Biological Conservation 157 (2013) 50–59

Contents lists available at SciVerse ScienceDirect

Biological Conservation

journal homepage: www.elsevier.com/locate/biocon

An evaluation of the effectiveness of a direct payment for biodiversity conservation: The Bird Nest Protection Program in the Northern Plains of Cambodia

Tom Clements [a,b,c,*], Hugo Rainey [a], Dara An [a,d], Vann Rours [a], Setha Tan [a,e], Sokha Thong [a], W.J. Sutherland [b], E.J. Milner-Gulland [c]

[a] Wildlife Conservation Society, 2300 Southern Boulevard, Bronx, NY 10460, USA
[b] Conservation Science Group, Department of Zoology, University of Cambridge, Downing Street, Cambridge CB2 3EJ, UK
[c] Department of Life Sciences, Imperial College London, Silwood Park Campus, Buckhurst Road, Ascot SL5 7PY, UK
[d] Ministry of Environment, Royal Government of Cambodia, Cambodia
[e] Forestry Administration, Ministry of Agriculture, Forestry and Fisheries, Royal Government of Cambodia, Cambodia

ARTICLE INFO

Article history:
Received 27 March 2012
Received in revised form 5 July 2012
Accepted 18 July 2012

Keywords:
Payments for Environmental Services (PES)
Direct payments
Nest protection
Endangered species conservation
Impact evaluation

ABSTRACT

Direct payments for the protection of biodiversity (a type of payment for environmental services) have been proposed as an effective tool for delivering conservation outcomes, in a way that also delivers development benefits to local people. Using an impact evaluation framework, this paper analyses the effectiveness of a direct payment program that was established for nine globally threatened bird species in the Northern Plains of Cambodia. The program provided conditional payments to local people to protect nests, since most of the species were highly threatened by the collection of eggs and chicks. Since the program's inception in 2003 it has protected >2700 nests over >2000 km^2 of habitat at a cost of $30,000 annually, with 71–78% of the costs paid directly to local people. Payments significantly improved the success rates of protected nests in comparison with control sites, leading to population increases for at least three species. However, payments did not influence other threats to species, such as land clearance, and have failed to arrest declines in at least one species' population. The average payment per protector was a significant contribution to incomes in remote rural villages. However, the program only benefited a small proportion of people, causing some local jealousies and deliberate disturbance of nesting birds. The program demonstrates that direct payments can be a highly effective conservation tool in those cases where payments correctly target the cause of biodiversity loss. The results also suggest that it is important to consider how decisions over beneficiaries are made, especially in situations where property rights over biodiversity are unclear, if payments are to be socially acceptable. This has important implications for the design of payment schemes in conservation more generally.

1. Introduction

The history of conservation and development for the past 30 years has been dominated by discussions over how to appropriately integrate conservation and poverty alleviation goals (Roe, 2008) and navigate trade-offs between these two objectives (McShane et al., 2010). Dominant discourses include viewing local poverty as a threat to conservation that must be addressed, for example leading to over-exploitation of threatened species, or emphasise a rights-based approach that conservation activities should not compromise local poverty reduction (Adams et al., 2004). Direct payments for biodiversity conservation – a type of payment for environmental services (PES) – have been proposed by Ferraro (2001; Ferraro and Kiss, 2002) as a more effective mechanism for encouraging local actors to deliver conservation outcomes in a way that also provides local development benefits, in comparison with indirect interventions such as integrated conservation and development programs. Based upon Ferraro (2001; Ferraro and Kiss, 2002) a direct payment scheme involves a negotiated payment provided to a seller conditional upon a particular conservation outcome being achieved. The approach assumes that the seller has partial or total control over the conservation outcome. This definition is consistent with the broad framework for analysing all types of PES proposed by Sommerville et al. (2009), which is less restrictive than the original PES definition of Wunder (2007). Direct payments, and PES approaches in general, have received a significant level of interest since they were first proposed, and a relatively large number of both government- and user-financed programs have been identified (for reviews see Ferraro

* Corresponding author at: Conservation Science Group, Department of Zoology, University of Cambridge, Downing Street, Cambridge CB2 3EJ, UK. Tel.: +44 (0)1223 336600.
E-mail address: tclements@wcs.org (T. Clements).

0006-3207/$ - see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.biocon.2012.07.020

and Gjertsen, 2009; Milne and Niesten, 2009; Pattanayak et al., 2010). However, very few studies have analysed the extent to which payments are effective at conserving biodiversity (Pattanayak et al., 2010); the majority of evaluations that have been completed are focused mainly on habitat conservation and forest protection (Pattanayak et al., 2010). Similarly, very few studies report the extent to which payments contribute to local livelihoods. Evaluating existing direct payment programs is particularly relevant given the rapid expansion of proposed PES programs, both nationally and internationally (such as Reducing Emissions from Deforestation and forest Degradation, REDD; Clements, 2010).

The effectiveness of direct payments at conserving biodiversity depends upon the extent to which they adequately address the principal threats to biodiversity, as with any conservation intervention (Salafsky et al., 2002). Proponents of direct payments have argued that a key advantage is that payments are targeted (Ferraro, 2001), however this is only appropriate when the activities targeted are appropriate to reduce biodiversity loss. This implies the importance of having a sound understanding of the underlying dynamics of the complex social-ecological system within which the direct payments interventions are implemented (Ostrom, 2007). The underlying causes of biodiversity loss are complex and operate at multiple scales – from local to national to global – and payments, due to their targeted nature, may only be effective at addressing some of these.

Payments also influence the social system, through the provision of economic incentives to people involved in the program. Although economic considerations certainly influence individuals' decisions to engage in behaviours (Persky, 1995), additional factors including social norms (Bowles, 2008) and procedural and distributive fairness are known to impact individuals' motivation (Fehr and Falk, 2002). Perceptions of unfairness can undermine the effectiveness of incentives, even if they provide apparent net benefits (Proctor et al., 2009; Sommerville et al. 2010). In addition to providing economic incentives, developing positive local attitudes is therefore key to any direct payment scheme. Local perceptions of a direct payment program may be particularly important when local property rights are unclear, and therefore the decision over who benefits is not straightforward. In many countries, land ownership and resource tenure are poorly defined, with land and resources technically still owned and managed by the state (Agrawal et al., 2008), and institutions are weak (Barrett et al., 2001). Unclear property rights and weak institutions are thought to make implementation of any payment program considerably more difficult (Wunder, 2007; Engel et al., 2008).

This paper evaluates the effectiveness of a direct payments program for protection of globally threatened nesting birds in the Northern Plains of Cambodia. The Northern Plains was considered an ideal landscape to trial a direct payments program; the area supports a large number of bird species of high conservation concern that are heavily threatened by annual collection of eggs and chicks for consumption and trade. The effectiveness of the program in conserving biodiversity was determined using impact evaluation methods; comparing the success rate of nests protected by the program with those from matched controls without an intervention (Ferraro and Pattanayak, 2006). Its effectiveness in providing development benefits was determined by investigating the distribution of payments and local perceptions of the scheme. We address four research questions: (1) how have payments affected the threats to nesting birds?; (2) have payments for nest protection led to increases in species' populations?; (3) was the distribution of the protection payments fair and equitable?; and (4) to what extent have payments changed local attitudes towards bird conservation? Based upon the answers to these questions, we consider the extent to which the payments were achieving their goals in the context of the threats to the target species and the mechanism by which the social and economic incentives generated by the payments led to effective biodiversity conservation.

2. Methods

2.1. Study area

The Northern Plains of Cambodia is one of the largest remaining areas of deciduous dipterocarp forest, a critically important ecosystem for biodiversity that once spread across much of Indochina and Thailand and supported the greatest aggregation of large mammals that existed outside the African savannahs (Wharton, 1966). The landscape is located along the border with Thailand and Laos, and contains two conservation areas: the 4025 km^2 Kulen Promtep Wildlife Sanctuary, established in 1993 and managed by the Ministry of Environment, and the 1900 km^2 Preah Vihear Protected Forest, declared in 2002 and managed by the Forestry Administration of the Ministry of Agriculture, Forestry and Fisheries (Fig. S1). Both conservation areas contain or are used by local villages that practice paddy rice cultivation or upland shifting cultivation for rice and other crops (McKenney et al., 2004). Forest resources are a crucial livelihood safety net, essential for families that lack sufficient agricultural capacity, providing cash income particularly from the sale of liquid resins from dipterocarp trees (McKenney et al., 2004).

The Northern Plains landscape supports some of the most important populations in the region of at least 15 globally threatened bird species, including five listed as Critically Endangered on the IUCN Red List (WCS, 2009). These include resident populations of some of the rarest birds in the world (Hirschfeld, 2009): Giant Ibis *Pseudibis gigantea*, White-shouldered Ibis *Pseudibis davisoni* and Asian vultures (Clements et al., 2012), in addition to Greater Adjutant *Leptoptilus dubius*, Lesser Adjutant *Leptoptilus javanicus*, Oriental Darter *Anhinga melanogaster* and Sarus Crane *Grus antigone*. Strategies for bird conservation in the Northern Plains had little room for error, because populations of each of these globally threatened species numbered from tens to a hundred when they were first discovered in the early 2000s. Hunting, disturbance of breeding sites and egg and chick collection by local people were considered the principal threats. Egg and chick collection was generally undertaken opportunistically, often during trips to collect forest resources. More recently, habitat clearance has emerged as an important additional threat: national deforestation rates in Cambodia are 0.85%/year (Forestry Administration, 2011) driven by a variety of processes, including large-scale development projects such as agro-industrial concessions, improved road access, population growth, and encroachment both by landless in-migrants and local villages (Cambodia R-PP, 2011).

2.2. Bird Nest Protection Program

The Bird Nest Protection Program was initiated in 2003 by the Wildlife Conservation Society (WCS) in collaboration with the Ministry of Environment and the Forestry Administration of the Ministry of Agriculture, Forestry and Fisheries. The program was designed to rapidly locate, monitor and protect the remnant bird populations across the landscape as complement to longer-term activities to strengthen institutions for environmental protection, such as protected areas, and to clarify land tenure and resource management rights of local people. Originally initiated on a pilot basis, by 2009 the program was operating in 24 villages across both conservation areas. The same approach has subsequently been replicated at other sites in Cambodia by several other organisations.

Under the program, nests were located by local people (usually resin-tappers or local farmers), or community rangers contracted by WCS seasonally to undertake research. The rangers were often well-known hunters, hired specifically to reduce hunting pressure and for their knowledge of species' ecology. Local people received a reward of US$5 for reporting a nesting site. For all species except Giant Ibises a permanent protection team of two people was established for each nest, or colony of adjutants or darters. The people who found the nest were invited to form the protection team, otherwise nest protectors were sought from local forest product collectors or the nearest village. Giant Ibises were not thought to be valued for trade or consumption and hence were not given intensive protection, but predator-exclusion belts were placed around the base of nesting trees from 2006 because these had been shown to increase nesting success (Keo et al., 2009). Prior to 2008 protectors received a payment of $1 per day for their work and an extra $1 per day upon completion if chicks successfully fledged. The total payment of $2/day was judged an acceptable daily wage based on village consultations. From 2008 payments were increased to $2.50/day total due to rising food prices based upon requests from local nest protectors. Community rangers received a monthly salary ($50–$70) plus the same daily payment. Protection teams remained in place until the last chick fledged, or until the eggs hatched in the case of Sarus Cranes (which are precocial). All of the costs of the program were recorded, including the payments made to protectors, and other costs such as monitoring visits, travel and surveys.

Protection teams were visited every 1–2 weeks by the community rangers, and monthly by WCS monitoring staff to collect data on the location of each active nest, dates of laying, hatching and fledging, habitat type, nest characteristics, and the number of birds, eggs, and chicks present for each species on each visit. Nests were deemed to have failed if they became unoccupied prior to fledging. Monitoring staff investigated all cases of nest failure to determine the cause, and payments were not made if nests failed due to human disturbance or collection.

2.3. Evaluating the conservation impact of the program

In order to evaluate the impact of the program on nesting success, from 2009 to 2011 nests of the same species were monitored, but not protected, by community rangers around seven control villages in the same landscape. Controls were selected using covariate matching, a technique used to select sites that share similar characteristics to intervention sites (Abadie and Imbens, 2006). Matching used four variables – the village population size in 2005, forest extent in 2006, and distances to nearest all-day market and all-weather roads. These variables were chosen because villages involved in the program tended to be smaller and located in remote areas that had high forest cover. Covariate matching was carried out in *R* 2.13.0 using the package 'matching' (R Development Core Team, 2011) to select controls that were statistically indistinguishable with respect to the matching variables from villages where the bird nest program was being trialled. Balancing tests were used to show that there were no significant statistical differences between the final matched sample and the villages engaged in the program, for the variables used (see Supplemental Materials for details). All nests found around the control villages were monitored using the same data collection techniques as used for the nests engaged in the protection program, and cases of nest failure were investigated by monitoring staff to determine the cause.

Nest success rates during 2009–2011 were calculated for the 65 control nests of Lesser Adjutant and Sarus Crane, 527 protected nests of Lesser Adjutant and Sarus Crane, 22 protected nests of Greater Adjutant and 60 unprotected Giant Ibis nests. Daily nest survival rates were calculated in program MARK, assuming a constant rate for each species (Rotella, 2011). Post-hoc tests were done using CONTRAST (Hines and Sauer 1989) comparing nest survival between controls and protected nests of Lesser Adjutant and Sarus Crane, between protected nests of Greater and Lesser Adjutant, and between the unprotected Giant Ibis and protected nests of Lesser Adjutant and Sarus Crane.

Population estimates for each species in each year were calculated based on the number of occupied nests observed, as a measure of the number of breeding pairs. Such population estimates can be problematic because the detectability (the proportion of nests present in the area but not seen) might vary over time and could not be calculated accurately. Detectability could fluctuate between years for a range of reasons, including changes in survey coverage or observers, or in nesting behaviour; it could also trend over time, for example if observers became more efficient at finding nests. Changes in survey coverage could be accounted for by estimating the area visited in each year, but changes in observer efficiency could not, and could be a source of bias in this dataset leading to trends appearing more positive than they really are. From 2005, all rangers and survey staff were ask to maintain tracks of their trips using Global Positioning System (GPS) devices, by recording one point every 30 min. Survey coverage was then estimated as the number of kilometre squares visited during these surveys from July–December each year, corresponding to the period in which nests were located. Population data were analysed using generalised linear models with quasi-poisson errors and a log-link function in *R* 2.12.2 (R Core Development Team, 2011) to investigate differences in trends over time for each species.

2.4. Evaluating the social impact of the program

The distribution of payments to local people between and within villages was investigated during four seasons, from 2005 until 2009. For each village participating in the program, data were recorded on the total number of households, the number of households with nest protectors, the identity and occupation of nest protectors and all payments made. These data were used to determine the percentage of households engaged in the program, the distribution of the payments made between villages, and the distribution of payments made to individual nest protectors. The payments received by protectors were compared to standard estimates of household consumption in rural forested regions of Cambodia, available from the 2007 Cambodia Socio-Economic Survey (World Bank, 2009).

Local attitudes to the program were investigated by conducting semi-structured interviews with 467 households from 8 villages where the program operated between December 2009 and January 2010. The questionnaire design was informed by focus group discussions conducted during 2007–2009. Questions focused on respondents' knowledge of the program, how they thought it operated and who benefited, and whether they considered the rules fair. Interviews lasted about 50 min, and were conducted by trained Cambodian social researchers. Anecdotal information on local conflicts over the program were collected from WCS staff and discussions with other organisations that had replicated the program in Cambodia.

3. Results

3.1. Bird Nest Protection Program: species protected and costs

Over 2700 nests of 11 globally threatened or Near-threatened species were located and protected during 2003–2012 (Supplemental Materials, Table S2). Some of the species' populations are of high conservation significance. Minimum population sizes in 2011 in the Northern Plains are estimated at 40 breeding pairs of Giant Ibis (15% of the global population), 5 pairs of White-shouldered Ibis

Table 1
Bird Nest Protection Program: Costs, 2005–2009. The program cost $26–31,000 annually, of which 71–78% were payments made to local people, with monitoring costing 22–29%.

	2005–2006	2006–2007	2007–2008	2008–2009
Local payments	$20,350	$19,289	$19,508	$22,556
(%)	(78%)	(74%)	(72%)	(71%)
Nest protection payments	$10,425	$10,786	$10,933	$11,890
Community rangers	$9925	$8503	$8575	$10,666
WCS monitoring	$5603	$6630	$7474	$9375
(%)	(22%)	(26%)	(28%)	(29%)
Expenses	$2506	$3470	$3914	$5195
Salaries	$3098	$3160	$3560	$4180
Total	$25953	$25,918	$26,986	$31,930
Nests protected	217	342	416	360
Average cost/nest	$120	$77	$66	$89

Table 2
Nesting Success Rates during 2009–2011 for unprotected control nests, Giant Ibises (which were not protected by the program) and for three species that were protected by the program: Greater Adjutant, Lesser Adjutant and Sarus Crane. Daily nest survival rates were calculated using the program MARK (Rotella, 2011).

Treatment	Species	Locations/colonies	Nests	Success (%)	Daily survival rate
Controls	All	28	66	36.4	
	Lesser adjutants	26	64	37.5	98.81% ± 0.19%
	Sarus cranes	2	2	0.0	92.47% ± 6.01%
Protected	All	256	746	88.5	
	Lesser adjutant	64	431	94.4	99.94% ± 0.01%
	Sarus crane	96	96	87.5	99.64% ± 0.10%
	Greater adjutant	9	22	68.2	99.71% ± 0.11%
Not protected	Giant Ibis	60	60	86.7	99.80% ± 0.07%

(one of four known nesting sites in mainland Southeast Asia), 50 pairs of Sarus Crane, 250–280 pairs of Lesser Adjutant (equal to the largest known population in Indochina), and 10 pairs of Greater Adjutant (one of two known nesting sites in Southeast Asia). Tables S3 and S4 in the Supplemental Materials provide details of species' differences in the nesting season and choice of nesting site.

The total cost of the program was around $26,000 per year in 2005–2008, increasing to $32,000 from 2008 to 2009 as a consequence of rising prices, particularly for food and transport (Table 1). The average cost per nest protected was $65–$120. The average cost declined as the number of nests increased, partly because monitoring costs were shared between adjacent sites and because a greater number of nests were found per colony. 71–78% of the total cost went directly to local people, either protectors or community rangers. 22–29% was spent on external oversight of the program by trained WCS monitoring staff, including nest verification visits and administration of nest protection payments, but excluding higher-level oversight of the program.

3.2. Impact of payments on nesting success and species' populations

The success rate of protected nests was 88.5% during the 2009–2011, in comparison with a success rate of 36.9% for unprotected controls of the same species during the same period (Table 2, Fig. 1). The difference in the success rates between the protected and control nests of Lesser Adjutant and Sarus Crane are highly significant ($\chi^2 = 26.3$, d.f. = 1, $P < 0.001$). Giant Ibises, which were not protected but did have predator exclusion belts installed (Keo et al., 2009), had a success rate of 86.7%, similar to the rate observed in another study in the same area (Keo et al., 2009), and not significantly different from protected nests of Lesser Adjutant and Sarus Crane ($\chi^2 = 0.01$, d.f. = 1, $P = 0.914$). Of all the protected species, only Greater Adjutant had a moderate nest success rate (68.2%), and this was significantly lower than that for protected nests of Lesser Adjutant ($\chi^2 = 4.35$, d.f. = 1, $P < 0.05$).

For protected nests the most significant cause of nest failure was natural predation by crows, civets and other carnivores, and birds of prey, accounting for 6–8% of incidences over five years and over 120 nests in total. A further 6–8% of nests or nesting colonies were accidentally lost due to wind, rain, flooding of Sarus Crane breeding sites, or chicks falling from trees. It is possible that some of these nests may have been collected. Human disturbance, land clearance or tree cutting accounted for up to 3% of nest or colony failures, and eggs or chicks were collected from a further 3% whilst the protectors were absent. Similar causes of nesting failure were recorded for Giant Ibis, which was not protected, with the exception of natural predation, which was significantly reduced through the use of predator exclusion belts (Keo et al., 2009). By contrast, 77% of 22 unprotected (control) nests or colonies were harvested for eggs and chicks, and the trees used by one Adjutant colony were logged. Of the protected species, only Greater Adjutant colonies had high rates of failure due to human causes (14–25%). Table S5 in the Supplemental Materials provides a full breakdown of the causes of nest failure.

The numbers of nests recorded by observers changed considerably between 2004–2005 and 2011–2012 for most species (Fig. 2). During this period survey effort declined by about 20% from approximately 2400 km^2 to 1900 km^2, suggesting that the recorded changes in nest numbers were not due to increased survey effort, although it is possible they were caused by changes in detectability. However, the fact the same group of observers recorded some species increasing significantly, whilst observing static or declining trends for other species breeding at the same time in the same habitats, suggests that the results indicate relative trends rather than simply observer bias. Survey coverage was lowest in the 2008–2009 season, when surveys started a month later than usual and after some Giant Ibises had finished nesting. Data for the 2010–2011 season were omitted because the onset of the wet season was considerably delayed, so most species started nesting 1–2 months later than normal, and numbers of all early nesting species (Giant Ibis, Lesser Adjutant and Sarus Crane) were low. A

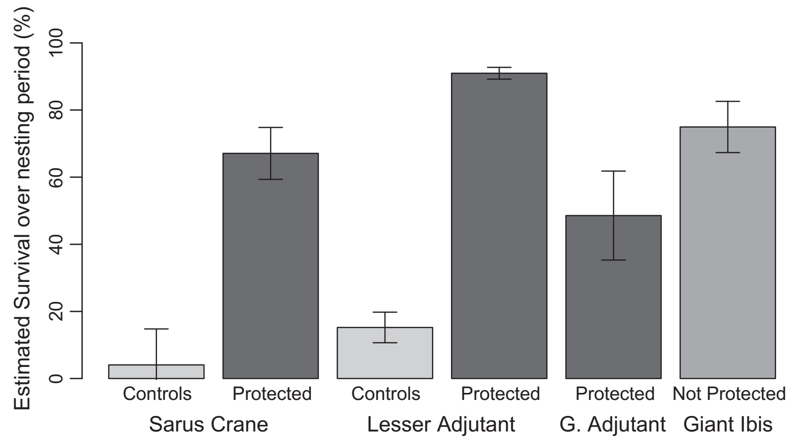

Fig. 1. Estimated nest survival over the entire nesting period during 2009–2011 for unprotected controls and protected nests of Sarus Crane and Lesser Adjutant, protected nests of Greater Adjutant, and Giant Ibises (which were not protected by the program). Estimates were calculated using the program MARK (Rotella, 2011), and standard error bars are given.

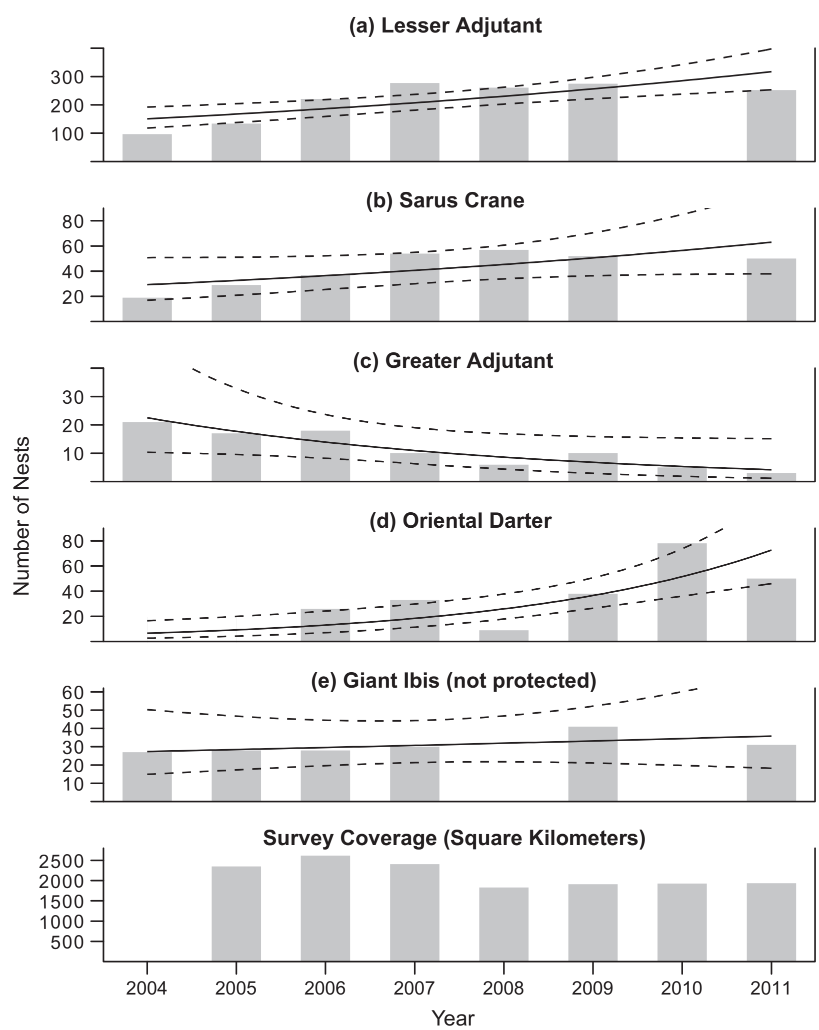

Fig. 2. Breeding bird populations in the Northern Plains, for (a) Lesser Adjutant; (b) Sarus Crane; (c) Greater Adjutant, and (d) Oriental Darter, all of which were targeted by the payment program; and (e) Giant Ibis, the only species which was not protected. The predicted values and 95% confidence intervals for the best fitting generalised linear model of nest numbers are also shown (see Table S6 for details). Survey coverage (final panel) was constant or declined slightly during the study period, suggesting that observed increases in species populations were not due to greater survey effort.

full breakdown of the generalised linear model of trends in species' populations is given in the Supplemental Materials (Table S6). Breeding populations, calculated as the number of nests observed, of Lesser Adjutant and Oriental Darter increased significantly through the study period ($P < 0.001$ in both cases), and there was some evidence for increases in Sarus Cranes ($P = 0.088$). The observed population increases for Lesser Adjutants, Oriental Darters and Sarus Cranes are consistent with internal recruitment, based

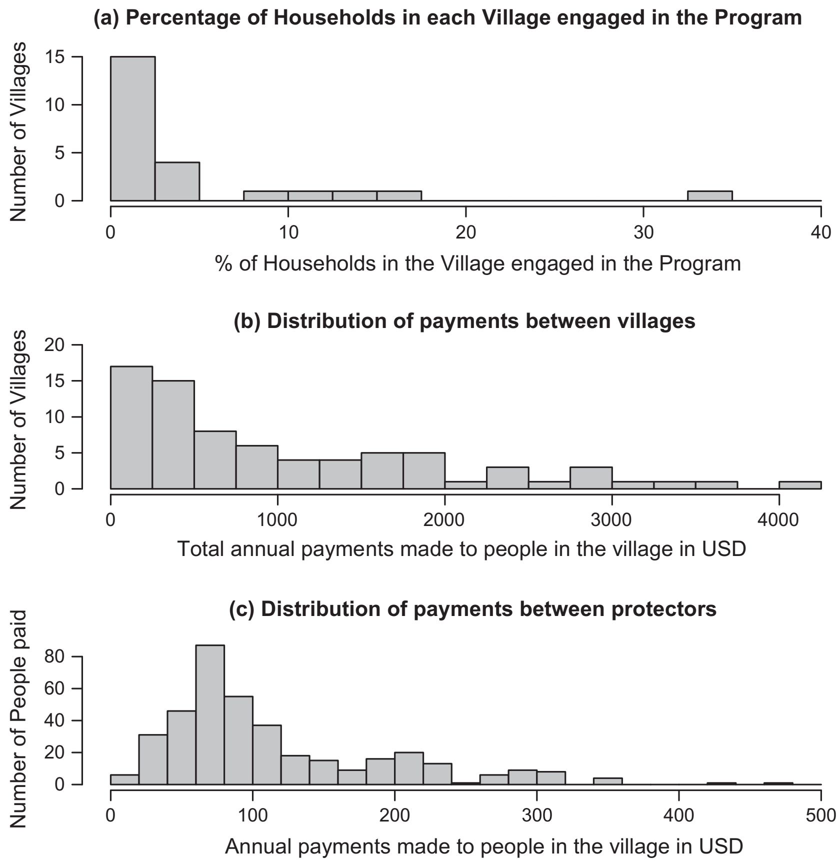

Fig. 3. Who benefited from nest protection payments between 2005 and 2009? The histograms show (a) the percentage of households in each village receiving payments; (b) distribution of the total annual ayments received by people in each village; and (c) distribution of annual payments to individual nest protectors. Histogram (c) has peaks at $80, for nest protectors that were employed protecting a single species over two months or less, $160 for protecting Lesser Adjutants (3–4 months) and $300 for protecting Greater Adjutants (up to 6 months).

upon what is known about the age at which birds reach sexual maturity (del Hoyo et al., 1996). Successful breeding by Sarus Cranes in the Northern Plains may account for the growing number of birds seen since 2007 at dry season feeding sites elsewhere (Evans et al., 2008). By contrast, there is no evidence for changes in the numbers of Giant Ibis, which was not impacted by nest collection ($P = 0.644$), implying that other factors, such as natural predation and conversion of feeding habitats to agriculture, are the primary threats to this species (An, 2008; Keo, 2008). There was some evidence for population decreases in Greater Adjutants ($P = 0.059$), probably due to a combination of disturbance of feeding sites, poisoning, and cutting of nesting trees. On several occasions the main colony at Antil village was deliberately disturbed, before the nest protectors arrived, by land grabbers who did not want the presence of a breeding colony to draw attention to their activities. The birds moved to another site but in diminished numbers.

3.3. Social impacts of the program

The program benefits about 100 households each year, of the approximately 4000 households across the 24 villages where the program operates. In the majority of villages, <5% of households were engaged in the program (Fig. 3a), although in a few villages up to 33% of households were involved. The majority of villages received <$750 per year, but with some villages earning >$2000 per year (Fig. 3b). Total payments varied depending upon the number of key species present, or species with particularly long breeding periods. Antil village received the greatest amount, with >$14,000 of payments over the four years, mainly due to the presence of the Greater Adjutant colony, which requires at least 6 months of protection each year. The average payment per nest protector was $80–$160, but there was considerable variation in the payments made, depending upon the species protected (as different species needed protecting for different periods of time, Fig. 3c). Some individuals were specialist protectors, switching species depending on the season and receiving continual employment for several months. Community rangers received significantly more, averaging $500–$800 per year with a maximum of >$1200. The distribution of payments is therefore quite uneven both between and within the villages, with only a small number of people generating high incomes from nest protection. The average payment per protector is significant in comparison with the 2009 estimate of household consumption in rural forested regions from the 2007 Cambodia Socio-Economic-Survey of $329 ± 16 (World Bank, 2009).

Despite the uneven distribution of benefits and the small number of people involved, 67% of 467 households interviewed were familiar with the program and could accurately describe how it worked. Of these, the vast majority thought that the distribution of benefits was fair (95%, Table 3), and understood that the primary beneficiaries were individual households (93%). There was no suggestion that traditional rules existed regarding the management of birds, or that these might have been crowded out by the initiation of the program. In villages where a moderate percentage of people (c.10%) were engaged in the program, respondents thought that it benefited the village as a whole (67%), whereas in villages with limited involvement in the program fewer respondents thought

Table 3
Attitudes of local people towards the bird nests protection program, based on a sample of 467 households interviewed across 8 villages, 5 of which were regularly involved in the program, and 3 of which had only limited involvement. 67% of respondents (315 households) were aware of the program and could describe broadly how it worked, data are based on responses from these interviews.

			Involvement in Bird Nests Program			
			Limited		Regular	
Variable	Question	Response	Result	%	Result	%
Villages interviewed						
Number of Villages			3		5	
Average Village Population (2008, Households)			116		146	146
Average number of Households engaged in the Program/village/year		Yes (%)	1	(1%)	13	(10%)
Annual average value of payments made per village/year		$/village/year	$87		$2103	
Aware of the program ($n = 467$)		Yes (%)	76	(47%)	239	(78%)
For the 315 households that are aware of the program:						
Existence of prior rules?	Can describe traditional rules regarding birds?	Yes (%)	0	(0%)	0	(0%)
Knowledge of the program	Can describe the conditions (to protect birds)?	Yes (%)	70	(92%)	221	(92%)
Household beneficiaries	Benefit directly from the program?	Yes (%)	6	(8%)	62	(26%)
	Female-headed households? (divorced, widowed or single)	Beneficiaries (%)	0	(0%)	1	(2%)
		Non-Beneficiaries (%)	2	(3%)	13	(7%)
	Average Age of household head (years)	Beneficiaries	36		41	
		Non-Beneficiaries	41		41	
Perceptions?	Who manages the program?	Village Authority? (%)	0	(0%)	0	(0%)
		Villagers? (%)	15	(20%)	54	(23%)
		WCS? (%)	47	(62%)	169	(71%)
Who benefits?	Who can participate?	Anyone? (%)	76	(100%)	239	(100%)
	Is the program fair?	Yes (%)	73	(96%)	225	(94%)
	Village Authority?	Yes (%)	0	(0%)	0	(0%)
	WCS or WCS's friends?	Yes (%)	0	(0%)	12	(6%)
	Individual households?	Yes (%)	71	(93%)	222	(93%)
	Village?	Benefit a lot (%)	21	(28%)	160	(67%)
		No benefit (%)	54	(71%)	71	(30%)
		Lose out (%)	1	(1%)	8	(3%)

the village benefited (28%). Most people correctly saw the program as being directly managed by WCS, especially in those villages with high involvement in the program (71%), rather than by local people. Even so, it was universally understood that anyone could participate (100%). Participating households were similar to non-participants in most characteristics, with the exception of a slight bias towards male-headed households (Table 3). Despite this overall positive assessment of the program, conflicts over who should receive payments and jealousy regarding the amounts paid were observed, particularly in Antil village (where people were paid for up to six months to protect Greater Adjutants). This type of resentment was also observed by other organisations piloting the same approach at other sites in Cambodia (WWF, pers. comm.). Antil differed from the other villages, because non-participants overwhelmingly saw the program as providing no benefits to the village (76%), suggesting a substantial level of local disquiet.

4. Discussion

4.1. The effectiveness of direct payments as a conservation intervention

Direct payments for conservation, and results-based incentive mechanisms in general, such as PES and REDD, have received considerable attention over the past decade, and a large number of such programs exist in both marine and terrestrial environments in both developed and developing countries (Milne and Niesten, 2009; Pattanayak et al., 2010), including widespread use of payments for nesting turtles (Ferraro and Gjertsen, 2009) and birds (Verhulst et al., 2007). The Bird Nests protection program analysed in this paper is consistent with Ferraro's definition of a direct payment program, and Wunder's (2007) strict definition of PES. Proponents have argued that direct payments may provide an effective mechanism to deliver biodiversity conservation outcomes, in a way that also provides potentially significant contributions to local livelihoods (Ferraro and Kiss, 2002). The Bird Nests Protection program meets many of these claims concerning the effectiveness, costs, and development benefits of payment programs.

The evidence suggests that nest protection payments were an effective way to ensure that large numbers of globally threatened birds that were threatened by nest collection successfully bred in the Northern Plains. Leakage (displacement of bird harvesting activity to other sites) is unlikely to have occurred due to the large distances involved: villagers would have had to move significant distances (>10 km) to find unprotected bird populations. As a consequence of the program, populations of some of these species may have increased considerably based upon the population data presented. However, the success of a targeted results-based payments program depends upon the extent to which the outcome that is rewarded (nest protection) accurately reflects biodiversity conservation needs (Redford and Adams, 2009; Gibbons et al., 2011). Payments had limited impact on species such as the ibises and Greater Adjutants, for which the main threats to nesting birds were natural predation and habitat clearance by villagers or outsiders (An, 2008; Keo, 2008; Keo et al., 2009; Wright, 2012; Wright et al., 2012). Protectors were unable to prevent any of these threats. This emphasises the importance of designing conservation interventions based on clear conceptual models of threats to biodiversity, how interventions affect these threats, and the resulting impacts of interventions on conservation targets (Salafsky et al., 2002; Margoluis et al., 2009). When the program was designed in 2003, nest collection was the greatest threat to breeding bird populations. Since 2006, deforestation rates have increased considerably in Cambodia and in the study area (Forestry Administration, 2011), and the failure of the payment program to incentivise habitat protection raises considerable concerns about its long-term effectiveness.

The nest protection program was relatively inexpensive, in comparison with other types of conservation interventions such as protected area management (James et al., 2001) or integrated conservation and development projects (Wells et al., 1999). The majority of funds went to local people. This substantiates theoretical claims that direct payment programs would have low administrative costs, and would provide significant benefits at the local level (Ferraro and Kiss, 2002). The payments provided a legal income from the birds instead of illegal hunting and trade. Payment amounts were highly significant in poor remote rural villages relative to other sources of income, suggesting that they made a contribution to local livelihoods.

In conclusion, the bird nests protection program was a highly effective conservation intervention to protect highly threatened globally significant biodiversity, in a way that was rapid to establish, cost-efficient and delivered significant benefits to local people. The sustainability of user-financed direct payments programs, such as this one, are however a concern since they are reliant upon continual funding (Swart, 2003). If the payments ceased it is possible that some of the nest protectors and local rangers (many of whom had previously been well-known hunters) would return to nest collection.

4.2. Social acceptance of external payments: equity and fairness

The extent to which payments are socially-appropriate, equitable, fair, or designed to build local support for conservation is often not an explicit consideration in the design of PES programs (Jack et al., 2008; Pascual et al., 2010). Critics have raised concerns that payments may 'crowd-out' local social norms, monetising behaviours and outcomes that may previously have had non-monetary local values (Bowles, 2008; Redford and Adams, 2009; Clements, 2010). There was no evidence in the bird nests case that prior social rules existed regarding management of breeding bird populations, or that these were crowded out by introduction of the payments.

Brown and Corbera (2003) distinguish between three elements of equity in PES programs: equity in access, equity in decision-making and equity in benefits. The bird nests protection program scores highly against only one of these three criteria. The program was designed to be, and recognised by local people as, open to participation by anyone from the local villages. Local people were not, however, involved in any aspects of decision-making, as the program was administered externally by WCS staff. Externally-imposed rules and incentives may lead to perceptions that incentives are unfair (Fehr and Falk, 2002). Finally, the distribution of benefits was highly inequitable both between and within villages: only a small number of households in the villages benefited, and even fewer received high payments.

Researchers have suggested that there is a trade-off in program design between efficiency, in terms of the cost for protecting biodiversity, and equity in the distribution of benefits (Proctor et al., 2009; Pascual et al., 2010). Payment programs could be designed to be more egalitarian but that this would be less cost-efficient as the payments are likely to be less precisely targeted to those able to deliver conservation outcomes. Pascual et al. (2010) propose a range of fairness criteria for distribution of benefits from PES programs, from simple compensation based on the costs of providing the ecosystem service, to pro-poor payments that aim to maximise net benefits to the poor, even at a cost of efficiency loss. The distribution of benefits under the Bird Nest Protection Program was at the compensation end of this spectrum, rewarding protectors based upon the opportunity cost of their labour to protect the nests (their minimum willingness to accept).

Despite the uneven distribution of payments, however, the program had broad support across all the villages, was generally seen to benefit the village as a whole, and was overwhelmingly viewed as fair. This is probably explained by three observations. Firstly, protectors were generally chosen from local forest users or farmers, who had the strongest claims to ownership of the area in the absence of property rights. Secondly, the payment levels were based on the number of days worked, with the daily rate based on an acceptable local wage. Differential payments are seen as fair so long as the payment level is commensurate with effort (Konow, 2003). Thirdly, in Cambodia international non-government organisations, such as WCS, commonly provide services usually provided by the state and tend to be viewed positively as service providers (Malena and Chhim, 2009). The evidence suggests that the bird nests protection program was administered correctly: there was very little evidence for elite capture, or the program being seen to disproportionately benefit ‘friends’ of WCS.

Nevertheless, interview reports suggested that a small minority of local people did not support payments, perhaps due to the uneven distribution of benefits. The level of local disquiet was greatest in the village where payments were made for Greater Adjutants, which were the most valuable species in the program (due to their long nesting time), but where few people benefited to a great degree due to the small number of nesting sites. As a consequence, the Greater Adjutant colonies were not effectively protected by the program and have continued to decline.

4.3. Design, implementation and evaluation of payment programs

The last two decades have seen a rapid expansion of policy approaches that provide conditional incentives for provision of social and environmental services in developing countries, such as Conditional Cash Transfers (Fiszbein and Schady, 2009), Direct Payments for Biodiversity Conservation, and Payments for Environmental Services (PES), including REDD, with billions of dollars spent on such programs globally (Fiszbein and Schady, 2009; Diaz et al., 2011). Whereas Conditional Cash Transfer programs have incorporated and facilitated rigorous impact evaluations as part of their implementation, most PES or direct payment programs have not been subjected to the same standards (Pattanayak et al., 2010). Consequently, a recent PES review concluded “we do not yet fully understand either the conditions under which PES has positive environmental and socioeconomic impacts or its cost effectiveness” (Pattanayak et al., 2010).

This study has shown that it is possible to incorporate rigorous impact evaluation into the implementation of a direct payment for biodiversity conservation program. To be effective, evaluation needs to consider at least three aspects: (1) the details of program implementation, including the cost and distribution of payments made, (2) the impact of payments on the conservation threats they were designed to address; and (3) the impact of the payment program on conservation targets, such as increases in species populations (Wilkie, 2004). Such comprehensive evaluation at multiple levels is important in the context of complex socio-ecological systems, where it is challenging to separate out the impact of a single intervention. Experimental or quasi-experimental techniques are necessary in order to assign causation to conservation interventions in the context of other processes (Ferraro and Pattanayak, 2006).

Implementation of payment programs in the context of weak institutional frameworks and unclear property rights creates significant challenges (Muradian et al., 2010). This study has shown how a simple direct payments program implemented by an external agency, targeting only a single metric (nest success), without explicit consideration of the distribution of benefits or other social issues, can be extremely successful in conservation terms and also deliver significant local benefits. It has also demonstrated two potential pitfalls with such a program design: (1) targeting a single conservation metric is risky when there are multiple changing threats to species’ populations; and (2) compensating individuals directly for species protection, ignoring issues of equitability, may lead to unintended consequences. Most significantly, in the context of rapid land-use change, weak institutions and unclear property rights over land and natural resources, this type of program is best viewed as a complement, not a substitute, to other types of interventions, including protected area management, local management of natural resources, and development of sustainable financing (Clements et al., 2010).

Acknowledgments

The program was undertaken with the permission and support of the Ministry of Environment and Ministry of Agriculture, Forestry and Fisheries of the Royal Government of Cambodia and the Preah Vihear Provincial Authority. We would like to thank all the WCS, CENTDOR and Government staff for their hard work and dedication. Our deepest thanks go to the local people in Preah Vihear. The work was funded by WCS, the Global Environment Facility, United Nations Development Program, Angkor Centre for Conservation of Biodiversity, Disney Wildlife Conservation Fund, Akron Zoo and the Critical Ecosystem Partnership Fund. The Critical Ecosystem Partnership Fund is a joint initiative of l’Agence Française de Développement, Conservation International, the Global Environment Facility, the Government of Japan, the MacArthur Foundation and the World Bank. A fundamental goal is to ensure civil society is engaged in biodiversity conservation. This research was partly funded by the generous support of the American people through the United States Agency for International Development (USAID), under the terms of the TransLinks Cooperative Agreement No. EPP-A-00-06-00014-00 to WCS, a Miriam Rothschild scholarship from the University of Cambridge to TC, and a Royal Society Wolfson Research Merit award to EJMG. Finally, we would like to thank Eleanor Briggs for her unwavering support for conservation in Cambodia over the years.

Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.biocon.2012.07.020.

References

Abadie, A., Imbens, G., 2006. Large sample properties of matching estimators for average treatment effects. Econometrica 74, 235–267.

Adams, W.M., Aveling, R., Brockington, D., Dickson, B., Elliott, J., Hutton, J., Roe, D., Vira, B., Wolmer, W., 2004. Biodiversity conservation and the eradication of poverty. Science 306, 1146–1149.

Agrawal, A., Chhatre, A., Hardin, R., 2008. Changing governance of the world’s forests. Science 320, 1460–1462.

An, D., 2008. Agricultural Expansion and Its Effects on Breeding Habitat of Giant Ibis Pseudibis Gigantea in Kulen Promtep Wildlife Sanctuary, northern Cambodia. Department of International Environmental and Agricultural Science, Tokyo University of Agriculture and Technology.

Barrett, C., Brandon, K., Gibson, C., Gjertsen, H., 2001. Conserving tropical biodiversity amid weak institutions. Bioscience 51, 497–502.

Bowles, S., 2008. Policies designed for self-interested citizens may undermine “the moral sentiments”: evidence from economic experiments. Science 320, 1605–1609.

Brown, K., Corbera, E., 2003. Exploring equity and sustainable development in the new carbon economy. Climate Policy 3S1, S41–S56.

Cambodia R-PP, 2011. Cambodia REDD+ Readiness Preparation Proposal. Submission to the Forest Carbon Partnership Facility of the World Bank. March, 2011. Forestry Administration, Phnom Penh.

Clements, T., 2010. Reduced expectations: the political and institutional challenges of REDD+. Oryx 44, 309–310.

Clements, T., Gilbert, M., Rainey, H.J., Cuthbert, R., Eames, J. C., Pech, B., Seng, T., Song, C. S., Tan, S., 2012. Vultures in Cambodia: population, threats and conservation. Bird Conservation International. http://dx.doi.org/10.1017/S0959270912000093.

Clements, T., John, A., Nielsen, K., An, D., Tan, S., Milner-Gulland, E.J., 2010. Payments for biodiversity conservation in the context of weak institutions: comparison of three programs from Cambodia. Ecol. Econ. 69, 1283–1291.

del Hoyo, J., Elliott, A., Sargatal, J., 1996. Handbook of birds of the world. vol. 3. Hoatzin to Auks. Lynx Edicions, Barcelona.

Diaz, D., Hamilton, K., Johnson, E., 2011. State of the Forest Carbon Markets 2011. Ecosystem Marketplace, Washington, DC.

Engel, S., Pagiola, S., Wunder, S., 2008. Designing payments for environmental services in theory and practice. an overview of the issues. Ecol. Econ. 65, 663–674.

Evans, T.D., van Zalinge, R., Hong, C. & Seng, K. H., 2008. Records of non-breeding Sarus Cranes in Cambodia in the 2007/8 dry season, including results of the annual census. Wildlife Conservation Society – Cambodia Program, BirdLife International in Indochina and the Forestry Administration of the Ministry of Agriculture, Forestry and Fisheries, Phnom Penh.

Fehr, E., Falk, A., 2002. Psychological foundations of incentives. Eur. Econ. Rev. 46, 687–724.

Ferraro, P., 2001. Global habitat protection: limitations of development interventions and a role for conservation performance payments. Conserv. Biol. 15, 990–1000.

Ferraro, P.J., Gjertsen, H., 2009. A global review of incentive payments for sea turtle conservation. Chelonian Conserv. Biol. 8, 48–56.

Ferraro, P.J., Kiss, A., 2002. Direct payments to conserve biodiversity. Science 298, 1718–1719.

Ferraro, P.J., Pattanayak, S.K., 2006. Money for nothing? A call for empirical evaluation of biodiversity conservation investments. PLoS Biol. 4, 482–488.

Fiszbein, A., Schady, N., 2009. Conditional Cash Transfers: Reducing Present and Future Poverty. World Bank Policy Research Report, World Bank, Washington, DC.

Forestry Administration, 2011. Cambodia Forest Cover 2010. Forestry Administration, Phnom Penh.

Gibbons, J.M., Nicholson, E., Milner-Gulland, E.J., Jones, J.P.G., 2011. Should payments for biodiversity conservation be based on action or results? J. Appl. Ecol. 48, 1218–1226.

Hines, J.E., Sauer, J.R., 1989. Program CONTRAST – A General Program for the Analysis of Several Survival or Recovery Rate Estimates. US Fish & Wildlife Service, Fish & Wildlife Technical Report 24, Washington, DC.

Hirschfeld, E., 2009. Rare Birds Yearbook 2009. Birdlife International, Cambridge.

Jack, B.K., Kousky, C., Sims, K.R.E., 2008. Designing payments for ecosystem services: lessons from previous experience with incentive-based mechanisms. Proc. Nat. Acad. Sci. 105, 9465–9470.

James, A., Gaston, K.J., Balmford, A., 2001. Can we afford to conserve biodiversity? Bioscience 51, 43–52.

Keo, O., 2008. Ecology and Conservation of Giant Ibis in Cambodia. PhD Thesis. University of East Anglia.

Keo, O., Collar, N.J., Sutherland, W.J., 2009. Nest protectors provide a cost-effective means of increasing breeding success in Giant Ibis *Thaumatibis gigantea*. Bird Conser. Int. 19, 77–82.

Konow, J., 2003. Which is the fairest one of all?: a positive analysis of justice theories. J. Econ. Literat. 41, 1186–1237.

Malena, C., Chhim, K., 2009. Linking citizens and the state: an assessment of civil society contributions to good governance in Cambodia. World Bank, Phnom Penh.

Margoluis, R., Stem, C., Salafsky, N., Brown, M., 2009. Using conceptual models as a planning and evaluation tool in conservation. Eval. Program Plann. 32, 138–147.

McKenney, B., Yim, C., Prom, T., Evans, T., 2004. Focusing on Cambodia's High Value Forests: Livelihoods and Management. Cambodia Development Resource Institute and Wildlife Conservation Society, Phnom Penh.

McShane, T.O., Hirsh, P.D., Trung, T.C., Songorwa, A.N., Kinzig, A., Monteferri, B., Mutekanga, D., Thang, H.V., Dammert, J.L., Pulgar-Vidal, M., Welch-Devine, M., Brosius, J.P., Coppolillo, P., O'Connor, S., 2010. Hard choices: Making trade-offs between biodiversity conservation and human well-being. Biol. Conserv. 144, 966–972.

Milne, S., Niesten, E., 2009. Direct payments for biodiversity conservation in developing countries: practical insights for design and implementation. Oryx 43, 530–541.

Muradian, R., Corbera, E., Pascual, U., Kosoy, N., May, P.H., 2010. Reconciling theory and practice. an alternative conceptual framework for understanding payments for environmental services. Ecol. Econ. 69, 1202–1208.

Ostrom, E., 2007. A diagnostic approach for going beyond panaceas. Science 104, 15181–15187.

Pascual, U., Muradian, R., Rodríguez, L.C., Duraiappah, A., 2010. Exploring the links between equity and efficiency in payments for environmental services: a conceptual approach. Ecol. Econ. 69, 1237–1244.

Pattanayak, S.K., Wunder, S., Ferraro, P.J., 2010. Show me the money: do payments supply environmental services in developing countries? Rev. Environ. Econ. Policy 4, 254–274.

Persky, J., 1995. Retrospectives: the ethology of Homo economicus. J. Econ. Perspect. 9, 221–232.

Proctor, W., Koellner, T., Lukasiewicz, A., 2009. Equity considerations and markets for ecosystem services. In: Kumar, P., Muradian, R. (Eds.), Payments for Ecosystem Services. Oxford University Press, New Delhi, pp. 17–43.

R Development Core Team, 2011. R: A language and environment for statistical computing. R Foundation for Statistical Computing: Vienna, Austria. <http://www.R-project.org/>.

Redford, K.H., Adams, W.M., 2009. Payment for ecosystem services and the challenge of saving nature. Conserv. Biol. 23, 785–787.

Roe, D., 2008. The origins and evolution of the conservation-poverty debate: a review of key literature, events and policy processes. Oryx 42, 491–503.

Rotella, J., 2011. Nest survival models. In: Cooch, E., White, G. (Eds.), Program MARK: A Gentle Introduction, 10th ed. <www.phidot.org/software/mark/docs/book/>.

Salafsky, N., Margoluis, R., Redford, K.H., Robinson, J.G., 2002. Improving the practice of conservation: a conceptual framework and research agenda for conservation science. Conserv. Biol. 16, 1469–1479.

Sommerville, M., Jones, J.P.G., Milner-Gulland, E.J., 2009. A revised conceptual framework for Payments for Environmental Services. Ecol. Soc. 14 (2), 34, <www.ecologyandsociety.org/vol14/iss2/art34>.

Sommerville, M., Jones, J.P.G., Rahajaharison, M., Milner-Gulland, E.J., 2010. The role of fairness and benefit distribution in community-based payment for environmental services interventions: a case study from Menabe, Madagascar. Ecol. Econ. 69, 1262–1271.

Swart, J., 2003. Will direct payments help biodiversity? Science 299, 1981.

Verhulst, J., Kleijn, D., Berendse, F., 2007. Direct and indirect effects of the most widely implemented Dutch agri-environment schemes on breeding waders. J. Appl. Ecol. 44, 70–80.

WCS, 2009. List of animals on the IUCN Red List found in Cambodia. Wildlife Conservation Society – Cambodia Program, Phnom Penh.

Wells, M., Guggenheim, S., Khan, A., Wardojo, W., Jepson, P., 1999. Investing in biodiversity: a review of indonesia's integrated conservation and development projects. Directions in Development Series. World Bank, Washington, DC.

Wharton, C.H., 1966. Man, fire and wild cattle in North Cambodia. In: Proceedings of the 5th Annual Tall Timbers Fire Ecology Conference, pp. 23–65.

Wilkie, D., 2004. Technical Manual 3: Measuring our Effectiveness: A Framework for Monitoring. Wildlife Conservation Society, Bronx, NY.

World Bank., 2009. Poverty profile and trends in Cambodia, 2007. Findings from the Cambodia Socio-Economic Survey. Poverty Reduction and Economic Management Sector Unit, East Asia and Pacific Region, World Bank, Washington, DC.

Wright, H.L., Collar, N.J., Lake, I.R., Net, N., Rours, V., Sok, K., Sum, P., Dolman, P.M., 2012. First census of the White-Shouldered Ibis *Pseudibis davisoni* reveals roost-site mismatch with Cambodia's protected areas. Oryx 46, 236–239.

Wright, H.L., 2012. Synanthropic survival: low-impact agriculture and white-shouldered ibis conservation ecology. PhD Thesis. University of East Anglia, Norwich.

Wunder, S., 2007. The efficiency of payments for environmental services in tropical conservation. Conserv. Biol. 21, 48–58.