Environmental Conservation 37 (4): 398–409 © Foundation for Environmental Conservation 2010 doi:10.1017/S0376892910000779

Integrated management of coastal resources and human health yields added value: a comparative study in Palawan (Philippines)

THEMATIC ISSUE
Interdisciplinary Progress in Environmental Science & Management

LEONA D'AGNES*, HEATHER D'AGNES, J. BRAD SCHWARTZ, MARIA LOURDES AMARILLO AND JOAN CASTRO
PATH Foundation Philippines Inc., 10/F Unit 1009 Tower 2, Cityland Condominium 10, 154 HV Dela Costa Street, Salcedo Village, Makati City 1227, Philippines
Date submitted: 30 November 2009; Date accepted: 18 May 2010; First published online: 22 November 2010

SUMMARY

A quasi-experimental design was used to test the hypothesis that there will be a significant improvement in both coastal resource management (CRM) and human reproductive health (RH) outcomes by delivering these services in an integrated manner as opposed to delivering either in isolation. The CRM, RH and integrated CRM+RH interventions were tested in three island municipalities of Palawan. Pre-project (2001) and post-project (2007) measurements of dependent variables were gathered via biophysical and community household surveys. Regression analyses indicate the CRM+RH intervention generated higher impacts on human and ecosystem health outcomes compared to the independent CRM and RH interventions. Improvements in coral and mangrove conditions are attributed to the effects of protective management by collaborating peoples' organizations. The same institutions managed RH activities that enabled contraceptive access and a significant decrease in the average number of children born to women in the study area. Other trends showing a significant reduction in income-poverty among young adults infer added value. To ensure long term sustainability of CRM gains and prevent over-use of coastal resources, integrated forms of management that engage communities in the simultaneous delivery of conservation and family planning services are needed.

Keywords: coastal resource management, family planning, food security, human-ecosystem health, human reproductive health, integrated population-environment, interdisciplinary approach, marine biodiversity conservation, sustainable development, synergistic approach

INTRODUCTION

Philippine human population density and growth drive unsustainable patterns of marine resource extraction that in turn undermine the biological diversity and productivity of coastal ecosystems and habitats (Pauly & Chua 1988; Cicin-Sain & Knecht 1998; Cruz-Trinidad *et al.* 2002; Alcala & Russ 2002; Green *et al.* 2003), yet population factors are often overlooked in conservation strategy formulation. The Philippine National Biodiversity Strategy and Action Plan (Ong *et al.* 2002), for example, recognizes population pressure as a root cause of biodiversity loss, but does not propose actions to address that threat. This study used a population-environment approach to address both rapid population growth and marine resource decline in an integrated fashion in selected rural coastal areas in southern Philippines.

The Philippines is recognized as the epicentre of marine diversity and its coastal and marine resources are an important economic resource and food, especially protein, source (White & Cruz-Trinidad 1998; Carpenter & Springer 2005). Yet, <4% of Philippine coral reefs are in excellent condition and fisheries resources are overexploited (Courtney *et al.* 1999; Licuanan & Gomez 2000; Israel & Banzon 2002; Alcala & Russ 2002; Green *et al.* 2003; DA/BFAR [Department of Agriculture/Bureau of Fisheries and Aquatic Resources] 2004; World Bank 2005; White *et al.* 2006). One reason for fisheries decline and coastal habitat degradation is increased anthropogenic pressure on the resources owing to large coastal populations' dependency on marine resources for income, food and habitat (Pauly & Chua 1988; Cicin-Sain & Knecht 1998; Courtney *et al.* 1999; Cruz-Trinidad *et al.* 2002). Sixty-two per cent of Filipinos reside in the Philippine coastal zone (DENR-DILG [Department of Environment and Natural Resources-Department of the Interior and Local Environment] 2007) and the density of human settlements averages 286 persons per km^2 (World Bank 2005; ADB [Asian Development Bank] 2006) as compared to 255 nationwide (NSO [National Statistics Office] Philippines 2000). In the biodiversity-rich marine corridors of the Danajon Bank and Verde Island Passage, population densities exceed 600 persons per km^2 (CIESIN [Centre for International Earth Science Information Network] 2000; PFPI [PATH Foundation Philippines Inc.] 2009), densities three times the level associated with high biodiversity loss (Harrison 1997). The human populations in marine hotspot regions are growing at a faster pace than the Philippine national average figure of 2.04% a year (NSO Philippines 2007) which already surpasses the average growth rate for the world as a whole (1.4%), for developing countries (1.6%) and for global biodiversity hotspots (1.8%) (Cincotta *et al.* 2000). For example, in Tawi-Tawi province, whose surrounding seas contain 25% of the

*Correspondence: Leona D'Agnes e-mail: ldagnes@gmail.com

coral reef cover in all of the Philippines (NOAA [National Oceanic and Atmospheric Administration] Ocean Explorer 2007), the population is expanding annually by 5.53% (NSO Philippines 2009) owing to the province's above-average rates of total fertility, migration and population momentum (DeLaPaz & Colson 2008). To keep pace with the current rate of population growth, in 2002 Armada (2002) estimated that fish stock must increase by 30% by 2010, a tall order given the overstressed state of Philippine marine-coastal ecosystems and the prevailing open access regime, which in effect encourages overfishing (Silvestre *et al.* 1989).

Pauly and Chua (1988) first analysed the interrelationships among population-environment dynamics and overfishing in coastal Philippines. Subsequently Pauly (1994) outlined a three-pronged approach to roll-back overfishing and restore coastal habitats: (1) create land based alternative employment opportunities for young fishers; (2) rebuild traditional management mechanisms to limit entry complemented by modern measures such as the establishment of marine protected areas (MPAs); and (3) ensure that women in rural coastal communities have the means to limit the number of children they want to bear. Pauly (1994) noted that women's right to family planning was largely negated by husbands and other powerful men (conservative politicians and religious leaders) in Philippine society. This observation holds fast to this day, with Filipino women still having more pregnancies than they want owing to sociocultural constraints and lack of access to contraceptive services (Alonzo 2004; Engelman 2008). This situation is particularly acute in rural coastal Philippines where health infrastructure is poor and communities are geographically isolated and difficult to reach.

The Philippine non-profit organization PATH Foundation Philippines Inc (PFPI) Integrated Population and Coastal Resource Management (IPOPCORM) initiative takes an interdisciplinary approach to address overfishing and high population growth in coastal Philippines. IPOPCORM's central organizing theme is food security from the sea, assuring people's access to an affordable and sustainable supply of marine resources. This is particularly important considering the high levels of poverty and malnutrition in coastal Philippines, where 80% of fisher households earn below the poverty threshold (DENR-DILG 2007) and where children in fisher households are three times more likely to suffer from malnutrition compared to children in other households (M.A. Amarillo, L. D'Agnes & J. Castro, unpublished data 2005). Fish and other aquatic products supply 35–45% of the total animal protein intake of Filipinos (White 2008) and as much as 70% in small islands (DENR-DILG 2007). Managing these resources is an important factor for coastal food security. The IPOPCORM model uses a holistic approach to achieve food security by simultaneously (1) improving management of coastal resources; (2) supporting alternative livelihoods among fishers to reduce fishing pressure; and (3) easing population pressure by expanding access to family planning services.

Marten's (2001) linked 'eco-social systems' concept provides the theoretical basis for integrating human health and natural resource management by assuming that small improvements in ecological and social systems can reinforce one another and catalyse feedback loops and synergies that tip a whole system from ruin to restoration (Fig. 1).

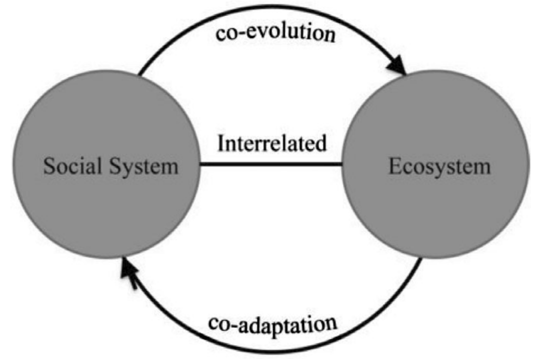

Figure 1 Linked eco-social systems concept.

Researchers and practitioners in the population–environment field hypothesize that projects that deliver integrated conservation and health services, including family planning and reproductive health (hereinafter labelled RH), resonate with rural communities and result in more community buy-in, greater acceptance of the interventions, and better conservation and health results (D'Agnes & Margoluis 2007; Pielemeier *et al.* 2007). These integrated projects may also add value to conservation and health efforts by enhancing natural resource sustainability and quality of human life (White *et al.* 2005; Pielemeier *et al.* 2007) and by alleviating poverty (Merrick 2002; DeSouza 2004). One possible reason is that biodiversity conservation measures can require communities to forego income and the provision of health services may balance the community's opportunity costs by improving welfare (Melnyk 2001). Incorporating gender perspectives can also help to remediate disparities in natural resource management (D'Agnes *et al.* 2005) and other inequitable social arrangements in rural communities, which may cause both rapid population growth and environmental degradation in many developing countries (Mazur 2009).

While RH interventions are likely to play only a limited role in the resuscitation of Philippine marine resources, nevertheless it will be difficult to sustain conservation gains without parallel effort to address demographic factors and related gender inequity issues in coastal Philippines, particularly the high rate of unintended pregnancy among women and teens and their lack of access to contraceptive services (Engelman 2008; Guttmacher Institute 2009). This is particularly true in biodiversity rich coastal areas, such as those bordering marine protected areas, where communities acutely lack access to RH services and unmet need for family planning is high due to either geographic remoteness or political and social opposition or some combination of both factors. By demonstrating the improved outcomes that result from delivering RH services in an integrated fashion with marine conservation interventions, this study argues that integrating population perspectives into natural resource management agendas enhances and ultimately improves conservation objectives, while also addressing a root cause of resource degradation and human poverty.

METHODS

The study used a quasi-experimental evaluation design to test IPOPCORM's central hypothesis that there will be a significant improvement in coastal resource management (CRM) outcomes and RH outcomes by delivering these services in an integrated manner as opposed to delivering either intervention in isolation. Quasi-experimental design studies, also described as nonrandomized pre-post intervention studies, aim to evaluate benefits of specific interventions that occur in situations not conducive to experimental control (Cook & Campbell 1979). Quasi-experimental research designs use comparison groups matched on certain characteristics to measure an intervention's impact. Threats to validity are minimized by accounting, during the analysis, for pre-existing factors that could affect the outcome difference between treatment and comparison groups. This study collected data in three comparison groups, further described below, in 2001, before the standardized intervention and, in 2007, after the standardized intervention had been implemented for at least four years in all research sites. Two stages of regression analyses on these data, bivariate and multivariate, demonstrate whether the difference in the pre-post groups is attributable to the intervention.

Three island municipalities in northern Palawan province Philippines (Fig. 2) served as the experimental sites for evaluation of the independent CRM intervention (Cuyo), the independent RH intervention (Busuanga) and the integrated CRM+RH intervention (Culion). Site selection was informed by recommendations from the provincial government, available biodiversity data (Werner & Allen 2000) and their ranking as top priority areas for conservation of marine biodiversity (DENR [Department of Environment and Natural Resources] and UNEP [United Nations Environment Programme] 1997). The experimental sites were also matched in terms of population size (ranging from 14 600 to 18 600 inhabitants) and socioeconomic condition. All encompassed poor rural subsistence communities with sizeable numbers of households living in poverty and dependent on coastal-marine resources for subsistence and livelihood. Each was an underserved area in terms of health, CRM and other public services owing to their isolated location, poor transportation and telecommunications infrastructure, and relatively small internal revenue allotment. The ecosystems in the study sites were not as degraded and their population densities were not as high as in other coastal areas of the country (NSO 2000; MERF [Marine Environment and Resource Foundation] Inc. 2001). Thus, the important drivers for coastal resource use, such as food and livelihoods, could be detected in the changes in their ecosystem states and associated resources.

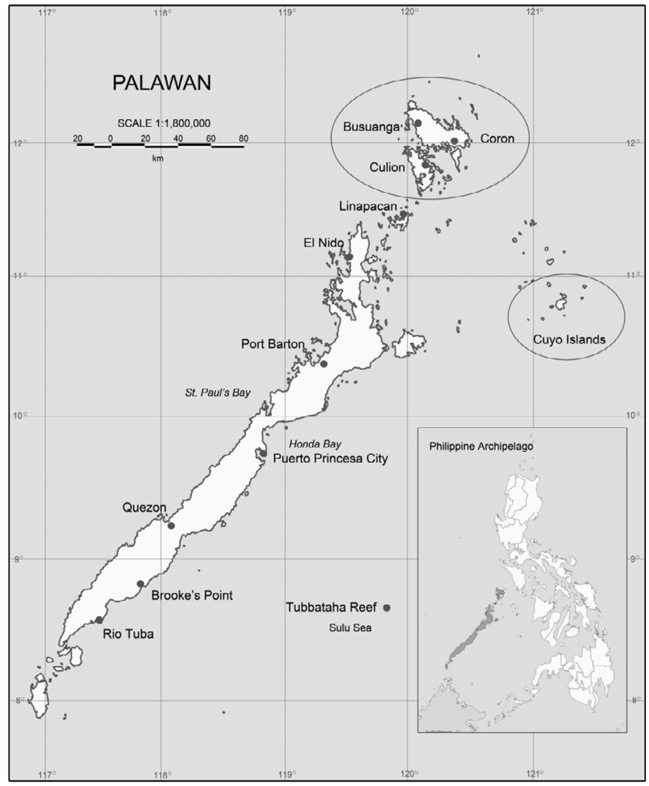

Figure 2 Location of the operation research sites in Palawan province (Philippines).

The original evaluation design included a control site, for which no intervention was to be made, for comparison purposes. Unlike the experimental sites, the comparison site experienced substantial development inputs from local government and other sources during the course of the study. These inputs effectively disqualified that municipality as a suitable control for purposes of this evaluation. We choose instead to compare the impact of the integrated (CRM+RH) intervention to the impact of the independent CRM and the independent RH interventions.

Intervention models

Three distinct interventions were delivered by different non-governmental organization (NGO) teams working in partnership with PFPI, local government units (LGUs) and peoples' organizations (POs; for example associations of fisherfolk, women and youth). Each intervention model consisted of a standardized set of activities comprising service delivery, information education and communication (IEC) and policy advocacy interventions. The same community-based approach to service delivery was applied in each model in order to build the capacity of local institutions to manage, implement and sustain the interventions. In each site, the characteristics of the LGUs and POs were similar. The POs were all newly established as part of the project CRM interventions. The LGUs' capacity to implement CRM and RH was very low, evidenced by a lack of dedicated staff with technical knowledge and skills in these areas.

The CRM intervention supported participatory coastal resource assessment (PCRA), establishment and management of marine and mangrove protected areas (MPAs), mangrove reforestation, increased enforcement, and peer education and behaviour change communication (BCC) interventions to encourage community compliance with MPA management practices, the Philippine Fisheries Code and municipal ordinances prohibiting dynamite and cyanide use in fishing. Policy advocacy inputs targeted to LGUs used a rights-based approach to strengthen enforcement of the Philippine Fisheries Code, particularly the provision affording small-scale fishers with preferential access to municipal waters.

The RH intervention supported family planning information and counselling for informed choice, community-based distribution and social marketing of non-clinical methods of contraception (such as condom and pill), referral for other services and care, and peer education and BCC to reduce risk of unplanned pregnancy and sexually transmitted infections including HIV/AIDS. Policy advocacy inputs targeted at LGUs used a rights-based approach to expand women's access to the full range of pregnancy prevention methods and youth's access to sexual and RH information and services.

The integrated approach included both types of interventions (CRM+RH) delivered as one service package. Supplementary policy advocacy inputs targeted to LGUs encouraged coordination and collaboration across the health and environment sectors and integration of RH into CRM agendas to enhance food security and operational efficiencies.

All three intervention models incorporated an economic development component that supported small and environment-friendly enterprise development (EED) opportunities and micro-credit facilities targeted mainly at women and youth in the communities due to their higher poverty incidence (NSCB [National Statistical Coordination Board] Philippines 2007). In the CRM and integrated CRM+RH study areas, fisher households received top priority as their families were more likely to be displaced by the MPAs and, thus, in need of a safety net during the period of regeneration of fish sanctuaries.

Methods for the biophysical surveys

Pre-intervention (2001) and post-intervention (2007) resource and ecological habitat assessments were conducted in the three experimental sites by an independent marine research institute. The condition of coral reefs and mangroves and their associated fish and benthic communities were appraised using similar methods for both survey rounds. Benthic coral data were gathered via line intercept transect (LIT) technique and underwater video belt transect (UVBT) surveys (adapted from English *et al.* 1997). These methods recorded each life form, at the taxon level, intercepted at regular points along a 50 m transect. All transect lines were placed in locally recognized areas of high fisheries value or good coral reef health, and a global positioning system (GPS) device recorded the location of each transect line. At the time of the 2001 round of data collection, all transects were in non-managed areas that were, in essence, open access fishing grounds. In 2007, the same transects in the CRM and CRM+RH sites were located in areas that had been under improved management, due to the application of the CRM interventions, with significant restrictions on fishing effort for at least three years. Transects in the RH site were located in non-managed open access fishing areas.

Fish visual census (English *et al.* 1997) was used to collect reef fish data using the same transects used for the benthic survey. All fish falling within 2.5 m both sides and 5 m above the transect line were identified at the species level; each individual species was counted and its total length (in cm) was approximated in order to estimate fish biomass. Target species (for example surgeonfish and parrotfish) were recorded first, followed by the slow-moving reef fish (such as damselfish or cardinal fish).

For mangrove resources, the transect line plot (TLP) method adapted from Cabahug (1986) was used to assess the structural formation, stand growth and density, species association, zonation and species diversity of mangrove areas. Transects considered the different land uses, forest conditions and extent of mangrove areas perpendicular to the shorelines and riverbank. As with the coral and fish transects, all TLPs were in non-managed areas at the time of the baseline (2001) survey while, in 2007, the same transects were in areas of improved management in the CRM and CRM+RH sites and in non-managed areas in the RH site.

Methods for the community household surveys

Pre-project (2001) and post-project (2007) household surveys were conducted in the same three study municipalities by independent demographic and health research teams affiliated with the University of the Philippines. In each municipality, a sample of nine coastal *barangays* (villages) was randomly selected with probability proportional to the size (PPS) of the barangay. A complete list of households was obtained from each study barangay. From the list, sampling frames for four different study populations were derived, and then a sample of households was drawn using the systematic random sampling technique.

The four different study populations taken from the sample households included: male youth (age 15–24 years), female youth (age 15–24 years), adult women in the reproductive age group (15–49 years) and adult men (15–60 years). Once a sample of households was selected for one age-sex group, those households were no longer eligible for sampling in the succeeding age-sex groups. This prevented the possibility of an individual being included in both the youth and the adult sample. Different household samples were used for the baseline and post-project measurements. In 2007, the researchers did not attempt to follow-up the same households and individuals that were surveyed in 2001 because they wanted to obtain a cross section of the population at the two different time points. The goal was to sample 400 households

Table 1 Dependent variable indicators used in analysis (RH = reproductive health, CRM = coastal resources management).

Indicator type	*Indicator name*	*Indicator definition*
RH	PARITY	Number of children ever born to women of reproductive age (WRA = 15–49 yrs)
RH	CON_W	Changes in contraceptive prevalence (all methods) among WRA
RH	MOD_F	Contraceptive prevalence (modern methods) among young females, 15–24 yrs
RH	SEX_M	Sexual behaviour among young males, 15–24 yrs
RH	CON_YF	Changes in youth (15–24 yrs) contraceptive use during first sex
RH	CON_YL	Changes in youth contraceptive use during most recent sexual encounter
Food security	FISHER	Household dependent on full-time fishing
Food security	CYA	Community knowledge of cyanide use
Food security	DYA	Community knowledge of dynamite use
CRM/Coral	Live coral cover	Per cent of live coral cover
CRM/Coral	Mortality index	Ratio of live to live and dead coral
CRM/Coral	Development index	Degree of coral reef assemblage development
CRM/Coral	Condition index	Degree of coral reef assemblage and stress
CRM/Reef Fish	Species richness	Number of fish species
CRM/Reef Fish	Mean density	Mean number of fish per square metre
CRM/Reef Fish	Mean biomass	Mean quantity of fish in metric tonnes per square km (target and all species)
CRM/Reef Fish	Size frequency	Modal size (cm) for the target species (Acanthuridae, Scaridae, and Serranidae)
CRM/Mangrove	Volume	Cubic metres of mangroves per hectare
CRM/Mangrove	Density	Number of mangroves per hectare
CRM/Mangrove	Mean DBH	Mean density at breast height (cm)
CRM/Mangrove	Mean height	Mean height in metres
CRM/Mangrove	Regeneration	Number of hectares of regeneration

and 400 respondents per municipality for each survey round, which, for all practical purposes, was achieved.

Indicators and means of measurement

The study examined twenty-two dependent variable indicators to determine change in CRM, RH and food security status in the study sites (Table 1). All CRM indicators were considered impact indicators as they measured change in the status and diversity of coral reef, reef fish and mangrove biophysical conditions, theoretically due to the application of the CRM intervention. All CRM indicators were measured at the barangay level, since the CRM interventions primarily impacted shallow coastal habitats within 15 km of the barangay shoreline and were implemented through barangay level management structures, such as POs and barangay development councils.

The effects of health interventions introduced through programme activities must have an impact on the population, and hence the outcomes of a programme must be measured at the population level. All of the RH impact indicators were measured at the municipal level since the project's reproductive health and family planning inputs covered all barangays in the study municipality. The PARITY indicator reflects changes in population growth, theoretically due to the application of the RH interventions, by measuring changes in the average number of children born to women of reproductive age (WRA; 15–49 years old). The CON-W indicator reflects access to and use of RH information and services and pregnancy prevention methods among WRA. Four other RH impact indicators (CON_YF, CON_YL, MOD-F and SEX_M) manifest youth's access to and subsequent use of sexual and RH education and services and contraceptive methods.

Three proxy indicators for food security at the household and individual level (micro-level) included household dependency on full-time fishing (FISHER) and community respondents' knowledge of cyanide (CYA) and dynamite (DYA) fishers in their area. We acknowledge that these are not standard food security indicators, but elected to use them because of the links between subsistence fishing, food insecurity, and illegal and unsustainable fishing practices in coastal Philippine (Bayer & Atchue 2001). We also concede that knowledge in the community of individuals that engage in dynamite and cyanide fishing is not a perfect measure of the actual level of dynamite and cyanide fishing practices, but knowledge of these fishers within the community is likely to be positively correlated to these damaging fishing practices. The original study design also included an indicator to measure change in the nutritional status of under-five children at the household level. However, because the method used to weigh children in the 2007 survey round differed appreciably from the method used at baseline (2001), the nutrition indicator and data were eliminated in the final analysis.

Statistical methods

The biophysical (CRM) and the socio-demographic (RH and food security) data were analysed separately. We determined spatio-temporal trends for the CRM indicators using a PC-ORD software package for multivariable analysis of ecological community data. Statistical significance was determined at the

Table 2 Independent socioeconomic variables used in multivariate regressions to control for differences in the characteristics of the respondents and households that are shown in other studies to influence the RH dependent variables.

Variable type	*Variable name*	*Definition*
RH	Culion	Location of household is Culion Municipality (CRM+RH intervention) (yes = 1; no = 0)
RH	t_Culion	Time interaction variable, location is Culion in 2007 (yes = 1, no = 0)
RH	Busuanga	Location of household is Busuanga Municipality (RH only intervention) (yes = 1; no = 0)
RH	t_Busuanga	Time interaction variable, location is Busuanga in 2007 (yes = 1; no = 0)
RH	Cuyo	Location of household is Cuyo Municipality (CRM only intervention) (yes = 1; no = 0)
RH	t_Cuyo	Time interaction variable, location of household is Cuyo in 2007 (yes = 1; no = 0)
RH	Wealth index	Household asset ownership index derived from principle component analysis
RH	Age	Age of respondent (years)
RH	Education	Number of years education
RH	Tenure	Length of residence in barangay
RH	Working	Respondent currently working (yes = 1; no = 0)
RH	Married	Respondent currently married (yes = 1; no = 0)
RH	Household size	Number of individuals in household
RH	Fisher	Adult (>14 yrs) respondent primary occupation fisher
RH	2007 Survey	Dummy variable for follow up survey (2007 survey = 1; 2001 survey = 0)

0.05 level. LIT and Video benthic data were analysed using the REEFSUM program applied in Microsoft Visual Foxpro version 6. We used the TWINSPAN (two-way indicator species analysis; Hill 1979) classification method to arrange multivariable data in an ordered two-way table by classification of individuals and attributes. We also used detrended correspondence analysis (DCA) to determine relationships among sites and life forms, given their arrangement in an ordination space, which is based on correlation values and resemblances.

For the RH and food security data, bivariate changes were initially examined for each of the three interventions by subtracting the baseline (2001) value of each dependent variable in each intervention group from the post-project (2007) value of the dependent variable in the same intervention group, and testing the statistical significance of each of these (first difference) changes. Consistent with public health literature, statistical significance was determined at the 0.10 level. We tested the hypotheses for the integrated approach by performing multivariable regression analysis for each indicator from pooled 2001 and 2007 household survey data, including independent variables (Table 2) to account for the location (intervention municipality) of the household and a time-interaction variable for each intervention municipality to examine relative changes in the indicators between interventions over time, while holding other independent factors constant.

The standard errors of the coefficient estimates obtained from the regressions are corrected for multiple observations in each barangay using the cluster command in STATA. The Probit model used for the regressions is represented by the equation: $Pr(yi = 1) = F(xi'b)$ where the dependent variable yi can be only one or zero, and the continuous independent variables xi are estimated, and where b is a parameter to be estimated, and F is the normal cumulative distribution function.

Each regression combines all of the observations from the three municipalities in the two household surveys taken in 2001 and 2007. This allows a comparison to be made of the statistical significance of the differences in the changes of each of the indicators between the three interventions over time (difference-in-difference test). Specifically, the results found for the time interaction variable for the CRM+RH intervention (t_Culion) indicates the direction of the change in the indicator in the CRM+RH municipality between 2001 and 2007, and whether the change in the indicator is statistically significant compared with the change in the indicator for the comparison (omitted) municipality. The comparison municipality for parity (PARITY = mean number of children born), contraception (CON_W, MOD_FL, CON_YF, CON_YL) and sexual activity among young males (SEX_M) is the RH municipality (Busuanga). The comparison municipality for the food security indicators (FISHER, CYA and DYA) is the CRM intervention (Cuyo).

A set of independent socioeconomic variables (Table 2) was included in the regression analysis to control for differences in the characteristics of the respondents and households shown in other studies to influence RH dependent variables (Bulatao & Lee 1983, Akin *et al* 1986; Akin & Schwartz 1988; Ainsworth *et al* 1996). Ordinary least squares (OLS) regression analysis was used for the one continuous dependent variable (number of children born), and Probit regression analysis was performed for the other categorical (1 = yes, 0 = no) dependent variables.

The independent socioeconomic variables used in the multivariable regression analysis include wealth, age, and education, tenure in the barangay, work status, marital status and household size. We also included the presence of a full-time fisher in the household in the multivariable analysis as an indicator of knowledge of cyanide and dynamite fishing, under the assumption that fishers may be more aware of local community practices. In the absence of data on household

Table 3 Indicator values, trends and statistical significance of first differences for CRM indicators by intervention, for the years 2001 and 2007. $^{*}p < 0.05$, (i) = increasing trend, (d) = decreasing trend.

Indicator type	*Indicator*	*RH+CRM intervention*		*RH intervention*		*CRM intervention*	
		2001	*2007*	*2001*	*2007*	*2001*	*2007*
CRM: coral reef	Live coral cover (%)	25.2	31.8	20.6	33.7	22.5	39.2
	Mortality index (%)	0.4	0.3	0.4	0.3	0.4	0.3
	Development index	0.7	0.6	1.0	0.7	0.3	0.5
	Condition index	−0.4	−0.1*(*i*)	−0.5	−0.1	−0.2	0.1
CRM: reef fish	Species richness (*n* of species)						
	All species	92	148	122	139	90	199
	Target species	38	56	4.0	59	33	51*(*i*)
	Density (individual m^{-2})						
	Target species	0.2	0.1	0.1	0.1	0.2	0.2
	Total	1.6	1.3	1.6	0.9*(*i*)	1.0	1.8
	Biomass (tonne km^{-2})						
	Target species	11.7	18.0	4.1	10.9	7.2	38.8
	Total	17.3	39.6	9.8	24.5	11.9	54.8
	Size frequency (cm)						
	Acanthuridae	12.5	11.5	13.2	13.2	12.4	17.6
	Scaridae	16.9	17.5	13.4	16.7	16.3	17.0
	Serranidae	13.5	13.2	13.1	14.0	16.3	12.5
CRM: mangrove	Volume (m^3 ha^{-1})	6	12*(*i*)	62	4*(*d*)	104	4*(*d*)
	Density(*n* ha^{-1})	1019	478	1058	137*(*d*)	6970	57*(*d*)
	Mean DBH (cm)	7	15*(*i*)	16	17	7	14
	Mean height (m)	3	7	4	5	8	5
	Regeneration (ha)	23 316	701*(*d*)	19 963	207	8856	153*(*d*)

income or wealth, household ownership of assets, which serve as a proxy for household wealth, was used as the basis for constructing a wealth index using principal components analysis (PCA). Previous studies indicate that such index is a robust measure of socioeconomic status (Filmer & Pritchett 1999; Wagstaff & Watanabe 2003). The tenure variable captured the effect of migration through the assumption that the more time the individual and household has lived in the municipality the more likely the individual and household will be responsive to the interventions designed to change behaviour.

RESULTS

CRM indicators

Of the eighteen CRM indicators, the CRM+RH municipality experienced no significant change in 14, three significant increases in two categories (benthos and mangrove), and one statistically significant decrease (mangrove regeneration) (Table 3). By comparison, the two experimental sites where the independent interventions were applied each experienced two or more significant decreases in mangrove indicators (including regeneration), and only one significant increase (for example reef fish density for the RH site and reef fish target species richness for the CRM site). Because no detectable change suggests stability and is a better result than a statistically significant decrease for these indicators, and since the CRM+RH intervention achieved two more statistically significant increases than the independent interventions, the integrated intervention outperformed the RH and CRM interventions for these indicators.

It is worth mentioning that a severe coral bleaching incident in 1998 impacted coral reef ecosystems across the Philippines. During the time period of this study, it was expected that corals would show improvement overall as they recovered from the bleaching event. This may explain why most of the study indicators of coral reef health, such as live coral cover and the mortality and development indices, do not show any statistically significant difference between the study sites. The condition index did show a statistically significant increase in the CRM+RH site, which indicates the efficacy of protective management.

RH and food security indicators

There were statistically significant differences in two of the six reproductive health indicators (CON_YF and SEX_M) between the CRM+RH intervention and the RH intervention (Table 4). The positive and statistically significant result found for CON_YF suggests that the increase in the likelihood of young females and males using a contraceptive method during first intercourse between 2001 and 2007 in the CRM+RH municipality was greater than the change in this indicator in the RH municipality, holding all other factors constant. Similarly, the negative and statistically significant result for SEX_M suggests that the decrease in the likelihood that a young male is sexually active in the

Table 4 Multivariable regression results for the effects of location and other independent variables on indicators in pooled 2001 and 2007 surveys. Ordinary least squares (OLS) regression results for PARITY, and Probit regression results for all other indicators where the results indicate the marginal effects (DF/dx) on the probability of each indicator. $^*p < 0.10$.

Variable	*PARITY*	*CON_W*	*MOD_FL*	*CON_YF*	*CON_YL*	*SEX_M*	*FISHER*	*CYA*	*DYA*
Municipality									
Culion (CRM+RH))	0.191	0.084	−0.007	−0.073*	0.052	0.189*	0.004	0.046	0.025
t_Culion	−0.49	−0.12	0.066	0.132*	0.019	−0.116*	−0.168*	−0.103*	−0.075*
Busuanga (RH only)	–	–	–	–	–	–	0.078	−0.029	−0.133*
t_Busuanga	–	–	–	–	–	–	−0.119	−0.037	0.221*
Cuyo (CRM only)	−0.383	−0.13	0.073	0.044	0.081	−0.010*	–	–	–
t_Cuyo	0.469	−0.052	−0.063	0.028	−0.065	0.033	–	–	–
Wealth index	−0.1	−0.013	0.006	0.007	0.015*	0.023*	−0.054*	−0.008	−0.013*
Age	0.128*	−0.002	0.007	−0.007	0.006	0.048*	−0.003	0.003*	0
Education	−0.147*	0.007	−0.001	0.004	0.001	0.002	−0.026*	0.009*	0.005
Tenure	−0.014*	−0.003	−0.003*	−0.003*	−0.002*	−0.006*	0.001	−0.002*	0.001
Working	0.099	0.011	0.032	−0.001	−0.025	0.014*	–	0.035	0.042*
Married	1.189*	0.150*	0.069*	0.027	0.079*	–	0.075	0	0.001
Household size	–	−0.02	−0.003	−0.004	−0.005	−0.012	−0.01	0.005	0.003
Fisher	–	–	–	–	–	–	–	0.017	0.023*
2007 Survey	−0.252	0.229*	0.122*	−0.025	0.111*	0.099	0.182*	0.084*	−0.070*
Number of observations	300	302	302	563	563	655	386	2251	2251
Log likelihood ratio	–	−184.48	−198.18	−164.62	−159.05	−305.21	−190.42	−1247.8	−1125.32

CRM+RH municipality was greater than the change in this indicator in the RH municipality, holding all other factors constant. The difference-in-difference test results for the other reproductive health indicators (PARITY, CON_W, MOD_FL, and CON_YL) were not statistically significant and suggest that the CRM+RH intervention performed equally well as the independent RH intervention for these indicators. The PARITY (mean number of children born) result implies a significant decline in population growth in both the CRM+RH and RH sites, which indicates the efficacy of reproductive health and family planning interventions.

There were significant changes in all three food security indicators (FISHER, CYA, DYA) between the CRM+RH intervention and the CRM intervention (Table 4). The negative difference-in-difference result found for full-time fishers (FISHER) indicates that the small (and insignificant) increase in the likelihood of being a full-time fisher in the CRM+RH municipality was less than the larger (and significant) increase in the likelihood of being a full-time fisher in the CRM municipality. The statistically significant negative results for CYA and DYA suggest that the decrease in the likelihood of respondents' knowledge of cyanide and dynamite fishing in the CRM+RH municipality was larger than in the CRM municipality, all else being constant.

Other data trends from the 2001 and 2007 household survey rounds in the CRM+RH site reflect a significant decline in the incidence of income-poverty among young (15–24 years) adults as measured by the proportion earning monthly income from all sources totalling <1500 Philippine pesos (Php 50 = US$ 1.00, January 2001). Independent programme monitoring data from 2003 and 2004 support this finding (Montebon *et al.* 2004).

DISCUSSION

Impact on ecosystem health

Of the eighteen biophysical variables measuring change in status and health of shallow habitats in the CRM+RH site, seventeen either improved or remained stable. The significant increase in coral condition is attributed to the recovery in some hard coral species consequent to the establishment in 2004 of a MPA (1.11 km^2 in size), with project support and community involvement. Likewise, improvements in mangrove conditions are ascribed to the vigilance and enforcement efforts of local POs, which the project mobilized and empowered. By providing stewardship opportunities, the POs helped in changing the attitude of the community towards management and conservation of coastal resources. One PO, for example, reforested about 10 ha of logged-over areas and was able to reduce mangrove cutting and charcoal making by 50% (compared to baseline). Although the reef fish indicators demonstrated no significant change, the disaggregated data from the sanctuary area in the CRM+RH site indicate total biomass increased by 31 tonne km^{-2} in the 2007 survey. Other factors that could have impacted the reef fish parameters include increased artisanal fishing effort at the perimeter of the MPA (where the MPA acts as a magnet for fishers) or laxity in enforcement effort (where fishers are still fishing in the MPA).

The statistically significant increase in reef fish species richness in the CRM municipality can in part be attributed to the project's establishment of a MPA (1.08 km^2) in 2003 with community involvement. Another probable factor is the isolated nature of the island ecosystems in the CRM site, which showed higher variability and potential receptiveness to CRM intervention responses at baseline compared to the other study areas (MERF 2001).

The significant increase in reef fish density in the RH site (Busuanga) was unexpected since the project supported no CRM interventions in that study area. However, information from provincial government sources indicates the LGU created and enforced a MPA in one of the study barangays during the course of the present study. The LGU also granted concessions to private groups that established pearl farms in the study area, which can produce the same 'refuge effect' as a well-managed MPA. These factors may have contributed to the fish density outcome.

Impact on human health and well-being

The CRM+RH intervention generated the desired impact on all nine of the RH and food security indicators. Moreover, it exceeded the impact of the independent RH and the independent CRM intervention for five of the nine indicators and performed equally as well for the remaining four indicators. This strongly suggests that the CRM+RH approach yields a larger impact on human health and food security compared to the sectoral management approaches.

Qualitative information from IPOPCORM's monitoring system offers insights into the community's receptivity to the CRM+RH intervention, which reportedly emulated their lifestyles more closely than the single-sector approaches (Hermann 2004). Whereas the gains from the integrated approach were perceived to benefit everyone in the community in terms of improved food security, women were perceived as the main beneficiaries of the RH intervention while fishers were thought to gain the most from CRM. The perception of equitable distribution of benefit may have engendered a deeper level of solidarity and community of practice in the CRM+RH site, resulting in larger impact.

Both the integrated and independent RH interventions delivered the same sexual and RH education and services to youth in the study municipalities. However, the two models employed different BCC strategies to encourage responsible sexual practices among youth. In the RH site, conventional methods (such as 'just say no') were promoted whereas in the integrated site the concept of 'stewardship' was advanced in a dual context. Youth were encouraged to become stewards of the environment and their sexuality in order to enjoy a brighter future. They were also encouraged to spearhead coastal conservation actions in their villages to improve food security for current and future generations. The stewardship BCC strategy may have contributed to the significantly higher impact on youth RH outcomes reflected in the indicator results (CON_YF and SEX_M) for the integrated site. As such, we hypothesize a connection between youths' stewardship acts and their positive feelings about themselves. Additional research is needed to determine if self-efficacy was a significant moderator between youths' pro-environmental behaviours and more responsible sexual practice.

IPOPCORM engaged a wide range of stakeholders in the pursuit of a shared vision of improved food security. This focus, and the broad support it garnered, helped to deflect criticism from conservative and religious groups opposed to family planning in the Philippines thus enabling a more conducive environment for behaviour change among adults and youth in the CRM+RH study area compared to the non-integrated programme sites (Hermann 2004). In the RH intervention site, several peer educators reportedly faced opposition from conservative/religious factions in their villages, which may have compromised their ability to deliver services to some target groups, particularly youth.

The income-poverty result in the integrated CRM+RH site suggests added-value and the model's potential for reducing vulnerability to poverty at the micro-level. Programme monitoring data point to an increase in non-fishing sources of income (for example seaweed cultivation) as possibly influencing this outcome (Montebon *et al.* 2004). Other contributing factors could be the EED inputs and youth's improved practice for family planning and subsequent pregnancy prevention in the integrated site, which allowed them to take advantage of economic development opportunities. The significant increase in full-time fishing effort in the CRM site may explain why income-poverty persisted in that study area despite similar EED inputs. Other data from the 2007 round of household surveys point to an increase in the mean number of household members in the CRM site, which could have diluted the effects of EED.

Given that poor individuals and households are more vulnerable to the impacts of climate change (UNFPA [United Nations Population Fund] 2009), the income-poverty outcome in the integrated CRM+RH site confers further added value in terms of the community's ability to cope with future environment and climate change. Similarly, the reduction in destructive fishing in the same study area may enhance coral reef resilience against future bleaching events by reducing anthropogenic stress on the ecosystem (Grimsditch and Salm 2006).

Over the six-year period of the study, the budgetary support for field implementation totalled US$ 101 500 for the RH intervention compared to US$ 139 200 for the CRM intervention and US$ 218 300 for the integrated CRM+RH intervention. Even though the integrated approach cost more to field, the cost was less than the combined cost of the two independent interventions signifying value-added in terms of cost efficiency.

Implications for policy and programme development

Overall, the integrated CRM+RH intervention generated a greater impact on the majority of the indicators used in the study to measure improvements in human and ecosystem health (Table 5). Improvements in biophysical parameters reflect both the efficacy of protective area management and the vigilance and enforcement efforts of local POs. The same institutions managed RH activities that enabled contraceptive access in the communities, improved reproductive health outcomes among youth and a significant reduction in the average number of children born to women of reproductive

Table 5 Statistically significant trends on selected indicators (2001–2007). Δ = trend in desired direction, O = trend in undesired direction, — = no trend.

Indicators	*CRM+RH*	*RH Only*	*CRM Only*
RH and food security indicators			
Youth contraceptive use during first sexual experience (CON_YF)	Δ	—	—
Proportion of young (15–24) males sexually active (SEX_M)	Δ	—	—
Proportion of households dependent on fishing (FISHER)	Δ	—	—
Community knowledge of dynamite use in fishing (DYA)	Δ	—	—
Community knowledge of cyanide use in fishing (CYA)	Δ	—	—
CRM indicators			
Coral reef: condition index	Δ	—	—
Reef fish: target species richness	—	—	Δ
Reef fish: total species density	—	Δ	—
Mangrove: volume	Δ	O	O
Mangrove: density	—	O	O
Mangrove: mean diameter at breast height	Δ	—	—
Mangrove: regeneration	O	—	O

age. These findings support the project's central hypothesis and imply that it will be difficult to ensure long-term sustainability of CRM gains and prevent over-use of coastal resources unless integrated forms of management that combine conservation with family planning are delivered simultaneously and with community involvement. They also have implications for similar ecologically significant biodiversity rich areas in the Philippines and neighbouring countries where demographic dynamics pose challenges to return on investment in biodiversity conservation.

Study limitations

Owing to its inherent complexity, limitations may have influenced study outcomes. We acknowledge that the indicators used in this analysis to measure CRM all focus on biophysical parameters, while CRM, in a broader sense, entails fishing pressure and effort, as well as larger governance issues such as the level of organization of community and peoples' organizations and the capacity of the local governments to create structures to manage and protect their natural resources. The study design was not able to incorporate quantitative measurements for processes that might have affected the changes in the status of resources, such as governance mechanisms that could have lead to effectiveness of management, law enforcement and compliance. We collected fishing effort data, specifically catch per unit of effort (CPUE), for this study, however the qualitative methods used were not consistent across sites and thus the data were not viable for the purposes of this comparison study. This is unfortunate, as an analysis of fisheries catch data could support the study's biophysical results and further demonstrate increase in total fish biomass. In addition, catch data could also further demonstrate how increases in total fish biomass in MPAs translate to increases in fish catch and, subsequently, fishers incomes. Future research should be sure to incorporate fisheries catch data as well as capture the strength of management and governance institutions that play a role in effective CRM.

There are inherent limitations in the quasi-experimental research design, especially the difficulty in controlling for confounding factors that are threats to the internal and external validity of the study. For example, effects of site-specific factors and inherent geographical differences between the three municipalities (such as island isolation and accessibility) on the status of the coastal habitats and resources could provide an alternative explanation for the biophysical results beyond the impact of the CRM intervention. Similarly, unanticipated factors such as remittances from overseas workers may have influenced the income-poverty outcome which was not accounted for in the research design.

ACKNOWLEDGEMENTS

We thank the David and Lucile Packard Foundation for generously supporting this study. We also thank USAID's Office of Population and RH for its support via the Population Reference Bureau (PRB), CDM International and the Building Actors and Leaders for Excellence in Community Development (BALANCED) Project. The views and opinions of authors expressed here do not necessarily state or reflect those of the Packard Foundation, the US Government or USAID. Lastly we thank Anil Bamezai of RAND Corporation for his guidance on the quasi-experimental design.

References

ADB (2006) Integrated coastal resource management project document [www document]. URL http://www.adb.org/Documents/RRPs/PHI/33276-PHI-RRP.pdf

Ainsworth, M., Beegle, K. & Nyamete, A. (1996) The impact of women's schooling on fertility and contraceptive use: a study of

14 sub-Saharan countries. *World Bank Economic Review* **10**(1): 85–122.

Alcala, A.C. & Russ, G.R. (2002) Status of Philippine coral reef fisheries. *Asian Fisheries Science* **15**: 177–192.

Alonzo, R.P. (2004) Population and poverty: the real score. Discussion paper 415, pp. 2–22. University of the Philippines School of Economics, Quezon City, Philippines.

Armada, N. (2002) Current approaches in fishery resources appraisal and the need for inclusion of demographic information [Philippines]. In: *FAO Fisheries Technical Paper* (439). ed. L.V. Villareal, V. Kelleher & U. Tietze. Rome, Italy: FAO.

Akin, J. & Schwartz, J.B. (1988) The effect of economic factors on contraceptive choice in Jamaica and Thailand: a comparison of mixed multinomial Logit results. *Economic Development and Cultural Change* **36**(3): 503–527.

Akin, J., Griffin, C., Guilkey, D. & Popkin, B. (1986) The demand for primary health care services in the Bicol region of the Philippines. *Economic Development and Cultural Change* **34**(4): 755–82.

Bayer, T.G. & Atchue, J.A. (2001) Enforcing coastal management regulations to enhance food security in the Philippines. *InterCoast* **39**: 8–9.

Bulatao, R.A. & Lee, R.D. (1983) An overview of fertility determinants in developing countries. In: *Determinants of Fertility in Developing Countries, Volume 2*, ed. R.A. Bulatao & R.D. Lee, pp. 757–787. New York, NY, USA: Academic Press.

Cabahug, D.M. (1986) Timber producing mangrove species volume functions in Palawan for mangrove timber inventory uses. *Bakawan II Newletter* **1**: 7.

Carpenter, K.E. & Springer, V.G. (2005) The center of the center of marine shorefish biodiversity: the Philippine Islands. *Environmental Biology of Fishes* **72**: 467–480.

CIESIN (2000) Population density within and outside of 10 meter low elevation coastal zone [www document]. URL http://sedac.ciesin.columbia.edu/wdc/downloads/maps/population/Low_Elevation_Coastal_Zone/The_Philippines_10m_LECZ_and_population_density.pdf

Cincotta, R., Wisnewski, J. & Engelman, R. (2000) *Nature's Place: Human Population and the Future of Biological Diversity*. Washington, DC, USA: Population Action International.

Cinin-Sain, B. & Knecht, R.W. (1998) *Integrated Coastal and Ocean Management. Concepts and Practices*. Washington, DC, USA: Island Press.

Cook, T.D. & Campbell, D.T. (1979) *Quasi-Experimentation: Design and Analysis Issues for Field Settings*. Chicago, IL, USA: Rand McNally College Publishing Co.

Courtney, C.A., Atchue, J.A, Carreon, M., White, A.T., Smith, R.P., Deguit, E., Sievert, R. & Navarro, R. (1999) *Coastal Resource Management for Food Security*. Makati City, Philippines: Bookmark, Inc.

Cruz-Trinidad, A., White, A.T., Gleason, M. & Pura, L. (2002) Overfishing: more than a fisher's problem. An analysis of overfishing in the Philippines and its causes. *OverSeas* **5**(2) [www document]. URL http://www.oneocean.org/overseas/200202/overfishing.html

DA/BFAR Philippines (2004) *Turbulent Seas: The Status of Philippines Marine Fisheries*. Cebu City, Philippines: CRMP: 328 pp.

D'Agnes, H., Castro, J., D'Agnes, L. & Montebon, R. (2005) Gender issues within the population-environment nexus in Philippine coastal areas. *Coastal Management Journal* **33**(4): 447–458.

D'Agnes, L. & Margoluis, C. (2007) *Integrating Population, Health and Environment Projects: A Programming Manual*. Washington, DC, USA: USAID: 106 pp.

DeLaPaz, M.C.G. & Colson, L. (2008) Population, Health and Environment Issues in the Philippines: a profile of the Autonomous Region of Muslim Mindanao (ARMM). Policy Brief. Washington, DC, USA: Population Reference Bureau.

DENR-UNEP (1997) *Philippine Biodiversity. An Assessment and Action Plan*. Makati City, Philippines: Bookmark, Inc.: 298 pp.

DENR-DILG Philippines (2007) *Improving the Governance of Philippine Coastal and Marine Areas: A Guide for Local Government Units*. Quezon City, Philippines: EcoGov2 Project.

DeSouza, R.-M. (2004) Harmonizing population and coastal resources in the Philippines. *World Watch Magazine* **17**: 5.

Engelman, R. (2008) *More: Population, Nature and What Women Want*. Washington, DC, USA: Island Press: 320 pp.

English, S.C., Wilkinson, C. & Baker, V. (1997) *Survey Manual for Tropical Marine Resources*. Townsville, Australia: Australian Institute of Marine Science (AIMS): 368 pp.

Filmer, D. & Pritchett, L. (1999). The effect of household wealth on educational attainment: evidence from 35 countries. *Population and Development Review* **25**(1): 85–120.

Froese, R. & Pauly, D. (2004) Global information system on fish [www document]. URL http://www.fishbase.org/home.htm

Gomez, E.D., Aliño, P.M., Licuanan, W.R. & Yap, H.T. (1994) Status report on coral reefs of the Philippines. In: *Proceedings of 3rd ASEAN-Australia Symposium on Living Coastal Resources: Status Reviews*, ed. C.R. Wilkinson, S. Sudara & L.M. Chou. Townsville, Australia: AIMS.

Green, S.J., White, A.T., Flores, J.O., Carreon, M.F. & Sia, A.E. (2003) Philippine fisheries in crisis: a framework for management. Technical Paper. Cebu City, Philippines: CRMP-DENR.

Grimsditch, G.D. & Salm, R.V. (2006) *Coral Reef Resilience and Resistance to Bleaching*. Gland, Switzerland: IUCN.

Guttmacher Institute (2009) Meeting women's contraceptive needs in the Philippines. *In Brief* **1**: 1–8.

Harrison, P. (1997) Population and sustainable development: five years after Rio. UNFPA Report United Nations Population Fund, New York, NY. USA.

Hermann, C. (2004) The rewards of innovation: a review of the successful piloting of the Integrated Population and Coastal Resources Management Project (IPOPCORM). PATH Foundation Philippines Inc., Manila, Philippines.

Hill, M.O. (1979) TWINSPAN: A Fortran program for arranging multivariate data in an ordered two-way table by classification of the individuals and attributes. Section of Ecology and Systematics, Cornell University. Ithaca, NY, USA.

Israel, D.C. & Banzon, C.P. (2002) Overfishing in the Philippine marine fisheries sector: a disaggregated analysis. Report. Economy and Environment Program for Southeast Asia, Singapore.

Licuanan, W.Y. & Gomez, E.D. (2000) Philippine coral reefs, reef fishes, and associated fisheries: status and recommendations to improve their management. Global Coral Reef Monitoring Network Report. AIMS, Townsville, Australia.

Manthachitra, V. (1994) Indices assessing the status of coral-reef assemblage: formulated from benthic lifeform transect data. In: *Proceedings, Third ASEAN-Australia Symposium on Living Coastal Resources: Volume 2*, ed. C.R. Wilkinson, S. Sudara & L.M. Chou, pp. 41–50. Townsville, Australia: AIMS.

Marten, G.G. (2001) *Human Ecology: Basic Concepts for Sustainable Development*. London, UK: Earthscan Publications.

Mazur, L. (2009) *Pivotal Moment: Population, Justice, and the Environmental Challenge*. Washington, DC, USA: Island Press.

Melnyk, M. (2001) Community health and conservation: a review of projects. Report by USAID Biodiversity Support Program and USDA Forest Service. Washington, DC, USA:

MERF Inc. (2001) Resource and ecological habitat assessment of island-ecosystems in Northern Palawan. Report prepared for PATH Foundation Philippines, Inc., MERF, Quezon City, Philippines.

Merrick, T.W. (2002) Population and poverty: new views on an old controversy. *International Family Planning Perspectives*: **28**(1): 41–46.

Montebon, R., D'Agnes, L., Castro, J. & Aquino, C. (2004) IPOPCORM behavioral monitoring surveys: Consolidated report 2003–2004. PFPI, Makati City, Philippines.

NOAA Ocean Explorer (2007) Exploring the inner space of the Celebes Sea [www document]. URL http://oceanexplorer.noaa.gov/explorations/07philippines/background/tawitawi/tawitawi.html

NSCB Philippines (2007) Poverty incidence and magnitude of poor populations by sector: 2000 and 2003 [www document]. URL -http://www.nscb.gov.ph/pressreleases/2007/Sept21_PR-200709-SS1-04_Poor.asp

NSO Philippines (2000) Census of population and housing by region and province [www document]. URL http://www.census.gov.ph/census2000/index.html

NSO Philippines (2007) 2007 Census of population [www document]. URL http://www.census.gov.ph/data/census2007/index.html

NSO Philippines (2009) Tawi-Tawi Quick Facts: 2000 Census of Population and Housing in Tawi-Tawi Province, Philippines (Fact Sheet). NSO, Manila, Philippines.

Ong, P.S., Afuang, L.E. & Rosell-Ambal, R.G. (2002) *Philippine Biodiversity Conservation Priorities: a Second Iteration of the National Biodiversity Strategy and Action Plan*. Manila, Philippines: DENR, Biodiversity Conservation Program-UP Center for Integrative and Development Studies & Conservation International.

PFPI (2009) Demographic profile of coastal municipalities bordering the Verde Island Passage and demographic profile of the Danajon Bank and vicinity [www.document]. URL http://www.pfpi.org

Pauly, D. (1994) From growth to malthusian overfishing: stages of fisheries resources misuse. South Pacific Commission. *Traditional Marine Resources Management and Knowledge Information Bulletin* **3**: 7–14.

Pauly, D. & Chua, T.E. (1988) The overfishing of marine resources: socioeconomic background in Southeast Asia. *Ambio* (**17**) 3: 200–206.

Pielemeier, J., Hunter, L. & Layng, R. (2007) Assessment of USAID's population and environment projects and programming options. Washington, DC, USA: Global Health Technical Assistance Project, US Agency for International Development.

Silvestre, G., Miclat, E. & Chua, T.E., ed. (1989) *Towards Sustainable Development of the Coastal Resources of Lingayen Gulf, Philippines*. Manila, Philippines: Philippine Council for Aquatic and Marine Research and Development.

UNFPA (2009) *Facing a Changing World: Women, Population and Climate*. New York, NY, USA: United Nations Population Fund.

Wagstaff, A. & Watanabe, N. (2003) What difference does the choice of SES make in health inequality measurement? *Health Economics* **12**(10): 885–890.

Werner, T.B. & Allen, G.R., eds (2000) *A Rapid Marine Biodiversity Assessment of the Calamianes Islands, Palawan Province, Philippines. Rapid Assessment Program (RAP) Bulletin of Biological Assessment No. 17*. Washington DC, USA: Conservation International.

White, A.T. (2008) Status of coastal and marine resources: implications for fisheries management and poverty in southeast Asia. In: *Poverty Reduction Through Sustainable Fisheries: Emerging Policy and Governance Issues in Southeast Asia*, ed. R. Briones & A. Garcia, pp. 199–232. Singapore: Institute of South East Asian Studies.

White, A.T. & Cruz-Trinidad, A. (1998) The Values of Philippine Coastal Resources: Why Protection and Management are Critical. Cebu City, Philippines: CRMP.

White, A.T., Christie, P., D'Agnes, H., Lowry, K. & Milnec, N. (2005) Designing ICM projects for sustainability: lessons from the Philippines and Indonesia. *Ocean and Coastal Management* **48**: 271–296.

White, A.T., Gomez, E.D., Alcala, A.C. & Russ, G.R. (2006) Evolution and lessons from fisheries and coastal management in the Philippines. In: *Fisheries Management: Progress Towards Sustainability*, ed. T.R. McClanadan & J.C. Castilla, pp. 88–111. Oxford, UK: Blackwell Publishing Limited.

World Bank (2005) *Philippines Environment Monitor 2005: Coastal and Marine Resource Management*. Washington, DC, USA: The World Bank Group.