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Tuna: fish and fisheries, markets and sustainability

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Context of the report

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It has been elaborated through a review of the scientific and grey literature, as well as interviews with numerous experts and stakeholders at the global, regional and national level.

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List of acronyms

ACP	Africa, Caribbean and Pacific
AGOA	African Growth and Opportunity Act
BF	Bluefin Tuna
CCBST	Commission for the Conservation of Southern Bluefin Tuna
CMM	Conservation and Management Measure
EBA	Everything But Arms
EFSA	European Food Safety Authority
EII	Earth Island Institute
EPA	Economic Partnership Agreement
EU	European Union
EEZ	Exclusive Economic Zone
FAD	Fish-Aggregating Device
FAO	United Nations Food and Agriculture Organization
FOS	Friend of the Sea
FTA	Free Trade Agreement
GRT	Gross Registered Tonnage
GSP	Generalized System of Preferences
IATTC	Inter-American Tropical Tuna Commission
HACCP	Hazard Analysis and Critical Control Point
ICCAT	International Commission for the Conservation of Atlantic Tunas
IEPA	Interim Economic Partnership Agreement
ILO	International Labor Organization
IOTC	Indian Ocean Tuna Commission
IPNLF	International Pole and Line Foundation
ISSF	International Sustainable Seafood Foundation
JFA	Japan Fisheries Authority

LDCs	Least Developed Countries
MFN	Most Favored Nation
MMPA	Marine Mammal Protection Act
MSC	Marine Stewardship Council
MSY	Maximum Sustainable Yield
NGO	Non-Governmental Organization
NOAA	National Oceanic and Atmospheric Administration
NTR	Normal Trade Relations
OPRT	Organization for the Promotion of Responsible Tuna Fisheries
PNG	Papua New Guinea
SAC	Scientific Advisory Committee
SIDS	Small Island Developing States
TAC	Total Allowable Catches
TUF	Thai Union Frozen Food
ULT	Ultra Low Temperature
VMS	Vessel Monitoring System
WCPFC	Western and Central Pacific Fisheries Commission
WCPO	Western and Central Pacific Ocean
WWF	World Wildlife Fund

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1. Introduction: the place of the tuna sector in the seafood industry

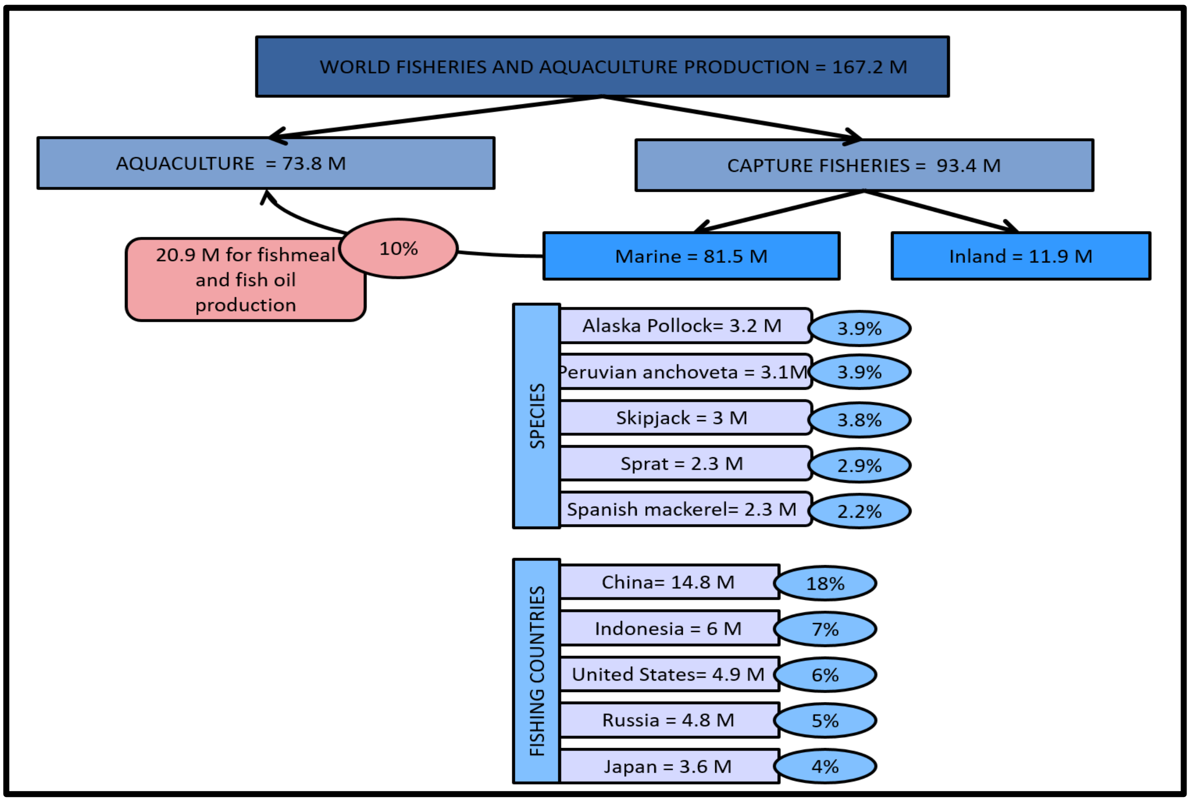
1.1 The global seafood industry[1]

1.1.1 Supply increasingly dependent on aquaculture

For fifty years, global fisheries production has been steadily increasing. While capture fisheries peaked in the 1990s and have since levelled off, aquaculture production has seen significant growth. In 2014, the contribution of the aquaculture sector to fish supply for human consumption for the first time exceeded supply from wild-caught fish sector (FAO 2016a). This growth in aquaculture production is driven by China, which accounts for 60% of world production (FAO, 2016b).

In 2014, capture and aquaculture production stood at 167 million tonnes, 44% of which derived from aquaculture (FAO, 2016b) (Figure 1). Capture fisheries, mainly marine catches, totalled some 93 million tonnes (FAO 2016a).

Figure 1: World fisheries and aquaculture production in 2014 (Source: M. Lecomte, based on FAO, 2016b).



[1]Seafood includes fish, cephalopods, shellfish (molluscs and crustaceans) as well as seaweeds and marine plants.

For the first time since 1998, the Peruvian anchoveta no longer ranked as the top species caught (Figure 1). The Alaska pollock accounted for the highest production, followed by the Peruvian anchoveta, skipjack tuna, sprat and Spanish mackerel (FAO, 2016b). These five species represent 17% of world marine catches. In 2014, the catches of four species groups with high commercial value (tunas, lobsters, shrimps and cephalopods) reached record levels (7,7 million for tunas, 160,000 tonnes for American lobster, 3.5 million tonnes for shrimps and 4.8 million tonnes for cephalopods) (FAO, 2016b).

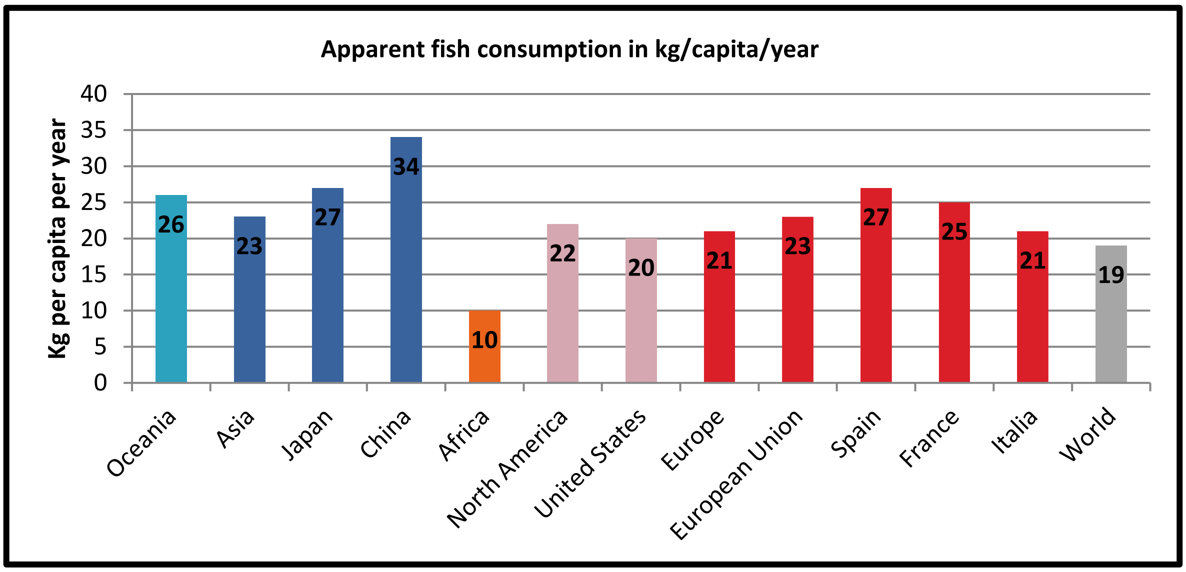
Overall, the status of the world's marine fish stocks has not improved. The share of sustainably fished stocks declined from 90% in 1974 to 68.6% in 2013 (FAO, 2016b). Currently, 31.4% of marine fish stocks are fished at a biologically unsustainable level (FAO, 2016b). The stocks of the ten most-productive species are now fully fished with a very limited potential for increases in production (FAO, 2016b). This means that world fish production is highly dependent on the world's aquaculture production.

1.1.2 Global consumption of fish and fisheries products on the rise

Overall, 87% of world fish production is for direct human consumption (FAO, 2016b). The remaining 21 million tonnes are mostly used by the fishmeal industry (FAO, 2016b).

At the global level, fish consumption has more than doubled over recent decades, rising from an average 9.9 kg per capita per year (kg/cap/year) in the 1960s to 20.1 kg in 2014 (including 9.5 kg from capture fishing) (FAO, 2016a; GLOBEFISH, 2016). This increase is partly linked to the sharp rise in per capita fish consumption in developing countries (from 5.2 kg in 1961 to 17.8 kg in 2010), although the highest levels of consumption are still found in developed countries (23 kg in 2013) (FAO, 2014; FAO, 2016b). According to the model developed by the world bank, the total fish production will be 186 million tons in 2030, with 62% of food fish produced by aquaculture by 2030, whereas the total fish consumption is estimated at 151 million tons in 2030 (World Bank 2013). Figure 2 shows per capita fish consumption in various countries and groups of countries. Oceania has the highest fish consumption of all continents, followed by Asia.

Figure 2: Apparent fish consumption in kg/capita/year (Source: FAO/OECD, 2015; Lem, 2014)

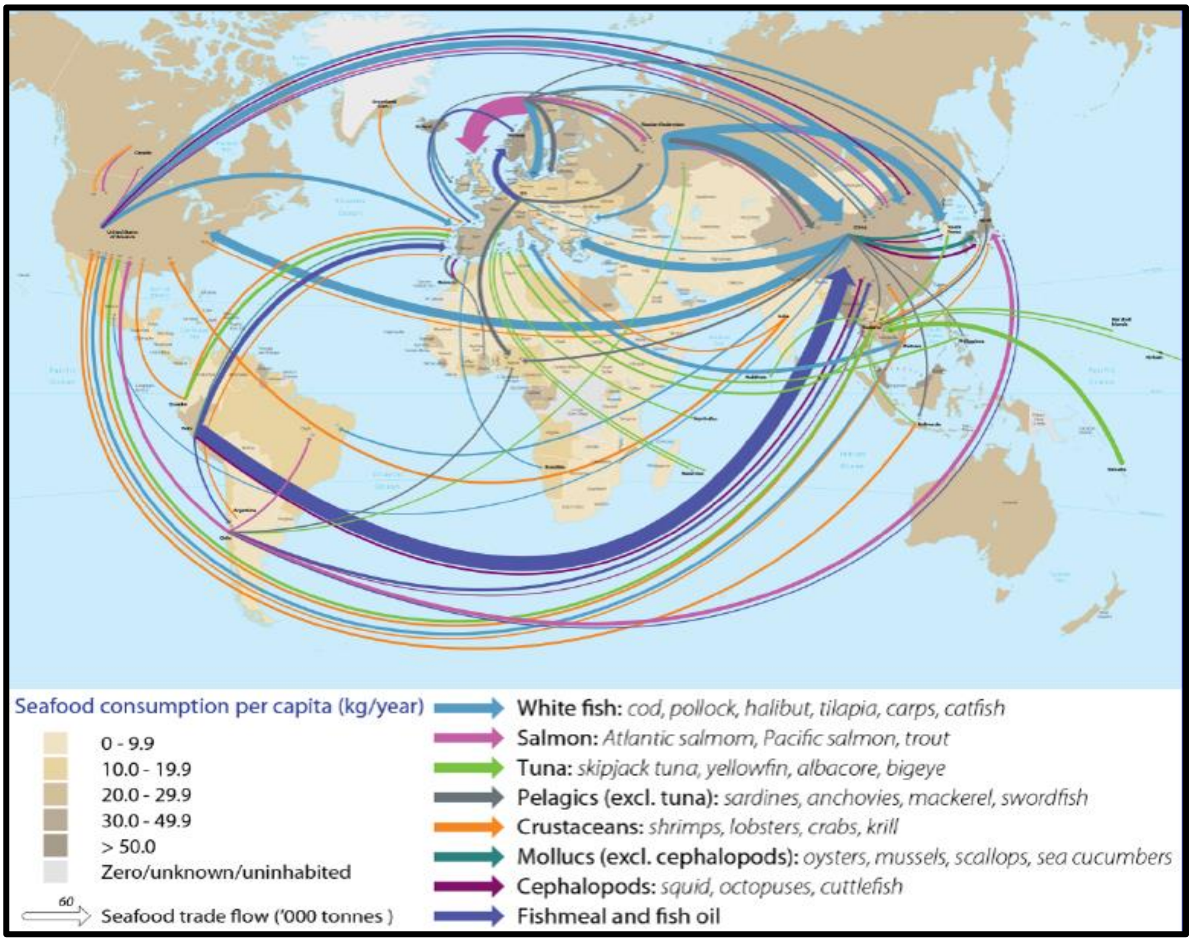


Nutritionally, fish is a relatively important source of animal protein. In 2013, it accounted for 6.7% of total world protein consumption, and 17% of global animal protein intake (FAO, 2016a).In some coastal countries, fish proteins provide up to 50% of total protein intake (especially in Indonesia, Bangladesh and Kiribati) (Cury and Yunne, 2006).

1.1.3 Seafood products at the heart of international trade

Seafood products are one of the most traded commodities in the world: in 2012, some 200 countries reported exporting fish and fishery products (FAO, 2014). In 2014, fish and fishery products accounted for 9% of total agricultural exports and 1% of world merchandise trade in terms of value (FAO 2016a), with exports worth US$ 148 billion (FAO 2016a). The main fish and fishery products traded internationally are shrimp (15% of export value), salmon (14%), whitefish (e.g., hake and cod, 10%), tuna (9%) and fishmeal (3%). Together, these products represent 51% of global fish and fishery product exports (Potts *et al.*, 2016). Figure 3 depicts the main flows of this trade.

Figure 3: Main global seafood trade flows in quantity (Source: Nikolik, 2015)



China is a major player in the capture fisheries and aquaculture trade, being not only the world's leading producer but also top exporter of these products (FAO, 2016b).

The main poles of consumption are Japan, United States (US), and European Union (EU). These markets rely heavily on seafood imports to meet their domestic demand products: in 2014, their imports totalled 63% of imports by value and 59%by volume of global imports (FAO, 2016b). In 2014 and 2015, the EU was by far the largest market for fish imports, way ahead of the United States and Japan, with a market estimated at US$ 54 billion (FAO 2016a).

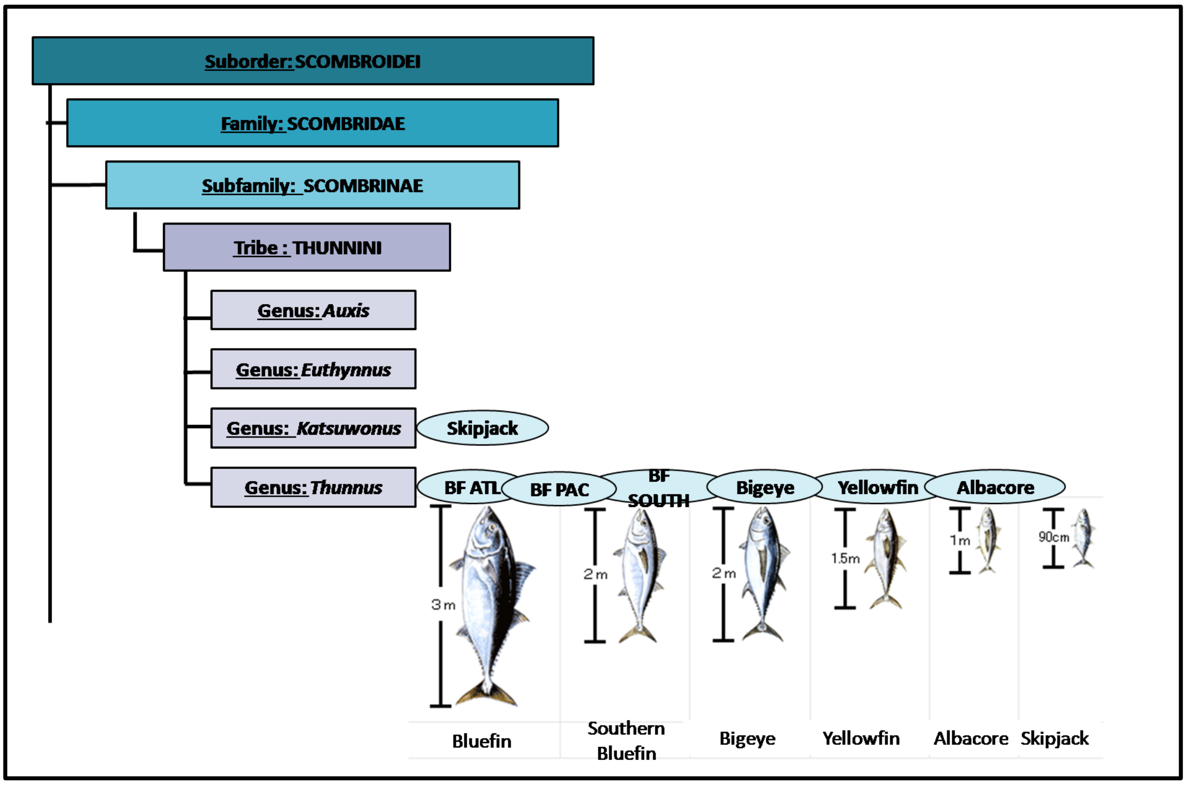
Over half (60%) of fish exports by value come from developing countries (FAO, 2016b). They play a key role in these countries' economies, as in value they outstrip the main agricultural exports such as rice and sugar (FAO, 2016b). In these countries, consumption of fish products depends on local production and is more tied to supply than demand. However, consumers in emerging economies are currently seeing a more diversified supply of fish following an increase in seafood imports (FAO 2016a).

1.2 The size of the tuna industry

1.2.1 The different species of tuna

The term “tuna” denotes several species of ocean fish in the Thunnini tribe. Within this tribe, 14 species are divided into 4 genus: *Auxis*, *Katsuwonus*, *Euthynnus* and *Thunnus* (Figure 4).

Figure 4: Classification of scombroids and the main commercial tuna species (Source:Goujon, 2013)



Among these fourteen species, seven are of major importance for trade. Present in the three oceans (except for the Atlantic and Pacific Bluefin tunas), these species (Table 1) are highly migratory, gregarious and predatory (Goujon, 2013).

Table1: Major species of commercial tunas

English name	Scientific name	FAO abbreviation
Skipjack tuna	*Katsuwonus pelamis*	SKJ
Yellowfin tuna	*Thunnus albacares*	YF
Bigeye tuna	*Thunnus obesus*	BE
Albacore tuna	*Thunnus alalunga*	ALB
Atlantic Bluefin	*Thunnus thynnus*	ABF
Pacific Bluefin	*Thunnus orientalis*	PBF
Southern Bluefin	*Thunnus maccoyii*	SBF

1.2.2 World tuna production

All tuna comes from capture fisheries. In 2014, commercial tuna catches stood at 5 million tonnes and represented 5.5% of global capture fisheries.

1.2.3 World tuna consumption

Tuna is one of the most popular seafood products worldwide (Guillotreau *et al.*, 2016). World tuna consumption is estimated at 0.45 kg per capita per year, which represents 2.2% of global fish consumption (Glitnir, 2007). This level of consumption is close to the global consumption of Nutella (0.51 kg per capita per year) (Mitzman, 2014), with canned tuna being the most frequently consumed form (Chemerinski, 2013).

1.2.4 A globalised market

The tuna market is a global market. In 2013, almost half (46%) of tuna catches were traded on the international market through globalised value chains (FAO, 2015). In the international fishery trade, tuna is the fourth most traded product and accounts for 9% of the overall value of seafood exports, after shrimps (15%), salmon (14%), and whitefish (10%) (Potts *et al.*, 2016).

1.3 Objectives of the report

The tuna industry is one of the most complex and dynamic fish and fishery sectors (Hamilton *et al.*, 2011). In 2014, its final sale value was estimated at US$ 33 billion, equivalent to 24% of the global fisheries industry[2] (Macfadyen, 2016). The purpose of this report is to shed light on and analyse the different links in this chain. Section 2 presents the various market segments of tuna production, while Section 3 decrypts the two main markets – canned tuna and sashimi. Section 4 identifies the key factors shaping global demand, and Section 5 concludes with a synthesis of the main trends of the global tuna market.

[2] If this is based on G. Nikolik (2015), who estimated the export value of fish and fisheries products at US$ 140 billion (Nikolik, 2015).

2. Global tuna production

In 2014, tuna production stood at 5 million tonnes, with an ex-vessel value of US$ 9.76 billion (Macfadyen, 2016). This production came chiefly from capture fishing (2.1) and more marginally from tuna-fattening farms (2.2).

2.1 Global tuna catches

2.1.1 The different types of fishing gear used

The main types of fishing gear used to capture tuna are the purse-seine net, longline, pole-and-line and gillnet. Other more artisanal gears are also used but this accounts for only a relatively small share of total catches.

2.1.1.1 Purse seining

A purse seine is a long trapezoid-shaped net that encircles the school of tuna, which is then trapped as the bottom edge of the net is drawn tight. Purse seiners are usually large vessels between 45 and 115 metres long (ICCAT, 2008). They typically use advanced technology to detect, capture and conserve the tuna. The operation take place above the thermocline[3]and the tuna species targeted are mainly skipjack and yellowfin in tropical waters, and albacore and bluefin in temperate waters (Majkowski, 2003b). Once on board, the tuna are stored in brine tanks at temperatures from-17 to -20°C (Groizeleau, 2014). Some more recently constructed seiners are equipped with freezer tunnels for stowage at -55°C and target European sashimi markets and steak tuna markets.

Seiners work on two fishing strategies: they can cast their seine on free tuna schools or target schools that have gathered around natural or man-made floating objects that attract tuna swimming underneath. Most of these floating objects, dubbed drifting fish aggregating devices (FADs), are man-made floating structures made of wood. These have been increasingly used since the 1990s, and currently almost 65% of purse-seine catches are carried out using FADs (Scott and Lopez, 2014). On average, the sets of purse-seine on FADs are 50% more productive[4]than on free-school (Scott and Lopez, 2014). Worldwide, it is estimated that nearly 91,000 FADs are deployed annually, which is not without impact on the marine environment and international markets (Scott and Lopez, 2014).

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[3]A thermocline is the transition layer between warmer mixed water at the ocean's surface and cooler deep water below(NOAA 2015).
[4]In terms of tonnes per set for the three tropical tuna species combined (Scott and Lopez, 2014).

In terms of catch, FAD fishing results in a significant level of unwanted by-catches: 4–5% of catches per set comprise non-targeted species, such as turtles, rays and other fish species (Scott and Lopez, 2014). Moreover, the yellowfin and bigeye tuna harvested by FAD fishing are smaller (<10 kg) and often juvenile, which heightens the risk of recruitment overfishing of these two species (Scott and Lopez, 2014).

FADs also impact the environment given that10% of these devices are lost each year (Maufroy *et al.*, 2015). Finally, the use of FADs also impacts international tuna markets. Some authors are of the view that FAD fisheries have been responsible for the fall in albacore prices in recent years (Brus, 2016a). The restrictions on FAD fishing[5] in the West Pacific (the most productive ocean) also help to make the global market more transparent and predictable (Brus, 2016a). When these fishing bans are lifted, the peak supply coincides with a dip in skipjack prices in the international market (BRUS 2016a). Currently, drifting FADs are only weakly controlled by the Regional Fisheries Management Organizations (RFMOs), whereas the technology is becoming increasingly effective, with presence of electronic buoys attached to the FAD providing more on more precise information to the master-fisher (localisation, presence of tuna…) and improving fishing efficiency.

2.1.1.2 Longline

A longline consists of a main line, suspended close to the surface, with branch lines attached to it with several thousand baited hooks. Mainly operating in the Pacific, there are two vessel types:

- The industrial distant-water longliners, particularly Taiwanese and Japanese, which supply tuna frozen. Their fishing trips last from 18 months to two years.
- Semi-industrial longliners, used mostly in China and Indonesia, which supply fresh tuna. Their trips usually last less than one month.

Industrial longliners are generally between 30 and 70 metres long. These vessels are equipped with storage facilities allowing freezing at ultra-low temperatures (from -40°C to -60°C), which helps to preserve the quality of the fish and meet sashimi market standards. The cost of fuel for these fleets is extremely high, so the profitability of their fishing operations depends greatly on at-sea transshipment of most of their catches onto support vessels, which also ensure their refuelling, bait replenishment and provisioning. These vessels are thus able to operate at sea for more than a year without berthing.

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[5] Fishing ban in East Pacific ocean from July to August and FAD ban in West Pacific from July to September

2.1.1.3 Pole-and-line

Pole-and-line technique involves fishing tuna with poles equipped with a line and hook and is reputed to be the most selective: "one man, one fish, one hook at a time". This fishery operates surface fishing and mainly targets albacore tuna. On board, the catches are generally stored in tanks filled with salt-water ice slurry (Majkowski, 2003a). The main pole-and-line fisheries are from Japan, Indonesia and the Maldives (Gillett, 2016). Currently, this fishing technique is widely advocated by environmental NGOs as being the most sustainable method and the demand for tuna from bait-boat catches is on the rise, especially in the European markets.

2.1.2 The overcapacity of the world's tuna fleet

The notion of fishing capacity is a concept whose definition varies depending on whether it derives from biologists, economists or managers (FAO, 1999; Martin, 2012). However, the commonly accepted definition is the quantity of fish that can be fished by a fishing unit (i.e., a vessel or fleet) (FAO 1999). For the tuna fisheries, the approximation of capacity most often used is the number of vessels for longline fleets, and the fish-holds' capacity for purse-seine fleets (Miyake *et al.*, 2010). The problem of the excess fishing capacity of tuna fleets has been recognised for some twenty years (Miyake *et al.*, 2010). Overcapacity seems to be a feature common to all the regional fisheries management organisations (RFMOs)and leads to excessive fishing effort (WWF, 2016).

In 2012, the companies that were members of the International Sustainable Seafood Foundation (ISSF) committed voluntarily to cease building new vessels unless they scrapped an equivalent capacity (ISSF 2016a).However, to promote adhesion to this voluntary commitment, an 18-month moratorium was introduced ahead of effective implementation. In addition, this commitment did not include the seiners already under construction at the time (Valsecchi, 2016). As a result, between 2010 and 2015, 134 seiners and 136 longliners were built and put into operation (Valsecchi, 2016).

This resolution ignited a wave in purse seiner construction, and leads to the construction of faster and bigger vessels. This helped to end the growth of purse seine vessels but contributes to increase the fishing capacity per seiner (BRUS, 2016a).The overcapacity of fleets is not only defined by the number of vessels (ISCF, 2009). Other factors are also taken into account, such as the vessel's storage capacity, their size and fishing efficiency (notably the technological advances that enhance a vessel's efficiency) (Miyake *et al.*, 2010).

In purse seine fisheries, support or auxiliary vessels play a major role. These are not fitted with fishing gear but help one or more fishing vessels to detect tuna schools and manage the FADs (Assan *et al.*, 2015). These support vessels should also be factored in when evaluating capacity as they help to improve the seiners' fishing efficiency. In addition, increasingly sophisticated FAD technology improves fleet efficiency, a prime example being the development of buoys equipped with echo-sounder devices that provide real-time information on the amount of biomass located under the rafts (ISI FISH, 2016).

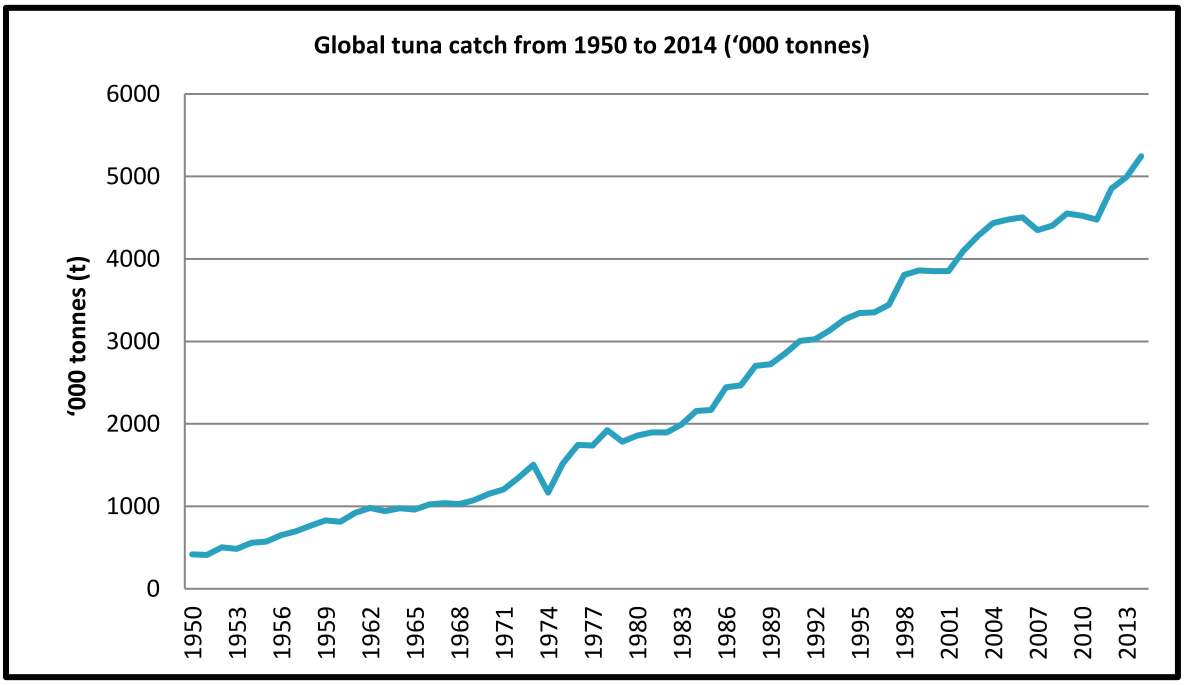
This overcapacity is particularly problematic when it comes to the aspirations of some developing countries (notably island nations) to develop their own tuna fishing fleets. In fact, as most of the global tuna fleet is owned by developed countries, either indirectly or via joint-ventures, developing countries are now claiming their right to develop their own fishing industry (Atuna, 2009).

In addition to the official fleet, there is also a "ghost fleet" comprising vessels over 40 years old that should have been scrapped. These vessels are sometimes put back into operation when market prices raise, thus creating market distortions and making it difficult to manage quotas and catches. The annual catch of this fleet is estimated to be in the region of 600,000 tonnes (Valsecchi, 2016).

2.1.3 Catches are levelling off

Global tuna catches have rapidly and steadily increased since the 1950s (Figure 5).From 1950 to 2015, the global catch rose from 500,000 tonnes to 5 million tonnes, representing a 1,000% increase. During the period 1960–1990, annual catch growth was 7%; this slowed down to 3.3%between 1990 and 2000 then to 2.5%between 2000 and 2015. For the period 2010–2025, a 2% growth is projected, which points to a levelling off of catches (Valsecchi, 2016).

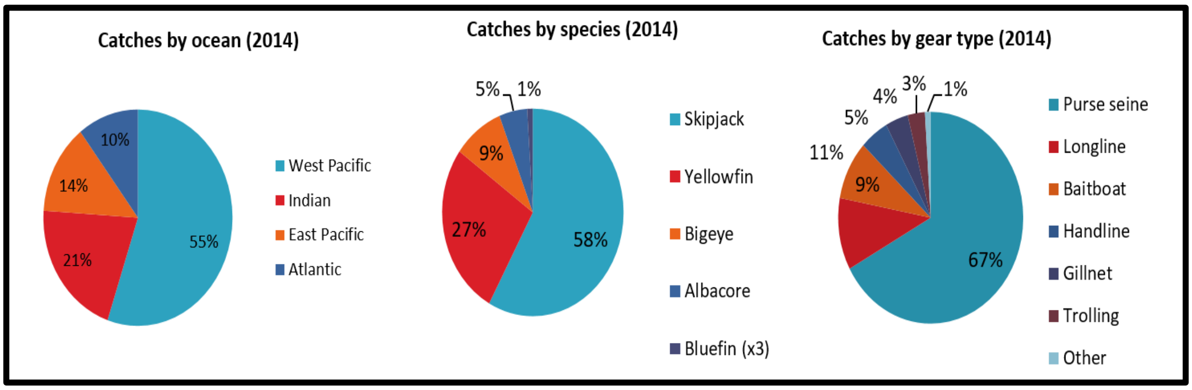
Figure 5: Global tuna catch from 1950 to 2014 (Source: FIGIS, 2016)



2.1.4 Catch distribution

Figure 6 shows the distribution of commercial tuna catches by ocean, species and fishing gear.

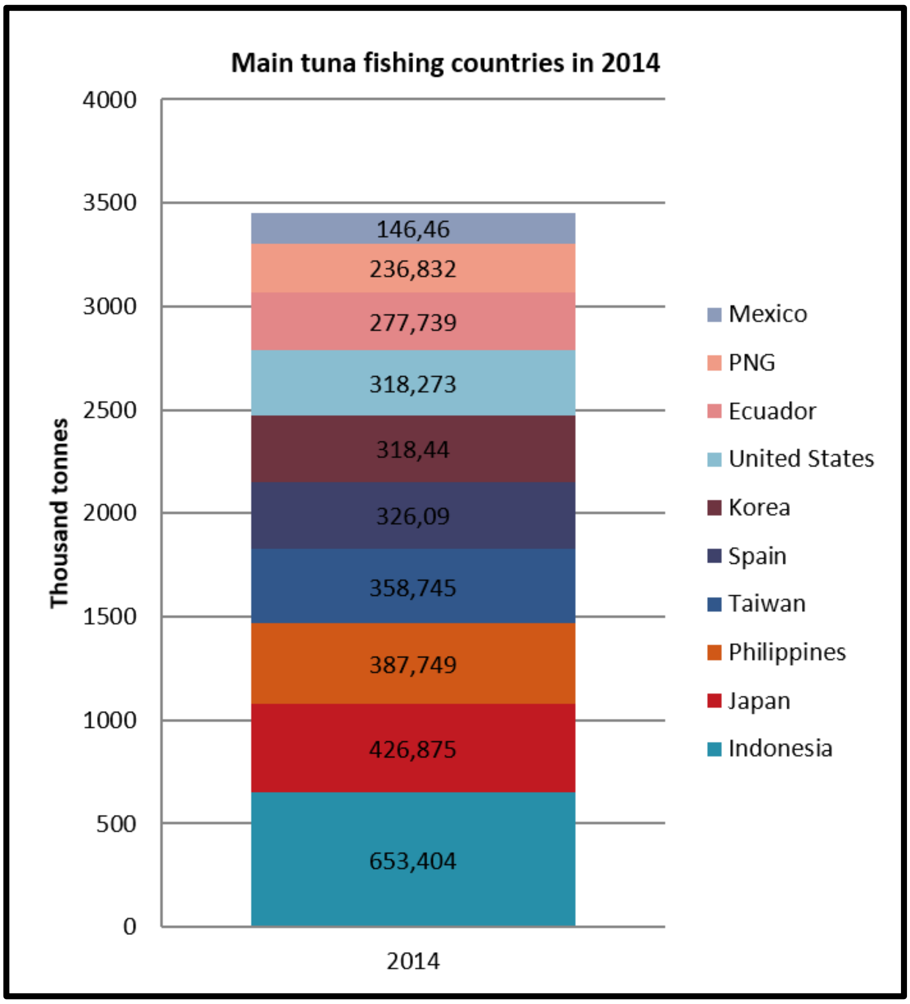
Figure 6: Distribution of commercial tuna catches by ocean, species and gear in 2014 (Source: ISSF, 2016)



Most tuna are caught in the West Pacific. The Indian Ocean, in second position, accounts for 21% of catches and the Atlantic 10%. Skipjack represents 58% of the global catch and is the most fished species in each ocean. Yellowfin is the second most fished tuna species, accounting for 27% of catches, followed by bigeye and albacore. The three bluefin species represent an infinitesimal share of catches (less than 1%). The most productive fishing gear in all three oceans is the purse-seine, which accounts for 67% of catches, mainly of skipjack and yellowfin. Longline, in second position with 11% of catches, accounts for most bigeye, albacore and southern bluefin catches. Next comes pole-and-line (8%), which accounts for a significant share of skipjack catches, then handline gear and gillnets, which each represent 5% of catches.

Among the fishing nations, Indonesia is in the lead in terms of tuna catches, with 12% of the global catch (Figure7). The Indonesian fleet, which uses an unmatched variety of gears, operates in the Pacific and the western part of the Indian Ocean. Japan, in second position, accounts for 8% of catches and fishes almost exclusively in the Western and Central Pacific. The Philippines, in third place, represents 7% of catches, using mainly purse-seine and pole-and-line gear (Macfadyen *et al.*, 2016).

Figure 7: Main tuna fishing countries in 2014 (Source: MACFADYEN 2016))



2.2 Tuna aquaculture production: fattening farms

Tuna aquaculture production began in the 1990s. Aquaculture farming involves fattening wild-caught tuna, mainly bluefin, in large cages. The caught fish are fattened until they reach a commercial size. Currently, three bluefin species are used in this activity: the Atlantic bluefin (mainly in the Mediterranean), the Pacific bluefin (Japan and Mexico) and the southern bluefin (Australia)[6] (Benetti, Partridge and Buentello, 2015).

In 2012, there were 54 farms, located on the Mediterranean rim (Italy, Spain, Malta, Croatia and Turkey), in Australia, Mexico and Japan, with an overall nominal capacity of 50,000 tonnes (Macfadyen

[6]Although there have been attempts to farm yellowfin tuna in Mexico and Oman, this species is not yet produced commercially.

et al., 2016). In 2014, effective production of these farms stood at 36,350 tonnes distributed as shown in Table 2 below.

Table 2: Aquaculture production of the three Bluefin tuna species in 2014 (Source: Tveteras and Nystoyl, 2015)

Region	Species	Production in 2014 (t)
Japan	Pacific BF	9 000
Mexico	Pacific BF	4 500
Australia	Southern BF	8 350
Mediterranean	Atlantic BF	14 500
TOTAL		36 350

The tuna farms belong to vertically integrated joint ventures, owned by Japanese, Koreans and Spanish interests. Regarding the Mediterranean tuna farms, the two main companies are the Japanese firms Mitsui and Company Ltd and Mitsubishi Corporation, and the Spanish firm Ricardo Fuentes e Hijos SA. Japanese firms are the main investors in Mediterranean tuna farms (LONGO, 2015).

Almost all production from these farms is destined for the Japanese sashimi market –to the extent that some authors have dubbed them "sushi farms" (Longo, 2015; Kurokura *et al.*, 2012). Farmed tuna can have a very high market value on the end markets. In 2011, the average ex-farm price for Mediterranean and Australian farms was 15,7 $/kg . Final market price for high grade bluefin tuna range between 40 to 100 USD/kg (Benetti, Partridge and Buentello, 2015).

Figure 8 summarises the main species and associated fishing gear involved in tuna production.

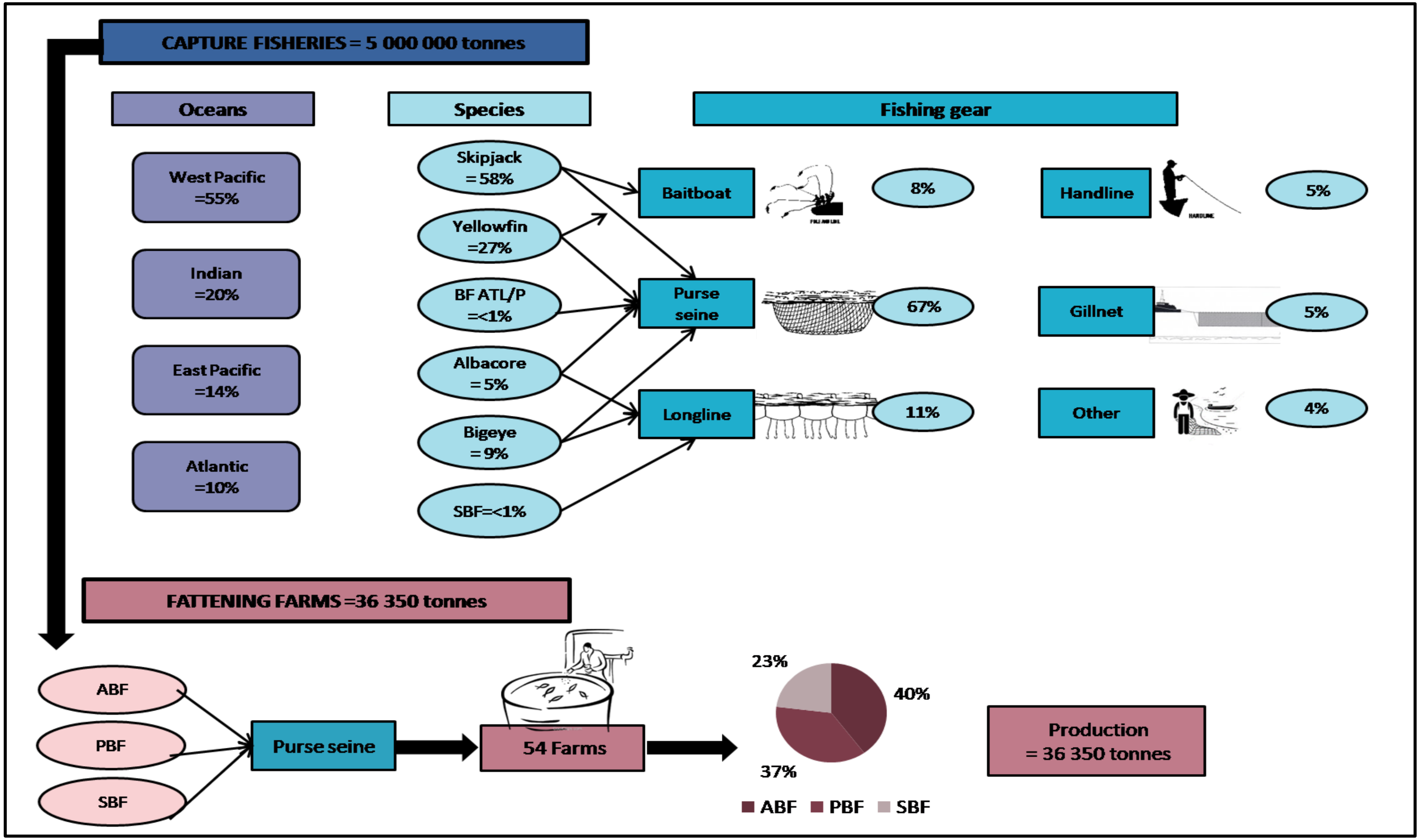


Figure8: Tuna production (Source: M. Lecomte, based on Macfadyen et al., 2016; Tveteras and Nystoyl, 2015)

3. Main tuna markets

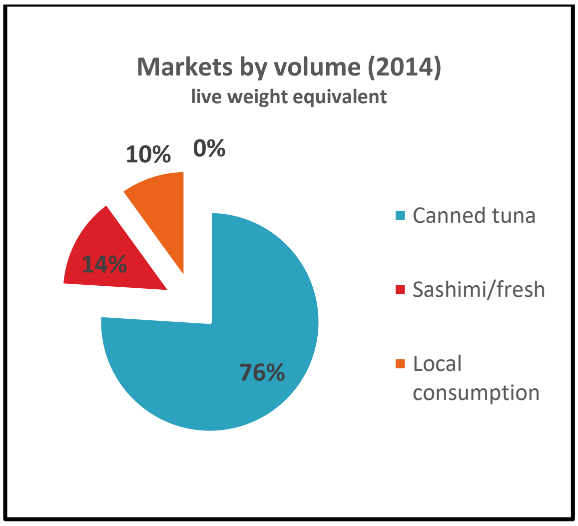
3.1 Main forms of consumption

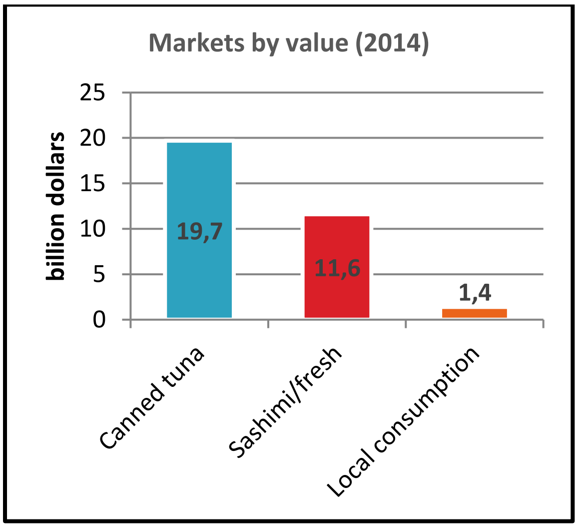
Tuna is supplied for consumption in several different product forms (Macfadyen and Defaux, 2016):

- Canned tuna, by far the most widespread form, and tuna pouches;
- Sashimi/sushi tuna, specific to the Japanese market;
- Tuna consumed as steaks, mainly on European and American market;
- Fresh tuna or dried/salted/smoked tuna on local markets;
- Katsuobushi, a Japanese condiment made with flakes of dried bonito or skipjack tuna, which are fermented then smoked.

Figure 9 shows the share of these different forms of consumption. For simplicity of analysis, steak tuna has been included in the sashimi category, while katsuobushi, which is specific to the Japanese market, has been integrated into the canned category. The Japanese katsuobushi market was estimated at 36 000 tons in 2014 (Kawamoto, 2016). The market for tuna consumed as steak is estimated at 47 500 tons (ITC Trade Map, 2016, Bailly, 2016).

Figure 8 : Market share of the different product forms by volume and value (Source: Macfadyen, 2016)





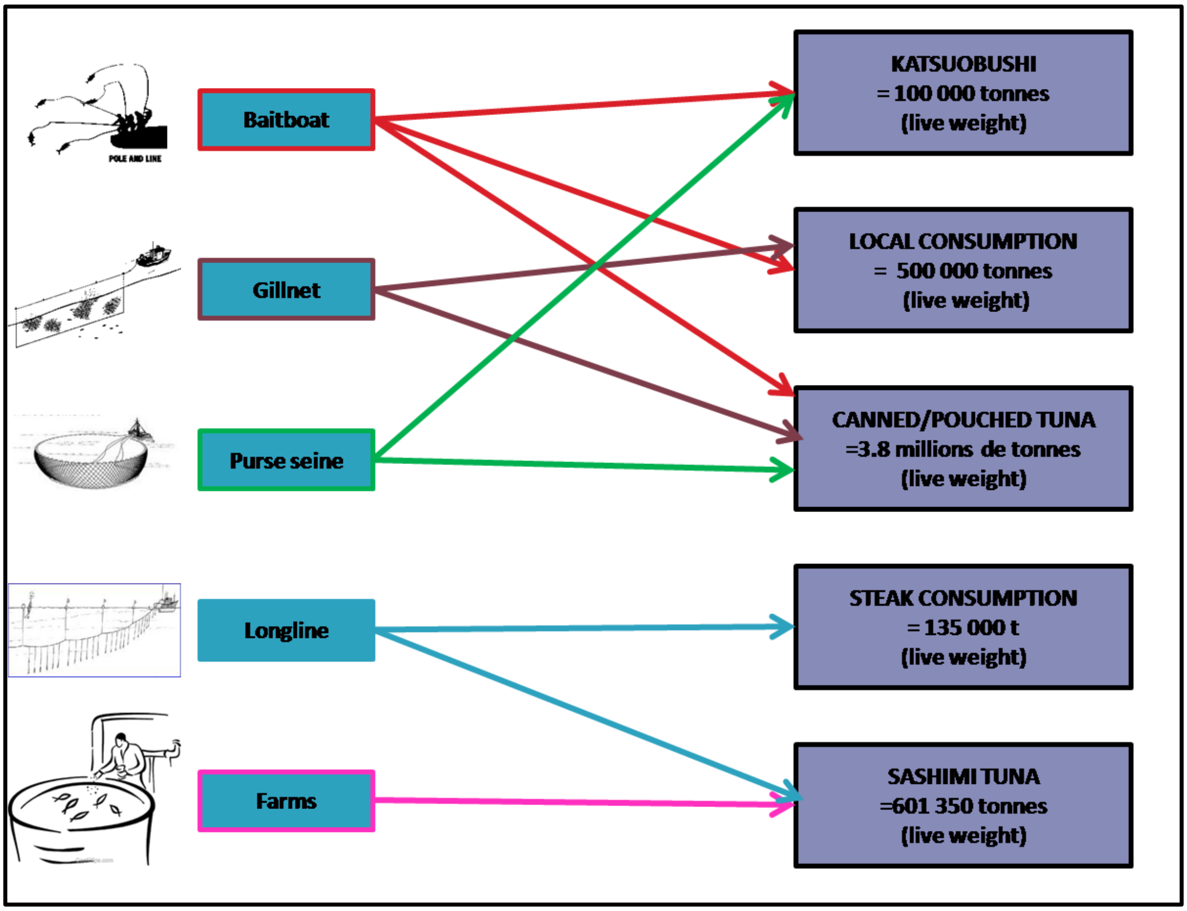
Both in terms of volume (76% live weight equivalent) and value (60%), canned tuna is the foremost form of consumption. Although sashimi-grade tuna represents only 14% of tuna catches, this market accounts for 36% of the global tuna market in terms of value. This clearly shows that sashimi tuna is a high-end market, where catches bring in elevated prices.

In terms of markets, the main areas of consumption are concentrated in: Japan, leader on the global tuna market (all forms of consumption combined), the US and the EU (Kawamoto, 2016).Although local consumption accounts for a sizeable share of catches (10%), it represents only 4% of market value: the consumed value of catches is on the whole twice the ex-vessel value, as only a very low margin is taken during processing (Macfadyen *et al.*, 2016).

Each of these forms of consumption is typically associated with a specific fishing technique and/or tuna species (Figure 10):

- Almost all purse seine catches (mainly skipjack) are destined for canning;
- Longline and liners catches are destined for the sashimi market (except for yellowfin, generally destined for canning);
- Gillnetter catches go to canneries and local markets as dried or smoked products;
- Pole-and-line catches have multiple destinations: canned tuna markets (mainly for eco-label canning), the katsuobushi market and the fresh tuna consumption market.

Figure 9: The main forms of tuna consumption (Source: M. Lecomte, based onMacfadyen *et al.*, 2016)

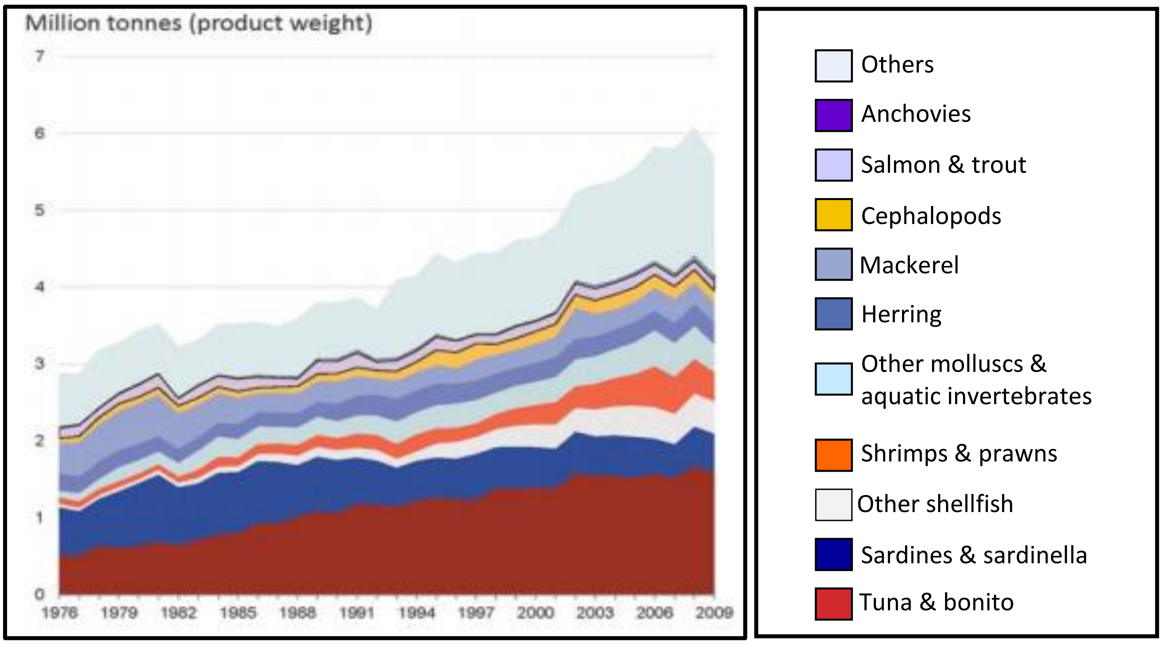


Two main value chains can be identified: the value chain for canned tuna, which supplies a global mass market, and that of sashimi-grade tuna destined for a high-end market with catches bringing in higher prices. The sections below describe in greater detail the canned tuna and sashimi-grade tuna sectors.

3.2 Canned tuna

Tuna is a major commodity for the seafood canning industry being the world's leading canned seafood species in terms of volume (Figure 11):

Figure 10: Global production of canned fish and fishery products in 2009 (million tonnes, product weight) (Source: Vannuccini, 2012)



Likewise, in the tuna industry, canned tuna stands as the leading product in terms of value (60% of total value, Figure 9). Each year, nearly 75% of tuna catches are destined for canning – in 2014, equivalent to 3.8 million tonnes. Figure 12 depicts the sector's overall organisation.

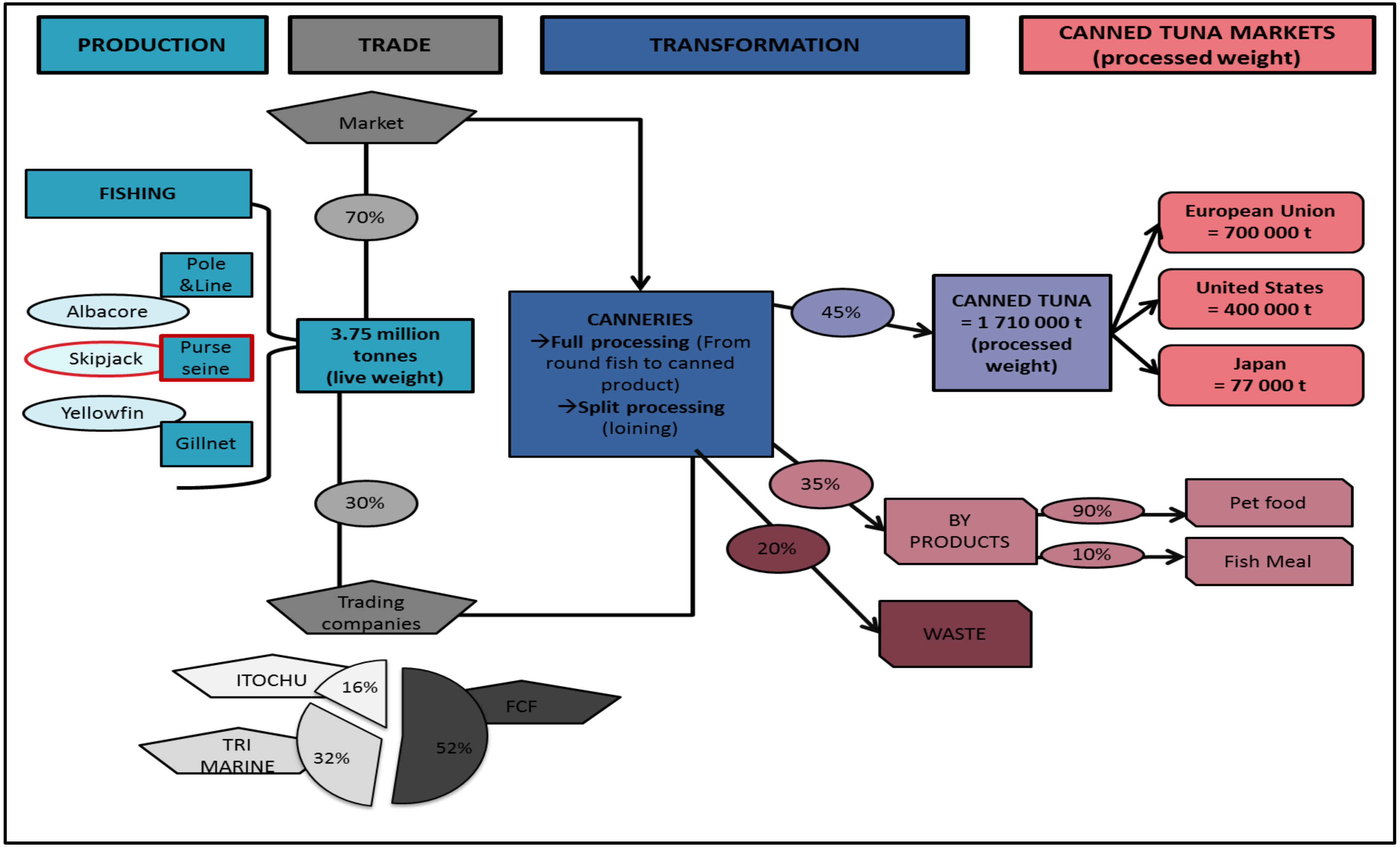


Figure 11: The canning industry (Source: M. Lecomte based on Macfadyen *et al.*, 2016; Hamilton *et al.*, 2011))

3.2.1 Production dominated by the purse-seine fleet

The main species used for canning are the skipjack, yellowfin and, to a lesser extent, albacore tuna. The most-harvested species, the skipjack, is mainly destined for staple consumer products whereas the yellowfin and albacore are sold at higher prices. The largest markets for the albacore are the United States, France and Spain (Oceanic Development, Poseidon Aquatic Resource Management Ltd, and MegaPesca Lda, 2005).

Most of these species are caught by purse-seiners (67% of world catches) and to a lesser extent by pole-and-line vessels (10% of total world catch). In March 2015, 1,955 tuna purse-seiners were in operation (Justel-Rubio and Restrepo, 2015). The main countries operating a purse-seiner fleet are: the United States, South Korea, Spain, Papua New Guinea (PNG) and Taiwan (Guitton *et al.*, 2016). In 2014, these fleets accounted for 47% of purse-seine catches (Guitton*et al.*, 2016).

The purse-seiner fleet is part of a globalised international industry and most of the vessels belong to large industrial groups or investment groups. Very few purse-seiners are now owned by family businesses. Among the reasons for this concentration are the high operating costs and overheads, and vertical integration allows vessel owners to cut production costs while at the same time securing their supplies (Miyake *et al.*, 2010).

Pole-and-liners account for a lesser share of catches (11%) and their number is declining due to their increasing operating costs (Gillett, 2016). Today, a growing fraction of their catches goes to the market for ecolabelled products.

3.2.2 Sale of catches: the role of major trading companies and Bangkok

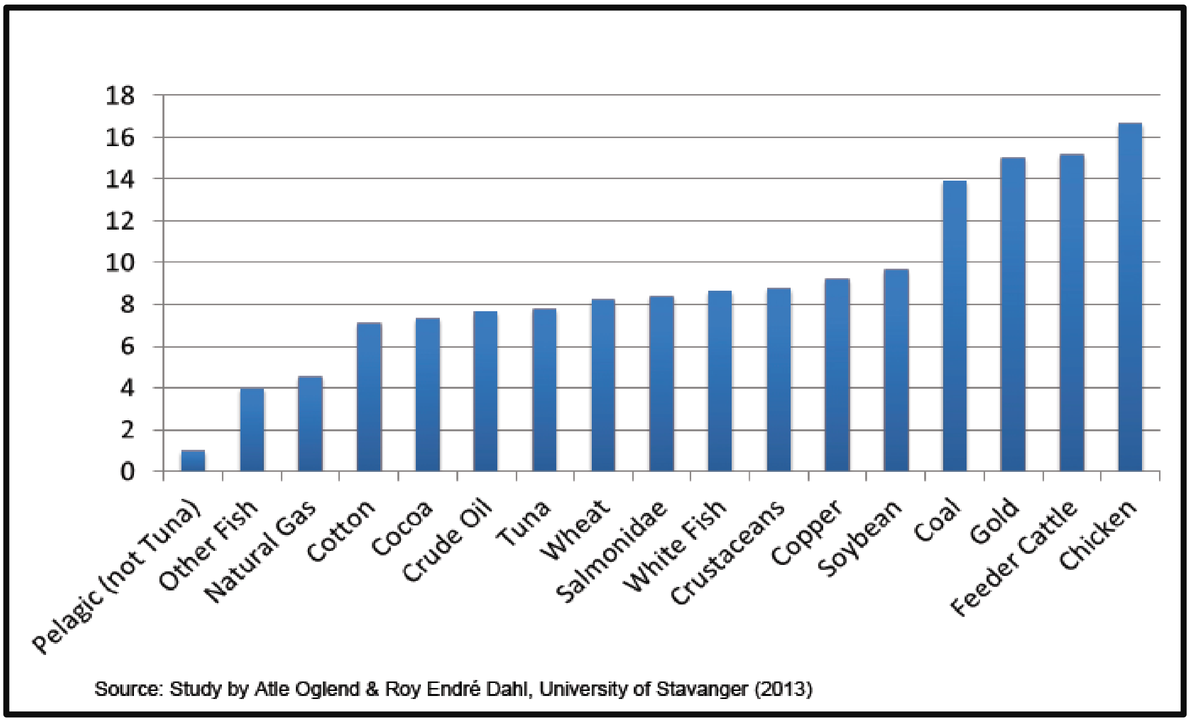
Once landed, purse-seiner catches for canneries are sold on international markets or to trading companies.

When purse-seiners are owned by the large vertically integrated groups, they are required to supply the groups' own factories. On the other hand, purse-seiners belonging to fishing firms can sell their catches either directly on international markets or to trading companies. These vessels use two sales channels: either the fishing company has a commercial firm in charge of selling catches from the entire fleet or each ship's captain can sell his catches individually (Campling, 2012).

3.2.2.1 The tuna market: the role of Bangkok

The leading marketplace for canning-grade tuna is Bangkok. Indeed, Thailand is the world's foremost canning operator and Thai imports destined for canneries accounted for almost half of the world's skipjack and yellowfin imports in 2010 (Guillotreau *et al.*, 2016). The main suppliers to the Thai market are Taiwan (20% of imports), the United States (19%) and South Korea (17%) (Guillotreau *et al.*, 2016). Given the huge quantities purchased by the Thai canneries, the price of frozen tuna in Bangkok serves as the international benchmark for whole round tuna destined for canning (Ecuador, Côte d'Ivoire, Seychelles, Spain) (Guillotreau *et al.*, 2016). The round tuna price is thus almost uniform across the world and also highly volatile, as is the price of crude oil (Figure 13).

Figure 12: Volatility ranking for major commodity prices (lower is more volatile) (Source: Lem, 2016 based on Dahl and Oglend, 2013



3.2.2.2 The major trading companies

The role of trading companies is to purchase the raw materials (fresh-caught tuna) from the fishing vessels and to coordinate their transport to tuna canneries. Providing highly efficient services, these companies are key links in the canned tuna supply chain (Hamilton *et al.*, 2011). In fact, the sale of catches to trading companies enables vessel operators to focus their efforts on fishing rather than having to deal with financial, administrative and logistic aspects and the risk associated with selling their catches. For the canneries, purchasing raw material from these companies ensures easier access to supplies as it allows them to avoid having to manage a large number of vessel owners selling in small catch volumes (Hamilton *et al.*, 2011).

The market is currently dominated by three companies: Itochu, Tri Marine and FCF. Between them, these firms handle almost 30% of the world's canning-grade tuna catch (Table 3). They thus provide

80% of the raw material needs of Thai canneries (which are the world's leading producers of canned tuna). As the Thai canneries do not own their own fleets, they rely heavily on the trading companies (Campling, Havice and Ram-Bidesi, 2007; Barclay, 2010). Of the three companies, FCF handles the largest volumes of catch and tuna trading is its core business.

Tri Marine has chosen a vertical- integration strategy, extending its activities to the entire tuna supply chain, and has a more global presence (especially in the European market). Itochu handles the lowest volumes of tuna and has a more diversified business model including seven lines of business (Hamilton *et al.*, 2011).

Table3: Annual volumes sold by the three major tuna trading companies (Source: Hamilton *et al.*, 2011;Tri Marine, 2013)

Company	Volumes sold
FCF	650 000 tonnes/year
Tri Marine	400 000 tonnes/year
Itochu	200 000 tonnes/year
Total	1 250 000 tonnes/year

3.2.3 Canned-tuna processing: production overcapacity

The tuna processing industry started up in Europe in the 1950s before gradually expanding into countries with available low-cost labour in the 1980s. Today, canned tuna is produced in nearly 40 countries (Figure 14). The three major producers are Thailand, Spain and Ecuador. The main landing ports and processing facilities are Bangkok (Thailand), Pago Pago (American Samoa) and Manta (Ecuador) (Guillotreau *et al.*, 2016). Most of these canneries belong to vertically integrated transnational firms that own the leading tuna brands sold on consumer markets.

The canneries use two types of raw material: whole frozen tuna (known as "round tuna") or loins. Many canneries use both forms of tuna for their production (Miyake *et al.*, 2010).

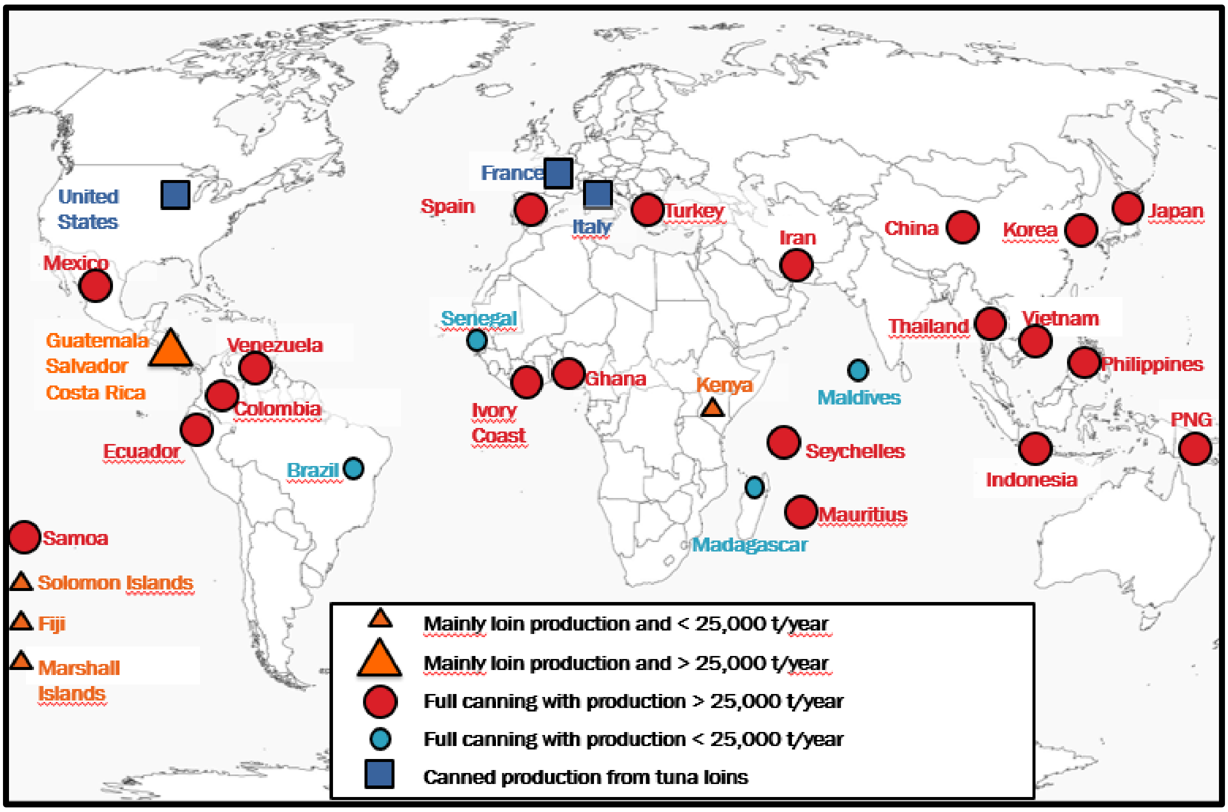
For round tuna, they use two supply channels. The first involves direct sourcing from the landings of fishing vessels offloaded in a port close to the canneries (whether or not the vessels are owned by the canneries). This "traditional" form of supply is still used by the canneries in Tema (Ghana) and those based on islands such as Papua New Guinea or the Seychelles. The second supply channel involves using reefer vessels that transport round tuna in bulk to the canneries. This supply method is becoming increasingly widespread, particularly in the Thai canning factories (Miyake *et al.*, 2010). Generally, the canneries' demand for frozen tuna is fairly price-elastic (Guillotreau *et al.*, 2016). In the Western and Central Pacific Ocean and the Indian Ocean, elasticity of demand for frozen round tuna lies in the region of 1.55 (Garcia del Hoyo, Jimenez-Toribio and Guillotreau, 2010; Bertignac *et al.*, 2000; Guillotreau *et al.*, 2016). This means that a 1%increase in ex-vessel prices would lead to a more than proportional decrease in demand from the canneries (Guillotreau *et al.*, 2016).

Until the 1990s, round tuna was the most common form of supply: the whole tuna was canned within a single production unit. This canning method is called "full processing" or "full canning". In recent years, some canneries have opted to source their supplies in the form of loins. This process is known as "split processing". The canned production process is based on two production units: one processing plant produces the loins, which are then purchased by a cannery to produce cans of tuna. The use of loins is a growing trend in canneries in developed countries and offers several advantages. It helps to reduce labour costs, as nearly 80% of these costs in canned tuna production are incurred by cooking, cleaning, and loining the fish (Miyake *et al.*, 2010). Likewise, the utilisation of loins helps to reduce transport costs as loins represent only 45% of the weight of a whole fish. In addition, loins can be shipped in containers rather than bulk reefers, which also lowers costs (Campling, 2016).

Thus, supplying tuna in loins allows canneries in developed countries to significantly reduce their production costs and remain competitive with respect to the low production costs of some developing countries. The European tuna loin market is expanding rapidly as shown by the speed at which the autonomous tariff quota[7]for loins is exhausted each year. This source of supply depends heavily on European and American tariff policies and will remain so as long as these countries continue to protect their domestic canning plants (Campling, 2016).

[7]Tariff quotas constitute an exception to the normal state of affairs since they permit, during the period of validity of the measure and for a limited quantity, the total (total suspension) or partial waiver (partial suspension) of the normal duties applicable to imported goods. They are normally granted to raw materials, semi-finished goods or components not available in the EU (suspensions) or which are available but in insufficient quantities (tariff quotas), but no tariff quotas are granted for finished products (Source: European Commission, 2016a).

Figure 13: Location of main tuna canneries (Source: Campling, 2015a; Campling, Havice and Ram-Bidesi, 2007; Hamilton *et al.*, 2011)



At the present time, the combined maximum production capacity of these tuna canneries is higher than global catches. In 2012, there were an estimated 184 canneries with a total capacity of 15,940 tonnes/day, whereas tuna catches amounted to 13,389 tonnes/day (Table4). This excess capacity is even more evident when compared to the catch effectively destined for canning, which amounts to 10,042 tonnes/day.

Table4: Comparison of combined tuna canning capacities and tuna fleet catches in 2012 (Source: Hsu, 2012; FIGIS, 2016)

Combined capacity of tuna canneries (2012)	15 940 tonnes/day
Total catches (2012)	13 389 tonnes/day
Catches destined for canning (2012)	10 042 tonnes/day

3.2.4 By-products and waste from the tuna processing industry

Canned tuna processing generates a sizeable quantity of by-products and waste. On average, the meat destined for canning represents 45% of the fish's live weight[8] (Macfadyen and Defaux, 2016). The remaining 55% constitute processing residues, composed as follows (Macfadyen and Defaux, 2016):

- 35% of the live weight constitutes by-products that will be used by other industries and transformed in co-products. 10% of these by-products (generally, red meat) are used for animal feed. The heads are sometimes used to produce fish oil. The remaining 90% is used to produce fishmeal.
- 20% of the live weight is non-reusable waste, including mainly blood and water.

In 2014, by-products from the canning industry were valued at US$ 300 million, i.e. 0,9% of final value of the global tuna sector (Macfadyen and Defaux, 2016).

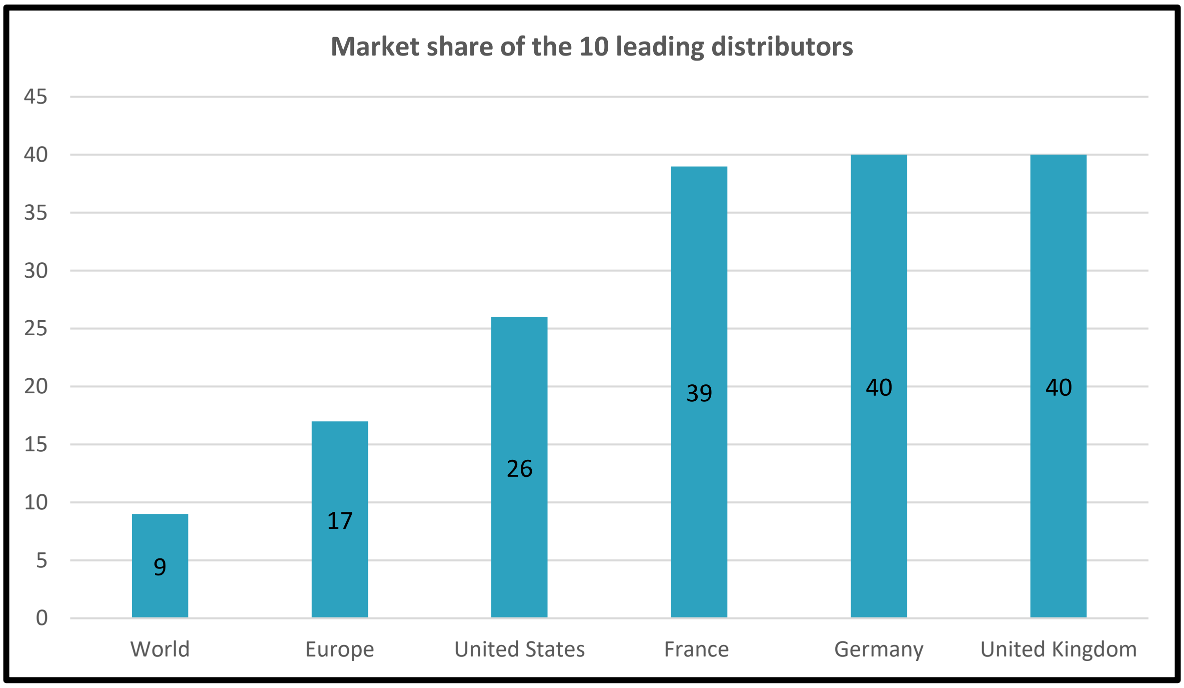
3.2.5 The key role of retailers and transnational firms

In European and American markets, supermarkets and hypermarkets dominate canned tuna distribution chains. These retailers thus play a key role and act as an interface between the canners and consumers.

On these traditional markets, the retail sector is characterised by a high degree of concentration. In the US, the 10 leading retailers have 25.5% of market share, while on the main canned tuna markets in Europe (France, Germany, United Kingdom, and Spain) their market share borders on 39% (Figure 15).

[8]This conversion factor nonetheless varies depending on the size and species of the tuna processed.

Figure 14: Market share of the top 10 distributors in various countries and groups of countries in 2012 (Source: MESIC, 2015)



This high level of concentration means that the canners find themselves dealing with a relatively small number of buyers and depend on only a handful of retailers to sell their products. The retailers are thus able to unilaterally impose their terms and conditions on the canners. In fact, whereas the canneries' demand for frozen tuna is price-elastic, consumer market demand is considered to be inelastic both in Europe and, to a lesser extent, in the United States (Guillotreau *et al.*, 2016). As a result, retailers use multiple strategies to mitigate increases in raw tuna prices and keep retail prices stable (Guillotreau *et al.*, 2016). These strategies involve using their private-label brands reducing the quantity of tuna in the can, using tuna mixed with vegetables, etc. (Guillotreau *et al.*, 2016). Retail prices on supermarket shelves thus fluctuate much less than ex-vessel prices (Jiminez-Toribio, Guillotreau and Mongruel, 2010).

Canned tuna products are thus increasingly produced in canneries under direct contract to retailers and sold under the supermarkets' own (private) labels (Hamilton *et al.*, 2011). These private-label cans give retailers a fairly high margin despite their low retail prices (Miyake *et al.*, 2010).

On top of using private labels, retailers also exert vertical pressure on the sectors upstream in the supply chain or, in other words, on the canneries (Miyake *et al.*, 2010). Canneries engage in a price negotiating system with the retailers in order to produce products at the lowest possible prices. The retailers sign annual contracts with the canneries specifying a given quantity at a fixed price. This price is fixed in line with Bangkok price forecasts over the year. Should a price hike occur, it is very difficult for the canneries to renegotiate these contracts in their favour so that the price increase is absorbed by the canneries. Thus "*when prices rise, it is very difficult to pass this on to the retailers, and when prices drop, competition increases and the same retailers obtain discounts*" (Lem, 2016). This pressure on costs is then transferred to the ship-owners to make them decrease their sales price.

Alongside these retailers, a handful of firms operating at several levels of the supply chain share the global market for canned tuna. These are mainly vertically integrated companies whose brands (national labels) are leaders on end markets, as shown in Figure 16.

These firms are seen as some of the industry's key players (Österblom *et al.*, 2015). They are present worldwide via extensive networks of subsidiaries and dominate canned tuna sales, both in terms of value and volume, with brands that dominate the main consumer markets. These firms are also involved in the principal tuna RFMOs, be it through their presence as observers or their participation in the industry's delegations. They take part in the global governance of the tuna sector (Österblom *et al.*, 2015).

Among these firms, Thai Union, a Thai company, is the world leader in the canned tuna segment, with an annual canned production estimated at 300,000 tonnes (i.e., 18% of global canned tuna production) (TUF, 2016). Its brands (*Chicken of the Sea, John West, Petit Navire*, *Mareblu*) dominate the main canned tuna markets.

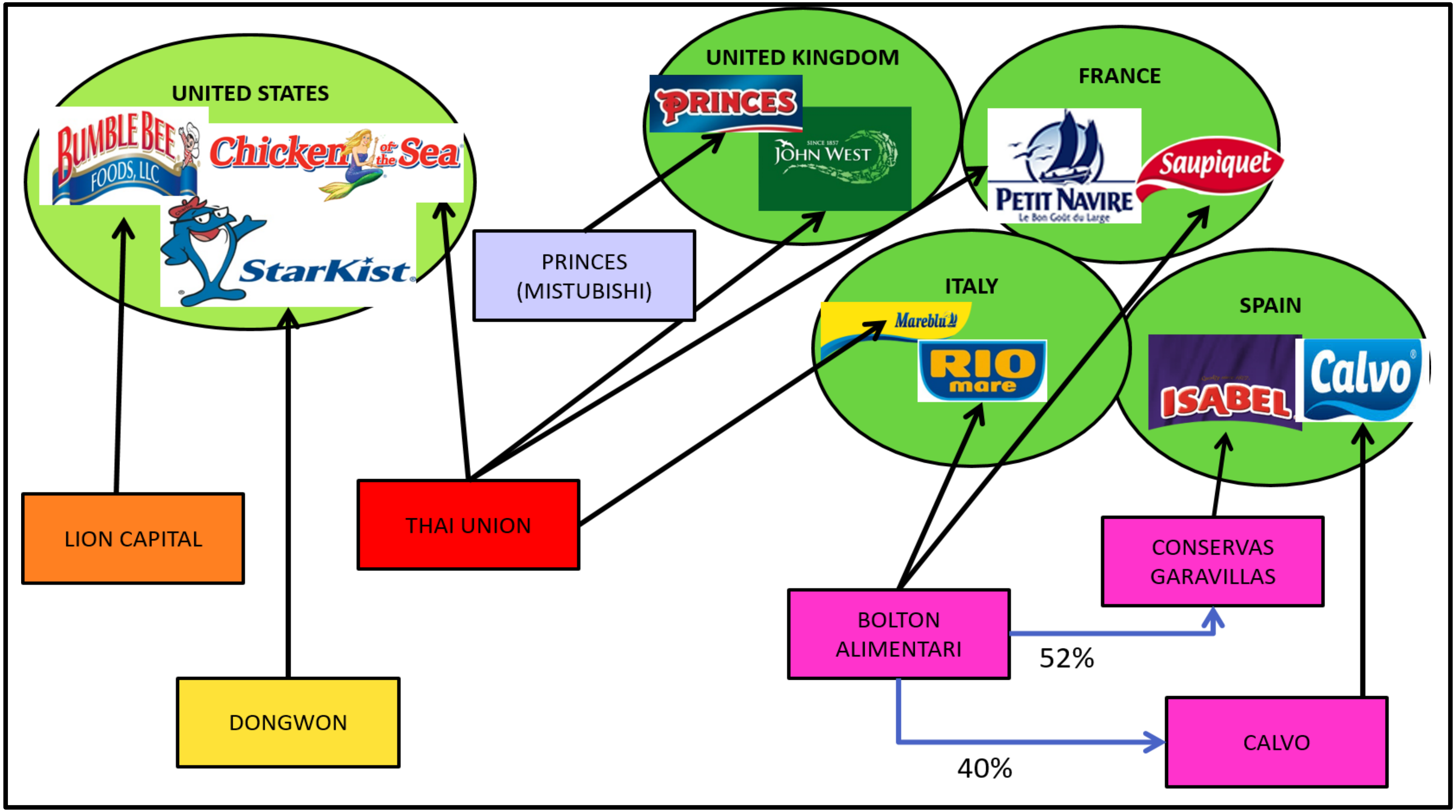


Figure 15: Main canned tuna markets and associated brands (Source:M. Lecomte, 2016,based on TUF, 2016; Lion Capital, 2014; Kalla, 2013; Bolton Alimentari, 2014; Dongwon, 2013)

3.2.6 Traditional canned tuna markets now maturing

Canned tuna is a low-cost product distributed worldwide (Hamilton *et al.*, 2011). In 2014, the global market of canned tuna was estimated at 1.7 million tonnes (processed weight) valued at US$ 19 billion (Macfadyen, 2016).

The principal markets for canned tuna are the EU and the US. These markets are globally integrated and form a single interdependent market (Jimenez-Toribio, Guillotreau and Mongruel, 2010). Import prices for tuna canned in brine, for example, follows the same long-term trends on both the EU and US markets (Jimenez-Toribio, Guillotreau and Mongruel, 2010; Miyake *et al.*, 2010) and demand is considered to be relatively inelastic (Jimenez-Toribio, Guillotreau and Mongruel, 2010; Guillotreau *et al.*, 2016).

These traditional markets are currently maturing, with consumption levels stabilising in the EU and declining in the US. Growth in the sector is thus tied to demand from the Middle East, Latin America and other emerging markets such as Eastern Europe and Asia (CAMPLING 2015c; GLOBEFISH 2016b). The Middle East's canned tuna market is estimated at 134,000 tonnes, valued at US$ 1 billion (excluding Iran), while Latin America currently accounts for 15% (250,000 tonnes) of world canned tuna consumption (Chemerinski, 2016; Sengupta, 2016).

3.2.6.1 The European Union market

The EU market is the world's largest market for canned tuna, with annual consumption reaching around 700,000 tonnes[9] (Vieites Baptista de Sousa, 2012). It is the only market that combines strong demand and high prices (Campling, Havice and Mc Coy, 2015). Within the EU, canned tuna is the most consumed seafood, with consumption standing at around 2.02 kg per capita in 2012 (EUMOFA, 2015).

In the 1990s, domestic production dominated supply but, since 2002, most of the canned tuna consumed in the EU is imported (Hamilton *et al.* 2011). Currently, the EU's self-sufficiency rate for tuna is 26%, tuna being one of the most imported products (EUMOFA, 2015). In 2013, European production of canned tuna stood at 166,000 tonnes, with Spain as the leading producer (AGRITRADE, 2014). The main suppliers of European imports (in volume) were Ecuador, Mauritius, Thailand, Seychelles and the Philippines (GLOBEFISH, 2015).

Within the EU, the largest markets for canned tuna are Italy, the United Kingdom, France, Spain and Germany. In terms of volume, the United Kingdom is in first place, followed by Italy, then France

[9]Processed weight.

(Figure17). Yet, these European markets are not all homogenous, either in terms of the type of products consumed or of prices. The Italian market generates the highest value with prices averaging 20 times more than those in the other markets, while Spain comes first for per capita consumption of canned tuna, even though its market volume is lower (Campling, 2015b). As for the type of canned product consumed, the main markets divide into three categories (Campling, 2015b):

- The market in northern European countries (United Kingdom, Germany). These mainly consume low-cost skipjack (mostly in brine) imported from Southeast Asia (mainly from Thailand);
- The market in southern European countries (Italy, Spain). These are both tuna-canning countries that mainly process yellowfin and are typified by high consumption of yellowfin in olive oil;
- France is an intermediate market where both above-mentioned products are consumed. The flagship product here is “natural tuna”, which consists of yellowfin in brine, canned raw.

Currently, European canned tuna markets are dominated by a handful of trading companies, processors and retailers that wield considerable market power (Guillotreau, Mongruel and Jimenez-Toribio, 2008). In some European countries, notably in Spain, the domestic canning industry has considerable influence and exerts a high degree of market power over retailers and consumers (Guillotreau, Mongruel and Jimenez-Toribio, 2008). In southern European markets, for instance, the industry has imposed on consumers differentiated yellowfin products that yield higher gross margins (Guillotreau, Mongruel and Jimenez-Toribio, 2008).

In each of these markets, large retailer chains dominate the sales channels with their private-label brands. In the United Kingdom and France, the market share of the top five supermarket chains reaches 80% (Hamilton *et al.* 2011). In 2010, the market share of private-label products was 60% in France, 50% and42% in the United Kingdom (Brus, 2011). The EU market is also the foremost market for ecolabelled seafood products (notably, Germany and the Netherlands) (CBI, 2015). The most widely used ecolabel is that of the Marine Stewardship Council (MSC) (Campling, Havice and Mc Coy, 2015). In recent years, European demand for products from pole-and-line or free-school fishing has been on the rise (GLOBEFISH, 2014).

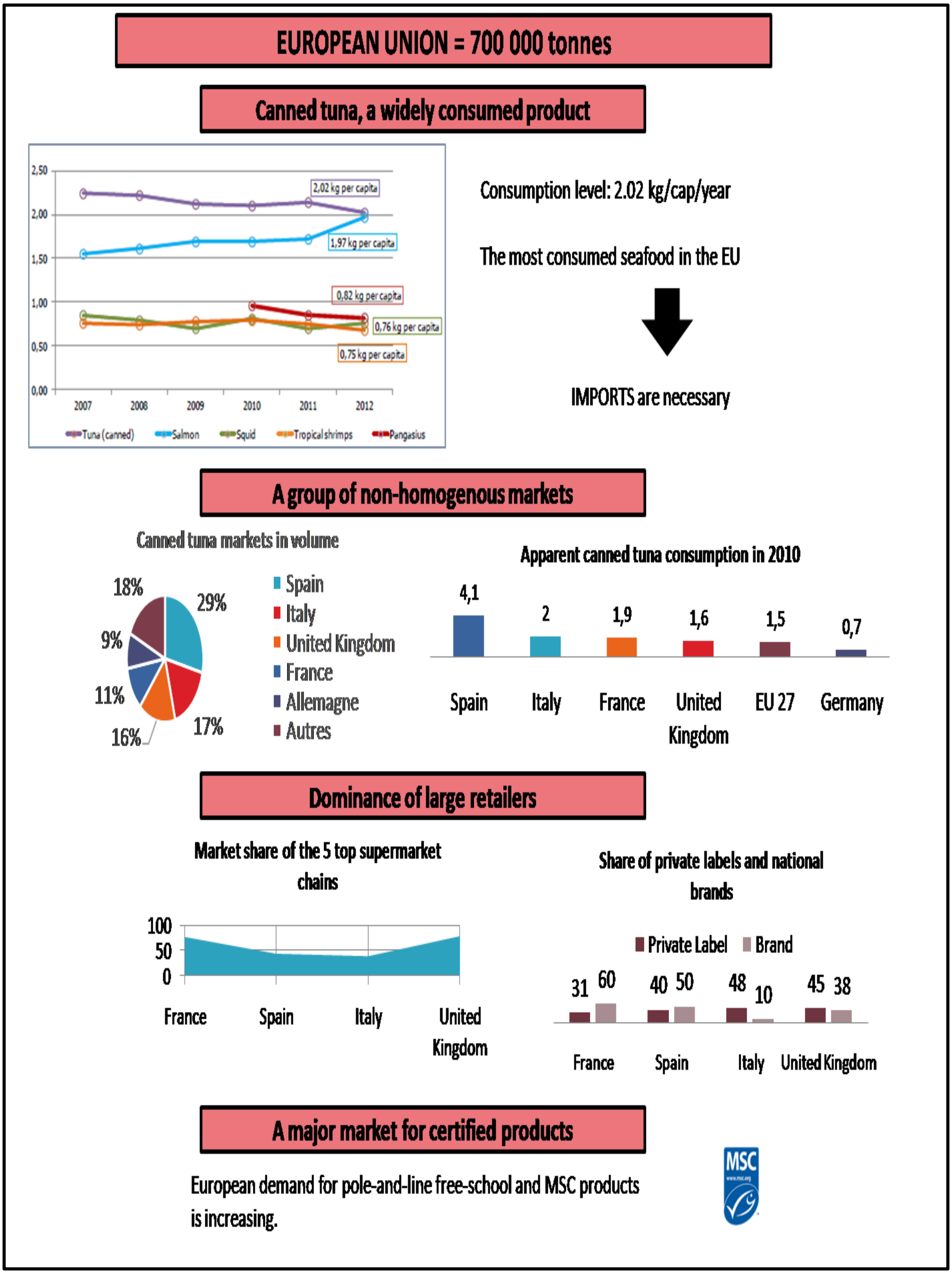


Figure 16: The European Union market (Source: M. Lecomte, based on Hamilton *et al.*, 2011; EUMOFA, 2015; Brus, 2011)

3.2.6.2 The United States market

The US market is the second-largest market in terms of volume after the EU market. It is also one of the longest-standing markets and provided the impetus for the development of the export-oriented tuna-canning industry in Japan and Thailand (Hamilton *et al.*, 2011).

Tuna is the third most frequently consumed fish and seafood product on the American market and represents 37% of all fish and seafood products consumed in the United States in 2013 (INTRAFISH, 2015). In 2015, canned tuna had a household penetration rate of 67% (compared with 72.3% in 2011) (Melbourne, 2016). However, like the consumption of fish and seafood products overall, canned tuna consumption has been declining since the 2000s (Figure 18). As a result, the US market has stagnated in recent years, with an estimated average annual volume of nearly 400 000 tonnes valued at US$ 1.6 billion in 2015 (Campling, Havice and Mc Coy, 2015; Havice, Mc Coy and Campling, 2016).

American demand for canned tuna is relatively inelastic (Daloonpate, 2002). One explanation for this low sensitivity to price variation is that American consumers perceive canned tuna (Guillotreau *et al.*, 2016) as being an inexpensive product for seasonal consumption (Guillotreau *et al.* 2016). Higher or lower prices would not dramatically change consumption levels (Guillotreau *et al.*, 2016).

Given that domestic production is decreasing, the American market is more and more dependent on imports. In 2014, canned tuna production was 177,354 tonnes and accounted for 53% of total consumption (NOAA, 2014). The main source of supply for American canned tuna is Thailand (46% of imports in 2014), then to a lesser extent China (12%) and Vietnam (8%) (ITC Trade Map, 2016).

In the US, the vast majority of canned tuna is sold through retail channels, which concentrate 62% of sales in value. It is a key category in this distribution channel. The average value of the consumer basket is higher when canned tuna is in the basket. This product is used as a loss leader and represents a key product in the retailers' marketing strategies (Melbourne, 2016). Tuna cans are often sold as a promotional item to drive purchase volumes (Atuna 2013b). In this retailing strategy, supermarkets use their private-label brands to increase their profit margin and it is the suppliers who absorb the cost of these promotions (Hamilton *et al.*, 2011).

There are two distinct market segments in the American market: "light meat" tuna and "white meat". The "light meat" (mainly skipjack) is the cheapest product on the market and accounts for the highest sales volumes (68% of sales volume in 2015). The term "white meat" refers to albacore, which constitutes the premium market in the United States. It accounted for 35% of sales in value in 2014 (Melbourne, 2016). The American canned tuna market also breaks down into tuna canned in oil and tuna in brine. In the 1980s, the public's growing awareness of health issues boosted consumption of tuna "in brine" rather than "in oil" (Campling, 2016). Currently, canned tuna in oil represents a small market segment – in 2013, this was no higher than 5% of canned tuna imports (by volume) (NOAA, 2014).

The canned tuna market has an oligopolistic structure in which three brands concentrate 81.5% of sales by volume and 85% of the market in value: *Starkist, Bumble Bee* and *Chicken of the Sea* (Melbourne, 2016). *Starkist* is market leader with 40.5% of market share, followed by *Bumble Bee* (25.6%) and *Chicken of the Sea* (15.4%) (Melbourne, 2016). *Starkist* dominates the light meat segment, while *Bumble Bee* is the leader for white meat tuna (Melbourne, 2016). In December 2015, the US Justice Department blocked the takeover of *Bumble Bee* by Thai Union (which already owned *Chicken of the Sea*), deeming that this merger would have created a monopolistic situation and harmed competition (PDM Seafood Mag, 2015). This shows the level of concentration of the American market. To differentiate themselves from these three tuna giants, the small brands (*Wild Planet, American Tuna*) specialise in sustainable fishing products, proposing only pole-and-line-caught tuna (GLOBEFISH, 2014). This differentiation strategy also corresponds to a recent increase in demand from US consumers for sustainable tuna. From 2012 to 2017 there have been a 10 fold increase in the grocery stores carried pole and line tuna and the sales of those stores of pole and line albacore and skipjack have increased by over 4 times (SUN, 2017). Note that American demand for ecolabelled tuna does not meet the same consumption criteria as those for conventional canned tuna. For example, ecolabelled albacore was perceived as a luxury good for which demand increases more than proportionally as household income rises (Sun *et al.*, 2012).

Finally, in recent years the US market has increasingly turned to tuna pouches (Atuna, 2016). In 2014, the pouched tuna market reached a volume of 2 million cases, or 8% of "shelf-stable" tuna sales in volume, equivalent to 15.5% of sales value (Atuna, 2016). The three major brands (*Bumble Bee, Chicken of the Sea, Starkist*) have thus expanded their pouched product lines by adding "gourmet" pouches (Atuna, 2016). Figure 18 summarises the key features of the US canned tuna market.

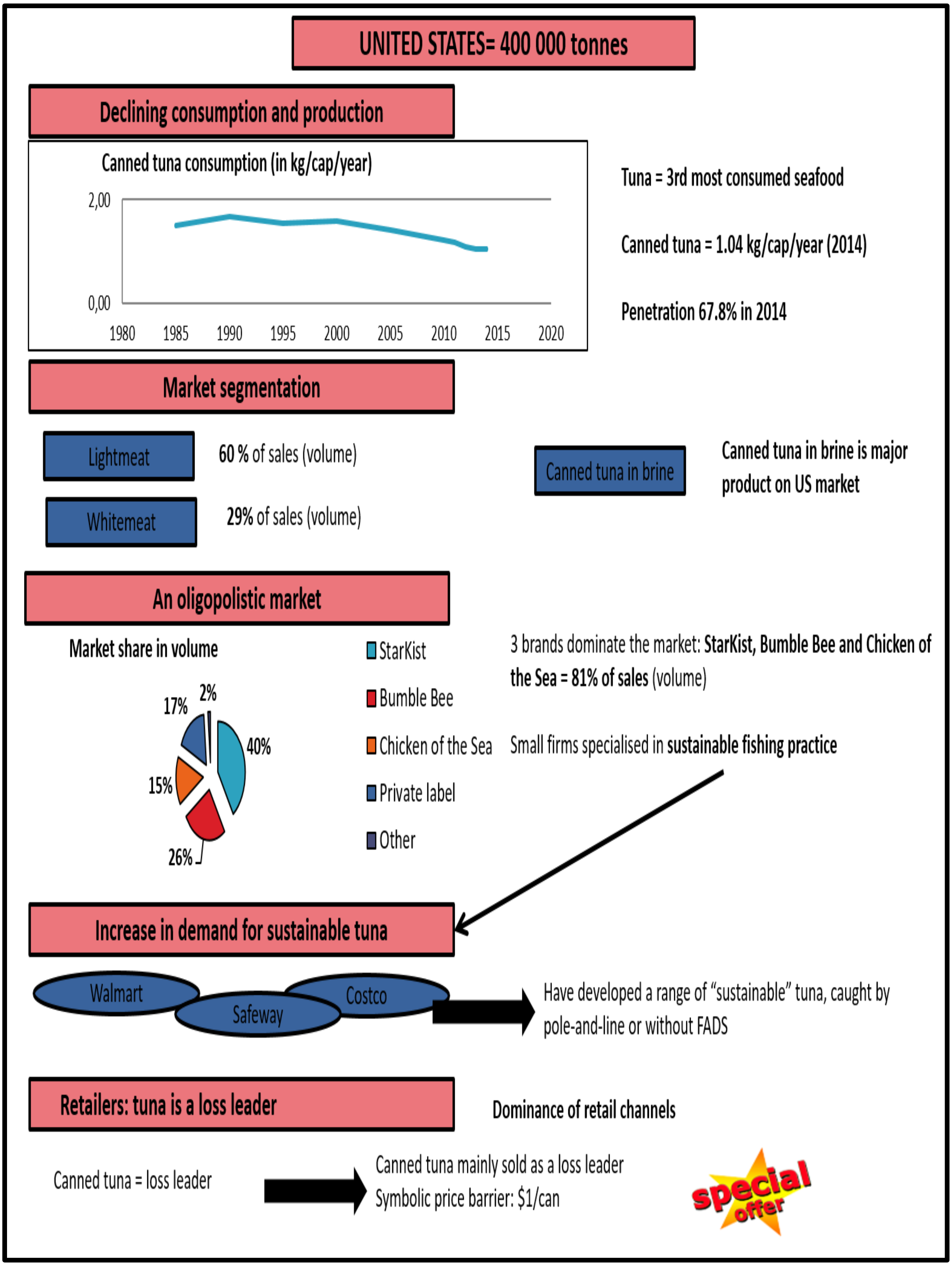


Figure 17:The United States canned tuna market (Source: M.Lecomte, based on Hamilton *et al.*, 2011; Melbourne, 2016; NOAA, 2014)

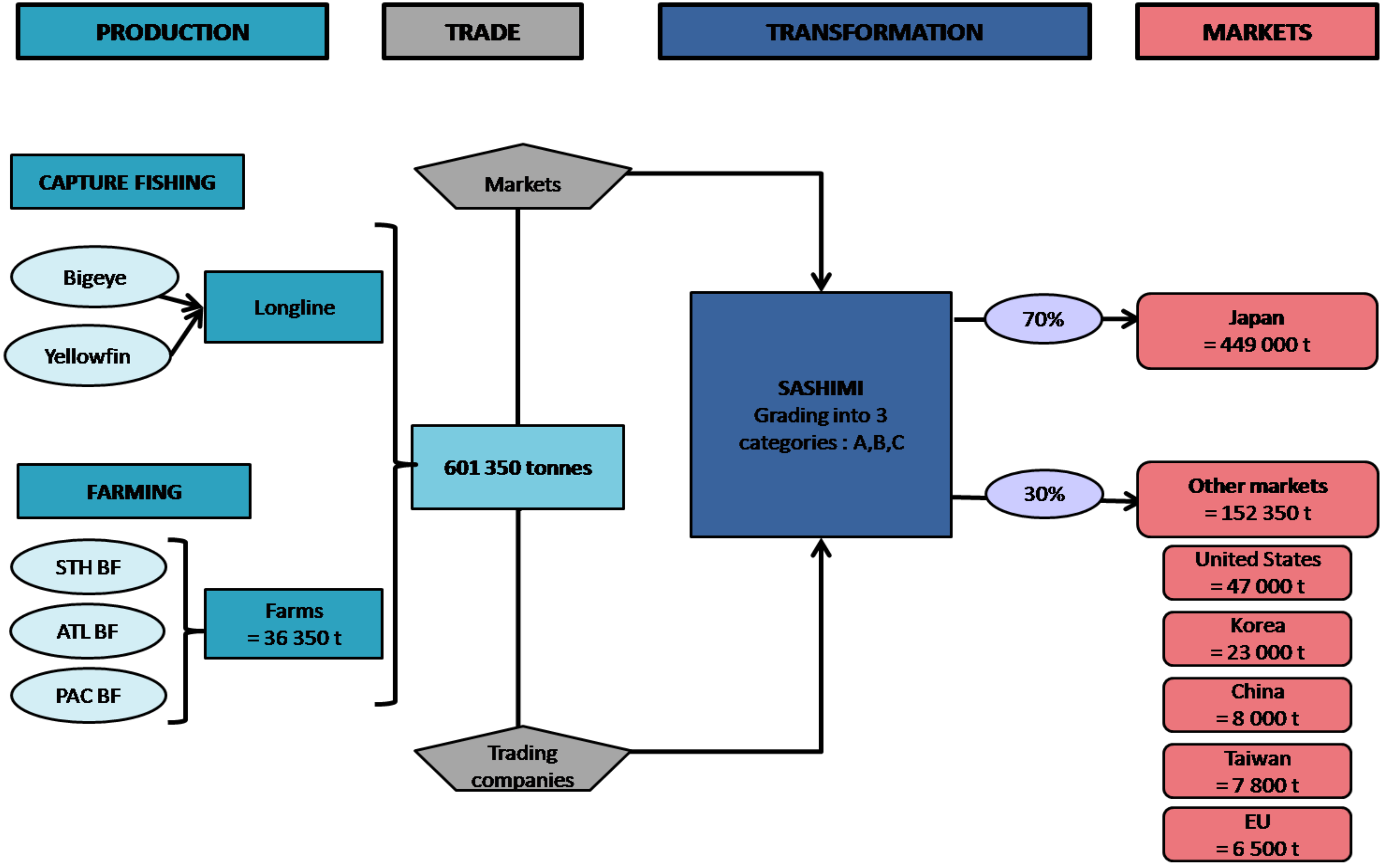
3.3 Sashimi-grade tuna

Sushi and sashimi are internationally known terms but often misused. Sashimi denotes sliced raw fish meat traditionally served with soy sauce, wasabi and condiments. Sushi is made of vinegar-treated rice, garnished with different ingredients: fish, eggs or vegetables. Tuna sashimi is one of the main materials used for sushi.

In the past, the sashimi market was limited to Japan but, in the 1990s, this form of consumption gradually expanded into Europe and North America. Japan nonetheless remains the largest (both by volume and value) and most influential market (Miyake, Guillotreau and Sun, 2010).

International trade statistics tend to lump together into the category tuna destined for sashimi and other forms of tuna for direct human consumption (i.e., loins or fillets). It is thus very difficult to separate out these two markets (Miyake, Guillotreau and Sun, 2010). In this section, we consider only the sashimi market, attempting to exclude as far as possible other forms of tuna for direct human consumption. Figure 19 shows how this sector is organised.

Figure 18: The sashimi sector (Source :M. Lecomte, based on Hamilton *et al.*, 2011; Macfadyen *et al.*, 2016; Tveteras and Nystoyl, 2015)



3.3.1 Sashimi-grade tuna production: the longline fleet and fattening farms

The main species used for sashimi are the three bluefin species (Atlantic bluefin, Pacific bluefin and Southern bluefin), followed by bigeye and, to a lesser extent, yellowfin and albacore. Most of the tuna destined for the sashimi market is caught by the longline fleet, while fattening farms supply most of their bluefin tuna to the Japanese market.

Currently, the world's longline fleet comprises 944 vessels (OPRT, 2015) and in 2014 their catches accounted for 11% of global catches (Macfadyen, 2016). The largest fleets are Taiwanese (285 vessels) and Japanese (213 vessels), which alone account for half of the world's longline catches (Hamilton *et al.* 2011). However, over recent years, the distant-water longline fleet has been declining in the Pacific and Indian Oceans (Guillotreau *et al.*, 2016). This decrease is linked to stringent conservation measures, the reduction of the fleet's fishing capacity and the rise in fuel prices (Guillotreau *et al.*, 2016). On the other hand, inshore longline fleets have been increasing in recent years, their share of global catches rising from 15% in the 1970s to 30% in the early 2000s (Guillotreau *et al.*, 2016). Many coastal countries have in fact increased their longline fleet, principally to target the export of fresh sashimi.

Japan is the biggest market for bluefin tuna worldwide: it consumes almost 90% of the bluefin catches (GLOBEFISH, 2017). The main source of bluefin for the Japanese market is farmed production, which accounts for 86% of bluefin imports to Japan. The chief sources of supply for Japan are Australia (8,893 tonnes) and Mexico (5,415 tonnes) (Sanada, 2015).

Combining these two types of production, the total supply of sashimi-grade tuna stood at 601,350 tonnes in 2014 (Table5).

Table5: Global sashimi supply (Source: ISSF, 2016; Tveteras and Nystoyl, 2015)

Type of production	Volumes produced in 2014
Longline fishing	565 000 tonnes
Fattening farms	36 350 tonnes

3.3.2 Classification of tuna for the sashimi market

The sashimi market (and more specifically the Japanese market) is complex and sensitive to the species, quality and origin of the fish, as well as the amount of fish in cold storage (Miyake *et al.*, 2010).

Tuna destined for sashimi are inspected and graded on a scale from A to C (A denoting the highest grade and C the lowest) according to various quality attributes: freshness, colour, fat content and shape (Blanc, 2002;Carroll, Anderson and Martinez-Garmendia, 2001). This classification provides a common language that simplifies communication between sellers and buyers and facilitates sorting the fish for different markets and forms of consumption (Bartram, Garrod and Kaneko, 1996). This grading also integrates the effects that the fishing gear type, the on-board handling and storage have on the quality of the fish(Bartram, Garrod and Kaneko, 1996). The variations in price according to the quality of the tuna are extremely high and quite unlike other markets (Miyake *et al.*, 2010). Each of the grades is linked to the end uses and the different markets (Bartram, Garrod and Kaneko, 1996). Grade-A tuna is generally sent headed and gutted to the Japanese and US markets. Grade-B tuna is usually processed into loins and exported to the EU and US markets, while grade C tuna is destined for the other sashimi markets or consumed fresh.

3.3.3 Global sashimi markets

The global sashimi market is estimated at 601 350 tonnes annually (in live weight) (Kawamoto, 2016; Hamilton *et al.*, 2011). Japan, the world's largest market, accounts for more than 80% of consumption. As such, the market has been described by some authors as a monopsony (Yamashita, 2006). The United States, in second position with 47,000 tonnes, is a growing market. Secondary markets are gradually developing in East Asia given the increasing popularity of Japanese gastronomy in these countries (Kawamoto, 2016). These sashimi markets are also globally integrated and linked to the Japanese market (Pan, Sun and Squires, 2010; Guillotreau *et al.*, 2016). The principal market place for sashimi-quality tuna is the Tsukiji wholesale fish market in Tokyo, where the tuna for the sashimi market are sold by auction.

3.3.3.1 The Japanese market

The Japanese sashimi market was estimated at 449,000 tonnes in 2014 (Kawamoto, 2016). Until the 1980s, the main source of supply for this market was the domestic fleet. Thereafter, declining tuna catches in the Pacific Ocean led to an increasing reliance on imports (Tada and Harada, 2009). After 1990, due to the collapse of southern bluefin catches, imports of wild bluefin have gradually been replaced by farmed bluefin either from Japanese farms or imported from other countries (Tada and Harada, 2009).

Currently, the Japanese tuna market is stagnant due to changes in consumer purchasing preferences and declining household incomes (Campling and Havice, 2013). Over the past ten years, the amount of tuna consumed (all forms of consumption combined) has fallen by 25% (Kawamoto, 2016). The sashimi market has not escaped this trend, with consumption dropping by 30% from 1995 to 2014 (Figure 20). This decline in the sashimi market can be explained by several factors:

- an overall decrease in fish consumption in favour of meat, especially for young consumers (MAFF, 2013);
- the westernisation of consumer preferences (Terazono, 2016);
- the declining popularity of tuna for sashimi consumption (Hamilton *et al.*, 2011);
- a decrease in consumer income levels since the economic recession (Hamilton *et al.*, 2011);
- saturation of the sushi-bar market (Benetti, Partridge and Buentello, 2015).

Given the combination of these different factors, the Japanese sashimi market is declining and demand is not likely to pick up in the foreseeable future. On the other hand, the growth of sushi restaurants worldwide could offset this stagnation of the Japanese market (Benetti, Partridge and Buentello, 2015).

Most of the tuna sold on the Japanese market is frozen, harvested by Japan's distant-water fleet or imported. Fresh tuna is mainly sourced from catches by Japan's inshore fleet. The three bluefin species (*maguro* in Japanese) are the most sought-after on the Japanese sashimi market and bring in the highest prices.[10] Fresh Atlantic bluefin tuna is considered to be the topmost quality product on the Japanese markets (Benetti, Partridge and Buentello, 2015). Farmed and frozen tuna, on the other hand, is not viewed as a high-quality grade and is directed to the mid-end market (Benetti, Partridge and Buentello, 2015). In terms of quality, bigeye ranks second after bluefin and accounts for most tuna on the sashimi market. It is the leading species present in sales channels and regularly consumed by Japanese households (OPRT, 2016). Albacore and yellowfin are also used for the mid- and low-end sashimi markets.

The distribution channels on the Japanese market are complex and depend on the species and their origin (domestic or imported). Imported tuna generally pass through trading companies, which then sell the fish to processors or wholesale markets (Kawamoto, 2016). Some low-grade tuna imports are sold directly to retailers (Miyake *et al.*, 2010). Tuna caught by the domestic fleet is sold on markets at the landing ports either by auction or directly to the food service industry or retail stores. Tuna sold in auctions is channelled to the wholesale markets (for premium-quality tuna) or sold directly to retailers who then sell on to supermarket chains, the food service industry and retail stores (Kawamoto, 2016). Figure 20 summarises the key features of the Japanese sashimi market.

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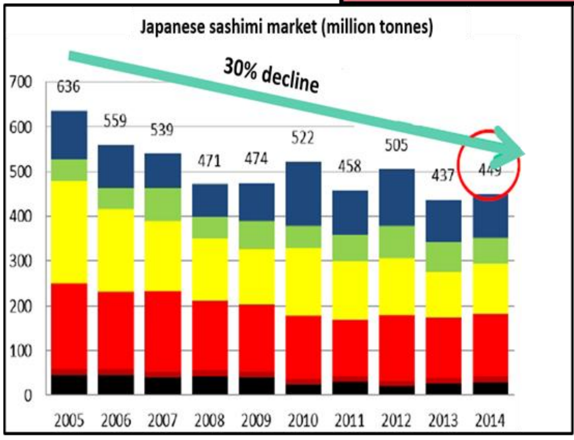
[10] The first bluefin tuna of the year in 2016 auctioned on Tsukiji market fetched the price of €108 500 (i.e., €503/kg).

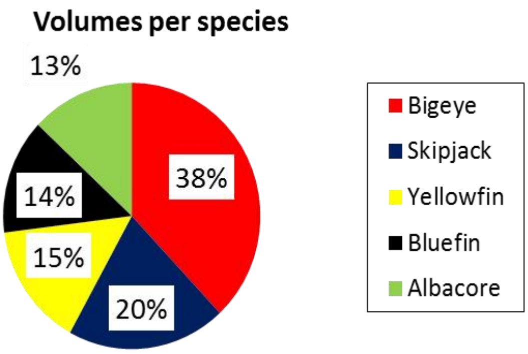
JAPAN = 449 000 tonnes

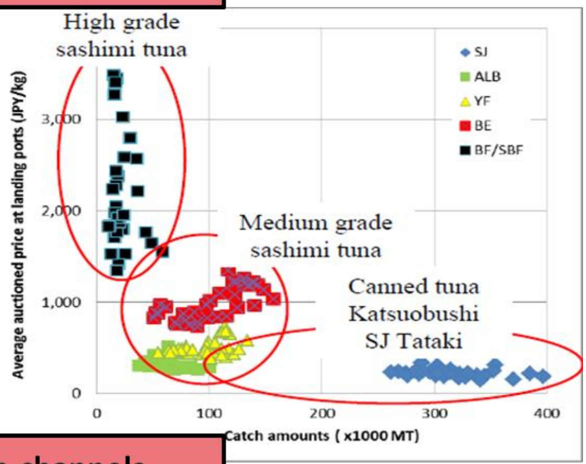
Declining consumption



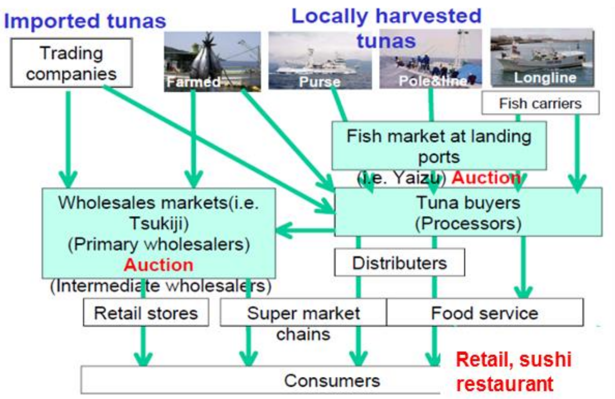
- Decline **in fish consumption**
- **Westernisation** of consumer preferences
- Drop in **popularity** of sashimi tuna
- Decrease **in household income**
- **Saturation** of sushi bar market

Market segmentation





Distribution channels



Complex distribution channel dependent on :

- Origin (imported/domestic)
- Species
- Quality

Figure 19: The Japanese sashimi market(Source: M. Lecomte, based on Hamilton *et al.*, 2011; Kawamoto, 2016; Benetti, Partridge and Buentello, 2015)

4. The key factors influencing the global tuna market

The tuna industry is a globalised industry and its supply chains are influenced by numerous actors (States, markets, civil society) that intervene at different levels of the chain. The global tuna market is impacted by a great many factors (Miyake *et al.*, 2010), notably by standards, tariff systems and the trends in consumer preferences for sustainable products.[11]

4.1 Standards

4.1.1 The Regional Fisheries Management Organisations role in managing production

Tuna production, both in terms of capture and farmed production, is regulated by regional fishing management organisations (RFMOs). These are intergovernmental bodies whose members come from “coastal” countries in the zone in question and “fishing” countries with interests in the region’s fisheries. Except for the Commission for the Conservation of Southern Bluefin Tuna (CCSBT), which is species-specific, the tuna RFMOs manage tuna stocks on the basis of geographical zone. The five tuna authorities are listed in Table6 below.

[11]Note also that another key factor impacting the tuna industry relates to the exchange rate of the three main currencies used by the industry: the US dollar, the European euro and the Japanese yen (Guillotreau *et al.*, 2016). These three monetary zones correspond to the main areas of tuna consumption. For example, if the dollar depreciates against the euro, this makes tuna products from Central America more competitive than European tuna products (Miyake *et al.*, 2010; Guillotreau *et al.*, 2016).

Table6: List of tuna RFMOs (Source: ISSF, 2016)

Jurisdiction	RFMO	Targeted species and associated stocks	Number of stocks
Atlantic Ocean	International Commission for the Conservation of Atlantic Tunas (ICCAT)	Bigeye (1) Yellowfin (1) Skipjack (2) Atlantic bluefin (2) Albacore (3)	9
Indian Ocean	Indian Ocean Tuna Commission (IOTC)	Bigeye (1) Yellowfin (1) Albacore (1) Skipjack (1)	4
Pacific Ocean	Western and Central Pacific Fisheries Commission (WCPFC)	Bigeye (1) Yellowfin (1) Skipjack (1) Albacore (1)	4
	Inter-American Tropical Tuna Commission (IATTC)	Bigeye (1) Yellowfin (1) Skipjack (1) Pacific bluefin (1) Albacore (1)	5
Austral ocean	Commission for the Conservation of Southern Bluefin Tuna (CCSBT)	Southern bluefin (1)	1

These RFMOs are mandated to ensure sustainable exploitation of fish stocks. To do so, they establish conservation and management measures that may entail (Dross, 2013):

- limits placed on the quantities fished (total allowable catch - TAC) or on the fishing effort (number of vessels, the duration of fishing activities);
- technical measures (authorised fishing gear);
- measures relating to control (inspections, observations, catch reporting) and sanctions;
- environmental measures to reduce by-catches or protect vulnerable marine ecosystems (Wright *et al.*, 2014).

These conservation and management measures are binding for fishing fleets, and in some cases for the fattening farm business. The rules, especially those regarding TACs or fishing bans, have a direct impact on production in the tuna industry. The most strictly managed fisheries are those targeting bluefin tuna, whose stocks have reached critical levels.

4.1.2 The fight against illegal, unreported and unregulated fishing

At the global level, the estimates for illegal, unreported and unregulated (IUU) fishing[12] range between 11 and 26 million tonnes per year (i.e., 15% of global catch), leading to a loss of 10 to US$ 23.5 billion annually (Agnew *et al.*, 2009). A study conducted in 2016 on tuna fisheries in the Pacific estimated the total volume of tuna catches through IUU fishing at 306,440 tonnes with a value of US$ 616.1 million (MRAG Asia Pacific, 2016). The fight against IUU fishing involves a great many actors at both the national and international level.

Many RFMOs have adopted measures to combat IUU fishing mainly by reinforcing controls and blacklisting vessels that contravene the rules in force.

In June 2016, 29 States[13]signed the Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (PMSA). This is the first international treaty to expressly cover IUU fishing (FAO, 2016b). The agreement authorises a port State to deny port entry to vessels that it suspects are engaged in IUU fishing activities (FAO, 2016b).

On 1 January 2010, the EU implemented a community-wide system aimed at preventing, deterring and eliminating IUU fishing when it brought into force the Council Regulation EC No. 1005/2008 (European Commission, 2009). This Regulation extends the EU's regulatory powers, notably the DG MARE, over fisheries outside its jurisdiction. In fact, the Regulation covers all seafood products harvested by vessels operating under the jurisdiction of EU member States, as well as vessels operating on the high seas or

[12]IUU fishing denotes illegal, unreported and unregulated fishing. Illegal fishing denotes fishing conducted by fishing vessels in contravention of national and international laws and regulations. Unreported fishing denotes activities that have not been reported or misreported to the relevant national authority or RFMO. Unregulated fishing denotes fishing activities conducted in the area of application of an RFMO by: vessels without nationality, or by those flying the flag of a State not party to that organisation or by a fishing entity in a manner that is not consistent with or contravenes the measures of that organisation (Leroy, Galletti and Chaboud, 2016).

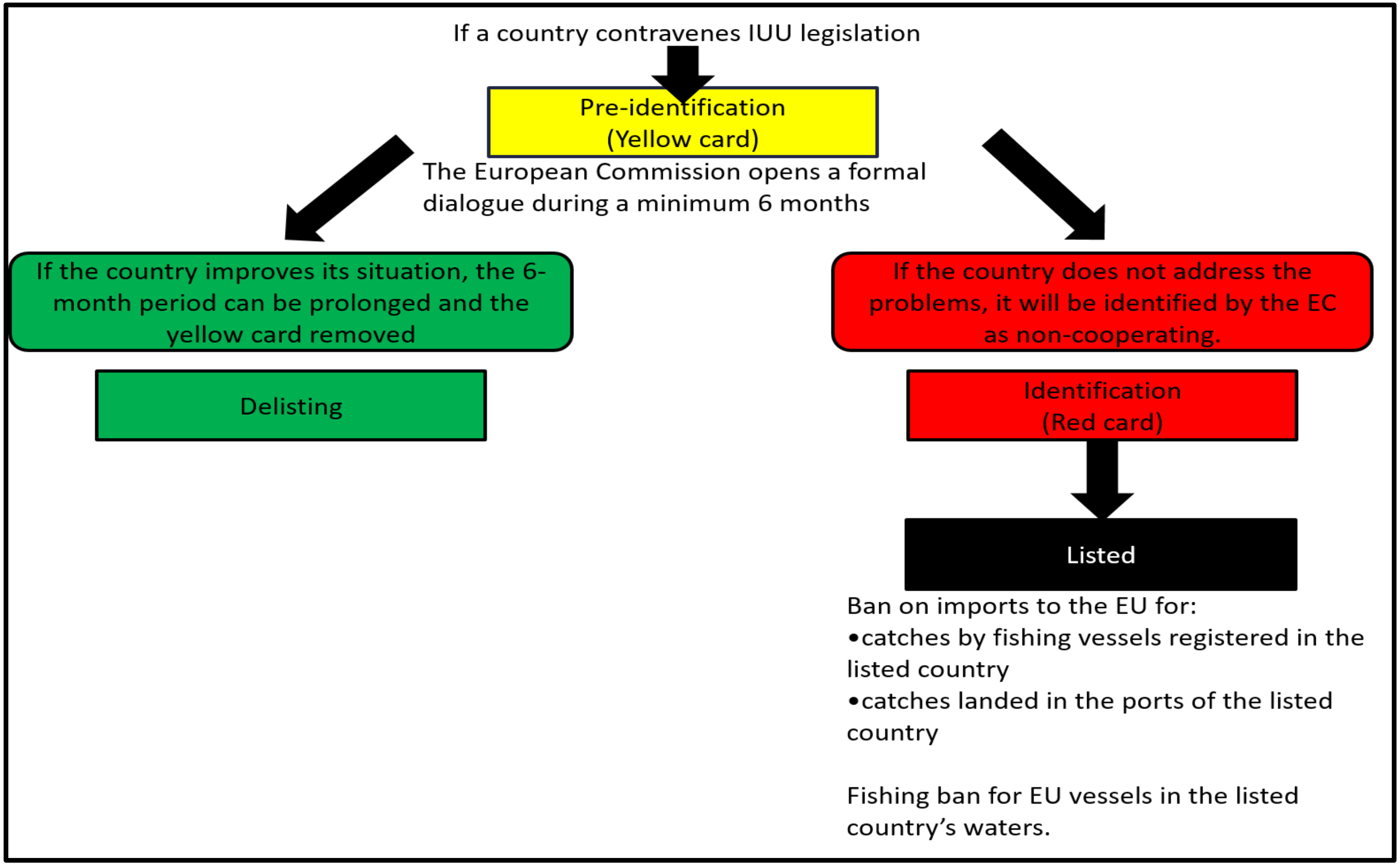
[13]Australia, Barbados, Chile, Costa Rica, Cuba, Dominica, the European Union (as a member organization), Gabon, Guinea, Guyana, Iceland, Mauritius, Mozambique, Myanmar, New Zealand, Norway, Oman, Palau, Republic of Korea, Saint Kitts and Nevis, Seychelles, Somalia, South Africa, Sri Lanka, Sudan, Thailand, Tonga, the United States of America, Uruguay, and Vanuatu.

in waters under the jurisdiction of third countries (non-member States) (European Commission, 2009). Coastal, flag or port States need to meet three conditions (Miller, Bush and Mol, 2014):

- Any fish imported to the EU must be accompanied by a catch certificate; Third countries must have a competent domestic authority that can attest to the veracity of the information contained in the catch certificate;
- Vessels must not be listed among those recognised by the EU as carrying out IUU fishing;
- The fish from third countries identified by the EU as a non-cooperating States are prohibited. Export to the European market of fish from these countries is prohibited and their catch certificate will not be accepted.

The EU has put in place a stepwise approach to establish a list of non-cooperating third countries. If a country does not abide by the European directives to prevent and eliminate IUU fishing, it is first identified and sanctioned with a yellow card (Figure 21).

Figure 20: The European Union’s IUU system(Source: European Commission, 2015b)



The yellow card is delivered as a warning: the country is asked to take firm measures to combat IUU fishing. The yellow card can be withdrawn once the country concerned has adapted their governance measures to combat illegal fishing. Should the country fail to improve its situation (*i.e.*, if it does not implement significant measure to fight IUU fishing), it is considered to be non-cooperating and sanctioned with a red card, which entails a temporary prohibition to export to the European market. In April 2016, Kiribati, Sierra Leone and Trinidad and Tobago received a yellow card warning, while Sri Lanka's red card was lifted. Thailand and Taiwan still have a yellow card(European Commission, 2016b).

4.1.3 Health standards

Tuna consumption has been linked to several health hazards, the most common being histamine poisoning and mercury contamination.

Histamine (or scombroid poisoning) is one of the most common health hazards linked to tuna consumption (IFREMER, 2008). This does not simply involve fish consumed fresh as histamine is a heat-stable molecule that cannot be destroyed by cooking, freezing or smoking (IFREMER, 2008). Canned tuna is thus also concerned by this type of infection. In 2013, the Hagoromobrand recalled 6.72 million de cans of tuna that had excessive histamine levels (Atuna, 2013).

Tuna consumption can also lead to mercury poisoning, whatever the species of tuna consumed and regardless of whether they are canned or fresh. However, the risk of poisoning is higher for sashimi tuna as the selected fish are larger and thus more likely to have accumulated high mercury levels (Josupeit and Catarci, 2004). The issue of mercury is particularly present on the US market, where public campaigns covering the impact of mercury on human health are frequently organised. These campaigns have a direct impact on US tuna consumption but, once a campaign has finished, the effects only last for a short time (Miyake *et al.*, 2010; Guillotreau *et al.*, 2016).

As with all foodstuffs, tuna-based products are subject to health standards that impact access to some markets for tuna-based products. EU health regulations are one of the most complex and stringent conditions for third countries wishing to export their fish and fishery products to the Community market (Blaha, 2016). For instance, to access the European market, canned tuna products must have been produced in conditions regarding hygiene and control standards that are "*at least equivalent*" to those in force in the EU. Companies that process tuna-based products must thus implement an

HACCP[14] system that is certified by the national competent sanitary authority that is recognized by European health authorities (CBI, 2015). Upgrading processing units and maintaining sanitary standards may prove very costly for third countries and impact their competitiveness on international markets.

4.2 Tariff regimes and how they influence market access

By setting special tariffs on certain products, trade and tariff policies directly influence not only market access for processed products, but also the location of production activities.

Customs tariffs impact the trade of tuna-based products either directly via the implementation of import/export restrictions or indirectly via the setting up of tariff barriers. These customs tariffs thus impact not only producers' competitiveness but also the location of processing units (Campling, 2016).

For the tuna supply chain, trade regimes have most impact on the canned tuna industry. In this sector, the two most impactful trade regimes are those of the EU and the US. In fact, these two markets represent72% of the global canned tuna market (in volume) and both have large canning facilities on their territories. The Japanese trade regime has less impact given the relatively low level of tariff barriers to processed fish(9% against 16% for the EU and 20% for the US) and the smaller market volume (around 100,000 tonnes) (Campling, 2016). The following paragraphs will thus address the US and EU tariff regimes.

In general, each country has two types of customs regime:

- A most-favoured-nation system, which defines the general tariff terms and conditions applicable to all third countries;
- Preferential trade arrangements, which comprise unilateral or reciprocal agreements and provide preferential tariffs for the countries concerned.

4.2.1 The general system: a tariff escalation policy for tuna-based products

Analysis of the general tariff policies of the US and the EU shows the existence of a tariff escalation policy for tuna-based products: the higher the level of processing, the higher the applicable tariffs (Campling, 2016). The tariff for round tuna imports destined for processing is zero, whereas that for imports of canned tuna is 24% in the EU and 35% in the US (Campling, 2016). The introduction of these

[14] The HACCP (Hazard analysis and critical control point) system is based on seven principles aimed at identifying, assessing and controlling the significant hazards regarding food safety and setting up control systems (FAO, 1997).

policies can be explained by the weight of domestic canneries in both countries. The tariffs enforced are a way of protecting the domestic processing industry and discouraging the development of processing activities in the countries supplying the raw material (Campling, 2016).

4.2.2 Preferential tariffs that influence the location of canneries

In both the United States and Europe, the above-described general system allows for exemptions under the preferential trade arrangements. These may be unilateral agreements under a generalised system of preferences (GSP),or reciprocal agreements in the form of free trade agreements (FTAs) (Oceanic Development, Poseidon Aquatic Resource Management Ltd, and MegaPesca Lda, 2005).

The EU's preferential tariff arrangements allow for tariff exemptions for imports subject to clauses of origin (usually called the rule of origin): tuna used as raw material must also originate in the beneficiary country. This rule of origin is based on the "wholly obtained" rule. Under the Africa, Caribbean and Pacific (ACP) and GSP regimes, this rule is defined as follows (Commission Européenne, 2014):

- All fish is automatically "wholly obtained" when caught within the territorial waters (12 nautical miles from the coast) of the beneficiary country;
- If the fish is caught outside these territorial waters (i.e., in the EEZ or high seas), it may be considered to originate in the beneficiary country concerned (or in the European Union) if: the vessel is registered or recorded in and flagged by the beneficiary (or by an EU member State), and meets one of the following conditions: a) it is at least 50%-owned either by nationals of the beneficiary country or of a member State, or b) it is owned by a company whose head office and main economic activities are located in the beneficiary country or in a member State and which is at least 50%-owned by the beneficiary country, by a member State or by public authorities or nationals of the beneficiary country or a member State;
- This fish must then be processed in canneries located on the territory of the beneficiary country.

These preferential arrangements are summarised in Table 7 below.

Table7: Trade preference systems in the European Union and the United States (Source: Campling, 2016; Dross, 2015; European Commission, 2015a)

<table>
<tr><th colspan="4">European Union</th></tr>
<tr><th colspan="2">Preference system</th><th>Countries concerned</th><th>Associated tariff reductions</th></tr>
<tr><td rowspan="3">Generalised Scheme of Preferences (GSP)</td><td>Standard GSP</td><td>30 developing countries (Indonesia, Vietnam)</td><td>Customs duties are reduced to20.5% instead of 24% for loins and canned tuna</td></tr>
<tr><td>GSP+</td><td>13 developing countries identified as “economically vulnerable” (Philippines)</td><td>Full removal of tariffs for countries that ratify and implement core international conventions on human and labour rights, environment and good governance
Duty-free access for canned tuna and tuna loins instead of the 24%duty on exporting countries.</td></tr>
<tr><td>EBA (Everything but Arms)</td><td>49 least developed countries (LDCs)</td><td>Duty-free and quota-free access to all products (except arms and ammunitions)</td></tr>
<tr><td colspan="2">ACP countries and Economic Partnership Agreements (EPA)</td><td>79 countries</td><td>Duty-free access and simplified rules of origin</td></tr>
<tr><th colspan="4">United States</th></tr>
<tr><td colspan="2">Preference system</td><td>Countries concerned</td><td>Associated tariff reductions</td></tr>
<tr><td colspan="2">GSP</td><td>Developing countries</td><td>Duty-free access, except for canned tuna, which is a product subject to a Most Favoured Nation (MFN) tariff rate</td></tr>
<tr><td colspan="2">Free trade agreements</td><td>20 countries</td><td>Duty-free access</td></tr>
<tr><td colspan="2">Island territories</td><td>(Puerto Rico and American Samoa)</td><td>Duty-free access for all exported products provided they do not have more than 70% foreign component value. Exemptions from duties of the US Federal Government and the American Samoa Government</td></tr>
</table>

Accordingly, the countries supplying the EU and the US imports of staple tuna products reflect these preferential tariff arrangements. The EU's main suppliers are Ecuador (free-trade agreement), Thailand (most favoured nation), Mauritius (economic partnership agreement), the Seychelles (economic partnership agreement) and the Philippines (GSP+) (Campling, 2016). In total, 75% of canned tuna benefit from duty-free access to the European market *via* these preferential regimes (Campling, 2016; Dross, 2015).

4.2.3 Conclusion regarding tariff policy

In both the US and the EU, the general tariff escalation policy enables domestic canners to source supplies of raw materials at a low price, from anywhere in the world. On the other hand, canneries based in countries benefiting from an ACP or GSP+ regime are constrained by the rule of origin. Under the European regime, the rule of origin requires that these canneries process fish caught by vessels belonging to European or national interests. Insofar as countries under the ACP or GSP+ regime do not generally have a domestic fleet, the main beneficiaries of the EU's preferential trade regime are the owners of European vessels, who thus have the advantage of a captive market for their catches (Campling, 2015b).

In 2012, the European Union reformed the generalised scheme of preferences (Regulation 978/2012) which came into effect on 1 January 2014. The most recent changes are:

- Thailand, Ecuador and Maldives are to leave the generalised scheme of preferences as of 1 January 2015, as the World Bank now classifies them as upper middle-income countries;
- As of 25 December 2014, the Philippines can export tuna to Europe duty-free instead of paying the 20.5% import duty.

As for Ecuador, the signing of a free-trade agreement in 2014 along with a regulation that entered into force on 1 January 2015 ensures the continuity of the preference system for Ecuadorian products. On the other hand, Thailand has ceased to benefit from the GSP scheme since January 2015, which means higher import duties on Thai products: for canned tuna, this represents a 3.5 percentage point rise (from 20.5% to 24%). However, in order to benefit from the 20.5% rate, Thailand was required to respect the rule of origin, but now, this is no longer the case (Dross, 2015).

These changes in the generalised scheme of preferences are key for the canned tuna and tuna loins industry. This is especially the case of the changes affecting the Philippines and Thailand, which are two major producers. However, a study conducted in 2015 estimated that, for the time being, supplies to the EU had not been impacted by the recent changes to the tariff regime (Dross, 2015).

4.3 The consumer trend towards sustainable products

4.3.1 The sustainability of tuna products, a concern for consumers

Over the past decade, the sustainability of fish and fishery products has become a major issue for many consumers, especially those in developed countries (Leadbitter and Benguerel, 2014). A survey conducted by Globescan in 2015 revealed that 72% of respondents (seafood consumers) thought that saving the oceans depended on the consumption of "sustainable" seafood products (MSC, 2016b). Within the tuna supply chain, tuna markets are a focus of attention for environmental NGOs, which produce recommended guidelines and organise boycotts of products deemed unsustainable. This concern for sustainability is especially visible in the canned tuna sector and focuses on three main issues (Brus, 2016b):

- The status of tuna stocks;
- The sustainability of fishing techniques, particularly their impact on by-catches;
- The working conditions on board the vessels and in the canneries.

Table 8 illustrates the status of the tuna stocks in terms of species and oceans:

- Allskipjack stocks havebiomass (B) and mortality (F) levels comptatible with the maximum sustainable yield (MSY) levels (Biomass higher than Biomass than MSY and F lower than F at MSY;
- All bluefin stocks have criticalbiomass levels;
- The Mediterraneanalbacore have critical biomass and mortality levels;
- Bigeye stocks in the Atlantic and West Pacific Oceans are at critical biomass and mortality levels;
- Yellowfin are at critical levels in the Atlantic and Indian Ocean, and is not in a good health in East and West Pacific;
- The Atlantic Ocean seems to be the most overexploited and overfished.

This means that it is difficult for consumers to have a clear picture of the sustainability of consumed tuna, given that the status of stocks varies considerably depending on the species and the ocean (Brus, 2016b).

Table8: Summary of the status of the 23 tuna stocks in 2016 (Source :ISSF 2017)

Species	Stock	Catches (10^3t)	Biomass (B)	Mortality (F)
ALBACORE	**TOTAL**	**212**		
	North Pacific Albacore	65	$B>B_{MSY}$	$F<F_{MSY}$
	South Pacific Albacore	68	$B>B_{MSY}$	$F<F_{MSY}$
	North Atlantic Albacore	26	$B<B_{MSY}$	$F< F_{MSY}$
	South Atlantic Albacore	15	$B<B_{MSY}$	$F\approx F_{MSY}$
	Mediterranean Albacore	3	Unknown	$F< F_{MSY}$ (uncertainty of data)
	Indian Albacore	35	$B > B_{MSY}$	$F< F_{MSY}$ (uncertainty of data)
BIGEYE	**TOTAL**	**407**		
	East Pacific Bigeye	105	$B > B_{MSY}$	$F<F_{MSY}$
	West Pacific Bigeye	129	$B<B_{MSY}$	$F>F_{MSY}$
	Atlantic Bigeye	80	$B<B_{MSY}$	$F>F_{MSY}$
	Indian Bigeye	93	$B>B_{MSY}$	$F<F_{MSY}$
SKIPJACK	**TOTAL**	**2 782**		
	West Pacific Skipjack	1828	$B > B_{MSY}$	$F\leq F_{MSY}$
	East Pacific Skipjack	331	$B>B_{MSY}$	$F<F_{MSY}$
	East Atlantic Skipjack	209	$B>B_{MSY}$	$F< F_{MSY}$
	West Atlantic Skipjack	20	$B>B_{MSY}$	$F< F_{MSY}$
	Indian Skipjack	394	$B>B_{MSY}$	$F<F_{MSY}$
YELLOWFIN	**TOTAL**	**1 347**		
	East Pacific Yellowfin	258	$B \leq B_{MSY}$	$F<F_{MSY}$
	West Pacific Yellowfin	573	$B>B_{MSY}$	$F<F_{MSY}$
	Atlantic Yellowfin	109	$B<B_{MSY}$	$F< F_{MSY}$ (large fishing effort)
	Indian Yellowfin	407	$B<B_{MSY}$	$F>F_{MSY}$

	TOTAL	**43**		
BLUEFIN	Pacific Bluefin	11	$B<B_{MSY}$ has not been estimated by SAC.	$F>F_{MSY}$ has not been estimated by SAC.
	East Atlantic Bluefin	16	$B>B_{MSY}$ (uncertainty of data)	$F< F_{MSY}$ (Thanks to TACs and control measures)
	West Atlantic Bluefin	2	$B<B_{MSY}$	$F< F_{MSY}$
	Southern Bluefin	14	$B<<B_{MSY}$	$F< F_{MSY}$

As far as fishing sustainability is concerned, the main consumer concern is the level of by-catches (mainly dolphins, turtles and sharks) and the use of fish aggregating devices (FADs). This technique is strongly criticised as it results in a high volume of by-catches and the catch of juvenile tuna. The UK market is particularly sensitive to this issue and many retailers have committed to discontinuing sales of FAD-caught tuna.

The tuna fishing method advocated by some NGOs as being the most sustainable is pole-and-line. Reputed to be the most selective, this technique entails almost no by-catches. However, as it accounts for only 8% of global catches, more and more retailers have developed product ranges based on tuna harvested using free-school techniques (MSC, 2016a).

Finally, the question of working conditions on fishing vessels and in canneries has only recently emerged in the wake of numerous surveys and news reports on cases of slavery and forced labour in several fish and fishery industries. In the tuna industry, it is mainly Asian fishing vessels and canneries that have been singled out for their poor working conditions (Greenpeace, 2015c).

4.3.2 The development of ecolabels and voluntary commitments

With the issue for sustainability firmly in mind, many ecolabels provide certification for tuna catches and the industry's actors have committed to implementing voluntary standards that best meet consumer concerns.

4.3.2.1 Ecolabels

In addition to the regulations and measures introduced by States and the RFMOs, ecolabels and certification bodies have recently emerged as a means of encouraging fisheries to adopt better fishing practices. This development relies on market forces to create an incentive in terms of price or access to new markets (Gutierrez *et al.* 2016).

Currently, the demand for ecolabelled seafood products is on the rise, particularly in the North American and European markets (Potts *et al.* 2016). The ecolabelling of products has become an increasingly important and even necessary factor to access some markets.

In 2015, certified catches represented 18.6 million tonnes, or 20% of global wild catch seafood, tuna holding third place in certified catches with a 10% share (Potts *et al.*, 2016). Among the labels certifying tuna fisheries, Friend of the Sea (FOS) and the Marine Stewardship Council (MSC) are world leaders in capture fisheries certification, while Dolphin Safe specifically covers the tuna industry. The Fair Trade label is the leading standard for capture fisheries fair trade (Fair Trade, 2016). The first fishery to be awarded Fair Trade certification was the handline-caught Moluccan yellowfin tuna.

These ecolabels have developed very different business models. MSC-certified production is mainly sourced from developed countries and feeds into these countries' distribution channels. FOS-certified production is sourced from developing countries and serves more industrial markets (Potts *et al.*, 2016). The Dolphin Safe label is found on close on 90% of the world's canned tuna.

Table9 summarises the main characteristics of the three ecolabels: MSC, Friend of the Sea and Dolphin Safe.

Table9: Summary of differences between the three leading ecolabels (Source: Miller and Bush, 2015; Potts *et al.*, 2016; WWF, 2012)

Criterion	MSC	Dolphin Safe	FOS
Scientific rigour	3 levels of analysis: principles, criteria and performance indicators	Lack of scientific coherence and a system of standards and criteria for evaluation	Based on FAO guidelines
Accessibility	Certification costly and not readily accessible to developing countries	Very accessible as it involves few changes	Certification inexpensive and accessible to developing countries
Transparency	Public certification methodology Public objections procedure Chain of custody to guarantee traceability	Little communication on the evaluation method No objection procedure	Little information available on governance, independence and organisational structure Objection procedure unclear and not accessible to all
Certification methods	Certification ensured by third-party body with independent auditors	"Self-certification" by skippers	Certifying bodies directly mandated by FOS
Socioeconomic Aspects	Not present	Not present	Present
Impact	"Golden standard"-20% of global tuna catches certified	90% of global canned tuna *Dolphin Safe*-certified Powerful media and market impact	22% of global tuna catches certified

4.3.2.2 The voluntary commitments by the industry's actors

In addition to ecolabels, many of the industry's actors are taking action to promote the sustainability of their business and products. For example, some ship-owners have fixed voluntary limits on the number of FADs they use. This is the case of the French tuna purse-seiners, which have set a limit of 150 active buoys per vessel (cf. the decision no. 10 of 23 November, 2011) (ORTHONGEL, 2011).

Under pressure from environmental NGOs, the media and consumers, an increasing number of large retailers have committed to sustainable sourcing policies. These commitments, directly or indirectly linked to the demands of environmental NGOs, can be divided into three types (Leadbitter and Benguerel, 2014):

- Remove the species/stocks at risk from their supplies;
- Adopt sourcing policies that foster more sustainable/responsible fishing practices – for tuna, the most selective fishing gear is said to be pole-and-line;
- Source supplies from MSC-certified or ecolabelled products.

Table 10 shows the commitments made by some large retailers.

Table10: Commitments of some retailers for sourcing tuna supplies(Source: Leadbitter and Benguerel, 2014; Greenpeace, 2015a; Greenpeace, 2015b)

Country	Retailer	Tuna supply policy
France	Carrefour	Carrefour has committed to source only MSC-certified tuna products
France	Système U	Système U has committed to cease selling tropical FAD-caught tuna by the end of 2016 for products sold under its private-label brands
United Kingdom	Marks & Spencer	All canned tuna sold by Marks &Spencer is pole-and-line-caught tuna
United Kingdom	Sainsbury's	All canned tuna sold by Sainsbury's is pole-and-line-caught tuna
Germany	EDEKA	EDEKA plans to source MSC-certified tuna products
United States	Walmart	Walmart has committed to sourcing only MSC-certified tuna products

As Table 10 indicates, product sourcing policies most often involve increasing ecolabelled products, primarily MSC-labelled products, and appear to offer retailers concrete solutions that can attest to their commitment to sustainability.

In terms of strategy, some retailers (notably German and British) have already committed to sourcing only ecolabelled products (mainly MSC) and plan to ask national brands to do the same (Brus, 2016b).

Other retailers use sustainability as a means for improving the image of their own private-label brands compared to other national brands (Brus, 2016b). In the United Kingdom, some retailers even propose their private labels for certified or pole-and-line/free-school tuna at more attractive prices compared to unsustainable national brands labels (Brus, 2016b). The additional cost for these products is transferred to the unsustainable products and brands in line with the “polluter pays” principle (Brus, 2016b). Many retailers, such as Super U, have also developed their own ranges of canned pole-and-line tuna (Greenpeace, 2015a). More recently, several retailers[15] have sent a letter to the IOTC asking for a 20% reduction in yellowfin catches and the introduction of rules for managing catches (Valo, 2016).

Given this supply policy, which takes unsustainable products off the shelves (in line with some retailers’ commitments), and a pricing policy that proposes more attractive prices for “sustainable” tuna than for “unsustainable” tuna, consumers are encouraged to shift their preference to sustainable tuna products (Brus, 2016b).

4.3.3 Labelling and voluntary commitments: a useful approach – albeit with limited effects

Ecolabel certification and the solutions introduced by some of the industry’s actors do have some limitations, which are presented in Figure 22.

[15] Casino, Carrefour, Picard, Les Mousquetaires, Leclerc, as well as the *John West* and *Mareblu* brands owned by the Thai Union group (Valo, 2016).

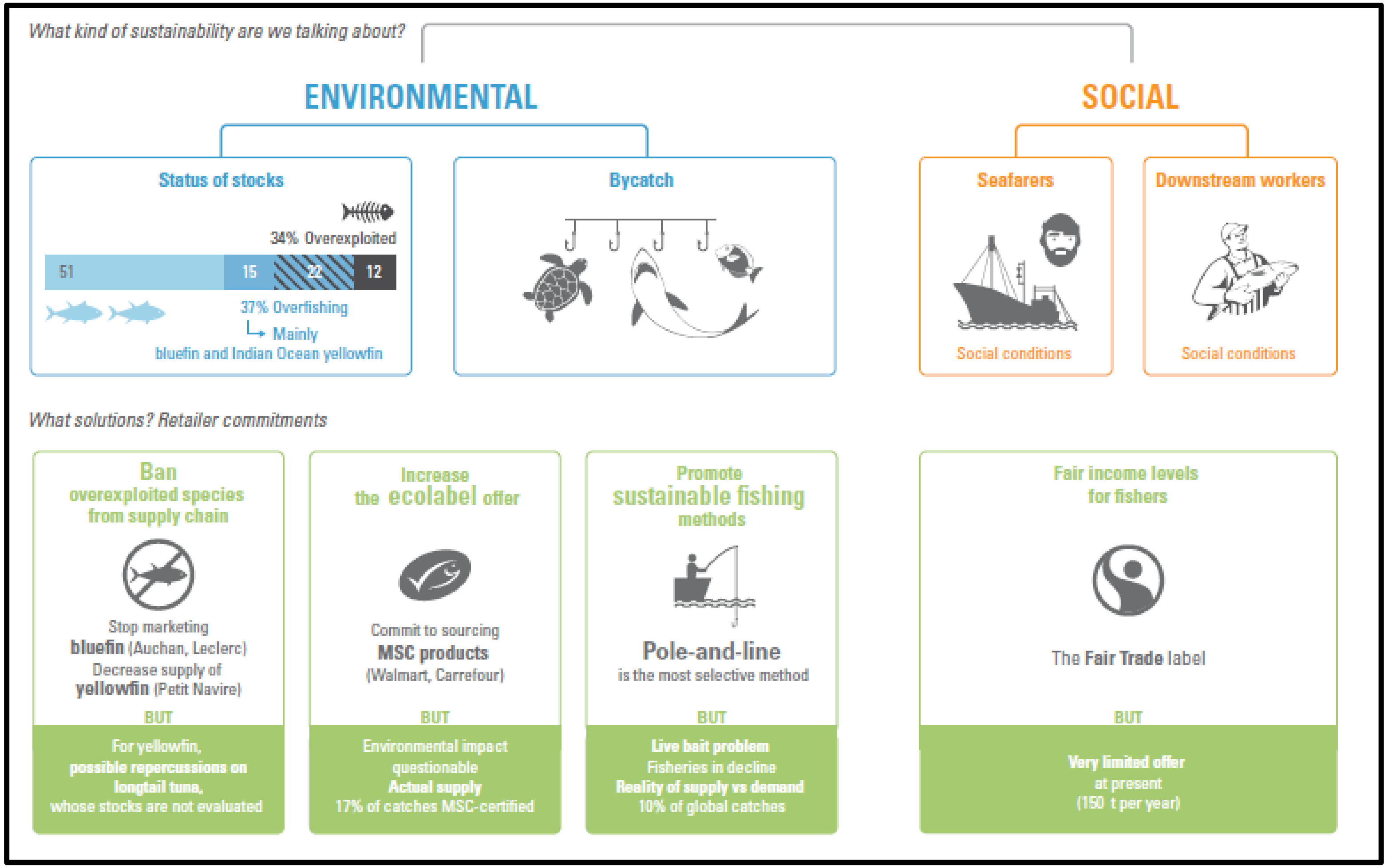


Figure 21: Limits of sustainability approaches (M. Lecomte, based on diverse sources)

The first limitation is that the proliferation of ecolabels and voluntary commitments creates some confusion for consumers, thus presenting a challenge for the credibility of the labelling schemes (Miller and Bush, 2015;Relot and Caillart, 2009).

The second is linked to the reality of supply: MSC tuna catches account for only20 % of the global tuna catch (Potts *et al.* 2016). Pole-and-line fishing, deemed to be the most environmentally sustainable, accounts for only 8% of the global catch(ISSF, 2016). Assuming that all the catches purchased by canneries are canned, this corresponds to a volume of 244,000 tonnes, which cannot even meet US market demand. Moreover, the environmental impact of this fishery on the reef fish used as bait is not negligible (Gillet, 2012). Lastly, this type of fishery has been declining for some fifty years in all of the world's oceans due to high operating costs (labour and fuel) (Gillet,2016).

Apart from Fair Trade, ecolabels certifying catches do not (or very little)cover the social dimensions of production(Potts *et al.*, 2016; Stradoudakis *et al.*, 2016). The MSC label, for example, does not integrate working conditions or wage-related aspects, such as a minimum wage, written work contracts (Potts *et al.* 2016). Likewise, few voluntary commitments take social and economic criteria into account.

Ease of access to obtaining ecolabels also poses a problem. Catch certification has been limited to fisheries already operating in a fisheries management context supported by a robust national management infrastructure (Potts *et al.* 2016). Most certification schemes require that specific management structures and plans, as well as auditing procedures to obtain certification, to be implemented (Potts *et al.*, 2016). As a result, certified fisheries are generally those that already have management frameworks or those with the means and structures needed to rapidly improve their existing management and become eligible for certification (Tlusty, 2012). Fishery size is also an important factor given the high fixed costs involved in the certification process (Potts *et al.* 2016). Additionally, the certification cost and related administrative constraints mean that developing world fisheries find it difficult to access certification (Potts *et al.*, 2016). The FOS and MSC ecolabels do not include specific standards adapted to developing world fisheries and local auditors(Potts *et al.* 2016). The MSC thus primarily certifies developed countries' fisheries and the markets served are mainly those of the EU and USA (Potts *et al.* 2016). In 2015, 89% of the MSC's supply was from developed countries and out of the 3,000 MSC-certified products marketed, 75% were sold in 12 European or North-American countries (Potts *et al.*, 2016).

The credibility of some of these labels is also questionable. Dolphin Safe, which certifies that tuna has not been caught by nets encircling dolphins, has little scientific credibility outside the context of the East Pacific Ocean as this is the only ocean basin where this fishing technique is used (Miller and Bush, 2015; Korber, 1998).

The proven impact of these ecolabels sometimes comes under debate. A 2012 study by Froese and Proelss found, for instance, that some stocks certified by FOS and MSC were actually overfished.[16] According to these authors, 11% of MSC-certified stocks and 53% of FOS-certified stocks did not dispose of enough information to establish stock status or the level of exploitation (Froese and Proelss, 2012). For stocks where information was available, 19% of FOS-certified stocks and 31% of MSC-certified stocks were overfished[17] (Froese and Proelss, 2012).

Furthermore, certification does not necessarily lead to an improvement in the situation of certified fishery stocks. In the case of MSC certification, some stocks with biomass levels below MSY biomass levels did not see their biomass levels increase following certification. In fact, half of the stocks that were overfished in 2011 did not experience an increase in their biomass after certification (Froese and Proelss, 2012). This reason for this seems to be the fact that, once the fisheries had obtained certification, they did not adequately implement improvements. A study by MRAG showed that the biggest change comes about when the fisheries attempt to meet the minimum MSC criteria in order to obtain certification. Once certified, and as long as it holds to these minimum criteria, a fishery does not necessarily put an improvement process in place (MRAG, 2011). Moreover, in the MSC certification system, there is no incentive mechanism spurring fisheries to reach a 100% score (Potts *et al.* 2016).

Finally, there is regular criticism of the lack of transparency in the governance of some ecolabels (Miller and Bush, 2015). The certification process or objection procedures are not always clear or explicit, and objection procedures may be very expensive. For example, the MSC charges USD 8,000 to launch an objection to a certification (Potts *et al.* 2016).

[16] Here, we present the results without taking into account the debate that followed this publication and which mainly focused on how the concept of overfishing was to be defined (see Agnew *et al.*, 2013; Froese and Proelss, 2013).

[17] Reminder: here, we consider that there is overfishing when $B<B_{MSY}$

5. Conclusion

5.1 Tuna, a major global market within the fish and fisheries sector

Today, the production of capture fishing seems to have reached a threshold, and the potential for increasing fish production largely depends on the growth of aquaculture (FAO, 2016b). In tandem, in the space of 50 years, seafood consumption per capita has more than doubled, and population growth coupled with improved living standards in some emerging countries would suggest that consumption is set to rise (Vannuccini, 2012; FAO, 2016b). From 2012 to 2021, the projected rise in fish consumption per capita in developing countries is estimated at 20% (Vannuccini, 2013).

Tuna fisheries production also seems to have reached a threshold, and given the status of some tuna stocks, the possibilities of increasing catches seem limited. In 2014, tuna catches reached 5 million tonnes, with a final consumed value of US$ 33 billion (Macfadyen, 2016). On traditional markets, global tuna demand is dormant, while new markets are developing a certain appetite for tuna, mainly in the emerging countries (Campling, 2015; Miyake *et al.*, 2010). The growth in demand for canned tuna is in the order of 3% annually (Mullon *et al.*, 2016). The tuna supply chain is one of the largest in the fish and fisheries industry, accounting for 5% of the total fish industry and 4% of capture fisheries production (Figure 23).

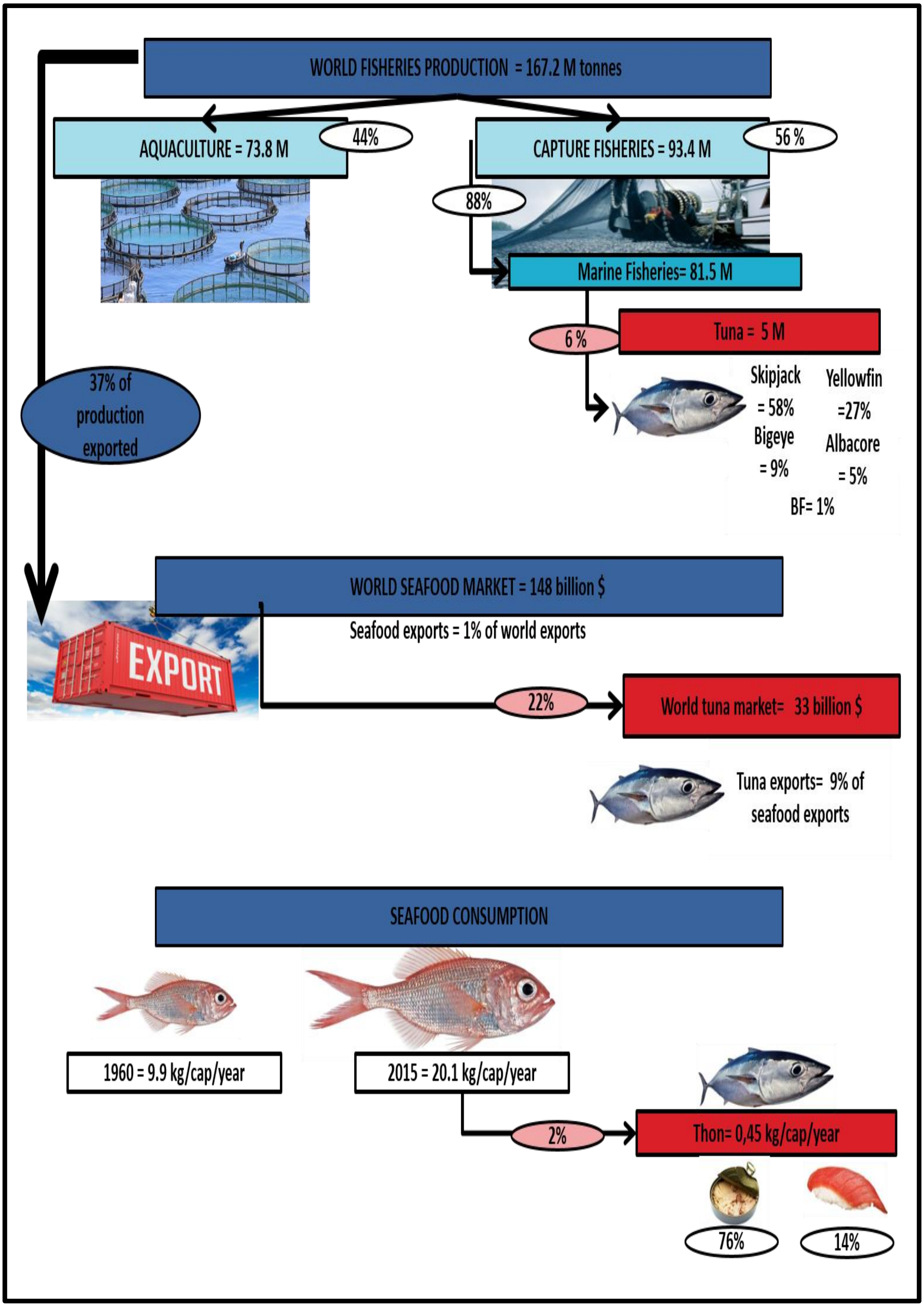


Figure 22: Global aquaculture and fishery production and the tuna supply chain (Source: M. Lecomte, based on FAO, 2016b; Macfadyen *et al.*, 2016)

5.2 A global market involving numerous actors

The tuna supply chain is a global industry, with fishing zones spread over all of the world's oceans, processing factories on every continent, and a variety of end markets (Barclay, 2010;Josupeit and Catarci, 2004). Figure 24 presents an overview of how this supply chain is organised.

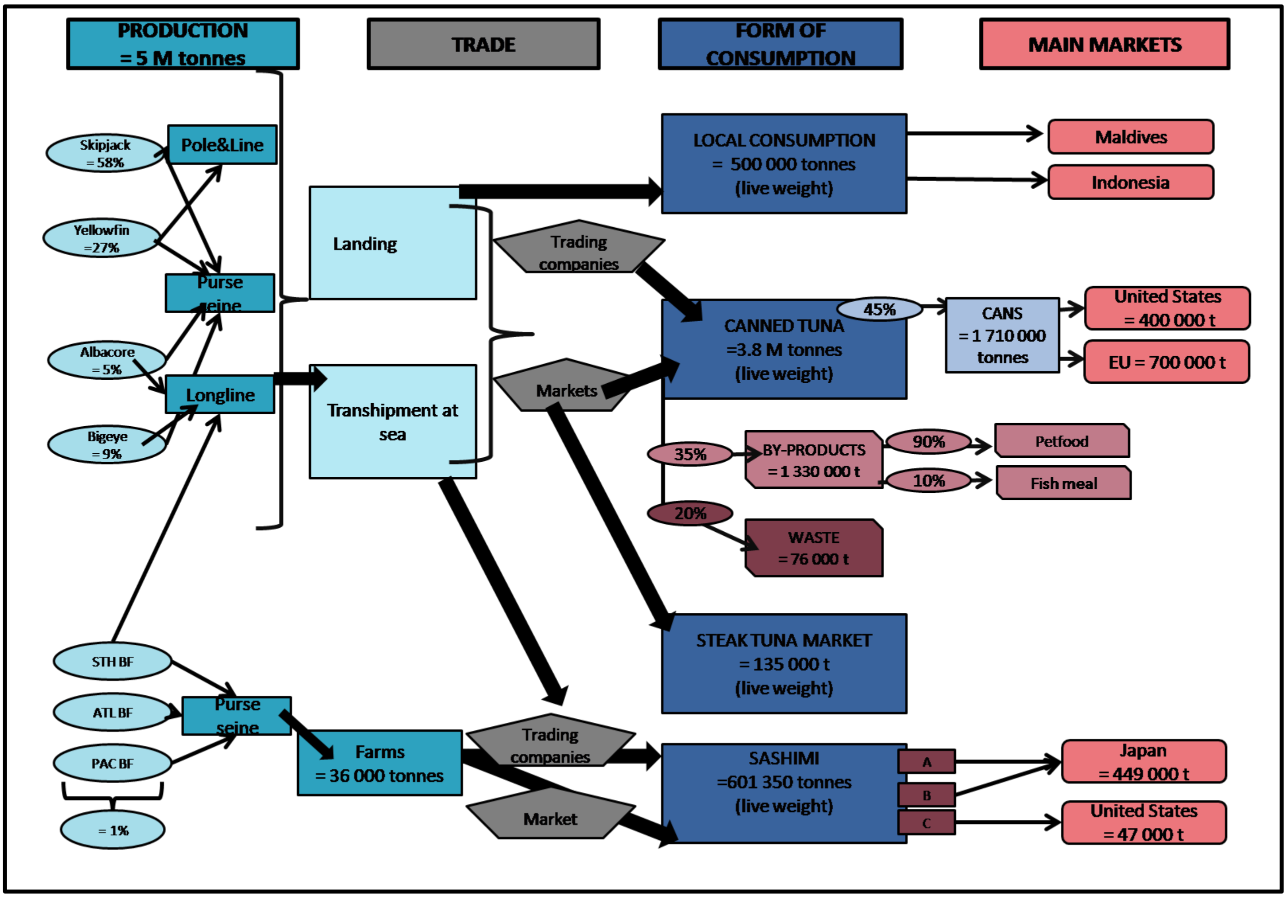


Figure 23: The tuna supply chain (Source: M.Lecomte, based on Macfadyen *et al.*, 2016; Macfadyen, 2016; Hamilton *et al.*, 2011)

As for production, the main fleets are purse-seiners and longliners. They are mostly industrial-scale fleets that typically require a high level of investment (a new tuna seiner may cost €20 million). Whereas seiners target tuna species such as skipjack and yellowfin destined for canning, longliners target higher-value species, mainly bigeye and albacore destined for the sashimi market.

The catches are sold directly on international markets, either through companies directly linked to the fleets or through trading companies. The latter are particularly important for the Thai canners and for the buyers supplying the Japanese sashimi market (Hamilton *et al.*, 2011).

Canned tuna represents the largest market segment, and takes up 76% of global tuna catches (Macfadyen *et al.*, 2016). As a global commodity, canned tuna is widely distributed on international markets (Macfadyen and Defaux 2016). Generally, the demand for canned tuna varies according to the species, the distribution channels and to whether or not the product is ecolabelled (Guillotreau*et al.* 2016).

Sashimi-grade tuna, formerly limited to the Japanese market, is now developing on other markets, especially in the United States (Miyake *et al.*, 2010). This tuna constitutes a high-end segment and over the period 2011–2012, prices for sashimi tuna were five times higher than those for round tuna destined for canning (Guillotreau *et al.*, 2016).

Some fishing countries (mainly Indonesia, the Maldives, Sri Lanka and some Pacific islands) are also important markets for tuna, which is consumed in a variety of forms: fresh, dried, salted or smoked (Macfadyen and Defaux, 2016). Of the 500,000 tonnes destined for the local consumer market, 200,000 tonnes were sourced from the Western and Central Pacific, 100,000 tonnes from the West Indian Ocean and 127,750 tonnes from the East Indian Ocean (Macfadyen and Defaux, 2016).

5.3 The canning industry, between horizontal and vertical concentration

The canned tuna sector is characterised by its high level of concentration, both horizontal and vertical (Guillotreau *et al.*, 2016), which can be explained by the tension between the need for a low-price product and the rise in operating costs for fishing and processing activities (Guillotreau *et al.*, 2016).

5.3.1 Buyer concentration and the weak bargaining power of the fleets

Purse-seiner tuna catches are bought by trading companies or canneries that are usually owned by vertically integrated firms. These buyers are typically highly concentrated and vertically integrated (Adolf, Bush and Vellema, 2016; Campling, 2012). Three trading companies (FCF, Tri Marine, Itochu) control the bulk of supplies to Thai canneries, which produce most of the world's canned tuna. Two of these trading companies (Tri Marine and FCF) are vertically integrated and possess their own fleets and canneries (Hamilton *et al.*, 2011; FCF Fishery, 2015; Tri Marine, 2013). On the canned tuna market, seven firms (Thai Union, Dongwon Group, Bolton Group, Grupo Calvo, Conservas Garavilla, Princes, Hagoromo) dominate sales with a strong market position (Österblom *et al.*, 2015).Most of these companies relies on Tri Marine and FCF for their canneries supply : Tri Marine supplies the brands of Bolton Group, *Chicken of the Sea* and *Starkist* whereas FCF supplies *Bumble Bee, Princes Tuna* and *Chicken of the Sea*. Most of these firms own fleets and canneries and enjoy strong bargaining power given the volumes purchased and their brands' large market shares (Österblom *et al.*, 2015; Adolf, Bush and Vellema, 2016). In addition, the firms play an active role within the RFMOs, be it as observers or members of associations that group the industry's players (ISSF and OPRT) (Österblom *et al.*, 2015).

The oligopolistic organisation of these buyers makes it hard for the seiner fleets to negotiate their catches (Adolf, Bush and Vellema, 2016; Campling, 2012). Vessels owned by a vertically integrated downstream firm are compelled to supply the group's canneries (wherever these may be located) (Campling, 2012). For vessels owned by firm specialised uniquely in fishing activities, catches are sold directly on international markets or via trading companies (Campling, 2012). If these vessels are part of a small fleet, the negotiations may be unbalanced, as these small firms have only a limited bargaining power faced with relatively concentrated buyers able to compare ex-vessel prices on the main markets in real time (Campling, 2012). Moreover, the volumes sold by these fishing firms are relatively small, which leaves the bargaining power in the buyers' hands, especially when tuna supply is abundant (Campling, 2012). To avoid being captive to buyers operating in the landing ports, some fishing firms own their own freezing cargo vessels (reefers) which they use to tranship their catches to buyers further afield (Campling, 2012). Other specialised fishing firms work in collaboration and create trading companies that negotiate with buyers on their behalf (Campling, 2012). This type of organisation enables them to sell larger volumes of catches and boost their bargaining power vis-à-vis the canneries (Campling, 2012).

Yet, tuna fleets have only a limited bargaining power vis-à-vis highly concentrated and vertically integrated buyers (firms or trading companies) who control market demand for round tuna (Adolf, Bush and Vellema, 2016).

5.3.2 The power of large retail chains

On traditional canned tuna markets, the retail sector is organised as an oligopsony, with a limited number of large companies that control canned tuna distribution channels (Adolf, Bush and Vellema, 2016). The major supermarkets in the United States (Walmart, Safeway, and Kroger) and Europe (Carrefour, Metro Tesco, Scharz, Aldi, Rewe, Edeka, Auchan and Ahold) are thus able to impose their pricing policy and products on the upstream actors (Campling, Havice and Ram-Bidesi, 2007). Through their private-label products and rear margins, they influence the direct margins of the canneries (Miyake *et al.*, 2010; Oceanic Development, Poseidon Aquatic Resource Management Ltd, and MegaPesca Lda, 2005).

The influence of these large retail chains can also be seen on the canned tuna consumer markets. Over the short term, canned tuna retail prices vary very little year-on-year, despite the volatility of round tuna prices (Macfadyen and Defaux, 2016; Lem, 2016). What explains this is the retailers 'policy of keeping sales prices steady (which sometimes entails "loss leader" sales strategies) and the fact that the retailers' and canneries' inventories and stocks help to cushion fluctuations in round tuna prices (Macfadyen and Defaux, 2016). As a result, changes in ex-vessel prices do not travel down the supply chain through to the cans sold in supermarkets (Macfadyen and Defaux, 2016).

Figure 25 shows how bargaining power is distributed in the canned tuna industry.

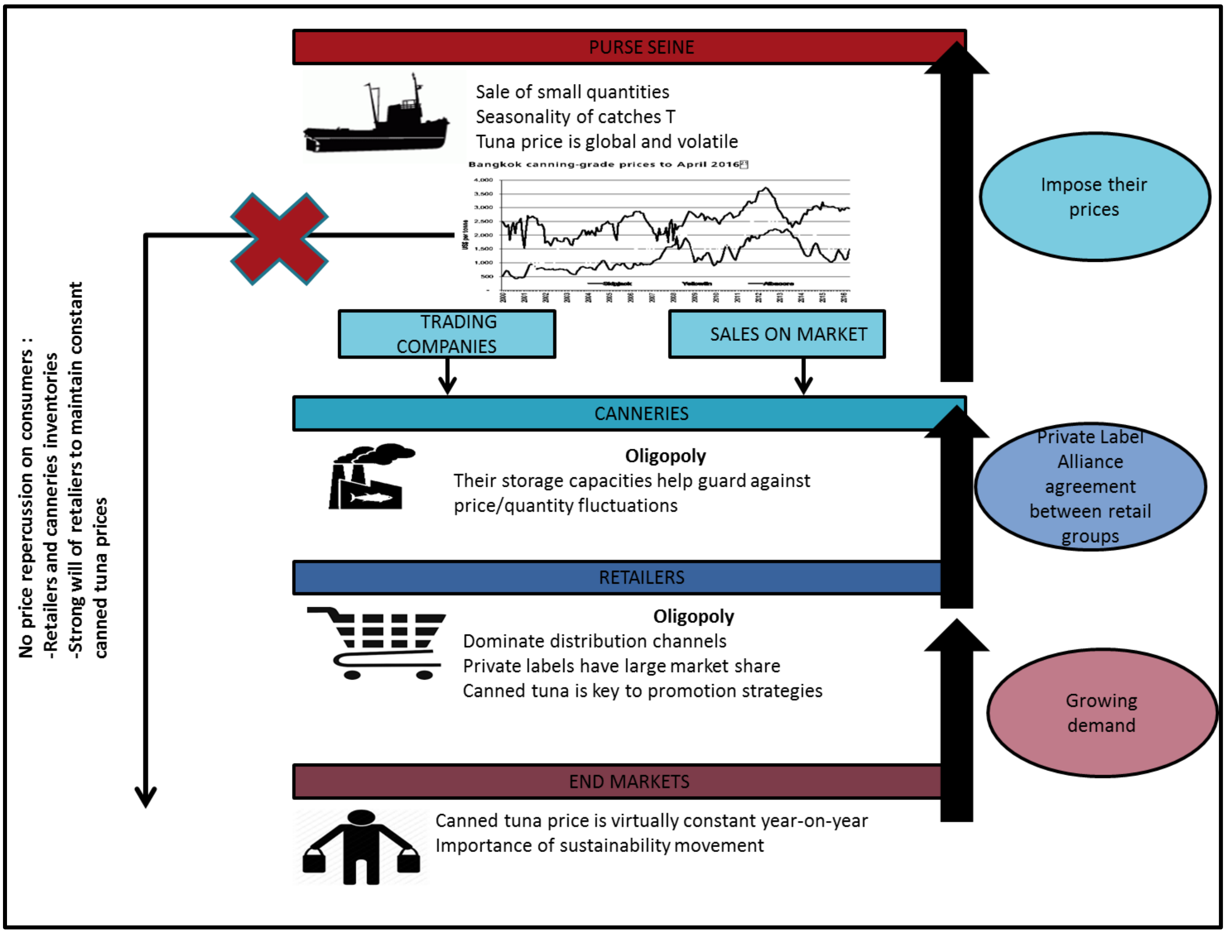


Figure 24: Bargaining power of the canning industry actors (Source: M. Lecomte, based on CAMPLING, 2012; Guillotreau, Mongruel and Jimenez-Toribio, 2008; Macfadyen and Defaux, 2016; Miyake *et al.*, 2010))

5.4 Towards an increasing global demand: what consequences for the tuna fisheries?

At the present time, the growth in both world population and income point to probable changes in future global demand for tuna (whether consumed fresh or canned) (Campling, 2015; Miyake, Guillotreau and Sun, 2010; Mullon *et al.*, 2016). Based on various assumptions about world population growth and the increase in GDP per capita in some emerging countries, some authors project that world demand for tuna may well reach 7.8 million tonnes by 2025 (Valsecchi, 2016).

Yet, the global demand for tuna differs according to the type of product. While canned tuna demand is inelastic and insensitive to price variations, the demand for fresh and frozen tuna is a function of inverse demand, which links quantities and prices (Miyake *et al.*, 2010; Holt and Bishop, 2002). These two markets thus show different consumption trends.

The canned tuna market is volume-based, with a low-price product. Between 1976 and 2011, based on global canned tuna imports, demand grew by around 3%annually (Mullon *et al.*, 2016). In 2015, the low prices for round tuna had very little impact on canned tuna demand on the EU and US markets, which signals the saturation of consumer demand on the traditional markets (GLOBEFISH, 2016b). The leading exporters (Thailand, Ecuador, Spain) have seen their export revenues fall and have directed their production towards emerging markets in some developing countries (GLOBEFISH, 2016b). Canned tuna imports to Middle Eastern markets, especially Egypt, Saudi Arabia and the United Arab Emirates, have increased significantly. On the contrary, Southeast Asian demand remains relatively flat despite the fact that the countries in the region have local canning factories (Anthonysamy, 2016).

On the other hand, the market for sashimi-grade tuna and fresh tuna constitutes a higher-value market which tends to develop in European and North American countries. In 2015, US imports of fresh and frozen tuna rose by 24%, driven by the high demand from the retail and food service industry (GLOBEFISH, 2016b). Consumption of sushi and sashimi is increasingly popular on the European and US markets, notably in the food service sector(Cherry, 2016), where there are some 16,000 sushi restaurants (Cherry, 2016).

This increase in the demand for tuna is driven by some emerging country markets (especially for canned tuna) and is not without effect on the tuna fleets' fishing efforts. A 2016 study established a clear relationship between global demand for tuna and the catch level (Mullon *et al.*, 2016). The increase in global demand seems to lead to a rise in prices and profits, which in turn fuels increased investment in fishing capacity, then greater pressure on fishing, resulting in the rapid decline of stocks and their possible collapse (Mullon *et al.*, 2016).

According to this model, a 6% increase in tuna demand (canned or fresh) over a period of more than ten years would lead to steady investment in fishing capacity and cause the collapse of the tuna industry were there to be no regulatory measures to limit catches, investment and the technical efficiency of vessels (Mullon *et al.*, 2016).

Moreover, the increase in global demand has repercussions on the tuna fleet's fishing effort. Today, however, commercial tuna catches seem to have reached a threshold and the overall status of stocks leaves little room for any increase in future catches, as current catches are already close to MSY levels. Some authors estimate that the maximum potential in catches lies somewhere between 6.3 and 6.8 million tonnes (Valsecchi, 2016).

Thus, given the current status of tuna stocks, it would seem difficult for the fishing fleet to meet global demand.

To maintain a satisfactory level of stocks, the fishing effort needs to be regulated. This is mainly the responsibility of the five tuna RFMOs, who are each in charge of managing tuna fisheries in their assigned ocean basin. Currently, the main management tools envisaged involve setting up fishing closures or marine protected areas, and restricting the use of FADs (Kaplan *et al.*, 2014; Mullon *et al.*, 2016). However, implementing this last measure is complicated as shown by recent IOTC meetings. Moreover, the increased capacity of some vessels compels them to adopt a volume-based strategy, where by greater quantities are harvested to make the investments profitable. As a result, it is becoming difficult to limit the tonnage fished by this type of vessel as this would mean jeopardising the ship owners' profitability.

In view of the growing demand and the sometimes difficult and thus slow implementation of tuna regulations, there is a danger than the fishing effort could increase up to levels that are no longer sustainable for tuna stocks.

Thus, the movement towards sustainability, even though its effects are still limited in some cases, could lead actors to adopt more sustainable fishing strategies to meet the high current demand (nonetheless limited to canned tuna markets). Yet, what still needs to be defined is the extent to which these measures based on market incentives will prove effective in driving the shift towards more sustainable fishing practices.

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