

# Variation of Scale Characteristics of Coho Salmon with Sampling Location on the Body

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**ABSTRACT:** Scales from coho salmon (*Oncorhynchus kisutch*) were used to determine whether location within a relatively small area of the body above the lateral line between the dorsal and adipose fins would affect the values of five characters of the scales, including total radius, radius of the freshwater zone, and number of circuli in the freshwater zone. Scales taken from two areas an equal distance above the lateral line and a short distance apart did not differ significantly for any of the characters; however, those taken farther above the lateral line had significantly lower values for all five characters. I conclude that substantial error can be introduced into interpretation of scale data if scales from each fish are not sampled from precisely the same area of the body. A well-chosen scrape sample yielded a result as satisfactory as that of a "preferred" or "key" scale.

Scales of Pacific salmon have been used by fishery scientists in seemingly simple studies, such as aging, and in more intricate studies, to separate distinct stocks (Major et al. 1972). In general, biologists have found it beneficial to take scales from standard areas of the fish's body, since scales first form on different areas of their bodies at different times. Scales below and above the lateral line may form at different times and have different measurements throughout the life of the fish. Because the size of scales vary with body area, body-scale relations with different slopes and intercepts may be obtained when scales are taken from different parts of the body (Hile 1970). Similarly, since the time of scale formation varies with body area, the number of circuli formed on a scale during the first year of life varies by area as well.

In the past, the problem of differential scale location characteristics has been reduced by sampling "standard areas" of fish. In salmon, this area has often been above the lateral line, between the dorsal and adipose fins. In separating stocks of salmon, biologists with the International North Pacific Fisheries Commission have often elected to take a "preferred" or "key" scale (Fig. 1), which is the scale between the dorsal and adipose fins two rows above the lateral line scale, along a posteriorly directed diagonal from the posterior insertion of the dorsal fin (Clutter and Whitesel 1956).

The collection of preferred scales poses several problems. Many scales are unusable because they are regenerated. Conditions at sites where samples are taken, such as fish companies or boat docks, are often not con-

ducive to making exact selections. Sampling a preferred scale in the field during adverse weather can be difficult. Yet the area above the lateral line between the dorsal and adipose fins may be too wide to provide the accuracy required in many studies.

My objectives were to determine (1) how scale characteristics of coho salmon (*Oncorhynchus kisutch*) varied within the area above the lateral line between the dorsal and adipose fins, and (2) whether a precisely taken scrape sample of scales could be effectively substituted for the tedious and often impractical sampling of the preferred scale.

## Methods

Scales were collected on 18 November 1977 from 30 adult coho salmon that returned to Alsea River Salmon Hatchery, Oregon. All fish were later determined to be age 1.1 (one freshwater and one ocean annulus; fish in its third year of life).

Four distinct samples were taken from the left side of each fish: the preferred scale, and 6 scales from each of three areas (A, B, and C of Fig. 1) above the lateral line and between the dorsal and adipose fins. Area A is a rectangle vertically bounded by and including scale rows 1 and 3 above the lateral line and horizontally bounded by and including the two scales anterior and posterior to the preferred scale. Area B is a rectangle vertically bounded by and including scale rows 1 and 3 above the lateral line and horizontally bounded by and including the two scales anterior and posterior to that scale two rows above the lateral line, which was directly below the posterior insertion of the dorsal fin. Area C is a rectangle vertically bounded by and including scale rows 6 to 12 above the lateral line and bounded horizon-

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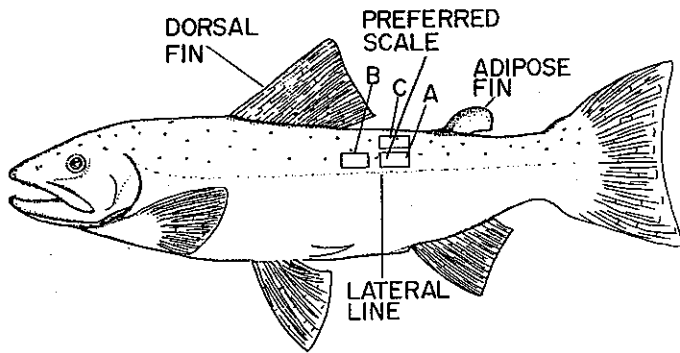


Fig. 1. Location of sampling areas for scales used in this study. The preferred scale is within area A.

tally by the dorsal extension of the boundaries from area A. Area C is thus directly dorsal to area A.

Scales were mounted on gummed cards and impressions of the scales were made on acetate sheets under heat and pressure, by methods similar to those described by Clutter and Whitesel (1956). Scale impressions of the preferred scale and one of the six scales from each of areas A, B, and C for each fish were examined with the aid of a projector at a magnification of  $80\times$ . The following measurements were taken: (1) total scale radius, (2) radius of the freshwater zone at  $20^\circ$  ventral to the longest axis, (3) number of circuli in the freshwater zone at  $20^\circ$  ventral to the longest axis, (4) radius of the freshwater zone at  $90^\circ$  ventral to the longest axis, and (5) number of circuli in the freshwater zone at  $90^\circ$  ventral to the longest axis (Fig. 2). From these measurements and counts, two other values were calculated: character 2 divided by character 3 (character 6) and character 4 divided by character 5 (character 7). I designated characters 6 and 7 as distance per circulus at  $20^\circ$  and  $90^\circ$ ,

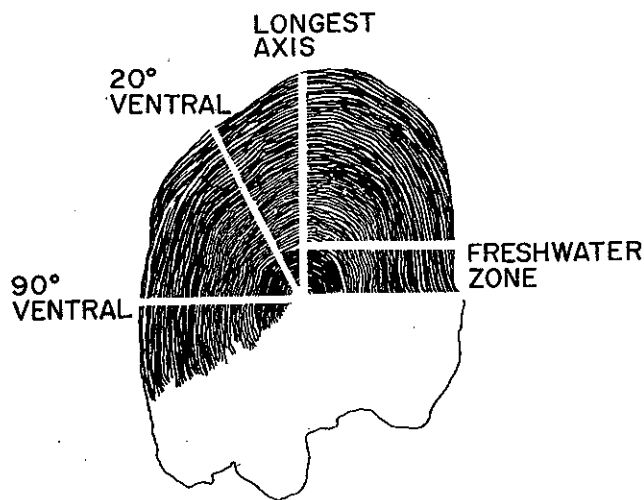


Fig. 2. Scale of salmon, showing lines  $20^\circ$  ventral and  $90^\circ$  ventral to the longest axis.

respectively. Comparisons between scale locations were made for characters 1, 2, 3, 6, and 7. For each of these five characters, means and 95% confidence intervals for 30 scales, each from a different fish, were calculated for areas A, B, and C.

Only 18 of the preferred scales were usable; the rest were regenerated. These 18 scales were compared with corresponding samples taken from areas A, B, and C of these same fish. Means and 95% confidence intervals were calculated for areas A, B, and C, and for the preferred scales.

Data were subjected to a one-way analysis of variance. When significant differences between treatment means were found, means were compared by using the method of least significant difference (Snedecor and Cochran 1967).

## Results

No statistical differences were found between area A and area B for any of the characters. Scales from area B were statistically different in all five characters from those of area C. Scales from areas A and C were statistically different in all characters except distance per circulus at  $20^\circ$  (Table 1). Scales from area C averaged only 78% of the total radius of scales from area A; the freshwater scale radius at  $20^\circ$  averaged only 69% of that of area A; only 72% as many freshwater circuli were present at  $20^\circ$  as were present in area A; mean distance between circuli at  $90^\circ$  was only 87.6% of that of area A (Table 2).

In the second group of comparisons, in which 18 of the samples were used for comparison with the preferred scales, significant differences between means were found for four of five characters; distance per circulus at  $20^\circ$  was the only character where treatment means were not statistically different (Table 2). None of the means of characters of area A, area B, or the preferred scales were statistically different from each other. Means for area C differed from those of area A, area B, and the preferred scales for four of the five characters. Comparisons of the preferred scales with scales from areas A, B, and C are shown in Table 1.

## Discussion

It is evident that, even within the area above the lateral line between the dorsal and adipose fins, significant variations in scale characteristics exist among scales taken from a coho salmon. It is therefore important to specify precisely where on the fish the scales are to be taken. Even in age and growth studies, care in collecting scales can reduce error and lead to more consistent results. It is imperative that the location for taking scales from a fish be precisely defined for studies employing numbers of circuli or freshwater scale radius as characters.

Table 1. Comparisons of means from areas A, B, and C (Fig. 1), and the preferred scales (P) for five characters, showing significant differences between means for one area and those for each other area. Comparisons among areas A, B, and C were made for a sample of 30 fish and those with the preferred scale for 18 fish.

Character	Locations compared					
	Area comparisons <sup>a</sup>			Preferred scale comparisons <sup>a</sup>		
	A and B	A and C	B and C	P and A	P and B	P and C
Total scale radius	NS	**	**	NS	NS	**
Freshwater scale radius at 20°	NS	**	**	NS	NS	**
Number of circuli at 20°	NS	**	**	NS	NS	**
Distance per circulus at 20°	NS	NS	**	NS	NS	NS
Distance per circulus at 90°	NS	**	**	NS	NS	**

<sup>a</sup> NS = not significant; \*\* = highly significant ( $P < 0.01$ )

Since spawning salmon reabsorb the outer edges of their scales, measurements of total scale radius in this study are not exact. Nevertheless, the results tend to indicate that body-scale relation can vary substantially within a relatively small scale-sampling area on the fish. Verification of the differences in body-scale relation with area of sampling should be possible if the coho salmon used were caught in the ocean, where their scales are intact.

The results also indicate that a sample of scales taken from the area closely surrounding the preferred scale (area A) yields results similar to those based on the preferred or key scale. Sampling from area B also yields satisfactory scales. A good representative sample can be obtained by following the diagonal scale row from the posterior insertion of the dorsal fin to the lateral line, and taking scales from a row or two above the lateral

line. Scales taken from area B also provide an adequate sample. Most errors result from taking scales too far above the lateral line, where part of the early life history of the fish is not recorded on the scale. In general, for coho salmon, scales should be taken close to the lateral line.

### Acknowledgments

I thank Carl B. Schreck for his critical review of the manuscript, and Harry H. Wagner, James Lichatowich, and Tumi Tomasson for their comments. This report is Technical Paper 4851 of the Oregon State University Agricultural Experiment Station. The Cooperative Fishery Research Unit is jointly sponsored by Oregon State University, the Oregon Department of Fish and Wildlife, and the U. S. Fish and Wildlife Service.

Table 2. Means and (in parentheses) 95% confidence intervals of length (cm × 80) or counts for five scale characters from areas A, B, and C (Fig. 1), and preferred scale. Values for the first three columns were calculated from a sample of 30 fish, and values for the last four from a sample of 18 fish.

Character	Sampling locations						
	Area comparisons			Preferred scale	Preferred scale comparisons		
	Area A	Area B	Area C		Area A	Area B	Area C
Total scale radius	30.02(0.96)	30.65(1.06)	23.53(0.81)	30.21(1.31)	29.98(1.31)	30.29(1.53)	23.64(1.07)
Freshwater scale radius at 20°	7.21(0.32)	7.04(0.34)	5.00(0.34)	7.19(0.50)	7.28(0.48)	7.03(0.50)	5.12(0.49)
Number of circuli at 20°	38.40(1.31)	36.83(1.42)	28.00(1.93)	38.89(1.77)	38.28(1.64)	37.28(1.77)	28.27(2.38)
Distance per circulus at 20°	0.188(0.006)	0.191(0.006)	0.179(0.007)	0.184(0.007)	0.190(0.008)	0.188(0.008)	0.181(0.010)
Distance per circulus at 90°	0.193(0.005)	0.199(0.005)	0.168(0.006)	0.193(0.007)	0.191(0.006)	0.195(0.006)	0.169(0.009)

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*Accepted 18 January 1979*

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