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# The Relationship Between the Establishment of Marine Protected Areas and Biomass Productivity of Municipal Fisheries in the Philippines

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ABSTRACT: The Coral Triangle is a global hotspot of marine biodiversity, and is of utmost economic and ecological importance to the Southeast Asia and Far Southwestern Pacific regions. In 2007, the Coral Triangle Initiative was proposed and created by what is now called the CT6 countries – the Philippines, Indonesia, Malaysia, Papua New Guinea, Timor Leste, and Papua New Guinea – in order to foster an international, multisectoral framework for the collaborative management of the Coral Triangle's resources and preservation of value for the region's socioeconomic and ecological well-being. This thesis aims to investigate one of the claims of the Coral Triangle, which is how the establishment of local marine protected areas (MPAs) by municipal governments is related to the biomass productivity of fisheries in the Philippines.

## 1. Introduction

With an area of 2.3 million square miles (5.7 million square kilometers), the Coral Triangle is roughly half the size of the United States of America. Its total coverage includes the territorial waters of the six countries that have come to be known as the CT6 (Coral Triangle 6): the Philippines, Indonesia, Malaysia, Timor Leste, Papua New Guinea, and the Solomon Islands. The Coral Triangle is a global hotspot of marine biodiversity, and is of utmost economic and ecological importance to the Southeast Asia and Far Southwestern Pacific region. It is the location of the highest coral diversity in the world. Seventy-five percent of known coral species and 40% of the world's coral reef fish species can be found here. The Coral Triangle also plays an important role providing migration corridors and spawning/nursery grounds for tuna, supporting a multi-billion dollar global tuna industry. The region is of vital economic significance because the Coral Triangle's reefs, mangroves, and other natural habitats have an estimated value of more than US$2.3 billion[1]. Its nature-based tourism industry alone generates US$12 million annually[2]. The Coral Triangle is also important for the densely populated areas that live within it, many of whom depend directly and indirectly on the bounty of the sea. Over 150 million people live within the delineation of the Coral Triangle, and of these, 2.25 million are fishers who are directly dependent on its resources for their livelihood and sustenance[3]. The CT6 countries have recently recognized the area's richness of resource and revenue-generation potential, and have started up the Coral Triangle Initiative (CTI) in order to better manage its

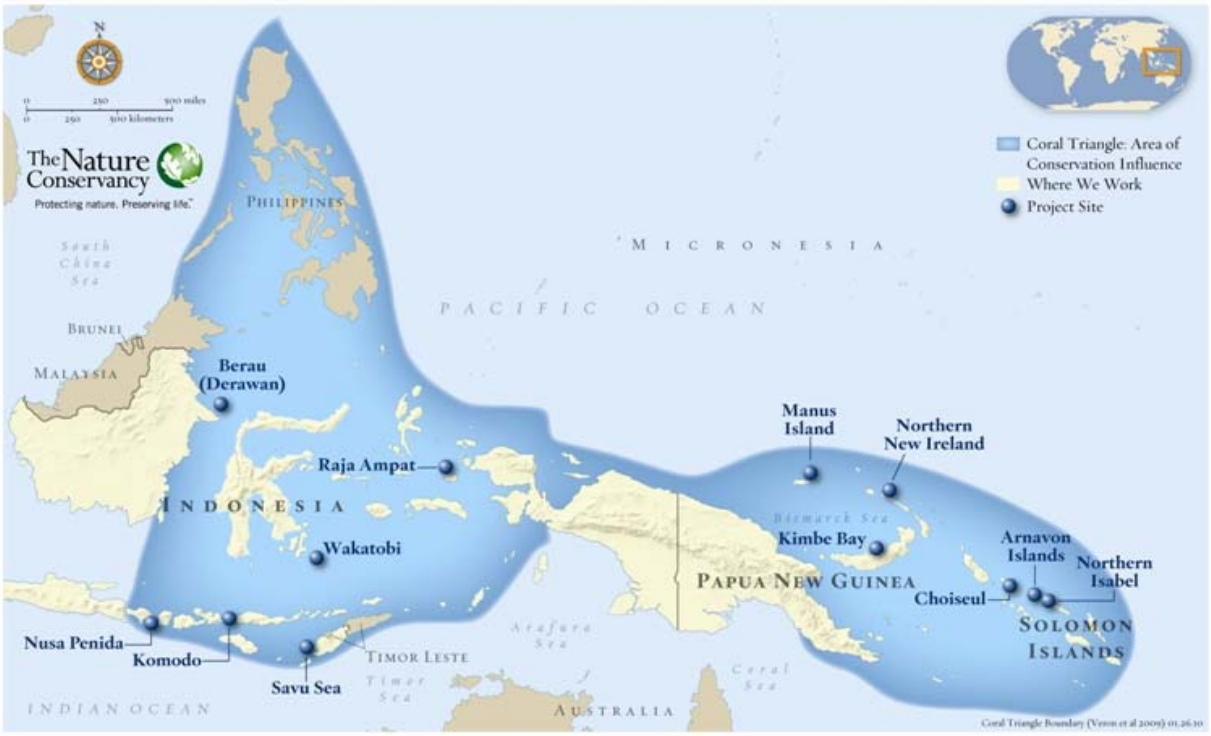
1 "The Nursery of the Seas." WWF. http://www.worldwildlife.org/what/wherewework/coraltriangle/

2 "Why is the Coral Triangle...?" WWF. http://www.panda.org/what_we_do/where_we_work/coraltriangle/coraltrianglefacts/

3 The Nature Conservancy: Coral Triangle Center. www.coraltrianglecenter.org

bounty for long-term sustainable use.

**Figure 1.1: Delineation of the Coral Triangle**




Source: The Nature Conservancy

The Coral Triangle's bounty is attractive to many sectors of society, and without its proper management and maintenance, it is vulnerable to exploitation and destruction. This has come to pass in many forms, including but not limited to pollution, overfishing, overcapacity, destructive fishing practices, and poaching. The Coral Triangle Initiative (CTI) was conceived in 2007, officialized during the first formal CTI Senior Officials Meeting (SOM) in Bali of 2007 of that same year in order to foster an international, multisectoral framework for the collaborative management of the Coral Triangle's resources and preservation of value for the region's socioeconomic and ecological well-being. It aims to do this through a program of coastal resource management training, capacity building, the establishment of marine protected areas (MPAs), the fostering of community participation, the proliferation of information-sharing and

education, and the enhancement of legal enforcement on multiple levels of government.

One of the more recent ventures of information-sharing was a regional exchange for the CT6 countries during which a delegation from each of these countries gathered to participate in educational activities, contribute to open discussion, and watch presentations about coastal resource management from representatives of the host government as well various institutes and organizations of CTI-relevant issues and topics. The first CTI Regional Exchange was held in Cebu, Philippines from June 27 to July 3, 2009, and it was entitled "Enhancing Local Government and Stakeholder Capacity for Ecosystem-based Fisheries Management4". The CT6 delegations learned about the concepts, models, lessons, and approaches to ecosystem-based fisheries management from presentations prepared by such organizations and institutions as Fisheries Improved for Sustainable Harvest (FISH), the United States CTI Support Program, World Wide Fund for Nature-Philippines, Conservation International, Philippine governmental bodies such as the Department of Environment and Natural Resources (DENR) and the Department of Agriculture (DoA), the Philippine Environmental Governance Project (EcoGov), local Philippine mayors, and many more. The delegates also had the opportunity to share their experiences in their respective countries with regard to coastal resource management, laying on the table for feedback and critique their attempts to vitalize their fisheries, environmental problems, and the poverty of fishing-dependent communities. Furthermore, the CT6 delegates participated in field activities carried out on a barangay-level by trained members of the village community in order to see how training and capacity building have been beneficial in terms of putting coastal resource ownership and stewardship into the hands of the fishing communities

4 This first CTI Regional Exchange was hosted by the Philippine CTI National Coordinating Committee, arranged through a partnership with the US CTI Support Program, United States Agency for International Development (USAID), and FISH.

who most relied on them for their day-to-day survival[5].

To further enhance this experience, the CTI Regional Exchange was held in conjunction with the Philippines' 2nd Conference of Coastal Municipalities (2-CCM), which took place from June 28-30, also in Cebu. The 2-CCM is an event during which the mayors of the Philippines' coastal municipalities gather to network, plan, discuss, and recognize various municipalities' efforts and achievements in coastal resource management. The CT6 delegations were given the opportunity to attend -CCM events learn about what the Philippines has been doing in terms of facing the challenges of managing coastal municipalities and the progress they have achieved.

This thesis aims to investigate one of the claims this first USCTI Regional Exchange, which is how the establishment of local MPAs by municipal governments is related to the biomass productivity of fisheries in the Philippines. The Coral Triangle Initiative is taking a holistic approach to coastal resource management that encompasses environmental health, economic productivity, and poverty alleviation. This is one way to illuminate the complex relationships between them. The crux of the question can be boiled down to, "What is the relationship between localized marine environmental protection in the Philippines and the local fisheries' success, especially with regard to the locality's socioeconomic well-being?" Since this first CTI Regional Exchange is touting the Philippines as an example, the question will be investigated in context of the Philippines, examining the situation further and analyzing how well it holds up as an example.

There is potential for such an analysis to help improve and provide informational support for future policy and programmatic endeavors that aim to manage the Philippine marine ecosystem that would yield multisectoral benefits, not just for the Coral Triangle Initiative and

5 A 'barangay' is the smallest administrative division in the Philippines, equivalent to a village or a district.

its constituents and collaborators, but for global marine biodiversity, international development, and the self-sufficiency of coastal resource-dependent countries.

## 2. Literature Review

Coral Triangle Initiative aims to tackle the coastal marine resource degradation issue in a holistic fashion, taking into account not just environmental concerns but economic and social ones as well. In the CTI's own words from the official CTI secretariat website, the Coral Triangle Initiative is

> centered around high-level political commitments and proactive implementation by governments of the Coral Triangle area, and supported and carried forward by private sector, international agency and civil society (NGO) partners, could provide a major contribution toward safeguarding the region's marine and coastal biological resources for the sustainable growth and prosperity of current and future generations.[6]

In the Philippines and other developing countries over the years, the debates have been loud and fervent with one side arguing for the environmental conservation/preservation and another side arguing that these environmental concerns are interfering with people's rights to make a living, especially since the people most negatively affected by restrictions on environmental resources tend to be those who are living in poverty. This is not to say that the debate is nearly so dichotomous; that would be an oversimplification. Environment-centric and people-centric development are inextricably entwined, and the most successful development endeavors tend to be interdisciplinary and encompassing by nature. The aims of the Coral Triangle Initiative is to try and make it is possible to account for both these sides, of many sides, and indeed to impress upon the actors and stakeholders that it is absolutely vital to accommodate

6 "Coral Triangle Initiative on..." CTI Secretariat.

both these arguments.

Although the area encompassed by the Coral Triangle has always been diverse, the delineation of it is new. The Coral Triangle Initiative was an idea put forth by Indonesian president Susilo Bambang Yudhoyono in August 2007 to seven other leaders in the region, proposing this initiative that would manage, safeguard, and preserve the sustainability and diversity of the coral reefs and fisheries, which would then help to ensure their countries' economies and food security. The response to the idea was positive, and further organization and endorsement led to the leaders formally presenting the framework for the Coral Triangle Initiative during the APEC Leaders Declaration on Climate Change, Energy Security and Clean Development in September of 2007. Two months later, the Brunei-Indonesia-Malaysia-Philippines East ASEAN Growth Area (BIMP-EAGA) and ASEAN also officially supported the Initiative. The six governments then met in a pivotal first formal CTI Senior Officials Meeting (SOM) in Bali in December 2007, where they agreed on:

1) A common understanding of the value of the CT's marine and coastal biological resources;
2) A provisional set of nine Guiding Principles;
3) A framework for a "CTI Plan of Action" to be developed during 2008 and adopted at the highest political level.[7]

Even beyond the Coral Triangle, the oceans are an important source of ecological and socioeconomic benefits. The preservation and management of marine ecosystems is important not just for archipelagic or peninsular countries that are heavily dependent on such resources. The ecosystems of the world provide goods and services that are valued at at least US$33 trillion annually, and 63% of this – or US$21 trillion – is garnered from the world's oceans[8]. Oceans are

7 "Coral Triangle Initiative on..." CTI Secretariat.

8 Tighe, Stacey. "Session 3: Why manage coastal and marine resources?" CTI Regional Exchange 2009 participant binder. Philippines Coral Triangle Initiative.

also a vital safeguard against food insecurity. Close to 1 billion people depend on fisheries as their primary source of animal protein, and over 50 million families are directly or indirectly dependent on marine capture or inland fishing for their livelihood/employment[9].

**Figure 2.1: Global Biodiversity Hotspots**


*Source: Conservation International*

The Coral Triangle encompasses three previously designated biodiversity hotspots: Wallacea, and the Philippines (see Figure 2.1). Over 1.1 billion people (approximately 20% of the world's population) live in biodiversity hotspots, and population growth in such hotspots is nearly 40% greater than in non-biodiversity hotspots, due to both high fertility and migration[10]. Such population growth often leads to an increased stress on the environment due to the increased growth rate. The traditional Malthusian argument has long been deconstructed: an increase in population does not necessarily have to lead to a tragic depletion of resources.

9 Tighe, "Session 3."

10 Cincotta, Richard P., Jennifer Wisnewski, and Robert Engelman. *Nature* 404 (1999): 990-92. Web. 5 Nov. 2009. <http://www.nature.com/nature/journal/v404/n6781/full/404990a0.html>.

However, in order to make this so, consumption, harvesting, and processing have to be regulated to ensure long-term sustainability. Lackadaisical management of resources and an open-access fishing policy in the Philippines have led to – and are still leading to – overtaxed habitats, environmental degradation, resource depletion, and the worsening of poverty.

Ecologically, such mindful stewardship is especially important in the the Philippines because the country is considered to be one of the top-twenty five most biodiverse countries in the world, according to Biodiversity Hotspots. Scientists describe the country as "the center of marine shorefish diversity with the 'richest concentration of marine life on the entire planet'."[11] Four-hundred eighty-eight out of 500 coral species worldwide can be found in the Philippines, as well as approximately 2400 species of fish[12]. Tellingly, it is also a country with high rates of endemism, but also has among the highest rates of endangered species in the world[13]. This points to the Philippines ecosystem being especially fragile, and vulnerable in the face of a lack of protection and mismanagement of the environment and its resources. The question then is how to preserve this biodiversity, this wide range of flora and fauna, while also taking into account the economy's need to harvest and process these resources, as well as the fisherfolk's right to make a living.

**Figure 2.2: Diversity and Endemism in the Philippines**

11 Carpenter, K.E. and V.G. Springer. 2005. Environmental Biology of Fishes (2005) 72: 467-480.

12 "Philippine Facts | About the Philippines." *Information on the Philippines*. Web. 21 Mar. 2010. <http://www.philippinedomain.com/philippine-facts.htm>.

13 "Biodiversity Hotspots - Philippines." *Biodiversity Hotspots - Home*. Web. 16 Feb. 2010. <http://www.biodiversityhotspots.org/xp/hotspots/philippines/Pages/default.aspx>.

DIVERSITY AND ENDEMISM

| Taxonomic Group | Species | Endemic Species | Percent Endemism |
|---|---|---|---|
| Plants | 9,253 | 6,091 | 65.8 |
| Mammals | 167 | 102 | 61.1 |
| Birds | 535 | 186 | 34.8 |
| Reptiles | 237 | 160 | 67.5 |
| Amphibians | 89 | 76 | 85.4 |
| Freshwater Fishes | 281 | 67 | 23.8 |

*Source: Conservation International – Biodiversity Hotspots*

The Philippines, like many archipelagos, is a fishing-dependent country. In the Philippines, the value of fisheries exports alone amounts to approximately US$525 million[14]. The value of *all* fish and marine resources contribute approximately US$1.35 billion to the economy[15]. Ironically, among fisherfolk households, 80% live below the poverty threshold. Poverty incidence in fishing households is higher at 61.9% than those in non-fishing households at 33.7%[16]. This is a discrepancy that the Coral Triangle Initiative hopes to mitigate. In the Philippines, as in many island countries, the sea becomes a *de facto* 'employer of last resort'. If someone in a rural fishing village cannot find a job, cannot support themselves, then they can always turn to the sea. However, this is becoming less and less the case because there are less fish to catch because too many fishers are catching them, whether commercial, subsistence, or otherwise. The benefits of coastal marine resources have not thus far been equitably distributed.

14 ***FAO Fisheries & Aquaculture Department***

15 World Bank 2005?

16 Israel, D.C.2004. Economics and environment in the fisheries sector. pp. 131–137. In:DA-BFAR, 2004, q.v

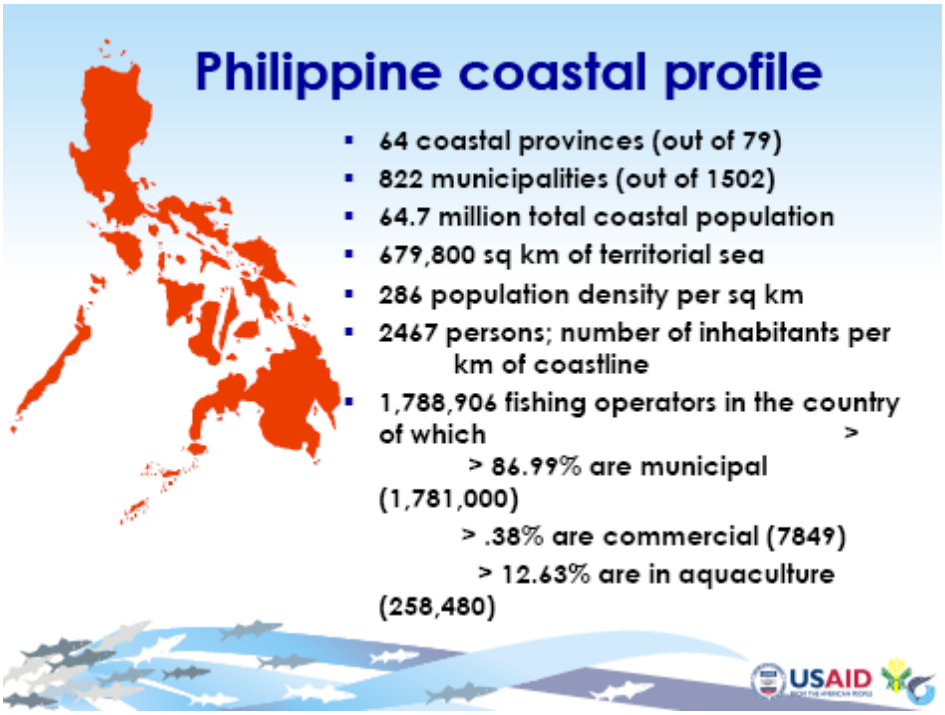



**Figure 2.3: Philippine Coastal Profile**

*Source: Tighe, "Session 3." CTI Regional Exchange 2009*

The Philippine fisheries are one of the focus sites wherein the economic and environmental concerns intersect. Fisheries are culturally, economically, and ecologically important to the Philippines and other Coral Triangle countries. They contribute significantly to income, employment, foreign exchange earnings, nutrition, and thus to the overall stability of the country. In the Philippines, the sea is a significant food basket that guards against food insecurity, helping to maintain the food supply of the whole country and provides livelihood to almost 2 million fishers and their families[17]. However, despite the fact that the Philippines is a holder of the megabiodiversity designation and is one of the world's largest fish-producing nations, it is also among the ten low-income, food-deficit countries of the world. Fish capita

17 Tighe, "Session 3." CTI Regional Exchange.

consumption of fish dropped from 40 kg in 1987 to 24 kg in 1996[18].

The threats to fisheries happening in the Philippines is reflective of the worldwide trends. According to the FAO, the global outlook of fisheries and their resources remain precarious[19]. The overexploitation and overfishing of the fisheries is directly related to overcapacity and population growth, exacerbated by destructive fishing methods. The economic loss due to overfishing is estimated to be at about P6.5 billion annually[20]. Relatedly, the annual fish harvest no longer keeping pace with population growth (FISH 2007). There has been an increase in demand for fish, which leads to overfishing. Fish will continue to become more expensive to consumers, with serious repercussions to protein-deficit countries. Resultantly, fish are being harvested at a level 30% to 50% higher than natural production capacity (WB 2005). The world population of the current 6 billion will continue to grow by over 60 million people per year, with nearly half this growth in areas within 100 kilometers of a coastline[21]. In this way, fish decline will surely affect food security. As previously mentioned, the increasing population is becoming a strain on the fisheries. This overfishing also tends to target certain fish species, as certain species of fish are higher valued than others at market. Overfishing is exacerbated by overcapacity, especially when coupled with illegal and destructive fishing practices. In the municipal waters of the Philippines, only passive fishing gear is allowed, but illegal fishers tend

18 Kurien 2002; Bernascek 1996.

19 Tighe, "Session 3." CTI Exchange 2009.

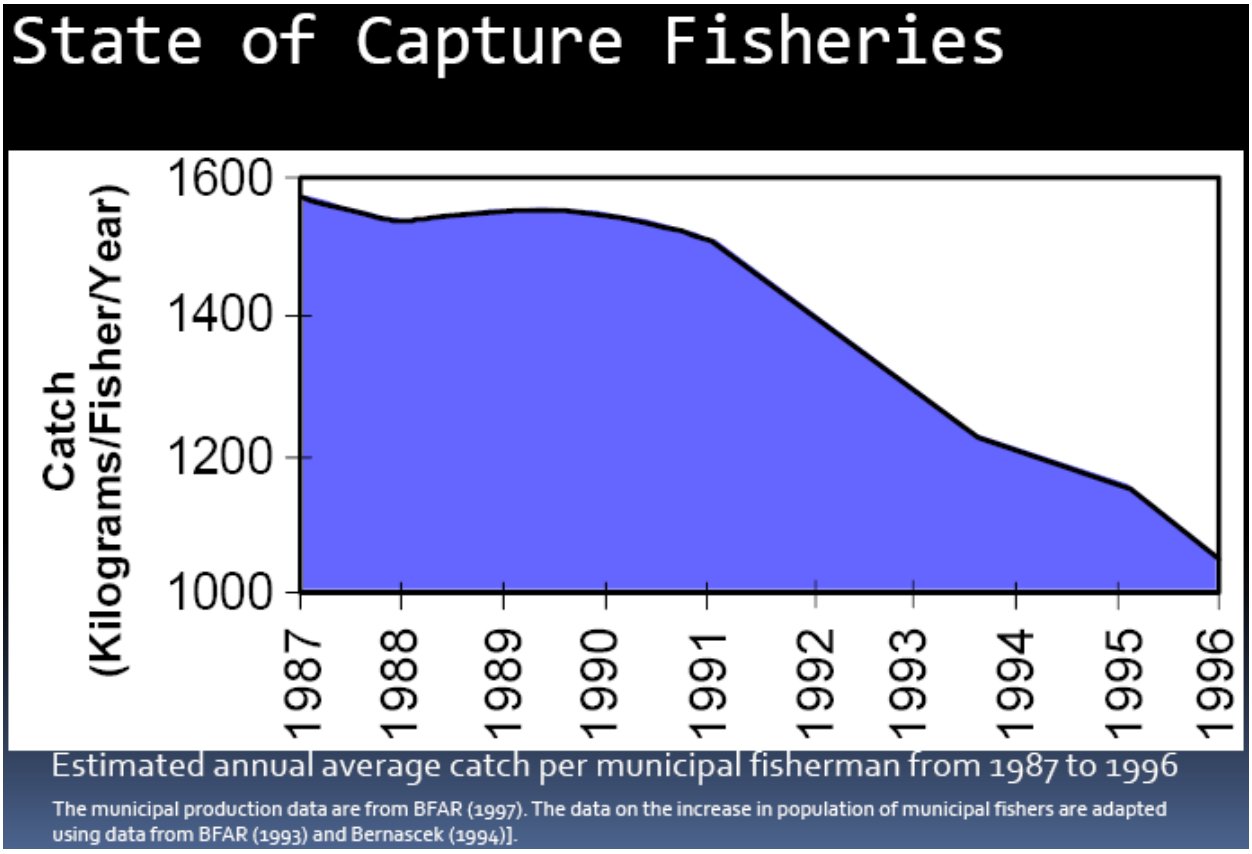
20 "UnderwaterTimes | Scientists: The Philippines Is the World's 'Center of Marine Biodiversity'; Announce Alarm over Marine Threats." *UnderwaterTimes.com | News of the Underwater World*. Web. 5 Feb. 2010. <http://www.underwatertimes.com/news.php?article_id=64017239105>.

21 Tighe, "Session 3." CTI Exchange 2009.

to use active fishing gear. However, these methods exacerbate a self-perpetuating cycle in which there are too many fishers and not enough fish. This in turn leads to increasingly desperate fishing practices e.g. cyanide fishing, fine-meshed nets, dynamite blast fishing (S6), poaching, cob-cob, likom, muro-ami (banging corals to scare the fish out), spear-fishing using compressors, and many others (S14). Increasingly active and destructive fishing methods yield a higher fish catch, but they are incredibly damaging to the environment as well as dangerous to the fishers themselves. For example, cyanide fishing can lead to poisoning and paralysis, and dynamite fishing can lead to dismemberment.

**Figure 2.4: State of Capture Fisheries in the Philippines**

*Source: Nygiel B. Armada, "Session 6: Fisheries resource management: principles, concepts, and application." CTI Regional Exchange 2009.*




To mitigate and repair the effects of such threats to the environment, the Philippines

decided to better organize fisheries management. As defined by the UN Food and Agriculture Organization (FAO),

> fisheries management involves a complex and wide ranging set of tasks, which collectively have the end goal of ensuring the continued productivity of the resources and their sustained optimal benefits to society. Fisheries management entails the conduct of responsible and sustainable strategies and activities within the context of environmental, social, economic and conservation considerations (Cochrane & Pitcher 2002)[22].

Between the years of 1998 and 2001, the Philippine government underwent the process of gaining legislative support via a series of planning workshops, which led to the adoption and approval of a Five Year Coastal Resource Management (CRM) Plan. Coastal waters provide only 12% of Philipine waters, but they are most productive. They are critical life-support systems for aquatic living resources. Before the CRM program was in place, there was massive destruction of coral reefs and its marine ecosystem through unregulated anchoring, poaching, and unregulated disposal of all types of waste, causing serious pollution in the coastal and marine environment.

The focus here is on municipal waters for a number of reasons. For one, the local governments and communities are the official keepers and caretakers of these vibrant, rich ecosystems, as well as instrumental in poverty programs. Coastal ecosystems such as mangrove swamps, coral reefs and seagrass beds contribute more than half of the ocean's values, and are the ones most accessible to the populations that depend on them. Decentralization in the Philippines means that local governments, with help from the community, manage and maintain their own municipal waters. This is in accordance with Local Government Code, 1991 (Republic

22 Pitcher, T. and Cochrane, K. 2002. The Use of Ecosystem Models to Investigate Multispecies Management Strategies for Capture Fisheries.

<http://www2.fisheries.com/archive/publications/reports/report10_2.php>

Act 7160), which mandated it, and the Fisheries Code of 1998 (Republic Act 8550), which reaffirmed the local government code, and assigned the frontline enforcement of the first 15 kilometers of municipal waters to over 900 coastal municipalities. (After the 15$^{th}$kilometer, the waters are under the jurisdiction of the Bureau of Fisheries and are relegated to EZZ.) The Philippine Constitution and Fisheries Code provide for the preferential use of municipal waters by municipal fishers. However, marine fisheries have reached a ceiling and the high prices and increasing demand have made the Philippines' open access to fishery resources increasingly non-viable. Open access fishing has led to overfishing, overcapacity, resource depletion, environmental degradation, and economic inefficiencies.

From 2001 to 2005, the new administration then reviewed and streamlined the Five Year CRM Plan before submitting it to the Sangguniang Bayan, which is the legislature of Philippine municipal governments, in order for it to be enacted as a municipal ordinance consistent with the Local Government Code (RA 7160) and the Fisheries Code of the Philippines (RA 8550). Of course, top-down legislation of this kind has to be supported by bottoms-up community participation. This movement came in the form of the fisherfolk organizing into an association called Bantay Dagat (Tagalog for 'Sea Patrol'), which serves as marine deputies. The Bantay Dagat is a fisheries patrol force made of civilian volunteers that aim to keep a 24-hour watch over Philippine coastal waters up 15 kilometers from shore.

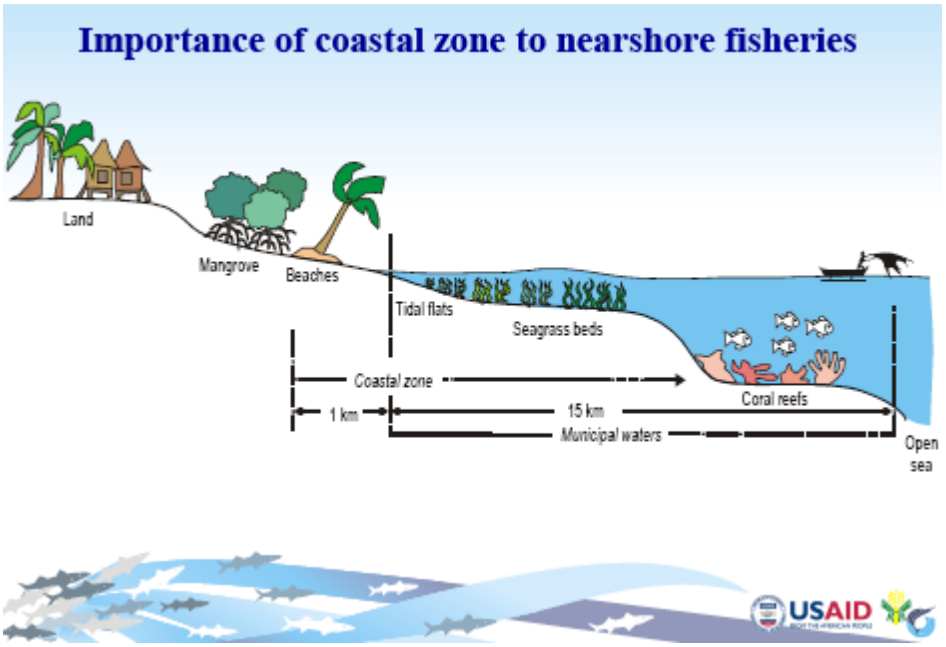



**Figure 2.5: Importance of coastal zone to nearshore fisheries**

*Source: Tighe, "Session 3." CTI Regional Exchange*

Establishing MPAs is an important part of the Philippine CRM plan. The previous paragraph mentions the participation of civil society, and that is why MPAs are important. MPAs are entry points for community participation in fisheries management. They facilitate the community's learning and appreciation of the principles of fisheries management. Within an MPA, there would be restrictions on gear, minimum mesh sizes, closed seasons, registration, and mandatory license to do certain things within the delineation of the MPA. The MPA would be co-managed and enforced by the local government unit and the community. The establishment of MPAs therefore would ideally protect against unauthorized fishing, and also help to grow the most productive parts of Philippine marine ecosystem, and help towards the mitigation of poverty. The criteria for selecting an area to be designated an MPA are as such:

1) ecological importance - contributes to maintenance of essential ecological processes or life support systems
2) social importance - local, national, or international heritage, historic, cultural, aesthetic, educational, recreational

3) economic importance - existing or potential contribution to economic value by virtue of protection of recreation, subsistence use by traditional inhabitants, tourism, refuge, nursery area, recruitment source for commercially important species
4) practicality/feasibility considerations - social and political acceptability, community support, ease of manageability[23]

The goal of ecosystem management is to conserve the structure, diversity and function of ecosystems through a focus on biophysical/natural components, which is why this thesis is investigating the biomass productivity of the municipal fisheries. The ecosystem-based approach system to coastal resource management is geographically specified, adaptive, takes account of ecosystem knowledge and uncertainties, considers multiple external influences, strives to balance diverse societal objectives[24].

The Philippines needs multi-sectoral cooperation from various institutions that can play a wide range of management roles. For example, even though it's local governments that establish the MPAs, it is often other organizations that manage and maintain the MPAs. As mentioned before, MPAs are better in networks, better than to have many than to have an isolated one, no matter how big it is. Effective governance at both national and local level is vital for the optimal and sustainable use of marine fisheries resources. If we look at the information, we are in great need of fishery data for these. This is why studies like these are necessary. The Coral Triangle will encourage us to keep better tabs and accounting of the resources and revenue coming in and out of the Coral Triangle, and thus help us be more aware of what it is we are protecting and what we need to protect further.

## 3. Data Description

23 Jatulan, William. "Session 14: Establishing and Managing Marine Protected Areas (MPAs)." CTI Regional Exchange 2009. Participant binder.

24 Abbey, Michael. "Session 15: Ecosystem Approaches to Fisheries Management." CTI Regional Exchange 2009.

This paper will utilize time-series data from CountrySTAT Philippines and the Coastal Conservation Education Foundation (CCEF) from a period of 25 years starting from 1984 up to 2008. The outcome variable is the biomass productivity of municipal fisheries. The two main predictors are the number and hectare value of MPAs established a year, and the two covariates are Philippine gross national product (GNP) and the gross value added (GVA) of Philippine fisheries.

The Philippine government only started regularly establishing MPAs in the late 1980's, and the rate of establishment increased in the mid-1990's. Between 1996 and 1998, the fishery and coastal environment problems were addressed - with the assistance of various NGOs and governmental bodies, as well as the active participation of community members and stakeholders – with the introduction of the CRM program. This was initiated with the establishment of three pilot MPAs in Dauin, Negros Oriental. Economic data tends to be better documented and extensive than environmental data, but this thesis's utilization of them is constrained by the availability of MPA data. Before the mid-1980's, there were only two MPAs established – one in 1940 and the other in 1974. It would be of little use to extend the time-series analysis of MPAs back further than the mid-1980s.

The data for the main predictors were gathered from the CCEF website, which has a downloadable MPA database. The CCEF does intersectoral work advocating best-practice environmental management methods. Their primary objective is to aid local governments with the management of coastal resources. This involves advisory and contract work from governments, corporations, and other non-governmental organizations. Recently, CCEF has begun participating in national-level MPA activities through its contribution of management tools like the MPA Rating and Database System, from which data for the total number and

hectare value of MPAs established per year have been gathered. They have previously collaborated with the National Geographic Society, the National Oceanic and Atmospheric Administration (NOAA) of the United States Department of Commerce, and the University of California Santa Barbara's National Center for Ecological Analysis and Synthesis, among others. CCEF's research focuses on fisheries and coral reefs.

Covariate data was gathered from CountrySTAT Philippines, which is accessible through the Philippine government's Bureau of Agricultural Statistics (BAS) website. CountrySTAT data has been widely used in research studies and as support in policy-making. The data is made available through a partnership between the United Nation's Food and Agricultural Organization (FAO) and the Philippine Statistical Association (PSA). To quote the CountrySTAT website, CountrySTAT is

> a Web-based information technology system for food and agriculture statistics at the national and subnational levels. It provides decision-makers access to statistics across thematic areas such as production, prices, trade and consumption (CITE). … The FAO forms partnerships through national and regional CountrySTAT projects with countries' statistical offices and various ministries – such as that of agriculture, fisheries, and forestry, among others – in order to advocate the deployment of the system. The government of the countries that utilize it then makes a contribution to ensure its utilization and maintenance[25].

**4. Model Variables**

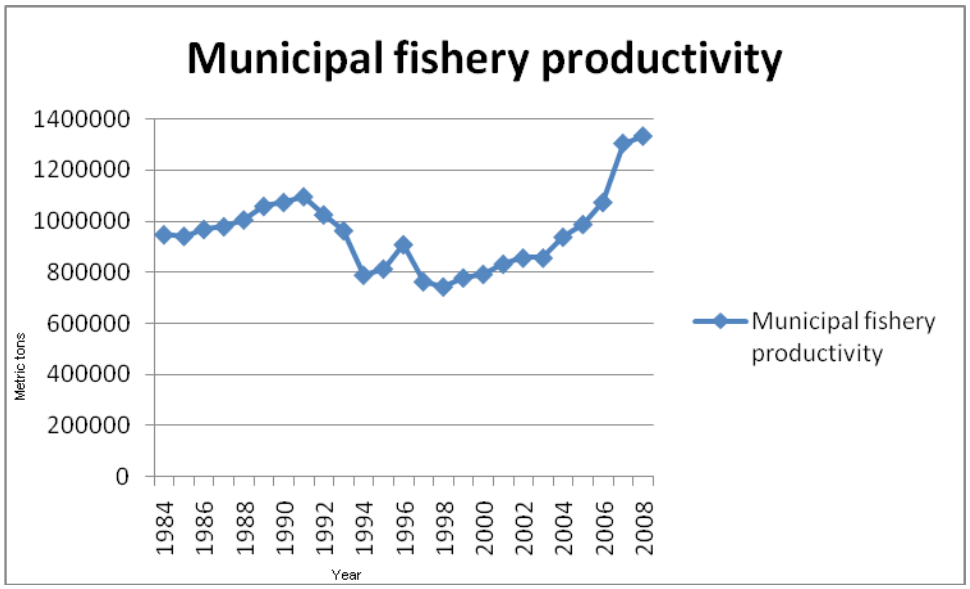
The *outcome variable* is the Philippines' municipal marine fishery production, measured in metric tons. Municipal fishery production is significant because although much of the maintenance of local MPAs is carried out by non-governmental entities - such as the Hingotanan

25 "CountrySTAT: CountrySTAT Home." *FAO: FAO Home*. Web. 22 Dec. 2009. <http://www.fao.org/economic/ess/countrystat/en/>.

East Sanctuary Fishermen's Association and the Bantay Dagat Fish Wardens, for example - municipalities are the ones who establish them. As previously mentioned, Philippine municipal governments and its local units are the front-line managers of municipal waters.

This thesis aims to investigate the biological objective of fisheries management, which as previously mentioned, includes the maintenance of the appropriate biomass value of these fisheries within the MPAs so that it remains at or above the levels necessary to ensure their continued productivity.

**Figure 4.1: Municipal fishery productivity (measured in metric tons)**




As the graph of Figure 4.1 demonstrates, municipal fishery productivity has been steadily increasing since the mid-1990's. A slow but steady increase in the mid-80's was mitigated by a decline in the mid-1990's. The increase in productivity that follows, however, corresponds with the Philippines' deployment of CRM plans. One would want to infer that the establishment of the CRM program that came in conjunction with the Fisheries Code of 1998 (Republic Act 8550) has been successful. That is to say, the adoption and proliferation of this program is strongly correlated with the the improved biomass productivity of the municipal fisheries. The graph also

displays that the biggest increase in productivity takes place from the year 2006 to 2007, and this is significant because this is when the Coral Triangle Initiative began to increase the vehemence of its activities and fostering of its philosophy throughout the Coral Triangle region.

The two main *independent variables* are the total number of MPAs in the Philippines per year and the total hectares of MPAs in the Philippines per year. These predictors are meant to be the proxy representation of marine environmental protection. While it is important to keep of track of how many MPAs have been established as a shorthand for the country's increasing awareness and advocacy when it comes to issues of environmental protection, this thesis hypothesizes that the total hectare value would actually be more significant and enlightening as a predictor as opposed to the number of MPAs. The reasoning behind this is that the number of MPAs do not tell us how big or small these MPAs are. Three MPAs might actually have a smaller coverage area than one large MPA, which would result in the the latter MPA having a greater role and impact on marine environmental protection, which in turn would have a more significant interplay with the outcome variable of municipal fishery productivity. The total hectare value has been log-transformed in order to normalize the distribution of the data to make it more amenable to regression analysis.

**Figure 4.2: Total number of local MPAs established per year**

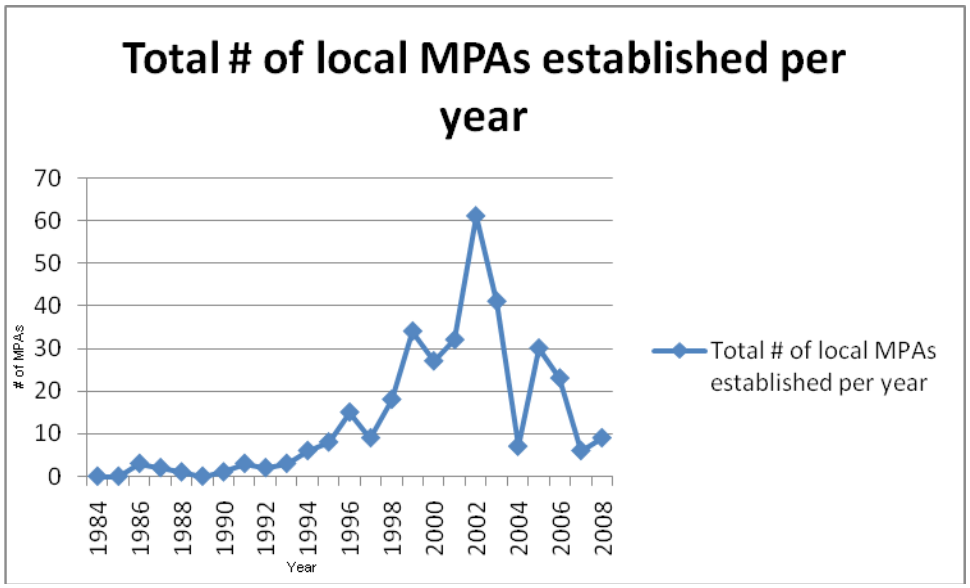
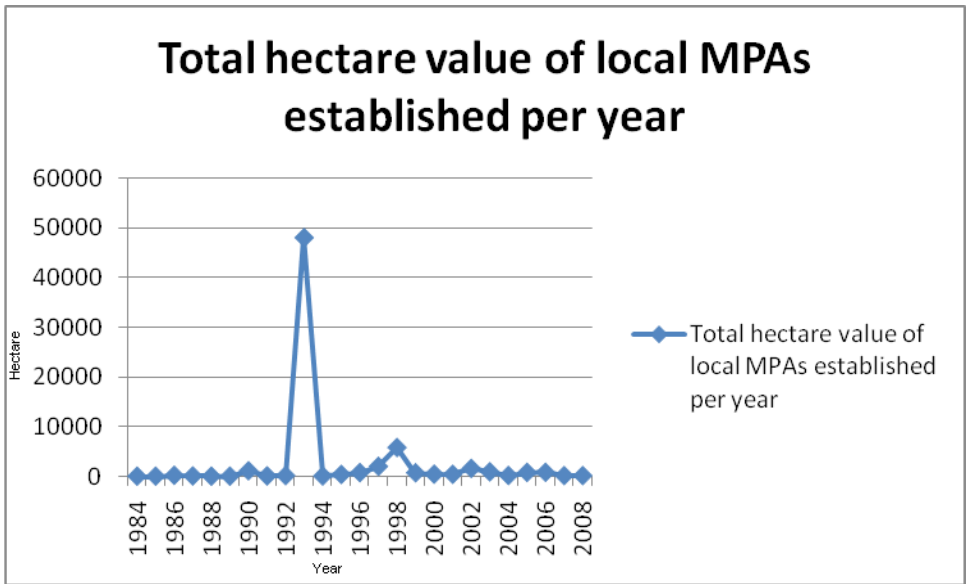



Figure 4.2 shows a steady increase in the rate of MPA establishment up until the late 1990s, when it spiked in the early 2000s and afterward became more sporadic. The graph shows that rates of MPA establishment in the past couple of years have returned to what they were in the early 1990s. It would be enlightening to know what it was that caused the sharp rates of decline in MPA establishment rates in the early 2000s.

**Figure 4.3: Total hectare value of local MPAs established per year (pre-log transform)**



What is immediately noticeable about Figure 4.3 is the massive outlier in 1993. More hectares of MPA was established in 1993 than in any other year. When compared with Figure 4.2 for the number of MPAs established per year, however, it is interesting to note that 1993 was an unremarkable year as far as establishment of the total number of MPAs per year goes. Essentially what we see here is that although the number of MPAs established a year may vary, the hectare value generally stays the same. Further investigation into the outlier in Figure 4.3 reveals that it is caused by the municipality of Calatagan in Batangas, which established the entirety of Calatagan's municipal waters as a marine reserve. It might be interesting to do a study that specifically focuses on this MPA in order to see how the declaration of all municipal waters as MPA works, especially in light of how it has been found that MPAs work best in networks of smaller but strategically situated and interrelated MPAs. Size, therefore, is something of a lesser concern.

**Figure 4.4: Summary of total hectare value of MPAs established per year**

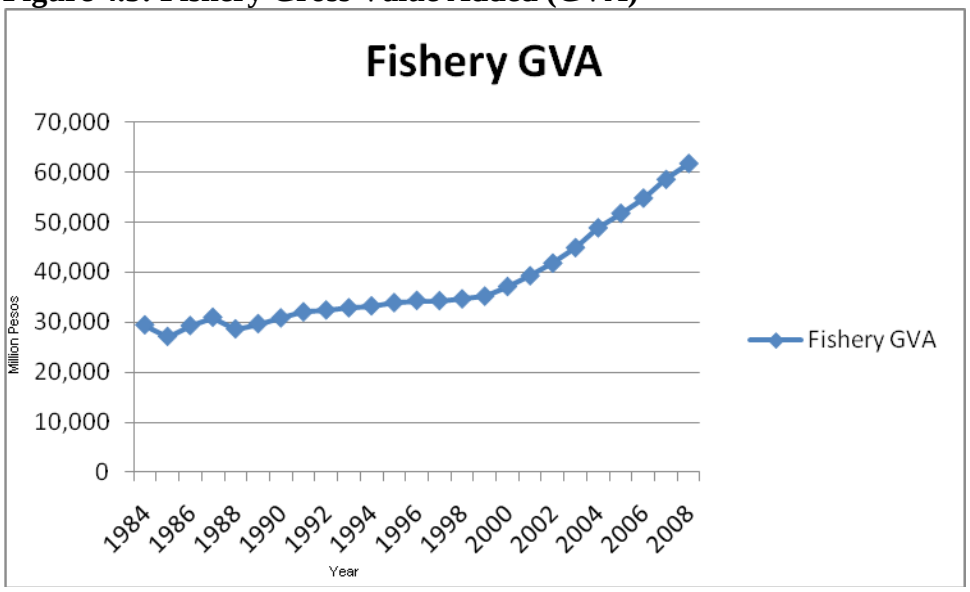
| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| LhMPA | 25 | 2571.733 | 9558.508 | 0 | 48100 |

As we can see from Figure 4.4 above, the average hectare size of an MPA is approximately 2562 hectares, but considering the dramatic uniqueness of the outlier, a median value would perhaps be preferable.

There are two *covariates*: the Philippines' GNP and its fishery GVA. Since the main predictors aim to represent the biological objective and touch upon the ecological objective of fisheries management, then the covariates are meant to represent the economic and social objectives of fisheries management. The social objective is said to be maximizing employment

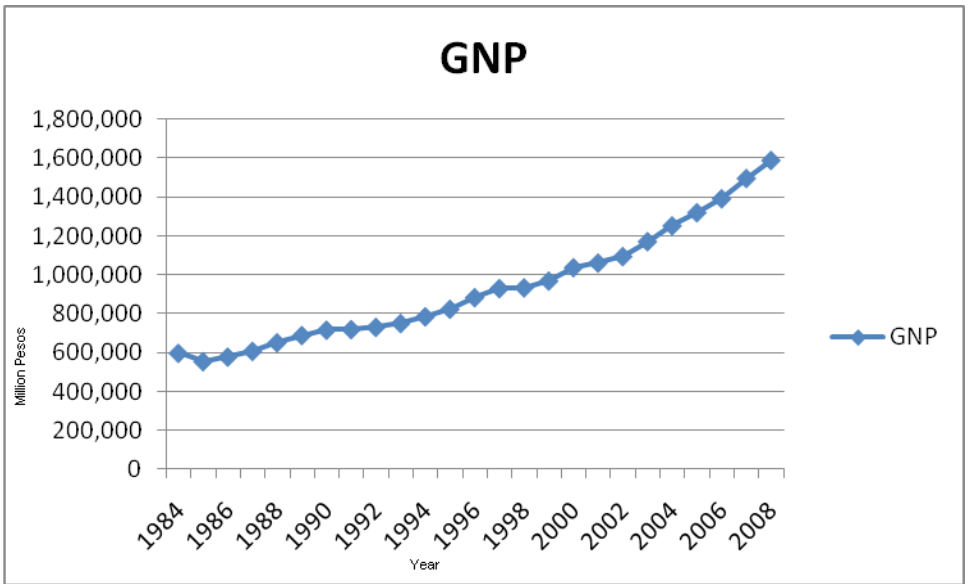
opportunities for those dependent on fisheries for their livelihoods, and the economic objective is the optimization of the benefits gained from fisheries via the maximization of fishers' net incomes. These two objectives are encompassed by the covariates.

**Figure 4.5: Fishery Gross Value Added (GVA)**




The fishery GVA value is an economic measure of the output value of goods and services in the fishery sector, but undistorted by tariffs and subsidies.

**Figure 4.6: Gross National Product (GNP)**




As we can see from Figure 4.5 and Figure 4.6, the values for both have been on a steady increase, which is a typical trend for macroeconomic indicators such as GNP and GVA. It is expected that these steady increases in GNP and fishery GVA values will contribute to relationship between the establishment of marine protected areas and the productivity of municipal fisheries.

**Figure 4.7: Correlation matrix of model variables**

| | PFMuni | LnMPA | logLhMPA | gnp | gva_f |
|---|---|---|---|---|---|
| PFMuni | 1.0000 | | | | |
| LnMPA | -0.3839 | 1.0000 | | | |
| logLhMPA | -0.3226 | 0.3497 | 1.0000 | | |
| gnp | 0.3823 | 0.4085 | 0.1247 | 1.0000 | |
| gva_f | 0.5404 | 0.2833 | 0.0337 | 0.9724 | 1.0000 |

We can see straight off that the predictors and covariates are fairly correlated to the outcome variable. The fishery GVA is more than 50% correlated, which is worrying because its inclusion might mean it would skew and overdetermine the model. As a covariate, it would appear to be too influential. We see from this that the establishment of MPAs both have a

negative correlation with the the productivity of municipal fisheries. This supports how this study needs a time lag model, because while it makes sense that the same-year analysis of MPA establishment would reveal that MPA establishment is negatively correlated, it might take some time for the effect of the MPA to make itself known. Interestingly there is also a strong correlation between number of MPAs established and GNP, which would make sense in that increased biomass productivity of municipal fisheries would contribute to the market value of goods and services produced in the Philippines.

## 5. Methodology

Assessing the relationship between marine environmental protection and the biomass tonnage productivity of municipal fisheries in the Philippines will be done via univariate and multivariate regression analysis. Because we are using time-series data, we will approach the issue in two ways: 1) multivariate regression analysis of municipal fishery productivity and its *same-year relationship* marine environmental protection as represented through the establishment of MPAs, and 2) multivariate regression analysis of the municipal fishery productivity and its *one-year lagged relationship* the establishment of MPAs. The one-year lagging is to give time for the MPAs to have effect on the fishery productivity. That is to say, to account for the possibility that the effects of the establishment of MPAs might not manifest themselves immediately, but will make themselves felt for various reasons over the year. For example, to give fish the time to breed in order to multiply themselves, which would contribute to the fishery biomass.

These two approaches will be expressed via three model variations. The first is the *single variable model*, in which the outcome variable is regressed on each of the predictors and covariates separately, in order to better gauge the specific nature of the individual variables. The

second is the *multivariate model*, in which the outcome variable will be regressed on all the predictors and covariates simultaneously. The third is the *lagged multivariate model*, in which the outcome variable is lagged by one year before being regressed on all the predictors and covariates simultaneously.

## 6. Results

| *Descriptive Statistics* | *Model 1: Individual Predictors* | *Model 2: Same-Year Multivariate Model* | *Model 3: Lagged Multivariate Model* |
|---|---|---|---|
| OUTCOME VARIABLE **Biomass productivity of municipal fisheries** | | | |
| Intercept | - | 498705.300000 | 629036.800000 |
| R-squared | - | 0.731600 | 0.626400 |
| PREDICTOR VARIABLES | | | |
| **Total number of MPAs established** (coeff.) | -3671.100000** | -3019.780000** | -3487.052000** |
| T-statistic | -3.240000 | -2.050000 | -2.130000 |
| P-value | 0.004000 | 0.056000 | 0.048000 |
| R-squared | 0.146500 | - | - |
| **Total hectare value of MPAs established (logged)** (coeff.) | -61400.200000 | -14569.890000 | 1087.451000 |
| T-statistic | -1.720000 | -0.660000 | 0.060000 |
| P-value | 0.102000 | 0.515000 | 0.950000 |
| R-squared | 0.104100 | - | - |
| **GNP** (coeff.) | 0.164883 | -0.970062** | -0.863914** |
| T-statistic | 1.350000 | -3.820000 | -2.900000 |
| P-value | 0.191000 | 0.001000 | 0.010000 |
| R-squared | 0.105200 | - | - |
| **Fishery GVA** (coeff.) | 7.330882** | 37.903710** | 30.692170** |
| T-statistic | 2.270000 | 5.590000 | 3.990000 |
| P-value | 0.033000 | 0.000000 | 0.001000 |
| R-squared | 0.228900 | - | - |

| | | | |
|---|---|---|---|
| ** = statistically significant | | | |

## Single-Variable Model

### Main Predictors

*Total # of MPAs per year*

```
Linear regression                               Number of obs =
25
                                                F(  1,    23) =
10.47
                                                Prob > F      =
0.0036
                                                R-squared     =
0.1465
                                                Root MSE      =
1.4e+05

------------------------------------------------------------------------------
             |               Robust
      PFMuni |      Coef.   Std. Err.      t    P>|t|     [95% Conf.
Interval]
-------------+----------------------------------------------------------------
       LnMPA |    -3671.1   1134.379    -3.24   0.004    -6017.743   -
1324.457
       _cons |    1003937    35878.7    27.98   0.000     929716.3
1078158
------------------------------------------------------------------------------
```

This model shows that the predictor is significant (t-score = -3.24), as per the hypothesis, and it has a negative relationship with the outcome variable. That is to say, the establishment of fewer MPAs can be said to be associated with an increase in municipal fishery productivity, presumably because the establishment of such MPAs imposes restrictions on fishers that

disallow them from fishing and harvesting fishery biomass from the sea. However, although the predictor is statistically significant, the R-squared value is relatively low ($R^2 = 0.15$), suggesting that the inclusion of other variables would be desirable for a more thorough analysis.

*Total hectares of MPAs per year*:

```
Linear regression                                       Number of obs =
22
                                                        F(  1,    20) =
2.95
                                                        Prob > F      =
0.1015
                                                        R-squared     =
0.1041
                                                        Root MSE      =
1.6e+05

------------------------------------------------------------------------------
-
             |               Robust
      PFMuni |      Coef.   Std. Err.      t    P>|t|     [95% Conf.
Interval]
-------------+----------------------------------------------------------------
-
    logLhMPA |   -61400.2   35770.05    -1.72   0.102    -136015.2
13214.81
       _cons |    1106847   102679.1    10.78   0.000     892662.2
1321032
------------------------------------------------------------------------------
-
```

As with the variable for the total number of established MPAs per year, the variable for logged total hectares of MPAs established per year also has a negative relationship with the biomass tonnage productivity of municipal fisheries. Interestingly, however, this predictor is not significant (t-score = -1.72). This goes against the hypothesis, which believes that the total hectare value would be a more concrete and thus more significant predictor of fishery

productivity than the total number of MPAs established, due to the fact that this variable would more specifically state just how much of the marine area is under protection. However, this does not seem to be the case. Furthermore, the R-squared value is relatively low ($R^2 = 0.10$). As with the single-variable model for total number of MPAs established, it would appear that including more variables in the multivariate model analysis would be advisable.

Covariates

*GNP (gross national product)*

```
Linear regression                               Number of obs =
25
                                                F(  1,    23) =
1.81
                                                Prob > F      =
0.1912
                                                R-squared     =
0.1052
                                                Root MSE      =
1.5e+05

------------------------------------------------------------------------------
             |               Robust
      PFMuni |      Coef.   Std. Err.      t    P>|t|     [95% Conf.
Interval]
-------------+----------------------------------------------------------------
         gnp |   .1648831   .1224293     1.35   0.191    -.0883811
.4181474
       _cons |     799889   106351.7     7.52   0.000     579883.7
1019894
------------------------------------------------------------------------------
```

GNP does not prove to be statistically significant in the single-variable model (t-score =

1.35). That is to say, the biomass tonnage productivity of municipal fisheries do not appear to be significantly affected by the gross national product. Similar to the previous single-variable models, the R-squared value is also relatively low ($R^2 = 0.11$).

*Fishery GVA (gross value added)*

```
Linear regression                                       Number of obs =
25
                                                        F(  1,    23) =
5.17
                                                        Prob > F      =
0.0327
                                                        R-squared     =
0.2289
                                                        Root MSE      =
1.4e+05

------------------------------------------------------------------------------
             |               Robust
      PFMuni |      Coef.   Std. Err.      t    P>|t|     [95% Conf.
Interval]
-------------+----------------------------------------------------------------
       gva_f |   7.330882   3.224602     2.27   0.033      .660284
14.00148
       _cons |   676162.7   120784.3     5.60   0.000     426301.3
926024.1
------------------------------------------------------------------------------
```

The fishery GVA covariate is significant (t-score = 2.27). Considering that this is the 'real' value of final goods and services produced in the Philippines' fishery sector (that is to say, undistorted by subsidies and tariffs), this is unsurprising. This fishery GVA variable has the highest R-squared value of all the single-variable models, though at $R^2 = 0.22$, it is still quite

low.

The R-squared values of all the single-variable models indicate that the inclusion of more variables is advisable in order to carry out a more thorough analysis of the effect of marine environmental protection on fishery productivity. Thus, we move now to the analysis of the multivariate models.

**Same-year Multivariate Model**

```
Linear regression                                       Number of obs =
22
                                                        F(  4,    17) =
20.13
                                                        Prob > F      =
0.0000
                                                        R-squared     =
0.7316
                                                        Root MSE      =
92537

------------------------------------------------------------------------------
-
             |               Robust
      PFMuni |      Coef.   Std. Err.      t    P>|t|     [95% Conf.
Interval]

-------------+----------------------------------------------------------------
-
       LnMPA |   -3019.78   1470.563    -2.05   0.056    -6122.397
82.83596
    logLhMPA |  -14569.89   21920.22    -0.66   0.515     -60817.5
31677.72

       gva_f |   37.90371    6.77907     5.59   0.000     23.60112
52.20629

         gnp |  -.9700615    .253678    -3.82   0.001    -1.505275   -
.4348478
```

```
       _cons |   498705.3   107531.2     4.64   0.000     271834.2
725576.4
------------------------------------------------------------------------------
-
```

Comparing the results of the single-variable models with the results of this multivariate model shows that GNP has become a significant predictor (t-score = -3.82), but that its relationship with the outcome variable has changed from positive to negative. As with the single-variable models, only one of the main predictors (total number of MPAs established) is statistically significant, and even then just barely. The t-score for this variable indicates statistical significance, but the P-value indicates that it is not statistically significant, but only by a marginal account. For purposes of this study, the predictor will be considered close enough to significant to be designated as such.

The covariates, both of which are economic  nature, are statistically significant. The R-squared value for this model is high ($R^2 = 0.73$), and here indicates that 73% of the variations in the biomass productivity of municipal fisheries are accounted for by the independent variables. Thus, the model fit is quite high for this model. Judging from the t-score and p-values of the predictors, however, the question arises whether the model fit is due more to the economic covariates rather than the environment-centric main predictors. That is to say, despite the high R-squared value, perhaps this model is not truly and representatively investigating the research question this thesis has specified.

**One-year Lagged Multivariate Model**

```
Linear regression                                      Number of obs =
22
                                                       F(  4,    17) =
```

```
10.02
                                                      Prob > F      =
0.0002
                                                      R-squared     =
0.6264
                                                      Root MSE      =
93667

------------------------------------------------------------------------------
             |               Robust
 lag1_PFMuni |      Coef.   Std. Err.      t    P>|t|     [95% Conf.
Interval]
-------------+----------------------------------------------------------------
       LnMPA |  -3487.052   1638.582    -2.13   0.048    -6944.158   -
29.94568
    logLhMPA |   1087.451    17071.7     0.06   0.950    -34930.68
37105.59
       gva_f |   30.69217   7.691465     3.99   0.001      14.4646
46.91975
         gnp |  -.8639141    .298275    -2.90   0.010    -1.493219   -
.2346089
       _cons |   629036.8    94220.5     6.68   0.000     430248.9
827824.7
------------------------------------------------------------------------------
```

With an R-squared value of 0.63, the one-year lagged multivariate model has a lower model fit than the same-year multivariate model. This seems to indicate that the one-year lag to account for the time it takes for the effects of the predictors and covariates to make themselves felt on the outcome variable is not as significant as previously hypothesized. However, an R-squared value of 0.63 is still relatively high. It is conceivable that the lagged model might be improved with the inclusion of more variables that perhaps increase in relevance during the passing of the year. Another thing that future research studies on similar subjects might want to

do is lag their multivariate model more than one year, and see if there is a longer-term effect on the outcome variable.

The other concerns that are brought up by this lagged multivariate model is much similar to the same-year multivariate model. The significant variables in both models are the same. The t-scores and p-values of the covariates still indicate that these economic covariates are more significant than the main predictor of total number of MPAs established per year.

## 7. Discussion & Conclusion

As the data shows, only one of the main predictors – total number of MPAs established per year – is significant. This goes against the thesis hypothesis that the total hectare value of MPAs would serve as a more concrete indicator of and contributor to the biomass productivity of Philippine municipal fisheries. However, this makes more sense if we juxtapose this upon the finding that the best-practice method of MPA establishment/maintenance is to have a network of MPAs maintained collaboratively. It is also a possibility that the hectare value of MPAs might serve better as a covariate for the total number of MPAs established a year, rather than a main predictor in of itself. To review, the criteria for the selection of a marine area to be designated an MPA are ecological importance, social importance, economic importance, and practicability and feasibility. The hectare value of the MPA may not be as important because no matter how large an MPA is, the true midwife to its success is not size but manageability. An MPA as large as the one that the municipality of Calatagan declared in 1993 might cover an extensive area, but it is precisely its large size that would make its management, policing, and preservation difficult. It would therefore be much more practical and feasible to have multiple smaller MPAs, which would be easier to upkeep and whose success would be easier to ensure.

It would also be informative for future research to account for specific characteristics of the MPAs, such as how much cubic area they cover, what their biodiverse species breakdown is like, and primary reasons for the MPA having been declared as such, among other things. It would also be enlightening to do region-specific or even MPA-specific studies in order to glean with more specific data what the effect of such endeavors of environmental protection have on the productivity of fisheries, and what better research questions could be asked that would better illuminate how to contribute to the success of the Coral Triangle Initiative.

Environmental protection via the establishment of marine protected areas in order to improve Philippine fisheries is just one prong of the Coral Triangle Initiative. There are several angles from which one can approach coastal resource management. The establishment of MPAs is an ecosystem-based measure and intervention. However, one can also approach coastal resource management through species-specific intervention, gear-specific management, registration and licensing, zoning of fisheries uses, fishery law enforcement, and joint fishery law enforcement. Future multivariate analysis looking into issues of fisheries and coastal resource management would benefit from investigating these issues in order to get as comprehensive a scope on marine resources as possible.

One must keep in mind that the most successful development initiatives are interdisciplinary, collaborative, and multisectoral. That is to say, it would be advisable to integrate the coastal resource management program with other initiatives. The Philippines recognizes this and is integrating the CRM program with the municipalities' Comprehensive Land Use Plan (CLUP) and the Forest Land Use Plan (FLUP). This would be beneficial to coastal resource management and the protection of the marine ecosystem because unplanned developments on land can easily lead to the destruction of marine habitats via pollution runoff.

There has also been an ordinance passed under the Co-Management Agreement with the Department of Environment and Natural Resources for the preservation of the forestland and watershed areas, in order to prevent erosion that may cause flooding and the siltation of the MPAs during heavy rain. Relatedly, the coastal resource management program is also working together with Ecological Solid Waste Management (ESWM) Plan and Ordinance in order to address the problem of intrusion and improper disposal of all types of garbage to the coastal zone. Collaboration with the Department of Education has made it mandatory for teachers to insert coastal resource management into the classroom agenda (S15). The designated department of the Philippine National Police (PNP) is required to submit a quarterly report on apprehension of violators, and number of incidents acted that are related to MPA violations. Collaborative actions and initiatives such as these will help to ensure the overall success of coastal resource management and the Coral Triangle Initiative.

In addition to the preservation of marine biodiversity, resource preservation, and coastal resource management, it would also be advisable to provide alternative livelihood training so that fisherfolk can have the option of applying for jobs that aren't fishing. A variegated employment sector is always beneficial. Although the sea is an employer of last resort, it cannot be the *only* employer. Coastal resource management programs need to be bolstered by capacity development and competence building.

Ultimately, the goals of the Coral Triangle Initiative are  sustainable use/management, managed fisheries, participatory and informed decision-making processes and tools. The low prioritization of marine resources need to be changed through education and information-sharing on all levels. Traditional mindsets to open-access need to be changed as well, although this will ostensibly be the most difficult. What is important is to educate the collective consciousness on

resource management issues. Information, education, and communication is especially key in this case.

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