ESM 260 - Applied Marine Ecology
Winter 2020
Homework Assignment 1
Due: *22 January*

An initial step in the process of ecology is to identify *patterns* in nature. Once patterns have been identified, it then is possible to generate potential explanations (alternative hypotheses) and to design research to test those alternatives. The exercise for Homework Assignment 1 is to identify patterns in the abundance of organisms (*don't underestimate the amount of time this exercise will take*!). The subsequent 2 homework assignments will address the next steps in the scientific process: generation of alternative hypotheses and design of research tasks to distinguish among alternatives. These 3 homework exercises will be based on the Cook Islands problem set - '*Unraveling the Mystery of the Rarotongan Lagoon'*.

The material you will need to submit to Hunter is (1) a 2 page or less narrative (typed - double-spaced) that addresses the questions below and (2) a series of *Excel* or R graphs as requested. Remember to put your name on the narrative pages and graphs, and to email to Prof. Lenihan. Please make sure the homework file name includes your name or, if you work in a team of two, both student's name. Use format for all assigments submitted: ESM 260_Homework 1_your name".

Exercise For each question where relevant, discuss the patterns you believe are real and state what the trend is for those patterns. Be sure to put a title on each graph and *label each axis* fully!

1. For data set I (***Mean Density of Adults***) compare and contrast changes in the Rarotongan and Aitutaki Lagoons since 2009. For each organism, make a histogram that displays the mean density of the organism (y-axis) at Rarotonga and Aitutaki for 2009 and for 2018 (in Excel select data to be graphed, press 'Chart' icon, chose 'Chart Type' = 'Column'; 'Format' = '1' and follow instructions). Add the 95% confidence intervals to each graph (select a graph; on Tool Bar press 'Insert' then 'Error Bars', select 'Both', select 'Custom', enter correct value in '+' and '-' boxes, press 'OK'). In your narrative, state which organisms that showed a statistically significant difference in density between Rarotonga and Aitutaki, and which showed a statistically significant difference between 2009 and 2019. State what the trends are. For now, we'll adopt the convention that 2 means are statistically different if the mean of each is not included in the 95% confidence interval of the other mean.

2. Do the same as in Question 1 for the recruits (young) of each fish species.

3. Use data sets I and II to calculate the density of fish recruits per 100 m^2 ***area of reef***. Note that the density of fish recruits is given as the number per 1 m^2 of ***microhabitat***, so you will need to figure out how to calculate the density of recruits per 100 m^2 of reef area (not all of which is covered by the microhabitat occupied by the fish). For each fish species, make an XY Scatter plot to reveal the relationship between the density (per 100 m^2 for reef area) of recruits and adults. Each place and time will be 1 data point, so each graph will have 4 data points. (To make a plot, select data, press 'Chart Wizard' icon, select 'Chart Type' = 'XY (Scatter)', 'Format' = '1' and follow instructions). Add a linear trend line to each plot (select a graph, on Tool Bar press 'Insert' then 'Trendline', select 'Trend/Regression Type' = 'Linear', select options, check box 'Display R-square Value on Chart', press 'OK'). Label the axes. Which species show correlations in adult and recruit densities and what are those relationships?

4. For each species of fish, make an 'XY Scatter' plot (with linear trend line and R-square value) of the relationship between density of adults and density of microhabitat used by their young. (You need to make 4 different plots, 1 per fish species.) Which show a relationship? What are the trends?

5. For each species of fish, calculate for each year and lagoon the density of adults per area of bottom covered by the microhabitat used by the young. For each species of fish, make a histogram of the mean density of adults per area of juvenile microhabitat (use the same graphing method as in Question 1; you will need to make 4 different graphs, 1 per species of fish). Which species show apparent differences in the density of adults per area of juvenile microhabitat between Rarotonga and Aitutaki and between years? (Do not concern yourself with the 95% CI for these comparisons, just look to see which, if any, appear extremely different.) What are those trends?

6. For each pair of fish species, make an 'XY(Scatter)' plot (with linear trend line and R-square value) for the densities of adults (i.e., plot the densities of one species against another; you need to make 6 different graphs). Which show patterns and what are those trends?