

Status Overview and Recommendations for the Conservation of Milky Stork *Mycteria cinerea* in Malaysia

Final Report of the 2004/2006 Milky Stork Field Surveys in the Matang Mangrove Forest, Perak, Malaysia

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Foreword

The Milky Stork as a flagship species for conservation has been long recognized by the government of Malaysia. The waterbird monitoring programme at the Matang Mangrove Forest began in 1973 when PERHILITAN established its office in Kuala Gula to focus on monitoring the Black-crowned Night-heron nesting populations. At that time, the Milky Stork was also found there by PERHILITAN, but this was not properly documented until 1983. Records of this species were documented by Interwader, the forerunner of Wetlands International.

To ensure the conservation of the rarest bird species of Malaysia, a regular monitoring programme on Milky Storks was implemented and daily wildlife management tasks was carried out by PERHILITAN in the Matang Mangrove Forest area. The Perak state Forest Department also classified two areas, Pulau Kelumpang Lake and Pulau Terong Lake (the Milky Stork's main feeding, roosting and breeding habitat) as Protective Forest under its working plan.

However, the efforts undertaken by the various government agencies have not prevented the decline of the Milky Stork population. The population has dropped more than 90% from 100 to 150 individuals in the 1980s to less than 10 birds currently. The total number of waterbirds using the area has also declined by more than 75%.

The Wetlands International/PERHILITAN joint project initiated in August 2004 started at the right time to obtain a sound understanding of the Milky Stork in the Matang Mangrove Forest. Under the project, the population status of the Milky Stork and its habitat is clearly identified, the factors causing the decline of the Milky Stork and the threats to the survival of Milky Stork are assessed, and conservation measures for the long-term survival and recovery of the species are proposed.

I highly appreciate the painstaking effort by the staff of Wetlands International and PERHILITAN in producing this report and for making the crucial recommendations for the conservation and recovery of the Milky Storks in the Matang Mangrove Forest. PERHILITAN fully endorses the proposed recommendations and will seek the necessary resources to fully implement the recommendations proposed in the report by working closely with other government agencies, NGOs and local communities to ensure the Milky Stork and its habitat are conserved.

Finally, we wish the Milky Stork a bright future in Malaysia!

Dato' Hj Musa Bin Nordin
Director General
Department of Wildlife and National Parks (PERHILITAN),
Peninsular Malaysia

Message from Nagao Natural Environment Foundation

Nagao Natural Environment Foundation (NEF) supported the research work of the “Ecological assessment of Malaysia’s last remaining wild population of the globally threatened Milky Stork *Mycteria cinerea*” for two years from 2004 to 2005. On the completion of this research, NEF is pleased to extend its support for the publication of this important report that includes valuable data and information based on the research results. We strongly believe that this publication will make great contributions to the conservation of the bird in Malaysia and the adjacent countries.

In Japan, Oriental white storks *Cinonia boycian* once inhabited many of the rural areas across the country. However, due to overhunting and rapid deterioration of the environment, they drastically decreased in number and finally went nationally extinct in the wild some 35 years ago. Presently, the local government and community of the area that became the last habitat of the bird in Japan are making efforts toward the reintroduction and conservation of the species introducing genetically identical specimens from a neighbouring country. The concerned people in the area are also working on improving the local environment and raising public awareness so that the stork can be released to the wild someday.

To avoid making the same situation occurred in Japan, conservation of the milky stork in Malaysia is our great concern. On behalf of the NEF, I would like to express our sincere respects and congratulations on compiling this report. We strongly encourage the concerned people in Malaysia and adjacent countries to use this publication as a reference toward the Milky Stork conservation activities.

Yasuhiko Taki
President
Nagao Natural Environment Foundation

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Important new information on captive birds and captive breeding of Milky Storks was also contributed by a large number of Zoological Parks and Gardens. In particular, we would like to thank Dr. Mohamad Bin Ngah, Doreen Khoo Say Kin, Claire Beastall and Renee Yee (Zoo Negara, Malaysia), Deoh Cheng Kung (Langkawi Bird Park, Malaysia), Dr. Gino Ooi (Butterworth Bird Park, Malaysia), Dr. Kevin Lazarus and Mazwin Marjan (Taiping Zoo, Malaysia), Tan Yu Keong (KL Bird Park, Malaysia), Mohd Nawayai Yasak (Malacca Zoo, Malaysia), Zakaria Razali (Johor Zoo, Malaysia), Charlene Yeong (Singapore Zoo, Singapore), and Lai Mun (Jurong Bird Park, Singapore). In addition, Jonathan Murry kindly visited Dusit Zoo, Bangkok, Thailand and provided information on the situation there and we would like to thank Cathy King for reviewing the information on captive breeding and hybridisation issues for this report, and providing additional, valuable information. Dorren Khoo Say Kin of Zoo Negara and Anthony Sebastian of the Malaysian Nature Society kindly reviewed the information on the Milky Stork re-introduction programme at Kuala Selangor Nature Park.

For information further afield, we thank Yus Rusila Noor, Frederic Goes and Philip Round for providing updated information on the Milky Stork in Indonesia, Cambodia and Thailand respectively.

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Lastly we would like to express our thanks to the project sponsors. The main sponsor was the Nagao Natural Environment Foundation (Japan) who supported the comprehensive field surveys and the aerial survey of Milky Stork populations in the Matang Mangrove Forest as well as co-funded the publication of this report. Without this crucial funding and support, the project would not have been initiated and implemented. Finally, we would like to acknowledge the Tan Kean Cheong Bird Conservation Memorial Fund (Malaysia) which provided co-funding for supporting the publication of this report.

Summary in English

Background

The Milky Stork, *Mycteria cinerea* is a large waterbird with a restricted distribution in Southeast Asia. Globally, the species has been listed by IUCN/BirdLife International as “Vulnerable” (BirdLife International 2004) with an estimated World Population of only 5,550 birds (Wetlands International 2002). Most of these birds are believed to be concentrated in Indonesia, with smaller populations in west Malaysia, Cambodia, Thailand, and possibly Vietnam.

Within Malaysia, the Matang Mangrove Forest, Perak has always been a stronghold for the species, although historically the species used to occur along much of the west coast south to Johor (Wells 1999). Throughout the 1980s, between 100 and 150 Milky Storks were found around the two largest mangrove areas in the Matang Mangrove Forest (Parish and Wells 1984, Parish and Wells 1985, Silvius *et. al.* 1987, Siti Hawa Yatim 1989).

The status of the Milky Stork in Malaysia has been closely monitored by the Department of Wildlife and National Parks (PERHILITAN) since the late 1980s. The results of the monitoring indicate that Milky Stork populations have undergone a massive decline (more than 90%) over the last 20 years. However, without comprehensive surveys to assess the population over the whole area these figures may be misleading.

The main goal of the 2004/2006 Milky Stork Field Surveys in Malaysia, jointly undertaken by Wetlands International and PERHILITAN with support from Malaysian Nature Society volunteers, was to re-assess the status and population size of Milky Stork in Malaysia, and specifically at the Matang Mangrove Forest and adjacent coastal areas in Perak. More specific objectives were to:

- Define population status of the Milky Stork at the Matang Mangrove Forest, Perak.
- Define threats to the Milky Stork in the project area, and possible factors responsible for any population decline.
- Better understand the conservation needs of the Milky Stork, particularly habitat and food requirements.
- Review historical data to assess ecological and habitat changes.
- Make recommendations for the conservation and management of the species and its habitats.

In consideration of the potential for re-introduction of the species into Malaysia, an inventory of captive breeding programmes for the species was also carried out in Malaysia and neighboring countries. The focus of this was to document the potential for hybridisation between Milky Stork and Painted Stork.

Results of the study

- **Decline of Milky Stork and overall waterbird populations at Matang Mangrove Forest and adjacent coastal areas.**
 - Maximum number of Milky Stork recorded were nine individuals in October 2004, the Milky Stork population in Malaysia has been undergone a decline to less than 10 birds. The Milky Stork may still attempt to breed at Pulau Kelumpang Lake, however no breeding success was confirmed during the survey period. The total number of wintering waterbirds represents a decline of between 75 to 95% over a period of between 10 to 17 years.

- **Current Status of Milky Stork habitats.**

- Conservation of important Milky Stork habitats and areas. The lake at Pulau Kelumpang was confirmed to be the most important feeding, roosting and breeding area for Milky Stork in the Matang Mangrove Forest and adjacent coastal areas. Apart from February and March 2005 (when the lake was dry) Milky Stork was recorded at the lake on every visit. The lake at Pulau Terong appears to provide an important alternative site for the Milky Stork population during periods when the lake at Pulau Kelumpang is too disturbed or dry. Despite its importance as an alternative site – for Milky Stork roosting, feeding or escaping from disturbance – it would appear that the buffer zone of protected forest around the lake at Pulau Terong may be too limited to provide a safe and undisturbed refuge for long periods of time. Apart from the small population of Milky Stork, other large “Vulnerable” waterbirds such as Lesser Adjutant (all year round) and Spot-billed Pelican (for non-breeding period) also use the lake and surrounding mangrove forest on Pulau Kelumpang. The fact that the area is large enough to support small numbers of these sensitive birds indicates that the protective buffer zone forest established around the lake at Pulau Kelumpang is probably of a size that provides some conservation benefits for large waterbirds.
- Ecological changes in Milky Stork habitats. Mangrove forest vegetation structure on Pulau Kelumpang appeared to have changed little in the last two decades. The area remains an accreting mangrove forest consisting of predominantly *Avicennia marina* trees. The vegetation structure at Pulau Terong also appears to have remained stable over the corresponding period. The lake water at Pulau Kelumpang was brackish (3.2 to 8.5 ppt), weakly alkaline (pH 7.65 to 8.5) and with high conductivity (4.3 to 14.8 mS/cm). The lake water at Pulau Terong was less brackish (and more fresh) than Pulau Kelumpang (1.2 to 4.8 ppt), but near neutral (pH 6.73 - 7.6) and also with high conductivity (3.0 - 10.2 mS/cm). Nutrient levels at both lakes were slightly high. The hydrology of the lakes at Pulau Kelumpang and Pulau Terong appear to be more heavily influenced by rainfall than by tidal events.
- Possible limiting factors for Milky Stork breeding success. Lack of successful breeding at Matang (and in Malaysia) is probably related to a lack of large tracts of undisturbed, tall, mature mangrove forest. Apparent lack of suitable nest trees (tall, dead mangroves) in a rather young, accreting mangrove forest of *Avicennia marina* and continuously high levels of disturbance. Other factors such as changes in prey species populations, changes in ecological condition of habitats and high densities of predators such as Brahminy Kite and White-bellied Sea Eagle may threaten the survival and breeding success of Milky Stork at Matang Mangrove Forest. Other predator species such as Monitor Lizard, Long-tailed Macaque and Silvered Leaf Monkey could have an impact on the breeding success of Milky Stork.
- Changes in Milky Stork prey populations and foraging grounds. Previous studies (Silvius *et al.* 1987, Swennen and Martejijn 1985) at Matang Mangrove Forest and along the adjacent coastline show that at that time Milky Stork used the inter-tidal mudflats along this coast for feeding. The main prey items recorded were large mudskippers of the genus *Periophthalmus*. During the last ten years, there have only been occasional records at Matang of Milky Storks in the inter-tidal mudflat zone – most of the records have been at the two lakes or of flying birds. It is possible that either the prey species populations in these areas have decreased substantially and/or these areas have become more disturbed and unsuitable for feeding Storks.

- **Human Impacts**

- Forestry Management in the Matang Mangrove Forest. The 40,466 ha Matang Mangrove Forest is managed by the Perak State Forestry Department. “Protective Forest” covers an area of 7,360 ha, or 18.2% of the Forest Reserve. In these areas wood harvesting is strictly prohibited. One of the largest blocks of Protective Forest in the Forest Reserve is the entire outer area of Pulau Kelumpang, covering 1,883 ha, with the 4 ha lake at its centre. Another important, although much smaller, Protective Forest zone surrounding the lake at Pulau Terong is 103 ha. For effective conservation of the Milky Stork population at Matang Mangrove Forest larger areas of undisturbed mangrove forest, forming more effective buffers around each of the lakes at Pulau Kelumpang and Pulau Terong will be necessary.
- Human disturbance. Milky Storks are wary of the presence of humans and are very sensitive to disturbance. On eight of the 11 survey visits to the lake at Pulau Kelumpang they took flight at the approach of the survey team at a distance of about 100-200 m. Forestry activities, fishing activities and hunting were noted as potentially having a significant impact on the Milky Stork population and breeding success at Matang.

- **Other issues**

- In captive and free-flying zoo flocks, hybridization between Milky Stork and Painted Stork has been reported at Zoo Negara, Kuala Lumpur, and as potentially occurring at Singapore Zoo and Dusit Zoo, Bangkok. Although there have been no confirmed hybrids reported in wild populations (however a recent report from Thailand may yet prove to be the first case), it is a particular concern for the conservation of the Malaysian population of Milky Stork. If this occurs the wild gene pool of any remaining wild Milky Stork populations, or even a future re-introduced population, could be negatively impacted. The fact that two species of *Mycteria* (Milky Stork and Painted Stork) have cross-bred with *L. javanicus* (Lesser Adjutant) in captivity might also lead to the possibility of hybridization in the wild if con-specific partner choice is limited. Lessons learned from the joint PERHILITAN/Zoo Negara/MNS captive breeding and re-introduction programme for Milky Stork at Kuala Selangor underline what a long-term and high cost conservation effort such programmes are. Better information on wild populations and their ecological requirements, and coordinated planning of any future release programmes should be priorities.

Recommendations

Recommendation 1: Increase the Global Conservation Status for the species from “Vulnerable” to “Endangered”.

Recommendation 2: Use Milky Stork as a “flagship” conservation species to underline the need to protect and conserve coastal wetlands, particularly inter-tidal mangroves and mudflats, throughout Malaysia and the region.

Recommendation 3: Enlargement of the “Protective Forest” and stork lake buffer zone at Pulau Kelumpang.

Recommendation 4: Enlargement of the “Protective Forest” and stork lake buffer zone at Pulau Terong.

Recommendation 5: PERHILITAN and Forestry Department to formalize the designation of the “Protective Forests” proposed under the Matang Mangrove Forest Working Plan under the

Wildlife Act (1972). This may be in the form of gazettelement of Wildlife Sanctuaries to include Pulau Kelumpang and Pulau Terong and the coastal fringe along their shorelines.

Recommendation 6: PERHILITAN to implement a “Milky Stork patrolling and management schedule” and establish a new office at Kuala Sepetang to facilitate such operations.

Recommendation 7: The potential to erect and manage suitable artificial nesting platforms for Milky Storks at Pulau Kelumpang and Pulau Terong should be further investigated.

Recommendation 8: In view of its importance as the last refuge for the Milky Stork in Malaysia, its historical and cultural heritage as the World’s longest continuously managed mangrove forest and for it’s contribution to local livelihoods and the national economy, the State Government of Perak nominate the Matang Mangrove Forest as a wetland of international importance under the Ramsar Convention (1971).

Recommendation 9: To continue to monitor the existing population of Milky Stork at Matang Mangrove Forest and adjacent areas to further increase our understanding of the population, its habitat preferences, and food and feeding habits, predators and threats.

Recommendation 10: Specific research recommendations at Matang Mangrove Forest to be carried out for conservation and future re-introduction of the Milky Stork.

Recommendation 11: Any future attempts to initiate a Milky Stork re-introduction programme in Malaysia must be carefully considered in terms of the long term costs and benefits. As a prerequisite to any such attempts, conservation and protection of the main habitats and areas for Milky Stork must be guaranteed. Furthermore, the risk of hybridization with free-flying zoo-bred populations of Painted Stork must be carefully monitored.

Summary in Bahasa Malaysia

Latar Belakang

Burung Upeh, *Mycteria cinerea* merupakan sejenis burung air yang besar dengan taburan yang agak terhad di Asia Tenggara. Di dunia spesies ini disenaraikan oleh IUCN/Birdlife International sebagai *vulnerable* (Birdlife International 2004). Populasi burung ini dianggarkan lebih kurang 5,550 ekor di dunia (Wetlands International, 2002). Sebahagian besar daripada burung ini boleh didapati di Indonesia, dengan populasi yang kecil di pantai barat Semenanjung Malaysia, Cambodia, Thailand dan berkemungkinan juga di Vietnam.

Di Malaysia, Hutan Simpan Paya Bakau Matang, Perak merupakan satu-satunya kawasan yang masih menampung populasi Burung Upeh ini. Walaubagaimanapun mengikut sejarah, ianya pernah direkodkan di sepanjang pantai barat semenanjung sehinggalah ke Johor (Well 1999). Di sepanjang tahun 1980an, antara 100-150 ekor Burung Upeh telah direkodkan di sekitar kawasan paya bakau di Matang (Parish dan Well 1984, Parish dan Well 1985, Silvius et.al. 1987, Siti Hawa Yatim 1989).

Di Malaysia, Populasi Burung Upeh ini dipantau dengan rapi oleh pihak Jabatan Perlindungan Hidupan Liar dan Taman Negara (PERHILITAN) sejak akhir tahun 1980an. Keputusan pemantauan tersebut menunjukkan populasi burung ini telah menurun dengan begitu ketara (lebih daripada 90%) dalam masa 20 tahun lepas. Walaubagaimanapun, tanpa bancian yang menyeluruh, kadar penurunan ini mungkin agak mengelirukan.

Tujuan utama kajian Burung Upeh yang dijalankan bagi 2004/2006 di Malaysia, dengan kerjasama antara Wetlands International (WI), Jabatan PERHILITAN dan pasukan sukarelawan daripada Malayan Nature Society (MNS), adalah untuk menilai semula status dan populasinya di Malaysia, terutama di kawasan Hutan Simpan Paya Bakau Matang dan kawasan-kawasan beting Lumpur di sekitarnya. Objektif terperinci kajian ini ialah:

- Mendapatkan status populasi Burung Upeh di Hutan Simpan Paya Bakau Matang, Perak
- Mengenalpasti ancaman-ancaman terhadap Burung Upeh di kawasan kajian, dan faktor-faktor utama yang menyebabkan penurunan populasi burung ini.
- Mengetahui dengan lebih mendalam keperluan-keperluan yang dikehendaki, terutamanya di segi sumber makanan dan habitatnya.
- Menbuat *review* keatas ekologi dan perubahan habitat melalui data-data sedia ada.
- Membuat syor-syor yang penting dijalankan untuk tujuan konservasi dan pengurusan spesies ini dan habitatnya.

Bagi program pelepasan semula spesies ini di Malaysia, satu bancian keatas populasi dalam kurungan spesies ini telah juga dijalankan di Malaysia dan di negara-negara jiran. Fokus bancian adalah mendokumentasikan potensi *hybridization* di antara populasi Burung Upeh dan Burung Botak Padi (*Painted Stork*).

Keputusan

- **Penurunan populasi Burung Upeh dan lain-lain burung air di Hutan Simpan Paya Bakau Matang dan sekitar pesisiran pantainya.**
 - Jumlah terbanyak yang dicatatkan bagi Burung Upeh ialah sembilan ekor dalam bulan Oktober 2004, menunjukkan penurunan jumlah sehingga kurang daripada 10 ekor. Burung Upeh masih mencuba untuk membiak di Tasek Pulau Kelumpang, walaubagaimanapun tidak terdapat sebarang kejayaan yang

dicatatkan sepanjang kajian dijalankan. Jumlah keseluruhan burung-burung air yang dicatatkan di sini juga menunjukkan penurunan sehingga 75-95% dalam tempoh di antara 10 hingga 17 tahun.

- **Status terkini habitat Burung Upeh**

- Konservasi kawasan-kawasan dan habitat penting bagi Burung Upeh. Tasik di Pulau Kelumpang disahkan merupakan kawasan terpenting untuk Burung Upeh yang berada di Hutan Simpan Paya Bakau Matang dan sekitarnya, mencari makan, berehat dan membiak. Selain daripada bulan Februari hingga Mac 2005 (apabila tasik ini kering), Burung Upeh telah direkodkan pada setiap kali bancian dijalankan. Tasik di Pulau Terong pula merupakan tasik alternatif yang juga penting bagi populasi Burung Upeh ketika tasik di Pulau Kelumpang kekeringan atau terdapat gangguan di situ. Walaupun tasik ini merupakan tasik alternatif buat burung-burung ini untuk berehat, mencari makan atau berlindung sementara daripada gangguan, kawasan penampakan yang dilindungi di sekitar tasik Pulau Terong, mungkin terlalu kecil untuk memberikan perlindungan yang diperlukan untuk jangka masa yang lama bagi burung-burung ini. Selain daripada Burung Upeh, lain-lain burung air yang *vulnerable* seperti Burung Botak Kecil (sepanjang tahun) dan Burung Undan Paruh Titek (*Spot-billed Pelican*) (musim bukan membiak) juga menggunakan tasik Pulau Kelumpang dan kawasan paya bakau disekitarnya. Kawasan Pulau Kelumpang sedia ada di dapati boleh menampung populasi Burung Upeh dan lain-lain burung air yang besar yang sensitif kepada gangguan. Ini menunjukkan luas kawasan penampakan tersebut cukup untuk menyediakan tempat perlindungan bagi burung-burung ini.
- Perubahan ekologi bagi habitat Burung Upeh. Hutan Paya Bakau di Pulau Kelumpang tidak banyak berubah sejak dua dekad dulu. Kawasan tersebut masih terdiri daripada hutan paya bakau yang *accreting*, sebahagian besarnya terdiri daripada pokok-pokok *Avicennia marina*. Vegetasi di Pulau Terong juga kelihatan stabil pada masa yang sama. Air yang terdapat di Tasik Pulau Kelumpang adalah payau (3.2 – 8.5 ppt), sedikit berakali (PH 7.65 – 8.5), dengan kekonduksian yang tinggi (4.3 – 14.8 mS/sm). Di Pulau Terong, air tasiknya kurang payau (lebih bersih) dibandingkan dengan Pulau Kelumpang (1.2 – 4.8 ppt), tetapi lebih hampir neutral (PH 6.73 -7.6) dan mempunyai kadar kekonduksian yang juga tinggi (3.0 – 10.2 mS/sm). Paras nutrien bagi kedua-dua tasik agak tinggi. Hidrologi bagi kedua-dua tasik juga lebih dipengaruhi oleh air hujan daripada air pasang surut.
- Faktor-faktor yang mempengaruhi kejayaan pembiakan Burung Upeh. Kegagalan pembiakan Burung Upeh di Matang (dan di Malaysia) mungkin ada kaitannya dengan ketiadaan kawasan hutan paya bakau yang luas dengan pokok-pokok yang tinggi dan tua serta tidak diganggu. Kekurangan pokok-pokok (yang tinggi dan mati) di kawasan hutan paya bakau yang muda dan *accreting* dengan pokok *Avicennia marina* yang sentiasa terganggu merupakan faktor utama kegagalan burung-burung ini membiak. Faktor lain yang juga memainkan peranan penting juga menyumbang kepada kegagalan pembiakan ialah penurunan populasi spesies pemakanannya (*prey species*), pertukaran ekologi habitatnya, peningkatan populasi pemangsa seperti Burung Lang Merah dan Lang Siput juga menyumbang kepada kegagalan pembiakan Burung Upeh di kawasan Hutan Paya Bakau Matang ini. Lain-lain spesies pemangsa seperti Biawak Air, Kera dan Lotong Kelabu juga mungkin menyebabkan kegagalan pembiakan Burung Upeh ini.
- Pengurangan spesies pemakanan dan kawasan mencari makan Burung Upeh. Kajian terdahulu yang dijalankan (Silvius et.al. 1987, Swennen dan Marteiijn 1985) di Hutan Paya Bakau Matang dan kawasan persisiran pantai yang

berhampiran telah menunjukkan Burung-burung Upeh ini menggunakan kawasan beting Lumpur di sepanjang pantai di sini untuk mencari makan. Makanan utama yang direkodkan ialah ikan belacak daripada genus *Periothalmus*. Daripada kajian yang telah dijalankan di sepanjang 10 tahun yang lepas, Burung Upeh ini hanya dilihat sekali sekala mencari makan di sepanjang beting Lumpur (*intertidal mudflat zone*)- biasanya ianya kelihatan di kedua-dua tasik di Pulau Kelumpang dan Pulau Terong atau ketika terbang. Terdapat kemungkinan populasi spesies yang menjadi makanannya di kawasan-kawasan tersebut telah berkurangan dengan kadar yang tinggi dan/atau kawasan-kawasan ini telah terganggu dan tidak sesuai lagi untuk burung-burung ini mencari makan.

- **Impak manusia**

- Pengurusan hutan di Hutan Simpan Paya Bakau Matang. Hutan Paya Bakau Matang yang mempunyai keluasan 40,466 ha diurus oleh Jabatan Perhutanan Negeri Perak. Kawasan perlindungan (*protective forest*) mempunyai keluasan 7,360 ha, atau 18.2% daripada keseluruhan Hutan Paya Bakau Matang. Di sini tiada pembalakan dibenarkan. Salah satu daripada kawasan perlindungan terbesar di sini ialah keseluruhan hutan di Pulau Kelumpang, dengan keluasan 1,883 ha dengan tasik di tengahnya mempunyai keluasan 4 ha. Satu lagi kawasan penting, yang lebih kecil ialah kawasan hutan yang diperindungi di sekeliling tasik di Pulau Terong, dengan keluasan 103 ha. Bagi memberi perlindungan yang lebih efektif kepada Burung Upeh di Hutan Simpan Paya Bakau Matang, kawasan perlindungan yang tidak di ganggu yang lebih luas adalah diperlukan sebagai kawasan penampakan (*buffer zone*) di sekeliling tasik-tasik di Pulau Kelumpang dan Pulau Terong.
- Gangguan manusia. Burung Upeh amat peka terhadap kehadiran manusia dan amat sensitif terhadap sebarang gangguan. Dalam lapan daripada 11 bancian yang dijalankan di Pulau Kelumpang, burung-burung ini didapati terbang apabila pihak pengkaji berada pada jarak antara 100-200 m. Aktiviti-aktiviti yang dijalankan termasuk pembalakan, menangkap ikan dan memburu dicatatkan berpotensi mempunyai kesan yang penting terhadap populasi Burung Upeh dan keupayaan pembiakannya di Matang.

- **Lain-lain isu**

- Kumpulan yang berada dalam kurungan dan yang terbang bebas, kacukan di antara Burung Upeh dan *Burung Botak Padi* pernah direkodkan di Zoo Negara, Kuala Lumpur dan juga di Singapore Zoo dan Dusit Zoo, Bangkok. Walaupun sehingga kini tiada laporan khusus yang menunjukkan terdapatnya kacukan di dalam populasi liar (laporan terkini daripada Thailand mungkin merupakan kes yang pertama), kacukan merupakan masaalah yang perlu diberi perhatian serius dalam program konservasi Burung Upeh di Malaysia. Jika perkara ini terjadi, populasi liar atau populasi Burung Upeh dalam kurungan yang bakal dilepaskan kelak boleh membawa kesan negatif. Kedua-dua spesies *Mycteria* (Burung Upeh dan *Burung Botak Padi*) pernah direkodkan boleh membiak dengan *L. javanicus* (Burung Botak Kecil) dalam kurungan. Oleh yang demikian terdapat kemungkinan ini juga boleh terjadi di habitat liar jika tidak terdapat pasangan yang mencukupi. Program pelepasan semula yang telah dijalankan dengan kerjasama PERHILITAN/Zoo Negara/MNS di Kuala Selangor menunjukkan ianya memerlukan masa yang panjang dan memakan belanja yang besar. Maklumat yang lebih baik bagi populasi liar dan keperluan ekologi burung ini adalah amat penting. Perancangan yang lebih teliti diperlukan bagi program pelepasan yang akan dijalankan di masa hadapan.

Cadangan-cadangan

Cadangan 1: Meningkatkan status konservasi secara global bagi spesies ini daripada *vulnerable* kepada terancam.

Cadangan 2: Menggunakan Burung Upeh sebagai “*flagship*” spesies bagi menunjukkan keperluan melindungi dan mengekalkan kawasan tanah lembap kawasan pantai, terutamanya kawasan *inter-tidal* di paya bakau dan beting lumpur, di seluruh Malaysia dan seluruh Asia Tenggara.

Cadangan 3: Memperluaskan kawasan perlindungan dan kawasan penampakan di sekeliling tasik di Pulau Kelumpang

Cadangan 4: Memperluaskan kawasan perlindungan dan kawasan penampakan di sekeliling tasik di Pulau Terong

Cadangan 5: PERHILITAN dan Jabatan Perhutanan sama-sama berusaha meletakkan kawasan perlindungan yang dicadangkan (termasuk Pulau Kelumpang, Pulau Terong dan beting Lumpur di sepanjang pantai) di bawah Hutan Simpan Paya Bakau Matang ini sebagai kawasan Perlindungan di bawah Akta Perlindungan Hidupan Liar (1972). Ini boleh dibuat melalui *gazettement* kawasan tersebut sebagai Santuari Burung.

Cadangan 6: Jabatan PERHILITAN perlu mewujudkan jadual pengawasan (*patrolling*) dan pengurusan dan menjadikan Kuala Sepetang sebagai pos kawalan.

Cadangan 7: Kebarangkalian pembinaan *platforms* buatan manusia bagi menyenangkan Burung-burung Upeh ini membuat sarang-sarang mereka di Pulau Kelumpang dan Pulau Terong perlu difikirkan.

Cadangan 8: Kawasan Hutan Simpan Paya Bakau Matang ini amat penting kepada populasi terakhir Burung Upeh di Malaysia, dan juga terkenal di seluruh dunia sebagai kawasan hutan paya bakau yang paling baik dan lama diurus. Hasil pengurusannya juga banyak menyumbang kepada ekonomi negara dan ekonomi rakyat setempat. Oleh yang demikian, pihak Kerajaan Negeri patut mencadangkan kawasan ini diistiharkan sebagai kawasan paya bakau yang penting di peringkat antarabangsa di bawah *Ramsar Convention* (1971).

Cadangan 9: Meneruskan program pemantauan keatas populasi Burung Upeh yang masih tinggal di Hutan Simpan Paya Bakau Matang dan kawasan sekitarnya bagi menambah kefahaman terhadap populasi burung ini, keperluan habitatnya, makanan dan habit pemakanannya, pemangsa dan gangguan-gangguan terhadap populasinya.

Cadangan 10: Membuat cadangan-cadangan penyelidikan yang khusus di Hutan Simpan Paya Bakau Matang bagi mendapatkan maklumat untuk tujuan konservasi dan plan pelepasan semula spesies burung ini.

Cadangan 11: Sebarang cadangan untuk program pelepasan semula burung Upeh di Malaysia perlu dibuat dengan teliti dengan mengambil kira kos jangka panjang dan keuntungannya. Sebelum ianya dijalankan, status konservasi kawasan keliaran Burung Upeh ini perlu dipastikan. Selain daripada itu, potensi kacukan dengan populasi *Burung Botak Padi* yang terbang bebas daripada Zoo juga perlu diberi perhatian serius.

1. Introduction

1.1 Background

The Milky Stork, *Mycteria cinerea* is a large waterbird with a restricted distribution in Southeast Asia. Globally, the species has been listed by IUCN/BirdLife International as “Vulnerable” (BirdLife International 2004) with an estimated World Population of only 5,550 birds (Wetlands International 2002). Most of these birds are believed to be concentrated in Indonesia (mainly in SE Sumatra) with much smaller populations in Java and Sulawesi, west Malaysia, Cambodia, Thailand, and possibly in Vietnam. The status of the species has recently been well documented in the “*Threatened Birds of Asia*” (BirdLife International 2001), from which much of the overview of status and distribution in section 2 is taken.

Within Malaysia, the northwest coast of Perak State and more specifically the area consisting of the Matang Mangrove Forest has always been a stronghold for the species, although historically the species used to occur along much of the west coast south to Johor (Wells 1999). Throughout the 1980s between 100 and 150 Milky Storks were found around the two largest mangrove areas in the Matang Mangrove Forest – either on the vast inter-tidal mudflats around the mangrove “islands” of Pulau Kelumpang and Pulau Terong, or within two large flooded depressions (“lakes”) amongst dense mangrove forest within these two areas (Parish and Wells 1984, Parish and Wells 1985, Silvius *et al.* 1987, Siti Hawa Yatim 1989). During the same time, the inter-tidal flats of the Matang Mangrove Forest were also found to be nationally, regionally and globally significant for other waterbirds, supporting large numbers of Lesser Adjutant and internationally significant numbers of migratory shorebirds with counts of between 18,500 and 31,500 waterbirds recorded annually during the years 1989 to 1992 (Scott and Rose 1989, Perennou *et al.* 1990, Perennou and Mundkur 1991, Perennou and Mundkur 1992, Siti Hawa Yatim and Ismail Hj. Mamat 1994).

In the late 1980s and early 1990s attempted breeding of Milky Stork at Matang was closely monitored by the Department of Wildlife and National Parks, Peninsular Malaysia (PERHILITAN), however in the following decade only sporadic monitoring was undertaken. In recent years there has been more regular monitoring of the Milky Stork population at Pulau Kelumpang, but little effort has been focused on Pulau Terong. The results of this monitoring indicate that the Milky Stork population has undergone a massive decline (more than 90%) over the last 20 years. However, without comprehensive surveys to assess the population over the whole area these figures may be misleading. There has been no assessment of the status of the species at Pulau Terong since 1986. Populations of other waterbirds, and particularly migratory shorebirds, at Matang Mangrove Forest have also been perceived to be in decline, but likewise no comprehensive surveys have been undertaken since the late 1980s.

In tandem with these efforts to conserve the last remaining habitat and wild population of the Milky Stork in Matang, a captive breeding programme for Milky Stork at Zoo Negara, Kuala Lumpur started in 1987. This was Phase I of a joint PERHILITAN/Zoo Negara/Malaysian Nature Society programme to re-introduce the species into the wild at the Kuala Selangor Nature Park. The re-introduction programme (Phase II) at the Kuala Selangor Nature Park was conducted between 1996 and 2004. In 1996 a large aviary was constructed in the Park and birds transferred from Zoo Negara. In early 2003 the first bird was “released” into the wild, and although attempted wild breeding was recorded later in 2003 there was no successful fledging of chicks. Although this programme was not able to achieve its objective of establishing a free-flying, breeding population of Milky Stork at the Nature Park, it has demonstrated that Milky Storks are able to adapt to a free-flying existence, and will attempt to breed. The programme provides valuable insights into planning and implementing any future Milky Stork re-introduction programmes in Malaysia.

Despite all these efforts it was apparent that by 2004 the wild population of Milky Stork in Malaysia was at a critically low level. Reasons for the decline remained largely unknown and no comprehensive population monitoring has been undertaken for nearly 20 years. To address these information gaps, a joint Wetlands International/PERHILITAN survey with support from MNS volunteers was organized from August 2004 to January 2006. The main aims of the survey were to gain a better understanding of the current population status, assess ecological change in the main habitats, assess threats to the species and evaluate species' conservation needs. The surveys focused on the Matang Mangrove Forest and adjacent coastal areas in Perak. The results of the study are documented in this report and based on these findings conservation recommendations have been formulated to assist government management authorities and conservation agencies in Malaysia and researchers throughout the species range states.

1.2 Objectives of the survey

The main goal of the 2004/2006 Milky Stork Field Surveys in Malaysia was to re-assess the status and population size of Milky Stork in Malaysia, and specifically at the Matang Mangrove Forest in Perak. More specific objectives were to:

- Define population status of the Milky Stork at the Matang Mangrove Forest, Perak.
- Define threats to the Milky Stork in the project area, and possible factors responsible for any population decline.
- Better understand the conservation needs of the Milky Stork, particularly habitat and food requirements.
- Review historical data to assess ecological and habitat changes.
- Make recommendations for the conservation and management of the species and its habitats.

1.3 Methods and areas surveyed

1.3.1 Area covered

The project focused on the Matang Mangrove Forest, where the Milky stork has been recorded historically, as well as the adjacent northern coast of Kuala Gula - Kuala Kurau - Tg. Piandang. The latter area is adjacent to the Matang Mangrove Forest and the coastal mudflats serve as potential feeding habitat for the species (see Figure 1).

The survey area was divided into 8 sections, these were:

- A - Pulau Kelumpang Lake;
- B - Inter-tidal mudflats at Bang Zhu Kao, Kuala Gula;
- C - Coastal zone and rivers surrounding Pulau Kelumpang;
- D - Coastal zone and rivers surrounding Pulau Sangga Kechil & Besar;
- E - Coastal zone and rivers surrounding Pulau Terong;
- F - Pulau Terong Lake;
- G - Pulau Pasir Hitam & South Sg. Kerang coast; and
- H - Kuala Gula - Kuala Kurau - Tg. Piandang coast.

1.3.2 Time schedule and survey team

More-or-less monthly visits (of 3-5 days per visit) were carried out during August 2004 to January 2006. However, no visits were made in November 2004, December 2004, April 2005, September 2005 and October 2005.

The project team was led by David Li, Waterbird Conservation Officer of Wetlands International, and supported by John Howes, an Associate Expert of Wetlands International and Rahmah Ilias,

PERHILITAN research officer. Field survey participants included both PERHILITAN staff and volunteers of the Malaysian Nature Society and Wetlands International, namely Zainal Abidin B. Mat, Mohamad Aminurddin B. Ahmad, Shazatul Farina Bt. Abd. Latiff, Mohamad Zainuddin Bin Busrah, Mohammad Tahir Abd. Karim, Mohd Zakimi Bin Mat Yunus, Hamzah Saad, Abu Bakar B. Mat Non, Ishak B. Jusoh, Mohammad Radzay B. Osman, Zamrin B. Zainal, Suria B. Ibrahim, Mohd. Rani B. Cha, Zulkanain B. Talib, Abd. Rahman B. Ahmad, Badrul Hisham Abd. Rashid, Lim Kim Chye, Lim Aun Tiah, Yeap Chin Aik, Cheang Kum Seng, Yang Chong, Nancy Drilling and Crawford Prentice. Table 2 provides the time schedule and team members for each field survey.

1.3.3 Survey methods

Terrestrial surveys were conducted both on foot and by using boats. In addition an aerial survey was also undertaken. Terrestrial surveys on foot were generally used in areas with easy land access such as sections A, B and F. Boats were used to survey the wide, inter-tidal mudflats such as in sections C, D, E and H during periods of in-coming or receding tides, as well as to transfer the survey team to and from Pulau Kelumpang and Pulau Terong during the high tides.

An aerial survey using a Cessna 172 was carried out on 12 January 2005. The flight departed from Subang Airport in Kuala Lumpur at 12:00 and returned at 17:00. Flight duration within the Matang Mangrove Forest was from 13:50 to 15:10 during an incoming tide.

Counts of Milky Stork and other waterbirds were normally made by accurate counting of individual birds; estimates of flock size were used when large numbers of flying or distant flocks were observed. Binoculars (Swarovski SLC 10x42WB, Nikon 8X36, Leica 10X40B and Minolta 10X40) and telescopes mounted on tripods (Leica APO Televid 62 and Nikon Fieldscope 20-45x) were used to identify species at long distance. Birds were identified in the field using Sonobe and Usui (1999) – additional back-up references used to identify species not immediately assigned to any species were Wells (1999), Robson (2000) and Jeyarajasingam and Pearson (1999).

In most cases, the sites were surveyed during periods of incoming tide. When there was enough time to permit an extended survey, counts were undertaken under different tidal conditions to ensure that the maximum possible number of waterbirds was recorded. However, considerable care was taken to avoid duplicating counts from feeding and roosting sites.

Five water quality parameters were collected *in-situ* at both Pulau Kelumpang Lake and Pulau Terong Lake using portable water quality meters. Water quality meters of model YSI 30, YSI 60 and YSI 550A are used. The parameters collected *in-situ* were water temperature, salinity, pH, Dissolved Oxygen and conductivity.

In addition, a 1000 ml water sample was taken at both sampling stations and stored at low temperature in an ice box. These samples were sent to the laboratory to determine a further 8 parameters: Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Total-Nitrogen, Total Phosphate, Total Alkalinity, *E. coli* and Total Coliform. All water samples were taken during peak tide.

Climate (rainfall) data was provided by the Malaysia Meteorological Service and tidal information was obtained from the Hydrographic Department, Royal Malaysian Navy (2005). Information on mangrove vegetation and management was mainly extracted from Azahar and Nik Mohd Shah (2003).

1.3.4 Collecting and compiling data

Standard site description and waterbird count forms designed and tested by Wetlands International were used for the surveys.

Site description forms enabled standard data to be collected on types of wetlands, vegetation, uses of and threats to wetlands. Waterbird count forms provided a standard list of all waterbirds, against which numbers could be tallied (the standard list included pelicans, herons, egrets, storks, ibises, rails, shorebirds, gulls and terns). In addition, wetland-dependent raptors and kingfishers are also included.

Data were collected according to the eight survey sections defined in section 1.3.1. Maximum monthly counts made within each section were summed to give a total monthly count for the whole project area. Count data was further divided into four “seasons” and the highest monthly count of each species within each season was used to calculate the total number of waterbirds using the project area during the winter season, northward migration, summer season and southern migration period respectively (refer to Table 9 and Annex E, F, G, H and I).

The sequence and nomenclature of bird species used in this report largely follow Wetlands International (2002) and del Hoyo *et al.* (1992, 1996). English names and scientific names of bird species and other wildlife species are shown in Annex K.

2. Results and Discussion

2.1 Overview of the status and distribution of Milky Stork

2.1.1 Species distribution and status in range countries

The Milky Stork is restricted to Southeast Asia, with an historical range including Cambodia, Indonesia, Malaysia, Thailand and Vietnam. The total population of the species in the wild has recently been estimated at 5,550 birds, with most of these (5,400 birds) in Indonesia, 100 in Malaysia and only 50 in Cambodia (Wetlands International 2002). Populations in Thailand and Vietnam are thought to be locally extinct. The status and distribution of the species in each of the range states are outlined below (much of this information is extracted from the “*Threatened Birds of Asia*” (BirdLife International 2001) with some recent updates provided where available) and in Figure 2.

Cambodia

Historical reports indicate that the species was always uncommon in Cambodia (e.g. Delacour 1929); it was described as “rare” by the 1960s (Thomas 1964) and has apparently undergone subsequent declines (Scott 1992). No breeding birds were found in an extensive survey of waterbird breeding colonies around Tonle Sap in 1998, although locals reported that small colonies still exist (Goes *et al.* 1998). The annual Asian Waterbird Census (AWC) recorded no more than 5 individuals from 1999 to 2005, and the species was restricted to Prek Toal and Ang Tropeing Thmor Reservoir (Goes 2005). Recent reports indicate that not more than 20-30 individuals may remain in the country (K. Davies and Hong Chamann, pers. comm., October 2005), although comprehensive surveys of coastal areas are still required to fully understand the situation in Cambodia (Frederic Goes, per. comm, October 2005).

Thailand

Although the evidence is scant, it suggests that the species might have occurred regularly in the south, possibly breeding along the coasts (Morioka and Yang 1990). However, it is perhaps more likely that it was always scarce in the country and it is now apparently locally extinct (Treesucon and Round 1990).

The most recently records were of two birds amongst a flock of Painted Stork at Huai Talad Non-hunting area, Buriram from November 2003 to November 2004. Besides this, one individual was recorded with a flock of Painted Stork at Wat Khao Takhrao, Petchaburi in August-September 2003 and November 2004 (Round and Jukmongkol 2004; Round and Jukmongkol 2005; Oriental Bird Club Bull. 38 [2003]: 77).

Vietnam

There is no unequivocal evidence that the species ever bred in the country and it is certainly now only a vagrant (Collar *et al.*, 1994, Eames and Tordoff, in prep.). The most recently record was of four adults at Tri Su Mangroves, ca. 5 km from Chau Doc on 3 May 2003 (Oriental Bird Club Bull. 38 [2003]: 77).

Peninsular Malaysia

In the early part of the 20th Century, Robinson and Chasen (1936) considered the species “not rare in suitable localities”. For example, it was noted as “not uncommon” on the Selangor coast. Between 1944 and 1957 however, none were observed on the Selangor coast by Madoc, while Medway and Wells (1976) added that “on many visits to the Selangor mudflats during 1961–71 this stork was never seen”. At that time the species was only known in Kerian district, Perak (Medway and Wells 1976). In 1983 an aerial survey between Kuala Lumpur and Langkawi yielded sightings of 115 individuals, a group of 36 south of the Larut estuary and 79 around the

Kuala Gula area (Parish and Wells 1984). Later, PERHILITAN recorded a higher number of 130 individuals in 1984 and around 130-150 birds in 1989 (Siti Hawa Yatim 1989).

More detailed and contemporary information on the status and distribution of the Milky Stork in Malaysia is provided in section 2.2.

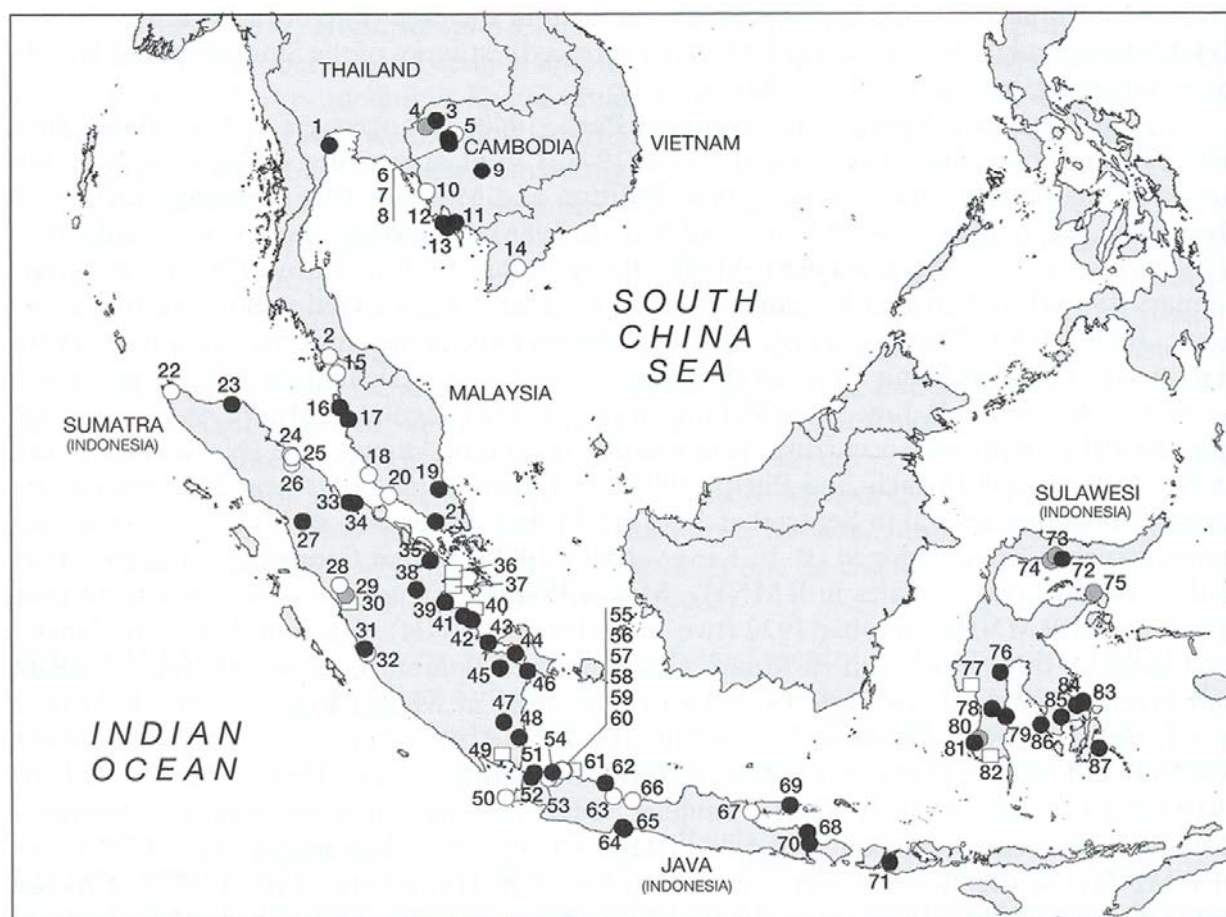
Indonesia

W. Davison (in Hume 1873) mentioned “an enormous flock” in Aceh, northernmost Sumatra, suggesting that the species was previously very common on Sumatra. By the end of the 1980s the island was indeed recognised as the global stronghold of the species, with a population estimated to be around 5,000 individuals (Silvius and Verheugt 1989). In 1985, 116 were counted in Lampung province (Milton and Marhadi 1985). Counts in October–November 1984 were of 3,053 birds in the provinces of Riau (703), Jambi (763) and South Sumatra (1,587); in July–August 1985 of 1,029 in Jambi (697) and South Sumatra (732); and again in March–April 1986 of 1,937 in Jambi (1,134), and South Sumatra (803); on the basis of this data these three provinces were judged to hold the majority of the world population (Danielsen and Skov 1985, Silvius 1988). In September 1988 at Tanjung Koyan 300–400 nests were estimated, with a total of 500 birds including at least 50 juveniles; at Tanjung Selokan 300 nests were estimated, with a total of 150 birds including several juveniles; and on the Banyuasin peninsula 280 nests were observed along with 250 adults and 100 juveniles (Danielsen *et al.* 1991a), with as many as 1,000 birds there subsequently (Verheugt *et al.* 1993). During numerous field visits to the Berbak National Park, Sumatra in 2001-2004, Yus Rusila Noor (pers. comm., February 2006) only recorded two individuals there compared to 127 individuals that were recorded in 1986 (A. Elliott *per* T.P. Inskipp *in litt.* 1997).

Early in the twentieth century the species was clearly seasonally very common in Java, with large colonies (“many nests”, or 75–100 nests) noted in the Citarum delta (Bartels 1915 – 1930, Hoogerwerf 1936a). By the mid-1980s, the breeding population was tiny but the island experienced influxes of other birds (Lambert and Erftemeijer 1989); the total population of West Java was estimated at c. 400 (356–408 individuals) (Allport and Wilson 1986, Verheugt 1987). Over 1,000 individuals have been reported to visit the north-east coast of Java seasonally (Hancock *et al.* 1992), but this is possibly an overestimation. Surveys of the south coast of Central Java yielded a minimum of 164 birds, but without confirmation of breeding (Erftemeijer *et al.* 1988), and surveys in East Java found only 38 birds (Erftemeijer and Djuharsa 1988). Pulau Rambut may be the last breeding site on the north coast of Java, since the species is known to have ceased breeding on Pulau Dua in 1975 and at an unspecified date in the Brantas and Solo deltas of East Java, indicating a considerable decline; the maximum number of nests found in 1984 was 14 on Pulau Rambut (Allport and Wilson 1986). According to Yus Rusila Noor (pers. comm., February 2006), Imannudin recorded 64 individuals on Pulau Rambut in 2001 and 22 individuals in Muara Gembong in August 2005 which were supposed to be part of Pulau Rambut's population. Yus Rusila Noor regularly made in situ observations of the Milky Stork on Pulau Dua from 1997 to mid-2005, and recorded a maximum of 20 individuals. In March 2005, he saw a pair sitting in a nest, but there was no proof of breeding in the subsequent weeks. These records show that the last remaining breeding population in Java is decreasing. A record of 170 individuals on Madura (Oriental Bird Club Bull. 24 [1996]: 59–65) suggests that the island may support an important population, at least seasonally. The population on Sulawesi appears to have increased in recent years, although this is almost certainly a result of greater observer coverage and surveying of new areas, especially in South-east Sulawesi (Bishop, *in press*). As many as 73 birds were discovered at a variety of coastal sites in South Sulawesi in 1986, suggesting a modest resident population in the province (Uttley 1987). South-east Sulawesi may hold a small but valuable population, with 173 in Rawa Aopa Watumohai National Park in 1995 (Sibuea 1996). Breeding has not been proven on the island (Bishop, *in press*), although sightings of juveniles suggests that it is very likely to occur. In 1996 the species was also noted at three localities on Buton, with 21 birds in one tree, and an immature also seen, suggesting local breeding (Catterall, *undated*).

A comprehensive survey on the species distribution and population size in Indonesia has yet to be made. Annual AWC counts at selected sites in Indonesia (Li and Mundkur 2004, and unpublished AWC data) have only recorded two at Lubuk Minturun, West Sumatra in 1999, 71 at Bagan Percut, North Sumatra in 2000, a total of 12 recorded at five sites in 2002 (one at Muara Angke and six at Pulau Rambut, Jakarta, two at Sungai Cemara Beach and two at Berbak National Park and surrounding area, Jambi, one at Rawa Pacing, Lampung). Thirty-one were recorded in 2003, with 30 at Rawa Aopa National Park, SE Sulawesi and one at Rawa Pulo, East Java.

Figure 2: Distribution of the Milky Stork in the range states



Note:

The map is extracted from BirdLife International (2001). Site number and name please refer to the original publication. Number 16 (Pulau Kelumpang Lake) and 17 (Pulau Terong Lake) on the map refers to the field study area under this project.

2.1.2 Ecological requirements

Information on the ecological requirements of the species is surprisingly good, with much of the information coming from fairly recent (1980-1990) surveys and studies in Indonesia, Malaysia and Cambodia. The information provided below is largely extracted from the *Threatened Birds of Asia* (BirdLife International 2001):

Habitats

Throughout much of its range, the Milky Stork is essentially a coastal species, favouring mangroves, mudflats and estuaries (Hancock *et al.* 1992). It also feeds in rice fields and brackish water fish ponds (Verheugt 1987). This is certainly the case in Sumatra, although it occasionally visits back swamps along the river floodplains up to 150 km from the coast; during spring tides, birds often roost in remnant trees in rice fields (Verheugt *et al.* 1993; Danielsen and

Skov 1985, 1987). Roost sites are sometimes in the crowns of tall mangrove trees (Hancock *et al.* 1992), although they also regularly roost on the ground on inter-tidal mudflats or in marshes (Bartels 1915–1930), a factor that makes the species relatively easy to count, even from the air (e.g. Parish and Wells 1985). In Peninsular Malaysia, historically the species was “more exclusively marine” than its congener the Painted Stork (Robinson and Chasen 1936), the suggestion being that the two separate ecologically where ranges overlap (Morioka and Yang 1990). However, both species are reported to frequent the same marshy plains in Cambodia, often in the same flock (Delacour and Jabouille 1931), and recent reports from the area suggest that they use similar habitats (Mundkur *et al.* 1995, C. M. Poole in litt. 1997); moreover, local people report that they breed alongside each other in flooded forest around Tonle Sap (Goes *et al.* 1998). In Cambodia, Milky Storks frequent flooded forest in freshwater habitats and mangroves in coastal habitats (Mundkur *et al.* 1995, Sun Hean in litt. 1997). Concentrations have also been recorded at brackish water fishponds in Sulawesi (Andrew and Holmes 1990).

Foraging and food

At Sungai Burong, Malaysia, the bulk of the diet appeared to be large mudskippers *Periophthalmus spp.* of 10–23 cm in length; the estimated weight of fish eaten in one observation of 39 minutes was 225 g (Swennen and Marteijn 1987). In Indonesia the species has also been reported consuming snakes and frogs (Hoogerwerf and Siccama 1937–1938), and fish (Bartels 1915–1930). It has been reported that nestlings are fed on eels and mudskippers up to 20 cm in length (Hoogerwerf 1936b). Milky Storks often feed in aggregations with other wading birds, such as Lesser Adjutant and egrets (Verheugt 1987; Hancock *et al.* 1992), and the species generally employs a tactile foraging technique, involving standing still or walking through mud and usually shallow water, probing with a partly opened bill, or drawing it in an arc from side to side, until a prey item is located by touch (Bartels 1915–1930, Swennen and Marteijn 1987, Silvius 1988, Indrawan *et al.* 1993); it has also been observed seeking food by foot-stirring (Hoogerwerf 1936b). Less frequently, individuals either detect prey by sight or root them from their burrows (Swennen and Marteijn 1987, Silvius 1988). On locating a mudskipper hole an individual will probe its bill in the immediate vicinity 10–15 times, sometimes immersing the whole bill and head into the mud and then hauling out the prey once it has been secured in the bill (del Hoyo *et al.* 1992). Birds have been observed feeding in loose flocks between 50 and 100 m apart (A. Elliott per T. P. Inskipp in litt. 1997), but sometimes they will move in a single tight flock, flushing fish in shallow water (Indrawan *et al.* 1993). At Pulau Dua, Indonesia, considerable nocturnal activity was noted, with birds both foraging and visiting nests during hours of darkness, at least under a full moon (Hancock *et al.* 1992).

Breeding

Seasonality: There appears to be marked differences and seasonality in breeding throughout the range of the species. At Tonle Sap, Cambodia, egg-laying apparently takes place during the dry season in January and February (Parr *et al.* 1996), while in Malaysia two nests contained three eggs on 18 August (Robinson and Chasen 1936) and the Kuala Gula colony was noted as “active” in November (Hancock *et al.* 1992). In Indonesia, breeding occurs during the “dry season” and usually lasts until October (Hancock *et al.* 1992). Clutches taken on Java date from March, May and July (Hellebrekers and Hoogerwerf 1967), a Javan colony mostly contained fledged and almost full-grown young (with one clutch unhatched) in July (Hoogerwerf 1936a). In July 1919, nests were active at the Citarum delta on Java, most containing three eggs, some with newly hatched chicks and a very few with chicks close to fledging (Bartels 1915–1930). In Sumatra a bird was seen in breeding plumage in May (Nash and Nash 1985) and egg-laying occurs in June–August (Hancock *et al.* 1992).

Nest structure and sites: Breeding is colonial, often occurring in multi-species aggregations. In Sumatra the species has been recorded nesting alongside Lesser Adjutant, Black-headed Ibis and several species of heron (Danielsen *et al.* 1991a). Although breeding has never been authenticated at Tonle Sap, Cambodia, local reports suggest that the species nests in colonies containing Painted Stork, Lesser Adjutant and Spot-billed Pelicans during the dry season (January and February) (Mundkur *et al.* 1995, Goes *et al.* 1998).

Breeding colonies in Indonesia vary considerably in structure – with reports of some birds nesting close to the ground in dense stands of mangrove fern (*Acrostichum spp.*), others in mature mangroves or dead and dying mangrove trees between 8 and 30m off the ground, with some colonies close to the sea and others far inland. The major breeding colonies in Sumatra were mostly in mangrove back swamps; at Tanjung Koyan the colony was some 2 km from the coast, in dense beds of *Acrostichum spp.* fern, with nests built 3–4 m high in bushes around a small pool; at Tanjung Selokan, about 1–2 km from the coast, nests were 5–15 m high in 10–12 dead trees within a 15 ha flooded area; on the Banyuasin peninsula, between 3–4 km inland, nests were 2–6 m high in small bushes around a pool in dense *Acrostichum spp.* fern beds (Danielsen *et al.* 1991a); and at Kuala Betara, the colony was situated in the outer mangrove fringe between 8 to 12 m high in *Avicennia sp.*, and *Rhizophora apiculata* mangrove trees (Danielsen and Skov 1985, 1987; Silvius 1988). Two other nesting colonies were also reported further inland (Danielsen and Skov 1985).

On Java a colony of 75–100 nests was reported in large *Avicennia marina* trees covering an area of 4.5 ha, with each tree generally holding 5–7 nests, sometimes 10, rarely only 2–3 (Hoogerwerf 1936a). In the Citarum Delta only very tall trees were used, one of these containing 22 nests (Bartels 1915–1930). Verheugt (1987) reports that nests at Pulau Rambut were between 8–30 m above the ground, although in other areas such as Pulau Dua nests may have originally (prior to disturbance) been as low as 4 m above the ground (Hancock *et al.* 1992).

In Malaysia, a colony of 20 nests was between 8 and 10 m high in both living and dead mangrove trees, mostly the latter (Siti Hawa Yatim 1989); in another case two nests were placed in the tops of mangrove trees (Robinson and Chasen 1936). Nests are fairly bulky structures of sticks, lined with fresh leafy twigs, in general resembling the nests of Grey Heron but containing thicker branches (Hoogerwerf 1936a; Robinson and Chasen 1936). Twigs and fresh leaves for the nest are sometimes collected from some distance away (Bartels 1915–1930).

Clutch size, incubation and fledging: Nine clutches from Java consisted of three eggs (Hellebrekers and Hoogerwerf 1967), although nests in one large colony held mostly two young, one with one and a few with three (Hoogerwerf 1936a), and clutches of four eggs have been recorded (Hoogerwerf 1949). In 1984, nests at Pulau Rambut, Java, mostly contained two young (Verheugt 1987). Two nests in Malaysia both contained three young (Robinson and Chasen 1936). The incubation period is estimated at 27–30 days; by 6–7 weeks the young are able to leave the nest and fly poorly, and by eight weeks they fly well but are still fed in the nest by parents (Hoogerwerf 1936b). Small young are fed more frequently than large young; before they are four weeks old chicks may be fed twice per hour, whereas older nestlings may only be fed once per afternoon (Hoogerwerf 1936b). When temperatures are high, adults sometimes bring water to the nest and drool it from their bills to cool the nestlings or allow them to drink (Hancock *et al.* 1992).

Migration and movements

No Milky Stork population undertakes a regular long distance migration, although birds in Cambodia (and possibly Thailand and Vietnam) appear to make seasonal movements in relation to wet and dry periods. Although Malay Peninsula and Sumatran birds seem to be essentially resident there may be some movement across the Malacca Straits. Movements have also been observed across the Sunda Straits (between Sumatra and Java) and further east in Sumbawa and Bali suggesting some regular, small-scale dispersal does take place.

Most waterbirds that breed around Tonle Sap, Cambodia leave the area during the wet season, visiting wetlands across Cambodia (C. M. Poole in litt. 1998, Goes 1999). The recent sighting of birds in the Gulf of Thailand coincides with this annual wet-season exodus (C. M. Poole verbally 1999), and the species may be an overlooked regular, but rare, visitor to the area (P. D. Round in litt. 1999).

In Peninsular Malaysia, the Perak population is essentially resident (Wells 1999). The few sightings from Johor are probably occasional wanderers from the Riau and Jambi populations on

Sumatra, only 70 km distant (Hawkins and Howes 1986). A record from north-west Bali in October 1982 of a bird flying east during a raptor migration (Ash 1982, NJC), and other sightings to the east in Sumbawa suggests that individuals occasionally wander for longer distances. In addition, two birds were observed crossing the Sunda Straits in September 1984 (Allport and Wilson 1986), a flock of presumed immigrants was seen flying east at Serang, West Java, again in September 1984, and spring migration was noted in April 1985 when two small groups were seen flying in a north-westerly direction, leaving mainland Java and traveling towards Sumatra (Verheugt 1987). Although such movements cannot be considered true migration (Silvius and Verheugt 1989), the likely provenance of all these birds is south-east Sumatra, suggesting a minor annual migration (Hancock *et al.* 1992).

2.2 Milky Stork in the Matang Mangrove Forest and adjacent coastal areas, Perak

2.2.1 Historical information on Milky Stork at Matang Mangrove Forest (from 1983 to mid-2004)

The population of Milky Stork in Malaysia is confined to the west coast of Peninsular Malaysia. At the beginning of the 20th century, the species was recorded along the entire west coast of Peninsular Malaysia from the northern state of Kedah to the southern state of Johor. According to Wells (1999), the species was recorded from the coast of Kedah in the 1930s. In Selangor, the species nested at Pulau Ketam through the early 1930s, but there is no record after 1935. In Melaka, the species were recorded in the mid-19th Century, and in southwest Johor, the species was recorded in the 1950s at the Benut Forest Reserve.

In August 1983, an aerial survey from Perlis to Selangor along the west coast of Peninsular Malaysia conducted by the INTERWADER Programme (a forerunner to Wetlands International) recorded 115 Milky Stork in the Matang Mangrove Forest, Perak. A subsequent aerial survey in September of the same year recorded 97 birds in the same area. Follow-up ground surveys in the Matang Mangrove Forest recorded 101 birds in 1984 and 1986 (Parish and Wells 1984, Parish and Wells 1985, Silvius *et. al.* 1987, J. Howes pers. obs.). In the mean time, surveys conducted by PERHILITAN recorded 130 birds in September 1984 and between 130 and 150 birds in March 1989 (Siti Hawa Yatim 1989). Since that time, the species has only been regularly found in Malaysia in the Matang Mangrove Forest and adjacent areas (see Table 1) although vagrants or wanderers have been recorded in Benut Forest Reserve, southwest Johor, with two in February 1985 and one on 16 March 1986 and one at Kuala Sala, Kedah in 16 November 1992 (Wells 1999). A single Milky Stork was also reported from Permas Jaya, Johor on 28 and 29 March 2003, six there in 2 April, and another single at Kampong Senibong in the same area in 30 March 2003 (Oriental Bird Club Bull. *Birding Asia*, No. 1 [June 2004]: 80). However, it is believed that these birds are most likely free-flying birds from the Singapore Zoo. A report from Sungai Kinchin, Pahang in July 1989 (BirdLife International 2001) is believed to be erroneous, Wells (1990) only refers to Storm's Stork from this site.

In the Matang Mangrove Forest, during the 1980s the species was frequently observed both at the lakes on Pulau Kelumpang and Pulau Terong as well as on the inter-tidal mudflats opposite Kulau Gula village. However, since the 1990s they have mostly been observed at the lakes with only occasional records from the mudflats and in the last five years, they have not been recorded on the mudflats at all.

Attempted breeding of Milky Stork at Matang Mangrove Forest was first recorded by PERHILITAN in 1989, with a total of 21 nests found at Pulau Kelumpang (Siti Hawa Yatim 1989, Asian Wetland News Vol 2, No.2 [Dec 1989]: 1). Only two eggs hatched from these 21 nests and neither young survived. Remnant of egg shells were found under the nesting trees (Siti Hawa Yatim, pers. obs.). Although there were no direct observations of predation of Milky Stork eggs or young, monitoring of the breeding colony by PERHILITAN at this time reported that Brahminy Kites were disturbing the Milky Stork nests, and that Water Monitors and Common Palm Civet were other potential predators and that these may have been a contributing factor to the zero survival rate. In 1990, breeding was again attempted at Pulau Kelumpang, however the number of nests was less than the previous year and again there was no successful breeding observed (Siti Hawa Yatim, pers. obs.). In October 1997, 11 Milky Stork nests were found at Pulau Kelumpang during an aerial survey, but once again no successful breeding was recorded (Siti Hawa Yatim, pers. obs.).

Surveys conducted between 1983 and 2004 at Matang Mangrove Forest by INTERWADER (Wetlands International) and PERHILITAN indicate that the Malaysian population of Milky Stork has been in steady decline since the early 1980s. The population has declined from over 100 individuals in the 1980s to not more than 10 birds in 2002-2004, indicating that the species is almost certainly facing the threat of local extinction in the wild in Malaysia (see Table 1).

Table 1: Numbers of Milky Stork recorded at Matang Mangrove Forest between 1983 and 2004

Date	Number	Site	Survey method	Reference/observers
1983				
17 August	115	Pulau Kelumpang 74, Pulau Terong 36	Aerial Survey	Parish and Wells 1984
29 August	30+	Pulau Kelumpang	Ground survey	Parish and Wells 1984
2-3 September	97	Matang Mangrove Forest	Aerial survey	Parish and Wells 1984
1984				
26 July	101	Pulau Kelumpang	Ground survey	Observed by J. Howes and F. Lambert.
September	130	Pulau Kelumpang	Ground survey	Siti Hawa Yatim 1989
8 October	101	Pulau Kelumpang	Ground survey	Parish and Wells 1985
1986				
31 January	34	Pulau Terong	Ground survey	Silvius <i>et al.</i> 1987
26 March	35	Pulau Kelumpang	Ground survey	Silvius <i>et al.</i> 1987
July	101	Pulau Terong	Aerial survey	Silvius <i>et al.</i> 1987
1989				
January	3	Matang		Scott and Rose 1989
March	130-150	Pulau Kelumpang	Ground survey	Siti Hawa Yatim 1989
November	21 nests	Pulau Kelumpang	Ground survey	Siti Hawa Yatim 1989
1990				
9 January	62	Pulau Kelumpang	Ground survey	Perennou <i>et al.</i> 1990
March	76	Kuala Gula-Kurau, Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1990
April	69	Kuala Gula-Kurau, Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1990
June	0	Kuala Gula-Kurau, Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1990
July	0	Kuala Gula-Kurau, Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1990
August	0	Kuala Gula-Kurau, Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1990
November	1	Kuala Gula-Kurau, Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1990
December	4	Kuala Gula-Kurau, Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1990
1991				
16 January	1	Pulau Kelumpang	Ground survey	Perennou and Mundkur 1991
2 February	23	Pulau Kelumpang	Ground survey	Perennou and Mundkur 1991
February	51	Kuala Gula-Kurau, Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1991
March	4	Kuala Gula-Kurau, Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1991
April	0	Kuala Gula-Kurau, Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1991
May	39	Kuala Gula-Kurau, Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1991
June	50	Kuala Gula-Kurau, Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1991
July	4	Kuala Gula-Kurau, Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1991
August	31	Kuala Gula-Kurau, Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1991
September	0	Kuala Gula-Kurau, Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1991
1992				
26 January	4	Pulau Kelumpang	Ground survey	Perennou and Mundkur 1992,

Date	Number	Site	Survey method	Reference/observers
				PERHILITAN Annual Report 1992
February	42	Kuala Gula-Kurau, Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1992
March	35	Kuala Gula-Kurau, Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1992
April	5	Kuala Gula-Kurau, Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1992
May	7	Kuala Gula-Kurau, Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1992
June	0	Kuala Gula-Kurau, Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1992
July	43	Kuala Gula-Kurau, Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1992
August	39	Kuala Gula-Kurau, Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1992
September	27	Kuala Gula-Kurau, Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1992
October	7	Kuala Gula-Kurau, Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1992
November	0	Kuala Gula-Kurau, Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1992
December	4	Kuala Gula-Kurau, Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1992
1993				
Date unspecified	38	Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1993
1994				
Date unspecified	39	Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1994
1995				
September	42	Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1995
1996				
Date unspecified	6	Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1996
1997				
June	40	Pulau Kelumpang	Ground survey	PERHILITAN Annual Report 1997
1998				
September	32	Matang	Ground survey	PERHILITAN Annual Report 1998
1999				
July	24	Matang	Ground survey	PERHILITAN Annual Report 1999
2002				
20 December	6	Pulau Kelumpang	Ground survey	PERHILITAN-Kuala Gula
2003				
4 January	7	Pulau Kelumpang	Ground survey	PERHILITAN-Kuala Gula
20 January	8	Pulau Kelumpang	Ground survey	PERHILITAN-Kuala Gula
24 February	1	Pulau Kelumpang	Ground survey	PERHILITAN-Kuala Gula
18 March	3	Pulau Kelumpang	Ground survey	PERHILITAN-Kuala Gula
19 May	6	Pulau Kelumpang	Ground survey	PERHILITAN-Kuala Gula
15 July	6	Pulau Kelumpang	Ground survey	PERHILITAN-Kuala Gula
2004				
7 February	8	Pulau Kelumpang	Ground Survey	PERHILITAN-Kuala Gula, Yeap <i>et al.</i> 2004
23 March	10	Pulau Kelumpang	Ground survey	PERHILITAN-Kuala Gula
5 May	2	Pulau Kelumpang	Ground survey	PERHILITAN-Kuala Gula

2.2.2 Current Milky Stork population at the Matang Mangrove Forest (August 2004-January 2006)

Between August 2004 and January 2006 a comprehensive survey to assess Milky Stork populations at Matang Mangrove Forest, and to evaluate reasons for the population decline, was undertaken.

The surveys targeted two clearings (so-called “lakes”) within the mangrove forest on Pulau Kelumpang and Pulau Terong where historically most Milky Storks have been observed. Most previous surveys had concentrated on the Pulau Kelumpang “lake” and the Pulau Terong “lake” had not been assessed since 1986. By including both Pulau Kelumpang and Pulau Terong in the survey a more comprehensive picture of the population number and status could be gained. Earlier surveys had showed that birds moved between these two lakes and that counts at any one lake may not reflect the true situation (Silvius *et al.* 1987).

These “lakes” are actually depressions in the ground formed by either subsidence or shrinkage of the soil layer. Historical accounts show that they were once forested and it is likely that excessive water-logging has led to the death of mangrove trees in these depressions and resulted in the formation of the clearings. The “lakes” appear to be ephemeral in nature with periods of complete drying interspersed with times of water retention. Surveys were also conducted along the inter-tidal flats within the Matang Mangrove Forest and to the north, but no Milky Storks were recorded in these areas.

Between August 2005 and January 2006 a total of 13 ground surveys and one aerial survey were carried out. During the three ground surveys in August-October 2004 it was not possible to survey Pulau Terong, but during January 2005 to January 2006 both Pulau Kelumpang and Pulau Terong were visited on each survey (except in July 2005 when only Pulau Terong Lake was visited) to ensure more complete coverage was made. During this period the maximum count of Milky Stork at Matang Mangrove Forest was found to be very low with only nine individuals counted in October 2004. The highest count in 2005 was eight birds in June 2005 and 4 birds in January 2006. The comprehensive survey confirmed the severe decline of the Milky Stork population in Malaysia. An overview of the survey results is given in Table 2 and Figure 3.

2.2.3 Possible recent breeding of Milky Stork

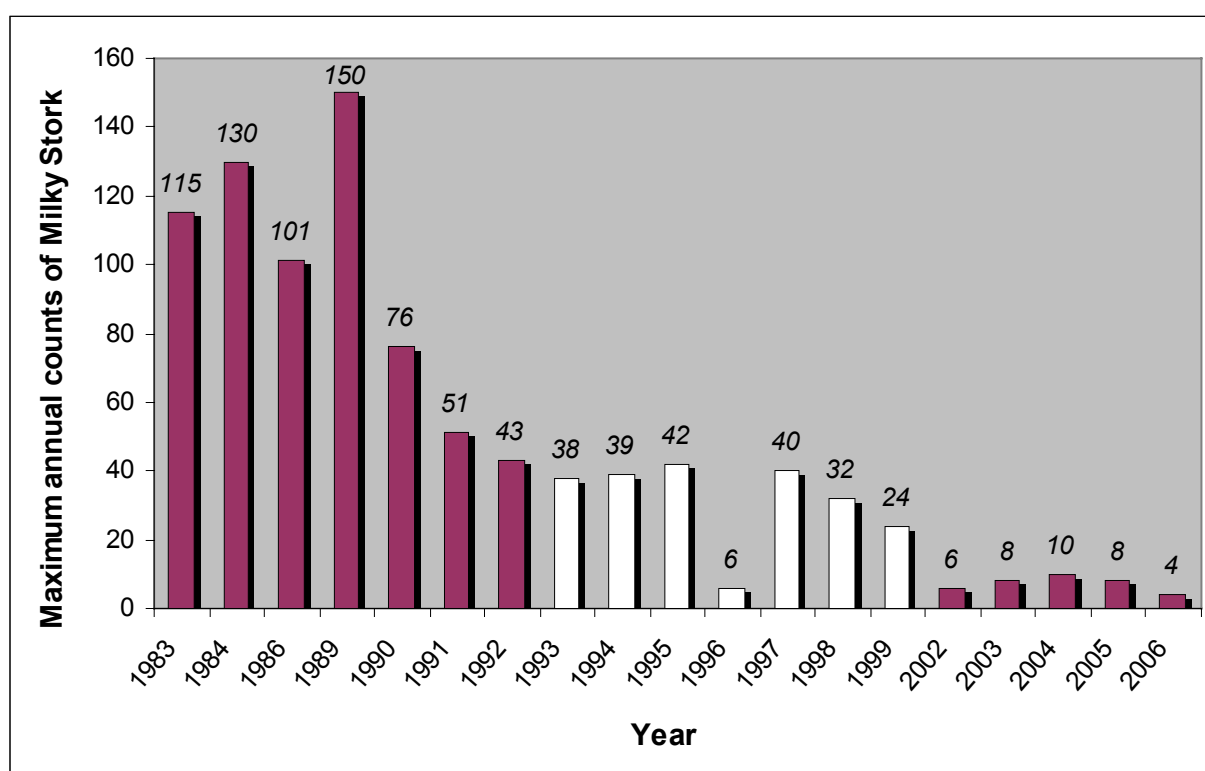
Between August 2004 and January 2006 there were no confirmed records of breeding by Milky Stork at Matang Mangrove Forest. However, there were several reports of possible breeding activity, indicating that even with such a small population size the species may still be attempting to breed at the site.

A large nest at Pulau Kelumpang Lake was reported on 14 October 2004 although no birds were in attendance it was thought to be a stork nest. On 29 December 2005, three large nests were observed at the lake. Milky Storks were recorded in the nest tree, but they flew after the survey team arrived at the site. Retrospective records showed that Milky Storks were observed in the same tree (prior to the construction of the nests) in late November 2005. The nests were built in the top of a 5 m tall *Avicennia marina* tree. The diameter of the nests was about 50 cm and they contained medium sized twigs. However, when the nest tree was visited on 17 January 2006, there were no longer any nests in the tree and no juvenile birds present at the lake.

Table 2: Numbers of Milky Stork recorded at Matang Mangrove Forest between August 2004 and January 2006

Date	Number of Milky Stork		Survey method	Observers / Counters
	Pulau Kelumpang Lake	Pulau Terong Lake		
2004				
17 August	8	Not surveyed	Ground survey	David Li, Lim Kim Chye, Cheang Kum Seng, Mohd Zakimi Bin Mat Yunus, Hamzah Saad, Mohammad Tahir B. Abd. Karim.
16 September	5	Not surveyed	Ground survey	Lim Kim Chye, Mohammad Tahir B. Abd. Karim.
14 October	9	Not surveyed	Ground survey	David Li, Nancy Drilling, Yang Chong, Mohd Zakimi Bin Mat Yunus, Abu Bakar Mat Non.
2005				
12 January	2	0	Aerial survey	David Li, John Howes, Crawford Prentice.
25-27 January	3	0	Ground survey	David Li, Lim Aun Tiah, Lim Kim Chye, Mohammad Tahir B. Abd. Karim.
23-24 February	0	6	Ground survey	Rahmah Ilias, Zulkanain B. Talib, Mohammad Tahir B. Abd. Karim.
24-26 March	0	0	Ground survey	David Li, Lim Kim Chye, Zainal Abidin B. Mat, Mohamad Aminurddin B. Ahmad, Shazatul Farina Bt. Abd. Latiff, Mohamad Zainuddin B. Busrah, Mohammad Tahir B. Abd. Karim, Hamzah Saad.
24-26 May	6	0	Ground survey	Rahmah Ilias, Zainal Abidin B. Mat, Abd. Rahman B. Ahmad, Mohammad Tahir B. Abd. Karim, Hamzah Saad.
22-23 June	8	0	Ground survey	Mohamad Zainuddin Bin Busrah, Ishak B. Jusoh, Mohd. Rani B. Cha, Hamzah Saad, Mohammad Tahir B. Abd. Karim.
5 July	Not surveyed	4	Ground survey	Hamzah Saad, Mohammad Tahir B. Abd. Karim, Zamrin B. Zainal, Suria B. Ibrahim.
22-23 August	3	0	Ground survey	David Li, John Howes, Rahmah Ilias, Zainal Abidin B. Mat, Mohamad Aminurddin B. Ahmad, Mohammad Tahir B. Abd. Karim, Ishak B. Jusoh, Mohammad Radzay B. Osman.
30 November – 1 December	6	0	Ground survey	Rahmah Ilias, Zainal Abidin B. Mat, Mohamad Aminurddin B. Ahmad, Ishak B. Jusoh, Abu Bakar Mat Non, Mohammad Radzay B. Osman, Badrul Hisham Abd. Rashid.
29 December	7	0	Ground survey	Zainal Abidin B. Mat, Mohamad Aminurddin B. Ahmad, Mohamad Zainuddin Bin Busrah, Hamzah Saad, Mohammad Radzay B. Osman and Badrul Hisham Abd. Rashid.
2006				
16-18 January	4	0	Ground survey	David Li, Lim Kim Chye, Mohd. Rani B. Cha, Hamzah Saad, Abu Bakar Mat Non, Mohammad Radzay B. Osman and Badrul Hisham Abd. Rashid.

Figure 3: Maximum annual counts of Milky Stork in Matang Mangrove Forest from 1983 to 2006



Note: White color used for 1993 to 2002 as only one visit were made during the year, therefore the data may not reflect the maximum number of Milky Stork for the year.

2.2.4 Ecological assessment of Milky Stork habitats at Matang Mangrove Forest

The Matang Mangrove Forest covers a total area of 40,466 ha of mangrove forest and was gazetted in 1902. Since 1904, regular 10-year working plans have guided management of the Forest Reserve, whose principal aim has been to produce fuel wood and poles, on a sustainable basis within an ecologically sustainable, socially acceptable and economically viable framework. The forestry rotation period is 30 years with thinning during the 12th and 18th year. The Forest Reserve is managed by the Perak State Forestry Department (Azahar and Nik Mohd Shah 2003).

The Matang Mangrove Forest has 28 species of true mangrove and 13 species of associated mangrove species. The two species which have highest economic value are *Rhizophora apiculata* and *Rhizophora mucronata*.

A new approach to mangrove management has been adopted in the current (2000-2009) working plan, with the forest divided into four management categories based upon their functional roles (see Figure 4). It has been recognized that one of these functions is conservation of important biological diversity and at Matang the conservation of the Milky Stork in particular is highlighted. As a result, one of the management categories is "Protective Forest" covering an area of 7,360 ha, or 18.2% of the Forest Reserve. In these areas wood harvesting is strictly prohibited. One of the largest blocks of Protective Forest in the Matang Mangrove Forest is the entire outer area of Pulau Kelumpang – at the center of this is the most important zone for Milky Stork conservation. Another important Protective Forest zone surrounds the lake at Pulau Terong, although this is much smaller in extent. Other Protective Forest zones include areas of accreting "new" mangrove forest (principally *Avicennia marina* forest), dryland back mangroves, and functional forest such as Virgin Jungle reserves (VJR), old growth areas, research areas, etc.

2.2.4.1 Pulau Kelumpang

Mangrove vegetation structure: The most important area for Milky Stork in the Matang Mangrove Forest is a small (4 hectare) “lake” in the middle of the western part of Pulau Kelumpang (See Figure 1). Pulau Kelumpang is divided by small rivers into two main parts, the western part of which coincides with Forestry Compartment 11 and covers an area of 2,593 ha (see Figure 5) (Azahar and Nik Mohd Shah 2003). Much of the area is dominated by accreting *Avicennia marina* mangrove forest totaling 1,883 ha in area. In addition, there are 65 ha of Archaeological Buffer Reserve as protective forest, 353 ha of transitional new forest classified as restricted productive forest and serving as a buffer zone for the new forest reserve. There are still 288 ha along the river classified as productive forest.

This area is one of the most rapidly accreting areas within the Matang Mangrove Forest. The area of *Avicennia marina* forest on Pulau Kelumpang has increased from 240 ha in 1950 to 1,883 ha in 2005, extending 2.8 km to the seaward or the equivalent of 72m/year at its widest stretch over the last 50 years (Azahar and Nik Mohd Shah 2003).

Silvius *et al.* (1987) established nine mangrove vegetation sampling and monitoring plots on Pulau Kelumpang in 1986, five of these were to the west of the “lake” area and the remaining four near the Sg. Sangga Pasir to the east. Plot II (located 50m west of the “lake”) consisted of a pure stand of *Avicennia marina* – with about 60% of the trees showing signs of some die-back. They also noted that there was no regeneration of seedlings on the forest floor and recorded that there were numerous dead *Avicennia* tree stumps in the lake water. This was also observed in July 1984 (J. Howes, pers. obs.). In August 2005 the forest in this area was still dominated by *A. marina* but many of the trees were now more healthy and showing good leaf cover. In addition, there were one or two mid-sized *Bruguiera cylindrica* near the lake edge and the lake itself was devoid of any dead tree stumps.

Mangrove vegetation along the creek to the west of the lake was also described in Plot III of Silvius *et al.* (1987). This area was fairly uniform, mature (13m tall) *A. marina* forest with isolated *Rhizophora mucronata* trees along the creek edge. They also noted about 30% of the *Avicennia* trees were dead or dying in this area, and that there was abundant regeneration. In August 2005, the situation was a little different. The dominant tree species was still mature *A. marina* with a high density of regeneration and an abundance of deadwood. It was noted that besides *R. mucronata* there were also other mangrove tree species colonizing the area. These included regenerating *B. cylindrica*, *R. apiculata* and *Xylocarpus granatum*.

Lake water quality: No historical data is available on water quality of the lake at Pulau Kelumpang, however Howes (pers. obs.) noted that in July 1984 the Pulau Kelumpang lake water smelt of rotten eggs (indicating a high hydrogen sulphide content), was warm in temperature (ca. 25°C) and a cloudy, grey colour.

In January, August, November and December 2005, four water quality samples were taken from the western edge of the lake. Salinity was low, ranging from 3.2 to 8.5 ppt, indicating brackish water. The lake water was also weakly alkaline, between pH 7.65 and 8.5 and conductivity levels were wide ranging, decreasing from 14.8 mS/cm in January to 4.3 mS/cm in December (see Table 3). The low values recorded in December were indicative of dilution due to heavy rainfall between September and December 2005 (see Table 4).

A detailed laboratory analysis of water quality was carried out in November 2005. The value of Total Suspended Solids was low, at 16 mg/l, whereas the Total Dissolved Solids was lower than saline water, indicating brackish water. High nutrient content was recorded with Ammoniacal Nitrogen and Phosphate values moderately high, at 3.2 mg/l and 0.76 mg/l respectively. This was most probably due to high levels of bird excrement, although total coliform and *E. coli* content was low, at 3250 and 1850 CFU/100 ml respectively.

The Chemical Oxygen Demand (COD) was high, at 114.5 mg/l. Heavy metal concentrations (Fe, Cr, Pb, and Zn) were low. Mg, K and Na concentrations also were low, indicating brackish water.

The value of Oil and Grease detected was high compared to mangrove ecosystems in Johor where highest levels were 5 mg/l (Wetlands International - Malaysia 2005).

The lake water quality can be classified as Class III-V, based on the Ammonium-Nitrogen, COD and *E. coli* results (Department of Environment 2005a). The bacteria content and Oil and Grease levels exceeded the Interim Marine Water Quality Standards set by the Department of Environment (2005b).

Table 3: Water quality results of water samples from Pulau Kelumpang Lake, 2005

Parameter/Sampling	Method of analysis	26 January	22 August	30 November	29 December
Salinity, ppt	YSI 30	8.5	5.6		3.2
pH	YSI 60	8.5	8.1		7.65
Conductivity, mS/cm	YSI 30	14.8	10.32		4.3
Total Suspended Solids (mg/l)	APHA 1998			16.0	
Total Dissolved Solids (mg/l)	APHA 1998			11313	
Ammoniacal nitrogen (N-NH ₃) (mg/l)	HACH 1992			3.2	
Phosphate (PO ₄ ³⁻) (mg/l)	HACH 1992			0.76	
Chemical Oxygen Demand (COD) (mg/l)	HACH 1992			114.5	
Fe (mg/l)	APHA 1998			0.18	
Cr (mg/l)	APHA 1998			0.009	
Pb (mg/l)	APHA 1998			<0.001	
Zn (mg/l)	APHA 1998			<0.0002	
Mg (%)	APHA 1998			3.75	
K (%)	APHA 1998			1.2	
Na (%)	APHA 1998			16.9	
Oil & Grease (mg/l)	APHA 1998				9.9
Total coliform (cfu/100ml)	Membrane filtration				3250
E-coli (cfu/100ml)	Membrane filtration				1850

Hydrology and lake water levels: There has been much speculation about the origin and hydrology of the “lake” at Pulau Kelumpang. Silvius *et al.* (1987) offer perhaps the best theory as to its formation, postulating that it was caused by the uneven shrinkage and sinking of the coastal clay deposits during dry spells. In places where the trees have already died they theorize that the exposed mud will dry faster than in areas with tree cover, thus exacerbating the drying and sinking of the already formed basin.

The origin of the water within the lake is likely to be a combination of several factors. These include rainfall, extreme high tidal events and capillary action of water through the sub-soil (also tidally influenced). Whatever the origin of the water, as time progresses the lake depression becomes water-logged and the trees die due to a lack of oxygen in the soil (permanent inundation will even kill mangrove trees like *A. marina* that have developed pneumatophores to cope with daily water-logging during high tides). The brackish nature of the water seems to support the idea that water is both from saline (tidal) and precipitation (rainfall) origins. It is known that before the 1990's, on the highest tides some salt water used to reach the lake (Siti Hawa Yatim, pers. obs.). However Table 4 indicates that even during 2.9 to 3.1 meter high tides in February and March 2005 the lake was still dry and that during ten visits to the lake in 2004 and 2005 tidal water inflow to the lake was never observed, even during the high point of the

highest tide of the month. This supports the theory that most of the water in the lake originates from local rainfall. In February-March 2005 the lake bed at Pulau Kelumpang was dry. This was the first recorded instance of such a phenomenon in 21 years of survey.

Table 4: Water level at Pulau Kelumpang Lake, height of highest monthly tides at Lumut and monthly rainfall for Bagan Serai, August 2004 to December 2005

Month/ year	Aug 04	Sep 04	Oct 04	Nov 04	Dec 04	Jan 05	Feb 05	Mar 05	Apr 05	May 05	Jun 05	Jul 05	Aug 05	Sep 05	Oct 05	Nov 05	Dec 05
Water level	High	High	Very High			High	Dry	Dry		High	High	High	Low			High	High
Highest Tide (m) ¹	3.0; 3.0	3.1; 3.2	3.3; 3.2	3.3; 3.0	3.1; 2.8	3.0; 2.8	3.0; 2.9	3.1; 3.0	3.2; 3.2	2.9; 3.1	2.9 3.1	2.8; 3.1	2.9; 3.2	3.0; 3.3	3.1; 3.4	3.2; 3.2	3.1; 2.9
Rainfall (mm/month) ²	62.3	289.3	162.9	288.1	86.7	34.4	34.1	116.6	160.8	102.1	98.9	80.9	85.4	206.6	345.6	217.4	151.7

Notes:

1-Tide Tables for Lumut, Perak (Hydrographic Department of Royal Malaysian Navy 2005)

2: Rainfall data from Malaysia Meteorological Service (Jabatan Perkhidmatan Kajiucaca Malaysia), JKR Bagan Serai Station (E100°32', N05°01').

Populations of Milky Stork prey species: Swennen and Marteiijn (1987) provide some of the best information on prey species and diet in Malaysian Milky Storks. They found that the bulk of the diet appeared to be large mudskippers *Periophthalmus spp.* of 10–23 cm in length; the estimated weight of fish eaten in one observation of 39 minutes was 225 g. Mudskippers (and eels) up to 20cm in length are also mentioned as food items for Milky Stork nestlings in Indonesian studies (Hoogerwerf 1936b). There seems little doubt then that mudskippers form a major part of the dietary need.

Although mudskippers are a common sight in the inter-tidal areas at Matang Mangrove Forest, there have been no quantitative assessments of these or any other Milky Stork prey species at the Forest Reserve or within the lake at Pulau Kelumpang. What is known is that even in the early 1980s when stork populations were much higher, few Milky Storks were actually observed foraging on the vast inter-tidal mudflats at Matang. Silvius *et al.* (1987) postulated that the storks must often feed in other areas which may be situated further inland (although this is now considered unlikely). During the 2004-2006 surveys Milky Storks were observed feeding on mudskippers and other fish in the lake at Pulau Kelumpang. However during periods of extreme drying (February and March 2005) it is unlikely that the population of fish could survive as the dry lake bed was found to be littered with large numbers of dead gastropod snails.

2.2.4.2 Pulau Terong

Mangrove vegetation structure: The “lake” at Pulau Terong is located about 12 km SE of the lake at Pulau Kelumpang (see Figure 1). It forms a second important area for Milky Stork in the Matang Mangrove Forest. The lake is only about 100-150m from the western coastline of Pulau Terong and is about 8 hectares in size.

The mangrove forest on Pulau Terong is one of the major “Productive Forest” areas within Forest Compartment 64 of the Matang Mangrove Forest (Figure 6). The 362 ha block along the western coast and surrounding the lake has been classified as “Restrictive Productive Forest” and is not proposed for logging (Azahar and Nik Mohd Shah 2003). The Restrictive Production Forest includes 103 ha of Buffer Zone Forest around the lake, 23 ha of Dryland Forest to the immediate east, and the remainder (228 ha) consists of “Seaward Berus Forest” – a more-or-less monospecific stand of *Bruguiera cylindrica* of uniform age and height. The seaward edge of the *B. cylindrica* forest is heavily eroding with a steep mud cliff and a ridge of deposited shell-

sand (unlike the accreting western shore of Pulau Kelumpang), and it is likely that this erosion has resulted in a decrease in the distance between the lake and the coast over the last 20 years. To the immediate east of Forest Compartment 64, the forest is predominantly Productive Forest consisting of *Rhizophora apiculata*, which was being logged during 2005.

Lake water quality: No historical data is available on water quality of the lake at Pulau Terong. Three water quality samples were taken between August and December 2005. Salinity was found to be very low, at 1.2 - 4.8 ppt, indicating brackish water. The lake water was near neutral, at pH 6.73 - 7.6 and conductivity levels were high (3.0 - 10.20 mS/cm) although Dissolved Oxygen levels were low at 2.28 mg/L. (see Table 5).

A detailed laboratory analysis of the December water sample indicated that Total Suspended Solids were high, at 70.4 mg/l, whereas Total Dissolved Solids were low, at 4309. These values are indicative of dilution due to heavier rainfall in October and November 2005 (see Table 6). Ammoniacal Nitrogen levels were lower than those recorded at Kelumpang Lake, possibly due to less birds contributing waste to the lake water. Phosphate concentrations were higher, at 1.1 mg/l and total coliform and *E. coli* concentrations were very high.

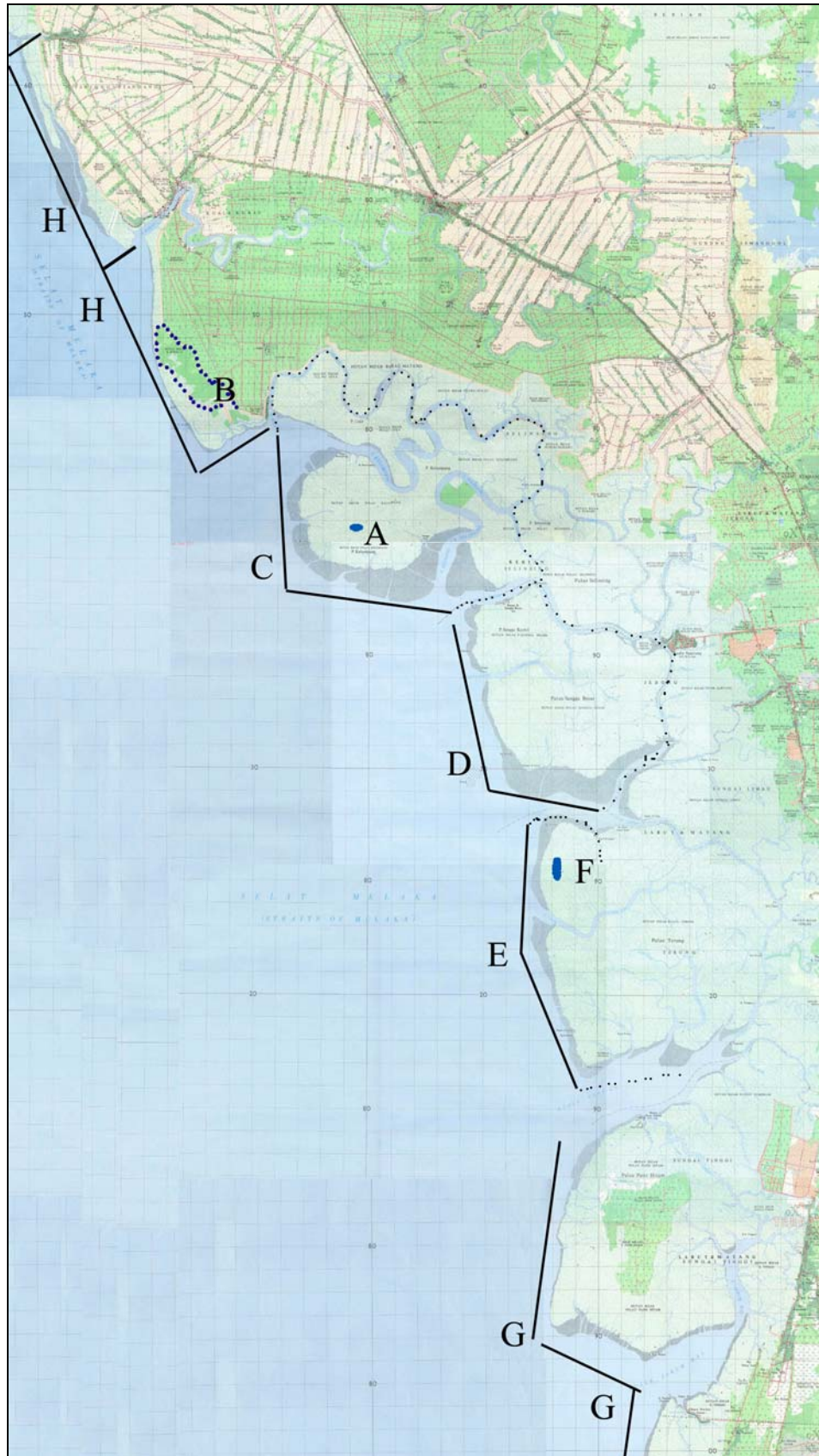
The Chemical Oxygen Demand was high, at 102.0 mg/l. Heavy metal concentrations (Fe, Cr, Pb, and Zn) were low. Mg, K and Na concentrations were also low.

The value of Oil and Grease detected was high compared to mangrove ecosystems in Johor where highest levels were 5 mg/l (Wetlands International - Malaysia 2005).

Table 5: Water quality results of water samples from Pulau Terong Lake, 2005

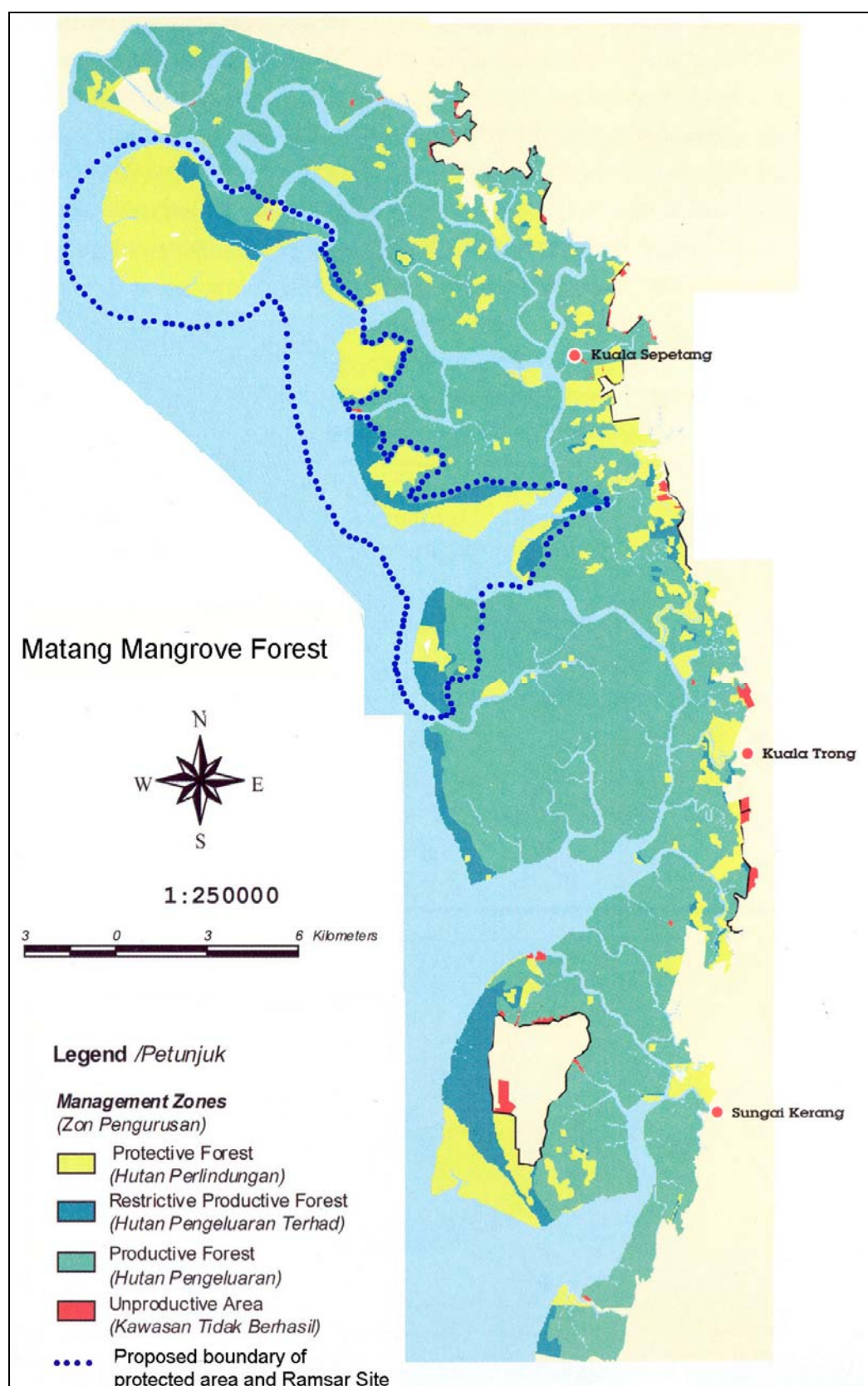
Parameter / Sampling	Method of analysis	22 August	1 December	29 December
Salinity, ppt	YSI 30	4.8		1.2
pH	YSI 60	7.6		6.73
Conductivity, mS/cm	YSI 30	10.20		3.0
Dissolved Oxygen, mg/L	YSI 550A	2.28		
Total Suspended Solids (mg/l)	APHA 1998		70.4	
Total Dissolved Solids (mg/l)	APHA 1998		4309	
Ammoniacal nitrogen (N-NH ₃) (mg/l)	HACH 1992		1.4	
Phosphate (PO ₄ ³⁻) (mg/l)	HACH 1992		1.1	
Chemical Oxygen Demand (COD) (mg/l)	HACH 1992		102.0	
Fe (mg/l)	APHA 1998		2.06	
Cr (mg/l)	APHA 1998		0.076	
Pb (mg/l)	APHA 1998		<0.001	
Zn (mg/l)	APHA 1998		<0.0002	
Mg (%)	APHA 1998		1.35	
K (%)	APHA 1998		0.42	
Na (%)	APHA 1998		5.4	
Oil & Grease (mg/l)	APHA 1998			14.2
Total coliform (cfu/100ml)	Membrane filtration			Too numerous to count (after 100 x dilutions)
E-coli (cfu/100ml)	Membrane filtration			Too numerous to count (after 100 x dilutions)

Figure 1: Survey areas in the Matang Mangrove Forest and adjacent coastal areas



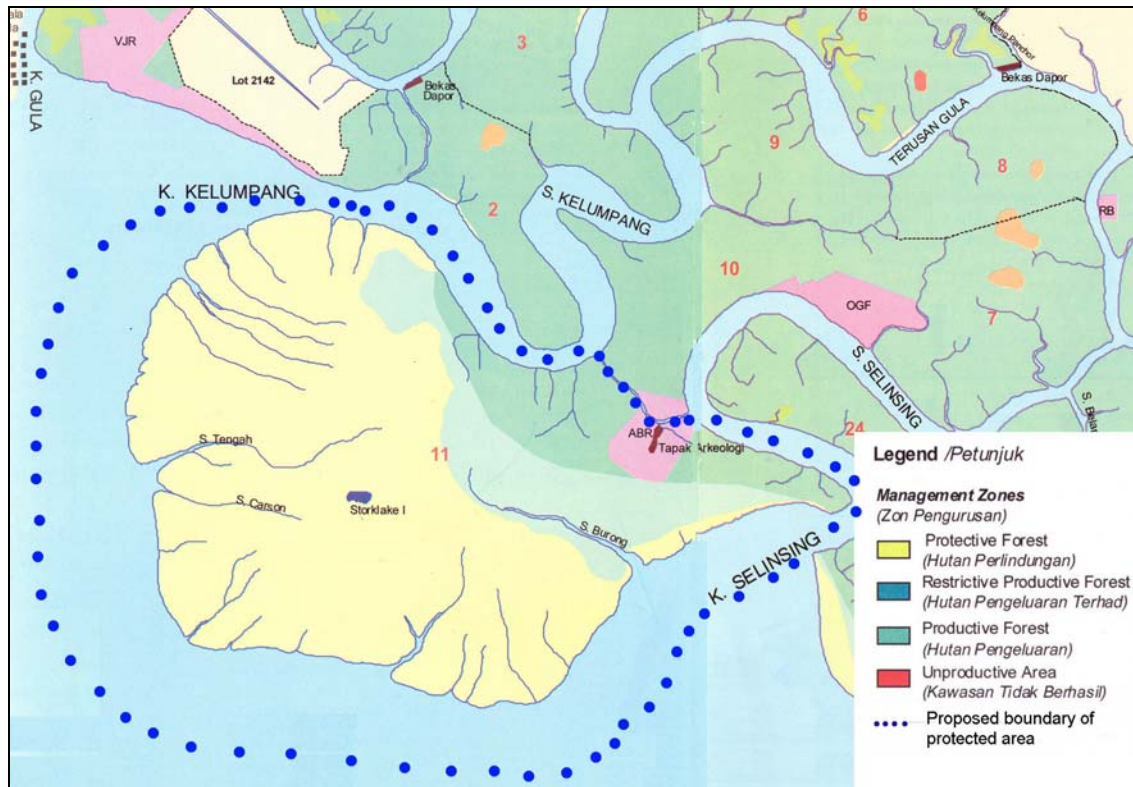
Note: A - Pulau Kelumpang Lake; B - Inter-tidal mudflats at Bang Zhu Kao, Kuala Gula; C - Coastal zone and rivers surrounding Pulau Kelumpang; D - Coastal zone and rivers surrounding Pulau Sangga Kechil & Besar; E - Coastal zone and rivers surrounding Pulau Terong; F - Pulau Terong Lake; G - Pulau Pasir Hitam & South Sg Kerang coast; and H - Kuala Gula - Kuala Kurau - Tg. Piandang coast.

Figure 4: Forest Management Zones in Matang Mangrove Forest and proposed area for protection



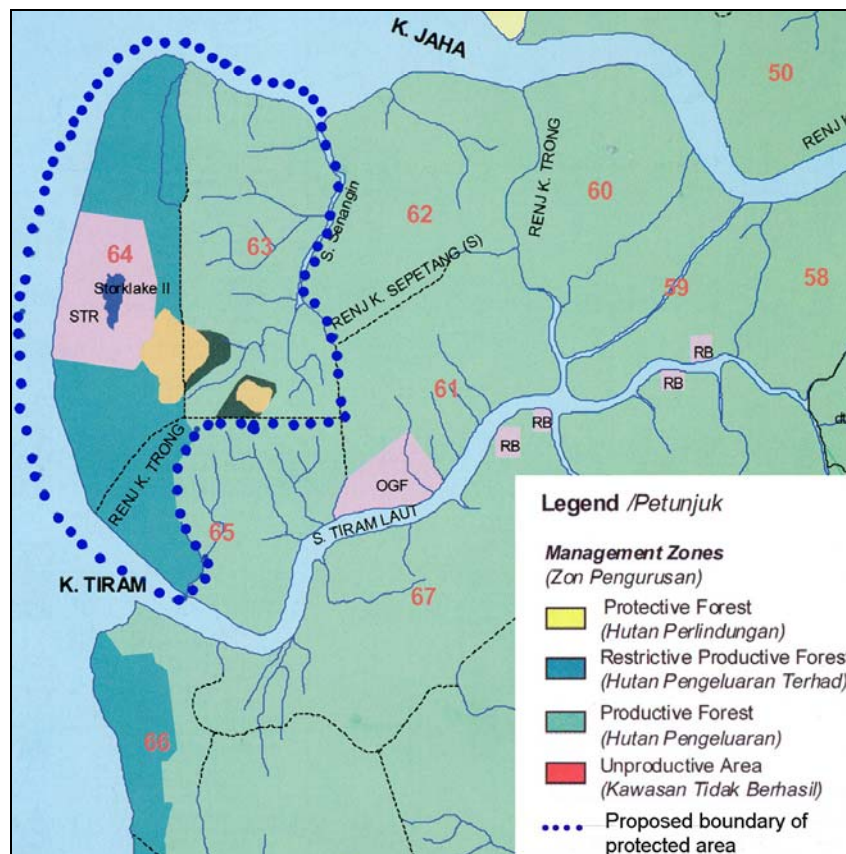
Note: Map extracted from Azahar and Nik Mohd Shah (2003).

Figure 5: Map of Pulau Kelumpang and proposed area for protection



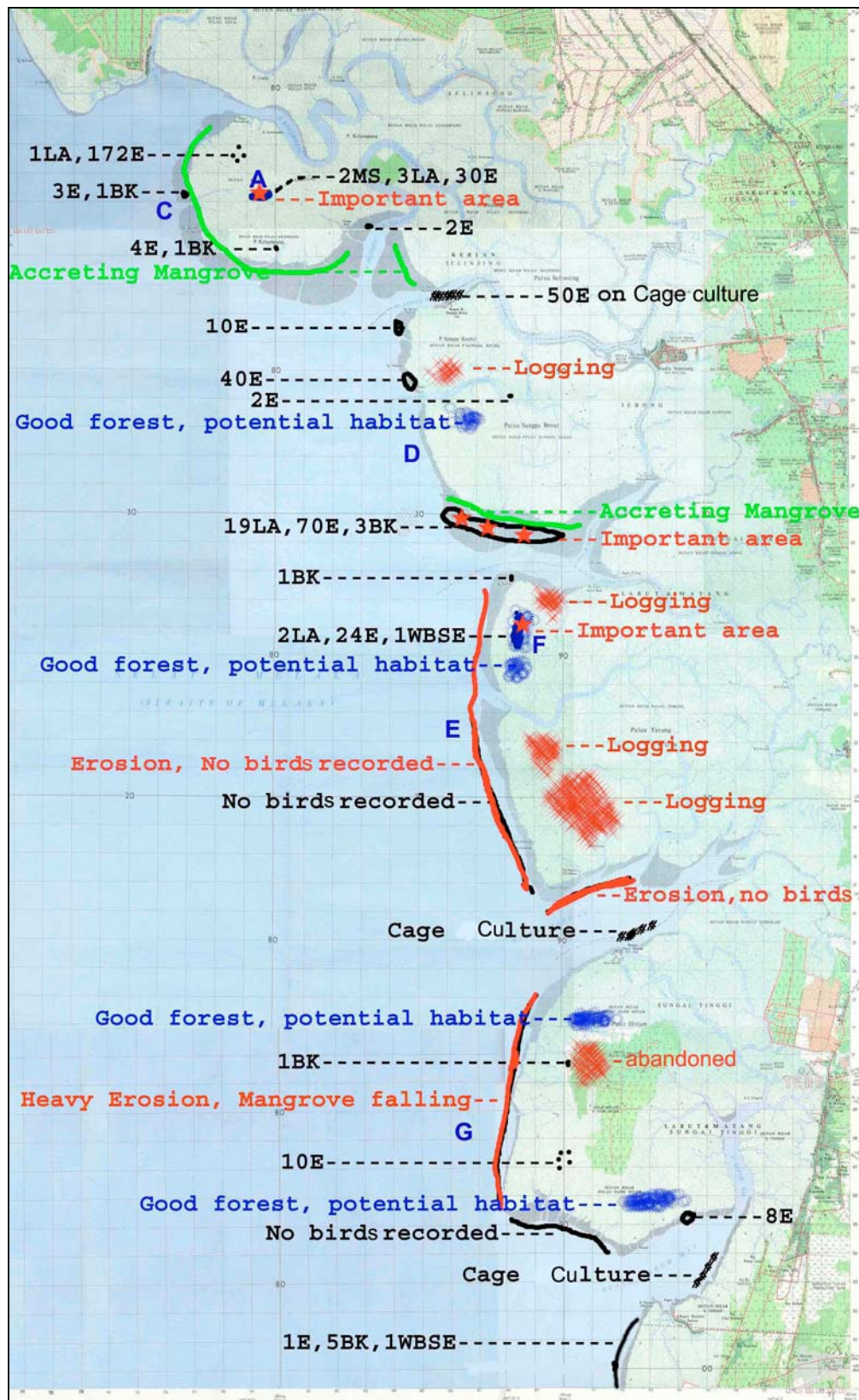
Note: Map extracted from Azahar and Nik Mohd Shah (2003).

Figure 6: Map of Pulau Terong and proposed area for protection



Note: Map extracted from Azahar and Nik Mohd Shah (2003).

Figure 8: Habitat status and distribution of the large waterbirds at Matang mangrove forest recorded during aerial survey on 12 January 2005



Note:

- 1: A - Pulau Kelumpang Lake; C - Coastal zone and rivers surrounding Pulau Kelumpang; D - Coastal zone and rivers surrounding Pulau Sangga Kechil & Besar; E - Coastal zone and rivers surrounding Pulau Terong; F - Pulau Terong Lake; and G - Pulau Pasir Hitam & South Sg Kerang coast.
 2: E - Egrets, LA - Lesser Adjutant, MS - Milky Stork, BK - Brahminy Kite, WBSE - White-bellied Sea Eagle.

Annex L: Pictures of Milky Storks, their habitat in Matang Mangrove Forest and suspected hybrids of Milky Storks and Painted Storks



Picture 1: Aerial view of Pulau Kelumpang Lake (photo by John Howes).



Picture 2: Aerial view of Pulau Terong Lake (photo by Crawford Prentice).



Picture 3: Milky Stork at Pulau Kelumpang Lake (photo by Lim Kim Chye).



Picture 4: Flying Milky Stork at Pulau Kelumpang Lake (photo by Cheang Kum Seng).



Picture 5: Milky Stork nest in 1989 at Pulau Kelumpang Lake (photo by Siti Hawa Yatim).



Picture 6: Suspected Milky Stork nest in December 2005 at Pulau Kelumpang Lake (photo by Zainal Abidin B. Mat).



Picture 7: Suspected Hybrid of Milky Stork and Painted Stork (right) at Zoo Negara, Kuala Lumpur (photo by David Li).



Picture 8: Suspected Hybrids of Milky Stork and Painted Stork (all three birds) at Dusit Zoo, Bangkok (photo by Jonathan Murry).

The lake water quality can be classified as Class IV-V, based on the Ammonium-Nitrogen, COD and *E. coli* results (Department of Environment 2005a). This result indicates that the lake is highly polluted and not suitable as waterbird habitat as food source may be limited. The bacteria content, Oil and Grease and Total Suspended Solids levels exceeded the Interim Marine Water Quality Standards set by the Department of Environment (2005b).

Hydrology and lake water levels: The process of lake formation at Pulau Terong is likely to be similar to that outlined above for Pulau Kelumpang. However, unlike Pulau Kelumpang, there is an historical precedent for periods of drying out – Silvius *et al.* (1987) reported that in June 1986 the lake was almost dry. In 2005, the lake bed was also dry in February and March and as shown in Table 6 there appears to be no correlation between tidal height on the highest monthly tide and hydrological inflows to the lake basin. The topography of Pulau Terong, coupled with a lack of creeks near to the lake basin seems to imply that this lake is more heavily influenced by rainfall patterns than by tidal cycles. This is supported by the fact that very low rainfall in February 2005 (5.2 mm only) and low rainfall in March 2005 (63.9 mm) were insufficient to recharge the lake in these months.

Table 6: Water level at Pulau Terong Lake, height of highest monthly tides at Lumut and monthly rainfall for Sitiwan, January to December 2005

Month/year	Jan 05	Feb 05	Mar 05	Apr 05	May 05	Jun 05	Jul 05	Aug 05	Sep 05	Oct 05	Nov 05	Dec 05
Water level	High	DRY	DRY	-	High	High	High	Low			High	High
Highest Tide (m) ¹	3.0; 2.8	3.0; 2.9	3.1; 3.0	3.2; 3.2	2.9; 3.1	2.9; 3.1	2.8; 3.1	2.9; 3.2	3.0; 3.3	3.1; 3.4	3.2; 3.2	3.1; 2.9
Rainfall (mm/month) ²	88.4	5.2	63.9	161.2	109	79.6	110.6	263.6	106.2	369.4	316.6	312.7

Notes:

1 - Tide Tables for Lumut, Perak (Hydrographic Department of Royal Malaysian Navy 2005).

2 - Rainfall data from Malaysia Meteorological Service (Jabatan Perkhidmatan Kaji cuaca Malaysia), Sitiawan Meteorological Station (E100°42', N04°13').

Populations of Milky Stork prey species: See comments under Pulau Kelumpang section above. There are no records of Milky Storks actually foraging at Pulau Terong and it seems unlikely that the necessary prey items (predominantly fish such as mudskippers) would be able to adapt to a prolonged cycle of wet and dry periods. The only record of large numbers of Milky Storks at Pulau Terong (101 in June 1986, Silvius *et al.* 1987) indicates that this area was used as a roost site rather than a feeding area.

2.3 Waterbird populations in the Matang Mangrove Forest and adjacent coastal areas, Perak

2.3.1 Changes in waterbird populations in the Matang Mangrove Forest and adjacent coastal areas between 1983 and 2006

The first broad-scale assessment of stork and shorebird populations in the Matang Mangrove Forest and the adjacent coastal areas in Perak were made in August and September 1983 (Parish and Wells 1984). Follow up surveys were conducted in October 1984 (Parish and Wells 1985). The main focus of these surveys was to assess the importance of the west coast of Malaysia for migratory shorebirds during southward migration. Maximum totals of 6,599 birds of 14 species were recorded during southward migration in 1983 and 2,695 birds of 15 species in October 1984. Annex A provides an overview of the 1983 and 1984 waterbird counts.

The first comprehensive waterbird study was carried out at Matang Mangrove Forest and adjacent coastal areas during September 1985 to April 1986 with a focus on large waterbirds (including storks) and migratory shorebirds (Silvius *et al.* 1987). The total numbers of waterbirds recorded were 4,555 birds of 24 species during southward migration (September-October 1985), 7,999 birds of 36 species in winter (January-February 1986) and 6,187 birds of 32 species during northward migration (March-April 1986). Annex B provides an overview of the waterbird counts.

Comprehensive wintering waterbird counts in the Matang Mangrove Forest and adjacent coastal areas started in earnest in January/February 1989 as part of the region-wide Asian Waterbird Census (AWC). Between January/February 1989 and January 1992, four sets of comprehensive data were collected on wintering waterbird populations. During this period total numbers of waterbirds ranged between 18,500 and 31,500 of between 36 and 44 species (Scott and Rose 1989, Perennou *et al.* 1990, Perennou and Mundkur 1991, Perennou and Mundkur 1992, Siti Hawa Yatim and Ismail Hj. Mamat 1994). Annex C provides an overview of the comprehensive AWC counts between January 1989 and January 1992.

Between 1993 and 1998 and in 2000 the AWC was not conducted at Matang Mangrove Forest although Siti Hawa Yatim and Ismail Hj. Mamat (1994) summarized the results of the 1993 wintering waterbird count for the whole of Perak recording a total of 18,009 waterbirds of 40 species.

The area covered in 1999 was not specified and in 2001 the survey only covered the coast of Kuala Gula-Kuala Kurau (Li and Mundkur 2004). Therefore these counts were extremely low (1,274 birds and 794 birds respectively) and the data are therefore not directly comparable to the 1989-1992 data set. Between January 2002 and January/February 2004, comprehensive counts using the AWC methodology and survey areas were once again initiated. During these surveys relatively low numbers of birds and species were also recorded, with 4,057 birds (of 24 species) in January 2002, 1,269 birds (of 14 species) in January 2003 and 1,015 birds (of 14 species) in January/February 2004 (Yeap 2002, Yeap *et al.* 2003, Yeap *et al.* 2004). Annex D provides an overview of the comprehensive AWC counts between 1999 and 2004.

The most recent winter waterbird counts (January/February 2005 and November 2005/January 2006) at Matang Mangrove Forest and adjacent coastal areas, and perhaps the most comprehensive in coverage since 1989 to 1992 recorded only 2,141 birds of 22 species and 2,324 birds of 28 species respectively (see Annex F and J).

A summary of the main AWC wintering waterbird survey results from 1986 to 2006 is provided in Table 7 and Figure 7.

Table 7: Summary of wintering waterbird counts at Matang Mangrove Forest and adjacent coastal areas between 1986 and 2006 showing main waterbird groups and total numbers of species recorded (Refer to Annex indicated for comprehensive data)

Waterbird ¹ Groups\ Year	1986 Annex B	1989 Annex C	1990 Annex C	1991 Annex C	1992 Annex C	1999 Annex D	2001 Annex D	2002 Annex D	2003 Annex D	2004 Annex D	2005 Annex F	2006 Annex J
Spot-billed Pelican											1	
Oriental Darter ²												
Nesting Black-crowned Night-heron		2,000	2,525	600	10,653							
Other Egrets & herons	273	302	610	2,195	3,134	143	393	535	733	581	1,089	1,450
Milky Stork	23		62	1	4				8	8	6	7
Lesser Adjutant	37	19	39	48	46	20	3	26	57	3	38	27
Black-headed Ibis ³											1	1
Rails	6	15	299	54	2				6		5	13
Masked Finfoot	3											
Shorebirds	6,908	15,963	11,374	15,690	16,674	872	160	1,379	337	206	717	604
Gulls & terns	749	4,333	3,617	4,537	1,007	239	238	2,117	128	217	284	222
Total waterbirds	7,999	22,632	18,526	23,125	31,520	1,274	794	4,057	1,269	1,015	2,141	2,324
Total species	35	41	44	40	36	18	6	24	14	14	22	28

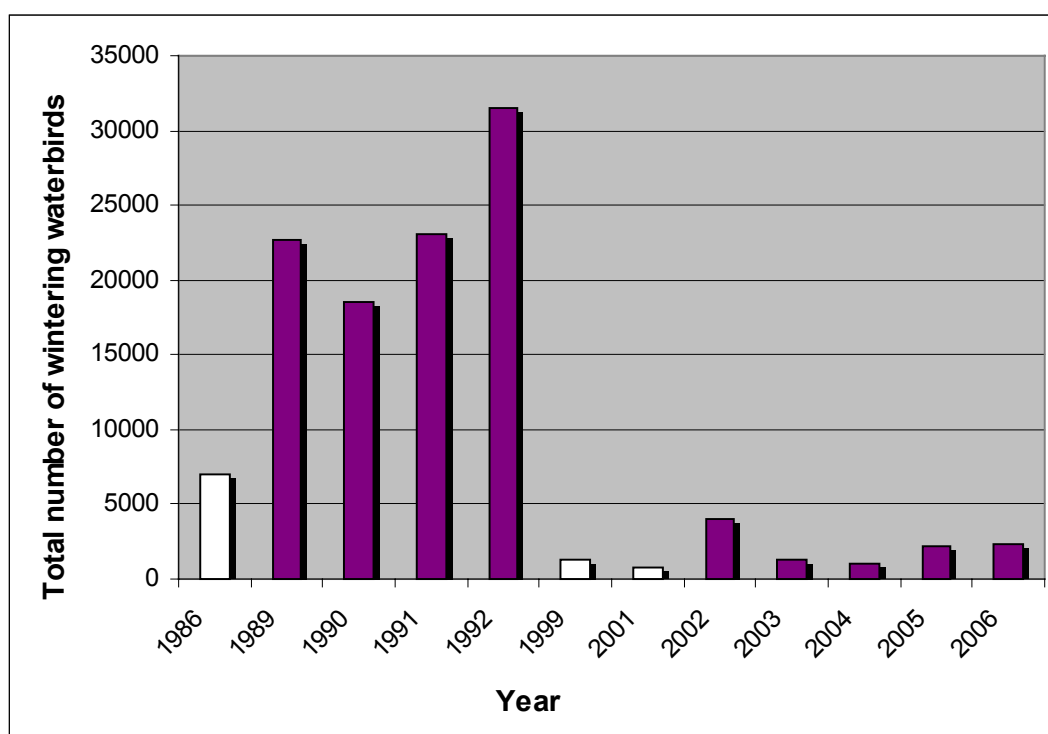
Notes:

1- Columns in grey shade represent counts from broadly comparable AWC survey areas in Matang Mangrove Forest. Other data represent a sub-set of the AWC survey area.

2 - One bird recorded in 1986, but not recorded during the AWC wintering count, not been seen since then (Siti Hawa Yatim, pers. obs.).

3 - A single bird was first recorded during the winter of 1989 and has been seen in some of the winters since then, but not during the AWC count between 1989 to 2004 (Siti Hawa Yatim, pers. obs.).

Figure 7: Total number of wintering waterbirds recorded at Matang Mangrove Forest and adjacent coastal areas between 1986 and 2006



Note:

White columns refer to partial counts only and therefore the data do not reflect the maximum number of waterbirds for the Matang Mangrove Forest and adjacent coastal areas.

Comparisons between the AWC count data for 1989, 1990, 1991 and 1992 and more recent AWC count data from 2002, 2003, 2004, 2005 and 2006 reveal a catastrophic decline in the overall wintering waterbird populations in the Matang Mangrove Forest and adjacent coastal areas. Even when counts of Black-crowned Night-Heron – a common breeding species at Sg. Burung in the 1980s, but now no longer breeding at the site having shifted to Bagan Serai Town – are removed from the analysis, the total number of wintering waterbirds recorded in 1989 to 1992 is still in the order of 16,000 to 22,000 birds, compared to counts of between 1,015 and 4,057 for recent years (2002 to 2006). This represents a decline of between 75 to 95% over a period of between 10 to 17 years.

Apart from overall declines in wintering waterbird numbers, and the obvious declines in Milky Stork and Black-crowned Night-Heron populations, there have been dramatic population declines amongst several other waterbird groups at Matang Mangrove Forest and adjacent coastal areas in the last 10-15 years. In particular the number of shorebirds in 2002-2006 (206 - 1,379 individuals) has fallen by between 88-99% from the 1989-1992 figures (11,374 - 16,674 individuals). The numbers of gulls and terns recorded also indicate severe population declines, with 128 to 2,117 individuals recorded between 2002 and 2005, compared to 1,007 - 4,537 individuals recorded in 1989 to 1992. Both these groups serve as environmental indicators with respect to the health of coastal environments – the gulls and terns as direct indicators of fisheries production and the shorebirds as direct indicators of inter-tidal productivity.

Closer scrutiny of the AWC survey results show that the most dramatic declines in waterbird populations have taken place along the coastline to the north of Matang Mangrove Forest – specifically from Kuala Gula to Kuala Kurau and Tg. Piandang on the Penang State boundary. During 1989-1992 this coastline accounted for between 75% and 92% of the total waterbirds recorded in the whole area with totals of 20,370 (1989), 16,872 (1990), 17,467 (1991) and 29,154 (1992). During surveys of the same area in 2005 and 2006, whilst the number of waterbirds recorded accounted for 58% and 42% of all waterbirds recorded, total counts were only 1,246 birds and 969 birds respectively (see Table 8).

Table 8: Comparison of wintering waterbird counts from Matang Mangrove Forest and adjacent coastal areas, 1983 to 2006

Site \ Year	1986	1989	1990	1991	1992	1999	2001	2002	2003	2004	2005	2006
Matang Mangrove Forest (A,C,D,E,F & G)	7,703	2,262	1,654	5,658	2,366	Combined count	Not surveyed	Combined count	Combined count	Combined count	895	1,355
Kuala Gula-Tg. Piandang (B & H)	296	20,370	16,872	17,467	29,154		804				1,246	969
Total waterbirds	7,999	22,632	18,526	23,125	31,520	1,274	804	4,057	1,269	1,015	2,141	2,324

Note:

A - Pulau Kelumpang Lake; B - inter-tidal mudflats at Bang Zhu Kao, Kuala Gula; C - Coastal zone and rivers surrounding Pulau Kelumpang; D - Coastal zone and rivers surrounding Pulau Sangga Kechil & Besar; E - Coastal zone and rivers surrounding Pulau Terong; F - Pulau Terong Lake; G - Pulau Pasir Hitam & South Sg Kerang coast; and H - Kuala Gula - Kuala Kurau - Tg. Piandang coast (see Figure 1).

2.3.2 Waterbirds in the Matang Mangrove Forest and adjacent coastal areas between August 2004 and January 2006

Between August 2004 and January 2006, a total of 39 species of waterbirds and 8 wetland-dependent bird species were recorded in the Matang Mangrove Forest and adjacent coastal areas (Annex E, F, G, H, I and J).

Besides Milky Stork, two other species listed as “Vulnerable” by IUCN/Birdlife International (BirdLife International 2004) were recorded. A single Spot-billed Pelican on the lake at Pulau

Kelumpang in January 2005 represents the first confirmed record of this species in Malaysia for 45 years (Wells 1999). The second “Vulnerable” species recorded was Lesser Adjutant, which was recorded in fair numbers on each survey with a highest count of 41 individuals in August 2005; the species is widespread throughout the Matang Mangrove Forest. In addition, two species listed as “Near-threatened” by IUCN/Birdlife International were also recorded – Black-headed Ibis, an individual at Bang Zhu Kao mudflat in both January 2005 and January 2006 and Asian Dowitcher, two birds recorded feeding in the lake at Pulau Kelumpang in August 2005.

Other globally significant waterbird species that have previously been recorded in the Matang Mangrove Forest but were not recorded during the 2004-2006 surveys, include the “Endangered” Nordmann’s Greenshank (reported in Scott and Rose 1989 and Chan Ah Lah pers. obs. in November 2002), the “Vulnerable” Masked Finfoot (Silvius *et al.* 1987), and “Near-threatened” Oriental Darter in 1986 (Siti Hawa Yatim, pers. obs.).

The most numerous waterbird species recorded were Great White Egret (508 in January 2006), Little Egret (629 in January 2005), Lesser Sandplover (102 in October 2004), Whimbrel (168 in January 2006), Common Redshank (332 in January 2005), Brown-headed Gull (150 in January 2005) and Little Tern (104 in October 2004). The Brahminy Kite is the most common and numerous raptor species with a highest count of 88 individuals recorded in August 2005.

Table 9 provides a summary of peak counts of species and species groups during four defined periods: southward migration (August-October), winter (November-February), northward migration (March-April) and summer (May-July).

Table 9: Maximum counts of waterbirds at Matang Mangrove Forest and adjacent coastal areas during southward migration, winter, northward migration and summer periods in 2004-2006 (Refer to Annex indicated for comprehensive data)

Species/ season	Southward Migration (August-October 2004, Annex E)	Winter (January-February 2005, Annex F)	Northward Migration (March 2005, Annex G)	Summer (May-July 2005, Annex H)	Southward Migration (August 2005, Annex I)	Winter (November 2005-January 2006, Annex F)
Spot-billed Pelican		1				
Egrets and Herons	458	1,089	867	86	398	1,450
Milky Stork	9	6	0	8	3	7
Lesser Adjutant	31	38	19	9	41	27
Black-headed Ibis		1				1
Rails		5	44		4	13
Shorebirds	543	717	462	276	409	604
Gulls and terns	154	284	161	18	90	222
Total waterbirds	1,195	2,141	1,553	397	945	2,324

2.3.3 Assessment of waterbirds and habitats using aerial survey (January 2005)

Aerial survey is a quick and efficient method to survey large areas of remote or difficult to access terrain such as the inter-tidal mangrove forests and mudflats of the Matang Mangrove Forest. Although the 12 January 2005 aerial survey was primarily focused on assessing the Milky Stork population at Pulau Terong and Pulau Kelumpang it also provided an opportunity to record other large species (notably Lesser Adjutant), habitat changes and to gain an impression of the overall coastal zone.

The detailed distribution of waterbirds is given in Figure 8. Results show that the lake at Pulau Kelumpang and the Kuala Larut river mouth were the most important areas for waterbirds at that

time. The lake at Pulau Terong held few birds but the survey team members were able to note the presence of mature and large mangrove trees in the area that could provide suitable stork nesting habitat. A follow up ground survey was conducted during 24-27 January 2005 and this generally confirmed the results of the aerial survey. Table 10 provides a comparison between the results of the January 2005 aerial and ground surveys.

Table 10: Large waterbirds counted by aerial survey on 12 January 2005 and ground survey on 25-27 January 2005

Species	Aerial survey count	Ground survey count
Spot-billed Pelican		1
Egrets	417	556
Milky Stork	2	3
Lesser Adjutant	25	24
Total waterbirds	444	584
Brahminy Kite	12	36
White-bellied Sea Eagle	2	2

Note:

Ground survey results in this table do not include site B – Inter-tidal mudflats at Bang Zhu Kao, Kuala Gula. This site is not within the boundary of the Matang Mangrove Forest Reserve and was not covered by the aerial survey on 12 January 2005.

2.4 Captive breeding and re-introduction programmes for the Milky Stork in Malaysia and neighbouring countries

2.4.1 Status of captive stocks of Milky Stork

As the wild population of Milky Stork has declined over the last 20 years in Malaysia, the captive-bred population has steadily risen, with several zoological gardens in the country and neighbouring countries now holding captive stock of the species. In several cases these captive birds are free-flying and the provenance of some apparently wild birds must be carefully assessed. Captive-bred birds that are released into the wild outside of a carefully controlled management and release programme rarely survive for long. They may also harbor disease and parasites which can negatively impact wild populations and in some cases hybridization may weaken the genetic stock. It is therefore imperative that captive-bred Milky Stork populations and any proposed and on-going release programmes in Malaysia and neighbouring countries are fully documented and shared between appropriate parties before conservation plans for the species can be adequately devised.

Attempts were made in late 2005 to contact all zoological parks and gardens in Malaysia, as well as in Singapore and Thailand, to assess their captive Milky Stork stock and document any proposed programmes for exchange, release, etc. The results of these discussions are collated in Table 11.

Of particular relevance to conservation of the Milky Stork in Malaysia are the lessons learned from the joint PERHILITAN/Zoo Negara/Malaysian Nature Society programme to captive breed and release Milky Storks into the Kuala Selangor Nature Park. An assessment of this programme is outlined in section 2.4.2 of this report. Lastly the potential threat to wild Milky Stork populations from hybridization with free-flying and seemingly well-established flocks of the closely related Painted Stork is also assessed in section 2.4.3.

Table 11: Status of captive stock of Milky Stork and Painted Stork in Malaysia and neighbouring countries

Institution / Contact person	Status of Milky Stork	Status of Painted Stork	Hybrids
Langkawi Bird Park, Kedah Mr. Deoh Cheng Kung (General Manger)	None	Three birds obtained from Zoo Negara, kept inside aviary.	None
Butterworth Bird Park, Penang Dr. Gino Ooi (Director)	Three birds obtained from Zoo Negara in 2004, 2 survived. No breeding recorded. The birds are not caged, but flight feathers have been cut to prevent flight.	One obtained from Zoo Negara. The bird is not caged, but its flight feathers have been cut to prevent flight.	None
Taiping Zoo, Perak Dr. Kevin Lazarus (Director), Ms. Mazwin Marjan (Assistant Curator).	In January 2002, 16 birds obtained from Zoo Negara, 14 survived. The birds were not caged, and flight feathers were cut to prevent flight. By 2004 flight feathers had grown back and the birds flew off and never returned. All birds had a metal ring on one leg. Two more birds were obtained from Jurong Bird Park, Singapore in July 2005. They are currently caged to	None	None

Institution / Contact person	Status of Milky Stork	Status of Painted Stork	Hybrids
	prevent escape.		
Zoo Negara, Kuala Lumpur Dr. Mohamad Bin Ngah (Director), Doreen Khoo Say Kin (Assistant Curator), Claire Beastall and Renee Yee (Education Dept.)	Ninety-one birds in the zoo, most of them are caged. One is free-flying with the Painted Stork flock. The original stock (7 chicks purchased from Singapore in late 1987) was thought to be Painted Storks. Some birds were also later acquired from Rotterdam Zoo, Netherlands and San Diego Zoo, USA.	A total of 312 birds in the zoo, most are free-flying, and are regularly recorded at a number of sites around Kuala Lumpur/Petaling Jaya. For example, lakes in the Flamingo Hotel, Putrajaya wetland, etc. Stock originally acquired from Sri Lanka.	Two confirmed, at least 3-4 suspected. DNA test results are awaited on blood samples taken from 33 "Painted" and 15 "Milky" Storks. In the early 1990s, a Lesser Adjutant x Painted Stork hybrid was found. The bird died a few years later.
Kuala Selangor Nature Park, Selangor Ref: Sebastian and Sebastian (2005).	Ten (probably 3 males and 7 females) obtained from Zoo Negara in 1998. The birds were housed in a large enclosure and have attempted to nest since 2002 (no success). One bird escaped in April 2003 and the rest were released in May 2003. A nest was observed in the Nature Park later the same month, but the chicks did not survive. The birds left the Park in July 2003, and have only returned to the park occasionally since then. Four individuals that are regularly seen along the Sungai Buloh coast by birdwatchers are believed to belong to this group.	None	None
KL Bird Park, Kuala Lumpur Tan Yu Keong (General Manager)	Ten obtained from Zoo Negara in 2002. A juvenile was hatched in 2005. So currently 11 in stock. The birds are kept in the main Aviary.	No, but occasionally free flying Painted Storks land on the roof of the Bird Park Aviary.	None
Malacca Zoo, Melaka Mr. Mohd Nawayai Yasak (Director)	In 2004, 10 obtained from Zoo Negara and all survived. Nesting observed in June 2005 but no eggs produced. Kept in aviary. Plan to release F2 generation into lake beside Zoo.	None	None
Johor Zoo, Johor Mr. Zakaria Razali (Manager)	None	In July 2005, 5 pairs obtained from Zoo Negara. Kept in aviary.	None
Singapore Zoo, Singapore Charlene Yeong, (Research and Conservation Officer)	There are about 50 Milky and Painted Stork in total at the Zoo. All were free-flying between the Zoo and Night Safari, but 21 have been trapped and housed in a meshed enclosure. The others are still free-flying, but the Zoo management plans to trap them also.	See comment under Milky Stork.	It's possible that these two species have hybridized at the Zoo, although no details are available. Blood was extracted from the nine "Painted" and 12 "Milky" Storks trapped, DNA test results

Institution / Contact person	Status of Milky Stork	Status of Painted Stork	Hybrids
			are awaited.
Jurong Bird Park, Singapore Ms. Lai Mun (Education Officer)	There are currently four Milky Storks in the Park and all of them are caged in the Wetlands exhibit.	There is only one Painted Stork in the Park. It is caged in the Wetlands exhibit.	Cathy King (per. comm., Dec 2005) confirms that a Lesser Adjutant (male) X Milky Stork (female) Hybrid hatched on 20 December 1987 at the Bird Park.
Dusit Zoo, Bangkok, Thailand Jonathan Murry, pers. obs., October 2005	The Zoo has six Milky Storks in the aviary. There is no confirmation of any Milky Stork nesting this year, or if they have ever bred at all.	The Zoo has about 65 Painted Storks in the aviary, and 8 free flying. Nesting was observed in October 2005, with six chicks and one egg recorded in the aviary. None of these belonged to mixed or hybrid pairs.	In the Dusit Zoo collection, one "Milky Stork" shows a very strong pink blush, and two "Painted Storks" show the reduced black scapulars that might indicate hybrids. (see Picture 8) 30 Painted Storks were recently transferred to the Chiang Mai Night Safari, some of which may possibly be hybrids.

2.4.2 Milky Stork re-introduction programme at Kuala Selangor

In response to an apparently declining wild population in Malaysia, the joint PERHILITAN/Zoo Negara/Malaysian Nature Society "Milky Stork Breeding and Re-introduction Programme" was initiated in the late 1980s. The aim of the programme was to establish a free-flying breeding population within the Kuala Selangor Nature Park (KSNP) and eventually to re-establish the species at other sites along the Selangor coastline. The programme was designed around two phases, Phase I (1987-1996) was to build up a stock of breeding adults in captivity (based at Zoo Negara) and Phase II (1996-2004) was to release 2nd generation free-flying storks into the KSNP after breeding had been achieved in the large purpose built aviary within the Nature Park (Sebastian and Sebastian 2005). An overview of the results of the Programme (adapted from Sebastian and Sebastian 2005) is presented below:

Under the "Milky Stork Breeding and Re-introduction Programme", 10 (probably 3 males and 7 females) were obtained from Zoo Negara in 1998. The birds were housed in the on-site aviary and after settling in and modifying the feeding arrangements the first reported nesting took place in March 2002. Between 2002 and 2003 a total of six nesting attempts were made – but unfortunately all proved to be unsuccessful (eggs were hatched but no young were fledged). After one bird escaped through a tear in the netting in April 2003, it was decided to release all the birds from the aviary (in May 2003). Within weeks the free-flying birds began courtship and gathering nest materials in the KSNP, eventually building three nests on a low tree within the lake within the Grey Heron colony. A total of six eggs were laid between 30 May and early June 2003, of which five eggs hatched. Three hatchlings died within a few days, but two survived for 45 days until a storm in July toppled the nest, killing the chicks. At least five adult birds visited the lake system within the KSNP on a regular basis up to the end of 2004 and it is expected that breeding attempts may once again begin here. Four individuals regularly seen on the Sungai Buloh coast by Malaysian birdwatchers are believed to belong to the KSNP group.

The “Milky Stork Breeding and Re-introduction Programme” has required significant financial resources over its period of operation. A total of RM 436,714 (equal to US\$118,000) was spent from 1996 to 2004 for phase II at Kuala Selangor Nature Park (Anthony Sebastian, per. comm., December 2005). Sebastian and Sebastian (2005) highlight the lack of substantial funding to maintain the aviary, feed and monitor the Milky Storks, as well as a lack of expertise in stork behaviour and breeding biology as the major problems and constraints to the success of the programme. Although the programme was not able to achieve its objective in establishing a free-flying, breeding population of Milky Stork at the KSNP, it has demonstrated that the Milky Storks are able to adapt to a free-flying existence in the area, and will attempt to breed if conditions are suitable. The programme provides a valuable benchmark for planning and implementing any future Milky Stork re-introduction programmes in Malaysia.

2.4.3 Hybrids between Milky Stork and other stork species

2.4.3.1 *M. cinerea* (Milky Stork) X *M. leucocephala* (Painted Stork) hybrids

Zoo Negara, Malaysia has confirmed that a free-flying Milky Stork has hybridized with a free-flying Painted Stork. This has also apparently occurred at Singapore Zoo and Dusit Zoo, Bangkok, Thailand, although DNA testing has yet to confirm these cases (see Table 11).

DNA tests have confirmed that two *M. cinerea* X *M. leucocephala* hybrids are present at Zoo Negara. One of the hybrids closely resembles Milky Stork, but has some small black spots on the white wing and a difficult to see pink tinge to the tail feathers. The other young hybrid has a much paler wing colour than Painted Stork. Two additional birds amongst the free-flying flock are suspected to be hybrids (one an adult bird and one a juvenile). When compared to adult Painted Stork, the adult “hybrid” has a pink, rather than orange bill and head color, which more closely Milky Stork (see Picture 7). The upper wing color also seems much paler than Painted Stork, which has a more colorful wing. The juvenile “hybrid” has a very pale upper wing compared to other juvenile Painted Storks. It is also possible that *M. cinerea* X *M. leucocephala* hybrids closely resemble either of the two species and can only be identified through DNA testing. In Dusit Zoo, Bangkok, Thailand at least three birds show signs of being *M. cinerea* X *M. leucocephala* hybrids (Jonathan Murry, pers. obs., October 2005) (see Picture 8).

A recent record (on 31 August 2003) of a possible *M. cinerea* X *M. leucocephala* hybrid amongst the possibly wild population of Painted Stork at Wat Khao Takhrao, Thailand is also of note. The bird in question was originally identified as a “Milky Stork” and then thought to be a leucistic Painted Stork or a hybrid. Some black freckling is visible on the scapulars in photographs, while observers have reported that it possesses an all-dark under wing (Round and Jukmongkol 2003; Oriental Bird Club Bull. Birding Asia, No. 1 [2004]: 87; Phil Round, pers. comm., September 2005).

The potential for Milky Stork and Painted Stork to hybridize is obvious from the above-mentioned examples – although the viability of the off-spring is yet to be determined. However, these findings do underline the potential threat to the conservation of Milky Stork in countries like Cambodia (and possibly Thailand and Vietnam) where the two species overlap in range and their nesting and feeding habitat requirements. With the decline of the Milky Stork in Cambodia, reportedly not more than 20-30 individuals are left (K. Davies and Hong Chamann, pers. comm., October 2005), there is more potential for hybridization to take place when the rarer Milky Storks cannot find suitable mates amongst the mixed Stork colonies.

2.4.3.2 *Mycteria* spp. (Milky Stork and Painted Stork) X *Leptoptilos* spp. (Adjutant Stork) hybrids

There are three reported instances of hybridization of storks of the Genus *Mycteria* with Lesser Adjutant (*Leptoptilos javanicus*).

In the early 1990s, a Lesser Adjutant *L. javanicus* reportedly hybridized with a Painted Stork *M. leucocephalus* at Zoo Negara, Malaysia. The hybridization occurred in the large, free-flying Painted Stork colony, which also contains 1-2 Lesser Adjutants and 1-2 Greater Adjutants. The parent birds paired up for several seasons (although it is not known if the Painted Stork parent was the same bird as the free-flying flock are not banded). Of the three or four hybrid chicks that fledged, one resembled a Lesser Adjutant, the others were taller than Painted Stork and had some features of Lesser Adjutant. Zoo Negara staff managed to capture three of the chicks but they died shortly afterwards. The remaining bird disappeared (D. Khoo Say Kin, pers. comm., October and December 2005).

A further record of a Painted Stork *M. leucocephalus* X Lesser Adjutant *L. javanicus* hybrid has been reported from the Dehiwela Zoo, Colombo, Sri Lanka. Four broods were reared between 1940 and 1942, between a pair of semi-captive individuals housed five miles apart (Hill 1943). It was not recorded which species was the male and which the female of the pair. Cathy King (pers. comm., August 2005) has a photo of a hybrid of this combination at the same zoo, photographed by C. Schmidt in 1969.

On 20th December 1987 a *L. javanicus* (male) X *Mycteria cinerea* (female) hybrid was hatched at the Jurong Bird Park, Singapore (in litt. S. Thiruchelvam to K. Brouwer). Both parents were free-flying and nested in a tree on the Bird Park grounds. Cathy King (pers. comm., August 2005) has photos of a hybrid chick in the early 1990's. This individual was later killed by a Milky Stork in one of the enclosures (In litt, Dr. Won to K. Brouwer, September 1994).

3. Conclusions

3.1 Decline of Milky Stork and overall waterbird populations at Matang Mangrove Forest and adjacent coastal areas

- In October 2004 the maximum number of Milky Stork recorded were nine individuals, the highest count in 2005 was eight birds in June 2005 and only 4 birds were recorded in January 2006.
- The results of the study clearly show that the Milky Stork population in Malaysia has undergone a steady decline since the 1980s; the population has dropped by more than 90%, from 100 to 150 individuals in 1980s to less than 10 birds to date.
- Although attempted breeding by Milky Stork has been recorded at Pulau Kelumpang Lake in 1989, 1990 and 1997, and in the Kuala Selangor Nature Park in 2003, breeding success in Malaysia during the last 20 years has more than likely been zero. This conclusion is supported by the fact that no juvenile or immature birds have been observed in Malaysia, or at Matang Mangrove Forest, since 1983. During the period August 2004 – January 2006 there was no confirmation of breeding at Matang Mangrove Forest, although in October 2004 and again in December 2005 several large nests believed to belong to Milky Stork were observed at Pulau Kelumpang Lake.
- Comparisons between AWC count data from 1989 to 1992 and more recent AWC count data from 2002 to 2006 reveal a catastrophic decline in the overall wintering waterbird population in the Matang Mangrove Forest and adjacent coastal areas. Even when counts of Black-crowned Night-Heron are removed from the analysis (a common breeding species in the 1980s), the total number of wintering waterbirds recorded between 1989 and 1992 are still in the order of 16,000 to 22,000 birds, compared to counts of between 1,015 and 4,057 for recent years (2002 to 2006). This represents a decline of between 75 to 95% over a period of between 10 to 17 years.
- These population declines are also reflected in the number of waterbirds recorded in Pulau Terong Lake. In January 1986, the lake supported 2,577 shorebirds (Silvius *et al.* 1987), the highest count during the 2004/2006 period was only 231 birds in February 2005.
- Dramatic population declines were also observed in other groups of waterbirds at Matang Mangrove Forest and adjacent coastal areas in the last 10-17 years. In particular the numbers of shorebirds in 2002-2005 (206 to 1,379 individuals) have fallen by about 88-99% from 1989-1992 levels (11,374 to 16,674 individuals). The numbers of gulls and terns also shows a severe decline with between 128 and 2,117 individuals recorded during 2002-2006 compared to between 1,007 and 4,537 individuals recorded between 1989 and 1992. Both these groups serve as environmental indicators with respect to the health of coastal environments – the gulls and terns as direct indicators of fisheries production and the shorebirds as direct indicators of inter-tidal benthic productivity.
- The most dramatic declines in waterbird populations have occurred along the coastline to the north of Matang Mangrove Forest – specifically from Kuala Gula to Kuala Kurau and Tg. Piandang on the Penang border. During 1989-1992 this coastline accounted for between 75% and 92% of the total waterbirds recorded in the whole area with totals of 20,370 (1989), 16,872 (1990), 17,467 (1991) and 29,169 (1992). During surveys of the same area in January 2005 and January 2006, whilst the number of waterbirds recorded here accounted for 58% and 42% of all waterbirds recorded respectively, the total counts were only 1,246 and 969 birds respectively.

- It is postulated that these drastic declines in waterbird populations are linked to erosion cycles along the Matang coastline. High rates of erosion tend to scour the inter-tidal mudflats resulting in lower densities of benthic bivalves, gastropods and polychaete worms (all important waterbird and marine fish prey organisms). Evidence of heavy erosion in the Pantai Panchor and Pulau Pasir Hitam areas and along the west face of Pulau Terong was obvious in 2005 and may support this theory.
- It was also noted that in some areas in the Matang Mangrove Forest the inter-tidal flats were actively accreting – especially the areas around Pulau Kelumpang and the mouth of Sg. Selinsing, around Pulau Sangga and at Kuala Larut on the Pulau Sangga side.
- On a more positive note, populations of egrets and Lesser Adjutant appear to have remained relatively stable throughout the 20-year period. This may reflect the broader ecological requirements of these species in comparison to those of the Milky Stork.

3.2 Current status of Milky Stork habitats

3.2.1 Conservation of important Milky Stork habitats and areas

- The lake at Pulau Kelumpang was confirmed to be the most important area for Milky Stork in the Matang Mangrove Forest and adjacent coastal areas. Apart from February and March 2005 (when the lake was dry) Milky Stork was recorded at the lake on every survey date. During periods of prolonged drying out of the lake at least some of the Milky Stork population moves to the lake at Pulau Terong, although it is not known if this is the only alternative site.
- The lake at Pulau Terong appears to provide an important alternative site for the Milky Stork population during periods when the lake at Pulau Kelumpang is too disturbed or dry. This is supported by the fact that during February 2005, when the lake at Pulau Kelumpang was dry, six Milky Storks were observed in the lake at Pulau Terong (even though this lake was also dry at the time). However, as noted by Silvius *et al.* (1987) the Pulau Terong Lake provided an important refuge for up to 101 Milky Stork in March 1986 even when partially dried out.
- Despite its importance as an alternative site – for Milky Stork roosting, feeding or escaping from disturbance – it would appear that the buffer zone of protected forest around the lake at Pulau Terong may be too limited to provide a safe and undisturbed refuge for long periods of time, particularly as the Milky Stork appears to be sensitive to human disturbance. This is supported by the fact that during the surveys, Milky Stork was only observed twice at this lake (February 2005 and July 2005).
- Apart from the small population of Milky Stork, other large “Vulnerable” waterbirds such as Lesser Adjutant (all year round) and Spot-billed Pelican (for wintering) also use the lake and surrounding mangrove forest on Pulau Kelumpang. The fact that the area is large enough to support small numbers of these sensitive birds indicates that the protective buffer zone forest established around the lake at Pulau Kelumpang is probably of a size that provides some conservation benefits for large waterbirds.
- It is possible that with continued conservation of a large forest buffer zone at Pulau Kelumpang, coupled with better enforcement to reduce disturbance of the area and management to create suitable nesting habitats that Matang Mangrove Forest will continue to support a small population of Milky Stork.

- There is no recent or historical evidence to suggest that the Matang population of Milky Stork is linked to Indonesian populations across the Malacca Straits and in terms of conservation of the Matang population, there is little likelihood that this population will be augmented by new birds from the south-east Sumatran and north Javan breeding grounds. Although previous studies have shown that Milky Storks in Java do undertake some migration/movements away from the breeding areas (Verheugt 1987) and the January 2005 record of a Spot-billed Pelican at Pulau Kelumpang seem to suggest that some movements of large waterbirds across the Straits of Malacca may occur.

3.2.2 Ecological changes in Milky Stork habitats

- The mangrove forest vegetation structure on Pulau Kelumpang appears to have changed little in the last two decades. The area remains an accreting mangrove forest consisting of predominantly *Avicennia marina* trees. Rates of accretion were estimated at 72 m/year over the last 50 years.
- Although comparative data are lacking, according to forest records the vegetation structure at Pulau Terong appears to have remained stable over the corresponding period. This area is higher and drier than Pulau Kelumpang and is dominated by *Bruguiera cylindrica* trees. The island is however eroding, and severe erosion along its west-facing edge was noted in 2005.
- The lake water at Pulau Kelumpang was brackish (3.2 to 8.5 ppt), weakly alkaline (pH 7.65 to 8.5) and with high conductivity (4.3 to 14.8 mS/cm). Nutrient concentrations were moderately high, at 3.2 mg/l AN-N and 0.76 mg/l P respectively. These results support the theory that the hydrology of the lake is largely rain fed with tidal influences probably only occurring on the very highest tides or through sub-soil capillary action.
- The lake water at Pulau Terong was less brackish (and more fresh) than Pulau Kelumpang (1.2 - 4.8 ppt), and near neutral (pH 6.73-7.6) and also with high conductivity (3.0-10.2 mS/cm). Low levels of Dissolved Oxygen (2.28 mg/L) indicated low productivity. Nutrient levels were high, at 1.4 mg/l AN-N and 1.1 mg/l P respectively. These results support the theory that the hydrology of the lake is more influenced by local precipitation than by tidal influxes. Although as with Pulau Kelumpang, tidal influences may play a role during the very highest tides or through sub-soil capillary action.
- Supporting the theory that the hydrology of the lakes at Pulau Kelumpang and Pulau Terong are more heavily influenced by rainfall than by tidal events are the monthly rainfall data for Bagan Serai and Sitiawan and the tidal records for Lumut. Months when the lakes were either dried up (February-March) or at low water levels (early August) broadly corresponded with the lowest monthly rainfalls, despite these months having constant highest tides of between 2.8 and 3.2 m above sea level. There was also no evidence during the surveys of tidal water in-flow to either lake during the highest tide periods.

3.2.3 Possible limiting factors for Milky Stork breeding success

- Information from the Sumatran breeding grounds of the Milky Stork seem to suggest that they require either tall mature mangrove trees or isolated water bodies surrounded by dense thickets of mangrove fern (*Acrostichum spp.*) for successful breeding. In both cases, breeding areas are surrounded by wide expanses of largely undisturbed mangrove forest in areas that are difficult to access for humans. Lack of successful breeding at Matang (and in Malaysia) is probably related to a lack of large tracts of undisturbed, tall, mature mangrove forest. The lake and surrounding mangrove forest at Pulau Kelumpang is probably the last remaining area of mangrove along the west coast

of Malaysia that is either large enough or remote enough to support a small colony of breeding Milky Storks.

- Probably one of the biggest limiting factors to the breeding success of Milky Stork at Matang Mangrove Forest is the apparent lack of suitable nest trees (tall, dead mangroves) in a rather young, accreting mangrove forest of *Avicennia marina*.
- Other factors such as changes in prey species populations, changes in ecological condition of habitats (such as erosion and pollution), continuously high levels of disturbance – by crab fishermen, wild pig hunters and even researchers, and high densities of natural predators, have all undoubtedly played a role in limiting breeding success at Matang Mangrove Forest.
- Of these, the high densities of natural predators, particularly raptors, such as Brahminy Kite may also play a role in the survival and breeding success of Milky Stork at Matang Mangrove Forest. For instance, in August 2005 a large dusk roost of 86 Brahminy Kites was observed in the mangroves along the Sungai Sangga Besar. Earlier field observations by PERHILITAN in 1989 seem to support this theory – with Brahminy Kites loitering around the breeding colony and preventing both adult Storks from leaving the nests unguarded (Siti Hawa Yatim, pers. obs.).
- Other potential predatory species such as Water Monitor, Long-tailed Macaque, Silvered Leaf Monkey and Common Palm Civet all occur in reasonably large concentrations throughout the Matang Mangrove Forest. All of these species could have an impact on the breeding success of Milky Stork through predation of eggs and unfledged chicks. Evidence of broken egg shells beneath the nest trees was reported in 1989, along with foot prints and tracks of Water Monitor. This indicates that predation of eggs by Water Monitors in particular may also be an important limiting factor. At that time PERHILITAN attempted to prevent Water Monitors from climbing the nest trees by placing aluminium zinc around the tree trunks, but it was believed that breeding failure was largely due to the presence of the Brahminy Kites (Siti Hawa Yatim, pers. obs.).
- Whilst the results of this study were not able to shed more light on any of these factors, it is highly likely that as the Milky Stork population at Matang Mangrove Forest declined during the 1990s so these factors would have become more intense.

3.2.4 Changes in Milky Stork prey populations and foraging grounds

- Previous studies (Silvius *et al.* 1987, Swennen and Marteiijn 1985) at Matang Mangrove Forest and along the adjacent coastline show that at that time Milky Stork used the inter-tidal mudflats along this coast for feeding. The main prey items recorded were large mudskippers of the genus *Periophthalmus*.
- It is possible that either the prey species populations in these areas have decreased substantially (possibly linked to coastal erosion cycles) and/or these areas have become more disturbed and unsuitable for feeding Storks. During the surveys Milky Storks were observed feeding in the lake at Pulau Kelumpang – although observations of their prey species were not made. During the last decade, there have only been occasional records of Milky Stork in the inter-tidal mudflat zone at Matang. All other records have either been at the two lakes or of flying birds. There was no Milky Stork recorded on the inter-tidal mudflats during the survey period.

3.3 Human impacts

3.3.1 Forestry management in the Matang Mangrove Forest

- The 40,466 ha Matang Mangrove Forest is managed by the Perak State Forestry Department. In the 2000-2009 Working Plan, the Forest Reserve is divided into four management categories based upon their functional roles. One of these functions is the conservation of important biological diversity in “Protective Forest” zones. At Matang, the conservation of the Milky Stork is highlighted, although most (74%) of the Forest Reserve is zoned for wood production on a 30-year rotation under “Productive Forest”.
- “Protective Forest” covers an area of 7,360 ha, or 18.2% of the Forest Reserve. In these areas wood harvesting is strictly prohibited. One of the largest blocks of Protective Forest in the Forest Reserve consists of the entire outer area of Pulau Kelumpang, covering 1,883 ha, with the 4 ha lake at its centre. A second important Protective Forest zone, which surrounds the lake at Pulau Terong, is 103 ha.
- The establishment of Protective Forest zones within the Matang Mangrove Forest aimed at conserving and buffering important Milky Stork habitats is undoubtedly a step in the right direction for the conservation of this species in Malaysia. At least at Pulau Kelumpang, the Protective Zone covers a significant area of mangrove that will almost certainly be necessary for the future re-establishment (by natural or artificial means) of a Milky Stork population. The “stork lake buffer” zone at Pulau Terong is probably too small to serve a similar function as it was noted in 2005 that forestry activities in the adjacent Productive Forest block almost certainly had a disturbing effect on waterbirds at the lake.
- For effective conservation of Milky Stork populations at Matang Mangrove Forest larger areas of undisturbed mangrove forest, forming more effective buffers around each of the lakes at Pulau Kelumpang and Pulau Terong will be necessary.

3.3.2 Human disturbance

- Milky Storks are wary of the presence of humans and are very sensitive to disturbance. Siti Hawa Yatim (pers. obs.) reports that in the 1980s and 1990s when the population was larger, the presence of the research team at Pulau Kelumpang Lake often disturbed the roosting birds, causing them to take flight and disappear for sometime. More recently, during eleven visits to the Pulau Kelumpang Lake between August 2004 and January 2006, at which storks were present, on eight occasions the birds took flight at the approach of the survey team, even at a distance of between 100-200 m. It is generally considered that successful breeding by large waterbirds also requires large areas of undisturbed habitat and low levels of disturbance.
- Three main types of human disturbance were noted as potentially having a significant impact on the Milky Stork population and breeding success at Matang. These were forestry activities, fishing activities (especially crab fishermen) and hunting.
- Disturbance of the lake at Pulau Terong by logging activities and forestry workers is likely a significant factor limiting use of this area by Milky Stork. During aerial surveys in January 2005 and ground survey in March 2005 several temporary logging “camps” were noted within a few hundred meters of the lake, in the adjacent Forest Compartment 63. During ground surveys in March and August 2005, the sound of chain saws could be clearly heard from the lake.
- Disturbance of the lake at Pulau Kelumpang by crab fishermen is thought to be a regular occurrence. A “trail” adjacent to the access creek in August 2005 was very well worn

(trampled down pneumatophores and a clear cut trail through regenerating mangrove) and this is almost certainly the result of high levels of visitor use. Although not recorded in 2004/2005, levels of disturbance of the lake at Pulau Terong are also likely to be high as the lake is only 10 minutes walk in from the seaward edge of the mangrove.

- Although there was no evidence to suggest that Milky Storks or other waterbirds are being hunted at Matang Mangrove Forest, at both lakes there was evidence (discarded shotgun cartridges) that hunting for other species (principally Wild Pig) was a regular occurrence. This was confirmed by PERHILITAN officers on site and would certainly lead to disturbance of roosting and nesting birds.
- Regular disturbance of the lakes by researcher visits and other visitors (bird watchers, tourists, university students, etc) may also have a disturbing effect on Milky Storks at both lakes (see the first bullet point in this section). It is unknown how many visits to the lakes at Pulau Kelumpang and Pulau Terong, outside of this survey programme, have taken place during the project period.

3.4 Other issues

- In captive and free-flying zoo flocks, hybridization between Milky Stork and Painted Stork has been confirmed at Zoo Negara, Kuala Lumpur, and has been reported (but not yet confirmed) at Singapore Zoo and Dusit Zoo, Bangkok.
- Although there have been no confirmed hybrids reported in wild populations (however a recent report from Thailand may yet prove to be the first case), it is a particular concern for the conservation of the Malaysian population of Milky Stork. Free-flying Painted Stork (and possibly Painted X Milky hybrids) within the Kelang Valley and as far south as Putrajaya, have the potential to disperse to coastal areas within Selangor. If this occurs the wild gene pool of any remaining wild Milky Stork populations, or even a future re-introduced population, could be negatively impacted.
- There are also records of captive stocks of the two species of *Mycteria* hybridizing with *L. javanicus*. It is possible that hybridization could also occur in the wild if con-specific partner choice was limited.
- Lessons learned from the joint PERHILITAN/Zoo Negara/MNS captive breeding and re-introduction programme for Milky Stork at Kuala Selangor underline what a long-term and high cost conservation effort such programmes are. Better information on wild populations and their ecological requirements, and coordinated planning of any future release programmes should be priorities.

4. Recommendations

4.1 Promoting the conservation status of the Milky Stork

Recommendation 1: Due to a lack of recent information on the status of Milky Stork populations in SE Sumatra (observation at a number of sites in Java and Sumatra has showed a decline in populations) and a severe decline in the Malaysian population it is recommended that the Global Conservation Status for the species be increased from “Vulnerable” to “Endangered”.

Recommendation 2: Within Malaysia (and Indonesia) there is a need to enhance public awareness of the status of the threatened Milky Stork to aid the conservation of the species and its habitats. It is recommended that Milky Stork be used as a “flagship” conservation species to underline the need to protect and conserve coastal wetlands, particularly inter-tidal mangroves and mudflats, throughout Malaysia and the region. Specific awareness programmes targeting residents and resource users at Matang should be implemented.

4.2 Improving conservation and management of Milky Stork habitat at Matang Mangrove Forest

Recommendation 3: Enlargement of the “Protective Forest” and stork lake buffer zone at Pulau Kelumpang.

It will be necessary for the Forestry Department to review the existing Matang Mangrove Forest Working Plan (2000-2009) to provide “Protective Forest” status to the entire west part of Pulau Kelumpang (total of 2,593 ha). This will require a termination of logging activities in 288 ha of “Productive Forest” in Forest Compartment 11. Refer to Figure 5 for the proposed boundary.

Recommendation 4: Enlargement of the “Protective Forest” and stork lake buffer zone at Pulau Terong.

It will be necessary for the Forestry Department to review the existing Matang Mangrove Forest Working Plan (2000-2009) to provide “Protective Forest” status and increase the stork lake buffer zone to encompass the whole of Forest Compartments 63 and 64 on Pulau Terong. This will increase the size of the protective buffer zone around the lake at Pulau Terong to 750 ha. This will require a termination of logging activities in 356 ha of “Productive Forest” within Forest Compartment 63. Refer to Figure 6 for the proposed boundary.

Recommendation 5: PERHILITAN and Forestry Department to formalize the designation of these “Protective Forests” under the Wildlife Act (1972). This may be in the form of gazettelement of Wildlife Sanctuaries to include Pulau Kelumpang and Pulau Terong and the coastal fringe along their shorelines (which have already been defined as Protective Forest or restrictive productive Forest under the Matang Mangrove Forest Working Plan (2000-2009)). A proposed boundary for such a protected area in the Matang Mangrove Forest is shown in Figure 4. The proposed protected area should include the coastal zone from Kuala Gula to Kuala Kurau (part of zone H) and the inter-tidal mudflats at Bang Zhu Kao, Kuala Gula (zone B) with a seaward boundary at the lowest limit of Spring Tides (See Figure 1).

Recommendation 6: PERHILITAN to implement a “Milky Stork patrolling and management schedule” and establish a new office at Kuala Sepetang to facilitate such operations. The schedule should ensure that regular patrols of the mangrove forests surrounding the lakes on Pulau Kelumpang and Pulau Terong take place in order to control illegal activities and curb disturbance.

Recommendation 7: Malaysia ratified the Ramsar Convention on Wetlands of International Importance in 1994. To date, Malaysia has nominated four Ramsar sites, one in Pahang and three in Johor. It is recommended that in view of its importance for biodiversity conservation and as the last refuge for the Milky Stork in Malaysia, its historical and cultural heritage as the World's longest continuously managed mangrove forest and for its contribution to local livelihoods and the national economy, the State Government of Perak nominate the Matang Mangrove Forest as a wetland of international importance under the Ramsar Convention on Wetlands of International Importance (1971). The boundary of the proposed Ramsar site would correspond to the proposed protected area under Recommendation 5.

Recommendation 8: The potential to erect and manage suitable artificial nesting platforms for Milky Storks at Pulau Kelumpang and Pulau Terong should be further investigated. Information of the design of platforms, their positioning in the areas and other factors such as predator guards, should be taken from successful stork breeding programmes in other countries and from the successful trials at Zoo Negara (and possibly Kuala Selangor Nature Park). Trial platforms could be erected during periods when there are no Milky Storks using the sites (dry periods) to minimize disturbance.

4.3 Enhancing monitoring and scientific research on Milky Stork at Matang Mangrove Forest

Recommendation 9: Despite the dramatic decline in the Milky Stork population at Matang Mangrove Forest and in Malaysia as a whole it remains necessary to continue to monitor the existing and future population at Matang Mangrove Forest and adjacent areas to further increase our understanding of the population, its habitat preferences, predators and threats. Such monitoring will contribute to the long-term conservation of the Milky Stork in Malaysia.

Recommendation 10: Specific research recommendations at Matang Mangrove Forest include the following:

- Re-sampling of the nine mangrove permanent quadrates established by Silvius *et al.* (1987) in 1986 to assess changes in the mangrove vegetation structure on Pulau Kelumpang.
- Undertaking more comprehensive water quality studies of the two lakes and analysis of the results to provide information for management.
- Establishing a baseline for water depth studies at the two lakes, by erecting a simple water depth gauge and regularly monitoring water levels.
- Regular sampling of populations of the main Milky Stork prey organisms, *Periopthalmus spp.*, mudskippers at the lakes and on the inter-tidal mudflats.
- Studying the effects of chemical use in up stream oil palm plantations along the Kelumpang River in relation to the availability of Milky Stork prey organisms in the inter-tidal mudflats.
- Collecting quantitative data on the numbers of visits crab fishermen, hunters, tourists, etc., make to the lakes each month.
- Interpreting past aerial photos or satellite images to calculate rates of, and severity of, coastal erosion along the Matang and adjacent northern coastline.
- Conducting quantitative surveys to assess changes in off-shore and coastal fisheries at Kuala Gula over the last 15 years. This may be possible through analysis of fisheries landing data for Kuala Gula and Kuala Kurau.

4.4 Future re-introduction programme for the Milky Stork

Recommendation 11: Any future attempts to initiate a Milky Stork re-introduction programme in Malaysia must be carefully considered in terms of the long term costs and benefits. As a prerequisite to any such attempts, conservation and protection of the main habitats and areas for Milky Stork must be guaranteed. In addition, as part of the preliminary preparation for any re-

introduction attempt, a fuller understanding of the reasons for past population decline and the lack of breeding success must be gained. The *Guidelines for Re-introductions* by IUCN (1998) should be used as the key reference for development of the Milky Stork re-introduction programme. Furthermore, the risk of hybridization with free-flying zoo-bred populations of Painted Stork must be carefully monitored. If necessary, the free-flying Painted Stork populations will need to be managed (trapped or eradicated) in order to prevent their spread within Malaysia. Release programmes also need to consider potential for movement by released storks and the distances they are known to travel – for instance any released Milky Storks might return to Zoo Negara or other points of origin.

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6. Annexes

Annex A: Comprehensive stork and shorebird counts at Matang Mangrove Forest and adjacent coastal areas (1983-1984)

(Extracted from Parish and Wells 1984, Parish and Wells 1985, Silvius *et al.* 1987)

Species/ date	17 August 1983	28&29 Aug 1983	3 September 1983	Peak count of Southward Migration	3-11 October 1984
Site coverage*	A, B, C, D, E, F, G & H	B & H	A, B, C, D, E, F, G & H	A, B, C, D, E, F, G & H	A, B, C & H
Survey method	Aerial Survey	Ground survey	Aerial Survey		Ground Survey
Milky Stork	115	30	97	115	101
Lesser Adjutant	107	40	46	107	
Pacific Golden Plover		30		30	306
Grey Plover		1		1	
Lesser Sand Plover		310		310	365
Black-tailed Godwit		250	700	700	94
Bar-tailed Godwit					40
Unidentified snipes		1		1	
Whimbrel		180		180	279
Eurasian Curlew					15
Unidentified curlews		250	185	250	
Common Redshank		350	2,549	2,549	253
Marsh Sandpiper		1		1	361
Common Greenshank		10	156	156	78
Terek Sandpiper		5		5	575
Common Sandpiper		305		305	53
Ruddy Turnstone					1
Red-necked Stint					2
Curlew Sandpiper		2		2	170
Unidentified shorebirds		200	2,787	1,887	2
Total storks and shorebirds	222	1,675	6,520	6,599	2,695

Note:

A - Pulau Kelumpang Lake; B - Inter-tidal mudflats at Bang Zhu Kao, Kuala Gula; C - Coastal zone and rivers surrounding Pulau Kelumpang; D - Coastal zone and rivers surrounding Pulau Sangga Kechil & Besar; E - Coastal zone and rivers surrounding Pulau Terong; F - Pulau Terong Lake; G - Pulau Pasir Hitam & South Sg Kerang coast; and H - Kuala Gula - Kuala Kurau - Tg. Piandang coast (see Figure 1).

Annex B: Comprehensive waterbird counts at Matang Mangrove Forest and adjacent coastal areas (1985-1986)

(Extracted from Silvius *et al.* 1987)

Species/ date	South Migration Period (27 September-30 October 1985)	Winter Season (3 January-26 February 1986)	North Migration Period (16 March- 6 April 1986)
Site coverage*	A, C, D, G & H	A, D, E, F, G & H	A, C, F, G & H
Great White Egret		106	72
Intermediate Egret		14	
Green-backed Heron	59	71	2
Chinese Pond-Heron		9	11
Unidentified pond-herons			3
Little Egret	26	20	23
Unidentified Pacific Reef- Egret or Chinese Egret		40	
Unidentified egrets		12	
Black-crowned Night Heron		1	
Milky Stork		23	9
Lesser Adjutant	27	37	37
White-breasted Waterhen		6	
Masked Finfoot		3	2
Pacific Golden Plover	88	16	158
Grey Plover	3	34	47
Little Ringed Plover			4
Lesser Sand Plover	498	475	241
Greater Sand Plover	1	50	26
Unidentified Sand Plover		158	
Asian Dowitcher	8		38
Black-tailed Godwit	1,115	1,589	890
Bar-tailed Godwit		10	17
Unidentified snipes			2
Whimbrel	154	22	816
Eurasian Curlew	526	5	10
Common Redshank	999	1,261	1,594
Marsh Sandpiper	73	561	366
Common Greenshank	172	80	88
Wood Sandpiper		1	5
Terek Sandpiper	67	12	700
Common Sandpiper	132	30	23
Ruddy Turnstone	1	20	
Red-necked Stint	1	40	31
Long-toed Stint			1
Curlew Sandpiper	189	1,885	579
Broad-billed Sandpiper		9	5
Unidentified shorebirds	300	650	
Brown-headed Gull		2	
Gull-billed Tern	2	7	2
Lesser Crested Tern		6	
Greater Crested Tern		10	
Common Tern	60	9	140
Little Tern	4	20	30
Whiskered Tern	40		215

Species/ date	South Migration Period (27 September-30 October 1985)	Winter Season (3 January-26 February 1986)	North Migration Period (16 March- 6 April 1986)
White-winged Tern	10	5	
Unidentified terns		690	
Total waterbirds	4,555	7,999	6,187
White-bellied Sea Eagle	8	4	2
Brahminy Kite	35	38	50
Common Kingfisher	1	22	2
Stork-billed Kingfisher		5	3
Ruddy Kingfisher	1		
Black-caped Kingfisher	1	12	12
Collared Kingfisher		18	4

Note:

A - Pulau Kelumpang Lake; B - Inter-tidal mudflats at Bang Zhu Kao, Kuala Gula; C - Coastal zone and rivers surrounding Pulau Kelumpang; D - Coastal zone and rivers surrounding Pulau Sangga Kechil & Besar; E - Coastal zone and rivers surrounding Pulau Terong; F - Pulau Terong Lake; G - Pulau Pasir Hitam & South Sg Kerang coast; and H - Kuala Gula - Kuala Kurau - Tg. Piandang coast (see Figure 1).

Annex C: Comprehensive AWC count at Matang Mangrove Forest and adjacent coastal areas (1989-1992)

(Extracted from Asian Waterbird Census database, managed by Wetlands International)

Species/ date	8-9 January & 5-7 February 1989	7-11 January 1990	12-16 January 1991	26-28 January 1992
Site coverage*	B, C, D & H	A, B, C, D & H	A, B, C, D & H	A, B, C, D & H
Grey Heron	3	14	9	3
Great White Egret	44	51	56	316
Intermediate Egret	18	63	27	100
Purple Heron	20	5	12	1
Green-backed Heron	49	98	39	54
Chinese Pond-Heron	14	68	35	7
Little Egret	149	210	2,009	2,382
Chinese Egret	5	2	6	3
Pacific Reef-Egret		2		
Unidentified egrets		84		268
Black-crowned Night-heron	2,000	2,525	600	10,653
Malayan Night-Heron		6		
Yellow Bittern		7	2	
Milky Stork		62	1	4
Lesser Adjutant	19	39	48	46
Cotton Pygmy-Goose		8		
Slaty-breasted Rail			1	
White-breasted Waterhen	15	267	51	2
White-browed Rail		3		
Watercock		2		
Common Moorhen		19	2	
Black-winged Stilt	4	4	2	
Pacific Golden Plover	68	599	50	169
Grey Plover	419	378	579	408
Little Ringed Plover	15			
Lesser Sand Plover	295	18	1,554	353
Greater Sand Plover	34		90	100

Species/ date	8-9 January & 5-7 February 1989	7-11 January 1990	12-16 January 1991	26-28 January 1992
Common Snipe			8	
Asian Dowitcher	10	5	5	6
Black-tailed Godwit	45	555	98	1,200
Bar-tailed Godwit	89	15	153	127
Whimbrel	212	313	480	471
Eurasian Curlew	219	87	200	203
Common Redshank	1,928	1,192	2,440	3,828
Marsh Sandpiper	4,509	1,730	5,075	2,093
Common Greenshank	2,274	44	83	112
Nordmann's Greenshank	2			
Wood Sandpiper		13	108	
Terek Sandpiper	611	1,504	870	1,187
Common Sandpiper	24	81	44	76
Ruddy Turnstone	7			
Great Knot	10			
Red-necked Stint	102	1,085	70	650
Long-toed Stint	50			
Curlew Sandpiper	3,501	1,100	1,281	2,505
Broad-billed Sandpiper	5	551		230
Unidentified shorebirds	1,530	2,100	2,500	2,956
Brown-headed Gull	90	113	232	84
Black-headed Gull	4			
Gull-billed Tern		20		
Lesser Crested Tern		30		42
Greater Crested Tern	4	95	260	5
Black-naped Tern	293		20	76
Common Tern	80	466	1,466	150
Little Tern	267	516	1,862	79
Whiskered Tern	1,395	277	697	218
Unidentified terns	2,200	2,100		353
Total waterbirds	22,632	18,526	23,125	31,520

Note:

A - Pulau Kelumpang Lake; B - Inter-tidal mudflats at Bang Zhu Kao, Kuala Gula; C - Coastal zone and rivers surrounding Pulau Kelumpang; D - Coastal zone and rivers surrounding Pulau Sangga Kechil & Besar; E - Coastal zone and rivers surrounding Pulau Terong; F - Pulau Terong Lake; G - Pulau Pasir Hitam & South Sg Kerang coast; and H - Kuala Gula - Kuala Kurau - Tg. Piandang coast (see Figure 1).

Annex D: Partial AWC counts at Matang Mangrove Forest and adjacent coastal areas (1999-2004)

(Extracted from Yeap 2002, Yeap *et al.* 2003, Yeap *et al.* 2004 and Asian Waterbird Census database, managed by Wetlands International)

Species/ date	9 January 1999	26 January 2001	10-11 January 2002	4, 21-22 January 2003	13-14 January & 7 February 2004
Site coverage*	C & H (?)	H	C, D & H	A, C, D & H	A, C, D & H
Grey Heron			4		1
Great White Egret	36	14	159	67	21
Intermediate Egret	7		27	9	
Cattle Egret			3	36	
Green-backed Heron	14		13	24	21
Chinese Pond-Heron	2		3	13	
Little Egret	79	379	145	145	185
Unidentified egrets	5		180	439	353
Black-crowned Night-heron			1		
Milky Stork				8	8
Lesser Adjutant	20	3	26	57	3
White-breasted Waterhen				6	
Pacific Golden Plover			2		
Lesser Sand Plover	2		2		4
Black-tailed Godwit			5		
Bar-tailed Godwit	15		71		
Whimbrel	75		38	38	24
Eurasian Curlew	75	19	90		
Common Redshank	300		234	25	69
Marsh Sandpiper	300		12		
Common Greenshank	1	1	16		1
Terek Sandpiper	100		65		2
Common Sandpiper	4		9	14	6
Curlew Sandpiper			390		
Unidentified shorebirds		140	445	260	100
Brown-headed Gull		23	176	6	150
Lesser Crested Tern			4		
Common Tern	34				
Little Tern	2				
Whiskered Tern	3		700		8
White-winged Tern				1	
Unidentified terns	200	215	1,237	121	59
Total waterbirds	1,274	794	4,057	1,269	1,015

Note:

A - Pulau Kelumpang Lake; B - Inter-tidal mudflats at Bang Zhu Kao, Kuala Gula; C - Coastal zone and rivers surrounding Pulau Kelumpang; D - Coastal zone and rivers surrounding Pulau Sangga Kechil & Besar; E - Coastal zone and rivers surrounding Pulau Terong; F - Pulau Terong Lake; G - Pulau Pasir Hitam & South Sg Kerang coast; and H - Kuala Gula - Kuala Kurau - Tg. Piandang coast (see Figure 1).

Annex E: Total number of waterbirds recorded at Matang Mangrove Forest and adjacent coastal areas during southward migration, August-October 2004

Species/ date	17 August 2004			16 September 2004	14-16 October 2004					Peak count during southward Migration ²
	A	B	Total	A	A	B	C	D	Total	
Great White Egret	20	1	21	7	1		13+	6	20	21
Purple Heron	1		1	1						1
Green-backed Heron							9		9	9
Unidentified pond-herons		2+	2		5		1		6	6
Little Egret	5	5+	10	2	7	10+	358	38	413	413
Black-crowned Night-heron	7		7							7
Yellow Bittern						1			1	1
Milky Stork	8		8	5	9				9	9
Lesser Adjutant	30	1	31	3	2	2	8	5	17	31
Pacific Golden Plover						16			16	16
Lesser Sand Plover		20+	20			102			102	102
Whimbrel		10+	10			62	4		66	66
Common Redshank	100	20+	120	5	1	65	31		97	120
Marsh Sandpiper				14		2			2	14
Common Greenshank	1		1	2		2			2	2
Terek Sandpiper		1	1			10+			10	10
Common Sandpiper		2+	2	1	2	1	1		4	4
Unidentified shorebirds							167	42	209	209
Little Tern							60	44	104	104
Unidentified terns							50+		50	50
Total waterbirds	172	62	234	40	27	263	652	135	1,137	1,195
Brahminy Kite	3	2+	5		2	5+	28+	5	40	40
White-bellied Sea-eagle							2		2	2
Common kingfisher						1	2		3	3
Stork-billed Kingfisher						1			1	1
White-throated Kingfisher						1	1		2	2
Black-caped Kingfisher						3	1		4	4
Collared Kingfisher		3+	3			3	2+		5	5

Notes:

1: A - Pulau Kelumpang Lake; B - Inter-tidal mudflats at Bang Zhu Kao, Kuala Gula; C - Coastal zone and rivers surrounding Pulau Kelumpang; D - Coastal zone and rivers surrounding Pulau Sangga Kechil & Besar; E - Coastal zone and rivers surrounding Pulau Terong; F - Pulau Terong Lake; G - Pulau Pasir Hitam & South Sg Kerang coast; and H - Kuala Gula - Kuala Kurau - Tg. Piandang coast (see Figure 1).

2: Numbers highlighted in grey used to determine the peak count of each species during southward migration.

Annex F: Total number of waterbirds recorded at Matang Mangrove Forest and adjacent coastal areas during the winter season, January-February 2005

Species/ date Site coverage ¹	12 January 2005 ²						10, 24-27 January 2005 ³								23-24 February 2005				Peak winter count ²
	A	C	D	F	G	Total	A	B	C	D	E	F	H	Total	A	C	F	Total	
Spotted-billed Pelican							1							1					1
Grey Heron							1	1				8		10					10
Great White Egret							45	15	60	5	2	24	52	203	1		4	5	203
Purple Heron							1	6						7					7
Green-backed Heron								5	6		1	1	3	16		3	1	4	16
Chinese Pond-Heron								10					2	12					12
Unidentified pond-herons							1					2		3			1	1	3
Little Egret							6	10	235	6	3	1	368	629			18	18	629
Unidentified egrets	30	181	172	24	10	417		10	7	162			30	209		2	105	107	209
Milky Stork	2					2	3							3			6	6	6
Lesser Adjutant	3	1	19	2		25	9	5		12		3	1	30		8	30	38	38
Black-headed Ibis								1						1					1
White-breasted Waterhen							2					2		4	3			3	4
Unidentified rails												1		1					1
Pacific Golden Plover								9						9					9
Lesser Sand Plover								90						90					90
Greater Sand Plover								1						1					1
Whimbrel								51	1				8	60			1	1	60
Common Redshank							10	200	119		3			332	3		63	66	332
Marsh Sandpiper							2					35		37	5			5	37
Common Greenshank								1	1			4		6	30			30	30
Terek Sandpiper								50						50					50
Common Sandpiper								8	6	2	2			18					18
Unidentified shorebirds									55			5	30	90					90
Brown-headed Gull													150	150					150
Whiskered Tern													4	4					4
Unidentified terns										5			125	130					130
Total waterbirds	35	182	191	26	10	444	81	473	490	192	11	86	773	2,107	42	13	229	284	2,141
Black-shouldered Kite								4						4					4
Brahminy Kite		2	3		6	11	6		11	16	3			36		27	2	29	36
White-bellied Sea Eagle				1	1	2			1		2			3					3
Common kingfisher								1	2	1				4					4
Stork-billed Kingfisher								2	1		1			4		1		1	4
Black-caped Kingfisher								2	2		1	1	2	8					8
Collared Kingfisher								5	3			1		9		2		2	9

Notes:

1: A - Pulau Kelumpang Lake; B - Inter-tidal mudflats at Bang Zhu Kao, Kuala Gula; C - Coastal zone and rivers surrounding Pulau Kelumpang; D - Coastal zone and rivers surrounding Pulau Sangga Kechil & Besar; E - Coastal zone and rivers surrounding Pulau Terong; F - Pulau Terong Lake; G - Pulau Pasir Hitam & South Sg Kerang coast; and H - Kuala Gula - Kuala Kurau - Tg. Piandang coast (see Figure 1).

2: Numbers highlighted in grey used to determine the peak count of each species during winter.

Annex G: Total number of waterbirds recorded at Matang Mangrove Forest and adjacent coastal areas during northward migration, March-April 2005

Species/ date	24-26 March 2005							
Site coverage*	A	B	C	D	E	F	H	Total
Grey Heron		2						2
Great White Egret		2	70		1	15	20	108
Purple Heron		1						1
Green-backed Heron		3	2		1	2		8
Unidentified pond-herons		12		1		10		23
Little Egret		3	314		1	1		319
Unidentified egrets		20	99	284			2	405
Black-crowned Night-heron		1						1
Milky Stork								0
Lesser Adjutant	3	2	7	6			1	19
White-breasted Waterhen		40						40
Ruddy-breasted Crake		2						2
Watercock		2						2
Pacific Golden Plover		1						1
Lesser Sand Plover		48						48
Whimbrel		10						10
Common Redshank		41	80		1	4	150	276
Marsh Sandpiper	30	30						60
Common Greenshank	15					3		18
Terek Sandpiper		20						20
Common Sandpiper		3			1			4
Red-necked Stint		1						1
Unidentified shorebirds			14	10				24
Brown-headed Gull							80	80
Whiskered Tern			21	30			30	81
Total waterbirds	48	244	607	331	5	35	283	1,553
Black-shoulder Kite		1						1
Brahminy Kite	10	7	17	24	1			59
White-bellied Sea-eagle			1	1				2
Stork-billed Kingfisher		1			1			2
Black-caped Kingfisher		1	1					2
Collared Kingfisher		1	3					4

Note: A - Pulau Kelumpang Lake; B - Inter-tidal mudflats at Bang Zhu Kao, Kuala Gula; C - Coastal zone and rivers surrounding Pulau Kelumpang; D - Coastal zone and rivers surrounding Pulau Sangga Kechil & Besar; E - Coastal zone and rivers surrounding Pulau Terong; F - Pulau Terong Lake; G - Pulau Pasir Hitam & South Sg Kerang coast; and H - Kuala Gula - Kuala Kurau - Tg. Piandang coast (see Figure 1).

Annex H: Total number of waterbirds recorded at Matang Mangrove Forest and adjacent coastal areas during the summer season, May-July 2005

Species/ date	24-26 May 2005				22-23 June 2005				5 July 2005	Peak Summer Count ²
Site coverage ¹	A	C	F	Total	A	F	C & D	Total	F	
Grey Heron			1	1					1	1
Great White Egret	1		6	7					11	11
Purple Heron	2			2						2
Green-backed Heron			3	3						3
Little Egret	23	30	1	54	15	1		16		54
Unidentified egrets		15		15		5		5	25	15
Milky Stork	6			6	8			8	4	8
Lesser Adjutant	7		1	8	3	1	5	9	5	9
Lesser Sand Plover		10		10						10

Species/ date	24-26 May 2005				22-23 June 2005				5 July 2005	Peak Summer Count ²
Site coverage ¹	A	C	F	Total	A	F	C & D	Total	F	
Whimbrel		1		1						1
Eurasian Curlew		3		3						3
Common Redshank	40	211		251			230	230		251
Terek Sandpiper		3		3			11	11		11
Common Tern									17	17
Little Tern							1	1		1
Total waterbirds	79	273	12	364	26	7	247	280	63	397
Brahminy Kite	9	3	5	17			7	7	7	17
White-bellied Sea Eagle			1	1						1
Oriental Honey Buzzard			6	6						6
Collared Kingfisher	1			1						1

Notes: 1: A - Pulau Kelumpang Lake; B - Inter-tidal mudflats at Bang Zhu Kao, Kuala Gula; C - Coastal zone and rivers surrounding Pulau Kelumpang; D - Coastal zone and rivers surrounding Pulau Sangga Kechil & Besar; E - Coastal zone and rivers surrounding Pulau Terong; F - Pulau Terong Lake; G - Pulau Pasir Hitam & South Sg Kerang coast; and H - Kuala Gula - Kuala Kurau - Tg. Piandang coast (see Figure 1).

2: Numbers highlighted in grey used to determine the peak count of each species during summer.

Annex I: Total number of waterbirds recorded at Matang Mangrove Forest and adjacent coastal areas during southward migration, August 2005

Species/ date	22-23 August 05					
Site coverage*	A	C	D	F	H	Total
Grey Heron	3					3
Great White Egret	18	3	4	2	11	38
Green-backed Heron	2	1		2	1	6
Little Egret	139	170		1	10	320
Unidentified egrets			21			21
Black-crowned Night-heron		10				10
Milky Stork	3					3
Lesser Adjutant	31		3	1	6	41
White-breasted Waterhen		4				4
Kentish Plover				1		1
Lesser Sand Plover				26		26
Asian Dowitcher	2					2
Black-tailed Godwit	1					1
Whimbrel		7				7
Eurasian Curlew					1	1
Common Redshank	200	30	30	9		269
Marsh Sandpiper				6		6
Common Greenshank	40			15		55
Terek Sandpiper				2		2
Common Sandpiper		4		2	1	7
Curlew Sandpiper				2		2
Unidentified shorebirds			30			30
Greater Crested Tern			1			1
Common Tern		4	2		25	31
Little Tern		1	1			2
Whiskered Tern			1		5	6
Unidentified terns			50			50
Total waterbirds	439	234	143	67	60	945
Brahminy Kite	7	8	69	2	2	88
White-bellied Sea-eagle		2	1			3
Collared Kingfisher		2		2		4

Note: A - Pulau Kelumpang Lake; B - Inter-tidal mudflats at Bang Zhu Kao, Kuala Gula; C - Coastal zone and rivers surrounding Pulau Kelumpang; D - Coastal zone and rivers surrounding Pulau Sangga Kechil & Besar; E - Coastal zone and rivers surrounding Pulau Terong; F - Pulau Terong Lake; G - Pulau Pasir Hitam & South Sg Kerang coast; and H - Kuala Gula - Kuala Kurau - Tg. Piandang coast (see Figure 1).

Annex J: Total number of waterbirds recorded at Matang Mangrove Forest and adjacent coastal areas during the winter season, November 2005 - January 2006

Species/ date Site coverage ¹	30 November – 1 December 2005					29 December 2005					16-18 January 2006								Peak winter count ²
	A	C	D	F	Total	A	C	D	F	Total	A	B	C	D	E	F	H	Total	
Grey Heron						2			1	3		1				1		2	3
Great White Egret						21	10	30	1	62	105	16	61	227	1	2	96	508	508
Intermediate Egret											10		1					11	11
Purple Heron						1				1	1	3	1			1		6	6
Cattle Egret													18				35	53	53
Green-backed Heron									4	4	2	8	8	2		1	1	22	22
Unidentified pond-herons											1	24	14	10		1		50	50
Little Egret		25			25	9	10			19	60	32	260	54			49	455	455
Unidentified egrets		5		1	6	13				13		4	265	55	1		15	340	340
Black-crowned Night Heron													1					1	1
Yellow Bittern											1							1	1
Milky Stork	6				6	7				7	4							4	7
Lesser Adjutant						3				3	1	2	2	19	1	2		27	27
Black-headed Ibis												1						1	1
White-breasted Waterhen												4	9					13	13
Red-wattled Lapwing													3					3	3
Pacific Golden Plover												10						10	10
Lesser Sand Plover												34						34	34
Bar-tailed Godwit												1						1	1
Whimbrel												68	5	95				168	168
Common Redshank							21			21	5	109	63	61		1		239	239
Marsh Sandpiper												1		5				6	6
Common Greenshank													1			1		2	2
Common Sandpiper						1				1		7	3					10	10
Terek Sandpiper												54						54	54
Unidentified shorebirds													2	75				77	77
Brown-headed Gull																	25	25	25
Common Tern		30	30		60														60
Little Tern														25			1	26	26
Whiskered Tern														10				10	10
Unidentified terns													7	71			23	101	101
Total waterbirds	6	60	30	1	97	57	41	30	6	134	190	379	724	709	3	10	245	2,260	2,324
Black-shouldered Kite												4	2					6	6
Brahminy Kite								1				7	23	5	4		5	44	44
White-bellied Sea Eagle																	1	1	1
Common kingfisher													2					2	2
Stork-billed Kingfisher						1			1	2		1	3					4	4
White-throated Kingfisher												2						2	2
Black-caped Kingfisher							1			1	1	8	2	2				13	13
Collared Kingfisher						1				1	2	15	7				1	25	25

Notes:

1: A - Pulau Kelumpang Lake; B - Inter-tidal mudflats at Bang Zhu Kao, Kuala Gula; C - Coastal zone and rivers surrounding Pulau Kelumpang; D - Coastal zone and rivers surrounding Pulau Sangga Kechil & Besar; E - Coastal zone and rivers surrounding Pulau Terong; F - Pulau Terong Lake; G - Pulau Pasir Hitam & South Sg Kerang coast; and H - Kuala Gula - Kuala Kurau - Tg. Piandang coast (see Figure 1).

2: Numbers highlighted in grey used to determine the peak count of each species during winter.

Annex K: English and scientific names of wildlife species mentioned in the report

English Name	Scientific Name	English Name	Scientific Name
Waterbirds			
Spot-billed Pelican	<i>Pelecanus philippensis</i>	Kentish Plover	<i>Charadrius alexandrinus</i>
Oriental Darter	<i>Anhinga melanogaster</i>	Lesser Sand Plover	<i>Charadrius mongolus</i>
Grey Heron	<i>Ardea cinerea</i>	Greater Sand Plover	<i>Charadrius leschenaultii</i>
Great White Egret	<i>Ardea alba</i> (<i>Ardea modesta</i>)	Unidentified Sand Plovers	<i>Charadrius mongolus</i> / <i>Charadrius leschenaultii</i>
Intermediate Egret	<i>Egretta</i> (<i>Ardea</i>) <i>intermedia</i>	Common Snipe	<i>Gallinago gallinago</i>
Purple Heron	<i>Ardea purpurea</i>	Unidentified snipes	<i>Gallinago</i> spp.
Cattle Egret	<i>Bubulcus ibis</i> (<i>Ardea ibis</i>)	Asian Dowitcher	<i>Limnodromus semipalmatus</i>
Green-backed Heron	<i>Egretta</i> spp.	Black-tailed Godwit	<i>Limosa limosa</i>
Chinese Pond-Heron	<i>Butorides striatus</i>	Bar-tailed Godwit	<i>Limosa lapponica</i>
unidentified pond-herons	<i>Ardeola bacchus</i>	Whimbrel	<i>Numenius phaeopus</i>
Little Egret	<i>Ardeola</i> spp.	Eurasian Curlew	<i>Numenius arquata</i>
Chinese Egret	<i>Egretta garzetta</i>	Unidentified curlews	<i>Numenius</i> spp.
Pacific Reef-Egret	<i>Egretta eulophotes</i>	Common Redshank	<i>Tringa totanus</i>
unidentified egrets	<i>Egretta sacra</i>	Marsh Sandpiper	<i>Tringa stagnatilis</i>
Black-crowned Night-heron	<i>Nycticorax nycticorax</i>	Common Greenshank	<i>Tringa nebularia</i>
Malayan Night-heron	<i>Gorsachius melanolophus</i>	Nordmann's Greenshank	<i>Tringa guttifer</i>
Yellow Bittern	<i>Ixobrychus sinensis</i>	Wood Sandpiper	<i>Tringa glareola</i>
Heron	<i>Ardeidae</i>	Terek Sandpiper	<i>Xenus cinereus</i>
Milky Stork	<i>Mycteria cinerea</i>	Common Sandpiper	<i>Actitis hypoleucos</i>
Painted Stork	<i>Mycteria leucocephala</i>	Ruddy Turnstone	<i>Arenaria interpres</i>
Storm's Stork	<i>Ciconia stormi</i>	Great Knot	<i>Calidris tenuirostris</i>
Lesser Adjutant	<i>Leptoptilos javanicus</i>	Red-necked Stint	<i>Calidris ruficollis</i>
Greater Adjutant	<i>Leptoptilos dubius</i>	Long-toed Stint	<i>Calidris subminuta</i>
Black-headed Ibis	<i>Threskiornis melanocephalus</i>	Curlew Sandpiper	<i>Calidris ferruginea</i>
Cotton Pygmy-Goose	<i>Nettapus coromandelianus</i>	Broad-billed Sandpiper	<i>Limicola falcinellus</i>
Slaty-breasted Rail	<i>Gallirallus striatus</i>	Unidentified shorebirds	<i>Charadrii</i> spp.
White-breasted Waterhen	<i>Amaurornis phoenicurus</i>	Brown-headed Gull	<i>Larus brunnicephalus</i>
Ruddy-breasted Crake	<i>Porzana fusca</i>	Black-headed Gull	<i>Larus ridibundus</i>
White-browed Rail	<i>Porzana cinerea</i>	Gull-billed Tern	<i>Sterna nilotica</i>
Watercock	<i>Gallicrex cinerea</i>	Lesser Crested Tern	<i>Sterna bengalensis</i>
Common Moorhen	<i>Gallinula chloropus</i>	Greater Crested Tern	<i>Sterna bergii</i>
unidentified rails	<i>Rallidae</i> spp.	Black-naped Tern	<i>Sterna sumatrana</i>
Masked Finfoot	<i>Heliopais personata</i>	Common Tern	<i>Sterna hirundo</i>
Black-winged Stilt	<i>Himantopus himantopus</i>	Little Tern	<i>Sterna albifrons</i>
Red-wattled Lapwing	<i>Vanellus indicus</i>	Whiskered Tern	<i>Chlidonias hybridus</i>
Pacific Golden Plover	<i>Pluvialis fulva</i>	White-winged Tern	<i>Chlidonias leucopterus</i>
Grey Plover	<i>Pluvialis squatarola</i>	Unidentified terns	<i>Sterninae</i> spp.
Little Ringed Plover	<i>Charadrius dubius</i>	Gulls and terns	<i>Laridae</i>
Wetland-dependent raptors and kingfishers			
Black-shoulder Kite	<i>Elanus caeruleus</i>	Stork-billed Kingfisher	<i>Halcyon capensis</i>
Brahminy Kite*	<i>Haliastur indus</i>	Ruddy Kingfisher	<i>Halcyon coromanda</i>
White-bellied Sea Eagle*	<i>Haliaeetus leucogaster</i>	White-throated Kingfisher	<i>Halcyon smyrnensis</i>
Oriental Honey Buzzard	<i>Pernis ptilorhynchus</i>	Black-caped Kingfisher	<i>Halcyon pileata</i>
Common Kingfisher	<i>Alcedo atthis</i>	Collared Kingfisher	<i>Todiramphus chloris</i>
Mammals			
Long-tailed Macaque	<i>Macaca fascicularis</i>	Silvered Leaf Monkey	<i>Semnopithecus cristatus</i>
Common Palm Civet	<i>Paradoxurus hermaphroditus</i>	Wild Pig	<i>Sus scrofa</i>
Reptiles			
Water Monitor	<i>Varanus salvator</i>		
Fishes			
Large mudskippers	<i>Periophthalmus</i> spp.	Gastropod snails	<i>Terebralia palustris</i>