Designcraft for experiments

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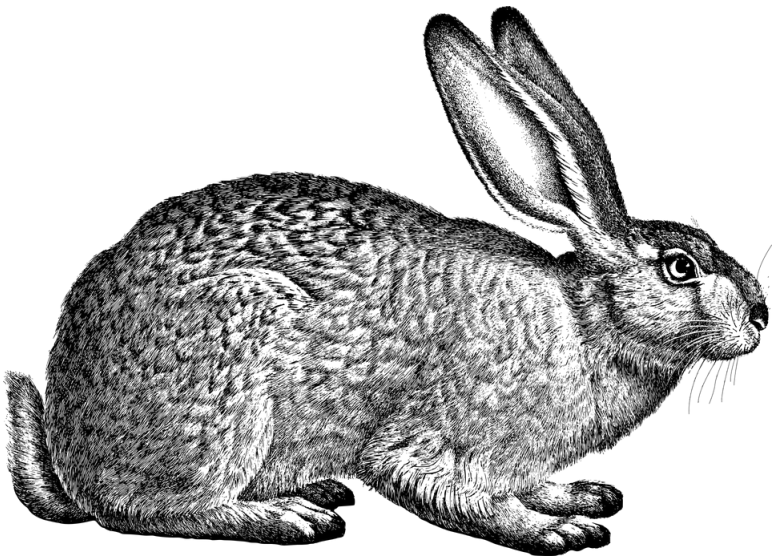
Chapter 1

Introduction



Welcome to experimental design. There are two sets of three exercises provided to explore principles for better experiments. This is a simple book to support the practical, at-home learning associated with experimental design. The text 'Experimental Design for the Life Sciences' underpins the design principles (Ruxton and Colgrave., 2018).

There are two primary modules.

(1) Field experiments comprises three outdoor experiments to explore sampling heterogeneous, complex processes in natural systems. The purpose is to provide choice. You need to try each, briefly, as a pilot experiment only. Then, select one to pursue in depth and write up as a research article.

(2) The data experiments describe the opportunity to use design thinking to structure existing data that others have already collected. The same principles for better experiments still apply in how you reuse the data. There are also three examples provided. Select only one and write up as a note.

Both report formats supported by FACETS. It is the first and only open access science journal in Canada.

Field experiments gear and prep

Data-design experiment prerequisites

Chapter 2

Balcony birdwatching

Bird observation, from a distance.

Learning outcomes

1. Identify common species of birds locally.

2. Collect a dataset.

3. Connect principles of experimental design to implementation.

4. Write clear and reusable meta-data.

Steps

1. Scout out a location with more than a single species of birds and a frequency of a few different individuals of birds over a 5-10 minute duration.

2. Select a good spot to the observe birds at your designated location. It can be a balcony or quiet spot. Vegetation such as trees or shrubs can facilitate observation of birds by providing habitat.

3. Choose a distance that permits enough resolution to see plumage and what an individual bird is doing (depending on whether you are using binoculars, a spotting scope, or unassisted with your vision). There are considerable merits to observing birds more simply (Wilkinson et al., 2014). You are also welcome to address any visibility or spotting challenges using bird calls to record frequency of birds in a sampling region.

4. Specify a duration to sample, for instance, 60 minutes when you have observed the most birds in your scouting exercise. Remember, this is a pilot experiment. Take qualitative notes, sketch, and complete this datasheet.

5. Use your notes to complete a meta-data file, i.e. a description of how the data were collected, whether, when, and what each attribute in your dataset means.

6. Sign out a bird guide for your region from the library or university or try out a free app for now to support identification.

Data

Here is a sample datasheet for the pilot experiment. This is set up as species-level observations, i.e. each row or replicate is a species of bird you observe. This datasheet is for the pilot experiment, and it is a stepping stone for the

deeper dive experiment if you choose to complete this experiment for your first report. A more detailed datasheet can consider duration or start and stop times of each individual bird, more details on the environment, or record interesting ecological or environmental variables that are present in the environment too - noise, disturbance, squirrels, other birds, etc.

Sample data set
In this example, the field observations were coded as one species per behaviour per row. Data can be organized in many different formats depending on the approach to collecting the data in the field or the lab, the instrument or method used, preference, or accepted standards within the domain of study.

rep	date	researcher	location	species	frequency	behaviou
1	15/9/2020	cl	High Park, Toronto	House sparrow	12	flying
2	15/9/2020	cl	High Park, Toronto	Blue jay	2	foraging
3	15/9/2020	cl	High Park, Toronto	Cedar waxwing	1	perching
4	15/9/2020	cl	High Park, Toronto	Cedar waxwing	3	foraging
5	15/9/2020	cl	High Park, Toronto	Dark-eyed junco	2	flying
6	15/9/2020	cl	High Park, Toronto	Black-capped Chickadee	3	foraging
7	15/9/2020	cl	High Park, Toronto	Black-capped Chickadee	2	posturin
8	15/9/2020	cl	High Park, Toronto	Black-capped Chickadee	3	interacti
9	15/9/2020	cl	High Park, Toronto	Black-capped Chickadee	2	sitting
10	15/9/2020	cl	High Park, Toronto	Wood thrush	2	flying
11	15/9/2020	cl	High Park, Toronto	Wood thrush	5	on groun
12	15/9/2020	cl	High Park, Toronto	Northern flicker	1	perching

Meta-data

In many disciplines of science, meta-data are the descriptive elements of the dataset. They provide a clear means for discovery and reuse of data collected - by you in future and for others (Heidron, 2008; Reichman et al., 2011). For the purposes of our practical learning in experimental design here, describe what each column in our dataset means, describe the structure of your dataset (i.e. each row is a species-level observation, or plot, or transect), describe the duration of sampling, location, and provide a bit of guidance for someone to use in inspecting the dataset. It is very similar to the methods in conventional publications or standard reports, but it ensures each attribute in the dataset has a brief description. It is also superb preparation for the methods if you choose to write a report.

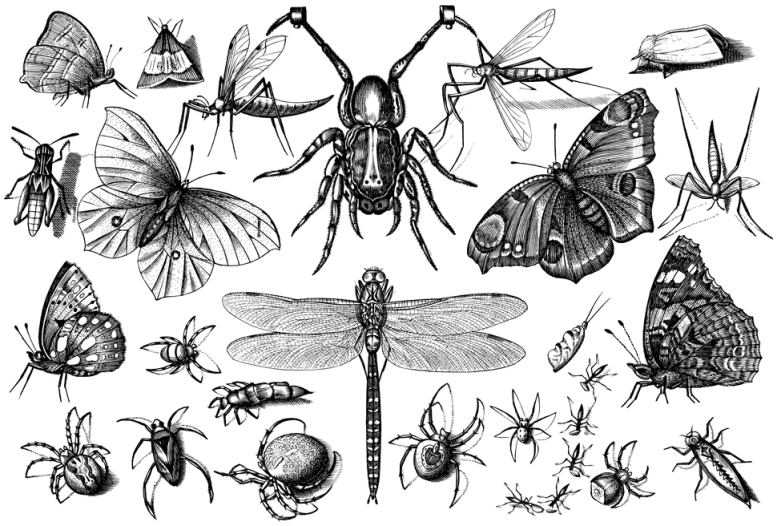
Deeper dive

If you choose this adventure, your goal is to experiment with the method of animal observation to test a hypothesis and predictions. The text ‘Experimental

Design for the Life Sciences' does an excellent job of explaining how to set up hypotheses and predictions (Ruxton and Colgrave., 2018). Pilot experiment first, think, explore your data and notes, then write your ideas down that you want to test. A hypothesis is a clear explanation of how a system works (LaPlaca et al., 2018; Bains, 2005). The predictions are logical and resonable outcomes if the hypothesis is a good approximation of how the system works, i.e. the key variables that make it work. Predictions should be testable and read like simple sentences that describe results. The goal of the deeper-dive experiment is to take your pilot experiment, examine what worked and did not work so well in your experiment, and do a deeper and more thorough job of testing a key idea that you are interested in associated with bird communities in your backyward or neighbourhood. The goal should be to explore one key factor the describes how the species locally interact within one another, the environment or other species, or resources.

Chapter 3

Backyard bioblitz



A bioblitz is a biodiversity survey that is done rapidly for a specific place.

Chapter 4

Solo surveys

Distributed ecological networks often use surveys done by individuals or small-teams to compile data on species or communities. Transects and quadrats are typically used to structure these 'walk-through' surveys to estimate abundances and distributions of focal species.

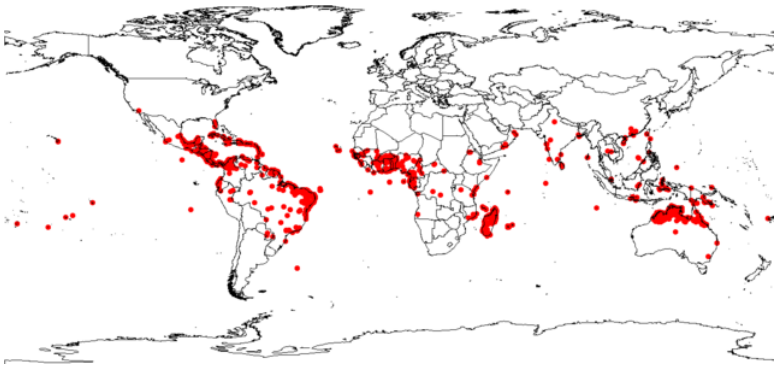
Chapter 5

Magic data

Magic the Gathering is a popular collectible card game that includes strategy and chance.

Chapter 6

Diversity data



Diversity data from ebird or any citizen science project.

Chapter 7

Human data

Data associated with humans. Fitbit steps and sleep.

Chapter 8

Final notes

Observations and conclusions.

Bibliography

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