

Montserrat 101N – Analyzing Environmental Data
Information on Midterm Projects
January 16, 2018

General Information

One of the larger assignments for our seminar this semester will be a group project leading to

- an *oral presentation* to the assembled Natural World Cluster (to be given the evening of Monday, March 12 in Rehm Library), and
- a *follow-up paper*, due Friday, March 23.

Students in all of the Montserrat seminars will be doing oral presentations this spring. The faculty teaching the other Natural World seminars this year have expressed a strong interest in hearing, and having their students hear, what our seminar has been doing this year. As you might know from talking to students in the other seminars, we are all approaching the natural world from very different directions and from the points of view of different areas of human knowledge. So as our seminar's assignment of this type, we will be working on putting together a program of presentations around the general theme of *mathematical modeling*, with examples showing the sorts of insights the quantitative, "systems," and other mathematical techniques we have been studying can give into various questions.

The Oral Presentations

- There will be 5 groups (two with 4 members and three with 3) We will discuss the process of forming the groups and choosing the topics for the presentations (see below) in class. *All groups must be determined and topics chosen by Friday, February 2, at the latest.*
- Each group will be responsible for about 10 - 12 minutes of the program. Each member of each group will give roughly equal parts of the group's presentation (about 3 minutes) and part of your grade will reflect how well-prepared you are and how successfully you communicate the ideas in your presentation.¹
- The groups will want to use PowerPoint to prepare slides for the presentations and we will prepare carefully in class so that you are comfortable presenting somewhat technical material to a large audience.
- Make no mistake – this is going to be challenging. You will need to focus on just the right information to convey to get the points you want to make across in a (very) limited amount of time. It's going to take a lot of preliminary work and practice for this not to seem a bit terrifying(!) But being comfortable with speaking in public this way is a very valuable skill to have in many different walks of life and that is part of the reason for this assignment and the Montserrat focus on this skill this year!

Possible Topics for the Oral Presentations and Papers

- (1) *Mathematical modeling in general, exponential models, an important application* – In the presentation, you would start with a general discussion of the questions: Just what is a *mathematical model* and how are they developed? Illustrate this with an exponential model

¹If you believe you have a disability that prevents you from participating in this sort of presentation, you should contact the Disability Services Office, have them verify this and contact me as soon as possible so that we can work out an alternate way to meet this course requirement.

for radioactive decay and discuss *radiocarbon dating* using the isotope C^{14} (Carbon-14). For the paper, you would then go into much more detail about how this idea was developed, how it is used in practice, what variants and related methods people use to estimate the ages of organic and non-organic materials, and so forth.

- (2) *The “systems” perspective* – For the presentation, you would begin by introducing the concept of balancing and reinforcing feedback loops in systems along the lines suggested by Donella Matthews in Chapter 1 of *Thinking in Systems*. Give some everyday examples like the ones discussed there, then formulate quantitative versions as difference equations and discuss their properties. For the paper, you would go into more detail about these models and the effect of *delays*. Develop models that exhibit the sorts of oscillations Matthews describes in her Chapter 2.
- (3) *Exponential and logistic population models* – In the presentation, you would introduce exponential and logistic population models as difference equations for the population function $Q(n)$, with n the discrete time. For the paper, you would go on to discuss other discrete time population models such as the *Gompertz* models, that do not have some of the problematic aspects of the logistic model from the biological point of view.
- (4) *Systems of difference equations and epidemic models* – In the presentation, you would introduce the SIR model we studied last semester and indicate how it describes a certain class of infectious disease outbreaks. For the paper, you would then go on and study how the SIR model can be modified to take other aspects of infectious diseases and public health interventions into account. For instance, how can models like this help plan public health measures such as vaccination campaigns, quarantines, etc.?
- (5) *Modeling extraction of nonrenewable resources* – For this presentation (which is more challenging because it’s one of the less familiar ones for us as of the start of the semester), you would discuss the models for the economic systems governing extraction of non-renewable resources like coal or oil – see the discussion on pages 60 - 66 of *Thinking in Systems*. Formulate the models using the ideas for difference equations that we have discussed and discuss the behavior of the solutions. The paper would then be devoted to a more detailed discussion of these topics.
- (6) *Modeling harvesting of renewable resources* – In the Chapter 7 project from last semester, we discussed the effect of various harvesting strategies on natural resources such as fisheries. We were essentially looking at this “from the fishes’ point of view” without taking into account the economic factors that would drive people to change their harvesting strategies over time. For this project presentation (which is also more challenging because it’s one of the less familiar ones for us as of the start of the semester), you would discuss the models for the economic systems governing harvesting of renewable resources – see the discussion on pages 66 - 72 of *Thinking in Systems*. Formulate the models using the ideas for difference equations that we have discussed and discuss the behavior of the solutions. The paper would then be devoted to a more detailed discussion of these topics.
- (7) *A topic of your own* – I am also open to considering a topic that your group would specify and carry out with my guidance. If you want to try this, you will need to present a proposal and get my approval for your topic *no later than Friday, February 2*.