraser's (2006) water quality index (WQI) measures human-related disturbance such as agricultural and urban development around coastal wetlands (e.g., Seilheimer and Chow-Fraser, 2006) in a 'snap-shot' view based on parameters (e.g., temperature, turbidity) that are fairly variable in time and space, whereas indices based on biological communities provide more integrative measures of wetland condition. Existing indices based on coastal wetland vegetation combine data across wetland vegetation communities including meadow marsh, emergent, and submerged zones (Albert and Minc, 2004; Croft and Chow-Fraser, 2007; Rothrock and Simon, 2006). Since annual changes in emergent vegetation coverage are probably controlled by fluctuating water levels (Chow-Fraser et al., 1998; Keddy and Reznicek, 1986) and water level regulation on Lake Ontario has affected the extent and species composition of meadow marsh zones (Wilcox et al., 2005; Wilcox et al., 2008), vegetation indices that incorporate emergent and meadow marsh vegetation communities cannot discriminate

* Corresponding author at: Canadian Wildlife Service, Environment Canada, 4905 Dufferin Street, Toronto, ON, Canada M3H 5T4. Tel.: +1 416 739 4939.
E-mail address: Greg.Grabas@ec.gc.ca (G.P. Grabas).

0380-1330/$ – see front matter.
doi:10.1016/j.jglr.2012.02.014

between impacts of water level regulation and the influence of natural water level fluctuation. Furthermore, Johnston et al. (2008) suggested that human-related disturbance across the Lake Ontario basin is so high that the remaining emergent taxa are not responsive to more subtle differences among wetlands. An index of biotic integrity (IBI) for Lake Ontario coastal wetlands that exclusively uses the SAV community may be more reflective of wetland disturbance than previously developed indices that incorporate additional vegetation communities.

Currently, there is no index for Lake Ontario coastal wetlands solely based on the SAV community. To address this gap, we have developed a SAV index of biological integrity (SAV IBI) that is sensitive to human-related disturbance and incorporates attributes of the SAV community such as floristic quality, species richness, and abundance (Albert and Minc, 2004; Oldham et al., 1995). To select suitable metrics for the SAV IBI, we used Chow-Fraser's (2006) WQI as a proxy measure of human-related disturbance. We validated the SAV IBI using additional datasets from Lake Ontario and Lake Erie. Because SAV provides habitat for fish (Jude and Pappas, 1992) and marsh birds (Lantz et al., 2010; Shirley et al., 2003) we also examined the relationship between SAV IBI and the fish and breeding marsh bird communities.

Methods and materials

Field sampling

Biotic communities

To develop the SAV IBI, SAV communities were sampled during the summer months (mid-July to mid-September) from 2003 to 2009, across 46 Canadian Lake Ontario coastal wetlands (Fig. 1A) through

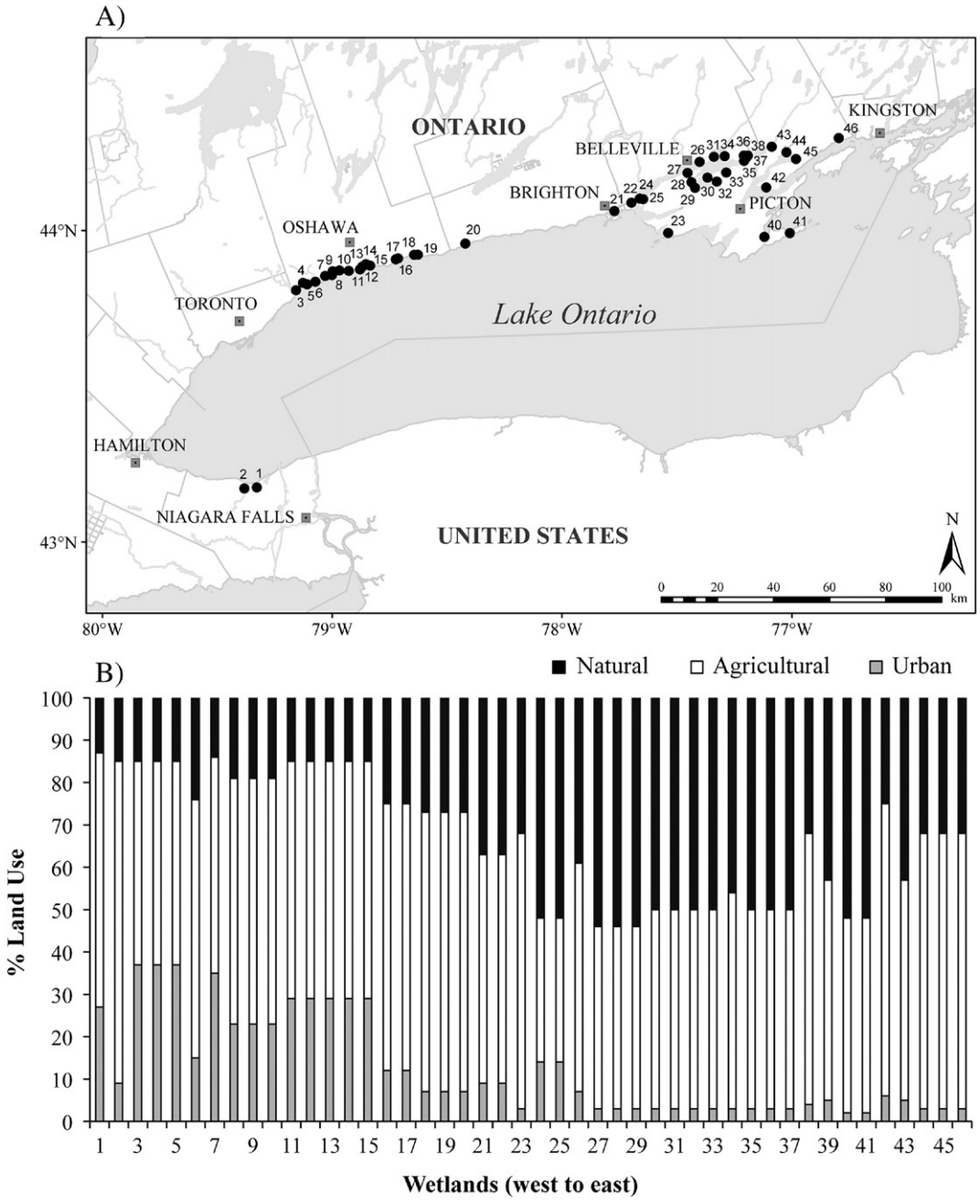

Fig. 1. The upper panel (A) shows locations of Lake Ontario coastal wetlands sampled for submerged aquatic vegetation. The names of these wetlands are listed in Appendix A, from west to east, starting with Four Mile Pond located in the Niagara Falls region (1) and ending with Parrott's Bay (46). The lower panel (B) shows the relative percentage of land use grouped into three categories: 1) urban, 2) agricultural, and 3) natural (SOLRIS, 2008) for wetlands shown in panel A.