Review questions for Wetland Ecology

Welcome! These are review questions for the second edition of *Wetland Ecology*: *Principles and Conservation* (2010, Cambridge University Press). Please feel free to share them. If can answer these questions, you have mastered the material in the book. Instructors may also find these questions useful in preparing exams. If you find oversights, or have suggestions for improvement, please contact the author and I will update them. Note that questions in *italics* are supplementary, and not directly answered in the book.

Chapter 1

1. Give a concise definition of a wetland. What are the three key components of the definition, and how is each related to hypoxia?
2. Draw a soil profile in an wetland, and contrast it with a terrestrial soil profile. Explain the main outputs to the atmosphere from each. (p.16)
3. What is meant by the term causal factor? By definition, a wetland has flooding as the primary causal factor. List three other casual factors.
4. There are six types of wetlands. Name each kind, and provide a brief description. (p. 5-6) Give 1-2 causal factors for each type of wetland.
5. Distinguish between a swamp and a marsh, using the definitions in this book. Explain how increasing water level can turn a swamp into a marsh.
6. What is aerenchyma? What is its function? Draw a labelled cross section of a plant stem showing aerenchyma.
7. List the world's ten largest wetlands. Distinguish between those that are floodplains, and those that are peatlands.
8. List five services performed by wetlands. Distinguish between a regulation service and a production service.

Chapter 2

1. What is a flood pulse? Give some examples of plants or animals that are adapted to flood pulses.
2. How do temporary high water levels increase wetland area? How do temporary low water levels increase wetland area? What are the long-term consequences of completely stable water levels?
3. What is a wet meadow, and how are they dependent upon flood pulses?
4. Describe the downstream effects on wetlands when a dam is built on a river. Explain the historic example of the Peace Athabasca. *Find another example near your community.*

Go online to see if you can find more information about the new dam proposed for the Peace-Athabasca.

5. Define a peatland. Why does peat accumulate in a landscape? How does peat accumulation affect the transition from a fen to a bog? What is an ombrotrophic bog?
6. What is a vernal pond? Give some examples of vertebrate species that depend upon vernal ponds.
7. Why are fish-free ponds necessary for the reproduction of many kinds of frogs and salamanders?
8. *Watch this very short you film mapping the installation of dams in the United States: https://www.youtube.com/watch?v=R8mz1o8aq1s. Give three likely consequences for wetlands and watersheds. Look online for a map showing the existing dams around the entire Earth.*

Chapter 3

1. What are the two main nutrients that determine plant production in wetlands? What is the principle reservoir for each, and how do they get into wetland plants?
2. Give an example of a wetland that is controlled by low nutrients. One of the best studied examples is the Everglades. What was the limiting nutrient in the Everglades?
3. Give some distinctive characteristics of wetlands that have naturally low levels of nutrients. (Don't forget to go back to Figures 1.17 and 1.18 in Chapter 1.)
4. What is a carnivorous plant? Explain why a plant would be selected to evolve the capacity to trap insects? What does the presence of a carnivorous plant tell you about environmental conditions in a wetland? *Where is the nearest population of carnivorous plants to your own community?*
5. Why is it usually harmful to add nitrogen to watersheds? Explain how nitrogen used in Ohio causes fish kills in the Gulf of Mexico. Explain how nitrogen used in animal feed lots is reducing the area of heathlands in Europe. Note that the first is based on transport by the direct flow from land to sea, while the second is based on atmospheric transport. What measures can be taken to reduce eutrophication?
6. Explain how calcium affects species composition in wetlands, independent of the effects of N and P.

Chapter 4 Disturbance

1. What is the definition of disturbance? What are the four properties of a disturbance? Explain how disturbance affects the species composition of wetlands for three of the following examples: fire, grazing, logging, waves.
2. Distinguish between the term "disturbance" and the term "perturbation".

3. What is a seed bank? How do seed banks enhance the recovery of vegetation after disturbance? Describe the importance of seed banks in prairie potholes (Figure 4.3). *What are some common seed bank species in your part of the world? As a laboratory exercise, collect some sediment from a local wetland and take the challenge of identifying the species that emerge. Are there animals that have a similar method of reproduction?*
4. Explain how rivers naturally reshape wetlands, and therefore enhance biological diversity. Don't forget to refer back to Figure 1.23.
5. Explain how fire creates diversity in the Everglades (Figure 4.6).
6. Leaf litter often reduces plant diversity. Explain how fire affects litter accumulation (Figure 4.7).
7. What is a prairie pothole (recall 2.3.4)? How does disturbance by muskrats shape the composition of vegetation in potholes?
8. Describe the impacts of logging on cypress swamps of coastal Louisiana.
9. Describe the role of hurricanes as a natural disturbance in wetlands. Give a minimum of four mechanisms, with examples.
10. Describe the role of mowing and peat-cutting in anthropogenic landscapes (look ahead to Figure 6.7 as well.).

Chapter 5 Competition

1. A surprising number of people think and write about competition as if it were symmetric. What is meant by asymmetric, or one-sided competition? Give three examples.
2. What is the definition of competition? Why are tall plants generally better competitors than short plants?
3. Explain how patch dynamics can allow a weak competitor to survive in a landscape with a much stronger competitor.
4. Explain how gradients can allow a weak competitor to survive in a landscape with a much stronger competitor.
5. Distinguish between a core habitat and a peripheral habitat in the centrifugal organization model. What processes may maintain peripheral habitats? How have humans affected peripheral habitats?

Chapter 6 Herbivory

1. How is herbivory a natural disturbance?
2. Probably the best predictor of the food quality of plants is nitrogen content. What is the typical nitrogen content of a wetland plant? *If a wetland is fertilized, what consequences might ensue for plants and herbivores?*

3. Use the example of muskrats and geese to demonstrate how herbivores potentially have high impacts on vegetation.
4. Explain how exclosures provide experimental evidence of the importance of herbivory. *Find an exclosure experiment in a recent scientific journal and describe how the exclosures were built, and what results were found.*
5. Distinguish between animals that eat living plants, as opposed to organisms that eat dead plants. Which group of herbivores process most of the plant material in wetlands?
6. Distinguish between top down and bottom up control of species composition. Give an example of each. Explain how large predators like alligators or wolves could control the plant biomass in a wetland.
7. A plant cannot run away from herbivores. So how do they defend themselves?
8. Explain how selective grazing can either increase or decrease plant diversity. How does competition play a role in determining the outcome?
9. What is the logistic model for herbivore-plant relationships? What is meant by P, g and K? Sketch the behaviour of this simple predator-prey model by plotting dP/dt (plant growth rate) against P (plant biomass). Note that the author of *Wetland Ecology* used dV/dt on the figure axis, but dP/dt in the caption. Don't make the same mistake. What is meant by a stable as opposed to an unstable equilibrium point?

Chapter 7 Burial

1. Distinguish between autogenic and allogenic burial in wetlands.
2. River deltas provide a striking example of allogenic burial. How do dams affect rates of allogenic burial and the growth of deltas?
3. Explain how pointed shoots, rhizomes and seeds each allow plants to recover from episodes of allogenic burial.
4. What is a levee? How do natural levees, as opposed to artificial levees, form? What is a polder? Why does building a levee cause a polder to sink? (p.197)
5. Why does peat accumulate in some wetlands? What are the approximate rates of burial in a peatland?

Chapter 8 Other Factors

1. Many coastal ecologists treat salinity as one of the most important causal factors in wetlands, while in this book I treat it as a secondary. What the four main types of coastal marsh arrayed along a salinity gradient?
2. What is a salinity pulse? Why are they associated with hurricanes?

3. What is meant by the term species pool? What is the effect of salinity on the species pool of plants? Explain using the example of mangrove swamps (mangal) compared with freshwater swamps.
4. Describe some of the negative effects road networks have upon wetlands. Consider both direct and indirect effects.
5. Explain what is meant by the term coarse woody debris. What are some effects of coarse woody debris in wetlands? What are some benefits of coarse woody debris on shorelines? *Why, then, do government agencies spend so much money removing coarse woody debris after storms?*
6. Many wetland form along small streams. Briefly describe the Rosgen stream classification system, with a focus on wetlands. Which combinations of causal factors produce the most wetlands along streams?
7. One could argue that all of the worlds conservation problems are rooted in human population growth. Consider the drainage of interior wetlands, the expansion of levee systems in alluvial wetlands, the building of hydro-electric dams, overfishing, and eutrophication. Explain how each one is linked to human population growth. *Look on the web to find the current population size of Earth. Which countries have the highest rates of population growth?*
8. Define mangal. How is it related to the term mangrove? Write a paragraph on the Sundarban mangrove swamp. Where is it? What are some important ecological characteristics? Describe its connection glaciers in the Himalayan Mountains. *What is the rare of human population growth in this ecological region? What is the current status of the tiger population?*

Chapter 9 Diversity

1. Distinguish between the term "diversity" and the term "species richness". What are the two formulae used to measure diversity?
2. List the four general causes of diversity in wetlands.
3. Explain how diversity changes with distance from the equator. Consider that the Amazon River basin, near the equator, has 1000 species of flood tolerant trees. Also consider Figure 9.14. *How many flood tolerant trees occur in your ecological region?*
4. Explain how topographical variation increases the diversity of a wetland. Use one or more of the following examples: coastal vegetation (Figure 8.7, Figure 8.9), peatlands (Figure 7.9), floodplains (Figure 2.12, Figure 7.7), the Everglades (Figure 4.6), freshwater shorelines (Figure 2.27) or prairie potholes (Figure 2.20).
5. What is the general relationship between species richness and wetland area? (p. 239). Explain the equation $S = cA^z$. What is a typical value for z? *Much of the original work on this topic was done on islands; explain how wetlands can be considered to be islands. If you double the size of a protected area, how many more species would you generally add?*

6. Now consider fish diversity. Explain how all of the above affect how many fish species are found in wetlands. Which three rivers have the most kinds of fish in the world?
7. Fish can also be a causal factor. Explain how fish can change the species composition of (1) insects, (2) amphibians and (3) wading birds.
8. What do Eskimo Curlew tell us about the role of overhunting in controlling bird species composition in wetlands? *Which species of waterfowl are now threatened by overhunting?*
9. There are more than 5000 species of amphibians in the world. What are some important factors that control their abundance in wetlands? (hint: think about salinity, topography, adjoining forests, presence of roads). *How many wetland amphibians occur in your ecological region?*
10. Sketch and explain the intermediate biomass model for plant diversity in wetlands (Figure 9.15). Why does high biomass often lead to low diversity? Explain how eutrophication can cause high biomass.
11. What is a species pool? What does the Eriksson equation tell us about the relationship between the pool in the landscape, and the actual number of species seen in a particular wetland? *Find a list for your ecological region of the species pool for fish, birds, amphibians, and plants. Can you determine the pool for groups of insects such as butterflies, dragonflies or beetles?*
12. What is the IUCN Red List? Which groups of organisms have the most species at risk? *Find three examples of red-listed species in your ecological region.*

Chapter 10 Zonation

1. Why are wetlands on shorelines useful tools for studying wetland ecology? Define the term zonation. Discuss the relative importance of factors including flooding, sediment type, competition and herbivory in producing wetland zonation.
2. At which elevation on a typical shoreline is primary production highest (Figure 10.2)? At which elevation is plant diversity highest (Figure 9.9)?
3. Define the term succession. Often, people carelessly assume that zonation is 'succession'. What is the untested assumption that they making?
4. Distinguish between the terms ecological and physiological response curve. When you see a plant zone in a wetland, you are seeing the only the ecological response curve. What kind of experiment would be needed to obtain a physiological response curve?
5. Many wetland plants actually grow somewhat better at high elevations than those in which they normally occur (Figure 10.9). Why might this be the case? Explain how a wetland plant might be termed a "stress tolerator" and how shallow water might be a "refuge" for weak competitors.
6. Give one example of a positive interaction that might explain species distributions in a wetland.

7. Sketch the four typical zones of a New England salt marsh. *Sketch the zones from a wetland near your own community.*
8. Shorelines with rising sea levels have some distinctive features. Draw a labelled sketch illustration of such a shoreline. What are the rates of change of sea level on a shoreline nearest your community?
9. What are four properties that can be quantitively measured in plant zonation patterns?
10. Explain what is meant by the term boundary clustering. How are the data for such a study collected? What three patterns are statistically possible? What does it mean when we say that upper boundaries are more clustered than lower boundaries? *This chapter had examples spanning the period 1976-1997. Can you find any more recent examples? Can you find any examples from tropical or subtropical wetlands?*

Chapter 11 Services

1. Define the term "ecological service". Why does the author recommend you use this term rather than "ecological function"? Review Section 1.6 and Table 1.7, and briefly explain the four categories of service: regulation service, carrier service, production service and information service.
2. Define the term Annual Net Primary Productivity (ANPP). How is it measured? Give the productivity per year for wetlands and for tropical rain forests. How does this compare to cultivated land?
3. What is meant by the concept of carbon storage? How and where is carbon stored in wetlands? *What is the current level of atmospheric carbon dioxide?*
4. How do wetlands produce methane? Why does it matter? What is the current level of atmospheric methane? Rice paddies are an anthropogenic wetland – how do they compare to natural wetlands in methane production (Table 11.1)?
5. Why is coal called a fossil fuel? In what kinds of habitats did coal form? Explain the role of coal in carbon storage.
6. What are the three processes of nitrogen fixation? Yes, it is biological, atmospheric and industrial. Explain the first two. When did the third begin? And how did it lead to dead zones in coastal areas? *And who was Fritz Haber, who invented the Haber process in the first place?*
7. The Earth's atmosphere is about 80 percent nitrogen, but a majority of plants are limited in their growth by lack of nitrogen. Explain this apparent paradox. Read White, T.C.R. 1993. *The Inadequate Environment: Nitrogen and the Abundance of Animals*. Berlin: Springer. *So, are food webs limited by energy or nitrogen? Why do most ecology books, and wetland ecology books, assume the former?*
8. What is meant by the term biodiversity? Explain how wetlands support biodiversity in the biosphere. Give some examples from different ecological groups including fish, amphibians, and mammals.

9. How do we put an economic value on ecological services? What are the three most valuable services provided by the Pantanal wetland (Table 1.8)?
10. Flood pulses may be important in the ecology of wetlands (Chapter 2), but flooding can also have extreme negative consequences for humans, particularly humans who construct homes in floodplains. How do wetlands reduce flood pulses? How do levees make flood pulses more extreme? What is the estimated value of wetlands for flood control (Table 11.5)?
11. Explain how different materials in peat (e.g. pollen, plant fragments, insect fragments) can allow us to reconstruct past environments. *Locate a nearby example from your landscape where such a core has been examined, and use it to describe the past 5000 years of vegetation in your landscape. If you can't find a nearby example, ask your professor to help find one. Go with a group of students to visit the location from which the core was extracted, and consider how the landscape would have appeared during past millennia.*

Chapter 12: Research

1. Many articles and reports published on wetlands contain one of four basic sets of information: species accounts, delineation, inventory, evaluation. Explain what is meant by each one.
2. What is wetland evaluation? List the four main classes of criteria used in Ontario, Canada. (Table 12.1). *Is there a similar evaluation system for your part of the world? List their criteria. Comment upon the differences.*
3. So much has been published on single species accounts, and our journals continue to publish ever more species-based work. Explain, using the logic of Rigler, why such work is of limited value. How many pairwise interactions are possible within a single wetland containing 1000 species?
4. Explain the difference between small, medium, and large number systems. Why does it matter?
5. List five state variables of wetlands that are not based upon a single species.
6. Apart from single species, why are there also so many studies of single wetlands? Why does this make it so difficult to find real scientific relationships? *What is meant by the term replication*? Why do so few studies replicate across wetlands? Select of volume of a recent wetland journal, and count how many of the studies replicate across wetlands. Now look at Figure 12.3 and 12.4. Can you find any other examples of large scale patterns in this book? Can you find any recent examples of such large scale relationships wetlands in recently published research?
7. Explain why science in ecology requires simplification. Hint: there are 350,000 species of plants in the world. *How many species of fish, birds, and amphibians are there in the world?* What is a 'functional group'? Give some examples of functional groups in birds, fish, insects.

8. Why is it more difficult to find functional groups in plants than animals? Why is it, paradoxically, even more necessary to do so? Explain the Raunkiaer system for plant functional types. What are its limitations for wetland ecology? Describe some other approaches to finding plant functional types. Distinguish between ruderal, interstitial and matrix species in herbaceous wetlands.
9. What is mean by the terms 'species pool' and "environmental filter" What are the main filters that operate in wetlands? Don't forget to review Section 1.7 on causal factors in wetlands. *Where would you go to find the species pool of birds, fish or plants in your landscape?*
10. Explain the difference between description and prediction. What is meant by the term 'attitudinal inertia"? Give an example from wetland ecology. *Give an example from your recent personal experience.*

Chapter 13 Restoration

1. What is mean by the term restoration? Distinguish this term from mitigation, rehabilitation and preservation.
2. How does one choose the restoration target? Why is it important to be explicit?
3. Many people assume that a water control structure is the obvious solution to most wetland restoration projects. Explain some of the costs inherent in water control structures.
4. Discuss the trade-offs in small scale as opposed to large scale restoration projects.
5. Why are there so many examples of failed restoration projects?
6. Why is long term monitoring important in wetland restoration? Discuss some possible state variables that should be included in a monitoring program. *Is there a monitoring program for a wetland near your community? Who pays for it? What data are being collected? Where are the data stored?*
7. What is an invasive species? Why are invasive species harmful? *Give three examples from your part of the world. In which biogeographic region did each of these originate? How were they transported the location where they are invasive?*
8. What is a treatment wetland? Explain how a treatment wetland can provide a service but not qualify as wetland restoration.

Chapter 14 Conservation and Management

1. Explain how a protected areas system has three components: cores, buffers and corridors. *Give an example from near your university. Now find an example on a different continent.*

2. What is a Ramsar site (Figure 14.9)? *Look online to determine the process for having a wetland declared a Ramsar site. Where is nearest one to your community? Go to Ramsar online and find their global map. How many sites are there? If you could pick just one for an all expense paid visit, which one would you choose? Write a paragraph justifying your choice, and stating three distinctive species you would like to see.*
3. *Find a map of the wetlands around your community, approximately for a 30km radius. (As a model, look at Figure 12.2). Who did the mapping? If there is no such map, why not? Identify the government agency that should be doing the work.*
4. Give a brief history of the wetlands in Mesopotamia. Describe changes in both area and composition. *How big are these wetlands now? Can you find a recent aerial photograph? Can you find any information on restoration in progress? What is the current status of the Basra warbler? Look it up on the IUCN red list.*
5. What is a state variable? What is an indicator? What is an indicator species? Give some examples of each for wetlands.
6. Explain how eutrophication causes undesirable changes in wetlands. Explain how invasive species are linked to eutrophication? Why are carnivorous plants are particular risk?
7. Past climates produced different distributions of lakes and wetlands. Many large lakes that formed during and after the last ice age are now dry, and have left behind clay plains or salt flats. (p. 399-40) *Where was the biggest one near your community? Write a paragraph on the formation and disappearance of Lake Agassiz as an example. Write another paragraph about the formation and current status of Great Salt Lake.*
8. Wetland restoration in Louisiana may involve planting cypress trees, which were the original forests. What are some alternative future states if such attempts at restoration fail? Discuss the arguments for and against planting mangroves instead of cypress.
9. The real challenge in managing wetlands is managing people. Explain why this might be the case. Give some examples from this book. *Give some examples from other sources.*
10. Is there a special place in hell for Dr. John Gifford? Why would I ask? (p. 384)
11. Is there a special place in hell for Nicolae Ceausecu? Why would I ask? (p. 372)
12. List some other people who have done great harm to wetland conservation. List some other people who have been of great service to wetland conservation.
13. Distinguish between the concept of science and policy. Explain why good science does not necessarily lead to good policy.