What's Eating Kaho'olawe's Marine Debris?

"Sharkastics" Are Providing Many Clues, and it's Not Fantastic News...

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Introduction to Kaho'olawe

The island of Kaho'olawe (20 35'N 156 35'W) is the smallest of the eight main Hawaiian Islands at 45 square miles, and is located ~7 miles south of East Maui. The Kaho'olawe Island Reserve is the largest State-held, contiguous marine reserve in the Main Hawaiian Islands. It encompasses a two-mile radius surrounding Kaho'olawe's ~26 miles of coastline, totaling ~78 square miles of marine protected area. Unauthorized access to the Island and into these waters is illegal. Commercial activities are prohibited, and access is limited to cultural, restoration, resources monitoring, and cleanup activities, potentially providing a variety of relatively undisturbed, natural habitats for marine life. Kaho'olawe's terrestrial and nearshore ecosystems are recovering from overgrazing by feral ungulates, ranching activities and fifty years (1941-1990) of live-fire military exercises and training (Figure 3). The most serious ecological consequence of these actions may be the resulting heavy sedimentation in the nearshore area of the island during heavy rains (Figure 2). Some areas remain pristine while lingering sedimentation in other areas may shade out corals and algae thereby affecting the dynamics of the reef ecosystem.

Figure 1. Kaho'olawe is rich in cultural history.

Figure 3. Navy's operation Sailor's Hat (Feb 6. 1965).

Figure 2. Flowing into Honokanai'a Bay.

Congress mandated the U.S. Navy to remove all unexploded ordnance and other debris left on the Island, but this effort ended prematurely so the KIR remains a dangerous place. The State of Hawai'i's Kaho'olawe Island Reserve Commission (KIRC) oversees the continuing cleanup, environmental and cultural restoration of the Island in order to return it to a future recognized, sovereign Hawaiian entity (Figure 1).

Kaho'olawe has a rich cultural history with close ties to the ocean and its creatures. This relationship is studied in both traditional and western ways. Kaho'olawe is recognized by Hawaiians as the physical manifestation of Kanaloa, the Hawaiian god of the ocean and the foundation of the earth, highlighting the Island's sacredness and cultural significance. This Native Hawaiian cultural reserve is an important place where traditional Hawaiian practices may be renewed and passed on to future generations.

Kaho'olawe's Marine Debris

Kanapou Bay, which spans over eight kilometers (five miles), is located on the eastern side of the island and is especially heavily concentrated with marine debris (Figures 4 & 5). Since 2003, this has been the site of KIRC-coordinated large-scale annual cleanups. The shear expense of these cleanups has unfortunately limited their frequencies, making the desired thorough cleanup of the beach unattainable with the constant influx of debris. KIRC is very grateful for receiving a 2010 NOAA Community-based Marine Debris Removal Project Grant. The funded project focuses on the bay's 4.5-acre Keoneuli Beach, which is approximately 800 meters (0.5 miles) long. During the course of this 18 month project, the KIRC plans to remove an estimated 15 tons of debris from this beach and rocky coastline, effectively providing a clean slate for monitoring Kanapou's re-accumulation rate (Figure 6).

Figure 4. Keoneuli Beach in Kanapou Bay and the rocky cliffs where marine debris accumulates (Molokini & Maui at the top of the photo).

Figure 5. Northern end of Keoneuli Beach.

2010-2011 Kanapou cleanup events will utilize approximately 150 volunteers; record the quantity and type of marine debris (Figure 10); assess the sharkastics issue (see impacts section); sort and divert as much as possible from the Maui landfill by recycling or re-using the applicable diverted marine debris in upland Kaho`olawe erosion control efforts (Figure 7); remove the debris by helicopter sling loads and KIRC's landing craft (Figures 8 and 9); feature the project in public outreach events, presentations, workshops and conferences; create a permanent educational display; create short films to be used in presentations and as public service announcements; and highlight the project online.

Figure 7. Kaho'olawe's net erosion control experiment.

Figures 8 & 9. Kaho'olawe's marine debris removal methods: by air and by sea.

Kanapou Debris Re-accumulation

Figure 6. The Southern end of Keoneuli Beach with before and after cleanup pictures showing the fast re-accumulation rates. Unfortunately, the March 11, 2011 tsunami moved all of the debris everywhere so this experiment and our "clean slate" section is no more… Note beware of bombs sign. Other Kanapou dangers include its remoteness, typically rough ocean conditions, murky "shark-infested" waters, and extreme weather conditions. Extra safety precautions are made.

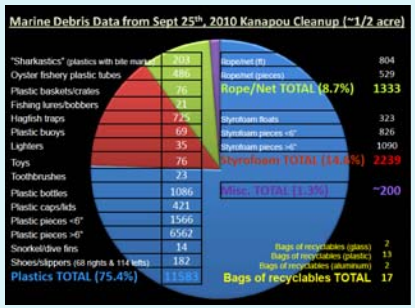

Figure 10 [right]. Kaho'olawe's sorted marine debris totals from the "Get the Drift & Bag It" cleanup.

Research Methodology

The KIRC Ocean Resources Management Program is tasked with assessing and protecting the coastal zones and Reserve waters (2-nautical mile boundary). To survey Kaho'olawe's ~47-km coastline, standardized, circumnavigational aerial surveys are flown every month (since 2003) using a long ranger helicopter in addition to vessel and land-based research. Helicopters provide an excellent platform for not only documenting marine debris accumulations, but also identifying marine animals (sea turtles, sharks, fish, manta rays, and seabirds) associated with them.

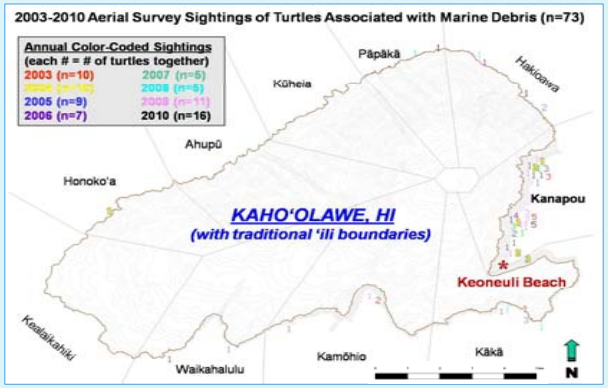

Figure 11. Map of the seventy-three sightings of sea turtles associated with marine debris from eighty-seven aerial surveys.

Aerial Survey Results

Eighty-seven monthly, standardized aerial surveys from 2003-2010. A total of 576 turtles were found (range= 1-20, st dev= 3.6, mean= 6.2 turtles/survey) and a total of 73 of these turtles were found associated with floating marine debris (Figures 11 & 12). This equates to 12.7% of all turtles seen being associated with marine debris, a rather high percentage. None were entangled. This map is a good representation of where debris accumulates along the coast of Kaho'olawe (the highest concentration being in Kanapou). Besides fish, no other species were seen amongst the debris so impacts, if any, are unknown.

Figure 12. Green sea turtle & fish swimming in debris.

Discussion of Marine Debris Impacts

It is unclear why turtles associate with marine debris lines, but they are found there in 'clusters', not just singly, so it seems something is drawing them to the debris. It is quite possible that they are attracted to these materials as potential sources of food, as floating objects generally attract a number of creatures, but since these turtles are likely green sea turtles who are predominantly vegetarians when they are mature, this leads to another theory. The majority of these turtles is small in size, so these turtles may have actually been floating with these materials pelagically during their "lost phase" of development and drifted in with the currents. They are thought to be omnivores at this point. It is a concern that these turtles are consuming plastics and other unnatural materials (Mascarahnas *et al.* 2004). Upon necropsy of hundreds of green and hawksbill turtles that have stranded throughout the Main Hawaiian Islands since the 1980s, finding plastics in stomach contents is very rare (personal communication, NOAA-NMFS' G. Balazs 2010). This doesn't mean that Hawaiian turtles aren't eating these materials; this may be more of a pelagic behavior so it goes unnoticed, they may be surviving the ingestion, or dying before stranding so they are not found/necropsied. Only one turtle has stranded on Kaho'olawe (at Kanapou in 1999), but it was not necropsied, so this plastic ingestion question remains unanswered at this point.

Figure 13. Entangled shark found at Kanapou.

One small entangled shark was found during a 2006 Kanapou cleanup, but it was buried in a culturally-sensitive way and not necropsied (Figure 13). It has been widely proclaimed that sharks consume "anything and everything", and some studies support this but information is lacking in Hawai'i (Lowe *et al.* 1996).

Upon close inspection, most plastic pieces and other types of marine debris found in Hawai'i have bite marks (jagged serrations and/or punctures) from sharks and/or possibly other animals (apex predator fish, monk seals, turtles, seabirds?). We coined them "sharkastics" and want to determine their distribution and impacts.

Figure 14. Kanapou sharkastics- note measurements.

Out of thousands of pieces of plastic, we've collected hundreds of obvious cases of sharkastics of all shapes, colors and sizes. Out of the 531 sharkastics collected from Kanapou during 4 cleanups in 2010, the highest frequency of pieces were white, faded blue/green and black (Figure 15). This collection not only shows what these animals are biting/ingesting, but it may also be a good representation of the colors of plastic that are in the ocean environment.

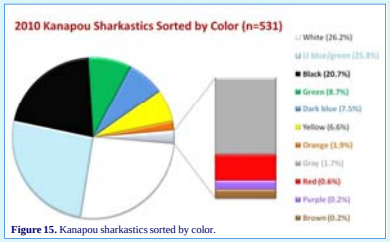

Figure 15. Kanapou sharkastics sorted by color.

It has been widely recognized that if animals are in fact consuming this non-biodegradable debris, toxins can be transferred and the objects can cause blockages and subsequent food and faecal impactions in the intestines causing medical complications including starvation. The extent of this problem hasn't been researched in Hawai'i, even though sharkastics are commonly found throughout the Hawaiian Islands. Is it a global issue with serious impacts to species survival? We want to find out!

References

Lowe, C.G., B.M. Wetherbee, G.L. Crow, and A.L. Tester. 1996. Ontogenetic dietary shifts and feeding behavior of the tiger shark, *Galeocerdo cuvier*, in Hawaiian waters. Environmental Biology of Fishes 47: 2703-211.

Mascarahnas, R., R. Santos, and D. Zeppelini. 2004. Plastic debris ingestion by sea turtles in Paraíba, Brazil. *Mar.Pollution Bull.* 49: 354-355.

Mahalo nui loa... to NOAA's Marine Debris Division!