Journal of Great Lakes Research xxx (2014) xxx–xxx

Contents lists available at ScienceDirect

Journal of Great Lakes Research

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

Conservation and management of fisheries and aquatic communities in Great Lakes connecting channels

The North American Laurentian Great Lakes are linked by a unique series of riverine and lacustrine waters known as the Great Lakes connecting channels that are as integral to the basin's ecology and economies as the lakes themselves. The St. Marys River (SMR) is the northernmost channel and flows from Lake Superior to Lake Huron. Waters from the upper Great Lakes (Lakes Superior, Michigan, and Huron) empty from Lake Huron via the St. Clair–Detroit River system (SCDRS, also known as the Huron–Erie Corridor) into Lake Erie. The SCDRS is composed of the St. Clair River, Lake St. Clair, and the Detroit River. The Niagara River (NR) serves as the outflow from Lake Erie into Lake Ontario. The NR above Niagara Falls is bisected by Grand Island and contains several other islands and man-made embayments whereas the NR below the falls is more linear. The outflow from Lake Ontario, representing the natural outlet of all the Great Lakes, is the St. Lawrence River (SLR) which empties into the Gulf of St. Lawrence in the northwest Atlantic Ocean (Fig. 1).

The impetus for this special issue arose from recent special focus given to Great Lakes connecting channels at professional conferences and at Great Lakes Fishery Commission meetings. In 2009 and 2011, the connecting channels were featured during symposia at the International Association for Great Lakes Research conferences held in Toledo, Ohio and Duluth, Minnesota, respectively, with an emphasis on their history, ecology, and management of aquatic communities and fisheries. Each of the connecting channels was represented during the 2011 common session of the Great Lakes Fishery Commission Lake Committee Meetings held in Ypsilanti, MI. During that meeting, scientists studying the St. Marys River discussed the past decade of sport-fishery harvest surveys and the status of the open-water fish community. Members of the St. Clair–Detroit River science team described the history of the Huron–Erie Corridor (HEC) Initiative, recent accomplishments in restoration and research, and the future strategic framework. Niagara River researchers emphasized habitat restoration needs for that system. Muskellunge (*Esox masquinongy*) population trends and fish community objectives were presented for the St. Lawrence River. During the spring of 2011, ecology of the St. Marys River was the focus of a special issue of the Journal of Great Lakes Research (Vol. 37: Suppl 2), which included ten papers covering a wide range of issues ranging from the ecological status, environmental history, sediment quality sites (AOCs), crustacean and zooplankton communities, population genetics of walleye (*Sander vitreus*) and yellow perch (*Perca flavescens*), identifying salmon, movement and habitat characteristics of lake sturgeon (*Acipenser fulvescens*), nearshore fish community, and long-term trends in the open-water fish community (Moerke and Werner, 2011).

These connecting channels share several common attributes relevant to aquatic resource management including: 1) a binational border between the United States and Canada, 2) aquatic resources generally managed under collaborative multi-jurisdictional authorities (Donahue, 1986; GLFC, 1980), 3) productive aquatic communities including fish populations of substantial sport, commercial, and ecological value, 4) areas of high human population density that use water for industrial, hydro-electric, agricultural, and municipal purposes, 5) impacts by invasive aquatic species, 6) degraded habitats and aquatic populations due to the consequences of habitat destruction and alteration, 7) regions designated as Great Lakes Areas of Concern (AOCs) with beneficial use impairments (BUIs), and losses of aquatic habitat function and 8) new and ongoing efforts and assessments for aquatic habitat and population rehabilitation. In this introduction to the special issue, titled *Conservation and management of fisheries and aquatic communities in Great Lakes connecting channels*, we provide background information on the physical, biological, and social settings for each Great Lakes connecting channel to serve as contextual information for the papers in this volume.

St. Marys River

The St. Marys River connects Lake Superior with Lake Huron where the Sault Locks have facilitated regional and international shipping routes for over 150 years. The river features rapids, numerous embayments, riparian fringe wetlands, and an island archipelago, which provide a diverse array of aquatic habitats for migrating and nesting birds, and spawning and nursery habitat for fishes. Commercial, recreational, and First Nations subsistence fishing are common along SMR (Gebhardt et al., 2002). The SMR watershed has the lowest human population (139,187 people; Table 1) among the connecting channels, with the majority of the population residing at the bordering towns named Sault Ste. Marie, in Michigan and Ontario (Fig. 1).

The SMR is the second shortest (120 km) of the connecting channels between the Laurentian Great Lakes and has the lowest amount of annual discharge (2119 m^3/s; Table 1). Barriers to flow on the SMR include the Sault Locks, hydroelectric plants, and the compensating works (a 16-gated control structure) at the head of the St. Marys Rapids. Freighters with a draft less than 6.5 m are able to travel through the upper Great Lakes (Michigan, Huron, Superior) (Edwards et al., 1989). Annual shipping traffic for 2011 was estimated at 7215 ships with commercial freight in excess of 68,032,861 tons (USACE, 2011). Major freight included iron ore, coal, wheat, limestone, and oilseeds (USACE, 2011). The compensating works administered by the International

http://dx.doi.org/10.1016/j.jglr.2014.03.003
0380-1330/Published by Elsevier B.V. on behalf of International Association for Great Lakes Research.

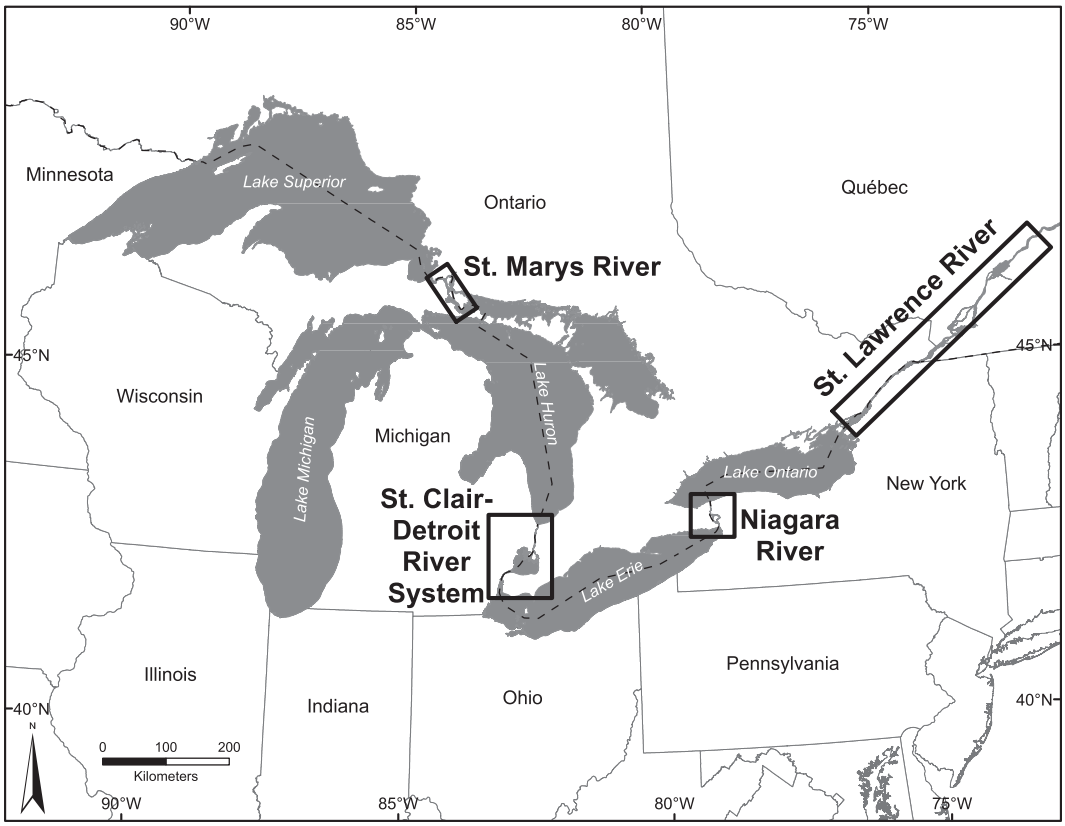

Fig. 1. The Laurentian Great Lakes and connecting channels.

Joint Commission (USACE, 2006b) were built in 1916 to enhance flow conditions for hydroelectric power. Hydroelectric power generation on the SMR uses 93% of the total river flow (Edsall and Gannon, 1993).

The SMR watershed and wetlands provide habitats supporting high biodiversity (Environment Canada, 2010a). Of the four connecting channels, the SMR has the highest percentage of forested land use and wetlands (Table 2) with the majority of its wet meadows and emergent wetlands remaining intact and extending along the river in unbroken stretches (Albert, 2003). The bulk of recreational fishing takes place on the rapids and in the lower river, with anglers targeting 85% warmwater species (yellow perch, walleye, and northern pike (*Esox lucius*)) and 15% coldwater species (Pacific salmons (*Oncorhynchus* spp.), rainbow trout (*Oncorhynchus mykiss*), and brown trout (*Salmo trutta*)) (Edsall and Gannon, 1993). Fielder et al. (2002) estimated that over $11 million (US) dollars were generated in Michigan and Ontario from the 1999 open-water fishery and the 2000 ice fishery in the SMR.

Stressors to the ecological integrity of the SMR system include impacts to fish populations by the parasitic sea lamprey (*Petromyzon marinus*), untreated outflow from wastewater treatment plants, shoreline development, and sediment discharge from the steel, pulp, and paper industries (Environment Canada, 2010a). The SMR is an AOC shared by the United States and Canada, one of five sites shared by both countries in addition to nine Canadian sites and 25 United States sites (Environment Canada, 2010a). There is a large bi-national effort between the United States and Canada to further improve the health of the system by working on the AOCs. There are 10 BUIs for the

Table 1
Demographic attributes of the Laurentian Great Lakes connecting channels. Population numbers derived using US 2010[e] and CA 2011[f] census data and ArcGIS with 80.5 km buffer on each side of the connecting channels.

	Length (km)[a]	Elevation change[c] (m)	Discharge (m^3/s)[d]	Population (# of people)[e,f]	Waterborne commerce (metric tons)	Barriers[a,b]
St. Marys River (SMR)	120	6.7	2119	US 47,749 CA 91,438	1,556,571.16[h] Drummond Island, MI	Hydroelectric power plants, Soo Locks, Compensating works
St. Clair–Detroit River System (SCDRS)	148	2.5	5323	US 5,075,129 CA 621,037	15,293,482.7[h] Detroit, MI	No barriers to flow
Niagara River (NR)	58	99.3	5786	US 1,246,680 CA 2,535,695	1,444,399.58[h] Buffalo, NY	Niagara Falls, International Control Works
St. Lawrence River (SLR)	853	74	6945	US 290,243 CA 6,753,177	30,000,000[g] Montreal — Lake Ontario Section	Moses Saunders Dam, Lake Ontario Locks

[a] USACE (2006a).
[b] USACE (2007).
[c] Edwards et al. (1989).
[d] Noorbakhsh (2011).
[e] USCB (2010).
[f] Statistics Canada (2011).
[g] USACE (2003).
[h] USACE (2004).

Please cite this article as: Roseman, E.F., et al., Conservation and management of fisheries and aquatic communities in Great Lakes connecting channels, J Great Lakes Res (2014), http://dx.doi.org/10.1016/j.jglr.2014.03.003