Kalimantan's tropical peat-swamp forests are important for Storm's stork (*Ciconia stormi*) conservation

Susan M. Cheyne[1,2,3], Simon J. Husson[2,3], Marc Dragiewicz[2], Lindy J. Thompson[2], Adul[2,3], Karen A. Jeffers[2,3], Suwido H. Limin[3] and **David A. Ehlers Smith[2,3]**

[1]Wildlife Conservation Research Unit (WildCRU), Department of Zoology, Oxford University, Abingdon Road, OX13 5QL, UK
[2]Orangutan Tropical Peatland Project (OuTrop), Jl. Semeru 91, Palangka Raya, Central Kalimantan, Indonesia
[3]Centre for International Cooperation in the Management of Tropical Peatlands (CIMTROP), University of Palangka Raya, Indonesia

Corresponding Author: David A. Ehlers Smith, Email: *dehlerssmith@outrop.com*

Introduction

The Storm's stork (*Ciconia stormi*) is listed on the IUCN Red List 2012 as endangered, because it has a small, rapidly declining population owing to destruction of lowland forest habitat throughout its range (BirdLife International, 2001; IUCN, 2012). Its reported range extends from southern Thailand, where it is almost certainly extinct (Round, 1988; Round & Brockelman, 1998), through most of Sundaland (Peninsular Malaysia and the islands of Sumatra and Borneo.) It is known from six river systems in Peninsular Malaysia (Hancock et al., 1992; Luthin, 1987) and is reportedly widespread (albeit rare and found at extremely low density) in Sumatra and Borneo, with apparent concentrations in Sabah and Brunei, northern Borneo, and in south-eastern Sumatra (BirdLife-International, 2001). It favors forested lowland habitat, occurring in both dry and swamp forests, as long as there is access to permanent sources of freshwater (BirdLife-International, 2001; Collar et al., 1994; Danielsen et al., 1997). The global population is estimated to be 400-500 individuals with estimates of up to 250 individuals in Indonesia and 150 individuals in Malaysia (BirdLife-International, 2013).

Methods

Study site and study species

The Sabangau Forest is a 568,000 ha area of tropical peat-swamp forest located between the Sabangau and Katingan Rivers in Central Kalimantan, Indonesia, and is one of the largest areas of lowland rainforest remaining in Borneo. It is important both as a major store of terrestrial organic soil carbon and for biodiversity conservation (Cheyne, 2008; Ehlers Smith & Ehlers Smith, 2013; Morrogh-Bernard, et al., 2003; Page et al., 1999; Page et al., 2002). The forest has been intensely selectively-logged, first by commercial operations from the 1970s to 1997 and illegally until 2003 (Morrogh-Bernard et al., 2003). Approximately 15% of the original forested area has been burnt by fire since 1997, a consequence of peat drainage and extended periods of drought (Page et al., 2002). Disturbance levels vary throughout, from pristine to heavily-degraded. Much of the forest was designated as Sebangau National Park by the Indonesian Government in 2004, and subsequent conservation management has largely stopped illegal logging and reduced the severity of fire events.

Fifty thousand hectares in the northern Sabangau Forest was established for research purposes and is managed by the Centre for International Cooperation in Management of Tropical Peatland (CIMTROP). Since 1993, this is the site of a long-term program of field research on peat-swamp forest ecology, biodiversity, restoration and sustainability. The principal research site is the Natural Laboratory for Peat-swamp Forest Studies (NLPSF) field station (2º 19' S; 113º 54' E).

Data collection

Animal sightings have been recorded here since 1993, either opportunistically or by transect survey and point count; and since 2008 by automatic camera traps. Cuddeback Expert cameras (http://www.cuddeback.com/) were set up within the 15 km^2 core study area

Received 12th March, 2014; Revision accepted 23rd April, 2014.

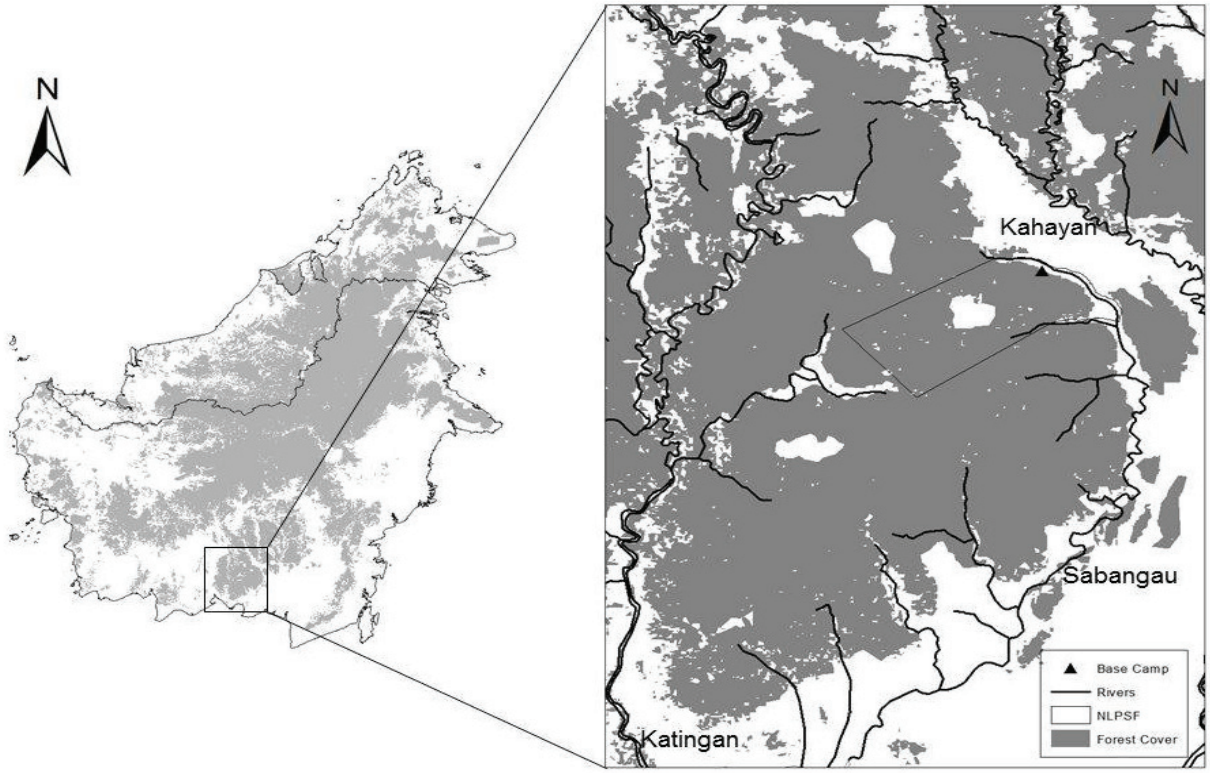

Figure 1. Study location and boundary of the Natural Laboratory for Peat-Swamp Forest Studies (NLPSF) within Sabangau Forest, Central Kalimantan.

by the Orangutan Tropical Peatland Project (OuTrop) with the primary objective of surveying cats. Twenty-two cameras have been permanently sited in pairs at 11 locations since May 2008 and checked once every 14 days. The date and time of all photos is automatically recorded and the location of each camera was recorded by GPS.

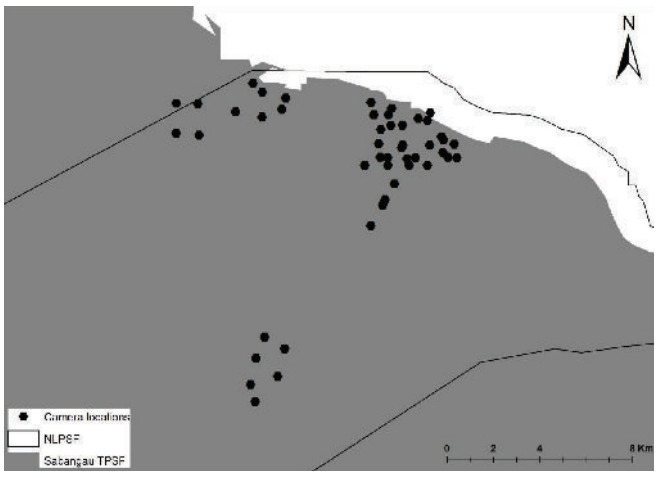

Figure 2. Location of camera traps throughout the Natural Laboratory for Peat-swamp Studies (NLPSF) within Sabangau tropical peat-swamp forest (TPSF).

Results

Storm's stork was first recorded here in peat-swamp forest near to the NLPSF in July 1993 (Page et al., 1997); subsequent sightings were made in sedge swamp along the Rasau River (2º 29' S; 114º 00' E) in July 1999; in forest near to Paduran River (2º 44' S; 114º 48' E) in July 2002 and in forest near to the NLPSF in February 2005 (Tab. 1; Fig. 1). Each sighting consisted of a lone individual.

During a 4 year period, Storm's storks were photographed 32 times at 5 different locations (Tab. 2; Fig. 2). 4 of these locations, where 78.1% (N = 25) of the photographs were taken, have a permanent water source nearby in the form of a logging canal (Fig. 3).

Discussion

The camera-trap photographs presented here provide evidence of a population of Storm's stork in Sabangau Forest in Central Kalimantan, Indonesia and highlight the contemporary importance of peat-swamp forests for

Table 1. Dates and locations of Storm's stork sightings in Sabangau tropical peat-swamp forest. Area A = close to permanent water; Area B = open areas accessible to flying storks.

Date	Time	Location	# birds	Area A	Area B
Jul-93	-	1	-		
Jul-99	-	2	-		
Jul-02	-	3	-		
Feb-05	-	1	-		
14-Jul-08	14:34	9	1	Y	Y
07-Aug-08	11:17	5	1	Y	Y
28-Sep-08	08:26	10	1	Y	Y
06-Oct-08	06:40	10	1	Y	Y
07-Oct-08	05:48	9	1	Y	Y
13-Dec-08	12:11	10	1	Y	Y
06-May-09	07:00	10	1	Y	Y
06-May-09	15:30	10	1	Y	Y
07-May-09	13:52	10	1	Y	Y
12-May-09	05:43	10	1	Y	Y
16-May-09	11:47	9	1	Y	Y
16-May-09	11:50	10	1	Y	Y
18-May-09	05:22	10	1	Y	Y
01-Jul-09	12:04	10	1	Y	Y
08-Aug-09	16:28	10	1	Y	Y
10-Aug-09	06:44	10	1	Y	Y
21-Nov-09	11:34	5	1	Y	Y
09-Dec-09	12:33	5	1	Y	Y
09-Dec-09	12:35	5	2	Y	Y
27-Sep-10	07:05	N5	1	N	N
25-Dec-10	12:19	N7	1	N	N
25-Dec-10	09:09	N8	1	N	N
28-Dec-10	15:37	N7	1	N	N
16-Jan-11	08:04	N8	1	N	N
17-Feb-11	14:18	N5	1	N	N
13-Jul-12	15:28	N12	1	N	N

Table 2. Total trap nights and trap night frequency of Storm's storks recorded in Sabangau tropical peat-swamp forest between August 2008 and August 2012

Total trap nights	Total Storm's stork trap nights	Trap night frequency	Total independent animal photos	Total independent Storm's stork photos	Frequency of Storm's stork photos
35,129	22	0.06	2,955	32	1.08

species conservation in Sundaland. Borneo's forested lands, both dryland and swamp and mangrove forests, are being lost at an unprecedented rate (Curran et al., 2004; Langner et al., 2007; Miettinen et al., 2011) and the threat to its' fauna and flora is severe (e.g. Rautner et al., 2005; Wich et al., 2012; Ehlers Smith 2014). The destruction of much of Sundaland's primary dryland (including dipterocarp and kerangas) forests has led to peat-swamp forest being recognised as a vital refuge for many lowland specialists in Sundaland including primates (Cheyne et al., 2007; Ehlers Smith & Ehlers Smith, 2013; Morrogh-Bernard et al., 2003); bats (Struebig et al., 2007); arthropods (Houlihan et al., 2012) and felids (Cheyne & MacDonald, 2011). Peatland covers a vast area (ca. 6 million ha) of the lowlands of Kalimantan (Rieley et al., 1996) and most of this remains forested. Prior to 1990 this habitat was little studied and believed to be low in biodiversity and unimportant for conservation (Neuzil 1997), but this notion has since been dispelled (Cheyne et al., 2007; Morrogh-Bernard et al., 2003; Ehlers Smith & Ehlers Smith, 2013; Neuzil 1997; Page et al., 1999; Page et al., 2002). It is likely, therefore, to play a similar role for many species of birds, particularly wetland species such as the Storm's stork. Contemporary and historical locality data describe peat-swamp forests as important habitat for the Storm's stork across Southeast Asia, including Sumatra, Peninsular Malaysia, and Borneo (Birdlife International, 2012). While it is without question that anthropogenic disturbances have resulted in a decline in the Storm's stork across its' range, it may be that peat-swamp forests have been providing a crucial refuge for the species during the accelerated loss of riverine and lakeland habitats within dryland forests. Indeed, the frequency with which this endangered species has been photographed here is particularly encouraging, especially as this area was previously heavily logged; the assertion that Storm's stork may

Figure 3. Camera trap records of Storm's storks in Sabangau tropical peat-swamp forest at the same location.

persist in selectively-logged forest is supported here (Lambert, 1992). In addition to Sabangau, Storm's stork has been reported from several other peat-swamp forests in Kalimantan (C. Traeholt, pers. comm.), including Tanjung Puting National Park, Central Kalimantan; Gunung Palung National Park, West Kalimantan; and the catchments of the Kapuas, Kahayan, Rungan and Seruyan Rivers in Central Kalimantan (BirdLife-International 2001; BirdLife-International 2008). Danielsen et al., (1997) estimated a species density of ca. one stork per 30-60 square kilometres in primary swamp forest in Sembilang National Park in Sumatra. A crude application of that density to the 5,680 km2 of the Sabangau National Park suggests a possible population of 95-190 individuals here, and perhaps a further 100-200 individuals in the adjacent and ecologically-similar peat-swamp forests in the catchments the Katingan, Kahayan, Rungan and Kapuas Rivers.

Further surveys to determine the distribution, population and habitat requirements of Storm's storks are urged by the IUCN Red List 2012 authors (IUCN, 2012), although locating nests, necessary for accurate surveys, is particularly difficult (Danielson et al., 1997). Additional data from rivers and lakes in dryland habitats may offer insights into the species; movements in response to habitat loss. Regardless, the peat-swamp forests of southern Kalimantan are likely to form a major refuge for this species, and further peatland protection, rehabilitation and restoration measures are urgently required.

Acknowledgements

We thank the Indonesian State Ministry of Research and Technology (RISTEK), the Directorate General of Forest Protection and Nature Conservation (PHKA) and Center for the International Cooperation in Sustainable Use of Tropical Peatlands (CIMTROP) for research permissions. This work was supported by grants from the Panthera Foundation. The camera trapping research is part of a collaborative project between Panthera, WildCRU and the Orangutan Tropical Peatland Project (OuTrop). We gratefully acknowledge the contribution of all the researchers who assisted with the project: Ambut, Andri Thomas, Iwan, Ramadhan, Santiano, Twentinolosa, Yudhi Kuswanto and all the OuTrop volunteers. Finally thanks to Fransiskus Agus Harsanto for Indonesian translations.

References

BirdLife-International. (2001). Threatened birds of Asia: the BirdLife International Red Data Book. BirdLife International, Cambridge, UK.

BirdLife-International. (2012). *Ciconia stormi*. IUCN 2012: IUCN Red List of Threatened Species.

Cheyne, S.M., Thompson, C.J.H., Phillips, A.C., Hill, R.M.C. and S.H. Limin (2007). Density and population estimate of gibbons (*Hylobates albibarbis*) in the Sebangau Catchment, Central Kalimantan, Indonesia. *Primates* **49**:50-56.

Cheyne, S.M. and D.W. Macdonald (2011). Wild felid diversity and activity patterns in Sabangau peat-swamp forest, Indonesian Borneo. *Oryx* **45**:119–124.

Collar, N., Crosby, M.J. and A.J. Stattersfield (1994). Birds to Watch 2. Birdlife International : Cambridge, UK.

Curran, L.M., Trigg, S.N., McDonald, A.K., et al. (2004). Lowland forest loss in protected areas of Borneo. *Science* **303**:1000–1003.

Danielsen, F., Kadarisman, R., Skov, H., Suwarman, U. and W.J.M. Verheugh (1997). The Storm's stork *Circonia stormi* in Indonesia: breeding biology, population and conservation. *Ibis* **139**:67-75.

Ehlers Smith, D.A. and Y.C. Ehlers Smith (2013). Population density of *Presbytis rubicunda* in Sabangau tropical peat-swamp forest, Central Kalimantan. *American Journal of Primatology* **75**:837-847.

Ehlers Smith, D.A. (2014). The effects of land-use policies on the conservation of Borneo's endemic *Presbytis* monkeys. *Biodiversity and Conservation* **23**:891-908.

Hancock, J.A., Kushlan, J.A. and M.P. Kahl (1992). Storks, Ibises and Spoonbills of the World. Academic Press: London and San Diego.

Houlihan, P.R., Harrison, M.E. and S.M. Cheyne (2012). Habitat preference and community composition of tropical butterflies in a Bornean peat-swamp forest: Impacts of forest disturbance on butterfly diversity. doi: 10.1016/j.aspen.2012.10.003

IUCN. 2012. Red List of Threatened Species. IUCN.

Lambert, F.R. (1992). The consequence of selective logging for Bornean lowland forest birds. *Philosophcial Transactions of the Royal Society of London* **335**:443-457.

Langner, A., Miettinen, J. and F. Siegert (2007). Land cover change 2002–2005 in Borneo and the role of fire derived from MODIS imagery. *Global Change Biology* **13**:2329–2340.

Luthin, C. (1987). Status and conservation priority for the world's stork species. *Colonial Waterbirds* **10**:181-202.

Miettinen, J., Shi, C. and S. Liew (2011). Frontiers in the ecology and environment: two decades of destruction in Southeast Asia's peat-swamp forests. *Frontiers in Ecology and Environment* **10**:124–128.

Morrogh-Bernard, H., Husson, S., Page, S.E. and J.O. Rieley (2003). Population status of the Bornean orang-utan (*Pongo pygmaeus*) in the Sebangau peat swamp forest, Central Kalimantan, Indonesia. *Biological Conservation* **110**:141-52.

Neuzil S.G. (1997). Biodiversity and Sustainability of Tropical Peatlands. Samara: Cardigan, UK.

Page, S.E., Rieley, J.O., Shotyk, Ø.W. and D. Weiss (1999). Interdependence of peat and vegetation in a tropical peat swamp forest. *Philosophical Transactions of the Royal Society of London B* **354**:1885-1807.

Page, S.E., Siegert, F., Boehm, H.D.V., Jaya, A. and S. Limin (2002). The amount of carbon released from peat and forest fires in Indonesia during 1997. *Nature* **420**:61-5.

Rautner, M., Hardiono, M. and R.J. Alfred (2005). Borneo: treasure island at risk. Status of forest, wildlife, and related threats on the island of Borneo. Frankfurt: WWF Germany.

Round, P.D. (1988). Threatened Forest Birds of Thailand. International Council for Bird Protection: Cambridge, UK.

Round, P.D. and W.Y. Brockelman (1998). Bird communities of disturbed lowland forest habitats in southern Thailand. *Natural History Bulletin of the Siam Society* **46**:171-196.

Struebig, M.J., Harrison, M.E., Cheyne, S.M., and S.H. Limin (2007). Intensive hunting of large flying-foxes (*Pteropus vampyrus natunae*) in the Sebangau Catchment, Central Kalimantan, Indonesian Borneo. *Oryx* **41**:1-4.

Wich, S.A., Gaveau, D., Abram, N., Ancrenaz, M., Baccini, A., et al. (2012). Understanding the impacts of land-use policies on a threatened species: Is there a future for the Bornean orang-utan? *PLoS ONE* doi:10.1371/journal.pone.0049142