**Detailed explanation of how we performed size-standardization**

*Written by Kaija Gahm on 28 April 2021*

*Based on notes from Chris Solomon and discussion on same date*

Notes:

1. When we refer to “the coefficient” of a model below, we’re talking about coef(model)[2], which is the Estimate for log(fishStdLength)
2. log() always refers to the natural log, ln().

**Paraphrasing Chris’s notes:**

Andrew [Hendry] pointed Chelsea towards Kaeuffer et al. 2012 (p 406) for instructions on how to do the size-correction. That paper refers back to Reist 1986. Based on those, here’s what we want to do:

For each trait that we need to size-correct, fit three models for the regression of log(trait) on log(fishStdLength)

1. Pooled model: log10(trait) ~ log(fishStdLength)
2. Model with common slope, different intercepts: log(trait) ~ log(fishStdLength)+lakeID
3. Model with different slopes, different intercepts: log(trait) ~ log(fishStdLength)\*lakeID

Use a general linear tests (anova() function) to go through the sequence of ANCOVA tests on that sequence of models. Compare c to b to determine whether different slopes are needed; if not, compare b with a to determine whether different intercepts are needed. Document the results of these tests.

If model c or model b is needed, use the coefficient from model b in subsequent calculations. If model a is sufficient, use the coefficient from model a.

The fact that you use the model b coefficient whether model b or model c is the best fit is weird, but it’s definitely what Reist says. Seems to be an accepted method in the field. Taking it on faith that that’s correct—Andrew seems to know what he’s doing.

The other confusing thing here is that even after fitting a model that includes lakeID as one of the terms (either model b or model c), we still only use the one overall coefficient. We don’t use separate lake-specific coefficients to standardize the trait for fish in each lake separately. Instead, we essentially assume that the allometric coefficient is a constant for the species.

**Calculations to size-standardize the trait:**

There are two forms of the equation for size-standardization. Here, I’ll show how the two are the same.

Variable shorthands:

ts = size-standardized trait value

t = trait value for an individual fish

c = the chosen model coefficient (see note at the top)

l =the standard length for an individual fish

m = the mean standard length across all fish in all lakes

One way to write the calculation (Reist)

ts = exp(log(t) – c(log(l) – log(m)))

Another way to write the same calculation (Kaeuffer)

Here’s math showing how we can get from the second form to the first (they are indeed equivalent)

1. (Kaeuffer equation)
2. (take the log of both sides)
3. (exponentiate both sides)
4. (product rule)
5. (power rule)
6. (quotient rule)
7. (factor out a -1 to give us the Reist equation)