Principles of Designing Experiments

IUFRO-SPDC

Snowbird, UT September 29 – Oct 3, 2014

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Experimental Design

- The statistical models used to assess treatment effects
- Concerned with the analyses of existing data
- ANOVA is the subject of books entitled “Experimental Design”

Designing Experiments

- Concerns the “logistics” of the experimental process
  - Translating questions into formula
  - Formula into treatment levels
  - Sampling schemes
  - Treatment layout
  - Measurements
  - Choosing tests
  - Determining results (Experimental Design)

Green's 10 Principles

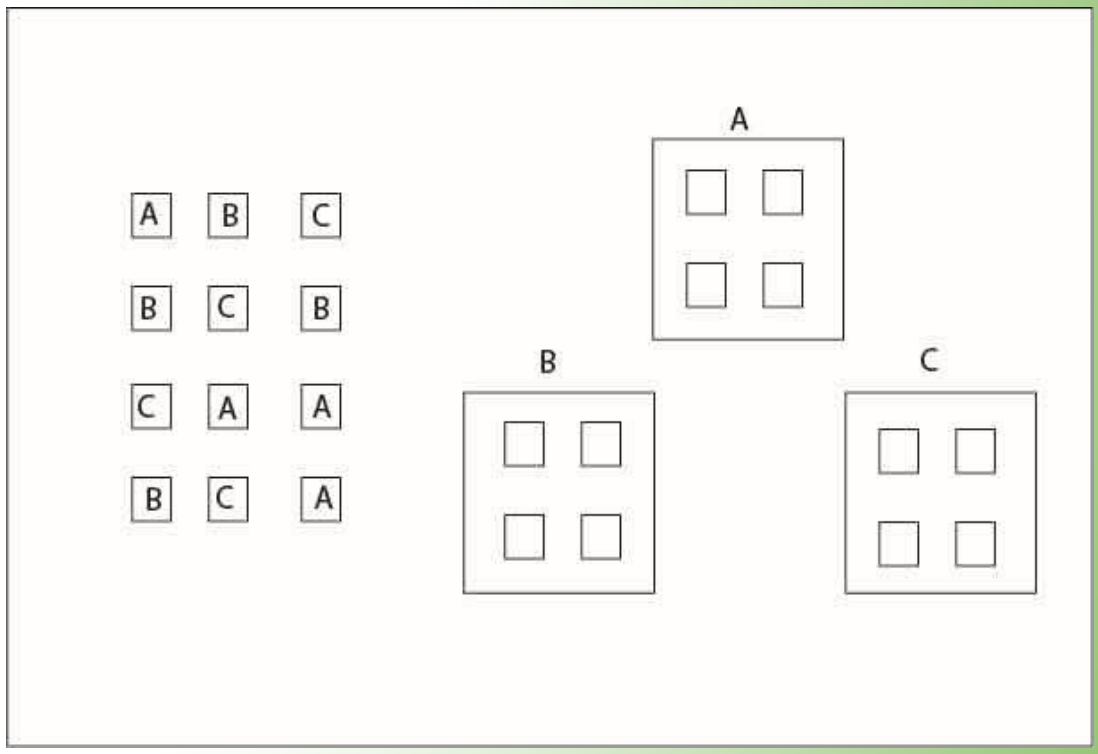
1. Be able to state concisely to someone else what question you are asking. Your results will be only as coherent and as comprehensible as your initial conception of the problem.

Green's 10 Principles

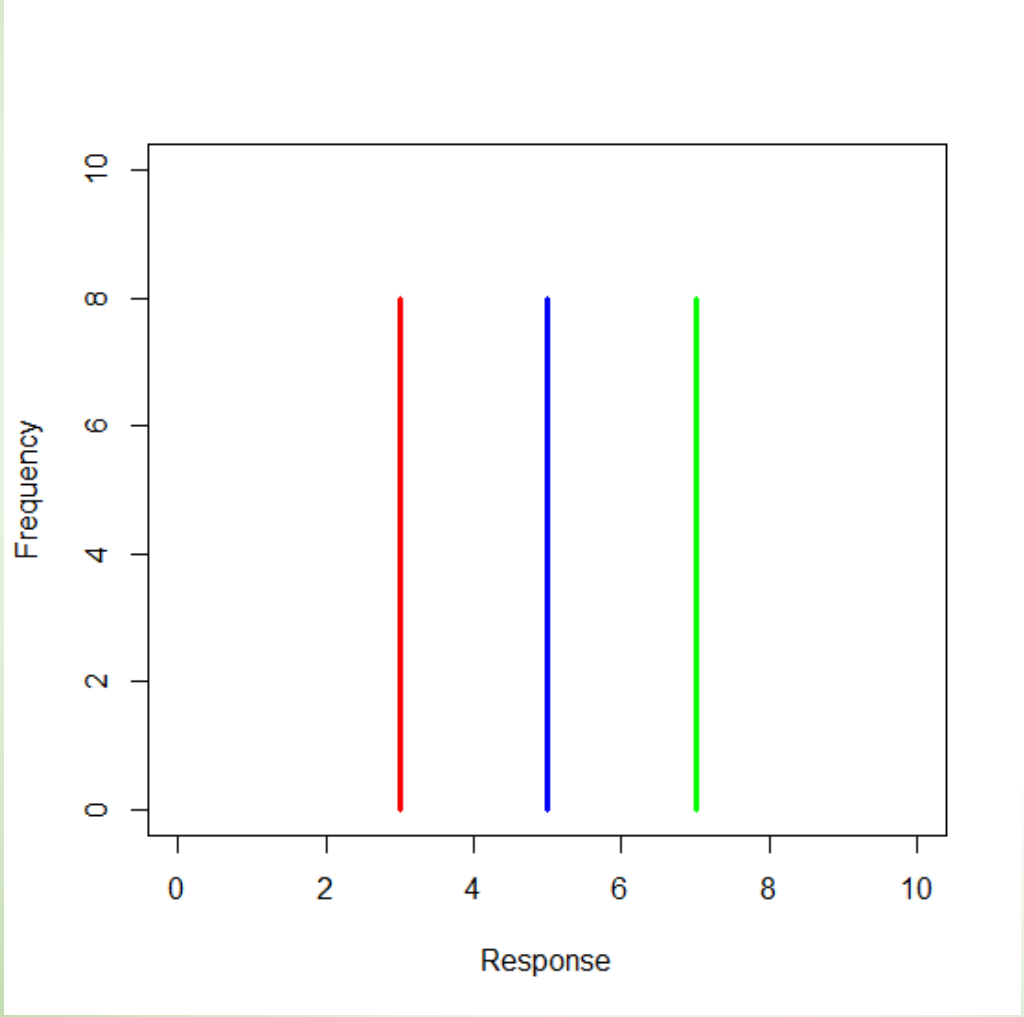
2. Take **replicate** samples within each combination of time, location, and any other controlled variable. Differences among can only be demonstrated by comparison to differences between.

Replication

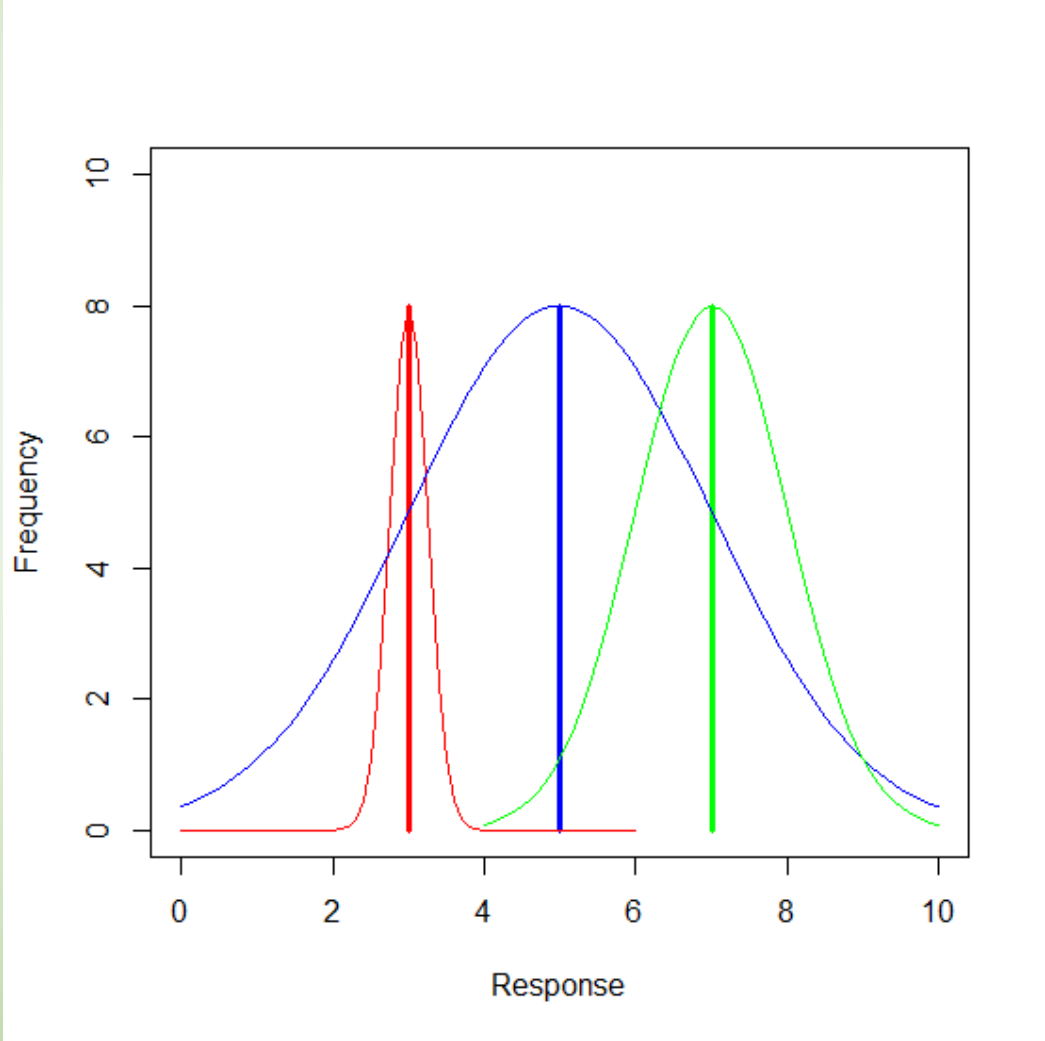
- A replicate is an independent sample unit
- Equal probability of having a treatment applied to it
- The level at which the treatment is applied
- Any measurement made below the level of treatment is a subsample
- A psuedoreplicate is a subsample used as a replicate



Differences within vs between



Differences within vs between



Green's 10 Principles

3. Take an equal number of samples within each combination of time, location, and any other controlled variable. Putting samples in "representative" or "typical" places is not sampling.

Green's 10 Principles

4. To test whether a condition has an effect, collect samples both where the condition is present and where the condition is absent, but all else is the same. An effect can only be demonstrated by comparison with a control.

Green's 10 Principles

5. Carry out some preliminary sampling to provide a basis for evaluation of sample design and statistical analysis options. Those who skip this step because they do not have enough time usually end up losing time.

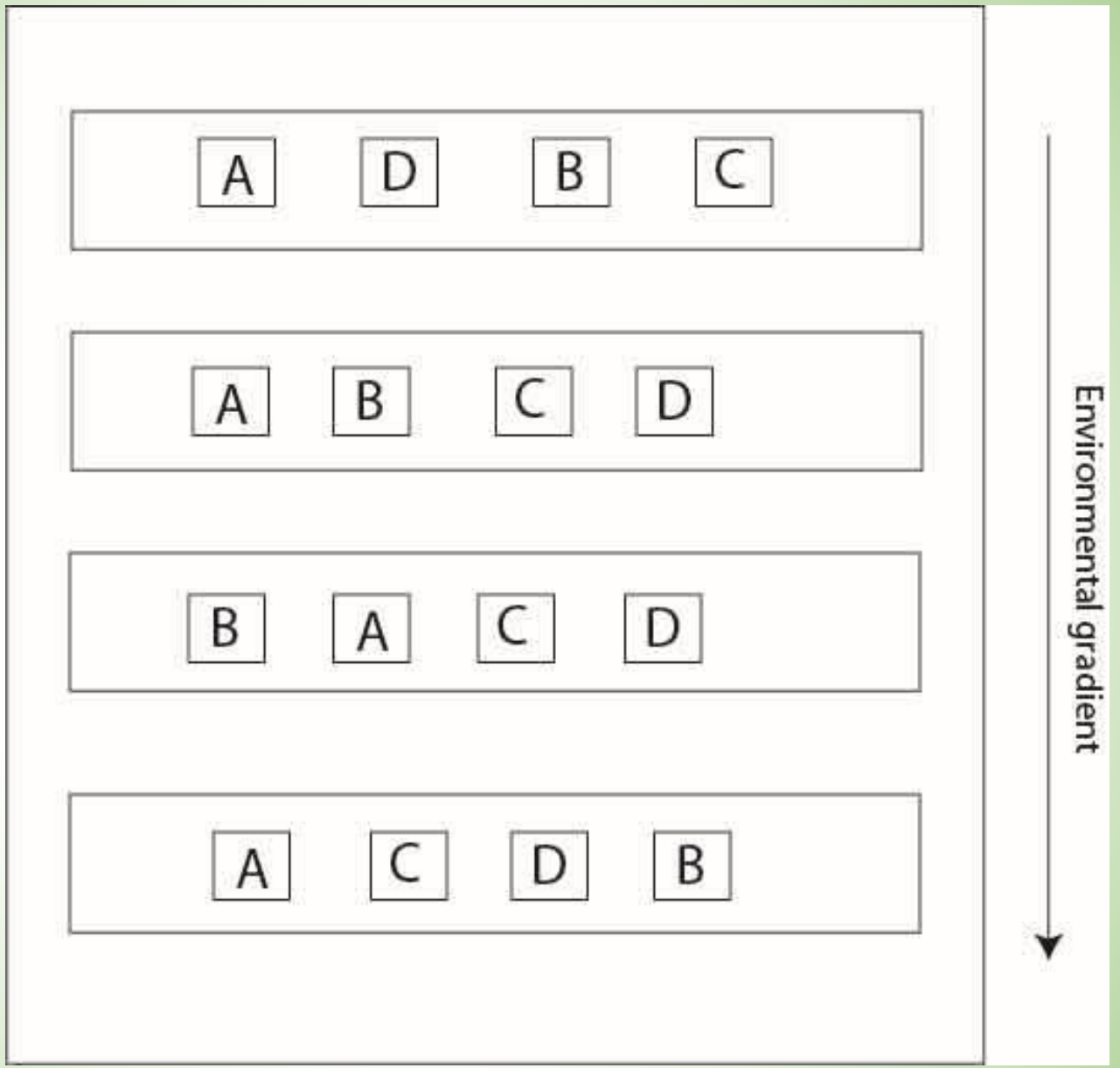
Green's 10 Principles

6. Verify that your sampling device or method is sampling the population you think you are sampling, and with equal and adequate efficiency over the entire range of sampling conditions to be encountered. Variation in efficiency of sampling from area to area biases among-area comparisons.

Green's 10 Principles

7. If the area to be sampled has a large-scale environmental pattern, break the area up into relatively homogeneous subareas and allocate samples to each in proportion to the size of the subarea. If it is an estimate of total abundance over the entire area that is desired, make the allocation proportional to the number of organisms in the subarea.

Blocking



Green's 10 Principles

8. Verify that your sample unit size is appropriate to the size, densities, and spatial distributions of the organisms you are sampling. Then estimate the number of replicate samples required to obtain the precision you want.

Size factors

Green's 10 Principles

9. Test your data to determine whether the ERROR (residual) variation is homogeneous, normally distributed, and independent of the mean. If it is not, as is ~~frequently~~ [occasionally] encountered in field data, then (a) appropriately transform the data, (b) use a ~~distribution-free~~ [robust] statistical procedure, (c) use a sequential sampling design, (d) test against simulate H0 data; [or (e) use a mixed modeling approach].

Green's 10 Principles

10. Having chosen the ~~best~~ [most powerful] statistical method to test your hypothesis, stick with the result. An unexpected or undesired result is NOT a valid reason for rejecting the method and hunting for a "better" one.