Fish in disguise: Seafood fraud in Korea

A briefing by the Environmental Justice Foundation

ENVIRONMENTAL JUSTICE FOUNDATION

Protecting People and Planet

Executive summary

Between January and December 2018, the Environmental Justice Foundation (EJF) used DNA testing to determine levels of seafood fraud in the Republic of Korea. The results showed that **over a third of samples tested were mislabelled**. This mislabelling defrauds consumers, risks public health, harms the marine environment and can be associated with serious human rights abuses across the world. These findings demonstrate the urgent need for greater transparency and traceability in Korean seafood, including imported products.

Key findings:

- Over a third of seafood samples (34.8%, 105 of 302 samples) genetically analysed were mislabelled.
- Samples labelled Fleshy Prawn, *Fenneropenaeus chinensis* (100%), Japanese Eel, *Anguilla japonica* (67.7%), Mottled Skate, *Raja pulchra* (53.3%) and Common Octopus, *Octopus vulgaris* (52.9%) had the highest rates of mislabelling.
- Not a single sample labelled Fleshly Prawn was the correct species.
- Mislabelling was higher in restaurants, fish markets and online than in general markets or superstores.
- By processed types, sushi (53.9%), fresh fish (38.9%) and sashimi (33.6%) were the most likely to be mislabelled.
- The seafood fraud identified by this research has direct negative impacts for consumers. It is clear that for some species sampled consumers were likely to be paying more than they should. For example, more than half of the eel and skate samples that were labelled domestic were actually found to be imported, which can cost only half of the price of domestic products. Swordfish mislabelled as Bluefin Tuna can be sold for four to five times as much. Uncertainty of the origin and identity of the product on sale also raises concerns regarding food safety and hygiene.
- 27.8% of meat labelled Minke Whale was in fact dolphin or Finless Porpoise, which poses risks to public health and the management of protected species. Dolphin meat contains dangerously high mercury levels, and Finless Porpoises are a protected marine species by the Korean Marine Mammal Protection Act (1972).

318 samples covering 12 seafood groups (11 separate species and one grouping containing several species of tuna) were collected over the course of a year, with 302 successfully identified using their DNA analysis. With the exception of one of the 12 groups, all the samples were purchased in Seoul.

Introduction

In recent years, South Korea has had one of the world's highest rates of seafood consumption per capita, reaching 60 kg per year (the highest in the world in 2016). Along with the ever-growing demand, consumer awareness of health-related issues around seafood is also increasing. Unfortunately, the growth of the market has not been followed by a transparent and traceable system for providing information on seafood products, hence consumers often find confusing if not misleading labels when making their choices. In fact, this issue – seafood mislabelling – represents one of the most common fraudulent practices in the fishery sector. Seafood fraud takes place when the declared market name of the product is different from what the consumer actually receives. Intentional and regular mislabelling and substitution are considered illegal food counterfeiting.

Official labelling panel showing the origin of seafood products

Mislabelling directly affects ordinary consumers and the seafood market in various ways;

1) It is a **fraud** that causes **economic damage**: Mislabelling cases occur in one direction; cheaper seafood disguised as more expensive types. The fact that it is very rarely the other way around suggests these incidents are not accidental, but designed to increase profit at consumers' expense. Equally, such seafood fraud commonly targets high value species, again attempting to maximise profit and limit costs at the expense of consumers and law abiding businesses. These illegal activities have a direct negative impact on the seafood sector, damaging the livelihoods of honest law-abiding fishers and suppliers.

2) It puts **public health at risk**: There are numerous potential health risks associated with mislabelling seafood species. Substituted seafood often comes from fish processing or aquaculture facilities with poor, unregulated hygiene standards. In the case of a food poisoning outbreak, for example, mislabelled products mean the authorities and retailers cannot track down the provenance to investigate the root cause.

3) It impacts the **marine environment**: Products of illegal, unreported and unregulated (IUU) fishing can easily enter the market when traceability and correct labelling are not required. This makes protecting endangered species and managing critical fish stocks increasingly challenging, having detrimental effects on sea life and threatening sustainable fisheries for future generations.

4) Its products are often tainted by **human rights** abuses: Mislabelled seafood often comes from IUU fishing. These products are likely to be associated with extremely poor conditions and human rights abuses of the workers involved. Non-governmental organizations and media outlets have regularly observed serious human rights abuses of fishery workers in IUU fishing operations around the world.

As numerous mislabelling cases have been reported in the media, terms such as mislabelling and 'seafood fraud' have become increasingly familiar headlines in Korea. Although some of these illicit practices are typically associated with imported products from China, the public also fear Japanese seafood affected by post-Fukushima radiation will enter the market. As the mislabelling issue gained a higher profile, the Ministry of Oceans and Fisheries (MOF) of Korea introduced the Seafood Traceability System (STS)[1] to tackle this problem and ensure consumer safety. The STS consists of providing a track record of a product at a glance using barcode and QR code-based information technology, but its application is voluntary.

Code sample of the Seafood Traceability System

It has now been more than ten years since its adoption, though, and participation rates in the STS have remained disappointingly low. Recently, this has led to scrutiny during annual National Assembly Audits. Lack of strong implementation measures from the government, resistance from the industry and producers fearing additional costs, low incentive and limited interest from consumers have all contributed to the current failure of the STS.

Although Korea has officially pledged to the international community that it will combat IUU fishing, the Korean market is still vulnerable to IUU products that lack proper hygiene and regulatory standards, which has serious implications considering the nation's heavy dependence on seafood. A transparent and traceable supply chain is the only effective way to counter this issue in order to secure a legal, sustainable and ethical seafood market.

The first step to solving this problem is assessment and identification of the mislabelling issue. Unfortunately, there have been no systematic, rigorous studies of seafood fraud in Korea. EJF therefore decided to conduct the first-ever comprehensive DNA-based seafood mislabelling test in Korea to assess the magnitude and specifics of the problem.

Materials and methods

Sample collection

EJF gathered 318 samples from 12 groups over a period of a year, from January to December 2018. Most of the samples were collected inside the Seoul Metropolitan area where about half of national consumption is concentrated. One species, Minke Whale, mainly consumed outside the capital, was sampled in Ulsan, Busan and Pohang.

The team aimed to collect 30 samples for each group, but the final numbers for each depended on financial or logistical issues, or quick seasonal turnaround of the product. The average number of collected samples was 25 per group.

Sampling outlets varied between restaurants, fish (seafood) markets, superstores[2] and others. Of the total 302 valid samples, 137 (45%) samples were purchased in restaurants as a sit-in meal or as a 'take away' product; 82 (27%) samples were procured from the well-known major fish markets in Seoul[3]; while 30 (9.9%) were obtained from superstores.[4]

The labels of the products (name and provenance) were recorded using photographs. When there was no visual information printed on the receipt or on the sample packaging or when vague or generic names were used to describe the seafood on sale, sample collectors verbally asked the vendor to better identify the species. In restaurants, the staff were asked to consult the chef when they were not able to provide the information. As scientific names are not well-known, all questions were asked in common or market names. In some cases, conversations between the collector and vendor were recorded in audio files.

The names of the commercial companies are not disclosed in this report in order to protect privacy.

Seafood group selection

Rather than sampling random seafood to provide a generic view of mislabelling, this project selected a list of priority groups to focus on. The criteria for the selection were:

1) Seafood groups that have previously been identified as prone to mislabelling or substitution: this means that mislabelling incidents had been identified by governmental authorities or publicly reported by the media.

2) Seafood that is widely available to consumers. Exotic species that the average consumer has very little opportunity to purchase were excluded. However, mislabelling cases have rarely been reported among the most popular species in Korea. This is partly because some popular species such as Chub Mackerel (*Scomber japonicus*) are low-cost and do not have a more expensive counterpart that it would be worth substituting. In addition, mislabelling often occurs when imported seafood is labelled as more desirable domestic seafood; however, popular species such as farmed Salmon from Norway or Alaskan Pollock from Russia do not have a competitive domestic equivalent, and are therefore not prone to mislabelling.

3) Seafood groups that it is possible to identify with DNA-based testing. Since domestic seafood is more desirable and expensive than imported counterparts, there have been numerous cases where imports have been mislabelled as Korean-caught (such as Japanese anchovy (*Engraulis japonicas*) imported from Japan). However, since Korean and Japanese anchovy are the same species, merely different populations, the genetic differences are almost non-existent. It is therefore not possible to determine the geographical origin of these species with current DNA testing facilities available in Korea[5].

Finally, groups were divided into three provisional price categories[6]. Although intentional mislabelling of species of high market value means higher impact in terms of economic loss, we also included some middle to lower priced species – where they matched all three of the abovementioned criteria – in order to make the whole selection familiar to the average consumer.

In conclusion, 12 groups were selected as follows:

- Japanese Eel (*Anguilla japonica*)
- Minke Whale (*Balaenoptera acutorostrata*)
- Patagonian Toothfish (*Dissostichus eleginoides*)
- Nibe Croaker (*Miichthys miiuy*)
- Yellow Croaker (*Larimichthys polyactis*)
- Common Octopus (*Octopus vulgaris*)
- Red Sea Bream (*Pagrus major*)
- Mottled Skate (*Raja pulchra*)
- Bluefin Tuna (*Thunnus thynnus*)
- Other tuna, including: Albacore Tuna (*Thunnus alalunga*), Yellowfin Tuna (*Thunnus albacares*), Bigeye Tuna (*Thunnus obesus*), Skipjack Tuna (*Katsuwonus pelamis*)
- Fleshy Prawn (*Fenneropenaeus chinensis*)
- Largehead Hairtail (*Trichiurus japonicus*)

Tuna species were divided into two groups; Bluefin Tuna and other tunas. Bluefin Tuna were analysed separately because of their exceptionally high price and critically endangered status. Although tuna stocks have some international regulation, sources indicate that they are still targets for substitution by similar species such as swordfish or marlins. For example, Korean authorities discovered frozen swordfish being sold as tuna when tuna catch decreased in 2009. Tuna sampling focused on tuna for sashimi or sushi rather than canned tuna, which is usually cheaper Skipjack Tuna.

Among the selected 12 groups, three (Japanese Eel, Red Sea Bream, Yellow Croaker) belong to the 'applicable (but not mandatory) list' in the current Seafood Traceability System.

DNA analysis

The DNA tests were carried out by the Korea Institute of Ocean Science and Technology (KIOST) East Sea Research Institute in Uljin city.

In recent years, DNA-based techniques have been widely used in species identification, including the assessment of mislabelling. DNA has high stability and relative ease of isolation, even from highly processed foods. For example, DNA has been successfully extracted from toothfish and croaker samples that had been fried.

- **DNA extraction**

A small section of muscle was taken from the inner part of all collected samples. Muscle tissues were rinsed with distilled water and preserved in 99% ethanol at -20˚C for further DNA analysis. Genomic DNA was extracted from the muscle tissue of each specimen, using the *AccuPrep*® Genomic DNA Extraction Kit (Bioneer Co., KOREA).

- **Polymerase Chain Reaction (PCR) Amplification**

To identify seafood species that came from a variety of retailers and processors, five different primer sets were used including COI universal primer. All primer sets used in this study are listed in Table 1. The PCR amplifications for the COI gene were conducted in 20ul reaction mixtures containing 2.0ul of a 10X reaction buffer, 0.25mM of dNTP, 0.2uM each primer, 1U of Top DNA polymerase (Bioneer Co., KOREA), and 2ul of Template DNA.

Extracting DNA © EJF

Thermocycling conditions were as follows: initial denaturation for 5 min at 94˚C, followed by 35 cycles of denaturation for 30 s at 94˚C, annealing for 30 s at 51˚C, and extension for 1 min at 72˚C, followed by a final extension for 10 min at 72˚C. The PCR product was electrophoresed on a 1.5% agarose gel to check integrity, and then it was purified by using the Universal DNA purification Kit (TIANGEN, China).

Primer name	Sequence (5′ - 3′)
LCO1490	GGTCAACAAATCATAAAGATATTGG
HCO2198	TAAACTTCAGGGTGACCAAAAAATCA
mlCOIintF	GGWACWGGWTGAACWGTWTAYCCYCC
FishCOI-Jang_01F	GTGXXXXXXXXXXXATT
FishCOI-Jang_163F	GATXXXXXXXXXXXGCC
FishCOI-Jang_190F	GTAXXXXXXXXXXXAGT
FishCOI-Jang_908R	GCAXXXXXXXXXXXCAT
FishCOI-Jang_1133R	TGGXXXXXXXXXXXCAT
COI MINKE-01F	ATGXXXXXXXXXXXGAC
COI MINKE-1055R	TTCXXXXXXXXXXXCGG

Table 1. PCR primers used in the amplification of samples analysed in this study

- **Sequencing and data analyses**

The purified fragments were sequenced using the ABI 3730xL DNA Analyzer (Applied Biosystem, Foster City, USA). DNA sequences were analysed using BioEdit (Version.7.0.5). Identification of DNA sequences at species level was accomplished using both the BOLDSYSTEMS (http://www.boldsystems.org) selecting 'species level barcode records' database and the BLAST on the NCBI (http://www.blast.ncbi.nlm.nih.gov/Blast.cgi) search engine. Since records deposited only in the BOLD database have been validated for both the DNA sequence and specimen data, we used this repository as our final criteria for identifying seafood species. Only sequences with a similarity index ≥98 % were considered a valid match.

In cases of ambiguous results obtained from NCBI and BOLD databases, further phylogenetic analysis including DNA sequences from both databases was performed using the Neighbour-Joining (NJ) method.

Photo: A local restaurant advertising it only sells '*Anguilla japonica*' (photo above in the image), not to be confused with imported species. Domestic products can be double the price.

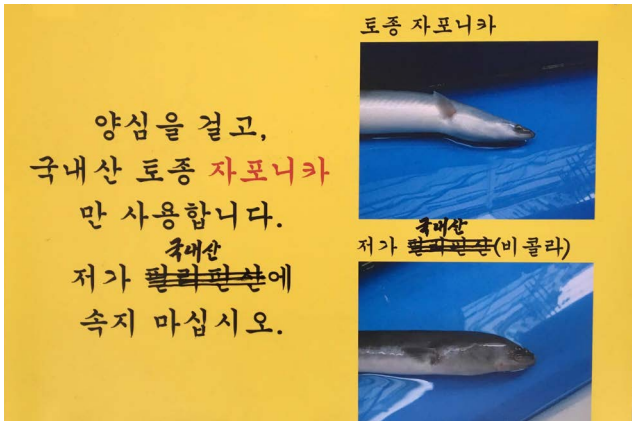
Results

The DNA extracted from 302 of the 318 (95%) samples was successfully amplified and analysed. Some incorrectly collected samples were excluded. Overall, 105 of the 302 (34.8%) fish samples analysed were different species to the ones indicated, i.e., they were mislabelled. This number is far higher than the international average of 20%[7]. Given that the DNA testing facilities available were not able to distinguish different populations of the same species (e.g. Yellow Croaker), and species where the taxonomy is not fully resolved (e.g. Largehead Hairtail)[8], the mislabelling rate calculated here maybe an underestimate. Our study may exclude some imported seafood being sold as domestic seafood. These cases are especially common in Chinese or Japanese-caught fish[9]. Additionally, the study could not include seafood from private events – such as weddings or receptions – which are difficult to sample and are thought to have high levels of fraudulent seafood[10].

Seafood groups

Many cases of mislabelling represented relatively 'subtle' substitutions of species with little difference in appearance, which makes mislabelling difficult to detect even for a well-informed fish buyer.

Mislabelling rates were especially high in the cases of Japanese Eel, Common Octopus, Mottled Skate and Fleshy Prawn, all exceeding 50%. In fact, a startling 100% mislabelling rate was found in the case of Fleshy Prawns. In the case of Mottled Skates, more than half of those labelled as domestic skates were in fact different species imported from Europe or America. Rapidly declining domestic skate stocks mean they can fetch double the usual price of imported substitutes. Eels found in Korean markets are often labelled as domestically caught (Japanese Eel, *Anguilla japonica*), but this study found that many were in fact different species from distant regions such as Europe, America or the Philippines. Domestic eel can be more than twice as expensive as imported eel. This is why some restaurants highlight the fact that they offer domestic eel exclusively.



27.8% of samples sold as Minke Whale were substituted for dolphin or Indo-Pacific Finless Porpoise. Finless Porpoise and several species of dolphin are protected by law, therefore commercial distribution and consumption is illegal. Dolphin meat is also known to contain dangerously high mercury levels, presenting a risk to public health.

There was no mislabelling found in any Jeju Largehead Hairtail. This means that Largehead Hairtail from Atlantic oceans (i.e. imported products from Senegal) is not disguised as domestic according to this survey. However, since the available DNA testing technology does not allow us to distinguish domestic Jeju Largehead Hairtail from Japanese Largehead Hairtail, it is still possible that mislabelling exists, as various media reports suggest.

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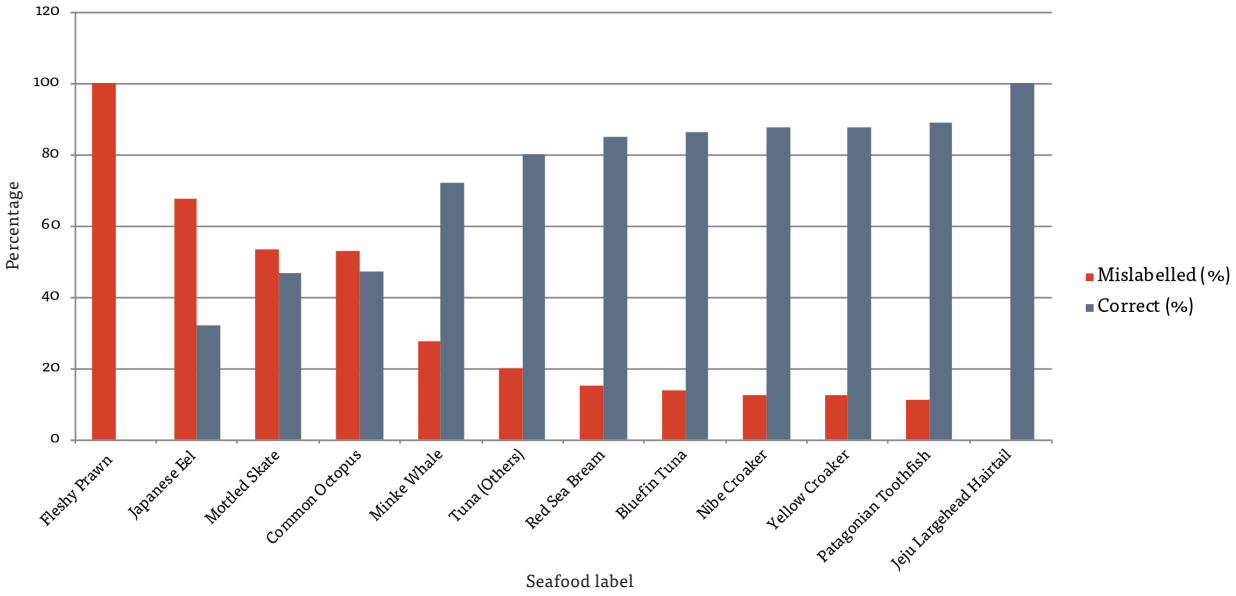
The common mislabelling examples are as follows

Species	**Mislabelling rate %** (mislabelled/samples)	**Scientific Name**	**Common Substitution**	**Scientific Name**
Largehead Hairtail	0 (27/27)	*Trichiurus japonicus*	N/A	N/A
Patagonian Toothfish	11.1 (3/27)	*Dissostichus eleginoides*	Antarctic Toothfish	*Dissostichus mawsoni*
Nibe Croaker	12.5 (1/8)	*Miichthys miiuy*	Red Drum	*Sciaenops ocellatus*
Yellow Croaker	12.5 (4/32)	*Larimichthys polyactis*	Large Yellow Croaker	*Larimichthys crocea*
Red Sea Bream	15 (3/20)	*Pagrus major*	Nile Tilapia	*Oreochromis niloticus*
Atlantic Bluefin Tuna	13.8 (4/29)	*Thunnus thynnus*	Yellowfin Tuna, Swordfish	*Thunnus albacares, Xiphias gladius*
Other tunas (Yellowfin Tuna, Bigeye Tuna, Skipjack Tuna etc.)	20 (6/30)	*Thunnus albacares, Thunnus obesus Katsuwonus pelamis etc.*	Swordfish, Striped Marlin	*Xiphias gladius, Kajikia audax*
Minke Whale	27.8 (5/18)	*Balaenoptera acutorostrata*	Indo-Pacific Finless Porpoise, Short-beaked Common Dolphin	*Neophocaena phocaenoides, Delphinus delphis*
Common Octopus	52.9 (9/17)	*Octopus vulgaris*	Coconut Octopus	*Amphioctopus marginatus*
Mottled Skate	53.3 (16/30)	*Raja pulchra*	Longnose Skate, Yellownose Skate	*Raja rhina, Zearaja chilensis*
Japanese Eel	67.7 (21/31)	*Anguilla japonica*	Punctuated Snake-eel	*Ophichthus remiger*
Fleshy Prawn	100 (33/33)	*Fenneropenaeus chinensis*	White-leg Shrimp	*Litopenaeus vannamei*

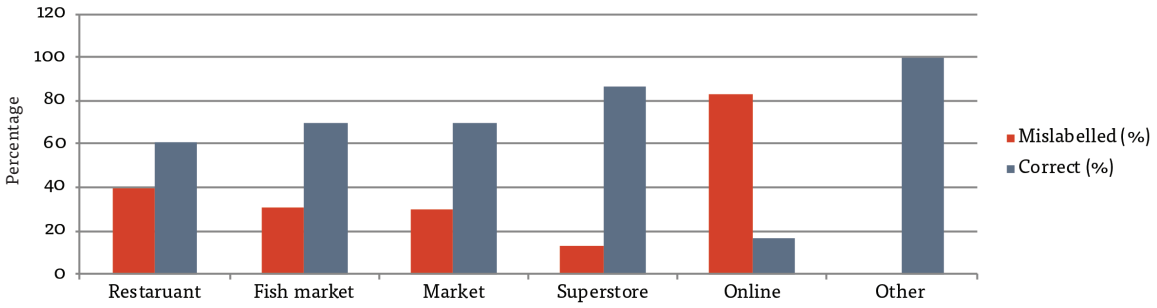


Percentage of samples which were found to be a different species than indicated on the label.

Outlets

More mislabelling was found in restaurants (39.4%) and fish markets (30.5%) than in general markets (30.0%). Superstores (13.3%) were the outlets with the most correct labelling. Online samples were the most often mislabelled (83.3%) but the sample size was smaller than other groups. Notably, mislabelling was found in a random testing of different samples inside a single package of croakers (normally comprised of more than 20 fish in one package) purchased via the internet, which indicates that correctly labelled species may be mixed with a portion of substitutes in online products.

Outlet	Sample	Mislabelled	Mislabelled Rate (%)
Restaurant	137	54	39.42
Fish market	82	25	30.49
Market	40	12	30.00
Superstore	30	4	13.33
Online	12	10	83.33
Other	1	0	0.00
Total	**302**	**105**	



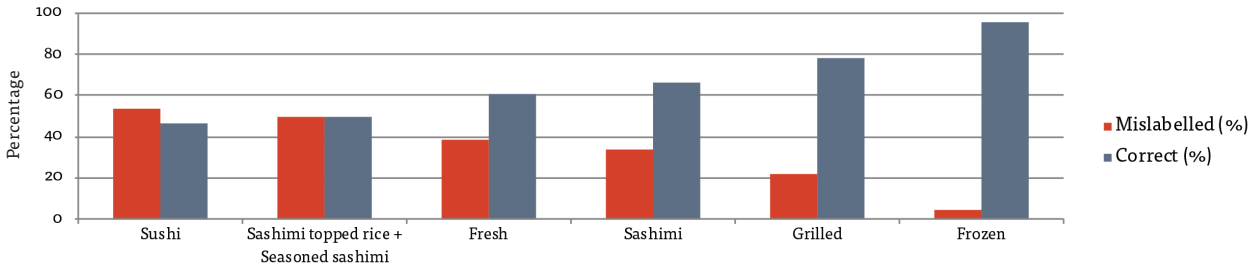
Price

Mislabelling was found more often in high (31.3%) or mid-priced products (40%) than the lower price ones (6.3%).[11] Financial incentives are likely to have been a driving factor for this potentially deliberate substitution, since the majority of mislabelling cases were of high-value fish species substituted with lower-value ones, not the other way around. However, there were some cases where higher priced tunas were labelled as lower priced products, or when similar priced tunas were substituted. This may be innocuous but needs further analysis to draw any conclusion since even among the same species, the price of different parts of the fish body can differ greatly.

Other findings

Out of the processing types, sushi (53.9%), fresh fish (38.9%) and sashimi (33.6%) were the most frequently mislabelled.

Process type	Sample	Mislabelled	Mislabelled Rate (%)
Sushi	26	14	53.85
Sashimi topped rice + Seasoned sashimi	10	5	50.00
Fresh	108	42	38.89
Sashimi	110	37	33.64
Grilled	27	6	22.22
Frozen	21	1	4.76
Total	**302**	**105**	



Especially concerning was to find species such as European Eel (*Anguilla anguilla)*, which is classified as critically endangered in the International Union for Conservation of Nature Red List, being sold as Korean domestic eel. The Marine Stewardship Council recommends avoiding consumption of European eel at any stage in its lifecycle.[12]

Fish labelled as Patagonian Toothfish – which previous reports had found to in fact be Oil-fish (*Ruvettus pretiosus*)[13] – did not appear to have been subject to seafood fraud in our study, with a mislabelling rate of just 11.1%. All the mislabelled samples of Patagonian Toothfish were identified as Antarctic Toothfish (*Dissostichus mawsoni*), a closely related species that does not have significant difference in prices. Since these two species are generically marketed as 'Mero' in Korea (called 'Chilean Sea Bass' in the USA) it is impossible to determine which species the consumer is purchasing without detailed labelling. Nevertheless, it is important to distinguish the two species because the Antarctic Toothfish is relatively well-managed under tight conservation management, whereas the Patagonian Toothfish is often related to IUU fishing and the conservation status is unknown.[14]

Recommendations

In December 2018, the Ministry of Ocean and Fisheries proposed a plan to make the Seafood Traceable System (STS) mandatory for two seafoods, dried Yellow Croaker and raw Oyster. Although it is a positive step forward, this plan is too limited to address the scale of the ongoing issue that has been highlighted by this study. Apart from the fact that the scheme is largely voluntary, there are other important problems in the STS that need to be addressed.

For example, the information provided in the current system is too rudimentary, only indicating the name, origin and its processing establishment. In addition, the STS does not include any of the imported species, and the Catch Document Scheme which is supposed to control import products is confined to only a small amount of the imports[15]. In light of these problems, EJF suggests a set of recommendations to respective stakeholders as follows.

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The Ministry of Ocean and Fisheries in Korea:

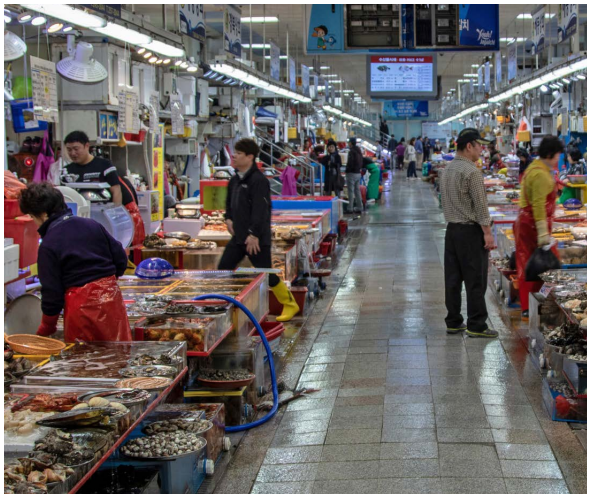
- Expand the STS mandatory list to at least ten species, beginning with those that are prone to mislabelling such as Japanese Eel, Mottled Skates, Common Octopus and Fleshy Prawn.
- Reform the STS to an all-encompassing tracking system to enhance traceability 'from bait to plate', indicating information about the producer, catch location and other basic information – on the 'who, what, when, where, and how' of fishing operations.[16]
- Extend the Catch Document Scheme to all imported products, as in the European Union, in order to prevent illegally fished and/or misrepresented seafood from entering the Korean market.
- Improve the simplified catch document requirements to filter out forged catch documents.
- Implement a universal nomenclature for labelling to ensure that confusing market names, such as tuna and swordfish, whale and dolphin, can no longer be used to hide seafood fraud.
- Ban sales of the meat of protected marine species such as whales, dolphins and porpoise.
- Subject to further analysis, the public should be informed of the fact that certain species, such as Fleshy Prawn, are extremely likely to be mislabelled.
- Ban imports of seafood that originate from processing establishments with questionable hygiene standards (for instance, Yellow Croaker from Sierra Leone has no fish processing establishments that are qualified to export to the European Union).
- Implement EJF's ten principles for transparency (see EJF's 2018 report *Out of the Shadows*[17]).

Retailers and producers:

- Fully endorse the STS and prioritize purchase of traceable products.
- Design a due diligence process for legal, ethical and sustainable seafood procurement.
- Build a complementary mechanism to filter out illegal, dishonestly labelled products.
- Request seafood products that are certified to be legal, ethical and sustainable.
- Seafood businesses should work to ensure the near-term adoption and implementation of EJF's ten principles for transparency (see EJF's 2018 report *Out of the Shadows*[18]).

Consumers:

- Ask questions about the name and origin of seafood products when purchasing.
- Use the STS and demand clear and transparent information.



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It is important to note that these recommendations are not exhaustive.

References and Notes

1 http://www.fishtrace.go.kr

2 Medium-sized to large supermarkets or shops selling household goods and food, generally called "marts"(마트) in South Korea.

3 Noryang-jin, Garak, Gangseo and Mapo fish (seafood) market.

4 Others were obtained in general markets (40 samples), on-line (12) and one sample in a wedding buffet, respectively.

5 Recent studies have developed technologies to discriminate the geographical origin of fish by analysing DNA fragments of microorganisms (bacteria) living on fish.
See: https://www.ncbi.nlm.nih.gov/pubmed/24834835

6 Three price categories (provisional grouping according to preliminary market survey):
- High price: from 30,000 KRW to 100,000: Atlantic Bluefin Tuna, Japanese Eel, Minke Whale, Mottled Skate
- Middle price: around 20,000 to 30,000 KRW: Nibe Croaker, Fleshy Prawn, Patagonian Toothfish, Red Sea Bream, Common Octopus, Tuna (Yellowfin Tuna, Bigeye Tuna etc.)
- Low price: less than 20,000 KRW: Yellow Croaker, Largehead Hairtail

7 https://usa.oceana.org/press-releases/1-5-seafood-samples-mislabeled-worldwide-finds-new-oceana-report

8 According to recent studies of mitochondrial DNA, two taxonomic species of Largehead Hairtails or "*Trichiurus lepturus complex*" should be considered as valid species names – *Trichiurus japonicus* (known as "Japanese or Korean Cutlassfish" in Korea), *Trichiurus lepturus* (known as "Imported or Distant Water caught Cutlassfish" in Korea). With the current available DNA facility, it is possible to identify whether a Largehead Hairtail sample is *T. japonicus*, but cannot identify if the sample was caught off Korea or Japan. Also, if the sample's genetic data did not match with *T. japonicus*, it is still difficult to determine if the fish is exactly *T. lepturus* or other hybrids.

9 For instance, Korea imports 800,000 tons of seafood from China annually. In 2017, a government report showed 7 out of 10 Chinese fish processing establishments that export to Korea were found to have poor hygiene conditions, not qualifying for Korean food safety and hygiene standards.
See: https://news.joins.com/article/22067356

10 Widespread unregulated and mislabelled seafood in private events has been reported in Korea.
See: https://slds2.tistory.com/1817

11 Categories rearranged by actual market price: The actual prices of the seafood products were slightly different from what was researched in advance and therefore the price groupings were revised.
High price: around 30,000-50,000 KRW in average
- Nibe Croaker: 41,857 KRW
- Atlantic Bluefin Tuna: 36,300 KRW
- Japanese Eel: 34,390 KRW

Middle price: around 20,000 to 30,000 KRW in average
- Minke Whale: 26,000 KRW
- Fleshy Prawn: 24,862 KRW
- Patagonian Toothfish: 23,703 KRW
- Red Sea Bream: 23,050 KRW
- Common Octopus: 22,085 KRW
- Tuna (Yellowfin Tuna, Bigeye Tuna etc.): 21,093 KRW
- Mottled Skate: 20,541 KRW

Low price: less than 20,000 KRW in average
- Yellow Croaker: 18,232 KRW
- Largehead Hairtail: 8,750 KRW

12 https://www.theguardian.com/food/2019/apr/03/deadly-appetite-10-animals-we-are-eating-into-extinction

13 https://www.ytn.co.kr/_ln/0115_201609072209482782

14 https://oceana.org/marine-life/ocean-fishes/patagonian-toothfish

15 The current system requires catch documents for croakers from West Africa (Bobo and Longneck Croakers) and Pacific Saury etc. It does not cover other major import products such as shrimp, prawn or squid. Additionally, according to EJF investigations, simplified catch documents that accompany croakers imported from West Africa can easily be forged; the fish caught by IUU fishing trawlers can be falsely certified as legally caught artisanal product.

16 WWF has produced a separate set of recommendations to address traceability systems in *Traceability Principles for Wild-Caught Fish*.
Principle 1 — Essential Information
Principle 2 — Full Chain Traceability
Principle 3 — Effective Tracking of Product Transformations
Principle 4 — Digital Information and Standardized Data Formats
Principle 5 — Verification
Principle 6 — Transparency and Public Access to Information
See: https://www.worldwildlife.org/publications/traceability-principles-for-wild-caught-fish-products

17 https://ejfoundation.org/reports/out-of-the-shadows-improving-transparency-in-global-fisheries-to-stop-illegal-unreported-and-unregulated-fishing

18 Ibid.

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