Investigating Seafood Fraud Using DNA Barcoding

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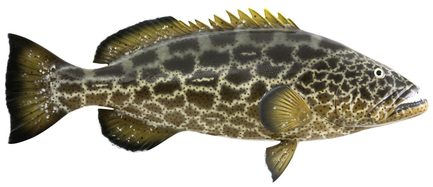
Abstract

The purpose of this project is to identify fish fraud in the U.S., of which many restaurants and seafood markets are guilty of, unknowingly in their sale of seafood to consumers. Awareness of the occurrence of fish fraud is vital because, in many cases, endangered or threatened species are substituted for more abundant, but costly to obtain, species. Additionally, we are creating a case study (a pilot has already been used for a college genetics class at St. Francis College and at the St. Francis College Summer Science Academy for High School Students in 2020) with the aim of teaching students about seafood fraud and wildlife forensics. The case study is being developed for publication at the National Center for Case Studies in Teaching Science (http://nccsts.org) housed at SUNY Buffalo.

Previous attempts to combat seafood fraud failed due to extremely complicated supply chains, the large numbers of organizations fighting this issue, a lack of resources provided, and the difficulty identifying species of seafood. Currently, efforts such as an Action Plan promulgated by the Presidential Task Force on Combating Illegal, Unreported and Unregulated Fishing and Seafood Fraud, can potentially decrease fraud, but this is still not enough. There is hope that the United States and European Union will implement coordinated programs and enforcement mechanisms. (Lambert, 2017).



Black grouper, as shown above, is frequently mislabeled and substituted with...

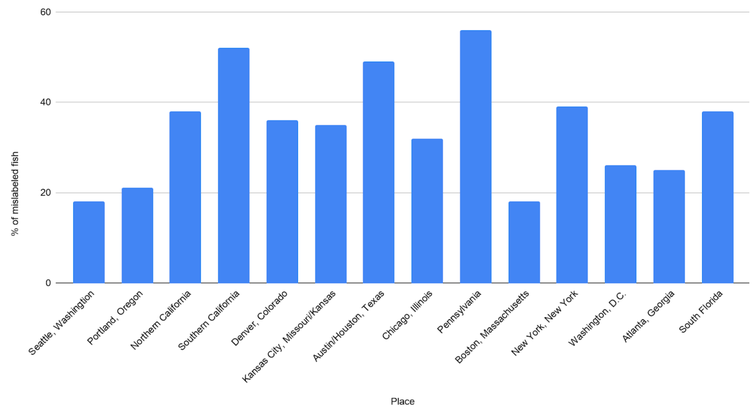
Endangered gulf grouper; 36% mislabeled in Denver, Colorado

Specific Aims

The goal of this project is to promote awareness about and prevent the mislabeling of various aquatic species in order to preserve endangered species and ensure that food that is sold is safe for consumption and to investigate how the different types of DNA used for barcoding, such as mitochondrial DNA, microsatellite DNA, and ribosomal DNA are used to identify seafood fraud

Grouper, as shown above, is frequently mislabeled and substituted with...

King Mackerel; 38% mislabeled in South Florida
King Mackerel, due to its high mercury levels, is on the FDA's DO NOT EAT list



This data is based on Oceana's study on Seafood Fraud in the U.S., which reveals that Pennsylvania has the highest rate of mislabeled fish in the U.S.

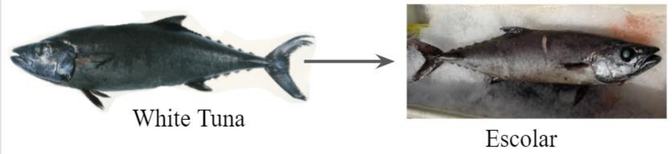
Snapper, as shown above, is frequently mislabeled and substituted with ...

Rockfish; 38% mislabeling in North Carolina

Fish fraud is a big issue because it can cause environmental and health problems. Sometimes, fish are replaced with those from an endangered species. Some species are in danger of overfishing and harmful fishing and aquaculture practices. This is not beneficial to the environment and it could disrupt the habitat of many animals. Other times, fish are replaced with fish that can cause health issues to the consumers. Consumers also choose to eat seafood for its nutrition value. They would avoid certain seafood that would contain high levels of methylmercury, lead, or other heavy metals. The FDA are also advising pregnant women and children to avoid eating such species. Consumers are paying higher prices for wild-caught fish rather than farm-raised ones that may have been treated with antibiotics and pesticides. It is not right that consumers are not getting the nutrients they are trying to acquire and instead are getting an unknown fish.

How can we use DNA barcoding to identify fish fraud?

- The cytochrome C oxidase (COI) gene fragment has proven to be most effective in the identification of 98% marine fish species and 93% freshwater fish species.
- For DNA extraction, a piece of tissue (fin clips and muscle), approx. 5 x 5 mm size) was excised
- The quality and the quantity of the extracted DNA were measured with an UV spectrophotometer (Beckman, Brea, CA) by taking the optical density (OD) at 260nm and 280nm.
- Approximately 655 bp of a region of mitochondrial Cytochrome C Oxidase subunit I was PCR amplified using primers Fish F1 (50-TCA ACC AAC CAC AAA GAC ATTGGC AC- 30) and Fish R1 (50-TAG ACT TCT GGG TGG CCA AAG AATCA- 30)
- The amplifications were performed in 25 microliter reactions containing 1 □ assay buffer (100 mM Tris, 500mM KCl, 0.1% gelatin, pH 9.0) with 25mM $MgCl_2$ (ThermoFischer Scientific, Mumbai, India), 10 piko moles of each primer, 200mM of each dNTP



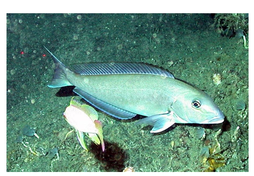
In many places, consumers believe they are being served white tuna when in reality they are being served escolar. 84% of white tuna samples were actually escolar, a species which can cause serious digestive issues for those who eat more than a few ounces.

Discussion

Based on this project we need more policies to correct fish mislabeling. There needs to be an increase in seafood inspections. In addition, there should be more information provided to the consumers about the species. This includes how the fish were caught, where they were caught, and if any additives were used during processing.

Red Snapper is frequently mislabeled and substituted with...

Tilapia; 56% mislabeling in Pennsylvania



Tilefish, due to its high mercury levels, is on the FDA's DO NOT EAT list
Tilefish; 39% mislabeling in New York City