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STATUS AND CONSERVATION OF GLOBALLY THREATENED PRIMATES IN THE SEIMA BIODIVERSITY CONSERVATION AREA, CAMBODIA

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STATUS AND CONSERVATION OF GLOBALLY THREATENED PRIMATES IN THE SEIMA BIODIVERSITY CONSERVATION AREA, CAMBODIA

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Front Cover

Black-shanked Douc © Allan Michaud.
Male Yellow-cheeked Crested Gibbon © Matt Hunt.
Germain's Silvered Langur © Allan Michaud.
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អ រាល់កិច្ចការដែលបានធ្វើកន្លងមកនេះ សុទ្ធតែមានការអនុញ្ញាត្ត និង ការគាំទ្រពីរាជរដ្ឋាភិបាលកម្ពុជា។ សូមថ្លែងអំណរគុណយ៉ាងជ្រាលជ្រៅចំពោះការគាំទ្ររបស់រដ្ឋបាលព្រៃឈើ នៃក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និង នេសាទ។ ជាពិសេស **ឯកឧត្តម ឆិ សុគន្ធ** និង លោក **ម៉ែន តីមឿន** ប្រធានការិយាល័យការពារ សត្វព្រៃ។ សូមថ្លែងអំណរគុណផងដែរចំពោះ **ឯកឧត្តម ឡាយ សុខា** អភិបាលខេត្តមណ្ឌលគីរី និង **ឯកឧត្តម កែវ ហាន** អភិបាលរងខេត្តមណ្ឌលគីរី ដែលជានិច្ចជាកាលបានគាំទ្រចំពោះសកម្មភាពរបស់គំរោង ដែលអាចនាំឆ្ពោះទៅរកភាពជោគជ័យ។

អ្នកនិពន្ធសូមសំដែងនូវការដឹងគុណចំពោះប្រជាជនមូលដ្ឋាននៅស្រុកកែវសីមា ដែលបានចូលរួមក្នុង ដំណើរការសិក្សាស្រាវជ្រាវនេះ។ ជាពិសេសចំពោះអ្នកដឹកនាំក្រុម និង ជំនួយការដូចជា លោក ជា ឆេន អន សំអាត ដែន អំបញ្ចុ វ៉ាន្ដី ផាត ប្លូ វ៉ាង សារ៉ែត គឿន ត្រឿត ច្បើន ឡែន វ៉ាន្ដី និង លោក ព្រិន ចញ។ សម្ភារៈភស្តុភារ និងបច្ចេកទេសបានទទួលការជួយជ្រោមជ្រែងពីលោក ម៉ែន សូរិយន់ ខ្សែវ រិទ្ធិភ័ណ្ឌ Tom Evans និង លោក Joe Walston ។ សូមថ្លែងអំណរគុណផងដែរ ចំពោះ លោក, Barney Long, Emma Stokes, and Carly Starr ចំពោះការផ្តល់គំនិតយោបល់បន្ថែមលើគំរោងនេះ។ ជាងនេះទៅ ទៀត អរគុណចំពោះលោកស្រី Samantha Strindberg ដែលបានជួយរៀបចំបែបផែនសិក្សាស្រាវជ្រាវ និង វិភាគទិន្នន័យដែលទទួលបាន។

ការសិក្សាស្រាវជ្រាវតាមដានពពួកពានរសត្វ នៅតំបន់អភិរក្សជីវៈចំរុះ"សីមា"នេះ បានទទួលការឧបត្ថម្ភ គាំទ្រពី U.S. Fish and Wildlife Service's Great Ape Conservation Fund, the MacArthur Foundation and Danida.

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EXECUTIVE SUMMARY

The Seima Biodiversity Conservation Area (SBCA) is a globally important area for biodiversity conservation located in eastern Cambodia. Established in 2002 and managed by the Forestry Administration it is the site of a long-term conservation program of the Wildlife Conservation Society (WCS) – Cambodia Program. The vision of the area is "*a well-managed forest landscape that supports increasing wildlife populations and improving livelihoods for the people who currently live there*". This is to be achieved by a combination of protected areas management, engaging local stakeholders and programs to stabilise land-use.

A biodiversity monitoring program to guide conservation efforts and measure the success of the project began in 2002. This program is now one of the largest and most intensive of its kind in South-East Asia, and aims to:

- To measure changes in the populations of target species: Tiger *Panthera tigis*, Asian Elephant *Elephas maximus*, Green Peafowl *Pavo muticus*, Yellow-cheeked Crested Gibbon *Nomascus gabriellae* and Black-shanked Douc *Pygathrix nigripes*.
- To measure changes in the populations of important large carnivore prey species: Banteng *Bos javanicus*, Gaur *Bos gaurus*, Sambar *Cervus unicolor*, muntjacs *Muntiacus/Megamuntiacus* and Eurasian Wild Pig *Sus scrofa*.
- To use the results to direct, adapt and refine conservation activities of the project.

The SBCA is home to at least seven - and possibly more - species of primate, all of which are listed as Globally Threatened or Near Threatened: Pygmy Loris, Black-shanked Douc, Germain's Silvered Langur, Long-tailed Macaque, Stump-tailed Macaque, Northern Pig-tailed Macaque, Yellow-cheeked Crested Gibbon (and possibly another loris species). Since 2002 efforts have been made to monitor the diurnal species through a combination of line transects and listening posts.

Adequate data have been obtained for Black-shanked Douc and Yellow-cheeked Crested Gibbon to allow for an assessment of population estimates and trends. The data suggest that populations of both species have increased since the start of intensive conservation efforts. The SBCA is home to a large population of Yellow-cheeked Crested Gibbons. The study area is home to an estimated 933 groups (630-1,383). Assuming an average group size of four, the total population in the study area in 2007 is estimated at 3,732 (2,519-5,531) individuals. This is from an area of just 789 km^2 though the total area of suitable habitat in the SBCA is estimated at 2,061km^2. Given this the total population size in the SBCA is likely to be considerably higher. The population of Black-shanked Doucs in the SBCA is very large. The density of groups in 2007 is estimated at 7.57 groups/km^2 in the study site, and the total population estimated at 42,603 (27,309-66,460). Assuming a total area of suitable habitat of 2,061km^2 the total population estimate for the SBCA could be much higher.

These species are under-surveyed throughout the rest of their range, but it is probable that the SBCA is home to the largest populations of Yellow-cheeked Crested Gibbon and Black-shanked Douc in the world. The conservation of these populations is therefore of global importance.

The Forestry Administration currently employs two main strategies for protecting these internationally important primate populations:

- Active law enforcement by a large team of forest rangers. Up to five teams are in the forest at any one time and patrol efforts have focussed on areas that are

critically important to primates and other species of conservation concern

- Land-use planning and community engagement. Stabilising land-use in the face of economic land concessions and spontaneous in-migration is critical to protecting primate habitat. This has been achieved in partnership with law enforcement efforts to ensure that while outsiders are prevented from illegally settling within the SBCA, current residents are allowed to maintain and develop their livelihoods within the laws.

Recommendations for the improved monitoring of primates are:

- Increase the survey effort
- Increase the number of line transects
- Research group size and dynamics

Recommendations for continued successful conservation of primates are:

- Expansion of the law enforcement effort
- Expanding land-use planning to villages throughout the landscape
- Refine the boundaries of the SBCA
- Zoning of the SBCA
- Strengthen the legal framework for protection of the SBCA from Ministerial Declaration to Prime Ministerial Subdecree

សេចក្តីសង្ខេប

តំបន់អភិរក្សជីវៈចម្រុះ"សីមា"(SBCA) គឺជាតំបន់មួយដែលមានសារៈសំខាន់ជាសាកល សម្រាប់ធ្វើការអភិរក្សជីវៈចម្រុះ។ តំបន់នេះស្ថិតនៅភាគខាងកើតនៃប្រទេសកម្ពុជា បង្កើតឡើងដោយប្រកាសលេខ ២៦០ ប្រក.កសក ចុះថ្ងៃទី១២ ខែសីហា ឆ្នាំ២០០២ ដោយក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ។ តំបន់នេះត្រូវបានគ្រប់គ្រងដោយរដ្ឋបាលព្រៃឈើ សហការជាមួយកម្មវិធីអភិរក្សរយៈពេលវែងរបស់អង្គការសមាគមអភិរក្សសត្វព្រៃប្រចាំនៅកម្ពុជា។ គោលបំណងរួមនៃកិច្ចអភិរក្សតំបន់នេះ គឺ "គ្រប់គ្រងតំបន់ទេសភាពព្រៃឈើឱ្យបានល្អ ដើម្បីបង្កើនសារព័ន្ធព្រៃឈើ និងសត្វព្រៃ និងបង្កើនផលចំណូលជីវភាពគ្រួសាររបស់ប្រជាជនដែលកំពុងរស់នៅក្នុងតំបន់នេះ"។ សមិទ្ធផលនេះបានបង្ហាញឱ្យឃើញតាមរយៈការអនុវត្តន៍កម្មវិធីគ្រប់គ្រងតំបន់ ដោយមានការចូលរួមពីប្រជាពលរដ្ឋដែលរស់នៅក្នុងតំបន់ និង កម្មវិធីប្រើប្រាស់ដីធ្លីដើម្បីធ្វើឱ្យមានស្ថេរភាព ។

កម្មវិធីតាមដានការប្រើប្រាស់ជីវៈចម្រុះបានចាប់ដំណើរការពីឆ្នាំ២០០២ គឺដើម្បីឈានឆ្ពោះទៅរកការខិតខំអភិរក្ស និងវាយតម្លៃ ទៅលើភាពជោគជ័យនៃគម្រោង។ បច្ចុប្បន្នកម្មវិធីនេះជាកម្មវិធីដ៏ធំ មួយនៅតំបន់អាស៊ីអាគ្នេយ៍ និងមាន សកម្មភាពយ៉ាងសកម្ម។ គោលបំណងនៃកម្មវិធីនេះមានដូចខាងក្រោម:

- ដើម្បីវាយតម្លៃការប្រែប្រួលសារព័ន្ធប្រភេទសត្វព្រៃមួយចំនួនដូចជា: ខ្លាធំ ដំរី ក្ងោក ទោចថ្ពាល់ ល្មើង និងស្វាក្រវ៉ាត់ ជាដើម។
- ដើម្បីវាយតម្លៃការប្រែប្រួលសារព័ន្ធប្រភេទសត្វព្រៃមួយចំនួនដែលមានសារសំខាន់ចំពោះប្រភេទមំសាសី(ស៊ីសាច់ជាអាហារ)ដូចជា: ទន្សោង ខ្លឹង ប្រើស ឈ្លួស និងជ្រូកព្រៃ ជាដើម។
- ដើម្បីប្រើប្រាស់លទ្ធផលទាំងនោះដោយផ្ទាល់សម្រាប់លើកគម្រោងផែនការសកម្មភាពអភិរក្ស និងអនុវត្តជាក់ស្តែង។

យ៉ាងហោចណាស់ តំបន់ SBCA គឺជាទីជម្រករស់នៅពពួកពានរទាំងអស់ដែលបានចុះក្នុងបញ្ជីជាប្រភេទកំពុងរងគ្រោះថ្នាក់ជាសាកល ឬកំពុងឈានទៅរកការរងគ្រោះថ្នាក់ ដូចជា រញ៉ីភ្លើង និងប្រផេះស្វាក្រវ៉ាត់ ស្វាព្រោម ស្វាក្តាម ស្វាអង្គត់ ស្វាត្រោស ទោចថ្ពាល់ល្មើង (និងអាចមានប្រភេទផ្សេងទៀត

នៃសត្វរញ្ជៃ)។ លទ្ធផលទាំងនេះទទួលបានពីការចុះអង្កេតតាមដានដោយប្រើវិធីសាស្ត្របន្ទាត់ត្រង់ស៊ុក និង ការស្តាប់សម្លេង ដោយក្រុមការងារសិក្សាស្រាវជ្រាវចាប់តាំងពីឆ្នាំ ២០០២។

ចំពោះទិន្នន័យនៃប្រភេទស្វាក្រវ៉ាត់ និងទោចថ្ពាល់លឿង ក្រុមការងារបានសិក្សា និងទទួលបានគ្រប់គ្រាន់សម្រាប់ធ្វើការប៉ាន់ស្មានចំនួនសារព័ន្ធ និងការគិតគូរពីអត្រាកំណើនរបស់វា។ ទិន្នន័យនេះអាចបញ្ជាក់បានថាចំនួនពពួកពានរទាំងពីរប្រភេទមានការកើនឡើងខ្លាំង ចាប់ពីពេលគម្រោងអភិរក្សដំណើរការតាំងពីដើមដំបូងមកម្ល៉េះ។ SBCA គឺជាជម្រករស់នៅដ៏សំខាន់សម្រាប់ពពួកប្រភេទទាំងពីរខាងលើនេះ។ តាមការប៉ាន់ស្មាន ពពួកសត្វទាំងពីរនេះមានចំនួន ៩៣៣ក្រុម (ចន្លោះពី៦៣០-១.៣៨៣ ក្រុម) ត្រូវបានកំណត់ក្នុងតំបន់សិក្សា។ បើសិនជាយើងគិតជាមធ្យមក្នុងក្រុមនីមួយៗមាន៤ក្បាល នោះក្នុងឆ្នាំ២០០៧ នេះ ចំនួនសរុបពានរទាំងពីរប្រភេទនេះមានប្រមាណ ៣.៧៣២ក្បាល (ពីចន្លោះ ២.៥១៩-៥.៥៣១ក្បាល)។ ទិន្នន័យសរុបខាងលើនេះ គឺគ្រាន់តែជាចំនួនដែលបានប៉ាន់ស្មានចេញពីផ្ទៃដី ៧៨៩គម^{២} នៃផ្ទៃដីសរុបរបស់តំបន់ដែលនឹងត្រូវសិក្សាប្រមាណជា២.០៦១គម^{២}។ ដូចនេះ ចំនួនសរុបនៃប្រភេទទាំងពីរខាងលើ ក្នុងតំបន់ SBCA ទាំងមូលអាចសន្និដ្ឋានបានថា មានចំនួនច្រើនជាងនេះ។ ជាពិសេស ចំនួនសារព័ន្ធនៃប្រភេទស្វាក្រវ៉ាត់នៅក្នុងតំបន់ SBCA នេះ មានចំនួនច្រើនជាងគេ។ ក្នុងឆ្នាំ ២០០៧ ដង់ស៊ីតេនៃក្រុមរបស់ពានរទាំងពីរប្រភេទនេះមាន ៧,៥៧ក្រុម/គម^{២} នៅក្នុងតំបន់ដែលបានធ្វើការសិក្សា ហើយដែលចំនួនប៉ាន់ស្មានសរុបនៃប្រភេទនេះអាចមាន ៤២.៦០៣ក្បាល (ចន្លោះពី ២៧.៣០៩-៦.៤៦០ក្បាល)។ ដូច្នេះនៅលើផ្ទៃដីសរុប២.០៦១គម^{២} SBCAនេះ គឺចំនួនរបស់វាអាចមានច្រើនជាងនេះ។

ប្រភេទទាំងនេះកំពុងត្រូវបានចុះអង្កេតបន្តនៅតាមទីជម្រកផ្សេងៗទៀតក្នុងតំបន់ SBCA នេះ។ តំបន់អភិរក្សជីវៈចំរុះ"សីមា" គឺជាជំរកដ៏មានសក្តានុពលខ្ពស់ និងមានវត្តមានប្រភេទនេះច្រើនជាងគេនៅលើពិភពលោក។ ដូច្នេះការអភិរក្សសារព័ន្ធប្រភេទសត្វទាំងពីរខាងលើ គឺមានសារសំខាន់ជាសាកល ។

បច្ចុប្បន្នរដ្ឋបាលព្រៃឈើ កំពុងអនុវត្តយុទ្ធសាស្ត្រទាំងពីរសម្រាប់ធ្វើការអភិរក្សសារព័ន្ធប្រភេទពានរ ដែលមានសារសំខាន់ជាសាកល:

- ពង្រឹងការអនុវត្តច្បាប់យ៉ាងសកម្ម ដោយពង្រីកក្រុមមន្ត្រីចុះល្បាតគ្រប់ទីកន្លែង។ ករណីនេះនៅរាល់ពេលចុះល្បាតនីមួយៗ ក្រុមចុះល្បាតទាំង ៥ក្រុមត្រូវចុះទៅកាន់កន្លែងណាដែលមានវត្តមានពានរទាំងនោះ និងប្រភេទសត្វដទៃទៀត ដែលត្រូវធ្វើការអភិរក្សផងដែរ។

- ចូលរួមអនុវត្តផែនការប្រើប្រាស់ដី និងការងារសហគមន៍។ ភាពឯកទេរនៃការប្រើប្រាស់ដីដែលកំពុងប្រឈមនឹងបញ្ហាដីសម្បទានសេដ្ឋកិច្ច និងចលនាធ្វើចំណាកស្រុក ឬប្តូរទីតាំងរស់នៅរបស់ប្រជាពលរដ្ឋ គឺជាបញ្ហាសំខាន់នៅក្នុងការការពារទីជម្រករស់នៅរបស់ពពួកពានរទាំងនោះ។ បញ្ហានេះនឹងត្រូវដោះស្រាយតាមរយៈការចូលរួមពង្រឹងការអនុវត្តន៍ច្បាប់ដើម្បីតាមដាន ទប់ស្កាត់ការផ្លាស់ទីជម្រកនៃអ្នកស្រុកពីខាងក្រៅមករស់នៅក្នុងតំបន់ SBCA ដោយខុសច្បាប់ និងធានាថាអ្នកមានលំនៅអចិន្ត្រៃយ៍នៅក្នុងតំបន់ស្រាប់ ត្រូវបានអនុញ្ញាតការគាំពារ និងការប្រកបមុខរបរសម្រាប់ផ្គត់ផ្គង់ជីវភាពគ្រួសារស្របតាមច្បាប់កំណត់។

អនុសាសន៍សម្រាប់ជម្រុញការតាមដាន និងត្រួតពិនិត្យនៃការអភិរក្សពពួកពានរទាំងនេះ រួមមាន:

- បង្កើនការចុះអង្កេត ស្រាវជ្រាវ
- បង្កើនចំនួនពេលចុះអង្កេតតាមវិធីសាស្ត្រត្រង់ស៊ិក (ធ្វើនៅពេលថ្ងៃ)
- ស្រាវជ្រាវអំពី បរិមាណតាមក្រុមនីមួយៗ និងភាពប្រែប្រួលចំនួនតាមក្រុម។

អនុសាសន៍សម្រាប់បន្តភាពជោគជ័យលើការអភិរក្សពពួកពានរទាំងនេះ រួមមាន:

- បន្តការពង្រឹងការអនុវត្តច្បាប់
- បន្តអនុវត្តផែនការប្រើប្រាស់ដីរបស់អ្នកភូមិដែលរស់នៅក្នុងតំបន់ការពារទេសភាពនេះ។
- ចុះបោះបង្គោលព្រំ និងកំណត់ព្រំប្រទល់ ឬដែននៃតំបន់ SBCA នេះ។
- បែងចែកតំបន់ SBCA នេះតាមលក្ខណៈវិនិច្ឆ័យសំខាន់នីមួយៗនៅក្នុងកិច្ចអភិរក្ស។
- ពង្រឹងការអនុវត្តប្រកាសលេខ ២៦០ ប្រក.កសក ចុះថ្ងៃទី ១២ ខែសីហា ឆ្នាំ២០០២ ស្តីពី ការបង្កើតតំបន់អភិរក្សជីវចម្រុះ "សីមា" របស់ក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ និងរៀបចំសេចក្តីព្រាងអនុក្រឹត្យ ស្តីពី ការបង្កើតតំបន់ "អភិរក្សជីវចម្រុះ សីម៉ា"។

INTRODUCTION

The Seima Biodiversity Conservation Area (SBCA) is home to at least seven Globally Threatened primate species. Surveys and annual monitoring of many of these species have taken place in the area since 2000. This report presents the results of five years of annual monitoring activities. The report focuses on the two most studied primates, Yellow-cheeked Crested Gibbon *Nomascus gabriellae* and Black-shanked Douc *Pygathrix nigripes*. The distribution of both of these species is restricted remnant forest fragments in eastern Cambodia, and southern Viet Nam. At the time of writing they are listed as Vulnerable and Endangered respectively on the IUCN Red List (IUCN 2006). The SBCA may be the single most important site for the conservation of both of these species.

The Seima Biodiversity Conservation Area

The Seima Biodiversity Conservation Area (SBCA) was declared in 2002 by decree of the Ministry of Agriculture, Forestry and Fisheries of the Royal Government of Cambodia. The total size of the Conservation Area is 3,034 km^2 (303,400 Ha). The core area is 1,550 km^2 (155,500 Ha) and is entirely within Mondulkiri province. The combined area of the eastern and western buffer areas is 1,484 km^2 (148,400 Ha) in both Mondulkiri and Kratie provinces (Map 1).

The site remains approximately 98% forested and contains an unusually high diversity of forest types (Walston *et al.* 2001, WCS/FA 2006a, Zimmerman and Clements 2002) (Map 2). These forests form a very complex mosaic that may be dependent on water availability, soil type, topography and other physical factors that are not fully understood. Four crude forest types are generally recognised in SBCA:

- Evergreen forest. These forests form the southerly extremes of the Annamite range, and are found in the hilly southern parts of the conservation area. It is characterised by being almost entirely evergreen, with a tall canopy (up to 40 m), 3 layers of vegetation and an understorey that is rich is rattans and lianas. The evergreen forests are likely to be especially important for their floristic richness and endemism.
- Semi-evergreen forest has a similar structure to evergreen forest but includes a varying proportion of deciduous trees that lose their leaves in the dry season. It is found throughout the conservation area often forming gallery forest along rivers and water courses through the deciduous dipterocarp forest, or on isolated hills.
- Mixed deciduous forest, which in SBCA is usually dominated by *Lagerstroemia* tree species. This can have a very open understorey, or sometimes a dense bamboo understorey.
- Deciduous dipterocarp forest, which is more widespread in the north and west of the conservation area. This forest is open with low canopy (20m) and only 2 strata. The tree flora is dominated by a few deciduous dipterocarp species. The understorey is grassy or rich in short stemmed bamboo.

Other vegetation types that are found in SBCA include dense patches of bamboo, areas of regenerating swidden fields (*chomkar*) and the unusual grasslands of the Sen Monorom plateau. These areas may be relatively species poor when compared to the major forest types, but are important habitat for some wildlife species. Bamboo, for example appears to be important for Asian Elephants *Elephas maximus* and Orange-necked Partridges *Arborophila davidi*.

The SBCA is unusual in South-East Asia in that it conserves large areas of both

evergreen and deciduous forest, and the transition between the different forest types. This is interspersed with open grassland areas, permanent rivers and water sources. Additionally several locations have many mineral licks that are used by ungulates, with over 40 licks having recently been mapped (Bussey *et al.* 2005). This has resulted in a highly productive landscape with the potential to hold very large populations of species of conservation concern. This mosaic of forest types probably contributes to the high species richness in the area. To date 326 bird species, nearly 80 mammal species and over 50 reptile and amphibian species have been recorded in SBCA (WCS/FA 2006a). There are sure to be many more reptiles, amphibians and small mammals that have not yet been recorded. 42 species that are Globally Threatened, near threatened or data deficient have been recorded in SBCA (Table 1). The SBCA is particularly important for the conservation of several highly endangered mammal and bird species (Walston *et al.* 2001, WCS/FA 2006a).

Table 1: Number of threatened species in the SBCA

Class	*Number of Globally Threatened or Near Threatened species present in SBCA (number of species that are not yet confirmed, but suspected to occur, in brackets)*					
	Critical	*Endangered*	*Vulnerable*	*LR/near threatened*	*Data deficient*	*Total*
Mammals		5	10 (+3)	2 (+3)	2 (+3)	19 (9)
Birds	3 (+1)	2	5 (+1)	7 (+1)		17 (2)
Reptiles	(+1)	2	2 (+2)	1		4 (3)
Amphibians			1			1
Total	3 (+2)	9	17 (+7)	10 (+4)	2 (+3)	42 (14)

Table 2: Importance of the SBCA for several species

Species	*IUCN Category*	*Importance of SBCA*
Black-shanked Douc (*Pygathrix nigripes*)	Endangered	Global
Germain's Silvered Langur (*Trachypithecus germaini*)	Data Deficient	Probably Global
Yellow-cheeked Crested Gibbon (*Nomascus gabriellae*)	Vulnerable	Global
Dhole (*Cuon alpinus*)	Endangered	Probably Regional
Tiger (*Panthera tigis*)	Endangered	Regional, potential for Global
Asian Elephant (*Elephas maximus*)	Endangered	Regional
Eld's Deer (*Cervus eldii*)	Vulnerable	Possibly Global
Banteng (*Bos javanicus*)	Endangered	Global
Orange-necked Partridge (*Arborophila davidi*)	Endangered	Possibly Global
Green Peafowl (*Pavo muticus*)	Vulnerable	Global
Germain's Peacock Pheasant (*Polyplectron germaini*)	Low Risk/NT	Global
White-rumped Vulture (*Gyps bengalensis*)	Critically Endangered	Probably Global
Giant Ibis (*Pseudibis gigantea*)	Critically Endangered	Global
White-winged Duck (*Cairina scutulata*)	Endangered	Probably Regional
Yellow-headed Temple Turtle (*Heiremys annandalii*)	Endangered	Unknown
Elongated Turtle (*Indotestudo elongata*)	Endangered	Unknown

Conservation of the SBCA

In 2000, nationwide surveys begun by the Wildlife Conservation Society (WCS) and the Royal Government of Cambodia identified a forest concession in the east of the country as one of the most important sites for wildlife conservation in Cambodia, possibly the region (Walston *et al.* 2001). At the time the area was being actively managed for timber harvesting by Samling International. Initial work by WCS aimed to reduce the impact of logging operations on wildlife, for example by reducing hunting by

company staff. Logging operations have since been suspended and in 2002 the area was declared a Biodiversity Conservation Area by the Minister of Agriculture, Forestry and Fisheries. A long-term collaborative project is now underway with the Government's Forestry Administration (FA) to develop the area as a 'Conservation Landscape' where conservation can be integrated with the needs of local communities and national development goals.

The vision of the Seima Biodiversity Conservation Project is "*A well-managed forest landscape that supports increasing wildlife populations and improving livelihoods for the people who currently live there*" (WCS/FA 2006b). To achieve this the project has two main objectives: an increase in populations of all globally threatened wildlife species, and to secure the livelihoods of the current inhabitants of the area. The Project at present has 3 main strategies: to strengthen the legal framework for the conservation area, on-site law enforcement, and to engage with local communities to help secure their land rights and promote their livelihoods. In addition to this there is a research and monitoring component that covers both the wildlife and socio-economic aspects of the project (WCS/FA 2006b). The Project is staffed primarily by government employees principally from the FA, but also includes members of the Departments of Agriculture and Land Management, some non-government individuals and members of several local communities. WCS provides technical support through full and part time advisors, financial and other programmatic support.

The US Fish and Wildlife Service (USFWS) has been a partner in the conservation project since 2002. WCS/FA received support from the Great Apes Conservation Fund (GACF) to initiate conservation actions for the Yellow-cheeked Crested Gibbon in the SBCA in 2002 and 2004. In 2002, through a field program involving surveys and habitat mapping, broad distribution patterns of gibbons were determined, with an intensive study of focal groups habitats being used to determine habitat affinities and priority areas for conservation (Clements 2003). In light of the success of the initial work, the focus switched to strengthening long-term conservation strategies that would build on the new understanding, and the reduction of threats to the Gibbon population. The GACF provided support to continue monitoring primate populations, improved law enforcement efforts, and for land-use planning to identify and conserve key areas of gibbons and other threatened primates. In addition to the GACF, USFWS has partnered WCS/FA through the Asian Elephant Conservation Fund, and the Rhinoceros and Tiger Conservation Fund. Significant multi-year funding has also been provided by The MacArthur Foundation, which has been instrumental in supporting the establishment and growth of the project.

Primates of the Seima Biodiversity Conservation Area

The SBCA is home to at least seven, and probably more, species of primate. This high species richness is comparable with areas internationally famous for their primates such as Kibale in Uganda with ten species (Chapman *et al.* 2000). All of the species in SBCA are Globally Threatened, Near Threatened or Data Deficient as defined by the IUCN Red List (IUCN 2006). To date wildlife research and monitoring in the SBCA has concentrated on two species, Black-Shanked Douc and Yellow-cheeked Crested Gibbon, which are both target conservation species for the SBCA. This report focuses on the status of these two primates. A summary of the status of the other six species is given below. Less research has been carried out on the other primate species in SBCA. Information on these species is gathered from the annual monitoring and other anecdotal reports and indicates that populations of all of these

species in SBCA are at least of national importance.

Loris species (*Nycticebus* spp)

Lorises are the least well-known primates of the SBCA. They are strictly nocturnal and while they are regularly reported, few formal records exist. The taxonomy and distribution of these animals globally is poorly understood. At least one, possibly two species of loris are found in eastern Cambodia. The Pygmy Loris (*Nycticebus pygmaeus*) is definitely known to occur, though other forms are reported to occur both from locals and researchers. A second species, the Northern Slow Loris (*Nycticebus bengalensis*) is known from other parts of the country and may possibly exist within the SBCA. However, it is also possible that no second species occurs or that a distinct and currently undescribed form exists in the area. The Pygmy Loris occurs only in southern China, Lao PDR, Viet Nam and Cambodia (east of the Mekong), and is typically seen in semi-evergreen and secondary forests (Groves 1971; Dang Huy Huynh 1998; Polet 2004). The Pygmy Loris and Northern Slow Loris appear to be sympatric throughout much of the Pygmy Loris's range (Ratajszczak 1998). Throughout their range both species of loris are widely trapped and traded, principally for the pet and traditional medicine trade, and are reported to be the most common mammal used in traditional Khmer medicine (Walston 2004). Both species are currently listed as Vulnerable on the IUCN Red List (IUCN 2006) and are on Appendix 1 of CITES (CITES 2007).

Direct field sightings, and examination of confiscated animals confirm that Pygmy Loris is present in the SBCA. Observations in May 2007 suggest the Northern Slow Loris may possibly occur, however confirmation is pending further examination (C Starr *pers comm.*). Nationwide surveys in 2006 found that lorises are now found very infrequently in most of Cambodia, and many communities have reported they have become absent in forest areas near to villages (C. Starr *pers comm.*). Surveys in the SBCA have resulted in higher encounter rates of lorises than other surveyed areas within Cambodia (C. Starr *pers. comm.*).

Yellow-cheeked Crested Gibbon (*Nomascus* (=*Hylobates*) *gabriellae*)

The Yellow-cheeked Crested Gibbon is endemic to southern Viet Nam, eastern Cambodia and possibly extreme southern Lao PDR (Groves 2001, Duckworth *et al.* 1999, Geissmann *et al.* 2000). Within its range the species has only a limited distribution, being restricted to evergreen and semi-evergreen forested areas within predominantly deciduous forests of the southern Indochinese lowlands. The species is currently classified on the IUCN Red List as Vulnerable given the past and ongoing habitat loss and poaching in its limited distribution (IUCN 2006). Specifically, intensive logging, mass human immigration to rural areas, and widespread hunting have reduced the evergreen forests in the Viet Nam part of its range to small, isolated fragments. However, Cambodian forests where the species occurs have remained largely intact due to 30 years of regional and civil conflict that only abated recently. It has recently been recommended that its status be increased to Endangered (Geissmann 2007).

Geissmann *et al.* (2000) considered "Yellow-cheeked crested gibbon the most common of the crested gibbons". However, given the perilous state of populations of the other *Nomascus* gibbons (all of which are found only east of the Mekong) this statement may not be too encouraging. The population of *N gabriellae* gibbons in Lao PDR is probably restricted to the southernmost part of the country. There is some debate as to whether the gibbons in this area are *N. gabriellae* or *N. leucogenys*. No population estimates are available. The status of *N. gabriellae* in Viet Nam is also unclear. It is present in Nam Cat Tien National Park, Bu Gia Map National Park and several other forest blocks in southern Viet Nam, but no population estimates have yet been

presented. In Cambodia, as elsewhere, *N. gabriellae* is only found east of the Mekong. Populations are reported from Snoul Wildlife Sanctuary and Phnom Prich Wildlife Sanctuary, but little is known of the status of gibbons in these areas. Crested Gibbons are known from Virachey National Park, in north-eastern Cambodia. There is some debate as to what species these are and this population may be of *N. leucogenys siki* (Konrad and Geissmann 2006).

Black-shanked Douc (*Pygathrix nigripes*)

Three species within the genus *Pygathrix* are now generally recognised (Groves 2001). All three species are restricted to the evergreen and semi-evergreen forests east of the Mekong in Lao PDR, Viet Nam and Cambodia (Nadler *et al.* 2003, Timmins and Duckworth 1999). Due to their limited natural range and the high levels of hunting and habitat loss throughout their range they are now all considered to be globally Endangered (IUCN 2006). The Black-shanked Douc has the southern-most distribution of the Doucs and is confined to the forests of the southern Annamite range in Viet Nam and Cambodia. In Viet Nam it has a fragmented distribution with many populations under pressure due to forest disturbance/conversion and hunting. Only two Vietnamese protected areas are reported to have significant and stable populations, Nam Cat Tien National Park and Nui Chui Nature Reserve. The latter has "probably the largest sub-population of this species [in Viet Nam], with estimated 500-700 individuals" (Nadler *et al.* 2003). The species is also recorded from Bu Gia Map National Park. In Cambodia, in addition to the SBCA, the species is also recorded in Snoul Wildlife Sanctuary, Phnom Prich Wildlife Sanctuary, Mondulkiri Protected Forest, and Phnom Nam Lyr Wildlife Sanctuary as well as several other unprotected evergreen forest blocks in Mondulkiri and Ratanakiri. Doucs are also know to occur in Virachey National Park, and are likely to be *P. nigripes*, however one photographed in Virachey NP in 1999 showed intermediate characteristics and may be Grey-shanked Douc (*P. cinerea*) (Nadler *et al.* 2003).

Long-tailed Macaque (*Macaca fascicularis*)

This macaque is widespread throughout mainland and insular South-East Asia. It ranges from the islands of eastern Indonesia and the Philippines to central Viet Nam, Lao PDR and across to coastal Myanmar (Corbet and Hill 1992). Although it can be tolerant of urban environments, naturally it associates with coastal, mangrove and riparian forests, rarely far from water. Although widespread and less sensitive to habitat disturbance than many other primates, the species is at threat from over collection for the use in biomedical testing. It is currently listed as Low Risk / Near Threatened (IUCN 2006)

This species is still relatively abundant in SBCA. Habitat preference is for the evergreen and semi-evergreen forest, usually in riparian areas, including bamboo near streams and pools. Large-scale trapping of live Long-tailed Macaque started in 2006, reportedly for trade to 'farms' in China and Viet Nam. If this trade continues it may pose a significant threat to this species in Cambodia and in much of its range.

Northern Pig-tailed Macaque (*Macaca leonina*)

This monkey also has a widespread distribution in Asia, being found from Bangladesh, across in a belt through southern China and into Cambodia and southern Viet Nam (Groves 2001). Throughout their range Pig-tailed Macaques are found in tall evergreen, and semi-evergreen forest formations. They are at present listed as Vulnerable (IUCN 2006).

This species of macaque is moderately abundant in SBCA. Habitat preference is for evergreen and semi-evergreen forests where it appears to be more frequently encountered than Stump-tailed or Long-tailed Macaque.

Stump-tailed Macaque (*Macaca arctoides*)

Stump-tailed Macaques (also known as Bear Macaques) are found from north-eastern India, to China and parts of mainland South-East Asia (Corbet and Hill 1992). Throughout their range they are confined to evergreen forest formations. In the lower Mekong region therefore they are confined to the forests of the Annamite chain, the Cardamom Mountains and other smaller patches of evergreen forest. They are at present listed as Vulnerable (IUCN 2006)

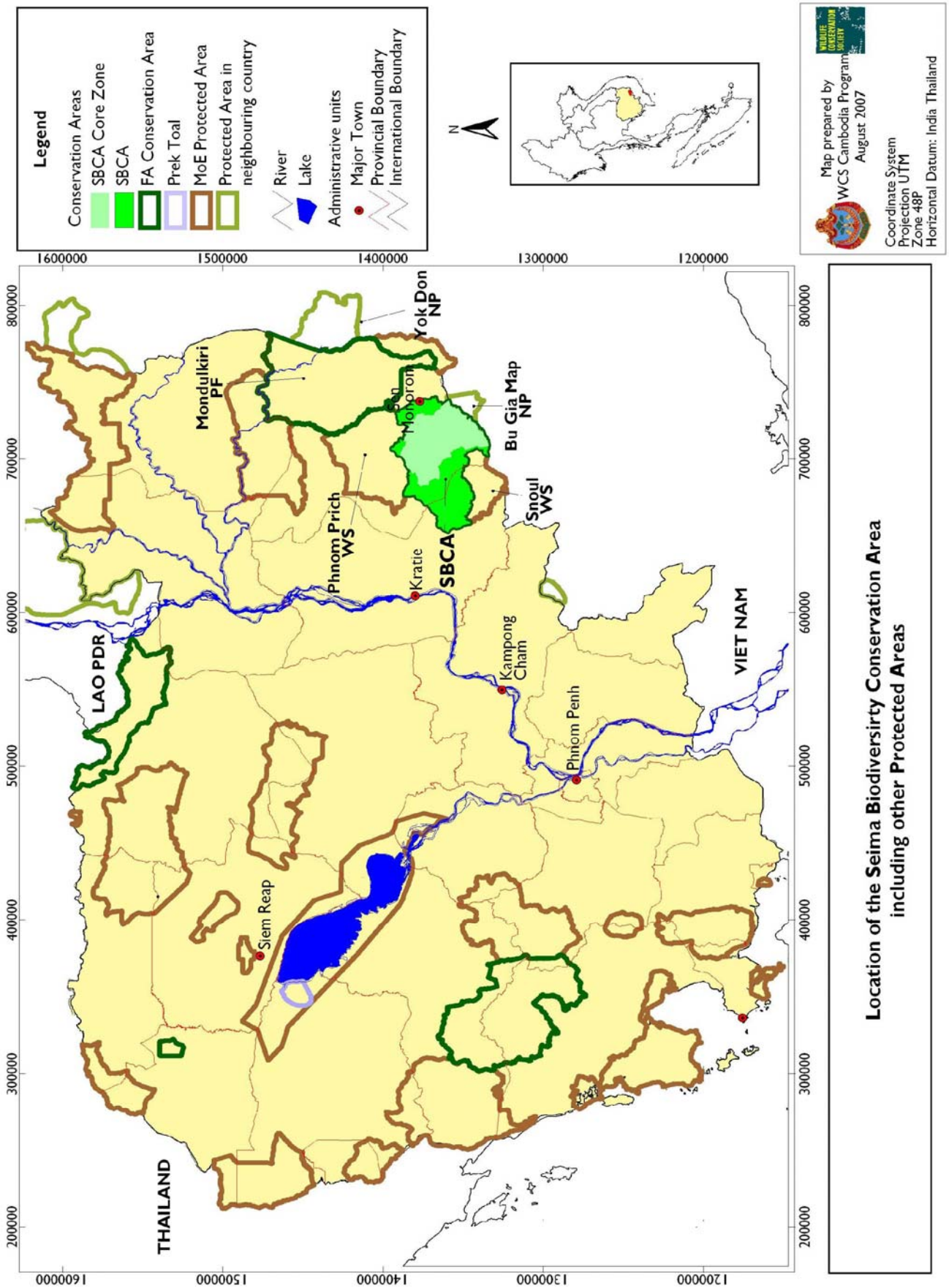
This is the least frequently recorded of the three macaque species in the SBCA. Habitat preference seems to be almost exclusively in the evergreen forest or semi-evergreen forest with a highly evergreen character. Although encounters with groups of Stump-tailed Macaques are relatively rare during the monitoring they can form large social groups of tens of animals. The low encounter rate means that a density estimate has not yet been calculated for this species in the SBCA.

Germain's Silvered Langur (*Trachypithecus germaini*)

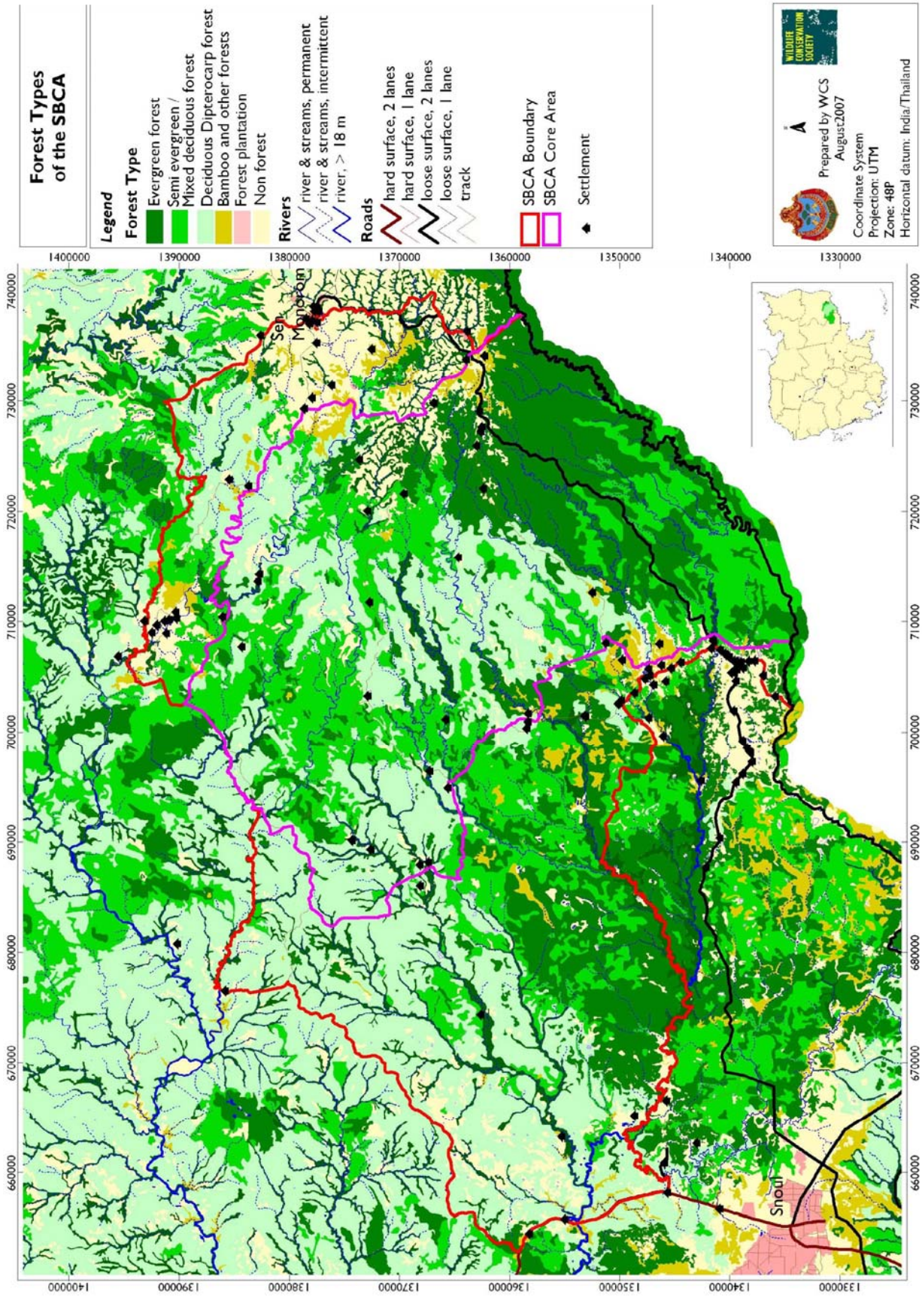
The global status of this species is unclear. It has been considered as a subspecies of *Semnopithecus cristata* (Corbet and Hill 1992) though for the purposes of this report we are following Groves 2001 and consider *T. germaini* a separate species from *T. cristata*. The latter is relatively abundant in suitable habitat in Sumatra, Borneo and the west coast of the Malay peninsular but *T. germaini* is considered "widespread but is a very rare species in much of its range" (Nadler *et al.* 2003). Globally this species is probably highly threatened. There is a paucity of records, all of which are from disjunct populations. The species depends on riparian forests, which are highly threatened from disturbance and conversion. In recent times it has only been recorded in seven locations in Viet Nam and seven in southern Lao PDR (Duckworth *et al.* 1999). In eastern Cambodia this species is also found in gallery forest in Mondulkiri Protected Forest and Phnom Prich Wildlife Sanctuary. Elsewhere in Cambodia a large population is reported from the seasonally flooded forest surrounding Tonle Sap (Davidson 2006). Additionally there are populations in the Cardamom mountains, southern Ratanakiri and Preah Vihear.

This is the least frequently recorded of the diurnal primates in the SBCA. Records indicate that its distribution is restricted to riparian forest. Most of these records come from corridors of semi-evergreen gallery forest in the deciduous dipterocarp forest areas. There have been only twelve records of groups of this species from the core area of SBCA. In early 2006 there were three records from the western buffer zone of SBCA. This low number of records throughout the SBCA may reflect the relatively limited time that has been spent in the north and west of the SBCA. The species is probably under-reported and may occur widely in suitable habitat throughout the north and west of the site. If so, it would further increase the sites' global importance for primate conservation.

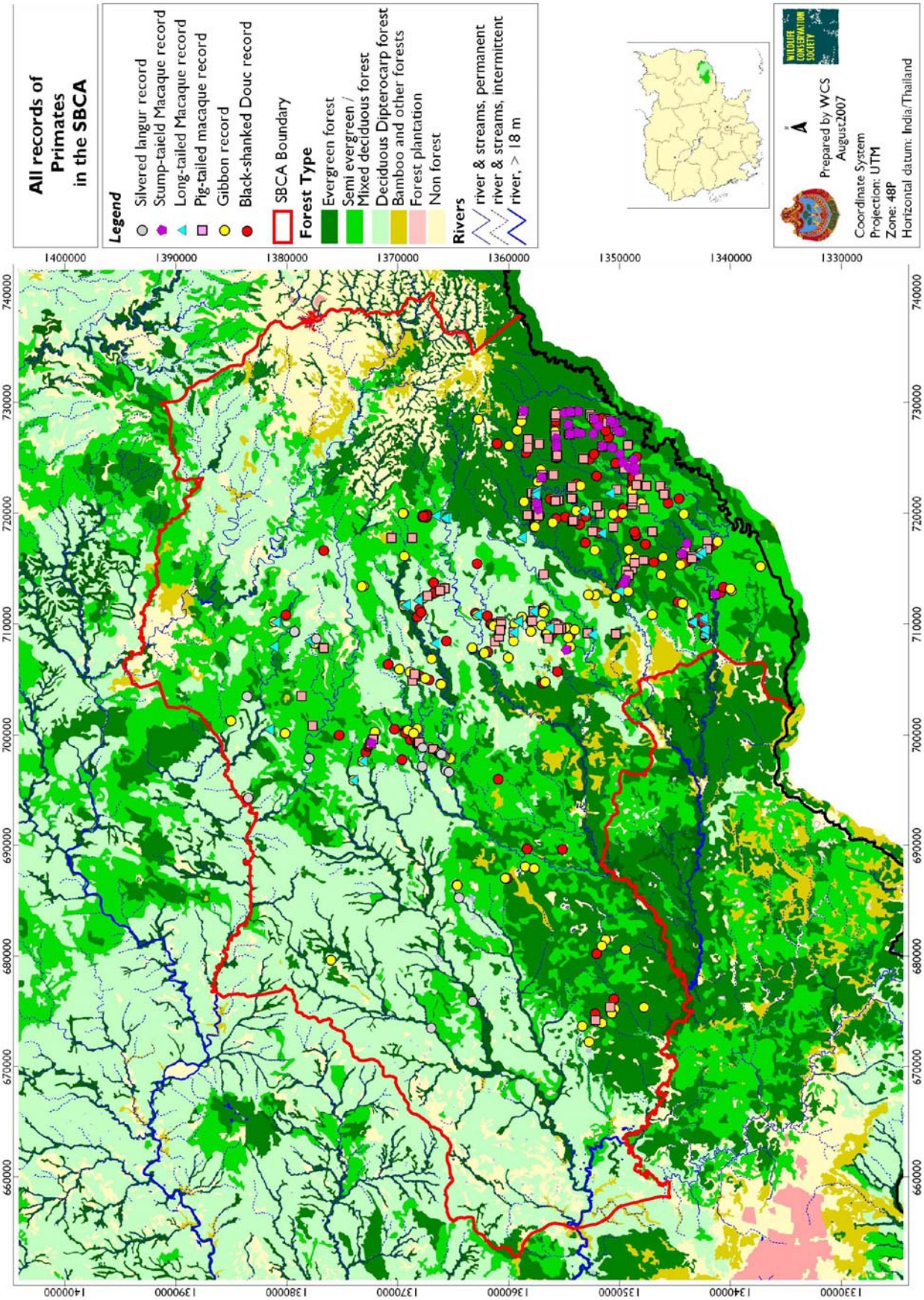
Map 1: Location of the SBCA in eastern Cambodia



Map 2: Forest Types of the SBCA



Map 3: All Records of Primates in the SBCA



METHODS

Biodiversity Monitoring in the SBCA

A monitoring program is required in order to measure whether the Seima Biodiversity Conservation Project is meeting its objectives. A livelihood monitoring program is under development, to measure progress towards meeting the livelihood targets. To examine the impact of law enforcement activities a program is being implemented that monitors illegal activities in the area. Monitoring of wildlife to measure whether the project is meeting its objective to increase populations of key species was initiated in 2002.

A baseline survey conducted in 2002 collected comparable data from across all of the approximately 1,500 km^2 core area. These data were to facilitate the identification of key locations for wildlife and, if necessary, inform the realistic demarcation of the conservation project. Data were collected along randomly placed transects. Animals were sufficiently rare in many areas that sightings were infrequent. This preliminary survey focused, therefore, on the recording of signs (tracks, faeces etc). It was found that in some areas wildlife observations, principally of Black-shanked Douc were frequent enough to suggest that a monitoring program might try to use distance sampling (Burnham *et al.* 1980, Buckland *et al.* 1993, 2001) to estimate absolute densities of key species. To test this a subset of the transects were re-surveyed to calculate the mean and variance of encounters with species.

Results from the baseline were used to determine the importance of different areas for wildlife. The core area was divided in to sectors that were placed into four levels of importance for wildlife. Sectors with very low importance are those that had significantly fewer wildlife signs. These tended to be areas with relatively high human populations and are not considered an immediate priority for generalised wildlife conservation. A group of sectors had significantly greater amounts of key species signs and were assigned the highest priority. The remaining areas were relatively poor for wildlife but there was some evidence that suggests they may be important for specific species such as elephant or wild cattle. These priority wildlife areas were used to define the area of 1086 km^2 which has been used for wildlife monitoring activities from 2003 to the present.

The 2002 results also provided a rigorous statistical base to guide the development of permanent monitoring framework. They suggested a monitoring program of sufficient power required the establishment of 12-15 transects 4-5km in length across those parts of the core area identified as being of 'high' or 'medium' importance for wildlife, stratified for forest type and location in the core area (generally north, central and south). Fourteen pairs of permanent transects were selected and have been used annually.

The use of listening posts for monitoring the gibbon population was tested as part of an intense study of douc and gibbons carried out from 2002 to 2004 (Rawson 2004, Rawson *et al.* in press). To ensure that permanent listening posts are distributed appropriately across the whole of the survey area, they are placed at the start and end of each of the random, stratified line transect pairs. There are at present (June 2007) 28 permanent listening posts.

The aims of the wildlife monitoring activities are:

- To measure changes in the populations of target species: Tiger, Asian Elephant, Green Peafowl, Yellow-cheeked Crested Gibbon and Black-shanked Douc.

- To measure changes in the populations of important large carnivore prey species; Banteng, Gaur, Sambar, muntjacs and Eurasian Wild Pig.
- To use the results to direct, adapt and refine conservation activities of the project.

All monitoring is carried out by permanent staff of the project. The teams consist of FA staff, Cambodian WCS staff, and assistants from local communities. Several of the assistants are former hunters and expert at spotting animals in the thick forest.

Survey Methods

Data on the status of Black-shanked Douc and Yellow-cheeked Crested Gibbon has been gathered in several ways. Annual biodiversity monitoring, through the use of line transects and listening posts, is the primary source of information. Secondary data is in the form of anecdotal reports, and some species-specific observations and studies.

Line Transects

Fourteen transects four kilometres in length were established in January-February 2003. All transects are located within a 1,086 km^2 survey area that was identified in the 2002 preliminary surveys as the key area for wildlife (Clements 2003). Each four kilometre line surveyed in two sections, of two kilometres each, resulting in 28 spatial replicates. Transects are placed randomly, with stratification by broad forest type (evergreen forest, semi-evergreen forest, deciduous dipterocarp forest) and location (approximately southern, central and northern SBCA) (Map 4) . The distribution ensures that transects are representative of the forests, topography and varying human pressures present within the SBCA. The start middle and end points of each transects are marked and geo-positioned. Transects are cut, to allow observers to walk quietly along them, and marked to allow observers to focus on recording wildlife rather than navigation. However care is taken not to cut the transects too wide in order to minimise use by wildlife. Transects are cleared and re-marked each year, at least one month before the start of surveys. Training takes place annually to ensure data collection quality is maintained (see appendix A for summary of training results). There is some variation in observer skill, but this is small enough so as to not effect the results.

In 2003 and 2004 transects were used for simultaneous collection of information on wildlife signs and observations of animals. Two surveys were completed in 2003 (119.6 km) and four in 2004 (239.2 km).

In order to reduce fatigue and confusion, and improve data quality based on the 2004 test results (An Dara and Clements 2005) the methods were modified for 2005 and 2006. The cut transects are used for collection of observation data only. The length of the survey units was reduced to two kilometre sections. Camps are located at a suitable distance from the starting point of each transect at permanent water sources.

Methods follow a standardised protocol to ensure that different teams collect the same information. The two-kilometre observation transects are walked by a two-man team from 06:00-09:00, when animals are most active and easy to observe. For each animal (or animal group) encountered the following information is recorded: co-ordinate (recorded using a GPS unit, usually Garmin 12X), group size, distance from the centre of the group to the observers (with a laser rangefinder), compass bearing to the centre of the group from the observer and the compass bearing of the transect line. The latter three pieces of information are required to calculate the perpendicular distance for distance sampling. The transects are cut and marked so that observers can easily follow the survey line and concentrate on searching for wildlife, rather than path-finding.

There are 28 two-kilometre transects; each was surveyed twice per year in 2005 and

2006 resulting in 112 km per year in 2005 and 2006. In 2007 survey effort was increased to improve the precision and accuracy of the density estimate, and in an attempt to increase the number of encounters with ungulates. In 2007 each of the 28 transects was surveyed three times, resulting in a survey effort of 168km.

Data were analysed using the Distance 5 computer package.

Listening Posts

Yellow-cheeked Crested Gibbon produce highly audible calls which can be easily recognised and tape-recorded. Male gibbons either call singly or in a duet with their mate (if in a family group). A relative index of calling males or groups can be calculated by recording the number of calls heard from a fixed point during a known interval.

Twenty-eight points, located at the start and end of each observation transect pair, are used. Map 4 shows the location of the permanent listening posts in the survey area. Monitoring is conducted in January and February, which previous research (Rawson 2004) has shown to be the peak calling season for gibbons in the area. All listening posts are surveyed from 5:30-7:30 a.m. For every call, the observer records the time, compass bearing, estimated distance category (near, medium, far) and, whether the call is from a lone male or a duet. Detailed standardised protocols are provided in An Dara and Clements (2005). Since 2004 each post has been surveyed twice annually, giving 56 post-days per year. Gibbons typically call from a single location on any one morning. The survey teams are sufficiently well trained and experienced (see appendix A for results of annual training) that they can distinguish between different groups or individuals based on the bearing from the listening post to the call, and the estimated distance. Data are analysed to give a minimum number of gibbon groups, and calling males, per listening post. Any variation between listening posts is not important. The same points are used every year and the results are used to compare year to year variation in calling frequency, the data are not used to compare calling frequency at different posts within a single year.

Anecdotal Reports

Additional information in the form of anecdotal records and reports has been gathered since 2000. Observations of primates, and gibbons heard calling are noted, and the geographic location recorded with a GPS. These records are collected by the monitoring teams outside the formal surveys, by law enforcement ranger patrols, and other visiting researchers, tourists and interested parties. Typically only location data, and on occasion group size, is recorded. All data are stored in a database. These data therefore provide little extra information on the size of the populations, but they are used to help understand more about the distribution of primates within the site. For the less frequently recorded species such as lorises and Silvered Langur, these are currently the only sources of information available to the Project.

Other studies

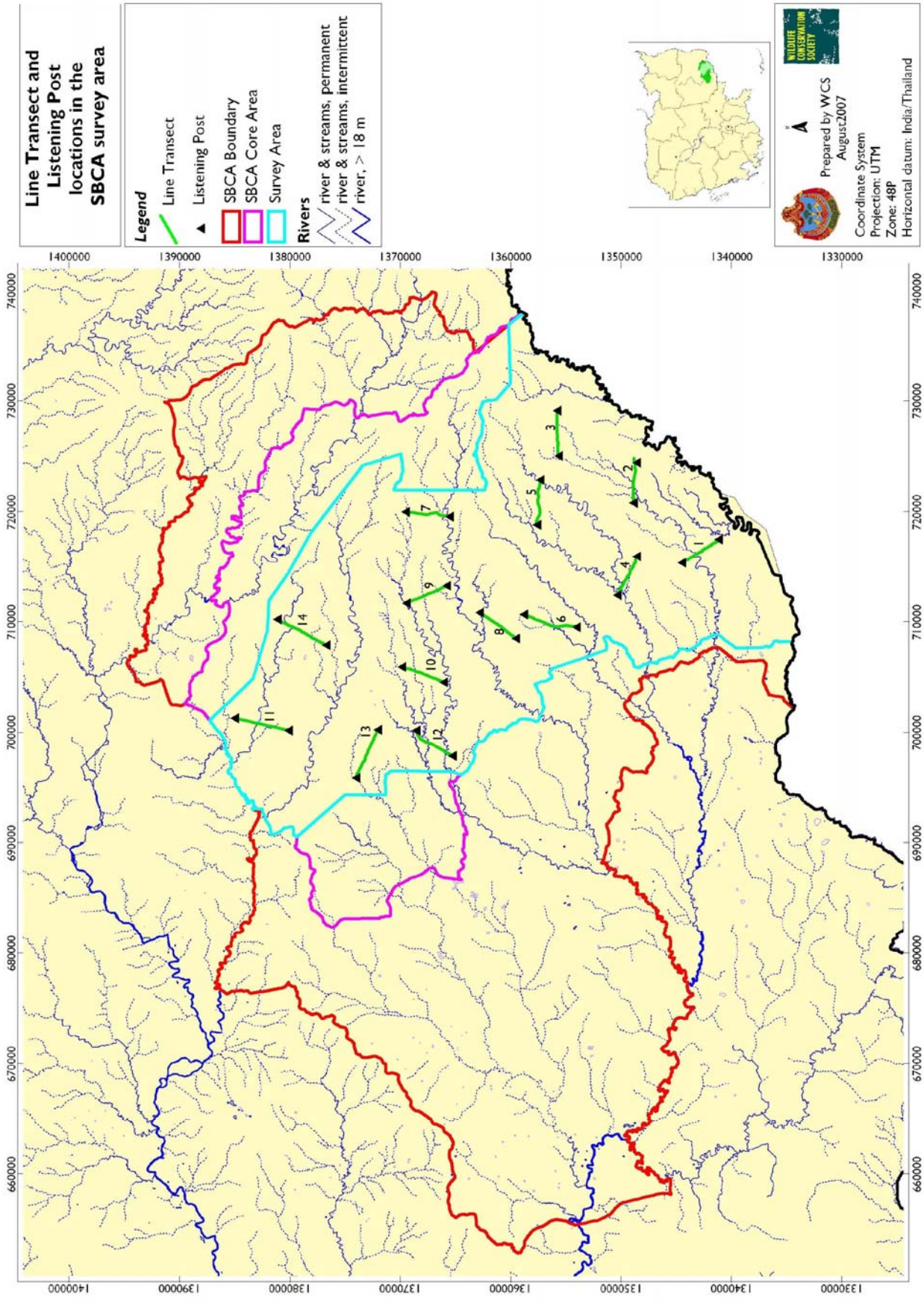
As part of a longer term study on primates in the area (Rawson 2004, Rawson *et al.* in press) an intensive study of gibbon calling behaviour was carried out from December 2003 to January 2004. Gibbon calls were recorded over 13 consecutive days in December and 14 in January, from half an hour before sunrise, to 12 noon. Data on the time that the call started, the estimated distance to the calling gibbons (only duets were recorded), bearing to the calls and weather conditions were recorded.

These data can be used to investigate the effect of weather, and the calling probability of any one group on a single day.

Vegetation patterns in the SBCA are very complicated (Zimmerman and Clements 2002) (Map 2). The area is a mosaic of different forest formations that vary not only in terms of species composition, but

also structurally and in the proportion of deciduous species. Inaccuracies in available maps meant that it was not possible to place all transects entirely within a single forest formation. In order to account for this a post hoc assessment of forest type along the transects was carried out. This assigns 100m segments of the transects as either 'deciduous' or 'evergreen' based on canopy cover. In this system 'deciduous' refers to deciduous dipterocarp forest, and 'evergreen' to all evergreen, semi-evergreen, and mixed deciduous forest forms. The three forest forms that are considered 'evergreen' vary in the proportion of deciduous trees, but are all similar structurally, consisting of three strata, and a more a typically complete canopy cover. This is in contrast to the deciduous dipterocarp forest with has only two strata, and a lower and much more open canopy. Analysis of most accurate forest cover map available (JICA 2000) gives a figure of 789km^2 of combined evergreen /semi-evergreen forest in the study area. This is most likely an underestimate as some smaller patches of evergreen/semi-evergreen forest and strips of gallery forest are not recognised in the dataset.

Map 4: Permanent Transect and listening post locations



RESULTS

Yellow-cheeked Crested Gibbon

Calling probability

Overnight rain has been shown to reduce the probability of calling (Rawson 2004). Rawson *et al* (in press), analysed additional data to investigate the effect of other weather data. The effect of rain, wind, cloud and fog were examined. Calling probability was significantly negatively correlated with rain, strong wind, and overnight rain. Fog and cloud cover did not have any significant impact on calling. Due to this weather effect, mornings with strong wind and/or rain were removed from the analysis of listening post data.

Rawson *et al* (in press) showed that mean value for calling probability during good weather was 0.560 (±0.032). Application of the equation $p(m) = 1 – [1 – p(1)]m$ showed that the proportion of groups heard at any one location on fine days in the dry season would be 56.0% for one day, 80.6% for two days, 91.5% for three days, 96.3% for four days and 98.4% for five days. Brockelman and Ali (1987) suggest that only survey periods with a calling probability of over 0.90 be used when calculating population estimates. During the annual monitoring only two survey mornings are carried out per post. The monitoring data have not therefore been used to estimate population size, but are used as an index used to monitor gibbon population trends.

Trends

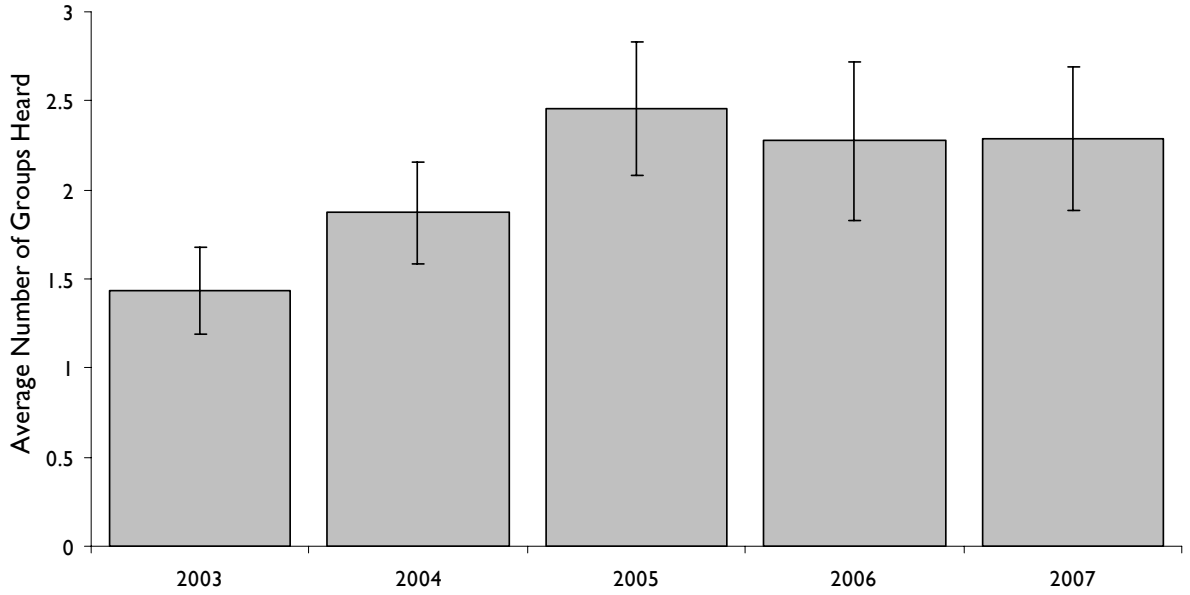
Listening post surveys were completed in January-February 2003, 2004, 2005, 2006 and 2007. Fewer posts were surveyed in 2003 as they were just being established; otherwise the reduction in datapoints (from n = 56) is indicative of days lost due to poor weather.

The average number of gibbon groups heard from the posts increased significantly from 2003 to 2006 ($F = 7.81$, d.f. = 1, 141, $p < 0.01$), by an average of 8.5% per year (Figure 1). There were significant differences between the number of groups heard between different posts ($F = 3.81$, d.f. = 27, 141, $p < 0.001$). The trend has levelled off over the period 2005 – 2007. This may indicate that the population is at, or close to, carrying capacity.

Table 3: Number of gibbon calling groups per post

Year	*mean*	*95% Confidence Interval*	*n*
2003	1.43	1.19 - 1.68	23
2004	1.87	1.58 - 2.16	54
2005	2.45	2.08 - 2.83	53
2006	2.28	1.83 - 2.72	40
2007	2.29	1.88 - 2.69	56

Figure 1: Number of gibbon groups heard at listening posts



Results should not be interpreted as numerically equivalent increases in population as calling behaviour probably varies with density and hunting pressure. For example, a reduction in threats may encourage groups to call more frequently (in itself an indicator of reduced threats). Research elsewhere suggests that calling frequency may also increase as group densities increase. Nonetheless, an increasing trend in calling numbers is probably a good indicator of an increasing trend in density of gibbon groups.

Population Estimate

Line transect data have been used to estimate the density of gibbon groups in the survey area. This method has proven to be a suitable method for survey gibbons elsewhere (Nijman and Menken 2005). Listening posts can also be used to estimate density (Nijman and Menken 2005). This approach was followed in Rawson *et al.* (2007) for the SBCA, who calculated that in 2004 there were 809 gibbon groups with a 95% confidence interval of 646-972 groups, assuming a listening radius of 1.5km.

Insufficient observations of gibbons were obtained from the line transects to allow estimation of the detection function. Gibbons were seen six times in 2005, five times in 2006 and ten times in 2007, a total of 21 detections. As more data are collected in subsequent years it should become possible to estimate a gibbon-specific detection function. For the current data the detection function obtained for 2005, 2006 and 2007 for the Black-shanked Douc (see below) was used instead. The observed effective strip width for doucs varies from 31 to 38m. This is slightly larger than other published estimates for gibbons, e.g. Nijman and Menken (2001) found a strip width of 26.0 m for *Hylobates muelleri* in Borneo. The forests in the SBCA are on average more open than dense evergreen forests in Borneo, suggesting that the effective strip width should be larger, however gibbons are likely to be less detectable than the other arboreal primate species, which exist in larger groups. The population estimates were obtained using standard distance calculations, based on the effective strip width and the year-specific encounter rate for gibbon groups.

All gibbon groups were recorded in 'evergreen' segments of the transects. For the estimation of density therefore total survey effort is the total effort within 'evergreen' sections. The total number of gibbon groups is based on the area of potential habitat, ie the area of 'evergreen' forest forms. The overall area surveyed by the line transects was 789km^2 of potential

habitat. The variance of the density and group number estimates was calculated using the delta method (Buckland *et al.*, 2001). Given that the effective strip width has probably been over-estimated these results may under-estimate the total population size. Gibbon groups tend to consist of an adult pair and one to three young or sub-adults (Geissmann *et al.* 2000). So assuming a group size of four, the total population in the study area in 2007 is 3,732 (2,519 - 5,531) individuals (Table 4).

Table 4: Yellow-cheeked Crested Gibbon density and population estimates for the Seima Biodiversity Conservation Area (SBCA) line transect distance-sampling. Standard Errors are given in brackets

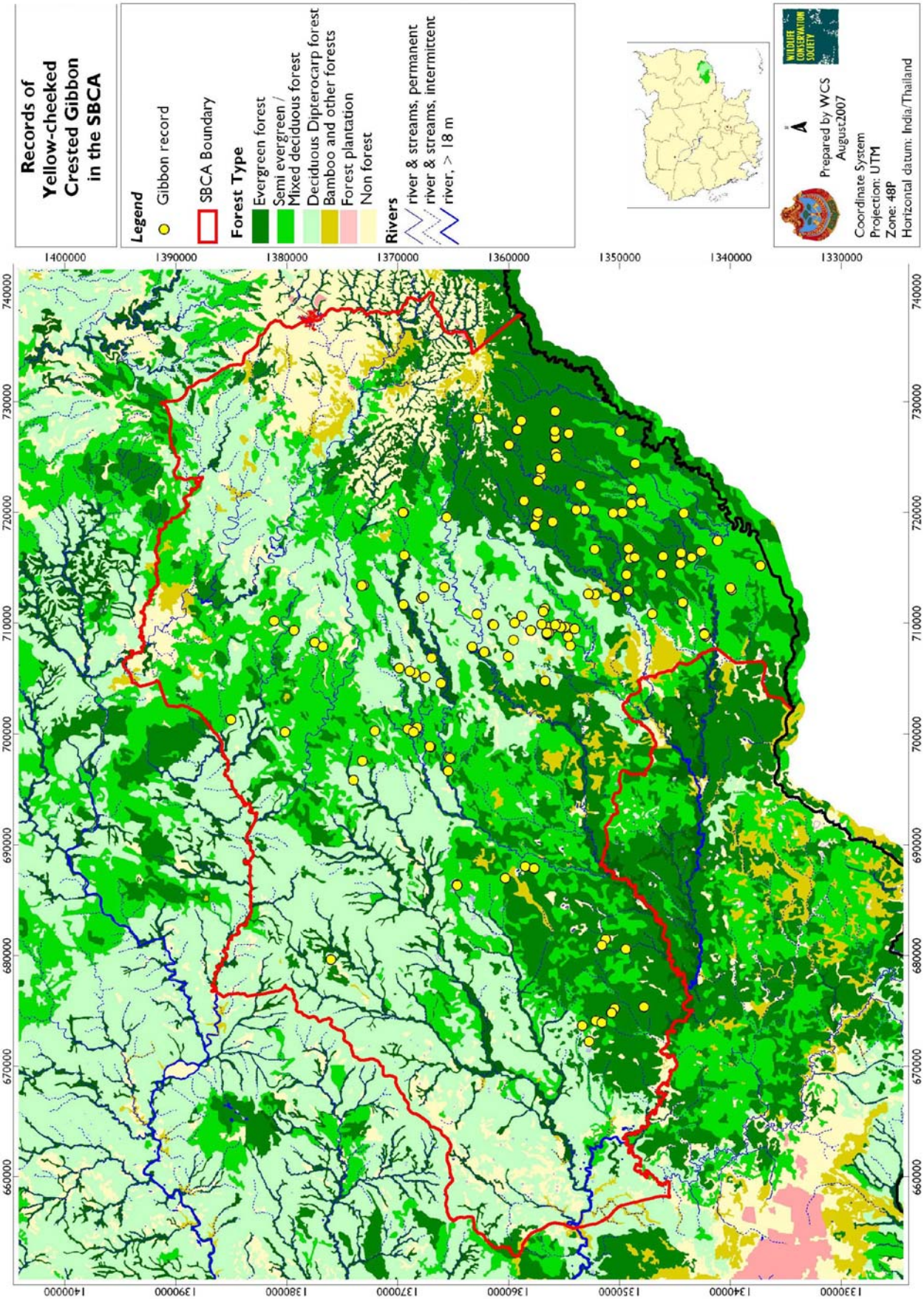
Parameter	*2005*	*2006*	*2007*
Survey effort (km)	90	90	135
Number of encounters	6	5	10
Effective Strip Width (m)	33.9 m (25.6 - 45.0)	38.0 m (30.0 - 48.2)	31.3 m (25.6 - 38.2)
Density of groups ($\hat{D}$) /km²	0.98	0.73	1.18
Number of groups ($\hat{X}$)	**773**	**575**	**933**
95% Confidence Interval	478 - 1,250	352 - 939	630 - 1,383
Coefficient of Variance	43.7%	45.7%	29.8%

Range

Mapping of the point location data shows that Yellow-cheeked Crested Gibbon are widespread throughout the SBCA (Map 5). Comparing these data with distribution of forest types suggests that the Gibbons prefer tall evergreen, semi-evergreen and mixed deciduous forest types.

Observations of gibbons in heavily logged areas, and on the fragmented forest edge near farms indicate that individuals may be fairly tolerant of moderate levels of forest disturbance (E Pollard *pers obs*).

Map 5: All gibbon records in the SBCA



Black-shanked Douc

Trends

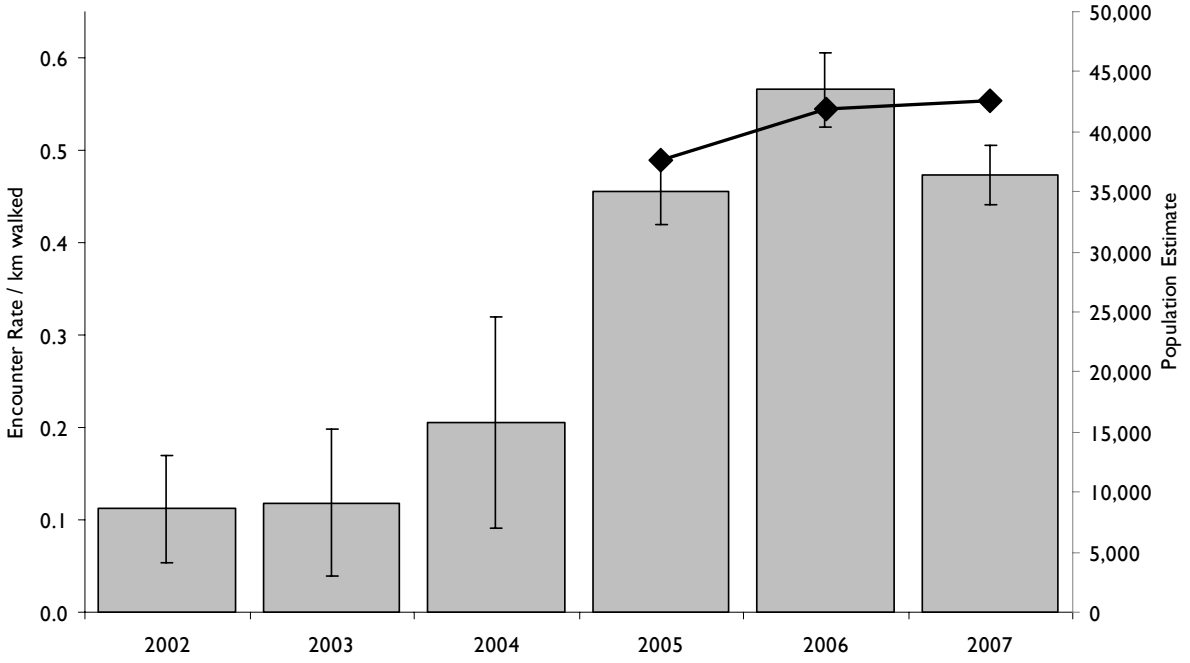
Encounters with doucs on the line transects increased dramatically between 2002 and 2006 (Figure 2). Over the period 2005 – 2007 is appears that the trend may be stabilising (Table 5). This increase may be due to improved observer skill over the multiple years of survey. Alternatively it could be in large part due to behaviour change. The greatly reduced hunting pressure since the start of the conservation project may mean that primates are less shy, and easier to encounter on line transects. Assuming these provisos however it still may indicate a recovery of the population since the start of the project. Observed groups frequently include young indicating that the population is reproducing and there is recruitment.

Annual variations in the encounter rate could be caused by several factors. Environmental conditions vary annually. For example there were strong winds in early 2007. Observers commented that doucs were harder to see, and less mobile on windy days. By contrast 2006 was an unusually wet dry season. Early rains led to an earlier leaf flush which may have affected the encounter rate in predominately deciduous parts of the site.

Table 5: Encounter rate with Black-shanked Douc along line transects

Year	*Transects*	*Km walked*	*Sightings*	*Mean*	*95% Confidence Interval*
2002	38	152	17	0.11	(0.05 - 0.17)
2003	14	92	12	0.12	(0.04 - 0.20)
2004	14	92	28	0.21	(0.09 - 0.32)
2005	28	90	41	0.46	(0.42 - 0.49)
2006	28	90	52	0.57	(0.53 - 0.61)
2007	28	135	64	0.47	(0.44 - 0.51)

Figure 2: Encounter rate and population estimate for Black-shanked Douc in the SBCA survey area



Population Estimate

Since 2005 encounter rates have been high enough to estimate absolute densities of Black-shanked Douc in the study area. Although the number of encounters in 2005 and 2006 were lower than the 60-80 observations required for generating an accurate population estimate by distance sampling, it is sufficient to produce an approximate estimate. Since 2007 an increased survey effort has resulted in a more suitable number of encounters. In addition, as data is accumulated in subsequent years the accuracy of the detection function estimation will improve, and this can then be applied to population estimates in all years, thus increasing the precision of these estimates further.

A detailed analysis of douc records show that none have been recorded in deciduous dipterocarp portions of the transects. For the purpose of the analysis only 'evergreen' portions of the transects are used. Interpretation of land use data from 2000 shows that 789km^2 of the study area is evergreen/semi-evergreen forest.

The data have been examined closely and do not violate the assumptions of distance sampling (appendix B). From 2005 to 2007 the density of groups has been calculated for the study site (Table 6) and has not changed dramatically. Group density does however continue to show an upward trend.

There are at least three variables that affect the data; dectectability, strip width and group size. Detectability does not change significantly between years, however the effective strip width is wider in 2006 in comparison with 2005. To some extent this corrects for the increased encounter rate in 2006. This also explains the apparent disparity between a decrease in observed encounter rate, and an increase in estimated group density. Although encounter rate in 2007 was markedly lower than in 2006 (Table 5), the group density is higher in 2007 (Table 6). Poor conditions, notably high winds at the start of the survey period, may have affected observability, which is reflected in the small effective strip width (Table 6)

Group size also differs between years but not significantly. It is hard to count group size accurately in the tall dense evergreen forest, and the estimate of group size is probably relatively crude. Other studies (B. Long *pers comm*) have shown that doucs live in a dynamic 'fusion – fission' social structure. A large group of animals breaks down into smaller sub groups for foraging and general day to day behaviour. It is only on occasion that these large groups re-form. In these surveys 'groups' refers to the smaller social units, that are in fact part of a larger unit. In the absence of better data on group size the mean from all years has been calculated. Using this pooled mean an estimate of the population of Black-shanked Douc in the study area can be calculated (Table 7). The estimate from 2007 is 42,603 individuals (27,309-66,460).

Table 6: Density estimates for Black-shanked Douc groups in the SBCA survey area

Parameter	*2005*	*2006*	*2007*
Survey effort (km)	90	90	135
Number of encounters	42	52	66
Effective Strip Width (m)	33.9 m (25.6 - 45.0)	38.0 m (30.0 - 48.2)	31.3 m (25.6 - 38.2)
Density of groups ($\hat{D}$) /km^2	6.70 (4.06 – 11.05)	7.44 (4.74 – 11.67)	7.57 (4.97 - 11.54)
Number of groups ($\hat{X}$)	**5,283**	**5,866**	**5,972**
95% Confidence Interval	3,202 - 8,715	3,738 - 9,207	3,919 - 9,101
Coefficient of Variance	25.3%	22.7%	21.1%

Table 7: Population estimate for Black-shanked Douc in the SBCA survey area

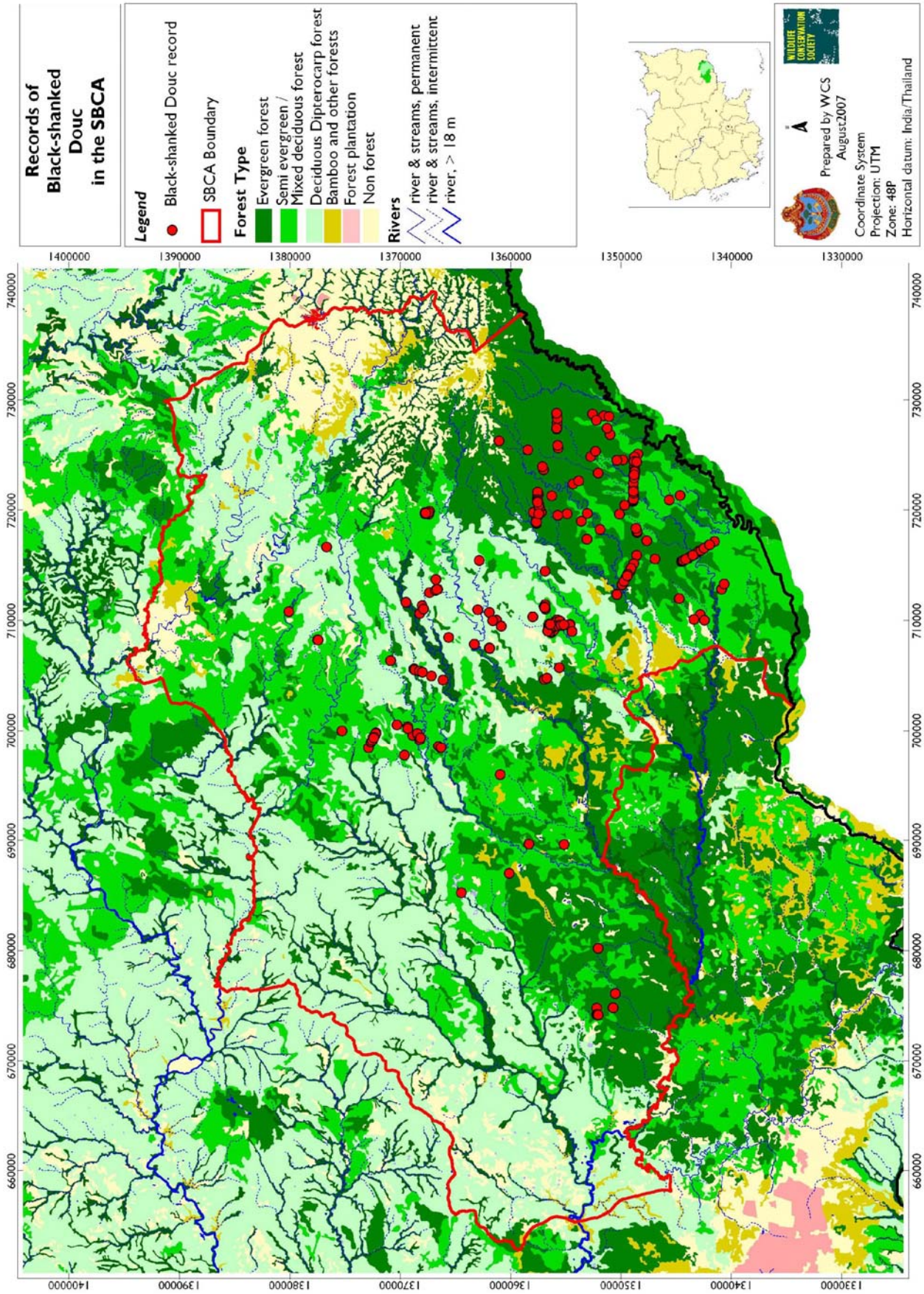
Parameter	*2005*	*2006*	*2007*
Number of groups ($\hat{X}$)	5,283 (3,202 - 8,715)	5,866 (3,738 - 9,207)	5,972 (3,919 - 9,101)
Mean Group Size (pooled)	7.1 (6.1 - 8.3)	7.1 (6.1 - 8.3)	7.1 (6.1 - 8.3)
Estimated population size	**37,692**	**41,848**	**42,603**
95% Confidence Interval	22,399 - 63,426	26,087 - 67,131	27,309 - 66,460
Coefficient of Variance	26.4%	23.9%	22.4%

Range and behavioural observations

Black-shanked Doucs are frequently observed in the evergreen and semi-evergreen forests, including in trees along the edge of the main road to Sen Monorom. Records show that they are found throughout the SBCA in suitable forest types (Map 6). Densities are probably highest however in the evergreen and semi-evergreen areas. They have also been observed in *Lagerstroemia* dominated mixed-deciduous forest, and riparian forest corridors through deciduous dipterocarp forest. Groups have been seen in heavily degraded areas near to farm land, and in bamboo dominated forests in the south-west of the core area. Densities are probably lower in these areas, but this does indicate that Black-shanked Doucs can survive in heavily degraded forest. On a few occasions doucs have been recorded in deciduous dipterocarp forest areas but this may just be groups crossing between patches of semi-evergreen forest.

Previous studies have claimed that doucs do not go to the ground, and that they are entirely arboreal (Lippold 1998, in Nadler *et al.* 2003). In the course of the monitoring and other work Black-shanked Douc have been observed and photographed on the ground on several occasions.

Map 6: All Black-shanked Douc records from the SBCA



DISCUSSION

The SBCA is home to seven - and possibly more - species of Globally Threatened or Near Threatened primate species. Monitoring of two of these indicates that populations have probably grown since the start of conservation activities in 2002. This is likely due to control of hunting, logging and clearance of forest, which was widespread from the mid 1990s until 2002. A nationwide gun confiscation scheme (Ratha *et al.* 2003) may also have had some beneficial impacts on primate conservation. Between 1998 and 2003 over 111,000 weapons were collected and destroyed nationwide. The reduced access to firearms probably led to reduced hunting with firearms. Not all weapons were collected however, and some people retain firearms but may be reluctant to use them in public. Thus although not all firearms were collected, it is likely that this program has seen a reduction of hunting primates with guns in some areas.

The importance of the SBCA for the conservation of these species needs to be put into context globally, and regionally.

Very little is known of the status of lorises in Cambodia, and the lower Mekong (Viet Nam, Lao PDR, Cambodia and eastern Thailand) region in general. It is still not clearly known how many species of loris occur in eastern Cambodia, including SBCA. Lorises are collected for trade throughout the region, and numbers could be depressed across their range (Streicher 2004, CITES 2007). Recent reports suggest that both loris species are highly threatened in Viet Nam, and are now rarely recorded in the wild (Streicher 2004). The situation is more favourable in Lao PDR, which may remain the stronghold for the Pygmy Loris (Duckworth *et al.* 1999). With such high pressures in Cambodia and Viet Nam, information on their status in a well-protected site is of significance. The SBCA is of at least national importance for the conservation of Pygmy Loris. Pending clarification of its taxonomic status and distribution, the site may also be of regional importance for the conservation of Northern Slow Loris.

No attempt has yet been made to measure the absolute density of any of the macaque species in SBCA. The encounter rate with macaques is too low to produce enough results for an accurate density estimate. An increase in survey effort is planned as part of the expansion of the biodiversity monitoring program. In the future it will be possible to estimate the population of at least the Pig-tailed Macaque and Stump-trailed Macaque. The Long-tailed Macaque has localised distributions along watercourses. Randomly placed line transects and distance sampling will not therefore be applicable for measuring its density as the model assumes as homogeneous distribution through the study area. The regularity of observations of all the macaque species does, however, indicate that they are probably still reasonably abundant in the SBCA. As with elsewhere in the region (S. Roberton *pers comm*) Long-tailed Macaques in Cambodia are being collected intensively. The impact of this is not yet known, but it may be dramatic. A large population of all three species of macaques may well exist in the SBCA, and with increasing threats outside the conservation area the SBCA is of increasing importance nationally and regionally for all three macaques.

It is not yet possible to estimate the population of Germain's Silvered Langur in the SBCA. Globally this species is probably highly threatened. It is found only in parts of Myanmar, Thailand, Cambodia, southern Viet Nam, and southern Lao PDR. It is dependent on riparian forests, a threatened habitat in the region. It is now very rare in Thailand, Lao PDR and Viet Nam, and its status in Myanmar is unknown. Given this any healthy population is of global

significance. The population in the SBCA inhabits forest that is contiguous with similar habitats in Phnom Prich Wildlife Sanctuary and Mondulkiri Protected Forest. Silvered Langurs are recorded regularly in these protected areas (A Maxwell *pers comm.* Tordoff *et al.* 2005). The population of Germain's Silvered Langur in SBCA alone is of at least national importance, but as part of a wider population throughout the dry forests of Mondulkiri is part of a globally important population. The Mondulkiri population may be the largest of this species remaining anywhere in the world.

The SBCA is home to a large population of Yellow-cheeked Crested Gibbons. Assuming a group size of four, the total population in the study area in 2007 is 3,732 (2,519 - 5,531) individuals. This is from an area of 789 km^2 but the total area of suitable habitat in the SBCA is estimated at 2,061km^2 (study area and all remaining 'evergreen' forest combined). Given this the total population size in the SBCA is likely to be much higher. The density of gibbon groups is currently estimated at 1.18 groups/km^2. This is possibly an underestimate for several reasons, for example the estimated strip width may be too large, and other studies have suggested that gibbons are under-reported in line transects as they are hard to observe, that they are easily disturbed and flee quickly and quietly (Nijman and Menken 2005). There are few reliable, comparable density estimates for *Nomascus* gibbons elsewhere. Density estimates exist for *Hylobates* gibbons in several places, but it is questionable whether density estimates for one genus in Sundaic forests can be compared with that for *Nomascus* gibbons in the lower Mekong. *Hylobates meuleri* densities in unlogged forests of Borneo have been reported at 2.9 ±0.2 groups/ km^2 (Nijman and Menken 2005) and 3.0 groups/ km^2 (Leighton 1987). *Nomascus* densities by contrast have been reported at around 1.3 groups/ km^2 (Geissmann *et al.* 2007) for *N. siki* in central Viet Nam and 0.67 groups/ km^2 for *N. concolor* in southern China (in montane sub-tropical forest).

The gibbon density in SBCA may be low because it is under-recorded, or possibly the high amount deciduous forest formations result in a naturally lower population density, or both. Given the large area of potential habitat available however, this population is of global conservation significance. Yellow-cheeked Crested Gibbons still remain reasonably widespread in southern Viet Nam (B Long *pers comm.*), but nowhere are they numerous (Geissmann *et al.* 2000). There is a potentially large population of gibbons in north-east Cambodia, in the Virachey National Park region (Traeholt *et al.* 2005) but there is at present no accurate population estimate, nor is it even clear to which species they belong. SBCA has almost certainly the largest single population of 'typical' (*sensu* Konrad and Geissmann 2006) Yellow-cheeked Crested Gibbons remaining in the world.

The population of Black-shanked Doucs in the SBCA is very large. The density of sub-groups in 2007 is estimated at 7.57 groups/km^2 in the study site, and the total population estimated at 42,603 (27,309 – 66,460). Assuming a total area of suitable habitat of 2,061km^2 (study area and all remaining evergreen/semi-evergreen forest combined) the total population estimate for the SBCA will be much higher. It is unlikely however that the density of doucs found in the study area is uniformly applicable across the whole SBCA. Densities are possibly lower in the areas that have been impacted less by conservation activities. The western part of the buffer area has, for example, to date been patrolled less frequently than the core area. Given experiences in the SBCA and elsewhere in Cambodia it is reasonable to assume that pressures are greater in the un-patrolled portion and densities of primates lower.

Density estimates for other douc populations, of any of the three species are not available. The largest single reported population to date is from one of 500-700 Black-shanked Doucs in Nui Chui National

Park in Viet Nam (Nadler *et al.* 2003). It must be noted however that few detailed surveys have been carried out in Viet Nam, and it is possible that populations are being under reported. Smaller populations of douc have been recorded from elsewhere in Cambodia, including parts of Virachey National Park, Phnom Prich Wildlife Sanctuary, Mondulkiri Protected Forest and Phnom Nam Lyr Wildlife Sanctuary (WWF *in litt*) but very little is known about these populations. The SBCA population is the largest reported population of Black-shanked Douc anywhere in the world, and could represent more than half of the total world population for the species.

The data show no significant increase in density of douc groups from 2005 to 2007. There does appear to be an upward trend. This may be an artefact of increased skill of surveyors, or a change in behaviour as primates become more tolerant of people. It is however also likely to indicate a genuine increase in populations since the start of the project. Although the primate populations may now be at or close to carrying capacity it is possible that in the future the populations of all primates may increase further. As large areas of disturbed forest recover, and the carrying capacity of the forest will improve, thus populations may increase. Studies elsewhere have shown that gibbon and other primate densities are lower in disturbed forest than in undisturbed forest (Johns 1992, Chapman *et al.* 2000, Plumptre and Greiser Johns 2001). Almost all of the evergreen/semi-evergreen areas SBCA have experienced some disturbance from logging (C. Chhen *pers comm*, E. Pollard *pers obs*); in some areas this disturbance has been intense (for example heavy roading in the southern areas of the site). As these areas recover habitat suitability, e.g. density of food trees, should improve and the carrying capacity may increase. With continued active conservation the importance of the area may increase further. At the time of writing intensive conservation activities are being carried out in only a portion of suitable primate habitat. As the conservation program continues to expand and develop, more of the population will be fully protected and will be able to recover further

SBCA contains probably the world's largest population of Black-shanked Douc and the typical form of Yellow-cheeked Crested Gibbon. A globally important population of Germain's Silvered Langur may also be located in the north of the SBCA. The area also has important populations of Pygmy Loris and three species of macaque. The SBCA is unquestionably of international importance of the conservation of these Globally Threatened primates. Continued protection of the area is critical to the survival of these species.

CONSERVATION OF PRIMATES

Threats to Primates

The threats to the primates of southern Mondulkiri are similar to those facing primates throughout South-East Asia (Geissmann *et al.* 2001, Nadler *et al.* 2003, Duckworth *et al.* 1999, Mittermeier *et al.* 2006). They are facing direct persecution for subsistence and trade, and are losing their forest habitat through legal and illegal activities.

There has probably been a long history of low-level subsistence hunting in the area by the resident Bunong people. The opening of the concession and return of people to their villages in the mid 1990s saw a resumption of hunting. The influx of people, outside interests and prevalence of firearms is thought to have led to a much higher level of hunting than in previous decades. A survey in 2001 (Piseth 2002) reported widespread hunting of Black-shanked Douc. In all five villages that were surveyed people reported hunting doucs for subsistence. Gibbons were also reported to be widely hunted. This was primarily for trade, where young gibbons are sold to middle men, and into the pet trade. Adult gibbons were not sold, but were usually for home consumption. The impact of this hunting is not known. It is possible that the relatively recent return of people to the area and large area of forest means that primate populations were not reduced dramatically in the period prior to the conservation project.

Lorises are also reported to be widely shot and trapped. This is almost exclusively for trade. They are used in Khmer traditional medicine, or traded internationally to supply Vietnamese or Chinese medicinal markets (Lynam and Soriyun 2004, Walston *et al.* 2001).

A more recent survey (WCS *in litt*), indicated that hunting is still a common activity, 19 – 63% of families in study villages reported to hunt regularly. This is mainly hunting of monitor lizards (*Varanus* spp) and small game; it is not clear how widespread hunting of primates is at present.

The large scale collection of Long-tailed Macaques started in 2006. This has been reported from all over Cambodia and mainland South-East Asia (S. Roberton *pers comm*), and is thought to be connected to the trade in animals for use in biomedical testing.

Logging activities in the 1990s probably brought additional threats and stresses to the primate populations. Studies elsewhere (Johns 1986, 1992, Plumptre and Greiser Johns 2001) have shown that in many situations gibbon and other arboreal primate populations in logged forest are at a lower density than in un-logged forests. Harvesting of timber trees, especially when not carried out to the highest standards (Meijaard and Sheil 2007) can alter dramatically the structure and composition of the forest. The impacts from logging include roads, and felling that fragments the forest, and targeted and accidental damage to key food trees. When commercial logging ceased in southern Mondulkiri in 1999 most of the forest had been disturbed to some extent, some areas intensively. It is assumed that this has depressed primate populations from their pre-logging levels.

Some small-scale illegal logging continues, but the impact of this on primate populations is unknown. It is unlikely that localised felling of a small number of trees has a significant effect on primates.

Complete clearance of forest for conversion to agriculture, or estate crops can have massive impacts on primate populations. Since the late 1990s large areas of forest in the Snoul Wildlife Sanctuary, bordering the SBCA, have been cleared illegally. This has

principally for small scale farming by in-migrants from other regions of Cambodia (Evans and Delattre 2005). This area previously supported primates (Walston *et al.* 2001), but is now almost completely denuded of natural forest, and most primates are generally absent. There are occasional reports of loris in cashew plantations, and some crop raiding by macaques along the forest edge, but the area is unsuitable for doucs or gibbons. The large-scale commercial conversion of forests for plantation crops, such as rubber and cassava, has become a threat more recently. Thousands, or sometimes tens of thousands of hectares of forest are proposed for conversion. This would involve the complete clearance of all natural forest, and the planting of cash crops. Such plantations clearly have a devastating impact on forest biodiversity, including primates.

Clearance of forest, continued illegal logging, and extensive hunting continues to be a considerable problem outside the SBCA. Approximately one third of the Snoul Wildlife Sanctuary is proposed to be degazetted in 2007 and the area is likely to be completely cleared and converted to estate crops. Hunting remains a problem throughout the remaining part of the Wildlife Sanctuary. Germain's Silvered Langus could be critically endangered globally, their conservation in the SBCA is of high importance. Severe and persistent threats throughout the range of the Yellow-cheeked Crested Gibbon and Black-shanked Douc emphasise further the need for effective conservation strategies within the SBCA. The area holds possibly the largest populations in the world for both species. Protection of these endangered species in the SBCA is essential for the conservation of the species globally.

Conservation Strategies used in the SBCA

A variety of conservation strategies could be employed. The FA currently uses two main interventions to help protect primates and other species of conservation concern in the SBCA: active law enforcement, and land-use planning. In addition a range of other programs support and enhance these on-going field activities (WCS/FA 2006b). Political support is garnered at the local, provincial and national level to help address issues ranging from large-scale economic land concessions, to localised disputes over resource access. Education and awareness of environmental issues is carried out by all components of the project, and through partnerships with other organisations. These and other activities help provide a suitable enabling environment. The core conservation strategies however remain law enforcement, together with land-use planning and community engagement.

Law enforcement

The enforcement of laws protecting forests and biodiversity are controversial in some quarters (Colchester 2000, 2006). In many cases it can lead to conflict with local communities, and some consider it an infringement on basic human rights (Colchester 2000). The conservation of biodiversity however, is not possible without active application of laws designed to protect it (Jepson *et al.* 2001, WWF 2004). Although there remain problems with quantifying the success of enforcement efforts, several studies have attempted to show a positive link between enforcement and the effectiveness of protected areas to control threats (Bruner *et al.* 2001).

Law enforcement in the SBCA has to date managed to balance successful application of the law with support from local populations. This has been achieved without significant conflict. The law enforcement strategy for the SBCA was designed in 2004 (Lyman and Soriyun 2004). It addresses the main threats to the site and primates. The basis for all activities is the active enforcement of key legal frameworks, specifically the forest law, land law, protected species law. There are no laws, regulations and policies specific to the management of the SBCA. The strategy is to simply enforce existing national-level laws.

At present protection of the globally important primate populations is carried out through two main methods: regular foot and vehicle patrols, and permanently manned guard posts. These programs have been effective in controlling the principal threats of hunting, and of habitat loss due to conversion to agriculture. The FA have hired and trained 28 staff from the FA, police, military and local communities to undertake patrolling activities with support from WCS. These staff have been equipped and trained to carry out wildlife enforcement activities and record and collate primate and other wildlife information. Patrolling is now continual, with up to five teams in the field at any one time. One team is based at each of the four stations, with an addition quick response team based at the SBCA basecamp.
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Table 8 shows a summary of patrol effort from July 2004 to June 2007. Patrols now regularly visit most of the core area of the SBCA, including all critical primate habitat. This high level of patrolling is supported by an informant network of local villagers who report illegal activities to the law enforcement team leaders. The law enforcement team has been very effective at reducing illegal activities across most of the core area of the SBCA.

Table 8: Patrol effort from July 2004 to June 2007

	04/05	*05/06*	*06/07*
Number of Patrols	223	398	479
Patrol Days	252	512	696
Patrol Nights	29	114	217
Total Km patrolled	4,897	8,830	12,448
Av Days on Patrol	1.13	1.29	1.45
Av Nights on Patrol	0.13	0.29	0.45
Av Patrol Size (pax)	4	3	3
Av Patrol Dist. (km)	21.9	22.2	26.1

Ranger stations are located at strategic locations along the main road through the SBCA and in the heart of the core area at Sre Pleng. Additional stations are being built at other strategic locations on access roads around the core area. The four completed stations are now fully staffed and functional, and have allowed a broadening of the range of patrol activities across the core area, which until now have largely been restricted to locations in relatively close proximity to the original Keo Seima and O'Reang stations. These stations are manned permanently and serve as bases for patrols to more remote areas of the conservation area. Additionally they act as portals to control access to the forest.

A specialised database, MIST (Management Information SysTem) is used to monitor and assess patrol effort and success. Enforcement teams record continuously their location, and the locations of any illegal activities encountered. These data are compiled and are used to track patrol effort, coverage and extent of illegal activities encountered. These data can be used to show the degree to which critical primate habitat has been patrolled (Map 7). In addition this information shows that since the start of intensive patrolling in 2004 there have been very few documented cases of hunting of primates. In that time there has been only one case of hunting Black-shanked Douc, and no cases of hunting gibbons. Nine cases involving Northern Pig-tailed Macaque were reported, mainly involving animals caught crop raiding. Hunting undoubtedly still occurs to some extent, especially in the areas that are patrolled less frequently. These figures do suggest however, that hunting of primates in the core zone is now a rare activity.

The patrols, and political support have been successful in controlling encroachment, and conversion. The whole of the SBCA is still nearly 98% forest cover. The success in controlling encroachment is most clear when compared to the neighbouring sections of Snoul Wildlife Sanctuary, which have been nearly totally cleared in the last five years.

Land-use planning

The law enforcement work has been a success in part because of support from important members of the local communities. They have been supportive of

the activities because law enforcement also protects their resources and traditional lands.

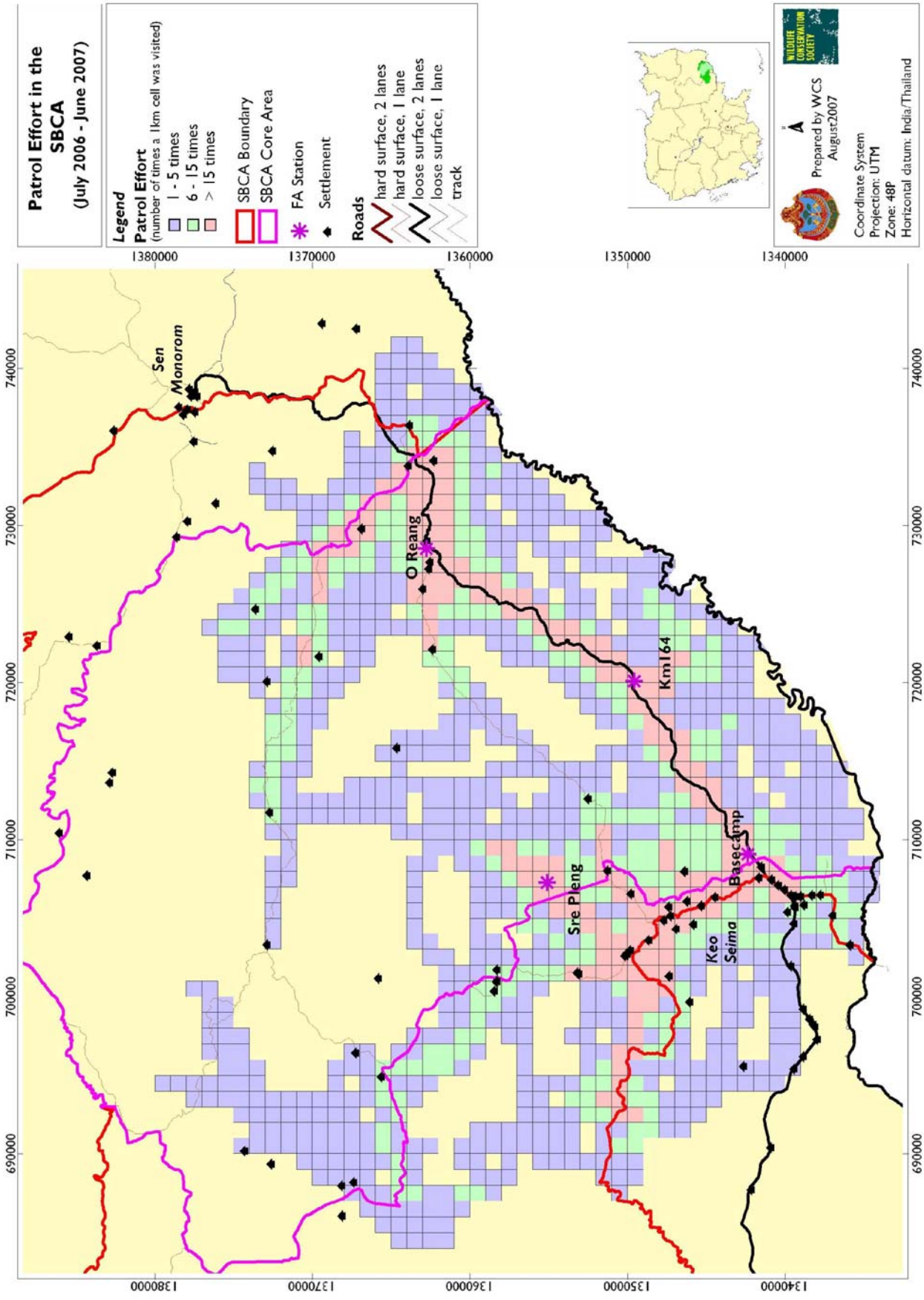
Approximately 10,000 people live in settlements within or bordering the SBCA (Map 2). Around 70% of this population are from Bunong or Stieng ethnic groups (Evans and Delattre 2005). A large proportion of them are reliant on forest lands which are used for their traditional swidden agricultural system. There is also high dependence on forest products for consumption and sale. Principal among these is the collection of resin from forest trees (mostly from mature *Dipterocarpus alatus*) the sale of which is a vital source of cash income (Evans *et al.* 2002). Other important natural resources include rattan, bamboo, and fish (Degan *et al.* 2004). Part of the philosophy of the Seima Biodiversity Conservation Project is that the SBCA supports the livelihoods of the areas traditional inhabitants (WCS/FA 2006b). A key strategy to achieve this is by controlling illegal land claims and clearing of forest, securing traditional tenure rights over the land and stabilising land use. Law enforcement to control clearing of forest helps protect vital primate habitat, as well as securing forest areas for the current residents.

In partnership with this however a process of land-use planning is required to ensure that resource gathering and farming practices that are carried out within the SBCA are compatible with the goals of biodiversity conservation. By stabilising land-use across the landscape the project will ensure that forest habitat is retained for primates and other species.

The SBCA contains many indigenous enclave villages and is fringed by large recent Khmer settler populations. Both situations require the Project to engage with communities to agree land-use zones and use regulations because the laws themselves are sometimes quite vague. The Project works with partners at a local, provincial and national level. One village in the SBCA is a national pilot site for the application of village-level land use planning and the development of communal tenure. If successful these methods will be used across the SBCA in coming years. This work is done under the general heading of PLUP (Participatory Land-use Planning) which includes participatory research, legal extension, mapping, community organising and conflict resolution.

In 2007 PLUP is being implemented in three villages in the SBCA totalling about 760 families, with over 3,600 people. The PLUP team comprises an FA leader (from the Community Forestry Office), provincial staff from the Departments of Land Management, Agriculture and Environment, and one non-government staff member. Two are women and one is ethnic Bunong. In conjunction with PLUP the Project works to enable villages to apply for Communal Title in accordance to the national Land Law. The Minister of Interior approved community registration in April 2007. Andoung Kraloeng is only the third village in Cambodia to achieve this and now has the legal standing to request that their lands should be formally registered and titled. This will simultaneously help them to protect their resource base, strengthen existing collective management systems for common property resources and slow in-migration to sensitive areas.

Map 7: Patrol effort in the SBCA core area



RECOMMENDATIONS

Research and monitoring

The following activities are recommended to increase the accuracy of population estimates:

1. Increase the survey effort. This should increase the number of encounters with gibbons and macaques and enable a density estimate to be calculated. Increasing effort can be achieved through two means. Increasing the number of times each transect is walked per year, and increasing the number of transects in the SBCA. One relatively simple way to increase the number of times transects are walked is to carry out evening counts in addition to morning walks. The primate behaviour in the evenings is not known in the SBCA. This may initially affect the encounter rate. Data from morning and evening walks needs to be compared to assess whether the assumptions of distance sampling are still met. Increasing the number of transect lines, probably by creating new permanent transects to the west of the existing ones, is logistically more complicated. The advantage of increasing the number of spatial replicates is that it ensures that a density estimate that is representative of a wider area is obtained.
2. The addition of new transects will also result in the addition of extra permanent listening posts. This will improve knowledge of the distribution of gibbons, and allow for monitoring over a larger area.
3. Research into group size and dynamics. One source of error in the estimation of total populations of Black-shanked Douc is the variation in recorded group size. During the line transect surveys observed group sizes have varied from one to more than 30. This may reflect difficulties in observing and counting the whole group, but also be due to the dynamic nature of douc groups. An independent survey of douc groups to determine their size and structure could be used to provide a mean group size that can be applied to the group density to calculate population size. Groups that are more habituated, for example along the main road, could be used for this survey.
4. Research into the distribution and population size of Germain's Silvered Langur in the SBCA. More information is required about the importance of the SBCA for this primate, both in terms of the population within SBCA, and in connection with populations in neighbouring protected areas.

Conservation

The following actions are recommended to improve the conservation of primates.

1. Law enforcement activities should be expanded to cover a larger area of the SBCA. Most important for the conservation of primates would be increased activities in the evergreen forests of the western buffer area.
2. Land-planning should work from the lessons learned in the pilot villages to expand into other villages.
3. The current boundaries of the core area exclude important areas of primate habitat, for example to the east of the road from Sre Preah to Sre Chhuk, and the corridor of forest linking SBCA with Phnom Nam Lyr Wildlife Sanctuary. These areas should be included in the core area.
4. Zoning of the core area should include strict conservation areas. No access or resource gathering by local villagers would be allowed in these areas. They should be selected for their importance to the conservation of primates and other endangered species, but establishment of these areas should be a

participatory and transparent process involving all relevant stakeholders.

5. Strengthen the legal framework for protection of the SBCA from Ministerial Declaration to Prime Ministerial Subdecree.

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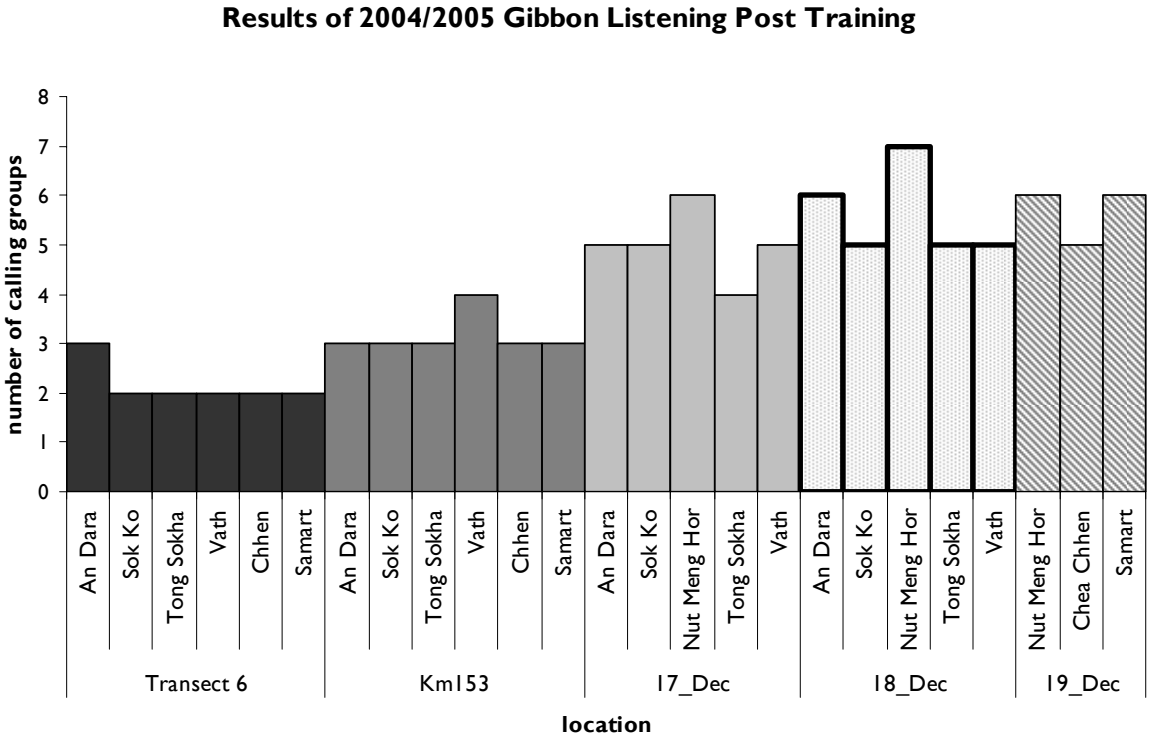
APPENDICES

A. Training results

2004

Training of listening post techniques, and testing whether the teams gave uniform results took place on the 15th to 19th December 2004.

Recorders were remarkably consistent at recording vocalisations. The results for Yellow-Cheeked Gibbon are given below. Data were collected from three locations on five days. ANOVA indicated that there was no significant difference between observers (F = 2.506, d.f. = 6,14, P = 0.074). Although in general Nut Meng Hor – who has worked on Gibbons for the past 2 years – recorded higher numbers than the other observers. The average CV was 14.4%.



ANOVA: Gibbon Vocalisations (2004 training)

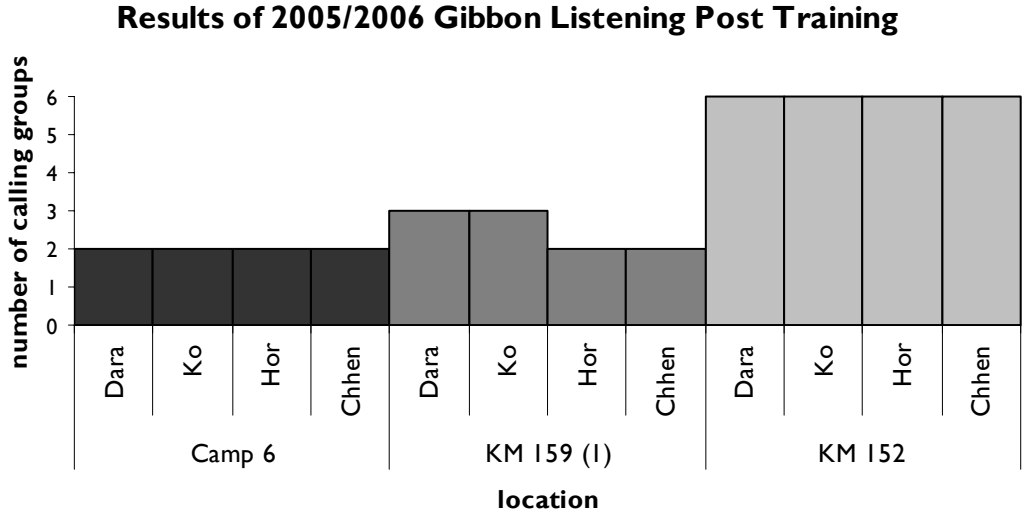
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3.940(a)	10	.394	28.352	.000
Intercept	45.096	1	45.096	3245.278	.000
OBSERVER	.209	6	.035	2.506	**.074**
SAMPLE	2.865	4	.716	51.542	.000
Error	.195	14	.014		
Total	48.248	25			
Corrected Total	4.134	24			

a R Squared = .953 (Adjusted R Squared = .919)

These results confirmed that the teams give consistently similar results. There is therefore little observer bias.

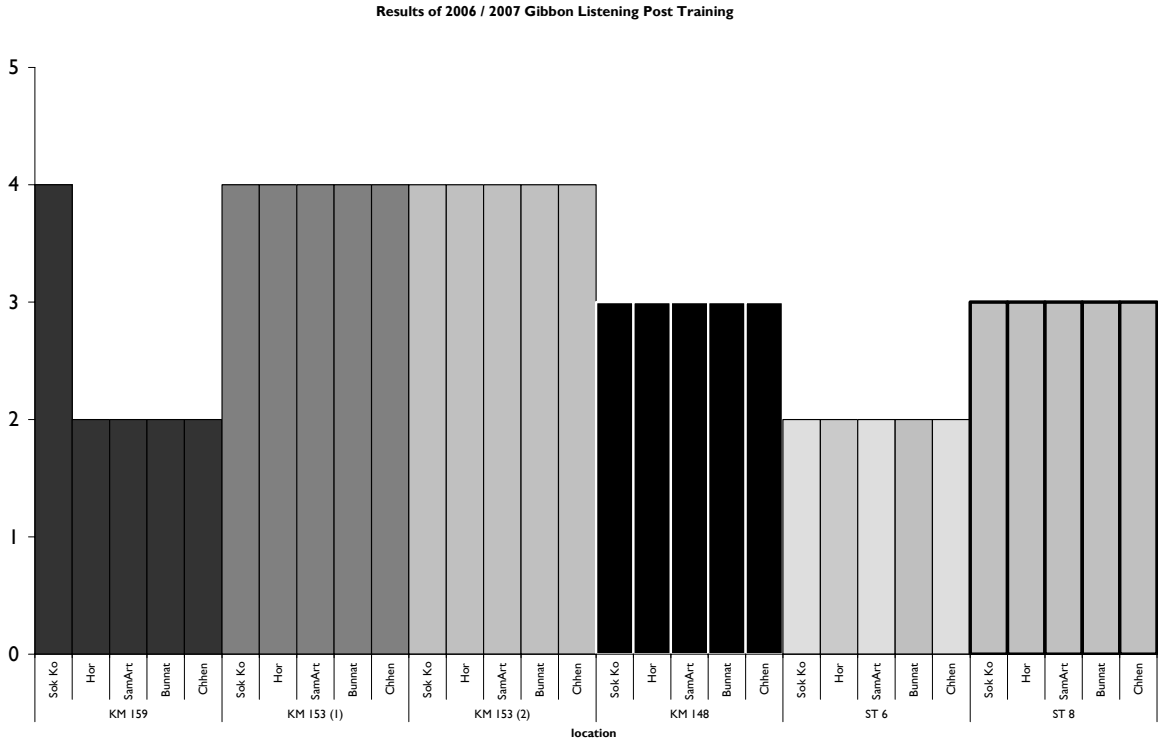
2005

The same training was conducted from the 14th to 17th December 2005, with equally consistent results.



2006

Training was repeated again in November 2006. Results showed that consistency has been maintained. The mean CV was 5.32%.

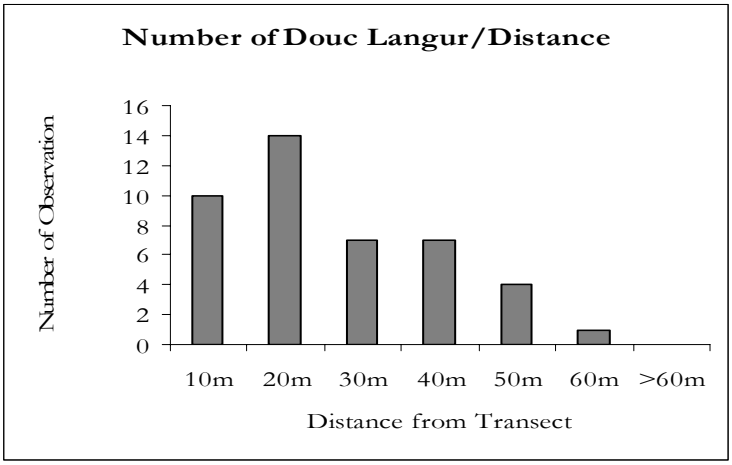

Results of 2006 / 2007 Gibbon Listening Post Training
5
4
3
2
1
0
Sok Ko
Hor
SamArt
Bunnat
Chhen
KM 159
KM 153 (1)
KM 153 (2)
KM 148
ST 6
ST 8
location

B. Testing Distance assumptions

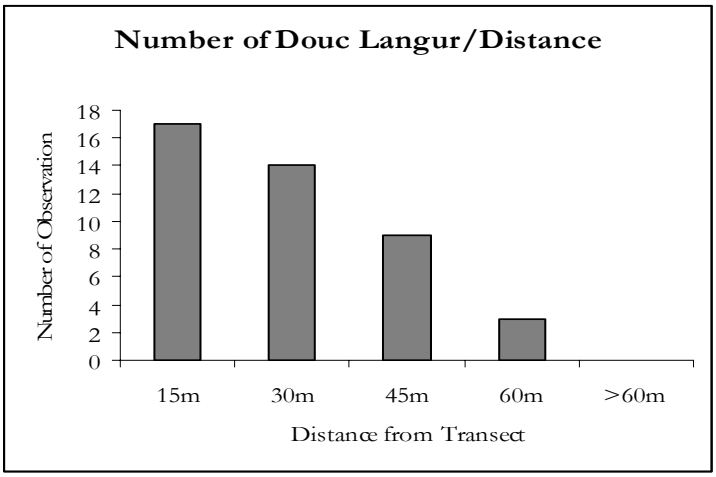
The 2005 data were checked thoroughly to test the applicability of this method for monitoring the douc population. Histograms of the frequency of Douc sightings in distance classes from the transect line are given in Chart 1. This approximates to the shape of the detection function. Distance sampling assumes that all animals on the transect line are seen: i.e. the peak of the histogram should be in the smallest distance category. This is not the case for the 10m classes histogram – suggesting that some animals had moved before they were observed. However this effect is not particularly strong – as shown in the 15m classes histogram.

Chart #1: Number of Douc groups seen at distances from the transects

(a) 10m classes



(b) 15m classes



The assumptions of distance sampling would also be violated if surveyors failed to measure the distance from the transect to the precise centre of the group. This would be easy to underestimate, as Douc groups can be very large and widely dispersed. In this case the resulting population estimate would be greater than the true value. However, there is no evidence that distances were under-estimated as the histograms show a large number of observations at >30m from the transect and the distribution of distances for large groups (>10 individuals) is not significantly different to that for the entire dataset (Kolomogorov-Smirnov test, $Z = 0.831$, $P = 0.495$).

C. Survey Dates

Table 9: Transect survey dates

Tsct	2003		2004		2005		2006		2007		
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	3rd
1a	21 March	01 May	14 January	10 February	27 January	26 March	08 March	29 March	29 Dec 06	21 Jan 07	27 Feb 07
1b					27 February	30 April	16 March	5 May	30 Dec 06	23 Jan 07	28 Feb 07
2a	03 March	05 May	27 January	11 March	24 January	25 March	05 February	03 April	25 Dec 06	13 Feb 07	23 Mar 07
2b					24 February	29 April	12 March	4 May	26 Dec 06	14 Feb 07	24 Mar 07
3a	28 February	07 May	27 January	9 March	21 January	23 March	7 March	31 March	23 Dec 06	08 Feb 07	02 Mar 07
3b					22 February	28 April	11 March	29 April	24 Dec 06	09 Feb 07	04 Mar 07
4a	18 March	03 May	10 January	13 March	22 January	22 March	09 March	30 March	21 Dec 06	25 Jan 07	04 Mar 07
4b					19 February	02 May	15 March	07 May	22 Dec 06	27 Jan 07	05 Mar 07
5a	03 February	08 May	18 January	7 March	17 January	22 March	10 March	26 March	21 Dec 06	21 Jan 07	26 Feb 07
5b					19 February	27 April	26 March	28 April	22 Dec 06	23 Jan 07	28 Feb 07
6a	04 February	05 May	12 January	15 January	18 January	25 March	23 February	28 February	26 Dec 06	21 Jan 07	27 Feb 07
6b					25 February	29 April	24 February	28 April	27 Dec 06	23 Jan 07	01 Mar 07
7a	16 March	30 April	9 January	11 March	16 January	25 March	09 March	27 March	02 Jan 07	25 Jan 07	09 Mar 07
7b					19 February	26 April	10 March	26 April	03 Jan 07	27 Jan 07	11 Mar 07
8a	26 February	03 May	9 January	13 March	16 January	24 March	26 February	29 March	24 Dec 06	02 Feb 07	03 Mar 07
8b					21 February	27 April	27 February	29 April	25 Dec 06	03 Feb 07	05 Mar 07
9a	01 March	02 May	15 January	9 March	19 January	26 March	12 March	30 March	04 Jan 07	07 Feb 07	21 Mar 07
9b					22 February	27 April	13 March	2 May	05 Jan 07	09 Feb 07	19 Mar 07
10a	19 March	05 May	20 January	07 March	21 January	28 March	05 February	31 March	21 Dec 06	12 Feb 07	23 Mar 07
10b					25 February	28 April	03 March	1 May	21 Dec 06	14 Feb 07	25 Mar 07
11a	21 March	06 May	09 January	30 April	16 January	22 March	05 February	26 March	03 Jan 07	21 Jan 07	26 Feb 07
11b					19 February	27 April	23 February	27 April	02 Jan 07	23 Jan 07	28 Feb 07
12a	16 March	01 May	24 January	27 April	23 January	29 March	06 February	30 March	25 Dec 06	07 Feb 07	20 Mar 07
12b					28 February	29 April	02 March	30 April	24 Dec 06	09 Feb 07	22 Mar 07
13a	19 March	03 May	18 January	28 April	22 January	26 March	09 February	29 March	27 Dec 06	12 Feb 07	24 Mar 07
13b					25 February	29 April	27 February	29 April	28 Dec 06	14 Feb 07	26 Mar 07
14a	24 March	05 May	14 January	29 April	19 January	24 March	08 February	28 March	30 Dec 06	27 Jan 07	02 Mar 07
14b					21 February	28 April	25 February	28 April	31 Dec 06	25 Jan 07	04 Mar 07

Table 10: Listening post dates

Listening post number	2003		2004		2005		2006		2007	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
1_ST1		01 May	15 January	16 March	27 January	01 March	25 January	15 March	22 January	03 March
2_FT1		02 May	14 January	17 March	28 January	28 February	27 January	17 March	24 January	06 March
3_ST2		05 May	27 January	11 March	25 January	26 February	06 February	12 March	12 February	22 March
4_FT2		06 May	28 January	12 March	26 January	25 February	07 February	14 March	15 February	25 March
5_ST3		07 May	27 January	09 March	22 January	21 February	22 January	07 March	07 February	03 March
6_FT3		08 May	28 January	10 March	23 January	23 February	24 January	12 March	10 February	05 March
7_ST4		03 May	10 January	13 March	23 January	18 February	22 January	09 March	26 January	26 February
8_FT4		08 May	11 January	14 March	23 January	20 February	24 January	16 March	28 January	01 March
9_ST5		08 May	18 January	07 March	18 January	18 February	27 January	10 March	22 January	27 February
10_FT5		09 May	19 January	08 March	19 January	20 February	26 January	14 March	24 January	01 March
11_ST6	26 February	01 May	13 January	15 March	19 January	24 February	25 January	23 February	22 January	28 February
12_FT6		02 May	14 January	16 March	20 January	26 February	26 January	25 February	24 January	02 March
13_ST7	16 March	30 April	10 January	12 March	17 January	18 February	23 January	08 March	26 January	10 March
14_FT7		01 May	11 January	11 March	18 January	20 February	24 January	11 March	28 January	12 March
15_ST8	27 February	03 May	09 January	14 March	17 January	23 February	24 January	26 February	25 January	04 March
16_FT8	28 February	04 May	10 January	13 March	17 January	22 February	23 January	14 March	04 February	06 March
17_ST9	02 March	02 May	15 January	10 March	19 January	21 February	06 February	12 March	10 February	22 March
18_FT9	04 March	03 May	16 January	15 March	20 January	23 February	27 January	14 March	08 February	20 March
19_ST10	21 March	06 May	20 January	08 March	21 January	24 February	07 February	02 March	13 February	24 February
20_FT10	19 March	05 May	21 January	07 March	22 January	26 February	06 February	4 March	15 February	26 March
21_ST11	23 March	08 May	09 January	13 March	17 January	18 February	07 February	22 February	22 January	27 February
22_FT11	24 March	06 May	10 January	14 March		20 February	06 February	24 February	24 January	01 March
23_ST12		01 May	26 January	06 March	24 January	01 March	04 February	07 February	10 February	23 March
24_FT12			25 January	07 March	23 January	28 February	08 February	03 March	08 February	21 March
25_ST13		03 May	20 January	07 March		27 February	10 February	1 March	12 February	25 March
26_FT13	21 March	04 May	19 January	09 March	23 January	26 February	10 February	28 February	15 February	27 March
27_ST14	26 March	05 May	15 January	11 March	20 January	23 February	09 February	27 February	28 January	05 March
28_FT14		06 May	14 January	12 March		22 February	10 February	26 February	26 January	03 March

D. Survey waypoints

Table 11: Locations of start and end of wildlife observation transects

	Start		End	
Transect name	E	N	E	N
1a	715359	1344471	716379	1342723
1b	716379	1342723	717515	1341141
2a	720826	1348878	722825	1348829
2b	722825	1348829	724431	1348551
3a	725028	1355640	727096	1355779
3b	727096	1355779	729142	1355781
4a	715963	1348572	714128	1349381
4b	714128	1349381	712413	1350324
5a	722883	1357320	720885	1357519
5b	720885	1357519	718817	1357600
6a	710665	1358787	709914	1356925
6b	709914	1356925	709692	1354962
7a	720029	1369489	719782	1367490
7b	719782	1367490	719587	1365551
8a	708503	1359518	709724	1361127
8b	709724	1361127	710820	1362806
9a	713262	1365762	712417	1367586
9b	712417	1367586	711670	1369454
10a	705956	1369834	705302	1367877
10b	705302	1367877	704579	1366048
11a	707899	1376702	708846	1378425
11b	709330	1379268	710209	1381113
12a	700178	1368544	698863	1366982
12b	698863	1366982	697841	1365267
13a	700277	1372013	698353	1372877
13b	698023	1373031	695871	1373970
14a	700199	1380112	700633	1382067
14b	700777	1382861	701321	1385007

UTM. Zone 48P. datum India - Thailand

Table 12: Location of listening posts

Listening Post number	E	N
1_ST1	715359	1344471
2_FT1	717515	1341141
3_ST2	720826	1348878
4_FT2	724431	1348551
5_ST3	725028	1355640
6_FT3	729142	1355781
7_ST4	715963	1348572
8_FT4	712413	1350324
9_ST5	722883	1357320
10_FT5	718817	1357600
11_ST6	710665	1358787
12_FT6*	709521	1354020
13_ST7	720029	1369489
14_FT7	719587	1365551
15_ST8	708503	1359518
16_FT8	710820	1362806
17_ST9	713262	1365762
18_FT9	711670	1369454
19_ST10	705956	1369834
20_FT10	704579	1366048
21_ST11	707899	1376702
22_FT11	710209	1381113
23_ST12	700178	1368544
24_FT12	697841	1365267
25_ST13	700277	1372013
26_FT13	695871	1373970
27_ST14	700199	1380112
28_FT14	701321	1385007

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datum India – Thailand
*12_FT6 lies 1km south of the end of the transect