**Demonstration via simple random sampling of n=1 weights and number of individuals (chapter 4 Lohr)**

Observers go to market and select one box (n=1). Box *i* contains *y* fish. Total weight of the fish in the box *x* is registered. the weight of all fish at the market is also available. They wish to estimate the number of fish in the market and generally do this using the three-rule

(1)

Where is called “raising factor” and is number of fish per weight unit in that box.

If one considers that

And, in this case, because *n* = 1,

Which is an estimate (with n=1) of the average number of fish per box. In the same way

Which is an estimate (with n=1) of the average weigh of a box.

It follows from this that (1) can be re-written as

(2)

The above expression is similar to Lohr (2010, section 4.1.1, point 2). In my mind this demonstrates that the usual “three rule” is a special case of the ratio where n = 1. Because of that when we “raise” length frequencies we have no variance in nor .

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**Demonstration via simple random sampling of n=1 cluster with weight and number of individuals fully recorded (chapter 5 Lohr)**

In the case of market sampling, boxes are clusters of fish with unequal size; in the field situation above the weight of individual fish was not measured: only the aggregate where is the number of fish in the box *i* is available. Similarly, the number of fish in the box *i* results from the aggregation of the number of fish per length class, i.e., where *h* is length class and *H* is the number of length classes, but for practical sampling purposes the latter is likely irrelevant since it configures a census.

Approaching the situation from a cluster sampling perspective, the unbiased estimator for is, according to Lohr 5.12

where *N* is the number of boxes in the market and *n* is the number of boxes sampled and is the number of fish in each box. In the present case, n = 1 so

From the expression above it is noticeable that is an estimate with *n* = 1 of the average number of fish in a box.

In the field situation originally mentioned, *N* is generally unknown and approximated by

Since here n = 1, we cannot calculate the variance associated to and also cannot calculate the variance associated to which therefore is assumed to be known (). The expression than becomes

where ^w(1) =

w(1)=

as in Lohr (2010, section 4.1.1, point 2).

**Comparison of situations where is known and is not known**

**Check:** If N is known, is affected by sampling error in M1. If N is not known is affected by both sampling error in *and* sampling error in . As such the quality of the estimate will likely be worse in the case of N unknown even if we do not know the extent (because *n* = 1).

**What about using weights to approximate sampling probabilities**

It is possible to approximate

***Additional comment:*** *sometimes is known, situations is the situation found in the field, when e.g, one knows the total number of baskets in discards and samples 1 basket counting the fish [check: counts of fish per species are counts per domain and can be calculated similarly].*

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The previous situation can be generalized to yield the results in Lohr (2010, section 4.1.1, point 2) if one considers n > 1 boxes sampled separately i=1…n. In that case, the *i-th* box contains yi fish and weights *xi*. Under those circumstances

And

From this follows that

Leading by substitution to the Lohr (2010, section 4.1.1, point 2).