Shark Finning at Cocos Island:

Managing Illegal Fishing in the Offshore Waters of Costa Rica

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When the buying stops, the killing can too.

Introduction

Cocos Island is the marine jewel of Costa Rica. Celebrated as "the sharkiest place on Earth," it attracts tourists and poachers alike. The waters surrounding the island have been protected, to some degree, since 1984, yet shark populations are in decline. In this paper, I present two hypotheses: (1) Current enforcement strategies are not protecting sharks from shark finning at Cocos Island, and (2) Stakeholder engagement is the missing link. Based on our discussions in class and research for this paper, I hypothesized that involving fishermen in the design and implementation of the Cocos Island protected area would reduce illegal fishing; however, I discovered that engaging fishermen is, in this case, impractical or impossible. I present three alternative recommendations for reducing shark finning within the reserve: (1) increased enforcement capacity, (2) the widespread ratification of the Port State Measures Agreement, and (3) reduction in the demand for shark fins.

Historical and Global Context

Cocos Island is located 532 km to the southwest of Cabo Blanco, in the Pacific Ocean, halfway between the continent and the Galapagos Islands (*Figure 1*). The only people present on the island are personnel from the Ministry of Environment, Energy and Telecommunications (MINAET), the National Coastguard Service (SNG) and MarViva, along with a small number of dive tourists and dive operators. There is no native population.

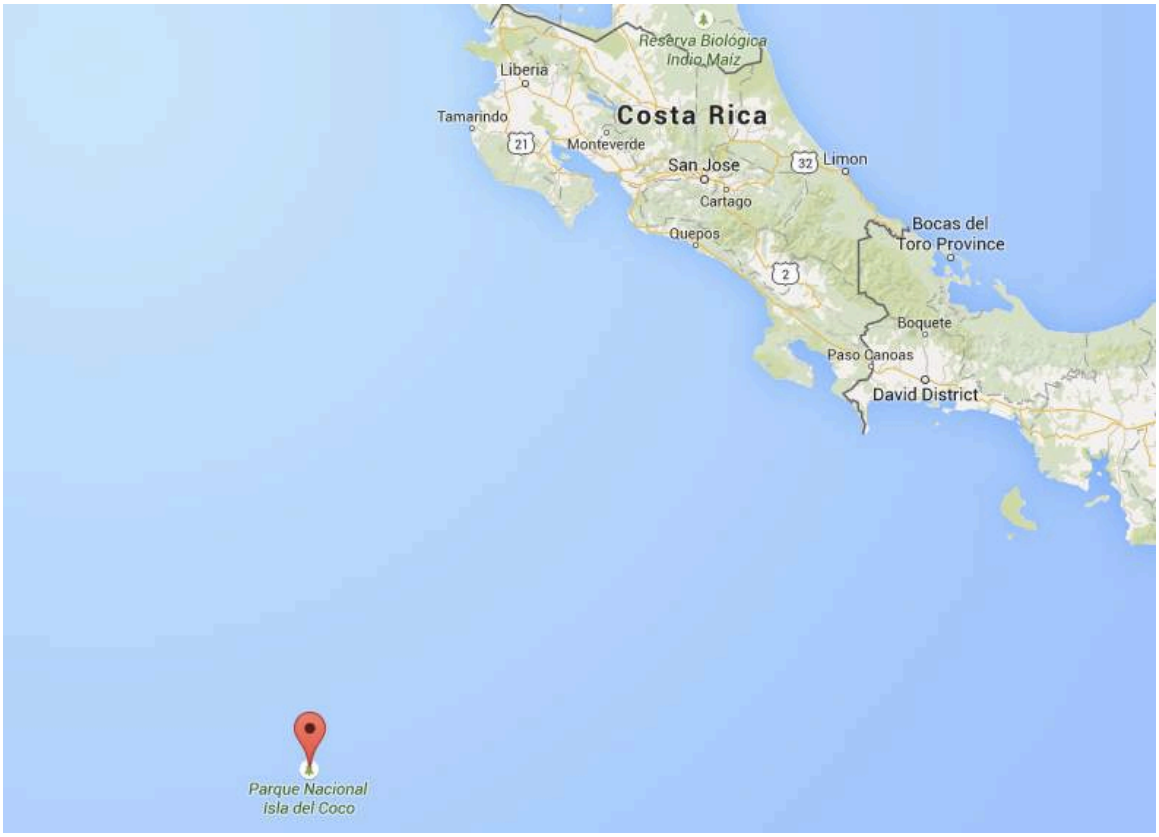

Figure 1: Cocos Island is remote and isolated from management in Costa Rica. It is home to large oceanic species of elasmobranchs, cetaceans, and sea turtles. Image: Google Maps

In 1978, Cocos Island was established as a National Park (PNC), and in 1984, park status was extended to the coastal environment, creating one of the world's first marine protected areas (MPAs). In 2001, these boundaries were extended to encompass 22.2 km^2 around the island, and in 2011, park boundaries extended once again to include 9,640 km^2, an area known as the

Seamounts Marine Management Area. Now one of the largest MPAs in South America, PNC faces new challenges. Enforcement capacity has not kept up with area expansion, technological improvements to fisheries, and the increased organization of illegal (IUU) fishing.

Dive Tourism

Heralded as "the sharkiest place on Earth", PNC attracts dive tourists the world over. Based on the latest available data, in fewer than one hundred expeditions, Cocos Island generates approximately US$6,309,490 for the private sector and between US$441,490 and US$451,290 in park fees for PNC annually (Bigue et al. 2010, 6). The main attraction at PNC is diving with large schools of scalloped hammerhead sharks, which can only be witnessed in a handful of places on Earth. In her profile of Cocos Island for *Sport Diver Magazine*, one diver writes, "It's a destination of superlatives with its big animals, bigger schools and the biggest adrenalin rushes" (Bradley 2008). Though Cocos Island is home to beautiful reef fish, sea turtles, and cetaceans, it is the shark population that drives dive tourism. Survival of the sharks is critical to the survival of the industry.

Shark Finning

Unfortunately, the impressive abundance of large pelagic sharks that attracts divers also attracts visitors of a different kind: fishermen. While shark products include meat, liver, cartilage, teeth, skin, and oil, it is the high market value of shark fins that drives the demand for these animals. Shark fins are consumed primarily in Hong Kong for shark fin soup, an expensive delicacy often served at banquets and weddings. The fin itself does not contribute to the flavor of the soup but is believed by some to have medicinal properties (though no support exists for such claims) and is recognized as a status symbol. A bowl of shark fin soup costs ~USD$100, and fins are sold for ~USD$650 per kilogram (Karpus, WildAid). The differential price of a shark's body parts (the meat is relatively cheap) creates a perverse incentive for fishermen. Designed to free up room in a ship's hull, "shark finning" involves slicing off a shark's fins and

throwing its body overboard. The still-breathing shark will often float underwater, unable to swim until it bleeds or starves to death or is eaten by other sharks. Of the fourteen shark species most prevalent in the shark fin trade, all have experienced population declines ranging from 40-99%, and all appear on the International Union for the Conservation of Nature (IUCN) red list (Whitcraft et al. 2014, 5) (*Table 1*).

COMMON NAME	SCIENTIFIC NAME	FIN PRODUCT NAME	IUCN RED LIST STATUS	IUCN TREND	DECLINE*
BLUE SHARK	*Prionace glauca*	Ya Jian	NT	Unknown	60–87%
SHORTFIN MAKO SHARK	*Isurus oxyrinchus*	Qing Lian	VU	Decreasing	40–99%
SILKY SHARK	*Carcharinus falciformis*	Wu Yang	NT	Decreasing	60–91%
DUSKY SHARK	*Carcharinus obscurus*	Hai Hu	VU	Decreasing	62–92%
SANDBAR SHARK	*Carcharinus plumbeus*	Bai Qing	VU	Decreasing	65–97%
TIGER SHARK	*Galeocerdo cuvier*	Ruan Sh	NT	Unknown	65–99%
HAMMERHEAD SCALLOPED/ SMOOTH	*Sphyrna lewini/ zygaena*	Chun Chi	EN/VU	Unknown/ Decreasing	79%–total collapse
GREAT HAMMERHEAD	*Sphyrna mokarran*	Gu Pian	EN	Decreasing	79%–total collapse
THRESHER SHARKS COMMON, BIGEYE, PELAGIC	*Alopias*	Wu Gu	VU	Decreasing	50–83%
BULL SHARK	*Carcharinus leucaas*	Sha Qing	NT	Unknown	98.6–99.99%
OCEANIC WHITETIP	*Carcharinus longimanus*	Liu Qiu	VU	Decreasing	70–99%

Table 1: Fourteen species most prevalent in the shark fin trade (Whitcraft et al. 2014).

Shark finning is banned in many parts of the world, including Costa Rica, but disturbing loopholes exist that perpetuate its legal practice. For example, the Costa Rican law requires shark fins be “attached” when landed (Regulation AJDIP/47-2001). One judge’s interpretation of the law led to the creation of a gruesome practice known as “spining”, by which all meat is removed from the shark, leaving only its fins attached to its naked spine (Fendt 2014c) (*Figure 2*). In another instance, INCOPESA, the agency responsible for writing fisheries regulations,

ruled that fins removed and re-attached to sharks could be landed. Agency inspectors looked the other way when “Frankenstein” sharks poured into port, with lots of fins sewn onto just a few bodies (Shannon 2013).

Figure 2: Left: Shark “spining”, the practice created by a loophole in Costa Rican law. Photo credit: Interpol, via Vice News (Fendt 2014a), Right: Shark fins dry on a Hong Kong rooftop. Photo credit: Associated Press.

Furthermore, where the financial reward exceeds the cost of evading authorities, sharks are harvested illegally. A 2006 study estimated that between 26-73 million sharks are killed each year for their fins; this figure does not include sharks killed for other purposes or as bycatch (Clarke et al. 2006, 1119). A 2013 study estimated that between 63-273 million sharks are killed in total each year, up to 7.9% of all the sharks in the ocean (Worm et al. 2013, 194). This paper will examine the role of the global shark fin trade at PNC and will offer some reasons for hope.

Ecological and Economic Importance of Sharks

Sharks are apex predators on the reefs and in the pelagic zone at Cocos Island. They are considered “keystone species” by ecologists, meaning the loss of sharks results in a trophic cascade that can lead to the collapse of other species, including corals. Sharks keep fish populations in check, targeting old, sick, and wounded individuals. This has the effect of controlling disease and maintaining ecosystem health. This happens in two important ways: (1) mesoconsumers, organisms like rays and jacks that serve as both prey and predators, can

proliferate, increasing pressure on animals lower on the food chain, or (2) mesoconsumer behavior can change. When sharks are in the area, mesoconsumers avoid their hunting grounds; once sharks disappear, mesoconsumers expand into these areas, increasing pressure where previously only a small number of sharks hunted (Heithaus et al. 2008, 2-3). Where coastal populations rely on marine resources, sharks play an important role in maintaining fisheries health.

However, this argument holds little weight at Cocos Island, where only a few Costa Rican rangers and dive operators live. But a study in Palau, a dive destination similarly reputed for its sharky waters, revealed that a shark can generate far more revenue alive than dead (Vianna et al. 2012). Annually, shark diving in Palau was responsible for USD$1.2 million in salaries to the local community and generated USD$1.5 million in taxes to the government. If the population of approximately 100 sharks that interact with tourists at popular dive Palauan sites was harvested by fishermen, their economic value would total at most USD$10,800. The Costa Rican government should take studies such as this into account when ruling on shark finning and allocating resources to enforcement at Cocos Island.

Hypotheses

1. *Current enforcement strategies are not protecting sharks from shark finning at PNC.*

In order to assess this hypothesis, I examine how pelagic populations have changed over time. Though the MPA is relatively new, citizen scientists have collected preliminary data that suggest pelagic populations are in decline. This is in agreement with limited records and anecdotal evidence from park rangers that illegal fishing is occurring at alarming rates within park boundaries. I confirm my first hypothesis and turn to Hypothesis 2 to address its cause.

2. *Stakeholder engagement is the missing link.*

My second hypothesis focuses on the cause of Hypothesis 1 (the decline of shark populations within the park) and requires a multi-disciplinary approach. I examine literature from the fields of anthropology, economics, sociology, business, and political science. I first look to community-based versus top-down approaches to marine reforms, where previous researchers have found a connection between the level of community involvement and the level of compliance. This research suggests that engaging fishermen in the design and implementation of an MPA results in better compliance and reduced cost of enforcement. However, when I compare the fishing communities at Cocos Island to those engaged in successful community-based projects, I find that a parallel cannot be drawn. Because the fishermen engaged in IUU fishing at Cocos Island are foreign, transient, and evasive, engaging them would be unrealistic and unlikely to yield results. I reject my second hypothesis, explore the IUU fishing industry, and make alternative recommendations based on my findings.

Hypothesis 1: Current enforcement strategies are not protecting sharks from shark finning at PNC.

My initial motivation for this investigation was a highly publicized paper released in March of this year entitled “Shifting elasmobranch community assemblage at Cocos Island – an isolated marine protected area” (White et al. 2015). This study utilizes citizen science data in order to assess changes in shark, ray, and skate populations from 1993-2013. This time series spans all three relevant periods of the MPA: pre-2001, when the waters surrounding Cocos Island were not protected beyond the coast; 2001-2011, when the MPA extended only a few miles off the coast; and post-2011, when the MPA was expanded greatly to encompass pelagic habitat. Because little time has passed since the expansion of the park in 2011, a longer time

series is needed to capture the true effectiveness of the MPA offshore; however, this study is a jumping-off point for discussions of shark population health at PNC.

Researchers analyzed observations of various shark species as recorded by divemasters from 1993-2013. They found that nearshore, reef-associated species had flourished, especially tiger sharks, whose occurrence increased an astounding 79% per year. However, pelagic species had declined markedly. Scalloped hammerhead occurrence declined between 19-45% and silky sharks 91%. One notable exception to this trend is the whitetip reef shark, which declined 77%. This species may be more highly targeted for its fins than are other reef-associated species (Friedlander et al. 2012, 334). Its decline therefore suggests that the decline in pelagic shark species at Cocos Island is not the result of bycatch in illegal tuna fishing, environmental factors, or any other threat, but represents targeted fishing for sharks for their fins. The results of this study concur with those of another, published in 2012 using similar methodology (Friedlander et al. 2012) (*Figure 3*).

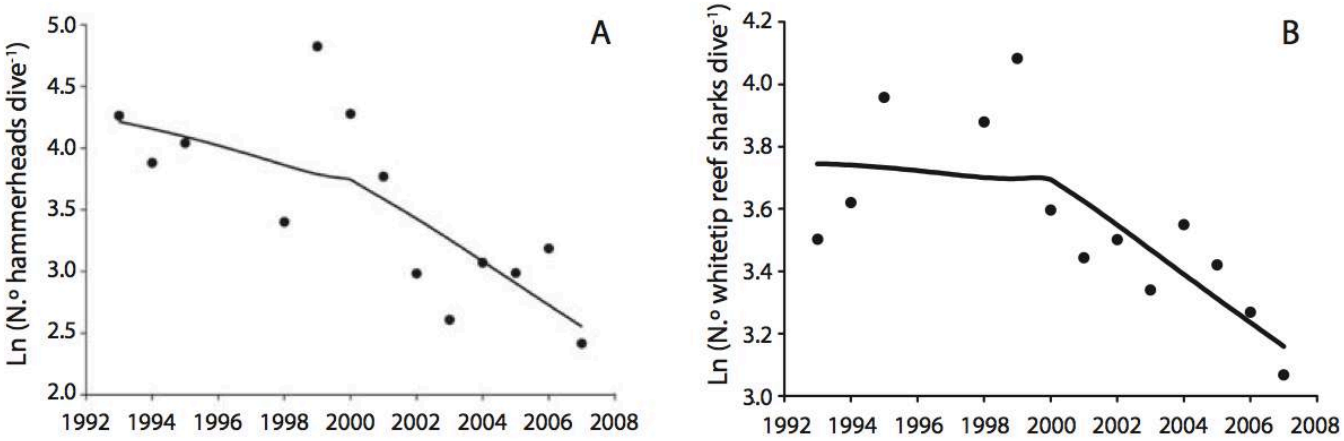

Figure 3: (A) number of hammerheads observed per dive, (B) number of whitetip reef sharks observed per dive. (A) demonstrates an 11-fold decline in observations from 1993-2007. (B) demonstrates a 2.8-fold decline.

Researchers uncovered more than an 11-fold decline in hammerheads and a 2.8-fold decline whitetip reef sharks from 1993 to 2007 (Friedlander et al. 2012, 330). These figures suggest shark finning is occurring within MPA boundaries at Cocos Island.

However, declining pelagic shark populations at Cocos Island do not necessarily imply shark finning. Numerous factors determine shark abundance and distribution, including El Niño Southern Oscillation (ENSO) events, availability of food, and disease. I will now turn to available records and anecdotal accounts of shark finning within the MPA to confirm that IUU fishing is the most likely cause of the decline in shark species observed at PNC.

Three groups are responsible for surveillance and detection of illegal vessels at PNC: the Ministry of Environment, Energy and Telecommunications (MINAET), the National Coastguard Service (SNG), and MarViva, a regional NGO. Official ranger data from 2008 (Bigue et al. 2010, 12) record an average 75.4 observations per month (an "observation" is recorded when an illegal vessel is seen but not intercepted) and 37 findings in one year (a "finding" is the discovery of gear in the water, usually abandoned by fleeing vessels) of 104.5 miles (168.176 km) of longline. 81 individual sharks were reported hanging from these abandoned longlines. MarViva's data paint an even grizzlier picture: 1512 km of longline, 48,551 hooks, and 459 hooked sharked from 2004-2007 (Friedlander et al. 2012, 334). These observations are believed to represent only a small fraction of vessels on the water because enforcement capacity is extremely low. I will address the challenges facing MPA surveillance teams in more detail under the subheading "Monitoring and Enforcement". Also note that these figures are from before 2011, when the park was expanded by several thousand square kilometers.

The cruel fact that shark finning occurs with impunity at the park in well known. One journalist benefited from candid conversations on the topic with rangers and fishermen during her 2013 investigation (Shannon 2013). She writes, "At his station on Cocos, Ranger Geiner Golfin shows off a big hook for snaring sharks. He says it's part of an unending haul of

confiscated illicit equipment that, in just one recent month, included 200 miles of fishing line and 700 buoys." Captain Jose Calderon laughed at the ease with which he was able to illegally capture and fin sharks. "'When the inspector came to check the freezers', he says with a chuckle, 'they'd never check the engine room. So we'd hide all the fins in the engine room.' ... 'It was easy,' Calderon laughs. 'It was really easy.'" Accusations of corruption are common at the agency level, and equipment and personnel on the ground are ludicrously insufficient. These factors contribute to a reputation of poor enforcement and easy theft of marine resources that, combined with a reputation for the "sharkiest waters on Earth", attracts shark fishermen to PNC.

I have demonstrated that pelagic shark populations, as well as whitetip reef sharks, are in decline at Cocos Island. These species are targeted for their fins to make the Chinese delicacy shark fin soup. Detection data and anecdotal evidence support my hypothesis that shark finning is responsible for this decline. Having shown that current enforcement strategies are not protecting sharks from shark finning at PNC, I will move on to Hypothesis 2, an investigation of the root cause of this failure.

Hypothesis 2: Stakeholder engagement is the missing link.

There are diverse and sometimes conflicting stakeholders concerning Cocos Island, including government surveillance organizations, regional and international NGOs, legal fishermen in the surrounding waters, tourists, dive operators, and, as I have just established, illegal fishermen. These stakeholders have unequal voices in the design and implementation of the MPA, and I hypothesized that by engaging illegal fishermen in the conversation, compliance with MPA regulations would improve.

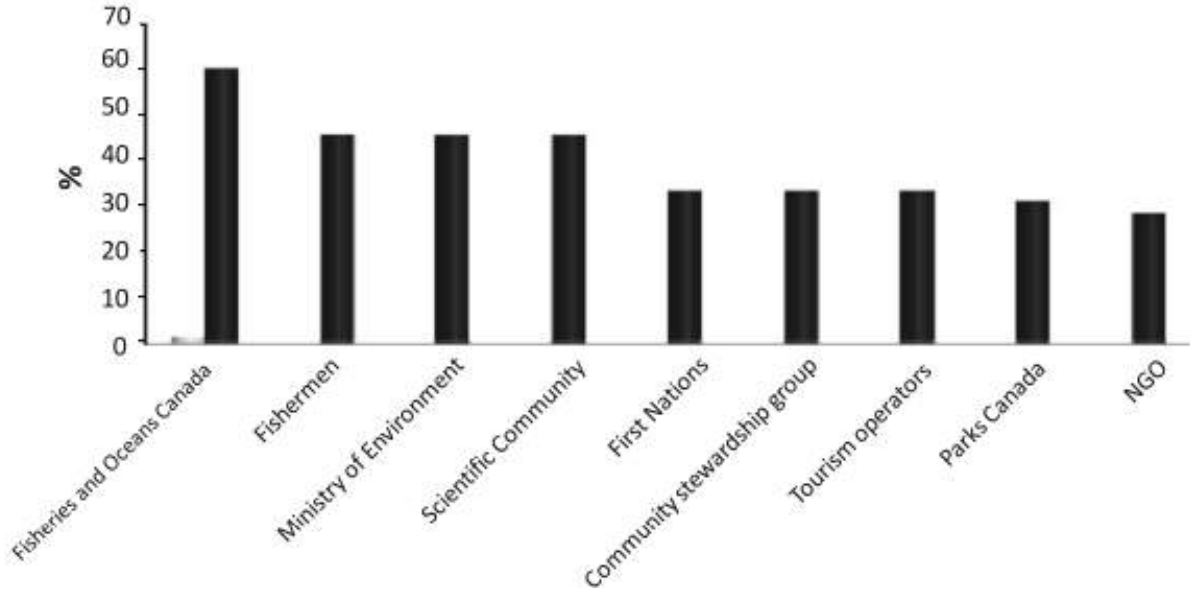

Figure 4: Who should be participating in MPA design and implementation? (Heck et al. 2011)

In her study of MPA effectiveness in Canada, researcher Nadine Heck contends, "A participatory approach has the potential to enhance evaluation capacity, to increase credibility and acceptance of results, to strengthen relationships between managers and local stakeholders, and to address more locally relevant information" (Heck et al. 2011). She surveyed key stakeholders, asking, "Who should be participating in MPA design and management?" (Heck et al. 2011, Figure 2) (*Figure 4*). The reality in Canada, like in Costa Rica, is that only government officials and select NGOs are engaged in the process; however, over 40% of those surveyed believed that fishermen should be involved. A comparable study is not available for Costa Rica, but I think we can take these results as an indication that fishermen should at least be given the opportunity to participate in MPA design and implementation.

In its report "Best practices in governance and enforcement of marine protected areas," FAO outlines five stages of MPA establishment and management (Christie et al. 2007, 200). Local stakeholders are to be engaged from the beginning and at every stage. Review of the benefits and refinement of education and outreach are key steps to be revisited at multiple

junctures. The authors justify the time-consuming process of community engagement by emphasizing its positive effect on compliance: “Participatory, fair and transparent plan preparation leads to stakeholder compliance because they have a ‘stake’ in the plan; real education takes place during this process and time is not as important as a good plan that is accepted by the stakeholders, both private and public.” This insistence is based on compelling results from studies carried out by other researchers on compliance across MPAs with different levels of community engagement. One study found that community support was significantly related to an increase in hard coral cover (Walmsley & White 2003). Another found that high public support for an MPA increases the potential for greater voluntary compliance (Viteri & Chávez 2007). Yet another revealed that perceptions of legitimacy (fairness, justification, and necessity) influence compliance (Hauck 2008). These studies suggest that including fishermen in the planning and implementation of the Cocos Island MPA has the potential to improve compliance with regulations and reduce the cost of enforcement.

These studies, combined with our conversations and readings in class, seemed to be supporting my hypothesis – in fact, in the first draft of this paper, I wrote that Hypothesis 2 was “confirmed”. Unfortunately, upon further investigation, I discovered I was overlooking a key variable: characterization of the fishermen at Cocos Island. For my hypothesis to hold, I need to demonstrate that the successful engagement of fishermen elsewhere is directly translatable to PNC. In each of the case studies I assessed, fishermen were local, long-term residents with an economic and moral interest in the future health of the ocean ecosystem in question. The fishermen at PNC, by contrast, aren’t local stakeholders. They have little incentive to invest in the future health of the ecosystem and personally receive few benefits; in fact, many are fishing against their will. It is difficult to determine who exactly these fishermen are, how many there are, where they are from, how long they fish in the area, etc. because their activity is IUU: illegal, unreported, and unregulated. My analysis will necessarily rely on generalizations about

the IUU fishing industry and speculation from within Costa Rica, which I will discuss in greater depth under the next subheading, “Powerful Incentives for IUU Fishing”. What is clear is that engaging these fishermen is unrealistic or impossible and unlikely to yield results. I reject my second hypothesis. I instead conclude that increasing monitoring and enforcement, increasing international engagement, and reducing demand for shark fins is necessary to end shark finning at Cocos Island. I discuss each of these recommendations further under the heading “Recommendations for the Future”.

Powerful Incentives for IUU Fishing

Because IUU fishing is, by definition, unreported, it is difficult to estimate its extent. One heavily-cited study from 2009, based on data from 1980-2003, found that the global annual economic loss to IUU fishing lies somewhere between USD$10-23 billion (Agnew et al. 2009). For comparison, the Food and Agriculture Organization of the UN (FAO) estimated the global annual value of all legal wild seafood to be USD$58.2 billion in 2002, the second highest year of the data set (FAO 2004). This means that from 1980-2003, IUU fishing comprised at *least* 17% of the global catch. The global annual value of legal wild seafood had increased to USD$129.2 billion by 2012, the latest available estimate (FAO 2014). It is projected to continue to increase at a rate of 3.2% per year (FAO 2014). It is likely that the value of IUU fishing has also increased in this period. The Agnew study estimated that between 2000-2003, IUU fishing comprised 22% of all catch in Western Central America (Agnew et al, 2009, Table 1). As fisheries technologies have improved and IUU fishing has become increasingly organized and expansive, it is almost certain that IUU fishing pressure in the region – especially in the remote waters of Cocos Island – has increased. Because fishing of any kind is illegal at PNC, by definition 100% of fishing is IUU fishing.

I have already detailed the economic incentive for shark finning; however, the causes of IUU fishing are social as well as economic. The prevalence of poor economic conditions and

prospects in some developing countries create a ready and cheap labor pool for IUU vessels to exploit (Le Gallic & Cox 2006). Workers are dispensable. Most of the IUU fleet is from the Far East, where one powerful crime organization, parading as a legitimate corporation (Pacific Andes, the largest fish fillet producer globally by volume), controls IUU vessels all over the world (Agnew & Barnes 2004). Individual vessels, therefore, are also dispensable, and the cost of doing business is dispersed and reduced. These vessels have frequently been implicated in human trafficking, drug trafficking, and slavery (UNODC 2011). A 2011 paper by the U.N. Office on Drugs and Crime concludes, "Perhaps the most disturbing finding of the study was the severity of the abuse of fishers trafficked for the purpose of forced labour on board fishing vessels. These practices can only be described as cruel and inhumane treatment in the extreme. Fishers are held as de facto prisoners of the sea, and the study documents several instances of reported deaths, severe physical and sexual abuse, coercion and general disregard for the safety and working conditions of fishers. A particularly disturbing facet of this form of exploitation is the frequency of trafficking in children in the fishing industry" (UNODC 2011). Some of the chilling details of this report are worth including here:

> Victims of trafficking at sea are deprived of their freedom of movement. Fishing vessels are equipped to stay for prolonged periods of time at sea and are increasingly fishing at a far distance from shore as fish stocks closer to land are becoming depleted in many regions around the world. Food, fuel and other supplies are often transferred to the vessel via supply vessels. With the possibility of at-sea transshipment a vessel may stay at sea for many years at a time without coming to port. Fishers report that they are traded from vessel to vessel whilst at sea to meet crewing needs. Without the possibility of escape, victims of trafficking are held as de facto prisoners at sea. There are also reports that large numbers of fishers are kept in "work camps" on board derelict vessels functioning as

> mother ships some 200 nautical miles off shore. Fraud and deception often takes place in the form of false promises regarding work conditions or payment.

It is suspected that such vessels comprise 95% of the IUU fishing vessels in Costa Rica (Fendt 2014a) (Boddiger 2003).

As IUU fishing becomes increasingly organized and fishing technologies improve, areas previously protected by their remoteness are increasingly within reach. The high value of shark fins, the abundance of sharks within the MPA, the availability of cheap labor, and the low cost of evasion at PNC (discussed further under "Monitoring and Enforcement") create powerful incentives for illegal fishing at within its nominally protected waters.

What Gives?

Monitoring and Enforcement

Given the impossibility and likely futility of engaging fishermen in the design and implementation of the Cocos Island MPA, effective monitoring and enforcement is essential.

The surveillance and enforcement team at Cocos Island is poorly equipped to handle illegal fishing within the MPA. The three previously mentioned surveillance organizations on the island (MINAET, SNG, and MarViva) are all understaffed and underequipped. MINAET employs 22 permanent staff at the island and owns two boats, SNG employs five rangers and owns one boat, and MarViva employs two permanent staff and owns one boat. Of the four boats on the island, only two are fast enough to intercept fishing vessels (Bigue et al. 2010). Economic resources are also insufficient, with funds totaling just USD$715,326 in 2010 (Bigue et al. 2010). Only USD$107,000 came from the government of Costa Rica, with MarViva and park fees comprising the remainder. As a result, equipment at the island is out-of-date and often out-of-service. For example, in its review of enforcement capacity at Cocos Island, WildAid reports, "For seven months in 2009, not only did the telephone malfunction, but the cellular phone

antennas were also damaged. There is Internet service, but only at 128 kbps bandwidth. The HF radio was also broken" (Bigue et al. 2010). Without communication between vessels or on land, the surveillance team at PNC cannot be expected to reach its full effective potential. Furthermore, even when boats are intercepted, fishermen are not held responsible for their actions. It is impossible to discuss shark finning at Cocos Island without discussing corruption.

Corruption

The first shark finning case to ever reach trial in Costa Rica (April 2014) resulted in a victory for illegal fishermen (Fendt 2014a). Kathy Tseng, a Taiwanese-Costa Rican businesswoman, was charged with landing 652 spined sharks at Puntarenas in 2011 (I detailed the gruesome practice known as spining under the subheading "Shark Finning"). Luis Dobles, INCOPESCA's executive director (the organization responsible for regulating marine resources in Costa Rica), allowed the boat to dock and unload its product, but a local prosecutor ordered customs officials to destroy the shark spines with fins. Last April, the judge ruled that Tseng had not violated the law, and the government of Costa Rica was required to pay USD$6, 622.46 to captain Su Hsien Feng, who operated under Tseng, for the seized catch. Even if Tseng had been found guilty, it is unlikely she would have served any of the proposed one-year sentence due to overcrowding in prisons (Fendt 2014b). There are ongoing investigations of both Dobles and Tseng, who in 2010 was also accused of human trafficking after authorities discovered 36 Asian slaves working at the group's fishing company. Dobles's case is still under investigation and appears unlikely to go to trial (Fendt 2014a). Corruption, like IUU fishing, is difficult to quantify, but accusations of bribery appear to be supported by the dearth of prosecutions under the shark finning ban (Boddiger 2003).

Effective and transparent governance is key to controlling IUU fishing. The same 2009 study that estimated the global value of IUU fishing assessed the role of governance in regulating it. The authors found an inverse correlation between World Bank governance indices

(Rule of Law, Control of Corruption, Regulatory Quality, and Government Effectiveness) and illegal fishing (Agnew et al. 2009, Figure 2) (*Figure 5*).

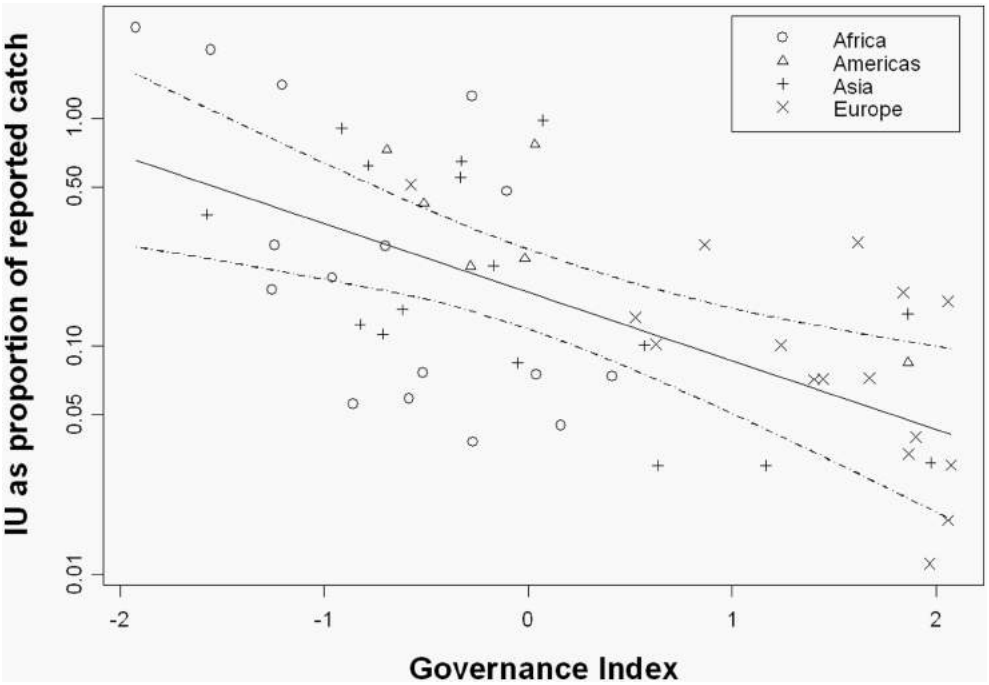

Figure 5: Relationship between World Bank governance indices (Rule of Law, Control of Corruption, Regulatory Quality, and Government Effectiveness) and illegal fishing. Countries in the Americas are represented by triangles (R^2 0.400, $p<0.001$, $n = 54$) (Agnew et al. 2009).

Costa Rica scores in the 60-70 percentile for each of these variables (World Bank 2014). This relationship indicates that Costa Rica is vulnerable to exploitation by the industry and that measures should be taken to counter its threat to marine ecosystems and human lives.

Recommendations for the Future

In order to address the challenges of shark finning at PNC, Costa Rica must engage local and international stakeholders. I recommend a three-pronged approach to ending IUU fishing for sharks at Cocos Island: (1) increased enforcement capacity through improved infrastructure, increased staff, and introduction of new surveillance technologies, (2) increased international information sharing through the widespread passage and ratification of the Port

State Measures Agreement, and (3) reduction in the demand for shark fins through awareness campaigns.

Increased Enforcement Capacity

PNC desperately needs more staff and better equipment, including boats fast enough to intercept IUU vessels in a chase. In the short term, engaging tour operators has the potential to increase the number of vessels "patrolling" the MPA. The same study from Canada that asked key stakeholders who should be involved in the design and implementation of MPAs (*Figure 4*) asked which stakeholders would be interested in participating in monitoring of the MPA (Heck et al. 2011, Figure 3). Nearly 60% of tour operators indicated that they would be interested. Though no quantitative assessment of tour operators' role in enforcement of large MPAs has been published, anecdotal evidence from the Galápagos Islands indicates tour operators can play a role in monitoring and enforcement (personal communication, William Durham). I have personally been on a dive boat at Shark Reef Marine Reserve in Fiji when the captain veered off course to intercept shark finners within MPA boundaries. Dive operators know that tourists come for the sharks; therefore, they have a direct economic incentive to protect them.

However, boats are only effective at stopping fishing once it has been detected, and patrols boats only encounter vessels at random. New technologies offer low-cost surveillance solutions to the challenge of vessel detection: Project Eyes on the Seas, a tool introduced by The Pew Charitable Trusts in January of this year, "merges satellite tracking and imagery data with other sources of information, such as fishing vessel databases and oceanographic data, to help monitor seas across the globe" (Pew 2015). Automatic alerts are triggered when the computer detects: patterns of vessel movements or speeds typical of fishing, a vessel that has stopped signaling its position, two vessels in close proximity (a possible sign of transshipment of fish or other goods), or a vessel that crosses a "virtual geofence" to enter a marine reserve or other area of restricted use (Pew 2015). Such technology is more cost effective than the current

method of patrolling because rangers can use boats only when and where they know fishing to be occurring. By updating and acquiring more equipment, increasing staff, and employing new technologies like Project Eyes on the Seas, PNC can vastly improve its enforcement and monitoring capacity. This will require the Costa Rican government – and potentially the international community of concerned parties – to dedicate more funds to park management, but the value of healthy marine ecosystems at Cocos Islands is incalculably high.

Port State Measures Agreement (PSMA)

IUU fishermen rely on ports like Puntarenas known for lax law enforcement or limited inspection capacity. The PSMA, an FAO treaty, seeks to crack down on these so-called "Ports of Convenience" by requiring signatories to refuse port entry or access to port services, including landing and transshipment of fish, to foreign-flagged vessels known to have engaged in IUU fishing (FAO 2009). They are also required to share information with the governments that flagged the vessels with IUU product, when discovered during inspection (FAO 2009). This measure is intended to deter "Flags of Convenience," the practice of registering ships in a sovereign state different from that of the ship's owner in order to reduce operating costs or avoid stricter regulations of the owner's country. This practice explains why Panama and Liberia account for over a quarter of the world's fleet (UNCTAD 2009, 44). Tellingly, 99.83% of Panama's vessels are foreign-owned, and 99.99% of Liberia's are foreign-owned. IUU fishing is an international problem, requiring international attention. The widespread adoption of the PSMA offers the opportunity to reduce corruption and increase the cost of IUU fishing. Once the cost exceeds the rewards, IUU fishing will no longer be profitable, and its main driver will have been eliminated.

Reduce the Demand for Shark Fins

WildAid, a San Francisco-based international NGO, has been effective at reducing demand for shark fins through awareness campaigns. Of those surveyed that reported they

stopped eating shark fin soup in the past three years, 64.8% responded that they did so because of “awareness campaigns” (Whitcraft et al. 2014). WildAid enlisted Yao Ming, former NBA basketball player and Chinese icon, to raise the Chinese consciousness on the issue of shark finning (*Figure 6*). They have urged Chinese nationals and the international community to sign the pledge not to consume shark fin soup. The slogan “When the buying stops, the killing can too” has been adopted by a wide range of anti-shark fin activists and has since been more broadly applied to the trade in all endangered species (WWF, WildAid, Animal Planet).

Figure 6: Yao Ming urges us to “Say no to shark fin soup” (WildAid.org).

The Hong Kong and Chinese governments have also played an important role in reducing demand. Both have banned the soup from official banquets, and 28.2% of respondents to the WildAid survey reported that they stopped eating shark fin soup because “the government banned it from banquets” (Whitcraft et al. 2014). Increasing the moral cost to consumers of eating shark fins has the potential to curb demand and, in turn, supply. In the next section, “Reasons for Hope,” I will examine the evidence for the decline in demand for shark fins.

We can all play a role in ending the demand for shark fins by communicating the importance of protecting these charismatic creatures and educating others about the cruel and wasteful practice that is shark finning. By reducing the global demand for shark fins, we can reduce pressure on sharks at Cocos Island and ensure their protection into the future.

Reasons for Hope

A combination of awareness campaigns and government action has significantly curbed demand for shark fins in recent years. Wild Aid reports an 82% decline in sales of shark fins in Guangzhou, a 47% decline in the retail price of shark fins in China, and a 57% decline in the wholesale price of shark fins in China over last two years (Whitcraft et al. 2014). 24 airlines, 3 shipping lines, and 5 hotel groups have banned shark fins from operations, and 25% of high-end restaurants in Beijing have dropped shark fin soup from their menus (Evans 2014). The Chinese government instated the banquet ban in 2012 in a push to end corruption and stifle extravagant spending (Evans 2014), and the Hong Kong government followed suit a year later, citing environmental concerns (news.gov.hk 2013). Local businessmen bemoan the decline in popularity of shark fins. Chen Zhibin, owner of Beijing's Yupin Shark Fin Emporium, laments, "The amount that we're selling now is only half as much as when we started" (Evans 2014). Hong Kong businessman Ng Goon Lau established a shark fin trading company in 1984. In the 1980s, he was selling close to one and a half tons of shark fins per year; by 2012, that number dropped to one fifth of a ton. He attributes the decline to consumer boycotts and has since quit the business altogether (Chen 2014). Bad news for the shark fin business, good news for sharks.

There is real hope that we will end the mass slaughter of sharks and the enslavement of people aboard shark finning vessels in the next decade. The elimination of shark finning would significantly reduce the pressure on sharks at Cocos Island and beyond. Until recently, discussions of shark finning offered little optimism. But we have begun to turn the tide.

Conclusion

I have demonstrated that shark finning is occurring at Cocos Island, and that Asian crime organizations are the likely culprits. Ending the slaughter will require the engagement of the

international community, through information sharing, sanctions on illegal fishing, consciousness raising, and likely financing to improve enforcement capacity at PNC. Together, we can ensure the protection of “the sharkiest place on Earth” for future generations.

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