Growth Dynamics of Brown Trout in Southeastern Minnesota

Nicole Petrovskis, Department of Fisheries and Wildlife

Introduction

Scales have been widely used to age fish due to their information in the growth and longevity of individuals (Schneider et al., 2000). Scale samples are advantageous because they can be collected without the sacrifice of the individual (Schneider et al., 2000). The number of scales covering the body remains constant throughout the life of brown trout (Schneider et al., 2000). Because of this, scale growth is proportional to fish growth.

As the scale grows, seasonal ridges, or annuli, grow on the edge of the scale (Schneider et al., 2000). Annuli are spaced farther apart in spring because of greater food availability and warming temperatures, which results in greater growth (Schneider et al. 2000). More closely spaced annuli form in winter as a consequence of reduced food availability, which results in slower growth (Schneider et al. 2000). Closely spaced ridges form annuli, true year markers (Schneider et al. 2000). Much like tree rings, annuli can be counted to determine the age of a trout.

Purpose

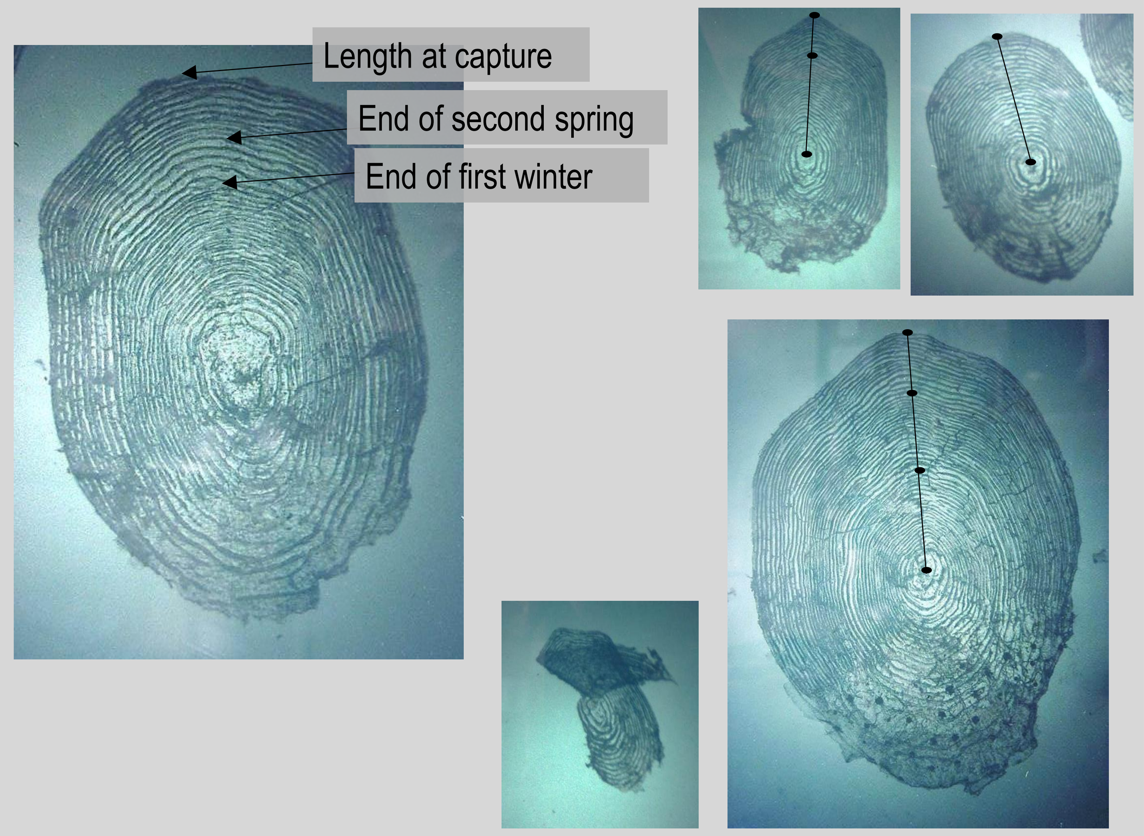
The plasticity of fish to adapt and survive is phenomenal. Seasonal habitats showcase this flexibility of growth and other physiological functions (Neehham et al. 1945). Brown trout are not native to the United States but has become one of the most widely distributed freshwater fish species in the United States (Zimmerman and Vondracek, 2007). Growth of brown trout is an important factor for trout management such that larger adults will produce more offspring and increase the organism's lifetime reproductive fitness (Dieterman et al., 2012). Larger bodied trout is also important economical and aesthetical factors, since anglers prefer healthy streams with larger catch. Faster growth has been documented in spring and summer seasons, where as overwinter growth is less studied. Winter foraging habits is essential knowledge for management. Cold-adapted invertebrates have the potential to increase the abundance of trout in the winter relative to streams that do not support these resilient invertebrates. Leonard C. Ferrington Jr. found some insect fauna that are capable of growing at low water temperatures. He also found that more than 50 species of aquatic insects grow and emerge as adults during winter, of those at least 25 occur in south-eastern Minnesota streams. The differential growth rates among streams will be used in a larger collaboration project for the Environment and Natural Resources Trust Fund: Predicting and Mitigating Vulnerability of Trout Streams. One portion of the project aims to see how aquatic insects control patterns of productivity and yield of trout in streams of south-eastern Minnesota in the winter. The project focuses on ultra-cold stenotherm (UCS) winter-developing species and their thermal preferences and life histories. This will help researchers better understand how in-stream habitat can be structured to increase abundances and growth of UCS species that are shown to be important in trout diets

Scale Collection and Analysis

Scale samples were collected from south-eastern Minnesota streams to quantify seasonal age and growth of brown trout. Trout samples were be collected from segments of Minnesota streams within catchments that are considered by Department of Natural Resources as supporting sustainable trout sport fishing activities. Trout were collected using routine electro-shocking methods.

Age determination of the brown trout required the use of a binocular microscope to enlarge images of the scale samples. To determine the age of fish, contrasting bands of the annuli were counted caused by cyclic environmental changes. Annuli was measured to determine the age of the fish at the time of capture. Scale growth is a factor of fish length, thus the relationship was used to obtain information past growth of the trout aging software, FishBC, and a linear growth model

Fish Scales



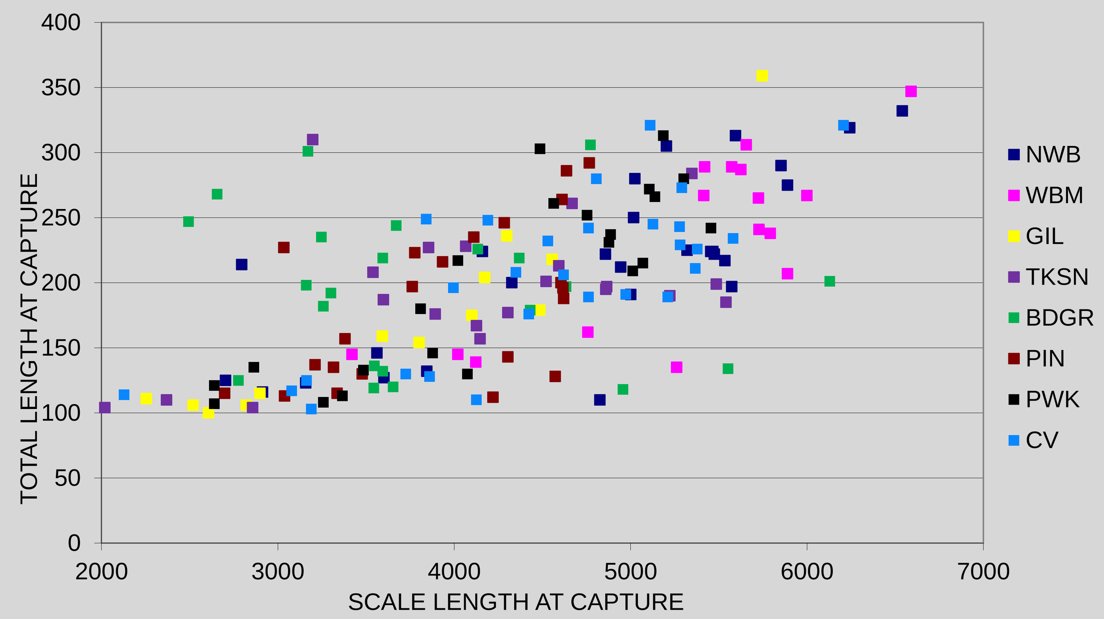
Back Calculations

- FishBC measures relative scale size from digitized images
- Lengths of scale at annual markers was used, along with the total length of the fish at capture to back calculate length at previous years
  - Total length includes the entire length of the trout, including the tail

- Back Calculations were conducted using the Fraser-Lee model which incorporates the fact that trout are not born with scales, they develop at a certain length
- Trout length at scale development (c) is 35mm

Analysis

- 8 streams in southeastern Minnesota were compared to find a growth differential among streams
  - 30 individuals were sampled from each stream
- Winter stream data was analyzed
  - Scales were collected from November-January, 2011
  - Lengths were determined by age at last full year
- FishBC was used to determine the length of the scale at capture and relative lengths of scale lengths from previous years will be used to back calculate previous fish body lengths using the Fraser-Lee Model



Fraser-Lee Model

The Fraser-Lee Model shows a relationship of scale length and body length with a non-zero intercept.

$$L_i = \frac{S_i}{S_c}(L_c - c) + c$$

Where:

L_c = length at capture

L_i = back-calculated length at annulus i

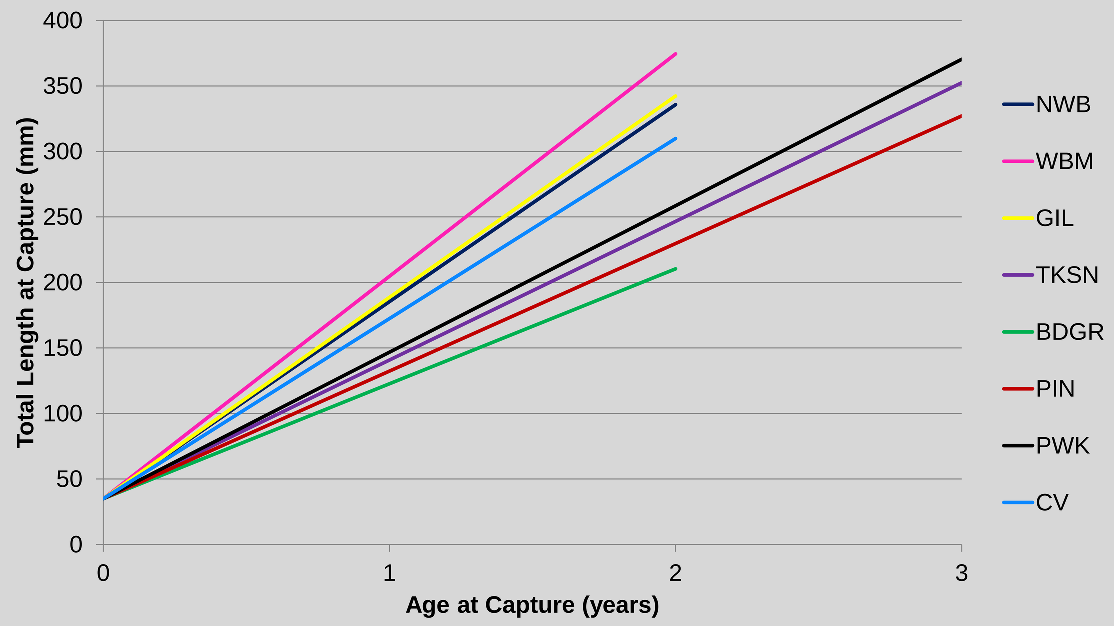
S_c = total scale radius

S_i = scale radius to annulus i

c = length of trout when scales develop

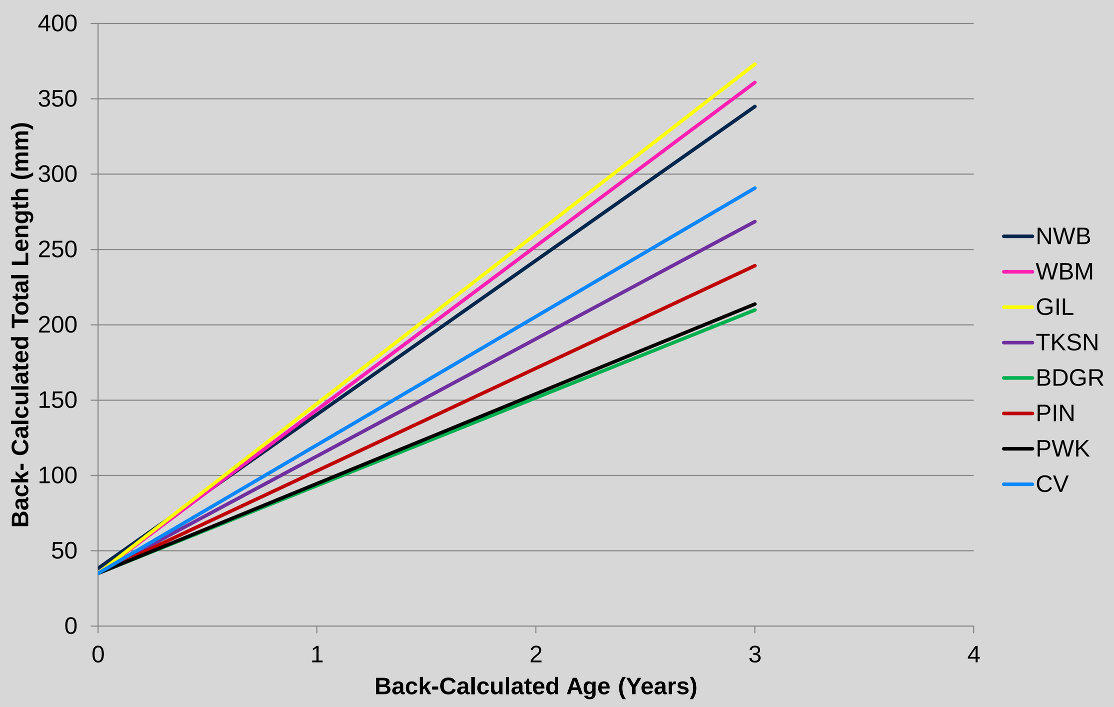
The addition of c is necessary since trout are not born with scales on the body.

Length and Age at Capture



Results

- Different growth rates were found among streams in Southeastern Minnesota, however, significant differences among streams were not found.
- Differences in increments between years among lakes were found but were not solid evidence of growth differences.
  - Larger sample size would be needed to quantify how much growth rates among streams differed.
- Some streams were highly varied with respect to the amount of variance when fitted on the Fraser-Lee model.
- Environmental and demographic stochasticity could be a factor in growth differentials.



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