Biology for environmental management pocketguide

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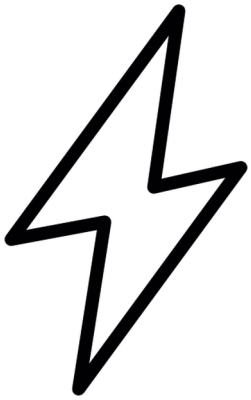
Contents

Chapter 1

Introduction



Welcome to biology for environmental management. The goal of this course is to examine global grand challenges that we face through the lens of solutions from science. Science can be magical because it provides us with incredible outcomes in so many domains of the human endeavour. Here, we work to find the magic spells from science for the environment to promote the well-being of people and the planet.

If you are electing to engage with this learning opportunity formally for BIOL4265 at York University, here is the official course outline.

There is an opportunity for us to mobilize science to do social good. We we can leverage what we know, what we do not know, i.e. uncertainty, and what we need to know, to enable conservation, protection, and better management of the environment. This benefits the environment. It benefits us. Here are the ten simple rules the underpin an evidence-informed philosophy for the entire course (Lortie and Owen, 2020).

Learning outcomes

1. Critically read environmental science peer-reviewed journal publications.
2. Reverse-engineer the critical reproducible science tools using peer-reviewed publications.
3. Appreciate the extent and scope of environmental challenges we face globally.
4. Explain the balance between direct human needs and environmental health.
5. Do a formal synthesis such as meta-analysis or systematic review.
6. Effectively communicate scientific synthesis findings to the public.

Structure

Module 1.

Read a total of 9 useful peer-reviewed science publications.
Test your practical knowledge by applying to a new challenge.

Module 2.

Choose your own adventure (i.e. a dimension of an environmental challenge you care about).
Draw a comic or infographic to communicate challenge to the public.
Write a short synthesis paper on this topic for a scientific audience.

Rationale

For each environmental management challenge case examined, students will be responsible for reading the literature provided at their own pace. The professor will facilitate learning as needed.

The goal is to become more literate environmental citizens and develop, consolidate, and evaluate critical environmental science thinking and problem solving.

The first module highlights some of the most pressing challenges and more common replicable tools used by the scientific community. The summative test is provided immediately at the start of course to enable asynchronous work and provide a clear, transparent, and testable outcome for this module.

The second module provides an opportunity for students in this upper-year offering to do a deep dive into a topic that care about deeply. The dimension of the challenge and the solution they pick is open provided it is well articulated. The graphical assignment is a stepping stone or scaffolding to the final paper.

It is also a chance to be as creative as students elect to be with communicating science to the public. The final paper is an Ignite, Forum, or Mini-review format contribution on their topic appropriate for a general science journal. These types of papers are increasingly common and important in science and used extensively for evidence-informed decision making by leaders.

License

Chapter 2

Outline

Here is an overview of the content and topics covered in this course of study. Complete are your own pace, asynchronously. However, please check the official course outline if you are doing the work for credit to ensure you submit summative work at the appropriate times.

Instructions

Read and and use the papers to link environmental challenges that we collectively face with potential solutions. Only one solution per challenge is suggested here, but there are many dimensions to each challenge and numerous solutions too.

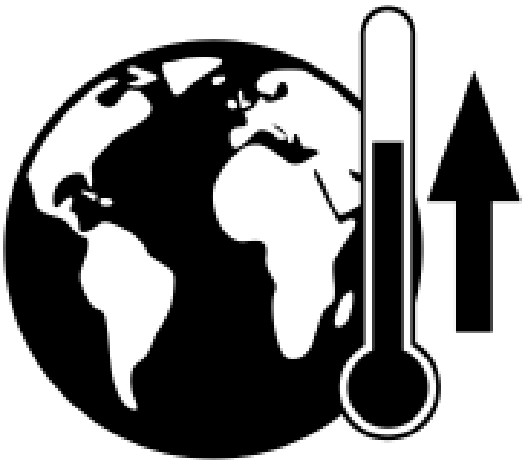
The link to decks are optional. They are my interpretation of the papers from a science-to-magic philosophy and identify the salient elements and concepts from each reading that resonated with my perspective as an ecologist.

Schedule

week	grand challenges
1	[Ten simple rules to facilitate evidence implementation in the environmental sciences](https://
2	[climate change](https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2010GL042845) & [
3	[pollinator declines](http://science.sciencemag.org/content/339/6127/1611) & [deck](https://fi
4	[invasive species](https://link.springer.com/article/10.1007/s10530-017-1461-x) & [deck](https:
5	[land use challenges](https://esajournals.onlinelibrary.wiley.com/doi/full/10.1002/ecs2.2367) &
6	prep for test
7	[take-home test](http://www.nrcresearchpress.com/doi/10.1139/cjfas-2016-0520#.W6Uwoy-ZM
8	choose your own adventure (i.e. challenge): search lit, read, sketch ideas
9	complete & submit scientific comic or infographic
10	choose your own adventure: write paper (review, systematic review, or meta)
11	choose your own adventure: write paper
12	choose your own adventure: submit final synthesis paper

Chapter 3

Climate change



Learning outcomes

1. Explore one set of dimensions associated with a changing climate.
2. Link science for cities to your life.

3. Explore one tool that can enable replicable solutions.

Context

We experience weather but live with climate. Climate is complex. Climate change has both effects on us and is a response to many drivers including anthropenic processes. The reading provided examines urban effects specifically (McCarthy et al., 2010). Use the ten simple rules suggested to structure your analysis of this paper (Lortie and Owen, 2020). There is at least one solution that can enable better science. Replication and being able to test the same ideas again can be done using an open-source, and free, programming language to work with data, draw plots, and do statistics. R is one such tool, and it can be used to promote solutions for others to try with their challenges because the code can be shared (i.e. fondly recall math classes, show your work), and this documentation of science using data improves our solutions (Lortie, 2017).

Reflection questions

1. What are some of the other dimensions of climate change?
2. What tools or other solutions do scientists in many fields use to address a changing climate?
3. What is the biggest challenge of this issue that must be addressed and would R help?

Formative checklist or steps

1. Read the paper.

2. Consider the questions provided, to guide your thinking and practice implementing evidence to do magic (i.e. potentially use science to address challenges). These are not graded, and the purpose is to reflect and actively engage with readings.

3. Review the slide decks (optional) after you read and consider the two papers to see if similar concepts resonated with you.

Chapter 4

Pollinator declines

Learning outcomes

1. Appreciate the relative importance of pollinators globally.
2. Identify the links between pollinators, plants, and functional ecology.

3. Explore one tool that can enable replicable solutions.

Context

We need to eat. Pollinators provide many fundamental ecological services including interactions with plants that we use for crops and sustenance. Most

flowering plants are not wind pollinated. This reading explores co-occurrence patterns between plants and pollinators to document long-term declines (Burkle et al., 2013). Not great news. However, there are solutions - many. One of the most exciting to me is citizen science. Citizen science is a powerful tool for conservationists (McKinley et al., 2017). It is also profound because we are all citizens, together, and scientific thinking comes naturally to humans. We love to count, observe natural systems, and have strong inherent tendencies to connect with nature. This is a solution for many global grand challenges associated with the environment.

Reflection questions

1. Does the species/taxa of pollinators matter?

2. Citizen science can measure processes, but can it also be used to help conserve or protect or restore too?

3. How can citizen science at universities be better enabled? How do we link what we learn with what we do?

Formative checklist or steps

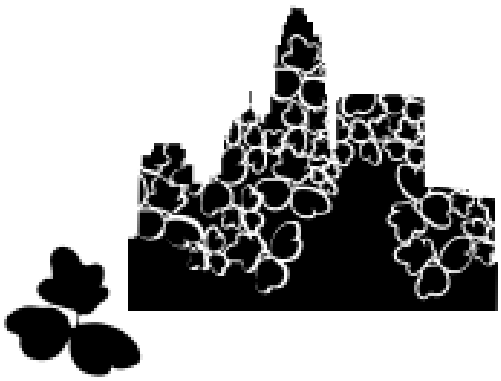
1. Read the paper.

2. Consider the questions provided, to guide your thinking and practice implementing evidence to do magic (i.e. potentially use science to address challenges). These are not graded, and the purpose is to reflect and actively engage with readings.

3. Review the slide decks (optional) after you read and consider the two papers to see if similar concepts resonated with you.

Chapter 5

Invasive species



Learning outcomes

1. Be able to define invasive species.
2. Describe some of the ways that ecologists test invasive species.

3. Examine whether a grand challenge needs a small or large (even global) team.

Context

Invasive species are a global issue. Introduced species that become invasive can dramatically and irrevocably modify ecosystems. The paper provided here is an exceptional example of leveraging fundamental science, i.e. biogeography, with the contemporary study of this issue (Nielsen et al., 2017). To study a species from one place in another, particularly between continents, teams in science can do the work more efficiently and more effectively. Team science is thus a logical solution to this issue (Goring et al., 2014). As you know from your science work, collaboration is not always easy though particularly when the work is being evaluated - whether in a class for groupwork or by a university of its researchers or by funding agencies in contrasting the merit of a researcher. Working with others to tackle global grand challenges is critical, but we also need to adapt how we value work in teams in science.

Reflection questions

1. What is biogeography?

2. Are invasive species always 'bad' or problematic?

3. How we up-value scientists that are more inclusive and collaborative?

Formative checklist or steps

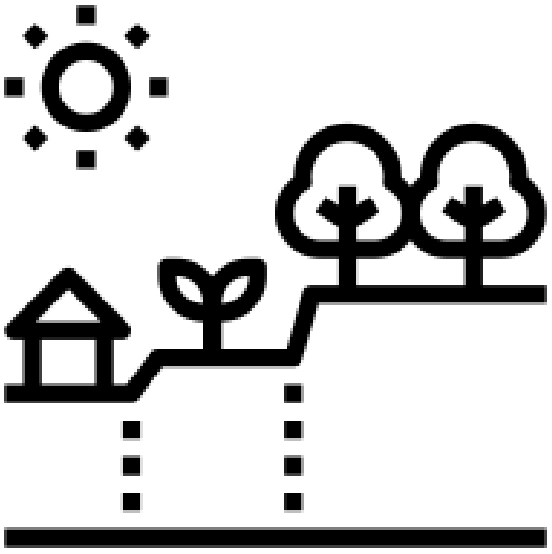
1. Read the paper.

2. Consider the questions provided, to guide your thinking and practice implementing evidence to do magic (i.e. potentially use science to address challenges). These are not graded, and the purpose is to reflect and actively engage with readings.

3. Review the slide decks (optional) after you read and consider the two papers to see if similar concepts resonated with you.

Chapter 6

Landuse challenges



Learning outcomes

1. Be able to describe and differentiate restoration from other challenge & solution categories.
2. Explore one set of ideas that link land use to people.

3. Understand some of the variety of synthesis tools available to contemporary scientists.

Context

Land is a commodity. We compete with plants and other animals for space. Land literally provides the space for most components of human society through provision of direct and indirect ecosystem services. In the challenge reading, a synthesis of the restoration research for drylands in California was summarized (Lortie et al., 2018). The technique or replicable solution used was a formal systematic review, but there are many such synthesis tools (Lortie, 2014). Synthesis tools provide the big picture to frame questions and evaluate the relevant merit or at least frequency that scientists use one technique versus another.

Reflection questions

1. Is better late than never possible for many other ecosystems in addition to drylands?

2. Why was the direct human dimension of restoration in drylands not examined in this case study challenge?

3. What synthesis technique described in the solution paper best matched your thinking style?

Formative checklist or steps

1. Read the paper.

2. Consider the questions provided, to guide your thinking and practice implementing evidence to do magic (i.e. potentially use science to address challenges). These are not graded, and the purpose is to reflect and actively engage with readings.

3. Review the slide decks (optional) after you read and consider the two papers to see if similar concepts resonated with you.

Chapter 7

Test prep

Learning outcomes

1. Be able to select your own solution to an environmental challenge.
2. Appreciate that there are many dimensions to every challenge.

3. Write a clear, short description linking a replicable tool to a challenge studied in the scientific literature.

Context

Lakes and other bodies of water are our natural canary-in-the-coalmine tools to examine many components of global change. Here, the test paper is provided in advance (Vogt et al., 2017).

Use the 'ten simple rules to facilitate evidence implementation…' (Lortie and Owen, 2020) and 'ten simple rules for more objective decision-making' (Fletcher et al., 2020) to structure notes and test prep.

Steps for test prep

1. Read the challenge paper.

2. Make a list of all the solutions that they used.
3. Select one solution, find a paper about that solution, see test question.

4. Re-read the ten simple rules that underpins this course and read the ten simple rules for making better decisions too.
5. Go to next chapter in this resource for the test.

Chapter 8

Test

Instructions

1. Read this paper (Vogt et al., 2017).
2. Answer the following questions.
3. Use **no more than on page per answer** with at least an 11point font, 1inch margins, and single-spacing.

Test questions

1. Describe the environmental management challenge case associated with this topic and publication. In the summary, please ensure that you cover the following:

(a) link the basic science to the management (i.e. explain what the authors tested & measured and then how this can relate to management),

(b) highlight the extent (i.e. explain if it is a global, regional, or local issue and why), and

(c) propose the implication of ignoring this issue.

total = **10** points.

2. Describe why this is not an environmental management challenge – i.e. play the 'devil's advocate' because we know this happens all the time or more fairly every environmental issue is a balance between direct and indirect benefits from a natural system. Do not use fallacious arguments or *ad hominem* to do this. Use the following lines of argument:

(a) list 2 critical limitations of the study (or what viable improvements are needed),

(b) highlight the direct needs of people for the system/idea/issue and explain,

(c) explain a 'hope for the best' strategy that maximizes direct benefit to humans and propose an argument for the resilience/recovery/buffering of the system without a big change (i.e. business as usual model).

total = **10** points.

3. Reverse engineer a general, replicable solution to this challenge.

(a) list solutions beginning with the most evident in descending relevance order,

(b) propose and explain the replicable solution that is most relevant based on research,

(c) cite the research you did to design your replicable solution by providing the citation to two solution papers and include just a single sentence for each explaining why you selected that paper as evidence.

total = **20** points.

Format for answers

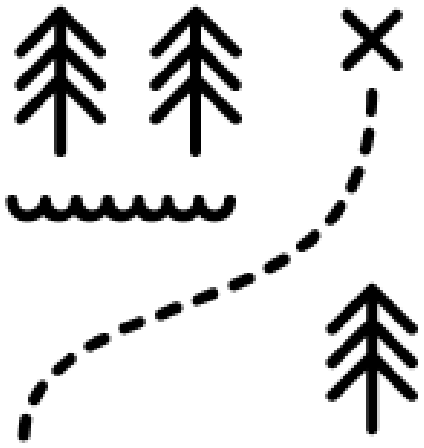
1. Write in full sentences, no more than 1 page per answer.

2. Total of 3 pages :).

3. Include your name, surname, and student ID at the top of each page.
4. Work in your preferred text editor, but you must submit responses as a single file in PDF format only to turnitin.com. Class ID and key provided in the official course outline.

Chapter 9

Synthesis science



Learning outcomes

1. Develop your capacity to review scientific literature and scope critical ideas.
2. Turn your passion and interests into formal scientific evidence for social good.

3. Synthesize peer-reviewed science papers.

Context

Time to choose your own adventure. Flex your creativity. Apply your critical thinking skills to an environmental challenge that is important - to **you**! Find your science-to-magic workflow and do a scientific synthesis. The United Nations Sustainable Development Goals (i.e. SDGs) are a perfect place to begin. There are a total of 17 goals describing 169 targets as of 2021. Virtually every single goal is directly or indirectly tied to the environment. Some, are very direct such as clean water, life on land, life below water, climate action, zero hunger, and poverty. We need natural systems to sustain and support these goals. Natural systems now need us, and now you here, to summarize the scientific evidence for some focused element of a goal. This is a just a suggested focus - any environmental management challenge is fair game for synthesis and certainly will benefit from the process.

Synthesis

Scientific synthesis is big picture science that describe a set of studies on a pinpointed topic (Lortie, 2014). There are at least three simple and direct options that are amenable to a capture of the research associated with the environmental challenge you identified.

(1) Narrative review as a highlight, short commentary, or new idea paper that is a snapshot of the key findings from a field research summarizing the main discoveries and/or listing the most critical research gaps. Papers like these are often called **Insights**, **Forum**, or **Ignite**.

(2) Systematic reviews are similar to narrative reviews, but clear criteria are listed explaining how you selected papers (i.e. these search terms used in the Web of Science, only studies that had these key inclusion attributes, etc.). Systematic are more replicable because others could follow your steps and get the same set of papers and hopefully reach similar conclusions about the corpus of evidence. These reviews also typically provide some simple quantitative data about the set of studies such as number of countries where the research was done, total sample sizes, number of variables examined, or any attributes that describe what the research was for a specific detail. The narrative component is similar to the first option because it can state what we know and what do not but these reviews do so *much* more precisely. Even a few numbers go a long way to convincing people about the extent that we know or have studied a subject in science. Papers like these are often termed **Short Commentary** or **Mini-Review**.

(3) Meta-analyses are systematic reviews plus for each primary study you summarize, you capture the relative efficacy of the treatment tested. Papers like this are often termed **Reviews** or **Meta-analyses** but other terms can be used too. Note: in some fields of research the terms 'systematic review' and 'meta-analysis' are used interchangeably, but in most envi-

ronmental sciences, meta-analyses always have a measure of the strength of evidence from each studied included in the synthesis whilst systematic reviews typically do not.

So for instance, narrative review might provide insights into vaccine research and reported that we have tested three vaccine types but need to test more alternatives. A systematic review would state this too but mention how they checked the science, i.e. we checked 100 papers using these terms x,y, & z in Web of Science, and it might also state how many people were tested in total in all studies. This is thus a more powerful synthesis. However, the gold standard would be the meta-analysis that can summarize all of the above but also reports how well each vaccine type tested actually works on average across all the studies for each one.

Summary of options

synthesis	elements
narrative review	summary, insights, next steps
systematic review	summary, insights, next steps, explanation of how studies were selected in the review, can hav
meta-analyses	all of above possible but must also include an assessment of the strength of evidence of each s

Steps

1. Review the 17 SDGs.
2. Familiarize yourself again with the scientific synthesis options that can describe and capture the state-of-the-art research for any environmental challenge.
3. Select a topic that you care about.
4. Check Google Scholar and/or The Web of Science trying different terms.
5. If too many studies still, filter than to most cited or the last three years of research only.
6. Get those papers.
7. Do a quick read of at least the abstracts.
8. Take a break.
9. Reflect on the environmental challenge you want to tackle and ensure the terms you used and the papers you have are studying the dimension of the challenge you want to summarize.

10. Go for it. Decide if it makes sense to do a short narrative, systematic, or meta.

11. Compile whatever evidence you need from the studies to do a,b, or c (ie ideas and concepts, count up factors or replicates, or for a meta, do they all or most report similar data and list a mean and sample size you can use).

12. Move onto next step - infographic or comic.

Outcomes from this work

1. A clear vision of the challenge you want to tackle.

2. A set of ideas, papers, and the outcome you ultimately provide.

3. The evidence you need to work some magic - ie to draw a comic/infographic and then write a very short paper using one of the three formats (narrative, systematic, or meta).

Chapter 10

Scientific communication

Chapter 11

Meta-analyses

Chapter 12

Paper writing

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