

# ENVIRONMENTAL VARIABILITY AND SURVIVAL OF STEELHEAD PARR IN A THERMALLY DIVERSE WATERSHED

## Abstract

In watersheds with diverse instream habitats, such as the Betsie River in northern Michigan, production of early life history stages of fishes can be concentrated into a few critical habitat units. The Betsie River watershed is atypical of the neighboring watersheds due to its thermal properties. The main channel supports a popular migratory salmon and steelhead fishery, but is marginal habitat for resident trout because summer temperatures are high. Tributaries in the watershed are spring-fed and provide colder habitats in summer. The objectives of our study were to quantify the density and mortality of steelhead *Oncorhynchus mykiss* parr throughout the watershed and to evaluate the influence of different thermal macrohabitats on steelhead parr production. From 1993-1996, parr abundance was estimated at 14 sites by use of depletion sampling and smolt out-migration was estimated by visual methods. Density of steelhead parr ranged from 0/ha to 3000/ha at sampling sites. We found 62% of age-0 parr and 50% of the age-1 parr in the main channel. The remaining parr were found in the tributaries which comprise only 11% of the total stream area in the watershed. Smolts out-migrated at annual densities ranging from 11.9/ha to 22.0/ha. Annual instantaneous mortality rates ( $Z$ ) ranged from 0.710 to 3.578 and were the greatest for age-1 and age-2 parr. Mortality was greater during severe winters and at sites in the main channel. Because many parr were found in the few tributaries sampled, and because survival was higher in these streams, the small tributaries are valuable to the overall production of steelhead from this watershed.