

**Assessing the scalability of small-scale ornamental mariculture as an  
alternative livelihood to fishing in the Spermonde Archipelago, Southwest  
Sulawesi, Indonesia**

by  
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## **ABSTRACT**

As with many marine areas throughout Indonesia, the coral reefs and fishery resources of the Spermonde Archipelago have become increasingly degraded largely due to overfishing and destructive fishing practices. As part of its Sustainable Solutions Program, Mars Inc. is working to restore marine resources in the Spermonde Archipelago by developing marine ornamental mariculture businesses as a sustainable alternative livelihood to fishing. Through semi-structured interviews with Spermonde fishers, this study evaluates the scalability of Mars' livelihood strategy and its potential to reduce fishing effort by assessing fishers' perceptions and knowledge of marine ornamental aquaculture. Of the total respondents, 78% were interested in ornamental aquaculture as a business opportunity, and 60% stated they would either reduce the time they spent fishing or stop altogether if they had an aquaculture business. However, 72% of respondents were unwilling or unable to invest in a business, expressing concern about market uncertainties and the profitability of the business. The results of this study reveal several challenges with deploying a market-based approach to livelihood diversification in the Spermonde Archipelago, and will be used to help inform Mars' future approach to its livelihood strategy.

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## INTRODUCTION

### *Marine Biodiversity in the Coral Triangle*

The Coral Triangle is a biogeographic term referring to the tropical marine waters of Malaysia, the Philippines, Indonesia, Papua New Guinea, the Solomon Islands, and Timor Leste (Figure 1). The region is considered the global epicenter of marine biodiversity, with the highest coral and coral reef fish diversity found anywhere in the world –76% and 37%, respectively (Veron et al. 2009). The Coral Triangle contains nearly 73,000 sq. km of coral reefs, more than 30% of the global total coral reef cover (Burke et al. 2012, Hoegh-Guldberg et al. 2009). With its rich coastal and inshore resources, the region directly supports the livelihoods of over 120 million people, and provides important spawning and nursery grounds for commercially valuable species, including the multibillion-dollar global tuna fisheries.

**Figure 1. The biophysical boundary of the Coral Triangle**



Source: [http://wwf.panda.org/what\\_we\\_do/where\\_we\\_work/coraltriangle/coraltrianglefacts/](http://wwf.panda.org/what_we_do/where_we_work/coraltriangle/coraltrianglefacts/)

## ***Overfishing and Destructive Fishing in Indonesia***

Centrally located within the Coral Triangle, Indonesia is a sprawling archipelagic nation composed of over 17,000 islands. Indonesia's coral reefs are the most biologically rich in the world, more so than any other Coral Triangle country, with over 590 recorded species of hard coral and at least 2,200 reef fish species (Allen 2008; Jawad 2013). This staggering amount of marine biodiversity represents more than 95% of the total number of species recorded throughout the entire Coral Triangle area (Veron et al. 2009). The country's fisheries directly and indirectly support livelihoods for 5 million people, and provide the backbone for marine and fishery industries that constitute 20% of the national GDP (Indonesia National Plan of Actions 2009).

However, nearly 95% of Indonesia's coral reefs are severely threatened by overfishing and destructive fishing practices, land-based pollution, coastal development, and coral bleaching, making this a high priority region for coral reef conservation initiatives (Burke et al. 2012). Overfishing and destructive fishing are the greatest cause of deteriorating and disappearing coral reef ecosystems in Indonesia, affecting more than 90% of the country's coral reefs. In some areas such as Sulawesi, overfishing and destructive fishing activities have left no reef untouched (Figure 2). Nearly a quarter of Indonesia's 247 million people live within 30 km of a coral reef, greatly exacerbating problems associated with coastal development. And in addition to fisheries production for export to international markets, the country must keep up with massive domestic demand – Indonesians consume more fish and seafood than any one of their Southeast Asian neighbors (Burke et al. 2012). Adding fuel to the fire, the number of fishers has increased by 40% over the past decade, largely due to a lack of employment opportunities, limited personal assets in terms of land and finances, and the open-access nature of marine fisheries (Indonesia National Plan of Actions 2009).

**Figure 2. Reefs at risk from overfishing and destructive fishing**



Source: Burke et al. 2012

Destructive fishing practices common throughout the Indonesian archipelago include blast fishing (also known as dynamite fishing) and cyanide fishing. The Japanese introduced blast fishing to Indonesian fishers during World War II as an easy, quick, and profitable method to catch schools of reef fish, and since then the practice has become so prevalent in coral reef fisheries that it could be considered a traditional fishing method (Pet-Soede and Erdmann 1998; Pet-Soede et al. 1999). Beyond the direct environmental impacts of blast fishing on coral reef ecosystems, the socioeconomic implications are devastating. Cesar et al. estimate that costs of blast fishing to Indonesian communities are up to four times greater than the direct benefits to the fishermen, and that the foregone value in coastal habitat protection, ecosystem services, tourism, and non-destructive fisheries amounts to USD \$ 3.8 billion over the last several decades (Cesar et al. 2004). However, the low costs of making bombs (\$USD 1.00-2.00) combined with fast, easy financial gain and poor enforcement provides fishers with high incentive to enter and remain in the blast fishery (Cesar et al. 2004).

In addition to blast fishing, cyanide fishing poses a serious threat to coral reefs throughout Indonesia. It is a highly unsustainable practice, resulting in coral bleaching and high mortality rates for both target and non-target organisms (Wabnitz 2003). Sodium cyanide, which is used to poison and stun fish for live capture, is predominantly used in three commercial fisheries in Indonesia: live reef food fish, rock lobsters, and ornamental fish (Pet-Soede and Erdmann 1998). Introduced to Indonesian fishers by Taiwanese and Chinese fishing vessels in the mid-1980s, cyanide was originally used for the emerging live reef fish food trade (Halim 2002; DeVantier et al. 2004). In the mid to late 1990s, cyanide fishing became popular practice with the marine ornamental fishery as an easy method to capture ornamental fish for the growing international aquarium trade.

Although Indonesia outlawed destructive fishing practices (including the use of poison) in 1985, high financial rewards to fishers, coupled with weak law enforcement and widespread corruption in government, have done little to disincentive the practice. Fishers in the live reef fish food trade can make 2 to 25 times more the amount for live fish than for a dead fish of the same species and size, easily earning 3-10 times the average monthly salary of traditional artisanal fishers (Erdmann and Pet-Soede 1997; Halim 2010). Despite the direct gain to fishers, the estimated economic loss to from cyanide fishing in Indonesia is USD \$46 million annually (Burke et al. 2002).

Destructive fishing in the Indonesian archipelago has been the focus of numerous conservation efforts, including high profile campaigns from the World Wildlife Fund, decade-long training programs sponsored by the Marine Aquarium Council, and large-scale coral reef conservation programs such as the Coral Reef Rehabilitation and Management Program funded by the World Bank and the Asian Development Bank. Despite these efforts, the country lacks a

systemic enforcement plan on both the national and local level, and for many of the fishers living in impoverished coastal and island communities, destructive fishing is an opportunity to make money ‘the easy way’ (Pet-Soede et al. 1999). While conservation campaigns and programs may create awareness in a fishing community about the negative impacts of destructive fishing, fishers have little incentive to stop or transition to a more sustainable fishing method.

## ***The Spermonde Archipelago***

### ***The Biophysical Environment***

The Spermonde Archipelago, one of the many island chains scattered across Indonesia, is located off the coast of Makassar, the provincial capital of South Sulawesi. The archipelago extends 60 km offshore, consisting of approximately 150 islands that span an area of 60,000 ha (Radjawali 2012; [www. ecocsi.org](http://www.ecocsi.org)). The islands are part of a large coral reef-based ecosystem, made up of fringing, barrier, and submerged patch reefs (Radjawali 2012; Tomascik et al. 1997). The archipelago can be divided into four distinct biological zones based on the cross-shelf distribution of coral species: inner zone; middle-inner zone; middle-outer; zone and outer zone (Moll 1983; Chozin 2008). The delineation of these four zones closely aligns with the bathymetric lines that run parallel to the coastline (Pet-Soede et al. 2001). There are two seasons in the Spermonde: a rainy season from November to April and a dry season from May to October.

### ***The Socioeconomic Environment***

An estimated 6,500 households and over 46,000 people are scattered across the Spermonde Archipelago (Ferse et al. 2012; Syakir 2006). Spermonde villagers rely heavily on

the surrounding reefs for food, income, material resources, and coastal protection. Although many of the inhabited islands are within a two to three hour ferry ride from the provincial capital of Makassar, the islands lack many of the resources and amenities compared to mainland and coastal communities on Sulawesi. Spermonde villagers face fresh water scarcity, poor waste management and sanitation (trash is dumped on the beach and taken out by the tide), and limited access to schools and health care. Severe erosion is also a major problem for many of the islands.

The Spermonde Archipelago is widely considered to be the largest coral reef fishery in Indonesia (Pet-Soede and Erdmann 1998). Fishing is the dominant source of livelihood on the islands, and for many families, often the sole source of income (Ferse et al. 2012; ecocsi.org). A 2008 survey of every second household on the island of Pulau Badi found that 73 percent of the men were fishers, 52 percent of the women identified themselves as housewives, 18 percent (men and women) were traders, 4 percent (men and women) were entrepreneurs, and 12 percent had other jobs (Ferse et al. 2012). These percentages correspond to an official occupation breakdown for the wider Spermonde area (Ferse et al. 2012; BPS 2009). Although the type of fishery and method of fishing may differ from island to island, fishing is a large part of the culture – and an essential livelihood—for communities throughout the archipelago.

Due to a lack of alternative livelihoods to fishing and/or supplemental forms of income on the islands, fishing effort remains constant throughout the year (Pet-Soede et al. 2001). Fishing activity ranges spatially from small-scale – which is limited to the resource space of an individual fisherman – to large-scale, which includes the 2800 km<sup>2</sup> continental shelf area of the Spermonde (Pet-Soede 2001). Spermonde fishing fleets are diverse, employing 22 different gear types and 10 different boat types (Pet-Soede 2001). In a study of Spermonde fisheries conducted from January 1996 to January 1997, Pet-Soede et al. found that hook-and-line fishers in 4m long

canoes made up the majority of mean daily fishing effort, while lift-net fishers in 10 to 20m long motorized boats made up a close second (2001). On average, 517 fishing units operate within the 2800 km<sup>2</sup> shelf daily, catching 21 tons fish per day (Pet-Soede et al. 2001).

The high level of fishing effort throughout the Spermonde is partly a reflection of the growing demand in the live reef food fish trade (LRFFT) – the trade in live reef fish for consumption. The LRFFT is driven primarily by consumer demand in Hong Kong, Singapore, Taiwan, and mainland China (Erdmann and Pet-Soede 1997). For the people of the Spermonde Archipelago, live reef food fish (LRFF) is one of the most important sources of livelihoods (Radjawali 2012). The high potential rewards have incentivized cyanide fishing and overexploitation of LRFF species throughout the entire Spermonde Archipelago.

In addition to high fishing effort, destructive fishing practices such as blast fishing have destroyed much of the coral reef ecosystem in the Spermonde. It has been estimated that up to 15% of fishers in some of the Spermonde villages are blast fishermen, with their catches constituting anywhere from 10-40% of the total landing for the Spermonde reef fishery (Pet-Soede and Erdmann 1998; Chozin 2008). Blast fishing operations in the Spermonde range from individual fishermen who use 1-3 bombs per day, to large-scale operations with crews of 15-20 men (Pet-Soede and Erdmann 1998).

In addition to fishing, the marine ornamental trade provides another livelihood for Spermonde villagers. In terms of volume, Indonesia is the largest exporter of marine ornamental species to international consumer markets, depending heavily on the harvesting of coral reef biota to supply the trade (Shuman et al. 2004; Reksodihardjo-Lilley and Lilley 2007). With its vast reef system, the Spermonde Archipelago has emerged as one of the most important ornamental fisheries in Indonesia, specifically for ornamental corals (Ferse et al. 2012). Partly

because of its proximity to the Makassar airport, the Spermonde Archipelago has become one of four main coral collection sites in Indonesia. While there are only an estimated 100 fishermen involved in the ornamental coral trade, the harvesting effort is high, and the contribution of each participant is relatively large (Bruckner and Borneman 2006; Ferse et. Al 2012).

Studies of the Spermonde ornamental fishery show that the marine ornamental trade provides both fulltime livelihoods as well as supplemental income to many of the islands' fishers (Bruckner and Bornemann 2006; Ferse et al. 2012). Local fishers that live in the archipelago are at the very bottom of the marine ornamental supply chain. They sell to local collectors who usually supply the fishers with equipment and pay for the costs of transporting the products to Makassar. The local collectors sell to middlemen in Makassar, and the middlemen work directly with commercial export businesses most often based out of Jakarta or Bali. Suppliers keep prices low, and pay fishers per fish rather than a fixed wage, spurring overharvesting and opportunistic selling practices at the producer level (Lilley and Lilley 2007). Between coral mining (physically ripping ornamental corals from the reefs with crow bars) and the extensive use of cyanide to capture marine ornamental fish, the ornamental fishery has contributed to the devastation of the Spermonde's coral reef ecosystem. Increasing global demand for marine aquaria species continue to exert pressure on Spermonde's coral reefs while driving unsustainable practices throughout the archipelago. The marine aquarium trade is discussed in further detail below.

## **SMALL-SCALE MARINE ORNAMENTAL AQUACULTURE**

### ***The Marine Aquarium Trade: Socioeconomic Impacts on Producer Communities***

In order to understand the potential of small-scale ornamental aquaculture as an alternative livelihood to fishing, it is first necessary to place small-scale ornamental aquaculture

in context of the broader marine ornamental trade and existing supply chain networks. The marine aquarium industry's estimated annual worth is USD \$ 200-300 million, and includes trade of live coral reef fish, corals, and invertebrates (Wabnitz et al. 2003; Wood 2001; Shuman et al. 2004). While certain species of corals and fish are sourced from commercial aquaculture production, the marine aquarium trade relies heavily on the harvesting of wild-caught species, sourcing an estimated 98% from the wild (Reksodihardjo-Lilley and Lilley 2007; Wood 2001). Indonesia is the largest supplier of marine ornamentals to major markets in North America, Europe, and Asia, and together with the Philippines provide 85% of market demand (Kessler 2013). The heavy dependence on wild-caught ornamental species –along with destructive collecting practices, overharvesting of target organisms, and physical damage to coral reef habitat— raises serious concerns about the sustainability of the marine aquarium industry and the direct impact on coral reef ecosystems in producer countries. These conservation issues, coupled with lax government policies and trade regulations within Indonesia, have placed the marine aquarium trade on a highly unsustainable trajectory.

In addition to unsustainable environmental practices, the marine ornamental trade also perpetuates socioeconomic hardship and inequality in producer communities. Marine ornamental fishermen in Indonesia are generally uneducated, impoverished, and often trapped in informal, hierarchical patron-client systems (Reksodihardjo-Lilley and Lilley 2007; Ferse et al. 2012). In a paper on the ornamental coral fishery in the Spermonde Archipelago, Ferse et al. (2012) explains that the ornamental coral fishery is organized by a patron-client structure, referred to as the *punggawa/sawi* system. The *punggawa/sawi* relationship in the Spermonde is similar to patron-client systems common throughout small-scale fisheries in developing countries (Ferse et al. 2012). The *punggawa* (aka patrons) are usually wealthier locals, who have starting capital and

own the fishing boats, materials, and gear that they supply to the *sawi* (aka fishermen). The relationship between a *punggawa* and a *sawi* is both a social and financial one – feelings of kinship and trust are tied to strong dependence on credit, debts, and access to end markets.

Because fishermen in producer communities are generally poorly educated, face limited employment alternatives, and dependent on *punggawa* for employment and credit, they lack the negotiating power and leverage needed to attain better prices for the fish and corals that they collect. The fact that ornamental fishers are paid per fish, rather than a steady wage, exacerbates conditions of poverty and inequality at the producer level of the marine ornamental supply chain, and incentivizes overfishing and further erosion of the resource base (MAMTI 2006; Reksodihardjo-Lilley and Lilley 2007).

In addition to poverty, ornamental fishers face serious health risks associated with unsafe fishing practices. The boats they go out in are often poorly maintained and lack any type of safety equipment (Cartwright et al. 2012). Hookah diving, in which fishers use compressors with long hoses that supply them with air, can result in decompression sickness, paralysis, and sometimes death (Reksodihardjo-Lilley and Lilley 2007). Health risks associated with cyanide exposure is an additional concern.

The typical marine ornamental supply chain has multiple steps, with each player capitalizing on greater profit margins the farther up they are in the chain. In other words, the value of the species substantially increases as it moves through the supply chain, from fisher to collector, collector to middleman, middleman to exporter, exporter to importer, importer to wholesalers, and wholesalers to end retailer/consumer (Wood 2001). For example, for an Indo-Pacific blue tang (*Paracanthurus hepatus*), which is now rare on Indonesian reefs due to over collecting, a fisher will earn USD\$ 3.50- 4.50, while the commercial exporter will sell it to a wholesaler for

USD\$ 10.00 (PC with Spermonde fishers and commercial exporter). Skipping to the end of the supply chain, the end customer will end up paying USD\$ 50.00 or more for a blue tang. For the Ocellaris clownfish (*Amphiprion ocellaris*), which are cheap but traded in very high volume, fishers might earn USD\$ 0.10 per fish, while the exporter will make USD\$ 0.75-0.80 for that same clownfish (PC with Spermonde fishers and commercial exporter). The end consumer will buy it for at least USD\$ 14.00.

### ***Small-scale Marine Ornamental Aquaculture as a Sustainable Livelihood Alternative***

Livelihood diversification has become a commonly advocated strategy for development and conservation programs that aim to alleviate poverty and address critical marine resource issues for small-scale fishing communities in developing countries (Allison and Ellis 2001; Allison and Horemans 2006). The alternative livelihoods approach emphasizes the vulnerability of fishing communities to fluctuations in fisheries resources, and seeks to reduce that vulnerability by reducing the dependence of the community on the natural resource base (Ellis 2000; Ferse et al. 2012). Small-scale ornamental aquaculture could potentially be an important part of diversifying livelihoods in fishing communities where ornamental fishing occurs. Because commercial exporters of marine ornamental fish and corals depend heavily on unsustainable fishing practices and fluctuating supply of wild-caught species, the advantage of marine ornamental aquaculture over other livelihood alternatives is that it can generate sustainable income, reduce pressure on coral reef resources, *and* address existing market demand by creating high value alternatives to wild caught species (Job 2005; Pomeroy et al. 2006; Ferse et al. 2012).

Generally ornamental fishers only sell to the local collectors that they work for, with no direct connection to actors higher up on the supply chain. However, if fishers could contract directly with middlemen or exporters, then they could eliminate transaction steps between themselves and the buyer, potentially capturing and retaining higher value for their product at the producer level. With a small-scale aquaculture business, fishers could contract directly with exporters in Bali or Jakarta, eliminating the local collectors and middlemen.

The Food and Agriculture Organization of the United Nations (FAO) defines small-scale aquaculture as the farming of aquatic organisms in which there are:

- (1) “Systems involving limited investment in assets, some small investment in operational costs, including largely family labor and in which aquaculture is just one of several enterprises” (FAO 2009)
- (2) “Systems in which aquaculture is the principal source of livelihood, in which the operator has invested substantial livelihood assets in terms of time, labor, infrastructure and capital” (FAO 2009)

Large aquaculture operations such as fish or shrimp ponds are not feasible on small islands, where space is limited and environmental conditions vary (Bunting 2009). However, recent development efforts in the Spermonde Archipelago have focused on small-scale mariculture tanks that can easily fit behind or in-between houses. While small islands lack the resources, infrastructure and amenities to support sophisticated aquaculture production, these business models incorporate simple technology and minimum building materials, with the idea that this type of market-based livelihood strategy can be easily adapted and scaled throughout the Indo-Pacific region.

### ***Mars Sustainable Solutions***

Mars Inc. is a global manufacturer of chocolate and confectionary, pet food, and other food products, and the 3<sup>rd</sup> largest held private company in the U.S. As part of its corporate social responsibility program, Mars Sustainable Solutions, Mars Inc. is actively working to improve its sustainability practices not only with the cacao it sources from Indonesia, but with other regional sustainability initiatives as well. As part of its regional sustainability initiatives in Indonesia, Mars Sustainable Solutions is developing sustainable alternative livelihood strategies in the Spermonde Archipelago. One of the livelihood strategies that Mars is working on is developing small-scale ornamental mariculture business models as an alternative to ongoing destructive fishing and overharvesting of coral reef resources.

With ornamental aquaculture, there is already an established end market and existing demand for high-value products. While revenue for these models will depend on the species cultivated, the yield, and market value, the estimated revenue from these models is between USD\$ 4,000 and \$10,000 per year (Bunting 2009). Mars has already worked with one family for the past several years to set up, train, and manage an ornamental seahorse business. Mars helped connect the family directly to the commercial exporter in Bali, effectively cutting out multiple levels in the supply chain. The family sells approximately 200 seahorses per month to the exporter. After money is invested back into the business and operational costs are accounted for, the family is earning a monthly income of US\$ 175.00 (personal communication with Dr. Sven Blankenhorn, June 20, 2012). This figure is four times the average income for Spermonde families (personal communication with Dr. Sven Blankenhorn, June 20, 2012). In terms of providing a highly profitable and sustainable income to a Spermonde family, this business model

is a game changer. But right now it is only changing the game for one family. This is where my research project comes into play.

## **PROJECT DESCRIPTION**

The purpose of this study is to assess whether the small-scale mariculture operation that has proven to be successful for one family can be replicated and scaled up to a broader community wide level in the Spermonde Archipelgo. This study seeks to characterize fishers' attitudes towards small-scale marine ornamental aquaculture as a livelihood option in the Spermonde Archipelago, Indonesia, and attempts to understand how those perceptions might affect the potential scalability of marine ornamental aquaculture as an alternative livelihood strategy. Furthermore, the study seeks to determine whether fishermen view ornamental aquaculture as a potential replacement for fishing incomes, or rather, as a supplemental income opportunity.

## **MATERIALS AND METHODS**

### ***Study Areas and Target Population***

I interviewed 27 Spermonde fishermen who were either former participants in the ornamental fishery or currently involved in the fishery. I wanted to focus on how ornamental fishers, or former ornamental fishers, felt about ornamental aquaculture businesses as a livelihood alternative in order to assess whether ornamental aquaculture appealed to them, their motivating factors to pursue or not pursue an aquaculture business, and whether they would reduce or stop fishing for wild-caught species. Previous or current level of engagement could

include ornamental fishing as a supplemental income (primary source of income came from a different activity) or as a primary source of income. I included both categories in order to maximize my sample size.

The Spermonde study area consisted of 5 islands: Pulau Badi, Sarappo Keke, Pajenenkang, Balang Lompo and Barrang Lompo. These sampling sites were determined by several factors. First, proximity to Makassar is a limiting factor to aquaculture development. Thus, islands that were more than a day's speedboat ride from Makassar were excluded from this study. Secondly, since the focus of this study was to assess fishers' perceptions of ornamental aquaculture as an alternative to fishing and particularly as an alternative to ornamental fishing, sample sites were limited to islands in which previous research studies had established them as places where ornamental fishers and/or collectors lived. According to Syakir (2006), these islands included Barrang Lompo, Balang Lompo, Lae-lae, Sarappo Keke, and Papandangan. However, after visiting the islands of Lae-lae and Papandangan, we were told by fishermen and village leaders that there were no ornamental fishers in the community, and thus no interviews were conducted at these two sites.

As the study progressed, the island of Pajenenkang was included in the study area after learning from other fishers that there were several men on Pajenenkang that were full-time ornamental fishers from 2007 to 2012. Pulau Badi, the island with Mars' successful seahorse aquaculture prototype, was also included in the study sample in order to determine whether local perceptions of ornamental aquaculture on the island differed from the other islands that did not have ornamental aquaculture businesses.

The provincial capital of Makassar was also included in the study area, where a single interview took place at the home of a collector who worked for a commercial marine ornamental

export company. The interview was the only one conducted in Makassar and was arranged by Mars on my behalf. The point of the interview was to assess whether an actor higher up in the supply chain valued marine ornamental aquaculture as an alternative supply source and whether he would be interested in investing in marine ornamental aquaculture start-ups on the Spermonde Islands.

Two interviews were conducted in Kuta, Bali, at the facilities of two large commercial marine ornamental export companies. The companies are both well-known exporters of marine ornamental fish and coral species to markets in Asia, Europe, and the United States. Each interview was conducted with a head figure of the company and was arranged by Mars Symbioscience on my behalf. The purpose of these interviews was to characterize supply and demand trends for marine ornamental species, concerns about long-term supply, added value of sustainably sourced products, and exporters' potential interest in investing in Mars' marine ornamental aquaculture models in the Spermonde Archipelago.

### ***Interviews***

Interviews were conducted between June 11, 2013 and July 3, 2013. I developed three distinct interview guides (see Appendix A, B, and C): one interview guide for Spermonde fishermen, one for the family with the seahorse aquaculture business on Pulau Badi, and another interview guide for the commercial export businesses in Bali. Mars Symbioscience reviewed the draft questions before finalizing the interview questions and implementing the interview period. The interviews were carried out in compliance with Duke University's IRB protocol. Participation was on a voluntary basis. All interviews were conducted in a semi-structured format, where the guides served as a reference and helped the interviews stay focused, but

allowed for flexibility to pursue new themes and leads as they arose from conversation (Merriam 2001).

Because very few of the islanders speak English and because I did not speak Bahasa Indonesia or the local dialect, Mars Symbioscience hired a translator who had previous research experience on the islands and an existing network of contacts. Thus, all interviews are a translation from Bahasa Indonesia, or the local dialect of Bahasa Makassar, to English. The translated responses to interview questions were written in a notebook throughout the duration of each interview. Interviews varied from 30 to 60 minutes in length, with most being closer to the 60-minute length. Overall, there were 32 interviews: 27 Spermonde fishermen and local collectors; 2 family members with the seahorse business; 1 commercial collector in Makassar; and 2 commercial exporters in Bali.

The interviews with Spermonde fishermen and collectors usually took place within the interviewee's home or sitting out on chairs in front of their home. During these interviews, there were often other family or community members present despite interviews being conducted one-on-one. The non-interviewees often would interrupt the interview to add their opinion or try to help the interviewee respond to a question. However, these interviews were still treated as a single respondent since the interviewee's responses were the bulk of the interview.

For the interviews with Spermonde fishermen, I was interested in speaking with people who were currently or had once been engaged in the marine ornamental fish and coral trade on either a full-time, part-time, or opportunistic basis. I utilized a snowball sampling technique in which potential interview candidates were identified by starting with one or two key informants who then identified or referred the researcher to other appropriate interview candidates (Atkinson and Flint 2001). Given the small sample size, the results presented here should be interpreted

appropriately. I make no claims that they are generalizable to a broader population or statistically significant. The data are more of a characterization and assessment of fisher perceptions and knowledge of ornamental aquaculture as a business opportunity.

After selecting which islands to include in the Spermonde study area, the process of interviewing candidates usually involved arriving at the island in the morning, asking villagers which house the *kepala desa* (village leader) lived at, and then meeting with the *kepala desa* to explain our reasons for visiting the island and the nature of the research project. The *kepala desa* would often give us names of fishermen he thought we should speak with or physically lead us to a fisherman's home. Once I had secured an interview with a fisherman, the interviewee would often refer us to other fishers involved in the Spermonde ornamental fishery.

I collected additional information on topics including but not limited to Spermonde island fisheries, marine ornamental fishing and supply networks, marine ornamental aquaculture, and sustainable livelihoods through participant observation, informal data collection, and personal communication with Dr. Sven Blankenhorn, Aquaculture Advisor at Mars Symbioscience during the time I was in Sulawesi.

### ***Data Analysis***

Interviews were transcribed into Microsoft Word documents and a Microsoft Excel spreadsheet. I coded text to note respondents' general attitudes towards marine ornamental aquaculture and their underlying motivations for why they would or would not attempt ornamental aquaculture.

## RESULTS

### *Demographics*

All respondents in this study were male, including the commercial collector in Makassar and the two commercial exporters in Bali. Of the Spermonde Archipelago respondents, all 27 had previously or are currently engaged in the Spermonde ornamental fishery (includes fish and coral species) as either fishers (n=23) or local collectors (n=4), with more than half of all respondents (59%) currently engaged in the fishery as a primary source of income (Table 1). It should be noted that sampling was not evenly distributed across the 5 islands, with 48% (n=13) of the respondents living on Barrang Lompo.

The average family size of the Spermonde interviewees in this study is 5.25 people per household. For this study, only general questions about income were asked (i.e. Does ornamental fishing cover your family's basic needs?) so average monthly income data for this particular subset of the population is unknown. However, average monthly income per household in the Spermonde Archipelago is approximately USD\$ 45.00 (PC with Dr. Blankenhorn).

**Table 1.** Respondents' involvement in the Spermonde ornamental fishery

Island	Total	Currently involved <i>n</i> (%)		Formerly involved <i>n</i> (%)	
		Primary Income	Supplemental Income	Primary Income	Supplemental Income
Pulau Badi	6	-----	-----	3 (50%)	3 (50%)
Balang Lompo	3	2 (67%)	-----	-----	1 (33%)
Barrang Lompo	13	12 (92%)	1 (8%)	-----	-----
Pajenenkang	2	-----	-----	2 (100%)	-----
Saroppo Keke	3	2 (67%)	-----	-----	1 (33%)

## ***Characterizing perspectives of ornamental aquaculture as a livelihood option***

### ***1. Familiarity with aquaculture***

Of the 27 Spermonde respondents, 48% (n=13) did not know what aquaculture was, 22% (n=6) knew what aquaculture was but did not have any previous experience or exposure to it, and 30% (n=8) knew what aquaculture was and had some level of previous experience or exposure (Table 2). These findings and the implications for developing ornamental aquaculture as a scalable livelihood strategy for Spermonde communities are discussed in greater detail below.

Of the 14 interviewees that knew what aquaculture was, 43% (n=6) are currently engaged in the ornamental fishery fulltime and earn 100% of their income is from ornamental fishing or collecting, whereas 57% of interviewees that knew what aquaculture was were previously but no longer engaged in the ornamental fishery (Table 3).

Of the 13 respondents that did not know what aquaculture was, 85% (n=11) were from Barrang Lompo. This figure could be a result of the uneven sampling distribution noted earlier, where nearly half of all respondents in this study are from Barrang Lompo. Of the 13 interviewees who did not know what aquaculture was, 85% (n=11) are currently engaged in the ornamental coral fishery as either fishers or local collectors (Table 4).

**Table 2.** How responses to “Are you familiar with aquaculture?” compare across the 5 sampling sites

		No, I do not know what it is <i>n</i> (%)	Yes, I know what it is and I have experience <i>n</i> (%)	Yes, I know what it is but do not have any experience <i>n</i> (%)
Island	Total			
Pulau Badi	6	-----	3	3
Balang Lompo	3	1	2	-----
Barrang Lompo	13	11	1	1
Pajenenkang	2	-----	2	-----
Saroppo Keke	3	1	-----	2
<b>Total</b>	<b>27</b>	<b>13 (48%)</b>	<b>8 (30%)</b>	<b>6 (22%)</b>

**Table 3.** Livelihoods of the respondents who are familiar with aquaculture and their current or previous level of involvement and income in the Spermonde ornamental fishery (n=14)

Livelihood	Total	Currently involved		Formerly involved	
		Primary	Supplemental	Primary	Supplemental
Long-line Fisherman	7	-----	-----	4	3
Ornamental Fisherman	4	4	-----	-----	-----
Coral Fisher	1	1	-----	-----	-----
Boat Captain	1	-----	-----	-----	1
Coral Collector	1	1	-----	-----	-----
<b>Total</b>	<b>14</b>	<b>6</b>	<b>0</b>	<b>4</b>	<b>4</b>

**Table 4.** Livelihoods of the respondents who are not familiar with aquaculture and their current or previous level of involvement and income in the Spermonde ornamental fishery (n=13)

Fishers	Total	Currently involved		Formerly involved	
		Primary	Supplemental	Primary	Supplemental
OF* and Coral Fisher	5	4	1	-----	-----
Coral and Spear Fisher	2	2	-----	-----	-----
Coral Fisher	1	1	-----	-----	-----
OF Fisher	2	-----	-----	-----	2**
<b>Collectors</b>					
Coral Collector	2	2	-----	-----	-----
OF and Coral Collector	1	1	-----	-----	-----
<b>Total</b>	<b>13</b>	<b>10</b>	<b>1</b>	<b>0</b>	<b>2</b>

\*OF = ornamental fisher

\*\*Current livelihoods of these two respondents are crab fisher and sea cucumber fisher

Of the 14 respondents that knew what aquaculture was, only 8 claimed to have previous experience with it. Of those 8 with previous experience, 5 were formerly but no longer engaged in the Spermonde ornamental fishery, 2 respondents are currently engaged in the fishery as fulltime ornamental fishers, and 1 is a local collector in the ornamental coral trade. Their experiences and levels of engagement with aquaculture vary, but seem to be mainly a result of various training programs sponsored by different parties – of the 8 respondents, 7 said that they learned about aquaculture through training programs and most of these programs were related to “friendly” ornamental fishing techniques, not to actual aquaculture.

One of the respondents from Pulau Badi who previously ornamental fished as a supplemental income said he went to training in Makassar that was sponsored by the Association Diving School (ADS) where he learned about aquaculture and how to dive with a compressor. Another former participant in the ornamental fishery from Pulau Badi said that CV Dinar, a large

commercial exporter of ornamental fish, corals, and invertebrates, sponsored training programs in Makassar and Balang Lompo where he learned about coral, seaweed, and fish aquaculture. Two former fulltime ornamental fishers from Pajenenkang said they gained aquaculture experience when DKP sponsored them to go to Denpasar, Bali in 2008 and 2009 for a United Nations training program. And two-fulltime ornamental fishers from Balang Lompo said they gained aquaculture experience when Hasanuddin University in Makassar (UNHAS) provided a training session on Barrang Lompo. Thus of the 8 respondents who claimed to have aquaculture experience, only 1 of them had actual hands-on experience working for DKP raising grouper in floating cages. The other 7 respondents' experiences were a result of training programs where the main objective was to teach fishers about sustainable ornamental fishing techniques.

## *2. Interest in marine ornamental aquaculture as an income-generating business*

In addition to characterizing respondents' familiarity with aquaculture, another objective of the study was to assess the level of interest in marine ornamental aquaculture as a potential livelihood option. Overall, the data indicate a very high interest in ornamental aquaculture. Seventy-eight percent (n=21) of the Spermonde interviewees responded "yes" when asked if they were interested in ornamental aquaculture as a business (Table 5). When asked why there were interested, most individuals explained that it was an opportunity to make money. Other reasons people gave included "because it is a good income" (n=2), "it is an easy way to make money" (n=3), "I wouldn't have to go out fishing on my boat anymore" (n=3), and "I wouldn't have to go out diving anymore" (n=1).

Two of the 3 individuals who said they wouldn't have to go out on their boat anymore if they had an ornamental aquaculture business were fulltime ornamental fishermen from Balang

Lompo. Both men owned their own boats, and said that an ornamental aquaculture business would save them money because they wouldn't have to buy diesel for their boats or pay to take their 2-3 men fishing crews out. A fulltime ornamental coral fishermen from Barrang Lompo said that an aquaculture business would give him the option of no longer having to go out on his boat to dive for corals. The idea of not having to go out to sea everyday to fish seemed appealing to many of the individuals I spoke with.

**Table 5.** How responses to “Are you interested in aquaculture as a business?” compare across the 5 sampling sites

		Yes, I am interested <i>n</i> (%)	No, I am not interested <i>n</i> (%)	I do not know <i>n</i> (%)
<b>Island</b>	<b>Total</b>			
Pulau Badi	6	6	-----	-----
Balang Lompo	3	3	-----	-----
Barrang Lompo	13	8	3	2
Pajenekang	2	2	-----	-----
Saroppo Keke	3	2	1	-----
<b>Total</b>	<b>27</b>	<b>21 (77.8%)</b>	<b>4 (14.8%)</b>	<b>2 (7.4%)</b>

Respondents' interest in aquaculture was often conditional upon several different factors. Of the 21 individuals who expressed interest in aquaculture as a business opportunity, 47.6% (n=10) claimed they would be interested only if certain conditions could be guaranteed. Five respondents said they would be interested as long the aquaculture could provide enough income to pay for their basic expenses (most fishermen I spoke with said basic needs included coffee, sugar, rice, diesel for their boats, cooking oil, and cigarettes). Three respondents said that they were interested as long as there was a “good market” for marine ornamental species, and 2 fulltime ornamental fishers said they were interested in ornamental aquaculture as long as someone provided the necessary training and if there was an “available market.”

Seventy-five percent (n=3) of the people who said they were not interested in aquaculture were from Barrang Lompo, and all 3 individuals said that there was not enough space to set up an aquaculture business. The 4<sup>th</sup> individual who said he wasn't interested was a longline grouper fisherman from Saroppo Keke with only 1 month of previous ornamental fishing experience. He said that he was not interested because he has no knowledge of it and thinks it would be very difficult to do. Two interviewees that claimed they did not know if they were interested were both from Barrang Lompo, and did not know how they felt about ornamental aquaculture because neither one knew enough about the subject.

### *3. Interest in a co-operative aquaculture business*

A part of the perceptions of aquaculture that I wanted to assess in this study was how fishermen in the Spermonde felt about a cooperative aquaculture business because I was interested in evaluating the potential for scaling up Mars Symbioscience's aquaculture prototype on a broader community level. Of the 27 interviews with Spermonde fishermen and collectors, 63% (n=17) said they would be interested in a group or cooperative aquaculture business while 15% (n=4) said they would prefer to work alone. The other 6 respondents did not know or were not interested in ornamental aquaculture.

For the 17 respondents who expressed interested in a cooperative business structure, being able to choose their group members appeared to be extremely important to them and 53% (n=9) said that they would prefer to work only with family members. The word 'trust' was a word I heard often during this part of the interview, when respondents would mention they would prefer to work with family or other people they knew could be trusted.

While not all respondents commented on an ideal group size, those who did comment seemed to prefer a group size limited to 2-5 members. A few of the interviewees with minimal ornamental fishing experience mentioned they would prefer to work with people who had more extensive experience working with marine ornamental fish.

#### *4. Potential of marine ornamental aquaculture to reduce fishing pressure*

In addition to assessing the level of interest in marine ornamental aquaculture as an income generating business, another objective of the study was to determine whether these businesses – if replicated on a larger scale in Spermonde communities – could help reduce fishing efforts on Spermonde reefs by replacing fishing livelihoods with aquaculture livelihoods. When asked how much time they would be willing to devote on a daily basis to aquaculture, only 15 of the 21 respondents interested in ornamental aquaculture as a business had some idea of the time they were willing to put into aquaculture or whether they would subsidize their aquaculture income by continuing to fish. Of those 15 individuals, 60% (n=9) said they would stop fishing if they had an aquaculture business that generated an income equal to or greater than their current income. It should be noted that 8 of those 9 respondents were engaged in the Spermonde ornamental fish and coral fishery as a fulltime livelihood (100% of income came from ornamental fishing), either as fishers (n=7) or local collectors (n=1).

Of the 15 respondents who had an idea of how they would manage their time, 5 said they would continue to fish, either at continued or reduced amounts. One of these individuals, an ornamental fish and coral fisher, explained that if the aquaculture business generated the same amount of income as he made now, then he would decrease the amount of time he spent going out to fish for ornamental species. However, if the business generated a greater amount of

income than he currently made, then he would give up ornamental fishing entirely. A local coral collector said he would split his time between aquaculture and his coral business by attending to the aquaculture business the first half of the day and his coral collecting business the latter half of the day. Another respondent, a boat captain who used to fish for ornamental species as a supplemental income, explained that he would alternate jobs by allocating a day for each activity. The 4<sup>th</sup> individual, a captain of a 15-person purse seiner and former supplemental ornamental fisher, explained that he would allocate whatever time he had left over after fishing to his aquaculture business. The 5<sup>th</sup> respondent, a long-line fishermen and former fulltime ornamental fisher, explained that he was not sure how much time he would allocate towards aquaculture but that he would run the business with other people so that he could continue to fish.

Overall, of the 15 respondents who were interested in aquaculture as an income generating business and expressed some idea of time management, 60% said they would stop fishing if they had an aquaculture business that generated the same amount of money as they made currently. The remaining 40% said they would continue to fish, but several of those individuals indicated they would decrease the amount of time they allocated to fishing activities.

##### *5. Willingness and/or ability to self-finance an aquaculture business*

As part of characterizing fishers' perceptions of ornamental aquaculture as a potential livelihood, I wanted to assess how willing or able people were to invest in or self-finance a potential aquaculture business. While Mars funded the seahorse aquaculture prototype on Pulau Badi, they hope to include formal Indonesian institutions, such as the Bank Rakyat Indonesia (BRI) in developing a microcredit program as a mechanism for Spermonde villagers to finance

future ornamental aquaculture models. I wanted to assess how fishers felt about formal financing mechanisms, as most of them do not have the collateral to take out loans from banks and when they do borrow money, most of them borrow via local, informal networks.

Most respondents did not answer questions related to personal finances and savings. Only 7 interviewees responded definitively: 5 said they did not have enough money, 1 said he did not know enough about investing, and 1 said that he would invest if he knew there was a “promising market” and a “good price.”

The results indicate a low willingness to invest – 6 interviewees responded “no” when asked if they were willing to invest knowing there may not be an immediate payback. Eight respondents said they would not personally invest but would prefer a partner who could invest 100%. Knowing there was a market demand and a good return on investment seemed to be common concern. Of the 6 respondents who said they were willing to invest, 3 said they would want a 50/50 investment scheme where they invest in half of the business. Two interviewees said they would invest but not up front, only once they knew the business was profitable.

The results also indicate a very low willingness to borrow money, with 55% of interviewees responding ‘no’ when asked if they would be willing to borrow money to start an ornamental mariculture business. Reasons for not wanting to borrow money included “I do not know if it’s a profitable business” and “I am worried about being able to pay back the money I borrow.” Interviewees who responded “yes” to borrowing money often specified that they would not borrow money from the bank, but would borrow from an investor instead. Respondents often mentioned that banks are difficult to deal with and that it was better to borrow money from local *punggawa*. One interviewee said that the maximum loan a bank will give a fisherman is IDR 5,000,000 (US\$ 445.00) and even then, the fishermen must have some kind of collateral such as

a boat (June 17, 2013). Another respondent expressed concern about borrowing money through formal institutions, and explained that high interest combined with inflexible loan terms meant that the bank would seize his house if he were unable to make his payments.

### ***Perceptions higher up in the marine ornamental value chain***

To get a better understanding of perceptions of ornamental aquaculture from higher up in the marine ornamental value chain, I interviewed a middleman based out of Makassar and two commercial exporter businesses in Bali. I was interested in understanding the potential of small-scale marine ornamental aquaculture businesses in the Spermonde to meet exporter demand, and in determining whether commercial exporters were interested in investing in the aquaculture models on the islands.

One of these businesses I spoke with is the largest exporter of ornamental corals in Indonesia, selling mostly to markets in Europe and the United States. They source approximately 20% of their marine ornamental coral from Sulawesi. The representative I interviewed explained that corals from Sulawesi are much brighter than coral from other regions, but that there is often a higher mortality associated with marine ornamentals (fish and coral) from Sulawesi producers. When asked whether sustainably bred species from aquaculture earned a higher selling price than wild-caught ornamentals, the exporter explained that it is not sustainability that the end consumer necessarily cares about, but rather it is the quality of the species that results in a higher selling price. As an export business, they are interested in buying species from aquaculture because captive-bred marine ornamentals are often better quality than those caught from the wild. Thus quality, not sustainability, is the driver of purchasing practices. Furthermore, raising ornamentals in aquaculture incurs higher production costs than wild-caught species. Therefore, as an exporter,

they sell marine aquaculture-bred fish and corals for twice as much as wild caught ornamentals. Buyers in the U.S. and other import markets will pay that premium because of quality controls that aquaculture can ensure.

When asked if they would invest in the small-scale aquaculture businesses Mars was developing in the Spermonde Archipelago, the exporter explained that as a business, they are not concerned with producer communities or in working with them. They are only concerned about getting their products to market. If they were to work with producers on the islands, then those people “must be professional and have the financial means to see the project through (PC with PT Agung 7/2/2013). The exporter also stressed that if they were to enter into a contract with aquaculturists on the islands, then the person must have the technical knowledge to make it a successful business venture.

The second commercial exporter I spoke with echoed the sentiments of the first exporter in terms of contracting directly with producer communities in the Spermonde. As an export business, they focus on the buying and selling of ornamental fish, not on the breeding. Trade, not production, is their priority. And while they would like to contract directly with the producers on the Spermonde islands, middlemen are a necessity because it is the middlemen that have the capital to pay for freight and shipping costs from Makassar to Bali. Furthermore, a middleman consolidates product streams by acting as the single buyer for multiple producers and overcomes barriers to shipping because they aggregate product and ship in bulk quantities. Like the first exporter, the company is not interested in investing in small-scale aquaculture businesses but they are interested in buying the product if it is something they can sell to export markets.

In terms of supply and demand trends, both companies said that marine ornamental fish that are high volume and low cost are popular with the wholesale businesses they sell to. Among

the top volume fish they trade are: Blue-green Chromis (*Chromis viridis*); Blue Devil Damsel fish (*Chrysiptera cyanea*); other damselfish species including the Three Striped Damsel fish (also known as Humbug Dascyllus) (*Dascyllus aruanas*); and the Ocellaris clownfish (*Amphiprion ocellaris*). Wholesale costs for these fish are very low – the exporter sells a single Blue Devil for USD \$0.30, damsels for \$0.30-0.65, and Ocellaris clownfish for \$0.75-0.80. While more expensive species are traded as well, the exporters explained there is less demand than for the low-cost/high volume species.

The middleman I interviewed in Makassar was employed by an Indonesian commercial marine ornamental export business. Because an aquaculture business could potentially cut out the middleman by contracting directly with exporters, I was interested to know what he thought of aquaculture businesses on the Spermonde islands and whether he viewed potential aquaculture businesses as a threat. However, his perspective of aquaculture was that it was beneficial to him, because aquaculture was a mechanism for quality control, and for stable supply. He expressed interest in diversifying sourcing channels, explaining that he did not want to rely solely on wild caught species. When asked if he would invest in an aquaculture business on the islands, he said ‘yes,’ but that he would want to be the sole investor.

## **DISCUSSION**

Because coral reef aquaculture development is still in its very early stages, an important first step in assessing the outcome of small-scale aquaculture as an alternative livelihood is to understand the attitudes and perceptions of local villagers towards aquaculture (Pomeroy 2006; Ferse et al. 2012; von Essen et al. 2013). The purpose of this study is to characterize fishers’ attitudes of ornamental aquaculture as a business opportunity to better understand the potential

implications of those perceptions to developing marine ornamental aquaculture as an alternative livelihood to fishing in the Spermonde Archipelago. While the data are not generalizable to a broader population, the data can be used to inform and strengthen Mars' approach to its mariculture program.

### ***Familiarity with aquaculture***

With 48% of respondents saying they did not know what aquaculture was, the findings from this part of the study reinforce the notion that ideas and knowledge that may be well known in coastal or mainland communities may not transfer to physically isolated island communities. One of the major challenges to developing alternative livelihoods in the Spermonde islands is the geographic distance of these communities from coastal communities on 'mainland' Sulawesi. This physical disconnectedness impedes the transfer of ideas and knowledge from linked coastal communities on Sulawesi to the outlying communities of the Spermonde Archipelago (Personal communication with Dr. Blankenhorn, June 26, 2012). Although the Department of Marine Affairs and Fisheries (DKP) has invested in aquaculture research and development throughout Southwest Sulawesi, there is a lack of government aquaculture programs in the Spermonde Archipelago.

Eighty-five percent of the respondents who were not familiar with aquaculture were engaged in the ornamental coral fishery as either coral fishers or local collectors. While there may be several explanations for why the individuals engaged in the ornamental coral fishery were less knowledgeable about aquaculture than other interviewees, none of the coral fishers or collectors had participated in any of the training programs mentioned by the ornamental fisher interviewees who had gained aquaculture knowledge/experience through those programs. The training programs the other interviewees had participated in and learned about aquaculture from

were specifically targeting fishers who were involved in the marine ornamental fish trade, rather than the coral trade (Personal Communication with COREMAP representative, June 25, 2013).

Pulau Badi was the only island in the study where 100% of respondents knew what aquaculture meant and knew of Mars' seahorse project. This may be a reflection of Mars' presence on Pulau Badi and the years they've spent on the island working with the family to set up the seahorse prototype. One of these respondents explained how he heard "good feedback" about the seahorse business from other people on the island, and that if Mars approached him to start an ornamental aquaculture business he would be very interested.

If one of the major challenges to livelihood diversification in the Spermonde Archipelago is the transfer of knowledge and ideas from the mainland, then perhaps the transfer of knowledge about aquaculture can happen (or is happening) on a much more localized scale. In a paper on community-based aquaculture in India, Radheyshya (2001) explains how "poverty in general and ignorance in particular stand as two main barriers in the development of such capacities." With nearly half of all respondents in this study saying they were unfamiliar with aquaculture, then Pulau Badi might provide the 'mainland' from which knowledge about ornamental aquaculture can emanate from, helping to overcome a general lack of knowledge and understanding about ornamental aquaculture as a livelihood opportunity.

The family on Pulau Badi who has been successfully managing the seahorse mariculture business knew what aquaculture was in general terms but had no previous experience with it before working with Mars on the seahorse prototype. So while previous knowledge or experience with aquaculture might not a prerequisite for successfully running an aquaculture business, it might be an important part of developing community-based aquaculture businesses considering

respondents with past knowledge and/or experience seemed more willing to pursue ornamental aquaculture as a business opportunity than those who lacked knowledge and/or experience.

### ***Interest in marine ornamental aquaculture as an income-generating business***

With nearly 80% of interviewees expressing interest in ornamental aquaculture, the general lack of knowledge about aquaculture did not seem to affect the level of interest in marine ornamental aquaculture as a business opportunity. The high level of interest may be a positive indicator for scaling up Mars' mariculture model. However, for many of the respondents, their interest in an aquaculture business was conditional upon knowing that the business could provide enough income to pay for their families' basic needs. Other main concerns included knowing that there was a "good" market for marine ornamentals, or even knowing there was a market at all. Another concern was also having available space to build a mariculture tank. Barrang Lompo, the island with the highest number of respondents not interested in ornamental aquaculture, is a very densely populated island with little available land. All of the respondents from Barrang Lompo who were not interested in ornamental aquaculture cited the lack of open property as a major problem – even if they were actually interested, they didn't have the space for it.

Many of the interviewees who were formerly engaged in the Spermonde marine ornamental trade, either on a fulltime or supplemental basis, stopped ornamental fishing because they weren't making enough money from it, they didn't have a buyer, and/or they had to depend on unreliable public ferries to get to and from Makassar in order to deliver their products to market. While these concerns are related to respondents' experiences with ornamental fishing, the same concerns appear to be surfacing in regards to ornamental aquaculture. Addressing these

basic concerns may be fundamental to successfully scaling up ornamental aquaculture as an alternative livelihood, especially for fishers who have a skeptical outlook on the marine ornamental trade and/or have had negative experiences as participants in the marine ornamental fishery.

While people on Pulau Badi might be aware of how successful the seahorse business is, that information has not necessarily spread to other communities. Perhaps these concerns could be mitigated and respondents could have more confidence in ornamental aquaculture if they knew there is a good market for marine ornamentals, a fair price, and a committed buyer. In a paper about attitudes of villagers toward community-based mariculture in North Sulawesi, Indonesia, von Essen (2013) explains, “initially, a few local pioneers eager to carry out mariculture are needed to serve as a positive role model, encouraging other community members to join in.” Respondents indicated a high level of interest in marine ornamental aquaculture but their interest was often conditional upon knowing in advance about market opportunities and income. Furthermore, the fact that it may take months of hard work to see any money from the business is a major challenge to getting villagers interested in ornamental aquaculture (Personal communication with Dr. Blankenhorn, July 1, 2012).

The family with the seahorse business is arguably the “pioneer” in their community and is proof that there is a market for marine ornamentals, a steady income from the business, and a successful way to transfer marine ornamentals via public boat. According to one of the members of the family with the seahorse business, “people don’t have an incentive” to commit to Mars’ alternative livelihood projects because there is no money to be made upfront, and that “people don’t want to do aquaculture so the best way to get people interested is to show them a good, working model” (June 11, 2013). If Spermonde villagers were presented with a “good working

model”, then it could be extremely helpful in addressing major concerns that might hinder scaling up marine ornamental aquaculture as a livelihood alternative on the islands.

### ***Interest in a co-operative business***

One of the most important yet challenging aspects of developing small-scale ornamental aquaculture on the Spermonde islands is involvement on a community level, rather than individual and single-family business units (Personal communication with COREMAP representative, June 25, 2013). The results from this study reinforce that notion – while interest in ornamental aquaculture as a business opportunity was close to 80%, interest in a cooperative business was slightly less at 63%. While 63% might not seem very low, more than half of those respondents willing to work in a cooperative said they would do so with only family members because family could be managed and trusted more easily than non-family. Additionally, most of these respondents emphasized the importance of being able to choose their group members. This group selectiveness that respondents displayed might be a major factor that makes developing community-based aquaculture businesses on the islands so challenging.

In addition to selectivity in choosing group members, another major challenge to scaling up the ornamental aquaculture prototype on a broader community level is the fact that there are parts of the community that do not want the system to change, specifically the *punggawas* who provide loans and equipment to fishers and then make money by buying those fishers’ catch at a discounted rate (Personal communication with Dr. Sven Blankenhorn, July 1, 2012). Ferse et al. (2012) explain that because *punggawas* play a central role in trade in the Spermonde Archipelago, especially for marine export commodities such as ornamental fish and corals, they are both part of the problem and solution to developing alternative livelihoods on the islands.

While researching the ornamental coral industry in the Spermonde islands, Ferse et al. (2012) found that *punggawas* were not interested in venturing into mariculture because they perceived this as a “riskier enterprise compared to relying on fishermen to provide them with ornamental corals.” Because *punggawas* exert considerable influence in the ornamental fishery in the Spermonde, they have the potential to either hinder or help promote more sustainable practices among fishers (Ferse et al. 2012). Thus including *punggawas* in livelihood development and management strategies, including Mars’ ornamental aquaculture program, could be instrumental in how community members, particularly fishers, perceive mariculture and how they organize themselves in terms of a business structure.

### ***Potential of marine ornamental aquaculture to reduce fishing pressure***

In addition to diversifying livelihoods in the Spermonde Archipelago, mariculture is an opportunity to reduce pressure on local coral reef and fishery resources (Ferse et al. 2012). While the respondents in this study expressed a high interest in marine ornamental aquaculture as a business opportunity, many of them did not know how or if they would divide their time between fishing and aquaculture. Only 15 respondents had an idea of how they would manage their time, and 60% of those said they would stop fishing if the aquaculture business generated an income equal or greater to their current income. Nearly every single respondent who expressed interest in no longer fishing was engaged in either the marine ornamental fish or coral fishery as a fulltime livelihood, and the idea of making a living by being able to stay on land seemed very appealing to most of them.

In speaking with people at Mars and the family with the seahorse business, ornamental mariculture is a fulltime operation that requires close monitoring and daily attending. However,

lacking detailed knowledge and experience with aquaculture, most respondents did not have a grasp on the time commitment that managing a mariculture business entails. Respondents who said they would continue to fish while managing an aquaculture business thought that the two activities could be juggled in a variety of ways including: alternating days for each activity; splitting the day in half between the two activities; spending whatever time was left after fishing to tend to aquaculture; and having group members tend to the business while the respondent was out fishing. Thus for these respondents, mariculture would be a supplemental income to fishing rather than an alternative income.

The potential danger with developing mariculture as a livelihood strategy is that villagers could invest the profits from mariculture into fishing activities rather than reinvesting back into the mariculture business, effectively increasing fishing pressure on nearby reefs instead of decreasing it (Sievanen et al. 2005). In a study of villagers' attitudes towards mariculture in two fishing communities in northern Sulawesi, von Essen et al. (2013) found that 28% and 21% of fishers would have used the "hypothetical profits from mariculture exclusively to invest in their current activity, e.g. to purchase fishing gear or boats, rather than reinvest into their mariculture." While 33% of respondents in this study said they would stop fishing if mariculture earned a comparable income to fishing, a high level of interest and acceptance of mariculture does not necessarily reflect an eventual and sustained participation and effort in mariculture projects (von Essen et al. 2013). Von Essen et al. (2013) also found that many of the respondents in their study viewed mariculture as "less cumbersome and time consuming than fishing," but that because fishing was "valued as a challenging activity with a long tradition," several respondents were hesitant to quit fishing in favor of mariculture.

Community-based approaches to livelihood diversification often assume fishermen will give up fishing if there is a more lucrative livelihood alternative thus resulting in reduced pressure on local marine resources (Crawford 2002). However, fishers often weigh non-economic considerations such as the socio-cultural value and personal gratification gained from fishing more heavily than economic considerations (von Essen et al. 2013). Even if fishers have a profitable mariculture business, there is a low likelihood that they will fully replace fishing with mariculture (von Essen et al. 2013). Thus in attempting to replicate and scale up ornamental mariculture on the Spermonde islands, one can not assume that fishers will leave traditional fishing livelihoods for the economic benefit and security of a mariculture business. Educating and informing fishers of how much time and labor a mariculture business requires may be an important part of managing expectations and helping fishers understand that mariculture is a fulltime livelihood. However, it is also equally important to acknowledge the sociocultural importance of traditional fishing livelihoods to Spermonde villagers, and understand how that plays into the long-term development of small-scale mariculture on the islands.

### ***Willingness and/or ability to self-finance an aquaculture business***

This study revealed a high unwillingness or inability to invest or borrow money to finance an ornamental mariculture business. Most respondents were not willing to invest at all, or preferred an investment scheme where someone else fully financed the business. More than half of respondents were also unwilling to borrow money as well, citing difficulty dealing with banks and being able to pay back loans. Respondents were very concerned with investing or borrowing money for a market they weren't sure was there and a business that they didn't know was profitable right away. The respondents who were willing to borrow money from an "investor"

often mentioned that borrowing money from *punggawa* was better than borrowing from banks. Thus for those respondents who would borrow or invest money in an ornamental mariculture business, it appears that *punggawa* would play a central role as investors.

These findings align with several other studies of mariculture in small fishing communities as well as what I heard from speaking with people at Mars. On Pulau Badi, the seahorse business has taken nearly four years of trial and error to be the success that it is today and for the family to see returns on investment (Personal communication with Dr. Blankenhorn, July 1, 2012). Villagers on Pulau Badi are not willing to put time, effort, or any other investment into a business that does not see immediate profits (Personal communication with Dr. Blankenhorn, July 1, 2012). Furthermore, because mariculture is such an abstract and alien concept to most villagers, they are not willing to invest in a business that they have little trust and familiarity with (von Essen et al. 2013).

Respondents' low willingness to borrow or invest from formal lending institutions poses a challenge to the long-term development of mariculture on the islands by making a sustainable financing mechanism hard to implement, and emphasizes the importance of patron/client relationships on the islands.

## **CONCLUSION**

This study sought to characterize and assess fisher perceptions and knowledge of ornamental aquaculture as a business opportunity and alternative livelihood to fishing in the Spermonde Archipelago, Indonesia. While the findings are not generalizable to a broader population, the data can be used to help inform Mars' future approach with its Sustainable Solutions Mariculture Program by highlighting several challenges to implementing a market-

based livelihood strategy that involves transitioning villagers from traditional fishing livelihoods to mariculture enterprises.

While the level of interest in ornamental mariculture was high, fishers expressed various concerns with pursuing an ornamental mariculture business – including market and income uncertainties –as well as a high unwillingness to invest or finance a business. Furthermore, it is not clear if respondents would transition to mariculture as a fulltime livelihood or if they would continue to fish, raising questions of how effective mariculture would be in reducing fishing pressure on local reefs.

While fishers' expressed a high interest in ornamental mariculture as a business opportunity, their concerns and skepticism of the marine ornamental fishery—coupled with complex patron/client networks— may pose several challenges to the potential scalability of small-scale ornamental mariculture as an alternative livelihood strategy for the Spermonde Archipelago.

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## **APPENDIX**

### *Appendix A. Interview Guide for Spermonde Fishermen*

[\* = priority questions]

**First, I would like to know a little bit about your household and how you make a living.**

1. How many people are in your household?
2. What do people in your household do to make a living?
  - a. How much time would you say you spend per week doing each activity?
  - b. About how much income do you get from each activity?
3. Does anyone fish? (if not mentioned)
  - a. What type of fish do you catch?
  - b. What gear do you use?
4. Do you have a boss?

**Second, I would like to learn about the aquarium trade in your community and potential business opportunities for aquaculture**

5. Are you familiar with ornamental fish and coral?

- a. Do you or have you collected ornamental fish or coral?
  - b. What methods did you use to collect the fish or coral?
  - c. How long have you been involved in ornamental fishing?
6. Is harvesting for ornamental species currently taking place in your community?
    - a. What harvesting practices are currently being used in your community or at nearby reefs?
    - b. Have you noticed a decline in ornamental species available for harvest?
  7. What ornamental species do you find around this area?
    - a. Which of those species are the most valuable in terms of selling price per fish?
    - b. What is the most valuable in terms of volume?
  8. Who do you sell the fish you collect to?
    - a. How often?
    - b. Does your buyer place an order with you first or do you catch the fish and then try to sell them?
    - c. How big are the orders?
  9. Approximately, what percentage of your income is from ornamental fishing?
    - a. What other sources of income do you have?
  10. \*Are you familiar with aquaculture?
    - a. How did you learn about it?
    - b. What were your past experiences?
  11. \*Are you interested in ornamental aquaculture as a business?
    - a. Why or why not?
    - b. How much time would you be willing to spend on aquaculture?
    - c. How much money would the business need to bring in in order for you to be interested?
  12. \*Are you interested in a co-operative or community aquaculture business?
    - a. Do you know of other people who may be interested in a co-operative as well?
    - b. Would you be happier to doing the business on your own, with another person, or with other families in your community?
  13. \*Do you have capital or savings to invest in an ornamental aquaculture business?
    - a. Would you be willing to invest in the business knowing that there may not be an immediate payback?
    - b. Would you be willing to borrow money to start such a business?

1. Before the seahorse business, what were you doing to earn money?
  - a. Were you involved in the marine aquarium trade before the seahorse business?
  - b. For how long?
  - c. What species did you collect/fish?
  - d. What gear did you use?
  - e. Would you say you fish less, the same, or more than you did before you had the seahorse farm?
  
2. Were you familiar with aquaculture before Mars introduced you to it?
  - a. Did you or someone else you know participate in aquaculture?
  - b. Why did you decide to try the seahorse aquaculture business?
  
3. What percentage of your family's income is from the seahorse farm?
  - a. Do you earn less, the same, or more than before you had the seahorse farm?
  - b. Does the income cover your basic expenses?
  - c. Has the income from selling seahorses increased since your first sale?
  - d. What other sources of income do you currently have?
  - e. How many people besides you does this farm support?
  
4. Who do you sell the seahorses to?
  - a. How much do you sell the seahorses for?
  - b. Has the price you received for the seahorses increased or decreased? And by how much?
  - c. Who does your buyer sell the seahorses to?
  
5. Did you have capital or savings to invest in the seahorse farm?
  - a. How much?
  - b. How much money does it take to maintain the farm?
  
6. Overall, how do you think things are going with the seahorse business?
  
7. What has been the most difficult part of operating the business?
  
8. How do you think other people in your community feel about the seahorse business or other types of aquaculture?
  - a. Do you know of other people who are interested in starting an aquaculture business to raise aquarium species?

- b. Do you think people in your community would be interested in a co-operative or community aquaculture business?
9. Would you like raise other ornamental species?
- a. Which ones, and why?
10. In your opinion, what would be the best way to spread ornamental fish aquaculture to other people and communities?

### *Appendix C. Interview Guide for Commercial Exporters in Bali*

1. What are the major ornamental species that you buy from the South Sulawesi/Spermonde area?
2. Which species from the Spermonde reefs are the most profitable in terms of wholesale value?
  - a. Do you buy marine ornamental species endemic to Spermonde reefs? (only found in the Spermonde area)
3. Which ornamental species have the highest survival rate? The lowest?
  - a. Where in the supply chain is mortality rates the highest?
  - b. What is the greatest cause of mortality in the ornamental supply chain?
4. How much of your overall supply comes from fish collectors in South Sulawesi/Spermonde communities?
5. Have you noticed a decline in supply from your collectors in that area?
6. Are you worried about reliable long-term supply?
7. Do you think ornamental aquaculture is a realistic business venture for Spermonde communities?
  - a. Why not? (if answer is 'no')
8. Would you be willing to buy from a co-operative or community business?
9. Willing to invest?
10. Would you pay more for species you knew were sustainably produced?
11. What opportunities are there for certification schemes?