ESM 260 - Applied Marine Ecology (Winter 2020)
Homework Assignment 2: Hypothesis Formulation
Due: *5 February*

Now that you have identified certain patterns in the data of marine organisms in the lagoons of Rarotonga and Aitutaki, the second step in the scientific process is to develop alternative explanations for those patterns. Thus, for each ecological pattern of interest, you need to formulate specific but *alternative hypotheses* that could account for the observed pattern. There are 2 kinds of 'differences' in the abundance patterns for some of the organisms in the Cook Islands: spatial differences (i.e., between the 2 lagoons) and temporal differences (i.e., a change in the abundance of a population in 1 or both lagoons between 2009 and 2019). The set of hypotheses to explain one of these differences needs to be sufficiently specific to provide insight: postulating, for example, that a change in abundance of a species from 2009 to 2018 resulted from 'a change in the environment of the Rarotongan Lagoon' is far too vague to help develop useful understanding. A hypothesis should include (1) a statement as to the nature of the possible change in the environment, (2) how that change may have influenced the demographic rate(s) of the organism in question (which often arise through alterations of other aspects of the biotic or abiotic environment of the organism), and (3) and how those potential changes in demographic rates may have been translated into changes in population abundance. Thus, a useful hypothesis consists of a logical chain of events that lays out a feasible scenario that specifies explicitly *how* the abundance of a population may have been altered. A hallmark of a good hypothesis is the extent to which it helps you identify particular events or features that must be true if the explanation is sufficient to account for the observed pattern. It is these critical events and features that provide the basis for conducting the research to test your hypothesis.

It inevitably is the case that many possible explanations exist for any single pattern of interest. If we focus solely on 1 hypothesis, it is easy to overlook or otherwise miss what actually may be responsible for the pattern. This is a primary reason why it is crucial to consider several alternative hypotheses at the same time. Ideally, each hypothesis in the set of alternatives that you formulate identifies a unique aspect that sets it apart from the others. For example, consider the effect of a kelp forest on the abundance of adult striped surfperch. Surf perch inhabit kelp forests where they depend heavily on the availability of red "understory" algae that in turn supports their favorite food, crustaceans (e.g., amphipods, isopods, and small crabs). One hypothesis (H1) might be that the presence of a dense kelp forest reduces light levels reaching the ocean bottom, which in turn reduces the amount of red algae from which adult striped surfperch feed. This in turn may decrease the fecundity of adult fish and/or increase the mortality and/or emigration rates of adults. Lowered birth rates and elevated loss rates result in lowered abundance of adult striped surfperch. A second hypothesis (H2) might be that kelp bass, the primary predator of baby striped surfperch, recruit in greater numbers to reefs with dense kelp forests. Greater density of kelp bass may increase the mortality rate of young striped surfperch such that fewer young survive to adulthood. Fewer young surviving to adulthood results in fewer adults in the local population. In these 2 alternative hypothesis, the effect of kelp on abundance of adult surfperch arises through different pathways that affect different life stages and demographic rates of the fish.

Instructions Answer each question below in a written narrative that must be no longer than a total of 2 single spaced (typed) pages. Give complete but <u>concise</u> answers.

Exercise Use the background information given in the *Unraveling the Mystery of the Rarotongan Lagoon* handout and your interpretation of the graphs of data you prepared in Homework Assignment 1 to answer the following.

1. Separately for each of the <u>non-fish</u> species that changed through time in the Rarotongan Lagoon, develop 2 alternative hypotheses for that change that are consistent with the data and background information. Include a brief description of the existing evidence that forms the logical basis for each hypothesis.

2. Separately for Spotted Damselfish and Yellow Damselfish, develop 2 alternative hypotheses for factors that influence abundances of adults that are consistent with the data and background information. Include a brief description of the existing evidence that forms the logical basis for each hypothesis.

3. For Surgeonfish develop 2 alternative hypotheses for the patterns of change in adult abundances both among lagoons and through time which are consistent with the data and background information. Include a brief description of the existing evidence that forms the logical basis for each hypothesis.