F-80-R-9, Michigan
Study 230556 **New Study: 2007-08**

Name of Study: Effects of restrictive minimum size limits and gear restrictions on brook trout populations in the Black River, Michigan.

A. Problem: Major changes to stream trout angling regulations were adopted in Michigan in 2000. All trout streams became subject to one of seven stream regulation types (hereafter referred to as Type 1 through Type 7 streams). Daily creel limits were reduced on all steams (except no-kill streams). Increases in minimum size limits for one or more trout species were applied to approximately 16% of the total mileage of streams subject to the seven regulation types. Legislation adopted in the early 1970s prohibited the Michigan Department of Natural Resources (MDNR) from applying regulations to restrict terminal tackle to artificial flies or lures to more than 100 miles of stream in Michigan. Thus, virtually no change in the mileage of gear-restricted water occurred in 2000 because this ceiling had been reached. In 2002 the ceiling was raised to 212 miles and the MDNR was mandated to prepare a set of criteria to evaluate potential streams where gear restrictions might be applied. Criteria were developed to evaluate if streams already subject to gear restrictions (types 5, 6, and 7) were appropriately designated as well as to estimate whether gear restrictions for some type 1-4 streams were desirable.

In 2000, the least restrictive regulation (Type 1) was applied to 84% of designated stream-trout waters. Type 2, 5, 6, or 7 regulations were the new regulation type most often applied to reaches of inland trout streams isolated from the Great Lakes by upstream migration barriers. Type 2 regulations imposed higher minimum size limits on all trout species but no new gear restrictions. Presently 605 miles of stream in Michigan are subject to Type 2 regulations. This is nearly 88% of the *inland* trout stream mileage with more-restrictive-than-normal regulations (higher size limits and/or gear restrictions, types 2, 5, 6, or 7). Type 6 regulations mandate the same minimum size limits as Type 2 regulations but restrict anglers to use of only artificial flies or lures (no bait angling) and reduce creel limits to 2 fish per day. Some managers and anglers advocate Type 6 regulations because hooking mortality is lower with artificial flies and lures compared to bait angling, but the 100-mile limit on gear-restricted streams precluded such designations in 2000. Population dynamics models incorporating natural mortality, angling mortality (harvest and hooking mortality combined), and growth rate predict that a change from Type 2 to Type 6 regulations is likely to increase angler catches and standing stocks only if certain conditions are met. Trout populations most likely to respond positively are those where trout grow rapidly, have relatively low rates of natural mortality and high rates of angling mortality. Trout growth rates are known for many Michigan streams, but few data are available on the magnitude of natural and angling mortality in the stream reaches where Type 2 regulations have been applied.

There is a need to measure the potential benefits of applying Type 6 regulations on a stream presently managed under Type 2 regulations. Brook trout in the Black River (Cheboygan River watershed) grow relatively rapidly so Type 2 regulations were applied to a long reach of the stream in 2000. The Black River is potentially a good candidate for gear restrictions (Type 6 regulations) because angling pressure is believed to be high and brook trout are very vulnerable to capture by angling; hence large numbers of sublegal-sized brook trout are likely captured and released by bait anglers. However, without a field test of gear restrictions we can not reliably predict if reduced hooking mortality under Type 6 regulations will reduce total mortality rates enough to significantly influence population size structure. Information gained from this study will help guide regulation decisions made for other brook trout streams in Michigan.

B. Objectives: To determine if restricting anglers to use of only artificial lures or flies on a reach of the Black River results in an increase in survival and abundance of larger and older brook trout as compared to a reach of the same river where bait angling is permitted.

C. Justification: When major changes in trout regulations were adopted in 2000, the MDNR made a commitment to their stakeholders that effects of the regulation changes on target fish populations would be evaluated. Some stakeholders had the expectation that the mileage of streams subject to gear restrictions would be greatly expanded if the legislated ceiling of 100 miles of gear-restricted waters was raised or removed. Still others hoped that regulations on certain streams would be liberalized if results of the evaluation indicated that restrictive regulations had not enhanced angling success or trout populations. Unfortunately, pre-regulation-change data on trout population densities, survival rates, or angling mortality were available for only a few stream reaches where more restrictive regulations were applied in 2000. Trout population data that were available had been collected for other purposes such as evaluations of habitat improvement work so a rigorous evaluation of the effects of regulation changes was confounded with effects of other variables. To date, budget and personnel shortages in MDNR Fisheries Division have allowed for only superficial and often inconclusive evaluations of the effectiveness of the regulation changes. If conducted, this study can be built upon in the future. For example, anecdotal information suggests that brook trout in the Black River move long distances upstream and downstream over the course of the year. If this is true, it has implications for the length of stream that should be managed under a more protective regulation type in order to be effective. Private funding to purchase PIT tags is being sought. If we obtain such funding a tagging and clipping effort could yield much insight into the normal range of trout movement in this stream. Such information would also aid in interpretation of data collected during the course of this study while also providing valuable individual-based growth data.

This study is intended to help us determine if restricting anglers to the use of artificial lures and flies as mandated by Type 6 regulations will result in higher total survival rates and higher abundance of larger brook trout in the Black River as compared to abundance in reaches managed under Type 2 regulations that allow bait angling. Brook trout survival rates and population structure will also be monitored in a reference reach that is still managed under the same minimum size limit and gear restrictions (8 inches and bait angling permitted) that applied to the entire river prior to 2000.

D. Expected Results and Benefits: Results of this study will assist managers in making decisions on which regulations to apply to certain Michigan trout streams by estimating the effects of restricting gear to artificial lures and flies on brook trout population abundance and size structure in the Black River. Recreational benefits and public value generated by trout streams can be enhanced through more restrictive regulations yet biological and other constraints do not assure such enhancement. This study is an attempt to reduce the uncertainty about the effects of gear restrictions on trout population structure in a stream where brook trout grow relatively rapidly and are exposed to substantial angling effort.

E. Background: Michigan has a long history of regulating trout harvest via a variety of regulations. The first minimum size limit was established in 1881, the first spawning season closure in 1889, and the first flies-only rule in 1907 (Clark et al. 1981). Little is known about the effectiveness of these early regulations, but with the advent of stream electrofishing in Michigan around the 1940s a better tool for estimating trout abundance was born. A resurgence of interest in special restrictive regulations started about 1945 and continues today. Intensive long-term studies of the effects of angling regulations have been conducted on branches of the Au Sable River, the Pigeon River, Hunt Creek, the Rifle River, and Gamble Creek (e.g. McFadden et al. 1967; Shetter 1969; Latta 1973; Alexander et al. 1979, Clark and Alexander 1985; Clark and Alexander 1992). Because many of these studies were conducted within the boundaries of dedicated trout research areas anglers were required to report all their harvest so the effects of angling could be closely evaluated. Effects of hooking mortality were also investigated and reported in the classic studies by Shetter and Alison (1955, 1958). These and other studies conducted in Michigan and elsewhere provided the basis for development of population dynamics models capable of accurately predicting stream trout responses to different regulation types when appropriate input

data were available (Clark et al. 1980). Data on recruitment, trout growth rates, natural mortality rates, and angling mortality (including hooking mortality) are the essential input variables needed to predict the likely effects of a given regulation. Unfortunately, data on one or more of these variables is lacking for most Michigan streams.

Data on growth rates are most readily available to fisheries managers formulating regulation type recommendations. Trout growth rates have been determined for many Michigan streams and may be inferred for many others based on water temperature data. In general, trout in streams selected for more restrictive angling regulations in 2000 grew near or above state-average rates. However, few data on mortality rates were available for the streams selected for more restrictive regulations. Therefore managers relied on their personal observations and angler reports to infer levels of angling effort and harvest. Reaches of the Black River where this study will be conducted are easily accessible to anglers. Observations by MDNR fisheries managers suggest that angling effort is high and it is very likely that large numbers of sub-legal-sized brook trout are caught and released by bait anglers. Brook trout are 5 to 20 times more vulnerable to capture than brown trout (Alexander and Nuhfer 1993) so hooking mortality associated with even modest levels of bait angling could negate the potential benefits of the higher size limit applied in 2000. Mean density of brook trout ≥10.0 in (the present minimum size limit) at the population index station at Main River Bridge in 2005-06 was only half as high as mean density for the years 1986, 1991, and 1996 when an 8.0 inch minimum size limit was in effect. This temporal decline in abundance could be due to factors such as lower recruitment but data currently available are insufficient to test this hypothesis. This proposed study will use a Before-After-Control-Impact (BACI) design in an attempt to account for temporal variation in brook trout density unrelated to the treatment (regulation change).

F. Procedure: The effects of applying Type 6 regulations on a reach of the Black River will be evaluated based on density and size structure of brook trout populations estimated during August each year of the study. Age structure of the population and cohort total mortality rates will also be determined. In 2008, the regulations applied to a reach of the Black River upstream from "the stairs [T32N, R1E, S31 SESE]" near Town Corner Lake to Tin Shanty Bridge Road will be changed from Type 2 to Type 6. Regulations downstream of the Town Corner Lake area stairs to Tower Dam will remain designated as Type 2 and waters upstream from Tin Shanty Bridge will remain designated as Type 1 waters (Figure 1). Brook trout populations will be estimated at a minimum of one index station in reaches of water subject to Type 2 and Type 6 regulations. Survey sites where populations have been previously estimated will be used so that data previously collected can be incorporated into analyses to the greatest extent possible. An index station on a reach of the East Branch Black subject to Type 1 regulations will be sampled to provide reference data at a site where no regulation changes have occurred for many years. I selected a site on the East Branch Black River rather than the mainstem as a temporal reference for Type 1 brook trout waters for two reasons. First, the Type 1 sampling site on the East Branch (old railroad bridge site) is distant from the mainstem sampling sites so immigration of fish from waters subject to more restrictive regulations is less likely to occur. Secondly, young-of-year (YOY) brook trout abundance at the best accessible sampling site within the Type 1 regulations reach (McKinnon's Bend) on the mainstem has historically been low. Hence, it would not provide a good index of annual reproductive success for this Type 1 stream reach. Moreover, population data collected at the McKinnon's Bend site on the mainstem in the past suggest that substantial numbers of yearling-and-older trout immigrate to this reach because they are far more numerous than YOY. Young-of-year abundance at the East Branch Black River site in past years has been relatively high so the precision of year class abundance estimates and annual survival rates are expected to be higher than at the McKinnon's Bend site. A matrix of population data collection years and survey sites that will be used for this proposed study is shown in Table 1. Data collected at other trout population index stations under Federal Study 230737 may also be used to provide additional reference sites during data analyses.

Job 1. Conduct annual population estimates at index stations and collect biological data such as total fish lengths, weights, and scale samples. A three-anode, 240 volt DC tow barge electrofishing unit will be used to capture trout. Population estimates will be made using two-pass mark and recapture methods. Scale samples or dorsal fin rays will be collected from a subsample of fish and read to determine their age. These data will be used to apportion population estimates by length groups into estimates by age group. Electronic recording thermometers will be deployed at all index stations to record water temperatures at hourly intervals throughout the entire study.

Job 2. Analyze data. A Before-After-Control-Impact (BACI) analysis will be used to evaluate effects of different regulation types on brook trout population structure and dynamics (Table 1).

Job 3. Write annual performance report.

Job 4. Write manuscript for publication. A fisheries research report or journal publication will be prepared describing the findings of the evaluation.

Job 5. Publish manuscript. This job entails final editing and printing of the research manuscript produced under job 4.

Job 6. Write final report. A final report citing the publication produced under job 5 will be prepared.

G. Schedule/Budget[1]:

Proposed work	2007-08	2008-09	2009-10	2010-11	2011-12
Job 1 Conduct surveys and process samples	16,478	17,302	18,167	NA	NA
Job 2 Analyze data	2,196	2,306	2,421	2,542	NA
Job 3 Write annual performance report	1,644	1,726	1,812	1,903	NA
Job 4 Write manuscript	NA	NA	NA	15,768	NA
Job 5 Publish manuscript	NA	NA	NA	NA	6,953
Job 6 Write final report	NA	NA	NA	NA	580
Totals	20,318	21,334	22,400	20,213	7,533

[1] NA = not scheduled

H. Geographical locations: Hunt Creek Fisheries Research Station, Lewiston, Michigan. Black River watershed in Montmorency, Otsego, and Cheboygan counties, Michigan.

I. Personnel: Andrew J. Nuhfer and Todd Wills, Research Biologists; Tom Adams, Fisheries technician; Short term workers; Management Unit personnel; Research Administrative personnel, and editor.

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Table 1.–Matrix of sampling years that will be used in the analyses. In 2008, regulations in the treatment zone will be changed from the current type 2 regulations to type 6 regulations. The primary reference zone for type 2 regulations is at Sid's landing and the secondary reference is at Main River Bridge on Blue Lake Road (SFR study 230737 population index site).

	Before regulation-change						After regulation-change		
Study reach	1991	1996	1998	2005	2006	2007	2008	2009	2010
Mainstem Black River treatment zone (Springs)	X	X			X	X	X	X	X
Mainstem Black River primary reference zone (Sid's)	X	X			X	X	X	X	X
Mainstem Black River secondary reference zone (Blue Lakes Road Bridge)	X	X		X	X	X			
East Branch Black River Old RR Bridge (Type 1)	X		X			X	X	X	X

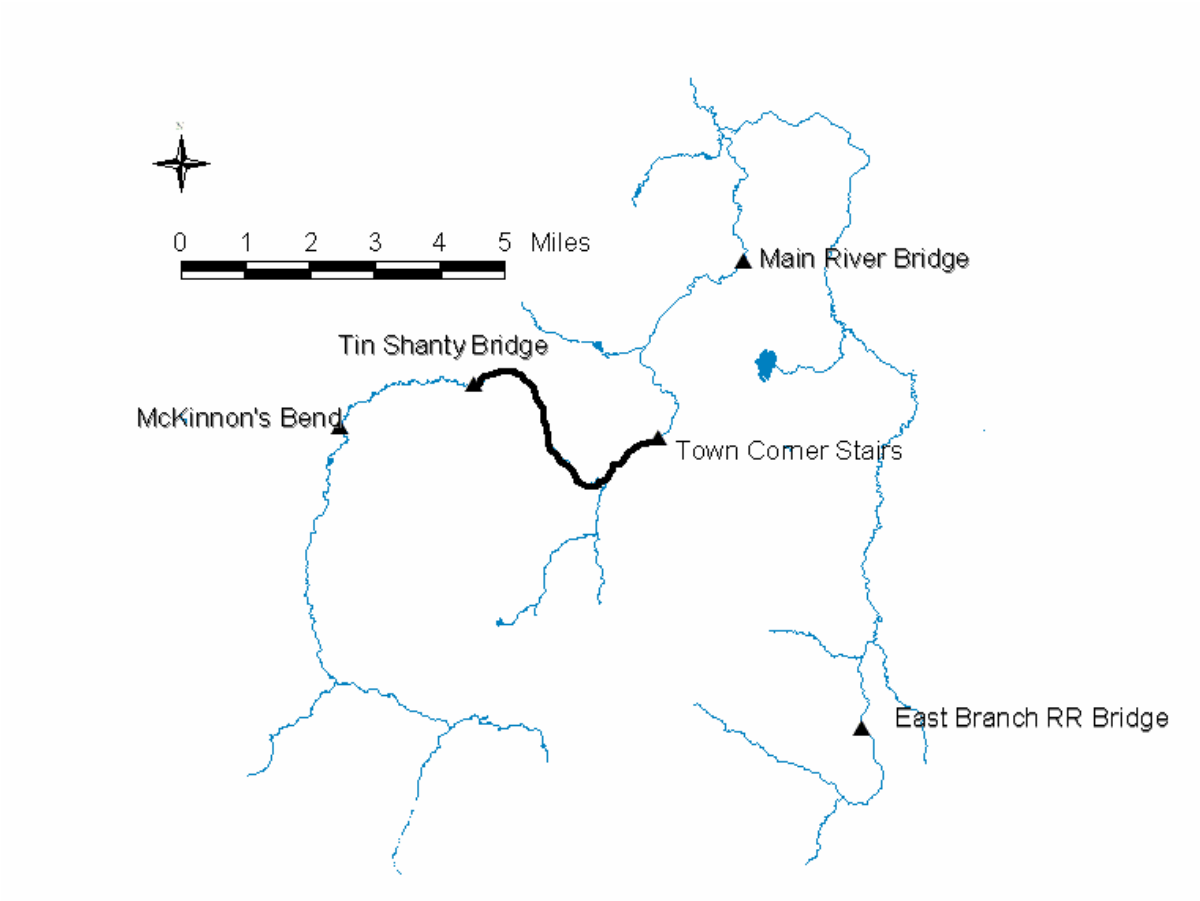

Figure 1.−Black River study area. Type 1 regulations will remain in effect on the mainstem upstream of Tin Shanty Bridge Road and on all of the East Branch Black River. In 2008, regulations will change from Type 2 to Type 6 between Tin Shanty Bridge and Town Corner Stairs (heavy black line). Type 2 regulations will remain in effect on the mainstem downstream of Town Corner Stairs to Tower Dam.