

## SECOND FIELD ECOLOGY SYMPOSIUM, “BIODIVERSITY MANAGEMENT”

*Tommaso Savini<sup>1</sup>, Marie-Claude Huynen<sup>2</sup>, Carola Borries<sup>3</sup>, and George A. Gale<sup>1</sup>*

Following the response to the first Field Ecology Symposium in 2005 with over 100 registered and approximately 90 people attending (GALE & SAVINI, 2005), we organized a second event hosted by King Mongkut's University of Technology Thonburi (KMUTT). The second Field Ecology Symposium (25–28 January 2007) focused on the theme of “Biodiversity Management”, although the presented papers covered a wide range of topics beyond this theme. We hope that in future years additional themes will be explored depending on local and regional interest, including such topics as marine ecology and conservation, long-term monitoring, animal re-introductions, mangrove ecology, etc.

The symposium was designed with the following goals:

1. To be truly “international”. For this, an international organizing committee was established, which included researchers from two universities outside Thailand (Liege University, Belgium, and Stony Brook University, USA). In addition, we strongly encouraged ecologists from outside Thailand, particularly those from the region, to participate.
2. To provide graduate students with the opportunity to present their work in an atmosphere similar to an international meeting and receive constructive scientific feedback from a scientific audience. For this purpose we covered the travel expenses as well as accommodation during the entire period of the conference for all presenting students. Moreover, in keeping with the spirit of the symposium we also kept registration costs very low (500 baht for students and 1000 baht for non-students).
3. To allow researchers and students in particular, to exchange ideas and build collaborative partnerships.
4. To invite several well-published ecologists from Thailand and abroad to provide researchers, especially students, with new perspectives and ideas for research.

### Outputs

In 2007 we had over 120 registered participants from 12 countries (Belgium, Canada, Denmark, Germany, Hong Kong, India, Japan, Laos, Malaysia, Singapore, Thailand and the United States), and over a hundred persons actually attended. Fifty-six gave oral presentations, including 27 students, and 17 gave posters (some of which were in the form of proposals rather than completed research), including 12 students.

---

<sup>1</sup> Conservation Ecology Program, School of Bioresources and Technology, King Mongkut's University of Technology Thonburi, Bangkok

<sup>2</sup> Department of Sciences and Management of Environment, Behavioral Biology Unit, University of Liege, Belgium

<sup>3</sup> Department of Anthropology, Stony Brook University, USA

To reach as wide and diverse a group of interested researchers as possible, the abstracts from the Symposium were compiled into a booklet and distributed amongst the participants. Additional copies were sold to non-participants. These abstracts have been edited and are printed below.

We would like to establish the symposium as a regular event—either occurring every two years or annually, depending on interest and availability of institutional hosts. We have already made some progress in getting other universities to host a future meeting in 2008 or 2009. We very much want to make this meeting a regular national/regional/international event, *not* a KMUTT event. In addition, because graduate students are now required to present papers at international conferences as part of their degree or scholarship requirements, this conference series offers a unique opportunity to internationalize Thai students in the field.

The symposium was sponsored by KMUTT, Thai Biodiversity Research and Training Program (BRT), PTT Exploration and Production Public Company (PTT-EP), Wildlife Conservation Society (WCS), Thai Airways International, World Wide Fund for Nature Thai Program, Toyota Motor Thailand, Kasikornbank, and the Integrative Primate Socio-Ecology Group (IPSE) of Max-Planck Institute for Evolutionary Anthropology.

#### REFERENCE

- GALE, G. A., AND T. SAVINI. 2005. First Field Ecology Symposium, "Forest Ecology and Restoration", 28<sup>th</sup>–30<sup>th</sup> January 2005. *Nat. Hist. Bull. Siam Soc.* 53: 145–180.

## ABSTRACTS OF ORAL PRESENTATIONS

### **Biodiversity Management and the Issues of Wildlife Trade**

*R. C. Kirkpatrick*

TRAFFIC East Asia, 22 Stanley Street, Central, Hong Kong

Good conservation must be based on good science. This has proven particularly difficult for wildlife trade, however. The biological impact of wildlife trade is often unclear. Even less clear is the impact of conservation policies designed to mitigate biological threats that may arise from wildlife trade.

TRAFFIC is the joint wildlife trade program of WWF and IUCN. TRAFFIC's conservation programs in Asia are designed to (1) fight illegal trade, particularly that involving high profile "conservation flagships" such as tigers and elephants, and (2) support legal trade, particular for wildlife commodities such as timber, fish, and traditional plant medicines. Our principle method is fundamental research, using trade statistics as "proxies" for biological information. In collaboration with partners, we use this research to promote evidence-based conservation policy and public advocacy.

This talk will review current challenges to biodiversity management in Asia presented by wildlife trade, and on-going actions to mitigate threats. Emphasis will be placed on how different types of research—the analysis of trade statistics, the monitoring of wildlife markets, and field studies of wild populations—can work together to ensure that conservation policy is based on, and continually tested through, systematic and replicable science. Relevant examples for Asia will be highlighted, including elephants, humphead wrasse, and pangolin.

### **Primates of Thailand: an Update on Species and Subspecies**

*Andreas Koenig and Carola Borries*

Department of Anthropology, Stony Brook University, New York, USA

Located at the biogeographic crossroads of Southeast Asia, Thailand is characterized by a diverse mammalian fauna mainly from the Indochinese and the Sundaic subregions. Some years ago 13 to 14 species of extant nonhuman primates were recognized as native to the country. More recent taxonomic overviews suggest, however, 18 species with a total of 25 or even 29 subspecies. Here, we will review the current species and subspecies assignments and the respective distributions. We will further identify major gaps in knowledge and promising avenues of future research.

The recent increase in the number of species is partly due to the elevation of northern and southern subspecies to species status (slow loris, pig-tailed macaque, *surilis*). In addition, genetic work on Vietnamese *Trachypithecus phayrei crepusculus* indicates a close relatedness to other Vietnamese *Trachypithecus* species instead of to the dusky leaf monkey (*T. obscurus*) making an elevation to species status necessary (*T. crepusculus*). If confirmed for Thai *T. p. crepusculus*, the former 'Phayre's leaf monkey' would become the 'grey or ash gray langur'. On the species level, most experts agree in terms of species numbers, even though taxonomic names may vary (e.g., for Indochinese lutungs). Experts disagree in the designation and number of subspecies. With few exceptions for the genus *Macaca* and the family of Hylobatidae, this concerns mainly the subfamily Colobinae. Groves (2001) described 9 subspecies of colobines, whereas Brandon-Jones *et al.* (2004) suggest as many as 13 subspecies. In conclusion, at present, species and subspecies designations are poorly resolved and highly debated, especially in the subfamily of Colobinae. Even though recent genetic work has added some clarification, more genetic work, morphological descriptions, and field studies are urgently needed. This could help to confirm or reject species or subspecies status and clarify distributions. More importantly, it would help to prioritize assessments of population status and conservation planning.

### **Parasite Host Relationships between *Cordyceps* Fungi and their Ant Hosts in the Khao Chong Forest Dynamics Plot, Trang Province, Thailand**

*David P. Hughes<sup>1</sup>, Maj-Britt Pontopiddan<sup>1</sup>, Maria Moltesen<sup>1</sup>, Nigel Hywel-Jones<sup>2</sup>, Winanda Himaman<sup>3</sup> and Jacobus J. Boomsma<sup>1</sup>*

<sup>1</sup>Centre for Social Evolution, Department of Population Biology, University of Copenhagen, Denmark DK-2100

<sup>2</sup>Mycology Laboratory, BIOTEC Central Research Unit, 113 Paholyothin Rd., Klong 1 Kong Luang, Pathum Thani 12120

<sup>3</sup>Forest Entomology and Microbiology Group, Forest and Plant Conservation Research Office, National Parks, Wildlife and Plant Conservation Department, 61 Phaholyothin Road, Chatuchak, Bangkok 10900

Here we report our initial results of a study into the evolutionary ecology of *Cordyceps* fungal infection in ants. The fungus *Cordyceps* kills its ant host in a dramatic way. Dead ants can be found attached to the underside of leaves following an adaptive manipulation of host behaviour by the fungus. At special places in the forest, ant hotspots, or graveyards, can be found containing many hundreds of ants in a 10x10 m plot. Outside of these hotspots the density of dead ants is considerably lower. It is probable that the high densities serve to enhance spore transmission. This may come at a considerable cost as the fungus itself is susceptible to natural enemies in the form of a dipteran larva and a hyperparasitic fungus. We have also characterized the phenology of infection from the moments before death and following death (using field based observations and SEM). This long-term study will elucidate the duration of time the fungus can continue to reproduce from its dead host. Finally, we will describe our ongoing work in ant-*Cordyceps* co-evolutionary relationships using a number of DNA-based techniques.

## **Study of Forest Dynamics and Change on the Mo Singto Plot, Khao Yai National Park, Thailand**

*Warren Y. Brockelman*

Department of Biology, Faculty of Science, Mahidol University, Salaya, Phutthamonthon,  
Nakhon Pathom 73170, and Ecology Laboratory, BIOTEC Central Research Unit, 113 Science Park,  
Klong Luang, Phaholyothin Road, Phatum Thani 12120

A major objective of long-term ecological research sites is to measure change. The change could be due to direct effects of pollution, changes in climate (possibly indirect effects of atmospheric pollution), effects of use or harvest, or the natural dynamics of the system. Measuring long-term changes is called “monitoring”. Effective monitoring should be carried out using standardized methodology on the same populations in the same place. Long-term forest dynamics plots are the ideal sites on which to monitor changes in forests due to climate. On such plots, effects of relatively small changes in climate can be detected by measuring phenology of individual trees, and by studying seedling recruitment and tree growth. Changes in moisture and humidity could affect any part of the plant life cycle, and may affect each species differently. Changes in animal populations may affect the dispersal of seeds of plants whose fruits they consume. The Mo Singto Plot in Khao Yai Park is being used to document growth, mortality, seed dispersal and recruitment for a large number of species. Some tree species show irregularities in their size distributions on the plot, suggesting that populations are unstable or have been changing. One tree species, *Nephelium melliferum* (Sapindaceae) has a spatial distribution that suggests changes: young trees tend to occupy shadier and moister sites than older trees. Fruits of this species are highly favored by gibbons; but the abundance of gibbons has not changed in recent decades, so that seed dispersal does not appear to be a problem. Continuing research will attempt to determine if moisture and shade variations differentially affect seedling recruitment and growth. There are great opportunities for coordinated teamwork involving many researchers on plots such as Mo Singto because of the diversity and complexity of the ecosystem, and the detailed inventories that have been carried out.

## **Spatial Variation in Solar Irradiance and the Recruitment of Rainforest Trees at Khao Yai National Park, Thailand**

*David B. Greenberg<sup>1,2</sup>, Warren Y. Brockelman<sup>3</sup>, and Anuttara Natalang<sup>3</sup>*

<sup>1</sup>School of Science, Walailak University, Thaiburi, Thasala, Nakhon Si Thammarat 80160

<sup>2</sup>Dept. of Ecology, Evolution, & Marine Biology, University of California, Santa Barbara,  
CA 93106, USA

<sup>3</sup>BIOTEC Central Research Unit, 113 Phaholyothin Road, Klong 1, Klongluang, Pathum Thani 12120

Studies of tree distributions at the Mo Singto Forest Dynamics Plot (Khao Yai National Park, Thailand) suggest that the recruitment of some species may be limited by very recent climate change. While large individuals ( $\geq 10$  cm DBH) of the wild rambutan *Nephelium*

*melliferum* Gagnep. (Sapindaceae) are distributed over the entire 30 ha plot, small individuals (< 10 cm DBH) seem restricted to certain areas. *N. melliferum* seeds appear to be dispersed widely across the site (by white-handed gibbons, *Hylobates lar*), so we are investigating whether sites lacking saplings have become unsuitable for germination or seedling survival. These sites could have aspects and slope angles that orient them toward the sky, for example, in which case they would receive greater insolation and might be the first to become too hot and dry from climate change. We used models of topographic variation at Mo Singto and the sun's daily trajectory across the sky to compute spatial variation in aspect, slope, and cumulative annual insolation across the plot. Sites occupied by adult and sapling *N. melliferum* do not differ significantly in aspect, but saplings occur on 11% steeper slopes (so, less-oriented to the sky) with 2% lower annual insolation than adults. The biological significance of receiving 2% less solar radiation each year is unclear, so we will follow with field measurements to determine the differences in ground temperature and soil moisture between sites occupied by saplings and adults. We will also conduct experiments to evaluate if germination success and seedling survival are lower on slopes occupied by adults, to determine if these higher-insolation sites have become too hot and dry for recruitment in this species.

## **The Ecotone of Primary and Secondary Forest, Mo Singto, Khao Yai National Park, Thailand**

*Yingluck Ratanapongsai<sup>1,2</sup> and Warren Y. Brockelman<sup>2</sup>*

<sup>1</sup>Department of Biology, Faculty of Science, Mahidol University, Samsennai, Phayathai, Bangkok, 10400

<sup>2</sup>Center for Conservation Biology, Institute of Science and Technology for Research and Development, Mahidol University, Salaya Campus, Phutamonthon, Nakorn-Prathom 73170

The ecotone of primary and the secondary forest is located in the northern part of the Mo Singto long term forest dynamics plot. All trees larger than 1 cm dbh but smaller than 10 cm dbh, were censused in 2001, and the second census occurred in 2004. Tree diversity, composition, abundance, as well as growth rates and mortality rates were compared across the ecotone. Canopy coverage across the ecotone was measured in the second census by hemispherical photographs in wet and dry seasons. The study found that the total number of stems decreased slightly from the first census whereas Simpson's index of diversity increased from 0.839 to 0.868. *Polyalthia evecta* was the most abundant species in primary forest and had no mortality, while, *Eurya nitida* was the most abundant in secondary forest but had a low average growth rate of 0.008 cm dbh per year. The species with the highest average growth rate was *Knema elegans*. The forest preference of each species can be divided into primary forest (15 species), secondary forest (6 species), the ecotone (5 species) and one species that did not prefer any of the forest types based on the ecotone weight. The change in abundance across the ecotone can be separated into 5 models. The canopy coverage across the ecotone in the dry season was significantly lower than in the wet season, but did not differ between forest types.

## **Conservation Lessons from the Threatened Pileated Gibbon: a Story from Thailand**

*Sompod Srikosamatara and Warren Y. Brockelman*

Department of Biology, Faculty of Science, Mahidol University, Rama 6 Road,  
Bangkok 10400, Thailand

The conservation history of the pileated gibbon is a good case from which conservation biologists working in Thailand and adjacent regions can get insights from past efforts and for future directions. Scientific studies of this species since 1970s and 1980s can be considered as minimum requirements for conservation. Information has been also integrated into wildlife management authorities, zoo networks, the general public, and international conservation groups. Even so, the populations countrywide are steadily declining even in protected areas. This talk will review past studies and past conservation efforts and highlight the population situation in a historic site where a study on ecology and behavior of this species has been done. The population density at this site has declined from 5 to 0.87 groups/km<sup>2</sup> or 36 to 19 groups during 1978 to 2006. The rate of decline was about 0.61 group/year for the past 28 years. Waves of non-timber forest product collection covering *Aquillaria crassna* core wood, *Sterculia lychnophora* seeds and sap collection of *Dipterocarp alatus*, *D. intricatus* and *D. tuberculatus* have also resulted in hunting of the gibbons. The guard station located nearby the site has not functioned effectively in conservation. A few individuals can have great impacts on the population decline at this site. Conservation efforts should be combined using more effective law enforcement and win-win solutions with these individuals.

## **Immigration and Emigration of Females Reflect Competition for Group Membership in Phayre's Leaf Monkeys**

*Carola Borries<sup>1</sup>, Eileen Larney<sup>2</sup>, Amy Lu<sup>2</sup> and Andreas Koenig<sup>1</sup>*

<sup>1</sup>Department of Anthropology, Stony Brook University, USA

<sup>2</sup>Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University, USA

In some primate taxa female immigration and emigration (i.e., dispersal) is common particularly in prosimians, platyrrhines, colobines, and hominoids (apes and humans). Given that dispersal is often risky and thus costly, explanations for its occurrence are required. Here we report on the pattern of dispersal in Phayre's leaf monkeys (*Trachypithecus phayrei*) and analyze the correlates of disappearances/ emigrations and immigrations. Data were collected from five neighboring groups at the Phu Khieo Wildlife Sanctuary, Thailand from the year 2000 onwards. All group members were known individually based on natural markers such as shape of muzzle, eye rings and crest as well as scars. Females dispersed much more frequently than males. Most females dispersed before they began to reproduce, as juveniles, although more than 40% of the cases concerned adult females.

We witnessed female dispersal during encounters between neighboring groups. Overall the dispersal distance seems rather short. Emigrations occurred more frequently during the mating season and immigrations during the birth season. Females usually dispersed alone, but co-dispersal occurred as well. Adult females left after having lost their infant, left together with their infant, or they left their infant behind. Several dispersal events were preceded by severe fights leaving group members injured. Most immigrations took place into groups with more than one adult male and of average adult female group size. These results suggest that female Phayre's leaf monkeys compete for group membership particularly during the mating season. For reasons yet to be disclosed, the ideal group seems to have more than one adult male and about four adult females.

### **The Question of Pigtail Macaque (*Macaca nemestrina*) Population Density in the Khao Yai National Park, with Preliminary Data on the Ecology of a Semi-habituated Troop**

*Marie Claude Huynen<sup>1</sup>, H  l  ne Bernard<sup>1</sup>, Alice Latinne<sup>1</sup> and Tommaso Savini<sup>1,2</sup>*

<sup>1</sup>Department of Sciences and Management of Environnement, Behavioral Biology Unit,  
University of Liege, Belgium

<sup>2</sup>Conservation Ecology Program, School of Bioresources & Technology, King Mongkut's University  
of Technology Thonburi, Bangkok

Too many species are still known only by short studies done a long time ago. Although they provided precious information at the time of their publication, data available are too scanty to be used when defining policies of research and conservation of wild primates at the present time. There is however a great necessity of refining data available on many emblematic species. The Pigtail macaque, *Macaca nemestrina*, famous in Thailand, is described either as a shy macaque, exploiting large home ranges with widely distributed resources, or as a crop raiding pest, although traditionally used in coconut and mango picking. These contrasting views require examining the macaques' distribution in various environments, taking into account human disturbance of forests and presence of human related resources (gardens and crops, or other human managed areas, from roads to tourist installations).

As a part of a global project aiming at comparing pigtail macaques in various environments, we conducted a four-month study in Khao Yai National Park aiming at drawing a first estimation of population structure, home range and feeding ecology of a semi-habituated troop of pigtail macaques in a human managed area, and at testing a method of density assessment in an undisturbed part of the forest.

The semi-habituated troop was estimated at 40 macaques and was followed daily to collect data on activity budgets and diet. The troop home range size was about 1 km<sup>2</sup>, with a 15 ha core area including the main human managed area of the park where the monkeys spent 50 % of their time. The diet was mostly frugivorous, but also included mushrooms, insects, various birds' eggs or nestlings, and a lot of human food, given by tourists, found in garbage cans, or stolen from houses. The importance of the contribu-



tion of each of these food sources in their diet still has to be determined. The surveys on transects in the remote forest area gave too few data to allow the calculation of a valid density estimate in this short period of time. The surveys are to be prolonged for at least another year. In addition, a troop has been regularly heard in vicinity of the transect area, which suggests the possibility to begin the habituation and systematic observation of a second troop for comparison.

## **Range Use of Assamese Macaques (*Macaca assamensis*, Primates) in their Natural Habitat**

*Julia Ostner, Daniel Pesek, Brigham J. Whitman, and Oliver Schülke*

Integrative Primate Socio-Ecology Group, Max-Planck Institute for Evolutionary Anthropology,  
Deutscher Platz 6, 04103 Leipzig, Germany

The stunning diversity of animal societies can be structured at three levels: species and populations may vary in their social organization, their social structure, and their mating system. All species of the genus *Macaca* (Primates) live in cohesive multimale-multifemale groups with male dispersal and mate promiscuously but vary tremendously in their social structure, i.e., the pattern of social relationships between individuals. A prominent evolutionary explanation for the variation in social structure is the socio-ecological model that relates food resource characteristics to different modes of food competition that in turn are thought to determine patterns of social relationships in a population. The macaques of Thailand offer a unique opportunity to test this idea. At some places several species are sympatric and supposedly share large parts of their ecology while at the same time they represent the whole continuum of social relationships from the highly aggressive, despotic, nepotistic and intolerant rhesus macaque (*M. mulatta*) via the more relaxed species like longtailed, pigtailed and Assamese macaque (*M. fascicularis*, *nemestrina*, *M. assamensis*) to the highly tolerant stumptail macaque (*M. arctoides*) with high conflict symmetry, conciliatory tendency and low kin bias. In order to start elucidating minor ecological differences between species, we report on the first study on wild Assamese macaques living at Phu Khieo Wildlife Sanctuary, Chaiyaphum Province, in their natural habitat under conditions that are likely responsible in shaping their social relationships. We compare group composition to that of provisioned Assamese macaques studied in Northeast India and to those macaque species that have been studied extensively in the wild. And we analyze seasonal effects on daily travel distances and home range use to approximate the effect size of variation in food availability.

## **Preliminary Evidence for Ecological Risks among Juvenile Phayre's Leaf Monkeys**

*Kerry Ossi<sup>1</sup>, Carola Borries<sup>2</sup> and Andreas Koenig<sup>2</sup>*

<sup>1</sup>Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University, USA

<sup>2</sup>Department of Anthropology, Stony Brook University, USA

According to the juvenile risk aversion and the ecological skill-learning hypotheses, immature primates are still developing ecological skills such as those needed for predator avoidance and foraging. As a result, the juvenile period is a time of increased mortality risks. We investigated this assumption during a study of Phayre's leaf monkeys (*Trachypithecus phayrei*) at Phu Khieo Wildlife Sanctuary, Chaiyaphum province in northeastern Thailand. If juveniles are less efficient foragers than adults, then they should: 1) dedicate more time to feeding and foraging than adults, and/or 2) rely more on food items that are 'easier' to find or obtain. If juveniles face greater predation risk, then they should spend less time than adults at the highest and lowest tree heights.

Activity data were collected on all individuals from two habituated groups (12 juveniles, 14 adults; May through November 2004) using scan sampling. Activity budgets, diet and heights were compared between juveniles and adults using a Wilcoxon's signed-rank test with months as blocks to control for seasonal variation. Juveniles dedicated a greater proportion of observation time to feeding than did adults ( $P < 0.05$ ) and relied more on leaves in their diet ( $P < 0.05$ ), while adults tended to eat fruit and flowers more often ( $P < 0.1$ ). These differences might be attributed to feeding competition, which weighs more heavily on smaller juveniles. In addition, dietary differences may be related to leaves being easier for inexperienced juveniles to find and eat. In contrast to predictions about predation avoidance, juveniles did not use forest levels differently than adults. However, this result may not be unexpected if high competition at food patches forces juveniles to utilize more vulnerable spatial locations despite the potential risks.

## **A Pilot Project of Reintroducing a Threatened Species, Pileated Gibbons, in Khao Khieo – Khao Choompoo Wildlife Sanctuary, Chonburi, Thailand**

*Nantawan Yatbantoong<sup>1</sup>, Pongchai Dangsee<sup>2</sup> and Sompoad Srikosamatara<sup>1</sup>*

<sup>1</sup>Department of Biology, Faculty of Science, Mahidol University

<sup>2</sup>Krabok Koo Wildlife Breeding Center, Department of Wildlife, National Park and Plant Conservation, Ministry of Natural Resources & Environment

Pileated gibbon (*Hylobates pileatus*) is classified as vulnerable among 162 threatened species in Thailand (IUCN 2006). It is one of the most threatened primates due to habitat loss and hunting. However, many pileated gibbons are kept in captivity. Gibbon reintroduction is one choice for these captive gibbons and can be important for future conservation

programs. Lessons learned and accumulated experiences can help to develop efficient rehabilitation and reintroduction methods to cope with pet and confiscated gibbons in the future. This pilot project is a collaboration between an academic institution and conservation management authorities. The study has been using the best possible science combined with practical considerations. Six captive pileated gibbons have been released into Khao Khieo – Khao Chompoo Wildlife Sanctuary. Observation times for each released gibbon have varied from 31 to 678 hours. Five trials have been made: (1).release pair 1 in site 1 for 1 month, (2).recapture and release pair 1 in site 2 for 12 months, (3) release pair 2 in site 2 with 2 gibbons (pair 1) in an area for 20 days, (4) transfer male no.2 to adjacent area for 6 months and (5).release pair 3 to site 2 with 4 gibbons in the neighborhood for 3 months. The preliminary analysis of male no.2 in trials 3 and 4 showed that 3 weeks after release, the animal rested less (from 68% to 37%) and foraged more (from 16% to 27%). Twenty-two weeks after release, he played less (from 12% to 0%), traveled and called more (from 4% to 31% and 0% to 8%, respectively). Self grooming behavior was inconsistent about 1% in week 1 and week 22 after release. The area covered by this male was about 5.1 ha. He traveled 423 m/day on average (146–901 m/day).

## **Pileated Gibbon (*Hylobates pileatus*) Survey and Conservation in Thailand**

*Rungnapa Phoonjampa<sup>1</sup> and Warren Y. Brockelman<sup>2</sup>*

<sup>1</sup>WWF International Thailand Programme 104 Outreach Building, AIT, Paholyothin Road, Klong Nung, Klong Luang, Pathumthani 12120

<sup>2</sup>Department of Biology, Faculty of Science, Mahidol University, Rama 6 Road, Bangkok 10400

This research was carried out in 17 protected areas during April 2004 – March 2005, with the objective of obtaining rough population estimates of pileated gibbons (*Hylobates pileatus*) within the protected areas overlapping the species range in Thailand, and to provide field data for the preparation of a species action plan for the conservation priorities for the species. Listening post surveys were used to survey the pileated gibbon populations. A habitat assessment was carried out in primary forest to determine the area of suitable forest for gibbons, using Landsat images with Arcview GIS software. These methods were conducted in the largest protected areas including Khao Yai National Park (NP), Pang Sida NP, Tab Lan NP, Khao Soi Dao Wildlife Sanctuary (WS), and Khao Ang Ru Nai WS. The small protected areas in the range of pileated gibbon (5 national parks and 7 wildlife sanctuaries) were also evaluated qualitatively using questionnaires and interviews of local staff and villagers.

Results from the gibbon surveys in the five largest protected areas showed that suitable habitat of pileated gibbons occupies approximately 3,800 km<sup>2</sup> with an estimated 3,000 breeding groups, or about 12,000 individuals (assuming an average of 4 individuals per group, 2 of which are adults). Khao Yai NP had 610 km<sup>2</sup> of suitable habitat and a population of approximately 630 groups with the density of 1.03 groups/ km<sup>2</sup>, Pang Sida NP and the contiguous Tab Lan NP combined had 1,743 km<sup>2</sup> and contained 1,150 groups

(0.66 groups/ km<sup>2</sup>); Khao Soi Dao WS had 568 km<sup>2</sup> of suitable habitat with 378 groups (0.67 groups/ km<sup>2</sup>) and Khao Ang Ru Nai WS had 876 km<sup>2</sup> with 843 groups (0.96 groups/ km<sup>2</sup>). Pileated gibbons are still present in 10 out of 12 of the smaller protected areas. Habitat loss and hunting are the most serious problems for the largest pileated gibbon populations in Thailand. Education for local villagers and their cooperation, along with effective patrolling are strongly needed for long-term gibbon conservation.

## **Density, Behavior, and Ecology of White-handed Gibbons (*Hylobates lar*) in a Dry-evergreen Forest of Northeastern Thailand**

*Mayuree Umponjan<sup>1</sup>, Naris Bhumpakphan<sup>1</sup>, and Andreas Koenig<sup>2</sup>*

<sup>1</sup>Department of Forest Biology, Faculty of Forestry, Kasetsart University, Bangkok 10900

<sup>2</sup>Department of Anthropology, Stony Brook University, Stony Brook, NY, USA

Most previous studies on white-handed gibbons (*Hylobates lar*) characterizing them as monogamous, frugivorous primates living in small territories have been conducted in evergreen forests. Given that habitat differences affect behavior and ecology, one should expect that gibbons in areas with lower productivity live at lower densities, have larger home ranges and less fruit in the diet. The current study is a first step towards testing this prediction. It was conducted at Phu Khieo Wildlife Sanctuary, Chaiyaphum Province, Northeast Thailand, from November 2003 to October 2004. Density was estimated via the auditory method (2 listening posts;  $\geq 2$  days each month). In addition, a semi-habituated group was followed for 2–4 days every month. The activity of each individual was noted every 20 minutes via scan sampling and locations were determined using a GPS receiver. Density was estimated at 2.5 groups and 8.4 individuals per km<sup>2</sup>. This result matches very well the results on home range size. It was estimated at 59.7 ha (95% kernel) with a non-overlapping core area of 41 ha. The most common activity of the adult gibbons was locomotion (28.5%) followed by feeding (25.3%) and affiliative behavior such as grooming and playing (18.3%). The diet was dominated by ripe fruits (42%) in addition to unripe fruits (16%) and young leaves (22%). Compared to other studies the density of this population appears to be very low and the home range size is one of the largest ever reported. The gibbons of Phu Khieo WS moved longer and had less fruit in the diet than other populations. It is possible that either a lower productivity of the forest or the highly diverse animal community (e.g., 8 primate species) at Phu Khieo WS do not allow for higher densities. Lower productivity would also explain the rather low amount of fruits in the diet. Future studies should directly estimate the habitat productivity and between-species competition in this population. Furthermore, it would be desirable to directly compare the forest composition and phenology to other forests inhabited by white-handed gibbons.

## Are Gibbons and Hornbills Food Competitors?

*Chuti-on Kanwatanakid-Savini<sup>1,2</sup> and Tommaso Savini<sup>3</sup>*

<sup>1</sup>Department of Biology, and <sup>2</sup>Thailand Hornbill Project, Department of Microbiology, Faculty of Science, Mahidol University, Rama 6 Rd., Bangkok 10400, Thailand

<sup>3</sup>Conservation Ecology Program, School of Bioresources & Technology, King Mongkut's University of Technology Thonburi, Bangkokthien, Bangkok 10150, Thailand

In most Southeast Asian forests both frugivorous hornbills and gibbons live in extended sympatry. Their common food preference for ripe fruit plays a significant role in forest ecology due to their function as seed dispersers but on the other hand, might play an important role by increasing food competition. Here we combined results obtained during both long-term and detailed short-term, socio-ecological studies on feeding ecology and reproductive strategies on white-handed gibbon and hornbill populations at Khao Yai National Park. Our results show an extended overlap in the breeding period between both animal groups at Khao Yai National Park with gibbon conception clustered between February and April and hornbills nesting between January and June. During this period both gibbon and hornbills show a high dependence on good quality food resources. As aggressive interactions between hornbills and gibbons were never observed, we assumed feeding competition between the two species to be a simple exploitation assessed by a) investigating the level of diet overlap between species, b) measuring nutritional quality of individual food items and c) quantifying the abundance of shared food species in the habitat. Our results show a high degree of dietary overlap between the two animal groups during the breeding period creating the potential for competition based on simple exploitation of higher quality resources. Moreover, a detailed analysis on the type and direction of overlap show an asymmetry in the direction of competition which might place hornbills at a disadvantage relative to gibbons.

## The Science and Art of Monitoring Wild Tigers

*K. Ullas Karanth*

Technical Director –Tigers Forever, Wildlife Conservation Society

Science essentially involves confronting our 'models' of nature against data from the real world, in a continuous effort to refine our knowledge of the system under study. Scientific monitoring of animal populations is therefore best viewed in the context of questions such as why monitor, what to monitor and how to monitor. This talk will cover reasons for which wild tiger populations need to be monitored, what are the 'state variables' that we need to monitor and how we can go about monitoring these parameters of interest. Measurement of parameters such as habitat occupancy and population abundance as well as vital rates that drive changes in these variables are examined in the context of modern survey sampling methods, parameter estimation and modeling approaches. Thereafter the critical issue of integrating knowledge of tiger ecology with the local social context

and the availability of human, technical and financial resources is discussed. Thus, we see that inevitably, the science of monitoring tigers turns into something of an art too. The challenges involved in the social process of integrating scientific monitoring data on tigers into practical conservation or management measures in the real world is illustrated based on examples from long-term work in India. A vision of how ecological knowledge about tigers can be applied to managing wild tiger populations across large landscapes is presented in the context of the new WCS initiative *Tigers Forever*.

## **Effects of Human–Carnivore Conflict on Tiger and Prey Populations in Lao PDR**

*Arlyne Johnson, Chanthavy Vongkhamheng, Venevongphet, Thavisouk Saithongdam and Michael Hedemark*

Wildlife Conservation Society, Box 6712, Vientiane, Lao PDR

Unique to South-east Asia, the Lao People's Democratic Republic contains extensive habitat for tigers and their prey in a multiple-use protected area system covering 13% of the country, although the abundance or distribution of these populations remains unknown and human–carnivore conflict is largely unmanaged. We examined the abundance and distribution of tiger and prey in the 3,446-km<sup>2</sup> Nam Et – Phou Louey National Protected Area (NPA) on the Lao-Vietnam border, which also reports a relatively high incidence of large carnivore attacks on livestock. We did intensive camera-trap sampling of large carnivores and prey and collected baseline data on incidents of large carnivore depredation of livestock from NPA villages. Tiger density for the sample area ranged from 0.2–0.7 individuals/100 km<sup>2</sup>. Relative abundance of large ungulates was low throughout whereas that of small prey was significantly higher where human density was lower. Tiger poaching, followed by prey depletion, are factors having the greatest effect on tiger abundance in northern Lao PDR.

## **Crop Damage Assessment and Pattern of Human–elephant Conflict in Kaeng Krachan National Park**

*Puntipa Pattanakaew<sup>1</sup>, Simon Hedges<sup>2</sup>, Thongbai Charoendong<sup>1</sup>, Petch Manopawitr<sup>1</sup> and Chumpon Kaewket<sup>3</sup>*

<sup>1</sup>Wildlife Conservation Society-Thailand Program

<sup>2</sup>Wildlife Conservation Society-Asia Program

<sup>3</sup>Kaeng Krachan National Park

Human–elephant conflict (HEC) is a major problem around Kaeng Krachan National Park (KKNP). The commonest form of HEC is crop raiding by elephants, and this can be a major burden on farmers and lead to bad feelings towards protected areas and elephants. The aim of the project was to quantify and then reduce levels of HEC around

KKNP. Thus, data on the spatial and temporal distribution of crop raiding by elephants is necessary. From November 2004 to September 2006, 604 HEC incidents were recorded at the southern part of KKNP using a standardized protocol. The incidents were found in 17 villages in 2 provinces and 219 farmers were affected. The number of incidents in the first year was much higher than the second year. Seasonal change was not related to this pattern since the number of incidents between the wet and dry seasons was not significantly different. The results indicated that the distance from agriculture field to forest edge correlated with the number of incidents ( $R^2 = 0.84$ ). The majority of incidents (66%) took place in locations that did not have crop protection schemes, where as only 22% of the incidents happened in places which had cooperative guarding (> 4 people guarding). Spotlighting, fire crackers and human voices were the most common forms of elephant deterrent methods. The most common number of raiding elephants was 1–4 individuals (55%) and 2100–2359 h was the most active period for elephant raiding (37%). Fifty-two species of crops were damaged by elephant but only 22 species were eaten. The most targeted crops for elephant raiding were banana (26%), pineapple (22%), and jackfruit (15%). Crops eaten by elephant were mostly in the mature stage (56%). The estimated market value of the damaged crops was relatively high (131,765 USD/year) compared to the local economy (864 USD income per capita). We have conducted experiments to assess effectiveness of several mitigation methods since October 2006. The pattern of HEC and the findings from the experiments helped find more appropriate mitigation methods. Long-term solutions for the HEC problem in KKNP is likely to be alternative landuses and substantially increased cooperation among local stakeholders.

### **Rodent Pest Control in Oil Palm Plantations through the Reintroduction of Artificial Barn Owl (*Tyto alba*) Nests, Chumporn Province, Southern Thailand**

*Greangsak Hamarit<sup>1</sup>, Sara Bumrungsri<sup>2</sup>, Sunate Karapan<sup>2</sup>, and Vijak Chimchome<sup>1</sup>*

<sup>1</sup> Department of Forest Biology, Faculty of Forestry, Kasetsart University

<sup>2</sup> Department of Science, the Prince of Songkla University

Barn owls (*Tyto alba*) have been proposed as a means of rodent control in agricultural areas, especially in oil palm plantations. Due to the habitat alteration and abundant food, rodents are extremely numerous in oil palm plantations and cause considerable damage to crops resulting in financial losses. Traditionally, rodenticides have been applied to control pest rodents periodically and thus the ecosystem is contaminated, and predators including other non-target wildlife harmed. Reintroduction of young barn owls hatched from artificial nest boxes in an oil palm plantation at Amphoe Prasaeng, Suratthani Province were introduced into a palm plantation in Amphoe Pratew, Chum-porn Province by using a soft-release technique and provisioning of artificial nest boxes. We introduced 30 barn owls and installed 125 plywood nest boxes in the 20 km<sup>2</sup> oil palm estate. Twenty four broods were produced in the 2005/2006 breeding season with  $5 \pm 2$  eggs/nest and  $2.3 \pm 1.5$  chicks/brood on average and 80 birds in total. The total barn owl population after the

first year was estimated to be 110 owls. After 3 years of the barn owl reintroductions, the number of rats, estimated by spotlighting count techniques, decreased from 37.5 to 5.0 rats/ha. This system benefits the oil palm plantation owners by allowing them to stop using rodenticides while improving ecosystem health.

## **Studying the Effect of Forest Connectivity on Ecological Processes—Implications for Wildlife Movements and the Management of Protected Area Networks**

*Scott Harrison*

BC Hydro, 6911 Southpoint Drive, Burnaby, British Columbia, Canada, V3N 4X8

A challenge for ecologists is to develop ecological theory that describes the dynamics of organisms while simultaneously exploring solutions for the conservation of organisms in the context of human land-use. Theory suggests that the ecological processes of natality, survival, movement, and juvenile dispersal define population demography through births, deaths, immigration, and emigration. Applied ecologists work to understand the dynamics of populations faced with human-induced perturbations. For example, applied ecologists are often interested in understanding how human land-use affects forest connectivity and how changes in forest connectivity affect the effectiveness of protected areas. Three key design features improve the rigor of studies intended to address applied ecological questions:

- 1) the examination of ecological processes,
- 2) the use of comparative treatments to collect empirical field data, and
- 3) a spatial scale of the research that is relevant both to the study species and to human land-use.

Research with these three features provides valuable empirical data to assist the sustainable management of natural resources; however, it is difficult to conduct studies with this level of rigor. Moreover, determining ecological limits is fraught with challenges that reflect the inherent diversity, complexity, and dynamics of ecological systems. Ultimately, there is always uncertainty associated with determining what levels of human actions might exceed ecological thresholds.

Adaptive management is a structured, iterative process that guides management and enables humans to learn how to maintain ecological systems while benefiting from ecosystem goods and services. Adaptive management uses multiple, competing hypotheses and proper experimentation to enable managers to embrace uncertainty and to learn how the ecological system responds to different management actions.



## **How Much Protected Area is Enough to Conserve Biodiversity in Thailand?**

*Yongyut Trisurat*

Department of Forest Biology, Faculty of Forestry, Kasetsart University, Bangkok 10900, Thailand

Protected areas in Thailand were first established 40 years ago. The total area of existing protected areas covers 18.1% of the country's land area and the Class 1 watersheds, another form of protection, encompasses 18.2%. The government of Thailand intends to increase the protected area systems to 25% of the country in 2006 and 30% in 2016. There are always questions arising about how much is enough to effectively protect biodiversity. The objective of this paper is to assess the representation of ecosystems in the protected area network. This paper also recommends which under-represented ecosystems should be added to fill the gaps in representativeness. The research applies a gap analysis and a comparison index (CI) to assess the representation of ecosystems within the protected area network. Spatial analyses were applied to measure three aspects of representativeness, namely, forest type, elevation, and natural land system. The analyses indicate that the existing protected area system covers 24.4 percent of the country's land area, nearly meeting the 25% target proposed by the National Forest Policy; and 83.8% of these areas are under forest cover. Most protected areas are situated in higher elevations, where biological diversity is less than in lowlands. In addition, they are not well distributed within the 25 river basins. Mangrove forest and riparian floodplain are extremely under-represented in the existing system. Peat swamp forest, dry dipterocarp forest and beach forest are relatively well represented. In addition, these five ecosystems are threatened by human pressures and natural disasters; therefore they should be targeted as high priorities for the selection of new reserves. Future research should incorporate aquatic and marine ecosystems, as well as animal distributions, which were not included in this research due to a lack of data.

## **Can Wetland Ecosystems in the Lower Songkram River Basin Be Saved?**

*Samang Homchuen<sup>1</sup>, Yasushi Sasaki<sup>2</sup> and Mitsuaki Omuro<sup>2</sup>*

<sup>1</sup>Department of Environmental Science, Faculty of Science, Khon Kaen University, Khon Kaen 40002

<sup>2</sup>Department of Civil Engineering, Faculty of Engineering, Saitama University, Saitama 338-8570, Japan

The Lower Songkram River Basin (LSRB) encompasses a broad range of wetland habitats associated with the functional floodplain ecosystem that link to the Mekong basin. Due to the variety of habitat types, the basin contains valuable natural resources. Communities located along the Songkram floodplain exhibit a high degree of dependency on wetland resources for their livelihoods such as capture fisheries, fish processing, harvesting wetland products, agriculture and livestock grazing. Thailand's economic

development during the past decade resulted in changes of local livelihood and greater complexity. Fish captured as a means to barter for essential goods has changed to fishery for cash income. Conflicts are occurring between small and large-scale fishers. Wetland ecosystems in the LSRB are gradually being converted to farmlands such as eucalyptus plantations and tomato fields. The wetland ecosystems are also deteriorating from human activities, especially big dams on the upper Mekong Basin and weirs as well as from the impact of climate change. The study conducted during 2004–2006 on wetland ecology, biodiversity, resource utilization in the LSRB indicates that impacts to wetland ecosystems and community structures are well-recognized but practical and economical wetland ecosystem management at local and regional scales remains limited. Due to early water level decreases in the dry season, construction of check dams in sub-tributaries is recommended to balance water levels and extend flooding periods.

### **Biodiversity and Economic Value of Wetland Resources at the Nong Han Wetland, Udonthani Province**

*Adcharaporn Pagdee<sup>1</sup>, Samang Homchuen<sup>1</sup>, Narumon Sangpradab<sup>2</sup>,  
Chuthima Hanjavanit<sup>2</sup> and Pornchai Uttharak<sup>2</sup>*

<sup>1</sup>Department of Environmental Science, Faculty of Science, Khon Kaen University, Khon Kaen, 40002

<sup>2</sup>Department of Biology, Faculty of Science, Khon Kaen University, Khon Kaen, 40002

A biodiversity survey was conducted at the Nong Han wetland, Udonthani, and within a 3-km proximity, from June to August 2006 as part of Udonthani's provincial environmental and natural resources management plan. Because biodiversity greatly contributes to human well-being, especially local subsistence, an economic valuation was carried out to estimate net direct benefits that local communities derived from their biodiversity resources. In total, 200 household representatives participated in the economic valuation survey. Nong Han is the second largest wetland in the Northeast and declared an internationally important wetland site. The area is surrounded by marshes, agricultural zones, dikes, and scattered woodlands. A populated island called Donkaew is situated in the southwestern end of the wetland. The survey identified 177 plant species, including 114 tree species and 63 aquatic plants. Of the trees, 74 are native and 40 are introduced. For aquatic plants, 38 species are marginal, 10 species are floating, 9 species are emerged, and 6 species are submerged. In total, 16 orders, 44 families, and 74 species of invertebrates were identified from Ekman bottom grab and pond net samples. Arthropods represent the most diverse and abundant invertebrates, followed by mollusks and annelids. Forty-six species of fish from 18 families were recorded from fish captured by local villagers. Approximately, 98% of the fish recorded are native and 2% are introduced (Cichlidae Family). Fifty-two bird species were observed using point count methods. *Ploceus hypoxanthus* is considered Near Threatened by IUCN (2006), and *Ardea purpurea* is classified as Endangered according to Thailand's red data list (1999). A net economic value of these biodiversity resources estimated from gross direct benefits and direct costs, including harvesting tools and equipment, traveling and labor costs is 10,534 baht/household, accounted for 32% of an annual household income of this local economy. In conclusion, Nong Han is home to

a great amount of biodiversity which local subsistence depends upon. Inventory of the resources and their economic values is necessary for biodiversity management because it provides useful information that enables decision makers to develop management plans that represent congruence between habitat protection and sustainable use.

## **External Morphological Characters of Tadpoles Related to Different Habitat Types in Chiang Dao, Chiang Mai Province**

*Ruthairat Songchan<sup>1</sup> and Jarujin Nabhitabhata<sup>2</sup>*

<sup>1</sup>Department of Forest Biology, Faculty of Forestry, Kasetsart University, Bangkok, Thailand

<sup>2</sup>National Science Museum, Bangkok, Thailand

Research was conducted in the District of Chiang Dao, Chiang Mai Province between January–December 2005. Data were collected in different habitat types six times, with 327 individuals collected at 61 sample points. Six environmental factors were measured at each sample point. Nineteen tadpole species were encountered during the study. Four species were recorded only in permanent water, three species only in temporary ponds, and twelve species occurred in both kinds of water bodies. *Rhacophorus bipunctatus* used more habitats than other species. The results from using cluster analysis based on 22 external morphological characteristics with 62.5% dissimilarity/disagreement could divide tadpoles into five groups. In addition, the results using ordination techniques, graphically demonstrated a scattering of samples and environmental factors. This was clearly seen in two dimensional coordinates in axes 1 and 3. The percentage of variance explained was greatest for axis 1, at 8.2%. Percent of variance explained by axes 2 and 3 was 8.0% and 7.4% respectively. The cumulative percentage in axis 1 was 8.2%, while those for axes 2 and 3 were 16.2% and 23.6% respectively. The consistency value of scatter was highest in axis 1, which was 0.856. Those for axis 2 and 3 were 0.842 and 0.779. From the six environmental factors, the level of rainwater was the most significant factor for the occurrence of each group of tadpole in the study area.

## **Pollen-limited Seed Initiation in *Etlingera littoralis* (Zingiberaceae) at Khao Nan National Park**

*Susan J. Mazer<sup>1</sup>, Hathaikarn Sittha<sup>2</sup>, Rattachak Chucham<sup>3</sup>, Tunjit Sritongchuay<sup>3</sup> and Napat Kittipanangkul<sup>4</sup>*

<sup>1</sup>Department of Ecology and Evolutionary Biology, University of California, Santa Barbara, California, U.S.A.

<sup>2</sup>Department of Botany, Chulalongkorn University, Bangkok

<sup>3</sup>Prince of Songkla University, Hat Yai, Songkhla Province

<sup>4</sup>Department of Biology, Walailak University, Thasala, Nakhon Si Thammarat Province

*Etlingera littoralis* (J. König) Giseke (Zingiberaceae) is a perennial herbaceous species with pseudostems that reach 2–3 m in height; it occurs commonly in the rainforest

understory throughout the Malay Peninsula and Indonesia. We used this species as a model in which to conduct the first investigation in Thailand (to our knowledge) of pollen limited reproduction in a wild species. An individual or population is defined as pollen limited when the addition of pollen to open flowers results in an increase in one or more components of reproduction (e.g., seed development, seed set, fruit set, or seed or fruit yield) relative to that of unmanipulated flowers. Accordingly, studies of pollen limitation can be used to assess the degree of pollinator service experienced by natural plant populations relative to their potential to use pollen to achieve maximum seed production. To determine whether seed development is pollen limited in natural populations of *E. littoralis* at Khao Nan National Park (Khlong Klai Basin, Nakorn Sri Thammarat Province), we compared rates of seed initiation (detected as ovule expansion five days after pollination) in 29 hand-pollinated vs. 30 control inflorescences in secondary forest adjacent to a rubber tree farm and agricultural land. We examined all ovules in three ovaries per inflorescence, classifying each ovule as either expanding or failing to expand (a total of > 23,000 ovules were observed). Ovaries in hand-pollinated inflorescences contained a significantly higher proportion of expanding ovules than did ovaries in Control inflorescences (68% vs. 28%). Moreover, more than twice as many Control ovaries (N = 20) contained no expanding ovules (seed initiation rate = 0) relative to the number of hand-pollinated ovaries in this category (N = 8). We conclude that seed initiation rates were limited by natural levels of pollen deposition during the study period (April 2006), but we cannot infer that levels of mature seed production would also have been pollen-limited. Spontaneous seed abortion prior to seed maturation could equalize rates of seed production per fruit or per inflorescence between hand-pollinated and unmanipulated inflorescences.

### **Pollination Ecology of *Oroxylum indicum* Vent. (Bignoniaceae), in Southern Thailand**

*Tuanjit Srithongchuay and Sara Bumrungsri*

Biology Department, Faculty of Science, Prince of Songkla University, Hat Yai, Songkhla Province

In the Bignoniaceae family, studies on the breeding system and pollination has shown some instances of co-evolution with their pollinators. The floral biology of *Oroxylum indicum* is of interest in terms of its relationships with pollinators. The floral biology and pollination ecology of this tropical pioneer tree were determined. The study was conducted in southern Thailand. The flowers vary between 30 and 60 flowers in an inflorescence. Corolla is infundibuliform, 5-lobed. The corolla tube is purple-red externally, and creamy internally. Anthesis occurred shortly after the flowers opened in the evening. The stigmas remained receptive from the period of flower opening through the whole first night. Five pollination treatments tested the fruit set: natural pollination, automatic self pollination, self induced pollination, hand pollination, and insect pollination. The best fruit set produced 52% of the flowers in the hand-cross pollination. *O. indicum* is a self incompatible tree and the pollination experiments have indicated that cross pollination is necessary for setting fruit. The differences in fruit set between natural conditions and hand cross pollination were not significant. The flowers were visited during the night by bats and moths. Only the fruit

bats, *Eonycteris spelaea*, however, were important pollinators. *O. indicum* is extremely dependent on fruit bats for its reproductive success. Floral characteristics of *O. indicum* closely correspond to the well-known pollination syndrome of chiropterophily.

### **Pollinator Limitation on Fruit and Seed Sets in *Etlingera elatior* (Jack) R.M. Smith (Zingiberaceae) at Khao Nan National Park**

*Napat Kittipanangkul and Chatchai Ngamriabsakul*

School of Science, Walailak University, Thasala, Nakhon Si Thammarat, Thailand

Although *Etlingera elatior* (Jack) R.M. Smith (Zingiberaceae) or torch ginger is widely cultivated as an ornamental plant in tropical gardens, the pollination of the species has never been studied. The floral morphology and pollination biology of *E. elatior* were investigated at Khao Nan National Park, Nakhon Si Thammarat, southern Thailand. Its inflorescences and flowers are red with long corolla tubes, suggesting the nature of a bird pollination syndrome. This was confirmed by 132 hours of observation. Three species of birds (spiderhunters; *Arachnothera affinis*, *A. chrysogenys*, and *A. longirostra*) and a species of stingless bee (*Trigona collina*) were found to be pollinators. Visitation rates of pollinators were generally high, averaging at 3.71 flowers per minute for the stingless bee and 2.96 flowers per minute for the spiderhunters. In addition, numbers of fruit set were counted to verify the effectiveness of the pollinators. Mean fruit set per inflorescence was 5 times higher on unmanipulated flowers than partial-bagged flowers ( $P < 0.0001$ ), and mean seed set per fruit was 3 times higher ( $P < 0.0001$ ). These results suggest that pollinator limitation would occur in *E. elatior*, if there was a lack of spiderhunters. There was no significant difference between unmanipulated flowers and hand-pollinated flowers in mean seed set per fruit ( $P = 0.664$ ), while mean fruit set per inflorescence of unmanipulated flowers was 2 times higher than hand-pollinated flowers. However, bagged flowers gave no fruits. The height of the inflorescence and the number of fruit set on individual inflorescences were significantly related: number of fruits =  $-328.19 + 4.31 \times \text{Height}$  (linear regression,  $R^2 = 0.889$ ,  $F=144.621$ ,  $P < 0.0001$ ). These relationships infer that taller inflorescences have a greater chance of pollination by spiderhunters than lower inflorescences.

## **Evolutionary Diversification of a Mutualism**

*Rhett D. Harrison*

Smithsonian Tropical Research Institute Casilla 2072, Avenida Balboa, Panama, Republic of Panama

Figs are one of the most important plant genera in tropical forests and are remarkable for the diversity of species that co-exist. Indeed throughout the tropics they are often the most diverse genus of dicotyledonous plants, and assemblages are particularly rich in the Asian region. At Lambir Hills over 80 species co-exist. Figs are also known for their unique pollination system in which tiny seed predator-pollinator wasps raise their offspring in the fig inflorescence. Figs and their pollinators have co-evolved for at least 80 million years. Moreover, the pollinators co-exist with a taxonomically diverse suite of non-pollinating fig wasps, including competitors and parasitoids, which together can form assemblages of over 20 species per fig host. Finally, to conservation biologists, figs are renowned for the importance of their fruit to wildlife. Over 1200 species of vertebrate eat figs globally, and locally the proportion of bird and mammal assemblages feeding on figs varies from 15% to over 30%. Thus, understanding the evolutionary and ecological factors underlying the diversity of figs may lead us to a better appreciation of the diversity of life, especially in tropical forests. Focusing on the monoecious hemi-epiphytic figs, often erroneously known as “Stranglers”, which form a particular species-rich group of closely related species, I describe the niche differentiation among species with respect to colonization environment, phenology, and dispersal behavior of their pollinators. Separate guilds occupy emergent, canopy, and understorey hosts. Species found higher in the canopy have larger inflorescences, flower less frequently, and their pollinators fly higher above the canopy, compared to species found lower in the canopy. These results illustrate the evolutionary diversification of figs and how the intricate mutualism with their pollinator has both contributed to and constrained their evolution.

## **Seed Dispersal and Forest Restoration: a Pantropical Comparison**

*Richard T. Corlett*

Department of Ecology & Biodiversity, University of Hong Kong, Pokfulam Road, Hong Kong, China

Seed dispersal is a key process in the recovery of forest ecosystems on deforested sites. Animals disperse the seeds of most woody plants in the tropics, so differences between regions in the disperser fauna could have major implications for the recovery process. The five major tropical forest regions (Asia, Africa, Madagascar, Neotropics, and New Guinea) are distinct ecological and biogeographical entities and their forests can be viewed as more or less independent evolutionary responses to similar environments. Recovering forest landscapes in Asia and Africa share many disperser taxa (e.g. bulbuls, pteropodid fruit bats, cercopithecine monkeys, viverrids), while there are both similarities and differences between these areas and Madagascar and New Guinea. By contrast, the disperser fauna in the Neotropics is dominated by endemic bird and mammal families

with, in several cases, well-documented differences in the way fruits are acquired and processed and seeds are transported and deposited. For example, the tanagers (Thraupinae), particularly *Thraupis* spp., are in many ways the Neotropical counterpart of the open-country bulbuls, but, unlike bulbuls, they often mash fruits before swallowing so large seeds are dropped. There are similar contrasts in the way Old and New World monkeys and fruit bats process fruits and disperse seeds.

The consequences for woody succession of these dichotomies in the behavior of the major frugivore families in the Old and New Worlds has not yet been investigated, but there are striking differences in the relative importance of different animal groups in dispersing seeds into open areas which may, at least in part, be a reflection of these differences in behavior. In the Neotropics, early successional woody vegetation is typically dominated by tiny-seeded pioneers, which are often dispersed by fruit bats, while in the Asian tropics such vegetation is usually dominated by larger-seeded plants dispersed by passerine birds. Unfortunately, there is insufficient information at present to extend this comparison to the other tropical forest regions. An interesting twist to this story is that several species of woody pioneers have been transported outside their regions of origin and have become invasive species in other regions, where they are dispersed by native animals.

Differences between regions at the later stages of succession have not been documented but would, again, be expected on the basis of known differences in disperser behavior. Where disperser faunas are more or less intact, the apparently greater willingness of Old World primates and terrestrial herbivores to cross open areas may facilitate the dispersal of large-seeded plant species into fragmented successional vegetation. On the other hand, the reported larger size of fruits and seeds in the Old World may make dispersal of late-successional plants more vulnerable to the hunting that has eliminated all large frugivores from vast areas.

## **Characteristics of Vertebrate-dispersed Fruits in a Hill Evergreen Forest of Khao Yai National Park, Thailand**

*Shumpei Kitamura<sup>1,2</sup>, Takakazu Yumoto<sup>1,3</sup>, Pilai Poonswad<sup>2</sup> and Prawat Wohandee<sup>4</sup>*

<sup>1</sup>Center for Ecological Research, Kyoto University, 2-509-3 Hirano, Otsu, Shiga, 520-2113, Japan

<sup>2</sup>Thailand Hornbill Project, Department of Microbiology, Faculty of Science, Mahidol University, Bangkok 10400

<sup>3</sup>Research Institute of Humanity and Nature, Kamigamo-Motoyama 457-4, Kyoto, 603-8047, Japan

<sup>4</sup>National Park, Wildlife and Plant Conservation Department, Paholyothin Road, Bangkok 10900

We examined characteristics of vertebrate-dispersed fruits (81 species of 34 families) in a hill evergreen forest of Khao Yai National Park, Thailand in order to test the generality of patterns of fruit characteristics observed elsewhere in Thailand as well as Southeast Asia. The distribution of most fruit characteristics was highly skewed. Median fruit weight for the species investigated was 0.83 g (range 0.02–89.5) and the median fruit diameter was 8.6 mm (range 3.2–81.6). The median weight of seeds was 0.09 g (range 0.01–3.3) and the median seed diameter was 5.2 mm (range 0.1–16.9). More than half the fruit species had a single seed (56%). Most of the fruits were indehiscent with a thin husk (78%),

followed by dehiscent fruits (14%; Celastraceae and Euphorbiaceae), indehiscent fruits with a thick husk (6%; Zingiberaceae), and nuts (3%; Fagaceae). The commonest fruit colors in the forest were black (31%) and red (24%), followed by orange (14%). Despite the different floral composition between hill evergreen forest and moist evergreen forest in Khao Yai, there are not significant differences among fruit characteristics, except for fruit/seed size; there are much smaller fruits and/or seeds in hill evergreen forest than in moist evergreen forest. This probably reflects occasional periods of low temperature in the dry season which has limited the distribution of large-fruited families in hill evergreen forest such as the Annonaceae, Meliaceae, and Myristicaceae, which are otherwise common large-fruit families in moist evergreen forest and lowland dipterocarp forest in Thailand as well as Southeast Asia.

### **Mallards as Seed Dispersers: Gut Retention Time, Seed Retrieval and Germination of Different Wetland Plant Species, Pacific Northwest, USA**

*Chanpen Wongsriphuek<sup>1,3</sup>, Bruce D. Dugger<sup>2</sup> and Anne M. Bartuszevige<sup>2</sup>*

<sup>1</sup>Department of Biology, Faculty of Science, Mahidol University, Rama 6 Road, Bangkok 10400

<sup>2</sup>Department of Fisheries & Wildlife 104 Nash Hall, Corvallis, Oregon 97331 USA

<sup>3</sup>Center for Conservation Biology, Institute of Science and Technology for Research and Development, Mahidol University, Salaya, Phutthamonthon 4 Road, Nakhon Pathom 73170

Seed dispersal capabilities of wetland plants are poorly understood, but may be both passive and active. Waterfowl commonly eat the seeds of wetland plants and therefore may be important active dispersers of wetland seed, either transporting seeds externally or in their digestive track. Species like mallard (*Anas platyrhynchos*) that have global distributions, travel great distances between breeding and wintering areas, and use isolated wetlands throughout their range, may be particularly important for some species. We investigated the ability of wetland plant seeds to survive in the gut of mallards by feeding a known number of seeds from several common wetland plant species to captive mallards. We collected fecal samples every 4 hours up to 48 hours. All of seeds recovered were germinated and recorded up to 60 days. Total retrieval and germination of seeds differed among plant species and decreased significantly over retention time. Most seeds were recovered during the first 4 h ( $66.11 \pm 9.22\%$ ), but some seed species were recovered up to 48 h. The highest percentage of viable seed recovered was *Rumex crispus* (5.28%) while the lowest was found in *Echinochloa crusgalli* (0.61%). Based on mallard flight speed, they are able to transport seeds approximately 400 km typically and up to 2500 km rarely. We found a low proportion of wetland plant species seed dispersed (max =1.56%, min =0.01%). Nevertheless, the movement of the thousands of mallards among wetlands becomes a significant dispersal mechanism of many wetland plant species, particularly during migration.



## **Managing Forest Succession for Biodiversity Recovery: Balancing Ecological and Economic Needs**

*Stephen Elliott<sup>1</sup> and David Blakesley<sup>2</sup>*

<sup>1</sup>Forest Restoration Research Unit, Biology Department, Science Faculty, Chiang Mai University, Chiang Mai

<sup>2</sup>Wildlife Landscapes, 16 Small Hythe Close, Bearsted, Maidstone, Kent ME15 8JJ, UK

With more than half of Earth's primary tropical forest gone and no signs that rates of forest loss will decline over the next few decades, survival of tropical biodiversity will depend increasingly on innovative technologies and novel socio-economic mechanisms to restore forests where they have been destroyed. At the same time, as human populations and affluence in developing tropical countries grow, compromises must be made between the ecological necessities for effective biodiversity restoration and the realities of meeting the economic needs of local people. This paper reviews the range of current restoration options in landscapes subjected to various levels of degradation. It stresses the need to select appropriate techniques according to critical points in the ecological succession sequence including i) the point at which reduced tree seed sources and/or seed-dispersing animals become limiting; ii) the point at which cover of shrubs and herbs exceeds that of trees and iii) the point at which soil degradation becomes limiting. The roles of accelerated (or assisted) natural regeneration (ANR), the framework species method and the maximum diversity methods of forest restoration and use of nurse crops (foster ecosystems) in addressing these constraints are discussed. Even forms of forestry, primarily designed to yield economic benefits, can be modified to stimulate biodiversity recovery. Traditional single species plantations can be sensitively managed to encourage natural regeneration of many indigenous forest tree species, provided weeding, thinning and harvesting are carried out with minimum damage to the understorey. Mixed species plantations and agro-forestry systems provide greater structural diversity for colonization by wildlife, whereas analogue forestry attempts to closely mimic the tropical forest structure using economic species. Although some trade-off between biodiversity and economic yield is inevitable, restoration forestry can be modified to increase economic yield (and make it more attractive to local people) and economic forestry can be managed more sensitively to increase biodiversity recovery.

## Effects of Planted Trees and Bird Community on Natural Seedling Recruitment in a Forest Restoration Area Using the Framework Tree Species Method

*Chawapich Wydhayagarn*

Forest Restoration Research Unit (FORRU), Biology Department, Science Faculty,  
Chiang Mai University, Chiang Mai

Forest restoration using framework tree species involves attracting seed-dispersing animals, such as birds that can help increase seedling recruitment by dispersing seeds into planted areas. This study was carried out to determine the effects of framework trees species and bird community on natural seedling recruitment in a forest restoration area using the framework species method of the Forest Restoration Research Unit (FORRU) Biology Department, Faculty of Science, CMU at Ban Mae Sa Mai Mae Rim District, Chiang Mai in Doi Suthep-Pui National Park. Natural tree seedlings were surveyed beneath five framework tree species, which have different abilities to attract seed-dispersing birds. The framework tree species were *Erythrina subumbrans*, *Hovenia dulcis*, *Melia toosenden*, *Prunus cerasoides* and *Spondias axillaris*. Five individual trees of each species were selected (25 trees in total) from 3 planted plots of the same age (8-years-old) in different areas. All natural tree seedlings present in each plot were surveyed. Seedlings were labeled, identified, and classified according to their seed-dispersal mechanism. Bird observations using binoculars were done on each framework tree to determine species richness, diversity, abundance and density, which were assumed to affect natural seedling recruitment.

## Natural Establishment of Tree Seedlings in Forest Restoration Trails in Northern Thailand

*Khwankhao Sinhaseni, Stephen Elliott and Prasit Wangpakapattanawong*

Forest Restoration Research Unit (FORRU), Biology Department, Science Faculty,  
Chiang Mai University, Chiang Mai

The Forest Restoration Research Unit (FORRU), Chiang Mai University, has successfully adapted the framework species method of forest restoration to accelerate natural forest regeneration on deforested sites in northern Thailand. The method involves planting 20–30 indigenous forest tree species selected for fast growth, resilience to weeds and fire and attractiveness to seed-dispersing animals. Trial plots to test the technique have been established annually in Doi Suthep-Pui National Park, northern Thailand, since 1998. The objectives of the research were presented i) to determine if forest restoration encourages recruitment of non-planted tree species in the planted areas to increase tree species diversity and return the species composition of planted areas to that of natural forest ii) to determine the effects of the tree species planted, planting density, plot-age and fire on naturally tree seedling establishment. The study was carried out using two seedling survey

techniques. To determine the effects of planting density on natural seedling establishment, 30 x 10 m<sup>2</sup> rectangular sample units were established in the centre of plots planted in 1999 at 3 different densities (2.3, 1.8 and 1.5 m between trees at planting time). To determine the effects of plot age on natural tree seedling establishment, circular sample units 10 m in diameter were laid out across plots planted in 1998 and 2002 and non-planted control plots. The results showed that the numbers (density) of seedlings increase with plot age and the 1.8 m between trees at planting time (3,125 trees/ha) resulted in the most efficient natural seedling establishment. Furthermore, seeds of most tree species are dispersed into the planted plots by animals (rather than wind). The mortality of seedlings in the control sites was higher than in restoration areas. Therefore, the framework species method is effective at accelerating forest regeneration.

### **Using Avian Species Richness and Avian Community Composition as Indicators of Successful Forest Restoration**

*Tidarach Toktang<sup>1</sup>, Steve Elliot<sup>1</sup> and George A. Gale<sup>2</sup>*

<sup>1</sup>Department of Biology, Faculty of Science, Chiang Mai University, Suthep Road, Chiang Mai

<sup>2</sup>King Mongkut's University of Technology Thonburi, School of Bioresources and Technology, 83 M. 8, Thakham, Banghuthien, Bangkok

This study was carried out to examine the effects of forest restoration on the species richness and composition of bird communities in northern Thailand. Bird surveys were carried out in framework species plantations, established by the Forest Restoration Research Unit at Ban Mae Sa Mai in Suthep-Pui National Park. Surveys were carried out from June 2002 to July 2003. Point counts and the Mackinnon list technique were used to determine the species richness, diversity, abundance and density of birds in non-planted control plots and planted plots of different ages established in 1998, 2000 and 2002. Eighty-eight bird species were recorded from 57 genera and 30 families, this included 69 resident and 19 species of migratory birds. Thirty-six bird species were observed in the non-planted control plots and 68 species in planted plots; 43, 45 and 47 species in recently planted plots, 2-year-old and 4-year-old planted plots respectively. Bulbul species e.g. Red-whiskered Bulbul, Sooty-headed Bulbul and Flavescent Bulbul were the dominant species in the planted plots. Chestnut-capped Babbler, Red-whiskered Bulbul and Grey-breasted Prinia were the dominant species in the non-planted control plots. The Mackinnon lists suggested that the highest species richness of birds was in the 2-year-old planted plots, followed by the control plots, recently planted plots and lastly 4-year-old planted plots. The point counts suggested that the planted plots had higher richness and diversity than control plots. Similarity indices suggested that the oldest planted plots were most similar to medium-aged planted plots and were most different from recently planted plots. Non-planted control plots had a higher density of birds of open areas than planted plots, whilst forest birds had a higher density in the planted plots. This study showed that planting framework tree species increased bird species richness, and attracted several bird species which could disperse seeds into the planted areas and thus help to accelerate forest regeneration. In addition, tree planting attracted progressively more forest birds as the plots matured.

## Effects of Herbivory and Season of Clearing on Species Composition and Algal Succession in a Tropical Intertidal Shore, Phuket, Thailand

Jaruwan Mayakun<sup>1</sup>, Jeong Ha Kim<sup>2</sup> and Anchana Prathep<sup>1</sup>

<sup>1</sup>Seaweed and Seagrass Research Unit, Centre for Biodiversity of Peninsular Thailand, Department of Biology, Faculty of Science, Prince of Songkla University, Hat Yai, Songkhla Province

<sup>2</sup>Department of Biological Science Sungkyunkwan University Suwon, South Korea

The effects of herbivores and coral removal on species composition and algal succession were experimentally tested in a tropical intertidal shore of Phuket Island, Thailand. To determine the effect of coral removal on algal succession, dead coral patches were cleared, and cages were set up to exclude fish herbivory. The experimental design comprised 1 clearing (20 cm x 20 cm), 2 seasons of clearing (January 2004 and July 2004) and 2 categories of herbivory: five fully caged (25 cm x 25 cm x 20 cm, mesh size was 2 cm x 2 cm) and five uncaged plots both experimental and control plots. The results indicated that the pattern of algal community development during succession was in the middle stage and algal succession followed an inhibition model. In this succession process, an ephemeral alga, *Ulva paradoxa* was the early colonist which inhibited the settlement of the later species, *Polysiphonia sphaerocarpa* and *Dictyosphaeridia* stage of *Padina*. Seasons of clearing influenced the abundances in the algal succession. *U. paradoxa* was able to reproduce and recruit throughout the year. Algal abundance, however, was not influenced by grazing. It might be a result of resident herbivorous damselfishes excluded other herbivores from their territories and maintained algae as algal farms. Unexpectedly, the *Ulva* cover in the caged plots (without fish), had a lower algal coverage. These excluded fish plots might allow smaller grazers to feed on the new colonized algae, thus reducing the algal cover within the cages. Further experiments on the role of herbivory are still needed for a better understanding of its function and other aspects of disturbance on algal succession should be investigated in this tropical intertidal shore.

## Comparing Methods to Determine Distribution and Movement Patterns of Forest-dwelling Mountain Goats

Georgie Harrison

Wildfor Research, 1958-A Buena Vista Ave., Comox, British Columbia, Canada, V9M 2A7

Standardized methods for monitoring movements and habitat use of mountain goats (*Oreamnos americanus*) in forests are not well developed and methods for studying goats in open areas may not be suitable for forest-dwelling populations where visibility is low. We compared direct and indirect methods of observation to record the presence of mountain goats along a small canyon east of the Canadian Rocky Mountains. Observation methods consisted of visual sightings of goats, the use of remote cameras, and

locating goat sign (i.e., hair, tracks, and pellets) within belt transects and plots along the top of 29 discontinuous cliffs from February to October. Belt transects were the most reliable single method of recording presence of goats on cliffs during winter and summer. Belt transects alone, however, were limited to recording presence-absence data. Other methods are required if data on population structure, individuals, behavior, daily activity, or intensity of use are needed.

## **Distribution and Abundance of Malayan Tapir (*Tapirus indicus*) in Thailand**

*Budsabong Kanchanasaka*

Wildlife Research Division, National Park, Wildlife, and Plant Conservation Department,  
Paholyothin Road, Bangkok 10900

Tapirs differ from other large herbivores in that their pattern of defecation is not random. Therefore, individual track identification was applied for the study of their distribution and abundance in southern Thailand. The distribution and density of Malayan tapirs was studied in Khlong Saeng Wildlife Sanctuary during 2000–2001. Tapir tracks were surveyed in an area of 200 km<sup>2</sup> and plaster of Paris casts of new and well defined tracks were made for individual identification. The population density was estimated at 0.041 individuals/km<sup>2</sup>. Home range size was estimated to be 12–34 km<sup>2</sup>. Tracks and dung of tapirs were found from riparian areas up to hill areas but the highest frequency of occurrence was at low and middle elevations. Most of the tapir population in Thailand occurs inside of protected areas. The distribution of tapirs was surveyed in the protected areas during 2004 to 2006. Seven forest complexes in the west and south reported the presence and sign of Malayan tapirs. Most of the records were in evergreen and deciduous forest. The total population of Malayan tapirs in Thailand's protected areas was estimated to be between 678–986 individuals.

## **Distinguishing Signs of Asiatic Black Bears and Sun Bears, and Applications for Research and Conservation**

*Robert Steinmetz*

WWF–Thailand, PO Box 4, Asian Institute of Technology, Patumthani 12120, Thailand

Asiatic black bears and sun bears are sympatric in mainland Southeast Asia and face similar threats of habitat loss and commercial poaching. Bears are rarely seen, but they leave indirect signs, especially claw marks on climbed trees. These markings, which are potentially valuable indicators of the behavior and population status of these species, have limited usefulness if the two species can not be differentiated. To develop criteria for distinguishing claw marks, we measured 119 claw mark imprints from 42 black bears

and sun bears of both sexes in Thailand and Cambodia. Three width variables were significantly greater for black bears than sun bears. A three-step discriminant function model was developed with these variables to separate claw marks to species. The procedure correctly classified 95% of claw marks from the experimental animals. Tested on wild bears (at sites where only one species occurs), the procedure correctly classified 91% of claw marks of black bears in China ( $n = 94$ ) and 100% of claw marks of sun bears in Borneo ( $n = 11$ ). The main limitation of the method was in distinguishing young, small black bears (cubs and yearlings) from sun bears. Research and conservation applications of this method include (1) determining species distribution, (2) monitoring population status, (3) investigating ecology, and (4) involving protected area personnel in data collection. The method was applied in a Thai wildlife sanctuary to investigate the feeding ecology and habitat use of sun bears and black bears. Results indicated that these bears eat fruits from > 160 tree species and overlap substantially in diet (86%). Both species used lowland forest types extensively (deciduous forest: 10 climbed trees/ha; evergreen forest: 32 climbed trees/ha). In montane forest (>1200 m elevation), however, black bears were predominant (climbing 14 trees/ha) while sun bear sign was scarce. On a wider scale, the method was recently applied in a national survey of the distribution of bears in 78 Thai protected areas. The results have been used to produce distribution maps for sun bears and black bears in Thailand, and allow a broad evaluation of the conservation status of the species.

## **The Bornean Sun Bear and Bearded Pig Research and Conservation Project**

*Siew Te Wong*

Wildlife Biology Program, Department of Ecosystem and Conservation Science, College of Forestry  
and Conservation, University of Montana, Missoula, Montana 59812, USA

The tropical forests of Southeast Asia are extremely rich in biodiversity and contain valuable tropical timber. Permanent conversion of forests into plantations of rubber and oil palm is continuing to rapidly reduce forest areas. The remaining forests are either completely or selectively logged, to maximize revenue and to feed the high demand for tropical timber. Forest harvest is converting much of the tropical rainforests of Southeast Asia into secondary forest communities and fragmenting once-contiguous blocks of habitat into isolated islands. Other impacts include habitat destruction and degradation, the alteration of plant species composition, and increased hunting pressure due to poaching. The Malayan sun bear (*Helarctos malayanus*) and the bearded pig (*Sus barbatus*) are sympatric species that live in the tropical rainforests of Borneo and Southeast Asia. Both species overlap in certain aspects of their food habits and habitat use. Both fulfill important ecological functions: seed dispersal, seed predation, and seed bed preparation. Malayan sun bears and bearded pigs are forest-dependent species, thus any human disturbance of their habitat has the power to impact survival. However, the nature and extent of this impact is unknown. Sun bears and bearded pigs also have in common that very little is understood about either species, which increases their vulnerability and makes conserva-

tion and management programs nearly impossible to implement. This project is designed to gather information on the effects of selective logging on sun bears and bearded pigs of Borneo. We seek to understand how seasonal changes in rain forest foods affect the physical condition of sun bears and bearded pigs in logged versus unlogged (primary) forests. This will be accomplished by comparing animal densities, food abundance, food habits, and physical condition of bears and pigs in logged versus unlogged forests. The project will evaluate the effects of habitat alteration and how this interacts with natural fruiting cycles. It will also identify critical resources for their survival (i.e. *ficus spp*) and give much needed data to support and guide forest management recommendations. Project results will provide information to improve conservation, wildlife management, and forestry practices for all range countries of Malayan bears and bearded pigs.

### **Individual Identification of Wild Asian Elephants Using Non-invasive Genotyping**

*Chalita Kongrit<sup>1,3</sup>, Chomcheun Siripunkaw<sup>1,3</sup>, Varaporn Akkarapatumwong<sup>2</sup>, Warren Y. Brockelman<sup>1,3</sup>, Sompoad Srikosamatara<sup>1</sup>, Praneet Teerakiatipisarn<sup>4</sup>, Paitoon Indarabhut<sup>4</sup> and Lori S. Eggert<sup>5</sup>*

<sup>1</sup>Department of Biology, Faculty of Science, Mahidol University, Rama 6 Rd., Bangkok 10400

<sup>2</sup>Institute of Molecular Biology and Genetics, Mahidol University, Salaya, Phutthamonthon, Nakhon Pathom 73170

<sup>3</sup>Center for Conservation Biology, Institute of Science and Technology for Research and Development, Mahidol University, Salaya, Phutthamonthon, Nakhon Pathom 73170

<sup>4</sup>Salak-Pra Wildlife Sanctuary, Department of National Parks Wildlife and Plant, Kanchanaburi

<sup>5</sup>Division of Biological Sciences, University of Missouri-Columbia, Columbia, MO 65211, USA.

Non-invasive genotyping is an alternative approach to studying wild animals without disturbing them. DNA samples can be obtained from several sources, e.g., hair, feces, feathers, egg shells and saliva. This technique provides information about individual- and sex identification and can be used to study number/sex of individuals, demography, genetic status, distribution, behavior and mating systems of populations. We applied non-invasive genotyping, using microsatellite markers, to study wild Asian elephants in Salak-Pra Wildlife Sanctuary, Thailand. This population is living in small fragmented habitat and is isolated from the rest of the western forest complex. Basic information such as population size, sex ratio and genetic status are required to plan effective conservation management programs for them. Choosing appropriate genetic markers is an important step in obtaining reliable results. We developed 18 new microsatellite loci specific for Asian elephants and tested for polymorphism in 13 zoo elephants. All loci showed moderate to high polymorphism. We then applied these microsatellite loci and previously developed sexing (ZFX/ZFY) markers to 22 randomly selected dung samples from the samples collected from Salak-Pra Wildlife Sanctuary during a preliminary study in 2004–2005. These markers showed a high potential to assign sex and distinguish individuals from others, with all 22 samples having both individual and sex determined. In fact, it was determined that two of the 22 samples were from the same individual. All loci were in Hardy-Weinberg equilibrium with observed heterozygosities ranging from 0.200 to 0.842. Our analyses showed that at

least 10 microsatellite loci are required to identify individuals and distinguish them from siblings. Population estimation, age structure and genetic diversity of this population are currently being studied.

## **DNA Markers and their Potential Applications in Studying the Behavioral Ecology of Wild Asian Elephants**

*Chomcheun Siripunkaw<sup>1,2</sup>, Chalita Kongrit<sup>1,2</sup>, Lori Eggert<sup>3</sup>, Varaporn Akkarapatumwong<sup>4</sup>, Sompoad Srikosamatarat<sup>1</sup>, Praneet Treerakietpisan<sup>5</sup>, Paitoon Intarabudra<sup>5</sup> and Warren Y. Brockelman<sup>1,2</sup>*

<sup>1</sup>Department of Biology, Faculty of Science, Mahidol University, Rama 6 Rd., Bangkok 10400

<sup>2</sup>Center for Conservation Biology, Institute of Science and Technology for Research and Development, Mahidol University, Salaya, Nakhon Pathom 73170

<sup>3</sup>Division of Biological Sciences University of Missouri-Columbia, Columbia, MO 65211, USA

<sup>4</sup>Institute of Molecular Biology and Genetics, Mahidol University, Salaya, Nakhon Pathom 73170

<sup>5</sup>Salak Pra Wildlife Sanctuary, Department of National Parks Wildlife and Plant Conservation, Kanchanaburi 63000

Molecular techniques and DNA markers have been used to address questions in ecology and conservation genetics. We are interested in microsatellite genotyping and sequencing of the Major Histocompatibility Complex (MHC) gene as tools to study the behavioral ecology of Asian elephants, specifically paternity, male reproductive success, and female preference. In theory, the distinguishing properties of microsatellite markers including being a highly polymorphic, co-dominant marker amplifiable by PCR, could enable us to study parentage assignment in wild elephant populations using DNA derived from fecal extraction. We have developed dinucleotide repeat microsatellite primers for the Asian elephant and determined that 10 loci can be used as a multilocus genotyping panel. This panel can be used to assign the most likely parents for an offspring, based on a 97% probability to exclude candidates for the first parent and 99% probability to exclude candidates for second parent when the first parent is known. These probabilities were calculated using genotypes of 22 individuals wild elephant from Salak Pra Wildlife Sanctuary using the program CERVUS (version 2.0). We believe that combining these genetic techniques with field observations that determine the mother (i.e., first parent) would allow a higher probability (i.e., 99%) when determining paternity (i.e., second parent). While neutral markers like microsatellites are advantageous in their ability to measure overall genetic diversity and parentage analyses, other DNA markers like MHC genes are under selection pressures and can provide a measure of fitness-related genetic variation. The MHC genes are known to have roles in the vertebrate immune system. Our preliminary screening of the DQB region of the MHC genes in the Salak Pra elephant population showed variation in nucleotide sequences with more nonsynonymous than synonymous amino acid substitutions. These results correspond to other studies of the DQB region in different species. We believe that the combination of microsatellite and MHC studies is likely to provide more understanding of the behavioral ecology in wild Asian elephant in the near future.



## Monitoring Nest Predation of Forest birds Using Video Surveillance—Preliminary Results

Andrew J. Pierce and Korakoch Probprasert

King Mongkut's University of Technology Thonburi, Conservation Ecology Program,  
83 Moo 8 Thakham, Bangkhuntien, Bangkok

Nest success of tropical birds is typically lower than 20% and consequently has important implications for their breeding success and life histories. Failure of nests may be attributed to numerous factors with predation being the most significant. Observing predation events in the field, however, occurs rarely and is usually restricted to daytime predators. In order to study nest fates and identify nest predators at Khao Yai National Park, Thailand, we developed a continuous video surveillance system that connected an infrared camera to a digital video recorder. The system was portable and could run for three days unchecked. Data was stored on digital video discs making it easier to analyze and store than videos tapes that previous systems have used. During February – August 2006 a total of 32 nests were monitored. Cameras did not result in any nest abandonment and failure rates were the same as nests monitored that did not have cameras. A total of 5,770 hours of footage were recorded at the nests of 8 species of bird. Partial or complete losses of clutch or brood were recorded at 25 out of the 32 nests (78%). A total of 24 predation events were recorded including three multiple predation events involving different predators. Pig-tailed Macaque (*Macaca nemestrina*) was the most frequently recorded predator with eight predation events. Birds depredated seven nests: Green Magpie *Cissa chinensis* (3 nests), Crested Goshawk *Accipiter trivirgatus* (2 nests) and one nest each by Crested Serpent Eagle *Spilornis cheela* and Puff-throated Bulbul *Alphoixus pallidus*. The latter, taking eggs from a Black-naped Monarch *Hypothymis azurea* nest, was particularly notable. Snakes were involved in five predation events and three non-primate mammals (Common Palm Civet *Paradoxurus hermaphroditus*, a rat *Maxomys surifer* and a Northern Tree Shrew *Tupaia belangeri*) took all or part of the contents of one nest each. The rat, civet, an unknown predator and all the snakes were the only nocturnal predators and accounted for 33% of predation events. The four non-predation losses were due to structural damage, egg breakage, a nestling dying in the nest and another falling out of the nest. Data was also collected on incubation, feeding rates and nest defense and stored on digital video discs for future analysis.

**Intra- and Inter-specific Aggressive Behavior, Food Habitat,  
Roosting Behavior of Two Species of Mynas in Bangkok:  
A Study to Understand Mynas Invader Potential**

*Intanon Kolasartsanee and Sompoad Srikosamatara*

Department of Biology Faculty of Science, Mahidol University, Rama 6 Road, Bangkok 10400

Invasive species are ranked as second behind habitat destruction as a cause of the biodiversity crisis. The Common Myna has been categorized as one of the hundred worst invasive species by the IUCN. They have invaded Australia, New Zealand, South Africa, Hawaii, Fiji, Solomon Islands, and some other oceanic islands but they are a native species in Thailand. Studying their ecology and behavior in their native habitat may shed additional light on their invasive abilities. Intra- and inter-specific aggressive behaviors, their food habits and habitats were studied at the Faculty of Science, Mahidol University, Phayathai Campus in Bangkok. Roosting sites around Bangkok were surveyed and located on maps. The numbers of mynas were counted. It has been found that the intra- and interspecific aggressive indices were 0.39, 0.62, respectively for Common Myna and 0.26, 0.29, respectively for White-vented Myna (a native, non-invasive species). Common Myna flock in smaller groups (less than 4 individuals per group) than White-vented Myna (18 individuals per group can be seen). The distribution of Common Myna was uniform. (Mean value of group size was 1.15, 2.10 individuals, and variance was 0.72, 0.38, in the morning and the evening respectively). The distribution of White-vented Myna was also uniform but tended to be more random in the morning and clumped in the evening (mean group size was 1.12, 1.68 individuals, and variance was 1.06, 3.54, morning and evening respectively). For roosting, populations were counted in 5 places. Their total populations were 569, 381, 525, 197 and 520, respectively. The ratio of White-vented Mynas to Common Mynas were 442:127, 148:233, 460:65, 0:197 and 314:206 at Chaopraya Hospital, Makro Charun, Wat-Muang, Bangkae district, Naluang junction in the Rajburana district and Chitlada Palace, respectively. Their population ratios were 4:1, 0.5:1, 7:1, 0:197 and 2:1, respectively. The nearest roosting area distances were 2.81 km, 2.81 km, 9.91 km, 3.00 km and 4.88 km, respectively. It is concluded that Common Myna is much more aggressive, live and forage in smaller groups in broader microhabitats and occupy a broader ecological niche in their native habitat. These characteristics may make Common Myna a better invader than the White-vented Myna.

## **A Glimpse into the Cooperative Breeding Behavior of the Puff-throated Bulbul in Khao Yai National Park**

*Kihoko Tokue*

King Mongkut's University of Technology Thonburi, Conservation Ecology Program, 83 Moo. 8 Thakham, Bangkhuntien, Bangkok

Puff-throated Bulbul (*Alophoixus pallidus*) is the most abundant and perhaps one of the most important seed dispersing species found on the Mo Singto Long-term Biodiversity Plot at Khao Yai National Park, Thailand. Yet, this species is probably the most understudied species for the same reason. Evidence also suggests that cooperative breeders may be particularly sensitive to habitat degradation, and fragmentation, and thus the reduction of such species could have significant effects on normal forest regeneration processes. In 2005, after a year of suspecting cooperative breeding behavior, this species was documented to breed cooperatively for the first time. Here we will discuss preliminary data on the frequency of cooperatively breeding in this species and nest visitation rates.

## **Vertical Stratification of the Bird Assemblage between Abandoned Settlement Areas and Primary Dry Evergreen Forests in Thung Yai Naresuan Wildlife Sanctuary**

*Prateep Duengkae<sup>1</sup>, Vijak Chimchome<sup>1</sup>, Utis Kutintara<sup>1</sup> and Anak Pattanavibool<sup>2</sup>*

<sup>1</sup>Forest Biology Department, Faculty of Forestry, Kasetsart University, Bangkok 10900

<sup>2</sup>WCS Thailand Program 55/259 Muang Thong Proj 5, Soi, 3 Pak Kret, Nonthaburi 11120

Vertical stratification of the bird assemblage between abandoned settlement areas (ASA) and dry evergreen forests (DEF) was investigated in Thung Yai Naresuan Wildlife Sanctuary a Natural World Heritage Site. The research objective was to examine bird species diversity and assemblage patterns in each vertical stratum and the degree of specialization of each bird species in both habitats. A permanent line transect was used for the field survey. The study revealed 170 bird species. Diversity indices of vertical strata in the ASA tended to be lower than those in the DEF sites. The bird community in the DEF and ASA was classified into 3 major groups: ground level, lower canopy (1–5 m in the ASA and 1–15 m in the DEF) and upper canopy (5–>25 m in the ASA and 15–>25 m in the DEF). Most species were relatively generalized in their behavior and used resources across broad ranges of microhabitats. The study also demonstrated that bird diversity along a vertical structural gradient showed a clear pattern between human-disturbed and the primary forest areas. Recommendations are given to limit human disturbances as much as possible to allow for maximum avian diversity to recover.

## **Tree and Bird Diversities in an Urban Green Area: The Overlooked Role of the Understory**

*Wonrawee Jirawaree and Sompoad Srikosamatara*

Department of Biology, Faculty of Science, Mahidol University, Rama 6 Road, Bangkok 10400

The Tree Garden or Urban Forest at the Faculty of Science, Mahidol University, Phayathai Campus is unique and a source of pride for the Faculty of Science and has received an award from the Bangkok Metropolitan Authority. The Faculty has made a special policy to promote the area as an outdoor classroom. To understand its potential, biodiversity and ecological knowledge are required. This study was intended to examine the composition of plants and animals in the area by focusing primarily on species and distributions of trees and birds. Trees were identified, mapped and converted to an electronic file as part of a GIS database, together with a IKONOS satellite image and bird survey data. The study indicated that the total area of the Faculty of Science is 6.5 ha. There were more than 1,815 trees consisting of 30 families of 73 species and 25 bird species. The area can be divided into six zones based on their biodiversity components. The forest plantation zone was the most diverse area with 38 tree species and 21 bird species.

Due to changes in land use in the faculty, Oriental Magpie-Robin, Streak-eared Bulbul, Pied Fantail, and sunbirds are found to be more restricted from previous observations in which the birds could be found easily, even in disturbed habitats. In particular, the role of the understory trees, in some green zones which were recently paved for recreation and human-use was overlooked. The land-use system of paying attention only to the upper-storey trees has affected the composition of the understory bird community, which has impacted to the ability of the area to be an outdoor museum of natural history that the faculty had dreamed for.

## **A comparative Study of Diets of Great hornbill (*Buceros bicornis*) and Rhinoceros Hornbill (*Buceros rhinoceros*) During the Breeding Season in Budo Su-Ngai Padi National Park, Southern Thailand**

*Sukanya Chaisurinane*

King Mongkut's University of Technology Thonburi, Conservation Ecology Program,  
83 Moo 8 Thakham, Bangkhuntien, Bangkok

Due to the decreased availability of potential nest trees and food sources at Budo Su-Ngai Padi National Park from illegal logging and slash and burn cultivation; the hornbill population is facing serious threats including increased inter and intraspecific competition for nest trees and food sources. The main objective of this study was to compare the food delivered to nests of the Great Hornbill (*Buceros bicornis*) and Rhinoceros Hornbill (*B. rhinoceros*) to better understand the food requirements and composition of these two species and how they share resources. The study was conducted in Budo during the

breeding season, January to July 2003 and 2004. Great Hornbill (GH) and Rhinoceros Hornbill (RH) were observed for 1488.5 h and 811 h, respectively. The entire breeding cycle of Great and Rhinoceros Hornbills were  $110.6 \pm 6.7$  days (March to July) and  $121.7 \pm 10.4$  days (March to July), respectively. The consumption rate of figs was significantly different between hornbills (GH, 75.9 g/observation hour (57.2%) and RH 135.5 g/obs. h (72.4%); Mann-Whitney  $U = 2.0$ ,  $P = 0.003$ ), while those of non-fig fruits and animal matter were not significantly different. Thus, this study showed that Great and Rhinoceros Hornbills had no difference in the duration of breeding and used many of the same main food resources, which are mostly available during the breeding season. They partitioned resources by switching the rank of the most consumed fruit species in each phase of the breeding season (incubation, nestling, etc.). This partitioning may reduce food competition. However, more studies on fruit food crop availability and abundance are needed to better assess food resource use by these hornbills and if food availability effects hornbill breeding success. This may enhance hornbill conservation in the long run.

## **Spatial and Seasonal Dynamics of a Lepidopteran Herbivore Community in Tropical Thailand**

*David Lohman<sup>1,4</sup>, Stuart Davies<sup>2</sup>, Sarayudh Bunyavejchewin<sup>3</sup> and Naomi Pierce<sup>1</sup>*

<sup>1</sup>Department of Organismic & Evolutionary Biology, Harvard University, Cambridge MA, USA

<sup>2</sup>Center for Tropical Forest Science, Smithsonian Tropical Research Institute, Balboa, Panama

<sup>3</sup>Silvicultural Research Division, Department of National Parks, Wildlife and Plant Conservation, Paholyothin Road, Bangkok 10900

<sup>4</sup>Department of Biological Sciences, National University of Singapore

The world-wide network of forest dynamics plots (FDPs) managed by the Center for Tropical Forest Science (CTFS) provide an unparalleled opportunity to study the effects of tree diversity and spatial organization on the ecology of plant consumers. We report on the first 14 months of a project in the Khao Chong FDP in Trang, Thailand, which has a 3–4 month dry season. Using the spatially explicit vegetation dataset of the FDP, we selected 15 isolated and 15 aggregated individuals from each of 4 tree species to examine the effects of conspecific host plant density on the intensity of herbivory and the diversity of lepidopteran (moth and butterfly) herbivores on a particular host species. This targeted sampling approach was supplemented by a different rearing scheme in which all lepidopteran herbivores within two small but diverse sub-plots were reared and identified to assess the host breadth of Lepidoptera at our site. Standard methods of insect sampling at both canopy and understory levels, including butterfly fruit traps, transects, and UV moth traps, allow us to assess the effectiveness of our rearing and to describe the seasonality and spatial (canopy-understory) distribution of adult Lepidoptera.

## Management Impact on the Ground Cover Vegetation and Beneficial Insects in a Litchi Orchard of Mountainous Northern Thailand

*Dirk Euler<sup>1</sup>, Konrad Martin<sup>1</sup> and Vichian Hengsawad<sup>2</sup>*

<sup>1</sup>Institute for Plant Production and Agroecology in the Tropics and Subtropics, University of Hohenheim, Stuttgart-Hohenheim, Germany

<sup>2</sup>Postharvest Technology Institute, Faculty of Agriculture, Chiang Mai University, Chiang Mai

As a consequence of increasing land pressure, sustainable agricultural production in mountainous northern Thailand is aggravated by erosion, soil degradation, weed pressure and pest problems. As studies from subtropical Asia demonstrated, erosion and soil fertility in orchards are influenced by the diversity and composition of ground cover vegetation. Additionally, the management of ground cover vegetation in orchards has significant effects on beneficial arthropods. Knowledge of the ecological relations between management, the composition of the ground cover vegetation and the presence of beneficial insects may facilitate the development of appropriate strategies for sustainable land use in fruit tree production systems in northern Thailand. In this study we therefore analyzed the influence of different management measures on the ground cover vegetation and its subsequent effects on the abundance of beneficial insects. In a litchi orchard, effects of four different combinations of two pesticide (with vs. without) and mowing (monthly vs. once per year) treatments on the ground cover vegetation and its influence on the presence, abundance and diversity of a group of beneficial insects (Hymenoptera: Parasitica plus Chrysidoidea) were recorded in four subdivided subplots. Plant species coverage (%) was estimated and flowering was recorded using 10 randomly placed vegetation quadrats (1m<sup>2</sup>). Abundances of Hymenoptera families were obtained by 4 randomly positioned Malaise traps in each combination plot. Vegetational changes due to mowing or herbicide application depended on reactions of individual plant species and were not significantly related to plant diversity. The total numbers of Hymenoptera at monthly and annually mown sites with or without insecticide application were also not significantly different. Differences in hymenopteran abundances were also attributed to responses of specific Hymenoptera families. The results, based on the specific management conditions in each subplot, indicated that large-scale and simultaneously applied homogeneous treatments, such as regular mowing of ground cover vegetation in orchards, are apparently insufficient to sustain distinct successional stages of vegetation with a high diversity at a sufficient spatial and temporal scale, and therefore are unable to sustain suitable habitat complexes required by beneficial arthropods. The results indicate that only spatial and temporal stochastic treatments might generate desired patch-dynamics of vegetation to provide a suitable environment to increase biodiversity.

## Survey on Species Diversity and Seasonal Abundance of Fireflies (Coleoptera: Lampyridae) in Khao Yai National Park, Thailand

*Anchana Thancharoen and Sangvorn Kitthawee*

Department of Biology, Faculty of Science, Mahidol University, Rama 6 Rd., Bangkok 10400

The fireflies (Coleoptera: Lampyridae) of Thailand have been little studied in many aspects, particularly their taxonomy, behavior, and ecology. Because of the lack of taxonomic work, field studies of fireflies are often confronted with the problem of unknown species. However, there is an urgency to field studies due to the continuing decrease of Thai firefly populations. In this study, diversity and abundance of firefly populations in different seasons were studied to survey species composition and to examine the seasonal change of numbers and species of fireflies at Pha Kluay Mai waterfall, Khao Yai National Park, Nakhon Ratchasima province, Thailand. The field studies were conducted during June 1998–November 1999. Data were collected on 11 species of fireflies, none of which could be identified to species. Among the 11 unidentified species, 4 known genera were represented—*Diaphanes*, *Lamprigera*, *Luciola*, and *Pyrocoelia*—and 3 species were of unknown genus. In addition, a pictorial key was created for identification of these species. The species diversity of fireflies was greater in the rainy season ( $H' = 1.191$ ) than in the dry season ( $H' = 0.082$ ). The number of different species present was lower in winter and was influenced inversely by maximum temperature. The ecological attributes of firefly populations and adaptations that allow them to coexist in the same habitat are discussed.

## Long-term Tiger Population Monitoring Program for Strengthening Conservation in the Western Forest Complex

*Simcharoen Saksit<sup>1</sup>, Anak Pattanavibool<sup>2</sup>, Sompoad Daungchantrasiri<sup>1</sup>, Boonyang Srichan<sup>1</sup> and Ullas Karanth<sup>3</sup>*

<sup>1</sup>Wildlife Research Division, Department of National Park, Wildlife, and Plant Conservation, Chatuchak, Bangkok 10900

<sup>2</sup>Wildlife Conservation Society Thailand Program, PO Box 170, Lak Si, Bangkok

<sup>3</sup>Wildlife Conservation Society India Program, Centre of Wildlife Studies, 823 13<sup>th</sup> Cross Road, Jayanagar 7<sup>th</sup> Block (West), Bangalore, Karnataka–560 082, India

The Western Forest Complex (WEFCOM) has been classified as a global priority under the Tiger Conservation Landscape (TCL) Class I, “landscapes that have habitat to support at least 100 tigers, evidence of breeding, minimal-moderate levels of threat, and effective conservation measures in place. Since 2004, WCS Thailand has assisted the Department of National Park, Wildlife, and Plant Conservation (DNP) in using a wildlife-based approach called the Living Landscape Program (LLP) to help strengthen conservation of Huai Kha Khaeng and Thung Yai Wildlife Sanctuaries (HKK-TY). The tiger is one of the target landscape species under the LLP conceptual model. The WCS Tigers Forever

has targeted to increase density of tigers by about 50% within 10 years. In 2005–06 the Thailand tiger team has completed camera trapping covering an effective sampling area of about 1,262 km<sup>2</sup> in HKK. The sample area was divided into 8 blocks with a total of 136 trapping points. The camera trapping season lasted from November 2005 – June 2006. The number of tiger photographs collected from 2,020 trap-nights was 105 pictures, 55 right flanks and 50 left flanks, from 25 adult tigers. The preliminary capture analysis with the  $M_h$  model estimated the density of tigers at 2.61 (SE = 0.35) tigers/ 100 km<sup>2</sup>. Under WCS Tigers Forever, the long-term monitoring system for the population of tigers and prey will cover about 2,100 km<sup>2</sup> in HKK–TY in which the monitoring will be done annually. The Tigers Forever has identified the WEFCON landscape of 18,000 km<sup>2</sup> as Thailand's tiger conservation landscape and the monitoring will use "patch occupancy" as an indicator with the monitoring frequency of every 2 years. With the combination of law enforcement monitoring and other interventions we wish to maintain the ecosystem integrity of HKK–TY as the ultimate goal.

## **Forty Years of Research on the Population Dynamics of Black Grouse (*Tetrao tetrix*) in the Belgian Hautes-Fagnes**

*P. Poncin<sup>1</sup>, C. Keulen<sup>2</sup>, M. Loneux<sup>1</sup> and J. C. Ruwet<sup>1</sup>*

<sup>1</sup>University of Liège, Biology of Behaviour Unit, 22 quai Van Beneden, B-4020 Liège, Belgium

<sup>2</sup>CRNFB : Centre de Recherche de la Nature, des Forêts et du Bois. Avenue Maréchal Juin 23, B-5030 Gembloux, Belgium

Black Grouse is one of the most endangered species in central and western Europe, and the Hautes-Fagnes plateau in Belgium is the west-most part of its distribution. In the middle of the sixties, when the number of birds was very low, research programs were undertaken in order to improve stock management. The populations have now been checked continuously during the past 40 years. Organizing inventories and description of arenas where males (cocks) gather in spring for lekking (the places to watch and count them). The increase in population at the end of the 1960s (the population reached its maximum, 200 individuals at the end of the 1970s) allowed the development of research on territorial and social behavior on the display arenas. Annual campaigns of census on the arenas, in collaboration with the agents of the DNF (Direction National of Forests) were carried out, as well as the detailed study of the black grouse behavior (territoriality, aggressive behavior, and reproductive success) during the spring season displays, leading to the production of a didactic and a public-oriented movie. This is the kind of information allowing, through a better knowledge of the species biology and the constraints of its environment, to build efficient protocols of protection and management. Very few laboratories can claim to have gathered data over such a long period of time, which allowed the modeling of the population dynamics related to climatic fluctuation. Studying behavior, genetics, and habitats of reproduction and feeding is essential to design efficient management policy in support of protection of species habitat, and the species wild populations, and ultimately in preserving the country's richness.



## Status and Distribution of Green Peafowl in Thailand

*Wina Meckvichai<sup>1</sup>, Suthatipong Asirapoj<sup>1</sup>, Sawai Wanghongsa<sup>2</sup> and  
Chatchawan Pitdamkham<sup>3</sup>*

<sup>1</sup>Department of Biology, Faculty of Science, Chulalongkorn University, Phayathai Road, Pratumwan, Bangkok

<sup>2</sup>Wildlife Research Bureau, Department of National Parks, Wildlife and Plant Conservation Phaholyothin Road, Chatuchak, Bangkok

<sup>3</sup>Wildlife Conservation Bureau, Department of National Parks, Wildlife and Plant Conservation Phaholyothin Road, Chatuchak, Bangkok

The distribution of viable populations of Green Peafowl (*Pavo muticus imperator* Delacour, 1977) in Thailand was formally reported along Huai Kha Khang basin in western Thailand. However, more populations of Green Peafowl have been recently found at Ping, Yom, Eng and Nan basins in the north and at the Mae Klong basin as well as the Srinakarin reservoir in western Thailand due to more intensive surveys. The northern population is estimated to be 500 birds (1999–2001 and 2004–2005) while the western population is estimated to be about 1,500 birds (2006) using rapid assessment surveys. The northern population is declining due to threats from hunting, egg collecting, pesticide poisoning, habitat disturbance, habitat fragmentation and habitat modification. Meanwhile, the western population is increasing due to the strict enforcement of wildlife management in the Huai Kha Khang Wildlife Sanctuary, and this population remains the most important population in the conservation of Green Peafowl in Thailand, and probably in the world.

## Distribution and Abundance of Hume's Pheasant in Thailand

*Apirat Iamsiri<sup>1</sup> and George Gale<sup>2</sup>*

<sup>1</sup>Joint Graduate School of Energy and Environment, King Mongkut's University  
of Technology Thonburi, Bangkok

<sup>2</sup>School of Bioresources and Technology, King Mongkut's University of Technology Thonburi, Bangkok

A summary of all known Thai records of Hume's Pheasant is summarized according to published records and data held on file by the Bird Conservation Society of Thailand Records Committee, with three new locations found in this study viz. Mae Daet Noi village, Doi Inthanon National Park and Mae Lao Mae Sae Wildlife Sanctuary. However Mae Lao-Mae Sae Wildlife Sanctuary was quite close to those found in Mae Jok Luang Watershed and may be considered as the same forest block.

At Doi Suthep-Pui National Park the species was thought to have been extirpated since 1935 and was found again at the same site in November 1998 and has been frequently observed up to the present. The absence of records for over 60 years, during which intermittent and frequent bird surveys were carried out, suggests that a small population remained throughout this period, but remained undetected. As hunting pressure was reduced and as habitat protection improved, this either allowed numbers to build up, or birds became more detectable due to partial habituation to humans. This is possibly the same case as at Doi Pha Hom Pok, where there was no record after February, 1938. In summary, the

bird was found from north of the Ping River and across the watershed in the Mekong Drainage (including Doi Pha Hom Pok) to the south at Doi Inthanon National Park, and only west of the Ping River. Although Om-Koi Wildlife Sanctuary was suspected as suitable habitat, there is no confirmed record. The most abundant area of the pheasant was a forest at Mae Daet Noi village and elsewhere around this village including Huai Puu and Mae Ta-la Nuea villages. Total habitat available for the pheasant was approximately 2,000 km<sup>2</sup> and the total Thai population was estimated at 4,000 individuals assuming most of this habitat is occupied.

## POSTERS

### **Influence of Food Availability on Puff-throated Bulbul (*Alophoxius pallidus*) Movement Patterns**

*Daphawan Khamcha*

Conservation Ecology Program, School of Bioresources and Technology, King Mongkut's University of Technology, Thonburi, Bangkok

Successful reproduction and recruitment of tropical forest trees is highly related to the movement of frugivores. Frugivorous birds represent a high proportion of the seed dispersers in tropical forest. Seed dispersal by frugivorous birds can be advantageous to trees by: 1) helping seedlings escape from competition from conspecifics near the parent tree, 2) decreasing rates of density dependent fungal infection, 3) reducing risk from seed predation near the parent trees, and 4) dropping seeds in more suitable microenvironments (better soil, moisture, sunlight, etc.). There are six frugivorous bird families which are highly frugivorous, Columbidae, Psittacidae, Pycnonotidae, Bucerotidae, Sturnidae and Lybiidae. The family Pycnonotidae (the bulbul family) is a particularly important seed disperser for small seeded trees in tropical forest and especially in disturbed or deforested areas. To understand the interaction between Puff-throated Bulbul and their foods and the influence of food resources on Puff-throated Bulbul movement patterns will be studied at the Mo-singto Long-term Biodiversity Research Plot, Khao Yai National Park. Fifteen groups of birds will be randomly visited and followed for 2 hours/month. This movement data will be mapped out in the Arcview software using the Animal Movement extension to determine movement patterns, and distance moved. Different seasons may show fluctuations in food availability and food abundance, and movement patterns of frugivorous birds may demonstrate variation in distance, frequency of fruit tree selection associated with these changes. Normally frugivorous birds will move in relation with food resources which can provide the best foods. Understanding Puff-throated Bulbul movement patterns can be applied to the improvement of evergreen forest restoration in tropical Asia.

## **An assessment of the Behaviors of Reintroduced Asiatic Black Bear *Ursus thibetanus* in the Wild as Predictors of Reintroduction Success**

*Dusit Ngoprasert*

Conservation Ecology Program, King Mongkut's University of Technology Thonburi 83 Moo 8,  
Thakham, Bangkuntien, Bangkok

Bears are important for the maintenance of tropical forest as they act as seed dispersers and predators, but are poorly studied in Thailand and globally threatened by habitat loss and the wildlife trade. For threatened species such as bears, captive breeding and release into the wild can be an effective method to improve the size and longevity of wild populations and maintain the genetic diversity in isolated populations. However, reintroduction of captive-bred animals to the wild is a difficult scientific process. Often such reintroductions are not successful, and one of the primary reasons is the quality of the captive environment. Failed reintroductions not only means that animals often die shortly after release into the wild, but can also mean that they become potential nuisances or dangerous to local people. The objective of this research will be to define habitat suitable for reintroduction of captive-bred bears into the wild. Suitable habitat is important because the population dynamics are strongly affected by social structure and ecological interactions. Choosing sites for release will require consideration of several factors that affect survival and reproduction, e.g. the level of effective core areas, habitat productivity, as well as the distribution and size of the remaining wild population. In addition, level of human disturbance, cost and logistics will also be included in the site assessment. To increase the rate of success, a pre-release program into semi-wild habitat is currently recommended. Enclosures will be created with electric fencing inside natural forest habitat to provide foraging training for the bears. Behavior of reintroduced bears will be observed to determine feeding and foraging adaptation to wild foods. To assess their ability to re-adapt to the wild behavior, observations will be conducted on reintroduced bear in soft release enclosures and after they are released into completely wild habitat. This project will be conducted in collaboration with the Department of National Parks, Wildlife, Plant Conservation and Dusit Zoo. The study will help improve understanding of how captivity impacts the ability of captive bears and other large mammals to return to the wild and provide important information on how to increase the success of reintroductions.

## **Human Local Communities, Partners in Conservation Biology Research: Case of the Study of *Macaca nemestrina* in Thailand**

*Françoise Noel-Lambot*

University of Liege, Department of Environmental Sciences and Management, 22,  
quai Van Beneden, 4020 LIEGE, Belgium

Few studies have been carried on *Macaca nemestrina* in natural settings and data relevant for Thailand are even rarer. For these reasons, we are trying to collect a maximum of data on these macaques in various regions of Thailand, using mainly interviews of people living in contact with them (rural communities, professionals of the forest as well as trainers of macaques and private owners using them for picking coconuts). In this way, we are exploring the often extensive knowledge of the environment that some of the local people possess. Of course it is necessary to consider these data with care and to validate them as often as possible with personal observation and by cross-checking the accounts.

The interest of this approach is twofold:

1. Gathering a large amount of information on the species in question: ecology, behavior, distribution, population density and its adaptations and interactions with humans.
2. Reaching a better understanding of the relationship between humans and macaques; the attitudes of humans towards the various primate species as well as, more generally speaking, the ways people look at their environment, play a pivotal role in terms of conservation of biodiversity.

## **Breeding or Catching Macaques for Collecting coconuts in Thailand**

*Françoise Noel-Lambot*

University of Liege, Department of Environmental Sciences and Management, 22,  
quai Van Beneden, 4020 LIEGE, Belgium

The annual production of coconuts in Thailand is 1,400 million tons. In numerous places in Thailand as well in several other countries of South-East Asia, *Macaca nemestrina* is of valuable assistance in the harvesting of this crop. Interviews in rural communities indicate that breeding is not widespread and that animals are often taken from wild populations. In a spirit of species protection, it would be useful

1. to evaluate the number of *M. nemestrina* working in coconut plantations,
2. to determine their origin
3. to promote and encourage breeding programs

## **Home Range and Feeding Ecology of Pigtail Macaque (*Macaca nemestrina*) in Khao Yai National Park (Thailand): Comparison of Human Managed and Remote Forest Areas**

*Gilles Bottin and Marie-Claude Huynen*

University of Liege, Department of Environmental Sciences and Management, 22,  
quai Van Beneden, 4020 LIEGE, Belgium

We propose to investigate the effects of human settlements on pig-tailed macaque ecology and behavior in Khao Yai National Park by comparing ranges, activity budgets, foraging behavior and diet of two monkey populations living in contrasting habitats: one close to the park headquarters, which provide a highly accessible and concentrated food source to the animals, and a second in a forest area remote from human disturbance. This project requires:

Locating and habituating the two troops to an observer's presence

Following the troops for at least a whole year, 3 to 4 times a week during their entire activity period (from one sleeping site to the following), to collect data on group size, composition and feeding ecology (time and activity budgets of groups, range size, location of sleeping sites, animal and plant items consumed, inter-specific interactions).

Systematically recording resource availability throughout the year by monitoring phenological transects, and assorted nutrient analysis (proteins, lipids, carbohydrates, fibers, tannins)

Assessing the role of macaques as seed dispersers, and therefore, their role in the maintenance and regeneration of the forest.

The first benefit expected from this project is to obtain better knowledge of the pig-tailed macaque in wild habitat in Thailand, and to assess quantitatively the impact of the human habitat proximity on its ecology. Moreover, this will provide a basis allowing for comparison with the distribution and ecology of populations studied in adjacent countries.

## **Arthropods in the Diet of the Coral-Billed Ground Cuckoo as Revealed by Stomach Content Analysis**

*John Milne*

Department of Biology, Faculty of Science, Mahidol University, Rama 6 Road, Bangkok 10400

The Coral-billed Ground-Cuckoo (*Carpococcyx renauldi*) is an uncommon, resident bird of forests in eastern Thailand. Despite its large size, this bird is difficult to see and consequently its diet is little known. The fortuitous finding of a dead bird in Khao Yai National Park allowed the examination of the bird's stomach contents. Numerous body fragments of a wide range of arthropods were found. Preliminary identifications indicate that termites (Order Isoptera) (as given by numerous soldier termite mandibles) formed a major part of the Ground-Cuckoo's food before it died, with scarab and other beetles (O.

Coleoptera), centipedes (Class Chilopoda), orthopterans (O. Orthoptera) and ants (Family Formicidae, O. Hymenoptera), also being eaten. Identification to lower taxonomic levels, e.g., family or genus, may be possible if fragments are compared with whole body arthropods collected from Ground-Cuckoo habitat. The types of arthropods found in the Ground-Cuckoo's stomach correlate well with its terrestrial habit.

## **Spatial Use, Social Structure, and Food Habits of Bengal Slow Loris, *Nycticebus bengalensis*, in Different Logged Habitats**

*Manoon Pliwsungnoen*

Conservation Ecology Program, King Mongkut's University of Technology Thonburi 83 Moo 8,  
Thakham, Bangkuntien, Bangkok

Slow lorises (*Nycticebus sp.*) are Asian, solitary social-group prosimians. Little is known about them due to their small size and nocturnal life style. Even though field techniques have long been developed, overall, information about lorises is still globally rare. The objectives of this study are: (a) to define spatial use, (b) investigate social structure, (c) examine food habits, and (d) compare spatial use, social structure and food habits between Bengal Slow Loris (*N. bengalensis*) populations in two habitats with different logging histories. Two forest protection units, Namtok Bo Tong and Lum Changwat in the Khao Ang Runai Wildlife Sanctuary were selected. Radio-collared animals (following the regulations of the Department of National Parks, Wildlife and Plant Conservation Department) will be followed from dusk to dawn, Sherman live-traps and mist nets will be used as traps. All activities and foods of focal animals will be recorded in 5-minute intervals where those of non-focal individuals will be simultaneously recorded by scanning every 5 minutes. Home ranges of each individual/group will be based on a series of hourly recorded locations and estimated by both 95% minimum convex polygons (MCP) and a kernel estimator, where the differences between sites will be tested by Man-Witney *U* tests. Social structure refers to the number of individuals, sex, and age classes of a group of animals which is defined by their social activities and overlapping home ranges. Correlations of both home ranges and social structures will be considered with abundance of food resources in their areas occupation. Diet composition will be presented as a percent of occurrence and diet diversity between sites will be compared using the Shannon diversity index.

## **Habitat Use, Movement Pattern and Home Range of Siamese Fireback *Lophura diardi* and Silver Pheasant *L. nymthemera*, Khao Yai National Park, Thailand**

*Niti Sukumal*

Conservation Ecology Program, School of Bioresources & Technology, King Mongkut's University of Technology Thonburi 83 Moo 8, Thakham, Bangkuntien, Bangkok

Pheasants are one of the most threatened bird groups in the world. Siamese Fireback *Lophura diardi* and Silver pheasant *L. nymthemera* are resident birds in Thailand and their populations here are highly threatened from hunting and habitat loss. This study will focus on habitat use, movement patterns and home range sizes of these two species based on birds ringed and/or collared with radio transmitters (following the regulations of the National Parks, Wildlife and Plant Conservation Department). These methods will be used to locate their positions in order to observe habitat characteristics and food resource use. The habitat use observations will consider habitat characteristics including forest types, geographical features and food distribution used by the two birds and compared with unused areas. The movement patterns will consider food distribution patterns and habitat characteristics because my hypothesis is that clumped food resources should lead to lower daily travel distances and that they should prefer areas with a high density of understorey plants. The home range sizes will be assessed based on the composition of forest types in their home range and food distribution patterns and how this influences seasonal changes in home ranges. From preliminary data on home range size based on birds ringed, Siamese Fireback was 14.77 ha from data on 2 males and 1 female of one group, while Silver Pheasant was 3.8 ha with 2 males and 1 female of one group. The overlap in home ranges was 2.51 ha. This study will consider habitat characteristics and food resources that influence their habitat use, movement patterns, and home range size. Upon approval, I plan to use radio-telemetry on these two species for more reliable data collection and which will provide baseline information on suitable habitat availability for these two species and could provide decision support for better protection of their habitat.

## **Monitoring and Managing Biodiversity of Aquatic Areas Subjected to High Economic Constraints: A Case Study in Belgium**

*P. Poncin<sup>1</sup>, M. Loneux<sup>1</sup>, C. Keulen<sup>2</sup> and J. C. Ruwet<sup>1</sup>*

<sup>1</sup>University of Liège, Biology of Behaviour Unit, 22 quai Van Beneden, B-4020 Liège, Belgium

<sup>2</sup>CRNFB : Centre de Recherche de la Nature, des Forêts et du Bois. Avenue Maréchal Juin 23, B-5030 Gembloux, Belgium.

The Meuse River, at the Belgian–Dutch border, has undergone large hydraulic projects like the creation of the Albert Canal and the rectification of the river Meuse, that isolated some meanders. One of them called “Vieille Meuse” (the “Old Meuse” at

Lanaye (4 ha stretch of water bordered by about 3 ha of land) has become year after year a site of high biological interest. Due to economic priorities, this site is entirely or partially threatened today by the extension of the neighboring locks. In order to preserve the ecosystems present in this part of the Meuse Valley, the Walloon Ministry of public works (M.E.T.) burrowed in 1986 a substitution site located some 500 meters upstream to the "Vielle Meuse", named the "Nouvelle gravière" (the "New gravel-pit"). In 1993, we have been in charge to compare the biological diversity of both sites, and to establish a management plan for the new gravel-pit. Accordingly we have described and characterized the main bird habitats and the main fish spawning sites in the Old Meuse. Compared to the biodiversity of the Old Meuse and its higher spawning interest, the "New gravel-pit" was not so developed but the biodiversity and characteristics of the various habitats were quite similar. Ten years later, an update of the biodiversity study and habitat cartography performed on the "New Gravel-Pit" using the same bird and fish survey methods allowed us to evaluate the success of this landscape management operation.

## **Elephant Distribution and Threat Assessment in Kaeng Krachan National Park: A Case of Effective Evidence-Driven Conservation**

*Petch Manopawitr<sup>1</sup>, Puntipa Pattanakaew<sup>1</sup>, Nont Kaewwan<sup>1</sup>, Thongbai Charoendong<sup>1</sup>, Suitpatee Siethongdee<sup>1</sup>, Simon Hedges<sup>2</sup> and Apicha Yoosomboon<sup>3</sup>*

<sup>1</sup>Wildlife Conservation Society – Thailand Program

<sup>2</sup>Wildlife Conservation Society – Asia Program

<sup>3</sup>Kaeng Krachan National Park, Thailand

Kaeng Krachan National Park (KKNP), Thailand's largest national park (2,915 km<sup>2</sup>), is part of a protected forest complex covering 4,373 km<sup>2</sup> at the southern end of the Tenasserim Range. There are reasons to believe that KKNP contains a large and internationally significant population of Asian Elephants but little is known about the current distribution of elephants within the park or the threats to the elephants and their habitat. We assessed the distribution of the elephant population in KKNP and identified threats using Recce survey transects (RST). We used program DISTANCE to place 103 RSTs (1 km long with 5 km inter-transect intervals) systematically throughout the park. Over 30 park staff received training on elephant dung-count based survey methods using RSTs and conducted joint surveys with us. From January to June 2006, 81 RSTs were completed, representing a dry season survey. These RSTs represented a total distance of 60.32 km, and 227 dung piles were found on 10 RSTs. Dung-pile encounter rates will be used to decide appropriate methods to assess the size of the elephant population in the following year. In addition, 627.07 km of transects were surveyed between RSTs providing the first comprehensive survey for KKNP. Our survey showed that elephants were confined to a much smaller proportion of the park than frequently cited. Elephant sign and dung-piles were found only along the Petchburi River, the Central and the Southern zones. The survey also revealed that poaching and illegal human activities were rampant throughout KKNP. The Mae Pradon area in the northeast and Bang Kloy area in the northwest, where elephants were absent, had the highest encounter rates of illegal human activities. The most encountered



threats were illegal camps, poaching evidence and NTFP collection respectively. Five temporary checkpoints were added by park authorities in high-risk areas from July to October 2006. Patrol task forces were set up and received systematic patrol training in December 2006. Effectiveness of this operation will be assessed by a program of law enforcement monitoring (LEM). Regular LEM work will be focused at the identified high-risk areas. The LEM data collected will be assessed regularly to determine the level of threats and what additional measures need to be taken.

## **An Analysis of the Group Composition of the Puff-throated Bulbul (*Alophoixus pallidus*) in Khao Yai National Park Using DNA Techniques**

*Phetprakhai Wonkson*

Conservation Ecology Program, School of Bioresources & Technology, King Mongkut's University of Technology Thonburi, 83 Moo 8, Thakham, Bangkuntien, Bangkok

The Puff-throated Bulbul (*Alophoixus pallidus*) is a common resident bird in evergreen forest in central Thailand. For example, in Khao Yai National Park they occur at high density (> 3 birds/ha), and comprise approximately 15% of all individual birds and 9% of the total avian biomass. They disperse at least 77 species of plants seeds. Cooperative breeding behavior in this species has recently been discovered but we still understand relatively little of the structure of this cooperative breeding system and why they "choose" to behave this way. Furthermore, recent evidence suggests that cooperative breeders may be particularly sensitive to habitat degradation, and fragmentation, and thus the reduction of such species could have significant effects on normal forest regeneration processes. The research will focus on this species in and around the Mo-Singto Long-term Study Plot in Khao Yai, focusing on group composition, reproductive success and sex ratio within broods. This study has three objectives: (a) To investigate group composition and relationships between adults and nestlings by using DNA analysis (following the regulations of the National Parks, Wildlife and Plant Conservation Department); (b) To investigate the influence of group size and habitat quality on reproductive success; and (c) to investigate the sex ratio of helpers and nestlings. DNA techniques will help us to solve basic questions regarding the breeding behavior of this species. In the case of Puff-throated Bulbul, blood samples from both adults and young will be collected by catching adults in mist nets and young from the nest before fledging. Improvement of DNA analysis techniques with such species can also be applied in the future for the study of more threatened species.

## **Effects of Landscape Characteristics on Migratory Shorebird Communities in the Inner Gulf of Thailand**

*Siriya Sripanomyom*

Conservation Ecology Program, School of Bioresources & Technology, Kingmongkut's University of Technology Thonburi, Bangkok

Shorebirds are long-distance migrants which are highly dependent on a restricted number of good quality wetlands during their journeys. The Inner Gulf of Thailand is regularly visited by roughly 54 species of migratory shorebirds with an estimated total number of at least 100,000 birds per year, and is classified as an internationally important site under the Ramsar Convention criteria. However, even the most basic ecological information about the gulf is mostly unknown. In contrast, a number of threats continue disturbing the area. Moreover, most of the entire area lies outside the protected area system and has little legal protection. As a result, the inner gulf and its shorebirds urgently require scientific study to build up baseline information. The objectives of this study are to analyze landscape characteristics of shorebird stopover sites in the Inner Gulf of Thailand and investigate their influences on shorebird communities, and define indicator species, keystone habitat structures and priority sites for conservation. Twenty sample sites of 1-km radius will be systematically placed along the east coast to west coast of the inner gulf. Number of individuals of every shorebird species present in each sample site will be counted four times during the non-breeding season from year 2006 to 2007. SPOT-5 satellite images will be used to extract thematic data in each sample site using a combination of GIS techniques and an analysis of landscape metrics using program FRAG-STATS. Similarities of shorebird communities among all sample sites and relationship of shorebird communities with landscape characteristics will be analyzed using multivariate statistics techniques in Program R. This study will provide an outline of important habitat characteristics relating to migratory shorebird communities which can be used as a scientific baseline for extended studies, conservation plans, land-use management, developing legal protection and facilitate in raising public awareness of the most distinctive wetland and most important habitat for shorebirds in the entire country.

## **Effects of Food Supply on Foraging Patterns and Weights of Wintering Shorebirds on a Managed Wetland in the Inner Gulf of Thailand**

*Somchai Nimnuan*

Conservation Ecology Program, School of Bioresources & Technology, Kingmongkut's University of Technology Thonburi, Bangkok

The Inner Gulf of Thailand is a wetland of international importance and is particularly important as a wintering and staging area for migrant shorebirds of the East Asian-Australian Flyway. Because the relationship between mudflats and food availability of shorebirds

is strong and due to the increase in coastal reclamation and pollution from industrial and other sources, development of management plans for this area is of critical importance. The objectives of this study are to monitor the food availability for shorebirds to determine whether the seasonal variation in food availability affect shorebird prey capture rates, chasing rates, pace rates, and weights, and to measure differences between juvenile and adult shorebirds in prey capture rates, pace rates, and body weights. The study will be conducted between August 2006 to January 2008 at the Laem Phak Bia Environmental Research and Development Project, Phetchaburi province and compared with the same species foraging in salt marsh in Khok Kham Samut Sakhon province. Invertebrate sampling, biometric data from captured (and released) birds, and observations of foraging activities will be used in this study. Differences in food availability, foraging activities and weights will be examined in three seasonal periods, August–October, November–February and March–May. Differences between periods will be tested using Kolmogorov-Smirnov two-group tests. Studies of food supplies simultaneously with feeding rates of adults and juveniles will provide useful information regarding the fate of shorebirds that use the Inner Gulf as a wintering ground and provide the information for future management plans. Preliminary data will be discussed.

### **Taxonomy of the Genus *Caulokaempferia*, Family Zingiberaceae, in Pho Khou Kwaye Protected Area and Boloven Plateau, The People's Democratic Republic of Lao**

*Supachai Koonterm<sup>1</sup>, Samang Homchuen<sup>1</sup> and Chayan Picheansontorn<sup>2,3</sup>*

<sup>1</sup>Department of Environmental Science, Faculty of Science, Khon Kaen University, Khon Kaen 40002

<sup>2</sup>Department of Pharmaceutical Botany and Pharmacognosy, Faculty of Pharmaceutical Sciences, Khon Kaen University, Khon Kaen 40002

<sup>3</sup>The Academy of Sciences, The Royal Institute of Thailand, The Grand Palace, Naphralan Rd., Bangkok 10200

This taxonomic study aims to review the literature on the genus *Caulokaempferia*, family Zingiberaceae in the People's Democratic Republic of Lao (Lao PDR) and neighboring countries. The study is also to survey and identify *Caulokaempferia* specimens according to their morphology in the Pho Khou Kwaye protected area, Bolikhamxay Province and Boloven Plateau, Champasak Province, Lao PDR. The distribution of *Caulokaempferas* ranges from northern India to Phutan, Myanmar, Thailand, China, and Vietnam. Over 50% of *Caulokaempferas* species found are endemic, in which their center of diversity is in Thailand. However, there is an increasing number of records of new species of which *Caulokaempferia burtii* K. Larsen & Jenjitt is reported in Lao PDR. Thus, it is possible that more *Caulokaempferia* species will be observed in Lao PDR due to its ecological characteristics. According to field surveys, preliminarily, five species of *Caulokaempferas* were discovered of which only three specimens were given scientific names, including *Caulokaempferia bractceata* K. Larsen & S.S. Larsen, *C. laotica* Picheans. & Mookamul, and *C. burtii* K. Larsen & Jenjitt. The other two specimens are in the process of being identified and description. In addition, this study provides the world's first report of

natural habitats of *C. bracteata* K. Larsen & S.S. Larsen and *C. burtii* K. Larsen & Jenjitt. The first *Caulokaemfera* was observed at latitude 18° 24' N and longitude 103° 5' E in the Pho Khou Kwaye Protected Area, Vientiane, and the second was found at latitude 15° 04.585' N and longitude 106° 12.364' E, Pra Cave, Boloven Plateau, Pakchong City, Champasak Province. Both *Caulokaemferas* were found in very humid areas. *C. bracteata* K. Larsen & S.S. Larsen was observed on cracked sandstones in dry evergreen forest at 987 m above mean sea level, while *C. burtii* K. Larsen & Jenjitt. was discovered in a rocky field covered by mosses at 1,275 m above mean sea level.

**The Effect of Habitat Quality on Home Range Size, Group Dynamics and Breeding Success in Puff-throated Bulbul (*Alophoixus pallidus*; Family Pycnonotidae) at Mo Singto, Khao Yai National Park**

*Supatcharee Dhanasarnpaiboon*

Department of Biology, Mahidol University, Rama 6 Road, Bangkok 10400

Home range size is influenced by the number of individuals in a group and the availability of food or nesting sites. The study species, Puff-throated Bulbul is very common in tropical evergreen forest and are easily seen in the lower canopy and middle storey. The study aims to measure the habitat quality and determine the relationship between habitat quality and home range size, group size, and breeding success. A color-ringed population at Mo Singto Long Term Biodiversity Research Plot at Khao Yai National Park is currently monitoring the number of individuals in a group. Home range sizes are estimated by accumulating monthly line transect survey, and spot mapping data. A number of variables relating to habitat quality such as density of vegetation, basal area, presence of streams, and fruit abundance are used to describe habitat quality. Nesting environments of 30 nests were measured by using 5-m-radius circular sampling plots. The home ranges of 22 groups were well defined in the breeding season of 2006. Average group size was  $3 \pm 1.13$  individuals (range 2–5 individuals). Average home range size was  $1.09 \pm 0.56$  ha (ranging from 0.42 to 3.03 ha). There is a weak relationship between group size and home range size (linear regression;  $P < 0.05$ ,  $n = 22$ ,  $R^2 = 0.186$ ). There was no relationship among vegetation structure, home range size and group size. Seventy-eight nests confirmed to be active were found during the breeding season 2006 (March–July). Twelve nests were successful (producing at least 1 fledgling). There was no difference between nesting environments of successful and unsuccessful nests. The preliminary data cannot explain the relationships among habitat quality, home range size and group size. Fruit abundance might be an important factor to determine these relationships. Further study will focus on the food availability within the home ranges.

## **Re-introduction of Captive and Captive-born White-handed Gibbon (*Hylobates lar*) into Khao Phra Theaw Non-hunting Area, Phuket, 2002–2006**

*Suwit Punnadee, Thipparat Mingpijan and Owart Maprang*

Gibbon Rehabilitation Project (GRP), Wild Animal Rescue Foundation of Thailand (WARF), Phuket

The Gibbon Rehabilitation Project aims to rehabilitate captive and captive-born White-handed Gibbon (*Hylobates lar*) back into their natural habitat. This report is not the result of a planned study on a particular aspect of the re-introduction programme. The data utilized are collected by staff after a release, with or without ongoing research. Staff and volunteers go into the forest on a regular basis (feeding, cutting trails, mapping etc.) and whilst they are there they can report any activities observed. For this reason, data collection and analysis touch upon the general aspects that are characteristic of a gibbon group, including the activity budgets, social behavior and relations among group members, diet and feeding behavior and home range use. Between October 2002 and October 2006, 16 gibbons were released into Khao Phra Theaw Non-hunting Area using a soft-release method. Ten gibbons have survived in this re-introduction site. The female offspring of the first group was born on 21<sup>st</sup> Oct. 2002 and the second offspring was born on 21<sup>st</sup> Oct. 2006. The first and second of these families no longer rely on provisioned food. The adult male (Rambo) of the second group returned to the rehabilitation site seven times. A decision was made to capture him and keep him in captivity; hence he will not be released again. A third group was released in 2004 but soon after an adult male and adult female went missing on 21<sup>st</sup> Feb. 2005 and 30<sup>th</sup> Nov. 2005, consecutively. Her bones and fur were found in a poachers' camp on 17<sup>th</sup> Mar. 2006. The male offspring was accepted into the second group and the female offspring was attacked by the second group. She was then brought back to our rehabilitation site. We have also released a sub-adult male (Bank) and juvenile male (Khan Ngean) on 7<sup>th</sup> Feb. 2006 after Rambo left his group and returned to the rehabilitation site. Bank replaced Rambo and became the head of the second group. Khan Ngean died three days after release because of mesenteric volvulus.

## **Post-fledging Survival and Juvenile Dispersal of Puff-throated Bulbul (*Alophoixus pallidus*)**

*Wangworn Sankamethawee*

Conservation Ecology Program, School of Bioresources and Technology, King Mongkut's University of Technology Thonburi, Bangkuntien Campus, Bangkok

Generally, juvenile dispersal has a significant impact on population dynamics. *Alophoixus pallidus* probably is the most abundant bird species in mid-elevation evergreen forest in Thailand, but general information on the population ecology is almost unknown for any bulbul species. This study will focus on a population in the Mo-Singto Plot, Khao Yai National Park. Mist-netting and individual marking will be initiated for various data

collection including survival, group structure, and territory maps. Breeding vacancies, nest distribution, nest success, and post-fledging survival will be monitored. Radio telemetry (following DNP regulations) will be used as supplementary data on movement and long-distance dispersal. Expected results will provide better understanding of life history traits and how social status influences timing of juvenile dispersal as well as settlement patterns of dispersing individuals. This information is also important to determine their ecological requirements particularly habitat occupancy and how cooperative breeding is involved.

## **The Effects of Forest Structure and Food Abundance on the Small Carnivore (Mammalia: Carnivora) Communities in Thung Yai Naresuan Wildlife Sanctuary, Western Thailand**

*Wanlop Chutipong*

Conservation Ecology Program, School of Bioresources and Technology, King Mongkut's University of Technology Thonburi, Bangkokthien Campus, Bangkok

Small carnivores are diverse in terms of species and ecology ranging from meat-oriented to omnivorous species. In Thung Yai Naresuan Wildlife Sanctuary, western Thailand, there are 28 species of mammalian carnivores, 23 of which are considered 'small carnivores'. This group of species includes five families: Mustelidae, Viverridae, Herpestidae, Felidae, and Canidae. Little is known about their population density and dynamics due to their elusive behavior and low abundance. Small carnivores feed largely on small mammals and fruits. The variation in density of small mammals and availability of fruits due to habitat configuration (e.g., fire) and heterogeneity of habitat at both local and landscape scale could have major impacts on the distribution and abundance of small carnivores. However, there is very little knowledge for conservation biologists on how small carnivore community responds to these habitat features. This study is planned to investigate the relationship between habitat characteristics among different forest types in Thung Yai west, e.g., semi-evergreen, mixed deciduous and savannah forests, and the species diversity of small carnivore community. The following variables will be investigated: 1) the availability of food resources among forest types (small mammals and fruit—since some carnivores include plant materials in their diet in larger proportions, e.g., palm civets); 2) the pattern of occurrence of small carnivores among forest types; 3) the relationships between pattern of occurrence of small carnivores and the abundance of small mammals and fruit and habitat structure (i.e. percent ground cover, tree density); and 4) the multi-species occupancy model of small carnivores. In order to effectively protect and maintain a diverse small carnivore community it is essential to understand its structure and dynamics of the population. This study anticipates that the results derived will provide valuable data for the management and conservation of the small carnivore community.