A COMPARISON OF SCALE, FINRAY AND OTOLITH DERIVED AGES

IN DOLLY VARDEN CHAR AND CUTTHROAT TROUT

by

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ABSTRACT

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Twenty-four Dolly Varden char from the lower Skeena River and 28 cutthroat trout from Mosquito Lake on the Queen Charlotte Islands were aged independently using finrays, otoliths and scales. For Dolly Varden char where only finrays and otoliths were used, age uniformity was obtained for only six fish. Age differences of one and two years occurred in eight cases each (16 fish) while the remaining two fish were aged with a difference of three and four years. Average Dolly Varden age based on finrays and otoliths was 5.9 and 6.7 years respectively and age class dominance was six years regardless of the method used. For cutthroat trout where all three structures were used for aging, age uniformity was not obtained for a single fish and in only 11 cases was there a pair of identical ages. Maximum individual age differences of 1, 2, 3, 4 and 5 years accounted for 18.5, 33.3, 26.6, 14.8 and 3.7% respectively. Average ages determined from finrays, otoliths and scales were 6.3, 5.6 and 3.9 years, while the dominant cutthroat trout ages from these structures were 5, 4 and 3 years respectively. Implications of these discrepancies to the management of Dolly Varden and cutthroat trout sport fisheries are discussed.

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INTRODUCTION

Angler success trends in addition to changes in growth rates and age structure of trout populations are parameters frequently used to manage sport fisheries. In trout (oncorhynchus sp.), age information is most often obtained from scale analysis while in char (salvelinus sp.) this procedure is more difficult due to small size of scales. Alternate structures for aging char include otoliths and finrays. Finrays can furthermore be collected without sacrificing fish. The present study compares ages derived by interpreting scales, finrays and otoliths independently of an anadromous Dolly Varden char (salvelinus malma) population from the lower Skeena River and of a resident cutthroat trout (oncorhynchus clarki) population from Mosquito Lake, Queen Charlotte Islands.

METHODS

Fish were angled with conventional gear, frozen whole and stored. After thawing, fork lengths were measured, scales, finrays and otoliths removed and placed in separate paper envelopes. All structures were later analyzed independently. For Dolly Varden, only finrays and otoliths were analyzed. Readers had considerable experience aging fish and were deemed competent.

Structure removal and age determination procedures were carried out according to Chilton & Beamish (1982). The two-tailed paired-sample t test (Zar, 1974) was used to compare aging method groups.

RESULTS

DOLLY VARDEN CHAR

A sample of 24 Dolly Varden char ranging from 26.5 to 49.0 cm. fork length was obtained January 24, 1988 from the lower Skeena River. All finrays and otoliths were readable. Age uniformity from the two structures was obtained for only six (25%) fish. Age differences of 1 and 2 years occurred in eight cases each (total of 16 fish or 66%), while a difference of 3 and 4 years was obtained in the remaining two (9%) fish. Mean age of all fish sampled based on finrays was 5.9 years while for otoliths it was 6.7 (Table 1). The two methods were significantly different, p= .015. Using otoliths on average aged fish .8 years older than did the finray method.

Age class dominance was six years regardless of method. Ages determined from finrays ranged from three to nine years, while for otoliths ages ranged from five to ten years (Table 2). Finray

analysis resulted in 45.8% of Dolly Varden being less than six years old, while with otoliths only 16.7% were younger than the dominant age. The distribution of ages was therefore markedly different for the two aging techniques used.

Fork lengths of fish aged six years or older were similar in both aging method groups. At age five however, the finray group was considerably longer than the otolith group of similar age.

Annual growth of Skeena River Dolly Varden char was slow for the ages examined. Growth for finray aged fish was 2.65 cm./year, while for otoliths it was 3.34 cm./year (Table 3).

Table 1. Finray and otolith determined ages of Dolly Varden char angled during late January from the lower Skeena River.

Fish Number	Fork Length cm.	Age, Years Finray	Otolith	Age Difference Years
1	32.5	5	7	2
2	27.5	4	5	1
3	35.0	5	6	1
4	38.5	7	8	1
5	32.5	5	5	0
6	34.0	6	6	0
7	33.5	5	6	1
8	27.5	4	5	1
9	35.0	6	6	0
10	37.0	5	7	2
11	44.5	6	10	4
12	44.0	9	9	0
13	26.5	3	5	2
14	26.8	3	5	2
15	35.0	4	6	2
16	34.0	6	6	0
17	38.0	9	6	3
18	40.0	5	6	1
19	40.0	8	6	2
20	39.0	6	8	2
21	39.0	6	7	1
22	45.0	6	8	2
23	43.0	9	8	1
24	49.0	9	9	0
	mean	5.9	6.7	1.3

Table 2. Age frequency determined from finrays and otoliths of Dolly Varden char angled during late January from the lower Skeena River.

Age Years	Number of Fish			
	Finrays		Otoliths	
	N	%	N	%
3	2	8.3	0	-
4	3	12.5	0	—
5	6	25.0	4	16.7
6	7	29.2	10	41.7
7	1	4.2	3	12.5
8	1	4.2	4	16.7
9	4	16.7	2	8.3
10	0	—	1	4.2

Table 3. Fork length at various ages determined from finrays and otoliths of Dolly Varden char angled during late January from the lower Skeena River.

Age Years	Mean Fork Length			
	Finrays		Otoliths	
	cm.	S.D.	cm.	S.D.
3	26.6	.2	-	—
4	30.0	4.3	—	—
5	35.1	3.0	28.3	2.8
6	38.6	4.7	36.2	2.5
7	38.5	—	36.3	3.4
8	40.0	—	41.4	3.1
9	43.5	4.5	46.5	3.5
10	—	—	44.5	—
Fork Length* =	2.65 (age) + 20.2		3.34 (age) + 13.8	
corr.	.97		.94	

*Calculated from mean fork lengths in this table.

CUTTHROAT TROUT

A sample of 28 cutthroat trout ranging from 21.5 to 56 cm. fork length was obtained May 28, 1989 from Mosquito Lake, Queen Charlotte Islands. All finrays and otoliths were readable while one scale sample was not.

Age uniformity from the three structures was not obtained for a single fish (Table 4). In only 11 cases (39.3%) was there a pair of similar ages. The remaining 60.7% of the individual fish sampled had different ages for all three structures. Maximum individual age differences of 1, 2, 3, 4, and 5 years accounted for 18.5, 33.3, 26.6, 14.8 and 3.7% respectively of all fish sampled. Mean ages derived from finrays (6.3 years) and otoliths (5.6 years) were almost two years greater than scale determined ages (3.9 years, Table 4). All three methods were significantly different from each other. Results of the two-tailed paired-sample t test were; for fins and otoliths $p = .005$, for fins and scales $p = .000$, for otoliths and scales $p = .000$.

Age class dominance as determined from finrays, otoliths and scales was 5 years (35.7%), 4 years (35.7%) and 3 years (48.2%) respectively (Table 5). Both finray and otolith analysis resulted in considerable 8 and 9 year olds while none were of this age in the scale group. Although the pattern of age class frequency was somewhat similar for all three structure types, finray and otolith ages were 2 and 1 years older respectively than scale determined ages (Table 5).

Fork lengths of fish at any given age were largest for scale determined ages and smallest for finray ages as a direct result of the aging technique employed (Table 6). Scale analysis resulted in younger fish than the two other methods and therefore the size at age would be larger. The mean yearly fork length increase obtained from analyzing finrays, otoliths and scales were 3.96, 5.53 and 6.75 cm respectively (Table 6). Scales would therefore indicate substantially greater annual growth than would a similar analysis using either finrays or otoliths.

Table 4. Finray, otolith and scale determined ages of cutthroat trout angled during late May from Mosquito Lake, Queen Charlotte Islands.

Fish	Fork Length	Age (Years)			Age Difference (Years)	
Number	cm.	Finray	Otolith	Scale	Max.	Min.
1	56	6	8	6	2	0
2	45	5	6	5	1	0
3	53	6	7	6	1	0
4	52	8	9	6	3	2
5	54	8	8	R	—	0
6	54	8	7	7	1	0
7	44	9	6	5	4	1
8	44	8	7	5	3	2
9	51	9	6	6	3	0
10	41	7	7	5	2	0
11	30	5	4	3	2	1
12	30	5	4	3	2	1
13	30	6	5	3	3	1
14	33	9	7	4	5	2
15	34	6	5	3	3	1
16	26	5	4	3	2	1
17	29	5	4	4	1	0
18	29	5	4	3	2	1
19	37	8	7	4	4	1
20	31	6	6	3	3	0
21	28	5	4	3	2	1
22	24	5	4	2	3	1
23	27	5	4	3	2	1
24	34	5	5	3	2	0
25	25	6	4	3	3	1
26	32.5	7	7	3	4	0
27	29.5	7	5	3	4	2
28	21.5	3	4	2	1	1
	mean	6.3	5.6	3.9		

R = resorbed, not readable

Table 5. Age frequency determined from finrays, otoliths and scales of cutthroat trout angled during late May from Mosquito Lake, Queen Charlotte Islands.

Age Years	Number of Fish					
	Finray		Otolith		Scale	
	N	(%)	N	(%)	N	(%)
2	0	-	0	—	2	(7.4)
3	1	(3.6)	0	—	13	(48.2)
4	0	—	10	(35.7)	3	(11.1)
5	10	(35.7)	4	(14.3)	4	(14.8)
6	6	(21.4)	4	(14.3)	4	(14.8)
7	3	(10.7)	7	(25.0)	1	(3.7)
8	5	(17.9)	2	(7.1)	0	—
9	3	(10.7)	1	(3.6)	0	0
	28	(100)	28	(100)	27	(100)

Table 6. Fork length at various ages determined from finrays, otoliths and scales of cutthroat trout angled during late May from Mosquito Lake, Queen Charlotte Islands.

Age Years	Mean Fork Length					
	Finray		Otolith		Scale	
	cm	S.D.	cm	S.D.	cm	S.D.
2	-	-	-	-	22.8	4.8
3	21.5	—	-	-	29.7	5.4
4	-	-	27.0	2.8	33.0	4.0
5	30.2	5.9	31.9	2.5	43.5	1.7
6	38.2	13.0	42.8	8.4	53.0	2.2
7	34.3	6.0	42.1	8.8	54	—
8	48.2	7.5	55.0	1.4	—	—
9	42.7	9.1	52.0	-	—	—
Fork Length* =	3.96 (age) + 10.77		5.53 (age) + 5.85		6.75 (age) + 8.94	
corr.	.91		.95		.98	

* Calculated from values in this table.

DISCUSSION

Accuracy in determining fish age has been plagued with difficulties stemming from both aging structure used (Mills and Beamish, 1980;Sharp and Bernard, 1988) and structure interpretation (Beamish and Fournier, 1981; Mann and Steinmetz, 1985).

In Dolly Varden char aged here, the finray method resulted in an average age of 5.9 years with a range of three to nine years. Their growth based on finrays was estimated at 2.65 cm./year and the dominant age was six. Using otoliths of these same fish resulted in an average age of 6.7 years, with a range of five to ten years while growth was estimated at 3.34 cm./year. Their dominant age based on otoliths was also six years.

For cutthroat trout, analyses using finrays resulted in an average age of 6.3 years with a range of 3 to 9 years and also resulted in the slowest growth of 3.96 cm./year. Otolith determined cutthroat trout ages averaged 5.6 years (range 4 to 9) and growth was estimated at 5.53 cm./year. Youngest average age of 3.9 years was obtained using scales and ranged from 2 to 6 years. Estimated growth of cutthroat trout was also highest for the scale group at 6.75 cm./year. Considerable and significant differences in age and growth results within the same trout or char population can therefore be obtained depending on the structure used.

In some age validation studies, scale determined ages were compared to known stocking dates of marked fish (Herstagen, 1985; Davis and Sloane, 1986; Parkinson, 1989) with variable results between readers. Interpretation inconsistencies between readers rather than structure type used could therefore also contribute to different age results and compound the difficulty in aging fish.

The use of scales for aging Mosquito Lake cutthroat trout would indicate primarily young and rapid growing fish. This may lead managers to assume either a productive population and/or a population subject to high mortality (exploitation). The reverse would be true if either finrays or otoliths were used for age and growth analysis of these fish. Consistency in the use of structure is likely the best approach to detect changes in age and growth of specific trout or char populations over the long term.

Validation of the three aging methods was not possible since none of the fish were marked previous to sampling. Comparing a number of different aging structures in age validation studies has not been attempted and continues to be a problem for fisheries management (Beamish and McFarlane, 1983). The present study is no exception. No attempt was therefore made to speculate on the actual accuracy of the ages obtained by the three aging techniques.

RECOMMENDATIONS

1. In the absence of age validation information, consistency in the use of structures for age determinations is recommended.

2. Validation of the various aging techniques must be determined if age and growth information continues to be used for Dolly Varden char and cutthroat trout management.

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