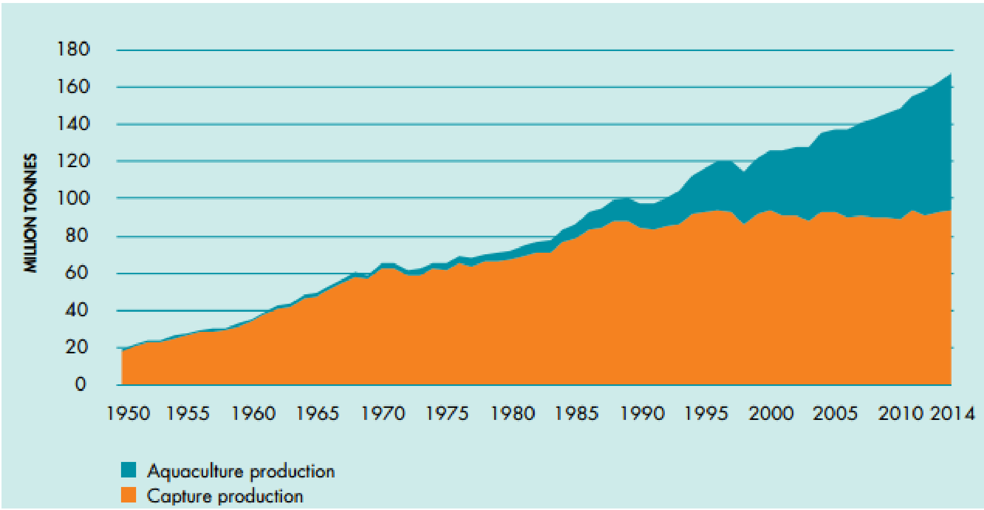
Authent-Net Commodity Status Report

Commodity: seafood

State of the Art of the commodity:

1. Market Share of Commodity:

The total worldwide seafood production considering both fisheries and aquaculture in 2014 was 167.2 million tonnes, and has increased steadily from 145.9 million tonnes in 2009.[1] The growth is mainly driven by increased production in the aquaculture sector, which has increased by 32% over the aforementioned six-year period, with traditional capture fisheries have only increased by 3.5%for the same period. Estimated total production for 2015 is 171 million tonnes, with 93.5 tonnes originating from wild capture fisheries and 77.5 million tonnes from aquaculture; and forecasts for 2016 are predicting total production of 174.1 million tonnes where 92.7 million tonnes come from wild capture and 81.4 million tonnes from aquaculture.[2] Despite a robust growth in aquaculture, traditional fisheries remain the largest sector by volume, on the other hand the aquaculture sector is overtaking capture fisheries as the min producer of seafood for human consumption.



World capture fisheries and aquaculture production

A total of 71% of the world's seafood production originates from Asia, with the greater part being located in Southeast Asia. China is the by far the largest producing country in the world contributing 37%, while other major producers in the region are Indonesia, Japan, Viet Nam and India. Outside of Asia, key producers include the US, Russia, Peru and Norway.

2. Process Specificity of commodity (production/welfare):

The majority of fish products, 87% in 2014, are used for direct human consumption, with the rest mainly going to the production of fishmeal, fish oil and as raw material for feed in the aquaculture sector.

[1] FAO 2016. *The State of World Fisheries and Aquaculture 2016: Contributing to food security and nutrition for all*. Rome. 200 pp.

[2] FAO Food Outlook October 2016

Fish for human consumption is processed and made available in a variety of ways, but is mainly fresh, chilled or frozen, or in some way cured (mainly salted, dried or smoked).

There has been an increasing demand for utilization of rest raw material from fisheries, both for edible and non-edible uses. Rest raw materials include offal, heads, frames and waste cuts and can have high nutritional values. Previously these were either used for silage and fishmeal or simply discarded, but new technologies and increased demand have opened up new markets, thereby decreasing waste from fish production.

3. Trade of Commodity:

Fish is the single-most traded (across borders) food commodity in the world. Around 36% of the total seafood production is destined for export, if counted by live weight, which in 2014 equalled roughly US$148 billion.

According to the latest forecasts, international trade in fish and fishery products will remain steady, in terms of volumes in 2016 (60 million tonnes). Prices of seafood products have been unstable during 2016, which makes it difficult to predict the value of export flows, but the most recent forecasts are expecting the value to increase by over 4% between 2015 and 2016 from $134,1 billion to $140 billion, which will though be well below the 2014 high of $148.3 billion.

WORLD FISH MARKET AT A GLANCE

	2014	2015 *estim.*	2016 *f'cast*	Change: 2016 over 2015
	million tonnes			%
WORLD BALANCE				
Production	**167.2**	**171.0**	**174.1**	**1.8**
Capture fisheries	93.4	93.5	92.7	-0.9
Aquaculture	73.8	77.5	81.4	5.0
Trade value (exports USD billion)	**148.3**	**134.1**	**140.0**	**4.4**
Trade volume (live weight)	**60.0**	**59.9**	**60.0**	**0.2**
Total utilization	**167.2**	**171.0**	**174.1**	**1.8**
Food	146.3	149.4	152.8	2.3
Feed	15.8	16.5	16.2	-1.8
Other uses	5.1	5.1	5.1	0.0
SUPPLY AND DEMAND INDICATORS				
Per caput food consumption:				
Food fish (kg/yr)	20.1	20.3	20.5	1.1
From capture fisheries (kg/year)	10.0	9.8	9.6	-1.8
From aquaculture (kg/year)	10.1	10.5	10.9	3.9

FAO FISH PRICE INDEX (2002-2004=100)	2014	2015	2016 *Jan-Jun*	Change: Jan-Jun 2016 over Jan-Jun 2015 %
	157	142	143	-1.6

Source: FAO Fish Price Index: Norwegian Seafood Council (NSC)
Totals may not add up due to rounding

World fish market at a glance according to FAO food Outlook report from October 2016

Measured in value, major exporting countries include China, Thailand, Norway and Viet Nam, with the latter showing strong growth alongside India. The majority of exports from developed countries is destined towards other developed countries, but an increasing amount has been exported to developing countries over the last few decades as well. This increase is partly due to new consumer patterns in growing economies, but also due to outsourcing of processing to countries with lower production costs. Among exporters, suppliers in Asia are expected to incur strong declines in the value of their exports, especially China, the Philippines and Thailand. Only Vietnam look set to see the value of fish exports rise. The value of fish exports is expected to decrease for most countries in Latin America and the Caribbean, with the exception of Argentina and Brazil, which have regained competitiveness. In Europe, the diversification into new markets, should support a recovery in Norway's fish earnings from the fall incurred in 2015, following the embargo introduced by the Russian Federation.

Japan and the US are the largest single importers of fishery products alongside the EU, with the three responsible for roughly 57% of the total global import. However, the EU has considerable interregional differences. Traditional importers such as Canada, the United States, the EU and Japan are anticipated to face lower fish import bills in 2016. These are also expected to decline in emerging economies such as Brazil, partly reflecting the expected negative impact of the depreciating currency on the country's purchases.

Key KNOWN Authenticity Issues with this commodity (links):

1. Substitution

Species substitution

The ongoing growth in trade and consumption of fish has led to an increase potential for species substitution or mislabelling. This fraudulent practice can have several harmful consequences. For example, conservation and management programs can be negatively affected when endangered species are mislabelled. Alternatively, mislabelling can expose consumers to health risks associated with certain species such as allergens or toxins. However, the incentive for fish species substitution is generally financial, where species of lower quality are mislabelled as a higher-quality species that fetch a higher market price. In any case, incidences of species substitution can lead to consumer mistrust and confusion which in turn can lead to general avoidance of fish products.

Numerus DNA-based techniques have been applied to detect commercial species substitution, including traditional sequencing, FINS (forensically informative nucleotide sequencing), RFLP (restriction length polymorphism), RAPD (random amplified polymorphic DNA), SSCP (single-stranded conformational polymorphism), AFLP (amplified fragment length polymorphism), species specific multiplex PCR and real time PCR. Each of these methods has its advantages and disadvantages and methods are generally select by the quality of the starting material (degree of processing) and the number of species that must be differentiated.
Traceability tools and mass balance calculations are also being applied to detect species substitution fraud. Initial detection via such traceability is then usually confirmed by DNA-based techniques

2. Addition of substance X

Salt
The addition of salt at low concentration affect the water binding ability of muscle proteins, and thus salt has mainly be used to increase weight of fish product (addition of water). Added salt content can be detected using standardised chemical assays.

Benzoic acid
Pelagic fish can be immersed into benzoic acid solution, a preservative, to increase shelf life of marinated products. Addition of benzoic acid can be detected using standardised chemical assays.

Citric acid, ascorbic acid and Erythorbic acid
Citric acid, ascorbic acid and Erythorbic acid can be added to seafood as a preservative and to maintain white colour of whitefish products. This means that they can also be used to "fake" freshness of seafood products. Addition of citric acid, ascorbic acid and Erythorbic acid can be detected using standardised chemical assays.

Carbon monoxide
Carbon monoxide can be added to seafood in order to maintain red colour of tuna meat. Addition of carbon monoxide can be detected using standardised chemical assays.

Injection of vegetable protein
Injection of vegetable protein can be applied to incorporate additional water into the fish muscle, and hence increase weight. Addition of vegetable protein can be detected using standardised chemical assays.

Phosphates
Phosphate can be added to seafood to increase the product weight by incorporating additional water into the fish muscle. It can also be added to inhibit negative quality changes occurring during storage. Phosphates can be detected using standardised chemical assays.

3. Process/production/welfare deception

Frozen sold as fresh
Seafood products that have been frozen and then later thawed are often sold as fresh, without labelling accordingly. Fresh seafood is generally more expensive than frozen, which provides incentives to fraudulently claim that it is fresh. Labelling laws require "previously frozen" products to be labelled as such. Frozen seafood sold as fresh can be detected using NIR and other enzymatic methods.

Geographical origin
Seafood products are often sold with falsified information on geographical origin. Fish coming from unsustainably harvested stocks, illegally caught fish (IUU) and any examples where geographical location can have effect on price is an incentive to falsify information on origin. Falsifying labels of individual producers that have strong market presence or eco-labelling (as well as labelling claiming other favourable attributes) are another manifestation of this problem.

To determine the geographic origin of seafood there are several methods that can be applied:

Genetic methods, such as microsatellite and SNPs, can in some cases distinguish between different geographical stocks of the same species. Otolith microchemical analysis is used to characterize movements, and natal origin of fish. The concentrations of elements and isotopes in otoliths are compared to those in the water in which the fish inhabits in order to identify where it has been. The most effective way for initial detection of this type of fraud is to use traceability and documentation, which are for the most parts a requirement when importing and trading fish within the EU. The application of these traceability data can though be enhanced to facilitate detection of food fraud.

Inconstancies between amounts bought and sold
Illegally caught fish (IUU), species substitution, addition of substances and other such fraudulent acts do usually result in inconsistencies between amount bought and sold. Detection of this is primarily facilitated by strict traceability and documentation requirements within the EU. Catches, landings, trade of raw material, transhipment and more data is required to be documented. The fraud can therefore in most cases be determined by output-/input analysis

Product labelled with ambiguous/vernacular name
Products are in some cases labelled with ambiguous names that consumers do not know and cannot connect with the "common name". Labelling regulations within the EU require producers to use common name and scientific name (Latin name), but this is in some cases being falsified. This kind of fraud can be detected using same methods as for species substitution.

Water injection/overglazing to increase weight
Adding water to the product using injection or excessive glazing is a common way of selling water as more expensive fish tissue. Water and/or brine injection can be determined by analysing the proximate composition of the product, especially water content. Overglazing can be determined by the weight difference before and after thawing of the product. Glazing content can also be determined by direct analyse of the glaze according to the Codex method without thawing the product.

Not disclosed whether farmed or wild caught
EU labelling laws require producers to clearly state whether the seafood is farmed or wild caught. In most cases the wild capture fish is more expensive (this is though not absolute). Analysis of proximate composition and texture can be performed in order to determine whether fish is wild or farmed.

(Possibly listed in most common to least common type of known fraud with regards to this commodity) – Needs to link to FI terms?

Existing relevant information on methods:

The following standards are approved by the Association of Agricultural Chemists (AOAC International), the European Committee for Standardization (CEN) or are currently used as internal validated and accredited methods.

ADDITIVES

Benzoic acid and sorbic acid detected by Gas Chromatographic method – AOAC 983.16
http://www.eoma.aoac.org/methods/info.asp?ID=9379
N-Nitrosamines in Minced Fish–Meat and Surimi–Meat Frankfurters detected by Gas Chromatographic-Thermal Energy Analyzer Method - AOAC 991.28
http://www.eoma.aoac.org/methods/info.asp?ID=16655

WEIGHT

Fish Flesh Content (FFC) in Frozen Coated Fish Products by gravimetric method - AOAC 996.15
http://www.eoma.aoac.org/methods/info.asp?ID=19545
Net contents of frozen seafoods by gravimetric method – AOAC 963.18
http://www.eoma.aoac.org/methods/info.asp?ID=19528

IDENTIFICATION OF FISH SPECIES

Identification of fish species by Starch Gel-Zone Electrophoresis Method – AOAC 962.15
http://www.eoma.aoac.org/methods/info.asp?ID=20089
Identification of fish species by Acrylamide Disc Electrophoresis Method – AOAC 967.14
http://www.eoma.aoac.org/methods/info.asp?ID=20106
Identification of fish species by Thin-Layer Polyacrylamide Gel Isoelectric Focusing Method – AOAC 980.16
http://www.eoma.aoac.org/methods/info.asp?ID=20140
Identification of fish species by Cellulose Acetate Strip Method – AOAC 970.32
http://www.eoma.aoac.org/methods/info.asp?ID=20157

NATIONAL DATABASES FOR GENOMIC AND PROTEOMIC SPECIES IDENTIFICATION

Ittiobase – created by a National Research Laboratory (IZSVE)
http://90.147.123.23/ittiobase/

IDENTIFICATION OF THAWED FISH

Distinction of fresh and thawed fish by a validated histologic method, accredited by the Italian accreditation body (ACCREDIA) that is a member of the European Accreditation (EA)
Microscopical freezing alterations/Histologic analysis of fish muscle – MI 10DG136 rev 2/1 2016
http://www.accredia.it/accredia_labsearch.jsp?ID_LINK=293&area=7&dipartimento=L,S&desc=Laboratori&&&&
http://www.ncbi.nlm.nih.gov/pubmed/22856584

FISH FRESHNESS

Detection of Trimethylamine nitrogen in seafood by colorimetric method – AOAC 971.14
http://www.aoacofficialmethod.org/index.php?main_page=product_info&cPath=1&products_id=976

IDENTIFICATION OF IRRADIATED FISH

Foodstuffs. DNA comet assay for the detection of irradiated foodstuffs. Screening method – EN 13784:2002
http://shop.bsigroup.com/ProductDetail/?pid=000000000030014688

Species substitution

FINS (forensically informative nucleotide sequencing)

Bartlett SE, Davidson WS. 1992. FINS (forensically informative nucleotide sequencing): a procedure for identifying the animal origin of biological specimens. Bio Tech 12(3): 408–11.

RFLP (restriction length polymorphism)

Liu ZJ, Cordes JF. 2004. DNA marker technologies and their applications in aquaculture genetics. Aquaculture 238:1–37.

RAPD (random amplified polymorphic DNA)

Ramella MS, Kroth MA, Tagliari C, Arisi ACM. 2005. Optimization of random amplified polymorphic DNA protocol for molecular identification of Lophius gastrophysus. Cienc Tecnol Aliment Campinas 25(4):733–5.

SSCP (single-stranded conformational polymorphism)

Rehbein H, Kress G, Schmidt T. 1997. Application of PCR-SSCP to species identification of fishery products. J Sci Food Agric 74:35–41.

AFLP (amplified fragment length polymorphism)

Liu ZJ, Cordes JF. 2004. DNA marker technologies and their applications in aquaculture genetics. Aquaculture 238:1–37.

Online resources:

Fish Barcode of Life (FISHBOL) - http://www.fishbol.org/

FishTrace Database - http://www.fishtrace.org

Genetics for Identification of Fish Origin - http://fishgen.jrc.it/welcome.php3

Regulatory Fish Encyclopedia (RFE) - http://www.cfsan.fda.gov/~frf/rfe0.html

Labelfish starndar operating procedures(SOP) - http://labelfish.eu/noticia/labelfish-standard-operating-procedure/

Citric acid
Citric Acid Assay Kit, Cat. No. 10 139 076 035 (enzymatic method)

Carbon monoxide
Anderson, C. R. and W.-H. Wu (2005). "Analysis of Carbon Monoxide in Commercially Treated Tuna (Thunnus spp.) and Mahi-Mahi (Coryphaena hippurus) by Gas Chromatography/Mass Spectrometry." Journal of Agricultural and Food Chemistry 53(18): 7019-7023.

Injection of vegetable protein
Amino acid composition: ISO 13903:2005. "Determination of amino acids content". Geneva, Switzerland: The International Organization for Standardization.

Water content: ISO 6945:1993. "Determination of moisture and other volatile matter content." Geneva, Switzerland: The International Organization for Standardization.

Phosphate
Nguyen, M. V., J. O. Jonsson, G. Thorkelsson, S. Arason, A. Gudmundsdottir and K. A. Thorarinsdottir (2012). "Quantitative and qualitative changes in added phosphates in cod (Gadus morhua) during salting, storage and rehydration." LWT - Food Science and Technology 47(1): 126-132.

Frozen-thawed fish marketed as fresh fish
Uddin, M., E. Okazaki, S. Turza, Y. Yumiko, M. Tanaka and Y. Fukuda (2005). "Non-destructive Visible/NIR Spectroscopy for Differentiation of Fresh and Frozen-thawed Fish." Journal of food science 70(8): c506-c510.

Rehbein, H. and S. Cakli (2000). "The lysosomal enzyme activities of fresh, cooled, frozen and smoked salmon fish (Onchorhyncus keta and Salmo salar)." Turkish J. Vet Animal Sci 24: 103-108.

Karoui, R., E. Thomas and E. Dufour (2006). "Utilization of a rapid technique based on front-face fluroescence spectroscopy for differentiating between fresh and frozen-thawed fish fillets." Food Research International 39: 349-355

Foucat, L., R. Taylor, R. Labas and J. P. Renou (2001). "Characterization of frozen fish by NMR imaging and histology." Am Lab 33(38-43).

Kitamikado, M., C. Yuan and R. Ueno (1990). "An enzymatic method designed to differentiate between fresh and frozen-thawed fish." J Food Sci 55: 74-76.

Water injection/overglazing to increase weight
Water content: (ISO 6466:1993. "Determination of moisture and other volatile matter content (6496)." Geneva, Switzerland: The International Organization for Standardization.); drip loss (weight loss during thawing); water holding capacity (Eide, O., T. Borresen and T. Strom (1982). "Minced fish production from capelin (Mallotus villosus) A new method for gutting, skinning and removal of fat from small fatty fish species." Journal of Food Science 47: 347-349); weighing of glaze (Codex alimentarius 191-195).

Official Bodies/ Countries involved in control funding of this commodity:

list of organisations that are involved in funding authenticity research for this commodity

International funding:

- European Commission - Research and Innovation (http://ec.europa.eu/research/index.cfm)

Nordic funding:

- Working Group for Fisheries (AG-Fisk) (http://www.norden.org/en/nordic-council-of-ministers/council-of-ministers/nordic-council-of-ministers-for-fisheries-and-aquaculture-agriculture-food-and-forestry-mr-fjls/institutions-co-operative-bodies-working-groups-and-projects/working-group-for-fisheries-ag-fisk).
- NORA - Nordisk Atlantsamarbejde (Nordic Atlantic Cooperation) (http://www.nora.fo/en/frontpageuk/)
- Nordic Innovation (http://www.nordicinnovation.org/en-GB/)

UK funding

- Department for Environment, Food and Rural Affairs (Defra) - https://www.gov.uk/government/organisations/department-for-environment-food-rural-affairs
- Food standards agency - https://www.food.gov.uk/
- Marine Scotland - http://www.gov.scot/Topics/marine

Norwegian funding

- Fiskeri- og Havbruksnæringens Forskningsfond, FHF (The Norwegian Seafood Research Fund)
- Norges Forskningsråd (The Research Council of Norway)

Iceland

- RANNIS Rannsóknamiðstöð Íslands (The Icelandic Centre for Research).
- AVS Aukið virði sjávarfangs (R&D Fund of Ministry of Fisheries and Agriculture in Iceland).

France

- DGCCRF / DGDDI: SCL – laboratoire de Marseille LABO13@scl.finances.gouv.fr Official control of inspecting food additives, authenticity, labelling, production mode, nutritional aspects and contaminants level.
- Ministère de l'Agriculture, de l'Agroalimentaire et de la forêt - DGAL : http://agriculture.gouv.fr/mots-cl%C3%A9s/dgal: Monitoring and researching food contaminants, persistent organic pollutants (dioxins, PCBs), heavy metals (lead, cadmium, mercury) and phytosanitary products (chlordecone) etc.
- Ministère des Affaires sociales et de la Santé: ANSES http://social-sante.gouv.fr/ministere/acteurs/agences-et-operateurs/article/anses-agence-nationale-de-securite-sanitaire-de-l-alimentation-de-l monitoring and researching for food safety and risks evaluation, such as histamine levels in fish products, presence of nematodes etc.
- CIRAD: recherche agronomique pour le développement: http://www.cirad.fr/nos-recherches/resultats-de-recherche/%28themes%29/peche-et-aquaculture working on determination of fish origin by DNA analysis of bacteria profile located on fish skin.

Spain

- Ministry of Agriculture, Food and Environment (MAGRAMA): http://www.magrama.gob.es
- Producers' organisations that are involved in traceability and research i.e. AECOC - http://www.aecoc.es/?id=146&plantilla=11&target=Men%FA%3ASectores+de+actividad and ANFACO CECOPESCA - http://www.anfaco.es/es/index.php

Italy

- Ministry of Agriculture, food and forests (MIPAAF) – General Management for Sea Fishery and Aquaculture https://www.politicheagricole.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/7486
- National Institutes that collaborate with MIPAAF:
- Institute for Economic Research in Fishery and Aquaculture (IREPA) http://www.irepa.org/
- Council for Agricultural Research and Analysis of Agricultural Economy (CREA) http://www.crea.gov.it/
-National Association of Fish companies (ASSOITTICA) http://www.assoittica.it/

Gaps:

- Lack of easy-to-use traceability software that allows for automated data entry and communication between systems.

- National and international databases of seafood fraud incidents cataloguing the scope and details of seafood fraud.

- Harmonize the use of analytical authentication methods for the testing of seafood (could for example include isotopic ratios database).

- Harmonized databases on chemical contents and nutritional components taking into consideration geographic-, maturity-, seasonal components.

- Improved methods for speciation of fish in fish products (such as surimi and other products where speciation is complicated).

- Lack of official methods to distinguish farmed and caught fish.

- Lack of methods to distinguish fresh from thawed cephalopods and crustaceans.

- Lack of methods to detect H_2O_2 treatment in seafood products.

- Harmonize naming conventions in seafood labelling.

- validated methods to detect geographic origin.

List of known gaps in Food Authenticity Research in this commodity.