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Sustainable Aquaculture as a Solution for Food and Livelihood Security in the Coral Triangle: Recommendations for Strategic Investment

By Dr. Lida Pet-Soede and Dr. Geoffrey Muldoon

Case studies developed with Candhika Yusuf of WWF-Indonesia, Joel Palma of WWF-Philippines, Ernest Chiam of WWF-Malaysia, and Ngo Tien Chuong and Huynh Tien Dung of WWF-Vietnam

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Cover image:

Fisherman harvesting farmed fish such as Groupers, Trouts, etc. Palawan, Philippines

Abstract

Aquaculture production has exploded in recent decades, primarily in the Asian part of the Coral Triangle region, and now comprises many species using multiple production systems. When well managed, aquaculture can be a very efficient method of protein production with low green house gas emissions, low freshwater requirements, and minimal use of land compared to other forms of livestock production. Uniquely, it can support coastal communities that have few alternatives to making a living.

Live reef fish trade in Kudat, Sabah, Malaysia. © Jurgen Freund / WWF-Canon

There are abundant examples of detrimental aquaculture practices being implemented in Asia and the Coral Triangle resulting in adverse modifications to habitat, varied harmful impacts of pollution and effluent discharge, poor water quality leading to declining fish health and productivity, and weakening of natural stocks from escaped farmed stocks, and introduced diseases. In many areas, there continues to be a reliance on the use of wild-caught juvenile stocks which are ranched and grown out to market size. In some areas, these ecosystem impacts leave communities with diminishing opportunities to make a living in their coastal areas.

Even as awareness around the consequences of these impacts increases, governments increasingly promote aquaculture as both a partial solution to relieving pressure on wild-caught fish stocks and an opportunity to produce more animal protein to feed the world's expanding population and in some instances, supporting livelihoods and alleviating poverty. While aquaculture will comprise an increasingly significant component of the region's economy, the sector must expand in a responsible way that minimizes environmental and social impacts while contributing increasingly to daily protein needs and supporting viable livelihood for coastal communities. This transformation of the aquaculture sector continues to be hampered by a lack of investment, access to credit, and social inequity.

To achieve the goals of the Coral Triangle Initiative on Coral Reefs, Food Security and Livelihoods (CTI-CFF), strategic investments must be made to reduce the negative footprint of current aquaculture operations in this region. Investment for expansion of seafood production must focus on reducing impacts of existing farming practices through innovation and promoting low footprint aquaculture (LFA).

While investment in technology and improvements can alleviate negative impacts, investing in LFA will not only contribute significantly to sustaining local livelihoods of men and women but it can provide an efficient form of food security in terms of domestic consumption in the Coral Triangle and revenues from exports. These investments must contribute to a reduction in the use of wild-caught fish for feed as well as to reducing local and regional conflicts between communities, sectors, and countries that otherwise may compete for jobs and food from the Coral Triangle.

This discussion paper aims to describe trends in aquaculture development around Asia and summarize some learning on best practices in different current types of aquaculture.

We make recommendations for investors and other parties interested to support sustainable aquaculture as part of a blue economy[1] for livelihoods and food security in the Coral Triangle region.

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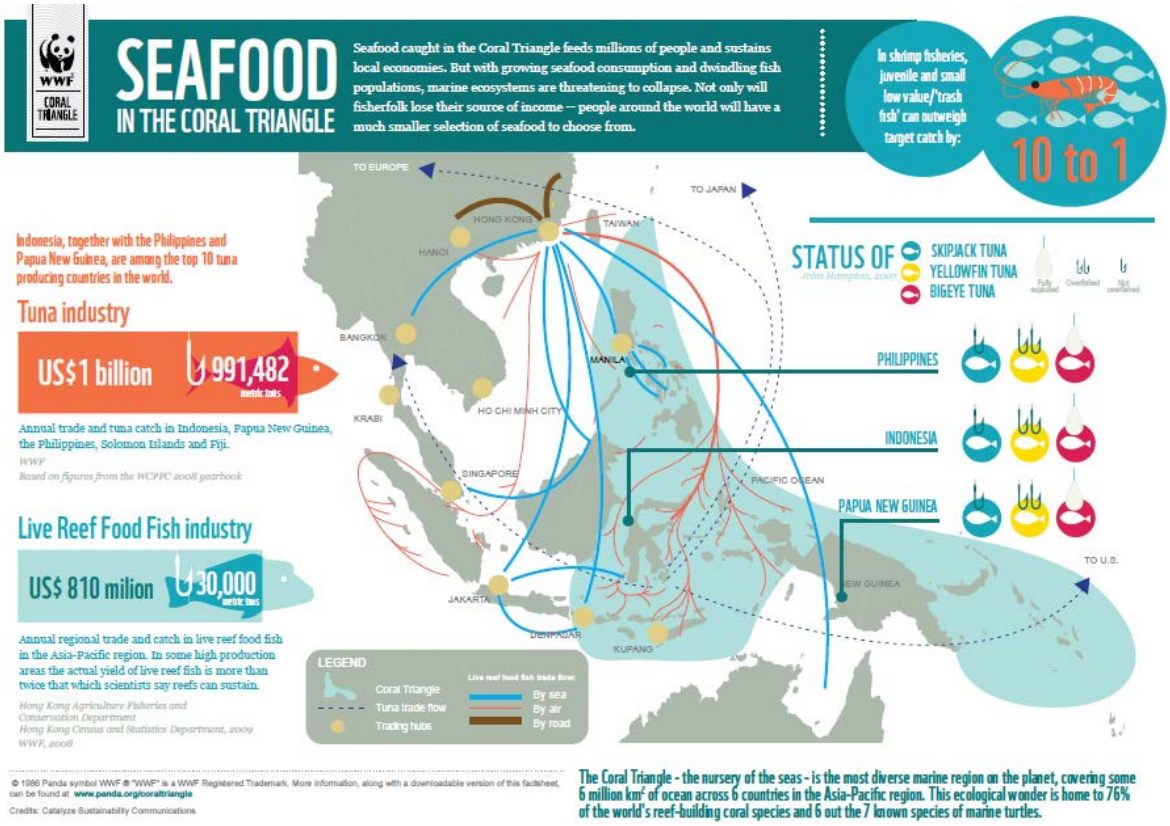
1 A Blue Economy is about more than just an overarching "green economy in a blue world" approach; it is about recognizing how innovation and technology and new partnerships can not only reduce environmental impacts and industry footprint but support livelihoods in areas that are remote for communities that have few alternatives other than to exploit natural resources (See: WWF and Blue Economies in the Coral Triangle Discussion paper by Jackie Thomas and Lida Pet-Soede).

Introduction

Global seafood demand is expected to grow by at least an additional 35 million metric tons by 2030 (Mora et al., 2009), spurring on fisheries, fish farmers, processors, suppliers, and retailers to meet this demand. Increases in demand of this magnitude will place enormous pressures on already highly stressed marine ecosystems and unless significant changes in fishery management and aquaculture production methods can be applied, supplies will continue to dwindle.

The waters in the Coral Triangle region, which includes Indonesia, Malaysia, Papua New Guinea, the Philippines, Solomon Islands and Timor-L'Este, produce a lot of seafood that is caught, farmed, and processed in a diverse industry that supports livelihoods in coastal and urban areas and consumed locally, regionally, and globally (Figure 1).

Figure 1. Some figures on wild-caught seafood in the Coral Triangle



A recent report by the Asian Development Bank (2013) estimated the combined value of capture fisheries and aqauculture in the six Coral Triangle countries was US$11.7 billion in 2007, contributing between 1.2–6.8% of the national Gross Domestic Products.While data are incomplete for Malaysia and the Pacific part of the region, the same report estimates that the seafood sector employs at least 2.7 million people as farmers and further 4.9

million as fishers. In Malaysia, 10% of the aquaculture workforce are women, mostly engaged in the marketing and processing part of this sector (FAO, 2012).

The Asian Development Bank (ADB) report summarises that marine and brackishwater aquaculture now contribute 13% to food fish production in the Coral Triangle. The supply and consumption of fish per capita of Malaysia, the Philippines, and Indonesia has increased since 1961, with especially fast growth in Malaysia, and is above the average values for Asia in 2009. This is reinforced by the fact that more than 20% of the total animal protein consumed on average in these countries between 2007-2009 came from seafood (FAO, 2012; Table 1). Generally, seafood comprises a higher percentage of protein in-take for the poor compared with the rich, making the poor more dependent on fish for food security (Kent, 1997). Based on expected population increases in the Asia Pacific region[2], more fish will be needed to feed a growing population, exclusive of the trend of increasing per capita annual fish consumption due to rising incomes and increasing urbanization. World per capita fish consumption is expected to rise 16% by 2021 with Oceania and Asia (including China) showing the highest growth rate (OECD/FAO, 2013). However, future increases in per capita fish consumption will depend on the availability of fishery products and with capture fisheries production stagnating, increases will need to come from aquaculture[3].

Table 1. Importance of fish in Coral Triangle countries' diets

	Per capita annual fish consumption (kg)[i]	**Percent of animal protein intake from fish**
Indonesia	21	53 – 58
Malaysia	58.5	34.5 - 38.5
Papua New Guinea	10 (rural); 28 (urban)	n/a
Philippines	39	42.8
Solomon Islands	31 (rural); 45 (urban)	94 (rural); 83 (urban)
Timor-Leste	4	n/a

**The fish per capita supply in the Solomon Islands is higher compared with the Oceania average, but Papua New Guinea and Timor-L'Este are at regional average levels. Source: ABD, 2013.*

2 The population of the Pacific Islands will increase by an estimated 50% by 2030 (SPC, 2008) while the populations of Indonesia, Philippines, and Malaysia will increase by 22%, 30% and 37% respectively (World Bank, 2012)

3 Sources: Indonesia, Malaysia: ftp://ftp.fao.org/FI/DOCUMENT/tsunamis_05/issues/fish_and_nutrition.pdf; Laureti in Choo. Philippines: Laureti in Choo; http://www.ats.agr.gc.ca/asean/4406_e.htm. PNG and Solomon Islands: http://www.spc.int/sppu/images/spc%20policy%20brief%201-_008%20fish%20and%20food%20security.pdf Timor-L'Este: http://www.fao.org/docrep/005/Y9571E/Y9571E00.HTM#22

Despite the obvious social and economic importance of coastal ecosystems of the Coral Triangle, in terms of fish production and consumption, they are among the most threatened in the world (Burke et al, 2012). And while the trade in seafood can bring tremendous benefits, seafood's contribution to food security will remain precarious in the face of poorly managed fisheries. Weak governance not only threatens countries' abilities to produce and consume seafood domestically but also to export it and use the trade system to purchase other foods. Improved governance is essential to sustain or increase seafood's contribution to food security (Smith, Roheim *et al*, 2010).

Coral Triangle country governments have continued to struggle over recent decades to improve their management capacity and allocate resources across vast oceans and thousands of kilometres of coastlines in order to provide adequate control over their marine resources. As a consequence, the ability of these oceans to continue producing sufficient seafood for domestic, regional, and global consumers is being compromised by declining quality of the ecosystems, and with that traditional fisheries livelihoods for rural coastal communities are increasingly at risk.

Hook and line fisherman with his day's catch of a dozen live coral trout (Plectropomus leopardus) to sell to a LRF grower. Taytay, Palawan, Philippines. © Jürgen Freund / WWF-Canon

In 2007, the leaders of the six Coral Triangle countries recognized that the economy, food security and the livelihoods of the people living in the region were under threat from a range of impacts on the oceans and coasts, including climate change, unsustainable fishing practices, pollution, and ocean acidification. This provided the catalyst for these leaders to work together on a common platform for sustainable management of marine resources in the Coral Triangle. In 2009, they launched the Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI-CFF). The CTI-CFF Regional Plan of Action together with the National Plans of Action for each of the six Coral Triangle countries, have provided an effective platform for regional collaboration and national prioritization and for delivery of critical marine commitments made through various multilateral environmental agreements including the UN Convention on Biological Diversity and the UN Conference on Sustainable Development. More importantly, these collective actions have supported the countries' own coastal livelihoods and seafood security needs [4].

Increasingly concerned with the dual challenges of feeding their own people and generating income from the export of seafood to other parts of the world, Coral Triangle country governments are looking to aquaculture as a solution to meet their nations protein needs, to generate export revenues and to create jobs. For example in Indonesia, where production from marine and brackishwater systems has risen 14-fold in just 7 years, the Ministry of Marine Affairs and Fisheries (MMAF) is targeting further increases in total seafood production with a goal of expanding production of 10.76 million tonnes in 2010 to 27.32 million tonnes by 2015. This was projected to provide its people with an average of 40 kg of fish per capita and the country with revenues from seafood exports of 6 billion US$ by 2015. The MMAF projects these targets will be met by stablising production from wild capture at 5.5 million tonnes per year and increasing aquaculture production from 5.0 million tonnes in 2010 to 21,81 million tonnes. Aquaculture production in turn is envisioned by MMAF to be achieved by supporting integrated farming for shrimp, tuna, seaweed, pangasius, tilapia, and cold-water species such as salmon, by extending farming areas especially outside Java, by developing feed and hatchery industries and by domesticating new species (Nikujuluw pers.comm. 2013).

While countries are placing an increasing emphasis on expanding aquaculture production to meet the future protein needs of their people and to provide food security and livelihood opportunities, this needs to be balanced against potential deleterious impacts that such an expansion could cause such as habitat loss and destruction, declining water quality, increased pressure on wild stocks for fishmeal, and bio-security. A transition to increased aquaculture production will need a greater emphasis on investment in innovation to lower a country's *seafood footprint* per unit of production and to transforming farming practices to reduce impacts.

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4 However, a recent ADB report (2013) evaluates how the CTI-CFF Regional Plan of Action (RPOA) has been silent on benefits and impacts of aquaculture.

Aerial view of shrimp ponds carved out of mangrove forest in the Sarawak Mangrove Reserve area, Sarawak, Borneo, Malaysia. © naturepl.com / Tim Laman / WWF-Canon

Moreover, recognizing that business and industry are key for innovation and hold significant economic power and direct influence over patterns of resource use and exploitation, government programs alone will not be sufficient to transform current practices. Investments and initiatives must align and will need to come in the form of public and private sector investment that supports innovation and improvement.

Market incentives such as certification of sustainable seafood are not necessarily successful in developing Asian countries, especially where the majority of production is destined for the domestic market. In Asian domestic markets, the influence of discerning retailers is limited and the consumer's choice is mostly influenced by price and availability. Seafood certifications limited appeal in the Asian urban seafood markets, compared to those in Europe, the USA, and Australia, is a result of several years of awareness campaigning to encourage consumers to choose their seafood responsibly and the fact these consumers have considerable, more disposable income. Moreso perhaps is that these consumers can choose from a wide variety of animal protein sources compared to Asian consumers where seafood is generally a more significant part of the total animal protein consumed and dietary preferences (FAO, 2012).

Within the Coral Triangle region, currently, there are too few incentives for enterprises and communities to exploit seafood resources sustainably or to start new endeavours that require large investments in research and development and/or infrastructure. A new

management and conservation paradigm is needed that harnesses the power of the private sector to bring about change at the level where it matters most: at the very base of the resource in its eco-system and with the communities that depend on seafood for their livelihoods.

These men harvested about 4 tons of milkfish (chanos chanos) from this pond and fish immediately put to ice and brought to nearby processing plant for deboning and other processes. Alsons Aquaculture. Sarangani, Southern Mindanao, Philippines. © Jürgen Freund / WWF-Canon

Green development and green economy are buzz words that are increasingly heard throughout the Coral Triangle. While there are no formal definitions, these terms are generally understood to be about the intersection between environment and economy[5] – that is, the way in which the social, economic, and ecological dimensions of sustainable development can be better integrated. More recently, the term “Blue Economy” has begun to be advocated by regional governments to recognise the oceans-related links between the private sector and sustainability. In order to realise this, it will be important to enable responsible public private partnerships in the aquaculture sector by redirecting significant investments strategically.

5 See the official Rio+20 website: http://www.uncsd2012.org/rio20/index.php?menu=62

I. Issues

1.1 Trends in Aquaculture Development

According to the FAO[6] (2012), capture fisheries and aquaculture supplied the world with 168.5 million tons of fish in 2010 with 35% of that produced by China alone and with aquaculture accounting for almost 79 million tons (47%) of this total. China on its own accounts for 70% of the worlds aquaculture production (Hongzhon, 2012). Globally, fish supply was 15.4 kg per person in 2009, and fish represented 6.5% of all protein consumed globally. Despite advances in the production of high-value carnivorous species (i.e. salmon) more than 70% of farmed fish are herbivores, omnivores, or filter-feeders (such as carp, tilapia, or mussels) (ARD, 2006). China dominates the global market for farmed tilapia, accounting for around 40% of global aquaculture production of almost 3.4 million tons in 2010 (FAO, 2009). Other major tilapia producing countries include Egypt, Indonesia, Thailand, and the Philippines. While aquaculture production increased by 90% in the decade between 2000 and 2010, capture fisheries production fell by 5.6% over this period. Importantly, less fish were being produced with vastly increased capacity and effort, indicating that Maximum Sustainable Yield had been surpassed.

These increased investments by governments and the private sector into expanding capacity, has seen the production in Coral Triangle countries from capture and aquaculture grow consistently over the period 2000 to 2010 (Table 2). Overall capture production in the Coral Triangle countries increased by 32% from 2000 to 2010, with tuna and grouper production in the Coral Triangle countries increasing by 77% and 53% respectively over this period. For aquaculture, overall production increased by 145% between 2000 and 2010, with fisheries production from aquaculture increasing by 138%. Total fisheries production from capture and aquaculture sources increased by 45% over the period from 2000 to 2010.

Table 2. Fisheries production in tonnes in Coral Triangle countries from capture and aquaculture in 2000 and 2010

Mode of Production	2000	2010
Capture production	6 884 655	9 087 825
Tuna	888 628	1 570 110
Grouper and Snapper	206 143	315 770
All Other fishes	5 787 884	7 199 945
Aquaculture production[1]	929 250	2 276 449
Fishes	734 023	1 753 605
Crustaceans	195 227	522 845
Total Fishery Production	**7 813 905**	**11 364 274**

Source: FishStat J, FAO, 2011, figures include Marine and Brackish-water production from aquaculture

6 FishStat J (FAO, 2012)

In Coral Triangle countries, aquaculture strategies differ regionally,with the Pacific countries more focused on the expansion of freshwater aquaculture, while the Southeast Asian countries appear to concentrate more on high-value carnivorous species (ADB, 2013). Indonesia and the Philippines contribute 95% to the aquaculture production in the Coral Triangle and are among the top 10 world aquaculture producers by volume, contributing 3.85% and 1.24%, respectively, to global aquaculture production (ADB, 2013).

Some of the data for Indonesia show that 85% by volume and 65% by value of Indonesian exports of frozen whole fishes goes to Thailand and the People's Republic of China, while the United States receive <1% of exports by volumes and 6% by value. The US and EU receive 48% by volume and 66% by value of exports of fish meat and mince while other Asian countries receive 52% by volume and 50% by value. Of these Asian countries, Japan receives 32% by volume and 42% by value while other Asian countries receive 10% by volume and 4% by value. The US and EU receive 32% by volume and 42% by value of frozen shrimp while other Asian countries receive 10% by volume and 4% by value.

It would be interesting to understand why seafood production strategies differ between Coral Triangle countries and to look in detail at where in the world Coral Triangle produced seafood is consumed in order to create some scenarios on the needs and opportunities for investments in sustainable seafood production.

Aquaculture for production of protein will likely expand even further, particularly in the Asia Pacific region and especially in mainland China. While this expansion may not directly relieve pressure on wild caught fish stocks, many suggest that aquaculture expansion will be pivotal to fill the demand for animal protein growing with the world's human population (Weeratunge, 2009). Replacing beef and pork with seafood from well-managed aquaculture operations could bring positive benefits and is starting to occur in some areas.

Past experience with impacts of different systems of aquaculture on the natural and social-economic environment must be considered when promoting further development. An evaluation of governance schemes[7] around aquaculture projects is also important to avoid un-clarity of roles, responsibilities, and benefits for different stakeholders when aiming for sustainable seafood production and sustainable livelihoods.

7 Monteray Bay Aquarium in their 2009 State of the Seafood Report, noted that while, "Aquaculture management varies widely by country, there have been no global assessments of management effectiveness in this area."

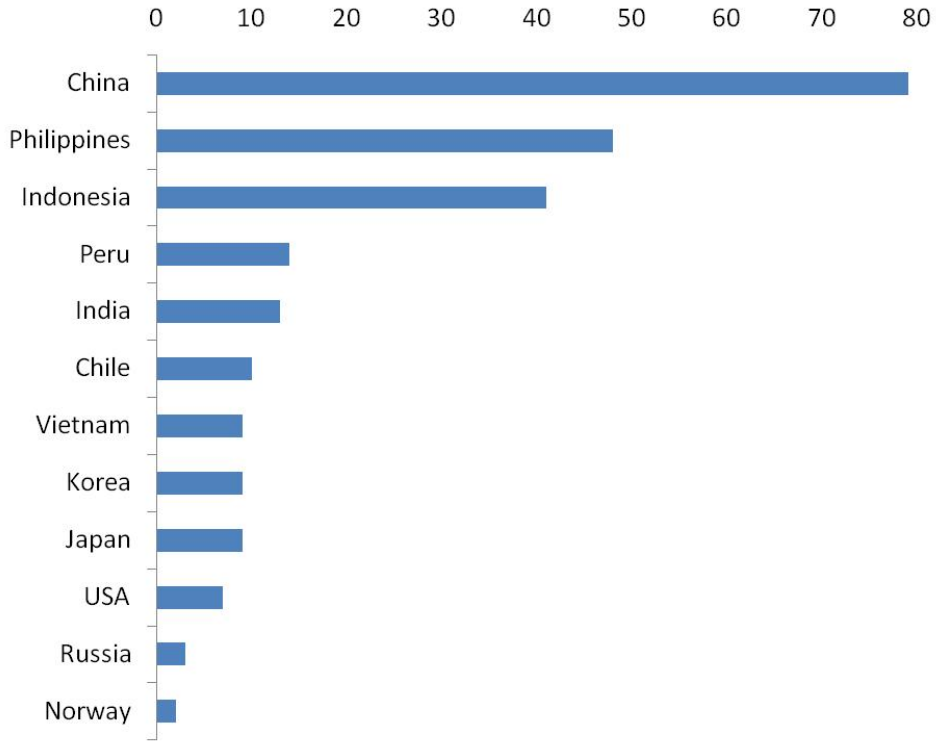
1.2 Impacts of Aquaculture in the Coral Triangle and Broader Southeast Asian Region

In order to simply maintain current levels of per-capita consumption, by 2030 the world will require at least another 23 million tons of aquatic animal food (FAO, 2012). According to the Organization for Economic Cooperation and Development (OECD) however, per capita fish consumption will increase by 16% in the next decade, escalating demand even further. Aquaculture will have to provide the bulk of these additional fish consumption needs.

Farmed seafood comes from a wide range of production systems which affect the overall foot print measured from life cycle assessments mostly as combination of a carbon and land use footprint per kg protein. In general however, fish feed production is most energy intensive, followed by the operations of water pumps and other water quality related equipment. The land use is significantly less relative to other production forms of animal protein (Nydam et al., 2012).

Asia's existing aquaculture and fisheries have a lower average marine ecological footprint than Europe's fisheries and aquaculture (Figure 2), an Asian sustainability success that is not widely appreciated (Powell, 2012). To a large extent, this is due to differences in seafood species at low trophic levels.

Figure 2. Comparison of efficiency of fish production in kg of fish produced per kg of primary productivity (Powell, 2012).



Generally, farming of herbivores and filter-feeders also has lower environmental impacts than farming of carnivorous species, particularly in marine environments. Also, closed systems generally have fewer impacts on marine ecosystems than open systems. Further, small-scale and low input-low output farming operations with the farmer as main shareholder and livelihoods as the motivation, often show greater operational longevity than intensive farming systems owned by external investors that have primarily a profit imperative. One example of a successful low footprint, stable farmed seafood in Asia is carp—the most important food fish in the world which is a low trophic level species farmed and eaten commonly in China.

In Asia, most aquaculture development has occurred in the coastal area, where access to seawater for pond recirculation is less challenging and where open access and incomplete regulation on coastal water use rights, have kept investment costs low. Aquaculture production in the Coral Triangle is dominated by seaweed and a few major fish**8** species including carp (Common and Silver Barbs), tilapia, and pangasius as freshwater species and shrimp, grouper, milkfish as marine or brackish-water species as well as smaller quantities of other species such as abalone, lobster, amd sea cucumber (Table 3).

Table 3. Dominant category of farmed seafood per Coral Triangle country

Country	Most dominant farmed category
Indonesia	Seaweed, shrimps, milkfish, giant gourami, grouper and mud crab
Malaysia	Seaweeds, cockles, shrimp/prawns (Hawaiian white shrimp and tiger prawn), barramundi, grouper, and mussels.
Philippines	Seaweed (mainly Kappaphycus and Eucheuma spp.), milkfish, shrimp (mainly tiger prawn, Penaeus monodon), oyster (mainly slipper cupped oyster Crassostrea iredalei), mussel (mainly green mussel Perna viridis), and groupers (mainly 'ranched' for the live reef fish trade)
Papua New Guinea	Limited marine and brackishwater aquaculture but some seaweeds, giant clams, crocodile, milkfish, mullet, mussels, oysters, and prawns
Solomon Islands	Some seaweeds, tilapia, sea cucumber, and marine ornamentals, including corals and giant clams
Timor L'Este	Promoted mostly brackishwater aquaculture (particularly tiger shrimp and milkfish) in some districts, including Liquica and Manatuto. Freshwater aquaculture, particularly of common carp, was promoted in Ermera, Aileu, Manufahi and Viqueque districts, where freshwater fish hatcheries were established. Aquaculture activities virtually collapsed during the conflict period.

Source: FAO Country Profiles in ADB, 2013

8 We don't address seaweed culture in this paper, while this provides significant employment in remote areas, there is hardly an immediate contribution to food security.

The impacts and production issues differ across various species and production systems and some of these are described below.

Habitat Impacts

Habitat impacts vary significantly with the species being farmed, the type of production system used, and the scale and location of the farm. In the Coral Triangle region, mangrove forests have been heavily impacted as coastal lands are converted to shrimp farms. The FAO (2006) estimates that as much as 10% of global mangrove forest has been lost due to shrimp farming (Boyd and Clay, 1998; FAO, 2007)[9], with mangrove loss in Asia estimated at almost 40% with more than half these losses caused by shrimp aqauculture (Valiela et al, 2001). In Thailand alone, an estimated 55% of total mangrove area has been lost, with more than 30% due to conversion to shrimp farms (Barbier and Sathirathai, 2004). In general, there are fewer new shrimp farms now being located in mangroves and overall the conversion of other sensitive habitats into aquaculture operations has diminished significantly (Montarey Bay Aquarium, 2009).

Clear cut of mangrove forests for fish pond. (generally practiced in the 1970s) Sibuyan Island Philippines.
© Jürgen Freund / WWF-Canon

9 According to White and Leon (2004), mangrove cover across the Philippines has declined by 75% since the early 1900s, largely to clear areas for fishponds to support a growing aquaculture industry.

With even lower costs of investment than land-based aquaculture, traditional cage culture is on the rise. Seabed and coral reef conversion or deterioration has been observed in Thailand, Indonesia, Vietnam, and Malaysia. Coastal aquaculture is prevalent across Vietnam and historically, the northern provinces have supported extensive lobster and grouper culture production. It is estimated that 80-90% of coral reefs in these provinces within or adjacent to Halong Bay[10] have been destroyed leading to major contraction in aquaculture in the area as seed availability from the wild has all but disappeared. Coastal aquaculture is now concentrated in central Vietnam (i.e. Nha Trang, Phu Quoc) farming shrimp, barramundi, lobster, and grouper through a combination of land-based and sea cage culture.

The area of available sites with optimal environmental attributes such as adequate water exchange, protection, limited pollution, and which are near trading hubs, is diminishing. Further consolidation of cage producers into fewer sites will exacerbate environmental impacts, while relocating farmers to new locations risks expanding negative impacts into previously unaffected locations. Especially in the more remote parts of the Coral Triangle, where land remains cheap or can be easily appropriated due to unsubstantiated tenure claims and unclear ownership, it is still less expensive to convert new habitat than to restore and reuse derelict ponds for farming.

Pollution

Nitrogen, phosphorus, and organic matter are the key nutrients that are released from nearly all forms of agriculture and aquaculture. These nutrients act as fertilizers in the oceans and can choke oxygen out of water or change species assemblages. While intensive aquaculture may have more noticeable and localized impacts, semi-intensive and extensive production may be discharging higher loads of these nutrients over time. Some forms of aquaculture production such as grouper farming result in excessive use and discharge of nutrients from feeding, pesticides, antibiotics, antifoulants, and disinfectants that are flushed out of the ponds or leaked from cage culture operations. These can have signifcant measurable impacts on the local ecosystem, especially when natural water exchange rates are low. Furthermore, the cumulative ecological effects of the use of these chemicals including bio-accumulation of toxins in wildlife and producing antibiotic-resistant bacteria have not been evaluated within an “ecosystems” framework such that long-term consequences are unknown.

10 Provinces such as Quang Ninh and Hai Phong.

Introduced Species and Escapes

Introduced species are often preferred for their higher prices and export potential. Escapes of these can have devastating effects on the original species diversity and population structure of an area. This includes changes in the trophic balance of the natural system, or in the genetic patterns of native species due to interbreeding. Escapes of cultured fish where the species is present in the natural environment may also have detrimental effects on the natural strain if cultured species are capable of breeding with native species.

Farmed fish can escape from all aquaculture systems but its prevalence will depend on systems and species. Escapes from tilapia farms are much higher in pond systems than cages because stocked tilapia reproduce in ponds and fry can easily escape small screen openings, whereas the opposite is the case with farmed milk fish and rabbit fish, that escape easily from cages during storm surges, typhoons and periods of intense rainfall as often occurs in the Philippines (NACA, 2012). Similarly in Malaysia, where grouper cage culture is prominent, escapes are common from cages that are located in waters that are explosed to the impacts of monsoons. These escapes can be of particular concern in hybrid groupers. While the ability of hybrid species to reproduce naturally is unknown and generally considered unlikely unless hormonally induced, these hybrid species will compete with wild stocks for food. Hybridization began in the 2000's with the first tiger grouper/ giant grouper hybrid species, and has expanded rapidly since[11]. There are now an estimated 2,800 cages in the Coral Triangle and a further 3,000 in China, mainly Hainan, and Taiwan (Irwin Wong, *pers comm*). Escapes are not uncommon and losses in excess of 600-700 hybrid individuals have been experienced in Sabah, Malaysia. These hybrid species have later shown up in trawl nets at sizes in excess of 2.5kg.

Spread of Disease

Intensive farming systems are more stressful for cultured species, thus generating a greater likelihood of the outbreak of diseases (e.g., through parasites, bacteria, viruses, etc.). These disease incidences have significantly impacted natural and farmed populations and surrounding ecosystems. In the Coral Triangle region this is most obvious in shrimp farming, where its rapid development has caused huge disease outbreaks and subsequent collapses in production (Monterey Bay Aquarium, 2009). Rapid expansion in grouper farming has likewise resulted in disease outbreaks, usually as a result of exceeding the carrying capacity of the water body. In Malaysia, grouper farming has expanded greatly in

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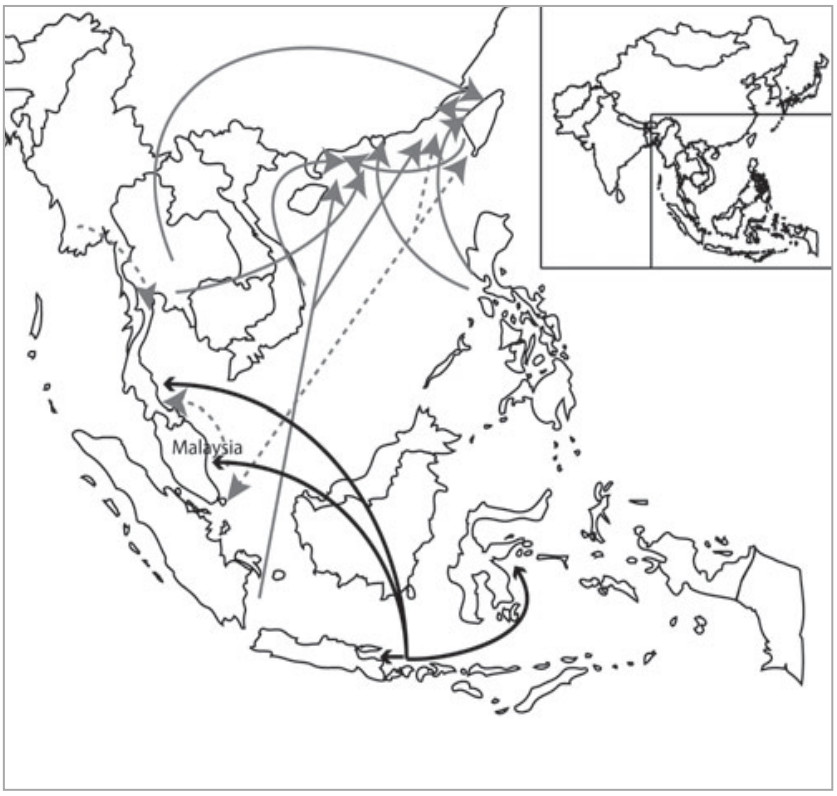
11 Peninsular Malaysia has over 800 cages stocking these specimens; Sabah about 1,000 cages. Southern Philippines have an estimated 400 cages and Indonesia about 1,200 cages. Moreover, Hainan and Taiwan have approximately 1,000 and 2,000 cages respectively holding this species (Irwin Wong, *pers comm).*

the States of Johore Bahru, Selangor, and Penang. In Kukup, Johore, an estimated 11,400 cages or wells covering approximately 40 hectares now occupy waters around Kukup Island. In recent years, these grouper farmers have observed much higher incidences of disease leading to mortality as well as experiencing reduced productivity and lower quality product. Declining water quality from overcrowding, high nutrient loads, and carrying capacity of the water body being exceeded are considered the main causes of these problems (Ernest Chiam, *pers comm*).

The rapid expansion in aquaculture production has been accompanied by increasing specialisation through the supply chain. This has seen an increase in trans-boundary movement of brood stock, fry, and fingerlings over large distances both domestically and internationally. This practice brings with it increased risk of diseases, which can be highly contagious and can spread rapidly across national borders, causing serious consequences. Examples include the unregulated exchange of grouper seed and brood stock (Figure 3) throughout the region. Continuing this practice may lead to losses of overall genetic diversity on natural populations and cultured stocks alike (De Silva, 2009).

Figure 3. Movement of grouper genetic resources through exchange of grouper brood stock and fry



Source: Modified from Sadovy, 2005. Thicker arrows indicate movement of grouper genetic material based on personal observations (De Silva, 2009).

Biosecurity and control of disease is often practiced through anti-parasitic chemicals and antibiotics but this could lead to chemical/antibiotic-resistance and direct impacts on local flora and fauna. There is ample evidence of trans-boundary movement of poor quality finfish seed, including grouper species, leading to high fingerling mortality and deformity (Arthur and Bondad-Reantaso, 2004). Using "cleaner fry" is one solution, but costs of testing fry and logistics surrounding the low availability of testing laboratories throughout remote areas cause small scale farmers to use antibiotics to reduce risks of diseases.

Impacts on Wild Stocks and Natural Resources

Much of the aquaculture industry depends on catching fish to feed fish with trash fish, fishmeal and fish oil, derived from industrial and artisanal fisheries, for shrimp and other carnivorous fish production (Tilman et al., 2002). According to the FAO, around 81% of global farmed fish and crustacean production and 60% of global farmed aquatic animal production are feed-dependent, Moreover, only 8 species or species groups account for 62% of the total feed used. Southeast Asia dominates production of these species[12].

There are concerns that these "feed fish fisheries" can have livelihood and food security consequences by diverting fish from direct human consumption to aquaculture. The situation in Asia is ambiguous where the use of such feedstuff in small-scale aquaculture is disadvantagous for some but has considerable livelihood benefits for others (Huntington and Hasan, 2010). From a social perspective, there is little evidence that an increase in fishmeal production will result in a decrease in consumption of these fish by the poor (Allison et al., 2011), but there are likely to be considerable impacts on fish stocks from aquaculture-related overfishing in the Coral Triangle, with its challenges being the lack of accurate data, suitable regulations, and enforcement.

12 These include grass and common carps and Indian carps, tilapia, white-leg shrimp, Atlantic salmon and pangasius.

Fish pond caretaker feeding and checking on status of sea bass being reared in the new pond carved out of mangrove forest near Sungai Petani, Kedah, Malaysia. © naturepl.com / Tim Laman / WWF-Canon

Trinidad (ADB, 2013) describes impacts of the increasing demand for trash fish with her case description of fish kills in the Philippines that were ultimately traced to an overheated aquaculture sector. Invariably, the costs associated with losses to other economic sectors, losses incurred by various government agencies, and the opportunity costs of use of these protein sources are not being taken into account when evaluating the efficiency, or otherwise of the farming of fish for food. In the same report Trinidad estimates that Malaysia will require at least 800,000 tonnes of trash fish costing roughly US$640 million to achieve a target production of 165,000 tonnes of marine fish – this for an economy whose trash fish for feed requirements comprised of 20% of total capture fisheries production in 2009. Contrast this with Indonesia's own target to increase aquaculture production from 5.0 million tonnes to 21,81 million tonnes in the next 5 years which, while including a high proportion of aquatic plants, will encompass numerous fish-fed species (Nikujuluw pers.comm. 2013).

In Indonesia, it is estimated that shrimp feed production in 2010 and 2011 was roughly 250,000 metric tonnes with 55% coming from imported fishmeal and 45% from domestic fishmeal sources – mainly Bali sardine (*Sardinella longiceps*). For tilapia, feed production in Indonesia in 2010 was approximately 540,000 metric tonnes with 60% of fishmeal imported and 40% coming from domestic sources. Domestic fishmeal for tilapia feeds comes from two main sources: captured wild Bali sardine; and fishery by-products comprising a mix of unprocessed Bali sardine used for canning and by-catch products such

as Layang scad (*Decapterus macrosoma*), round hering (*Disumeiria acuta*), and fringscale sardine (*Sardinella fimbiriata*). Furthermore, of the 5 major tilapia feed manufacturers in Indonesia, they estimate the domestic fishmeal comprises 80% sardinella species and 20% from by-catch products. Lastly, for grouper, of the 30,000 metric tonnes of feed production in 2010, 67.5% came from imported species – mainly Peruvian anchovy (*Angraulis ringens*) and the remaining 37.5% was Bali sardine, *Sardinella longiceps* from Bali Bay/Banyuwangi areas (Surdaryono & Hasan, 2011).

Many of the slow growing predatory fish that fetch high prices in the seafood trade, don't breed, grow, and mature well in captivity. Capture-based aquaculture or ranching, which entails collecting juveniles “growing them out” in confinement structures is still very prevalent in the Coral Triangle region. Ranching is a major concern not only because of the ecosystem impacts from the removal of juveniles from the wild but also because, in the case of highly carnivorous fish, this requires they be fed a diet of fish. For many of these slow-growing predatory fish, food conversion ratios (FCRs) using trash fish is high; around 6–8:1[13] during grow-out (NACA, 2010) In essence, this means fishing both ends of the ecological spectrum from target to non-target fish to complete a production cycle.

Lampung Province, Indonesia. © Tantyo Bangun / WWF-Canon

13 Food Conversion Ratios of 6–8 :1 imply 6–8 kilograms of trash fish will yield 1extra kilogram of farmed fish.

Social and Economic Impacts

Aquaculture is increasingly recognised as essential to meeting the future food security demands of the region (Hall et al., 2010). Importantly also, around the world, aquaculture already provides more than 100 million people with employment (FAO, 2012) and the Rio+20 conference saw groups as FAO and others promote aquaculture to strengthen economic viability of isolated areas and also as a way to enhance the status of women.

In Asia, most aquaculture development has occurred in coastal areas, where access to seawater for pond recirculation is less challenging and where open access and incomplete regulation on coastal water use rights help keep down investment costs for systems such as cage culture. Today, the aquaculture sector provides many livelihoods in areas where few alternative sources of income exist.

Despite these benefits, there are concerns that trends in aquaculture are contributing to the marginalisation of poorer fishers, traders, farmers, and processors in the region through an emphasis on the production of high-value export quality species, which can impede market access for many communities and lead to an unequal distribution of supply chain benefits for food security and employment.

A massive workforce of more than 300 women expert deboners debone milkfish (Chanos chanos) in this plant churning out products that is 60% for export market in North America and 40% consumed locally. Sarangani, Southern Mindanao, Philippines. © Jürgen Freund / WWF-Canon

There are especially clear indications that women are being forced out of employment in this sector where investments have supported the upscaling of aquaculture operations (FAO, 2012). It is important to consider the different dimensions of livelihood security that are crucial to improving food security (Foale et al., 2013) and invest in better understanding both the means of production and gender and equity issues in order to ensure fairness in access to food and jobs (FAO, 2012).

It is acknowledged that for some species, such as grouper, the capital investment requirement for grow-out is within the financial means of small producers, particularly where start-up loans or other incentives are made available (Pomeroy, 2004; 2006). However, the capital requirements for the brood-stock and hatchery/nursery infrastructure places aquaculture opportunities beyond the financial reach of most small-scale producers (Pomeroy et al., 2005; 2006). Despite these observations, access to credit remains the main obstacle and this is mostly related to the high production risks associated with aquaculture. Current estimates suggest that between one third to a half of fish and shrimps put into cages or ponds are lost as a result of poor health management before they reach marketable size (Tan et al., 2006).

Grouper Trade. Palawan, Philippines. © Gregg Yan / WWF-Philippines

Capture-based aquaculture is increasingly being recognized as an issue of global importance with estimates that capture-based aquaculture (CBA) comprises about 20% of all marine aquaculture production (Lovatelli and Holthus, 2008). Pomeroy (2008) suggests there are social, environmental, and economic advantages and disadvantages when comparing full-cycle aquaculture with capture-based aquaculture, particularly when focusing on the provision of employment and income to communities. Species of high market value or that are readily available naturally can be farmed without needing to develop hatcheries or breeding programs. Although this lack of domestication hinders genetic improvement. While CBA is practiced on many high-value species such as tuna and grouper, it is also used for low-value, low-trophic level fish species requiring minimum inputs. This latter application can provide food security and an additional income source to rural communities (Lovatelli and Holthus, 2008).

However, the "ranching" of various species can lead to significant stock depletion and transfer of disease, as well as having a higher contribution to overfishing, which in the longer term will diminish overall societal benefits.

Prices of fisheries commodities have been found affected by the rate of expansion of aquaculture – rapid growth would drive down prices of capture fisheries commodities, while slow growth will cause prices to rise and ultimately impact on access to fish supply (ADB, 2013). Some of our observations indicate a more complex relation between growth and prices:

- Rapid growth can lead to lower prices (lower margins);
- Rapid growth in culture will lead to increase in demand for feed causing feed prices to rise;
- Rapid growth in cultured species that lowers prices can spill-over into wild-caught fisheries, lowering the price of wild fish and impacting on fisher incomes (salmon is a developed world example);
- Slower than desired growth in culture production can place pressure on wild-caught species and increase in demand for wild will increase price, which in turn is incentive for increased effort; and
- Increased fish prices (domestically) can create food security issues for poorer communities.

These complex relations can be studied to great detail, but will be much affected by the level of governance and power of the market[14].

14 ADB (2013) mentions how the aquaculture sector differences in availability of information related to resource use and governance could lead to economic and social inequality (Cabral and Aliño, 2011). This information can be used by those in power for discretionary decisions that benefit only few individuals, including themselves. Information of this nature is crucial, especially for tenure and access rights.

Table 4. Comparison of the different Coral Triangle farming benefits in terms of food security and jobs

Species	Production System [1]	Siting [2]	Market [3]	Business Model [4]	Productivity Indicators	Livelihoods, Jobs & Food Security & Footprint Indicators	Benefit Rating
Tilapia	P (E to SI) C (SI to I) *Cages – low capital req.*	F, B	NC, D, E(↓ price)	SS, MSE, I	▪ Production costs ↓ ▪ Domestic revenue ↑ ▪ Yields (~10MT/ha) ▪ Yields per area ↑ ▪ High revenues relative to other agriculture	▪ Low trophic-level species, ▪ Low protein (fish) feed requirement ▪ Food supply benefits outweigh price ▪ Viable self-employment (gender) ▪ Affordable protein source	High
Pangasius	P (E to SI) C (SI to I)	F, B	NC, D, E(↓ price)	SS, MSE, I	▪ Production costs ↑ ▪ Domestic revenue ↓ ▪ Yields (~100MT/ha) ▪ High stocking density ▪ High revenues relative to other agriculture	▪ Low trophic-level species, ▪ Medium protein (fish) feed requirement ▪ High reproductive/yield capacity ▪ High disease/environment resistance ▪ Highly variable international price ▪ Affordable protein source	High
Shrimp	P (E to SI) C (SI to I)	M, B	Some D Mainly E (↑ demand & ↓ price)	SME, I (Increasing Intensive systems)	▪ Higher ROI than fish ▪ Yields vary from: ▪ (E = ~500kg/ha ▪ (SI = 1 – 5MT/ha) ▪ (I = 10 – 20 MT/ha)	▪ Lower trophic-level invertebrate, ▪ Medium protein (fish) feed requirement ▪ Volatile market, Vulnerable to disease ▪ Turnkey operation model successful ▪ Major Environmental impacts (costs) ▪ Large viable SS industry in VN and TH ▪ Medium to Higher labour intensity	Medium to High

Milkfish	C (I) P (SI to E) *(Polyculture)*	B	E (↑ % qty) D (↓ % qty), (Trend toward value-adding)	SME, I	▪ High % feed costs ▪ Domestic revenue ↓ ▪ Yields (~20MT/ha) ▪ Static productivity ▪ High relative revenues	▪ Lower trophic-level species, ▪ Higher protein (fish) feed requirement ▪ Lucrative Poly-culture (Tilapia, shrimp) ▪ Tolerant to extreme conditions ▪ Static domestic / export markets ▪ Less affordable protein source	Medium
Grouper	C (SI to I)	M	Some D (live, fresh/frozen), Mainly E (static demand & ↑ price)	MSE, I	▪ Production costs ↑ ▪ High export revenues ▪ Yields (10 – 30MT/ha) ▪ Higher FCR	▪ High trophic-level species, ▪ High protein (fish) feed requirement ▪ Volatile market, Vulnerable to disease ▪ Mainly for export/culinary tourism ▪ Medium capital requirement	Medium to Low

[1] C = Cage, P = Pond, E = Extensive, I = Intensive, SI – Semi-Intensive

[2] M = Marine, F = Freshwater, B = Brackish-water

[3] E = Export, D = Domestic, NC = Non-commercial

[4] SS = Small-scale/subsistence, MSE = Medium Scale Enterprise, I = Industrial, T = Turnkey (sell see and buyback harvest)

1.3 Lessons learned by WWF from Aquaculture Cases in the Region

WWF cares about how the demand for seafood is impacting—and will continue to impact—the environment and communities. Already, for example, more than 85% of the world's marine fish stocks are either fully exploited or overfished. And certain communities adjacent to fish farms feel their livelihoods impacted because, for instance, the farms have limited their access to natural resources. Recognizing the need to continue to engage a broad and diverse group of people in the development of global standards for responsible aquaculture, WWF initiated eight roundtables, called the Aquaculture Dialogues, starting in 2004. More than 2,000 people – farmers, conservationists, academics, government officials, and others – participated. They have created standards that will minimize the key negative environmental and social impacts for bivalves (clams, mussels, scallops, and oysters), tilapia, pangasius, and abalone. Standards for shrimp, salmon, trout, seriola, and cobia are expected to be completed in 2012. When finalized, the standards are given to the Aquaculture Stewardship Council (ASC), which is responsible for working with independent, third party entities to certify farms that are in compliance with the standards.

Annexed are some cases where WWF supports transformation of an particular aquaculture sector in the Coral Triangle and broader region.

II. Options for Improvement of the Aquaculture Sector

Over the past decades, significant progress has been made to mitigate negative impacts of aquaculture. Scientific research and investments in the development of new techniques has supported some reduction of the sector's environmental footprint and improvements in production efficiencies. However, in relation to substitution, there is ample evidence of advances in fish farming not resulting in reduced fishing pressure on wild stocks (California Environmental Associates, 2011).

2.1 Research and Development

Investments in research were often motivated following a collapse in productivity caused by the very impact of unsustainable management practices. Additionally, as the value of intact coastal ecosystems for coastal protection and as fish nurseries was better understood, stricter regulations on the preservation of coastal mangrove and sea grass areas resulted in a sharp decline in conversion of these habitats for aquaculture[15]. Particularly, the efforts to rebuild livelihoods in the areas hit by the tsunami of 2004, such as Aceh in West Sumatra,

15 Various awareness campaigns created positive pressure for the preservation of coastal ecosystems and the devastating impacts of the 2004 Asian Tsunami. This further underlined the significance of intact mangrove and other coastal habitats for the protection of people and infrastructure in coastal areas all along the Coral Triangle region.

illustrated the relevance and importance of spatial planning and integrated coastal zone management for achieving sustainable aquaculture.

As feeds are one of the most important cost factors in aquaculture production, and a source of risk where it is not available at a constant high quality, there has been considerable research and development into improved food conversion ratios (FCRs)[16]. Technical improvements in holding facilities and recirculation technology have reduced the negative impacts of effluents and escapes and investment in technology for full-cycle aquaculture of higher-valued export species improved the economic feasibility of such enterprises relative to the costs of wild capture of these species.

2.2 Collaboration and Certification

Building upon this new knowledge, multi-stakeholder aquaculture dialogues[17] on various high value seafood commodities have paved the way for consensus building on best practices respecting different interests within the aquaculture sector. The related market-based instruments are now rewarding compliance with best practice standards that recognize socio-economic criteria (Fair Trade,) and environmental impacts (Aquaculture Stewardship Council, Aquaculture Certification Council and Global G.A.P) as well as Organic brands (Naturland and Bio Suisse[18]).

In 2009, the ASC was founded as an independent not for profit organization by WWF and IDH (Dutch Sustainable Trade Initiative). It administers global standards for the most significant farmed seafood species. The standards were developed though a highly-credible, transparent, science-based, and multi-stakeholder process. This included convening hundreds of aquaculture producers, seafood processors, retail and foodservice companies, scientists, conservation groups, and the public to discuss how to best support the production of responsibly-farmed seafood through science-based standards. The standards include strict requirements for minimization of escapes, chemical use, sea lice numbers, predator control, and effluent release as well as strict requirements for feed ingredients from sustainable sources, habitat protection, and freshwater smolt production. Each standard also contains a comprehensive set of requirements to ensure social responsibility and enforces a much greater degree of transparency. These specific requirements will

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16 ADB (2013) suggests more research to improve the feed conversion ratio for species requiring a large input of trash fish. Investments could prove to be efficient in the long run and decrease dependence on wild-caught trash fish.

17 WWF-US has led the *Aquaculture Dialogue* program which is developing standards for the most important aquaculture species including tilapia, pangasius, shrimp, salmon and bivalves (abalone, oysters) to be used by the ASC to certify farmed seafood.

18 Species covered include many of those produced in the Coral Triangle region including black tiger shrimp (*Penaeus monodon*), Pacific white shrimp (*Penaeus vannamei*), tilapia, and pangasius.

ensure that only the most up-to date operators and those with the best sites will be able to comply with the standards and gain ASC certification.

Pangasius fish are unloaded onto the docks at the Hùng Vuong Factory near My Tho city, in the Mekong Delta, Vietnam.. Hùng Vương is one of the leading producers of Pangasius fish and is in the process of seeking ASC Certification. © WWF-Canon / Greg Funnell

The ASC's mission is to transform aquaculture towards environmental and social sustainability using efficient market mechanisms which create value across the chain. The ASC believes that providing a staged journey through exponentially strict and metrics-based standards is an efficient way to promote improvement, and an effective way to collectively drive the change toward more responsible farming practices.

The ASC's aquaculture certification program and seafood label will recognize and reward responsible aquaculture. The certification of aquaculture operations and of the seafood chain of custody will be carried out by independent third-party Certification Bodies (CBs). To be able to offer certification these CBs will have to be accredited by Accreditation Services International (ASI), an independent organization which has been appointed by ASC to take this responsibility. A CB will audit the farm against the Dialogue standards and then issue an ASC certificate. The ASC itself will not issue certificates. These types of third party programs offer the highest level of assurance and mean that the outcome is unbiased. Most of the other existing certification programs – and the standards they use – are not effective at making the aquaculture industry more sustainable (WWF, 2007). The ASC will be the most credible entity for environmental and social standards because its standards

will be measurable, based on sound science, created by a broad and diverse group of stakeholders, and developed through a transparent process. If we want to see change on the water, we need to back this hard work with a credible independent entity that makes it easy for producers, who comply with the standards, to become certified.

ASC certification is increasingly viewed by buyers, particularly in Europe, as the standard to strive for. Farmers holding ASC certification will be able to supply the most demanding and highest-paying markets. In addition, WWF is working in the consuming countries to encourage buyers to pay a premium price for ASC certified product and the more this can be achieved, the wider will be the move in Vietnam towards responsible practices. Adopting more responsible practices will also increase the future sustainability of the industry in Vietnam, protecting incomes and employment for the long term. Aquaculture over the last thirty years has seen many boom-and-bust cycles in different regions of the world and with various species. Many of the collapses have been due to environmentally damaging operating practices and a disregard for future sustainability. Vietnam can build a long-term industry by following more prudent practice - industry leaders and government are already cognizant of this, and are acting accordingly.

Currently, in the Coral Triangle region, various stakeholders are positive to start an *Aquaculture Dialogue* process and implement resulting standards through the ASC. These dialogues have encompassed a variety of species produced in developed (e.g., salmon, trout) and developing (shrimp, tilapia, pangasius) countries. There have been marked successes for some species such as ASC certified tilapia available from Indonesia and ASC certified pangasius from Vietnam. However much of the aquaculture production in the Coral Triangle remains outside these best-practice or standards frameworks and continue to generate negative social and environmental impacts. In addition, much of this production is traded through the domestic markets which do not have a requirement for certified product.

2.3 Future Investment

Given the issues raised in this paper, the following recommendations are put to government and development partners for consideration of re-directing existing and new investments strategically:

1. Invest in reducing the footprint of the existing aquaculture sector and phase out high footprint, low employment types quickly;
2. Invest in expanding low foot print aquaculture only inside Coral Triangle and in countries that heavily rely on Coral Triangle seafood;
3. Invest in shifting the balance between wild capture and aquaculture where needed; and
4. Invest in raising awareness, sharing of lessons and innovation, and collaboration for effective food production and livelihood creation.

There is still some work to be done to develop some of the specific technical and substantive policy positions to support decisions in specific investment strategies. The acceptability and suitability of farming top-order carnivores and reducing their requirements for fish meal and improving feed efficiency, must be discussed in light of competition with food security and contributions to employment of those who have few alternatives.

The role of government versus private sector in developing aquaculture should be made explicitly clear in relation to the objectives of employment and food security for the various investment schemes that will be considered. The legal support for the adoption of a Precautionary Approach to aquaculture policy and legislation, should be considered with particular emphasis on habitat and pollution impacts, feed requirements, and socio-economic goals. Improvements in technology, transfer of existing knowledge, and improved infrastructure such as improved feeds giving better FCR's, substitution of fish meal and fish oil, and construction of hatcheries, must be facilitated widely and in a pre-competitive fashion.

We see three main enabling conditions for the sets of recommendations:

A. *Enhance internal education and awareness within government departments and amongst agencies.*

   The majority of expansion of aquaculture programs is subsidized by dedicated departments within the agricultural or fisheries agency of the central governments. The government's aquaculture programs however, need to become more integrated with other fisheries and ocean relevant government departments as well as land and marine spatial planning agencies. It is also crucial that lower administrative levels of government within the provinces and districts be engaged in the process of determining the most suitable and sustainable approaches to develop this form of food production.

   This can be done through:

   - A conscious drive through the CTI-CFF collaboration (possibly through a road show) on the aquaculture work and its potential benefits – if conducted properly - to marine conservation, food security, and livelihoods[19];
   - A more integrated planning process between central government agencies and provincial and district authorities that are tasked with creating and implementing programs to support national targets;

19 ADB (2013) suggests that the CTI-CFF can be utilized as a forum for knowledge sharing on best aquaculture practices as well as those experiences that should not be emulated. The fish kill experiences of the Philippines can be instructional, especially as Malaysia prepares to expand mariculture of high-value species. The CTI-CFF can tap aligned institutional groupings, such as the Association of Southeast Asian Nations (ASEAN), SEAFDEC, and SSME, for knowledge sharing.

- Enhancing capacity of government research centres in the Coral Triangle region for influencing aquaculture development policies and industry practices; and
- Connecting/facilitating groups and organizations to become part of the existing aquaculture networks, to magnify responsible practices, to increase supply into the markets that recognize such initiatives, and apply lessons to engage in campaigns on responsible seafood production and consumption.

B. *Increase and coordinate the participation of the private sector in the Coral Triangle region to Aquaculture Dialogue type processes and support for ASC or equivalent standards.*

This can be achieved through two related approaches: the Aquaculture Dialogues; and Aquaculture Improvement Projects (AIPs).

There is a need to consider how to promote new Aquaculture Dialogues (e.g., grouper, milkfish) at the producer country level that address other relevant species. Platforms such as Seafood Savers in Indonesia and the regional Asia Pacific Sustainable Seafood Trade Network[20] are suitable mechanisms to engage with individual farmers or farmer associations, such as the newly formed Malaysia Fish Farmers Association of Malaysia, to instigate more responsible farming.

This can be done through:

1. Working with Coral Triangle countries to build capacity through aquaculture associations and round tables and assist directly in alleviating environmental impacts and improving farming practices through AIPs. An AIP is a structured approach that utilizes the power of the private sector and markets[21], to incentivize farmers, to implement stepwise improvements in their farming practices and production protocols, to become more responsible producers, and ultimately to comply with the ASC standards;
2. Advocate and assist in ASC certification of Aquaculture Dialogue target species starting with tilapia, shrimp, and pangasius as well as initiating new dialogues for other species such as grouper or milkfish that draw on the approach undertaken with the WWF Dialogue process;
3. Collaborate with commercial and development finance institutions in support of finance facilitation for AIPs leading to ASC certified products;

20 http://www.wwf.or.id/tentang_wwf/upaya_kami/marine/howwework/campaign/seafood_savers/ and www.panda.org/apsstn

21 Mainly export markets at this stage.

4. Harness the power of the WWF network in importing countries to further incentivize producers to adopt responsible practices and certification; and
5. Address new development initiatives and small-scale farmer relevant technologies and provide policy and technical advice as to how they can be supportive of the blue economy framework.

C. *Supporting policy change with solution oriented positions that have been vetted by relevant industry and community groups.*

The Coral Triangle governments require clear and justifiable evidence for the support of certain types of aquaculture. Governments will need to differentiate between current and emerging aquaculture sectors. Governments should be asking more from emerging industries as they will have learned valuable lessons from past aquaculture producers. This can be done through:

- Working with experts from the region within enabling agencies like the Network of Aquaculture Centers of Asia, Worldfish, Secretariat of the Pacific Community, ACIAR, the World Bank and others;
- Strengthening existing strategic partnerships with the private sector and enabling agencies and developing new strategic partnerships; and
- Developing strategic partnerships with other NGOs working in the region.

The growing need for aquaculture to contribute to food security, especially in Asian countries will require governments to actively support the growth of the sector and stimulate private sector investment (Hall et al).

III. Discussion

The CTI-CFF has an important opportunity at hand. As food security is one of its higher-level outcomes, and aquaculture is used by countries as a strategy towards that end, ADB (2013) and Foale et al. (2013) remind us that issues related to aquaculture must be recognized and reflected in the Regional Plan of Action, consistent with the Ecosystem Approach to Fisheries Management. Challenges and opportunities specific to the sector have been described above, but there are additional context that can be considered when looking at the broader picture.

3.1 The Risks of Maintaining Business as Usual

Cook (WWF, 2009) found that while some authors have predicted doomsday scenarios of conflict exploding out of environmental degradation, empirical evidence has shown it to be a more complex interaction. Rather than interstate conflicts, changes in the environment or movements of people that increase the risks of violence have primarily been intra-state, domestic conflicts (Goldstone, 2001). Cooks brief review suggests that it is safe to say that there can be a connection, which differs from there generally being a connection (WWF, 2009).

In the Coral Triangle region, poor communities and weak states are more vulnerable to insecurity from resource degradation and environmental shocks and stresses (Grimble et al, 2002). If these resources become scarcer, some may come into conflict with others in the community for control over the remaining resources. Additionally, if governments are weak and unable to provide a safety net for people, there may be conflict between people and government forces.

Maritime boundary quarrels exist in Southeast Asia. Thailand was renowned for its illegal fishing in the Gulf of Thailand, inciting the ire of many of its neighbours (Dokken, 2001). Vietnam, the Philippines, and China have difficult relations over control of the Spratley Islands in the South China Sea. By the early 1980s, most governments in the region had declared exclusive economic zones of 200 miles around their territories, allowing foreign fishers only with formal access agreements to enter these EEZs (Butcher, 2004).

Besides international disputes, there are also conflicts between the industrial, offshore fishers and the artisan, near shore fishers. The industrial fishers have highly efficient equipment and sometimes illegally fish in the near shore areas, which is off limits to them. These artisan fishers do not have the equipment (boats and fishing gear) to fish further away from the coast and therefore are in competition with the industrial fishers (Pomeroy et al., 2007). Violent clashes between the artisanal fishers and the large-scale commercial trawlers have occurred in the Coral Triangle and between different groups of tuna fishers. These underline increasingly the need to secure fish in a sustainable and equitable way.

It will be important to consider how to ensure continued interest in consumption and farming of low footprint species and prepare investments with the future consumption patterns in mind, not just what is required currently and not just in the type of activities that we know and master today. There are several scenarios that can be envisioned for the future preferences, demands, and needs in seafood. If, for example, China will shift its current consumption and production from carp, to species higher in the trophic level, the negative impacts related with the production of these higher footprint species will be greatly magnified. Its time to do some future thinking and investing.

Harvesting carp and other fish on Mr Ma's fish farm, Shezhong Village, Linghu County, Zhejiang Province, China. The total sum of carp produced on these relatively small farms is more than the total amount of fish produced any other nation. © WWF-Canon / Elma Okic

3.2 The Role of Development Aid and Trade

Trade and development assistance are the key avenues through which countries interact – the two fundamental instruments of foreign policy. Additionally, there is no doubt that private sector financing of fisheries in terms of private investment would massively outstrip any subsidies or development assistance offered by governments. Trade and development assistance policies and private investment flows have enormous potential, both positive and negative, to influence the management of natural resources, encourage transparency and accountability, and impact domestic governance capacity. This is certainly true in the fisheries sector, where policies and their implementation have direct, measurable, and often major impacts on livelihoods and the national economies of coastal and island developing states.

It is very difficult to get investment data, at least officially or collected on a consistent basis. The OECD recently looked at foreign direct investment in the fisheries sector and had no luck at all in getting hold of decent data as fisheries is lumped with agriculture and forestry in official statistics.

There has been significant past experience however in investing development aid in aquaculture. Many of those projects failed as the private sector was not ready or interested in co-investing in projects and their focus was often more financial than on the production of protein for immediate and future food and employment needs. The challenge is to get good contacts with the existing processing and buying part of the industry in the region and stimulate collaboration with the private sector investment banks and credit facilities. Additionally, following existing trade relations between countries would also be meaningful to enhance the feasibility of new investments in the aquaculture sector.

3.3 Life Beyond Growth

Aquaculture as an industry, particularly in the Asia Pacific, is here to stay and the real question becomes what is the investment agencies, governments and development agencies responsibility toward ameliorating impacts and restoring ecosystems. The major outcome of the discussions underway in various expert and collaboration platform would be the alignment of responsible investment in emerging economies. Aquaculture of certain species, especially of higher level carnivores and the “ranching” of wild-caught juveniles/fry (and in some cases both) are already well entrenched and growing rapidly and these industries persist and continue to expand as do their impacts.

On a per kg comparison, arguably, the grouper and shrimp production, contributes less to food security for local Coral Triangle communities than the production of tilapia or carp. On the other hand, the wild capture of grouper and shrimp can be argued to impact the future of local food security negatively, hence a case for aquaculture of these species is valid, provided it can reduce exploitation levels in the wild and be made economically viable.

In terms of food security, producers in Asia, especially China, Vietnam, India, and Indonesia, have benefited from culturing low trophic-level species, such as carps, barbs, tilapias, and pangasius, by easing dependence on high-protein feeds, and thus reduced the vulnerability of their sectors to externalities.

In terms of job security, aquaculture development must make sufficient credit available to small-scale producers, not only for start-up but to access technology that can reduce investment risks such as the uninsured risk of loss of fish stocks (i.e., disease or mortality) and risks in price fluctuations.

A feed barge at one of the Hùng Vương Pangasius fish farms in the Mekong Delta, Vietnam. © WWF-Canon / Greg Funnell

Important investment questions include: What are acceptable performance levels when looking at food security and employment instead of cash profits or financial returns on investments? Which species are appropriate, not only in terms of low footprint but particularly because their production will employ most people and provide a reasonable profit? Do the consumers want to eat that fish, do people want to stay in this type of jobs? What is the potential impact if China changes its consumption of mostly dometically produced low footprint farmed carp to other species that need to be imported from elsewhere?

In the Coral Triangle, the CTI-CFF needs to make a decision to either abide with the views of some Government Aid Agencies (GAAs), donors, and partners who see aquaculture issues as falling outside traditional livelihood or conservation paradigms (i.e., ecosystem approaches) or to work to influence these partners and collaborate to minimize impacts and optimize outputs in terms of food security and livelihoods.

IV. Conclusion

The aquaculture industry has caused significant impacts to the marine environment. Better management of aquaculture expansion will allow for healthier ecosystems offering higher community and ecosystem resilience in the face of increasing pressures from climate change, ocean acidification, and other imminent or rising threats to ocean life. Knowledge, interest, and opportunities exist to invest in the right type of aquaculture. It's time for action.

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References

Allison EH. Aquaculture, fisheries, poverty and food security. working paper 2011-65. Commissioned for OECD. Penang: Worldfish Centre; 2011 p. 60

Arthur, J.R. and Bondad-Reantaso, M.G. (eds.) 2004. Capacity and Awareness Building on Import Risk Analysis (IRA) for Aquatic Animals. Proceedings of the Workshops held 1-6 April 2002 in Bangkok, Thailand and 12-17 August 2002 in Mazatlan, Mexico. APEC FWG 01/ 2002, NACA, Bangkok. 203p

Asian Development Bank, 2013. ECONOMICS OF FISHERIES AND AQUACULTURE IN THECORAL TRIANGLE (EFACT) :FINAL REPORT June 2013.TA7307-REG: Technical Assistance for Regional Cooperation on Knowledge Management, Policy and Institutional Support to Coral Triangle Initiative (Financed by the Asian Development Bank, Australian Agency for International Development, and the Global Environment Facility). Prepared by Pacific Rim Innovation and Management Exponents Inc. (PRIMEX) Manila, Philippines for the Asian Development Bank (ADB). 153 pp.

AtKissen, S., 2012. Life Beyond Growth. Alternatives and Complements to GDP-Measured Growth as a Framing Concept for Social Progress. 2012 Annual Survey Report of the Institute for Studies in Happiness, Economy, and Society — ISHES (Tokyo, Japan). 73 pp

Banks, R., and Macfadyen, G. 2010. A blueprint for sustainable tropical shrimp trawl fisheries. Report prepared for WWF by Poseidon ARM LTD 135 pp.

Barbier, E. and Sathirathai, S. (2004). Shrimp Farming and Mangrove Loss in Thailand. Edward Elgar Publishing, United Kingdom, 268pp

Boyd C.E., and Clay, J.W. (1998) Shrimp Aquaculture and the Environment. Scientific American Magazine; June 1998 p59.

Burke L., Reyton, K., Spalding, M., and Perry, A., 2012. Reefs at Risk Revisited in the Coral Triangle. World Resources Institute Publication 86 pp.

Butcher JG, 2004. The Closing of the Frontier: A History of the Marine Fisheries of Southeast Asia c 1850-2000. Singapore: Institute of Southeast Asian Studies.

California Environmental Associates, 2012. Charting a Course to Sustainable Fisheries. 119 pp plus annexes.

De Silva, S. and Phillips, M. (2010) Live Reef Food Fish Trade Aquaculture Study (2010) Report prepared for WWF Coral Triangle Global Initiative by Network of Aquaculture Centres in Asia-Pacific

Dokken K. 2001. Environment, security, and regionalism in the Asia-Pacific: is environmental security a useful concept? Pacific Review 14 (4): 509-530.

FAO. 2007. *The World's Mangroves 1980-2005*. A Thematic Study Prepared in the Framework of the Global Forest Resources Assessment 2005. Rome: Forestry Department, Food and Agriculture Organization of the United Nations

FAO (2009) Cultured aquatic species information programme. *Oreochromis niloticus*. Retrieved from http://www.fao.org/fishery/culturedspecies/Oreochromis_niloticus/en

FAO, (2012), The State of World Fisheries and Aquaculture in 2012. Food and Agriculture Organization of the United Nations. Rome. 148 pp.

Foale, S., Adhuri, D., Alino, P., Allison, E.H, Andrew, N., Cohen, P. Evans, L., Fabinyi, F., Fidelman, P., Gregory, C., Stacey, N., Tanzer, J., and Weeratunge, N. (2013) Food security and the Coral Triangle Initiative, Marine Policy 38, 178-183

Goldstone J, 2001. Demography, environment, and security. In: Environmental Conflict, PF Diehl and NP Gleditsch, eds. Westview Press.

Grimble R, C Cardoso, and S Omar-Chowdhury, 2002. Poor people and the environment: issues and linkages. Natural Resources Institute, University of Greenwich; Woodward.

Hall, S.J, Delaporte, A., Phillips, M.J., Beveridge, M. ,O'Keefe M. (2011) Blue Frontiers: Managing the Environmental Costs of Aquaculture.Penang:TheWorldfish Centre; 2011

Haylor G, Briggs M R P, Pet-Soede L, Tung H, Yen N T H, Adrien B, O'Callaghan B, Gow C, DeVantier L, Cheung C, Santos R, Pador E, de la Torre M, Bulcock, P and Savage W. 2003. improving coastal livelihoods through sustainable aquaculture practices a report to the collaborative apec grouper research and development network (fwg/01/2001)

Hongzhon, Zhang, 2012. China's food security: sourcing from the seas. Commentary 2 pp. S.Rajaratnam School of International Studies, NTU. RSISPublication@ntu.edu.sg Editor RSIS Commentaries, Yang Razali Kassim.

Huntington, T.C. and Hasan, M.R. (2009). Fish as feed inputs for aquaculture – practices, sustainability and implications: a global synthesis In M.R. Hasan and M. Halwart (eds). Fish as feed inputs for aquaculture: practices, sustainability and implications. FAO Fisheries and Aquaculture Technical Paper. No. 518. Rome, FAO. pp. 1–61

International Bank for Reconstruction and Development (2006) Aquaculture: Changing the Face of the Waters Meeting the Promise and Challenge of Sustainable Aquaculture. The World Bank. 148p.

International Institute for Sustainable Development (IISD) (2011). Greening China's Fish and Fish Products Market Supply Chains. IISD. Canada. 151p

Kent G. 1997. Fisheries, food security, and the poor. Food Policy 22 (5): 393-404.

Lovatelli, A. and Holthus, P.F. (eds) (2008). Capture-based aquaculture. Global overview. *FAO Fisheries Technical Paper*. No. 508. Rome, FAO. 298 p.

Mora C, Myers RA, Coll M, Libralato S, Pitcher TJ, et al. (2009) Management Effectiveness of the World's Marine Fisheries. PLoS Biol 7(6). Case Study Report 89pp.

Nikijuluw, Victor PH, 2013. Executive Secretary of NCC-CTI-CFF Indonesia. Presentation on the Indonesian Seafood Sector and Support of CTI-CFF referencing MMAF data 2009.

Nydam, D., Rood, T., and Westhoek, H., 2012. The price of protein: review of land use and carbon footprint from life cycle assessments of animal food products and their substitutes. Food Policy Vol. 37, Issue 6 760-770.

Pomeroy R.S, Agbayani, R., Duray, M., Toledo, J. and Quinitio, G. (2004). The financial feasibility of small-scale grouper aquaculture in the Philippines. Aquaculture Economics & Management 8(1/2).

Pomeroy R.S., Parks, J.E., and Balboa, C.M. (2005) Farming the reef: is aquaculture a solution for reducing fishing pressure on coral reefs?

Pomeroy R.S., Sugama, K., Slamet, B., and Tridjoko. (2006). The Financial Feasibility of Small-Scale Grouper Cromileptes altivelis Aquaculture in Indonesia. Asian Fisheries Science 19(2006):27-42 27. Asian Fisheries Society, Manila, Philippines

Pomeroy et al. 2007. Fish wars: Conflict and collaboration in fisheries management in Southeast Asia. Marine Policy 31:645-656.

Pomeroy, R. (2008) Social and economic impacts of capture-based aquaculture in Lovatelli, A.; Holthus, P.F. (eds) Capture-based aquaculture. Global overview.p41-66. *FAO Fisheries Technical Paper*. No. 508. Rome, FAO. 2008. 298 p

Roheim, C.A., Asche, F., and Santos, J.I. (2011) The Elusive Price Premium for Ecolabelled Products: Evidence from Seafood in the UK Market. Journal of Agricultural Economics

Smith, M.D., Roheim, C.A., Crowder, L.B., Halpern B.L., *et al*. (2010). Sustainability and Global Seafood, *Science* Vol. 327 no. 5967 pp. 784-786.

SPC 2008. Secretariat of the Pacific Community. Fish and Food Security Policy Brief. January 2008. Available online at http://www.spc.int/sppu/images/spc%20policy%20brief%201-2008%20fish%20and%20food%20security.pdf

Tilman, D., Cassman, K.G., Matson, P.A., Naylor, R. and Polasky, S.(2002) Agricultural sustainability and intensive production practices. Nature 418, 671-677

Valiela, I., Bowen, J.L. and York, J.K. (2001) Mangrove Forests: One of the World's Threatened Major Tropical Environments, BioScience *Vol. 51 (10) pp 807-815* .

Weeratunge, Nireka. 2009. The Place of Fisheries in markets and food security in an urbanizing world: Outlook for EAS Countries. The WorldFish Center, Penang, Malaysia

White, A. T., and R. O. D. D. Leon. 2004. “Mangrove Resource Decline in the Philippines: Government and Community Look for New Solutions.” In *In Turbulent Seas: The Status of Philippine Marine Fisheries*, edited by DA-BFAR (Department of

Agriculture-Bureau of Fisheries and Aquatic Resources). Cebu City, Philippines: Coastal Resource Management Project of the Department of Environment and Natural Resources

WWF 2007 “Benchmarking Study: Certification Programs for Aquaculture". Copy can be obtained from authors.

WWF 2009. Promoting a Security Agenda within the Coral Triangle Initiative, strategy input paper by Jonathan Cook. 35 pp. Available upon request by lead author.

WWF 2013. WWF and Blue Economies in the Coral Triangle: Developing and Demonstrating Blue Economies for Sustainable Development and Profitable Resource Use in the Region. Discussion paper.

Yosef, S. (2009). Farming the aquatic chicken: improved tilapia in the Philippines. In: Millions Fed, pp125-130. International Food Policy Research Institute, Washington D.C

Annexes – Case Studies from WWF Experiences around the Region

Case studies were developed with Candhika Yusuf of WWF-Indonesia, Joel Palma of WWF-Philippines, Ernest Chiam of WWF-Malaysia, and Ngo Tien Chuong and Huynh Tien Dung of WWF-Vietnam.

Case A: Tilapia

Indonesia and the Philippines accounted for approximately 11 percent and 9 percent respectively of global tilapia production (IISD, 2011). Aquaculture production of tilapias in Malaysia[22] is expanding rapidly and is seen by the Malaysian government as an important species for future food security and export earnings. There even is an ACS certified Tilapia farm in the North of Peninsular Malaysia. Tilapia farming has expanded greatly globally and in the Coral Triangle as tilapia accepts cheap feeds with a higher percentage of plant proteins and these fish are relatively resistant to poor water quality and disease, and as such can be cultured intensively and economically.

Within in Indonesia, Tilapia is the second largest aquaculture commodity, after the seaweeds, and the largest fresh-water aquaculture commodity in 2010 (Figure 4). The increased demand for tilapia caused that subsistence-based production now competes with larger, export-driven production and this created greater environmental impacts and weakening of the position of small farmers. Bad practice in discharge of waste water and effluents led to lower water quality, use of chemicals and aquatic medicines are released into the surrounding environment, pollution from feed and/or fertilizer inputs and escapes was also rampant. Because tilapia farming is most often carried out in land-based ponds, mangrove clearing and soil salinization are other negative environmental impacts. Tilapia, however, are a lower trophic level species with smaller footprint and lower energy consumption than many other farmed species[23]. The growth period of tilapia is about six months from fingerling to commercial-sized fish and yields can reach up to 12 tonnes per hectare (Cui, Personal comment).

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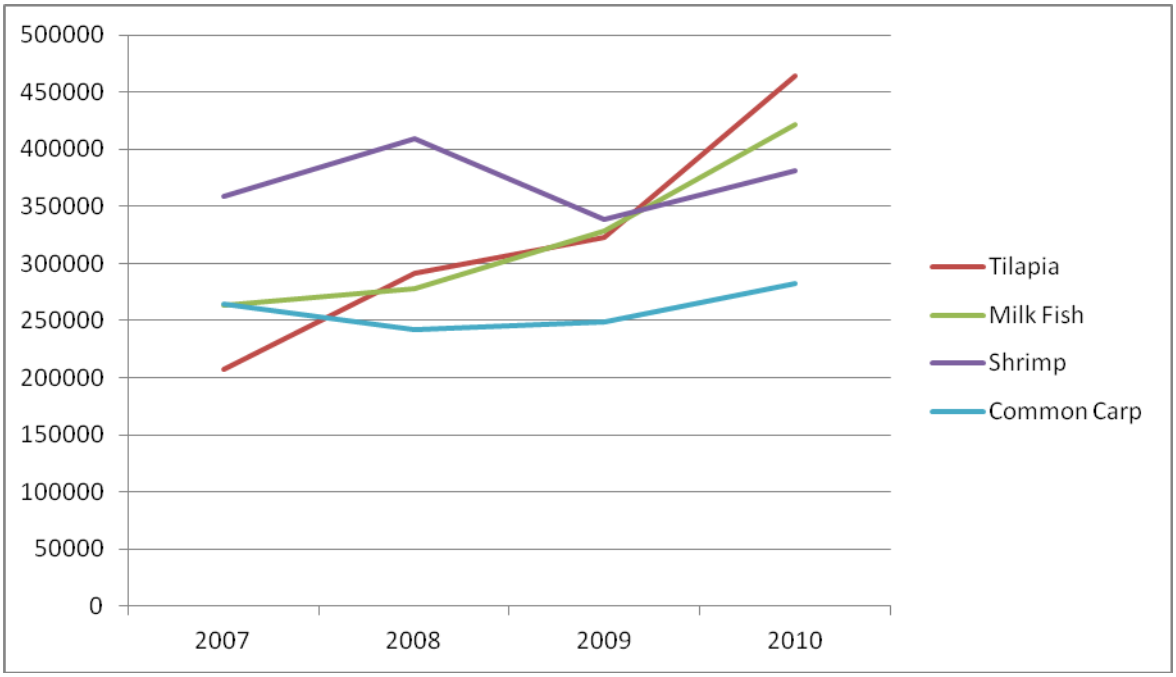
22 A Tilapia farm in Lake Temenggor in Northern Peninsular Malaysia has recently been ASC certified.
23 To produce one kilogram of tilapia likely would save more than 40% of the energy required to produce a similar amount of aqua cultured salmon, and 30% of that of pangasius.

Despite the large production volumes, Tilapia aquaculture appears to still be dominated by small scale farmers with Malaysia perhaps as slightly different (larger farms). One major exception in Indonesia is an integrated Tilapia farming operation run by PT Aquafarm Nusantara[24], which has production sites in Toba Lake, Sumatra and several places in Central Java. PT Aquafarm Nusantara is one of only a few companies to have obtained the ASC certification for its Tilapia product, a milestone which was achieved in 2012. According to the Toba Lake Ecosystem Management Coordination Authority[25], Tilapia has been cultured on Toba Lake since 1986. In 2008, within Toba Lake's total surface area of 110,260 Ha, there were 6269 tilapia licensed aquaculture units, made up of 4922 units operated by small scale farmers, and 1347 units operated by PT Aquafarm Nusantara.

Figure 4. Indonesian Aquaculture Production Statistics (excluding seaweed).



Source: MMAF, 2011

WWF-Indonesia began coordinating a program in 2010 aimed at engaging small-scale tilapia farmers in Toba Lake to benchmark their operations against the ASC Tilapia standard. While these small-scale farmers may not yet comply fully with the ASC Standard, the Standard has been the point of reference to minimize or eliminate the key, negative impacts of that aquaculture activity. Using this approach has seen compliance of some farm operations increase from 63 percent to 81 percent with improvement observed across legal compliance, site management, water quality, nutrient utilization efficiency, bio-security

24 Regal Springs.
25 Badan Koordinasi Pengelolaan Ekosistem Kawasan Danau Toba (BKRPDT)

(escapes) chemical use and social and gender equity issues. The one area where improvement was more difficult to monitor was feed sourcing and usage where feed manufactures have been reluctant to provide information. A primary objective of this exercise has been to demonstrate how an internationally endorsed market-based standard (the ASC Tilapia Standard) can be used to guide small-scale farmers to adopt new and better practices. Based on the pilot project, a "living" Best Management Practice manual has been produced for Tilapia as a guidance document for small-scale farmers to develop a step-wise approach to reaching the ASC Tilapia Standards, as well as improve quality and production. The BMPs manuals will be peer reviewed periodically.

Herbivorous and omnivorous species, such as carps, milkfish, mullets, eels and tilapias can address basic needs for food and with genetic improvements in tilapia (Yosef, 2009), it is a key species in support of improved food security. Tilapia remains a very important species in Indonesia with regards food security and livelihoods, however several issues and challenges have arisen with regards markets and livelihoods and protection of the environment. These include:

1. Ironically, one of the main challenges in attracting Tilapia producers to participate in this BMP project has been the fact that domestic market prices for Tilapia are as much as 30% higher than the prices able to be paid by PT Aquafarm for product for the export market[26]. With no buyer demand for "better" or more responsibly produced Tilapia for the domestic market, there is no incentive for producers to agree to abide by Tilapia standard
2. A smaller preferred market size for domestic as opposed to export markets, which is influencing small-scale producers to cater to this domestic market, not only for price but to the reduce risk of fish mortality.
3. Despite the clear benefits from "clusters" of small-scale farmers joining together to work on collective issues such as improving ambient water quality, competitive pressures among small-scale farmers are often greater forcing them to compete for market share,
4. The issue of a lack of domestic demand for Standards compliant product is not restricted to Tilapia and is symptomatic of the challenges faced regionally in using market incentives to drive improved performance
5. Fresh/chilled tilapia is sold at less than a third of live tilapia making selling fish in live form an attractive value addition process. If the higher market price would be fairly shared with the farmers, such value-adding for domestic markets both magnifies livelihood benefits for farmers and tilapia complements food security needs.

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26 Note that a similar difference in prices exists in Malaysia with domestic "certified" Tilapia retailing for 7 Malaysian Ringgit per kilogram as compared with 4 Ringgit for exported Tilapia product

Case B: Shrimp

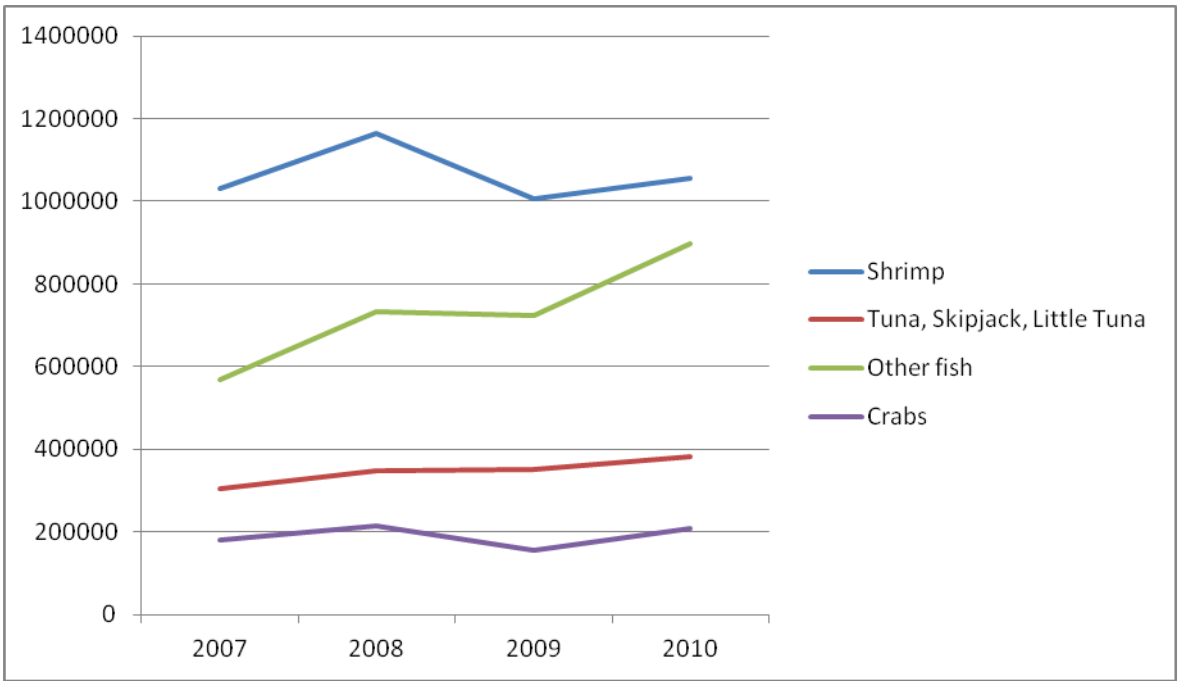
Shrimp farming and related declining prices of shrimp have had some impacts on the trawl shrimp fishery. This is one of the most unselective and damaging fishing methods in the world and particularly known for its high levels of by-catch on non-target species. Banks and Graeham (2010) describe the Coral Triangle shrimp fisheries as being fuelled by short term objectives for profit, resulting in many social conflicts over access to fishing grounds and the impacts on other fisheries target species. 40% of the shrimp catches in the Coral triangle region come from Indonesia and Vietnam and 60% of that is caught with these unsustainable trawl, that are relative small scale at about 8-12 m. Their recommendation for a blue print towards sustainable shrimp production included clear recommendations to cut at least 50% of the fishing effort for shrimp to restore sustainable levels.

In 2010, Shrimp was the fourth largest aquaculture commodity produced in Indonesia, and the largest by export value (Figure 5). In the early 1980's shrimp production was dominated by intensive culturing of Tiger shrimp (*Penaeus monodon*) but disease outbreaks duing the 1990's resulted in the industry switching its focus to Pacific White Shrimp (*L. vanammei*).In the period since, production of Tiger shrimp has slowly increased although White Shrimp remains the predominant species cultured.

Under this broader context, in 2009, WWF-Indonesia began work with traditional small scale tiger shrimp (*P. monodon*) farmers in Aceh and Tarakan – East Kalimantan to implement a Shrimp Best Management Practice program that used the final draft of Shrimp Standard produced by the multi-stakeholder Shrimp Aquaculture Dialogue (ShAD). Sustainable shrimp farming in extensive systems could possibly make up part of the drop in production to a still growing demand, and provide important livelihoods at the same time.

A year later, together with Oxfam Novib, IUCN – NL, Wetlands International Indonesia Program and Telapak, a consortium was formed with a Responsible Shrimp Culture Improvement Program (RSCIP) and the consortium conducted a gap analysis at 6 major shrimp production sites through out Indonesia (Lhokseumawe in Aceh, Tarakan & Mahakam in East Kalimantan, Bone in South Sulawesi, and Lamongan & Banyuwangi in East Java) to identify suitability of traditional shrimp aquaculture operations for certification against both the Draft ShAD Standard and the Global GAP Standard.

Figure 5. The export value of Indonesian Fisheries 2010 (US 1.000)



Source : MMAF, 2011

From the gap analysis seven major areas were identified for improvement:

Socio-economic Issues

The working relationships between workers and farm owners, specifically the rights of farm workers and obligations of owners for fair and responsible farm operations.

Most criteria addressed under GLOBAL G.A.P and ShAD Standards are irrelevant to the "traditional" farms observed due to the scale of business and the nature of the relationship between farm owners and farm managers. Unlike major farms targeted by these Standards, 'farm owners' in this study usually had only one employee; the farm manager. The relationship was more partnership then employee-worker making the need for representatives or associations, as called for, unnecessary. Likewise the socio-cultural nature of the relationship between owner and managers/workers means that 'formal' contractual arrangements are shunned Transaction and operational costs, payments for harvest shares etc. are shared publicly among the surrounding community and where those prevailing social values are violated, sanctions are agreed and enforced by the community. In summary, assumptions regarding relationships between owners and managers or workers that form the basis of GLOBALG.A.P and ShAD Standards doesn't accommodate the diversity of prevailing patterns of shrimp cultivation in Indonesia.

The obligations of farm owners to undertake practices that will minimize or eliminate negative socio-economic impacts onto surrounding communities.

The relevance of this criteria is limited in farms that are traditionally run with individual, not company scale, ownership that predominated in the assessment sites. Where farms are sited close to communities such as in Bone or Banyuwangi, farm owners are not outside companies, but part of the community and decisions are made through the consensus of farmers and non-farmers alike at village meetings. In other sites, farms are sited far from settlements, with little or no community interaction. Because of the nature of kinship among farmers and non-farmers, conflicts are resolved mutually following traditional values.

Recruitment, farm workers in populated sites (i.e. Bone, Banyuwangi, Lamongan and Lhokseumawe) are recruited locally on the basis of trust and reliability. This in turn is reinforced by profit sharing systems that prevail amongst farm owners and workers. With remoter farms (i.e. Mahakam and Tarakan) kinship ties are equally as important, although may extend beyond village boundaries

Environmental and Biodiversity Issues

Waste Management

Waste; such as empty chemical containers, effluent and sludge are poorly managed in small scale shrimp farming with farmers have limited knowledge as to impacts. Improving the performance of small-scale farms in relation to waste management would benefit from “clustering” of farms so as to manage effluent discharge more efficiently at scale and make monitoring of receiving water a group as opposed to individual responsibility, making compliance with Standards more achievable.

Habitat Protection

Most of traditional farms were constructed on the basis of optimizing mangroves/intertidal areas, which are considered as un-used (non-productive) area. Environmental and biodiversity aspects have never been important due to lack of farmer and community awareness on its benefits.

Biodiversity Management

The small-scale nature of Shrimp farming in the six (6) sites and lack of availability of information has made identifying biodiversity impacts from broodstock sourcing, mainly of Tiger Shrimp, such as from by-catch difficult. With regard to sources of feed, while certified imported fish meal is available, there is a reliance on domestic fish and many mills in Indonesia are currently unable to identify either the source of

domestic fish for fish meal or whether it is being responsibly managed. Moreover, small-scale farmers will tend to be price as opposed to quality driven when it comes to feed.

Farm Operations

Farm management and Traceability

Most small-scale farmers lack the technical skills to optimize farming production. The document requirements needed to meet farm management guidelines at all control points, as specified under GLOBALG.A.P or ShAD standards, is onerous for small-scale farmers. Where possible, guidelines should be streamlined to ease the burden on small scale shrimp farms, but not to the detriment of good controls. With regards traceability systems, certification needs along the supply chain (e.g. hatchery, farm, processing plants, and feed mill etc.) are costly and complex. “Cluster” certifications is one approach that can help relieve certification-related expenses, allow for farms to access market advantages and improve buying power for feed and seedlings and managing risks associated with food safety and environmental standards more efficiently. All these will improve the likelihood of small-scale farms complying with performance-based certification Standards such as ASC. Performance-based certification provides more flexibility for farmers to meet certain standards than does procedures-based certification.

Feed Management

Small scale shrimp farms in Indonesia are more reliant on natural feeds and there is only limited use of compounded feed among this group. Fulfilling Standards requirements in relation to feeds is to a large extent dependent on feed mills. Many mills are unable to vouch for their domestic sources of feed and until this is resolved, it will impede small-scale farmers from the certification process and from compliance with existing Standards

Chemicals

The major chemicals used in small-scale shrimp farming are pesticides use to tackle “pest” infestations (e.g. snails), particularly when farming extensively in mud flat areas, where this fauna competes with cultured shrimp for natural feeds and space. Moreover, most small-scale farm owners and managers are unaware of wider impacts of ongoing pesticide use. While an outreach and education program is needed, in the immediate term research is needed to examine residue impacts on shrimps

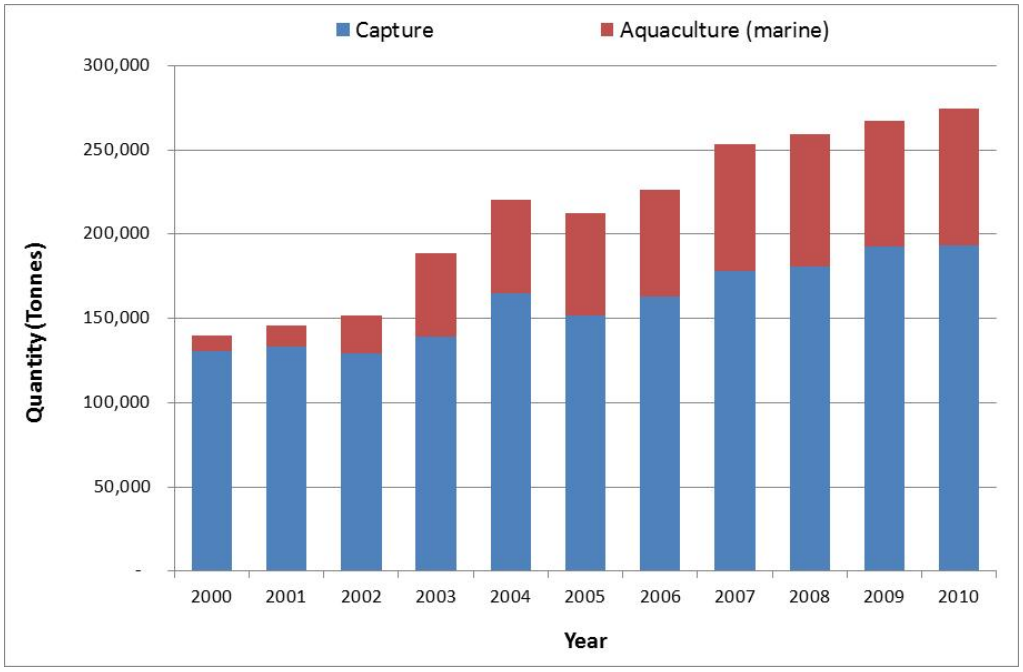
Disease Management

The majority of small scale farmers are culturing Tiger shrimp, and there are ongoing issues with disease. While in the longer term, application of SPF concepts to Tiger shrimp farming, along with domestication and selective breeding will contribute to disease prevention, the main challenge for farmers have been preventing the transfer of disease horizontally (between farms) and vertically (from one culturing period to the next).

Case C: Grouper

Grouper is one of highest-valued seafood species in Asia. The global production of cultured grouper developed rapidly, especially in China & the countries of Southeast Asia. Based on FAO fisheries statistical data, in 2010, the production of groupers from the Asia-Pacific was almost 275,000 tons, comprising 193,000 tons from capture and more than 81,000 tons from aquaculture production. This represents a 48% increase in capture production & 750% increase in culture production since the year 2000. During the same period, the relative contribution of cultured grouper to the total grouper production increased from 7% to about 30%, on the back of significant production increases in mainland China[27] (Figure 6).

Figure 6: Global Grouper Production 2000 – 2010



Source: FAO Fishstat Database

27 Note that prior to 2003, data on grouper culture production from China were limited and as such significant increases post 2003 lack substantiated baseline information.

In mainland China, grouper is farmed almost entirely to meet domestic demand whereas in the Coral Triangle grouper is farmed or ranched mainly for export as live reef fish. Because certain grouper species can fetch a higher price in the Live Reef Food Fish Trade (LRFFT), there has been an adequate incentive to not only fish for more wild catch, but also to look to aquaculture, or more precisely ranching of these species to generate increased production levels and more stable supplies.

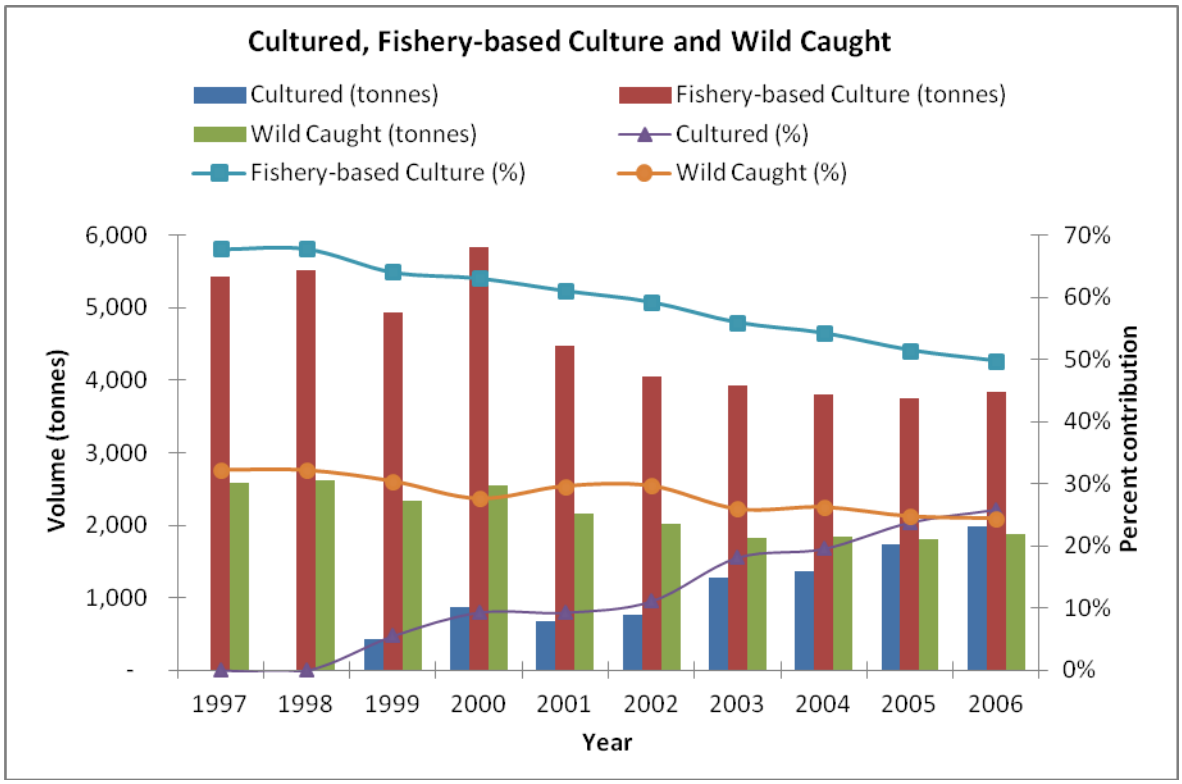
Since its start, grouper farming has substantial environmental impacts, in spite of the relatively small volumes involved or the relative small size of the individual production facilities. The farming of these carnivorous species has placed a large demand on wild fish. As full-cycle grouper farming was in its infancy, grouper brood stock were taken from the region's already highly stressed coral reefs, and many of juvenile groupers were removed from the wild for grow-out. In many cases the capture methods were highly destructive for the reef for example use of cyanide to support easy capture of large mature individuals or for other reef fish species for example that ended up as by-catch in light traps used at sea grass beds and mangrove areas. This not only affected the overall reef fish population dynamics but also reduced the replenishment of natural grouper populations. Furthermore, over the years, a lot of other fish has been caught to feed the grouper in captivity. The combination of fishing, grow-out and farming of groupers added greatly to an already over-exploited reef environment.

Grouper farming comprises a mix of small and medium enterprises with small-scale farmers often engaged in extensive farming of fingerlings produced in full-cycle hatcheries e.g. Peninsula Malaysia, and ranching mostly carried out by small-scale fishers who firstly depleted wild stocks of large size groupers and now grow out wild-caught juveniles to market size e.g. Sabah, Malaysia, Tayaty Bay in Palawan, Philippines, Halong Bay in Vietnam and multiple locations in Indonesia including Lampung in in Sumatra, Kepulauan Karimunjawa in Java, Berau and Bontang in East Kalimantan, Spermonde, Wakatobi and Banggai in Sulawesi and on Lombok in Nusa Tenggara Barat.

With advances in technology for hatchery production of grouper fry and because of the potentially high return from selling grouper species into the LRFFT, development organizations e.g. Australian Centre for international Agricultural Research, Network of Aquaculture Centres of Asia, have for some time identified grouper production as providing a high livelihood potential (Haylor et all, 2003). With these and other groups providing enabling support, production sources have shifted to meet the continuously growing demand in the LRFFT since 1997. For example in North Sumatra, former shrimp farmers are converting part of their farms to grouper nurseries. A farmer can purchase fry from hatcheries in Bali and in 3 months' time, sell the juvenile grouper at a 300% profit.

The contribution from wild-capture production has been stable or declining while the contribution from full-cycle cultured grouper has increased steadily to 25% of total volumes, (Figure 7). While pressure on wild stocks did not obviously reduce, there is reason to believe that it did not increase much either, which is a positive side effect of the development of livelihoods in grouper aquaculture.

Figure 7: Grouper contribution to the trade in LRFF from full-cycle cultured, fishery-based culture and Wild-caught sources, 1997 – 2006



Source: De Silva, 2009

In 2010, WWF supported a regional exchange between government and private sector on the Live Reef Food Fish Trade and through that promoted the need for Public-Private Partnerships (roundtables) for full-cycle aquaculture/ mariculture of important LRFT species using Better Management Practices. The recommendation of a roundtable was for future consultation and collaboration towards a more sustainable national mariculture industry was endorsed by participants. Later that year, WWF Malaysia facilitated the establishment of a stakeholder forum (i.e. roundtable) to improve production processes along the supply chain and to develop pilot projects to demonstrate application of best-practices. Several discussions and stakeholder meetings resulted in the formation of the Marine Fish Farmers Association of Malaysia in 2011. A period of exchanging knowledge and views on several aspects and impacts of the grouper farming industry was required for the MFFAM to begin to champion environmental outcomes but this is now happening across Malaysia. The next steps were to link this initiative to the broader region and the possibility for eventual distinction between good and bad practices, whereby market

incentives would have something more concrete than a BMP approach available. The stakeholders involved however agreed the following relevant points:

- To avoid engaging in a multi-year Dialogue with the goal of developing a "Standard" as expense and time commitments are relatively high; but rather develop better management practices that could be used as a tool to grow out Grouper in a more responsible manner
- Utilize better management practices templates for Tilapia, that is user friendly, as a "working document".
- Convene workshops (2) bringing together representative from producers, academia, local NGOs and government agencies with inputs and revising the manual in the same Tilapia template and print as a publication to be used in the field to significantly reduce environmental impacts associated with open-cage grouper culture in the region

In August of 2012, WWF reached out to ASC to propose Grouper be considered as one of the next Dialogues. This was followed up with a meeting with ASC at the Seafood Summit in Hong Kong. Initially this received support but as the ASC was in a period of consolidation it would not consider new dialogues for 18-24 months. Their advice however was to develop a "standard" consistent with existing Standards that could more easily be rolled into the ASC when the time came. This is now ongoing.

More recently, in late 2012, WWF was asked to provide input into the new proposed legislation in Hong Kong around implementation of BMPs on sea cage farming of grouper, with the government considering lifting a multi-year moratorium on issuing of new mariculture licenses for grouper culture in HK. This is further indication of the general support for implementing BMPs regionally, and importantly in consumption markets. More recently industry in Malaysia has identified a need to implement a BMP system to meet market expectations in Europe.

Looking at the broader context of full-cycle grouper farming however, the challenges of sustaining livelihoods while protecting the environment can be easily demonstrated and must still be addressed:

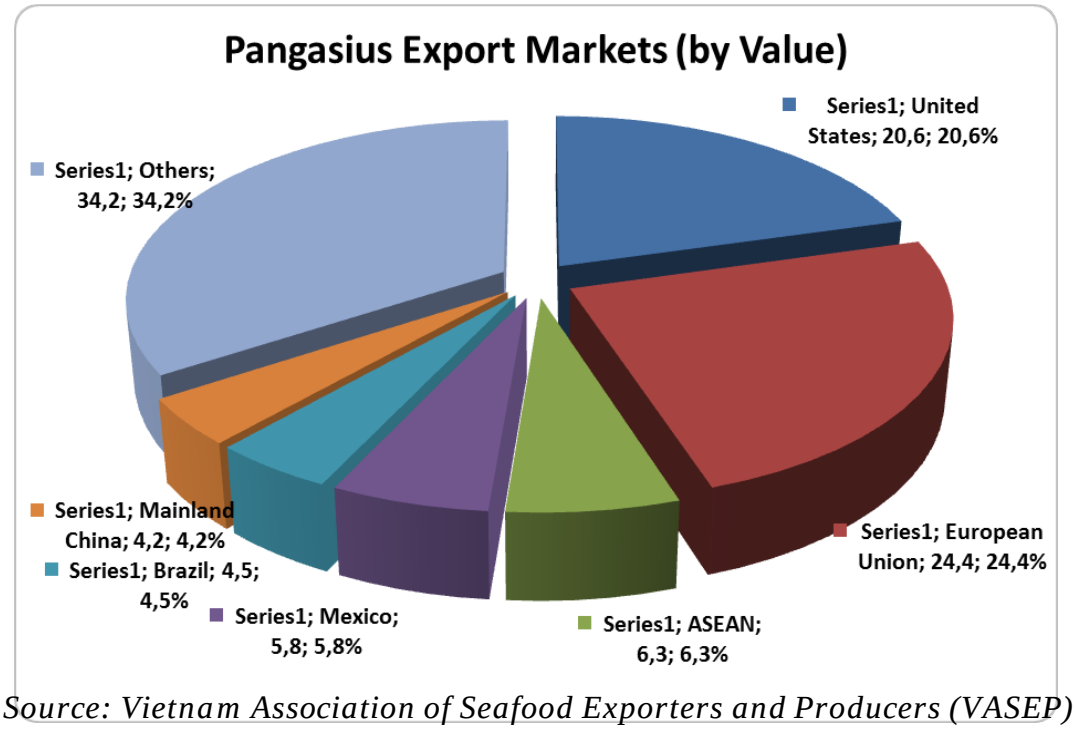
- Supplying aquaculture farming operations with hatchery fry for grow-out as opposed to sourcing from the wild is preferable, but does not guarantee reduced impacts on wild stocks. As with Salmon (Roheim *et a*l., 2011), there will likely be distinct markets for farmed and wild-caught fish. The evidence suggests that increases in full-cycle grouper production are being easily absorbed by the market while for wild-caught fish demand exceeds supply and drive continuation of over-exploitation.
- Targeting of wild-caught juveniles for ranching remains prevalent in many places in the Coral Triangle region due to a lack of alternative livelihoods in communities dependent on already heavily overexploited stocks and due to a lack of investment, by the government and/or the private sector in local hatchery technology.

- The intensification of farming grouper will increase the demand for fish to feed these grouper. Sources of fishmeal production not only compete directly with use of that fish protein for human consumption but destructive capture methods (e.g. blast fishing) are often used to collect these fish for feed.
- Many of the communities most in need of livelihood and poverty alleviation options are marginalized and have limited or no market access. In addition to the need for improving technical capacity, there are geographic barriers to sourcing hatchery seed, to storing artificial pellet feeds and most importantly to buyer networks. For most grouper production, proximity to market will determine financial viability.

Case D: Pangasius

The farming of Pangasius – in Vietnam, mainly *tra* (*Pangasianodon hypophthalmus)* – is one of the fastest growing types of aquaculture in the world. The growth in Pangasius aquaculture is driven, in large part, by the dramatically increased demand for *tra* and *basa* in the marketplace. Pangasius is sold to more than 130 countries globally, mainly in the form of white fillets. The United States was for a number of years the major market for *tra* and *basa* (as much as 80% of total exports), but that changed in 2010 and 2011, as the United States' share of exported Pangasius decreased, falling to only 18.4 per cent by value in 2011. In that year European Union countries dominated, taking 29.1 per cent by value (Figure 5). In 2012, this trend is reversing, as prices are rising to substantially higher levels in the USA than in Europe and there is as yet less insistence in the USA on environmental certification.

Figure 8. Pangasius export markets in 2012 by product value



Source: Vietnam Association of Seafood Exporters and Producers (VASEP)

According to the FAO (2010), Vietnam accounts for about 85 per cent of world's Pangasius farming. In 2011, Vietnam produced and exported approximately 600,000 tons of Pangasius fillet from an estimated 5-6000 ha of ponds with an export value of USD 1.85 billion, representing 1 per cent of total GDP and making it an important sector for Vietnam. This can be contrasted against the "Global" production of Pangasius in 1995 of just over 10,000 tons. In 2011 Vietnam. Most of Vietnam's Pangasius farms are located in the Mekong Delta provinces of An Giang, Dong Thap, Ben Tre and Can Tho. Farms vary in size from less than 1 hectare to more than 100 hectare. The sector is a major provider of employment in these provinces, particularly in the processing plants that fillet and freeze Pangasius for export.

The Vietnamese Pangasius sector has developed very significantly in the period 2001 to 2011with the area under production increasing 5-fold to reach 6,000 ha in 2011. Over this same period, the annual commercial production of fish (live weight) increased 36 times, from 37,500 MT to 1,350,000 MT. During this period the volume of exported Pangasius fillets jumped more than 40 times, from 17,000 MT in 2001 to over 600,000 MT in 2011 with related export revenue increasing by 45 times, from US$ 40 million to US$ 1.85 billion. The number of export markets has also risen from a few Asia destinations to now exporting to more than 136 countries and territories around the world.

Overall, the main environmental issue emanating from Pangasius farms in Vietnam are: i) the release of nitrate and phosphate into to rivers and water systems, ii) the source of fish meal used in feeds, iii) fish health management and food safety, iv) the destruction of natural habitats and iv) data collection and monitoring. Although the quantities of nitrate and phosphate effluents flowing from Pangasius farms into the Mekong River system are small relative to the volume of water moving seawards through this river system, and minor compared to the inputs from agriculture, Pangasius farming is a contributor to reduced water quality in the Mekong system. It is important for the ecology of the Mekong that efforts are made to reduce potentially damaging effluents from all sources, including aquaculture farms.

The rapid growth of the Pangasius aquaculture industry in Vietnam has raised a number of environmental and social concerns, and WWF is collaborating closely with the Pangasius farming industry, government officials and NGOs to promote a move towards more responsible farming methods. In 2007, a group of 81 people met in Vietnam as part of the first Pangasius Aquaculture Dialogue to begin to develop global standards for the Pangasius aquaculture industry. Seven key issues were identified during the first meeting these being:

- **Legal Frameworks** - Farms are sometimes constructed and/or operated outside the legal framework for addressing environmental, social and food safety issues of relevance to the area where the farming occurs

- **Farm Siting, Land, and Water Use** - As new farms are established, sensitive habitat can be destroyed and water often is diverted, which can affect other water users and the environment
- **Water Pollution and Waste Management** - Excess waste can pollute the water and negatively affect plant and animal habitat
- **Broodstock, Genetics, and Biodiversity** - Pangasius that escape from aquaculture facilities may compete with wild fish and affect ecosystems, especially in areas where Pangasius is not yet established
- **Feed Management** - Use of fishmeal, fish oil and trash-fish as Pangasius feed is resulting in depletion of food sources that other fish rely on. Also, feeding trash-fish to Pangasius can cause unsustainable harvesting and water pollution.
- **Health Management, Veterinary Medicines, and Chemicals** - Pangasius farms are prone to health problems that can impact farmed and wild stocks. Also, the inappropriate use of veterinary medicines and chemicals can have unintended consequences on the environment and human health, such as antibiotic resistance and unsafe products.
- **Social Responsibility/User Conflicts** - Large numbers of workers are employed on Pangasius farms and in processing plants, placing labor practices and worker rights under public scrutiny. Also, conflicts can arise among users of the shared resources.

Over a three-year period, 550 more people have joined the discussion culminating with the release of the first set of credible global standards for the Pangasius aquaculture industry in August of 2010. This WWF-led Pangasius Aquaculture Dialogue initiative was motivated by the need to minimize the potential negative impacts Pangasius farming can have on the environment and society. Pangasius farmers can be audited against these standards and if they meet with or exceed the various performance criteria, will earn a label from the ASC, certifying that their seafood has been farmed in an environmentally-sustainable and socially-responsible way.

In late 2010, the Vietnamese government, industry bodies and media reacted strongly to a red (unsustainable) listing for Pangasius (tra catfish) in some of WWF European seafood guides given its significant contribution to the Vietnamese economy and the number of jobs supported. Negotiations over this issue resulted in WWF and Vietnam signing an agreement with the main industry bodies; the Vietnam Fisheries Society (VINAFIS) and the Vietnam Association of Seafood Exporters and Producers (VASEP) in December 2010 to work together cooperatively under a timetabled plan to lift the proportion of certified responsibly farmed Pangasius from its current level of 0.5 percent to 100 percent of production by 2015.

The cooperative agreement committed the industry to achieving Aquaculture Stewardship Council (ASC) certification[28] for 50 percent of the total Vietnamese Pangasius production in increments with 10 percent to be attained by 2012, 30 percent by 2014 and 50 percent by 2015, with a 75 per cent long term goal.

To gain ASC certification, farms need to meet 103 performance-based standards. These include, environmental aspects, such as: maximum limits on the discharge of nitrogen and phosphorus to water bodies; minimum limits on the oxygen content of discharged water; maximum limits on water abstraction per ton of fish produced; maximum stocking densities; minimum growth and survival rates; maximum limits on feed conversion rations (i.e. kilograms of fish feed used to produce a kilogram of fish), restrictions on the sourcing of fishmeal used in feed to ensure it comes from sustainably operated fisheries; limitations and controls on the use of antibiotics and other medications; controls on the disposal of waste, including the sludge from ponds.

With more than 90 per cent of world's exports of Pangasius sourced from Vietnam, this agreement has provide the opportunity to profoundly influence the uptake of responsible farming, not just for Pangasius but for the aquaculture sector more generally, particularly in southeast Asia where challenges in incentivizing farmers to improve practices are considerably greater than in developed countries.. More than ten of Vietnam's biggest Pangasius producers, including the country's two biggest producers and exporters; Hung Vuong Corp. and Vinh Hoan Corp; are already involved workings with WWF or other partners in programs to move towards compliance and certification, either under the ASC or an equivalent scheme. These pioneering companies are setting an example for the wider industry; and if the market responds appropriately, a major shift of the industry to responsible farming methods could be triggered.

Certified farms using the ASC label will gain a commercial advantage, rewarding them for their high environmental performance. With the farms currently taking steps towards ASC compliance, WWF estimates the industry is halfway towards the Cooperation Agreement target of 10 per cent of Vietnam's Pangasius exports being ASC-certified by the end of 2012. During 2012, WWF is working hard to sign up enough additional farms to hit the 10 per cent target. The December 2012 target for Pangasius certified under all available certification schemes is 25 per cent. VASEP data currently shows that target has already been met. Meeting the ambitious targets for ASC certification requires more and more markets to demand ASC product. Currently, countries like Austria, Germany, Netherlands and Switzerland have much interest in certified product and take about the 10 per cent of exports covered in the 2012 target for Vietnam. New markets are going to have to come on board in order to help incentivize Vietnam to certify more than 10 per cent of its production.

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28 The ASC runs a third party certification program to certify farms that are in compliance with the standards for responsible.

The Coral Triangle in numbers

US$ 1 Billion

Annual tuna trade from Indonesia, Papua New Guinea, Philippines. Solomon Islands, and Fiji

+120 Million

People directly dependent on the Coral Triangle's marine natural resources

6M+ Square KM

Total area of the Coral Triangle

37%

of known reef fish species

76%

of known coral reef species on the planet

6 of 7

of the world's marine turtle species

US$ 810 Million

Annual regional trade in live reed food fish in Asia-Pacific

WWF

Why we are here

To stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature.

www.panda.org/coraltriangle

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