

# Model Based Statistics in Biology

## Chapter 3.1 Logical Re-scaling

ReCap. Quantitative Reasoning(Ch 1)  
Quantities (Ch2)  
Re-Scaling (Ch3)  
3.1 Logical Re-scaling  
3.2 Operations on Ratio Scale Quantities  
3.3 Descriptive Statistics and Rescaling  
3.4 Unit Conversion and Rigid Rescaling

Not here last time?  
Course Outline  
Name on roster

on chalk board

### Recap Chapter 1

Quantitative reasoning: Example of scallops, which combined stats and models

### Recap Chapter 2

Quantities: Five part definition

Measurements made on four types of scale: nominal, ordinal, interval, ratio

Data collection, recording, and error checking

Graphical and tabular display of fully defined quantities

Units are useful in reasoning about quantities.

Distinguish derived from base units, then define standard multiples.

Dimensions (groups of similar units) are useful in quantitative reasoning.

Today: **Rescaling Quantities**

Begin with logical rescaling (from one type of unit to another).

### Wrap-up:

Re-scaling is a common technique in quantitative biology.

Logical re-scaling = re-scaling from one type of measurement scale to another.

Logical rescaling changes the type of measurement scale. There are 12 possible rescalings among the 4 types of measurement scale.

Draw arrows in  
table from right to  
left, to start.

Table 3.1

less detail more detail

Nominal Ordinal Interval Ratio

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←

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Add arrowheads to table,  
pointing right.

2

Logical rescaling has many applications. For example, it may be necessary to recalibrate a quantity from a ratio to ordinal or nominal scale if data are uneven in quality. A series of annual observations that began as casual observations, and then became more standardized to greater detail over the years, could all be converted to a nominal scale (presence or absence of a phenomenon) that would be consistent across the entire series.

Another application of logical rescaling is exploratory data analysis to discover pattern. Rescaling to a less detailed quantity often makes it easier to pick out pattern. For example, a series of satellite images can be remeasured to a nominal scale (presence or absence of weather fronts) to obtain a useful quantity for understanding the effects of weather systems on bird migration (Alerstam 1990).

One common application of logical rescaling is the conversion of interval or ratio scale data to a rank type of scale, for statistical evaluation of outcomes via nonparametric methods. The advantage of this, before the common availability of computers, was that all possible outcomes could be tabulated, allowing an exact estimate of Type I error, the error of accepting a difference that does not exist. Computers now make it possible to use randomization tests (Manly 1991) to estimate Type I error without rescaling quantities to ranks. These randomization tests have better discriminating capacity than tests that rescale the data to ranks. In statistical jargon, randomization tests have lower Type II error than those based on rescaling to ranks. Despite the clear advantages of randomization tests over tests that reduce data to ranks, the rank-based relics have remained in use because of their availability in statistical packages for computers.

Rescaling to a nominal scale is used in classification, including taxonomy. Clustering algorithms transform quantities measured on several types of scale (Jardine and Sibson 1971) to a nominal scale quantity, the classification.

Rescaling to a more detailed scale is also useful. A common example of this is ordination, which combines several quantities measured on any type of scale into one quantity measured on a ratio scale. The purpose of analysis may be to rank objects, but most ordination techniques produce interval or ratio scale quantities, not ordinal scale quantities. The literature on techniques is vast (Seal 1964, Kershaw and Looney 1985, McGarigal *et al* 2000) but attention to type of measurement scale is rare (Gower 1987).

Another look at 3.1

Above each of the 12 arrowheads in Table 3.1, place a check mark if you have used this form of logical rescaling.