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Trade secrets: Renaming and mislabeling of seafood

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Abstract

As the global trade and market for seafood has grown, so have the twin problems of renaming and mislabeling. Resource scarcity, the potential for greater profits, and weak legislation have all encouraged incorrect labeling, the results of which include consumer losses, the subversion of eco-marketing, further degradation of fisheries resources, and even adverse effects on human health. This paper examines the extent and consequences of renaming and mislabeling seafood, the state of current legislation, and the importance of future policies, with particular attention to the US, where 80% of the seafood is imported and more than one-third of all fish are mislabeled. Policy recommendations include governments' support for a global mandate to label species, country of origin, and catching or production method on all seafood with high penalties for infractions. Chain of custody standards, such as those recently implemented by the Marine Stewardship Council (MSC), should also be considered for adoption worldwide. To garner support for this legislation, consumers must become better acquainted and concerned with their seafood and its origins.

Keywords: Eco-label; Fisheries; Globalization; Mislabeling; MSC; Renaming; Seafood; Substitution; Traceability

1. Introduction

In the 1980s, capture fisheries peaked [1]. This same decade, trade liberalized and the traceability of all products, including seafood, became a concern. The Uruguay Round of trade negotiations (1986–1994) further enhanced trade in seafood [Timothy Hansen, Director, US Seafood Inspection Program, pers. comm.]. In the years that followed, more fish stocks collapsed around the world [2], and the issue of traceability, particularly for illegal, unreported, and unregulated (IUU) fisheries, was identified as a factor contributing to overfishing [3].

The highest priority, in terms of traceability, is combating the global IUU fisheries kept afloat by nations that provide flags of convenience and relaxed import and export regulations. Worldwide, thousands of fishing boats scour the seas and employ fishing practices that would be illegal in their home nations [4].

The renaming and mislabeling of seafood is also significant in terms of global seafood traceability concerns. There are several factors to consider when labeling seafood, such as: (a) species' identity; (b) country of origin; (c) production method; (d) potential eco-labels. Primarily because consumers, especially in the US, are generally unfamiliar with seafood products, each of these factors can be an opportunity for mislabeling. In contrast, wholesalers are often very familiar with their products. Though fishers mislabel seafood, especially if they caught it illegally, the literature reviewed here suggest that mislabeling is most often done by distributors and the final seafood retailer (e.g., fishmongers and restaurants) for the sake of increased profits. A further complicating factor is that many labeling regulations only apply to wholesalers, not restaurants. The widespread mislabeling of seafood negatively affects consumers in terms of price, their ability to make eco-friendly purchases, and potentially their health. Mislabeling also contributes to the further erosion of fisheries, not only because consumers cannot make informed decisions on behalf of conservation, but also because mislabeling undermines import/export seafood regulations.

Globally, the United Nations Food and Agriculture Organization (FAO) *Codex Alimentarius* require the country of origin of all food products to be identified with

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the exception that "when a food undergoes processing in a second country which changes its nature, the country in which the processing is performed shall be considered to be the country of origin" [5]. A recent study indicates only one-quarter of cans of tuna were labeled with a country of origin, often Thailand, even when the tuna was not caught, but only canned there [6]. Similarly, US supermarkets sell cans of 'Wild Alaska salmon' with a 'product of Thailand' label [authors' pers. obs.].

Many FAO member nations, opposed to any barriers to trade, resist labeling requirements and debate which fish species can share a common commercial name. For example, there is disagreement between Peru and the European Union (EU) as to what constitutes a 'sardine' [7]. For these reasons and other producer concerns over label costs, the FAO *Codex* may owe its continued viability more to its utility for tax purposes than consumer awareness or protection.

Given the lax FAO requirements, some member nations have adopted their own seafood labeling policies. In 2002, the EU implemented regulations to identify the official commercial and scientific name, the origin, and the production method (farmed or caught from the wild) for all fishery and aquaculture products [8], though evidence calls into question how closely these standards are being followed [e.g., 9]. In the US, the government recognizes that seafood is often mislabeled, but the enforcement of federal labeling requirements does not reflect a great deal of concern.

As early as the 1930s, canned mackerel was being labeled and sold as 'salmon' [10]. But it was not until 1991, after the expansion of seafood trade globally, that the US Food and Drug Administration (FDA) established the Office of Seafood and a 60% increase in funding for seafood inspection [11]. After testing seafood for 10 years (1988–1997), the National Seafood Inspection Laboratory issued a press release indicating that 37% of fish and 13% of other seafood (shellfish are more difficult to disguise) were labeled incorrectly [12].

The FDA now maintains a list of seafood names for industry to use in uniformly labeling its product. The agency provides an online 'regulatory encyclopedia' with the official names for fish and photos of their fillets for use by federal, state, and local officials as well as seafood purchasers (see http://vm.cfsan.fda.gov/~frf/rfe0.html). But legislation that would require adequate seafood labeling requirements has been continually weakened, as was the case with the Country of Origin Label (COOL) Legislation in the US, which revised the country of origin labeling requirements and made them voluntary rather than mandatory, in part owed to a nearly US$30 million lobbying campaign [13]. Furthermore, COOL legislation exempts fish markets, restaurants, and fishing vessels [14] as well as processed imports [15] from registering in the program.

Existing US seafood labeling regulations are by and large the result of protectionism. However, after September 11, 2001, the US food supply was analyzed and found to be a security liability; subsequently, the US Bioterrorism Act of 2005 required all links in the food and feed supply chain to be traceable [16]. But, in 2006, the FDA had only enough resources to check 1% of the 8.9 million food shipments imported [17]. The Agency tested only 0.59% of seafood imports in 2006—two-thirds the amount of imported seafood tested in 2003 [15].

Rather, the traceability of seafood in the US becomes a political priority when the protection of seafood producers is at stake. In Maine, lobster fishers, who started an 'Imposter Lobster' campaign, are working to restrict the use of the 'Maine lobster' label by processors in New Hampshire and Nova Scotia [18]. But, of all fish, it is catfish that wields the greatest clout in US Congress.

In 2000, fish farmers in the southern US felt that catfish from Vietnam (which was not permitted to call itself catfish, and is therefore known as 'basa') should be labeled and sold as 'Vietnamese'—the "Product of Vietnam" label on the box apparently not capturing the depth of its foreignness. At the time, Vietnamese catfish accounted for nearly 20% of the US market for catfish [19]. So southern US Congressmen introduced a bill that required wholesalers and restaurants to correctly label fish—but not all fish, just Vietnamese catfish. A few restaurants questioned why labeling catfish from Vietnam was necessary while labeling their imported crawfish from China was not [20].

To the chagrin of US fish farmers, Vietnamese catfish were also marketed as "Delta fresh catfish" and "Cajun Delight catfish". In 2001, the US Farm Bill was amended so that the term "catfish" could only be used for species of fish raised in the southern US, and not for their close cousins from Southeast Asia [19]. The farming of catfish, sponsored by the US Agency for International Development (USAID) as part of a post-war reparation project, and again after the 2004 tsunami [21], had been, apparently, too successful.

2. Fish phonies

Financial incentives are the strongest motivation to rename fish with more appetizing titles or mislabel seafood as a high-priced species. Many fish are given an entirely new name (often similar to that of an already popular fish) to boost sales (Table 1). Concerned with the public image of fish such as the hogsucker (*Hypentelium* spp.) and stumpknocker (*Lepomis punctatus*), the US National Marine Fisheries Service (NMFS), from 1973 to 1981, spent US$8.5 million to determine which "underutilized" fish species should be renamed [22]. Even without this expenditure, fish with ugly names would have likely been rechristened.

Cheap hake from South Africa and an Indonesian fish called 'Malabar blood snapper' are now both marketed as 'Scarlet snapper' [20]. In California, rockfish can be sold as Pacific red snapper [11]. Slimeheads were sensibly renamed 'Orange roughy' [23]. Aside from being marketed as 'Cajun

Table 1
Some cases of renaming seafood to improve marketing[a]

Scientific name	Original name	Renamed	Remarks (source)
Hoplostethus atlanticus	Slimehead	Orange roughy	Originally named 'slimehead' in 1957, it was renamed in 1979 as the seafood market changed [23]
Dissostichus elegenoides	Patagonian toothfish	Chilean sea bass	Renamed in late 1970s by a fish merchant from California. In 1994, fish merchants appealed to the FDA to change the name officially, which the FDA refused on grounds that Patagonian toothfish falls outside of the sea bass family [27]
Glyptocephalus cynoglossus	Witch	Torbay sole	Renamed by Marks & Spencer, the UK grocer, after an English bay where the fish is often found [25]
Squalus acanthias	Spiny dogfish	Rock salmon, Hass	From 1973 to 1981, the National Marine Fisheries Service (NMFS) spent US$8.5 million investigating which "underutilized species" with a bad image should be renamed [22]
Ruvettus pretiosus	Oilfish	Blue cod	A Toronto consumer fell ill after eating oilfish that was labeled as 'Blue cod' steaks at a Chinese supermarket [28]
Sebastes spp.	Rockfish	Pacific red snapper, Rock cod	In California, Rockfish can be sold as Pacific red snapper but, outside of California, the US FDA only allows *Sebastes* spp. to be sold as 'Rockfish' [11]
Merluccius capensis and *Merluccius paradoxus*	South African hake	Scarlet snapper	"Anything that is red is going to be sold as red snapper, no matter what it is," said one restaurant supplier (quoted by [20])
Lutjanus malabaricus	Malabar blood snapper	Scarlet snapper	
Anoplopoma fimbria	Sablefish	Black cod	[29]
Oncorhyncus keta	Chum salmon	Silver brite salmon	This mislabel is common in Chicago and probably elsewhere [30]
Ictalurus punctatus	Channel catfish	Southern trout, Ocean catfish	One of the names used to rid catfish of their original image (think Porgy and Bess in "Catfish Row") [Authors' personal observation]
Pangasius bocourti	'Basa'	Cajun delight catfish, Delta fresh catfish, White roughy, Pacific dory, Grouper teammate	[19,24]
Cancer irroratus	Rock crab	Peekytoe crab	Once discarded as trash crab, rock crabs underwent a marketing makeover in the mid-1990s and, renamed as 'Peekytoe crab', have now become the "culinary darlings" of many chefs [31]

[a]The scientific names of fish and invertebrates were verified using FishBase (www.fishbase.org) and SeaLifebase (www.sealifebase.org), respectively.

delight', catfish from Vietnam has also been sold as 'Pacific dory', 'White roughy', and 'Grouper teammate' [20,24]. The UK grocer Marks & Spencer got permission from trade authorities to sell Witch as 'Torbay sole' [25]. In the early 1990s, tilapia importers tried to rename their commodity 'St. Peter's fish', since it can be found on the Sea of Galilee in Israel and the name would resonate in the Bible Belt; however, the US FDA did not allow the evangelical makeover [11]. Renaming, though not of fish, can also occur for the sake of political advantages. In 2002, Austin Mitchell, a Labour MP in Britain, temporarily changed his name to Austin Haddock during Seafood Week, to encourage fish consumption and garner support from his fishing constituency [26].

The problem of renaming fish is eclipsed, however, by the magnitude of mislabeling fish as a different species (Table 2). Many different fish species masquerade as *Lutjanus campechanus,* 'the' Red snapper in the US, found in the southern Atlantic and Gulf of Mexico and a best-selling restaurant fish. In 1992, the FDA intercepted around 550 kg of fresh rockfish from Canada mislabeled as Red snapper [11], but this indictment was minuscule compared to the amount of Red snapper fraud that has occurred over the last two decades. Several studies indicate that 70–80% of 'Red snapper' sold in the US is some other fish [12,32,33]. In one recent case involving Chicago sushi restaurants, all 14 'Red snappers' sampled were actually some other fish species [34]. South of the equator, a similar

Table 2
Some better documented cases of fraudulent mislabeling of seafood for purposes of deceiving customers[a]

You are in	You purchase (common name)	Which is supposed to be (scientific name)	But you get (scientific name)	Also called (common name)	Remarks/source
US	Red snapper	*Lutjanus campechanus*	*Sebastes* spp. *Oreochromis* spp. *Coryphaena hippurus* *Ictalurus punctatus*	Rockfish Tilapia Mahi Mahi Channel catfish	Studies indicate that 70–80% 'Red snapper' sold in the US is some other fish [12,32,33,48,49]
US	Grouper	*Epinephelus* spp., *Mycteroperca* spp.	*Ictalurus punctatus* *Merluccius* spp. *Oreochromis* spp. *Theragra chalcogramma*	Channel catfish Hake Tilapia Alaska pollock	Grouper from the Gulf of Mexico was once abundant. Now, as much as 70% of tested 'groupers' (mostly in Florida) have been mislabeled [24,36,40,42]
US	'Wild' salmon	*Oncorhynchus* spp.	*Salmo salar*	Farmed salmon	Many 'wild' salmon are actually farmed, particularly outside of the salmon season [9,44]
US	Mahi Mahi	*Coryphaena hippurus*	???	Yellowtail	[50]
US	Halibut	*Hippoglossus* spp.	???	Sea bass	[50]
US	Orange roughy	*Hoplostethus atlanticus*	*Pseudocyttus maculatus* *Zeus faber*	Oreo dory John dory	[49] [49,50]
US	Swordfish	*Xiphias gladius*	*Isurus oxyrinchus*	Mako shark	[49,50]
US	Cod	*Gadus morhua*	*Theragra chalcogramma*	Alaska pollock	[50]
US	Dover sole	*Microstomus pacificus*	*Atheresthes stomias*	Arrowtooth flounder	The irony is that *Microstomus pacificus* does not occur in Dover [49]
US	Red drum	*Sciaenops ocellatus*	*Pogonias cromis*	Black drum	[49]
US	Rock cod	Scorpaenidae	*Squalus acanthias*	Spiny dogfish	[51]
US	Monkfish	*Lophius* spp.	*Tetrodon* spp.	Pufferfish	Two Chicago customers recently fell ill after ingesting tetrodotoxin found in their 'monkfish', which was actually pufferfish [52]
US	Shrimp, crabs, scallops, lobsters	Crustaceans, Decapods	Protein fibers extracted from offal	Surimi	One New Yorker complained bitterly about surimi substitution—tired of receiving "additive laden, colored, and extruded cheap fish sausage" in lieu of the shellfish he ordered (quoted in [53])
US	Beluga caviar	Eggs of *Huso huso*	Eggs of *Cyclopterus lumpus* Eggs of *Polyodon spatula*	Lumpfish roe Paddlefish roe	[54] [49]
US	Scallops	Pectinidae	Various	Skate wings	[49]
US	Patagonian toothfish	*Dissostichus eleginoides*	*Dissostichus mawsoni*	Antarctic toothfish	[27]
US	Lobster	*Homarus* spp., *Panilurus* spp., *Panulirus* spp.	*Nephrops norvegicus*	Langoustine or scampi	[16]
US	White perch	*Morone americana*	*Perca flavescens*	Yellow perch	[49]
US	Zander	*Sander lucioperca*	*Perca flavescens*	Yellow perch	[49]
US	Sauger	*Sander canadensis*	*Sander vitreus*	Walleye	[49]
US	Pink salmon	*Oncorhynchus gorbuscha*	*Oncorhynchus keta*	Chum salmon	[49]

Table 2 (*continued*)

You are in	You purchase (common name)	Which is supposed to be (scientific name)	But you get (scientific name)	Also called (common name)	Remarks/source
Hong Kong	Atlantic cod	*Gadus morhua*	*Ruvettus pretiosus*	Oilfish	[55]
France	Thon blanc	Thunninae	*Lamna nasus*	Porbeagle	French common name: 'Requin taupe commun' [56]
			Alopias vulpinus	Thintail thresher shark	French common name: 'Renard de mer' [56]
Ecuador	Tilapia	*Oreochromis* spp.	*Merluccius gayi*	South Pacific hake	[57]
	Weakfish Flounder	Scioenidae Pleuronectidae			
Ecuador	Tuna Flounder	Thunninae Pleuronectidae	Selachians	Shark	[58]
Colombia	Pargo rojo	*Lutjanus* spp.	*Oreochromis* spp.	Tilapia	[Jeffrey Wielgus, University of British Columbia Fisheries Centre, pers. comm]
Australia	Barramundi	*Lates calcarifer*	*Lates niloticus* *Polydactylus macrochir*	Nile perch King threadfin	13% of barramundi tested in an Australian study were mislabeled [35]
Australia	King George whiting	*Sillaginodes punctatus*	*Micromesistius australis* *Merlangius merlangus* *Sillago* spp. *Merluccius* spp.	Southern blue whiting North sea whiting Silver whiting Hake	[59]
Australia	Red emperor	*Lutjanus sebae*	*Lethrinus choerorhynchus* *Lethrinus miniatus*	Spangled emperor Redthroat emperor	41% of Red emperors tested in an Australian study were mislabeled [35]
Australia	Dhufish	*Glaucosoma hebraicum*	*Glaucosoma buergeri* *Glaucosoma scapulare*	Northern pearl perch Pearl perch	46% of Dhufish tested in an Australian study were mislabeled [35]

[a]The scientific names of fish and invertebrates were verified with FishBase (www.fishbase.org) and SeaLifeBase (www.sealifebase.org), respectively.

problem occurs with the antipodean analog of Red snapper: around 40% of Red emperors (*Lutjanus sebae*) in Australia are labeled incorrectly [35].

The mislabeling of grouper is nearly as problematic. Grouper are overfished in the Gulf of Mexico and now, particularly at restaurants, many inexpensive fish are sold in its place. A string of grouper scandals was uncovered in Florida, where as much as 70% of fish labeled 'grouper' were actually another species. The catfish, hake and tilapia that appeared during one of the samples not only fell outside any grouper genus, they fell outside the broader family of sea basses to which all grouper belong [24,36–42].

Seafood species may also be labeled as the correct species, but hide the fact that they have been farmed. A report that analyzed salmon from several different states showed that, when wild salmon are abundant (during the summer and fall), they are correctly labeled. Outside of the season for wild salmon, more than half of the sampled 'wild' salmon were actually farmed [43]. Similarly, three-quarters (6 of 8) of 'wild' salmon fillets sampled by the *New York Times* in its namesake city's Fulton Market were actually farm raised [44]. The mislabeling of farmed fish as 'wild' is not confined to the US—a look at more than 100 samples from retailers in the United Kingdom found that 15% of 'wild' salmon, 11% of 'wild' sea bream, and 10% of 'wild' sea bass were actually farmed [9]. It is rare, but occasionally this type of mislabeling occurs by accident. In one study, a farmed salmon escaped to the wild—in spite of salmon farm claims of zero escapement—and was then caught and sold as wild [44], its ghost posing deep ontological questions.

For seafood awareness programs to obtain their desired outcomes (including improving the ecological health of fisheries), it is essential that seafood consumers have accurate information and that eco-labels acquire and/or maintain their integrity. But to increase profits, reputation, and/or because of the inconsistent availability associated with eco-friendliness, fishers and seafood companies also mislabel seafood products as environmentally friendly.

In 2003, the Puget Customer's Co-op (PCC) Natural Markets in Seattle, Washington was caught mislabeling between 4% and 5% of its fish with the label "EcoFish", a certification sticker that denotes the seafood has been harvested in an environmentally responsible manner [45]. After this discovery, EcoFish suspended its program at all PCC markets [46]. Two salmon purchased during the Consumer Reports study [43] were labeled as 'organic' (both turned out to be farmed), though no federal rule exists for using the term 'organic' on fish. The giant retailer Wal-Mart was accused in January 2007 of mislabeling foods with 'organic' labels at dozens of stores in five states—this from a company that pledged to source all fish from sustainable sources by 2010 [47].

3. Consequences of mislabeling

3.1. Consumer and government economic losses

For free market economics to function properly, consumers require perfect information [60]. Not only is some of the information about seafood imperfect, it is often deceptive. The mislabeling of fisheries products most often occurs after they are purchased from the fishers, who are most often 'price-takers'. The price for certain fish can be high, even in terms of ex-vessel prices, due to resource scarcity. Rather than pay high prices, distributors, retailers, and restaurants often buy fish of lesser value, illegally sell these fish as their higher value relatives, and accrue the windfall profits. The consumer, meanwhile, loses.

When rockfish was renamed Pacific red snapper, restaurants profited from the substitution, not consumers [20]. When white sturgeon caviar is marked as 'beluga caviar', consumers pay five times too much [61]. In 1989, the US FDA detained a 20,400-kg shipment of Oreo dory (*Pseudocyttus maculatus*) imported from New Zealand and bound for Ohio markets as Orange roughy (*Hoplostethus atlanticus*). Ohioans might not have detected the difference in taste, but they would have surely been upset to pay three times more for the fish [11]. Diners at one Florida restaurant would have also been angry had they known they paid US$23.95 in 2006 for 'champagne-braised black grouper' that was actually tilapia. The value of frozen catfish, when sold as grouper, quadruples, as does the loss to consumers [41]. In New York City, wild salmon can sell for as much as US$64/kg, while farmed salmon goes for US$11–26/kg [44]. But farmed salmon sold as wild salmon can exceed the price of genuine wild salmon when it is sold outside the wild salmon season [43].

In addition to consumers, governments can lose financially due to mislabeling. In January 2007, Mr. Danny Nguyen and his two seafood companies were charged with a 42-count criminal indictment for mislabeling over a hundred tonnes of Vietnamese catfish as grouper and other fish so as to avoid US anti-dumping duties that were put in place for catfish in 2003 [62]. Nguyen's company and nine others were charged with selling nearly five million kg of Vietnamese catfish falsely labeled as sole, grouper, conger pike, and flounder [63].

3.2. Resource losses

Renamed and mislabeled fish can have dire consequences for species that are under protection and/or are illegal to sell. In a document on the promotion of shark products for export, one finds that, "In the USA, shark meat sale has a better chance of growth under anonymity" [64]. This is true in other parts of the world, too (see Table 2). In Ecuador, sharks are filleted, relabeled and sold in city markets as flounders or even tuna [58]. Approximately 40% of the nearly 200 shark fillets tested in a New Zealand study were not lemon sharks, as the label indicated, but were instead hammerhead, bronze whaler, and school sharks, which are illegal to harvest [65].

Overfishing in the Caspian Sea, where most of the world's caviar originates, has driven many of the 25 species of sturgeon there close to extinction. Meanwhile, US imports of caviar have doubled since 1991 [66]. How to feed the US appetite for caviar? In a 1996 case, 2000 adult sturgeon in the Columbia River, Oregon, were killed to illegally harvest 1500 kg of caviar, which was relabeled and sold as imported beluga and Russian oestra caviar [61]. In the late 1990s, examination of 95 different samples of caviar being sold in New York City found that 23% were mislabeled with respect to species [67].

Lack of traceability and re-labeling of fish also undermines environmental regulations. Over a 5-year period, Neptune Fisheries imported at least 85,500 kg of mislabeled undersized lobsters to the US from Nicaragua, where the export of such small tails (i.e., juvenile lobsters) is illegal [68].

3.3. Undermining of eco-campaigns

Renaming and mislabeling of seafood also prevents 'eco-aware' consumers from making effective purchasing decisions on behalf of conservation [69]. Many exporters and even domestic suppliers are able to sell their fish as eco-friendlier versions due to the lack of traceability. With the extensive mislabeling of farmed salmon as wild, how meaningful is a boycott of farmed salmon, such as the Living Oceans Society's 'Farmed and Dangerous' campaign, if farmed salmon pose in the market as wild?

Similarly, there has been a widespread campaign in Europe to raise awareness of the negative effects of farm-raised shrimp, the production of which can destroy mangrove habitat and reduce water quality [70]. As a result, Thai shrimp, which account for nearly 30% of global production, are often exported labeled as 'wild-caught' rather than 'farm-raised' [71]. For its eco-friendly and mercury-free reputation along with its price, tilapia has moved up from the 9th to the 5th most consumed fish in the US. In Ecuador, the Whitefish Association of Ecuador now sells South Pacific hake filleted and labeled as tilapia [57].

Renaming and mislabeling also generates confusion among those consumers who support boycotts and stronger regulations. The 'Take a Pass on Chilean Sea Bass' campaign had to navigate around the fact that Chilean sea bass is actually Patagonian toothfish (*Dissostichus eleginoides*) and that, in recent years, Antarctic toothfish (*Dissostichus mawsoni*) has been substituted for its sparse relative. Furthermore, illegal shipments of toothfish enter the country labeled as crayfish or under the generic label of 'frozen fish fillet' [27,72].

Mislabeling also gives consumers the sense that supply is keeping up with demand. When there was a moratorium on US grouper fishing between 2004 and 2005, mislabeled fish served to sustain demand for an overfished stock. When English fishers exceed their cod quota, they label their cod as ling to pass it through customs [73], but the reverse is also true. Consumers are sold sablefish (*Anoplopoma fimbria*) as 'black cod', groupers as 'rock cod', and the poisonous oilfish as 'blue' or 'Atlantic cod' (see Table 2). The collapse of the Northern cod stocks off Newfoundland, Canada, might have gotten a lot of media attention, but to the consumer, cod stocks seem just fine.

3.4. Health concerns

Properly labeling seafood is not only required for economic and ecological reasons, but also for health reasons. In the US, it is estimated that seafood products cause 18–20% of the food borne illnesses contracted by 76 million Americans each year [15]. Mislabeling contributes to illness in the US and beyond. For instance, two Chicago consumers recently fell ill after ingesting the tetrodotoxin found in pufferfish, which was mislabeled as 'monkfish' [52].

Oilfishes (common names include: oilfish, escolar, rudderfish, butterfish, ruddercod, and snake mackerel) are indigestible by about half of all people and its wax esther content has made its sale illegal in Italy and Japan. For many years, oilfishes have caused outbreaks of diarrhea among consumers in Australia, where food and agricultural officers determined the problem to be one related to incorrect marketing [74]. Consumers in Hong Kong recently got a potent dose of incorrect marketing when a large shipment of oilfish (*Ruvettus pretiosus*) from Indonesia was labeled as 'Atlantic cod' and more than 600 consumers became ill [55].

The correct labeling of species is also important in terms of contaminants. The risk of poisoning due to the consumption of neurotoxins (e.g., mercury) through predatory fish, particularly tuna, has been debated for the last 40 years. In the US, consumers have been warned about canned tuna and told that albacore tuna, labeled often as 'white tuna', is highest in mercury, while cans of 'chunk light' or 'light tuna' are composed of tuna species with lower mercury content. But about 90 million cans of 'light tuna' sold in the US each year contain yellowfin tuna, which has mercury levels equivalent to that of albacore [6,75,76]. Rather than properly labeling their products, tuna producers have chosen to reduce risk by decreasing the amount of tuna in a can by roughly 15% to exactly 170 g (6 oz) and thus stay below the 'allowable' limit for mercury [6].

Mercury is also a concern for individuals still consuming whale meat. In Japan, about 40% of what is supposed to be baleen whale meat is mislabeled dolphin or other toothed whale meat, which has an average mercury level of 370 parts per million (ppm)—925 times higher than the Japanese legal limit for mercury (which is, with 0.4 ppm, lower than the US limit of 1.0 ppm) [77,78].

Aside from species labeling, labeling the country of origin and the production method is also important for human health. Recently, high pesticide residuals have been found in Chinese shellfish that pose a risk to humans [79]. A study of more than 700 salmon samples from around the world also confirmed the need for labeling. Hites et al. [80] found farmed salmon contain higher concentrations of contaminants than wild salmon. Moreover, salmon farmed in European countries have significantly higher levels of contamination than those raised in North and South America.

4. Discussion

In 2006, assuming a conservative 15% of farmed salmon were mislabeled (some investigations have found as much as 75%), 212,250 tonnes of farmed salmon were sold worldwide as wild. The consumer losses for these mislabeled salmon alone were at least US$2 million in illicit gains for the distributors and/or retailers as reward for their deception. Meanwhile, farmed salmon production (and its associated negative ecological impacts) expanded. The consumer's ability to impact the market, by avoiding farmed salmon, for instance, was made less effective. Furthermore, consumers of the fraudulent salmon ingested more contaminants than they would have had their salmon really been wild caught.

The importance of properly labeling food (centered mainly on quality and health concerns) has been debated for at least a century. In the early 1900s, the public, stirred by Upton Sinclair's investigation into the horrifying realities of slaughterhouses in *The Jungle* [81], clamored for food safety standards. In the case of seafood, the government regularly seized canned fish in the 1920s, which it described in one case as "filthy, putrid, and decomposed". The canneries refused to clean up their practice, claiming the government could not prove the putrid fish were actually harmful to consumers [10,82]. Early proponents of the US consumer movement, who founded the group that now issues *Consumer Reports*, independently tested products and lobbied the government for better grading and labeling of products. The work by the *Consumer Reports* team in the 1920s and 1930s prompted governments to outlaw blatantly false claims in advertising, to establish quality standards for consumer goods, and to become actively involved in labeling them [83]. But, then as

now, labeling requirements are slow to take effect. In 1973, nearly 100% of over 2000 people interviewed in the US were in favor of a nutrition label on food products [84]. Yet, the US Nutrition Labeling and Education Act did not pass until 1990 and was not implemented until 1994. In Canada, nutrition label requirements were not made mandatory until 2005.

In terms of seafood, the mislabeling issue and the fishing industry's resistance toward (and power to contest) labeling standards is more than a century old. In 1906, after *The Jungle* [81] triggered public outrage, there was overwhelming Congressional support for a new Food and Drug Act. The US Secretary of Agriculture's first response to the new act was to weaken it: the Maine fish packers wanted to allow all small pelagic fish to be labeled as 'sardines', which the Secretary granted [10]. Industry's ability to weaken labeling legislation that is backed by popular support continues today. In April 2005, Country of Origin Label (COOL) Legislation went into effect for seafood, but after legislators struck "the onerous mandatory system" and established instead "a rigorous voluntary program". Agribusiness (e.g., Wal-Mart Stores, Tyson Foods, the American Meat Institute) participated in the political process with a US$29.2 million lobbying campaign against COOL legislation [13]. This in spite of the fact that several studies have indicated one-third of all seafood sold in the US is mislabeled [12,30].

The fishing industry's standard argument is often that proposed labeling legislation is too costly. But the costs associated with mislabeling are also high: consumer and resource losses, eco-label ineffectiveness, and health concerns. Today the market climate is one that encourages consumers to be responsible for their health and the health of the environment. While it is true that consumers should have a better understanding of their seafood (appearance, flavor, and origin), awareness alone will not protect consumers from deceit in the seafood market.

There are straightforward approaches that have proven effective at testing seafood for validity to the species level, including biochemical techniques, DNA fingerprinting, and assays [8,65,67]. A database is also under construction that catalogues the molecular genetics of different seafood species [85]. While these techniques are relatively inexpensive, they require complex technologies, human resources, and political will, and are thus likely unrealistic in the developing world, where the majority of seafood consumed in developed countries originates. Until such methods become economically and politically viable, labeling is likely to remain an important, though cumbersome, component of international trade.

A global mandate for species, country of origin, and production method labeling as well as verifiability of eco-labels is necessary for all seafood. At the international level, the FAO *Codex Alimentarius* should require actual geographic site of origin, not just the place of processing. The US, which imports more than 80% of its seafood, could move from protecting catfish producers in the southern US from competitive imports to becoming a leader for seafood labeling in the global arena. Though recent years have affirmed the Marine Stewardship Council (MSC) as the leader of eco-labeling, any attempts in this vein by the International Standards Organization (ISO), which has its own evaluation and certification scheme to assess sustainable fisheries, should collaborate with the MSC so that consumers are not further inundated with information to the extent that efforts become counter-productive [86].

Perhaps the best method to ensure labeling standards is with a third-party validation from 'cradle to plate'. To improve traceability and retain public confidence in labeling claims, the MSC recently implemented a Chain of Custody certification that guarantees fish buyers that their seafood can be traced back through the supply chain from the point of sale to the fishery of origin [87]. The MSC chain of custody standards could be adopted nationally and/or globally.

Additionally, the penalties for mislabeling and illegally harvesting fish must be raised. The fines for mislabeling foods as organic are high—up to US$10,000 in some cases [47]. But fines for illegally catching fish—never mind mislabeling them—are minimal. In the case of the two poachers who were indicted on grounds of illegally harvesting American sturgeon caviar (and selling it as imported Russian caviar), their fines totaled US$17,375—less than 1% of the estimated US$2 million the pair made on the sale [61].

Marine conservation non-profits should also continue efforts to win legislation for seafood traceability, including labeling standards. The National Environmental Trust (NET) published a report on Patagonian toothfish [72] revealing that a considerable amount of illegal toothfish enters the US intermingled with other seafood or under the nondescript title 'frozen fish fillet'. NET have worked to prevent fish from entering the US under such a vague description but, so far, have not had success.

In 1992, *Consumer Reports* [30] published an article titled, "The label said Snapper, the lab said baloney". Fifteen years later, the mislabeling of Red snapper is, if anything, more widespread (e.g., [33]). Red snapper began disappearing a half century ago, but one would never know by reading a menu. Using old menus from the 1850s onward, researchers are presently gaining insights into historical marine abundance [88,89]. In the future, due to the rampant mislabeling of seafood today, this sort of study would be futile.

Of greater concern is that species are mislabeled because there is a shortage of the desired species or because the species itself was illegally caught (illegal, because there is a shortage). Species are renamed because an ever-growing demand for seafood creates new markets for fish that were once considered unmarketable (e.g., slimeheads, toothfish). Today's renaming and mislabeling is not only an indication of cheating, but is, fundamentally, an indication that global fisheries are in distress.

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