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Poverty and protected areas: An evaluation of a marine integrated conservation and development project in Indonesia

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ABSTRACT

Protected areas are currently the primary strategy employed worldwide to maintain ecosystem services and mitigate biodiversity loss. Despite the prevalence and planned expansion of protected areas, the impact of this conservation tool on human communities remains hotly contested in conservation policy. The social impacts of protected areas are poorly understood largely because previous evaluations have tended to focus on one or very few outcomes, and few have had the requisite data to assess causal effects (i.e. longitudinal data for protected and control sites). Here, we evaluated the short-, medium- and long-term impacts of marine protected areas (MPAs) that were specifically designed to achieve the dual goals of conservation and poverty alleviation (hereafter "integrated MPAs"), on three key domains of poverty (security, opportunity and empowerment) in eight villages in North Sulawesi, Indonesia. Using social data for villages with and without integrated MPAs from pre-, mid- and post-the five-year implementation period of the integrated MPAs, we found that the integrated MPAs appeared to contribute to poverty alleviation. Positive impacts spanned all three poverty domains, but within each domain the magnitude of the effects and timescales over which they manifested were mixed. Importantly, positive impacts appeared to occur mostly during the implementation period, after which integrated MPA activities all but ceased and reductions in poverty did not continue to accrue. This finding questions the efficiency of the short-term approach taken in many international donor-assisted protected area projects that integrate development and conservation, which are often designed with the expectation that project activities will be sustained and related benefits will continue to accumulate after external support is terminated.

1. Introduction

It is widely recognized that there is global biodiversity crisis, and environmental degradation is expected to accelerate with profoundly changing socioeconomic (e.g. human population growth, economic development and urbanization) and climatic conditions (Halpern et al., 2008; Rinawati et al., 2013; Thomas et al., 2004). Protected areas are commonly employed worldwide as a principal tool for maintaining biodiversity and key ecosystems services (Millennium Ecosystem Assessment, 2005). While protected areas as a management strategy for nature conservation has a long history, in the 1980s the prevailing top-down protectionist paradigm was replaced by an approach that was, at least in principle, more sensitive to the rights and needs of local people (Campbell et al., 2010). This shift took place in part because of concern about the disproportionate costs of conservation imposed on poor communities in developing countries, especially given the geographic juxtaposition of biological wealth and human poverty (Sunderlin et al., 2005). Further, there was growing recognition of the importance of gaining local communities' support for protected areas to achieve conservation goals, particularly in developing countries where resources for enforcement are scarce. The dual goals of conservation and poverty alleviation have since underpinned conservation philosophy and practice in most developing countries (Pelser et al., 2013). This approach to protected areas continues to be implemented under a number of guises, including community-based conservation, co-management, and integrated conservation and development.

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Despite the paradigm shift toward including poverty reduction as a goal of many protected areas, few evaluations of protected areas have assessed the social impacts of protected areas, instead focusing the biological domain (Fox et al., 2012; Miteva et al., 2012). Reviews of social impacts of protected areas (e.g. Agrawal and Redford, 2006; Carneiro, 2011; Mascia et al., 2010) have found mixed evidence. For example, economic impacts of protected areas – one of the most commonly assessed impacts – have been found to be both positive (e.g. Andam et al., 2010) and negative (e.g. Maliao and Polohan, 2008), and there are too few case studies from which to extract explanations and generalizations. Thus the social impacts of protected areas remain poorly understood (Ferraro et al., 2011; Mascia et al., 2010). Previous social impact evaluations have tended to suffer from two broad shortcomings: first, studies often examined one or very few impacts of protected areas (Agrawal and Redford, 2006; Mascia et al., 2010); and, second, few evaluations have had the requisite data to assess causal effects of protected areas (Andam et al., 2010).

The first shortcoming of existing social impact evaluations of protected areas – the focus on one or very few outcomes – has led to very narrow definitions of costs or benefits of conservation (Agrawal and Redford, 2006; Carneiro, 2011; Coad et al., 2008). For example, evaluations in developing countries have often measured poverty based solely on material and monetary assets (Pelser et al., 2013). Following Sen's (1976) criticism of this narrow definition of poverty, there has been a consensus in the theoretical literature on a multidimensional definition of poverty (Agrawal and Redford, 2006). The World Bank's strategy for poverty alleviation is based on such a definition, whereby poverty is due to a lack of opportunity, empowerment, and security (World Bank, 2001). However monetary-based poverty indices continue to be used in many protected area assessments (e.g. Andam et al., 2010; Ferraro et al., 2011).

The second barrier to advancing knowledge of the social impacts of protected areas is the dearth of data required to assess causal effects (Miteva et al., 2012). This is despite increasing interest in social monitoring of conservation projects, for example SocMon for coral reefs (Bunce et al., 2000). The few existing empirical impact evaluations have tended to rely on comparisons of outcomes in: (1) sites with and without protected areas for a single time period (e.g. de Sherbinin, 2008; Tobey and Torell, 2006); or (2) protected area sites before and after the intervention was implemented (e.g. Gjertsen, 2005; Leisher et al., 2012b). These two approaches rely on assumptions that are rarely met: that there was no difference between control and protected area sites prior to the intervention; and that there were no concurrent macro-changes that would affect outcomes (Gertler et al., 2011). Subsequently, there have been repeated calls for evaluations to use longitudinal data for protected and control sites to avoid the need for these assumptions (Ferraro and Pattanayak, 2006; Schmitt and Osenberg, 1996). Further, given that the outcomes of protected areas can be related to the duration of their implementation (Baral et al., 2007; Russ and Alcala, 2004), longitudinal analysis using multiple points in time, including ex-post assessment, is crucial for a comprehensive understanding of social impacts. The few social impact evaluations that have used longitudinal data for control and project sites exist only for terrestrial sites in Bolivia (Canavire-Bacarreza and Hanauer, 2012), and Thailand and Costa Rica, where a number of studies have used country-wide data sets (e.g. Andam et al., 2010; Ferraro and Hanauer, 2011; Ferraro et al., 2011). However, these studies adopted a narrow definition of poverty with monetary-based indices, and only assessed impacts over one time period.

Given the prevalence and planned expansion of protected areas – the target set by the Convention of Biological Diversity is to protect 10% of marine and 17% of terrestrial areas by 2020 (CBD, 2010) – understanding their social impact is of crucial policy importance, and is increasingly advocated as a priority topic of research (Sutherland et al., 2009). To address gaps in understanding of the social impacts of protected areas, we examined the impact of marine protected areas – designed to achieve the dual goals of conservation and poverty alleviation (hereafter "integrated MPAs") – on poverty of associated villages in North Sulawesi, Indonesia. Using data from pre-, mid-, and post-implementation for villages with and without MPAs, we asked "How do integrated MPAs affect key domains of poverty over the short, medium and long term?".

2. Materials and methods

2.1. Integrated MPAs in North Sulawesi

The Coastal Resources Management Project (CRMP; locally known as Proyek Pesisir) implemented integrated MPAs (all <14 ha) during 1997–2002 in four villages in North Sulawesi, Indonesia (Fig. 1). The project was jointly run by USAID and Indonesia's National Development Planning Agency (BAPPENAS), and cost over US$ 1.4 million (Pollnac et al., 2003). Integrated MPA plans were developed through a participatory planning process lasting two years, after which they were formally adopted by village ordinance. Notably, the village ordinances relating to the prosecution of poachers were not supported by any district or higher governance level legislation. Various development activities were simultaneously carried out under the CRMP, including improving access to drinking water, livelihood training and environmental education. After the withdrawal of external support in 2002, the villages continued to manage their MPAs to varying extents; currently MPA rules are not enforced in any of the villages and only the MPAs in the villages of Blongko and Talise are still marked with buoys.

2.2. Sampling

We studied the four villages in North Sulawesi, hereafter referred to as "MPA villages", pre-, mid-, and post-implementation of the integrated MPAs (1997, 2000, 2002, respectively; Pollnac et al., 2003) and in 2012, 10 years after the withdrawal of external support. To estimate the counterfactual outcomes, we concurrently studied four control villages (Fig. 1). These were selected to match key attributes of MPA villages that were likely to affect outcomes of the integrated MPAs, such as aspects of poverty and use of marine resources, including distance to markets, population size, and fisheries dependence. We used household surveys to gather quantitative data of several indicators of poverty, followed by semi-structured interviews with key informants, including heads of village, members of MPA groups, and traditional leaders. The two kinds of data were intended to triangulate results and aid our understanding of the possible causal mechanisms behind changes in poverty indicators. Households within villages were systematically sampled, whereby a sampling fraction of every *i*th household (e.g. 2nd, 3rd, 4th) was determined by dividing the total village population by the sample size (De Vaus, 1991; Henry, 1990). This sampling strategy ensured that the sample was random but also geographically representative. We surveyed over 2000 respondents during the entire study. At each village at each point in time, the number of surveys conducted per village ranged from 40 to 140, depending on the population of the village and available time at each site.

2.3. Poverty indicators

To develop a framework for assessing the impact of integrated MPAs on poverty, we drew on the World Bank's multidimensional

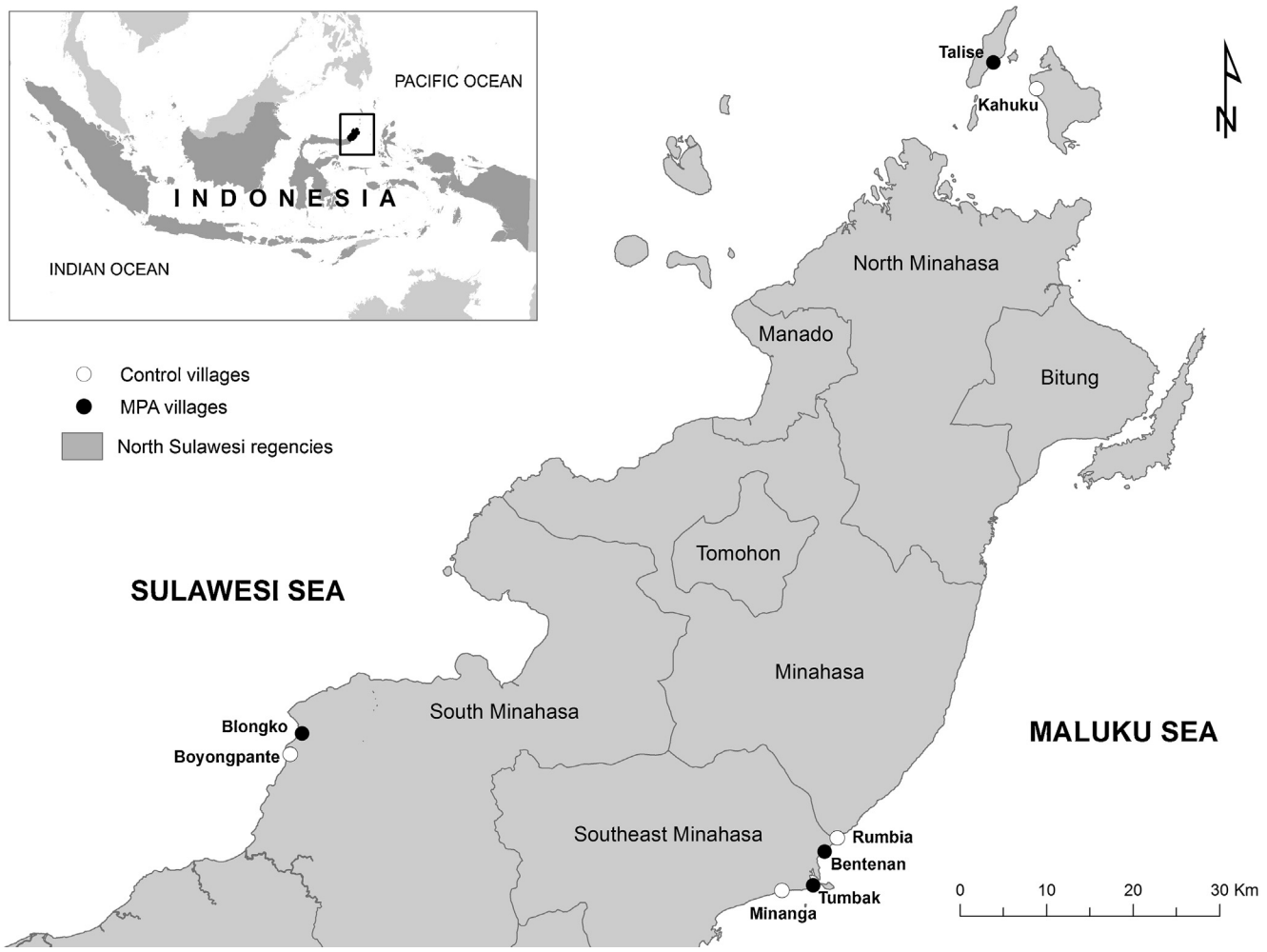

Fig. 1. Location of villages with integrated MPAs (closed circles) and without integrated MPAs (open circles) in the province of North Sulawesi, Indonesia.

definition of poverty (World Bank, 2001) and its applications to examining the relationship between natural resource management and poverty (e.g. Leisher et al., 2012a; Scherl et al., 2004; van Beukering et al., 2013). The framework is composed of three domains of poverty: security, opportunity, and empowerment (Table 1). The premise of the framework is that poverty alleviation requires: (1) enhancement of security against adverse shocks to the social–ecological system; (2) promotion of material opportunities, including financial and human assets; and (3) empowerment of stakeholders to shape decisions that affect their lives (World Bank, 2001). The three poverty domains and their respective components are complementary and interconnected; consequently affecting a component of poverty in one poverty domain will affect underlying causes of poverty addressed in the other two domains (World Bank, 2001). Components of this framework contain themes addressed in parallel literatures, for example the premise of the security domain reflects key concepts embedded in social resilience (Adger, 2000). Likewise, the opportunities domain reflects important components of the Sustainable Livelihoods Framework (Scoones, 1998). The three domains of poverty can be represented by ten components, operationalized in this study by context-specific indicators tailored to assess the impact of the integrated MPAs on poverty alleviation (Table 1). These indicators are not intended to represent all facets of each component or domain of poverty. Rather, the indicators we used measure some aspects of poverty that could be affected by the integrated MPAs. Indicators concerning respondents' perceptions of the state of various aspects of their surrounding environment were assessed using a 15-point scale to allow for fine ordinal judgments. To operationalize the scale, we used a visual self-anchoring ladder-like diagram, a technique developed by Cantril (1965), which has been used previously in studies of natural resource management (e.g. Maliao and Polohan, 2008; Pomeroy et al., 1996). The 15 steps represented a continuum of scenarios from the worst to best for that indicator. Some of the poverty indicators were assessed at each of the four sampling periods, whereas others were assessed only in the most recent two or three sampling periods (Table A.1).

2.4. Data analyses

To assess whether integrated MPAs significantly affected the poverty indicators (Table 1), we drew on the difference-in-differences method (Gertler et al., 2011), a quasi-experimental technique from the econometrics literature on impact evaluation. The difference-in-differences method compares changes in outcomes over time between impact and control groups, and thus accounts for bias due to: (1) initial difference between groups, and (2) changes that are a result of broader-scale trends (Gertler et al., 2011). The design involved testing the effect of two explanatory variables – time and presence of integrated MPAs – on each of the poverty indicators (our response variables). A significant interaction between the two explanatory variables indicates that the integrated MPAs had an effect, such that changes in the poverty

Table 1
Framework for assessing the impact of MPA management on poverty, which is based on the World Bank's strategy for poverty alleviation (World Bank, 2001) and its applications to examining the relationship between natural resource management and poverty (e.g. Scherl et al., 2004).

Poverty domains and components	Indicator	Description
Security		
Livelihood diversity	Average number of different occupations	Total number of different occupations in the household divided by the number of household members
Resource dependence	Fisheries dependence	Whether fishing is the primary livelihood for the household
Conflict	Frequency of illegal fishing[a]	Perception of indicator based on a 15-point scale
Well-being	Present well-being	Present household well-being reported as worse, same or better than five years ago
	Future well-being	Expectation of household well-being in five years being better or worse than present well-being
Opportunity		
Financial capital	Wealth (material style of life)	Principal component score based on the type of wall, floor, roof and window, and the presence or absence of a toilet, lounge suite, display cabinet and modern stove (further details Table A.2)
Human capital	Environmental knowledge	Score based on responses to eight statements concerning the relationship between coastal resources and human activities (further details Text A.1)
Natural capital	Condition of local marine environment	Perception of indicator based on a 15-point scale
	Fish catch from local area	Perception of indicator based on a 15-point scale
Empowerment		
Resource access	Marine resource control	Perception of indicator based on a 15-point scale
Influence in community	Ability to influence community affairs	Perception of indicator based on a 15-point scale
Governance mechanism	Prosecution of fishing in the MPA	Perception of indicator based on a 15-point scale
	Local government support for MPA	Perception of indicator based on a 15-point scale
	Enforcement of fishing laws	Perception of indicator based on a 15-point scale

[a] 'Illegal fishing' refers to all fishing practices (including bombing and cyanide fishing) that are banned under national law in Indonesia.

indicator over time differed significantly between MPA villages and control villages. Conversely, a non-significant interaction and a significant effect of integrated MPAs would indicate that the control and MPA villages differed significantly but the presence of integrated MPAs did not affect that difference.

We tested for interaction effects between time and integrated MPAs over different time periods for each of the poverty indicators individually. For poverty indicators for which we had baseline (i.e. pre-MPA) data (see Table A.1), we tested for interaction effects for three time periods: 1997–2000, 1997–2002, and 1997–2012, representing the short-, medium- and long-term impacts of the integrated MPAs, respectively. For indicators without baseline data (see Table A.1), we tested for interaction effect between each sampling event: 2000–2002 and 2002–2012. We tested for interaction effects using statistical models appropriate for the respective types of data. For present well-being (ordered categorical data) we used a proportional odds model, while for fisheries dependence and future well-being (dichotomous categorical data) we used a generalized linear mixed model with a binomial distribution. For all other indicators (continuous data) we used a general linear mixed model. The relevant assumptions were tested for each of the statistical models (e.g. normality and homogeneity of variances for linear mixed models). For two indicators – prosecution of fishing in the MPA and local government support for MPA – we tested for the effect of time but not the interaction effect because these indicators were only relevant in MPA villages. Village was set a priori as a random factor for all of the analyses because of the hierarchical nature of the data (i.e. respondents were nested in villages).

For indicators that were significantly affected by the integrated MPAs over at least one time period, we used standardized effect sizes to compare changes in poverty indicators between MPA and control villages, which allowed us to compare across indicators based on different measures. We used Cohen's *d* effect statistic with a bias correction for all continuous poverty indicators analyzed using general linear mixed models, and odds ratios for the remaining categorical indicators. Confidence intervals were calculated using percentile bootstrapping (1000 replications) to account for non-independence of the data arising from repeated sampling within each village. For indicators without baseline data, we used *t*-tests to compare the indicator values from MPA and control villages for the earliest year for which we had data. All analyses were conducted using R software (version 2.15.1).

3. Results

Our results indicate that the integrated MPAs significantly affected all three poverty domains (Table 2), but effects differed between indicators in terms of the magnitude and timescales over which they manifested (Fig. 2).

3.1. Security domain

Changes in security during 1997–2012 differed between indicators, suggesting integrated MPAs can have a mixed effect on this poverty domain (Fig. 2a). Fisheries dependence was reduced by integrated MPAs; households in MPA villages were 80% more likely to undertake an activity other than fishing as their primary livelihood in 2002, compared to 1997, while control villages showed little change. Although fisheries dependence increased in both control and MPA villages post-implementation, fisheries dependence did not return to baseline levels in MPA villages (Fig. 2a). Livelihood diversity decreased for both MPA and control villages during the experimental period, but the decrease was greatest for control villages, indicating that integrated MPAs had a positive effect on livelihood diversity. Perception of present well-being was negatively affected by integrated MPAs. While households in MPA villages were 39% more likely to rate their well-being in a higher category in 2000 than in 1997, households in control villages were 153% more likely to rate their well-being more highly in 2000. Further, while perceived well-being in MPA villages decreased after the first three years of integrated MPA implementation and did not return to the level in 2000, well-being in control villages showed little change. Lastly, perceived future well-being and frequency of illegal fishing were not significantly affected by the integrated MPAs over any time periods (Table 2).

Table 2
Summary of results of analyses testing for an interaction between presence of integrated MPA management and time (i.e. a significant effect of integrated MPA management) for each poverty indicator over multiple time periods. Bolded values are significant at $\alpha = 0.05$.

Poverty domains and components	Indicator	*p* value (management × time interaction)		
		Time period		
		1997–2000	1997–2002	1997–2012
Security				
Livelihood diversity	Average number of different occupations	**0.0461**	**0.0001**	**<0.0001**
Resource dependence	Fisheries dependence	**0.0009**	**6.63×10^{-6}**	**0.0010**
Conflict	Frequency of illegal fishing			0.2182[b]
Well-being	Present well-being	**0.0002**	**4.32×10^{-11}**	**1.94×10^{-6}**
	Future well-being	0.5420	0.5080	0.7800
Opportunity				
Financial capital	Wealth	**0.0136**	**0.0002**	**0.0137**
Human capital	Environmental knowledge	**0.0003**	**0.0435**	**0.0013**
			2000–2002	2002–2012
Natural capital	Condition of local marine environment			**0.0049**
	Fish catch from local area		0.5658	**0.0041**
Empowerment				
Resources access	Marine resource control		0.2060	**0.0103**
Influence in community	Ability to influence community affairs		0.5508	0.1034
Governance mechanism	Prosecution of fishing in the MPA			0.1651[a]
	Local government support for MPA			**0.0005**[a]
	Enforcement of fishing laws			**0.0027**

[a] *p* value relates to the effect of time not to the interaction between integrated MPA management and time because data for control villages were not available for these indicators.
[b] The interaction between presence of integrated MPA management and time was tested for 2002–2012 for the indicator frequency of illegal fishing.

3.2. Opportunity domain

Opportunity increased for MPA villages but did not change significantly, or increased by a lesser extent, for control villages during integrated MPA implementation (i.e. 1997–2002), indicating that integrated MPAs positively affected opportunity (Fig. 2). During integrated MPA implementation, wealth, environmental knowledge, and fish catch increased for both control and MPA villages, although the increase was significantly greater for MPA villages. However, post-implementation (i.e. 2002–2012) changes in opportunity indicators in MPA villages either matched that of the control villages (e.g. environmental knowledge; Fig. 2a), were less than those in the control villages (e.g. natural capital indicators; Fig. 2b), or were partially reversed after gains in opportunity in MPA villages prior to 2002 (e.g. wealth; Fig. 2a).

3.3. Empowerment domain

The effect of the integrated MPAs on the domain of empowerment differed between indicators. Perceived ability to influence community affairs appeared not to be affected by the integrated MPAs, and perceived prosecution of fishing in the MPA did not change significantly over time in the MPA villages. For indicators that were significantly affected by integrated MPAs, the general effect in control and MPA villages was uniform across all indicators, except local government support for MPAs. Empowerment increased for both MPA and control villages from mid-implementation (i.e. 2000) until 2012, but these increases were significantly larger for control villages than MPA villages post-implementation (post-2002; Fig. 2b). These results indicate that integrated MPAs had a negative effect on empowerment over the period analyzed. However, empowerment could have increased in MPA villages during the initial years of implementation for which we lack data. This possibility is supported by data from the beginning of the periods analyzed. Resource control and ability to influence community affairs were significantly higher for MPA than control villages in 2000, as was enforcement of fisheries laws in 2002 (Fig. 3).

4. Discussion

Although protected areas are currently the dominant approach to mitigating environmental degradation and biodiversity loss, their effect on associated human communities remains poorly understood, and is intensely debated in conservation policy (Agrawal and Redford, 2006; Andam et al., 2010). Using data from pre-, mid-, and post-implementation of integrated MPAs for villages with and without MPAs in North Sulawesi, we found that the integrated MPAs appeared to contribute to reducing the three key domains of poverty (security, opportunity and empowerment) during the implementation period, but these improvements tended not to continue to accrue after external support was withdrawn. The magnitude of the effects and timescale over which they manifested were mixed, but positive impacts spanned all poverty domains. We first discuss the temporal trends in impacts of the integrated MPAs on poverty, and then explore the impacts on each of the poverty domains.

4.1. Temporal trends in effects of integrated MPAs on poverty

Many conservation and development projects funded by multilateral development banks and international donors, such as the integrated MPAs in North Sulawesi, are designed with the expectation that outcomes will be achieved within the implementation period and that project activities will persist and related outcomes will continue to accrue after external support is withdrawn (Olsen and Christie, 2000). A key finding from our study is that the integrated MPAs did appear to contribute to poverty alleviation, but these improvements occurred mostly during the implementation period and did not continue to accumulate after the large injection of funds and external expertise had been terminated. During the decade after implementation

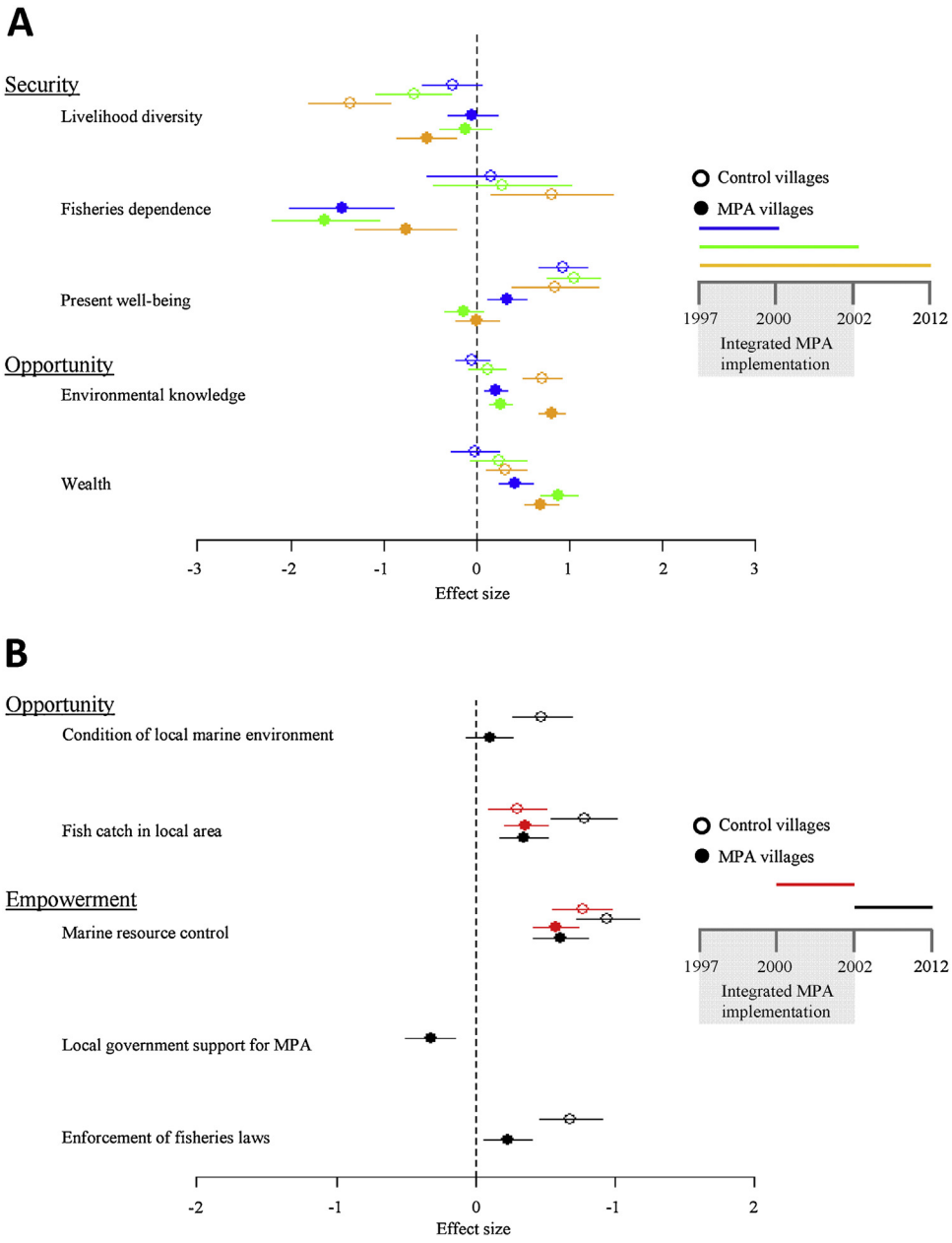

Fig. 2. Changes in poverty indicators under the poverty domains of security, opportunity and empowerment. Poverty indicators in (A) were assessed during 1997–2000 (blue line), 1997–2002 (green line) and 1997–2012 (yellow line), and those in (B) were assessed during 2000–2002 (red line) and 2002–2012 (black line). Changes in poverty indicators in villages with integrated MPAs (closed circles) and without MPAs (open circles) are indicated by effect sizes and bootstrapped 95% confidence intervals. The impact of integrated MPAs on security was mixed; integrated MPAs appeared to increase livelihood diversity, decrease fisheries dependence, and in general have a negative effect on well-being. Wealth and environmental knowledge under the opportunity domain increased for MPA villages but did not change significantly, or increased by a lesser extent, for control villages during integrated MPA implementation (i.e. 1997–2002), indicating a positive effect of integrated MPAs. Indicators under the domain of empowerment generally increased for both MPA and control groups from mid-integrated MPA implementation (i.e. 2000) until 2012. However, increases were significantly greater for control villages than MPA villages, particularly post-integrated MPA implementation. Effect sizes for fisheries dependence and present well-being were calculated using odds ratios, and are represented here on a logarithmic scale. The effect statistic used to calculate the effect size for the other indicators was Cohen's *d* with a bias correction.

finished, project activities all but ceased and changes in poverty indicators in MPA villages either matched those of the control villages (e.g. environmental knowledge), were less than those of the control villages (e.g. empowerment indicators), or gains in poverty alleviation in MPA villages which occurred prior to 2002 were partially lost (e.g. fisheries dependence and wealth). Previous studies in the Philippines have also found that community-based fisheries management projects had positive social impacts within the implementation periods (e.g. Baticados and Agbayani, 2000), and that the activities of such projects are commonly not sustained after external support is terminated (e.g. Pomeroy and Carlos, 1997).

One likely reason for the lack of sustainability of projects such as the integrated MPAs is their short funding cycles (typically three to five years; Bottrill et al., 2011; Keppel et al., 2012), which do not reflect the time necessary to develop the attitudinal, behavioral, and socioeconomic changes required for stakeholders to continue undertaking conservation activities unaided (Blom et al., 2010). Indeed, a study of a conservation and development project in Nepal found that the focus of the project progressed from development,

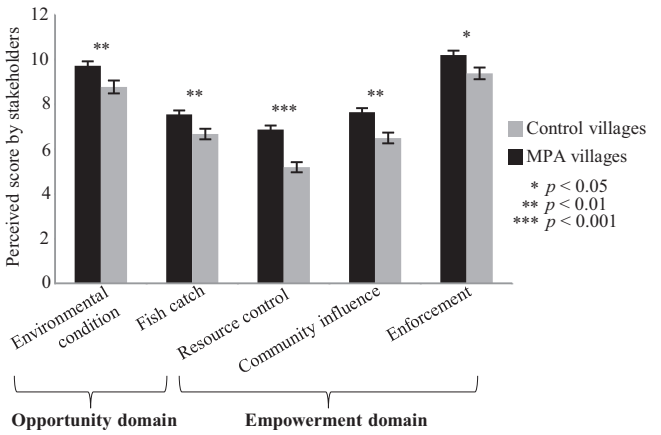

Fig. 3. Mean perceived scores of a subset of poverty indicators under the poverty domains of opportunity and empowerment. Scores are for villages with integrated MPAs (black) and without integrated MPAs (gray) in 2002 (for enforcement and environmental condition) and 2000 (for resource control, community influence and fish catch). For all five indicators, the mean perceived score for MPA villages was significantly greater than for control villages (significance level indicated by asterisks). Error bars show standard errors of the mean.

through a transitional period of institutional strengthening, toward conservation (Baral et al., 2007). The authors suggested that at least a decade is required to build capacity for, and interest in conservation amongst local people. Institutional strengthening is also critical to long-term success because projects are often hindered by lack of local government interest or parochial village politics (e.g. Christie, 2004; Webb et al., 2004). We also found that respondents' perceptions of local government support for MPAs decreased significantly post-implementation, which many respondents attributed to issues unrelated to the MPAs. For example, in the village of Blongko, the current head of the village does not support the MPA because the leader of the MPA group is his political rival.

Our findings about the temporal trends of effects of integrated MPAs on poverty have important implications for future design and evaluation of conservation and development initiatives. Our results suggest that the short-term approach taken in many international donor-assisted protected area projects can be adequate to reduce poverty, but only within the implementation period. Further, these findings highlight that short-term projects are insufficient to motivate sustained project activities required for continual achievement of development and conservation outcomes after external support is withdrawn. Other studies have similarly suggested that longer project timeframes are necessary to sustain funding, build capacity, and gain broad-based support for project activities from both villagers and local governments (e.g. Keppel et al., 2012; Olsen and Christie, 2000). Related literature in resource management suggests that gaining ongoing support from local governments will also require institutional strengthening, for example by fostering linkages with higher levels of governance (Ostrom, 1990). Further, conservation projects that rely on community support, such as those in this study, should seek to strengthen or maintain the institutional design principles (Ostrom, 1990; e.g. graduated sanctions, clearly defined boundaries) thought to facilitate collective action outcomes such as improved livelihoods and compliance in fisheries co-management (Cinner et al., 2012). The time required to achieve project sustainability will depend on the context, with some authors suggesting one to several decades (e.g. Baral et al., 2007; Torell et al., 2004), while others advise that indefinite commitment is needed in some sites (e.g. Christie et al., 2009).

Our findings also emphasize the importance of carrying out evaluations at multiple points in time after projects are initiated, a recommendation which has been advocated by a number of authors (e.g. Baral et al., 2007; Miteva et al., 2012). In particular, ex-post assessments are critical because results from evaluations within the project implementation phase can be different from ex-post evaluations, as we found. Despite this need, a recent review of co-managed fisheries found that ex-post assessments are rare (Evans et al., 2011).

4.2. Security domain

The impact of the integrated MPAs on the poverty domain of security differed between indicators, with positive impacts on livelihood indicators and negative impacts on perceived well-being. The reduction in fisheries dependence in MPA villages during the implementation period was not completely sustained after 2002. Achieving permanent livelihood shifts is difficult, as found by other conservation and development projects (e.g. Weber et al., 2011), because livelihood behavior is affected by a multitude of socio-cultural factors (OECD, 2007), such as family traditions (Terkla et al., 1988) and occupational attachment and identity (Marshall, 2010; Pollnac et al., 2001). Further, broader-scale trends, such as the decline in seaweed farming due to disease in North Sulawesi over the same period (Pollnac et al., 2003), probably contributed to increased fisheries dependence in both control and MPA villages. The integrated MPAs were associated with greater livelihood diversity, probably through alternative livelihood programs, but there was an overall decline over time in the number of livelihoods per household member in both control and MPA villages. This decrease in livelihood diversity probably reflects broader macro-economic trends whereby increasing development and wealth promotes livelihood specialization (Cinner and Bodin, 2010; Hill et al., 2012).

The negative changes in perceived well-being that we found in MPA villages were at odds with changes in other indicators of poverty, such as wealth, that were positively affected by the integrated MPAs. Previous studies have found that perceived well-being has been both positively and negatively affected by conservation projects, including protected areas (e.g. Gockel and Gray, 2009) and co-management (e.g. Evans et al., 2011). Respondents' sense of well-being is likely to be influenced by other factors affected by the integrated MPAs, such as conflict, which has sometimes been found to increase under community-based fisheries management in developing countries (e.g. Clarke and Jupiter, 2010; Evans et al., 2011). While we did not have quantitative data on conflict (apart from that potentially arising from illegal fishing), our key informants recalled a number of issues related to the integrated MPAs which led to conflict, such as the misuse of project funds, inequitable sharing of benefits, and confusion over property rights. For example, the village of Talise has an ongoing dispute with a neighboring village, Kinabohutan, regarding the location of the MPA. Poaching by Kinabohutan residents as a result of this dispute continues, and led to at least two violent interactions between villagers during the implementation period (Pollnac et al., 2003). Another significant source of conflict reported by respondents was that few poachers were punished; in the village of Blongko, members of the MPA group staged a demonstration about this governance failure by fishing together in the MPA. This lack of enforcement of MPA rules is likely to be partially due to the limited ability of villagers to pursue prosecution of poachers under the village ordinance pertaining to the integrated MPAs, because the ordinance is not supported by any district or higher governance level legislation relating to prosecution of poachers. Thus to reduce the likelihood of conflict related to MPA management, it is critical that projects such as the integrated MPAs foster appropriate governance

mechanisms, including nested governance systems, graduated sanctions and context-appropriate mechanisms to resolve conflict (Ostrom, 1990).

The negative effect of the integrated MPAs on well-being could also be due to respondents' expectations of project outcomes that were not realized. For example, many respondents mentioned they were told that establishing MPAs would bring tourism business to their villages but this had not occurred. Exaggerating the benefits of such projects to stakeholders – which appears often to be the case in regards to tourism potential (e.g. Fabricius et al., 2001; Magome et al., 2000) – is counterproductive because it can lead to disillusionment and distrust. Thus, it is imperative to the success of such projects that stakeholders have realistic expectations of outcomes and related benefits, a recommendation made also by a recent evaluation of a terrestrial conservation and development project (Pelser et al., 2013).

4.3. Opportunity domain

The integrated MPAs initially promoted important aspects of the opportunity poverty domain but impacts did not continue to accrue post-implementation. Improvement in environmental knowledge is a principal outcome expected from integrated conservation and development projects, and some evaluations have detected such changes (e.g. Leisher et al., 2012b). Although we found that the integrated MPAs improved environmental knowledge during the implementation period, increases in knowledge after 2002 (i.e. post-implementation) were comparatively much larger for both MPA and control villages. This suggests that although the project achieved some success in improving environmental knowledge, broader-scale factors, such as regional media awareness campaigns or growing national awareness of environmental issues, were likely to be more important in influencing people's understanding of social-ecological systems.

Wealth was positively affected by the integrated MPAs during the implementation period, a finding consistent with some recent evaluations of protected areas (e.g. Andam et al., 2010; Sims, 2010) and fisheries co-management (Evans et al., 2011). Increases in wealth could be due to a number of project activities aimed at improving livelihoods and living conditions in general, such as farm productivity training, revolving funds for fishing gear, and construction to prevent floods. Improvements in household wealth could also relate to increased fisheries yield, which was perceived to be greater in MPA villages than control villages midway through the project.

4.4. Empowerment domain

The poverty domain of empowerment increased for both MPA and control villages from mid-MPA implementation until 2012. Increases in empowerment in MPA villages were either the same or significantly less than for control villages, depending on time period and empowerment indicator. This indicates that the integrated MPAs either had no effect or negatively impacted different components of empowerment. The positive changes in empowerment in all villages probably reflect the Indonesia-wide devolution of power to local government since the passing of the decentralization laws (Law Nos. 22 and 25) in 1999, and their revisions in 2004 and 2008. This shift in governance has provided opportunities for local villages to participate in decision-making processes about natural resources (Siry, 2011).

Two plausible explanations exist for the apparent lack of a positive effect of the integrated MPAs on empowerment. First, it could be an artifact of our sampling method. We have data on this poverty domain only from mid-project implementation, but improvements in empowerment could have already occurred during the initial years of implementation. Indeed, the level of all empowerment indicators was higher for MPA than control villages in 2000/2002. This is expected because many of the project activities that should build empowerment occurred in the initial years of implementation (i.e. 1997–2000). These activities included facilitating land tenure and various village ordinances concerning, for example, MPAs and associated management groups – activities that many respondents and key informants mentioned as foremost benefits of the project. The second explanation is that integrated MPAs did inhibit overall feelings of empowerment for many villagers. This could be part because villagers are largely unable to pursue prosecution of violators of the integrated MPAs, given that the related village ordinance is not supported by any higher governance level legislation relating to prosecution of poachers. Further, although common property management, such as the integrated MPAs, is often associated with shifts in property rights and governance toward local stakeholders (Ostrom, 1990), reallocation of power might not always be equitably distributed and might provide opportunities for local elites to control resources (Béné et al., 2009; Glaser et al., 2010). Indeed, reviews of MPAs (Maliao et al., 2009; Mascia et al., 2010) and co-managed fisheries (Evans et al., 2011) have found both negative and positive changes in perceptions of empowerment in associated communities.

4.5. Critiques and caveats

Existing evaluations of the impacts of protected areas on people have tended to suffer two broad limitations, which we have endeavored to overcome. First, evaluations have tended not to assess the full suite of social impacts that conservation initiatives are likely to have, instead often evaluating only one or very few impacts (Agrawal and Redford, 2006; Carneiro, 2011). Although our evaluation included 14 indicators of three domains of poverty, we were unable to consider some important aspects of poverty that could potentially be impacted by protected areas, such as power dynamics, which could have explained the observed negative changes in perceived well-being. Likewise, the only indicator of the human capital component we operationalized was environment knowledge, yet there are other aspects of human capital that could potentially be affected by the integrated MPAs, such as livelihood skills acquired from alternative livelihood training sessions. Further, while we represented natural capital under the opportunity domain using perception data, given that stakeholders' perceptions of ecological condition can differ from that gathered using biological monitoring (Daw et al., 2011), it would be preferable to have had both perception and biological data to represent this poverty component. Nevertheless, our study highlights the inadequacy of using a single indicator (e.g. monetary-based indices) to evaluate social impacts because the impacts of the integrated MPAs differed between indicators.

The second common limitation of existing evaluations of protected areas is that the appropriate data are often lacking to overcome two important forms of bias that impede attribution: (1) confounding factors correlated with project and outcomes; and (2) selection bias, whereby project units are selected on the basis of characteristics that also affect outcomes (Ferraro, 2009). We sought to overcome these biases by using longitudinal data for MPA villages and control villages which were coarsely matched according to key attributes of the MPA villages likely to affect outcomes of the integrated MPAs. This approach relies on the parallel trends assumption (Gertler et al., 2011): that, in the absence of management, changes in poverty in MPA villages would be parallel to those in control villages. While our coarse matching approach sought to meet this assumption, it might have been better fulfilled if we had used statistical matching techniques

(which our data would not allow), which involves matching project and control units based on characteristics assumed to affect project participation and outcomes (Gertler et al., 2011). However, in reality these characteristics are often not observable or quantifiable, and change over time. A randomized experimental design is optimal for undertaking impact evaluation, but this technique has yet to be used in conservation evaluation because it is seldom feasible or ethical to randomly allocate conservation interventions (Miteva et al., 2012).

5. Conclusions

We provide empirical evidence that integrated MPAs can contribute to poverty alleviation. Within each poverty domain, the temporal persistence of effects was mixed, but positive impacts spanned all three domains. Many conservation and development projects, such as the integrated MPAs, are designed with the expectation that project activities will be sustained and related outcomes will continue to accumulate after external support is terminated (Olsen and Christie, 2000). However, we found this was not the case. Our results suggest that improvements occurred mostly during the five-year implementation period, after which project activities all but ceased and accumulation of outcomes did not continue. This finding questions the cost-effectiveness and efficiency of the short-term approach taken in many international donor-assisted protected area projects that integrate conservation and development (Bottrill et al., 2011; Keppel et al., 2012), and suggests that long-term conservation and development goals require long-term commitment from implementation agencies and donors. However, given that the effect of protected areas on people is likely to vary with project and context (Cinner et al., 2012), only through the accumulation of studies such as ours can we obtain an understanding of the heterogeneous impacts of protected areas, and learn to design projects to better achieve social goals. Given the present dearth of research on the social impacts of protected areas (Ferraro et al., 2011; Mascia et al., 2010), further research involving estimation of counterfactual outcomes is urgently needed. Additionally, our study highlights the importance of evaluating multiple outcomes at several points in time after projects are initiated (including ex-post assessments), because impacts are likely to vary over time and between poverty domains. Improving understanding of the social impacts of protected areas is of vital policy importance given that protected areas are one of the principal tools employed to mitigate the adverse effects of global environmental change, and that their prevalence and planned expansion requires vast investments of time and money. More importantly, as global protected area coverage increases, millions more people in developing countries will be affected. An understanding of the social impacts of protected areas is therefore crucial to designing projects that improve the well-being of people, and thus that have a greater likelihood of achieving positive environmental outcomes.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:10.1016/j.gloenvcha.2014.04.003.

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