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# Greening China's Fish and Fish Products Market Supply Chains

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Federal Department of Economic Affairs FDEA  
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China Aquatic Products Processing and Marketing Alliance (CAPPMA) is a non-profit organization. It consists of seafood producers, processors, traders, distributors, suppliers, and institutions for fisheries research and education, as well as relevant social entities that provide various services for seafood processing and marketing. Its objectives are dedicated to improve the self-discipline mechanism among members in their business operation, to standardize and maintain order in the seafood market, to protect the members' legal rights, to coordinate relationships among domestic enterprises and international parties, to upgrade technology and management in China's seafood industry, to enhance the awareness of credibility needs within the industry and to improve seafood quality security, to promote the prosperity and stability of markets, and to ensure sustainable fisheries development. Further information is available at [www.cappma.org](http://www.cappma.org)

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## 1.0 Introduction

### 1.1 Background and Purpose of Study

#### 1.1.1 *China's Fisheries and Aquaculture in a Time of Transition*

Over the past two decades China's involvement with world fisheries and trade in aquatic products have increased dramatically, making it the world's largest producer, consumer and exporter of seafood. As global fish stocks continue to decline, China has become a pivotal link in determining the sustainability of global fish supply chains. While it is increasingly recognized that sustainable production, processing and trade in fish products will need to be based on global cooperation, it is also ever more clear that China will need to play a critical role in ensuring the success of such efforts. However, the pathway to building and implementing such cooperative efforts is far from self-evident. The depth of the challenge rests in the complexity the sustainability threats facing global fisheries and the complexity of the global fisheries trade.

By way of example, China is now a leading processing nation—not only for products consumed domestically, but also for export. Some of the raw materials supplying China's massive processing industry are aquacultured in China or elsewhere, some are catches from Chinese vessels operating within China's territorial seas and Exclusive Economic Zone (EEZ) or in other parts of the world, and some by fleets of other nations which then send the products to China for processing and then export to markets such as Japan, the EU and the U.S. and many other countries. One of the byproducts of the geographic complexity of global seafood supply chains is the challenge of linking sustainability impacts to specific biological species and stocks, ecosystems and various products elsewhere in the chain. Identifying such links, however, is crucial to developing appropriate management approaches as well as ensuring the appropriate delegation of responsibilities.

China has a large stake in such efforts, and has taken a number of steps to address the activities of its own fisheries and processors, but there will be pressures for more action. Also, new issues continue to enter the sustainability arena. For example, climate change is already a factor in fisheries management, and will be an important element to consider in future investments for coastal aquaculture, investments in fisheries fleets, and in relation to certain aspects of the pricing and supply of products. Recently, there have been significant efforts to establish voluntary certification programs such as those of the Marine Stewardship Council (MSC). Importing countries are becoming much more demanding about chain of custody stewardship, plus health and safety considerations like those considered under Hazard and Critical Control Points (HACCP) principles.

As a result of the growing sustainability challenges facing the seafood sector, rising global awareness of the seriousness of those challenges, and China's burgeoning production and consumption levels, China will play an increasingly important role in securing the long term sustainability of the sector.

As a first step towards enabling China to take on this role, this project conducted a Global Commodity Chain Sustainability Analysis on three Chinese fish supply chains with the objective of facilitating the adoption of effective sustainable development strategy and policy making within the Chinese government and across its bilateral and multi-lateral cooperation. The analysis is partly based on methodology used by the International Institute for Sustainable Development (IISD) in previous studies undertaken in cooperation with the Ministry of Commerce (MOFCOM).<sup>12</sup>

The current study has been carried out during a time of unprecedented interest in environment and development within China. It is being completed at the very start of the 12<sup>th</sup> Five Year Plan (2011-2015), and during a transformative time when China is placing great emphasis on expanding its domestic consumption and is starting to expand its foreign direct investment and seeking to build new avenues for bolstering trade. There is a growing realization that it will be necessary to expand international cooperation and pay greater attention to ways in which China can shift its economic growth into less ecologically damaging activities, including a low carbon economy.

In recent years, China has entered into new regional trading and other relationships including free trade with ASEAN, various arrangements involving development assistance, trade and investment in Africa, and agreements with Latin American and Asian countries. These arrangements are intended to be mutually beneficial so that the success China has experienced with its economic growth can be spread, but also so that China can secure both new opportunities for its own development and access to needed resources.

Fisheries and aquaculture are among the most difficult components of this new phase of Chinese trade and cooperation. Ensuring sustainability of aquatic resources is not an easy undertaking, as many countries have discovered. The decline of cod stocks in Europe and North America, the difficulty of maintaining high quality ocean environments around aquaculture operations in many parts of the world, and the damage caused by large "factory fishing operations" have been well

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<sup>1</sup> The "Sustainable Development: China and Global Markets" Project, initiated by IISD and MOFCOM in 2006, with financial support from the Swiss State Secretariat for Economic Affairs (SECO), examined the ecological impacts and shared responsibilities of China and its trading partners in several commodity supply chains. The overall goal of this ongoing project is to integrate sustainable development concerns into trade/economic policies of the Chinese government as well as countries supplying raw materials to China and countries consuming Chinese products internationally. The market supply chains include forest, cotton, e-products and copper. As well, IISD in cooperation with China's National Development Reform Commission published a major report in November 2010 entitled *Elements of a Sustainable Trade Strategy for China*. Further information on these studies is available at <http://www.iisd.org>.

<sup>2</sup> A summary of this document by Arthur Hansen is available at <http://www.iisd.org/publications/pub.aspx?id=1474>

documented—along with grave concerns about illegal, unreported and unregulated (IUU) fisheries throughout the world and in the open ocean. China is linked into the complex oceanic exploitation and management systems in ways that are not well understood, either within China or outside of the country.<sup>3</sup> Market supply chains are a critical part because seafood often moves great distances from point of capture or production before reaching final consumers. During that journey, its origin, identity and certainly the circumstances of production may be lost or altered. Without good traceability it becomes difficult to assess whether the fish or other aquatic product was obtained and processed in a way that was sustainable. The criteria of sustainability also need to be reasonably defined, but generally will take into consideration social, economic and environmental factors.

### **1.1.2 International Interests, Campaigns and Dialogues**

In past years there have been a number of international campaigns directed towards Chinese fishery and trade practices. One example that was of particular concern to Australian interests was the flow of Patagonian toothfish (*Dissostichus eleginoides*), also called Chilean sea bass. This fish, which is found in Antarctic waters, was being caught in large numbers, processed in China, then either consumed domestically or sent abroad for further processing in other countries such as Canada, before ending up in restaurants, on business class airplane meals and in homes in the U.S., Europe and elsewhere. The situation has evolved now to the point where it is possible to buy Marine Stewardship Council certified fish from the South Georgian Antarctic fisheries, demonstrating that sustainability solutions can be found. After 2000, the U.S. also denied the entry of toothfish that could not be shown to be legally harvested. Currently, however, IUU toothfish catches remain a problem, even with considerably greater monitoring in Antarctic waters.

Another example is a product that enters mainly into the Chinese marketplace. This is shark fin, which has been prized for millennia in China for festive occasions such as weddings. Many species are involved, leading to a drastic decline in shark populations throughout the world's oceans. Yet within China there are famous figures such as the basketball player Yao Ming who has made it clear that no shark fin soup would be served at his wedding. In the U.S. a ban is now in place on landing shark fins detached from the shark. It is not a great stretch to imagine a campaign against countries that take sharks in large numbers or that import shark fins. There also could be targets set against other forms of trade, as Canada has discovered in its ongoing struggle with European interests that would like to see a ban on Canadian seal hunting.

The rising international interest in the health of the oceans, the concern over food security and the general interest in environmental matters are potent drivers that will focus sustained interest on Chinese seafood trade practices. An example of a serious effort to develop a good understanding

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<sup>3</sup> The work of Shelley Clarke in studies undertaken via TRAFFIC provides the most coherent picture of Chinese fish trade linkages, along with statistical data bases published by FAO and the Chinese Fisheries Statistics Yearbook.

and dialogue is a major study conducted by the David and Lucile Packard Foundation on China's fisheries and aquaculture.<sup>4</sup> This very recently completed study has attempted to develop a framework that might be used to understand and engage China on seafood sustainability concerns. It is intended for use by various interests, including international non-governmental organizations such as the World Wildlife Fund (WWF) as well as those within government and various stakeholders.

### 1.1.3 Purpose of Study

The overall purpose of IISD's work on Chinese market supply chains is to support the Ministry of Commerce (MOFCOM) in its efforts to integrate sustainable development into China's policies. The more detailed statement of purpose for this fisheries and aquaculture study is to:

- Assess supply chain sustainability challenges and opportunities both within and outside of China
- Provide strategic policy guidance for the Government of China towards the development of sustainable supply chains and markets
- Facilitate the adoption of sustainable trade policy in the upper levels of the Chinese government.

The outputs are three unpublished market supply chain case studies plus this synthesis report based on the individual studies plus some additional material. The three supply chains are Chinese tilapia aquaculture, cod reprocessing in China, and the supply of coral reef fish primarily from Southeast Asia (and their aquaculture in China) to Hong Kong and mainland China.

No single study or initiative is likely to satisfy the needs of sustainable development in China's massive seafood sector. Certainly there is already a strengthening of efforts on the part of the associations and other representatives of the industry. The China Aquatic Products Processing & Marketing Association (CAPPMA) is an example where this is taking place. However, these efforts are taking place against a backdrop of continuing high growth in seafood demand within China, an evolving system of regulation and monitoring, and limited understanding of the full picture of Chinese involvement in world fisheries.

Furthermore, the relationship between trade and sustainable development is still a relatively new subject in most international agreements, and therefore the mix of available tools to implement sustainability initiatives in fisheries and aquaculture market supply chains is still quite experimental, and often reliant on voluntary action or "soft" regulation such as certification. The topics and cases selected in the current work are significant and lead to some clear and implementable

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<sup>4</sup> January 2011. *Sustainable Fisheries and Aquaculture in China: Scoping Opportunities for Engagement*. The David and Lucile Packard Foundation.

recommendations directed to the fisheries and aquaculture industry of China, the Government of China, and various stakeholders within and outside of China.

## 1.2 Methodology

The study applies IISD's generic Global Commodity Supply Chain Sustainability Analysis (GCCSA), methodology (see Appendix 1.1 for more detail) and approaches used by others.<sup>5</sup> The GCCSA, through its unique seven stage research process (rationale; market statistics; supply chain structure; supply chain governance; supply chain environmental impacts; supply chain social impacts; and policy analysis) is designed to provide a snapshot of the relationship between key sustainability hotspots, market trends and commercial governance of global supply chains, as key ingredients of an assessment of effective policy intervention. One of the unique characteristics of the GCCSA is its ability to provide a basis for generating policy recommendations that are directly relevant to actual supply chain relations and conditions thereby allowing for more efficient interventions. Importantly, by looking at the role of international supply and demand in determining the sustainability of China's global supply chains, the analysis is particularly suited to identifying shared solutions along the supply chain.

Recognizing the challenge of applying the GCCSA methodology to the entire fish products supply chain, the project partners have identified a select number of species and supply chain flows for the application of the analysis. The criteria for choosing the supply chain flows/species for detailed analysis within the context of this project were chosen based on the following parameters:

- Importance of the supply chain flow/species to: the Chinese economy, sustainable development concerns, and international trade.
- Other practical constraints, such as availability of data, political importance, and representativeness.

Applying these criteria to a number of candidate market supply chains (see Chapter 3), the project partners initially agreed to limit the application of the methodology to three or possibly four supply chain flows. At a July 2009 scoping meeting, the partners agreed that two of the supply chains would be tilapia (to be led by the CAPPMA team) and cod, to be led by the international team with major inputs from Dr. Shelley Clark. Other supply chain flows were not settled at that time, but later an examination of live reef food fish trade (LRFFT) for groupers and wrasses originating primarily in Southeast Asia to meet Chinese market needs was added as the third market supply chain. This case included consideration of the rise of grouper aquaculture in China. The third supply chain example was more difficult to fit into the IISD framework used in the first two. Instead, it drew upon the

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<sup>5</sup> Especially the analysis approach of Dr. Geoffrey Muldoon and his associates in the third market supply chain.



expertise of a leading international specialist (Dr. Geoffrey Muldoon) on this market chain plus interviews within China by CAPPMA. Figure 1.1 contrasts the three types of market supply chain: The red supply flow represents cultured fish exported for international consumption; the green supply flow represents wild fish caught outside of China, imported for processing, and then exported for international consumption; the third (blue) supply flow represents wild fish caught outside of China, imported for processing and consumption in China.

The work is primarily intended to be a research effort. The results are intended to be used by policy-makers within government, by CAPPMA and others seafood industry businesses, and by those engaged in promoting sustainability development.

**FIGURE 1: THREE MARKET SUPPLY CHAINS**

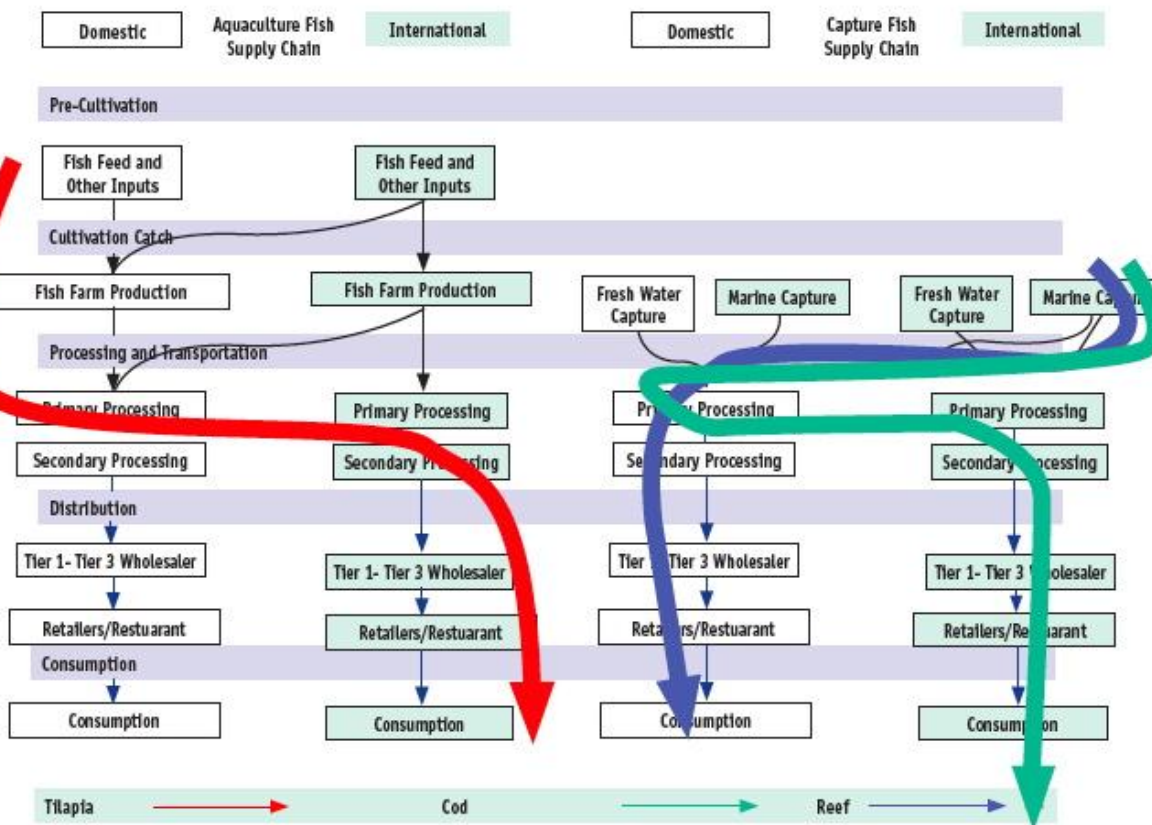


Figure 1.1 Examples of Chinese fish market supply chains.

### 1.3 Report Outline

This synthesis report is divided into several chapters: 1. Background and Purpose. 2. Trade, Sustainability and Engagement covering China's role in world fisheries and aquaculture trade, international and Chinese aquatic resources, the significance of this sector in WTO agreements and action; and various sustainability criteria for fisheries and aquaculture that may be used in the framework for analysis; plus results of other relevant studies by international organizations interested in working with China on sustainable fisheries and aquaculture. 3. Overview of species for market supply chain analysis. Notes on nine specific fisheries and aquaculture supply chains of high interest, even though not all could be analyzed in detail for this study. 4. Sustainability case study of tilapia supply chain. 5. sustainability case study of China's cod supply chain. 6. Sustainability case study of live reef food fish (LRFF) supply chain. 7. Conclusions and recommendations.

## Appendix 1.1 China and Global Fish Markets: A Framework for Global Commodity Chain Sustainability Analysis (Prepared By Jason Potts, IISD)

### Description

This document sets forth the core elements of the framework for the supply chain studies. This framework is proposed as the basis for the Chinese and international supply chain case studies.

### Elements of the Framework

The framework will provide a descriptive backdrop or background to the analysis. It is, essentially, a brief summary of the Global Commodity Chain Sustainability Analysis (GCCSA) at a high level for the supply chain. As such, the main elements should follow the main elements of the GCCSA as follows:

#### 1. Rationale for choosing this supply chain

- a. Why is this product and supply chain flow particularly important for: 1. China 2. Sustainability 3. International trade
- b. Are there other reasons for focusing on this supply chain (such as availability of data; political importance).

#### 2. Supply Chain Structure

**Objective:** To provide a basic overview of the product and supply chain in question

#### Key Questions:

- a. What are the main stages of the supply chain (briefly describe each stage and include a flowchart diagram)
- b. For the purposes of this analysis—where does the supply chain start and where does the supply chain end? Are circular relationships through recycling or composting possible?

**Graphic Output:** A flow chart describing the specific stages of the supply chain.

#### 3. Market Size and Trends

**Objective:** To provide a snapshot of actual and expected supply, demand and the relevant importance of specific sources of production and consumption with respect to the target country

**Key Questions:**

- a. Global production levels
- b. Chinese production levels
- c. Total volume of Chinese imports
- d. Total volume of Chinese exports
- e. Top five exporters of product to China
- f. Top five importers of product from China
- g. The proportion of national trade of the product which is traded to or from China for top five import and export countries
- h. Estimated quantities of illegal trade
- i. Market drivers for the supply chain (population, demographics, technology, availability of substitutes)
- j. Expected market trends at the global and national levels-are markets for the product expected to grow or decrease in the future?

**Graphic Output:** Bar charts showing most important producers/processors/traders etc.

**4. Commercial Governance**

**Objective:** To identify the distribution of market power and decision making authority across the supply chain and across specific supply chain actors

**Key Questions:**

- a. Who are the top five processors and producers in China?
- b. Who are the top five processors and producers in the international trade of the product?
- c. Are there high levels of concentration at any stages of the supply chain?
- d. Who are the major Chinese, foreign national and international associations in the product supply chain? Do any of these associations set enforceable rules or criteria for private sector behaviour along the supply chain?

**Graphic Output:** A flowchart showing what decisions are taken where along the supply chain.

**5. Environmental Impacts**

**Objective:** To assess the global environmental impacts of a product's lifecycle as well as the relative importance of specific stages of a product over the supply chain

**Key Questions:**

- a. What are the main environmental impacts from the chain?
- b. Things to look for:
  - i. For aquaculture, include possible environmental impacts of fish meal and/or soy meal.
  - ii. Water conservation/pollution (both for production and processing)
  - iii. Illegal, unreported and unregulated fishing
  - iv. Overfishing
  - v. Bycatch issues
  - vi. Climate change (for production and processing)
  - vii. Biodiversity impacts

**Graphic Output:** A flowchart or bar chart linking most important environmental impacts (positive or negative) along the different stages of the supply chain. The chart should show the relative importance of the different environmental impacts.

**6. Social Impacts**

**Objective:** To identify key social impacts and issues along the supply chain

**Key Questions:**

- a. What are the main social impacts from the chain (processing and production)? Include in this considerations of:
  - i. Worker welfare
    1. Health and safety
    2. Working conditions and wages
    3. Discrimination
    4. Freedom of association
    5. Role and treatment of women
  - ii. National economic welfare
    1. Contribution of the sector (e.g. fisheries) to national GDP
    2. Importance of the product (e.g. tilapia) to the sector as a whole
  - iii. Millennium Development Goals: Poverty reduction and distribution of revenues
    1. How important is the sector, or specific elements of the supply chain to a broader poverty reduction strategy?
    2. Are some regions or stages of the supply chain receiving proportionately higher benefits than others?

- iv. Community health and safety
  - 1. Are there any documented threats to community health and safety through processing or production impacts on environment?
- v. Consumer health and safety
  - 1. Are there any documented threats to consumer health and safety through consumption of the products?

**Graphic Output:** possibly charts on economic importance of the sector or product to Chinese and/or global economy.

## 7. Key Policy Developments

**Objective:** To identify the legal framework governing production, trade and consumption of the product under consideration

### Key Questions:

- a. What are the main relevant Chinese laws to the supply chain or product?
- b. Are there any new relevant policies under development?
- c. What are the key international policies including:
  - i. foreign national legislation (e.g. US, EU, Japanese legislation)
  - ii. multilateral treaties (Convention on Biodiversity, CITES, Regional fisheries agreements)
  - iii. international voluntary initiatives (e.g. Marine Stewardship Council or Aquaculture Stewardship Council) related to the supply chain or product? (provide a one paragraph description of relevant legislation including the scope of coverage and the agency or institution responsible for enforcement.
  - iv. What is the relationship between sustainability issues and WTO negotiations?
- d. How is the supply chain reacting to the mentioned policy developments?

**Graphic Output:** A table listing policies and a scope of coverage

## 2.0 Trade, Sustainability and Engagement

### 2.1 China's Role in World Fisheries and Aquaculture

Over the past two decades China's involvement with world fisheries and trade in aquatic products has increased dramatically. China is now a leading processing nation—not only for products consumed domestically, but also for export. Some of the raw materials are aquacultured in China or elsewhere, some are catches from Chinese vessels operating within China's Extended Economic Zone (EEZ) or in other parts of the world, and some by fleets of other nations which then send the products to China for processing and then export to markets such as Japan, the EU and the U.S., or many other countries. This is a complicated situation, made more complex by declines in many of the world's fisheries. There is widespread concern about illegal, unreported and unregulated (IUU) fisheries throughout the world, and about capacity to manage aquatic resources sustainably. In addition, there are health and safety concerns as well as sustainability concerns about aquaculture.

In China's case, specifically, there have been a number of issues raised in the past. These include problems such as the import into China of Patagonian toothfish, with processing and export to markets in North America and Europe. Much of the overfishing around the world for sharks and rays is for markets in Asia, with China being a prominent one. Reef fisheries in Southeast Asia that supply markets in China, and also some shrimp fisheries in Southeast Asia carried out to supply markets, are examples of activities that are not considered sustainable. Fisheries in waters off Africa are another area of concern.

Aquaculture is now becoming as important as global fisheries in market supply chains, but problems also exist. For example, Chinese exports of aquacultured products are subject to considerable scrutiny due to reports of contaminants including heavy metals, antibiotics and other medicines and bacteria. The potential exists for non-tariff trade barriers being imposed in the form of excessive health and sanitation requirements.

Trade in aquatic products is undergoing considerable scrutiny since it is a key avenue for enhancing global efforts on sustainable development. China has a large stake in this effort, and has taken a number of steps to address the activities of its own fisheries and processors, but there will be pressures for more action. And new issues are entering the sustainability arena. For example, climate change is a factor in fisheries management already, and will be an important element to consider in future investments for coastal aquaculture, investments in fisheries fleets, and in relation to a number of aspects related to the pricing and supply of products. In recent times, there have been major efforts to establish voluntary certification programs such as those of the Marine Stewardship

Council (MSC). Importing countries are becoming much more demanding concerning chain of custody stewardship, plus health and safety considerations, such as those associated with Hazard and Critical Control Points (HACCP).

China thus needs to have a good understanding of what the pressures upon it are likely to be as its own demand for fish products increases, and as it tries to build an even greater position as an important producer, processor and exporter of aquatic products. Certainly, China's seafood processing industry in particular has had a significant learning curve during the past 10 to 15 years on these matters, but is likely to be subject to new challenges in the coming decade when there will be a greater emphasis on how the ecological impacts of fisheries and aquaculture.

## 2.2 WTO Agreements and Action on Fisheries and Aquaculture

Like other components of the MOFCOM–IISD work on market supply chains, the results of this analysis are intended to provide strategic policy guidance of value to the Government of China on how it can make its supply chains and markets sustainable and therefore secure continued economic growth, environmental sustainability and the improved well-being of China's people. The results are intended to facilitate the adoption of sustainable development in trade policy by both China and possibly other nations engaged with China in aquatic resources trade. It is therefore important that the work contributes directly to China's interests in the World Trade Organization (WTO) and other international trade and environment arrangements.

Fisheries issues occasionally have been quite prominent in WTO trade disputes as in, for example, the well-known tuna-dolphin case, but they certainly have not been as significant as many other disputes brought forward. It is in other aspects of WTO negotiations and implementation that fisheries and aquaculture trade get considerable attention. Some of the important areas are briefly described below.

- *Subsidies*—under the Doha Round there has been an intensive effort by some interests to reduce fuel or other subsidies to the fish catching industry on the grounds that the subsidies contribute to overfishing and stock reductions. Agreement on this matter has not yet been achieved, and there are significant concerns about removing subsidies to small-scale fisheries.
- *Eco-labelling*—voluntary labelling practices are not reconciled with WTO rules, and therefore labelling issues related to sustainable production are subject to considerable interpretation.
- *Market access*—both tariff and non-tariff barriers exist, generally to the detriment of developing nations. These barriers often can only be removed at considerable cost, if at all.
- *Sanitary and Phytosanitary Measures (SPS) and Technical Barriers to Trade (TBT) agreements*—both



agreements are intended to ensure a scientific basis exists for regulating trade in fish and other products that might affect human health and safety, and, in the case of TBT, also the environment. These are becoming more important with aquaculture that may involve additives, pollutants or residual drugs.

- *WTO and the multilateral environmental agreements (MEAs)*—the reach of MEAs into the area of trade is on the increase, and there is still no overall reconciliation either among the MEAs, or between the WTO and MEAs. Therefore there are considerations related to the Biological Diversity Convention, United Nations Convention on the Law of the Sea (UNCLOS), the Convention on International Trade in Endangered Species (CITES), the United Nations Framework Convention on Climate Change (UNFCCC), the Food and Agriculture Organization’s (FAO’s) Code of Conduct for Responsible Fisheries (CCRF), and various fish stock agreements such as those for migratory species like tuna.

The existing and potential significance of WTO rules and possible effects of the Doha Round negotiations that are relevant to sustainable development need to be taken into account. However, it is not apparent that WTO challenges are likely to be the key concerns. Much of the pressure will come directly from the demand side of supply chains, especially those from regions such as European and North American markets, plus international organizations concerned about the health of ocean ecosystems, decline in wild fisheries, impacts of aquaculture, health and safety concerns such as the presence of toxic substances in fish, and from the world fishery management bodies such as FAO (“responsible fisheries”) and regional fishery management organizations. This means that so-called “soft” or voluntary measures such as those of the Marine Stewardship Council (MSC) for certification of fisheries, and campaigns such as those being waged over trade in shark fins, seafood guides that are influencing chefs and major restaurants, and the actions of large retail chains such as Walmart in their sourcing for seafood are much more likely to be creating sustainability pressures on existing market supply chain approaches.

What is clear is that aquatic resource supply chains present a number of analytical challenges related to trade. First, the sector is highly fragmented, with a very substantial number of products and producers. There is also a great amount of under-reported activity around the world, and efforts to evade detection (the IUU fisheries). Thus it is not a simple matter to obtain accurate statistics. Second, the causal factors of fishery decline are rarely simple, and fishing mortality is only one source. Third, the tendency has been to create products that are easily substituted for one another: for example, white-fleshed fish of some species ends up being sold under a variety of names in world markets, or sometimes recorded incorrectly as it passes through ports. And fourth, fish that may have been part of the world’s IUU catch can gain respectability and be recorded as a “legitimate” catch or product as they pass through a market chain. These challenges need to be taken into consideration when assessing data validity and needs for improvement.

### 2.3 Sustainability Criteria for Aquatic Supply Chains

A list of criteria was developed around the three key themes of ecological, economic and social sustainability in order to provide a framework for assessing the sustainability of global commodity chains for aquatic products. The study team<sup>6</sup> first developed an expansive list of sustainability issues for capture fisheries, aquaculture production, and fish processing through brainstorming. This master list was then condensed, rationalized and organized under ecological, economic and social sustainability themes. In order to ground truth the scope and specificity of the condensed list it was then compared, point-by-point, to the criteria applied under several sustainability evaluation schemes for fisheries and aquaculture products.

These schemes included the FAO eco-labelling criteria,<sup>7</sup> the WWF seafood guide criteria,<sup>8</sup> the Greenpeace “red-grade” criteria for unsustainable fisheries and aquaculture,<sup>9</sup> and the MSC fisheries assessment methodology.<sup>10</sup> In addition, five fisheries profiled under the Sustainable Fisheries Partnership’s FishSource database, i.e. Eastern Bering Sea Alaska pollock, Indonesian blue swimming crab, Chilean Pacific jack mackerel, Eastern Atlantic Northern bluefin tuna and Flemish cap northern prawn, were used as case studies to identify key issues under the 12 headings used by FishSource to assess sustainability. The final list of 17 sustainability criteria resulting from this exercise is given in Box 2.1.

One noteworthy point of departure between our 18 sustainability criteria and the other schemes to which they were compared is that the criteria below are outcome, rather than input, orientated. For example, several of the schemes used in the groundtruthing exercise assessed the aquatic product on the basis of whether certain principles were applied in its management, whereas the following criteria focus primarily on whether the management achieves a sustainable outcome. Specifically, several schemes called for application of ecosystem-based fisheries management approaches. In contrast, our criteria consider whether ecosystem impacts are prevented and/or mitigated. The advantage of the second approach is that it can apply more broadly across fisheries, culture operations and even processing facilities, but still capture the fundamental ecological concerns.

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<sup>6</sup> This aspect of the study was carried out by Dr. Arthur Hanson and Dr. Shelley Clarke with review provided by CAPPMA. It is intended to provide a comprehensive view of sustainability related to fisheries and aquaculture but without the expectation that all criteria might be met either in the short-term or within any one certification or other initiative.

<sup>7</sup> FAO (2005). *Guidelines for the Eco-labelling of Fish and Fishery Products from Marine Capture Fisheries*. FAO, Rome.

<sup>8</sup> This reference is currently problematic as these criteria are not in the public domain. I understand, though, that WWF intends to publish them shortly.

<sup>9</sup> Greenpeace (2009). Greenpeace “Red-Grade” Criteria for unsustainable fisheries and unsustainable aquaculture. Retrieved from <http://www.greenpeace.org/international/seafood/red-list-of-species>

<sup>10</sup> Marine Stewardship Council (2008). Fisheries Assessment Methodology and Guidance to Certification Bodies Version 2. Retrieved from <http://www.msc.org/about-us/standards/fam/download>

Although these sustainability criteria have been developed with China's fish supply chains in mind, it is acknowledged that they aim to embody global best practices which may not be immediately achievable in developing countries. It is therefore important to consider the efforts already underway in China to meet international certification standards. In fact, there are already a few facilities in China which have achieved certification for shrimp and tilapia production under the Aquaculture Certification Council (which certifies facilities to the Global Aquaculture Alliance standards), for example. Also, Chinese processing facilities are quite used to dealing with a variety of health and safety standards (domestic and international), and also do reprocess some MSC-certified fish catches.

There are also a large number of facilities which have achieved certification to various international sanitary standards such as the HACCP Principles incorporated into ISO 22000 and extensively used, for example, in U.S. Food and Drug Administration inspections, Good Manufacturing Practice (GMP) standards and the British Retail Consortium (BRC) Global Standard for Food Safety, as well as Chain of Custody certification under the Marine Stewardship Council scheme. These achievements in the field of food quality and safety address some of the issues in the sustainability criteria presented below (e.g., traceability, freedom from contamination and perhaps others). However, they are inherently narrower in scope as they do not involve consideration of resource impacts on natural populations of fish or on the environment external to the processing plant.

Recognizing and encouraging the existing efforts of China's fish-related industries to achieve international certification is a useful first step toward building awareness of the demands of external markets. While focusing on sanitary certifications is undoubtedly a useful starting point, and one whose example can be followed, it is also important to gradually expand the scope of issues to more fully address the ecological, economic and social sustainability of the industries. Addressing this full spectrum of issues may not be possible in the short term, but it should remain a long-term goal both to manage development of China's domestically-orientated industries and to respond to pressures emanating from international markets.

**Box 2.1 Sustainability Criteria for Aquatic Supply Chains.****Ecological Factors:**

1. If wild-caught, biomass of the target species is maintained at a level which will allow optimal productivity and harvest over time, even under sub-optimal or fluctuating environmental conditions, with a low risk of stock decline/collapse (or if depleted, stocks are being managed for recovery/rebuilding).
2. If wild-caught, the operation of the fishery does not alter the structure or function of the ecosystem (habitat or species assemblages) and allows for the maintenance of biodiversity and ecological equilibrium.
3. If cultured or processed, construction and/or operation of the facilities does not directly or indirectly cause changes in the structure or function of critical ecologically valuable habitat or ecologically healthy ambient conditions.
4. If cultured, feed and brood stock inputs are fully traceable and supplied from sustainable sources.
5. If cultured, operation of the facilities does not present an unacceptable risk of release of alien or invasive species (possibly including genetically modified organisms), and/or disease pathogens, into 'natural' ecosystems.
6. If wild-caught, cultured or processed, a life cycle analysis shows no significant contribution to climate change (e.g. sea level rise and ocean acidification).

**Economic Factors**

7. If wild-caught or cultured, the operations are not predicated upon subsidies, taxes or other economic instruments which are considered to be environmentally or economically perverse and/or do not fully reflect externalities.
8. If wild-caught, cultured or processed, there is full or maximum practicable utilization and value obtained from harvested resources, including bycatch and byproducts, and minimization of waste.
9. If wild-caught, cultured or processed, the operations are conducted with highly efficient use of resources, for example, best practice feed conversion rates for culturing and low carbon production, processing and distribution.

**Social and Regulatory Factors:**

10. If wild-caught or cultured, operation of the fishery/facility does not impinge upon traditional rights or local dependence on the resource, including issues of subsistence use and non-extractive cultural significance, and if disputes arise there is a forum for their resolution.
11. If cultured or processed, the operations are conducted in a manner which promotes local community well-being, including conditions for the workers themselves whether local or migrant.
12. If cultured or processed, facility discharges do not present an unacceptable risk to human health.
13. If processed, full supply chain traceability is maintained with adequate health and sanitary precautions taken to ensure potential sources of contamination are avoided and harmful substances are not introduced.
14. If wild-caught or cultured, operations are conducted in full compliance with international and national conservation and management measures, and this is documented through monitoring and enforcement programs.
15. If wild-caught, applicable fisheries management systems are considered to be based on the best available information, and are precautionary, effective and transparent.
16. If wild-caught, the fishery is not subject to illegal, unreported or unregulated (IUU) fishing activities to the extent that its management is undermined and/or its sustainability is threatened.
17. If wild-caught, cultured or processed, operations are conducted with cognizance of environmental and sustainability best practice including, *inter alia*, transparent reporting, independent product certification, and/or continuous improvement.

## 2.4 Engagement and Dialogue for Sustainable Fisheries and Aquaculture

China's vast and still-expanding market supply chains make the country somewhat vulnerable in the face of growing international interests in restricting trade to sustainably produced products. Furthermore, fish sustainability is an important element of food security for China. While these points are central to the rationale for the current study, it also has been possible to draw upon additional perspectives based on what others say about the sustainability of aquatic resources used by China.

A document worthy of attention is a recent unpublished WWF–China paper by Wang Songlin<sup>11</sup> which takes a first look at sustainability concerns for Chinese aquatic products, with the suggestion that transformational change is required in order to find sustainability solutions to global fishery and aquaculture problems in which China now plays a major role through both its domestic and traded aquatic products.

Another very recently completed study commissioned by the David and Lucile Packard Foundation is entitled *Sustainable Fisheries and Aquaculture in China: Scoping Opportunities for Engagement*.<sup>12</sup> This work included extensive interviews (including with both CAPPMA and IISD members engaged in the DFID-MOFCOM study) and site visits in China. The work was conducted by several environmental and development groups, and in collaboration/partnership with WWF International and WWF China. The study produced up-to-date information and observations that are complementary to our own study, including several recommendations that provide a useful framework for the future of international cooperation with China. The document was discussed at the January 2011 International Seafood Conference held in Vancouver, Canada, where China seafood matters were a prime subject of attention.

This section reviews some of the points made in the conceptual paper of Wang Songlin and the more in-depth Packard Foundation study. The purpose is to identify the most relevant and potentially useful results and recommendations. Some of the recommendations are brought into our own recommendations since it is valuable to have a common framework drawing upon the best available studies.

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<sup>11</sup> Wang Songlin (2009). *The First Attempt to Understand China's Seafood Issues. Marine Capture Fishery, Mariculture, Re-Processing Industry, and Consumption of Live Reef Fishery and Shark Fin*. Retrieved from [http://pollock.ru/files/insertfiles/the\\_first\\_attempt\\_to\\_understand\\_chinas\\_seafood\\_issues\\_s.wang.pdf](http://pollock.ru/files/insertfiles/the_first_attempt_to_understand_chinas_seafood_issues_s.wang.pdf)

<sup>12</sup> Shashi Buluswar, Sonila Cook, John Stephenson, Bruce Au, Swati Mylavarapu, and Naveed Ahmad (2011, January). *Sustainable Fisheries and Aquaculture in China: Scoping Opportunities for Engagement*. Prepared for the David and Lucile Packard Foundation by Dalber Global Development Advisors, SeaWeb and the Sustainable Fisheries Partnership in collaboration with Melanie Siggs of SeaWeb, Katherine Short and Wang Songlin of WWF, and Dick Jones of Sustainable Fisheries Partnership.

### 2.4.1 WWF-China

Globally, WWF is one of the leaders in seeking sustainability of fisheries and aquaculture. It is monitoring ecological issues in the most significant ocean areas of the world such as the high biodiversity Coral Triangle Region of Southeast Asia. It also has pioneered seafood sustainability certification via its co-founding of the Marine Stewardship Council. WWF-China has given attention to Chinese seafood sustainability needs in recent years, although its work more or less remains at an exploratory level.

The paper by Wang Songlin notes a number of important points about the current status of sustainability of aquatic production in China. He provides several suggestions for action in support of fisheries and aquaculture sustainability, including the following:

- The transformational change needed in the global situation cannot be realized without properly engaging China. This will require a comprehensive strategy for organizations wishing to do so, including WWF.

White-fleshed fish such as cod and other such species processed in China, although not necessarily caught in Chinese waters or consumed in the country, are often subject to IUU practices, and so the priority with China should be to seek reform of China's import inspection and seafood traceability system.

- Small pelagics are a major part of China's production, consumption and import. A portion of these pelagics end up as fishmeal or food for aquacultured species. Therefore three priority actions are suggested: encouraging ecosystem-based management of China's domestic fisheries, especially to support the sustainability of small pelagic species; encouraging certified Peruvian anchovy fisheries, which might remove some of the pressure on overfished stocks elsewhere; and making better links between the Chinese aquaculture demand for fish meal and other aquatic food sources and decline in small pelagics throughout the global ocean ecosystem.
- Step up progress on improving environmental and sustainability standards related to Chinese aquaculture, including steps towards international standards and certification for responsible aquaculture practices.
- Carry out coordinated efforts on communication and dialogue to deal with difficult issues such as curtailing consumption of shark fin and unsustainably produced live reef fish, with the involvement of prominent individual groups such as the China Entrepreneur Club, and with the development of sustainable seafood guides directed to Chinese consumers, restaurants and food retailers.

- Address other sensitive issues such as fishery subsidies including definition of better economic and financial alternatives.

#### **2.4.2 Packard Foundation Study: A Focus on Engagement**

The Packard Foundation study is a response to China's critical significance to the global seafood industry. It has attempted to provide a current assessment of the Chinese seafood industry and expand the availability of information in order to open "doors in core parts of the industry in mainland China. ... Our aim is to enable dialogue on the sustainability challenges and to create partnerships to pursue possible solutions with key local stakeholders." The study did not cover the EEZ and offshore fishing, live reef fish trade, sea turtle trade and tuna fishing—elements that are of significance to Hong Kong and Taiwan fisheries and trade as well as to emerging markets in China. The details of the overall approach are indicated in Box 2.2. Six dimensions of environmental and socio-economic sustainability factors were examined: depletion of fish stock, environmental degradation, depletion of clean water resources, scale of industry, employment and economic importance, human health and food supply risks.

At a workshop held in the U.S., but involving both Chinese and international participants, the various sustainability issues facing the seafood industry of China were identified, followed by potential approaches for tackling these challenges. The results are shown in Box 2.3. The individual approaches are varied, and for the most part are neither unique to China, nor do they contain any major surprises. Taken together, they present a comprehensive approach that would take time to implement, and would involve various actors along the supply chains.

While all of the potential approaches are of value, the study attempted to further consider priorities that might be most fruitful for specific situations/species and on this basis plotted out a wide range of engagement options (see Figure 2.1). Out of some 22 options, five were selected for what appeared to be high value from an environmental perspective and for their likely ease of implementation. These five engagement opportunities are shown in Box 2.4. The study provides considerable detail on the process involved in the selection, and especially the rationale for each choice. It should be noted, however, that a substantial number of the potential approaches not selected from Figure 2.1 also have merit; overall, it is a good list for future consideration both by the Chinese fisheries and aquaculture industry and by the various stakeholders inside and outside of China interested in sustainable development of these sectors.

**Box 2.2 Roadmap for Increasing Sustainability in China's Seafood Industry.**

This approach has entailed first understanding the scale of seafood production, processing, and consumption in China as well as the stakeholders involved in the industry. Next, the analysis looked at the relative sustainability challenges posed by high-priority fish types in the mainland Chinese market by studying 23 fish types across six dimensions of sustainability, including three environmental dimensions and three socio-economic dimensions. From these 23 fish types, 10 were further prioritized based on their relative sustainability challenges in order to analyze their value chains and develop archetypal engagement models which could be applied more broadly.

These engagement models include a range of demand- and supply-side approaches: (i) public awareness campaigns, (ii) standard and certification regimes, (iii) new industry tools for improved inputs and production processes, (iv) new industry tools around research, data and traceability, and (v) government regulation and policy. The range of potential engagement opportunities within these broader categories was investigated to understand how much of the overall sustainability challenge would be addressed and how feasible implementation would be. This included mapping key stakeholders in the government, civil society, and private industry to understand their willingness and capacity to address sustainability concerns. These numerous engagement opportunities were then prioritized based on an assessment of their potential impact and feasibility.

*It is important to note that a species-by-species analysis is used for identifying the main sustainability challenges; the engagement opportunities identified to address these sustainability challenges are, by design, cross-species, not species-specific.”*

Source: Packard Foundation Report



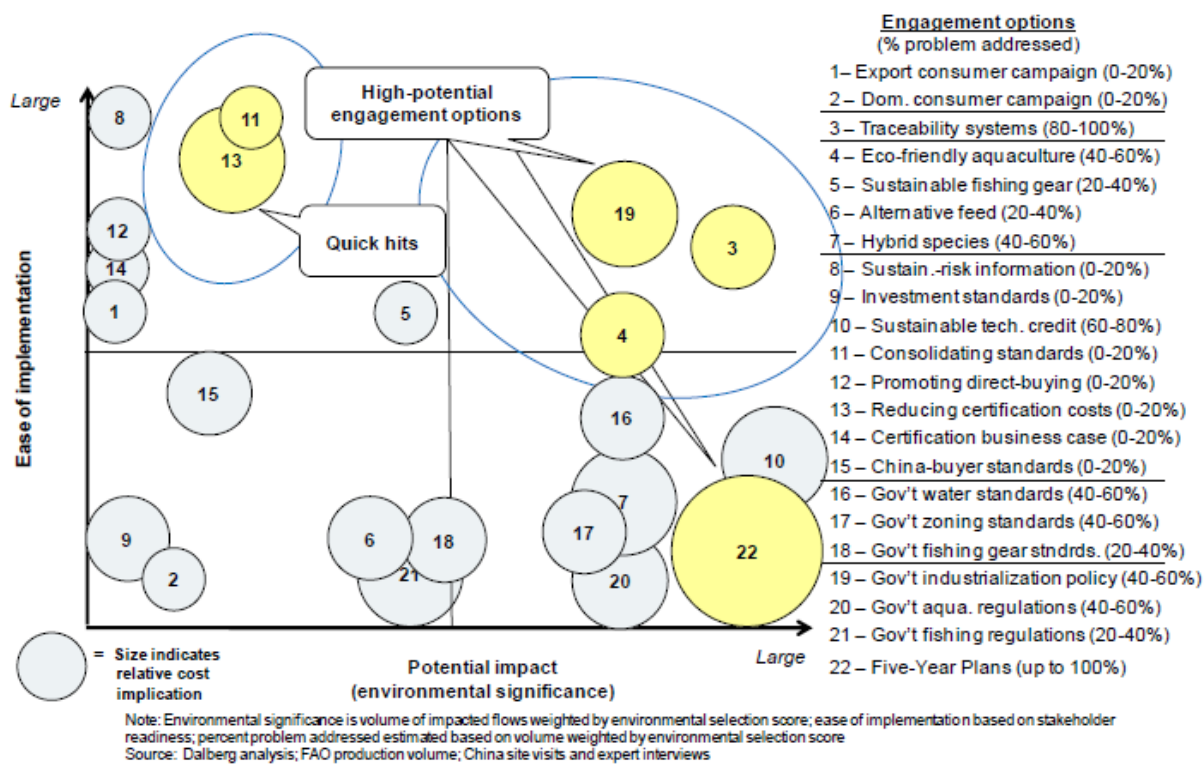
**Box 2.3 Potential approaches to tackle Chinese fisheries and aquaculture sustainability challenges.**

Sustainability issues and challenges in Chinese context	Potential effective approaches to tackle sustainability challenges
<ul style="list-style-type: none"> <li>• Processing / production of IUU fish in China</li> <li>• Strain on fish feed stock due to growing aquaculture production</li> <li>• Depletion of Chinese EEZ fish stock</li> <li>• China's role in distant water fisheries</li> <li>• Inconsistency of certification standards</li> <li>• Keep the seafood industry growing as a driver of economic development</li> <li>• Major data gap in projected growth of aquaculture and feed requirements</li> <li>• Increased Chinese investments in external production / processing markets</li> <li>• Weaknesses in US policy vs. EU</li> <li>• Role of non-native species</li> <li>• GM species</li> <li>• Limited consumer preference for sustainable seafood</li> </ul>	<ul style="list-style-type: none"> <li>• Development / refinement of traceability system</li> <li>• Investment in / collaboration with fish meal production companies to provide sustainable fishmeal options</li> <li>• Technology transfer or promotion of efficient aquaculture production techniques (e.g., multitrophic / polyculture, urban aquaculture)</li> <li>• Engagement of government to influence long-term strategy / vision via trigger points               <ul style="list-style-type: none"> <li>• Food safety / security</li> <li>• Job security</li> <li>• Energy</li> <li>• Reputational concerns</li> </ul> </li> <li>• Harmonization of certification standards               <ul style="list-style-type: none"> <li>• Potentially using key buyers (e.g., Walmart / Carrefour)</li> <li>• Coordination of NGO efforts</li> </ul> </li> <li>• Reinforcing regulatory regimes of target markets of Chinese investment</li> <li>• Harmonization of global regulation / legislation</li> <li>• Financier-led standards</li> <li>• Modification of incentive structure of various players in the value chain</li> </ul>

Source: Packard Foundation Study

**Box 2.4 Five specific engagement opportunities recommended by the Packard Foundation study for China sustainable fisheries and aquaculture.**

Development and deployment of a single integrated national traceability system for fisheries and aquaculture, with a management and oversight body.
Cooperation and support for the government's effort to improve the quality control of aquaculture production through consolidation and industrialization.
Investment in R&D and technical assistance to improve aquaculture production practices.
Creation of consolidated standards in China for major fisheries and aquaculture fish types and more affordable certification procedures.
Support for the development of Five-Year Plans which incorporate sustainability principles for fisheries and aquaculture in order to establish effective national-level policies.



**Figure 2.1 High potential engagement options.**

Source: Packard Foundation Study

### 3.0 Overview of Species for Market Supply Chain Analysis

The issue of how many and which species might be considered for the overall study was not an easy one to resolve, since China is such a major producer, processor (and reprocessor) and consumer of seafood. We wished to have representatives from each of the three key types of supply chains noted in Figure 1.1. And it is important to examine those likely to illustrate good stewardship, as well as those with major problems, either inside or outside of China. There are also issues of data access, quality and availability. Therefore, at the July 2009 scoping meeting, the IISD team agreed to bring forward brief overviews on nine species, including those featured in the first two preliminary supply chain analyses. The eight species (or clusters of species) are: tilapia, cod, pollock, tuna, shark, squid, leopard coral trout, and largehead hairtail. Although this is a large number, and only three or four can be chosen, including the work already started on cod and tilapia, it likely will be instructive to learn from selected aspects of several more of these species, without doing a full market supply chain.

Similarly, there are some high profile species that have not been selected for analysis, including Patagonian toothfish (often called Chilean sea bass), farmed and wild salmon, several important reef fishes, and a number of important invertebrates such as abalone, octopus, scallops, spiny lobster and sea cucumbers. Although the amount of attention we can give to these is limited, there might be lessons learned from literature review, for example on the effects of introducing MSC certification into at least one part of the Patagonian toothfish production chain.

The following nine charts provide a production, trade and consumption snapshot based on global production, current and future trends, China's role, and key drivers related to trade.<sup>13</sup>

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<sup>13</sup> These have been prepared by Dr. Shelley Clarke.

### Box 3.1 Tilapia (*Oreochromis niloticus*)

Global Production	Current and Future Trends
<p>Tilapia (all species) is the second most important group of farmed fish after carps, and the most widely cultured of any farmed fish.<sup>1</sup> (Approximately 650,000 t per year of tilapia is also produced from capture fisheries but none of it from Chinese fisheries).<sup>2</sup> Aquaculture production has grown rapidly since the early 1980s and now totals over 2.1 million t per annum<sup>1</sup> based primarily on one species, Nile tilapia (<i>Oreochromis niloticus</i>).<sup>1</sup> Since tilapia can accept feeds with a higher percentage of plant proteins (or other agriculture byproducts, e.g. manure) and are relatively resistant to poor water quality and disease, they can be cultured intensively and economically.<sup>1</sup> Yield for a skinless fillet is 33 per cent.<sup>1</sup></p>	<p>Global production has grown at an exponential rate of approximately 14 per cent per year.<sup>1</sup> The development of sex reversal techniques for female tilapia in the 1970s allowed for the introduction of male monoculture populations which grow twice as fast and produce uniformly-sized individuals for market.<sup>1</sup> Current estimates suggest that tilapia culture produces more fish protein than it consumes but an ongoing trend toward higher quality products would be expected to lead to a greater use of fish meal and fish oil as feed for tilapia, thus reducing efficiency.<sup>4</sup></p>
China's Role	Key Drivers
<p>China's production in 2007 (1.1 million t) far surpassed the other top producing countries of Egypt, Indonesia, Thailand, and the Philippines, each of which cultured no more than 300,000 t.<sup>2</sup> China reports exporting only about 200,000 t in 2007 which may suggest that a substantial proportion of production is consumed in China.<sup>2</sup></p> <p>China reported mostly processed exports in the categories of "prepared and preserved" and "frozen fillets" with 64 per cent to the United States and 31 per cent to Mexico.<sup>3</sup> U.S. demand is attributed to China's low production costs (0.55-0.65 USD/kg).<sup>1</sup></p>	<p>Premium production for higher grade export markets may increase quality standards but decrease efficiency.<sup>4</sup> Dependence on the U.S. market belies a sensitivity to U.S. demand and hence market perception. Some seafood sustainability guides advocate avoidance of China-produced tilapia due to issues relating to operational waste management, antibiotic and pesticide residues, and treatment with carbon monoxide which can mask spoilage.<sup>5,6,7</sup> There have been some recent efforts within China to certify tilapia production to various national and international organic, or other "green" standards.<sup>8</sup></p>

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### Box 3.2 Pollock (*Theragra chalcogramma*)

Global Production	Current and Future Trends
<p>Pollock is a temperate, pelagic, whitefish species usually caught by midwater trawl.<sup>1</sup> Although there are other species sometimes referred to as pollock, the most important commercial species is Alaskan pollock (<i>Theragra chalcogramma</i>) fished by U.S. (1.4 M t) and Russian (1.2M t) fleets in the north Pacific.<sup>2</sup> Production levels may be somewhat unpredictable due to the dependence of the current stock levels on favourable recruitment and juvenile survival conditions.<sup>1</sup> Yield ratios for fillets are slightly less than 50 per cent. The U.S. pollock fishery is certified under the Marine Stewardship Council (MSC) eco-label; the Russian pollock fishery is working toward achieving this certification but has previously been accused of unsustainable harvest practices.<sup>3</sup></p>	<p>Pollock catches peaked in 1986 at levels more than double current catches.<sup>2</sup> Stock levels in recent years are thought to have been depressed by an increase in water temperature which reduces juvenile survival<sup>6</sup> but the stock is not currently considered depleted.<sup>1</sup> In the U.S., fishery harvesting has been constrained to mitigate negative effects on marine mammals (prey competition) and salmon (bycatch).<sup>1</sup> In recent years, pollock has been in demand as a preferred substitute for cod in addition to its long-standing use for its roe (Japan market), as a base for surimi products, and for fish oils and meals.<sup>3</sup></p>
China's Role	Key Drivers
<p>It is estimated that China processes 210,000 t of pollock products for the European Community and United States markets.<sup>4</sup> This amount equates to approximately 15–20 per cent of the global catch.<sup>4</sup> Although pollock are primarily imported to China for processing and re-export, a small amount of product likely remains in China for consumption. It is difficult to obtain precise information about processing of pollock in China due to the absence of species-specific commodity codes in the China coding system<sup>5</sup> but it is undoubtedly one of the primary processing trade species.</p>	<p>As it is highly substitutable with other wild-caught whitefish, as well as tilapia and catfish, demand for pollock is subject to price competition leading to fluctuations in supply and demand.<sup>3,7</sup> Some seafood companies have begun using pollock's relatively high omega-3 content as a selling point.<sup>8</sup> Several NGOs objected to the MSC certification of part of the pollock fishery on the grounds of poor management of a declining stock and marine mammal interactions.<sup>9</sup></p>

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### Box 3.3 Cod (*Gadus morhua* and *Gadus macrocephalus*)

Global Production	Current and Future Trends
<p>Two species of cod comprise the majority of global production: Atlantic cod (<i>Gadus morhua</i>) and Pacific cod (<i>Gadus macrocephalus</i>).<sup>1</sup> Both species are temperate, pelagic whitefish caught primarily by midwater trawl.<sup>3,7</sup> Currently catches of Atlantic cod are roughly 775,000 t per year with the major fisheries conducted by Norway, Russia and Iceland.<sup>1</sup> Pacific cod catches currently total approximately 332,000 t primarily by U.S. fleets with considerably smaller catches by Russia and Japan.<sup>1</sup> Yield ratios for fillets are slightly less than 50 per cent. A portion of the U.S. Pacific cod fishery (116,000 t)<sup>4</sup> and a small segment of the Norwegian Atlantic cod fishery (5,000 t),<sup>5</sup> both of which are longline fisheries, are certified under the Marine Stewardship Council (MSC) eco-label.</p>	<p>Atlantic cod catches peaked in the late 1960s at nearly 4 M t but have collapsed to roughly 20 per cent of that level.<sup>7</sup> Pacific cod catches have declined slightly from levels of over 400,000 t in the late 1980 and early 1990s.<sup>3</sup> Pacific cod is considered to be resilient to fishing pressure.<sup>3</sup> Small quantities of Atlantic cod (<math>\leq 14</math> t) have been farmed in recent years<sup>7</sup> but several major producers are struggling or have closed down.<sup>8</sup></p>
China's Role	Key Drivers
<p>China processes 110,000 t of cod products for the European Community and United States markets.<sup>6</sup> This amount equates to approximately 15-20 per cent of the global catch.<sup>6</sup> Although cod are primarily imported to China for processing and re-export, a small amount of product likely remains in China for consumption. Although cod is undoubtedly a major processing trade species, the reliability of China's trade statistics for cod may be compromised by mixing of cod and pollock under the same commodity code.<sup>2</sup> There is a small cod fishery in China's Yellow Sea (21,000 t per year).<sup>1</sup> These fish are consumed domestically.<sup>6</sup></p>	<p>NGO's consumer campaigns may have dampened demand for cod by highlighting problems with IUU fishing and stock declines.<sup>9</sup> A few Atlantic cod fisheries appear to be rebuilding and have applied for MSC assessment.<sup>10</sup> IUU fishing for cod in the Barents Sea has been successfully combatted by NEAFC port State controls.<sup>11</sup> Limited incidents of circumvention of these port State controls by landing in China have been reported.<sup>12</sup></p>

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### Box 3.4 Tuna (*Thunnus* spp. and *Katsuwonus pelamis*)

Global Production	Current and Future Trends
<p>The most important commercial species of tuna are Atlantic, Pacific and southern bluefin (<i>Thunnus thynnus</i>, <i>T. orientalis</i> and <i>T. maccoyii</i>), bigeye (<i>T. obesus</i>), yellowfin (<i>T. albacares</i>), albacore (<i>T. alalunga</i>) and skipjack (<i>Katsuwonus pelamis</i>).<sup>2</sup> Total catch of these species has grown steadily since the 1960s but appears to have declined in the last two years.<sup>1,2</sup> Currently, skipjack comprise 51 per cent of the global catch, and 70 per cent of the global catch is taken by purse seine.<sup>2</sup> There are concerns about bycatch of sharks, seabirds, turtles and dolphins in association with tuna fisheries.<sup>2</sup> The top five tuna fishing entities worldwide are Japan, Taiwan, Indonesia, the Philippines and Spain.<sup>2</sup> Cannery-based processing is concentrated in Thailand (24 per cent) and Ecuador (12 per cent) and the U.S. is the world's largest market for canned tuna (15 per cent).<sup>2</sup> One Pacific albacore fishery is certified to the MSC standard.<sup>3</sup></p>	<p>Several tuna stocks, including the eastern and western stocks of bluefin tuna in the Atlantic and southern bluefin tuna in the Indian Ocean, are considered to be overfished and/or subject to overfishing.<sup>2</sup> Bigeye, yellowfin, Pacific bluefin and albacore are also at risk of becoming overfished or becoming subject to overfishing in some parts of their range.<sup>2</sup> The largest market for fresh and frozen tuna, Japan, appears to be shrinking while other markets such as the EU and U.S. are expanding.<sup>2</sup> Tuna farming, initiated on a commercial scale in the 1980s, now produces up to 60,000 t per year.<sup>2</sup> In addition to the usual concerns associated with aquaculture, tuna farming comes under particular criticism for overharvesting of juveniles and highly inefficient feed conversion ratios (25:1).<sup>9</sup></p>
China's Role	Key Drivers
<p>China developed a distant water tuna fleet in the Pacific in the 1990s, and with expansion of operations in the Pacific and extension to the Atlantic and Indian Oceans in the last decade China's catches now total nearly 100,000 t per year.<sup>1,2</sup> China exports a small amount of canned tuna (~7000 t per year) to the EU, U.S. and Japan.<sup>4</sup> China processes a small, but growing, amount of tuna at a handful of plants in Shandong and Tianjin primarily for re-export to Japan, but increasingly also the U.S. and EU.<sup>4</sup> Although there have been suggestions that tuna consumption in China is increasing rapidly,<sup>5</sup> it appears that re-exported quantities account for most of the increase in imports.<sup>6</sup></p>	<p>In 2010 CITES will consider a proposal to list Atlantic bluefin tuna on Appendix I, which would result in a trade ban.<sup>7</sup> Opponents of the ban maintain that the Regional Fisheries Management Organizations can best manage the stocks.<sup>7</sup> Five small tuna fisheries (New Zealand, Canada, Maldives, Japan and St. Helena) are currently under MSC assessment.<sup>3</sup> In addition to stock sustainability concerns, campaigns highlighting mercury content in tunas may be affecting consumer demand.<sup>8</sup> Recently, a canning industry group (ISSF) has formed to lobby for sustainable management of tuna stocks.<sup>2</sup></p>

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### Box 3.5 Shark (various species)

Global Production	Current and Future Trends
<p>A wide variety of shark species are taken as non-target and target catch and are either discarded alive or dead, finned or fully utilized.<sup>1</sup> Capture production of sharks peaked in 2003 at just over 600,000 t but has declined slightly since then.<sup>3</sup> The five largest shark fishing entities are India, Indonesia, Taiwan, Spain and Mexico.<sup>3</sup> Shark meat is most heavily imported by southern European and Latin American countries including Spain, Uruguay, Italy, and Brazil and also South Korea, whereas major exporters include Taiwan, Spain and Uruguay.<sup>3</sup> Hong Kong reports the largest quantities of shark fins imported followed by China.<sup>3</sup> A study of the species composition of the Hong Kong shark fin trade found that blue (<i>Prionace glauca</i>), shortfin mako (<i>Isurus oxyrinchus</i>), silky (<i>Carcharhinus falciformis</i>), sandbar (<i>C. obscurus</i>), bull (<i>C. leucas</i>), three hammerhead (<i>Sphyrna</i> spp.), and three thresher (<i>Alopias</i> spp.) sharks were heavily utilized.<sup>4</sup></p>	<p>The global catch of sharks has declined since 2003 in parallel with a trend of decrease in the quantity of shark fin traded through Hong Kong.<sup>2</sup> There are insufficient data on the levels of the shark fin trade in Mainland China to determine trends in the trade overall.<sup>4</sup> In the past five years, shark finning has been prohibited by several Regional Fisheries Management Organizations (RFMOs) and countries but enforcement is thought to be limited.<sup>7</sup> Of the 11 species found in the Hong Kong fin trade, the IUCN Red List in 2009 listed three as threatened, six as vulnerable and three as near threatened.<sup>5</sup> Three shark species—basking (<i>Cetorhinus maximus</i>), whale (<i>Rhincodon typus</i>) and great white (<i>Carcharodons carcharias</i>)—are listed by CITES on Appendix II (trade controls) and all but one sawfish species (<i>Pristis</i> spp.), whose fins are used in the trade, were listed by CITES on Appendix I (trade ban).<sup>5</sup></p>
China's Role	Key Drivers
<p>As China's commodity coding system reports frozen shark meat and fins in aggregate, it is difficult to measure the full extent of the trade.<sup>6</sup> The top supplier of dried fins to China is Taiwan and the top supplier of frozen shark meat or fins to China is Spain.<sup>6</sup> Small amounts of shark products are re-exported from China.<sup>6</sup> While wholesale prices for shark meat are general low (&lt;US\$10 per kg), retail prices for fins in Hong Kong range from US\$100-500 per kg.</p>	<p>Awareness of the inherent vulnerability of sharks to overfishing is growing and at any one time there are several ongoing public campaigns against shark finning and the fin trade. Artificial shark fin, long shunned as a counterfeit product, is now being openly served in some restaurants as an alternative. While RFMOs have shown some interest in shark stock assessments, data are extremely limited; therefore, the urgent need for management requires detailed knowledge that is not readily available.</p>

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**Box 3.6 Jumbo flying squid (*Dosidicus gigas*), Argentine shortfin squid (*Illex argentinus*) and Japanese flying squid (*Todarodes pacificus*)**

Global Production	Current and Future Trends
<p>There are three major species in global squid fisheries: the jumbo flying squid, the Argentine shortfin squid, and the Japanese flying squid.<sup>1</sup> China, Peru, South Korea, Japan, Taiwan and Argentina report the largest amounts of capture production of these species and “various squids.”<sup>1</sup> Spain and Italy are the largest importers of squid products, together accounting for 52 per cent of world trade.<sup>1</sup> Major exporters of squid products include South Korea, Argentina, Taiwan, Spain, the U.S., New Zealand, Thailand, the Falkland Islands, and India.<sup>1</sup> The flying squid species are taken by jiggers, which typically have little or no bycatch.<sup>3</sup> The Argentine shortfin is taken by trawls.<sup>7</sup> Previous use of drift nets is now banned in international waters.</p>	<p>Catches reached a global peak of 4.3 Mt in 2006, but production is unstable, with recent declines in Japanese flying and Argentine shortfin catches.<sup>2</sup> It has been suggested that cephalopod catches have increased as a result of increased abundance in response to overfishing of groundfish stocks<sup>9</sup>. Since squid species have short lifecycles they are heavily influenced by environmental conditions such as climate change and thus require management which can respond rapidly to interannual variability as well as longer term oceanic regime shifts.<sup>6</sup></p>
China’s Role	Key Drivers
<p>China’s catch of the three major squid species (718,000 t in 2007) accounts for 26 per cent of the global catch of major squid species. In 2002–2006, 52 per cent of China’s reported distant water fisheries catch was composed of Argentine shortfin and jumbo flying squid.<sup>4</sup> As of 2004, there were 115 China-flagged fishing vessels fishing for squid off Argentina and Peru.<sup>4</sup> China imported over 270,000 t of cuttlefish and squid in 2006 mainly from Peru, Argentina, the U.S., and North and South Korea.<sup>5</sup> China exports squid products (103,000 t) to a number of countries including Japan, the U.S., and Taiwan.<sup>5</sup> This squid trade is almost entirely in processed products.</p>	<p>There appear to be limited sustainability concerns associated with squid as compared to other seafood species due to their short life cycle and high reproductive capacity, and the low levels of bycatch associated with jig fisheries.<sup>8</sup> However, concerns exist for some populations regarding IUU fishing on migratory populations on the high seas.<sup>8</sup></p>

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### Box 3.7 Leopard Coral Trout (*Plectropomus leopardus*)

Global Production	Current and Future Trends
<p>This species (known by the common names coral trout, leopard coral trout, and leopard coral grouper) is found in reef habitats throughout southeast Asia and northern Australia.<sup>1</sup> The only catch reported to FAO of leopard coral trout was 6000 t by Indonesia in 2000.<sup>2</sup> However, as many of these fish are likely to be caught by small-scale, artisanal fishers in developing countries, reported catches are likely to be underestimates.<sup>6</sup> The supply chains are characterized as long, complex, and, due to high transport costs, controlled by dealers in Hong Kong.<sup>6</sup></p>	<p>Leopard coral trout imports to Hong Kong increased steadily from 2000–2007 to over 3000 t per year, primarily from Australia and the Philippines.<sup>3</sup> Live reef fish fisheries in southeast Asia are considered to far exceed sustainable levels.<sup>9</sup> With the exception of Australia, most fisheries lack appropriate control structures suggesting that sustainability is unlikely to be achievable in the short term.<sup>9</sup></p>
China's Role	Key Drivers
<p>Commodity codes for Mainland China do not distinguish this species.<sup>4</sup> However, it is estimated that about 60 per cent of the international trade live reef fish transits Hong Kong, with about 50 per cent of this destined for Mainland China.<sup>6</sup> The annual quantity and value of the trade through Hong Kong is estimated at 13,000–14,000 t and US\$400 million.<sup>8</sup> Leopard coral trout comprised about half of the live fish reef traded during a Hong Kong survey in 1999–2003 with a wholesale price of US\$36 per kg (mid-to-high range among live reef fish).<sup>6</sup></p>	<p>The IUCN Red List notes concerns for <i>P. leopardus</i> associated with declining catch rates and targeting of juveniles for “grow-out” operations, thus reducing spawning populations, as reasons for listing this species as “near threatened.”<sup>5</sup> Other concerns include destructive fishing techniques, vulnerable life history characteristics, and potentially increasing demand by Chinese consumers.<sup>9</sup> There have been some experiments with this species involving use of coded wire tags to facilitate traceability.<sup>7</sup></p>

Sources:

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### Box 3.8 Largehead Hairtail (*Trichiurus lepturus*)

Global Production	Current and Future Trends
<p>Capture production of hairtails (<i>Trichiurus lepturus</i> and unidentified hairtails) has totalled approximately 1.5 t in recent years of which 60 per cent has been taken by China in the northwest Pacific.<sup>1</sup> Other leading hairtail producing countries (India, South Korea, Indonesia and Pakistan) report no more than 10 per cent of the global production each.<sup>1</sup> Ninety-five percent of hairtails are mature after one year<sup>2</sup> and the species is believed to be highly resilient to fishing pressure.<sup>4</sup> Portions are eaten grilled or fried or as sashimi.<sup>3</sup> China is by far the world's largest importer of hairtail (158,000 t in 2006).<sup>1</sup> India is the dominant global exporter, followed by China.<sup>1</sup></p>	<p>A study conducted in the late 1980s warned that stock depletion would occur and catches would decline gradually unless measures to control fishing were implemented.<sup>2</sup> It is not known whether such management measures were taken, but catches in China have tripled<sup>1</sup> and global catches have increased by 50 per cent.<sup>3</sup></p>
China's Role	Key Drivers
<p>The hairtail fishery is the largest in China.<sup>2</sup> There are separate East China Sea and Bohai/Yellow Sea stocks, with the East China Sea stocks fished mainly out of China's largest domestically-based fishing port at Zhoushan, Zhejiang Province.<sup>2</sup> China, the world's largest importer of hairtail, receives substantial quantities (152,400 t in 2006) from India and Thailand.<sup>5</sup> China also exports a relatively small amount of frozen hairtail to Korea (20,000 t in 2006).<sup>5</sup></p>	<p>Key drivers of hairtail production, trade and consumption are not known.</p>

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### Box 3.9 Shrimp (*Penaeus* spp. and *Acetes* spp.)

Global Production	Current and Future Trends
<p>Approximately 100 species of shrimp comprise the majority of the world's capture production and 10 species are used in commercial production.<sup>1</sup> Global production has grown steadily by ~5 per cent per year to a total of 6.5 M t in 2007, of which 50 per cent is captured (3.25 M t) and 50 per cent is cultured (3.28 M t).<sup>2</sup> About 60 per cent of all shrimp enter international trade, and about 60 per cent of traded shrimp are cultured.<sup>1</sup> In general, the shrimp trade has not grown in value over time as supply exceeds weakening demand.<sup>6</sup> Since 2005, the U.S. and Japan have been the largest importers of shrimp with 25 per cent and 13 per cent of the market, respectively, but the EU as a whole receives 36 per cent of the production.<sup>2</sup> Since 2005, the largest shrimp exporters are Thailand, China, Vietnam and India.<sup>2</sup></p>	<p>China's cultured shrimp industry expanded rapidly in the late 1980s around the Bohai Gulf, employing over 1 million people, but it crashed due to severe disease epidemics in the early 1990s<sup>4</sup> which also affected the wild populations.<sup>1</sup> In recent years, the industry has rebounded explosively, quadrupling between 2002 and 2007,<sup>2</sup> on the basis of <i>P. vannamei</i> culture in southern and central China.<sup>4</sup> Development of the domestic market in China has been encouraged and appears to be occurring.<sup>1,6</sup> Most wild shrimp stocks are fully exploited and cannot accommodate further expansion.<sup>1</sup> Increasing fuel costs may shift markets more toward farmed shrimp.<sup>1</sup></p>
China's Role	Key Drivers
<p>China produces 40 per cent (1.2 Mt) of the world's wild-caught shrimp. About half of this quantity is akiami shrimp (<i>Acetes</i> spp.), used to make fermented shrimp paste, which does not generally enter international trade. China also produces 40 per cent of the world's farmed shrimp (1.3 M t). Whiteleg shrimp (<i>P. vannamei</i>) comprises 85 per cent of this production. This species demands less protein as feed than other commonly cultured shrimp and has a feed conversion ratio of 1.2 to 1.8<sup>5</sup> (2.1 in China according to some sources).<sup>7</sup> Juveniles (seed) are produced in hatcheries<sup>7</sup>. Disease issues are a concern reportedly affecting 15–20 per cent of all acreage and causing 1 million t of lost product each year.<sup>7</sup> China's exports of processed shrimp in recent years have been mainly destined for the United States, Spain, Japan, Mexico and Korea.<sup>3</sup> Most internationally traded shrimp is sold in frozen, graded form whole or as tails only.<sup>1</sup></p>	<p>There are concerns, including within China, that shrimp farming is poorly regulated and a major contributor to water pollution through nutrient and drug residue discharges.<sup>7</sup> As China's largest market, U.S. trade policy is a major driver of trade patterns in several ways. First, the U.S. currently detains all imports of farmed shrimp from China unless they are proven through third-party testing to be free of drug residues.<sup>8</sup> Second, the U.S. has certified China's shrimp fisheries as posing no danger to sea turtles thereby averting a ban on wild-caught shrimp.<sup>1</sup> Finally, the U.S. has imposed tariffs on farmed shrimp from China as an anti-dumping measure.<sup>1</sup> Most U.S. sustainable seafood guides label farmed and wild imported shrimp as "red/avoid" due to pollution and by-catch issues.<sup>9</sup> Social impacts associated with shrimp farming are also sometimes cited.<sup>1</sup> Two Chinese shrimp farms have been certified under the Aquaculture Certification Council system.<sup>10</sup></p>

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## 4.0 Sustainable Analysis of China Tilapia Products Supply Chain<sup>14</sup>

### 4.1 Rationale for Choosing Tilapia Supply Chain

Tilapia has been cultured in many countries all over the world since the 1970s.<sup>15</sup> After more than three decades of developments, tilapia farming now takes place in more than 80 countries.<sup>16</sup> It has become one of the most widely-farmed fish types, and was the third highest in the international trade of farmed aquatic products, behind salmon and shrimp. Total production reached 3.5 Mt in 2008, out of which 2.8 Mt were farmed products. Tilapia has become popular globally among consumers for its tasty meat, free of intramuscular bones; International demand from North America, Europe, Africa, the Middle East, Oceania and many other countries and regions has been continuously increasing. Tilapia could become one of the major sources of animal protein in the future due to growing demand in the global seafood market. China has become the world's leading producer and exporter of tilapia.

While international commentary about tilapia sustainability has been relatively positive, sourcing from Asia, including China, has been discouraged in a number of seafood watch guides issued by various NGOs. For example, the WWF has generally rated the fish as “unsustainable because of issues related to harmful environmental effects, including chemical use, waste spilling into waterways, risks of disease and escapes and weak regulation of aquaculture in many producing areas.”<sup>17</sup> Through the Aquaculture Stewardship Council, WWF has recently released a tilapia stewardship standard for certification. Tilapia in Indonesia and Honduras are currently being certified, but so far not many Chinese tilapia aquaculture businesses have started this process.

#### 4.1.1 Advantage of Developing Tilapia Aquaculture

Of the many tilapia species (which originate in Africa), only a limited number are suitable for intensified farm production. There has been a fast development all over the world with introduced tilapia species in recent decades, and improved species have been developed through many years of crossbreeding. The current commercially-farmed tilapia species are Nile tilapia (mostly Gift Nile), Ao-ni tilapia ( $O.aureus\♂ \times O.niloticus\♀$ ), and Red tilapia ( $O.mossambicus\♀ \times O.niloticus\♂$ ). Compared with other species, tilapia has the following advantages:

<sup>14</sup> This chapter was prepared by CAPPMA with additional inputs and editing by IISD.

<sup>15</sup> Fisheries and Agriculture Organization (FAO) (1975). “Culture of Tilapia.” *FAO Aquaculture Bulletin* 7 (1-2),7-8.

<sup>16</sup> See <http://www.abouttilapia.com>

<sup>17</sup> See [http://www.panda.org/wwf\\_news/?198341/Indonesia-and-Honduras-tilapia-swim-into---seafood-guide-upgrade](http://www.panda.org/wwf_news/?198341/Indonesia-and-Honduras-tilapia-swim-into---seafood-guide-upgrade)

- High output and short growing period
- High survival rate in the nursery period and the fry can be supplied throughout the year
- Easy farming management and better disease resistance
- Convenient compound feed supply
- Low-farming costs
- Easy processing into fresh or frozen fish fillets.

#### 4.1.2 Fast Growth of the Global and Chinese Tilapia Industry

##### Status of Global Tilapia Aquaculture Development

In the past decades, the global tilapia industry has seen tremendous changes and a rapid increase in overall farm yield. Production has increased from 0.4 Mt in 1990 to 1.1 Mt in 1999 and to 2.8 Mt in 2008. Wild catch output was merely stable at about 0.7 Mt.<sup>18</sup>

China ranks first in tilapia aquaculture production. In 2008 it accounted for 40 per cent of global production. Prior to 2008, Egypt was the second largest producer, accounting for 10 per cent of global production. Indonesia's production grew rapidly in 2008 and the yield increased 0.101 Mt compared to 2007, to take the place of Egypt, thus making it the second largest producer (see Figure 4.1).

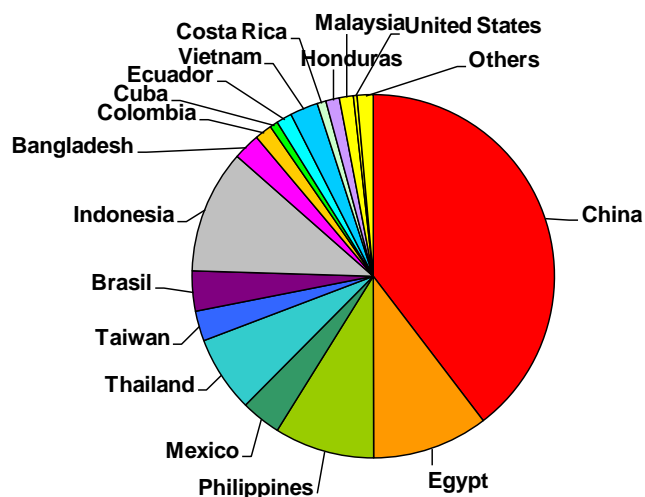


Figure 4.1 World Tilapia Farming Production in 2008.

<sup>18</sup> American Tilapia Association

## The Status of China's Tilapia Aquaculture

Chinese tilapia production has grown by an annual average of 13.4 per cent over the past 10 years<sup>19</sup> (see Figure 4.2). China has stayed as the top producer<sup>20</sup> for many years. Tilapia production accounted for 6 per cent of the freshwater farmed fish in 2008<sup>21</sup> in China, but its farming distribution in China was uneven. Farming in southern areas such as Guangdong, Hainan, Guangxi and Fujian provinces experienced rapid development due to a favourable climate. Total production of the four provinces accounted for about 90 per cent of national production.

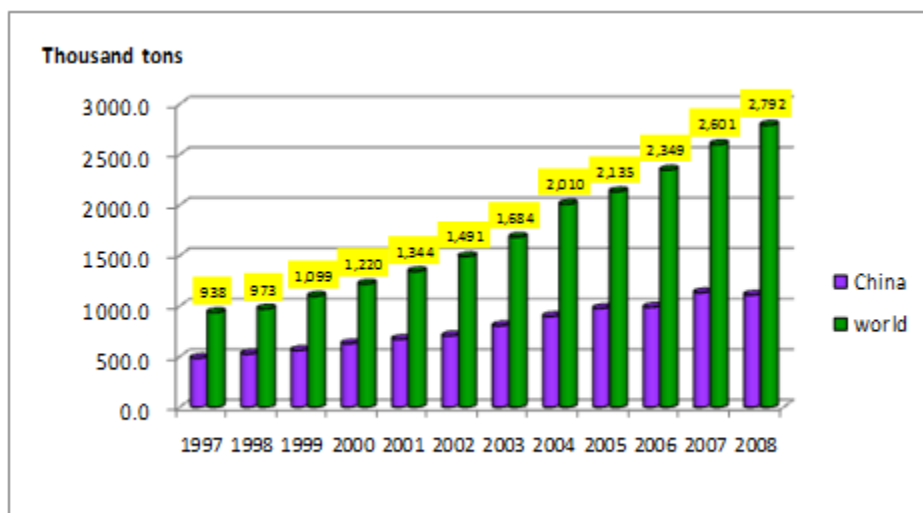


Figure 4.2 Increasing global and Chinese production in tilapia farming from 1997 to 2008.

Because tilapia is a tropical fish, the prolonged cold and snow storm at the beginning of 2008 caused the death of large numbers of tilapia in south China. The total production was 1.11 Mt, down 2.1 per cent compared to 1.13 Mt in 2007. As the biggest major producer, Guangdong suffered the greatest loss with a decrease of 12.6 per cent compared to the same period a year earlier (See Table 4.1). Hainan was not affected by the 2008 storm, with a 20.2 per cent increase in production, which reached 217,000 t. Guangxi and Fujian were also slightly influenced but still had a tiny increase; their production reached 165,000 and 95,000 tonnes respectively.

<sup>19</sup> 2008 China Fisheries Statistics Yearbook

<sup>20</sup> American Tilapia Association

<sup>21</sup> 2008 China Fisheries Statistics Yearbook



**Table 4.1 Production in China’s major tilapia farming Areas (Unit: 1000 t).**

Area	2008	2007	Increase/decrease	Growth ( per cent)
Guangdong	518	593	-75	-12.6
Guangxi	165	158	7	4.6
Hainan	217	181	36	20.2
Fujian	95	90	5	5.7
Total (include others)	1110	1134	-24	-2.1

## Sustainability Implications of Rapid Growth in Production of Tilapia

It is a remarkable story that a fish as plain as tilapia could achieve such success over a period of less than two decades in several major countries and especially in China. With the rapidity and level of expansion, it would be equally or even more remarkable if the story were as successful in terms of protecting the environment in the many locations where tilapia are found. By comparison with many other species, culture of tilapia has lower feeding demands in terms of animal protein, fewer diseases, and other attributes that make it attractive ecologically and also enhance the income of rural farmers. There are good reasons to believe that it could become a success story for rural sustainable development. However, as others have noted, the story could also be one of growing concern if environmental standards are not properly observed at the farm level, or if there are other problems. Han Han, who studies tilapia environmental and sustainability issues, suggests that in China the following concerns need to be addressed:<sup>22</sup> water shortages and pollution, disease control and antibiotic use, the escape of tilapia and biodiversity impacts on other fish, prepared food sources, and traceability from production areas to final point of sale.

## 4.2 Global Trade of Tilapia Products

### 4.2.1 Production and Export of Major Producers

#### Production

The top producers, such as China, Indonesia, Egypt, the Philippines, and Thailand account for 76.7 per cent of the global production. As indicated in Figure 4.3, the five countries all showed a positive growth trend, and 70 per cent of the increased tilapia production is from Indonesia.

#### Export

China is the world’s biggest tilapia exporter. Its major markets are the U.S., Mexico, Russia, and the EU. The U.S. and Mexico have been the traditional markets, although Russian market share began to expand after 2005, becoming the third largest market for China. However, Russia stopped importing for several months during the 2008–2009 financial crisis. Meanwhile, the EU market grew

<sup>22</sup> <http://www.seafoodchoices.com/seafoodsummit/documents/Han,Han.pdf>

steadily and it became the fourth largest export market: It is expected to be the fastest growing market in the future.

Before 2005, more than 70 per cent of China’s tilapia products were exported to the U.S. While the U.S. is still the major export market, China’s share of the market declined 23 per cent in 2008 compared to 2005. Currently the export markets have expanded to more than 70 countries in 2008 compared to 40 countries in 2007.<sup>23</sup>

Before 2002, the biggest supplier to the U.S. tilapia market was Taiwan. Mainland China had a rapid growth in its tilapia industry after that, and it has replaced Taiwan as the leading U.S. supplier as a result of lower labour costs and richer farming resources. There have been no increases from Costa Rica and Ecuador since 2002. However, the small import volume from Honduras and Indonesia continues to increase. From Honduras, fresh fillets accounts for 98 per cent of the total exported products. Though it was just 4.7 per cent of the imported tilapia volume, it accounted for 8.6 per cent of the total imported tilapia value. The price for fresh fillets was higher than for frozen fillets.<sup>24</sup>

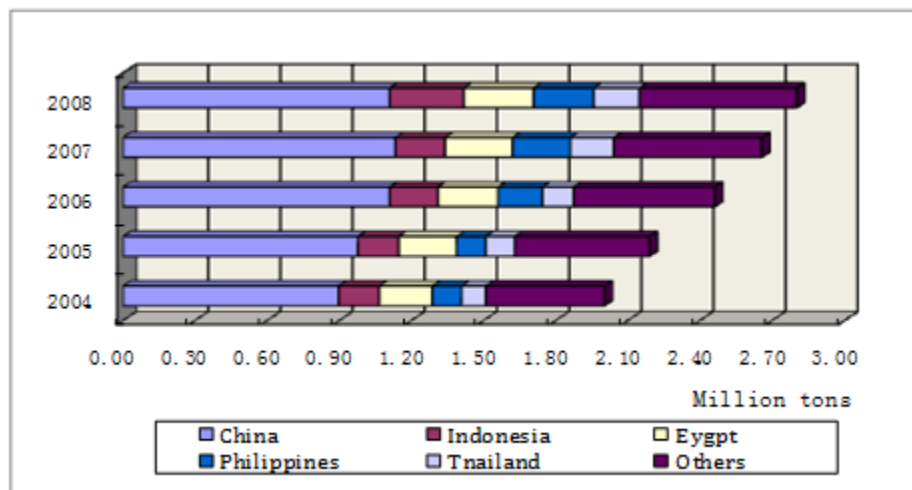


Figure 4.3 Main tilapia producing countries (2004–2008).

#### 4.2.2 Major Importing Countries and Markets

As seen in Figure 4.4, a steadily increasing consumption trend since the 1980s can be seen in the U.S. It consumed 0.229 Mt of tilapia (calculated by live weight) in 2004, and the number doubled in 2008, to 0.453 Mt. In 2008, the average consumption increased from 0.5 pound per capita in 2002 to 1.19 pounds.<sup>25</sup>

<sup>23</sup> Fisheries Bureau, Ministry of Agriculture

<sup>24</sup> National Oceanic and Atmospheric Administration (NOAA)

<sup>25</sup> American Tilapia Association

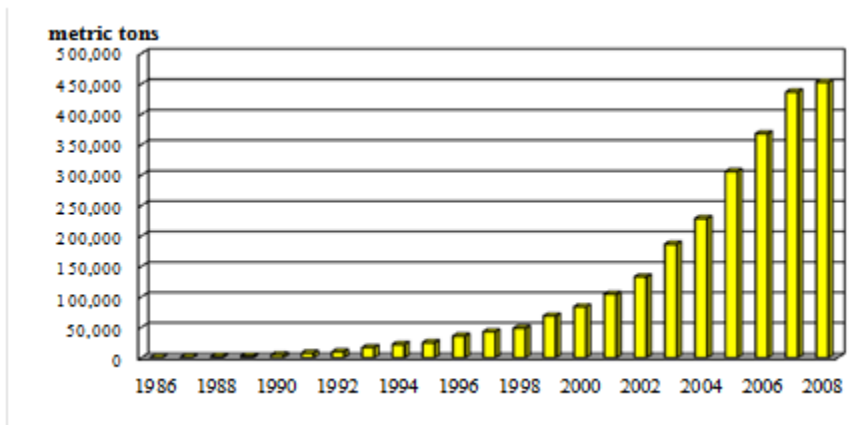


Figure 4.4 American tilapia consumption (live weight).

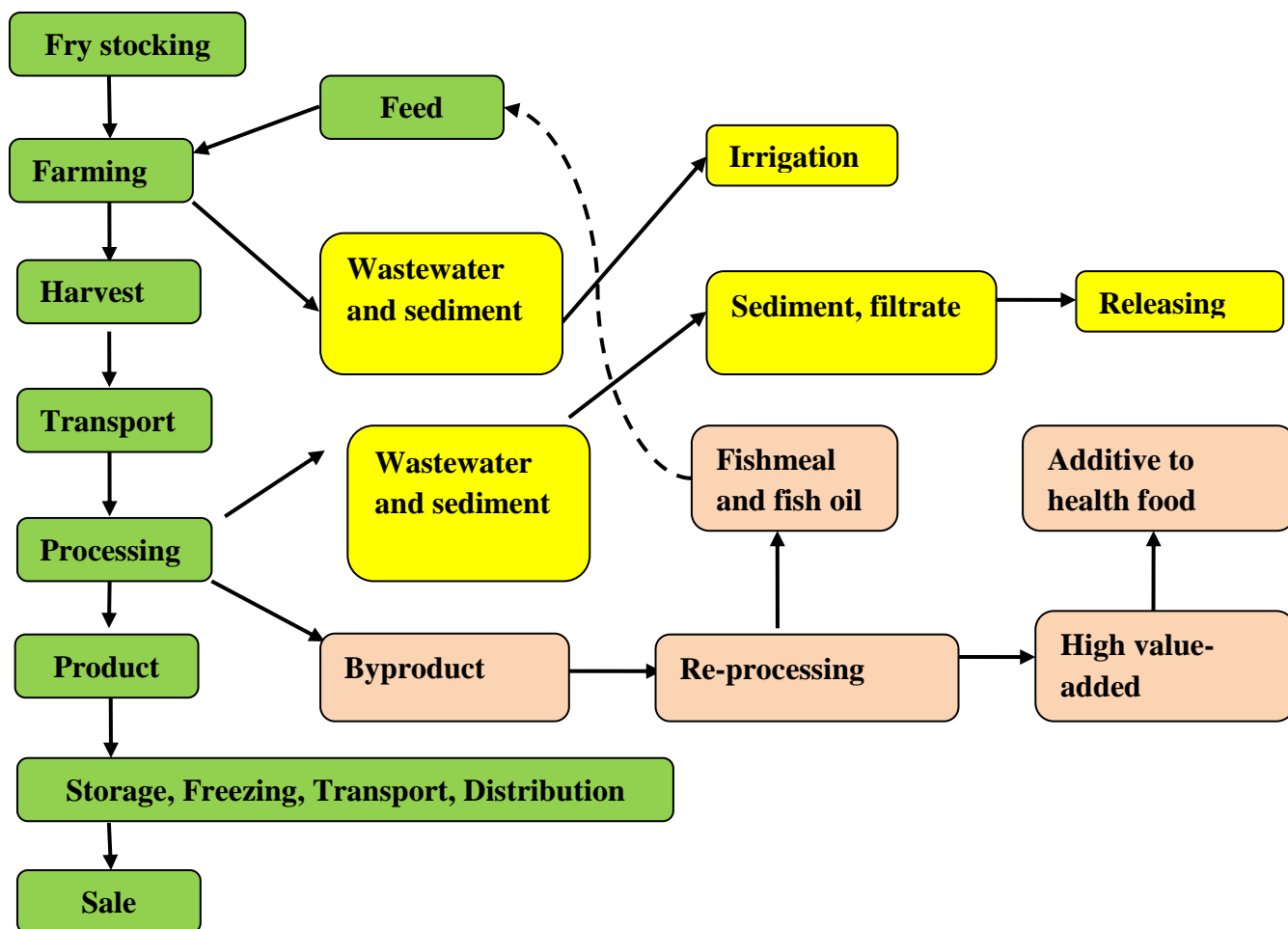


Figure 4.5 Linkages in tilapia product supply chain.

### 4.3 The Structure of the Tilapia Products Supply Chain

The tilapia supply chain includes farming, harvest, transport, processing, trading and the waste disposal from various stage of production, and utilization of the by-products during processing (see Figure 4.5).

Another view of tilapia supply chains and some of their important influencing bodies is provided by Han Han in Figure 4.6. This diagram incorporates the academic, scientific, industry and governmental offices that have been important in accelerating the pace of Chinese tilapia development and which are also essential for sustainable development improvements.

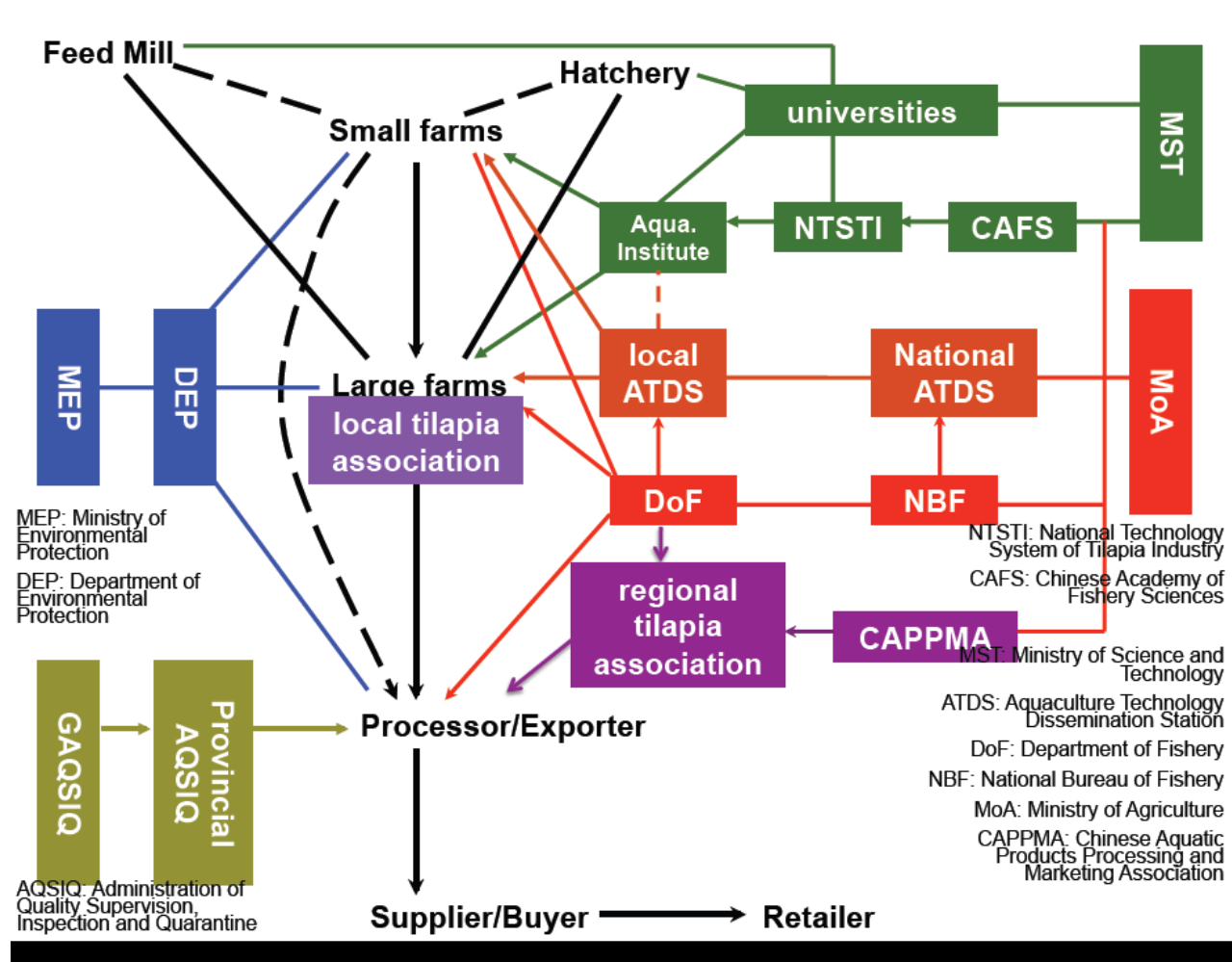


Figure 4.6 Influential institutions in China's tilapia market supply chain.

Source: Han Han presentation on *Promoting Sustainable Tilapia Aquaculture in China*. Global Seafood Conference, Vancouver, Canada, February 1, 2011.

### 4.3.1 Farming Model

Year-round farming is possible in a few areas such as Hainan, Guangdong, Guangxi and Fujian. The growth period of tilapia is about six months from fingerling growth stage to commercial-sized fish. The yield can reach 12 tonnes per hectare. Pond and net cages are the current cultivation methods in China. Of these methods, pond cultivation is the more popular.

Pond farming includes monoculture and polyculture (with silver carp, bighead carp and shrimp by feeding compound feed). Monoculture has been the most common technique, but the polyculture model is increasing in popularity each year. Domestic institutes have conducted research on polyculture of tilapia with the shrimp *Litopenaeus vannamei*, resulting in improved environmental and ecological conditions. During the experiment, no diseases occurred, while there was both an improved growth rate and increased production. Floating-bed soilless plants can also improve water quality by absorbing the nitrogen and phosphate in the water. That is also the new development direction for a healthy and ecological tilapia farming model in the future, which can also increase economic benefits for farmers.

Cage net culture is mainly implemented in reservoirs with a high unit production rate. The products tends to be superior due to the good water quality.

### 4.3.2 Tilapia Farming

Tilapia farming is only allowed under aquaculture licenses obtained from the government. Production involves activities such as the stocking of fry, feeding, daily management of the pond, and harvesting.

Before the stocking of fries, the pond must be cleaned with chemicals such as bleaching powder (calcium hypochlorite) or lime.

During feeding, normally two to three times in the daytime, a regular patrol is combined with feeding, inspection on fish activities, food intake situation, etc.

Daily management includes keeping the water fresh and clean, observing water quality every day, preventing disease. Timely pumping of water into and out the pond is needed to maintain appropriate volume and quality in order to achieve the desired fish growth. Maintaining farming records is a requirement.

Harvest with a drag net takes place after the water is drained.

Cost breakdown of Chinese tilapia production: according to a study of the main tilapia producing areas in 2008 by CAPPMA, the cost of farmed tilapia in pond is indicated in Table 4.2, which shows that the total cost of farming tilapia in a pond is about 8500 RMB/tonne. Feed is the major cost, accounting for 67 per cent of the total. Labour makes up 13 per cent and pond rental 10 per cent, purchase of fry 2 per cent and other costs account for the final 8 per cent.

**Table 4.2 Cost of Chinese tilapia production in 2008 (Unit: RMB/tonne).**

Items	500g-750g	750g-1000g	>1000g
Feed	5210	5729	5942
Fry	278	211	171
Labour	944	1082	1133
Pond Rental	807	918	1009
Water and Electricity	234	260	296
Equipment	113	126	139
Other Costs	192	225	272
Total Cost	7770	8549	8962

### 4.3.3 Tilapia Processing

The term “frozen whole” includes: whole frozen tilapia, gutted and scaled tilapia, and gilled, gutted and scaled tilapia. Frozen whole are the most basic processed products and involve relatively simple processing technology, lower market price and profits. The proportion of frozen whole tilapia exports from China has decreased yearly.

Frozen fillets include regular-skinned fillets, deep-skinned fillets and skin-on fillets. More than 80 per cent of tilapia products exported from China are frozen fillets. The proportion of frozen fillets has increased in recent years.

The major export market of fresh fillets is the U.S. However, due to the long distance and high cost of transportation by air for China's fresh fillets to U.S., there is a very low volume of fresh fillets exported from China. Ecuador and Honduras, by taking advantage of geographic proximity, export a large number of fresh fillets to the U.S.

Other processed forms are breaded fillet and stick, belly, fish jaw, surimi, skin-made products and so on.

Currently, the major traded products are live fish, fresh fillet, frozen fillet and frozen whole. Fresh fillets sell at the highest price, but frozen fillets are perhaps the most sustainable product. Live fish is the major product in China's domestic market, but it consumes more energy for transporting since only 30 per cent is live fish and 70 per cent is water. Meanwhile the fresh fillet supply has been

restricted by storage conditions and a short quality guarantee period. Frozen fillets have no such problems, but Chinese consumers have a preference for fresh fillets. Compared to frozen wholes, frozen fillets have more complicated processing; however, these fillets can be sold at a higher price and have a bigger market.

#### **4.3.4 Comprehensive Utilization of By-products**

Utilization of by-products in processing has a significant sustainability impact. The huge amount of wastes after processing such as head, tail, bone, skin, scale, viscera and broken meat accounts for about 63 per cent of the total weight. Full use of these by-products is essential to encourage rational use of resources and sustainable development.

By-products have been steamed, screwed, ground, crushed, screened, and packaged and the fish oil produced during pressing separated.

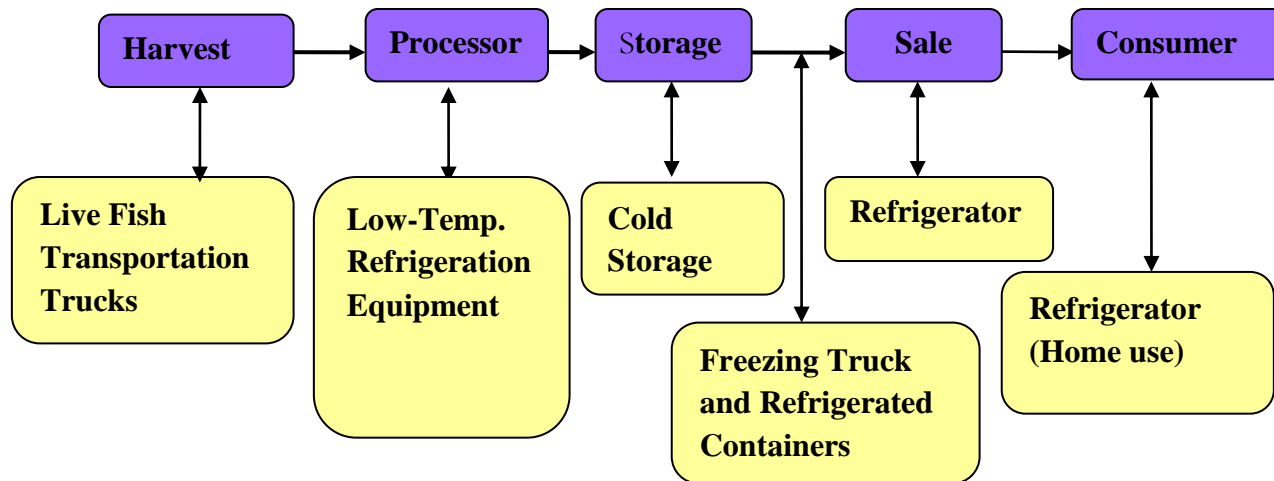
Tilapia skin is rich in collagen and its hydrolysis products contain anti-oxidation biological peptides. Collagen and polypeptide products can be produced by enzymolysis technology. Collagen and polypeptide are major ingredients in cosmetic products and can be processed to high-valued albumen powder.

As the emerging technologies develop further, zero-waste and efficient usage of resource can become achievable goals, with environmental, social and economic benefits.

#### **4.3.5 Tilapia Products Cold Chain**

Global food product trade in general has been greatly facilitated by cold storage. About 38 per cent of aquatic products are internationally traded, and half of the trade volume is produced in developing countries; 80 per cent of the products are exported to developed countries. Cold storage has played a key role in development of these supply chains. This certainly has been the case for China's tilapia international trade development.

The tilapia cold chain mainly includes purchasing fish from farmers and carrying it to the processing factory, processing, freezing, transporting, distributing to the customers as noted in Figure 4.7.



**Figure 4.7** Tilapia supply chain for cold storage products.

Tilapia are purchased from the pond and transported to the processing factory by truck in a water tank for short distances. If the trip lasts for four to five hours, oxygenation of the tank is needed to ensure that tilapia do not die from lack of oxygen.

The fillet or frozen whole will be frozen by single-freezing or flat plane freezing machine under -40 C, and then moved to a packing room of -22 C for sub-packaging. Packaged products are transported back to cold storage with a temperature of about -20 C. Tilapia processing factories, no matter large or small, have their own cold storage, which can reduce the expense of storage leasing and transportation.

Refrigerated vehicles, cabinets or insulated vans (for short distances only) are used for product transportation and distributions, kept at a temperature of -18 C or lower.

#### **4.3.6 Product Quality Security**

Chinese standards for tilapia product quality and safety are as follows: pollution-free food, green food, and organic food. The common goal of these standards is to ensure product quality, safety and environmental friendliness. The pollution-free aspects include three objectives with a number of regulations:



- To ensure the aquaculture areas and products are pollution-free

*GB18406.4-2001 Safety Quality for Agricultural Products, Safety Requirements for Pollution-free Aquatic Products*

*GB 18407.4-2001 Safety Quality of Agricultural Products, Safety Producing Areas Environmental Requirements for Pollution-Free Aquatic Products*

- Tilapia Production Process Control

*NY 5051-2001 Pollution-free Products, Water Quality for Freshwater Culture*

- Agriculture Quality Safety

*NY/T 5335-2006 Pollution-free Products, Original Environment Investigation Specification*

*NY 5072-2002 Pollution-free Products, Safety Limited Factors on Fish Feed*

#### **4.3.7 Energy Consumption in the Tilapia Supply Chain**

Energy consumption in the course of food production is becoming a major concern for the general public, particularly with respect to carbon emissions. Data on energy consumption and flow in tilapia aquaculture are lacking, but it is obvious that tilapia would require less energy than salmon and catfish when producing the equivalent quantity of protein. To produce one kilogram of tilapia likely would save more than 40 per cent of the energy required to produce a similar amount of aquacultured salmon, and likely would save more than 30 per cent compared to aquacultured catfish. Also, comparing growth cycles, tilapia fry can grow to a commercial size in six months, while salmon and catfish can barely grow to commercial size in less than 12 months. Although there are no specific standards on the energy consumption for tilapia production, tilapia is a lower energy-intensive species. The International Standards of Responsible Tilapia Aquaculture (ISRTA) has stated that on-farm energy consumption and sources will be monitored on a continuous basis, and production facilities shall develop in the direction of energy saving and emissions reduction.

## 4.4 Current Situation and Trend Analyses of Tilapia Markets

### 4.4.1 Major Export Markets Distribution of Chinese Tilapia Products

The traditional export markets of Chinese tilapia have been the U.S. and Mexico. Export volume to the U.S. and Mexico rose from 2002 to 2007 (See Figure 4.8), with an average growth rate of 64.9 per cent and 137.3 per cent, respectively. There has been a slip of exports to the U.S. and Mexico due to the snow storm in 2008 in China. Russia and the EU have been the emerging export markets since 2006, with an average growth rate of 104.8 per cent and 67 per cent respectively.<sup>26</sup> Since 2006, there has been a trend toward market diversity of Chinese exports. As indicated in Figure 4.8, the market share exported to the U.S. and Mexico has decreased year by year.

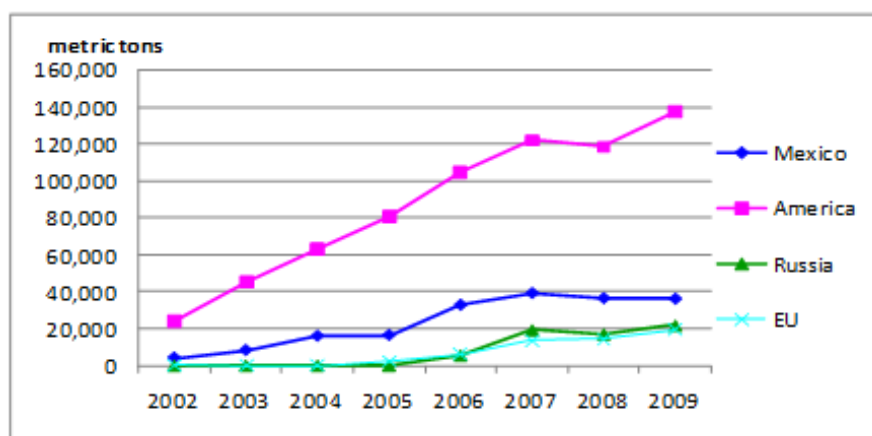


Figure 4.8 Main export markets of Chinese tilapia in recent years.

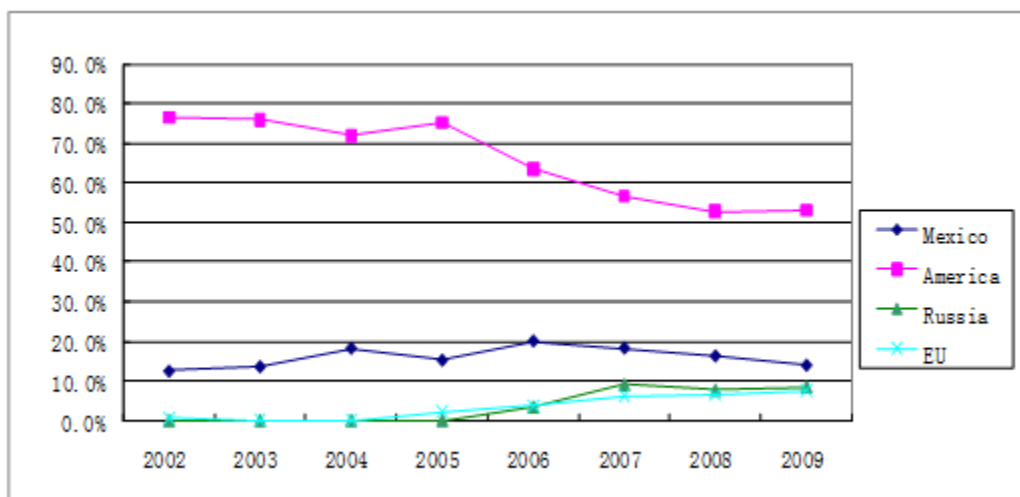


Figure 4.9 Changes of China's main export market share.

<sup>26</sup> Fisheries Bureau, Ministry of Agriculture

#### 4.4.2 China Domestic Consumption

China domestic consumption is concentrated in southern areas, such as Guangdong, Guangxi, Hainan, Yunnan and Chongqing. Traditionally, these consumers prefer to buy live fish. As tilapia can barely survive below 10 C, live tilapia transportation was limited in northern China and during winter in southern China.

Referring to the data from 2007–2008 in Table 4.3, with the growing demand of international markets, and a slower development in the domestic market, national consumption took 45.4 per cent of total production in 2008, which represents a decline of 3.6 per cent from 2007. It is expected that the domestic consumption of tilapia will likely increase after the full implementation of China’s policy for stimulating domestic consumption, even though international consumption will remain at a stable level.

**Table 4.3 2007–2008 Chinese tilapia production and domestic consumption.**<sup>27</sup> Unit: Thousand Tonnes

Year	Total Production	Export Volume	Material Volume	Domestic Sales Volume	Domestic Sales Proportion
2006	990	164	386	604	61.0%
2007	1133	215	578	555	49.0%
2008	1110	224	606	504	45.4%

#### 4.4.3 Chinese Tilapia Industry Trends

The Chinese tilapia industry has now entered an adjustment period. With the increase in costs and appreciation of the RMB, there will be no big benefit for tilapia aquaculture and processing. The result will be stable production levels.

However, the products will be diversified and established as an independent brand. By continuously developed processing technology and expanding markets, China will shift from frozen whole, frozen fillet to high value-added products and establish its own brand for these products.

The market will become more diversified and the traditional export market will be tending towards stability. New markets will become the new growth poles.

The domestic market has potential for development. During the financial crisis of 2008, China promulgated a series of "maintaining growth, expanding domestic demand" policies. Companies also see the huge potential of the domestic market. They are not only constantly expecting to expand their international market, but are also trying to develop the domestic market. It will take some time to find out public preferences and perhaps to shape appropriate public tilapia consumption patterns in China.

<sup>27</sup> 2006–2008 China Fisheries Statistics Yearbooks and Import and Export Statistics by Fisheries Bureau, MOA

#### **4.4.4 Global Tilapia Aquaculture Area Expansion**

Some rural areas in Africa, Southeast Asian and Latin America countries have relatively low labour costs and a tropical climate which is suitable for tilapia farming. Such areas will become competitive locations for tilapia expansion in the future. And indeed, Chinese aquaculture investment may spread to some of these areas.

#### **4.4.5 Substitute Competition**

European and American consumers are used to white-fleshed fish. Currently the popular white-fleshed fish species with high global consumption volume are cod, catfish and flatfishes, etc. They can probably be partly substituted by tilapia in view of production costs and resources protection, as long as supplemental feed levels are kept reasonably low.

#### **4.4.6 Market Driving Factors**

Demand for aquatic products will increase with population growth and urbanization. The world population, now at about 6.9 billion, will reach more than 7.5 billion by 2020. It was declared by FAO that wild fish catch has stayed constant for several years while world population and average demand for fish products keeps increasing. This has led to an imbalance in supply and demand in the international market. Commercial aquaculture is filling part of the gap, but cannot fully satisfy the demand. Tilapia aquaculture has some advantages, such as fast growth, short maturation period and low energy consumption comparing to other farmed fish.

Demand for fish protein and white-fleshed fish tends to grow with improved understanding of the value of fish to good health. With traditional diets changing and people paying more attention to healthy foods, overall global demand for fish is rising.

Hatchery breeding and farming technologies have been resolved and provide a good foundation for intensive culture in ponds; cages can supply the fish year round. As a white-fleshed fish, tilapia has a wide market appeal.

Marine resources protection has been implemented around the world. As a consequence of several factors, capture products generally have not increased in recent years. Restricted by quota, cod, as a popular white fish product, has been on the decline, which leaves a market opportunity. Tilapia has been accepted by more and more markets looking for white-fleshed fish substitute products. Tilapia aquaculture has obvious competitive advantages compared to other farmed fish from technological, cost and level of inputs perspectives.

## 4.5 Commercial Management

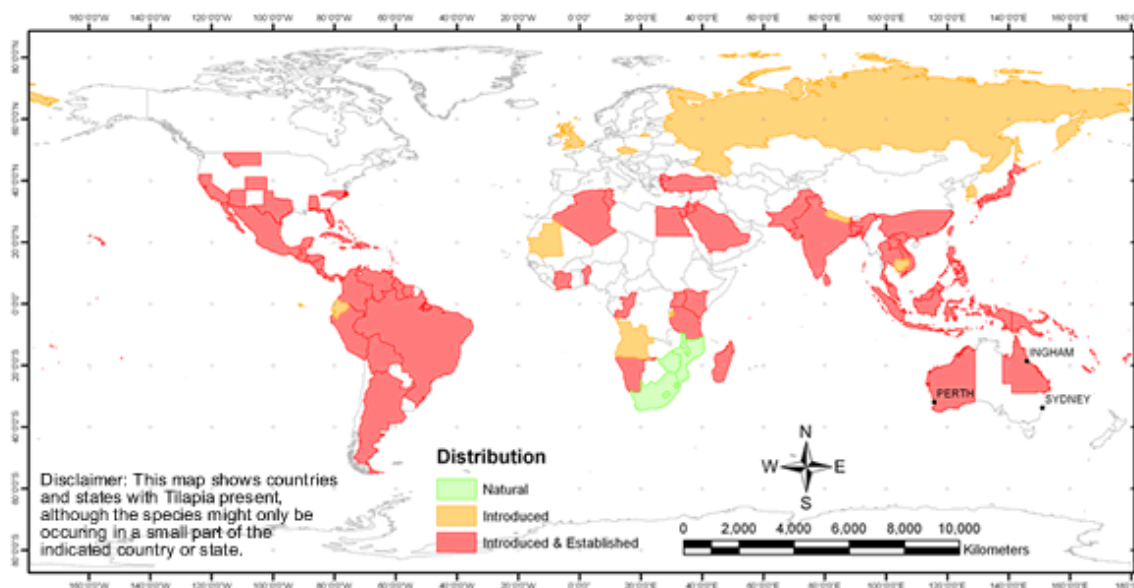
### 4.5.1 Major Global Farming and Processing Enterprises

#### Global Distribution of Tilapia Farming Areas

The major tilapia producers around the world are China, Egypt, Indonesia, the Philippines, Thailand (see Figure 4.10).<sup>28</sup> China has about 40 per cent of the world’s farmed tilapia, making it the largest tilapia producer in the world (see Table 4.4). Indonesia is the second largest producer, with 11 per cent of global production. Egypt produces a similar volume in comparison to Indonesia, but it is consumed domestically. There are other major producers and exporters in mid- South America like Brazil, Ecuador, Honduras and Costa Rica.

**Table 4.4 Percentage (by country) of world tilapia production.**

Countries/Areas	% of total	Countries/Areas	% of total
China	39.6%	Taiwan	2.7%
Indonesia	11.0%	Vietnam	2.5%
Egypt	10.3%	Bangladesh	2.4%
Philippines	8.9%	Colombia	1.5%
Thailand	6.8%	Ecuador	1.4%
Mexico	3.6%	Malay Archipelago	1.2%
Brazil	3.6%	Honduras	1.2%



**Figure 4.10 The distribution of tilapia aquaculture.**

<sup>28</sup> China Fish Statistics Year Book, Import & Export Statistics from Ministry of Agriculture of P.R. China, 2006-2008

#### 4.5.2 Tilapia Farming Area Distribution in China

Maoming and Gaoyao in Guangdong, Wenchang in Hainan are the major tilapia farming areas in China. See Table 4.5:<sup>29</sup>

#### Distribution of China’s Major Processers

China’s tilapia enterprises are mainly located in Guangdong, Hainan and Guangxi. Major tilapia suppliers and producers include the following:

- Guangdong Maoming Changxing Seafood Co. Ltd
- Guangdong Gaoyao Zhenye Seafood Co. Ltd
- Guangdong Zhanjiang Evergreen Group
- Guangdong Lushi Seafood. Ltd
- Hainan Xiangtai Fishery Co. Ltd
- Hainan Sky-blue Ocean Foods Co. Ltd
- Hainan Evernew Foods Co. Ltd
- Guangxi Baiyang Group Co. Ltd
- Guangxi Beihai Baotong Frozen Food Co. Ltd
- Fujian Tong An Yuan Shui Frozen Food Factory

The above companies export nearly half of the total volume of China tilapia products.

**Table 4.5 China’s major aquaculture areas and production.**

Main aquaculture district	Aquaculture area (Thousand hectares)	Production (Thousand tonnes)
Maoming	15	150
Gaoyao	7	82
Wenchang	8	132

#### 4.5.3 Global Tilapia Associations and Organizations

Some key organizations related to the tilapia industry and sustainable tilapia are as follows:

- Global Aquaculture Alliance<sup>30</sup>
- World Wildlife Fund<sup>31</sup>

<sup>29</sup> South Daily

<sup>30</sup> <http://www.gaalliance.org/>

<sup>31</sup> <http://www.wwf.org/>

- Global Good Aquaculture Practice<sup>32</sup>
- Food and Agriculture Organization of the United Nations<sup>33</sup>
- World Aquaculture Society<sup>34</sup>
- National Fisheries Institute<sup>35</sup>
- American Tilapia Association<sup>36</sup>
- South Africa Tilapia Association<sup>37</sup>
- China Aquatic Products Processing and Marketing Association<sup>38</sup>

It is fair to say that all these organizations would like to see the industry develop sustainably and continue to meet the increasing demand for production growth with safe, high quality products, while providing employment opportunities and protecting the environment adequately.

#### **4.5.4 Relevant Regulations and Standards**

International and domestic industrial associations and organizations have developed a number of regulations and standards relevant to sustainable tilapia farming, processing and marketing; in particular, there are Hazard Analysis Critical Control Point (HACCP), Best Aquaculture Practices (BAP), International Standards for Responsible Tilapia Aquaculture (ISRTA), Global Good Agricultural Practices (Global GAP) and the Guide of Aquaculture Certification (GAC), and a series of Chinese regulations. How these link to stages in the supply chain are noted in Figure 4.11.

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<sup>32</sup> [http://www.globalgap.org/cms/front\\_content.php?idcat=9](http://www.globalgap.org/cms/front_content.php?idcat=9)

<sup>33</sup> <http://www.fao.org/>

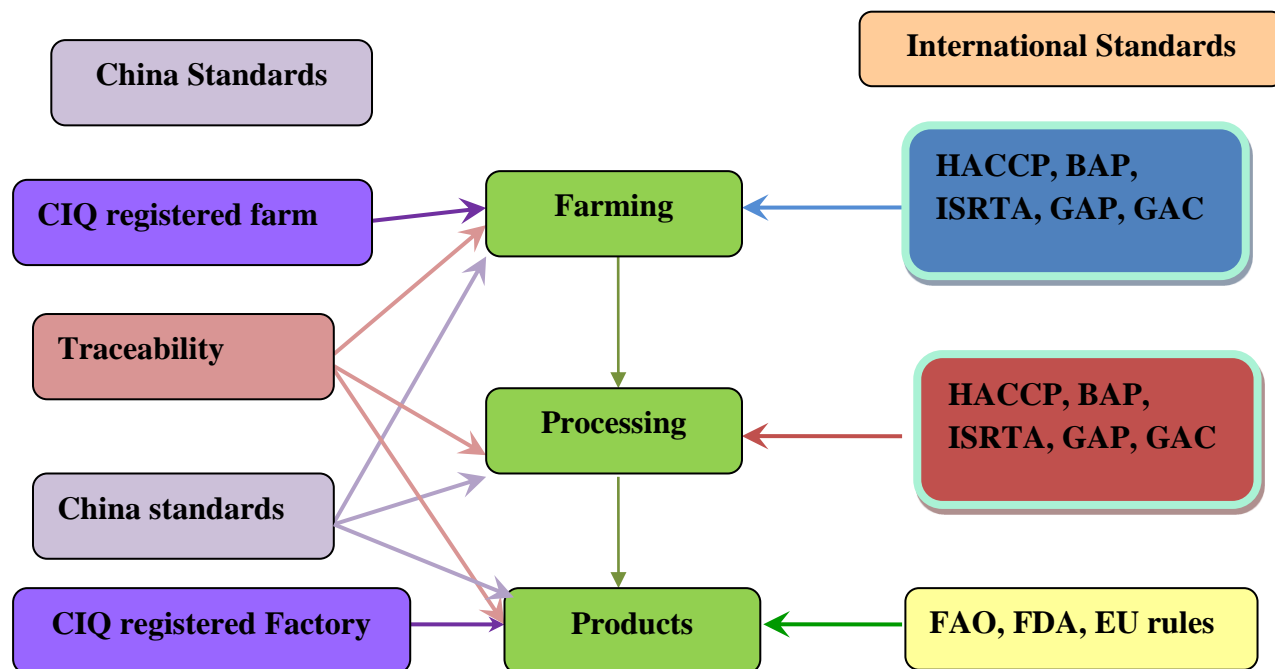
<sup>34</sup> <https://www.was.org/Main/Default.asp>

<sup>35</sup> <http://www.fisheries.org/afs/index.html>

<sup>36</sup> <http://ag.arizona.edu/azaqua/ata.html>

<sup>37</sup> <http://www.sea-ex.com/aquaculture/aqua-associations-southafrica.htm>

<sup>38</sup> <http://www.cappma.org/>



**Figure 4.11 Standards implemented in tilapia supply chains.**

Hazard Analysis Critical Control Point (HACCP) was published by the Codex Alimentarius Commission. HACCP is a management system in which food safety is addressed through the analysis and control of biological, chemical, and physical hazards from raw material production, procurement and handling, to manufacturing, distribution and consumption of the finished product. It is a process of avoiding risks through risk identification and damage eliminated or reduced to the level that consumers' acceptance.

The Best Aquaculture Practices (BAP) certification mark is a trademark of the Global Aquaculture Alliance that is licensed to the Aquaculture Certification Council (ACC) for use only by BAP-certified facilities. The BAP standards and guidelines have four parts: community, environment, food safety and traceability. Part of ACC's mission is to help educate the aquaculture public to realize the benefits of applying Best Aquaculture Practices and the advancing scientific technology that directs them. By implementing BAP standards, program participants can better meet the demands of the growing global market for wholesome seafood produced in an environmentally and socially responsible manner. Certifications for nursery, farm, processing and feed factory can be included.

International Standards for Responsible Tilapia Aquaculture (ISRTA) was issued by the World Wildlife Fund (WWF) Tilapia Aquaculture Dialogue (TAD). ISRTA covers major impacts related to



tilapia aquaculture: effluents in the water, compromise of ecological integrity of aquaculture facilities, pollution from inputs used at aquaculture facilities, socioeconomic impacts and states the possible resolution of such issues.

Global Good Agricultural Practice was established by the Euro-Retailer Produce Working Group (EUREP). GLOBALGAP is a private sector body that sets voluntary standards for the certification of production processes of agricultural (including aquaculture) products around the globe. It is process control from the source to dining table.

Guide of Aquaculture Certification (GAC) was initiated by FAO, which aimed to provide guidance for establishment, preparation and enforcement of certification. It includes animal health and welfare, food quality safety, environment and social responsibility.

The China Entry-Exit Inspection and Quarantine Bureau (CIQ), is in charge of national quality, metrology, entry exit commodity inspection, entry-exit health quarantine, entry-exit animal and plant quarantine, import-export food safety, certification and accreditation, standardization, as well as administrative law-enforcement.

Domestic Tilapia Standards include:

*SC 1027-1998: Nile Tilapia (Genetic Resources Identification)*

*SC 1042-2000: Blue Tilapia (Genetic Resources Identification)*

*GB/T 19528-2004: Technique standard in Parents Conserving of Hybrid between Nile tilapia♀ and Blue tilapia♂*

*SC/T 1044.3-2001: Technical specifications for Nile Tilapia Culture. Fry and Fingerlings*

*SC/T 1046-2001: Technical Requirement for Reproduction of the Hybrid F1 of Blue Tilapia ♂×Nile Tilapia ♀*

*NY/T 5054-2002: Pollution-Free Food Production—Nile Tilapia Aquaculture Technical Specifications*

*SC/T 1105-2007: Tilapia Fish Sex Determination Methods*

*SC/T 1025-2004: Nile Tilapia Compound Feed*

*GB/T 21290-2007: Tilapia Frozen Fillet*

*SC/T 3037-2006: Frozen Tilapia Fillet Processing Technology Specifications*

*DB46/T 130-2008: Gift Nile Tilapia Aquaculture Technology Specifications*

*SC/T 1045-2001 : Nile Tilapia Parents*

Tilapia traceability is an important issue. In order to improve consumers' safety and establish product brand advantage, the traceability system provides more detailed information for consumers. The research and development on a traceability system is coming to the end of primary testing in China. A small portion of products can be tracked from pond to dining-table. The research on traceability will continue in the coming years; in particular, traceability for tilapia will be a new trend for industrial development. This is, of course, a matter of considerable concern for any type of international certification system.

#### **4.5.5 Experience and Perception of Chinese Producers**

Shrimp imported from China, Vietnam and Indonesia to the EU were tested for chloramphenicol in 2002. Eel exported to Japan from Mainland China and Taiwan have been subject to inspection due to nitrofurans residue. Learning from these lessons, the Chinese industry and companies have realized that the health and safety aspects of aquaculture and processing is vital for sustainable industry development, and the Chinese government has paid close attention to food quality safety, especially in recent years. It is important to underline that such considerations are essential not only for export markets to the richer countries but also for domestic markets and for markets in developing regions if sustainable development protocols are followed.

Many large-scale fish processing companies have purchased testing equipment and have their own lab. The products would be self-tested before sending to CIQ.

Chinese enterprises also realize the importance of certification. The Aquaculture Certification Council (ACC) criteria are set for products exported to the USA market. At present, 27 Chinese tilapia enterprises have been approved by the ACC and gained the recognition of U.S. consumers, which means a better price for producers.

China's pollution-free food, green food and organic food certification can also help to increase the price of certified products in domestic market and the competitiveness.

## 4.6 Economic Impacts

### 4.6.1 GDP Contribution of China's Fisheries and Aquaculture

Fisheries have become an important industry for the agricultural sector and rural economy. Total fisheries output reached 520.3 billion RMB in 2008, which makes up 9.4 per cent of the gross output value of agriculture (See Figure 4.12). The total added value from the fishery economy is 318.7 billion RMB, which contributes 1.06 per cent of China's total GDP. Aquaculture accounted for 64 per cent of total fisheries output in 2008, which is 14 per cent higher than in 1990.<sup>39</sup> Aquaculture has become the major source of the increase in fisheries. China was the only country among the main fisheries nations where aquaculture production exceeds catch-based production.

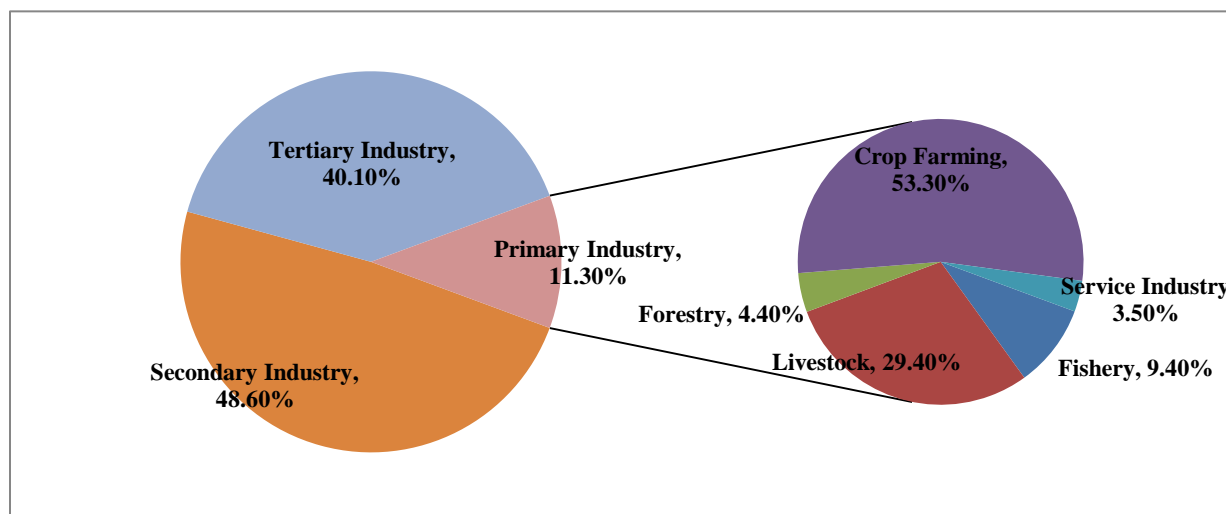


Figure 4.12 Contribution to GDP from China's main sectors.

### 4.6.2 Tilapia Position among China's Fisheries

There were 1.11 Mt of tilapia produced in 2008, which is 6 per cent of total freshwater fish aquatic production. Export value reached 0.73 billion dollars, accounting for 6.9 per cent of seafood exports. Tilapia is the primary finfish export from China.

Fisheries and aquaculture have been important parts of farmers' increased income in developing countries, including China. Fisheries also have provided sufficient high-quality protein for global populations and played an important role in helping solve world food problems. The Chinese government has designated tilapia as one of the eight leading fishery products.<sup>40</sup>

<sup>39</sup> National Bureau of Statistics

<sup>40</sup> [http://www.agri.gov.cn/xztz/t20080319\\_997367.htm](http://www.agri.gov.cn/xztz/t20080319_997367.htm)

### **4.6.3 Tilapia Supply Chain Contribution to Employment**

The development of tilapia aquaculture and processing in major producing areas has bolstered local economic prosperity. The local farmers lift themselves from poverty and some get rich by culturing tilapia. Tilapia processing also absorbs extra labour. There are more than 300,000 people working in tilapia aquaculture and processing. In addition, a large number of others are engaged in feed, nursery, transportation and marketing aspects of the supply chain.

## **4.7 Environmental Impacts**

### **4.7.1 Impacts on Environment from Points along the Supply Chain**

Each part of the supply chain interacts with the environment, as noted in Figure 3.13. Aquaculture can have both positive and negative effects on the environment, and while some are highly localized, others such as the rising demand for fish meal and fish oil in aquaculture feed products may have distant impacts on ocean resources such as the excessive harvest of small prey fish. On the positive side, complex aquaculture systems may involve multiple species in order to fully utilize organic matter and thereby remove nutrients that otherwise degrade aquatic habitats, for example causing algal blooms. Aquaculture can improve the local micro ecological environment, for example by increasing air humidity and relieving heat caused by high temperatures.

Farming and processing are the sources of the greatest environmental impacts, but other parts of the supply chain also contribute. For example, the transportation system to move fresh tilapia for domestic consumption means moving large quantities of water and relatively small amounts of fish, which is wasteful of energy.

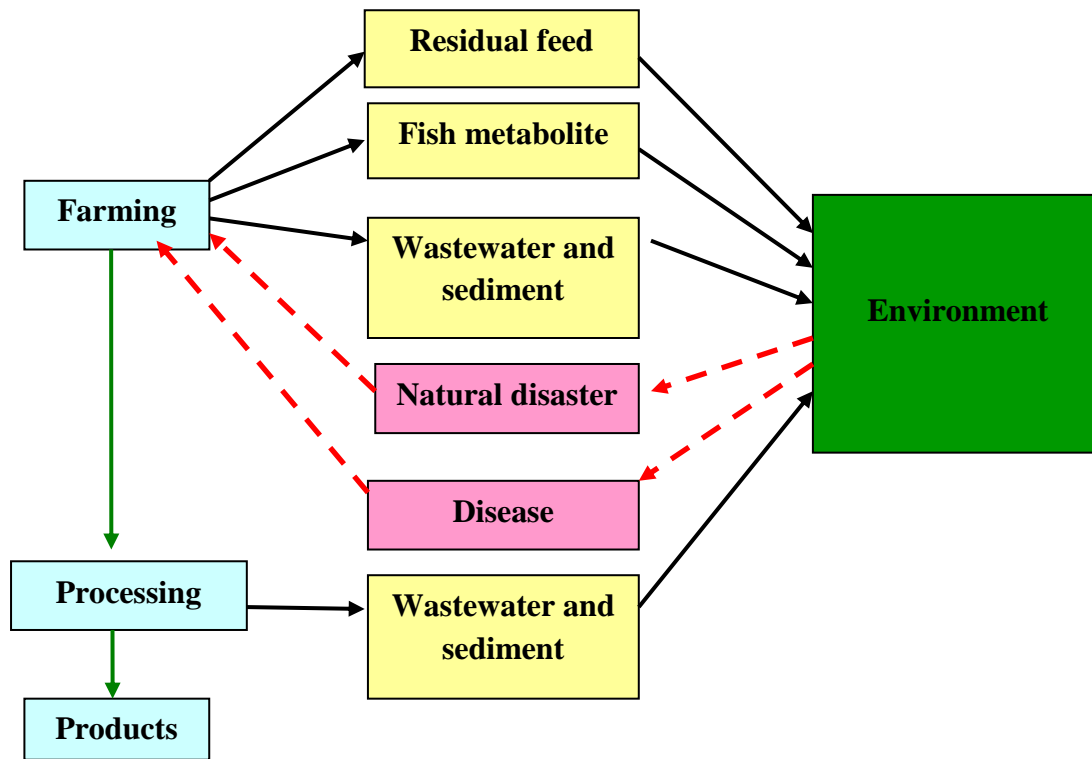


Figure 4.13 The interaction between the tilapia supply chain and the environment within China.

#### 4.7.2 Climate Impact on Supply Chains

##### Reduced Production Due to Weather and Climate

Extreme weather, such as cold fronts, snow, hurricanes, floods, droughts, if it occurs frequently, will cause great damage to the tilapia industry. Guangdong suffered the biggest loss in the 2008 snowstorm: 170,000 t of tilapia died from cold water temperatures. Guangxi also lost 4500 t.

##### Disease Caused by Climate Change

Disease is one of the key factors in tilapia production. It is always the result of a combination of pathogens, aquaculture environment, and the auto-immunity of the fish. Streptococcus infections first occurred in some parts of China in 2009, bringing great challenges to rational use of drug and vaccine research.

### 4.7.3 Farming Water and Sediment Disposal

Concern has been growing over water quality deterioration due to the increase in aquaculture activities. China has taken significant regulatory and practical measures to reduce water pollution. Major progress has been made in the last 10 years, with a number of major regulations regarding aquaculture water quality and water discharge, for example:

- Aquaculture water quality shall meet the National Standard: GB11607-89 Water Quality for Fisheries<sup>41</sup> (both fresh and seawater).
- Before aquaculture water can be discharged from ponds, it must first meet either Standard SC/T9101-2007 for freshwater ponds or SC/T9103-2007 for seawater ponds. The aquaculture farms' discharge water has been subject to unscheduled inspections by local environmental authorities.

According to the Water Pollution Prevention and Control Law of the PRC,<sup>42</sup> aquaculture farmers should protect the ecological environment of the water body, and scientifically determine stocking density, feeding, and medicine applications in order to prevent water pollution.

The Action Outlines for China's Aquatic Living Resource Conservation<sup>43</sup> clearly indicates the need for maintaining adequate aquaculture water quality monitoring, environment monitoring, fisheries medicine manufacturing approval, and inputs management. This outline recommends strengthening fry monitoring and management while implementing reasonable feeding and rational use of drugs in order to maintain the safety of aquatic products. Also, it establishes demonstration areas for healthy and ecologically-sound aquaculture, and actively explores the ecological culture model combined with traditional and modern methods, in order to reduce pollution from aquaculture.

In addition, there are related standards on surface water quality and irrigation water quality in GB 3838-2002.<sup>44</sup> National Environment Protection Standards of Surface Water Quality specify the water quality standards of rivers, lakes, canals, irrigation channels, reservoirs and other surface water bodies and of ground water bodies, including the limits for heavy metals, PCB, benzene, pesticide and sulfide, etc.

Aquaculture waste water for irrigation is a new ecological aquaculture model for sustainable development of planting and culturing combinations. The model not only saves water but also provide sufficient organic material to benefit plant growth. The University of Arizona has fully researched this culture model.

<sup>41</sup> <http://www.chinaba.com/info/bgw/bbgth/200907/W020090724340379526341.pdf>

<sup>42</sup> [http://www.gov.cn/flfg/2008-02/28/content\\_905050.htm](http://www.gov.cn/flfg/2008-02/28/content_905050.htm)

<sup>43</sup> [http://www.gov.cn/gongbao/content/2006/content\\_268886.htm](http://www.gov.cn/gongbao/content/2006/content_268886.htm)

<sup>44</sup> [http://www.gov.cn/gongbao/content/2006/content\\_268886.htm](http://www.gov.cn/gongbao/content/2006/content_268886.htm)

Ponds must be cleaned between each cycle of fish culture. The sediment in the aquaculture pond is a natural organic fertilizer for crop planting, which can save on costs.

#### 4.7.4 Prohibited Drugs in Nursery and Farming Stages

Methyl testosterone was used by some hatcheries to enhance the percentage of males. The Prohibited Animal Medicine and Other Compounds in Food Animals in 2002<sup>45</sup> listed it as one kind of hormone that can't be added to any food. The list also includes nitrofurans, malachite green, etc. A safer method is now used for increasing the rate of males. An extremely high male rate can be achieved under temperature-controlled conditions by hybridization.<sup>46, 47</sup> Due to its disproportionate effects on fish fry, methyl testosterone was hard to control since it was carried into the environment and water. But it is now allowed to be used for brood stock in the U.S.

Given that China's tilapia exports have been increasing, farmers have to obey not only the Nile Tilapia Aquaculture Technologies Specifications NY/T 5054-2001 but also be very careful with the drugs used in aquaculture. Before purchasing commercial fish, mandatory spot-checks must be performed. If illegal residue is discovered in the tested fish, the processing factories will refuse to purchase the lot, and the related local government will destroy the disqualified fish in an appropriate way. This is sufficient punishment to ensure that farmers do not use illegal drugs.

*Streptococcus glaciata* occurred in some areas in 2009 due to continuously high temperatures. The death of fish caused significant losses for farmers. Experts from universities and institutes conducted research on the diseased and dead fish, while requiring the farmers to deal with them in an appropriate way; for example, by burying the fish far away from water resources and aquaculture areas in order to segregate the diseased carcasses and to prevent further infections. A vaccine was successfully developed and is gradually being introduced in some areas.

#### 4.7.5 Escapees from Tilapia Farming

Tilapia escapes can occur on the farm or when transporting fish off the farm. Therefore, in regions where tilapia cannot exist in the wild for climatic reasons, such as where the natural water temperature is lower than 10 C in winter, the escapees may not be such a concern. Even when tilapia escape in warmer areas, they are males (selected for fast growth) and thus cannot reproduce. So far

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<sup>45</sup> "Prohibited Animal Medicines and Other Compounds in Food Animals." MOA Bulletin No. 193, <http://www.chinagmp.cn/PolicyList.asp?id=09227090513112>

<sup>46</sup> Baroiller, J.F., et al. (2009). "Tilapia Sex Determination: Where Temperature and Genetics Meet." *Comp. Biochem. Physiol.* doi:10.1016/j.cbpa.2008.11.018.

<sup>47</sup> Baras, E., Jacobs, B. & Melard, C. (2001). "Effect of Water Temperature on Survival, Growth and Phenotypic Sex of Mixed\_XX-XY/Progenies Of Nile Tilapia *Oreochromis Niloticus*." *Aquaculture* 192:187-199.

there are no natural tilapia species found in China's national waterbodies, and so the escapes aren't seen as a threat to biodiversity.

#### **4.7.6 Environmental Sustainability in Aquaculture**

The fast development of industry and economy very often conflicts with environmentally sustainable utilization. China has suffered from the destruction of environment during its development, and has taken measures on biodiversity protection.<sup>48</sup> China's Land Management Law<sup>49</sup> has indicated that occupation of basic farmland for aquaculture is prohibited.

Recirculation Aquaculture Systems (RAS) have been proposed as being very beneficial to the environment, but require significant investment and very high levels of management to operate successfully. However, they would only be relevant where there was an opportunity for production of very high value species. Freshwater RAS have been developed for tilapia farming, but have only limited prospects.

Compared to shrimp farming, tilapia farming may have less impact on the environment, as tilapia are held mainly in inland ponds or on saline-alkali land farms, rather than in seawater, though this can result in reduction of mangroves, or in soil salinization.

#### **4.7.7 Content of Fishmeal and Fish Oil in Compound Feed**

It is unlikely that the global production of fishmeal and fish oil for fish feed will continue to grow. As demand for feed has expanded, the price has grown. The high profit in supplying feed is resulting in over-catching of wild fish from the oceans. It is reasonable for the content of fishmeal and fish oil in the compound feed supply to be limited or reduced as a necessary means of protecting wild fish. Even so, with the continuing rise in demand for aquacultured fish globally and in China, the total amount of fish meal and fish oil consumed may also continue to rise. Thus it is necessary to focus more attention on aquacultured species that have a lower demand for animal protein.

As an omnivorous fish, tilapia is less demanding on animal protein content, and feed protein content is generally less than 30 per cent. Some protein is from by-catch of wild fish; however, vegetable protein forms a large proportion. Reasonable inclusion rates of fishmeal and fish oil in feed can still allow nutritional balance and fast growth without affecting the quality of tilapia. This may help to protect marine ecological food chains from excessive harvesting and avoid damage of marine ecological habitats.

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<sup>48</sup> United Nations Environment Program (2001, August). *Aquatic Biodiversity in the National Biodiversity Strategy and Action Plans of Signatories to the Convention on Biological Diversity*. <http://www.unep.org/bpsp/Fisheries/Argentina%20-%20Colombia.pdf>

<sup>49</sup> [http://www.gov.cn/banshi/2005-05/26/content\\_989\\_2.htm](http://www.gov.cn/banshi/2005-05/26/content_989_2.htm)



#### **4.7.8 Processing Sewage Discharge Management**

To prevent the processors' sewage from polluting natural water, it needs to be filtered, with the solids then discharged into a purification pool or tank for pretreatment before discharge. Both Chinese (GB8978-1996)<sup>50</sup> and international organizations have developed standards for water quality of factory sewage discharge. Fish processing factories must conform to these criteria in order to discharge waste water.

### **4.8 Social Impacts**

#### **4.8.1 Health, Safety and Social Security of Labour**

China's Labour Law<sup>51</sup> addresses the social issues of the Chinese workforce; for example safety, working hours and medical insurance, etc. A safe and healthy working environment and clean drinking water are essential for protecting workers. There should be no threat of poisonous material, harmful drugs or mechanical damage during production. The safety of workers should be well protected.

A huge amount of effort is involved in this labour-intensive industry. Contracts must be signed between enterprises and workers. According to the new Labour Law issued in 2008, a contract between employer and employee is required, and the workers' rights are expected to be well protected. This measure has improved labour harmony.

#### **4.8.2 Public Health and Security**

If aquaculture water and sediment have been recycled, the sewage must be disposed of after proper treatment, drugs and medicine are to be kept under strict control during culturing and processing of fish, and the by-products are to be fully utilized. If these guidelines are followed, the entire chain should present no harm to public health and security.

#### **4.8.3 Health and Security of Consumers**

In order to protect consumer health and security, China has implemented a series of regulations and overhauled its regulatory system; for example, in the *Food Safety Law*,<sup>52</sup> enacted in February 2009, a food recall system has been established for the first time; the *Banned List of Food Animal Veterinary*

<sup>50</sup> <http://www.tba.gov.cn:89/eword/uploadfile/20080327104654380.pdf>

<sup>51</sup> <http://www.people.com.cn/item/flfgk/rdlf/1994/111801199431.html>

<sup>52</sup> [http://www.gov.cn/flfg/2009-02/28/content\\_1246367.htm](http://www.gov.cn/flfg/2009-02/28/content_1246367.htm)

*Drugs and other Compounds* was published in 2002; and the *Hygienic Standards for Uses of Food Additives* which was issued in 2007, and is being continuously improved.

## 4.9 Development Policies

### 4.9.1 Sustainable Development Criteria and Regulations for Chinese Fish Products

Besides those discussed earlier, there are criteria governing the tilapia products supply chain (See Table 4.6). These standards are beneficial to the protection of the interests of practitioners and to maintain the future sustainable development of tilapia industry.

**Table 4.6 Some Chinese laws and regulations relevant to tilapia sustainable development.**

No.	Standard Names
1	Law of Fisheries, PRC
2	Environmental Protection Law, PRC
3	Marine Environment Protection Law, PRC
4	Law on Water Pollution Prevention and Control, PRC
5	Water Quality Standards in Fisheries (GB 11607-89)
6	Management Regulations for Aquaculture Quality & Safety
7	Approaches to Management of Qualification for Investigation and Identification of Fishery Pollution Accidents
8	Regulations and Procedures for Investigating and Handling Pollution Accidents in Fishery Waters
9	Freshwater Aquaculture Quality for “Pollution-Free” Aquaculture Food (NY 5051-2001)
10	Seawater Aquaculture Quality for “Pollution-Free” Aquaculture Food (NY 5052-2001)
11	Fishery Drug Application Guideline for “Pollution-Free” Aquaculture Food (NY 5071-2002)
12	Fishery Drug Residue Limit in Seafood for “Pollution-Free” Aquaculture Food (NY 5070-2002)
13	The Safety Quantity of Fishery Mixed Feed for “Pollution-Free” Aquaculture Food (NY 5072-2006)
14	Hazardous Chemicals Limit in Seafood for “Pollution-Free” Aquaculture Food (NY 5073-2006)
15	Production Area Environment Condition of Freshwater Aquaculture for “Pollution-Free” Aquaculture Food (NY 5361-2010)
16	Production Area Environment Condition of Seawater Aquaculture for “Pollution-Free” Aquaculture Food (NY 5362-2010)
17	“Green” Food – Fish Drug Application Guideline (NY/T 755-2003)
18	“Green” Food – Aquaculture Water Quality Standard (NY/T 391-2000)
19	National Agriculture Specialized Standards: Water Discharge Criteria for Freshwater Farmed Ponds (SC/T 9101-2007) and Water Discharge Criteria for Seawater Aquaculture (SC/T 9103-2007)
20	Regulation of Sample Inspection for Unapproved Drugs in Aquatic Fry (MOA Announcement No.1163-9-2009)
21	Quality Management Regulations for Aquaculture Products Processing (SC/T 3009-1999)
22	Aquaculture Products Sampling Method (SC/T 2016-2004)
23	Sample Regulation for Aquatic Animal Quarantine in Production Area (SC/T 7103-2008)

#### **4.9.2 Tariff Reduction Trend**

As one of the major seafood importing countries in the world, China has constantly reduced tariff rates since becoming a member of the WTO in December 2001. Most of the tariffs were lowered from 13 per cent to 5 per cent. At this point, China has established eight free trade areas and extended zero-tariff treatment to 10 countries of ASEAN. The trend of constantly lowering tariffs will continue.

#### **4.9.3 Subsidies to Tilapia Industry**

Chinese tilapia subsidies involved in the supply chain are as follows:

- Financial support through research and tilapia breeding projects;
- Through research funding to support new products, new technology research and developments in the tilapia supply chain.
- Some local governments give subsidies for the repair of old ponds, e.g., a lump sum grant of 3,000 RMB per hectare.

#### **4.9.4 Barriers in Seafood Trade**

To protect the domestic industry, some countries have implemented protectionist policies on imported seafood. For example, the U.S. imposed anti-dumping regulations on Vietnamese-produced catfish in 2003, imposed anti-dumping tariffs on six countries in 2004, and implemented Detention Without Physical Examination (DWPE) to Chinese catfish in 2007. Yet the situation in recent years has shown that these actions have had little influence on the tilapia trade.

Shrimp, catfish, crayfish and other products have been suffering globally from trade barriers. As a new industry, tilapia aquaculture has so far had no technical barriers to trade provisions and has not yet encountered the problems faced by these other species.

#### **4.9.5 Targets of Tilapia Industry Development in China (CAPPMA Suggestions)**

##### **Short-term Targets for the next 3–5 Years**

To improve current domestic standards and to remove inappropriate criteria while adding new standards. To align domestic with international criteria.

To establish a traceability system from pond to dining table.

To research and develop vaccines for disease prevention.

To implement an integrated tilapia technology export strategy through international cooperation projects. Because the Chinese tilapia industry plays a leading role in developing technology for breeding, aquaculture and processing, the advanced, integrated technologies can be exported to other developing countries in order to support them in development of their aquaculture industries.

### **Long-term Targets for the next 10 Years**

To set up a global tilapia information sharing system that includes all information and criteria for farming, processing, marketing, trading and the latest progress.

To develop a low carbon emission industrial business model and explore the proper way to reduce carbon emissions in the tilapia industry through such things as rational stocking density, proper feeding methods, healthy and ecologically-sound farming models, good operating specifications of transportation, refrigeration and processing.

To set up a Tilapia Industry Development Fund with support from international organizations, such as banks and foundations, to export or transfer technologies to other developing countries, to help solve food shortage problems.

To establish a unified supply chain platform which gives consideration to all benefits from both developing and developed countries, as well as producers and consumers, and set up standards in various stages of tilapia producing, processing, transportation and other sectors. It will help promote the economic integration of the global tilapia industry.

## **4.10 Commentary on the Tilapia Case Study from an International Perspective<sup>53</sup>**

The remarkably rapid expansion of tilapia from China into the global marketplace and its growth within the domestic marketplace is one of the most outstanding fisheries and aquaculture initiatives of the past 20 years. Unlike the dismal stories of wild fish, such as many of the white-fleshed species that tilapia products are replacing in supermarkets of numerous countries, tilapia presents a situation of ongoing opportunity. But with opportunity comes many challenges, particularly in regards to sustainable development.

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<sup>53</sup> This commentary has been prepared by Dr. Arthur Hanson as a supplement to the CAPPMA contribution

The clearest effort to define the sustainable development of tilapia has come from the international efforts of a roundtable dialogue process established by the WWF. The dialogue produced a set of eight principles, listed below:<sup>54</sup>

1. Obey the law and comply with all international, national and local regulations
2. Site and/or expand farms to conserve natural habitat and local biodiversity
3. Conserve water resources
4. Conserve fish species diversity and wild populations
5. Use resources efficiently
6. Manage disease and pests in an environmentally responsible manner
7. Ensure food safety and environmental health
8. Be socially responsible

As the CAPPMA team and others have noted, extensive effort has been put into developing relevant laws and regulations within China to address these health, safety and environmental management matters. It is also clear that there has been a concerted effort, especial on the socio-economic side, to provide considerable rural employment through the tilapia market supply chain. Thus it may be reasonable to consider that tilapia aquaculture, even on the massive scale currently being carried out in China, has the potential to be sustainably conducted. It could eventually be an important contributor to China's new green economy.

Other observers, for example, have documented sites in south China where tilapia cultivation appears to be undertaken with adequate environmental safeguards. The EU-China Trade Project examined sustainable aquaculture potential at a number of sites in both Hainan and Guangdong Provinces in the autumn of 2008. The study team reported the following findings based on visits to leading companies:<sup>55</sup>

The management of environmental sustainability was impressively demonstrated at the site visits: all facilities well situated without any visible signs of unfavourable environmental impacts on the surrounding areas; water resources were well used with farms and hatcheries minimizing on-site water exchange and most waste water receiving basic treatment before discharge for use as irrigation water or back into the surrounding water; all sites demonstrated good management, which lead to a low incidence of disease and the regulations on the use of aquaculture medicines was well communicated and understood; all hatcheries used farmed broodstock with strict

<sup>54</sup> <http://www.worldwildlife.org/what/globalmarkets/aquaculture/dialogues-tilapia.html>

<sup>55</sup> March 2009. Sustainable Aquaculture in South China – Shrimp and Tilapia Farming in Hainan and Guangdong Provinces. 62 pp. (Chinese and English versions combined) [www.euchinawto.org](http://www.euchinawto.org)

quarantine procedures on all imported broodstock. All farms and hatcheries exclusively used formulated, pelleted feed, which the feed factories produced from good quality raw materials and without using any waste products, medicinal or hormone additives or binding agents.

The EU-China team concluded that “with the current trend in the EU’s major retail and food companies towards implementing purchasing programs for the supply of environmentally sustainable aquaculture products, the need to adopt an international environmental sustainability scheme will significantly improve China’s supply opportunities.” That is indeed a worthwhile observation and one that is timely given that, as a result of the WWF-initiated Tilapia Aquaculture Dialogue, there now is not only a set of standards formulated around the eight principles noted above, but also robust indicators that can be used for certification.<sup>56</sup> It is anticipated that the certification process will operate via a new body, the Aquaculture Stewardship Council.<sup>57</sup> However it is not clear at this stage whether most large Chinese enterprises will participate, at least in these early days of such certification.

Clearly, however, there is interest, especially on the part of companies with direct ties to the U.S. and perhaps other countries with considerable experience and pressures for certification and traceability. An example is HQ Sustainable Maritime Industries Ltd., with tilapia aquaculture operations in Hainan. The company takes certification seriously as noted below:<sup>58</sup>

The Company holds HACCP and GMP certification from the U.S. FDA and the EU Code Assignment of Quality, permitting its products to be sold in these international markets. It has also achieved the ISO 9001 quality management system standards certification and the ISO 22000 certification for quality in food safety. The Aquaculture Certification Council, Inc. certified that HQS tilapia farming and processing standards met Best Aquaculture Practices and Moody International Certification Ltd. The Company's certified co-op farming and processing are in conformity with the new Global G.A.P., the Global Partnership for Good Agriculture Practice, standards for Tilapia. The Chinese government gave organic certification to the Company's tilapia processing, production, labelling, marketing and management system.

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<sup>56</sup> International Standards for Responsible Tilapia Aquaculture. December 2009.

<http://www.worldwildlife.org/what/globalmarkets/aquaculture/WWFBinaryitem14693.pdf>

<sup>57</sup> <http://www.ascworldwide.org/>

<sup>58</sup> “In addition to headquarters in Seattle, HQ has operational offices in Wenchang, Hainan.” The Company's website is: <http://www.hqfish.com/> <http://www.aquanet.com/with-extra-modules-mainmenu-70/1-latest-news/164-hq-sustainable-maritime-industries-inc-announces-participation-in-the-tilapia-2010-conference>

The HQ company experience is at the high end of what may be required of major aquaculture companies operating in China in the future, certainly over the 10 year time frame of further development laid out by CAPPMA. But what of the many smaller companies and individual farmers that have contributed to the growth of this industry? And what of at least some of the larger businesses that are probably operating somewhere well below the high sustainability performance level by comparison to the ideals of existing regulations and certification? Or companies that are selling into markets that are less demanding on sustainability concerns than the U.S. or the EU countries?

These three questions reflect the concerns of how to bring an entire sector first of all into the dialogue on sustainable development, and then into full compliance and, when appropriate, certification of their efforts. For at least some of the international markets this has already been done by Chinese enterprises with respect to Hazard Analysis and Critical Control Points (HACCP) which is a self-analysis necessary for exporting seafood products into the U.S. If the obligation is there (whether by regulation or market imperatives), or if there is a sufficient market opportunity opened up by embracing tilapia certification then it will almost certainly happen within China. But it may take considerable time.

The U.S.-based Sustainable Fisheries Partnership,<sup>59</sup> which has a sustainable tilapia program in China under its Aquaculture Improvement Partnership (or AIP, “an alliance of buyers, suppliers and producers”) sees a great need for capacity building, including mechanisms to improve the livelihoods of small-scale producers. The objectives of the partnership are to:

- Convene producers to reduce potential risks associated with tilapia farms in the natural environment and to prevent their introduction in pristine water bodies.
- Improve tilapia aquaculture management and compliance with eco-label standards.
- Create an environment where different stakeholders (producers, processors, exporters, etc.) can discuss and work together towards the sustainability of tilapia.
- Assist buyers on developing procurement policies.
- Improve small farmer capacity to achieve the sustainable farming.

This initiative is being undertaken first in Hainan, with work already underway. A number of lessons learned are useful to consider. These include: the importance of involving key stakeholders; collaborating with local institutions; taking into account regional or other characteristics; recognizing the value of demonstration farms; and taking into account factors such as extreme weather like the severe storm that impacted south China tilapia operations in 2008. Hopefully the AIP effort will be

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<sup>59</sup> <http://www.sustainablefish.org>; Han Han presentation to Global Seafood Conference, Vancouver, Canada. March 1, 2011. <http://www.seafoodchoices.com/seafoodsummit/documents/Han,Han.pdf>

helpful in linking smallholders into the broader picture of sustainable aquaculture. Many more such efforts will be required, given the number of farms and processors in local areas of south China. This will require the involvement of local governments and the relevant national agencies including the Ministry of Environmental Protection, the Ministry of Agriculture and others.

For the larger operations, especially those involved with export operations, the role of CAPPMA in promoting sustainable aquaculture should be helpful, but a more concerted and visible effort on the part of individual companies is needed, especially vertically integrated operations that include several components of the market supply chain. The major companies should consider taking an active role in introducing the new tilapia certification standard within China. This could be useful in ensuring “branding” of Chinese tilapia aquaculture as sustainable in the seafood markets of the world. And it could help to align the industry with the government’s goals of seeking green economic growth. WWF-China could be a helpful partner.

Also important is increasing Chinese consumers’ awareness of the desirability of eco-certified aquaculture products. Tilapia is not among the most favoured fish within China by any means, and there is a desire on the part of industry to stimulate demand, especially for frozen fillets. It might help to stimulate domestic sales if tilapia were perceived as a product that is cultivated in an environmentally sustainable fashion. This awareness-raising should be left mainly in the hands of the aquaculture industry, if possible, but it will require leadership, either by companies or associations such as CAPPMA.

The third question pertains to Chinese aquaculture products being sold in poorer countries, and very likely also to the conditions for investment in tilapia aquaculture ventures in Africa, Latin America, and other parts of Asia, and it should be addressed through national-level policies. Obviously, it would not be in China’s interests to sell really low-grade food products to anyone. However, it may be difficult to differentiate between products that have a large environmental impact and those that have been produced sustainably unless there is adequate traceability and other safeguards associated with certification or other reliable market mechanisms. In the case of tilapia products, it would be ideal if there could be a simple standard set that would provide for basic product quality and some recognition of basic environmental conditions being met in the production and processing stages. However, this approach would not be as comprehensive on sustainability matters as the WWF standard.

That China will need to look abroad for siting some of its future aquaculture growth is almost a given. There are not enough suitable land and water resources to accommodate the likely future growth of freshwater aquaculture. Growth of tilapia farming will be affected unless there are opportunities to invest in pond development elsewhere in the tropical world. Such expansion should



be done in an ecologically-sound way, if China is to build a reputation as a country that supports sustainable development. Thus China should be prepared to draw upon its best environmental management experience and best aquaculture practices in tilapia ventures undertaken in other countries. Such an approach will require guidance from government, understanding and diligent review on the part of the financial sector in China providing loans, lines of credit, and development assistance for foreign investment.

Overall, China's tilapia aquaculture is now one of the highest profile fishery activities in the world today. It has achieved a level of economic success that now must be safeguarded by creating a sustainable development approach that reaches both smallholders and large operators. The regulatory framework within China to address this challenge is quite extensive, and the means to provide assurance via international standards and indicators is also available. Thus considerable progress towards sustainable tilapia aquaculture should be possible over the coming period of the 12<sup>th</sup> Five Year Plan (2011–2015). Without such progress it is likely that some markets will weaken, especially in North America and Europe where sustainability questions about Chinese tilapia products are likely to be raised, as they have been in the past.

## 5.0 Cod Market Supply Chain Analysis<sup>60</sup>

### 5.1 Rationale for Choosing This Supply Chain

Cod (*Gadus morhua* in the Atlantic, and *Gadus macrocephalus* in the Pacific) has long been one of the most heavily utilized whitefish in western seafood markets. Cod's long-standing top rank in the European Union (EU)'s whitefish<sup>61</sup> supply was usurped by [Alaskan] pollock (*Theragra chalcogramma*) only in 2008 when 906,000 t of pollock and 849,000 t of cod were imported.<sup>62</sup> Nevertheless, cod remains the highest value whitefish species by a substantial margin (generally double the price of pollock).<sup>63</sup> China is the largest supplier of frozen wild-caught whitefish fillets to the EU market, contributing 36 per cent of the total supply.<sup>64</sup> However, due to recent strong growth in the market for Pangasius (a species of farmed catfish), Vietnam surpassed China as the leading supplier of whitefish to the EU in 2008.<sup>65</sup> Although these statistics indicate that cod, pollock and Pangasius are all important species to China's fish processing trade, the depleted status of several cod stocks suggest that this species is of greatest concern from an ecological perspective.

China's supply of cod for processing derives from stocks in four major fishing grounds: the northeast Pacific, the northwest Pacific, the northeast Atlantic and the northwest Atlantic. The status of these stocks range from severely overfished to resilient:<sup>66</sup>

- In the northeast Pacific, the U.S. cod fisheries (i.e., the Bering Sea and Aleutian Islands fishery of nearly 170,000 t per year and the Gulf of Alaska fishery of nearly 60,000 t per year) are currently certified as sustainable under the Marine Stewardship Council eco-label.<sup>67</sup>
- In the northwest Pacific, fisheries in the Russian Bering Sea take approximately 60,000 t of cod per year.<sup>68</sup> The Russian Far East cod fishery is not at present engaged in any sustainability certification processes, nor has it been subjected to any publicly available sustainability assessments. While concerns have been expressed about illegal, unreported and

<sup>60</sup> The draft version of this paper was prepared by Dr. Shelley Clarke under contract to IISD.

<sup>61</sup> Whitefish is defined by the EU Fish Processors Association (AIPCE) as including cod, saithe, hake, Alaska pollock, haddock, redfish, hoki and Pangasius (a kind of farmed catfish).

<sup>62</sup> AIPCE (EU Fish Processors Association). 2009. Finfish Study. 2007. Retrieved from <http://aipce-cep.org/documents/AIPCE-CEPFinfishStudy2009.pdf>

<sup>63</sup> *ibid*

<sup>64</sup> *ibid*

<sup>65</sup> *ibid*

<sup>66</sup> FAO (2009). Species Fact Sheets: *Gadus morhua* and *Gadus macrocephalus*. Retrieved from <http://www.fao.org/fishery/species/2218/en> and <http://www.fao.org/fishery/species/3011/en>

<sup>67</sup> See [www.msc.org](http://www.msc.org)

<sup>68</sup> FISHSTAT Plus. 2010. FishStat Plus: Universal software for fishery statistical time series. Retrieved from <http://www.fao.org/fishery/statistics/software/fishstat/en>

unregulated (IUU) fishing in the Russian portion of the Bering Sea, these concerns have focused on pollock<sup>69</sup> and salmon<sup>70</sup> rather than cod.

- In the northwest Atlantic, cod fisheries currently produce approximately 50,000 t per year, roughly 10 per cent of their production in the late 1980s.<sup>71</sup> Independent sustainability assessments are available for 11 cod stocks and substocks in this area ranging from the west coast of Greenland in the north to Georges Bank in the south.<sup>72</sup> Although the condition of each stock varies, many are characterized as collapsed and some are currently subject to fishing moratoria. In a few of the stocks, there is some evidence of gradual rebuilding and limited fishing is being allowed. None of these stocks are certified as sustainable or are known to be engaged in a sustainability certification program.
- In the northeast Atlantic, annual catches of cod during the period 2005–2008 have been on the order of 700,000 to 800,000 t.<sup>73</sup> However, there were serious concerns regarding IUU fishing of cod in the Barents and Baltic Seas areas during this period suggesting that catches may have been substantially higher.<sup>74</sup> Under measures taken by both governmental organizations and industry, IUU catches have been reduced (see Section 4.3), and at present certified sustainable stocks represent 6,000 t, and stocks under assessment for sustainability represent nearly 300,000 t, of the 862,000 t currently under quota in this region.<sup>75</sup>

As summarized in Table 5.1, the global catch of Atlantic and Pacific cod is currently on the order of 1.2 M t of which about 20 per cent is already certified as sustainable and about another 25 per cent is formally under assessment under the Marine Stewardship Council's eco-labelling program.<sup>76</sup> The extent to which China's fish processing industry is sourcing cod from each of these areas, as well as the extent to which the exact sources of China's cod supply can be determined, are discussed in Section 5.4.

## 5.2 Supply Chain Structure

The supply chain for cod processed in China originates with trawl, pot or longline-caught fish which are usually subject to primary processing (headed and gutted) and frozen at sea. These fish are

<sup>69</sup> WWF. 2008. *Illegal Fishing in Arctic Waters: Catch of Today-Gone Tomorrow?* Retrieved from [http://assets.panda.org/downloads/iuu\\_report\\_version\\_1\\_3\\_30apr08.pdf](http://assets.panda.org/downloads/iuu_report_version_1_3_30apr08.pdf)

<sup>70</sup> S. C. Clarke, M.K. McAllister and R.C. Kirkpatrick (2009). "Estimating Legal and Illegal Catches of Russian Sockeye Salmon from Trade and Market Data." *ICES Journal of Marine Science* 66(3): 532-545.

<sup>71</sup> FishStat Plus, *op. cit.*

<sup>72</sup> Sustainable Fisheries Partnership. 2010. <http://www.fishsource.org>

<sup>73</sup> FishStat Plus, *op. cit.*

<sup>74</sup> WWF (2008), and Album, G. and M. Esmark (2008). "IUU fishing in Arctic Waters: Barents Sea Cod—Where Did It Go?" Presentation to Chatham House, London, UK. March 2008. Retrieved from <http://www.illegalfishing.info/uploads/AlbumEsmark.pdf>

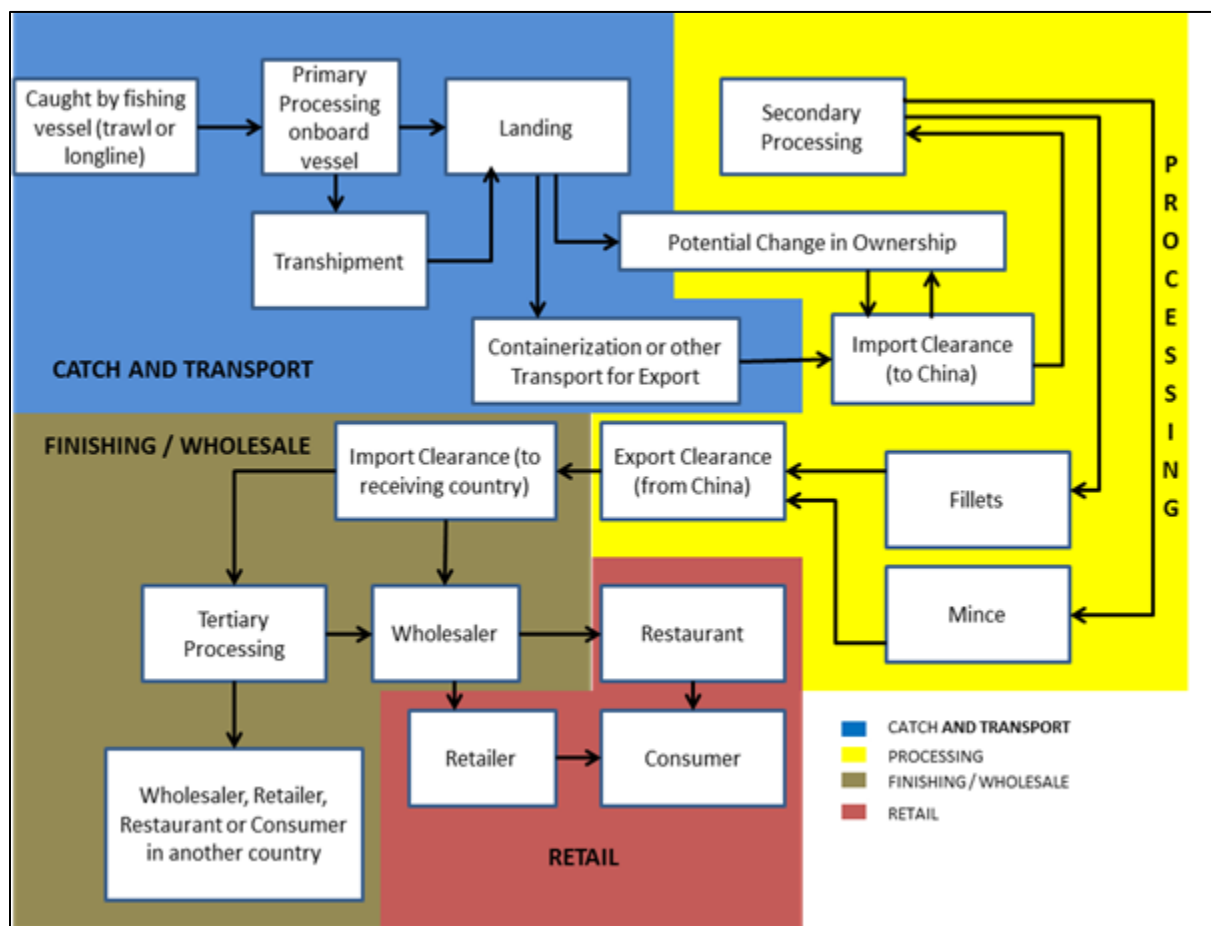
<sup>75</sup> G. Album, Friends of the Earth-Norway, personal communication.

<sup>76</sup> No cod fisheries are known to be certified or under assessment by any other seafood eco-labelling program.

landed by the fishing vessel (or trans-shipped at sea if authorized), in a port of the flag state or potentially in another country for containerization and shipment to China for processing. There may be one or more changes of ownership during this process (Figure 5.1).

**Table 5.1 Current catches of Atlantic and Pacific cod and the percentage of these which have been certified, or are under assessment to be certified, as sustainable by the Marine Stewardship Council’s eco-labelling program.**

Area	Current Total Quota (or Reported Catch) in tonnes	Certified Sustainable	Known to be Under Assessment for Sustainability
Northeast Pacific (Alaska)	~230,000	~230,000 (100%)	N/A
Northwest Pacific (Russian Far East)	~60,000	0%	0%
Northwest Atlantic (Canadian Maritimes / New England)	~50,000	0%	0%
Northeast Atlantic (Northern Europe)	~860,000	~6,000 (<1%)	~300,000 (35%)



**Figure 5.1 Supply chain components and linkages for cod.**

Primary processed materials sent to China are first subject to import checks and then released to an agent in China who may either process or sell the material. Custody of the fish may or may not go through several transfers of ownership before it reaches the processor. The processor then processes the fish based on the market demand for various types of products (e.g., different sizes and shapes of fillets). Trimmings may be collected for a mixed product called “mince” used in fish sticks/patties. Under China’s sanitary regulations, strict traceability should be maintained even for mince. Once processing is complete, inspectors check the products against sanitary standards and against expected yields (relevant for customs duties). The product is then exported, directly or indirectly, from China to the receiving country.

Health and sanitary checks are also undertaken when the shipment enters the major receiving markets (EU, U.S. and Japan), before the product is released into free circulation. It is not possible to rigorously assess the frequency of import detentions or rejections of Chinese fish into these markets because in most cases the watch lists or alerts which are posted as a result are not shared outside of the national import control system.<sup>77</sup> However, general information on fish shipment detention and rejection rates indicates that the vast majority of health and sanitary issues with Chinese fish products are associated with chemical and veterinary drug residues in aquaculture products.<sup>78</sup> Currently, a U.S. Food and Drug Administration ban on shrimp and catfish imports from China imposed in August 2007 continues to be in effect due to earlier incidents of veterinary drug contamination and ongoing, but not yet successful, attempts at resolution.<sup>79</sup> While these issues relate to China’s food safety traceability systems, the origin of the contamination in these incidents lies with fish culture practices which should have no bearing on the processing of wild-caught fish.

Once the shipment clears the import health and sanitary checks in the receiving country, the product may be sold to a processor for tertiary processing (e.g. breeding, adding of sauces, etc.), or to a wholesaler, retailer or distributor (e.g. to restaurants) and from there on to the consumer. It is possible that the receiving country will export the product to the final point of sale in another country, particularly if tertiary processing has occurred. The supply chain ends with consumption of the product by a consumer at home or in a restaurant/food service venue.

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<sup>77</sup> Clarke, S. (2009). “Understanding China’s Fish Trade and Traceability Systems.” TRAFFIC, Hong Kong.

<sup>78</sup> L. Ababouch, G. Gandini and J. Ryder (2005). “Causes of Detentions and Rejections in the International Fish Trade.” FAO Fisheries Technical Paper 473. FAO, Rome.

<sup>79</sup> World Fishing Today. FDA Of USA Has Shifted From Its Policy Regarding the Export of Chinese Shrimps by Ignoring Its Own Data. Retrieved from <http://www.worldfishingtoday.com/news/default.asp?nyID=4759>

## 5.3 Market Size and Trends

### 5.3.1 Global Production Levels

The global production of cod is compiled by FAO in two forms.<sup>80</sup> The capture production quantity for 2004–2008 varies from 1.1 to 1.2 Mt per year, with the largest catches reported by Russia, the U.S., Norway, and Iceland. The statistics for cod commodities production (i.e., fresh, frozen, salted, dried products) are considerably lower (500,000 t per year) perhaps reflecting only those products which enter international trade. The leading commodity producing countries are the same as those reporting the highest capture production.

The EU alone was estimated to have utilized 850,000 t of cod (live weight) in 2008, of which 86 per cent was imported rather than landed.<sup>81</sup> When compared to the global capture production value reported to FAO for 2007–2008 (1.1 M t per year),<sup>82</sup> this figure suggests that approximately 75 per cent of the reported global catch was utilized in the EU, thus confirming that this is the largest consumer market for cod.

### 5.3.2 Chinese Production Levels

The only cod landings reported by China are of unspecified Gadoid fishes (probably Pacific cod) at 10,000 to 25,000 t per year.<sup>83</sup> Traders report that these fish do not enter international trade on account of quality issues.<sup>84</sup>

China's production of processed cod for export thus derives entirely from imported materials which originate from one of the four stocks described in Section 5.1. China's import commodity coding system specifies a code for cod as distinct from other whitefishes; however, as is the case for most import statistics worldwide, the possibility exists that other species are sometimes recorded in this category. In fact, in China this problem is exacerbated by a lack of species-specific codes for some other key import species as well as confusion among common names for fish. For example<sup>85</sup>

- As there are no species-specific import commodity codes for major whitefish processing species such as Alaska Pollock, hoki, redfish and whiting, these species may be inconsistently recorded as cod, as unidentified species or as another species;

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<sup>80</sup> FAO Fishstat Database. 2010. Capture Production (1950–2008) and Commodities and Trade Databases (1976–2007). FAO, Rome.

<sup>81</sup> AIPCE, 2009. op cit

<sup>82</sup> FAO FishStat, 2010. op cit

<sup>83</sup> FISHSTAT, 2009. op cit

<sup>84</sup> Clarke, S. 2009. op cit

<sup>85</sup> Clarke, 2009. op cit

- Fish referred to as “saithe” or “coalfish” in EU markets are also sometimes referred to as “pollock” (even though these fish are different species and distributed separately over different ocean ranges from Alaska pollock). Even though there is a separate import commodity code in China for coalfish, this species may, like Alaska pollock, be recorded as “cod”;
- New Zealand is recorded as one of China’s major suppliers for “coalfish” even though coalfish are not found in New Zealand. Given the lack of an import commodity code for hoki, a major whitefish fishery in New Zealand, it is likely that large quantities of imported hoki are being recorded as “coalfish.”

These uncertainties are further compounded by China’s export commodity coding system which aggregates all wild and farmed processed fish fillets, except tilapia, under a single commodity code.<sup>86</sup>

In order to circumvent these statistical issues, exports of fillets of various whitefish species were calculated from EU, US and Japanese import statistics, all of which have more detailed systems for recording the species of imported fish fillets. As noted above, the main market for cod is in the EU, and China produced 52 per cent of the frozen cod fillets imported into the EU and 16 per cent of the total supply to the EU in 2008.<sup>87</sup> The EU’s dependency on foreign-supplied cod was estimated at over 90 per cent,<sup>88</sup> however, while most cod is caught outside of EU waters, some is processed in the EU, mainly in Poland. Overall, it was estimated that in recent years, China’s processed cod output represents 16–19 per cent of the global cod catch.<sup>89</sup>

### 5.3.3 Chinese Imports and Exports – Volumes and Partners

Notwithstanding the issues associated with the species-specificity of the import statistics for cod to China described above, this section explores what is known about the source of China’s raw materials for cod processing. As a cautionary note, Box 5.1 describes problems with traceability. These apply for fish entering China as well as other processing/importing countries. Cod is imported by China in two forms: fresh/chilled or frozen. The quantity of both product forms imported by China in 2003–2007 ranged from 463,000 to 670,000 t per year. The top six suppliers of China’s cod imports are shown in Figure 5.2.

On average, Russia supplies 65–85 per cent of the total supply.<sup>90</sup> One of the major reasons for this is that Russia produces cod from both its Atlantic and Pacific fisheries, although it should be noted

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<sup>86</sup> Clarke, 2009. op cit

<sup>87</sup> AIPCE. 2007. op cit

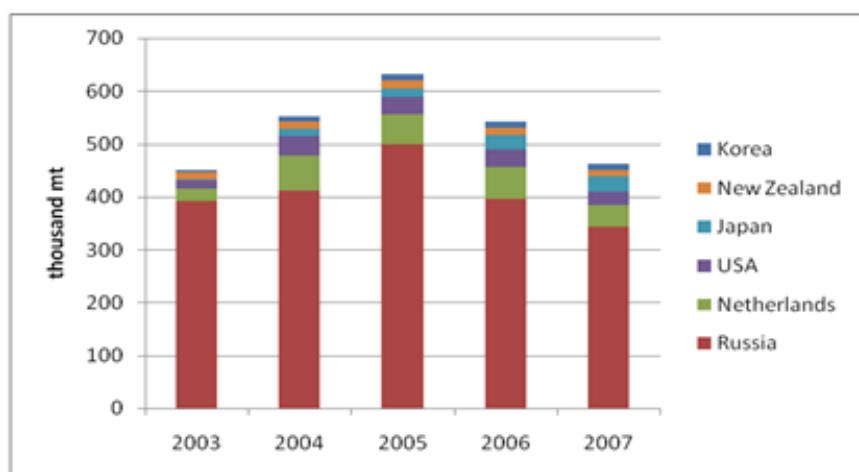
<sup>88</sup> ibid

<sup>89</sup> Clarke, 2009. op cit

<sup>90</sup> *China Customs Statistics Yearbook. 2003-2007*. Goodwill China Business Information, Hong Kong.

that the fishery in the Atlantic produces more than 10 times the reported catch of the Pacific fishery (see Table 5.1). Lack of access to Russian customs statistics prevents using these to calculate the percentage of the Russian cod catch that is supplied to China. (The quantities of cod reported to be imported by China from Russia exceed the catch quantities reported by Russia to FAO, perhaps because the China import figures also contain Russian [Alaska] pollock).

The other source countries for China’s cod supplies include the Netherlands, a containerized hub for cod from the northeast Atlantic; the U.S., Japan and South Korea, all of which produce cod from their own fisheries mostly on the Pacific stocks but perhaps in the case of the U.S. including small quantities from the northwest Atlantic stocks; and New Zealand, which does not produce or containerize cod and probably appears in this list due to the misclassification of hoki.



**Figure 5.2 China’s imports of cod from the top six supply countries.**

With regard to the disposition of processed cod products from China, it is not possible to identify the major recipients from China’s customs statistics because all fish fillets, regardless of species (except tilapia), are tabulated under a single commodity code. However, the results of an analysis of major receiving markets including the EU, the U.S. and Japan, and available China customs statistics are shown in Table 5.2.



**Table 5.2 Imports of unprocessed cod by China, exports of processed cod received from China by three suspected major markets (EU, U.S. and Japan) and the potential amount of cod destined for other markets (all quantities in t).**

	2004	2005	2006	2007
China's Imports of Unprocessed Cod	585,041	670,153	591,094	492,863
Expected Yield after Processing (assumes 70%)	409,529	469,107	413,766	345,004
Imports by EU	34,698	51,939	59,571	65,357
Imports by U.S.	25,189	34,752	38,807	42,810
Imports by Japan	18,018	18,819	25,174	25,328
Total Imports by EU, U.S. and Japan	77,905 (19%)	105,510 (25%)	123,552 (30%)	133,495 (39%)
Remaining amount either exported to other markets or consumed domestically	331,624	363,597	290,214	211,509

**Box 5.1 Current problems in assessing fish origin from customs statistics and potential traceability solutions**

To date, most publicly available information on the origin of fish products has derived from national custom statistics. These statistics, while often available online and sometimes free of charge, are not always reliable in terms of tracking quantities by species. This is because there is little detailed checking of the species of fish in containers or other shipped parcels by customs officials at border checkpoints due to inspectors' workload, lack of expertise and prioritization of checking for contraband.

In the private sector, however, companies have developed elaborate procedures to verify the species composition of the fish they import from foreign processing plants, including visual product inspection keys, traceability documentation systems, and even DNA testing (S. Clarke, personal observation). These records are not, however, made available outside the companies unless a specific incident or problem occurs. This is, for example, the case for Marine Stewardship Council traceability requirements: these are private documents between suppliers, processors and importers which are made accessible during system audits only.

In recent years, largely as a result of concerns about the environmental sustainability of the fishing activities producing the supply, governments and regional fisheries management organizations (RFMOs), have begun to mandate their own traceability schemes in the form of catch certificates (e.g., the EU IUU fishing regulation implemented January 2010) or catch documentation schemes (e.g., the toothfish Catch Documentation Scheme under the Commission for the Conservation of Antarctic Living Resources and the Catch Documentation Program under the International Commission for the Conservation of Atlantic Tunas). These systems focus on providing traceability for landed and traded fish catches rather than tracing batches of products through processing factories. These governmental and inter-governmental schemes provide data to agencies or committees which evaluate it, but in most cases will not release the data to the general public.

While fish product traceability is therefore evolving to become both more robust and more transparent on a variety of different fronts, there is still some distance to go before this information is made available to consumers or to independent auditors.

**References:**

Clarke, S. (2007). *Trading Tails: Linkages between Russian salmon fisheries and East Asian markets*. TRAFFIC East Asia, Hong Kong.  
 Clarke, S. (2004). *Shark Product Trade in Hong Kong and Mainland China, and Implementation of the Shark CITES Listings*, TRAFFIC East Asia, Hong Kong.  
 MRAG. (2009). *Best Practice Study of Fish Catch Documentation Schemes*. Technical and Compliance Committee Paper WCPFC-TCC5-2009-24 (Rev. 2). Western and Central Pacific Fisheries Management Commission, Pohnpei, Micronesia.

These figures suggest that 60 to 80 per cent of the expected cod output of China is exported to the EU, the U.S. and Japan. In order to explore where the remainder of the cod is destined, statistics for undifferentiated fish fillets were examined. It is not possible to know which of the countries receiving undifferentiated fish fillets from China are actually receiving cod, but countries receiving more than 100,000 t per year of undifferentiated fish fillets from China in 2004–2006 included Japan, the U.S. and Germany, and those receiving over 10,000 t per year included South Korea, the United Kingdom, France, Netherlands, Spain, Poland, and Russia. Most of the countries that are receiving undifferentiated fish fillets (i.e., with the exception of South Korea, Russia and Canada) are also the countries identified as China's main markets for processed cod—the EU, the U.S. and Japan. Therefore, despite the rather large amount of processed cod apparently destined for a market other than one of the three main markets in Table 5.1, it seems likely that the primary destinations for China's processed cod products, including those shipped as undifferentiated fish fillets, are indeed the EU, the U.S. and Japan.

Sources other than customs statistics indicate that, as stated earlier, the EU receives 52 per cent of its frozen cod fillets from China.<sup>91</sup> U.S. imports of cod in all forms from China grew steadily from 28 per cent of its total cod imports in 2003 to 72 per cent of its total cod imports in 2007. It is not possible to calculate a realistic estimate of the percentage of cod from China for Japan because cod fillets are grouped with several other major species under a single commodity code in Japan's statistical system.

In drawing these conclusions it should be noted that China's immediate import and export partners do not necessarily represent the key suppliers and consumers of cod. This is because most cod is shipped by sea as a frozen product and thus can withstand re-packing in major logistics hubs on its outbound (pre-processing) and/or inbound (post-processing) journeys. This presents the possibility for transshipment from the actual producer country to a transit country on the outbound route (such as noted above for the Netherlands), and for tertiary processing or other finishing/packaging in an intermediary country on the inbound route to the consumer country (such as breeding/coating and frying of fish sticks in the U.K., or final processing in Canadian plants prior to being sent to consumers in the U.S.).

#### **5.3.4 Estimated Quantities of Illegal Trade**

The most obvious problems with IUU fishing for cod have occurred in the Barents and Baltic Seas, two major fishing grounds in the northeast Atlantic which contain the world's largest cod fishery. In 2006, EU fish traders took action in response to a two-tiered pricing system for cod in which an approximately 20 per cent lower price was being offered for cod without traceability documentation.

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<sup>91</sup> AIPCE, 2009. op cit

Their action took the form of a 2006 voluntary agreement among EU processors to implement a “Control Document for Purchase of Barents Cod” which required that certain traceability standards be met or purchase be refused (Box 5.2).

The North East Atlantic Fisheries Commission (NEAFC) adopted Port State Control Measures in 2007 requiring that catches must be certified by the flag State as being within quota, properly reported, derived from authorized fishing operations, and originating in an area confirmed through Vessel Monitoring System (VMS) data before they can be landed or transhipped in ports of contracting parties. NEAFC also implemented blacklisting procedures for IUU fishing vessels in 2005. All of these measures have reportedly contributed to a reduction in IUU fishing of cod in the NEAFC area from level of 100,000 t per year to 10,000 t per year<sup>92</sup>. Nevertheless, some incidents of circumvention of the NEAFC port State controls by Russian vessels making unauthorized landings of Barents Sea cod into China have been reported.<sup>93</sup>

A similar “Control Document” was implemented by AIPCE for the Baltic Sea in 2007. Estimates from 2007 for the cod fishery in the Baltic Sea estimated that true catches were 35–45 per cent of reported catches.<sup>94</sup> A significant reduction in non-reported catches to just 6 per cent of reported landings is thought to have occurred in 2008, due to better enforcement of fishing controls.<sup>95</sup>

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<sup>92</sup> NEAFC (2009). World Ocean’s Day Press Release. Retrieved from [http://www.neafc.org/system/files/08062009\\_world\\_oceans\\_day\\_press\\_release.pdf](http://www.neafc.org/system/files/08062009_world_oceans_day_press_release.pdf)

<sup>93</sup> WWF (2008), op cit. and Album, G. and M. Esmark (2008). “IUU fishing in Arctic Waters: Barents Sea Cod —Where Did It Go?” Presentation to Chatham House, London, UK. March 2008. Retrieved from <http://www.illegalfishing.info/uploads/AlbumEsmark.pdf>

<sup>94</sup> <http://www.bsrac.org/archive/Dokumenter/Conference%20280306/IUU%20fishing%20The%20nature%20%20the%20problem%20Baltic%20Cod%20-%20BSRAC%2028-29%20March%202007.pdf>

<sup>95</sup> <http://www.ices.dk/committe/acom/comwork/report/2009/2009/cod-2532.pdf>

**Box 5.2 Industry warranty (“Control Document”) schemes for Barents Sea cod**

Control documents were designed for the cod fisheries of the Barents Sea beginning in 2006 as a means of eliminating IUU fishing. The system works under a voluntary system composed of a joint agreement among buyers and control documents enforced by third party auditing. Buyers warrant that they will not buy products from any supplier that:

- fails a third party audit;
- refuses a third party audit; or
- is discovered to have supplied illegal product.

If subscribed to by buyers which collectively comprise a significant portion of the trade in products from the fishery, this type of system effectively excludes IUU products from the supply chain. This is because those selling such products are unable to sell any product to any participating buyer if they meet any one of the three “blacklist” conditions above. Furthermore, buyers themselves also agree to subject their purchasing records to third party audit at any time. Under the system, every delivery of product must originate from legal vessels and this must be proven on demand. If this test is failed under an audit, then the supplier must be excluded from the system.

In 2005, IUU fishing of cod in the Barents Sea was estimated at 100,000 t worth US\$350 million per year. In 2007, once the system was fully implemented by AIPCE (the European whitefish processors' organization), IUU fishing for Barents Sea cod had been reduced by 23%. The total reduction in illegal Barents Sea cod between 2005 and 2007 has been estimated at 60,000 t worth US\$196 million.

**5.3.5 Market Drivers for the Supply Chain**

Market drivers for the cod supply chain, as for the supply chain of all fisheries products, are expected to include human population increase that will elevate demand for all foodstuffs. In addition, there are shifts in food consumption patterns toward more fish by more affluent consumers, and also away from those fish with high mercury content (tuna, swordfish), as part of a healthier diet. Though some of these consumers may be expected to prefer wild-caught over farmed species, and/or to prefer eco-labelled or fully traceable products, they are expected to be price sensitive and will not necessarily pay higher prices for such products if cheaper alternatives are available. As the EU whitefish market is somewhat fluid, if supplies of cod dwindle, it would be expected that processors and retailers would promote substitution with haddock, pollock, saithe, hake or hoki, or tilapia. For example, last year one major UK seafood company began promoting pollock by emphasizing its higher omega-3 content (relative to cod).

**5.3.6 Expected Market Trends at the Global and National levels**

Shortages in supply of Atlantic cod in EU markets in recent years have led to expansion of the Pacific cod fishery. At the same time, distributors have worked with some success to promote other whitefish as alternatives. Now that IUU fishing in two of the major, high production fishing grounds has been brought partially under control, and now that a substantial portion of the global production

has either been certified (see Section 4.1), or is under assessment for certification, it will be interesting to observe whether demand for cod specifically will strengthen relative to other whitefish.

The growth in China's per capita seafood consumption as levels of disposable income<sup>96</sup> increase will have a major effect on global seafood trends. For example, even in the period 1970–1990 China accounted for 27 per cent of the total growth in fish consumption<sup>97</sup> but at that time the trend was attributed to growth in domestic cultured fish supplies.<sup>98</sup> It would not be unreasonable to expect, however, that under current conditions of China's growing income levels, demand for wild-caught fish also will rise. Cod is not a traditionally popular species in China although the presence of a small, domestically-orientated cod fishery in the Yellow Sea suggests that there is at least a limited market for the species in China.

## 5.4 Commercial Governance

A study of China's fish processing industry attempted to identify the largest processors of various fish types based on company-specific import statistics<sup>99</sup>. One of the drawbacks of this method was found to be that the business entity importing the fish raw materials may be an import-export company or broker which may then distribute or sell the materials to various factories for processing, thereby masking the identities of the factories themselves. Nevertheless it was clear that there are two major whitefish and salmon fish processing centers in China for the international market: Qingdao in Shandong Province and Dalian in Liaoning Province. Qingdao factories tend to process a wider variety of fish and mainly serve the EC market, whereas Liaoning focuses more heavily on cod and the U.S. market. The Qingdao area processes 53 per cent of China's imported whitefish whereas the Dalian area processes another 40 per cent.<sup>100</sup>

Major international seafood companies trading cod products into and out of China include Ocean Trawlers, Pacific Andes, Foodvest, Icelandic, Seachill and Trident. Large processors in China which do not have an obvious presence in international markets (other than as suppliers) include Longyuan, Unibond and Zhengjin. The trade is highly diversified and fluid. While 50 companies produce 60 per cent of China's exported fish fillets, the remaining 40 per cent are produced by another 473 companies. Furthermore, only 30 per cent of the imported whitefish shipments (20 per cent by weight) are returned to the foreign owners after processing. The majority of the raw materials are sold into China and may potentially change hands one or more times before being sold as a finished product to a foreign buyer and exported.

<sup>96</sup> <http://www.fao.org/DOCREP/003/X8002E/x8002e07.htm>

<sup>97</sup> <http://www.fao.org/DOCREP/006/AC442e/AC442e13.htm>

<sup>98</sup> <http://www.fao.org/DOCREP/003/X8002E/x8002e07.htm>

<sup>99</sup> Clarke, S. (2009). op cit

<sup>100</sup> Clarke, S. (2009). op cit.

The European Processors Association (AIPCE) is a well-organized and powerful force in the EU. AIPCE has promoted voluntary measures for its members to combat IUU fishing and has lobbied for practicality in the application of the EU IUU fishing regulation. The National Fisheries Institute plays a similar role in the U.S., though it has a relatively greater focus on public information and marketing than does AIPCE. There is no functioning fish processors association in China and most operations are run with a high level of secrecy and a low level of intra-industry interaction.

## 5.5 Environmental Impacts

According to a recent study,<sup>101</sup> the largest amount of carbon emissions associated with the fish re-processing trade in China derive from the fishing activity itself rather than any transport or processing. In fact, calculations showed that the increased efficiency of use of the raw material (yield) possible through China's use of skilled manual labour more than offsets the greenhouse gases used to transport the material to and from China by container ship. The study also noted major differences in carbon emissions from various fisheries depending on stock abundance, fishing technology and the distance to fishing grounds; that air freighting substantially increased carbon emissions; and that processing and packaging generally make very small contributions to overall emissions.

The primary environmental impacts, other than carbon emissions, associated with the processing facilities themselves are expected to be freshwater usage and wastewater discharge. The main concerns are chemical oxygen demand (COD) and biological oxygen demand (BOD) impacts on the environment from plant discharges. CAPPMA reports that the State Council has conducted a survey along the coast of aquatic producer sites with a focus on these two types of pollutants. The State Council expected to take steps to eliminate high waste situations via financial incentives—less financial support and more taxes. According to the State Council survey, the pressures are not that bad, in part because the leftovers after processing are used for a variety of products, like fish meal. The demand for fish meal has risen, leading to major price increases. The utilization rate is much higher than in many other countries, meaning less goes into waste streams.

Within the fish plan, in addition to washing of products at several stages, production lines must be sanitized after each batch and there may be additives such as polyphosphates added to fillets as a means of retaining their water content, which may lead to both COD, and BOD discharges.

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<sup>101</sup> Seafish Authority (2008). Briefing Paper: CO2 emissions—Case Studies in Selected Seafood Product Chains. Retrieved from <http://www.seafish.org/pdf.pl?file=seafish/Documents/SeafishCO2EmissionsBriefingPaperJan2008.pdf>

The non-carbon emissions-based impacts of cod fishing are relatively less severe in cod fisheries than in many other fisheries. Bycatch and habitat effects depend heavily on whether trawl, longline, or other gear is used. Benthic habitat disturbance is often associated with trawling, but the tendency of cod to aggregate results in relatively low bycatch compared to other trawl fisheries. Longlines do not damage habitat as much as trawls but may hook seabirds in areas with high seabird abundance. Marine mammal interactions may also be a problem in some areas<sup>102</sup>.

Due to their high value, cod stocks are generally subject to intensive management relative to most other fish stocks and stock status is generally well-known. However, lack of sufficiently precautionary management has led to severe stock declines in some Atlantic populations from which they have not yet recovered. Cod is listed on many sustainable seafood guides published by non-governmental organizations with varying precision regarding the stock and gear type used to catch the fish. Nevertheless, there is generally consensus that Pacific cod caught by longlines are “best choices” (green rating), Pacific cod caught by trawls are “good alternatives” (yellow rating), and Atlantic cod are those to “avoid” (red rating). A summary of the recommendations of the Audubon Society, the Blue Ocean Institute, Environmental Defense, the Marine Conservation Society (U.K.), the Monterey Bay Aquarium and Sea Choice Canada is presented in Table 5.3.

A diagram of environmental impacts associated with cod fishing and cod processing and distribution is shown in Figure 4.3. Impacts are classified into tiers as follows: the green tier contains impacts which may be important in localized fisheries/areas but do not have a major impact on the sustainability of the supply chain overall; the yellow tier contains impacts which have received focused attention from environmental groups and affect the supply chain over a broad area but which may be disputed in some cases; the red tier contains impacts which represent major threats to the sustainability of the supply chain for which there is general agreement that further mitigation is necessary.

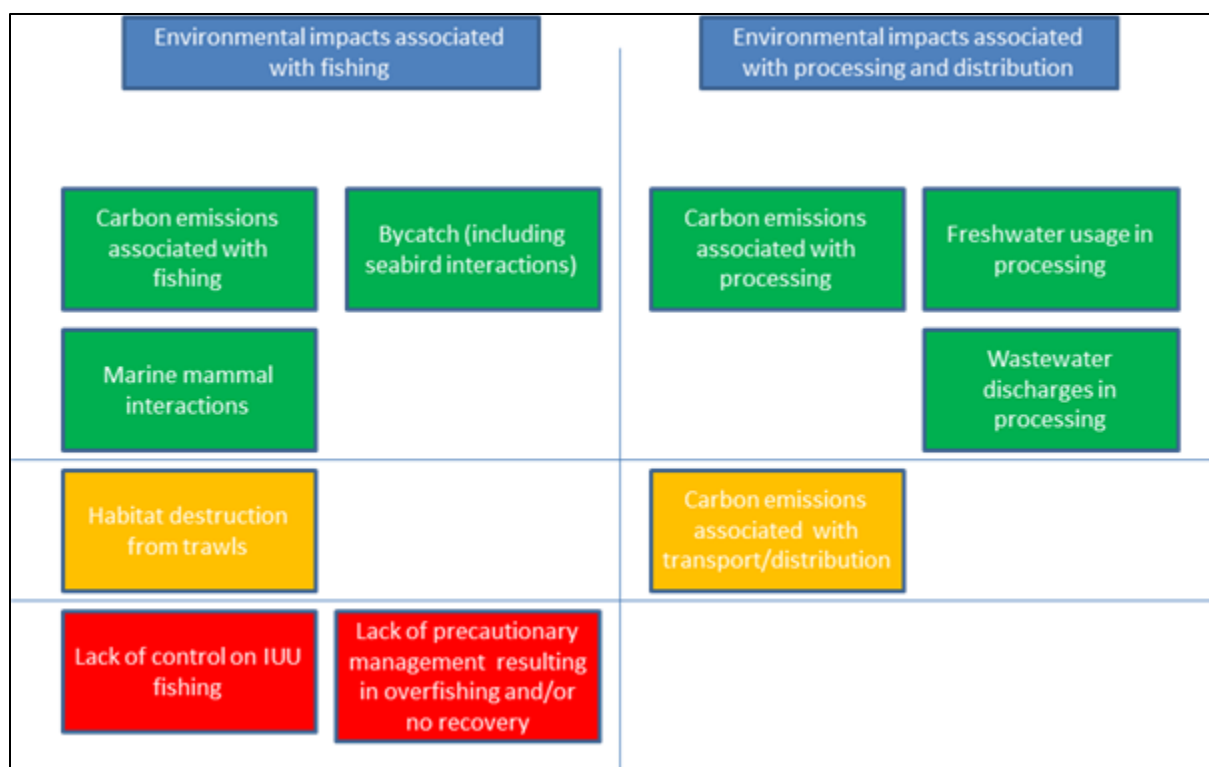
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[http://www.montereybayaquarium.org/cr/cr\\_seafoodwatch/content/media/MBA\\_SeafoodWatch\\_PacificCodReport.pdf](http://www.montereybayaquarium.org/cr/cr_seafoodwatch/content/media/MBA_SeafoodWatch_PacificCodReport.pdf)

**Table 5.3 Summary of the number of ratings for cod fisheries given by seven sustainable seafood guides.<sup>103</sup>**  
**Note that not every guide ranked Pacific and Atlantic cod.**

Species	Stock	Gear Type	Number of Green Ratings	Number of Yellow Ratings	Number of Red Ratings
Pacific cod	n/a	n/a	1		
	n/a	Bottom longline	1		
	n/a	Line caught	1		
	n/a	Bottom longline, jig, pot	1		
	Alaska	Longline	2		
Pacific cod	n/a	n/a		1	
	n/a	Trawl		2	
	Canada, U.S.	Trawl		1	
Atlantic Cod	n/a	n/a			7



**Figure 5.3 Environmental impacts associated with cod fishing and cod processing and distribution. (See text for explanation of the coloured tiers)**

<sup>103</sup> M. Armsby and C.A. Roheim (2009). *A Consensus Seafood Guide*. University of Rhode Island. Retrieved from [http://seagrant.gso.uri.edu/sustainable\\_seafood/pdf/ConsensusSeafoodGuide.pdf](http://seagrant.gso.uri.edu/sustainable_seafood/pdf/ConsensusSeafoodGuide.pdf)



## 5.6 Social Impacts

Specific data on the fish re-processing sector, which includes cod and other fish, is generally lacking due to the fact that most statistics are compiled for capture fisheries and aquaculture only. Obtaining an estimate of the value associated with cod processing in particular is complicated by the fact that while import values are declared, export values for cod fillets cannot be separated from the other fish fillets under the undifferentiated “fish fillet” customs commodity code.

Labour statistics from 2004 indicate that over 13 million people were employed in the fisheries sector in China, including 7.1 million in the primary sector, 1.8 million in capture production, and 4.5 million in aquaculture. Another 0.8 million were employed in the secondary sector and an additional 5.9 million in part-time work. It is not clear whether fish factory workers are classified as working in the fishery sector or perhaps in manufacturing.<sup>104</sup>

The largest fish processing factories in China employ over three thousand workers and provide housing and meals as well as other benefits. Working conditions are generally sanitary but may be considered harsh, as the job involves long shifts standing in cold temperatures, often working with knives. Concerns regarding eye damage from UV light rooms used to better see and remove parasites from fillets have been raised, but this procedure is used in salmon processing, and not employed for processing cod.

Workers are usually paid by the number and quality of fillets they produce but in general monthly salaries range from 1,500 to 2,800 RMB (US\$220 to US\$410).<sup>105</sup> In recent years several factory managers have complained of labour shortages, explaining that benefits such as housing, food and annual leave must be competitive with other facilities within, and outside of, the sector in order to retain skilled workers. As the coastal regions of China develop, the factory worker population is being drawn from farther-flung regions of the Chinese hinterland. However, more recently China’s fish processing factories have been suffering from shortages of raw materials and/or lack of orders and have been shutting down for months at a time or operating only part-time. During such erratic closure periods workers receive a small portion of their wages as compensation.<sup>106</sup> Workers generally return home only once annually at the Lunar New Year festival, necessitating an approximately three-week shutdown of processing operations throughout the industry each year at this time.

There are several health and safety issues for the consumer associated with processed fish fillets. At plants processing for the international market, all fillets are X-rayed to ensure that no metal parts from knives or other machinery have broken off inside the fillet. It is not clear, however, whether

<sup>104</sup> [http://www.fao.org/fishery/countrysector/FI-CP\\_CN/en](http://www.fao.org/fishery/countrysector/FI-CP_CN/en)

<sup>105</sup> H. Cui, CAPPMA, personal communication.

<sup>106</sup> *ibid*

this is a regulatory requirement or merely a best practice standard. There have been recent controversies regarding the use of additives such as polyphosphates to fish fillets, but it should be noted that such additives are not illegal in all consumer markets (e.g., they are not illegal in the U.S) and in fact may be requested under the processing contract.<sup>107</sup> While conditions in some of the larger and better run factories meet or exceed international sanitary standards, independent and Chinese government analyses both substantiate that small food workshops serving the domestic market (employing fewer than 10 people), especially those in rural areas, pose problems for quality assurance. For this reason the Chinese government is actively engaged in rectifying conditions in small food processing plants.<sup>108</sup>

## 5.7 Key Policy Developments

Chinese laws and regulations relevant to the supply chain for cod include customs regulations which are applied by the China Customs Administration. These regulations specify the requirements for import documentation and clearance, e.g. the certificate of origin, and regulations and procedures for auditing product yields for the purposes of duty assessment. China classifies all processed fish products as being “products of China” if the value added during processing increases by  $\geq 40$  per cent or the four-digit tariff code heading changes, e.g., from 0303 for frozen fish to 0304 for frozen fillets.<sup>109</sup> While this policy has attracted some criticism on the basis that it could serve to conceal the true origin of IUU-derived fish products, it has been advocated by many countries as appropriate.<sup>110</sup> The extent to which China’s fish processing industry would benefit from, or be disadvantaged by, a change in WTO rules of origin which might force China to modify this current practice remains to be assessed.

Regarding sanitary issues, the China Administration of Quality Supervision, Inspection and Quarantine and its regional China Inspection and Quarantine (CIQ) Bureaus are responsible for sanitary checks of imported materials for processing and outgoing finished products (exports). CIQ is also responsible for day-to-day auditing of processing facilities. CIQ’s traceability systems and tools are developing rapidly and already represent a solid foundation for documenting the origin of processed fish materials back to the original imported shipment.<sup>111</sup> However, their primary focus is food safety, and a recent decision has been made to create a new system in response to the EU’s IUU fishing regulation to be managed by the China Bureau of Fisheries.

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<sup>107</sup> Clarke, S. (2009). *op cit*

<sup>108</sup> Clarke, S. (2009). *op cit*

<sup>109</sup> Lu, B. (2006). “Asian Experience With Rules of Origin with the Emphasis of China [sic].” Workshop on the importance of Rules of Origin and Standards of Integration, Boao, Hainan, China, June 27, 2006. Retrieved from [http://siteresources.worldbank.org/INTEAPREGTOPINTECOTRA/Resources/5793861152907302538/LU\\_Bo.ppt#340,15,Slide 15](http://siteresources.worldbank.org/INTEAPREGTOPINTECOTRA/Resources/5793861152907302538/LU_Bo.ppt#340,15,Slide 15)

<sup>110</sup> Clarke, S. (2009). *op cit*

<sup>111</sup> Clarke, S. (2009). *op cit*

The responsibility for maintaining documentation of the origin of China's fish raw materials back to the Chinese fishing vessel, as required under the EU IUU fishing regulation and under catch documentation schemes (see Box 5.1), has been assigned to the China Bureau of Fisheries (BOF). BOF is responsible for validating the catch and trade documents accompanying imports of these species to China. BOF is also the lead agency for ensuring that catch certificates are provided with all fish shipments imported to China for processing, and for ensuring that these certificates remain linked to the product up until the point at which they are exported from China. It appears that BOF, through its non-governmental coordinating body CAPPMA (the China Aquatic Products Processing and Marketing Association), is in the process of implementing a tracking system<sup>112</sup> similar to that currently employed by the China Customs Administration for tracking product yields.<sup>113</sup> This distinct effect on reducing IUU fishing products processing has been apparent since the system became fully operational as of January 1, 2010.

There are no multilateral treaties specifically relevant to the trade of cod into China for processing. Management of cod stocks is the responsibility of RFMOs such as the North Atlantic Fisheries Organization (NAFO) in the northwest Atlantic; the International Council for the Exploration of the Sea (ICES) and North East Atlantic Fisheries Commission (NEAFC) in the northeast Atlantic; or of national authorities (e.g. in the North Pacific where the governments of Russia, the U.S., and other countries manage cod stocks in their respective EEZs). In addition, two voluntary initiatives by industry to combat IUU fishing for cod in the Barents Sea and in the Baltic Sea are described above in Section 5.3. Efforts toward attaining certification as a sustainable fishery for various cod stocks are described in Section 5.5.1.

The Marine Stewardship Council's sustainability certification program requires strict chain of custody standards to be upheld, and there have been some incidents of facilities in China having their certificates withdrawn due to non-compliance. However, in principle, since CIQ's traceability system requires the same basic principles as the MSC, there should be no fundamental problem for Chinese processors in complying with the MSC's eco-label chain-of-custody requirements. Some China-based fish processing operations are accredited to the British Retail Consortium's (BRC) food safety standard.<sup>114</sup> While this is an important step toward ensuring quality, this standard does relate directly to sustainability issues.

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<sup>112</sup> D.Z. Lee, CAPPMA, personal communication

<sup>113</sup> see Clarke, S. (2009) for a full description

<sup>114</sup> <http://www.brcglobalstandards.com/standards/food/>

## 5.8 Conclusions

### 5.8.1 Traceability

The cod case study is designed to be representative of China's important fish reprocessing trade. In the main, China's role is a mid-chain one, since in most cases it is neither harvesting the fish nor consuming it. The key sustainability issue for China therefore seems to be the extent to which China's handling of the fish allows full traceability between the fishery and the consumer. Establishing such traceability (see Box 5.1 and Box 5.2) allows for market preferences for sustainable products to be transmitted through the supply chain to encourage sustainable harvesting practices. The lack of such traceability breaks the linkage between markets and fisheries, and negates the value of any sustainability policies put in place "downstream" from the point of extraction/catch.

At the moment, there are two separate traceability systems operating in China: the sanitary system managed by CIQ and the new EU catch certificate scheme managed by Bureau of Fisheries (BOF) delegated to CAPPMA. These systems do not appear to be closely linked. The sanitary system is covered in detail in the 2009 TRAFFIC report. The new EU catch certificate scheme is well-understood from the perspective of the EU requirements, but, as it has only been in operation for a relatively short period, the procedures used by China to comply with the EU requirements may require adjustment. This will require thinking that goes beyond merely satisfying the requirements of the EU catch certificate scheme.

There are many sustainability issues which are not necessarily covered by this scheme since it is aimed only at establishing legal provenance based on confirming that the fishing vessel was properly licensed. In addition, there are many imported fish raw materials which are not subject to the EU catch certificate scheme. By focusing only on the EU requirements, China leaves itself open to a range of accusations of "laundering" illegal or unsustainable fish, as was the case several years ago with Patagonian toothfish processing from fish taken in Antarctic waters.

Beyond the EU catch certificate scheme, China needs to consider traceability requirements arising from RFMO catch documentation schemes (tuna and toothfish), potentially CITES (e.g., concerning the on-going debate about the status of Atlantic bluefin) and schemes developed by countries other than the EU, especially with regard to the U.S. China should also consider how to maintain traceability for certified sustainable fish that do not fall under any of the above regulatory systems. In all cases, the key point is to link documentation attached to the shipment at import to documentation attached to the shipment at export. While the provision and use of the information is not China's responsibility, this linkage clearly is. However, at present, the responsibility is split (or perhaps even duplicated) between different government agencies and it appears that some important information is being lost because of the lack of a coherent system to hold it.

Options for China to respond to current and future pressures for traceability of fish supply beyond documentation of legal provenance (e.g. exact species identification, more precise location of catch data, and fishery information such as gear type, etc.) need to be explored and recommendations made in a more fine-grained way, for example, related to fisheries from particular regions, particular fleets, and with greater identification of species. It will be necessary to improve statistical data gathering and to work closely with the seafood processing industry and retailers who increasingly are concerned about traceability. As the CEO of one major North American fish processor mentioned at the latest global seafood conference held in Vancouver in February 2011, the coming five years will be a shift away from past practices and will see emphasis placed on the whole market supply chain's practices.

### **5.8.2 Chinese Processor Participation in Sustainability Certification**

One of the areas for attention is increasing the percentage of Marine Stewardship Council certified re-processed fish handled by Chinese seafood companies. This is particularly a concern for sources from countries such as Russia. It is good that Barents Sea cod and haddock being caught by Russian ships for the Ocean Trawlers Group have been MSC certified since late 2010. Chinese reprocessors could accelerate the demand for certification by setting goals for increases in amount of MSC certified fish and also by expanding the range of processed fish types.

### **5.8.3 Improvements to the Fish Statistical Data System**

At the moment, many problems exist in the Chinese data gathering system, including misidentification of species, problems with accuracy concerning the amount of fish recorded, and the actual origin, and other aspects related to traceability. These are not problems that China can solve on its own, but because the percentage of the world's fish catch moving through China is so high, it is a strategically important country in terms of addressing these issues. It is important to do so for a number of reasons. First, it is essential in order to control IUU. Second, it is the fundamental way to address traceability and, ultimately, contribute to sustainable fisheries management. Third, better statistics will lead to greater confidence and credibility with partners in the market supply chains, especially as they face increasing scrutiny on issues of sustainable, responsible fisheries.

The improvements within China need to be done in a perhaps more coordinated fashion among different agencies, and in a way that not only meets immediate needs and demands from outside countries and bodies such as the EU, but in a way that genuinely builds capacity within China to extract the maximum value out of its information base. This should be considered part of the trend towards scientific development in China.

Statistical data gathering in international fisheries and in the movement of raw product, semi-finished, and fully-processed product requires a lot more cooperation among the international bodies responsible for such monitoring and the actors directly involved in the supply chains. With modern data management tools, it should be possible to be much more precise about these transfers and the process should be much more open and transparent. China should consider a more proactive role because it is involved at such a large scale, and also because it is now developing skills and personnel levels beyond those of many other countries. The question is, why bother? The answer is the same as for any other natural resource commodity. Knowledge of sources and accurate trading information can translate into security of supply and competitive advantage in export product marketing.

#### **5.8.4 Optimizing Social and Economic Benefits of Fish Re-processing**

The remarkable transformation of the world's fish processing brought about by the efficient and inexpensive Chinese seafood processing industry has also brought employment to a substantial number of Chinese workers, even though the actual numbers are difficult to accurately determine. It is likely that the story is far from over. Indeed it would be unfortunate for the industry if it should remain at the current level of sophistication and approach.

There should be considerable potential to move into arrangements where more complete processing takes place in China, with a broader range of value-added projects. This is in line with national priorities. It might also be possible to integrate the domestic market needs with those of international trade, creating even greater scale than now exists. The advantage of doing so would not only relate to the financial bottom line, but could help to expand certification and other sustainability best practices to the domestic marketplace.

Another important matter is working conditions, pay scales and other socially-significant matters pertaining to large fish processing operations. These have not been receiving the same level of external scrutiny as some other sectors such as the electronic assembly plants and some other export-oriented industries. This could change at any time, but even without external drivers, workers will be demanding more in the years ahead—not only in income, but also improvements in health and safety, and amenities important for quality of life including those in the immediate environment of the work place. Making progress on such issues is necessary for the re-processing industry to thrive.

### **5.8.5 Creating Model Environmental Management Programs at Facilities**

Fortunately China has learned to turn what others might consider waste into revenue streams as products. Inedible fish parts are rather fully utilized, including skin, bones, oil, etc. This is a way to meet rising demand for fish meal, and for higher value products such as cosmetics, nutraceuticals, and chemical ingredients. It is a means to reduce pollution in the vicinity of fish plants.

But there is still room for improvements, including building pollution prevention rather than pollution control strategies, reduction in water use, better energy efficiency and consideration of how to implement low carbon practices. In line with the priorities of the 12<sup>th</sup> Five Year Plan fish processing plant operators should consider how their operations could meet environmental objectives that will help to meet targets for reduction of harmful nitrogen compounds, greenhouse gases, and other pollutants.

### **5.8.6 Looking Ahead**

It is encouraging that Chinese large-scale fish processing, as exemplified by cod re-processing, has reached a stage where genuine environmental and sustainable development progress is possible. It is a different industry today compared to a decade ago, and it is fortunate that despite much of the dismal international news about the state of ocean fisheries, there is evidence of the new models such as certification and traceability beginning to take hold, and of modern facilities in tune with the need of demanding markets such as some in the EU. This decade offers the opportunity to make a transition where processing of fish in China will expand and support the global effort for sustainable fisheries.

## 6.0 Live Reef Food Fish Trade (LRFFT) Case Study<sup>115</sup>

### 6.1 Background

The LRFFT supply chain study is quite different in nature from those described in the previous two chapters, involving the import of “live” coral reef fish species, especially grouper (family *Serranidae*) and snapper (family *Lutjanidae*), drawn from the Indo-west Pacific and certain parts of the Indian Ocean, but principally from the Coral Triangle (CT) countries<sup>116</sup> adjacent to the South China Sea.

While LRFF are widely consumed in East Asian countries, they are most well known as a high value food for consumption in the restaurant trade, where demand has historically been concentrated in Hong Kong and southern China. Most LRFF enter Mainland China as re-exports from Hong Kong but there is a growing trade directly from the producing countries to Mainland China. Moreover, the distribution of these fish within China is expanding northward rapidly and there are now burgeoning markets for LRFF in Shanghai and Beijing as well as a number of second-tier cities such as Chengdu (Songlin Wang, personal communication). In addition, there is now a substantial aquaculture trade for some species, including fish cultured in Taiwan and exported to Mainland China. The Live Reef Food Fish Trade (LRFFT), while a comparatively small fishery in terms of volume, is a highly valuable fishery estimated to have a retail value of up to a billion dollars annually according to the WWF.

There has been considerable concern expressed about the sustainability of this trade. Much of the concern emanates from the issue of destructive fishing practices such as the use of cyanide to capture fish, which causes collateral damage upon reefs and other non-target species. However it is the more common issue of overfishing, and particularly the capture and retention of juvenile or undersize fish, that poses the greatest threat to the sustainability of this trade.

The value added within the market supply chain in Hong Kong and Mainland China is at the retail level, since the consumption of these fish is extremely popular at higher-priced seafood restaurants, especially in Southern China and Hong Kong. The fish are consumed at wedding banquets and on festive occasions such as the Spring Festival. During periods of high demand, the wholesale price may rise to over 1400 RMB (about US\$200) per kilogram.

Historically, most LRFF have come from wild-capture but with rapid improvements in breeding and farming technology there is an increasing volume of grouper and snapper species coming to markets

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<sup>115</sup> This case study reflects the combined effort of CAPPMA staff, Dr. Geoffrey Muldoon of WWF-Bali Office and the editorial effort and inputs of Dr. Arthur Hanson

<sup>116</sup> The largest countries in the Coral Triangle Area are Indonesia, Malaysia, the Philippines and Papua New Guinea.



from full-cycle aquaculture (FCA) production. While many of these culture operations are based in the CT countries, mainly Indonesia and Malaysia, Mainland China has started to culture the reef fishes (especially groupers), with an estimated 50 per cent or more of domestic demand being met from cultured fish.

Efforts to reform and transform this trade have been underway for a number of years through various international bodies such as the WWF, The Nature Conservancy (TNC), Conservation International (CI) and national non-government organizations; enabling agencies such as the Asian Development Bank, Worldfish, Australian Centre for International Agricultural Research (ACIAR) and the Secretariat of the Pacific (SPC).

Despite ongoing efforts reduce resource and environmental impacts, success has been limited, and the LRFFT continues to pose major challenges to future sustainable use of this marine resource. There remains a need for a whole chain-of-custody approach that would support responsible fisheries capture and aquaculture through trade mechanisms and market-based initiatives. Various meetings, most recently an Asia–Pacific Economic Cooperation (APEC) sponsored gathering held in Bali in March 2011, have attempted to find solutions involving producers, traders and the LRFFT demand side. Several years ago a voluntary sustainability certification concept was proposed<sup>117</sup>, but uptake to date has been nil. There are concerns that some species such as the humphead wrasse will become very scarce to the point of being listed as endangered under CITES. At present, the grouper fisheries appear to be highly damaging to coral reef ecosystems, so that short-term income gains by fishers, traders and others may lead to longer-term decline and loss of livelihood.

### **6.1.1 Unsustainable Expansion of the Grouper Supply Chain Sources**

Live reef fish species have long been traded in Hong Kong and southern China as a luxury food, and until the 1970s most of the demand was met from nearby waters. As these reefs began showing signs of depletion, seafood traders started to look farther. In the intervening decades, the LRFFT has expanded outward from Hong Kong in an ever-widening arc, with the Coral Triangle now being the major source (Figure 6.1). While the trade promises revenue and wealth to coastal communities it can also bring with it potentially serious environmental, social, and economic impacts.

In comparison to many other fisheries in the region, the LRFFT is small in terms of volume. The regional annual trade in LRFF is estimated to be around 30,000 t<sup>118</sup> compared with tuna exports from the Coral Triangle, estimated to be almost 1 million t annually (WWF). Despite its small volume, however, LRFFT is an extraordinarily lucrative commodity. The estimated value of the

<sup>117</sup> The International Standard for the Trade in Live Reef Food Fish Retrieved from [http://www.spc.int/DigitalLibrary/Doc/FAME/InfoBull/LRF/15/LRF15\\_23\\_Muldoon.pdf](http://www.spc.int/DigitalLibrary/Doc/FAME/InfoBull/LRF/15/LRF15_23_Muldoon.pdf)

<sup>118</sup> Sadovy et al (2003). *While Stocks Last: The Live Reef Food Fish Trade*. Asian Development Bank Studies Series

trade, at least US\$800 million annually, is not much less than the value of tuna exports. The highest level of revenue from catching and selling a reef fish is while it is still alive, earning local fishers in the Coral Triangle as much as 10 times the value of that same fish sold frozen or fresh but dead. The veracity of regional trade estimates, however, is uncertain due to a lack of reliable data from both source and demand countries. A more defensible, although still incomplete,<sup>119</sup> estimate is that of around 16,000 to 18,000 t of LRFF being imported into Hong Kong annually, representing probably around 70–80 per cent of the total regional trade in LRFF (Table 6.1).



Figure 6.1 Expansion of the LRFFT by decade since the late 1970's.

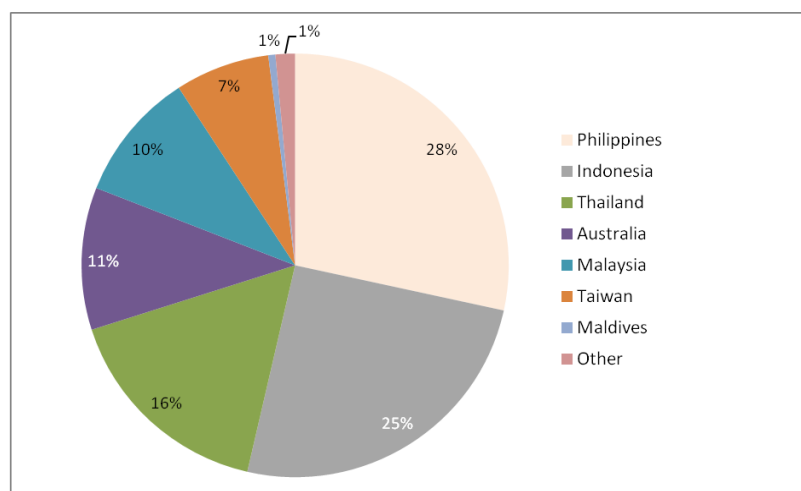
<sup>119</sup> A major reporting loophole exists in Hong Kong whereby registered vessels which import LRFF by sea are not required by law to declare their cargo or its origins. While a voluntary reporting scheme is in place, imports are likely being heavily under-reported (see Section 3, Supply Chain).

**Table 6.1 Imports (tonnes) of Live Reef Food Fish into Hong Kong by Mode of Transport from 1999 to 2009.**

Year	Mode of Transport		Total Imports
	Air/Sea/Road	Fishing Vessel <sup>1</sup>	
1999	9,134	5,600	14,735
2000	9,897	7,225	17,122
2001	9,970	3,870	13,839
2002	10,166	3,007	13,173
2003	10,622	2,841	13,462
2004	10,696	3,954	14,650
2005	11,376	4,345	15,721
2006	11,582	4,092	15,673
2007	10,630	3,411	14,042
2008	8,378	3,059	11,437
2009	8,668	3,644	12,312

<sup>1</sup> Fishing vessel quantities are under-estimated as a result of there being no requirement for Hong Kong registered live transport vessels (LTVs) to declare imports entering by sea. These quantities are thought to capture 30–40 per cent of all shipments of LRFF into Hong Kong<sup>120</sup>

The Coral Triangle countries of Indonesia, the Philippines and Malaysia accounted for almost two-thirds (64 per cent) of all imports into Hong Kong in 2009. Other major source countries of LRFF imported into Hong Kong are Australia, Thailand and Taiwan (see Figure 6.2).



**Figure 6.2 Imports of LRFF into Hong Kong by source country for 2009.**

It is widely acknowledged that a large proportion of these imports are re-exported, with mainland China being the major recipient. Quantities, however, are anecdotal, with the most recent published estimate of 55 to 60 per cent of Hong Kong imports re-exported to mainland China being in

<sup>120</sup> McGilvray, F. and Chan, T.C.C. (2001). *The Trade in Live Reef Food Fish: A Hong Kong Perspective*. International Marinelife Alliance. Hong Kong

2000.<sup>121</sup> This “benchmark” has been disputed by regulatory authorities in Hong Kong, which has in turn been challenged by unofficial market data collected in southern China (WWF Hong Kong, unpublished data). Regardless of the ambiguity of the data sources for this trade, mainland China has been and will continue to be a major stakeholder in this trade.

Careful analysis of reef food fish market supply chains therefore will provide a window into a topic that is likely of growing significance to China. While unsupported by official data, the supply of these fish to southern China clearly has been steadily increasing in recent years, and with increased wealth, demand is likely to increase further. This will place pressure on the current supplies, as well as amplify sustainability concerns, in source countries. China therefore, will be well-placed to influence sustainability outcomes through one of several means.

First, Chinese traders and consumers could seek participation in sustainably produced fish. This could be done in cooperation with Hong Kong restaurants, traders and the fisheries Chamber of Commerce. Certainly if stocks do continue to decline, it will be a “lose-lose” situation at both ends of the market supply chain.

Second, Chinese aquaculture, with its advanced approaches and multiple skills, may be in a position to hasten the transition from wild reef fish to cultivated stocks. Some of this effort could be within Chinese waters, but perhaps there also will be opportunities for initiatives in other parts of the CT regions aided by Chinese R&D, expertise, investment and other inputs.

And third, there is a remarkable opportunity for China to move into a proactive sustainability stance for this particular market supply chain. It is possible because so much of the trade is directed to the Chinese market place (including Hong Kong). If sustainability considerations are neglected in this trade, it will be very easy to point fingers when the decline takes place. However, if there is a proactive and positive outcome, it will protect a valuable market not only by providing benefits to Chinese traders and restaurants, but also by rewarding the primary producers including fishers in coastal communities throughout the CT region.

Thus the study intends to provide recommendations that might be directly beneficial to Chinese participants in the current market supply chains as well as to aquaculture businesses and others able to support innovative approaches that can address unsustainable growth in these supply chains.

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<sup>121</sup> Chan, P. S. W. (2000). “The Industry Perspective: Wholesale and Retail Marketing Aspects of the Hong Kong Live Reef Food Fish Trade.” *SPC Live Reef Fish Information Bulletin* 7:3–7.

## 6.2 Profile of Some Frequently Traded Species

There are many species of reef fish but a relatively small number of target species (see Table 6.2) for the LRFFT, including various groupers, snappers and wrasses. However many other fish species end up as food sources for the LRFF when they are held for periods of time between capture, being traded and transported or, in the case of juveniles, being held in grow-out or aquaculture operations.

The universal Harmonized Code System (HCS) is used in Hong Kong, China to monitor food imports and this was improved in 1997 to identify LRFF categories<sup>122</sup> and refined again in 1999 to enable LRFF imports to be distinguished by key species and country of origin, further improving monitoring capacities.

**Table 6.2 The Principal Species in the Live Reef Food Fish Trade showing FAO's (Common English) names with names used by the Agriculture, Fisheries and Conservation Department (AFCD) and the Census and Statistics Department (CSD) in Hong Kong in parentheses.**

FAO (Common English) Name	Scientific Name	Value	HCS
Humpback (highfin) grouper	<i>Cromileptes altivelis</i>	High	
Humphead (Napoleon) wrasse	<i>Cheilinus undulates</i>	High	
Leopard (leopard) coral grouper	<i>Plectropomus leopardus</i>	High	
Spotted (spotted) coral grouper	<i>Plectropomus maculatus</i>	High	
Squaretail (squaretail) coral grouper	<i>Plectropomus areolatus</i>	Medium	
Spotted (spotted) coral grouper	<i>Plectropomus maculatus</i>	Medium	
Giant (giant) grouper	<i>Epinephelus lanceolatus</i>	Medium	
Brown marbled (tiger) grouper	<i>Epinephelus fuscoguttatus</i>	Medium	
Camouflaged (flowery) grouper	<i>Epinephelus polyphekadion</i>	Medium	
Orange-spotted (green) grouper	<i>Epinephelus coioides</i>	Low	
Hong Kong (red) grouper	<i>Epinephelus akaara</i>	High	Other grouper
Malabar (Malabar) grouper	<i>Epinephelus malabaricus</i>	Low	Other grouper
Greasy (greasy) grouper	<i>Epinephelus tauvina</i>	Low	Other grouper
Duskytail (duskytail) grouper	<i>Epinephelus bleekeri</i>	Low	Other grouper
Red or Mangrove Snapper	<i>Lutjanus Argentimaculatus</i>	Low	

This table has grouped these main species by value (high, medium, low) with the highest priced fish being the humphead wrasse and the humpback grouper followed by the leopard and spotted groupers. Section 6.4 will present more detailed market trend information (wholesale and retail prices, volumes traded, source countries) for selected LRFF species.

While humphead wrasse and the humpback grouper are the most valuable fish traded, collectively they represent less than 1 per cent of total LRFF imported into Hong Kong, while the next most valuable species, the coral trout species (*Plectropomus spp*) has historically accounted for more than 20

<sup>122</sup> Prior to 1997, data were very coarse, with both marine and freshwater live fish categorized broadly as either food or ornamental fish.

per cent of the trade, increasing in recent years to more than approximately 30 per cent of all fish traded (Figure 6.3).

Based on these data, along with advice of experts familiar with both China and Southeast Asian fisheries,<sup>123</sup> a sensible candidate and industry “bellwether” is the leopard trout or leopard coral grouper (*P. Leopardus*). The species is widespread in East and Southeast Asia (see Figure 6.4) and is listed as “Near Threatened” under the IUCN Red List within some parts of its range due to overfishing and declining trends in fish populations. The main sources of this fish for the market (in order of importance) are: the Philippines, Indonesia, Australia and Malaysia which collectively account for more than 95 per cent of all imports into Hong Kong.

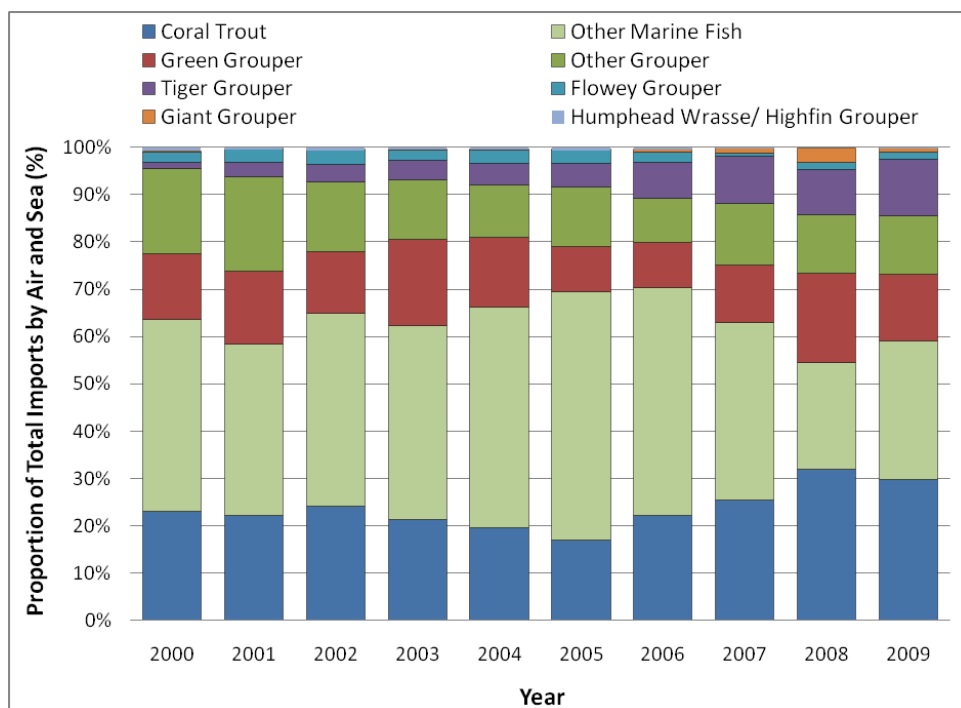


Figure 6.3 Volume of target species traded as a percentage of total LRFF imported into Hong Kong for the years 2000 to 2009 (Source AFCD and CSD).

<sup>123</sup> These include Dr. Meryl Williams, an advisor to the MOFCOM-IISD initiative and coordinator of Asia Fish-Watch and Professor Yvonne Sadovy, the Chair of the IUCN Groupers and Wrasses Specialist Group

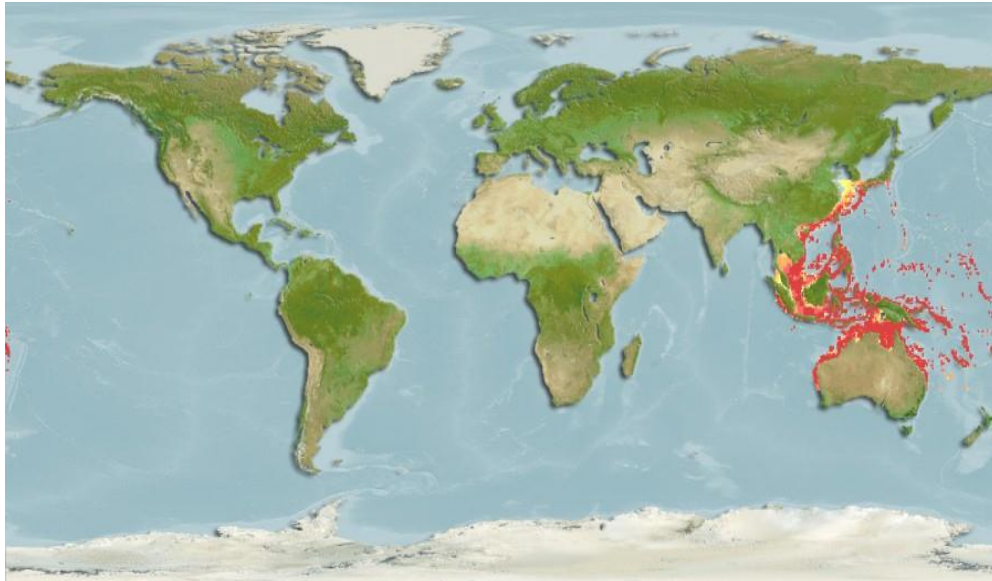


Figure 6.4 Distribution (Red) of Leopard Coralgrouper (*Plectompus leopardus*) (Source: Fish Base).

### 6.3 Status of Grouper Production and Distribution

Live reef fish for consumption are now sourced from more than 20 countries, although the majority of trade can be accounted for from a handful; Indonesia, the Philippines, Australia, Malaysia, Thailand, and Taiwan. Historically, small and infrequent shipments of LRFF have been exported from the Maldives, Seychelles, Papua New Guinea, Marshall Islands, the Solomon Islands and Fiji although political, operational and transport difficulties have tended to beset the trade in these countries<sup>124</sup> (Figure 6.5).

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<sup>124</sup> Shakeel and Ahmed (1997); Smith (1999); McGilvray and Chan (2001)

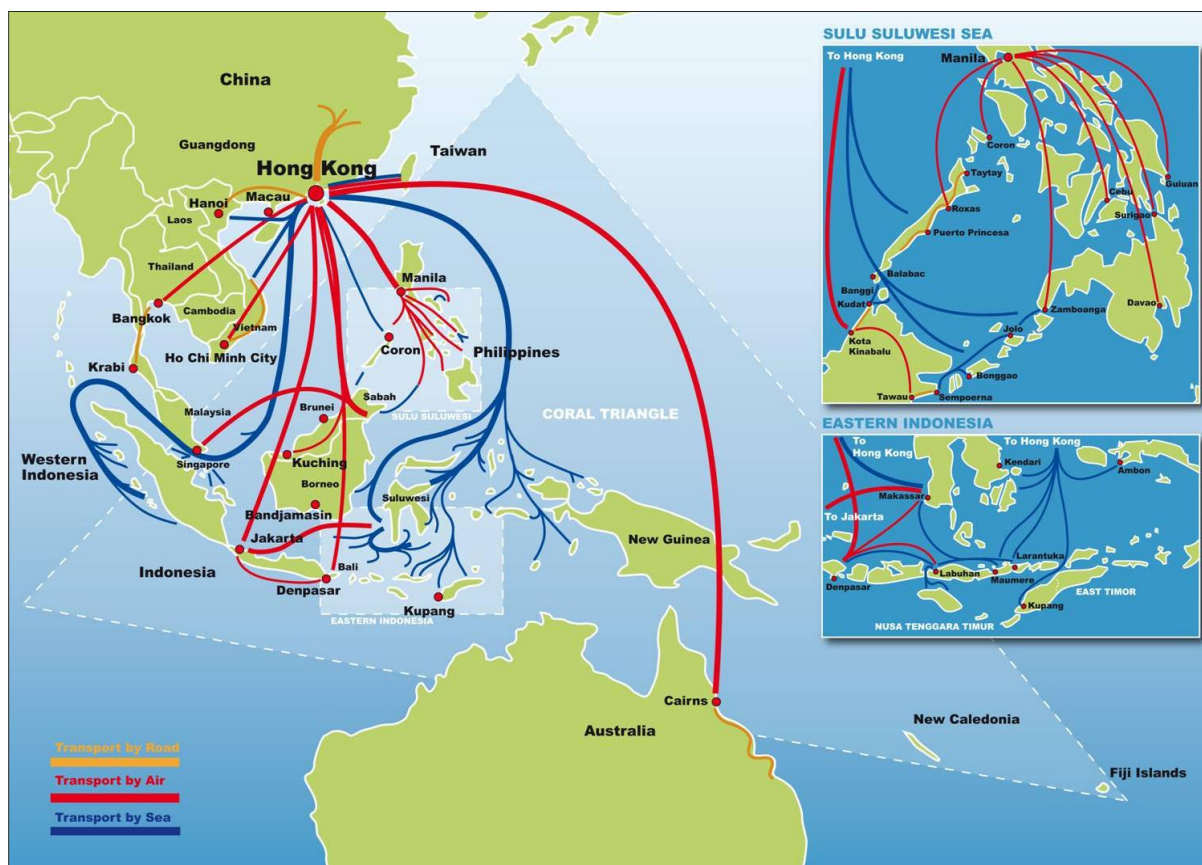


Figure 6.5 Map showing the major source countries and trading routes, (by Air, Sea and Land) of Live Reef Food Fish into Hong Kong and mainland China.

There is a large transboundary movement of fish between the Philippines and Sabah. It is estimated that up to 90 per cent of LRFF traded in Semporna in eastern Sabah are caught in southern Philippine waters around Mindanao and Tawi Tawi, while up to 80 per cent of LRFF traded in Kudat in western Sabah are coming from central and southern Palawan in the Philippines.<sup>125</sup> These transboundary movements need to be taken into account when examining export trends from Malaysia as these Filipino “imports” are recorded as exports “from” Malaysia into Hong Kong (see Section 6.4).

The regional nature of the trade and the transborder movement of commodities and income can negatively impact coral reef ecosystems, while national efforts will only deal with sustainability issues

<sup>125</sup> Daw, T. (2002). *Preliminary Assessment of the Live Reef Fish Trade in the Kudat Region*: Final Technical Report. WWF Malaysia. Suliarsa, M.S. (2002). *Understanding the Live Food Fish Trade: A Preliminary Assessment in the Semporna and Tawau Area*. Final Technical Report. WWF Malaysia. Muldoon, G.J. (2007) *The Live Reef Fish Trade in the Sulu-Suluwesi Marine Ecoregion: A Trade Scoping Study*. Final Technical Report. WWF Indonesia.



on the supply side and at a country level. The pressure to meet growing consumer demand is persistent, and initiatives must embrace the entire supply chain, which requires regional and transnational efforts.

The demand for LRFF is leading to what many believe is heavy over-exploitation of target species. In some parts of the Coral Triangle, localized depletions have occurred to the extent that the trade is no longer economically viable<sup>126</sup> while in other areas evidence of overfishing of target stocks is clear.<sup>127</sup> While the catchment area for the LRFFT has radiated outward since the 1970's (Figure 6.1), it has also moved progressively through national waters, systematically depleting localized stocks before moving onto new fishing grounds. In Indonesia there has been a gradual movement of fishing activity from the west (West Java, Southern Sumatra) to the east, as far as West Papua, while in the Philippines the move has been in a north to south direction, such as along the island province of Palawan.

And yet data on the rates of exploitation of reef species for the LRFFT are limited. In the face of a paucity of data, the issue of sustainability may be best addressed through estimating yields by reef area. Potential yields of grouper species from reefs in moderate condition are estimated to be approximately 0.4 tons per km<sup>2</sup>. Using estimates of the total reef area of the Indo-Pacific region and grouper production, overall grouper yields were estimated at 0.5 tons per km<sup>2</sup>. Taking into account the relative intensity and geographic location of most fishing efforts, however, the average grouper yield is estimated to be closer to 2 tonnes per km<sup>2</sup>, well above what would be considered sustainable.<sup>128</sup>

Presently, trade agreements between Hong Kong and mainland China mean lower tariffs imposed on LRFF entering PRC through Hong Kong.<sup>129</sup> However, when LRFF enter mainland China directly, limited capacity presently exists to record and monitor these imports.

## 6.4 Structure of the Grouper Supply Chain

To understand grouper supply chains, production is examined from both wild-capture and aquaculture sources. Wild-caught grouper tend to be mainly harvested by non-Chinese national fishermen, but may be transhipped in whole or in part by Chinese vessels. For cultured groupers, China is the world's largest producer of "low-value" grouper species, almost all of which would be

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<sup>126</sup> Examples are northern Palawan province in the Philippines and Berau District, East Kalimantan in Indonesia

<sup>127</sup> Scales, H., et al. (2007). Impacts of the live reef fish trade on populations of coral reef fish off northern Borneo. *Proceedings of the Royal Society B* (274), 989–994

<sup>128</sup> Sadovy et al. (2003). *While Stocks Last: The Live Reef Food Fish Trade*, Asian Development Bank Studies Series

<sup>129</sup> In contrast to the PRC mainland, which imposes a tariff of 12 per cent on food imports, Hong Kong, China is a tariff-free port. Moreover, LRFF entering PRC through Hong Kong, China attract a tariff of only 3 per cent.

for domestic consumption but there would still be some grouper species from aquaculture that have been imported.

The grouper supply chain for wild-caught species and for non-mainland-China-cultured product consumed in mainland China can be considered in two distinct stages. The first stage, which is well documented, is from the fishing grounds in source countries to the point of arrival in Hong Kong, which itself is a major consumer of LRFF. The next stage of the supply chain from the point of entry into Hong Kong, via air or sea shipment, into restaurants in Hong Kong or for re-export into and distribution throughout mainland China is less well understood (Figure 6.6 provides a schematic overview of the various market supply chains). In this diagram, *Coordinator* describes the first collector of LRFF from the fisher and who usually operate at or near the fishing grounds, particularly when remote from major transit hubs while *Collector* describes the second buyer who is responsible for transshipping fish to the point of export, and *Exporter* refers to the agent responsible for transporting LRFF to consumer markets.

Because many fishing grounds for LRFF are remote and distant from major markets, and supply chains are complex, custody of the fish will pass through many different agents before reaching their final destination—mainly restaurants. The market chain can be shorter in some countries than in others. The supply chain originates with fishers who catch fish using preferably hook-and-line but also other means including poisoning with cyanide and use of explosives. They sell their catch to coordinators and collectors who consolidate catches near the fishing grounds in holding pens (ranging from floating sea cages to land-based tanks).

Fish too small for market are kept in floating cages and “grown-out” until they reach marketable size (i.e. 500–600 grams) while “good” size fish are transferred to hubs for export to demand markets, either by sea or air, with the mode of transport dictated by the opportunity to access air transport and the value of the fish.<sup>130</sup> Based on available data, more than 70 per cent of all LRFF imported into Hong Kong are transported by air, although this is higher in some countries (e.g. Australia, the Philippines) where nearly all LRFF exports are delivered by air (Figure 6.7). Proportions also differ by species, with more than 95 per cent of leopard coral grouper transhipped to Hong Kong by air as compared with around 50–60 per cent for lower value species such as green and tiger grouper.<sup>131</sup> The reliability of these estimates is questionable, due largely to there being no requirement for Hong Kong registered live transport vessels to declare their imports. Despite the AFCD having a

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<sup>130</sup> For higher value, more abundant species such as leopard coral grouper and various epinephelids and even juvenile humphead wrasse the preference is to use air transport to maintain fish health and quality although many are transported by sea in remote areas such as eastern Indonesia or in order to transport LRFF unreported or illegally. Lower value cultured fish are often transported by sea due to economic considerations.

<sup>131</sup> Hong Kong AFCD and Hong Kong Census and Statistics Department, 2009.

voluntary declaration system in place, it is regarded that estimates of LRFF imports into Hong Kong via fishing vessels capture only 30–40 per cent of all sea shipments.

Those LRFF remaining in Hong Kong are reconditioned for further short periods before being passed onto wholesalers and retailers (e.g. restaurants) for purchase and consumption by a consumer at home or display in tanks before being purchased by the consumer. Those LRFF being re-exported to mainland China may be transhipped by air, by road or by sea, although sea transport is widely seen as the most widespread means of transportation (see Section 6.3).

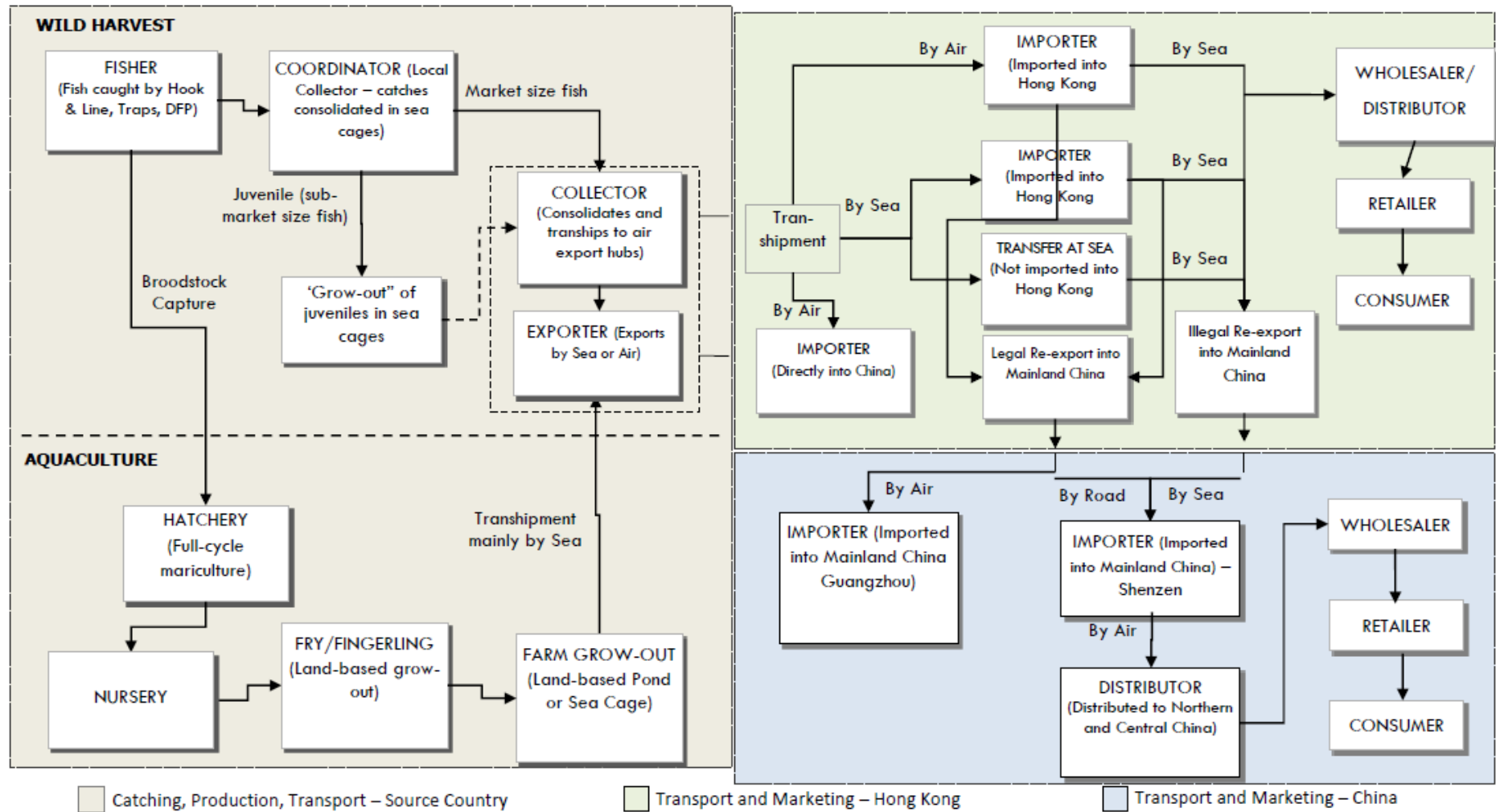
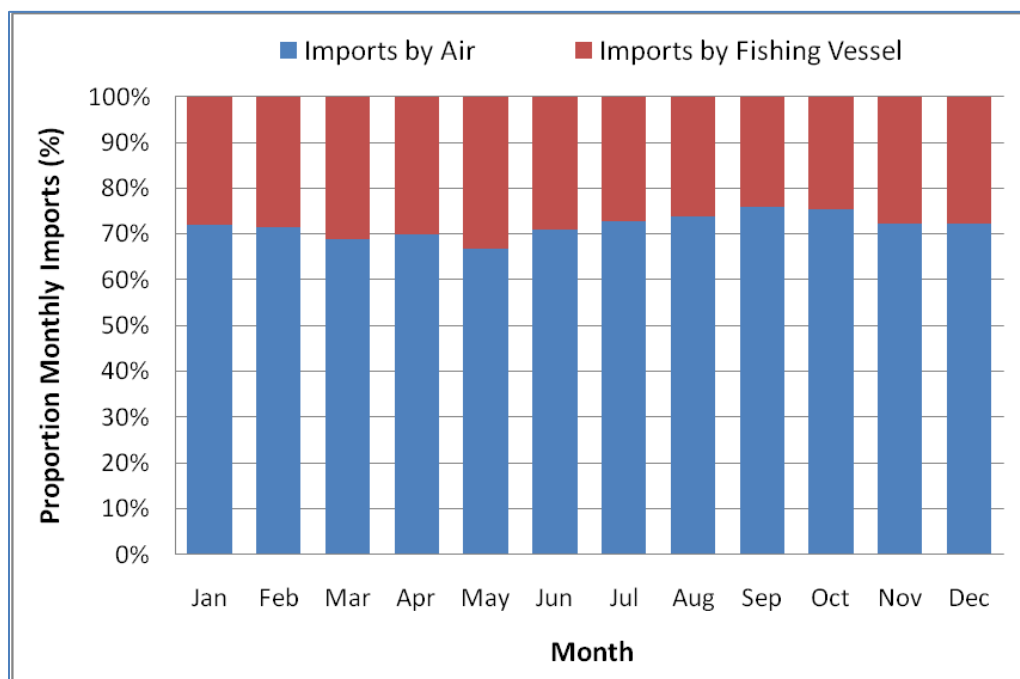


Figure 6.6 Supply chain component linkages for aquacultured and wild-caught live reef food fish from source countries to Hong Kong and mainland China



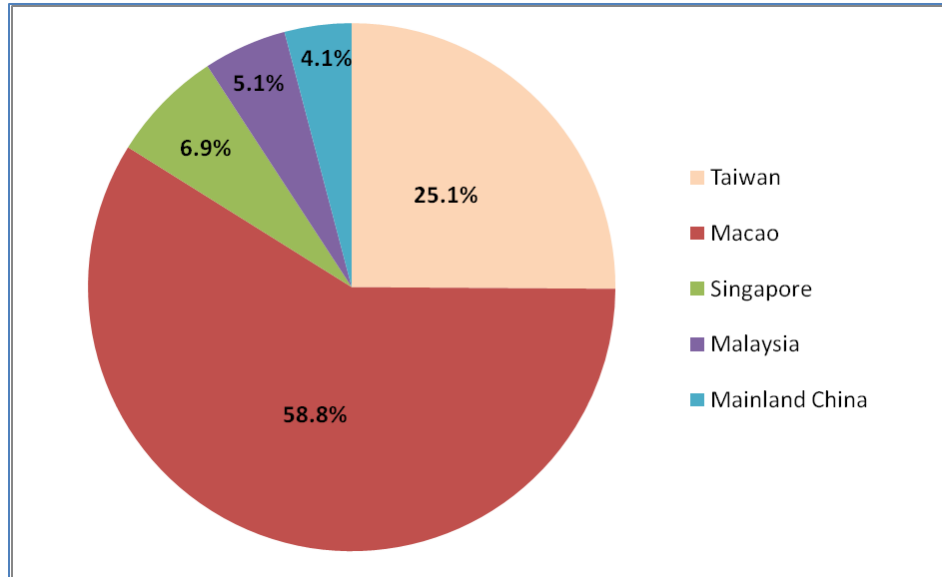
**Figure 6.7** The proportion of total “recorded” LRFF species imported into Hong Kong arriving by sea or by air  
 Source: Hong Kong AFCD and CSD, 2009

### 6.5 Re-Export of LRFF to Mainland China

The only known records of re-exports of LRFF to mainland China are retained by the AFCD; however, these are considered to be unreliable estimates. Compounding the unreliability of these data is the route by which most LRFF are thought to enter mainland China. For those LRFF imported into Hong Kong, most are “re-exported” to mainland China using widely acknowledged informal or “unofficial” trading routes—transported by sea across the border to Yantian and then by road to Shenzhen before distribution throughout China (historically mainly to Guangzhou but increasingly to Beijing and Shanghai). Furthermore, there is an “unknown” quantity of LRFF shipped from source countries which are transferred at sea, just before entering Hong Kong waters, to vessels bound for mainland China.

According to the AFCD, “official” re-exports of LRFF to mainland China account for only 4 per cent of all re-exports, with the main destination ports being Macao and Taiwan (Figure 6.8). However, market interviews conducted by WWF Hong Kong in Shenzhen suggest a somewhat different breakdown. Based on recorded imports into Hong Kong of roughly 3,600 t of leopard coralgroupers in 2009, approximately 20 per cent of these can be accounted for from an estimate of

trading volumes given by a small sample traders in Shenzhen;<sup>132</sup> suggesting that the estimate of 50–60 per cent of Hong Kong imports being re-exported to mainland China may be reasonable.



**Figure 6.8 Re-exports of Live Reef Food Fish from Hong Kong to major destinations for 2008**

Source: Hong Kong AFCD and CSD, 2009.

Trade agreements between Hong Kong and mainland PRC have meant lower tariffs on LRFF entering PRC through Hong Kong than on those entering PRC directly. While the PRC has now joined the World Trade Organization (WTO) and is entering into bilateral and multi-lateral Free Trade Agreements (FTAs), which will significantly reduce tariffs, these have yet to take effect making Hong Kong still the most attractive option for trade with mainland China. Despite this and with LRFF entering mainland China continuing to attract a tariff of 12 per cent, there remains a strong incentive to avoid this charge.<sup>133</sup> At present, there is limited capacity to record and monitor such imports or trade between Hong Kong, China and mainland PRC and given the relative insignificance of the LRFFT compared with other traded seafood commodities (e.g. Cod, Pollock, Tilapia, Shrimp), more needs to be done to mobilize Chinese government authorities to eliminate these loopholes. At present the traceability of product within China is difficult, especially in the rigorous fashion required for an internationally compatible approach such as might be found in a certification system.

<sup>132</sup> Shenzhen is regarded as the gateway to mainland China with Hong Kong remaining the major import hub. Based on market research conducted by WWF in Hong Kong, the routes of LRFF are considered to be:

- ⇒ From Hong Kong to Shenzhen then Guangzhou and from Guangzhou to Shanghai and Beijing
- ⇒ From Hong Kong to Shenzhen then directly to Shanghai and Beijing.

<sup>133</sup> There was a recent clampdown by Chinese/Hong Kong authorities regarding declaration of imports and subsequent payment of applicable import duties for seafood products being transhipped into mainland China via Hong Kong, including lobster and LRFF but we are not aware of the latest developments on this.

## 6.6 Vertical and Horizontal Cooperation

While horizontal cooperation at various stages along the chain does occur, vertical cooperation, or integration, in fishery chains usually reflects: perishability of the product; variability in product quantity and quality; consumer awareness of product quality; and economies of scale. Key objectives of vertical cooperation in the market chain include: increasing profits through greater market share, improved product quality and product branding. An example would be higher prices paid for Australian LRFF in Hong Kong markets because of its high quality and consistency of supply. Within the LRFF trade, opportunities for vertical cooperation exist for both the wild-caught and aquaculture sectors. Vertical integration along the market chain for wild-caught LRFF usually occurs at the collection/export stage of the source country supply chain and the import/distribution stage of the import country supply chain (Figure 6.9).

These vertical relationships tend to hinder efforts to identify the distribution of final product value along the market chain and, ultimately, to understand pressure points and bottlenecks where market incentives can be targeted to achieve sustainability outcomes. Market structures in developing country fisheries, such as the LRFF, with complex market chains tend to be fixed such that reducing vertical links in the chain to benefit small-scale fishers is unlikely to be possible.<sup>134</sup> Also, governance and distributional outcomes are often skewed toward agents, such as wholesalers and exporters, thereby marginalizing small-scale fishers.

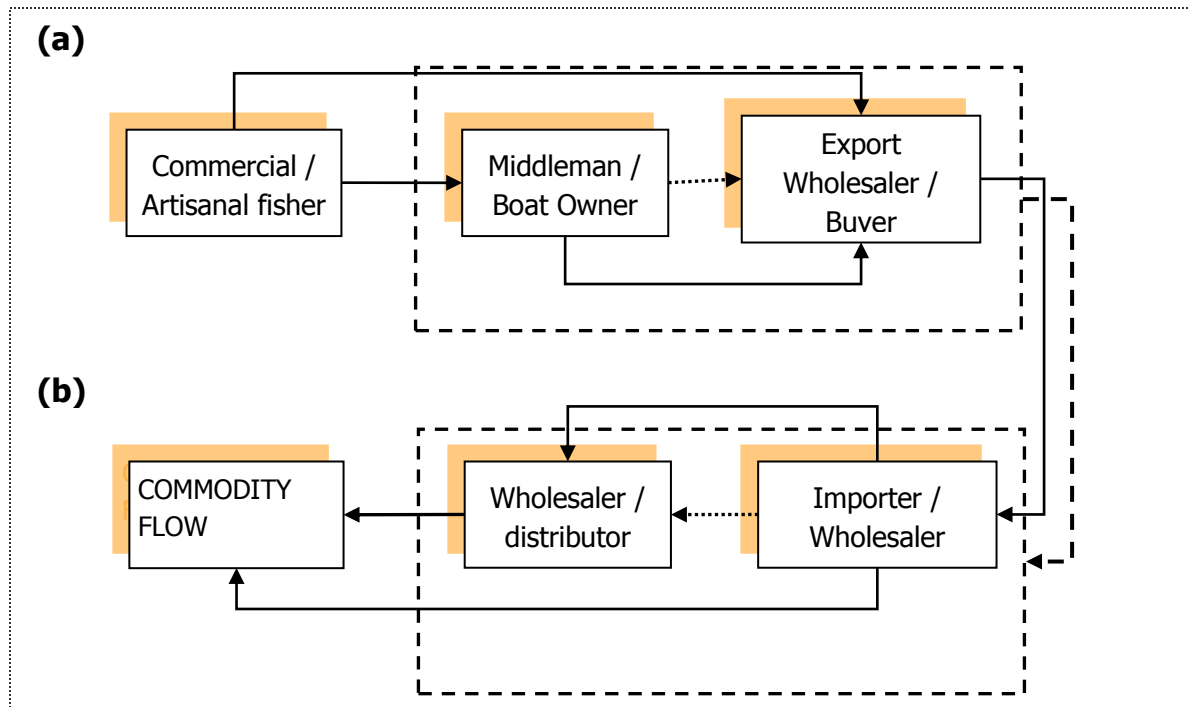
Although horizontal cooperation could occur at various stages along the market chain for LRFF and could enhance bargaining power and lead to improved returns, significant obstacles and barriers remain to its effective implementation including limited access to credit and information. Because it is a secretive and collusive industry, however, perhaps the most intractable barrier to LRFF reform is that of access to markets. In most countries, the LRFF typically operates as an oligopsony whereby traders act as both collector and exporter. In many cases, the wholesaler in Hong Kong, who sells direct to retailers, may directly or indirectly own or finance trading stations in source countries, thereby effectively controlling the entire market chain from point of production to point of consumption. Often credit is provided to fishers in the form of gear and other resources with this patronage arrangements consigning fishers to a cycle of debt and obligation from which they cannot escape. Fishers who are not beholden to traders in this way may have stronger bargaining rights.

Another obstacle arises from the fact that the considerably higher prices paid for LRFF tends to make fishers more opportunistic, serving as a disincentive for cooperation on sustainability efforts.

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<sup>134</sup> MacFadyen G. et al. (2003). Background Paper on the International Seafood Trade and Poverty. Report prepared under the EC-PREP project (EP/R03/014). *International Seafood Trade: Supporting Sustainable Livelihoods among Poor Aquatic Resource Users in Asia*. Poseidon Aquatic Resource Management Ltd (UK).

A final obstacle is the highly inelastic supply of fishing effort in LRFF fisheries.<sup>135</sup> Fluctuations, or expected changes in prices, would, in normal circumstances, influence fishing effort and hence catch rates,<sup>136</sup> but the artisanal and subsistence nature of the fishery, coupled with a highly over-exploited stock,<sup>137</sup> suggests the impact of “price” *per se* on production decisions will be minimal<sup>138</sup> (Wohlgenant 2001).



**Figure 6.9 Supply chain model for wild-caught live reef food fish for (a) the supply or export and (b) the demand or import sectors of the market chain. The dashed boxes at export and import stages along the chain and the dashed line between these stages indicate potential vertical linkages between market chain agents.**

## 6.7 Illegal, Unreported and Unregulated (IUU) Fishing

For Illegal, Unreported and Unregulated (IUU) fishing the focus is often on the “illegal” aspect but it comprises *illegal* fishing activity conducted by national or foreign vessels, *unreported* fishing activity

<sup>135</sup> The highly inelastic supply of effort is typical of zero opportunity cost fisheries that prevail in developing countries whereby there are few alternative sources of income and certainly none as lucrative as the LRFT.

<sup>136</sup> Because LRFT target species have been heavily depleted in the region, the fishery is operating well beyond maximum sustainable yield and catch is thus also likely to be inelastic (Copes, 1972).

<sup>137</sup> Many reef-based fisheries of South-East Asia are considered to be at the stage of ‘Malthusian’ over-fishing, in which immature fish form a large proportion of the total catch (Munro, 1996).

<sup>138</sup> Seasonal (monsoonal) factors have a great bearing on the allocation of effort (See section 3.4).



that has not been reported (or has been misreported) and *unregulated* fishing activity carried out by vessels without nationality, or that are flying the flag of a state not party to an organization<sup>139</sup>.

The major aspect of IUU relevant to the trade is unreported fishing (non-reporting or misreporting and under-reporting of fish catch) associated with the collection of LRFF from within provincial or national jurisdictions of source countries (i.e. Indonesia, the Philippines and Malaysia) and their subsequent export to markets in Hong Kong and mainland China. Considerable illegal fishing associated with the LRFF is also conducted by national vessels in the form of blast-fishing and use of poisonous substances such as sodium cyanide, which in addition to impacts on target species also damages coral reefs. Foreign fishing vessels are also known to be involved in illegal fishing activities. According to a recent APEC Fisheries Working Group report on IUU fishing in the Sulu Sulawesi Sea, retained statistics on IUU fishing are a gross underestimate.<sup>140</sup>

Both Meere and Lack (2008) and Palma and Tsamenyi (2008) concur on the factors contributing to the prevalence of IUU in the region, which have great relevance to the LRFF. Overfishing is cited as one of the foremost causes of IUU fishing, motivating incursions from fishing fleets from economies with already overfished resources seeking to maintain catches by fishing illegally in the waters of nearby countries, adding further to fishing pressure and the likelihood of overfishing in those waters. But it is the combination of many factors that make IUU a profitable and relatively low risk activity.

In the case of the LRFF, IUU persists due to: economic incentives such as increasing demand for seafood, particularly in mainland China and rising prices for an already high-value luxury commodity; weak governance and MCS capabilities and poorly resourced domestic fisheries management; plus limited employment and livelihood opportunities among coastal fishers and subsidies both in source and demand countries. Socio-political and economic conditions reinforce weak governance outcomes and provide fertile ground for corruption in relation to fisheries management and fisheries access arrangements. All these factors entrench unregulated fishing and encourage ongoing unreported, under-reported or misreported LRFF shipments from municipal waters to markets.

Perhaps the most important example of the IUU problem is that of the humphead wrasse (HHW), a threatened species listed under Appendix II of the Convention for International Trade in

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<sup>139</sup> Meere, F. and Lack, M. (2008). *Assessment of Impacts of Illegal, Unreported and Unregulated (IUU) Fishing in the Asia-Pacific: A report for the APEC Fisheries Working Group*.

<sup>140</sup> Palma, M.A., and Tsamenyi, M. (2008). *Case Study on the Impacts of Illegal, Unreported and Unregulated (IUU) Fishing in the Sulu Sulawesi Sea*. Report to the APEC Fisheries Working Group.

Endangered Species (CITES).<sup>141</sup> As an extremely expensive fish—it can sell for upwards of US\$265/kg at wholesale<sup>142</sup>—for which trade is restricted, there is tremendous incentive for IUU fishing of HHW, which occurs mainly in Indonesia where licensed fishing vessels enter municipal waters to collect HHW for shipment directly to Hong Kong or mainland China. Anecdotal reports describe an extensive export trade of undersized (juvenile) fish from Indonesia (i.e., < 1 kg), with as much as 90 per cent of all harvested species captured using cyanide while practices such as improper use of export licenses, inadequate inspection protocols at both source and demand end of the supply chain and poor MCS relating to enforcement of CITES all contribute to the extensive IUU fishing of this species in remote eastern Indonesia. Interestingly, it has been suggested that if there were to be an effectively enforced moratorium or ban on exports of HHW, sea transport of LRFF to Hong Kong and mainland China from eastern Indonesia would cease, as it is only the lucrative trade in HHW that makes this shipment of LRFF from this area viable.<sup>143</sup>

## 6.8 Current Situation and Market Trends

### 6.8.1 Global Production Levels

Global production of all groupers (see Figure 6.10 for production between 1950 and 2009), including those for non-live markets and consumption, is estimated by FAO to be 226,000 t in 2009,<sup>144</sup> but, given underreporting and the subsistence nature of many reef fisheries, this is likely to be a considerable underestimate of actual landings. The major grouper fishing nations of relevance and their landings are China (86,000 t), Indonesia (65,000 t), the Philippines (18,000 t), and Malaysia (9,000 t) with the trend in all these countries being one of increasing reported landings since the 1980s.<sup>145</sup> The vast majority of landings reported to FAO are of dead rather than live fish.<sup>146</sup> Of note is that Sadovy et al. (2003) estimated additional landings from LRFF fisheries (including culture), not captured by FAO, of 53,000 t in 2001.

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<sup>141</sup> CITES Appendix 2 species are those which may be threatened with extinction unless trade is subject to strict regulation.

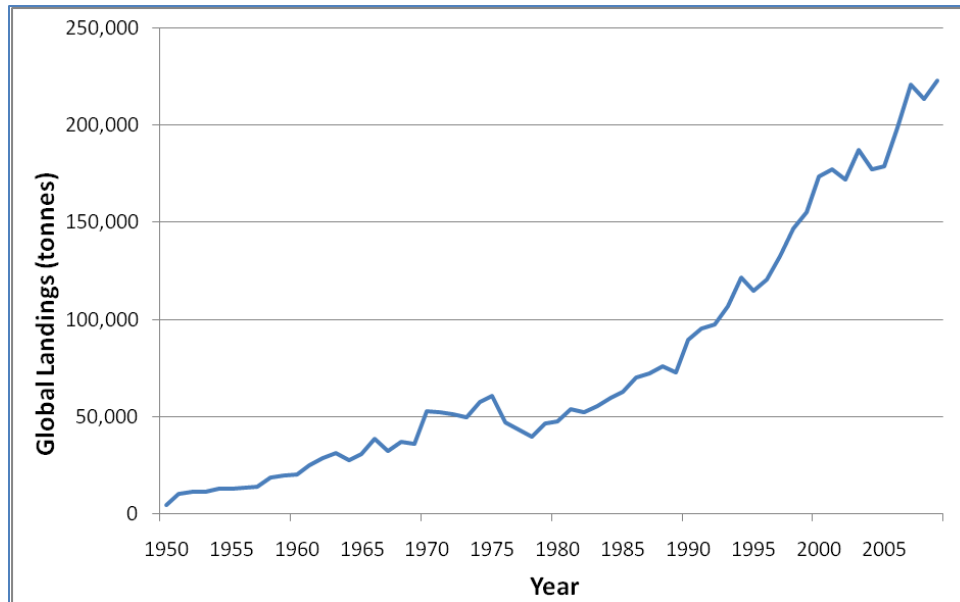
<sup>142</sup> This price is from the Jing Shen Wholesale Market in Beijing (Mike Fabinyi, personal observation). Historically in Hong Kong, retail prices can be as much as 70–80% higher than wholesale prices.

<sup>143</sup> Personal observation (Heru Purnomo)

<sup>144</sup> FAO Fishstat Database.(2010). *Capture Production (1950-2009) and Commodities and Trade Databases (1976-2008)*. FAO, Rome.

<sup>145</sup> China began reporting only in 1990.

<sup>146</sup> On assumption that LRFF capture fisheries data are excluded from FAO data but LRFF cultured output is included in FAO data and total wild-caught live grouper “production” including mortalities was 53,000 t.



**Figure 6.10 Annual reported landings of groupers in the Eastern and Western Indian Ocean and Pacific Northwest, Southwest and Western Central Oceans from 1950–2009**

Source: FAO Fishery Information Data and Statistics Unit

### 6.8.2 Chinese Production Levels

China only began reporting production statistics to the FAO in 1990. In 2009, China reported a six-fold increase in grouper production from 1990, with this production likely to be almost entirely from aquaculture. In that same time, Hong Kong’s production of grouper, also mainly from aquaculture, has from the late 1990’s remained steady at around 1,000 t annually.

Most of the grouper production, for both mainland China and Hong Kong coming from aquaculture, would be of lower value species, and it is assumed is mainly for domestic consumption at home as opposed to the more lucrative restaurant trade. The high-value target species being sought for the restaurant trade would be mainly imported from the Coral Triangle countries of Indonesia, the Philippines and Malaysia.

## 6.9 Major Source Markets

Quite extensive studies have been undertaken in the past half decade after a flurry of earlier work that resulted in reports such as the major study published in 2003 by the Asian Development Bank (*While Stocks Last: The Live Reef Food Fish Trade*). The most careful analytical work has been through work carried out Geoffrey Muldoon and William Johnston through a major study involving researchers throughout the region and undertaken through the Australian Centre for International

Agricultural Research.<sup>147</sup> This work was published in 2006 and 2007. It therefore does not have the latest trends in growing demand for reef food fish in China. The most comprehensive overview paper is by Muldoon and Johnston (2006), Market Chain Analysis for the Trade in Live Reef Food Fish. This paper provides a good overview from an economics viewpoint of the trade, include analysis of transportation. It does not cover sustainability aspects but does try to take into account the artisanal fisheries nature of much of the trade. The paper is accessible at [http://www.aares.info/files/2006\\_muldoon.pdf](http://www.aares.info/files/2006_muldoon.pdf)

Figure 6.11 shows statistics on wild and farmed fish entering China or produced in China based on estimates from Chinese sources. These statistics likely do not represent the entire picture, but do demonstrate the importance of aquacultured fish.

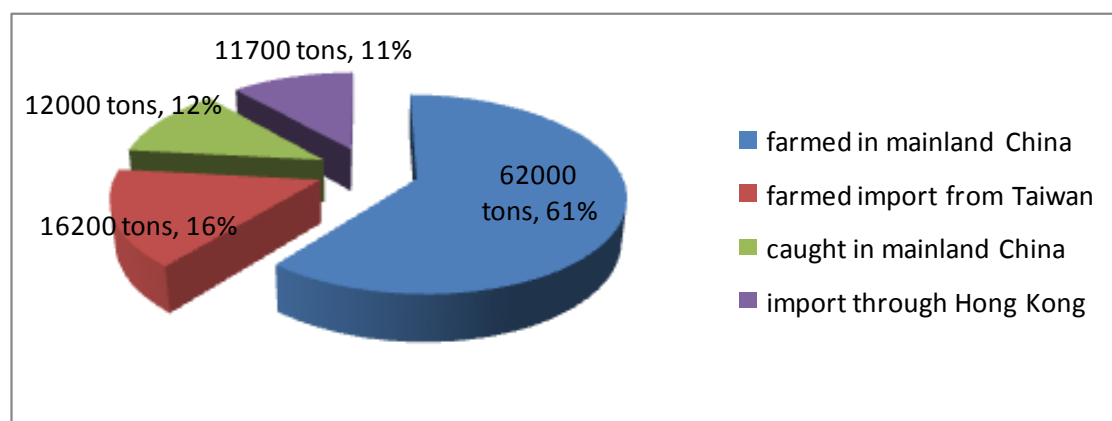


Figure 6.11 Coral reef food fish in mainland China and Hong Kong.

### 6.9.1 Aquacultured Species and Distribution

Japan first began to research the breeding and farming of CRFF in the 1960s. In the 1970s, Southeast Asian countries, Australia, China and Taiwan all started to carry out research work in LRFF artificial propagation technology. At present, the main breeding species include: orange-spotted grouper, brown-marbled grouper, malabar grouper, banded grouper, giant grouper, Hong Kong grouper, longtooth grouper, duskytail grouper, small-toothed rockcod, red-spotted rock cod and *miniatus* grouper, etc.

At present, China has exploited and farmed more than 10 species of LRFF. The main farming species of each province is different because littoral water environments are not the same. Table 6.3 shows the main farmed CRFF species in coastal provinces of South China.

<sup>147</sup> ACIAR Working Reports Number 60 and 63.

**Table 6.3 Farmed species of LRFF in South China coastal provinces.**

Province	Farmed Species
Zhejiang	Banded Grouper, Hong Kong Grouper
Fujian	Banded Grouper, Hong Kong Grouper
Guangdong	Malabar Grouper, Duskytail Grouper, Giant Grouper Brown-marbled Grouper, Orange-spotted Grouper
Guangxi	Banded Grouper, Hong Kong Grouper, Arrowtooth eel, Duskytail Grouper, <i>Epinephelusfario</i>
Hainan	Brown-marbled Grouper, Giant Grouper, Malabar Grouper, Banded Grouper

LRFF aquaculture in Taiwan is centralized in the south—Tainan County, Tainan City, Gaoxiong County, Gaoxiong City and Pingdong County. They contributed 90 per cent of the total production. The main species is banded grouper.

### Farming Mode

There are four modes of farming CRFF: traditional cage, pond, big deep water net-cage, and factory.

- Traditional net-cage cultivation is also called raft culture, which is the main mode adopted at present for its low one-time investment.
- Above sea level in-pond cultivation has better outcomes. In Fujian, Guangdong, Hainan and some other places, it is common to use former higher-level shrimp ponds to farm LRFF. This mode offers higher food conversion ratios, and lower risk by avoiding typhoon and red tide damage.
- Large net-cage cultivation in deep water is a new farming mode started in recent years. It can help to expand the farming area into more open waters. Using this mode to farm CRFF not only permits faster fish growth and higher quality product, but also degrades residual feed and feces to protect the environment.
- Factory style cultivation involving recirculating water aquaculture is widely used in South China coastal areas. This mode has the character of high output, quick returns and reasonable environmental effects.

### Differences between Farmed and Captured LRFF

Generally speaking, the price of wild-caught fish is 10–20 per cent higher than farmed, but sometimes the price gap is not obvious. It is difficult for the average consumer to separate captured fish from farmed fish based on exterior appearance. Insiders say that the differences are mainly related to colour, shape and taste. Captured live fish are worth more when directly marketed than if caught under-size and grown-out, when body colour may be faded. The fish shape is also significant.

The fully farmed fish have a fat abdomen from feeding heavily, while the leaner captured fish has a better taste. However, dealers prefer farmed products because of ease of transport, even size and other characteristics such as ability to be produced on demand.

In China, the consumption of farmed products may account for more than 80 per cent of the total LRFF trade, while captured products represent less than 20 per cent. The main reason is that in recent years the artificial propagation technique of LRFF fry in China and Taiwan has become better understood. With the rapid growth and increased efficiency of aquaculture, the production of farmed fish is above 80,000 t, which greatly surpasses the volume of captured wild fish. In the market of China and Hong Kong, farmed fish have become the dominant product instead of captured fish. This observation needs to be tempered by two considerations. One is the difficulty of obtaining good statistics that would include IUU wild fish trade, and, second, the growth in the Chinese market is substantial as urban incomes rise. This growth in consumption of farmed fish may be paralleled by growth in wild fish consumption that is less well recorded by comparison to aquaculture products in official statistics.

### **6.9.2 Wild-capture LRFF**

#### **Catching of Live Reef Food Fish**

At present, overseas capture of LRFF is usually by angling, and perhaps the usage of cyanide is decreasing in some areas. At sea, exporters set up net-cages and special collectors buy fish from fishers and farm the captured fish in the net-cages. Over about one week, 2 t of various-sized fish are collected and taken by ship to the exporters, where they are stored in temporary tanks while awaiting export. The undersized fish will still grow-out in the temporary cage until they reach commercial size. Figure 6.12 shows the ships used in catching LRFF.



**Figure 6.12** Capture ships used in Indonesia.

Mortality rate in catching differs according to place. The rate is as high as 50 per cent in Southeast Asian countries and probably in different locations within countries. Factors such as inexperienced fishers and limited skills influence mortality. In Hong Kong and Guangdong the mortality rate is very low due to their more careful operation.

### **Export of LRFF**

After the collected fish are brought to the export bases, it takes 10–20 minutes to disinfect the fish in fresh water for the purpose of killing surface parasites. After the fish are stocked in the temporary tanks of the exporters they stay a short time (several hours to three days) with no feeding in order to keep the water clean and reduce the transport mortality rate.

When dispatched by ship the fish are placed into big plastic barrels equipped with oxygen and filter systems. Some big exporters use timed aerators (Figure 6.13) so that high density transport can be supported—up to 300 standard fishes in 3 cubic metres of water. It can effectively decrease the mortality rate to under 5 per cent but the plastic barrels cost US\$1000 each. After delivery the barrel will be taken back for the next transport.



**Figure 6.13** Equipment used by Pulau Masin (exporter) in Indonesia.

### **6.9.3 Port Trade of Mainland China LRFF**

LRFF from South East Asian countries and Australia are given to Chinese traders after entering into Hong Kong's sea area. Chinese traders transport the fish to Shenzhen by ship. Shenzhen is the main distribution centre of coral reef food fish from Southeast Asian countries and Australia. Traders always have their own ships (although small-scale traders rent vessels) and temporary farming tanks. LRFF are in the temporary tanks for a short time, just several days. In order to avoid disease for high density transport, they are fed fresh live trash fish.

The temporary tanks can hold 40 tons of fish, not only LRFF but also other seafood. While traders take wild products back to Mainland China, they also take farmed LRFF from mainland China to Hong Kong market. It depends on the market price. They only sell the high value farmed species.

The timing for traders to import products is flexible. It mainly depends on the supply situation of overseas LRFF. At the time of major Chinese holidays the price rises, and the volume of imports is huge. In normal times the volume of stock averages 3 to 4 t/day. LRFF trade in Shenzhen is controlled by several big traders. Figure 6.14 shows some details of the trade.

1. Shenzhen dock in Shenzhen city; 2. ordinary ships for transporting LRFF from Hong Kong to Shenzhen, two tonnes every time; 3. using bigger ships for landing anesthetized giant grouper, the bigger ship is used to transport common priced fish and sea water is also from opponent vessels; 4. round-trip speedboat from Hong Kong to Shenzhen, about one hour for a single trip with a 0.5 t load, using to transport high value leopard coral grouper; 5. unconscious leopard coral grouper being landed from speedboat; 6. small handcart transports products back to booths; 7. inner structure of trade booths in Shenzhen; 8. trucks loading fish from booths for transport to Guangzhou, Beijing, Shanghai and other markets.







Figure 6.14 Shenzhen Live Reef Food Fish transport activities.

## 6.9.4 LRFF Trade in Wholesale Market of Mainland Chinese

### Types of Wholesalers

There are three types of wholesalers:

- Big wholesalers have their own booths in Shenzhen and their own booths in local large live seafood wholesale markets of Guangzhou, Beijing, Shanghai, the main consumption cities.

Their stock arrives as 2–3 t farmed and captured LRFF per day.

- First tier dealers don't have booths in Shenzhen, but have their own booths in the main consumption cities. They need to purchase from wholesalers. Shanghai and Beijing have plenty of this kind of dealer.
- Second tier dealers need to purchase from large wholesale markets. Their booths are located in other cities but not Guangzhou, Shanghai, Beijing and Shenzhen.

### Trading Time

LRFF trading time is different for various market styles and consumer requirements:

- Huangsha wholesale market in Guangdong ( Figure 6. 14–16 ) is the main live seafood trade market in China with a huge trading volume. Its products are mainly distributed to the Pearl River Delta and nationwide to other cities. Trading takes place between 2:00–5:00 am.

- Jingshen seafood wholesale market is the biggest live aquatic products wholesale market in Beijing. Its products mainly go to restaurants close to Beijing. The trade is finished before 6:00 a.m.; at that time there are no traffic jams.
- Tongchuan market is the biggest live aquatic products wholesale market in Shanghai. The main trading times focus on afternoon and night. 1:00–3:00 pm is the time for local restaurants to purchase. Consumers buy between 4:00–5:00 p.m. and ask for the cooking to be done in nearby restaurants. After 8:00 p.m., restaurants located in the Yangtze River Delta come to purchase.

Generally, products in wholesale markets will be sold in as few as two or three hours and no more than two or three days.



Figure 6.15 Huangsha wholesale market booths in Guangdong (Left); Nighttime trading in Tongchuan wholesale market Shanghai (Right).



Figure 6.16 LRFF temporary aquariums in wholesale market.

### **6.9.5 Sources of Products in Major Chinese Wholesale Markets**

Wild-captured LRFF traded in the Huangsha seafood wholesale market comes mainly from Australia or Southeast Asian countries through Hong Kong and Shenzhen. There are few farmed fish from Taiwan in the market and most farmed species are from Guangdong and Hainan provinces.

The source of LRFF in Beijing Jingshen aquatic products wholesale market has the same type of situation as Guangzhou Huangsha. Its trading volume is smaller than Shanghai but the proportion of top grade fish is large.

In Shanghai's Tongchuan seafood wholesale market, the Guangdong dealers work in captured fish while the Fujian dealers focus on farmed fish. Some of the wild captured LRFF come from Shenzhen, and others types depending on the convenient air transport of Shanghai, so that the leopard coral grouper can be transported to Shanghai from the Philippines directly by air with a high survival rate and good selling opportunities. Farmed fish is mainly from Taiwan through Raoping County, Guangdong. The main trading species is banded grouper. At the same time, farmed LRFF from Hainan, Guangdong, Fujian also account for a certain proportion. In general, there is less high value LRFF in the Shanghai market than in Guangzhou and Beijing, and mid-value fish are dominant.

### **6.9.6 Transport to Market**

#### **Transport of captured fish**

Collectors abroad generally transport fish to the export bases by trucks. Exporters of Southeast Asian countries and Australia use air transport when sending high value fish such as leopard coral grouper, humpback grouper and humphead wrasse. Other species of fish in South East Asian countries are transported by ships. Generally, the volume sent by ship is high, accounting for 80 per cent of Hong Kong imports. After the LRFF have arrived in Hong Kong, mainland Chinese traders transport them to Shenzhen dock by ships. Then, products go to Guangzhou and other such big cities by trucks. The overland distribution of LRFF in mainland China is more than 95 per cent by truck. The transport trucks are equipped with aerators, thermostats and water cycling systems to maintain a high survival rate of LRFF. The mortality also has a relationship to transport density and distance. In normal transport, mortality is low enough that can be ignored.

#### **Transport of Farmed Fish**

Farmed fish from Taiwan is sent to Raoping port in Guangdong by ships, then transported to other cities of China by trucks. Farmed LRFF in mainland China can be sent anywhere directly by wholesalers using trucks.

## Use of Fish Narcotics during Transport

For wild LRFF, a long transport period will lead to damage to the fish, so the usage of narcotics is required. It takes about 10 days to transport fish from Southeast Asian countries to Hong Kong. During the trip malabar grouper and giant grouper need anesthesia, while the thicker-skinned brown-marbled grouper do not. Although the transport time of high grade species such as miniatus grouper is short, they also need anaesthesia to reduce attrition rates. Products from Shenzhen and Guangdong to Beijing and Shanghai need a second dose of anesthetics. But fish on short distance trips such as from Shenzhen to Guangdong, or Fujian to Shanghai need no anaesthesia.

## 6.10 Terminal Consumption of LRFF in Mainland China

Up to 90 per cent of LRFF consumption is in restaurants, and family consumption is very small. Guangdong is the main consumption market for LRFF in China. Its consumption accounts for 75 per cent of the total in the Pearl River Delta. Consumption in Beijing is between the levels found in Guangzhou and Shanghai, with generally local consumers. Shanghai's consumption is centralized in the Yangtze River Delta. The consumption excepting Shanghai in the Yangtze River Delta accounts for 65 per cent in total. Thus the local consumption of Shenzhen ranks in fourth place.

## 6.11 Pricing of Reef Fish along the Supply Chain

Table 6.4 shows the retail price of LRFF in current markets. The same standard leopard coral grouper has different price for different colours. Red coloured fish are more expensive because of Chinese preferences. In addition, there is a huge price gap between live and dead fish. The price of dead fish is 30 per cent lower than for a live one.

**Table 6.4 LRFF price in mainland China markets.**

Species	Price (RMB/Kg)	Species	Price (RMB/Kg)
Leopard coral Grouper	400-700 normal season		
1000-1200 spring festival	Humpback Grouper	400-700 normal season	
1000-1200 spring festival			
Humphead wrasse	1600-2000	Yellow Grouper	270
Longpectoral Grouper	240	Duskytail Grouper	130-140
Spotted coral Grouper	340	Brown-marbled Grouper	152

## 6.12 Factors Influencing the Fluctuation in Price

In the last decades LRFF wholesale prices have not shown large changes. Compared with 10 years ago, the overall price decreased 10 per cent because the production of farmed fish increased every

year, which fills the gap of market supply and demand. But the price of LRFF fluctuates greatly during different periods of the year, varying 30 to 40 per cent. The main factors are as follows:

- During holidays, consumption volume rises and the price is high.
- Price relation with daily supply quantity and quality in the wholesale market. If one species is abundant, its price will be low; if scarce the price will be high.
- High mortality during transport also leads to price increasing temporarily.

Production of coral reef food fish offers high profit levels for farmer and fishers. The margin rate is 10–30 per cent for exporters but they also are affected by high transportation costs. The benefit to importers of mainland China is not high, with a 5 per cent profit margin. But the quantity of fish is huge. In normal seasons the profit is significantly lower than during festivals. The profit margin of wholesalers and retailers is about 10 per cent. The highest margin rate exists in restaurant where profit can reach more than 50 per cent. Figure 6.17 provides a summary of profits along the supply chain.

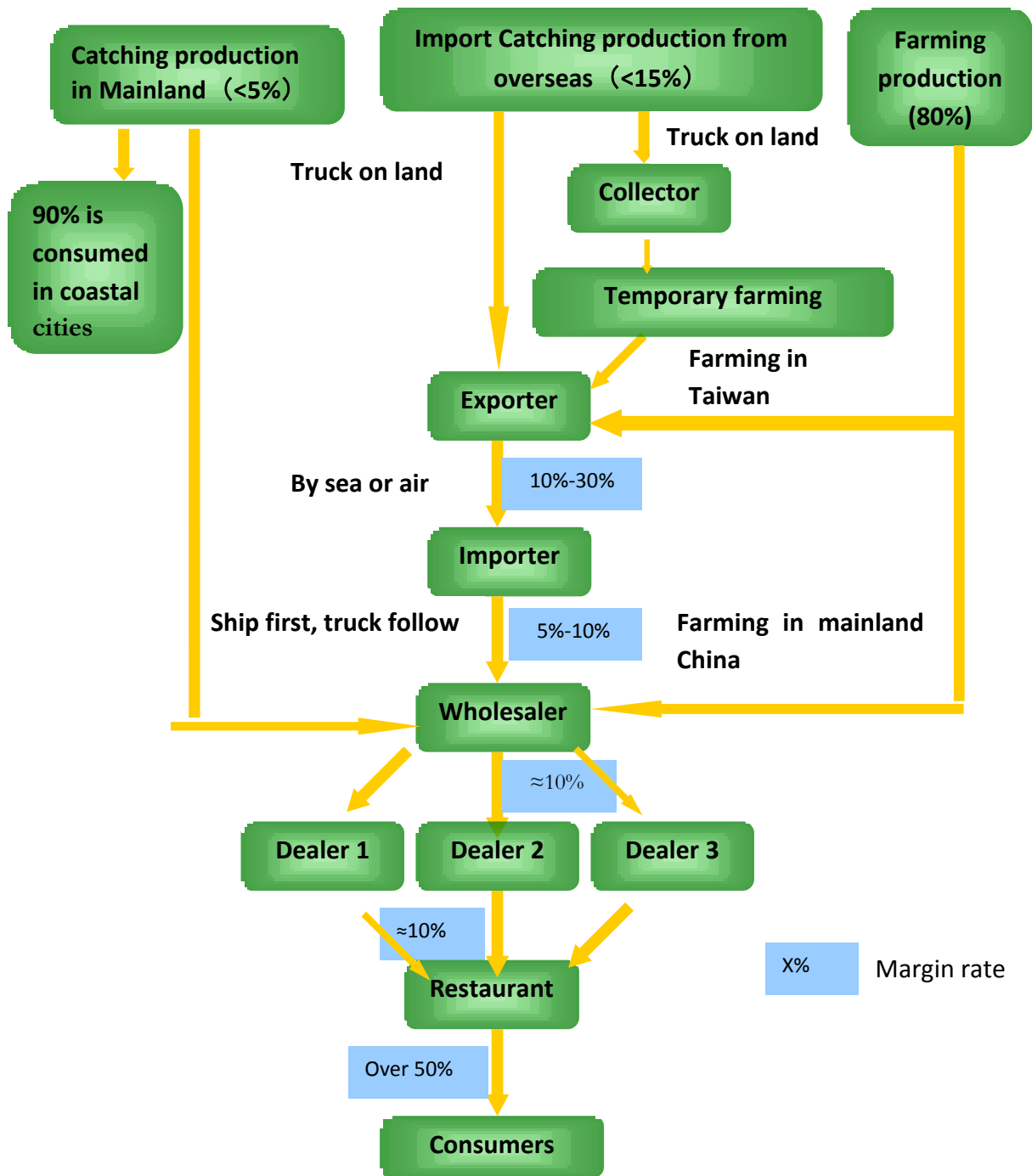


Figure 6.17 Pricing structure diagram of LRFF supply chain.

## 6.13 Analysis of Industry Trends

### 6.13.1 Industry Trends of LRFF

With the exhaustion of resources in former coral reef food fish (CRFF) fishing areas and the continuous shift into the exploitation of new fishing areas, the CRFF resource base is gradually declining. The need for protection of LRFF resources already has attracted the attention of various global NGOs and others. Setting reasonable and sustainable catch levels will place higher requirements for resource protection. Australia is a good example where sustainable harvest of reef fishes seems possible. Undersize fish are not allowed to be taken in order to ensure sustainable supply of LRFF for all fishing areas. Protecting the reef fish plays an important role in protecting the overall reef biological environment. The stewardship approach of Australia needs to be followed elsewhere in the Coral Triangle region.

Because the wild reef fish resources are limited, farmed LRFF will account for a bigger segment in markets of the future. It is predicted that in the near future farmed fish will increase to 90 per cent of total consumption. It is an inexorable trend to further improve LRFF aquaculture by artificial propagation techniques to more species and to achieve other breakthroughs. With the Economic Cooperation Framework Agreement (ECFA) signed between China and Taiwan in 2010 live reef food fish are now listed as tariff-free products. It provides preferential treatment for shipment of live reef food fish from Taiwan to China. These will be farmed fish, probably supplied in greater numbers.

The rise of farmed LRFF leads to falling prices in every link along the supply chain. Although the costs of feed, labour, energy and inputs are increasing globally, prices of LRFF generally have not risen over the last decade. The increasing volume of farmed supply in this industry and the stable price of LRFF could have resource protection benefits. But the diet of fish protein and the necessary quality of the living environment make CRFF farming a high energy consumption and high-investment industry. Improving the farming environment and developing a reasonable scale are key issues. More scientific effort should be put into research on reducing farming costs, improving farming environment and decreasing disease outbreaks.

### 6.13.2 Factors Driving Demand

China's economic improvement and seafood consumption increases are the main driving force of LRFF consumption. The Chinese preference for live seafood cannot be changed in a short time. As economic development proceeds, consumption demands for top/middle grade seafood is increasing.



LRFF, with its appealing texture and delicious flavour, is well received by the middle class. With the Chinese middle class expanding, there is a wide space for broadening LRFF consumption. Some species fall into the category of luxury consumption, where scarcity and very high price are valued greatly. This type of luxury demand is unlikely to be satisfied by aquacultured products.

For several species, the breakthroughs in artificial propagation of fry means that aquaculture can be less dependent on harvesting young fish from the wild, and the skill of pond or cage cultivation is now well understood, promising year round supply of LRFF. Along with the price drop of LRFF, it will attract more consumers to eat farmed LRFF. The dilemmas here are, first, that it will heighten interest in LRFF, and some fraction of consumers will likely then seek out the scarcer wild fish, and, second, that aquaculture still places demands on fish protein to feed the aquacultured groupers.

### 6.13.3 Environmental Impacts

The demand for LRFF is leading to what many believe is heavy over-exploitation of target species. In some parts of the Coral Triangle, localized depletions have occurred to the extent that the trade is no longer economically viable<sup>148</sup> while in other areas evidence of overfishing of target stocks is clear.<sup>149</sup> While the catchment area for the LRFFT has radiated outward since the 1970's (Figure 6.1), it has also moved progressively through national waters, systematically depleting localized stocks before moving onto new fishing grounds. In Indonesia there has been a gradual movement of fishing activity from the west (West Java, Southern Sumatra) to the east, as far as West Papua, while in the Philippines the move has been north to south, such as along the island province of Palawan.

### “Boom-to-Bust” Fishery Practices

Figure 6.5 depicted the contribution of supply countries to total imports of LRFFT into Hong Kong and mainland China. The relevance of these supply trajectories goes to the heart of the environmental impacts of this trade and sustainability issues. The LRFFT has often been characterised as a “boom-to-bust” fishery, where the trade systematically depletes local stocks before moving into new areas. While the timeline for moving from boom to bust can be decades as opposed to years, there is evidence of the dramatic overexploitation of fish stocks of target species and industry mainstays such as leopard coral grouper. This is occurring to the extent that the trade may no longer be economically viable, and, where it still operates, it is doing so in an unsustainable manner.

<sup>148</sup> Examples are northern Palawan province in the Philippines and Berau District, East Kalimantan in Indonesia

<sup>149</sup> Scales, H et al. (2007). *Impacts of the live reef fish trade on populations of coral reef fish off northern Borneo*. Proceedings of the Royal Society B (274), 989–994

The decline in relative importance of the Philippines from 2006 onwards coincides with the recognized closure of fishing grounds in northern Palawan. Moreover, surveys conducted by WWF in the Philippines reveal that in some areas, between 60 per cent and 80 per cent of all fish are being taken from the reefs as juveniles with some weighing as little as 100-200 g, to be “grown out” in cages for about 8 to 10 months, until they reach market size, usually around 500g.<sup>150</sup> As a portent of things to come, the relative rise in prominence of Indonesia as a supplier of leopard coral grouper coincides with continuing easterly movement of the LRFFT into the eastern Nusa Tenggara Timur and West Papua and exploitation of new sources of fish to replace depleted or declining stocks in central and western Indonesia.

### **Overexploitation at the Expense of the Reef Ecosystem**

Data on the rates of exploitation of reef species for the LRFFT are limited. In the face of data scarcity, the issue of sustainability may be best addressed by estimating yields by reef area. Potential yields of grouper species reefs in moderate condition are estimated to be approximately 0.4 t per km<sup>2</sup>. Using estimates of the total reef area of the Indo-Pacific region and grouper production, overall grouper yields were estimated at 0.5 t per km<sup>2</sup>. Taking into account the relative intensity and geographic location of most fishing efforts, however, the average grouper yield is estimated to be closer to be 2 t per km<sup>2</sup>, well above what would be considered sustainable.<sup>151</sup>

There also are significant impacts directly arising from the capture of live food fish such as groupers. Other species are taken, sometimes to serve as feed for the groupers. And use of cyanide will destroy reef components. The fear is that reef biodiversity is under threat, at a time when most of the coral reefs are seriously stressed by other factors such as climate change, high sea urchin abundance and many forms of human use and over-exploitation.

The response of countries in the region to problems of coral reef decline has been to define the Coral Triangle Initiative (CTI).<sup>152</sup> The initiative was formed by Indonesia, Philippines, Malaysia, Solomon Islands, Timor Leste and Papua New Guinea. The CTI has been supported by Asia-Pacific Economic Cooperation and various other sources such as the Asian Development Bank and the GEF, and NGOs, especially the World Wild Fund (WWF). Its purpose is achieving sustainable development of the coral reef triangle by establishing a series of standards including those regarding coral reef catch and food safety. This support opens the opportunity to address major environmental issues regionally but also in the context of global concerns such as biodiversity protection, climate change and achieving poverty reduction. The coral reefs in the Coral Triangle

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<sup>150</sup> These juvenile fish are being harvested from reefs before they have had an opportunity to reproduce and thereby sustain populations in the wild.

<sup>151</sup> Sadovy et al (2003). *While Stocks Last: The Live Reef Food Fish Trade*. Asian Development Bank

<sup>152</sup> <http://www.cti-secretariat.net/>

region are among the most diverse reef ecosystems, and also the most endangered, in the world. The CFI presents a new, even unprecedented, opportunity to address unsustainable exploitation of coral reef ecosystems.

The International Standard for the Trade in Live Reef Food Fish was issued by the Marine Aquarium Council, The National Oceanic and Atmospheric Administration (NOAA), The Nature Conservancy and MacArthur Foundation in 2004. The main purpose of this standard is to improve the sustainable fishing industry via voluntary certification. The standard is based on keeping or rebuilding current existing target fish numbers with consideration of ocean ecological sustainability but permitting further use of living aquatic resources. The problem is implementing such a system with many thousands of local fishers scattered over a very large ocean space. Therefore it would have to work with collectors and traders who traditionally have simply moved to new areas when reef resources are depleted. Even though this standard represents one of the best hopes for future sustainability, its implementation will be a difficult challenge.

In 2004 the CITES Conference of Parties placed the humphead wrasse into Appendix II. Any species covered by this Convention will receive trade monitoring and restrictions meant to safeguard against further decline. That this system is not working well is indicated in numerous documents and discussions since that time. An example is a submission by Indonesia to the CITES CoP 15 held in 2010.<sup>153</sup>

Major discrepancies in international trade records of Humphead Wrasse have been detected, indicating that, despite ongoing efforts to ensure that trade is documented, improvements are needed to improve enforcement capability. There are three particular areas that need attention.

- 1) Mainland China is a major consuming region for Humphead Wrasse and fish have been seen on sale in shops; there are no records reported to CITES of imports into mainland China. Therefore, there appears to be no authorization for importation of Humphead Wrasse.
- 2) Singapore is a re-exporter of Humphead Wrasses which have their origins mainly in Indonesia and Malaysia waters, possibly elsewhere. This species does not come from Singapore waters because the species is depleted in Singapore waters. Therefore any records of Humphead wrasse exported from Singapore should appear as re-exports and indicate the source country. Hong Kong's import records for 2005 and 2006 show significant Humphead Wrasse volumes coming from Singapore as "exports" rather than "re-exports," i.e. with no indication of the country of origin. Officials of the Wildlife Regulatory Branch, Agri-Food

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<sup>153</sup> <http://www.cites.org/eng/cop/15/doc/E15-51.pdf> CoP 14 document No. 51

and Veterinary Authority of Singapore indicate that they did not issue any re-export permits for Humphead Wrasse to Hong Kong in 2005 and 2006, and none were reported to CITES.

- 3) Humphead wrasse are being included in mixed fish shipments being traded internationally by air, as detected on multiple occasions by customs officials at Hong Kong airport. Inspections of live fish consignments need to be checked more vigorously at ports of export, and customs officials could benefit by training in species identification.

So, while China and other jurisdictions noted are members of CITES, this example of the difficulty in monitoring IUU fish trade is typical of the practical difficulties of reef fisheries protection being encountered at present.

#### **6.14 Conclusions and Action for Sustainability**

The live reef food fish supply chain presents major challenges for shifting from the current practices to more sustainable approaches. The key unsustainable elements that need to be addressed are the following:

- Overexploitation of a number of species, often with fishing practices that have collateral ecological damage to coral reefs and to non-targeted species.
- Extensive Illegal, Unregulated and Unreported (IUU) fisheries throughout much of the vast Coral Triangle area.
- High demand and expanding trade of threatened species such as the humphead wrasse without adequate regulatory safeguards required under CITES.
- Substantial mortality as a consequence of some transportation methods between capture and the final marketplace.
- Capture of juvenile fish before they have a chance to reproduce, and the grow-out of these fish by feeding them other fish to fatten them to market size.
- High consumption of fish protein by aquacultured LRFF and other issues regarding sustainability of farmed groupers within China, while demand continues to rise in many parts of China.

Coupled with these sustainable development concerns is a set of difficult management, administrative and institutional matters for urgent attention. The three most important are as follows:

- Significant gaps in the statistical data and scientific information needed to fully understand the dynamics of reef fish stocks under various pressures and to accurately the magnitude of trade flows into the main markets, especially into China. These problems need to be tackled

by producer countries and the importing countries, especially Hong Kong and China. Regional and global fisheries and environmental organizations, especially FAO, regional trade agreements such as those between ASEAN and China, China and Taiwan, and global trade bodies such as the secretariat of CITES could be helpful in setting out protocols for data gathering, and acceptable practices. The issues associated with IUU are critically important.

- Inability to implement sustainable development initiatives at the most strategically important points along the market supply chain and to secure cooperation from all the important players, including producers, traders, wholesale and retail operators. Entrenched approaches by the important players at all levels (production, trade and consumption) reward continuation of unsustainable practices for wild reef fish exploitation. Generally the players fail to engage on these issues in the broader context of either sustainable fisheries or sustainable trading arrangements. Awareness on the part of consumers in China and Hong Kong appears to be limited so that pressures for sustainable seafood choices are markedly less than in western Europe or North America, for example.

This is where the proposed LRFF certification system that so far has not gained much support on the part of producers and traders could be extremely valuable. It would provide a basis initially for dialogue among the important members of the market supply chain, and eventually could serve as the basis for agreement on what constitutes a sustainable approach. It is likely that the impetus for a shift will have to come from non-governmental organizations, but it is necessary for both industry and government to participate.

- The optimal arrangements between the rapidly expanding aquaculture of reef species, including their food sources, and the existing reef fisheries need to be worked out in a fashion that is more sustainable for both. There are major opportunities if a long-term sustainable aquaculture vision can be developed. This vision will include considerable science and technology investment, consideration of aquaculture expansion within China and also in some of the Coral Triangle countries, improved traceability of products, and mechanisms to ensure harvest of young fish and other resource management associated with reef fish aquaculture is kept within sustainable limits.

In the coming years the international dialogue about sustainable live reef food fish trade is likely to become much more intense. Certainly it will involve major international organizations, both intergovernmental and non-governmental, the Coral Triangle countries, and, of course, the governments of reef fish consuming countries in Southeast and East Asia. Much of the focus will be on the links in the supply chain, especially those between primary producers and entry into Hong Kong and China. These elements of the trading system do not appear to be well-prepared for a transition.

Thus the steps required for the move towards sustainability of reef fisheries and aquaculture should start with awareness-raising and action in the marketplaces where demand is greatest: Hong Kong and mainland China's coastal large cities and ports. Hong Kong and mainland China governments could move quickly to improve the statistical data systems that would help to close trading loopholes in ports of entry such as the limited reporting from ship landings. It is also possible to develop traceability and chain of custody systems for some of the most threatened species such as the humphead wrasse, as quantities are fairly limited, and mostly move by air. This will require cooperation from airlines so that they do not move shipments without adequate documentation of species, and eventually, of certification so that IUU products are eliminated. The good aspects of the Hong Kong statistical reporting system could be quickly adopted in mainland China, and improved communications between the two systems could reduce discrepancies of data that currently exist.

Already, some chefs in international hotels such as the Marriott in Hong Kong are working towards assurances that their fish supplies are drawn from sustainable sources. This effort needs to be encouraged via trade associations such as the Chamber of Commerce in Hong Kong. But the effort will have to be extended on a much broader scale, and especially needs the cooperation and involvement of major seafood restaurant chains in mainland China.

Additional outreach to the Chinese public is needed. The objective should be to make consumers understand the relationship of catching and consuming LRFF with protecting coral reef, fish resources and biodiversity. Ultimately the purpose should be to reduce growth in the consumption of wild captured LRFF. Reinforcing the publicity of LRFF resources protection can be done through print and broadcast media.

A globally-shared scientific and economic information platform of LRFF knowledge is urgently required. It should contain up-to-date information on catching, farming, supply chains and all other aspects of this sector. As the largest consuming nation of reef fish, China should be an important contributor, but also user of this knowledge. It would be useful for a future meeting of key scientists, NGOs and others concerned about these fisheries to take place in mainland China.

The trade agreements China has put in place bilaterally and multilaterally (e.g., ASEAN-China) are opening freer trade on many items, including fisheries. It is important to bring in concrete measures for sustainable resource use and traceability for both food safety and ecological sustainability either within the agreements or in parallel with them. So far this has not happened for reef fish trade. Certainly, a robust LRFF trade certification arrangement worked out by stakeholders would provide a good basis, even if it operates on a voluntary basis. The number of traders and wholesalers is quite limited, even though there are thousands of individual producers. The existing effort on trade certification is stalled and needs to be restarted. It was based on the model that has proven useful in

other settings, including the Marine Stewardship Council, the Marine Aquarium Council, and others such as the Roundtable on Sustainable Palm Oil certification.

It would be strategically valuable to initiate a roundtable process, endorsed by the Government of China and by national governments of the Coral Triangle countries, in order to develop certification for living reef food fish trade (LRFFT). Simultaneously, it is possible to consider possible action in trade forums such as the Committee of Parties for CITES, and in regional trade discussions. So far there has not been full agreement within CITES to accelerate the pace of action for protecting humphead wrasse, as requested by Indonesia. This deserves further attention from both consuming and producing countries.

The opportunity to develop a sustainable, healthy farming mode of LRFF should not be lost. By rationalizing the farming density, improved feeding mechanisms so they are less dependent on harvest of small fish, and with standardized transport operations that minimize losses reef aquaculture can progress to a more sustainable basis. It is important to strengthen research efforts such as seeking further breakthroughs of artificial propagation and for developing vaccines to prevent fish diseases. Perhaps it would be possible to develop a domestic certification system that would emphasize higher quality of aquaculture products, and thereby reduce the price differential between farmed and wild fish. If so, this might take some pressure off wild stocks. Certainly a good approach to protect LRFF resources is to have high-standard aquaculture models of LRFF. Encouraging Chinese investment in overseas reef fish aquaculture in the Coral Triangle countries is likely to be worthwhile in the future.

The steps outlined above all need to be initiated over the coming three to five years, but action should be started as soon as possible since consumption growth is likely to continue over the coming decade, even if wild supplies are unsustainable. It will be a difficult undertaking because the supply of wild fish is so dispersed. However, the market supply chains are quite limited in terms of the number of actual traders, ports of entry and final destinations of products. It is thus possible to transform this system into one that is far more sustainable than at present.

## 7.0 Conclusions and Recommendations

### 7.1 Conclusions

China's fishery and aquaculture sector leads the world. Whatever the directions of China's future expansion of production, import and export, and domestic consumption, it will affect the potential of global aquatic resources to become sustainable in their use and regeneration. The great range of products, the success with aquaculture, which now exceeds fisheries in scale, and the ability to create a great variety of market supply chains in an adaptive fashion are positive signals of a dynamic development capacity in China's aquatic resource exploitation. The economic result has been important since millions of livelihoods have been maintained or added in the last two decades of expansion into aquaculture and fish processing and re-processing for export. China has been able to add value to its fish products, with high utilization rates of caught fish ("there is no such thing as trash fish in China"), and by extracting novel products such as ingredients for cosmetics and medicines from aquacultured species. The fundamental question is whether the exponential growth can continue, or is China already experiencing limits as to what it might expect to harvest from the sea, lakes and rivers, and from flooded lands and other areas where aquaculture takes place.

The answer to this question lies not only in ecological limits, including land, clean water and ocean space that is environmentally suitable and available for aquaculture, but also in the issues associated with the market supply chain, including trade and investment practices, and pressures arising from those seeking environmentally sound practices in resource use, or seeking limits for a variety of other reasons. We could not explore all of the important factors likely to affect sustainability of China's aquatic resource systems and market demands such as, for example, the growing demand for fish meal and bait-sized fish for aquaculture, or a workable path towards reduction in shark fin consumption in order to halt the alarming decline in global shark fins. However clearly there are lessons to be taken from the analysis of the three market supply chains.

In Chapter 2 we identified 17 sustainability criteria that might be used to provide some guidance as to whether activities in the living aquatic resource sector were following a sustainable path. It is doubtful that any country could claim success in fully meeting these criteria at the present time. The health of the oceans is believed to be under growing threat, and there are no real boundaries to this threat. Nor are there boundaries to the transfer of aquatic resource products. No matter how remote the fisheries, there may be a good chance that its products will end up in China on the way to a final consumer destination. This movement can be an impediment to sustainability, especially when, as so often happens, the catch is from an illegal, unregulated or unreported source. In aquaculture there may be greater hope for accurate traceability, but the rapid growth of this sector strains ability to



manage many of the issues of intensive cultivation. Furthermore, international development of appropriate standards and certification is still at a relatively early stage, and where they are available, as now is the case of tilapia, uptake by producers and traders has not been great.

The formal international trade rules affecting aquatic resources, while providing quite good safeguards for health and safety, especially for export products sent to some rich parts of the world such as the EU, U.S. and Japan, are still lacking when it comes to addressing environmental and ecological sustainability. The issue of fisheries subsidies, which are highly damaging in terms of overfishing, is still unresolved at the level of the WTO. There has been limited ability to resolve matters such as overexploitation of threatened or endangered high economic value species (e.g., the coral reef groupers examined in this study) by turning to the Convention on Trade in Endangered Species (CITES) for support. And regional fisheries management organizations have had difficulty limiting unsustainable levels of fishing for bluefin tuna and other luxury food items from the sea.

These examples are cited to give a sense of how widespread and serious the problems of sustainable market supply chains have become, and of how solutions are needed that involve the most significant components in the supply chain if there is to be real progress. It is for this reason that China is now perceived to be the most important link in the chain. Not only is the country so involved, but it has the means and, very likely, the will to create positive changes.

The Government of China has clearly stated its aspirations to accelerate action that will support an improved environment and development relationship in order to achieve an environmentally friendly society. It wishes to tackle ocean environmental issues, make fisheries sustainable, and to protect biodiversity. The Government is well aware of the pollution problems in lakes and rivers, and coastal areas, including the implications for aquaculture. It is also aware of the issues associated with destruction of wetlands and other natural aquatic habitats by land reclamation. Thus there will be ongoing pressure to reduce pollution from fish ponds and fish plants and to protect important ecological habitat. These measures should help to restore and safeguard aquatic habitats, which are often among the most threatened ecosystems. As well, there appears to be an extensive body of laws and regulations that, if well applied, could support sustainable development for fisheries and aquaculture.

When it comes down to how well the environmental protection system is working for securing the environmental security of aquatic resources, the picture is not very clear. Certainly there are excellent models of aquaculture, with integrated environmental management capacity; and also seafood processing facilities capable of handling certification demands of many types, especially in the reprocessing sector. Yet these are not the norm. Monitoring for compliance with the many aquaculture regulations certainly occurs, but the need is great, and capacity likely quite limited at the

level of small farms. There is limited transparency in the statistical system for fish processing, and significant problems with accurate documentation of species and other necessary information for traceability to be possible for many of the most significant types of supply chains, including the two oceanic chains studies examined (cod and live reef food fisheries).

China needs time now for ecological stewardship to catch up after the frenetic economic growth of the past two decades. Not only is this essential for creating better sustainability in its aquatic resource supply chains, but also for building better communication on sustainability issues with consumers and within the aquatic products sector. Fish and other forms of aquatic products form a basic, relatively low cost component for food security in China, but also increasingly are part of the luxury trade in food—high end products for which demand rises with scarcity and cost. In between, domestically and in the market places of the world where Chinese-processed aquatic production ends up, are many opportunities for increasing value-added, sustainably certified products.

In the effort required to make the transition to sustainable fisheries and aquaculture two important points should never be overlooked: (1) the effort can be staged over a period of time that allows for learning and pilot efforts, starting with simpler or more urgent needs; and (2) the effort should be profitable if accompanied by good communications concerning benefits to consumers (health, safety and quality) and to the environment.

## 7.2 Recommendations

The primary audiences for the recommendations from this study are policy-makers in the Government of China concerned about sustainability aspects of trade and investment, especially on topics related to fisheries and aquaculture, plus those directly involved in the industry, whether as producers, processors, traders, financiers or industrial associations. In addition, the various stakeholders in China and internationally such as non-governmental organizations, and international bodies and research organizations may find the recommendations helpful in guiding their interests and work.

The recommendations are oriented towards policy needs, and in the interests of keeping a focus on a select group of high priority, practical and implementable suggestions, their number has been kept reasonably small.

- 1. The Government of China should set in place a robust long-term sustainable fisheries and aquaculture trade policy governing both domestic aquatic production for export, and imported seafood intended for domestic consumption or for reprocessing for export.**

China's success in expanding its fish and aquaculture production and processing carries with it new levels of responsibility for ensuring sustainability of products whether for domestic or export markets. This includes consideration of internationally-defined objectives such as reduction in illegal, unregulated and unreported (IUU) sources of aquatic products; addressing pollution from processing facilities, aquaculture and other sources; and harm to marine and aquatic ecosystems and species as a consequence of harvesting or other activities.

Sustainable trade policy should address these and other problems at critical points in the market supply chain using a combination of regulatory and market-based approaches. These approaches may include improved enforcement of national and international conservation and environmental measures, economic instruments to limit participation and catches, and compulsory or voluntary certification systems such as those now in use for cod and other species through the Marine Stewardship Council and the proposed standard for tilapia cultivation. The sustainability trade policy should also take into account stepped-up action for conserving threatened or endangered species via the Convention on International Trade in Endangered Species (CITES), including some shark species and coral reef fish intended for live reef trade.

Greater attention needs to be paid to sustainability concerns for trade in fishmeal, fish oil and other products in feed for aquaculture. These concerns include overfishing of small pelagic fish species, excessive amounts of bycatch taken in order to meet demands for aquaculture feed, and harvest of juvenile fish as fish food for high value aquacultured fish such as groupers. It is important to note that further promotion of efficient omnivorous feeders such as tilapia into world markets is a means of reducing pressure on fish protein sources could be part of a Chinese sustainable fisheries and aquaculture trade policy.

An aquatic trade policy for China should address five significant elements:

- (1) Promotion and stronger support for sustainable fisheries and aquaculture initiatives within international trade agreements such as the WTO, via regional fisheries agreements from wherever China catches or sources aquatic products, and through the FAO initiatives for responsible fisheries and aquaculture.
- (2) Improvement of quality and sharing of information regarding the presence and impacts of unsustainable practices and policies within market supply chains.
- (3) Formulation of a strategy for branding China as a source of safe, healthy and environmentally responsibly aquatic products. For this branding effort to be successful, policy (e.g., for incentives) will be needed to stimulate aquatic products industries into greater participation in strategy implementation of the strategy.

- (4) Link aquatic product sustainability trade objectives with 12<sup>th</sup> Five Year Plan objectives for environmental improvement, for example, with those for improving freshwater and marine habitat protection, for sustainable aquaculture and for fisheries conservation, and for fish processing pollution reduction. More generally, this link should be made for low carbon economy, energy intensity reduction and greenhouse gas reduction as well.
- (5) Improve sustainability guidelines and, as necessary, regulations that cover Chinese trade and investment abroad for fisheries and for aquaculture.

**2. Work collaboratively to set in place enabling policies for fisheries and aquaculture sustainability certification covering a range of aquatic products starting with products entering export markets and eventually covering domestic consumption as well.**

The move towards sustainably harvested, produced and processed aquatic products is gaining world-wide momentum, and China will benefit from being proactive. To do so will require consideration of accreditation arrangements that are compatible with Chinese interests and needs but also meet international standards. Some Chinese fish processors are already taking Marine Stewardship Council-certified products for export-oriented reprocessing, but in general the level of participation needs to be accelerated and additional species such as tilapia added.

The enabling policies could include a clear statement by the Government of China concerning the need for and desirability of Chinese aquatic products industries to participate in reputable certification schemes; establishment of incentives for early acceptors of certification; an accreditation and auditing policy to ensure that certification systems used within China are credible; and promotion of certification as part of the branding of Chinese export products as sustainable.

While sustainability certification initially could be oriented mainly towards products exported from China, eventually certification should also be considered for key products consumed domestically. It would be desirable to establish seafood certification pilot projects, for example in some coastal cities, or for certain types of fisheries such as the live reef food fish trade (e.g. groupers sold for the restaurant trade).

It should be emphasized that good certification demands accurate identification of the product and its origin, good traceability, and sustainability criteria that can be monitored. These points are covered in the next recommendation.

### **3. Develop a national sustainable fisheries and aquaculture traceability system for seafood and other aquatic products imported, produced or processed in China.**

Good traceability and chain of custody arrangements are essential for credible market-based sustainability certification. The market-oriented systems now in place have been developed through roundtable mechanisms that bring together the stakeholders, industry representatives, governmental bodies and scientists. The elements of the specific certification systems are detailed and auditable at the level of individual stocks as well as market supply chains.

In the Chinese situation where the potential number of sustainable certification systems eventually could become quite large, the following become very important: to build more complete data systems with better information on individual species and stocks; better information on catches of Chinese distant water fleets; closer cooperation with international bodies to ensure accuracy and compatibility of data; and efforts to close loopholes through which aquatic products enter the country with inadequate identification.

Thus, as part of developing the national traceability system, consideration should be given to a thorough overhaul of the national statistical data gathering for fisheries and aquaculture in order to provide more accurate information and to make it more relevant to trade and sustainability considerations.

Another important part of traceability is constructing good channels for information flow and communication regarding topics such as IUU-sourced materials, accurate naming of products being imported or exported, and verification of chain of custody. These appear to be matters of pressing concern for some supply chains, including some white-fleshed commodity fisheries, and for some of the boat-shipped live food fish supply chains, for example. It is a reason for the strong interest expressed by groups outside of China for greater engagement with China on fish and aquaculture market supply chains.

Traceability is, of course, an essential part of quality assurance systems for health and safety considerations of aquatic products. It will be useful to link policies for environmental and sustainability traceability with these other considerations in order to avoid unnecessary duplication of effort, and to reduce costs.

- 4. Create a sustainable aquaculture policy at the national level with considerable capacity development for regulating and managing future growth. Such a policy would help to safeguard the reputation and quality of products exported from China as well as Chinese aquaculture investments elsewhere in the world.**

The great success of aquaculture in terms of its current rapid growth in quantity and range of products also raises expectations concerning its future role in rural development, food security, and the national economy. China now has more experience with aquaculture than probably any other country in the world. Sharing that experience with others for example in other parts of Asia and Africa is likely and will require policies that optimize benefits for both China and other countries hosting Chinese investments in aquaculture abroad. Domestically, there is a need to consider how much consolidation is needed to optimize production systems for efficiency and use of inputs, to improve environment, and to maximize social benefits locally. This is an important topic for trade products such as tilapia, since limits will otherwise be reached on the ability to increase exports of this commodity trade.

The trade and investment implications of a sustainable aquaculture policy are quite considerable. They include matters such as the possible roles of genetically modified organisms (GMO) in Chinese aquaculture; science and technology advances required for reliable sources of young animals, disease control with minimal use of medications, food conversion, improving water quality, control of invasive species; and maintaining markets and the competitiveness of Chinese products.

Capacity development is essential and in line with policies for scientific development and for a science-based economy.

- 5. Set in place policies for containment of growth, substitution of existing products, and other means to avoid further ecological and conservation damage arising from luxury imported fish products from species believed to be in decline in areas outside of China.**

Extremely high value imported seafood such as shark fin, some live reef fish used on festive occasions or in very high priced restaurant meals, some tuna species, and rare crustaceans are examples of products that are threatened—but where demand is still rising in the Chinese marketplace. Such products will become even more valuable as they decline in abundance, and therefore require special attention in trade policies. If trade continues to grow in such circumstances, it likely will be at the expense of China's sustainable development reputation.

To change the situation will require policies and actions for awareness-raising that may take years to be fully effective. This is a task that cannot be done by government alone but requires participation by individuals well known within China to take a personal stand on such products and who are prepared to campaign with peers as well as the general public.

The Government of China is in a position to address the subject of unsustainable luxury seafood consumption in a variety of policy ways. One is to work closely with producer countries to reduce or eliminate IUU fishing of threatened species (an example is the humphead wrasse). Another is to shift effort away from fish and shellfish stocks that are in decline and substitute species that are more abundant or develop aquaculture of the threatened species. While this happens at present for some scarce types of seafood, it is not totally successful, and other methods are needed as well. Generally the situation will be aided by policies that promote stronger international cooperation and improvements to transparency, monitoring and reporting.

**6. Ensure that trade and competitive advantages associated with sustainable development of marine and freshwater Chinese products are identified and realized through effective working relationships of government and industry.**

China's overall approach of seeking a low carbon economy, promoting resource efficiency, and generally building a stronger environment and economy relationship provides a macro-policy framework that should provide future competitive advantage of value to sustainable aquatic resource development and trade. The concrete ways, however, should be carefully assessed and reinforced for each major product. This will require on-going research and development that is best done through joint efforts involving individual enterprises, industry associations and government bodies including MOFCOM, the Ministry of Agriculture, and perhaps others.