BIOL 410 – Population and Community Ecology

Population model assignment, Fall 2015

Assignment worth 20% of the final grade, comprised of four components worth 5% each.

Objective

Models are important tools for population and community ecologists. Models provide a conceptual and quantitative framework to:

(1) Document what we know about population processes.
(2) Better understand a particular component of the system.
(3) Make projections regarding future population states.
(4) Identify component of the system that need to be examined in more detail.

Mode development begins by clearly identifying the scientific question being addressed, and by extension, the objective of the model. The scientific questions and hypothesis being tested are the primary determinants of model structure and will strongly influence where model development efforts should be focused. Once the scientific questions and model objectives are clearly defined the next step is to identify the key state variables and processes that are assumed to influence the systems. Following this the modeller then begins to sketch-out the links amongst them. This thought exercise is the heart of modelling, and often requires the most thought and time. After the structure of the model is defined the main challenge is to parameterize the model, normally using literature derived values or directed experiments.

Assignment

You will sequentially build a population model across the semester. The model will be primarily visual and verbal, focused around a relationship diagram. You are free to choose any species you like, however, your task will be easier if you choose a well-studied organism that has been the focus of considerable life-history and ecology research. Choosing a species that you are interested will also help to keep the project interesting. You can focus on a specific population, or you can model the population dynamics of the species more generally.

This process will be done in stages, first describing your species and its standard life history characteristics, and then adding influences of such effects as intraspecific competition, interspecific competition, predation, habitat fragmentation etc. With each stage, you will determine not only what affects population structure, but where within the organism's life history these affects are most likely to be felt. You will determine the first order effects (e.g. how the effects directly affect birth/death rates of your population), but also how second order effects between these influencing processes and how these might translate down to your organism.

Each part of this process will be due several weeks after we have discussed some of these effects within class. For each stage, you must use primary literature to support your model ideas.

By the end the project you goal is to identify the most important processes influencing the population and include them in the model in a suitable way. Each statement about the population, and the processes that influence it, must be supported by references from the primary literature.

Part I – Describe the life history of your organism. (Max 1 page text plus references)

- Provide a description of the life-history of the species.
  - What happens as individuals progress from birth do death?
  - What is the species' reproductive strategy (e.g., monogamous, polygamous, angiosperm, gymnosperm, etc.)?
  - What are the key sources of mortality?
- Identify the age/stage/size classes that best represent the demographic structure of the population.
- Briefly identify the key environmental factors and processes that likely influence the transitions between life stages. At this stage you don't need to provide quantitative data, just a description of the process. You might want to consider the size of your current population and suggest which of these processes is likely to have greater influence if you have current estimates of your population size.

Part II – Describe the factors that influence within species processes, and produce a simple graphical representation of the species life cycle (i.e. diagrammatic life table). (1 page diagram, Max 1 page text plus references)

- Starting from the previously defined life history diagram, describe how each population process will result in a change in N. If possible, start to compile quantitative estimates of stage specific survival probabilities and fecundity.
  - Describe how the processes may interact (e.g. how do deaths influence births?).
  - If there is sufficient data available, build a life table and calculate R, G and r.
- Describe how factors such as habitat quality, food availability and intraspecific competition influence survival and fecundity.
- Describe when in the species life cycle dispersal occurs, and if intraspecific factors will influence immigration and/or emigration.
- Identify environmental factors that may influence the population processes.
  - E.g. habitat quality influencing survival and fecundity
  - Habitat fragmentation influencing immigration and/or emigration rates
- Produce a graphical population model that includes all of the above described population stages and population processes (transitions).

Part III – Describe relevant interspecific interactions and processes, and estimate the relative magnitude of their impacts within the context of the above defined model. (Max 1 page text plus references)

- Most populations live in communities where other species can have a direct or indirect influence on the dynamics of the focal population. Describe the key interspecific interactions that will influence the dynamics of your population, considering factors such as:
  - Prey species and availability
  - Competitors
  - Predators
  - Parasites
  - Disease
- Estimate the relative importance of each of these processes, and if possible produce a quantitative estimate of the processes population impact.

Part IV – Combine information from the previous sections into a complete population model and create a graphical representation of the models structure. (1 page diagram, Max 1 page text plus references)

- Evaluate the relative importance of all previously described interactions and processes (both intraspecific and interspecific), and identify key factors that you think should be retained in the final model. Provide a written justification for your decisions that is supported by primary literature references. The decision to retain a process or state should reflect both the estimated importance of the factor as well as the ability to accurately estimate required rate and state variables.
- Consider potential second order interactions between the retained processes and briefly describe these indirect interactions.
- Finally, consider limitations of your model now that it is nearing completion. Models are representations of reality, thus, no model is a perfect reflection of a real population. Modellers must be aware of what is missing from their models and be prepared to speculate or hypothesize the effects of such omissions. This could include omitted processes (abstraction) or a description of knowledge gaps for your species of interest.

Evaluation Criteria

Each component of the model will be worth 5%.

Within each component, I will be marking based on the logic of your arguments, supporting evidence that you present for your ideas, identification of where and how your processes will affect final population outcomes, and understanding of the inter-linkages between processes. I will also be marking based on grammar and presentation, as well as correct formatting for references.

Formatting should follow the minimum formatting requirements as specified for the journal Ecology.

http://esapubs.org/esapubs/AuthorInstructions.htm#mfr