ASSESSMENT OF AN ENVIRONMENTALLY-FRIENDLY METHOD OF ORNAMENTAL FISHING ASSOCIATED WITH REVENUES OF FISHERS IN TEJAKULA SUB-DISTRICT, BULELENG REGION, BALI, INDONESIA

Thesis Research

By:
STELLA SHERLEY MIRYAM PASARIBU-GUZINA

Certificate, Peace Centre Burg Schlaining (Austria), 2000
Postgraduate Diploma, Warwick University (UK), 1998
Certificate, Strathclyde University, Scotland (UK), 1996
BSc. Hasanuddin University (Indonesia), 1994

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the required standard

Dr. Brian Belcher, Thesis Supervisor
Centre for Livelihood Ecology
ROYAL ROADS UNIVERSITY

Dr. Tony Boydell, Thesis Coordinator
School of Environment and Sustainability
ROYAL ROADS UNIVERSITY

Michael-Anne Noble, Director
School of Environment and Sustainability
ROYAL ROADS UNIVERSITY

Abstract

This study examined the impact of reformed fishing and reef management practices in a community-based marine ornamental fishery in Tejakula sub-district, Bali, Indonesia, on the development of effective community-based natural resource management.

With the absence of cyanide fishing for one decade, the coral reef condition has improved from 26% of area coverage to 53%. T-test result shows that there is no significant difference in individual fishing revenue and a considerable decrease in total fishery revenue. The fishers have benefited in resource conservation and a 73% decrease in fishing costs. The overall number of ornamental fishers has declined, due to social pressure, a smaller overall fishing space because of No Take Zones (NTZ), and fewer orders for ornamental fish.

Environmental education for local community members is critical to maintain adherence to the reformed method of fishing. Clear definition of the NTZS policy should be acknowledged to avoid recurring conflict among stakeholders.

Keywords: ornamental fish, cyanide fishing, Tejakula, barrier net.

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Chapter One: Introduction

Background and Issues

This thesis investigates the relationship between the adoption of an environmentally-friendly method of fishing for ornamental fish and sustainable livelihoods in Tejakula sub-district, Bali. The use of barrier nets was adopted as an alternative to cyanide fishing. This reformed fishing method is expected to allow the reef and associated fish populations to recover, and to subsequently improve the income of local fishers. Healthy coral reef systems are seen as foundational to achieving improved livelihoods (Frey, 2012). The current study collected data on: 1) the ecological condition of the coral reef; 2) ornamental fishing costs and revenues to assess if a decade of using the reformed fishing method has had an impact on both the coral reef condition and the income of ornamental fishers in Tejakula sub-district; and 3) prevailing social and market issues.

Cyanide fishing is practiced in many countries in the Indo-Pacific region, except Australia, the Caribbean, and Hawaii (Barber & Pratt, 1998). Initially, nets were used to catch ornamental fish in Tejakula sub-district. However, increased demand prompted the fishers to look for ways to improve their catch. In 1985, the cyanide method of fishing was introduced to help meet this demand. Fishers discovered that cyanide makes fish lethargic, thereby making them easier to catch. Subsequently, continued market demand and financial reward favoured the expansion of this fishing technique (Halim, 2002).

Destructive fishing practices are common in coral reef areas where population and economic pressures lead to a state of intense competitiveness among coastal villagers (McManus, 1997), such as in Tejakula sub-district, the poorest region in Bali (UNEP, 2005). During the twenty-five years that cyanide fishing had been used, there was a substantial reduction in the number of fish, including hardier fish like Letter Six (*Parachanturus hepatus*), that normally have a wide distribution and longer life span of up to 10 years (Local Government of Buleleng Regency, 2006). In 2000, environmental laws prohibiting the use of cyanide for fishing were tightened, forcing the fishers to return to more environmentally-friendly fishing methods. Switching was difficult since the fish population had rapidly decreased because of the cyanide (Dinas Kelautan dan Perikanan Kabupaten Buleleng, 2004).

Cyanide, besides endangering the coral reef and its biota, also brings human health risks, particularly to those who have direct contact with it. Nausea and gastritis are common symptoms of mild cyanide exposure, while larger doses can cause death (Scheer & Moss, 2011). Cyanide is toxic when inhaled, ingested or absorbed through the skin. Accidental cyanide poisoning in fishing communities has occurred, but not as frequently as might be expected (Helfman, 2007).

To preserve the livelihood of ornamental fishers in Tejakula sub-district, coral reefs must be sustained. Sustainability consists of three inter-related pillars: economic, social and environmental. The interrelation between these three pillars is integrated and necessary to ensure the continued sustainability of natural resources. The World Wildlife Fund (WWF) International and International Union for Conservation of Nature (IUCN) emphasize the link between environment, poverty eradication, and human well-being in the Outcome Document from the 2005 World Summit, stating the following: “We fundamentally depend on natural systems and resources for our existence and development. Our effort to defeat poverty and pursue sustainable development will be in vain if environmental degradation and natural resources depletion continue unabated” (Wilkins, 2008, p. 174).

This thesis provides recommendations for the existing management of ornamental fishing in Tejakula sub-district. Furthermore, the case of Tejakula ornamental fishers could be used to discourage ongoing cyanide fishing elsewhere. Their experience illustrates that while this practice initially increases fish hauls and associated revenues, it ultimately threatens livelihoods by permanently depleting fish stock and negatively impacting human health.

Economic Benefit.

Economic Aspect of Sustainable Development. In Indonesia, the root causes of destructive fishing method are as follows: population growth, poverty, limited economic opportunities, institutional and policy issues, limited existing regulation, lack of public and stakeholder awareness and involvement, and limited information for management (GEF, January 2004). The case of the Tejakula ornamental fishers is only one of hundreds of similar cases across Indonesia.

Coral reefs and their surrounding ecosystems, including sea grass beds, provide important fish habitat (Conservation International, 2008). About 30% of the entire world's coral reefs are located in Southeast Asia, with 18% of the total located in Indonesia and the Philippines (Wilkinson, 1998). Coral reefs are hotspots of marine biodiversity. In particular, Indonesia's coral reefs have some of the greatest coral reef diversity in the world, with more than 400 different species of coral recorded. A small coral reef in Indonesia may support over 300 species of coral, 700 species of fish and many thousands of other animals and plants (Wilkinson, 1998).

The sustainable economic benefit from coral reefs in Indonesia has been estimated at USD 1.6 billion per year (Burke, Selig, & Spalding, 2002), which includes fisheries, shoreline protection, tourism and aesthetic/biodiversity value. The calculation for fisheries was based on a market price of USD 1.5 per kg of reef fish and the assumption that fishing costs are 20% of revenue. The tourism value was based on wide range of tourism types. The aesthetic/biodiversity value was based on the assumption of an average expenditure (willingness to pay) of USD 4 per day for entrance to a marine sanctuary in support of conservation (Burke, Selig, & Spalding, 2002). In 2002, it was estimated that more than 32,000 km^2 of reefs were overfished in Indonesia, resulting in massive societal losses of USD 1.9 billion over 20 years (CI, 2008). Destructive fishing practices and resource exploitation in the marine aquarium trade are contributing to the depletion and destruction of the coral reefs of Indonesia. This has subsequently created poverty in coastal communities by removing or reducing economic and subsistence options for resource use. From an economic point of view, according to Edwards (2008), the total net benefit of cyanide fishing to individuals is USD 33,000 per km^2. However, the net loss from cyanide fishing to society rose from USD 43,000 to USD 476,000 per km^2, which is ten times the net profit (Edwards & Gomez, 2007). This information indicates that the high profit generated by destructive fishing methods lasts only a very short time, but has major long-lasting consequences, ultimately resulting in huge losses. The profit and loss of coral reefs are normally calculated using five methods of valuation techniques: Effect on Production (EoP), Replacement Cost (RC), Damage Cost (DC), Travel Cost (TC), and the Contingent Valuation Method (TCM) (Cesar & Chong, 2005).

Economic Impact of Cyanide Fishing in Tejakula Sub-District. The main reasons why Tejakula fishers took the short cut of using toxins were to catch more fish and increase family income (Initiative, 2005). However, after more than 20 years of cyanide fishing, damage to the coral reef peaked in 1999 (Bali News, 2011), and the resulting degradation of coral reef health worsened the fishers’ situation (Gunawan, 2012). As the population of ornamental fish declined in their local area, fishers travelled further to find healthier coral reefs with higher populations of fish (UNEP, 2005). The total costs incurred, including their time and cost of cyanide, was not comparable with the revenue they earned from their catch. In the meantime, they damaged the coral in every area where they used cyanide. However, since coral reef conditions have improved, ornamental fish have slowly returned and begun to repopulate the reefs. This study investigates whether or not the coral reef recovery has had an impact on ornamental fishers' income, and whether or not the environmentally-friendly fishing method will sufficiently stabilize the resource to provide a sustainable livelihood for both current and future generations.

Social Factor.

Social Interaction in Sustainable Development. The social pillar of sustainable development is described as a set of actions and efforts to promote development that does not deplete the stock of social and human resources, but rather contributes to the enhancement of their potential (Van Nierop, 2008). The set of actions or efforts can be a tradition or culture that protects the environment. For example, in Bali there is a concept of harmony called Tri Hita Karana, from the Sanskrit word meaning three causes of welfare, which describes the relationships between: 1) human and God; 2) human and other humans; and 3) human and surroundings or environment (Samadhi, 2004). This concept is becoming a guiding philosophy behind nature preservation in Bali, including Tejakula sub-district.

In Tejakula sub-district, an important relationship impacting the ornamental fishing industry is the bond that exists between fishers and middlemen, and the strong influence middlemen have over the fishers. During the cyanide period, middlemen provided the potassium cyanide to the fishers. Now that the reformed method of fishing has been implemented, middlemen support their fishers by providing non-destructive fishing equipment and ensuring cyanide is not used for fishing to promote fish quality. Good quality ornamental fish means more profit for the middlemen.

The concept of building a sustainable and harmonious community is also part of the social pillar (Van Nierop, 2008). The social pillar of sustainable development emphasizes equity and equality (Stevens, 2010), which is essential to achieving social justice for the community. However, in many places, inequalities exist, producing frustration and tension that may generate conflict and jeopardize the social fabric for generations to come (Dubois, 2005).

The position of one local group in a given community impacts the attitude of local authorities towards them, and improvements to the well-being of one group (e.g., education, health, employment, etc.) may be detrimental to another group (Lehtonen, 2004). Tourism entrepreneurs and ornamental fishers are two social groups in Tejakula sub-district that both benefit from the existence of coral reefs, but they do not have a good relationship. Ornamental fishers occupy the lower class due to their lack of education and lower economic level.

Social sustainability implies that future generations should inherit at least as many resources, in terms of capital or other potentialities, as the current generation (Dubois, 2005). This means that the next generation has the right to receive all the valuable resources from the current generation. In this sense, the current generation has a responsibility to preserve the existing resources from which they currently benefit. Whatever the current generation does to generate the capital for their living or other potential benefit, it should be done with full responsibility towards the future of their children.

Social Aspect Involvement in Tejakula Sub-District. This study depicts the social-economic relationship economic relationship between the main stakeholders of the ornamental fish trade in Tejakula sub-district that affect the fishers' income. There are many influencing social factors related to the fishing activities, and these aspects affect ornamental fishing income in different ways. Social culture not only impinges on the daily life of the local community, but also has a strong impact on how the fishing community deals with cyanide fishing, as well as local trade and the economy, such as where the fishers have to sell their catch and the price of fish.

Currently Tejakula sub-district is totally free from cyanide fishing. *Hukum adat* or custom law among the community is one of the main influences that prevent cyanide fishing (Partiana, 2012). If a fisher were caught using cyanide on the reefs, he would be warned once. If the violation occurred again, that individual would be turned over to the authorities (Frey, 2012). Furthermore, the fisher also would be ostracized by the fishing community (Soetikno, 2008).

The complicated social relationships between fishers, middlemen and exporters have a major role in determining the price of ornamental fish in the local market. Different interests among the community groups, such as those between the fishers and tourism entrepreneurs, have created a dilemma that currently has no easy solution (Mertan, 2012). Social justice, whereby every level of society has the right to be treated equally, is out of balance in Tejakula sub-district, and in fact, intimidation of one of the community groups exists.

Ecological Feature. Environmental sustainability is defined as the capacity of the environment to continue to properly function indefinitely (Van Nierop, 2008). The goal is to diminish environmental degradation, and to stop and reverse the process of destruction that leads to the degradation (Van Nierop, 2008). Compared with the other pillars of sustainability, the environmental pillar is much weaker than the economic and social pillars. This is because the protection of the environment lacks the moral significance attributed to the protection of human life (DELC, 2011). Environmental sustainability can be viewed as balancing the pillars of economic and social development (Bath, 2011). In economic terms, the environment is generally viewed as a “public good,” or in greatly simplified terms, something to be freely enjoyed by humans, owned by no one and having no economic value or cost (DELC, 2011). “It leaves the differentiation between environment and sustainable development and weakens the acceptability of sustainable development as comprising both economic and social development, and environmental protection (Wilkins, 2008). The achievement of progressive decisions on environmental and sustainable developmental issues often requires more political will than is available for all government levels (UNEP, NGOs, Alliance, & Service, 2007).

“As one of the oldest ecosystems on earth, coral reefs have functioned as natural barriers that protect nearby shorelines, protecting coastal lines and beaches, as well as a source of food and shelter of diverse species such as fish, invertebrate and so on” (Coral Reef: Reef Resilience Toolkit Module, 2007 – 2010). “Indonesia is the biggest archipelago country in the world, comprised of 17,508 islands, of which only 6,000 are inhabited. Indonesia has nearly 81,000 km of coastline, where the vast oceans spread from west to east along the equatorial line with an area of water over nearly six million square kilometers” (GEF, January 2004).

For years, Indonesia’s coral reefs have been exploited and destroyed for fisheries, tourism, research, and many other purposes. The desire for more profit by any means jeopardizes environmental sustainability. Thoughts of the resources’ future are usually considered only after the issue is clearly in sight. When the possible negative impact of cyanide actually happened, the Tejakula sub-district fishing community realized that the method they thought could improve their income was, in fact, destroying their livelihood resources.

Policy

After the International Coral Reef Symposium was held in Bali in October 2000, and following direct orders from the president of the Republic of Indonesia, laws preventing the use of cyanide were strengthened. According to one of the fishers in Tejakula sub-district, the law against cyanide fishing has been more strictly forced since 2000. This action was quite surprising since it had never happened before (Partiana, 2012). Since cyanide fishing had been practised for more than 20 years, the fishers were unprepared for such a sudden change in their way of fishing.

According to one of the fishers interviewed, the ENGOs (Environmental Non-Governmental Organizations) helped the local fishers adapt once cyanide fishing was banned. A local ENGO called Telapak was the first to come to Tejakula sub-district in the beginning of 2000. Telapak conducted education and awareness programs for the ornamental fishers in the village of Les, informing them about the dangers of potassium cyanide to marine life and to the fishers themselves, and introducing the environmentally-friendly fishing method of using barrier nets. “Local governments merely prohibited us from using cyanide, but they never told or showed us another alternative method that we could use to catch the ornamental fish. Telapak also told us not to catch ornamental fish with cyanide too, but in return they gave us training to catch fish with the nets so we could continue fishing without damaging the coral reef” (Partiana, 2012).

No Take Zones (NTZs) are part of the current implementation policy in Tejakula sub-district. Their initial purpose was to increase the population of ornamental fish. Research has shown that Marine Protected Areas (MPAs) can provide biological spillover benefits to adjacent fishing grounds by protecting spawning stock biomass and genetic diversity, allowing for more natural population structures and providing new recruits to the fishery (Carter, 2003). Although the purpose of the NTZ in Tejakula sub-district is good one, as will be discussed in this thesis, it has had unintended consequences within the Tejakula community, and has caused some ill will among stakeholder groups.

Project Participants

This study involved local authorities, non-governmental organizations, and the private sector, such as entrepreneurs/exporters. The non-governmental organizations included Yayasan Alam Indonesia Lestari (Indonesia Nature Foundation or LINI) and Indonesia Reef Check, which are the most active local ENGOs in Tejakula sub-district. LINI mostly provides environmental education and development programs to students and local ornamental fishers. LINI also acts as a bridge connecting environmental research with local fishers or fishers' associations and exporters (as data resources), working together in community-based fishery programs since 2005. Recently, they have been actively involved in an artificial coral reef project.

For the last five years, Indonesia Reef Check has been actively collecting coral reef data through surveys, and has been involved in the protection of coral reefs around the Tejakula sub-district. The purpose of their data collection is to obtain accurate information and monitor the condition of coral reefs that can be used as recommendations for policy purposes. For example, the Indonesia Reef Check has been used to guide the formation of the No Take Zone areas in the Tejakula sub-district. Other main participants in this study are the local ornamental fishers, the middlemen and the exporter. Most of the fishers are members of ornamental fishers association. These main stakeholders provided all the necessary information regarding revenues, fishing costs, and fish prices before and after the reformed method of fishing was implemented.

Purpose

The purpose of this thesis is to understand the impact of reformed fishing and reef management practices in a community-based marine ornamental fishery in Tejakula sub-district as a way to contribute to the wider development of effective community-based natural resources management. This thesis assesses the revenue generated by the non-destructive fishing method currently used by ornamental fishers, and explores whether or not the non-destructive fishing practice can continuously support the livelihood of ornamental fishers. The non-destructive fishing practice is expected to allow for the recovery of the habitat of ornamental fish, thereby increasing the population of aquarium fish as a main source of income for the fishers. This thesis provides information about the type of fishers, their fishing costs and net revenues during and after cyanide fishing which will be used to answer the questions in this thesis. Other significant factors affecting fishing revenue, such as the social relationships between the fish collectors and the middlemen/exporters, motivational factors, and policies are also discussed in this thesis.

Organization of Thesis

This thesis is organized into five chapters. Chapter Two presents a literature review on marine livelihoods, the ornamental fish trade, management of ornamental fish, and government regulations regarding cyanide fishing. The research method, including data collection and analysis, is discussed in Chapter Three. Chapter Four reviews the results and discusses fishing revenues, the coral reef condition and others factors supporting the reformed fishing method and significant issues related to the sustainability of environmentally-friendly fishing. Chapter Five presents this study's conclusions and recommendations based on the results.

Chapter Two: Literature Review

Marine Livelihoods and Coral Reef Conservation

According to Rhode (2007), livelihood comprises people, their capabilities and their means of living, including food, income, and assets. A livelihood is environmentally sustainable when it maintains or enhances the local and/or global resources, such as ornamental fish, on which livelihoods depend, and does not detrimentally impact other livelihoods. A livelihood is socially sustainable when it can cope with and recover from stress and shocks, and provide for future generations (Chambers, 1991). Definitions above describe how the sustainability of livelihood resources can continuously provide the supply from one generation to the next. To provide continuously means the resources must be sustained for the current and upcoming generations. To sustain means to preserve and keep resources from any possible destruction and future elimination.

Exploitation of natural resources to increase revenues commonly happens all over the world. On the land, people cut and burn forests to create fertile soil for farming, which provides a bigger income within a shorter period. The decision that allows deforestation of the land can lead to sedimentation and loss of coral reefs many miles away from the logging activity (Spurgeon, 2004). This action contributes to land erosion, flooding, and reduces the production of oxygen.

Underwater, coral reefs are considered to be the “rain forest of the sea” that should be protected to sustain the livelihood resources. However, the pressure of getting more money in less time encouraged the fishers in Tejakula sub-district to use cyanide for fishing, which ultimately led to the destruction of the coral reef as a “home” for ornamental fish. The pursuit of short-term gain “forced” the fishers to use any method, including destructive fishing, which caused reef destruction. Cyanide fishers sell as many fish as possible without consideration to their fishing method since the exporter orders more fish to satisfy the demand. However, cyanide toxicity causes high mortality among the ornamental fish, thereby reducing the supply. Unfortunately, the exporter is unwilling to pay more for increasingly difficult fish to catch. Since the fishers are being paid less per fish, they increase the cyanide concentration to increase their catch, but this merely increases the mortality rate up to 80% (Keller, 2001).

Cyanide is one of the fastest-acting poisons. “Once ingested, it cripples the body’s ability to transport oxygen and begins asphyxiating tissues almost instantly” (Simpson, 2001). One spray of cyanide, about 20 cc, can damage about 5 x $5m^2$ of coral reef within three to six months. Within this short period, the coral reef turns white and crashes into pieces. Most fishers use one to two 20 g sodium cyanide (NaCN) tablets in one liter of water (Dixon, 1981). Common cyanide concentrations used by fishers range from 1.5 to 120 grams per liter (Arifin, 2006). Cyanide impairs enzyme systems, which facilitate oxygen metabolism and other physiological functions in fish and invertebrates. It damages the liver, spleen, heart, and brain of the fish (Dixon, 1981). Research has shown that corals exposed to 10 ppt (parts-per-trillion) for longer than 10 minutes die within 24 hours; furthermore, within shorter exposure times and a lower cyanide concentration, the corals change from a normal brown colour to pale brown or white colour (Jones J. , 1997). Lower concentrations (520 mg/L) result in the loss of zooxanthellae and impair photosynthesis in corals, which may cause corals to die gradually (Jones R. &.-G., 1999). The death of coral reefs will turn the sea “rain forest” into a “desert,” and the fish will no longer have a place to reproduce. Therefore, the continuation of cyanide fishing will not only destroy most of the coral reefs, but the fishers’ livelihoods too. An estimated 320,000 to 640,000 kg per year of cyanide has been sprayed in Indonesia for live fish collection (Cesar, Economic Analysis of Indonesian Coral Reefs, 1996). From this information, it can be seen how vast coral reef destruction in Indonesia is occurring every year.

When the habitat of fish is destroyed, the number of fish inevitably decreases dramatically since their place of reproduction and food resources are reduced. In addition to cyanide, high levels of toxic metabolic waste are produced. Cyanide produces ammonia and nitrite, which stress the fish prior to their shipment and reduces their survival rates substantially (Nolthing, 2003). Fish stunned with poison are more prone to illness and have a high rate of mortality. Rubec (1986) said that about 50% of the exposed fish die from acute concentrations of cyanide applied in the reef (Rubec, Cruz, Pratt, Oellers, & Lallo, 2000).

According to Ferse (2010), the financial benefit of sustainable methods of capturing living specimens for the aquarium trade higher compared to destructive methods (Ferse, Manez, & Kunzmann, 2010). Evidence from the reefs of Fiji and Australia suggest that under proper management and monitoring plans, coral reefs can support an appropriate level of harvesting into perpetuity (Keller, 2001). Evidence from the Philippines showed that four years after a coral reef protected area was established as part of a cooperative community development project, the abundance of surgeon fish and fusilier (the main species fished locally) was ten times higher and their biomass was 40 times greater (Agbayani, Baticados, & Siar, 2000).

The international trade of ornamental fish has significant impacts upon the coral reefs through overfishing and the use of destructive fishing methods, such as cyanide poison (Moore & Best, 2001). Sustainable methods of ornamental fishing can prevent the continuation of reef destruction. Additionally, the cost of fishing can be reduced. The present value of benefits from the sustainable ornamental fishing sector is about three to five times the necessary additional cost, while its potential benefits are at least four times the cost of required investment (Sumalla, 2011). Over the long run, once the investment has been made, sustainable harvesting of ornamental fish is likely to cut operating costs. With the exception of cyanide, much of the equipment was transferable and the cost-conscious fisher needed to only invest in new nets (UNEP, 2005).

The Darwin final report in 2008 showed that in Buleleng district, two years (2005 – 2007) after the fishers stopped using cyanide, the diversity of ornamental fish species in Penyabangan village increased by almost 60% (Deri, 2008). Furthermore, when Blue Star, an ornamental fish exporter, participated with selected fishers in the experimental supply chain, the fishers earned a further 10% on their previous income through fair trade (ornamental fish certification), a shorter supply chain was developed, and rare species returned (Deri, 2008). This demonstrates that environmental-friendly fishing methods can improve local community livelihoods. Non-destructive fishing methods in Tejakula's area have brought similar positive changes. It is reported that more than 200 species of fish can be seen today, including one fish, the blue-ringed surgeon fish, which had disappeared after 1985. It now numbers in the thousands (UNEP, 2005).

Ornamental Fish Trade in Indonesia

According to Djamali (1998), Indonesia's waters have the richest diversity of marine ornamental fish of any exporting country with 254 species. The number of marine ornamental fish is predicted to be 1.5 billion fish spread out over the nine areas managed; five of them have the potential of more than 200 million fish (Mallawa, 2006). Ornamental fish trading is currently the largest live animal trade globally. Between 20 and 2.4 million ornamental fish are collected every year for the marine aquarium trade, and 1,471 different species of fish are traded globally (Wabnizt, 2003).

The Philippines and Indonesia – countries with the most extensive, diverse and threatened reefs – supply more than 80% of marine aquarium fish, and (for Indonesia) much of the live coral, in trade. Almost all of this is for export, only 1-2% of the harvest is for the domestic market (GEF, January 2004). Indonesia is one of the major suppliers of ornamental fish in the Southeast Asia – Australia region, exporting to the United States, Western Europe and Japan. More than 95% of the number of species exploited for aquariums is reportedly taken directly from the reef (Lecchini, 2006).

The export of ornamental fish from Indonesia generally increases every year. For example, between 2007 and 2010, the export amount increased by almost USD 3 million, reaching USD 10 million in 2010. Recently, Indonesia controlled 7.5% of the new ornamental fish trade in the world (Quantum Indonesia Translogic, 2010). Ornamental marine fish (i.e., coral reef fish) are more valuable than fish for human consumption. The retail value for a kilogram of coral reef fish intended for the aquarium trade is worth between USD 500 and USD 1,800, while the price of marine fish for human consumption ranges from USD 6 to USD 16.50 USD per kilogram (Wabnizt, 2003).

The ornamental fish industry has encouraged thousands of coastal fishers to earn extra money by collecting for the aquarium trade (Lilley & Lilley, 2007). Being largely uneducated and poor, these collectors resort to any method, including cyanide, to catch as many ornnamental fish as possible. “In order to collect particularly rare, highly priced, and difficult to catch species, which are very much in demand, sodium cyanide was used deliberately. Destructive fishing techniques and overexploitation of resources have left their mark on the reefs already, and target species have become much less abundant” (Haeger, 2004).

The environmentally-friendly method has become an economically viable alternative for these fishers,. With this method, a collector can catch the same amount of fish without the high reject rates, mortalities, and reef damage associated with cyanide use (Lilley R. , 2007). When undertaken responsibly, harvesting marine ornamentals alleviates poverty and supports livelihoods by providing one of the few potentially sustainable local industries in rural coastal villages, where few other options for income generation exist (GEF, January 2004). “Poverty reduction measures that take into account the economic, social and environmental specifics of an area are more likely to be successful and sustainable” (UNEP, Indonesia: Integrated Assessment of the Poverty Reduction Strategy Paper, with a case study on sustainable fishery initiatives, 2005).

Management of Ornamental Fisheries in Tejakula Sub-District

Tejakula sub-district is part of Buleleng regency, and Singaraja is the capital of the regency. Tejakula sub-district includes ten villages: Pacung, Sembiran, Julah, Bondalem, Tejakula, Les, Panuktukan, Sambirenteng, Tembok, and Madenan. Tejakula sub-district has a total land area of 97.68 km^2 and a population of 53,804. Within this population, there are 27,323 male and 26,572 female residents, representing a sex ratio of 102:100 (Dinas Kelautan dan Perikanan Kabupaten Buleleng, 2004). According to the census of 2004, there were 1,374 pelagic (food fish) and ornamental fishers registered. This number decreased gradually to 897 fishers registered in 2006, but climbed to 1,227 in 2007, and reached 1,285 in 2009 (Buleleng, 2010). There is no precise number of ornamental fishers in Tejakula’s sub-district, since many of the fishers easily adjust their job according to available opportunities. However, according to the ornamental fishers’ association leader and LINI’s field staff, currently, there are approximately 70 ornamental fishers in Tejakula sub-district (Mertan & Partiana, 2012).

According to UNEP's data (2005), Buleleng regency has the poorest people in Bali. After the economic recession that hit many Asian countries in 2001, including Indonesia, the per capita income of Buleleng was IDR 4.78 million (USD 537), which was much lower than the provincial average income of IDR 7.15 million (USD 803.4). When taking into account, the effects of inflation, the provincial average income per capita was IDR 2.49 million (USD 279.77); whereas the Buleleng regional average was only IDR 1.77 million (USD 198.88) (UNEP, 2005).

With 25.57 km of coastline, the beaches are composed of chunk-sized rocks, gravel and greyish-black sand. The sand was the result of volcanic eruptions from the surrounding mountains (Dinas Kelautan dan Perikanan Kabupaten Buleleng, 2004). The livelihood of the coastal community in Tejakula sub-district is mostly dependent on fishing since the land is very dry and not fertile enough for agriculture (Amanah, 2006).

The use of cyanide not only destroyed the coral reef ecosystem, but also impacted the number, variety and quality of ornamental fish. Since local fishing grounds were being depleted, fishers had to travel further to catch fish. This required more time, and cost them more money for fuel and equipment, efforts which brought no additional profit since the price of fish remained the same. The near-shore reef of Tejakula was important not only to the fishers, but also to the tourism and mari-culture industries (which harvest seaweed, grouper, and pearls). The economic value of the coral reef ecosystem is high, and therefore has to be sensibly managed and distributed among several stakeholders (UNEP, 2005). "When the coral reefs are protected, the recovery of reef fish and shell fish populations can be dramatic and rapid. But when the living coral reef itself has been destroyed, siltation often becomes a problem, preventing the settlement and growth of young coral. In this case, the recovery of reefs is a decades-long process at best" (GEF, January 2004).

In 2002, a management plan was developed for marine fishing inTejakula sub-district. It administered the use of ornamental fish and other marine biota for commercial purposes. Management of a community-based fishery was planned gradually through a consultation process that involved all stakeholders. Discussions were conducted in formal and informal meetings at the village, sub-district, and district levels (Dinas Kelautan dan Perikanan Kabupaten Buleleng, 2004). The guidelines of the fishery management plan included: 1) the geography of the utilization area; 2) the profile of the utilization area; 3) the history of coastal management in the area; 4) the list of stakeholders; and 5) the commercial list of the marine organisms. The management of marine ornamental fish and other marine organisms for trade in Tejakula sub-district is based on Law No.22, 1999 about Autonomy of the Province, Local Regulation, Villages Regulation, Agreement of Fishers Assembly, and Management Regulation Agreement (Dinas Kelautan dan Perikanan Kabupaten Buleleng, 2004).

Cyanide fishing has reduced the ecological stability and level of production of marine biota, and has placed economic pressure on those who depend on the reefs for their livelihood (Frey, 2012). To improve the coral reef condition, the No Take Zone (NTZ) has been created as a strategy for widespread reef restoration. This strategy is typically associated with the tourism industry that encompasses a community's entire reef, and prohibits all fishing activities so the reef can recover naturally (Frey, 2012). The NTZs have limited the fishing area available, and fishers can fish in areas where many of the coral reefs are still in poor condition. The spill-over from NTZs could accommodate this issue, but it will take time. So far the NTZs have become an ongoing issue between ornamental fishers and tourism operators.

Government Regulation of Cyanide Fishing

As the biggest archipelago country in the world and one of the countries that has the highest biodiversity in the world, Indonesia has numerous environmental protection regulations. There are several regarding the prohibition of fishing with poisonous or hazardous material, or any other destructive method that endangers environmental sustainability:

1. Act No. 5, 1983 about Exclusive Economy Zone,
2. Government Legislation No.15, 1984 about Natural Resources Management in Exclusive Economy Zone,
3. Act No.9, 1985 about Fisheries,
4. Government Regulation No.15, 1990 about Fisheries Business,
5. Act No.23, 1997 about Environmental Management,
6. Act No.31, 2004 about Fisheries,
7. Act No.22, 1999 about Local Authorities in conducting exploration, exploitation, conservation, and management of marine resources in coastal areas less than 12 miles,
8. Conclusion and Decision of Agriculture Ministry No.375/Kps/IK250/5/95 about Fishing Prohibition of Napoleon Wrasse (*Cheilinus undulatus*).

These regulations have provided a legal foundation to prohibit all methods of fishing, including cyanide, that have the potential to harm the habitat of life species. There are more than 100 regulations, acts and/or other decisions that support the prohibition of cyanide fishing, but the one specific regulation that applies directly to cyanide fishing is Act No.31, 2004 about Fishery. However, similar to other third world countries, the implementation of law in the field is far from what is expected. The situation is worsened by the corrupt mentality of many law enforcement personnel. Corruption at lower government levels is almost inevitable, considering the large bribes paid to lower salaried government officials (Pet, 1999), and corruption occurs at higher levels of government too. A lack of political will at all levels of government has hampered the implementation of law in the field (Pet, 1999).

Since cyanide fishing has generally been a lucrative business for key stakeholder groups, such as the vessel and holding-tank operators, exporters, and importers; military, police, and other officials are paid well for looking the other way (Barber & Pratt, 1998). When the authority is not able to function due to a corrupt mentality, it is difficult to expect that law enforcement can be effective.

The application of government regulations on the ground should be done jointly between authority and people. Without proper authority, the destruction of coral reefs will continue regardless of government regulations or legislation. To protect the coral reefs, all it takes is the determination of authorities to combat the cyanide fishing and support the non-destructive fishing method that already exists, such as in Tejakula sub-district.

Chapter Three: Methodology

Research Questions

This study explores the ecological and economic impacts of the reformed fishing practices adopted in Tejakula sub-district, and specifically asks:

1. Has the new fishing method and reef management practices improved the condition of the coral reef?
2. Has the new fishing method and reef management practices improved the revenues of fisher families?
3. What are the benefits of the new fishing method?

Research Objectives

The objectives of this study were:

1. To analyze the condition of the coral reef after the implementation of the reformed practices based on secondary data (coral reef data).
2. To analyze the fishing revenues before and after the implementation of the reformed practices based on primary and secondary data.
3. Develop recommendations for management improvements that will encourage sustainable livelihoods for the fishers in the project area and more generally among other coastal communities.

Research Methodology

Research Site. The study was done in Tejakula sub-district, Buleleng district, Bali province, Indonesia. Interviews were conducted in two villages where ornamental fishers live, Les and Tembok. Field-based data was collected from January 20 to March 15, 2012. Les has about 40 ornamental fishers, while Tembok has about 20 fishers. In Les there are three middlemen and one exporter company called Blue Star, while Tembok has two middlemen and one exporter company called CV Dinar.

Data on fishers' revenues and other supporting information, before and after the implementation of the reformed fishing method, were collected from fishers during interviews, using a questionnaire (see Appendix B). Additional supporting data, such as the price of ornamental fish (see Appendix A) were collected from the middlemen and exporter.

Methods.

Coral Reef Data. The data on coral reefs were obtained from the Indonesia Reef Cheeck and LINI, organizations that regularly monitor and conduct surveys of coral reefs in the area. The MAQTRAC (Marine Aquarium Trade Coral Reef Monitoring Protocol) was used to collect the coral reef data in Tejakula sub-district. These data were used to see if there had been a change in the percentage of healthy coral reef cover from 2003 to 2011, starting when reformed fishing had just begun and after the new management of fishing had been practiced continuously for an eight year period.

Fishers' Income Data and Ornamental Fish Prices. Currently, there are approximately 70 ornamental fishers in Tejakula sub-district. Interviews were conducted with 40 ornamental fishers, representing 57% of the total. Of the 40 ornamental fishers interviewed, 27 fishers, or 72.5%, were members of a fishers association called Mina Bakti Sowansari (MBS). This association is a social community of ornamental fishers that provides consultation for issues among the fishers. It also has a small financial role, providing small loans for fishers in need.

Information about the price of fish was based on purchasing data collected from fishers, middlemen and exporter during the interview process. The fishers' total gross revenue per year was calculated based on the midpoint of the weekly revenue range, multiplied by the average number of days fishing, which is 200 days a year.

Limitation of Available Fisher's Income Data. There is no uniformity in fish orders, with numbers and types of fish varying from day to day. Every day the ornamental fish caught changes according to demands from the buyer. Furthermore, these ornamental fishers do not maintain any formal records about the ornamental fish they sell. There is no record of total number of ornamental fish sold in 2000. Records from the middlemen's logbooks are also incomplete. Many pages have exposed to the sea water, making it difficult to read the blurry handwriting. Furthermore, some of the pages are without dates, months or years, or in some cases, the pages are completely missing. Due to these circumstances, the weekly midpoint revenue range was used to measure the revenue of ornamental fishers.

To support the accuracy of calculation and cross-checking, the total revenue per year is also calculated based on the number of fish that were caught in 2011, multiplied by the average fish price and divided by the number of fishers interviewed. Total fishery revenue in each period was derived from the average/mean net revenue per year per fisher (non-compressor and compressor) multiplied by the number of existing ornamental fishers (in 2000 there was 170 fishers and only 70 fishers in 2011). The total net revenue was based on the difference between total gross revenue and total fishing costs per year. These data illustrate changes in revenue after the barrier net fishing method was adopted in Tejakula sub-district.

Data Analysis. To determine if there was a change in revenue after the implementation of the environmentally-friendly method, net revenues before and after the reformed method of fishing was adopted were compared. Similar before and after comparisons were made regarding the species of fish caught and the actual price of fish based on data collected from the middlemen and exporter (see Appendix A of Prices of Ornamental Fish). Statistically, t-tests were used to see if there was a significant difference between revenues from the two periods. The coral reef data from 2003 to 2011 was used to determine the coral reef condition following usage of the reformed fishing method in Tejakula sub-district.

The value of the Indonesia Rupiah (IDR) 239.35 of Index Price 2011 is used to adjust all the cost and revenue data in 2000 to make the figures comparable to 2011 Indonesia Rupiah value. The exchange rate of USD 1 is equal to IDR 8,900.

Social Data. Social factors also affect the revenue of fishers. To see the complete picture on the socialization of the reformed method, information on other sources of income/side jobs, education, current ongoing issues and motivational factors that support this method was collected for further discussion, including the social status of ornamental fishers among the local community. Social data were collected using the questionnaire (see Appendix B of Questionnaire) via informal meetings with ornamental fishers.

Chapter Four: Results and Discussion

The ecological data of coral reefs were collected from the Indonesia Reef Check, which presented the condition of coral reefs in Tejakula sub-district. The data on revenue and costs of fishing in the two study periods were obtained from the fishers and middlemen themselves, and were used to determine if there was a significant difference in fishers' revenue and costs before and after the reformed method of fishing was implemented. Social data were collected during discussion with stakeholders about factors affecting revenue, the reformed method of fishing, and other significant issues relating to the current fishing method.

Reformed Fishing Method Will Sustain the Coral Reef Condition

Marine Aquarium Trade Coral Reef Monitoring Protocol (MAQTRAC) was used to measure the coral reef coverage in Tejakula sub-district. Coral reef coverage is an indicator of coral reef health (Beijbom, 2011). The coral reef lay on the seafloor, the ground that is at the bottom of the sea (Webster, 2012). The sample areas of coral reef data were determined based on discussions with fishers (Yahya, 2008); the fishing grounds where before and after reformed method of fishing was practiced.

Coral cover can be determined by several quantitative methods (Morelock, 2005). The MAQTRAC method includes: 1) the Manta Tow survey, to describe the general types and number of habitat in the area in the shallow area; 2) Fish Belt Transect, to assess the diversity of fish; 3) Time Swimming with stop watch, which is similar to the visual method of belt transect; and 4) Point Sampling, to determine the condition of coral reef (Yahya, 2008).

One of the methods used in Tejakula sub-district is the transect method, in which each transect, running parallel along the coral reef, consists of four repetitions that separate five meters each for 100 meters. Each transect has a five meter width by a 20 meter length by a five meter height (Yahya, 2008). Coral reef condition was determined based on three requirements: 1) 30 parameters of each coral reef description; 2) the amount of human activities in the location; and 3) the percentage of sea belt type including dead and live coral (Yahya, 2008). The highest percentage of cover normally has more diversity, which shows the coral reef is healthy and able to produce more marine organisms.

There are several fixed points of sampling (sample areas) that are measured. The coral cover in each point of sampling is ranked from the lowest to the highest. The lowest coral cover is the coverage of the live coral reef within an area which is less abundant compared to coverage of live coral reef within other areas. Conversely, the highest coral cover is the coverage of live coral reef within an area which is much higher compared to coverage of live coral live within other areas (Morelock, 2005). The average coverage is calculated from the total cover in each point of sampling divided by the number of sample areas. The measurement includes the abundance and distribution of organisms, number of coral species, fish species, and other organisms that reside in the coral reef (Beijbom, 2011).

Table 1

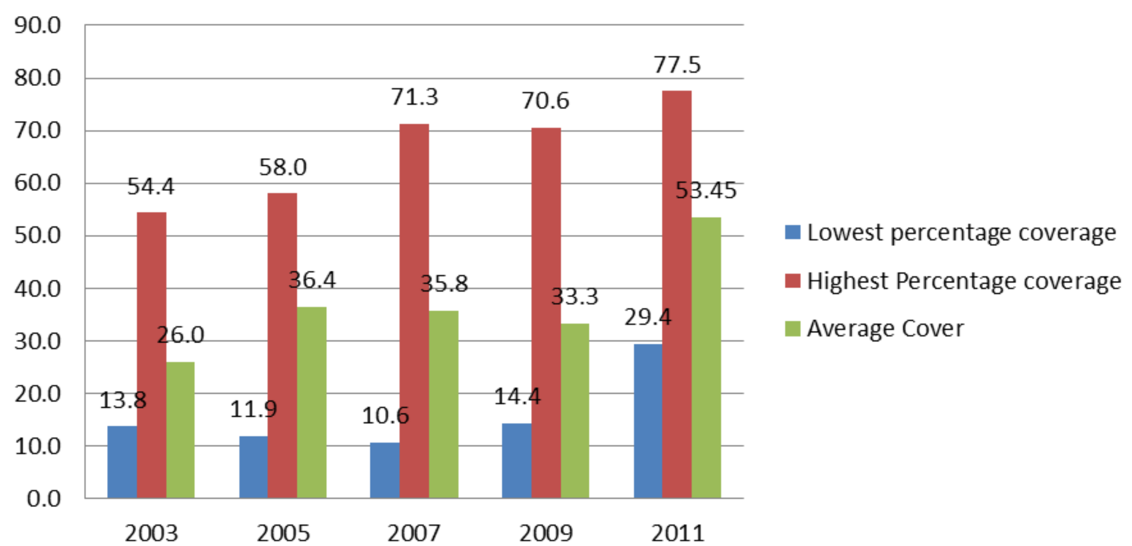
Coral Coverage in Tejakula Sub-District from 2003 to 2011

Year	Lowest Cover (%)	Highest Cover (%)	Average Cover (%)
2003	13.8	54.4	26.00
2005	11.9	58.0	36.40
2007	10.6	71.3	35.80
2009	14.4	70.6	33.30
2011	29.4	77.5	53.45

Note. Source: Indonesia Reef Check

Coral reef coverage is classified as follows: bad (0 – 24.99%), medium (25 – 49.99%), good (50 – 74.99%), and best (75 – 100%) (Yahya, 2008). However, reefs can be in pristine condition and have high fish abundance with a coral cover under 50%. Likewise, reefs with nearly 100% coral cover may have lower fish abundance (Cesar, Economic Analysis of Indonesian Coral Reefs, 1996). The coral reef data (see Table 1 and Figure 1) indicate that after the environmentally-friendly practice was implemented, the condition of the coral reef in Tejakula sub-district improved from the “medium” category (26%) in 2003 to the “good” category (53.45%) in 2011. This result indicates that the reformed method of fishing can give the coral reef an opportunity to recover. Over time, the productivity of the coral reef should improve and increase the amount of ornamental fish. Nevertheless, the data shows that from 2005 to 2009, the percentage cover of live coral had decreased slightly.

Figure 1. The percentage of live coral coverage in Tejakula sub-district from 2003 to 2011



In July 2009, after receiving a report from the local fishers in Tejakula, the Indonesia Reef Check conducted a survey and discovered that coral bleaching had occurred. The last coral bleaching event in Bali was recorded in 2005 when 75% of hard corals were bleached (Sartin, 2009). Coral reef bleaching happens when the sea surface temperature elevates 1˚C above the historical temperature for the area. The optimal temperature for most coral reefs is between 26 -

27°C. According to Guinotte (2003), high temperature regions are identified as those with a maximum monthly temperature >31.1°C, transitional regions as 30 - 31°C, and high normal regions as 29 - 30°C (Guinotte, 2003). During the survey period in Tejakula sub-district, the water temperature ranged from 29°C to 30°C, a moderate temperature elevation, explaining why the bleaching was not so severe (Sartin, 2009).

In general, the coral reef condition in Tejakula sub-district is slowly improving. With the barrier net method in place, coral reef coverage is expected to move from the current “good” category (53.45%) into the “best” category (75% up). Eventually, the rare (and expensive) species will produce more, and should improve the revenue of the ornamental fishers. Under natural conditions, a healthy coral reef can recover from natural disturbances, such as hurricanes, within 10 to 20 years (ESA, 2000). “If a reef is not completely degraded, then recovery is possible within a 10 to 20 year period,” said Dr. David Smith, Director of the Coral Reef Research Unit, University of Essex (Smith, 2012).

Review of the Fishers’ Revenue Before and After Reformed Fishing Method

Factors That Determine Fishing Costs. There are two main factors that determine fishing cost incurred by fishers: the type of fisher and their method of transportation to the fishing grounds.

Type of Fisher. There are two types of ornamental fishers in Tejakula sub-district: compressor fishers and non-compressor fishers. The compressor or hookah diving fishers use a compressor machine to dive down and catch the fish. They fish in deeper waters and at more distant coral reefs, and travel by fishing vessel to access these areas. Compressor fishers are divided into two groups: 1) those who own their equipment and vessels, and pay all the necessary fishing costs themselves; and 2) those who work as labourers for boat owners. While some of the boat owners are also middlemen, all of the middlemen in Tejakula sub-district are boat owners. Equipment used by compressor fishers consist of a compressor machine, air hose, goggles and fins, barrier net, scoop net, and a decompression bucket (which is a bucket used to acclimatize the fish to pressure changes).

Non-compressor fishers are those who fish at closer reef areas, since most of them do not have their own fishing vessel. They rely on public transportation or walk to the beach, and swim directly to the coral reef from the beach. Although some of them have their own vessel, without a compressor machine, they cannot go to the deeper coral reef areas. All of their fishing equipment is the same as the compressor fishers, except for the compressor machine. In addition, since they do not have a compressor machine for oxygen, the non-compressor fishers have to carry an inner tube filled with oxygen that is used to fill temporary plastic containers for live fish until they reach the beach or holding tank. The inner tube can also be used as a floatation device, allowing the fishers to take a short break between swimming to and from the beach (see Appendix F of Photographs).

During the cyanide period, there were two types of cyanide fishing operations in Indonesia: 1) large-scale operations working mostly in remote and pristine areas, and 2) small-to medium-scale operations working in more densely populated and exploited reef areas (Pet, 1999), such as Tejakula sub-district. In this area, most of the middlemen have bigger fishing vessels used to travel further away, such as Sulawesi and Ambon. Until recently, when the conditions allowed, they would travel up to four times a year, for periods of two weeks to one month at a time. Some of the ornamental fishers (both compressor and non-compressor) work in a fishing vessel that belongs to the middlemen. They get paid around IDR 1,500,000 per trip.

With a maximum of up to four trips a year, they could earn additional revenues of up to IDR 6,000,000 per year (Dete, 2012).

There is no clear information about the amount of fish caught by Tejakula fishers, either from their local coral reefs or from those reefs beyond the Tejakula sub-district, since the middlemen or exporters never recorded the source of the ornamental fish. However, since the majority of Tejakula ornamental fishers are small-scale, non-compressor fishers who do not own a vessel, it is assumed that most of the ornamental fish sold in the Tejakula market comes from the local reefs. The middlemen or boat owners, who sail to more distant areas, usually sell their catch to the nearest middleman or exporter on their way back to Tejakula. Although on occasion their catch goes through Tejakula's market chain, this occurs very rarely.

Transportation. There are different transportation methods fishers use to reach the beach. Some of them do not need any transportation because they simply walk to the beach behind their village and swim to nearest coral reef. The fishers who do not use public transportation or their own vehicle incur lower costs since there are no additional expenses for gasoline or public transportation.

There was one significant change in the price of ornamental fish during the transition period from the cyanide method to the barrier net method in 2000 to 2002. Since 2002 there have been some price fluctuations between IDR 50 to IDR 500. From the year 2000 during the cyanide period until 2011, the average inflation rate in Indonesia was relatively high. The index price of 2011, which is calculated from 2000 to 2011, was IDR 239.35 (see Table 3 of Inflation Rate and Index Price in Indonesia from 2000 to 2011). There are two prices of ornamental fish in the local market: the middlemen price and the exporter price. The exporter price is normally higher since the middlemen are an intermediary between fishers and exporters. The data of ornamental fish prices show that after the prices were adjusted with the index price of 2011, prices for many of the species actually declined (see Appendix A of Price List of Ornamental Fish).

Table 2

Type of Transportation Used by Ornamental Fishers

Type of Transportation	Non-Compressor Fisher	Compressor Fisher
Walking to the beach then using boat	2	9
Waking to the beach and swimming	3	-
Using public transportation to the beach then swimming	14	-
Using public transportation to the beach then using boat	-	-
Using own transportation (motor bike) to the beach then swimming	7	-
Using own transportation (motor bike) to the beach then using boat	3	1

Table 3:

Inflation Rate and Index Price in Indonesia from 2000 to 2011

Year	Inflation Rate (%)	Index Price (Base is 2000)
2000	9.0	100.00
2001	11.5	111.50
2002	11.9	124.77
2003	6.6	133.00
2004	6.1	141.12
2005	10.5	155.93
2006	13.2	176.52
2007	6.3	187.64
2008	9.9	216.11
2009	4.8	206.21
2010	5.1	227.13
2011	5.38	239.35

Note. Source: Index Mundi (www.indexmundi.com)

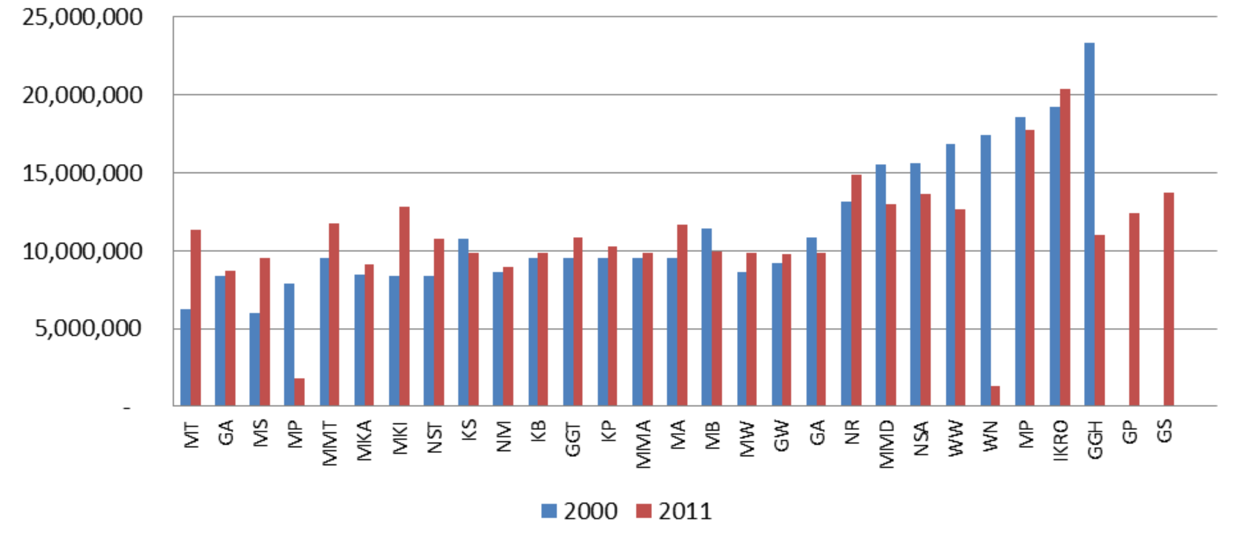
However, based on unadjusted numbers alone, the fishers and middlemen were under the impression that the fish prices had increased. Using the index price of 2011, of the 224 species of ornamental fish listed in the middlemen orders, only 27 species of fish (or 12%) increased in price. The price of the remaining 197 species dropped anywhere between 16% and 54%. In the meantime, of the 204 species accepted by the exporter, 138 species (67.6%) saw a price increase (see appendix A of Price list of ornamental fish).

In general, the exporter price is higher compared to the middlemen price. However, most of the fishers sell their catch to the middlemen, rather than to the exporter. A free market system in which ornamental fishers could sell their fish for the best price available is unlikely to happen due to the moral obligation fishers have to the middlemen. Most of the fishers are in debt to the middlemen for business loans and family needs. Of the 40 fishers interviewed, only five have managed to pay off their debt and are now free to sell their catch to different middlemen or exporters.

Revenue of fishers.

Net Revenue of Non-Compressor Fishers. The net revenue of Tejakula non-compressor ornamental fishers during the cyanide period (blue line) and using barrier nets (red line) is presented in Table 4 and Figure 2. The results show that although 9 out of 27 fishers experienced a reduction in income, 18 fishers realized an increase. There were two new ornamental fishers who started fishing after cyanide was no longer being used, and their data were not included in the calculation of the total and average values. The average revenue has slightly increased from IDR 11,507,593.52 to IDR 11,813,148.15 representing a 2.59% (IDR 305,554.63) increase with barrier nets (2011) instead of cyanide (2000). The statistical difference between the mean incomes before and after the reformed method of fishing was adopted was calculated using a t-ratio. Since this is a ‘before and after’ case, a paired sample t-test was used.

Figure 2. Net revenue of non-compressor fishers in period 1 (2000) and period 2 (2011)



t-Test: Paired Two Sample for Means (Revenue)

	Period 1	*Period 2*
Mean	11507593.52	11813148.15
Variance	1.95151E+13	8.59658E+12
Observations	27	27
Pearson Correlation	0.476	
Hypothesized Mean Difference	0	
df	26	
t Stat	-0.400	
P(T<=t) one-tail	0.346	
t Critical one-tail	1.706	
P(T<=t) two-tail	0.693	
t Critical two-tail	2.056	

$$t_{\text{obtained}} = = \frac{\bar{D}}{s\bar{D}} = \frac{305{,}554.63}{764{,}392.85} = 0.3997$$

The hypotheses are H0: $\mu 1 = \mu 2$, is the income of the Tejakula fishers is the same before and after barrier-net practice. H1: $\mu 1 \neq \mu 2$, $\mu 1<\mu 2$, or $\mu 1>\mu 2$, is the income of the Tejakula fishers is not the same or increased/decreased after barrier-net practice. If $t_{\text{obtained}} \geq t_{\text{criteria}}$, reject H0, and if $t_{\text{obtained}} < t_{\text{criteria}}$, do not reject H0.

Based on the calculation above, the result shows that $t_{\text{obtained}} < t_{\text{criteria}}$ (-0.3997<1.71 and -0.4< 2.06), indicating there is no significant difference between revenue before and after using the using net-caught fishing method. Given that some ornamental fish prices have increased, and that some of the rare and expensive species have returned, it was expected that there would have been some improvement in the fishers' revenue. However, in contrast, the data above shows that after more than a decade of reformed fishing, individual fishers' revenue has not significantly increased.

Table 4 shows the fishing costs of non-compressor fishers before and after the reformed fishing method was adopted. A paired sample t-test was used to assess the statistical significance of differences in fishing costs before and after the environmentally-friendly method was implemented.

t-Test: Paired Two Sample for Means (Cost)

	Period 1	*Period 2*
Mean	7588271.85	1972592.593
Variance	1.4365E+12	9.18005E+11
Observations	27	27
Pearson Correlation	0.571	
Hypothesized Mean Difference	0	
df	26	
t Stat	28.565	
P(T<=t) one-tail	1.826	
t Critical one-tail	1.706	
P(T<=t) two-tail	3.651	
t Critical two-tail	2.056	

$t_{\text{obtained}} = t = \frac{\bar{D}}{s\bar{D}} = \frac{5,615,679.6}{196,592.0873} = 28.565$

Table 4

Comparison of Revenues of Non-Compressor Fishers with Cyanide (Period 1) and with Barrier Nets (Period 2)

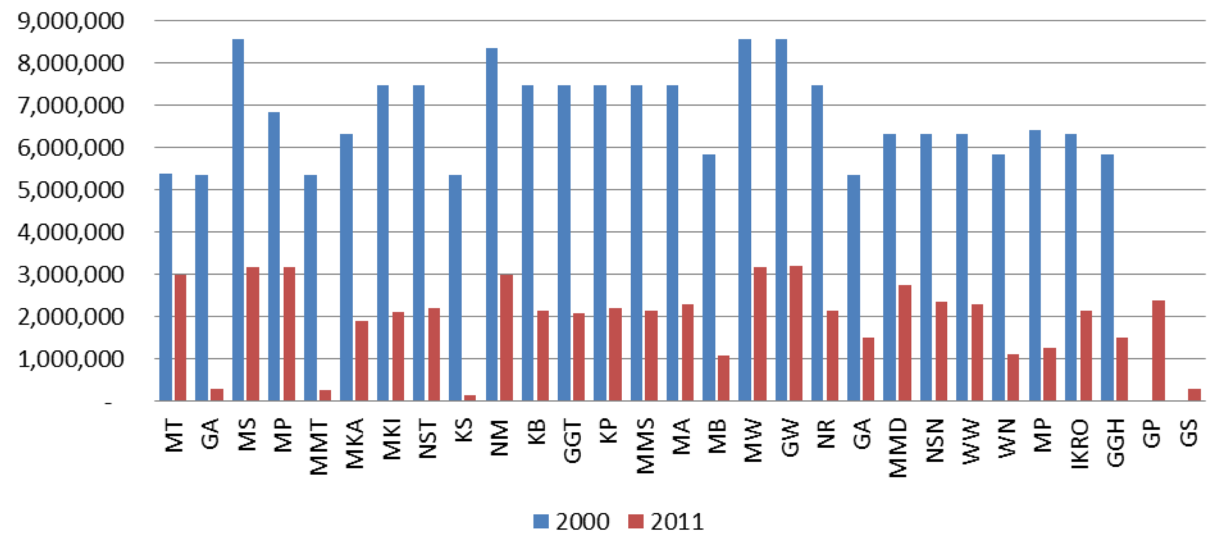
No	Name	Period 1 (2000)			Period 2 (2011)			Net Revenue Difference (Period 1 and 2)	Net Revenue Difference² (D²)	Cost Difference (Period 1 and 2)	Cost Difference² (D²)
		Yearly Revenue	Yearly Cost	Yearly Net Revenue	Yearly Revenue	Yearly Cost	Yearly Net Revenue				
1	MT	***12,254,720***	***6,031,620***	**6,223,100**	14,380,000	***3,000,000***	**11,380,000**	**5,156,900**	2.65936E+13	3,031,620	9.19072E+12
2	GA	***14,361,000***	***5,983,750***	**8,377,250**	9,000,000	***300,000***	**8,700,000**	**322,750**	1.04168E+11	5,683,750	3.2305E+13
3	MS	***15,557,750***	***9,574,000***	**5,983,750**	12,720,000	***3,180,000***	**9,540,000**	**3,556,250**	1.26469E+13	6,394,000	4.08832E+13
4	MP	***15,557,750***	***7,635,265***	**7,922,485**	21,000,000	***3,175,000***	**17,825,000**	**9,902,515**	9.80598E+13	4,460,265	1.9894E+13
5	MMT	***15,557,750***	***5,983,750***	**9,574,000**	12,000,000	***250,000***	**11,750,000**	**2,176,000**	4.73498E+12	5,733,750	3.28759E+13
6	MKA	***15,557,750***	***7,084,760***	**8,472,990**	11,000,000	***1,900,000***	**9,100,000**	**627,010**	3.93142E+11	5,184,760	2.68817E+13
7	MKI	***16,754,500***	***8,377,250***	**8,377,250**	14,950,000	***2,100,000***	**12,850,000**	**4,472,750**	2.00055E+13	6,277,250	3.94039E+13
8	NST	***16,754,500***	***8,377,250***	**8,377,250**	13,000,000	***2,200,000***	**10,800,000**	**2,422,750**	5.86972E+12	6,177,250	3.81584E+13
9	KS	***16,754,500***	***5,983,750***	**10,770,750**	10,000,000	***150,000***	**9,850,000**	**-920,750**	8.47781E+11	5,833,750	3.40326E+13
10	NM	***17,951,250***	***9,334,650***	**8,616,600**	12,000,000	***3,000,000***	**9,000,000**	**383,400**	1.46996E+11	6,334,650	4.01278E+13
11	KB	***17,951,250***	***8,377,250***	**9,574,000**	12,000,000	***2,150,000***	**9,850,000**	**276,000**	76176000000	6,227,250	3.87786E+13
12	GGT	***17,951,250***	***8,377,250***	**9,574,000**	12,925,000	***2,075,000***	**10,850,000**	**1,276,000**	1.62818E+12	6,302,250	3.97184E+13
13	KP	***17,951,250***	***8,377,250***	**9,574,000**	12,500,000	***2,200,000***	**10,300,000**	**726,000**	5.27076E+11	6,177,250	3.81584E+13
14	MMA	***17,951,250***	***8,377,250***	**9,574,000**	12,000,000	***2,150,000***	**9,850,000**	**276,000**	76176000000	6,227,250	3.87786E+13
15	MA	***17,951,250***	***8,377,250***	**9,574,000**	14,000,000	***2,290,000***	**11,710,000**	**2,136,000**	4.5625E+12	6,087,250	3.70546E+13
16	MB	***17,951,250***	***6,534,255***	**11,416,995**	11,000,000	***1,075,000***	**9,925,000**	**-1,491,995**	2.22605E+12	5,459,255	2.98035E+13
17	MW	***18,190,600***	***9,574,000***	**8,616,600**	13,000,000	***3,170,000***	**9,830,000**	**1,213,400**	1.47234E+12	6,404,000	4.10112E+13
18	GW	***18,812,910***	***9,574,000***	**9,238,910**	13,000,000	***3,200,000***	**9,800,000**	**561,090**	3.14822E+11	6,374,000	4.06279E+13
19	GA	***19,148,000***	***8,377,250***	**10,770,750**	15,000,000	***150,000***	**14,850,000**	**4,079,250**	1.03325E+12	6,227,250	3.87786E+13
20	NR	***19,243,000***	***5,983,750***	**13,259,250**	12,000,000	***2,150,000***	**9,850,000**	**-3,409,350**	2.84175E+12	5,833,750	3.40326E+13
21	MMD	***22,642,510***	***7,084,760***	**15,557,750**	15,740,000	***2,740,000***	**13,000,000**	**-2,557,750**	6.54209E+12	4,344,760	1.88769E+13
22	NSA	***22,935,000***	***7,084,760***	**15,850,240**	16,000,000	***2,350,000***	**13,650,000**	**-2,200,240**	4.01397E+12	4,734,760	2.2418E+13
23	WW	***23,935,000***	***7,084,760***	**16,850,240**	15,000,000	***2,300,000***	**12,700,000**	**-4,150,240**	1.72245E+13	4,784,760	2.28939E+13
24	WN	***23,935,000***	***6,534,255***	**17,400,745**	14,000,000	***1,105,000***	**12,895,000**	**-4,505,745**	2.03017E+13	5,429,255	2.94768E+13
25	MP	***25,730,125***	***7,180,500***	**18,549,625**	19,000,000	***1,250,000***	**17,750,000**	**-799,625**	6.394E+11	5,930,500	3.51708E+13
26	IKRO	***26,328,500***	***7,084,500***	**19,244,000**	22,500,000	***2,150,000***	**20,350,000**	**1,106,260**	1.22381E+12	4,934,760	2.43519E+13
27	GGH	***29,918,750***	***6,534,255***	**23,384,495**	12,500,000	***1,500,000***	**11,000,000**	**-12,384,495**	1.53376E+14	5,034,255	2.53437E+13
28	GP	New Fisher		-	14,800,000	***2,400,000***	**(*)12,400,000**				
29	GS	New Fisher		-	14,000,000	***300,000***	**(*)13,700,000**				
Total			***204,883,340***	**310,705,025**		***53,260,000***	**318,955,000**	**8,249,975**	**4.127E+14**	**151,623,340**	**8.786E+14**
Average			***7,588,271.85***	**11,507,593.52**		***1,972,592.59***	**11,813,148.15**	**305,554.63**		***5,615,679.6***	

Notes: The new fishers data (*) are not included in calculating the total and average numbers.

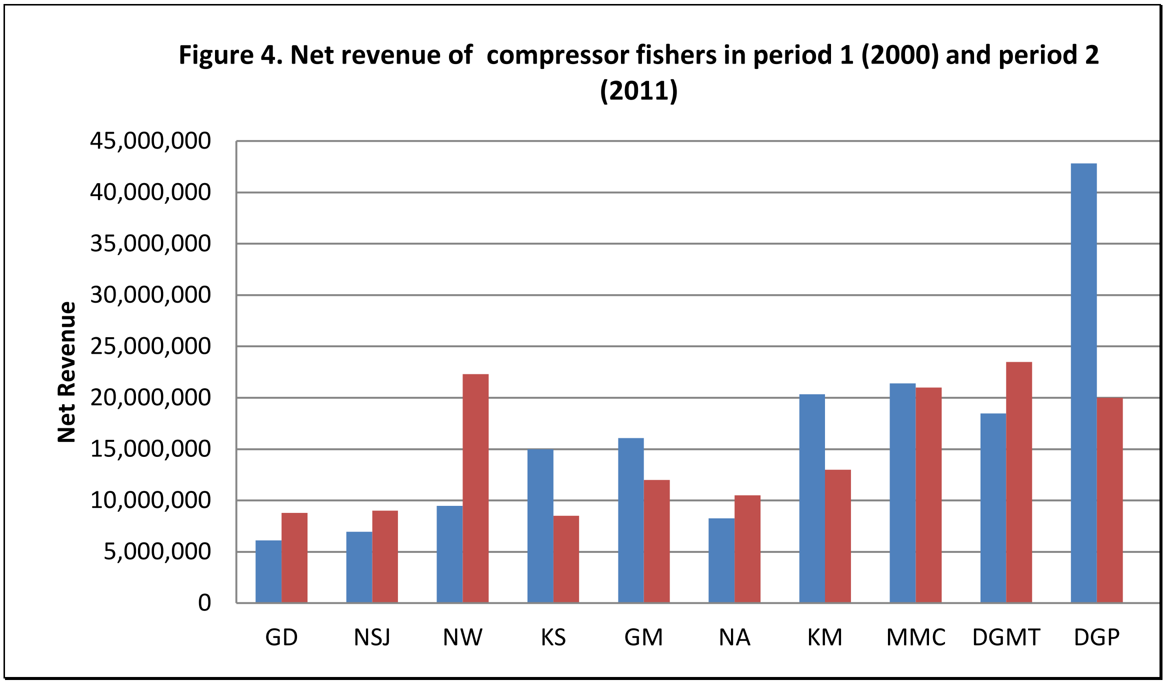
t_{obtained} is larger than t_{criteria}, 28.565>1.706 or 28.565>2.056, which means there was a significant change in fishing costs after using the reformed fishing method. Specifically, fishing costs were significantly reduced without using cyanide.

Figure 3 illustrates the fishing costs of non-compressor fishers with and without cyanide. Table 4 shows that the total yearly cost with cyanide was IDR 204,883,340. This cost is almost four times the total yearly cost of fishing with a net, which is only IDR 53,260,000. In 2000, using the cyanide method, each fisher spent an average of IDR 7,588,271.85, while in 2011 the average annual cost was IDR 1,972,592.59. Fishing costs associated with the net method were 74% less than using the cyanide method, an annual saving of IDR 151,623,340 or IDR 5,615,679.26 per fisher.

Figure 3. Yearly fishing costs of non-compressor fishers in period 1 (2000) and period 2 (2011)



Net Revenue of Compressor Fishers.



The results presented in Figure 4 and Table 5 indicate that five out of eleven fishers saw a decrease in income after using the barrier net method. All of these were compressor fishers who work with boat owners. In 2000, the total revenue with the cyanide method was IDR 184,287,533, compared with the total revenue in 2011 of IDR 148,600,000, indicating that the total revenue of the compressor fishers decreased 19.4% with the barrier net method.

t-Test: Paired Two Sample for Means (Revenue)

	Period 1	*Period 2*
Mean	18428753.25	14860000
Variance	1.46448E+14	3.73649E+13
Observations	10	10
Pearson Correlation	0.484830801	
Hypothesized Mean Difference	0	
Df	9	
t Stat	1.066	
P(T<=t) one-tail	0.157	
t Critical one-tail	1.833	
P(T<=t) two-tail	0.314	
t Critical two-tail	2.262	

$t_{\text{obtained}} = t = \frac{\bar{D}}{s\bar{D}} = \frac{-3,568,753.3}{3,347,895.69} = -1.066$

Again, a t-test was used to measure the difference in revenues of the compressor fishers to see whether or not there was a change after the barrier net method was implemented. Statistically, t_{obtained} is smaller than t_{criteria}, -1,066 < 2.833 or -1,066<2.262, which means that the net revenue of the compressor fishers has not increased with the current method.

Table 5 confirms that all the compressor fishers who work with boat owners or as labourers, saw their income decrease after using barrier nets for fishing. Compressor fishers who own their own vessel do not share their catch with others, while those who work as labourer fishers must share their catch with other fishers and middlemen or boat owners. According to the information gathered from the compressor fishers, the share between fishers and boat owners is 50-50. This means that 50% of the fishers' catch will be given to the boat owner, and the remaining 50% is normally divided between the fishers. In one fishing vessel, usually there are two fishers working together. Based on this agreement, a compressor fisher who works as a labourer for a boat owner earns only about 25% of the total catch. Since all the middlemen in Tejakula sub-district have their own vessels and most of the labourer fishers work for them, there is no possibility that the labourers could sell their catch elsewhere, regardless if the prices are cheaper compared to selling to the exporter directly.

Table 5

Comparison of Revenues of Compressor Fishers with Cyanide (Period 1) and with Barrier Nets (Period 2).

No.	Name	Period 1 (2000)			Period 2 (2011)			Net Revenue Difference (Period 1 and 2)	Net Revenue Difference^2 (D^2)	Cost Difference (Period 1 and 2)	Cost Difference^2 (D^2)
		Yearly Revenue	Yearly Cost	Yearly Net Revenue	Yearly Revenue	Yearly Cost	Yearly Net Revenue				
1	GR	***14,361,000***	***7,539,525***	**6,821,475**	10,000,000	1,200,000	**8,800,000**	1,978,525	3.91456E+12	6,339,525	4.01896E+13
2	NSJ	***15,318,400***	***7,539,525***	**7,778,875**	10,500,000	1,500,000	**9,000,000**	1,221,125	1.49115E+12	6,039,525	3.64759E+13
3	NW	***16,754,500***	***6,163,263***	**10,591,238**	25,000,000	2,700,000	**22,300,000**	11,708,763	1.37095E+14	3,463,263	1.19942E+13
4	KS	***16,754,500***	-	**16,754,500**	8,500,000	-	**8,500,000**	-8,254,500	6.81368E+13	-	-
5	GM	***17,951,250***	-	**17,951,250**	12,000,000	-	**12,000,000**	-5,951,250	3.54174E+13	-	-
6	NA	***17,951,250***	***8,736,275***	**9,214,975**	12,700,000	2,200,000	**10,500,000**	1,285,025	1.65129E+12	6,536,275	4.27229E+13
7	KM	***22,738,250***	-	**22,738,250**	13,000,000	-	**13,000,000**	-9,738,250	9.48335E+13	-	-
8	MMC	***23,935,000***	-	**23,935,000**	21,000,000	-	**21,000,000**	-2,935,000	8.61423E+12	-	-
9	DGMT	***35,902,500***	***15,270,530***	**20,631,970**	30,000,000	6,500,000	**23,500,000**	2,868,030	8.2256E+12	8,770,530	7.69222E+13
10	***DGP***	***47,870,000***	-	**47,870,000**	20,000,000	-	**20,000,000**	-27,870,000	7.76737E+14	-	-
11	GA		-		10,000,000	-	**(*) 10,000,000**				
Total			***45,249,118***	**184,287,533**		***14,100,000***	**148,600,000**		***1.13612E+14***	***31,149,118***	***2.08305E+14***
Average			***9,049,823.6***	**18,428,753.35**		***2,820,000***	**14,600,000**			***6,229,824***	***4.16609E+13***

Notes. The new fishers data (*) are not included in calculating the total and average numbers.

Table 5 shows that only five of the fishers interviewed have their own vessel and compressor for which they must pay their own costs, the rest are labourers who work for boat owners and have no need to pay the fishing costs.

t-Test: Paired Two Sample for Means (Cost)

	Variable 1	*Variable 2*
Mean	9049823.6	2820000
Variance	1.29224E+13	4.577E+12
Observations	5	5
Pearson Correlation	0.906077257	
Hypothesized Mean Difference	0	
Df	4	
t Stat	7.380	
P(T<=t) one-tail	0.001	
t Critical one-tail	2.132	
P(T<=t) two-tail	0.002	
t Critical two-tail	2.776	

$$t_{\text{obtained}} = t = \frac{\bar{D}}{s\bar{D}} = \frac{6{,}229{,}823.6}{844{,}132.90} = 7.38$$

t_{obtained} is larger than both t_{criteria} one-tail and t_{criteria} two-tail (7.38>2.13 and 7.38>2.78), indicating there is a significant difference between fishing expenses before and after the net-caught method. Regardless of the fact that the price of gasoline has almost doubled, the compressor fishers still incur lower costs using barrier nets compared to cyanide.

Before the net-caught fishing method was used, the price of gasoline was IDR 2,754.25 per liter. Currently, the price of gasoline has increased to IDR 5,000 per liter, which is almost double. Yearly costs incurred by fishers include fishing equipment, gasoline for transportation (motor bike and fishing boat), and public transportation. In addition, fishers need to pay for gear maintenance, such as nets. Furthermore, fishers with their own vessels also pay maintenance costs for their boats. Even though gasoline is more expensive than before, the data shows that fishing costs have actually fallen with the reformed fishing method.

During the cyanide period (2000), one pill of cyanide cost about IDR 5,000. The small-scale fishers, representing the majority Tejakula's fishers, used an average of two to three pills a day, costing IDR 10,000 to IDR 15,000 per day. Based on an average of 200 fishing days per year, every fisher needed to spend at least IDR 3,000,000 just for the cyanide. With the current method, the fishers have lower fishing costs. The barrier nets cost between IDR 150,000 to IDR 200,000. With good maintenance, a net can be used for a two to three year period. Some of the fishers know how to fix their own nets, which can save them some money. Other fishing equipment, such as goggles and fins, can last for four to five years with good care and maintenance (Partiana, 2012). With the barrier net fishing method, the average fishing cost per year is about IDR 200,000 to IDR 500,000, which much lower compared to the cyanide method.

Table 5 shows that compressor fishers (non-labourers) in total spent IDR 45,249,118 or IDR 9,049,823.6 for each fisher, during the cyanide period. After use of the barrier net, every year they spent IDR 14,100,000 in total or IDR 2,820,000 for each fisher or the compressor fishers were able to reduce their yearly fishing cost by up to 68.8%.

In 2000, when the number of fishers was 170, the total fishery net revenue was IDR 2,107,718,372. After a decade of reformed method fishing practices, and only 70 fishers, the total fishery net revenue in 2011 was reduced to IDR 881,396,250. This result shows that the total fishery revenue in 2011 is 58.2% lower compared with the year 2000.

From the data of net revenue in 2011 (period 2), the average yearly net revenue (AYR_{2011}) of both types of fishers (non-compressor and compressor) per year (see Table 4 and

5) is the total net revenue of non-compressor fishers per year (NCR) added to total net revenue of compressor fishers (CR) divided by the number of fishers interviewed (F): $AYR_{2011} = \frac{\text{NCR+CR}}{\text{F}} = \frac{345{,}055{,}000+158{,}600{,}000}{40} = 12{,}591{,}375$

Average daily net revenue in 2011 (ADR_{2011}) is revenue divided by the average number of fishing day per year (FD): $ADR_{2011} = \frac{\text{R}}{\text{FD}} = \frac{12{,}591{,}375}{200} = 62{,}956.88$

To cross-check the revenue of fishers, the average yearly net revenue for both type of fishers was also calculated by multiplying the number of total ornamental fish (TF_{2011}) sold in 2011 by the average price of fish (AFP_{2011}) and divided by the 40 fishers (F) interviewed. $AYR_{2011} = \frac{\text{TF}_{2011}\text{ x AFP}}{\text{F}} = \frac{151{,}590 \text{ x } 3{,}193}{40} = 12{,}100{,}671.75.$

Average daily revenue from this calculation is $ADR_{2011} = \frac{12{,}100{,}671.75}{200} = \mathbf{60{,}503.37}$ (Note: there is a small difference between the first and second calculation since there are five fishers interviewed who sell their small number of fish to exporter an amount that was not registered on the middlemen records).

The average yearly net revenue of both type of fishers in 2000 (Period 1) is IDR 12,374,713.95 (see Table 4 of Comparison of Revenues of Non-Compressor Fishers with Cyanide/Period 1 and with Barrier Nets/Period 2; and 5 of Comparison of Revenues of Compressor Fishers with Cyanide/Period 1 and with Barrier Nets /Period 2). Average daily net revenue for both types of fishers in year 2000 is $ADR_{2000} = \frac{12{,}374{,}713.95}{200} = 61{,}873.57$. This result indicates the daily revenue in 2000 and in 2011 is not much different.

Reasons Why the Fishers' Revenue Decreased Rather Than Increased.

Decline in Number of the Export of Ornamental Fish From Bali. The fishers' catch is based on orders from the middlemen or exporters. As mentioned before, every day the order is different, varying according to requests from the importer, which are determined by market demand. The statistical data from the Central Bureau of Statistics, Denpasar, Bali shows that the export of ornamental fish from Bali has been decreasing gradually since 2006 (see Table 6). Until 2005, the export of ornamental fish from Bali was stable, with an average export of USD 4.5 million per year. However, in 2005, the export plunged to about 50% from the previous year. This trend continued until 2011, with a bit of up and down, reaching the lowest export value of only USD 698,796 in 2011. The export reduction means fewer fish orders for the fishers, which indicates that the revenue of the fishers not only depends on the price of the ornamental fish in the market, but also on the export market.

According to the Bali Public Relations Bureau Chief, Ketut Teneng (2012), the export of ornamental fish from Bali has fluctuated greatly according to market demand, and for the five year period from 2006 to 2010, exports have decreased (Burhani, 2012).

Table 6

Export Volume of Ornamental Fish from Bali

Year	Volume	Value (USD)
2002	12,482,267	4,308,675.33
2003	11,648,139	4,571,930.84
2004	13,598,756	4,885,098.84
2005	12,972,982	4,714,734.98
2006	5,409,786	2,107,204.67
2007	3,683,911	1,525,351.1
2008	2,838,718	2,958,358.8
2009	2,872,491	839,033
2010	3,518,485	1,144,941.07
2011	2,507,000	698,796

Note. Source: Central Bureau of Statistic, Denpasar, Bali

No-Fly Ban From the European Union. An increase in the number of flight accidents by Indonesian airline companies prompted the European Union (EU) to announce a no-fly zone from Indonesia in 2007. Subsequently, there were no direct flights from Indonesia to EU cities (Drias, 2009). This situation affected Indonesia's export commodities, including ornamental fish. At the time, the largest importer of Indonesian ornamental fish was Europe (CCIF). From July 2007 to July 2009, the ban forced exporters to ship their commodities to Europe via Singapore or Kuala Lumpur. This was very detrimental to Indonesia since these transit countries imposed their own regulations, and subsequently these Indonesian products were automatically labeled as Malaysian or Singaporean products of export (Indonesia, 2008). During this period, Indonesian exporters lost most of their European buyers who switched their source of ornamental fish from Indonesian exporters to Malaysian or Singaporean exporters. Currently, Indonesia supplies approximately 90% of the ornamental fish imported by Singapore, and yet this neighbouring country controls 22.8% of the world market, while Indonesia's market share for the ornamental fish international trade is only 7.5% (Gustina, 2010). The International ornamental fish market directly impacts the situation in Tejakula sub-district since the fish catch is based on importer order demand.

Economic Crisis and Regulations. Another reason for the decline in the export of ornamental fish from Indonesia was the global economic crisis that reduced the purchasing power of export destination countries (Bali, 2012). Furthermore, since 2010, the EU has applied requirements and certification procedures for Indonesian exporters shipping fishery products, including ornamental fish, to EU countries. These stringent requirements monitor illegal fishing practices. This has become one of the main reasons that exports of ornamental fish from Indonesia, especially from Bali, have fallen (Montague, Oktaviani, & Ruche, 2010).

Other Reasons. With the barrier net method, the revenue of fishers is decreasing because they cannot catch all the species of fish, especially the rare and expensive ones (Wangak, 2012). Apart from destroying the coral reef ecosystem, the use of cyanide also reduced the numbers and variety of ornamental fish (UNEP, Indonesia: Integrated Assessment of the Poverty Reduction Strategy Paper, with a case study on sustainable fishery initiatives, 2005). There are some species of ornamental fish for which the price is always high, such as Emperor Angelfish (Pomacanthus imperator) or Blue Ring Angelfish (Pomacanthus annularis). These species are among the most popular in the aquarium fish trade, which has driven their prices higher than others. During the cyanide period, these expensive species had become the main target of fishing because of their popularity and high price. The fishers tried to catch as many as possible to increase their income, which led to a noticeable population decline. Even in the absence of cyanide fishing, these expensive species will not have enough time and opportunity to escalate their population compared with others, since the fishers will always try to catch them regardless of whether or not they are in the order list. In the meantime, the middlemen never reject any rare or expensive species because these can be easily sold to the exporters. In contrast, most of the less popular aquarium fish, such as the Brown Surgeonfish (Acanthurus nigrofuscus), can be found easily because their population is much higher compared to the expensive fish. The fishers will only catch these species when it is required on the order list. The opportunity for fishers of Tejakula sub-district to increase their revenues from rare, expensive species is greatly reduced because there are insufficient numbers of these species available. Due to the lower number of expensive species, the middlemen and/or exporters sometimes source these species from outside of Tejakula, although the quality of fish is not as good as ornamental fish from Tejakula sub-district.

Factor Affecting the Income of Fishers.

Skill in Using Nets. To use the barrier net properly, training is required. At the end of the cyanide period, Telapak, one of the ENGOs, provided training for all the ornamental fishers in Tejakula sub-district. However, skilled use of the net also depends on personal ability. Some of the fishers learned quickly and became very adept at using the barrier net. Consequently, these fishers collected more fish since they were faster than the other fishers. With their skill, they could easily trap the expensive species that were normally more difficult to catch (Partiana, 2012).

Physical Strength. It should be recognized that the fisher's job is hard work, requiring good stamina and physical strength to work long hours on the sea, sometimes under difficult conditions. Physical ability is particularly important for non-compressor fishers, since the longer a fisher can hold his breath, the more efficiently he can set up the net properly and trap the fish (Partiana, 2012).

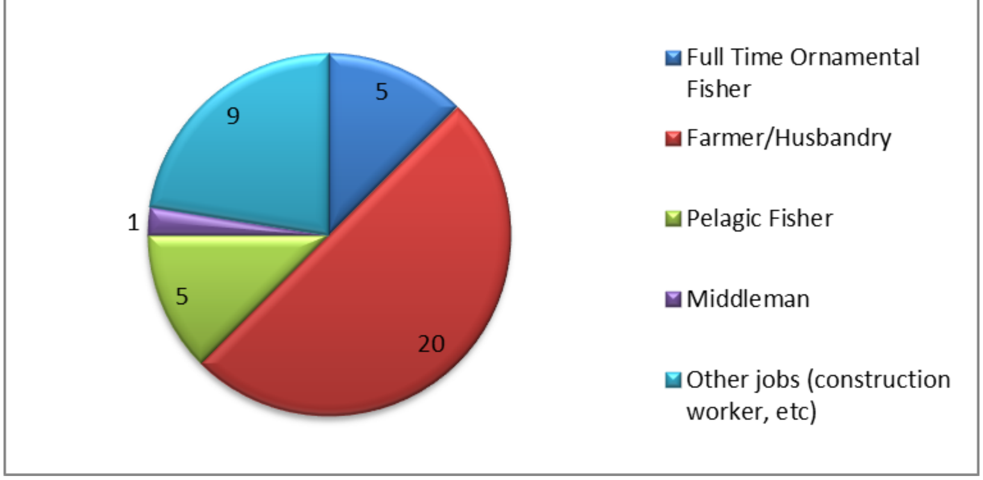
Social/Cultural Circumstances. The majority of the fishers sell their catch to middlemen. The reason they do this is because of their social obligation to the middlemen. Most fishers obtained a loan, such as their first payment, to buy equipment or even a vessel, from the middlemen. These loans were easily obtained, without explicit interest or a lot of paperwork required. In return, they became obliged to sell all their catches to the middlemen, even if they could get a better price from an exporter (Mulyono, 2012). This situation has happened not only in Tejakula sub-district, but in many other places in Asia and Africa (Merlijn, 1989). Fishers have subsequently become "economic slaves" to middlemen who provide them food, boats, and other necessary commodities, including cyanide (during the cyanide period), and in return, all of their catch is sold to the middlemen (Rubec, Cruz, Pratt, Oellers, & Lallo, 2000). One of the reasons why so many fishers initially started using cyanide was because they needed to pay off their debt to the middlemen (Halim, 2002).

Loans from middlemen are perpetuated from one generation to the next, continuing from father to child and so on. In emergency situations, when the fishers need money urgently for their family or any other reasons, the middlemen willingly lend it to them. Loan payments might be on an installment basis, or taken directly from the fish payment, or simply when the fishers have enough money to pay. This deep entrenchment of social obligation in the Balinese community might be contributing to the slow economic development of the fishers.

Additional Jobs/Sources of Revenue. Figure 5 shows that 50% of the fishers do farming/husbandry as side job since this is the easiest source of additional income that they can earn at home. 12.5% are full time ornamental fishers. Another 12.5 % are both ornamental and pelagic fishers, and 22.5% of the fishers work at a variety of different jobs. Only 2.5% are both ornamental fishers and middlemen. The fishers who do both ornamental and pelagic fishing work in both the mornings and afternoons. In the mornings, they fish for ornamental fish, and in the afternoon, they use their vessel to go into deeper waters to get fish for consumption.

The ornamental fishers (non-compressor and compressor) in Tejakula sub-district will do jobs that are available in their village or close by elsewhere. They can easily switch from one job to another side job. Some of the younger fishers prefer to work in construction. Since this type of job requires physical strength, younger fishers can do this job better than older fishers. During monsoon season, when the weather does not allow for fishing, they will do any alternative job that is available in order to financially support their families.

Figure 5: Side jobs of the fishers



There are two different monsoon seasons: one is during the rainy season in December, January and February; while the other one is during the dry season in August and September. All these seasons have strong surface and underwater ripple or waves that cause water turbidity (Partiana, 2012). All the seasonal jobs such as farmer/husbandry, construction worker, sand collector, fruit picker, carpenter and handyman are done during these five months. The side job of a farmer/husbandry is carried out at home. These fishers grow plants such as rambutan, mango, banana and corn as fodder to feed their animals such as pigs, chickens, cows, and ducks, which they then breed. One of the fishers interviewed has recently started a catfish farm, trading catfish juveniles to the restaurant trade across Bali.

Table 7:

Revenue from Side Jobs of Non-Compressor Fishers in Tejakula Sub-District

No.	Name	Side Job	Side Job Yearly Net Revenue (IDR)	Fishing Yearly Net Revenue (IDR)	Total Yearly Net Revenue (IDR)
1	MT	Construction Worker	2,250,000	12,260,000	14,510,000
2	GA	Farmer/Husbandry	2,400,000	8,700,000	11,100,000
3	MS	Sand collector	4,800,000	9,540,000	14,340,000
4	MP	Rambutan farmer	750,000	17,825,000	18,575,000
5	MMT	Pelagic Fisher	5,600,000	11,750,000	17,350,000
6	MKA	Fruit Picker	2,250,000	9,100,000	11,350,000
7	MKI	-	-	12,850,000	12,850,000
8	NST	Farmer/Husbandry	8,400,000	10,800,000	19,200,000
9	KS	Farmer/Husbandry	1,250,000	9,850,000	11,100,000
10	NM	Farmer/Husbandry	1,600,000	9,000,000	10,600,000
11	KB	Salt Collector/Husbandry	2,850,000	9,850,000	12,700,000
12	GGT	Farmer/Husbandry	2,450,000	10,850,000	13,300,000
13	KP	Farmer/Husbandry	1,100,000	10,300,000	11,400,000
14	MMA	Farmer/Husbandry	500,000	9,850,000	10,350,000
15	MA	Farmer/Husbandry	500,000	11,710,000	12,210,000
16	MB	Pelagic Fisher	4,400,000	9,925,000	14,325,000
17	MW	Farmer/Husbandry	3,000,000	9,830,000	12,830,000
18	GW	Pelagic Fisher, as a crew for big ship	6,000,000	9,800,000	15,800,000
19	GA	Farmer/Husbandry, joins a big vessel	2,300,000	14,850,000	17,150,000
20	NR	Construction Worker	4,800,000	9,850,000	14,650,000
21	MMD	Farmer/Husbandry	4,000,000	13,000,000	17,000,000
22	NSA	-	-	13,650,000	13,650,000
23	WW	Farmer/Husbandry	800,000	12,700,000	13,500,000
24	WN	-	-	12,895,000	12,895,000
25	MP	-	-	17,750,000	17,750,000
26	IKRO	Carpenter	4,550,000	20,350,000	24,900,000
27	GGH	Farmer/Husbandry	4,650,000	11,000,000	15,650,000
28	GP	-	-	12,400,000	12,400,000
29	GS	Construction Worker	2,700,000	13,700,000	16,400,000

Table 8

Revenue from Side Jobs of Compressor Fishers in Tejakula Sub-District

No.	Name	Side Job	Side Job Yearly Net Revenue (IDR)	Fishing Yearly Net Revenue (IDR)	Total Yearly Net Revenue (IDR)
1	GR	Farmer/Husbandry and joins the big boat	4,800,000	8,800,000	13,600,000
2	NSJ	Pelagic Fisherman	5,600,000	9,000,000	14,600,000
3	NW	Farmer/Husbandry	3,500,000	22,300,000	25,800,000
4	KS	Farmer/Husbandry	2,000,000	8,500,000	10,500,000
5	GM	Construction Worker	4,000,000	12,000,000	16,000,000
6	NA	Farmer/Husbandry	9,800,000	10,500,000	20,300,000
7	KM	-	-	13,000,000	13,000,000
8	MMC	Farmer/Husbandry	4,280,000	21,000,000	25,280,000
9	DGMT	Middleman	22,100,000	23,500,000	45,600,000
10	DGP	Farmer/Husbandry	4,220,000	20,000,000	24,220,000
11	GA	-	-	10,000,000	10,000,000

Motivational Factors that Support the Reformed Method of Fishing

The transition to the barrier net method was not an easy one, and it impacted both fishers and middlemen. The Ornamental fishers had to be trained how to use the nets properly. Additionally, the middlemen who regularly provided cyanide for their fishers had to stop purchasing the cyanide, thereby ending their "business relationship" with any sources of cyanide.

Economic Incentives. Although the price of only a few species of ornamental fish actually increased, both fishers and middlemen thought all the fish prices had improved, as earlier mentioned. One of the main reasons that the prices changed in the local market is because the method of fishing has changed. On the other hand, fishing costs have been considerably reduced since the fishers no longer need to buy cyanide. Instead they need to replace their barrier nets only once or twice a year, a cost to them that is much lower compared to purchasing cyanide. In this case, the fishers' increased revenue came from a decrease in their costs, rather than an overall increase in the price of ornamental fish. When fishers get more money for cyanide-free fish, they are extremely enthusiastic about switching to cyanide-free techniques

(Barber & Pratt, 1998). One of the actions that can be taken to limit cyanide fishing is to enhance fishing revenue. Policy reform and community-based arrangements are needed to establish incentives for cyanide-free ornamental fishing by promoting higher prices for net-caught ornamental fish (Rubec, Cruz, Pratt, Oellers, & Lallo, 2000). Most of the buyers prefer to buy the net-caught fish, but unfortunately, as mentioned before, certain rare and expensive species are limited in Tejakula sub-district, forcing the middlemen or exporters to buy them from outside fishers.

Quality of Fish. The reformed method has substantially reduced the mortality of ornamental fish in the market chain. Both fishers and middlemen agreed that the quality of the ornamental fish has increased by more than 50%, compared to when they used cyanide. Previously the mortality rate of ornamental fish was as high as 60% in comparison to the current situation, where the mortality rate is estimated at less than 20%. These deaths are mostly caused by human error in handling and transporting the ornamental fish (Pastika, & Mulyono, 2012). The assessment of fish quality is based on the fish mortality during transport from the sea (fishers) to the middlemen's temporary tank holders, and after being transported from the middlemen to the exporter in Denpasar (Mulyono, 2012). Fish exposed to cyanide that did not immediately die, suffered stress and damage that often led to their subsequent death (Dixon, 1981), at holding tanks, during transportation, or once in the hands of the importers.

Now that Tejakula sub-district is cyanide-free, exporters prefer to buy from these fishers (Mertan, 2012) because the quality of the ornamental fish is guaranteed to be 100% healthy. Fish sourced from outside of Tejakula sub-district, still go through the so-called "fish salon," where fin-tips are trimmed of damage caused by potassium cyanide (Mulyono, 2012). Furthermore, the risks to human health associated with cyanide exposure, such as headaches, vertigo or skin irritation (Partiana, 2012) have been eliminated in Tejakula sub-district.

Fishing Time. Initially, cyanide fishing seemed more efficient since more fish could be caught in less time without needing to chase and trap them. However, once the coral reefs had been destroyed, the population of fish radically declined. Many of the fish species became more difficult to spot in the fishing grounds, which forced the fishers to find new fishing areas. For compressor fishers, travelling farther away equated to spending more money on gasoline and food, and was also more time consuming. Non-compressor fishers needed more time to fill their orders since many of the fish caught died right after the cyanide spread. As the fish population declined, they needed to go to other places or other coral reef areas in order to get the fish species that were required (Arsana, 2012).

Currently, fishing time is much shorter, with most of the fishers returning home by noon. Although revenues have not significantly improved for the fishers with the barrier net method, this reduction in fishing time is beneficial since it affords them extra time for to take on additional jobs.

Resource Sustainability. Almost all (97.5 %) of the fishers said that the net-caught fishing method is more efficient and sustainable. Although it takes time to learn how to use the nets, once fishers are familiar with it and become skillful at it, fishing becomes more efficient. Once the net is set up, fishers can more easily collect only those fish they need for a given order, and then release the rest, thereby preserving them for future catches (Partiana, 2012). When cyanide was used, it would indiscriminately kill many fish, including the more expensive varieties.

All the fishers admitted that after more than a decade of using the barrier net approach, the population of ornamental fish is slowly returning to their fishing grounds as the coral reef conditions improve (Partiana, 2012). By continuously using the environmentally-friendly method, the coral reefs around Tejakula sub-district should recover and once again produce fish abundantly.

Other Significant Issues Related to the Reformed Fishing Method

There are some other important issues that should be considered regarding the reformed fishing method in Tejakula sub-district.

No Take Zones (NTZs). No Take Zones (NTZs) in Tejakula sub-district are located in the Bondalem coastal area and in Les (see Appendix E). NTZs are being proposed for another three areas: Penuktukan, Pacung and Sembiran. NTZ regulation is based on Local Regulation of Bali Province, No. 16, Year 2009 - 2029 on Spatial Planning. The NTZs establish protected areas for the ultimate purpose of re-establishing all the coral reefs, not just those in the NTZ, and repopulating them with ornamental fish (Go Blue Indonesia, August 25, 2009). Research has shown that by protecting spawning biomass and genetic diversity, Marine Protected Areas (MPAs) can provide biological spillover benefits to the remaining fishing grounds, allowing for more natural population structures and providing new recruits to the fishery (Carter, 2003).

Although NTZs in Tejakula sub-district were created to improve ornamental fish production (an outcome that would ultimately benefit the fishers), they have not been embraced or accepted yet by all fishers. Lack of information and understanding has created misinterpretations about them. Some of them thought that the NTZs were implemented to merely limit their movement when fishing. NTZs could be a socially efficient use of marine resources, even if it were not able to generate net economic benefits for fisheries (Carter, 2003). As well, NTZs could give the opportunity for rare and more expensive species to increase their population, thereby improving the fishers' livelihood.

However, recently the NTZ policy has been abused by some private tourism operators, who arbitrarily declare the beach and waters in front of their properties as "no take zones." These business owners prohibit fishing activities, although there is no supporting legislation, stating the area is only for tourism purposes, such as swimming, boating, and diving, including fishing with spear guns (Mertan, 2012). According to some fishers, there have been several incidents where the fishers have been thrown out by the business owners or taken to the police station with charges of trespassing (Mertan, 2012).

According to the leader of ornamental fishers group (Mertan, 2012), the existing NTZs currently have legal power since they were signed by the Buleleng regent. The signing and approving of these papers were based on the management plan of the Buleleng regency. According to Mertan (2012), the agreements were based on a lack of knowledge among some local communities in Tejakula sub-district. The information that the community received from local NGO's that marine biota and the coral reef within Tejakula waters should be protected underlined the importance of local fishers to the local economy. Instead, many ornamental fishers perceived the NTZs as punitive measures designed to jeopardize rather than support their livelihoods.

According to the 2010 census data, the total number of fishers in Tejakula sub-district was 1,285 (Buleleng, 2010), of which only 70 were ornamental fishers, or 5.5% of the total. Because they have been out-numbered by pelagic fishers, the position of the ornamental fishers in Tejakula sub-district is not as strong as the pelagic fishers. Subsequently, their fishing livelihoods are not perceived as important by locals (Pinkerton, 2009).

In Bali, tourism is always the number one priority and the main source of the province's revenue. This imbalance creates conflict between fishers and tourism entrepreneurs. A similar situation happened in other places such as in the United Kingdom. The conflict was between anglers and the local fishers. Anglers caught relatively few salmon through fly-fishing, but injected large sums of money into the local economy through tourism. On the other hand, local fishers caught many fish with nets, contributed relatively little in comparison to the local economy, but earned a direct living doing so. Issues relating to the overall distribution of benefits were of great importance (Spurgeon, 2004).

Reduction of the Ornamental Fishers' Population. According to Mertan, the leader of the fishers' association in Tejakula sub-district, as it is mentioned before, there were approximately 170 ornamental fishers in Tejakula subu-district in the year 2000, before the implementation of the reformed method of fishing. After the barrier net method was introduced to the fishing community, the number of fishers was reduced to only about 70 fishers (or about 58.7% less) by the year 2011. Regardless of the free training provided, the inability to effectively use the net became one of the main reasons the fishers decided to switch their main occupation (Mertan, 2012). Additionally, a LINI field staff reported that some fishers decided to shift to different occupations because of "intimidation" by the local authority and tourism entrepreneurs. Although the method of fishing has changed, the notion that ornamental fishing destroys the coral reef remains in people's minds. Many people, including local law enforcement, are suspicious that ornamental fishers in Tejakula sub-district are still using destructive fishing methods (Partiana, 2012).

The other reason that the number of ornamental fisher is down is age-related. When the reformed method of fishing was introduced, some older fishers quit because they felt too old to learn to use the net. Most of the younger non-compressor fishers are able to do their work efficiently and in a shorter time period compared to older compressor fishers. Of the 40 fishers interviewed, the youngest was in his early 20’s and the oldest was in his late 40’s or early 50’s. When they reach 50 years old, many fishers start slowing down, finding the work too physically exhausting. By their mid-50’s, many of them decide they are no longer able to fish and instead engage themselves with a different job that does not require as much physical strength and endurance.

One of the fishers interviewed decided to retire from the fishing industry after he was arrested in South Sulawesi for cyanide fishing. After being charged, he was placed under house arrest on his boat (he was forbidden to use his boat for 10 months), in his mid-50’s, he decided not to fish any longer. In spite of his decision to stop fishing, he was still interested in working in the ornamental fish industry, so he engaged with local ornamental fishers and helped them by sharing his experience and knowledge about the dangers of cyanide fishing.

The reduction of ornamental fish, due to the destruction of the reefs, has also impacted the number of fishers. Although the reefs have improved, their recovery is slower than with other marine ecosystems (Gaskill, 2012), and the damage by cyanide has been more destructive. The damage done by cyanide fishing to ornamental fish is greater than that for food fish, as the number of target fish per unit of reef area is much bigger (Maus, et al., 2000). When the reformed method of fishing began in 2000, the coral reefs were in bad condition as the result of cyanide fishing and productivity was low (Partiana, 2012). It takes time to improve coral reef production.

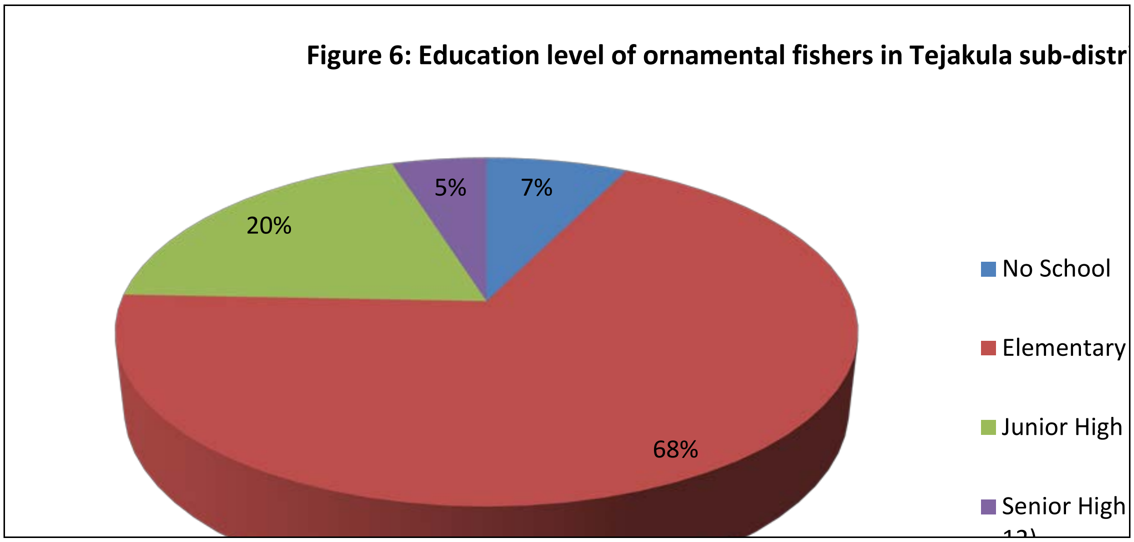
Furthermore, as earlier mentioned, the ornamental fish export market from Bali has shrunk since 2006. The export values of ornamental fish from Bali since 2006 have fluctuated (see Table 6) reaching the lowest export value in 2011 of USD 698,796, which is down 83% from the export value in 2006. Lower export revenues mean fewer orders for the fishers. However, this situation had been offset by the smaller number of fishers operating in Tejakula.

In 2000 when the number of fishers was 170 fishers, the NTZ policy had not been implemented yet in the area, so all 170 fishers could fish anywhere within the Tejakula sub-district area. Currently, with the number of fishers reduced to only 70 fishers, the reduced fishing grounds better accommodates the smaller number of fishers.

Education. The average level of education among the fishers in Tejakula sub-district is very low. Of the 40 fishers who were interviewed, only two (5%) had finished senior high school (Grade 12), while eight of the fishers graduated from junior high school (Grade 9). Twenty seven fishers (68%) had some or completed elementary school, while three of the fishers (7%) have never been in school or are illiterate. The majority of the fishers said that a lack of financial support was the main reason many did not continue their education. Aside from insufficient funds, most of the fishers admitted that influencers, such as their parents and friends, did not motivate them to continue their education. Most of the younger fishers have been involved in the fishing “business” from a very early age, starting out by helping their parents. By the time they reached the age where they could fish alone, education was no longer their main priority. The necessity of earning money has promoted the idea that education is not important.

Due to rural remoteness, limited level of education, and a large numbers of dependants, fishers tend to be socially and politically marginalized (Job, 2005). Retrospectively, their lack of education caused fishers to use cyanide without knowing its consequences. Through education, the younger generation will be better informed about the destruction associated with cyanide, and realize that it cannot sustain the livelihood of the fishers since it threatens natural resources.

Because of the size of the areas concerned, and the general lack of resources for enforcement, education appears to be more successful than legislation in controlling destructive fishing practices (Richmod, 1993). Another benefit of educating the younger generation is that they can learn to increase their revenues by choosing the best price or higher offer for their catch. Education can greatly affect the way fishers conduct their business. It can help them to improve their revenue by choosing the right place or person to sell their catch and knowing the appropriate price of fish.



Authority Involvement and Support. Currently, there is not enough support for and involvement in the Tejakula sub-district ornamental fishing industry from the local authority. Additionally, there is preferential treatment of tourism operators and a distrust among local authority figures that ornamental fishers are still using cyanide. There have been cases where the local police arrested ornamental fishers who were fishing near a tourist resort, based solely on the tourism operator's unfounded allegations of cyanide use.

These recent incidents are difficult for the fishers, who claim the local police never showed any interest in enforcing environmentally-friendly fishing practices during the cyanide period. At that time, when fishers were caught using cyanide, they only had to pay a “penalty” to be released from all charges (Partiana, 2012). The harassment by law enforcement workers and tourism operators is one of the reasons why many have stopped ornamental fishing. Furthermore, this situation illustrates that local law enforcers do not know or understand that ornamental fishers in Tejakula sub-district no longer use destructive fishing methods. The current unfair treatment of fishers by the local authority shows there is more concern for tourism compared to ornamental fishing.

According to the UNEP Report (2006), there were some reasons why the local government did not get involved in the fishing industry in Tejakula sub-district. One of them is the local government did not see any benefits to be had from their intervention. Lack of competence and technical expertise of local government workers made them remain passive. They were pleased if the ENGOs’ efforts were successful, but they would not take the blame it they failed (UNEP, Sustainable Trade and Poverty Reduction, New Approaches to Integrated Policy Making at the National Level, 2006).

Chapter Five: Conclusions and Recommendations

Conclusions

Over the past decade, during which the barrier net method of ornamental fishing has been practiced, the condition of the coral reefs in Tejakula sub-district has gradually improved, increasing from average percentage coverage of 26% to 53%. Surprisingly, further results indicate that there has been no statistically significant increase in revenue (using t-tests), for both compressor and non-compressor fishers, associated with barrier net fishing. Specifically, the total fishery revenue in 2000 (cyanide period) was 58.2% higher compared to the total fishery revenue in 2011 (barrier net period). However, it is expected that the fishery revenue will improve as the condition of coral reef continues to improve.

The results show that both non-compressor and compressor fishers have realized a significant reduction in their costs (73% lower) after using the reformed method of fishing. Although revenue has not increased as expected, other benefits have been observed from the environmentally-friendly method. First of all, increases in ornamental fish have occurred as the coral reef recovers, suggesting that the reformed method of fishing will guarantee the sustainability of the coral reef and consequently the livelihood of current and future ornamental fishers.

The export of ornamental fish from Bali has fallen since 2006. From 2007 to 2009, the European Union banned the Indonesian Flight Company from flying to European cities, forcing exporters to ship their ornamental fish through Kuala Lumpur or Singapore. Shipping through these cities automatically changed the ornamental fish to be labeled as goods exported from Malaysia or Singapore, rather than Indonesia. Additionally, the economic crisis in Europe and the certification procedure for Indonesian fishery products has reduced demand for ornamental fish from these countries.

The middlemen function as the main bridge between fishers and exporters since most of the fishers are obliged to sell their catch to the middlemen. Although middlemen pay less than exporters, the debt of gratitude to the middlemen is the main reason many of the fishers will not sell their catch directly exporters.

Interestingly, those fishers interviewed were under the impression that the price of ornamental fish had increased after a decade of using the barrier net method. However, price increases applied to only 12% of the total species in the local market (middlemen prices), when the current inflation rate was taken into consideration. Lack of information about the market and knowledge about fish prices and inflation rates led the fishers to believe that prices had increased, not decreased.

Ultimately, knowledge about their reliance on a healthy and sustainable coral reef for their livelihoods will be one of the primary motivators among fishers to continue using only environmentally-friendly collection practices in Tejakula sub-district. Although revenues have not improved, fishers have realized other benefits. For example, with less time fishing, the fishers can use the rest of their time to work additional jobs, thereby earning additional revenue for their families.

While NTZs can help preserve both the coral reef and its products as revenue sources, they should not be allowed to be abused by the tourism industry. The conflict of interest between tourism operators and fishers is inevitable because of their shared interest in the coral reef. However, the ornamental fishers' rights are not being supported by the local authority because they are out-numbered. As a result, they have decided to avoid the resort areas for fishing. The local authority should play a role in solving this ongoing issue, and should ultimately ensure that the already limited fishing grounds are not increasingly narrowed because of tourism interests.

Since the production of coral reefs in Tejakula sub-district is still relatively low, middlemen and exporters must sometimes buy from fishers outside of Tejakula to meet the market demand. There is no guarantee that these other fishers do not use cyanide, and therefore the quality of fish is not assured. However, certification required by EU ornamental fish importers since January 2010 could encourage middlemen and exporters to purchase ornamental fish only from non-cyanide fishers.

The number of ornamental fishers in Tejakula sub-district has fallen over a 10 year period, from approximately 170 to only 70 fishers. This large reduction of has been offset by the reduction of available fishing grounds as result of NTZs, and a decline in export orders of ornamental fish. The current low productivity of the coral reef could be considered an adjustment as well for the lower population of ornamental fishers.

Recommendations

Economic Benefit and Sustainability of Livelihood. Regardless that there is no significant difference in revenue between the two study periods, the continuation of the reformed fishing method in Tejakula sub-district should guarantee that the condition of the coral reef will improve, and it should ultimately provide an ongoing economic benefit to the local community. To help increase the available fishing grounds, the ornamental fishers' association, with the assistance of LINI, is currently working on an artificial coral reef project (see Appendix F). The project is very useful since it helps the natural coral reef to recover sooner and has already started producing ornamental fish. The artificial coral reef is strong enough for the coral larva to find the grip for their foundation to grow. Moreover, since the fishers do not have to wait until the natural coral reef recovers before ornamental fish are produced, they are benefiting already by increasing the amount of their catch. The efforts by the Tejakula's fishers over the last twelve years to improve the coral reefs conditions, including the artificial coral reef project, demonstrate the fishers' commitment to protect their fishing grounds and keep them cyanide-free, especially from free-riders that come from other areas.

Thus far the artificial reef project has only involved ENGO's and some financial institutes. The local authority has not yet been involved. However, their involvement will bring better recognition of environmentally-friendly fishing practices and the efforts undertaken by ornamental fishers in Tejakula sub-district. Also, the involvement of the local authority will help clarify any misconceptions about ornamental fishing activities in Tejakula sub-district.

The fact the quality of ornamental fish from Tejakula sub-district has been recognized by exporters could also be used to benefit of the fishers. Eventually, the quality of fish could be used as a bargaining tool to increase the price of ornamental fish from this area. Cooperation among the fishers through ornamental fishers' associations will be useful to achieve this goal.

Social Factor. To overcome their reliance on the middlemen, ornamental fishers should work together through associations to create a strong financial body that could be used to support association members, especially to help them pay back their loans to the middlemen. Once the fishers are no longer solely dependent on the middlemen, and can choose where to sell their catch, they will achieve the bargaining power needed to negotiate better prices. Having a choice of places to sell their catch will create a healthy free market, beneficial to the fishers. Consequently, ornamental fishers will learn about the market and fish prices. The younger generation of future ornamental fishers could acquire this knowledge through school.

Knowledgeable ornamental fishers could have an opportunity to create a better circumstance for all fishers, including themselves.

The ENGOs, such as LINI and Reef Check, who have gained the trust of the fishing community, could help the fishers make the free market a reality. To create a free market, the fishers need to release themselves from their never-ending bond with the middlemen. To do this, the fishers must find an alternative financial backer. To achieve this, it is most likely that a community institution will have to function as a financial institution, where new ornamental fishers will be able to borrow money to cover their start-up costs, and existing ornamental fishers will be able to pay off their loans to the middlemen. This effort has already been started by the fishers' association, Mina Bhakti Sowansari (MBS). However, financial training in term of managing savings and loans is still needed to improve the members' money management skills.

Livelihood for Coral Reef Sustainability. To maintain the viability of the fishers' livelihoods, the sustainability of coral reefs should be protected. In Tejakula sub-district, the value of the coral reefs not only applies to ornamental fishers, but also to the tourism industry.

According to one of the fishers interviewed, tourism and fishing can peacefully co-exist. Specifically, he has noticed many tourists watching him fish with his net. These tourists were amazed by his work, and he himself became the "attraction." These tourists were impressed with what they saw, and expressed an interest in seeing more fishers at work (Partiana, 2012). This experience, combined with other findings in this thesis, suggest that ornamental fishing could be incorporated in ecotourism attraction, equally benefiting both stakeholder groups.

Ecotourism is defined as responsible travel to natural areas that conserves the environment and improves the well-being of local people (The International Ecotourism Society). Ecotourism, when practiced in an appropriate way, can provide the local community with a viable source of income. As tourism becomes an important source of revenue, stakeholders become motivated to sustain it, thereby, becoming protectors of biodiversity and partners in conservation (CMS, 2009). An ecotourism initiative would not only help protect the natural resources in the area, but would also help create a better relationship between fishers and tourism entrepreneurs, who would come to rely on each other to enhance their livelihoods.

Policy and Authority Involvement. Support from the local authority and law enforcement officials could be valuable to the local ornamental fishers. Implementing an awareness and education program could provide accurate information about the reformed fishing method and its benefits, thereby clearing up any misconceptions about the fishers' reformed practices. It could also help them recognize environmental-friendly fishing activities in actual practice, and subsequently act fairly and unbiased in performing their duties as public protectors, particularly where tourism operators are concerned.

To accommodate this need, ENGOs could conduct additional environmental education activities that involve local authorities and law enforcers together with the fishers. Activities, such as diving together, would teach the local authorities how the reformed method of fishing is conducted. With an enhanced knowledge, they would better understand that apart from being an economic resource for the fishers, barrier net fishing is also sustaining the condition of coral reef, the health of which is very important to the local tourism industry.

While cyanide fishing is no longer an issue in Tejakula sub-district (Partiana, 2012), many cyanide fishers still operate in areas adjacent to Tejakula sub-district. There is concern that cyanide fishing could slip back into Tejakula sub-district through "free riders" from other places, especially after the condition of the coral reef improves and the population and diversity of fish increases. To prevent this from happening, Tejakula fishers could use this opportunity to actively promote their area as cyanide-free. Tejakula sub-district could become a model for other places in Bali, demonstrating that environmentally-friendly fishing can sustain the livelihood of ornamental fishers.

One of the reasons that cyanide fishing still occurs outside of Tejakula sub-district is because of corruption, especially among law enforcers, which is prevalent in developing countries. Corruption still occurs because law enforcement workers, who are typically low paid, are tempted by extra cash. Increasing their salary is difficult because budgets are insufficient and corruption exists at even the highest authority level. There is an alternative policy from the neighbouring Philippines that could be adapted and practiced in Indonesia. The Philippines' House of Representatives has passed the Sodium Cyanide Act that regulates the importation, distribution, and use of cyanide with the country (cyanide has many legitimate uses in industry). Although this type of law will undoubtedly be difficult to enforce, it should increase the price of cyanide in the black market to the point that alternative fishing techniques will become more attractive economically to those fishermen who are currently using cyanide (Barber, 1998). However, the commitment of law enforcers to support the existing law will still be needed to ensure that cyanide does not become an "alternative" source of earnings for corrupt law enforcers.

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Appendix A: Price list of ornamental fish

No.	Local Name	General Name	Scientific Name	Prices during the cyanide (IDR)	Average middleman current prices (IDR)	Differences between cyanide and current middlemen prices (IDR)	Exporter current prices (IDR)	Differences between cyanide and current exporter prices (IDR)
1	Angel Abu Biasa	Pearl Scale Angelfish	*Centropyge vrolikii*	1,196.75	1,000	***196.75***	2,000	***803.25***
2	Angel Abu Liris	Red Stripe Angelfish	*Centropyge eibli*	2,991.88	3,000	***8.13***	4,000	***1,008.13***
3	Angel Annularis	Blue Ring Angelfish	*Pomacanthus annularis*	23,935	40,000	***16,065***	40,000	***16,065***
4	Angel Asli	Three Spots Angelfish	*Apolemichthys trimaculatus*	23,935	17,500	***-6,435***	25,000	***1,065***
5	Angel Batman	Emperor Angelfish	*Pomancanthus imperator*	59,837.5	27,500	***-32,337.5***	50,000	***-9,837.5***
6	Angel Bk	Two Coloured Angelfish	*Centropyge bicolor*	5,983.75	3,000	***-2,983.75***	5,000	***-983.75***
7	Angel Biru	Keyhole Angelfish	*Centropyge tibicen*	1,196.75	1,750	***553.25***	2,500	***1,303.25***
8	Angel Doreng Asli	Regal Angelfish	*Pygoplites diacanthus*	23,935	17,500	***-6,435***	20,000	***3,935***
9	Angel Doreng Palsu	Barred Angelfish	*Paracentropyge multifasciata*	1,795.13	1,200	***-595.13***	3,000	***1,204.88***
10	Angel Ekor Panjang Biasa	Freckletail Lyretail Angelfih	*Genicanthus lamark*	5,983.75	5,000	***983.75***	6,000	***16.25***
11	Angel Hitam Polos	Midnight Angelfish	*Centropyge nox*	2,393.5	1,750	***-643.5***	3,500	***1,106.5***
12	Angel Kennedy	Coral Beauty Angelfish	*Centropyge bispinosus*	7,180.5	5,500	***-1,680.5***	20,000	***12,819.5***
13	Angel Swallow	Zebra Angelfish	*Genicanthus caudovittatus*	11,967.5	10,000	***-1,967.5***	15,000	***3,032.5***
14	Angel Ungu	Whitetail Pigmy Angelfish	*Centropyge flavicauda*	2,393.5	2,000	***-393.5***	2,000	***-393.5***
15	Angel Zebra	Many Banded Angelfish	*Paracentropyge multifasciatus*	5,983.75	3,000	***-2,983.75***	6,000	***16.25***
16	Bajing Laut	Saddleback Hogfish	*Bodianus bilunulatus*	2,393.5	4,000	***1,606.5***	5,000	***2,606.5***
17	Bajulan Api	Bluestripe Pipefish	*Doryrhamphus excisus excisus*	3,590.25	1,750	***-1,840.25***	3,5000	***-90.25***
18	Barong Gajah	Twinspot Lionfish	*Dendrochirus biocellatus*	11,967.5	7,000	***-4,967.5***	13,000	***1,032.5***
19	Betok Biru	Azure Demoiselle	*Crhysiptera hemicyanea*	1,196.75	1,500	***303.25***	1,000	***-196.75***
20	Betok Dua Strip	Twinspot Damselfish	*Chrysiptera biocellata*	1,196.75	1,250	***53.25***	1,700	***503.25***
21	Betok Ekor Kuning	Chinese Demoiselle	*Neopomacentrus bankanensi*	1,196.75	1,000	***-196.75***	1,000	***-196.75***
22	Betok KB	Surge Demoiselle	*Chrysiptera brownrigii*	1,795.13	1,000	***-795.13***	1,000	***-795.13***
23	Betok Merah	Speckled Damsel	*Pomacentrus bankanensis*	1,196.75	1,000	***303.25***	2,000	***803.25***
24	Betok Model	Ocellate Damselfish	*Pomacentrus vaiuli*	1,196.75	1,500	***-303.25***	1,500	***303.25***
25	Betok Star	Blacktail Chromis	*Chromis nigrura*	1,795.13	1,000	***-795.13***	1,250	***-545.13***
26	Betok Susu	White Damsel & Banded Damsel	*Dischistodus perspicillatus*	1,196.75	500	***-696.75***	1,000	***-196.75***

No.	Local Name	General Name	Scientific Name	Prices during the cyanide (IDR)	Average Middlemen Current Prices (IDR)	Differences between cyanide and current middlemen prices (IDR)	Exporter Current Prices (IDR)	Differences between cyanide and current exporter prices (IDR)
27	Betok Zebra	Tuxedo Angelfish	*Chrysiptera tricincta*	718.05	500	***-218.05***	1,000	***281.95***
28	Bibir Ungu	Purple Queen Anthias	*Pseudanthias tuka*	11,967.5	2,000	***-9,967.5***	3,000	***-8,967.5***
29	Bintang Malam	Talbot's Demoiselle	*Linckia laevigata*	957.4	500	***-457.4***	1,000	***42.6***
30	Blue Band	Blue Streak Devil Damsel	*Neoglyphidodon oxyodon*	1,795.13	1,000	***-795.13***	1,500	***-295.13***
31	Bluestone Biasa	Koran Angelfish	*Pomcanthus semicirculatus*	11,967.5	7,500	***-4,446.5***	10,000	***-1,967.5***
32	Blue Devil	Blue Devil Damsel	*Chrysipter talboti*	1,967.75	750	***-446.75***	1,000	***-196.75***
33	Blustone Melati	Black-Velvet Angelfish	*Chetodontoplus melanosoma*	23,935	25,000	***1,065***	20,000	***-3,935***
34	Botana Batu	White Freckled Surgeonfish	*Acanthurus grammoptilus*	1,196.75	750	***-446.75***	3,000	***1,803.25***
35	Botana Biru	Powder Blue Surgeonfish	*Acanthurus leucosternon*	23,935	25,000	***1,065***	25,000	***1,065***
36	Botana Biasa	Tomini Surgeonfish	*Ctenachaetus tominiensis*	1,196.75	1,000	***-196.75***	-	
37	Botana Coklat	Brown Surgeonfish	*Acanthurus nigrofuscus*	1,196.75	750	***-446.75***	2,000	***803.25***
38	Botana Kacamanta	Whitecheek Surgeonfish	*Acanthurus nigricans*	5,983.75	7,500	***1,516.25***	12,000	***6,016.25***
39	Botana Kasur	Clown Surgeonfish	*Acanthurus lineatus*	3,590.25	3,000	***-590.25***	3,000	***-590.25***
40	Botana Kuning	Orange Epaulette Surgeonfish	*Acanthurus olivaceus*	3,590.25	2,500	***-1,090.25***	6,000	***2,409.75***
41	Botana Liris	Convict Surgeonfish	*Acanthurus triostegus*	2,393.5	2,000	***-393.5***	2,500	***2,409.75***
42	Botana Mimik	Mimic Surgeon	*Acanthurus chronixis*	2,393.5	1,500	***-893.5***	4,000	***106.5***
43	Botana Model	Chocolate Surgeonfish	*Acanthurus pyroferus*	5,983.75	5,000	***-983.75***	12,000	***1,606.5***
44	Botana Naso Palsu	Scalpel Sawtail	*Prionurus scalprus*	1,795.13	1,500	***-295.13***	2,000	***204.88***
45	Botana Unicorn Ekor Putih	Spotted Unicornfish	*Naso brevirostris*	1,196.75	1,000	***-196.75***	2,000	***803.25***
46	Brajanata	Clearfin squirrelfish	*Neoniphon argenteus*	1,795.13	1,500	***-295.13***	3,000	***1,204.88***
47	Brownkelly	Harlequim Sweetlips	*Plectorhinchus chaetonoidea*	5,983.75	5,000	***-983.75***	5,000	***-983.75***
48	Bunglon Biasa	Golden Head Sleeper Goby	*Valenciennea strigata*	2,393.5	1,250	***-1,143.5***	1,500	***-893.5***
49	Bunglon Kotak Merah	Orange-Striped Goby	*Amblygobius decussatus*	2,393.5	1,250	***-1,143.5***	3,000	***606.5***
50	Bunglon Putih	Ladder Glider Goby	*Valenciennea sexguttata*	1,795.13	1,000	***-795.13***	1,500	***-295.13***
51	Bunglon Strip	Railway Glider Goby	*Valenciennea helsdingenii*	2,991.88	1,500	***-1,491.88***	2,000	***-991.88***
52	Bunglon Titik	Orange-Spottet Maiden Goby	*Valenciennea puellaris*	2,393.5	1,250	***-1,143.5***	2,000	***-393.5***
53	Bunglon Zebra	Sphinx Goby	*Amblygobius sphynx*	1,196.75	1,250	***53.25***	2,000	***803.25***
54	Buntel Babi Mapa	Map Puffer	*Arothron mappa*	3,950.25	1,750	***-1,840.25***	5,000	***1,409.75***
55	Buntel Biru	Black Spotted Pufferfish	*Arothron nigropunctatus*	3,950.25	5,000	*1,409.75*	4,000	***409.75***

No.	Local Name	General Name	Scientific Name	Prices during the cyanide (IDR)	Average Middlemen Current Prices (IDR	Differences between cyanide and current middlemen prices (IDR)	Exporter Current Prices (IDR)	Differences between cyanide and current exporter prices (IDR)
56	Buntel Lumut	Lantern Toby	*Canthigaster epilampra*	1,196.75	1,000	***-196.75***	2,000	***803.25***
57	Buntel Valentini Segra	Black Saddled Toby	*Canthigaster valentine*	1,196.75	750	***-446.75***	2,000	***803.25***
58	Burung Laut	Brown Sailfin Tang	*Zebrasoma scopas*	2,393.5	1,5000	***-893.5***	2,000	***-393.5***
59	Cantik	Royal Dottyback	*Pesudochromis paccagnellae*	1,795.13	1,500	***-295.13***	3,000	***1,204.88***
60	Clownfish Hitam	True Clown Anemon Fish	*Amphiprion percula*	3,590.25	2,500	***-1,090.25***	5,000	***1,409.75***
61	Dakocan Hitam	Three Spots Dimino Damsel	*Dascyllus trimaculatus*	957.4	500	***-457.4***	1,000	***42.6***
62	Dakocan Putih	Two Stripe Damselfish	*Dascyllus reticulatus*	718.05	500	***-218.05***	1,000	***281.95***
63	Dasi Biru	Bowtie Damselfish	*Neoglyphidodon melas*	1,795.13	1,500	***-295.13***	1,500	***-295.13***
64	Dianfish Ekor Bulat	Mccosker's Fisher	*Paracheilinus mccoskeri*	1,795.13	1,500	***-295.13***	1,500	***-295.13***
65	Dianfish Jantan	Filament Fin Flasher Wrasse	*Paracheilinus fiulamentosus*	2,393.5	1,000	***-1,393.5***	2,000	***395.50***
75	Jabing	Purple Tilefish	*Hoplolatilus purpureus*	1,196.75	1,000	***-196.75***	1,500	***303.25***
76	Jabing Anten	Black Filament Nematodes Goby	*Stonogobiops nematodes*	3,590.25	1,500	***-2,090.25***	3,000	***-590.25***
77	Jabing Aurora	Pinkbar Goby	*Amblyeleotris aurora*	1,795.13	1,500	***-295.13***	3,000	***1,204.88***
78	Jabing Gajah	Streamlined Spinefoot	*Siganus argenteus*	2,393.5	1,500	***-893.4***	5,000	***2,606.5***
79	Jabing Hitam	Yellow Tailed Blenny	*Ecsenius namiyei*	1,196.75	1,000	***-196.75***	2,500	***1,303.25***
80	Jabing Ekor Merah	Two Coloured Blenny	*Ecsenius bicolor*	2,393.5	1,500	***-893.5***	3,000	***606.5***
81	Jabing Kembang	Leopard Blenny	*Ecsenius brevis*	2,991.88	1,500	***-1,491.88***	3,000	***8.13***
82	Jabing Kipas	Two Spot Goby	*Signigobius biocellatus*	5,983.75	5,000	***-983.75***	1,750	***4,233.75***
83	Jabing Putih	Seram Blenny	*Salarias ceramensis*	1,196.75	1,000	***-196.75***	-	-
84	Jae-jae	Blue Green Chromis	*Chromis viridis*	718.05	500	***-218.05***	1,000	***281.95***
85	Jagungan Biasa	Harlequin Filefish	*Oxymonacanthus longirostris*	1,196.75	1,000	***-196.75***	2,500	***1,303.25***
86	Jenggot Biasa	Blacksaddle Goatfish	*Parupenueus rubescens*	1,196.75	1,000	***-196.75***	1,500	***303.25***
87	Jenggot Kuning	Yellowsaddle Goatfish	*Parupenueus cyclostomus*	2,393.5	2,000	***-393.5***	2,000	***-393.5***
88	Kambingan	Humphead Bannerfish	*Heniochus varius*	2,393.5	1,500	***-893.5***	2,500	***106.5***
89	Kakatua Ijo	Blue Barred Parrotfish	*Scarus ghobban*	1,196.75	750	***-446.75***	-	-
90	Kambingan Biasa	Indian Bannerfish	*Heniochus pleurotaenia*	1,1795.13	1,000	***-795.13***	1,000	***-795.13***
91	Kat Kat	Wasp fish	*Abiabys macracanthus*	2,393.5	1,500	***-893.5***	-	-
92	Keling	Cheeklined Wrasse	*Ocycheilinus diagramma*	1,196.75	1,250	***53.25***	2,000	***803.25***
93	Keling Batik	Leopard Wrasse	*Macropharyngodon meleagris*	1,196.75	1,000	***-196.75***	1,500	***303.25***

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94	Keling Dom	Clown Coris Wrasse	*Coris aygula*	35,902.5	40,000	***4,097.5***	40,000	***4,097.5***
95	Keling Liris	Six Stripe Wrase	*Pseudocheilinus hexataenia*	2,991.88	1,750	***-1,241.88***	2,500	***-491.88***
96	Keling MP	Disappearing Wrasse	*Pseudocheilinus evanidus*	3,950.25	2,500	***-1,090.25***	3,500	***-90.25***
97	Keling Negro	Black Leopard Wrasse	*Macropharyngodon negrosensis*	1,196.5	1,000	***-196.75***	1,500	***303.25***
98	Keling Perak	Red Coris Wrasse	*Coris gaimard*	1,196.5	750	***-446.75***	2,000	***803.25***
99	Keling Tandung Asli	Dragon Wrasse	*Novaculichthys taeniourus*	3,950.25	2,500	***-1,090.75***	2,500	***-1,090.75***
106	Kepe Meyeri	Meyer's Butterflyfish	*Chaetodon meyeri*	5,983.75	3,000	***-2,983.75***	7,000	***1,016.25***
107	Kepe Monyong Asli	Saddleback Butterflyfish	*Chaetodon ephippium*	5,983.75	5,000	***983.75***	5,000	***-983.75***
108	Kepe Monyong Biasa	Long Nose Butterflyfish	*Forcipiger flavissimus*	1,196.5	1,000	***-196.75***	1,500	***303.25***
109	Kepe Nanas	Rafflesi's/Latticed Butterflyfish	*Chaetodon rafflesi*	4,787	2,000	***-2,787***	3,000	***-1,787***
110	Kepe Origa	Threadfin Butterflyfish	*Chaetodon auriga*	4,787	2,500	***-2,287***	5,000	***213***
111	Kepe Panah	Chevron Butterflyfish	*Chaetodon trifascalis*	2,393.5	1,500	***-893.5***	2,500	***106.5***
112	Kepe Panda	Red Clownfish – Saddle	*Chaetodon weibeli*	2,393.5	2,000	***-393.5***	1,500	***-893.5***
113	Kepe Putih	Lined Butterflyfish	*Chaetodon lineolatus*	1,795.13	1,500	***-295.13***	2,000	***204.88***
114	Kepe Pyramid	Saddled Butterflyfish	*Chaetodon ulietensis*	11,967.5	7,000	***-4,967.5***	15,000	***3,032.5***
115	Kepe Roti	Bantayan Butterflyfish	*Chaetodon adeirgastos*	2,393.5	1,500	***-893.5***	2,000	***-393.5***
116	Kepe Susu	Melon Butterflyfish	*Chaetodon trifasciatus*	1,795.13	1,000	***-795.13***	1,000	***-795.13***
117	Kepe Tato	Sunset Butterflyfish	*Chaetodon pelewensis*	1,196.5	1,500	***303.25***	-	-
118	Kepe Tikar	Baroness Butterflyfish	*Chaetodon baronessa*	1,795.13	1,000	***-795.13***	1,000	***-795.13***
119	Kepe Tikar Ekor Kuning	Vagabond Butterflyfish	*Chaetodon vagabundus*	1,795.13	1,500	***295.13***	3,000	***1,204.88***
120	Kepe Kepe Sitrun Hijau	Peppered Buterfulyfish	*Chaetodon guttatissimus*	3,590.13	2,500	***-1,090.25***	4,000	***409.75***
121	Kepiting Anemon	Anemon Crab-Pink	*Neopenrolisthes maculate*	1,795.13	1,000	***-795.13***	1,500	***-295.13***
122	Kerapu Ekor Bulat	African Hind	*Chepalopholis taeniops*	3,590.13	2,000	***-1,590.25***	2,000	***-1,590.25***
123	Kerap Ekor Gunting	White-edge Lyretail	*Variola albimarginata*	3,590.13	2,500	***-1,090.25***	3,500	***-90.25***
124	Kerapu Merah	Swallowtail Hawkfish	*Cyprinocirrhites polycactis*	1,196.5	1,500	***303.25***	2,000	***803.25***
125	Kerapu MP	Lyretail Grouper	*Variola louti*	1,196.5	1,500	***303.25***	2,000	***803.25***
126	Kerapu Pelet	Arc-eyed Hawkfish	*Paracirrhites arcatus*	1,795.13	1,000	***-795.13***	1,500	***-295.13***
127	Kerapu Singa	Honeycomb Grouper	*Epinephelus merra*	2,393.53	2,000	***-393.5***	2,000	***-303.5***
128	Kerapu Tokek	Redspotted Hawkfish	*Amblycirrhitus pinos*	1,196.5	750	***-446.75***	1,500	***303.25***
129	KKO KK	Blue-sided Fairy Wrasse	*Cirrhilabrus cyaniopleura*	1,196.5	750	***-446.75***	1,500	***303.25***
130	KKO Milenium	Flavirdorsalis Wrasse	*Cirrhilabrus flavidorsalis*	2,393.53	1,500	***-893.50***	3,000	***606.5***

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131	KKO Model	Luboocki Wrasse	*Cirrhilabrus lubbocki*	3,590.13	2,000	***-1,590.25***	3,000	***-590.25***
132	KKO Model Asli	Red Margined Wrasse	*Cirrhilabrus rubrimarginatus*	4,787	2,500	***-2,287***	5,000	***213***
133	KKO Warna	Exquisite Wrasse	*Cirrhilabruse exquisitus*	2,393.53	2,000	***-393.50***	-	-
134	Klonpis	Ord. Clown Anemonfish	*Amphiprion ocellaris*	2,393.53	2,000	***-393.50***	2,000	***-393.5***
135	Koper Hitam	Reticulate Boxfish	*Ostracion solorensis*	2,393.53	2,000	***-393.50***	5,000	***2,606.5***
136	Koper Kuning	Polka Dot Boxfish	*Ostracion cubicus*	2,393.53	2,000	***-393.50***	5,000	***2,606.5***
143	Layaran Hitam	Philippine Pennant Coralfish	*Heniochus singularis*	2,393.53	1,500	***-893.5***	-	-
144	Lek Lek	Two Line Monocle Beam	*Scolopsis bilineata*	2,393.53	1,500	***-902.5***	1,500	***-893.5***
145	Lettersix	Blue Surgeonfish	*Paracanthurus hepatus*	35,902.5	35,000	***1,090.25***	45,000	***9,097.5***
146	Macanan	Oriental Sweetlips	*Plectorhinchus orientalis*	3,590.13	2,500	***-446.75***	-	-
147	Mandarin Biasa	Psychedelic Mandarinfish	*Synchiropus spledidus*	2,393.53	2,000	***-795.13***	3,000	***606.5***
148	Mandarin Sanur	Scooter Bleeny	*Synchiropus ocellatus*	2,393.53	1,500	***-893.5***	2,500	***106.5***
149	Mandarin Sanur Merah	Saddled Triplefin	*Enneapterygius atrogulare*	2,393.53	1,500	***-893.5***	3,000	***606.5***
150	Mandarin Terbang	Dragon Scooter Bleeny	*Dactylopus dactylopus*	11,967.5	5,000	***-6,976.5***	4,000	***-7,967.5***
151	Manukan	Blue Line Demoiselle	*Chrysiptera caeruleolineata*	1,196.5	750	***-446.75***	1,000	***-196.75***
152	Manukan Kuning	Red Honey Damsel	*Neoglyphidodon crossi*	1,795.13	1,000	***-795.13***	1,500	***-295.13***
153	Miles	Spotfin Lionfish	*Pterois antennata*	2,393.53	1,500	***-893.5***	2,500	***106.5***
154	Moris Idol	Moorish Idol	*Zanclus cornutus*	2,393.53	1,500	***-895.5***	2,500	***106.5***
155	Naso Asli	Naso Surgeonfish	*Naso lituratus*	7,180,5	6,000	***1,180.5***	-	-
156	Negroit Hitam	Black Saddleback Anemonfish	*Amphiprion polymnus*	2,393.53	1,250	***-1,143.5***	3,000	***606.5***
157	Nokfish	Twospot Dwarf Hogfish	*Bodianus bimaculatus*	7,180.5	4,000	***-3,180.5***	-	-
158	Nona Manis	Peach Fairy Basslet	*Pesudanthias dispar*	1,196.5	750	***-446.75***	1,500	***303.25***
159	Omang Omang Kaki Biru	Blueleg Crabs	*Calcinus elegans*	1,795.13	2,000	***204.88***	1,750	***-45.3***
160	Optis Titik Emas	Eclipse Hogfish	*Bodianus mesothorax*	3,590.13	2,000	***-1,590.25***	2,500	***-1,090.25***
161	Pala Aji	Bicolor Parrotfish	*Cetoscarus bicolor*	5,983.75	5,000	***-983.75***	10,000	***4,016.25***
162	Panter Merah	Golden Dottyback	*Pseudochromis aureus*	2,393.53	1,500	***-893.5***	3,000	***606.5***
163	Panter Merah Besar	Giant Dottyback	*Labracinus cyclophthalmus*	2,393.53	2,000	***-393.5***	-	-
164	Panter Model Hitam	Red-Spot Pervicfin Dottyback	*Pseudochromis polynemus*	2,393.53	2,000	***-393.5***	-	-
165	Pari	Blue Spotted Stingray	*Taeniura lymma*	5,983.75	5,000	***-983.5***	-	-
166	Pelet Merah	Orange Skunk Anemonfish	*Amphiprion sandaracinos*	2,393.53	1,500	***-893.5***	-	-

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167	Pensil Biasa	Longface Wrasse	*Hologymnosus doliatus*	1,196.5	1,000	***-196.75***	-	-
168	Pensil Merah	Mediterranean Rainbow Wrasse	*Coris julis*	2,393.53	2,000	***-393.53***	-	-
169	Pinguin Hijau	Green Birdmouth Wrasse	*Gomphosus caeruleus*	7,180.5	6,000	***-1,180.5***	12,500	***5,319.5***
170	Plantini Zebra	Blacksaddle Filefish	*Paraluteres prionurus*	1,196.5	750	***-446.75***	-	-
171	Platak Jenggot	Round Faced Batfish	*Platax teira*	1,196.5	1,500	***302.25***	4,000	***2,803.25***
177	Rambo Kuning	Yellowlined Anthias	*Pseudanthias luzonensi*	3,590.25	2,000	***-1,590.25***	2,000	***-1,590.25***
178	Rambo Oranye	Red-bar Anthias	*Pesudanthias cooperi*	3,590.25	2,500	***-1,090.25***	4,000	***409.75***
179	Rambo Special	Threadfin Anthias	*Nemanthias carberryi*	4,787	5,000	***213***	2,000	***-2,787***
180	Rambo Biasa	Bicolor Anthias	*Pesudanthias fasciatus*	1,196.5	750	***-446.75***	2,000	***803.25***
181	Rambo Ijo	Red-cheeked Anthias	*Pesudanthias huchtii*	1,196.5	500	***-696.75***	1,500	***303.25***
182	Rambo Merah	Stocky Anthias	*Pesudanthias hypselosoma*	1,196.5	750	***-446.75***	2,000	***803.25***
183	Roket Anten	Firefish	*Nematleotris magnifica*	7,180.5	5,000	***-2,180.5***	10,000	***2,819.5***
184	Roket Asli	Blacktail Goby	*Ptereleotris hereroptera*	2,393.53	1,500	***-893.5***	2,000	***-393.5***
185	Roket Biasa	Spottail Gudgeon	*Ptereleotris evides*	2,393.53	1,250	***-1,143.5***	1,500	***-893.5***
186	Roket Hijau	Blue Gudgeon	*Ptereleotris mircrolepis*	1,795.13	1,000	***-795.13***	-	-
187	Roket Pasir	Chamaeleon Sand Tilefish	*Hoplolatilus chlupatyi*	2,393.53	1,250	***-1,143.5***	1,000	***1,393.5***
188	Sadar	Vermiculated Spinefoot	*Siganus vermiculatus*	1,795.13	1,000	***-795.12***	2,000	***204.88***
189	Sadar Cicit	Foxface Rabbitfish	*Siganus vulpinus*	3,590.25	2,500	***-1,090.25***	6,000	***2,409.75***
190	Samadar Kuning	Coral Rabbitfish	*Siganus coralinus*	1,795.13	1,000	***-795.13***	2,500	***704.88***
191	Sampiran	Bicolor Fangblenny	*Plagiotremus landandus*	1,795.13	1,000	***-795.13***	2,000	***204.88***
192	Sampiran Putih	Siamese Blenny	*Meiacnathus smithii*	1,795.13	1,000	***-795.13***	-	-
193	Sapi-sapi	Long Horned Cowfish	*Lactoria cornuta*	7,180.5	3,000	***-4,180.5***	7,000	***-180.5***
194	Sersan Mayor	Banded Sergeant	*Abudefduf septembfasciatus*	718.5	500	***-218.5***	1,000	***281.95***
195	Sonang Biasa	Honeycomb Filefish	*Cantherhines pardalis*	1,196.5	1,000	***-196.5***	1,500	***303.25***
196	Sonang Ekor Merah	Redtail Filefish	*Pervagor melanocephalus*	2,393.53	1,500	***-893.5***	2,500	***106.5***
197	Sonang Merah	Blackbar Filefish	*Pervagor janthiinosoma*	1,795.13	2,000	***204.88***	2,500	***704.88***
198	Sonang Rambut	Radial Leatherjacket	*Acreichthys radiates*	1,196.5	2,000	***803,25***	5,000	***3,803.25***
199	Talasoma Ijo	Lyretail Crescent Wrasse	*Thalassoma lunare*	1,196.5	750	***-446,75***	-	-
200	Teluk Canus	Emperor Snapper	*Lutjanus seabe*	11,967.5	10,000	***-1,967.5***	-	-
201	Timunan	Blackstripe Coris	*Coris pictoides*	1,196.5	750	***446.75***	1,000	***-196.5***
202	Timunan Coklat	Assorted Wrasse	*Stethojulis trillineata*	1,196.5	1,000	***196.5***	1,500	***303.25***

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203	Titik Mas Asli	Diana's Hogfish	*Bodianus Diana*	2,393.53	2,000	***-393.5***	2,500	***106.5***
204	Tompel	Red Clown Anemonfish	*Amphiprion frenatus*	3,590.25	1,500	***-2,090.25***	2,500	***-1,090.25***
205	Totol Asli	Yellow Tail Tamarin Wrasse	*Anampses meleagrides*	7,180.5	6,000	***-1,180.5***	7,500	***319.5***
206	Triger BAbi	White-spotted Tamarin Wrasse	*Anampses melanurus*	1,795.13	1,000	***-795.13***	2,000	***204.88***
207	Triger Batu	Titan Triggerfish	*Balistoides viridescens*	1,795.13	1,000	***-795.13***	1,000	***-795.13***
208	Triger biru	Redtooth Triggerfish	*Odnonus niger*	2,393.5	2,000	***-393.5***	2,500	***106.5***
209	Triger Kaca	Pinktail Triggerfish	*Melichythys vidua*	3,590.25	2,500	***-1,090.5***	5,000	***1,409.75***
217	Udang MP Ungu	Shrimp Banded	*Stenopus hispodus*	1,196.5	2,000	***803.25***	2,000	***803.25***
218	Udang Pancasila	Harlequin Mantis	*Odotodactylus scyllarus*	2,393.53	2,000	***-393.5***	1,500	***-893.5***
219	Udang Pelet	White-banded Cleaner Shrimp	*Lysmata amboinensis*	7,180.5	6,000	***-1,180.5***	7,000	***-180.5***
220	Udang Wayang	Camel Shrimp	*Rhynchocinetes durbanensis*	1,196.5	750	***-446.75***	1,000	***-196.75***
221	Ular Zebra	Zebra Moray	*Gymnomuraena zebra*	7,180.5	6,000	***-1,180.5***	10,000	***2,819.5***
222	Valentina Biasa	False Eye Toby	*Canthigaster solandri*	1,675.45	250	***-1,425.45***	2,000	***324.55***
223	Valentina Zebra B	Valentini Mimic	*Paraluterus prionurus*	1,196.5	750	***-446.75***	2,500	***1,303.25***
224	Volitan	Lionfish	*Pterois volitans*	11,967.5	7,500	***-4,467.5***	13,000	***1,032.5***
Total				**933,105.98**	**703,950**	**-229,155.98**	**952,450**	***85,763.65***

Appendix B: Questionnaire

Questionnaire

I. Social Data

Date : ____

Background

Name : ____

Residence : ____

Residence Status □ Permanent resident

□ Temporary resident

Marital Status : ____________________________________

If yes, number of children

o 1

o 2

o 3

o 4

o More than ______________________

Education

o SD (Elementary)

o SMP (Junior High School)

o SMA (Senior High School)

o University Degree

How long have you been an ornamental fisherman? ____________________________

Member of fishermen group

□ No

□ Yes, If yes, the name of the group: ______________________________________

Occupation

□ Part time fisherman and other occupations: ____

□ Full time fisherman

II. Data of fishermen type and method of fishing

Type of Fisher

○ Non-compressor Fisher

○ Compressor Fisher

Transportation

□ walking to beach and swimming directly from the beach in front of the village

□ walking to the beach beach and using boat to the fishing location

□ using public transportation to the beach then swimming

□ using public transportation to the beach then using boat to the fishing location

□ using private transportation to the beach and continue swimming to the fishing location

□ using private transportation to beach and then using boat to the fishing location

Method of Ornamental Fishing

◊ Fishing with compressor machine

□ Compressor machine

□ Air hose

□ Goggle and fins

□ Barrier net

□ Scope net

□ Decompression bucket

◊ Fishing without using compressor machine

□ Goggle, fins and snorkel

□ Barrier net

□ Scope net

□ Inner tube

□ Basket

□ Decompression Bucket

III. Social-Economy Data

The Daily Current Income (IDR)

Higher weekly range : ____

Lower weekly range : ____

The Daily Income during the cyanide (IDR)

Higher weekly range : ____

Lower weekly range : ____

Fishing Cost (IDR)

Non-compressor Fisher

□ Equipment : ___________________________ (daily, monthly or yearly)

□ Public Transportation : ___________________________ (daily, monthly or yearly)

□ Gasoline : ___________________________ (daily, monthly or yearly)

□ Others : ___________________________ (daily, monthly or yearly)

___________________________ (daily, monthly or yearly)

Compressor Fisher

□ Equipment : ___________________________ (daily, monthly or yearly)

□ Public Transportation : ___________________________ (daily, monthly or yearly)

□ Gasoline : ___________________________ (daily, monthly or yearly)

□ Others : ___________________________ (daily, monthly or yearly)

: ___________________________ (daily, monthly or yearly)

How many day or month in a year, is a good time for fishing? ____________________________________

Whichever months is the weather not allowing for fishing? ______________________________________

When the weather is not allowing for fishing or there is no order from the middlemen/exporter, do you have additional jobs to do? ____

If yes, what type of jobs? ____

How much do you earn from the side jobs?

□ Daily : ____

□ Monthly : ____

□ Yearly : ____

When do you need money for emergency, who do you contact to get to borrow the money? ___________

_______________________________________ and why? ____

____

How do you pay your loan?

□ Installment

□ Taken from the fish payment

□ Others: ____

IV. Type of Selling

□ Directly to the middlemen

Name of the middlemen ____

□ Directly to the exporter

Name of the exporter ____

When you sell your fish, how is the payment going?

□ Directly after transaction

□ Not after the transaction, have to wait until the fish is transported to other places.

How many middlemen/exporter that become your buyer? ______________________________________

How long you have been selling your fish to this middlemen/exporter? ___________________________

Appendix C: Map of Indonesia (Source: Lonely Planet)

[1]

[1] Map is retrieved from http://www.lonelyplanet.com/maps/asia/indonesia/. Reproduced with permission of Lonely Planet. © Lonely Planet, 2013.

Appendix D: Map of Bali (Source: Lonely Planet)

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[2] Map is retrieved from http://www.lonelyplanet.com/maps/asia/indonesia/bali/. Reproduced with permission of Lonely Planet. © Lonely Planet, 2013.

Appendix E: Photographs

Figure 1: Net-fish caught with barrier net (courtesy of LINI, Indonesia)

Figure 2: After the fish get trap inside the barrier net, the fisher will collect the life fish with scoop net (courtesy of LINI, Indonesia)

Figure 3: Coral Reef Bleaching (Courtesy of LINI, Indonesia)

Figure 4: The non-compressor fishing equipment

Figure 5: The fish is separated according to the species and order at the temporary holding-tank owned by the middleman

Figure 6: One of the temporary holding-tanks owned by a middleman

Figure 7: A temporary holding-tanks that belongs to an exporter

Figure 8: The ornamental fish have been packed into plastic container and ready to be transported to the exporters in Denpasar, Bali

Figure 9: Pig husbandry is one of the major side jobs

Figure 10: Artificial Coral Reef

Figure 11: Artificial Coral Reef