Research methods 2

SIT – Iceland and Greenland: Climate Change and the Arctic

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Dan Govoni

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Survey of Academic Field Experiences (SAFE): Trainees Report Harassment and Assault

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In the field

- Keep a good field book
- Backup work as soon as possible
- Keep hard copy
- Completely fill out labels for each sample

In the lab

- Always keep a hard copy
- Backup your work regularly
- Get a place to keep your stuff out of the way and always keep it there

Two main types of studies

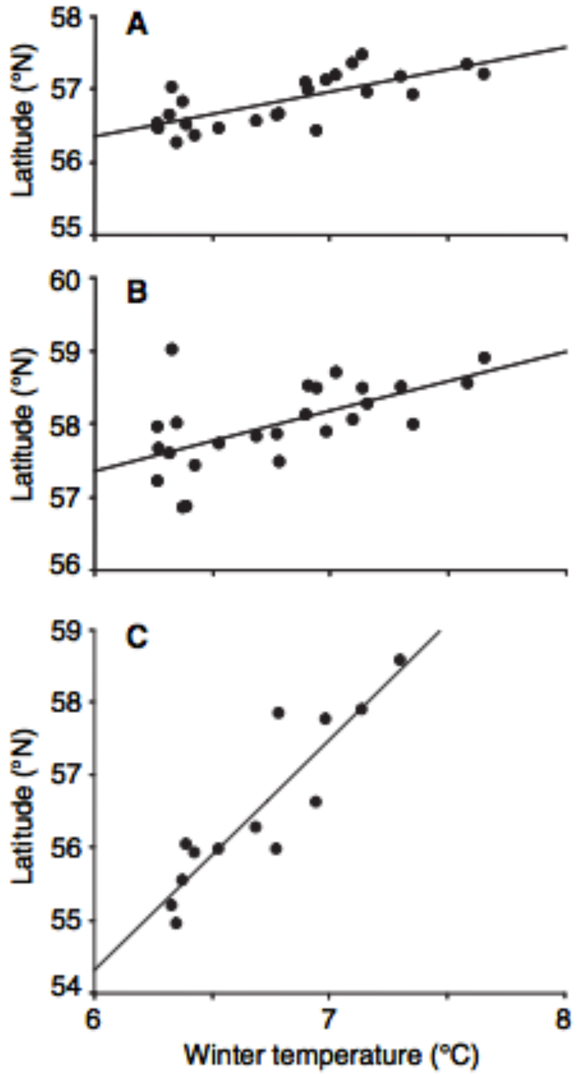
- Observational (mensurative experiments)
  - No manipulation by investigator

- Experimental (manipulative experiments)
  - Manipulation by investigator
  - Allows for determination of causal relationships

Observational studies

- Investigator makes observations about the study system, organism, population, or community

Observational studies



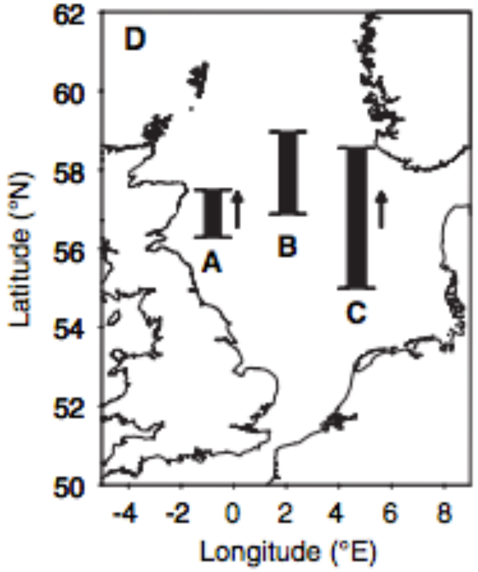


Fig. 1. Examples of North Sea fish distributions that have shifted north with climatic warming. Relationships between mean latitude and 5-year running mean winter bottom temperature for (**A**) cod, (**B**) anglerfish, and (**C**) snake blenny are shown. In (**D**), ranges of shifts in mean latitude are shown for (A), (B), and (C) within the North Sea. Bars on the map illustrate only shift ranges of mean latitudes, not longitudes. Arrows indicate where shifts have been significant over time, with the direction of movement. Regression details are in Table 1.

Perry et al. 2005

Observational studies

- Require replication (more on this shortly)
- Can make use of natural variability in study system
- Have tremendous value and set up causal inquiry down the road

Experimental studies

- Require
  - Control
  - Randomization
  - Replication
- Allow for strong inference (cause and effect)
- Uses treatments applied to experimental units
  - Treatment – set of conditions controlled/manipulated by the experimenter
  - Experimental unit – what treatment is applied to
    - Need to be independent

A quick note on independence

- When analyzing your data, independence means that sampling of one unit in your analysis has no effect on any other unit
  - This cannot be achieved after the fact, and it is only achieved through good study design

- Example: You want to know how ewes caring for lambs (1-10 scale of maternal care) affects stress hormone levels in a nationwide sample of lambs in Iceland. Two lambs from the same mother in this study would violate independence.

Example: effects of photoperiod on fish growth in the summer in Iceland

- Treatments
    - Control – normal daylight
    - Light treatment – 12 hours light, 12 hours dark
    - Light treatment – 6 hours light, 18 hours dark

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- Dependent variable –

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- Dependent variable – growth

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- What do you think of this study?

  I have decided to conduct a study in my yard; I want to see if availability of sunflower seeds in addition to natural food sources makes squirrels fat. At the beginning of October, I begin putting out sunflower seeds daily. By the end of the month, I notice that the squirrels are noticeably fatter. I conclude that sunflower seeds make squirrels fat.

Randomization (and interspersion)

- Randomization provides validity
  - Randomizing assignment of treatments controls for unintended bias in assigning treatments

- Blocking – each treatment is represented once per block

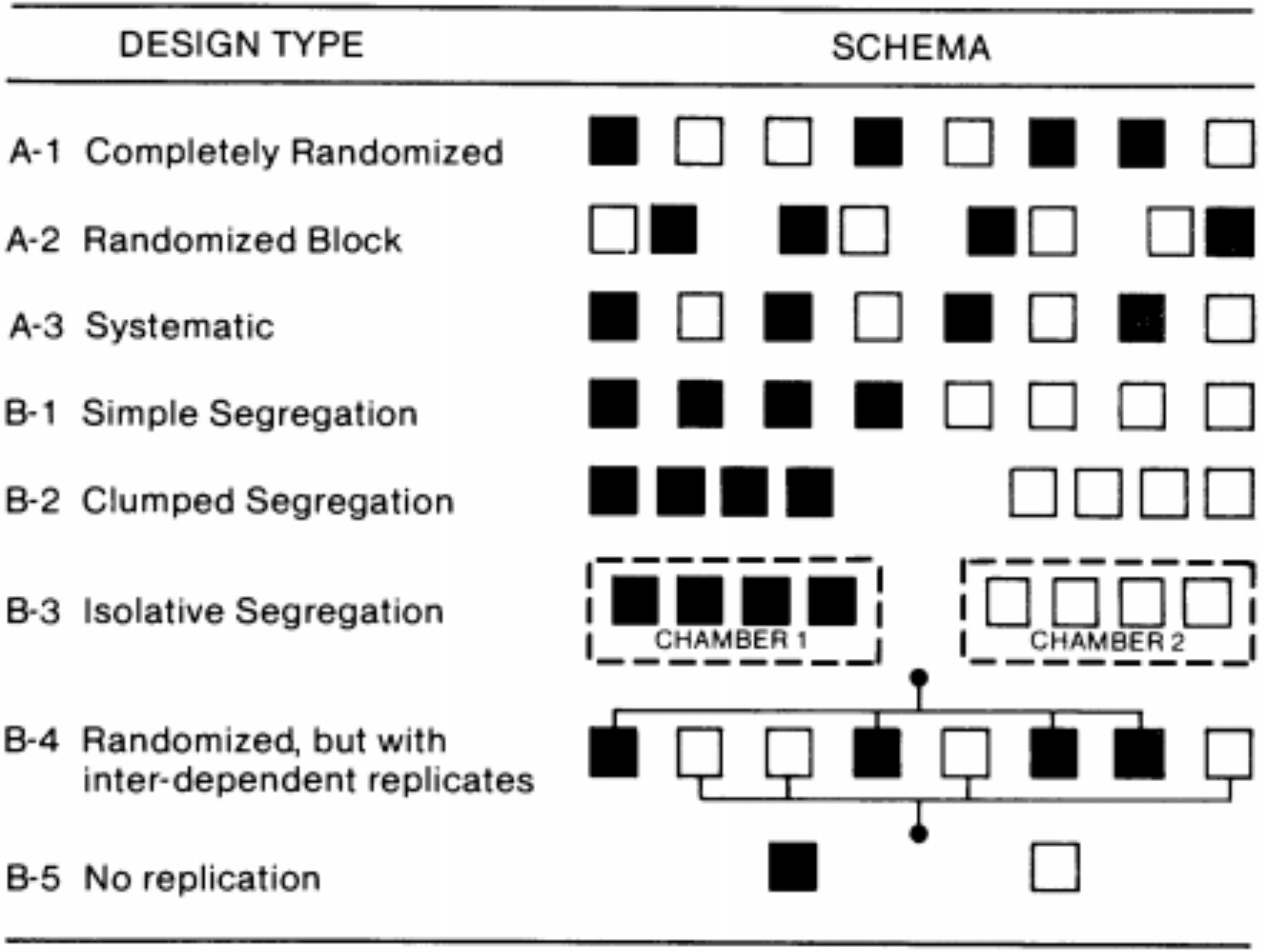

FIG. 1. Schematic representation of various acceptable modes (A) of interspersing the replicates (boxes) of two treatments (shaded, unshaded) and various ways (B) in which the principle of interspersion can be violated.

Hurlbert 1978

Replication

- Replication (in space and time) provides precision
- Replicates of each experimental unit are needed to estimate variability in our data
- (non-metric) Example:
  I added a control to my squirrel study.
  Control: n = 16, mean = 1.4 lbs., SD = 0.4 lbs.
  Seed tx: n = 16, mean = 1.6 lbs., SD = 0.6 lbs.

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  Control: n = 100, mean = 1.4 lbs., SD = 0.4 lbs.
  Seed tx: n = 100, mean = 1.6 lbs., SD = 0.6 lbs.

What do you think of this study?

- I hypothesize that stability of soils on mountain slopes affects primary productivity, and I design an experiment to test this hypothesis. I decide to use the mountain on this side of the fjord as my treatment. I apply sand to ten replicate plots on the mountain to stabilize the soil. I use the mountain over by the airport as my control, and I study ten replicate plots on it. I then take weekly measurements of productivity in the ten plots by measuring plant height.

What do you think of this study?

- I overheard someone saying that “really weak coffee is better for plants than water because it is essentially water, but it has a little extra stuff in it.” I designed an experiment where I planted two peas. I watered one with water and the other with really weak coffee. The really weak coffee pea plant grew and the the water one didn’t. I determined that really weak coffee is better for growing plants than water. Pretty great finding, right?

Let's design a study

- Hornstrandir
- Sea gulls eat grasses near the shore
- How does presence of predators (Arctic fox) affect net primary productivity?
- 5 km continuous patch of grass land along the beach

TABLE 1. Potential sources of confusion in an experiment and means for minimizing their effect.

Source of confusion	Features of an experimental design that reduce or eliminate confusion
1. Temporal change	Control treatments
2. Procedure effects	Control treatments
3. Experimenter bias	Randomized assignment of experimental units to treatments Randomization in conduct of other procedures "Blind" procedures*
4. Experimenter-generated variability (random error)	Replication of treatments
5. Initial or inherent variability among experimental units	Replication of treatments Interspersion of treatments Concomitant observations
6. Nondemonic intrusion†	Replication of treatments Interspersion of treatments
7. Demonic intrusion	Eternal vigilance, exorcism, human sacrifices, etc.

* Usually employed only where measurement involves a large subjective element.

† Nondemonic intrusion is defined as the impingement of chance events on an experiment in progress.