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Factors affecting fisherfolk's support for coastal resource management: The case of local government-initiated mangrove protection activities

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Abstract

This article examines factors that influence support for local-government initiated mangrove protection activities. Using an ordered probit approach, we show how fisher characteristics and regional variation affect the level of support given to mangrove protection activities. Our results suggest that education levels, knowledge of the dangers of mangrove depletion, and pre-existence of mangrove-related ordinances in their municipalities are the factors that significantly affect the level of support for mangrove protection activities. In addition, we find that surveyed fisher communities from the southern region of the Philippines are less likely to support mangrove protection activities probably due to the higher rate of poverty incidence in these areas. These results have important implications for local government units in charge of mangrove planning and management.

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1. Introduction

Coastal habitats across the world are under heavy population and development pressures. Mangrove forest areas have been particularly vulnerable to exploitation because they occupy coastal land that is easily converted to other uses and they contain valuable wood and fishery resources.[1] The scale of human impact on mangroves worldwide has increased dramatically over the past three decades or so, with many countries losing approximately 60–80% of mangrove forest cover that existed in the 1960s [1].

The Philippines is an example of a tropical country where significant mangrove forest areas have been lost and degraded. Forested mangroves have been reduced from about 450,000 ha in 1920 to only about 120,000 ha in the late 1990s [2]. The most common reason for the reduction of mangrove areas in the Philippines has been the conversion of these coastal mangrove areas to fishponds for aquacultural purposes [3–7]. Estimates of one-third to over one-half of total mangrove areas in the Philippines were destroyed due to pond culture conversion [5,8]. Valuation studies have indicated that the value of mangrove products and amenities lost due to pond conversion may range anywhere from $550 to $1550/ha/year [9,10].[2]

National laws[3] prohibit the cutting and harvesting of any mangroves in the country (particularly for the purpose of converting to fishponds), but these laws have not prevented continued mangrove forest decline. Despite the 1980 government ban on conversion of mangroves to fishponds, the rate of mangrove forest reduction still increased through the early 1990s [11]. This top-down regulatory approach had limited success because there has been no clear delineation as to which government agency (e.g. local, provincial, regional, etc.) is responsible for enforcing these laws [11,12,19]. Hence, even with a national law to ban cutting and harvesting of mangroves, enforcement problems allow for continued degradation of this resource.

This situation has prompted the Philippine government to attempt mangrove reforestation of abandoned fishponds and other previously occupied mangroves, with the assistance of development projects and new policies in the 1980s to 1990s [11]. There are a number of development projects and policies over the years that emphasize the role of community stewardship/involvement in management of mangrove resources.[4] An example of a development project is the Central Visayas Regional Project (CVRP) (1984–1992) where secure tenure is provided to coastal families in return for maintaining an area as a healthy mangrove forest [11]. This project allowed for rapid mangrove replanting, but the success rates were still less than 50% due to lack of information, lack of suitable planting materials, and incidence of planting outside of the natural mangrove habitat [11].

[1]Mangroves are forest areas found in the brackish water margin between land and sea in tropical and sub-tropical regions of the world. These are rich ecosystems providing a variety of economic and environmental functions and products [1].

[2]Some examples of the mangrove products and amenities lost when mangrove forests are cleared include: coastal erosion protection, dampening of storm surges and high winds from typhoons, flood control, maintenance of biodiversity, pollution abatement, and a variety of natural forestry products (like firewood and construction wood materials).

[3]Presidential Proclamation 2146, 1982 and Republic Act 7161, 1991.

[4]A comprehensive discussion of all the development projects and policies on sustainable mangrove management is beyond the scope of this article. We only discuss some illustrative examples here to provide some context of the status of mangrove management in the Philippines. For a more detailed discussion about these issues please see the article of White and DeLeon [11].

The mangrove decline also stimulated the development of mangrove-reforestation policies that use contracts with local communities through community-based forest management agreements (CBFMAs). CBFMA is a production sharing agreement between a local community and the government to sustainably develop, utilize, manage, and conserve a specific area of the forestland [11]. The first national policy on mangrove management that encouraged community stewardship was the Department of Environment and Natural Resources (DENR) Administrative Order (AO) 15 issued in 1990. Several other AO's were endorsed by DENR through the late 1990s that allowed for involvement of non-governmental organizations and people's organizations. Even with these AO's, the legal conflict between the total ban for cutting mangrove and the need for these CBFMA recipients to harvest limited amounts impeded successful outcomes from these agreements.

In light of the modest successes of managing mangroves at the community level, the Philippine government realized that the best approach to better improve the status of coastal mangrove areas is to implement a decentralized coastal resource management (CRM) system. That is, instead of the conventional, top-down system where the central government is responsible for CRM, local government units (LGUs) were seen as the best-positioned institution to effectively manage coastal resources as long as there is support (or buy-in) from the local fisher communities [12].[5] With the passage of the 1991 Local Government Code and the 1998 Fisheries Code, CRM is now viewed as among the inherent functions of LGUs in accordance with their general powers for management within their territorial jurisdiction. LGUs are now tasked to play a key role as front line stewards and the last safety net for the protection and management of coastal and marine resources in the Philippines—including mangroves [13].

With the responsibility of sustainably managing coastal mangrove areas, LGUs have to determine which types of mangrove protection activities have the greatest chance of succeeding. The LGUs in the Philippines acknowledge that for a mangrove protection activity to be successful and sustainable, the local stakeholders—the fisherfolks in the coastal mangrove areas—must support and buy-in to this approach. Thus, it is important for LGUs to investigate which mangrove protection activity (or activities) would likely be supported by fisher communities.

In addition, information about which factors affect fisherfolk's level of support would help LGUs determine whether camps of support for particular mangrove protection activities could be identified based on the fishers' attributes or regional location. This type of information will also help LGUs determine which type of fisherfolk they need to reach in order to increase support for and increase the success probability of these mangrove protection activities. Funding priorities and outreach activities can be targeted better with knowledge about fisher characteristics that significantly affect the likelihood of support.

The objective of this study, therefore, is to determine and examine the factors affecting local fisherfolk's propensity to support LGU CRM initiatives aimed at protecting mangroves in their region. Specifically, we want to explore which factors affect the support for an initiative to: (1) restrict conversion of mangroves into fishponds, and (2) revert abandoned fishponds to mangroves. An ordered probit approach is used to achieve these

[5]LGUs responsible for CRM are typically the municipalities and cities where coastal regions are part of their jurisdiction.

objectives. A survey of fisher communities in the major coastal regions of the Philippines provides the data for the analysis.

The remainder of the paper is organized as follows. A conceptual framework is presented in the next section. The empirical approach and data are then described in the next two sections (Sections 3 and 4). The empirical results and conclusions are then discussed in Sections 5 and 6, respectively.

2. Conceptual framework: a model of resource management support

In examining the determinants of fishers' level of support toward specific mangrove resource management activities, it is important to first develop a behavioral model of resource management support. A fisherfolk's level of support for a particular CRM policy, and specifically toward a specific mangrove protection activity, can be viewed as being borne out of expected utility-maximizing behavior. Let us develop our behavioral model by first assuming that there are i mangrove protection activities, $A_1, A_2, \ldots, A_i$. The expected utility for a particular protection activity, which we represent as, say, A_i, and evaluated in period zero can then be defined as

$$E\left[\sum_{t=0}^{T} r^t U_t^i | \Omega_0\right] = U^i(\Omega_0), \quad (1)$$

where E is the expectation operator, r is the discount rate ($0<r<1$), U_t^i is the utility under mangrove protection activity A_i at time t, and Ω_0 is the information set the operator has, upon which to base his expectations of future utility at time zero.

The expected present value of utility under all possible mangrove protection activities can be expressed as

$$U^0(\Omega_0) = \omega_1 U^1(\Omega_0) + \omega_2 U^2(\Omega_0) + \cdots + \omega_i U^i(\Omega_0), \quad (2)$$

where the weights ω_i sum to 1 (i.e. $\sum_{i=1}^{n} \omega_i = 1$). This expression can then be interpreted as the weighted average of the expected utilities from each mangrove protection activity. The weights will all be equal (i.e. uniformly distributed) if all mangrove protection activities are already being implemented and are all applicable to the fisherfolk in question. At the other extreme, if all mangrove protection activities are still to be implemented, then the weights can be viewed as the probability of a particular mangrove protection activity being implemented (as perceived by the individual). If all protection activities are equally likely to be implemented, then the weights for each policy/activity are uniform.

A fisherfolk supports a particular mangrove protection activity A_i when his expected utility under this specific activity significantly dominates his average expected utility (U^0) based on all mangrove protection activities. In contrast, a particular fisher would not support a mangrove protection activity if its expected utility is significantly less than U^0. A fisherfolk may also be indifferent to a particular mangrove protection activity if the expected utility from this activity is approximately the same as U^0. Clearly, an individual fisher can support more than one protection activity because more than one activity can have an expected utility significantly above U^0. However, no one can support all activities at the same time because, from Eq. (2), it is impossible to have U^i above U^0 for all i.

A fisherfolk's assessment of expected utility from the various mangrove protection activities is undoubtedly subject to error. Hence, the difference between the expected utility under a particular mangrove protection activity i (U^i) and the weighted average of the expected utility from all policies (U^0) can be represented as

$$\hat{U}^i = U^i - U^0 = \tilde{U}^i + \varepsilon^i, \tag{3}$$

where ε^i is an error term with mean zero and variance σ^i. The degree of uncertainty surrounding $\tilde{U}^i$ rises as the variance σ^i increases. If the fisher is risk averse, he/she will select critical values for $\hat{U}^i$ which will determine his/her level of support for mangrove protection activity i. Assuming that we only have two critical values—α_1^i and α_2^i,[6] then we can represent the fisherfolk's level of support for a particular mangrove protection activity as

$$\begin{aligned}
&-\infty < \hat{U}^i < \alpha_1^i \Rightarrow \text{do not support the mangrove protection activity,}\\
&\alpha_1^i < \hat{U}^i < \alpha_2^i \Rightarrow \text{indifferent toward the mangrove protection activity,}\\
&\alpha_2^i < \hat{U}^i < +\infty \Rightarrow \text{support the mangrove activity.}
\end{aligned} \tag{4}$$

The model above can then be used to develop an empirical approach for assessing the factors that affect a fisher's support for alternative local government-initiated mangrove protection activities.

3. Empirical approach

To make the conceptual framework operational for empirical analysis, the elements of Ω_0 must first be established. These, generally, will be characteristics of the fisher and attributes of the fishing operation. One reason these characteristics may be correlated with the difference in expected utility ($\hat{U}^i$) is that the level of support for mangrove protection activities may vary systematically by type of fishing operation, education, views about the coastal resource environment, or other individual attributes. Therefore, we can represent the unobserved latent variable $\hat{U}_j^i$ as

$$\hat{U}_j^i = \mathbf{x}_j'\beta^i + e_j^i \tag{5}$$

for $j = 1, \ldots, N$ observations, where $\mathbf{x}_j'$ is a $(N \times K)$ matrix of observations on a set of explanatory variables, β^i is a $(K \times 1)$ vector of unknown parameters, and e_j^i is a random error term independently distributed with distribution function F. If $\hat{U}_j^i$ was observed for all observations, then β^i could be consistently estimated by ordinary least squares (OLS) without a distributional assumption required on e_j^i. However, $\hat{U}_j^i$ is not observed for all j observations and only an ordered discrete integer variable Y_j^i, taking one of the values $\{m = 1, 2, \ldots, M\}$ is observed. In our context, this ordered discrete integer variable represent the fisherfolk's level of support for a particular mangrove protection activity i, ranging from "not support at all" to "strongly support". Hence, analogous to (4) above, Y_j^i is related to

[6]Note that choosing two critical values (or three levels of support) in the conceptual framework is an ad hoc choice to facilitate illustration. The number of critical values (or levels of support) can be tailored to be consistent with the scale used in any survey instrument.

the unobserved latent variable as follows:

$$Y_j^i = \begin{cases} 1 & \text{if } \alpha_0^i < \hat{U}_j^i < \alpha_1^i \\ 2 & \text{if } \alpha_1^i < \hat{U}_j^i < \alpha_2^i \\ \vdots & \vdots \\ M & \text{if } \alpha_{M-1}^i < \hat{U}_j^i < \alpha_M^i \end{cases} \tag{6}$$

with the α_m^i's being the additional threshold parameters (or critical values) such that $\alpha_0^i < \alpha_1^i < \cdots < \alpha_M^i$. Thus, the range of $\hat{U}_j^i$ is partitioned into M mutually exclusive intervals and the variable Y_j^i indicates the interval into which the particular observation falls. The probability of a particular observed outcome, for $2 \leqslant m \leqslant M-1$, is given by

$$\begin{aligned} \Pr[Y_j^i = m] &= \Pr[\alpha_{m-1}^i \leqslant \hat{U}_j^i < \alpha_m^i] \\ &= \Pr[\alpha_{m-1}^i - \mathbf{x}_j'\beta^i \leqslant e_j^i < \alpha_m^i - \mathbf{x}_j'\beta^i] \\ &= F(\alpha_m^i - \mathbf{x}_j'\beta^i) - F(\alpha_{m-1}^i - \mathbf{x}_j'\beta^i), \end{aligned} \tag{7}$$

where F is the cumulative distribution function of e_j^i and is assumed to contain no additional unknown parameters; so that, for example, e_j^i has a known variance. This assumption fixes the scale of the measurement of $\hat{U}_j^i$, but not the origin. Identification can be achieved by assuming a zero intercept (i.e. $\mathbf{x}_j'$ does not contain a constant term).

Assuming that $\alpha_0^i = -\infty$ and $\alpha_M^i = +\infty$, then the full set of probabilities of the possible outcomes (or the importance categories) can be compactly written as

$$\Pr[Y_j^i = m] = F(\alpha_m^i - \mathbf{x}_j'\beta^i) - F(\alpha_{m-1}^i - \mathbf{x}_j'\beta^i) \tag{8}$$

for all m. This defines a class of cumulative probability models in which known transformation of the cumulative probabilities is taken to be a linear function of the exogenous variables ($\mathbf{x}_j'$) and only the intercept in this function differs across categories:

$$F^{-1}\{\Pr[Y_j^i = m]\} = \alpha_m^i - \mathbf{x}_j'\beta^i. \tag{9}$$

The natural estimator for this type of model is the maximum likelihood (ML) estimator. Assuming that ($Y_{jm}^i = 1$) if $Y_j^i = m$ and ($Y_{jm}^i = 0$) otherwise, then the likelihood function for our model can be written as

$$\log L^i = \sum_{j=1}^{N} \sum_{m=1}^{M} Y_{jm}^i \log[F(\alpha_m^i - \mathbf{x}_j'\beta^i) - F(\alpha_{m-1}^i - \mathbf{x}_j'\beta^i)]. \tag{10}$$

This likelihood function is maximized with respect to $(\beta^i, \alpha_1^i, \alpha_2^i, \ldots, \alpha_{M-1}^i)$, i.e. $K + M - 1$ parameters, where K is the number of exogenous variables (which are the fisherfolk and fishing operation characteristics in our context), remembering that β^i (and K) does not include an intercept.

If the cumulative distribution function F is assumed to be standard normal then the model above represent the ordered probit specification [14,15]. On the other hand, if the cumulative distribution function F is assumed to be logistic then the model above represents the ordered logit specification [16]. The ordered probit model is by far the most popular choice in analyzing ordinal response variables and this specification is what we use in examining the factors that affect fisherfolk's support of mangrove protection activities.

Hence, if we assume that F is standard normal (i.e. $e_j^i \sim N(0, \sigma^2)$) and adopting the scale normalization $\sigma = 1$, the full set of probabilities in (9) can be expressed as:

$$\Pr[Y_j^i = m] = \Phi(\alpha_m^i - \mathbf{x}_j^i \beta^i) - \Phi(\alpha_{m-1}^i - \mathbf{x}_j^{\prime} \beta^i), \tag{11}$$

where Φ is the standard normal cumulative distribution function. The log-likelihood in (10) can just be modified by replacing F with Φ to obtain the parameter estimates through the ordered probit specification.

4. Description of the data and variables

To implement the empirical approach above, this study utilizes the results of an extensive 1999 survey of fisher communities in various major coastal and fishing regions of the Philippines.[7] The survey was conducted in 16 provinces of the Philippines: Quezon, Palawan, Albay, Cebu, Negros Oriental, Negros Occidental, Bohol, Aklan, Leyte, Davao Oriental, Davao Del Norte, Davao Del Sur, Misamis Oriental, Zamboanga Del Sur, Lanao Del Norte, and Sarangani. The first three provinces listed above are in the Luzon island group, the next seven provinces are in the Visayas island group, and the last six provinces listed above are in the Mindanao island group. A map of these provinces and island groups is seen in Fig. 1. Random samples of fishers were selected from the major coastal area(s) in each province, which resulted in a sample size of 700. These fisherfolks were personally interviewed by enumerators in order to gather all the information for the survey.

Consistent with our conceptual framework above, the dependent variable used in this study is an ordered response signifying a fisher's level of support for two specific mangrove protection activities—(1) reverting abandoned fishponds to a mangrove area (*Revert*), and (2) restricting conversion of mangroves into fishponds (*Restrict*). Hence, survey respondents were asked how much they would support these two mangrove protection activities if these activities were initiated and implemented by the local government. The surveyed individual then has a choice of any one of the following ordered response: strongly support, support, indifferent, do not support, or do not support at all. Therefore, the *Revert* or *Restrict* variables would be equal to 5 if the fisherfolk strongly supports the activity, equal to 4 if the fisherfolk support the activity, equal to 3 if the fisherfolk is indifferent, equal to 2 if the fisherfolk do not support the activity, and equal to 1 if the fisherfolk do not support the activity at all. Descriptive statistics for these two dependent variables, as well as the independent variables discussed below, are presented in Table 1.

The independent variables in our empirical model can be grouped into five major categories—(1) region variables, (2) socio-economic variables, (3) fishing operation variables, (4) knowledge variables, and (5) law-related variables. The region variables are included in the model to examine whether there are varying regional support for mangrove protection activities. In particular, two model specifications are used to reflect two different regional groupings. First, we use a more aggregate grouping of regions corresponding to the three

[7] This survey was conducted by MBL Trends, Inc. contracted by The Coastal Resource Management Project (CRMP) supported by the United States Agency for International Development (USAID) in the Philippines (Project No. 492-0444). The list of specific municipalities where the survey was conducted is available from the authors upon request. Note that CRMP's objectives are to develop innovative approaches to CRM and to assist national/local government units in their implementation of sustainable CRM activities [18].

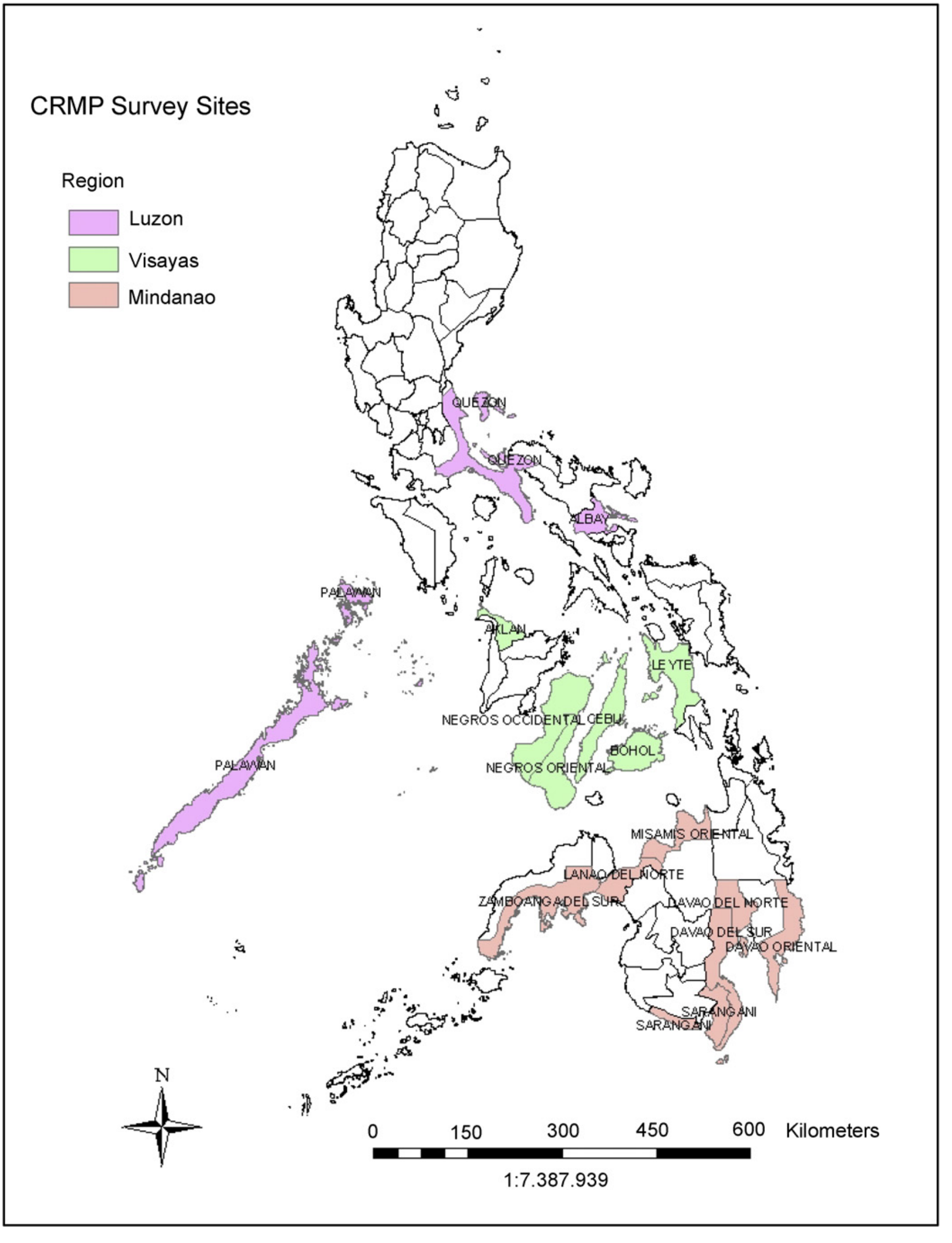

Fig. 1. Provinces where survey was conducted.

main island groups in the Philippines: Luzon, Visayas, and Mindanao (model 1). Second, we use regional variables based on the 16 provinces included in the survey (model 2). Dummy variables were created for all these regional groupings (See Table 1).

The socio-economic variables included in the empirical model includes ownership of agricultural land (*Agland*), number of years of education (*Educ*), and the fisherfolk's view on whether the coastal environment will be better in the future (*Environ*). The dummy variable regarding ownership of agricultural land is included in the model to give a sense of the financial situation of the fisher and his/her ability to shift livelihood from fishing to farming. We expect that ownership of agricultural land tend to reduce support for mangrove protection activities because the fisher would have alternative income aside from coastal activities and are not solely reliant on the coastal resource to have sustainable income over the long-run. Education levels are included because more informed fisherfolks tend to know that wanton extraction of coastal resources would not be sustainable in the long-run and that conservation policies are important. The *Environ* dummy variable is included to gauge the sentiment of the fisher with regards to the coastal environment. We expect that fishers that view the environment highly would tend to support mangrove protection activities.

The fishing operation variables included in the model are: the proportion of income from fishing (*%fishinc*), whether the fisher owns a "banca"[8] or not (*Banca*), weekly expenditures (in Philippine pesos) on maintenance of fishing gear (*Gear*). We expect all these variables to be directly (or positively) related to support for mangrove protection activities. Higher proportion of income from fishing is an indication of the level of reliance of the fisherfolk on the coastal resource for his livelihood. Ownership of a "banca" and weekly expenditures on maintenance of fishing gear also provides information about the size and scale of the fishing operation.

The knowledge variables included in the model pertain to the fisher's knowledge about mangrove-specific facts and/or issues. Dummy variables were created to indicate whether the surveyed fisher knows the erosion-reducing effect of mangroves (*Erosion*) and whether he/she knows that mangrove depletion could be dangerous to the health of coastal waters (*Danger*). Fisherfolks that tend to know these facts are more likely to support mangrove protection activities. The law-related variables in the model are those that indicate whether a particular mangrove-related regulation or ordinance is in place in the municipality where they live. Specifically, dummy variables were created that shows whether or not an ordinance to convert abandoned fishponds to new mangrove areas (*Ord1*) and whether or not an ordinance to restrict conversion of mangroves to fish ponds are already in place (*Ord2*). We expect that these ordinance dummies tend to have a positive effect on fisher support of mangrove protection activities.

5. Results and discussion

5.1. Distribution of support for mangrove protection activities

Figs. 2 and 3 show histograms that depict the distribution of fisherfolk's support for the two mangrove protection activities considered in this study. These distributions indicate that, in general, surveyed fishers in coastal regions of the Philippines would support mangrove protection activities that restrict conversion of mangroves and promote reversion of abandoned fishponds to mangroves. However, this information alone would

[8]A "banca" is a non-motorized boat that is typically used by small-scale fishermen in coastal areas of the Philippines.

Table 1
Descriptive statistics ($n = 700$)

Variable	Definition	Mean	St. dev.	Min.	Max.
(A) Dependent variables					
Revert	Response to: How much would you support a CRM activity that would revert abandoned fishponds to mangrove areas? (1 = do not support at all; 5 = strongly support)	3.585	1.267	1	5
Restrict	Response to: How much would you support a CRM activity that would restrict conversion of mangroves into fishponds? (1 = do not support at all; 5 = strongly support)	3.496	1.266	1	5
(B) Independent variables					
Region variables					
Luzon	1 if Luzon region, 0 otherwise (omitted category)	0.154	0.361	0	1
Visayas	1 if Visayas region, 0 otherwise	0.439	0.496	0	1
Mindanao	1 if Mindanao region, 0 otherwise	0.407	0.492	0	1
Bohol	1 if Bohol site, 0 otherwise	0.107	0.309	0	1
Cebu	1 if Cebu site, 0 otherwise	0.046	0.209	0	1
Negros Oriental	1 if Negros Oriental site, 0 otherwise	0.164	0.371	0	1
Quezon	1 if Quezon site, 0 otherwise (omitted category)	0.071	0.258	0	1
Albay	1 if Albay site, 0 otherwise	0.036	0.186	0	1
Aklan	1 if Aklan site, 0 otherwise	0.029	0.167	0	1
Negros Occidental	1 if Negros Occidental site, 0 otherwise	0.057	0.232	0	1
Leyte	1 if Leyte site, 0 otherwise	0.036	0.186	0	1
Zamboanga del Sur	1 if Zamboanga del Sur site, 0 otherwise	0.014	0.119	0	1
Misamis Oriental	1 if Misamis Oriental site, 0 otherwise	0.036	0.186	0	1
Davao del Norte	1 if Davao del Norte site, 0 otherwise	0.036	0.186	0	1

Table 1 (*continued*)

Variable	Definition	Mean	St. dev.	Min.	Max.
Davao Oriental	1 if Davao Oriental site, 0 otherwise	0.021	0.145	0	1
Davao del Sur	1 if Davao del Sur site, 0 otherwise	0.057	0.232	0	1
Palawan	1 if Palawan site, 0 otherwise	0.047	0.212	0	1
Sarangani	1 if Sarangani site, 0 otherwise	0.221	0.416	0	1
Lanao del Norte	1 if Lanao del Norte site, 0 otherwise	0.021	0.145	0	1
Socio-economic variables					
Agland	1 if owns agricultural land, 0 otherwise	0.129	0.335	0	1
Educ	No. of years of education	5.267	2.700	0	14
Environ	1 if fisherfolk believes that coastal environment would be better in the future	0.188	0.391	0	1
Fishing operation variables					
%fishinc	Proportion of income from fishing activities	73.639	19.692	12.5	87.5
Banca	1 if fisherfolk owns a banca, 0 otherwise	0.631	0.483	0	1
Gear	Weekly expenditures on maintenance of fishing gear	482.85	1514.01	5	9999
Knowledge variables					
Erosion	1 if fisherfolk knows about the erosion-reducing effect of mangroves	0.511	0.500	0	1
Danger	1 if fisherfolk knows that mangrove depletion could be dangerous to coastal water health	0.637	0.481	0	1
Law-related variables					
Ord1	1 if fisherfolk's municipality already implements an ordinance that reverts abandoned fishponds to mangrove areas	0.098	0.298	0	1
Ord2	1 if fisherfolk's municipality already implements an ordinance that restricts conversion of mangroves into fishponds	0.067	0.250	0	1

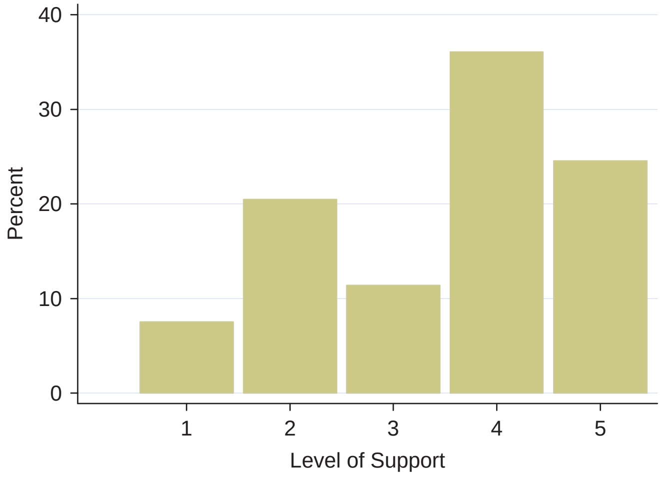

Fig. 2. Histogram for the *Restrict* variable: restricting conversion of mangroves into fishponds ($n = 700$).

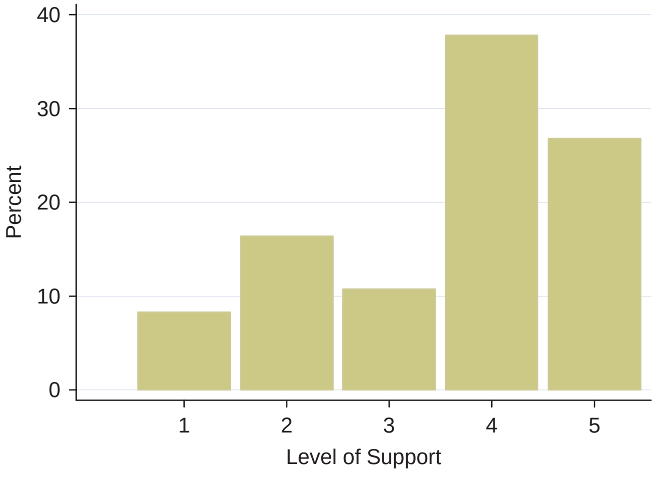

Fig. 3. Histogram for the *Revert* variable: reverting abandoned fishponds to mangroves ($n = 700$).

not show which fisher characteristics significantly affect their level of support. The results of the estimated probit model would give more useful insights that could be used by LGUs in planning and implementing different CRM programs.

5.2. Effects of fisherfolk and fishing operation characteristics on the level of support

Table 2 presents the parameter estimates of the ordered probit model where *Restrict* is the dependent variable. For model 1, the statistically significant variables (at the 10% level of significance) that are not regional dummies include *Educ*, *%fishinc*, *Banca*, *Gear*, *Danger*, and *Ord1*. On the other hand, for model 2, only *Banca*, *Gear*, *Danger*, and *Ord1* are non-regional variables that are statistically significant. Hence, owning a banca, expenditures on

Table 2
Estimated parameters of the ordered probit models: support for restricting conversion of mangroves into fishponds

Variable	Model 1[a]			Model 2[b]		
	Parameter	St. error	*p*-Value	Parameter	St. error	*p*-Value
Agland	−0.174	0.125	0.166	−0.076	0.129	0.557
Educ	0.043	0.015	0.005*	0.025	0.016	0.121
Environ	0.173	0.106	0.104	0.123	0.111	0.267
%fishinc	0.004	0.002	0.083**	0.004	0.022	0.111
Banca	0.280	0.087	0.001*	0.273	0.092	0.003*
Gear	0.001	0.00002	0.038	0.0001	0.00003	0.035*
Erosion	0.122	0.083	0.141	0.110	0.085	0.198
Danger	0.463	0.086	<0.001*	0.451	0.088	<0.001*
Ord1	0.446	0.239	0.062*	0.570	0.243	0.019*
Ord2	0.140	0.289	0.627	0.048	0.295	0.870
Visayas	−0.334	0.127	0.008	–	–	–
Mindanao	−0.477	0.127	<0.001*	–	–	–
Bohol	–	–	–	−0.572	0.201	0.004*
Cebu	–	–	–	−0.713	0.247	0.004*
Negros Oriental	–	–	–	−0.360	0.183	0.050**
Albay	–	–	–	−0.003	0.262	0.990
Aklan	–	–	–	0.484	0.310	0.118
Negros Occidental	–	–	–	1.023	0.252	<0.001*
Leyte	–	–	–	0.543	0.283	0.055**
Zamboanga Del Sur	–	–	–	−0.366	0.372	0.325
Misamis Oriental	–	–	–	−0.657	0.264	0.013*
Davao Del Norte	–	–	–	−0.479	0.263	0.069**
Davao Oriental	–	–	–	−0.176	0.308	0.567
Davao Del Sur	–	–	–	− 1.01	0.238	<0.001*
Palawan	–	–	–	0.674	0.256	0.009*
Sarangani	–	–	–	−0.153	0.178	0.391
Lanao Del Norte	–	–	–	0.329	0.330	0.319

Dependent variable: *Restrict*.
[a]Model 1 is where the regional dummies included are only *Visayas* and *Mindanao*.
[b]Model 2 is where the regional dummies included are the actual sites where interviews were conducted.
*Significant at the 5% level.
**Significant at the 10% level.

fishing gear, knowledge of whether mangrove depletion could be dangerous to the health of coastal waters, and an existing ordinance for reverting abandoned fishponds to mangroves, are the non-regional variables that are robust to alternative model specifications. This result suggests that these are the characteristics that significantly influence the strength of a fisher's support for a mangrove protection activity that would restrict conversion of mangroves to fishponds.

As is well known, the sign of the parameter estimates are only unambiguous for the ordered responses at the limits (i.e. $Restrict = 1$ and 5). In addition, the magnitudes of the coefficients are not directly interpretable as in OLS estimation [17]. In this regard, marginal effects for each ordered response need to be computed in order to properly interpret the

Table 3
Marginal effects of the independent variables for each outcome: support for restricting conversion of mangroves into fishponds

Variable	Model 1[a]: marginal effects (in %) for each support level					Model 2[b]: marginal effects (in %) for each support level				
	1	2	3	4	5	1	2	3	4	5
Agland	3.20	3.18	**0.37**	−2.77	−3.99	1.46	1.45	0.02	−1.63	−1.31
Educ	−0.28	**−0.62**	**−0.28**	−0.30	**1.48**	−0.16	**−0.35**	−0.15	− 0.12	0.78
Environ	**−2.51**	−3.34	−0.73	**1.85**	4.73	−1.87	−2.58	−0.36	2.14	2.67
%fishinc	−0.25	**−0.54**	−0.02	−0.03	0.13	−0.02	**−0.05**	−0.02	−0.02	0.11
Banca	**−4.12**	**−5.50**	**−1.16**	**3.24**	**7.53**	**−4.44**	**−5.68**	−0.62	**5.16**	**5.58**
Gear	−0.0004	−0.0009	**−0.0004**	−0.0004	**0.002**	−0.0004	−0.001	−0.0004	−0.0003	**0.002**
Erosion	−2.11	−2.31	−0.33	**1.81**	2.94	−1.99	−2.18	−0.12	2.26	2.03
Danger	**−6.08**	**−9.07**	**−2.29**	**4.10**	**13.33**	**−6.09**	**−9.47**	**−1.78**	**6.59**	**10.75**
Ord1	**−6.00**	−8.73	−2.14	**4.18**	12.69	**−7.30**	**−12.04**	−2.52	**7.79**	**14.07**
Ord2	−2.31	−2.71	−0.45	1.96	3.52	−0.87	−0.96	−0.06	0.99	0.90
Visayas	**7.21**	**5.46**	0.13	**−6.15**	**−6.65**	–	–	–	–	–
Mindanao	**10.68**	**7.72**	−0.22	**−9.32**	**−9.06**	–	–	–	–	–
Bohol	–	–	–	–	–	**14.39**	**7.90**	−1.73	**−13.48**	**−7.08**
Cebu	–	–	–	–	–	**19.15**	**8.39**	−2.79	**−16.83**	**−7.91**
Negros Oriental	–	–	–	–	–	**7.59**	**5.78**	−0.20	**−7.21**	**−5.96**
Albay	–	–	–	–	–	0.06	0.06	0.001	−0.07	−0.06
Aklan	–	–	–	–	–	**−6.57**	−10.26	−1.93	**7.26**	11.49
Negros Occidental	–	–	–	–	–	**−9.27**	**−20.10**	**−6.55**	**5.34**	**30.57**
Leyte	–	–	–	–	–	**−7.07**	**−11.47**	−2.32	**7.65**	13.22
Zamboanga Del Sur	–	–	–	–	–	8.32	5.97	−0.61	−8.43	−5.24
Misamis Oriental	–	–	–	–	–	**16.49**	**8.97**	−1.94	**−15.31**	**−8.21**
Davao Del Norte	–	–	–	–	–	11.53	**7.15**	−1.15	**−11.16**	**−6.36**
Davao Oriental	–	–	–	–	–	3.57	3.29	−0.035	−3.92	−2.91
Davao Del Sur	–	–	–	–	–	**30.00**	**7.46**	**−5.15**	**−22.83**	**−9.48**
Palawan	–	–	–	–	–	**−7.64**	**−14.20**	**−3.58**	**7.49**	**17.94**
Sarangani	–	–	–	–	–	2.94	2.97	0.05	−3.34	−2.63
Lanao Del Norte	–	–	–	–	–	−4.94	−6.92	−1.00	5.66	7.20

Dependent variable: *Restrict*.

[a]Model 1 is where the regional dummies included are only *Visayas* and *Mindanao*.

[b]Model 2 is where the regional dummies included are the actual sites where interviews were conducted.Figures in bold are statistically significant at the 10% level.

signs and magnitudes of each variable's effect. The marginal effects for the ordered probit models where *Restrict* is the dependent variable are shown in Table 3. The marginal effects for continuous variables are computed by taking the average of the marginal effects for each observation, rather than computing the marginal effect at the means of the variables. Note that for binary variables, the marginal effect is calculated based on the change in the predicted probability of an outcome moving from the omitted category to the included category (i.e. for binary variables moving from 0 to 1). The standard errors for these marginal effects are computed using the delta method.

For this paper, the ordered response of interest is for support levels 4 and 5, support and strongly support, respectively. That is, we want to know which variables significantly affect the probability of supporting or strongly supporting restricting conversion of mangroves

Table 4
Estimated parameters of the ordered probit models: support for reverting abandoned fishponds to mangroves

Variable	Model 1[a]			Model 2[b]		
	Parameter	St. error	*p*-Value	Parameter	St. error	*p*-Value
Agland	−0.193	0.127	0.127	−0.116	0.129	0.369
Educ	0.062	0.016	<0.001*	0.052	0.016	0.001**
Environ	0.173	0.107	0.107	0.131	0.112	0.242
%fishinc	0.001	0.002	0.657	0.001	0.002	0.821
Banca	0.201	0.087	0.021*	0.211	0.092	0.022*
Gear	0.00003	0.00003	0.377	0.00002	0.00003	0.479
Erosion	0.056	0.083	0.496	0.030	0.085	0.724
Danger	0.405	0.086	<0.001*	0.402	0.088	<0.001*
Ord1	0.278	0.237	0.241	0.338	0.240	0.159
Ord2	0.404	0.290	0.164	0.356	0.294	0.226
Visayas	−0.237	0.127	0.063**	–	–	–
Mindanao	−0.390	0.126	0.002*	–	–	–
Bohol	–	–	–	−0.424	0.201	0.035*
Cebu	–	–	–	−0.676	0.249	0.007*
Negros Oriental	–	–	–	−0.533	0.185	0.004*
Albay	–	–	–	−0.235	0.263	0.372
Aklan	–	–	–	0.694	0.325	0.033*
Negros Occidental	–	–	–	0.940	0.257	<0.001*
Leyte	–	–	–	0.455	0.293	0.120
Zamboanga Del Sur	–	–	–	−0.422	0.375	0.262
Misamis Oriental	–	–	–	−0.552	0.265	0.037*
Davao Del Norte	–	–	–	−0.715	0.265	0.007*
Davao Oriental	–	–	–	−0.156	0.319	0.625
Davao Del Sur	–	–	–	−0.658	0.238	0.006*
Palawan	–	–	–	0.328	0.250	0.190
Sarangani	–	–	–	−0.265	0.179	0.139
Lanao Del Norte	–	–	–	−0.081	0.328	0.805

Dependent variable: *Revert*.
[a]Model 1 is where the regional dummies included are only *Visayas* and *Mindanao*.
[b]Model 2 is where the regional dummies included are the actual sites where interviews were conducted.
*Significant at the 5% level.
**Significant at the 10% level.

to fishponds. Based on model 1, *Educ*, *Environ*, *Banca*, *Gear*, *Erosion*, *Danger*, and *Ord1* all positively influence the probability of supporting (*Restrict* = 4) and/or strongly supporting (*Restrict* = 5) restricting conversion of mangroves to fishponds. For model 2, *Banca*, *Gear*, *Danger*, and *Ord1* positively affects the probability of support level 4 and/or 5. Except for gear, the magnitudes of the effects of these variables are not trivial. For example, in model 1, a one year increase in education tends to increase the probability of a fisherfolk strongly supporting mangrove conversion restrictions by 1.48%. Among the dummy variables, knowledge about erosion effects and the danger caused by mangrove depletion, a positive outlook on the coastal environment, and the existence of an ordinance (to revert abandoned fishponds to mangroves) tend to have a very large effect on the probability of supporting the CRM activity of restricting mangrove conversions. Overall, the marginal effects in Table 4 suggest that fishers that have higher levels of education, have a positive outlook on the future of the coastal environment, owns a banca, knows the erosion effects/

Table 5
Marginal effects of the independent variables for each outcome: support for reverting abandoned fishponds to mangroves

Variable	Model 1[a]: marginal effects for each support level					Model 2[b]: marginal effects for each support level				
	1	2	3	4	5	1	2	3	4	5
Agland	3.59	3.06	**0.75**	−2.35	**−5.06**	1.94	2.00	**0.53**	−1.57	−2.90
Educ	−0.45	−0.75	**−0.41**	−0.60	**2.22**	−0.37	−0.62	**−0.33**	−0.40	1.71
Environ	**−2.45**	−2.77	−0.98	**0.88**	5.32	−1.54	−2.18	**−0.88**	**0.61**	3.99
%fishinc	−0.01	−0.01	−0.01	−0.01	0.03	−0.003	−0.01	−0.003	−0.003	0.02
Banca	**−3.17**	**−3.33**	**−1.05**	**1.68**	**5.87**	**−3.09**	**−3.69**	**−1.19**	**2.21**	**5.76**
Gear	−0.0002	−0.0003	−0.0002	−0.0002	0.0009	−0.0001	−0.0002	**−0.0001**	−0.0002	0.001
Erosion	−0.98	−0.93	−0.25	0.62	1.55	−0.48	−0.53	**−0.15**	**0.38**	0.78
Danger	**−5.69**	**−6.70**	**−2.41**	**2.26**	**12.54**	**−4.89**	**−6.90**	**−2.69**	**2.40**	**12.07**
Ord1	−4.18	−4.59	−1.53	**2.00**	8.30	**−4.14**	−5.77	**−2.24**	**2.01**	**10.13**
Ord2	**−5.59**	−6.61	−2.41	**2.03**	12.58	−4.31	−6.07	**−2.38**	2.00	10.75
Visayas	5.12	**3.59**	**0.578**	−3.81	**−5.48**	–	–	–	–	–
Mindanao	**8.63**	**5.81**	**0.848**	**−6.48**	**−8.80**	–	–	–	–	–
Bohol	–	–	–	–	–	**9.11**	**6.58**	**0.84**	**−8.03**	**−8.51**
Cebu	–	–	–	–	–	**17.19**	**8.67**	**−0.19**	**−14.63**	**−11.05**
Negros Oriental	–	–	–	–	–	11.49	**8.10**	**1.02**	**−9.93**	**−10.68**
Albay	–	–	–	–	–	4.56	3.89	0.74	−3.99	−5.20
Aklan	–	–	–	–	–	**−6.61**	−10.96	**−5.15**	−0.32	**23.04**
Negros Occidental	–	–	–	–	–	**−7.50**	**−13.80**	**−7.19**	−4.18	**32.67**
Leyte	–	–	–	–	–	**−5.13**	−7.62	**−3.17**	1.74	14.19
Zamboanga Del Sur	–	–	–	–	–	8.50	6.75	**1.14**	−7.35	−9.04
Misamis Oriental	–	–	–	–	–	**11.54**	**8.65**	**1.27**	**−10.07**	**−11.39**
Davao Del Norte	–	–	–	–	–	16.79	**9.89**	**0.58**	**−14.20**	**−13.06**
Davao Oriental	–	–	–	–	–	2.89	2.64	**0.57**	−2.50	−3.59
Davao Del Sur	–	–	–	–	–	**15.85**	**8.99**	0.32	**−13.55**	**−11.60**
Palawan	–	–	–	–	–	**−4.03**	**−5.68**	**−2.19**	**2.08**	**9.83**
Sarangani	–	–	–	–	–	4.97	4.51	**0.93**	−4.43	−5.99
Lanao Del Norte	–	–	–	–	–	1.32	1.39	**0.38**	−1.05	−2.05

Dependent variable: *Revert*.
[a]Model 1 is where the regional dummies included are only *Visayas* and *Mindanao*.
[b]Model 2 is where the regional dummies included are the actual sites where interviews were conducted.Figures in bold are statistically significant at the 10% level.

danger of mangrove depletion, and lives in a municipality with an existing mangrove protection ordinance tend to support/strongly support an activity that restricts conversion of mangroves into fishponds. Note that the signs of these variables follow our *a priori* expectations.

Let us now discuss the ordered probit model results for the *Revert* dependent variable. In both model specifications, *Educ*, *Banca*, and *Danger* are the non-regional variables that significantly affect the support level for a mangrove protection activity that would allow reversion of abandoned fishponds to mangroves (Table 4). As discussed above, the magnitudes of these parameter estimates are not directly interpretable and the signs are only unambiguous for the outer limit responses. Hence, to facilitate interpretation, the calculated marginal effects are presented in Table 5. For model 1, not owning agricultural

Table 6
Percentage of fisherfolks who consider themselves poor, by region (based on the 1999 CRMP survey)

Province	% of fisherfolks who consider themselves poor
Luzon	76
Albay	76
Palawan	73
Quezon	66
Visayas	83
Bohol	72
Cebu	81
Negros Oriental	89
Aklan	90
Negros Occidental	90
Leyte	84
Mindanao	86
Zamboanga Del Sur	80
Misamis Oriental	72
Davao Del Norte	80
Davao Oriental	87
Davao Del Sur	93
Sarangani	88
Lanao Del Norte	93

land, higher educational levels, a positive outlook toward the environment in the future, owning a banca, knowledge of the danger of mangrove depletion, and existing mangrove-related ordinances tend to positively affect the probability of supporting/strongly supporting (i.e. *Revert* = 4 or 5) an activity that reverts abandoned fishponds to mangroves. For model 2, the same variables significantly affect the probability of supporting/strongly supporting restriction of mangrove conversion to fishponds (except for owning agricultural land). Again, the signs of these variables are consistent with our *a priori* expectations. In addition, most of these variables have non-trivial marginal effects.

5.3. *Regional effects on the level of support*

The regional variables in Tables 2–5 also deserve some discussion here. Let us first discuss the regional effects for the model where *Restrict* is the dependent variable (Tables 2 and 3). The parameter estimates and marginal effects for the regional dummies indicate that there are significant regional variations in terms of the support for restricting mangrove conversion to fishponds. For the more aggregate regional specification in model 1, the results suggest that fisherfolks in Visayas and Mindanao have a lower probability of supporting a mangrove protection activity restricting mangrove conversion to fishponds, relative to the fisher communities in Luzon. In terms of model 2, relative to the omitted Quezon site,[9] Bohol, Cebu, Negros Oriental, Misamis Oriental, Davao del Norte, and

[9]We chose Quezon as the omitted site category because this is where the Philippine government has historically implemented mangrove/fisheries conservation awareness activities first. Hence, it is a good default category to compare the other sites to.

Table 7
Poverty incidence measures in the rural areas of selected Philippine provinces, 2005

Province	Poverty incidence levels
Luzon	
Albay	0.5185
Palawan	0.5750
Quezon	0.4782
Visayas	
Bohol	0.5017
Cebu	0.5330
Negros Oriental	0.5473
Aklan	0.5458
Negros Occidental	0.5558
Leyte	0.4798
Mindanao	
Zamboanga Del Sur	0.5217
Misamis Oriental	0.4828
Davao Del Norte	0.4167
Davao Oriental	0.5745
Davao Del Sur	0.3564
Sarangani	0.6778
Lanao Del Norte	0.5472

Note: Poverty incidence for a given area is defined here as the proportion of individuals living in that area who are in households with an average per capita expenditure below the poverty line.
Source: Ref. [20].

Davao del Sur are the sites that have a lower probability of supporting restrictions on mangrove conversion to fishponds. Only Aklan, Negros Occidental, Leyte, and Palawan have a higher probability of supporting an activity that restricts mangrove conversion to fishponds. The remaining sites not mentioned are not statistically different from the omitted Quezon site.

The regional dummy variables for the model with *Revert* as the dummy variable also show significant regional differences (Tables 4 and 5). In this case, the Visayas and Mindanao regions still tend to have lower support for restricting mangrove conversion compared to the Luzon region. For the more disaggregate specification, fisher communities in Bohol, Cebu, Negros Oriental, Misamis Oriental, Davao del Norte, and Davao del Sur tend to have a lower probability of supporting a mangrove protection activity that restricts mangrove conversion relative to the fishers in Quezon. On the other hand, the fisher communities in Aklan, Negros Occidental, and Palawan tend to have a higher probability of supporting mangrove conversion restrictions relative to Quezon province fisher communities.

These regional results strongly suggest that fishers from the Visayas and Mindanao provinces may not have strong mangrove protectionist attitudes, as compared to the Luzon provinces.[10] We believe the main reason behind this is the relatively higher poverty

[10] One reviewer argued that the Visayas region should have strong mangrove protectionist attitudes due to the implementation of the Central Visayas Regional Project (CVRP) in the mid-1980s to early 1990s. However, it should be noted that the Visayas fishers surveyed in this study may not be the same people who participated in the

levels in the rural coastal provinces of Visayas and Mindanao. As Table 6 shows, the proportion of surveyed fisherfolks who consider themselves poor[11] are relatively higher in Visayas and Mindanao. The coastal communities of Bohol and Cebu, for example, have been known to have higher population densities and poverty levels; and these factors have always been pointed to as the main causes of environmental degradation in the area [6]. According to a study by the Philippine National Statistical Coordination Board [20], rural poverty incidence in Bohol and Cebu, for example, are 0.5017 and 0.5330, respectively, which is higher than the Quezon rural poverty incidence of 0.4782 (see Table 7). In general, the poverty incidence measures in the rural areas of the surveyed Luzon provinces tend to be lower than the rural regions of the surveyed Visayas and Mindanao regions (Table 7).

In general, these regional results are helpful in terms of choosing locations for initial implementation of CRM activities, such as converting abandoned fishponds to mangroves (assuming it has not been implemented). In addition, these regional results would make local LGUs aware of whether fisherfolks in their respective areas tend to support (or not support) mangrove protection activities. LGUs in these "non-supportive" areas can then potentially re-allocate resources to increase educational and outreach programs about why mangrove protection activities are important. This could raise awareness about the benefits of mangrove protection activities and, hopefully, increase support for these activities in the future.

6. Conclusions and policy implications

Overall, the results above suggest that education levels, knowledge of the dangers of mangrove depletion, and pre-existence of mangrove-related ordinances in their municipalities are the strongest and most robust variables that tend to significantly affect the level of support for CRM activities that help protect mangrove resources. In addition, regional variation in support is evident, and that fisher communities from the southern regions of the Philippines (i.e. Visayas and Mindanao) are less likely to support mangrove protection activities.

It is apparent that providing more knowledge about the adverse consequences of mangrove depletion tends to increase support for protection activities. The empirical results also show that there are regions and provinces that do not tend to support mangrove activities. Thus, from a policy perspective, LGUs in areas with low support should take cue from these results and attempt to increase outreach programs to increase awareness about the erosion-reducing effects and the lost environmental amenities from

(*footnote continued*)
CVRP project. For example, the municipalities in Bohol province where CVRP was implemented (Bien Unido, Jetafe, Pres. C.P. Garcia, Talibon, and Ubay) were not the municipalities surveyed in this study (Buenavista, Calape, Clarin, Inabanga, and Tubigon) (see [21] for a complete list of CVRP municipalities). Most of the CVRP municipalities in other provinces (e.g. Cebu and Negros Oriental) did not overlap with our surveyed municipalities. In addition, it can be reasonably expected that the *Ord1* and *Ord2* dummies have been able to control the effects of previous mangrove initiatives in the regression model. Thus, controlling for past initiatives or ordinances, the surveyed fisherfolks in the Visayas and Mindanao regions tend to be inherently less supportive of mangrove conservation practices. Lastly, it can be argued that the negative poverty effect (discussed in the text) may have dominated the positive effects of previous initiatives; resulting in a negative regional dummy coefficients for some of the Southern provinces.

[11]These are fisherfolk perceptions who consider themselves as poor (self-rated) based on the MBL-Trends-CRMP survey.

cutting-down mangrove forest areas. Perhaps LGUs could partner with local environmental non-government organizations (NGO's) to help in this process. If fisher communities become more aware of the negative environmental effects of mangrove depletion, then it is more likely that they will buy-in to the LGU-led initiatives to protect this forest resource and at the same time it will make it easier for these LGUs to overcome the enforcement issues that have plagued these types of initiatives in the past.

In addition, promotion of alternative livelihood options that could substitute for the ventures that adversely affect mangroves should also be explored. It is entirely possible that low levels of support from fishers may be due to a lack of knowledge about alternative livelihood options that do not adversely affect coastal mangrove forests. For example, fisherfolks that operate small-scale pond culture ventures may not know that there are other "non-destructive" business options that they could pursue to earn a livelihood.[12] These fisher communities could then be encouraged to shift to other forms of livelihood that is less destructive to mangrove areas. Consequently, these fisher communities could potentially increase their support for mangrove protection activities (knowing that they have other non-destructive means for earning a living). In the end, with higher levels of fisher support, these mangrove protection activities would have a better chance to be effective in sustainably managing this forest resource.

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