effective design determines all evidence in science.
Christopher J. Lortie
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**Purpose of experimental design exercises**

**Learning outcomes:**
The primary objective of the labs is to provide you with an opportunity to further develop and refine your experimental design skills. Here are the learning outcomes associated with the activities this exercise set.

1. You will be able to design & execute an effective experiment.

2. You will be able to publish a dataset in a public repository with well-articulated meta-data.

3. You will be able to clearly write a well-structured manuscript suitable for publication in PeerJ pre-prints.

4. You will understand the difference between systematic reviews and meta-analyses.

5. You will be able to do a systematic review, analyse the research, and summarize in a manuscript suitable for publication in PeerJ pre-prints.

**Skills:**
(1) Experimental design

(2) Data collection

(3) Bibliographic data mining & primary research deconstruction & analyses.

(4) Effective synthesis and writing.

**Products & evaluation:**
Lab report from primary dataset 25%
Systematic review 25%

**Total (course) 50%**

Note: you must also publish datasets with meta-data & show workflows. These components will be graded so as to ensure that individual efforts are recognized.
## Schedule

The schedule is listed on the course website and as a google calendar.

<table>
<thead>
<tr>
<th>WK</th>
<th>Lab</th>
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<tbody>
<tr>
<td>1</td>
<td>No formal meeting. Get cracking on the textbook readings.</td>
</tr>
<tr>
<td>2</td>
<td>Logistics, get into groups, discuss labs, &amp; design of first experiment brainstorm.</td>
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<tr>
<td>3</td>
<td>In field, brainstorm, design experiment for your group.</td>
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<tr>
<td>4</td>
<td>First week of data collection.</td>
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<tr>
<td>5</td>
<td>Second week of data collection.</td>
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<tr>
<td>6</td>
<td>Third week of data collection.</td>
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<tr>
<td>7</td>
<td>Meet in lab to discuss analysis, reports, and plan write up.</td>
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<tr>
<td>8</td>
<td>Report due, discuss systematic reviews and examine sample publications.</td>
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<tr>
<td>9</td>
<td>Propose systematic review topics in lab.</td>
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<tr>
<td>10</td>
<td>Independent work processing the primary literature.</td>
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<tr>
<td>11</td>
<td>Final meeting to resolve systematic review papers.</td>
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<tr>
<td>12</td>
<td>Hand in systematic review at 230pm, no lab.</td>
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WK2. Logistics, get into groups, discuss labs, & design of first experiment brainstorm.

Location: Meet in the lab.
Tasks: Form groups, discuss lab structure with teaching assistant, plan upcoming fieldwork, sketch an experimental design.
Products: Discuss how to design an experiment and do a few sketches including factors, responses, and replication.

Description
1. In this lab, please work with the teaching assistant to form small groups of 4-5 individuals. Please ensure that at least one person in the lab has a laptop and is comfortable entering the data for the group directly in the field in the upcoming weeks.

2. The teaching assistant will give a short lecture on the lab format. She/he will also do a tutorial on KNB, Dataverse, and figshare as your data repository items.

3. The teaching will explain the art of experimental design and provide an example of how to sketch out an experimental structurally.

4. If you are unfamiliar with meta-data, also request a tutorial from the teaching assistant.

5. Explore myexperiment.org and consider this tool for sharing your workflows.

Products
At least one sketch of an experiment you designed.
At least one directed acyclic graph.
A sample, fun dataset published online.

Samples
Most figures posted on figshare here: http://figshare.com/authors/Christopher_Lortie/397067
Browse figshare and slideshare for inspiration in general.
Check knb and figshare for ecological datasets and examples of meta-data.
An overview figure showing the relationships between experiments.

<table>
<thead>
<tr>
<th>tool</th>
<th>trophic unpacking</th>
<th>indirect contrasts</th>
<th>experiments</th>
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<tbody>
<tr>
<td>restoration management</td>
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<td>butterfly</td>
<td>pollinators</td>
<td>video sweeps</td>
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<td>b</td>
<td>mouse</td>
<td>animals</td>
<td>tracking/trapping exclosures</td>
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<td>grass</td>
<td>annuals</td>
<td>addition/removal surveys density series</td>
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<td>tree</td>
<td>seedbanks</td>
<td>addition/removal surveys seed traps</td>
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<td>insects</td>
<td>arthropods</td>
<td>pan traps exclosures</td>
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<td>(5)</td>
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- Direct: solid line
- Indirect: dashed line
The concept of direct versus indirect interactions mapped out to overlay experiments onto.
A sketch of field sampling an area.

- Panoche
- (4) epidemio size by aspect $N, S, O$ (platau)
- (b) e+t plants & seeds
- (o) e+ lizards & rats platau

North
- Additional
- +/- epidemio
- pan trap insects
- e+t plants & seeds

South
- Restoration estimate restoration benefits though plants & soil facilitation
A sketch of how to measure a gradient in the field.

Mojave National Preserve

1. Measure Laminar size & map
2. Measure & photo seeds
3. Measure seed deposition - cups
4. Measure seed trapping
A sketch of growth-chamber trials to test for plasticity.
An experiment to examine creativity.

**Phase II:** An experiment to examine creativity inquires.

- **Questions**
  - A. Current questions
  - B. Affective questions
  - C. Cento questions
  - Compare population of questions

- **Substrate**
  - Video interviews
  - Blog posts
  - Tweets
  - Compare connectivity, volume, and quality of content

- **People**
  - TED
  - Students
  - RB, grid, flow
  - A. Test different sets of questions on all groups
  - B. Compare substrates from different groups
An experiment to sample a set of dunes for wind and ecology.

1. Wind temp
2. Trap insects
3. + wind
4. - wind
5. Measure ephedra size in map
6. Measure seedbank
A proposed pipeline for synthesis in ecology.

natural concepts ➔ functional concepts ➔ integrative concepts

(i) new results ➔ (ii) explanation ➔ (iii) explain new & old results

<table>
<thead>
<tr>
<th>directly observable</th>
<th>properties of natural concepts or relationships between them</th>
<th>theoretical constructions about organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>species</td>
<td>competition &amp; facilitation</td>
<td>community structure</td>
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</table>
WK3. Toxic Dump or Garden of Eden. A case study to practice experimental design.

Location: Meet in the lab then hit the field.
Tasks: Hike corridors, do observations, identify patterns, plan designs.
Products: Outlines & sketches of experiment you will begin next week.

Description
The purpose of this component of the labs is to critically think about real world issues and practical methods of testing questions. This will provide you with experience in developing and conducting a proper scientific experimental design from scratch.

1. Meet in lab from 230-240pm. Prompt.

2. Hike to nearby powerlines.

3. Conduct structured observations and identify important natural patterns.

4. Sketch out experimental design in field notebook. Discuss as group.

5. Present designs to teaching assistant whilst in field and ensure they are appropriate.

Products
A sketch and outline typed up of your experiment.
Your methods outlined in reasonable levels of detail.
Sample/template of your datasheets.
You meta-data template.
Background information

Are powerline corridors industrial barrens incapable of supporting life or area of opportunity for conservation biology?

Powerline corridors cause dramatic changes to the ecology of a landscape. Management of these corridors by Hydro companies often includes vegetation removal through chemicals/pesticides or mowing which "arrests" succession of the ecosystem resulting in limited biodiversity and vegetation (Niering and Godwin 1974). The contrast in vegetation of these corridors from the surrounding natural habitat creates edge effects and habitat fragmentation. The open area may also allow predators to more easily capture prey who would otherwise be protected by the dense vegetation of a forest or grassland. These alterations to the environment are so profound, that powerline corridors are often compared to the way a river defines a riparian habitat. The unique characteristics of these powerline corridors may therefore represent a new ecotype.

Though powerline corridors can negatively affect natural habitat, if properly managed, they can function as "greenways" within an urban centre (Seams 1995). The average powerline corridor in North America has approximately four times greater shrub density than an equivalent area of residential area (Geibert 1980). These utility corridors have the potential to act as source populations by facilitating the growth of plants throughout an urban community, but also the capacity to spread invasive species. Powerline corridors may also function as an animal habitat for insects, birds and rodents in an otherwise inhospitable urban environment. These characteristics make powerline corridors an attractive conservation tool in the management of urban ecosystems, but their effectiveness when compared natural or other urban environments has been poorly tested.
Figure 1: Map of powerline corridors in the Greater Toronto Area.
Figure 2: Goldenrod in full bloom along the Finch Hydro Corridor.
Figure 3: Invasion hypotheses and the mechanisms by which powerline corridors may operate on.

**Invasion Hypothesis**

- Disturbance Hypothesis (Mack et al. 2000)
- Evolution of increased competitive ability hypothesis (Blossey and Notzold 1995)
- Empty Niche Hypothesis (Levine and D’Antonio)
- Enemy Release Hypothesis (Keane and Crawley 2002)
- Facilitation Hypothesis (Bruno et al. 2003)
- Fluctuating Resource Availability Hypothesis (Davis et al. 2000)
- Novel Weapons (allelopathy) Hypothesis (Callaway and Aschehoug 2000)
- Propagule Pressure Hypothesis (Lonsdale 1999)

**Power line effects**

- Biotic corridors
- Early successional habitats
- Sinks/sources
- Provides connectivity of fragmented habitats
- Tree Suppression (biotically)
- Management of vegetation
- Fragmentation
- Edge-effects
- Herbicidal Treatments
- Maintenance of corridors (e.g., Repair trucks – dispersion?)
- Dispersal pathways

Lack of source for native populations?
Sample questions
Do powerline corridors function as an ecological source?
Is there greater species richness/diversity within corridor when compared to an urban area or natural habitat?
Are there more invasive or native species within the corridor when compared to a natural area?
Are there a greater number of pollinators, insects or other animals when compared to neighbouring areas?
Is the powerline corridor heterogeneous or homogenous throughout its length?
Are sections of corridor surrounded by urban habitat different in composition (vegetation or animal) than areas surrounded by natural habitat?
Are there edge effects?
Is there a difference in composition between the center of the corridor, the edge and a neighbouring area?

Resources


**WKS 4-6. Fieldwork**

**Location:** Meet in the lab then go immediately to field sites.

**Tasks:** Collect your datasets. Enter in the field.

**Products:** Provide/show excel file to teaching assistant every week to solicit feedback.

**Description**
Do your experiments and collect datasets.

**Products**
Excel data files.
Meta-data templates now completed.
Field notes or myexperiment.org project with workflow to show teaching assistant.

Remember, these products in their final forms will be graded. Get all the feedback you need/want now from the teaching assistant to capture the best scientific workflow and set of macroprocedures you can now.
WK7. Discussion & report planning in lab.

Location: Meet in the lab.
Tasks: Analyze datasets, meet with teaching assistant, present preliminary findings to lab, and plan report writing.
Products: Visualizations of findings and outline for papers.

Description
1. Work in the lab on analyses.
2. Each group should meet with teaching assistant in the first 1.5 hour.
3. In the remaining time, discuss findings as lab and plan reports.

Products
At least one plot of findings and outline for paper.
Dataset on figshare with doi and link.
One of your plots on plot.ly to share with the lab and/or teaching assistant.
WK8. Hand in report & discuss systematic reviews.

Location: Meet in the lab.
Tasks: Hand in lab report by 230pm. Discuss systematic reviews and critique several published examples.
Products: An outline and visual sketch of how a systematic review is done.

Description
1. 230-245pm. Hand in reports.

2. 245pm to 430pm. Lecture by teaching assistant on systematic reviews. PRISMA reporting, Web of Knowledge, and the Cochrane Collaboration.

3. Critique of several published examples of systematic reviews.

Products
At least one sketch of the concepts associated with a systematic review.

Resources
1. PRISMA: http://www.prisma-statement.org

2. The Cochrane Collaboration: http://www.cochrane.org

3. The handbook for systematic reviews: http://handbook.cochrane.org

4. The Centre for Evidence-Based Conservation: http://www.cebc.bangor.ac.uk


6. PLOSONE guidelines: http://www.plosone.org/static/guidelines#systematic

**WK9. Propose topics for review.**

**Location:** Meet in the lab.

**Tasks:** Propose topics to class. Discuss execution, data collection, & write-up.

**Products:** An Excel file prepared for processing all the publications for topic.

**Description**

1. Propose topics.

2. Discuss as lab.

3. Lecture by teaching assistant on how to process papers, enter data about the papers, and write-up your systematic review paper.

**Products**

Final sketch of design, excel file or table for entering attributes from papers, and statement of purpose for each of your systematic reviews.

Sample PRISMA report. This will be graded (final version) so get feedback now.
WK10. Work independently online, download pdfs, process primary-research papers.

Location: Work independently.
Tasks: Secure all primary-research papers on topic, download them, read them, process for key elements, enter data into Excel file, analyze findings, do at least one plot.
Products: At least one visualization of findings from systematic review. Post to figshare, blog, or email to teaching assistant for feedback.

Description
1. Work independently and get all your papers, download them, skim/read them, and enter the data.

2. Generate at least one visualization from findings.

3. Post figure to blog, figshare, or send to teaching assistant for feedback now. Consider also sending her/him the data file as well for suggestions.

Products
Library of pdfs.
Excel dataset completed.
One visualization for final paper.
Helping you publish, discover, and reuse research data

Credit
Credit, through a citable publication, for depositing & sharing your data

Reuse
Complete, curated & standardized descriptions enable the reuse of your data

Quality
Rigorous community based peer review

Discovery
Find datasets relevant to your research

Open
Promotes & endorses open science principles & available to all through a Creative Commons license

Service
In-house curation, rapid peer review & publication of your data descriptions
WK11. Final meeting to resolve systematic review papers.

Location: Meet in the lab.
Tasks: Discuss any outstanding issues with your systematic reviews.
Products: Draft of review.

Description
1. Meet with teaching assistant and groups to clarify and/or resolve any questions.

2. Present any findings to lab for additional feedback or ideas.

Products
Draft of paper ideal. Teaching assistant will not have time to read them but if you have it in hand during lab, you can show her/him and get advice on how to improve now before it is due.
At the very minimum, bring your findings completed and show them to lab group and teaching assistant.
Plot.ly of main finding of systematic review.
Dataset in figshare with doi and meta-data.
Environmental severity

(+)  \hspace{1cm}  (-)

Predators  \hspace{0.5cm}  Herbivores  \hspace{0.5cm}  Plants  \hspace{0.5cm}  Pollinators/Micro-organisms

Indirect interactions

(a) App. competition \hspace{0.5cm}  67
(b) Assoc. resistance \hspace{0.5cm}  17
(c) Expl. comp. & fac. \hspace{0.5cm}  10
(d) Indirect facilitation \hspace{0.5cm}  52
(e) Shared defenses \hspace{0.5cm}  1
(f) Trophic cascades \hspace{0.5cm}  1

Direct interaction

Indirect interaction

Future directions

Plant productivity

(+)

(-)
WK12. Hand in systematic review & discussion.

**Location:** Meet in the lab.

**Tasks:** Hand in lab report by 230pm. Discuss any outstanding lab issues.

**Products:** Systematic review paper.

**Description**
1. 230-245pm. Hand in reports.

2. Discuss big surprises as lab for 1 hour.

3. Compare your work to the published examples provided by teaching assistant.

**Products**
Your systematic review.
Published dataset.
PRISMA report.
Plot.ly figure
You made it, congratulations!