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FISHERIES DIVISION

TECHNICAL REPORT

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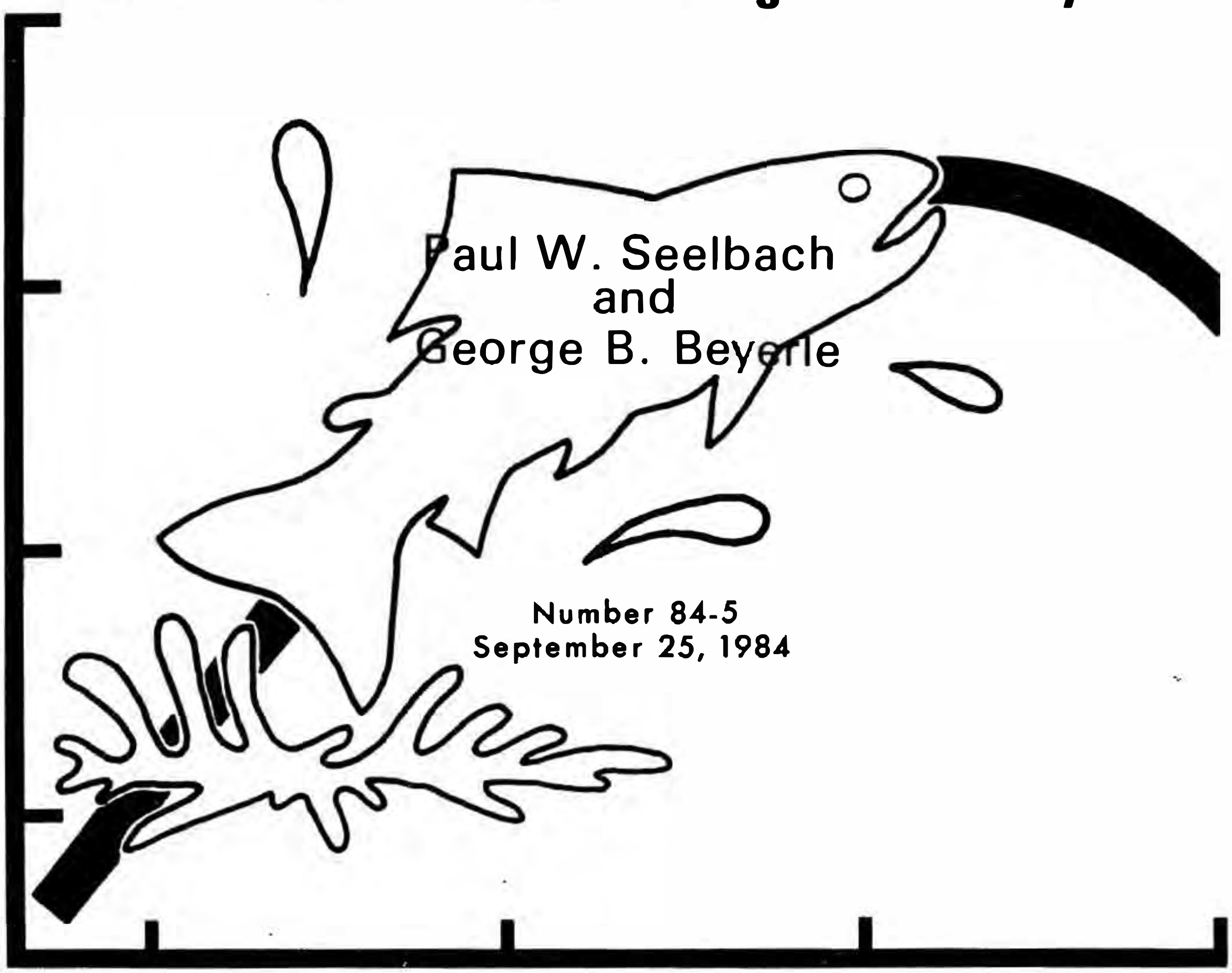

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INTERPRETATION OF THE AGE AND GROWTH OF ANADROMOUS SALMONIDS USING SCALE ANALYSIS

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Introduction

Scale reading is a widely used and valid method for aging salmonids (Havey 1959). Information on age and growth derived by scale reading provides the basis for a large part of the biological understanding of fish populations. Fishery biologists cannot begin to assess the effects of management programs or environmental influences on a population without accurate age determination of individual fish.

Michigan's anadromous salmonids spend part of their lives in nursery streams and/or hatcheries and part in the Great Lakes. The fish in one year class of salmonids may vary considerably in both age at smolting (migration to a lake) and age at sexual maturity (migration back to a stream). The size of adult anadromous salmonids is determined primarily by time spent in the Great Lakes, not by age (Maher and Larkin 1954; Michigan Department of Natural Resources, unpublished data). Thus, when aging anadromous salmonids, it is important to separate stream years from lake years in order to account for all the variations in growth patterns which may occur. Proper aging allows us to place fish into biologically meaningful groups and avoid misinterpretation of data. For example, age-4 steelhead (*Salmo gairdneri*) may have spent 1, 2, 3 years in a lake. To lump all these steelhead together as 4 years old, and determine an average length and weight, does not really explain what happened biologically. However, if we separate the steelhead into their various stream-age and lake-age groups, then we can look at what is happening to each group at specific points in time.

Scale Analysis

Nomenclature

Stream annuli are designated by arabic numerals, followed by a period or slash (virgule), followed by lake annuli in arabic numerals. The two sets of annuli added together represent total age (Godfrey et al. 1968; Hartman 1959; Narver 1969; Shapovalov and Taft 1954; Withler 1968). A steelhead which has spent 2 years in a stream and 2 years in a lake would be age 2.2 or 2/2 and would be total age 4.

Criteria for determining stream age and lake age

Anadromous trout and salmon scales usually show a pronounced and easily detectable difference between lake growth and stream growth (LaLanne and Safsten 1969, Maher and Larkin 1954). One year of stream growth typically consists of a period of fast growth (relatively widely spaced circuli), followed by a period of slower growth (closely spaced circuli). The annulus is detectable as a distinct "cutting over" of incomplete, closely spaced circuli, by a complete cirulus which marks the commencement of fast growth in spring (Fig. 1).

Lake growth is characterized by circuli being much more widely spaced than during fast stream growth (Fig. 1) and by the formation of an annual ring (Fig. 2). An annual ring is a crowding together of a circuli in a noticeable dark band. The annulus may form at the inner edge, anywhere within, or at the outer edge of the annual ring. Variability occurs in the width of the annual ring and in the clarity of the annulus, but aging is easier if the scale reader has these two features in mind.

Supplemental growth "checks" are similar to annuli and annual rings. No definite criteria can be given for the detection of supplemental checks. They are usually recognized by their unusual position in the pattern of scale growth and often cannot be traced around the entire sculptured portion. Annuli and annual rings occur at regularly spaced intervals on the scale; they usually can be traced around the entire sculptured portion. In smolts of steelhead, brown trout (Salmo trutta), Atlantic salmon (Salmo salar), and coho salmon (Oncorhynchus kisutch) the change from stream to lake growth often occurs in late spring, long after the annulus has formed. The resulting supplemental "smolt check" can be confused with a stream annulus (Fig. 3).

Hatchery growth may add confusion to the determination of stream age. An annulus formed while a fish is living under hatchery conditions is often hard to distinguish. On a hatchery fish "winter" and "spring" growth are not as distinguishable as on a wild fish and this can make the annulus hard to locate (Havey 1959). The scale reader must look carefully for the "cutting over" described previously (Fig. 4).

Diagrams of typical scales of anadromous salmonids are shown in Figure 5.

Age of fish collected at various times of the year

The arabic numerals used in age classification represent annuli, not growth seasons. This presents little problem when aging spring steelhead, where most fish have recently laid down an annulus or annual ring. All fish are considered to have a birthday on January 1. Therefore, fish collected between January 1 and the time of annulus formation in spring are aged as 1 year older than the number of visible annuli (or annular rings). The presence of the unseen (or virtual) annulus is recorded by adding an asterisk (*) to the age (Chapman 1958; Hartman 1959; Merna et al. 1981). A steelhead showing two stream annuli, two Lake Michigan annuli, and which was collected in January, before forming an annulus, would be age 2.3*. In fall collections of trout and salmon, only the annuli are counted and recorded (Fig. 5c).

Table 1 shows the possible ages for anadromous salmonids collected in Michigan.

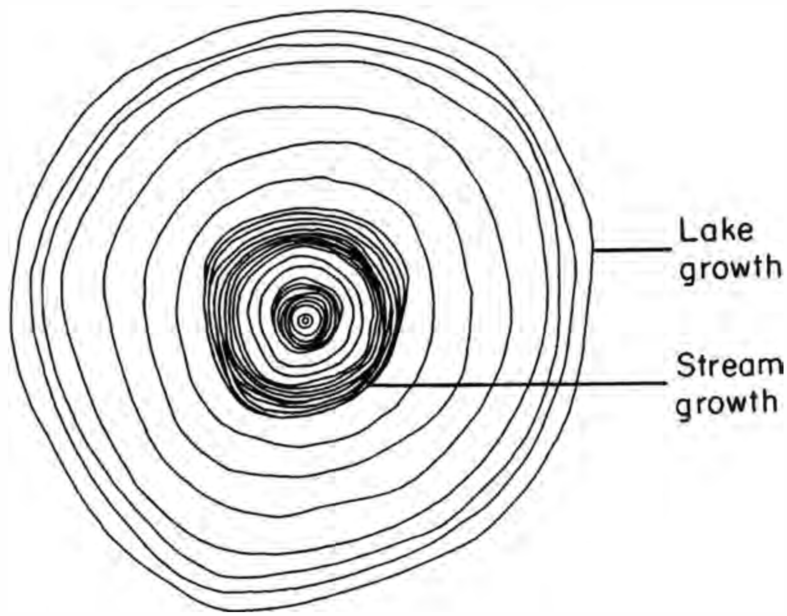

Figure 1. Stream and lake growth on an anadromous salmonid scale.

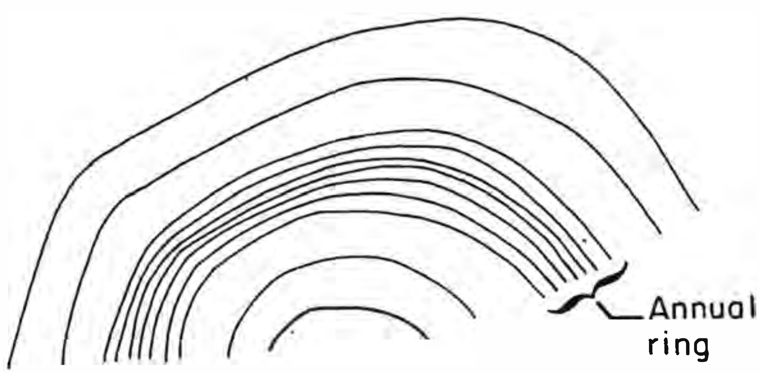

Figure 2. Annual ring during lake growth on an anadromous salmonid scale.

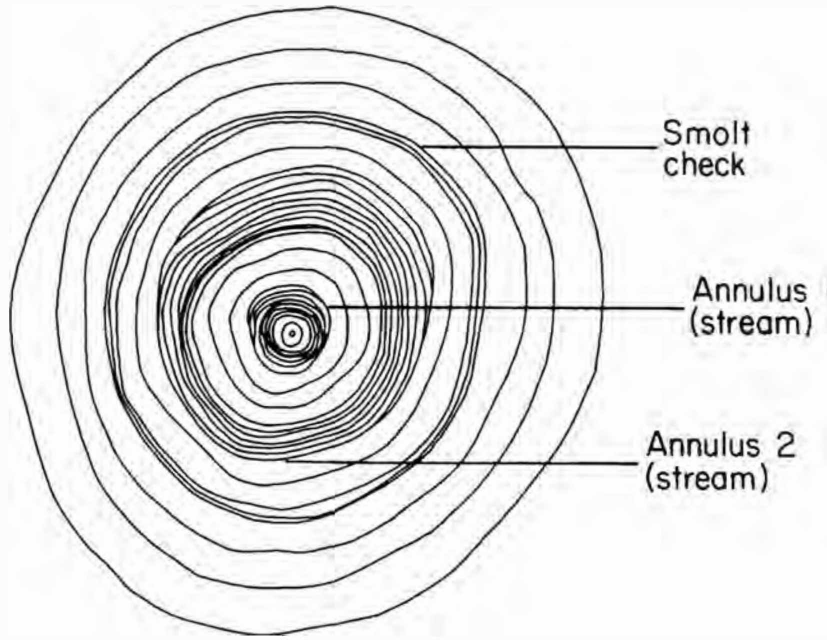

Figure 3. Scale of anadromous salmonid showing smolt check.

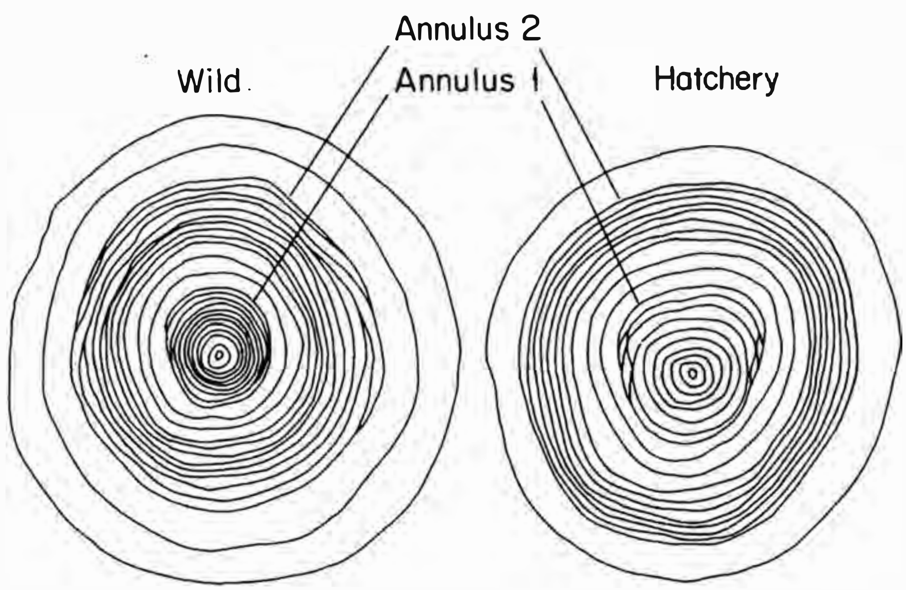

Figure 4. Comparison of annulus 1 in wild and hatchery-raised anadromous salmonids.

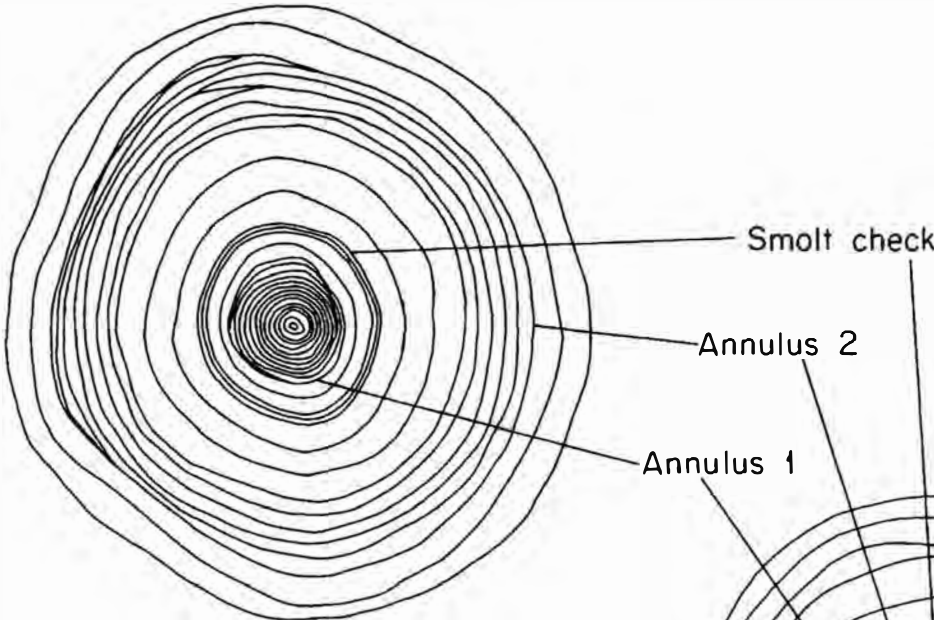

Figure 5a. Age 1.1 steelhead with smolt check.

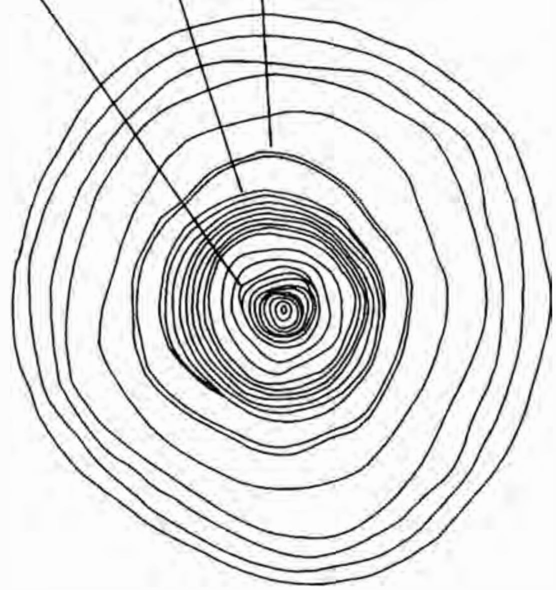

Figure 5b. Age 2.0 steelhead with smolt check.

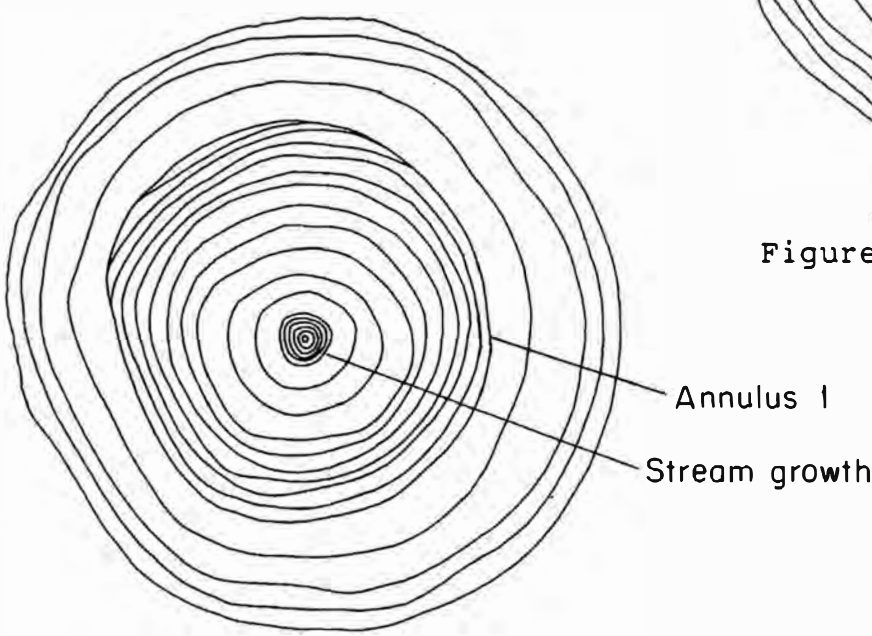

Figure 5c. Age 0.1 chinook salmon.

Figure 5. Diagrams of some typical scales of anadromous salmonids.

Table 1. Ages of anadromous salmonids in Michigan. (* = possible ages, ** = most common ages, *** = age of normal jack salmon.)

	Species			
	Steelhead, brown trout, and Atlantic salmon		Pacific salmon	
Age	Spring	Fall	Chinook Fall	Coho Fall
0.1			***	*
0.2			**	*
0.3			**	*
1.0		*		***
1.1	*	*	*	**
1.2	*	*	*	*
1.3	*	*	*	
1.4	*	*		
1.5	*			
2.0		*		
2.1	*	**		
2.2	**	**		
2.3	**	*		
2.4	*	*		
2.5	*			
3.0		*		
3.1	*	*		
3.2	*	*		
3.3	*	*		
3.4	*	*		
3.5	*			

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