ESM 260 - APPLIED MARINE ECOLOGY
WINTER QUARTER 2020

Background for Homework Assignments 1 - 3

UNRAVELING THE MYSTERY OF THE RAROTONGAN LAGOON

Ground Rules

1. The narrative below is background for Homework Assignments 1 - 3. **Turn in assignments** through email, with *Homework 1 due on 22 January, Homework 2 on 5 Feb, and Homework 3 on 19 February*.
2. The scenario below is largely contrived so looking up real 'facts' about the Cook Islands will not be useful; assume the background information below is reality and the data given are accurate estimates of conditions in the Rarotongan and Aitutaki Lagoons (photos of both islands provided).

Background Information

After receiving the highest scores in ESM 260, your name was posted on the global internet (www.envirowhiz.com) as a consultant available to address applied marine ecological issues. You have been contracted (for a handsome consulting fee of $1500 per day plus travel costs!) by the government of the Cook Islands, a small Polynesian nation in the South Pacific, to help identify and explore possible environmental impacts to the lagoon that encircles the main island of Rarotonga (the name 'Rarotonga' comes from how early Polynesian explorers found it, by sailing *raro* (down) and *tonga* (to the south) from the island of Raiatea in French Polynesia). [Editors' note: see google earth for maps]

The Cook Islands government is concerned that the once pristine Rarotongan Lagoon has been degraded to the point that it may be affecting both local tourism and a primary source of animal protein - coral reef fish. As expressed to you in a letter from the Rarotongan Island Council, "***Instead of visiting beautiful Rarotonga where half of all Cook Islanders live, tourists are now flocking to one of our small atoll islands - Aitutaki - where only 1% of our people reside. We're told the reason for this is that few corals are left in our Rarotongan Lagoon for tourists to observe by snorkel. This has damaged the local economy of Rarotonga. It was fortuitous that we began large-scale cultivated agriculture on the fertile slopes and coastal plain of Rarotonga earlier this decade. Growing pineapples, coconuts, guava and other tropical fruits in large cultivated areas has helped buffer our economy from declining tourism, and it has provided a steady source of food for our people. As it is, we have had to import an increasing share of our animal protein from Aotearoa*** [editors' note: 'Aotearoa' is the Maori name for New Zealand and means '*land of the long white cloud*'.]. ***Surgeonfish that our people catch from the lagoon and grill over an open fire historically has been a staple meal for Cook Islanders, yet catching surgeonfish in the Rarotongan Lagoon has become more and more difficulty despite increasing effort by our people to catch them. This also has caused us to stop serving our most prized national dish - Yellowfin Surgeonfish Tahitian Style - to visiting VIPs such as yourself***.

Curious as to why the Cook Islanders eat surgeonfish, which are herbivorous, instead of predatory coral reef fishes, such as coral trout (which eat surgeonfish and damselfish), you write the Rarotongan Marine Resources Bureau, which writes back: "***As with all coral reefs in this part of the South Pacific, coral reef fishes historically have contained some level of ciguatera - toxins from a dinoflagellate (similar to what causes your paralytic shellfish poisoning) that harms humans but not the fish*** [editors' note: see http://www.whoi.edu/science/B/redtide/illness/psp.html for description of effects on humans.]***. Herbivorous surgeonfish have the lowest level of ciguatera, and because the toxins are 'biomagnified' (accumulated in higher and higher concentrations up the food chain), the predatory reef fishes that eat surgeonfish are highly poisonous to humans. Therefore, it is safe to consume herbivorous surgeonfish, and it is not safe to consume***

predatory reef fishes. This has been known from the time of our ancestors, which has formed the basis for our cultural preference for herbivorous reef fishes. As far as a source of protein, it would matter little if we did consume coral trout or even plankton-eating damselfish as their numbers in the Rarotongan Lagoon also seem to have declined in the past decade. Enclosed are data collected in 2009 and 2018 from the Rarotongan and Aitutaki Lagoons. [editors' note: these data have been entered onto an *Excel* spreadsheet for you by your friendly Prof] ***We invite you to come - all expenses paid - to collect new data on these parameters in Rarotonga and Aitutaki.***"

You plan your trip using a travel guide that provides insight into basic items to bring: a hat, sunglasses, and sun screen lotion for protection from the tropical sun, mosquito repellent and mosquito net to sleep under (the only disease mosquitoes carry in the Cook Islands is dengue fever), and hard-soled wading shoes to protect from stings of the highly poisonous stonefish while wading in the lagoon. The travel guide mentions there is no need to worry about stepping on the spines of sea urchins because these herbivores ('plant eaters') historically have been absent from the Cook Islands. Your guidebook also provides a description of the Rarotonga, Aitutaki and their respective lagoons. For Rarotonga it says: "***Rarotonga is a spectacularly beautiful 'high' island formed when an underwater volcano pushed its peak above sea level several million years ago. The volcano has eroded somewhat into high mountain ridges flanked by well-watered valleys and a fertile coastal plain that have increasingly been cultivated for agricultural crops. The economy is largely based on agricultural production and tourism. Surrounding the entire island is a shallow enclosed lagoon with a single narrow passage through the fringing reef to the harbor town of Avarua. The coast of the lagoon has picturesque beaches and swaying palms, but because of little water exchange between the lagoon and the open ocean, water clarity in the lagoon can be low because of runoff following rainfall, which can occur at any time. We recommend taking a scuba diving course because the coral reefs outside of the enclosed lagoon are as good as they get. Anytime is a great time to visit any of the Cook Islands because there is no hurricane season. Since these island jewels are well off the normal hurricane track, the last to hit any of the Cook Islands was more than 200 years ago.***" For Aitutaki it states: "***Aitutaki is the classic Hollywood-movie South Seas island atoll - a gorgeous, large, well-draining lagoon formed when the volcano sank millions of years ago, leaving behind a few, small low-lying islets. The tiny but lush 'main' island is surrounded by the turquoise lagoon, which itself is fringed by palm-clad tropical islets called*** *motus ("MO-TWOS")*. ***White sand beaches dazzle the eye, and snorkeling, diving and fishing are great in the shallow lagoon year round - rain or shine. This is Bora-Bora without the exorbitant expense. The entire local economy of Aitutaki rests on tourism as the pearl-farming region lies further to the north, and the land area of Aitutaki is not conducive to agriculture. Be warned, however, that fruits and vegetables can be quite expensive as they must be imported from Rarotonga. This is a small price to pay for that South Seas paradise you've been dreaming of***."

You spend two glorious weeks in the Cook Islands - one week each on Rarotonga and Aitutaki. As warned, your welcoming dinner was not Yellowfin Surgeonfish Tahitian Style, but rather red deer venison (imported from Aotearoa) in a delightful coconut-guava sauce. You spent most of your time underwater collecting data in the two lagoons on the same parameters with identical methods as the Rarotongan Marine Resources Bureau did in 2009. You are now back at home with those data (which the Prof already have entered onto an *Excel* spreadsheet), and you must now prepare for the Cook Island government a report that describes changes in the lagoon ecosystem of Rarotonga since 2009, alternative hypotheses for the causes of that change, research that could distinguish among your alternative hypotheses and perhaps a management plan. The Cook Islands government, through the local Professor, requires you to answer a series of questions. These questions represent Homework Assignments 1 – 3.