Utilizing DNA Barcoding to identify species sold across the Caribbean and improve conservation

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Introduction

- The Caribbean contains the highest concentration of marine species in the Atlantic Ocean and is a hotspot of marine biodiversity.[1]
- In recent decades, marine ecosystems throughout the Caribbean have experienced a substantial decline in fish abundances.[2]
- Overexploitation of fish continues today despite conservation efforts partly due to illegal, unregulated, and unreported fishing and fish mislabeling.[3]
- In previous studies, fish products were found to be mislabeled and sold as less desirable species, endangered and threatened species, and species that can be dangerous to consume.[4]
- Seafood fraud negatively impacts ecosystems, fish, consumers, and honest fishers, restaurants, and markets.
- Without better management, population recovery is unlikely.
- 77% of fish labeled as the overfished red snapper (*Lutjanus campechanus*) on the East Coast of the United States were identified as less desirable species.[5]
- DNA barcoding allows us to identify fish which we would otherwise not be able to identify, for example a fish fillet or fish oil.
- DNA barcoding is a tool for determining which species are vulnerable to overfishing.

It is difficult and often inaccurate to identify a species based on its fillet

Grouper fillet

Catfish fillet

Cod fillet

Cobia fillet

Methods

- Fish and shark products were purchased from fish markets, restaurants, and supermarkets in Belize, Guatemala, Honduras, St. Kitts, and St. Maarten. Products ranged from cooked dishes to raw fillets and fish oil.
- Approximately 1 gram of tissue was collected and preserved in 95% ethanol.
- Genomic DNA was extracted from sample tissue
- Cytochrome oxidase I (a common gene used for barcoding) was amplified for each sample using polymerase chain reaction (PCR).
- PCR products were ran on a 1% agarose gel to confirm amplification of the correct fragment.
- Purified PCR products were sequenced
- BLAST, or Basic Local Alignment Search Tool, was used to identify samples by species

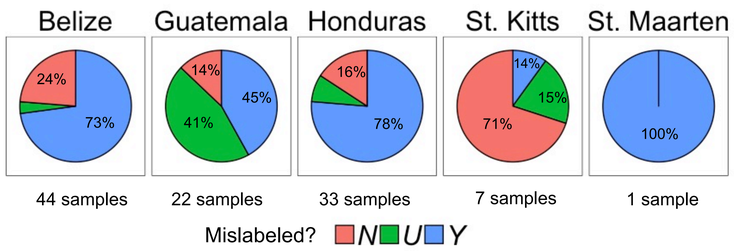
Results

Product label	Product identification
Snapper **(38)** 11%	*Hogfish* (7), *Black grouper* (4), *Black triggerfish* (4), *Barracuda* (3), *Gray angelfish* (3), Nassau grouper (2), *Swordfish* (2), *Common dolphinfish* (2), *Snook* (2), *Queen triggerfish* (1), *Horse-eye jack* (1), *Greater amberjack* (1), Yellow jack (1), Bar jack (1)
Catfish **(9)** 44%	*Cubera snapper* (1), *Black grouper* (1), *Barracuda* (1), *Snook* (1)
Grouper **(8)** 25%	*Catfish* (4), *Hogfish* (1), *Mutton snapper* (1)
Snook **(8)** 25%	*Yellow snapper* (1), *Red grouper* (2), *Cubera snapper* (3)
Cod **(6)** 0%	*Scalloped hammerhead shark* (1), *Silky shark* (1), *Blacktip shark* (1), *Nurse shark* (1), *Cobia* (1), *Atlantic sharpnose shark* (1)
Shark **(5)** 20%	*Catfish* (1) *Scalloped hammerhead shark* (1), *Tiger shark* (1), *Spinner shark* (1)
Yellowtail amberjack **(4)** 0%	*Hogfish* (1), *Mutton snapper* (1), *Greater amberjack* (1), *Catfish* (1)
Cubera snapper **(2)** 50%	*Atlantic goliath grouper* (1)
Salmon **(2)** 0%	*Almaco jack* (1), *Catfish* (1)
Barracuda **(1)** 0%	*Catfish* (1)
Yellowfin Tuna **(1)** 0%	*Japanese amberjack* (1)

Key	
Red	Critically endangered
Violet	Endangered
Yellow	Vulnerable
Blue	Near threatened
Green	Least concern
Black	Data deficient
Gray	Farmed

- The market label is in the “What you bought” column
- The identification is in the “What you got” column. Correct IDs are not shown.
- The number in parentheses shows how many samples were bought or identified
- The percentage shows how often the sample of that species was labeled correctly

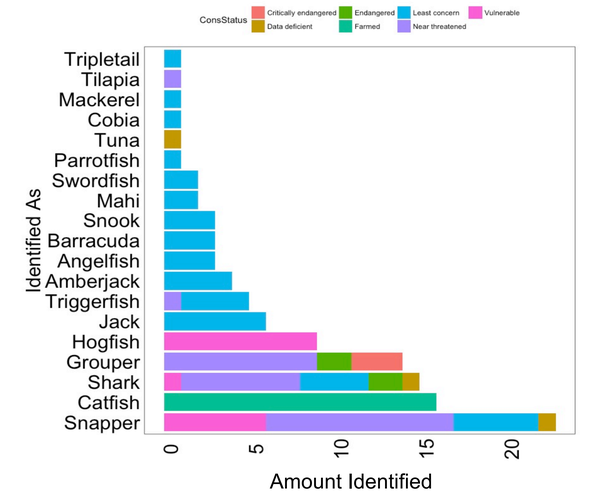
Percent mislabeled by country



- Red is “No”, not mislabeled.
- Green is “Uknown”. The sample collected was not originally labeled.
- Blue is “Yes”, mislabeled.

Results

IUCN status of identified species



Conclusions and Discussion

- 31% of the 107 samples tested were found to be mislabeled. However, 11% of the samples collected were not labeled to begin with.
- 89% of the 38 samples sold as snapper were mislabeled
- Species such as scalloped hammerhead shark contain mean mercury concentrations that exceed the regulatory limit of 1 mg kg^{-1}, yet were being sold as a fish that is safe to consume (cod in this case).[6]
- Threatened and endangered species were being sold as highly sought-after products such as snapper and grouper.
- Accurate labeling is required for effective conservation efforts and for consumer health. Better inspection and regulations are recommended.

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Citations

1. Roberts C, Mcclean C, Veron J, Hawkins J, Allen G. (2002). Marine biodiversity hotspots and conservation priorities for tropical reefs. *Science*, 295(5558).
2. Jackson, J. B.; Kirby, M. X.; Berger, W. H.; Bjorndal, K. A. (2001). Historical Overfishing and the Recent Collapse of Coastal Ecosystems. *Science*, 293(5530), 629-637.
3. Miller, D.M. & Mariani, S. (2010) Smoke, mirrors and mislabeled cod: poor transparency in the European seafood industry. *Front. Ecol. Environ.*, 8, 517–521.
4. Cox, C. E.; Jones, C. D.; Wares, J. P.; Castillo, K. D.; McField M. D.; and Bruno, J. F. (2013). Genetic testing reveals some mislabeling but general compliance with a ban on herbivorous fish harvesting in Belize. *Conservation Letters*.
5. Marko, P.B., Lee, S.C., Rice, A.M., *et al.* (2004). Mislabeling of a depleted reef fish. *Nature*, 430, 309–310.
6. Garcia, J.; Cadena, L.; Lozano, M. (2007). Total mercury content found in edible tissues of top predator fish from the Gulf of California, Mexico. *Toxicological & Environmental Chemistry*, 89(3), 507-522.