Chapter 1, Ecology and How To Do It: Answers to Review Questions

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1) Some temporal patterns in ecology need different lengths of time to be detected because of the levels of life (physical scales and temporal scales) that are investigated. Many different approaches are used to understand ecological processes and these processes can occur at a variety of time scales and at very different levels of life, from the molecular to the global level. Given the differences between the life of a single-celled organism and multicellular organisms, ecological investigations of these two different types of organisms would require very different lengths of time to detect patterns.

2) Descriptive studies are valuable because they often serve as a starting point for researchers. They act as a foundation to describe, understand, or explain some phenomenon, pattern, or observation. However, if a study is only descriptive it fails to explain what variables are important, and therefore limits the explanatory power of ecological research. That is why experiments are essential, because they aim to explain the processes responsible for such observations or phenomenon. Experiments allow researchers to control the variables under investigation and test how changes affect results. Descriptive studies do not include controlled, experimental manipulations.

3) A natural field experiment is an experiment that is not planned. Instead, researchers take advantage of a natural event that has occurred in the past, such as historical fires, floods, or the retreat of a glacier, to evaluate how ecological processes may be affected by such an event. As an example, refer to the Cedar Creek studies, where abandoned agricultural lands were studied to understand the process of succession. In this example, instead of forcing people off of currently inhabited agricultural land and waiting decades for succession to occur, the researchers used previously abandoned agricultural land and historical data to understand the process of succession.

4) A search of the term ecology returns many definitions. An appropriate definition should define ecology as a scientific study of species distributions and abundances, that focuses on how interactions among organisms and their environments determine distribution and abundance, and the relationships between species and the transformation and flux of energy and matter. This is an appropriate definition because it includes the multitude of ways in that the field of ecology studies various hierarchical levels of life.

5) The Cedar Creek study aimed to understand patterns of succession by looking at abandoned agricultural land at various stages. Had they only looked at a single field and monitored it for 50 years they would have had no

clear understanding of how the process of succession actually occurs. They would have had data for one site over that time period, but nothing to compare it with and no idea if the results were atypical or typical of the succession process. The use of multiple sites allowed the researchers to look at multiple successional stages and to compare data measured at all localities. With this approach, the researchers were able to observe trends across all sites and track the response of the environment through time. Any variation between sites was not an issue because they could compare responses at all sites to look for a trend, which they could not do with only one site. Had they only had one site they would have had no statistical power either (which is why we must include replicates, such as multiple sites, in the experimental design!).

6) In the catchment studies, the inputs of acids, nutrients, and other materials from the atmosphere were measured by the Hubbard Brooks scientists. They found that large amounts of nitrogen inputs (ammonium and nitrate) were being retained in their study forest. Clear-cutting resulted in a major loss of dissolved substances and 40% more of the input precipitation being exported. As plants begin to grow again in these forests, they will likely uptake precipitation and dissolved substances. As a result, the amount of precipitation and dissolved substances lost in the forest should decrease. Through time their concentrations should begin to resemble levels measured in the pre-cleared forest.

7) Whole-lake experiments, like the one performed in Canada using Lake 227, were performed to test how one abiotic variable (phosphorous) affects the stimulation of algal growth. Researchers were able to manipulate Lake 227 by dividing it in half with a plastic barrier and adding phosphorous to one side. Lake 227 had the lowest levels of dissolved carbon dioxide in all lakes studied, and the researchers knew that these very low levels of dissolved carbon dioxide limited algal production. The controlled addition of phosphorous to one side of the lake and the observed increase in algal production in that half, provides very strong support for the hypothesis that phosphorous greatly affects algal production without the need to replicate the experiment in numerous lakes.

8) The introduction of brown trout led to changes in the production of algae due to a reduction of invertebrate biomass. Laboratory experiments showed that brown trout caused behavioral changes in macroinvertebrates (mayflies), which feed on algae. Because of this disruption in feeding behavior, algal biomass reached unusually high values in sites with brown trout.

9) Our confidence in the predictions of models can be limited because we use them to explore situations where we actually do not have and maybe cannot obtain actual data. Also, models cannot be expected to predict a perfect and

complete description of the world. All models are limited to approximations, and rely upon our current state of knowledge. Therefore, if the data we have are not very reliable then the model likely will not make worthwhile predictions.

Challenge Questions

1) Ecological evidence can be gained in many ways. Descriptive studies, ecological models, and experimental studies can all be used to gather data and test a question. There are many approaches that could be used to test a question like "why are there more species in the tropics than at the poles?" One approach could be to use models with historical environmental data to test if more species evolved in the tropics due to habitat quality. Another approach could be to estimate numbers of species between the north and south poles and test if the number of species increases as you move closer to the tropics.

2) There are many similarities in the forces driving species richness in an oral community and a European grassland, which is why the science of ecology can operate at multiple scales. We can expect that oral communities experience environmental heterogeneity, competition, life and death, disturbances, and predation just like species in a European grassland or any other habitat for that matter. All living organisms are subject to such ecological processes.