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Investigations into Recent Declines in Survival of Brown Trout Stocked in Lake Charlevoix and Thunder Bay, Lake Huron

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Abstract.–Sharp declines in the Thunder Bay, Lake Huron and Lake Charlevoix brown trout fisheries prompted investigations into the causes of brown trout failures in these waters and possible solutions. Both Thunder Bay and Lake Charlevoix are located in the northern part of Michigan's Lower Peninsula. Test netting and diet studies of predators and prey in Thunder Bay during 1990 showed that piscivorous fish, particularly walleyes, consumed recently stocked brown trout, but that spawning aggregations of alewives during June appeared to buffer predation on stocked trout by offering ample alternate prey. The stocking date for brown trout, which had been early May, was therefore changed to mid-June in 1992. Two strains of brown trout, Wild Rose and Seeforellen, were selected for field evaluation based on evidence of satisfactory lacustrine performance elsewhere, and programmed for testing in Thunder Bay and Lake Charlevoix. These strains were also compared with Plymouth Rock strain, which had been stocked in both systems prior to the study. Both Seeforellen and Wild Rose strains produced greater returns and faster growth than Plymouth Rock strain. Seeforellen and Wild Rose strains were similar to each other with respect to returns to creel, growth rates, and longevity in the fishery. However, there was evidence that Seeforellen strain produced slightly better results in Thunder Bay. The brown trout fishery in Thunder Bay rebounded with successful stockings in 1991–95, but declined again as a consequence of poor survival of trout stocked after 1995. The short-term recovery was attributed to the later stocking window and deployment of the new test strains of brown trout. The brown trout failure after 1995 appeared to be caused by declining alewife abundance, which essentially "closed" the June stocking window. Predation on brown trout was probably exacerbated by an 8.4-fold increase in double-crested cormorant *Phalacrocorax auritus* numbers in the Thunder Bay area between 1989 and 1997. Offshore stocking had no measurable effect on survival of the 1996 and 1997 yearling cohorts; both nearshore and offshore treatments survived poorly in both years. The brown trout niche in Thunder Bay appeared to be tenuous. Zooplankton and other prey were scarce for age-1 brown trout. Diet of age-1 brown trout was chiefly terrestrial insects because the trout were too small to utilize the abundant adult alewives. Longevity of brown trout in the fishery was relatively short and few survived past age four. Thus, once recruited at age two to a size sufficient to feed on alewives, brown trout contributed to the fishery only one or two more years. Two successive year

class failures therefore were sufficient to cause collapse of the fishery. Unless alewives recover, predators decline, or another prey species (such as the round goby, a recent invader) alter the food web in a way that favors brown trout, the niche for put-grow-take brown trout management of Thunder Bay may have disappeared.

Introduction

Lakes Huron and Michigan host what are perhaps the world's largest put-grow-take salmonine recreational fisheries (Whelan and Johnson 2004). Natural recruitment failures were caused by sea lamprey (see Table 1 for scientific names of fish) depredations on native predator stocks, the overpopulation of invasive alewives, other invasive species, overharvest of native predator stocks, physical habitat loss, and water quality degradation (Smith 1968; Eshenroder et al. 1995; Johnson et al. 2004; Whelan and Johnson 2004). The 1960s and 1970s saw rehabilitation programs begin that included water quality initiatives, commercial fishing restrictions, intensive sea lamprey control, fishway construction, and extensive stocking of the system with coho and chinook salmon, and rainbow, lake, and brown trout (Tody and Tanner 1966; Eshenroder et al. 1995; Kocik and Jones 1999; Whelan and Johnson 2004). These changes led to ecologically balanced fish communities, recreational and commercial fisheries valued in excess of $2 billion annually, and restoration of self-sustaining lake trout in Lake Superior (Kocik and Jones 1999; Whelan and Johnson 2004). However, the salmonine fisheries of lakes Huron and Michigan remain principally supported by stocking. Self-sustaining naturalized populations of most introduced salmonine species have failed to develop. Where naturalized populations have developed, stocks remain recruitment limited (Keller et al. 1990; Whelan and Johnson 2004). In the case of brown trout, reproduction is limited to a few isolated populations. Thus, many of the salmonine fisheries of lakes Michigan and Huron, brown trout in particular, are dependent on continued success of put-grow-take stocking programs (Whelan and Johnson 2004).

Brown trout have been an important element of the recreational fishery of Thunder Bay, Lake Huron, since at least 1972 (Weber 1988). From 1972 through 1986, brown trout recreational harvest was loosely a function of stocking (R^2 = 0.27: estimated harvest as dependant variable versus number yearling brown trout stocked one year prior to harvest). Return to creel was near 10% during the early 1970s (Weber 1988). After 1986, however, the relationship between stocking and harvest weakened (R^2declining to 0.17). Recreational catch rates for brown trout were low in certain years, particularly 1979–84 and 1990–91 (Table 2). Hypotheses for the decline included:

- *A change in genetic strain of brown trout used for stocking may have contributed to a decline in post-stocking survival.* The Michigan Department of Natural Resources discontinued its own "Harrietta" strain brown trout broodstock in 1984. This strain of brown trout was no longer stocked after 1985 and other strains of brown trout were substituted.
- *An increase in predation rates on stocked trout contributed to a decline in post-stocking survival.* By the 1980s, walleyes appeared to be recovering in many locations in western Lake Huron, including Thunder Bay. Double-crested cormorants *Phalacrocorax auritus*, blue herons *Ardea herodias*, herring gulls *Larus argentatus*, and other fish-eating bird populations were also thought to be increasing. Thus, predation by recovering piscivorous birds and fish may have contributed to the declining recreational fishery.

This study was initiated to test if: 1) conditions of the receiving waters, such as food availability and predation on recently stocked yearling brown trout, were contributing to observed declines in the recreational harvest of brown trout; 2) the decline in stocking success and return to creel was associated with strains chosen for stocking; 3) there were differences in growth, longevity, and spawning dynamics of strains chosen for stocking; and 4) return to creel