**ESM 260 - Applied Marine Ecology (Winter 2020)**
**Homework Assignment 3: Tests of Hypotheses & Management Actions**
***Due:*** *19 February.*

Once alternative hypotheses have been developed for a pattern of interest, the next step in the scientific process is to devise research tasks that will show which hypotheses cannot be correct and which are supported by the new evidence. This step involves identifying the predictions of each hypothesis, and determining which of these predictions are critical in distinguishing among the alternative hypotheses. Once these critical predictions have been identified, sets of new observations and experiments can be designed and implemented to 'test' which (if any) of the potential explanations are supported. After these new observations and experiments have been completed, the data are analyzed and certain hypotheses can be rejected and (with luck) others can be retained. It almost always is the case that the new information you collect to test the original set of hypotheses will force you to rethink and revise your set of alternative hypotheses, including those that are supported in whole or part by the new evidence. The cycle then continues with you developing and conducting more novel observations and experiments to distinguish among the set of refined hypotheses. Ideally at some point you have collected sufficient evidence to reject most (initially) plausible hypotheses, and are left with just a single explanation that is consistent with all of the evidence. You have not 'proven' that this is the explanation; rather, you have not shown it to be false despite critical tests, and therefore you conclude that it is the most probable explanation.

Consider again our example of the effect of a kelp forest on the abundance of adult striped surfperch. One hypothesis (H1) is that a dense kelp forest reduces light levels reaching the ocean bottom, which reduces the amount of red algae from which adult striped surfperch feed (they eat mainly invertebrates, especially crustaceans- amphipods, ostracods, isopods- and polychaete worms), which in turn decreases the fecundity of adult fish and/or increases the mortality and/or emigration rates of adults. If this is a correct explanation, then you might predict among other things that: (1) red algae is less abundant under giant kelp than on an otherwise similar spot of reef without kelp, (2) the per capita and total production of babies by adult striped surfperch (per body size) vary positively with the amount of red algae per unit area of reef, and (3) adult striped surfperch have a higher per capita loss rate from death and/or migration in kelp forests than elsewhere. A second hypothesis (H2) is that kelp bass (they eat baby surfperch) recruit in greater numbers to reefs with dense kelp forests, and that greater density of kelp bass increase the mortality rate of baby striped surfperch such that fewer young survive to adulthood than are needed to replace the number of adults that die. You might predict that: (1) more kelp bass of sizes capable of eating baby surfperch live in kelp forests than on similar reefs without kelp, (2) the per capita mortality of baby striped surfperch increases with density of kelp bass, and (3) the per capita loss rate (death and/or migration) of adult striped surfperch does not differ (a) with the presence or absence of kelp and (b) with variation in density of kelp bass. These sets of predictions serve as a guide to the types of new observations (e.g., measurement of red algae, densities of kelp bass, birth, death and migration rates of young and adult striped surfperch as a function of kelp presence/absence) and experiments (e.g., manipulations of presence/absence of kelp and of kelp bass density) that are necessary to distinguish between the alternative hypotheses. Keep in mind that both might be occurring or that neither may be correct.

Suppose that you find that kelp bass do not affect mortality rates of baby striped surfperch, that the presence of kelp does not alter the amount of red algae or the loss rate of adult striped surfperch, but that kelp does lower the per capita and total production of baby striped surfperch. That is, you can reject H2 altogether, and that H1 is only partially supported. What's wrong with your original H1 is that kelp did not affect the area of microhabitat from which striped surfperch feed. The new data suggest that the lowered birth rate of striped surfperch results from adults getting less food under kelp. You now need to revise your original hypotheses in light of this new evidence. Perhaps you surmise that kelp affects the production rate of invertebrates that constitute the food of surfperch (H3), or that kelp increases the local abundance of another species (e.g., black surfperch) that competes with striped surfperch for the invertebrates (H4). You now have a new set of hypotheses to test with additional observations and experiments.

Why it is important to have this level of understanding for an applied issue in marine ecology? Suppose you are approached by an agency that wants to 'build' a kelp forest on a reef without affecting the abundance of striped surfperch there, and asks (pays) you to devise a management strategy to accomplish this. The success of any management strategy you develop will rest on understanding just how populations of striped surfperch are affected by kelp forests.

## Instructions

This is an exercise in developing (1) research tasks that constitute rigorous tests of alternative hypotheses and (2) management strategies that are likely to be effective. Answer each question below in a written narrative that must be no longer than a TOTAL of 2 single spaced (typed) pages. Be sure to give complete but concise answers.

## Exercise

**1.** Develop a set of <u>observations</u> and <u>manipulative field experiments</u> to test your 2 alternative hypotheses (from Homework 2) to explain the decline of (a) fine branching corals and (b) coarse branching corals in the Rarotongan Lagoon between 2009 and 2019. Briefly state the separate predictions of the 2 hypotheses per coral type and how the measurements you propose to make will distinguish between the alternative explanations.

**2.** Two alternative hypotheses to explain the patterns of abundance of Spotted Damselfish are (a) limitation of recruits from the supply of larvae ('supply limited') and (b) limitation of recruits from the amount of settlement habitat available ('habitat limited'). Develop a single <u>manipulative field experiment</u> that can distinguish between these 2 alternatives. Briefly state what outcomes you would expect from this experiment if local populations of Spotted Damselfish are (a) larval supply limited and (b) habitat limited.

**3.** Develop either a set of field observations or a manipulative field experiment to test 2 alternative hypotheses (from Homework 2) for the decline in abundance of adult Surgeonfish in the Rarotongan Lagoon. Briefly state the separate predictions of the 2 hypotheses and how the measurements you will make will distinguish between the alternative explanations.

**4.** Develop a management action that will result in the recovery of the abundance of branching coral in the Rarotongan Lagoon. Select one of the explanations you 'tested' in Question 1 above and base your proposed action on the assumption that that explanation for the decline in corals is correct.