Evidence of Wild Juvenile Lake Trout Recruitment in Western Lake Michigan

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Evidence of Wild Juvenile Lake Trout Recruitment in Western Lake Michigan


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Abstract

Lake Trout *Salvelinus namaycush* were extirpated from Lake Michigan by the early 1950s, and as part of an effort to restore naturally reproducing populations, hatchery-reared fish have been stocked since the early 1960s. Stocked fish are marked with a fin clip to differentiate them from wild, lake-produced Lake Trout; marking error for the 2007–2010 year-classes of Lake Trout stocked by federal hatcheries averaged 3.0%. Egg deposition, emergent fry, and wild juvenile Lake Trout have previously been observed, but no sustained wild recruitment has been measured in assessment surveys or in sport and commercial fishery catches. In 2011 and 2012, we caught juvenile Lake Trout in gill-net and bottom trawl catches that were targeting Bloater *Coregonus hoyi* in water depths greater than 80 m. Unclipped, wild Lake Trout represented 20% of all Lake Trout caught in a southern offshore region of Lake Michigan. In northwestern Lake Michigan wild recruits represented from 10% to 27% of the 2007–2009 year-classes, and we recovered a small number of wild Lake Trout from the 2010 year-class. This is the first evidence for consecutive year-classes of naturally produced Lake Trout surviving beyond the fry stage in Lake Michigan.

Lake Michigan once supported the world’s largest commercial fishery for Lake Trout *Salvelinus namaycush*, but in the 1950s all populations in Lake Michigan and in most other Great Lakes were extirpated due to predation by Sea Lamprey *Petromyzon marinus* and overfishing (Wells and McLain 1972; Holey et al. 1995; Hansen 1999). In 1960, the U.S. Fish and Wildlife Service (USFWS) began stocking Lake Trout fingerlings and yearlings to restore self-sustaining populations in Lake Michigan; Illinois, Michigan, and Wisconsin state agencies also stocked Lake Trout in later years. Between 2000 and 2010, an average of 2.8 million fall-fingerling and yearling Lake Trout were stocked annually in Lake Michigan. Stocked fish have been marked by the removal of one or more fins; fin clips were rotated every 6 years to help differentiate year-classes at re-capture. Also, a proportion of the 1984, 1985, 1988–2004, and 2009 year-classes, and all fish in the 2010–2011 year-classes were tagged with coded wire tags (CWT) and marked with an adipose fin clip. These marks and tags allowed stocked fish to be differentiated from wild fish. Fin clip marking error, measured as the percentage of fish that were unintentionally released without fin clips, averaged about 6% in federal hatcheries between 1990 and 2001 (Bronte et al. 2007). Despite nearly five decades of stocking, there has been no consistent wild juvenile Lake Trout recruitment in Lake Michigan as evidenced by the recovery of unclipped fish (Holey et al. 1995; Bronte et al. 2007, 2008; Madenjian 2012).

Stocked Lake Trout survive to spawn in Lake Michigan, and egg deposition (Marsden and Janssen 1997; Marsden et al. 2005), fry emergence (Jude et al. 1981; Wagner 1981; Janssen 2006), and recruitment of wild age-1 and older Lake Trout (Rybicki 1991) have been reported. However, recruitment of wild age-1 and older Lake Trout has been not been consistent. Population assessments performed between 1983 and 1989 in Grand Traverse Bay and nearby Platte Bay in northeastern Lake Michigan documented that 15% of the 1976 year-class, 8.9% of the 1981 year-class, and 5.7% of the 1983 year-class comprised unclipped, presumably wild Lake Trout (Rybicki 1991), but none thereafter.

Since 2010, the USFWS has collected Bloater *Coregonus hoyi* gametes during winter at multiple deepwater (>80 m) locations in western Lake Michigan to support reintroduction efforts into Lake Ontario. As part of these collections, many juvenile Lake Trout were captured, and here we summarize the demographics of this bycatch that provide evidence of consecutive and consistent natural reproduction by Lake Trout in Lake Michigan.

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<table>
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<th>Sample date (month/day/year)</th>
<th>Nights fished</th>
<th>Location</th>
<th>Depth range (m)</th>
<th>CPUE-km⁻¹·night⁻¹</th>
<th>Number caught</th>
<th>Number unclipped</th>
<th>Percentage unclipped (%)</th>
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<td>2/28/2012*</td>
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*Trawl tow, all other data describe gill-net lifts.
FIGURE 1. Lake Michigan showing gill-net and trawl survey locations in 2011 and 2012 where Lake Trout were captured in Bloater spawner surveys.
In 2011, three gill-net lifts were made in southern Lake Michigan, but Lake Trout bycatch was only retained from the last lift on February 10 (Table 1). A total of 295 Lake Trout were caught resulting in a CPUE of 24.2 fish/km of net per night fished. Lake Trout mean TL was 385 mm (SD = 101 mm) and 93% of the fish were less than 500 mm. The percentage of unclipped fish was 20.0% (59 of 295) and no CWTs or fin regeneration were detected in these unclipped fish. The majority of the unclipped fish were probably from the 2006 and 2007 year-classes based on the age–length frequencies of stocked fish (Figure 2). For fin-clipped fish less than 500 mm (n = 216), 3.7% were from the 2005 year-class, 42.6% from the 2006 year-class, 45.8% from the 2007 year-class, and 6.0% were from the 2008 year-class. No Lake Trout less than 500 mm possessed an adipose fin clip or a CWT.

In 2012, eight gill-net lifts off the northern Door Peninsula were made between January 21 and February 23. A total of 180 Lake Trout were caught and the mean CPUE was 0.8 (SD = 0.3). Lake Trout mean TL was 353 mm (SD = 86 mm); 14.4% (26 of 180) of all Lake Trout were unclipped and none of these fish contained CWTs. Six fin-clipped fish contained CWTs: two fish of the 2009 year-class and one fish of the 2010 year-class all stocked in the Northern Refuge, and one each from the 1999, 2000, and 2003 year-classes stocked in the Southern Refuge. The single bottom trawl tow near Manistowoc caught four Lake Trout. Three fish were unclipped (75%) and had a mean length of 190 mm (SD = 13 mm), while a 224-mm fin-clipped Lake Trout with a CWT code of the 2010 year-class stocked at multiple locations as fall fingerlings was also captured. The percentages of unclipped fish caught in 2012 were 22.7, 27.0, 10.0, and 60.0% for the 2007, 2008, 2009, and 2010 year-classes, respectively (Figure 3). Size comparisons within year-classes indicate unclipped Lake Trout were smaller than fin-clipped fish at ages 2 and 3, but modal size was similar for fish captured at ages 4 and 5 (Figure 3).

**DISCUSSION**

We have provided the first evidence of consistent recruitment of wild age-1 and older Lake Trout in Lake Michigan based on the percent of unclipped Lake Trout that exceeded the 3.0% lakewide marking error for Lake Trout stocked between 2007 and 2010. In northwestern Lake Michigan we observed contribution of wild recruits for the 2007 (22.7%), 2008 (27.0%), 2009 (10.0%), and 2010 (60.0%) year-classes (though the sample size for the 2010 year-class was small). The length frequencies of these fish at ages 4 and 5 were similar between wild and stocked fish, which suggests we can be reasonably confident in our year-class assignments where no otolith was available. Twenty percent of the Lake Trout we sampled in the southern offshore location in Lake Michigan were wild recruits, and length frequency comparisons suggested these were most probably age-5 fish from the 2006 year-class and age-4 fish from the 2007 year-class. The occurrence of these wild fish is much higher than can be attributed to marking error and provides evidence of some successful Lake Trout natural reproduction during 2007–2010 in northwestern Lake Michigan, in addition to the 2006 and 2007 year-classes in the southern portion of the lake.

Our findings are corroborated by a small yet notable increase in the mean percentage of unclipped Lake Trout caught in the standardized, multiagency, spring, graded-mesh gill net survey. The spring survey targets Lake Trout at depths between 15 and 61 m in nine nearshore areas and offshore in the Northern and Southern Refuges (Schneeberger et al. 1998). Generally Lake Trout recruit to this survey’s graded mesh (63.5, 76.2, 88.9, 101.6, 114.3, 127, 139.7, and 152.4 mm stretch mesh) beginning.
and later year-classes become vulnerable to the spring survey, but the percentage of unclipped recoveries lakewide reflects both the proportion of wild recruits relative to stocked fish and the spatial scale over which natural recruits are produced. In 2011, 16 of 154 (10.4%) Lake Trout sampled in the spring survey near Waukegan, Illinois, were unclipped (Steve Robillard, Illinois Department of Natural Resources, personal communication), which provides evidence that wild recruits are also being produced in Illinois waters in addition to the southern offshore and nearshore waters near Manitowoc and the northern Door Peninsula where we detected wild fish.

Impediments to natural reproduction of Lake Trout in Lake Michigan have been evaluated (Bronte 2003; Bronte et al. 2007, 2008) and are summarized as having poor survival of early life stages, a lakewide population too low to overcome bottlenecks, and inappropriate stocking practices. The management strategy to restore Lake Trout in Lake Michigan has been revised and implemented by the Lake Michigan Committee (Dexter et al. 2010) to address stocking practices and low abundance in selected areas of the lake, but the changes enacted will take years to evaluate their effectiveness. Currently Lake Trout total and adult abundance remains below target levels (Madenjian 2012). Thiamine deficiency complex has been implicated as the primary cause for poor survival of early life stages. This complex is linked to a maternal diet of Alewifes Alosa pseudoharengus that causes a thiamine deficiency in eggs that result in poor hatching success and high posthatch mortality among fry (Fisher et al. 1996). In Lake Michigan, mean egg thiamine levels in Lake Trout have increased in recent years and are correlated with a concomitant decrease in Alewife abundance (Riley et al. 2011). Lake Trout eggs now exceed the 4-nmol/g thiamine concentration threshold level and meet the definition of viable eggs for restoration efforts (Bronte et al. 2008) at most sites; this may partially explain the recent detection of wild recruits.

Based on our results, it appears that some reproduction of Lake Trout is now occurring in western Lake Michigan, albeit at a low level. As progress toward the abundance and egg quality targets for rehabilitation continues, we would expect increasing levels of wild recruitment to occur.

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REFERENCES


