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ORIGINAL PAPER

Local people value environmental services provided by forested parks

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Abstract Garnering support from local people is critical for maintaining ecologically viable and functional protected areas. However, empirical data illustrating local people's awareness of the importance of nature's services is limited; hence possibly impeding effective ecosystem (environmental)-services based conservation efforts. Using data from five protected forests in four developing Southeast Asian countries, we provide evidence that local people living near parks value a wide range of environmental services, including cultural, provisioning, and regulating services, provided by the forests. Local people with longer residency valued environmental services more. Educated as well as poor people

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valued forest ecosystem services more. Conservation education has some influence on people's environmental awareness. For conservation endeavors to be successful, large-scale transmigration programs should be avoided and local people must be provided with alternative sustenance opportunities and basic education in addition to environmental outreach to reduce their reliance on protected forests and to enhance conservation support.

Keywords Protected areas · Ecosystem services · Conservation · Conservation education · Livelihoods · Southeast Asia

Introduction

In addition to being crucial for imperiled biodiversity (Joppa et al. 2008), forested protected areas provide invaluable goods and services to humanity (e.g. flood protection, carbon sequestration, crop pollination; see for example Ricketts et al. 2004; Bradshaw et al. 2007). However because most tropical protected areas suffer from unsustainable exploitation (DeFries et al. 2005), the majority of these environmental (ecosystem) services are now in decline (Millennium Ecosystem Assessment 2005). Protected areas are generally surrounded by dense human populations that are placing increasing stresses on the ecosystems (DeFries et al. 2007). To exacerbate the situation, local people often are not supportive of reserves because such limit their access to natural resources and create human–wildlife conflicts (Sodhi et al. 2008). To alleviate such anthropogenic pressure, conservationists frequently argue that forests should be preserved for their ecosystem services, not just for the conservation of biodiversity (Daily 1997; Kareiva and Marvier 2007). The underpinning of the ecosystem-services basis conservation approach is that once local people see the value of forests, they may use it sustainably, thus also resulting in conservation benefits. However, there is no consensus as to whether local communities are actually aware of the importance of nature's services (Ghazoul 2007; Kremen et al. 2008). Even in cases where people do value certain ecosystem services, such studies are usually limited in scope or geographical coverage (e.g. Wilk 2000; Durand and Lazos 2008). Because effective conservation hinges on garnering support, local people first need to be aware of the purported benefits of nature. Nevertheless, reasonably comprehensive regional-scale data on such local awareness are lacking, which we aim to provide here.

We surveyed people around five forested parks in mega-biodiverse Southeast Asia to determine their perceptions of the value of these reserves. People were asked a wide range of questions on provisioning (e.g. food), regulating (e.g. flood protection), and cultural (e.g. worshipping places) services. Our objective was to determine whether local people ("end users") are indeed aware of ecosystem services rendered by the protected forests—a precursor to ecosystem-services based conservation initiatives such as payments for ecosystem services (Wunder 2007). Because socioeconomic variables such as education level, wealth and length of residency may be good predictors of conservation attitude and/or resource harvesting (Mehta and Heinen 2001; Lee et al. in press), we tested the hypothesis

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that socioeconomic variables are important in determining the level of awareness of ecosystem services provided by forests.

Materials and methods

People living in villages within 5 km of the following parks in Southeast Asia were targeted (Fig. 1; see Table 1 for park details): Gunung Halimun-Salak National Park (Indonesia); Hkakaborazi National Park (Myanmar); Aurora Watershed Forest Reserve (The Philippines); Tung Yai Naresuan Wildlife Sanctuary (Thailand); and Khao Bantad Wildlife Sanctuary (Thailand). Wherever possible, the head of each household was surveyed and 629 households were selected randomly. Interviews were conducted in local languages by native speakers. Interviews included a mixture of fixed response and open-ended questions.

It can be argued that our results could be biased by a tendency of people to tell us what we wanted to hear (Sheil and Wunder 2002). We attempted to avoid this bias by embedding the eleven questions about environmental services in a broader survey of 72 questions (Table S1). People were told that we were interested in determining their resource harvesting patterns. We also alternated the order of "yes", "no" and "maybe" answers in various questions to prevent the tendency to pick the first one (Table S1). Further, we did not have preconceived expectations and considered that people could be

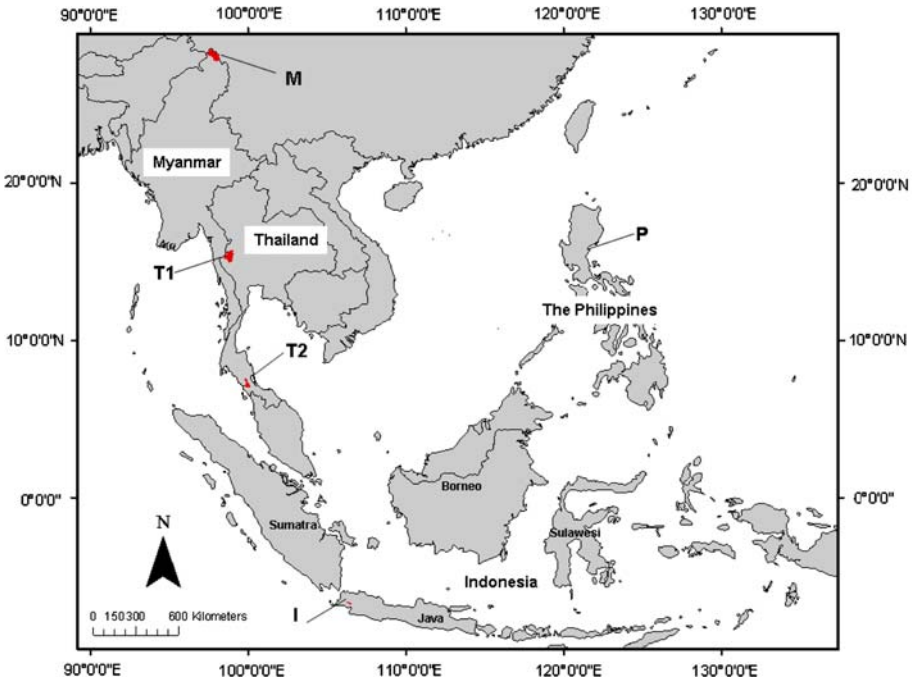

Fig. 1 Locations of forested parks in Southeast Asia. Park abbreviations are as follows: *I* Gunung Halimun-Salak National Park, Indonesia; *M* Hkakaborazi National Park, Myanmar; *P* Aurora Watershed Forest Reserve, the Philippines; *T1* Tung Yai Naresuan Wildlife Sanctuary; and *T2* Khao Bantad Wildlife Sanctuary, Thailand. See Park details in Table 1

Table 1 Summary information and data on socioeconomic and park-interaction factors for each park

	Park^				
	I Gunung Halimun-Salak National Park[a]	M Hkakaborazi National Park[b]	P Aurora Watershed Forest Reserve	T1 Tung Yai Naresuan Wildlife Sanctuary[c]	T2 Khao Bantad Wildlife Sanctuary
Country	Indonesia	Myanmar	The Philippines	Thailand	Thailand
Year established	1992	1996	1986	1974	1975
IUCN category	Unset	II	VI	IV	IV
Size (ha)	40,000	381,248	1,648	369,166	126,720
Longitude (DD)	106.4276	97.8232	121.5938	98.8081	99.9337
Latitude (DD)	−6.7033	28.1136	15.7380	15.3558	7.2380
Habitat	Mature and secondary lowland forests	Mature and secondary lowland to alpine forests	Mature and secondary lowland forests	Mature and secondary dry l owland and submontane forests	Mature and secondary lowland forests
Surrounding habitat	Agricultural areas (e.g. tea plantations)	Largely undisturbed	Mixed rural	Largely undisturbed	Rubber plantations
Socioeconomic and park interaction factors	Categories/Mean or SD				
Wealth level*	Below average	40	32	27	48	51
	Average	53	27	28	50	62
	Above average	49	30	0	48	65
	None	3	31	NA	2	97
Education level	Primary School	138	42	NA	112	69
	Junior High School	3	12	NA	19	27
	Senior High School	2	4	NA	8	2
	University	2	0	NA	5	4
Occupation	Farmer	139	88	25	101	45
	Others	9	1	30	44	147

Table 1 continued

Socioeconomic and park interaction factors	Categories/Mean or SD					
Length of residency	Mean	0.8	0.9	0.9	0.8	0.6
	SD	0.3	0.2	0.3	0.3	0.3
Household head age	Mean	39.8	43.2	37.6	47.8	38.3
	SD	14.2	12.5	13.2	14.4	13.0
Park conflict	No	90	79	42	142	159
	Yes	51	10	13	3	39
Conservation education	No	46	7	32	114	52
	Yes	101	82	23	32	144
Total subjects**		148	89	55	146	199

[a] GHSNP, also known as Halimun, expanded to 113,357 ha in 2003 (not updated in WDPA); [b] also known as Khakabo Razi NP in the literature; [c] also known as Thung Yai Naresuan WS in the literature

"*NA*" indicates missing data

* Wealth level for all parks except P is categorized to tertiles based on annual income

** Exclude eight (three, two, and three from M, P, and T1, respectively) subjects who are park rangers or wildlife staffs

^ Information for protected areas is obtained from http://www.wdpa.org/

unaware of environmental services (Ghazoul 2007; Kremen et al. 2008). Surveys were done by local assistants with differing education (primary, secondary or high school, or undergraduate degrees). Despite different surveyors, people and countries, similar trends indicate that observed patterns are likely to be robust and widespread.

We also tested whether key socioeconomic factors and park-related interactions, such as conservation education and conflict (e.g. land-rights), may predispose some people to value parks more than others (Table 1). We pooled "no" and "not sure" responses in order to perform binary logistic mixed effect regressions. Wealth and education were ordinal predictors (treated as linear for analyses) while conservation education, park conflict and occupation (farmers versus others) were binary predictors. Continuous variables were the length of residency and household head age. The sample sizes in multiple predictor models were restricted by missing educational data for the protected area in the Philippines. We assumed that by selecting a "yes" answer, people placed a positive value on the park; while a "no" or "not sure" answer suggested that they placed a negative value on the park. Generalized linear mixed effects modeling was carried out using library *Ime4* in R (R Development Core Team 2008). We included protected area and country as a hierarchical random effect to account for park-specific effect in people's responses. We did not carry out model selection as we are primarily interested in assessing the effects of all predictors on our responses. We also did not detect any multicollinearity among our linear predictors (spearman's $\rho < 0.25$). Chi-squared (exact method) analyses were performed using SPSS 15.

Results

For most ecosystem services (48 out of 55 cases for all parks), people unequivocally valued parks (χ^2 tests ≥ 8.2, $P = 0.01$, df $= 1$; Fig. 2; Table 2). Comparing across parks, we found some significant differences. For example, more people worshipped in parks in Myanmar (M) and Thailand (T1 and T2) than in Indonesia (I) and the Philippines (P) (Fisher's exact test = 473.3, $P = 0$, df $= 4$; Fig. 2; Table 3), possibly reflecting religious differences. Similarly, depleted prey abundance may have influenced people in the Philippines to discount the park as a source of bush meat (Fig. 2). Differences were also observed across parks when people were asked if parks were important for crop pollination. The number of people in parks T2 and I that value this particular service is not significantly different from those that do not (Fig. 2; Table 3). The reasons for these differences are unclear, but may be related to the cultivation of crops that are not dependent on animal pollinators (e.g. rice).

Separately, the level of education, affluence, conservation education, length of residency, and age of household head had significant effects on the magnitude of some observed trends after correcting for within-park variation (Table 4). The length of residency, level of education and affluence, and conservation education were the most important factors explaining our results in multiple predictor models (Table 5). People with proportionally longer residency valued the regulation (e.g., air quality and clean water) and provision (fish and game) services provided by the parks (Table 5). While people that are more educated valued parks for their regulating services, we find that poor people also appreciate them for their cultural services (Table 5). In addition, environmental education seemed to influence people's views of parks. For instance, locals who were environmentally educated seemed to value crop pollination as an important ecosystem service supported by the forested parks (Table 5). In addition, environmental education also interacted with education and wealth levels for some cultural services provided by the

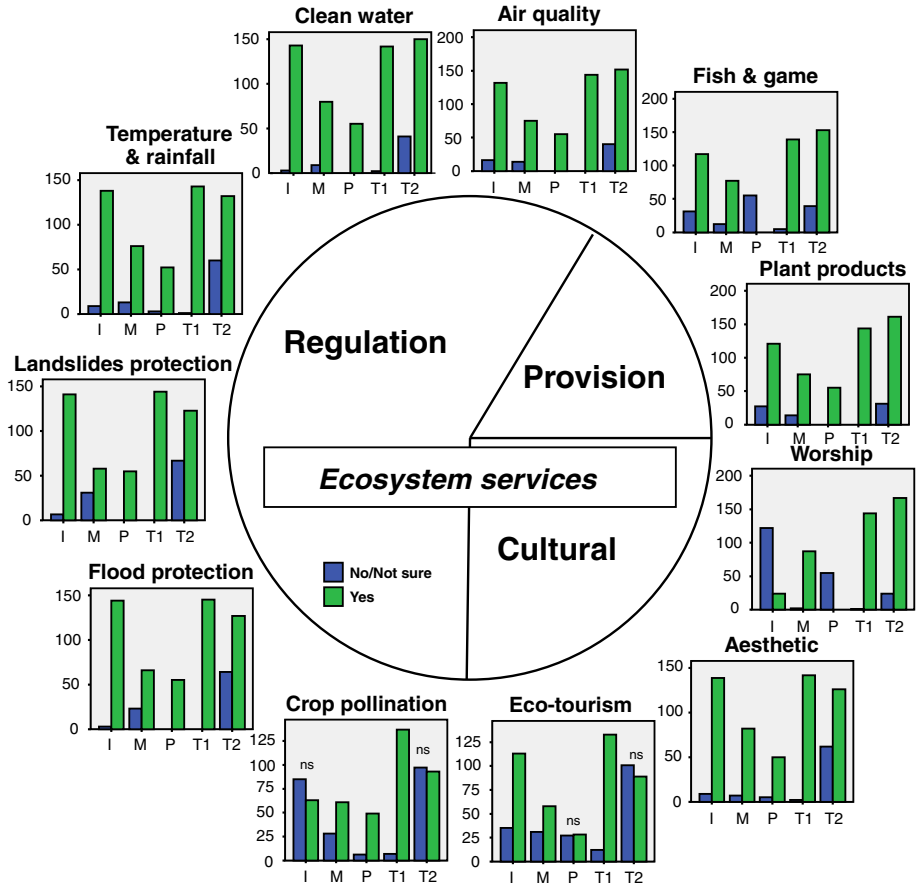

Fig. 2 People value major ecosystem services (regulation, provision and cultural) provided by forested parks. The *vertical axis* shows the number of households with either a "yes" or "no/not sure" response while the *horizontal axis* indicates the park abbreviations (refer to Fig. 1). Non-significant differences between responses within each reserve are indicated by "ns"

reserves such as aesthetic and eco-tourism (Table 5). Nevertheless, much of the variance in the data remained unexplained (only 3–59 and 7–53% explained in single and multiple predictor models, respectively; Table 4) suggesting that other factors may make local people value parks for the environmental services that they provide.

Discussion

Our results are from developing countries in Southeast Asia where people are generally impoverished and have relatively low literacy (http://hdrstats.undp.org/countries/#I). Conservation in this region should be of high priority due to the highest deforestation and endemism, at least for birds and mammals (Sodhi et al. 2004; Sodhi and Brook 2006; Sodhi et al. 2010). Local people heavily rely on forests for sustenance in Southeast Asia (Rao et al. 2002; Sodhi et al. 2008). However, many conservation endeavors, including protected

Table 2 Chi-squared test (exact method) results within each park

	Park																			
	Gunung Halimun-Salak National Park				Hkakaborazi National Park				Aurora Watershed Forest Reserve				Tung Yai Naresuan Wildlife Sanctuary				Khao Bantad Wildlife Sanctuary			
	No*	Yes	χ^2	*P*-value	No*	Yes	χ^2	*P*-value	No*	Yes	χ^2	*P*-value	No*	Yes	χ^2	*P*-value	No*	Yes	χ^2	*P*-value
Ecosystem services																				
Cultural																				
Worship	122	24	65.8	0.00	2	87	81.2	0.00	55	0	NA	NA	1	144	141.0	0.00	24	167	107.1	0.00
Aesthetic	9	139	114.2	0.00	7	82	63.2	0.00	5	50	36.8	0.00	2	142	136.1	0.00	62	126	21.8	0.00
Eco-tourism	35	113	41.1	0.00	31	58	8.2	0.01	27	28	0.0	0.21	12	133	101.0	0.00	101	89	0.8	0.43
Regulation																				
Air quality	16	132	90.9	0.00	14	75	41.8	0.00	0	55	NA	NA	0	144	NA	NA	40	152	65.3	0.00
Clean water	3	143	134.2	0.00	9	80	56.6	0.00	0	55	NA	NA	2	142	136.1	0.00	41	150	62.2	0.00
Temperature and rainfall	9	138	113.2	0.00	13	76	44.6	0.00	3	52	43.7	0.00	1	143	140.0	0.00	60	132	27.0	0.00
Flood protection	3	144	135.2	0.00	23	66	20.8	0.00	0	55	NA	NA	0	NA	NA	NA	64	127	20.8	0.00
Landslide protection	7	141	121.3	0.00	31	58	8.2	0.01	0	55	NA	NA	0	144	NA	NA	67	123	16.5	0.00
Crop pollination	85	63	3.3	0.08	28	61	12.2	0.00	6	49	33.6	0.00	7	137	117.4	0.00	97	93	0.1	0.83
Provision																				
Fish and game	31	117	50.0	0.00	12	77	47.5	0.00	55	0	NA	NA	5	139	124.7	0.00	39	151	67.7	0.00
Plant products	27	121	59.7	0.00	14	75	41.8	0.00	0	55	NA	NA	0	144	NA	NA	31	161	88.0	0.00

* Includes "not sure"

^ Result to nearest decimal place; DF is 1 for χ^2 test

"*NA*" indicates that χ^2 test is not applicable

Table 3 Contingency table analysis (exact test) results across parks

Ecosystem services	Across all parks		
	N	χ^2^	*P*-value
Cultural			
Worship	626	473.3	0.00
Aesthetic	624	84.0	0.00
Eco-tourism	627	94.4	0.00
Regulation			
Air quality	628	56.5	0.00
Clean water	625	59.6	0.00
Temperature and rainfall	627	82.4	0.00
Flood protection	627	132.0	0.00
Landslide protection	626	139.3	0.00
Crop pollination	626	143.1	0.00
Provision			
Fish and game	628	205.6	0.00
Plant products	628	52.3	0.00

^ Result to nearest decimal place; DF is 4 for χ^2 test

areas, have been relatively unsuccessful (Curran et al. 2004; Linkie et al. 2008). Therefore, there is an urgent need to device better conservation mechanisms in this region. Land-conservation through the maintenance of ecosystem services, as our data indicates, will probably have public support. There have been other studies showing that local people derive benefits (e.g. crop pollination) through the ecosystem services provided by the native forests (e.g. Klein et al. 2003). Local people may be supportive of conservation initiatives such as restoration and sustainable harvesting only if they see clear benefits (Badola and Hussain 2005; Allendorf et al. 2006; Kettle 2010). Therefore, in order for ecosystem-services based conservation initiatives to be successful, they should be backed by clear policy and livelihood-sustaining economic incentives (Ghazoul 2007, 2008; Kremen et al. 2008). In order for the local people to rely less on protected forests, the economic incentives can possibly be given to them through carbon credit, Reduced Emissions through Deforestation and Degradation (REDD) and/or bio-banking (firms making financial contribution towards biodiversity projects when undertaking new developments) schemes (Laurance 2006; http://www.un-redd.org/). A good model of this is Costa Rica where farmers are rewarded for good land-use practices through the carbon credit funds (Laurance 2006).

People's attitude and support for conservation are also influenced by factors such as education (e.g. Mehta and Heinen 2001; Lee et al. in press). It is thus not surprising that education also has some influence on whether people value the environmental services offered by the parks. More significantly, however, is how conservation education affects people's view of the parks' value. For three of the ecosystem services (aesthetics, eco-tourism, and clean water), we show that environmental education interacted with education to reinforce people's attitude in valuing the parks. Environmental outreach also appears to positively influence people in viewing the park as important for crop pollination and provisioning of fish and game. Our findings suggest that ecosystem-based conservation efforts may have the potential to be more widely accepted and hence can be one of the conservation strategies (Franklin 1993; Kareiva and Marvier 2007). Therefore, conservation endeavors in addition to economic incentives should provide basic formal education

Table 4 Simple binary logistic mixed effects model results

Response	Socioeconomic and park-interaction factors											
	Wealth level			Education level			Occupation (not farmer)^			Length of residency		
	N	*Z**	Dev[a]	*N*	*Z**	Dev[a]	*N*	*Z**	Dev[a]	*N*	*Z**	Dev[a]
Ecosystem services												
Cultural												
Worship	607	**−2.3**	58.5 (0.8)	578	1.1	51.0 (0.2)	626	1.8	58.1 (0.4)	628	−0.7	58.3 (0.1)
Aesthetic	605	**−3.2**	13.5 (2.3)	576	1.4	16.0 (0.4)	624	−0.4	14.2 (0.0)	626	1.8	14.6 (0.6)
Eco-tourism	609	−1.5	8.8 (0.3)	579	**4.2**	9.7 (2.9)	627	1.5	9.6 (0.3)	629	1.7	9.3 (0.4)
Regulation												
Air quality	609	**−3.0**	15.6 (3.1)	580	1.1	7.3 (0.3)	628	0.3	9.8 (0.0)	630	1.6	9.6 (0.6)
Clean water	606	**−2.7**	18.6 (2.0)	577	**2.8**	12.2 (2.4)	625	0.8	13.1 (0.2)	627	**3.3**	13.8 (2.8)
Temperature and rainfall	608	−1.2	12.7 (0.3)	579	**2.5**	14.1 (1.5)	627	0.7	13.6 (0.1)	629	**4.0**	13.7 (3.1)
Flood protection	608	−0.8	21.9 (0.1)	579	1.9	20.5 (0.8)	627	−0.2	23.4 (0.0)	629	**2.4**	22.6 (1.1)
Landslide protection	607	−1.4	23.0 (0.4)	578	**2.7**	20.0 (1.5)	626	−0.2	22.3 (0.0)	628	**2.0**	22.2 (0.7)
Crop pollination	607	1.1	15.4 (0.2)	578	**3.3**	14.2 (1.6)	626	0.3	15.2 (0.0)	628	**2.2**	15.0 (0.6)
Provision												
Fish and game	609	**−2.2**	29.0 (0.9)	580	**2.0**	3.4 (0.9)	628	0.8	27.6 (0.1)	630	**3.3**	27.4 (1.6)
Plant products	609	−0.3	8.6 (0.0)	580	−0.3	6.4 (0.0)	628	0.3	8.6 (0.0)	630	1.1	8.8 (0.3)

Table 4 continued

Response	Socioeconomic and park-interaction factors								
	Household head age			Park conflict (no)^			Conservation education (no)^		
	N	*Z**	Dev[a]	*N*	*Z**	Dev[a]	*N*	*Z**	Dev[a]
Ecosystem services									
Cultural									
Worship	631	−0.9	58.5 (0.2)	624	0.5	58.1 (0.1)	631	0.8	58.1 (0.1)
Aesthetic	629	**−3.2**	14.7 (2.0)	622	0.0	14.3 (0.0)	629	−0.3	14.7 (0.0)
Eco-tourism	632	**−3.3**	9.2 (1.4)	625	−0.3	8.9 (0.0)	632	1.9	9.0 (0.5)
Regulation									
Air quality	633	**−2.0**	9.6 (0.8)	626	−1.2	9.6 (0.3)	632	−1.9	9.4 (0.9)
Clean water	630	**−2.4**	13.8 (1.5)	623	1.9	13.8 (1.0)	629	−0.5	13.8 (0.1)
Temperature and rainfall	632	−0.1	13.8 (0.0)	625	**2.3**	13.9 (1.2)	631	1.2	14.1 (0.3)
Flood protection	632	**−2.0**	22.6 (0.8)	625	1.1	22.5 (0.2)	631	−1.0	23.0 (0.2)
Landslide protection	631	**−3.2**	22.4 (1.8)	624	−0.2	22.3 (0.0)	630	**−2.3**	22.8 (1.0)
Crop pollination	631	−1.2	15.2 (0.2)	624	0.4	14.8 (0.0)	630	**2.8**	15.3 (1.1)
Provision									
Fish and game	633	−1.5	27.3 (0.3)	626	0.7	27.7 (0.1)	632	**2.3**	27.3 (0.9)
Plant products	633	0.0	8.8 (0.0)	626	1.2	9.0 (0.3)	632	0.0	8.8 (0.0)

[a] Deviance explained in percentage (to nearest decimal place) expressed as total (fixed effect)

* Bold *Z*-values have $P < 0.05$

^ Binary response; reference category in parenthesis

Table 5 Multiple binary logistic mixed effects model results

Response	*Z*-value* of socioeconomic and park-interaction factors									*N*	Dev[a]
	Wealth level	Education level	Occupation (not farmer)^	Length of residency	Household head age	Park Conflict (no)^	Conservation education (no)^	Education level × conservation education	Wealth level × conservation education		
Ecosystem services											
Cultural											
Worship	**−3.2**	0.7	**2.3**	−0.4	−1.2	1.1	0.8	NA	NA	527	52.9 (3.0)
Aesthetic**	−0.2	**−3.1**	−1.3	1.4	−1.6	−0.6	−0.8	**4.0**	−1.7	525	21.5 (8.1)
Eco-tourism**	−0.2	−0.5	0.7	**−2.0**	**−2.8**	−0.6	−1.5	**3.3**	−1.5	529	16.4 (7.1)
Regulation											
Air quality	**−3.1**	0.7	0.6	**2.2**	−1.4	**−2.5**	**−2.0**	NA	NA	528	14.8 (7.3)
Clean water**	**−2.5**	−0.4	1.3	**2.6**	−1.5	0.3	**−2.7**	**2.0**	1.5	522	23.3 (13.6)
Temperature and rainfall	−1.5	**2.0**	0.5	**3.0**	0.3	0.8	0.9	NA	NA	524	19.2 (6.2)
Flood protection	−0.5	1.4	−0.6	1.0	−1.9	0.1	−1.3	NA	NA	524	23.8 (3.8)
Landslide protection**	−1.7	−0.5	0.4	1.1	**−2.1**	−1.7	**−3.0**	1.6	1.4	526	27.1 (7.3)
Crop pollination	−0.2	**2.6**	0.0	1.3	−0.8	0.1	**2.3**	NA	NA	523	17.0 (3.2)
Provision											
Fish and game	**−2.9**	1.3	0.7	**3.2**	−1.6	−0.1	**2.4**	NA	NA	528	9.9 (7.3)
Plant products	0.3	−1.0	0.7	0.2	0.0	0.3	−0.1	NA	NA	525	7.3 (0.5)

[a] Deviance explained in percentage (to nearest decimal place) expressed as total (fixed effect)

"*NA*" indicates that the factor is excluded in the multiple predictor mixed model

* Bold *Z*-values have $P < 0.05$

** A full model for each response is estimated using all factors. Due to the importance of conservation education, we also tested if including interaction term(s) (conservation education with education or wealth levels) will significantly improved the model fit. Analysis of deviance revealed that this is true for only four ecosystem service models (i.e. aesthetic, eco-tourism, clean water and landslide protection)

^ Binary response; reference category in parenthesis

for local communities, supplemented by environmental outreach, to enhance overall conservation support (Jacobson et al. 2006). However, current efforts to conserve endangered species must continue (e.g. Clements et al. 2010).

Some tropical protected areas may experience human population pressure along their boundaries with many of them seeking new opportunities and agricultural lands (DeFries et al. 2007; Joppa et al. 2009). However, our results show that people with lengthier residency at the site are more supportive of conservation support suggesting that large-scale transmigration programs should be minimized (Fearnside 1997; Lee et al. in press). Furthermore, negative park interactions such as park conflicts do not seem to have any effect on local people's view on the importance of the services provided by the parks. This is in contrast to studies that demonstrated that conservation attitudes are heavily influenced by park conflicts (e.g. land-rights conflict; Lee et al. in press). Nonetheless, better cooperation and coordination among governments, non-governmental organizations, private industry, and people will be required for tangible forest conservation in Southeast Asia (Sodhi et al. 2006; Koh and Wilcove 2007; Koh and Sodhi 2010).

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