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Long Term Population Dynamics of Brook Trout in Hunt Creek, Michigan, With and Without Fishing

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Abstract.—We monitored the brook trout *Salvelinus fontinalis* population in a 2-mile section of Hunt Creek, Michigan, for 44 continuous years. In the first 17 years (1949-65), the population was subjected to fishing. In the last 27 years (1966-92) all fishing was prohibited. We conducted a complete creel census from 1949 through 1965 and trout abundance estimates every fall from 1949-92 and every spring from 1959-93. Our primary objective in this study was to compare brook trout population characteristics between periods of fishing and no fishing. Angler harvest of brook trout dramatically decreased the abundance and survival of legal-sized fish in Hunt Creek. Because fish were heavily cropped when they grew to a legal length survival of all age classes older than age 1 was significantly lower when the population was subject to fishing and harvest. Conversely, annual survival of trout from age 0 to age 1 was significantly higher during the harvest period. A complete creel census of trout catch during the fishing period showed that lower fall stock sizes and survival rates (spring to fall) observed were attributable to angler harvest. Fall brook trout populations of legal-sized fish were 127% higher when not cropped. However, about half of the increase in fall standing crop that was stockpiled by September during fishing closure was lost to natural mortality before the following April. Thus, the mean stock of legal-sized fish was only 65% higher by spring. Trout growth during 27 years when the stream was closed to fishing was not significantly slower than during 17 years with fishing in spite of an increase in total fall standing crop of about 25%. Only young-of-the-year trout in one stream section were found to be significantly smaller during the fishing closure. Populations of sublegal fish were not significantly affected by fishing and hence they reflected the range in natural variation that might be expected in a trout stream with a stable flow regime. During the 44-year study period the largest fall population of sublegal fish in the entire study area was 1.9 times the smallest population, while the highest spring population was 2.2 times higher than the lowest. The fall brook trout population in the least perturbed upper 1-mile of the study reach exhibited a significant increasing trend in abundance over the 44-year period. This suggested that environmental conditions may have improved for brook trout in Hunt Creek, and possibly other northern Michigan trout streams, over the past half century when development activities have been minimal. Conversely, fall populations of sublegal trout declined significantly over time in the lower 1-mile of the study reach where habitat quality was degraded by an experimental addition of sediment during 1971-76. This suggests that the adverse effects of bedload sediment have persisted in this stable-flow stream for approximately 20 years.

Our findings suggest that fishing regulations that reduce angling mortality of intensively-fished brook trout in small streams should significantly enhance populations of larger trout and improve the total catch of trout by anglers.

A portion of Hunt Creek in Montmorency County, Michigan, located within the boundaries of the Hunt Creek Fisheries Research Area, was closed to fishing in 1966 to protect the stream and its trout for research. This allowed research to be conducted without the confounding factor of fishing. This provided the opportunity to compare the biological characteristics and responses of a brook trout *Salvelinus fontinalis* population when harvested (1949-65) and not harvested (1966-93). Our 44-year data set also provided a rare opportunity to document brook trout population characteristics and natural variation over time in a stream with minimal anthropogenic disturbances. Because brook trout are easier to capture by anglers than other trout species such as brown trout *Salmo trutta* (Schuck 1941; Cooper 1951, 1952; Alexander and Peterson 1983) we expected that fishing closure would result in higher survival and standing crops of brook trout (Hunt 1970). We also hypothesized changes in trout density due to fishing closure would have little effect on trout growth rates. Although inverse density dependent growth has been observed for *Salvelinus* sp. in lakes (Langeland 1986; Donald and Alger 1989) previous studies of the brook trout in Hunt Creek have shown little effect of trout density on growth (McFadden et al. 1967; Alexander and Hansen 1983, 1988). A similar lack of density dependent growth in stream environments has been reported for brown trout and rainbow trout *Oncorhynchus mykiss* (Alexander and Hansen 1983; Elliott 1985a, 1988, 1989a).

The primary objective of this study was to describe and compare the dynamics of a brook trout population when harvested and when not harvested by anglers. A secondary objective was to describe variation and trends of the trout population over time.

Study Area

The 2-mile study section of Hunt Creek is a small trout stream with an average annual discharge of about 27 cfs at the downstream end and 7 cfs at the upstream end. It is located east of the village of Lewiston in the north-central Lower Peninsula of Michigan (T 29N, R 2E, Sections 25, 35, and 36) (Figure 1). Stream discharge increases very rapidly between the upstream and downstream boundaries due to flows from five tributary streams and significant groundwater inputs within the experimental reach. Stream discharge in Hunt Creek is extremely stable because precipitation falls on deep sand and gravel-glacial drift that yields little surface runoff but high groundwater recharge. The stable supply of cold ground water (47-49^{o}F) and moderate stream gradients of 5-25 ft/mile (Shetter 1968) are typical of headwater brook trout streams throughout much of northern Michigan. Moving sediment concentrations in Hunt Creek are less than the average found in most northern Michigan streams because there are few human developments and no agricultural activity upstream from the study reach. The experimental stream section of Hunt Creek was composed of two contiguous 1-mile sections (Figure 1). The upper section (BC) has a surface water area of 1.7 acres. The lower section (ZA) has a surface water area of 2.56 acres. The total study reach is referred to as BCZA in this report.

The fish community within the experimental reach is predominantly brook trout with moderate populations of mottled sculpins *Cottus bairdi* and slimy sculpins *Cottus cognatus*. A few white suckers *Catostomus commersoni*, creek chubs *Semotilus atromaculatus*, fathead minnows *Pimephales promelas*, northern redbelly dace *Phoxinus eos*, bluntnose minnows *Pimephalesnotatus*, hornyhead chubs *Nocomis biguttatus*, central mud minnows *Umbra limi*,