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Habitat and Fish Community Changes in the Michigan Waters of Green Bay 1989–2005

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Abstract.–The Michigan waters of Green Bay support the largest recreational fishery in Michigan's Upper Peninsula, with anglers targeting walleye *Sander vitreus* and yellow perch *Perca flavescens* most of the year. The need for data to support fisheries management led to initiation of trawl and gill net assessment surveys in Little Bay de Noc (LBdN) and Big Bay de Noc (BBdN) (collectively Bays de Noc or BDN) in 1988. Jaw-tagging studies to characterize walleye movement, exploitation, and survival started in the late 1980s and early 1990s for LBdN, BBdN, and the Cedar and Menominee rivers. From 1988 to 2005, summer water clarity increased 45% in LBdN and 19% in BBdN, and August and September surface water temperatures increased 16%. Assessment survey data for the period showed declines in yellow perch, trout-perch *Percopsis omiscomaycus*, rainbow smelt *Osmerus mordax*, spottail shiner *Notropis hudsonius*, and alewife *Alosa pseudoharengus*, but increases in brook stickleback *Culaea inconstans* and smallmouth bass *Micropterus dolomieu*, suggesting a decreased pelagic component in the fish community. Several of these species concurrently declined in the diets of walleye and yellow perch as well. Round gobies *Neogobius melanostomus* made their first appearance in Bays de Noc (BDN) assessment catches in 1998, and as of 2005, made up over 75% of trawl catches. Eurasian ruffe *Gymnocephalus cernuus* were first detected in 2004, and currently are at relatively low abundance levels. Walleye and yellow perch were a focus of our study. Data from assessment, tagging, and creel surveys indicated a much larger population of walleye in LBdN (compared to BBdN), with unstocked year classes being well-represented, and provided good evidence for natural reproduction. Age estimates of fish from surveys showed few walleyes representing nine unstocked year classes in BBdN, and no walleyes from unstocked years in Cedar River. However, 11 of 15 unstocked year classes of walleyes were represented in the Menominee River. Based on 1,946 angler reports of jaw-tagged walleyes, we estimated angler exploitation (adjusted for nonreporting) and walleye survival from 1997–2005 for our study populations as follows: 10.4% and 54% in LBdN; 8.1% and 67% in BBdN; 7.5% and 76% in Cedar River; and 11.8% and 59% in Menominee River. Over 90% of recaptures of walleyes tagged in LBdN, BBdN, and the Menominee River occurred within 20 km of spawning areas where tagging occurred. In contrast, 66% of walleyes tagged in and near the Cedar River and recaptured by anglers were more than 40 km from tagging sites. As our study progressed, walleyes tagged at sites in LBdN and Menominee River and later recaptured in spring and summer were generally caught further and further from tagging sites, and the proportional contribution of summer-caught walleyes to the LBdN fishery declined substantially. Both observations meshed with angler complaints, suggesting a shift in the fishery in response to changing biophysical conditions in LBdN. Abundances of age-0 and age-1 and older yellow perch reached their lowest levels in BDN during 2000–05. There was little correlation in yellow perch trends among BDN, southern Green Bay, and other Lake Michigan locations, and further analyses indicated a need for additional sampling effort to increase precision of abundance indices for BDN fishes. Growth and survival of yellow perch have remained fairly steady over the study

period, and samples were consistently dominated by female fish. Open-water harvest and catch per angler effort data from sport creel surveys at LBdN, BBdN, Cedar River, and Menominee River areas generally showed increases for walleyes and declines for yellow perch from 1988 through 2005. Data for the LBdN ice fishery showed a decline for both species during this time. The dynamic nature of northern Green Bay, the importance of its aquatic communities and fisheries, and management issues (e.g., walleye rehabilitation, invasive species effects, cormorant-fish community interactions) justify the need for continued assessment effort. More intensive effort is needed in BDN to increase the accuracy and precision of abundance trends. Sampling should be expanded to adjacent areas to increase fish community assessment information for nearshore areas of Lake Michigan in Michigan's Upper Peninsula outside of BDN.

Introduction

Northern Green Bay (i.e., Michigan's portion of Green Bay) supports the largest recreational fishery in Michigan's Upper Peninsula (UP). Recreational angling effort in these waters, which averaged over 550,000 angler hours per year over the last two decades, is nearly equivalent to the 650,000 hours of summer effort estimated for US and Canadian waters of Lake Superior and more than three times higher than angling effort in Michigan waters of Lake Superior (Zorn 2005; Ebener and Schreiner 2007). Approximately 22% of Michigan's sportfishing effort on Lake Michigan during 2000–07 occurred in northern Green Bay (T. Kolb, Michigan Department of Natural Resources, personal communication). The northern Green Bay fisheries are clearly important to Michigan and Midwestern anglers and provide substantial socioeconomic benefits to the region.

Northern Green Bay anglers primarily target walleye *Sander vitreus* and yellow perch *Perca flavescens* in nearshore areas throughout most of the year, with some pursuing salmonids in spring and fall. Walleye populations consist of relatively discrete, rehabilitating stocks composed of both naturally-reproduced and stocked fish (Schneeberger 2000). Walleye rehabilitation efforts have occurred in these waters since 1969, with 40.4 million fry and 14.9 million fingerlings stocked through 2005 in Big Bay de Noc (BBdN), Little Bay de Noc (LBdN), Cedar River, and Stony Point (i.e., Lake Michigan about 13 km north of the Menominee River mouth) (Table 1). The contribution of hatchery fish to stock abundance is thought to vary among these four locations, but is not clearly understood. Yellow perch populations are sustained entirely by natural reproduction. In the late 1990s, angler catches of yellow perch in the bays de Noc (BDN) declined from levels in the previous decade. These declines were roughly concurrent with yellow perch declines elsewhere in Lake Michigan's main basin (Schneeberger 2000; Clapp and Dettmers 2004; Makauskas and Clapp 2008). Fishery assessment data were needed to help direct management of these percid stocks.

In addition to percid management issues, northern Green Bay has had a steady influx of invasive species, most of which were likely introduced through ship ballast water. Notable introductions of species into LBdN (and year we observed them) include the cladoceran *Bythotrephes cederstroemi* (1988), three-spine stickleback *Gasterosteus aculeatus* (1989), white perch *Morone americana* (1990), zebra mussel *Dreissenia polymorpha* (1993), and later, quagga mussel *Dreissenia bugensis*, round goby *Neogobius melanostomus* (1998), and Eurasian ruffe *Gymnocephalus cernuus* (2003). Monitoring was needed to document changes in the aquatic environment and fish community and to help direct future fishery management.

The importance of the fishery and fish stocks, the need for assessment data to support management, and the changing biophysical environment of northern Green Bay, especially in LBdN and BBdN, (referred to collectively as Bays de Noc or BDN) led to initiation of fishery assessment and tagging studies in the BDN in 1988 (Schneeberger 2000). The overall objectives of this report are: 1) to describe fish population trends for the BDN since 1989, as well as the current status of aquatic communities in the BDN, with emphasis on yellow perch and walleye; and 2) to characterize