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Progress Toward the Rehabilitation of Lake Trout (*Salvelinus namaycush*) in South Bay, Lake Huron

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ABSTRACT. *Our objective was to evaluate the status of lake trout* Salvelinus namaycush *rehabilitation in South Bay, Lake Huron. Standardized surveys were conducted to quantify natural recruitment, annual mortality, and the contribution of wild- versus hatchery-origin lake trout. Some indicators suggest a high level of natural recruitment. The spawning population was comprised of multiple ages, and the mean age of spawners (8.4 years for females, 7.9 years for males) was at least 1 year older than the age at 50% maturity (5.8 years). Estimated annual total mortality rates (0.20–0.25) and sea-lamprey induced mortality rates (0.02) were less than maximum allowable values. The proportion of wild-origin fish captured was high among spawners but varied among sampling programs (42% in fall trap nets, 70% in fall gill nets, and 88% in summer gill nets). A strong year class (1997) could be tracked from 2001 to 2005. Few fish were captured from early (< 1996) or later (1999–2002) year classes. Possible explanations for low natural recruitment during these later years include declining spawning habitat quality caused by low water levels and/or invasion of non-native mussels (*Dreissena *spp.) and/or direct or indirect effects of alewife* (Alosa pseudoharengus).

INDEX WORDS: *Lake trout, rehabilitation, Lake Huron.*

INTRODUCTION

Lake trout *Salvelinus namaycush* in the Laurentian Great Lakes supported a large commercial fishing industry in the nineteenth and first half of the twentieth century (Baldwin *et al.* 1979), but due to the combined effects of overfishing, sea lamprey *Petromyzon marinus* predation, and habitat degradation (Berst and Spangler 1972, 1973; Coble *et al.* 1990; Eshenroder *et al.* 1992, Walters *et al.* 1980), most existing populations were extirpated by the 1950s. A few remnant populations survived in Lake Huron (Parry Sound, Iroquois Bay), several populations (Gull Island Shoal, Cat Island, Stannard Rock, Thunder Bay, Slate Islands, Isle Royale, and Munising) comprising three distinct ecotypes (lean, humper, and siscowet) persisted in Lake Superior, but no populations survived in Lakes Erie, Michigan, or Ontario (Hansen 1996, Berst and Spangler 1973, Elrod *et al.* 1995, Holey *et al.* 1995, Leach and Nepszy 1976). As a result of this socioeconomic and biological catastrophe, fisheries agencies in Canada and the U.S. embarked on a major initiative to re-establish self-sustaining lake trout populations in the Great Lakes. Sea lamprey control, stocking of hatchery-origin lake trout (or lake trout-brook trout *S. fontinalis* crosses), and fisheries reg-

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ulations have been the main methods employed (Ebener 1998, Hansen 1999).

Rehabilitation of lake trout has not been achieved in the Great Lakes except in Lake Superior (Hansen *et al.* 1995) and in Parry Sound, Lake Huron (Reid *et al.* 2001). Wild-origin lake trout juveniles have been captured at only a few other natural spawning sites in Lake Huron, including South Bay, Gravelly Bay, Frazer Bay, and Iroquois Bay in Ontario and Thunder Bay, the Six Fathom Bank-Yankee Reef complex, Black River, and Rockport in Michigan (Anderson and Collins 1995, Desorcie and Bowen II 2003, Johnson and VanAmberg 1995, Madenjian *et al.* 2004, Nester and Poe 1984, Ontario Ministry of Natural Resources, unpubl. data).

Available evidence throughout the Great Lakes suggests that local adaptation to spawning habitat is of paramount importance in facilitating rehabilitation. Reid *et al.* (2001) concluded that in Parry Sound, the most important factors leading to the successful rehabilitation were 1) the pre-existence of a locally-adapted remnant population, 2) enhancement using hatchery-origin yearling lake trout derived from Parry Sound stock, 3) creation of a refuge from fishing, 4) harvest restrictions, and 5) sea lamprey control. Unfortunately, the majority of areas in Lake Huron lack a wild remnant population with locally-adapted traits. In these circumstances, the best option is to stock strains with proven fitness in a similar habitat (i.e., phenotype-habitat matching). For example, in South Bay, the stocking of lake trout from Lake Manitou, a nearby inland lake on Manitoulin Island, was an important factor leading to successful egg deposition and egg survival in the early 1990s (Anderson and Collins 1995). Our objective was to evaluate the current rehabilitation status of lake trout in South Bay using criteria outlined in lake trout rehabilitation plans for Lake Huron (Ebener 1998, Ontario Ministry of Natural Resources 1996). Specifically, we consider criteria related to annual mortality and age structure.

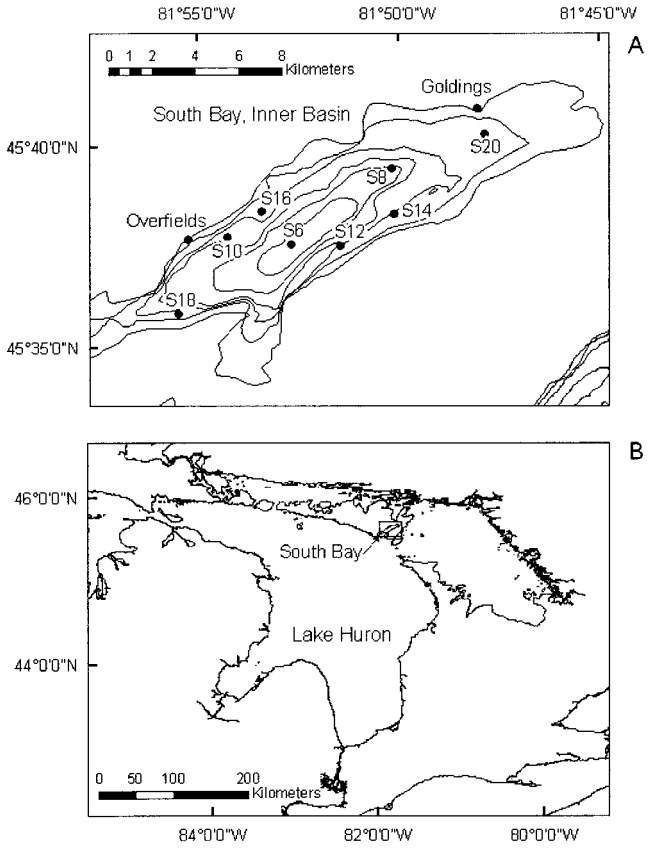

FIG. 1. Map of the inner basin of South Bay (A) and its location within Lake Huron (B). The map of South Bay shows the approximate locations for the two trap nets (Goldings and Overfields) and the eight temperature-stratified gill netting sites (Sx, where x is the temperature in degrees Celsius). Coastline and bathymetry data were mapped using GIS layers (glgis_gl_shore_noaa_70k and lake_huron_bathymetry) published by the Great Lakes Information Network (http://gis.glin.net/).

METHODS

Sampling Protocol

South Bay is a 26 km long embayment of Lake Huron located on Manitoulin Island, Ontario (Fig. 1). The current study focuses on the inner basin (length = 18.8 km, mean depth = 16 m, maximum depth = 58.5 m, surface area = 73.2 km^2; King *et al.* 1997). Following the extirpation of lake trout in the late 1940s (Fry 1953, Fry and Budd 1958), recovery efforts focused on the stocking of hatchery-origin splake (lake trout × brook trout), backcross (♂ splake × ♀ lake trout), and lake trout from a variety of source populations (Fig. 2). South Bay is one of 16 designated lake trout rehabilitation zones in the Canadian waters of Lake Huron (Ontario Ministry of Natural Resources 1996). Lake trout in South Bay are not harvested commercially but they are harvested in recreational and gill net subsistence fisheries. The first naturally reproduced lake trout since the 1948 year class were captured in fry emergence traps and trawl nets during 1987–1992 (Anderson and Collins 1995).

Lake trout were sampled in South Bay using