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Title: The uncertainty of seafood labeling in China: a case study on cod, salmon and tuna

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Abstract: Exotic marine fish products are increasingly appreciated in China. In this study, 100 samples of Cod, Salmon and Tuna products were collected from supermarkets in Shanghai, Nanjing and Hangzhou. First the information reported on the label were assessed in the light of the Chinese legislation, paying particular attention to the fish names and the geographical origin. Then, a comparative analysis of the official trade denominations adopted by five European countries (Italy, France, Germany, Spain and United Kingdom) for Cod, Salmon and Tuna was performed. Finally, the Chinese names of the species considered in the EU list were verified consulting the available international lists. Overall, 95% of the samples employed just generic names. In particular, 98% of Salmon and 100% of Tuna products were generically labeled while the labeling of Cod products was more diversified, even though 80% reported misleading or fake denominations. The results of this work highlighted the lack of a mandatory legislation on seafood traceability and of an official naming system. In particular, this study propose the introduction of a detailed Chinese naming system based on the Chinese Latin Dictionary for Seafood Names, following the EU approach. In fact, a not accurate labeling can have both economic and health implications for consumers as well as it may distort the true abundance of fish stocks. These drawbacks can be particularly serious considering the pivotal role of China in the global fishery industry.

Dear Editor,

we would like to submit the following manuscript for possible publication: *The uncertainty of seafood labeling in China: a case study on cod, salmon and tuna*

China's growth has determined an increase in citizens' purchasing power provoking profound changes in lifestyle and patterns of food consumption. In particular, seafood consumption has tripled over the last three decades and high value exotic marine species have become popular, taking the place of cheaper freshwater fishes, historically consumed in China.

Overall, the data on seafood production, processing and trade qualify China as the seafood factory of the world. However, there are still many shortcomings in the management of the fishery chain. In particular, unlike the majority of the Western countries, China still lacks of specific mandatory provisions for the labeling and of an official reference list of seafood trade names.

This work represents an attempt to assess the current Chinese regulatory framework on fishery traceability. In particular, we focused our attention on Cod, Salmon and Tuna. Then, considering that the traceability and labeling are two well implemented aspects of the EU's legal framework we analyzed the commercial designations adopted by 5 European Member States (MSs) (United Kingdom (UK), France, Italy, Spain and Germany). Finally, by consulting the available international lists we suggested possible implementations of the Chinese labeling system.

Our results shown the chaos affecting the Chinese seafood labeling and the inadequate implementation of traceability schemes. In fact, we found that 95% of the samples employed just generic names. 98% of Salmon and 100% of Tuna products were generically labeled while the labeling of Cod products was more diversified, even though 80% reported misleading or fake denominations. Chaotic labeling can have both economic and health implications for consumers. Moreover, considering the Chinese population size even a small growth in consumption will turn out in millions of new consumers greatly increasing the competition for what is a finite resource. Thus, China has the potential to impact greatly on the global trade and consumption of Cod, Salmon and Tuna. It is therefore necessary that China implements a legislative framework and a structured management system for the fishery sector also by the transition from voluntary to mandatory standards. In particular, we propose the introduction of a detailed Chinese naming system, at least for the species of Cod, Tuna and Salmon considered by the European lists.

We declare that the manuscript is an original contribution that has not been published elsewhere in the same form and that is not currently under consideration elsewhere.

Best regards

Andrea Armani

Dear Editor,

We are sending the revised version of the paper entitled "***The uncertainty of seafood labeling in China: a case study on cod, salmon and tuna***". We have followed the suggestion given by the reviewer trying to improve the manuscript.

Thank for reconsidering the paper

Best regards

Andrea Armani

Reviewers' comments:

The manuscript is interesting and relatively novel, in terms of its emphasis on global comparison and standardisation of seafood labels. However, it requires a series of modifications to bring it to publishable standard.

The authors sampled only 100 items (divided into 3 main product categories, cod, salmon and tuna): considering the enormous role of China in the global seafood trade, and the importance of these three product types have for the said global market, such sample size is very small. This is a major shortcoming, but the authors do not justify/acknowledge/discuss this, while instead it is a key issue.

Dear Reviewer, you are right, the number of collected samples is limited if considered in the light of the China's role in the seafood market. However, we would like to highlight that the number of samples analyzed in manuscripts dealing with the assessment of mislabeling in seafood products in extremely variable and often very low. See for examples the work of:

Chang et al., 2016 "DNA barcode identification of fish products in Taiwan: Government-commissioned authentication cases" (<http://www.sciencedirect.com/science/article/pii/S0956713516300354>)

N° of samples 34.

Pappalardo et al, 2015 "DNA barcoding species identification unveils mislabeling of processed flatfish products in southern Italy markets" (<http://www.sciencedirect.com/science/article/pii/S0165783614003294>)

N° of samples 40.

Cutarelli et al., 2014 "Italian market fish species identification and commercial frauds revealing by DNA sequencing" (<http://www.sciencedirect.com/science/article/pii/S0956713513004015>).

N° of samples 58.

Di Pinto et al., 2014 "DNA barcoding for detecting market substitution in salted cod fillets and battered cod chunks" (<http://www.sciencedirect.com/science/article/pii/S0308814613006869>)

N° of samples 65.

Nagalakshmi et al., 2016 "Mislabeling in Indian seafood: An investigation using DNA barcoding" (<http://www.sciencedirect.com/science/article/pii/S095671351530013X>).

N° of samples 100.

Moreover, we briefly discussed this point at line 136-139.

The paper is much too long. Some tables (e.g. Table 6) should be moved to the online supplementary material.

Table 6 has been removed from the text. It is now the Table 2SM

The long discussion is very descriptive and could be reduced by nearly 50%.

Discussion has been shortened (from 6181 words to 3969 word).

The objectives and focus of the study should be more clearly outlined towards the end of the Introduction.

The objectives of the study have been revised (line 74-83).

Data from Table 5 should instead be presented in a graphical way.

Done. Data of Table 5 are now reported in Fig. 3. However the original Table 5 has been maintained as Supplementary Material (now Table 1SM).

5. The authors should commit to a more concrete conclusion and recommendation. At this stage, even in the final conclusions, the reader is left with some sense of vagueness. There is an underlying sense of dismay for a presumed 'chaotic' situation of Chinese labels, but in fact the data show much compliance with current regulations. Instead, it would be very important to separate the issues of "compliance" with legislation and the need for a better labelling system following a EU-style approach. The two aspects are related, but are very different.

Conclusion and recommendation have been modified focusing on seafood denomination (section 3.4)

6. I am surprised the authors don't call for a "one species one name" approach, and promote identity of the "one-name" irrespective of the country in question: given the increasing globalization of seafood trade, there should be a global establishment and enforcement of the use of Latin names, as these are the only universal denominations that can be transferred across countries.

This is the approach we tried to propose in the original manuscript. It was obviously not clear enough. Thus we tried to better explain this concept (section 3.4.1).

Copy-editing requirements:

LANGUAGE

Eliminate the use of the first person ("we") in Abstract and text;

line 56: 'suffers from';

line 57: delete 'of';

line 352: 'threat to' not 'threaten for';

line 425: 'upmarket' not 'upscale';

line 430: 'names';

line 452: 'Although' not 'Despite';

line 456: 'In order to prevent...on 1st January 2010 the EU...';

line 522: 'strict' not 'severe';

line 526: 'is' not 'are';

All corrections have been made

FORMATTING

1 Please provide Highlights (see Author Guidelines/papers on journal website);

Highlights have been provided

2 Remove tables and figure from text file, and upload as individual files;

Tables removed from text and upload as individual file

3 For figure, remove fig caption from fig file and upload a separate fig caption file;

It has been done

4 For tables, retain table captions on individual table files;

Table captions retained on individual table files

5 As well as bracketed references to tables and figure in text file, insert text line breaks with notes to indicate their approximate positions e.g. Table 1 here;

Text line breaks with notes inserted

6 Colour is free for web version but costs for print version - suggest re-design in grayscale.

The color has been changed

Editorial Note: Please take account of all Review comments prior to re-submission.

Suggest paper is edited by someone with English as a first language, or equally fluent in English.

Done.

The uncertainty of seafood labeling in China: a case study on cod, salmon and tuna

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Highlights (for review)

We carried out a survey on seafood labeling standards adopted in China

We analyzed the label of 100 Salmon, Cod and Tuna products sold in Chinese markets

China should implement a specific legislative framework for seafood

China should establish a standardization system for seafood trade names

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The uncertainty of seafood labeling in China: a case study on cod, salmon and tuna

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4 **Abstract**
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7 Exotic marine fish products are increasingly appreciated in China. In this study, 100 samples of Cod,
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9 Salmon and Tuna products were collected from supermarkets in Shanghai, Nanjing and Hangzhou. First
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11 the information reported on the label were assessed in the light of the Chinese legislation, paying
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13 particular attention to the fish names and the geographical origin. Then, a comparative analysis of the
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15 official trade denominations adopted by five European countries (Italy, France, Germany, Spain and
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17 United Kingdom) for Cod, Salmon and Tuna was performed. Finally, the Chinese names of the species
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31 Names, following the EU approach. In fact, a not accurate labeling can have both economic and health
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33 implications for consumers as well as it may distort the true abundance of fish stocks. These drawbacks
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35 can be particularly serious considering the pivotal role of China in the global fishery industry.
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58 **Keywords:** Seafood labeling, Cod, Tuna, Salmon, Traceability, China
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1. Introduction

Since the economic reform and the market opening in 1978, China has experienced an exceptional economic growth that has determined an increase in citizens' purchasing power, provoking profound changes in lifestyle and food consumption [1]. In the last two decades the consumption of food of animal origin has increased, especially in urban areas [2]. In particular, seafood consumption has tripled over the last three decades and high value exotic marine species have become increasingly popular, taking the place of cheaper freshwater fishes, historically consumed in China [3] and [4]. While in the past marine species were consumed only in the coastal provinces, this consumption is gradually moving inland. Salmon (consumed as sashimi and sushi), for example, is currently considered "*the Prada of seafood in China*" because is foreign, modern and prestigious [4]. In fact, eating fresh salmon has grown as a status symbol in China where it is now among one of the most expensive seafood items on offer in restaurants [5]. The orientation towards imported fishery products was also influenced by the loss of confidence of the Chinese population in domestic foods following food safety scandals [Unknown. Norway increases salmon exports to China]. In 2006, ~93% of China imports of unprocessed fish consisted of cod (79%, all frozen), salmon (19%, fresh and frozen) and tuna (2%, all frozen). Interestingly, these products were not only intended for national consumption but also for processing and re-exporting [6]. The increase in the global demand for fish fillets and steaks has led to an impressive development of the Chinese fish-processing sector, which, following these new habits, is now also oriented to products destined to national consumption.

China currently holds 40% of the world seafood production, representing the world's leading producer and supplier, with an output of 43.5 million tons in 2013 [7]. Unfortunately, Chinese seafood is often subject to border notifications and import bans because of food safety issues [8], [9], [10] and [11].

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In order to cope with the worldwide recalls and to reestablish consumers' confidence in domestic foods, China's government has tried to overhaul the national food safety system [8]. Food safety in China has always been a growing concern, and for the first time since 2009,

In 2009, China has taken the first real step towards a stringent regulation of food safety in the country, by issuing the Chinese Food Safety Law, (FSL) which was subsequently enhanced by 2000 national standards, 2900 industrial standards, and over 1200 local standards regarding food, additives and labeling [12]. Then, on April 2015, the Standing Committee of China's legislative body and the National People's Congress adopted a revised version of the national FSL, which become effective as of October 1 2015. The new FSL has the objective to strengthen the protection of Chinese consumer's health and imposes more strict penalties for food safety related violations [13].

Despite these important changes, the fishery sector still suffers from significant legislative and managerial shortcomings. In particular, unlike most of the Western countries, China still lacks specific provisions for the labeling of fishery products and an official reference list of seafood trade names. In fact, with the exception of some basic compulsory labeling requirements established by the GB7718-2011 standard [14] and by the Decision General Order No. 123 of 2009 [15] (Table 1), only a few standards (mandatory and voluntarily) (Table 2), have been issued.

(Table 1 and 2 here)

The European Union (EU) is currently considered as the global leader in food traceability [16]. In the case of the fishery industry, traceability and labeling are just two aspects of the complex EU's legal framework, that deals with many other scopes such as the surveillance of fish stocks and the fight against illegal fishing activities [17]. In fact, the promotion and implementation of legal and sustainable seafood trade also passes through a consistent naming and labelling of seafood species [18], [19], [20] and [21].

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4 This work, by assessing the labeling conformity of three newly appreciated seafood species, Cod,
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75 Salmon and Tuna, in the light of mandatory and voluntary regulations implemented in China, represents
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96 a preliminary attempt to give a glance inside the current legislation adopted by this country to regulate
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1277 the seafood market. Contemporary the Chinese commercial denominations used for these species were
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1478 compared to the commercial designations officially adopted by 5 European Member States (MSs) (Italy,
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179 France, United Kingdom (UK), Germany and Spain) and by international lists such as the FAO Fisheries
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190 and Aquaculture Statistics and Information Service (ASFIS) [22], FishBase [23] and the Latin-Chinese
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2281 Dictionary of Fish Names (LCDFN) [24] to assess similarities and discrepancies. Finally, possible
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242 implementations for the creation of a Chinese seafood naming standardized system through the
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2683 introduction of an EU-style approach were suggested.
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28 294 **2. Materials and methods**

30 315 **2.1 Samples collection**

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346 One hundred fish samples, fresh, frozen and processed, either in bulk or packaged, were purchased in
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367 2014 (Table 3). The samples were collected in Shanghai (SH), Nanjing (NJ) and Hangzhou (HZ): for
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388 each city 5 supermarkets, belonging to different postal districts, were randomly selected. The samples
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419 were collected if reporting the ideograms 鳕 (*Xue*) or 金枪鱼 (*Jin Qiang Yu*) (alone or associated with
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4490 other terms) which correspond to the English terms Cod and Tuna, respectively. In the case of Salmon
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4691 different names are used depending on the location: 大马/麻哈鱼 (*Da Ma Ha Yu*) or 鲑鱼 (*Gui Yu*) in
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492 the Provinces of Heilongjiang, Jilin and Liaoning and 三文鱼 (*San Wen Yu*) in the cities of SH, NJ and
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5293 HZ (Yangtze Delta Region).
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5694 The labels of the packaged products were analyzed. In case of fish sold in bulk, the billboards
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596 displaying the product information were photographed. Finally, all the samples were logged with an
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65 internal code and filed.

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5 (Table 3 here)
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All the information reported on the labels or on the billboards was translated to English by a Chinese native speaker, also with the use of multimedia translation tools [25] and [26]. The information reported on the labels of packaged samples was assessed in the light of the Chinese general mandatory National Standard GB7718-2011, while information regarding bulk products (mainly reported on billboards) was assessed according to the Decision General Order No. 123 of 2009 which should be applied to “*foods produced (sub-packaged) and distributed within the borders of the People’s Republic of China*” (Table 1). Moreover, Chinese national (mandatory or voluntary) and professional voluntary standards on fishery products were also analyzed (Table 2). In addition, the information on geographical origin was assessed.

2.3 Analysis of the denomination adopted for Cod, Salmon and Tuna

2.3.1 European official lists of seafood denominations. The official list of 5 MSs, namely Italy [27-31], France [32], UK [33], Germany [34] and Spain [35], were analyzed. In particular, only those names that, translated from the official language of the MS to English, matched with Cod, Salmon and Tuna were considered (Table 4). Moreover, in order to better clarify the different national approaches for the management of seafood labeling, the ratio among the total number of commercial denominations used for Cod, Salmon and Tuna species and the corresponding number of species present in each lists, was calculated (Table 1SM), as in [36]. This ratio can be considered as an Index (Species Index, SI) that reflects the accuracy of each analyzed list in managing the commercial nomenclatures. In fact, an $SI > 1$ means that the trade names are more than the species and therefore the same species can be commercialized with more than one trade name. On the contrary, in the case of an $SI < 1$, the number of species is higher than that of the denominations. This means that different species share the same

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5 commercial designation. The most accurate situation (SI=1) is reached when the MS assigned to each
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7 species a univocal trade name. Moreover, since in some cases the MS assigned the same commercial
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9 designation to an entire genus, a second Index (Genus Index, GI) was calculated taking into account the
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11 number of trade names in relation with all the species belonging to a specific genus (Table 1SM).

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14 (Table 4 here)

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16 *2.3.2 International lists of seafood denominations in Chinese.* International lists, such as ASFIS [22]
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FAO Fisheries and Aquaculture Statistics and Information Service 2015], Fishbase [23] and the
Latin-Chinese Dictionary of Fish Names [24] were investigated to assess the Chinese names for Cod,
Salmon and Tuna species found in the EU lists analyzed. The Indices (SI and GI) were then calculated
(Table 2SM).

3. Results and discussion

3.1 Samples collection

In this survey, 100 samples of fish products (46 of salmon, 38 of cod and 16 of tuna) were collected.
Among these, 43% were fresh, 30% frozen and 27% variously processed. Forty-two percent of them
were packaged (64% processed and 36% frozen) and 58% in bulk (70% fresh and 30% frozen) (Table
1). Despite the number of samples is small, if compared to the overall amount of fishery products traded
from China, the outcomes of the present analysis could represent a first step into the main issues
affecting the sector. Moreover, they could be useful to focus further studies on high prized products that,
worldwide, are often affected by labeling non-conformities [37].

3.2 Chinese label inspection: trade name and origin

All the products presented a label in Chinese, while a small percentage (5%) reported the name of the
products also in English. All the 42 pre-packaged products presented a label fully conform to the
national standard GB7718-2011 [14] (Table 1). For the 58 samples in bulk, all the consulted billboards

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143 lacked information on the manufacturer and the production license number as required by the General
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144 Order n. 123 of 2009 [15] General Administration of Quality Supervision, Inspection and Quarantine
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145 2009] (Table 2).

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146 As concerns the food name, 71% of the samples employed a generic name, such as Cod (*Xue Yu*),
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147 Tuna, (*Jin Qiang Yu*) and Salmon (*San Wen Yu*), not attributable to any specific species. A scientific
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148 name, only required by voluntary standards for tuna intended for raw consumption (not collected in this
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149 work), was indicated only in 3% of the cases (all Cod frozen packaged samples) (Table 2).

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150 Although in China the indication of the seafood origin is not compulsory, 55% of the samples (41%
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151 packaged and 59% in bulk) provided it. The most part of the products (63%) were imported (Fig. 1.A)
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153 *3.2.1 Cod products.* Fifty three percent of the Cod samples were generically labeled as Cod (鳕鱼,
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154 *Xue Yu*) while the remaining 47% reported other Chinese related names (Figure 2).

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155 (Figure 2 here)

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37 As mentioned, a scientific name was reported only on the package of 3 samples. The first product,
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157 labeled as Cod, reported the scientific name *Albatrossia pectoralis*, commonly known as Giant grenadier
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158 [38]. The scientific name reported on the other two products, labeled as red cod, was *Pseudophycis*
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159 *bachus*, known as Red codling [39].

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47 The origin was reported in 31.5% of the Cod samples (Fig. 1.B). These outcomes confirm Cod as one
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161 of the most imported seafood in China for (re)processing. However, as previously described by Clarke
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162 (2009) [6], only a minimal amount of imported Cod products are intended for a direct commercialization
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163 on the Chinese market.

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164 *3.2.2 Salmon products.*

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Traditionally, the Chinese names *Da Ma Ha Yu* or *Gui Yu* have been used in some parts of China to identify several Salmonidae species captured in Chinese seas, while *San Wen Yu* was introduced later for *Salmo salar* following the beginning of its importation [40]. Over time, the Chinese population has begun to increasingly use the term *San Wen Yu*, which, on the basis of our results (Fig. 2) seems to be the most employed name. In fact, all the samples collected in this study were labeled as *San Wen Yu*. This name sounds more attractive than *Da Ma Ha Yu* or *Gui Yu* and therefore it is preferred by seafood merchants [40].

The origin was reported for 63% of the Salmon products (Fig. 1.C): those in bulk were mainly (91.5%) from Europe while 80% of the packaged were from China. Currently, most part of the Salmon is imported from Norway and Chile [41] because China does not hold a quota for fishing North Pacific Salmon [6] and the aquaculture of Salmon and other cold water fish species in China is unproductive because of the high sea water temperature [42]. Therefore, it may be assumed that Salmon products, which reported a Chinese origin, were imported from abroad as raw material and after being processed and transformed in China they lost their true origin. Misleading origin have already been reported by the Norwegian Institute of International Affairs which found that merchants use to falsely claim that salmon originates from other countries (mainly Norway) to boost sales and profits [40].

3.2.3 *Tuna products.* The samples were all simply labeled in Chinese as Tuna (*Jin Qiang Yu*) (Fig. 2).

However, 37.5% of them also reported an English name: Skipjack (83%) or Albacore (17%).

The origin of tuna products was reported on 81.3% of the labels. For the 83.5% of the samples a foreign country was indicated while only 16.5% declared China as the country of origin (Fig. 1.D). In fact, China only began to develop its Western Central Pacific Ocean (one of the main areas for Tuna fishing) purse seine fleet in 2001. China's expansion in the Tuna industry has been strongly supported by the government, leading to the development of large state-owned fishing enterprises for distant water

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5 fishing [45]. However, as the main areas of Tuna distribution do not include waters under Chinese
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7 jurisdiction, 70-85% of the processed Tuna is foreign-owned [6] and [46].
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10 **3.3 European and international lists of seafood denomination.** In EU, the mandatory information to
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12 be provided along the fishery chain were defined since 2001 and, in 2002, each MS was obliged to
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14 standardize trade names, setting up a list of commercial designations under which seafood must be
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16 marketed within its own territory [47]. For this reason, the official list of 5 MSs were used as a model to
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18 compare the Chinese seafood names found on the products and, possibly, to suggest an implementation
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20 of the actual system of fish naming in China, starting from Cod, Salmon and Tuna species of
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22 commercial interest in EU.
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26 It was found that while all the MSs use a single term for Tuna and Salmon species, Cod can be
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28 translated in two different ways in Germany (*Kabeljau* or *Dorsch*) [48] and Italy (*Merluzzo* or *Nasello*)
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30 (Table 4). In these cases, it was necessary to took into consideration both names. On the contrary, not
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32 exactly corresponding trade names such as *Tonnetto* in Italian, *Thonine* in French, *Salmonete* in Spanish
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34 and Codling in English, were not taken into consideration.
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38 The analysis showed that France is the MS with the highest overall number of trade names for Cod,
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40 Salmon and Tuna, followed by Spain, UK, Germany and Italy (Table 1SM).
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44 Analyzing the overall SI it can be observed that only in Germany SI=1, while, in the other MSs
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46 except for Italy (SI=0.81), the SI is always higher than 1 (Fig. 3).
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49 (Figure 3 here)

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51 **3.3.1 Cod.** Fishes labeled as Cod, from a narrow sense, should be only those referable to the Genus
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53 *Gadus* spp. (*G. morhua*, *G. macrocephalus*, and *G. ogac*) [50]. However, worldwide there are several
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55 other Cod-related species that are routinely consumed, such as *Theragra chalcogramma*,
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57 *Melanogrammus aeglefinus*, *Merlangius merlangus*, *Pollachius virens* and *Merluccius* spp [51].
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In the MSs' lists the number of trade names varied from 7 in Italy to 15 in Germany while the number of species was more variable, from 5 in Spain to 20 in Italy (Tables 4 e 5). All MSs had an SI >1, except Italy (0.75) (Fig. 3).

Analyzing the assigned trade names, a variable picture emerges and besides *G. morhua*, *G. macrocephalus* and *G. ogac*, which are identified in almost all MSs as “Cod”, “Pacific cod” and “Greenland cod” respectively, all the others *Gadiformes* are differently labeled in each MS (Table 4). Interestingly, in the German, Spanish and English list trade names referable to Cod were also assigned to species belonging to Scorpaeniformes and Perciformes.

In China, the naming system for Cod seems to be extremely complicated and other species distant from a phylogenetic point of view are indistinctly labeled as Cod. In particular *Anoplopoma fimbria*, *Dissostichus eleginoides* and *D. mawsoni* are often commercialized under this name. In order to harmonize the labeling, a guideline has been issued [52], recommending that the term Cod is restricted to species of the order Gadiformes, while, if used for *A. fimbria*, *D. eleginoides* and *D. mawsoni*, the scientific name or the common name recommended by the FAO must be also reported [52]. However, the use of only one name for 614 species belonging to the Gadiformes order [53] and for the other 3 species (*A. fimbria*, *D. eleginoides* and *D. mawsoni*), does not seem accurate enough (SI=0.0016). In fact, a misuse of denominations was highlighted in recent molecular surveys on Cod and Sablefish products sold on the Chinese market [50].

In the light of the implications that mislabeling can have on the management and sustainability of the Atlantic cod stocks [54] and [55] a specific denomination should be used at least to identify the three species of Cod and all the Cod-related species most consumed.

Looking at the ASFIS list, Fishbase and the LCDFN, 6, 43 and 32 Chinese names are reported, respectively, for the 32 Cod species found in the EU MSs' lists analyzed. The ASFIS list (SI=0.18) is

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4 undoubtedly less accurate than FishBase (1.34) and LCDFN (1) (Table 2SM). Interestingly, 78% of the
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6 Chinese names found in the LCDC matched those assigned to the same species by FishBase and ASFIS
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11 3.3.2 *Salmon*. Salmon is a generic name indicating several species belonging to two Genus:
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13 *Oncorhynchus spp.* and *Salmo spp.* [56]. In the MSs's lists analyzed, the species-specific commercial
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15 designations are usually formulated using the name Salmon/*Salmon*/*Saumon*/*Salmon*/*Lachs*
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17 accompanied by the region of origin (Pacific salmon, Atlantic salmon) or by other terms (Keta salmon,
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19 King salmon, Pink Salmon) (Table 4). A minimum of 7 different trade names are used in Italy, up to a
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21 maximum of 15 in France and UK and, in general, the species taken into consideration in the lists are
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23 always the same (Table 4).
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28 A specific Chinese name was found for all the 7 species considered in the EU MSs' list in the 3
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30 international lists consulted, which, according to their respective SI (ASFIS=1, Fishbase=1.28,
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32 LCDFN=1), were all found to be accurate (Table 2SM). With the exception of *S. salar*, *O. masou* and *O.*
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34 *nerka*, the other 4 species had the same name in all the lists.
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38 Looking at the results of this study, it seems that within the Chinese territory investigated the
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40 products are generically marketed as *San Wen Yu* without any reference to a specific species. However,
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42 considering the different qualities and drawbacks associated with each species of Salmon it is necessary
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44 to make a clear distinction at least between Pacific (*Oncorhynchus spp.*) and Atlantic (*Salmo spp.*)
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46 Salmon [18]. In fact, while the 6 species of the genus *Oncorhynchus* are mostly from wild capture
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48 (except for *O. kisutch* and *O. tshawytscha*) [57] and [58], the genus *Salmo* spp. and in particular *Salmo*
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50 *salar*, which represents the species with the highest market value within this genus, is mainly from
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52 aquaculture and is cheaper than the Pacific counterpart. The market replacement of farmed Atlantic
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54 salmon for wild Pacific salmon is known to occur frequently [56], [59], and [60].
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3.3.3 *Tuna*. According to their commercial value Tunas are distinguished in Bluefin and Yellowfin.

Bluefin tunas, such as *T. thynnus* (Atlantic bluefin tuna), *T. orientalis* (Pacific bluefin tuna), *T. maccoyii* (Southern bluefin tuna) and *T. obesus* (Bigeye tuna), have high selling prices and, due to a growing demand and overfishing, their stocks have continuously decreased in the last decades [61], [62], and [63]. Among Bluefin tunas, *T. thynnus* is often replaced with other fish (as red snapper) or tuna species, because of its supply shortage (very restrictive fishing quotas) and high market value [64]. The Yellowfin tunas, *T. albacares* (Yellowfin tuna), *T. tonggol* (Longtail tuna), *T. alalunga* (albacore) and *Katsuwonus pelamis* (skipjack) are cheaper and less subjected to overfishing than Bluefin tunas [63]. Thus, it is important to make an accurate differentiation in naming and labeling of tuna species because of the significant differences between them. Species like *K. pelamis*, *T. albacares* and *T. obesus* are still under the critical point of exploitation, while *T. maccoyii*, *T. orientalis*, *T. thynnus* and *T. alalunga* are critically endangered [65]. Therefore, if these different species were all labeled just as "Tuna" it would be impossible to differentiate those at risk from the others, to have correct data from captures and to properly manage the catches.

The fish species marketed as Tuna in UK, *Tonno* in Italy, *Thon* in France, *Atun* in Spain and *Thunfisch* in Germany, are only those belonging to *Thunnus* spp., with the exception in some MSs for *Allothunnus fallai* (Spain), *Katsuwonus pelamis* (France, Germany and UK) and *Auxis rochei* (UK). Apart from Germany, where all the listed tuna species have a unique commercial designation, in the other 4 MSs species-specific trade names are defined, from a minimum of 6 in Italy to a maximum of 11 in Spain (Table 4). Also for Tuna, the trade names are usually formulated adding the geographical origin or a particular characteristic of the species (Table 1SM).

In China, the market of Japanese seafood, such as sushi and sashimi, is small but growing, especially at a high income level [45]. It is plausible that consumers that can afford this kind of expensive dish

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5 pretend detailed information about the products. In fact, the scientific denomination for Tuna products
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10 can be voluntary reported only in case of products intended for raw consumption (Table 2)

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As regard the Tuna names in Chinese, the LCDFN reports a specific name for each species (n=11) present in the EU MSs's lists, with the most accurate IS (IS=1). The ASFIS provides a Chinese name just for 5 species (IS=0,45), while FishBase reports 39 different Chinese names (IS= 3,54).

3.4 Main shortcomings of the Chinese seafood traceability system and possible implementations

In 2013 China was the country with the highest number of notifications (433 of 3205) to the Rapid Alert System for Food and Feed (RASFF) and, among those attributable to food of animal origin, 60% were referred to fishery products for the presence of heavy metals, residues of veterinary drugs or prohibited substances [10]. However, no notifications for documental non-compliances have been reported. This situation is probably due to the fact that Chinese products intended for legal exportation are produced on the basis of the strict requirements of the importing countries [66]. Thus, Chinese operators must satisfy very restrictive labeling requirements for exported products, also providing detailed information because this kind of information is always checked. However, in a recent survey [67], it was found that in some cases false documentation can allow the entrance of Chinese IUU products into the US legal market. In fact, although China has joined several international agreements on the protection of fish stocks, it remains significantly involved in IUU fishing [46] and [68].

Overall, from the analysis of the origin of our products, it seems that high-quality seafood from UE and US are increasingly exported to China [3] and [69]. However, the most part of them have probably undergone one (or more) processing step in China, even though Chinese consumers are not always aware of this. Interestingly, in parallel, a reverse flow of low-quality food products has developed from China to Western markets. Low value species such as freshwater, are no longer the product with the strongest demand in China while they are consumed by Asian communities settled in Western countries

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[70] and [71]. Several studies conducted on such products commercialized on the Italian markets found them not compliant with the European legislation in terms of seafood traceability [71], [72], [73], [74] and [75].

On the basis of the analysis of the current Chinese legislation it is clear that this country does not possess a legal framework for the management of the seafood traceability comparable to the one implemented by the EU. Although over the years China has made considerable improvements, in 2014 China's food traceability regulations were scored as "Poor" due to the lack of mandatory traceability requirements (to date is in force the national voluntary standard GB/T 22005–2009 [76]. In particular, improvements are needed for (re)processed seafood [6] and [67]. In fact, the lack of a specific regulation establishing the mandatory information that must be provided with the accompanying documents or the labels along the chain greatly affects the transparency of the seafood sector. Finally, the use of generic names can increase the chaos fostering mislabeling.

Seafood mislabelling has been reported worldwide [6], [18], [21] and [70]. It occurs when a cheaper or more readily available species is substituted for one that is more expensive, desirable or in limited supply, and represents a form of economic deception for the consumers [77]. In fact, distributors and retailers, relying on consumers' unfamiliarity with fishes and on the increasing sale of processed products, replace valuable species with similar but cheaper ones [21] and [78]. In addition to this, errors and alterations of the labels can have serious health implications [71] and represent a real threat to the sustainability of seafood supply chains [6], [16] and [79]. An appropriate labeling is also important to trace products in order to combat IUU fishing [18]. In this context, further confusion can arise from the lack of a standardized national system for seafood naming similar to those implemented at the international level. In fact, seafood products are often identified or labeled with generic and common names, which often vary across or even within Chinese provinces and regions [40], generating a

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5 situation of great uncertainty. Even when a codified system has been proposed, as in the case of Cod, it
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7 seems to be too general on the basis of the SI calculated. Similarly, identifying all the species of *Salmo*
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9 spp. and *Oncorhynchus* spp. (about 64 species) as “Salmon” and all the species of *Thunnus* spp.,
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11 *Allothunnus* spp., *Katsuwonus* spp. and *Auxis* spp. (about 14 species) as Tuna determines a very low SI
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13 (0.015 and 0.07 respectively) also for these species. In fact, a SI close to zero indicates a maximum
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15 concentration of designations and is not representative of the species diversity, which is particularly
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17 relevant for the stock status and the commercial value [80] that can be extremely different within the
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19 same genus. The need to adopt a codified naming system appears particularly urgent considering that
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21 Pollock (and Cod-related species) and Salmon were the largest illegal import from China to the US [67]
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23 and that Tuna, Cod and Salmon are among the species most frequently involved in frauds [37].
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28 *3.4.1 Possible implementations.* The importance of establishing standard seafood names is essential
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30 for many aspects [21] and [81]. First, it allows promoting an effective traceability and food safety
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32 management to which the public confidence is closely related. In fact, a convoluted or too generic
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34 naming system can leave consumers confused [81]. Second, the standardization of fish naming is a key
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36 point for what concerns effective fisheries monitoring and management, as well as the sustainability of
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38 fisheries resources [81]. In this regard, the importance of labeling improvement and standardization of
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40 seafood naming list has been highlighted also in other countries, such as Malaysia [82], Taiwan [83] and
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42 South Africa [20] and [78]. In particular, in South Africa the urgent need to define ‘acceptable market
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44 name’ on the basis of the Latin name has been stressed [20] and [78].
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50 In the light of the aforesaid issues the implementation of a traceability system capable of detailing the
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52 journey of seafood along the supply chains up to the consumers as well as providing the mechanisms for
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54 quick and thorough product recall procedures is necessary in China. Moreover, it would be desirable that
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China, taking a lead from the European model, would define specific labeling requirements for seafood in particular for what concerns the scientific and commercial denominations.

In EU, the approach used by the MSs in the assignment of the trade name is generally based on the principle “One species - One name”, which provides a unique trade name for a specific species, characterized by a Latin binomial name which is universally recognized, regardless of the language [84].

On the contrary, the use of general and ambiguous names, can lead to confusion and undesired consequences [84]. However, this approach is not always practicable and, in some cases, MSs assign a commercial designation to the whole Genus or even to the Family, most likely to simplify lists and to overcome technical and commercial problems. For example, in the case of wild caught shrimp, it is technically impossible to separate the catch by species [85]. Therefore, allocating a trade name to the entire Gender/Family can streamline certain practices both on ship board and during sale. Moreover, in some other cases, several and different trade names can be assigned to a single species probably because the MS accepts to validate the most common names used to identify that species. The different approach in establishing seafood denominations could reflect the diversity of cultural preferences in seafood consumption across the EU [86] and [87] and may represent a way to protect local productions. In fact, the geographical origin is usually added to the name of the fish to characterize the products as exotic. In this way the number of denominations is continuously growing.

Despite this unavoidable shortcomings, the approach “One-species One-name” represents the best way to ensure a fair seafood trade and should be adopted and implemented also in China. However, the creation of an official list requires the intervention of the government and of qualified staff with expertise in taxonomy of fishery products. In particular, to produce the official list of Chinese seafood trade names, the responsible authorities should take into account the 3 international lists consulted in this work and in particular the LCDFN, which seems the most accurate and reliable source compared to

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ASFIS and FishBase. In fact, the SI calculated for Cod, Tuna and Salmon, on the basis of the scientific names and commercial names available on the LCDFN is always 1.

Since 1999, the authors of the LCDFN “*attempt to collect all currently valid fish species in the world from the literatures and give each genus and species a unique Chinese name*” with the goal to create a solid base for the standardization of fish names in China, Taiwan, and Hong Kong [88]. The dictionary provides the most updated fish checklist in China, including 4,621 species and, considering that some of them may have many different Chinese names (even up to six), only the most representative names have been chosen [88]. Therefore, in order to achieve a targeted and unambiguous standardization in the process of naming, the authors have preferred to maintain the old Chinese names used for a long time even if some new ones were defined [88].

However, the implementation of a standardization system based on Latin name could be extremely difficult in practice, as already highlighted in the field of Chinese botanical medicine where has been observed that the use of botanical names in replacement of the Chinese prescription name would be extremely difficult in practice. In fact, in China, millions of people are engaged in the Herbal industry but most of the practitioners does not know botanical name [89]. The same problems could be expected in the fishing industry. In particular, technical and practical difficulties could emerge at small retail stores, such as local fish markets or fishmongers where vendors are most probably not aware of scientific denominations and fish taxonomy and probably they are not even able to understand Latin language. Thus, unfamiliarity of Chinese sellers with taxonomy and Latin language could lead paradoxically to an increase of mislabeling. Therefore, it will be necessary that Chinese authorities, in addition to standardize seafood trade names, will begin a process of training for operators by providing detailed and practical guidelines on seafood labelling. Finally, it is desirable that molecular traceability should be used at official level to support documental traceability [90].

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Conclusion

China has the potential to impact greatly on the global trade and consumption of seafood. The current preliminary study on Salmon, Tuna and Cod, chosen as the most consumed and commercialized species globally, shows that the lack of a national mandatory regulation for fishery products could seriously affect the fishing industry, consumers' protection as well as the preservation of fish stocks. It is therefore necessary that China promotes the transition from voluntary to mandatory standards and that, as soon as possible, begins a process to implement an official and unique system for seafood denominations.

Conflict of interest

The authors of this article have no conflict of interest

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Figure 1. Origin of seafood products analyzed.

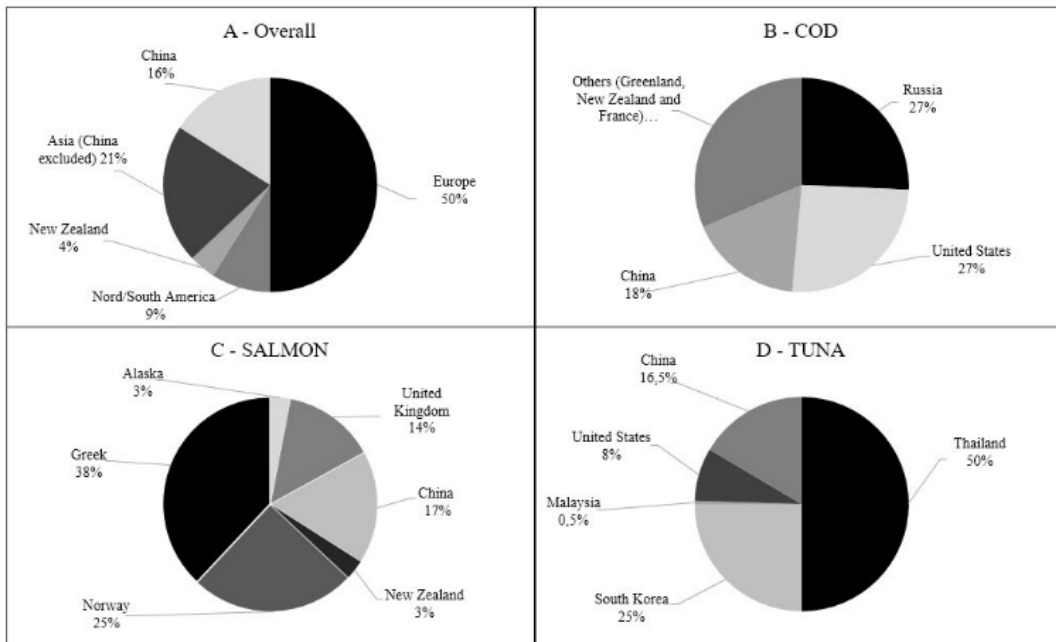
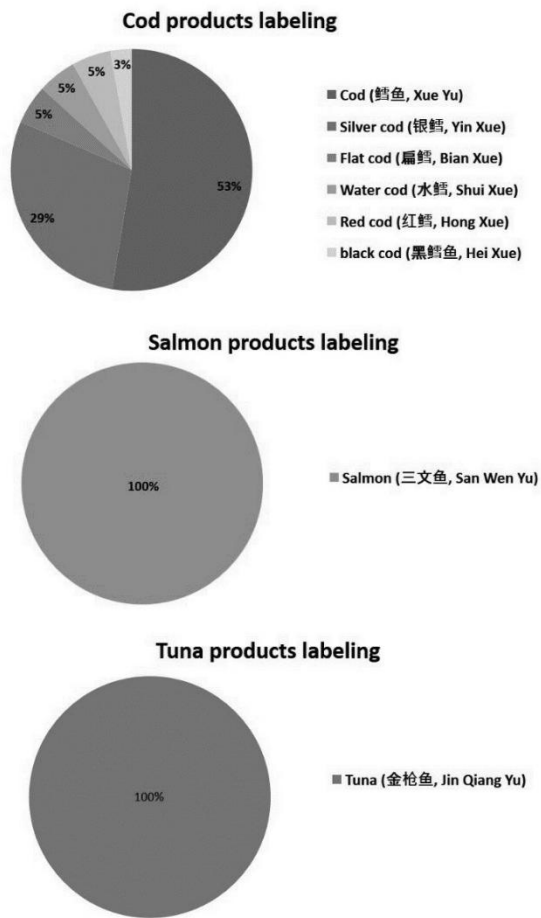


Figure 2. Chinese labelling for Cod, Salmon and Tuna products.



Figure

Figure 3. Number of species and trade names found in the Official lists of European MSs for Cod, Salmon and Tuna and the relative indexes: SI (number of trade names/number of species) and SG (number of trade names/ number of species belonging to Genus).

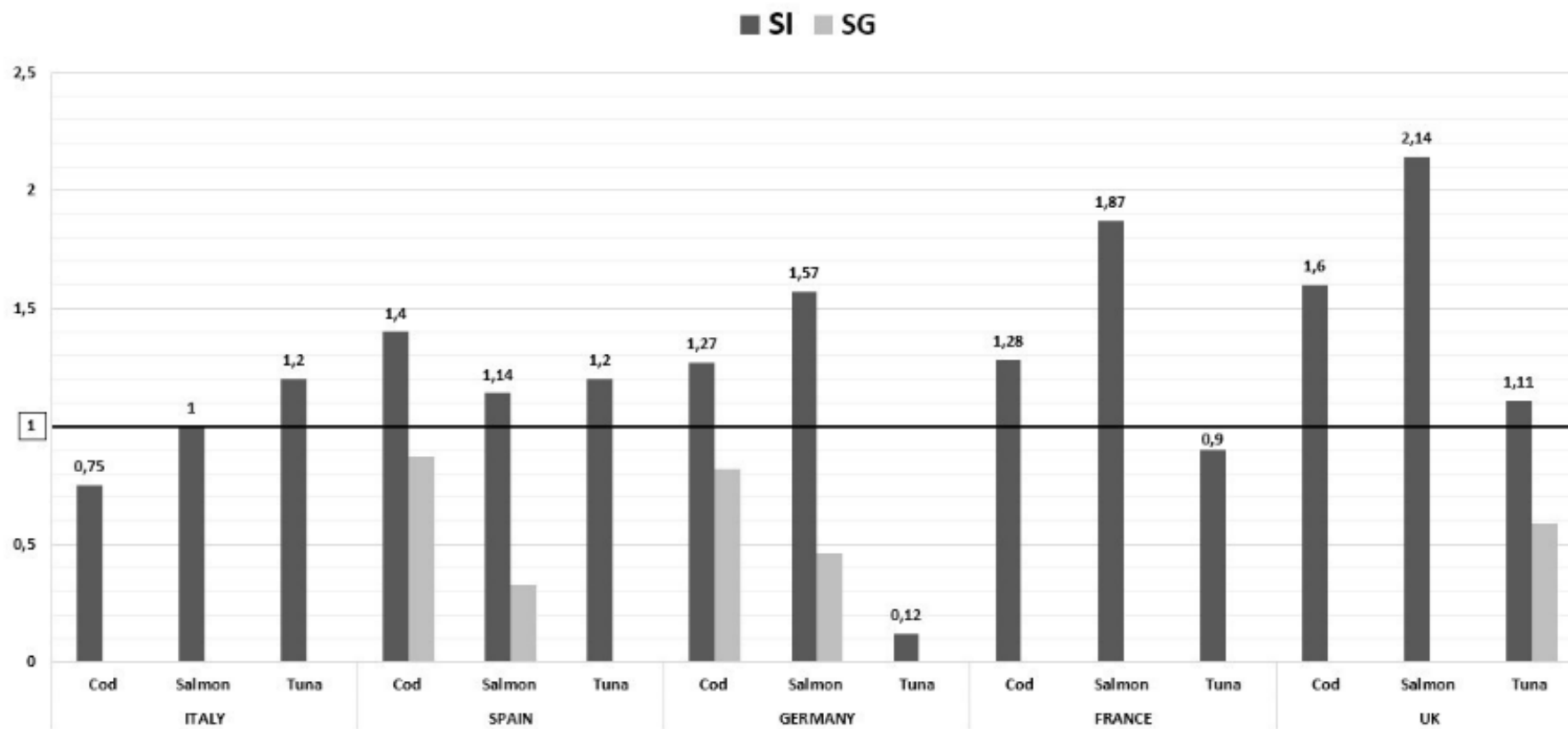


Table 1. Chinese regulations for food labeling.

Regulation and standard	Issued by	Applies to	Description	Content
Decision“Food labeling regulations” (General Order No. 123 of 2009)	General Administration of Quality Supervision, Inspection and Quarantine on changes (AQSIQ)	Food identity of food produced (sub-packaged) and distributed within the borders of the People’s Republic of China	This provision was issued according to the "Food Safety Law", "Product Quality Law", "the special provisions on Strengthening food and product safety supervision and management from the State Council", in order to strengthen the supervision and management of food identity, standardize the labeling of food identity, prevent the quality of fraud, protect the legitimate rights and interests of enterprises and consumers.	<ul style="list-style-type: none"> • Name of the food • The food origin (the city name) • The Manufacturer (name, address and contact information) • Date of production and expiration • Storage conditions • List of ingredients • Net and drained content for quantitatively-packed food • The code of standard for the product preparation • QS logo • Food production license number • Any other alert for human health protection and any other information required by some specific standards and regulations
The national food safety standards-- The general principles of the prepackaged food labels GB7718-2011	Ministry of Health	General Rules for the Labeling of Prepackaged Foods	This standard applies to the labels of pre-packaged food, provided to consumers no matter directly or not. This standard does not apply for prepackaged foods provide protection in the process of storage transportation of food storage and transportation packaging label, bulk food and is now sold.	<ul style="list-style-type: none"> • Name of the food • List of ingredients • Net Weight • Manufacturer and/or distributor (Name, address and contact information) • Date of production and expiration • Storage conditions • Food production license number • The code of the standard for the product preparation • And any other information required by some specific standards and regulations

Table 2. Chinese Standards for seafood labeling.

Type	Standard	Title	Description	The requirements for labeling
Mandatory National Standard	GB 2733-2005	Hygienic standard for fresh and frozen marine products of animal origin	This standard stimulates the fresh, frozen animal health indicators and test methods of aquatic products and the production process, packaging, marking, storage and transportation of hygienic requirements.	Prepackaged foods follow GB7718-2011
Voluntary National Standard	GB/T 18109-2011	Frozen fish	This standard specifies the requirements of frozen fish products, test methods, inspection rules, label , packaging, transport and storage. This standard applies to lead, to head, all the internal organs to or not to go to the internal organs, fit for human consumption of frozen fish products.	Prepackaged foods follow GB7718-2011 The production method and origin should also be illustrated.
Voluntary National Standard	GB/T 24403-2009	Canned Tuna	This standard stimulates the canned tuna product classification and product codes, technical requirements, test methods, inspection rule and labels , packaging, transportation, storage requirements. This standard applies to canned tuna products production, circulation and supervision and inspection	Prepackaged foods follow GB7718-2011
Water product Voluntary Professional Standard	SC/T 3117-2006	Tunas for raw consumption	The requirements of this standard specifies the raw tuna products, test methods, inspection rules, label , packaging, transportation and storage. This standard applies to the depth of the ice fresh or frozen scombridae tuna as raw materials, production of raw food products. Swordfish, swordfish section can be reference to other tuna products.	Prepackaged foods follow GB7718-2011 The scientific name, production method and capture date should be included.
Water product Voluntary Professional Standard	SC/T 3302-2010	Roasted fish fillet	The requirements of this international standard specifies the grilled fillet, test methods, inspection rules, label , packaging, transport and storage. This standard applies to ma3 mian4 cowfish, cod as raw material, through further, rinse, seasoning, drying, roasting and rolling loose manufactured products. Made of other ocean fish grilled fillet can reference implementation.	Prepackaged foods follow GB7718-2011
Commerce Voluntary Professional Standard	SB/T 10379-2012	Quick frozen prepared food	This standard stimulates the quick-frozen food modulation of terms and definitions, classification, raw materials and auxiliary materials, technical requirements, test methods, judging rule, labels , marks, packaging, transport and storage and to meet the requirements of sales and recall. This standard applies to define product production, inspection and marketing.	Prepackaged foods follow GB7718-2011

Table 3. Samples collected in this study.

Product state	Product presentation	Cod (鳕鱼, <i>Xue Yu</i>)	Salmon (三文鱼, <i>San Wen Yu</i>)	Tuna (金枪鱼, <i>Jin Qiang Yu</i>)	TOTAL
Fresh	Prepackaged	-	-	-	0
	In bulk	6	37	-	43
Frozen	Prepackaged	10	-	1	11
	In bulk	14	4	1	19
Processed	Prepackaged	8	5	14	27
	In bulk	-	-	-	0
TOTAL		38	46	16	100
Prepackaged		18	5	15	38
In bulk		20	41	1	62

Table 4. Trade names for Cod, Salmon and Tuna species adopted by Italy, Spain, France, Germany and UK.

Fish	Latin name	Italy	Spain	France	Germany	UK
Cod	<i>Anoplopoma fimbria</i>	△	Bacalao Negro de Alaska	△	△	△
	<i>Arctogadus glacialis</i>	—	—	Morue du Groënland; Morue; Cabillaud (frais ou surgelé)	—	—
	<i>Boreogadus saida</i>	—	—	Morue polaire; Morue; Cabillaud (frais ou surgelé); Morue (salée)	Polardorsch	—
	<i>Eleginus navaga</i>	—	—	Morue arctique, Morue, Cabillaud (frais ou surgelé), Morue (salée)	△	—
	<i>Eleginus gracilis</i>	—	—	Morue boréale; Morue; Cabillaud (frais ou surgelé)	△	Saffron cod
	<i>Gadus macrocephalus</i>	Merluzzo nordico	Bacalao del Pacifico; Bacalao de Alaska	Morue du Pacifique; Morue; Cabillaud (frais ou surgelé); Morue (salée)	Pazifischer Kabeljau	Cod; Pacific cod
	<i>Gadus morhua</i>	Merluzzo nordico	Bacalao	morue commune, morue, cabillaud (frais ou surgelé), morue (salée)	Dorsch	Cod; Codling
	<i>Gadus ogac</i>	Merluzzo artico	Bacalao de Groenlandia	Morue Ogac; Morue; Cabillaud (frais ou surgelé); Morue (salée)	Grönland-Kabeljau	Cod; Greenland cod
	<i>Gadus spp</i>	—	Bacalaos	—	Kabeljau	—
	<i>Macruronus magellanicus</i>	Nasello (Merluzzo) patagonico	△	△	—	△
	<i>Macruronus novaezelandiae</i>	Nasello (Merluzzo) neozelandese	△	△	△	△
	<i>Merluccius albidus</i>	Nasello (Merluzzo) atlantico	—	△	—	—
	<i>Merluccius bilinearis</i>	Nasello (Merluzzo) atlantico	△	△	△	—
	<i>Merluccius (Macruronus) capensis</i>	Nasello (Merluzzo) sudafricano	△	△	△	△
	<i>Merluccius hubbsi</i>	Nasello (Merluzzo) atlantico	△	△	△	—
	<i>Merluccius polli</i>	Nasello (Merluzzo) atlantico	△	△	—	△
	<i>Merluccius senegalensis</i>	Nasello (Merluzzo) atlantico	△	△	—	—
<i>Merluccius polylepis or Merluccius australis</i>	Nasello (Merluzzo) australe	△	△	—	—	

	<i>Merluccius gayi</i>	Nasello (Merluzzo) del Pacifico	△	△	△	—
	<i>Merluccius productus</i>	Nasello (Merluzzo) del Pacifico	△	△	△	—
	<i>Merluccius paradoxus</i>	Nasello (Merluzzo) dell'Oceano Indiano	△	△	△	△
	<i>Merluccius merluccius</i>	Nasello o Merluzzo	△	△	△	—
	<i>Mora moro</i>	△	△	△	Tiefseedorsch	—
	<i>Ophiodon elongates</i>	—	—	—	Lengdorsch	△
	<i>Paraperiscolias</i>	—	—	—	△	Blue cod
	<i>Phycis spp.</i>	—	△	—	Gabel dorsch	—
	<i>Pollachius virens</i>	Merluzzo carbonaro	△	△	△	△
	<i>Pseudophycis bachus</i>	—	△	△	Neuseeländischer Rot dorsch; Neuseeländischer Tiefseedorsch	Red cod
	<i>Salilota australis</i>	△	Brotola Criolla; Bacalao Criollo	△	Patagonischer Tiefseedorsch	—
	<i>Theragra chalcogramma</i>	Merluzzo d'Alaska; Pollack d'Alaska	△	△	△	△
	<i>Trisopterus luscus</i>	△	△	△	Franzosendorsch	△
	<i>Trisopterus minutus</i>	△	△	△	—	Poor cod
	<i>Urophycis chuss</i>	—	△	△	Roter Gabeldorsch	—
Salmon	<i>Oncorhynchus gorbuscha</i>	Salmone rosa	Salmon rosado	Saumon rose du Pacifique (pink)	Buckellachs	Pacific salmon or Pink salmon
	<i>Oncorhynchus keta</i>	Salmone keta	Salmon keta	Saumon kéta du Pacifique (chum)	Keta-Lachs	Pacific salmon or Chum salmon or Keta salmon
	<i>Oncorhynchus kisutch</i>	Salmone argentato	Salmon plateado	Saumon argenté du Pacifique (coho)	Coho-Lachs; Silberlachs	Pacific salmon; Coho salmon; Medium red salmon; Silver Salmon
	<i>Oncorhynchus masou</i>	Salmone giapponese	—	Saumon japonais du Pacifique (masou)	Masu-Lachs	Pacific salmon; Cherry salmon
	<i>Oncorhynchus nerka</i>	Salmone rosso	Salmon rojo	Saumon rouge du Pacifique (sockeye)	Rotlachs	Pacific salmon; Red salmon; Sockeye salmon
	<i>Oncorhynchus hawytsha</i>	Salmone reale	Salmon real	Saumon royal du Pacifique (king)	Königslachs	Pacific salmon; Chinook salmon; King salmon; Spring salmon

	<i>Oncorhynchus spp.</i>	—	Salmones del Pacifico	—	Lachs; Pazifischer Lachs; Wildlachs	—
	<i>Salmo salar</i>	Salmone	Salmon Atlantico; Salmón	Saumon atlantique; Saumon	Atlantischer Lachs; Lachs; Wildlachs	Atlantic salmon; Salmon
Tuna	<i>Allothunnus fallai</i>	—	AtunLanzon; Atun	—	—	—
	<i>Auxis rochei</i>	△	△	△	△	Bullet tuna; Melva
	<i>Katsuwonus pelamis</i>	△	△	Bonite à ventre rayé; Listao; Thon (conserves)	Thunfisch	Skipjack tuna; Tuna
	<i>Thunnus albacares</i>	Tonno a pinne gialle	Rabil/Atun de AletaAmarilla	Albacore; Thon albacore	Thunfisch	Yellowfin tuna
	<i>Thunnus alalunga</i>	△	Atunblanco; Bonito del Norte; Albacora	Germon; Thon germon; Thon blanc	Thunfisch	Albacore tuna
	<i>Thunnus atlanticus</i>	—	Atun de Aleta Negra; Atun	Thon à nageoires noires	Thunfisch	—
	<i>Thunnus maccoyii</i>	Tonno australe	Atun del sur; Atun	Thon rouge du sud	Thunfisch	Southern bluefin tuna
	<i>Thunnus obesus</i>	Tonno obeso	Patudo; Atun de ojo Grande; Patudo del Atlantico	Thon obese; Thon patudo	Thunfisch	Bigeye tuna
	<i>Thunnus orientalis</i>	—	Atun del Pacifico; Atun	—	—	Oriental bluefin tuna; Pacific bluefin
	<i>Thunnus thynnus</i>	Tonno; Tonno rosso	Atunrojo; Atun de Aletaazul	Thon rouge	Thunfisch	Bluefin tuna
	<i>Thunnus tonggol</i>	Tonno indopacifico	AtunTongol; Tongol; Atun	—	Thunfisch	—
	<i>Thunnus spp.</i>	—	—	—	—	Tuna; Tunny

—no mention

△the trade name is present in the list but different from Salmon/Cod/Tuna.

Table 1SM. Number of species and trade names found in the Official lists of European MSs for Cod, Salmon and Tuna and the relative indexes: Is (number of trade names/number of species) and Ig (number of trade names/ number of species belonging to Genus).

Species	Italy			Spain			Germany			France			UK		
	n° TN	n° SP	Index	n° TN	n° SP	Index	n° TN	n° SP	Index	n° TN	n° SP	Index	n° TN	n° SP	Index
Cod	15	20	Is:0.75	7	5 (1G:3)	Is: 1.40 Ig: 0.87	14	11 (2G:3-3)	Is:1.27 Ig: 0.82	9	7	Is:1.28	7	6	Is:1.16
Salmon	7	7	Is:1	8	7 (1G:17)	Is: 1.14 Ig: 0.33	11	7 (1G:17)	Is:1.57 Ig: 0.46	15	8	Is:1.87	15	7	Is:2.14
Tuna	6	5	Is:1.2	11	9	Is: 0.81	1	8	Is:0.12	9	10	Is:0.9	10	9 (1G:8)	Is:1.11 Ig:0.59
TOTAL	26	32	Is:0.81	32	20 (2G:20)	Is: 1.60 Ig:0.80	26	26 (3G:23)	Is:1.0 Ig:0.53	33	25	Is:1.32	32	22 (1G:8)	Is:1.45 Ig:1.06

TN, Trade names; SP, species

Table 2SM. Number of Chinese names for Cod, Salmon and Tuna species (reported in the EU MSs's official lists) found in ASFIS list, Fishbase and the Latin-Chinese Dictionary of Fish Name and the respective indexes Is (number of Chinese seafood names/total number species in EU MSs's lists).

SPECIES	Total n° of species in EU MSs's lists	ASFIS		FISHBASE		Latin-Chinese Dictionary of Fish Name (LCDFN)	
		n° of Chinese names	Is	n° of Chinese names	Is	n° of Chinese names	Is
Cod	32	6	0.18	43	1.34	32	1
Salmon	7	7	1	9	1.28	7	1
Tuna	11	5	0.45	39	3.54	11	1
TOTAL	50	18	0.36	91	1.82	50	1