

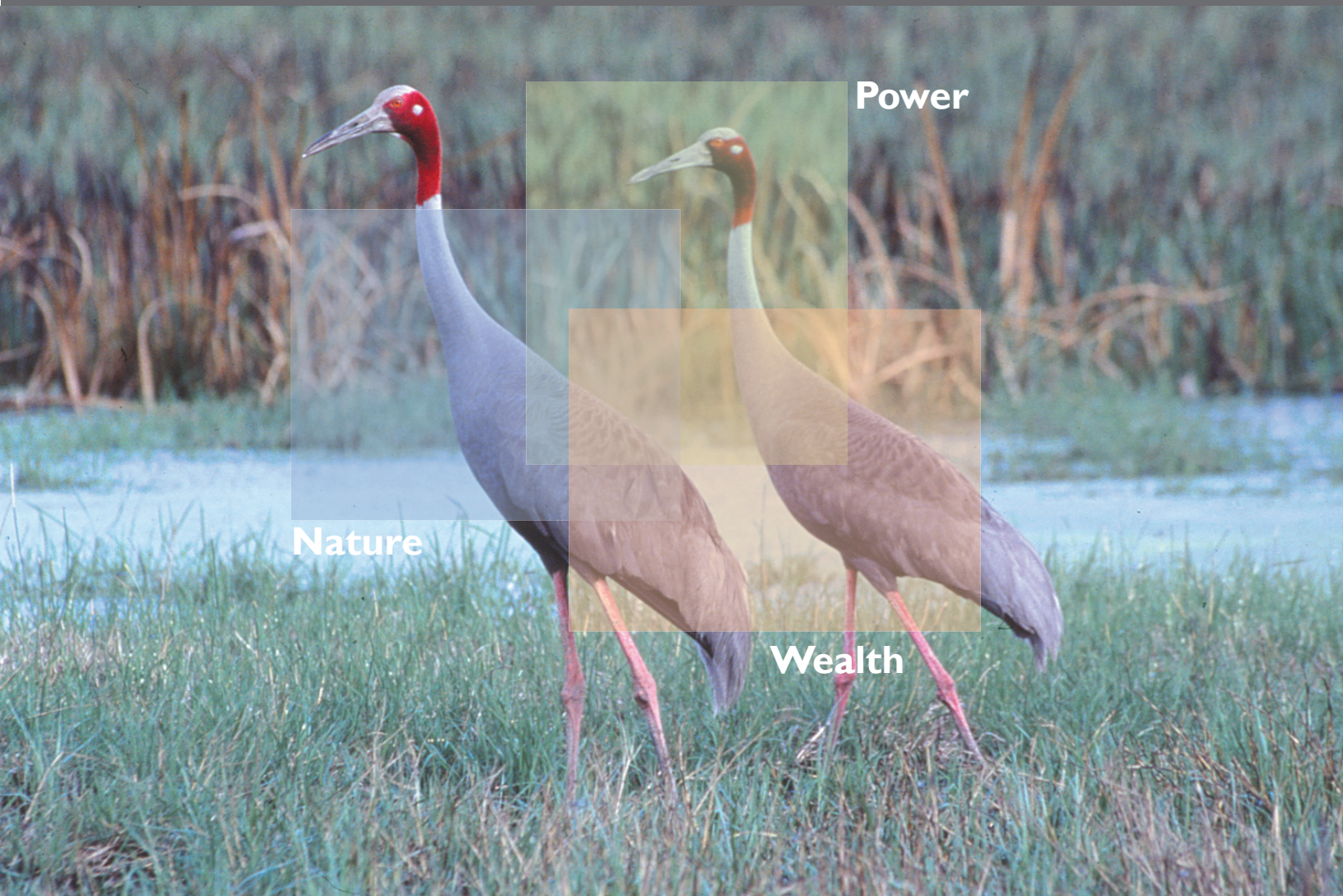


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Case Study:
Bird Nest Protection Program in the Northern Plains of Cambodia

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Case Study

Bird Nest Protection Program in the Northern Plains of Cambodia

Report prepared for WCS TransLinks Program

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August 2009

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Bird Nest Protection Program in the Northern Plains of Cambodia

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Abbreviations

ATT	Ang Trapeang Thmor
GDANCP	General Department of Administration for Nature Conservation Protection
GT-CR	Globally Threatened – Critically Endangered (<i>IUCN red list category</i>)
GT-EN	Globally Threatened – Endangered
GT-VU	Globally Threatened – Vulnerable
IUCN	International Union for the Conservation of Nature
KPWS	Kulen Promtep Wildlife Sanctuary
MAFF	Ministry of Agriculture, Forestry and Fisheries
MoE	Ministry of Environment
NSAID	Non-steroidal anti-inflammatory drug
NTFPs	Non-Timber Forest Products
PA	Protected Area
PVPF	Preah Vihear Protected Forest
WCS	Wildlife Conservation Society

Executive Summary

Direct payments for conservation – a payment for an environmental service – were proposed by Ferraro (2001) as an effective tool for delivering conservation outcomes. This case study describes a direct payment program that was established for nine Globally Threatened bird species in the Northern Plains of Cambodia, including five listed as Critically Endangered. All nine species were heavily threatened by collection of eggs and chicks from nesting sites for consumption or trade. Under the program, local people were offered conditional payments if they successfully protected nests until the chicks fledged. Since the program's inception in 2002, it has protected more than 1,550 nests and expanded to cover 21 villages over an area greater than 4,000 km² of habitat. Annual payments exceed \$30,000, of which 71-78% is made directly to local people, many of whom live on less than \$1 per day. The average annual payments per protector, \$80-\$160, are therefore significant in comparison with other forms of local cash income. This case study demonstrates that direct payments can be a highly effective and cost-efficient approach to deliver conservation outcomes in a manner that also supports local livelihoods.

Northern Plains of Cambodia

The deciduous dipterocarp forests that once spread across much of Indochina and Thailand supported the greatest aggregation of large mammals and waterbirds that existed outside of the African savannas (Wharton 1966). These forests have largely disappeared from Thailand and Vietnam, due to rapid expansion of rural populations and widespread conversion to intensified agriculture. The Northern Plains of Cambodia form the largest remaining contiguous block of

this unique and critically important habitat, and are listed as one of the Global 200 Ecoregions (Olson & Dinerstein 1998). The landscape is located in one of the poorest and most remote regions in Cambodia, Preah Vihear province. The Northern Plains are northwest of Siem Reap and the temples at Angkor and share Cambodia's northern border with Thailand and Laos. Much of the province is still covered in intact habitat – extensive areas of deciduous dipterocarp forest, with scattered seasonal wetlands (called trapeangs in Khmer) and large grasslands (veals), which flood during part of the wet season (June-October). Dense evergreen forest is found along water-courses and in the more fertile soils of the upland regions.

The first biological surveys of the Northern Plains were conducted in the late 1990s, after the cessation of conflict. These surveys revealed the continued presence of an assemblage of threatened species unparalleled elsewhere in the world, and perhaps the richest remaining example of deciduous dipterocarp forest avifauna. The area is either a last refuge for, or maintains a key population of, fifteen Globally Threatened and six Near-threatened bird species, including five listed as Critically Endangered on the IUCN Red List (WCS 2009). Two of these are the Giant Ibis (*Pseudibis gigantea*) for which the Northern Plains supports probably the largest remaining population, and the White-shouldered Ibis (*P. davisoni*), for which the area contains one of the only known nesting sites in Asia. These two ibises are amongst the most endangered bird species in the world (Hirschfeld 2009).



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Giant Ibis - one of the most endangered bird species on the planet

The Northern Plains is also of global importance for the conservation of Asian vultures, the White-rumped Vulture (*Gyps bengalensis*), Slender-billed Vulture (*G. tenuirostris*) and Red-necked Vulture (*Sarcogyps calvus*). In the Indian Subcontinent, populations of these three species have declined by over 96% since 1992 (Cuthbert et al. 2006, Pain et al. 2008, Prakash et al. 2007) and are now facing extinction in the wild. All three species are listed as Critically Endangered by the IUCN, the highest level of global threat status. Research has revealed that these declines are caused by livestock owners' use of the drug diclofenac, a non-steroidal anti-inflammatory drug (NSAID) similar to ibuprofen (Oaks et al. 2004). The drug is so toxic to vultures that even small quantities cause rapid death by renal failure. Outside the Indian subcontinent remnant populations of all three species exist in Cambodia, where diclofenac is not used, and Myanmar. The Northern Plains populations are therefore considered to be irreplaceably globally significant, representing one of the best opportunities for the survival of these species in the wild (Clements et al. 2009).

The landscape also supports a breeding population of Greater Adjutant Storks *Leptoptilus dubius* (GT-EN) – the only other nesting site in Southeast Asia is at Prek Toal on the Tonle Sap – in addition to White-winged Ducks *Cairina scutulata* (GT-EN), Lesser Adjutants *Leptoptilus javanicus* (GT-VU), Oriental Darters *Anhinga melanogaster* (NT), Black-necked Storks *Ephippiorhynchus asiaticus* (NT), Woolly-necked Storks *Ciconia episcopus* and Sarus Cranes *Grus antigone* (GT-VU). The latter is well-known for its dry season aggregations, particularly at Ang Trapeang Thmor (ATT); however, during the wet season it nests in the Northern and Eastern Plains. With breeding populations of nine Globally Threatened large bird species, the Northern Plains are of exceptional importance for wildlife conservation.

Conservation Strategies in the Northern Plains

Strategies for bird conservation have little room for error, because populations of all of these globally threatened species number from 10s to a few hundred. Hunting and nest collection, which are illegal, and disturbance of breeding sites were the principle threats in the 1990s and early 2000s. Collection of eggs and chicks was particularly severe for both Adjutant species and the Sarus Cranes; the latter is known to fetch a high market price. Collection was mostly undertaken by local villages, who kept the eggs and chicks with domestic chickens until they are able to sell them on to middlemen that traded with Thai and Lao border markets. In recent years, habitat clearance has emerged as an important additional threat. National deforestation rates in Cambodia were >0.5% annually between 2002 and 2006 (Forestry Administration 2008) driven by a variety of processes, including large-scale development projects such as agro-industrial concessions, improved road access, population growth, and smallholder encroachment both by landless immigrants and established communities (Forestry Administration 2009). Forest clearance is appealing to local people because

it is a relatively easy way to secure wealth; land is viewed as an open access resource and enforcement of land use regulations is rare. Many plots are claimed but not cleared, forcing new farmers in need of land for cultivation to move further into the forest (An 2008).

Initial conservation strategies in Cambodia focused on protected area (PA) management. The PAs were established from 1993 and have a small number of poorly paid staff with limited capacity or infrastructure, i.e. they are 'paper parks' (Wilkie et al. 2001). PAs usually contain existing human settlements with unclear property rights. The Cambodian PA system was also declared based on relatively little information and consequently excludes many areas of importance for biodiversity conservation, again not an uncommon situation (Brooks et al. 2004), emphasizing the importance of adopting a landscape approach to conservation. Under these conditions PA management is not sufficient to achieve biodiversity conservation goals, although Cambodia actually has robust national environmental legislation that includes complete protection of all rare or endangered species.

In 2002, the Wildlife Conservation Society (WCS), in collaboration with the General Department of Administration for Nature Conservation and Protection (GDANCP) of the Ministry of Environment (MoE) and the Forestry Administration of the Ministry of Agriculture, Forestry and Fisheries (MAFF), initiated a program of direct payments for biodiversity conservation (Ferraro 2001, Ferraro & Kiss 2002) in the Northern Plains. The program was designed to rapidly protect the remnant wildlife populations while complementing longer-term activities meant to strengthen institutions for environmental protection, such as protected areas, and clarifying land tenure and resource management rights for local people (Rock 2001). Activities focused on two PAs in the Northern Plains landscape: the 2,604 km² Kulen Promtep Wildlife Sanctuary (KPWS) in Preah Vihear province, which was established in 1993 and



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Darters

is managed by the Ministry of Environment, and the 1,900 km² Preah Vihear Protected Forest (PVPF), declared in 2002 and managed by the Forestry Administration of the Ministry of Agriculture, Forestry and Fisheries. Wildlife Sanctuaries are managed according to the Protected Areas Law (2008), whereas Protected Forests are managed under the Forestry Law (2002). Both PAs contain or are used by long-established villages that practice either lowland rain-fed paddy rice cultivation or upland shifting cultivation for rice and other crops, collection of forest products, and fishing (McKenney & Prom 2002, McKenney et al. 2004). Forest resources are a crucial safety net for the livelihoods of families that lack sufficient agricultural capacity, providing cash income, particularly from the sale of liquid resins from dipterocarp trees (McKenney & Prom 2002, McKenney et al. 2004).

Bird Nest Protection Program Description

In 2002, the Bird Nest Protection Program was initiated by government partners, with financial support from WCS, to locate, monitor and protect nesting sites. Under the program, local people and contracted community rangers locate nests within both KPWS and PVPF. Rewards of up to \$5 are offered to local people for reporting a nest. The community rangers are villagers that are given seasonal or annual contracts specifically to find and monitor bird nests. Usually only 1-2 people per village are selected based on existing knowledge of wildlife and the forest; many were previously hunters. Due to seasonal differences, birds can be located nearly all year round. The Sarus Cranes and Giant Ibises start to nest early in the wet season (June-July) and are usually found first, while the Adjutants and Darters begin to nest later in the wet season (September onwards). Vultures, White-shouldered Ibises and Black-necked Storks start to nest in the late wet season (November-December) and fledge in March-April. Greater Adjutants often do not fledge until early May.



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For all species except the ibises, a permanent protection team of two people is established for each nest (or colony, in the case of Adjutants and Darters). Giant Ibises do not require such intensive protection, because they are not valued for trade or local consumption, while White-shouldered Ibises are only monitored at the main site, Tmatboey, because they are the target of a community-based ecotourism program (Clements et al. 2008). If a nest is reported by local people then they are usually given the option to be employed as protectors by the community rangers. For other nests, volunteer protectors were chosen by the rangers from local farmers or resin-tappers or the nearest village. Crane nests are often located in grasslands that may contain active fields, while Adjutants and Ibises often nest in resin trees. For those Adjutant colonies of particular value for conservation, one community ranger may form a protection team with a single locally hired villager. Experiments in 2005 and 2006 demonstrated that plastic predator-exclusion belts placed around the base of nesting trees of Giant Ibis substantially reduced predation rates and increased nesting success (Keo et al. 2009); subsequently these were installed at all nesting trees.

In 2002-2008 protectors received \$1 per day for their work and, if the chicks successfully fledge, an extra \$1 per day worked upon completion. This total possible payment of \$2/day was judged an acceptable daily wage based on initial village consultations at the start of the project. From 2008, this was increased to \$2.50/day (\$1.25 per day up front and an extra \$1.25 per day if fledging is successful), due to rising food prices. The marginal value of a nest therefore increased with time: after two months guarding a nest a protector stood to lose \$60 (\$75 from 2008) if it was collected. Sarus Crane chicks are precocial – capable of moving around on their own after hatching – and require no further protection after this point. All of the other species targeted by this program have altricial chicks – incapable of moving around on their own soon after hatching. Therefore, for these species, the nest



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Saurus Crane eggs in a nest protected by local people

protectors remain until the last chick has fledged. Under the protection contracts, the nest protectors are required to maintain a 24-hour guard of the nesting site, basing themselves at sufficient distance so as not to disturb birds. Many protectors take it in turns to return to their home to collect food, or ask relatives to bring food to them in the forest. The protection teams are regularly visited every 1-2 weeks by the community rangers that are employed by WCS, and monthly by WCS monitoring staff, to verify results and collect data on species ecology.

Wildlife Sanctuary and Protected Forest staff regularly conduct awareness-raising activities in local villages to inform people about the nest protection scheme and the importance of conserving these key species. They also conduct enforcement activities against wildlife traders and monitor local and border markets. The nest protection program was initiated in four pilot villages in 2002 in KPWS and was extended to PVPF in 2004. By 2007 it was operating in more than 15 villages.

Results

Comparison of Species Ecology

Data on nesting seasons (Table 1) are similar to those found by other studies (e.g., Keo 2008, Wright 2008). Sarus Cranes, followed by Giant Ibises, are the first species to start nesting, laying eggs in the middle of the wet season (July-August). The Giant Ibises continue to feed chicks in the nest into the late wet season; in fact, chicks from one nest did not fledge until late November in the 2003 season. Darters start nesting in September and fledge in November. Both Adjutant species start to nest later in the dry season (September-October), with Lesser Adjutants generally fledging earlier (December-February) than Greater Adjutants (April-May). Wet season nesting times in PVPF are usually 2-4 weeks ahead of those in KPWS, possibly because of earlier rainfall.

White-shouldered Ibis – the rarest species – starts nesting in the late wet season or early dry season (December), and their chicks usually fledge in February or March. This is the reverse of the Giant Ibis

Table 1. Nesting seasons in the Northern Plains.

<i>Species</i>	<i>Date Found</i>	<i>Date Eggs Hatch</i>	<i>Date Fledge</i>
<i>Kulen Promtep Wildlife Sanctuary</i>			
White-shouldered Ibis	Dec-Jan		Feb-Mar
Giant Ibis	July-Aug		Sept-Nov
Sarus Crane	Aug	Sept	
Oriental Darter	Sept	Sept	Nov
Greater Adjutant	Nov	Late Dec-Jan	Mar-Apr-May
Lesser Adjutant	Sep-Oct	Dec	Dec-Feb
<i>Preah Vihear Protected Forest</i>			
Giant Ibis	July-Aug		Sep-Oct
Sarus Crane	July-Aug	Aug-Sep	
Lesser Adjutant	Aug-Oct	Nov	Dec-Jan

breeding season, presumably due to differences in feeding strategies (Wright 2008). White Shouldered Ibises choose to nest in exposed trees, often in ricefields after the harvest has been collected, and their proximity to people exposes them to opportunistic hunting pressure. Black-necked Storks and Vultures also nest during the late wet season and into the dry season.

Table 2 gives some details of the characteristics of the nests and nesting sites for each species, which are similar to other studies (e.g., Keo 2008, Wright 2008). Interestingly, with the exception of Sarus Crane, all of the species rely upon tall dipterocarp trees, which are of high timber value and are tapped by local people for resins (*Dipterocarpus* species only). The Adjutants are the only species to breed in evergreen forest in mixed colonies; Lesser Adjutants also breed in deciduous dipterocarp forest. Often, nest protection teams are formed from the same people who own the rights to tap resin from the nesting trees – in exchange for an agreement not to tap while the nests are active. The value of the resin from a nesting tree is perhaps \$2.50/month, which is considerably less than the income received from nest protection.

Nests Protected

The bird nest program has been successful at protecting nesting sites (Table 3), safeguarding a total of over 1,550 nests of globally threatened or near-threatened species since 2002. Most of this increase is due to greater numbers of Sarus Crane, Oriental Darter and Lesser Adjutant nests being found; the pattern for other species was more mixed and the number of Giant Ibis nests was fairly constant across time. Numbers declined slightly in 2008-9, mainly due to the failure of some Greater Adjutant nests, and the fact that fewer Oriental Darter

Table 2. Nest characteristics of different protected bird species.

<i>Species</i>	<i>Nest Description¹</i>	<i>Habitat</i>	<i>Predation</i>
Sarus Crane	Mound of sticks in grassland	Seasonally flooded grasslands	Asiatic Jackal
White-shouldered Ibis	Small platform of sticks at top of Trach tree	Deciduous Dipterocarp Forest	
Giant Ibis	Platform of sticks on the side branches of Trach, Tbeng or Koki.	Deciduous Dipterocarp Forest	Civets, Eagles?
Oriental Darter	Small nest platforms on trees and shrubs above inundated areas.	Flooded Forest along the Stung Sen river.	Large-billed Crows
Lesser Adjutant	Large nests in high trees, Trach, Tbeng, Chhoeutiel or Koki.	Deciduous Dipterocarp or Evergreen Forest	Large-billed Crows
Greater Adjutant	Large nests in high trees, Chhoeutiel.	Evergreen Forest	

¹Trach = *D. intricatus*, Tbeng = *D. tuberculatus*, Chhoeutiel = *D. alatus* & *costatus*, Koki = *Hopea odorata*

Table 3. Nests Protected: 2002-2009. '-' indicates species that were probably present, but were not protected in that year.

Species	2002-3		2003-4		2004-5		2005-6		2006-7		2007-8		2008-9	
	Nests (Colonies)	Chicks	Nests (Colonies)	Chicks	Nests (Colonies)	Chicks	Nests (Colonies)	Chicks	Nests (Colonies)	Chicks	Nests (Colonies)	Chicks	Nests (Colonies)	Chicks
Kulen Promtep Wildlife Sanctuary														
White-shouldered Ibis <i>Pseudibis davisoni</i>	1	2	1	1	2	4	3	4	4	2	5	7	5	4
Giant Ibis <i>Pseudibis gigantea</i>	-	-	5	n/a	9	12	7	14	9	16	11	12	10	17
Sarus Crane <i>Grus antigone</i>	-	-	6	n/a	3	3	7	11	9	12	19	30	24	36
Red-headed Vulture <i>Sarcogyps calvus</i>	-	-	-	-	1	1	1	1	-	-	-	-	-	-
Black-necked Stork <i>Ephippiorhynchus asiaticus</i>	-	-	-	-	-	-	2	6	3	10	2	5	2	7
Oriental Darter <i>Anhinga melanogaster</i>	13 (1)	22	-	-	-	-	-	-	26 (1)	53	84 (1)	103 (b)	9 (1)	(b)
Greater Adjutant <i>Leptoptilus dubius</i>	-	-	(a)	n/a	21 (2)	38	17 (2)	32	18 (2)	29	10 (2)	20	6 (3)	10
Lesser Adjutant <i>Leptoptilus javanicus</i>	-	-	34 (5)	52	32 (7)	56	38 (7)	68	140 (14)	239	159 (18)	310	146 (16)	304
Total	14	24	46+	53+	67	113	75	136	209	361	239	384	200	378
Preah Vihear Protected Forest														
Giant Ibis <i>Pseudibis gigantea</i>	-	-	-	-	18	34	21	38	19	36	19	19	7 (c)	n/a
Sarus Crane <i>Grus antigone</i>	-	-	-	-	16	19	22	30	28	39	35	42	33	54
White-rumped Vulture <i>Gyps bengalensis</i>	-	-	-	-	-	-	3	3	4	3	4	2	3	3
Red-headed Vulture <i>Sarcogyps calvus</i>	-	-	-	-	-	-	-	-	1	1	1	1	2	1
Lesser Adjutant <i>Leptoptilus javanicus</i>	-	-	-	-	65 (9)	66	96 (8)	186	81 (8)	140	118 (9)	166	115 (11)	185
Total	-	-	-	-	99	119	142	257	133	218	177	230	160	243+
Totals, both sites	14	24	46+	53+	166	232	217	393	342	579	416	614	360	621

(a) present

(b) some or all nests destroyed by crows

(c) incomplete surveys.

and Giant Ibis were found. In the case of Giant Ibis, this was almost certainly due to incomplete survey coverage in that season; the survey is not a complete census and, therefore, numbers of individual species may fluctuate between years due to either changes in the area surveyed or to actual changes in species' populations.

Survey coverage was calculated using the number of km² of suitable habitat visited by the community rangers and WCS monitoring staff during the breeding season (Table 4). The survey coverage was higher for Adjutants due to the longer breeding season and their broader habitat preferences, since they nest both in deciduous dipterocarp and evergreen forest. Overall, densities of Giant Ibises and Sarus Cranes in PVPF were much greater than in KPWS, although the surveyed area was approximately the same. The diversity of species was much greater in KPWS and, consequently, there was a much longer nesting season, with Greater Adjutants and White-shouldered Ibises not fledging until March-May.

Table 4. Densities of nests in 2005-2006.

Species	Kulen Promtep Wildlife Sanctuary		Preah Vihear Protected Forest	
	# km ² / nest	survey area	# km ² / nest	survey area
Giant Ibis	80 km ²	558 km ²	26 km ²	556 km ²
Sarus Crane	80 km ²	558 km ²	25 km ²	556 km ²
Lesser Adjutant	27 km ²	1,022 km ²	12 km ²	874 km ²
Greater Adjutant	60 km ²	1,022 km ²	(not present)	



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Greater Adjutant with Spot-billed Pelican chicks

Payments and Costs

Table 5 shows the payments given directly to protectors and the costs of monitoring and surveying in four seasons: 2005-6, 2006-7, 2007-8 and 2008-9. The total cost of the program was around \$26,000 per year from 2005-2008, increasing to \$31,000 in 2008-9 as a consequence of rising prices, particularly for food and transport. The average cost per nest protected is \$65-\$120. The average cost has declined as the number of nests has increased, partly because monitoring costs can be shared between adjacent sites and also due to greater number of nests at colonies. Depending on the year, 71-78% of the spending went directly to local people, either protectors or community rangers.

Around 100 individuals are employed each season, receiving \$80-\$160 on average (Table 5, Figure 1). There is considerable variation in the payments made, depending upon the species protected. Some individuals are specialist protectors, switching species depending on the season and receiving continual employment for several months. Figure 2 shows the distribution of payments over four seasons (2005-2009). The histogram has peaks at \$80 (for nest protectors that were employed protecting a single species over two months or less), at \$160 (for protectors protecting Lesser Adjutants for 3-4 months) and at \$300 (for those protecting Greater Adjutants for up to 6 months). Community rangers receive significantly more, averaging \$500-\$800 per year, with a maximum of more than \$1,200.

Table 5. Birds nest protection program costs - 2005-2009.

	2005-6	2006-7	2007-8	2008-9
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	\$9,925	\$8,503	\$8,575	\$10,666
WCS Monitoring	\$5,603	\$6,630	\$7,474	\$9,375
(%)	22%	26%	28%	29%
Expenses	\$2,506	\$3,470	\$3,914	\$5,195
Salaries	\$3,098	\$3,160	\$3,560	\$4,180
Total	\$25,953	\$25,918	\$26,986	\$31,930
Nests Protected	217	342	416	360
Average Cost/Nest	\$120	\$77	\$66	\$89
<u>Villages</u>				
Number of Villages	15	18	21	21
Average total payments/village	\$1,357	\$1,080	\$933	\$1,017
Maximum total payments/village ^a	\$4,013	\$3,525	\$3,487	\$3,267
<u>Nest Protectors</u>				
Number of nest protectors	88	102	105	88
Average payments/nest protector	\$119	\$107	\$108	\$135
Maximum payment/nest protector	\$474	\$356	\$292	\$343

^a Antil village received the greatest total payments in each year.

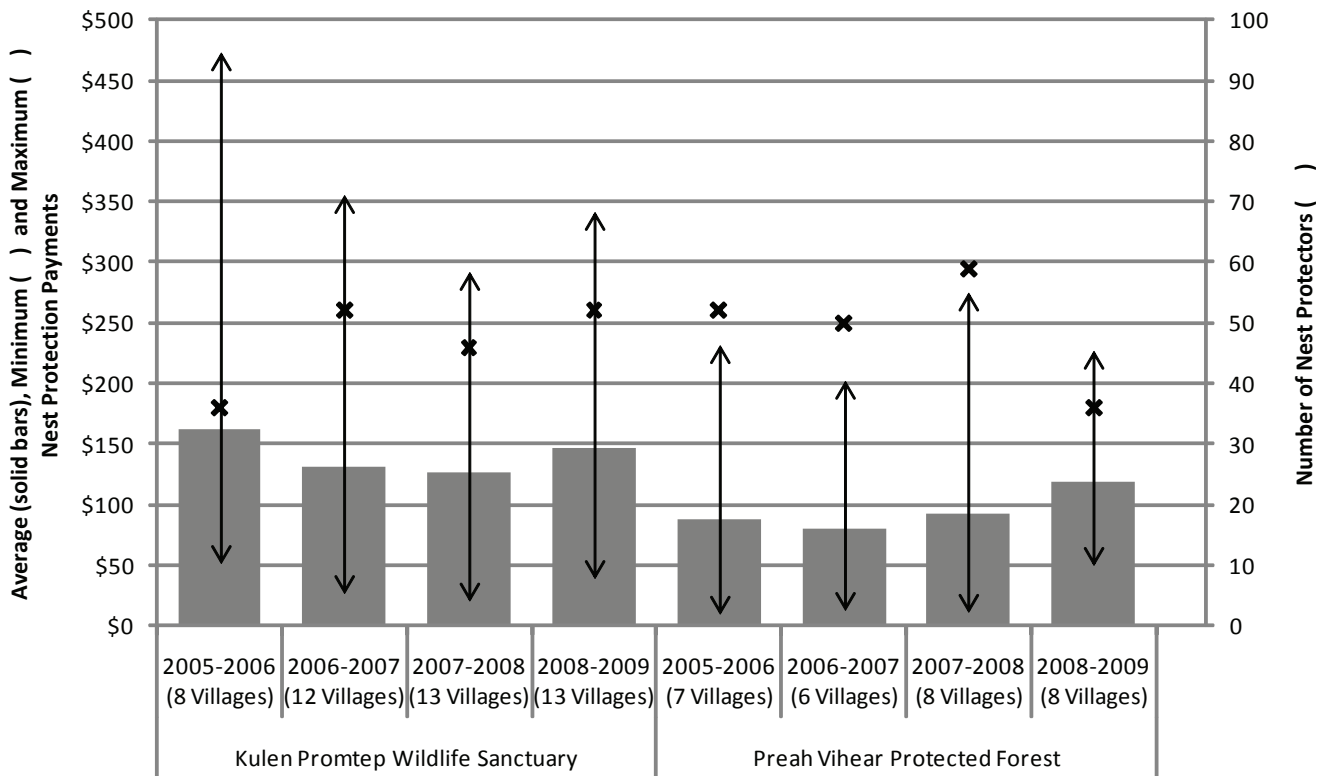


Figure 1. Average (solid bars), minimum (↓) and maximum (↑) payments to nest protectors in KPWS and PVPF during 2005-2009, and the number of protectors employed in each year (X).

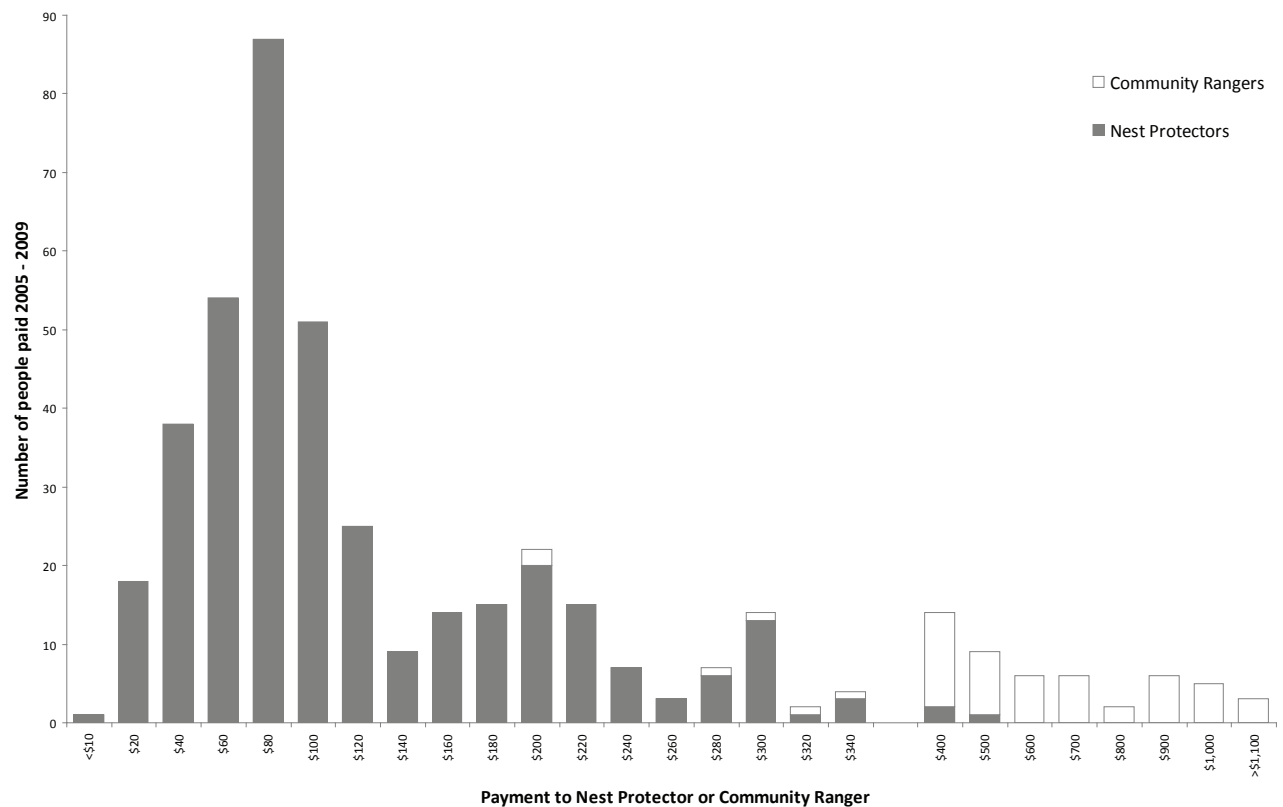


Figure 2. Distribution of payments to nest protectors and community rangers in 2005-2009 in KPWS and PVP.

Payments per village average \$900-\$1,400, depending on the year, with up to 21 villages engaged each season. Some villages earn considerably more due to the presence of a large number of key species, or species with particularly long breeding periods (Figure 3). Antil village made the greatest amount, totaling nearly \$14,000 over four seasons, mainly due to the presence of a Greater Adjutant colony which requires at least 6 months of protection each year.

Perceptions

In the 2005-2006 season, ten bird nest protectors in Dangphlat village, Preah Vihear Protected Forest were asked to complete a short questionnaire on their perceptions of the aims, methods and success of the direct payments program. The majority of the bird nest protectors came from low income families within the village; six interviewees only did shifting cultivation (they had no permanent paddy ricefields) and were not rice self-sufficient through the year. Five had to borrow money to buy food before they began protecting nests. All ten of the protectors interviewed clearly stated that they would protect nests again; six felt that they were being paid for both work and results while four perceived that they were paid solely for results, possibly a reflection of the system of paying \$1 per day and the remaining \$1 per day only once the chicks fledged. Nine thought that chick or egg collection was illegal.

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Greater Adjutants

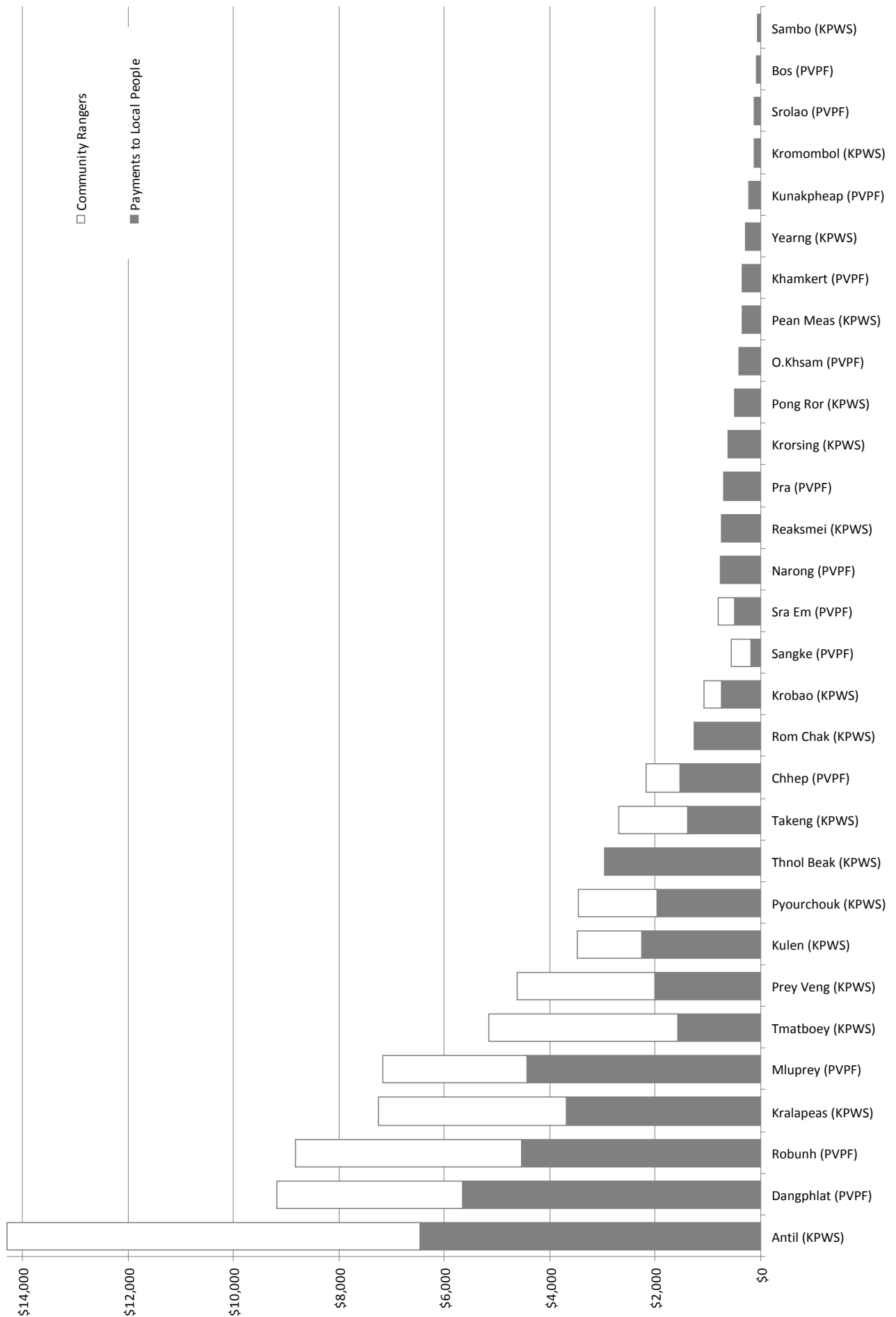


Figure 3. Distribution of payments to villages in KPWS and PVPF during 2005-2009.

Threats

The recorded cases of breeding failure for six species across three seasons (between 2006 and 2009) are shown in Table 6. Natural predation by crows, civets and other carnivores was the greatest cause of nest failure, accounting for 23 incidences, and over 100 nests, over the three years. Sixteen cases, accounting for 20 nests, of accidental loss were recorded; these were due to wind, rain, flooding of Sarus Crane breeding sites or chicks falling from trees. Human disturbance, such as collection of non-timber forest products, land clearance or tree cutting, accounted for 10 cases (17 nests) while at least five Sarus Crane nests, one Lesser Adjutant nest and four nests at the 2006 Oriental Darter colony were raided for eggs or chicks while the protectors were absent. Finally, one case of poisoning and one of domestic dog predation were recorded.

Discussion

Protection of Globally Threatened Breeding Bird Populations

The Bird Nest Protection program has proven to be an effective way to ensure that large numbers of globally threatened waterbirds successfully breed in both Kulen Promtep Wildlife Sanctuary and Preah Vihear Protected Forest. The overall number of nests found increased steadily each year until 2008 mainly due to Lesser Adjutant, Sarus

Table 6. Threats to nesting birds 2006-2009.

Cause		Giant Ibis	Greater Adjutant	Lesser Adjutant	Oriental Darter	Sarus Crane	White-shouldered Ibis	Total
2006-7	Accident	2 (Wind)	1 (Fell)			3		6
	Predation			1		5	1	7
	Land Clearance			1			1	2
	Nest Collection				1	1		2
	Domestic Dog					1		1
2007-8	Accident	3 (Wind)		2		3	1 (Fell)	9
	Predation		1		1 (Crows)	3		5
	Human Disturbance	2				1		3
	Land Clearance	1				1		2
	Nest Collection			1		2		3
2008-9	Accident	n/a				1		1
	Predation	n/a	1	1	1 (Crows)	7	1	11
	Human Disturbance/ Tree Cutting	n/a	2	1				3
	Nest Collection	n/a				2		2
	Poisoning	n/a	1					1

Crane, Oriental Darter and White-shouldered Ibis; Sarus Crane continued to increase in 2008-9. A full impact evaluation of the nest protection program would require comparison with the counterfactual (Ferraro & Pattanayak 2006), i.e. what would have happened if the nests had not been protected. This is beyond the scope of this case study, primarily because insufficient base line data exists from control sites. However, the high rate of nest collection for the same species at other sites (e.g. Bezuijen et al. 2008), suggests that the nest protection program has been successful at increasing breeding rates. Fluctuations in individual species numbers between years may also be a reflection of changes in survey coverage, rather than species' populations. The greater numbers of nests found, particularly for Lesser Adjutant, could be a result of improved awareness and geographical coverage of the program, as evidenced by the increase in the number of villages involved (from 15 in 2005-6 to 21 in 2007-8).

Nonetheless, there is evidence that some species' populations have increased due to nest protection. Sarus Cranes reach maturity at 2-3 years (del Hoyo et al. 1996), hence the observed increases, particularly since 2007, could be due to fledglings returning to breed. Successful breeding in the Northern Plains may account for the substantial increases in the number of cranes seen since 2007 at the dry season feeding site of Ang Trapeang Thmor (Evans et al. 2008); however the increases in dry season counts might also be caused by birds moving to Ang Trapeang Thmor from other sites. As documented elsewhere, the population of White-shouldered Ibis at Tmatboey in KPWS has risen from a single breeding pair in 2002 to 23 birds, and at least five breeding pairs, in 2008 (Clements et al. 2008). White-shouldered Ibis are monitored but not protected at Tmatboey, hence these increases may be due to local action by the village, possibly as a consequence of the community-based ecotourism program (Clements et al. 2008).



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White-winged Duck

Oriental Darters nested in Kulen Promtep Wildlife Sanctuary in 2001-2 and 2002-3, returning in 2006-7. Interviews conducted in 2001-2 suggested that the colony was around 34 nests, but it was collected (as it had been for many years). In 2002-3 the team managed to protect 13 nests, although another site was collected. It is unclear why the Darters then stopped nesting for the next three seasons, when adults were occasionally seen. Probably the previous collections had caused local breeding extinction, although it is possible that colonies existed but were not found. The recolonization that occurred in 2006-7 may have been by birds from the colonies at Prek Toal on the Tonle Sap, which increased from 235 pairs in 2001-2 to more than 4,000 pairs by 2007, due to the success of the local conservation program (Clements et al. 2007). The flood on the Stung Sen River was much higher in 2006-7 than in previous years, causing widespread inundation, which may have been a trigger for the birds to start breeding again. If Darter breeding is triggered by water levels, this might explain the fluctuations in breeding success between years.

Both Adjutant species in the Northern Plains initiate breeding several months earlier than the main breeding colonies on the Tonle Sap Great Lake at Prek Toal, where Lesser Adjutants start to build nests in late November, and Greater Adjutants in January (Clements et al. 2007). The extent to which these two sub-populations exchange individuals is unknown. Based upon available data, the Northern Plains sub-population of Lesser Adjutant is equal to or larger than Prek Toal (253 pairs, Clements et al. 2007), while the Greater Adjutant sub-population is significantly smaller than that at Prek Toal (55 pairs, Clements et al. 2007).

Threats to Breeding Bird Populations

The program's success at reducing nest collection rates by people is hard to assess because no figures are available on historical threats. Nevertheless, under the program, only seven cases of nest collection (all for Sarus Crane or Oriental Darter) have been recorded since 2006. Sarus Crane nests are also known to have been collected in 2004 and 2005. All cases were for nests that were unprotected, or when protectors were temporarily absent, suggesting that in the absence of protection a far greater number of nests would be lost each year. Both species are particularly vulnerable to collection; Sarus Cranes nest on the ground and Darters breed in low trees that are easy to climb. Other species tend to nest in tall trees that are much harder to access. It is possible that nest collection rates were under-reported as the causes of nest failure are not known in all cases.

As documented by other long-term studies in the Northern Plains (e.g., Keo 2008, Keo et al. 2009), predation by civets, martens, crows and birds of prey are significant causes of nest failure, accounting for over 100 nests in the four seasons for which data is available. This was despite the use of predator exclusion belts (Keo et al. 2009) in the majority of cases. Ground-based predators, such as civets and Yellow-

throated Marten (*Martes flavigula*), were often able to climb adjacent trees and then cross to the nesting tree. Sarus Cranes are particularly vulnerable because they nest on the ground and, consequently, lose eggs or chicks to predators such as Asiatic Jackal (*Canis aureus*).

The increase in numbers for Sarus Crane, Oriental Darter, White-shouldered Ibis and possibly Lesser Adjutant suggest that persecution and nest collection were the main factors limiting populations of these species. By contrast, Giant Ibis numbers have remained constant despite a high rate of breeding success (Keo et al. 2009), implying that other factors, such as conversion of feeding habitats to agriculture and human disturbance, are the primary threats to this species, as other studies have shown (An 2008, Keo 2008). Greater Adjutant numbers have declined steadily probably due to a combination of disturbance of feeding sites, poisoning, and recently cutting of nesting trees. In 2008, 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.

Direct Payments for Nest Protection

The forests in the Northern Plains are heavily used by local people, for resin-tapping, collection of other NTFPs, fishing, cattle-grazing and hunting. Although the human population density is low, it would be prohibitively expensive, if not impossible, for Wildlife Sanctuary and Protected Forest staff to police the entire forest. Therefore offering conditional incentives for conservation – so-called ‘direct payments’ – may be a useful way to engage local villages in species protection (Ferraro 2001, Ferraro & Kiss 2002). Proponents have argued that direct payments may provide a more effective and efficient mechanism to deliver conservation outcomes, in a way that may also provide significant contributions to local livelihoods (Ferraro & Kiss 2002).

The Bird Nests Protection program meets many of claims made about direct payments. The program is relatively inexpensive, costing \$26,000-\$30,000 per year, which is lower than other conservation activities aimed at reducing hunting (such as patrolling and enforcement). It should be noted that nest protectors are not government employees and hence do not have the same responsibilities as park staff. The program has been successful at protecting a large number of breeding birds’ nests, over 1,550 nests since its inception, at an average cost of around \$80 per nest. Moreover, the majority of payments (71-78%) go to local people, helping to build support and awareness for conservation. This provides a ‘legal’ income from the birds instead of illegal hunting and trade, helping to reinforce education efforts about the value and importance of the Northern Plains’ bird populations. In some cases payments have been made to former hunters. The popularity of the program is shown by the large number of birds that are reported directly by local people, which has led to the discovery of new breeding sites for globally threatened species such as the White-

rumped Vulture. The payments are highly significant in remote rural villages, and are used to pay for food, clothes, education and household improvements. The amounts paid, sometimes more than \$300 per individual, are a significant source of income in these remote rural villages, where families usually receive \$300-400 cash per year from other activities (WCS, unpublished data).

The program has been effective, therefore, at targeting an important threat to species conservation in this area: collection of nests for eggs and chicks. The Greater Adjutant and Giant Ibis examples demonstrate the main constraint with such a highly targeted program: it does not address other threats to the species. Forest clearance has increased rapidly in recent years in Cambodia (Forestry Administration 2008), and both interviews and field observations suggest that bird nest protectors are not able to protect breeding sites or feeding areas from other villagers or outsiders (A. John, pers. obs.). The program is therefore best viewed as a complement, not a substitute, to more traditional conservation approaches.

Acknowledgements

The work 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 and Government staff for their hard work and dedication. Our deepest thanks go to the community leaders and villagers in Preah Vihear, particularly Mr. Deb Kimoun in Tmatboey. 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. The authors would like to thank E.J. Milner-Gulland, Erika Reuter, J. Carter Ingram and David Wilkie, whose comments substantially improved an earlier draft. Finally, we would like to thank Eleanor Briggs for her unwavering support for conservation in Cambodia over the years.

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White-shouldered Ibis

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This publication is made possible 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 The Wildlife Conservation Society. TransLinks is a partnership of WCS, The Earth Institute, Enterprise Works/VITA, Forest Trends and The Land Tenure Center. The contents are the responsibility of the partnership and do not necessarily reflect the views of USAID or the United States government.

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