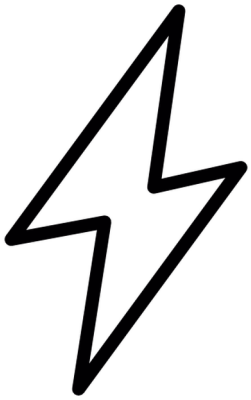
Biology for environmental management pocketguide

cjlortie

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.

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).

Course outline

If you are electing to engage with this learning opportunity formally, please see the official course outline for specific details.

There are three summative assessments.
1. Test (apply the challenge-solution framework).
2. Make a scientific comic or infographic for a new challenge of your choice.
3. Write a super short ignite synthesis paper.

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.

Steps

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.

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Topics

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.

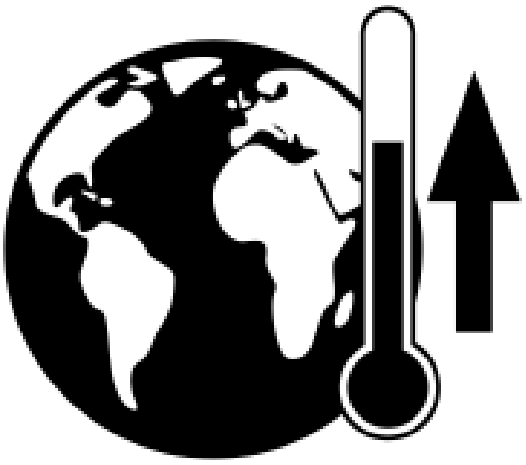
The link to decks are optional. They are my interpretation of the papers from a science-to-magic philosophy and identify the salient elements and concepts from each reading that resonated with my perspective as an ecologist.

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](https://www.facetsjournal.com/doi/full/10.1139/facets-2020-0108)
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 2

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 3

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

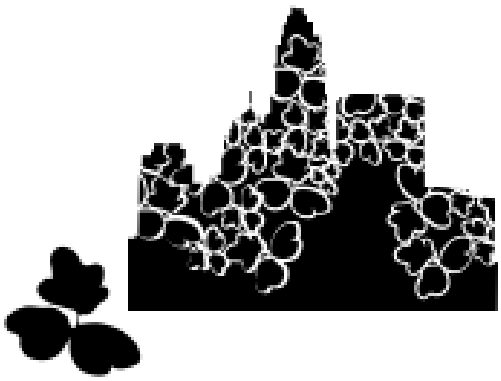
1. Read the paper.

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 4

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

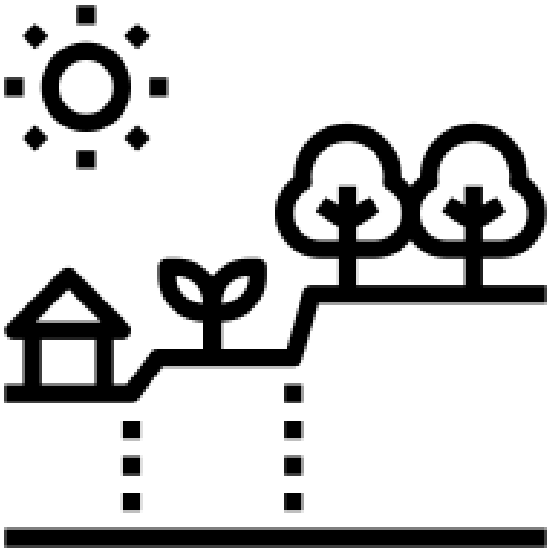
1. Read the paper.

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 5

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 6

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

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 provided in the test chapter herein.

2. Make a list of all the solutions that they used or could have considered.
3. Select one solution (a novel one not discussed yet), find 1-2 papers about that solution and 1-2 similar papers to the challenge, see test questions.

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.

General worflow for take-home tests

Traditional formative assessments such as in-class tests or exams are well understood. The rules of the game and extent of practice and experience with them vary from person-to-person, but most schools still adopt fixed-duration testing with limited to no access to outside materials. Open-book tests are common as well and typically include some access to resources such as notes or course materials but can also include open and online resources. The take-home test is a powerful and positive summative assessment instrument. However, effective study and prep can not always be clearly described for the learner. Strengths can include full and open access to materials online, experts, collaborative input, and adequate time to do deep work and think with reflection on insightful answers. Nonetheless, a limitation can be divergent expectations between student or learner and the graders. A take-home test is a bit of a chimera because it includes components of routine work, thinking, and depth associated with essays and papers but is nonetheless at times designed more as test with specific questions, Hence, a short primer on some ideas to consider from a workflow perspective are provided herein.

1. Read the test in advance and give yourself time to ruminate, reflect, and ideate.

2. Review test questions and ensure that you read all questions to the end before starting work.

3. If there are readings, compile and collate them in advance so you have everything you need in one place.

4. Review the rubric.

5. Reverse-engineer this rubric to populate a list of terms, ideas, or visual-text hooks (keywords or concepts) that a grader will likely seek in refereeing your work.
6. Open book = open information. Take advantage of related ideas, papers, reviews, and commit the appropriate and most parsimonious amount of time to secure supporting resources.

7. Set a time limit for specific tasks and block your time into meaningful chunks with clear intermediate-level goals. For instance, get papers in one block, review rubric in another, etc.

8. Write, take a break, and check rubric. Check your writing for clarity. If there are synthesis, design, or principle responses, step back, and consider high-level critical thinking elements or rules associated with good research planning.

9. Consider triage answers that do not match your cognitive style, expertise, or are dissatisfied with the response. Use point value and relative weighting to decide if there better ways to allocate your time or select between questions to submit if provided.

10. Simple, but review the instructions on formatting, submission, and guidelines for the format of the work. Submit.

Chapter 7

Test

Steps

1. Read this paper (Custode et al., 2021).
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.

Q 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).

Q 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 (with your novel one listed firstly),

(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 at least two solution papers and include just a single sentence for each explaining why you selected that paper as evidence. Additionally, include 1-2 papers, cited, that show it is an important and general challenge (see rubric). Ideal - a total of 4 citations, minimum 2 (depending on how well the citations fit with how you defined the bio4enviro challenge-to-solution workflow).

Q total = **20** points.

Instructions

1. Write in full sentences, no more than 1 page per answer.
2. Total of 3 pages :).

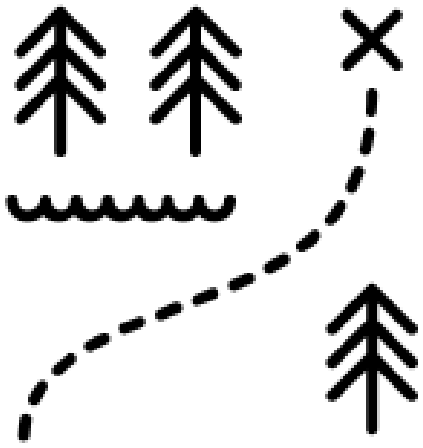
3. Include your name, surname, and student ID at the top of each page.
4. Work in your preferred text editor, but you must submit responses as a single file in PDF format only to turnitin.com. Class ID and key provided in the official course outline.

Rubric

item	concept	description
1	Q1a basic science	explain what was tested and measured
2	Q1a basic science	explain how this study relates to environmental management
3	Q1b extent	explain extent - global regional local and WHY
4	Q1c ignorance is bliss	propose implication of ignoring issue altogether and not managing
5	Q2a limitations	list 2 scientific limitations of study
6	Q2b direct needs	explain what people need from this system directly
7	Q2c strategy	propose a hope for best minimal management strategy for challenge
8	Q3a solutions	list at least 3 big picture reproducible solutions or tools and explain how each can
9	Q3b top solution	explain the top solution or tool to challenge based on your research i.e. at least on
10	Q3c citations	cite at least 2 (ideally 4) recent relevant papers - 1 or even 2 solution papers and 1
11	total	sum of above

Chapter 8

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

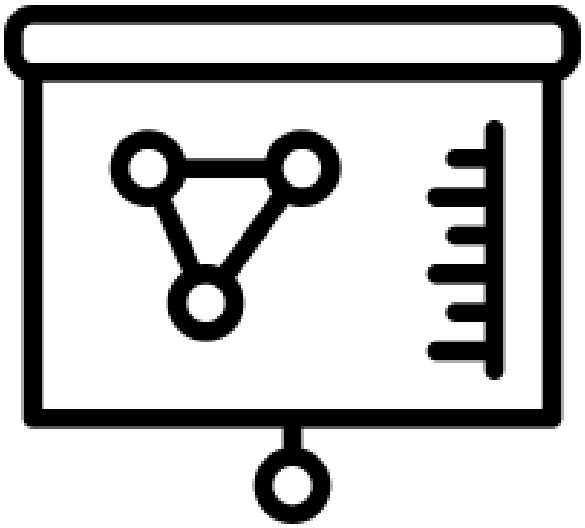
1. A clear vision of the challenge you want to tackle.

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 9

Scientific communication



Learning outcomes

1. Practice your communication skills.
2. Be creative.

3. Simplify complex scientific evidence appropriately.

Context

Scientific communication is now its own field of research and activity. It is critical that biology for environmental management promotes better communication. Without effective delivery of evidence, decisions that need science will struggle. Here, we use ten simple rules for scientific comics (McDermott et al., 2018) to inform our sharing the scientific synthesis work began in the previous chapter. Simplication of science and aggregation of complex evidence is not a trivial skill. It is a challenge to respectfully communicate science but ensure it is accessible to a wide audience. Comics are perfect. Infographics are also powerful, and they are typically more complex information but compile findings still very visually. A comic tells a story and shares the science whilst infographics are also visual but connect ideas in a mini-poster format to the share evidence. Here are examples of the very best from the journal Nature.

Instructions

This is a stepping stone assignment or scaffolding to recognize the work you have already done in preparation for your short synthesis paper. It also provides an opportunity be more visual, tell a story, be funny, or present the key evidence you found in an infographic.

If you elect to do a comic, you can draw by hand then scan it or sketch using a digital tool.
If infographic, try using a free online tool, Keynote on a Mac, or PowerPoint to draw a single-slide and put your key evidence there.

1. Use your evidence from your synthesis.

2. Pick a few key points. Tell a story visually.
3. Save to PDF (only this format will be accepted) and submit to turnitin.com. Class ID and key provided in the official course outline.

Rubric

item	concept	description	va
1	clarity	clear and informative visuals, compelling or funny and accessible graphics	
2	science	transparent science such as challenge-to-solution paradigm developed herein	
3	synthesis	big ideas put together effectively summarizing the field	
4	conclusions	conclusion, punchline, implication stated well	
11	total	sum of above	

Chapter 10

Meta-analyses

Learning outcomes

1. Examine scientific findings from a strength or evidence, big picture viewpoint.
2. Practice critical thinkings in evidence reuse in the sciences.

3. Be able to read evaluate published meta-analyses.

Context

As described in the 'scientific synthesis' section in this course, there are at least three contemporary tools available to a synthesis scientist in the environmental sciences. Narrative reviews are most effective when they briefly highlight key findings for a small field of research or identify critical gaps. Systematic reviews are more significant contribution to knowledge engineering because they provide the blueprint for replication, i.e. they describe how they selected the studies they summarized, and also because they provide more specific evidence. Finally, meta-analyses are the gold standard. For the purposes of this course of study, biology for environmental management, any of these three options are within reach. Nonetheless, metas can be demanding in time, and if you elect to tackle your environmental challenge with this tool, I recommend a very limited and restrictive set of studies. This can be done using very precise terms in The Web of Science or Google Scholar and/or limiting returns of papers to only the top 10-15 most cited or more recent 2-5 years. The capacity to critically examine a published meta is an invaluable asset to becoming a more literate citizen. The paper 'How to critically read ecological meta-analyses'(Shrier, 2015) is a resource developed for that purpose. Here is another 'how-to-read' published metas, and finally, if this is the synthesis tool for you, here is recent practical guide how to do meta-analysis (in eight steps).

Steps for this component

1. Read the suggested how-to paper.

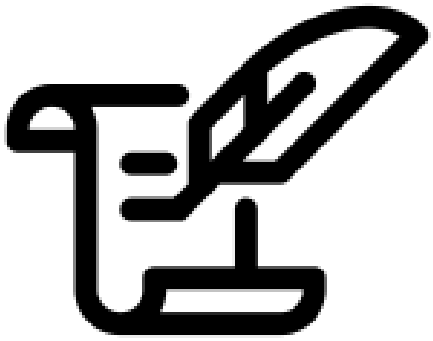
2. Compare and contrast the evidence you compiled for your synthesis and used for the comic or infographic and that you will use again for the final synthesis paper with the 'how to critically evaluate meta' ideas proposed.

3. Decide what is most appropriate based on the evidence and reporting provided in those peer-reviewed studies.

4. Skip ahead to the 'paper writing' section of this course and the 'paper' section too for rubric and instructions to facilaite the best decision for what category of paper you select to write. All the very, very short, but each differs slightly in they handle and present evidence.

Chapter 11

Paper writing



Learning outcomes

1. Critically weigh evidence to decide how to best report it.
2. Write a short synthesis paper.

3. Consolidate and hone your writing to be logical and structured even when short.

Context

Writing is an art. Telling a story well, even in science, is a fundamental professional life skill. Being brief is a virtue. Integrating evidence into scientific writing without being overwhelming is ideal. Here, you can tackle this by reusing your environmental evidence for the challenge you selected. This is an excellent, brief set of guidelines to consider, in general, to consider for better, more clearly structured writing (Mensh and Kording, 2017). Yes, there is always room for improvement.

Specific this course, you must choose narrative, systematic, or meta. This might have been decided right-up-front because of the nature of the challenge and the evidence that was reported in the papers you compiled. For instance, there was limited data you could extract from the papers, each paper tackled the same challenge but did so very differently, or it was not tractable to process the evidence more formally either then identifying what we know, do not, or where to go.

Steps for this component

1. Find your style.

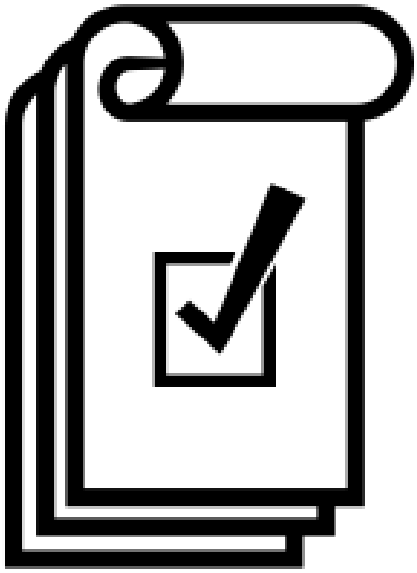
2. Organize your thoughts.
3. Decide if you need a single, simple graphic to support your paper.

4. Write your draft, rapidly, now. Correct later. Let is sit for while. Aim for <2500 words.

5. See final instructions and rubric in next section.

Chapter 12

Paper



Learning outcomes

1. Produce a clear, succinct summary of research.

2. Demonstrate mastery of evidence implementation for the environmental sciences.

3. Appreciate the challenge of effective simplification in the sciences.

Choices redux

(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 environmental 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.

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

Bottom line

Narrative review = Insights, Forum, or Ignite style paper common in current journals.
Max 2000 words (not including lit cited)
10-15 references

Highlight what we know, what we do not or a key gap we need to study (ie insights)

Systematic review = Short Commentary or Mini-review format in journals.

Max 2500 words (not including lit cited)
10 references

A few key quantitative details of the research literature such the frequency a specific concept is studied, total sample sizes or counts of variables measured. This is a comment on what we know with some evidence in numbers.

Meta-analysis = Review or Meta-analysis format paper.
2500 words (not including lit cited)
One figure plotting main finding of mean effects, i.e. a "Forest plot"
15 references

Find 5-10 papers that have the same data reported in each that you can use, get the means, r2, n or whatever is reported similarly, calculate a simple effect size such as ratio of treatment over control or a proportion that an intervention helped, plot this outcome, and write short paper commenting how well an intervention in the environmental sciences works (i.e. adding water to restore deserts or excluding cattle, one direct and simple variable that you care about)

Whatever format you elect to use the goal is to provide a super short & sweet synthesis of the research and clearly demonstrate that you used scientific evidence from papers that critically informs better environmental management choices.

Instructions

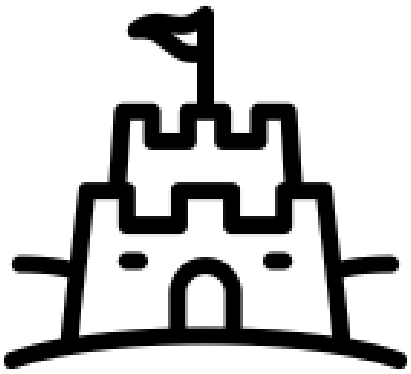
1. Select your format for paper. Here is an excellent example of guidelines for a world-class journal. ALL are short.
2. Find a few examples of that type of paper. Read them.
3. Include your name, surname, and student ID at the top of each page.
4. Strict adhere to word limits. A total of three short paragraphs, no more.
5. Write your paper in preferred text editor, print/save to PDF, save and submit to turnitin.com. Class ID and key provided in the official course outline.

Rubric

item	concept	description
1	title	clear and relevant
2	introduction	one paragraph, short and direct, states the environmental challenge, why we should care,
3	main text	one paragraph, state main findings for whatever format you selected
4	implications	final & single paragraph as well, state the meaning of what you found, how it can used, w
5	literature cited	10-15 references depending on type of paper, relevant, useful evidence, mostly recent i.e. l
6	transparency	clear writing, results, counts, plot or data clear if included, transparency in how evidence
11	total	sum of above

Chapter 13

CREATE



Learning outcomes

1. Creatively read scientific literature.
2. Hone your critical thinking.
3. Develop a new set of tools for processing readings.

CREATE philosophy

Science is creative. Reading scientific literature can also be a creative process. Active reading includes highlights, annotation, and note taking. These approaches to reading and study can increase retention, comprehension, and engagement with scientific ideas. However, the teaching philosophy and pedagogy of CREATE is novel and relevant and takes this one step further. **CREATE pedagogy** stands for **C**onsider, **R**ead, **E**lucidate the hypothesis or purpose, **A**nalyze and interpret data or evidence, and **T**hink of the next **E**xperiment. This reading process is creative, active, and phenomenal practice for all professional work.

If the process seems useful to you, please give it a try for this course. This work is **optional**, but it is literally only 5-10 minutes extra per week. Here are some proposed exercises for you to consider to test out the CREATE approach. If there is time in lectures, we will do them together. Use paper, Powerpoint, or any sketching digital tool you prefer to write or draw. If you elect to try them out and want to submit them as well, **optional**, there are spots provided in turnitin.com.

CREATE applications

example	CREATE application	instructions
1	new title & abstract	write a catchy, compelling alternative title to the rea
2	concept map	draw a Venn diagram, flowchart, or any type of visua
3	cartoon summary	draw a fun cartoon summarizing the reading, infogra
4	novel questions	a good reading or paper should generate as many ne
5	made-up data & predictive plotting	sketch a plot of data or relationship you would like t
6	experimental cartoon	sketch the experiment, schematic of methods describ
7	visual worflow	propose a next experiment to a paper as a simple wo
8	pros-cons table	make a short table summarizing the strengths and w
9	figure-legend improv	provide a figure legend for a data visualization from
10	best-sentence competition	from a paper, select a single sentence that resonated
11	shark tank	run a debate or shark tank of a published paper, use
12	KISS principle	keep it simple scientists, propose a simple, one-factor

Chapter 14

Life

Action

Make it count! Help those around you use scientific evidence to inform their decisions. Science can support better decisions in health, the environment, social policy, and all domains of the human endeavour. We need to make better decisions, and we can do it. Use your creative spirit and now finely-honed critical thinking. Be on the lookout for solutions. Frame problems in life, big or small, as challenges. Seek solutions in the obvious and in the novel. Less is more. Often the simplest fix is the best. Good luck, and I hope you enjoyed these materials and this course as much I did.

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