A Problem Of Exhaustion Of The Green Sea Turtle In The Andros Barrier Reef

Abstract

The following research was conducted in order to assess the effect(s) caused by the depletion of a specific predator, the Green Sea Turtle, in the Andros Barrier Reef on the coral reef growth of coral reefs and survival. More specifically a cascading top down effect on the coral reef ecosystem is inferred, since Green Sea Turtles both directly and indirectly control the amount of sea-grass and algae in this ecosystem. Excess nutrition could be regarded as a liability for the coral reefs, and the Green Sea Turtle is of help by clearing up the effects of excess nutrients and seagrass growth. The depletion of the Green sea Turtle directly contributes to growth and overabundance due to their role in regulation and consumption of the sea-grass and algae. It is quite important to observe how the level of nutrient production of the coral reef is detrimental to the Green Sea turtle survival. Moreover, the algae and sea-grass have a competitive relationship with the corals, contending for nutrients, sunlight, and space. The overgrowth of algae and sea-grass on the coral reef could dispatch large patches of corals, this is why it is such a source of interest in order to magnify its effects on these biological structures.

Introduction

The Andros Barrier Reef is the world's third largest barrier reef, extending approximately 220km from the Joulter Cays, found around the Andros Island, in the Bahamas (Davenport, 2008). The reef is divided into five main zones based on architectural formation, distribution and development; the lagoon, the outer-fore reef, the inner-fore reef, reef crest, and the back reef. The Andros is not considered as a "true" barrier reef system due to the shallow lagoon depth and close proximity of the shoreline. The Andros Barrier Reef slopes into a vertical cliff, which drops to a depth of approximately 2000 feet into an ocean trench, typically called "Tongue of the Ocean". The Andros Reef consists of small sized colonies of soft-bodied coral polyps. Their hard skeletons make up the reef exoskeleton. The main species of corals found in the Andros Reef are the smooth brain coral, staghorn coral, water gorgonia, and the sea rod.

Barrier reefs are of high importance because they are the most diverse ecosystem on earth; the Andros Barrier reef is home to twenty-five percent of all marine species (Cranton and Sanders, 1993). Scientist have described over 164 species of fish and coral which make up the Andros Barrier Reef. The coral reef relies on herbivorous fish to maintain the balance in algae formation and growth, since these compete with the corals for sunlight, space, and nutrients which are of extreme importance for coral reef survival. If unregulated, their growth could kill large patches of coral. In the following research, the effects of the depletion of reef sharks from the Andros Coral Reef, as well as inference upon the affects in growth of juvenile fish living in the sea-grass bed, are assessed. For the following, we propose that the depletion of the reef sharks on the Andros Barrier Reef will create a cascading top-down effect in the coral reef system.

The world's ecosystem is run through its trophic level. Trophic, which is derived from the Greek word for food and/or feeding, essentially describes an organism's position in the food chain.

This position is determined by the tendency for the organism to eat or be eaten. Primary producers, which are autotrophic, utilize the sun's energy for food and convert it to biomass. The biomass will in turn, be consumed by primary, secondary, and tertiary consumers. Each of these interactions would constitute as to what is known as an ecosystem's trophic level. As you can see from the figure above, the trophic dynamics of an ecosystem will yield a pyramidal shape with the bulk of primary producers on the bottom and a lower amount of top predators at the top. It is important for this distribution of organisms in their respective trophic levels to remain intact, for a shift in balance would yield undesirable effects for the ecosystem.

The relationship between the organisms of any ecosystem can be visualized through the organization of their respective trophic levels in a food chain. A food chain contains four main trophic levels: primary producers, primary consumers, secondary consumers, and tertiary consumers. The primary producers are the foundation of any food chain and consist of autotrophs that synthesize organic compounds through photosynthesis. In a coral reef, common autotrophs are phytoplankton (i.e. diatoms), algae, and zooxanthellae. Feeding off this first level of organisms are primary consumers. These consumers are herbivores, and include a range of marine life such as zooplankton, grazers, and invertebrate larvae, sea urchins, crabs, and sea turtles (CoralScience.org). They play an important role in the function of the coral reef system by regulating algae. Too much algae can be detrimental to corals and the ultimate result is the dying off of corals. Specific to the Andros Barrier Reef, the Queen Angel, King Angel, Green Turtle, and Parrot Fish (The Andros Barrier Reef) are all abundant primary consumers that feed on soft coral, coral skeletons, plants, and plankton.

The next trophic level of organisms in the food web is secondary consumers and consists of corallivores, piscivores (fish feeders), plankton feeders, and organisms that feed on other benthic invertebrates (i.e. primary consumers) (CoralScience.org). Secondary consumers found in the Andros Barrier reef include the Blue Tang, the Flying Gurnard, the Rock Lobster, and the Queen Trigger. They are known to feed on plankton, small crustaceans and invertebrates, worms, and sea urchins, respectively. At the top of the food chain are tertiary consumers, large fish that essentially eat smaller fish that are below them in the food chain. Tertiary consumers may be predators but may also be non-predatory as well. In the Andros, the tertiary consumers include the Great Barracuda, feeding on herring and tuna, the Green Moray, feeding on fish and squid, the Trumpet fish, feeding on small fish, and the Reef Shark, feeding on anything, including small fish and cephalopods.

The balance of each trophic level in an ecosystem is very important to the survival of the ecosystem. When we are faced with the question of which organisms in an ecosystem play a key role in the regulation of its trophic levels, ecologists solemnly believe it to be the apex predator. The trophic stability of an ecosystem is highly dependent on predation. Predation from an apex predator keeps other trophic levels in check by controlling the population of multiple species to the right proportion, preventing prey species from causing impairment to an ecosystem by becoming excessively populous (Menge and Sutherland). By keeping multiple trophic levels from going beyond their capacities, competition is eased and this would also allow growth and speciation to occur (Dodson 1974). Removing an apex predator from an ecosystem will cause the entire ecosystem to collapse.

The aforementioned truth about predation is that it helps the ecosystem. In the Andros barrier reef, the stability and diversity of the marine environment is kept intact through interactions with its top predator. The reef shark is known as the apex predator in the Andros barrier reef. Its presence is crucial for the survival of the ecosystem, so much so, that removing it will foreshadow inevitable destruction of the ecosystem in a top-down manner (Robbins 2006). Reef sharks, as apex predators, feed opportunistically as well as on sick, old and weak fish in their prey population. This tendency keeps the reef's population competitively "fit" and will allow diversity and speciation to take place in evolutionary time. Ecologists deem sharks to be a keystone species and the concept of an ecosystem deprived of their apex predator would cause the endangerment or extinction of many other marine species in a direct or indirect manner.

There have been many studies on the direct and indirect involvement of an apex species in an ecosystem. For the basis of our research, we will observe the study reported and conducted by the AAAS (American Association for the Advancement of Science). This organization performed a study on the impact of loss of an apex predator, specifically a shark, from its ecosystem. The group recorded the effects when the shark was scarce in the environment over long periods of time and interpreted the data over the course of several time periods. On several occasions where the declination of shark presence had taken place, there would be an increase in the number of prey organisms. Since a shark's diet consists of several species of prey, the prey would obviously experience an increase in numbers in their absence. The niche of a shark could not be intact with their declining numbers and primary consumers start to grow as seen by the model below made by the AAAS.

Due to the data above, we established the notion that losing an apex from our site would cause the increase of primary and secondary consumers, often referred to as mesopredators. Notably, reduction of the reef shark population would increase the amount of green sea turtles. Although green sea turtles are important for the health of coral reefs due to their consumption of algae, their over-abundance could be harmful for coral reef diversity. From our Andros-site food web, we observed that the only species keeping the green sea turtles at bay are the reef sharks. Without a predator, the green sea turtles experience unhindered growth and reproductive rates. The increased amount of green sea turtles would place immense pressure on the primary production of sea grass beds, being their dietary staple. Carnivorous as hatchlings but shifting towards herbivory post-maturation, adult green sea turtles only graze upon sea grass beds and algae. Eventually, their potential over-population would cause depletion of the sea grass beds, placing into motion a cascade-effect ultimately dealt with by the nursery fish. Sea-grasses shelter and host many of the coral reefs' nursery beds. It is one of the safest places for juvenile fish to grow because predators are less likely to prod around sea-grass beds as they typically opt for slightly bigger fish. With the absence of sea grass beds, nursery fish would not have a place to grow, which would cause under-population of future generations of marine life. Diversity and speciation would experience reduction, and one after another, a species would face extinction. This is an example of the top down cascading effect that removing the apex predator from the ecosystem has on the entire ecosystem. It is important to note that with the higher demand for fisheries to hunt sharks, typically for shark fin soup and culling practices, sharks are declining due to human involvement. We may soon see a situation similar to the one described above if nothing is done to alleviate the depletion of this important predator.

In conclusion, according to Robbins (2006), the removal of an environment's apex predator would inevitably foreshadow the top-down dismantling of the trophic web due to their opportunistic feeding habits. In opposition of biased data, reef sharks do not prey selectively on exclusively sick, weak, and elderly fish; their diets are all-inclusive and help to maintain equilibrium for the prevention of overpopulation and depletion of total resources. The influence of the apex predator is so imperative, that their absence permeates through the trophic web, signaling an increase of mesopredator populations. In the case of the Andros, the loss of the reef shark would cause drastic increases in the population of green sea turtles, placing an incredible amount of selective pressure on primary producers and smaller fish. Through the top-down cascade effect, the ultimate outcome displays a loss of diversity and speciation leading to extinction and the collapse of the local ecosystem. As stated above, the Andros reef's tertiary consumers include the Great barracuda, the Green Moray, the Trumpet fish, and the Reef shark as the apex predator in an area with over 164 fish and coral species and over twenty-five percent of all marine species as described by Crandon and Sanders (1993). However, this data may prove to be insufficient, as the presence of non-apex tertiary consumers may provide a trophic web buffer for the absence of the apex predator. Necessary data includes the inter- and intra-species exhibitions of predation and food-web interaction focused on tertiary consumers as well as longitudinal observations of a reef ecosystem that has lost the apex predator, with and without strong non-apex tertiary consumers for confirmation. What would occur with the loss of an important mesopredator such as the green sea turtle? How would other dominant non-apex predators react to the absence of the apex predator? What are some viable techniques for prevention of apex-loss? In the case of total tertiary consumer loss, would relocation of a known apex-predator from a similar environment suitably substitute for the original loss?