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Impact of MPA management variations on fishing income and movement in poverty among fishing households in Lagonoy Gulf, Philippines

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Abstract

Because MPAs in Lagonoy Gulf, Philippines are created and financially supported by local government units that maintain administrative autonomy under the state's Local Government Code and their political leadership changes every 3 years, their management regimes vary over time. It was posited that these variations will have differential impact on fishing incomes of fishers in communities with regularly and problematic MPA regimes in pre-and post-reference periods. Employing difference-in-differences approach using longitudinal data from various studies completed from 2004 and 2010, we report an impact evaluation of various operational regimes of MPAs on fishing income, causal relationships of variables to outcome, and the movement of fishers from poverty threshold between two time periods. We found that mean annual fishing income of fishers in regularly managed MPA is relatively higher than fishers in non-regularly managed and unmanaged MPAs; while Fishers in MPAs with non-regular and without management have relatively lower mean annual fishing incomes than those in managed MPA in Time 0. Also, we found a wider positive effect on mean annual fishing income of fishers in regular managed MPA against MPA without or almost without management. Our empirical analysis confirmed the treatment effect of MPA on mean annual fishing income of fishers and so for the other correlated variables of time, location and provincial socioeconomic condition and size differentials. The study also showed that the proportion of fishers with average annual fishing income above the arbitrary poverty threshold increases over time in MPAs. Policy implications in the context of managing small MPAs were discussed.

INTRODUCTION

In Lagonoy Gulf, there is an observed variation in the way MPAs are managed over time. Situated within the municipal waters, MPAs are delimited by political boundaries of their respective local government units (LGUs) whose electoral process undermine their long term operational sustainability due to periodic change in leadership of LGU chief executives. Under this electoral system for local governance, the mayor or chief executive of a coastal LGU may be perpetrated to serve over long years through continuously earning new mandate by the electorate, or dislodged from the service and the financial support for meaningful coastal resource management if unable to receive a fresh mandate in the next three-year term. Depending on the priority of a newly installed LGU executive, the political dynamics brought by an ever-changing leadership compromise the LGU's level of financial support to MPA law enforcement operations and management that may vary from regular managed, erratic managed or unmanaged at certain periods or throughout all of the periods of operation. In Lagonoy Gulf MPA contexts, several LGUs have manifested sustained and active support for MPA law enforcement operations since its establishment and until recently. These are considered as regular managed MPAs. On the other hand, other MPAs have manifested later support after their establishment where active law enforcement operations have been observed only in recent years due to changes in LGU leadership. These MPAs are considered as non-regular managed or erratic managed MPAs. There are also MPAs that belong to the usual "paper parks"- established and operated in

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paper, but without active law enforcement to protect its habitats and resources from irrational use. It is theorized that the type of MPA management regime whether regular managed, erratic managed and unmanaged over a significant operation periods may affect the annual fishing income of fishers as one of the expected socioeconomic outcomes of MPA resource governance.

While there are sufficient local information on the effect of MPA management regimes on its habitats and fishery resources e.g. Soliman et al. (2008) and David et al. (2004), literature are scanty on the economic impacts of MPA in Lagonoy Gulf, and perhaps in other parts of the country (Samonte et al. 2016) using changes in fishing income as outcome indicator. If ever, no serious attempt has been done to investigate the MPA impacts on fishing income using longitudinal data and control sites in Lagonoy Gulf area. Gourney et al. (2014) noted that only very few of the evaluation of social impacts of MPAs have had the requisite data to assess causal effects contributing to its poor understanding by stakeholders. Their study evaluated the short-, medium- and long-term impacts of marine protected areas (MPAs) using social data for villages with and without integrated MPAs from pre-, mid- and post-the five-year implementation period. Weigel et al. (2015) assessed the microeconomic effect of MPA by comparing two geographical strata (with or adjacent to MPA versus remote from MPA). However, the study acknowledges that a better comparative assessment would have been possible by using longitudinal data i.e. by the mean of a survey conducted over a multi-year period (before and after the setting up of MPA) and cited the relevance of an econometric technique called Difference-in-differences (DID) to process such longitudinal data and estimate causal relationship. Samonte et al. (2016) confirmed the scanty empirical case studies that demonstrate the MPA effect on fishers' income by fishers and explore the economic consequence associated with MPA implementation on fishers over the span of five years.

These pieces of emerging literatures on MPAs reflected the growing interest on its social and economic evaluations and the call for these evaluations to use longitudinal data for protected and control sites. While there has been consensus in the theoretical literature that only few existing empirical impact evaluations have tended to rely on comparisons of outcomes in: (1) sites with and without protected areas for a single time period; or (2) protected area sites before and after the intervention was implemented, nothing has yet been done to evaluate the consequence of a consistent active management of MPA versus erratic management or no management at all over a longer period of time.

This paper attempted to seek answer whether MPAs in Lagonoy Gulf increase mean annual fishing income of fishers and reduce poverty over a specific period of time. Specifically, it reports an impact evaluation of MPA operational regime on fishing income, estimate causal relationships of variables to outcome, and characterize the movement of fishers from poverty threshold between two time periods.

METHODOLOGY

This study employed a difference-in-differences approach to investigate whether fishers who fished in MPA community that has regular operational regime had higher fishing income than comparable fishers who fished in MPA community with problematic or erratic operational regime. Because Lagonoy Gulf MPAs are created and managed by LGUs that maintain management independence under the provisions of the Local Government Code of 1992, and their political leadership changes every 3 years, the operation of MPAs despite their ecological contiguity, was completely arbitrary. It is anticipated therefore that any variation in MPA operation that differentiates fishing incomes in pre-and post-reference periods will impact fishing incomes of fishers in MPA communities with regularly and problematic MPA regimes.

The current study has several methodological strengths. First, this study benefits from the close similarity of characteristics of the MPA communities being compared owing to their locations in Lagonoy Gulf sharing a contiguous space of the marine ecosystem. Second, the difference in MPA operation in pre-and post-reference periods varied among the selected MPA communities and therefore has the potential to lead to reasonably sized differences in target impact variable of annual fishing income. Third, comparisons are made following the same fishing communities over time. Fourth, bio-physical impacts of management regimes have been documented in Lagonoy Gulf MPAs, but none so far in terms of its impact on fishing income.

Institutional context

The San Miguel Island MPA was established in 1998. Its sanctuary covers 100 hectares, while its reserve is about 225 hectares. It is located in Barangay Sagurong, San Miguel Island in Tabaco City, and northern part of Lagonoy Gulf. This village has an area of around 265 hectares with a total population of 2,753 persons in 2008. In 2004, there are 450 households in the village. Of this, 215 are considered fishing households. These fishing households comprise 48 percent of the total households in the area. SMI MPA is endowed with coral reef, sea grass beds and mangroves habitats which habitats provide sedentary reef, seagrass and mangrove fishes. Foremost of these resources is the siganid fry which thrives

from the seagrass beds in the MPA. Migratory pelagic fishes also comprise part of the fishery resource. Coastal resource utilization pattern is dominantly extractive consisting of a subsistence fishery that is multi-gear and multi-species in nature. Some fishers use motorized boats to fish outside the municipal waters off to Sirangan fishing ground to catch tuna and tuna-like fishes. The MPA Management Council, a community-based MPA body that is multi-stakeholder in composition was given the right to make choices regarding aspects of MPA design and management in SMI MPA. It is composed of members of the village council representing the LGU, and the fisherfolks representing the resource users. The function of the MPA management Council includes advisory, planning and decision-making on MPA operations as well as enforcement and monitoring. The financial and administrative function is assumed by the LGU through the office of the City Agriculture as support to MPA operation. Decision-making in the MPA Council is both by consensus. The responsibility and authority to manage the MPA rests with the MPA Management Council and the Bantay Dagat. The Council manages the Bantay Dagat group tasked with enforcing the MPA rules and patrolling. The ordinance allots the MPA into two zones, namely sanctuary, a no take zone, and a reserve, a regulated fishing zone. The formal allocation rules strictly prohibit all forms of fishing and gathering of marine products from the sanctuary, except for scientific study. They however allow regulated fishing or fishing using traditional means and prohibit destructive fishing in the marine reserve. The penalty rule of the ordinance contains both imprisonment and imposition of penalty without details for the frequency of violations committed. These MPA institutional arrangements remained consistent until 2010.

The Atulayan MPA was established in 1993. It is one of the oldest MPAs in Lagonoy Gulf. Its sanctuary covers an area of 70 hectares, while its reserve is 72 hectares wide. It is located in Atulayan Island, Sangay, Camarines Sur, and southwestern part of Lagonoy Gulf. In 2004, the total population of the village was 702 persons. There were 113 households in the village. Of this, 88 are considered fishing households. These fishing households comprise 78 percent of the total households in the area. Atulayan MPA is gifted with extensive coral reefs encircling the whole island. Owing to its depth, the seagrass bed in the area is almost negligible and mangrove forest is almost non-existent. The area thus abounds in coral reef fishes. Migratory pelagic fishes such as tuna and tuna-like fishes also comprise a larger part of the resources. Coastal resource utilization in the Atulayan MPA is a combination of extractive and non-extractive activities. A similar subsistence multi-gear and multi-species fishery characterized the extractive resource use in Atulayan. Two forms of non-extractive resource use exist in the area consisting of tourism and aquaculture. The LGU municipal legislative council, a group of elected public officials to enact laws was given the right to make choices regarding aspects of MPA design and management. The Mayor, who serves as the Municipal Chief Executive and vested with executive power, provides the decision-making and absorbed most of the functions. These functions particularly the administrative and financial aspects were carried out through the Office of the Municipal Agriculture. The managing institutions in the MPA are composed of the office of the Mayor, the Municipal Legislative Council and the Philippine National Police (PNP) and the Municipal Agriculture Office (MOA) whose organizational structures are under the supervision of the Mayor. The PNP makes occasional patrolling in the MPA in collaboration with the office of the Municipal Agriculture Office. The ordinance allots the MPA into two zones, namely sanctuary, a no take zone, and a reserve, a regulated fishing zone. The formal allocation rules in the MPA strictly prohibit all forms of fishing in the sanctuary. While it prohibits destructive fishing in the reserve. The penalty rule of the ordinance contains both imprisonment and imposition of penalty. The institutional arrangement however changes in 2005 and in 2010 when an enhanced MPA design was enacted into law by the LGU that provides an accessible budget for Bantay Dagat members honoraria incentives, support for gasoline for patrolling, a multi-stakeholder MPA management body called Sangay Coastal Resource Management Board and development of CRM plan. In 2010, the LGU created a Coastal Resource Management unit to supervise the Bantay Dagat operations. At the time of the post evaluation period, several MPA-oriented management interventions such as the imposition of closed fishing season, and heightened MPA patrolling were implemented by the SCRMB and the LGU.

The Baybay-Jonop MPA was established in 2002. It is also one of oldest MPAs in Lagonoy Gulf. Its sanctuary covers 180 hectares, while its reserve is around 270 hectares in size. Its location extends between the two villages of Barangay Baybay and Jonop, in Malinao, Albay and south easternmost part of Lagonoy Gulf. Baybay, the main village has an area of 112 hectares, while that of Jonop, has 250 hectares. In 2004, there were 279 households in Baybay, of this, 90 are fishing households. This comprises 32 percent of the total households in the village. Malinao MPA has extensive mangrove forest and coral reef but less extensive seagrass beds. The mangrove forest dominated by *Nypa fruticans* provides the mangrove-related fishes and invertebrates. The seagrass beds produce siganid fry, while the near shore areas abound in milkfish fry. The coral reefs produce sedentary reef fishes. Resource utilization is mainly extractive that includes a subsistence fishery composed of siganids fry gathering, shell craft and nipa shingle making. The MPA decision-making right on

management is delegated to the Municipal Baywide Management Council (MBMC) composed of representatives from the LGU such as the Municipal Agricultural Office and the officers of people's and community-based organizations. The Bantay Dagat group composed of members from a community-based organization is tasked to enforce MPA rules. This group comprises the managing institutions of the MPA. The ordinance allots the MPA into two zones, namely sanctuary, a no take zone, and a reserve, a regulated fishing zone. The formal allocation rules strictly prohibit all forms of fishing and gathering of marine products from the sanctuary. The following activities are banned from the reserve, but were not explicitly stated in the ordinance: fishing using fine meshed nets, explosives, obnoxious substance, spear fishing with scuba gear and compressors, and gears with scare line. There were no enhancements in the MPA design until 2010. The 2002 MPA ordinance remained lacking in explicit provisions that provide for accessible budget for MPA patrolling and Bantay Dagat operation, and CRM plan (Fig. 1).

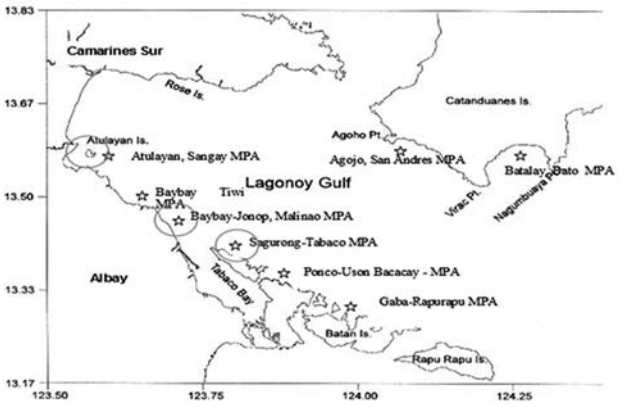

Fig. 1. Locations of the MPAs in Lagonoy Gulf (Source: Soliman et al. 2005a).

MPA management variations

To distinguish variants in MPA management levels, a set of criteria were employed modifying the MPA level of management advanced by Tighe et al. (2001). The MPA management was categorized as high or moderate. A high level is characterized as having management by objectives, management plan or operations plan is in place (e.g. MPA Ordinance, MPA Council), adequate human and other resources are available to address all stated objectives with actions and programs (e.g. Bantay Dagat, CRM Unit, Budget), and there is a high level of awareness of and adherence to management rules (e.g. MPA Use Rules are explicit); A moderate level is characterized as having active management addressing objectives (MPA, but not all elements of high level management are in place (may lack a management plan, have insufficient staff or enforcement capability, or not have programs addressing all objectives). Following these insights, a modified set of criteria was developed composed of 5 criteria that suits local conditions namely: (1) Rules for Managing Resources in MPA Design are Explicit (2) Budget for MPA Management are Accessible (3) MPA Management Council is Operational and Active (4) Enforcement Capability is Visible, and (5) Patrolling of Bantay Dagat is Regular.

The study sites were then subjected to these sets of criteria at two-time periods in 2004 and 2016. Using this set of criteria, a scoring of MPA management characteristics was done employing a binary coding system that assigns 1 if present, 0 otherwise for an MPA in each period. The MPAs are trichotomized into regular, erratic and unmanaged MPAs basing from the following scores: Regular managed MPA, if an MPA scored both in two-time periods across the 5 criteria; Erratic Managed MPA, if an MPA scored only in one period but failed in another period across the 5 criteria; and Unmanaged MPA, if an MPA failed to score both in two time periods across 5 criteria (Table 1). For the purpose of this study, as delimited by the set of criteria used and within the context of the evaluation period from 2004 until 2010 the following MPAs are distinguished as follows: SMI as Regular Managed MPA, Atulayan as Erratic Managed MPA and Malinao as Unmanaged MPA.

Data and Empirical Strategy

Data. To evaluate the impact of small MPAs on fishing income, data sets from surveys of fishing households in 2004 and in 2010 were utilized. Specifically, the evaluation used a gulf-wide household survey in 2004, and three separate household surveys of fishing communities in 2010.

In 2004, a total of 1,000 households were randomly selected from 15 coastal municipalities covering 3 provinces of Camarines Sur, Albay and Catanduanes bordering Lagonoy Gulf. This was implemented by Bicol University and partner institutions under the Lagonoy Gulf Socioeconomic Assessment Project funded under the Bureau of Fisheries and Aquatic resources-Fisheries Resource Management Project (BFAR-FRMP). The socioeconomic survey data covered sociodemographic and fishing information from fishers. The fishing information on income includes annual fishing income, cost of fishing operations, awareness of coastal environment.

In 2010, three household surveys were separately implemented. The first was the socioeconomic survey of San Miguel Island, Tabaco City jointly implemented by Bicol University, Kochi University and Partido State University researchers. A total of 343 fishing households were randomly selected as respondents from barangays Agnas, Hacienda,

Table 1. Variations in MPA management in three MPAs in Lagonoy Gulf.

Year	Criteria		Regular Managed	Erratic Managed	Unmanaged
			SMI MPA	Atulayan MPA	Malinao MPA
2004	1	Rules for Managing Resources in MPA Design	1	0	0
2016		are Explicit	1	1	0
2004	2		1	0	0
2016		Budget for MPA Management are Accessible	1	1	0
2004	3	MPA Management Council is Operational &	1	0	0
2016		Active	1	1	0
2004	4		1	0	0
2016		Enforcement Capability is Visible	1	1	0
2004	5		1	0	0
2016		Patrolling of Bantay Dagat is Regular	1	1	0
		Total 2004	5	0	0
		Total 2016	5	5	0
		Sum	10	5	0

Coding: present=1; absent=0

Regular managed MPA =if an MPA scored both in two-time periods across the 5 criteria; Erratic Managed MPA= if an MPA scored only in one period but failed in another period across the 5 criteria;

Unmanaged MPA= if an MPA failed to score both in two time periods across 5 criteria

Rawis, Sagurong,and Visita of San Miguel Island. Of these, 84 fishers have motorized boats; while 259 fishers have non-motorized boats. The socioeconomic survey data covered sociodemographic and fishing information from fishers. The fishing information on income includes annual fishing income, cost of fishing operations, awareness of coastal environment. The second was the socioeconomic survey of fishing and farming households in coastal villages of Malinao Albay. This was implemented by Partido State University and Bicol University under the Typhoon Reming Mangrove Rehabilitation Communities Impact Evaluation Research Project, funded by the Philippine Council for Aquatic and Natural Resources research and Development-Department of Science and Technology (PCAARRD-DOST). A total of 360 household head respondents in the coastal barangays of Bariw, Balading, Balza and Baybay were randomly selected. The survey covered personal information and information on farming and fishing income before Typhoon Reming in 2007, and post Typhoon in 2010 and coping strategies. The fishing income information consisted of monthly income from fishing activity. For this analysis, data sets from non-motorized fishing household respondents were disaggregated from the pooled 360 respondents' data. The third was the socioeconomic survey of fishing households and focus group discussion of households impacted by storm surge and related hydro meteorological risks in Atulayan Island. The survey included a total enumeration of 107 fishing households in the island implemented by Partido State University researchers funded by the Commission on Higher Education (CHED) under the project entitled, Resettlement Study of Atulayan Fisherfolks as Anticipatory Adaptive Strategy Against Climate Change Impacts. The socioeconomic survey consisted of sociodemographic information, fishing information, perception of change in coastal environment, decisions to be resettled in safer areas. The fishing information consisted of annual fishing income of households.

Data manipulation technique. From the data sets covering both household surveys conducted in 2004 and 2010, the information from fisher respondent households with non-motorized boats were disaggregated from pooled data composed of fishers with motorized boats and without motorized boats. Because fishers with motorized boats also went fishing offshore, the information from fishing households without motorized boats were selected and used in the analysis to separate the impact of MPA on fishing income. The fishing income information generated during the gulf-wide household survey in 2014 were disaggregated for Atulayan, Malinao and San Miguel Island. While the fishing income information generated from household survey in Malinao in 2010 which was in the form of monthly income

was extrapolated into annual fishing income. This was done by multiplying the individual household fishing income data by 10 months, assuming average 10-month effective fishing operations in a year. The annual and monthly fishing income data generated from the gulf-wide survey household in 2004 and from the Malinao household survey in 2010 made use of fishing income in the context of net income from fishing as understood by respondents. However, the fishing income data generated from separate household surveys in Atulayan and in San Miguel Island in 2010 were in the context of revenue from fishing activity wherein the net income was calculated from the difference between the sum of fishing expenses and the revenue from fishing.

The annual fishing income of selected fisher respondents without motorized boats from the 2004 survey disaggregated for Atulayan, San Miguel and Malinao MPAs were then assigned as data sets before the evaluation period, or time 0. While the annual fishing income of selected fisher respondents without motorized boats from the separate surveys conducted for Atulayan, San Miguel Island and Malinao MPA communities in 2010 were assigned as data sets after the evaluation period, or time 1. The fishing income data in 2010 and 2004 surveys were transformed to their net present values using 2016 as base year. This was done by employing the compounding technique on the fishing income values using a 5% discount rate. The 5% discount rate is the prescribed rate by Philippine Council for Aquatic and Agricultural Resources Research and Development-Department of Science and Technology (PCAARRD-DOST) in financial evaluation of government projects involving natural resources.

Empirical strategy. The data were analyzed following the difference-in-difference (DID) approach to estimate the treatment effect of various level of management in MPA on fishing income over a period of 6 years from 2004 to 2010. The calculation was done following the equation:

$$D = [RMPA_{T1} - RMPA_{T0}] - [EMPA_{T1} - EMPA_{T0}] \quad (1)$$

where D = difference-in-differences, or average change in average annual fishing income of respondents between treated and counterfactual covering 6 years; $RMPA_{T0}$ = average annual fishing income of fisher respondents in regular-managed MPA in 2004, Time 0; $RMPA_{T1}$ = average annual fishing income of fisher respondents in regular-managed MPA in 2010, Time 1; $EMPA_{T0}$ = average annual fishing income of fisher respondents in erratic-managed (non-regular, unmanaged) MPA in 2004, Time 0; $EMPA_{T1}$ = average annual fishing income of fisher respondents in erratic-managed (non-regular, unmanaged) MPA in 2010, Time 1.

Using the above equation, a total of four analytical DID models were estimated namely: Individual MPA category model (Model 1); Regular and Non-Regular MPA category model (Model 2); Regular and Unmanaged MPA category model (Model 3), and Regular and Erratic MPA category model (Model 4). Model 1 estimated the DID of independent MPA categories (SMI, Atulayan and Malinao); Model 2 estimated the DID between regular MPA (SMI) and Non-regular (Atulayan) managed MPAs; Model 3 estimated the DID between Regular managed (SMI) and Unmanaged (Malinao) MPAs; and Model 4 estimated the DID between Regular managed (SMI) and Erratic managed MPAs. The erratic managed MPA is represented by the average of the combined mean annual fishing income of fisher respondents in Non-regular managed (Atulayan) and Unmanaged (Malinao) MPAs.

The treatment effect of MPA, time, locational difference of MPA, and provincial difference in economic condition on fishing income and MPA size was tested for statistical significance using ordinalry least square regression following NLOGIT Routine. In this analysis, fishing income was designated as dependent (y) variable; while MPA, time, locational difference of MPA, and provincial difference in economic condition were designated as independent (x) variables. Dummy variables were used for MPA (0 = non-managed, non-regular, erratic managed MPA; 1 = regular managed MPA), time (0 = Time 0, 2004; 1 = Time 1, 2010), locational difference (1 = respondent reside in MPA located in mainland community; 0 = respondent reside in MPA located in island community), and provincial difference in economic condition (0 = respondents belongs to Camarines Sur province; 1 = respondent belongs to Albay province); size (Atulayan MPA = 1, small; SMI MPA = 2,medium; Malinao MPA = 3, large). The relationships were specified as:

$$Y = \alpha + \beta_0 + \beta_1 X_1, + \beta_2 X_2, + \beta_3 X_3, + \beta_4 X_4, + \beta_5 X_5, + \grave{e} \quad (2)$$

where Y = average annual fishing income of fisher respondents, α = intercept, β_0= slope of regression, X_1 = MPA dummy, B_1= partial regression coefficient of MPA dummy, X_2= time dummy, B_2= partial regression coefficient of time dummy, X_3 = respondents' MPA location dummy, B_3= partial regression coefficient of respondent's MPA location dummy, X_4 = respondents' provincial economic condition dummy, B_4 = partial regression coefficient of respondents' provincial economic condition dummy, X_5= size of respondents' MPA dummy, B_5 = partial regression coefficient of size of respondents' MPA dummy.

The changes in percentage of fishermen with annual fishing income within, above, below, and integrating annual fishing incomes within and below an arbitrary prescribed poverty threshold between periods of Time 0 and Time 1 for each category of MPA management regimes of regular, non-

regular and un-managed MPAs were calculated using histogram. The arbitrary poverty threshold adopted the United Nation's a dollar a day income for poor households which is equivalent to PhP 48 a day or PhP 17,520 annually. A bin range was created from the arbitrary poverty threshold value. The ranges were composed of 10 lower values and 10 upper values from the arbitrary annual poverty threshold value. The lower bin ranges were generated by cumulatively reducing the arbitrary poverty threshold value from 1 to 10 times, while the upper bin ranges were generated by increasing the arbitrary poverty threshold value from 1 to 10 times making a total of 21 bin ranges. Each data set of average fishing income in MPA categories in the two periods was subjected to histogram analysis using the 21 bin ranges and their frequencies in each range were summed according to poverty level: within poverty threshold (frequencies within PhP 17, 520); above poverty threshold (frequencies above PhP 17, 520) and lower than poverty threshold (frequencies below PhP 17,520). The sum of frequency counts in each poverty level was then expressed as percentage against the total number of cases for a given MPA management regime in a given period.

RESULTS

Changes in fishing income in regularly managed, non-regular managed and unmanaged mpas over two time periods

In Model 1, regularly managed (SMI) MPA posted the relatively highest mean annual fishing income than non-regular managed (Atulayan) and unmanaged (SMI) MPAs in Time 0. Atulayan, a non-regularly managed MPA posted lower mean annual fishing income than unmanaged Malinao MPA. The trend was sustained over the 6-year period through Time 1. The wide discrepancy in mean annual fishing income change between Time 0 and Time 1 is evident in non-regularly managed and unmanaged MPAs giving them some anomalously higher values compared with the regularly managed MPA (Table 1). These suggest that mean annual fishing income of fishers in regularly managed MPA is relatively higher than fishers in non-regularly managed and unmanaged MPAs. Fishers in MPAs with non-regular and absence of management have relatively lower mean annual fishing incomes than those in managed MPA in Time 0.

In Time 0 and even 6 years later through Time 1, the unmanaged MPA posted mean annual fishing income higher than the non-regular managed MPA. The higher fishing income value in the unmanaged MPA could be explained by the existence of open access situation created by the lack of management that allowed unregulated fishing within the MPA in the period covered by the study.

The anomaly in mean annual fishing income values observed in unmanaged and non-regularly managed MPAs which represent the extent of the difference of the mea annual fishing income of fishers generated from Time 0 to Time 1, suggest the wider discrepancy in unmanaged and non-regularly managed MPAs, while narrower in managed MPA. Model 2 shows that the mean annual fishing income of fishers in regular managed MPAs is consistently higher than in erratic managed MPAs in two time periods with the extent of discrepancy reaching almost four times (Table 2).

Table 2. Average Annual Fishing Income in Individual MPAs (Model 1) and in Regular Managed (SMI) and Erratic Managed MPAs (Model 2) in Time 1 (T_0, 2004) and Time 2 (T_1, 2010) periods and their differences.

	T_0	T_1	T_1-T_0
Model 1 (Individual MPA Categories)			
Regularly Managed MPA (SMI)	44,984	50,182	5,198
Non-Regular Managed MPA (Atulayan)	14,063	25,987	11,925
Unmanaged MPA (Malinao)	28,761	50,022	21,261
Model 2 (Regular Managed and Erratic Managed MPAs)			
Regular Managed MPA (SMI)	44,984	50,182	5,198
Erratic Managed MPA (Atulayan+Malinao/2)	21,412	38,004	16,593

Difference in changes on fishing income between regular and non-regular managed MPAs, between regular managed and unmanaged MPAs and between regular managed and erratic managed MPAs

The change in mean annual fishing income between regularly and non-regularly managed MPAs was estimated at PhP 6,727 per fisher per year (Model 1); while a change in mean annual fishing income valued at PhP 16,063 was estimated between regularly managed and unmanaged MPAs (Model 2). To distinguish the effect of regular MPA management on mean annual fishing income, the average of the combined mean annual fishing incomes from non-regularly managed and unmanaged MPAs was compared with the mean annual fishing income of regularly managed MPA. A difference of PhP 11,395 in mean annual fishing income was estimated representing the positive effect of regular MPA management against problematic MPA management regimes (Model 3). The data tend to suggest a wider positive effect on mean annual fishing income of fishers in regular managed MPA against MPA without or almost without management. The effect in unmanaged MPA is almost three times bigger than that in non-regular managed MPA. The positive effect on mean annual fishing income of fishers by regular management to any variation of problematic management regimes does not deviate much from the difference between regularly managed and unmanaged MPA regimes (Table 3).

Effect of MPA, time, location of community and provincial socioeconomic condition differentials on fishers' mean annual fishing income

Ordinary least square regression analysis confirmed the treatment effect of MPA on mean annual fishing income of fishers and so for the other correlated variables of time, location and provincial socioeconomic condition and size differentials.

The significant and positive correlation of MPA on mean fishing income indicates that MPA increases fishing income of fishers in Lagonoy Gulf. The significant and negative correlation of TIME on mean fishing income suggests the mean fishing income of fishers in both MPA and Non-MPA communities decreases with time consistent with the effect of time on value of money over time. The significant and positive correlation of location indicates that fishers residing in MPA community situated in more geographically advantageous locations such as in mainland area, tend to have higher mean annual fishing income. Conversely, fishers residing in MPA community that is situated in an island, has relatively lower mean fishing income. The significant and positive correlation of provincial socioeconomic condition differential to mean fishing income suggest that fishers residing in MPA community situated in Albay province having relatively robust economy tend to have higher mean annual fishing income. Invariably, this also suggest that fishers residing in MPA community situated in Camarines Sur province whose

Table 3. Difference-in-Differences in Fishing Income between Regular Managed (SMI) and Non-Regular Managed (Atulayan) MPAs (Model 1), between Regular Managed (SMI) and Unmanaged MPAs (Malinao) (Model 2) and between Regular Managed (SMI) and Erratic Managed MPAs (Atulayan + Malinao/2) (Model 3).

	T_1-T_0	DID
Model 1 (Regular and Non-Regular Managed MPAs)		
Regular Managed MPA (SMI	5,198	6,727
Non-Regular Managed MPA (Atulayan)	11,925	
Model 2 (Regular Managed and Unmanaged MPAs)		
Regular Managed MPA (SMI)	5,198	16,063
Unmanaged MPA (Malinao)	21,261	
Model 3 (Regular Managed and Erratic Managed MPAs)		
Regular	5,198	11,395
Erratic Managed MPAs (Atulayan+Malinao/2)	16,593	

Table 4. Result of the OLS regression analysis of fishers' mean annual fishing income with MPA, time, location and provincial socioeconomic condition and MPA size differential in Lagonoy Gulf.

Variables	Coefficient	Standard Error	t-ratio	P [|T|>t]	Mean of X
Constant	- 6.914	14.460	- 0.478	0.633	
T	- 0.017	0.008	- 2.068	0.040**	468.016
MPA	21.176	7.065	2.998	0.003**	0.403
PROV	29.217	9.574	3.052	0.003**	0.717
LOC	19.264	8.167	2.359	0.019**	0.471
SITE	26.907	7.930	3.393	0.001**	0.644

** significant at 5% level ($p<0.05$)

socioeconomic condition is not similar to Albay, tend to have relatively lower mean annual fishing income. The postive and significant correlation of size indicates that fisher respondents in communities with bigger MPAs tend to have higher fishing income (Table 4).

Movement in proportion of fishers with mean fishing income above, within, and below $1 a day in regular managed, non-regular managed and unmanaged MPAs in Time 1 (T_0, 2004) and Time 2 (T_1, 2010)

The proportion of fishers with mean annual fishing income above the arbitrary poverty threshold of a dollar a day increases from 77% to 89% over six years in regular managed MPA (SMI). However, the proportion of fishers with mean annual income from fishing above the arbitrary poverty threshold measly increased from 46% to 47% in non-regular managed MPA (Atulayan). The widest movement in proportion of fishers whose mean annual fishing income are above the reference poverty threshold was observed in unmanaged MPA (Malinao) with 72% of fishers in the fishing income category increasing to 95% in the periods covered.

For those fishers considered as ultra-poor who have mean annual fishing income way below the arbitrary poverty threshold of a dollar a day, their proportions in regular managed (SMI) and unmanaged (Malinao) MPAs have been reduced significantly within six years. While the reduction in ultra-poor fishermen consistently remained narrow in non-regular managed (Atulayan) MPA.

Also, the proportion of fishers whose mean annual income falls within the poverty threshold moved slightly downward over six years in regular managed (SMI) and unmanaged (Malinao) MPAs. It is interesting to note however, that such observation does not hold true in non-regular managed (Atulayan) MPA, which merely posted a slight upward movement in the same period.

Combining both the proportions of fishers belonging to the categories of having mean annual fishing income within and above the arbitrary poverty threshold, their mean annual fishing income average showed a significant reduction of almost two times over six years in regular managed (SMI) MPA. Quite surprisingly, the same holds true with mean annual fishing income of fishers in unmanaged (Malinao) MPAs which posted a reduction by more than four times. Interestingly, the non-regular (Atulayan) MPA merely posted a relatively small reduction in the proportion of fishers with average annual fishing income within and below the arbitrary poverty threshold combined.

The data indicated that the proportion of fishers with average annual fishing income above the arbitrary poverty threshold increases over time in MPAs. Regular managed MPA posted the highest increase in the proportion of fishers with average annual fishing income above poverty threshold in comparison with non-regular managed MPA. The later period anomalous observation on the comparatively higher proportion of fishers with mean annual fishing income above poverty threshold in Malinao MPA against SMI and Atulayan MPAs, despite its being unmanaged, could be explained by its advantageous locational and provincial economic condition differentials. Malinao, unlike SMI and Atulayan Islands, is located in mainland coastal community endowed with varied ecosystems and resources such as mangrove forest and seagrass beds aside from coral reefs. Unlike Atulayan Island which is remotely located in Camarines Sur province, Malinao is under the political jurisdiction of Albay province with

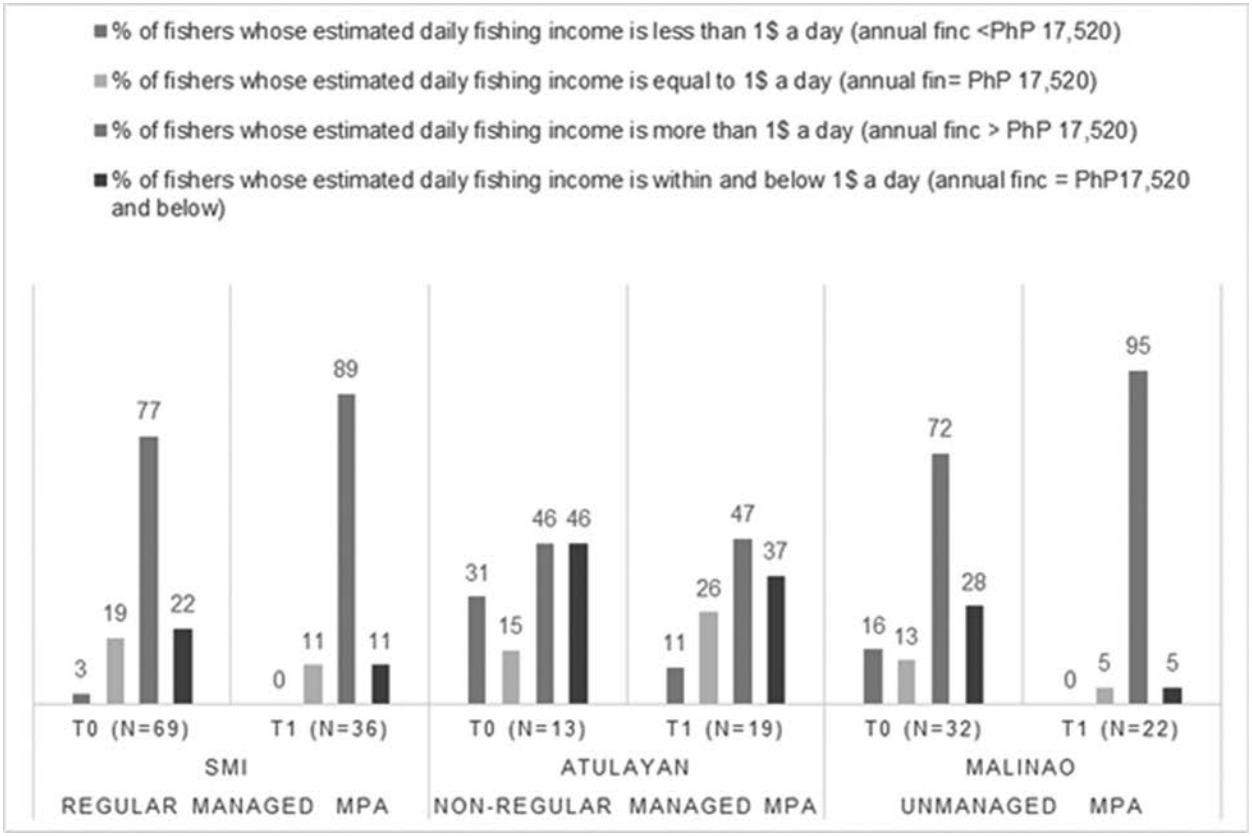

Fig. 2. Proportion of fishers with mean annual fishing income above, within, and below $1 a day in regular managed, non-regular managed and unmanaged MPAs in Time 1 (T_0, 2004) and Time 2 (T_1, 2010).

relatively robust economy. The locational and economic condition differential of Atulayan that is characterized as relatively smaller island and economically disadvantaged as compared with Malinao and SMI, also explain for its observed narrower increases in proportion of fishers with above and below the poverty threshold arbitrarily set in this study. This situation is demonstrated in the observed climb in the proportion of fishers with average annual fishing income within the poverty threshold of a dollar a day from 2004 to 2010 in Atulayan MPA (Fig. 2).

DISCUSSION AND CONCLUSION

The study demonstrated that MPA increases fishing income over time. This is despite the results of several studies showing that coral covers and associated habitats in these MPAs remained in their overall good to fair conditions, the reduced fishing area that resulted from regulated fishing activities within the core zones of the MPAs, and the inconclusive evidence pointing to the increase in fish catch of sustenance fishers in Lagonoy Gulf attributable to the implementation of coastal resource management regimes (For instance, Soliman et al. (2008) observed positive changes in the population of some commercially important reef fishes from 2004 to 2008 such as *Siganidae, Caesionidae* and *Serranidae,* composing a total of about 20% of all species). This deviation from *a priori* expectation could be explained in two contexts. The first context concerns the law of supply and demand; the second context concerns the quality of fish catch.

The first context could be explained by the fact that reduced fishing area and the regulatory measures of the MPA undeniably reduce the fishers' catch per unit effort that used to be observed when the fishery was in its open access state. This uniformed decrease in reef-based fisheries in these MPA communities reduces the supply of consumer-preferred reef fishes in the market within the span of the time covered by the study, triggering higher demand and commanding higher prices for the fish products. Also within the same reference periods saw many improvements in transportation infrastructures and communication facilities in the provinces covering the study areas allowing fish traders to access more competitive markets and influencing competitive selling price of raw fish catch by fishers. The higher selling price for fish catch afforded fishers with relatively higher profit margins that explained for their higher fishing income. Over the last six years and until present, the price of fish in the wet markets of Bicol Region has been steadily increasing. The increasing price of reef fish from PhP 80 per kilo in 2004, to PhP 120 in

2007, and PhP 240 and above in 2010 is fueled by the population growth of the Region coupled with the improving purchasing power of consumers and the expanding proportion of middle income group in the Philippine society in the recent years. In his study of a fishing community in the Philippines, Olsson (2009) confirmed that the benefits of road improvement were considerable and benefitted a great majority of population in the fishing community. In addition to their extensive direct effect of improved road, a number of complementary factors led to substantial indirect effects such as abundance of harvested resource in the community, a potential for technical innovations that increased production and productivity, available investment to support this increased production, abundant demand for this increased production in the market region (the market widened in spatial terms).

The second context could be explained by the fact that the regulatory mechanisms of MPA such as the no-take zone and reserve, while they reduce fishing areas, promote rational fishing that allows population enhancement of selectively caught fish species and enables fish stocks to achieve bigger harvestable sizes (An increasing number of studies have shown that fish populations inside reserves increase in size, live longer, grow larger and hence develop increased reproductive potential (McClanahan and Mangi 2000, Mosqueira et al. 2000, Roberts et al. 2001, Halpern and Warner 2002, Denny et al. 2004)). This in turn enable fishers to command relatively higher prices for their catch. The higher price imputed by consumers for premium fishes caught by sustenance fishers in these MPA areas afford them higher fishing income as before when the resource was at its open access state.

Over time, the mean annual fishing income is higher when management regime is regular and consistent, while the same effect is narrower when management regime is erratic. This is demonstrated by the mean annual fishing income variances between SMI and Atulayan MPAs. However, this study also showed that fishing income could possibly increase over time even if the MPA remained unmanaged as in Malinao. The former observation highlights the profound impact of MPA management regimes on fishing income of fishers in island communities whose economies are solely dependent on fishing. The latter observation highlights an artifact of open access impact, and the masking effect of a more endowed MPA community on fishing income of fishers even if they remained unmanaged. The anomalous observation on increase in mean fishing income in Malinao could be attributed to the medium-term after-effect of open access, rather than the conservation effect of regular MPA management. The fishing community of Malinao MPA is located in mainland area that is readily accessible to markets and characterized by varied economic activities made possible by its complex habitats and resources. Further, the Malinao MPA community has been a recipient of a community-based CRM intervention focusing on mangrove rehabilitation (Community-based Coastal Resource Management Project (CMCRMP) funded by the Department of Finance in 2004 and a fishery-resource management project in Sustainable Management of Coastal Resource (SUMACORE) funded by the Bureau of Fisheries and Aquatic Resources in 2008 (Bradecina 2011)). Both projects covered a livelihood development component, thus explaining relatively resilient economy of fishing households at the period covered by the study. The results of the regression analysis elucidating the positive and significant correlation of locational and provincial socioeconomic condition differential on fishing income as outcome variable support this argument.

These attributions on the potential of locational and provincial socioeconomic condition differential among MPA communities to mask and influence the direction of the impact on fishing incomes puts relatively smaller and less endowed island MPAs on a very marginalized situation. The relatively narrower observed differences in mean annual fishing income of fishers in non-regular managed Atulayan island MPA as compared with wider observed differences in mean annual fishing income in regular managed SMI MPA in time1 and time 2 highlighted the strong necessity of strictly promoting a consistent regular management regime in more marginalized, resource-dependent, less endowed smaller island MPAs if only to make economic impact of MPA more profound and discernible on these communities in medium and long term basis.

The movement in the proportion of fishers with fishing income above the arbitrary poverty threshold of a dollar a day set in this study strongly suggested the potential of MPA to contribute in the reduction of poverty in coastal communities. This study demonstrated that the proportion of fishers with mean fishing income earning less than a dollar a day were highly and moderately reduced in MPA communities with regular and non-regular management re = gimes respectively, and surprisingly even in unmanaged MPA. Whether or not this poverty reducing potential of MPA by increasing mean annual fishing income of fishers could be sustainable in managed and unmanaged MPAs on a long-term basis; and whether or not the increase in mean fishing income in unmanaged MPA is just an artifact of the medium-term after-effect of an open access fishery, require further studies in the future to obtain more enlightened conclusions.

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