



# Census of non-breeding Sarus Cranes in Cambodia and Vietnam 2011

Robert van Zalinge<sup>1</sup>, Tran Triet<sup>2</sup>, Tom Evans<sup>3</sup>,  
Hong Chamnan<sup>3</sup>, Seng Kim Hout<sup>1</sup> and Jeb Barzen<sup>2</sup>



<sup>1</sup> Wildfowl & Wetlands Trust – Cambodian Lower Mekong Wetlands Project

<sup>2</sup> International Crane Foundation – Vietnam Program

<sup>3</sup> Wildlife Conservation Society – Cambodia Program

Suggested citation: van Zalinge, R., Tran Triet, Evans, T., Hong Chamnan, Seng Kim Hout and Barzen, J. (2011) Census of non-breeding Sarus Cranes in Cambodia and Vietnam, 2011. Wildfowl & Wetlands Trust, Cambodian Lower Mekong Wetlands Project, Phnom Penh.

## Contents

Summary.....	1
អង្គប្រជុំ.....	<b>Error! Bookmark not defined.</b>
Introduction.....	4
Methods.....	7
Results.....	9
Discussion.....	11
Recommendations.....	14
References.....	15

## Acknowledgements

We thank the following surveyors for their assistance, and apologise to any who may have been omitted:

*Ang Trapeang Thmor* – Ngin Kamsan, Phaing Kimhour, Er Phun, Beang Bunthara, Kien Tan, Chhit Chha and Tak Sour

*Tonle Sap Grasslands* – Son Virak, Sin Sienglay, Chan Sok, Seng Ra, Meas Tho, and Men Roen

*Boeung Prek Lapeuv* – Seng Vanna, Dy Thon and Oeun Samouen

*Anlung Pring* – Uong Seth, But Sambat and Seang Sorya

*Western Siem Pang* – Mem Mai and Net Norin

*Kulen Promtep Wildlife Sanctuary* – Rours Vann, Nem Sophean, Prom Vorn, Tem Hoeung, Kroch Thoeung, Pen Leam and Hon Navy

*Preah Vihear Protected Area* – Taung Sokha, Heam Heng, Yong Yen and Say Lay

*Sites in Vietnam* – Tram Chim National Park; Lo Go Xa Mat National Park; Lang Sen Nature Reserve; Phu My Lepironia Wetland Conservation and Community Development Project; University of Science – Ho Chi Minh City.

We thank the various government agencies who provided permission to conduct these surveys, in particular the Forestry Administration and General Department for the Administration of Nature Conservation and Protection.

We also thank all our donors for supporting us in our efforts to conserve Sarus Cranes in South-East Asia, particularly Eleanor Briggs, BirdLife International in Indochina and the Critical Ecosystems Partnership Fund. The Critical Ecosystem Partnership Fund is a joint initiative of l'Agence Française de Développement, Conservation International, the Global Environment Facility, the Government of Japan, the MacArthur Foundation and the World Bank. A fundamental goal is to ensure civil society is engaged in biodiversity conservation.

Photo on title page of Sarus Cranes in Anlung Pring by Rob Shore.

## Summary

Synchronized counts were conducted, on a monthly basis, in Cambodia and Vietnam from January-April 2011 to monitor regional populations of Sarus Crane *Grus antigone*. The count held in late March forms the longest running part of the census, stretching back as far as 2001, with additional counts in January and February introduced in 2008 and a late April count conducted for the first time in 2010.

The highest count for 2011 was recorded in February with a total of 869 cranes counted across eleven sites. This is almost a record count, with the current record being 878 cranes counted in 2002. Peak counts for previous years have fluctuated between 700-900 birds, and there is no evidence of a clear trend since 2001 (figure 1). This suggests the total regional population has remained broadly stable over this period.

However, there is an issue of cranes being missed during the main late March/early April counts. These counts are presumed to give the closest estimate of the true crane population, with the majority of cranes being confined to relatively few suitable sites at the height of the dry season, but for the last two years the late March count has been lower than a preceding count. In 2010 the January, count exceeded the March count by 149 cranes, and this year the February count had 133 more cranes than were counted in March. The Mekong delta is suspected to be the location where cranes are being missed in March and more work needs to be done to try and find further locations used by cranes and ensure an as complete census as possible in this bio-geographical region. In the mean time it is important to keep conducting multiple counts within a single season.

Sarus Cranes use many different sites during the non-breeding season, so it is crucial to maintain a trans-national network of well managed protected areas to allow flexibility in movements as water conditions and feeding opportunities change. This is evident from the changing distribution of cranes from counts held in 2011. In January 53% of the total 579 cranes counted were concentrated at Boeung Prek Lapouv (BPL), while 22% had already arrived at Ang Trapeang Thmor (ATT). In February almost all had left BPL, ATT held 31% of 869 cranes counted across all sites, while Anlung Pring and Phu My held 30%. A new site was found in the Kieng Luong area and combined with the original count site, Kien Luong had a record 212 cranes or 24% of February's total count. By March ATT held 49% (of 736 cranes across sites), while Anlung Pring had 34% and Tram Chim held 13% of the total. In April distribution had shifted slightly again (and given that only 505 cranes were counted part of the population may have already started the return journey to their breeding grounds), with 28% at ATT, 24% at Anlung Pring and Phu My, 20% at Hon Chong, 10% at Tram Chim and 10% in the Tonle Sap grasslands.

Intensified land use and hydrological development is impacting the suitability of feeding sites in the non-breeding season. For example, within the last decade increasing irrigation needs for dry season farming around Boeung Prek Lapouv has led to the drying out of this wetland to such a degree that cranes now leave the site by the middle of the dry season and at Hon Chong, conversion of wetlands for intensive farming and shrimp production as well as the continued expansion of a clay pit for cement production has caused the numbers of cranes visiting this site to decline dramatically. In addition, intensified use of the Ang Trapeang Thmor Reservoir for irrigation needs to be understood as this may have large impacts on the wetland ecosystem and the cranes.

## លទ្ធផលនៃការធ្វើជំរឿនសត្វក្រៀមក្រាវលង្វាតំបន់ប្រចាំឆ្នាំ២០១១

ការរាប់ចំនួនសត្វក្រៀមក្រាវត្រូវបានធ្វើឡើងនៅពេលវេលាដូចគ្នាតាមខែនីមួយៗក្នុងប្រទេសកម្ពុជា និង ប្រទេសវៀតណាម ដែលជាប្រទេសក្នុងតំបន់ ដោយបានចាប់ផ្តើមពីខែមករា រហូតដល់ ខែមេសា ឆ្នាំ២០១១ ដើម្បីពិនិត្យតាមដានវត្តមាន និង រាប់ចំនួនសរុបរបស់វា។ ការរាប់ចំនួនសត្វក្រៀមក្រាវត្រូវបានធ្វើឡើងនៅចុងខែមីនា ជារៀងរាល់ឆ្នាំ ចាប់ផ្តើមពីឆ្នាំ២០០១កន្លងមក ប៉ុន្តែទើបតែមានការរាប់ចំនួនបន្ថែមធ្វើឡើងក្នុងខែមករា និង ខែកុម្ភៈ ចាប់ពីឆ្នាំ២០០៨ និង ចុងខែមេសា ជាលើកដំបូងក្នុង ឆ្នាំ២០១០ ប៉ុណ្ណោះ ។

ចំនួនសត្វក្រៀមក្រាវខ្ពស់បំផុតដែលគេកត់ត្រាបានក្នុងខែកុម្ភៈ ឆ្នាំ២០១១នេះ មានចំនួនសរុប៨៦៩ក្បាល ដោយបានរាប់នៅ ទីតាំងចំនួន១១កន្លែង ។ ចំនួនសរុបនេះស្មើតែដូចគ្នាទៅនឹងចំនួនដែលគេបានកត់ត្រាក្នុងឆ្នាំ២០០២ មានចំនួន ៨៧៨ក្បាល ។ ចំនួន សរុបរបស់វាខ្ពស់បំផុតមានការប្រែប្រួលពីចំនួន ៧០០-៩០០ក្បាល សម្រាប់បណ្តាឆ្នាំកន្លងមក ហើយវាគ្មានភស្តុតាងណាមួយមក បញ្ជាក់ឱ្យបានច្បាស់លាស់នូវការប្រែប្រួលនេះបានឡើយ ចាប់តាំងពីឆ្នាំ២០០១កន្លងមក(រូបទី២) ។ តាមរយៈការធ្វើជំរឿននេះ បានបង្ហាញឱ្យឃើញថា ចំនួនសត្វក្រៀមក្រាវសរុបក្នុងតំបន់មានសភាព ប្រសើរក្នុងកំឡុងរយៈពេលនេះ ។

ទោះបីជាយ៉ាងណាក៏ដោយ ក៏វាមានភាពខ្លះចន្លោះខ្លះដែរកើតមានឡើងនៅពេលមានការរាប់ចំនួនសត្វក្រៀម ធ្វើឡើង នៅចុងខែមីនា និង ដើមខែមេសា ។ ការធ្វើជំរឿននេះអាចផ្តល់ការប៉ាន់ស្មានមួយដែលមានចំនួនប្រហាក់ប្រហែលទៅនឹងចំនួនពិត ប្រាកដរបស់វា ដែលសត្វក្រៀមភាគច្រើនបានផ្លាស់ទីមករកចំណីប្រមូលផ្តុំក្នុងតំបន់សមស្របតែពីរ-បីតំបន់ប៉ុណ្ណោះ នៅក្នុងរដូវ ប្រាំង ។ ប៉ុន្តែសម្រាប់ពីរឆ្នាំចុងក្រោយនេះ ការរាប់ចំនួនរបស់វាធ្វើឡើងនៅចុងខែមីនា មានចំនួនទាបជាងការរាប់ចំនួនពីមុនៗ មក ។ ការរាប់ចំនួនក្នុងខែមករា ឆ្នាំ២០១០ សត្វក្រៀមមានចំនួនច្រើនជាងការរាប់ចំនួនក្នុងខែមីនា គឺចំនួន១៤៩ក្បាល ហើយក្នុង ឆ្នាំនេះការរាប់ចំនួនក្នុងខែកុម្ភៈមានចំនួនច្រើនជាងការរាប់ចំនួនរបស់វាក្នុងខែមីនា គឺចំនួន១៣៣ក្បាល ។ បណ្តាតំបន់ដែលស្ថិត នៅតាមដីសណ្តរទន្លេមេគង្គអាចចាត់ទុកថា ជាទីកន្លែងដែលមានការខ្លះចន្លោះក្នុងការរាប់ចំនួនសត្វក្រៀមក្រាវក្នុងខែមីនា ដូច្នេះការ ងារបន្តចាំបាច់ត្រូវស្វែងរកនូវទីកន្លែងដែលសត្វក្រៀមផ្លាស់ទីមករកចំណី និង ធានាថា ការធ្វើជំរឿនសត្វក្រៀមមានភាពប្រាកដ ប្រជាក្នុងទីតាំងភូមិសាស្ត្រជីវសាស្ត្រក្នុងតំបន់ (bio-geographical region) ។ នៅពេលជាមួយគ្នានេះដែរ វាមានសារៈសំខាន់ក្នុងការ បន្តរាប់ចំនួនរបស់វាឱ្យបានច្រើនដងក្នុងមួយរដូវរកចំណីរបស់វា ។

សត្វក្រៀមប្រើប្រាស់តំបន់ជាច្រើនកន្លែងផ្សេងៗគ្នាក្នុងរដូវមិនបង្កាត់ពូជ(រដូវប្រាំង) ដូច្នេះវាមានសារៈសំខាន់ណាស់ក្នុង ការរក្សានូវបណ្តាញការរាប់ចំនួនក្នុងប្រទេសនីមួយៗនៅតាមតំបន់ការពារ តំបន់គ្រប់គ្រង និងអភិរក្ស ឱ្យបានល្អធ្វើយ៉ាងណាត្រូវ ចេះបត់បែនទៅតាមស្ថានភាពទឹក និង ការផ្លាស់ប្តូរទីតាំងរកចំណីរបស់វា ។ នេះគឺជាភាពជាក់លាក់មួយអំពីរបៀបនៃសត្វ ក្រៀមទទួលបានពីការរាប់ចំនួនរបស់វាក្នុងឆ្នាំ២០១១ ។ ក្នុងខែមករា សត្វក្រៀមចំនួន៥៣%នៃចំនួនសរុប៥៧៩ក្បាល បានមក ប្រមូលផ្តុំនៅតំបន់អភិរក្សសត្វក្រៀមបឹងព្រែកល្អៅ ខណៈពេលនោះដែរមានសត្វក្រៀមចំនួន២២% មានវត្តមាននៅតំបន់អភិរក្ស សត្វក្រៀមអាងត្រពាំងថ្ម ។ ក្នុងខែកុម្ភៈ សត្វក្រៀមស្ទើរតែទាំងអស់បានហើរចេញពីតំបន់អភិរក្សសត្វក្រៀមបឹងព្រែកល្អៅ ហើយ តំបន់អភិរក្សសត្វក្រៀមអាងត្រពាំងថ្មបានកើនឡើងដល់៣១% នៃចំនួនសរុប៨៦៩ក្បាល រីឯតំបន់អភិរក្សសត្វក្រៀមអន្លង់ព្រីង និង តំបន់ Phu My (ក្នុងប្រទេសវៀតណាម) មានចំនួន៣០% ។ តំបន់រកចំណីថ្មីមួយទៀតទើបតែគេបានរកឃើញនៅតំបន់ Kieng

Luong (ក្នុង ប្រទេសវៀតណាម) ជាប់ជាមួយនឹងតំបន់មួយផ្សេងទៀតដែលគេបានរាប់ពីមុនៗមក សត្វក្រៀមមានចំនួន២១២ ក្បាលស្មើនឹង២៤% នៃចំនួនសរុបរបស់វា កត់ត្រាបានក្នុងខែកុម្ភៈ។ មកត្រឹមខែមីនា តំបន់អភិរក្សសត្វក្រៀមអាងត្រពាំងថ្ម មានចំនួនសត្វក្រៀមកើនឡើងដល់៤៩% តំបន់អភិរក្សសត្វក្រៀមអន្លង់ព្រីនមានចំនួន៣៤% និង តំបន់ Tram Chim (ក្នុងប្រទេស វៀតណាម)មានចំនួន១៣% នៃចំនួនសរុបរបស់វា ។ របាយក្នុងខែមេសា មានការប្រែប្រួលតិចតួច (សត្វក្រៀមសរុបមានចំនួន ៥០៥ក្បាលត្រូវបានគេកត់ត្រាដែលសត្វក្រៀមមួយចំនួនផ្សេងទៀត អាចផ្លាស់ទីវិលត្រលប់ទៅរកទីកន្លែងពងកូនរបស់វាវិញ) ក្នុង នោះតំបន់អភិរក្សសត្វក្រៀមអាងត្រពាំងថ្មមានចំនួន២៨% តំបន់អភិរក្សសត្វក្រៀមអន្លង់ព្រីន និង តំបន់ Phu My មានចំនួន ២៤% តំបន់ Hon Chong (ក្នុងប្រទេសវៀតណាម)មានចំនួន២០% តំបន់ Tram Chim មានចំនួន១០% និងតំបន់វាលលិចទឹក បឹងទន្លេសាបមានចំនួន១០% ។

ស្របពេលដែលការប្រើប្រាស់ដីធ្លី និងការអភិវឌ្ឍប្រព័ន្ធធារាសាស្ត្រមានការកើនឡើង ធ្វើឱ្យមានផលប៉ះពាល់ដល់ទី កន្លែងផ្តល់ប្រភពចំណីអាហាររបស់សត្វក្រៀមក្នុងរដូវកំណើ។ ឧទាហរណ៍ ក្នុងទសវត្សកន្លងមក មានតម្រូវការប្រព័ន្ធធារា សាស្ត្រច្រើនក្នុងការធ្វើស្រែជុំវិញតំបន់អភិរក្សសត្វក្រៀមបឹងព្រែកល្អៅ បានធ្វើឱ្យតំបន់ដីសើមនេះឆាប់រឹងស្ងួតហួតហែង ហើយ សត្វក្រៀមបានហើរចេញពីតំបន់នេះនៅពាក់កណ្តាលរដូវប្រាំង រីឯនៅតំបន់ Hon Chongវិញ ការប្រែក្លាយតំបន់ដីសើមទៅជាស្រែ បង្កា ព្រមទាំងការដឹកយកដីឥដ្ឋមកលាយជាមួយថ្មកំបោរសម្រាប់ផលិតស៊ីម៉ង់ត៍ បានធ្វើឱ្យចំនួនសត្វក្រៀមថយចុះយ៉ាង ខ្លាំង។ ជាងនេះទៀត ការកើនឡើងនៃប្រើប្រាស់តំបន់អភិរក្សសត្វក្រៀមអាងទឹកត្រពាំងថ្មសម្រាប់តម្រូវការស្រោចស្រពផល ដំណាំកសិកម្ម អាចមានផលប៉ះពាល់យ៉ាងធ្ងន់ធ្ងរដល់ប្រព័ន្ធអេកូឡូស៊ីតំបន់ដីសើម និង សត្វក្រៀមក្នុងតំបន់នេះ ។

## Introduction

### *Global status of Sarus Cranes and the South-East Asia regional census as a monitoring tool*

The Sarus Crane ranges from India to Australia and has been classified as “Vulnerable” to extinction (BirdLife International, 2011). It was once distributed throughout mainland South-East Asia, but has undergone a severe decline over the past 50 years through habitat loss and hunting, and is now restricted to parts of Cambodia, extreme southern Laos, southern Vietnam and parts of Myanmar (BirdLife International 2011). The population of Sarus Crane in Cambodia, Vietnam and Lao PDR, although not a distinct sub-species, is now isolated (Barzen and Seal 2001) and the severity of threats to Sarus Cranes across most of their range warrants conservation strategies to focus upon preventing further extinction of such fragmented populations (Jones *et al.* 2005).

Cranes breed in the wet season. Most breeding areas of the surveyed population are located in northern and eastern Cambodia with a very few nests likely to exist in southern Lao PDR, the Central Highlands of Vietnam, and possibly in southwest Cambodia (Barzen 2004; ICF, unpubl. data). Early in the dry season, in November to December, cranes start to move towards the floodplains where they will forage in wetlands until the early stages of the wet season (May to June). Feeding sites are widely distributed, but as water sources dry up, birds are concentrated at the few remaining suitable wetlands. The Wildlife Conservation Society (WCS) in Cambodia and the International Crane Foundation (ICF) in Vietnam, coordinate synchronized counts at key wetlands each year that help to assess the population levels and distribution of Sarus Cranes in the region. The census in Cambodia and Vietnam covers a large part of the known regional dry season distribution and is therefore a valuable monitoring tool.

### *Sites covered by the South-East Asia regional census*

Annual counts of Sarus Cranes *Grus antigone* have been held each year in Cambodia and Vietnam since 2001. As many as sixteen count sites (*e.g.* in 2006) are covered during a three day window. For sites in close proximity to each other the counts are exactly synchronized to be performed together, *e.g.* in the Mekong Delta region where there are many small sites cranes can move across within a day.

Crane distribution can be largely divided in to three distinct eco-regions: the deciduous forests of the northern and eastern plains in Cambodia; the Mekong Delta region of Cambodia and Vietnam; and the Tonle Sap lake basin, centered on grasslands and agricultural fields in the eastern floodplain and including Ang Trapeang Thmor, a large wetland in close proximity to the floodplain.

### Tonle Sap basin

The Tonle Sap basin count sites are usually grouped into two for reporting: Ang Trapeang Thmor and the Tonle Sap grasslands (which contain up to six count sites in any one year). Past monitoring has shown that cranes mainly feed in the Tonle Sap grasslands in the early stage of the dry season, with highest census counts obtained in January, when large tracts are suitable for foraging and have not yet dried out completely (see van Zalinge *et al.* 2008-2010). Some individuals and small groups remain in the Tonle Sap grasslands throughout the dry season, also making use of adjacent rice fields and irrigation reservoirs with shallow water that contain forage.

Much of the Tonle Sap grasslands are unprotected and most of the very large grasslands have disappeared over the past six-eight years (Gray *et al.* 2009, Packman *in prep.*). Current protected areas and where monitoring is focused are the three Bengal Florican Conservation Areas: Chikraeng (Siem Reap), Stoung and Baray (Kampong Thom). There are two unprotected crane sites: Krous Kraom, southwest of Kampong Thom town, which is usually included in the counts; and Preah-Net-Preah in Banteay Meanchey province, which has historic records, but where no cranes were found during visits to the site in 2009 and 2010.

Ang Trapeang Thmor (ATT) is a large man-made reservoir in Banteay Meanchey province. It is located very close to the Tonle Sap floodplain and there is considerable movement of many species between the floodplain and ATT at various times of the year (van Zalinge *et al.* 2008). Sarus Crane numbers start increasing at ATT as the dry season progresses with maximum counts typically occurring in March and April (WCS & ICF 2010). ATT is a permanent wetland with forage available for cranes even at the end of the dry season. Of all sites ATT holds the record number of cranes

counted with 439 cranes present in April 2008 (Ngin Kamsan *et al.* 2010). The average highest count per year, between 2004 and 2010 was 368. It is a Sarus Crane Reserve established by Royal Decree. However, in the last two years there have been major works on renovating and expanding the irrigation network below the reservoir. No impact assessment has been published and reserve staff were not consulted in the planning stage.

### Mekong delta

Substantial effort goes in to covering the many sites in the delta. Almost every year six sites in the Mekong Delta in Vietnam are included: Tram Chim National Park and a number of sites within the Ha Tien plain which have provincial protected area status: Lang Sen, Phu My, Kien Luong, Hon Dat and Hon Chong. Numbers at Hon Chong declined dramatically around 2007 and for the next two years the number of cranes counted in the Vietnamese Mekong Delta were about a hundred cranes lower than normal. This suggests that not all feeding sites had been identified (van Zalinge *et al.* 2010). However, there have since been recent increases observed at Phu My and Kien Luong, bringing numbers back to normal levels. The main period for crane presence at the sites is January to May.

There are three sites in Cambodia that we also include under the Mekong Delta sector. Boeung Prek Lapouv (BPL) is a Sarus Crane Reserve with similar ecology to that of the Tonle Sap lake. The site is heavily inundated in the flood season and cranes forage here in the early dry season, progressively leaving for other sites within the Mekong Delta as conditions become drier and the last having departed by mid February. Between 2004 and 2010 the average of the highest count per year was 250 cranes, which represents around 70% of the average totals for the Mekong Delta counted later in March. This gives an indication of the importance of BPL as an early dry season feeding site for cranes using the Mekong Delta.

Anlung Pring (previously referred to as Kampong Trach) is also a Sarus Crane Reserve, established in January 2011, and almost adjoining Phu My in Vietnam. Cranes frequently move *en masse* between the sites and any cross border movements occurring during the count period are recorded. Data are presented as from a single site. Cranes especially use Anlung Pring from January to May. Between 2004 and 2010 the average of the highest

count per year was around 170 cranes, the third highest total, after ATT and BPL.

### Northern and eastern plains

It is likely that small clusters of cranes gradually move out of their breeding grounds in the deciduous forests of the northern and eastern plains of Cambodia at the start of the dry season and gradually return once the rains set in. However, some individuals and pairs remain in this landscape throughout the dry season, feeding in the small wetlands and ponds that remain. The census includes the plains as although occurring at low density, the total number of cranes can be significant, *e.g.* in 2006, the highest count from the plains was recorded at fifty individuals, which was six percent of the total count in that year (Triet *et al.* 2007). As the area is large, a substantial amount of effort is required to cover all the potential locations and in practice only a non-random selection of the more promising locations is covered each year.

The three sites in the northern plains: Kulen Promtep Wildlife Sanctuary (KPWS), Preah Vihear Protected Forest (PVPF) and Western Siem Pang are included in most years but inclusion of sites in the eastern plains is highly variable between years. Western Siem Pang is currently not a protected area, but due to its high importance for various globally endangered species BirdLife International in Indochina and the Forestry Administration are working towards its official designation as such. In 2011, 26 nests were protected in KPWS and 24 in PVPF. Based on census data between 2008-2010, PVPF had the highest average number of cranes during the dry season (8.8 cranes, n=5) followed closely by KPWS (6.8 cranes, n=6), while Western Siem Pang had an average of 2.8 cranes (n=6). Of the sites in the eastern plains, Lomphat Wildlife Sanctuary is likely to hold the highest number of cranes and is occasionally included in the census, but capacity of staff to implement counts is still low. Mondulkiri Protected Forest has typically held at least ten cranes through each recent dry season, possibly significantly more (T. Gray pers. comm.).

There are two deciduous forest sites in Vietnam sometimes included in the counts: Yok Don National Park and Lo Go Xa Mat National Park. There have been no definite breeding records from these sites, but non-breeding cranes have been recorded in the past.

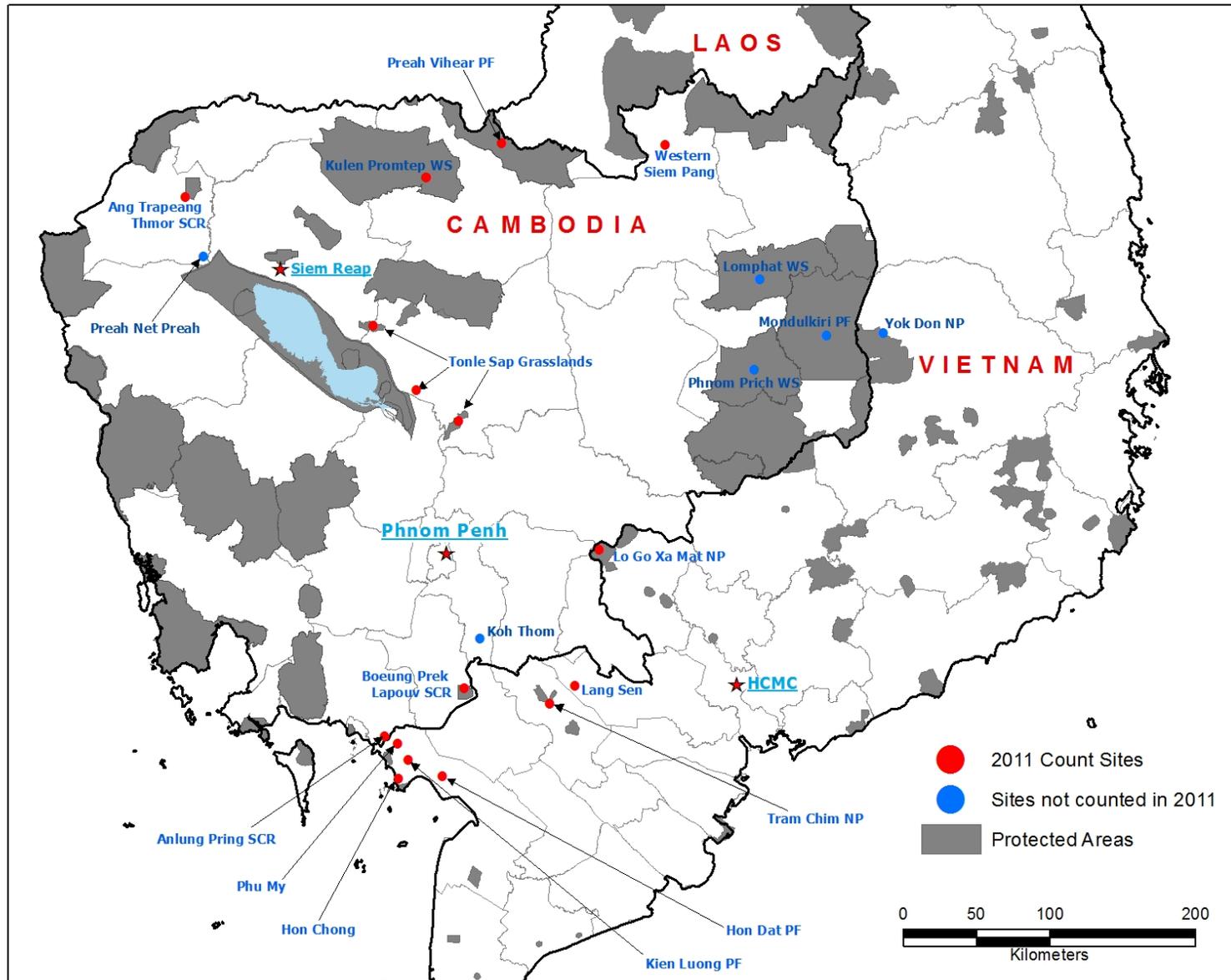


Figure 1. Map of Sarus Crane count sites in 2011

## Methods

During 2001-2007 a census was done once annually, in late March/early April, at the height of the dry season, when cranes were expected to be concentrated at the relatively few suitable wetlands that remain for feeding at this time of the year (Triet *et al.* 2006; Nguyen Phuc Bao Hoa *et al.* 2007). In 2008 it was decided to conduct counts once a month from January to March and assess shifts in distribution across sites as the dry season progresses (van Zalinge *et al.* 2009a; van Zalinge *et al.* 2009b). In 2010, April was added as a fourth counting period, as individual site monitoring data showed that there can be further shifts in distribution in the early wet season (van Zalinge *et al.* 2008; van Zalinge *et al.* 2010).

In 2011, crane counts were conducted across Cambodia and Vietnam on four dates (Table 1, Figure 1): 21-23 January (eleven sites), 25-27 February (eleven sites), 25-27 March (eleven sites) and 29-30 April (twelve sites). These include most of the sites where cranes are known to occur in the dry season, and all the most important known sites were covered in each census. For discussion and analysis, the regions covered were grouped in three broad ecological areas: the Tonle Sap Lake basin, the Mekong delta, and the northern and eastern deciduous forests regions (Table 1).

Sarus Cranes are more concentrated at some sites than others, requiring two survey approaches. ATT, Anlung Pring-Phu My and most of the sites in Vietnam are relatively small and Sarus Cranes congregate predictably in large numbers at the time of the census; in these areas coordinated surveys were carried out using teams of observers to perform synchronized counts covering the whole area. These counts were held at key times when the local population was likely to be grouped and not mobile - such as first thing in the morning or late in the afternoon when birds are present at roost sites.

At the other sites where the location of the cranes is less predictable, the survey approach was to travel around the area to make opportunistic crane observations during the day. Counters were allowed to give their own totals, which could be based on multiple days within the census period, but details on dates, times and locations of all observations were checked to try and avoid multiple counts of the same individuals, *e.g.* the

combination of time between crane observations and distance between observations was considered. Normally, areas counted on different days were sufficiently distant for it to be unlikely that individuals would have travelled from the first sites to be counted a second time. If sites were close enough to have allowed cranes to move from one site to another between counts, a conservative approach was adopted by taking the count from one site only.

Some counts from Western Siem Pang several days outside of the count period were used as this site is isolated from other count sites. However, it was not possible to use all data obtained as the time between counts was too large and double counting could have occurred.

Due to logistical and organizational constraints in conducting a region-wide census it was not always possible to conduct surveys at all sites for all of the dates and therefore effort was not constant for all months.

The crane site of Anlung Pring-Phu My is situated on the Cambodia-Vietnam border, and the cranes move daily between feeding and roosting sites on both sides of the border. For clarity, a single count is presented for both sites.

During the census periods observers counted the total number of cranes seen. Observers were also asked to record details of crane behavior, such as whether they were feeding, roosting, flying overhead, etc., as well as basic information about the site where the cranes were observed. Counting juveniles is encouraged, but is often difficult in large and distant groups, especially as counting teams rarely have telescopes.

Table 1. Count dates for sites surveyed during the 2011 Sarus Crane census (see Figure 1 for locations)

Site name	Country <sup>x</sup>	Count 1	Count 2	Count 3	Count 4	Organizations <sup>^</sup>
<i>Date of Count</i>						
<b><i>Tonle Sap basin</i></b>						
Ang Trapeang Thmor SCR <sup>y</sup>	C	21-22/1	26-27/2	25-26/3	29-30/4	FA/WCS
Tonle Sap Grasslands <sup>a</sup>	C	21-22/1	26-27/2	25-26/3	29-30/4	FA/WCS
<b><i>Mekong delta</i></b>						
Boeung Prek Lapouv SCR <sup>y</sup>	C	22/1	26-27/2	26-27/3	29-30/4	FA/FiA/WWT
Anlung Pring/Phu My <sup>‡</sup>	C/V	22/1	26/2	26/3	29/4	FA/WWT/ICF
Tram Chim National Park	V	22/1	27/2	26/3	29/4	NP
Lang Sen	V	22/1	27/2	26/3	29/4	ICF
Hon Chong	V	21-22/1	26-27/2	26-27/3	29/4	ICF
Kien Luong <sup>**</sup>	V	-	26-27/2	26-27/3	29/4	ICF
Hon Dat	V	-	-	26/3	29/4	ICF
<b><i>Northern/Eastern Deciduous Forests</i></b>						
Preah Vihear Protected Forest	C	21-23/1	25-27/2	-	29-30/4	FA/WCS
Kulen Promtep Wildlife Sanctuary	C	21-23/1	25-27/2	25-27/3	-	MoE/WCS
Western Siem Pang	C	24/1	-	-	23/4	FA/BL
Lo Go Xa Mat	V	22/1	27/2	26/3	29/4	NP

<sup>x</sup> C - Cambodia, V – Vietnam

<sup>^</sup>Participating organizations/institutions: BL- BirdLife International in Indochina; FA- Forestry Administration, Cambodia; FiA-Fisheries Administration, Cambodia; ICF- International Crane Foundation; MoE- Ministry of Environment, Cambodia; NP- National Park staff, Vietnam; WCS- Wildlife Conservation Society; WWT – Wildfowl & Wetlands Trust

<sup>y</sup> Sarus Crane Reserve

<sup>a</sup> includes Stoung, Chikraeng, Baray and Chong Doung Bengal Florican Conservation Areas (BFCAs), as well as grasslands in Krous Kraom

<sup>‡</sup> The Anlung Pring (Cambodia) and Phu My (Vietnam) sites are considered a single site for the purpose of the crane census and counted simultaneously due to their close proximity. Cranes move back and forth across the border each day between feeding and roosting site

<sup>\*\*</sup>In 2011 a second site was found at Kien Luong in February. Both the original and new sites were counted in every subsequent census period.

## Results

This is the second year since multiple counts throughout the dry season began in 2008 that the highest count did not occur around late March (Table 2). February had the highest number with 869 cranes counted at the eleven sites surveyed. This is only five cranes more than last year's maximum count in January and is the second highest total count on record (878 cranes were counted in March 2002). In late March 152 fewer cranes were counted at eight of the twelve sites covered. The January count in 2011 was almost 300 cranes lower than in 2010.

In the February count 562 cranes were counted in the delta and 295 in the basin, while in March,

numbers were almost equal between the regions at 361 in the delta and 373 in the basin (Figure 2). This makes a total of 201 fewer cranes counted in the delta in March compared to just one month earlier. By April, the total number of cranes counted dropped to around five hundred. The decline in numbers was greater within the basin than in the delta.

Within the delta a highly variable use of sites can be observed, with only Tram Chim and Anlung Pring - Phu My having cranes present in all census months.

Table 2. Minimum number of Sarus Cranes present at each site during the four 2011 censuses

Site	Jan	%	Feb	%	Mar	%	Apr	%
<b>Tonle Sap basin</b>								
Ang Trapeang Thmor	127	22	273	31	357	49	142	28
Tonle Sap Grasslands*	45	8	22	3	16	2	49	10
<b>Mekong delta</b>								
Tram Chim	28	5	63	7	94	13	48	10
Boeung Prek Lapouv	304	53	21	2	0	-	0	-
Anlung Pring/Phu My <sup>^</sup>	48	8	259	30	251	34	123	24
Hon Chong	0	-	2	<1	0	-	100	20
Lang Sen	0	-	5	1	11	1	2	<1
Kien Luong	0	-	96	11	1	<1	4	1
Kien Luong 2	0	-	116	13	0	-	22	4
Hon Dat	0	-	0	-	4	1	0	-
<b>Northern/Eastern deciduous forests</b>								
Preah Vihear Protected Forest	10	2	8	1	-	-	13	3
Kulen Promtep Wildlife Sanctuary	14	2	4	<1	2	<1	-	-
Western Siem Pang	3	1	-	-	-	-	2	<1
Lo Go Xa Mat	0	-	0	-	0	-	0	-
<b>Total</b>	<b>579</b>		<b>869</b>		<b>736</b>		<b>505</b>	

\* Jan: 14 in Stoung-Chikraeng, 12 in Krous Kraom and 19 in Baray; Feb: 7 in Stoung-Chikraeng, 9 in Krous Kraom and 6 in Baray; Mar: 3 in Stoung-Chikraeng and 13 in Krous Kraom; Apr: 6 in Baray, 43 in Stoung-Chikraeng

<sup>^</sup> Jan: 42 in Anlung Pring and 3 in Phu My; Feb: 231 in Anlung Pring and 28 in Phu My; Mar: 251 in Anlung Pring; Apr: 87 in Anlung Pring and 36 in Phu My

### Tonle Sap basin sites

The number of cranes counted at Ang Trapeang Thmor (ATT) gradually increased between January and March, with numbers dropping sharply in April. However, this was reversed in the Tonle Sap grasslands, where counts were highest in January and April.

The March count at ATT was 357 cranes, which is exactly the average of annual March/April counts at ATT since 2002 (Table 3). The April 2011 count was substantially lower than the 2010 count (366 cranes), possibly indicating an earlier departure to breeding grounds.

Within the Tonle Sap grasslands there are six sites (shown graphically as four sites in Figure 1 as some sites are adjacent to each other). Since cranes

appear to be highly nomadic in this area, with unpredictable fluctuations at individual sites, it is helpful to consider total counts for the six sites together. The highest numbers have typically been found in January, when conditions are still wet, however, this year's count was much lower than

past January counts have been, with an average of 153 cranes counted in previous years (2008-2010). The additional count in April picked up an increase in numbers towards the end of the non-breeding season, as was also observed in 2010.

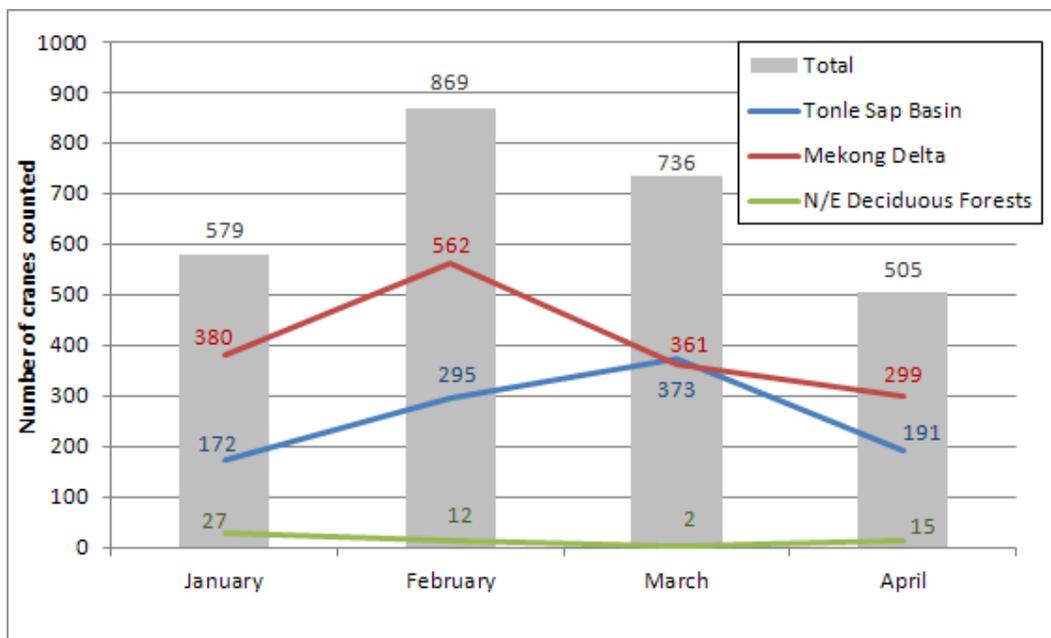


Figure 2. Fluctuations in crane numbers counted between census periods in 2011, by biogeographic region

### Mekong delta sites

The January count at Boeung Prek Lapouv (BPL) of 304 birds is a new site record. The previous highest count is 301 birds in January 2003. Annual peak counts from 2004 to 2010 have been between 210 and 297 cranes. The January 2011 count represents 35% of the highest total count recorded in a census month (869 cranes in February) and is 54% of the highest count for the delta (562 cranes in February). Cranes start abandoning the site as it becomes drier and the trend seems to be that this is occurring progressively earlier over time (Eames 2011). The last observation from BPL this year was 2 cranes on the 20<sup>th</sup> of February (A. John and R. van Zalinge, pers. obs.).

The Anlung Pring - Phu My site held 259 cranes in February. For Anlung Pring alone, the highest count was 251 cranes on 26 March. At nearby Kien Luong, in February, 116 cranes were found at a new location and this find contributed greatly to the overall count (13%). At the same time an almost equally high count (11%) was obtained from the original Kien Luong count site.

As in Anlung Pring, Tram Chim had cranes present in all census months, with the highest count occurring in March. A peak in March follows last year's results, but from 2005-2008 numbers at Tram Chim had consistently peaked in April (Nguyen Phuc Bao Hoa *et al.* 2007, van Zalinge *et al.* 2009a).

At Hon Chong no cranes were recorded until one hundred were found using the site in April. Although numbers are very variable, the site still holds significant value for crane conservation.

Crane numbers at Lang Sen and Hon Dat were very low with 11 and 4 cranes counted in each of the two respective sites in March.

### Northern/Eastern dry forests

In the Preah Vihear Protected Forest 8-13 cranes were found in census months and 2-14 cranes in Kulen Promtep Wildlife Sanctuary. Similar to other recent years, only 2-3 cranes were located in Western Siem Pang.

## Discussion

### Coverage and data quality

Coordinated counts of the main sites are intended to provide a minimum estimate of the total biogeographical population in the lower Mekong region. All the main known regularly used sites were covered during the 2011 census.

It has been an assumption since 2001 that late March/early April was the most efficient moment to conduct these counts, since the highest proportion of birds would then be concentrated in the smallest area of available habitat and the minimum estimate would be as close as possible to the true figure. Figure 3, below shows that when comparing January, February and March, March had the least variation between years and this stability would appear to make it a suitable month to use for annual counts. However, in 2010 and 2011 the peak counts did not occur in March, which means that cranes were not increasingly concentrated at current count sites than they were in January or February. Where had the missing cranes gone?

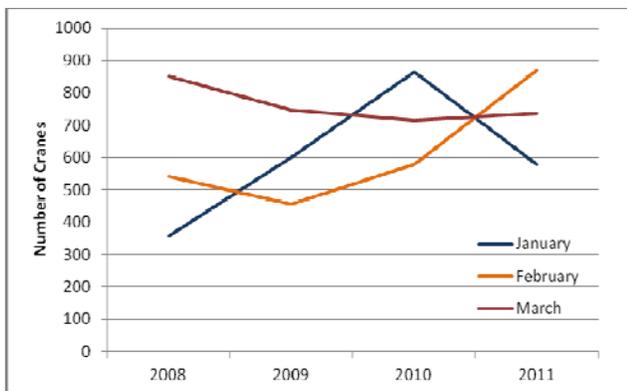


Figure 3. Crane numbers in January, February and March counts between 2008 and 2011

From Figure 2 and Figure 4 it can be seen that in both 2010 and 2011 the peaks in January and February compared to March occurred within the delta. Therefore, either the missing cranes moved out of the delta or the already evident periodic use of a wide variety of sites in the delta includes one or more unknown sites. The finding of a new site in February at Kien Luong helped push that month's count up considerably, however in March there were no cranes present. It is therefore quite possible that there are still more sites in the delta,

perhaps even transient sites that are only suitable for one or two years at a time, that are not being covered by the census. This could partly explain the high degree of variation in total counts between years (see next section) as has long been suspected.

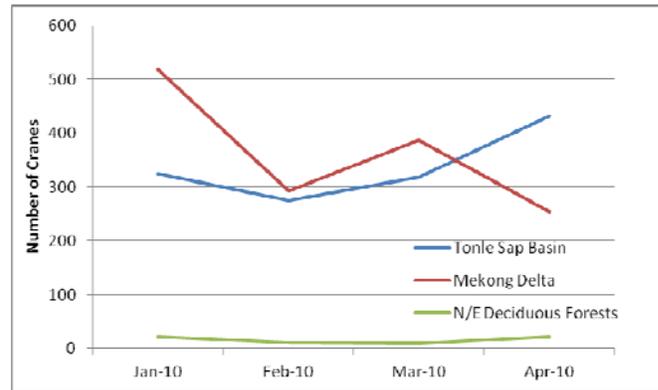


Figure 4. Monthly crane counts in 2010 for the different bio-geographic regions.

The problem of possible gaps in coverage needs to be resolved to increase the usefulness of the monitoring program. One likely candidate area to contain 'missing cranes' has been identified in the Vietnamese part of the delta, but it is a military-controlled area and access for ornithologists is not straightforward, and no count was done there in 2011.

Comments from the 2007 report regarding the difficulties of precise counting still hold, especially for large flocks. Numbers are probably often under-estimated, and if the level of under-estimate varies between years (due to e.g. observer differences, count timing, local movements, vegetation structure etc.) this could obscure gradual trends for several years. Counters also often concentrate on sites within a protected area while cranes may be periodically using nearby sites located outside of the PA. For the crane census it is important that sites, both in and outside of PAs, are identified and covered through preparatory visits before the census day(s).

### Totals compared to previous years

The hard effort of all counting teams, conducting counts four times a year, has paid off with maximum counts of 864 and 869 being obtained in 2010 and 2011, respectively.

The March counts show substantial fluctuation between 2001 and 2011 and no clear trend can be detected (Figure 5). For example the total count decreased by 122 individuals between 2006 and 2007, but then increased by 160 in 2008 (Table 3). Between 2009 and 2011 the March counts varied less, with totals between 715 and 747 cranes, although 2010 and 2011 data show that in these two years, at least around 140 cranes were consistently missed.

Aside from 2001, in which numbers were unusually low, presumably because too few sites were covered in that first year, minimum numbers have fluctuated between approximately 700 and 900 each year. There is therefore no evidence of any strong trend in the total population.

Sarus Cranes are long-lived, slow-maturing birds so short-term fluctuations are presumably due to changes in the proportion of birds counted during the census rather than absolute population size, but there may also be underlying trends in the true numbers, which are important to track for management purposes.

Mortality data are unavailable, although it is many years since there were reports of large-scale hunting or poisoning of cranes on their non-breeding grounds (*e.g.* Goes and Hong Chamnan 2001). Recruitment is also poorly known overall. Nest monitoring data from Kulen Promtep Wildlife Sanctuary and the Preah Vihear Protected Forest suggest high breeding success at protected nests, with 50 nests guarded and 73 chicks leaving the nest during the 2011 rainy season (WCS 2011). However, chicks are likely to still be very vulnerable before they develop flight feathers. Chicks are still occasionally found kept as pets by people living near breeding areas (H. Rainey and M. Handschuh, pers. comm.) and there is likely to be some trade.

It has not yet been possible to estimate reliably the proportions of first year birds in the non-breeding season population in recent years, but this is the most informative measure of annual recruitment and further efforts should be made to count first year birds separate from adults. First year birds can be differentiated reliably as they still have brown feathered heads, compared to the bare red heads of adults.

### *Trends in the two main sub-regions*

The proportion of cranes “wintering” in the Mekong delta versus the Tonle Sap basin, as indicated by regional counts, has changed over time. In the initial period from 2001 to 2003 crane numbers were substantially higher in the delta until conditions at Boeung Prek Lapouv had changed to such a degree that all cranes had left ahead of the census period (March). In 2007, after a huge drop in numbers at Hon Chong, the number of cranes counted in the delta remained lower than in the basin until 2009. During this period a gradual increase occurred within the basin. In the last three years the number of cranes within the two bio-geographic regions has been very similar, with numbers stable in the delta and a slight decrease occurring in the basin. However, as indicated earlier it may be that a substantial portion has been missed in the delta, following the decline in numbers at Boeung Prek Lapouv and Hon Chong in March (see “site-specific conservation issues”, below).

It is not yet clear if individuals will always fly to the same bio-geographic region post-breeding and if they may leave a region for another within the dry season. This is vital information to fully understanding the monitoring data. Monitoring data do indicate that frequent movements occur between sites within the delta.

### *Site-specific conservation issues*

Degradation of crane feeding sites in the Mekong delta may also be making it increasingly difficult for cranes to feed at the key sites for long periods of time. Cranes have stopped feeding at Boeung Prek Lapouv in the mid-late dry season since 2004, likely due to the drier conditions that still prevail today and that are progressively becoming more severe (Seng Kim Hout and J. Eames, pers. comm.). This is very likely to be the result of the expansion of dry season rice in this area and a correlated increase in irrigation.

The site at Hon Chong used to support as many as 360 cranes in March (see figure 6), however, the installation of a cement production plant has caused the numbers of cranes visiting this site to decline dramatically.

Compensatory increases have been observed at Anlung Pring and Phu My, and cranes currently

stay in large numbers throughout the dry season at Anlung Pring in particular.

A large network of irrigation channels linked to the Ang Trapeang Thmor reservoir was constructed in 2009. The infrastructure was poorly designed and is

currently not used to its full potential, however it is clearly the intent to intensify use of the reservoir, which will probably affect the flood regime and vegetation in the draw down zone where the cranes mainly feed.

Table 3. Annual census results for 2001-2011 in Cambodia and Vietnam

Location	Year	Sarus Crane numbers in end March/early April										
		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
<i>Tonle Sap basin</i>		228	345	339	365	334	373	402	475	367	319	373
Ang Trapeang Thmor SCR		228	345	339	365	334	373	394	439	320	313	357
Tonle Sap Grasslands			6				0	8	36	47	6	16
<i>Mekong delta</i>		411	527	494	417	366	391	272	371	365	387	361
Boueng Prek Lapouv SCR		27	155	138	0	0	0			0	0	0
Koh Thom								4		0	0	
Anlung Pring SCR <sup>^</sup>					126	56	136	131	183	225	140	251
Phu My				6								
Tram Chim NP		48	11	61	96	82	89	125	103	78	85	94
Lang Sen				0	0	0	0	0	7	12	13	11
Kien Luong PF <sup>~</sup>				29	0	0	0	0	7		143	1
Hon Dat PF				2	0	0	0	0	0		4	4
Hon Chong		336	361	258	195	228	166	15	71	50	2	0
<i>Northern/Eastern forests</i>		11	0	4	2	21	43	14	6	15	9	2
Lo Go Sa Mat NP			0	0	0	0	0		0			0
Yok Don NP				0	1	0	0					
Preah Vihear PF							12	8	0	9		
Kulen Promtep WS		11		2			7		4	4	7	2
Western Siem Pang IBA					2	21	0	2	2	2		
Lomphat WS							24	4				
Mondulkiri PF				2							2	
<i>Regional Total</i>		650	878	837	785	721	814	692	852	747	715 (864)*	736 (869)*
<i>Number of Count Sites</i>		5	6	12	12	12	16	13	12	11	12	12

\* The maximum count shown in parantheses if occurring in another month than March, for 2008-2011.

<sup>^</sup> Anlung Pring SCR was referred to as Kampong Trach in previous reports.

<sup>~</sup> In 2011 a second site was found near to Kien Luong and included here

Blanks denote site not surveyed in that year.

Source 2001-2007: Nguyen Phuc Bao Hoa *et al.* (2007). Source 2008-2010: van Zalinge *et al.* (2010)



Figure 5. Chart showing number of cranes counted end March/early April in Cambodia and Vietnam from 2001 – 2011. <sup>⊗</sup> points show the January 2010 and February 2011 total counts.

## **Recommendations**

1. Continue the January, February, March and April counts each year at the main wetland feeding sites.
2. Continue to synchronize counts within the Mekong delta, Tonle Sap grasslands and Ang Trapeang Thmor. Target roost sites identified ahead of the counts and conduct multiple consecutive counts limited to the very early morning (5:30-7:30) and evening (16:30-18:30).
3. Identify any new crane feeding sites in the Mekong delta ahead of the March count. This may require a remote-sensing study among other techniques.
4. Equip teams at main congregation sites with telescopes and attempt to count the number of first year birds in flocks.
6. Continue to include as many deciduous forest sites as possible in at least the main late March/early April count, and other counts where possible. Adding Lomphat and Mondulkiri Protected Forest to the March count next year may be a valuable addition.
7. Develop a methodology for assessing crane numbers in deciduous forest areas where cranes are scattered over a large area.
8. Conduct counts within the days set by the regional coordinator, otherwise they may not be useful.
9. Protected area staff should be attentive of the possibility that cranes are feeding outside of their protected area and cover such locations during the census. All counting teams should be attentive to the possibility that cranes are using temporary feeding sites, different from previous years.
10. Find volunteers to cover unprotected sites where cranes could potentially occur, such as around Preah-Net-Preah, Koh Thom, and Sre Ambel.

Furthermore, it is important to have more information on the ecology of Sarus Cranes, distribution based on changes in environmental conditions, and movement patterns between breeding and non-breeding areas. Such knowledge would help identify other important wetlands on

the Sarus Crane's migration route, identify key variables that might affect Sarus Crane distribution and make it possible to integrate measurement of such variables into the monitoring program.

ICF fitted satellite transmitters on four cranes in 1998 and three in 2001 as part of a study on crane migration. All cranes were also ringed. The data are currently being analyzed for publication. A crane was released at Ang Trapeang Thmor in April 2011 by the Angkor Center for the Conservation of Biodiversity (ACCB). The crane was fitted with a single black leg ring. Details on ringed birds should be shared with others and all local staff working at crane sites and census teams should report any observations of ringed cranes to better understand crane migration.

Conservation recommendations are beyond the scope of this report but, the irrigation project at Ang Trapeang Thmor and the degradation of sites within the delta, especially the progressively drier conditions at Boeung Prek Lapouv and the development that has occurred at Hon Chong, are of concern. It is crucial to maintain a trans-national network of well managed protected areas to allow flexibility in movements within the dry season as water conditions and feeding opportunities change. This will become ever more important as climate change alters the water regimes at key sites in unpredictable ways.

Within the Tonle Sap basin, Ang Trapeang Thmor is the key site and needs to be carefully managed for Sarus Cranes. Potential water level scenarios within the reservoir should be modeled based on future irrigation requirements downstream and the likely impact this will have on wetland vegetation.

## References

- Barzen, J. & U.S. Seal (editors) (2001). Eastern Sarus Crane PHVA Final Report. CBSG, Apple Valley, MN, USA. 187 pp.
- Barzen, J. (2004) An aerial survey of wetlands in northern Cambodia 2001. ICF Cambodia Office, Phnom Penh. 64 pp.
- BirdLife International (2011) Species factsheet: *Grus antigone*. Downloaded from <http://www.birdlife.org> on 25/9/2011
- Eames, J.C. (2011) Boeung Prek Lapouv Sarus Crane Reserve: a new dry grassland? *The Babbler* 37: 19. BirdLife International in Indochina.
- Evans, T., van Zalinge, R., Hong Chamnan and Seng Kim Hout (2008) Records of non-breeding Sarus Cranes in Cambodia in the 2007/8 dry season, including results of the annual census. Unpublished report
- Gray, T. N. E., Collar, N. J., Davidson, P. J. A., Dolman, P. M., Evans, T. E., Fox, H. F., Ro Borey, Hong Chamnan, Seng Kim Hout and van Zalinge, R.N. (2009) Distribution, status & conservation of Bengal Florican *Houbaropsis bengalensis* in Cambodia. *Bird Conservation International* 19: 1-14.
- Goes, F. & Hong Chamnan (2001) Conservation activities at Ang Trapeang Thmor Sarus Crane Conservation Area 1998-2000. Wildlife Conservation Society Cambodia Program, Phnom Penh.
- Jones, K.L., Barzen, J.A., Ashley, M.V. (2005) Geographic partitioning of microsatellite variation in the Sarus Crane. *Animal Conservation*, 8: p1-8.
- Nguyen Phuc Bao Hoa, Evans, T., Tran Triet, Watson, H., Hong Chamnan and Seng Kim Hout (2007) *Records of non-breeding Sarus Cranes in Vietnam and Cambodia. 2001-2007 dry seasons*. International Crane Foundation Vietnam Program, Ho Chi Minh City, Wildlife Conservation Society Cambodia Program, Phnom Penh and BirdLife in Indochina Cambodia Program, Phnom Penh.
- Packman, C., Collar, N. J., Evans, T. E., Gray, T. N. E., Hong Chamnan, Lovett, A.A., Son Virak, van Zalinge, R.N. and Dolman, P. M. (in press.) Accelerating conversion of the last of Southeast Asia's flooded grassland biome.
- Tran Triet, Nguyen Phuc Bao Hoa, Walston, J. (2006). *Sarus Crane counts in Vietnam and Cambodia- April 2006*. Unpublished report to the International Crane Foundation.
- van Zalinge, R.N, Tran Triet, Nguyen Phuc Bao Hoa, Evans, T., Hong Chamnan and Seng Kim Hout (2009a). *Census of non-breeding Sarus Cranes in Cambodia and Vietnam, 2008*. Wildlife Conservation Society Cambodia Program, Phnom Penh, International Crane Foundation Vietnam Program, Ho Chi Minh City and BirdLife in Indochina Cambodia Program, Phnom Penh.
- van Zalinge, R.N., Nguyen Phuc Bao Hoa, Tran Triet, Evans, T., Hong Chamnan, Seng Kim Hout and Barzen, J. (2009b). *Census of non-breeding Sarus Cranes in Cambodia and Vietnam, 2009*. In: Biodiversity monitoring in the floodplain of the Tonle Sap in 2008-9. pp.76-94. Wildlife Conservation Society Cambodia Program, Phnom Penh.
- van Zalinge, R.N., Tran Triet, Evans, T., Hong Chamnan, Seng Kim Hout and Barzen, J. (2010). *Census of non-breeding Sarus Cranes in Cambodia and Vietnam, 2010*. Wildlife Conservation Society Cambodia Program, Phnom Penh, International Crane Foundation Vietnam Program, Ho Chi Minh City and BirdLife in Indochina Cambodia Program, Phnom Penh.
- WCS (2011). Unpublished data from nest protection in the Northern Plains. Wildlife Conservation Society Cambodia Program, Phnom Penh.
- WCS & ICF (2010). Bird Counts at Ang Trapeang Thmor 2001-2010. Unpublished data.