Is That a Sea Cucumber or a Rock? A Biological Inventory of Pupukea's Shark's Cove Tide Pools

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In cooperations with Malama Pupukea-Waimea

Marina Ann Zannino

Abstract

Introduction

On June 26th, 2015 The Hawaii Department of Land and Natural Resources approved a rule to ban the harvesting of any species of sea cucumber for the following 120 days. This emergency ban was in response to an investigation being conducted by Hawaii's Division of Conservation and Resource Enforcement (DOCARE) confirming a new commercial fishing trend that was leading to the over-harvesting of sea cucumbers on the Hawaiian Islands. Over the course of the 120 days, researchers will be studying the effects that a large scale removal of sea cucumber would have on the reef and ocean.

Holothuroidea also known as sea cucumbers or loli in Hawaiian, are a species of echinoderms. Their bodies are soft and cylindrical, much like a cucumber from which they get the name. They are ocean dwellers, residing at depths up to 8.9 kilometers. Sea cucumbers live in many different marine environments throughout the world. Some species reside rocky substrates, suctioned to the side of coral or tucked underneath rocky ledges. Others can be found buried deep into the sandy ocean floor. Some species are planktonic, meaning they float along the ocean current.

Sea cucumbers are known as the vacuum cleaners of the ocean. Essentially, they are scavengers. These creatures feed on fish waste, algae, and small macroinvertebrates. They use small tubed feet to push the particles and food items into their mouth. A sea cucumber can have anywhere from 8 to 30 tube feet to assist in this process. Their body breaks down the materials into smaller particles and recycles it back into the ecosystem, much akin to the terrestrial earthworm.

Sea Cucumbers are diecious organisms, having two distinct sex among individuals. They can also reproduce sexually and asexually. Sexual reproduction is more common. A female sea

cucumber will dispense her eggs and a male with fertilize outside of the body. This results in planktonic larvae that eventually settle to the ocean floor and then undergo metamorphosis. They also participate in allele effects, where individuals must congregate in large social groups to be able to mate successfully. (Photo 1)When disturbed, some Sea Cucumbers emit a stick white thread to entrap their predators (Photo 2), others evacuate their internal organs. There are 1250 known species of sea cucumbers and more than 14 of them are based in Hawaii growing from 6 inches to 3 feet.

The most common sea cucumbers found in the tide pools of Hawaii are the Black Sea cucumber, ashy cucumber, banded cucumber, white-speckled sea cucumber, and difficult sea cucumber. However, less common species like the leopard sea cucumber, and the light-spotted can also be found.

Shark's Cove is located on the North Shore of Oahu in the town of Pupukea. Shark's Cove is on the north side of the Pupukea-Waimea marine life conservation district. The MLCD includes Shark's Cove, Kalua-Maua or Three Tables, and Waimea Bay. In the 1970's a group of divers confronted the North Shore Neighborhood Board on the scarcity of marine life in that region. In 1975 a survey was collected by Sea Grant to show strong support in making Pupukea a new marine life reserve with certain exceptions to limu or seaweed collecting and certain types of fishing. It wasn't until the 1990's did The Hawaii Department of Land and Natural Resources (DNLR) realized that enforcing these exceptions and rules were too difficult. Once again the North Shore Neighborhood Board was called upon.

After conscripting many amendments to change the rules of the MLCD and offering them to DLNR, Senator Robert Bunda and Representative Alex Santiago assembled stakeholders to also support rule changes to DNLR. After a public hearing, the boundaries of the Pupukea

MLCD were expanded and rules revised. In 2003, the MLCD became what we know today extending from Kulului point to the Wananapaoa Islets. Inside the MLCD one cannot take, injure, harass, or kill any marine life, bring any form of fishing equipment into the water that may be be used to harm or kill wildlife, take or degrade any coral or geological attributes to this area, or any equipment to alter and geological landscape. There are a few exceptions to these rules. One can collect limu kohu and limu lipe'epe'e up to 2 pounds, freeze-dried as long as the root is left; one can fish from the shore of Waimea bay with two poles per person, one line per pole, and two hooks per line. Lastly, during the months of August and September, one can possess a throw net to harvest 'opelu and akule during November and December. Even with these rules the MLCD is still under constant threat of poaching and over and ill use of the area. The tide pools at Shark's Cove even face more of a threat because there are even more exceptions regarding this area.

The tide pools that are located south of Shark's Cove were man made. They were created in the 1950's when they were blown out by dynamite to make gravel for the road base. Due to the unnatural way the tide pools were created, they are written to be the property of the City and County of Honolulu Pupukea Beach Park. Due to this fact, even though the tide pools are located in the MLCD, they are treated as if they are not. Though fishing is prohibited in the tide pools, possession of nets, spear guns and other fishing equipment is allowed. This, of course, makes it increasingly difficult to protect the tide pools and to stop poaching. This is what brought attention to the biodiversity index of sea cucumbers at this site.

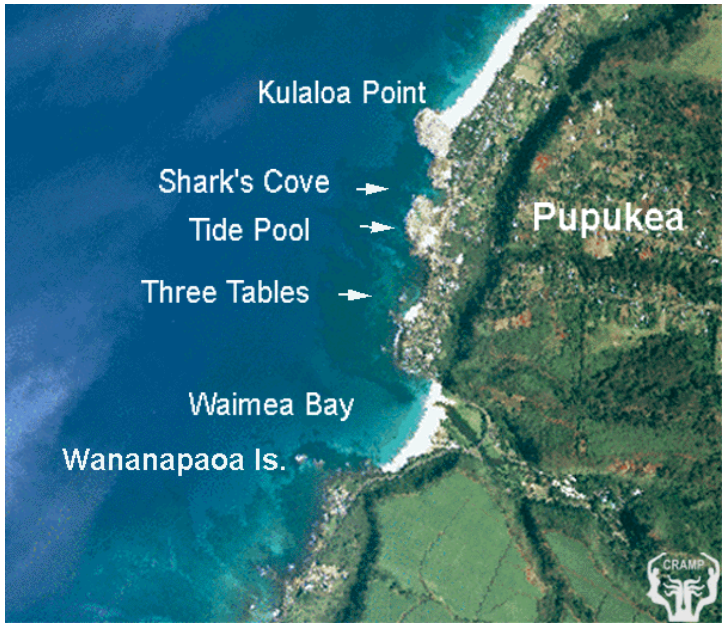
Objectives and Methods

Survey Site

Surveys were conducted at the tide pools in the ahupua'a, the Hawaiian division of land of

Pupukea, Shark's Cove, and Waimea Bay of the ahupua'a of Waimea. These three locations can be all found in Figure 1. Pupukea and Waimea are both low in population of residents, but during the time of the surveys, all sites were rather populated with tourists and visitors. SCUBA divers and snorkelers were common occurrence at the cove while casual beach-goers frequented the tide pools and Waimea often. Popular events like swimming and stand-up paddle board races were also being conducted during this time.

Figure 1



Objective 1: Determining Species Diversity, Species Richness and Biological Features of Sea Cumbers in the tide pools.

Species richness and diversity data of sea cucumbers were collected by doing a wide spread search without transect lines. Transect lines were omitted due to the sea cucumbers sessile behavior. Areas that had large numbers of specimens were re-visited along with exploring new regions with varying depths. These areas were chosen randomly and were not marked, returning was based on memory and photos taken of hotspots. Surveys were conducted twice a week between the hours of 9:00-13:00, with 1 hour to 2 hour durations. The surveys were done on July 7th, 9th, 15th, 17th, 21st, 23rd, 28th, and the 30th. A total of 8 surveys were done in the tide pools,

while 2 were done in Shark's Cove and the right side of Waimea Bay for a total of 12 surveys. Interns from Kupu Oahu Team B assisted in the collection.

During each visual survey, photos were taken of each species, width and length of the specimen was measured by a standard 12-inch plastic ruler. Photos were then taken with an iPhone 5c in a WaterShot casing. Once the photo was taken, the species was identified by comparing photo to photos in a *Hawai'i's Sea Creatures:A Guide to Hawai'I's Marine Invertebrate* written by John Hoover.

Objective 2: Measurement of Environmental Variables.

In this study, weather, water temperature, water depth, and environmental composition was taken note of to try and find a correlation between days were large numbers of sea cucumbers were found and their hotspots. Weather was observed once entering the tide pools and written down accordingly to each date. When a specimen was found, water temperature was next to the cucumber with a Taylor Compact Waterproof Digital Thermometer. Depth was then measure in feet by 2 5-foot tape measures. Environmental composition was observed by simple observing of the area around the specimen and what substrates it could be found in.

Objective 3: To compare findings in Tide Pools to Findings in Waimea Bay and Shark's Cove.

Due to the fact that the tide pools are not protected by the laws of the MLCD, I wanted to see if size, species, and abundance differed from the tide pools in Waimea Bay and Shark's cove. These surveys were conducted in the same way as the tide pools. Areas were chosen randomly and explored of any species of sea cucumbers. Areas that were proven to have specimens were

revisited and new areas were also examined. Measurements of lengths, depths, and species were taken and compared to that found in the tide pools.

Results

A total of 115 specimens were counted in the entire study. 78 individuals were counted in the tidepools, 15 in Waimea Bay and, 23 in Shark's cove. The most common species found in decending order were ; Holothuria atra (Black Sea Cucumber, Photo 3), Actinopyga mauritiana (White-Spotted Sea Cucumber, Photo 4), Holothuria difficilis (Diffucult Sea Cucumber, Photo 5), Holothuria hilla (Light-Spotted Sea Cucumber, Photo 6), Holothuria whitmaei (Teated Sea Cucumber, Photo 7), lastly Bohadschia argus (Leopared Sea Cucumber, Photo 2).

Table 1- Loli numbers in Waimea Bay, Tide Pools, and Shark's Cove.

	Waimea Bay/ # of individuals	Tide Pools / # of individuals	Shark's Cove / # of individuals
Actinopyga mauritiana	3	9	10
Bohadschia argus	N/A	1	N/A
Holothuria atra	12	57	13
Holothuria difficilis	N/A	4	N/A
Holothuria hilla	N/A	4	N/A
Holothuria whitmaei	N/A	3	N/A

From Table 1, the Black Sea Cucumber was the most common in all three areas, along with The White-Spotted Sea Cucumber. The reason N/A or not available is written in the columns instead of zeros is that the survey was done with a simple snorkel and mask. This prohibited deep diving for long periods of time and prevented the ability to check the ocean floor in Waimea Bay and Shark's Cove to look for these specimens.

Table 2- Daily inventory of Loli in the tide pools

	July 7th	July 9th	July 15th	July 17th	July 21st	July 23rd	July 28th	July 30th
Actinopyga mauritiana	-	1	1	1	2	-	4	-
Bohadschia argus	-	-	1	-	-	-	-	-
Holothuria atra	3	6	23	4	6	4	6	5
Holothuria difficilis	-	-	2	-	1	1	-	-
Holothuria hilla	-	-	3	-	-	-	-	1
Holothuria whitmaei	-	1	2	-	-	-	-	-

The probability of recounting the same individual repeatedly was very high due to the inability to tag the sea cucumbers. Table 2 provides a day by day inventory of the specimen ration found each day to display the species ratio and richness. The Black Sea Cucumber or *Holothuria atra* was continuously found in greater numbers compared to any other species each day. More specimens could have been found on the first day but, I was becoming familiar with the tide pools and learning popular environments for sea cucumbers. Individual day inventories were not added into Table 2 because of the study's focus being the tide pools.

Sea Cucumbers like extremely rocky substrates. The tide pools have many rocks and crevices that the sea cucumbers can wedge themselves happily into. This leads me to assume species the following species prefer shallower water; Black Sea Cucumber, White-Spotted Sea Cucumber, Teated Sea Cucumber, Leopard Sea Sucumber, and Difficult Sea Cucumber. The light-spotted sea cucumber was found at depths of 4 feet and over, suggesting that this species may prefer deeper water. Sea Cucumbers found in Shark's Cove and Waimea bay were well past 10 feet deep, suctioning to upward faces rocks, however, unlike they tide pools. These individuals were not gathered together but, rather spaced far apart. Weather however, did have a big effect on the number of Sea cucumbers counted in one day.

On days where the sun was out and the temperature was high, Sea Cucumbers were harder to find, the ones that were spotted had placed themselves strategically under rocks to block from the sun. Days of overcast, the numbers of sea cucumbers found were noticeably higher than that on hot days. I believe this is due to water temperature. When a Sea Cucumber was found, the average water temperature around the individuals was 72°-74° Fahrenheit. In deeper water like Waimea Bay and Shark's Cove, some individuals were found at 70° Fahrenheit. Hotter weather would cause the water to heat up making the sea cucumbers take refuges in shady fractures in rocks.

Regardless of the abundance found in the tide pools, individuals found in Shark's Cove and Waimea Bay were much larger than those found in tide pools.

Table 3- Average size comparison Actinopyga mauritiana and Holothuria atra.

	Waimea Bay & Shark's Cove/ Avg size in inches	**Tide Pools/ Avrage size in inches**
Actinopyga mauritiana	7''-12''	6''-8''
Holothuria atra	12''-16''	4''-9''

Table 3 displays the very noticeable size difference in individuals of the species listed above found in the tide pools compared to individuals found in Shark's Cove and Waimea Bay. The reason the other four species were omitted is that they were not found in Waimea Bay or Shark's Cove, so there wasn't any data to compare.

The information gathered in the study suspects that harvesting might have been done. Since the tide pools are not treated as if they were a part of the Pupukea MLCD, harvesting of the sea cucumbers could have very well been performed here. Harvesting creates reverse natural selection, where the large specimens are taken and smaller, less desirable ones are left. That

leaves the individuals with weaker genes to reproduce and create a feebler generation. This would explain the smaller sizes in the tide pools.

Conclusion

After all surveys were conducted it was determined that Black Sea Cucumbers were the most common species found in the North Shore Pupukea Tide pools. It is not certain what species is being targeted but, if the data shown in the tide pools is reflected on other parts of Hawaii, it is safe to say that mass amounts of them are being taken. Sea cucumber, as said above, are somewhat like scavengers. They eat animal scraps and plant matter along the ocean floor. This cleans and keeps the ecosystem healthy. If the numbers are depleted greatly, the health of the reef and ocean would greatly deplete. This would harm all other species living in the ocean including coral. One major thing that could have made this study better would have been a study extending from during the harvesting, throughout the four month ban, and then after decisions that were made. That way all changes in population counts could have been recorded and explained if the species prospered or failed.

Even though Sea Cucumbers are not a threatened species, even with the mass harvesting. The numbers people are collecting them at now could very well endanger their future in Hawaii. This could lead to sea cucumbers being placed on the IUCN Endangered Species list and maybe even becoming extinct in Hawaii. Sadly, when the demand for them is growing I can only imagine that the harvesting will progress to other Pacific islands and maybe the United States mainland's west coast. However, getting support behind them will be difficult with uneducated people because of their less than attractive appearance. That is why educational outreach and emphasis that everything is connected when protecting our resources is necessary.

What should result in the end of this four month ban are very strict rules protecting sea cucumbers. Eating sea cucumbers is a fairly new trend and with money involved, people are

more than likely to abuse any harvesting regulations that would be out into place.That means that perhaps a permanent ban may be the answer for this situation.

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Photos

Photo 1- *Holothuria atra and Holothuria difficilis displaying clumping.*

Photo 2- *Bohadschia argus emitting its sticky threads*

Photo 3 – *Holothuria atra*

Photo 4- *Actinopyga mauritiana*

Photo 5- *Holothuria difficilis*

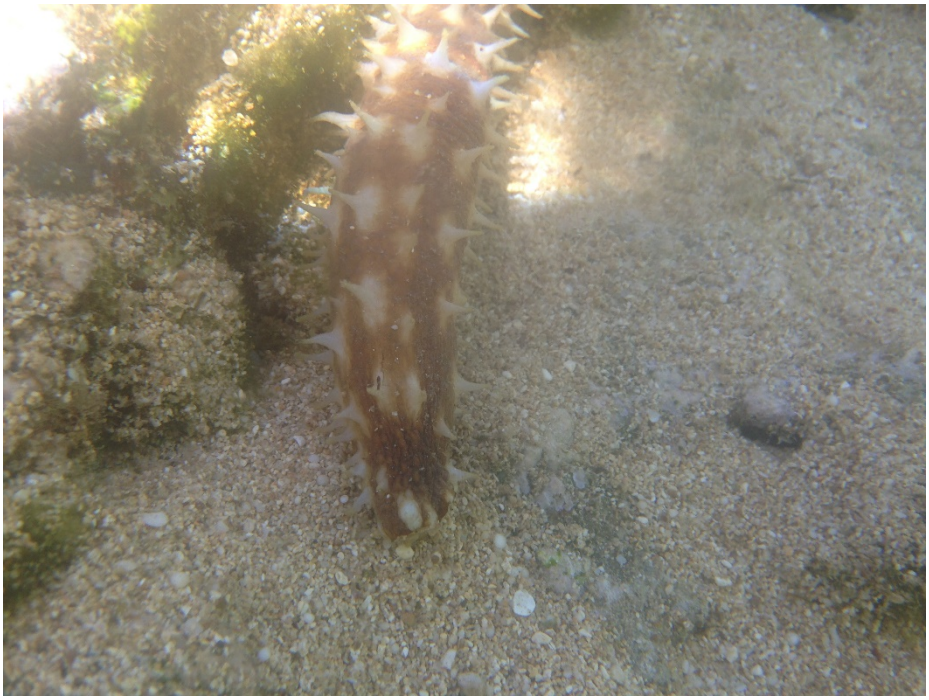

Photo 6- *Holothuria hilla*

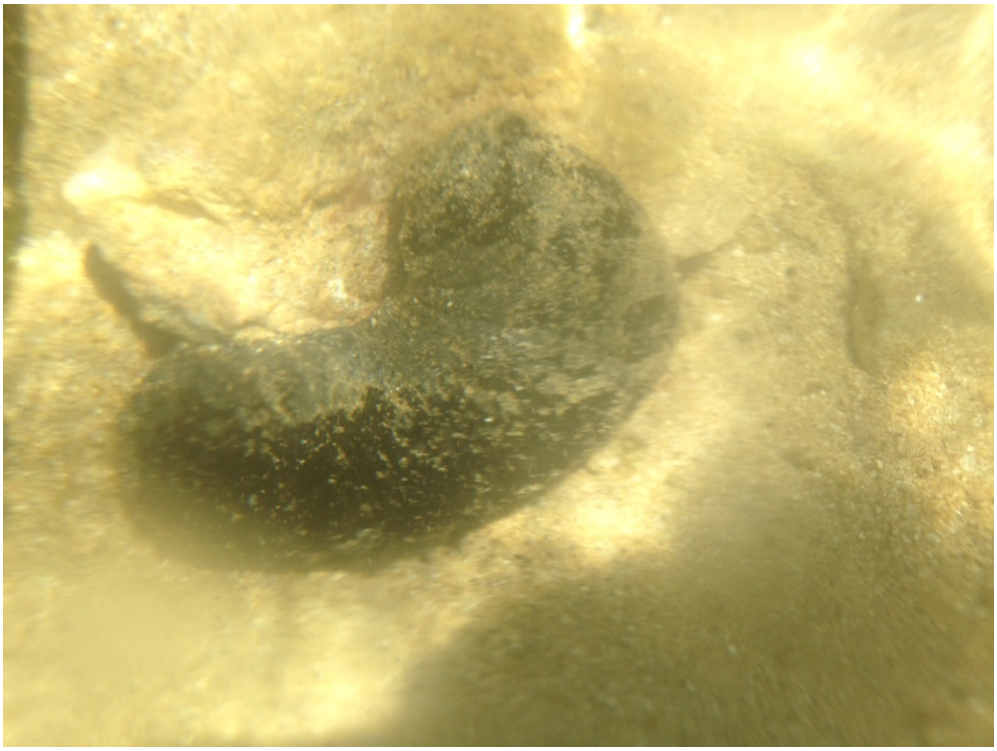

Photo 7- *Holothuria whitmaei with sand removed*

Photo 8- *The common substrate.*