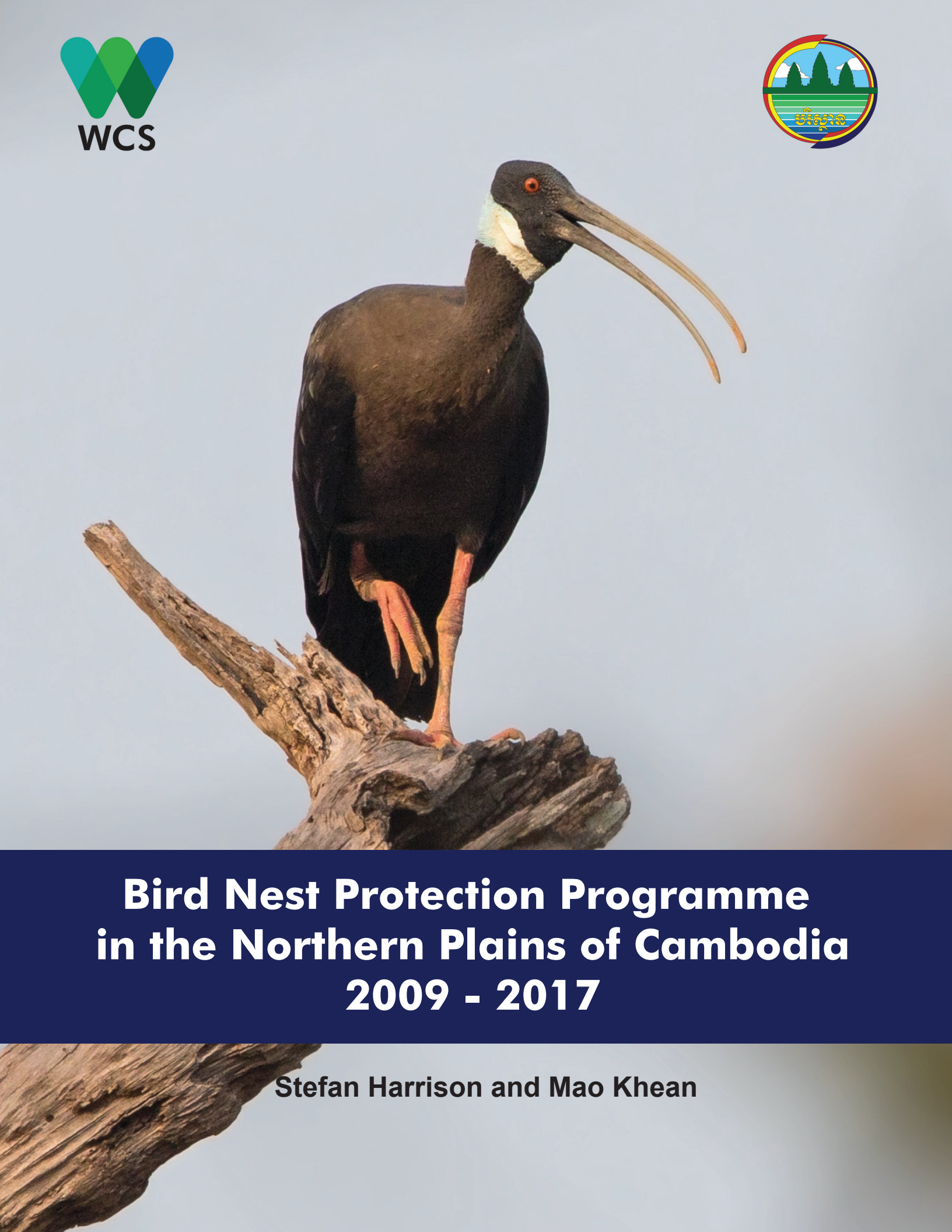

Bird Nest Protection Programme in the Northern Plains of Cambodia 2009 - 2017

Stefan Harrison and Mao Khean

Suggested Citation:

Harrison, S. and Mao, K. (2017) An Update to the Bird Nest Protection Programme in the Northern Plains of Cambodia, 2009 – 2016. Wildlife Conservation Society, Cambodia Programme, Phnom Penh.

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Abbreviations

ATT	Ang Trapeang Thmor
CWS	Chhep Wildlife Sanctuary
EDGE	Evolutionarily Distinct and Globally Endangered
ELC	Economic Land Concession
FA	Forestry Administration
GDANCP	General Department of Administration for Nature Conservation Protection
GT-CR	Globally Threatened – Critically Endangered
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
MIST	Management Information System
MoE	Ministry of Environment
NSAID	Non-steroidal anti-inflammatory drug
NTFPs	Non-Timber Forest Products
PA	Protected Area
PVPF	Preah Vihear Protected Forest
SLC	Social Land Concession
SMART	Spatial Monitoring and Reporting Tool
WCS	Wildlife Conservation Society

Conventions & Terms Used

EDGE Species

Evolutionarily Distinct and Globally Endangered (EDGE) species represent a disproportionate amount of unique evolutionary history. They have few close relatives, are often the only surviving member of their genus, and sometimes the last surviving genus of their evolutionary family. http://www.edgeofexistence.org/species/

Indochina

Cambodia, Laos PDR and Vietnam, excluding the remainder of Southeast Asia.

Khmer names

We have chosen to present English translations of Khmer place names in italics, respecting the convention that they are non-English words that are not in common usage in the English language, for which accepted spellings do not exist.

MIST

The Management Information System (MIST) preceded SMART and was used to store and analyse data collected by rangers patrolling the Protected Areas. It stored data on sightings of key species and illegal activities and mapped sightings.
http://www.ecostats.com/web/MIST

Non-timber Forest Product (NTFP)

Any commodity obtained from the forest, not including the harvesting of trees. Examples include resin, mushrooms and honey.

Projected Coordinate System

World Geodetic System UTM Zone 48N

Southeast Asia

The countries of Cambodia, Lao PDR, Myanmar, Thailand and Vietnam.

SMART

SMART (Spatial Monitoring and Reporting Tool) is a tool for measuring, evaluating and improving the effectiveness of wildlife law enforcement patrols and site-based conservation activities. http://www.smartconservationsoftware.org/what_is

Taxonomy

For birds, we follow the BirdLife Taxonomic Checklist v9.0 (http://datazone.birdlife.org/species/taxonomy)

Threatened species

The IUCN Globally Threatened categories are followed: CR: Critically Endangered, (being the highest level of threat), EN: Endangered and VU: Vulnerable. Details of the IUCN threat categories and criteria used to allocate species to categories are to be found at http://www.iucnredlist.org/technical-documents/categories-and-criteria/2001-categories-criteria. Species in these three categories are considered Globally Threatened and are listed on the IUCN *Red List of Threatened Species*. Additionally, species that may become Globally Threatened in the short-term are classified as Near Threatened because they almost meet the criteria for Threatened status. For birds, the most recent assessment (2014) is followed. For mammals and other taxa, the most up-to-date listing is used.

Trapeang

A seasonal or permanent static water body usually associated with Deciduous Dipterocarp Forest or grassland, frequently less than 1 ha in total area. *Trapeangs* are a critically important landscape feature in the dry-season because they provide water and feeding habitat for a host of different animal species during this drought-prone time of year.

Viel

Areas within the forest mosaic dominated by sedges and grasses and with only a sparse tree cover. *Viel*s vary in size from very small discrete forest glades, sometimes smaller than a hectare, to grasslands of tens of hectares.

Executive Summary

In the early 2000's the principal threat to nine globally threatened large waterbird species living in the Northern Plains of Cambodia was identified as wholesale collection of eggs and chicks from nesting sites (Clements *et al.* 2013). Direct payments for conservation were proposed as an effective way of delivering conservation outcomes (Ferraro 2001; Ferraro & Kiss 2002). The Bird Nest Protection Programme is a payments scheme designed to combat the threat of egg and chick collection. Under the scheme, local people living in two protected areas in the Northern Plains of Cambodia are offered conditional payments if they successfully locate, monitor and protect nests until fledging.

From 2002 until 2016, 3,813 nests and 6,806 fledglings have been safeguarded over an area greater than 4,000 km². Based on previous studies of this scheme (Clements *et al*. 2013), we estimate that approximately 3700 additional globally threatened birds have fledged as a direct result of this programme, at an approximate cost of $134 each.

Since 2008, the number of species protected by this scheme has increased from 9 to 11. The number of villages participating has grown from 21 to 48; the proportion paid directly to local people has remained at around 70%. Rural per capita income rose from below $1 per day in 2008 to $1.7 per day by 2013; daily payments to nest protectors rose from $2 to $3.5; annual payments have more than doubled, to regularly exceed $50,000. As well as payments made to community nest protectors, this expense includes the salaries of 15 locally employed Community Wildlife Rangers, which have also risen with rising costs. Average annual payments per protector of $140, remain significant in comparison with other forms of local cash income in rural areas.

Since 2008, over 61,000 ha of habitat within Chhep and Kulen Promtep Wildlife Sanctuaries has been lost to Social and Economic Land Concessions. These concessions are driving widespread land clearance and illegal logging of large, high-value timber species, favoured by large waterbirds for nesting. As an indication, 22.3% of deciduous forest in Cambodia was cleared between 2010 and 2014. Economic land concessions have also been shown to decrease rural household incomes in Cambodia (OHCHR 2007; Bues 2011; Neef & Touch 2012; Neef *et al*. 2013). From 2008 to 2016, the combined population of Chhep and Kulen Promtep Wildlife Sanctuaries rose by 27%. Land

concessions are driving rapidly expanding landless rural populations, creating a stimulus for illegal logging, land clearance, and hunting in the protected areas of the Northern Plains.

As a result of these evolving threats, the rate of bird nest detection has fallen by approximately 50% in the last five years. This reduction is attributed to dramatic declines in both adjutant species and Oriental Darter. Greater Adjutants no longer nests in the landscape and Lesser Adjutant nest numbers have fallen by 60% since 2009. These losses correspond to the targeted deforestation and degradation of evergreen and semi-evergreen forest – the favoured nesting habitat for these species.

The reduction in Oriental Darter nests located is a consequence of a lack of nest protection for this species which caused a resurgence of nest raiding, providing a counterfactual that demonstrates the efficacy of Nest Protection Programme in combatting egg collection.

This report argues that direct payments remain an effective and cost-efficient approach when dealing with the threat of nest predation and egg collection in a manner that supports local livelihoods, but reiterates the limitations of the scheme when contending against land clearance and habitat degradation, especially when driven by land concessions.

The primary threat to these species has shifted from egg collection to logging of nesting trees, driven mainly by an influx of Social and Economic Land Concessions. A number of recommendations are proposed to ensure the continued success of this payments scheme. Key proposals include the introduction of a Bird’s Nest Development Fund, with the aim of sharing incentives amongst the community, enabling greater leverage against the actors of illegal logging. In the face of increased human disturbance, we also advocate trialling full-time protection of ibis nests, which have previously only been monitored on a weekly basis. A review of the efficacy of predator exclusion belts should also be conducted as novel anecdotal evidence suggests they attract unwanted attention to nests.

1. Introduction

1.1. Scope

In 2009 WCS reported on the progress of the Bird Nest Protection Programme since its inception in 2002, and detailed the benefits of this scheme to both the wildlife and communities of the Northern Plains. Since 2009, the Bird Nest Protection Programme has expanded in area covered, in the number of communities receiving payments, and in associated costs. Over the same period, the type and severity of threat posed to key species has changed. Focussing on the period 2009–2016, this report provides an update on the Bird Nest Protection Programme, comparing the results to the 2009 report. We also propose recommendations for the future of the Bird Nest Protection Programme in view of developing threats to threatened bird species that depend on the protection of the Northern Plains for their long-term survival.

1.2. Objectives

- To describe the nesting ecology of key bird species in the Northern Plains and highlight any observed changes in behaviour over time.
- To evaluate the success of the Bird Nest Protection Program and provide an update to the 2009 (Clements *et al.* 2013) report *Case Study: Bird Nest Protection Program in the Northern Plains of Cambodia.*
- To reassess the threats to nesting birds identified in Clements *et al.* (2013) and to review conservation strategies relevant to the Bird Nest Protection Programme.

1.3. Background

1.3.1. The Northern Plains of Cambodia & Importance to Wildlife and People

Cambodia lies within the Indo-Burma biodiversity hotspot, among the most biodiverse regions on Earth (Myers *et al*. 2000; Tordoff *et al.* 2012a). The deciduous dipterocarp forests that once extended over much of Indochina supported the greatest aggregation of large mammals and water birds that existed outside of the African plains (Wharton 1966) and include four 'Last of the Wild' areas identified in the Indo-Malayan Tropical & Subtropical Dry Broadleaf Forests biome, which represent the wildest areas within each biome (Sanderson *et al.* 2002). This forest type has largely disappeared from Thailand and Vietnam, due to rapid expansion of rural populations and widespread conversion to intensified agriculture (Wohlfart *et al*. 2014). The Northern Plains of Cambodia forms the

largest remaining contiguous block of this fragile ecosystem and, as such, has been classified as a Global 200 Eco-region (Tordoff *et al.* 2012b).

The Northern Plains are located in Preah Vihear Province which, as of 2012, was ranked the poorest province in Cambodia (WSP-EAP *et al*. 2014). In one of the most remote regions of Cambodia, Preah Vihear Province, Northeast of Siem Reap and the temples at Angkor, shares its northern border with Thailand and Laos. Much of the Northern Plains is covered in intact habitat – extensive areas of deciduous dipterocarp forest (DDF), with scattered seasonal wetlands (*trapeangs* in Khmer) and large grasslands (*viels*), which flood during the wet season (June-October). In addition to a large network of forest *trapeangs* scattered across the landscape, other important water bodies include large rivers and tributaries to the Tonle Sap lake and Mekong river such as the *Stung Sen* and *Tonle Lapouv* respectively, and a number of smaller, ephemeral streams and rivers. Lowland broadleaf evergreen and semi-evergreen forest is found along these watercourses and in the more fertile soils of the upland regions. These patches of lowland evergreen forest are a vital feature of the mosaic DDF landscape that supports such a rich assemblage of species. Due to the density of high value timber growing in evergreen forests, this forest type is under greater threat from deforestation then the surrounding DDF. Not only do these areas of denser forest provide cover for secretive and often nocturnal animals seeking refuge during the day in an otherwise open landscape, but in the dry season, they provide an essential supply of water and foraging habitat for birds such as the Critically Endangered Giant Ibis *Thaumatibis gigantea*.

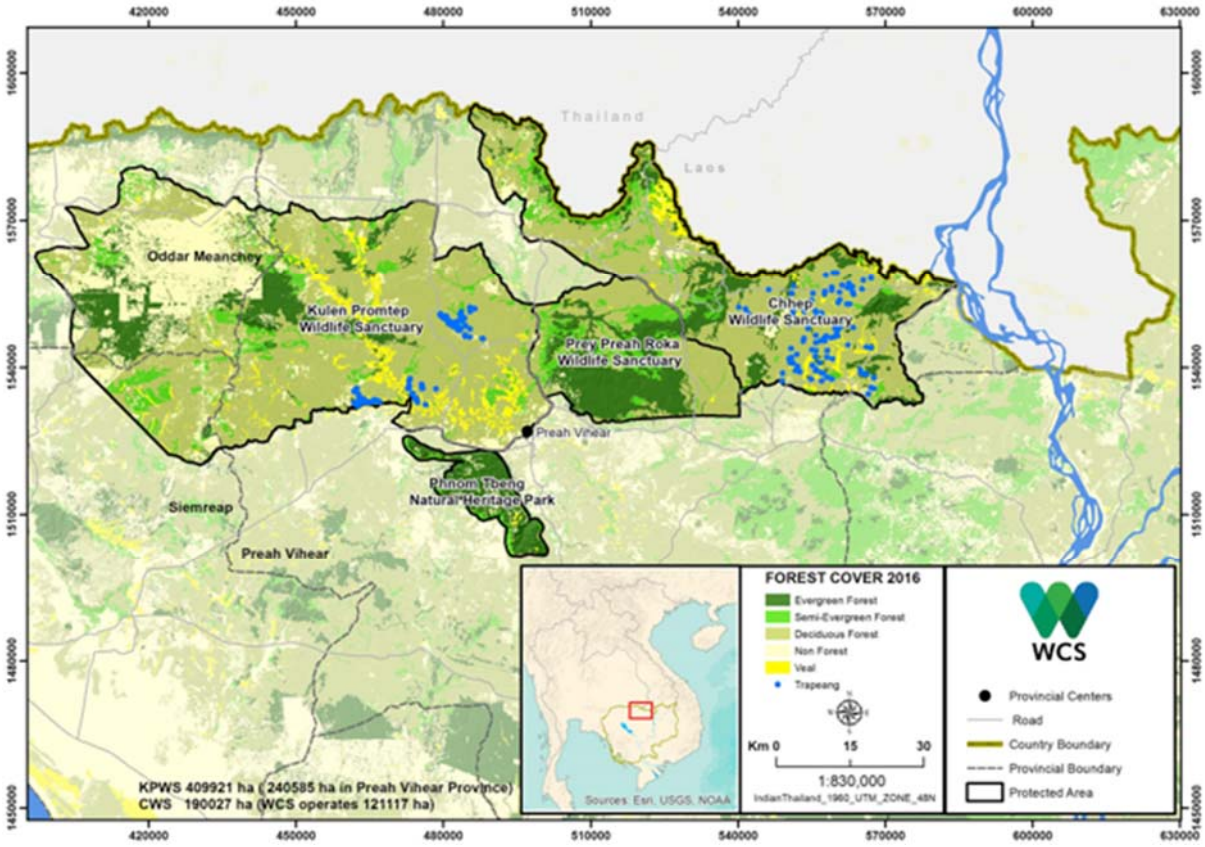
The first biological surveys of the Northern Plains were conducted in the late 1990s, after the cessation of conflict. Surveys revealed an unparalleled assemblage of globally threatened species and, with so many dry forest specialists; the Northern Plains represent perhaps the richest remaining example of deciduous dipterocarp forest avifauna in the region. 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. Two of these are the Giant Ibis, for which the Northern Plains supports probably the largest remaining population, and the White-shouldered Ibis *Pseudibis davisoni*. Both are considered to be some of the most endangered bird species in the world (Hirschfeld 2008) and the Northern Plains contain some of the few known nesting sites in Asia.

The Northern Plains landscape is also of global importance to the conservation of three species of Critically Endangered Vulture: The White-rumped *Gyps bengalensis*, Slender-billed *G. tenuirostris* and Red-headed Vulture *Sarcogyps calvus*. In the Indian subcontinent, populations of these three species have declined by over 96% since 1992 (Cuthbert *et al*. 2006; Prakash *et al*. 2007; Pain *et al*. 2008) and are now threatened with extinction in the wild. In Southern Asia, vulture declines were caused by veterinary *Diclofenac*, a non-steroidal anti-inflammatory drug (NSAID) (Oaks *et al*. 2004). Outside of the Indian subcontinent, remnant populations of all three species exist in Myanmar and Cambodia, where diclofenac is not used for agro-veterinary purposes. The Northern Plains vulture populations are therefore globally significant, and offers one of the best opportunities for the survival of these species in the wild (Clements *et al.* 2013).

The landscape has also supported breeding populations of at least seventeen Globally Threatened species including large waterbirds such as the White-winged Duck *Asarcornis scutulata*, Lesser Adjutant *Leptoptilus javanicus*, Greater Adjutant *Leptoptilos dubius,* Black-necked Stork *Ephippiorhynchus asiaticus*, Woolly-necked Stork *Ciconia episcopus,* Oriental Darter and Sarus Crane *Antigone antigone*. With breeding populations of so many Globally Threatened species, the Northern Plains presents exceptional conservation value.

1.3.2. The Northern Plains Protected Area Network

Chhep Wildlife Sanctuary, (CWS) was first established by Government Sub-Decree in 2002 under the auspice of *Preah Vihear Protected Forest* in order to “conserve plant and animal genetic resources through protection of flora and fauna and natural habitats”. This Sub-decree further states, that “management measures should be developed to ensure sustainable use of natural resources to improve living conditions of local people and to promote nature tourism”. The Bird Nest Protection Programme was one of a number schemes developed by WCS in line with these management aims. CWS totals 190,027 hectares and, until 2016 the Ministry of Agriculture, Forestry and Fisheries (MAFF) was responsible for its management. Since May 2016, jurisdiction of CWS was transferred to the Ministry of Environment (MoE). West of CWS is the 402,500 ha Kulen Promtep Wildlife Sanctuary (KPWS). Established by Government Sub-decree in 1993, KPWS has been under the management of the MoE since its formation. Approximately 240,000 ha of KPWS is located within Preah Vihear Province, the remainder is in Oddar Meanchey and Siem Reap provinces. WCS supports the conservation of KPWS in the portion located within Preah Vihear Province (Map 1).



Map 1. Habitats of the Northern Plains Landscape

The newly declared 90,000 ha protected area: Prey Preah Rokha Wildlife Sanctuary (PPRWS), forms a natural wildlife corridor linking the two Wildlife Sanctuaries. The Bird Nest Protection Programme does not yet cover PPRWS. The northern catchment of CWS supplies the Tonle Lapouv River, a tributary of the Mekong. KPWS, PPRWS and the remaining portion of CWS feed Cambodia's Stung Sen River, the largest undammed tributary to Tonle Sap Lake, making its headwaters within Preah Vihear Province nationally important for climate resilience and food security. PPRWS connects two otherwise disparate protected areas and bridges between these two important river catchments.

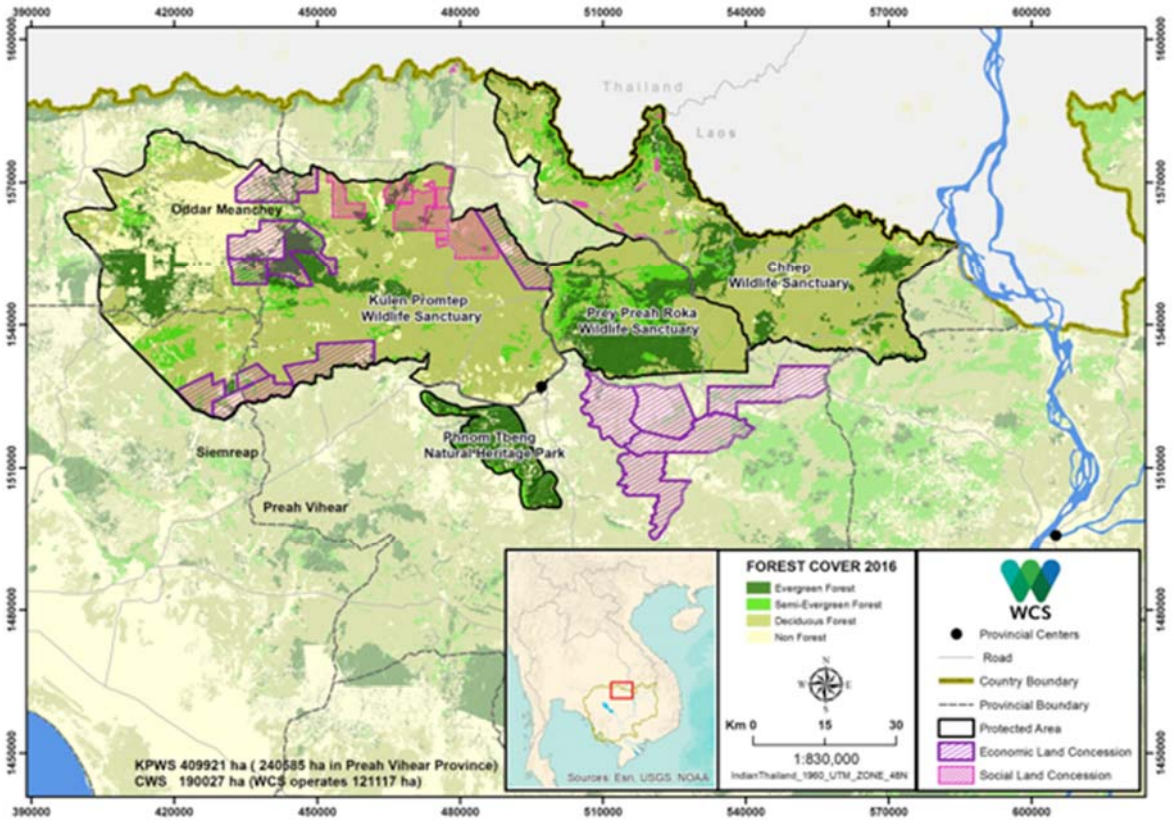
CWS and KPWS contain many long-established villages that practice either lowland rain-fed rice cultivation or upland shifting cultivation, collection of forest products, and fishing (McKenney & Prom 2002). Forest resources are a crucial safety net for the livelihoods of families that lack sufficient agricultural capacity, providing cash income, particularly from the sale of liquid resins from dipterocarp trees that are generally exported to Vietnam and used in the paint manufacturing industry (McKenney & Prom 2002).

1.3.3. Past Conservation Strategies and the History of The Nest Protection Programme

Initial conservation strategies in Cambodia focused on Protected Area (PA) management. In 1993, the first twenty-four Protected Areas were established in Cambodia. They had a small number of poorly paid staff with limited capacity or infrastructure, i.e. they were 'paper parks' (Wilkie *et al*. 2001). It is commonplace that Cambodian PAs are populated with settlements possessing 'soft' property rights. The Cambodian PA system was also based on relatively little information and consequently excluded many areas of importance for biodiversity conservation (Brooks *et al*. 2004). Despite Cambodia having robust national environmental legislation that includes complete protection of all rare or endangered species, under the above-mentioned conditions, PA management is often insufficient to achieve the desired biodiversity conservation goals (Brooks *et al*. 2004). A new Environmental Code, encompassing an updated Protected Area Law, is due in 2018.

By definition, populations of critically endangered species are small. As a result, strategies for their conservation have little room for error. In the 1990's and early 2000s, illegal hunting and nest collection were identified as the principle threats to the large, threatened birds of the Northern Plains (Clements *et al.* 2013). Collection of eggs and chicks was commonplace for Lesser Adjutants, Oriental Darters and Sarus Cranes with the latter fetching high market prices. The predominant perpetrators of egg collection were local villagers, who would either consume them locally or, in the case of Sarus Crane, would sell eggs and chicks onto middlemen, for trade at nearby Thai and Lao border markets (Clements *et al*. 2013).

In 2002, in response to these threats, Wildlife Conservation Society (WCS), in collaboration with the Ministry of Environment (MoE) and the Forestry Administration of the Ministry of Agriculture, Forestry and Fisheries (MAFF), initiated a programme of direct payments for biodiversity conservation in the Northern Plains of Cambodia (Ferraro 2001; Ferraro & Kiss 2002). The programme was designed to rapidly identify, monitor and protect the remnant wildlife populations while complementing longer-term management activities designed to strengthen institutions for environmental protection.



Map 2. Social and Economic Land Concessions in The Northern Plains

Between 2011 and 2012 contracts for a total of eighteen Economic Land Concessions (ELCs) covering over 132 km^2 and Social Land Concessions (SLCs) covering more than 27 km^2 were granted in KPWS. The purpose of these ELCs is cited as “Agro-industrial Plantation”. In preparing the land for such use, unmitigated habitat clearance is required. Since awarding these land concessions, there has been large-scale illegal logging by - or linked to - the proprietors of both ELCs and SLCs, extending beyond the boundaries of concessions and extending into the remaining portions of the Protected Area. Social Land Concessions provide accommodation and agricultural land to army personnel and their families and have also contributed significantly to population increases inside the Protected Areas, increasing incidences of illegal logging, land clearance and hunting within both PAs.

2. Methods

In 2002, with financial and technical support from WCS, the Bird Nest Protection Programme was trialled in four villages in KPWS, with the aim of locating, monitoring, and protecting the nesting sites of globally threatened bird species. Under the programme, nests were located by local people and locally contracted community wildlife rangers, hired by WCS. Rewards of $5 were offered to local people for reporting a nest of a focal species. Community rangers, typically villagers, were given annual contracts specifically to find and monitor nests. Usually two people per village were selected to guard a single nest (or nest colony in the case of Lesser Adjutants, Oriental Darters and White-rumped Vultures), based on existing knowledge of wildlife and the forest; many were previously hunters, hired specifically to reduce hunting pressure and for their local knowledge of species ecology (Clements *et al.* 2013). Due to phenological differences, nests are located throughout the year. After initial successes, the scheme was extended to communities in CWS in 2004.

For all species except the ibises, a permanent protection team of two people was established for each nest or colony. It was only deemed necessary to monitor Giant Ibis and White-shouldered Ibis once a week, due to the fact that they hold little trade value, are not consumed locally and therefore, are not targeted by hunters (Keo 2008).

If a nest is located and reported by local people, they are usually given the option of protecting the nest. When nests were located by Community Rangers, nest protectors are selected from nearby communities. Sarus Crane nests are located in flooded grasslands often containing active rice paddy, while adjutants and ibises often nest in resin trees. In each case the nearest respective rice farmer or resin collector was often selected as the nest protector on agreeing that they would not collect resin from nearby trees or they would leave their rice paddy fallow.

Experiments in 2005 and 2006 demonstrated that predator-exclusion belts placed around the base of Giant Ibis nesting trees substantially reduced predation rates and increased nesting success (Keo *et al*. 2009); subsequently these were installed at all nesting trees. From 2002-2008, protectors received $1 per day for their work and, if the chicks successfully fledged, an extra $1 per day worked upon fledging. This total possible payment of $2 per 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 per day ($1.25 per day up front and an extra $1.25 per day if fledging is successful), and from 2013 payments were again increased to a total of $3.5 per day due to rising living costs.

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 programme have altricial chicks – incapable of moving around on their own soon after hatching. For altricial species, nests are protected until the last nestling has fledged. Under nest protection contracts, nest guardians are required to maintain a 24-hour guard of the nesting site, basing themselves a minimum distance of 150m from the nesting tree so as not to cause disturbance. Nest protectors are reminded of their contractual and legal obligation not to hunt or log in the Protected Area. 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 visited every week by the community wildlife rangers that are employed by WCS, and monthly by WCS monitoring staff, to verify results and collect data on species ecology. WCS monitoring staff have trained community wildlife rangers to collect spatial and temporal data including the precise location of the nest / colony, date of laying, hatching and fledging, habitat type, nest characteristics, and the number of eggs and chicks visible. Nest protectors also investigate incidences of nest failure, in order to identify the cause where possible.

MoE and WCS staff conducted 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 (Clements *et al.* 2013). The community wildlife rangers use their knowledge of the area and historical records to identify nesting sites. In addition, they regularly encounter villagers in the forest who provide information on the location of new nest sites, in return for financial rewards.

A Spatial Monitoring and Reporting Tool (SMART) is used to measure, evaluate and enhance the effectiveness of wildlife law enforcement patrols and site-based conservation activities by facilitating the process of collection, storage, analysis and visualisation of data recorded by rangers patrolling both Wildlife Sanctuaries (Figure 1). Through mapping

observations of key species and illegal activities, the planning of monthly surveys can be informed by the requirements at that moment in time, be it hot-spots of illegal activity such as hunting or logging, or the key nesting habitat for a species at a specific time of year. Through recording survey data, SMART can also allow for the standardisation, or correction of annual survey coverage and effort.

Data on annual survey coverage was recorded in MIST and SMART for both sites from 2008 onwards, allowing a basic metric of survey effort to be calculated. As well as presenting raw data on nest and fledgling numbers, the number of nests located is also presented as a function of survey coverage, correcting for variations in survey effort. This metric only provides an approximation of survey effort, as accurate data on survey intensity within each kilometre square surveyed is unavailable.

Figure 1. Spatial Monitoring and Reporting Tool (SMART)

3. Results

3.1 Summary

Since 2002, the Nest Protection Programme has been successful in safeguarding almost 4,000 nests and 7,000 fledglings of Globally Threatened and Near Threatened species (Table 1). From 2002 – 2009 Sarus Crane, Oriental Darter and Lesser Adjutant accounted for 85% of nests located, monitored and protected (Table 1). Overall, the total number of nests protected rose from 2002 until 2008, after which numbers stabilised. Between 2007 and 2014 nest numbers appear to fluctuate biannually, in a cyclical fashion. However, since 2012, numbers have fallen at a steady rate (Figure 2). Overall trends in CWS broadly mirrored those in KPWS, albeit with slightly more pronounced declines in KPWS Figures 3 and 4). KPWS contains a greater diversity of protected species (Table 1).

Both adjutant species and the Oriental Darter accounted for 73% of all nests found since 2002. Overall reductions in nest numbers since 2012 predominantly reflect reductions in these species. Notably, Greater Adjutant has not nested in the landscape since 2013 (Table 1 and Figure 15). In 2004, there were in excess of 20 breeding pairs of Greater Adjutant in the Northern Plains. The Bird Nest Protection Programme has also failed to address declines of nesting Lesser Adjutants and Oriental Darters. Densities of Giant Ibis and Sarus Crane in CWS were greater than in KPWS. White-shouldered Ibises have consistently avoided nesting in CWS, preferring to nest near to Tmatboey Village in KPWS.

Figure 5 shows the number of bird nests located per number of kilometre square grids surveyed annually. This was compiled from data collected in MIST and (later) SMART. Data were only available for both sites since 2008 and show that the rate of bird nest detection has, by 2016, fallen by approximately 50% in the last five years.

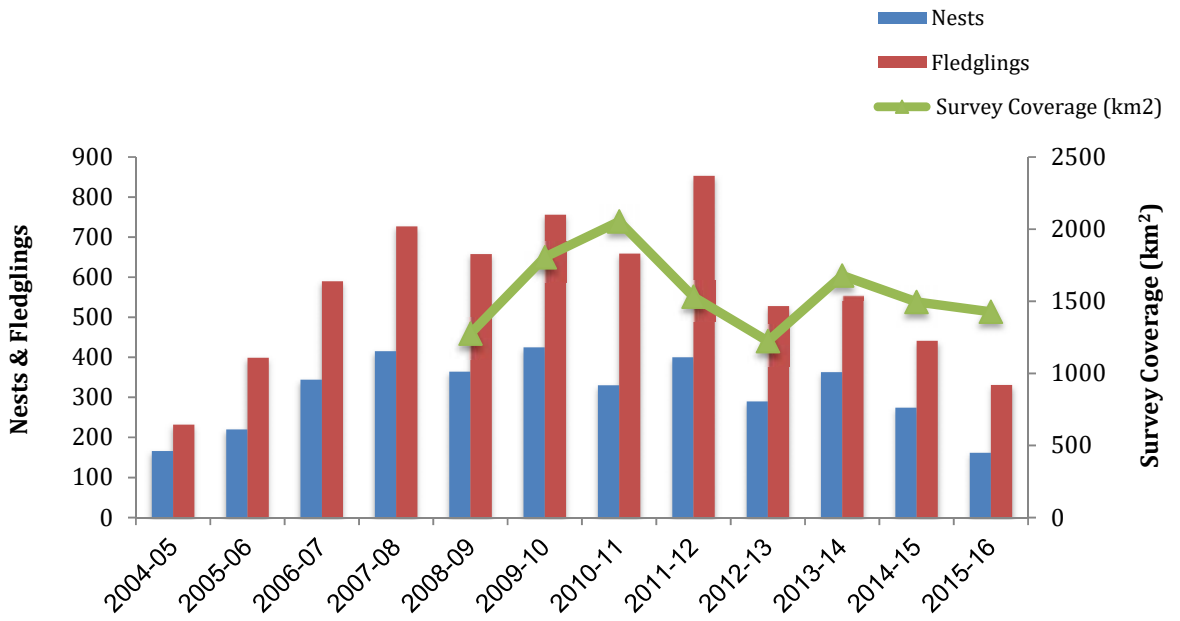


Figure 2. Total numbers of bird nests and fledglings in the Northern Plains. All Species. 2004 – 2016.

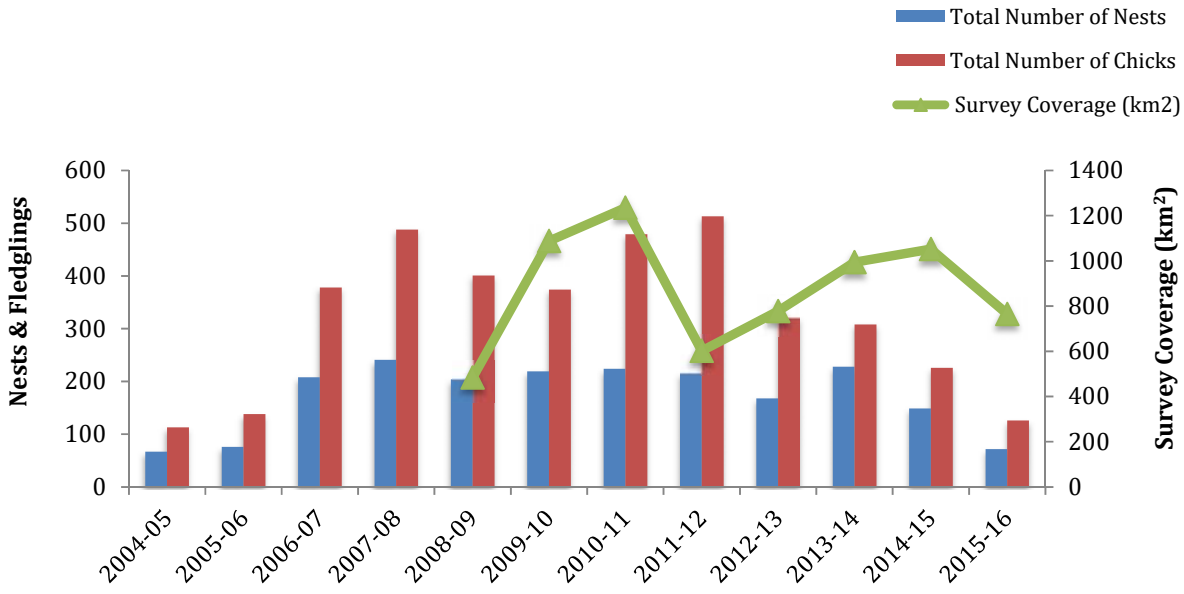


Figure 3. Total numbers of bird nests and fledglings in KPWS 2004 – 2016.

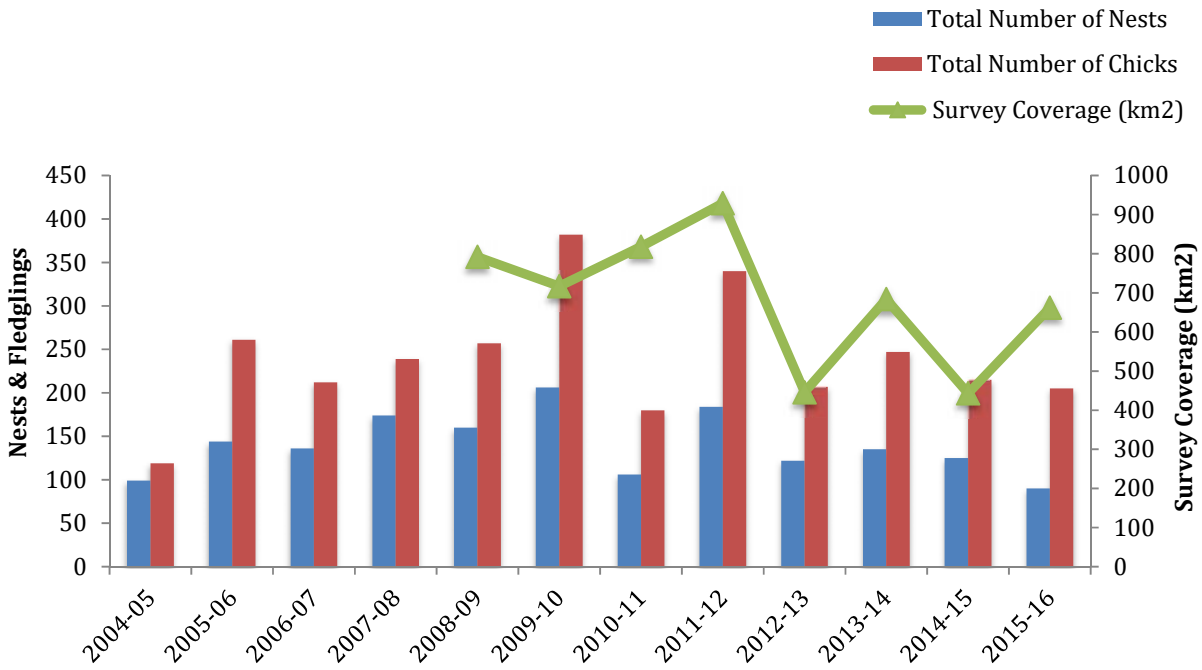


Figure 4. Total numbers of bird nests and fledglings in CWS 2004 – 2016.

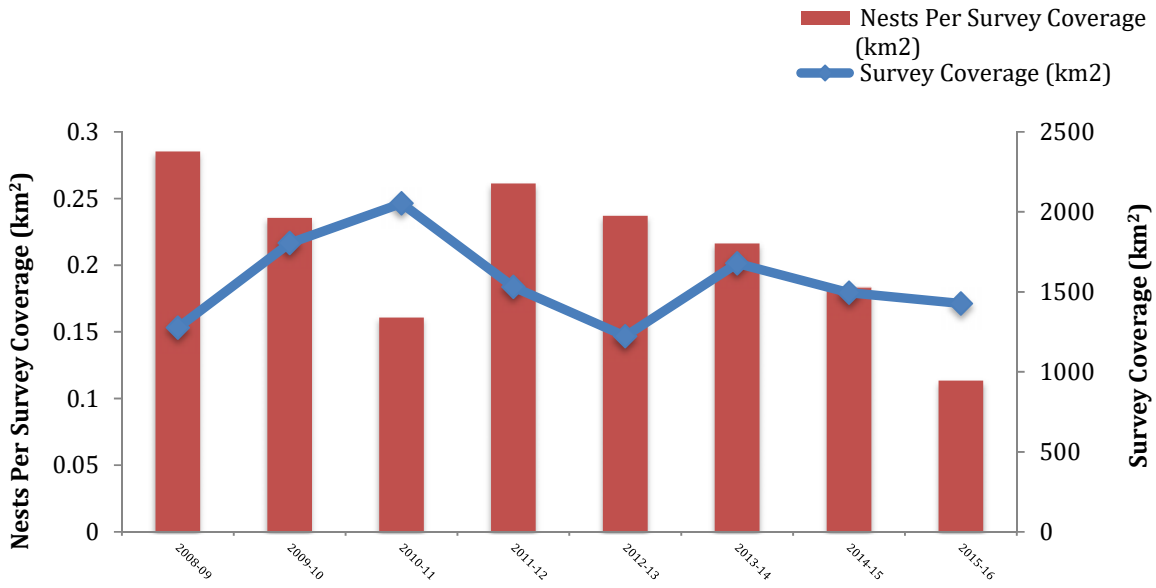


Figure 5. Nests Located Per Survey Coverage from 2008 – 2016 based on MIST and SMART data.

Table 1. Nests Protected: 2002 - 2016.

Species	2002 - 03						2003 - 04						2004 - 05						2005 - 06						2006 - 07						2007 - 08						2008 - 09						2009 - 10					
	Nests			Fledgling			Nests			Fledgling			Nests			Fledgling			Nests			Fledgling			Nests			Fledgling			Nests			Fledgling			Nests			Fledgling			Nests			Fledgling		
	KPNS	CKS	Total	KPNS	CKS	Total	KPNS	CKS	Total	KPNS	CKS	Total	KPNS	CKS	Total	KPNS	CKS	Total	KPNS	CKS	Total	KPNS	CKS	Total	KPNS	CKS	Total	KPNS	CKS	Total	KPNS	CKS	Total	KPNS	CKS	Total	KPNS	CKS	Total	KPNS	CKS	Total	KPNS	CKS	Total	KPNS	CKS	Total
White-shouldered Ibis	1	/	1	2	A	2	1	/	1	1	A	1	2	/	2	4	A	4	3	2	5	4	4	8	2	A	2	2	A	2	5	A	5	6	A	6	5	A	5	4	A	4	4	A	4	6	A	6
Giant Ibis	/	/	/	/	/	/	5	/	5	0	/	0	9	18	27	12	34	46	7	21	28	14	38	52	9	19	28	16	28	44	13	19	32	14	28	42	10	7	17	17	13	30	18	23	41	26	40	66
Sarus Crane	/	/	/	/	/	/	6	/	6	0	/	0	3	16	19	3	19	22	7	22	29	11	30	41	9	28	37	12	39	51	19	35	54	30	42	72	24	33	57	36	54	90	23	29	52	39	50	89
Lesser Adjutant	/	/	/	/	/	/	34	/	34	52	/	52	32	65	97	56	66	122	38	96	134	68	186	254	140	84	224	239	142	381	159	115	274	310	166	476	146	115	261	304	185	489	125	150	275	233	288	521
Greater Adjutant	/	A	/	/	A	/	/	A	/	/	A	/	21	A	21	38	A	38	19	A	19	41	A	41	18	A	18	29	A	29	10	A	10	20	A	20	6	A	6	10	A	10	10	A	10	19	A	19
Black-necked Stork	/	/	/	/	A	/	/	/	/	/	A	/	/	/	/	/	A	0	2	/	2	/	A	0	3	/	3	10	A	10	2	/	2	5	A	5	2	/	2	7	A	7	1	A	1	0	A	0
Oriental Darter	13	A	13	22	A	22	/	A	/	/	A	/	/	A	/	/	A	0	/	A	/	/	A	0	26	A	26	53	A	53	33	A	33	103	A	103	9	A	9	6	A	6	38	A	38	51	A	51
White-winged Duck	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	1	/	1	17	/	17	/	/	/	/	/	/	2	/	2	17	/	17	/	/	/	0	0	0
Masked Finfoot	/	A	/	/	A	/	/	A	/	/	A	/	/	A	/	/	A	/	/	A	/	/	A	/	/	A	/	/	A	/	/	A	/	/	A	/	/	A	/	/	A	/	/	A	/	/	A	/
Red-headed Vulture	A	/	/	A	/	/	A	/	/	A	/	/	A	/	/	A	/	/	A	/	/	A	/	/	A	1	1	A	0	/	A	1	1	A	1	1	A	2	2	A	2	2	A	/	/	A	/	/
White-rumped Vulture	A	/	/	A	/	/	A	/	/	A	/	/	A	/	/	A	/	/	A	3	3	A	3	3	A	4	4	A	3	3	A	4	4	A	2	2	A	3	3	A	3	3	A	4	4	A	4	4
Site Total	14	/	14	24	/	24	46	/	46	53	/	53	67	99	166	113	119	232	76	144	220	138	261	399	208	136	344	378	212	590	241	174	415	488	239	727	204	160	364	401	257	658	219	206	425	374	382	756

Species	2010 - 11						2011 - 12						2012 - 13						2013 - 14						2014 - 15						2015 - 16						2002 - 2016					
	Nests			Fledgling			Nests			Fledgling			Nests			Fledgling			Nests			Fledgling			Nests			Fledgling			Nests			Fledgling			Total Nests			Total Fledgling		
	SWNP	SBC	Total	SWNP	SBC	Total	SWNP	SBC	Total	SWNP	SBC	Total	SWNP	SBC	Total	SWNP	SBC	Total	SWNP	SBC	Total	SWNP	SBC	Total	SWNP	SBC	Total	SWNP	SBC	Total	SWNP	SBC	Total	SWNP	SBC	Total	SWNP	SBC	Total	SWNP	SBC	Total
White-shouldered Ibis	5	A	5	8	A	8	7	A	7	12	A	12	6	A	6	6	A	6	13	A	13	12	A	12	10	A	10	9	A	9	11	A	11	11	A	11	75	2	77	87	4	91
Giant Ibis	11	21	32	21	38	59	11	20	31	21	38	59	6	12	18	10	21	31	11	15	26	13	26	39	8	16	24	6	25	31	12	6	18	7	21	28	130	197	327	177	350	527
Sarus Crane	26	20	46	37	33	70	26	24	50	35	38	73	22	18	40	16	23	39	21	19	40	33	33	66	21	19	40	35	28	63	28	16	44	41	30	71	235	279	514	328	419	747
Lesser Adjutant	94	62	156	168	108	276	115	140	255	222	264	486	111	85	196	203	156	359	133	96	229	235	184	419	108	85	193	170	158	328	20	62	82	65	148	213	1255	1155	2410	2325	2051	4376
Greater Adjutant	5	A	5	11	A	11	3	A	3	6	A	6	3	A	3	7	A	7	A	A	0	A	A	0	A	A	0	A	A	0	A	A	0	A	A	0	95	A	95	181	A	181
Black-necked Stork	3	A	3	5	A	5	2	A	2	7	A	7	1	A	1	3	A	3	1	A	1	3	A	3	2	A	2	6	A	6	1	1	2	2	2	4	20	1	21	48	2	50
Oriental Darter	78	A	78	218	A	218	50	A	50	203	A	203	18	A	18	71	A	71	45	A	45	/	A	0	0	A	0	/	A	0	0	A	0	/	A	/	310	A	310	727	A	727
White-winged Duck	2	/	2	11	0	11	1	/	1	7	0	7	1	/	1	5	0	5	1	1	2	5	0	5	/	/	/	/	/	/	/	/	/	/	/	/	8	1	9	62	A	62
Masked Finfoot	/	A	/	/	A	/	1	A	1	/	A	/	/	A	/	/	A	/	3	A	3	7	A	7	/	A	/	/	A	/	/	A	/	/	A	/	4	A	4	7	A	7
Red-headed Vulture	A	2	2	A	0	0	A	/	/	A	/	0	A	/	/	A	/	/	A	1	1	A	1	1	A	3	3	A	2	2	A	3	3	A	2	2	A	13	13	A	8	8
White-rumped Vulture	A	1	1	A	1	1	A	0	0	A	/	/	A	7	7	A	7	7	A	3	3	A	3	3	A	2	2	A	2	2	A	2	2	A	2	2	A	33	33	A	30	30
Total	224	106	330	479	180	659	216	184	400	513	340	853	168	122	290	321	207	528	228	155	363	308	247	555	149	125	274	226	215	441	72	90	162	126	205	331	2132	1681	3813	3942	2864	6806

/ No data but nests presumed present A Nests absent

3.2 Summary of Nesting Ecology

Ecology of nesting seasons (Tables 2, 3, 4 and 5) broadly corresponds with that described in other studies (e.g., Keo 2008; Wright 2008; Clements *et al.* 2013). Sarus Crane, Giant Ibis and White-winged Duck are among the first species to nest, usually laying eggs during the wet season (June-August) and all sharing a peak nesting time in July. This is followed by Masked Finfoot in July, by Lesser Adjutant and Oriental Darter in August; Black-necked Stork and White-rumped Vulture in October; before White-shouldered Ibis, Greater Adjutant and Red-headed Vulture begin nesting in November, resulting in year-round, and often complimentary, nesting periods (Table 2). On average, wet season nesting times in CWS are usually 2-4 weeks ahead of those in KPWS. From 2009 – 2016, the nesting phenology of a number of species appears to exhibit more variability then between 2002 and 2008 (Table 3, 4 and 5).

Table 6 details nest characteristics for each species, which are similar to other studies (e.g., Keo 2008; Wright 2008; Clements *et al.* 2013). Notably, most species, with the exception of Sarus Crane and Masked Finfoot, rely upon tall dipterocarp trees, which are of high timber value and are used by local people for resin collection. The Adjutants are the only species to breed in evergreen forest in mixed colonies. Greater Adjutants will only nest in semi-evergreen or evergreen forest but Lesser Adjutants will often nest in the tallest and most dense dipterocarp trees in dry deciduous as well as evergreen forest.

Table 2. Peak nesting periods showing when the highest number of birds are incubating. Accumulated average from 2002 – 2016 data.

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
White-shouldered Ibis												
Giant Ibis												
Sarus Crane												
Lesser Adjutant												
Greater Adjutant												
Oriental Darter												
Black-necked Stork												
White-winged Duck												
Masked Finfoot												
Red-headed Vulture												
White-rumped Vulture												

Peak Nesting Period Nesting Period

Table 3. Comparison by site of nest location date between 2002 - 2008 and 2009-2016 in the Northern Plains.

Date Nest Located																								
KPWS	2002 - 2008												2009 - 2016											
Month	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Season	D	D	D	D	D	D	W	W	W	W	W	W	D	D	D	D	D	D	W	W	W	W	W	W
White-shouldered Ibis																								
Giant Ibis																								
Sarus Crane																								
Lesser Adjutant																								
Greater Adjutant																								
Black-necked Stork																								
Oriental Darter																								
White-winged Duck																								
Masked Finfoot																								
CWS	2002 - 2008												2009 - 2016											
Month	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Season	D	D	D	D	D	D	W	W	W	W	W	W	D	D	D	D	D	D	W	W	W	W	W	W
Giant Ibis																								
Sarus Crane																								
Lesser Adjutant																								
Black-necked Stork																								
White-winged Duck																								
Red-headed Vulture																								
White-rumped Vulture																								

Table 4. Comparison by site of date eggs hatched between 2002 - 2008 and 2009 - 2016 in the Northern Plains.

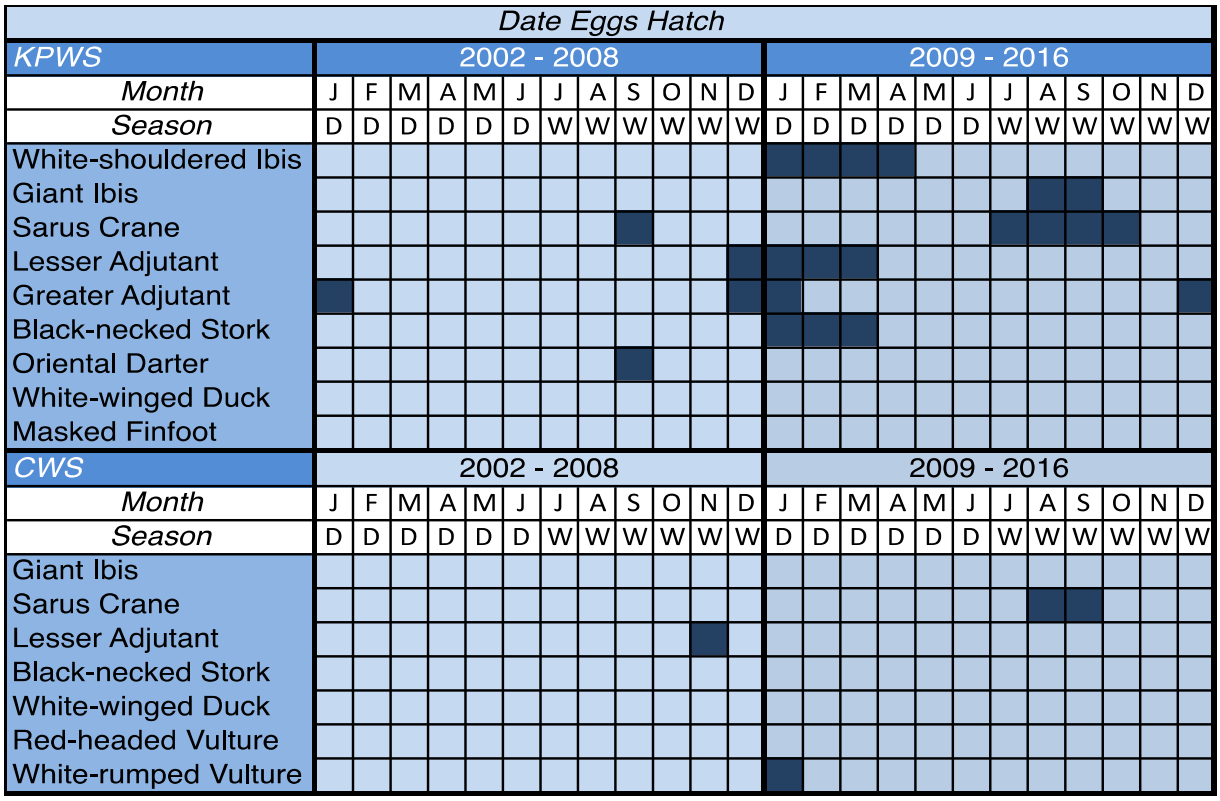


Table 5. Comparison by site of fledging dates between 2002 - 2008 and 2009 - 2016 in the Northern Plains.

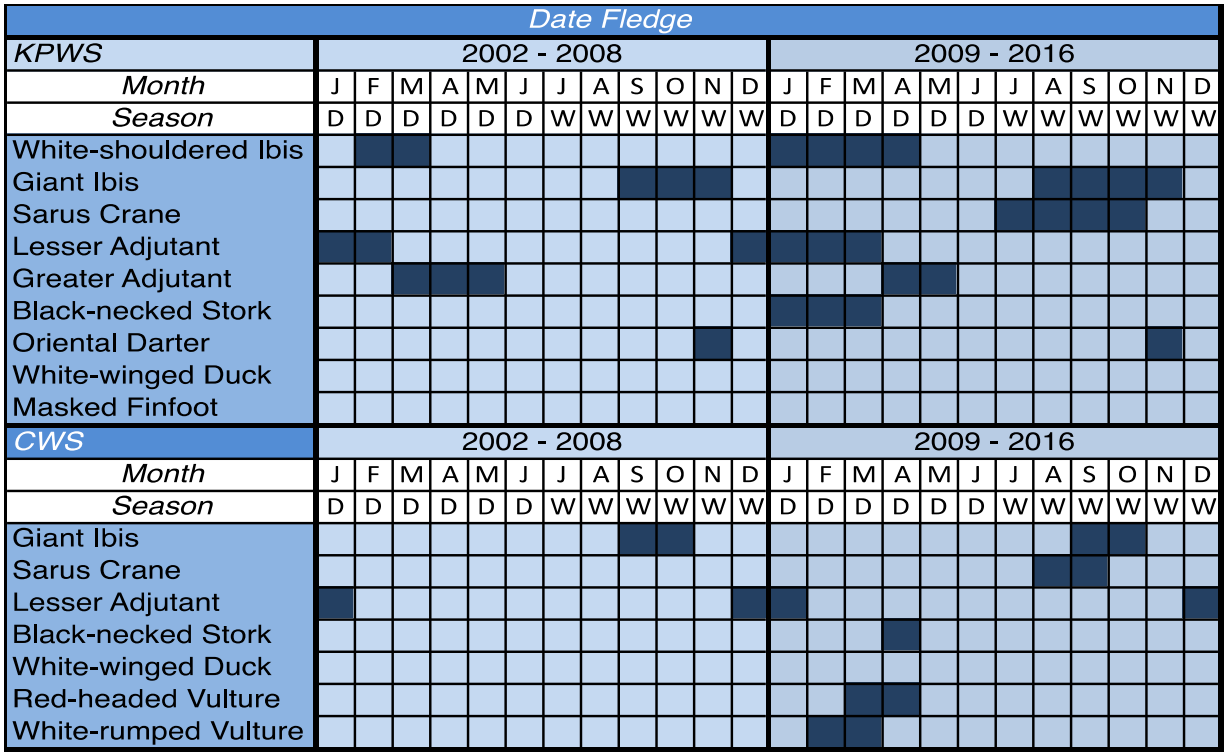


Table 6. Nest characteristics and habitat preference in the Northern Plains.

Species	*Nest Description**	*Nesting Behaviour*	*Habitat*
White-shouldered Ibis	Small platform of sticks at top of *Trach* tree	Solitary	Deciduous Dipterocarp Forest
Giant Ibis	Small platform of sticks at top of *Trach, Tbeng* or *Koki*	Solitary	Deciduous Dipterocarp Forest
Sarus Crane	Large mound of sticks and dry grass on ground	Solitary	Seasonally flooded grassland
Lesser Adjutant	Large nests in high trees, *Trach, Tbeng, Chhoeutiel* or *Koki*	Colonial	Deciduous Dipterocarp Forest, Semi-evergreen, Evergreen
Greater Adjutant	Large nests in high trees, *Chhoeutiel*	Colonial	Semi-evergreen, Evergreen
Black-necked Stork	Large platform of sticks at top of *Trach*, *Tbeng*	Solitary	Deciduous Dipterocarp Forest
Oriental Darter	Small nest platforms on trees and shrubs above inundated areas	Colonial	Flooded viels and flooded riverine Semi-evergreen and DDF
White-winged Duck	Nests high in tree in hollow. *Koki*, *Chhoeutiel*	Solitary	Riverine, Semi-evergreen, Evergreen
Masked Finfoot	Nests on platform of twigs on trees usually overhanging river	Solitary	Riverine, Semi-evergreen, Evergreen
Red-headed Vulture	Large platform of sticks at top of large *Trach, Tbeng* or *Koki*. Often associated with tangle of parasitic plant	Solitary	Deciduous Dipterocarp Forest
White-rumped Vulture	Large nest in high trees, *Chhoeutie*l	Semi-colonial	Deciduous Dipterocarp Forest, Semi-evergreen

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

3.3 Species Profiles

3.3.1 Giant Ibis *Thaumatibis gigantea*

Cambodia's national bird stands at 100cm tall and weighs over 4kg, making it by far the world's largest ibis. With an estimated global population of approximately 200 mature individuals, and a declining global population trend, the monotypic Giant Ibis is listed as Critically Endangered on the IUCN Red List. Based on its evolutionary distinctiveness and level of endangerment, the Giant Ibis is the highest ranked EDGE bird species globally. Giant Ibis forage for invertebrates, crustaceans, eels, small amphibians and reptiles in muddy substrate at marshes, trapeangs, rivers and seasonally flooded grasslands in open, predominantly deciduous dipterocarp lowland forest. A territorial species, usually observed in pairs or small groups, the Giant Ibis prefers to nest in excess of 3km from human habitation in tall Dipterocarpus trees (Keo 2018).

Nesting trend in the Northern Plains

Numbers of Giant Ibis nests have remained fairly stable over time, fluctuating significantly between years, with variation exceeding 100% from 2008 – 2010 (Figure 6). The number of nests located per area surveyed, also support this stability (Figure 7). Despite the stability within this range of variation, since 2009 numbers appear to be experiencing a gradual decline and breeding success has fallen (Figure 6).

Typically, Giant Ibises begin nesting in May (peaking in July) and continue to feed chicks in the nest well into the wet season (Table 4). Overall, the periods in which Giant Ibises started nesting, as well as the fledging period, had greater variation between 2009 - 2016 then between 2002 - 2009 (Tables 3, 4 and 5). Unusually, in 2016 one pair of Giant Ibises in KPWS began nesting in February, with chicks fledging in April and, in 2003 chicks from one nest did not fledge until late November. Giant Ibis and White-shouldered Ibis nesting seasons typically do not overlap. This behaviour has probably evolved to avoid competition (Wright 2008). More variable nesting behaviour may result from adaptation to increased human pressure within the landscape. It has been observed that disturbance to nests causes their abandonment and, after a month or so, nesting pairs will attempt a second brood, extending the effective nesting season, and subsequent costs of nest protection. Falls in the proportion of fledglings per nest, also suggests increased human disturbance and potentially also predation by growing crow populations, associated with rapidly expanding human settlements (Table 9). Map 3 shows how the distribution of Giant Ibis nests across the landscape has contracted. The Giant Ibis is a notoriously shy bird, preferring to nest more than 3km from human settlement (Keo 2008). This contraction in range is symptomatic of a reduction in availability of suitably remote nesting areas, reducing the effective carrying capacity of available habitat (An 2008).

Taking into consideration the reduced nesting and foraging habitat resulting from ELCs and SLCs, the relative stability of Giant Ibis nesting numbers is encouraging. However, continued monitoring is required to assess if numbers are beginning to decline, and protection of habitat is required to bolster against declines. Since 2011 surveys showed that 40% of *trapeangs* surveyed in the Northern Plains where lost to habitat clearance by ELCs and SLCs (WCS data). *Trapeangs* are a key feature of the Giant Ibis' preferred DDF habitat, providing essential foraging habitat, especially during the drought of the dry season. The reduction in number of *trapeangs* not only reduces foraging habitat, but also

increases the potential for human conflict, as local communities also rely on *trapeangs* for food. Moreover, evidence suggests that *trapeangs* are becoming increasingly clogged with vegetation due to a reduction in numbers of both wild and domestic wallowing ungulates (WCS data). This is thought to be causing a contraction of the foraging zone (consisting of muddy substrates), which would originally have been maintained by wallowing ungulates. The global effects of climate change are predicted to hit Asia the hardest (Field *et al*., 2014), posing a potentially catastrophic risk to dry season foraging habitat. To compensate for reduced foraging capacity, to ameliorate the additional source of competition between ibis and man, and to safeguard against the predicted effects of climate change, it is recommended that additional *trapeangs* are dug to replace those lost in the landscape, and remaining *trapeangs* are artificially deepened to increase their permanence throughout the dry season and their tolerance to climate change.

Most cases of Giant Ibis nest failure (Figure 8) are attributed to “Accidental” causes such as wind or as “Unknown”. However, in 2013 and 14 there were high incidences of nest predation, mostly by crows. Anecdotal observations suggest that as the human population density has increased in the Northern Plains, the population of crows has followed suit. It is recommended that crows are culled on a regular basis, to reduce this source of nest predation. With rapidly expanding human populations comes greater land conversion, namely to rice paddy, reducing the amount of remote nesting habitat required for the Giant Ibis (An 2008). The expansion of the Wildlife-Friendly Ibis Rice scheme across a greater proportion of rice farmers would increase overall compliance with land use law inside these Protected Areas, controlling further expansion of rice paddies into Giant Ibis habitat.

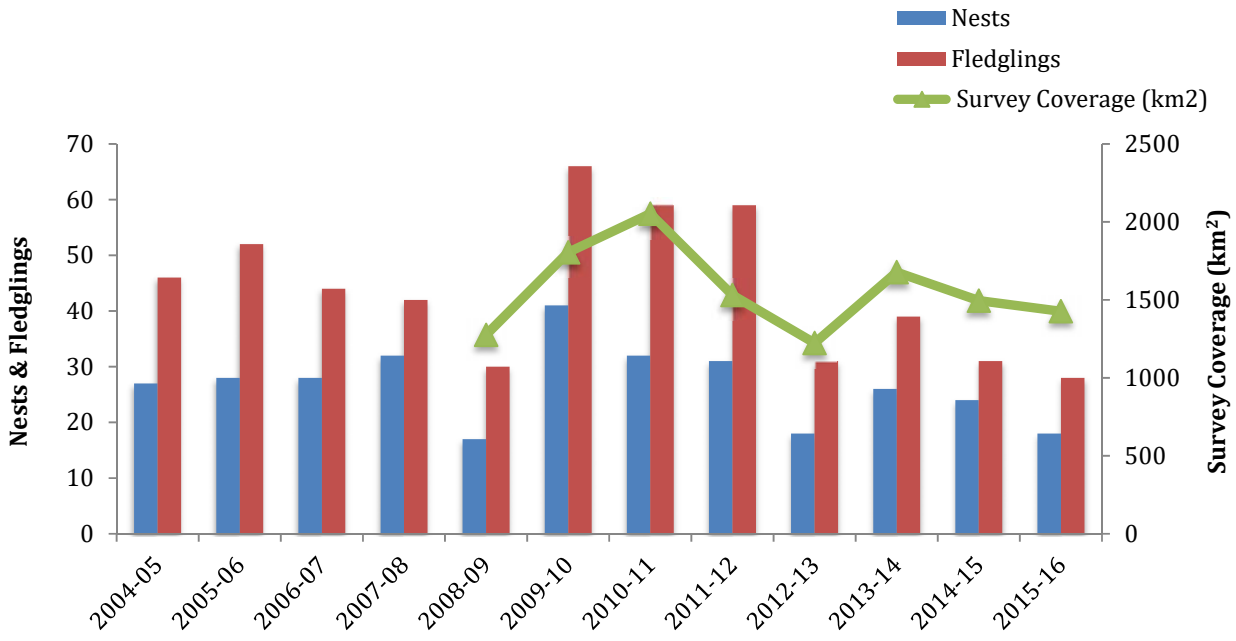


Figure 6. Total Numbers of Giant Ibis Nests & Fledglings in The Northern Plains 2004 – 2016.

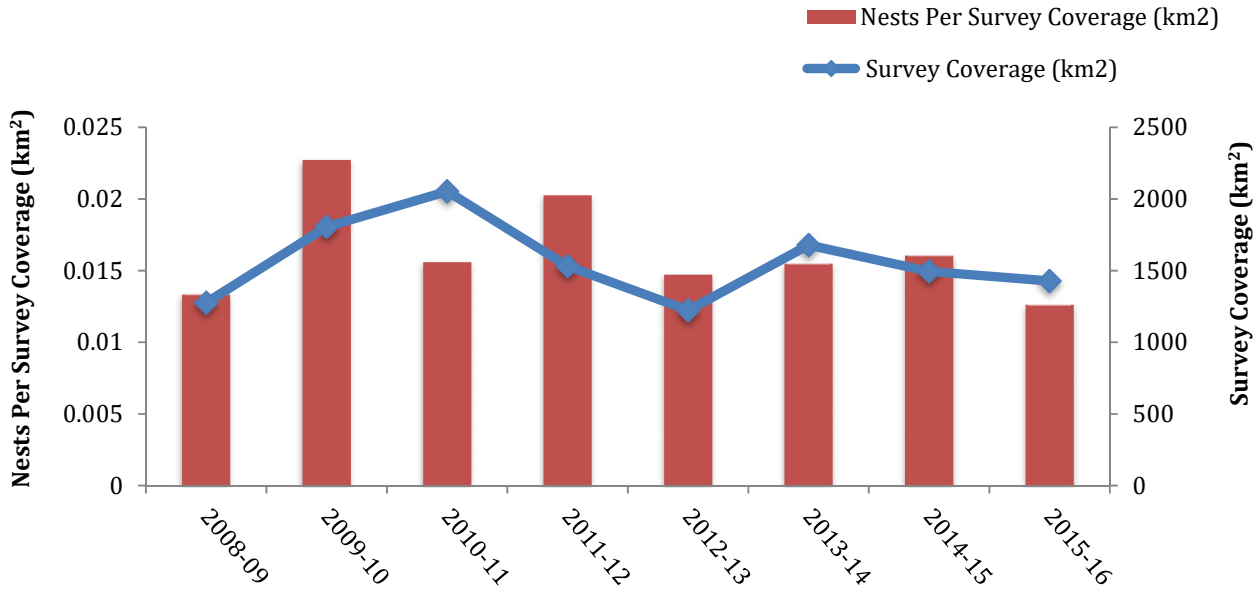


Figure 7. Giant Ibis Nests Located Per Survey Coverage in The Northern Plains 2008 – 2016.

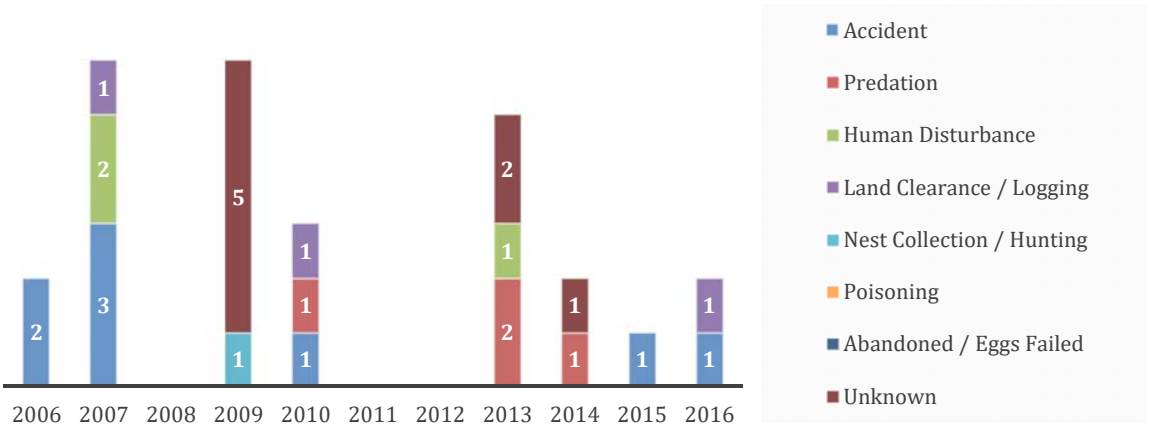
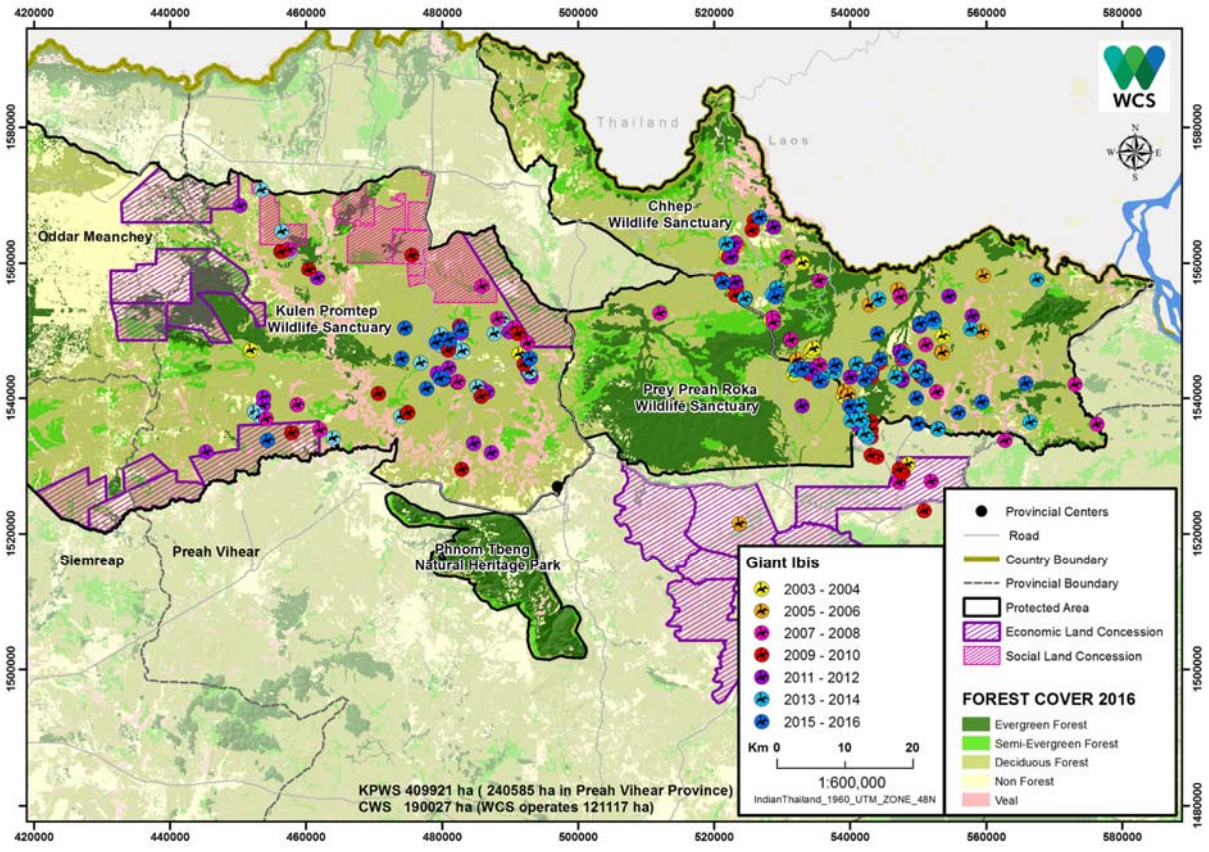


Figure 8. Causes of Nest Failure as a Proportion of Total Number of Giant Ibis Nests. 2006 – 2016.



Map 3 Distribution of Giant Ibis nests in the Northern Plains. 2003 - 2016

3.3.2 White-shouldered Ibis *Pseudibis davisoni*

A large dark ibis measuring up to 85cm with a distinctive pale collar. The global population is estimated at approximately 1,000 mature individuals and declining, warranting its listing as Critically Endangered on the IUCN Red List. Due to massive contraction of its previous range the White-shouldered Ibis was previously described as the most threatened large water bird in South-East Asia (Tordoff *et al*. 2005). Based on its evolutionarily distinctiveness and globally threatened status, the White-shouldered Ibis is ranked 16th on the EDGE list of endangered birds.

The White-shouldered Ibis has a similar diet to the Giant Ibis and will forage for invertebrates, crustaceans, eels, small amphibians and leaches in muddy substrate at marshes, *trapeangs*, rivers and seasonally flooded *viels* in open, predominantly deciduous dipterocarp lowland forest but, unlike the Giant Ibis, it shows a preference for riverine habitat and flooded forest. White-shouldered Ibises are social, often seen in large flocks. During the wet season, they congregate in large communal roosts, before pairing off and dispersing into the forest for nesting, at the start of the dry season.

Nesting trend in the Northern Plains

Numbers of White-shouldered Ibis nests have increased steadily since 2002 (Figure 9). The ratio of nests located relative to survey coverage has increased since 2011, with rate of nest location exceeding relative survey coverage in 2016 (Figure 10). White-shouldered Ibis nests are predominantly located around a single village in KPWS, *Tmatbauy*. A small number of nests have also been located in western and southern KPWS, and in recent years, nests have also been located outside of the protected areas, to the South of PPRWS, in an area that is also used by this population as a roost site. Bird watching tours managed by Sam Veasna Centre provide local people with income through community-based ecotourism in this village. Increases in the White-shouldered Ibis population may therefore be due to local action around Tmatbauy, at the confluence of multiple conservation schemes rather than nest protection alone (Clements *et al.* 2013).

Fledging success appears to fluctuate considerably (Figure 9). Nesting typically starts in the late wet season / early dry season (November - December). The peak nesting time is in January with chicks usually fledging in February or March but occasionally not until April. The periods in which White-shouldered Ibis started nesting, as well as the fledging period, had greater variation between 2009-2016 then from 2002-2009. As with the Giant

Ibis, a more variable nesting phenology may be the result of adaptations to intensified human pressure on the landscape. The White-shouldered Ibis nesting period is the reverse of the Giant Ibis. Complementary nesting behaviours have presumably evolved to avoid interspecific competition (Wright 2008). However, as strategies to avoid human disturbance become more highly selected for, competition with the Giant Ibis may no longer be the prevailing selective pressure, potentially causing a shift in this behaviour. Further evidence is needed to support this theory.

White-shouldered Ibis preferentially nest in tall Dipterocarpus trees in DDF where they are exposed to sunlight, often in or near to rice paddy (Table 6). Nesting usually commences following the rice harvest, when their proximity to people, and their habit for social roosting, exposes them to hunting. For reasons unknown, White-shouldered Ibis do not nest in CWS. Map 4 shows how the distribution of White-shouldered Ibis has remained mostly unchanged since 2004. Almost all nests are located around Tmatbauy Village where community based eco-tourism supports nest and monitoring activities for this species.

The threats applicable to Giant Ibis, especially the loss of foraging habitat, also apply to White-shouldered Ibis. Despite this, nest numbers in the Northern Plains are increasing, because the area around Tmatbauy has not been directly affected by ELCs and SLCs, and arguably because of the concentration of community based conservation initiatives in this area. White-shouldered Ibis, being more tolerant to human presence, are also inherently less likely to abandon nests as a result of disturbance, making them less sensitive to the pressure of human immigration into the protected areas. The expansion of the Wildlife-Friendly Ibis Rice scheme across a greater proportion of rice farmers would increase the overall level of compliance with land use law inside these Protected Areas, controlling further expansion of rice paddies into ibis habitat. The prevailing cause of White-shouldered Ibis nest failure (Figure 11) is predation by crows, suggesting control of crow numbers would also benefit this species.

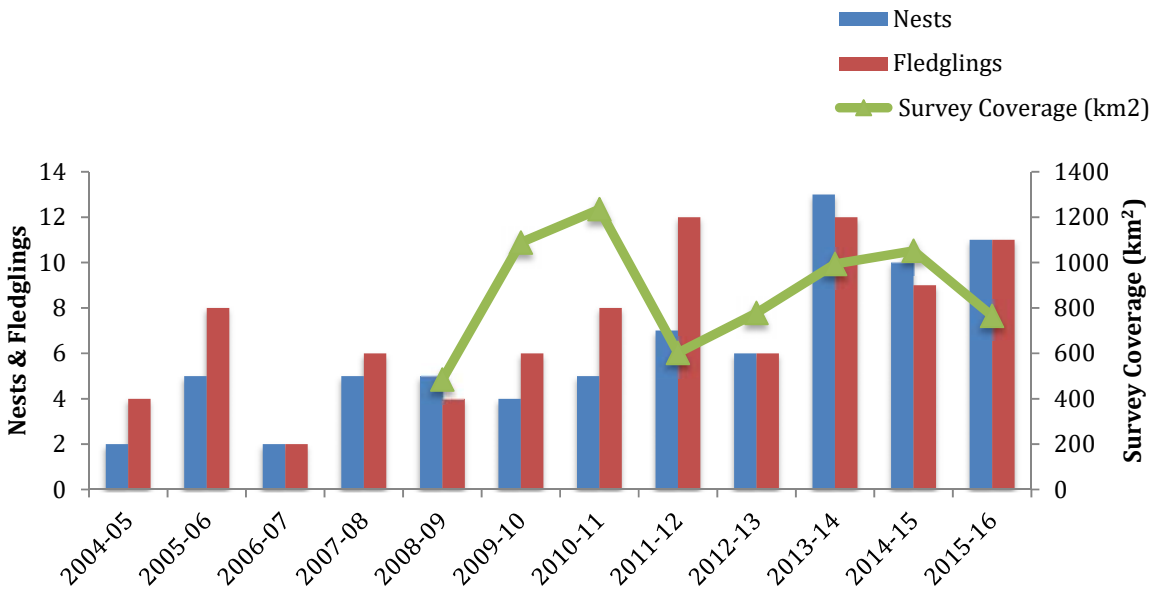


Figure 9. Total Numbers of White-shouldered Ibis Nests & Fledglings in The Northern Plains (KPWS only). 2002 – 2016.

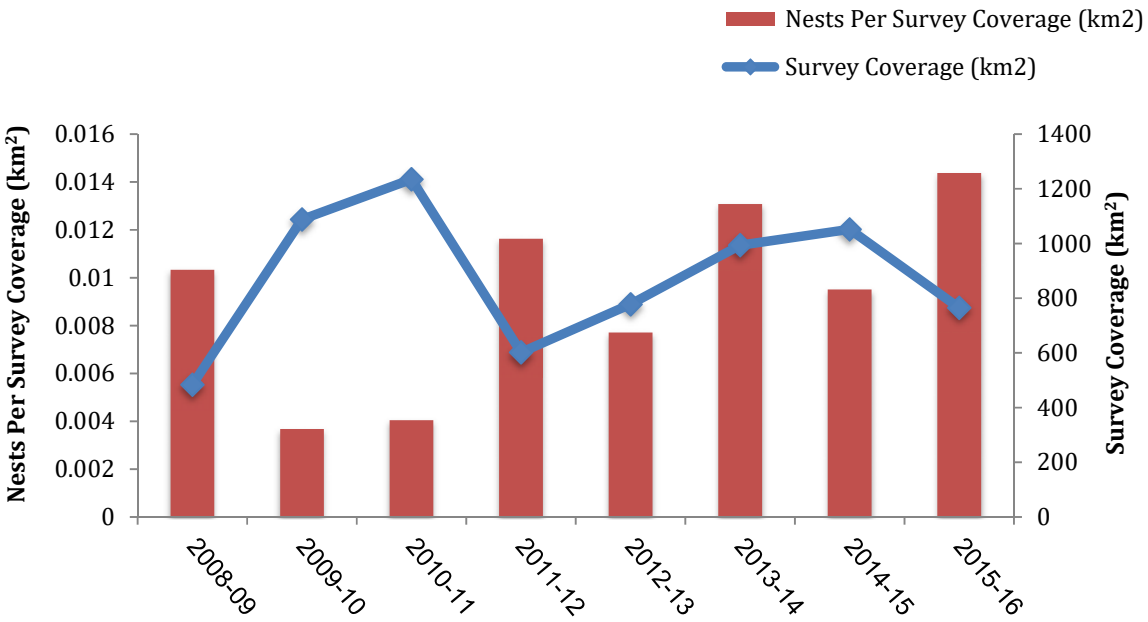


Figure 10. White-shouldered Ibis Nests Located Per Survey Coverage in The Northern Plains (KPWS only). 2008 – 2016.

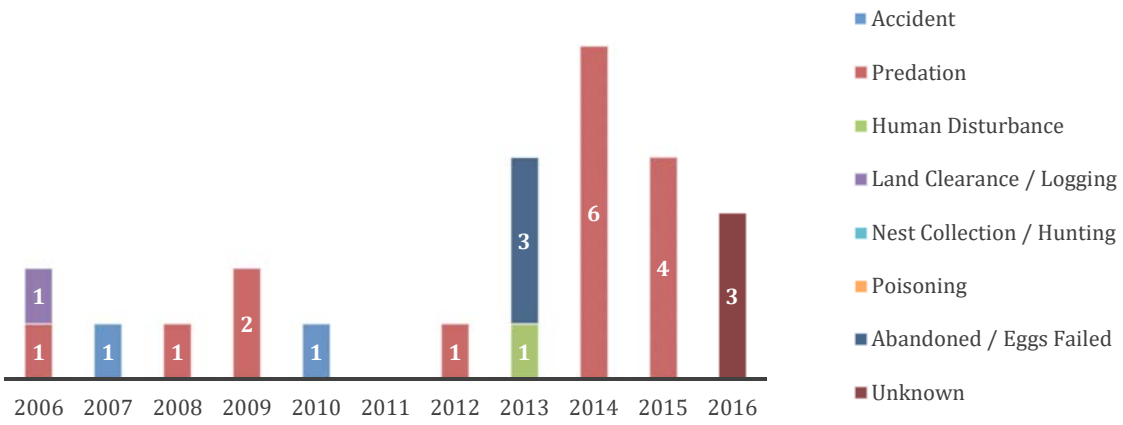
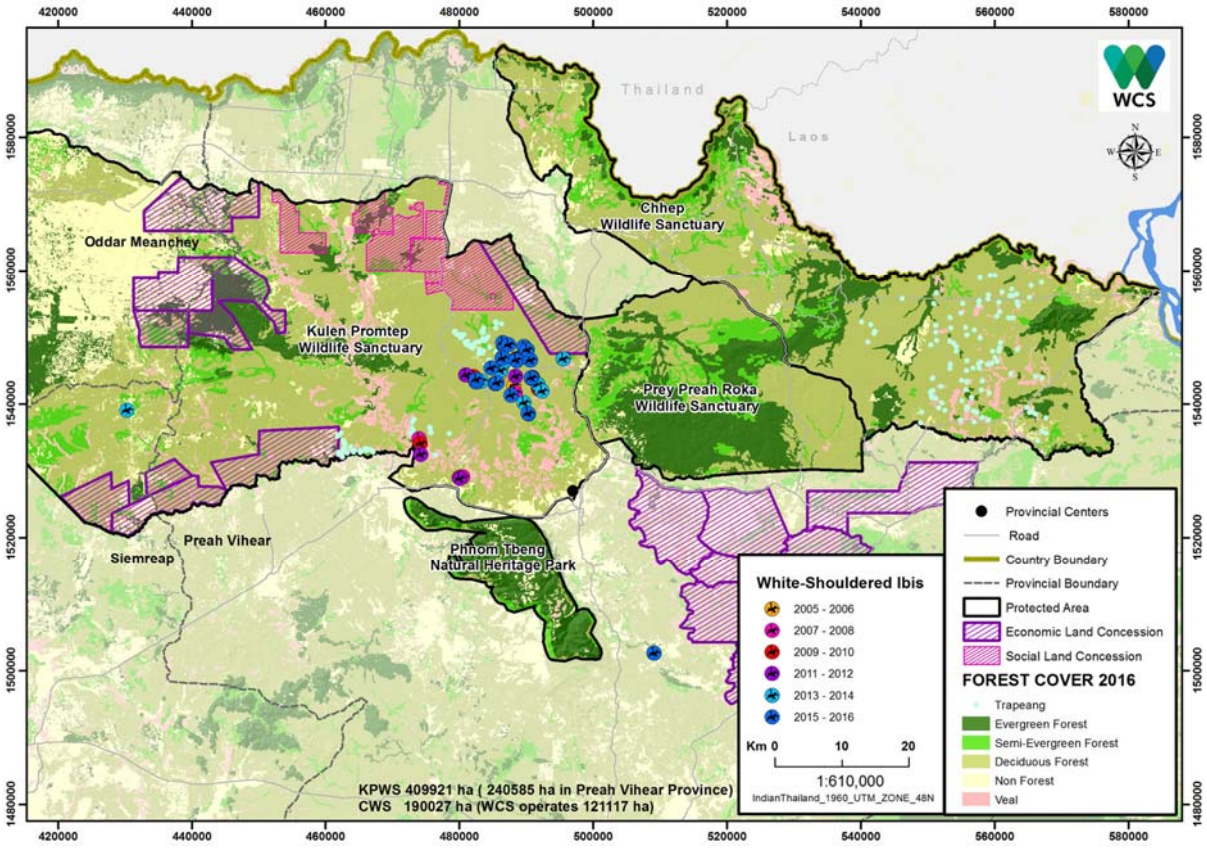


Figure 11. Causes of Nest Failure as a Proportion of Total Number of White-shouldered Ibis Nests. 2006 – 2016.



Map 4. Distribution of White-shouldered Ibis nests in the Northern Plains. 2005 – 2016.

3.3.3 Lesser Adjutant *Leptoptilos javanicus*

The Lesser Adjutant is a large stork reaching 130cm in height with a wingspan of over two meters. Despite an upper population estimate of 10,000 mature individuals, it is experiencing rapid population decline and its former range is seeing widespread contraction, warranting its Globally Vulnerable status on the IUCN Red List.

The diet of the Lesser Adjutant is varied, feeding on frogs, reptiles, fish, crustaceans, large insects, as well as young mammals and birds. Birds are distributed at low densities throughout mainland Southeast Asia and the eastern part of the Indian Subcontinent. It nests colonially in tall trees in both DDF and evergreen habitats across the Northern Plains.

Nesting trend in the Northern Plains

Numbers of Lesser Adjutant nests rose until 2008 but, since 2010 nest numbers have returned to 2005 levels. By 2016 nest numbers have seen a 60% reduction on 2009 numbers. Relative to survey coverage, there was a reduction in nests located in 2013, which dipped more significantly again in 2015.

In the Northern Plains Lesser Adjutants begin nesting at the end of the wet season (September-October) but can start nesting as early as August. Their peak nesting time is September and they usually fledge from December - March. The periods in which Lesser Adjutants started nesting had greater variation from 2009-2016 then from 2002-2009. From 2009-2016 they also fledged later in the season than during 2009-2016 (Table 5). In the Northern Plains Lesser Adjutants start breeding several months earlier than the main breeding colonies on the Tonle Sap Great Lake, where they start building nests in late November. The extent to which these two sub-populations exchange individuals is unknown.

Lesser Adjutants are prone to predation from mustelids, but the overriding cause of nest failure is attributed to land clearance and illegal logging (Figure 14) which increased from 2012 onwards and correlates with the influx of ELCs and SLCs in and surrounding the protected areas of the Northern Plains. Map 5 shows how Lesser Adjutant nest locations have shifted as areas of evergreen forest are cleared to make way for concessions. This is

particularly visible in KPWS (where ELCs are located) where nests are now more frequently located in DDF, reflecting a loss of undisturbed habitat.

Nest protectors may be able to provide some deterrent to logging during the nesting season, but once the chicks have fledged, and the nest guardian has left, they cannot defend the habitat from logging. It is therefore recommended that Lesser Adjutant habitat receives greater attention from law enforcement teams, at all times of year. The pending zonation of the protected areas in the Northern Plains and the agreement of management plans within zones is required to strengthen protection for this habitat, much of which is located in Community Protected Areas.

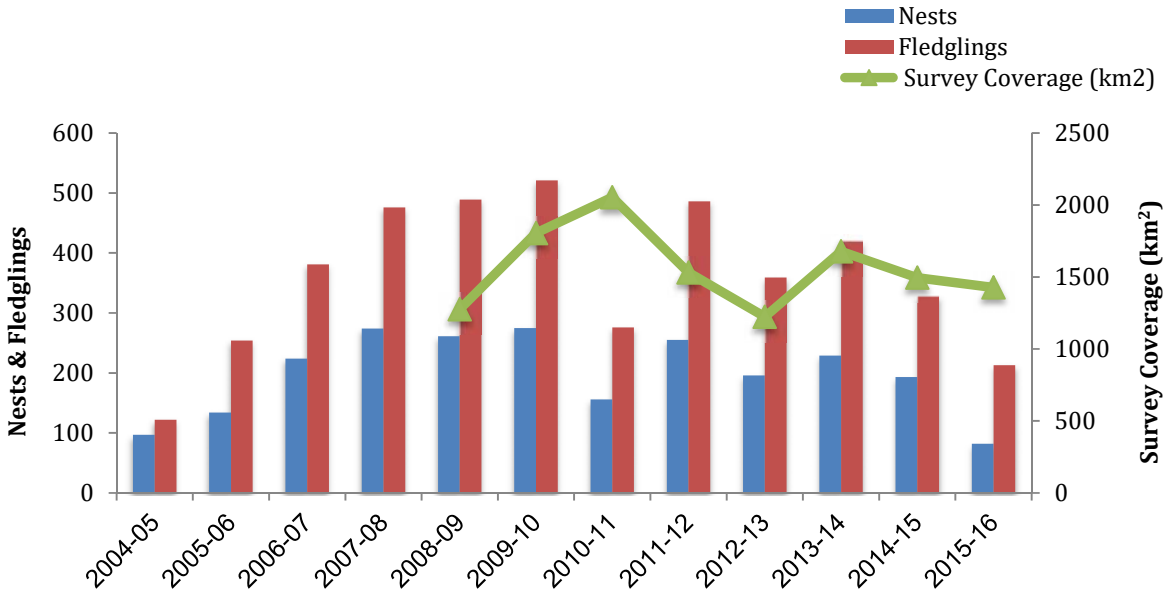


Figure 12. Total Numbers of Lesser Adjutant Nests & Fledglings in The Northern Plains Per km² Surveyed. 2003 – 2016.

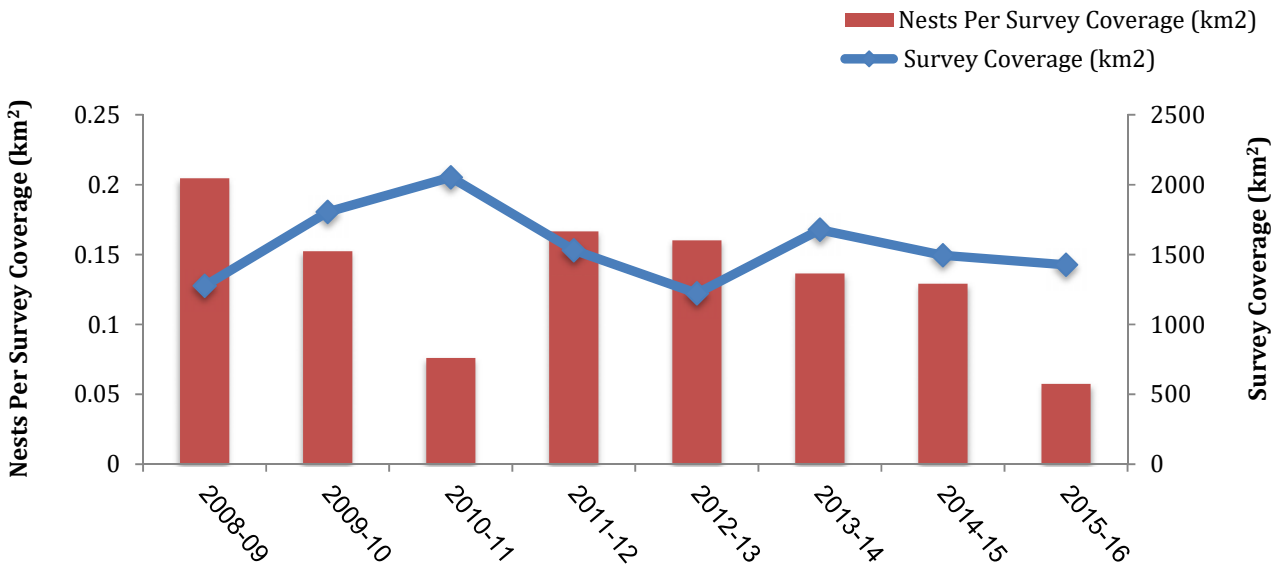


Figure 13. Lesser Adjutant Nests Located Per Survey Coverage in The Northern Plains. 2008 – 2016.

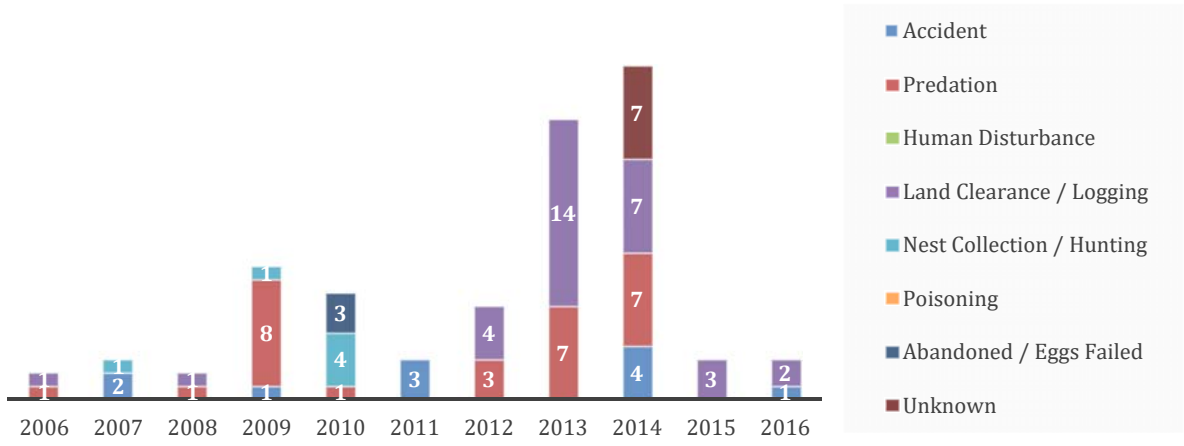
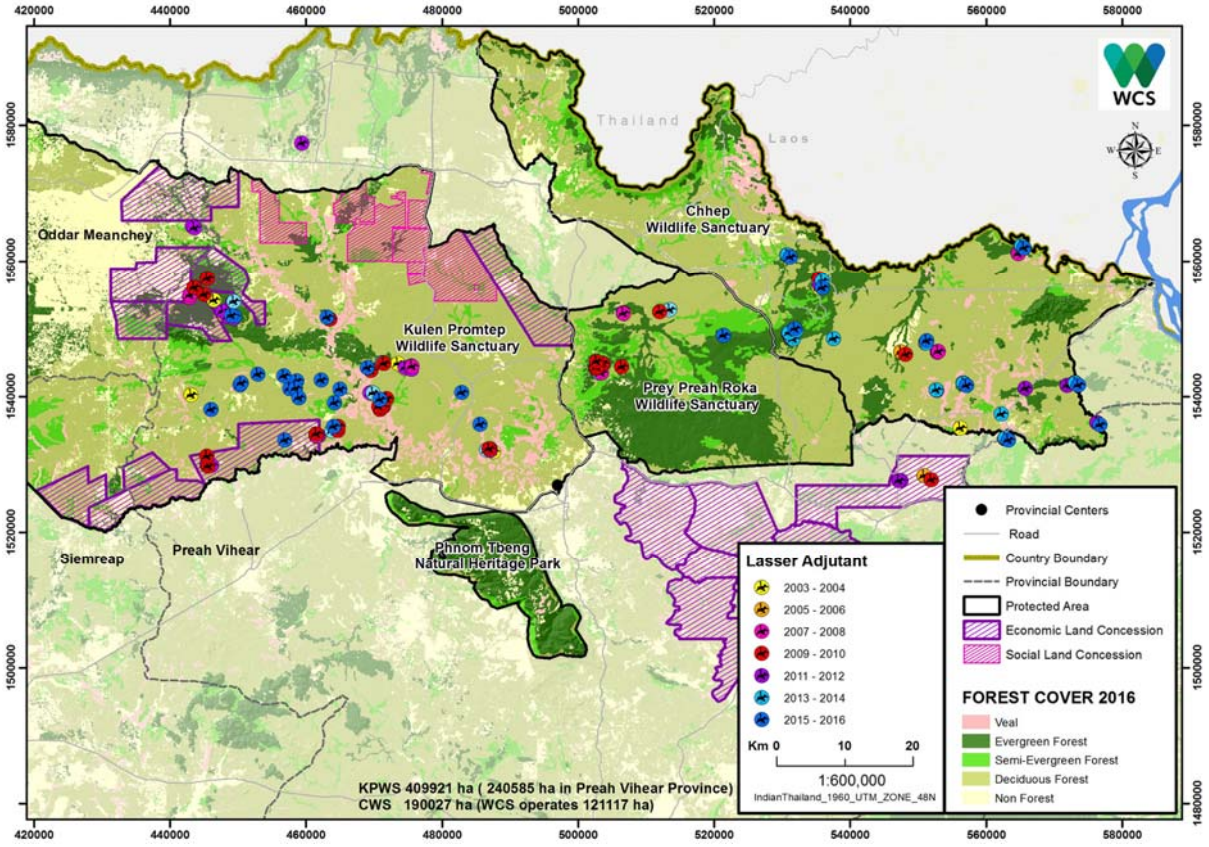


Figure 14. Causes of Nest Failure as a Proportion of Total Number of Lesser Adjutant Nests. 2006 – 2016*.



Map 5. Distribution of Lesser Adjutant nests in the Northern Plains. 2003 – 2016

3.3.4 Greater Adjutant *Leptoptilos dubius*

The Greater Adjutant is the largest stork species, measuring up to 150cm in height with a wingspan of around two and a half meters. The global population is thought to be rapidly declining and is estimated at 800-1,200 mature individuals. Its range across Asia has undergone widespread contraction warranting its classification as Globally Endangered on the IUCN Red List. Based on its evolutionary distinctiveness and vulnerable status, the Greater Adjutant is ranked the 73rd EDGE bird species.

The Greater Adjutant has a similar diet to the closely related Lesser Adjutant but will also scavenge on carrion. In the Northern Plains, it is often seen feeding at *trapeangs* and occasionally at “vulture restaurants” where slaughtered cows provide supplementary food for vultures. Although Greater Adjutants are frequently recorded in CWS (where vulture restaurants are located), they have only ever been found nesting in KPWS, with the exception of a single season where nests were found in PPRWS (Map 6). The Greater Adjutant nests in colonies, selecting the tallest trees, exclusively in evergreen and semi-evergreen forest.

Nesting trend in the Northern Plains

Records of Greater Adjutant nests peaked in 2004, when more than 20 nesting pairs were protected. Nest numbers subsequently fell until 2013, when they were no longer found nesting in the Northern Plains (Figure 15). Their relatively small population in the landscape made them less resilient to clearance of their nesting habitat. The rate of nests located by survey area covered suggests that their greatest rate of decline was in 2010, coinciding with when much of their habitat was cleared for ELCs. The Greater Adjutant is the only focal species in the landscape to exclusively nest in evergreen forest (Map 6). Once their nesting habitat was degraded they were apparently not left with the option to move to DDF like the Lesser Adjutants.

In the Northern Plains, Greater Adjutants began nesting in November or December (Table 3) and fledged between May and April (Table 5). Between 2002-2009 and 2009-2016, both the time that Greater Adjutants started nesting and the fledging time shifted to later in the season (Tables 3 and 5) This is presumably in response to greater human disturbance, but could also be linked to changing climatic conditions.

Records of nest failure were low for this species, but revealed predation, land clearance and logging to be the predominant cause of nest failure. As with other species, nest guardians are powerless to combat habitat clearance outside of the breeding season. In addition to the threat of logging, declines in Greater Adjutant numbers were also attributed to disturbance. 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 and by 2014 had been extirpated.

There was also a recorded incident of an adult Greater Adjutant being poisoned in 2008, resulting in the failure of the nest (Figure 17). Poisoning is a significant threat to waterbirds of the Northern Plains. Local villagers poison *trapeangs* to kill and collect frogs and fish as a source of food. If poisoned animals are fed upon by animals they too will be poisoned, potentially causing widespread deaths. A 2016 report by WCS tested the corpses of 6 animals that had died close to *trapeangs*, all were found to contain Carbofuran, a widely available poison used for this purpose (Pruvot 2016). In response to the threat of

poisoning, it is recommended that outreach activities such as community awareness raising and education are conducted to inform people to the costs of poisoning to environmental and human health.

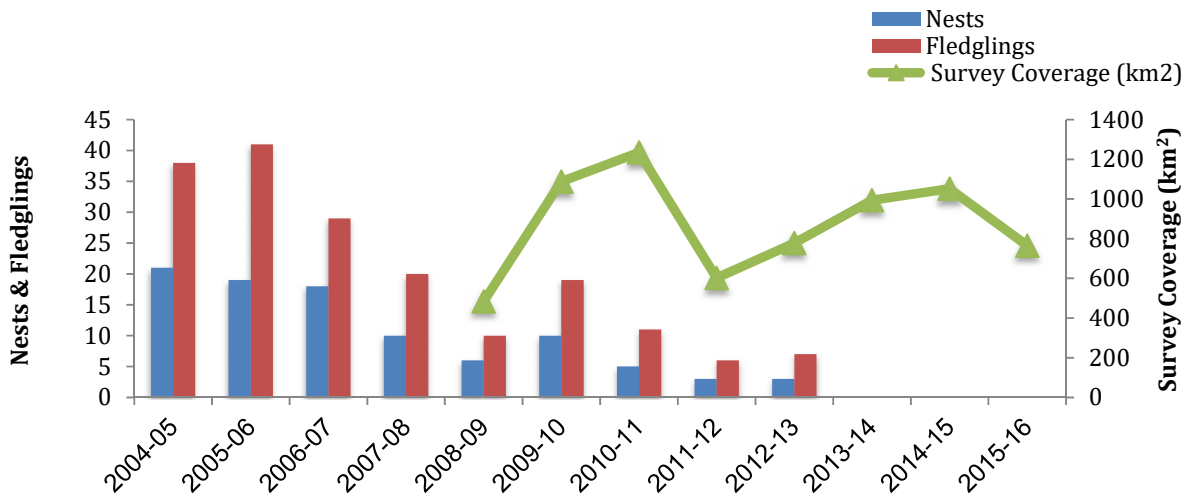


Figure 15. Total Numbers of Greater Adjutant Nests & Fledglings in The Northern Plains (KPWS only). 2004 – 2016.

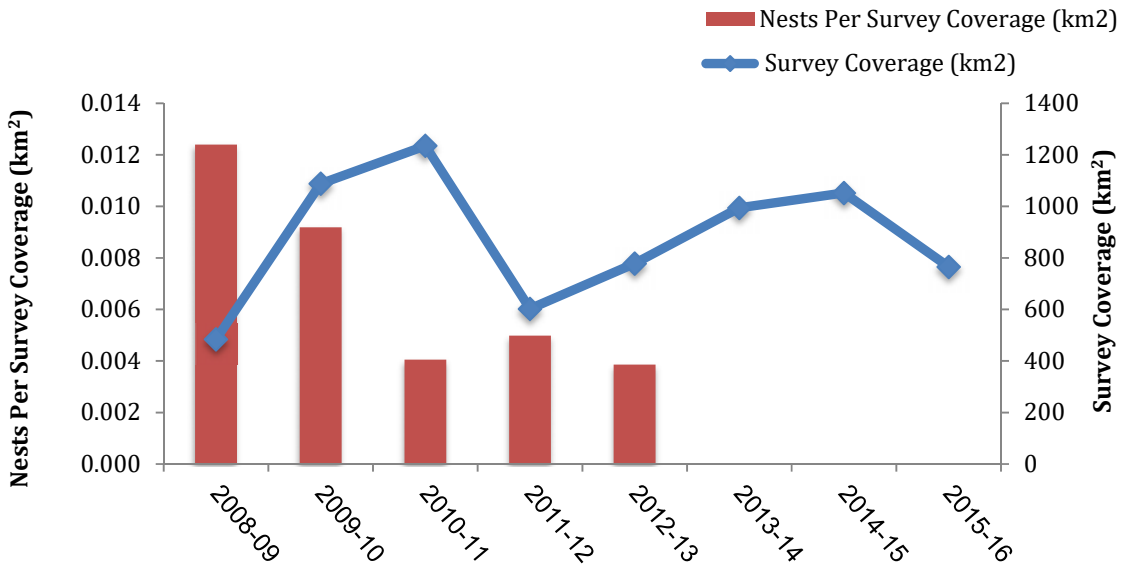


Figure 16. Greater Adjutant Nests Located Per Survey Coverage in The Northern Plains (KPWS only). 2008 – 2016.

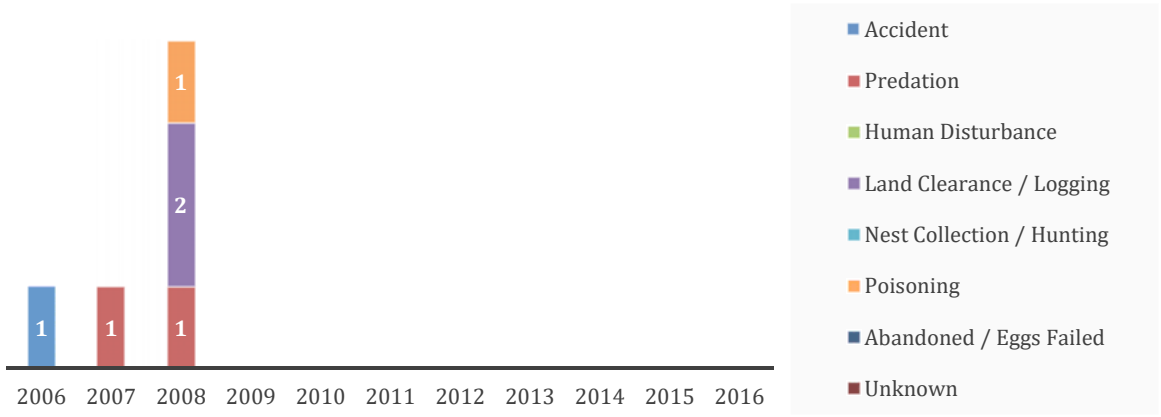
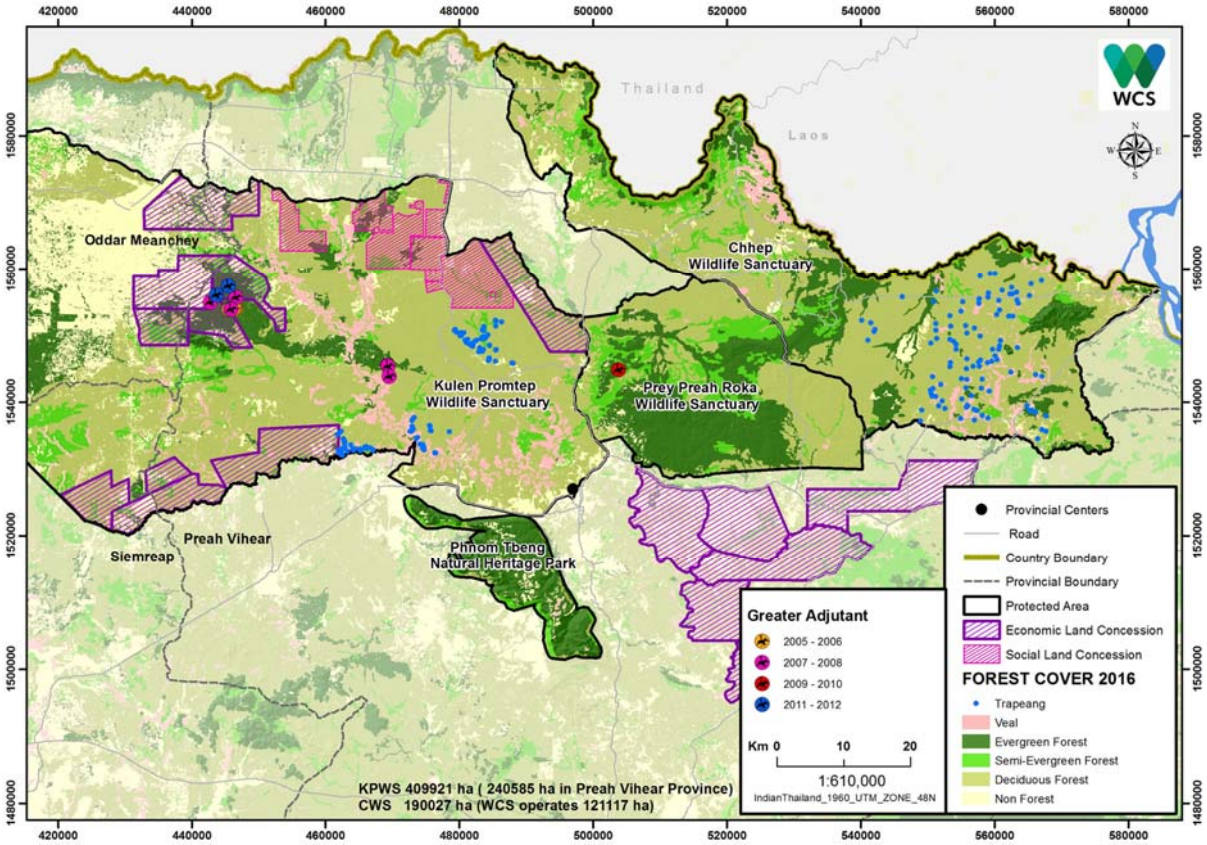


Figure 17. Causes of Nest Failure as a Proportion of Total Number of Greater Adjutant Nests. 2006 – 2016.



Map 6. Distribution of Greater Adjutant nests in the Northern Plains. 2005 - 2012

3.3.5 Sarus Crane *Antigone antigone*

This large non-migratory crane stands at up to 180cm tall. It is suspected to be suffering continued rapid population decline with an upper estimated global population of 15,000 mature birds. Population decline is thought to be the result of widespread degradation and destruction of wetland habitats, human exploitation and from the effects of wetland pollution. It is consequently listed as Globally Vulnerable on the IUCN Red List. In the Northern Plains, Sarus Cranes prefer open DDF forest associated with seasonally flooded grasslands and *trapeangs*. It is an omnivorous species, feeding on a variety of roots and tubers as well as invertebrates and amphibians. Ground nesting, the Sarus Crane builds a nest of twigs and dry grass in open flooded grassland.

Nesting trend in the Northern Plains

Sarus crane nest numbers rose from 2002 until 2008, after which nest numbers declined in 2009 before stabilising (Figure 17). Relative to survey coverage, there was a reduction in nests located in 2016 (Figure 18).

Sarus Cranes nest on the ground in flooded grassland or *trapeangs* within the flooded grassland. This species begins nesting as early as May at roughly the same time as Giant Ibis, with a peak nesting period in July (Table 2). From 2009-2016 Sarus Crane showed greater variation in the period they started nesting, compared to 2002-2009 (Tables 3, 4 and 5). This may be due to increased human use of grasslands, causing disturbance to nesting patterns. It may also be in response to more variable weather, as nest building is triggered by the onset of the rains, and nest failures caused by excessive rainfall may trigger a second breeding attempt. However, historic local weather data is not available to investigate this relationship further. Map 7 shows how Sarus Crane nests are now distributed across a more confined area, reflecting reduced habitat availability.

Sarus Crane nests are vulnerable to a number of causes of nest failure (Figure 19). “Accidental” causes of nest failure in this species equate to flooding of the nest. Sarus Cranes nests are situated on the ground in flooded grasslands to limit predation events. Unseasonal rains can cause nests to be flooded and eggs to fail, whilst unseasonal drought can leave nests exposed to terrestrial and air born predation, making Sarus Cranes particularly sensitive to climate change. Most predation events were by domestic dogs. Their ground dwelling situation, and high market value, also make them prone to

egg and chick collection which has remained a threat despite nest protection (Figure 19); 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 (Clements *et al*. 2013). Their preferred habitat in flooded *viels* is most threatened by conversion to rice paddy. The timing of *viel* clearance for paddy does not typically coincide with nesting, and is therefore underrepresented, as nest guardians are absent at this time of year.

Conservation recommendations include greater monitoring of *viels* by participatory land use planning teams, increased patrolling effort in *viels*, greater enforcement of the protected area law where there is illegal land conversion of *viels*, continuation of the Bird Nest Protection Programme, and control of dogs in the protected area. The latter is a contentious issue, which can be helped by the zonation process for protected areas, where more stringent control of domestic dogs could be exercised in Conservation and Core Zones. The expansion of the Wildlife-Friendly Ibis Rice scheme across a greater proportion of rice farmers would increase the overall level of compliance with land-use law inside the Protected Areas.

Sarus Crane chicks are precocial – capable of moving around on their own after hatching – and require no further protection after this point. As a result, nests are not protected for as long as an altricial species such as Lesser Adjutant. Thus, different nest protection regimes are reflected in different associated nest protection costs.

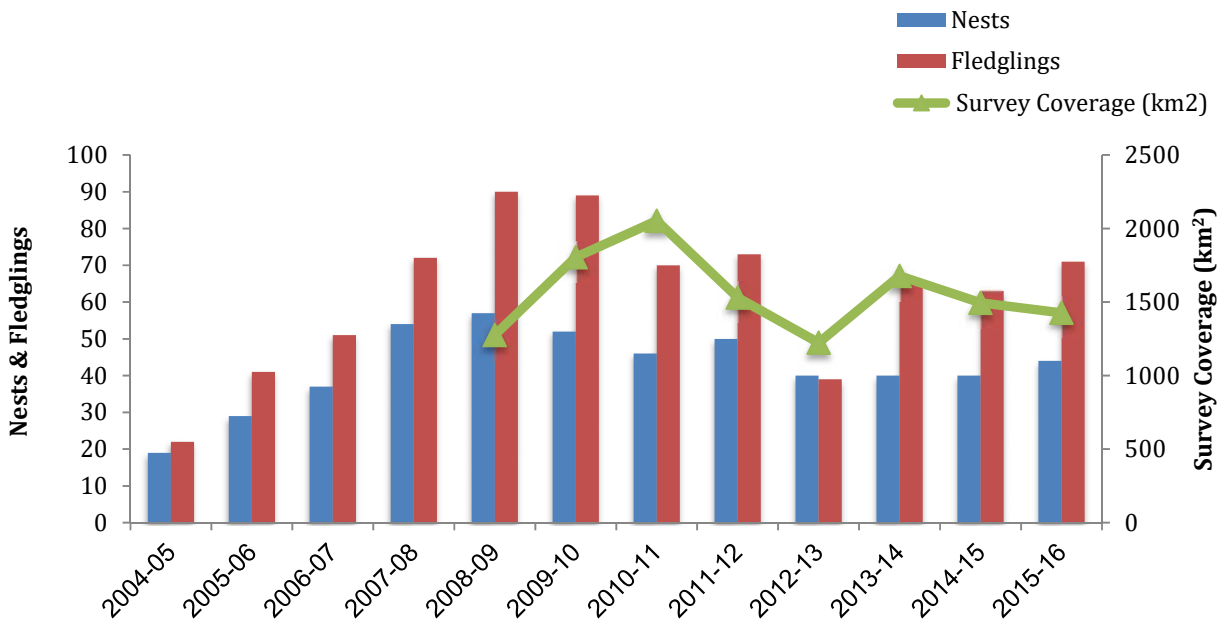


Figure 18. Total Numbers of Sarus Crane Nests & Fledglings in The Northern Plains 2003 – 2016.

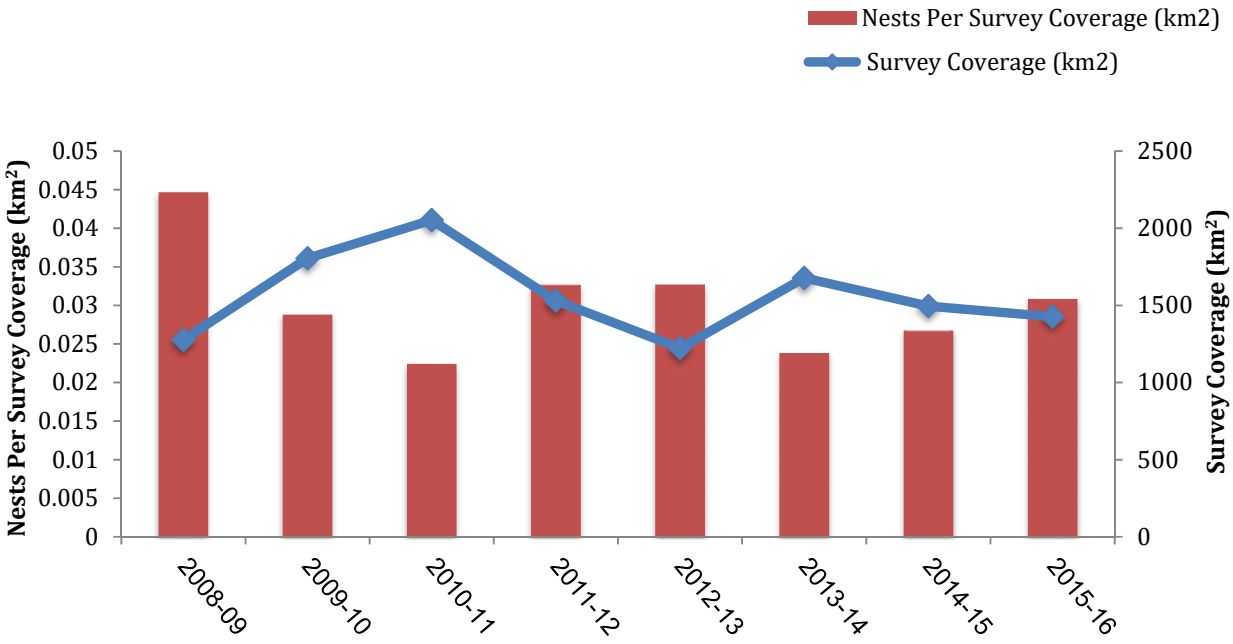


Figure 19. Sarus Crane Nests Located Per Survey Coverage in The Northern Plains 2008 – 2016.

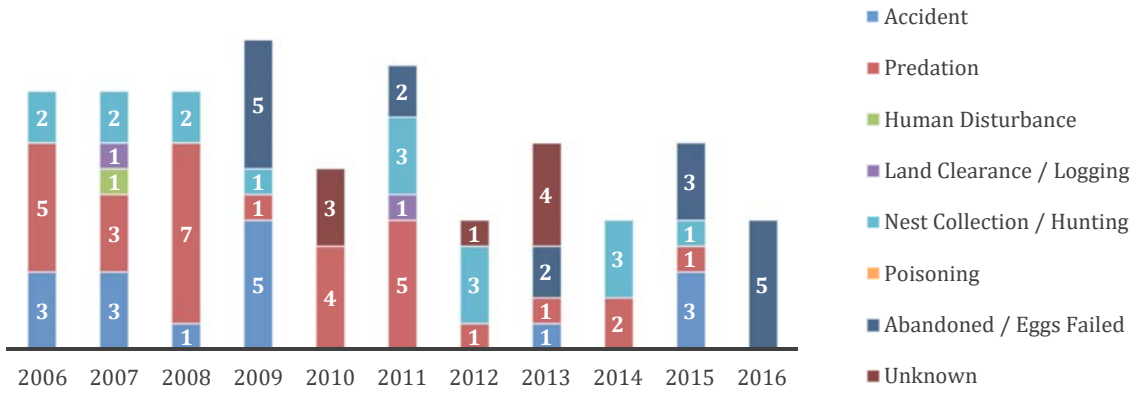
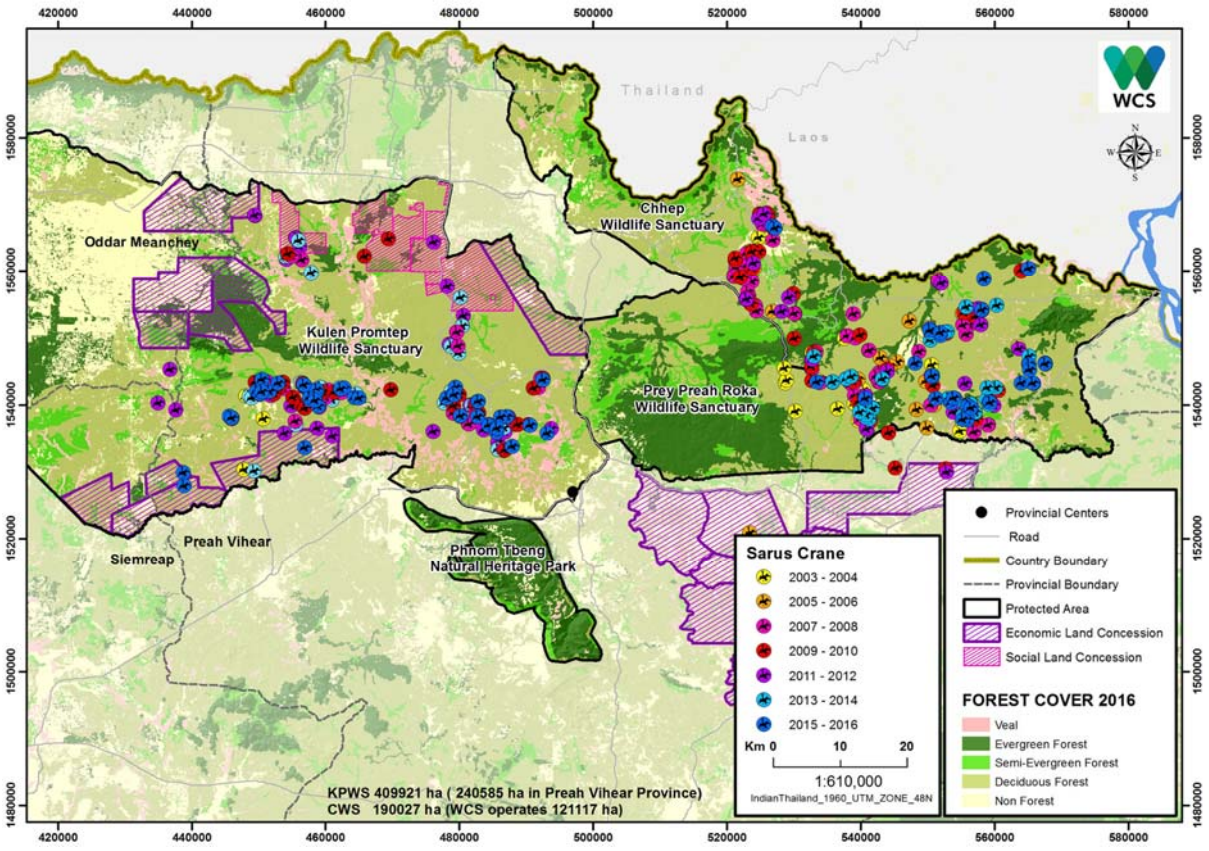


Figure 20. Causes of Nest Failure as a Proportion of Total Number of Sarus Crane Nests. 2006 – 2016.



Map 7. Distribution of Sarus Crane nests in the Northern Plains. 2003 - 2016

3.3.6 Black-necked Stork *Ephippiorhynchus asiaticus*

The Black-necked Stork is a large stork reaching 150cm in height with a wingspan of 230cm. A species existing at low densities across an expansive range, it has experienced moderately rapid population decline. The upper estimate of its global population is 21,000 mature individuals, and in Southeast Asia, its range has contracted widely. It is therefore classified as Near Threatened on the IUCN Red List. A wetland bird, often seen in flocks, it inhabits the open DDF forests of the Northern Plains and will forage at *trapeangs* and amongst flooded grasslands, in shallow water where it will feed on fish, reptiles and frogs, waterfowl, turtle eggs, crabs, molluscs, insects and other arthropods. It is a territorial breeder and nests in mature trees. It is a very scarce breeder throughout Cambodia.

Nesting trend in the Northern Plains

Black-necked Stork nest numbers have remained at a very low density, with 1-3 nests located per year since 2005. As a result of this low variation in number of nests found, nests located per survey area are mostly consistent with the level of survey coverage. Black-necked Stork typically begins nesting at the end of the wet season in October (Table 3), with a peak-nesting time in November (Table 2). Eggs usually hatch in January (Table 4) with chicks fledging soon after in the peak of the dry season (Table 5). Their nesting behaviour overlaps with White-shouldered Ibis and the two vulture species that nest in the Northern Plains. Black-necked Stork typically build large nests in the tops of *Trach* and *Tbeng* trees in DDF (Table 6), with a typical clutch size of 3 chicks per nest.

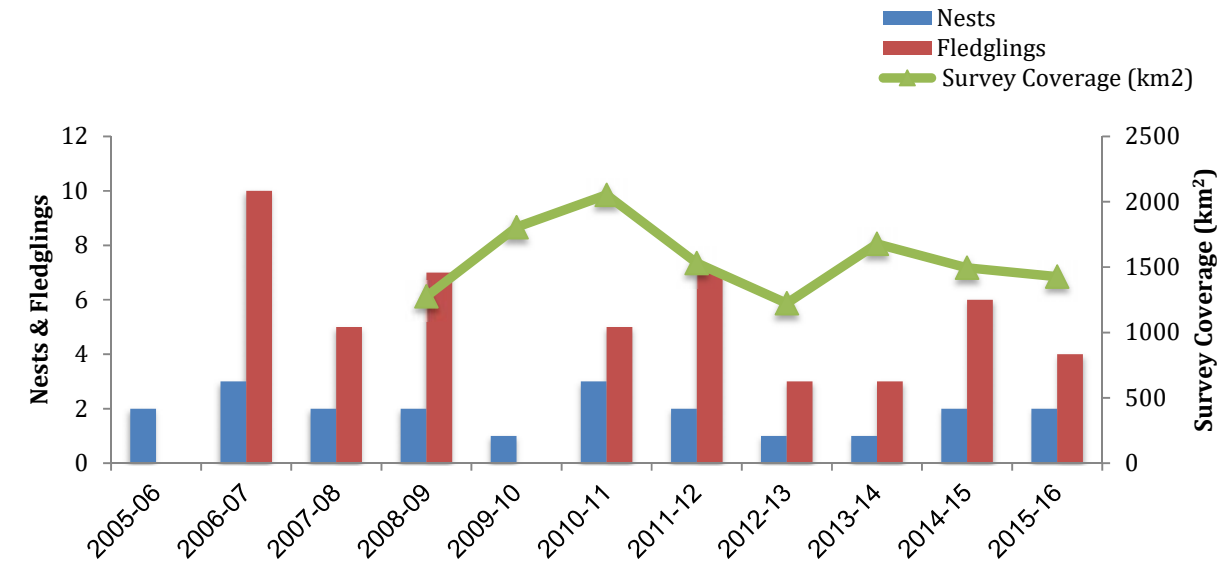


Figure 21. Total Numbers of Black-necked Stork Nests & Fledglings in The Northern Plains. 2005 – 2016.

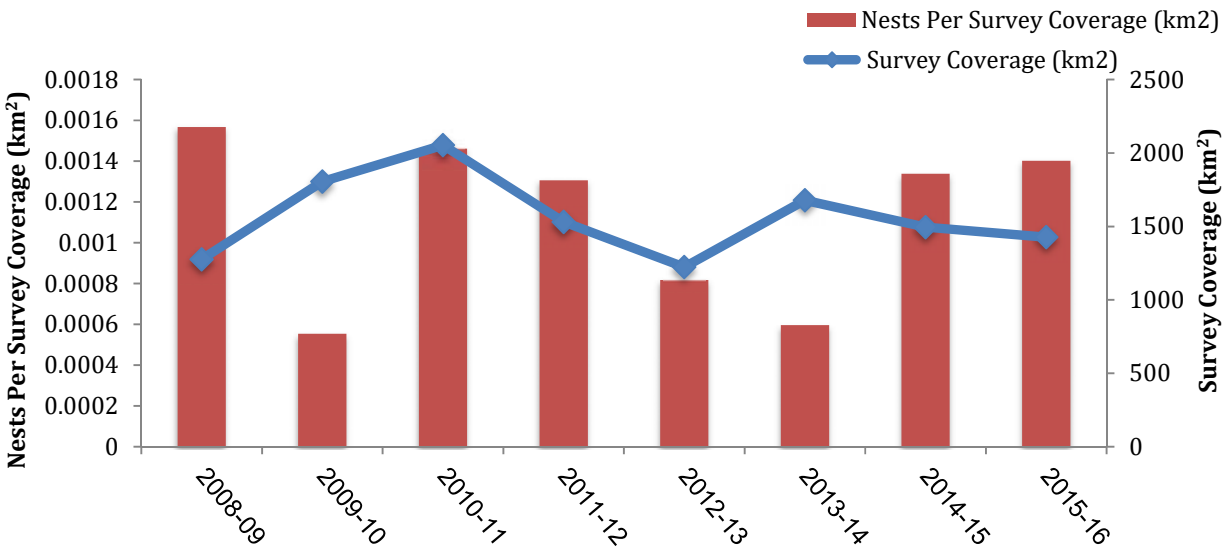


Figure 22. Black-necked Stork Nests Located Per Survey Coverage in The Northern Plains. 2008 – 2016.

3.3.7 Oriental Darter *Anhinga melanogaster*

The Oriental Darter is a relatively large member of the Anhingidae, reaching 97cm. Its diet consists almost exclusively of fish, which are caught by diving from the surface of the water. Oriental Darters are found throughout the Indian Subcontinent and Southeast Asia.

The global population is estimated at a maximum of 22,000 mature individuals. Its population is undergoing a moderately rapid decline over most of its range. It is therefore classified as Near Threatened on the IUCN Red List.

Nesting trend in the Northern Plains

Oriental Darter nests were recorded in their highest numbers in 2010, but have since fallen by 95%. Overall reductions are attributed to successive years of colony raiding. Darters nested in KPWS in 2001-2 and 2002-3 and interviews conducted in 2001-2 suggested that the colony was around 34 nests, but all eggs or chicks were taken (as they had been for many years). In 2002-3, 13 nests were protected at one site, although all the nests at another site were robbed. Recolonization occurred in 2006-7, perhaps through immigration from the colonies at Prek Toal on the Tonle Sap, which increased from 235 pairs in 2001-2 to more than over 7,300 pairs by 2009, due to the success of a slightly different nest protection programme (Clements *et al*. 2013).

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 go some way to explain fluctuations in breeding success between years. In 2013, there was another significant nest raiding incident (Figure 25), after which darters were not recorded nesting again until 2016, due to a lack of surveying in 2014 and 15. During this period, darters were excluded from the scheme as they were no longer deemed nationally threatened enough to warrant costly nest protection. This resulted in the wholesale egg collection that all but decimated darter nesting colonies in these nesting seasons. Surveys conducted in 2016 confirmed the presence of habitat suitable for nesting darters, but revealed remnant colonies that represent a 95% reduction on previous fledgling numbers. These results demonstrate how quickly large-scale egg collection resumes in the absence of nest protection.

In the Northern Plains, darters typically commence nesting in August (Table 3), with a peak nesting period in September (Table 2) and chicks usually fledge in November (Table 5). Oriental Darters nest colonially, building nest platforms in emergent shrubs and trees in flooded riparian DDF along the banks of the *Stung Sen* in KPWS (Table 6), as a result their nesting behaviour is driven by climatic patterns and flooding events and their easily

accessible nests (by boat) make for easy pickings to an egg collector. Records of nest failure for this species attribute the vast majority of cases to human disturbance causing nesting colonies to be abandoned and subsequent egg failure. A few incidences of nest failure were also attributed to opportunistic predation by crows (Table 7), also linked to disturbance.

If the remnant colony in KPWS is to survive, it is recommended that the Nest Protection Programme is reinstated as a priority for this species. Recent surveys confirmed that suitable riparian nesting habitat persists and that this species should be able to recover in the Northern Plains. Additional conservation management for this species should focus on combatting illegal fishing practices that threaten fish stocks, and increased riverine patrols focussed on nesting locations. It is recommended that the zonation of KPWS should result in management recommendations for protecting flooded riparian habitat.

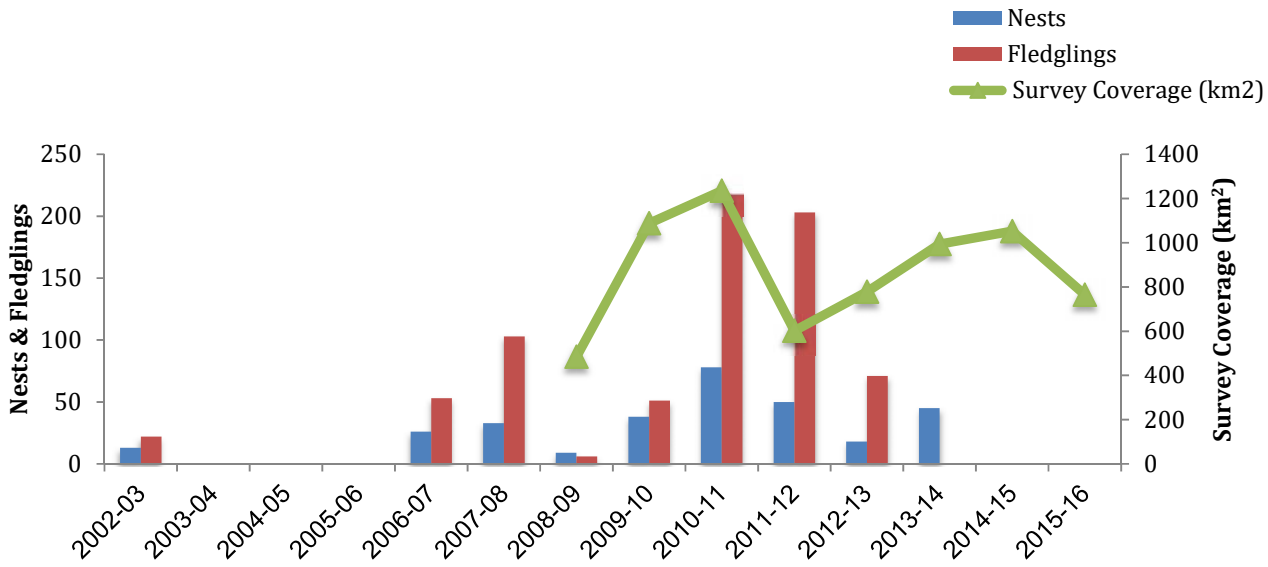


Figure 23. Total Numbers of Oriental Darter Nests & Fledglings in The Northern Plains (KPWS only). 2002 – 2016.

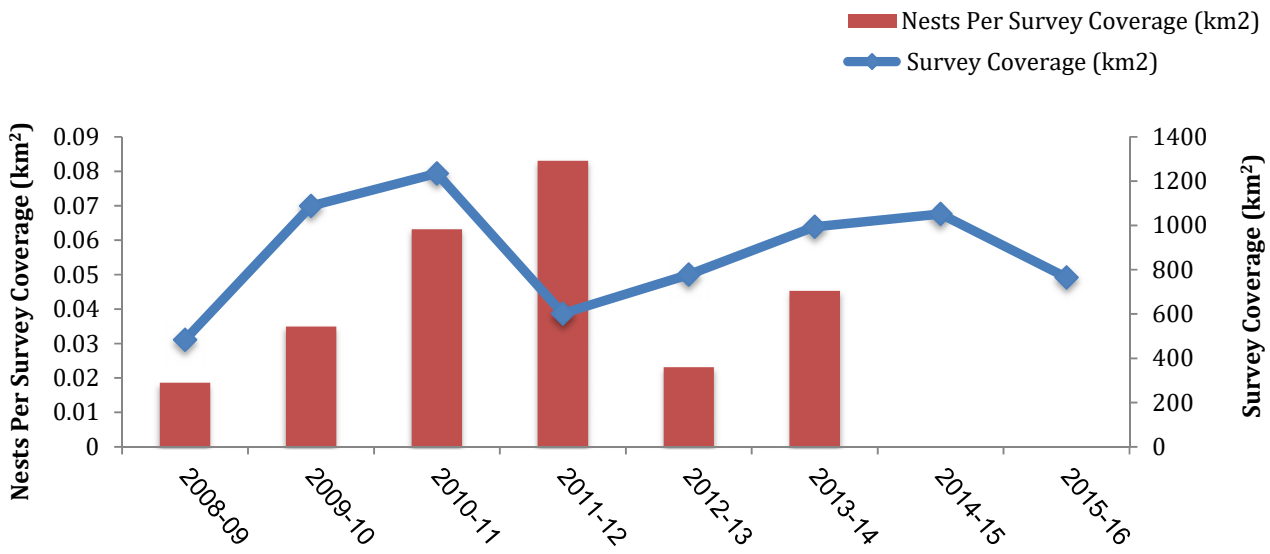


Figure 24. Oriental Darter Nests Located Per Survey Coverage in The Northern Plains (KPWS only). 2008 – 2016.

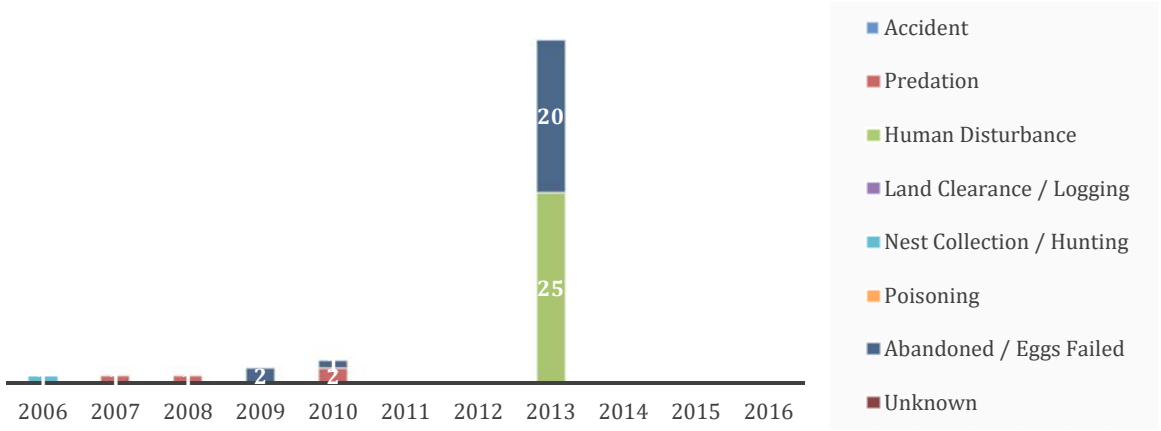


Figure 25. Causes of Nest Failure as a Proportion of Total Number of Sarus Crane Nests. 2006 – 2016.

3.3.8 Masked Finfoot *Heliopais personata*

Measuring up to 55 cm, the distinctive Masked Finfoot is an elusive species with a very small and rapidly declining population resulting from on-going habitat loss and degradation of riparian and riverine lowland forest. It has been classified on the IUCN Red List as Globally Endangered with an upper population estimate of 1,700 mature individuals spread thinly over a very large range. Cambodia is thought to support one of the most important

populations worldwide (Mulligan *et al.* 2013). The Masked Finfoot belongs to a very small family of tropical birds called the Heliornithidae, consisting of just three species, each allocated to their own genus and each on a different continent. Due to this level of evolutionary distinctiveness and its threatened status, the Masked Finfoot is ranked 45th on the EDGE bird list. Feeding on invertebrates, crustaceans such as shrimp, and small fish, it requires large areas of intact habitat and undertakes poorly understood seasonal movements.

Nesting trend in the Northern Plains

Masked Finfoot nests occur at very low densities and have only been recorded in two nesting seasons in the Northern Plains, between 2010 and 2013. Because of this, it is impossible to describe any meaningful trends in nesting numbers. Surveys in KPWS in 2016, recorded the presence of the species, but no nests or chicks were observed. In the Northern Plains, the Masked Finfoot is usually seen annually in small numbers. Records of chicks during 2013 indicate that it breeds successfully but only 4 nests have ever been found in KPWS. From 2009 until 2016, 145 records of Masked Finfoot (either directly observed, heard vocalisations or were caught on camera trap) in the Northern Plains. The nesting season begins in July and ends in October, when fledglings have been seen on the tributaries of the Stung Sen (Table 2). The Masked Finfoot prefers dense cover and undisturbed habitat, and nests consist of small platforms of twigs on trees overhanging rivers.

Threats are likely to include logging of nesting trees in semi-evergreen and evergreen riparian habitat, degradation of habitat, overfishing, accidental capture in fishing gear and poisoning by poison fishing.

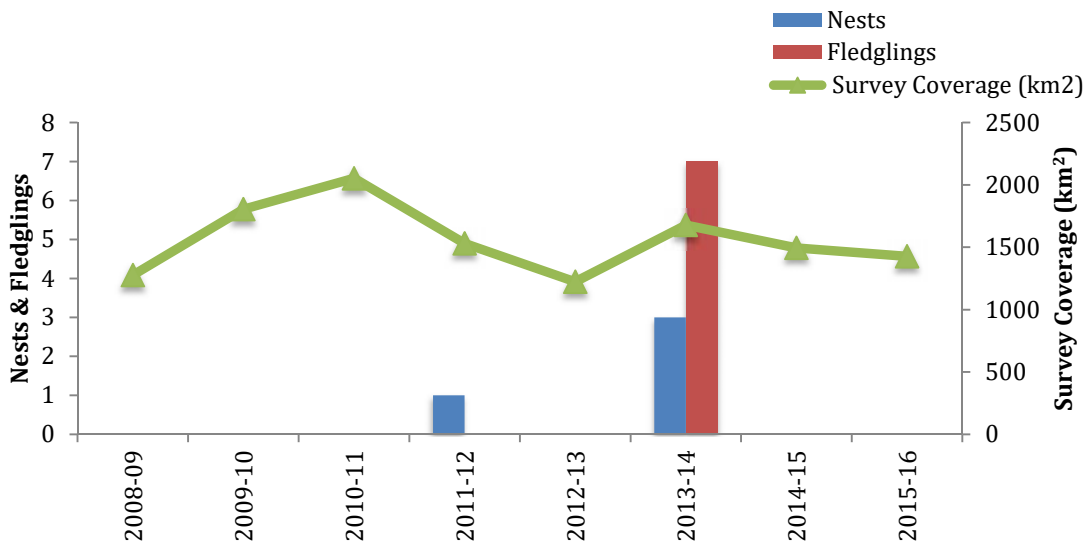


Figure 26. Total Numbers of Masked Finfoot Nests & Fledglings in the Northern Plains. 2008 – 2016.

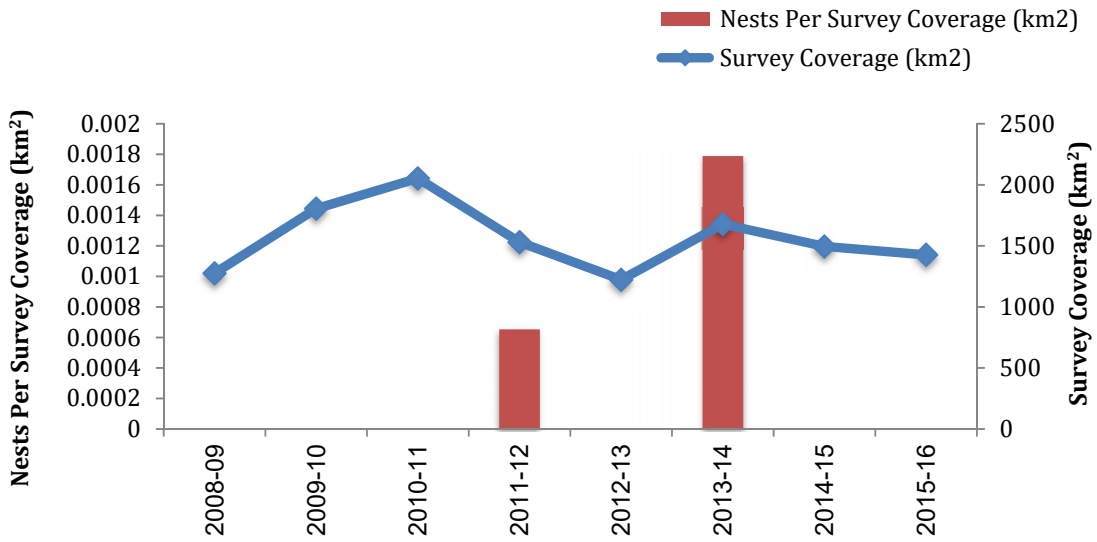
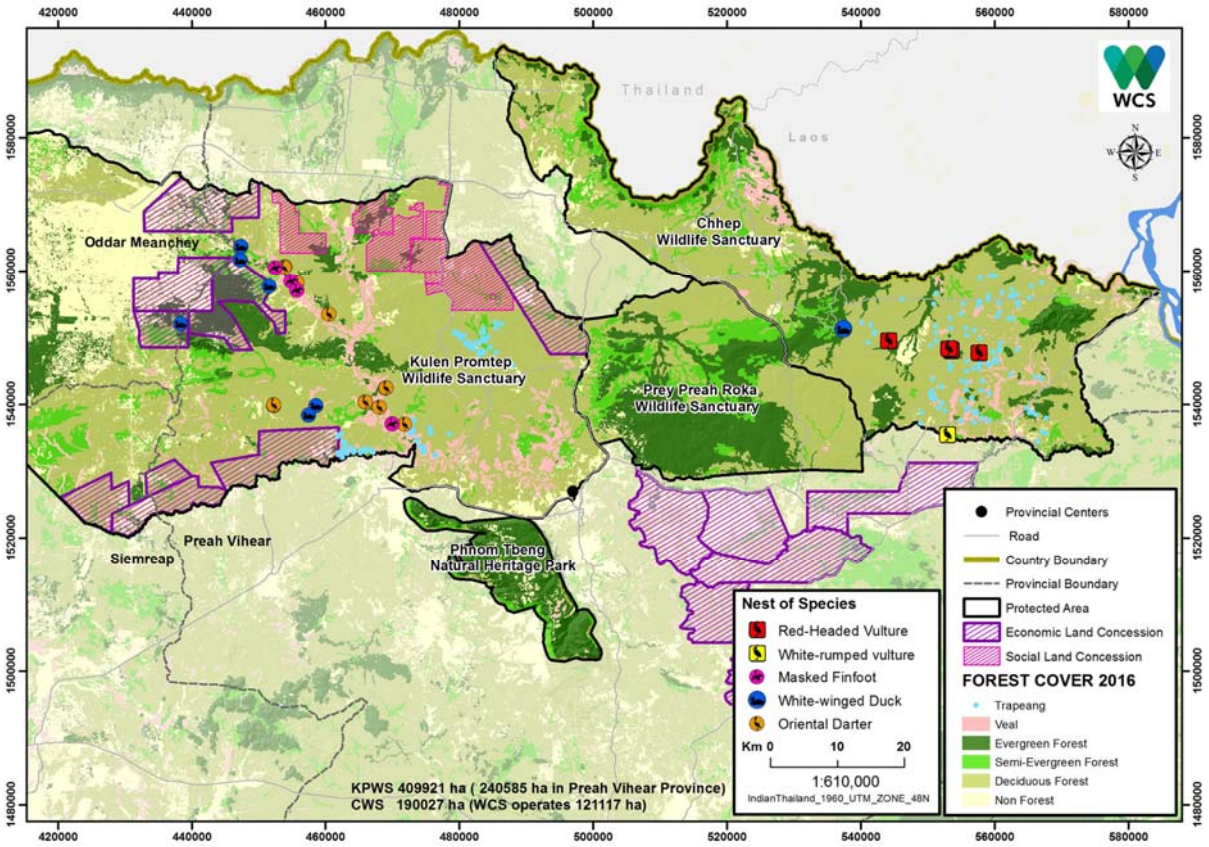


Figure 27. Masked Finfoot Nests Located Per Survey Coverage in The Northern Plains. 2008 – 2016.



Map 8. Distribution of Red-headed Vulture, White-rumped Vulture, Masked Finfoot, White-winged Duck and Oriental Darter nests in the Northern Plains. 2002 - 2016

3.3.9 White-winged Duck *Asarcornis scutulata*

A large, striking woodland species, measuring up to 80cm, the White-winged duck has an upper population estimate of 1,000 mature individuals. Its population is small and fragmented and is undergoing very rapid and continuing decline, as a result of the loss of undisturbed riverine habitats. It is therefore listed as Endangered on the IUCN Red List. It prefers slow flowing or stagnant water (including *trapeangs*) and prefers undisturbed evergreen or deciduous lowland riverine forest for its roosting and nesting sites, where it nests in tree hollows, high up in *Koki* and *Chhoeutiel* trees (Table 6).

Nesting trend in the Northern Plains

White-winged Duck nests are found at extremely low densities in the Northern Plains. A total of nine nests were located between 2006 and 2013, but none have been located since, despite concerted survey effort. Nesting commences in the late dry season (May) and chicks (up to seventeen) have been witnessed in September. Typically for Anatids, many chicks will fledge, but only a small percentage are likely to survive to adulthood, as a

high predation rate is expected. Threats are likely to include logging of tall nesting trees in riparian habitat, hunting (especially of birds at roost) and human disturbance.

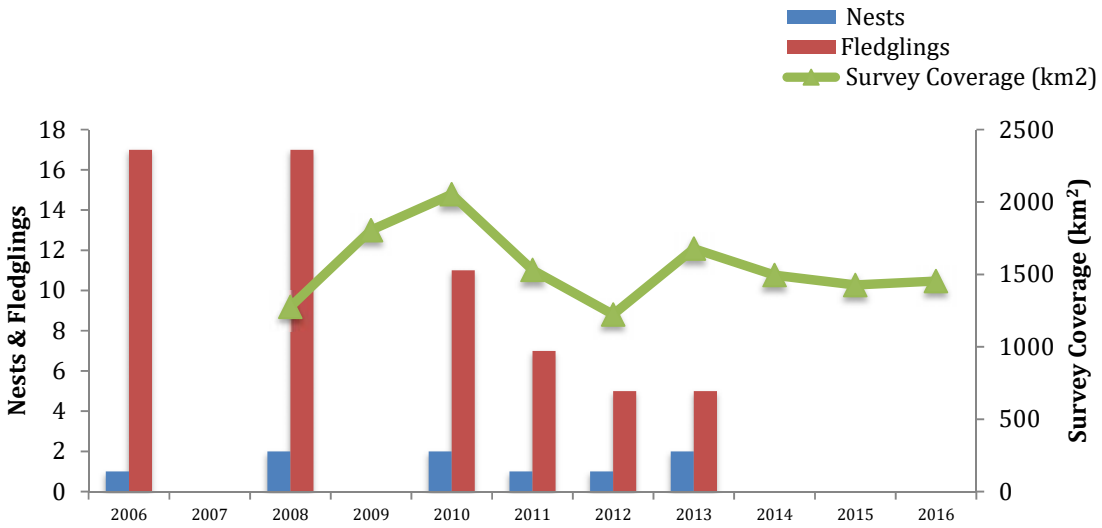


Figure 28. Total Numbers of White-winged Duck Nests & Fledglings in The Northern Plains. 2006 – 2016.

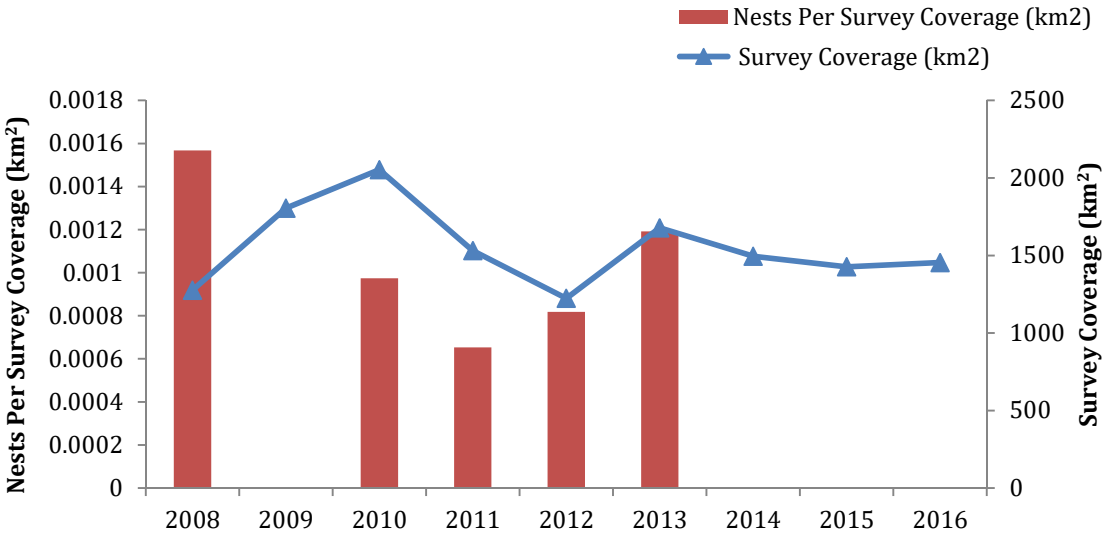


Figure 29. White-winged Duck Nests Located Per Survey Coverage in The Northern Plains. 2006 – 2016.

3.3.10 White-rumped Vulture *Gyps bengalensis*

The smallest of the Gyps vultures, the wingspan of the White-rumped Vulture can still reach over 2.5m. Between 1992 and 2007, White-rumped Vulture populations declined by 99.9% in India (Prakash *et al*. 2007). As a result of severe range contraction and massive population decline this species is classified as Critically Endangered on the IUCN Red List. Declines were caused by veterinary use of Diclofenac in cattle, which proved to be fatal when consumed by vultures. Diclofenac is not widely used in Cambodia, despite this, the species' range across Southeast Asia is now confined to populations in Cambodia and Myanmar due to historical persecution. Like most vultures their diet consists of carrion and they have been observed feeding on ungulate carcasses.

Nesting trend in the Northern Plains

Across the Northern Plains, White-rumped Vulture nests have only been located in CWS. Nests are found in very low densities with numbers remaining stable over the life of the programme. In 2011, no nests were located, however in 2012 a total of 7 nests were found, more than twice the typical annual average. In 2016, no nests were located. The White-rumped Vulture usually uses the same nest location year after year, making it easy to relocate nests. Therefore, when nests are not relocated, this raises particular concern as it suggests the breeding pair are no longer active. Birds start nesting in the early dry season (Table 3), with a peak nest season of November (Table 2), eggs hatch in January (Table 4) and chicks typically fledge by March or April (Table 5). White-rumped Vultures nest in small loose colonies, laying a single egg per nest. In the Northern Plains, White-rumped Vultures nest high in tall *Chhoeutiel* trees in DDF or semi-evergreen forest (Table 6). Since 2012, 100% of White-rumped Vulture chicks have fledged in the Northern Plains (Figure 28).

Although the reduction in range across Southeast Asia was probably caused by the collapse of ungulate populations coupled with persecution, perhaps the greatest current threat to vultures in the Northern Plains is untargeted poisoning (Loveridge *et al.* in prep.). This is usually done as an easy way of sourcing food for human consumption or to control stray dogs. To combat the treat of poisoning, it is recommended that community outreach and awareness raising activities are conducted to educate local people of the risks poisoning poses to themselves and the environment. Other threats to this species include the logging of tall nesting trees. The Bird Nest Protection Programme has been successful

in protecting all of the nesting trees that this species has used in the Northern Plains. The annual re-use of the same nesting trees makes it easier to control this threat. The main nesting site in the Northern Plains was near a village and the nesting trees are used for resin collection. The Nest Protection Programme has been successful in reducing human disturbance around this site, including ceasing resin collection during the breeding season. Law enforcement patrols and monitoring of participatory land use planning agreements should continue in nesting areas, especially when nest guardians are absent. Wildlife-Friendly Ibis Rice is an effective way of adding an extra level of land-use compliance in habit used by this species. Baffles attached to the base of nesting trees prevent terrestrial predators such as civets and martins from reaching eggs, and the use of this simple and cost effective measure should continue. The use of 'vulture restaurants' should continue to supplements the food shortage caused by reduced numbers of wild and domestic ungulates and because they facilitate population monitoring.

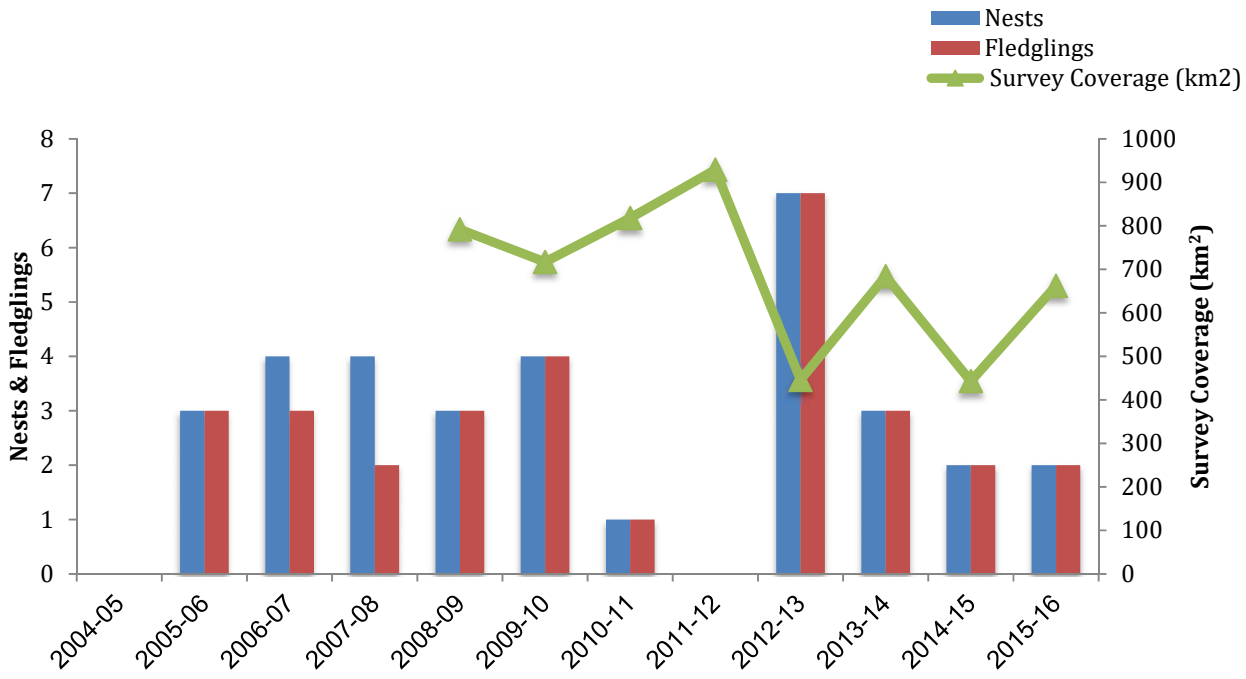


Figure 30. Total Numbers of White-rumped Vulture Nests & Fledglings in The Northern Plains (CWS only). 2002 – 2016.

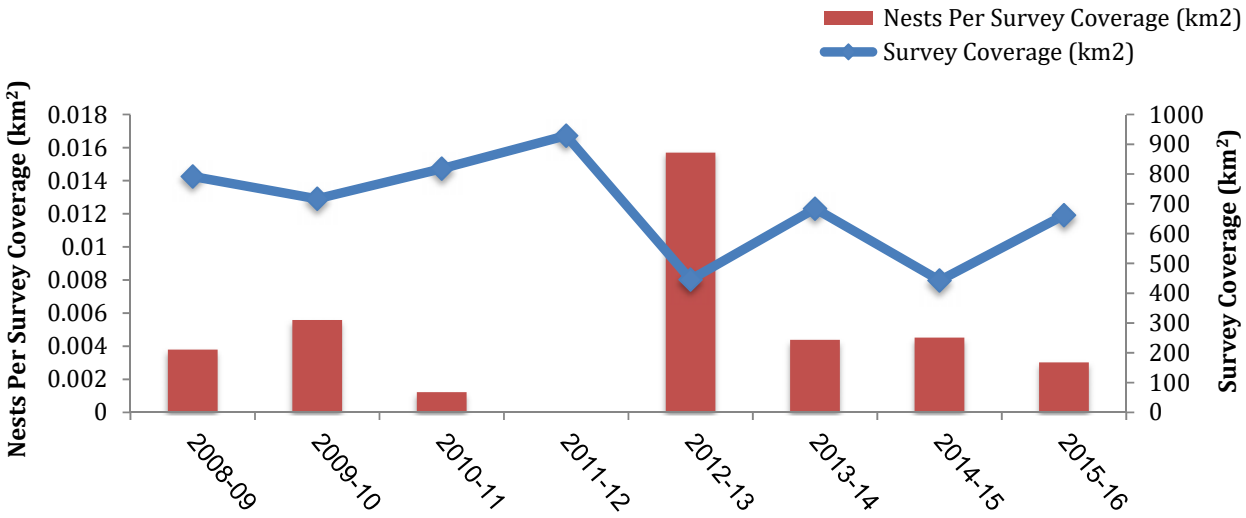


Figure 31. White-rumped Vulture Nests Located Per Survey Coverage in The Northern Plains (CWS only) 2008 – 2016.

3.3.11 Red-headed Vulture *Sarcogyps calvus*

This medium sized vulture is unmistakable with its bald red head. Unlike the White-rumped Vulture, which is more social, the Red-headed Vulture is usually found alone or in pairs. Like most vultures their diet consists of carrion and they have been observed feeding on the carcasses of large ungulates. However, the diet of the Red-headed Vulture is perhaps more varied than the other vulture species in Cambodia, and they will opportunistically feed on carcases of birds, turtles and fish.

Globally, the species has experienced a dramatic decline in both population size and distribution. In South Asia, it has been estimated that the population decreased by over 90% in just 10 years (Cuthbert *et al*. 2006). This decline has been primarily blamed on the use of the drug Diclofenac by veterinarians. In Southeast Asia Diclofenac use is not widespread, and yet the range of this species is now restricted to Myanmar and Cambodia as a result of collapses in ungulate populations and poisoning. As a result of its severely diminished population and contracted range, the Red-headed Vulture is classified as Critically Endangered on the IUCN Red List. Due to its threatened status and evolutionary distinctiveness, the Red-headed Vulture is ranked 27th on the EDGE list of Evolutionary Distinct and Globally Endangered birds.

Nesting trend in the Northern Plains

Similarly, to the White-rumped Vulture, Red-headed Vulture nests are only found in CWS. Nests are found in extremely low densities and appear to have remained constant over the life of the programme. The first nest was found in 2006, and in a good year perhaps two nests may be located. In some years no nests are located, but this is unsurprising when nests exist at such low densities.

The nesting season of the Red-headed Vulture matches that of the White-rumped Vulture with both species nesting in the dry season (Table 2) with chicks taking slightly longer to fledge on average than the previous species (Table 5). The Red-headed Vulture tends to be territorial, often using the same nest location year after year. The Red-headed Vulture prefers to nest in DDF, but nests have also been found in semi-evergreen habitat. They are solitary nesters and tend to select smaller species of trees than the White-rumped Vulture. They have been recorded nesting in Trach, Tbeng and Koki and their nests are often associated with large tangles of parasitic plants growing at the top of these trees (Table 6), presumably providing additional stability to the nest structure.

The Red-headed Vulture is susceptible to the same threats as the White-rumped Vulture, therefore the same conservation recommendations are suggested.

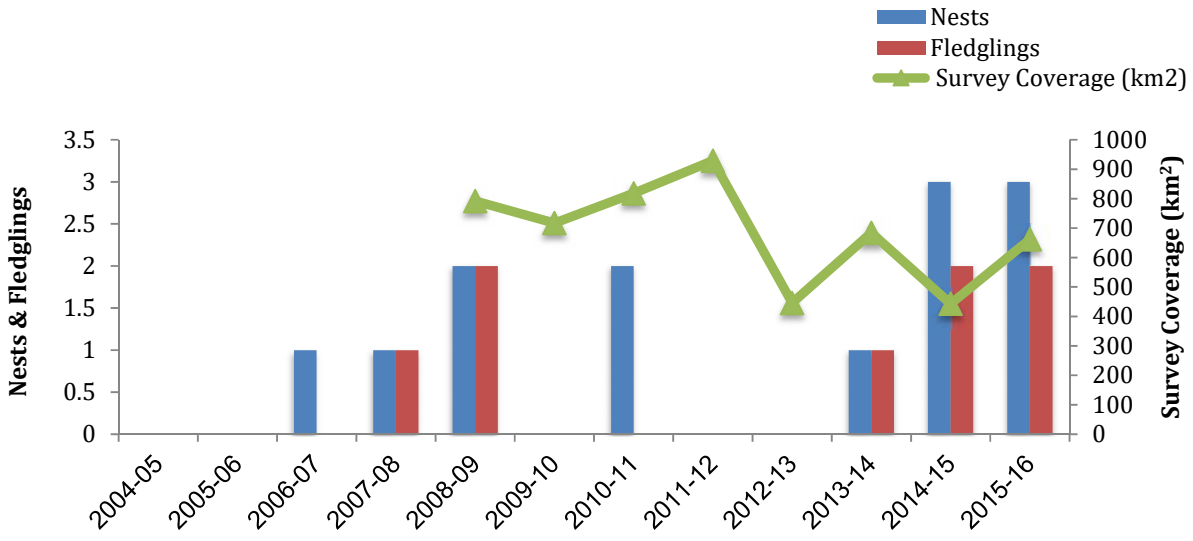


Figure 32. Total Numbers of Red-headed Vulture Nests & Fledglings in The Northern Plains. 2002 – 2016.

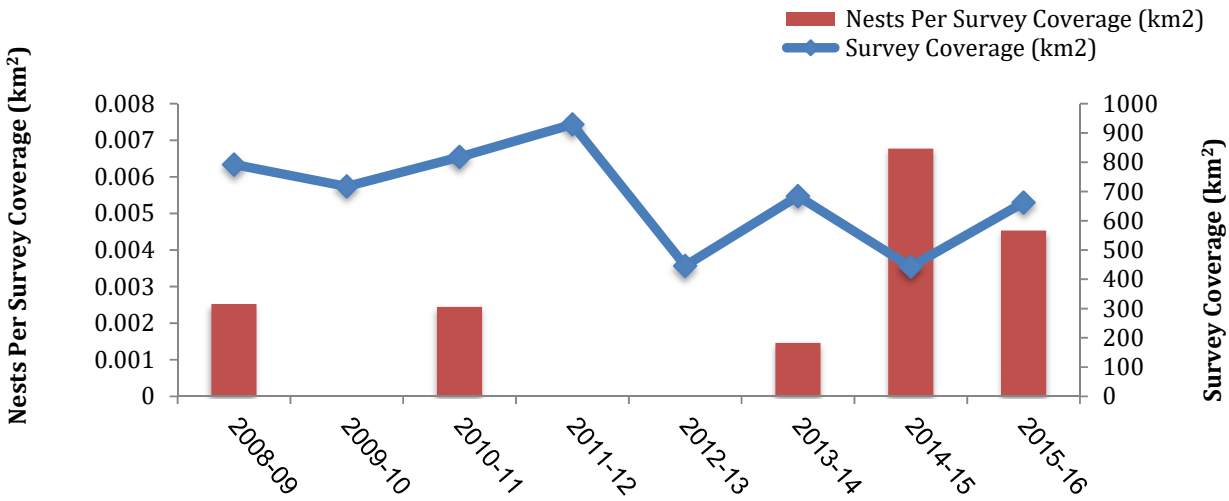


Figure 33. Red-headed Vulture Nests Located Per Survey Coverage in The Northern Plains. 2008 – 2016.

Other Notable Bird Species

3.3.12 Slender-billed Vulture *Gyps tenuirostris*

The third resident vulture of Cambodia, the Slender-billed Vulture has also experienced the same declines in population and range, and is also listed as Critically Endangered on the IUCN Red List. Although recorded on a monthly basis at "vulture restaurants" in CWS, no nests of this species have ever been located in the Northern Plains. Vulnerable to the same threats as the White-rumped Vulture, the same conservation recommendations are advocated.

3.3.13 Asian Woolly-necked Stork *Ciconia episcopus*

A medium-sized stork measuring up to 90cm tall, this wading Ciconiid forages for amphibians, reptiles, molluscs, crustaceans and other invertebrates in seasonally flooded *viels*, *trapeangs* and amongst riparian habitat. In the Northern Plains it is usually solitary, or seen in pairs. It is listed as Vulnerable on the IUCN Red List because of suspected undergoing rapid population decline owing mainly to habitat degradation and hunting (including nest collection). This species is not currently protected under the Nest Protection Programme, but its future inclusion should be considered due to its sensitivity to threat and globally declining population trend.

3.3.14 Grey-headed Fish Eagle *Ichthyophaga icthyaetus*

This stocky fish-eating raptor with a wing-span reaching 170cm is a monotypic species in the genus *Ichthyophaga*. Due to its specialist diet, it is closely associated with freshwater wetlands. Their large nests near the tops of very tall trees are frequently observed in the Northern Plains, especially along the banks of rivers. The Grey-headed Fish Eagle is a Near Threatened species that is scarce through Southeast Asia and the Indian Subcontinent. Considered rare in Cambodia, it is not uncommon in the Northern Plains. Threats to this species include loss of suitable wetland habitat, deforestation, over-fishing, siltation, persecution, human disturbance and pollution. The inclusion of the Grey-headed Fish Eagle in the Nest Protection Programme is recommended due to its sensitivity to these threats, globally declining numbers and what appears to be a healthy population in the Northern Plains. In addition to inclusion in the Nest Protection Programme, conservation recommendations include the control of illegal fishing techniques and increased patrols around known nesting locations.

3.4 Threats

The recorded cases of breeding failure for 10 species between 2006 and 2016 are shown in Annex 1. From 2006 until 2009 natural predation by crows, civets and other carnivores was the greatest cause of nest failure, accounting for 23 incidences, and more than 100 nests. This is in line with other long-term studies in the Northern Plains (Keo 2008). Although the use of predator exclusion belts has been demonstrated to reduce ground-based predation, civets and Yellow-throated Marten are often able to climb adjacent trees and cross into nesting trees. Ground nesting Sarus Cranes are particularly vulnerable to predation by Asiatic Jackal, monitor lizards, wild pigs and domestic dogs.

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 during high winds. Human disturbance, such as collection of NTFPs, land clearance or tree cutting, accounted for 10 cases (17 nests) whilst 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 (of a parent bird) and one of predation by domestic dog were recorded.

Since 2009 the threat from predation and accidental loss has remained high, but the threat from land clearance and human disturbance has increased with peaks in 2013 and 2014 where a combined total of 53 recorded nest failures were causes by human disturbance and abandonment of nests (as a result of human disturbance). The vast majority of these cases were caused by disturbance to Oriental Darter nest colonies.

Incidences of logging are underreported as a cause of nest failure data because logging will usually take place when nest protectors are not guarding nests, i.e. not during the breeding season. As a recommendation, it is suggested that law enforcement activities focus on priority nesting areas when it is not the nesting season.

Because the rate of nest failure will be relative to the number of nests, nest failure per total number of nests was calculated (Figure 34). This highlights peaks in nest failure in 2013 and 14 caused by high incidences of predation, land clearance, logging and human disturbance leading to nest abandonment (Annex 1).

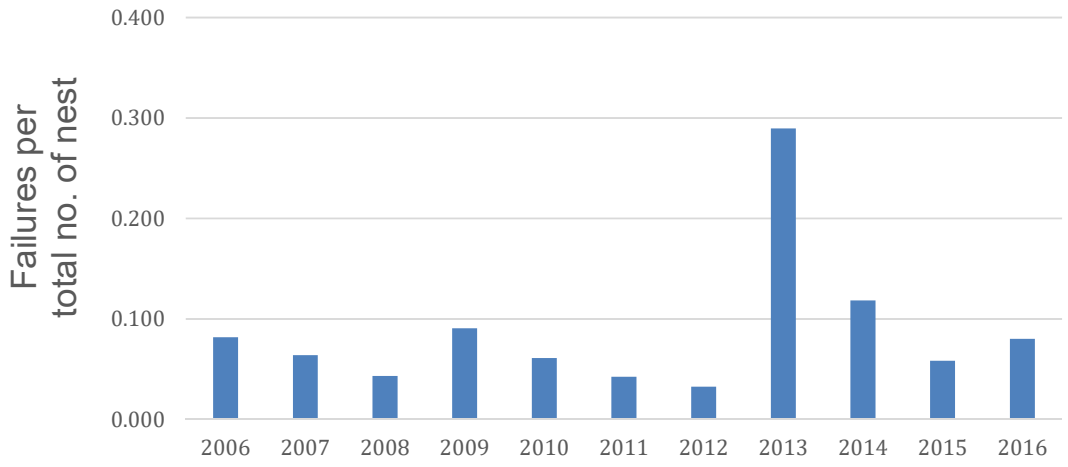


Figure 34. Incidences of Nest Failure Per Total Number of Nests

Table 7. Forest Cover Change in Cambodia 2010 – 2014. Adapted from Cambodia Forest Cover 2014, Forestry Administration, 2016.

Forest type	2010 (ha)*	2014 (ha)*	% Total Change	% Mean Annual Change
Evergreen forest	3499185	2973903	-15.01	-3.75
Semi-evergreen forest	1274789	1108320	-13.06	-3.26
Deciduous forest	4481214	3480532	-22.33	-5.58
Other forest [τ]	1108600	1422409	28.31	7.08
Total forest	10363788	8985164	-13.3	-3.33
Total non-forest	7796885	9175510	17.68	4.42

* Source: Cambodia Forest Cover 2014, Forestry Administration, 2016.
[τ] Includes agro-forestry cover

3.5 Land Clearance

From 2002 – 2008 national deforestation rates were < 0.5% (Forestry Administration 2008). From 2010 – 2016 national deforestation rates for deciduous forest in Cambodia were > 5% annually (Table 7). This increase has been driven by a variety of processes including population growth, smallholder encroachment both by landless immigrants and established communities but primarily by Social and Economic Land Concessions. 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 politically discouraged. Many plots are claimed but not cleared, forcing new farmers in need of land for cultivation to move further into the forest (An 2008).

Between 2008 and 2016, the population in the Northern Plains rose by 27% to almost 31,000 people (Table 9). This increase in population was a direct result of nationwide government initiatives, notably the issuing of 1.5 million hectares of Economic and Social Land Concessions between 2010 and 2014, including within protected areas, and the granting of individual land titles from 2013-14. These initiatives caused massive in-migration of people to the Northern Plains of Cambodia. Unsurprisingly, the rate of forest loss across Cambodia rose spectacularly between 2010 and 2014; with more than 22% of Cambodia's deciduous forest being cleared during this period (Forestry Administration 2016). The predominant habitat type in Preah Vihear Province is deciduous forest.

Table 8. Nest protection costs: 2002 - 2016.

	2005			2006			2007			2008			2009			2010		
	KPWS	CWS	Total	KPWS	CWS	Total	KPWS	CWS	Total	KPWS	CWS	Total	KPWS	CWS	Total	KPWS	CWS	Total
Local Payments ($)	7362	11545	18906	9646	6886	16532	12684	8200	20884	14544	10545	25089	17707	13933	31640	18739	13123	31862
(%)	78	74	76	82	74	79	70	74	72	72	52	62	72	71	72	61	68	64
Nest Protection Payments ($)	5280	7521	12801	7346	4586	11932	7710	3226	10936	8352	4420	12772	10225	8797	19022	10238	5636	15874
Community Ranger Payments ($)	2082	4024	6105	2300	2300	4600	4974	4974	9948	6192	6125	12317	7482	5136	12618	8501	7487	15988
Associated Costs ($)	2082	4024	6105	2050	2392	4442	5367	2906	8273	5673	9731	15404	6956	5654	12610	11771	6293	18064
(%)	22	26	24	18	26	21	30	26	28	28	48	38	28	29	28	39	32	36
Total ($)	9444	15568	25012	11696	9278	20974	18051	11106	29157	20217	20276	40493	24663	19587	44250	30509	19416	49926
Nests Protected	144	76	220	146	210	356	174	241	415	160	204	362	206	219	425	97	219	316
Average Cost / Nest ($)	66	205	114	80	44	59	104	46	70	126	99	112	120	89	104	315	89	158
Number of Villages	8	7	15	8	13	21	7	15	22	9	13	22	8	18	26	10	14	24
Average payments / village ($)	920	1649	1260	1206	530	787	1812	547	949	1616	811	1140	2213	774	1217	1874	937	1328
Number of Community Ranger	ND	ND	ND	ND	ND	ND	ND	ND	ND	7	11	18	12	9	21	10	7	17
Average Payment / Ranger ($)	NA	NA	NA	NA	NA	NA	NA	NA	NA	885	557	684	624	571	601	850	1070	940
Number of nest protectors	52	36	88	59	55	114	67	60	127	59	41	100	89	67	156	88	55	143
Average payment / nest protector ($)	102	209	145	125	83	105	115	54	86	142	108	128	115	131	122	116	102	111

	2011			2012			2013			2014			2015			2016			Mean	
	KPWS	CWS	Total	KPWS	CWS	Total	KPWS	CWS	Total	KPWS	CWS	Total	KPWS	CWS	Total	KPWS	CWS	Total	2005-09	2010-16
Local Payments ($)	18828	16059	34887	10382	6802	17184	15552	11472	27024	19895	13910	33805	26447	19895	46341	21491	19931	41422	22610	33218
(%)	61	79	68	71	81	75	57	65	60	64	73	68	69	79	73	68	83	75	72	69
Nest Protection Payments ($)	9695	8558	18253	4060	3292	7352	6655	4620	11275	8518	6572	15090	10449	8509	18958	5159	7259	12418	13493	14174
Community Ranger Payments ($)	9133	7501	16634	6322	3510	9832	8897	6852	15749	11377	7338	18715	15998	11386	27384	16332	12672	29004	9118	19044
Associated Costs ($)	11863	4393	16400	4183	1640	5823	11873	6304	18177	11187	5040	16227	11950	5370	17320	10024	3992	14016	9367	15147
(%)	39	21	32	29	19	25	43	35	40	36	27	32	31	21	27	32	17	25	28	31
Total ($)	30691	20452	51287	14565	8442	23007	27425	17776	45201	31082	18950	50032	38397	25265	63661	31515	23923	55438	31977	48364
Nests Protected	184	216	400	118	158	279	134	204	360	125	149	277	96	66	160	105	56	161	356	279
Average Cost / Nest ($)	167	95	128	123	53	82	205	87	126	249	127	181	400	383	398	300	427	344	92	202
Number of Villages	10	11	21	8	10	18	5	11	16	7	11	18	8	14	22	10	6	16	21	19
Average payments / village ($)	1883	1460	1661	1298	680	955	3110	1043	1689	2842	1265	1878	3306	1421	2106	2149	3322	2589	1071	1744
Number of Community Ranger	10	7	17	3	5	8	13	9	22	7	5	12	7	6	13	8	6	14	20	15
Average Payment / Ranger ($)	913	1072	978	2107	702	1229	684	761	716	1625	1468	1560	2285	1898	2106	2042	2112	2072	643	1372
Number of nest protectors	54	61	115	40	24	64	53	19	72	64	27	91	81	42	123	38	57	95	117	100
Average payment / nest protector ($)	180	140	159	102	137	115	126	243	157	133	243	166	129	203	154	136	127	131	117	142

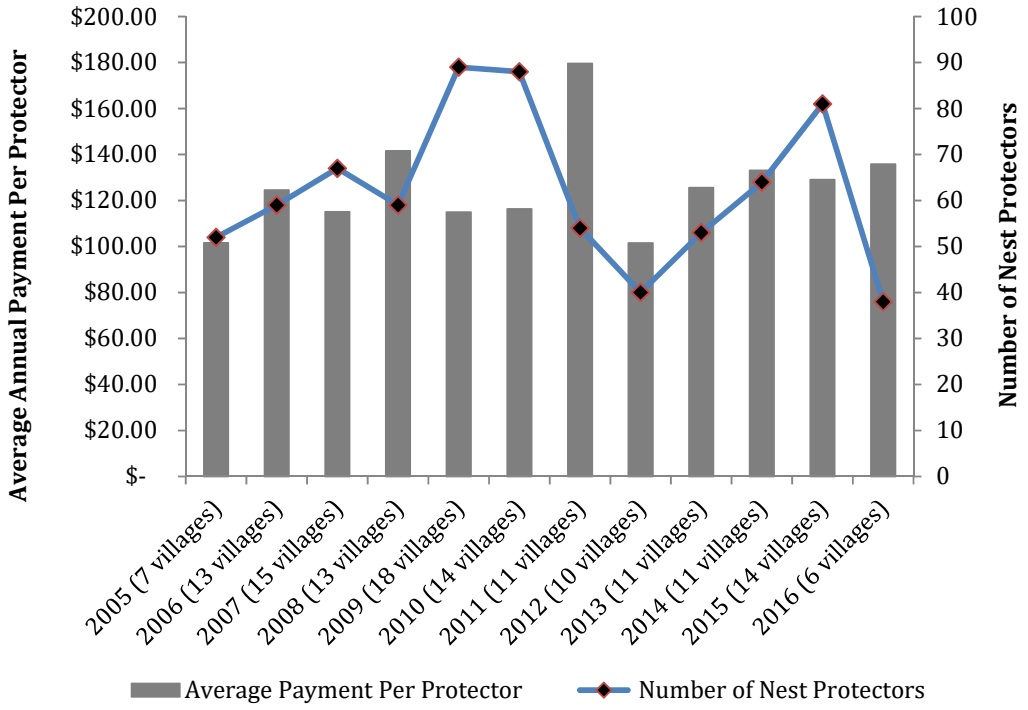


Figure 35. Number of Nest Protectors, Average Annual Payments Per Year, and Number of Villages Receiving Payments in KPWS. 2005 – 2016

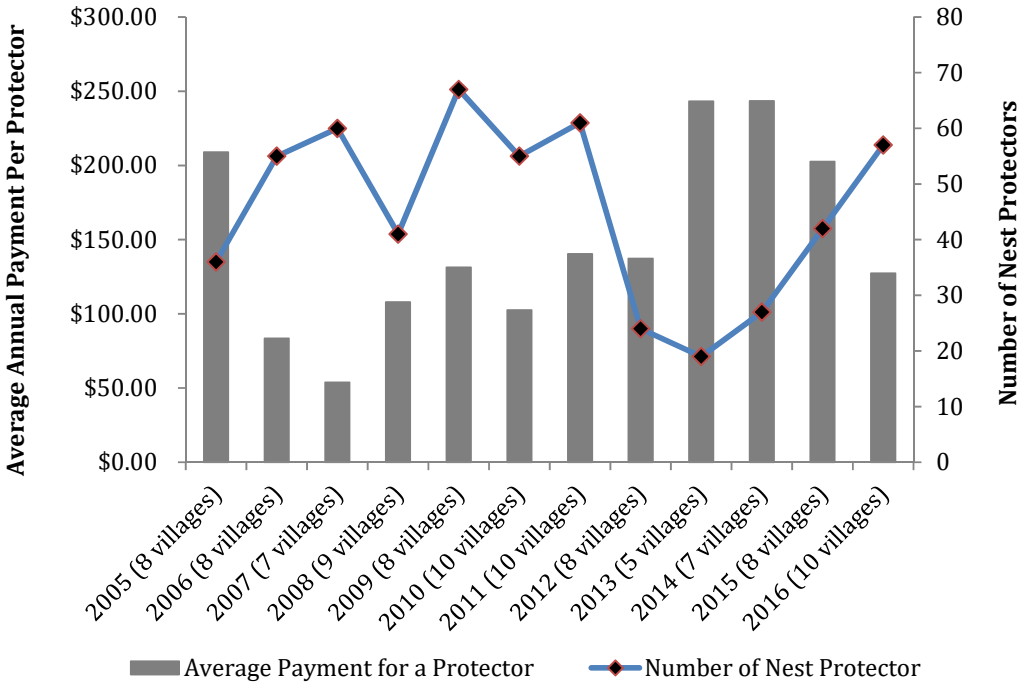


Figure 36. Number of Nest Protectors, Average Annual Payments Per Year, and Number of Villages Receiving Payments in CWS. 2005 - 2016

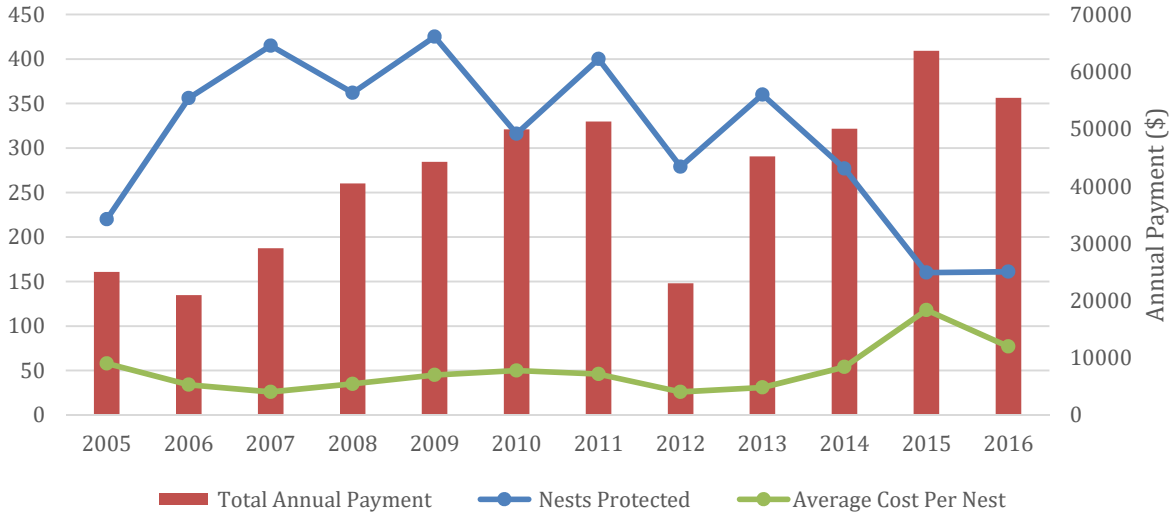


Figure 37. Number of Nests Protected and Annual Payments Per Year in The Northern Plains (CWS + KPWS). 2005 – 2016.

Table 9. Population Change in the Northern Plains. 2008 – 2016*.

	CWS	KPWS	CWS + KPWS
2008	4795	19588	24383
2016	6006	24849	30855
Difference	1211	5261	6472
% Increase	25	27	**27**

* *Data collected by WCS and Forestry Administration staff from village and commune level authorities.*

Table 10 Rural Income Cambodia. 2009 - 2013

	2009	2010	2011	2012	2013
Monthly Household Income (KHR)*	563000	697000	728000	816000	931000
Monthly Household Income (USD)	140.8	174.3	182.0	204.0	232.8
Yearly Household Income (USD)	1689	2091	2184	2448	2793
Daily Household Income (USD)	4.6	5.7	6.0	6.7	7.7
Daily Income (USD) Per Capita**	1.0	1.2	1.3	1.5	1.7

** http://www.nis.gov.kh/nis/CSES/Data/CSES_2013/CSES_Income_Expense.htm*

***Household = 4.6 people (2013)*

3.6 Payments & Costs

The forests of the Northern Plains are heavily used by local people, for resin-tapping, collection of NTFPs, fishing, cattle grazing and hunting. It would be prohibitively expensive, if not impossible, for patrol staff to police the entire forest to effectively control what people do. Therefore, offering conditional incentives for conservation through direct payments was proposed a useful way to engage local villages in species protection and to change behaviours (Ferraro & Kiss 2002).

The programme has been successful at protecting a large number of nests, almost 4,000 since its inception, at a current average cost of around $80 per nest. Nests protected by this scheme had an 88.5% fledging success rate, compared to only 36.9% for unprotected nests in the Northern Plains (Clements *et al*. 2013). This represents a 136% increase in nesting success as a result of nest protection. Since the average fledging success rate of protected nests is 2.4 times greater than that of unprotected nests (Clements *et al*. 2013), the total number of fledglings protected by this scheme represents approximately 2500 additional birds that otherwise are unlikely to have reached an age at which they could leave the nest. The average cost of each additional fledgling is $134. Moreover, the majority of payments (~70%) go to local people, helping to build support and awareness for conservation whilst directly improving livelihoods. This provides a legal income from protecting birds instead of illegal hunting and trade, and helps to reinforce education efforts about the value and importance of the Northern Plains' bird populations. In some cases, payments have even converted former hunters (Clements *et al*. 2013).

Table 8 shows the payments given directly to protectors and the costs of monitoring and surveying from 2005-16. The total cost includes that for Nest Protectors, Community Wildlife Rangers (including the cost of WCS monitoring oversight) and associated costs. On average, the total cost of the programme was around $31,977 per year from 2005-2009, increasing to an average of $48,364 per year from 2010-16. Total expenditure peaked in 2015 where it exceeded $63,000 (Table 8). Differences in yearly cost result from varying numbers of nest protectors and community wildlife rangers, with most of the increase in cost resulting from rising prices, particularly for food and associated transport costs (when rangers were provided with motorbikes), and increases in wages to nest protectors and wildlife rangers.

The average cost per nest protected has increased significantly since 2005 and ranges widely from $59 in 2006 to $398 in 2015. The reason for this large range is due to the loss of large nesting colonies of Adjutants and Darters, which would have previously brought down average costs per nest, where a colony of 100 Lesser Adjutants would only have required a single nest protection team. Lesser Adjutants currently nest in a larger number of smaller colonies consisting of perhaps five nesting pairs each, hence vastly increasing the expense per nest. Moreover, nesting seasons are now more prolonged then when the programme started, further increasing expenditure and decreasing cost efficiency. This is likely because of greater disturbance to nests resulting in breeding pairs that will often attempt a second brood. It is possible also that increasingly unpredictable weather patterns, driven by climate change are affecting nesting seasons, however this theory requires further validation.

Figure 37 shows how, in 2015 the cost of protecting a nest approached the number of nests located in that year. This represents a reduction in cost efficiency reflecting the loss of large nesting colonies which bring the average cost of nest protection down as a single nest protector can protect many nests. Increases in cost per nest also represents an increase in survey effort required to locate the nests as they become less densely distributed across the landscape.

Depending on the year, between 60 to 79% of the money spent on the nest protection programme went directly to local people living inside the protected areas. The amount of spending to local people has increased over the life of the programme, and the proportion of expenditure to local people has on average, remained constant. On average, approximately 109 individuals are employed as nest protectors each season, receiving an average of $129 per season. 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. Community rangers receive significantly more, averaging $643 from 2005-09, more than doubling to $1,372 per year between 2010 to 2016. Payments per village average $1,071 from 2005-09, increasing to an average of $1,744 per year from 2010 to 2016, depending on nest numbers and the number of villages engaged, which averages at 20 each season. Some villages earn considerably more due to their vicinity to a large number of key species, or species with particularly long breeding periods, such as Greater Adjutants, that required at least 6 months of protection each year (Table 1).

Payments are highly significant in remote rural villages, and are used to pay for food, clothes, education and household improvements. The amounts paid are a significant source of income in this context. The programme has been effective, therefore, at targeting an important threat to species conservation in this area: collection of nests for eggs and chicks.

Frequently, nest protection teams are composed of the same people who own the rights to collect resin from nesting trees - in exchange they agree not to collect resin while the nests are active. The value of the resin from a nesting tree is perhaps $5 month, considerably less than the income received from nest protection (Clements *et al*. 2013). In recent years, the price of resin has fallen as synthetic replacements become more economically viable (Rours Vann, *pers. comm.).* This is cause for concern, since the incentive not to log resin trees diminishes in line with the market price of resin. In light of this development, there was widespread illegal logging in Community Protected Areas (CPAs) in 2016, where the resin collection rights to a high proportion of trees where sold by CPA chiefs to illegal logging operations with links to neighbouring Social and Economic Land Concessions. If the price of resin continues to fall, the sustainable use of resin trees is also likely to diminish unless the threat of illegal logging from nearby land concessions is contained.

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 programme meets many of the claims made about direct payments. However, the programme is not inexpensive, currently costing $50-60,000 per year, yet this remains lower than other conservation activities such as patrolling and law enforcement. The Birds Nest Protection programme is typically less than 10% of the total annual cost of WCS's Northern Plains conservation program. It should also be noted that nest protectors are not government employees and hence do not wield the same power as park staff, so for the relative expense, it can still be regarded as a cost efficient.

3.7 Discussion

During the first few years of the programme, increases in nest numbers can largely be attributed to improvements in survey method, spread of knowledge of the nest location reward scheme, and extension of the scheme over an increasing area, covering a greater

number of species. The collection of survey effort data unfortunately does not extend to the beginning of the project, however, even if this data existed, the crudeness of this measure may not accurately account the impact of survey effort on nests located. In-depth temporal and spatial analyses of survey effort is required to produce more expressive measures of survey effort, relevant to each species.

The timing of declines since 2012 coincides with the influx of Economic and Social Land Concessions in and surrounding the protected areas. 22.3% of deciduous forest (the predominant forest type in Preah Vihear Province) was cleared between 2010 and 2014 in Cambodia.

With regard to the Critically Endangered White-shouldered and Giant Ibises, the Nest Protection Programme should broadly be viewed as a success. These species not only possess intrinsic value (reflected by their EDGE status), but as DDF specialists they act as indicator species for the health of deciduous dipterocarp forest, being sensitive to human disturbance, nesting in the tallest trees (favoured by loggers), and foraging in fragile wetland habitats. Numbers of White-shouldered Ibis have consistently trended upwards, whilst Giant Ibis nest numbers have remained more or less constant, albeit with a gradual downward trend in recent years. These successes are perhaps not reflected in the overall trend of nesting numbers because the ibises nest in DDF. Species such as the adjutants preferentially nest in denser evergreen forest, the forest type that is under greater pressure from illegal logging and the impact of Social and Economic Land Concessions. Indeed, the outright loss of breeding Greater Adjutants from the landscape is reflected in the preferential logging of their evergreen nesting habitat that has been targeted by illegal logging by ELCs.

As with the Greater Adjutant, dramatic declines in Lesser Adjutant nest colonies are primarily due to loss of and disturbance to nesting habitat. This threat is beyond the realm of what the Bird Nest Protection Programme is capable of combatting. The programme was designed to reduce incidences of egg collection by “providing payments to a seller conditional upon a particular conservation outcome being achieved – assuming the seller has at least partial control of the conservation outcome” (Ferraro 2001). Nest protectors are unable to combat illegal land clearance and logging by the virtue that they hold no stake in illegal activities driven by the external forces of Social and Economic Land

Concessions. Furthermore, such threats often occur when nest protectors are absent in non-breeding seasons. However, in the case of the Darters, temporary cessation of their protection in 2012 due to financial restrictions evidently caused local egg and chick collection to resume in the ensuing years, causing a 95% reduction in nest numbers. This detrimental result can be taken as evidence of how important continuity of protection is to the success of this programme, and as evidence that nest protectors successfully combat the threat of egg collection. The pattern of more pronounced declines in KPWS than in CWS corresponds to the higher concentration of ELCs and SLCs in and surrounding KPWS (Map 2).

Densities of Giant Ibis and Sarus Crane being greater in CWS than KPWS likely reflects proportional difference in suitable habitat, between the two sites (Map 2) as well as the higher density of people in KPWS (Table 9), which plausibly results in a higher proportion of nests reported. This pattern is unlikely a result of survey effort of wildlife rangers, which remained comparable between the two Protected Areas. The reason for an absence of White-shouldered Ibis nests in CWS is unknown. The greater diversity of species protected in KPWS results in a much longer nest protection season, and higher associated costs.

The 50% reduction in the rate of bird nest detection by 2016 (Figure 5), in the last five years, coincides closely with the occurrence of Social and Economic Land Concessions that were granted inside the protected areas of the Northern Plains over the corresponding period. It is also a reflection that, as nest densities decrease across the landscape, greater survey effort is required to find the same (or fewer) number of nests; a lower density of nests reduces the cost efficiency of the programme. The human population rose by 27% between 2008 – 2016 in the Northern Plains. As of 2016 there were more that 31,000 people living in both protected areas (Table 9). Such rapid population increase provides an indication of how pressure on nesting habitats will have risen as competition for resources intensifies.

Earlier average nesting times in KPWS are possibly linked to the wet season in CWS purportedly starting earlier than in KPWS (pers. comm., Rours Vann, Thong Sokha). Greater variability in nesting phenology from 2009 – 2016 compared to 2002 – 2008 (Table 3, 4 and 5) is possibly caused by increased levels of disturbance (stimulating

successive broods), climate change, or shifting competition, for example, it is difficult to know whether phenological changes are genuine or a result of improved data recording. The paucity of data on nesting phenology from 2002 – 2008 may suggest the latter.

Chapter 4. Conclusion

Despite having a basic metric for survey coverage, the extent to which fluctuations in nest numbers are due to variable survey effort remains unclear. It is therefore impossible to know if changes in the number of nests located are due to variations in the number of survey days and area surveyed or to actual changes in the numbers of nests. For this reason, it is difficult to comment empirically on the success of the nest protection programme. Nevertheless, under the programme, only 25 cases of nest collection have been recorded since 2002, although it is possible that nest collection rates were under-reported, as the causes of nest failure are not known in all cases. The popularity of the programme 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.

Reductions in numbers of nests located and protected since 2008 largely reflect falls in numbers of adjutant and Oriental Darter nests. Darters diminished as a result of egg collection that resumed as a result of a lack of nest protection. Adjutant numbers were impacted by an increase in Social and Economic Land Concessions within the protected areas. Forest clearance has increased rapidly in recent years in Cambodia (Forestry Administration 2016), 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, particularly outside of the breeding season.

Illegal logging driven by land concessions has been most intense in evergreen and semi-evergreen habitats, where the highest densities of the most valuable timber species exist and adjutants prefer to nest. A large proportion of adjutant nesting colonies were based in Community Protected Areas (CPAs). The success of CPAs is largely dependent on the presence of strong committee leadership and transparency. Pressure from ELCs to overexploit resources is a key issue for the future management of KPWS and one that threatens the successful protection of some of the most biodiverse habitats within the Northern Plains. The programme must therefore be viewed as a complement, not a substitute, to more traditional conservation approaches. This report advocates that implementation of the recommendations (Chapter 5) are vital to improve protection of species of high conservation value in the Northern Plains.

As a result, habitat clearance has overtaken egg collection as the main threat to nesting large waterbirds in the Northern Plains in recent years, as levels of egg collection are thought to have significantly reduced in unison with increased habitat clearance. Although it has not been possible to systematically collect data on egg collection, the sheer presence of nest protection teams acts as an obvious deterrent. Clements *et al.* (2013) showed, through comparing the success rate of protected nests with unprotected controls, Lesser Adjutant and Sarus Crane nest success in the Northern Plains increased from 37% to more than 85%, and a similar rate of increase is also apparent for Giant Ibis, using the predator exclusion bands (Keo *et al.* 2009).

Furthermore, in the absence of nest protectors for Oriental Darters in 2014-15, reports of wholesale egg collection resumed, suggesting nest protection is largely successful at contending with this threat and that, in its absence, a significant proportion of the 4,000 or so nests that were successfully protected, would otherwise have failed, in line with the high rates of nest collection for the same species at other sites (e.g., Bezuijen *et al*. 2009). This suggests that the nest protection programme has been successful at increasing breeding success, and that without it; reductions in nesting numbers would have been far greater.

Viewed in this light, the Nest Protection Programme must be regarded as a success in that it has safeguarded populations of a significant number of Globally Threatened species in the face of severe and evolving threats. Nest protection may not have proved successful in combatting habitat clearance, but is important to note that this payment scheme was never intended to protect birds from this type of threat, demonstrating the main constraint with such a highly-targeted programme.

Chapter 5. Conservation Recommendations

Bird Nest Protection Development Fund

PES schemes rely upon the actor having at least partial influence over the desired conservation outcome (a nest guardian preventing nest collection in this case), and payments are conditional upon delivery of the outcome. The success of this scheme could potentially be improved if conditional payments were not only paid to the nest protector, but also to a village development fund or equivalent. This would incentivise prevention of nest disturbance amongst communities and empower nest protectors with greater leverage amongst community members committing illegal activities. The aims of this PES scheme are to locate, protect and monitor nests of key species, but one of its shortfalls is the lack of protection for nesting trees whilst birds are not nesting. A development fund that is conditionally awarded at the beginning of the nest season may incentivise community protection of crucial nesting habitat during the non-breeding season. This fund could potentially be financed by revenue raised by community ecotourism.

Ibis Nest Protection

Giant Ibis and White-shouldered Ibis are only monitored weekly as the threat of nest collection was not deemed to be high for these species. However, the threat of land encroachment and hunting have grown to the point where it may be beneficial to instate full time nest guardians for these species, enabling faster reporting of emerging threats and responses by law enforcement patrol teams.

Increase Payments, Rewards & Conditional Payments

Increase rewards for locating nests to provide a greater incentive for locating new nest sites. The payments made to nest protectors should be increased to a total of $5 per day. The $1.50 increase should be a conditional payment awarded if nests are successfully protected.

Landscape Approach to Nest Protection

In 2016 PPRWS and Phnom Tbeng Natural Heritage Park (PTNHP) were declared protected areas. PPRWS links CWS to KPWS and PTNHP is adjacent to KPWS. By extending the reach of the Nest Protection Scheme to both these Protected Areas, more bird nests and habitat can be protected, bolstering protection for populations of threatened

species across the landscape.

Survey Effort

Develop a standard SMART survey protocol to be used by Community Wildlife Rangers for more accurate GPS tracking of survey time and area to allow a more accurate measure of survey effort.

Other Notable Species

Other Globally Threatened species such as the Grey-headed Fish Eagle and Woolly-necked Stork should immediately be included in the Nest Protection Programme.

***Trapeang* Management**

Trapeangs provide crucial foraging habitat for a number of the focal bird species in the Northern Plains. The loss of almost 40% of surveyed *trapeangs* in the landscape at the expense of Social and Economic Land Concessions represents a significant loss of foraging habitat (WCS unpublished data). In addition to wholesale loss, remaining *trapeangs* are becoming increasingly clogged with vegetation and are contracting as a result of fewer domestic and wallowing ungulates. Consideration should be given to mechanically creating trapeangs to replace lost habitat. In addition, the mechanical excavation of shrinking *trapeangs* is required to reverse their contraction and to allow them to retain water for longer during the dry season.

Ibis Captive Breeding

A captive breeding programme should be considered for Giant and White-shouldered Ibises. The Northern Plains is one of the very the last strongholds for Giant Ibis and one way of insuring against its extinction in the face of continued habitat loss, is to establish a captive population. Given its global rarity the same should be considered for White-shouldered Ibis. Neither species is currently held in captivity, however numerous successful captive breeding programmes exist of a range of other highly threatened ibis species around the world.

Control of Crows

Interviews and observations suggest crow numbers are on the rise (possible linked to expansion of human populations and increasing affluence leading to increased discards of

waste) in the Northern Plains. Crows are a major source of nest predation, particularly for ibises, and consideration should be made as to whether their population should be controlled by culling, as at other important waterbird breeding sites throughout the world.

Education and Awareness

Rural education programmes to raise awareness and understanding amongst rural communities of the benefits of the Nest Protection Programme and integrated conservation strategies.

Expanding the Ibis Rice scheme across the landscape will increase the overall strength and coverage of compliance to land-use regulations and protected area law.

Zonation

Under the 2008 Protected Area Law of Cambodia, zonation of PAs can introduce non-extractive zones that will bolster protection for species of high conservation value. Once the zonation process is complete, management plans and agreements are required to offer a higher level of protection to critical nesting habitats within CPAs and other extractive zones.

Law Enforcement

Greater protection and prioritisation of law enforcement effort is required, especially in semi-evergreen and evergreen habitat in CPAs, as well as in grasslands. CPA leaders should be replaced if their performance is deemed unsatisfactory by the MoE. Co-management should be considered to increase accountability in extractive zones, and to empower CPA committees. CPA committees taking part in joint patrols should have a separate and independent reporting line to MoE rangers.

Communication

There is a need to enhance communication links to increase the speed that real-time intelligence (collected by Community Rangers and Bird Nest Guardians) is relayed to law enforcement teams to enable more rapid response by law enforcement patrols.

Greater Gun Control

The Bird Nest Protection Programme has largely succeeded in controlling illegal nest and

egg collection. An area it has not been so successful in is combatting hunting of birds, as this occurs all year round (when nests are not being protected) and can happen away from nesting sites that are being protected, such as roost sites. Greater gun control is being written into the new Environmental Code for Cambodia and if this suggested legislation is adopted, stringent implementation by law enforcement teams is required.

Environmental Pollutants

Organochlorides such as DTT accumulate in food chains and cause thinning of eggshell of carnivorous birds, reducing breeding success. Despite being banned, DDT is widely available in rural Cambodia. The presence of organochloride in eggs of Globally Threatened carnivorous birds could be investigated to determine if it is a threat to large waterbirds in the Northern Plains.

Despite the use of veterinary NSAIDs being limited in Cambodia, there is a very real threat that with improvement in livestock farming practices the use of Diclofenac could rapidly rise. Surveys of livestock farming practices should be conducted regularly and lobbying for the outlaw of veterinary NSAID should continue.

An **audit of historic nesting trees** is underway to map and number trees in order to quantify the extent of disturbance to nesting trees and surrounding habitat both historically and into the future. It is recommended that this audit should shift from an absolute survey to a stratified sample by nesting numbers of each species, in order to expedite this time and resource thirsty project. This process could be supported with higher resolution remote sensing data to produce a measure of habitat degradation.

Behavioural and genetic studies of Giant and White-shouldered Ibis should be conducted using radio telemetry or similar, in order to understand ranging behaviour and genetic mixing of populations of these Critically Endangered species. This would also help identify previously unknown nesting sites that can be safeguarded by the scheme.

Acknowledgements

The authors wish to thank the Ministry of Environment (MoE) and in particular Mr Ea Sokha, Director of the Department of Environment, Preah Vihear Province; Mr Hong Daravuth, Director of Department of Northern Tonle Sap Protected Landscape; and Mr Sun Kong and Mr Song Chansocheat, the current directors of Kulen Promtep Wildlife Sanctuary and Chhep Wildlife Sanctuary respectively. We wish to thank Dr. Keo Omaliss, Deputy Director General of the Forestry Administration, and Mr Tan Setha, former Director of Preah Vihear Protected Forest (when that site, now Chhep Wildlife Sanctuary, was managed by the Forestry Administration). Thanks go to Mr Rours Vann, Mr Thong Sokha and Mr Sok Vutthin, to Mr Sok Raksa for producing maps and Mr Kong Socheat for SMART data analysis. Thanks to Alistair Mould and Simon Mahood for helpful comment and advice. Special thanks go to all of the conservation rangers and nest protectors who are to be credited with the management and protection of the birds in the Northern Plains. During the reporting period the Birds' Nest Protection Programme was funded by the USAID Supporting Forests and Biodiversity Project (implemented by Winrock International), and Akron Zoo, AFD, CEPF, EU, the MacArthur Foundation, Margaret A. Cargill Philanthropies, NORAD, SOS, SVC and USFWS. We wish to thank all of our supporters past and present for their financial support to the project.

Annex 1. Incidence & Cause of Nest Failure 2006 - 2016.

	Cause	Species										Sub Total	Total	Total No. Nests	Failures per no. nest
		Giant Ibis	White-shouldered Ibis	Greater Adjutant	Lesser Adjutant	Oriental Darter	Sarus Crane	Black-necked Stork	Masked Finfoot	White-rumped Vulture	Red-headed Vulture				
2006	Accident	2 (Wind)		1 (Fell)			3					6	18	220	0.082
	Predation		1		1		5					7			
	Human Disturbance														
	Land Clearance / Logging		1		1							2			
	Nest Collection / Hunting					1	2 (1 dog)					3			
	Poisoning														
	Abandoned / Eggs Failed														
	Unknown														
2007	Accident	3 (Wind)	1 (Fell)		2		3					9	22	344	0.064
	Predation			1		1 (Crows)	3					5			
	Human Disturbance	2					1					3			
	Land Clearance / Logging	1					1					2			
	Nest Collection / Hunting				1		2					3			
	Poisoning														
	Abandoned / Eggs Failed														
	Unknown														
2008	Accident						1					1	18	415	0.043
	Predation		1	1	1	1 (Crows)	7					11			
	Human Disturbance														
	Land Clearance / Logging			2	1							3			
	Nest Collection / Hunting						2					2			
	Poisoning			1								1			
	Abandoned / Eggs Failed														
	Unknown														
2009	Accident				1 (fell)		5 (4 flooded)	1				7	33	364	0.091
	Predation		2		8		1					11			
	Human Disturbance														
	Land Clearance / Logging														
	Nest Collection / Hunting	1			1		1					3			
	Poisoning														
	Abandoned / Eggs Failed					2	5					7			
	Unknown	5										5			
2010	Accident	1 (fell)	1							1 (fell)		3	26	425	0.061
	Predation	1			1	2	4					8			
	Human Disturbance														
	Land Clearance / Logging	1										1			
	Nest Collection / Hunting				4							4			
	Poisoning														
	Abandoned / Eggs Failed				3	1						4			
	Unknown						3	1		1	1	6			
2011	Accident				3 (fell)							3	14	330	0.042
	Predation						5					5			
	Human Disturbance														
	Land Clearance / Logging						1					1			
	Nest Collection / Hunting						3 (1dog)					3			
	Poisoning														
	Abandoned / Eggs Failed						2					2			
	Unknown														
2012	Accident												13	400	0.033
	Predation		1		3		1					5			
	Human Disturbance														
	Land Clearance / Logging				4							4			
	Nest Collection / Hunting						3					3			
	Poisoning														
	Abandoned / Eggs Failed														
	Unknown						1					1			
2013	Accident						1					1	84	290	0.290
	Predation	2			7		1					10			
	Human Disturbance	1	1			25						27			
	Land Clearance / Logging				14							14			
	Nest Collection / Hunting														
	Poisoning														
	Abandoned / Eggs Failed		3			20	2					25			
	Unknown	2					4		1			7			
2014	Accident				4							4	43	363	0.118
	Predation	1	6		7		2					16			
	Human Disturbance														
	Land Clearance / Logging				7							7			
	Nest Collection / Hunting						3					7			
	Poisoning														
	Abandoned / Eggs Failed														
	Unknown	1 (dead Parent)			7					1		9			
2015	Accident	1 (fell)					3					4	16	274	0.058
	Predation		4				1					5			
	Human Disturbance														
	Land Clearance / Logging														
	Nest Collection / Hunting						1					1			
	Poisoning														
	Abandoned / Eggs Failed						3			1	1	5			
2016	Accident	1			1							2	13	162	0.080
	Predation														
	Human Disturbance														
	Land Clearance / Logging	1			2							3			
	Nest Collection / Hunting														
	Poisoning														
	Abandoned / Eggs Failed						5 (flooded)					5			
	Unknown		3									3			
Combined	Accidental	8	2	1	11		16	1		1		40			
	Predation	4	15	2	28	4	30					83			
	Human Disturbance	3	1		4	25	1					34			
	Land Clearance / Logging	3	1	2	29		2					37			
	Nest Collection / Hunting	1			6	1	17					25			
	Poisoning			1								1			
	Abandoned / Eggs Failed		3		3	23	17					46			
	Unknown	8	3		7		9	1	1	3	2	34			
	Total	27	25	6	88	53	92	2	1	4	2		300		

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