Back-Calculation of Previous Length

Dr. Derek H. Ogle

Northland College

Vermont R Workshop
Burtlington VT
5-7 March 2014

Definition of Back-Calculation

Francis (1990) defined *back-calculation* as,

> *"... the dimensions of one or more marks in some hard part of the fish, together with its current body length, are used to estimate its length at the time of formation of each of the marks. ..."*
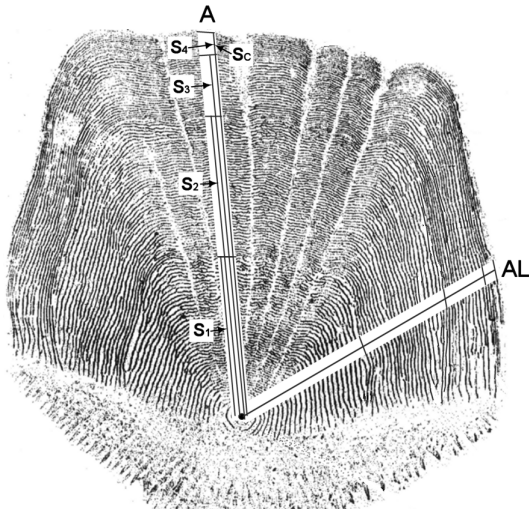
Mathematical Definitions

- S_C – Size (radius) of ageing structure at time of capture.

Mathematical Definitions

- S_C – Size (radius) of ageing structure at time of capture.
- S_i – Size (radius) of ageing structure when ith annulus formed.

Mathematical Definitions

- S_C – Size (radius) of ageing structure at time of capture.
- S_i – Size (radius) of ageing structure when ith annulus formed.

Mathematical Definitions

- S_C – Size (radius) of ageing structure at time of capture.
- S_i – Size (radius) of ageing structure when ith annulus formed.

- L_C – Size (length) of fish at time of capture.
- L_i – Size (length) of fish when ith annulus formed.

Mathematical Definitions

- S_C – Size (radius) of ageing structure at time of capture.
- S_i – Size (radius) of ageing structure when ith annulus formed.

- L_C – Size (length) of fish at time of capture.
- L_i – Size (length) of fish when ith annulus formed.

Fundamental Principle

- Growth of structure is proportional to growth of fish.

Fundamental Principle

- Growth of structure is proportional to growth of fish.
- Most simply, ratio of S_i to S_C is same as ratio of L_i to L_C.

$$\frac{S_i}{S_C} = \frac{L_i}{L_C}$$

Fundamental Principle

- Growth of structure is proportional to growth of fish.
- Most simply, ratio of S_i to S_C is same as ratio of L_i to L_C.

$$\frac{S_i}{S_C} = \frac{L_i}{L_C}$$

- For example, if structure size at i is 40% of the structure size at capture than fish size at i is 40% of fish size at capture.

Fundamental Principle

- Growth of structure is proportional to growth of fish.
- Most simply, ratio of S_i to S_C is same as ratio of L_i to L_C.

$$\frac{S_i}{S_C} = \frac{L_i}{L_C}$$

- For example, if structure size at i is 40% of the structure size at capture than fish size at i is 40% of fish size at capture.

- Algebraically re-arrange to get simplest back-calculation model.

$$L_i = \frac{S_i}{S_C} L_C$$

Fraser-Lee (Corrected Direct Proportion) Method

- Derived from "structure grows in direct proportion to the fish length after an initial adjustment for L when $S = 0$."

$$\frac{S_i}{S_C} = \frac{L_i - k}{L_C - k}$$

Fraser-Lee (Corrected Direct Proportion) Method

- Derived from "structure grows in direct proportion to the fish length after an initial adjustment for L when $S = 0$."

$$\frac{S_i}{S_C} = \frac{L_i - k}{L_C - k}$$

- Algebraically re-arrange to get final model.

$$L_i = \frac{S_i}{S_C}(L_C - k) + k$$

Fraser-Lee (Corrected Direct Proportion) Method

- Derived from "structure grows in direct proportion to the fish length after an initial adjustment for L when $S = 0$."
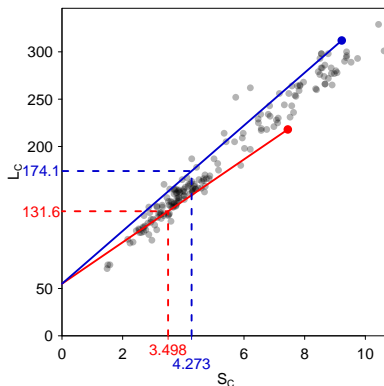
$$\frac{S_i}{S_C} = \frac{L_i - k}{L_C - k}$$

- Algebraically re-arrange to get final model.

$$L_i = \frac{S_i}{S_C}(L_C - k) + k$$

- k from
  - Known L when structure forms.
  - Published values (e.g., Carlander (1982)).
  - Intercept of L on S regression (i.e., a).

Fraser-Lee (Corrected Direct Proportion) Method

- Geometrically, L_i comes from a line between (S_C, L_C) and $(0, k)$.
  - In this example for Walleye, $k = 55$ as from Carlander (1982).

References

Carlander, K. D. 1982. Standard intercepts for calculating lengths from scale measurements for some centrarchid and percid fishes. Transactions of the American Fisheries Society 111:332–336.

Francis, R. 1990. Back-calculation of fish length: a critical review. Journal of Fish Biology 36:883–902.